1990

SERVICE MANUAL

ELECTRICAL

Jeep®

CHRYSLER MOTORS

Jeep
ELECTRICAL SERVICE MANUAL

1990 JEEP VEHICLES

To order the special service tools used and illustrated, please refer to the instructions on inside back cover.

CHRYSLER MOTORS
SERVICE & PARTS OPERATIONS

Jeep/Eagle reserves the right to make changes in design or to make additions to or improvements in its products without imposing any obligations upon itself to install them on its products previously manufactured.

FOREWORD

The information contained in this service manual has been prepared for the professional automotive technician involved in daily repair operations. Information in this manual is divided into groups. Each group covers a general vehicle system (brakes, steering, body, etc.). Each group is further divided to address individual components or systems within the group.

The Component and System Index, located at the back of this manual, will assist you in locating the correct group for the component or system you require.

These groups contain general information, diagnosis, testing, adjustment, removal and installation, disassembly and assembly procedures for the components.

The diagnosis charts are designed to help you locate and correct problems with a systematic approach. The tab locator at the right side of this page will help you quickly locate the first page of each group. The first page of each group contains an alphabetical index to assist in the location of the component or system.

The information, description, testing procedures and specifications were in effect at the time this manual was released for printing.

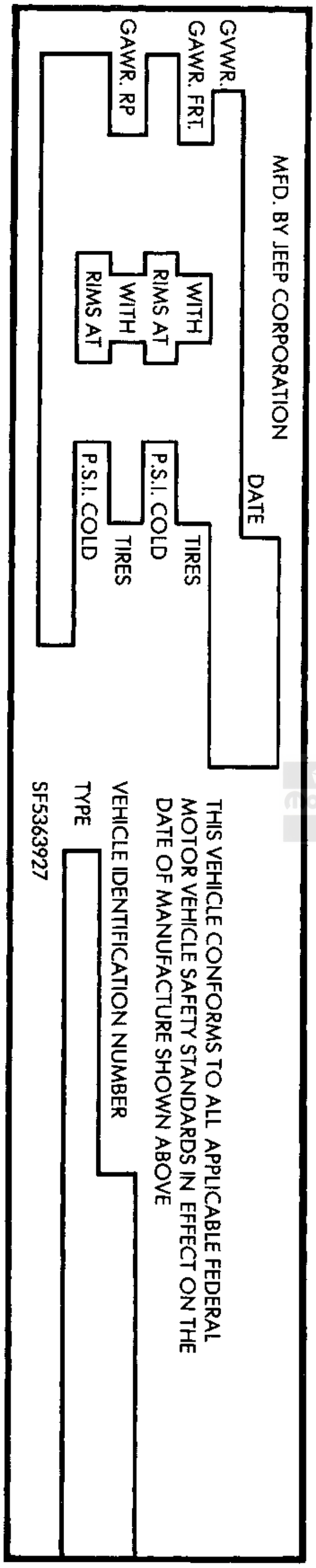
Chrysler Motors reserves the right to change testing procedures, specifications, diagnosis, or repair methods at any time without prior notice or incurring obligation.

The information describing the operation and use of standard and optional equipment is included in the Operating Instructions and Product Information manual located in the glove box.

> NOTE: FOR MECHANICAL INFORMATION, REFER TO THE "ENGINE, CHASSIS & BODY SERVICE MANUAL" - JEEP VEHICLES.

J901N-6

INTRODUCTION



J89IN-2

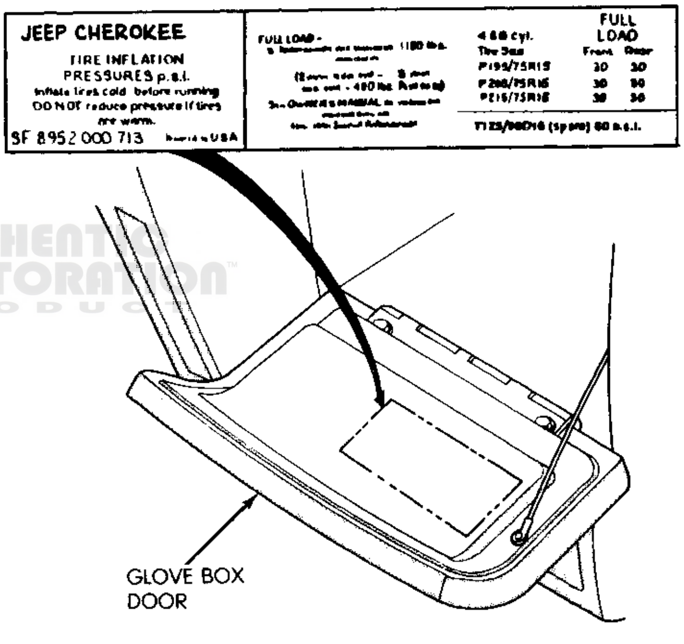
Fig. 1 Safety Certification Labels

VEHICLE SAFETY CERTIFICATION LABELS

A safety certification label (Fig. 1) is attached to all vehicles to certify that they conform to Federal motor vehicle safety certificate standards. The label lists the month and year of manufacture, gross vehicle weight rating (GVWR) and gross axle weight rating (GAWR). The label is located on the door pillar (driver's side).

TIRE INFLATION LABEL

Check the tires for visible signs of wear which may indicate underinflation or a need for front-end alignment, tire rotation or wheel balancing. Also check for bulging, cracks or other road hazard damage. Check and adjust the inflation pressures according to the specifications. The tire pressure specification sticker is located on the glove box door (Fig. 2).



J891N-3

Fig. 2 Tire Inflation Pressures

VEHICLE IDENTIFICATION NUMBER (VIN)

The Vehicle Identification Number (VIN) is located on the left side of the instrument panel at the base of the windshield. All VIN's contain 17 characters in a combination of letters and numbers that provide specific information about the vehicle (Fig. 3).

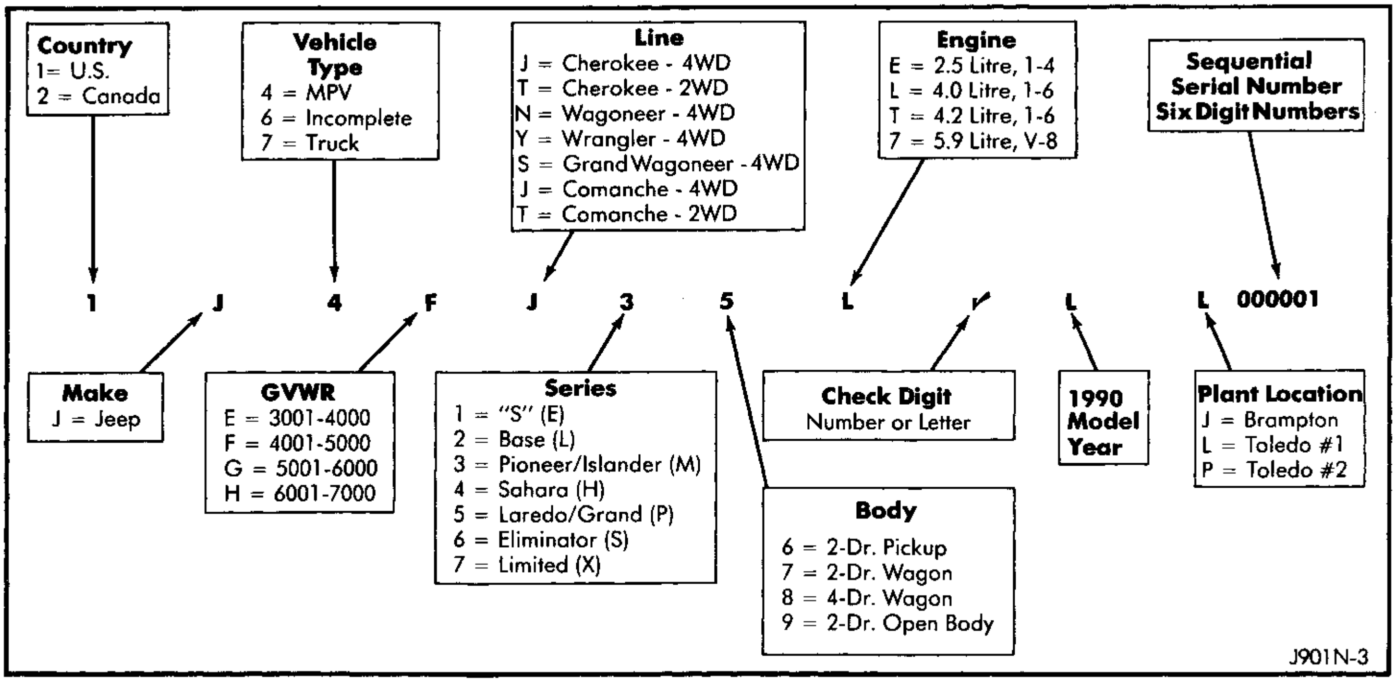


Fig. 3 Vehicle Identification Number (VIN)

BODY CODE PLATE

A metal Body Code Plate is attached to the driver's side of the dash panel in the engine compartment (Fig. 4). There are up to seven (7) lines of information on this plate. Information reads from left to right, starting with line 1 at the bottom of the plate to line 7 at the top.

Refer to the body code plate chart (lines 1 thru 3) for detailed information.

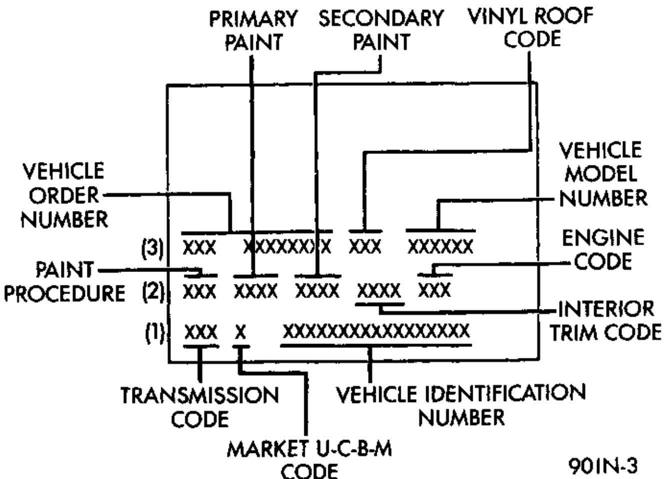


Fig. 4 Body Code Plate

Lines 4 thru 7, of the body code plate, are sequenced on the plate as follows:

- 3 digit sales codes
- 3 digit numeric codes
- 6 digit SEC codes

Line #1	Digits 1, 2, 3	Transmission Sales Code
	Digit 4	Open Space
	Digit 5	Market Code—U-C-B-M
	Digit 6	Open Space
	Digit 7 thru 23	Vehicle Identification Number
Line #2	Digits 1, 2, 3	Paint Procedure
	Digit 4	Open Space
	Digits 5, 6, 7, 8	Primary Paint
	Digit 9	Open Space
	Digits 10, 11, 12, 13	Secondary Paint
	Digit 14	Open Space
	Digits 15, 16, 17, 18	Trim Code
	Digit 19	Open Space
	Digits 20, 21, 22	Engine Sales Code
	Digit 23	Open Space
Line #3	Digits 1 thru 12	Vehicle Order Number
	Digit 13	Open Space
	Digits 14, 15, 16	Vinyl Roof Code (Door Combo Code—Pillette)
	Digit 17	Open Space
	Digits 18 thru 23	Model

When there is an SEC code to be punched on the body code plate and there is not enough room left on a line to punch the full 6 digits, the balance of that line will be left blank and the SEC code will be punched on the next line.

The last nine positions of line #7 will contain a two digit species, when applicable, and a six digit gateline sequence number (the last six numbers of the VIN).

The last code shown on either plate will be followed by END. When two plates are required, the last code space on the first plate will show CTD (for continued).

When a second plate is required, the first four spaces of each line will not be used due to overlap of the plates.

ENGINE BUILD DATE CODE

The engine Build Date Code is located:

- 2.5L Engine - On a machined surface on the right side of the cylinder block between the No. 3 and No. 4 cylinders.
- 4.0L and 4.2L Engines - On a machined surface on the right side of the cylinder block between the No. 2 and No. 3 cylinders.
- 5.9L Engine - On a plate attached to the right bank cylinder head cover.

The digits of the code identify the year (1st), month (2nd & 3rd), engine type/fuel system/compression ratio (4th & 5th), and day (6th & 7th) of engine build (Fig. 5).

EXAMPLE: 903MXO3

1st Digit (Year)	2nd/3rd Digit (Month)	4th/5th Digit (Type)	6th/7th Digit (Day)
7-1987 8-1988 9-1989 0-1990	01-12	HX MX CX NX	01-31

Letter Code	CID Liter	Fuel System	Comp. Ratio
HX	150-2.5L	TBI	9.2:1
MX	243-4.0L	MPI	8.8:1
CX	258-4.2L	2V	9.2:1
NX	360-5.9L	2V	8.25:1

J901N-8

Fig. 5 Engine Identification and Build Date Code

1990 MODEL IDENTIFICATION CHART

The Model Identification Chart identifies descriptive codes for all Jeep vehicles (Fig. 6). These codes are used in captions and references throughout this service manual. These Model codes are not to be confused with the Vehicle Identification Number (VIN) coding or other body style references.

VEHICLE NAME	MODEL
GRAND WAGONEER - 4DR/4WD	SJ
COMANCHE (SHORT BED) - 4WD	MJ
COMANCHE (SHORT BED) - 2WD	
COMANCHE (LONG BED) - 4WD	
COMANCHE (LONG BED) - 2WD	
CHEROKEE - 2DR/4WD	XJ
CHEROKEE - 4DR/4WD	
CHEROKEE - 2DR/2WD	
CHEROKEE - 4DR/2WD	
WAGONEER - 4DR/4WD	
WRANGLER - 4WD	YJ

J901N-9

Fig. 6 Model Identification Chart

1990 EXTERIOR DIMENSIONS

MODEL NAME	MODEL	WHEEL BASE cm/in	TRACK cm/in		OVERALL cm/in		
			FRONT	REAR	LENGTH	WIDTH	HEIGTH
Grand Wagoneer	SJ	276.1	150.9	146.8	473.5	190.0	168.7
4 DR-4 WD		108.7	59.4	57.8	186.4	74.8	66.4
Comanche (Short Bed)	MJ	286.8	144.8	144.8	455.2	182.2	164.4
2 DR-4 WD/6″ Wheels		112.9	57.0	57.0	179.3	71.7	64.7
(Short Bed)		286.8	147.3	147.3	455.2	182.2	164.4
7″ Wheels		112.9	58.0	58.0	179.3	71.7	64.7
Comanche (Short Bed)	MJ	287.3	144.8	144.8	455.2	182.2	162.1
2 DR-2 WD/6″ Wheels		113.1	57.0	57.0	179.3	71.7	63.8
(Short Bed)		287.3	147.3	146.3	455.2	182.2	162.1
7″ Wheels		113.1	58.0	58.0	179.3	71.7	63.8
Comanche (Long Bed)	MJ	303.3	144.8	144.8	496.6	182.2	164.4
2 DR-4 WD/6″ Wheels		119.4	58.0	58.0	195.5	71.7	64.7
(Long Bed)		303.3	144.8	144.8	496.6	182.2	164.4
7″ Wheels		119.4	58.0	58.0	195.5	71.7	64.7
Comanche (Long Bed)	MJ	303.8	144.8	144.8	496.6	182.2	162.1
2 DR-2 WD/6″ Wheels		119.6	58.0	58.0	195.5	71.7	63.8
(Long Bed)		303.8	144.8	144.8	496.6	182.2	162.1
7″ Wheels		119.6	58.0	58.0	195.5	71.7	63.8
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
2 DR-2 WD		101.4	58.0	58.0	165.3	70.5	63.4
7″ Wheels		257.6	144.8	144.8	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
4 DR-2 WD		101.4	57.0	57.0	165.3	70.5	63.4
7″ Wheels		257.6	147.3	147.3	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Wagoneer	XJ	257.6	147.3	147.3	420.0	179.1	161.5
4 DR-4 WD		101.4	58.0	58.0	165.3	70.5	63.6
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
2 DR-4 WD		101.4	57.0	57.0	165.3	70.5	63.4
7″ Wheels		257.6	147.3	147.3	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
4 DR-4 WD		101.4	57.0	57.0	165.3	70.5	63.4
7″ Wheels		257.6	147.3	147.3	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Wrangler	YJ	237.2	147.3	147.3	387.6	167.6	176.5
2 DR-4 WD/Hardtop		93.4	58.0	58.0	152.6	66.0	69.5

J901N-4

1990 INTERIOR DIMENSIONS

MODEL	MODEL	HEAD cm/(in)		LEG cm/(in)		SHOULDER cm/(in)		HIP cm/(in)	
		FRONT	REAR	FRONT	REAR	FRONT	REAR	FRONT	REAR
Grand Wagoneer	SJ	94.2 37.1	93.5 36.8	102.9 40.5	94.0 37.0	148.1 58.3	148.1 58.3	153.7 60.5	154.7 60.9
Comanche (Short Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Comanche (Short Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Comanche (Long Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Comanche (Long Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Wagoneer	XJ	97.3 38.3	96.5 38.0	104.4 41.1	89.7 35.3	140.5 55.3	140.5 55.3	140.5 55.3	113.0 44.5
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Wrangler (Hardtop)	YJ	102.1 40.2	102.9 40.5	100.1 39.4	88.9 35.0	134.8 53.1	143.0 56.3	134.8 53.1	91.4 36.0

J901N-5

TORQUE REFERENCES

Individual Torque Charts appear at the end of many Groups. Refer to the Standard Torque Specifications and Bolt Identification Chart in this Group for torques not listed in the individual torque charts (Fig. 7).

Note that the torque specifications given in the chart are based on the use of clean and dry threads. Reduce the torque by 10%when the threads are lubricated with engine oil and by 20%if new plated bolts are used.

Various sizes of internal and external hex-lobular (Torx) head fasteners are used as attaching hardware on numerous components and assemblies in Jeep vehicles. Due to the ever-changing usage and application of automotive fasteners, Torx-head fasteners may not be identified as such throughout this manual.

BOLT TORQUE

BOLT SIZE	GRADE 5 N·m	GRADE 5 ft-lbs (in-lbs)	GRADE 8 N·m	GRADE 8 ft-lbs (in-lbs)
1/4-20	11	(95)	14	(125)
1/4-28	11	(95)	17	(150)
5/16-18	23	(200)	31	(270)
5/16-24	27	20	34	25
3/8-16	41	30	54	40
3/8-24	48	35	61	45
7/16-14	68	50	88	65
7/16-20	75	55	95	70
1/2-13	102	75	136	100
1/2-20	115	85	149	110
9/16-12	142	105	183	135
9/16-18	156	115	203	150
5/8-11	203	150	264	195
5/8-18	217	160	285	210
3/4-16	237	175	305	225

J89IN-9

Fig. 7 Grade 5 and 8 Standard Torque Specifications

METRIC THREAD AND GRADE IDENTIFICATION

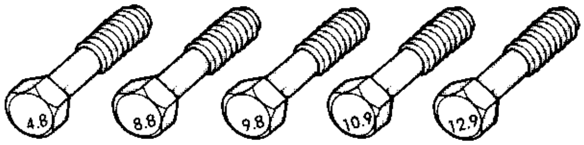
Metric and SAE thread notations differ slightly. The difference is illustrated in Fig. 8.

INCH		METRIC	
5/16-18		M8 X 1.25	
THREAD MAJOR DIAMETER IN INCHES	NUMBER OF THREADS PER INCH	THREAD MAJOR DIAMETER IN MILLIMETERS	DISTANCE BETWEEN THREADS IN MILLIMETERS

PR606B

Fig. 8 Thread Notation (Metric and SAE)

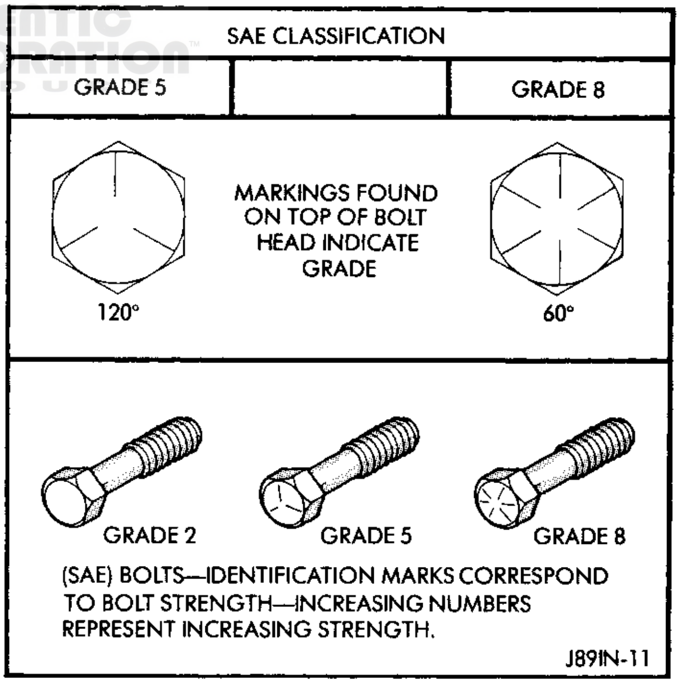
Common metric fastener strength property classes are 9.8 and 12.9 with the class identification embossed on the head of each bolt (Fig. 9). Some metric nuts will be marked with single digit strength identification numbers on the nut face.



METRIC BOLTS—IDENTIFICATION CLASS NUMBERS CORRESPOND TO BOLT STRENGTH— INCREASING NUMBERS REPRESENT INCREASING STRENGTH. J89IN-10

Fig. 9 Metric Bolt Identification

SAE strength classes range from grade 2 to 8 with line identification embossed on each bolt head. Markings corresponding to two lines less than the actual grade (Fig. 10). For Example - Grade 7 bolt will exhibit 5 embossed lines on the bolt head.



(SAE) BOLTS—IDENTIFICATION MARKS CORRESPOND TO BOLT STRENGTH—INCREASING NUMBERS REPRESENT INCREASING STRENGTH.

J89IN-11

Fig. 10 SAE Bolt Identification

INTERNATIONAL SYMBOLS

Some of the International Symbols shown below are used to identify controls and displays in this vehicle. These symbols are applicable to those controls which are displayed on the instrument panel or in the immediate vicinity of the driver (Fig. 11).

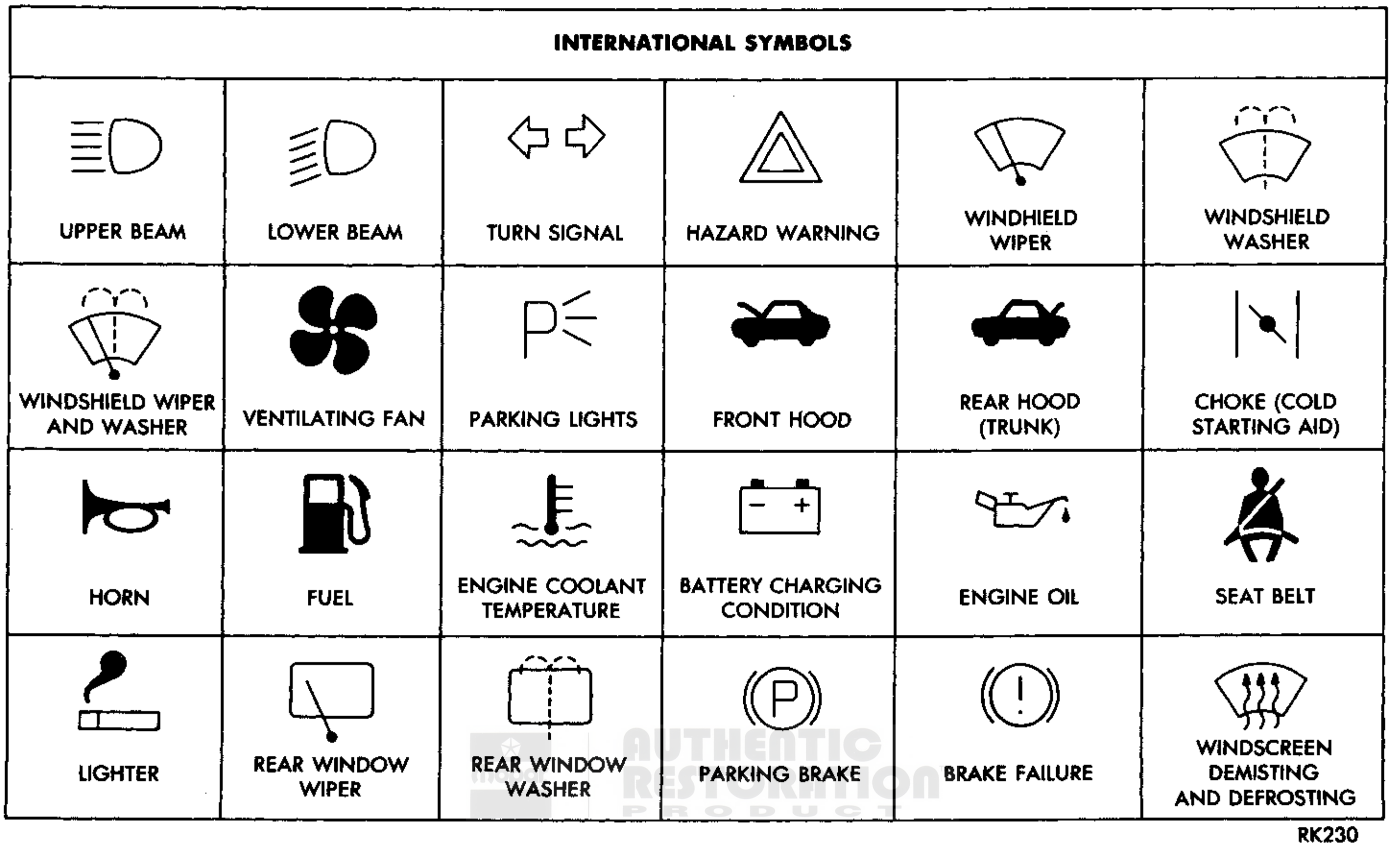


Fig. 11 International Symbols

METRIC SYSTEM

Artwork, specifications, and tightening references in this Service Manual are identified in the metric system and in the SAE system.

During any maintenance or repair procedures, it is important to salvage metric fasteners (nuts, bolts, etc.) for reassembly. If the fastener is not salvageable, a fastener of equivalent specification should be used.

WARNING: USE OF AN INCORRECT FASTENER MAY RESULT IN COMPONENT DAMAGE OR PERSONAL INJURY.

The metric system is based on quantities of one, ten, one hundred, one thousand, and one million (Fig. 12).

The following Tables will assist you in conversion procedures.

Mega - (M) Million
Deci - (D) Tenth
Kilo - (K) Thousand
Centi - (C) Hundreth
Milli - (m) Thousandth

J901N-2

Fig. 12 Metric Prefixes

CONVERSION TABLES

in-lbs to N•m

in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m
2	.2260	42	4.7453	82	9.2646	122	13.7839	162	18.3032
4	.4519	44	4.9713	84	9.4906	124	14.0099	164	18.5292
6	.6779	46	5.1972	86	9.7165	126	14.2359	166	18.7552
8	.9039	48	5.4232	88	9.9425	128	14.4618	168	18.9811
10	1.1298	50	5.6492	90	10.1685	130	14.6878	170	19.2071
12	1.3558	52	5.8751	92	10.3944	132	14.9138	172	19.4331
14	1.5818	54	6.1011	94	10.6204	134	15.1397	174	19.6590
16	1.8077	56	6.3270	96	10.8464	136	15.3657	176	19.8850
18	2.0337	58	6.5530	98	11.0723	138	15.5917	178	20.1110
20	2.2597	60	6.7790	100	11.2983	140	15.8176	180	20.3369
22	2.4856	62	7.0049	102	11.5243	142	16.0436	182	20.5629
24	2.7116	64	7.2309	104	11.7502	144	16.2696	184	20.7889
26	2.9376	66	7.4569	106	11.9762	146	16.4955	186	21.0148
28	3.1635	68	7.6828	108	12.2022	148	16.7215	188	21.2408
30	3.3895	70	7.9088	110	12.4281	150	16.9475	190	21.4668
32	3.6155	72	8.1348	112	12.6541	152	17.1734	192	21.6927
34	3.8414	74	8.3607	114	12.8801	154	17.3994	194	21.9187
36	4.0674	76	8.5867	116	13.1060	156	17.6253	196	22.1447
38	4.2934	78	8.8127	118	13.3320	158	17.8513	198	22.3706
40	4.5193	80	9.0386	120	13.5580	160	18.0773	200	22.5966

N•m to in-lbs

N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb
.2	1.7702	4.2	37.1747	8.2	72.5792	12.2	107.9837	16.2	143.3882
.4	3.5404	4.4	38.9449	8.4	74.3494	12.4	109.7539	16.4	145.1584
.6	5.3107	4.6	40.7152	8.6	76.1197	12.6	111.5242	16.6	146.9287
.8	7.0809	4.8	42.4854	8.8	77.8899	12.8	113.2944	16.8	148.6989
1	8.8511	5	44.2556	9	79.6601	13	115.0646	17	150.4691
1.2	10.6213	5.2	46.0258	9.2	81.4303	13.2	116.8348	17.2	152.2393
1.4	12.3916	5.4	47.7961	9.4	83.2006	13.4	118.6051	17.4	154.0096
1.6	14.1618	5.6	49.5663	9.6	84.9708	13.6	120.3753	17.6	155.7798
1.8	15.9320	5.8	51.3365	9.8	86.7410	13.8	122.1455	17.8	157.5500
2	17.7022	6	53.1067	10	88.5112	14	123.9157	18	159.3202
2.2	19.4725	6.2	54.8770	10.2	90.2815	14.2	125.6860	18.5	163.7458
2.4	21.2427	6.4	56.6472	10.4	92.0517	14.4	127.4562	19	168.1714
2.6	23.0129	6.6	58.4174	10.6	93.8219	14.6	129.2264	19.5	172.5970
2.8	24.7831	6.8	60.1876	10.8	95.5921	14.8	130.9966	20	177.0225
3	26.5534	7	61.9579	11	97.3624	15	132.7669	20.5	181.4480
3.2	28.3236	7.2	63.7281	11.2	99.1326	15.2	134.5371	21	185.8736
3.4	30.0938	7.4	65.4983	11.4	100.9028	15.4	136.3073	22	194.7247
3.6	31.8640	7.6	67.2685	11.6	102.6730	15.6	138.0775	23	203.5759
3.8	33.6342	7.8	69.0388	11.8	104.4433	15.8	139.8478	24	212.4270
4	35.4045	8	70.8090	12	106.2135	16	141.6180	25	221.2781

ft-lbs to N•m

ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m
1	1.3558	21	28.4722	41	55.5885	61	82.7049	81	109.8212
2	2.7116	22	29.8280	42	56.9444	62	84.0607	82	111.1770
3	4.0675	23	31.1838	43	58.3002	63	85.4165	83	112.5328
4	5.4233	24	32.5396	44	59.6560	64	86.7723	84	113.8888
5	6.7791	25	33.8954	45	61.0118	65	88.1281	85	115.2446
6	8.1349	26	35.2513	46	62.3676	66	89.4840	86	116.6004
7	9.4907	27	36.6071	47	63.7234	67	90.8398	87	117.9562
8	10.8465	28	37.9629	48	65.0793	68	92.1956	88	119.3120
9	12.2024	29	39.3187	49	66.4351	69	93.5514	89	120.6678
10	13.5582	30	40.6745	50	67.7909	70	94.9073	90	122.0236
11	14.9140	31	42.0304	51	69.1467	71	96.2631	91	123.3794
12	16.2698	32	43.3862	52	70.5025	72	97.6189	92	124.7352
13	17.6256	33	44.7420	53	71.8583	73	98.9747	93	126.0910
14	18.9815	34	46.0978	54	73.2142	74	100.3316	94	127.4468
15	20.3373	35	47.4536	55	74.5700	75	101.6862	95	128.8026
16	21.6931	36	48.8094	56	75.9258	76	103.0422	96	130.1586
17	23.0489	37	50.1653	57	77.2816	77	104.3980	97	131.5144
18	24.4047	38	51.5211	58	78.6374	78	105.7538	98	132.8702
19	25.7605	39	52.8769	59	79.9933	79	107.1196	99	134.2260
20	27.1164	40	54.2327	60	81.3491	80	108.4654	100	135.5820

N•m to ft-lbs

N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1	.7376	21	15.9888	41	30.2400	61	44.9913	81	59.7425
2	1.4751	22	16.2264	42	30.9776	62	45.7289	82	60.4801
3	2.2127	23	16.9639	43	31.7152	63	46.4664	83	61.2177
4	2.9502	24	17.7015	44	32.4527	64	47.2040	84	61.9552
5	3.6878	25	18.4391	45	33.1903	65	47.9415	85	62.6928
6	4.4254	26	19.1766	46	33.9279	66	48.6791	86	63.4303
7	5.1629	27	19.9142	47	34.6654	67	49.4167	87	64.1679
8	5.9005	28	20.6517	48	35.4030	68	50.1542	88	64.9545
9	6.6381	29	21.3893	49	36.1405	69	50.8918	89	65.6430
10	7.3756	30	22.1269	50	36.8781	70	51.6293	90	66.3806
11	8.1132	31	22.8644	51	37.6157	71	52.3669	91	67.1181
12	8.8507	32	23.6020	52	38.3532	72	53.1045	92	67.8557
13	9.5883	33	24.3395	53	39.0908	73	53.8420	93	68.5933
14	10.3259	34	25.0771	54	39.8284	74	54.5720	94	69.3308
15	11.0634	35	25.8147	55	40.5659	75	55.3172	95	70.0684
16	11.8010	36	26.5522	56	41.3035	76	56.0547	96	70.8060
17	12.5386	37	27.2898	57	42.0410	77	56.7923	97	71.5435
18	13.2761	38	28.0274	58	42.7786	78	57.5298	98	72.2811
19	14.0137	39	28.7649	59	43.5162	79	58.2674	99	73.0187
20	14.7512	40	29.5025	60	44.2537	80	59.0050	100	73.7562

in. to mm

in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
.01	.254	.21	5.334	.41	10.414	.61	15.494	.81	20.574
.02	.508	.22	5.588	.42	10.668	.62	15.748	.82	20.828
.03	.762	.23	5.842	.43	10.922	.63	16.002	.83	21.082
.04	1.016	.24	6.096	.44	11.176	.64	16.256	.84	21.336
.05	1.270	.25	6.350	.45	11.430	.65	16.510	.85	21.590
.06	1.524	.26	6.604	.46	11.684	.66	16.764	.86	21.844
.07	1.778	.27	6.858	.47	11.938	.67	17.018	.87	22.098
.08	2.032	.28	7.112	.48	12.192	.68	17.272	.88	22.352
.09	2.286	.29	7.366	.49	12.446	.69	17.526	.89	22.606
.10	2.540	.30	7.620	.50	12.700	.70	17.780	.90	22.860
.11	2.794	.31	7.874	.51	12.954	.71	18.034	.91	23.114
.12	3.048	.32	8.128	.52	13.208	.72	18.288	.92	23.368
.13	3.302	.33	8.382	.53	13.462	.73	18.542	.93	23.622
.14	3.556	.34	8.636	.54	13.716	.74	18.796	.94	23.876
.15	3.810	.35	8.890	.55	13.970	.75	19.050	.95	24.130
.16	4.064	.36	9.144	.56	14.224	.76	19.304	.96	24.384
.17	3.318	.37	9.398	.57	14.478	.77	19.558	.97	24.638
.18	4.572	.38	9.652	.58	14.732	.78	19.812	.98	24.892
.19	4.826	.39	9.906	.59	14.986	.79	20.066	.99	25.146
.20	5.080	.40	10.160	.60	15.240	.80	20.320	1.00	25.400

mm to in.

mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
.01	.00039	.21	.00827	.41	.01614	.61	.02402	.81	.03189
.02	.00079	.22	.00866	.42	.01654	.62	.02441	.82	.03228
.03	.00118	.23	.00906	.43	.01693	.63	.02480	.83	.03268
.04	.00157	.24	.00945	.44	.01732	.64	.02520	.84	.03307
.05	.00197	.25	.00984	.45	.01772	.65	.02559	.85	.03346
.06	.00236	.26	.01024	.46	.01811	.66	.02598	.86	.03386
.07	.00276	.27	.01063	.47	.01850	.67	.02638	.87	.03425
.08	.00315	.28	.01102	.48	.01890	.68	.02677	.88	.03465
.09	.00354	.29	.01142	.49	.01929	.69	.02717	.89	.03504
.10	.00394	.30	.01181	.50	.01969	.70	.02756	.90	.03543
.11	.00433	.31	.01220	.51	.02008	.71	.02795	.91	.03583
.12	.00472	.32	.01260	.52	.02047	.72	.02835	.92	.03622
.13	.00512	.33	.01299	.53	.02087	.73	.02874	.93	.03661
.14	.00551	.34	.01339	.54	.02126	.74	.02913	.94	.03701
.15	.00591	.35	.01378	.55	.02165	.75	.02953	.95	.03740
.16	.00630	.36	.01417	.56	.02205	.76	.02992	.96	.03780
.17	.00669	.37	.01457	.57	.02244	.77	.03032	.97	.03819
.18	.00709	.38	.01496	.58	.02283	.78	.03071	.98	.03858
.19	.00748	.39	.01535	.59	.02323	.79	.03110	.99	.03898
.20	.00787	.40	.01575	.60	.02362	.80	.03150	1.00	.03937

J901N-10

CONVERSION TABLES (CONT.)

Multiply	By	To Get	Multiply	By	To Get
in.-lbs.	x 0.11298	= Newton-Metres (N•m)	(N•m)	x 8.851	= in.-lbs.
ft.-lbs.	x 1.3558	= Newton-Metres (N•m)	(N•m)	x 0.7376	= ft.-lbs.
Inches Hg. (60°F)	x 3.377	= Kilopascals (kPa)	(kPa)	x 0.2961	= Inches Hg.
Pounds/Sq. In.	x 6.895	= Kilopascals (kPa)	(kPa)	x 0.145	= Pounds/Sq. In.
Inches	x 25.4	= Millimetres (mm)	(mm)	x 0.03937	= Inches
Feet	x 0.3048	= Metres (M)	(M)	x 3.281	= Feet
Yards	x 0.9144	= Metres (M)	(M)	x 1.0936	= Yards
Miles	x 1.6093	= Kilometres (Km)	(Km)	x 0.6214	= Miles
Miles/Hr.	x 1.6093	= Kilometres/Hr. (Km/h)	(Km/h)	x 0.6214	= Miles/Hr.
Feet/Sec.	x 0.3048	= Metres/Sec. (M/S)	(M/S)	x 3.281	= Feet/Sec.
Kilometres/Hr.	x 0.27778	= Metres/Sec. (M/S)	(M/S)	x 3.600	= Kilometres/Hr.
Miles/Hr.	x 0.4470	= Metres/Sec. (M/S)	(M/S)	x 2.237	= Miles/Hr.

COMMON METRIC EQUIVALENTS

1 Inch = 25 Millimeters
1 Foot = 0.3 Meter
1 Yard = 0.9 Meter
1 Mile = 1.6 Kilometers

1 Cubic Inch = 16 Cubic Centimeters
1 Cubic Foot = 0.03 Cubic Meter
1 Cubic Yard = 0.8 Cubic Meter

J901N-11

BATTERIES

INDEX

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Battery Box Screw	16 N•m (145 in-lbs)	11-20 N•m (95-180 in-lbs)
Battery Holddown Screw	8 N•m (75 in-lbs)	6-11 N•m (50-75 in-lbs)
Battery Cable Clamp	8 N•m (75 in-lbs)	7-10 N•m (60-90 in-lbs)

BATTERY CLASSIFICATIONS AND RATINGS (Fig. 1)

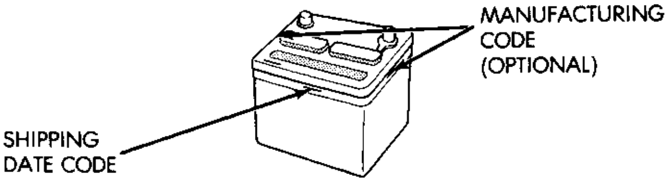
Group Size	Cold Crank AMPS	Reserve Capacity (Min.)	Engine	Vehicle Series
55	421	75	2.5L & 4.2L	YJ
56	452	81	2.5L & 4.2L	YJ
58	390	75	2.5L & 4.0L	All XJ/MJ
58	475	82	2.5L, 4.0L &5.9L	All XJ/MJ/SJ

J908A-1

Fig. 1 Battery Classifications And Ratings

BATTERY CODES

Each battery is date coded at the time of shipment from the manufacturer. This code is stamped into the edge of the plastic case cover (Fig. 2). A second code number stamped on the side of the battery case represents manufacturing data and may be ignored.



U.S. Date Codes			
Positions Example: 1 3 5 7 N 0 2 8 C 2 4 6 Owosso, 1990, 28, March		Position 4	7=1987 8=1988 9=1989 0=1990
		Positions 5 & 6	1 through 31 =
Postions 1 & 2	Optional	Position 7	A JAN G JUL B FEB H AUG C MAR J SEP D APR K OCT E MAY L NOV F JUN M DEC
Position 3	N=Owosso Y=Toledo L=Louisville G=Geneva		

J908A-3

Fig. 2 Battery Date Codes

BATTERY VISUAL INSPECTION AND REPLACEMENT

Removal and Inspection

(1) Make sure ignition switch is in OFF position and all battery feeds are OFF.

(2) Loosen the cable terminal clamps.

(3) If necessary, use a puller to remove the cable terminal clamps, and remove the negative cable terminal clamp first.

WARNING: WEAR A SUITABLE PAIR OF RUBBER GLOVES (NOT THE HOUSEHOLD TYPE) WHEN REMOVING A BATTERY BY HAND. IF THE BATTERY IS CRACKED OR LEAKING THE ELECTROLYTE CAN BURN THE SKIN.

(4) Remove battery hold-downs and remove battery from vehicle (Figs. 3, 4 and 5).

(5) Inspect the cable terminal for corrosion and damage. Remove the corrosion using a wire brush, or post and terminal cleaner, and a sodium bicarbonate/water solution. Replace cables that have damaged or deformed terminals.

(6) Inspect the battery tray and holddowns for corrosion. Remove corrosion using a wire brush and a sodium bicarbonate/water solution. Paint any exposed bare metal. Replace damaged components (Figs. 6, 7 and 8).

(7) Clean the outside of the battery case if the original battery is to be installed. Clean the top cover with di-

luted ammonia or a sodium bicarbonate/water solution to remove the acid film. Flush with clean water. Ensure that the cleaning solution does not enter the cells.

(8) Remove corrosion from the terminals with a wire brush or post and terminal cleaner. Inspect the case for cracks or other damage that would result in leakage of electrolyte.

Installation

(1) Refer to Specifications to determine if the battery has the correct classification and rating for the vehicle.

(2) Use a hydrometer to test the battery electrolyte. Charge the battery if necessary.

(3) Position the battery in the tray. Ensure that the positive and negative terminals (posts) are correctly located. The cables must reach their respective terminals (posts) without stretching (Figs. 3, 4 and 5).

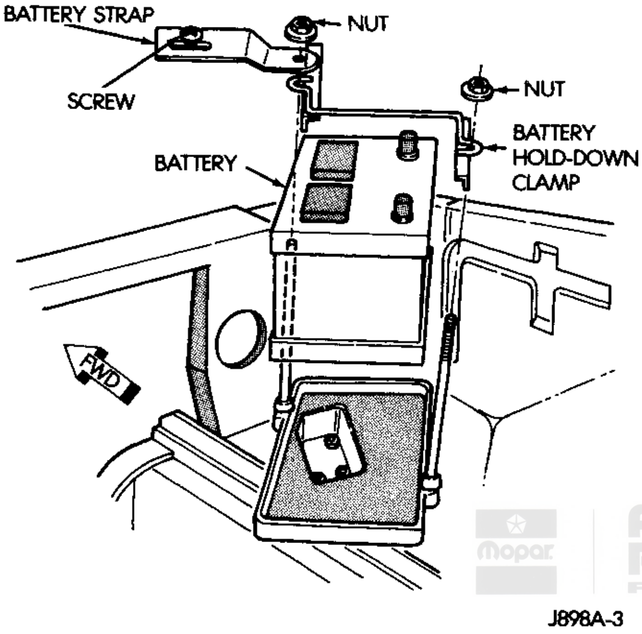


Fig. 3 Battery Holddown - XJ and MJ

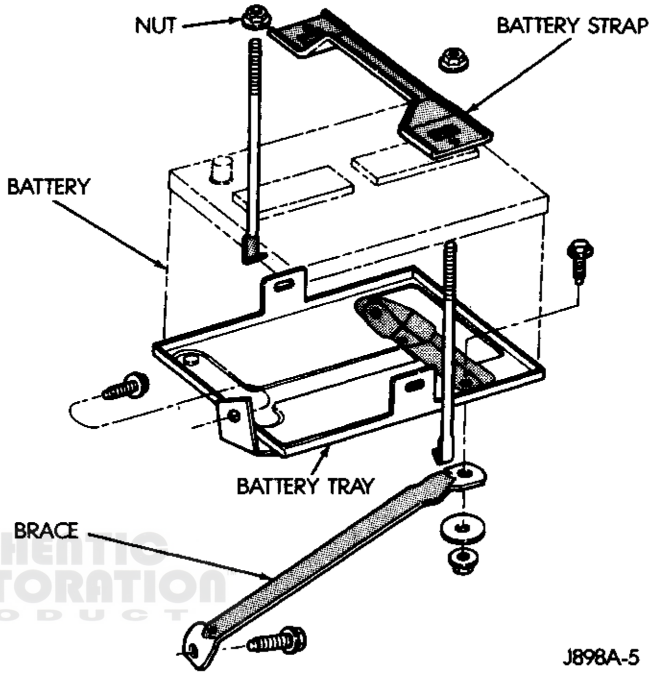


Fig. 5 Battery Holddown - SJ

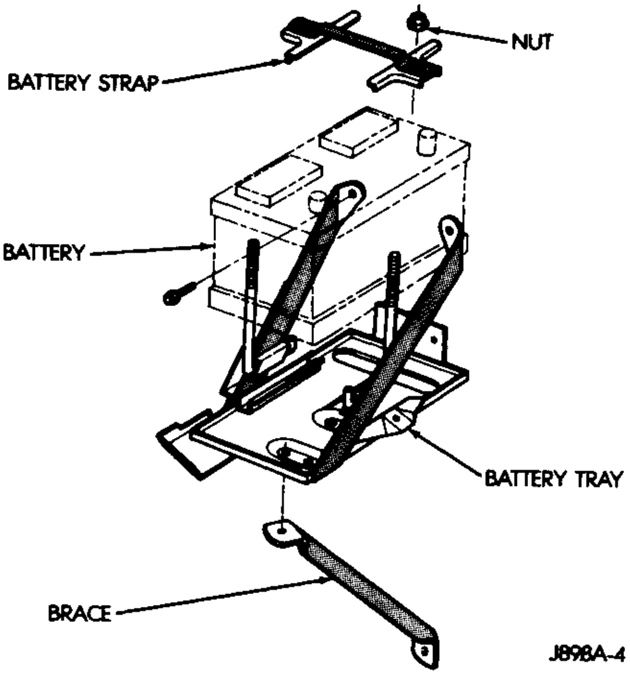


Fig. 4 Battery Holddown - YJ

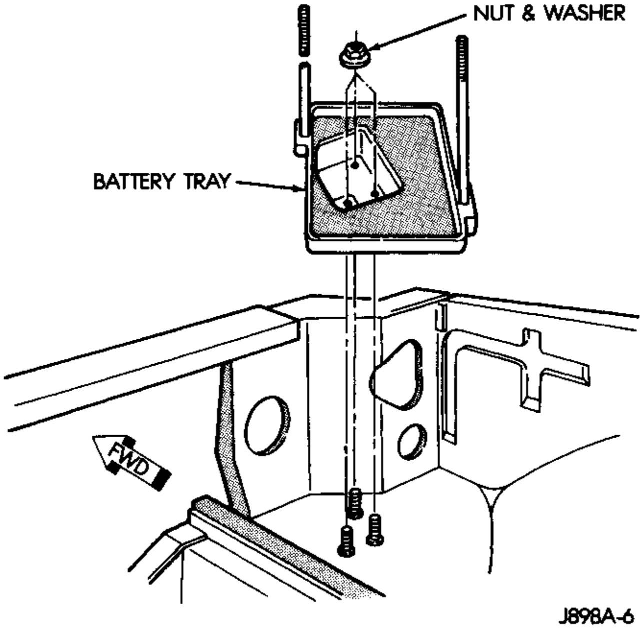


Fig. 6 Battery Tray - XJ and MJ

(4) Ensure that the tang at the battery base is positioned in the tray properly before tightening the holddown.

CAUTION: It is imperative that the cables are connected to the battery positive-to-positive and negative-to-negative. Reverse polarity will damage the alternator diodes and radio(s).

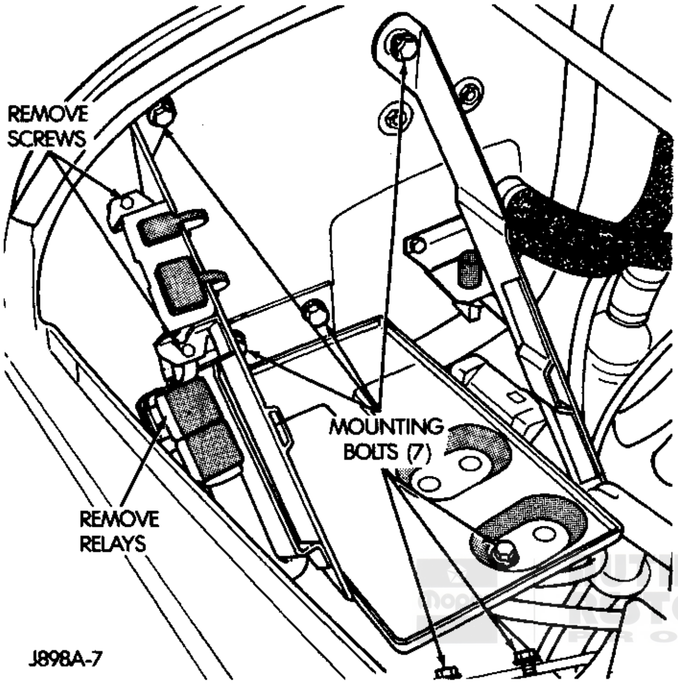


Fig. 7 Battery Tray - YJ

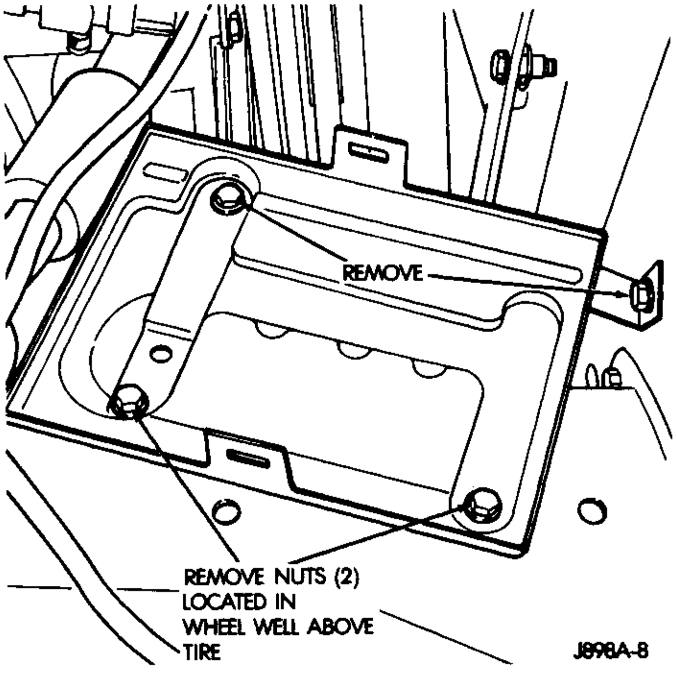


Fig. 8 Battery Tray - SJ

(5) Place the felt washer on the positive battery terminal.

(6) Connect the positive cable first. Then connect the negative cable. Tighten both cable terminal bolts to 8.5 N•m (75 in-lbs).

(7) Apply a thin coating of petroleum jelly or chassis grease to the cable terminals and the battery posts.

(8) Inspect the negative cable connections on the engine and the vehicle body for condition, security and electrical continuity.

BATTERY TESTING

General

A complete battery test includes cleaning the top of the battery case, cleaning the battery posts and cable terminals and performing hydrometer and heavy load tests.

The specific gravity is a ratio of the density of the electrolyte and the density of pure water. The electrolyte is composed of sulfuric acid and water. Acid comprises approximately 35%by weight or 24%by volume.

The condition of a battery may be determined from the results of two tests—state of charge (hydrometer test) and ability to supply current (battery load test).

Perform the hydrometer test first. If the specific gravity is less than 1.225, the battery must be charged before proceeding with further testing. A battery that will not accept a charge is defective and further testing is not necessary.

A battery with sulfated plates may require an overnight "slow charge" to determine if the sulfate coating is thin enough to be eliminated by a "charge".

A battery that has been fully charged but does not pass the battery load test is defective.

If a battery discharges and no apparent cause can be determined, the battery should be fully charged and allowed to stand on a shelf for three to seven days to determine if the self-discharge is excessive. A battery is fully charged when all cells are gassing freely and three corrected specific gravity tests, taken at one-hour intervals, indicate no increase in specific gravity.

Hydrometer Test

Periodically disassemble the hydrometer and wash components with soap and water. Inspect the float for possible leaks. If the paper inside has turned brown, the float is defective.

Prior to testing, visually inspect the battery for any damage (cracked container or cover, loose post, etc.) that would cause the battery to be unserviceable. To interpret the hydrometer correctly, hold it with the top surface of the electrolyte in the hydrometer at eye level.

Disregard the curvature of the liquid where the surface rises against the float because of surface cohesion (Fig. 9). Remove only enough electrolyte from the battery to keep the float off the bottom of the hydrometer barrel with pressure on the bulb released. Keep the hydrometer in a vertical position while drawing the electrolyte into the hydrometer and observing the specific gravity. Exercise care when inserting the tip of the hydrometer into a cell to avoid damage to the separators. Damaged separators can cause premature battery failure.

Hydrometer floats are generally calibrated to indicate the specific gravity correctly only at one fixed temperature, 80°F (26.6°C). When testing the specific gravity at any other temperature, a correction factor is required.

The correction factor is approximately a specific gravity value of 0.004, referred to as 4 points of specific gravity. For each 10°F above 80°F (5.5°C above 26.6°C), add 4 points. For each 10°F below 80°F (5.5°C below 26.6°C), subtract 4 points. Always correct the specific gravity for temperature variation. Test the specific gravity of the electrolyte in each battery cell.

Example: A battery is tested at 10°F (-12.2°C) and has a specific gravity of 1.240. Determine the actual specific gravity as follows:

- Determine the number of degrees above or below 80°F.

80°F - 10°F = 70°F

- Divide the above result by 10.

70°F 10 = 7

- Multiply the result from the previous step by the temperature correction factor (0.004).

7 x 0.004 = 0.028

- The temperature at testing was below 80°F, therefore the temperature correction is subtracted.

1.240 - 0.028 = 1.212

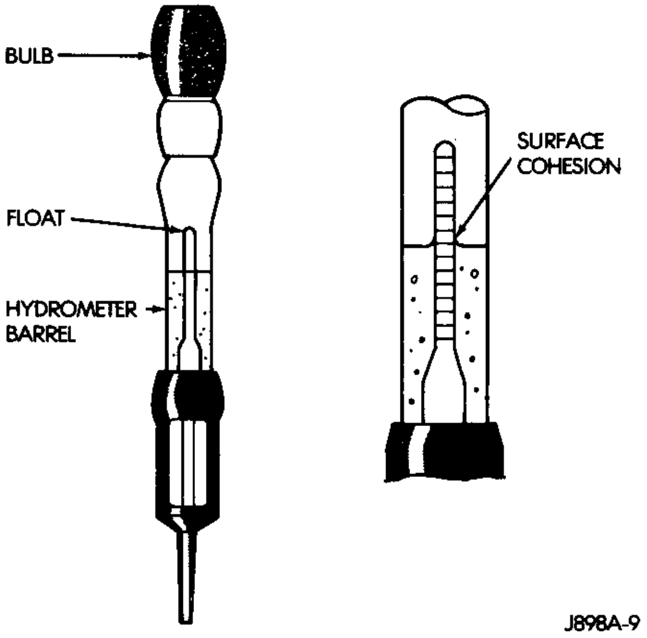


Fig. 9 Battery Hydrometer

The corrected specific gravity is 1.212.

The fully charged battery should have a temperature corrected specific gravity of 1.250 to 1.265

If the specific gravity of all cells is above 1.235, but the variation between cells is more than 50 points (0.050), it is an indication that the battery is unserviceable.

If the specific gravity of one or more cells is less than 1.235, recharge the battery at a rate of approximately 5 amperes until three consecutive specific gravity tests, taken at one-hour intervals, are constant.

If the cell specific gravity variation is more than 50 points (0.050) at the end of the charge period, replace the battery.

When the specific gravity of all cells is above 1.235 and variation between cells is less than 50 points (0.050), the battery may be tested under heavy load.

Battery Load Test

Connect test equipment and battery (Fig. 11) to perform the Battery Load Test. The procedures for this test are for the Volts-Amps Tester S-VAT-40. Refer to the manufacturers instructions if using another meter.

Before performing the battery load test, the battery must be FULLY CHARGED.

(1) Turn the carbon pile rheostat knob of the battery tester to the OFF position.

(2) Turn the volt selector knob to EXT 0-18VDC.

(3) Clamp directly on battery positive post.

(4) Clamp directly on battery negative post.

(5) Adjust amperes meter to read 0 by turning zero adjust knob.

(6) Turn carbon pile rheostat knob clockwise until the ammeter indicates the correct test amperage. Refer to Jeep Battery Classifications and Ratings.

(7) Maintain the load for 15 seconds. Note voltmeter reading and turn carbon pile to OFF.

State of Charge	Specific Gravity	Charge Rate	Charging Time
Fully Charged	1.280		
75% Charged	1.225	20	50 min
50% Charged	1.190	20	70 min
25% Charged	1.155	20	90 min
Discharged	1.120	5	12 hrs

J908A-2

Fig. 10 Battery Specific Gravity

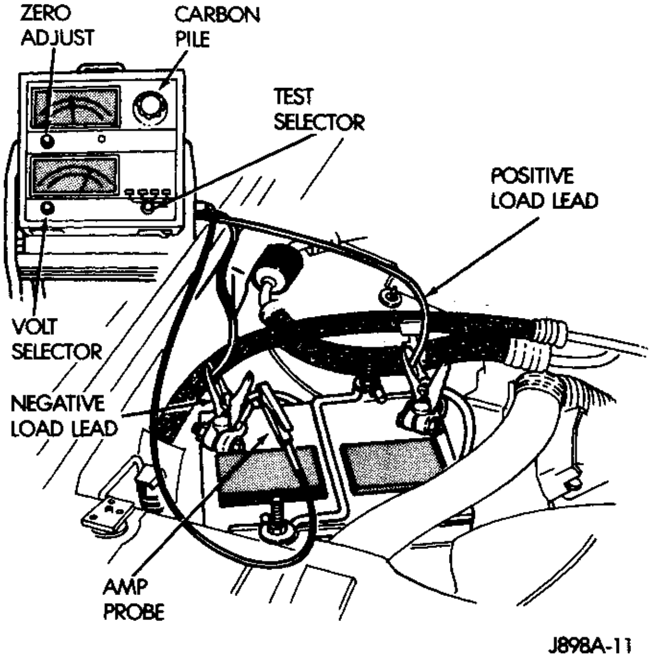


Fig. 11 Battery Load Test

(8) If the voltmeter reading fell below 9.6 volts, with the battery temperature at a minimum of 70°F (21°C), replace the battery.

STARTING SYSTEM

CONTENTS

2.5L ENGINES

INDEX

SPECIFICATIONS

Torque Specifications

Components	Service Set-To Torque	Service Recheck Torque
Starter Motor-to-Block Screws	24 N•m (18 ft-lbs)	18-34 N•m (13-25 ft-lbs)
Starter Terminal Screw	6 N•m (55 in-lbs)	4.5-8 N•m (40-70 in-lbs)

Starter Motor Specifications

Component	Specifications
Carbon Brushes	Minimum Length-8 mm (0.314 in.)
Ring/Pinion Clearance	0.6-6.2 mm (0.0236-0.244 in.)
Back lash (Meshed Ring & Pinion)	0.3-0.5 mm (0.0118-0.0197 in.)
Commutator Diameter	31.2 mm (1.23 in.)-32.3 (1.27 in.)
Out of Round	
Commutator	0.01 mm (0.0004 in.)
Armature (Core)	0.05 mm (0.002 in.)- 0.08 mm (0.003 in.)
Armature End Play	0.05 mm (0.002 in.)-
No Load Test With 11.5 volts	
Max. Amps	75
Min. RPM	2900
Solenoid Hold-in Winding Voltage	0.2V-2V
Solenoid Pull-in Winding Voltage	6V-7.3V
Starter Type	DW 1.4

J898C-1

Starter Motor Cold Cranking Specifications

Battery Test Voltage	12.5 Volts
Cold Cranking Voltage (Min.)	9.6 Volts
Cold Cranking Amps	160 Amps

GENERAL INFORMATION

The 2.5L engine starter motor incorporates several unique features to create an efficient, lightweight unit.

A planetary gear system (intermediate transmission) between the electric motor and pinion shaft makes it possible to reduce the dimensions of the starter, while obtaining a higher rotational speed of the starting motor to produce the same torque at the pinion.

The permanent magnet field consists of six two-component high strength magnets. The magnets are aligned according to their polarity and are permanently fixed in the stator frame.

The brush holder plate consists of a plastic baseplate with four tubular brush holders.

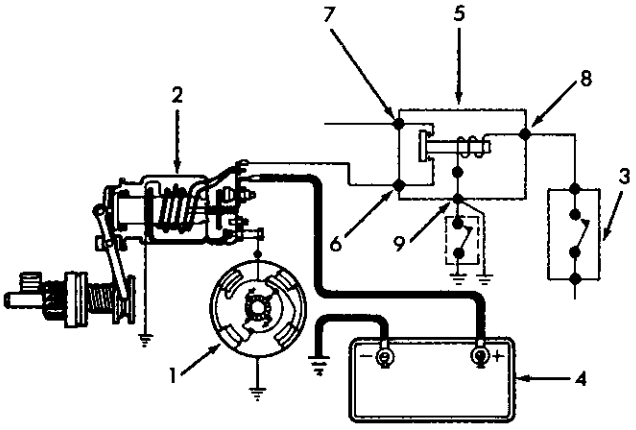
There are several procedures that must be followed when servicing this starter. Unlike other starter motors this unit is highly sensitive to hammering, shocks and external pressure.

CAUTION: The starter motor MUST NOT BE CLAMPED in a vise by the stator frame. Doing so may damage the magnets. It may be clamped by the mounting flange ONLY.

- Do not connect the starter motor incorrectly when electrical test are being performed. The magnets may be damaged and rendered unserviceable.
- Ensure cleanliness when performing repairs.
- Metal chips are attracted by the magnets and may not be completely removed from the stator frame. Chips in the ring gear can lead to failure of the starter.
- The armature, ring gear, overrunning clutch drive, and solenoid may be cleaned with compressed air. DO NOT use any liquid cleaning agent. Other components may be washed with cleaning solvents that are commercially available. DO NOT breathe the vapors.

STARTER MOTOR SIMPLIFIED CIRCUIT

Refer to Section 8W - Wiring Diagrams for Complete Schematic.



1. STARTER
2. SOLENOID
3. IGNITION SWITCH
4. BATTERY
5. RELAY
6. SOLENOID TERMINAL
7. BATTERY TERMINAL
8. IGNITION TERMINAL
9. GROUND TERMINAL

J898C-3

Fig. 1 Starter Motor Simplified Circuit

STARTER MOTOR DIAGNOSTIC INSPECTIONS

Before removing any unit from the starter motor system for repair, perform the following inspections:

Battery Inspection

To determine condition of the battery, perform the testing procedure outlined in the Battery Section.

Wiring Inspection

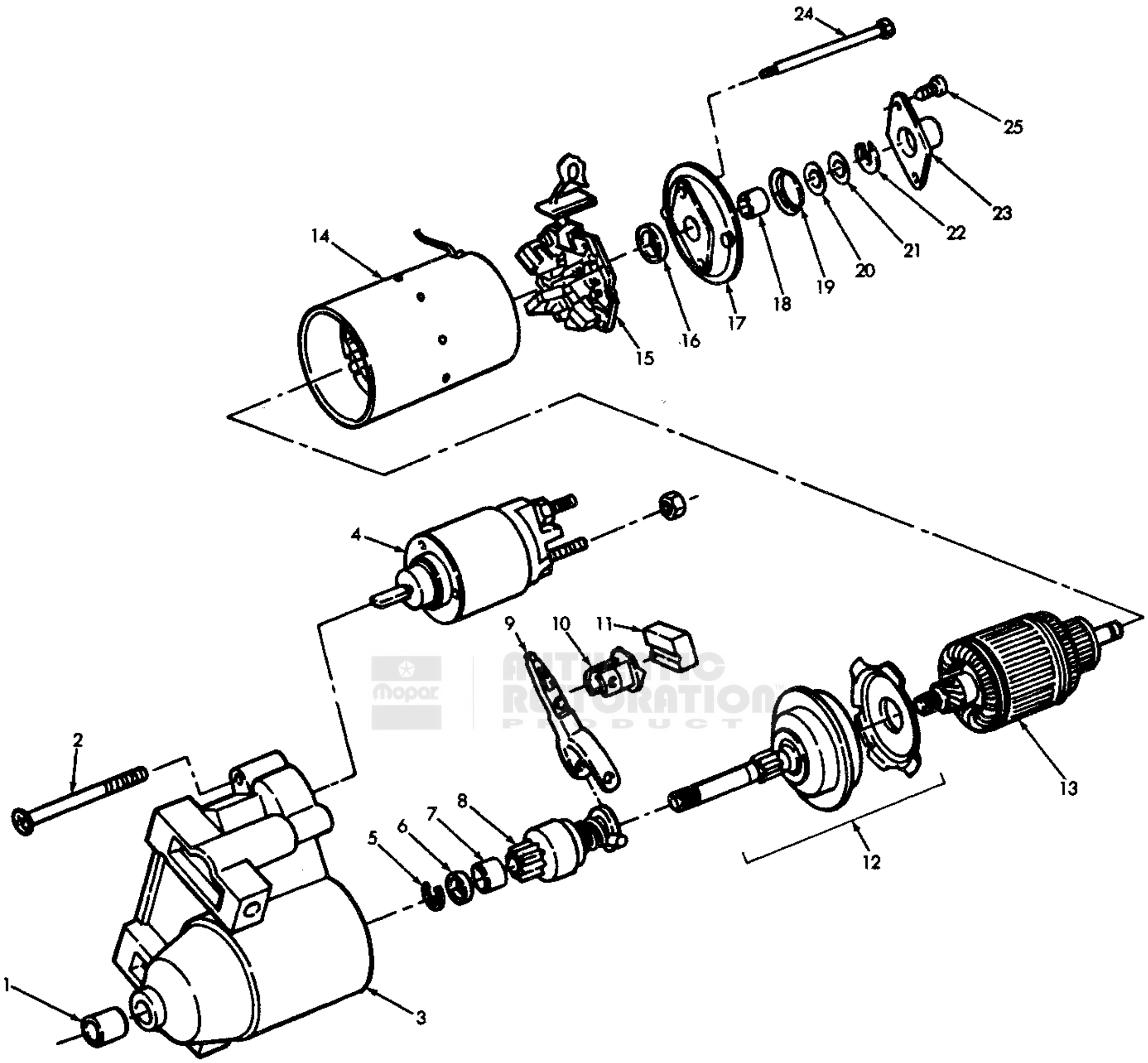
Inspect wiring for damage. Inspect all connections at the starter motor solenoid, relay, neutral safety switch (if equipped), back-up lamp switch connector, ignition/ start switch, and battery (including all ground connections). Clean and tighten all connections as required.

Solenoid, Relay and Ignition/Start Switch Inspection

Inspect the solenoid, relay and switch to determine their condition. Also, if equipped with automatic transmission, inspect condition of the neutral safety switch. (Testing information can be found in the following pages).

If the battery, wiring, switch, solenoid, relay and neutral safety switch are in satisfactory condition (and the engine is known to be functioning properly), remove the starter motor and follow procedures in the Testing Section.

Starter Motor Noise — To correct starter motor noise during starting, refer to the Starter Motor Noise Diagnosis Chart to determine the cause.



1. BUSHING
2. SCREW
3. SHIELD
4. SOLENOID SWITCH
5. RETAINER
6. STOP RING
7. BUSHING
8. OVERRUNNING CLUTCH DRIVE
9. FORK
10. BEARING PEDESTAL
11. SEALING RUBBER
12. PLANETARY GEAR SYSTEM
13. ARMATURE
14. STATOR FRAME
15. BRUSH HOLDER
16. GASKET
17. COMMUTATOR END SHIELD
18. BUSHING
19. SEAL RING
20. SHIM
21. SHIM
22. RETAINING WASHER
23. CLOSURE CAP
24. HEXAGON SCREW
25. SCREW

J898C-2

Starter Motor Exploded View - 2.5L Engine

STARTER MOTOR NOISE DIAGNOSIS

If the complaint is similar to Conditions No. 1 and No. 2, correction can be achieved by proper "shimming" according to the following procedures:

- Disconnect the battery negative cable (to prevent inadvertent starting of engine).

Two shim thicknesses are available. One is 0.381 mm (0.015 in.) and the other is 1.143 mm (0.045 in.). If shims are not available, they can be fabricated from plain washers or other suitable material.

If the complaint is similar to Condition No. 1, the starter motor must be moved toward the flywheel/driveplate. This can be accomplished by shimming ONLY the outboard starter motor mounting pad (Fig. 2).

This is generally a condition that causes broken flywheel/driveplate ring gear teeth or broken starter motor housings.

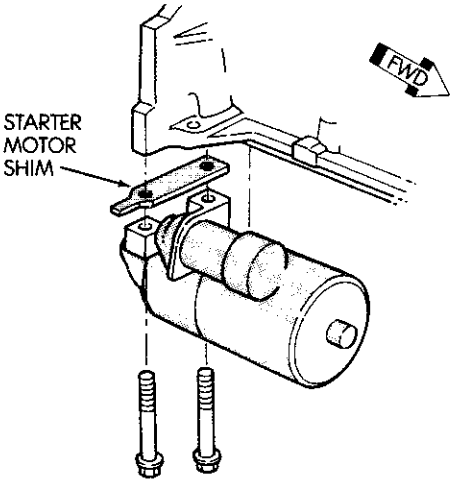
If the complaint is similar to Condition No. 2, the starter motor must be moved away from the flywheel/driveplate. This is accomplished by installing shim(s) across both mounting pads. More than one shim may be required.

If the battery, wiring, switch, solenoid, relay, and neutral safety switch are in satisfactory condition and the engine is known to be functioning properly, remove the starter motor and follow test procedures in the Starter Motor Testing section.

CONDITION	POSSIBLE CAUSE	CORRECTION
1. VERY HIGH FREQUENCY WHINE BEFORE ENGINE STARTS; ENGINE STARTS OK.	1. Excessive distance between pinion gear and flywheel/drive plate gear.	1. Shim starter motor toward flywheel/drive plate.
2. VERY HIGH FREQUENCY WHINE AFTER ENGINE STARTS WITH IGNITION KEY RELEASED. ENGINE STARTS OK.	2. Insufficient distance between starter motor pinion gear and flywheel/drive plate runout can cause noise to be intermittent.	2. Shim starter motor away from flywheel/drive plate. Inspect flywheel/drive plate for damage; bent, unusual wear, and excessive runout. Replace flywheel/drive plate as necessary.
3. A LOUD "WHOOP" AFTER ENGINE STARTS WHILE STARTER MOTOR IS ENGAGED.	3. Most probably cause is defective overrunning clutch. Clutch replacement normally corrects this condition	3. Replace overrunning clutch or drive assembly.
4. A "RUMBLE," "GROWL," OR "KNOCK" AS STARTER MOTOR COASTS TO STOP AFTER ENGINE STARTS.	4. Most probable cause is bent or unbalanced starter motor armature. Armature replacement normally corrects this condition.	4. Replace starter motor armature.

NOTE: A high frequency whine during cranking is normal for this starter motor.

J908C-2



J908C-1

Fig. 2 Starter Motor Shimming

STARTING SYSTEM TESTING

Cold Cranking Test

(1) Battery must first pass load and voltage drop tests and be fully charged before proceeding. Refer to Group 8A - Battery.

(2) Turn volt selector knob of a suitable volt-amps tester to 0-18VDC.

(3) Clamp on positive load lead.

(4) Clamp on negative load lead.

(5) Clamp on AMP probe with arrow pointing in direction (A) (Fig. 3).

(6) Adjust amperes meter reading to 0, by turning zero adjusting knob.

(7) Fully engage parking brake, place manual transmission in NEUTRAL, automatic transmission in PARK.

(8) Remote crank engine as shown in the following illustration, using a remote crank switch.

Remote Crank: Unplug (I) connection, place one lead on I, the other on battery positive post (Fig. 4).

(9) Depress remote crank switch. Note cranking voltage and amperage.

(10) Replace or rebuild starter motor if specifications are not met. Refer to Cold Cranking Specifications.

A cold engine will increase starter motor current.

Starter Motor Cable and Ground Cable Tests - (Voltage Drop Method)

The cable voltage drop tests will determine if there is excessive resistance in the high current circuit. When performing these tests, it is important that the voltmeter be connected to the terminals that the cables are connected to instead of to the cables themselves. For example, when testing between the battery and solenoid, touch the voltmeter test probes to the battery post and the solenoid threaded stud.

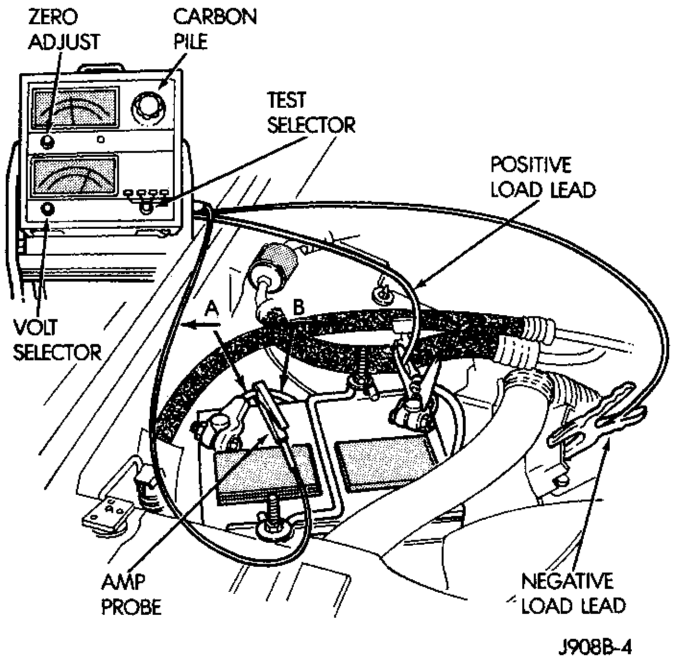


Fig. 3 Cold Cranking Test

Before performing the tests, assure the following procedures are accomplished:

- ignition control module (ICM) is disconnected
- transmission in NEUTRAL (manual transmission) or PARK (automatic transmission)
- parking brake applied
- battery is fully charged (refer to Group 8A - Battery)

(1) Measure between the battery positive post and the center of the B+ starter solenoid stud.

(2) Measure between the battery negative post and the engine block.

(3) Battery cable voltage drop **MUST NOT EXCEED 0.5V MAX.** (This is measured with the engine cranking).

(4) If test voltage exceeds 0.5V, clean metal surface. Apply a thick layer of silicone grease. Install a new cadmium plated bolt and star washer (brass nut on starter solenoid). Retest and replace cable if voltage is not below 0.5 volts.

Solenoid Testing

The solenoid can be tested electrically by connecting a battery of the specified voltage, a switch, and a voltmeter to the terminal for the two solenoid windings.

With all wires disconnected from the solenoid, connect the test equipment to solenoid terminal 50 and to the ground to test the hold-in coil winding (Fig. 5)

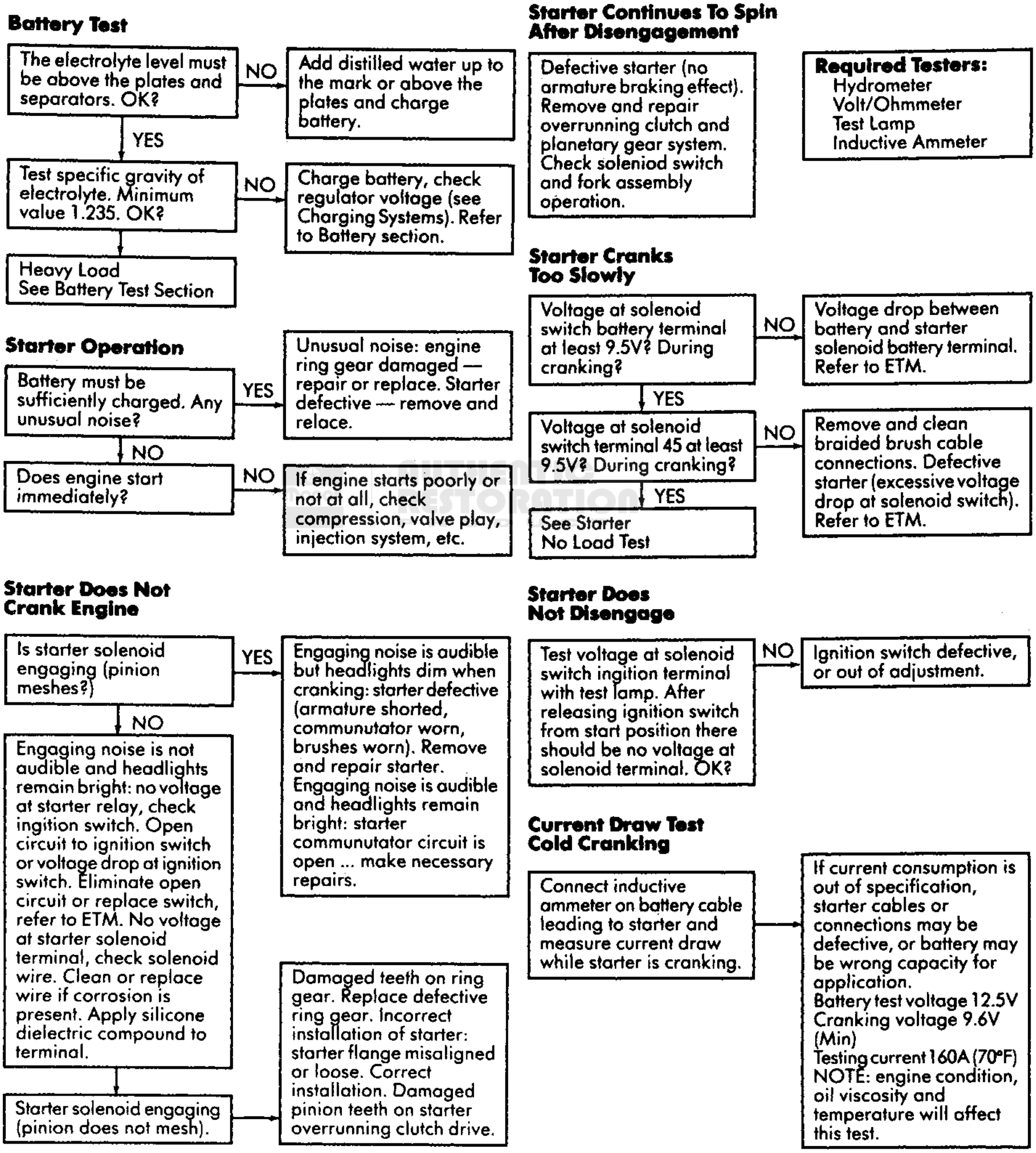
A high voltage indicates a high winding resistance. A low voltage indicates a low winding resistance.

Refer to the Specifications Chart.

To test the pull-in coil winding, connect the battery across solenoid terminal 50 and solenoid motor terminal 45.

To reduce voltage to the specified value, connect the carbon pile rheostat between the battery and terminal 45.

STARTING SYSTEM TROUBLESHOOTING



Battery Test

The electrolyte level must be above the plates and separators. OK?

NO: Add distilled water up to the mark or above the plates and charge battery.

YES: Test specific gravity of electrolyte. Minimum value 1.235. OK?

NO: Charge battery, check regulator voltage (see Charging Systems). Refer to Battery section.

Heavy Load
See Battery Test Section

Starter Operation

Battery must be sufficiently charged. Any unusual noise?

YES: Unusual noise: engine ring gear damaged — repair or replace. Starter defective — remove and relace.

NO: Does engine start immediately?

NO: If engine starts poorly or not at all, check compression, valve play, injection system, etc.

Starter Does Not Crank Engine

Is starter solenoid engaging (pinion meshes?)

YES: Engaging noise is audible but headlights dim when cranking: starter defective (armature shorted, communutator worn, brushes worn). Remove and repair starter. Engaging noise is audible and headlights remain bright: starter communutator circuit is open ... make necessary repairs.

NO: Engaging noise is not audible and headlights remain bright: no voltage at starter relay, check ingition switch. Open circuit to ignition switch or voltage drop at ignition switch. Eliminate open circuit or replace switch, refer to ETM. No voltage at starter solenoid terminal, check solenoid wire. Clean or replace wire if corrosion is present. Apply silicone dielectric compound to terminal.

Starter solenoid engaging (pinion does not mesh).

Damaged teeth on ring gear. Replace defective ring gear. Incorrect installation of starter: starter flange misaligned or loose. Correct installation. Damaged pinion teeth on starter overrunning clutch drive.

Starter Continues To Spin After Disengagement

Defective starter (no armature braking effect). Remove and repair overrunning clutch and planetary gear system. Check soleniod switch and fork assembly operation.

Required Testers:
Hydrometer
Volt/Ohmmeter
Test Lamp
Inductive Ammeter

Starter Cranks Too Slowly

Voltage at solenoid switch battery terminal at least 9.5V? During cranking?

NO: Voltage drop between battery and starter solenoid battery terminal. Refer to ETM.

YES: Voltage at solenoid switch terminal 45 at least 9.5V? During cranking?

NO: Remove and clean braided brush cable connections. Defective starter (excessive voltage drop at solenoid switch). Refer to ETM.

YES: See Starter No Load Test

Starter Does Not Disengage

Test voltage at solenoid switch ingition terminal with test lamp. After releasing ignition switch from start position there should be no voltage at solenoid terminal. OK?

NO: Ignition switch defective, or out of adjustment.

Current Draw Test Cold Cranking

Connect inductive ammeter on battery cable leading to starter and measure current draw while starter is cranking.

If current consumption is out of specification, starter cables or connections may be defective, or battery may be wrong capacity for application.
Battery test voltage 12.5V
Cranking voltage 9.6V (Min)
Testing current 160A (70°F)
NOTE: engine condition, oil viscosity and temperature will affect this test.

J898C-6

STARTER MOTOR TESTING

Once a problem has been traced to the starter motor, proceed with the following test procedure.

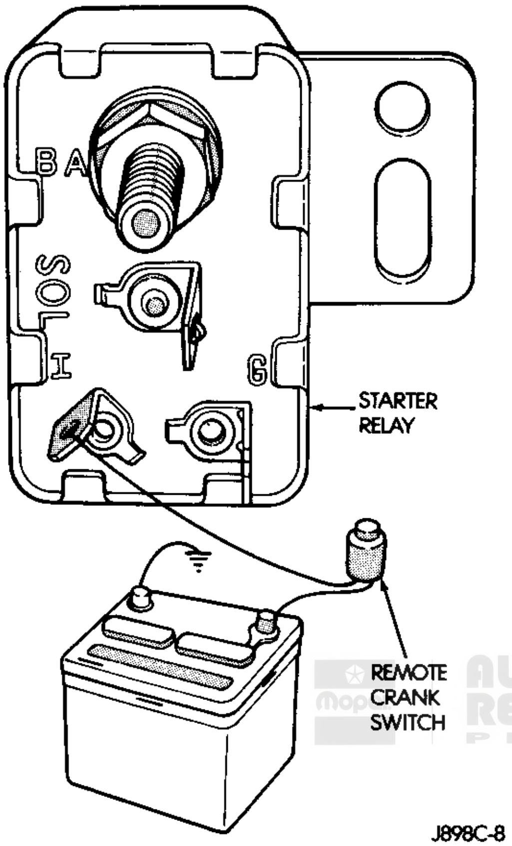


Fig. 4 Remote Crank Connection

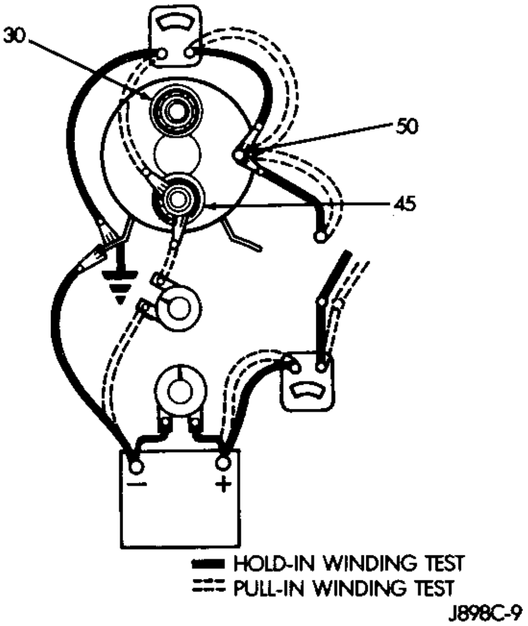


Fig. 5 Solenoid Test

With the starter motor removed from the engine, the pinion gear should be tested for freedom of movement by turning it on the screw shaft.

The armature should be tested for freedom of rotation by prying the pinion gear with a screwdriver to engage it with the shaft. Tight bearings, a bent armature or driveshaft, or a bent frame will cause the armature to not rotate freely. If the shafts do not rotate freely, the motor should be disassembled. However, if the shafts do rotate freely, the motor should be given a **No-load Test** before disassembly.

No rotation and high current flow conditions indicate one or more of the following:

- Connecting terminal or armature windings shorted to ground.
- Seized bearings (this should have been determined by rotating armature by hand).

No rotation and no current flow conditions indicate one or more of the following:

- Open armature windings (inspect commutator for badly burned commutator bars after disassembly).
- Broken brush springs, worn brushes, protruding insulation between commutator bars, or other causes could prevent good contact between brushes and commutator.

NO-LOAD TEST

CAUTION: Overheating, caused by excessive operation, will seriously damage the motor. NEVER OPERATE THE STARTER MOTOR FOR MORE THAN A 30-SECOND DURATION WITHOUT PAUSING to allow it to cool for a least two minutes.

(1) Connect a voltmeter between terminal 45 and the motor frame. Use a mechanical tachometer to measure armature speed (Fig. 6).

(2) Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch (in the OPEN position) from the solenoid battery terminal 30 to the solenoid terminal 50.

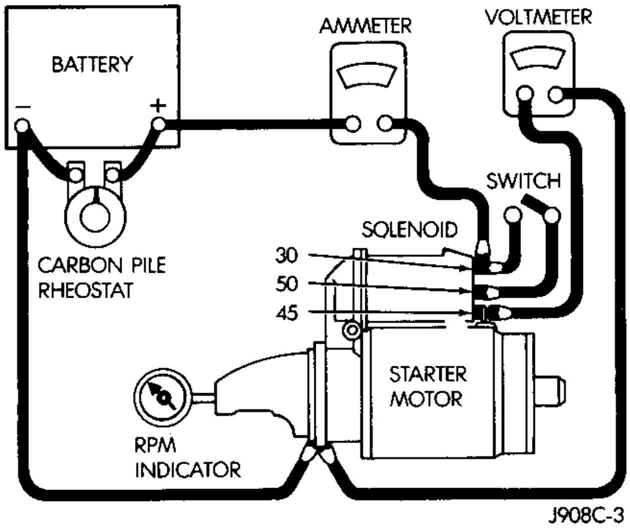


Fig. 6 Starter No Load Test

(3) Close the switch and compare the RPM, current, and voltage with those listed in the specifications.

It is not necessary to obtain the exact voltage specified because an accurate interpretation can be made by recognizing that if the voltage is slightly higher the RPM will be proportionately higher with the current remaining the same. However, if the exact voltage is desired, a carbon pile rheostat connected across the battery can be used to reduce the voltage to the specified value.

The specified current flow includes the solenoid current flow.

Disconnect test connections ONLY with the switch OPEN.

Interpret the test results according to the following criteria:

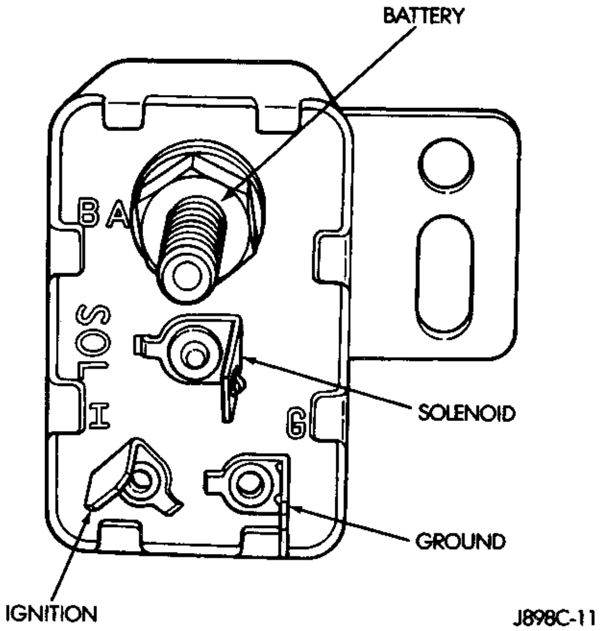
Normal Conditions - The rated current flow and specified no-load speed indicate normal condition of the starter motor.

Abnormal Conditions - The low no-load speed and high current flow indicate one of more of the following conditions:

- **armature drag** - caused by excessive friction-tight, dirty, or worn bearings, bent armature shaft, or bent frame
- **shorted armature winding** - determined on growler after disassembly.
- **grounded armature** - inspect further after disassembly.

STARTER RELAY

Starter Relay Connections



Starter Relay Test

WARNING: CHECK TO ENSURE THAT THE TRANSMISSION IS IN PARK (AUTOMATIC TRANSMISSION) OR NEUTRAL (MANUAL TRANSMISSION) WITH THE PARKING BRAKE APPLIED BEFORE PIN G IS JUMPED.

TEST	OK	NOT OK
Ignition in START	Relay clicks	Next step
Jumper pin G of relay to ground*	Relay clicks If OK, repair open to ground	Replace relay
Starter Solenoid terminal 50, disconnected**	Battery voltage If OK, replace/rebuild starter	Repair open to relay terminal SOL

* Ignition in Start

** Prevent terminal from touching metal parts

Starter Relay Removal

(1) Disconnect the battery negative cable.

(2) Identify, tag, and disconnect wires attached to the relay (Figs. 7 and 8).

(3) Remove the relay attaching screws and the relay.

Starter Relay Installation

(1) Install the replacement starter motor relay on the dash panel.

(2) Connect wires to the starter motor relay.

(3) Connect the battery negative cable.

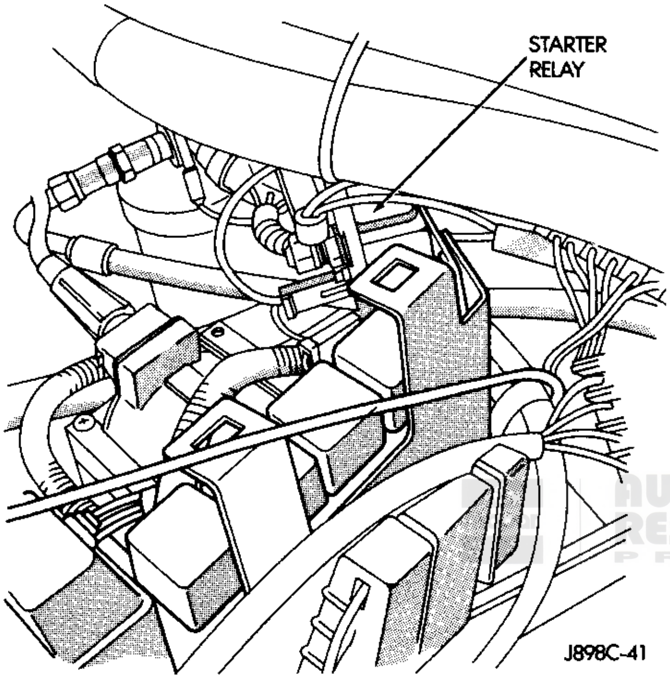


Fig. 7 Starter Relay Location - XJ and MJ

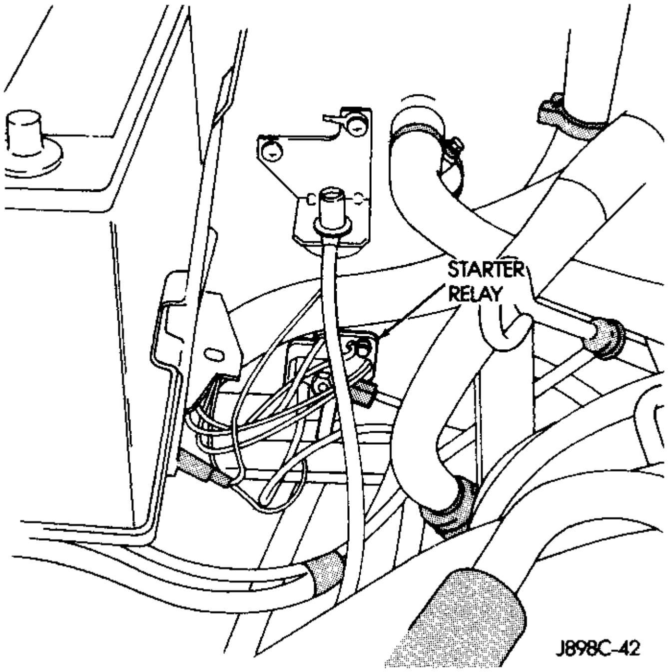


Fig. 8 Starter Relay Location - YJ

(4) Test relay operation.

STARTER MOTOR REMOVAL/INSTALLATION

YJ-2.5L Engine

(1) Disconnect the battery negative cable at the battery.

(2) Disconnect the battery cable from the starter motor B+ terminal (Fig. 9).

(3) Disconnect the solenoid feed wire.

(4) Remove the mounting screws.

(5) Remove the starter motor at the flywheel (drive plate) housing.

(6) To install the starter motor, reverse the removal procedures and torque the mounting hardware as shown.

(7) Connect the battery negative cable.

XJ And MJ 2.5L Engine

(1) Remove exhaust clamp from bracket (Fig. 10).

(2) Remove nut and bolt from forward end of brace rod (automatic transmission only).

(3) Remove nut from lower end of brace rod and (automatic transmission only).

(4) Remove brace rod and bracket (automatic transmission only).

(5) Remove nut, bolt and bracket from bell housing (manual transmission only).

(6) Disconnect battery cable and solenoid feed wire from solenoid (Fig. 11).

(7) To install the starter motor, reverse the removal procedures and torque the mounting hardware as shown.

(8) Connect the battery negative cable.

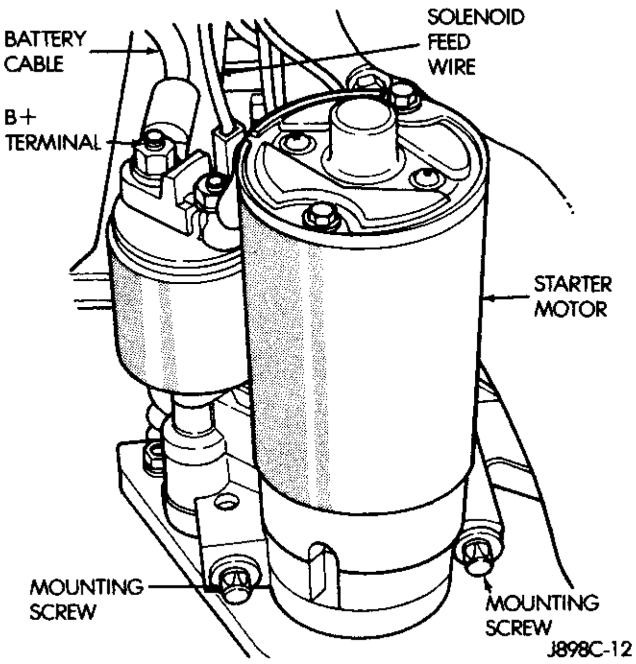


Fig. 9 Starter Motor Removal/Installation - 2.5L YJ

STARTER MOTOR DISASSEMBLY

General Information

CAUTION: Do not strike the thin wall stator frame with a hammer or other instrument. Do not clamp the thin wall stator frame in the jaws of a vice (Fig. 12). This may result in the permanent magnets being broken or the stator housing becoming deformed.

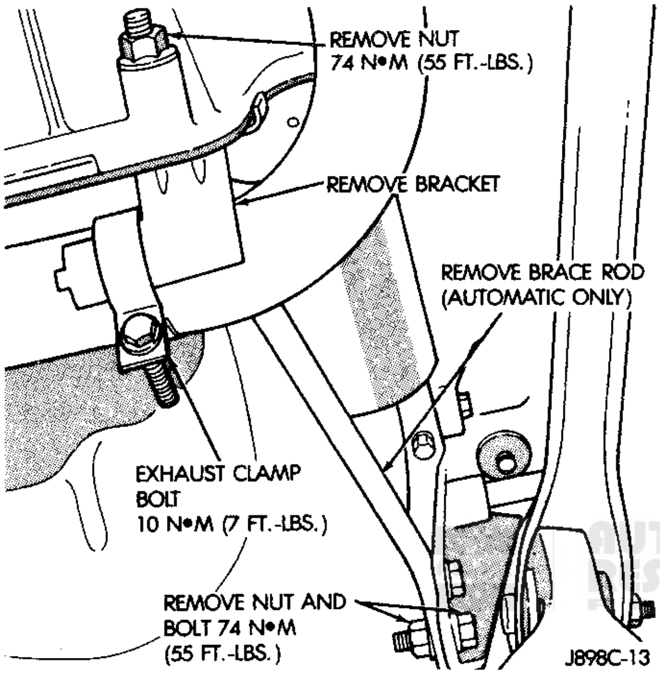


Fig. 10 Exhaust Clamp and Brace Removal - 2.5L XJ and MJ

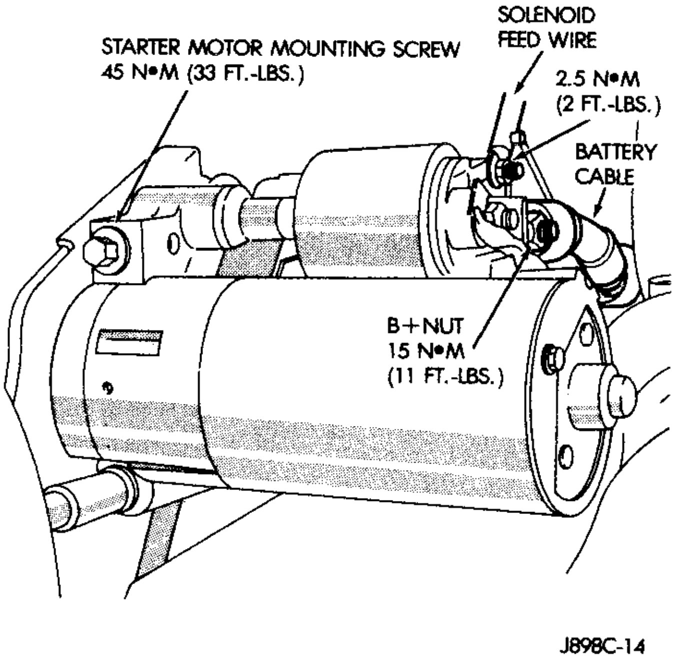


Fig. 11 Starter Motor Removal/Installation - 2.5L XJ and MJ

Solenoid Switch Removal

(1) Remove terminal 45 on the solenoid.

(2) Remove the three screws from the solenoid (Fig. 13).

(3) Remove the solenoid with the armature and return spring.

Stator Frame Removal

(4) Loosen the screws on the rear closure cap (Fig. 14), but do not remove them.

(5) Remove the hexagon screws running through the stator housing.

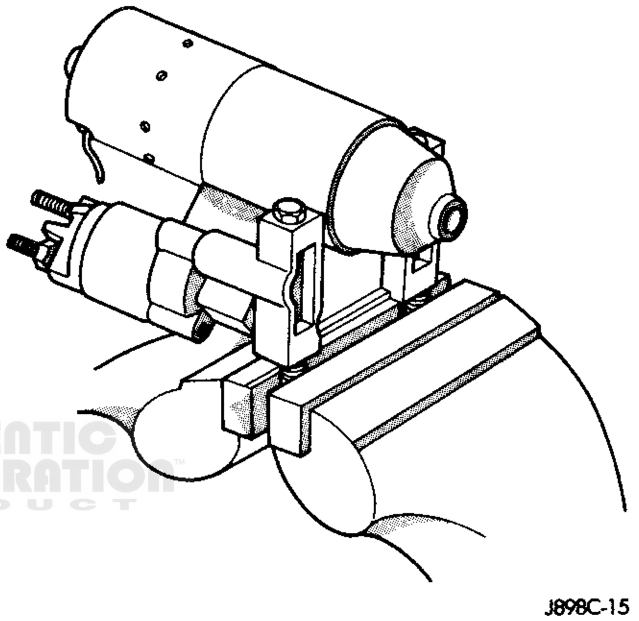


Fig. 12 Mount Starter Motor in Vise

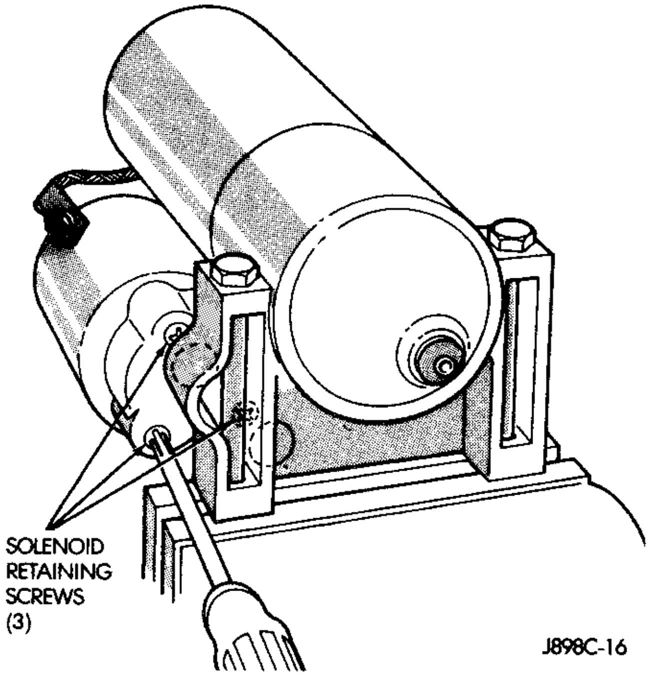


Fig. 13 Solenoid Removal

(6) Remove the stator frame with the cover plate, armature, and commutator end shield.

Armature Removal

(7) Remove the cover plate from the drive end-bearing end ring gear.

(8) Carefully press the armature (Fig. 15) with the commutator end shield out of the stator by hand. At the same time, push out terminal 45 with the sealing rubber.

Commutator End Shield Removal

(9) Remove the closure cap from the commutator end shield.

(10) Remove the retaining washer and shims from the armature shaft.

(11) Remove the commutator end shield (Fig. 16).

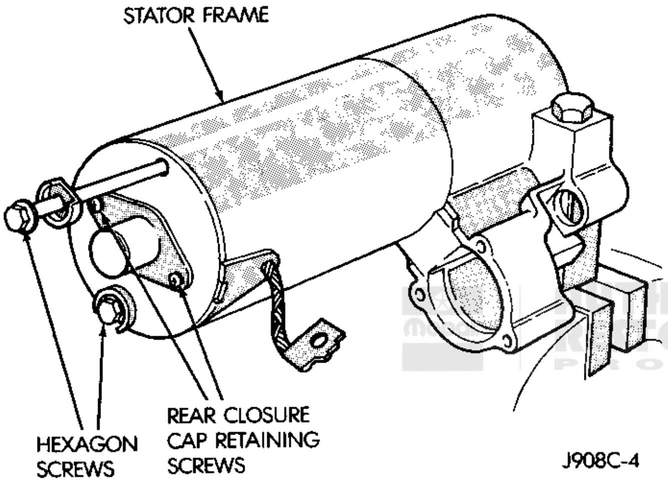


Fig. 14 Stator Frame Removal

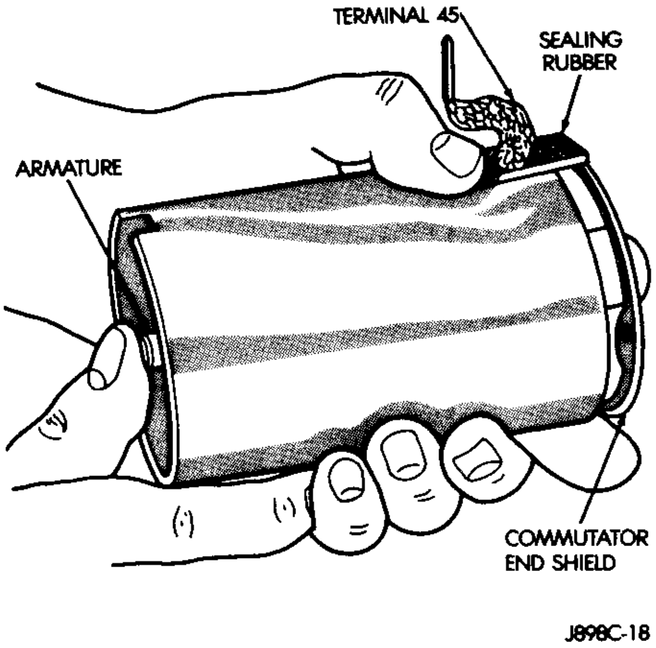


Fig. 15 Armature Removal

Brush Removal

(12) Slide special tool KDAL 5048 onto the armature shaft (Fig. 17).

(13) Slide the brush plate as far as it will go on to special tool KDAL 5048.

(14) Pull special tool KDAL 5048 with the brush plate off the armature shaft.

Overrunning Clutch and Planetary Gear Removal

(15) Remove sealing rubber (Fig. 18).

(16) Remove the planetary gear system (Fig. 19) with the overrunning clutch and fork assembly from the drive end shield.

To prevent damage to the planetary gear system when removing it from the overrunning clutch mount both assemblies onto mounting base special tool KDAL 5047 and stand it up vertically.

Using special tool KDAL 5028 (Fig. 20), and a rubber mallet, drive the stop ring down the input shaft.

Use a suitable set of pliers to bend the ends of the retainer far enough apart to allow removal without

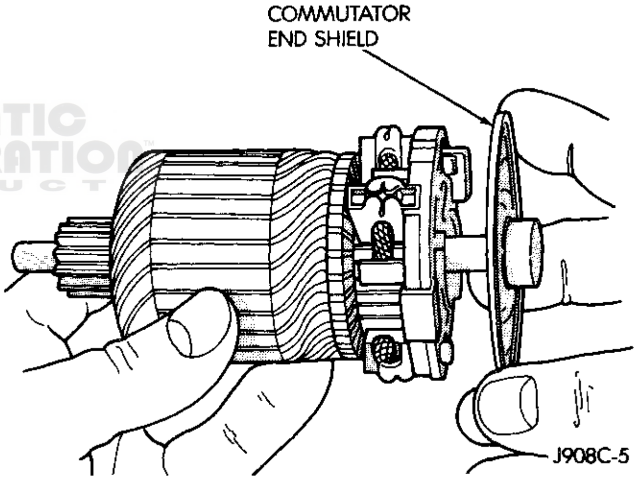


Fig. 16 Remove Commutator End Shield

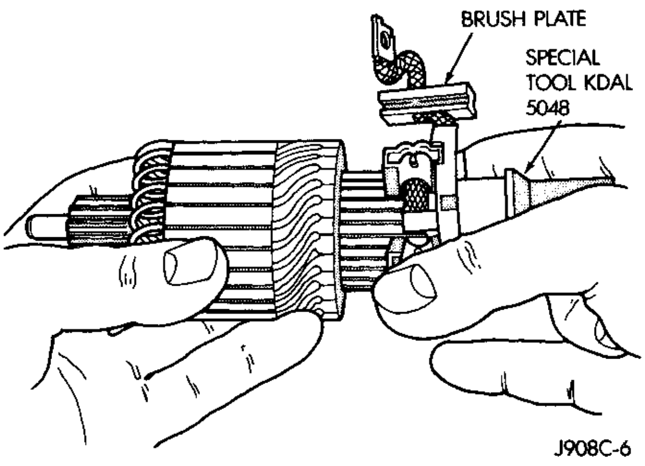


Fig. 17 Remove Brushes

damaging the drive shaft. If necessary, carefully remove any burr from the armature shaft, otherwise damage to the drive bushing may result.

STARTER MOTOR CLEANING AND INSPECTION

The armature, windings, overrunning clutch drive, and relay must be cleaned with compressed air and a dry rag. **Do not use liquid cleaning agents.**

Other parts, such as screws and the armature shaft may be cleaned with cleaning solvent.

Inspect all parts for wear and damage.

Replace any worn parts.

If the bushings in the drive end shield or the commutator end shield are worn, they are replaceable.

Inspect the stator frame and permanent magnets for damage.

DO NOT remove the magnets from the stator frame.

If the stator frame or magnets are damaged, replace the stator frame (magnets are included).

Driveshaft/Ring Gear Assembly Inspection

Loosen the retainer from the planetary gear drive. Remove the ring gear from the drive shaft.

Check the ring gear for cracks and wear.

Check the bushings in the ring gear for excessive play, wear, or for being out of round by moving the drive shaft from side-to-side.

Check the drive shaft bushing in the drive end shield and commutator end shield with plug gauge special tool KDAL 5049.

Inspect the drive shaft in the ring gear for wear or damage. Replace the shaft and ring gear if either is worn.

Overrunning Clutch Drive Inspection

If the fork lever is damaged, disconnect it by spreading the fork on the overrunning clutch drive. Also, if the bearing pedestal is damaged, separate it from the fork lever.

Inspect the bearing bushing in the overrunning clutch for wear.

Replace the overrunning clutch if the bearing bushing is worn.

Carbon Brush Inspection

The carbon brushes must have a MINIMUM length of 8mm (0.314 in.).

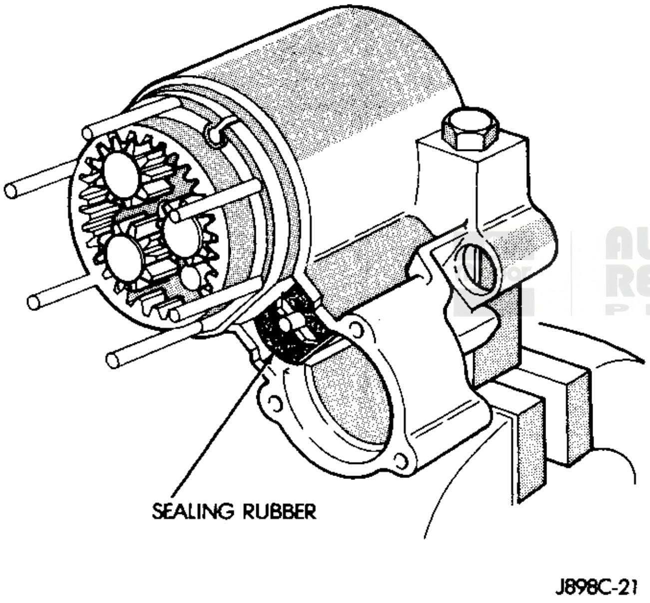


Fig. 18 Remove Sealing Rubber

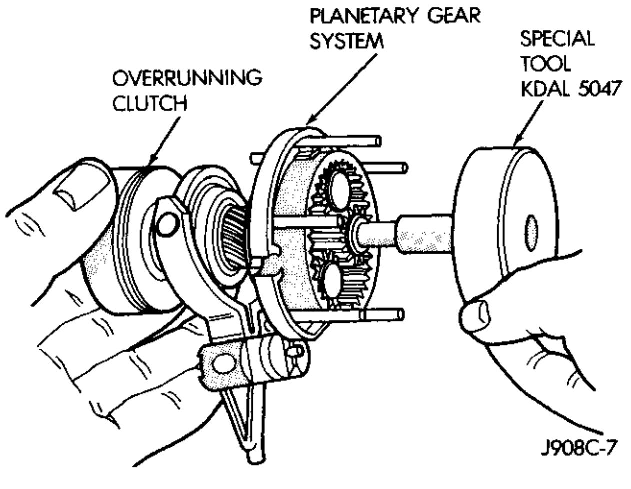


Fig. 19 Clutch and Gear Removal

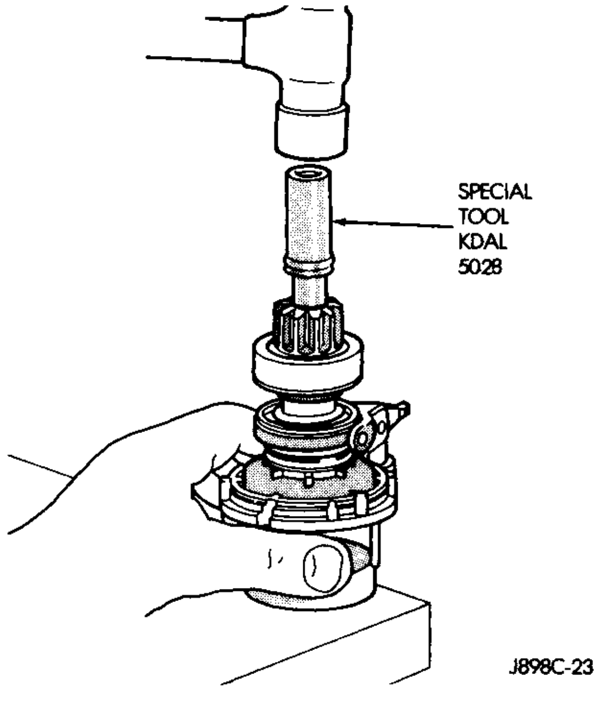


Fig. 20 Planetary Gear Removal

To measure the brushes, remove them from the brush holder (Fig. 21).

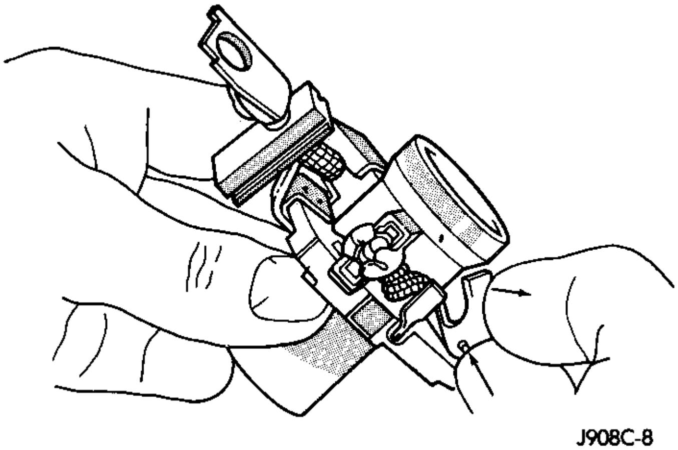


Fig. 21 Remove Brushes From Holder

ARMATURE TESTING

Armature Ground Test

(1) Place the armature in the growler jaws and turn the power switch to TEST position.

(2) Touch one test probe to the armature core (Fig. 22). Touch the other probe to each commutator bar one at a time and observe the test lamp. The test lamp should not light. If the test lamp lights on any bar, the armature has a short circuit to ground and must be replaced.

Armature Short Test

CAUTION: Never operate the growler with the power switch in the growler TEST position without an armature in the jaws.

(1) Place the armature in the growler jaws and turn the power switch to GROWLER position.

(2) Hold the steel blade parallel to, and touching, the armature core (Fig. 23). Slowly rotate the armature one or more revolutions in the growler jaws. If the steel blade vibrates at any area of the core, the windings have a short circuit and the armature must be replaced.

Armature Balance Test

(1) Place the armature in the growler jaws and turn the power switch to GROWLER position.

(2) Place the contact fingers of the meter test probe (Fig. 24) across adjacent commutator bars at the side of the commutator.

(3) Adjust the voltage control until the pointer indicates the highest voltage on scale.

(4) Test each commutator bar with the adjacent bar until all bars have been tested.

Zero voltage indicates a short circuit in the particular pair.

If there is a short circuit indicated, replace the armature.

Armature Runout Test

Check the runout of the armature (Fig. 25) as specified in the Specifications Chart.

If the armature is not within the specification, replace the armature.

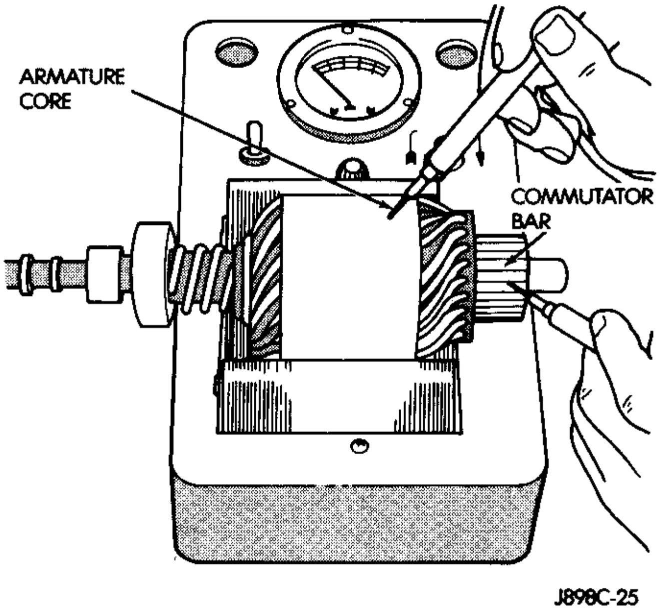


Fig. 22 Armature Ground Test

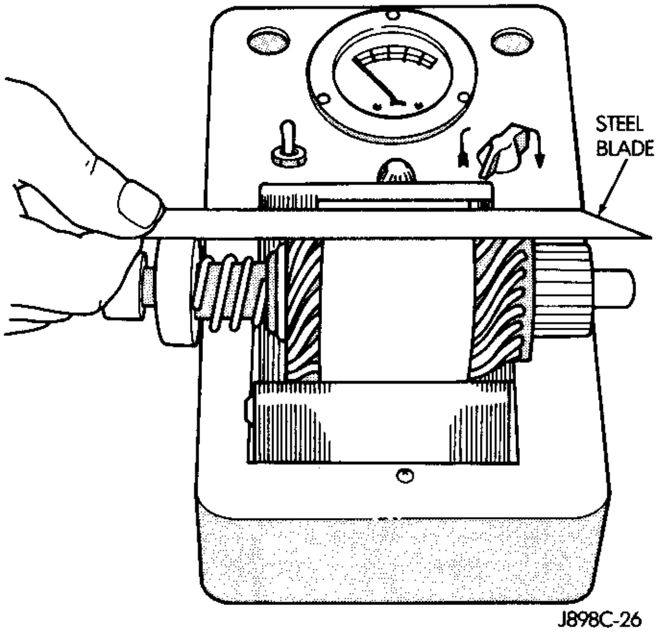


Fig. 23 Armature Short Test

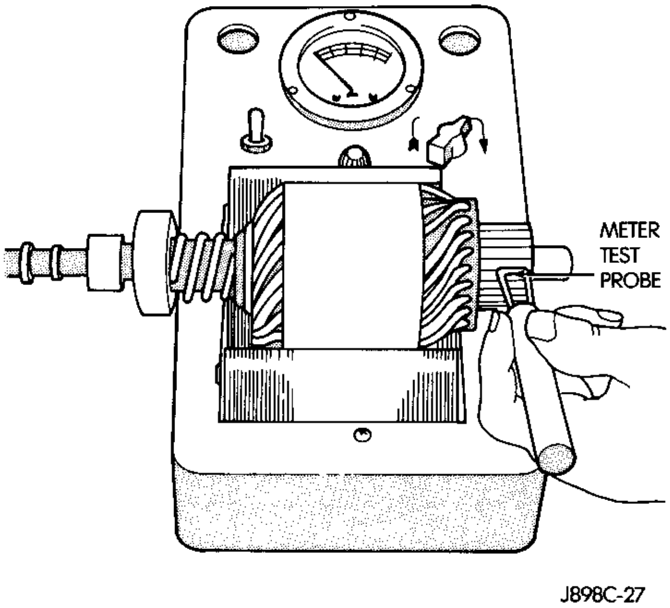


Fig. 24 Armature Balance Test

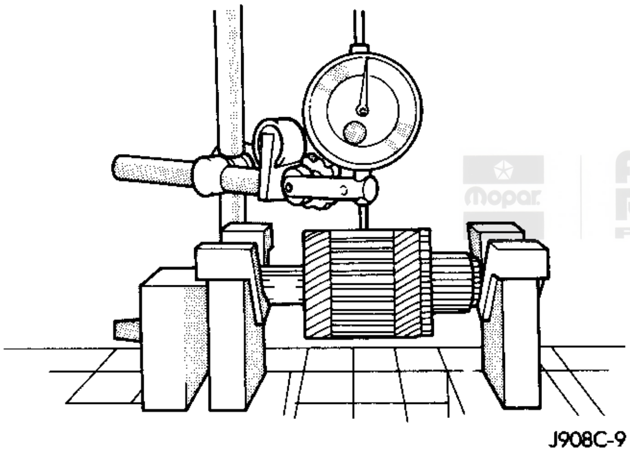


Fig. 25 Checking Armature Runout

STARTER MOTOR ASSEMBLY

Gear Drive with the Overrunning Clutch Installation

(1) Lightly oil the pinion bearing surface with **20W SAE** oil.

(2) Lightly grease the spiral spline with **Lubriplate** grease.

(3) Slide the overrunning clutch (Fig. 26) with the fork lever assembly on the drive shaft.

(4) Slide the stop ring onto the armature shaft.

CAUTION: When installing the new retainer, be careful not to scratch the armature shaft.

(5) Open the retainer and insert it into the drive shaft ring groove using pliers.

(6) Slide special tool KDAL 5028 onto the armature shaft (Fig. 27).

(7) Seat the stop ring using special tool KDAL 5487 (Fig. 27)

Overrunning Clutch and Planetary Gear Installation

(8) Lube the bearing with **20W SAE** oil.

(9) Insert the planetary gear train with the pinion (Fig. 28), overrunning clutch and fork lever into the drive end bearing housing.

The bevelled part of the ring gear points toward the bearing pedestal/relay.

(10) Insert the rubber seal.

(11) Position the cover plate (Fig. 29) on the ring gear so that the recess on the cover plate is seated in the locating lug on the ring gear.

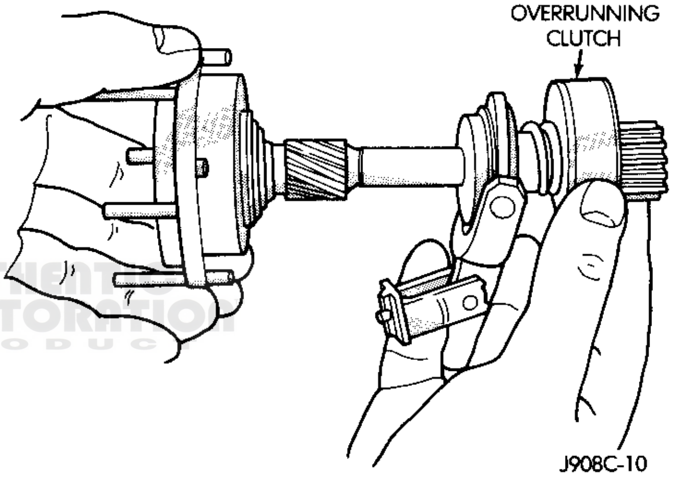


Fig. 26 Install Overrunning Clutch

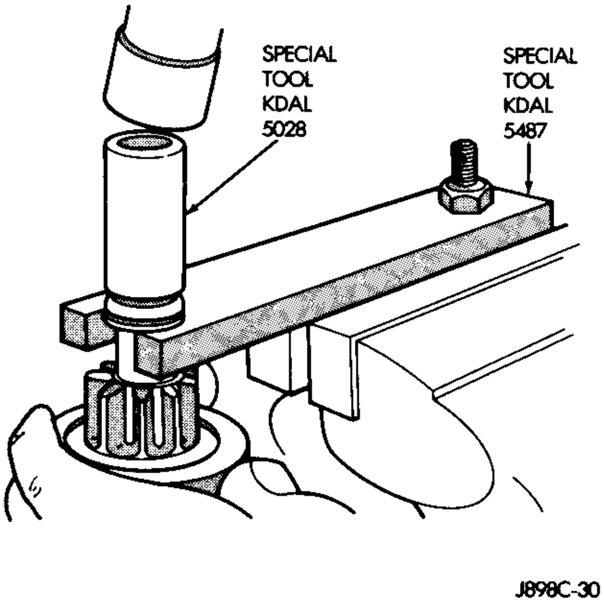


Fig. 27 Seat Stop Ring

Commutator End Shield Installation

(12) Position special tool KDAL 5048 (Fig. 30) with the brush plate, or the new brush plate with holding ring, on the armature shaft at the commutator end.

(13) Slide the brush plate over the commutator, making sure that the brush holders are properly seated in the anchor point.

(14) Remove special tool KDAL 5048, or the retaining washer.

(15) Lightly oil the gasket (felt ring) with **20W SAE** oil and slide it on the commutator end of the drive shaft.

(16) Lightly lubricate the commutator end shield bushing with **Lithium-based** wheel bearing grease.

(17) Slide the commutator end shield onto the armature shaft.

(18) Set the armature end play with one shim (Fig. 31).

(19) Insert the holding disc and check the end play. **The end play should be between 0.05 mm (0.002 in.) and 0.4 mm (0.016 in.). Three different shims are available: 1.0 mm (0.004 in.), 1.2 mm (0.047-in.), and 1.4 mm (0.055 in.).**

(20) After setting the armature end play, lubricate the retaining washer with **Lithium-based** wheel bearing grease.

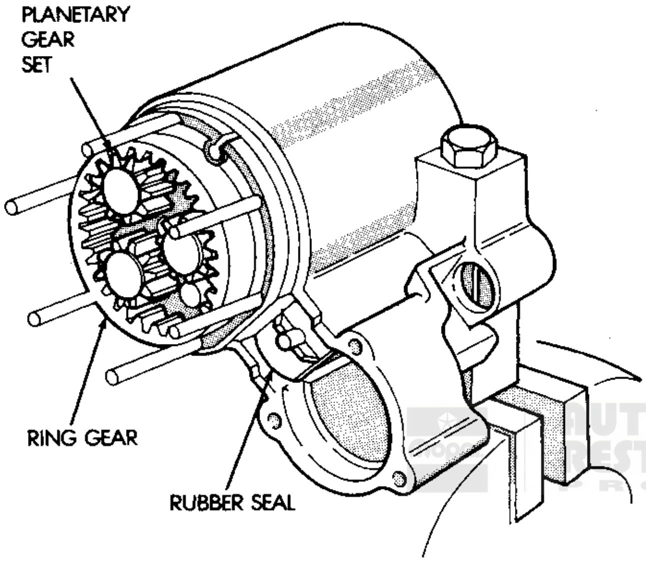


Fig. 28 Planetary Gear Installation

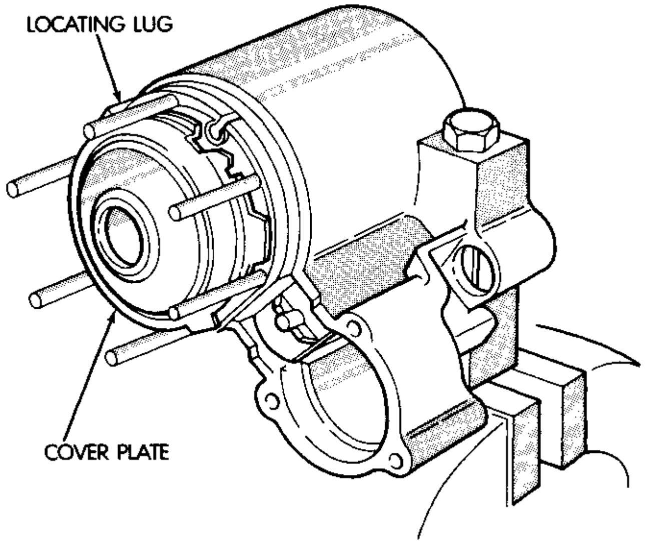


Fig. 29 Cover Plate Installation

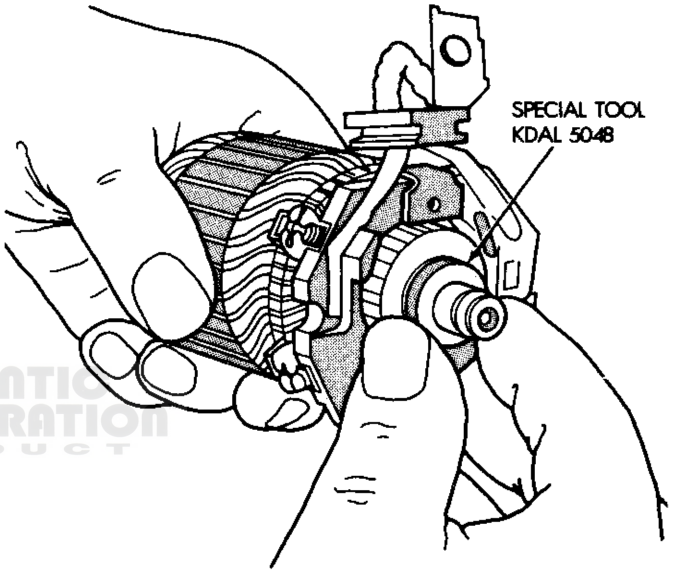


Fig. 30 Brush Plate Installation

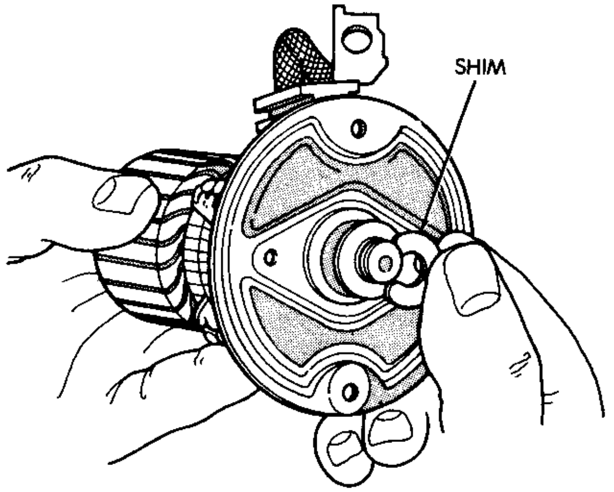


Fig. 31 Install Shim

(21) Mount the seal and closure cap (Fig. 32). Turn screws into place by hand far enough to hold the closure plate in place.

Stator Frame Installation

(22) Slide the armature with the brush plate and commutator end shield (Fig. 33) carefully into the stator frame.

(23) Fit the rubber seal on terminal 45 (brush plate) into the groove on the stator frame.

(24) Turn the pinion until the armature latches into the planet gears.

Be careful when turning the pinion. Do not use force.

(25) The groove on the stator frame fits onto the sealing rubber of the bearing pedestal.

(26) Turn the commutator end shield until the groove on the commutator end shield points to the sealing rubber.

(27) Install the hexagon head screws (Fig. 34) and tighten to 2.7-3.5 N•m (2.0- 2.6 ft-lbs) torque.

(28) Tighten the closure cap screws to 1.4-2.0 N•m (1.0-1.5 ft-lbs) torque.

Solenoid Switch Installation

(29) Hook the solenoid switch armature (Fig. 35) into the fork lever.

(30) Insert the solenoid armature return spring.

(31) Install the solenoid switch housing screws.

(32) Connect terminal 45 on the solenoid switch. Tighten nut no tighter than 2.5 N•m (22 in. lbs).

NEUTRAL SAFETY SWITCH

Refer to Group 21 for diagnostic, removal and installation procedures.

Check linkage adjustment before replacing the switch.

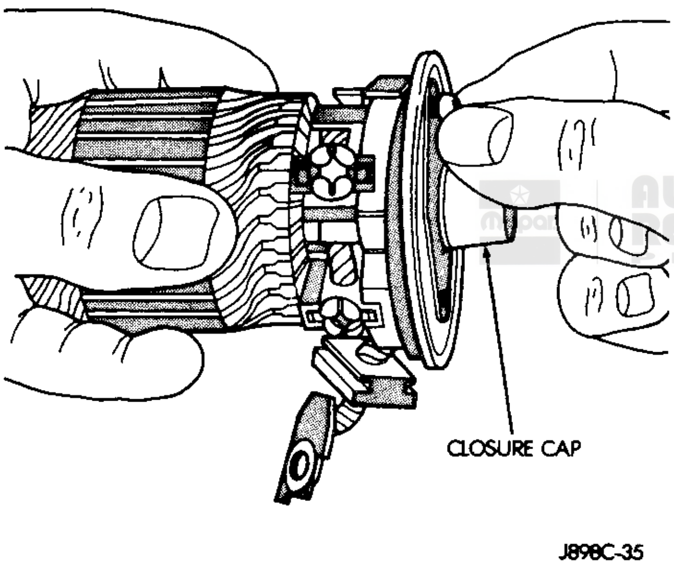


Fig. 32 Install Closure Cap

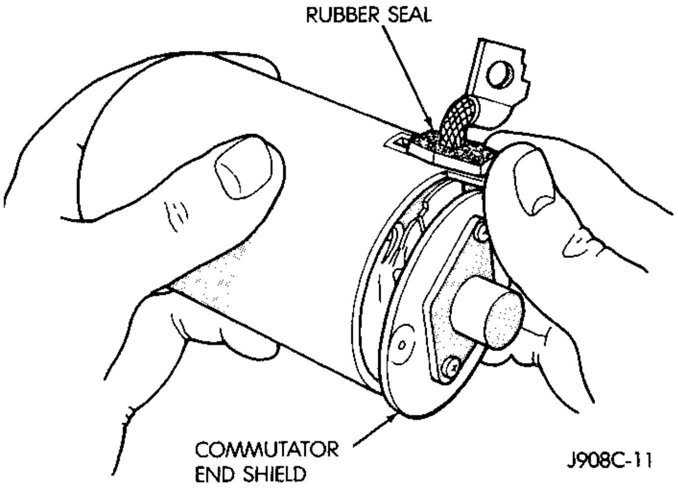


Fig. 33 Install Armature

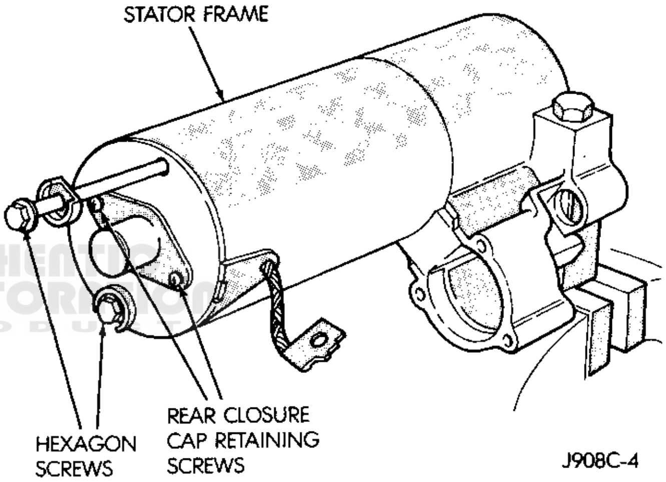


Fig. 34 Stator Frame Installation

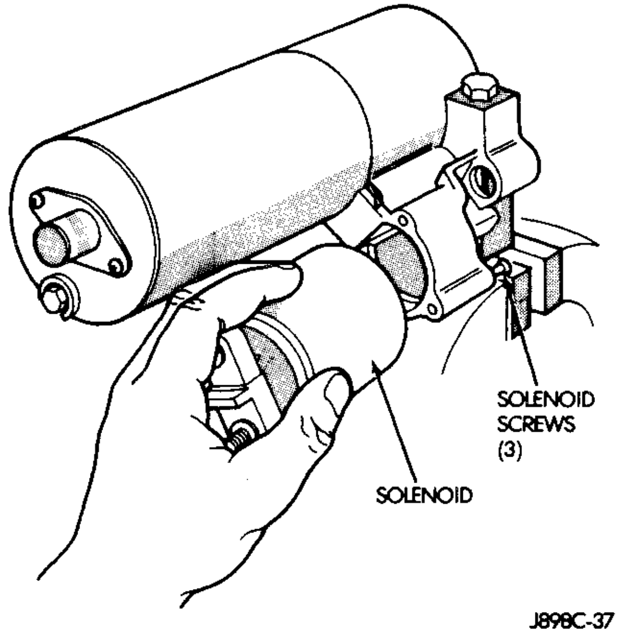


Fig. 35 Install Solenoid

4.0L, 4.2L AND 5.9L ENGINES

INDEX

SPECIFICATIONS

Torque Specifications

Component	Service Set-To Torque
Starter Motor Mounting Bolts	45 N•m (33 ft-lbs)
Starter Solenoid B+ Nut	9 N•m (80 in-lbs)
Starter Relay B+ Nut	6 N•m (55 in-lbs)

Starter Motor And Solenoid Testing Specifications

Component	Specifications
Carbon Brushes	Minimum Length-9 mm (0.354 in.)
Ring/Pinion Clearance	2-5 mm (0.078-0.196 in.)
Back lash (Meshed Ring & Pinion)	0.3-0.7 mm (0.012-0.028 in.)
Commutator Diameter	28.4 mm (1.118 in.)-29.5 (1.161 in.)
Run Out	
Commutator	0.03 mm (0.001 in.)
Armature (Core)	0.08 mm (0.003 in.)
Armature End Play	0.58 mm (0.023 in.)
No Load Test With 11.2 volts	
Max. Amps	80
Min. RPM	2500
Solenoid Hold-in Winding Voltage	3.5 Min.
Pull-in Winding Voltage	7.8 Max.

J898C-38

Starter Motor Cold Cranking Specifications

Battery Test Voltage	12.5 Volts
Cold Cranking Voltage (Min.)	9.6 Volts
Cold Cranking Amps	130 Amps

GENERAL INFORMATION

The Mitsubishi starter motor is a light-weight unit featuring a planetary gear drive and permanent magnets for current induction.

The planetary gear drive is splined to both the armature shaft and overrunning clutch. Starter torque is transmitted to the overrunning clutch pinion through the planetary gears which provide higher rotational speeds.

The starter magnetic field is produced by six permanent magnets. The magnets are mounted in the armature frame and positioned according to polarity. They are permanently attached to the frame and are not removable.

The starter motor is activated by a solenoid mounted on the overrunning clutch housing.

STARTER SERVICE INFORMATION

The Mitsubishi starter motor is a serviceable component and can be disassembled for repair.

Replaceable components include the solenoid, overrunning clutch, brushes brush holder, armature frame and magnets, overrunning clutch housing and the planetary gear drive assembly.

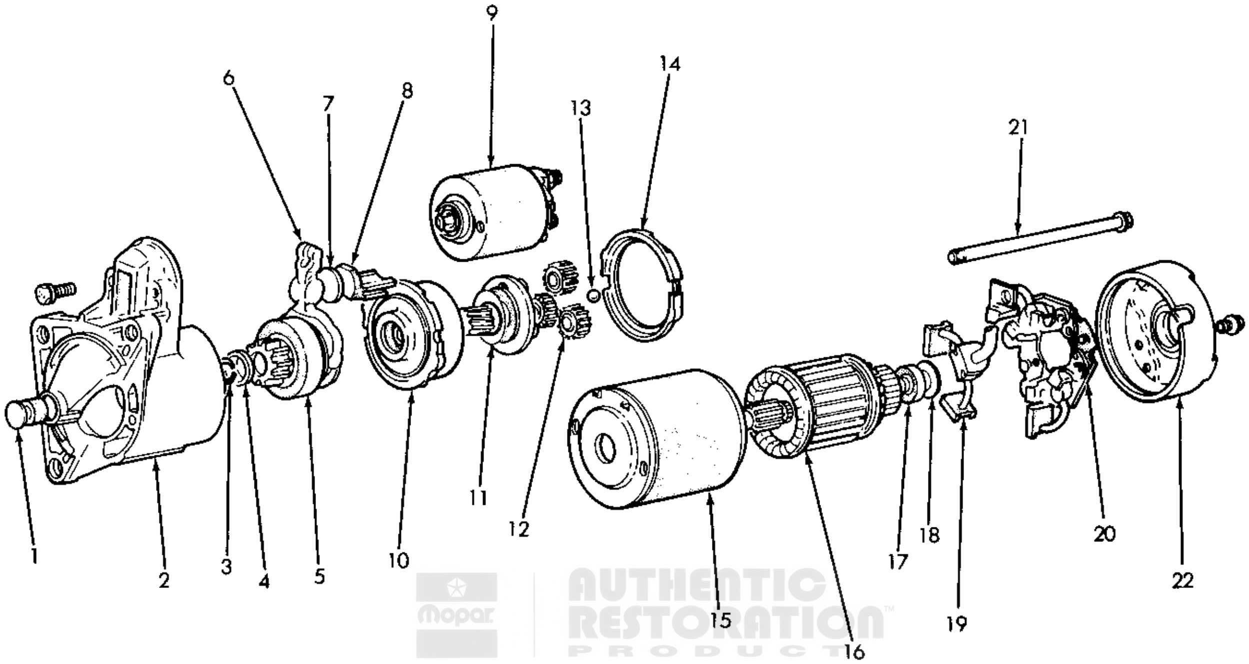
There are several precautions that must be observed when servicing this starter.

- Unlike other starter motors, this unit is highly sensitive to hammering, shocks, and external pressure.
- NEVER clamp the starter motor armature frame in a vise. Doing so may damage the magnets. It may be clamped by the mounting flange ONLY.

Do Not connect the starter motor incorrectly when electrical tests are being performed. The magnets may be damaged and seriously enough to require replacement.

Ensure cleanliness when performing repairs. Metal chips are attracted by the magnets and may not be completely removed from the stator frame. Chips in the ring gear can lead to failure of the starter.

The armature, armature frame, planetary gears, overrunning clutch drive, rubber parts and solenoid may be cleaned with compressed air. DO NOT use any liquid cleaning agent. Other components may be washed with cleaning solvents that are commercially available. DO NOT breathe the vapors.



1. BUSHING
2. OVERRUNNING CLUTCH HOUSING
3. SNAP RING
4. STOP RING
5. OVERRUNNING CLUTCH
6. CLUTCH YOKE
7. YOKE WASHER
8. RETAINER
9. SOLENOID
10. PLANETARY ANNULUS GEAR
11. PLANETARY CARRIER AND PINION SHAFT
12. PLANETARY GEARS
13. ARMATURE SHAFT BALL
14. SEAL RING
15. ARMATURE FRAME AND MAGNET ASSEMBLY
16. ARMATURE
17. BEARING
18. WASHER
19. CARBON BRUSHES
20. BRUSH HOLDER
21. ARMATURE FRAME BOLTS (2)
22. END COVER

E898C-66

Starter Motor - 4.0L, 4.2L and 5.9L Engines

STARTING SYSTEM TESTING

Cold Cranking Test

Battery must first pass load and voltage drop tests and be fully charged before proceeding.

(1) Turn volt selector knob to EXT 0-18VDC

(2) Clamp on positive load lead

(3) Clamp on AMP probe with arrow pointing in direction (A) (Fig. 1).

(4) Adjust amperes meter reading to 0, by turning zero adjusting knob.

(5) Fully engage parking brake, place manual transmission in NEUTRAL, automatic transmission in PARK.

(6) Remote crank engine as shown in the following illustration, using a remote crank switch.

(7) Remote Crank: Unplug (I) connection (Fig. 2), place one lead on I, the other on battery positive post.

(8) Depress remote crank switch. Note cranking voltage and amperage.

(9) Replace or rebuild starter motor if specifications are not met. Refer to Cold Cranking Specifications.

A cold engine will increase starter motor current.

Starter Motor Cable and Ground Cable Tests - (Voltage Drop Method)

The cable voltage drop tests will determine if there is excessive resistance in the high current circuit. When performing these tests, it is important that the voltmeter be connected to the terminals that the cables are connected to instead of to the cables themselves. For example, when testing between the battery and solenoid, touch the voltmeter test probes to the battery post and the solenoid threaded stud.

Before performing the tests, assure the following procedures are accomplished:

- ignition control module (ICM) is disconnected
- transmission in NEUTRAL (manual transmission) or PARK (automatic transmission)
- parking brake applied
- battery is fully charged (refer to Battery section)

(1) Measure between the battery positive post and the center of the B+ starter solenoid stud.

(2) Measure between the battery negative post and the engine block.

Battery cable voltage drop **MUST NOT EXCEED 0.5V MAX.** (This is measured with the engine cranking).

If test voltage exceeds 0.5 volts, clean metal surface. Apply a thick layer of silicone grease. Install a new cadmium plated bolt and star washer (brass nut on starter solenoid). Retest and replace cable if voltage is not below 0.5 volts.

Solenoid Testing

The solenoid can be tested electrically by connecting a battery of the specified voltage, a switch, and a voltmeter to the terminal for the two solenoid windings.

(1) With all wires disconnected from the solenoid, connect the test equipment to solenoid terminal 50 (Fig. 3) and to the ground to test the hold-in coil winding.

A high voltage indicates a high winding resistance. A low voltage indicates a low winding resistance.

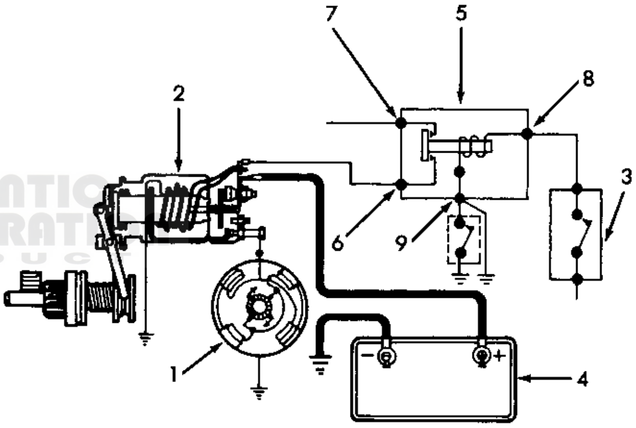
Refer to the Specifications Chart.

To test the pull-in coil winding, connect the battery across solenoid terminal 50 and solenoid motor terminal 45.

To reduce voltage to the specified value, connect the carbon pile rheostat between the battery and terminal 45.

STARTER MOTOR SIMPLIFIED CIRCUIT

(Refer to Group 8W - Wiring Diagrams for Complete Schematic)



1. STARTER
2. SOLENOID
3. IGNITION SWITCH
4. BATTERY
5. RELAY
6. SOLENOID TERMINAL
7. BATTERY TERMINAL
8. IGNITION TERMINAL
9. GROUND TERMINAL

STARTER MOTOR TESTING

Once a problem has been traced to the starter motor, proceed to the Test indicated.

With the starter motor removed from the engine, the pinion gear should be tested for freedom of operation by turning it on the screw shaft. The armature should be tested for freedom of rotation by prying the pinion gear with a screwdriver to engage it with the shaft.

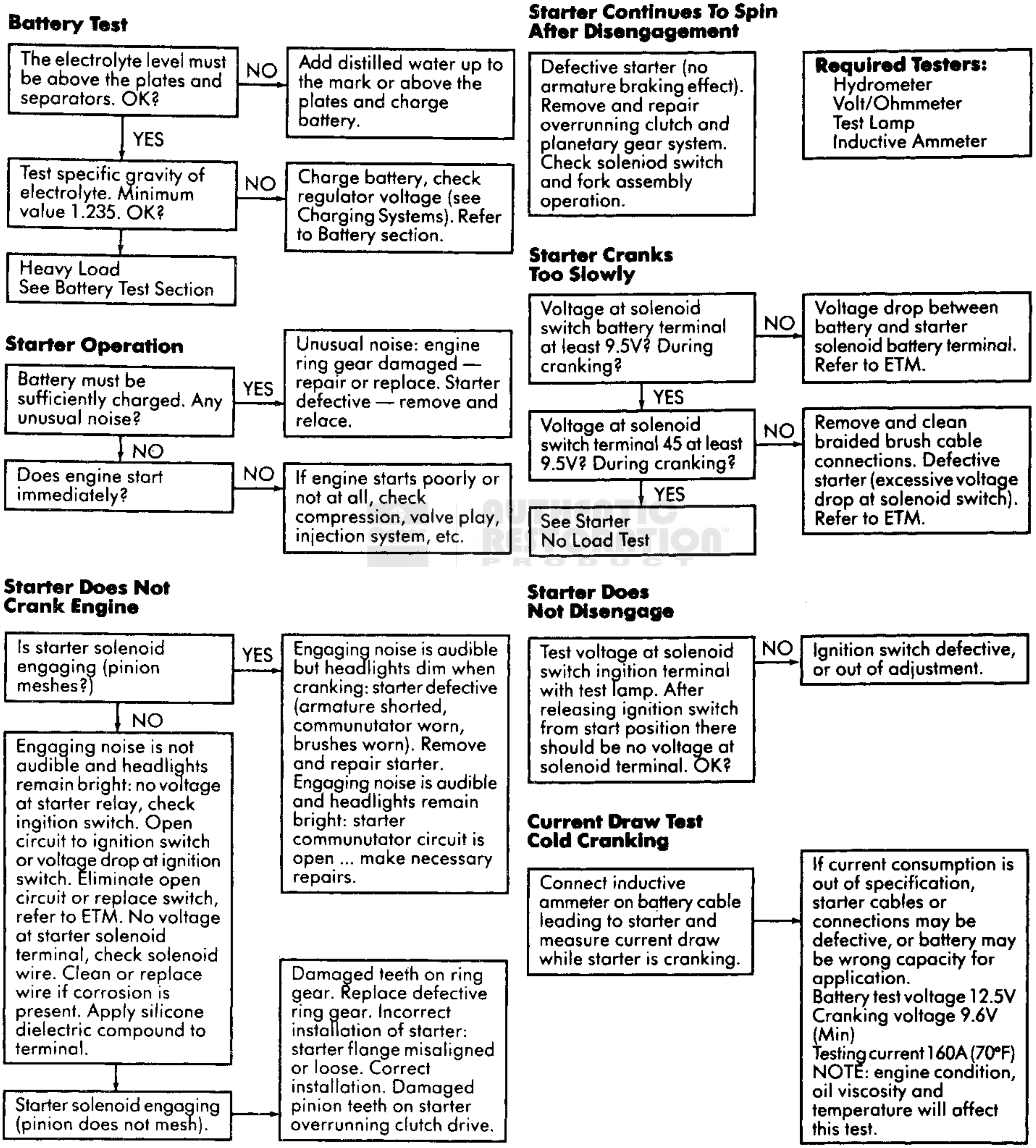
Tight bearings, a bent armature or driveshaft, or a bent frame will cause the armature to catch and not rotate freely.

If the shafts do not rotate freely, the motor should be disassembled.

If the shafts do rotate freely, the motor should be given a No-Load Test before disassembly.

No rotation and high current flow conditions indicate one or more of the following:

STARTING SYSTEM DIAGNOSIS



Battery Test

The electrolyte level must be above the plates and separators. OK?

Add distilled water up to the mark or above the plates and charge battery.

Test specific gravity of electrolyte. Minimum value 1.235. OK?

Charge battery, check regulator voltage (see Charging Systems). Refer to Battery section.

Heavy Load See Battery Test Section

Starter Operation

Battery must be sufficiently charged. Any unusual noise?

Unusual noise: engine ring gear damaged — repair or replace. Starter defective — remove and relace.

Does engine start immediately?

If engine starts poorly or not at all, check compression, valve play, injection system, etc.

Starter Does Not Crank Engine

Is starter solenoid engaging (pinion meshes?)

Engaging noise is audible but headlights dim when cranking: starter defective (armature shorted, communutator worn, brushes worn). Remove and repair starter. Engaging noise is audible and headlights remain bright: starter communutator circuit is open ... make necessary repairs.

Engaging noise is not audible and headlights remain bright: no voltage at starter relay, check ingition switch. Open circuit to ignition switch or voltage drop at ignition switch. Eliminate open circuit or replace switch, refer to ETM. No voltage at starter solenoid terminal, check solenoid wire. Clean or replace wire if corrosion is present. Apply silicone dielectric compound to terminal.

Starter solenoid engaging (pinion does not mesh).

Damaged teeth on ring gear. Replace defective ring gear. Incorrect installation of starter: starter flange misaligned or loose. Correct installation. Damaged pinion teeth on starter overrunning clutch drive.

Starter Continues To Spin After Disengagement

Defective starter (no armature braking effect). Remove and repair overrunning clutch and planetary gear system. Check soleniod switch and fork assembly operation.

Required Testers:
Hydrometer
Volt/Ohmmeter
Test Lamp
Inductive Ammeter

Starter Cranks Too Slowly

Voltage at solenoid switch battery terminal at least 9.5V? During cranking?

Voltage drop between battery and starter solenoid battery terminal. Refer to ETM.

Voltage at solenoid switch terminal 45 at least 9.5V? During cranking?

Remove and clean braided brush cable connections. Defective starter (excessive voltage drop at solenoid switch). Refer to ETM.

See Starter No Load Test

Starter Does Not Disengage

Test voltage at solenoid switch ingition terminal with test lamp. After releasing ignition switch from start position there should be no voltage at solenoid terminal. OK?

Ignition switch defective, or out of adjustment.

Current Draw Test Cold Cranking

Connect inductive ammeter on battery cable leading to starter and measure current draw while starter is cranking.

If current consumption is out of specification, starter cables or connections may be defective, or battery may be wrong capacity for application.
Battery test voltage 12.5V
Cranking voltage 9.6V (Min)
Testing current 160A (70°F)
NOTE: engine condition, oil viscosity and temperature will affect this test.

J898C-6

- connecting terminal or armature windings shorted to ground
- seized bearings (this should have been determined by rotating armature by hand)

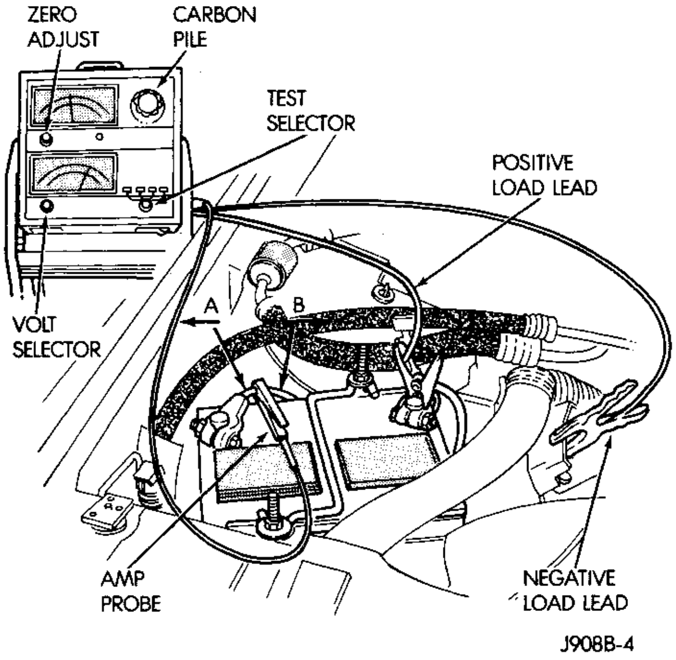


Fig. 1 Cold Cranking Test

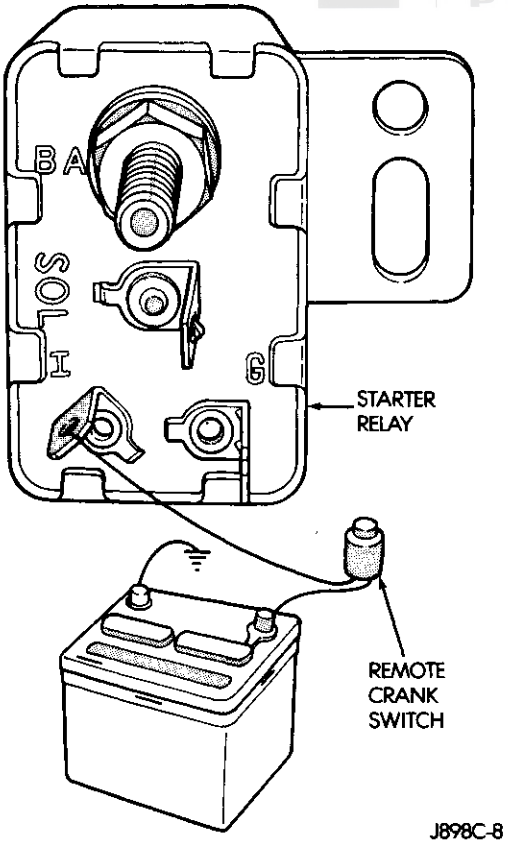


Fig. 2 Remote Crank Connection

No rotation and no current flow conditions indicate one or more of the following:

- open armature windings (inspect commutator for badly burned commutator bars after disassembly)
- broken brush springs, worn brushes, protruding insulation between commutator bars, or other causes could prevent good contact between brushes and commutator.

NO-LOAD TEST

CAUTION: Overheating, caused by excessive operation, will seriously damage the motor. Never operate the starter motor for more than a 30-second duration without pausing to allow it to cool for at least 2 minutes.

Connect a voltmeter (Fig. 4) between terminal 45 and the motor frame.

Install a mechanical tachometer on the overrunning clutch pinion shaft to measure armature speed.

Connect an ammeter between the positive post of a fully charged battery of the specified voltage and terminal 30 of the solenoid.

Connect the battery negative cable to the starter frame or housing.

Connect a test switch between terminals 30 and 50 of the solenoid. The switch should be in the open position.

Close the switch and compare the RPM, current, and voltage with those listed in the specifications.

It is not necessary to obtain the exact voltage specified because an accurate interpretation can be made by recognizing that if the voltage is slightly higher the RPM will be proportionately higher with the current remaining the same. If the exact voltage is desired, a carbon pile rheostat con-

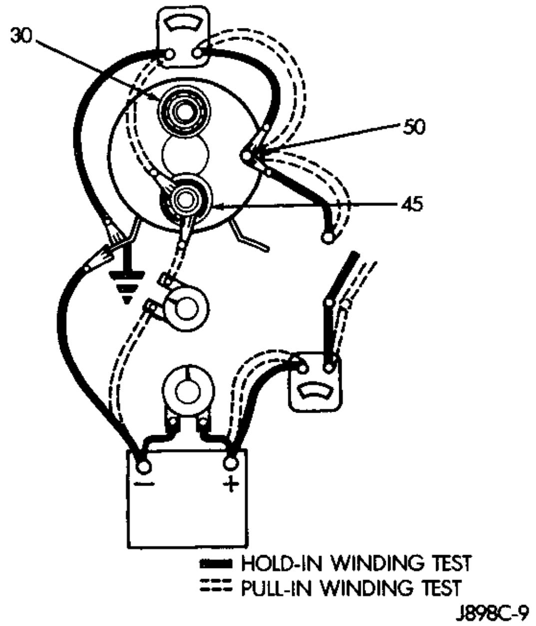


Fig. 3 Solenoid Test

nected across the battery can be used to reduce the voltage to the specified value.

The specified current flow includes the solenoid current flow.

Disconnect test connections ONLY with the switch OPEN.

Interpret the test results according to the following criteria:

Normal Conditions - The rated current flow and specified no-load speed indicate normal condition of the starter motor.

Abnormal Conditions - The low no-load speed and high current flow indicate one or more of the following conditions:

- **armature drag** - caused by excessive friction-tight, dirty, or worn bearings, bent armature shaft, or bent frame
- **shorted armature winding** - determined on growler after disassembly
- **grounded armature** - inspect further after disassembly

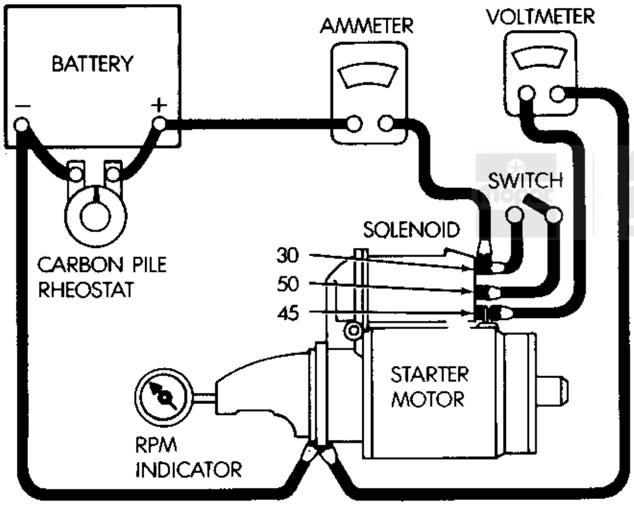


Fig. 4 Starter No Load Test

STARTER RELAY

Starter Relay Connections (Figs. 5 and 6)

Starter Relay Test

(1) Disconnect wire connectors from the I-terminal and G-terminal. Measure the resistance between the terminals with an ohmmeter. Correct resistance is approximately 22 ohms.

(2) Measure the resistance between either terminal and the battery negative post. Resistance should be infinite.

(3) If defective, replace the relay.

(4) If acceptable, connect wire connectors.

(5) Remove the SOL-terminal wire connector and connect a voltmeter between the terminal and the battery negative post.

(6) With the ignition switch in the start position, the voltmeter should indicate battery voltage (12 volts).

(7) If the battery voltage is not present, check the related wiring, bulkhead connector and ignition switch adjustment.

WARNING: CHECK TO ENSURE THAT THE TRANSMISSION IS IN PARK (AUTOMATIC TRANSMISSION) OR NEUTRAL (MANUAL TRANSMISSION) WITH THE PARKING BRAKE APPLIED BEFORE PIN G IS JUMPED.

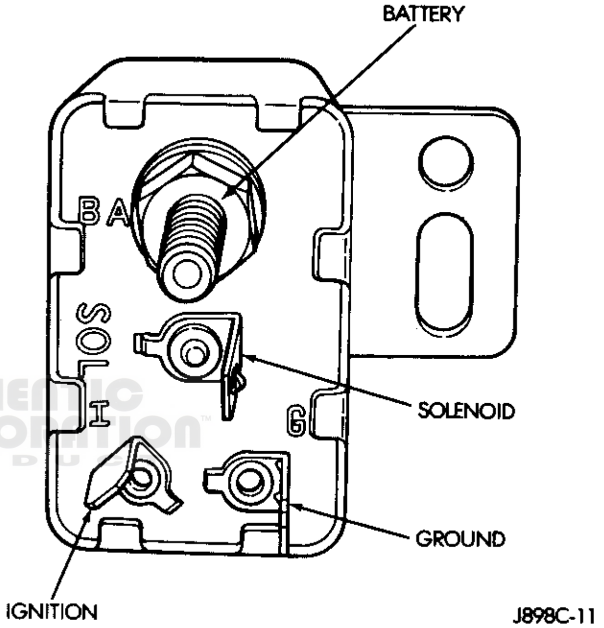


Fig. 5 SJ and YJ

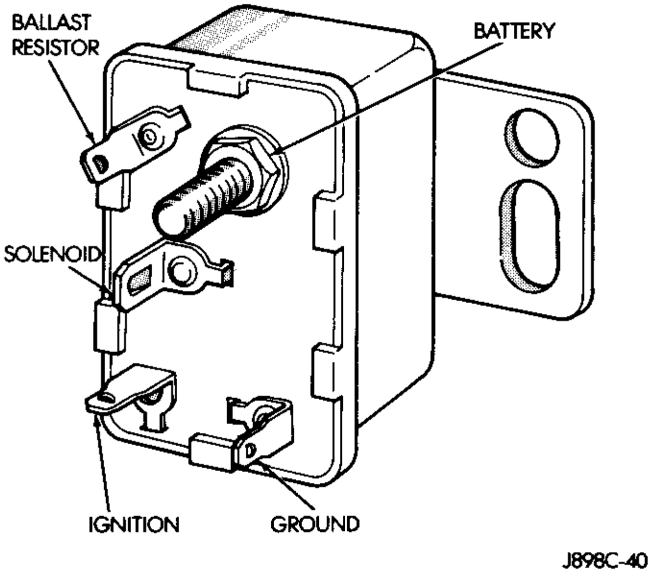


Fig. 6 XJ and MJ With 4.0L

(8) If battery voltage is present and the starter relay is not working, connect connector I and jumper terminal G to ground.

(9) If the starter relay does not click, repair the ground circuit.

Starter Relay Removal/Installation

(1) Disconnect the battery negative cable.

(2) Identify, tag and disconnect wires attached to the relay (Figs. 7, 8 and 9).

(3) Remove the relay attaching screws and the relay.

(4) Reverse the procedures for installation.

(5) Test relay operation.

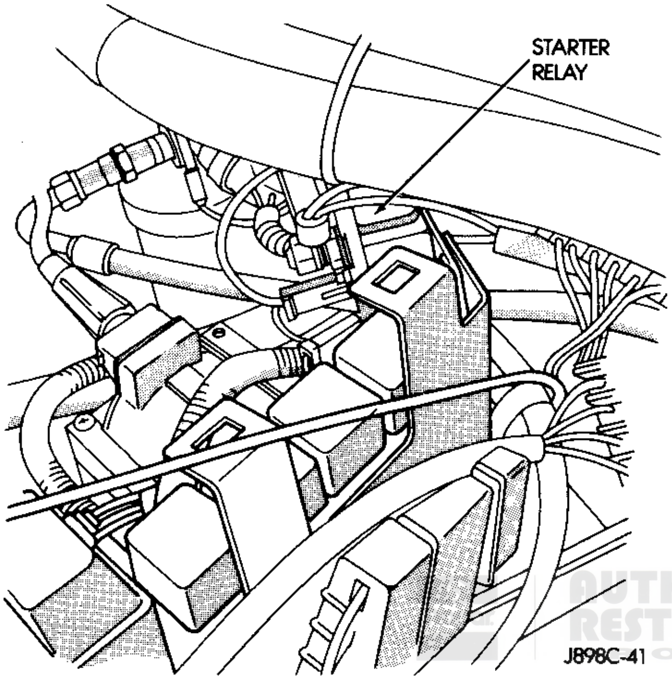


Fig. 7 Starter Relay - XJ and MJ

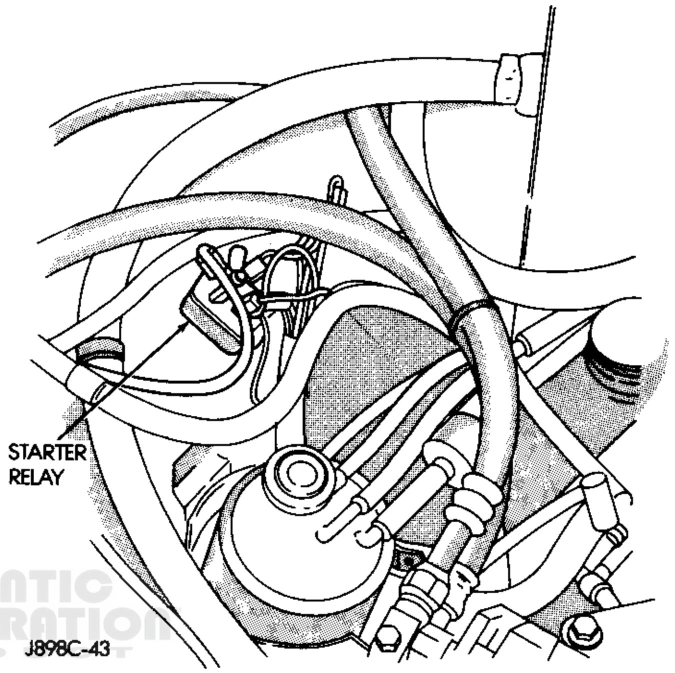


Fig. 9 Starter Relay - SJ

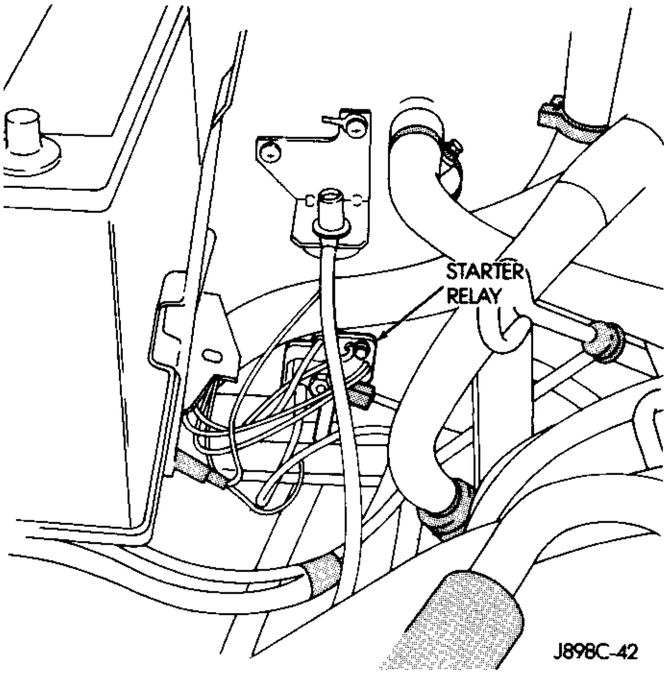


Fig. 8 Starter Relay - YJ

STARTER MOTOR REMOVAL/INSTALLATION

(1) Disconnect battery negative cable.

(2) Raise and support vehicle.

(2) Disconnect the battery wire and solenoid feed wire.

(3) Remove starter front mounting bolt (Fig. 1).

(4) Remove starter rear mounting bolt and remove starter.

(5) To install the starter motor, reverse the removal procedures and torque the mounting hardware as shown.

(6) Remove support and lower vehicle.

(7) Install battery negative cable.

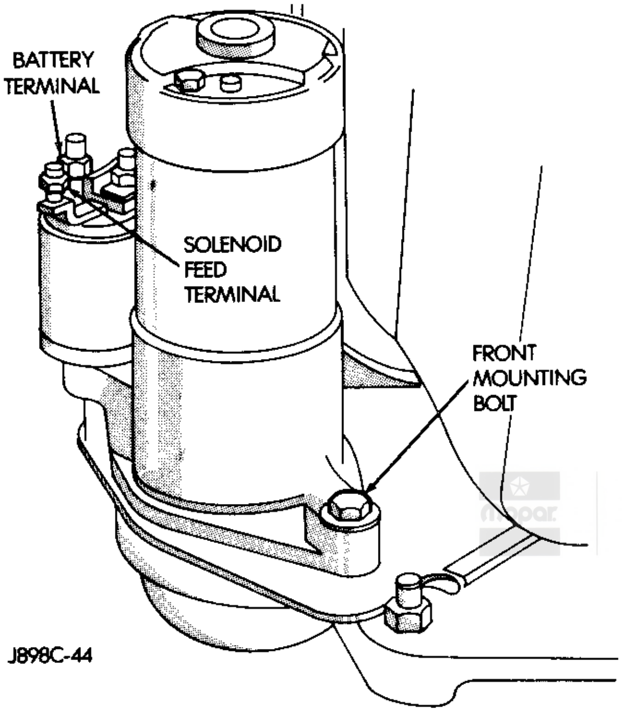


Fig. 1 Starter Motor Removal/Installation (Typical)

STARTER MOTOR DISASSEMBLY

CAUTION: Do not clamp the armature frame in a vise or strike it with a hammer during repair operations. The permanent magnets attached to the frame could be broken and the frame dented or deformed if mishandled. If the starter is to be mounted in a vise during repair, use only the mounting flange on the housing for clamping purposes.

(1) Remove the solenoid terminal nut and disconnect the brush holder connecting wire (Fig. 2).

(2) Remove solenoid screws (2) and remove the solenoid and solenoid plunger (Fig. 3).

(3) Loosen but do not remove two screws (Fig. 4) that attach the commutator shield to the brush holder plate.

(4) Remove the two armature frame through bolts.

(5) Slide the armature frame away from the overrunning clutch housing and remove retainer and washer.

(6) Remove the overrunning clutch housing from the armature frame (Fig. 5).

Do not lose the armature shaft ball when removing the stator frame.

(7) Remove the clutch fork from the overrunning clutch (Fig. 6).

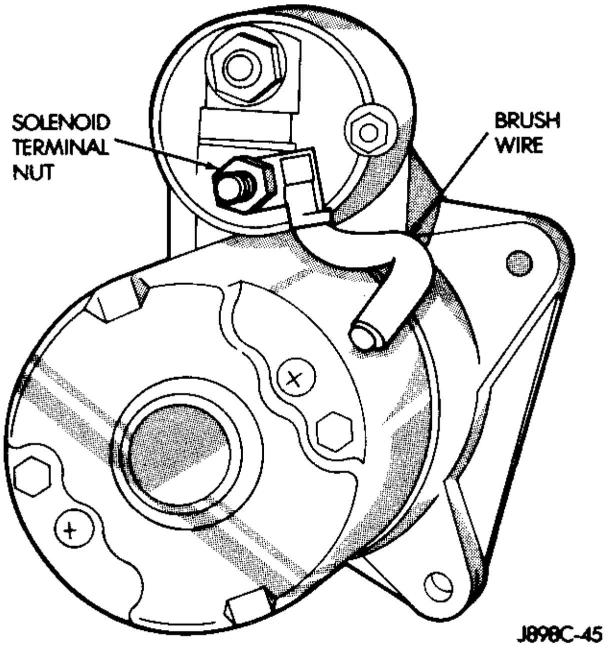


Fig. 2 Remove Brush Wire

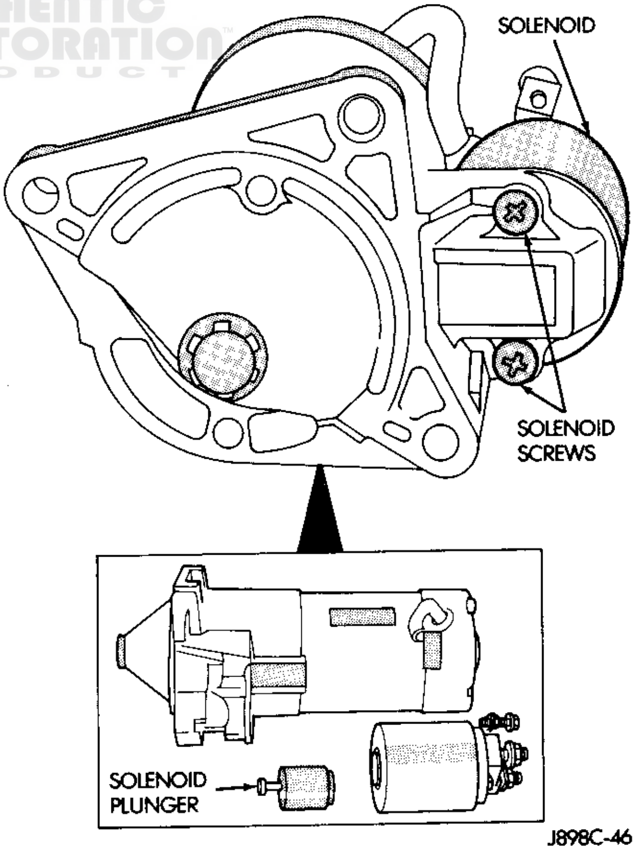


Fig. 3 Solenoid Removal

(8) Remove the overrunning clutch and from the armature (Fig. 7).

(9) Remove the two screws (Fig. 4) attaching the end cover to the armature. Remove the cover but do not remove the brush holder plate (Fig. 8).

(10) Remove the brush feed wire by sliding the wire and wire connector out of the cover.

(11) Install a 22 mm socket on the armature shaft.

(12) Slide the socket up against the armature commutator (Fig. 9). Then slide the brush holder onto the socket. Leave the socket in position in the brush holder for inspection and assembly.

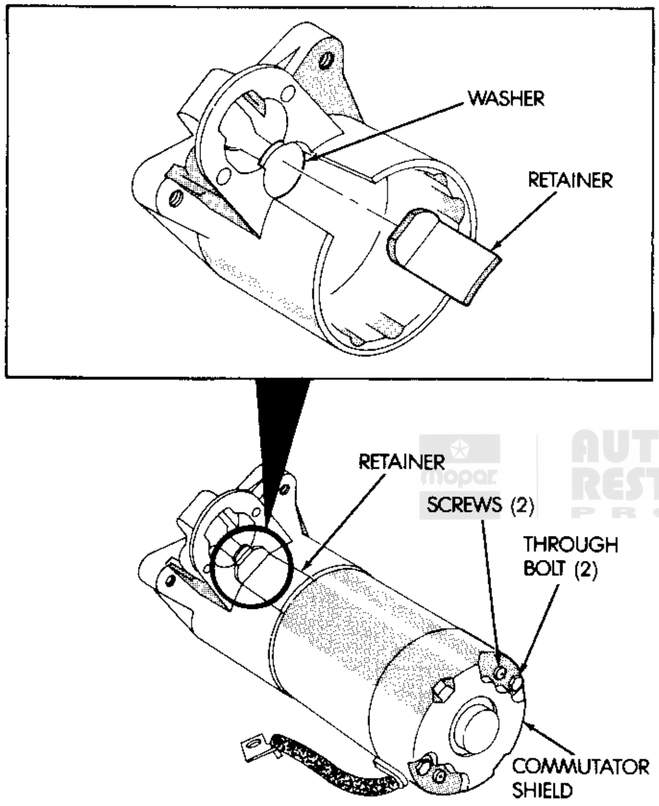


Fig. 4 Armature Frame Removal

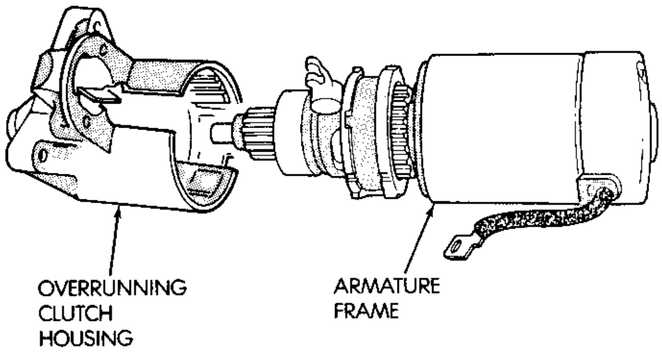


Fig. 5 Remove Overrunning Clutch Housing

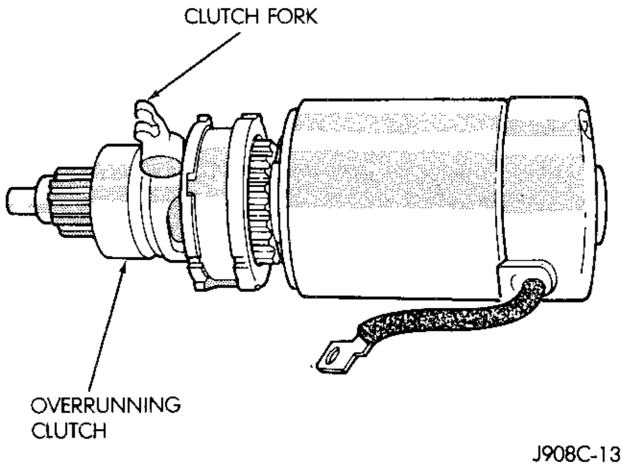


Fig. 6 Remove Clutch Fork

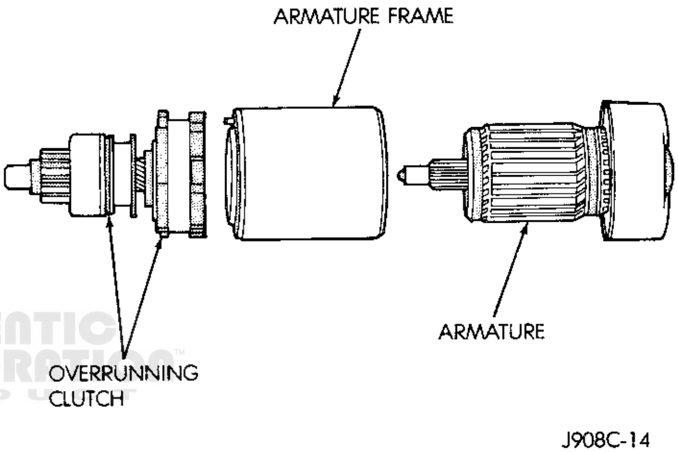


Fig. 7 Remove Armature

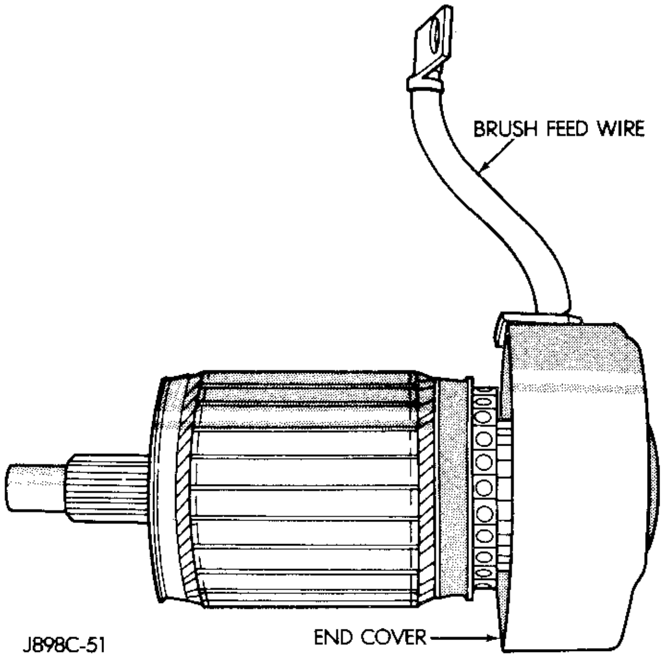


Fig. 8 Remove End Cover

(13) Remove the seal ring (Fig. 10) from the planetary gear assembly.

(14) Remove the planetary gears.

(15) Remove the gear carrier and pinion shaft from the planetary annulus gear.

(16) Place a 17 mm socket (Fig. 11) on the workbench. Place the planetary gear/overrunning clutch assembly in a vertical position (on end), so the entire assembly rests on the socket.

(17) Unseat the stop ring using a 12 point 14 mm socket. Install the socket on the pinion shaft and against the stop ring. Then strike the socket with a hammer to unseat the stop ring and expose the snap ring.

(18) Remove the 14 mm socket from the pinion shaft.

(19) Remove the snap ring and stop ring (Fig. 12) from the drive shaft.

(20) Remove overrunning clutch from pinion shaft.

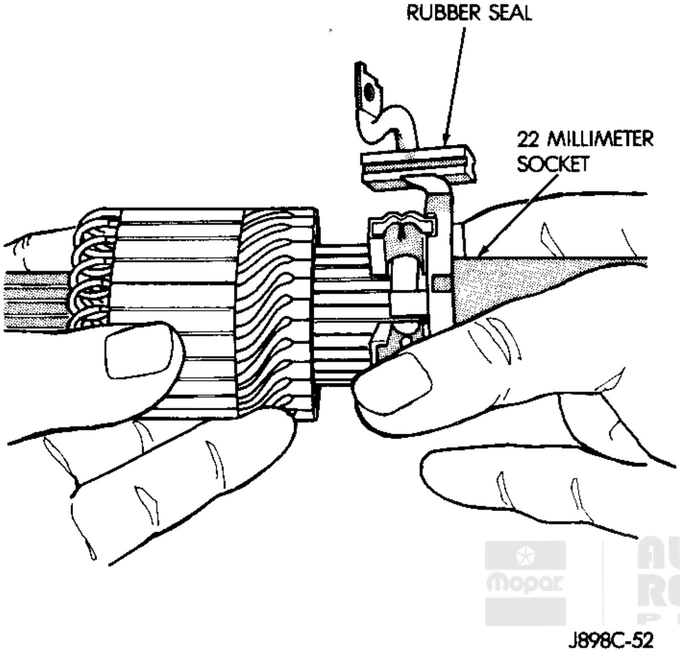


Fig. 9 Remove Brush Holder

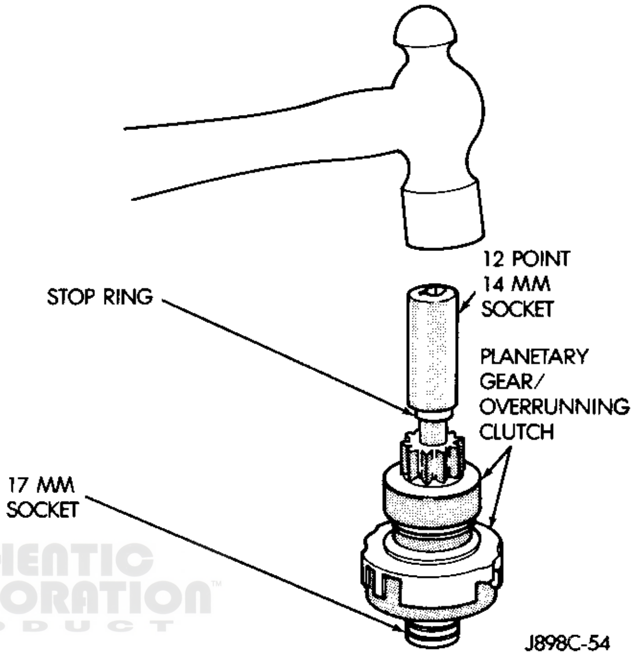


Fig. 11 Unseat Stop Ring

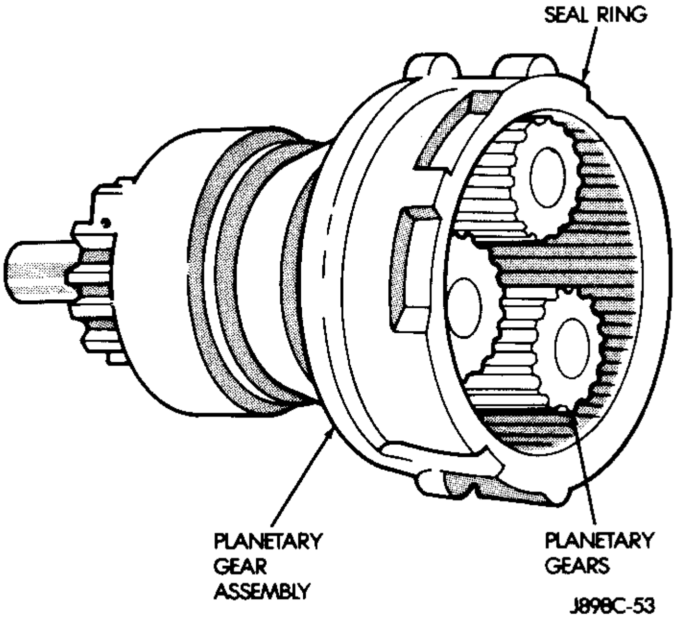


Fig. 10 Remove Planetary Gears

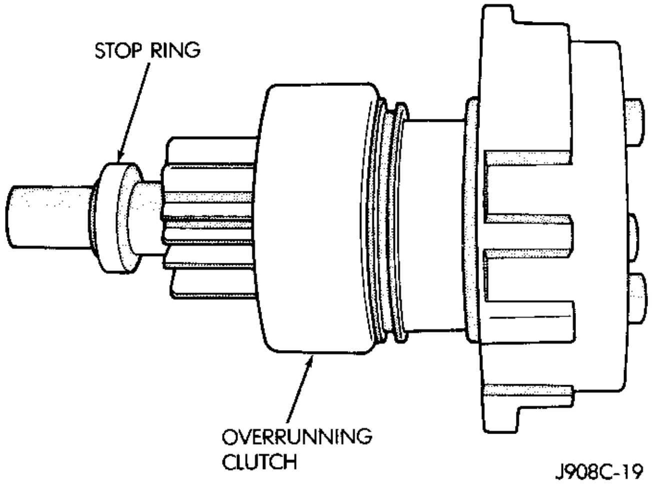


Fig. 12 Remove Snap Ring and Overrunning Clutch

STARTER MOTOR CLEANING and INSPECTION

Cleaning

Clean the armature, armature frame, overrunning clutch, solenoid, and brush holder assembly must only be cleaned with clean, dry cloths or compressed air. Do not use any liquid solvents on these components. All other starter components may be cleaned with mineral spirits or similar solvents.

Inspection

Inspect the stator frame and permanent magnets for damage. Do not remove the magnets from the stator frame. They are permanently attached. If the frame or magnets are damaged replace them as an assembly.

Inspect condition of the bushing in the armature end of the drive shaft.

Replace the planetary gear assembly and pinion shaft if worn or damaged.

Inspect the armature shaft bushing and bearing. Replace either part if worn. If the bushing or bearing has worn to the point where armature-to-frame contact has occurred, replace the starter motor as an assembly. Do not remove the socket unless assembly is to be replaced.

Inspect the brushes and brush holder. Replace the brushes if damaged or worn below the minimum length of 9 mm (0.035 in.) Replace the brush holder if cracked, bent, or distorted. Do not remove the socket from the brush holder unless the holder must be replaced.

ARMATURE TESTING

Armature Ground Test

Place the armature in the growler jaws and turn the power switch to TEST position.

Touch one test lead to the armature core (Fig. 1). Touch the other lead to each commutator bar and observe the test lamp. The test lamp should not light. If the test lamp lights on any bar, the armature has a short circuit to ground and must be replaced.

Armature Short Test

CAUTION: To avoid damaging the growler, do not operate the growler unless an armature is mounted in the growler jaws.

Place the armature in the growler jaws and turn the power switch to GROWLER position (Fig. 2).

Position the growler steel blade parallel to and touching the armature core (Fig. 2). Slowly rotate the armature one or more revolutions in the growler jaws. If the steel blade vibrates at any area of the core, the windings have a short circuit and the armature must be replaced.

Armature Balance Test

Place the armature in the growler jaws and turn the power switch to GROWLER position.

Place the contact fingers of the meter test lead across adjacent commutator bars (Fig. 3).

Adjust the voltage control until the pointer indicates highest voltage on scale.

Test each commutator bar with the adjacent bar until all have been tested. Zero voltage at any commutator bar indicates a short circuit in the pair being tested. The armature must be replaced if a short is discovered.

Armature Runout

Check the runout (Fig. 4) of the armature core and commutator as specified in Specifications.

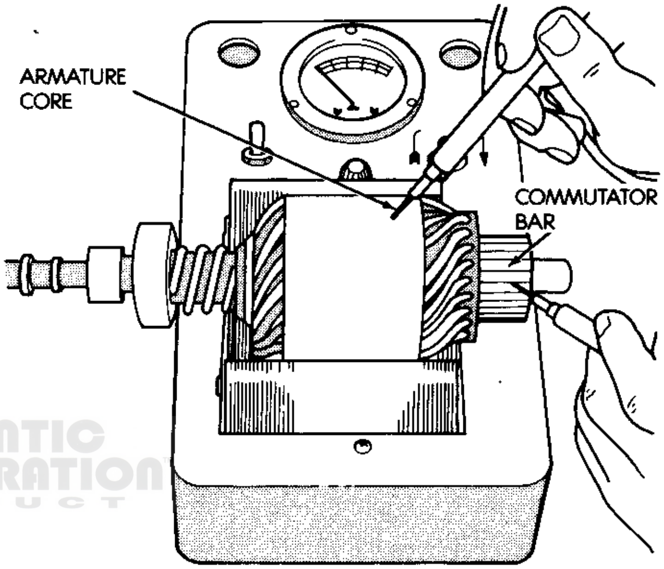


Fig. 1 Armature Ground Test

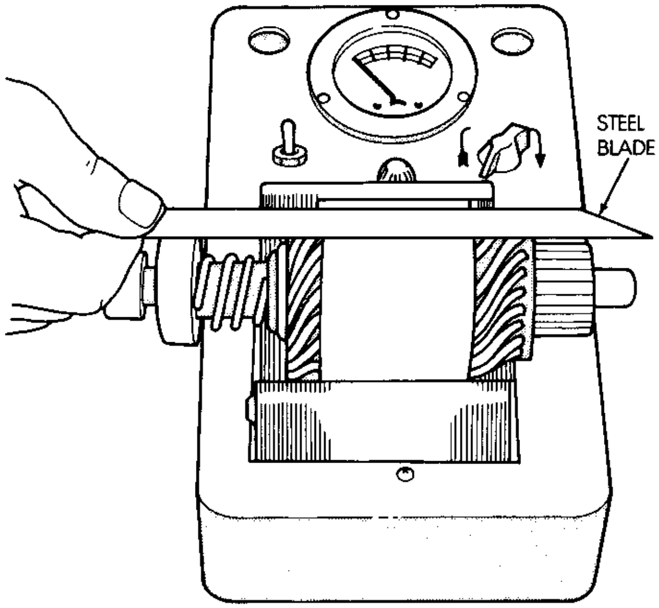


Fig. 2 Armature Short Test

Replace starter motor with remanufactured unit if it is not within specifications.

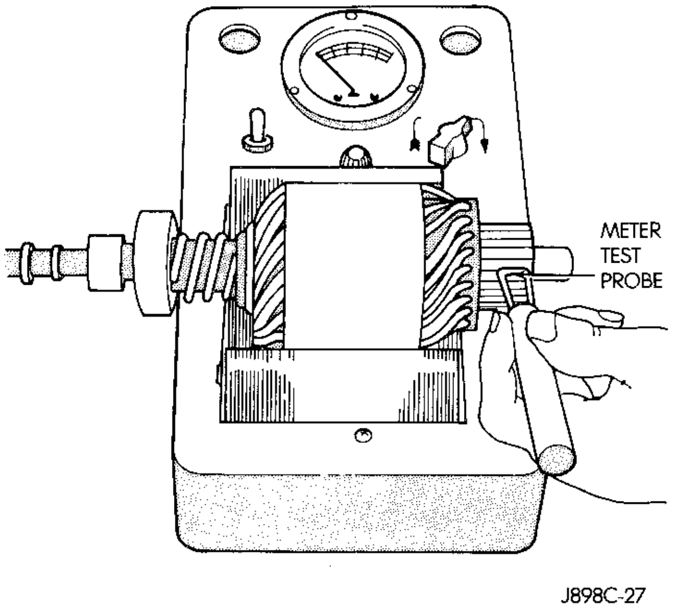


Fig. 3 Armature Balance Test

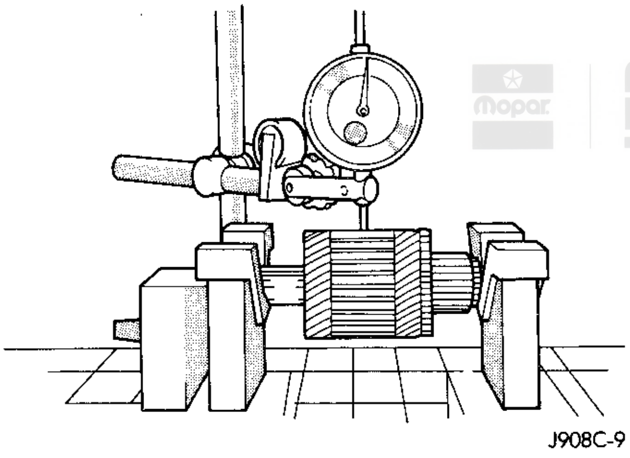


Fig. 4 Checking Armature Runout

STARTER MOTOR ASSEMBLY

(1) Install the planetary annulus gear (Fig. 1) on the gear carrier and pinion shaft.

(2) Lubricate the drive shaft and the bushing in the overrunning clutch with SAE 20W motor oil.

(3) Lubricate the spiral splines in the overrunning clutch bore with a coating of Lubriplate.

(4) Install the overrunning clutch (Fig. 2) on the pinion shaft.

(5) Install stop ring and snap ring on the pinion shaft as follows:

- Install the stop ring on the pinion shaft. Slide the stop ring past the snap ring groove.
- Expand and install the snap ring on the pinion shaft. Position the snap ring in the shaft groove and crimp the snap ring in place.
- Place battery terminal puller as shown (Fig. 3) and pull the stop ring against the snap ring.
- Check snap ring-to-stop ring alignment. If necessary, tap the snap ring with a screwdriver until aligned in the stop ring.
- Tighten the puller to seat the stop ring on and over the snap ring.

CAUTION: Do not scratch the drive shaft when installing the snap ring.

(6) Inspect the pinion shaft bushing surface (Fig. 4) after installing the snap and stop rings. Remove any small scratches or burrs on the drive shaft with crocus cloth or 400-600 grit sandpaper.

(7) Lightly lubricate the bushing in the overrunning clutch housing with SAE 20W oil.

(8) Slide on the clutch fork (Fig. 4) on the overrunning clutch.

(9) Install the planetary/overrunning clutch assembly in the overrunning clutch housing (Figs. 5 and 6).

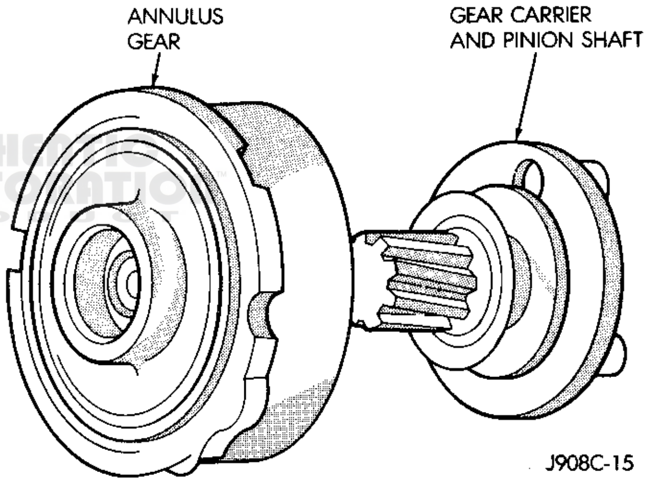


Fig. 1 Planetary Gear Assembly

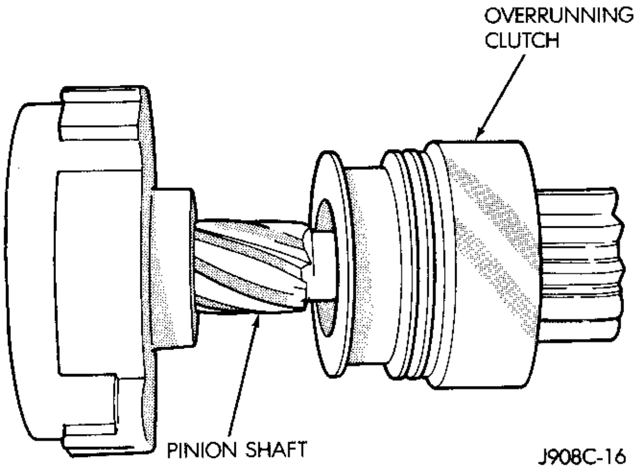


Fig. 2 Install Overrunning Clutch

(10) Be sure the locating lugs on the planetary annulus are properly aligned and seated in the housing.

(11) Lubricate the planetary gears with chassis grease and install the three gears on the planetary carrier shafts.

(12) Install the seal ring on the overrunning clutch housing. Position the largest lug on the seal ring at the top.

(13) If replacement brushes were installed in the holder, reinsert the socket (Fig. 7) through the brush holder to keep the brushes in position.

(14) Position the socket against the armature commutator (Fig. 8). Then slide brush holder and brushes on to the commutator and remove the socket.

(15) Verify that the brushes and brush retainers are seated in the holder.

(16) Install the bearing and washer on the armature shaft if not previously installed.

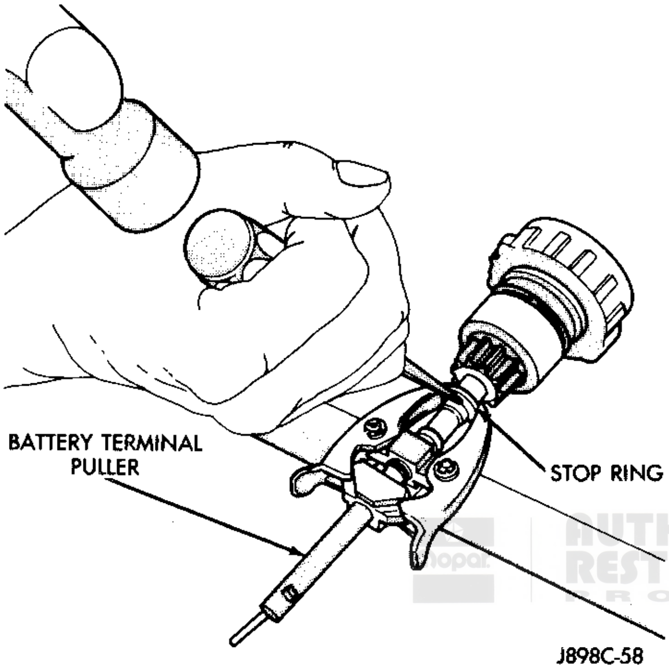


Fig. 3 Install Stop Ring

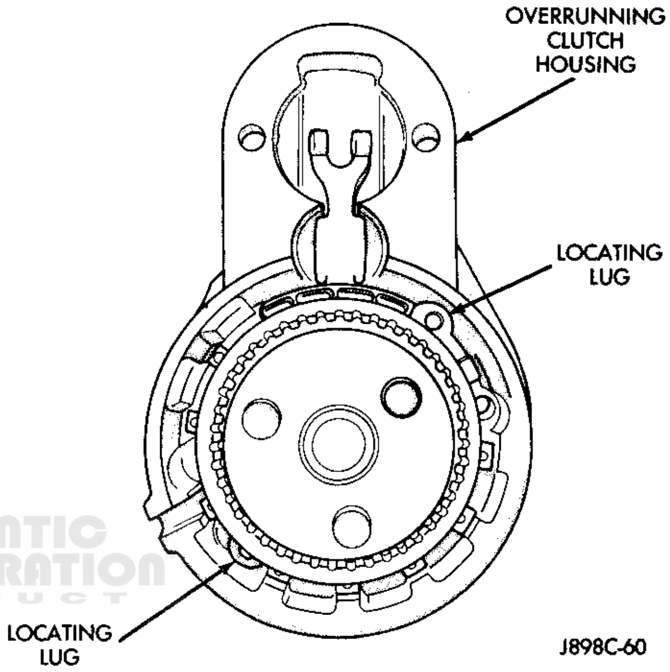


Fig. 5 Install Planetary/Overrunning Clutch

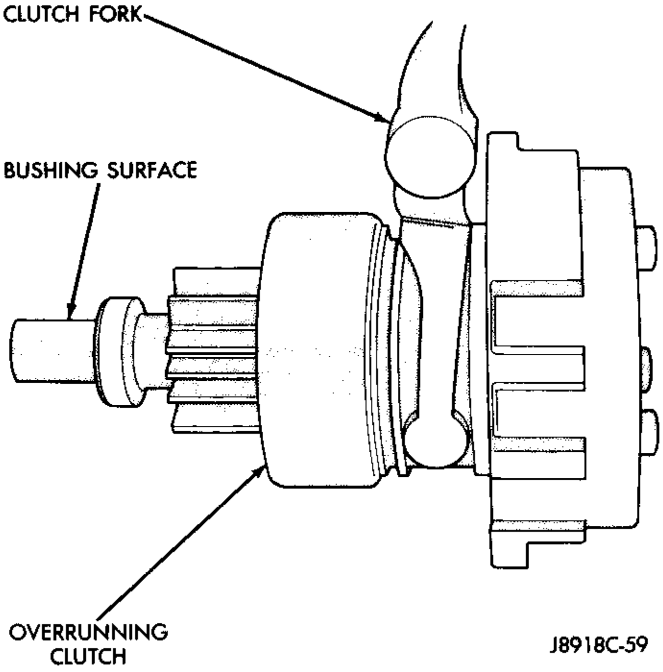


Fig. 4 Install Clutch Fork

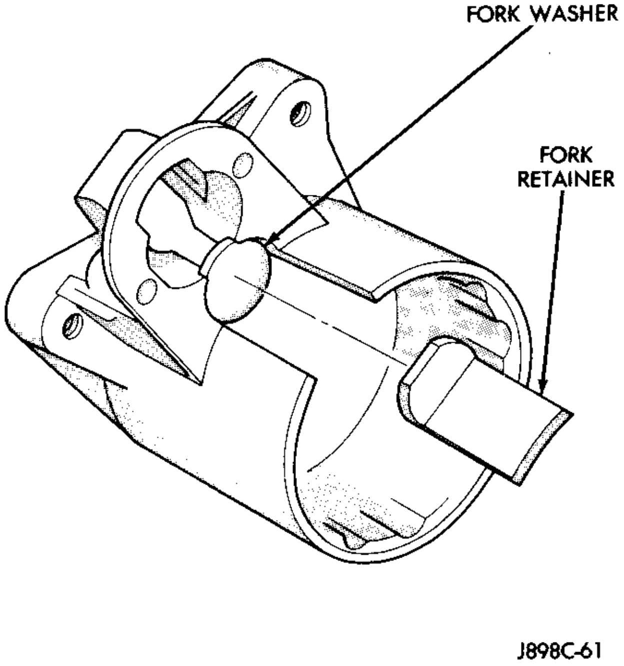


Fig. 6 Install Fork Washer and Fork Retainer

(17) Position the end cover (Fig. 9) on the brush holder.

(18) Align the brush connector wire and grommet in the end cover and push the cover into place.

(19) Install but do not tighten the brush holder screws.

(20) Install the armature frame (Fig. 10) on the assembled armature, brush holder and shield. Be sure to align and seat the brush connector wire grommet in the frame during installation.

(21) Install the ball in the splined end of the armature shaft. Use chassis grease to hold the ball in place if necessary.

(22) Install the armature and frame (Fig. 11) on the clutch housing. Rotate the armature frame until the alignment tabs on the frame seat in the clutch housing slots.

Be sure the armature shaft splines are seated in the planetary gears and the armature shaft is seated in the planetary bushing bore.

(23) Install the bolts that attach the armature frame to the overrunning clutch housing. Tighten the bolts to 3 N•m (28 in. lbs) torque.

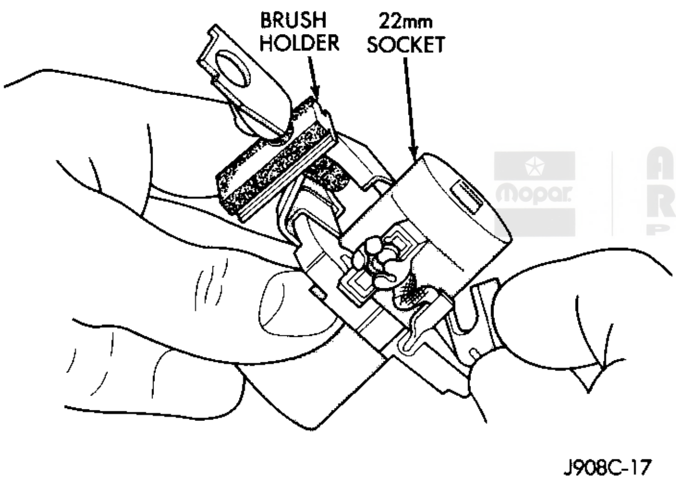


Fig. 7 Install Socket in Brush Holder

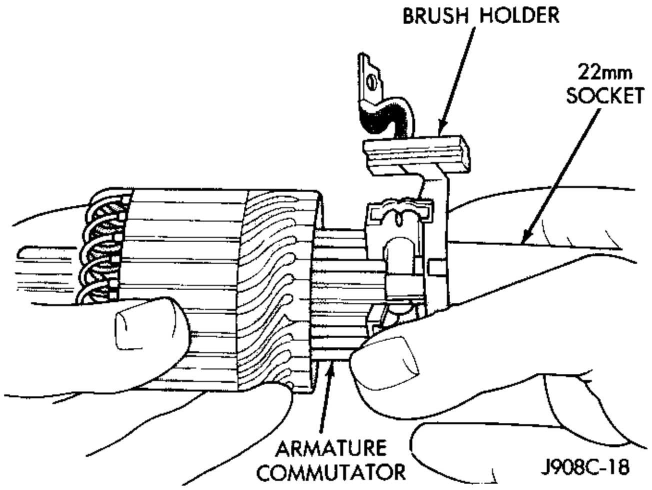


Fig. 8 Install Brushes Onto Commutator

(24) Tighten the brush holder attaching screws to 2 N•m (18 in. lbs) torque.

(25) Install the solenoid on the housing as follows:
- Engage the solenoid plunger in the clutch fork.
- Install the plunger return spring, spacer washer and the solenoid housing.
- Install and tighten the solenoid attaching screws.
- Attach the brush connecting wire to terminal 45 of the solenoid.

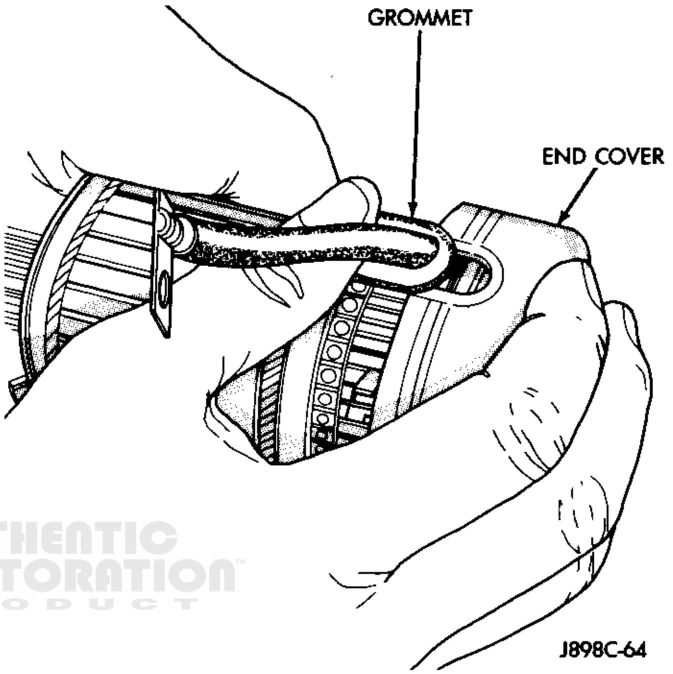


Fig. 9 Install End Cover

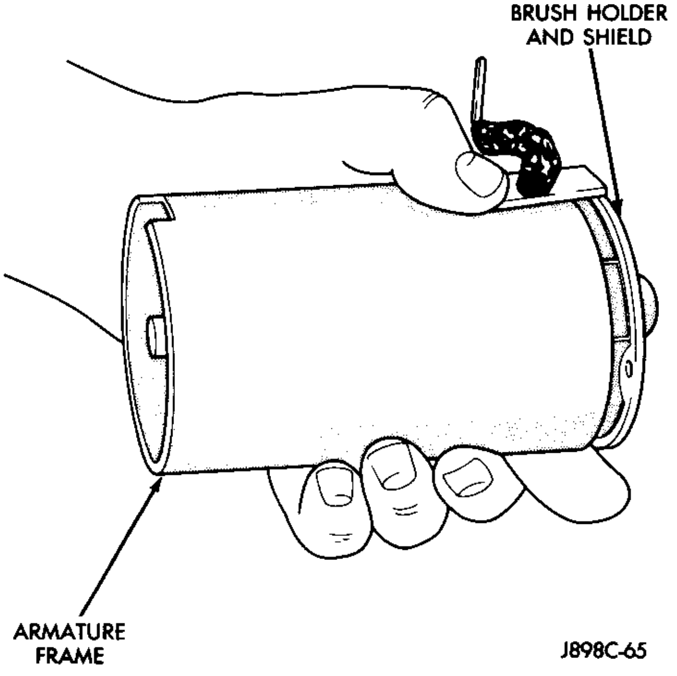


Fig. 10 Install Armature Frame

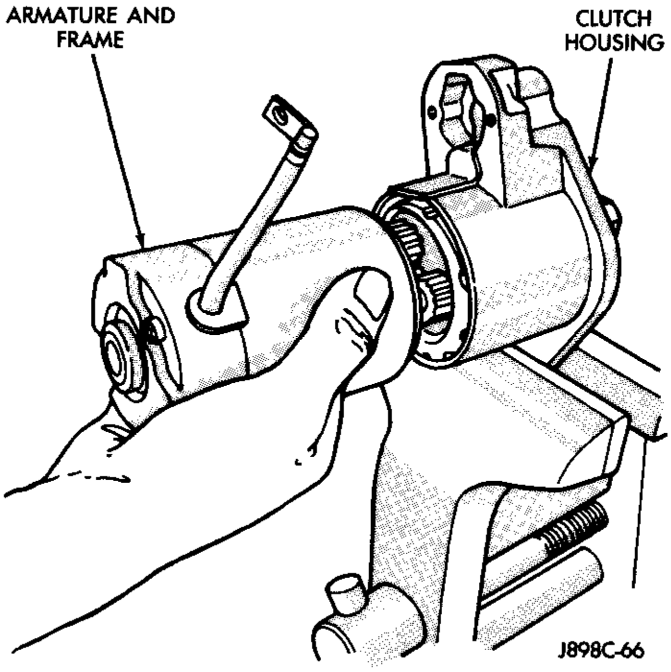


Fig. 11 Final Assembly

NEUTRAL SAFETY SWITCH

Refer to Group 21 for diagnostic, removal and installation procedures.

Check linkage adjustment before replacing the switch.

CHARGING SYSTEM

CONTENTS

XJ AND MJ

INDEX

SPECIFICATIONS

Output Specifications (Figs. 1 and 2)

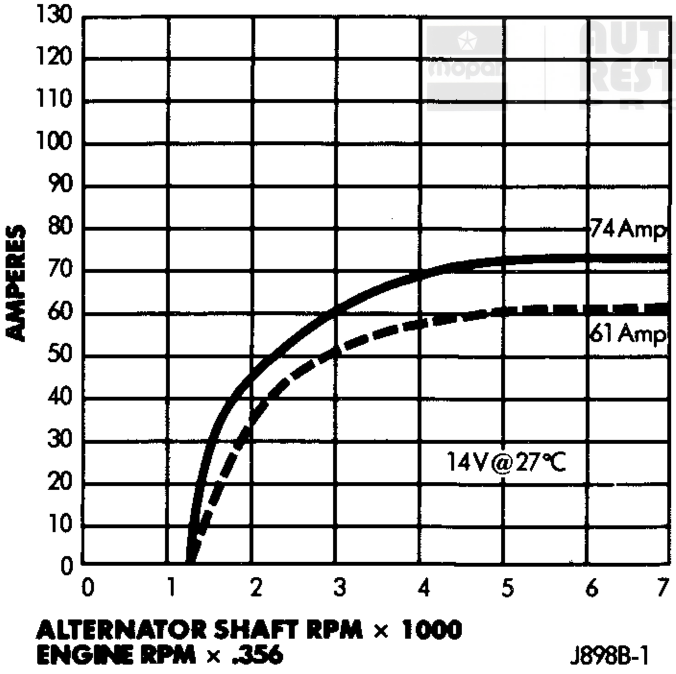


Fig. 1 CS 121 Output Specifications

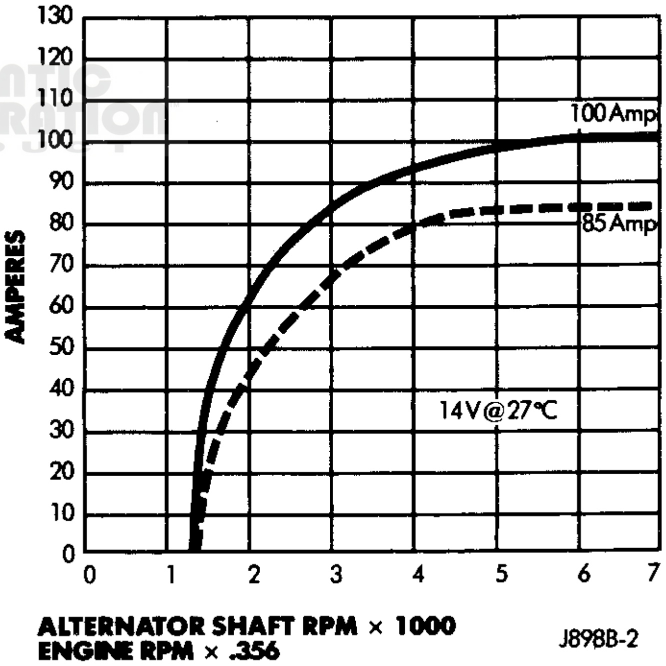


Fig. 2 CS 130 Output Specifications

Torque Specifications

Component	Service Set-To Torque	Service Recheck Torque
Alternator Mounting Bolts	38 N•m (28 ft-lbs)	31-41 N•m (23-30 ft-lbs)
Power Steering Pump Mounting Bolts	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)

Belt Tension

Engine	New Belt N(lbs-f)	Used Belt N(lbs-f)
4.0L & 2.5L	800-900 (180-200)	623-712 (140-160)

GENERAL

The amount of dc voltage produced by the alternator is controlled by the solid state regulator. A diode trio is not used. A feature of the regulator is that it will cause the charge indicator to be on with the engine running if the system voltage is too high or too low.

The alternator is belt-driven by the engine. The 4 cylinder engine utilizes two different drive belt configurations. The base unit incorporates a 61 AMP alternator with single pulley drive. The 4 cylinder with air conditioning incorporates serpentine drive with a 74 AMP alternator. The 6 cylinder package utilizes a dual pulley drive with a 61 AMP alternator standard and 85 AMP and 100 AMP rating as optional equipment.

OPERATIONAL CHECK WITH BATTERY INDICATOR

When operating normally, the indicator bulb will come on when the ignition switch is turned to the RUN or START position. After the engine starts, the indicator bulb goes off. With the engine running, the charge indicator should come on only when there is a problem in the charging system.

OPERATIONAL CHECK WITH VOLTMETER

When the ignition switch is turned to the RUN position, battery potential will register on the voltmeter. During engine cranking a lower voltage will appear on the meter. With the engine running, a voltage reading higher than the first reading (ignition in RUN) should register.

DIAGNOSTIC PROCEDURES

If the indicator operates abnormally, or if an undercharged or overcharged battery condition occurs, the following procedure may be used to diagnose the charging system.

Remember that an undercharged battery is often caused by accessories being left on overnight, or by a defective switch which allows a bulb, such as a trunk or glove box light, to stay on. This alternator does not have a test hole.

Visual Inspection

TEST	OK	NOT OK
Inspect condition of battery cable terminals, battery posts, connections at engine block, starter motor solenoid and relay	Clean and tight	Repair as required
Inspect all fuses in the fuse block for tightness in receptacles	Properly installed and tight	Repair or replace as required
Inspect the electrolyte level in the battery and add water if necessary	Battery passes test	Charge or replace battery as required
Inspect alternator mounting bolts for tightness	Properly torqued (refer to Torque Specifications)	Replace or torque bolt as required (refer to Torque Specifications)
Inspect alternator drive belt condition and tension	Drive belt serviceable	Tension or replace belt as required Refer to Belt Tension Specifications
Inspect connection at alternator B+ output	Clean and tight	Repair as required

Alternator Connections Test

Switch on, engine stopped, light should be on. If not, detach harness at alternator ground "L" terminal lead.

- Lamp lights, replace or repair alternator.
- Lamp does not light, locate open circuit between grounding lead and ignition switch. Bulb may be open.

Switch on, engine running at moderate speed. Light should be off. If not, detach wiring harness at alternator.

- If light goes off, replace or repair alternator.
- If light stays on, check for grounded "L" terminal wire in harness.

Alternator Output Test

- Detach wiring harness connector from alternator.
- With switch on, engine not running, connect voltmeter from ground to "L" terminal in wiring harness, and to "I" terminal, if used. Wiring harness may connect to either "L" or "I" or both.
- Zero reading indicates open circuit between terminal and battery. Correct as required.
- Re-connect harness connector to alternator.
- Run engine at moderate speed, electrical accessories turned off.
- Measure voltage across battery. If above 16.0 volts, replace or repair alternator.
- Connect ammeter and carbon pile at alternator output terminal. Turn on accessories. Using the carbon pile, apply a load to the battery to obtain maximum amperes output. Maintain voltage as 13.0 volts or above.
- If within 15 amperes of rated output, alternator is acceptable.
- If not within 15 amperes of rated output, replace or repair alternator.

Current Leakage Test

Current leakage refers to power being drained from the battery with the ignition turned off. Battery drain should not exceed 20 MA (20 milliamps = 0.020 amps), typical draw is 0.10 MA.

The 20 MA are needed to supply ECU memory, digital clock memory, and ETR (electronically tuned radio) memory.

Excessive battery drain is caused by items left turned on, internally shorted alternator, or intermittent short in wiring.

High current leakage may lead to an incorrect diagnosis and unnecessary battery replacement.

Current leakage up to 10 amps can be measured with the analog multimeter 260-7. Use the S-VAT-40 to first determine that current leakage is under 10 amps. Hook up test equipment (Fig. 3) for 10 amp testing.

If current draw is below 0.1 amp, shut off dome, map and courtesy lamps and go to 100 MA hookup. Failure to shut off dome, map and courtesy lamps will result in excessive current draw and meter damage when a door is opened.

Main power branches can be isolated by removing one lead at a time from the starter relay. Further isolation can be obtained by removing circuit breakers and fuses. The meter reading drops once the high current problem is found. Repair this section of the circuit, whether it is a wiring short or component failure.

ALTERNATOR REMOVAL AND INSTALLATION

4.0L Removal

WARNING: FAILURE TO DISCONNECT THE BATTERY NEGATIVE CABLE BEFORE DISCONNECTING THE RED (OUTPUT) WIRE CONNECTOR FROM THE ALTERNATOR CAN RESULT IN INJURY.

(1) Disconnect battery negative cable.

(2) Remove serpentine belt (Figs. 4 and 5).

(3) Raise and support vehicle.

(4) Unplug alternator connector.

(5) Unscrew alternator output nut (BAT) and remove lead.

(6) Remove alternator from vehicle (Fig. 6).

4.0L Serpentine Belt Installation

(1) Vehicle must be raised and supported.

(2) Install alternator with two mounting bolts. Torque bolts to 38 N•m (28 ft-lbs) (Fig. 6).

CAUTION: Never force a belt over a pulley rim using a screwdriver as the synthetic fiber may be damaged.

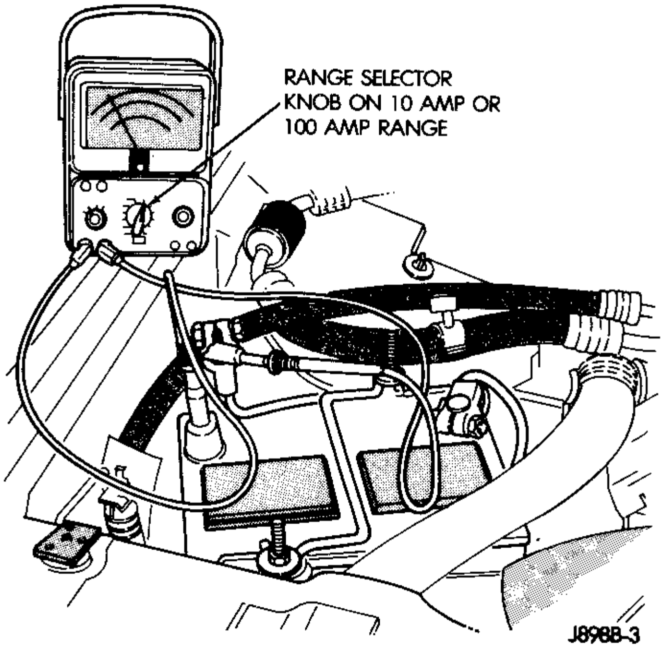


Fig. 3 Current Leakage Test

CAUTION: When installing a serpentine accessory drive belt, the belt MUST be routed correctly. The engine may overheat because the water pump will be rotating in the wrong direction if the belt is installed incorrectly. Refer to the appropriate accessory drive belt schematic for the correct belt routing (Group 7).

(3) Place serpentine belt over pulley.

(4) Attach alternator wires.

(5) Remove support and lower vehicle.

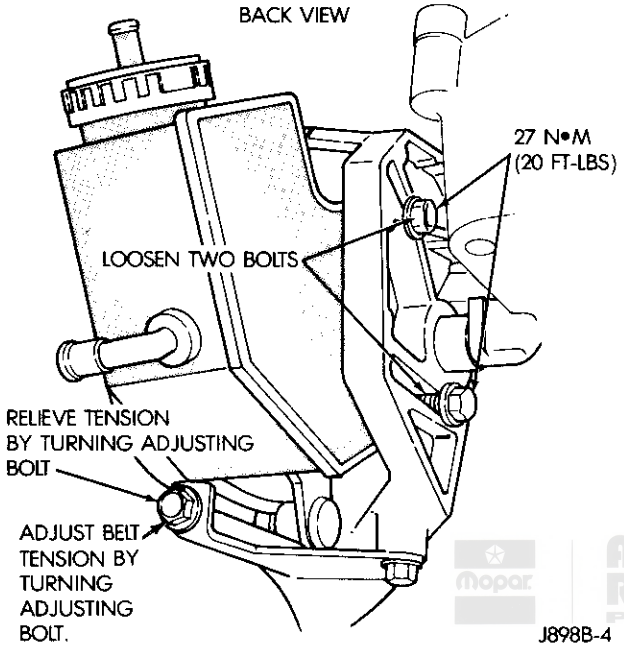


Fig. 4 Serpentine Belt Removal/Installation - 4.0L (Back View)

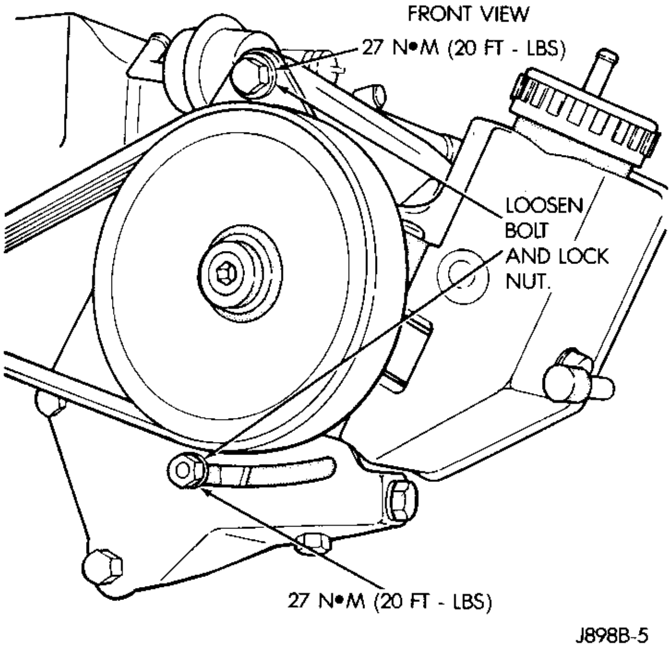


Fig. 5 Serpentine Belt Removal/Installation - 4.0L (Front View)

(6) Belt tension adjustment is made at the power steering pump (Fig. 4).

(7) Turn adjusting bolt until the belt has the correct tension as shown in Specifications.

(8) Tighten nuts and bolts.

(9) Attach battery negative cable.

2.5L Without A/C Removal

WARNING: FAILURE TO DISCONNECT THE BATTERY NEGATIVE CABLE BEFORE DISCONNECTING THE RED (OUTPUT) WIRE CONNECTOR FROM THE ALTERNATOR CAN RESULT IN INJURY.

(1) Disconnect battery negative cable.

(2) Disconnect two-terminal plug connector and red (output) wire connector at back of alternator.

(3) Remove alternator drive belt from alternator pulley (Figs. 7 and 8).

(4) Remove mounting bolts, washers and nuts and remove alternator from the mounting bracket (Fig. 9).

2.5L Without A/C Installation

(1) Attach alternator to the mounting bracket with three bolts and one nut. Torque bolts (Fig. 9).

(2) Connect the two-terminal plug connector and the red (output) wire connector to the alternator.

CAUTION: Never force a belt over a pulley rim using a screwdriver as the synthetic fiber may be damaged.

CAUTION: When installing a serpentine accessory drive belt, the belt MUST be routed correctly. The engine may overheat because the water pump will be rotating in the wrong direction if the belt is installed incorrectly. Refer to the appropriate accessory drive belt schematic for the correct belt routing (Group 7).

(3) Place alternator drive belt over pulley.

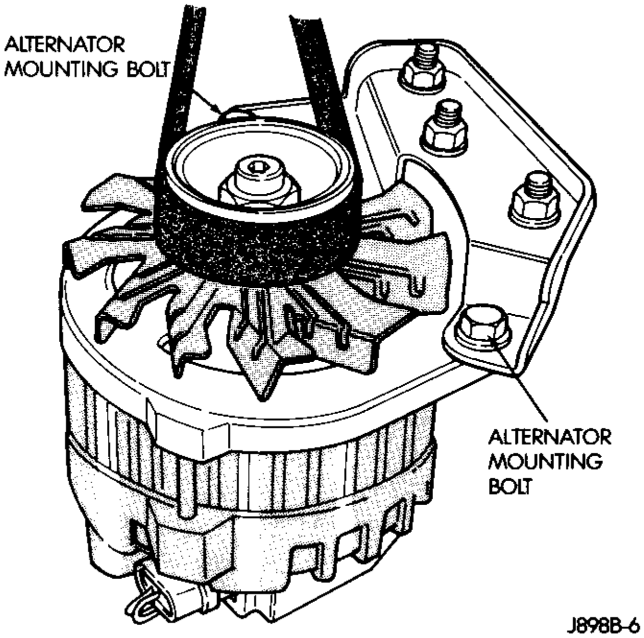


Fig. 6 Alternator Removal/Installation - 4.0L

(4) Belt tension adjustment is made at the power steering pump.

(5) Turn adjusting bolt (Fig. 8), until the belt has the proper tension as shown in Specifications.

When using the gauge on a notched belt, position the middle finger of the gauge in the notched cavity of the belt.

(6) Connect the battery negative cable.

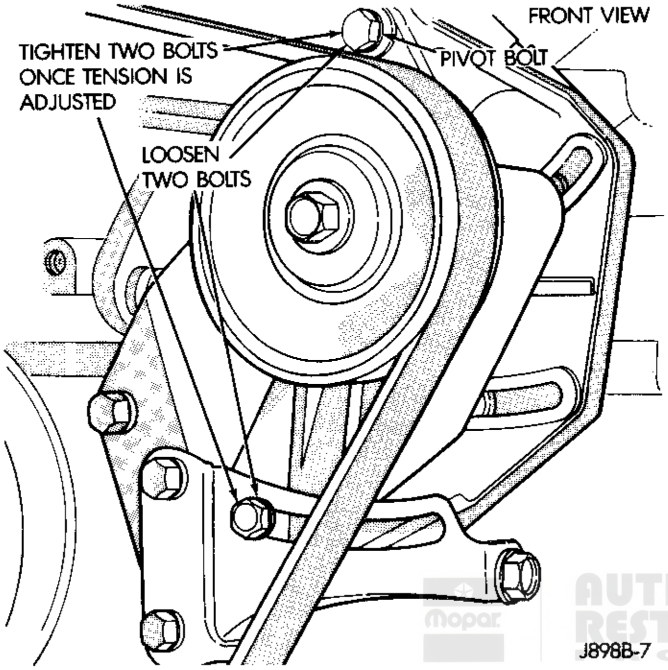


Fig. 7 Serpentine Belt Removal/Installation - 2.5L (Front View)

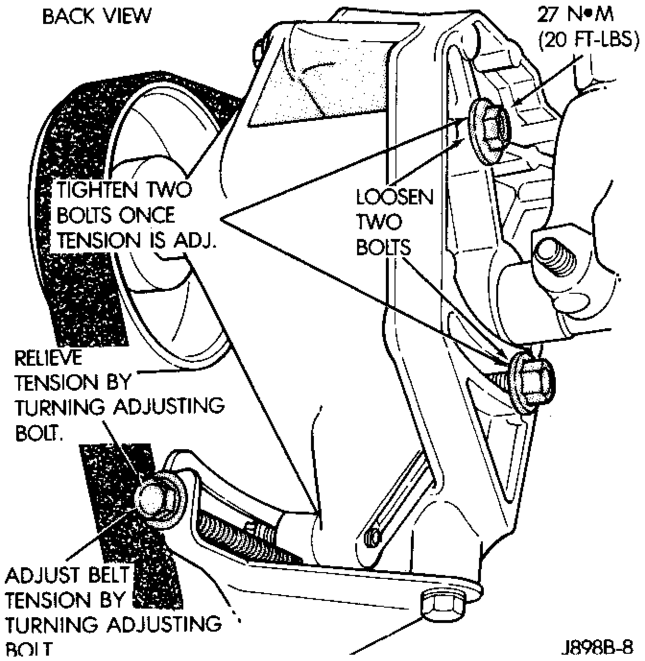


Fig. 8 Serpentine Belt Removal/Installation - 2.5L (Back View)

2.5L With A/C Removal

WARNING: FAILURE TO DISCONNECT THE BATTERY NEGATIVE CABLE BEFORE DISCONNECTING THE RED (OUTPUT) WIRE CONNECTOR FROM THE ALTERNATOR CAN RESULT IN INJURY.

(1) Remove the battery and battery tray (Refer to Group 8A-Batteries).

(2) Remove the serpentine belt (Figs. 7 and 8).

(3) Disconnect the two-terminal plug connector and red (output) wire connector at back of the alternator.

(4) Remove alternator (Figs. 10 and 11).

2.5L With A/C Installation

(1) Attach alternator to the mounting bracket with three bolts and one nut. Torque bolts (Figs. 10 and 11).

(2) Connect the two-terminal plug connector and red wire connector to the alternator.

CAUTION: Never force a belt over a pulley rim using a screwdriver as the synthetic fiber may be damaged.

CAUTION: When installing a serpentine accessory drive belt, the belt MUST be routed correctly. The engine may overheat because the water pump will be rotating in the wrong direction if the belt is installed incorrectly. Refer to the appropriate accessory drive belt schematic for the correct belt routing (Group 7).

(3) Place serpentine belt over pulley.

(4) Install serpentine drive belt.

(5) Belt tension adjustment is made at the power steering pump.

(6) Turn adjusting bolt (Fig. 8), until the belt has the proper tension as shown in Specifications.

(7) Install the battery tray and battery.

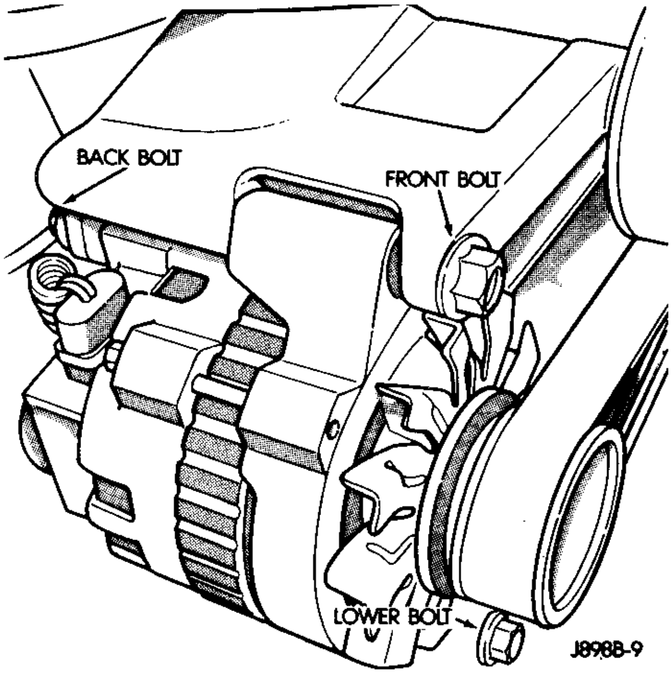


Fig. 9 Alternator Removal/Installation - 2.5L (w/o A/C)

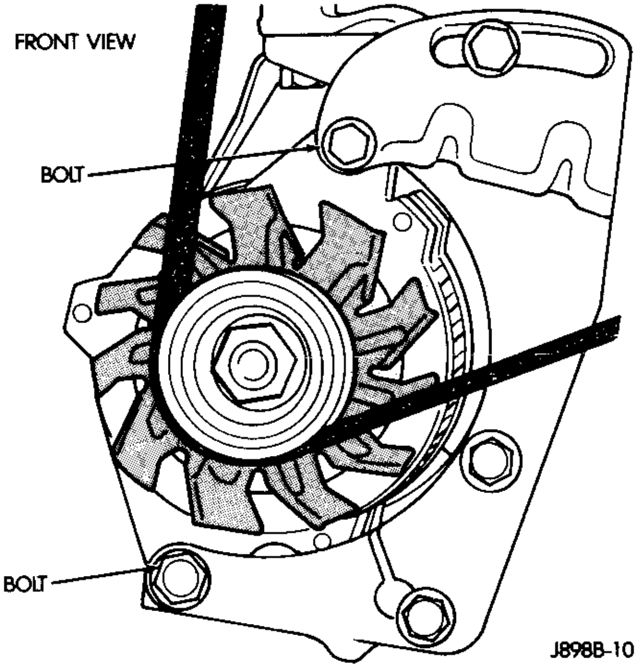


Fig. 10 Alternator Removal/Installation - 2.5L w/A/C (Front View)

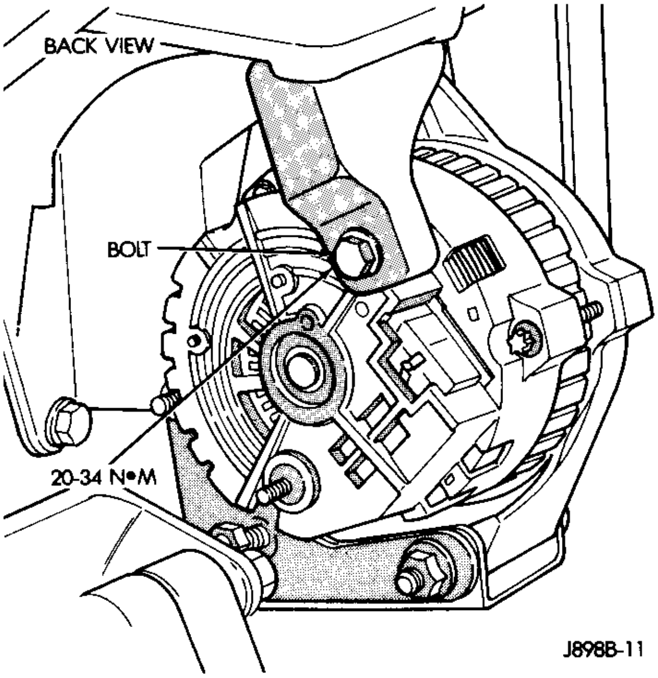


Fig. 11 Alternator Removal/Installation - 2.5L w/A/C (Back View)

SJ AND YJ

INDEX

TORQUE SPECIFICATIONS

Pulley Nut - All Vehicles

Component	Service Set-To Torque	Service Recheck Torque
Pulley Nut	81 N•m (59 ft-lbs)	54-108 N•m (39-79 ft-lbs)

YJ With 2.5L

Component	Service Set-To Torque	Service Recheck Torque
Alternator Adjusting Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Alternator Mounting Strap Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Alternator Pivot Bolt or Nut	38 N•m (28 ft-lbs)	27-48 N•m (20-35 ft-lbs)

YJ With 4.2L

Component	Service Set-To Torque	Service Recheck Torque
Alternator Adjusting Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Alternator Mounting Strap Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Alternator Pivot Bolt or Nut	38 N•m (28 ft-lbs)	27-48 N•m (20-35 ft-lbs)
Alternator to Bracket Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)

SJ

Component	Service Set-To Torque	Service Recheck Torque
Alternator Adjusting Bolt	24 N•m (18 ft-lbs)	20-27 N•m (15-20 ft-lbs)
Alternator Pivot Bolt	44 N•m (33 ft-lbs)	40-50 N•m (30-37 ft-lbs)

BELT TENSION SPECIFICATIONS

Type Of Belt	New Belt N(lbs-f)	Used Belt(lbs-f)
Serpentine Belt	800-900 (180-200)	623-712 (140-160)
V-Belt	533-711 (120-160)	400-511 (90-115)

OUTPUT VOLTAGE SPECIFICATIONS

Ambient Temperature °C (°F)	Acceptable Voltage Range
−18 to 10 (0 to 50)	14.3 to 15.3
10 to 38 (50 to 100)	13.9 to 14.9
38 to 66 (100 to 150)	13.4 to 14.4
66 to 93 (150 to 200)	13.0 to 14.1

J898B-12

Fig. 1 Output Voltage Specifications

GENERAL INFORMATION

This negative-ground system consists of two primary components: an alternator with an integral regulator and a battery. The non-repairable, non-adjustable regulator is a solid-state device located within the alternator housing.

The standard equipment alternator used with the 2.5L and 4.2L engines is rated at 56 amps. The optional, heavy-duty alternators for the 2.5L and 4.2L engines are rated at 66 and 78 amps.

The standard equipment alternator used with the 5.9L engine is rated at 78 amps.

ALTERNATOR

Other than a regularly scheduled drive belt tension adjustment, the alternator assembly requires no periodic adjustment or maintenance. The bearings have sufficient lubricant for the life of the alternator and do not require periodic lubrication.

VOLTAGE REGULATOR

The voltage regulator unit is attached inside the rear housing of the alternator. The voltage regulator is not adjustable or repairable.

CHARGING SYSTEM DIAGNOSIS

Servicing Precautions

To avoid damage to the charging system, always observe the following precautions:

- Do not attempt to polarize the regulator
- Do not short across or ground any of the terminals in the charging system except as specifically instructed
- When the output terminal circuit is open and the No. 1 and No. 2 wire terminals are connected to the alternator never drive the alternator with the engine
- Ensure that the alternator and battery have the same ground polarity
- When connecting a charger or a booster battery to the battery, connect the positive clamp to the battery positive terminal and the negative clamp to the engine block
- Never drive the alternator with the engine when the output terminal circuit is open (i.e., not connected).

Charging System Malfunction Symptoms

Malfunction of the charging system is usually indicated by one or more of the following symptoms:

- Faulty voltmeter operation
- An undercharged battery, indicated by slow engine cranking and battery electrolyte having low specific gravity
- An overcharged battery, indicated by excessive water usage.

Electrical Test Inspection

Prior to performing any electrical tests, visually inspect all charging system components and wiring for obvious faults.

Visual Inspection

Battery Posts, Engine Block, Starter Motor Solenoid

- Inspect for clean and tight cable terminal connections at the battery posts, engine block, and starter motor solenoid

Alternator, Starter Motor Solenoid, Alternator Voltmeter Wiring

- Inspect for corrosion and loose wire terminal connections at the alternator, starter motor solenoid, dash panel connector and the charging system indicator

Fuse Block

- Inspect all wires for cracked or broken insulation

Alternator Mounting Bolts/Ground

- Inspect to see that the alternator mounting bolts are tight and that alternator is properly grounded

Battery Fluid

- Inspect the electrolyte level in the battery and add water if necessary

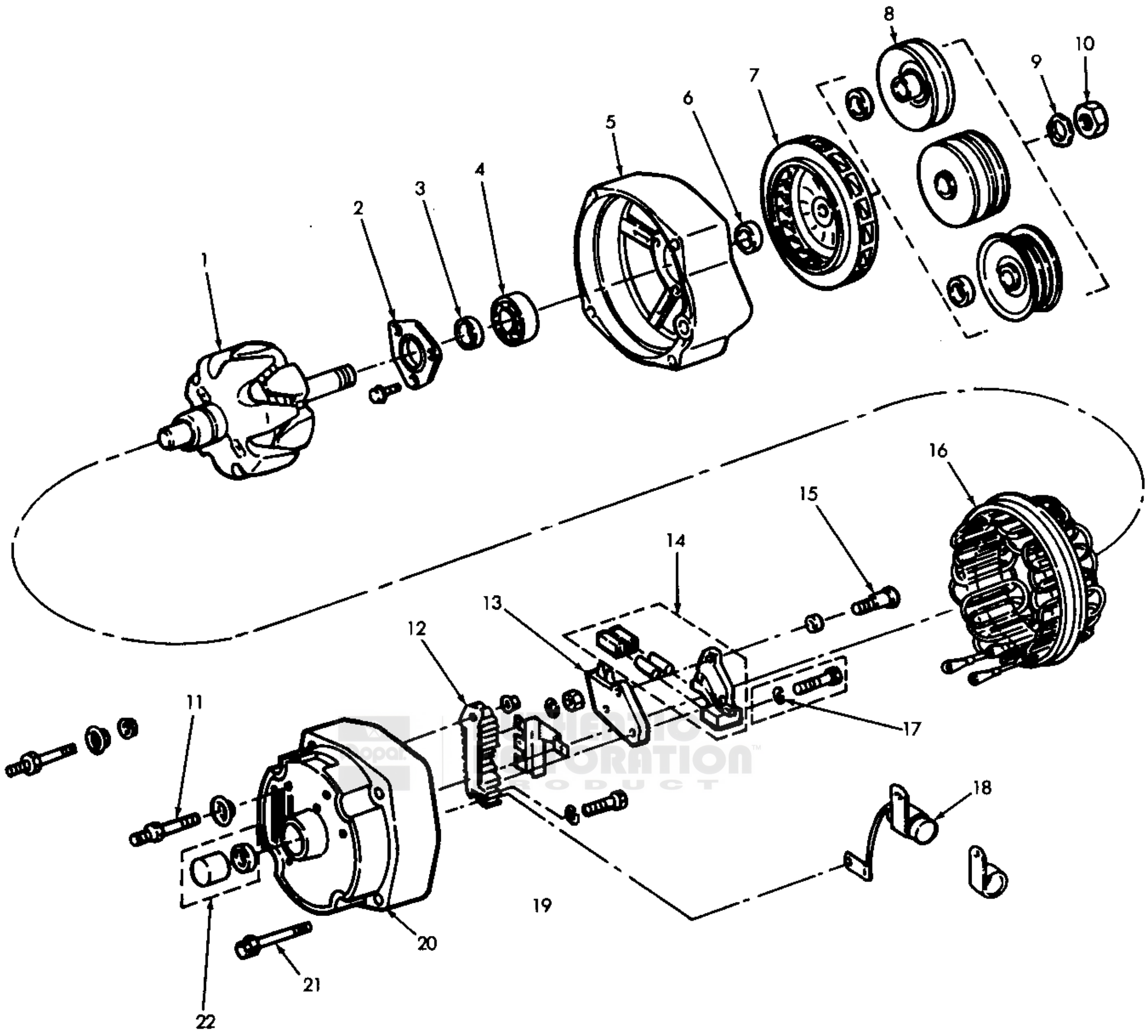
Alternator Drive Belt Tension

- Inspect and test the alternator drive belt tension

Alternator Noise

Unusual alternator noise may be caused by any one or more of the following conditions:

- Loose mounting bolts
- Loose or misaligned pulley
- Worn or contaminated bearings
- Out-of-round or rough slip rings
- Defective brushes
- Shorted rectifier diode(s) indicated by a high frequency whine



1. ROTOR
2. FRONT BEARING RETAINER PLATE
3. COLLAR (INNER)
4. BEARING
5. FT. HOUSING
6. COLLAR (INNER)
7. FAN
8. PULLEY
9. LOCKWASHER
10. PULLEY NUT
11. TERMINAL ASSEMBLY
12. BRIDGE RECTIFIER
13. REGULATOR
14. BRUSH ASSEMBLY
15. SCREW
16. STATOR
17. INSULATING WASHER
18. CAPACITOR
19. DIODE TRIO
20. REAR HOUSING
21. THROUGH-BOLT
22. BEARING AND SEAL ASSEMBLY

J898B-13

Fig. 2 Alternator Exploded View - SJ and YJ

Voltmeter Failure or Abnormal Indication Diagnosis

Test the alternator drive belt tension. Adjust the tension to the tension shown in Belt Tension Specifications.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS, OR FAN. DO NOT WEAR LOOSE CLOTHING.

Start and operate the engine at fast idle. Test the voltage across the battery terminals with a voltmeter. Refer to Output Voltage Specifications in the beginning of this section.

If the cluster voltmeter is not operating, refer to Group 8W - Wiring Diagrams for circuit information.

Refer to 8E - Instrument Panel for cluster disassembly.

Undercharged Battery

An undercharged battery, indicated by slow engine cranking and battery electrolyte having low specific gravity can be caused by either the accessories being left on for extended periods or improper drive belt tension.

Ensure that the undercharged condition has not been caused by accessories left on for extended periods.

Check the drive belt for proper tension.

If a battery defect is suspected, refer to Group 8A - Batteries.

Overcharged Battery

To determine battery condition, refer to Group 8A - Batteries.

If an obvious overcharge condition exists, as evidenced by excessive spewing of electrolyte, proceed to the Testing - Off-Vehicle Section and check the regulator with an approved regulator tester.

Battery Discharge Through Alternator

If the alternator is suspected of discharging the battery because of excessive current leakage, perform the following test procedure with a No. 158 bulb and bulb socket with attached jumper wires.

WARNING: FAILURE TO DISCONNECT THE BATTERY NEGATIVE CABLE BEFORE DISCONNECTING THE ALTERNATOR OUTPUT WIRE MAY RESULT IN INJURY.

(1) Disconnect the battery negative cable.

(2) Disconnect the output wire (red) from the alternator output terminal. Prevent this wire from touching any metal.

(3) Connect the test bulb jumper wires in series with the output wire and the alternator output terminal.

(4) Connect the battery negative cable. The bulb should NOT light. If the bulb lights, even dimly, replace the alternator bridge rectifier.

(5) Disconnect the battery negative cable and remove the jumper wires.

(6) Disconnect the wires from No. 1 and No. 2 terminals of the alternator.

(7) Connect the test bulb jumper wires between the No. 1 terminal at the alternator and the battery positive post.

(8) Connect the battery negative cable. The bulb should NOT light. If the bulb lights, even dimly, test the alternator diode trio.

(9) If the diode trio is NOT defective, replace the voltage regulator.

(10) Connect the test bulb jumper wires between the No. 2 terminal at the alternator and the battery positive post. The bulb should NOT light. If the bulb lights, even dimly, replace the voltage regulator.

TESTING ON VEHICLE

With the ignition switch ON and all wiring harness leads connected, connect a voltmeter from (Fig. 3):

- alternator “BAT” terminal-to-ground, 12.5V
- alternator No. 1 terminal-to-ground, 2-4V
- alternator No. 2 terminal-to-ground, 12.5V

A zero reading indicates an open in the circuit. Refer to Group 8W - Wiring Diagrams for schematic information.

Alternators have a built-in feature which avoids overcharge and accessory damage by preventing the alternator from turning ON if there is an OPEN in the wiring harness connected to the No. 2 regulator terminal.

Test the field windings for grounds or shorts. If defective, replace the rotor.

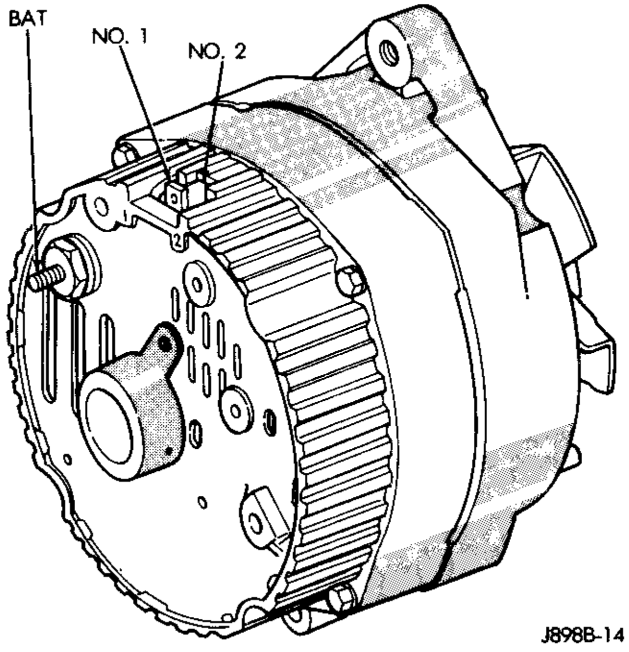


Fig. 3 Alternator Testing Locations

If the steps check satisfactorily, check the alternator as follows:

(1) Disconnect the battery negative cable.

(2) Connect an ammeter or alternator tester in the circuit at the "BAT" terminal of the alternator.

(3) Connect the battery negative cable.

(4) Turn on the radio, windshield wipers, lights high beam, and blower motor on high speed.

(5) Connect a carbon pile across the battery (or use the alternator tester).

(6) Operate the engine about 2,000 RPM.

(7) Adjust the carbon pile, as required, to obtain maximum current output.

- If ampere output is within 10 amperes of the rated output as stamped on the alternator frame, the alternator is **NOT** defective.

(8) Recheck the steps.

- If ampere output is NOT within 10 percent of the rated output, ground the field winding by inserting a screwdriver into the test hole (Fig. 4). The tab is within 19 mm (3/4 in.) of the casting surface.

CAUTION: To avoid damaging the alternator, do not force the screwdriver deeper than 25 mm (1 in.) into the end frame.

(9) Operate the engine at moderate speed as required.

(10) Adjust the carbon pile as required to obtain maximum current output.

(11) Check the field winding, diode trio, rectifier bridge, stator, and test the regulator with an approved tester as covered in the Testing Section.

Alternator Tester

Many testers are available to check the alternator. They provide a quick ON-VEHICLE test, and can save time over conventional diagnostic methods. Consult the manufacturer's instructions for usage.

ALTERNATOR REMOVAL AND INSTALLATION

ALL 2.5L, 4.2L w/o A/C except California - YJ and SJ

WARNING: FAILURE TO DISCONNECT THE BATTERY NEGATIVE CABLE BEFORE DISCONNECTING THE OUTPUT WIRE CONNECTOR (RED) FROM THE ALTERNATOR MAY RESULT IN INJURY.

Removal

(1) Disconnect the battery negative cable.

(2) Disconnect the two-terminal plug connector and output wire connector (RED) at the back of the alternator.

(3) Remove mounting and adjusting bolts, washers, and nuts (Figs. 5, 6, 7 and 8).

(4) Remove alternator drive belt from alternator pulley.

(5) Remove alternator from mounting bracket.

Installation

(1) Attach alternator to mounting bracket with washers and bolts. Tighten bolts finger-tight ONLY.

(2) Install alternator drive belt.

(3) Adjust belt to the tension shown in Belt Tension Specifications by prying on alternator front housing only.

(4) Tighten bolts and nuts (Figs. 5,6,7 and 8).

(5) Connect the two-terminal plug connector and output wire connector (RED) to the alternator. Torque the output wire nut to 4 N•m (3 ft-lbs).

(6) Connect battery negative cable.

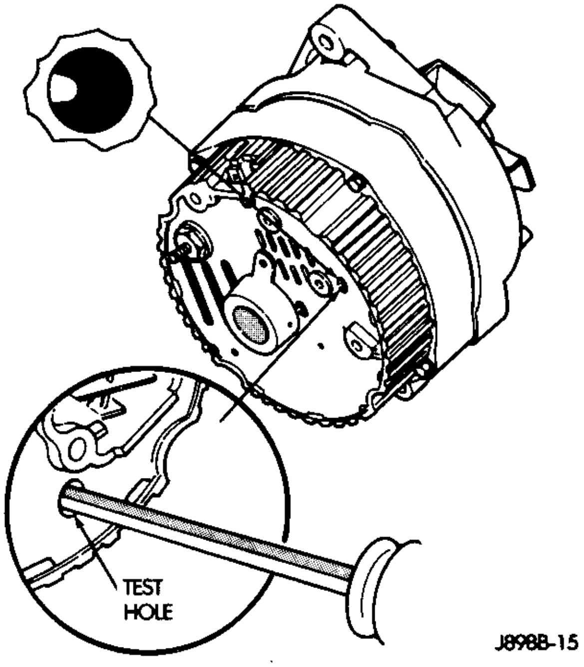


Fig. 4 Grounding The Field Winding

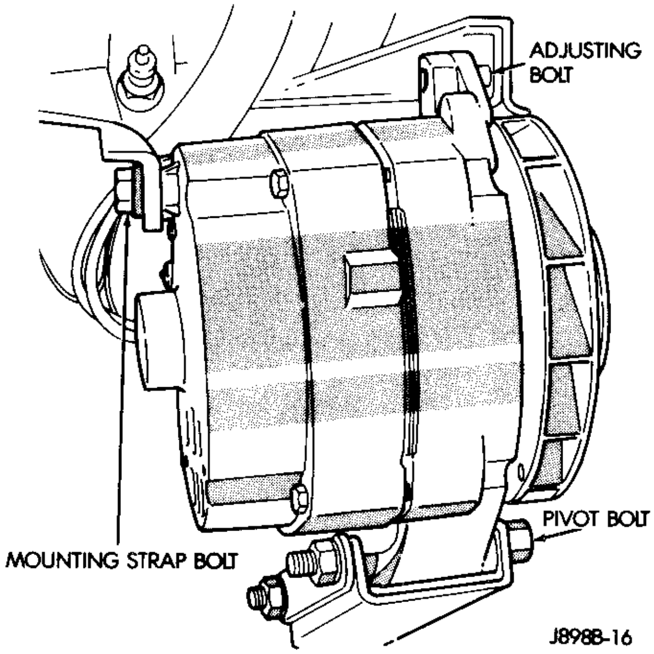


Fig. 5 Alternator Removal/Installation - 2.5L YJ

ALL 4.2L w/AC and Calif. - YJ

WARNING: FAILURE TO DISCONNECT THE BATTERY NEGATIVE CABLE BEFORE DISCONNECTING THE OUTPUT WIRE CONNECTOR (RED) FROM THE ALTERNATOR MAY RESULT IN INJURY.

Removal

(1) Disconnect the battery negative cable.

(2) Disconnect the two-terminal plug jumper harness connector and output wire connector (RED) at the back of the alternator.

(3) Remove alternator drive belt from alternator pulley (Fig. 9).

(4) Remove alternator from mounting bracket.

Installation

(1) Install the alternator to the bracket with three bolts as shown in Fig. 9.

(2) Install the belt over the pulley.

(3) Using a 1/2 inch drive wrench (Fig. 10) adjust belt to the tension shown in Belt Tension Specifications.

(4) Tighten bolts and nuts as shown in Torque Specification chart.

(5) Connect the two-terminal plug jumper harness connector and output wire connector to the alternator. Torque the output wire nut to 4 N•m (3 ft-lbs).

(6) Connect battery negative cable.

TESTING—OFF-VEHICLE

Rotor (Field) Winding-Short Circuit-to-Ground Test

Test Procedure

To perform this test, remove the rotor and front housing assembly from the stator and rear housing assembly. Refer to Alternator Overhaul for the procedure.

Perform the test with an ohmmeter set for the x1000 ohm scale or with a 110-volt test lamp.

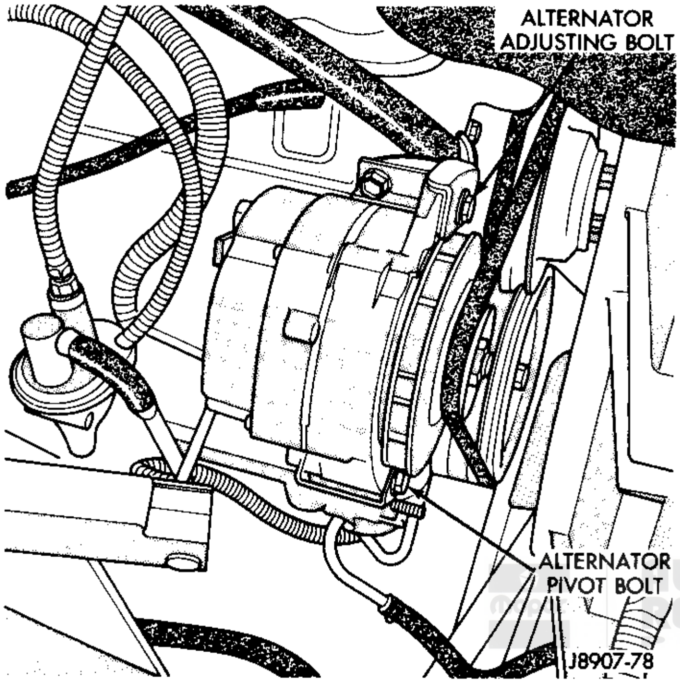


Fig. 6 Alternator Removal/Installation - 4.2L YJ w/o A/C (except California)

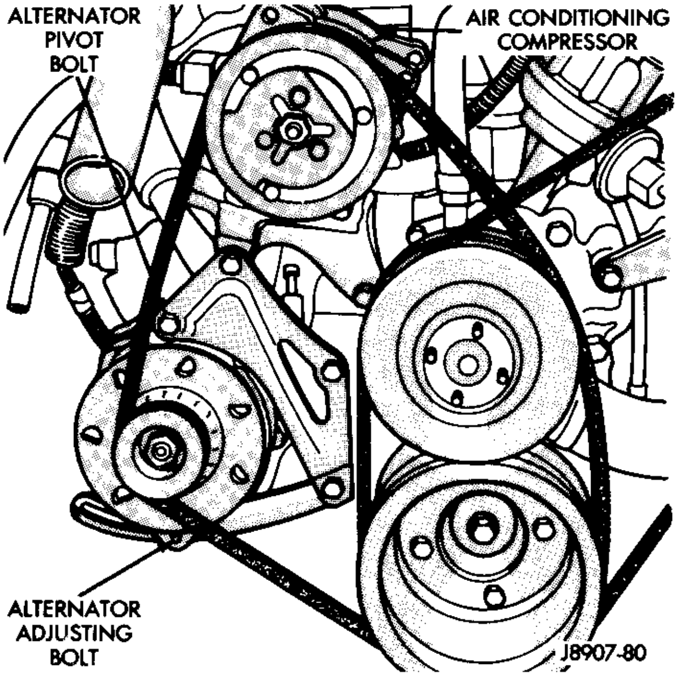


Fig. 7 Alternator Removal/Installation - SJ

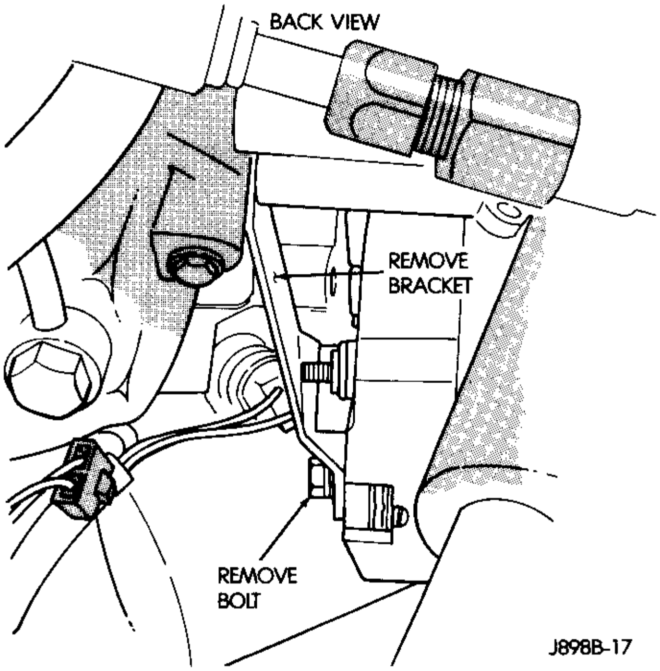
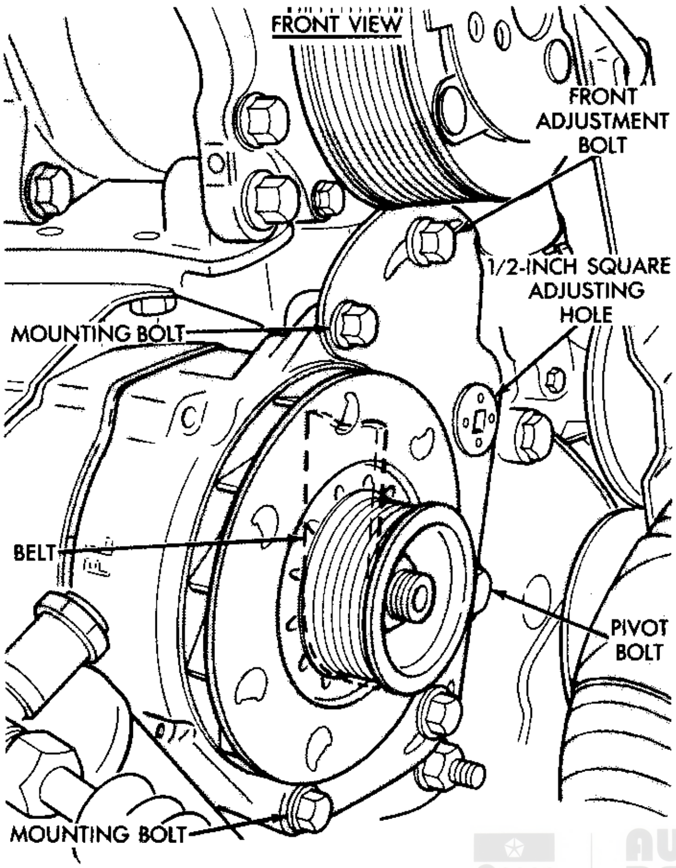


Fig. 8 Alternator Removal/Installation - SJ



BACK VIEW

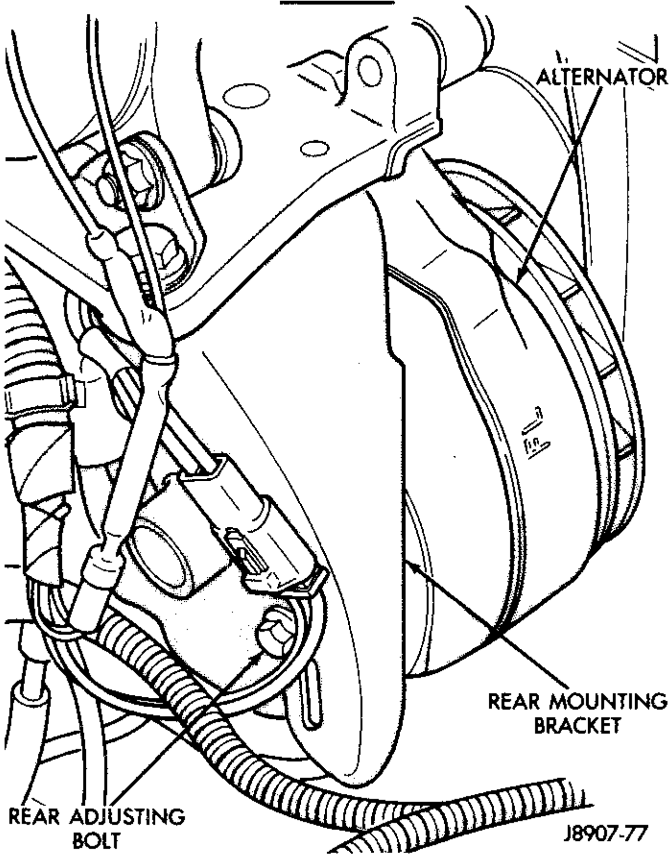


Fig. 9 Alternator Removal/Installation - 4.2L YJ (w/AC or Calif.)

Touch one test lead probe to the rotor shaft and touch the other probe to one slip ring (Fig. 11). Repeat with the other slip ring. In each test, the ohmmeter should indicate infinite resistance (no pointer movement) or the test lamp should NOT light.

Test Results

If the ohmmeter indicates other than an infinite resistance or the test lamp lights, a short circuit to the rotor shaft (ground) exists. Inspect the soldered connections at the slip rings to ensure they are secure and not shorted to the rotor shaft, or that excess solder is not shorting the rotor winding to the shaft. Replace the rotor, if defective.

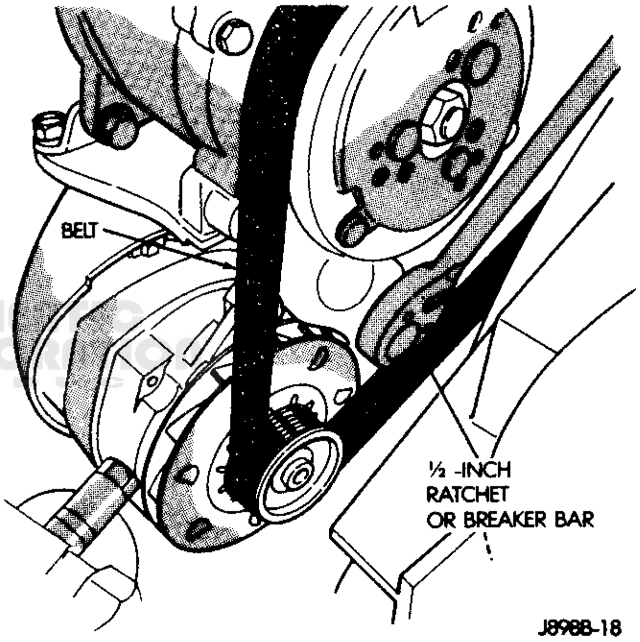


Fig. 10 Belt Tension Adjustment - 4.2L YJ (w/AC or Calif.)

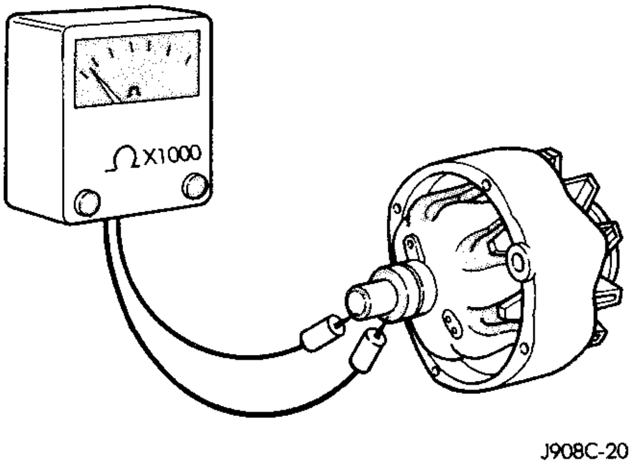


Fig. 11 Rotor (Field) Winding-Short Circuit-to-Ground Test

Rotor (Field) Winding-Open Circuit Test

Test Procedure

To perform this test, remove the rotor and front housing assembly from the stator and rear housing assembly. Refer to Alternator Overhaul for the procedure. Perform the test with an ohmmeter set for the x1 scale or with a 110-volt test lamp.

Touch one test lead probe to one slip ring and the other test lead probe to the other slip ring (Fig. 12). The ohmmeter should indicate 2.2 - 3.0 ohms or the test lamp should light.

Test Results

If the ohmmeter indicates infinite resistance or the test lamp fails to light, the rotor (field) winding has an open circuit.

An alternate test method is to determine the field winding resistance by connecting an ohmmeter to the two slip rings. If the resistance is less than 2.2 ohms at 27°C (80°F), the windings are internally shorted. If the resistance is more than 3.0 ohms at 27°C (80°F), the windings have excessive resistance. In both cases replace the rotor.

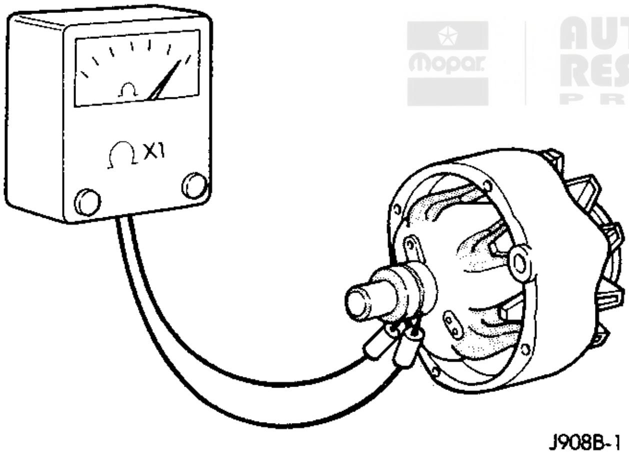


Fig. 12 Rotor (Field) Winding-Open Circuit Test

Rotor (Field) Winding Internal Short Circuit Test

Test Procedure

To perform this test, remove the rotor and front housing from the stator and rear housing assembly. Refer to Alternator Overhaul for the procedure. This test is performed with a 12-volt battery and an ammeter.

Connect the battery and ammeter in series with the slip rings (Fig. 13). The field current with 12 volts applied at 27°C (80°F) should be between 4.0 and 5.0 amps in both cases replace the rotor.

Test Results

Current flow exceeding 5.0 amps indicates internally shorted windings replace rotor.

The winding resistance and ammeter indication will vary slightly with winding temperature changes.

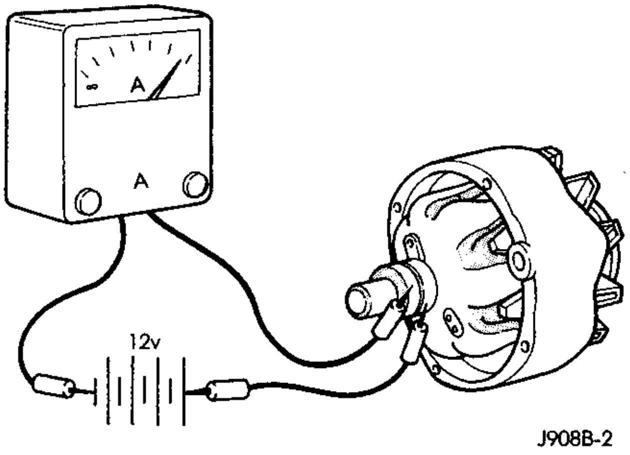


Fig. 13 Rotor (Field) Winding Internal Short Circuit Test

Stator Windings-Short Circuit to Ground Test

Test Procedure

To perform this test, separate the rear housing and stator from the rotor and front housing assembly.

Disconnect the stator winding terminals from the bridge rectifier (and diode trio) terminal studs. Refer to Alternator Overhaul for the procedure. Perform the test with an ohmmeter set for the x1000 scale or with a 110-volt test lamp.

Touch one test lead probe to the bare metal surface of the stator core and the other test lead probe to the end of one stator winding (Fig. 14). Because all three stator winding terminals are soldered together, it is not necessary to test each winding. The ohmmeter should indicate infinite resistance (no pointer movement) or the test lamp should not light.

Test Results

If the ohmmeter indicates other than an infinite resistance or the test lamp lights, the stator windings have a short circuit to the core (ground) and must be replaced.

Stator Windings-Continuity Test

Test Procedure

To perform this test, remove the stator and rear housing assembly from the rotor and front housing assembly. Refer to Alternator Overhaul for the procedure. An ohmmeter set for the x1 scale is used to perform the test.

Touch the ohmmeter test probes to any two stator winding terminals and note the resistance (Fig. 15). Test all the stator windings in this manner. Equal indications should be obtained for each pair of windings tested.

Test Results

An infinite resistance (no pointer movement) indicates open windings. Inspect the neutral junction splice for an inadequate solder connection. Resolder the connection even if it appears to be electrically and mechanically good. Retest for winding continuity. If an open circuit still exists, replace the stator windings.

An indication of more than one ohm indicates a possible cold solder joint. Inspect the neutral junction splice and resolder, if necessary.

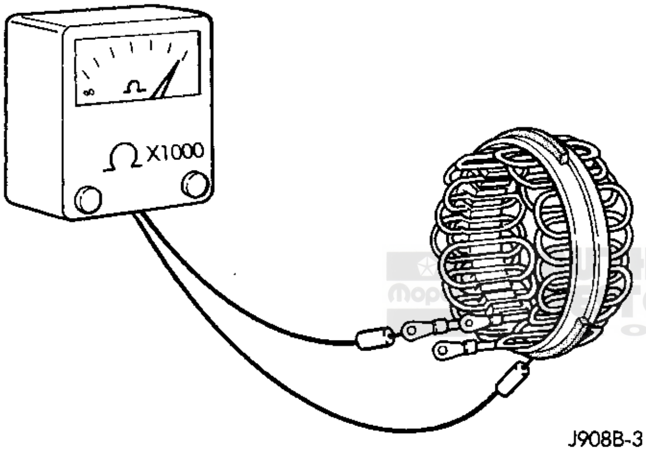


Fig. 14 Stator Windings-Short Circuit to Ground Test

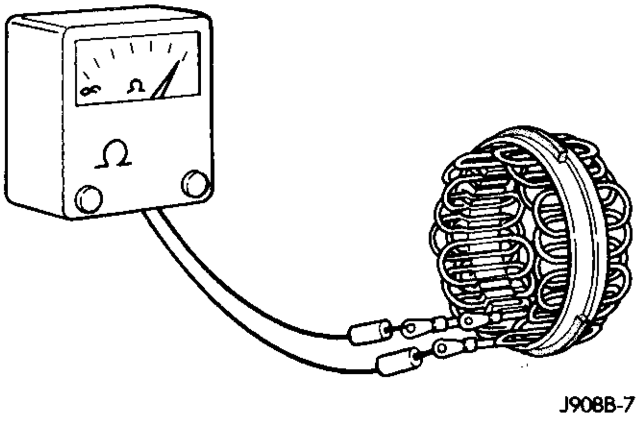


Fig. 15 Stator Windings-Continuity Test

Stator Windings-Internal Short Circuit Test

Test Procedure

An internal short circuit (e.g., between the adjacent windings) is difficult to locate without laboratory test equipment. If all other alternator test results are normal and the alternator fails to supply the rated output, shorted stator windings are probable.

Diode Trio-Short Circuit Test

The diode trio is tested in two ways:

- when installed in the rear housing, and,
- when removed from the rear housing.

CAUTION: DO NOT use high voltage test device, such as a 110-volt test lamp, to test the diode trio.

Test With Diode Trio Installed

Before removing the diode trio, connect an ohmmeter, with the lowest range scale selected, from the brush holder clip, to rear housing (Fig. 16) and note the resistance.

With the ohmmeter on its lowest scale, connect between the rear housing and the diode trio (Fig. 17).

For both meter readings reverse the test probe connections. If both indications are zero, inspect for a shorted brush holder clip caused by absence of the insulating washer/sleeve around the screws or damaged insulation.

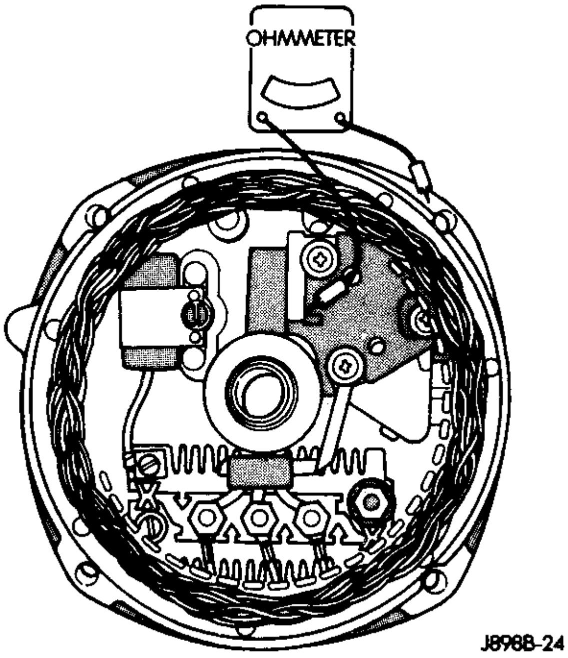


Fig. 16 Brush Holder Clip Test

Remove the screws to inspect the insulating washers/sleeves (Fig. 18). If insulator assemblies are correct and both ohmmeter observations are identical, replace the voltage regulator.

Test with Diode Trio Removed

(1) Remove the diode trio from the rear housing assembly.

(2) Use an ohmmeter having 1-1/2 volt cell for the test. Touch one test probe to the brush terminal (Fig. 19) and the other probe to one of the stator winding terminals. Observe the resistance on the lowest range scale.

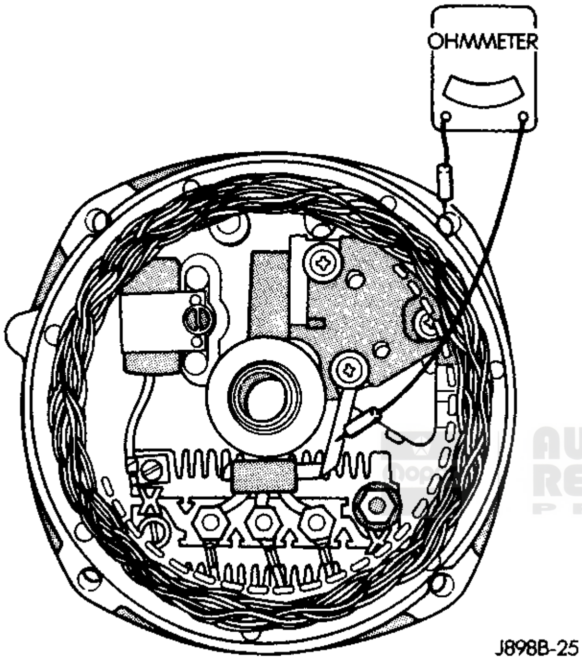


Fig. 17 Diode Trio Insulation Test

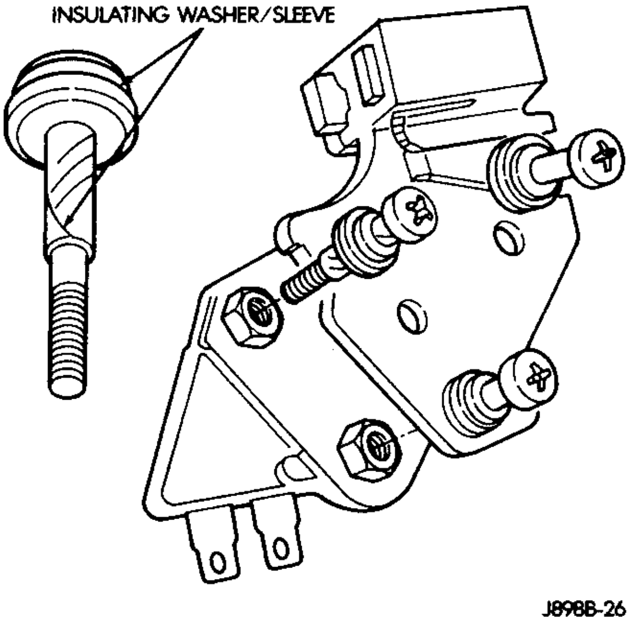


Fig. 18 Brush Holder Screws

(3) Reverse the probes at the same two terminals.

(4) Replace the diode trio if both resistances are identical. The good diode trio will have one high and one low resistance.

(5) Repeat the procedure for each stator winding terminal of the diode trio.

(6) Connect the ohmmeter test probes to any two stator winding terminals. If the resistance is zero, a shorted diode is indicated. Replace the diode trio. Repeat the test for each combination of stator winding terminals.

Bridge Rectifier Test

Test Procedures

(1) The bridge rectifier assembly contains six diodes.If one diode is defective, the entire bridge rectifier assembly must be replaced.

CAUTION: DO NOT use a high voltage test device, such as a 110-volt test lamp, to test the bridge rectifier. Press down firmly on the flat metal area surrounding the thread studs with the ohmmeter test probes.

(2) Firmly touch the ohmmeter test probes to the grounded heat sink and any one of three terminals. Note the resistance (Fig. 20).

(3) Reverse the ohmmeter test probe contacts to the grounded heat sink and the same terminal.Note the resistance.

(4) Repeat the procedure for the remaining two terminals.

(5) In the same manner as described above, test between the insulated heat sink and each of the three terminals (Fig. 21).

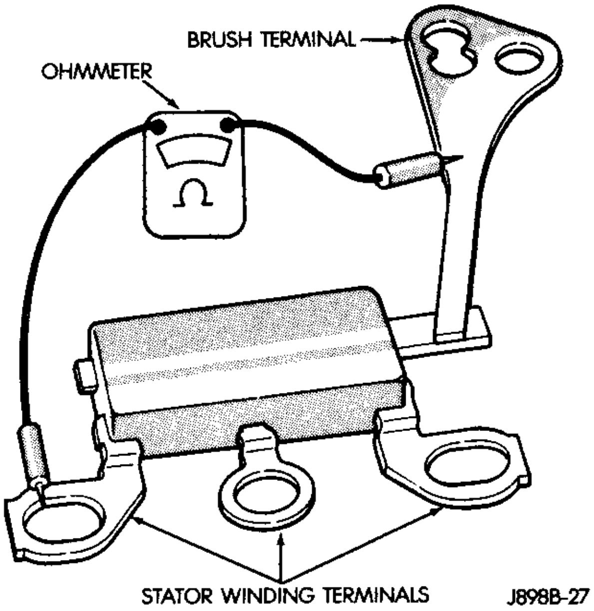


Fig. 19 Diode Trio Test

Test Results

Each combination of the terminal and heat sink tested should have one high and one low resistance. Replace the bridge rectifier, if any one pair of resistance indications is the same.

Replacement bridge rectifiers may vary in appearance but are completely interchangeable.

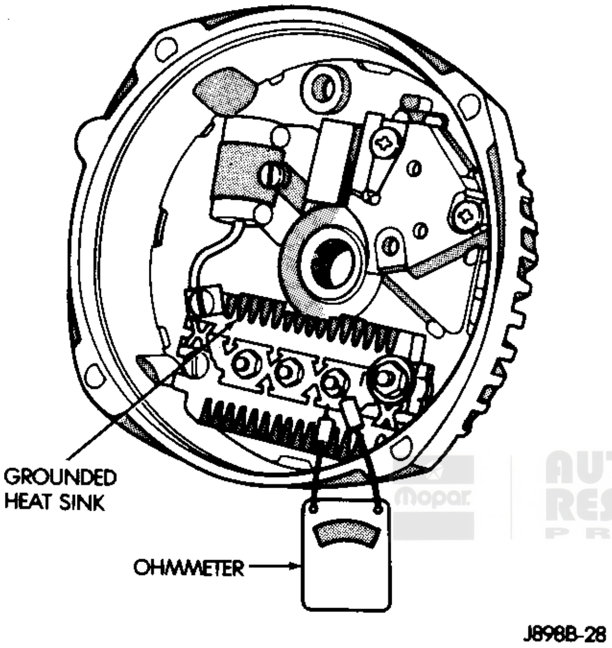


Fig. 20 Grounded Heat Sink Test

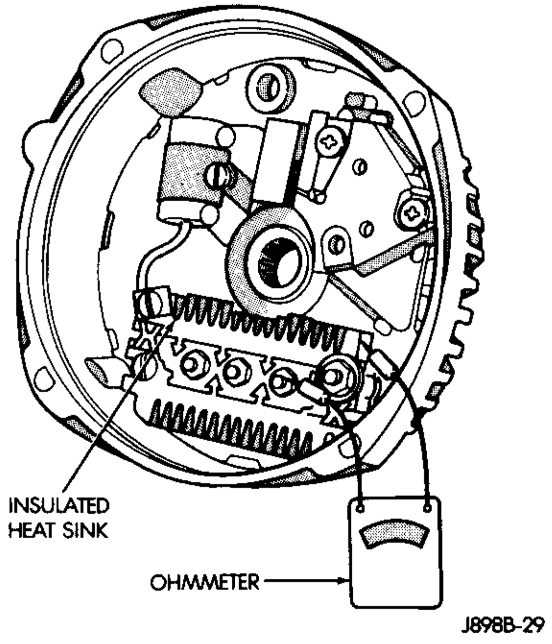


Fig. 21 Insulated Heat Sink Test

ALTERNATOR OVERHAUL

Disassembly

CAUTION: As the rotor and drive end (front) housing assembly is separated from the rear housing assembly the brushes can spring out onto the rotor shaft and come in contact with lubricant. Immediately clean the brushes that contact the shaft to avoid contamination by lubricant, otherwise, they will have to be replaced.

(1) Scribe across the front housing, stator frame and rear housing for assembly reference.

(2) Remove four through-bolts that connect the rear housing to the front housing.

(3) Separate front housing and rotor assembly from rear housing and stator assembly by prying housings apart with a screwdriver.

After disassembly, cover the rear housing bearings with tape to prevent entry of dirt and other foreign material. Also, cover the rotor shaft on the slip ring end with tape. Use pressure-sensitive tape, not friction tape, which would leave a gummy deposit on the shaft. If the brushes are to be reused, clean with a soft, dry cloth.

CAUTION: Avoid excessive tightening of the rotor in the vise to prevent rotor distortion.

(4) Place rotor in a vise and tighten vise only enough to permit removal of the pulley nut (Fig. 1).

(5) An alternate pulley nut removal procedure requires the use of an Allen wrench to prevent the rotor from turning while loosening the nut with a wrench.

(6) Remove the pulley nut, lockwasher, pulley, fan and outer collar.

(7) Separate the front housing from the rotor shaft.

(8) Remove the three stator winding terminal attaching nuts and washers and remove stator winding terminals from the bridge rectifier terminal studs.

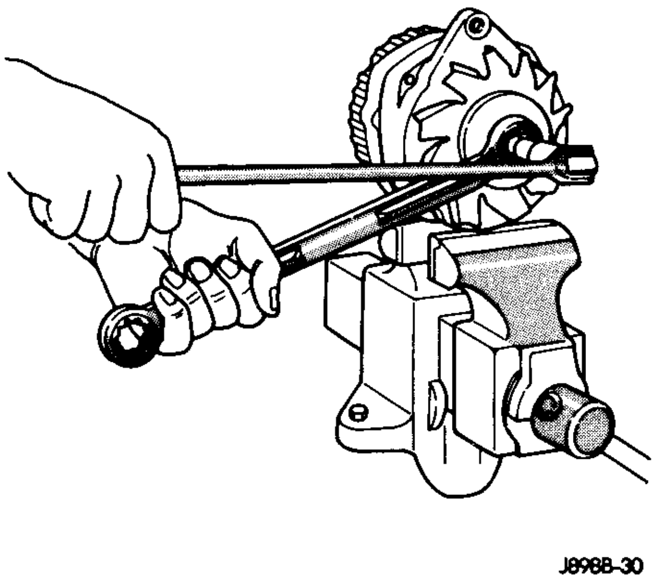


Fig. 1 Pulley Nut Removal

(9) Separate stator from the rear housing.

(10) Remove the diode trio strap terminal attaching screw from the brush holder and remove the diode trio.

(11) Remove the capacitor holddown screw.

(12) Disconnect the capacitor wire terminal from the bridge rectifier. Remove the capacitor.

(13) Remove the bridge rectifier attaching screws and the battery wire terminal (output) stud.

(14) Remove the bridge rectifier.

For assembly reference, note the insulator located between the heat sink and the rear housing.

(15) Remove the remaining two brush holder screws. Note the location of all the insulator washer/sleeves to facilitate the correct assembly.

(16) Remove the brush holder and brushes. Carefully note the position of the parts for assembly reference.

(17) Remove the voltage regulator.

(18) Remove the front bearing retainer plate screws, retainer plate and inner collar.

(19) Press out the front bearing and slinger from the front housing with the appropriate tube or collar.

If the bearing is in satisfactory condition, it may be reused.

(20) Press out the rear bearing from the rear housing using the tube or collar that fits inside the bearing housing. Press from inside of the housing toward the outside.

Replace the rear bearing if its lubricant supply is exhausted. Do not attempt to lubricate and reuse a dry bearing.

Cleaning And Inspection

CAUTION: DO NOT clean the rotor with a degreasing solvent.

(2) Inspect the slip rings for contamination and roughness. Clean with solvent. If necessary, clean and finish the slip rings with commutator paper, or 400 grit (or finer) polishing cloth.Do not use metal-oxide paper. Spin the rotor in a lathe or other rotating support while holding the abrasive against the rings.

When using an abrasive, support the rotor while spinning to clean the slip rings evenly. Cleaning the slip rings without support may result in flat spots on slip rings. This will cause brush noise and premature brush wear.

(3) True rough or out-of-round slip rings in a lathe to 0.051 mm (0.002 in.) maximum gauge indication. Remove only enough material to make the rings smooth and round. Finish with commutator paper, or 400 grit (or finer) polishing cloth, and blow away all dust.

CAUTION: DO NOT clean the stator with a degreasing solvent.

(4) Clean the stator by brushing with oleum spirits, or equivalent.

(5) Inspect the brush springs for damage or corrosion. Replace the springs, if there is any doubt about their condition.

(6) Inspect the brushes for wear or contamination. If the brushes are to be reused, clean them with a soft, dry cloth until it is completely free of lubricant.

(7) Inspect the condition of the brush holder screw insulating washer/sleeves for broken or cracked insulation (Fig. 2).

(8) Thoroughly clean the bridge rectifier, diode trio and voltage regulator with a brush and high pressure air.

Assembly

CAUTION: Overfilling may cause the bearing to overheat.

(1) Fill the cavity between the retainer plate and front bearing one- quarter full with Delco lubricant No. 1948791, or equivalent.

(2) Assemble the slinger and bearing into the front housing.

(3) Press the bearing into the housing with the appropriate tube or collar that fits over the outer bearing race.

Install a replacement retainer plate if the felt seal in the retainer plate has hardened.

(4) Install the inner collar, retainer plate and screws.

(5) Position the housing, outer collar, fan, pulley and washer on the rotor shaft and install the pulley nut.

(6) Place the rotor in a vise (Fig. 1). Tighten the vise only enough to permit tightening of pulley nut. Tighten the nut with 68 N•m (50 ft-lbs) torque.

(7) An alternate method of tightening the pulley nut requires the use of an Allen wrench to prevent the rotor from turning while tightening the nut with a torque wrench.

(8) If the rear bearing was removed, support the inside of the rear housing with a hollow cylinder.

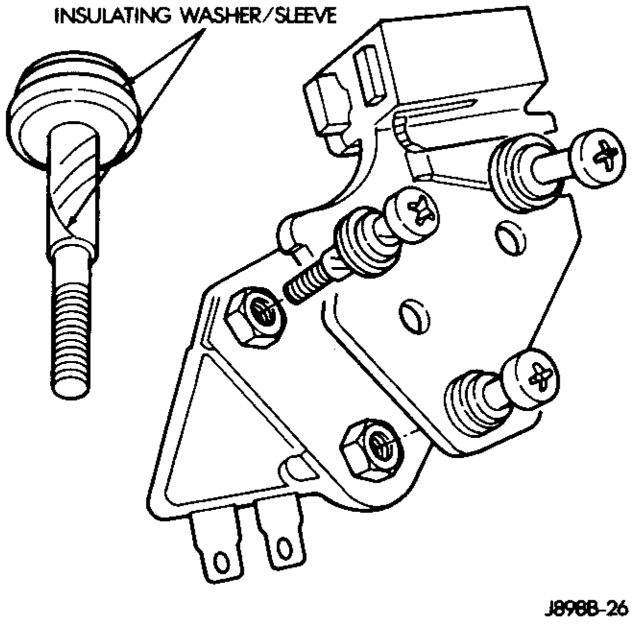


Fig. 2 Brush Holder Screws

CAUTION: Use extreme care to avoid misalignment or placing undue stress on the bearing.

(9) Place a flat plate over the bearing and press the bearing into the housing from the outside until the bearing is flush with the housing.

(10) Install a replacement bearing seal. Lightly lubricate the lip with oil to facilitate installation of the rotor shaft. Press the seal into the housing with the lip away from the bearing.

(11) Install the springs and brushes into the brush holder. The brushes should slide in and out of the brush holder without binding.

Should any of the brush holder assembly parts require replacement, it is necessary to replace the entire brush holder assembly. Individual parts are not serviced.

(12) Insert a straight wooden or plastic toothpick (to prevent scratching the brushes) into the hole at the bottom of the holder to retain the brushes.

(13) Install the voltage regulator.

(14) Attach the brush holder to the rear housing. Carefully note the correct locations for insulating the washer/sleeves. Allow the toothpick to protrude through the hole in the rear housing.

(15) Install the diode trio terminal strap attaching screw and insulating washer.

(16) Tighten the remaining two brush holder screws securely.

(17) Position the bridge rectifier on the rear housing with the insulator inserted between the insulated heat sink and the rear housing.

(18) Install the bridge rectifier attaching screw and battery wire (output) terminal stud.

(19) Connect the capacitor wire terminal to the bridge rectifier and tighten the screw securely.

(20) Install the capacitor holddown screw.

(21) Position the diode trio strap terminals on the bridge rectifier terminal studs.

(22) Install the stator in the rear housing.

(23) Attach the stator winding terminal to the bridge rectifier terminal studs. Secure with washers and nuts.

(24) Before joining the rotor and the front housing assembly with the stator and rear housing assembly, remove the protective tape and ensure that the bearing surface of the shaft is clean.

(25) Join the front housing and rear housing together with the scribe mark aligned.

(26) Install the four through-bolts and tighten securely.

(27) Remove the toothpick from the brush holder assembly. Rotate the rotor.

IGNITION

CONTENTS

GENERAL INFORMATION

INDEX

DISTRIBUTOR CAP

Inspection

Remove the distributor cap and wipe it clean with a dry lint free cloth. Visually inspect the cap for cracks, carbon paths, broken towers, white deposits on the inside (caused by condensation entering the cap through cracks), and damaged rotor button (Fig. 1 and Fig. 2). Replace any cap that displays charred or eroded terminals. The machined surface of a terminal end (faces toward rotor) will indicate some evidence of erosion from normal operation. Examine the terminal ends for evidence of mechanical interference with the rotor tip.

If replacement of the distributor cap is necessary, **transfer sparkplug wires from the original cap to the new cap one at a time. Ensure that each wire is installed into the tower of the new cap that corresponds to its tower position in the original cap. Fully seat the wires into the towers.**

If necessary, refer to the appropriate engine firing diagram (Figures 3, 4, 5).

DISTRIBUTOR ROTOR

Visually inspect the rotor for cracks, evidence of corrosion and the effects of arcing on the metal tip, and evidence of mechanical interference with the cap (Fig. 6). Some charring is normal on the end of the metal tip. The silicone dielectric compound applied to the rotor tip for radio interference noise suppression (six-and eight-cylinder engines) will appear charred. This is normal. **Do not remove the charred compound. Test the spring for insufficient tension. Replace a rotor that displays any of the adverse conditions. Coat the tip of a replacement rotor with Jeep/Eagle Silicone Dielectric Compound or equivalent.**

DISTRIBUTORS

2.5L and 4.0L Engines

The distributors used in 2.5L and 4.0L engines do not have built in centrifugal or vacuum assisted advance. Ignition timing advance is controlled by the Engine Control Unit (ECU). These distributors are locked in

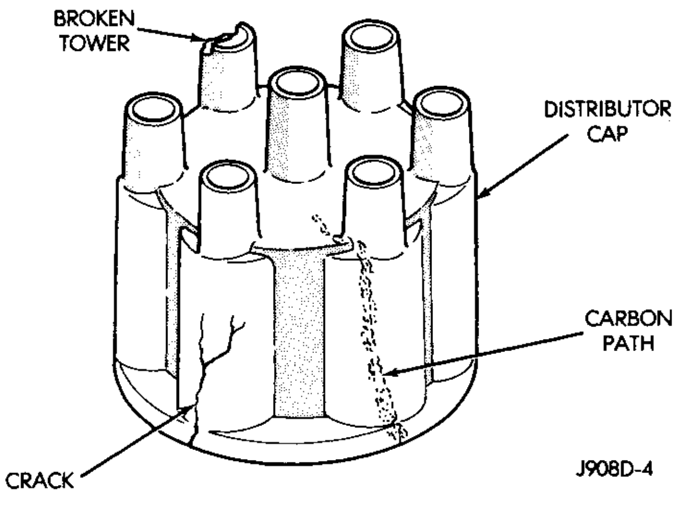


Fig. 1 Distributor Cap Inspection—External

place by an ear on the distributor housing that the hold down bolt passes through when the distributor is installed.

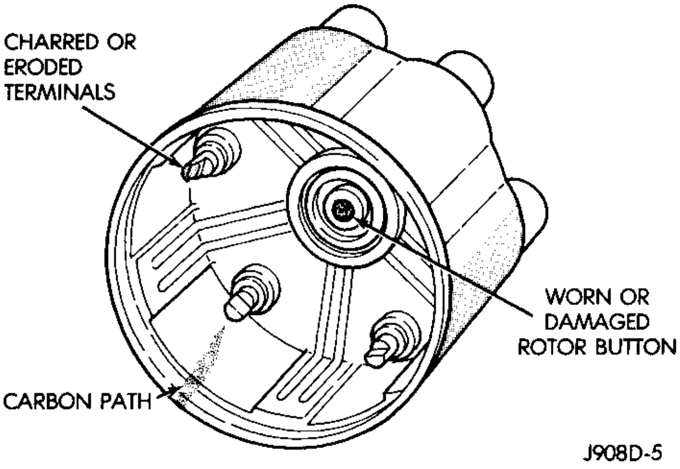


Fig. 2 Distributor Cap Inspection—Internal

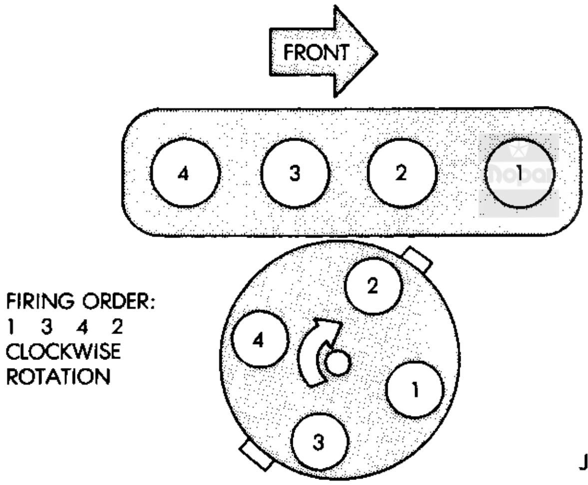


Fig. 3 Engine Firing Order—2.5L

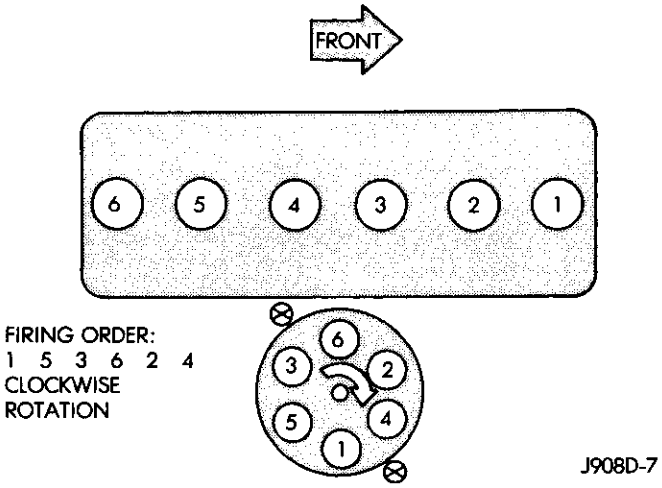


Fig. 4 Engine Firing Order—4.0L and 4.2L

4.2L Engines

The distributor used in 4.2L engines are equipped with centrifugal and vacuum assisted advance. Ignition timing is controlled through the engine Microprocessor Control Unit (MCU).

5.9L Engines

The distributor used in 5.9L engines are equipped with centrifugal and vacuum assisted advance to advance the engine timing the correct number of degrees during engine operation.

SPARK PLUG CABLES

Spark Plug cables are sometimes referred to as secondary ignition wires. The wires transfer electrical current from the distributor to individual spark plugs at

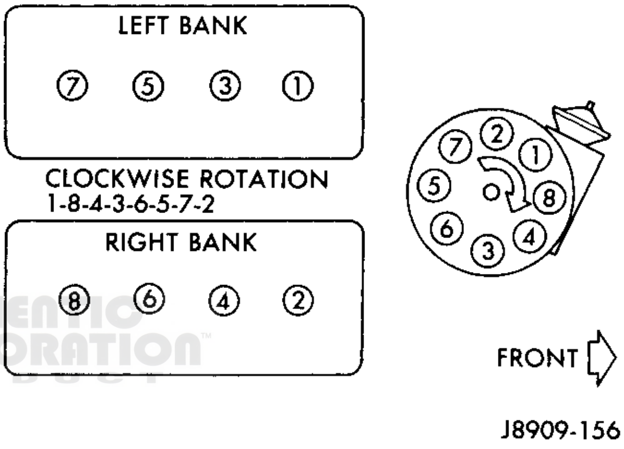


Fig. 5 Engine Firing Order—5.9L

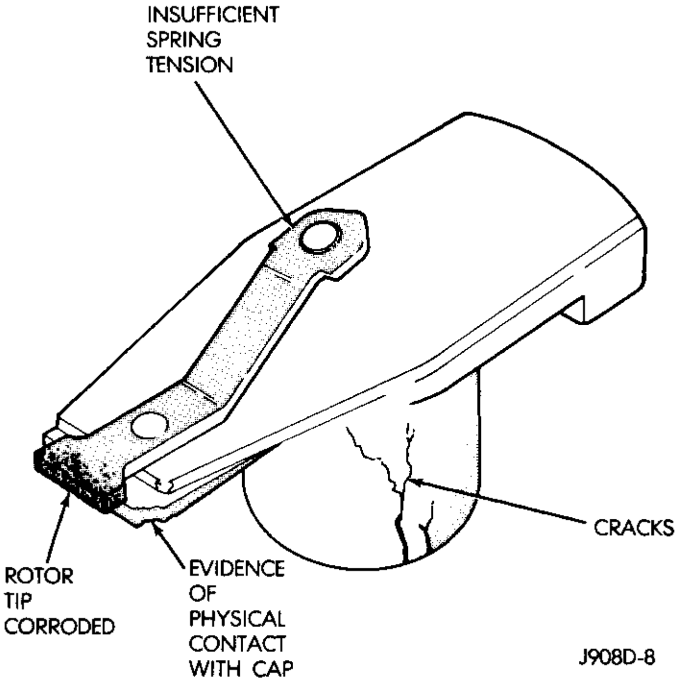


Fig. 6 Distributor Rotor Inspection—Typical

each cylinder. The spark plug cables are of nonmetallic construction and have a built in resistance. The cables provide suppression of radio frequency emissions from the ignition system.

Check the high-tension cable connections for good contact at the ignition coil, distributor cap towers and spark plugs. Terminals should be fully seated. The terminals and spark plug covers should be in good condition. Terminals should fit tightly to the ignition coil, distributor cap, and spark plugs. The spark plug cover (boot) of the cable should fit tight around the spark plug insulator. Loose cable connections can cause corrosion and increase resistance resulting in shorter cable service life. To maintain proper sealing at the terminal connections, the connections should not be broken unless they are damaged or testing indicates that high resistance, an open circuit, or other damage.

Clean high tension cables with a cloth moistened with a nonflammable solvent and wipe dry. Check for brittle or cracked insulation.

When testing secondary cables for damage with an oscilloscope, follow the instructions of the equipment manufacturer.

If an oscilloscope is not available, spark plug cables may be tested as follows:

CAUTION: Do not leave any one spark plug cable disconnected for longer than necessary during testing or possible heat damage to the catalytic converter will occur. Total test time must not exceed ten minutes.

With the engine not running, connect one end of a test probe to a good ground. Start the engine and run the other end of the test probe along the entire length of all spark plug cables. If cables are cracked or punctured, there will be a noticeable spark jump from the damaged area to the test probe. The cable running from the coil to the distributor cap can be checked in the same manner. Cracked, damaged or faulty cables should be replaced with resistance type cable which can be identified by the words "Electronic Suppression" printed on the cable jacket.

Use an Ohmmeter (tool C-4845 or an equivalent) to test for open circuits, excessive resistance or loose terminals. Remove the distributor cap from the distributor—Do not remove cables from cap. Remove cable from spark plug. Connect ohmmeter to spark plug terminal of cable and to corresponding electrode in distributor cap. Resistance should be within specifications shown in the resistance chart. If not, remove cable from distributor cap tower and connect ohmmeter to the terminal ends of cable. If resistance is still not within specifications, replace the cable. Test all spark plug cables in this manner.

To test coil to distributor cap cable, do not remove the cable from the cap. Connect the ohmmeter to the rotor button (center contact) and the terminal at the coil end of the cable. If resistance is not within specifications in the resistance chart, remove the cable from the distributor cap and connect the ohmmeter to the terminal ends of the cable. If resistance is still not within specifications, replace the cable. Inspect the coil tower for cracks, corrosion or oil leaks.

SPARK PLUG AND COIL CABLE RESISTANCE VALVES

INCHES	Ohms
0 to 15	3,000 to 10,000
15 to 25	4,000 to 15,000
25 to 35	6,000 to 20,000
Over 35	8,000 to 25,000

J908D-9

Replace cables one at a time to ensure that the correct firing order is maintained. Route the new cables in the same manner as the original cables keeping them away from accessory drive pulleys and exhaust manifolds securing them in the proper retainers.

To remove cables from spark plugs, twist the rubber protector boot approximately 1/2-turn to break the seal. Grasp the boot and pull it from the plug with a straight and steady pull. Do not pull on the wire itself because this will damage the conductor and terminal connection. Do not use pliers to remove the cable.

To remove cables from the distributor cap or ignition coil tower, loosen the boot first, then grasp the upper part of the boot and the cable and gently pull straight up.

SPARK PLUGS

Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order in which they were removed from the engine. An isolated plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in the maintenance chart in Group 0.

Spark plugs that have low milage may be cleaned and reused if not otherwise defective. Refer to the Spark Plug Condition section of this group. After cleaning, file the center electrode flat with a small point file or jewelers file. Adjust the gap between the electrodes to the specified dimension (Fig. 7). The gap for 2.5L, 4.0L and 4.2L engines is .88mm (.035 in). The gap for 5.9L engines is .84mm (.033 in).

Always tighten spark plugs to the specified torque. Over tightening can cause distortion resulting in a change in the spark plug gap. Tighten all spark plugs to 35 N•m (27 ft-lbs).

Spark Plug Condition

Normal Operating Conditions

The few deposits present will be probably light tan or slightly gray in color with most grades of commercial gasoline (Fig. 8). There will not be evidence of electrode burning. Gap growth will not average more than approximately 0.025 mm (.001 in) per 1600 km (1000 miles) of operation. Spark plugs that have normal wear can usually be cleaned, have its electrodes filed and regapped, and then reinstalled.

Some fuel refiners in several areas of the United States have introduced a manganese additive (MMT) for unleaded fuel. During combustion, fuel with MMT causes the entire tip of the spark plug to be coated with a rust colored deposit. This rust color can be misdiagnosed as being caused by coolant in the combustion chamber. Spark plug performance is not affected by MMT deposits.

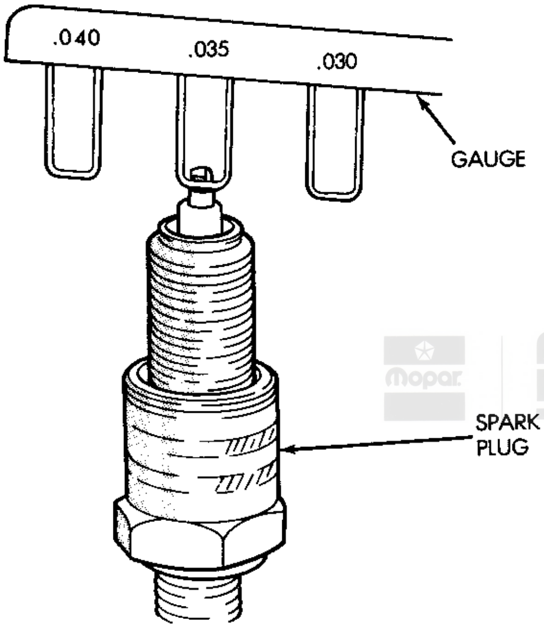


Fig. 7 Setting Spark Plug Gap - Typical

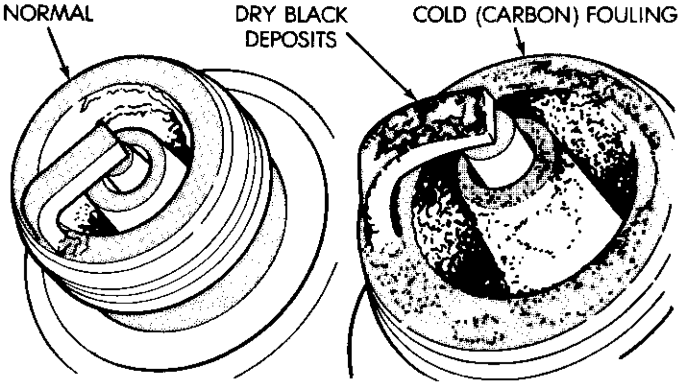


Fig. 8 Normal Operation and Cold (Carbon) Fouling

Cold Fouling (Carbon Fouling)

Cold fouling is sometimes referred to as carbon fouling because the deposits that cause cold fouling are basically carbon (Fig. 8). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or defective spark plug cables. Cold (carbon) fouling of the entire set may be caused by a clogged air cleaner, a sticking exhaust manifold heat valve (5.9L engine only) or a faulty carburetor choke (4.2L and 5.9L engines).

Electrode Gap Bridging

Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, the deposits partially liquefy and bridge the gap between the electrodes (Fig. 9). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using standard procedures.

Scavenger Deposits

Fuel scavenger deposits may be either white or yellow (Fig. 10). They may appear to be harmful, but this is a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation on the ground electrode and shell area may be heavy but the deposits are easily removed. Spark plugs with scavenger deposits can be considered normal in condition and can be cleaned using standard procedures.

Chipped Electrode Insulator

A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe

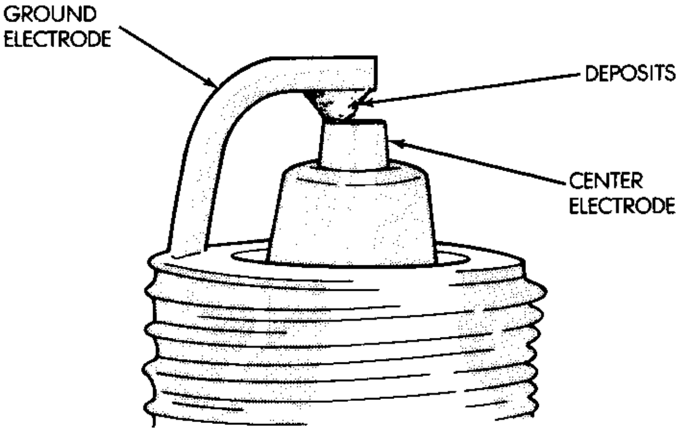


Fig. 9 Electrode Gap Bridging

detonation can also separate the insulator from the center electrode (Fig. 11). Spark plugs with this condition must be replaced.

Preignition Damage

Preignition damage is caused by excessive combustion chamber temperature. First, the center electrode dissolves the ground electrode dissolves somewhat latter (Fig. 12). Insulators appear relatively deposit free. Determine if the spark plug has the correct heat range rating for the engine, if ignition timing is over advanced or if other operating conditions are causing engine overheating. (The heat range rating refers to the operating temperature of a particular type spark plug. Spark plugs are designed to operate within specific temperature ranges depending upon the thickness and length of the center electrodes porcelain insulator.)

Spark Plug Overheating

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 13). The increase in electrode gap will be considerably in excess of 0.001 in per 1000 miles of operation. This suggests that a plug with a cooler heat range rating should be used. Over advanced ignition timing, detonation and cooling system malfunctions can also cause spark plug overheating.

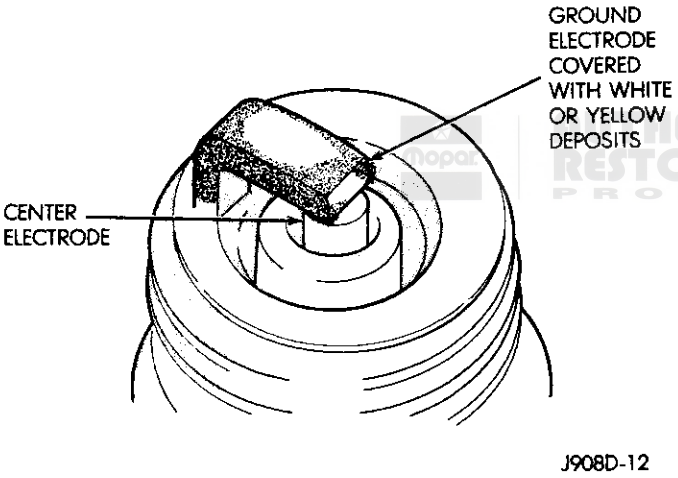


Fig. 10 Scavenger Deposits

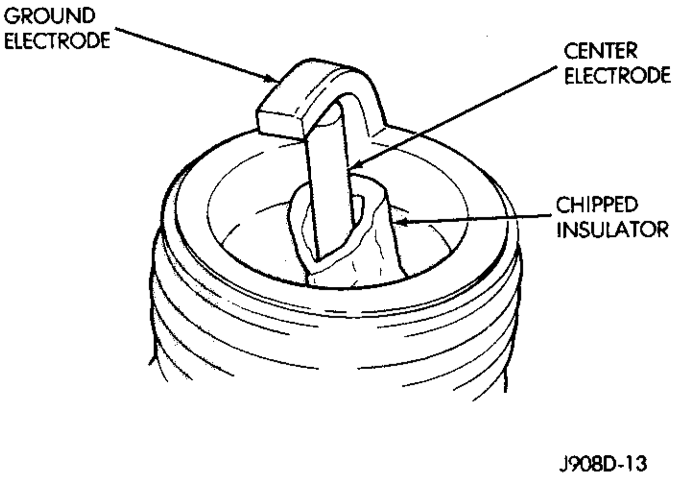


Fig. 11 Chipped Electrode Insulator

Spark Plug Service

Use care when disconnecting the spark plug and coil cable boots and cables. Twist the boot 1/2 turn and pull on the boot only to disconnect the cable.

When replacing the spark plug and coil cables, route the cables correctly and secure them in the appropriate retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

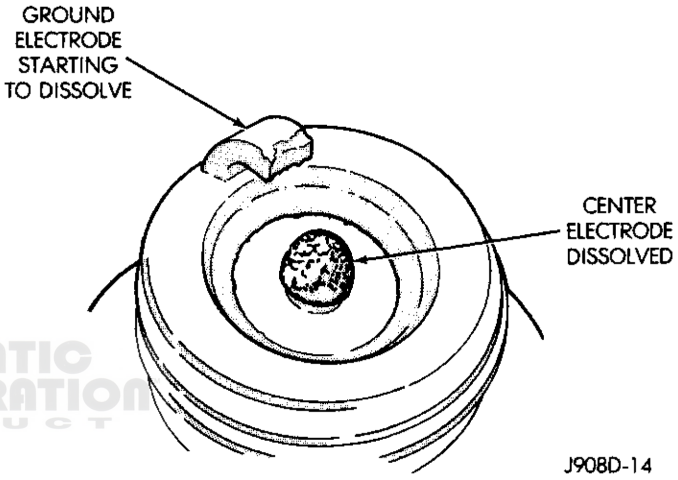


Fig. 12 Preignition Damage

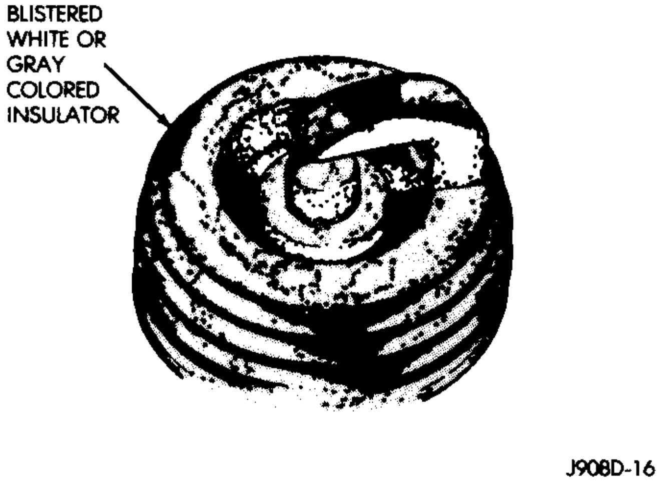


Fig. 13 Spark Plug Overheating

Spark Plug Removal

Always remove the spark plug cable by grasping at the spark plug boot turning the boot 1/2 turn and pulling straight back in a steady motion.

(1) Prior to removing the spark plug spray compressed air around the spark plug hole and the area around the spark plug.

(2) Remove the spark plug using a quality socket with a rubber or foam insert.

(3) Inspect the spark plug condition. Refer to Spark Plug Condition in this section.

Spark Plug Gap Adjustment

(1) Check the spark plug gap with a gap gauge. If the gap is not correct, adjust it by bending the ground electrode (Fig. 7).

Spark Plug Installation

(1) Start the spark plug into the cylinder head by hand to avoid cross threading.

(2) Tighten the spark plugs to 35 N•m (27 ft-lbs) torque.

(3) Install spark plug cables over spark plugs.

2.5L FOUR-CYLINDER ENGINE

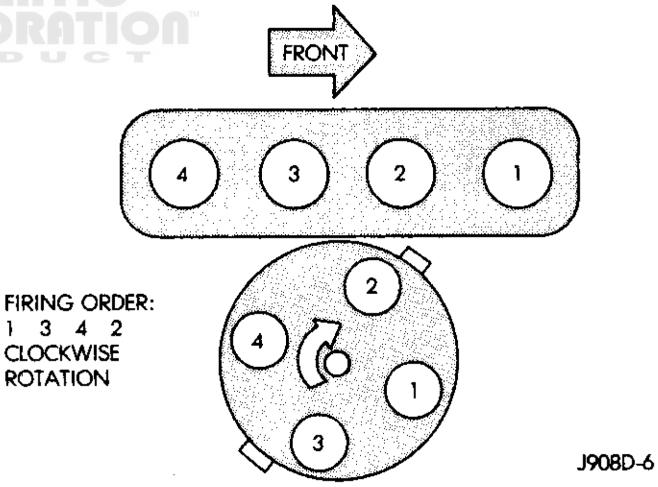
INDEX

SPARK PLUG SPECIFICATIONS

ENGINE	PLUG TYPE	ELECTRODE GAP	SPARK PLUG TIGHTENING TORQUE
2.5L	RC-12 LYC	0.88 mm (0.035 in.)	37 N•m (27 ft-lbs)

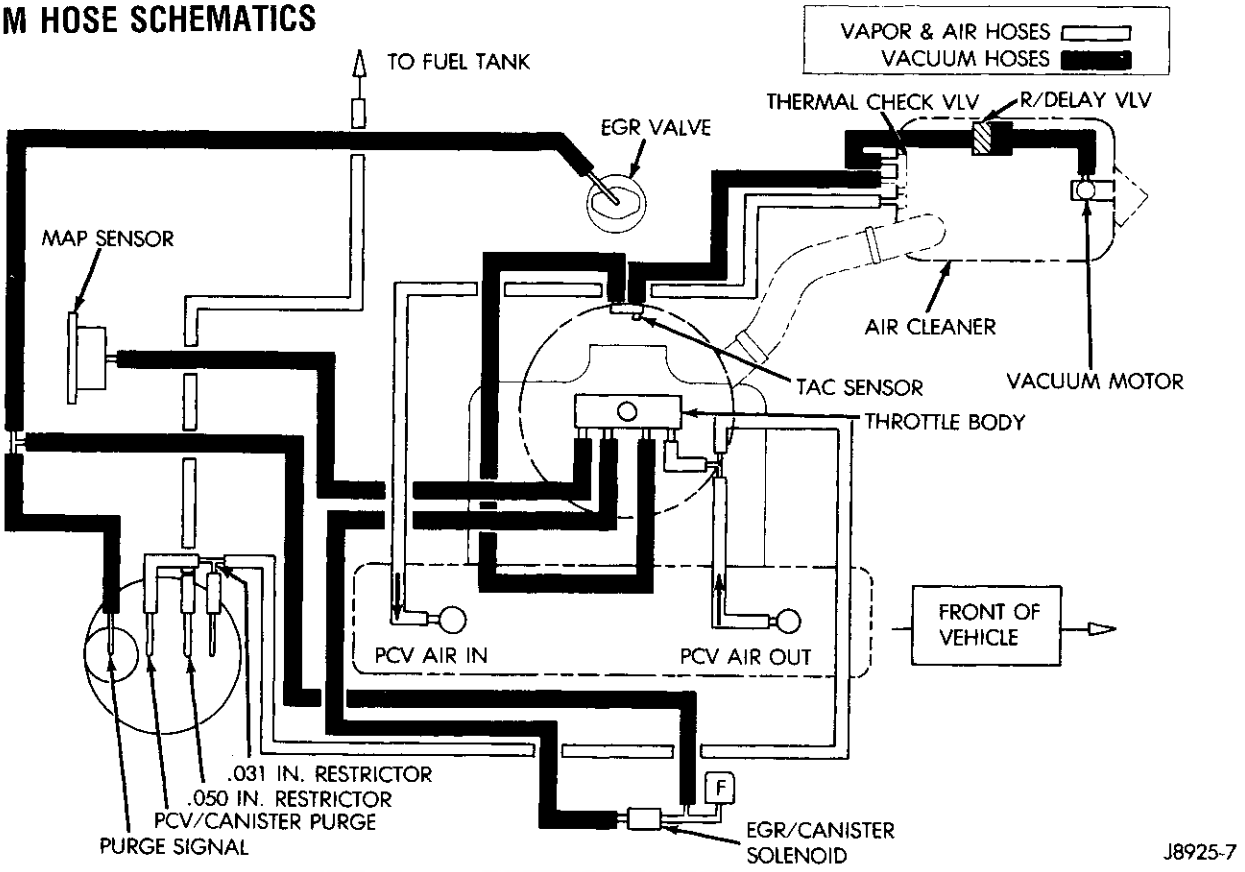
J898D-1

ENGINE FIRING ORDER

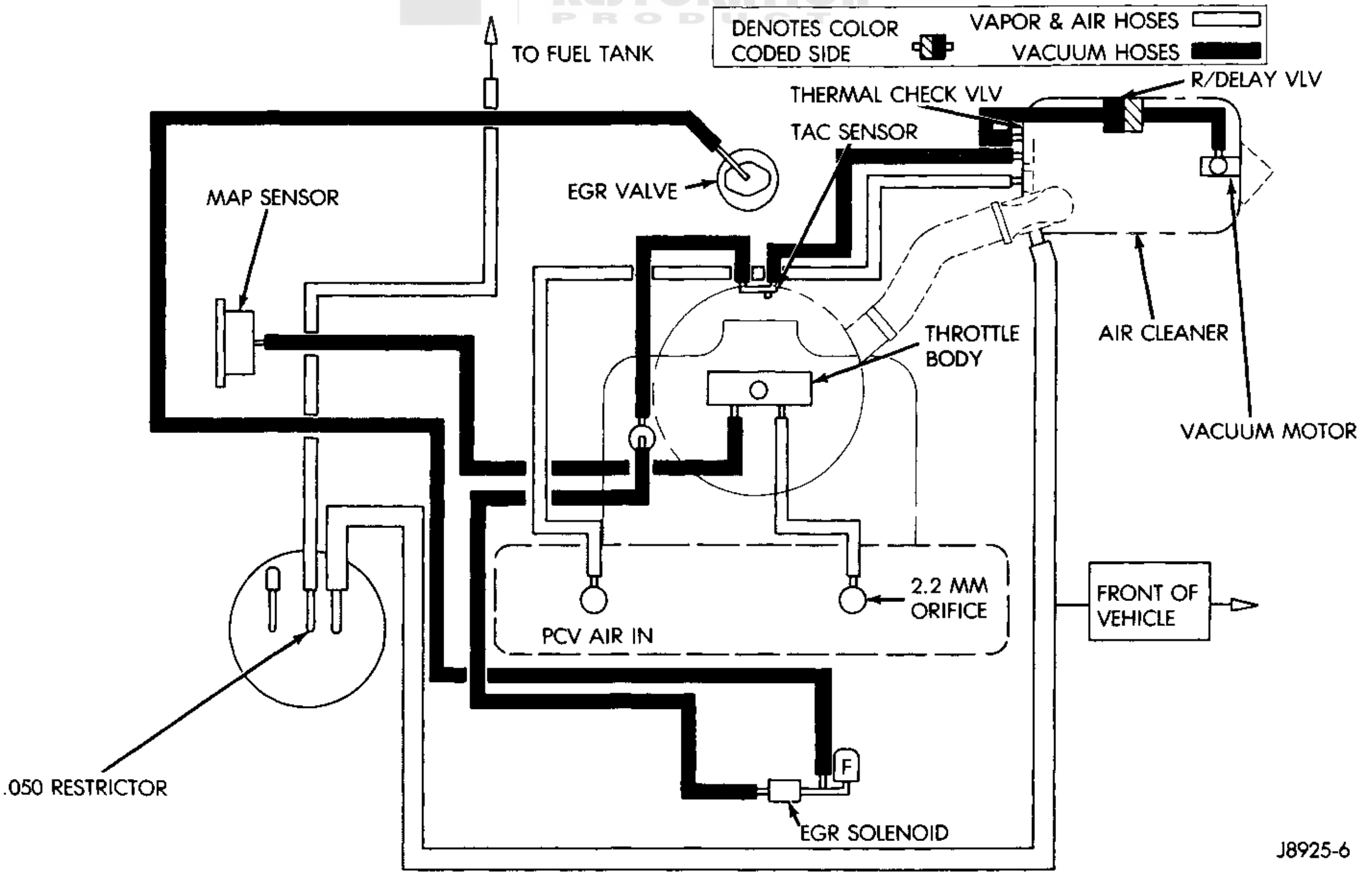


J908D-6

VACUUM HOSE SCHEMATICS



Vacuum Routing Schematic - 2.5L YJ



Vacuum Routing Schematic - 2.5L MJ and XJ

GENERAL INFORMATION

The 2.5L engine is a single point, throttle body fuel injected engine used MJ, YJ, and XJ vehicles. The ignition system is controlled by the engine Electronic Control Unit (ECU). The ignition system for the 2.5L consists of:

- Solid-state ignition control module.
- Ignition distributor that contains a rotor.
- Electronic control unit (ECU).

IGNITION CONTROL MODULE (ICM)

The solid-state Ignition Control Module (ICM—Fig. 1) is mounted on the right-hand side of the shock tower area in MJ and XJ vehicles and left of the battery on the dash panel in YJ vehicles.

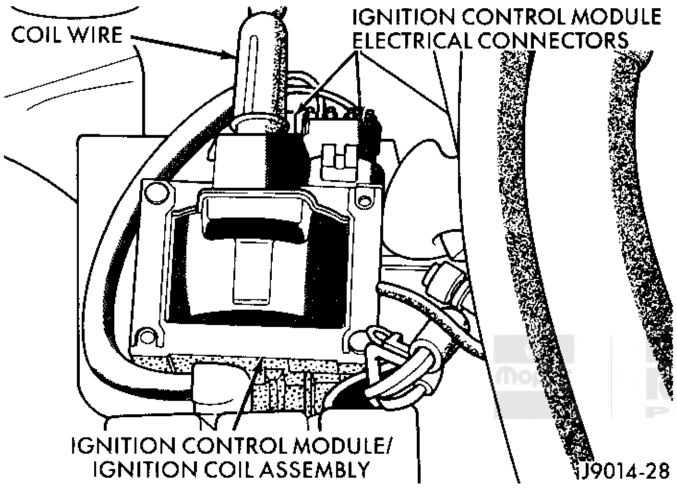


Fig. 1 Ignition Control Module—Typical

The ICM consists of a solid-state ignition circuit and an integrated ignition circuit and an integrated ignition coil that can be removed and serviced separately if necessary.

Ignition advance/retard is controlled electronically by the Electronic Control Unit (ECU). Electronic signals from the ECU to the ICM determine the amount of ignition timing advance, or retard, needed to meet various engine load requirements.

The ECU provides an input signal to the ICM. The ICM has only two outputs:

- Tach signal to the tachometer and diagnostic connector
- High voltage from the coil to the distributor cap

ICM CONNECTIONS

Electrical feed to the ICM is through terminal A of Connector No.1 on the module (Fig.2).

Electrical feed only occurs with the ignition switch in the START and RUN positions.

Terminal B of Connector No.1 is grounded at the engine oil dipstick bracket along with the ECU ground wire and oxygen (O_2) sensor ground.

The tachometer output signal wire of the ICM is connected to Pin No. 1 of the D1 diagnostic connector. The wire is routed to the diagnostic connector through a short section of the ECU harness, the engine and instrument panel harness. This type of routing eliminates any potential electrical interference in the various ECU circuitry.

Ignition firing signal from ECU terminal 27 are transmitted through terminal B of Connector No. 2 on the ICM. The ignition signal from the ECU is received by the ICM in the form of a 5 volt square wave. As the

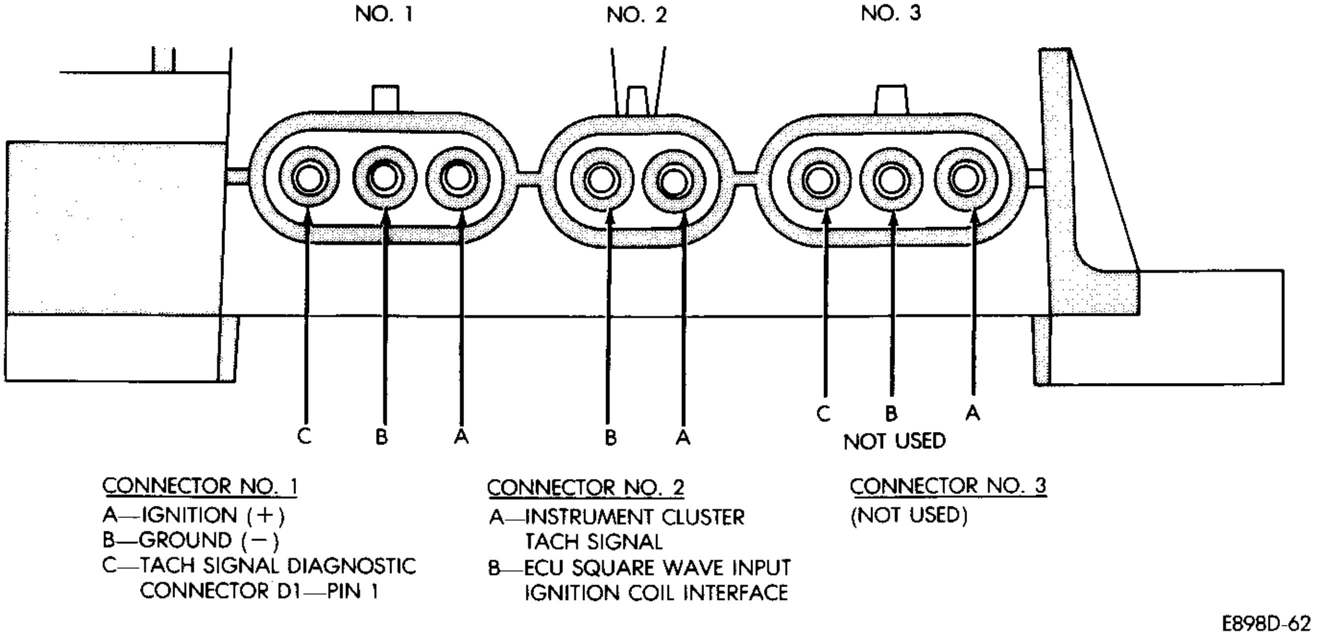


Fig. 2 ICM Connections

leading edge of the wave contacts the ignition circuitry the ICM, the ICM charges the coil primary windings.

When coil saturation occurs, the module circuitry opens the primary windings to collapse the magnetic field in the windings. This induces the high voltage in the coil secondary windings which is then transmitted to the spark plugs via the coil wire, distributor cap, and rotor.

ECU

The amount of electronic spark advance provided by the ECU is determined by five input factors, coolant temperature, engine rpm, manifold air temperature, manifold absolute pressure and throttle position (TPS).

Coolant Temperature Sensor (CTS)

The Coolant Temperature Sensor (Fig. 3) is installed in the intake manifold coolant jacket and provides an input voltage to the ECU. As coolant temperature varies the Coolant Temperature Sensors resistance changes resulting in a different input voltage to the ECU. Based on this input the ECU will:

- Adjust the injector pulse width. Colder coolant temperatures will result in longer injector pulse width and richer air-fuel mixtures.
- Compensate for fuel condensation in the intake manifold.
- Control engine warm-up idle speed.
- Increase the ignition advance when the coolant is cold.
- Energize the EGR valve solenoid thus preventing the flow of vacuum to the EGR valve.

Manifold Air Temperature (MAT) Sensor

The Manifold Air Temperature (MAT) sensor (Fig. 4) is installed in the intake manifold with sensor element extending into the air-fuel stream. The MAT sensor provides an input voltage to the ECU. As the temperature of the air-fuel stream in the manifold varies, the MAT sensors resistance changes resulting a different input voltage to the ECU.

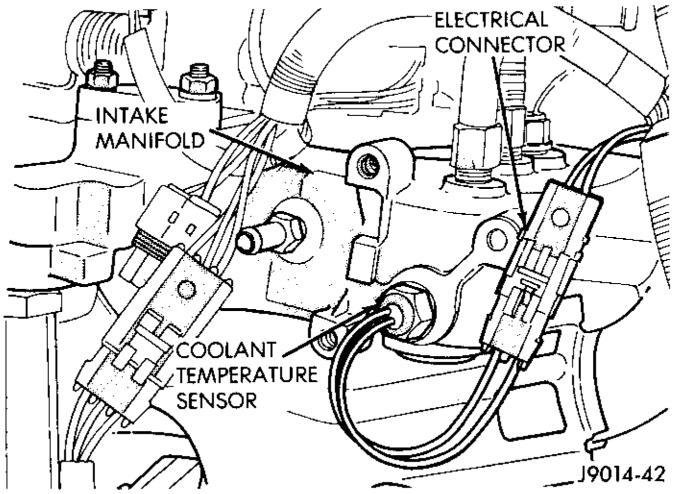


Fig. 3 Coolant Temperature Sensor

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor (Fig. 5) reacts to absolute pressure in the intake manifold and provides an input voltage to the ECU. As engine load changes manifold pressure varies, causing the MAP sensors resistance to change. The change in MAP sensor resistance results in a different input voltage to the ECU. The input voltage level supplies the ECU with information relating to ambient barometric pressure during engine start-up (cranking) and to engine load while the engine is running. The ECU computes this information and adjusts air-fuel mixture accordingly.

The MAP sensor is mounted under the hood on the dash panel and is connected to the throttle body with a vacuum hose.

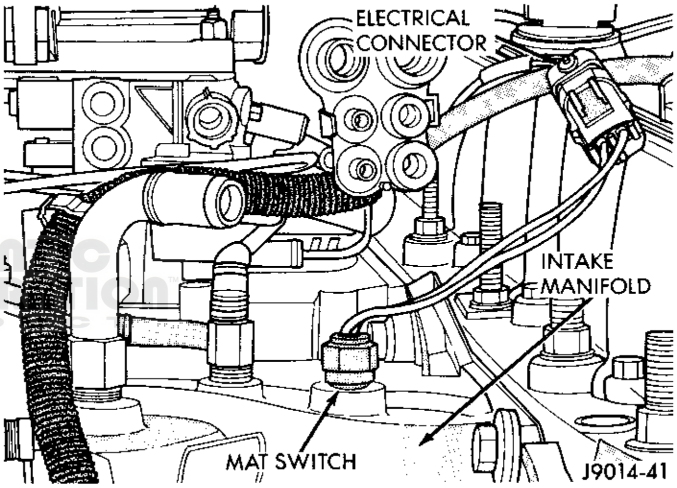


Fig. 4 Manifold Air Temperature Sensor

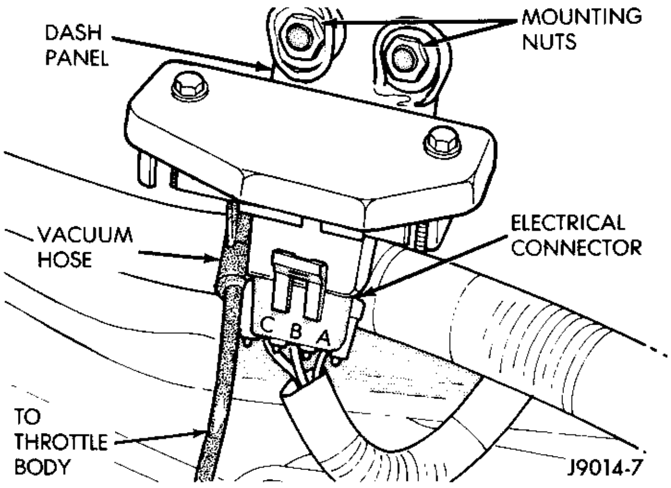


Fig. 5 MAP Sensor

Engine Speed Sensor (Crankshaft Position Sensor—CPS)

The engine speed sensor (Fig. 6) is attached to the flywheel/drive plate housing. The sensor detects the flywheel/drive plate teeth as they pass during engine operation and provides engine speed and crankshaft angle (position) information to the ECU.

The flywheel/drive plate has a large trigger tooth and notch located 90 degrees before each top dead center (TDC) position. There are 12 small teeth between the notch and TDC (Fig. 7).

When a small tooth and notch pass under the magnetic core in the sensor, the concentration and then collapse of the magnetic flux induces a small voltage (spike) into the sensor pick-up coil winding. These small voltage spikes enable the ECU to count the teeth as they pass the sensor.

When a large trigger tooth and notch pass under the magnet core in the sensor, the increased concentration and then collapse of the magnetic flux induces a higher voltage (spike) into the sensor pick-up coil winding (Fig. 8).

The higher voltage (spike) indicates to the ECU that a piston will be at the TDC position 12 teeth later. The ignition timing for the cylinder is either advanced or retarded as necessary by the ECU according to the sensor inputs.

Throttle Position Sensor (TPS)

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle valve shaft. The sensor is a variable resistor that provides the ECU with an input voltage that represents throttle valve position. Input voltage to the ECU from the TPS varies in an approximate range of from 1 volt at minimum throttle opening (idle) to 5 volts at wide open throttle. The ECU uses TPS input voltage to determine current engine operating conditions.

There are two different Throttle Position Sensors, one used with manual transmissions (Fig. 9) and one used with automatic transmissions (Fig. 10). The TPS used with automatic transmissions has two integral wire harness connectors (one four pin connector and one three pin connector) that plug into the engine wire

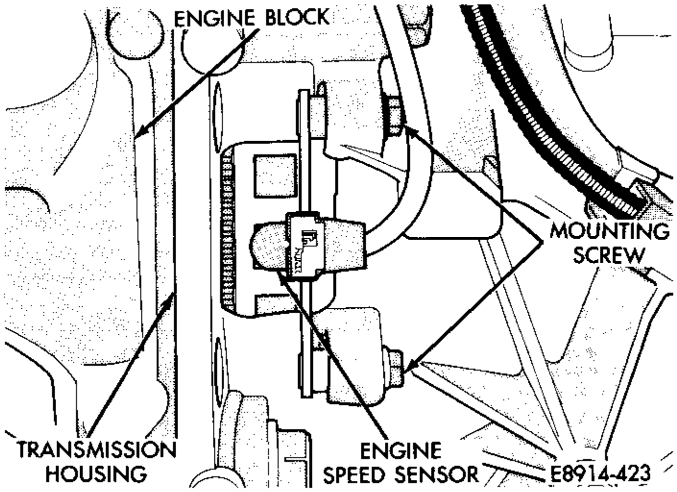


Fig. 6 Engine Speed Sensor

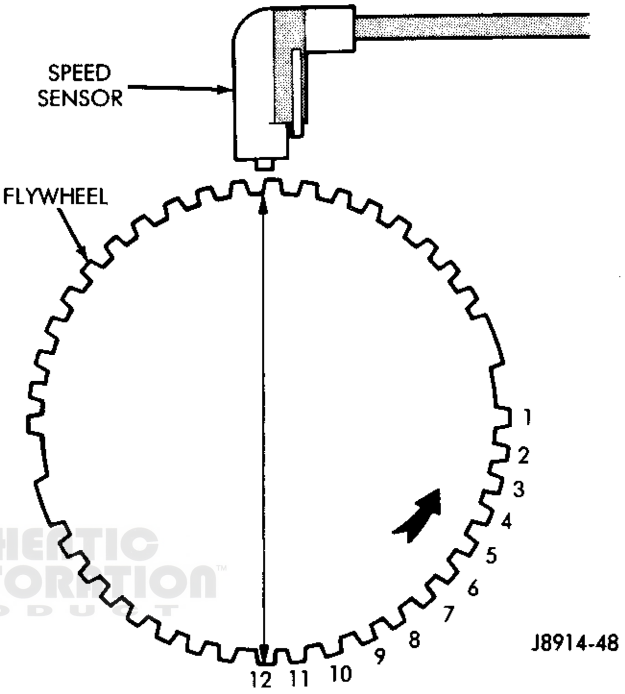


Fig. 7 Engine Speed Sensor and Flywheel

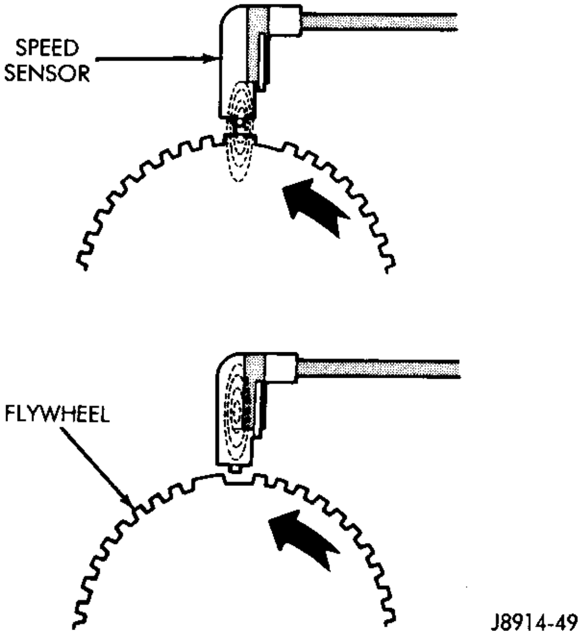


Fig. 8 Engine Speed Sensor Operation

harness. The four pin connector supplies input to the ECU while the three pin connector supplies input to the Transmission Control Unit. The TPS used with manual transmissions does not have an integral wire harness connector. The engine wire harness connects directly to the TPS used with manual transmissions.

DIAGNOSTIC PROCEDURES

Diagnostic Connector

The diagnostic connector allows the following test to be conveniently made right at the connector:

- Primary Circuit Test (D1-2) B+ after ignition
- Engine RPM Test (tachometer voltage) (D1-1)

Use D1-3 for vehicle ground.

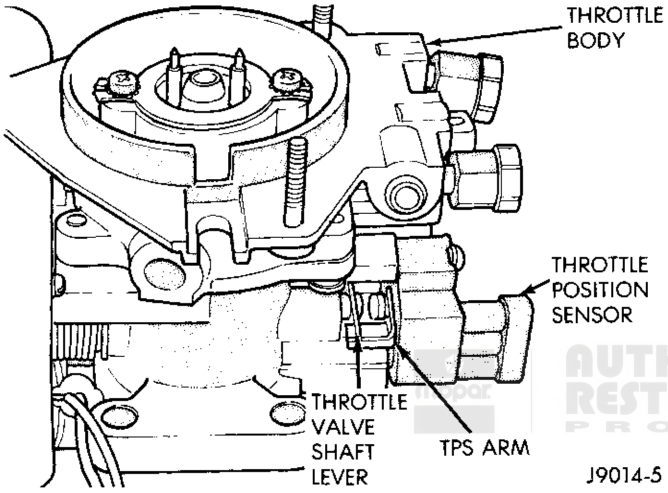


Fig. 9 Throttle Position Sensor—with Manual Transmission

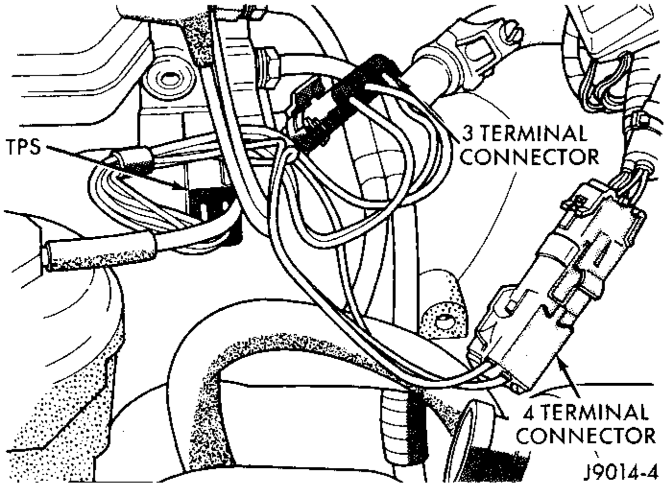


Fig. 10 Throttle Position Sensor—with Automatic Transmission

Secondary Circuit Diagnosis

CAUTION: When disconnecting a high voltage wire from a spark plug or from the distributor cap, twist the rubber boot slightly to break it loose. Grasp the boot, not the wire, and pull it off with a steady, even force.

Disconnect the ignition coil wire from center tower of the distributor cap. Use insulated pliers to hold a wire terminal approximately 12 mm (1/2 in.) from the cylinder block, head, or intake manifold.

WARNING: BE VERY CAREFUL WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE FITTING CLOTHING.

Rotate the engine with the starter motor and observe the wire terminal for an arc.

If an arc occurs, connect the ignition coil wire to the distributor cap by removing a wire from one spark plug.

Use insulated pliers to hold the wire terminal 12 mm (1/2 in.) from the engine cylinder head or block while rotating the engine with the starter motor. Observe the wire terminal for an arc.

If an arc occurs, inspect the fuel system for problems or the ECU sensors, using the DRB II tester, which may indicate incorrect ignition timing.

If no arc occurs, inspect for a defective rotor or distributor cap, or for defective spark plug wires.

Spark Plugs

Faulty or fouled plugs may perform well at idle speed, but at higher engine speeds they frequently fail. Faulty plugs can be identified in a number of ways: poor fuel economy, power loss, decrease in engine speed, hard starting and, in general, poor engine performance.

Spark plugs also malfunction because of carbon fouling, excessive electrode air gap, or a broken insulator.

Coolant Temperature Sensor Test

Disconnect the wire harness connector from the coolant temperature sensor (Fig. 3).

Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance should be less than 1000 with the engine warm. Refer to the resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

Test the resistance of the wire harness between ECU wire harness connector terminal 15 and the sensor connector terminal, and terminal 32 to the sensor connector terminal. Repair the wire harness if an open circuit is indicated.

Coolant Temperature Sensor Temperature-to-Resistance Values (Approximate)

°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

J8914-89

Manifold Air/Fuel Temperature (MAT) Sensor Test

Disconnect the wire harness connector from the MAT sensor (Fig. 4).

Test the resistance of the sensor with a input impedance (digital) volt-ohmmeter. The resistance should be less than 1000 ohms with the engine warm. Refer to the resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

Test the resistance of the wire harness between the ECU wire harness connector terminal 32 and the sensor connector terminal, and terminal 14 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

Manifold Air/Fuel Temperature Sensor Temperature-to-Resistance Values (Approximate)

°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

J8914-90

Manifold Absolute Pressure (MAP) Sensor Test

Inspect the MAP sensor vacuum hose connections at the throttle body and sensor. Repair as necessary.

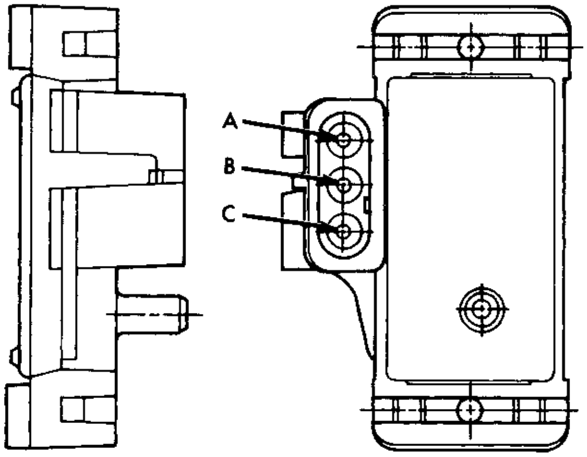
Test the MAP sensor output voltage at the MAP sensor connector terminal B (as marked on the sensor body) (Fig. 11) with the ignition switch ON and the engine OFF. Output voltage should be 4 - 5 volts. **The voltage should drop to 1.5 - 2.1 volts with a hot, neutral idle speed condition.**

Test ECU terminal 33 for the same voltage described above to verify the wire harness condition. Repair as necessary.

Test the MAP sensor supply voltage at the sensor connector terminal C with the ignition ON. The voltage should be 5 volts (±0.5V). Five volts (±0.5V) should also be at terminal 16 of the ECU wire harness connector. Repair or replace the wire harness as necessary.

Test the MAP sensor ground circuit at sensor connector terminal A and ECU connector terminal 17. Repair the wire harness if necessary.

Test the MAP sensor ground circuit at the ECU connector between terminal 17 and terminal 2 with an ohmmeter. If the ohmmeter indicates an open circuit, inspect for a defective sensor ground connection on the flywheel/drive plate housing near the starter motor. If the ground connection is good, replace the ECU. If terminal 17 has a short circuit to 12 volts, correct this condition before replacing the ECU.



A. Ground
B. Output Voltage
C. 5 Volts

J8914-91

Fig. 11 MAP Sensor Connector Terminals

Speed Sensor (Crankshaft Position Sensor-CPS) Test

Disconnect the speed sensor connector from the harness (Fig. 12).

Place an ohmmeter across terminals A and B (marked on connector). The meter reading should be 200±75 ohms (hot engine). Replace sensor if readings are not to specifications.

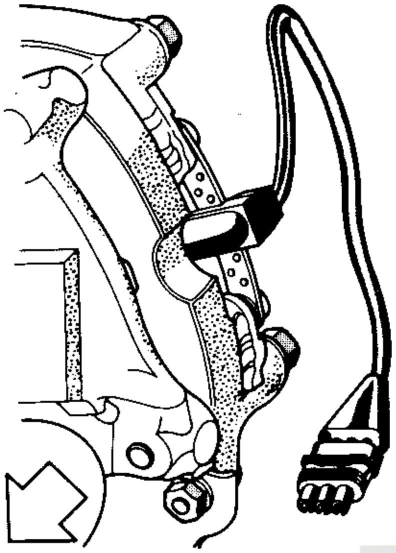
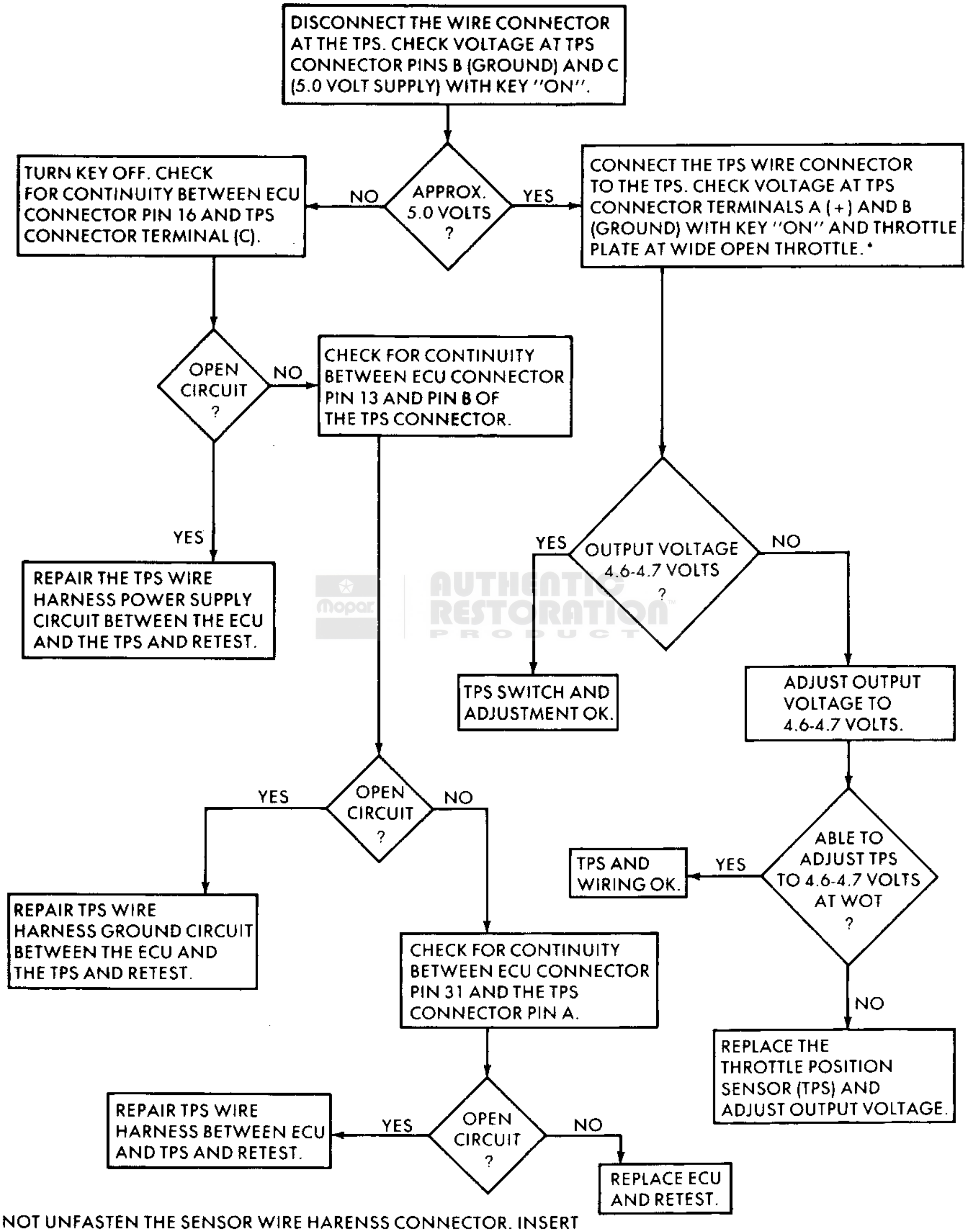


Fig. 12 Engine Speed Sensor

Throttle Position Sensor (TPS) Test

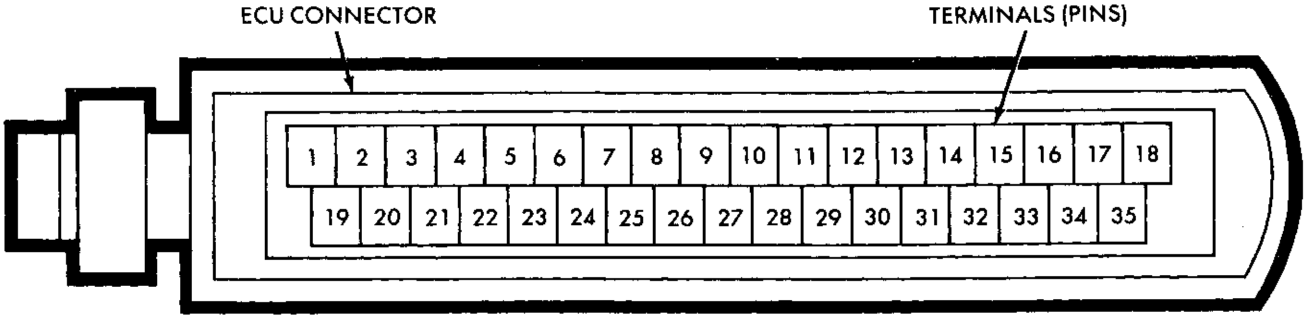


*DO NOT UNFASTEN THE SENSOR WIRE HARENSS CONNECTOR. INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS. ON SOME MODELS, IT MAY ALSO BE NECESSARY TO REMOVE THE THROTTLE BODY FROM THE INTAKE MANIFOLD, TO GAIN ACCESS TO THE SENSOR WIRE.

J8914-95

ECU Connector

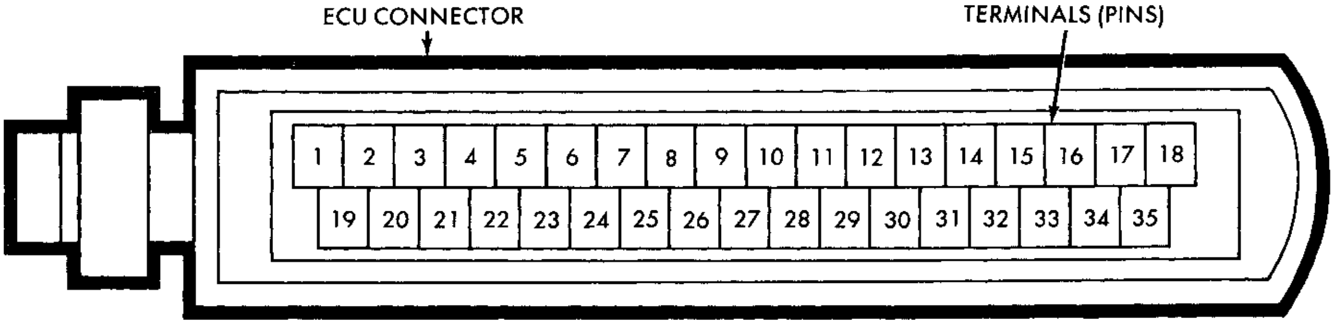
Terminal identification and specific circuit applications are detailed in the ECU connector charts (Figs. 13, 14).



1. Ground
2. Ground
3. Ignition Switch
4. Battery
5. EGR Valve/Canister Purge Solenoid
6. Fuel Pump Relay
7. B+ Latch Relay
8. WOT Switch
9. Not Used
10. System Ground
11. Speed Sensor (Crankshaft Position Sensor)
12. Park/Neutral Switch (auto. trans. only)
13. Throttle Position Sensor Ground
14. Manifold Air/Fuel Temperature Sensor
15. Coolant Temperature Sensor
16. 5.0 Volt Supply to Map Sensor and TPS Sensor
17. Manifold Absolute Pressure—Ground
18. Shift Lamp (manual trans. only)
19. System Power (B+)
20. Not Used
21. Injector
22. Not Used
23. ISA Motor Retract (reverse)
24. ISA Motor Extend (forward)
25. Closed Throttle (idle) Switch
26. Not Used
27. Ignition Control Module
28. Speed Sensor (Crankshaft Position Sensor)
29. Start Signal
30. A/C Request
31. Throttle Position Sensor
32. Temperature Sensor Ground
33. MAP Sensor Output
34. A/C Select
35. O$_2$ Sensor Input

J8914-88

Fig. 13 TBI ECU Connector Diagram - YJ



1. Ground
2. Ground
3. Ignition Switch
4. Battery
5. EGR Valve Vacuum Solenoid
6. Fuel Pump Relay
7. B + Latch Relay
8. Power Steering High Pressure Switch
9. Not Used
10. System Ground
11. Speed Sensor (Crankshaft Position Sensor)
12. Park/Neutral Switch (auto. trans. only)
13. Throttle Position Sensor Ground
14. Manifold Air/Fuel Temperature Sensor
15. Coolant Temperature Sensor
16. 5.0 Volt Supply to Map Sensor and TPS Sensor
17. Map Sensor Ground
18. Shift Lamp (manual trans. only)
19. System Power (B +)
20. Nut Used
21. Injector
22. A/C Compressor Clutch
23. ISA Motor Retract (reverse)
24. ISA Motor Extend (forward)
25. Closed Throttle (idle) Switch
26. Not Used
27. Ignition Control Module
28. Speed Sensor (Crankshaft Position Sensor)
29. Start Signal
30. A/C Select
31. Throttle Position Sensor
32. Temperature Sensor Ground
33. MAP Sensor Output
34. A/C Request
35. O_2 Sensor Input

Fig. 14 TBI ECU Connector Diagram - MJ and XJ J8914-87

Ignition System Diagnosis Chart

Condition	Possible Cause	Correction
WEAK SPARK OR NO SPARK AT PLUGS (ENGINE WILL NOT START).	(1) Loose or damaged coil rotor, distributor cap, ignition wires, or spark plugs.	(1) Refer to secondary circuit diagnosis. Replace as necessary.
	(2) Loose or dirty + or − wire connections at coil terminals.	(2) Clean terminals and wire connectors. Be sure wire connectors are properly seated **on** coil terminals and are not wedged between coil body and terminal.
	(3) Loose connectors at ICM or ECU.	(3) Verify that wire connectors are firmly plugged into ICM and/or ECU.
	(4) Loose or corroded battery ICM or ECU ground wire connections.	(4) Clean and retighten ground connections. (NOTE: All three are grounded at the engine oil dipstick bracket.)
	(5) Battery weak or discharged.	(5) Recharge battery. Replace battery if charging does not restore battery specific gravity to minimum of 1.235 or if battery fails heavy load test.
	(6) Low voltage across terminals A and B of the ICM connector 1.	(6) Check the voltage between terminals A and B using voltmeter. — With ignition On and a starter engaged (engine cranking), voltage should be minimum of 9.5 volts. If the voltage is OK, go to next step. If the voltage is low, check continuity of ICM and ECU ground wires. Repair or replace as necessary.
	(7) Malfunction in the ignition coil primary or secondary windings or coil is damaged (cracked or severely dented). (NOTE: Volt ohmmeter must have a minimum of 1 megohm impedance.)	(7) Check primary and secondary resistance with ohmmeter. The primary resistance should be 0.4 to 0.8 ohms maximum. Secondary resistance should be 2500 to 4000 ohms maximum. Replace coil if damaged or faulty. Proceed to next step if coil is OK.
	(8) Check TPS with DRB-II tester.	(8) Replace TPS if it fails DRB-II test sequence.
	(9) Check ECU and ICM with DRB-II tester.	(9) Replace ICM or ECU if either fails the DRB-II test sequence.

J908D-32

SERVICE PROCEDURES

Coolant Temperature Sensor (CTS)

Removal

(1) Disconnect wire harness connector (Fig. 15).

(2) Remove CTS from intake manifold from intake manifold and immediately plug hole to prevent coolant loss.

Installation

(1) Install CTS in intake manifold. Tighten sensor to 28 N•m (21 ft-lbs) torque.

(2) Connect wire harness to sensor connector.

Manifold Air Temperature (MAT) Sensor

Removal

(1) Disconnect wire harness connector

(2) Remove MAT sensor from intake manifold (Fig. 16).

Installation

(1) Install MAT sensor in intake manifold. Tighten sensor to 28 N•m (21 ft-lbs) torque.

(2) Connect wire harness to sensor connector.

Manifold Absolute Pressure (MAP) Sensor

Removal

(1) Disconnect wire harness connector from MAP sensor (Fig. 17).

(2) Disconnect vacuum hose from MAP sensor.

(3) Remove MAP sensor mounting nuts. Remove sensor.

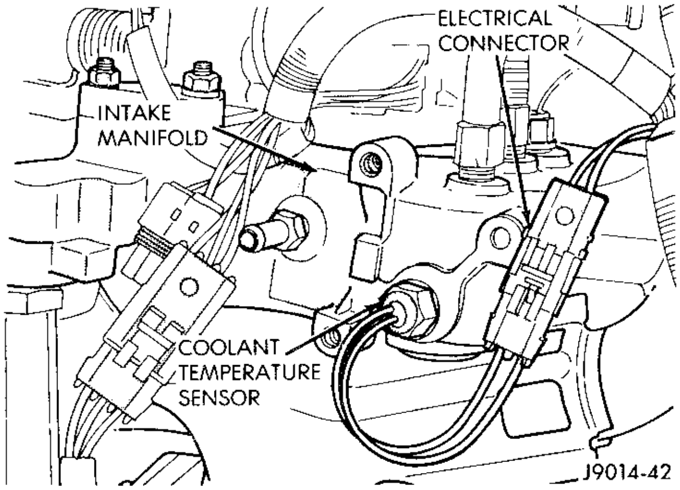


Fig. 15 Coolant Temperature Sensor Removal/Installation

Installation

(1) Install MAP sensor over studs. Tighten mounting nuts to 4 N•m (35 in-lbs) torque.

(2) Connect vacuum hose to MAP sensor.

(3) Connect wire harness connector to MAP sensor.

Speed Sensor (Crankshaft Position Sensor-CPS)

Removal

The engine speed sensor is mounted to the flywheel/driveplate housing at the rear of the engine cylinder block (Fig. 18).

(1) Disconnect speed sensor connector below MAP sensor in engine compartment.

(2) Raise and support vehicle.

(3) Remove speed sensor mounting nuts. Remove sensor.

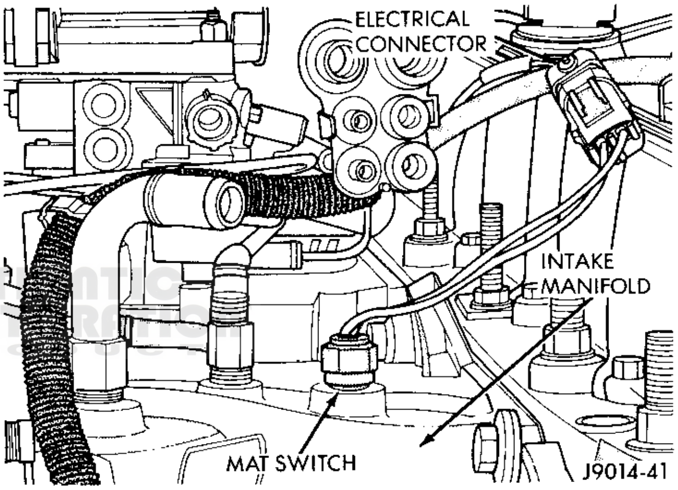


Fig. 16 Manifold Air Temperature Sensor Removal/Installation

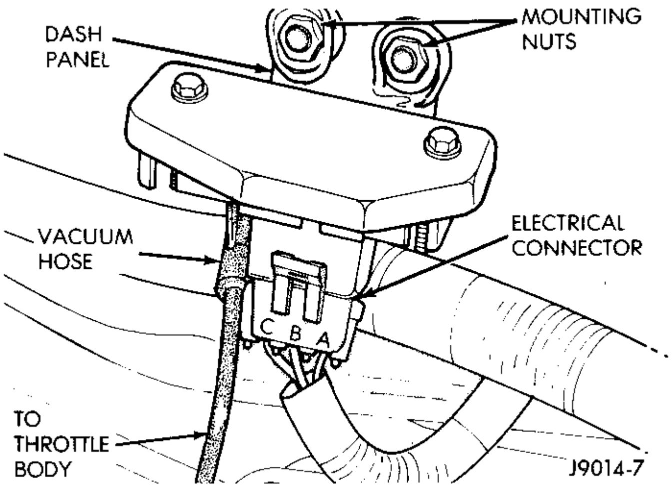


Fig. 17 MAP Sensor

Installation

(1) Install speed sensor. Tighten mounting bolts to 8 N•m (71 in-lbs) torque.

Throttle Position Sensor

Removal

(1) Remove upper and lower air inlet bonnet.

(2) If necessary, remove throttle body assembly as described in this section.

(3) Remove mounting screws.

(4) Remove throttle position sensor from throttle shaft lever (Fig. 19).

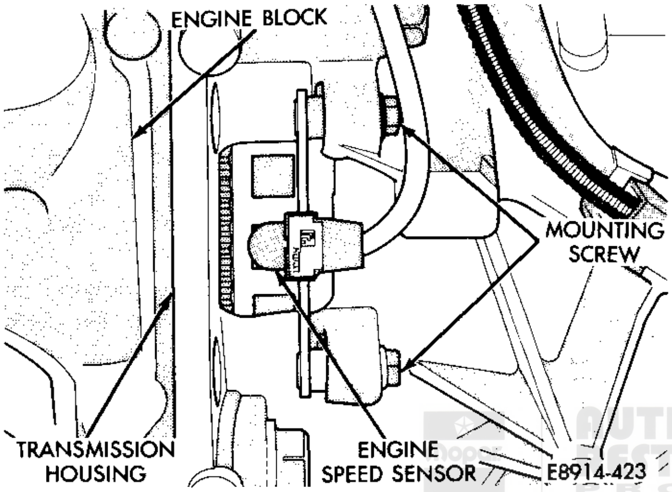


Fig. 18 Speed Sensor Remove/Install

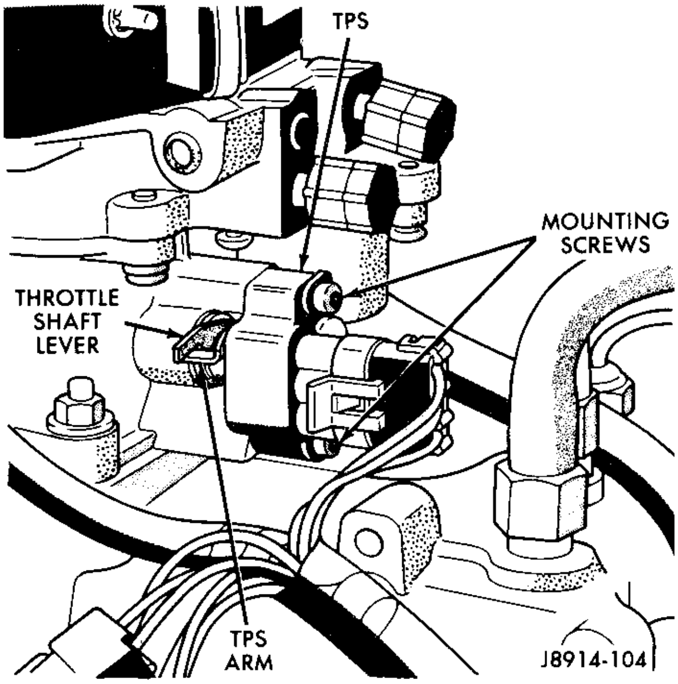


Fig. 19 TPS Remove/Install

Installation

(1) Install throttle position sensor. **Ensure that sensor arm is underneath arm of throttle valve shaft.**

(2) Tighten mounting screws.

(3) Adjust throttle position sensor. Refer to Throttle Position Sensor Adjustment switch as described in this manual.

(4) If removed, install throttle body assembly as described in this section.

(5) Install upper and lower air inlet bonnet.

Electronic Control Unit (ECU)

Removal

The ECU is located underneath the instrument panel between the steering column and heater A/C housing (Fig. 20). The ECU is mounted to a bracket by three screws. The bracket is attached to the dash by locknuts.

(1) Disconnect the battery negative cable.

(2) Remove locknuts securing the ECU to the dash (Fig. 20). Lower ECU and bracket.

(3) Remove ECU to mounting bracket screw (Fig. 21).

(4) Disconnect ECU wiring harness. Remove ECU.

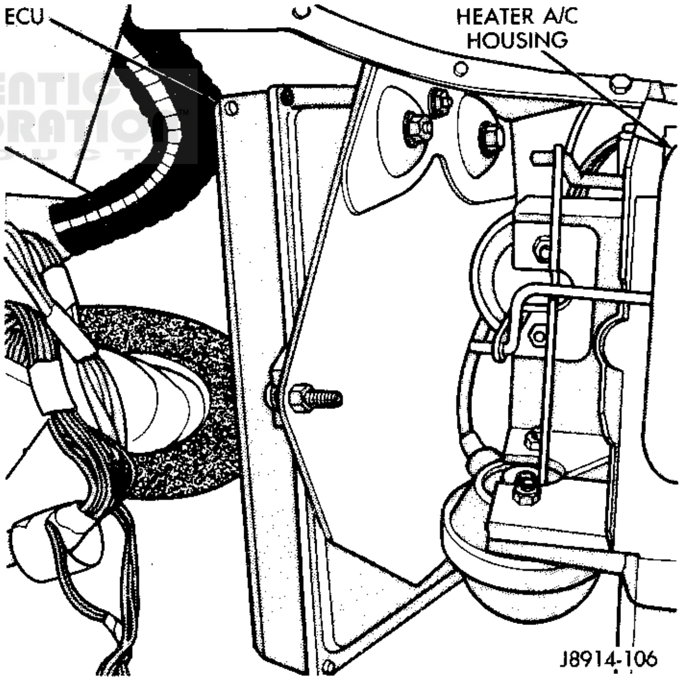


Fig. 20 ECU Location

Installation

(1) Connect ECU wire harness to ECU.

(2) Install ECU on mounting bracket. Tighten mounting screws securely.

(3) Position ECU and bracket assembly under instrument panel and install retaining locknuts.

(4) Connect battery negative cable to negative terminal of battery.

DISTRIBUTOR REPLACEMENT

Distributor Removal

(1) Unfasten the distributor cap retaining screws. Remove the distributor cap with the coil and spark plug wires connected and position aside.

(2) Disconnect the distributor primary wiring connector.

(3) Scribe a mark on the distributor housing in line with the tip of the rotor. Scribe a mark on the distributor housing near the clamp and continue the scribe mark onto the engine block in line with the distributor housing mark. Note the position of the rotor and distributor housing in relation to the surrounding engine components as reference points for installing the distributor.

(4) Remove the distributor hold down bolt and clamp.

(5) Lifting the distributor straight up, carefully remove the distributor from the engine.

Distributor Installation

Engine Not Rotated After Removal

This procedure assumes that the above distributor removal procedure was followed.

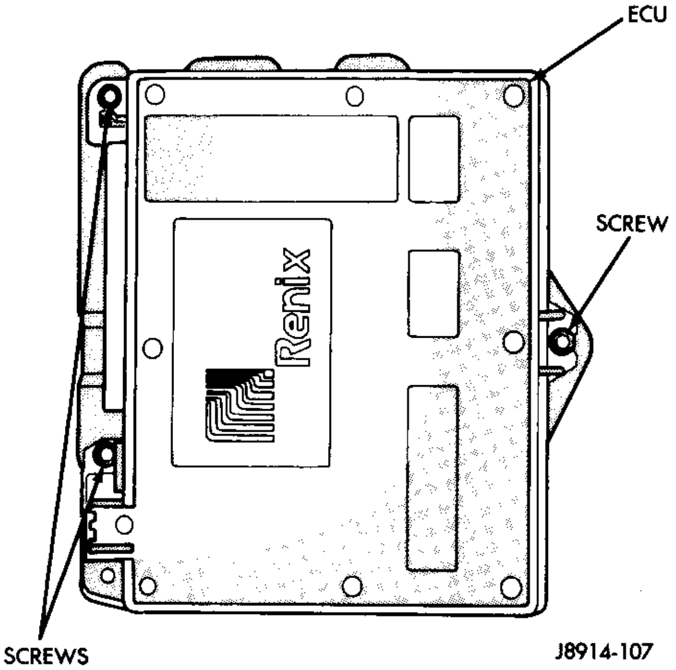


Fig. 21 ECU Remove/Install

(1) Clean the distributor mounting area of the cylinder block.

(2) Install a replacement distributor mounting gasket.

There is a fork on the distributor housing where the housing seats against the engine block. The slot in the fork aligns with the distributor hold down bolt hole in the engine block. The distributor is correctly installed when the rotor is correctly positioned and the slot in the fork is aligned with the hold down bolt hole in the cylinder block. Because of the fork on the distributor housing, initial ignition timing is not adjustable.

(3) Position the distributor shaft in the cylinder block. If the engine was not rotated while the distributor was removed, perform the following.

- align the rotor tip with the scribe mark on the distributor housing during removal; turn the rotor approximately 1/8-turn counterclockwise past the scribe mark

CAUTION: Assure that the distributor shaft fully engages the oil pump drive gear shaft. It may be necessary to slightly rotate (bump) the engine while applying downward hand force on the distributor body to fully engage the distributor shaft with the oil pump drive gear shaft.

- slide the distributor shaft down into the engine; align the scribe mark on the distributor housing with the corresponding scribe mark on the cylinder block.

It may be necessary to move the rotor and shaft slightly to start the gear into mesh with the camshaft gear and to engage the oil pump drive tang, but the rotor should align with the scribe mark when the distributor shaft is down in place.

- install the distributor hold down clamp and bolt. Tighten the bolt to 23N•m (17 ft-lbs).

(4) Install the distributor cap (with ignition wires) on the distributor housing (Fig. 22). Ensure that the pickup coil wire rubber grommet in the distributor housing aligns with the depression in the distributor cap and that the cap fits on rim of the distributor housing.

Two different diameter screws are used to retain the distributor cap.

(5) Apply Silicone Dielectric Compound, or equivalent, to the connector terminal blades and cavities. Connect the distributor primary wiring connector.

CAUTION: Do not puncture the spark plug wires or boots to make the connection. Use proper adapters.

Engine Rotated After Removal

There is a fork on the distributor housing where the housing seats against the engine block. The slot in the fork aligns with the hole for the distributor hold down bolt in the engine block. The distributor is correctly installed when the rotor is correctly positioned and the slot in the fork is aligned with

the hole for the distributor hold down bolt in the cylinder block. Because of the fork on the distributor housing, initial ignition timing is not adjustable.

(1) If the engine was rotated while the distributor was removed, it will be necessary to establish timing according to following procedure.

- remove the No. 1 spark plug; hold a finger over the spark plug hole and rotate the engine until compression pressure is felt; slowly continue to rotate the engine until the timing index on the vibration damper pulley aligns with the top dead center (TDC) mark (0 degree) on the timing degree scale; always rotate the engine in direction of normal rotation; do not turn the engine backward to align the timing marks
- using a flat blade screwdriver, rotate the oil pump gear so that the gear slot on the oil pump shaft is slightly past the 3 o'clock position (Fig. 23).
- With the distributor cap removed, install the distributor with the rotor located at the 5 o'clock position (Fig. 24).

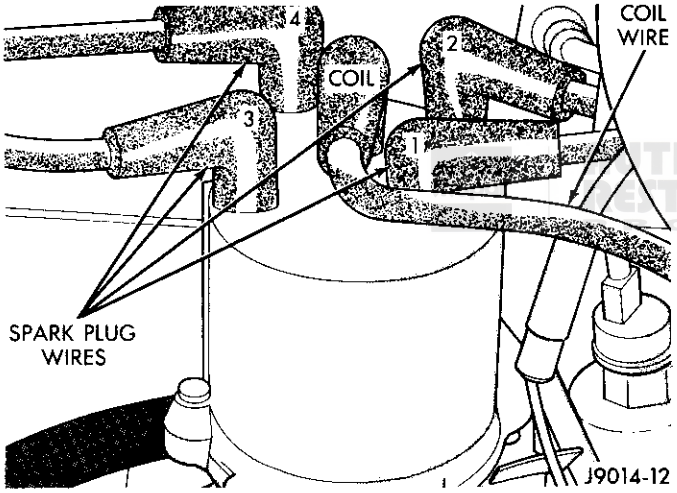


Fig. 22 Spark Plug Wire Positions

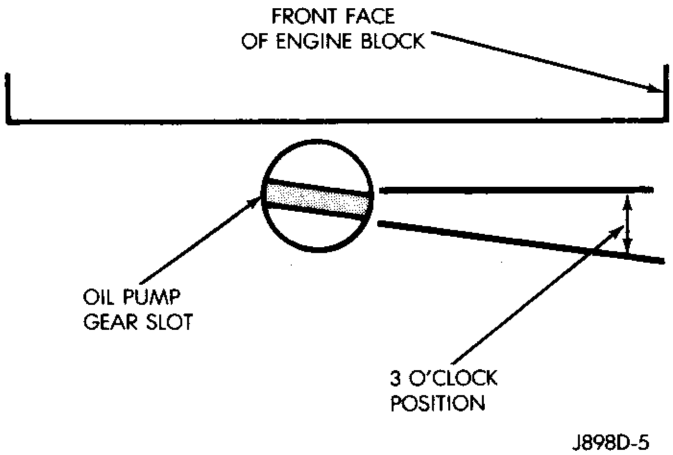


Fig. 23 Position Oil Pump Gear Slot

- When the distributor is fully engaged in its correct location, the rotor should be at the 6 o'clock position (Fig. 25).
- install the distributor hold down clamp and bolt. Tighten the hold down bolt to 23 N•m (17 ft-lbs).

CAUTION: If the distributor cap is incorrectly positioned on the distributor housing, the cap or rotor may be damaged when the engine is rotated with the starter motor.

(2) Install the distributor cap (with ignition wires) on the distributor housing (Fig. 22). Ensure that the pickup coil wire rubber grommet in the distributor

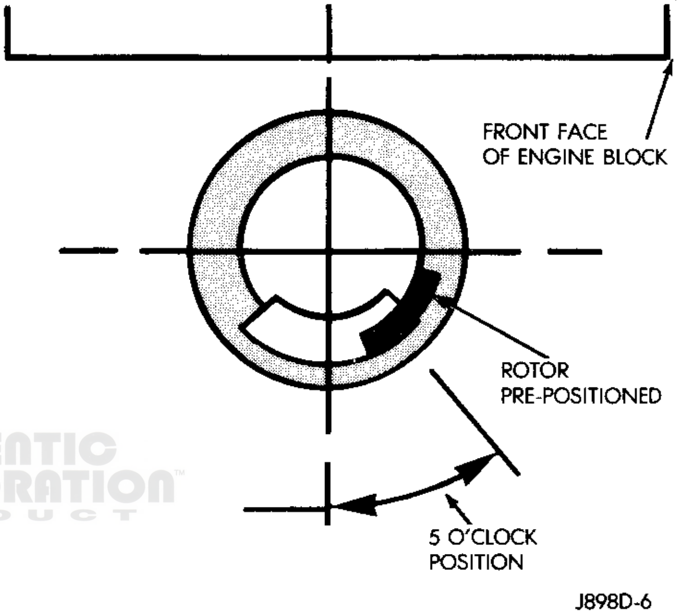


Fig. 24 Distributor Installation

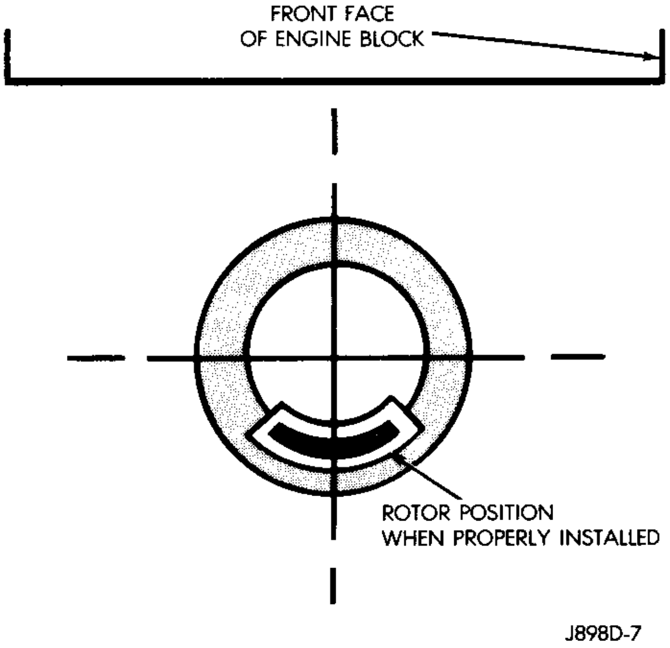


Fig. 25 Distributor Rotor Position

housing aligns with the depression in the distributor cap and that the cap fits on rim of the distributor housing.

Two different diameter screws are used to retain the distributor cap.

(3) Apply Silicone Dielectric Compound, or equivalent, to the connector terminal blades and cavities. Connect the distributor primary wiring connector.

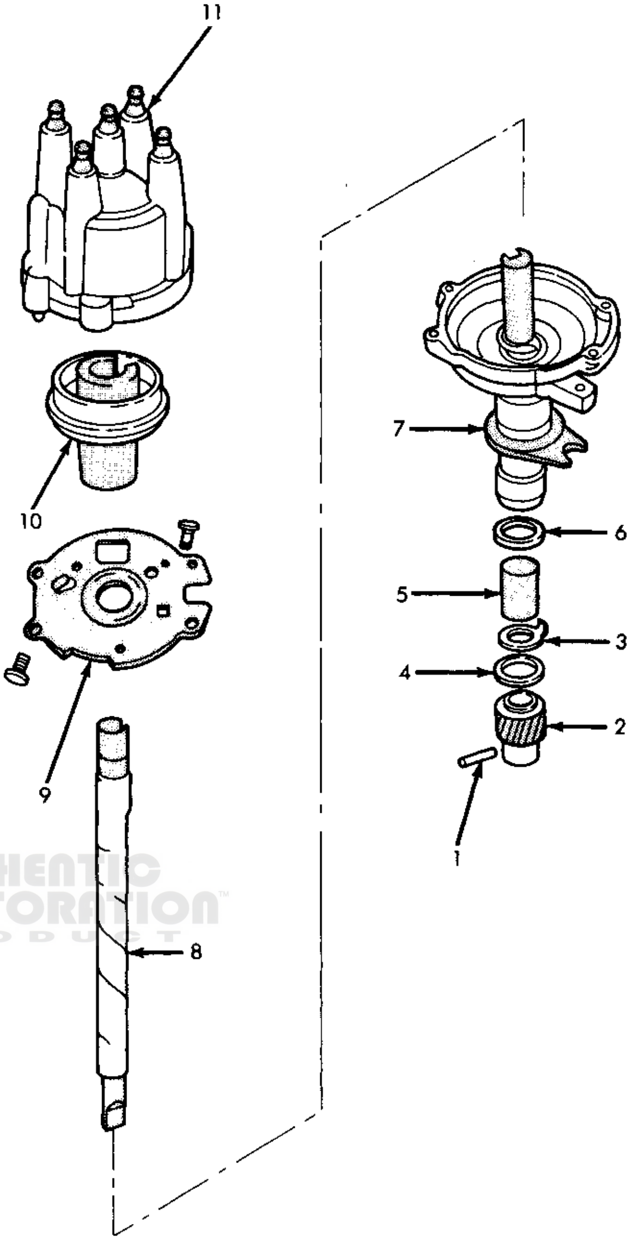
CAUTION: Do not puncture the spark plug wires or boots to make the connection. Use proper adapters.

DISTRIBUTOR COMPONENTS

An exploded view of the distributor used in the 2.5L engine is shown in Fig. 26 along with a list of its components.

A unique feature of the distributor assembly is the silicone applied to the rotor blade during manufacture. Radio interference is greatly reduced by the presence of a small quantity of silicon dielectric compound on the rotor blade. After a few thousand miles, this compound becomes charred by the high voltage current flowing through the rotor. This condition is normal. DO NOT scrape the residue from the rotor blade.

When installing a replacement rotor, apply a thin coat (0.03-0.12 in.) of silicone dielectric compound to the rotor blade.



1. PIN
2. GEAR
3. WASHER
4. SHIM
5. BUSHING
6. GASKET
7. HOUSING
8. SHAFT
9. PLATE
10. ROTOR
11. CAP, DISTRIBUTOR

J898D-8

Fig. 26 Distributor Components—2.5L Engine

4.0L SIX-CYLINDER ENGINE

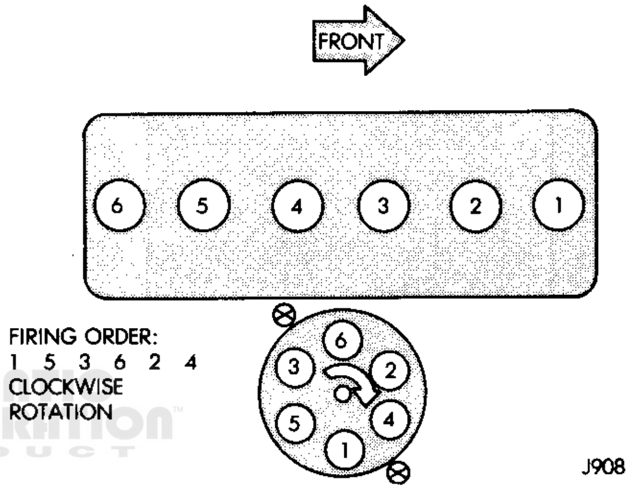
INDEX

SPARK PLUG SPECIFICATIONS

ENGINE	PLUG TYPE	ELECTRODE GAP	SPARK PLUG TIGHTENING TORQUE
4.0L	RC9YC	0.9 mm (0.035 in.)	37 N•m (27 ft-lbs)

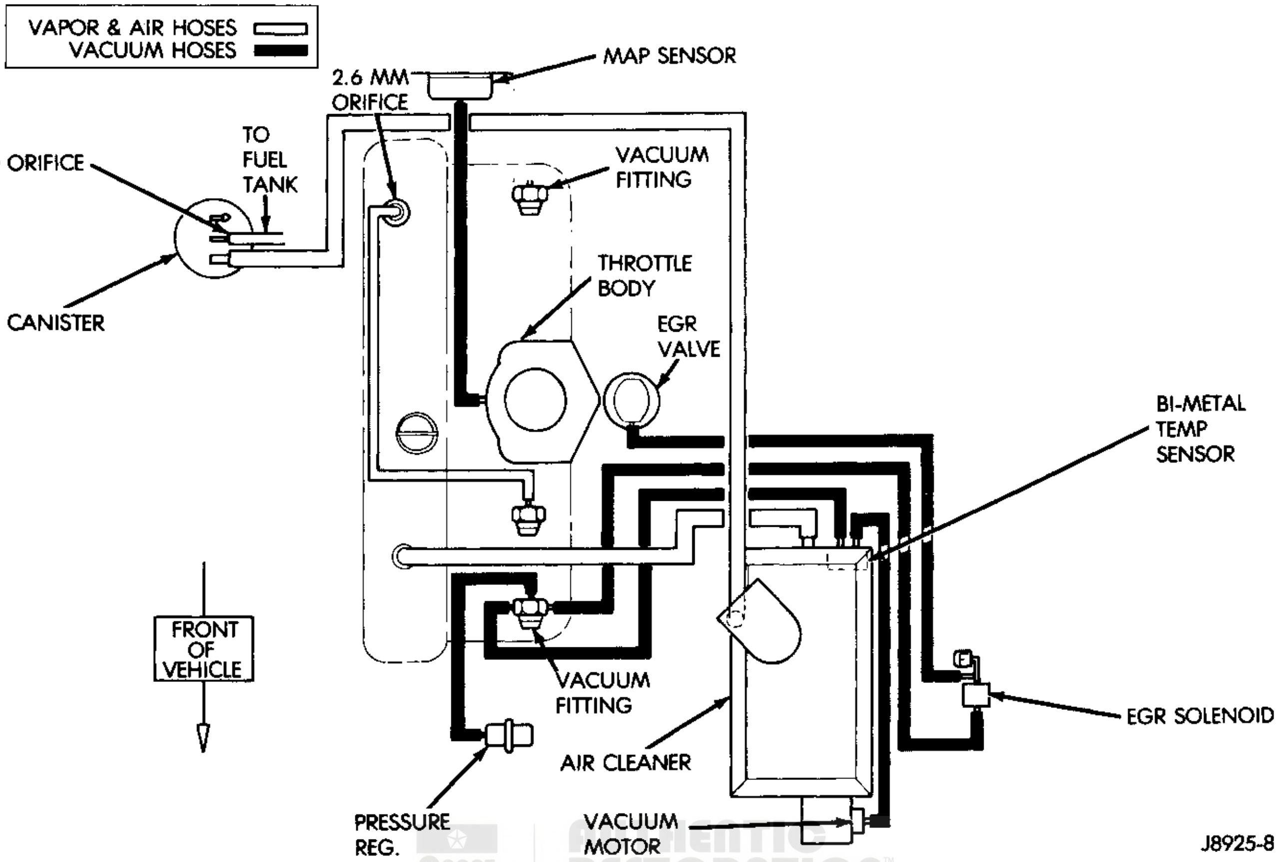
J898D-9

ENGINE FIRING ORDER



J908D-7

VACUUM HOSE SCHEMATIC



GENERAL INFORMATION

The 4.0L engine is a multi-point fuel injected engine that is used in MJ and XJ vehicles. The ignition system is controlled by the engine Electronic Control Unit (ECU). The ignition system used in the 4.0L engine consists of:

- A solid-state ignition control module, to generate the voltage for spark plug firing.
- An electronic control unit (ECU) to process input information to fire the ignition control module.

Ignition timing (advance/retard) is controlled by the ECU and is not adjustable.

- An engine speed sensor with flywheel trigger to input crankshaft position for the ECU.
- A sync pulse (stator) for firing order input to the ECU.

IGNITION CONTROL MODULE (ICM)

The ignition control module (ICM) is mounted to the ignition coil (Fig. 1). Based on control system inputs, the ECU triggers the ignition coil via the ignition control module. The ECU is able to advance or retard ignition timing by controlling the ignition coil through the ignition control module.

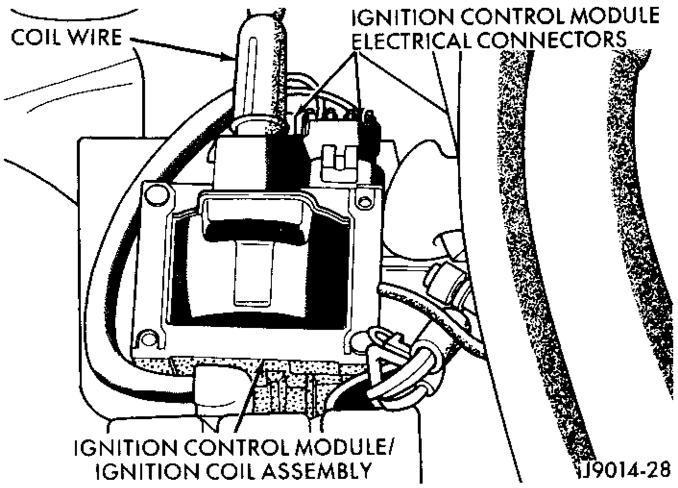


Fig. 1 Ignition Control Module

The ICM consists of a solid-state ignition circuit and an integrated ignition circuit and an integrated ignition coil that can be removed and serviced separately if necessary.

The ECU provides an input signal to the ICM. The ICM has only two outputs:

- Tach signal to the tachometer and diagnostic connector
- High voltage from the coil to the distributor cap

ICM CONNECTIONS

Electrical feed to the ICM is through terminal A of Connector No.1 on the module (Fig. 2).

Electrical supply only occurs with the ignition switch in the START and RUN positions.

Terminal B of Connector No.1 is grounded at the engine oil dipstick bracket along with the ECU ground wire and oxygen (O_2) sensor ground.

The tachometer output signal wire of the ICM is connected to Pin No. 1 of the D1 diagnostic connector. The wire is routed to the diagnostic connector through a short section of the ECU harness, the engine and instrument panel harness. This type of routing eliminates any potential electrical interference in the various ECU circuitry.

Ignition firing signal from ECU terminal 27 are transmitted through terminal B of Connector No. 2 on the ICM. The ignition signal from the ECU is received by the ICM in the form of a 5 volt square wave. As the leading edge of the wave contacts the ignition circuitry in the ICM, the ICM charges the coil primary windings.

When coil saturation occurs, the module circuitry opens the primary windings to collapse the magnetic field in the windings. This induces the high voltage in the coil secondary windings which is then transmitted to the spark plugs via the coil wire, distributor cap, and rotor.

ECU INPUTS

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor reacts to absolute pressure in the intake manifold and provides an input voltage to the ECU. As engine load changes manifold pressure varies, causing the MAP sensors resistance to change. The change in MAP sensor resistance results in a different input voltage to the ECU. The input voltage level supplies the ECU with information relating to ambient barometric pressure during engine start-up (cranking) and to engine load while the engine is running. The ECU computes this information and adjusts air-fuel mixture accordingly.

The MAP sensor is mounted under the hood on the dash panel and is connected to the throttle body with a vacuum hose (Fig. 3).

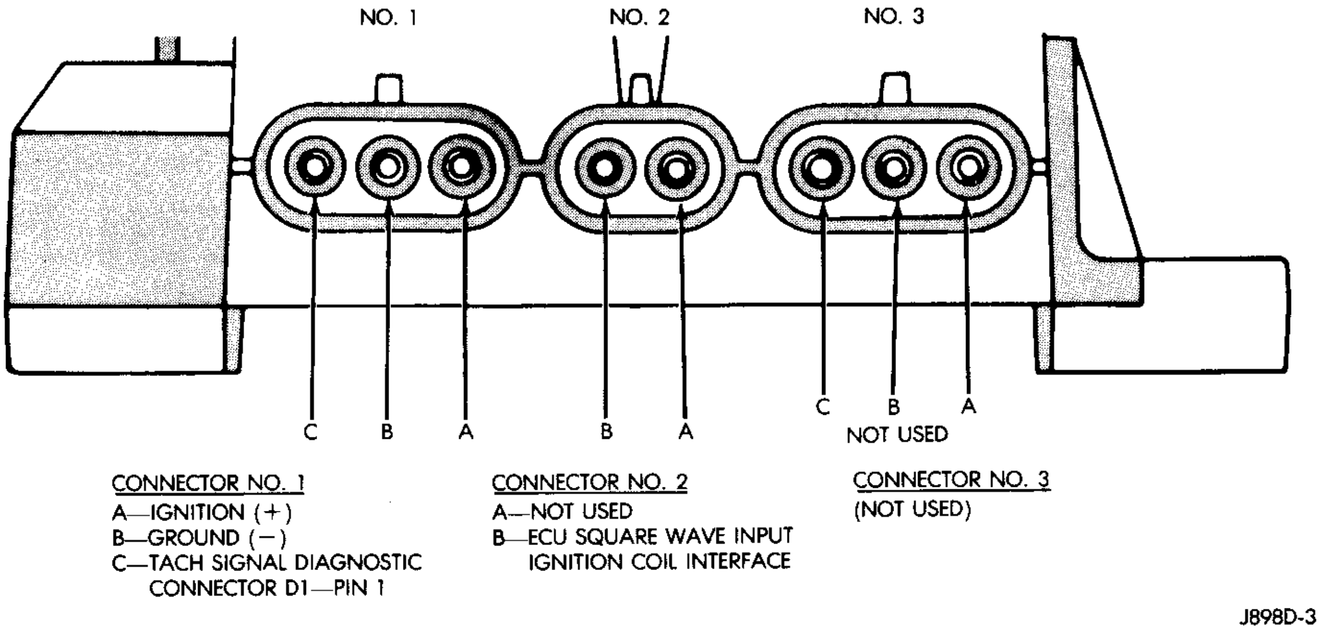


Fig. 2 ICM Connections

Coolant Temperature Sensor

The coolant temperature sensor is installed in the engine water jacket on the left side of the engine (Fig. 4). It provides an input voltage to the ECU. As coolant temperature varies, the Coolant Temperature Sensors resistance changes resulting in a different input voltage to the ECU. Based on this input the ECU will:

- Adjust fuel injector pulse width. Colder coolant temperatures will result in longer injector pulse width and richer air-fuel mixtures.
- Compensate for fuel condensation in the intake manifold.
- Control engine warm-up idle speed.
- Increase ignition advance when the coolant is cold.
- Energize the EGR valve solenoid thus preventing the flow of vacuum to the EGR valve.

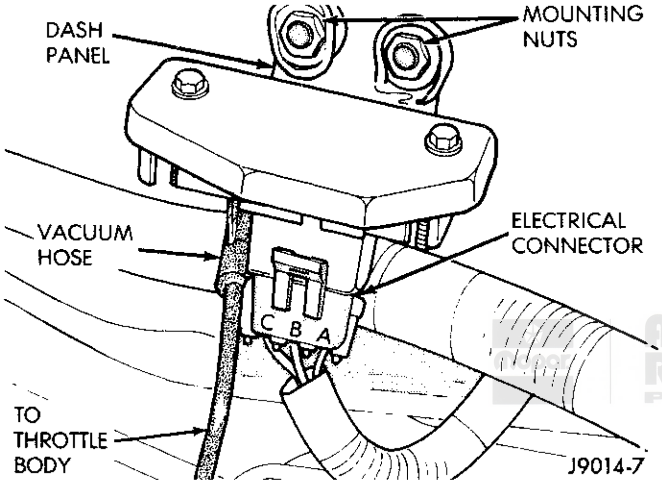


Fig. 3 MAP Sensor

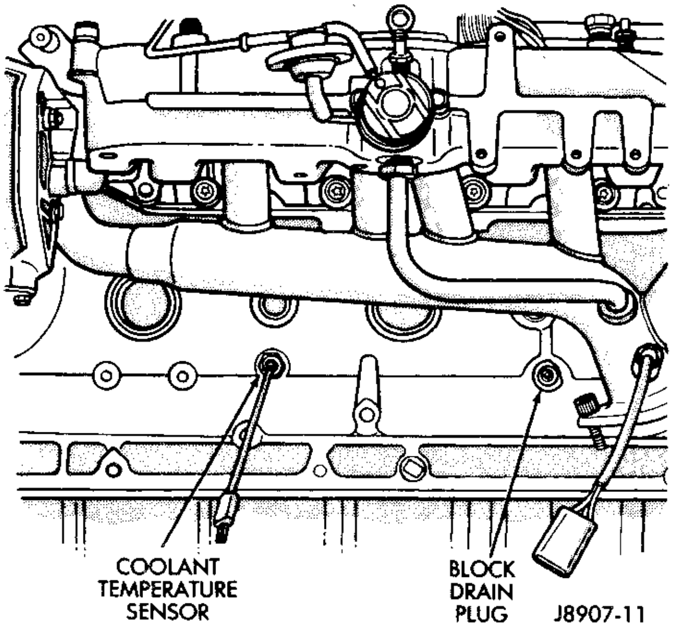


Fig. 4 Coolant Temperature Sensor

Manifold Air Temperature (MAT) Sensor

The Manifold Air Temperature (MAT) sensor is installed in the intake manifold with sensor element extending into the air-fuel stream (Fig. 5). The MAT sensor provides an input voltage to the ECU. As the temperature of the air-fuel stream in the manifold varies, the MAT sensors resistance changes resulting a different input voltage to the ECU.

Engine Speed Sensor (Crankshaft Position Sensor—CPS)

The engine speed sensor, attached to the flywheel/drive plate housing, provides an input signal to the ECU relating to crankshaft speed and angle (position) (Fig. 6). The ECU converts crankshaft speed into engine RPM and crankshaft angle to piston position. The speed sensor senses TDC, BDC and engine speed by detecting the flywheel teeth as they pass during engine operation. The speed sensor is non-adjustable.

The flywheel has three trigger notches, 120° apart (Fig. 7). There are 20 small teeth between each trigger notch. Each large trigger notch is located 12 small teeth before each Top Dead Center (TDC) position of the corresponding pistons.

When a small tooth and notch pass the magnet core in the sensor the concentration and then collapse of the magnetic flux induces a small voltage spike into the sensor pick-up coil winding. These small voltage spikes enable the ECU to count the teeth as they pass the sensor. When a large trigger tooth and notch pass the magnet core in the sensor, the increased concentration and then collapse of the magnetic flux induces a higher voltage spike into the sensor pick-up coil winding (Fig. 8).

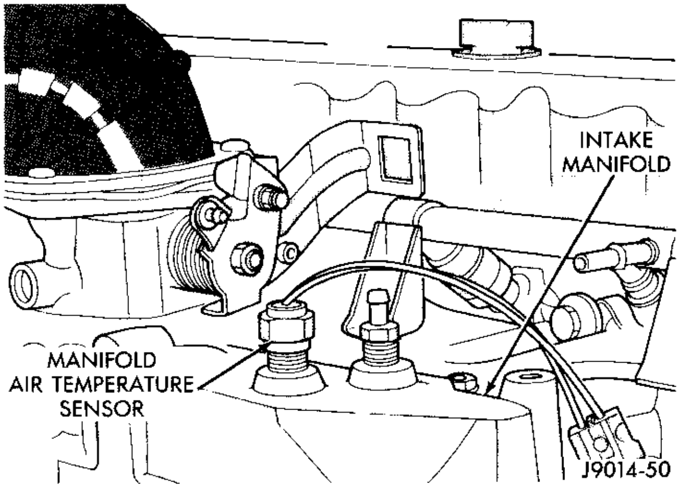


Fig. 5 Manifold Air Temperature Sensor

The higher voltage spike indicates to the ECU that a piston will soon be at the TDC position, 12 teeth later. The ignition timing for the particular cylinder is either advanced or retarded as necessary by the ECU according to sensor inputs.

Sync Pulse Signal (Stator)

The sync signal generator is located in the distributor and works in conjunction with the engine speed sensor to provide the ECU with inputs to establish and maintain correct injector firing order (Fig. 9). A pulse ring mounted to the distributor shaft references the position of pistons one and six as it rotates through the sync signal generator's magnetic field.

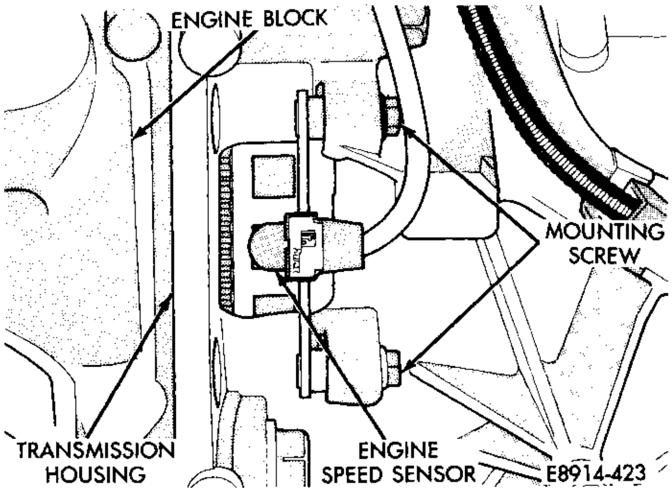


Fig. 6 Engine Speed Sensor

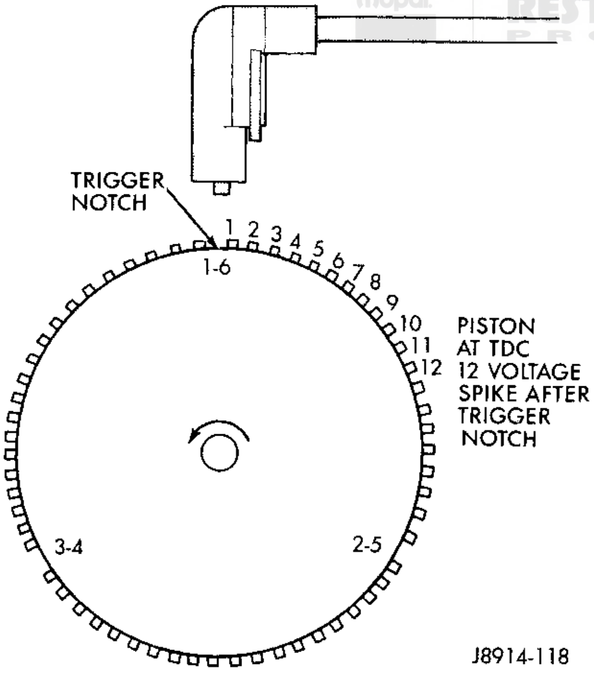


Fig. 7 Engine Speed Sensor, Trigger Notches and TDC Position

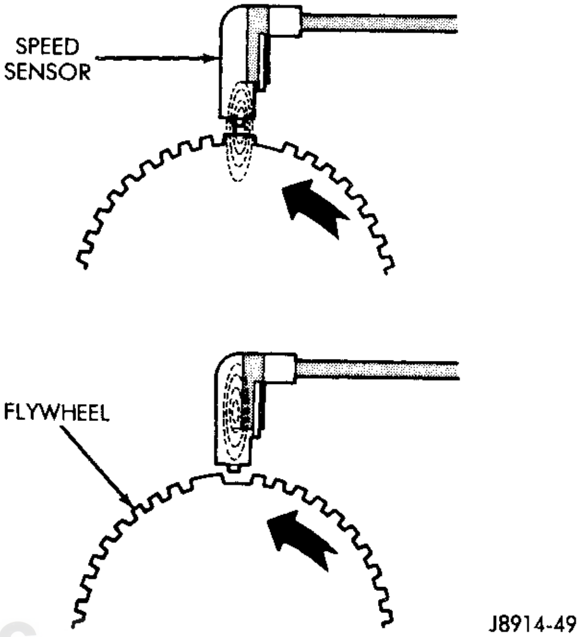


Fig. 8 Engine Speed Sensor Operation

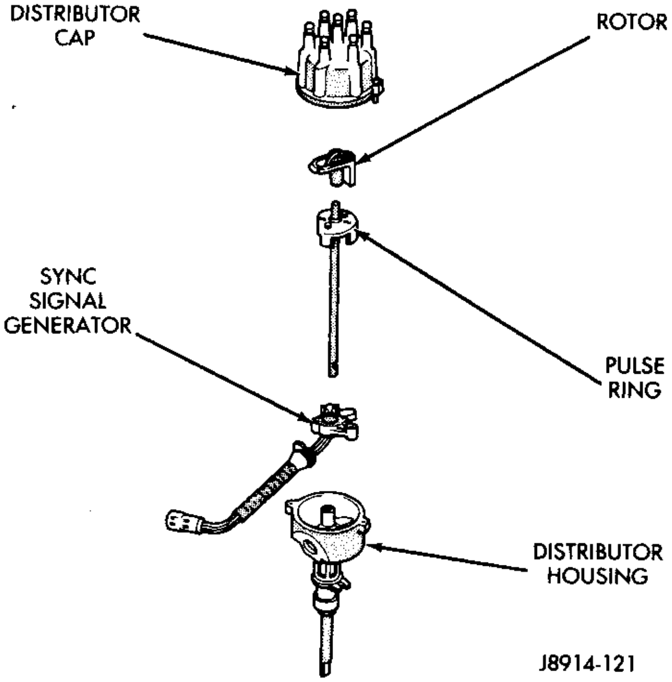


Fig. 9 Sync Signal Generator and Pulse Ring

The pulse ring rotates through the sync signal generator for 180°. When the leading edge of the pulse ring enters the sync signal generator, the magnetic field becomes weaker (Fig. 10). This indicates the position of piston number one to the ECU. When the trailing edge of the pulse ring leaves the sync signal generator the magnetic field becomes stronger. This indicates to the ECU the position of piston number six.

The sync signal input and speed sensor input allow the ECU to establish the necessary reference point to synchronize injection.

Knock Sensor

The knock sensor is located on the lower left side of the engine cylinder block just above the oil pan (Fig. 11).

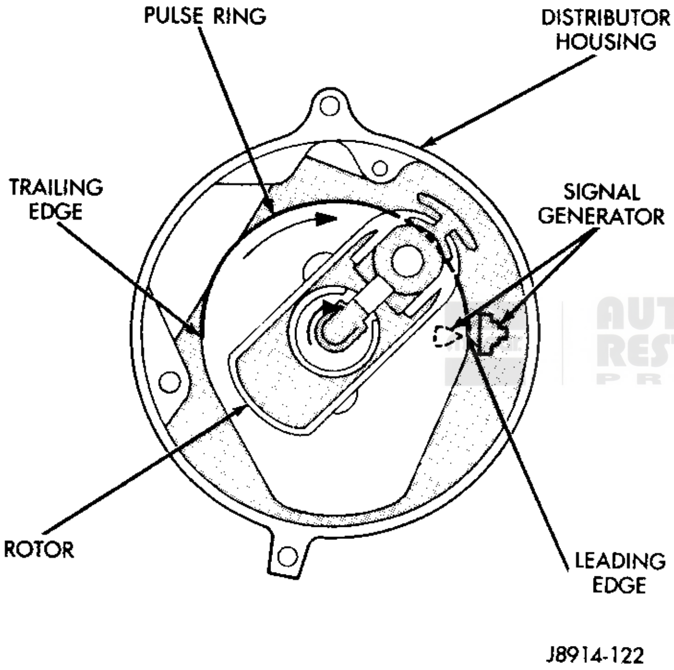


Fig. 10 Sync Signal Generator Operation

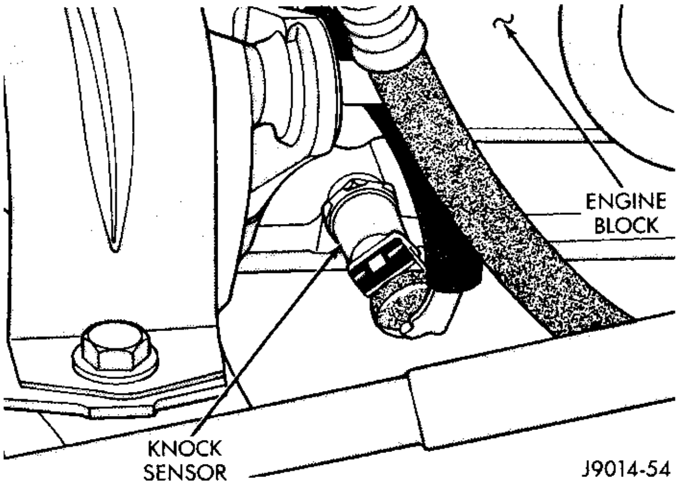


Fig. 11 Knock Sensor

The knock sensor provides an input to the ECU that indicates detonation (knock) during engine operation. When detonation (knock) occurs, the ECU retards the ignition advance to eliminate the detonation (knock) at the applicable cylinder(s).

Throttle Position Sensor (TPS)

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle valve shaft. The sensor is a variable resistor that provides the ECU with an input voltage that represents throttle valve position. Input voltage to the ECU from the TPS varies in an approximate range of from 1 volt at minimum throttle opening (idle) to 5 volts at wide open throttle. The ECU uses TPS input voltage to determine current engine operating conditions.

There are two different Throttle Position Sensors, one used with automatic transmissions (Fig. 12) and one used with manual transmissions (Fig. 13). The TPS used with automatic transmissions has two integral wire harness connectors (one four pin connector and one three pin connector) that plug into the engine wire harness. The four pin connector supplies input to the ECU while the three pin connector supplies input to the Transmission Control Unit. The TPS used with manual transmissions has an integral connector. The engine wire harness connects directly to the TPS.

DIAGNOSIS PROCEDURES

This section contains information for determining individual MPI system component performance. Diagnosis of ECU/Engine Control System is performed using the DRB II Service Diagnostic Tester. Refer to the tester manual for the appropriate system test procedure.

Coolant Temperature Sensor (CTS)

(1) Disconnect the wire harness connector from the CTS (Fig. 14).

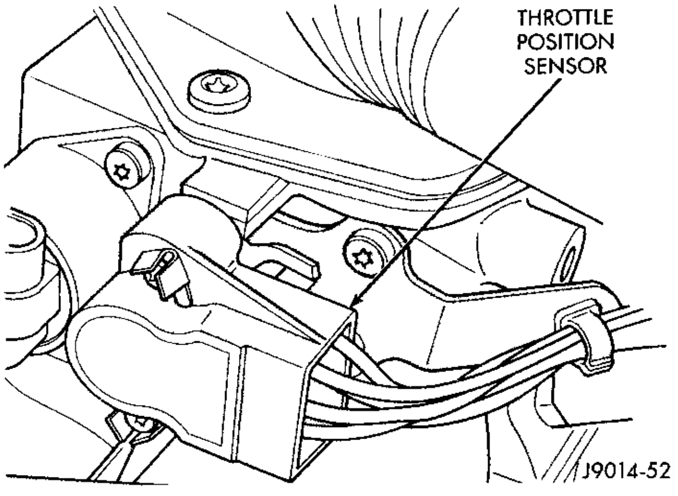


Fig. 12 Throttle Position Sensor—with Automatic Transmission

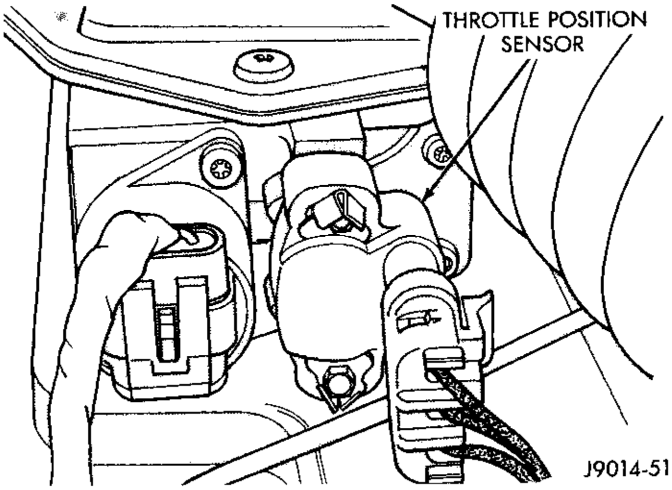


Fig. 13 Throttle Position Sensor—with Manual Transmission

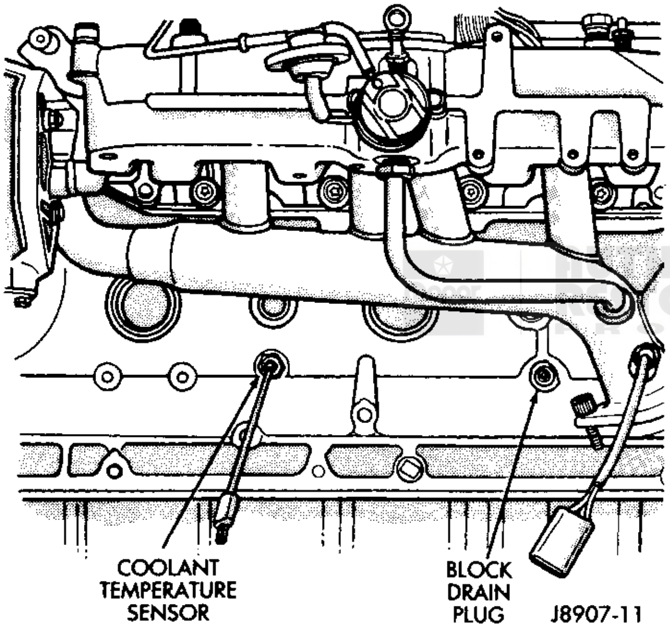


Fig. 14 Coolant Temperature Sensor

(2) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter.

The resistance should be less than 1000 ohms with the engine warm.

Refer to the resistance chart.

(3) Replace the sensor if it is not within the range of resistance specified in the chart.

(4) Test the resistance of the wire harness between ECU wire harness connector terminal D-3 and the sensor connector terminal, and terminal C-10 to the sensor connector terminal.

(5) Repair the wire harness if an open circuit is indicated.

Coolant Temperature Sensor
Temperature-to-Resistance Values
(Approximate)

°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	−7	13,500
0	−18	25,000
−40	−40	100,700

J8914-89

Manifold Air Temperature (MAT) Sensor Test

(1) Disconnect the wire harness connector from the MAT sensor (Fig. 15).

(2) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter.

The resistance should be less than 1000 ohms with engine warm. Refer to the resistance chart.

(3) Replace the sensor if it is not within the range of resistance specified in the chart.

(4) Test the resistance of the wire harness between the ECU wire harness connector terminal D-3 and the sensor connector terminal, and terminal C-8 to the sensor connector terminal.

(5) Repair the wire harness as necessary if the resistance is greater than 1 ohm.

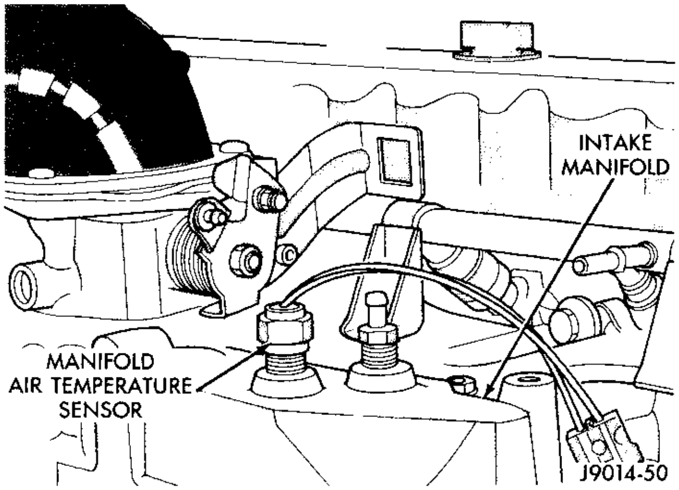


Fig. 15 Manifold Air Temperature Sensor

Manifold Air/Fuel Temperature Sensor Temperature-to-Resistance Values (Approximate)

°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

J8914-90

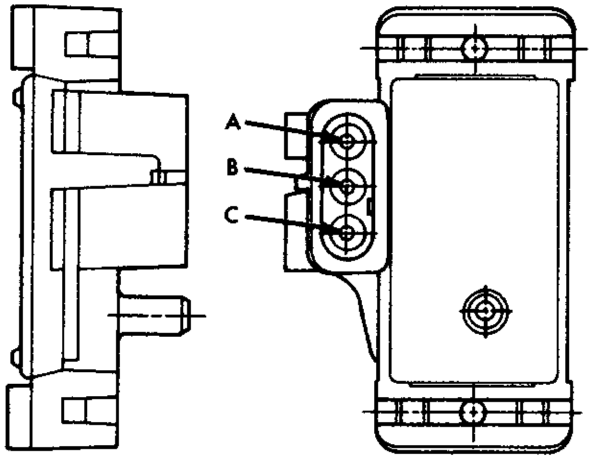
Manifold Absolute Pressure (MAP) Sensor Test

(1) Inspect the MAP sensor vacuum hose connections at the throttle body and sensor (Fig. 16). Repair as necessary.

(2) Test the MAP sensor output voltage at the MAP sensor connector terminal B (as marked on the connector) with the ignition switch ON and the engine OFF.

The voltage should drop to 0.5 to 1.5 volts with a hot, neutral idle speed condition.

(3) Test ECU terminal C-6 for the same voltage described previously to verify the wire harness. Repair as necessary.



A. Ground
B. Output Voltage
C. 5 Volts

J8914-91

Fig. 16 MAP Sensor Connector Terminals

(4) Test MAP sensor supply voltage at the sensor connector terminal C with the ignition ON.

The voltage should be 5±0.5 volts.

The same voltage should also be at terminal C-14 of the ECU wire harness connector.

(5) Repair or replace the wire harness as necessary.

(6) Test the MAP sensor ground circuit at sensor connector terminal A and ECU connector terminal D-3. Repair the wire harness if necessary.

(7) Test the MAP sensor ground circuit at the ECU connector between terminal D-3 and terminal B-11 with an ohmmeter.

If the ohmmeter indicates an open circuit, inspect for a defective sensor ground connection located on the right side of the cylinder block.

If the ground connection is good, replace the ECU.

If terminal D-3 has a short circuit to 12 volts, correct this condition before replacing the ECU.

Knock Sensor Test

(1) Connect DRB II diagnostic tester to the vehicle.

(2) Proceed to state display mode.

(3) Start engine.

(4) Observe knock unit value.

(5) Using the tip of a screwdriver, gently tap the cylinder block near the knock sensor and observe knock value.

(6) Knock value should increase while tapping on the cylinder block.

(7) If the knock value does not increase while tapping on the cylinder block near the knock sensor then check knock sensor for proper connection.

If connection is good then replace the knock sensor. Refer to the component replacement section of this manual for replacement procedures.

Speed Sensor Test

(1) Disconnect the speed sensor connector (Fig. 17) from the ignition control module.

(2) Place an ohmmeter between terminals A and B (marked on the connector).

Reading should be 200±75 ohms (hot engine).

(3) Replace sensor if readings are not to specifications.

Sync Pulse (Stator) Test

For this test, an analog voltmeter is needed.

(1) Insert the positive (+) voltmeter lead into the Blue wire at the distributor connector.

(2) Install the negative (-) voltmeter lead into the Gray W/tr wire at the distributor connector.

Do Not remove the distributor connector from the distributor.

Insert the voltmeter leads into the backside of the distributor connector to make contact with the terminals.

(3) Set the voltmeter on a 15 Volt A/C scale. Turn key on.

(4) The voltmeter should show approximately 5.0 volts.

(5) If there is no voltage, check the voltmeter leads for a good connection.

- If there is still no voltage:

(6) Remove ECU and check for voltage at pin C-16 and ground with harness connected.

- If there is still no voltage:

(7) Perform vehicle test using DRB II tester.

- If voltage is present:

(8) Check continuity between the Blue wire at the distributor connector and C-16 at the ECU.

(9) If there is no continuity, repair the harness as necessary.

(10) Check for continuity between the Gray W/tr wire at the distributor connector and pin C-5 at the ECU.

(11) If there is no continuity, repair the harness as necessary.

(12) Check for continuity between the Black wire at the distributor connector and ground.

(13) If there is no continuity, repair the harness as necessary.

(14) While observing the voltmeter, crank the engine; the voltmeter needle should fluctuate back and forth while the engine is cranking. This verifies that the stator in the distributor is operating properly.

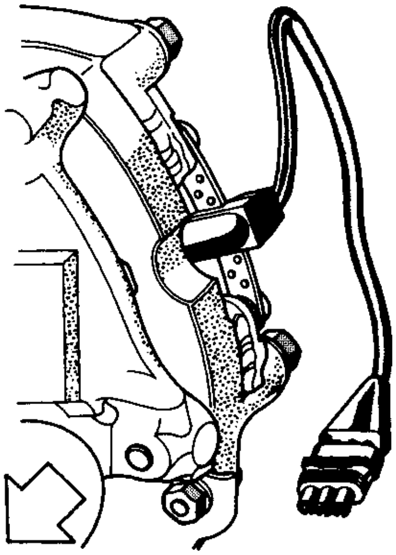
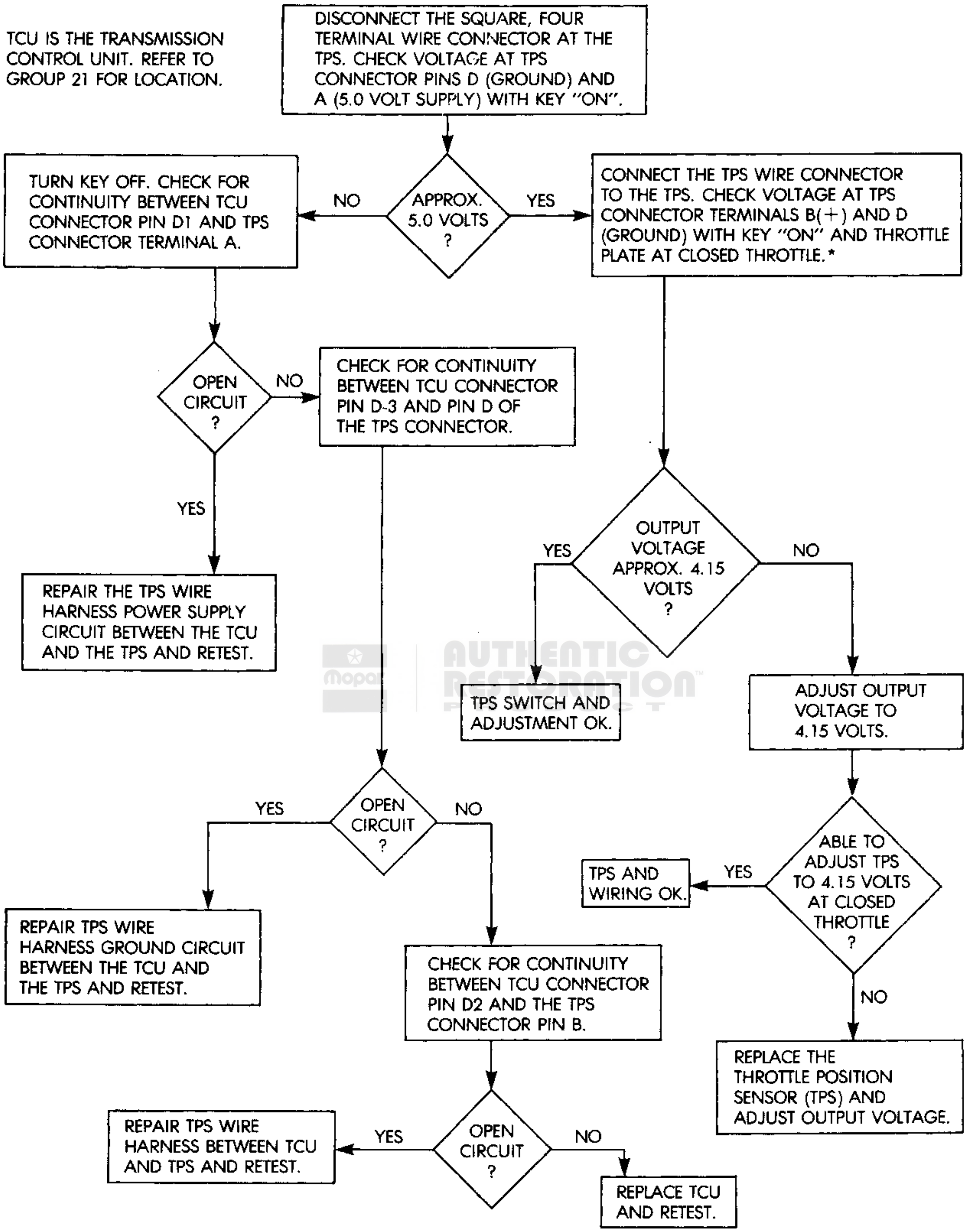


Fig. 17 Engine Speed Sensor

(15) If there is no sync pulse, replacement of the stator is necessary. Refer to the component replacement section of this manual for replacement procedures.

THROTTLE POSITION SENSOR (TPS) TEST—AUTO. TRANS.

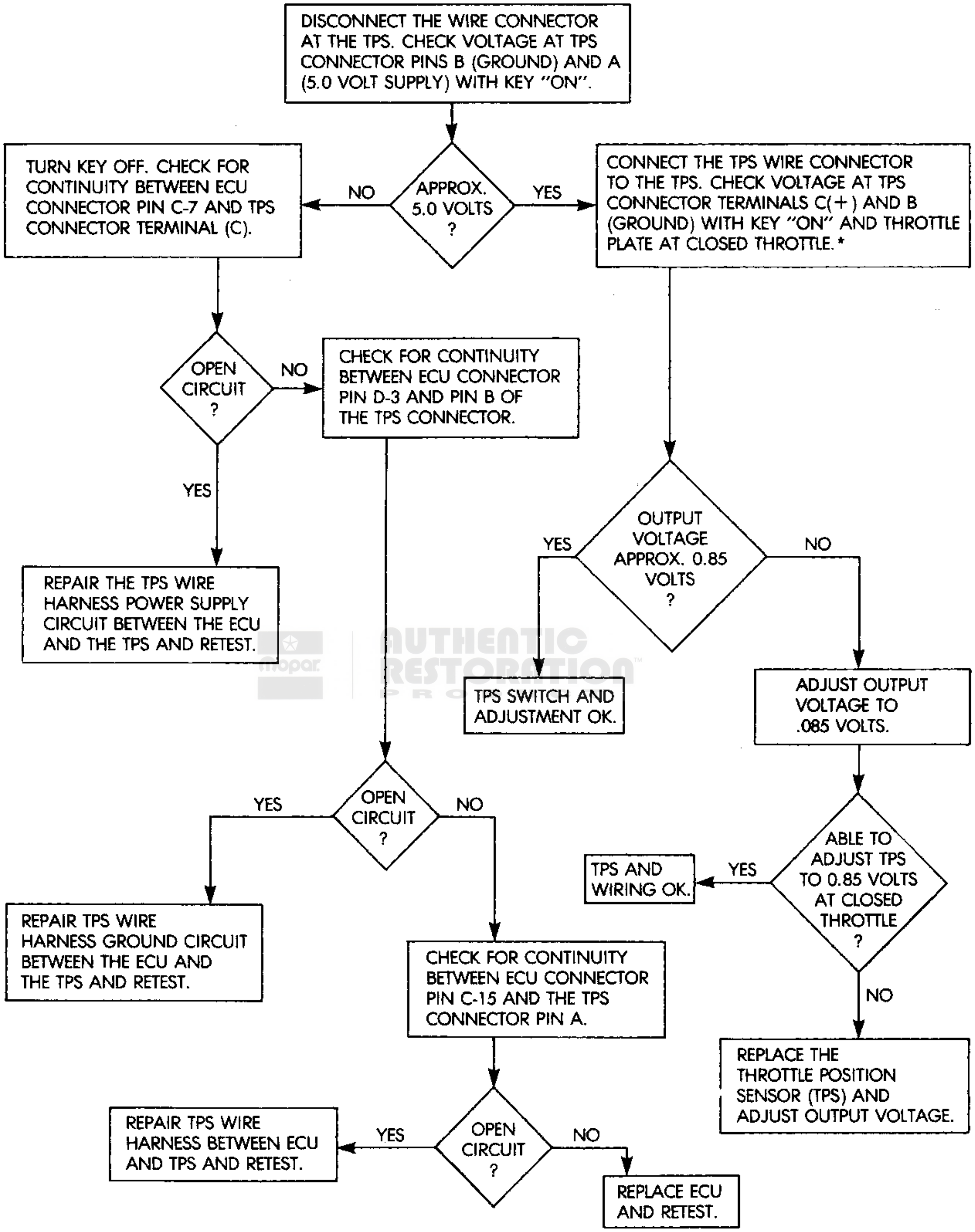


TCU IS THE TRANSMISSION CONTROL UNIT. REFER TO GROUP 21 FOR LOCATION.

*DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR. INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS.

J9014-130

THROTTLE POSITION SENSOR (TPS) TEST—MAN. TRANS.



*DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR. INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS.

J9014-131

Spark Plugs

Faulty or fouled plugs may perform well at idle speed, but at higher engine speeds they frequently fail. Faulty plugs can be identified in a number of ways: poor fuel economy, power loss, decrease in engine speed, hard starting and, in general, poor engine performance.

Spark plugs also malfunction because of carbon fouling, excessive electrode air gap, or a broken insulator.

SERVICE PROCEDURES

Coolant Temperature Sensor (CTS)

Removal

(1) Drain cooling system.
(2) Remove air cleaner assembly.
(3) Disconnect the CTS wire connector (Fig. 18).
(4) Remove the CTS from the engine block.

Installation

(1) Install the CTS into the cylinder block and tighten to 28 N•m (21 ft-lbs) torque.
(2) Connect the CTS wire connector.
(3) Install the air cleaner assembly
(4) Fill the cooling system.

Manifold Air Temperature (MAT) Sensor

Removal

(1) Disconnect the MAT sensor electrical connector (Fig. 19).
(2) Remove MAT sensor from the intake manifold.

Installation

(1) Install the MAT sensor into the intake manifold. Tighten to 28 N•m (21 ft-lbs) torque.
(2) Connect the MAT sensor electrical connector.

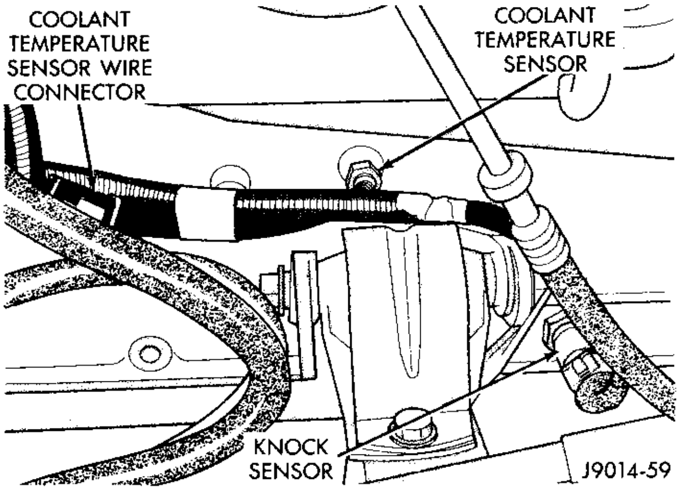


Fig. 18 Coolant Temperature Sensor Remove/Install

Manifold Absolute Pressure (MAP) Sensor

Removal

(1) Disconnect the MAP sensor electrical connector (Fig. 20).
(2) Remove the MAP sensor vacuum supply hose.
(3) Remove the MAP sensor retaining nuts and remove MAP sensor.

Installation

(1) Install MAP sensor to dash panel and secure with retaining nuts.
(2) Install the MAP sensor vacuum supply hose.
(3) Connect the MAP sensor electrical connector.

Knock Sensor

Removal

(1) Raise and support the vehicle.
(2) Disconnect the knock sensor wire connector (Fig. 21).

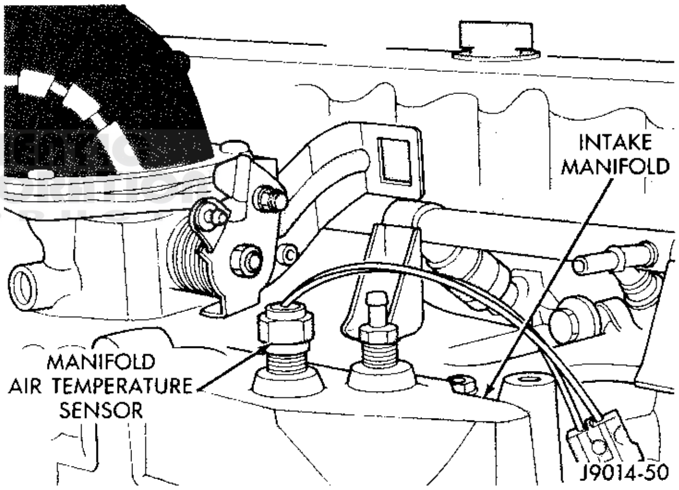


Fig. 19 Manifold Air Temperature Sensor Removal/Installation

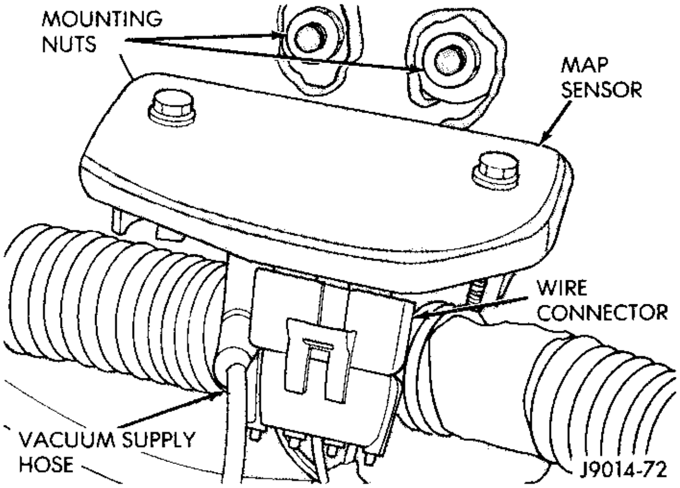


Fig. 20 MAP Senor Removal/Installation

(3) Remove the knock sensor.

Installation

CAUTION: The knock sensor MUST be tightened to the appropriate torque. Tightening torque is critical to knock sensor operation.

(1) Install the knock sensor into the cylinder block. Tighten to 10 N•m (89 in-lbs) torque.

(2) Connect the wire connector to the knock sensor.

(3) Lower the vehicle.

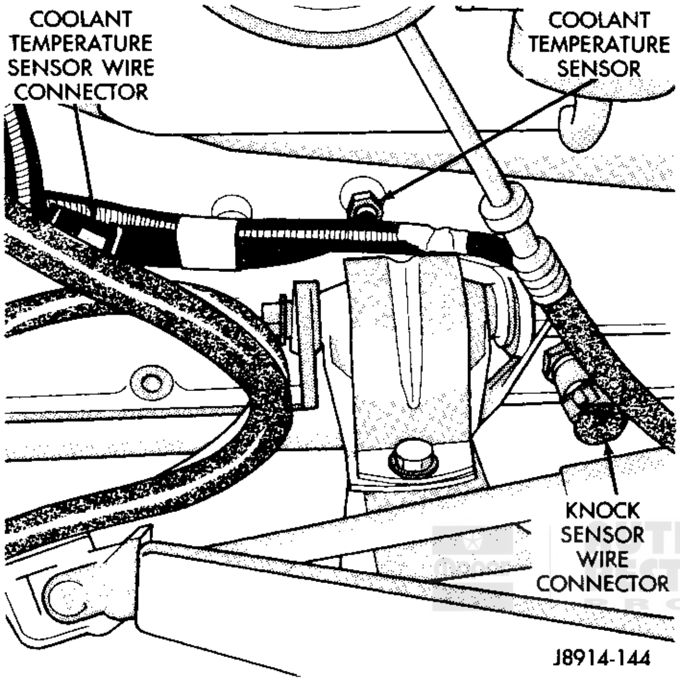


Fig. 21 Knock Sensor Removal/Installation

Engine Speed Sensor

Removal

(1) Disconnect the wire connector (Fig. 22).

(2) Remove 2 bolts attaching speed sensor to the transmission housing.

Installation

(1) Install the speed sensor using 2 shoulder bolts.

(2) Connect the wire connector.

Throttle Position Sensor

Removal

(1) Disconnect the TPS electrical connector(s).

(2) Bend the lock tabs back and remove the retaining screws (Fig. 23).

(3) Remove the TPS from the throttle plate assembly (Fig. 23).

Installation

(1) Position TPS onto the throttle plate assembly.

(2) Install and tighten retaining screws.

(3) Adjust the TPS. Refer to TPS adjustment procedure in this group.

(4) Bend the lock tabs over the mounting screws.

(5) Connect the TPS electrical connector(s).

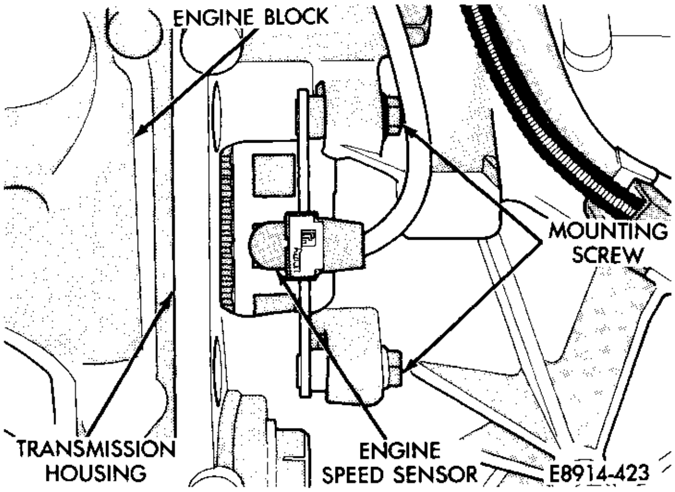


Fig. 22 Engine Speed Sensor

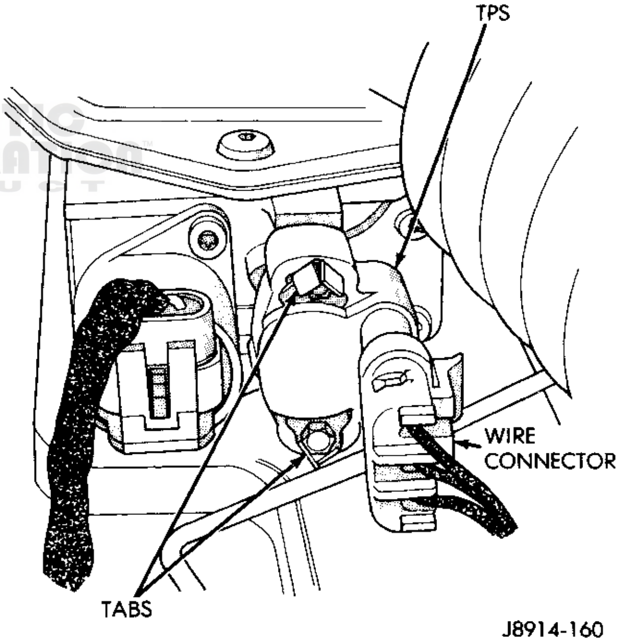


Fig. 23 Throttle Position Sensor Remove/ Install—Typical

Electronic Control Unit (ECU)

Removal

The ECU is located underneath the instrument panel between the steering column and heater A/C housing (Fig. 24). The ECU is mounted to a bracket by three screws. The bracket is attached to the dash by locknuts.

(1) Disconnect the battery negative cable.

(2) Remove locknuts securing the ECU to the dash (Fig. 24). Lower ECU and bracket.

(3) Remove ECU to mounting bracket screw (Fig. 25).

(4) Disconnect ECU wiring harness. Remove ECU.

Installation

(1) Connect ECU wire harness to ECU.

(2) Install ECU on mounting bracket. Tighten mounting screws securely.

(3) Position ECU and bracket assembly under instrument panel and install retaining locknuts.

(4) Connect battery negative cable to negative terminal of battery.

DISTRIBUTOR SERVICE

The distributor used in the 4.0L engine consists of an internal oil seal that prevents oil from entering the distributor housing. The seal is not serviceable.

Refer to Fig. 26 for an exploded view of the distributor and a list of its components.

Replacement

Removal

(1) Disconnect the battery negative cable.

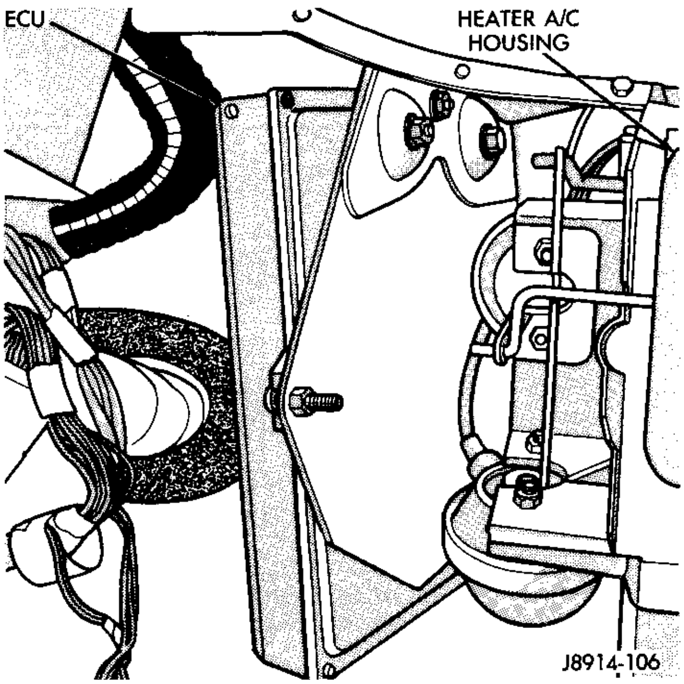


Fig. 24 ECU Location

(2) On vehicles equipped with A/C, remove the electrical cooling fan and shroud assembly from the radi-

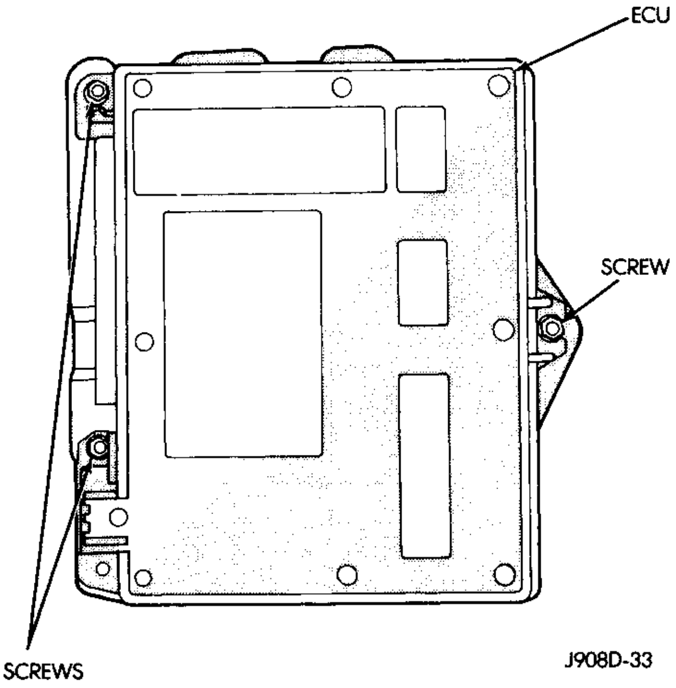


Fig. 25 ECU Remove/Install

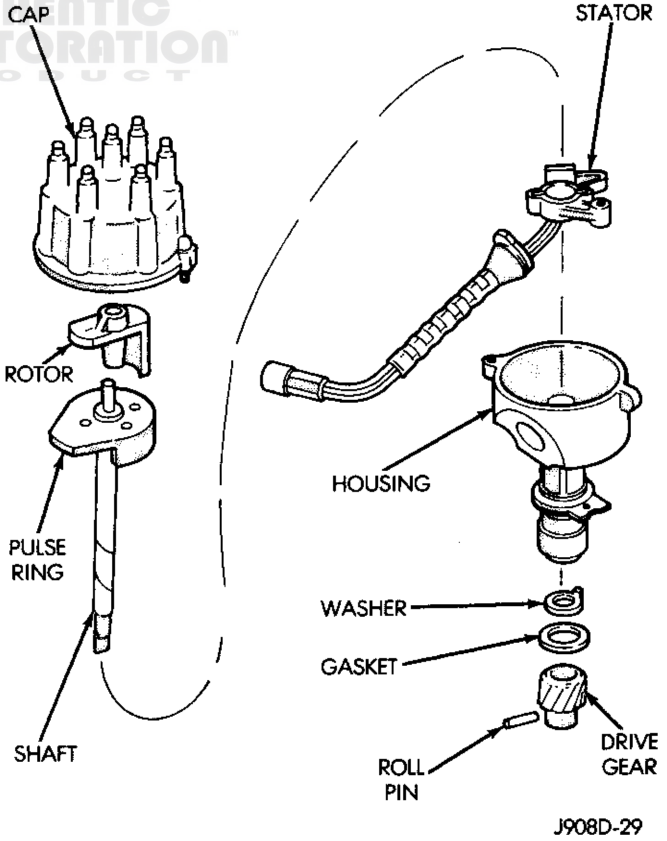


Fig. 26 Distributor—4.0L

ator. This will provide room to turn the engine with a socket and ratchet using the vibration damper bolt.

(3) Scribe a mark on the distributor housing below the left side of (past) the number one spark plug wire post of the distributor cap to use as a reference for #1 cylinder firing position (Fig. 27).

(4) Remove the distributor cap.

(5) Turn the engine in a clockwise direction until the rotor is approaching the scribe mark on the distributor housing. Then slowly turn the engine until the timing mark on the crankshaft vibration damper lines up with zero on the front cover timing scale (Fig. 28).

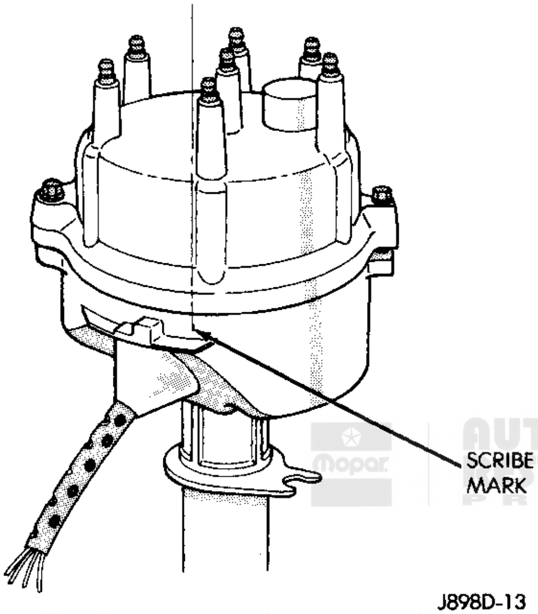


Fig. 27 Mark Distributor Housing

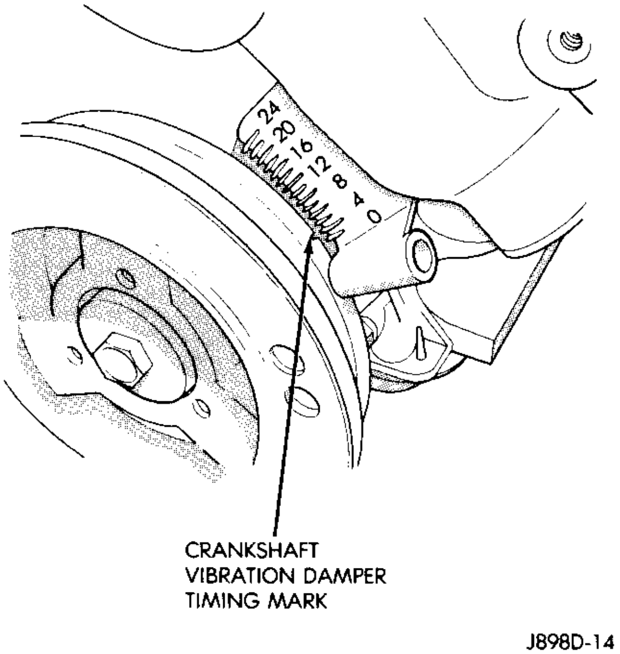


Fig. 28 Align Timing Marks

The timing mark is on the edge of the vibration damper closest to the engine front cover.

(6) Align the trailing edge of the rotor blade with the scribe mark on the distributor housing (Fig. 29).

(7) Remove the distributor hold-down bolt and clamp.

(8) Remove the distributor from the engine.

Installation

(1) If necessary, using a flat blade screwdriver, turn the oil pump gear shaft until the slot is slightly past the 11 o'clock position (Fig. 30).

The oil pump shaft is located down in the distributor hole.

(2) Install the rotor.

(3) Without engaging the distributor gear into the cam gear, position the distributor into the hole in the engine block. Be sure the distributor gasket is installed.

(4) Visually line up the hold-down ear of the distributor housing with the hold down clamp hole (Fig. 31).

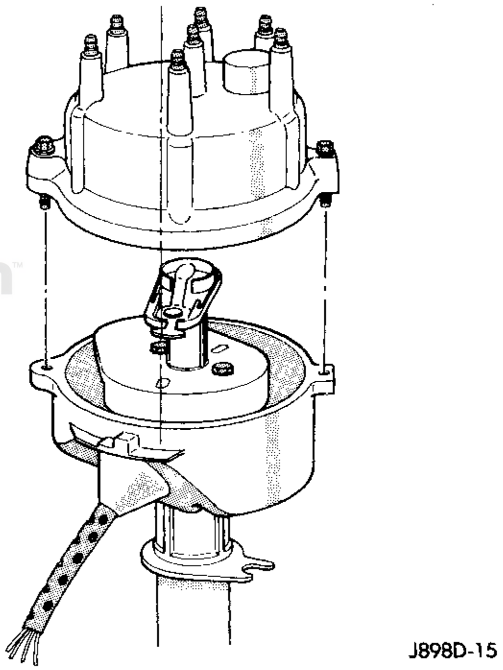


Fig. 29 Align Rotor Trailing Edge With Scribe Mark

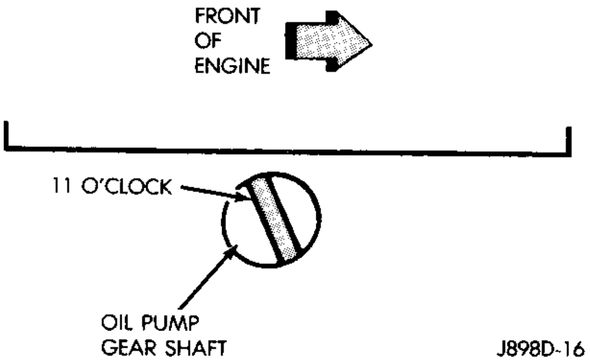


Fig. 30 Align Oil Pump Gear Shaft

(5) Turn the rotor to the 4 o'clock position (Fig. 32).

(6) Slide the distributor down into the block until it seats. Keep the hold-down ear aligned to the hole in the block.

(7) The rotor should be in the 5 o'clock position with the trailing edge of the rotor blade lined up with the scribe mark on the distributor housing (number one spark plug wire post location).

(8) Install the distributor hold-down clamp bolt and tighten to 13-19 N•m (9.5-14 ft-lbs).

(9) Install the distributor cap and connect the distributor electrical connector.

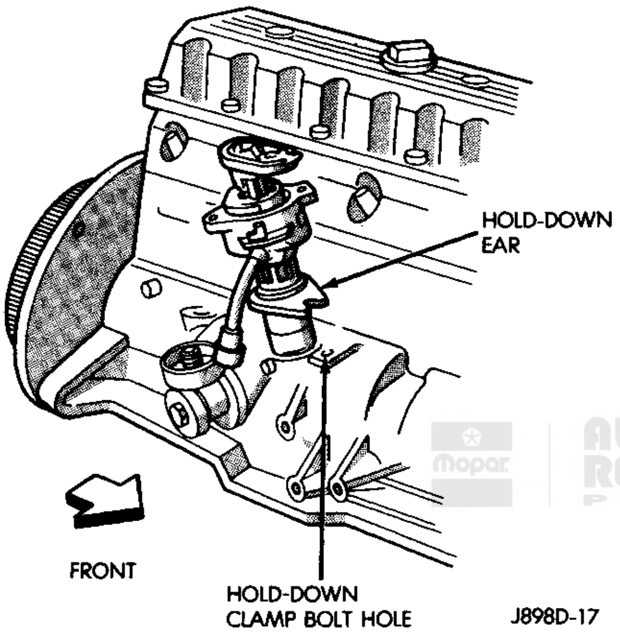


Fig. 31 Distributor Installation

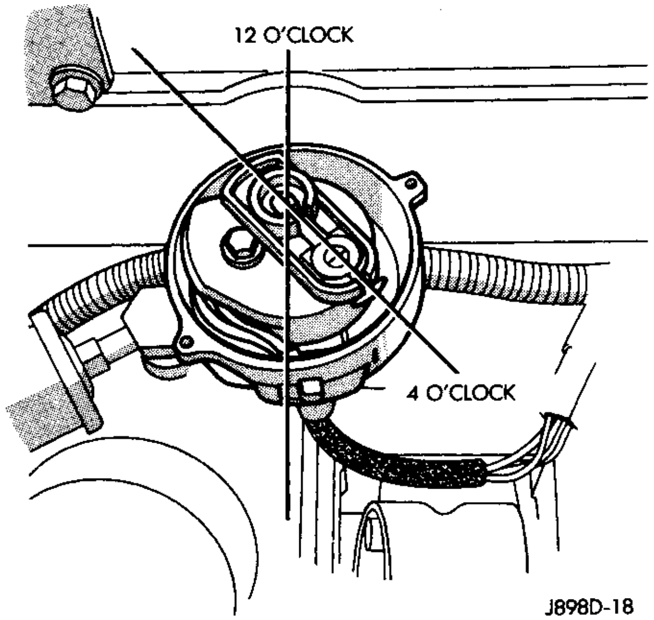


Fig. 32 Rotor Alignment

(10) Install electrical cooling fan and shroud if applicable.

(11) Connect battery negative cable.

STATOR REPLACEMENT

Removal

(1) Remove the distributor from the engine using the procedure outlined in Distributor removal.

(2) Remove the distributor rotor.

(3) Position the distributor in a vise.

(4) Remove the distributor gear from the shaft using a small punch and a hammer to drive out the retaining roll pin (Fig. 33).

(5) Remove the distributor shaft from the distributor housing.

(6) Remove the stator retaining screw.

Mark location of stator position for assembly reference.

(7) Remove the stator harness by pushing the grommet through the housing. Remove stator assembly (Fig. 34).

Installation

(1) Install stator assembly and retaining screw.

(2) Position the stator assembly harness through the distributor housing and push the grommet into position.

(3) Install distributor shaft into the distributor housing. If the shaft is equipped with seals make sure the are in place and not damaged.

(4) Install distributor gear washer and distributor gear onto the shaft.

(5) Install the distributor gear retaining pin.

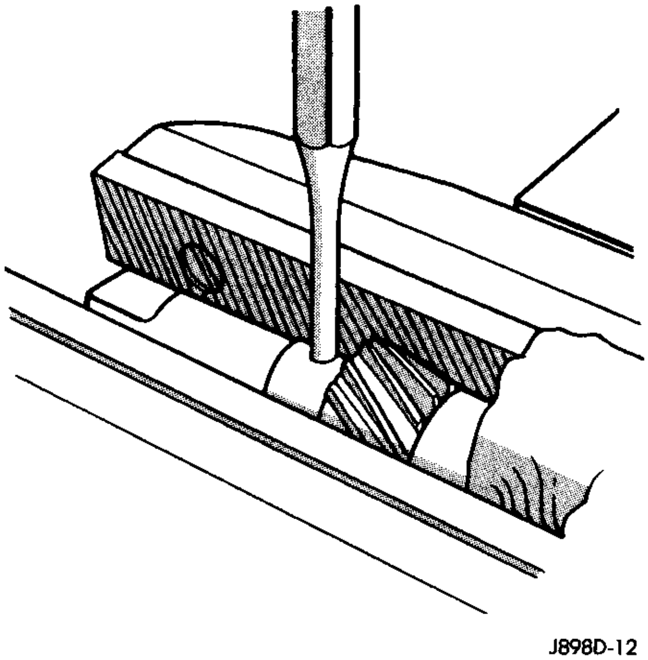


Fig. 33 Distributor Gear Removal/Installation

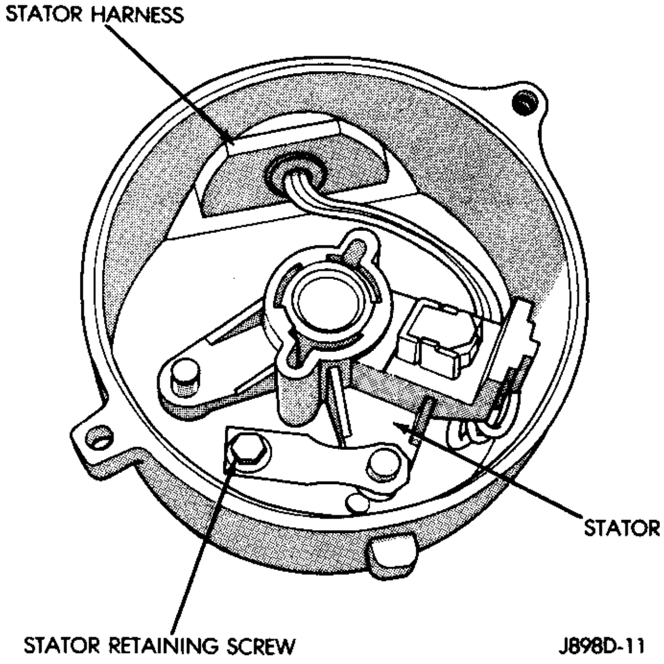


Fig. 34 Stator Removal/Installation

(6) Install the distributor rotor.

(7) Install the distributor to the engine using the procedure given in Distributor Installation.

Spark Plug and Ignition Coil Wire Replacement

Use care when disconnecting the spark plug and coil wire boots and wires. Twist the boot 1/2 turn and pull on the boot only to disconnect the wire.

When replacing the spark plug and coil wires, route the wires correctly and secure in the proper retainers. Failure to route the wires properly can cause the radio to reproduce ignition noise, cross ignition of the plugs or short circuit the wires to ground.

4.2L SIX-CYLINDER ENGINE

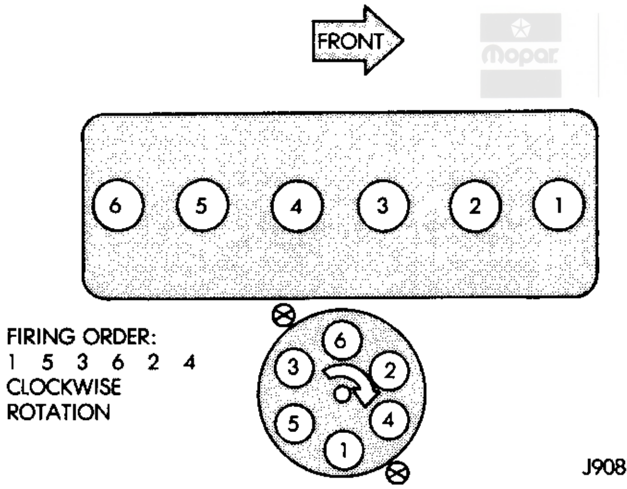
INDEX

SPARK PLUG SPECIFICATIONS

ENGINE	SPARK PLUG TYPE	ELECTRODE GAP	TIGHTENING TORQUE
4.2L	RFN-14LY	0.035 in	37 N•m (27 ft-lbs)

J908D-17

ENGINE FIRING ORDER



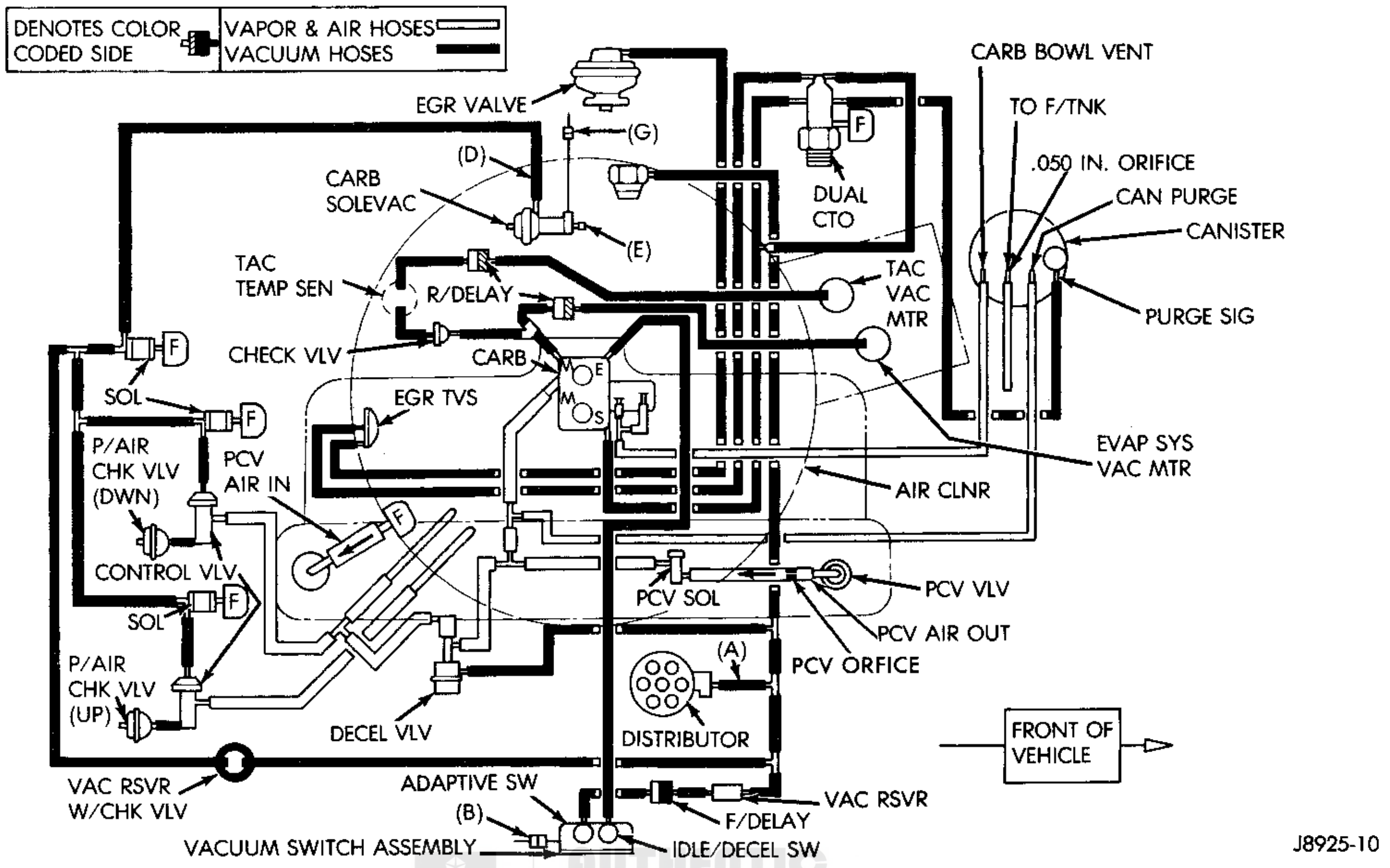
J908D-7

SSI DISTRIBUTOR AND IGNITION COIL SPECIFICATIONS

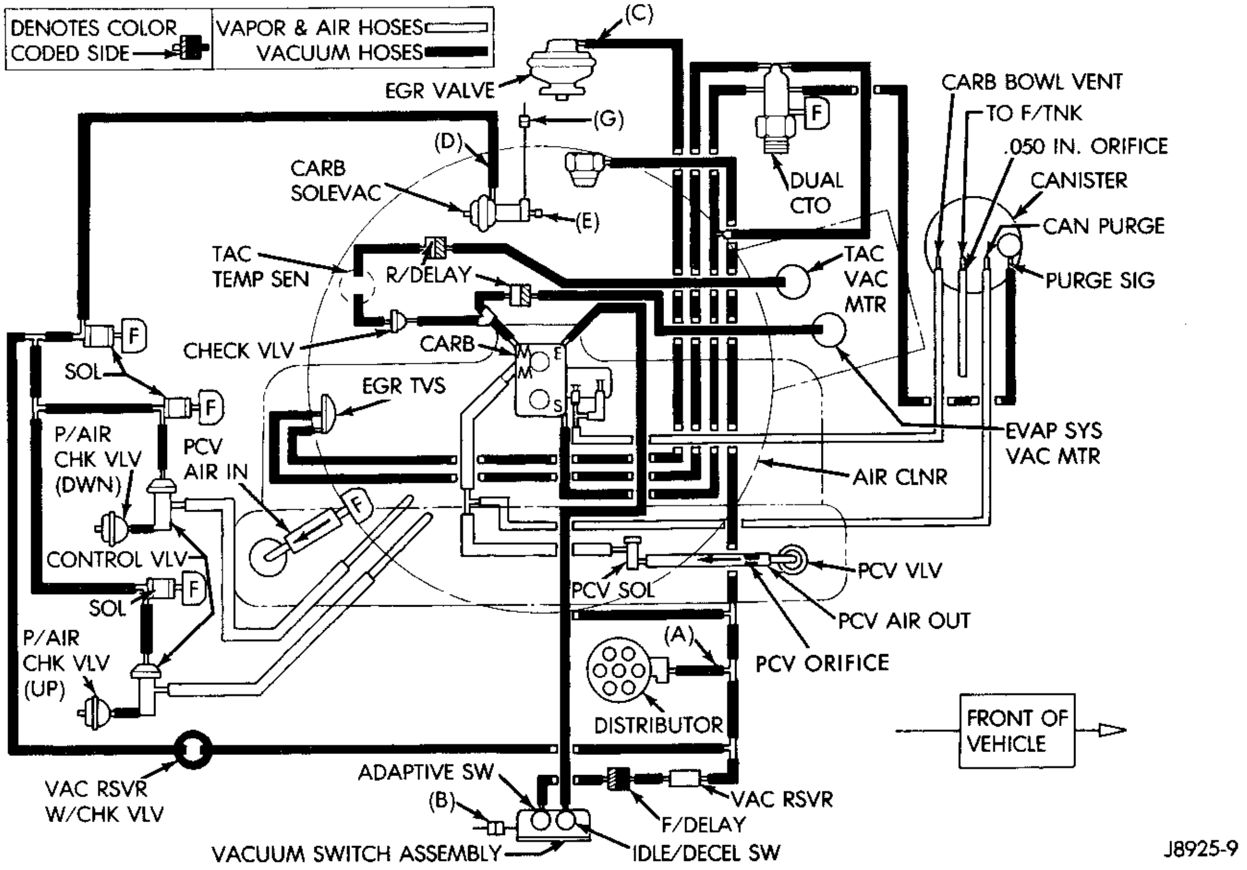
DISTRIBUTOR PICKUP COIL
RESISTANCE ....400 TO 800 OHMS @ 24°C (75°F)
IGNITION COIL
PRIMARY RESISTANCE ....1.13 TO 1.23 OHMS @ 24°C (75°F)
..............1.5 OHMS @ 93°C (200°F)
SECONDARY RESISTANCE....7700 TO 9300 OHMS @ 24°C (75°F)
........12,000 OHMS @ 93°C (200°F)
MINIMUM OPEN CIRCUIT OUTPUT
AT 1000 RPM......................................24KV
SPARK PLUGS
REQUIRED VOLTAGE AT 1000 RPM ....5 TO 16 KV
MAXIMUM VARIATION BETWEEN CYLINDERS ....3 TO 5 KV

J908D-3

VACUUM HOSE ROUTING SCHEMATICS



Vacuum Routing Schematic - YJ 4.2L With Manual Trans.



Vacuum Routing Schematic - YJ 4.2L With Auto. Trans.

GENERAL INFORMATION

The 4.2L engine is available in YJ vehicles. It is a carbureted engine equipped with a micro-computer controlled Fuel Feedback system.

Micro-Computer Unit

The ignition system is ultimately controlled by the Micro-Computer Unit (MCU). The MCU monitors various engine sensors that indicate engine operating conditions. One of these inputs originates from the distributor and represents engine speed which is used to determine ignition timing. The MCU processes ignition signals and then sends them to the ignition module. By modifying the signal it sends to the ignition module, the MCU can retard ignition timing in response to the various inputs it receives. The MCU also controls air-fuel ratio and the pulse air system. Refer to Group 14—Fuel for more information on the MCU and The Fuel Feedback System.

The MCU is a completely sealed module which is located behind the glove box next to the radio, if equipped (Fig. 1). It is not repairable and must be replaced as a unit if service is required.

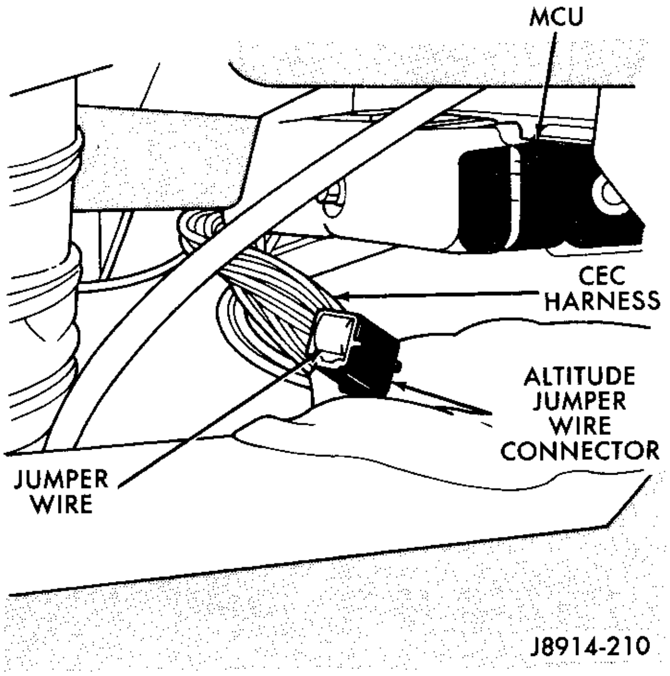


Fig. 1 MCU Location

Solid State Ignition System

A Solid State Ignition (SSI) system (Fig. 2) is used on the 4.2L six-cylinder engine. The SSI system is con-

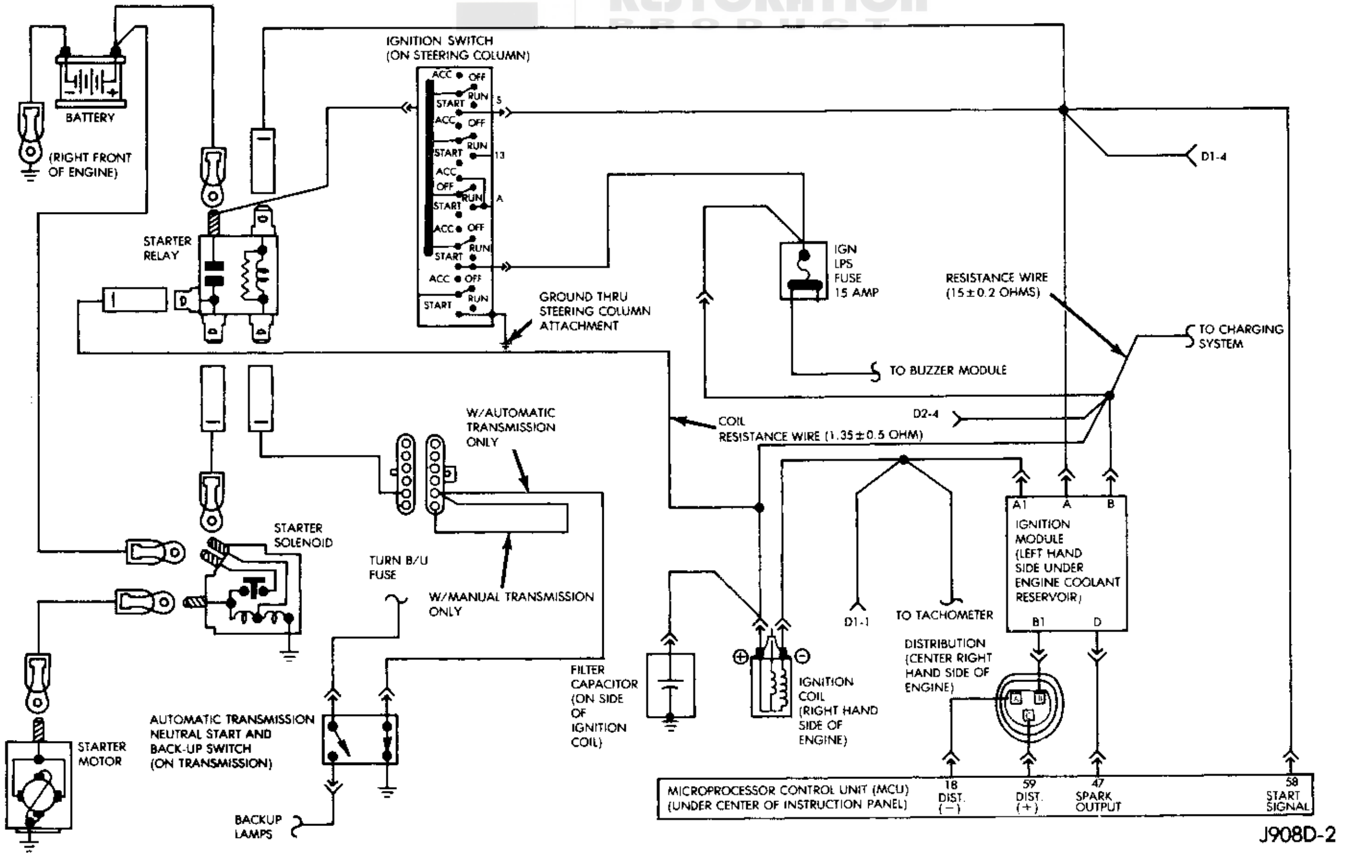


Fig. 2 Ignition Schematic—4.2L

trolled by the engine Micro-Computer Unit. The SSI system consists of the following components:

- ignition module
- ignition coil
- resistance wire
- distributor
- knock sensor
- distributor cap and rotor
- spark plugs and wires

IGNITION SYSTEM COMPONENTS

Ignition Module

The electronic Ignition Module (Fig. 3) is located in the engine compartment behind the bottom of the radiator overflow bottle. It is a permanently sealed, solid state module that is not repairable and must be replaced as a unit if service is required.

The Micro-Computer Unit (MCU) controls ignition coil operation through the ignition module. The MCU processes the ignition signals it receives and then sends a signal to the ignition module. The ignition module then interrupts the primary circuit to the ignition coil causing spark to occur. Dwell is adjusted automatically.

When disconnecting SSI system connectors, pull them apart with a firm, straight pull. DO NOT attempt to pry then apart with a screwdriver. When connecting them, press together firmly to overcome hydraulic pressure caused by the silicone dielectric compound.

If the connector locking tabs weaken or break off, do not replace the associated component. Bind the connectors together with tape or a harness tie strap to assure good electrical connection.

Ignition Coil

The ignition coil is mounted to the engine block next to the distributor (Fig. 4). Coil operation is dictated by the ignition module which is controlled by the MCU. The coil does not require special service other than maintaining the terminals and connectors.

When an ignition coil is suspected of malfunctioning, test it on the vehicle. A coil may "break down" after the engine has heated it to a high temperature. It is important that the coil be at operating temperature when tested. Perform the test according to the test equipment manufacturer's instructions.

Ignition Coil Connector

The ignition coil terminals and connector are of unique design. The connector is removed from the coil by grasping both sides and pulling away from the coil (Fig. 4).

When a tachometer is required for engine testing or tune-up, connect it using an alligator jaw type connector (Fig. 5).

Resistance Wire

A wire with 1.35 ohms resistance is provided in the ignition wiring to supply less than full battery voltage to the ignition coil after the starter motor solenoid is deenergized. During engine starting, the resistance wire is bypassed and full battery voltage is applied to the ignition coil. The bypass is accomplished at the I-terminal on the starter motor solenoid. Refer to the Wiring Diagrams for location of the resistance wire.

Distributor

The distributor consists of three groups of components: pickup coil and trigger wheel, ignition advance

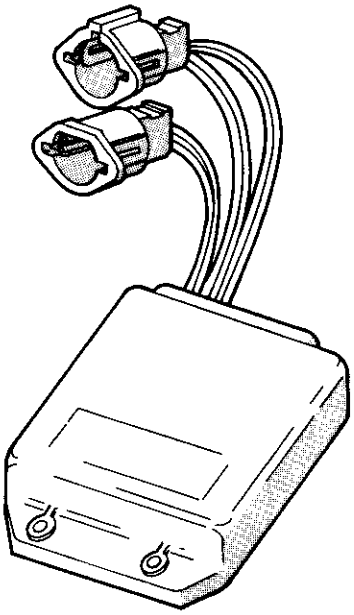


Fig. 3 Ignition Module

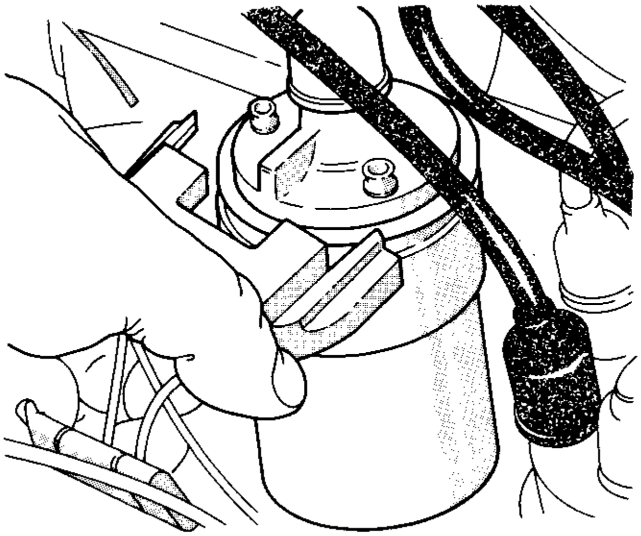


Fig. 4 Ignition Coil

mechanisms, cap and rotor. The distributor drive gear is installed on the distributor shaft and meshes with a spiral cut gear on the camshaft. The end of the distributor shaft is flattened and fits into a slot in the top of the oil pump and provides the force to drive the oil pump.

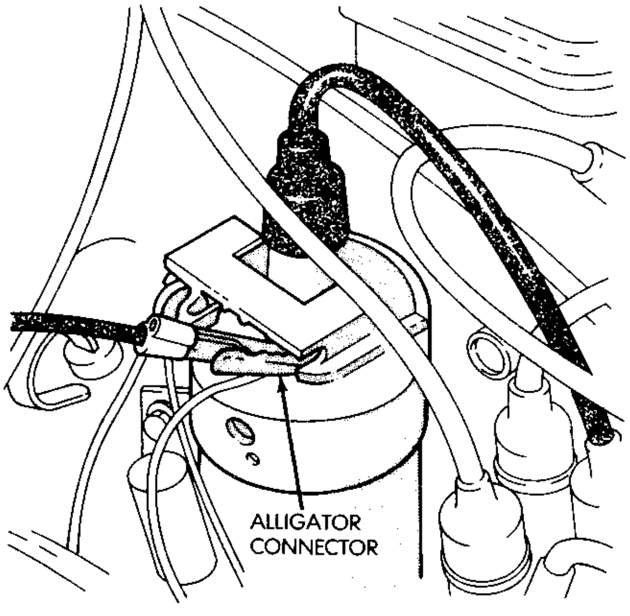


Fig. 5 Tachometer Connection

Pickup Coil and Trigger Wheel

The ignition coil primary circuit is opened and closed electronically by the ignition module. The distributor pickup coil and trigger wheel provide the input signal for the MCU.

The trigger wheel which is installed on the distributor shaft, has one tooth for each engine cylinder. The wheel is mounted so that the teeth rotate past the pickup coil one at a time.

The pickup coil has a magnetic field that is intensified by the presence of ferrous metal (contains iron - can be picked up with an ordinary magnet). The pickup coil reacts to the trigger wheel teeth as they pass. As a trigger wheel tooth approaches and passes the pole piece of the pickup coil, it reduces the reluctance (compared to air) to the magnetic field and increases field strength. Field strength decreases as the tooth moves away from the pole piece. This increase and decrease of field strength induces an alternating current (pulse) into the pickup coil, which triggers the MCU which in turn signals the ignition module. The control unit opens and closes the coil primary circuit according to the position of the trigger wheel teeth.

There aren't any contacting surfaces between the trigger wheel and pickup coil assembly, Because there isn't any wear, the dwell angle does not require adjustment. The dwell angle is determined electronically by the control unit and is not adjustable. When the ignition coil primary circuit is switched open, the MCU sends a signal to the ignition module that starts an electronic timer in the ignition module which keeps the coil primary only long enough for the electromagnetic field within the coil to collapse and the voltage to discharge. The ignition module then automatically closes the coil primary circuit. The period of time the circuit is closed is referred to as dwell.

Ignition Advance

Centrifugal (mechanical) advance is controlled by engine speed. Flyweights connected to the distributor shaft are thrown outward by centrifugal force. Higher engine RPM throws the weights further out. Calibrated rate springs are used to control this movement. The outward motion of the flyweights causes the rotor and trigger wheel to be advanced on the distributor shaft several degrees in the direction of normal rotation. This is referred to as centrifugal ignition advance.

When the engine is operating under light load, the carburetor throttle plates restrict airflow, causing a relatively lean mixture to enter the combustion chambers. Ignition must occur earlier because the lean mixture requires a longer time to burn. The vacuum ignition advance mechanism is used for this purpose. When carburetor ported or manifold vacuum is high, the vacuum advance mechanism moves the pickup coil assembly several degrees opposite to the direction the distributor is rotating. This causes the pickup coil to react to the presence of the trigger wheel teeth earlier. This is referred to as vacuum ignition advance. With low vacuum operating conditions, such as wide open throttle acceleration, a spring in the vacuum advance mechanism pushes the pickup coil back to a position of zero advance.

Cap and Rotor

The central tower on the distributor cap is connected directly to the high voltage at the coil. The current flows through the spring-loaded contact on the rotor to the carbon button in the cap. The rotor tip aligns with a contact in the cap that corresponds to the cylinder to be ignited just as the ignition coil output high voltage is applied to the rotor. In this way, each spark plug is "fired" in turn.

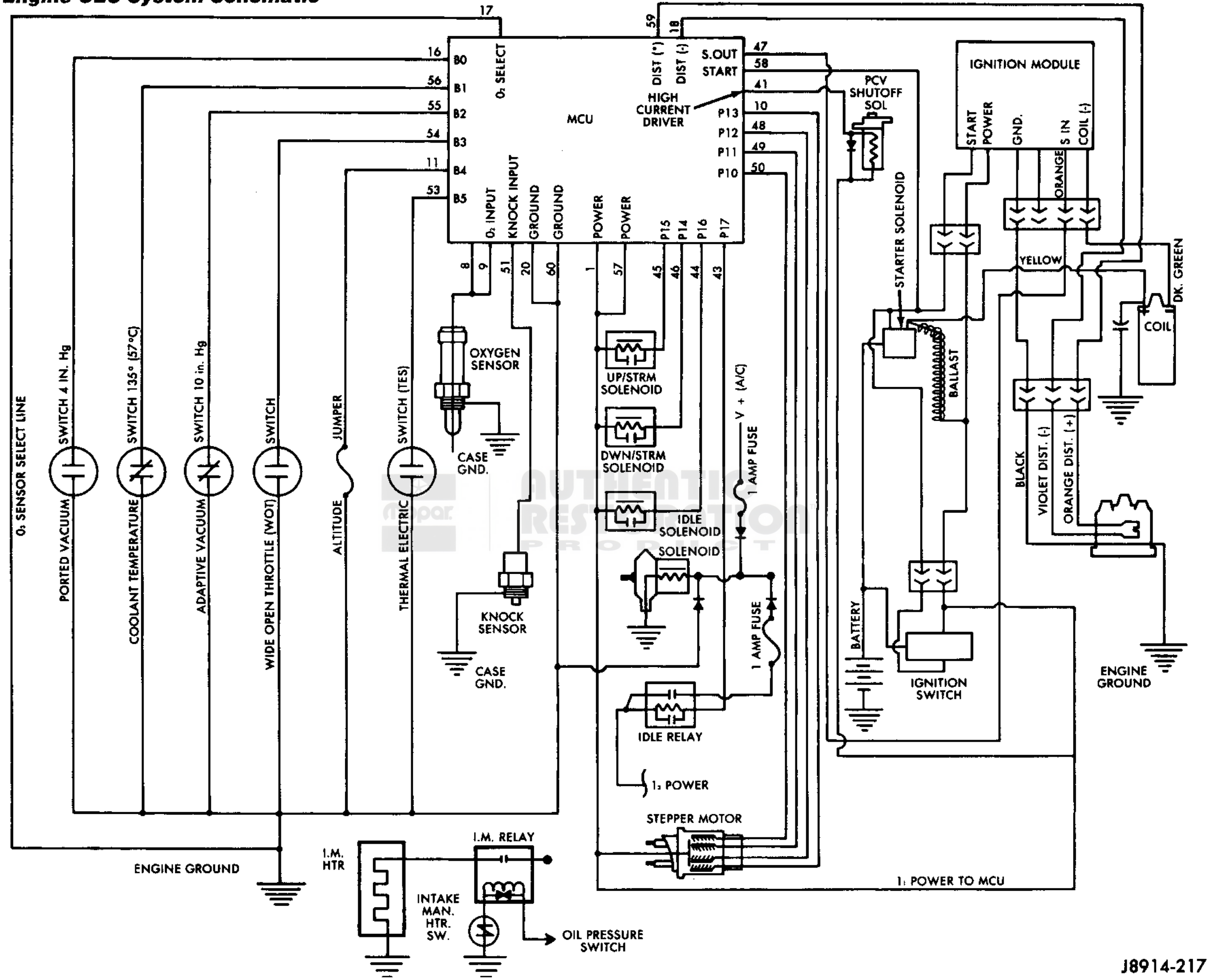
System Operation

The ignition module is activated by the MCU when the ignition switch is in the Start or On position. The primary circuit is closed and current flows through the coil primary winding. When the engine begins turning the distributor, the trigger wheel teeth rotate past the pickup coil assembly, As each tooth aligns with the pickup coil, the resulting pulse triggers the MCU which in turn signals the ignition module which closes the primary circuit. A high voltage is then induced in the coil secondary winding and current flows to the distributor cap and rotor. The rotor connects the high voltage to the proper spark plug. The timing of the ignition is constantly changed by the MCU, and vacuum and centrifugal advance mechanisms according to engine operation.

IGNITION SYSTEM DIAGNOSIS

The Computerized Emission Control (CEC) system which contains the MCU can be tested using the system tester, tool 7559. A schematic of the 60 way connector for the MCU and accompanying call outs can be found in the wiring diagrams section of this manual.

4.2L Engine CEC System Schematic

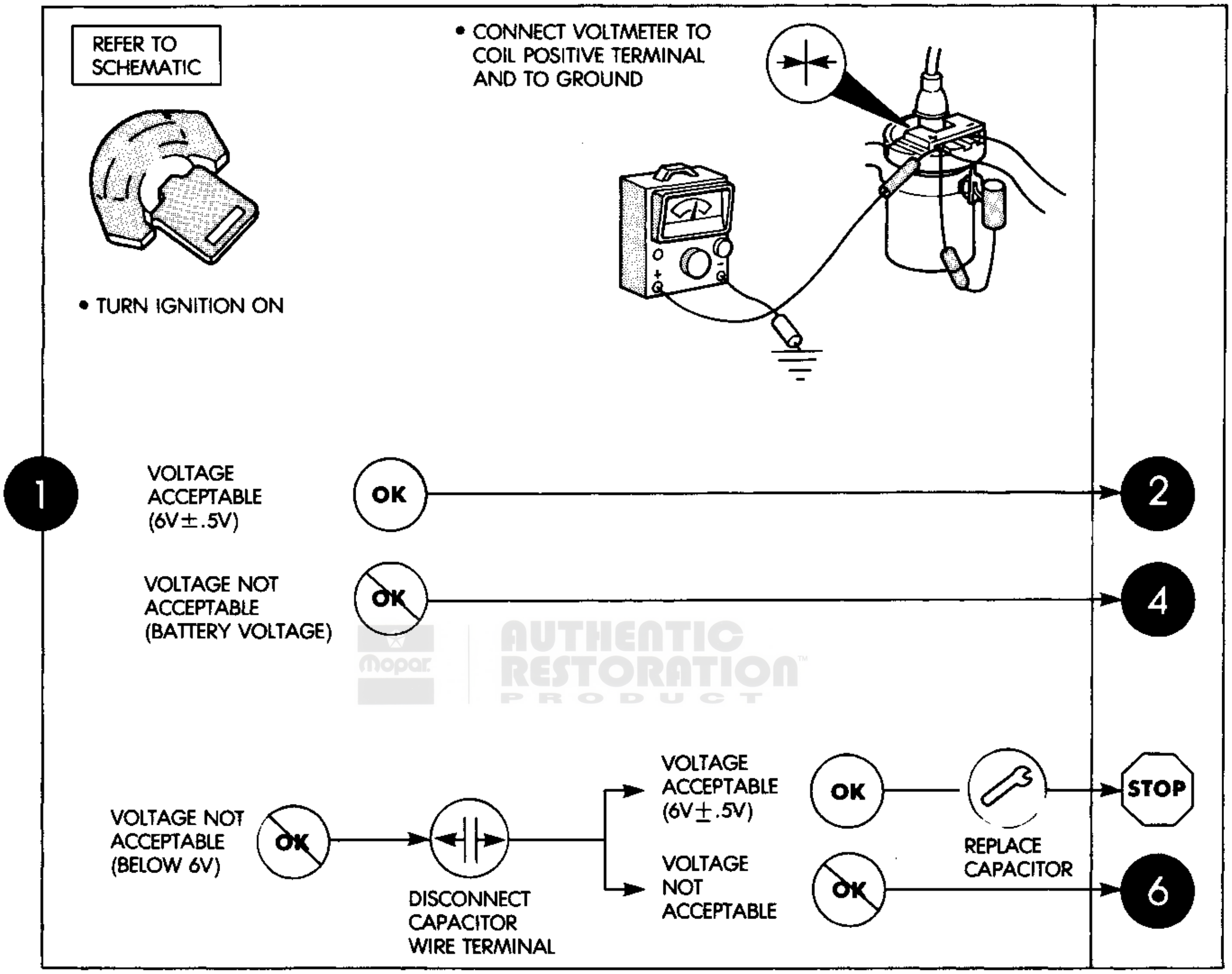


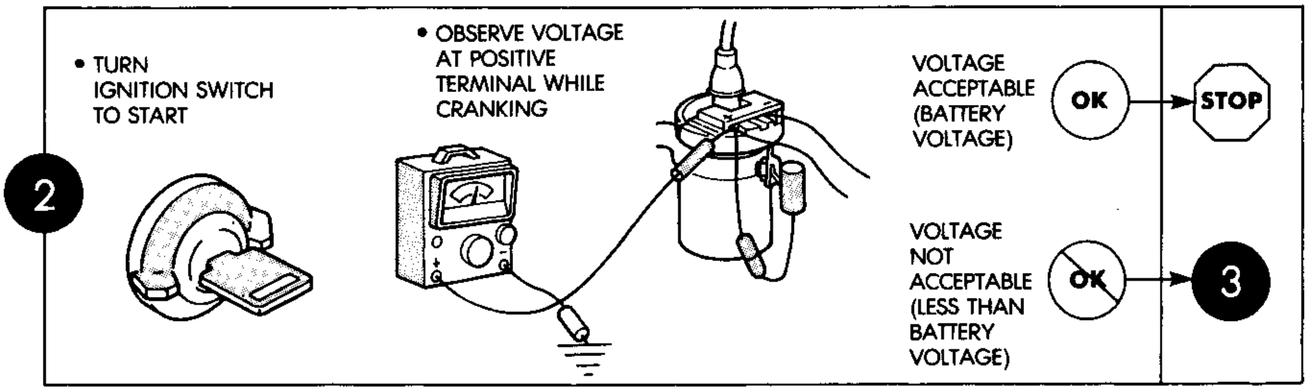
J8914-217

IGNITION COIL PRIMARY CIRCUIT FUNCTION:
Connects Battery Voltage To Coil and Coil To Ground

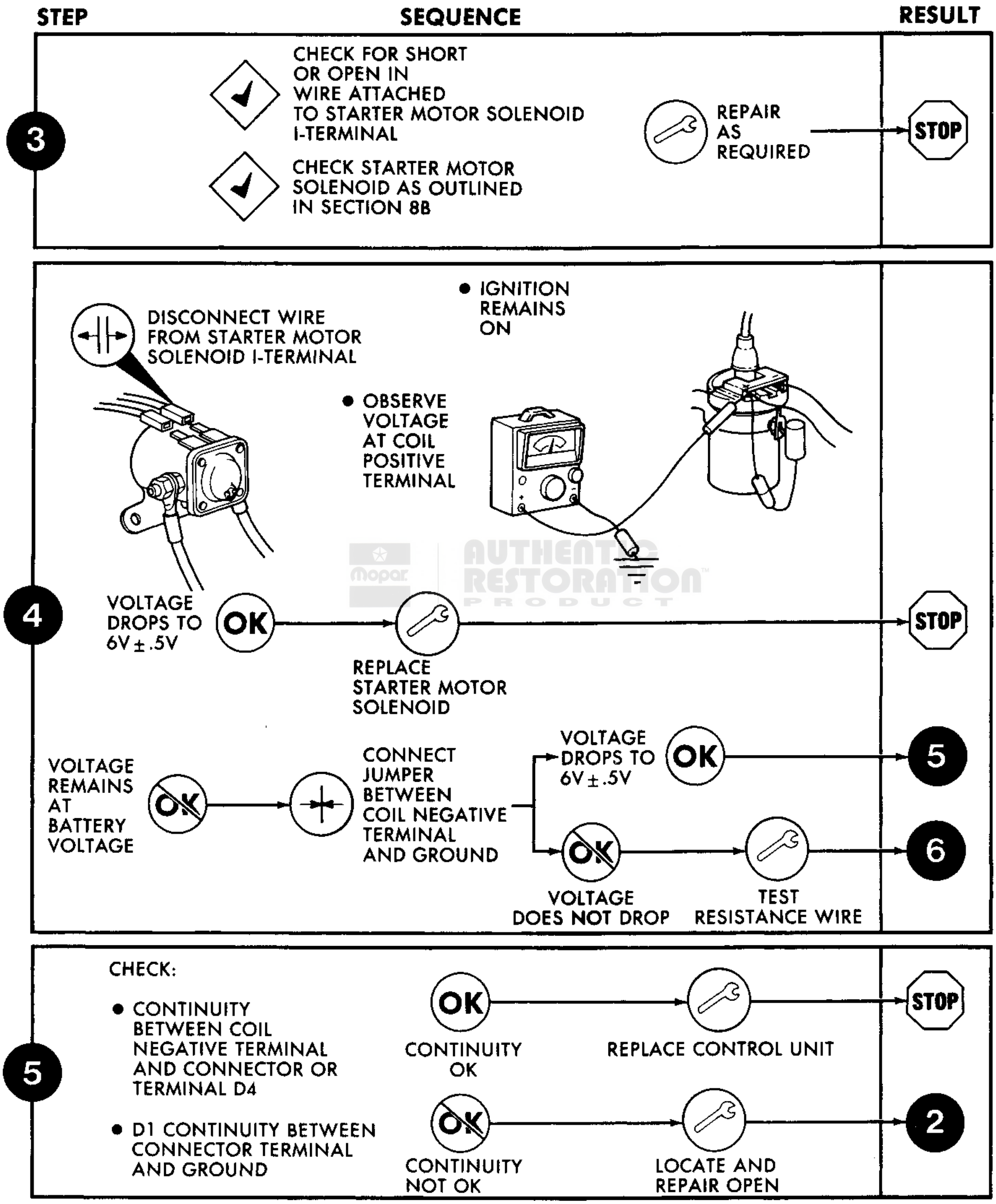
Chart 1

STEP **SEQUENCE** **RESULT**



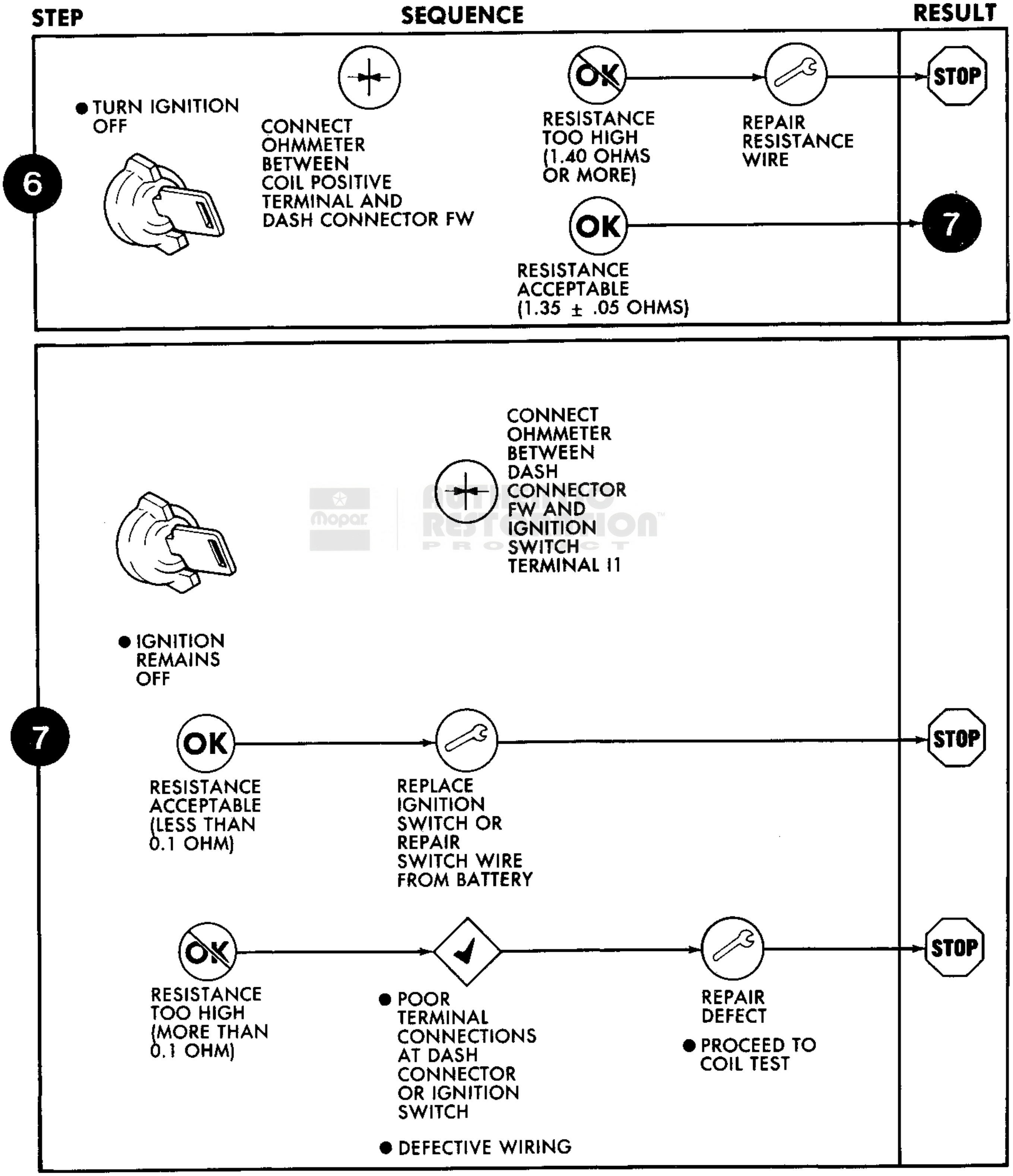


J908D-31


STEP
SEQUENCE
RESULT
3
CHECK FOR SHORT OR OPEN IN WIRE ATTACHED TO STARTER MOTOR SOLENOID I-TERMINAL
CHECK STARTER MOTOR SOLENOID AS OUTLINED IN SECTION 8B
REPAIR AS REQUIRED
STOP
4
DISCONNECT WIRE FROM STARTER MOTOR SOLENOID I-TERMINAL
● IGNITION REMAINS ON
● OBSERVE VOLTAGE AT COIL POSITIVE TERMINAL
VOLTAGE DROPS TO 6V ± .5V
OK
REPLACE STARTER MOTOR SOLENOID
STOP
VOLTAGE REMAINS AT BATTERY VOLTAGE
OK
CONNECT JUMPER BETWEEN COIL NEGATIVE TERMINAL AND GROUND
VOLTAGE DROPS TO 6V ± .5V
OK
5
OK
VOLTAGE DOES NOT DROP
TEST RESISTANCE WIRE
6
5
CHECK:
● CONTINUITY BETWEEN COIL NEGATIVE TERMINAL AND CONNECTOR OR TERMINAL D4
● D1 CONTINUITY BETWEEN CONNECTOR TERMINAL AND GROUND
OK
CONTINUITY OK
REPLACE CONTROL UNIT
STOP
OK
CONTINUITY NOT OK
LOCATE AND REPAIR OPEN
2

J898D-25

Chart 1

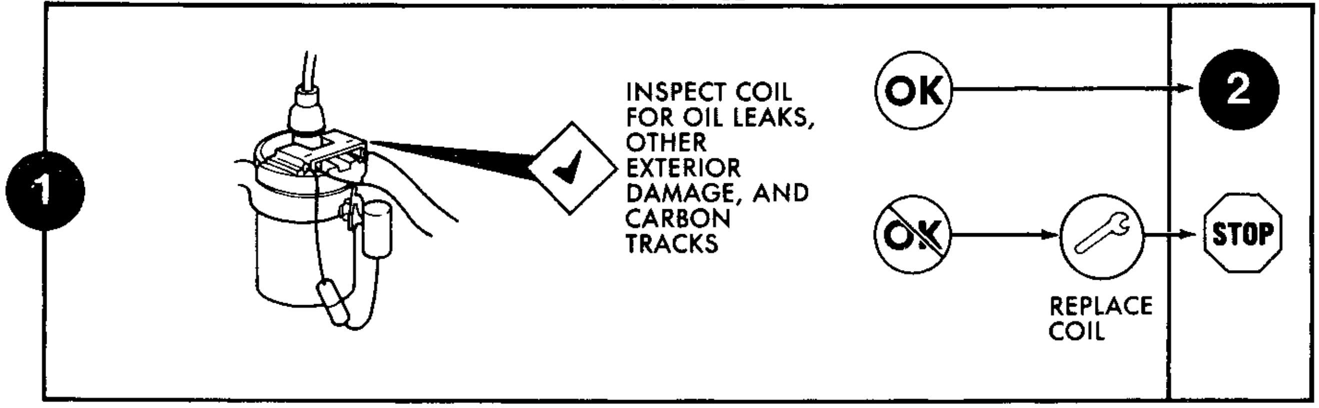


J898D-26

COIL TEST

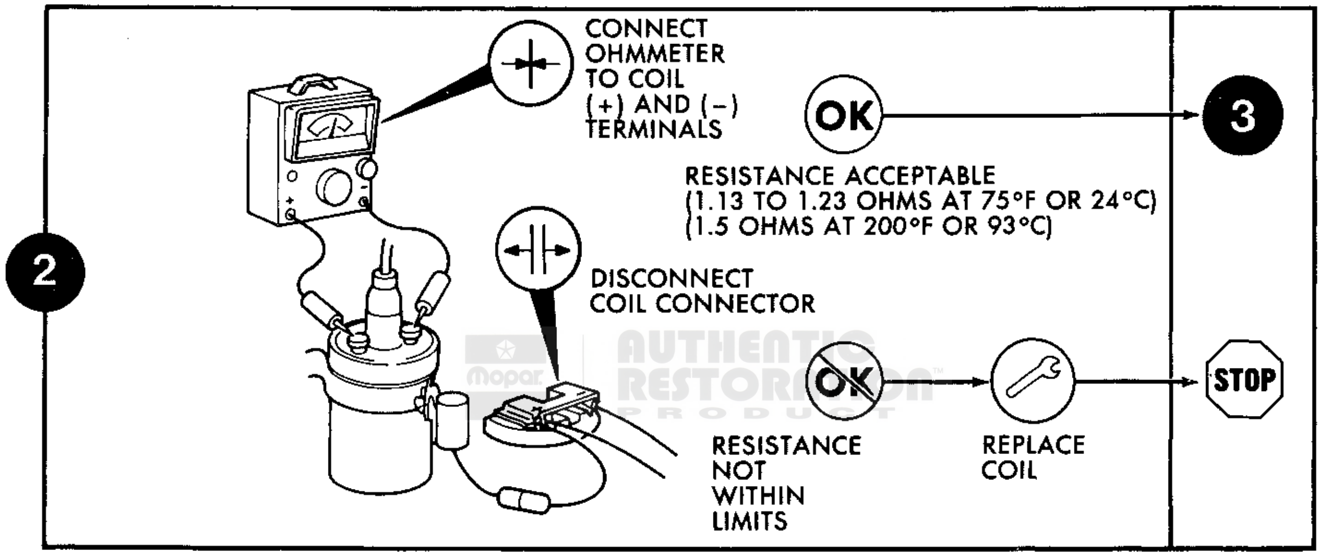
Chart 2

STEP SEQUENCE RESULT



INSPECT COIL FOR OIL LEAKS, OTHER EXTERIOR DAMAGE, AND CARBON TRACKS

REPLACE COIL



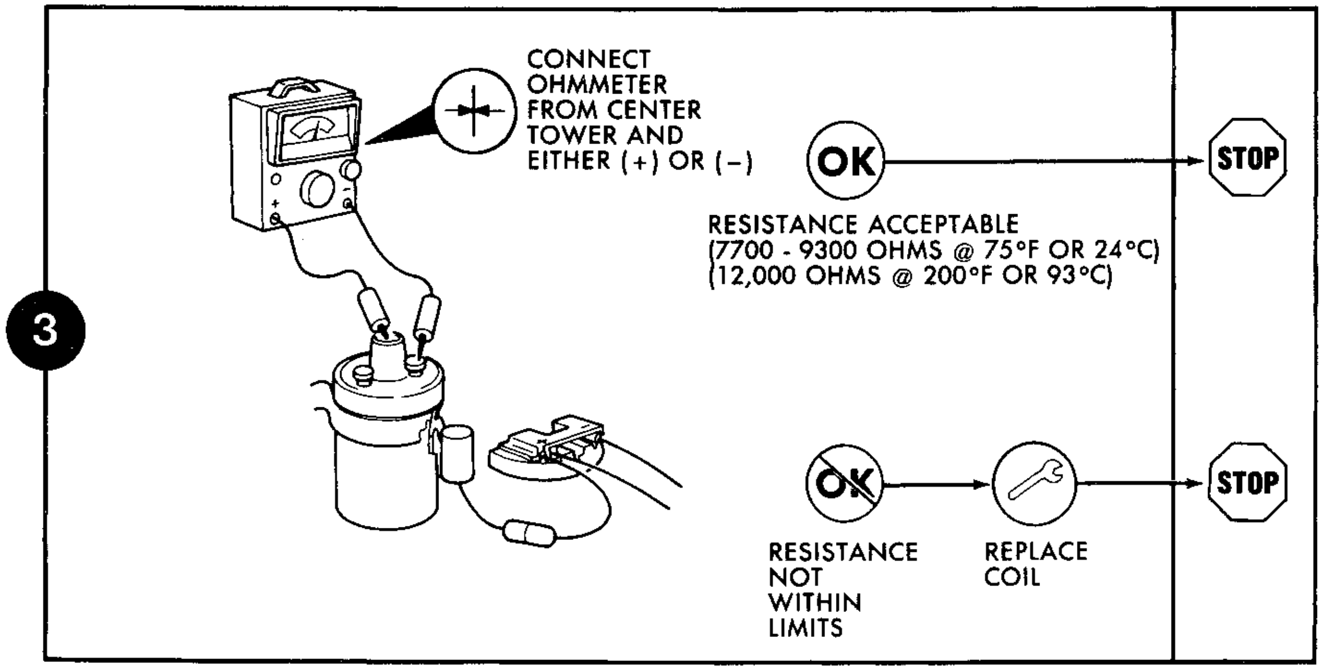
CONNECT OHMMETER TO COIL (+) AND (−) TERMINALS

RESISTANCE ACCEPTABLE
(1.13 TO 1.23 OHMS AT 75°F OR 24°C)
(1.5 OHMS AT 200°F OR 93°C)

DISCONNECT COIL CONNECTOR

RESISTANCE NOT WITHIN LIMITS

REPLACE COIL



CONNECT OHMMETER FROM CENTER TOWER AND EITHER (+) OR (−)

RESISTANCE ACCEPTABLE
(7700 - 9300 OHMS @ 75°F OR 24°C)
(12,000 OHMS @ 200°F OR 93°C)

RESISTANCE NOT WITHIN LIMITS

REPLACE COIL

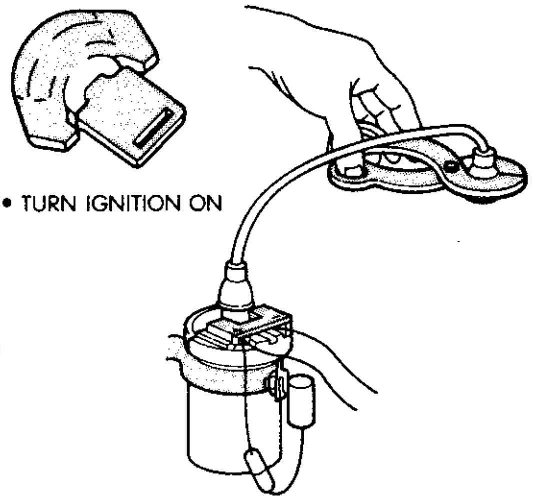
J898D-27

SENSOR CHECK AND CONTROL UNIT CHECK

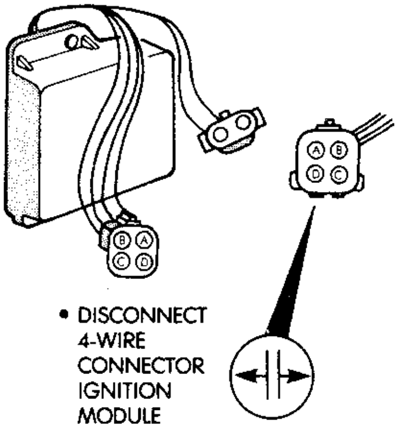
Chart 3

STEP **SEQUENCE** **RESULT**

1



- TURN IGNITION ON
- DISCONNECT COIL WIRE FROM CENTER TOWER OF DISTRIBUTOR AND HOLD 1/2-INCH FROM ENGINE WITH INSULATED PLIERS



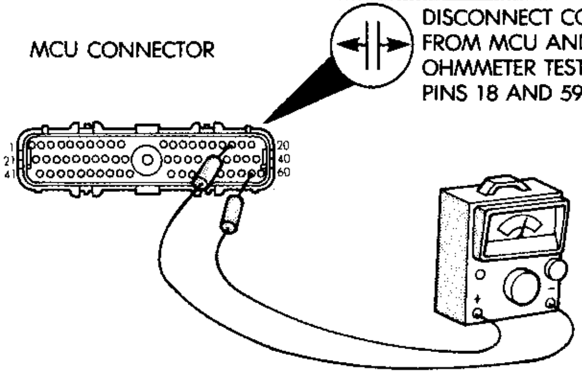
- DISCONNECT 4-WIRE CONNECTOR IGNITION MODULE

SPARK AT COIL WIRE (NORMAL) → **2**

NO SPARK → **5**

2

MCU CONNECTOR



DISCONNECT CONNECTOR FROM MCU AND CONNECT OHMMETER TEST LEADS TO PINS 18 AND 59 OF CONNECTOR

OK — OHMMETER INDICATES 400-800 OHMS (NORMAL) → **6**

~~OK~~ — OHMMETER DOES NOT INDICATE 400-800 OHMS → **3**

3

- DISCONNECT AND RECONNECT 3-WIRE CONNECTOR AT DISTRIBUTOR

OK — OHMMETER NOW INDICATES 400-800 OHMS → **6**

~~OK~~ — OHMMETER REMAINS OUTSIDE 400-800 OHMS → DISCONNECT 3-WIRE CONNECTOR AT DISTRIBUTOR → **4**

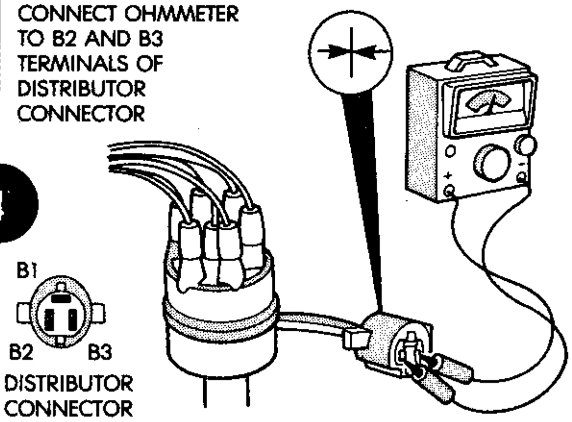
J908D-19

Chart 3

STEP — **SEQUENCE** — **RESULT**

4

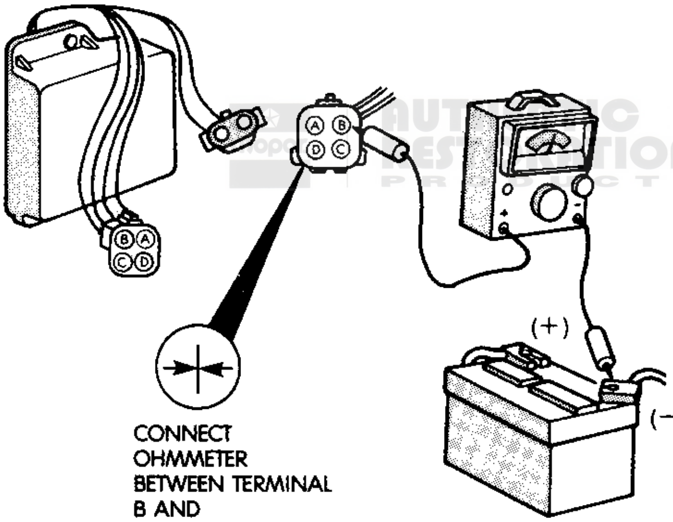
CONNECT OHMMETER TO B2 AND B3 TERMINALS OF DISTRIBUTOR CONNECTOR



OK → OHMMETER INDICATES 400-800 OHMS → REPAIR OR REPLACE HARNESS BETWEEN 3-WIRE AND 4 WIRE CONNECTOR → STOP

~~OK~~ → OHMMETER DOES NOT INDICATE 400-800 OHMS → REPLACE PICKUP COIL → STOP

5



CONNECT OHMMETER BETWEEN TERMINAL B AND BATTERY NEGATIVE TERMINAL

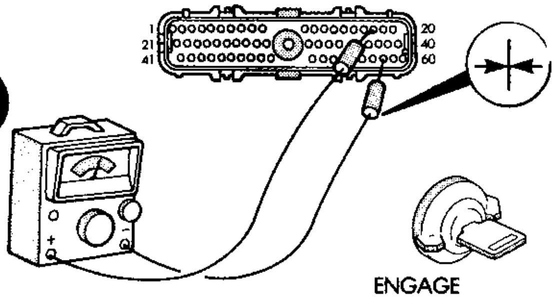
OK → OHMMETER INDICATES ZERO (NOT ABOVE 0.002 OHM) → 2

~~OK~~ → OHMMETER INDICATES ABOVE 0.002 OHM → LOCATE AND REPAIR SOURCE OF BAD GROUND → STOP

- GROUND CABLE RESISTANCE
- DISTRIBUTOR-TO-BLOCK RESISTANCE
- GROUND SCREW IN DISTRIBUTOR TO TERMINAL B

6

CONNECT DC VOLTMETER TEST LEADS TO PINS 18 AND 59 OF MCU CONNECTOR



ENGAGE STARTER MOTOR

OK → VOLTMETER FLUCTUATES, INDICATING PROPER PICKUP COIL AND TRIGGER WHEEL OPERATION → STOP

~~OK~~ → VOLTMETER DOES NOT FLUCTUATE → LOCATE AND REPAIR FAULT → STOP

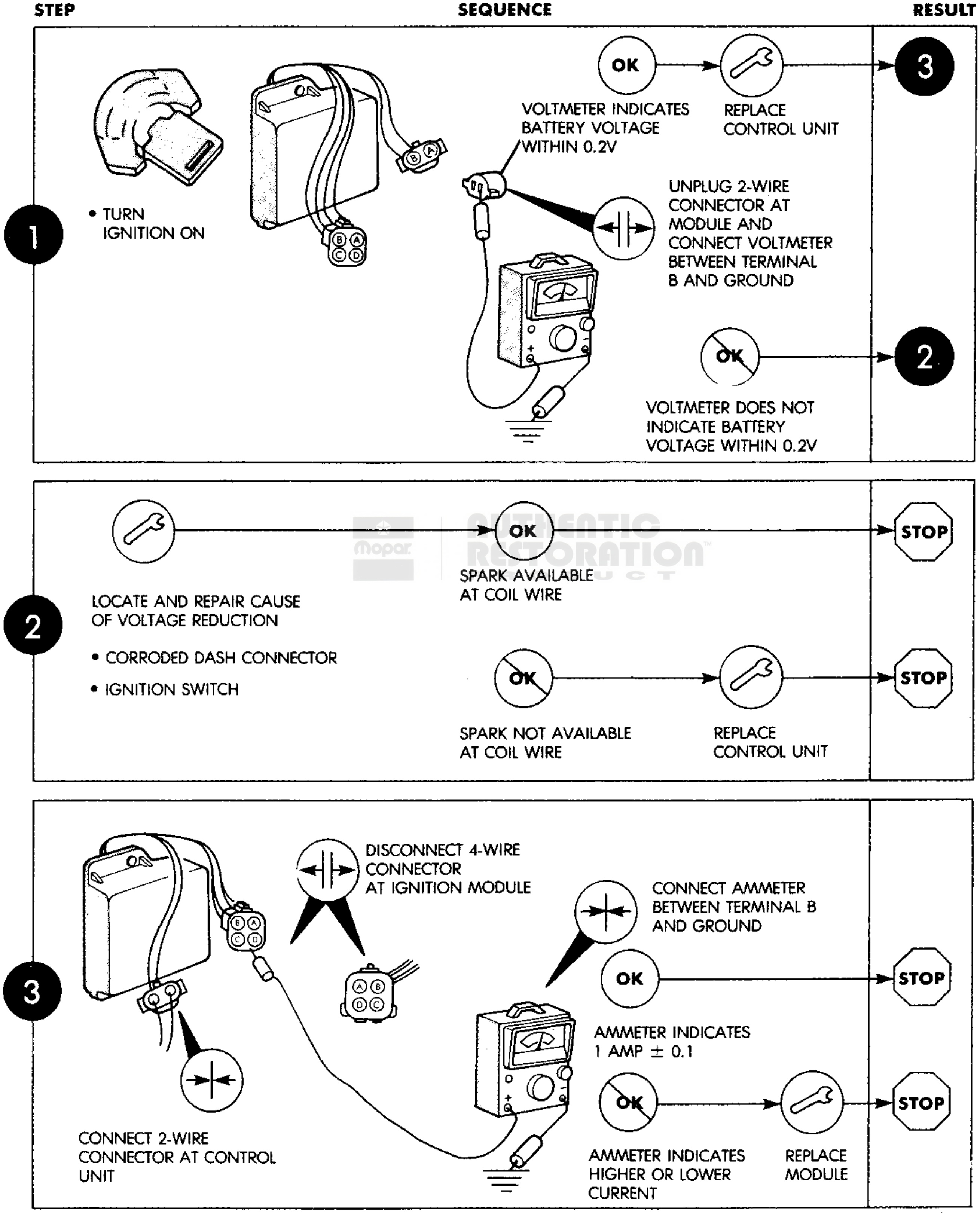
- DEFECTIVE TRIGGER WHEEL
- DISTRIBUTOR NOT TURNING
- MISSING TRIGGER WHEEL PIN

J908D-20

IGNITION FEED TO IGNITION MODULE

NOTE: DO NOT PERFORM CHART 4
WITHOUT PERFORMING CHART 1

Chart 4



Step 1:
- TURN IGNITION ON

UNPLUG 2-WIRE CONNECTOR AT MODULE AND CONNECT VOLTMETER BETWEEN TERMINAL B AND GROUND

VOLTMETER INDICATES BATTERY VOLTAGE WITHIN 0.2V → REPLACE CONTROL UNIT → 3

VOLTMETER DOES NOT INDICATE BATTERY VOLTAGE WITHIN 0.2V → 2

Step 2:

LOCATE AND REPAIR CAUSE OF VOLTAGE REDUCTION
- CORRODED DASH CONNECTOR
- IGNITION SWITCH

SPARK AVAILABLE AT COIL WIRE → STOP

SPARK NOT AVAILABLE AT COIL WIRE → REPLACE CONTROL UNIT → STOP

Step 3:

CONNECT 2-WIRE CONNECTOR AT CONTROL UNIT

DISCONNECT 4-WIRE CONNECTOR AT IGNITION MODULE

CONNECT AMMETER BETWEEN TERMINAL B AND GROUND

AMMETER INDICATES 1 AMP ± 0.1 → STOP

AMMETER INDICATES HIGHER OR LOWER CURRENT → REPLACE MODULE → STOP

J908D-27

ENGINE SPARK KNOCK (PRE-IGNITION) DIAGNOSIS

Spark knock (pre-ignition) can be attributed to several factors. The most common are ambient air conditions, such as air temperature, density and humidity.

High Underhood Air Temperature

Underhood air temperature is increased by the use of air conditioning (especially during long periods of idling), overloading (trailer pulling or operating in too high a gear) and the installation of accessories that restrict airflow.

Air Density

Air density increases as barometric pressure rises or as the air temperature decreases. A denser than normal mixture of air and fuel drawn into a cylinder has the same effect as increasing the engine compression ratio and this increases the possibility of spark knock.

Humidity

Low humidity increases the tendency for engine spark knock. High humidity decreases the tendency for engine spark knock.

Fuel Octane Rating

The 4.2L engine is designed to operate on unleaded fuel. Fuels having an equivalent research octane rating may vary in their antiknock characteristics for a given engine. It may be necessary to retard the initial ignition timing (not more than one degree from the specification) or select an alternate source of fuel.

Ignition Timing

Check the ignition timing to ensure it is adjusted to the specification.

The white paint mark on the timing degree scale identifies the specified timing degrees before top dead center (BTDC) at 1600 rpm, not top dead center (TDC).

Combustion Chamber Deposits

An excessive buildup of deposits in the combustion chamber may be caused by not using the recommended fuels and lubricants, prolonged engine idling or continuous low speed operation. These deposits can be reduced by the occasional use of carburetor and combustion area cleaners or by operating the engine at higher speeds.

Distributor Ignition Advance Mechanisms

Inspect the centrifugal and vacuum ignition advance mechanisms to ensure they are operating normally.

DISTRIBUTOR ADVANCE TESTS

Centrifugal Advance Test

(1) Set the parking brake. Shift automatic transmissions to PARK and manual transmissions to NEUTRAL.

(2) Start the engine and allow it to attain normal operating temperature. Ensure that the A/C is turned OFF, if equipped.

(3) With the ignition switch Off, disconnect the three-wire connector from the 4in. and 10-in. Hg vacuum switch assembly .

(4) Disconnect and plug the vacuum hose connected to the distributor vacuum advance mechanism.

(5) Connect a timing light between the No. 1 spark plug and wire.

(6) Connect the timing light power wire connectors according to the manufacturer's instructions.

(7) Connect a calibrated, expanded scale tachometer to the coil negative (TACH) terminal.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(8) Start the engine and slowly increase the speed while observing the timing mark and index with the timing light.

(9) The ignition timing should advance smoothly as the engine speed increases. Refer to the ignition advance curve illustrations.

(10) If the ignition timing advances unevenly, check and repair the centrifugal advance mechanism.

(11) Connect the distributor vacuum advance hose and the vacuum switch assembly three-wire connector.

(12) Remove the timing light and connect the No. 1 cylinder spark plug wire.

(13) Remove the tachometer.

Vacuum Advance Test

(1) Set the parking brake. Shift automatic transmissions to PARK and manual transmissions to the NEUTRAL position.

(2) Start the engine and allow it to attain normal operating temperature. Ensure that the A/C is turned OFF, if equipped.

(3) With the ignition switch OFF, disconnect the three-wire connector from the 4- in. and 10-in. vacuum switch assembly.

(4) Disconnect and plug the vacuum hose connected to the distributor vacuum advance mechanism.

(5) Connect a hand operated vacuum pump to the distributor vacuum advance mechanism.

(6) Connect a timing light between the No. 1 spark plug and wire.

(7) Connect the timing light power wire connectors according to the manufacturer's instructions.

(8) Connect a calibrated, expanded scale tachometer to the coil negative (TACH) terminal.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(9) Start the engine.

(10) Increase the engine speed and apply 60.9 kPa (18-in. Hg) vacuum.

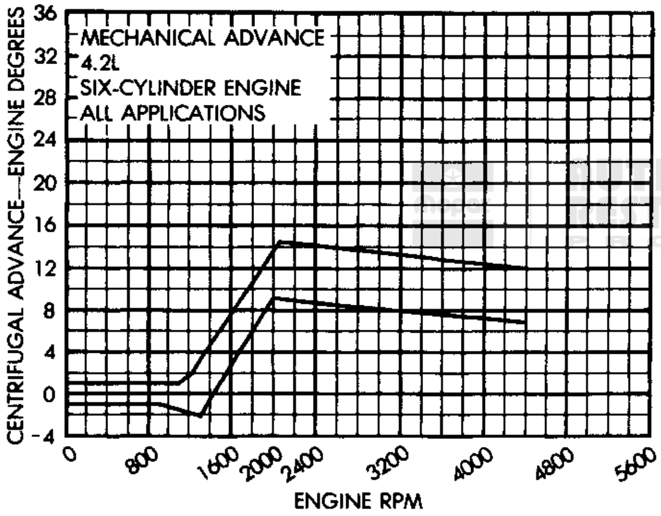
(11) Observe the ignition timing degree scale and index with the timing light.

(12) The ignition timing should advance smoothly. Refer to the ignition advance curve illustrations.

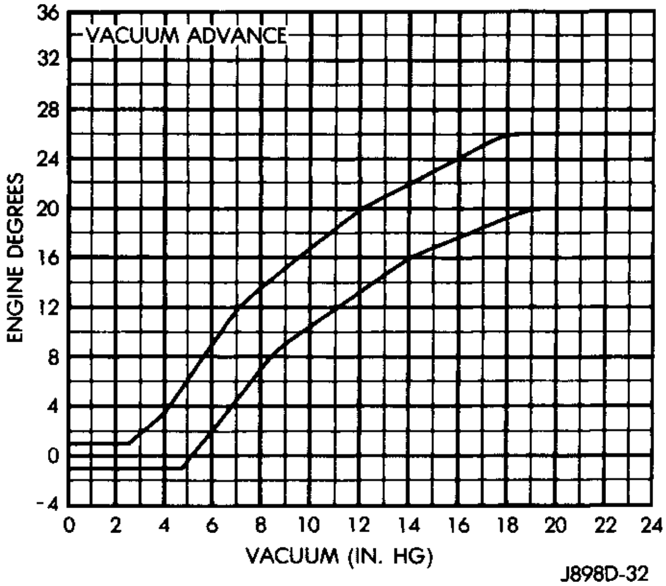
A defective FFB system MCU or ignition system ECU can alter the ignition timing.

(13) Remove the timing light and tachometer. Connect the spark plug wire.

Distributor Ignition Advance Curves



J898D-31



J898D-32

IGNITION COIL TESTS

The ignition coil can be tested on any conventional coil tester or with an ohmmeter. A coil tester is preferable because it can be used to detect faults that are impossible with an ohmmeter.

Primary Winding Resistance Test

(1) Remove the connector from the negative (-) and positive (+) terminals of the ignition coil.

(2) Set the ohmmeter for the low scale and adjust the pointer to zero.

(3) Connect the ohmmeter to the coil negative and positive terminals. The resistance should be 1.13-1.23 ohms at 24°C (75°F). If the coil temperature is above 93°C (200°F), 1.50 ohms is acceptable.

Secondary Winding Resistance Test

(1) Remove the high voltage ignition wire from the high voltage terminal of the ignition coil.

The ignition switch must be OFF.

(2) Set the ohmmeter for the x1000 scale and adjust the pointer to zero.

(3) Connect the ohmmeter to the brass contact in the high voltage terminal and to either primary winding terminal. The resistance should be 7700-9300 ohms at 24°C (75°F). A maximum of 12,000 ohms is acceptable if the coil temperature is 93°C (200°F) or more.

Current Flow Test

(1) Remove the connector from the ignition coil.

(2) Depress the plastic barb and withdraw the positive (+) wire terminal from the connector. The barb is visible from the coil side of the connector.

(3) Repeat the procedure for the negative (-) wire terminal.

CAUTION: Ensure the ammeter current rating is sufficient for the test.

(4) Connect the ammeter between the positive terminal and the disconnected positive wire.

(5) Connect a jumper wire from the coil negative terminal to a known good ground.

(6) Turn the ignition switch to the ON position.

(7) The current flow should be approximately 7 amps and should not exceed 7.6 amps.

If the current flow is more than 7.6 amps, replace the ignition coil.

(8) Leave the ammeter connected to the coil positive (+) terminal. Remove the jumper wire from the negative (-) terminal. Connect the coil green wire to the negative terminal. The current flow should be approximately 4 amps.

If the current flow is less than 3.5 amps, inspect for poor connections in the 4-wire (control unit) and 3-wire (distributor) connectors or poor ground at the ground screw inside the distributor. If the current flow is greater than 5 amps, the electronic control unit is defective.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(9) Start the engine. Normal current flow with the engine operating is 2.0 - 2.4 amps. If the current flow is not within specifications, the control unit is defective.

Ignition Coil Output Test

(1) Connect an oscilloscope to the ignition coil. Refer to the test equipment manufacturer's instructions.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(2) Start the engine and observe the secondary ignition voltage.

CAUTION: Do not remove the wires from the spark plugs for cylinders 1 or 5 when performing the next test because the pickup coil may be damaged.

CAUTION: Do not operate the engine with the spark plug disconnected for more than 30 seconds because the catalytic converter may be damaged.

(3) Remove one spark plug wire from the distributor cap. Observe the voltage applied to the disconnected spark plug wire on the oscilloscope. This voltage, referred to as open circuit output voltage, should be 24 kV (24,000 volts) minimum with an engine speed of 1000 rpm.

INTERMITTENT FAILURE DIAGNOSIS

Intermittent failure may be caused by loose or corroded terminals, defective or missing components, inadequate ground connections, or defective wiring.

INTERMITTENT FAILURE DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE FAILS TO START (NO SPARK AT PLUGS)	(1) No voltage to ignition system.	(1) Check battery, ignition switch and wiring. Repair as required.
	(2) Ignition module ground wires inside distributor open, loose or corroded	(2) Clean, tighten or repair as required.
	(3) Primary wiring connectors not fully engaged.	(3) Clean and fully engage connectors.
	(4) Ignition coil open or shorted.	(4) Test coil. Replace if faulty.
	(5) Ignition module defective.	(5) Replace ignition module.
	(6) Cracked distributor cap.	(6) Replace cap.
	(7) Defective rotor.	(7) Replace rotor.
	(8) Defective MCU.	(8) Replace MCU.
ENGINE BACKFIRES BUT FAILS TO START	(1) Incorrect ignition timing.	(1) Check timing. Adjust as required.
	(2) Moisture in distributor.	(2) Dry cap and rotor.
	(3) Distributor cap faulty.	(3) Check cap for loose terminals, cracks and dirt. Clean or replace as required.
	(4) Ignition wires not connected in correct firing order.	(4) Connect in correct order.
ENGINE RUNS ONLY WITH KEY IN START POSITION	(1) Open in resistance wire or excessive resistance.	(1) Replace resistance wire and harness assembly.
ENGINE CONTINUES TO RUN WITH KEY OFF	(1) Defective starter motor solenoid.	(1) Replace solenoid.
	(2) Shorted diode in alternator warning lamp circuit.	(2) Replace diode.

J908D-21

INTERMITTENT FAILURE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
ENGINE DOES NOT OPERATE SMOOTHLY AND OR ENGINE MISFIRES AT HIGH SPEED	(1) Spark plugs fouled or faulty.	(1) Clean and gap plugs. Replace as required.
	(2) Ignition wires faulty (including electronic retard).	(2) Check wires. Replace as required.
	(3) Spark advance system(s) faulty.	(3) Check operation. Repair as required.
	(4) S-terminal shorted to starter S-terminal in solenoid.	(4) Replace solenoid.
	(5) Trigger wheel pin missing.	(5) Install pin.
	(6) Ignition wires not connected in correct firing order.	(6) Connect wires correctly.
	(7) Two plug wires of consecutive firing cylinders routed next to each other.	(7) Re-route plug wires away from each other.
EXCESSIVE FUEL CONSUMPTION	(1) Incorrect ignition timing.	(1) Check timing. Adjust as required.
	(2) Spark advance system(s) faulty.	(2) Check operation. Repair as required.
	(3) MCU (microprocessor) faulty.	(3) Test system. Repair as required.
ERRATIC TIMING ADVANCE	(1) Faulty vacuum advance mechanism.	(1) Check operation. Replace if required.
	(2) Centrifugal advance weights sticking.	(2) Remove dirt, corrosion.
TIMING NOT AFFECTED BY VACUUM	(1) Defective vacuum advance mechanism.	(1) Replace vacuum advance mechanism.
	(2) Vacuum advance mechanism adjusting screws too far counterclockwise.	(2) Turn screw clockwise to bring advance within specifications.
	(3) Pickup coil pivot corroded.	(3) Clean pivot.
INTERMITTENT OPERATION	(1) Loose or corroded terminals.	(1) Tighten terminals, remove corrosion, apply electrical grease.
	(2) Defective pickup coil.	(2) Perform pickup coil test.
	(3) Defective ignition module.	(3) Perform control unit tests.
	(4) Loose ground connector in distributor.	(4) Clean and tighten ground connection.
	(5) Wires to distributor shorted together or to ground.	(5) Check for frayed, pinched, or burned wires.
	(6) Trigger wheel pin missing.	(6) Install new pin.

J908D-22

DISTRIBUTOR REPLACEMENT

Removal

(1) Unfasten the distributor cap retaining screws. Remove the distributor cap with the coil and spark plug wires connected and place aside.

(2) Disconnect and plug the distributor vacuum advance hose.

(3) Disconnect the distributor primary wiring connector.

(4) Scribe a mark on the distributor housing in line with the tip of the rotor. Scribe a mark on the distributor housing near the clamp and continue the scribe mark on the engine block in line with the distributor housing mark. Note the position of the rotor and distributor housing in relation to the surrounding engine components as reference points for installing the distributor.

(5) Remove the distributor hold down bolt and clamp.

(6) Withdraw the distributor carefully from the engine.

Installation

(1) Clean the distributor mounting area of the cylinder block.

(2) Install a replacement distributor mounting gasket.

(3) Position the distributor shaft in the cylinder block. If engine was not rotated while the distributor was removed, perform the following procedure:

(a) Align the rotor tip with the scribe mark on the distributor housing during removal. Turn the rotor approximately 1/8-turn counterclockwise past the scribe mark.

CAUTION: Ensure that the distributor shaft fully engages the oil pump drive gear shaft. It may be necessary to slightly rotate (bump) the engine while applying downward hand force on the distributor body to fully engage the distributor shaft with the oil pump drive gear shaft.

(b) Slide the distributor shaft down into the engine. Align the scribe mark on the distributor housing with the corresponding scribe mark on the cylinder block.

It may be necessary to move the rotor and shaft slightly to start the gear into mesh with the camshaft gear and to engage the oil pump drive tang, but the rotor should align with the scribe mark when the distributor shaft is down in place.

(c) Install the distributor hold down clamp and bolt, but do not tighten the bolt.

(4) If the engine was rotated while the distributor was removed, it will be necessary to establish timing according to the following procedure.

(a) Remove the No. 1 spark plug. Hold a finger over the spark plug hole and rotate the engine until the compression pressure is felt. Slowly continue to rotate the engine until the timing index on the vibration damper pulley aligns with the top dead center (TDC) mark (0 degree) on the timing degree scale. Always rotate the engine in the direction of normal rotation. Do not turn the engine backward to align the timing marks.

(b) Turn the distributor shaft until the rotor tip points in the direction of the No. 1 terminal in the distributor cap. Turn the rotor 1/8-turn counterclockwise past the position of the No. 1 terminal.

(c) Slide the distributor shaft down into the engine and position the distributor vacuum advance mechanism housing in approximately the same location (in relation to the surrounding engine components) as when removed. Align the scribe mark on the distributor housing with the corresponding scribe mark on the cylinder block.

It may be necessary to rotate the oil pump shaft with a long flat-blade screwdriver to engage the oil pump drive tang, but the rotor should align with the position of the No. 1 terminal when the distributor shaft is down in place.

(d) Install the distributor hold down clamp and bolt, but do not tighten the bolt.

CAUTION: If the distributor cap is incorrectly positioned on the distributor housing, the cap or rotor may be damaged when the engine is rotated.

(5) Install the distributor cap with the ignition wires on the distributor housing. Ensure the pickup coil wire rubber grommet in the distributor housing aligns with the depression in the distributor cap and that the cap fits on the rim of the distributor housing.

Two different diameter screws are used to retain the distributor cap.

(6) Apply Silicone Dielectric Compound, or equivalent, to the connector terminal blades and cavities. Connect the distributor primary wiring connector.

(7) Adjust the ignition timing. Refer to Ignition System Timing.

CAUTION: Do not puncture the spark plug wires or boots to make a connection. Use the proper adapters.

IGNITION SYSTEM TIMING

A graduated timing degree scale (Fig. 6) located on the timing case cover is used for reference when timing the ignition system.

A milled index notch in the vibration damper is used to align the No. 1 cylinder ignition position of the crankshaft with the correct timing degree mark on the graduated scale.

Magnetic Timing Probe

With both engines, a magnetic timing probe socket is provided integral with the timing degree scale for use with a special magnetic timing probe.

This special probe detects the milled notch on the vibration damper. The probe is inserted through the probe socket until it contacts the vibration damper.

Ignition timing can then be obtained from a meter or computer printout, depending on the type of equipment being used.

The probe socket is located at 9.5° ATDC, and the equipment is calibrated to compensate for this location.

Do not use the timing probe socket as a reference to check the ignition timing when using a conventional timing light.

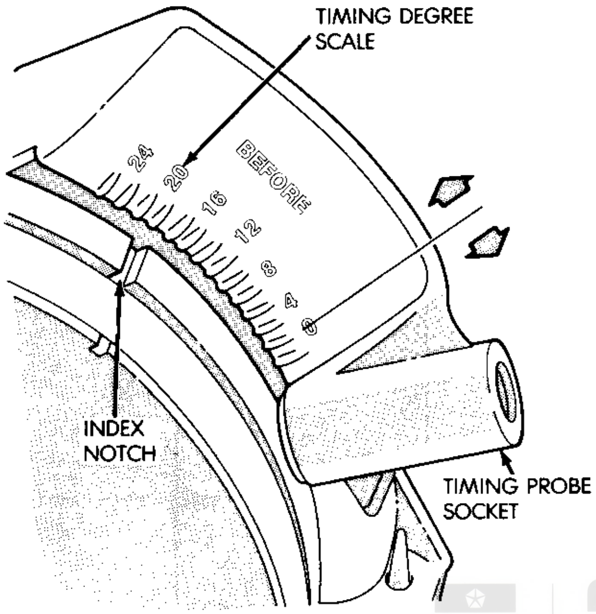


Fig. 6 Timing Mark Six Cylinder

Ignition Timing Procedure 4.2L

The ignition timing can be adjusted according to the following primary timing procedure.

(1) Set the parking brake. Shift automatic transmissions to PARK and manual transmissions to the NEUTRAL position.

(2) Start the engine and allow it to attain normal operating temperature. Ensure that the A/C is turned OFF, if equipped.

(3) With the ignition switch OFF, connect an ignition timing light and a calibrated, expanded scale tachometer.

If the timing light has an adjustable advance control feature, turn the control to the OFF position.

(4) Disconnect the 4-in. and 10-in. Hg (CEC System) vacuum switch assembly wire connector (located at the top of the cylinder head cover).

(5) Disconnect and plug the distributor vacuum advance hose.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN.DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(6) Start the engine.

(7) Increase the engine speed to 1600 rpm and check the ignition timing. If necessary, adjust the timing to the specification listed on the Emission Control Information label. Also, refer to the ignition advance curve illustrations.

(8) Tighten the distributor hold-down clamp and verify that the ignition timing is correct.

(9) Turn the engine OFF and remove the timing light and tachometer.

(10) Connect the No. 1 spark plug wire, if disconnected. Connect the hose to the distributor vacuum advance mechanism. Connect the wire connector to the vacuum switch assembly.

The ignition timing can also be adjusted according to the following alternate procedure.

Alternate Timing Procedure

The Alternate Timing Procedure does not require that the engine speed be increased to 1600 rpm.

(1) Set the parking brake.

(2) Shift automatic transmissions to PARK and manual transmissions to the neutral position.

(3) Start the engine and allow it to attain normal operating temperature. Ensure that the A/C is turned to the OFF position, if equipped.

(4) With the ignition switch OFF, connect an ignition timing light and a calibrated, expanded scale tachometer.

If the timing light has an adjustable advance control feature, turn the control to the OFF position.

(5) Disconnect the 4-in. Hg vacuum switch hose (located at the top of the cylinder head cover) and plug the hose opening.

The 4-in. Hg vacuum switch has black and red wires connected to it.

(6) Disconnect the distributor vacuum advance hose and connect the hose to the 4-inch Hg vacuum switch.

(7) Disconnect the knock sensor wire connector and connect the wire connector to the cylinder block (GROUND) with a jumper wire.

Grounding the knock sensor wire connector prevents electromagnetic interference (EMI) from causing erroneous reactions by the FFB system micro computer unit (MCU).

(8) Start the engine.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN.DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

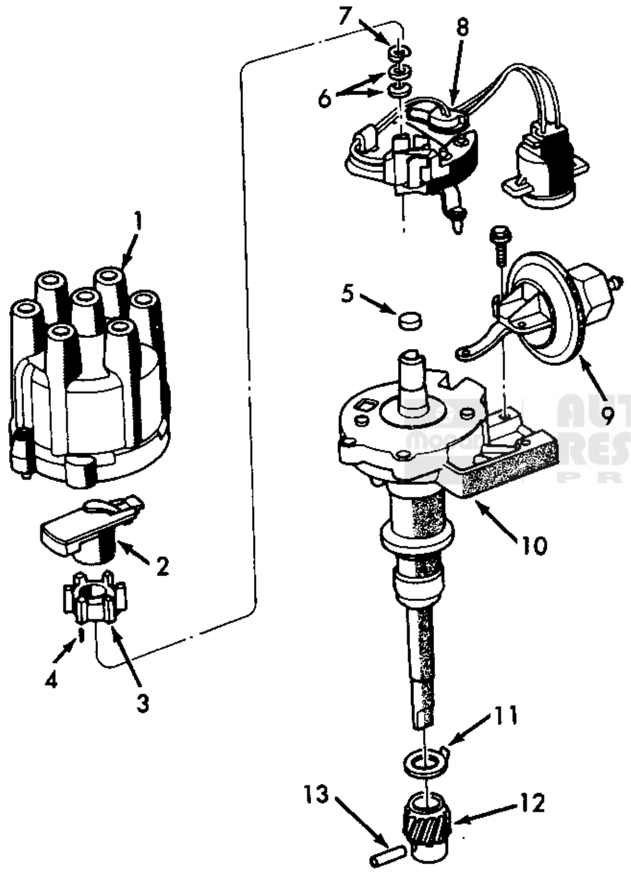
(9) With the engine at idle speed, check the timing. If necessary, adjust the timing one degree higher than the specification listed on the Emission Control Information label. Also, refer to the ignition advance curve illustrations.

With the alternate timing procedure, the basic timing must be one degree higher than the speci-

fication listed on the Emission Control Information label. For example, if the timing specification is listed as 6°±2° at 1600 rpm, the alternate procedure requires 7°±2° at idle speed.

DISTRIBUTOR COMPONENT REPLACEMENT

When replacing the pickup coil assembly, trigger wheel or vacuum advance mechanism, it is not necessary to remove the distributor from the engine. It is necessary to check ignition timing if the pickup coil assembly or vacuum advance mechanism is replaced. Refer to Fig. 7 for distributor component identification.



1. Distributor Cap
2. Distributor Rotor
3. Trigger Wheel
4. Pin
5. Wick
6. Washers
7. Retainer
8. Pickup Coil Assembly
9. Vacuum Advance Mechanism
10. Distributor Body
11. Washer
12. Gear
13. Pin

J898D-36

Fig. 7 Distributor Components

Trigger Wheel and/or Pickup Coil Assembly

Removal

(1) Place the distributor in a suitable holding device, if removed from the engine.

(2) Remove the cap.

(3) Remove the rotor.

(4) Remove the trigger wheel with Trigger Wheel Puller Tool 7804, or equivalent. Use a flat washer to prevent the puller from contacting the inner shaft. By prying alternately, two screwdrivers can be used to remove the trigger wheel from the shaft. Remove the pin.

(5) Remove the pickup coil retainer and washers from the pivot pin on the base plate.

(6) Remove the two pickup coil plate screws.

(7) Lift the pickup coil assembly from the distributor housing.

(8) If the vacuum advance mechanism is to be replaced, remove the screws and lift the mechanism out of the distributor housing. Do not remove the vacuum advance mechanism unless replacement is required.

Installation

(1) If the vacuum advance mechanism was removed, install it on the distributor housing with the attaching screws.

If a replacement vacuum advance mechanism is installed, refer to Vacuum Advance Mechanism for the calibration procedure.

(2) Position the pickup coil assembly into the distributor housing.

(3) Ensure the pin on the pickup coil assembly fits into the hole in the vacuum advance mechanism link.

(4) Install the washers and retainer onto the pivot pin to secure the pickup coil assembly to the base plate.

(5) Position the wiring harness in the slot in the distributor housing. Install the two pickup coil plate screws and tighten.

(6) Install the trigger wheel on the shaft with hand pressure. The long portion of the teeth must be up. When the trigger wheel and slot in the shaft are properly aligned, use a suitable drift and small hammer to tap the pin into the locating groove in the trigger wheel and shaft.

If the distributor is not installed in the engine, support the shaft while installing the trigger wheel pin.

(7) Install the rotor. Install the distributor cap.

Vacuum Advance Mechanism

Removal

(1) Remove the vacuum hose from the vacuum advance mechanism.

(2) Remove the attaching screws and remove the vacuum advance mechanism from the distributor housing. It is necessary to tilt the unit to disengage the link from

the pickup coil pin protruding through the distributor housing. It may be necessary to loosen the base plate screws for necessary clearance.

Installation

If a replacement vacuum advance mechanism is to be installed, calibrate as follows.

(1) Insert an Allen wrench into the vacuum hose tube of the original vacuum advance mechanism. Count the number of clockwise turns necessary to bottom the adjusting screw.

(2) Turn the adjusting screw of the replacement vacuum advance mechanism clockwise to the bottom. Turn it counterclockwise the same number of turns counted earlier.

(3) Install the vacuum advance mechanism on the distributor housing. Ensure that the link is engaged on the pin of the pickup coil. Install the retaining screws. Tighten the base plate screws, if loosened.

(4) Check the ignition timing and adjust, if required.

(5) Connect the vacuum hose to the vacuum advance mechanism.

Rotor

A unique feature of the SSI system is the silicone applied to the rotor blade during manufacture. Radio interference is greatly reduced by the presence of a small quantity of silicone dielectric compound on the rotor blade. After a few thousand miles, this compound becomes charred by the high voltage current flowing through the rotor. This is normal. Do not scrape the residue from the rotor blade.

When installing a replacement rotor, apply a thin coat 0.75 - 3 mm (0.03 - 0.12 in) of Silicone Dielectric Compound to the tip of the rotor blade.

5.9L ENGINES

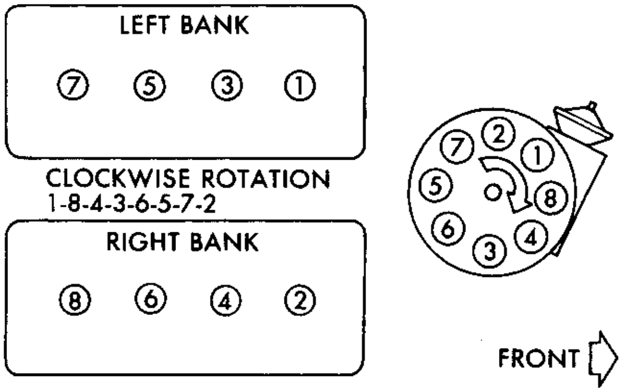
INDEX

SPARK PLUG SPECIFICATIONS

ENGINE	SPARK PLUG TYPE	ELECTRODE GAP	TIGHTENING TORQUE
5.9L	RN 12YC	0.033 in	37 N•m (27 ft-lbs)

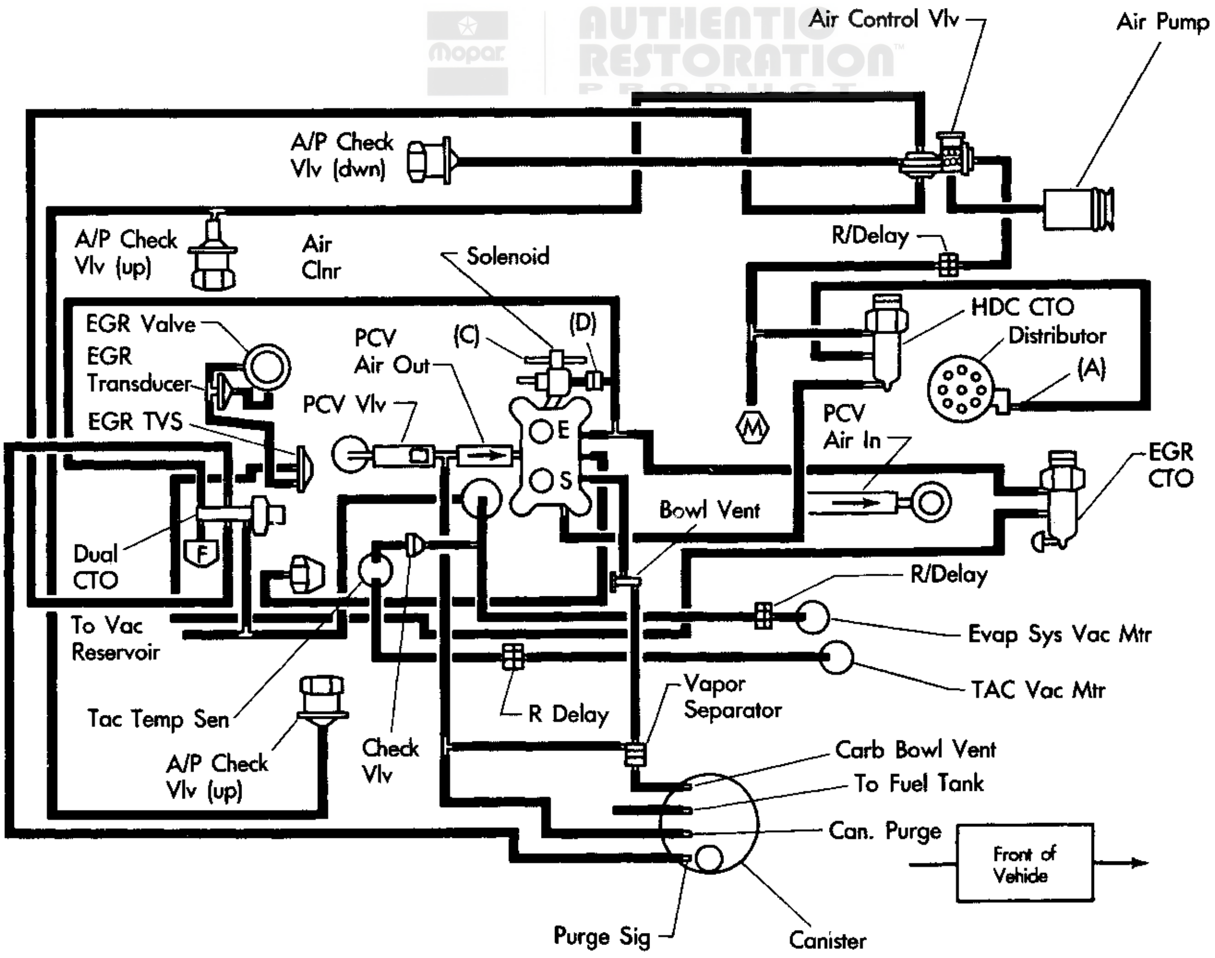
J908D-18

ENGINE FIRING ORDER



J8909-156

VACUUM HOSE SCHEMATICS



J9025-1

SJ Vacuum Routing Schematic

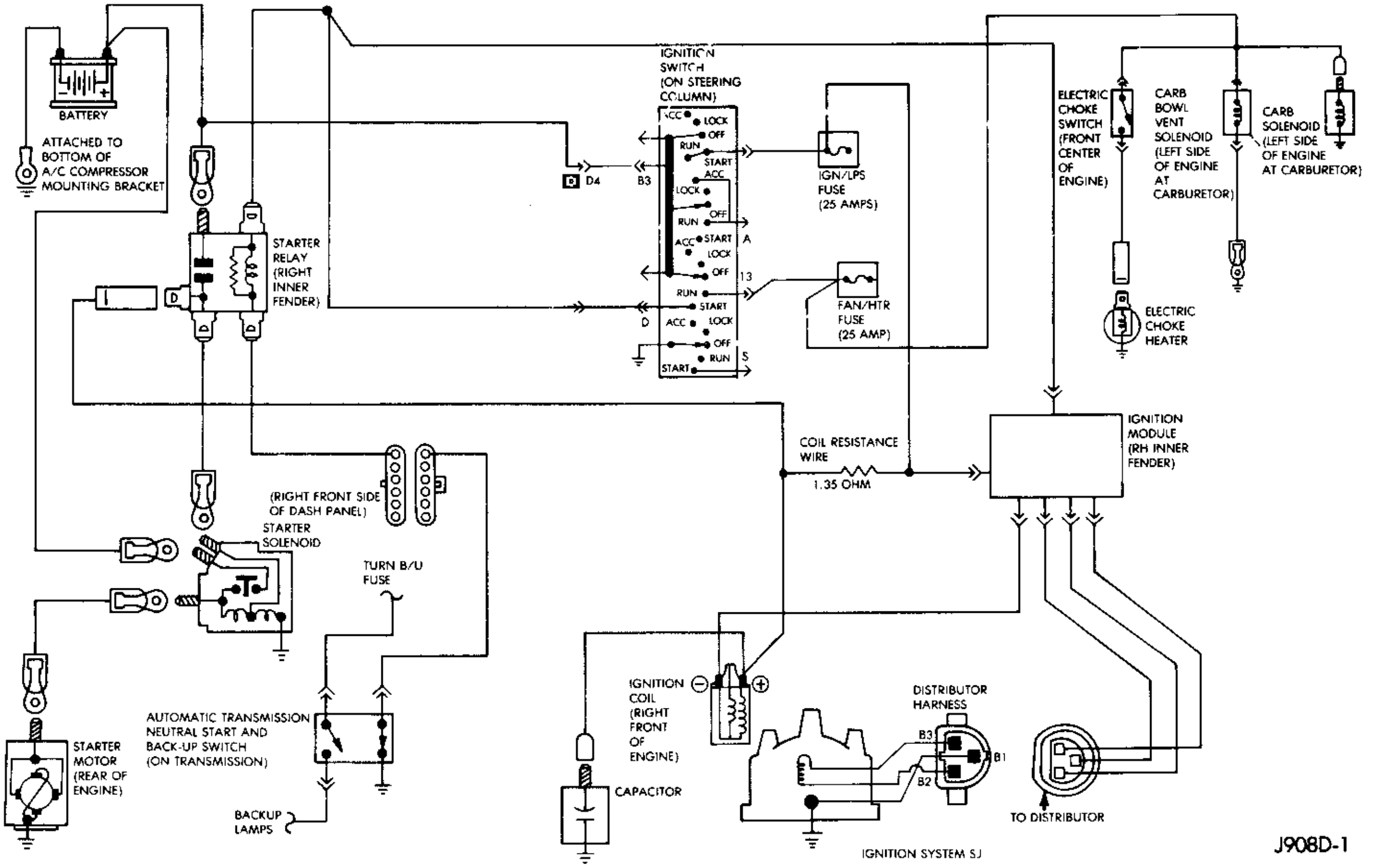


Fig. 1 5.9L Ignition Schematic

GENERAL INFORMATION

The 5.9L eight-cylinder is used in SJ vehicles. The engine is equipped with a carburetor. A Solid State Ignition (SSI) system (Fig. 1) is used on the 5.9L eight-cylinder engine. The SSI system consists of the following components:

- ignition module
- ignition coil
- resistance wire
- distributor
- knock sensor
- cap and rotor
- spark plugs and wires

IGNITION SYSTEM COMPONENTS

Ignition Module

The electronic Ignition Module (Fig. 2) is located in the engine compartment on the left wheel well. It is a permanently sealed, solid state module that is not repairable and must be replaced as a unit if service is required.

The ignition module processes the ignition signals it receives from the distributor and then interrupts the primary circuit to the ignition coil causing spark to occur. Dwell is adjusted automatically.

When disconnecting SSI system connectors, pull them apart with a firm, straight pull. DO NOT attempt to pry then apart with a screwdriver. When

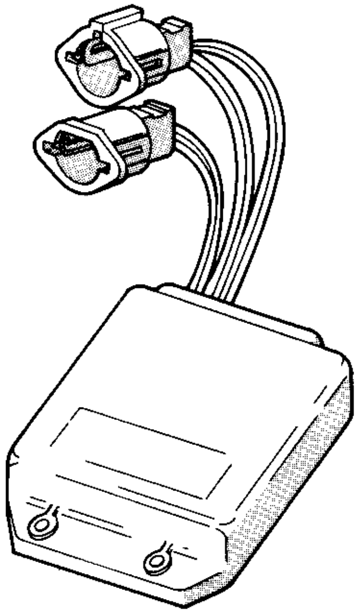


Fig. 2 Ignition Module

connecting them, press together firmly to overcome hydraulic pressure caused by the silicone dielectric compound.

If the connector locking tabs weaken or break off, do not replace the associated component. Bind the connectors together with tape or a harness tie strap to assure good electrical connection.

Ignition Coil

The ignition coil is mounted on a bracket connected to the intake manifold (Fig. 3). Coil operation is dictated by the ignition module. The coil does not require special service other than maintaining the terminals and connectors.

When an ignition coil is suspected of malfunctioning, test it on the vehicle. A coil may "break down" after the engine has heated it to a high temperature. It is important that the coil be at operating temperature when tested. Perform the test according to the test equipment manufacturer's instructions.

Ignition Coil Connector

The ignition coil terminals and connector are of unique design. The connector is removed from the coil by grasping both sides and pulling away from the coil (Fig. 3).

When a tachometer is required for engine testing or tune-up, connect it using an alligator jaw type connector (Fig. 4).

Resistance Wire

A wire with 1.35 ohms resistance is provided in the ignition wiring to supply less than full battery voltage to the ignition coil after the starter motor solenoid is deenergized. During engine starting, the resistance wire is bypassed and full battery voltage is applied to the ignition coil. The bypass is accomplished at the I-terminal on the starter motor solenoid. Refer to the Wiring Diagrams for location of the resistance wire.

Distributor

The distributor consists of three groups of components: pickup coil and trigger wheel, ignition advance mechanisms, cap and rotor (Fig. 5). The distributor drive gear is installed on the distributor shaft and meshes with a spiral cut gear that is installed on the nose (front) of the camshaft. The end of the distributor shaft is flattened and fits into a slot in the top of the oil pump and provides the force to drive the oil pump.

Pickup Coil and Trigger Wheel

The ignition coil primary circuit is opened and closed electronically by the ignition module. The distributor pickup coil and trigger wheel provide the input signal for the ignition module.

The trigger wheel which is installed on the distributor shaft, has one tooth for each engine cylinder. The wheel is mounted so that the teeth rotate past the pickup coil one at a time.

The pickup coil has a magnetic field that is intensified by the presence of ferrous metal (contains iron - can be picked up with an ordinary magnet). The pickup coil reacts to the trigger wheel teeth as they pass. As a trigger wheel tooth approaches and passes the pole piece of the pickup coil, it reduces the reluctance (compared to air) to the magnetic field and increases field strength. Field strength decreases as the tooth moves away from the pole piece. This increase and decrease of

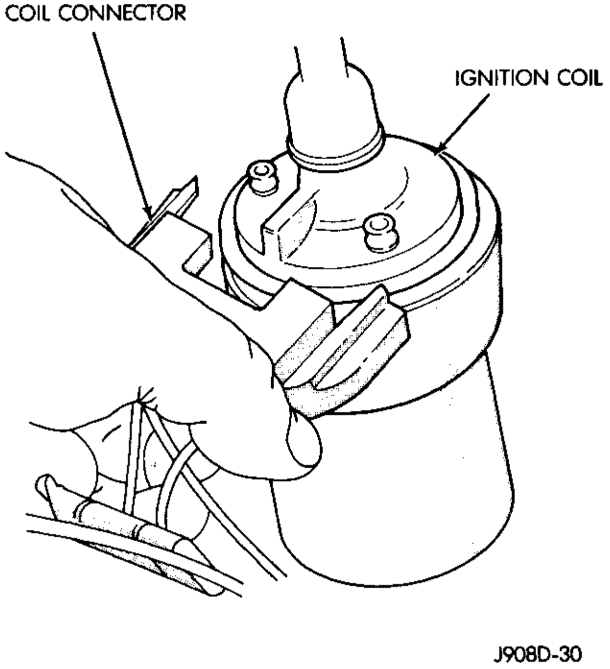


Fig. 3 Ignition Coil and Connector

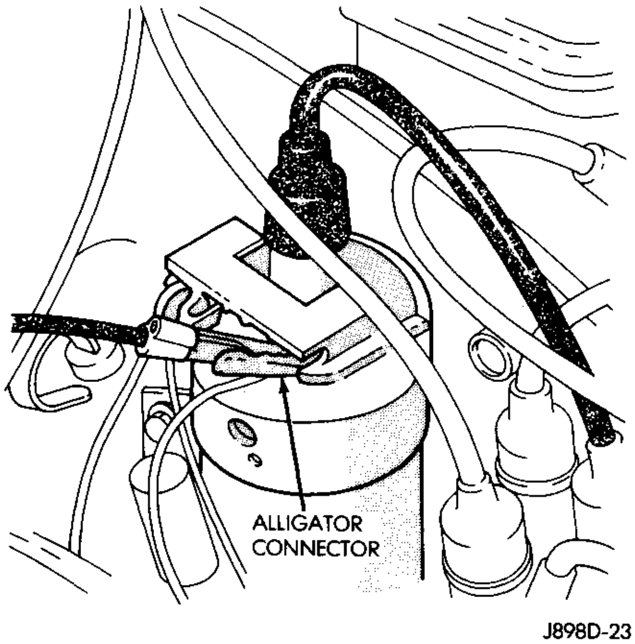


Fig. 4 Tachometer Connection

field strength induces an alternating current (pulse) into the pickup coil, which triggers the ignition module. The ignition module opens and closes the coil primary circuit according to the position of the trigger wheel teeth.

There is no contact between the trigger wheel and pickup coil assembly. Because there isn't any wear, the dwell angle does not require adjustment. The dwell angle is determined electronically by the control unit and is not adjustable. When the ignition coil primary circuit is switched open, an internal electronic timer in the ignition module keeps the coil primary only long enough for the electromagnetic field within the coil to collapse and the voltage to discharge. The ignition module then automatically closes the coil primary circuit. The period of time the circuit is closed is referred to as dwell.

Ignition Advance

Centrifugal (mechanical) advance is controlled by engine speed. Flyweights connected to the distributor shaft are thrown outward by centrifugal force. Higher engine RPM throws the weights further out. Calibrated rate springs are used to control this movement. The outward motion of the flyweights causes the rotor and trigger wheel to be advanced on the distributor shaft several degrees in the direction of normal rotation. This is referred to as centrifugal ignition advance.

When the engine is operating under light load, the carburetor throttle plates restrict airflow, causing a

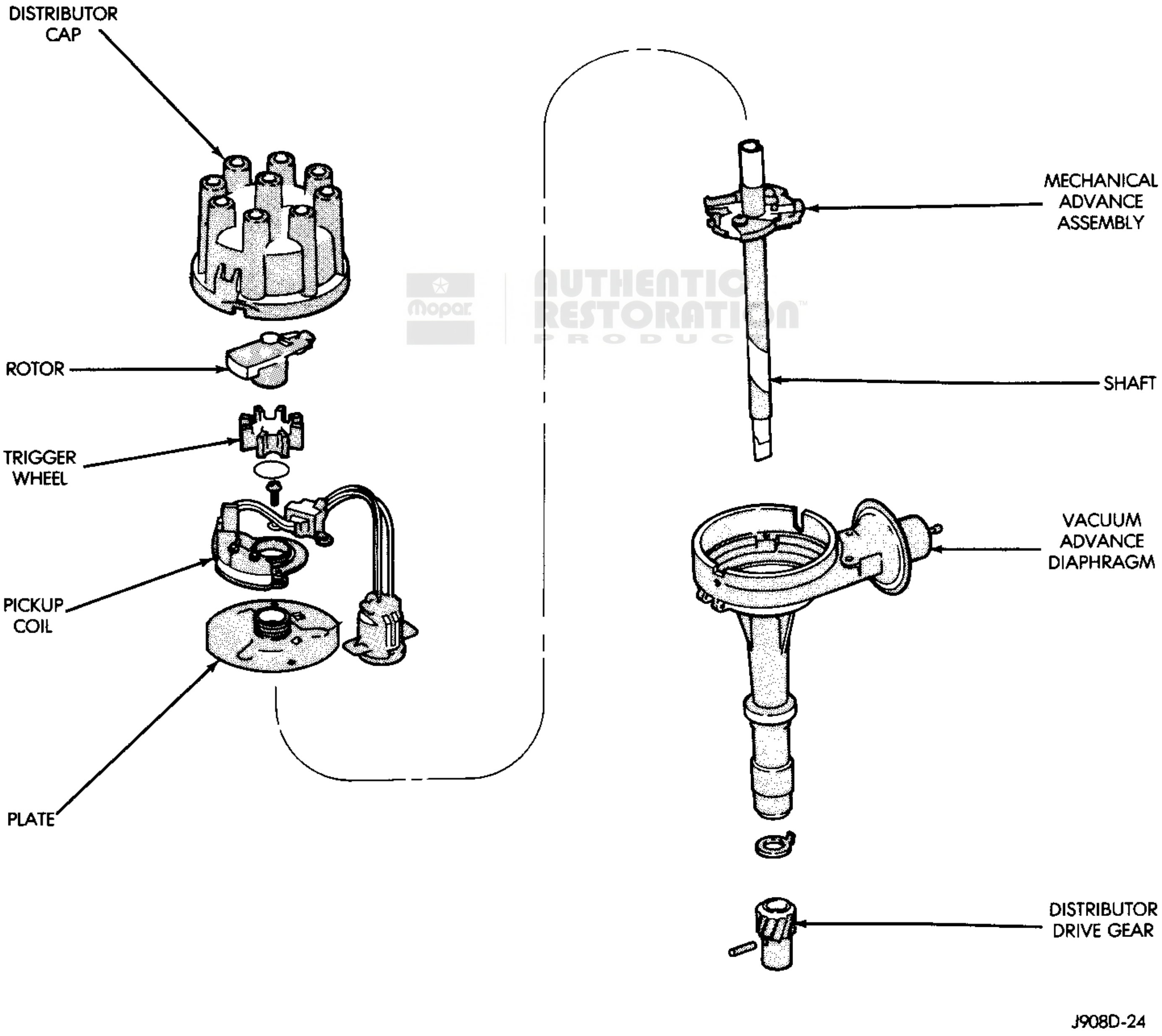


Fig. 5 Distributor—5.9L Engine

relatively lean mixture to enter the combustion chambers. Ignition must occur earlier because the lean mixture requires a longer time to burn. The vacuum ignition advance mechanism is used for this purpose. When carburetor ported or manifold vacuum is high, the vacuum advance mechanism moves the pickup coil assembly several degrees opposite to the direction the distributor is rotating. This causes the pickup coil to react to the presence of the trigger wheel teeth earlier. This is referred to as vacuum ignition advance. With low vacuum operating conditions, such as wide open throttle acceleration, a spring in the vacuum advance mechanism pushes the pickup coil back to a position of zero advance.

Cap and Rotor

The central tower on the distributor cap is connected directly to the high voltage at the coil. The current flows through the spring-loaded contact on the rotor to the carbon button in the cap. The rotor tip aligns with a contact in the cap that corresponds to the cylinder to be ignited just as the ignition coil output high voltage is applied to the rotor. In this way, each spark plug is “fired” in turn.

System Operation

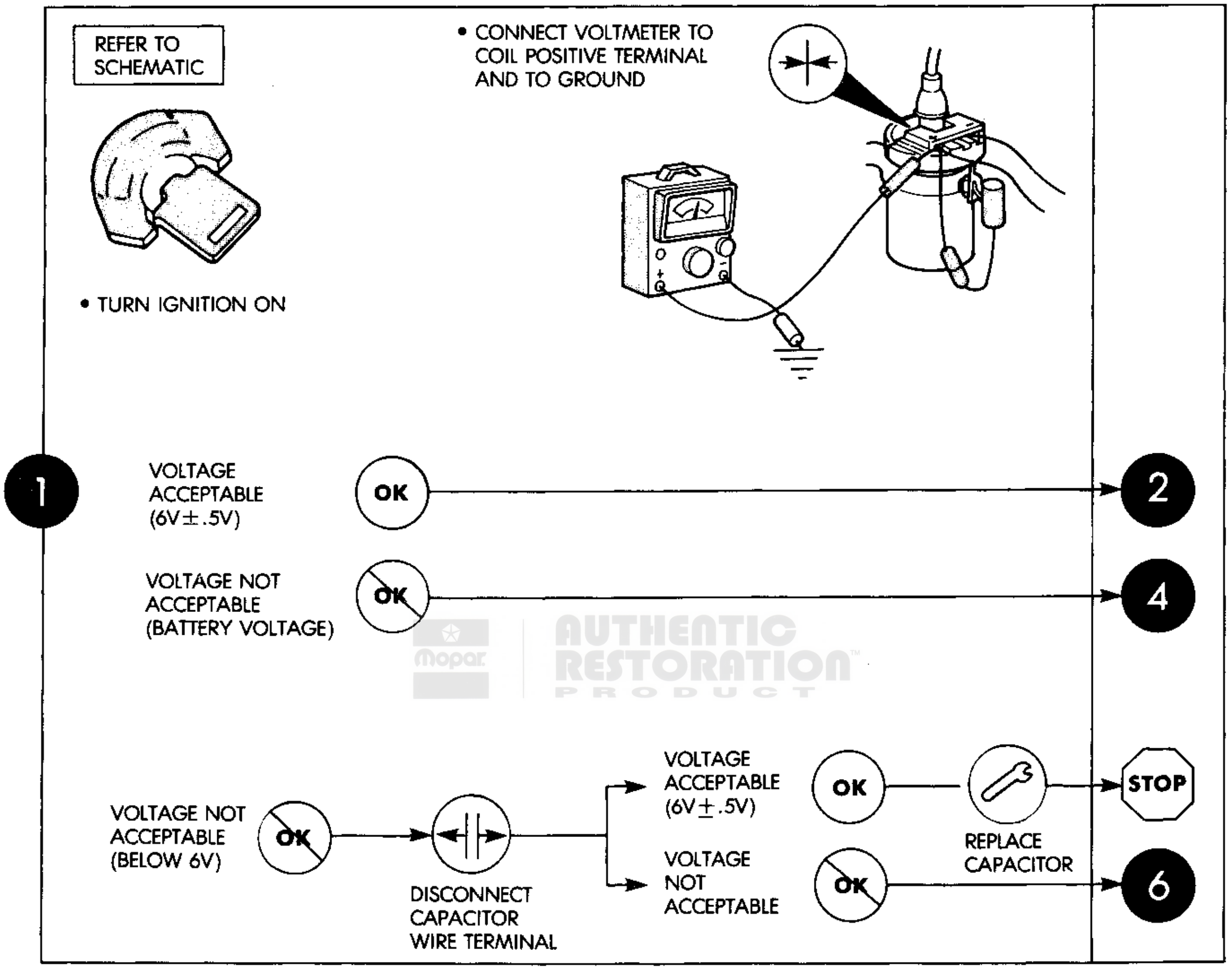
The ignition module is activated when the ignition switch is in the Start or On position. The primary circuit is closed and current flows through the coil primary winding. When the engine begins turning the distributor, the trigger wheel teeth rotate past the pickup coil assembly, as each tooth aligns with the pickup coil, the resulting pulse triggers the ignition module which closes the primary circuit. A high voltage is then induced in the coil secondary winding and current flows to the distributor cap and rotor. The rotor connects the high voltage to the proper spark plug. The timing of the ignition is constantly changed by electronic, vacuum, and centrifugal advance mechanisms according to engine operation.

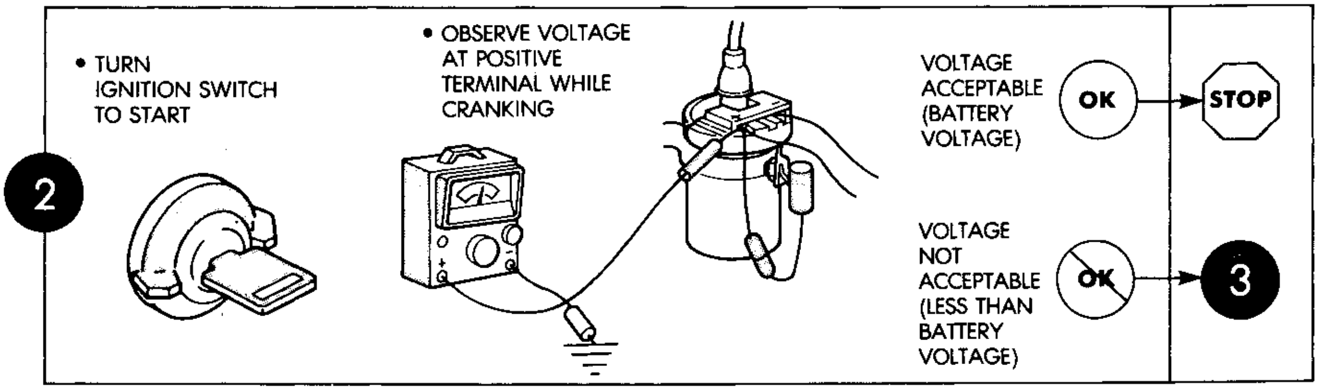
IGNITION SYSTEM DIAGNOSIS

IGNITION COIL PRIMARY CIRCUIT FUNCTION:
Connects Battery Voltage To Coil and Coil To Ground

Chart 1

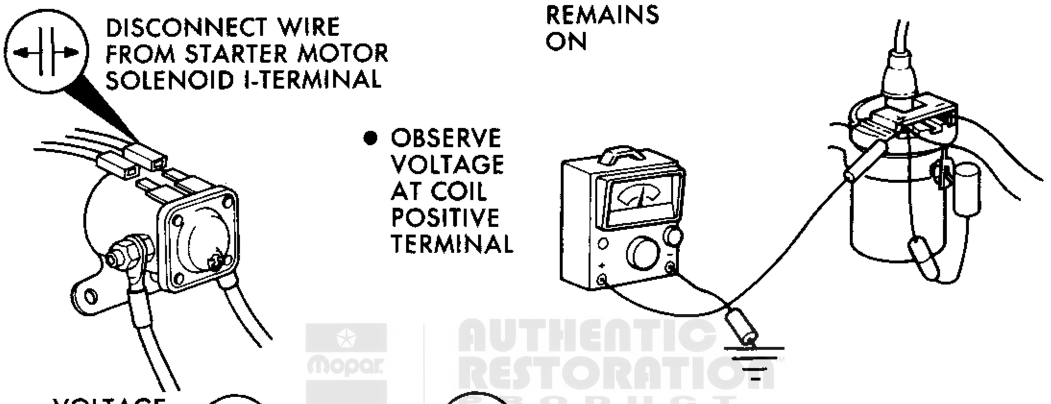
STEP **SEQUENCE** **RESULT**





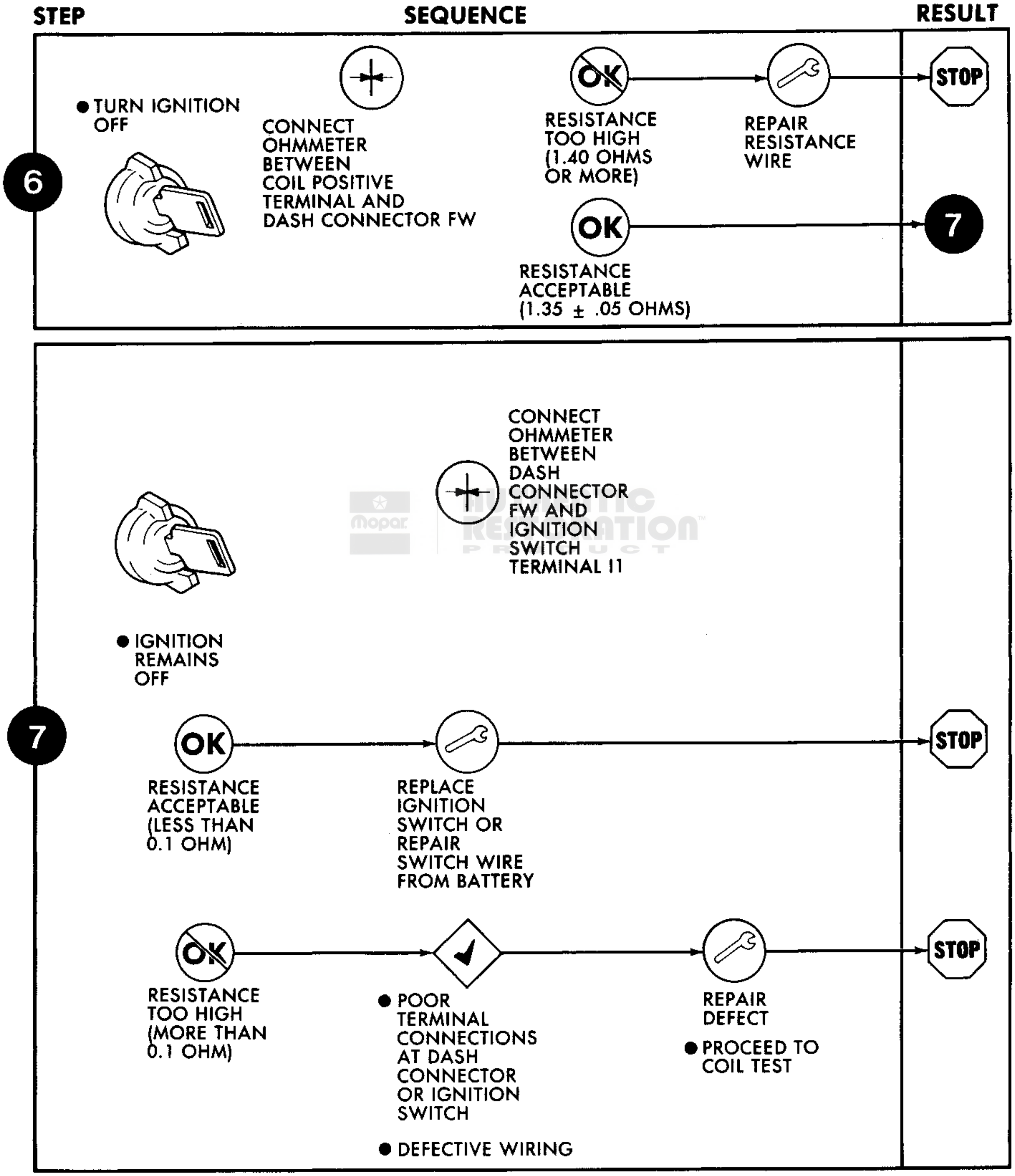
J908D-31

STEP	SEQUENCE	RESULT
3	CHECK FOR SHORT OR OPEN IN WIRE ATTACHED TO STARTER MOTOR SOLENOID I-TERMINAL CHECK STARTER MOTOR SOLENOID AS OUTLINED IN SECTION 8B REPAIR AS REQUIRED →	STOP
4	DISCONNECT WIRE FROM STARTER MOTOR SOLENOID I-TERMINAL ● IGNITION REMAINS ON ● OBSERVE VOLTAGE AT COIL POSITIVE TERMINAL	
	VOLTAGE DROPS TO 6V ± .5V — OK → REPLACE STARTER MOTOR SOLENOID →	STOP
	VOLTAGE REMAINS AT BATTERY VOLTAGE — NOT OK → CONNECT JUMPER BETWEEN COIL NEGATIVE TERMINAL AND GROUND → VOLTAGE DROPS TO 6V ± .5V — OK →	5
	→ VOLTAGE DOES NOT DROP — NOT OK → TEST RESISTANCE WIRE →	6
5	CHECK: ● CONTINUITY BETWEEN COIL NEGATIVE TERMINAL AND CONNECTOR OR TERMINAL D4 ● D1 CONTINUITY BETWEEN CONNECTOR TERMINAL AND GROUND	
	CONTINUITY OK → REPLACE CONTROL UNIT →	STOP
	CONTINUITY NOT OK → LOCATE AND REPAIR OPEN →	2



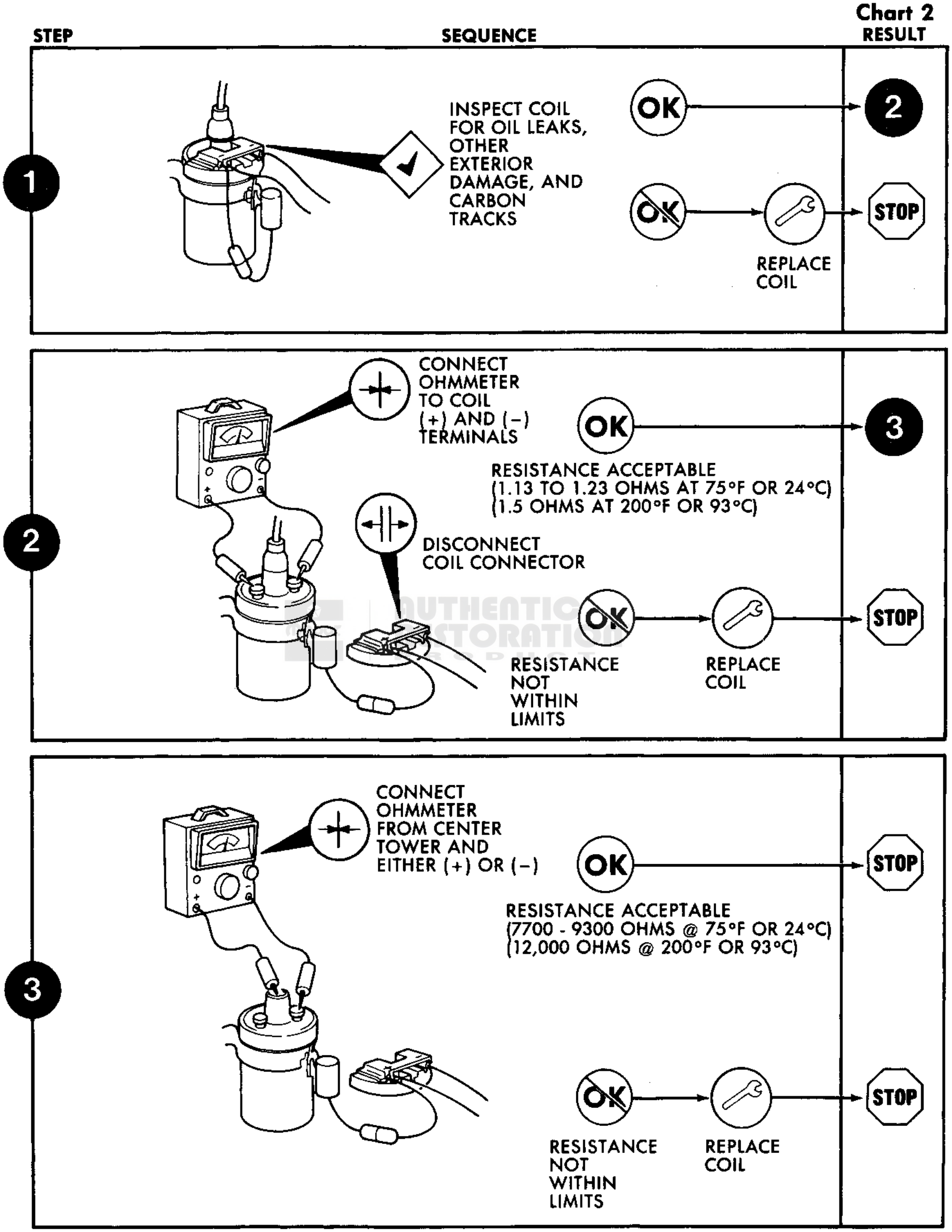
J898D-25

Chart 1



J898D-26

COIL TEST



1. INSPECT COIL FOR OIL LEAKS, OTHER EXTERIOR DAMAGE, AND CARBON TRACKS

2. CONNECT OHMMETER TO COIL (+) AND (−) TERMINALS

   DISCONNECT COIL CONNECTOR

   RESISTANCE ACCEPTABLE (1.13 TO 1.23 OHMS AT 75°F OR 24°C) (1.5 OHMS AT 200°F OR 93°C)

   RESISTANCE NOT WITHIN LIMITS

3. CONNECT OHMMETER FROM CENTER TOWER AND EITHER (+) OR (−)

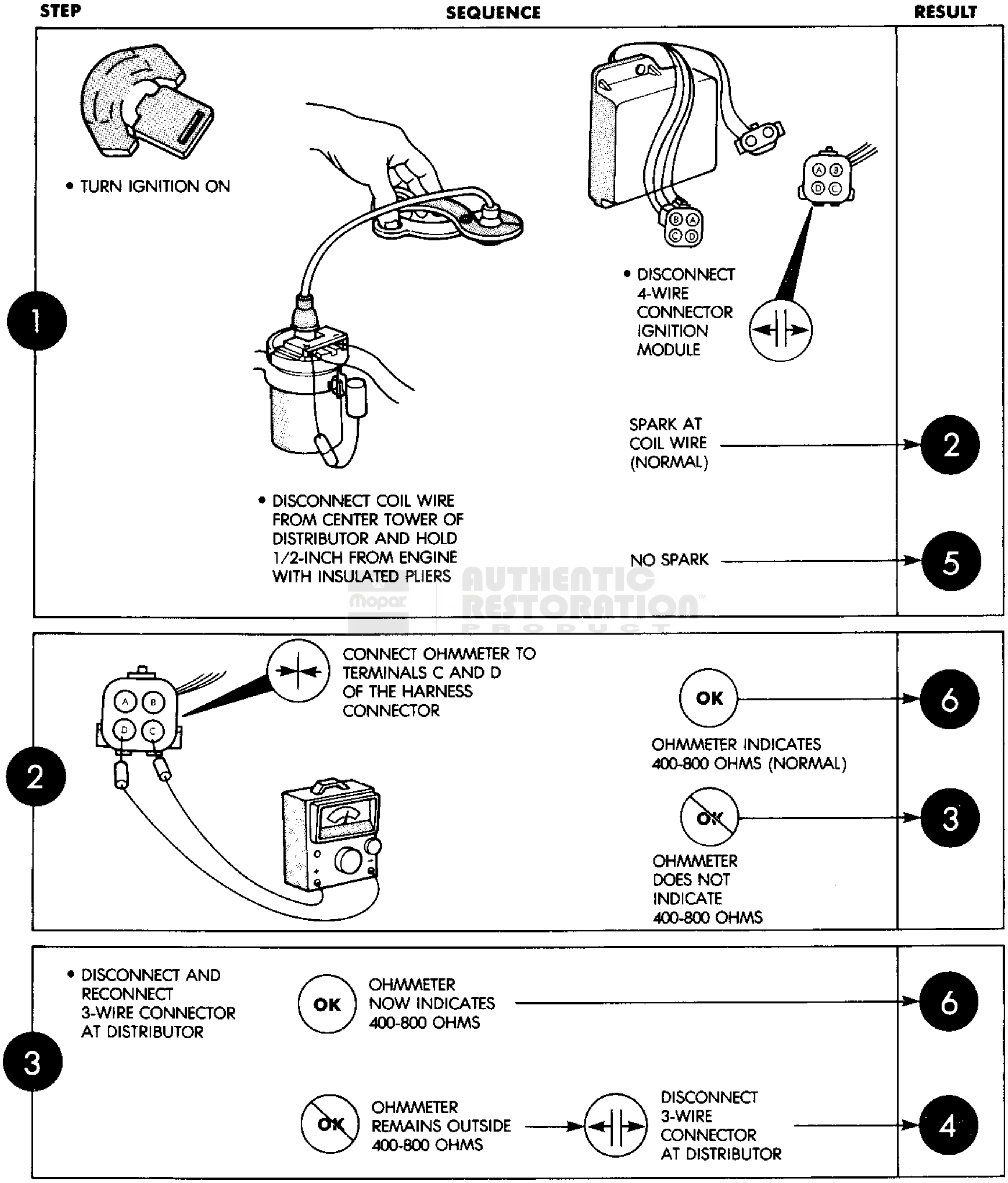
   RESISTANCE ACCEPTABLE (7700 - 9300 OHMS @ 75°F OR 24°C) (12,000 OHMS @ 200°F OR 93°C)

   RESISTANCE NOT WITHIN LIMITS

J898D-27

SENSOR CHECK AND CONTROL UNIT CHECK

Chart 3



- TURN IGNITION ON
- DISCONNECT 4-WIRE CONNECTOR IGNITION MODULE
- DISCONNECT COIL WIRE FROM CENTER TOWER OF DISTRIBUTOR AND HOLD 1/2-INCH FROM ENGINE WITH INSULATED PLIERS

SPARK AT COIL WIRE (NORMAL) → 2

NO SPARK → 5

CONNECT OHMMETER TO TERMINALS C AND D OF THE HARNESS CONNECTOR

OHMMETER INDICATES 400-800 OHMS (NORMAL) → 6

OHMMETER DOES NOT INDICATE 400-800 OHMS → 3

- DISCONNECT AND RECONNECT 3-WIRE CONNECTOR AT DISTRIBUTOR

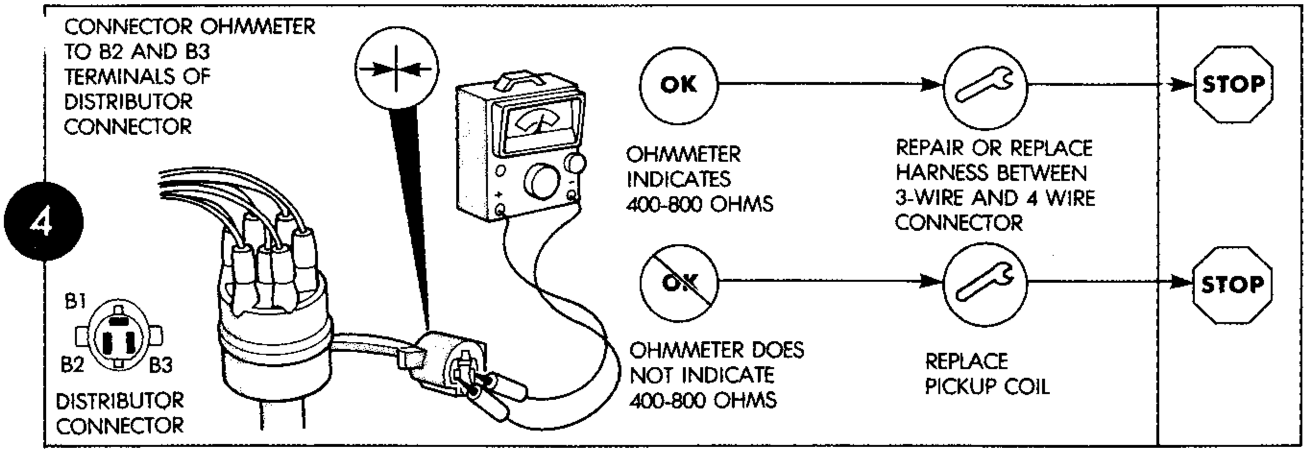
OHMMETER NOW INDICATES 400-800 OHMS → 6

OHMMETER REMAINS OUTSIDE 400-800 OHMS → DISCONNECT 3-WIRE CONNECTOR AT DISTRIBUTOR → 4

J908D-25

Chart 3

STEP **SEQUENCE** **RESULT**

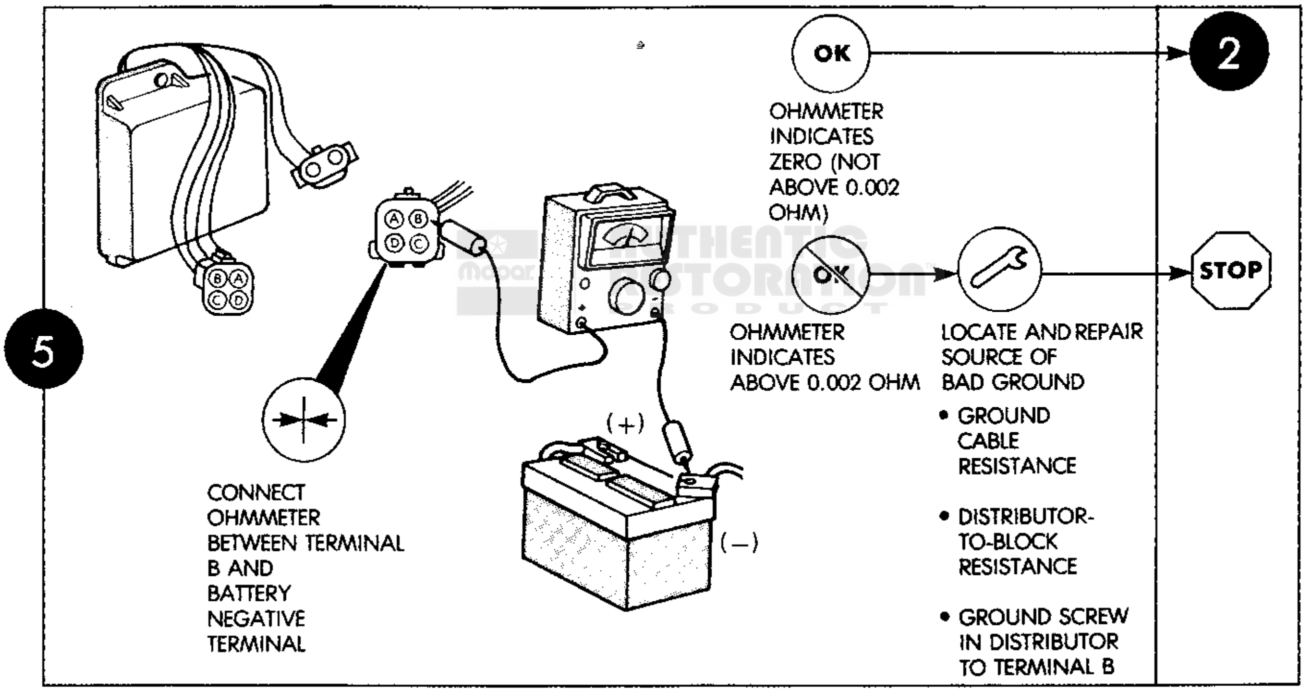


CONNECTOR OHMMETER TO B2 AND B3 TERMINALS OF DISTRIBUTOR CONNECTOR

DISTRIBUTOR CONNECTOR

OHMMETER INDICATES 400-800 OHMS → REPAIR OR REPLACE HARNESS BETWEEN 3-WIRE AND 4 WIRE CONNECTOR → STOP

OHMMETER DOES NOT INDICATE 400-800 OHMS → REPLACE PICKUP COIL → STOP

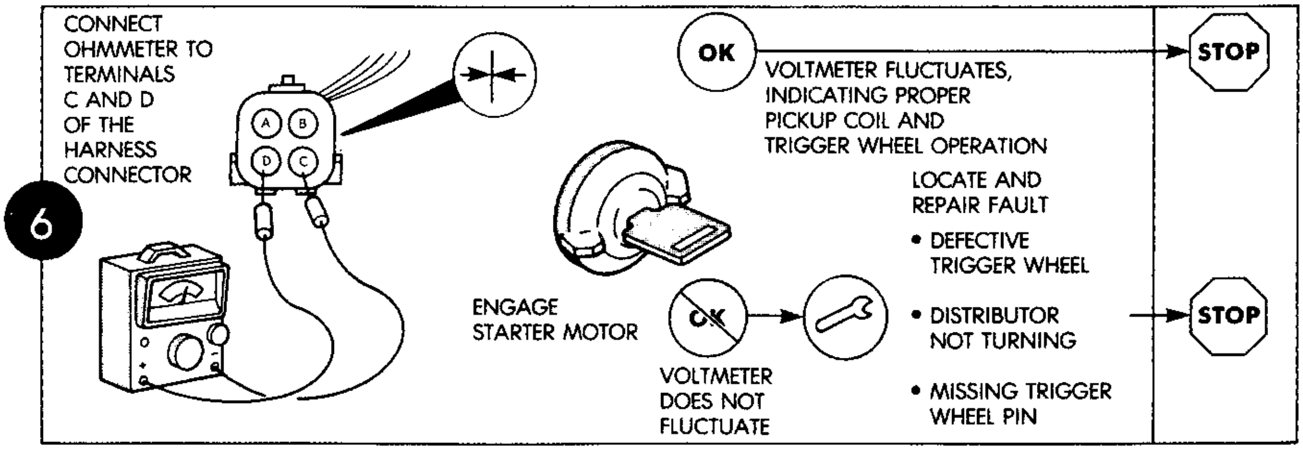


CONNECT OHMMETER BETWEEN TERMINAL B AND BATTERY NEGATIVE TERMINAL

OHMMETER INDICATES ZERO (NOT ABOVE 0.002 OHM) → 2

OHMMETER INDICATES ABOVE 0.002 OHM → LOCATE AND REPAIR SOURCE OF BAD GROUND → STOP

- GROUND CABLE RESISTANCE
- DISTRIBUTOR-TO-BLOCK RESISTANCE
- GROUND SCREW IN DISTRIBUTOR TO TERMINAL B



CONNECT OHMMETER TO TERMINALS C AND D OF THE HARNESS CONNECTOR

ENGAGE STARTER MOTOR

VOLTMETER FLUCTUATES, INDICATING PROPER PICKUP COIL AND TRIGGER WHEEL OPERATION → STOP

VOLTMETER DOES NOT FLUCTUATE → LOCATE AND REPAIR FAULT → STOP

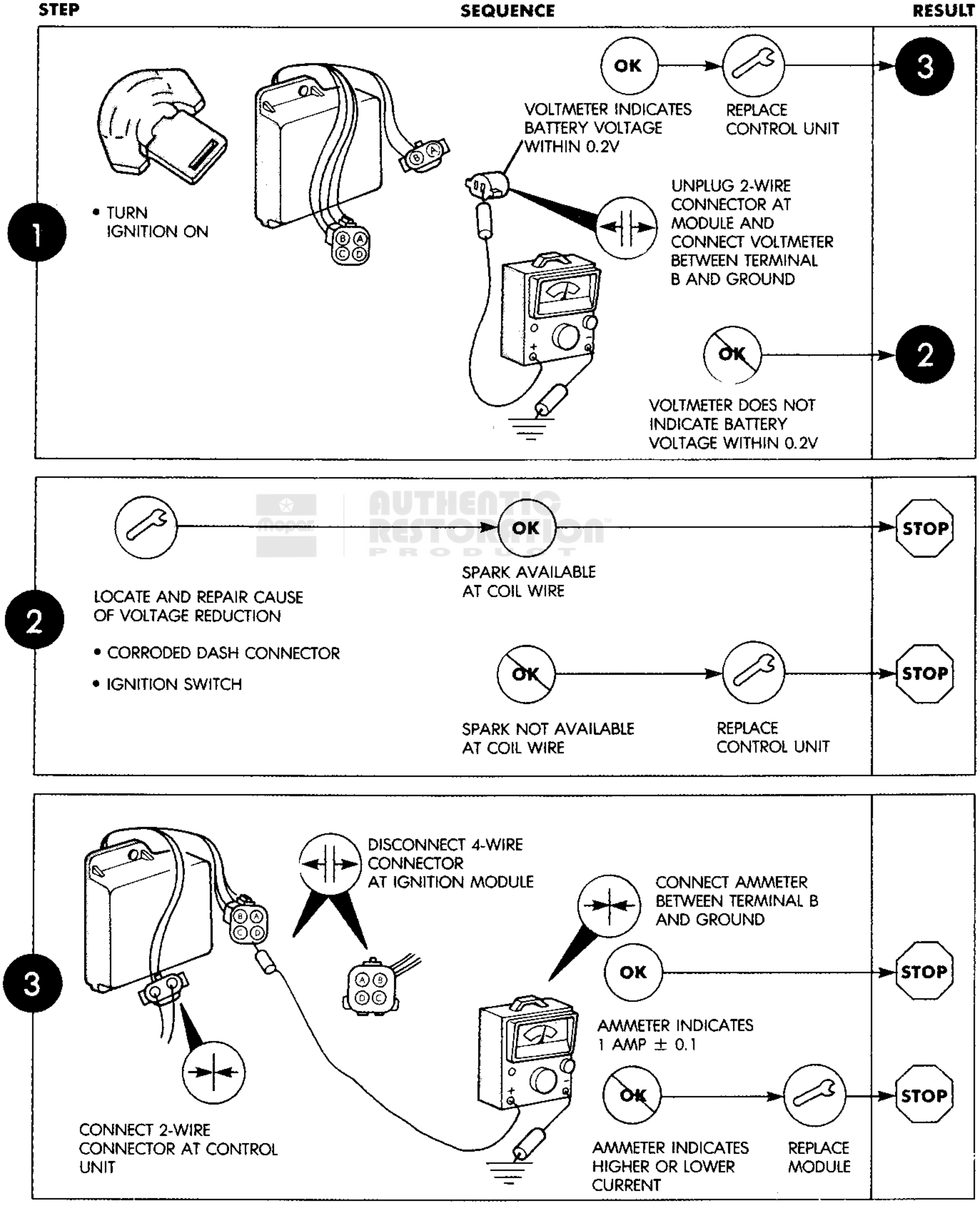
- DEFECTIVE TRIGGER WHEEL
- DISTRIBUTOR NOT TURNING
- MISSING TRIGGER WHEEL PIN

J908D-26

IGNITION FEED TO IGNITION MODULE

NOTE: DO NOT PERFORM CHART 4 WITHOUT PERFORMING CHART 1

Chart 4



J908D-27

ENGINE SPARK KNOCK (PRE-IGNITION) DIAGNOSIS

Spark knock (pre-ignition) can be attributed to several factors. The most common are ambient air conditions, such as air temperature, density and humidity.

High Underhood Air Temperature

Underhood air temperature is increased by the use of air conditioning (especially during long periods of idling), overloading (trailer pulling or operating in too high a gear) and the installation of accessories that restrict airflow.

Air Density

Air density increases as barometric pressure rises or as the air temperature decreases. A denser than normal mixture of air and fuel drawn into a cylinder has the same effect as increasing the engine compression ratio and this increases the possibility of spark knock.

Humidity

Low humidity increases the tendency for engine spark knock. High humidity decreases the tendency for engine spark knock.

Fuel Octane Rating

The eight cylinder engine is designed to operate on unleaded fuel. Fuels having an equivalent research octane rating may vary in their antiknock characteristics for a given engine. It may be necessary to retard the initial ignition timing (not more than one degree from the specification) or select an alternate source of fuel.

Ignition Timing

Check the ignition timing to ensure it is adjusted to the specification.

The white paint mark on the timing degree scale identifies the specified timing degrees before top dead center (BTDC) at 1600 rpm, not top dead center (TDC).

Combustion Chamber Deposits

An excessive buildup of deposits in the combustion chamber may be caused by not using the recommended fuels and lubricants, prolonged engine idling or continuous low speed operation. These deposits can be reduced by the occasional use of carburetor and combustion area cleaners or by operating the engine at higher speeds.

Distributor Ignition Advance Mechanisms

Inspect the centrifugal and vacuum ignition advance mechanisms to ensure they are operating normally.

Exhaust Manifold Heat Valve

This applicable to eight-cylinder engines only. If the heat valve sticks in the heat ON position, the intake manifold will be heated excessively.

DISTRIBUTOR ADVANCE TEST

Centrifugal (Mechanical) Advance Check

(1) Disconnect the vacuum hose from the vacuum advance mechanism and plug.

(2) Connect a timing light to the No. 1 spark plug and a tachometer to the ignition coil "tach" terminal.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(3) Start the engine and observe the timing degree scale and index with the timing light while the engine is idling.

(4) Slowly increase the engine speed to 2000 rpm. The timing should advance smoothly as engine speed increases.

Vacuum Advance Check

The engine must be warmed to normal operating temperature.

(1) Connect the vacuum hose to the vacuum advance mechanism.

(2) Observe the timing degree scale and index with the timing light while the engine is at idle speed.

(3) Slowly increase the engine speed to 2000 rpm. With vacuum applied, the ignition timing should advance sooner than with the centrifugal advance alone. At 2000 rpm, the vacuum advance should cause total advance to be more than with the centrifugal advance alone.

Distributor Advance Mechanism Testing—OFF-Engine

The distributor ignition advance may also be tested with the distributor removed from the engine. Follow the distributor test equipment manufacturer's instructions.

The information provided within the ignition advance curve illustrations is for on-engine testing.

If the distributor ignition advance is being tested with a distributor tester, convert the information within the ignition advance curves from engine rpm to distributor rpm and from engine degrees to distributor degrees:

Distributor RPM

- Divide the engine rpm by 2 to obtain the distributor rpm.

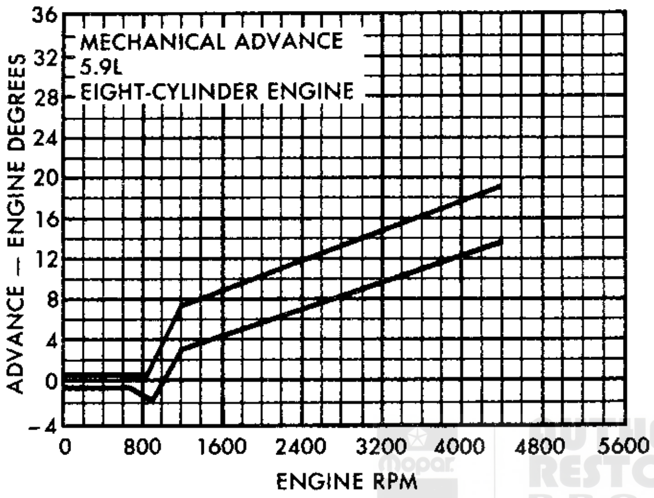
Distributor Degrees Advance

- Divide the engine degrees advance by 2 to obtain the distributor degrees advance.

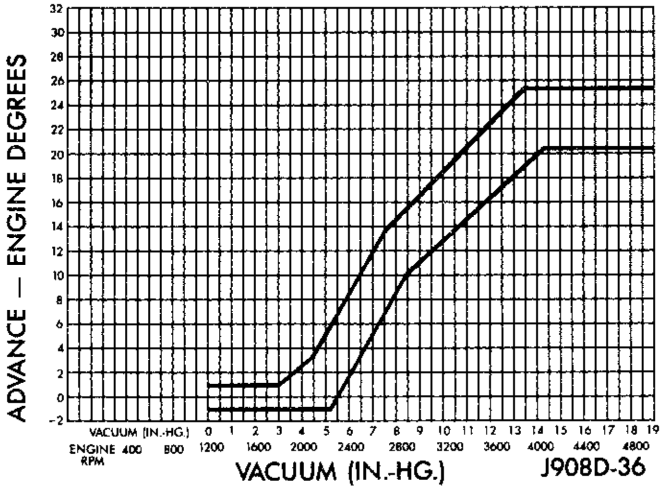
For example, if the ignition advance curve indicates 8 - 12 degrees advance at 2000 rpm, the corresponding on-tester specifications would be 4 - 6 degrees advance at 1000 rpm.

The specified kPa (in. Hg) of vacuum is the same, regardless if the test is on-engine or off-engine.

Distributor Ignition Advance Curves



J898D-39



J908D-36

IGNITION COIL TESTS

The ignition coil can be tested on any conventional coil tester or with an ohmmeter. A coil tester is preferable because it can be used to detect faults that are impossible with an ohmmeter.

Primary Winding Resistance Test

(1) Remove the connector from the negative (-) and positive (+) terminals of the ignition coil.

(2) Set the ohmmeter for the low scale and adjust the pointer to zero.

(3) Connect the ohmmeter to the coil negative and positive terminals. The resistance should be 1.13-1.23 ohms at 24°C (75°F). If the coil temperature is above 93°C (200°F), 1.50 ohms is acceptable.

Secondary Winding Resistance Test

(1) Remove the high voltage ignition wire from the high voltage terminal of the ignition coil.

The ignition switch must be OFF.

(2) Set the ohmmeter for the x1000 scale and adjust the pointer to zero.

(3) Connect the ohmmeter to the brass contact in the high voltage terminal and to either primary winding terminal. The resistance should be 7700-9300 ohms at 24°C (75°F). A maximum of 12,000 ohms is acceptable if the coil temperature is 93°C (200°F) or more.

Current Flow Test

(1) Remove the connector from the ignition coil.

(2) Depress the plastic barb and withdraw the positive (+) wire terminal from the connector. The barb is visible from the coil side of the connector.

(3) Repeat the procedure for the negative (-) wire terminal.

CAUTION: Ensure the ammeter current rating is sufficient for the test.

(4) Connect the ammeter between the positive terminal and the disconnected positive wire.

(5) Connect a jumper wire from the coil negative terminal to a known good ground.

(6) Turn the ignition switch to the ON position.

(7) The current flow should be approximately 7 amps and should not exceed 7.6 amps.

If the current flow is more than 7.6 amps, replace the ignition coil.

(8) Leave the ammeter connected to the coil positive (+) terminal. Remove the jumper wire from the negative (-) terminal. Connect the coil green wire to the negative terminal. The current flow should be approximately 4 amps.

If the current flow is less than 3.5 amps, inspect for poor connections in the 4-wire (control unit) and 3-wire (distributor) connectors or poor ground at the ground screw inside the distributor. If the current flow is greater than 5 amps, the electronic control unit is defective.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(9) Start the engine. Normal current flow with the engine operating is 2.0 - 2.4 amps. If the current flow is not within specifications, the control unit is defective.

Ignition Coil Output Test

(1) Connect an oscilloscope to the ignition coil. Refer to the test equipment manufacturer's instructions.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(2) Start the engine and observe the secondary ignition voltage.

CAUTION: Do not remove the wires from the spark plugs for cylinders 3 or 4 when performing the next test because the pickup coil may be damaged.

CAUTION: Do not operate the engine with the spark plug disconnected for more than 30 seconds because the catalytic converter may be damaged.

(3) Remove one spark plug wire from the distributor cap. Observe the voltage applied to the disconnected spark plug wire on the oscilloscope. This voltage, referred to as open circuit output voltage, should be 24 kV (24,000 volts) minimum with an engine speed of 1000 rpm.

INTERMITTENT FAILURE DIAGNOSIS

Intermittent failure may be caused by loose or corroded terminals, defective or missing components, inadequate ground connections, or defective wiring.

INTERMITTENT FAILURE DIAGNOSIS

Condition	Possible Cause	Correction
ENGINE FAILS TO START (NO SPARK AT PLUGS)	(1) No voltage to ignition system.	(1) Check battery, ignition switch and wiring. Repair as required.
	(2) Ignition module ground wires inside distributor open, loose or corroded.	(2) Clean, tighten or repair as required.
	(3) Primary wiring connectors not fully engaged.	(3) Clean and fully engage connectors.
	(4) Ignition coil open or shorted.	(4) Test coil. Replace if faulty.
	(5) Ignition module defective.	(5) Replace ignition module.
	(6) Cracked distributor cap.	(6) Replace cap.
	(7) Defective rotor.	(7) Replace rotor.
ENGINE BACKFIRES BUT FAILS TO START	(1) Incorrect ignition timing.	(1) Check timing. Adjust as required.
	(2) Moisture in distributor.	(2) Dry cap and rotor.
	(3) Distributor cap faulty.	(3) Check cap for loose terminals, cracks and dirt. Clean or replace as required.
	(4) Ignition wires not connected in correct firing order.	(4) Connect in correct order.
ENGINE RUNS ONLY WITH KEY IN START POSITION	(1) Open in resistance wire or excessive resistance.	(1) Replace resistance wire and harness assembly.
ENGINE CONTINUES TO RUN WITH KEY OFF	(1) Defective starter motor solenoid.	(1) Replace solenoid.
	(2) Shorted diode in alternator warning lamp circuit.	(2) Replace diode.

J908D-34

INTERMITTENT FAILURE DIAGNOSIS (CON'T.)

Condition	Possible Cause	Correction
ENGINE DOES NOT OPERATE SMOOTHLY AND OR ENGINE MISFIRES AT HIGH SPEED	(1) Spark plugs fouled or faulty. (2) Ignition wires faulty (including electronic retard). (3) Spark advance system(s) faulty. (4) S-terminal shorted to starter S-terminal in solenoid. (5) Trigger wheel pin missing. (6) Ignition wires not connected in correct firing order. (7) Two plug wires of consecutive firing cylinders routed next to each other.	(1) Clean and gap plugs. Replace as required. (2) Check wires. Replace as required. (3) Check operation. Repair as required. (4) Replace solenoid. (5) Install pin. (6) Connect wires correctly. (7) Re-route plug wires away from each other.
EXCESSIVE FUEL CONSUMPTION	(1) Incorrect ignition timing. (2) Spark advance system(s) faulty.	(1) Check timing. Adjust as required. (2) Check operation. Repair as required.
ERRATIC TIMING ADVANCE	(1) Faulty vacuum advance mechanism. (2) Centrifugal advance weights sticking.	(1) Check operation. Replace if required. (2) Remove dirt, corrosion.
TIMING NOT AFFECTED BY VACUUM	(1) Defective vacuum advance mechanism. (2) Vacuum advance mechanism adjusting screws too far counterclockwise. (3) Pickup coil pivot corroded.	(1) Replace vacuum advance mechanism. (2) Turn screw clockwise to bring advance within specifications. (3) Clean pivot.
INTERMITTENT OPERATION	(1) Loose or corroded terminals. (2) Defective pickup coil. (3) Defective Ignition Module. (4) Loose ground connector in distributor. (5) Wires to distributor shorted together or to ground. (6) Trigger wheel pin missing.	(1) Tighten terminals, remove corrosion, apply electrical grease. (2) Perform pickup coil test. (3) Perform control unit tests. (4) Clean and tighten ground connection. (5) Check for frayed, pinched, or burned wires. (6) Install new pin.

J908D-23

DISTRIBUTOR REPLACEMENT

Removal

(1) Unfasten the distributor cap retaining screws. Remove the distributor cap with the coil and spark plug wires connected and place aside.

(2) Disconnect and plug the distributor vacuum advance hose.

(3) Disconnect the distributor primary wiring connector.

(4) Scribe a mark on the distributor housing in line with the tip of the rotor. Scribe a mark on the distributor housing near the clamp and continue the scribe mark on the engine block in line with the distributor housing mark. Note the position of the rotor and distributor housing in relation to the surrounding engine components as reference points for installing the distributor.

(5) Remove the distributor hold down bolt and clamp.

(6) Withdraw the distributor carefully from the engine.

Installation

(1) Clean the distributor mounting area of the cylinder block.

(2) Install a replacement distributor mounting gasket.

(3) Position the distributor shaft in the cylinder block. If engine was not rotated while the distributor was removed, perform the following procedure:

(a) Align the rotor tip with the scribe mark on the distributor housing during removal. Turn the rotor approximately 1/8-turn counterclockwise past the scribe mark.

CAUTION: Ensure that the distributor shaft fully engages the oil pump drive gear shaft. It may be necessary to slightly rotate (bump) the engine while applying downward hand force on the distributor body to fully engage the distributor shaft with the oil pump drive gear shaft.

(b) Slide the distributor shaft down into the engine. Align the scribe mark on the distributor housing with the corresponding scribe mark on the cylinder block.

It may be necessary to move the rotor and shaft slightly to start the gear into mesh with the camshaft gear and to engage the oil pump drive tang, but the rotor should align with the scribe mark when the distributor shaft is down in place.

(c) Install the distributor hold down clamp and bolt, but do not tighten the bolt.

(4) If the engine was rotated while the distributor was removed, it will be necessary to establish timing according to the following procedure.

(a) Remove the No. 1 spark plug. Hold a finger over the spark plug hole and rotate the engine until the compression pressure is felt. Slowly continue to rotate the engine until the timing index on the vibration damper pulley aligns with the top dead center (TDC) mark (0 degree) on the timing degree scale. Always rotate the engine in the direction of normal rotation. Do not turn the engine backward to align the timing marks.

(b) Turn the distributor shaft until the rotor tip points in the direction of the No. 1 terminal in the distributor cap. Turn the rotor 1/8-turn counterclockwise past the position of the No. 1 terminal.

(c) Slide the distributor shaft down into the engine and position the distributor vacuum advance mechanism housing in approximately the same location (in relation to the surrounding engine components) as when removed. Align the scribe mark on the distributor housing with the corresponding scribe mark on the cylinder block.

It may be necessary to rotate the oil pump shaft with a long flat-blade screwdriver to engage the oil pump drive tang, but the rotor should align with the position of the No. 1 terminal when the distributor shaft is down in place.

(d) Install the distributor hold down clamp and bolt, but do not tighten the bolt.

CAUTION: If the distributor cap is incorrectly positioned on the distributor housing, the cap or rotor may be damaged when the engine is rotated.

(5) Install the distributor cap with the ignition wires on the distributor housing. Ensure the pickup coil wire rubber grommet in the distributor housing aligns with the depression in the distributor cap and that the cap fits on the rim of the distributor housing.

Two different diameter screws are used to retain the distributor cap.

(6) Apply Silicone Dielectric Compound, or equivalent, to the connector terminal blades and cavities. Connect the distributor primary wiring connector.

(7) Adjust the ignition timing. Refer to Ignition System Timing.

CAUTION: Do not puncture the spark plug wires or boots to make a connection. Use the proper adapters.

IGNITION SYSTEM TIMING

A graduated timing degree scale (Fig. 7) located on the timing case cover is used for reference when timing the ignition system.

A milled index notch in the vibration damper is used to align the No. 1 cylinder ignition position of the crankshaft with the correct timing degree mark on the graduated scale.

Magnetic Timing Probe

With both engines, a magnetic timing probe socket is provided integral with the timing degree scale for use with a special magnetic timing probe.

This special probe detects the milled notch on the vibration damper. The probe is inserted through the probe socket until it contacts the vibration damper.

Ignition timing can then be obtained from a meter or computer printout, depending on the type of equipment being used.

The probe socket is located at 9.5° ATDC, and the equipment is calibrated to compensate for this location.

Do not use the timing probe socket as a reference to check the ignition timing when using a conventional timing light.

Ignition Timing Procedure 5.9L

(1) Set the parking brake. Shift the transmission to PARK.

(2) Start the engine and allow it to attain normal operating temperature.

(3) Ensure that the A/C is turned OFF.

(4) With the ignition switch OFF, connect an ignition timing light and a properly calibrated tachometer.

(5) Disconnect and plug the distributor vacuum advance hose.

(6) Slightly loosen the distributor hold down bolt to allow adjustment.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(7) Start the engine.

(8) With the engine at idle speed, check and adjust (if necessary) the timing according to the specification listed on the Emission Control Information label located in the engine compartment.

(9) Tighten the distributor hold down clamp and verify that the ignition timing is correct.

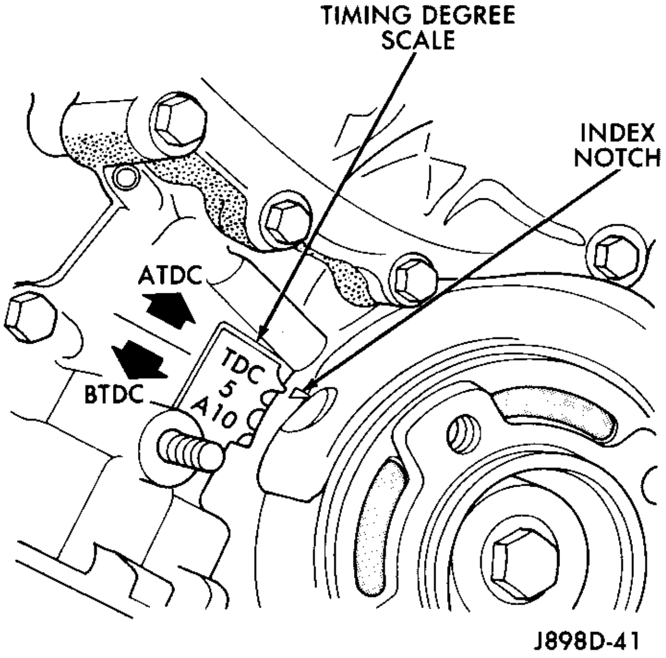


Fig. 7 Timing Mark Eight-Cylinder Engine

(10) Turn the ignition switch OFF and remove the timing light and tachometer.

(11) Connect the hose to the distributor vacuum advance mechanism.

DISTRIBUTOR COMPONENT REPLACEMENT

When replacing the pickup coil assembly, trigger wheel or vacuum advance mechanism, it is not necessary to remove the distributor from the engine. It is necessary to check ignition timing if the pickup coil assembly or vacuum advance mechanism is replaced. Refer to Fig. 8 for distributor component identification.

Trigger Wheel and/or Pickup Coil Assembly (Fig. 8)

Removal

(1) Place the distributor in a suitable holding device, if removed from the engine.

(2) Remove the cap.

(3) Remove the rotor.

(4) Remove the trigger wheel with Trigger Wheel Puller Tool 7804, or equivalent. Use a flat washer to prevent the puller from contacting the inner shaft. By prying alternately, two screwdrivers can be used to remove the trigger wheel from the shaft. Remove the pin.

(5) Remove the pickup coil snap ring from the central shaft. Remove the retainer from the vacuum advance mechanism-to-pickup coil drive pin and move the vacuum advance mechanism lever aside.

(6) Remove the two pickup coil plate screws.

(7) Lift the pickup coil assembly from the distributor housing.

(8) If the vacuum advance mechanism is to be replaced, remove the screws and lift the mechanism out of the distributor housing. Do not remove the vacuum advance mechanism unless replacement is required.

Installation

(1) If the vacuum advance mechanism was removed, install it on the distributor housing with the attaching screws.

If a replacement vacuum advance mechanism is installed, refer to Vacuum Advance Mechanism for the calibration procedure.

(2) Position the pickup coil assembly into the distributor housing.

(3) Attach the vacuum advance mechanism lever and the retainer to the pickup coil pin.

(4) Install the snap ring.

(5) Position the wiring harness in the slot in the distributor housing. Install the two pickup coil plate screws and tighten.

(6) Install the trigger wheel on the shaft with hand pressure. The long portion of the teeth must be up. When the trigger wheel and slot in the shaft are prop-

erly aligned, use a suitable drift and small hammer to tap the pin into the locating groove in the trigger wheel and shaft.

If the distributor is not installed in the engine, support the shaft while installing the trigger wheel pin.

(7) Install the rotor. Install the distributor cap.

Vacuum Advance Mechanism

Removal

(1) Remove the vacuum hose from the vacuum advance mechanism.

(2) Remove the distributor cap. Remove the retainer from the pickup coil pin. Remove the attaching screws and lift the vacuum advance mechanism from the distributor housing.

Installation

If a replacement vacuum advance mechanism is to be installed, calibrate as follows.

(1) Insert an Allen wrench into the vacuum hose tube of the original vacuum advance mechanism. Count the number of clockwise turns necessary to bottom the adjusting screw.

(2) Turn the adjusting screw of the replacement vacuum advance mechanism clockwise to the bottom. Turn it counterclockwise the same number of turns counted earlier.

(3) Install the vacuum advance mechanism on the distributor housing. Install the retaining screws. Position the vacuum advance lever onto the pickup coil pin and install the retainer. Install the distributor cap.

(4) Check the ignition timing and adjust, if required.

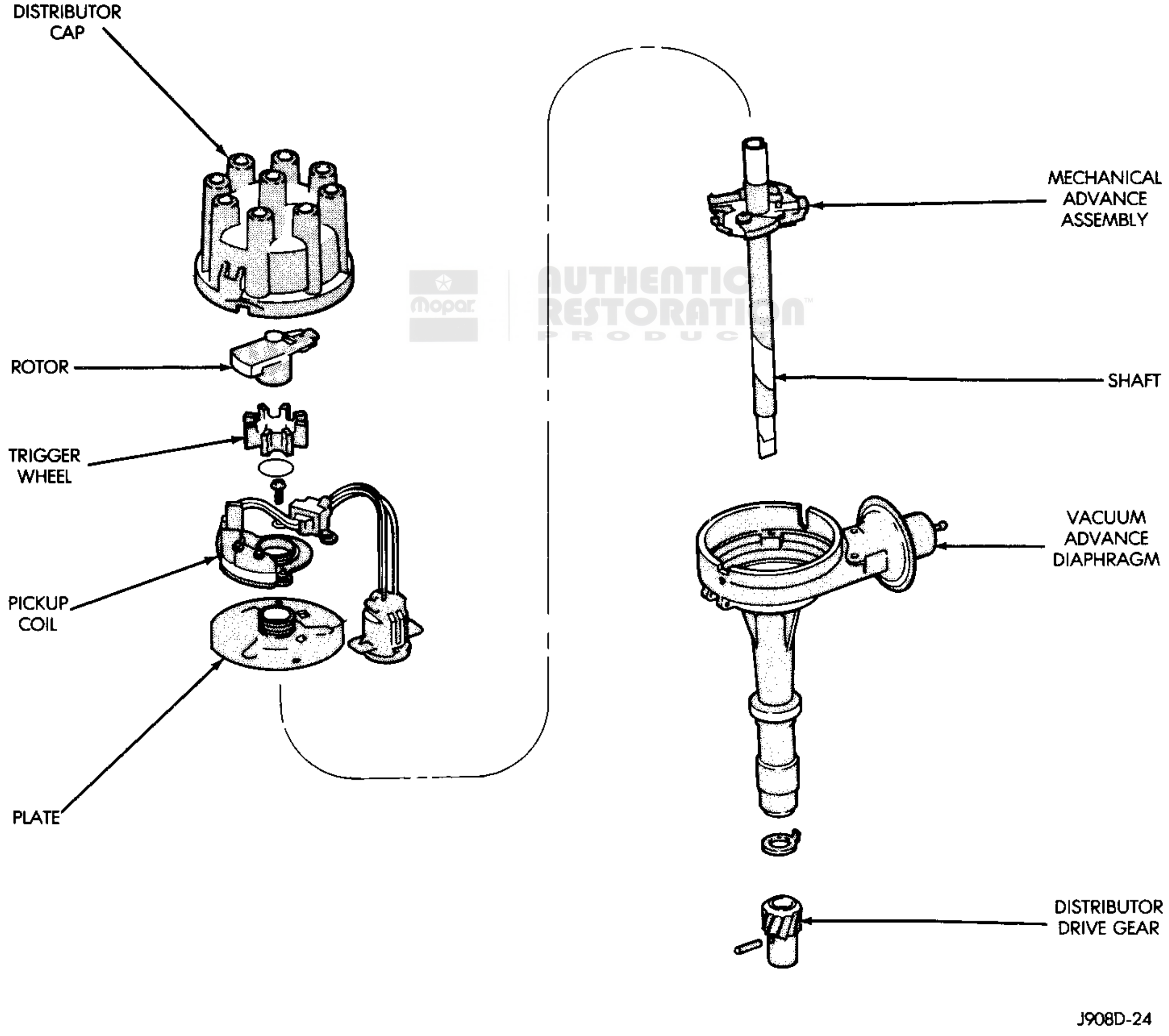


Fig. 8 Distributor Components

(5) Connect the vacuum hose to the vacuum advance mechanism.

Rotor

A unique feature of the SSI system is the silicone applied to the rotor blade during manufacture. Radio interference is greatly reduced by the presence of a small quantity of silicone dielectric compound on the rotor blade. After a few thousand miles, this compound becomes charred by the high voltage current flowing through the rotor. This is normal. Do not scrape the residue from the rotor blade.

When installing a replacement rotor, apply a thin coat 0.75 - 3 mm (0.03 - 0.12 in) of Silicone Dielectric Compound to the tip of the rotor blade.

VACUUM ADVANCE CONTROL SYSTEM

Manifold vacuum and carburetor ported vacuum are both used for the ignition vacuum spark advance mechanism on the eight cylinder engine. A coolant temperature override (CTO) valve determines the appropriate vacuum source, depending upon coolant temperature.

Vacuum Advance (Spark) Coolant Temperature Override (CTO) Valve

General

The distributor vacuum advance is controlled by either carburetor ported vacuum or manifold vacuum depending upon coolant temperature. This is accomplished by the vacuum advance control system. The CTO valve is screwed into the thermostat housing. A thermal sensor at the CTO valve tip is in contact with engine coolant. Depending on the coolant temperature, the CTO valve permits either manifold vacuum or carburetor ported vacuum to control the distributor vacuum advance (Fig. 9). When coolant temperature is below 104°C (220°F) carburetor ported vacuum is supplied to the distributor vacuum advance mechanism. Above 104°C (220°F) manifold vacuum is supplied.

Functional Test

Connect a vacuum gauge to the center port (D) of the CTO valve (Fig. 10). When coolant temperature is below 104°C (220°F) manifold vacuum should be indicated on the gauge. When coolant temperature is above 104°C (220°F) carburetor ported vacuum should be indicated on the gauge. **Ported vacuum is not available with the throttle closed. Ported vacuum is only available when the throttle is opened to achieve an engine speed of approximately 1000 RPM.**

The CTO is used to prevent overheating during high ambient temperature operating conditions. Defective valves must be replaced.

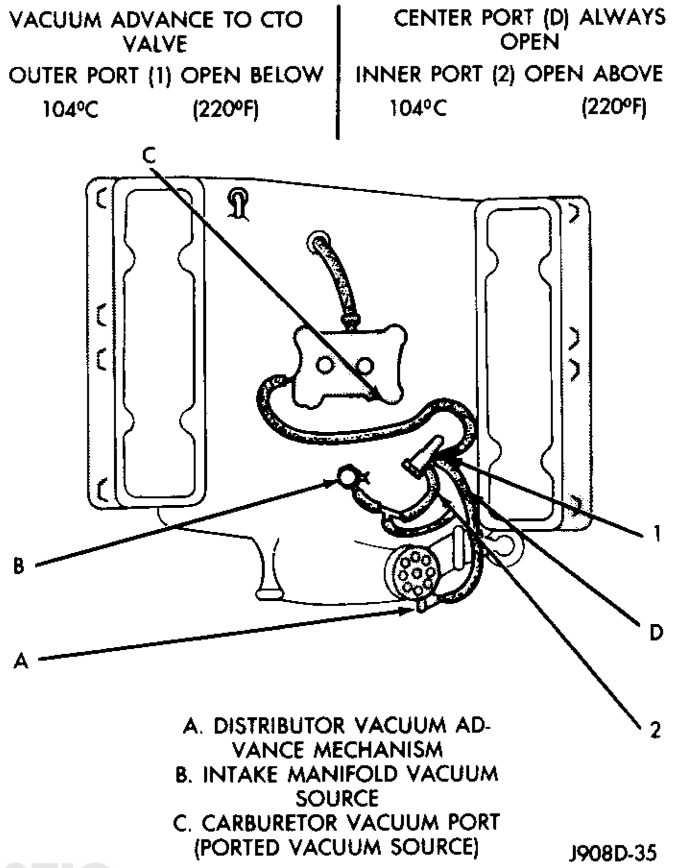


Fig. 9 Vacuum Advance Schematic

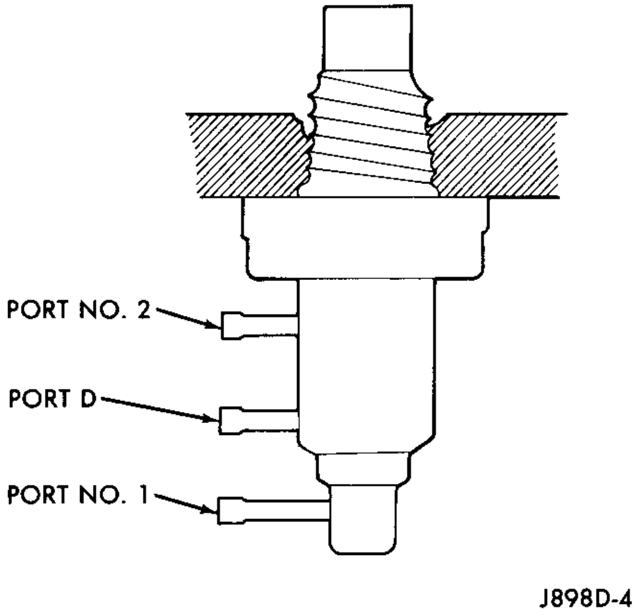


Fig. 10 Vacuum Advance CTO

Vacuum Advance CTO Valve Replacement

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM IS PRESSURIZED.

(1) Drain the coolant from the radiator. Use a clean container so that the coolant can be reused.

(2) Remove the air cleaner.

(3) Identify, tag and disconnect the vacuum hoses from the CTO valve.

(4) Using a 22.2mm (7/8 in.) open end wrench, remove the valve from the thermostat housing (or intake manifold).

(5) Install the replacement CTO valve.

(6) Connect the vacuum hoses to the valve.

(7) Install the air cleaner.

(8) Fill cooling system. Refer to Group 7, Cooling.

(9) Purge the cooling system of air.

IGNITION SWITCH

INDEX

GENERAL INFORMATION

The ignition switch is mounted on the lower section of the steering column and is connected to the key lock assembly by a remote lock rod.

IGNITION SWITCH REMOVAL

(1) Remove the lower instrument panel trim panel.

(2) Place the key lock in Off-LOCK position and remove the two switch attaching screws.

(3) Disconnect the switch from the remote rod.

(4) Disconnect the black harness connector then the white connector and remove the switch from the steering column.

IGNITION SWITCH TESTING

To test the ignition switch circuitry and continuity, place the slide bar in the position to be tested and use either an ohmmeter or Continuity Light.

Ignition switch slide bar positions can be easily identified by first locating the alignment hole located in the flat portion of the switch adjacent to the terminals. Starting from the alignment hole end of the switch, the switch positions are: Accessory, Off-LOCK, Off, On, and Start. Each position has a detent stop except Start which is spring loaded to release when the key is released.

No electrical resistance should be indicated (test lamp on) between two connected terminals. The maximum voltage drop between any two connected terminals, as shown in the Ignition Switch Chart, should not exceed 12.5 millivolts per amp. For example: If a 10-amp load is drawn through the switch, maximum voltage drop should be 10 x 0.0125 or 0.125 volt (Figs.1, 2).

IGNITION SWITCH INSTALLATION

Standard Column

(1) With the actuator rod disconnected, position the switch.

(2) Move the slider to the extreme left (Accessory position).

The left side of the ignition switch is toward the steering wheel.

(3) Position the actuator rod in the slider hole (Fig. 3) and install the switch to the steering column being careful not to move the slider out of the detent.

POSITION	CIRCUIT	
START	I-1, B-1 & S G-1, G-2	CONNECTED GROUNDED
ON	I-1 & B-1 A & B-2 I-3 & B-3	CONNECTED CONNECTED CONNECTED
OFF	OPEN	
OFF-LOCK	OPEN	
ACC.	A & B-2	CONNECTED

NOTE: B-1, B-2 & B-3 ARE COMMON CONNECTION.

J898D-46

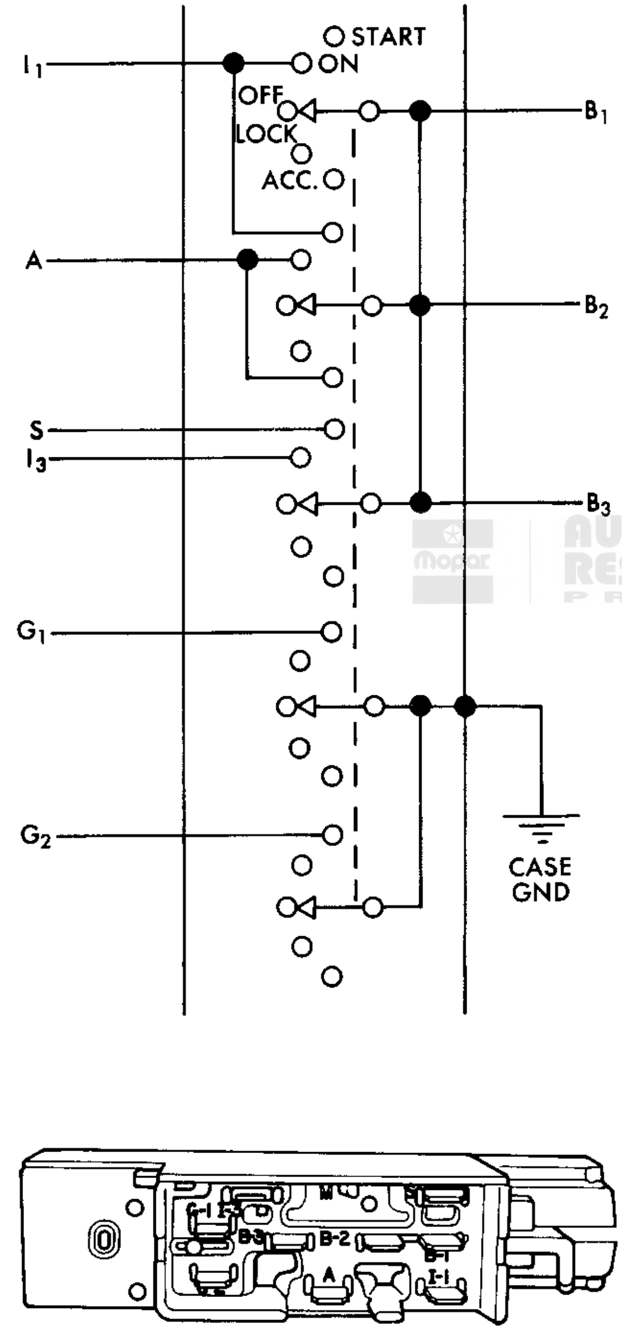
Fig. 1 Ignition Switch Terminal Connections

(4) Hold the key in Accessory position and push the switch down the column slightly to remove the slack in the actuator rod.

(5) Tighten the attaching screws securely.

(6) Connect the white connector and then the black connector to the switch.

(7) Install the lower instrument panel trim panel.



J898D-47

Fig. 2 Ignition Switch Terminals

Tilt Column

(1) With the actuator rod disconnected, position the switch.

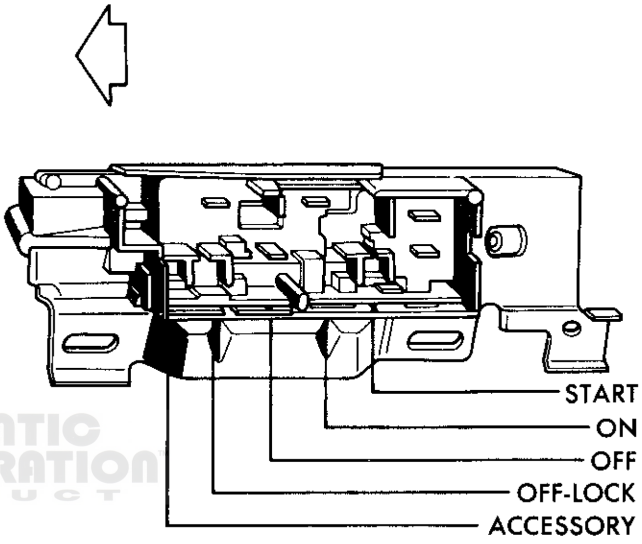
(2) Move the slider to the extreme right (Accessory position).

The right side of the ignition switch is downward from the steering wheel.

(3) Position the actuator rod in the slider hole (Fig. 4).

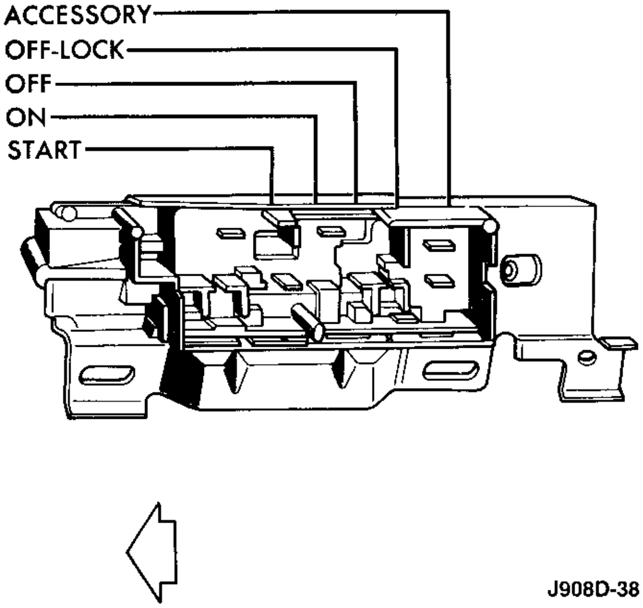
(4) Install the switch to the steering column but do not tighten the attaching screws.

(5) Lightly push the switch down the column (away from the steering wheel) to remove lash in the actuator



J908D-37

Fig. 3 Standard Column



J908D-38

Fig. 4 Tilt Column

rod, while holding the key in the Accessory position. Be careful not to move the slider out of the detent.

(6) Tighten the attaching screws securely.

(7) Connect the white connector and then the black connector to the ignition switch.

(8) Install the lower instrument panel trim panel.

TIGHTENING REFERENCE

TIGHTENING REFERENCE

Component	N·m	Ft.-Lbs. (In.-Lbs.)
DISTRIBUTOR HOLD DOWN BOLT	23 N•m	17 ft-lbs
SPARK PLUGS	37 N•m	27 ft-lbs

J908D-28

INSTRUMENT PANEL

CONTENTS

XJ AND MJ

INDEX

GENERAL

With the ignition switch in the RUN or START position, voltage applied to the instrument cluster is limited by the gauges fuse. The voltage applied to the instrument cluster is applied to all the gauges and indicators through the instrument cluster printed circuit.

With the ignition switch in the OFF position, voltage is not applied to the instrument cluster and the gauges do not indicate any vehicle condition.

Voltmeter

The voltmeter measures the output of the alternator when the engine is running. When the engine is not running the voltmeter measures battery voltage.

Oil Pressure Gauge

The oil pressure gauge pointer position is controlled by a magnetic field created by electrical current flow through the coils within the gauge. A change in the amount of current flow will change the magnetic field which changes the pointer position. The oil pressure sender is variable resistor that changes electrical resistance with a change in oil pressure (values shown in chart).

Oil Pressure Indicator

Voltage is applied to one side of the indicator bulb and the oil pressure switch is connected to the other side. When oil pressure is too low, the switch closes providing a path to ground, and the indicator lights.

Coolant Temperature Gauge

The coolant temperature gauge pointer position is controlled by a magnetic field created by electrical current flow through the coils within the gauge. A change in the amount of current flow will change the magnetic field which changes the pointer position. The temperature sender is a thermistor that provides a different electrical resistance for different temperatures of the coolant. As the resistance changes, the current changes and the pointer moves to a new position (values shown in chart).

Coolant Temperature Indicator

Voltage is applied to one side of the indicator bulb and the coolant temperature switch is connected to the other side. When coolant temperature is too high, the switch closes providing a path to ground, and the indicator lights.

SPECIFICATIONS

OIL PRESSURE GAUGE CALIBRATION

POINTER POSITION	RESISTANCE
0 psi Grad. ± 2°	1 ohm
40 psi Grad. ± 3½°	46 ohms
80 psi Grad. ± 3°	87 ohms

TEMPERATURE GAUGE CALIBRATION

POINTER POSITION	RESISTANCE
100°F Grad. ± 3½°	1365 ohms
220°F Grad. ± 2½°	93.5 ohms
260°F Grad. ± 2½°	55.1 ohms

FUEL GAUGE CALIBRAION

POINTER POSITION	RESISTANCE
Empty Grad. +0° −4°	1 ohm
1/2 Full Grad. ± 3½°	44 ohms
Full Grad. + 6° −0°	88 ohms

VOLTMETER CALIBRATION

VOLTAGE INPUT	POINTER POSITION
12V	12V Grad. ±6°
16V	16V Grad. ±3°

TACHOMETER CALIBRATION

ENGINE	FREQUENCY	INDICATION
4 CYLINDER	66.7 HZ	2000 RPM ± 140
	166.7 HZ	5000 RPM ± 140
6 CYLINDER	100 HZ	2000 RPM ± 140
	250 HZ	5000 RPM ± 140

J908E-30

Tachometer

The tachometer displays the engine speed, (RPM). With the engine running, the tachometer receives an engine speed signal from the negative side of the ignition coil (values shown in chart).

Fuel Gauge

The fuel gauge pointer position is controlled by a magnetic field created by electrical current flow through the coils within the gauge. A change in the amount of current flow will change the magnetic field which changes the pointer position. The fuel level sender is a variable resistor that changes electrical resistance depending on the level of fuel in the tank. As the resistance changes, the current changes and the pointer moves to a new position (values shown in chart).

Low Fuel Warning

The low fuel warning indicator glows when the fuel tank holds approximately two gallons. A low fuel warning module controls when the indicator will light. When the module senses 8 ohms or less from the fuel level sender for 10 continuous seconds, the indicator will light. The indicator will remain on until the module senses 11 ohms or more from the fuel sender for 20 continuous seconds.

Upshift Indicator (4 & 5 Speed Manual Transmissions) Except California

The upshift indicator lights when the engine speed is high enough to be shifted into a higher gear.

Voltage is applied through the indicator bulb to the upshift switch. The electronic control unit (ECU) measures manifold vacuum and engine speed. The ECU uses these two values to determine when to provide a ground for the indicator. The 2.5L upshift switch turns the indicator off by removing the ground path when the transmission is in high gear.

Brake Indicator

The brake indicator warns the driver that the parking brake is on or that the pressure in the brake system is unequal.

Voltage is applied through the brake indicator bulb to three switches. A path to ground for the current is available if:

- The brake warning switch is closed (with unequal brake system pressures), or
- The ignition switch is in START (to test the bulb), or
- The park brake switch is closed (with the park brake on).

4WD Indicator

COMMAND TRAC 4WD

The part time indicator lights when the vehicle is engaged in 4-wheel drive mode. Voltage is provided to one side of the indicator. A switch in the transfer case area is connected to the other side of the indicator. When the switch is closed, a path to ground is provided and the indicator lights.

SELECT TRAC 4WD

The 4-wheel drive indicator lights when the vehicle is engaged in full time 4-wheel drive mode. The Part Time indicator lights when the vehicle is in a part time 4-wheel drive mode. Voltage is provided to one side of the indicators. Switches in the transfer case area are connected to the other side of the indicator. When a switch is closed, a path to ground is provided and the indicator lights.

Emission Maintenance Timer and Indicator Light

The emission maintenance timer and indicator light are used to alert the owner when oxygen sensor-PCV valve replacement and other scheduled emission maintenance is required.

The indicator light is located in the instrument cluster. The timer is mounted on the dash panel to the right of the steering column.

The timer is operated by the ignition system. It activates illumination of the indicator light when vehicle mileage reaches the scheduled maintenance interval of approximately 133,000 kilometers (82,500 miles).

The life cycle of the timer coincides with the emission maintenance interval of 133,000 kilometers (82,500 miles). The timer cannot be reset after reaching this mileage interval. The timer can only be replaced or disconnected.

The oxygen sensor and timer are interdependent. If the timer should fail prematurely, the oxygen sensor must be replaced along with the timer. This is important in preserving the correct sensor replacement interval and ensuring proper engine performance.

Refer to Group 25 for replacement instructions.

TROUBLESHOOTING INSTRUMENT CLUSTER—XJ AND MJ

1. GAUGES AND INDICATORS—INOPERATIVE: Remove and inspect fuse

TEST	OK	NOT OK
Gauges fuse	Not blown	Replace fuse

2. GROUND: Remove Cigar Lighter

TEST	OK	NOT OK
Side of Cigar Lighter to ground	Zero ohms	Repair open to ground
Instrument Cluster connector terminal 5	Zero ohms	Repair open to ground

VOLTMETER—INOPERATIVE

TEST	OK	NOT OK
Ignition in RUN	Voltmeter reads battery voltage	Next step
Instrument Cluster connector terminal 6	Battery voltage If OK, replace meter	Repair open to Gauges fuse

OIL PRESSURE GAUGE—INOPERATIVE: Ignition in RUN

TEST	OK	NOT OK
Disconnect Oil Pressure Sender connector terminal S	Needle goes to H	Next step
Touch Oil Pressure Sender connector terminal S to ground	Needle goes to L If OK, replace sender	Repair open to gauge

OIL PRESSURE INDICATOR—INOPERATIVE: Ignition in RUN

TEST	OK	NOT OK
Touch Oil Pressure Switch terminal S to ground	Lamp lights If OK, replace switch	If bulb is OK, repair open to instrument cluster connector terminal 2

COOLANT TEMPERATURE GAUGE—INOPERATIVE: Ignition in RUN

TEST	OK	NOT OK
Disconnect Coolant Temperature Sender connector terminal S	Needle goes to C	Next step
Touch Coolant Temperature Sender connector terminal S to ground	Needle goes to H If OK, replace sender	Repair open to gauge

COOLANT TEMPERATURE INDICATOR—INOPERATIVE: Ignition in RUN

TEST	OK	NOT OK
Touch Coolant Temperature Indicator connector terminal S to ground	Lamp lights If OK, replace switch	If bulb is OK, repair open to instrument cluster connector terminal 14

TACHOMETER—INOPERATIVE: Engine Running

TEST	OK	NOT OK
Ignition module connector terminal C or diagnostic connector D1-1	AC voltage	Replace ignition module
Instrument cluster connector terminal 12	AC voltage	Repair open between ignition coil and instrument cluster
Inspect instrument cluster printed for cracks or poor connections	Replace tachometer	Replace printed circuit

FUEL GAUGE—INOPERATIVE: Ignition in RUN

TEST	OK	NOT OK
Disconnect Fuel Gauge Sender connector	Needle goes to F If gauge is OK, replace sender	Next step
Connect fuel Gauge Sender connector and disconnect instrument cluster connector terminal 15 or 17	0-88 ohms If OK, replace gauge	Repair open to sender

LOW FUEL WARNING—INOPERATIVE: Ignition in RUN

TEST	OK	NOT OK
Connect a ground wire to terminal 17 of the instrument cluster connector. Wait at least 10 seconds	Lamp (LED) lights If OK, replace sender	Replace module

UPSHIFT INDICATOR—INOPERATIVE: Ignition in RUN, Parking Brake ON, Transmission in first gear

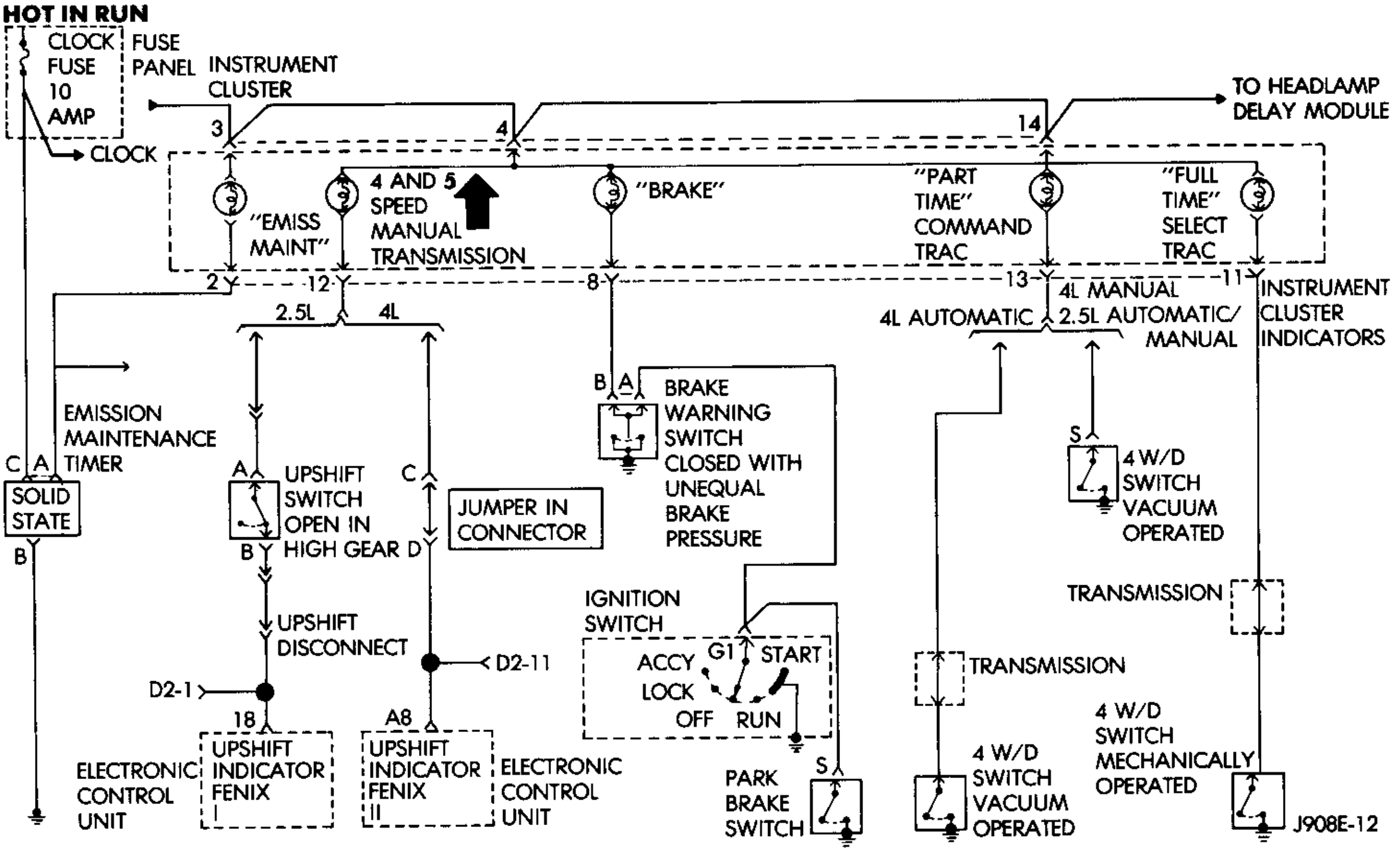
TEST	OK	NOT OK
(2.5L) Jumper D2-1 to ground	Lamp lights If OK, test ECU	Next step
(2.5L) Jumper upshift switch connector terminal A to ground	Lamp lights If switch OK, repair open to ECU	If bulb is OK, repair open to indicator
(4.0L) Jumper D2-11 to ground	Lamp lights If OK, test ECU	If bulb is OK, repair open to indicator

BRAKE INDICATOR—INOPERATIVE: Ignition in RUN, Parking Brake ON, Brake Warning Switch connector unplugged

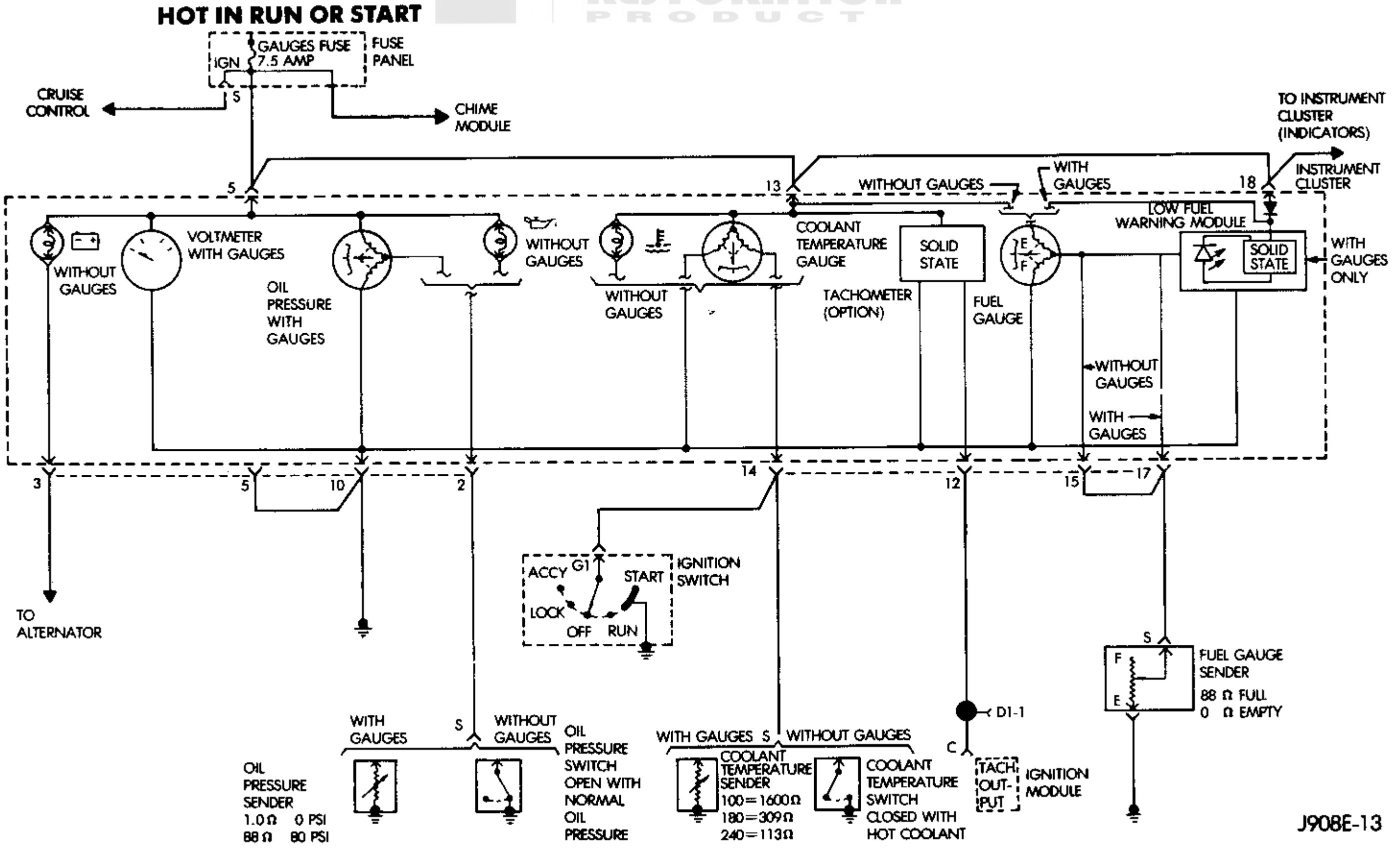
TEST	OK	NOT OK
Jumper Brake Warning Switch connector terminal B to ground	Lamp lights	If bulb is OK, repair open to indicator
Jumper Brake Warning Switch connector terminal A	Zero ohms If ok, check switch and /or brake system	Repair open to Park Brake Switch ground

PART TIME OR 4WD INDICATOR —INOPERATIVE: Parking Brake ON, Engine RUNNING, vehicle in 4WD Lock or 4WD

TEST	OK	NOT OK
Unplug switch and touch harness side of wire to ground	Lamp lights If OK, check switch operation, replace if bad	If bulb is OK, repair open to indicator



Instrument Cluster/Indicators—XJ and MJ



Instrument Cluster—XJ and MJ

CLOCK AND RADIO/CLOCK ILLUMINATION

Liquid Crystal Display (LCD) Clock

Battery power for the clock is available at all times at the clock connector terminal C. Ground for the clock is provided at clock terminal A.

Lighting for the display is controlled through the Radio/LCD Clock Illumination Relay. With the Headlamp switch in OFF and the Ignition Switch in ACCY or RUN, power flows from the Radio Fuse, through the normally closed contacts of the Radio/LCD Clock Illumination relay to the clock and the display is at full brightness.

Pulling the Headlamp switch to PARK or HEAD energizes the Radio/LCD Clock Illumination relay. This closes the normally open contacts of the relay and brightness for the clock display is now controlled by the Headlamp switch rheostat at clock terminal H.

Radio Illumination

With the Ignition Switch in ACCY or RUN, power flows from the Radio Fuse, through the normally closed contacts of the Radio/LCD Clock Illumination Relay to the Radio at the radio connector terminal 11.

Pulling the Headlamp switch to PARK or HEAD energizes the Radio/LCD Clock Illumination relay. This closes the normally open contacts of the relay, and the brightness for the radio display is controlled by the Headlamp switch rheostat. The back-lighting for the radio is also controlled by the Headlamp rheostat through radio connector terminal 10.

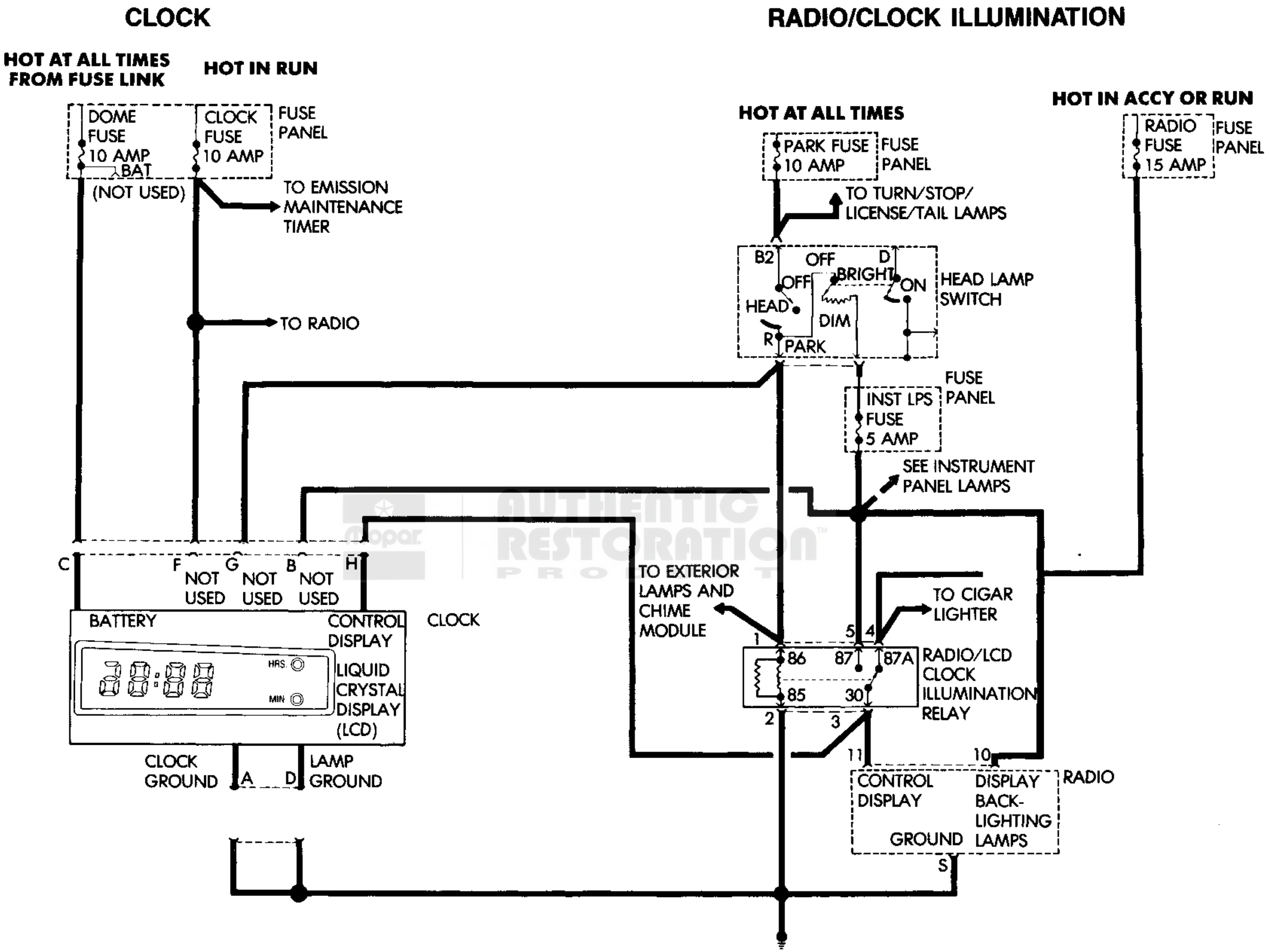
Troubleshooting

NO CLOCK DISPLAY VISIBLE: Clock Disconnected

TEST	OK	NOT OK
Clock connector terminal C	Battery voltage	Repair open from Dome fuse
Clock connector terminal A	Zero ohms	Repair open to ground

LCD CLOCK DISPLAY AND/OR RADIO DISPLAY DOES NOT DIM WITH LIGHTS ON: Ignition in ACCY, Lights ON

TEST	OK	NOT OK
Radio clock illumination relay connector terminal 1	Battery voltage	Repair open from Headlamp Switch
Radio clock illumination relay connector terminal 2 with lights OFF	Zero ohms If OK, replace Radio/LCD Clock Illumination Relay	Repair open to ground
Radio clock illumination relay connector terminal 5	Battery voltage	Repair open from fuse
Radio clock illumination relay connector terminal 3	Battery voltage	Replace Radio/LCD Clock Illumination Relay
Clock connector terminal H and/or Radio connector terminal 11	Battery voltage If OK, replace clock and/or radio	Repair open from Radio/LCD Clock Illumination relay connector terminal 3



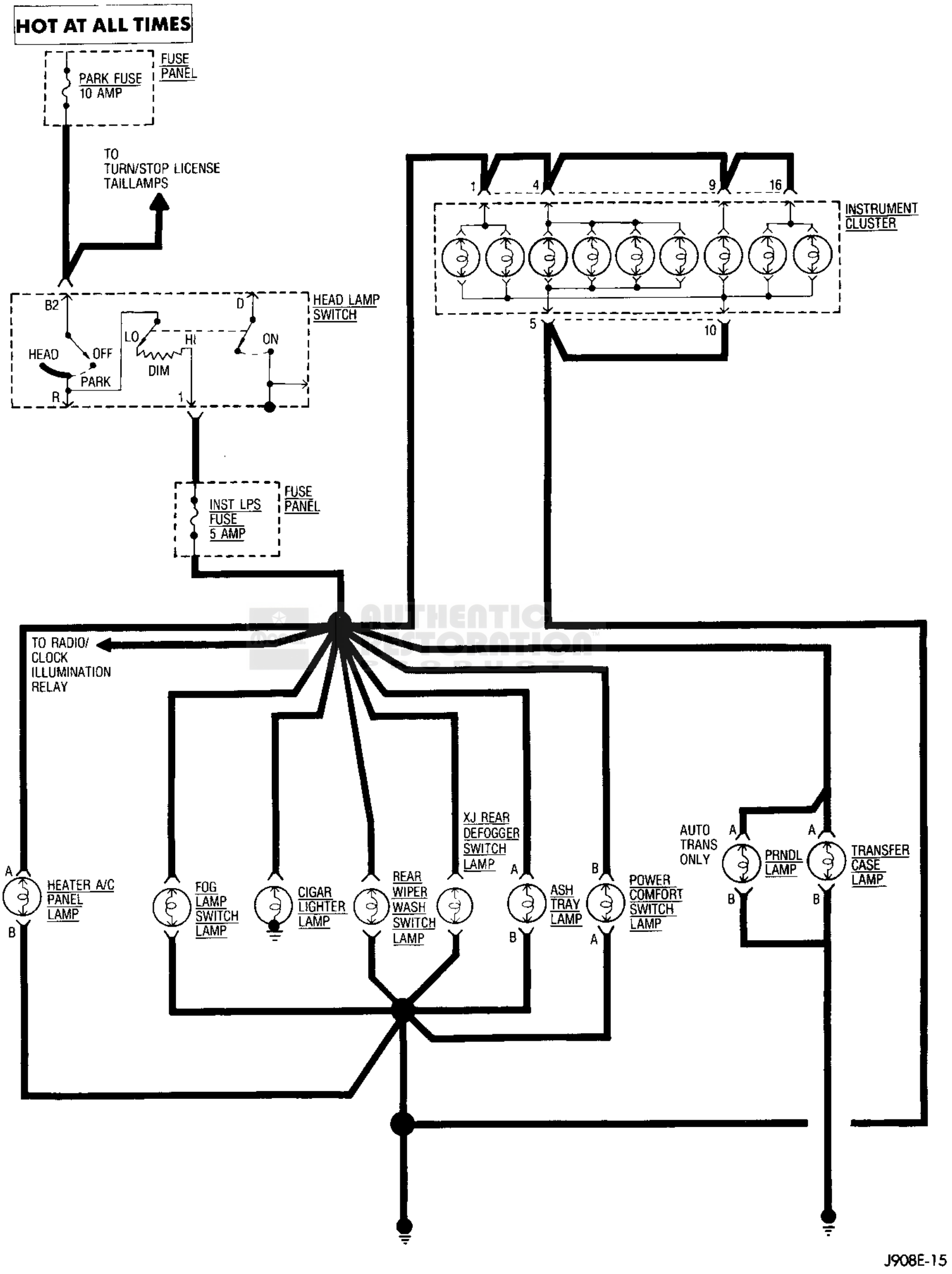
Radio/Clock Illumination Schematic

INSTRUMENT PANEL LAMPS

Voltage is applied at all times through the park fuse to the headlamp switch. The circuit continues through the instrument lamps fuse to the individual instrument panel lamps to ground. Lamp brightness is controlled by turning the headlamp switch knob.

INSTRUMENT PANEL LAMPS: ALL LAMPS INOPERATIVE; Parking Lamps ON

TEST	OK	NOT OK
Park fuse	Not blown	Replace fuse
Instrument Lamps fuse	Not blown	Replace fuse
Battery side of Inst. Lps. fuse with Rheostat turned CCW to CW (LO to HI)	Zero - Battery voltage	Replace headlamp switch
Ground side of Inst. Lps. fuse with Parking lamps OFF	Almost zero ohms (except bulb filament)	Repair open to ground If zero ohms, 12 volt supply wire from fuse is shorted to ground, repair short



Instrument Panel Lamps

EMISSION MAINTENANCE TIMER REPLACEMENT

The maintenance timer is mounted on the dash panel to the right of the steering column. Refer to Group 25 for replacement instructions.

GAUGE REPLACEMENT—INSTRUMENT CLUSTER REMOVED

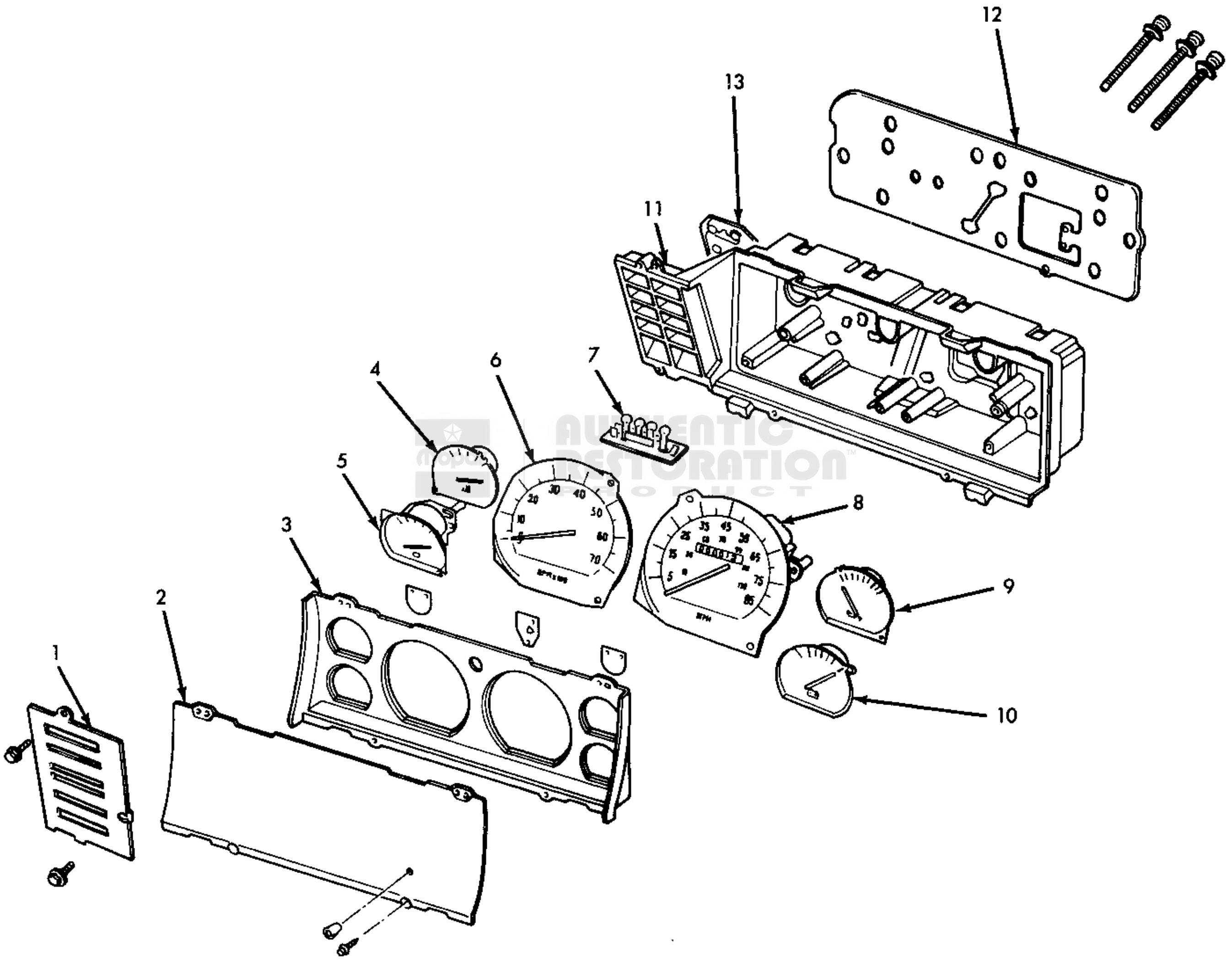
(1) Remove the cluster lens and gauge bezel (Fig. 1). If equipped with trip odometer, gently pull the knob of the trip odometer push pin.

(2) Remove the gauge attaching screws from the rear of mounting bezel. Remove gauge from front.

(3) Install the gauge. Install the attaching screws.

(4) Install the cluster bezel and lens.

(5) Install knob on trip odometer push pin.



1. Tell-Tale Display
2. Lens
3. Gauge Bezel
4. Engine Coolant Temperature Gauge
5. Fuel Gauge
6. Tachometer
7. Low Fuel Warning Module
8. Speedometer
9. Engine Oil Pressure Gauge
10. Voltmeter
11. Mounting Bezel
12. PC Overlay – Gauges
13. PC Overlay – Tell-Tales

J908E-31

Fig. 1 Instrument Cluster

SPEEDOMETER REPLACEMENT—INSTRUMENT CLUSTER REMOVED

(1) Remove the cluster lens and gauge bezel. If equipped with trip odometer, gently pull the knob of the trip odometer push pin.

(2) Remove two attaching screws from the rear of the mounting bezel.

(3) Remove one screw from the front of the speedometer.

(4) Remove the speedometer assembly.

(5) Install the speedometer. Install the attaching screws.

(6) Install the gauge bezel and lens.

(7) Install knob on trip odometer push pin.

TACHOMETER REPLACEMENT—INSTRUMENT CLUSTER REMOVED

(1) Remove the cluster lens and gauge bezel. If equipped with trip odometer, gently pull the knob of the trip odometer push pin.

(2) Remove five attaching screws from rear of the mounting bezel.

(3) Remove the tachometer assembly including the circuit board assembly.

(4) Install the tachometer. Install the attaching screws.

(5) Install the gauge bezel and lens.

(6) Install knob on trip odometer push pin.

PRINTED CIRCUIT BOARD REPLACEMENT—INSTRUMENT CLUSTER REMOVED

Disassembly (Fig. 2)

(1) Remove all attaching screws for gauges, tachometer, low fuel warning module and speedometer that are contacting the printed circuit board.

(2) Remove the lamp sockets from the circuit board.

(3) Remove the printed circuit board.

There is a separate printed circuit board for the warning lights that is removed by removing the lamp sockets.

Assembly

(1) Position the printed circuit board on the back of the instrument panel cluster.

(2) Remove gauge bezel and lens.

(3) Restrain the gauges, tachometer, speedometer and low fuel warning module.

(4) Install the lamp sockets.

(5) Connect the circuit board ground clip screw at the back of the speedometer housing.

(6) Install the gauge bezel and cluster lens.

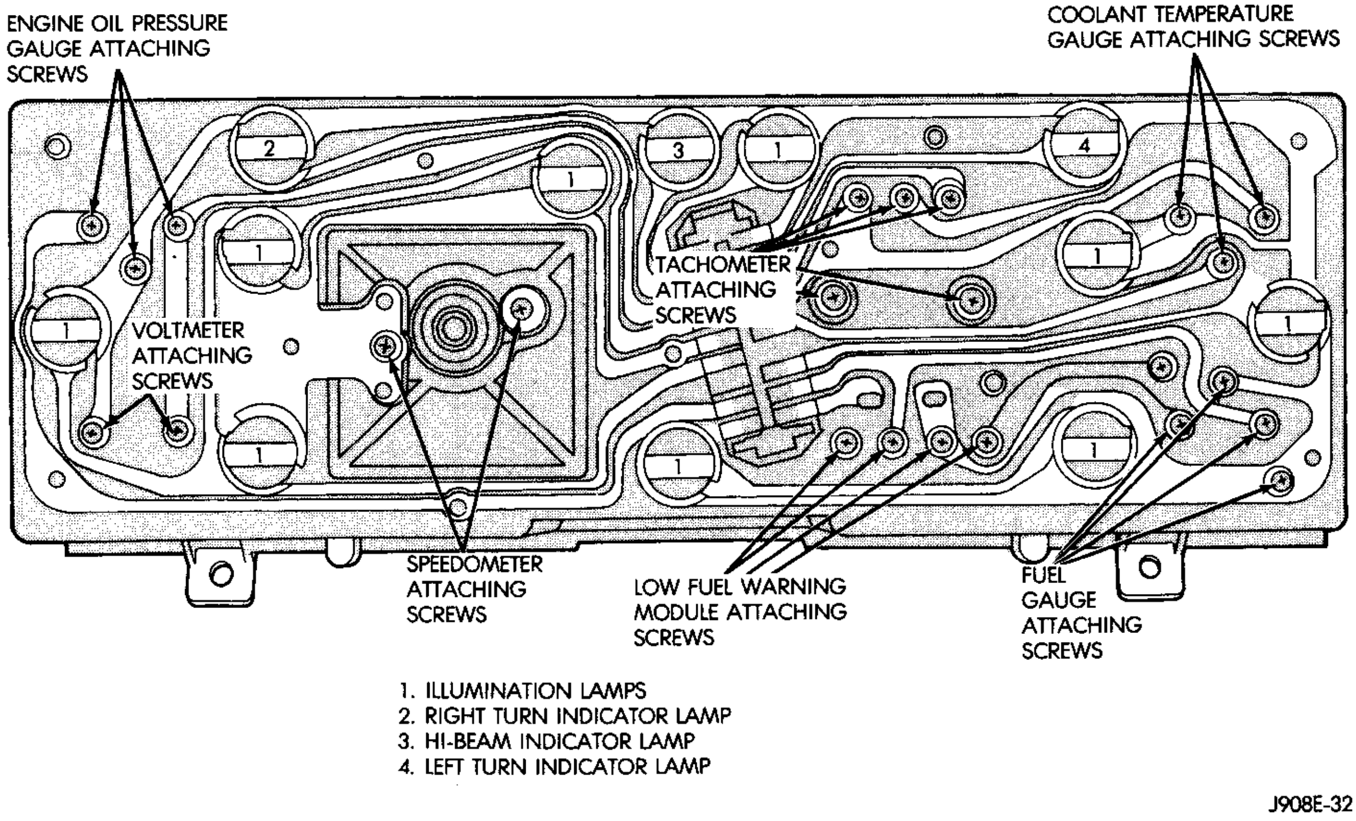


Fig. 2 Printed Circuit Board Removal/Installation

LOW FUEL WARNING MODULE REPLACEMENT—INSTRUMENT CLUSTER REMOVED

(1) Remove tachometer (refer to Tachometer Replacement).

(2) Remove 4 attaching screws from rear of mounting bezel.

(3) Remove module.

(4) Install new module using the attaching screws.

(5) Install tachometer.

GEAR SELECTOR INDICATOR REPLACEMENT—INSTRUMENT CLUSTER REMOVED

(1) Remove the screws from rear of mounting bezel holding Fuel Gauge in place.

(2) Remove 2 screws holding the gear selector indicator (Fig. 3).

(3) Pull the cable and clip through the hole in the mounting bezel and remove the indicator.

(4) To install the indicator, place the transmission in Park.

(5) Align the pointer on the indicator with the Park position.

(6) Install the indicator and cluster.

(7) Install the clip to the steering column shroud.

(8) Move the transmission shift lever to check proper alignment.

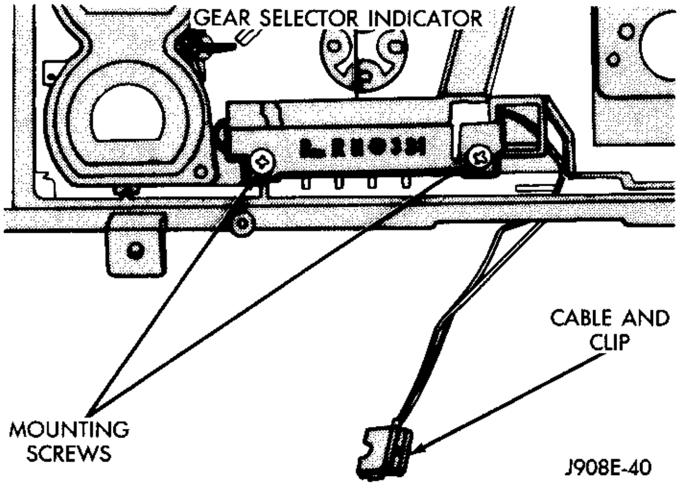


Fig. 3 Gear Selector Indicator

INSTRUMENT CLUSTER REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove the four instrument panel bezel attaching screws and remove the instrument panel bezel. Bezel is snap fit at locations shown (Fig. 4).

(3) Remove the cigar lighter housing attaching screws (Fig. 5).

(4) Remove the switch housing attaching screws (if equipped).

(5) Remove the instrument panel cluster attaching screws.

(6) Raise and support vehicle.

(7) Carefully remove the spring nut holding the speedometer cable in position on the driver's side upper control arm bolt (Fig. 6).

(8) Disconnect the speedometer cable from the cluster by squeezing the cable end and pulling.

(9) Pull out the cluster assembly far enough to disconnect the two multiple plugs (Fig. 7) and remove the instrument cluster.

To install the cluster, reverse the removal procedures.

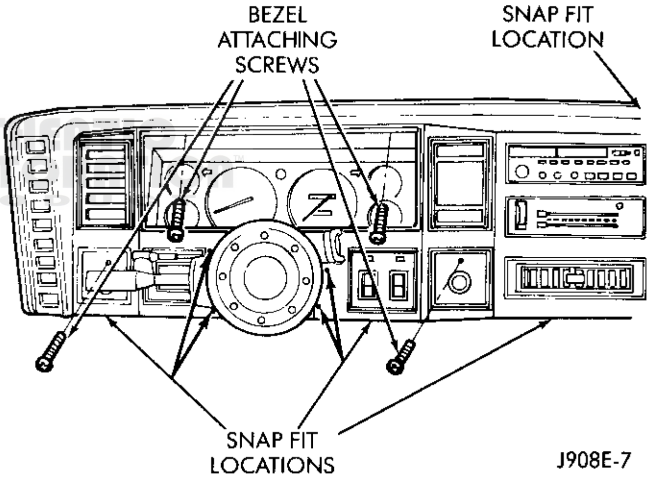


Fig. 4 Instrument Bezel Removal/Installation—XJ and MJ

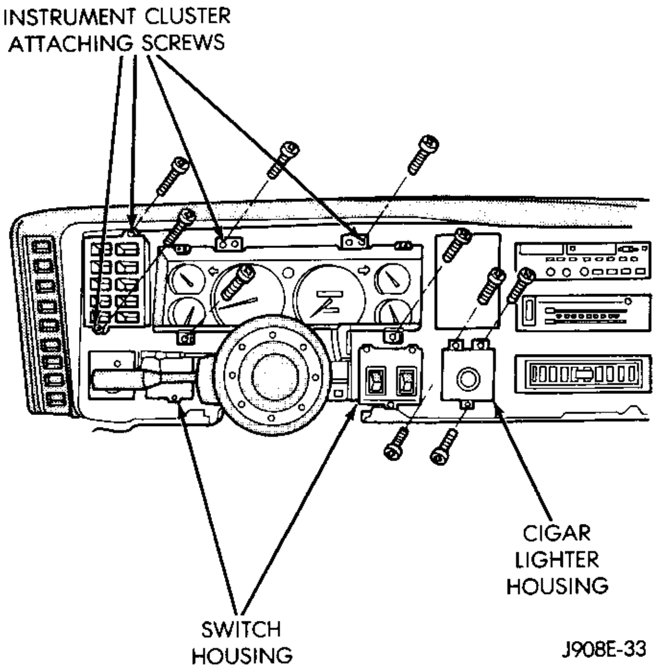


Fig. 5 Instrument Cluster Removal/Installation—XJ and MJ

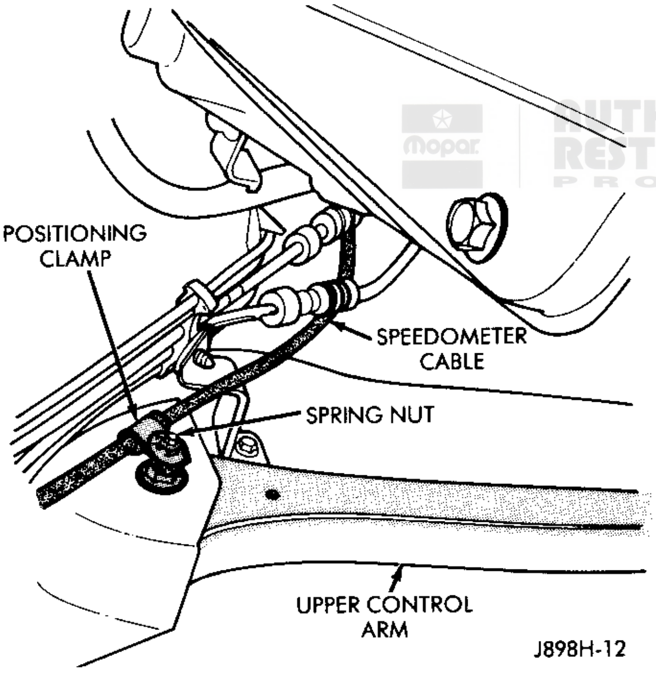


Fig. 6 Remove Speedometer Cable Positioning Clamp

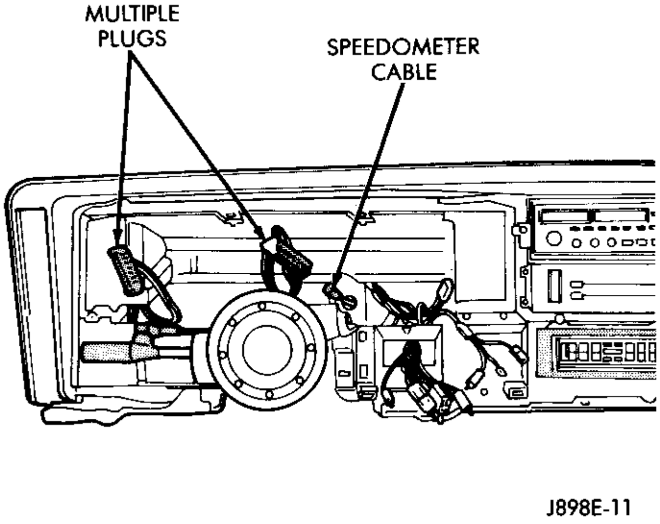


Fig. 7 Disconnect/Install Speedometer Cable and Multiple Plugs

INSTRUMENT PANEL REPLACEMENT (Fig. 8)

(1) Disconnect the battery negative cable.

(2) Remove the:

- Parking brake release handle
- lower heat/AC duct below steering column
- ash receiver
- lower instrument panel (Fig. 9)
- cluster bezel
- cluster assembly
- clock (if equipped)
- radio and heater control panel
- instrument panel switches
- headlamp switch
- antenna connector
- blower motor resistors
- ground lead
- disconnect glove box light
- defroster cowl panel

It may be necessary to remove the driver's side heat/AC outlet to gain access to the left hand defroster cowl panel retaining clip to aid in removal (Fig. 10).

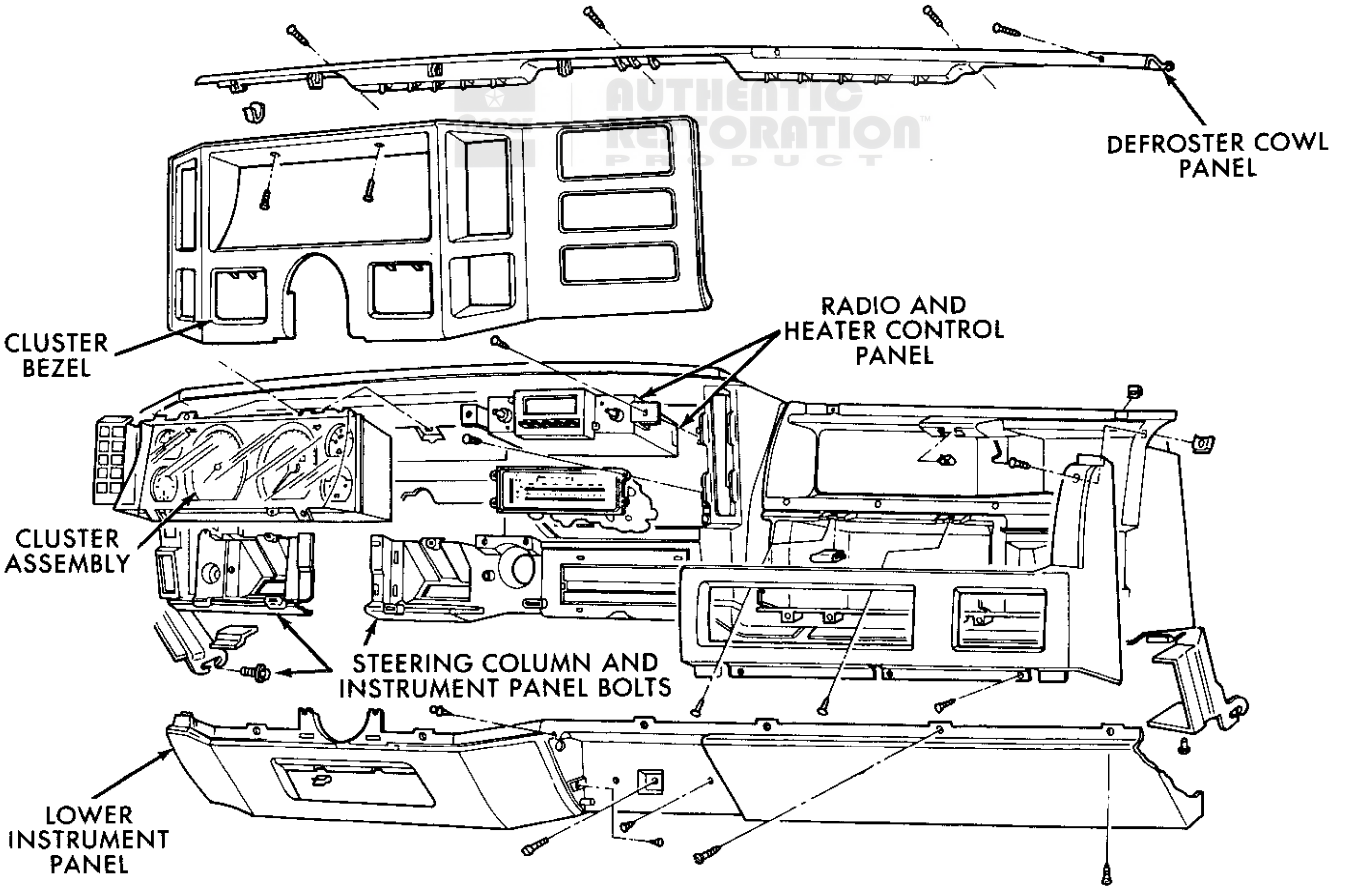
- instrument panel attaching bolts
- steering column attaching bolts
- instrument panel assembly

The instrument panel wiring harness is attached to the back of the instrument panel assembly and must be installed in similar fashion to facilitate installation.

(3) To install the instrument panel, position the instrument panel assembly on side mounting bolts (Fig. 11).

(4) Route the wiring harnesses and secure the instrument panel assembly mounting points.

(5) Reverse the removal procedures.



J898E-38

Fig. 8 Instrument Panel Exploded View

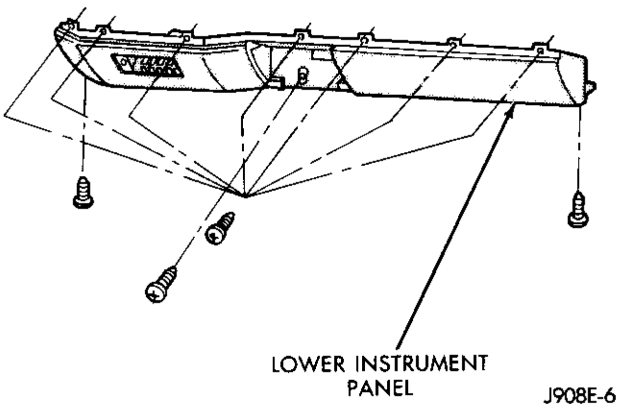


Fig. 9 Lower Instrument Panel Removal/Installation

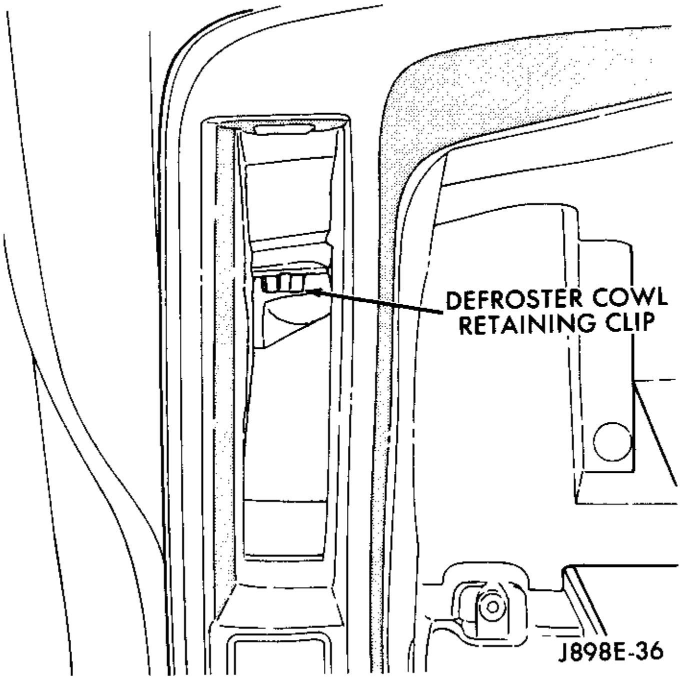


Fig. 10 Driver's Side Defroster Cowl Retaining Clip

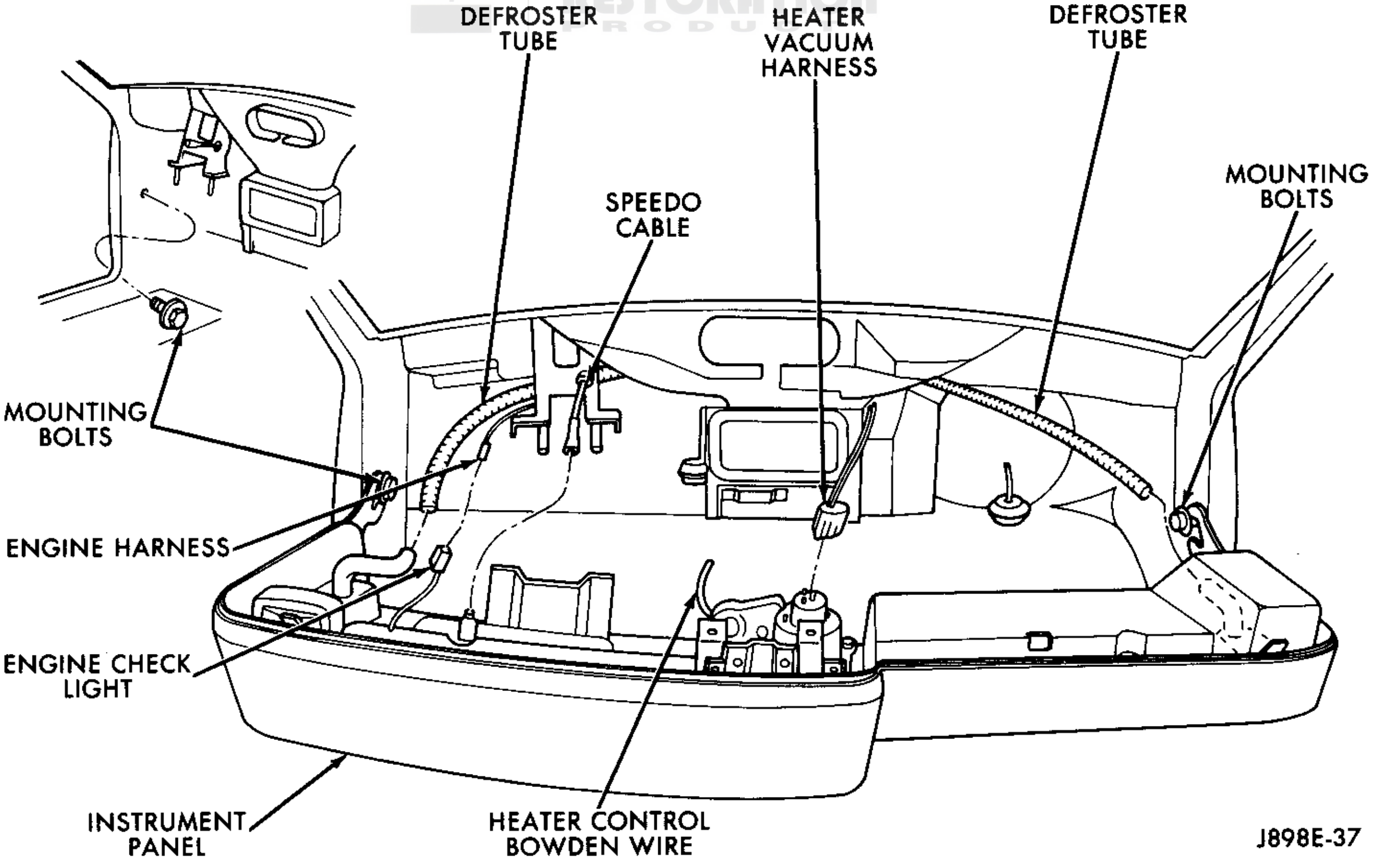
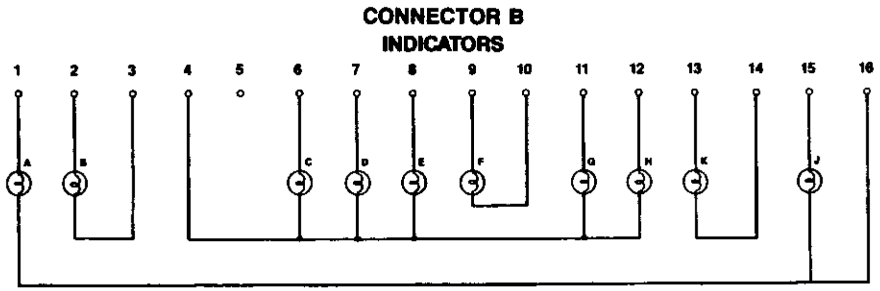
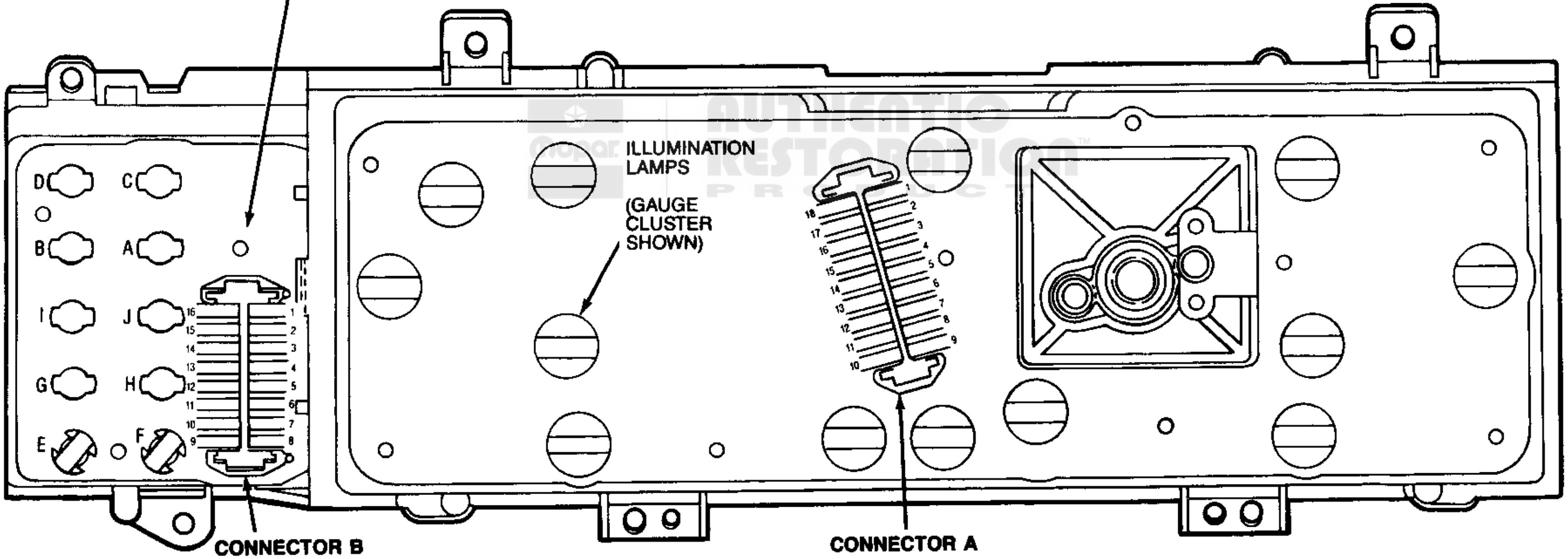


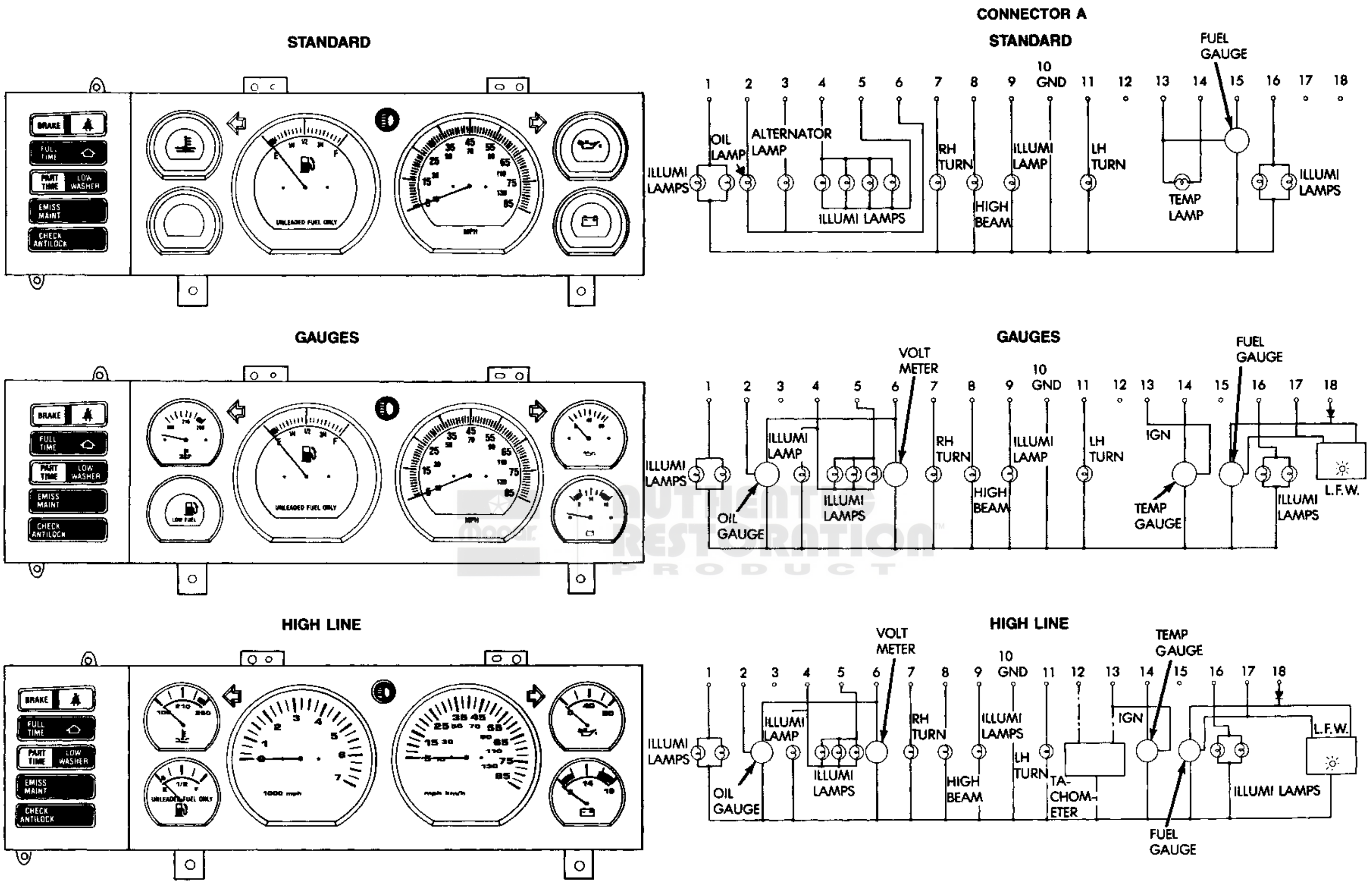
Fig. 11 Instrument Panel Installation

TER-MINAL	LAMP	
1	A	BLANK
2	B	CHECK ENGINE
3	B	CHECK ENGINE
4	—	IGN. FEED
5	—	ALT. FEED
6	C	BLANK
7	D	ANTILOCK
8	E	BRAKE
9	F	SEAT BELT
10	F	SEAT BELT
11	G	FULL TIME
12	H	SHIFT LAMP
13	K	PART TIME
14	K	PART TIME
15	J	LOW WASHER
16	—	GROUND





J898E-34


STANDARD
BRAKE
FULL TIME
PART TIME
LOW WASHER
EMISS MAINT
CHECK ANTILOCK
UNLEADED FUEL ONLY
MPH
CONNECTOR A
STANDARD
1 2 3 4 5 6 7 8 9 10 GND 11 12 13 14 15 16 17 18
ILLUMI LAMPS
OIL LAMP
ALTERNATOR LAMP
ILLUMI LAMPS
RH TURN
HIGH BEAM
ILLUMI LAMP
LH TURN
FUEL GAUGE
TEMP LAMP
ILLUMI LAMPS
GAUGES
LOW FUEL
GAUGES
1 2 3 4 5 6 7 8 9 10 GND 11 12 13 14 15 16 17 18
ILLUMI LAMPS
OIL GAUGE
ILLUMI LAMP
ILLUMI LAMPS
VOLT METER
RH TURN
HIGH BEAM
ILLUMI LAMP
LH TURN
IGN
TEMP GAUGE
FUEL GAUGE
ILLUMI LAMPS
L.F.W.
HIGH LINE
1000 rpm
mph km/h
HIGH LINE
1 2 3 4 5 6 7 8 9 10 GND 11 12 13 14 15 16 17 18
ILLUMI LAMPS
OIL GAUGE
ILLUMI LAMP
ILLUMI LAMPS
VOLT METER
RH TURN
HIGH BEAM
ILLUMI LAMPS
LH TURN
TACHOMETER
IGN
TEMP GAUGE
FUEL GAUGE
ILLUMI LAMPS
L.F.W.

J908E-34

YJ

INDEX

GENERAL

The gauge package contains four gauges and the clock. The gauges have a common battery feed from the gauges fuse and ignition switch. The clock is separately powered through the dome/courtesy fuse which receives constant battery feed through a fuse link. Although they have separate power sources, the four gauges and clock do share a common ground connection.

The voltmeter indicates electrical system voltage. When the engine is not running, the voltage registered is from the battery. After the engine is started, charging system voltage is indicated, In the gauge package, the voltmeter forms a parallel connection across the battery feed and ground.

The remaining gauges - oil pressure, fuel and coolant temperature - are connected to individual sender units. Variable resistors in the senders will change the amount of current allowed to flow through the gauge coils. As current flow through the coils varies, the position of the indicator needle will also vary.

The four gauges and the clock are connected to battery feed, ground and the sender units through a printed circuit mounted on the back of the gauge housing.

TROUBLESHOOTING GAUGE PACKAGE

All Gauges Inoperative

1. FUSE: Turn ignition switch to Run

TEST	OK	NOT OK
Gauges fuse	Not blown	Replace fuse
Measure voltage at battery side of gauges fuse	Battery voltage	Repair open from ignition switch

2. GAUGE PACKAGE GROUND: Separate Instrument Cluster connector from gauge package

TEST	OK	NOT OK
Measure resistance from Instrument Cluster connector terminal 3 to a clean chassis ground	Zero ohms	Repair open to ground

3. GAUGE PACKAGE: Turn ignition switch to RUN

TEST	OK	NOT OK
Measure voltage at instrument cluster connector terminals 2 & 5	Battery voltage	Repair open from fuse panel

If the voltmeter and oil pressure gauges are inoperative, an open exists in the jumper wire from gauge package terminal 2 to 5

Clock Inoperative

1. FUSE

TEST	OK	NOT OK
Inspect Dome/Courtesy fuse	Not blown	Replace fuse
Measure voltage at battery side of fuse	Battery voltage	Repair open from fuse link

2. PRINTED CIRCUIT/CLOCK: Separate Instrument Cluster connector from gauge package

TEST	OK	NOT OK
Measure voltage at instrument cluster connector terminal 7	Battery voltage	Repair open from fuse panel
Measure resistance from gauge package terminal 7 to clock battery terminal	Zero ohms	Replace/repair printed circuit
Measure resistance from clock ground terminal to gauge package terminal 3	Zero ohms	Replace/repair printed circuit If zero ohms replace clock

One Gauge Inoperative

NOTE: Does not apply to voltmeter

1. OIL PRESSURE SENDER: Turn ignition switch to RUN; separate oil pressure sender connector from oil pressure sender

TEST	OK	NOT OK
Measure voltage at oil pressure sender connector	Approximately 7.5 volts	Repair open from gauge package or printed circuit If 7.5 volts, replace sender

2. COOLANT TEMPERATURE SENDER: Turn ignition switch to RUN; separate coolant temperature sender connector from coolant temperature sender

TEST	OK	NOT OK
Measure voltage at coolant temperature sender connector	9 volts	Repair open from gauge package or printed circuit If 9 volts, replace sender

FUEL GAUGE SENDER: Turn ignition switch to RUN; separate fuel gauge sender connector from fuel gauge sender

TEST	OK	NOT OK
Measure voltage at fuel gauge sender connector terminal B	Approximately 7.5 volts	Repair open from gauge package or printed circuit
Measure resistance from fuel gauge sender connector terminal A to a clean chassis ground	Zero ohms	Repair open from fuel gauge sender connector to ground If zero ohms, replace sender

PRINTED CIRCUIT: Turn ignition switch to RUN; separate gauge package connector from gauge package Includes voltmeter sender unit

TEST	OK	NOT OK
Measure resistance from gauge package terminal 2 (fuel and coolant temp gauge) or from terminal 5 (voltmeter and oil pressure gauge) to gauge battery terminal	Zero ohms	Replace/repair printed circuit
Measure resistance from gauge package terminal 3 to gauge ground terminal	Zero ohms	Replace/repair printed circuit If zero ohms, replace gauge

GAUGE CALIBRATION VALUES

TEST	OK	NOT OK
Using the following charts, the calibration of the gauge can be checked	Indicator needle in correct position	Replace gauge

OIL PRESSURE GAUGE CALIBRATION

POINTER POSITION	RESISTANCE
0 psi Grad. ± 3.6°	1 ohm
40 psi Grad. ± 3.6°	46 ohms
80 psi Grad. ± 3.6°	90 ohms

TEMPERATURE GAUGE CALIBRATION

POINTER POSITION	RESISTANCE
180°F Grad. ± 3.6°	298 ohms
210°F Grad. ± 3.6°	185 ohms
240°F Grad. ± 3.6°	108 ohms

FUEL GAUGE CALIBRATION

POINTER POSITION	RESISTANCE
Empty Grad. $^{+0^\circ}_{-3.6^\circ}$	0 ohms
1/2 Full Grad. ± 3.6°	44 ohms
Full Grad. ± 3.6°	89 ohms

VOLTMETER CALIBRATION

VOLTAGE INPUT	POINTER POSITION
8V ± .5V	8V Grad.
14V ± .5V	14V Grad.
16V ± .75V	16V Grad.

J908E-35

Fig. 1 Gauge Specifications

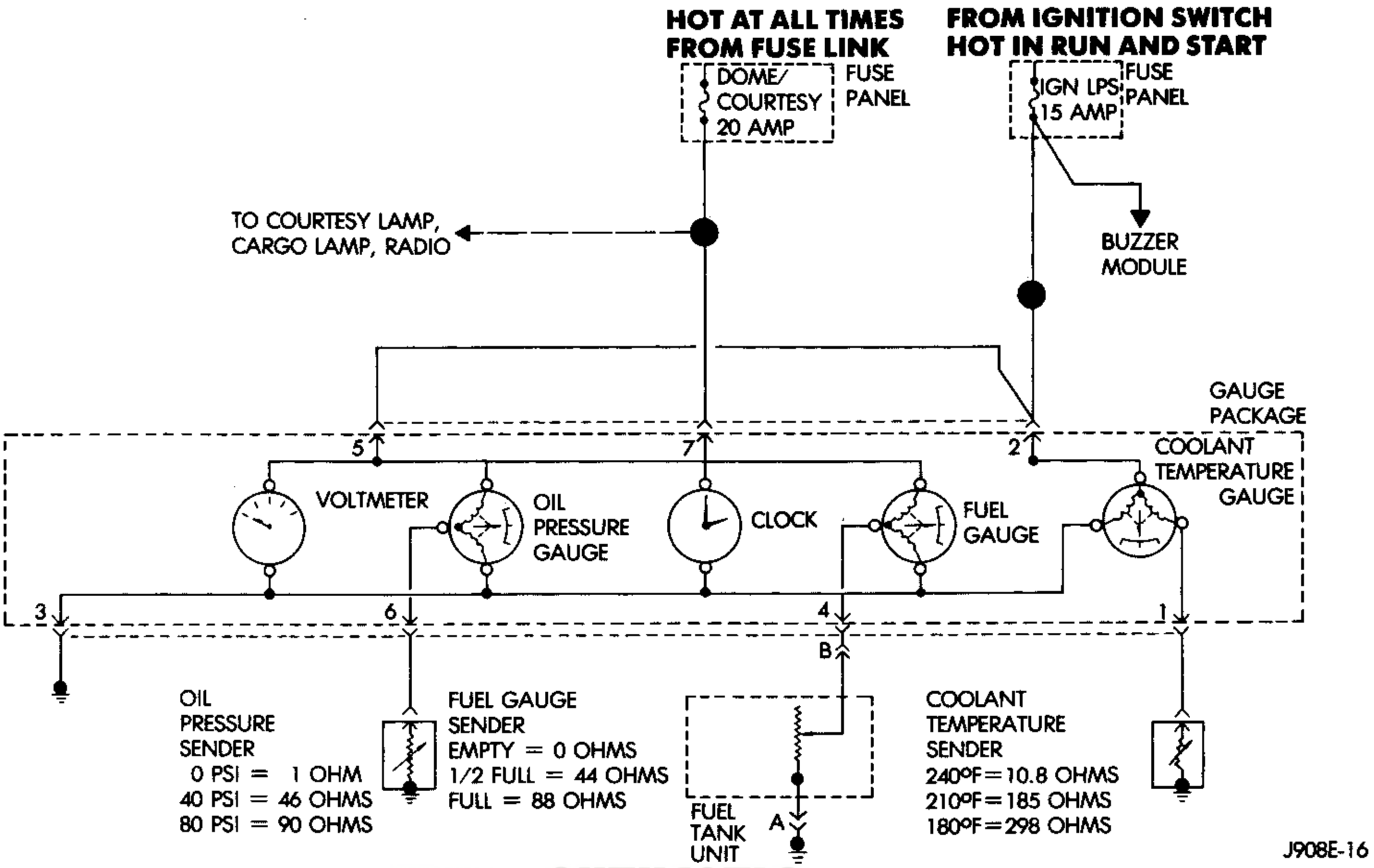


Fig. 2 Gauge Package Wiring Schematic—YJ

INDICATOR LAMPS

Description

The brake, upshift (2.5L engine with 5 speed transmission) (except California) and 4WD lamps are located in the indicator lamp panel above the steering column. The lamps share a common battery feed connection through the ignition switch and gauges fuse. Switches in series with ground circuits complete the indicator lamp circuit.

The 4WD indicator lamp circuit is completed by the Command Trac switch located below the battery. When vacuum is applied to the axle mounted shift motor, it is also applied to the Command Trac switch.

The upshift switch is normally closed to complete the circuit from the lamp to the electronic control module. Since further shifts are no longer possible in fifth gear, the switch is opened to prevent operation of the lamp. With a completed circuit the indicator lamp will be illuminated by the ECU. The numerous inputs received by the ECU enable it to indicate through the lamp the best time to upshift to a higher gear. The upshift lamp is turned off after a time delay if the indicated shift is not performed.

The brake indicator is a dual function lamp. It will indicate an unequal pressure condition in the brake hydraulic system and it will also indicate when the parking brake is engaged. Separate switches are used for each indicator lamp function. A switch mounted ion the brake pedal assembly will close a ground circuit whenever the parking brakes are applied. A second switch is installed in the brake hydraulic lines near the master cylinder. If the switch is balanced by equal pressure on both ends of the switch valve, the valve remains centered and the lamp remains off. If the valve is shifted by unequal pressure between the front or rear brake hydraulic systems, the lamp circuit is connected to ground. To make sure the brake lamp is functional before the vehicle is driven, it is illuminated through a ground circuit when the ignition switch is turned to the START position.

The emission maintenance timer is a switching device that is used to inform the driver when the emission system requires service. After approximately 2700 engine operating hours, the switch closes and provides a ground for the EMISSION MAINTENANCE lamp in the indicator lamp panel.

Troubleshooting—All Lamps Out

FUSE: Turn ignition switch to RUN

TEST	OK	NOT OK
Inspect Gauges fuse	Not blown	Replace fuse
Measure voltage at battery side of fuse	Battery voltage	Repair open from ignition switch
Measure voltage at Connector A terminal 5	Battery voltage	Repair open from fuse panel

Troubleshooting—One Lamp Out

1. BULB

TEST	OK	NOT OK
Measure resistance across bulb terminals	Zero ohms (except filament resistance)	Replace bulb

2.BULB SOCKET: Ignition in RUN

TEST	OK	NOT OK
Measure voltage at ground side of bulb	Battery voltage	Repair open from fuse panel
Measure voltage at battery side of bulb socket	Battery voltage	Replace/repair printed circuit

Troubleshooting—4WD Lamp Out

1. VACUUM SOURCE: Engine running; Command Trac switch in 4WD

TEST	OK	NOT OK
Check for vacuum supply to switch	Vacuum present	Repair as necessary

2. COMMAND TRAC SWITCH: Engine running; Command Trac switch 4WD; Command Trac Switch connector separated from switch

TEST	OK	NOT OK
Measure voltage at Command Trac switch connector	Battery voltage	Repair open from printed circuit
Measure resistance from switch housing to ground	Zero ohms	Clean ground connection If zero ohms, replace switch

Troubleshooting-Upshift Lamp Out

1. UPSHIFT LAMP SWITCH CIRCUIT: Ignition in RUN

TEST	OK	NOT OK
Connect a jumper wire from diagnostic connector terminal D2-1 to a clean chassis ground	Lamp ON	Lamp OFF; proceed to upshift lamp switch test Lamp ON; test ECU

2. UPSHIFT LAMP SWITCH: Ignition in RUN; transmission in 1st gear; jumper removed

TEST	OK	NOT OK
Measure voltage at upshift switch connector terminal A	Battery voltage	Repair open from printed circuit
Measure voltage at upshift switch connector terminal B	Battery voltage	Replace switch If battery voltage, repair open to ECU terminal 18

Troubleshooting-Brake Lamp Out

1. PARK BRAKE SWITCH: Ignition in RUN; parking brake applied; park brake switch connector separated from switch

TEST	OK	NOT OK
Connect a jumper between park brake switch connector and ground	Lamp ON	Lamp ON; replace switch Lamp OFF; repair open from ignition switch

2. BRAKE PRESSURE WARNING SWITCH: Ignition in RUN

TEST	OK	NOT OK
Measure voltage at brake pressure warning switch connector terminal B	Battery voltage	Repair open from printed circuit
Measure voltage at brake pressure warning switch connector terminal A	Battery voltage	Replace switch
Measure voltage at ignition switch connector terminal G1	Battery voltage	Repair open from brake pressure warning switch If battery voltage, replace ignition switch

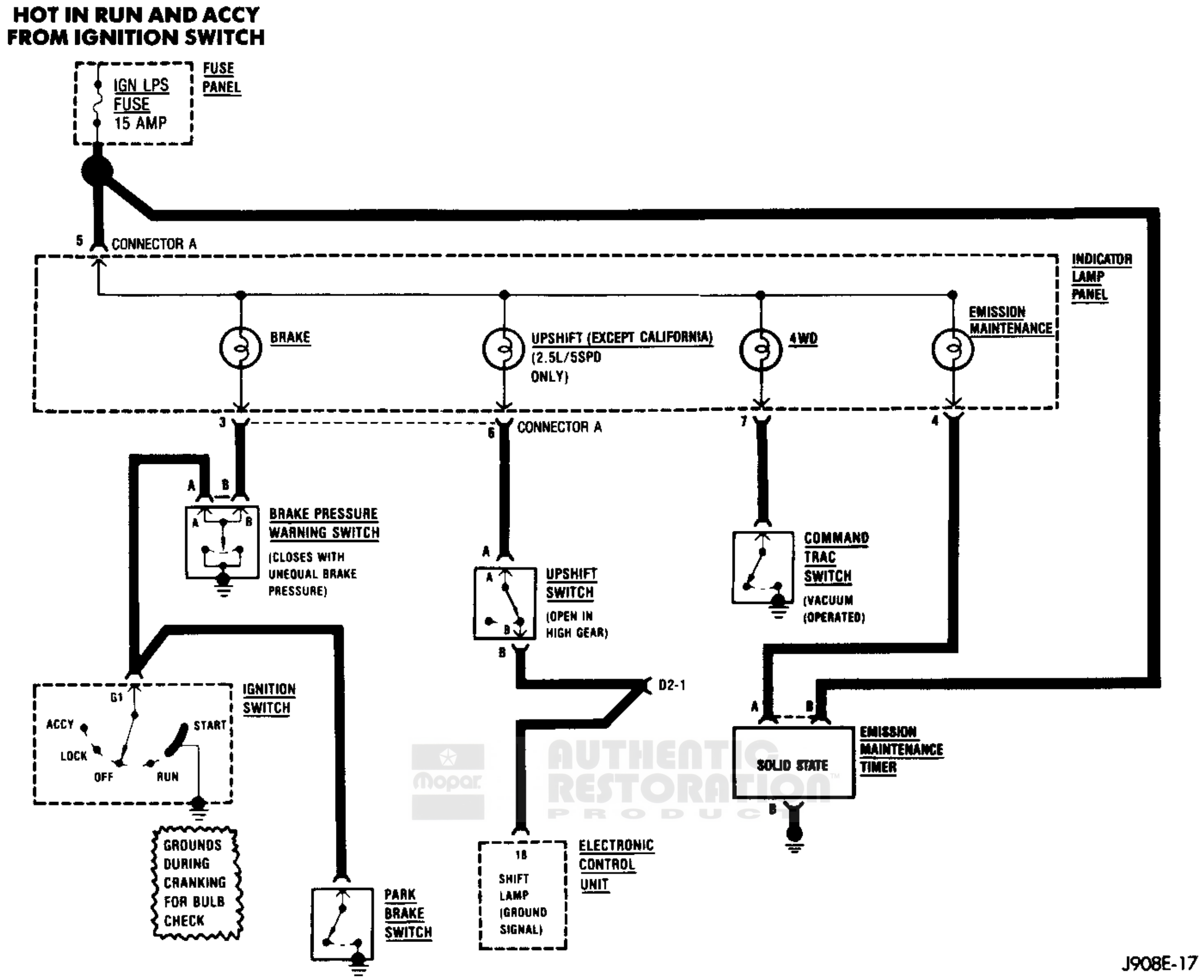


Fig. 3 Indicator Lamps Schematic

INSTRUMENT PANEL ILLUMINATION LAMPS

The instrument panel illumination lamps share two common connections. There is a splice after the ACCY Lamps fuse that connects the lamps to battery feed. There is also a splice that connects all lamps to ground. Because they share these common connection points in a parallel circuit, the illumination lamps will all come on at the same time. It also means one or more lamps can be out without affecting the operation of the other lamps.

On the battery side of the circuit, the headlamp switch illumination rheostat/switch and panel lamps fuse receive battery feed in series from the park/tail fuse. In the park lamp position, the headlamp switch completes the circuit from the park/tail fuse to the illumination rheostat/switch and panel lamps fuse.

The illumination rheostat contains a variable resistor that allows the driver to vary illumination intensity from off to full brightness.

Troubleshooting One Lamp Out

BULB, BULB SOCKET: Headlamp switch in HEAD for voltage tests; headlamp switch OFF for resistance tests; illumination rheostat/switch ON; indicator lamp panel connector separated from indicator panel

TEST	OK	NOT OK
Measure resistance across bulb terminals	Zero ohms (except filament resistance)	Replace bulb
Measure voltage at battery side of bulb terminal	Battery voltage	Replace printed circuit
Measure resistance from ground side of bulb terminal to indicator lamp panel terminal 3	Zero ohms	Replace printed circuit

Troubleshooting One Lamp Out

BATTERY FEED, GROUND: Headlamp switch in HEAD for voltage tests; headlamp switch OFF for resistance tests; illumination rheostat/switch ON

TEST	OK	NOT OK
Measure voltage at indicator lamp panel connector terminal 10	Battery voltage	Repair open from fuse panel
Measure voltage at indicator lamp panel connector terminal 12	Battery voltage	Repair open from fuse panel
Measure resistance from indicator lamp panel connector terminal 3 to a clean chassis ground	Zero ohms	Repair open between indicator lamp panel connector and ground

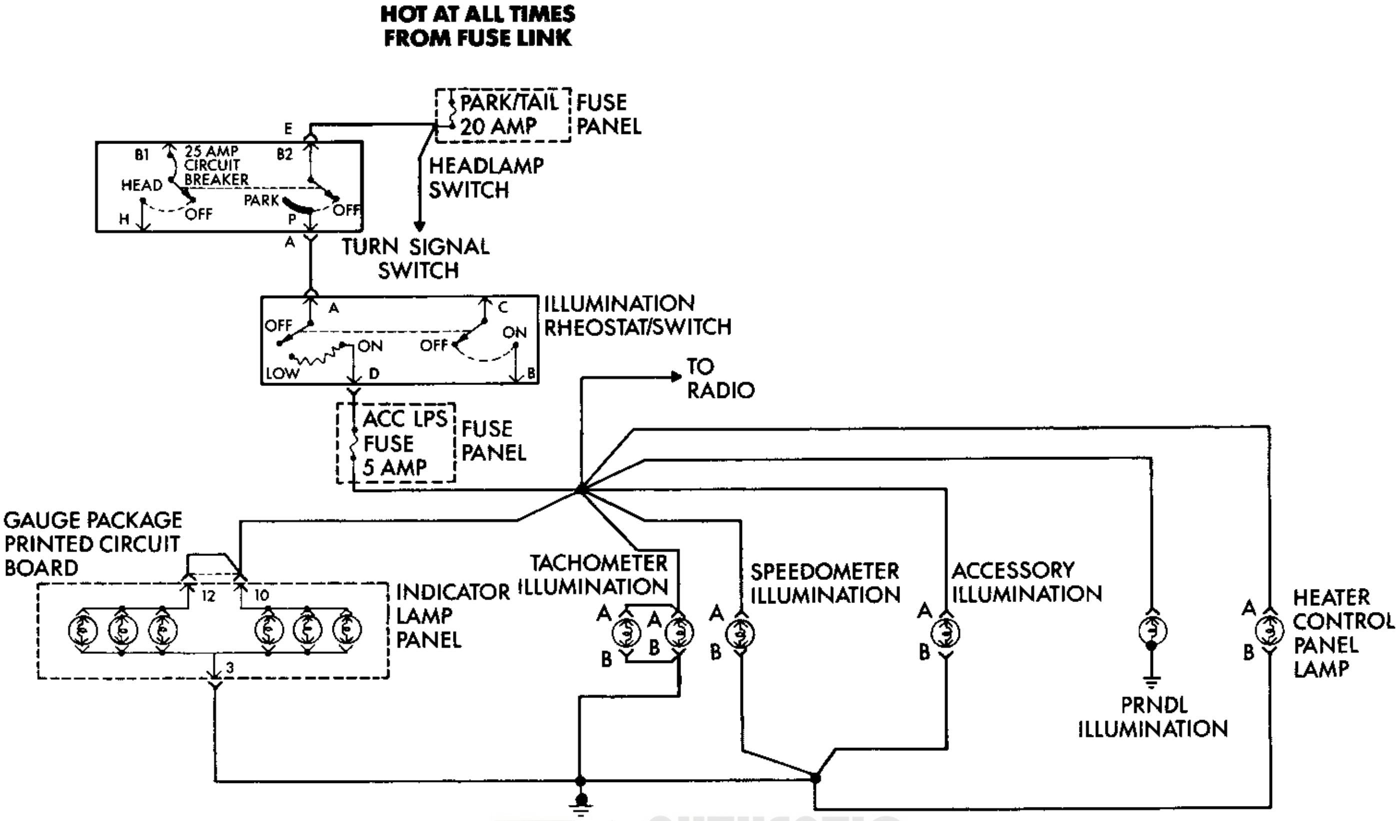
Troubleshooting All Lamps Out

FUSE: Headlamp switch ON; illumination rheostat/switch ON

TEST	OK	NOT OK
Inspect fuses	Not blown	Replace fuse
Measure voltage at battery side of panel lamps fuse	Battery voltage	Repair open from illumination rheostat/switch

ILLUMINATION RHEOSTAT/SWITCH: Headlamp switch ON; illumination rheostat/switch ON

TEST	OK	NOT OK
Check operation of taillamps	Taillamps ON	Test headlamp switch
Measure voltage at illumination rheostat/switch connector terminal D	Battery voltage	Replace rheostat/switch



J908E-10

Fig. 4 Instrument Panel Illumination Schematic

EMISSION MAINTENANCE TIMER REPLACEMENT

The emission maintenance timer is mounted on the dash panel to the right of the accelerator pedal. Refer to Group 25 for replacement instructions.

GAUGE CLUSTER REPLACEMENT

(1) Remove the six bezel screws (Fig. 6).

(2) Remove the six gauge housing mounting screws (Fig. 7).

(3) Disconnect the connector from the cluster.

(4) To install, reverse the removal procedure.

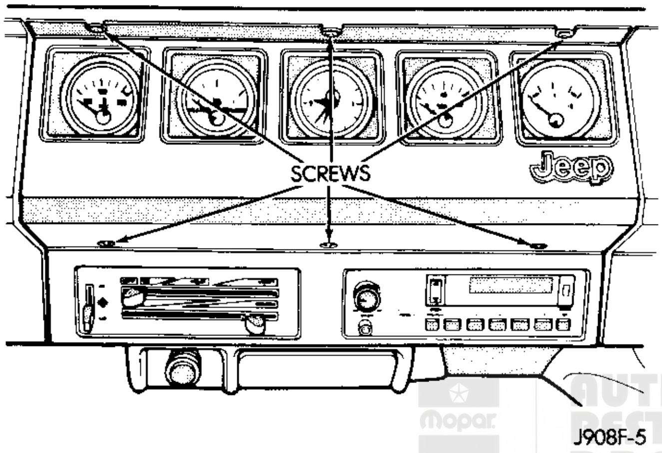


Fig. 6 Gauge Cluster Bezel Removal/Installation

INSTRUMENT PANEL GAUGE REPLACEMENT

This procedure is to be performed with the gauge cluster removed.

(1) Remove the plastic shield by releasing the seven plastic tabs with a screwdriver (Fig. 7).

(2) Remove metal shield.

(3) Completely remove gauge nut.

(4) To install, insert gauge into housing.

(5) Place gauge contact pins over gauge screw. The gauge contact pins will automatically be driven into gauge when gauge nut is tightened.

(6) Install metal shield.

(7) Install plastic shield.

CLOCK REPLACEMENT

This procedure is to be performed with the gauge cluster removed.

(1) Remove plastic shield by carefully releasing the seven plastic clips with a screwdriver (Fig. 7).

(2) Remove metal shield.

(3) Remove clock mounting screws.

Contact springs may fall out if gauge cluster is not held upright.

(4) Remove clock from gauge housing.

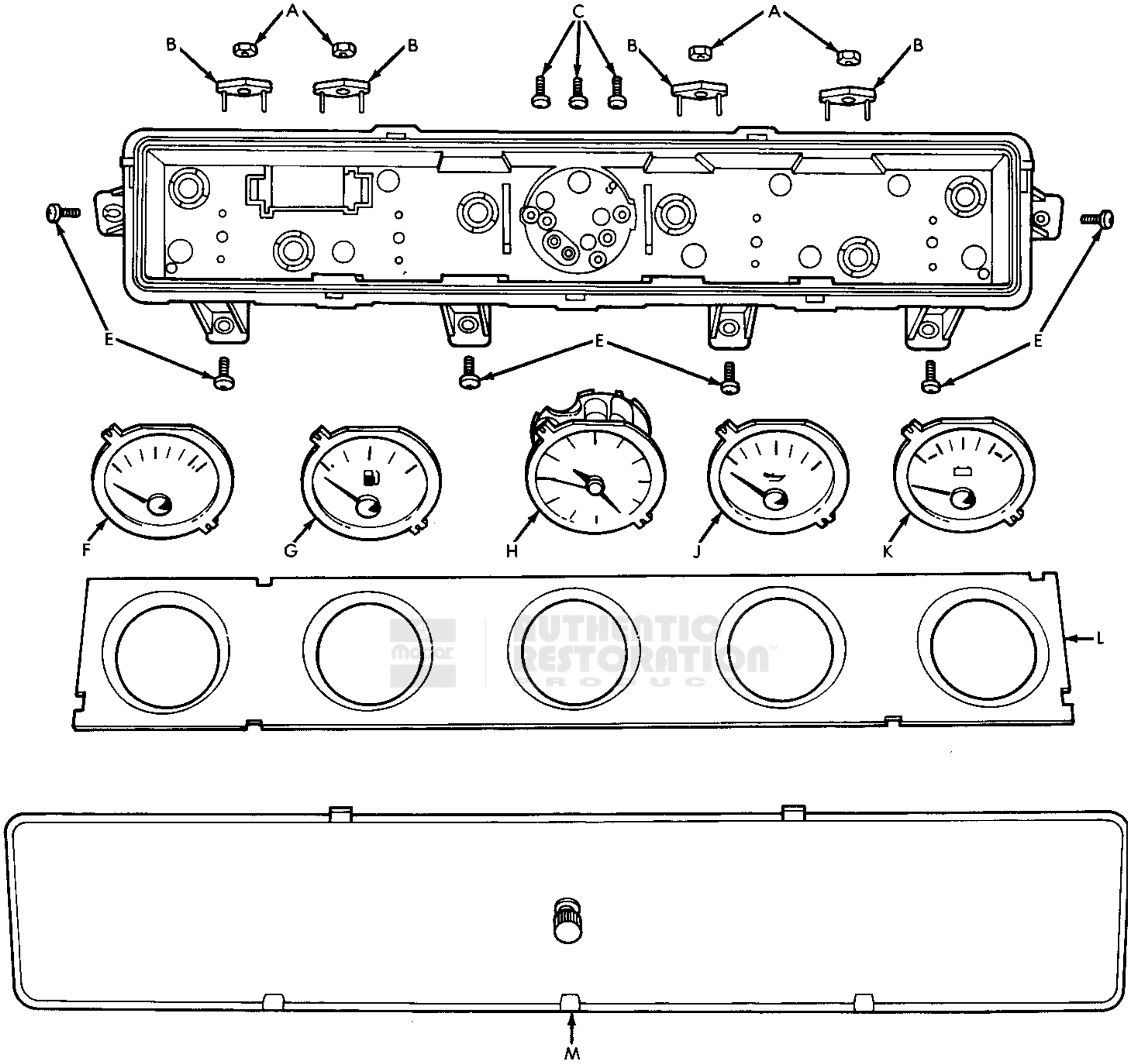
(5) To install, make sure contact springs are in position.

(6) Place clock into gauge housing.

(7) Install the clock mounting screws.

(8) Install metal shield.

(9) Install plastic shield.



A. GAUGE NUT(S)
B. GAUGE CONTACT PINS
C. CLOCK SCREW(S)
D. CONTACT SPRING(S)
E. GAUGE HOUSINGS MOUNTING SCREWS
F. COOLANT TEMPERATURE GAUGE
G. FUEL GAUGE
H. CLOCK
J. OIL PRESSURE
K. VOLTMETER
L. METAL SHIELD
M. PLASTIC SHIELD

J898E-14

Fig. 7 Gauge Cluster—Exploded View

INSTRUMENTATION SHROUD REPLACEMENT

(1) Remove six shroud screws (Fig. 8).

(2) Slide the shroud towards the steering wheel.

(3) Pull accessory illumination bulb socket out of bulb retainer (Fig. 9).

(4) Apply upward pressure to the shroud and downward pressure to the indicator panel. This will release the holding tabs (Fig. 10).

(4) Place the shroud under the steering column.

(5) Slide the indicator panel tabs into the shroud notches.

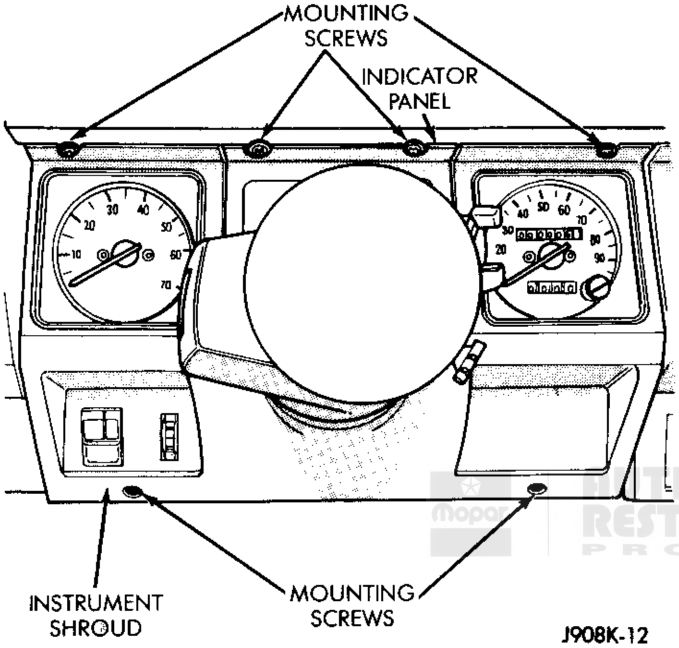


Fig. 8 Instrument Shroud Removal/Installation

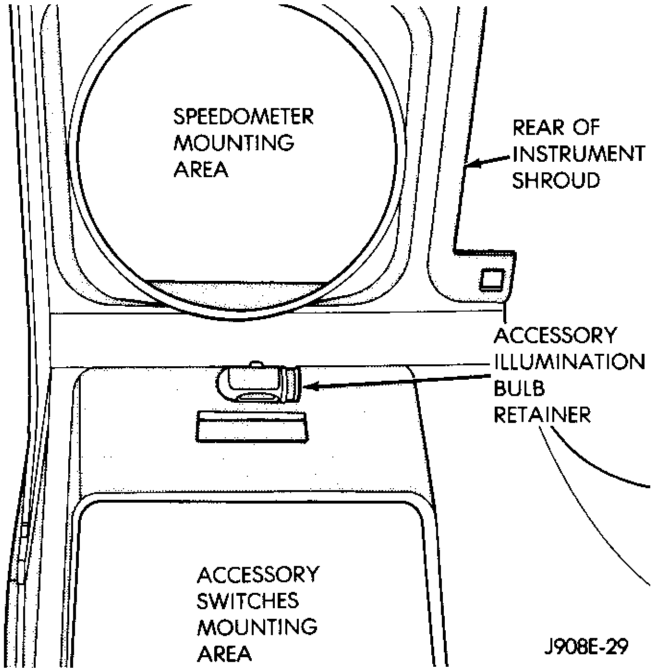


Fig. 9 Accessory Illumination Bulb Mounting

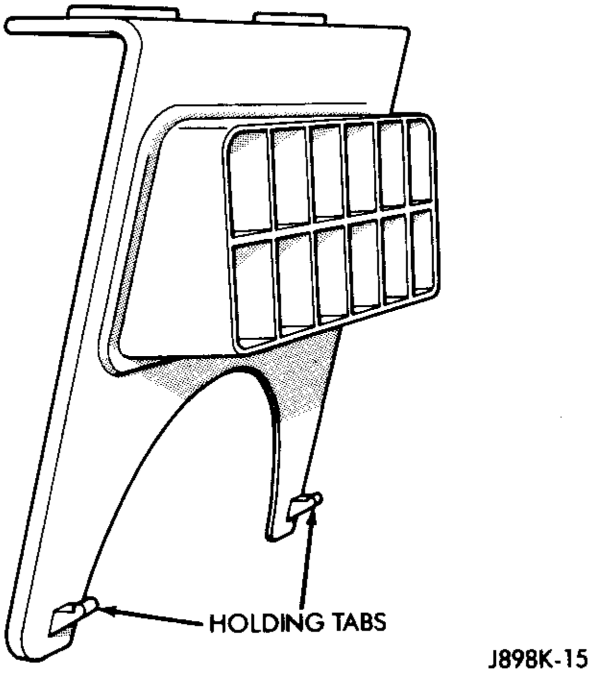


Fig. 10 Indicator Panel

(6) Place the assembled shroud over the indicator lamp foam gasket and tighten the indicator panel screws.

A fragile foam gasket is on the back of the indicator overlay. If the gasket is torn or distorted, replace with a new gasket.

(7) Install remaining four screws.

INDICATOR BEZEL REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove instrumentation shroud (Fig. 8). Refer to Instrumentation Shroud Replacement.

(3) Remove five bezel screws (Fig. 11).

(4) Disconnect two indicator connectors.

(5) To install, be sure the indicator wires are not pinched behind the bezel and install five bezel screws.

(6) Install the shroud as described in Instrumentation Shroud Replacement.

(7) Connect battery negative cable.

HEADLAMP SWITCH/ILLUMINATION RHEOSTAT/TACHOMETER/SPEEDOMETER REPLACEMENT

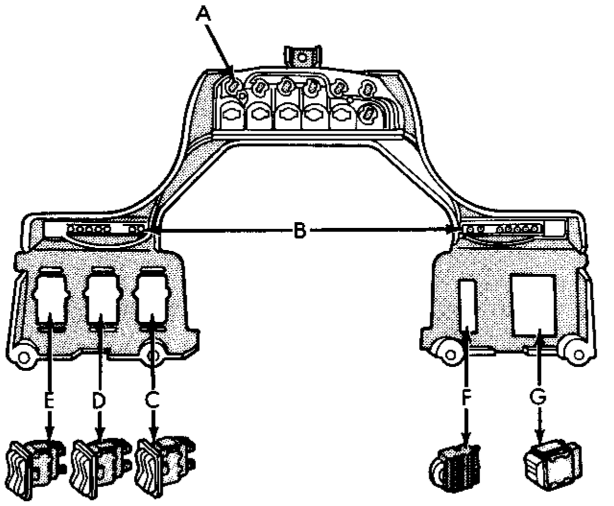
(1) Disconnect battery negative cable.

(2) Remove instrumentation shroud (Fig. 8). Refer to Instrumentation Shroud Replacement.

(3) Remove two screws from the item to be replaced (Figs. 12,13).

(4) Remove the switch connector,lead or cable.

(5) Reverse the removal procedures for installation. Refer to Instrumentation Shroud Replacement for shroud installation.



A. INDICATOR BULBS
B. INDICATOR PRINTED CIRCUIT CONNECTOR
C. FOG LAMP SWITCH
D. REAR DEFOGGER SWITCH
E. REAR WIPER SWITCH
F. ILLUMINATION RHEOSTAT
G. HEADLAMP SWITCH

J908E-28

Fig. 11 Instrument Panel Indicator Bezel

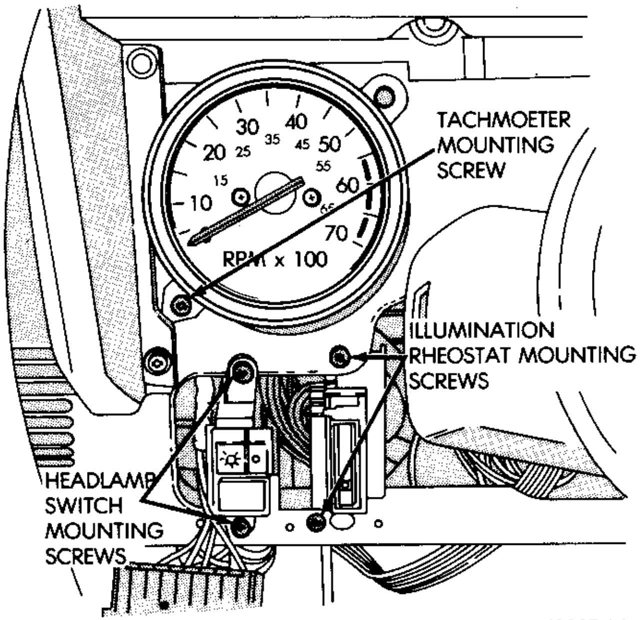


Fig. 12 Headlamp Switch/Illumination Rheostat/Tachometer

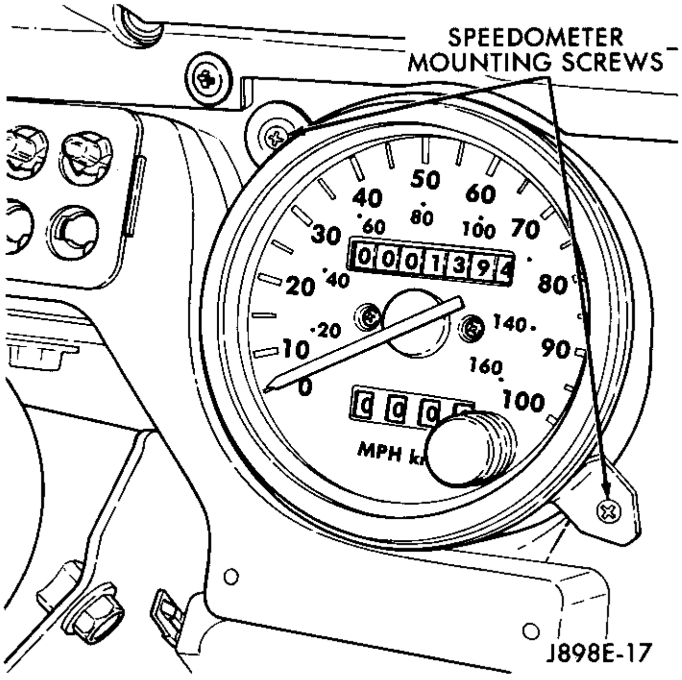


Fig. 13 Speedometer Removal/Installation

SJ

INDEX

INSTRUMENT CLUSTER GAUGE SPECIFICATIONS

OIL PRESSURE CALIBRATION

POINTER POSITION	RESISTANCE
0 psi Grad. ± .045	0 ohms
60 psi Grad. ± .090	64.8 ohms

TEMPERATURE GAUGE CALIBRATION

POINTER POSITION	RESISTANCE
186°F Grad. ± .090	226 ohms
246°F Grad. ± .045	82 ohms

FUEL GAUGE CALIBRATION

POINTER POSITION	RESISTANCE
Empty Grad. ± .045	5.5 ohms
Full Grad. ± .097	79.2 ohms

VOLTMETER CALIBRATION

VOLTAGE INPUT	POINTER POSITION
12V	12V Grad. ± .090
14V	14V Grad. ± .045

J908E-36

INSTRUMENT CLUSTER

Instrument Cluster Lamp Bulb Location and Specifications

Refer to Fig. 1 for lamp locations and to the specifications chart for bulb application and usage.

Replacement

(1) Disconnect the battery negative cable.

(2) Unsnap the tabs that retain the instrument panel bezel and remove the bezel (Fig. 2).

(3) Remove the screws that attach the instrument cluster to the panel (Fig. 3).

(4) Pull the instrument cluster outward and disconnect the speedometer and the cluster wire harness connectors.

(5) Remove the instrument cluster.

(6) To install, reverse the removal procedure.

Disassembly

(1) Remove the screws that attach the printed circuit board and cluster connector panel to the cluster housing (Figs. 4,5).

(2) Separate the housing and lens as an assembly from the connector panel.

(3) If the lens is to be replaced, remove the screws that attach the lens to the housing and remove the lens.

(4) To assemble, reverse the disassembly procedures.

Refer to Component Replacement—Instrument Cluster, for removal/installation of the circuit board, speedometer, clock, and individual gauges.

Component Replacement

Printed Circuit Board Removal

(1) Remove and Disassemble the instrument cluster.

(2) Unplug and remove the following:

- fuel gauge
- temperature gauge
- low fuel warning module
- oil pressure gauge
- voltmeter
- clock
- cluster lamp bulbs and sockets

(3) Slide the printed circuit board to the left to disengage it from the L-shaped tabs on the connector panel. Then lift and remove the circuit board.

Printed Circuit Board Installation

(1) Position the printed circuit board on the connector panel. Be sure the board is properly engaged with the tabs on the connector board.

(2) Install the gauges, clock, and fuel warning module on the connector panel. Be sure all components are firmly plugged into the panel.

(3) Install the cluster lamp bulbs and sockets.

(4) Assemble and install the instrument cluster.

Gauges/Clock/Low Fuel Warning Module—Removal

(1) Remove and disassemble the instrument cluster.

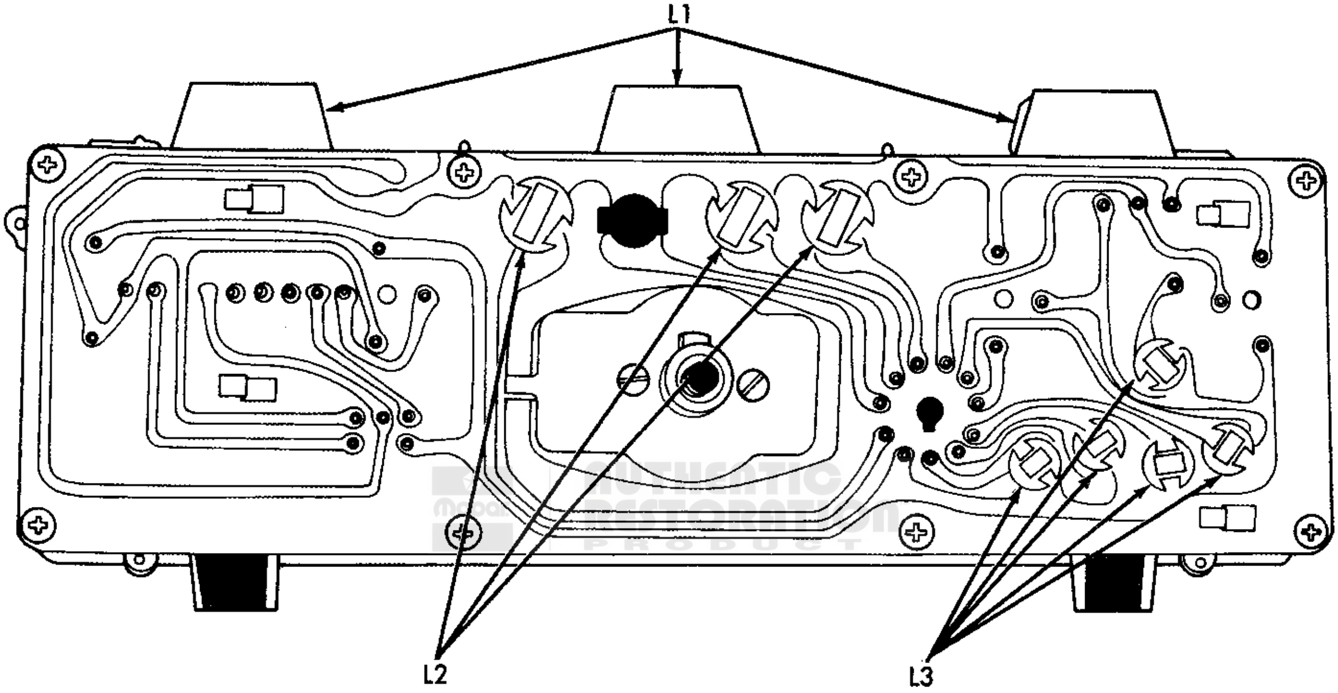
(2) Unplug and remove the component being replaced from the connector panel.

The fuel gauge and temperature gauge must both be removed before the low fuel warning module can be removed.

Gauges/Clock/Low Fuel Warning Module—Installation

(1) Install the replacement gauge/clock/fuel module. Be sure the replacement component is securely plugged into the connector panel and circuit.

(2) Assemble and install the instrument cluster.



INSTRUMENT CLUSTER LAMP BULB APPLICATION			
BULB LOCATION	TRADE NUMBER	USAGE	SOCKET COLOR
L1	161	3 Required	Black
L2	194	3 Required	Black
L3	7454	5 Required	Grey

J898E-21

Fig. 1 Instrument Cluster Lamp Bulb Application

Speedometer Removal

(1) Remove and disassemble the instrument cluster.

(2) Remove the two speedometer attaching screws.

(3) Remove the speedometer from the connector panel.

If a replacement speedometer is being installed, remove and reset the odometer. Refer to Odometer Setting—Replacement Speedometer.

(3) Position the speedometer in the connector panel and circuit board.

(4) Align the speedometer attaching screw holes and install the two attaching screws.

(5) Assemble and install the instrument cluster.

Replacement Speedometer—Odometer Setting

(1) Disengage the odometer retaining clip (Fig. 6). Twist the clip and push it downward to unhook it from the odometer and odometer mounting bracket.

(2) Lift and remove the odometer from the mounting bracket.

(3) Set odometer number wheels through to required mileage in a left-to-right sequence as follows:

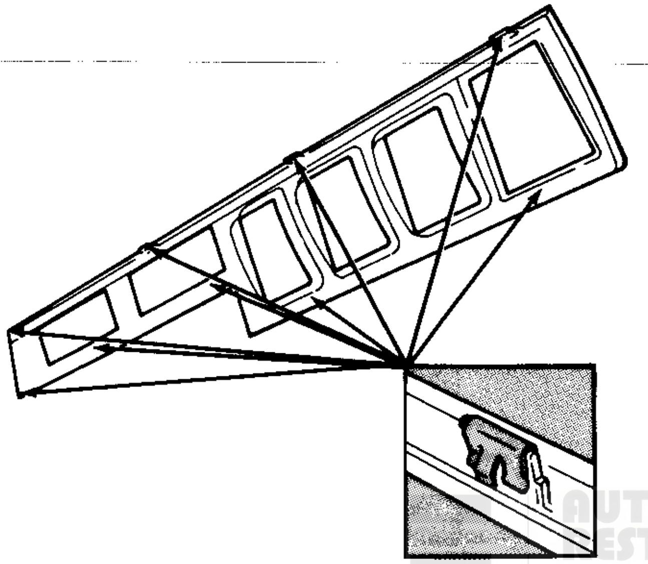


Fig. 2 Instrument Panel Bezel Retaining Clips

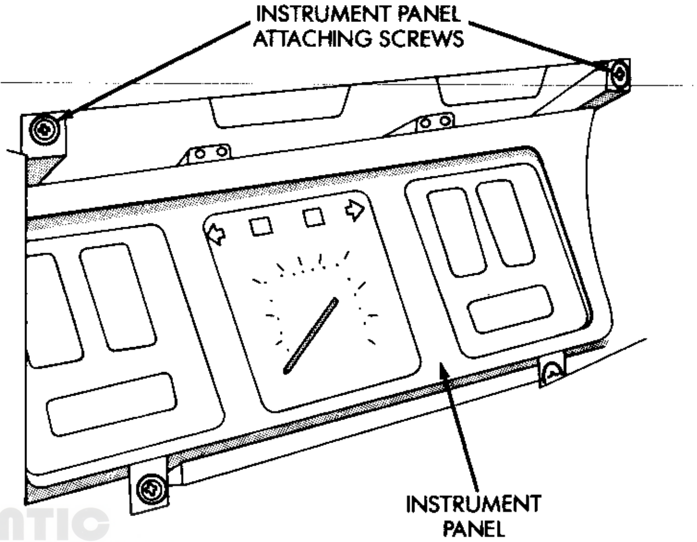


Fig. 3 Instrument Cluster Removal/Installation—SJ

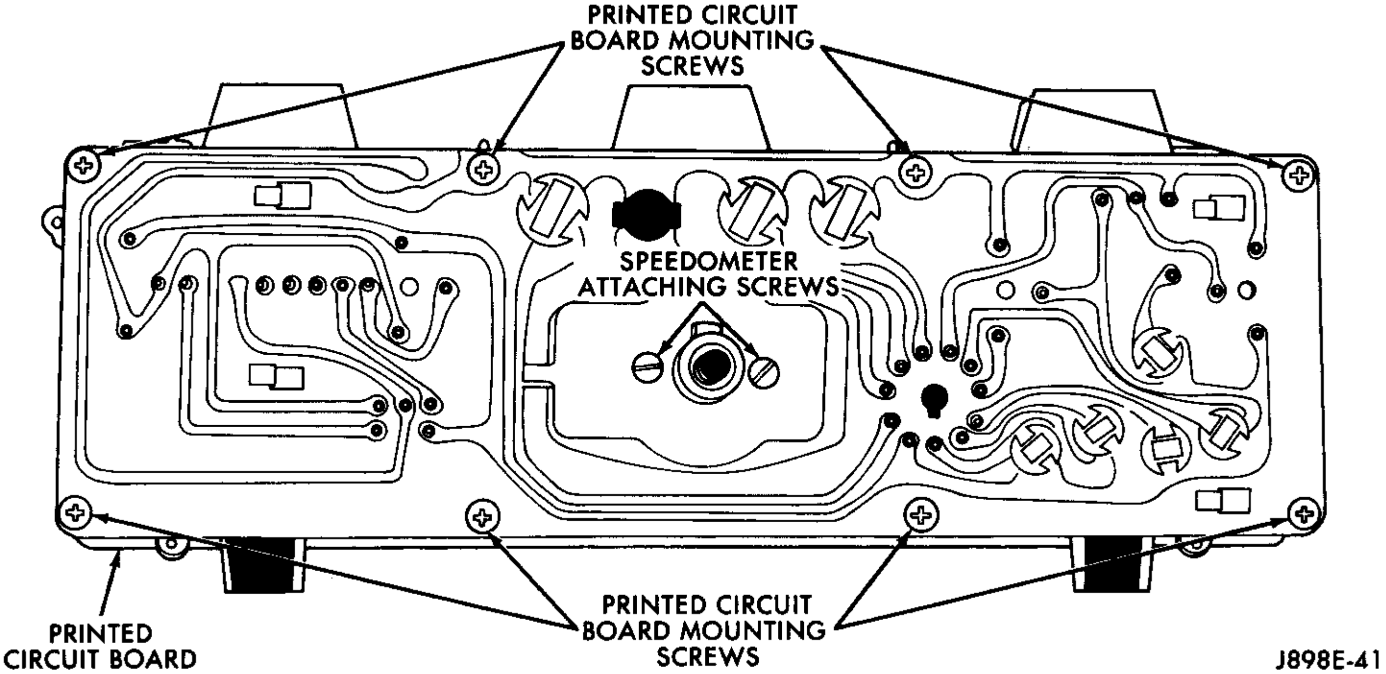


Fig. 4 Printed Circuit Board Removal/Installation

- Hold separator (1) from turning (Fig. 7). Then rotate number wheels (T) through (Y) in normal direction until desired number on wheel (T) is obtained.
- Align separator (5) with separator (6).
- Hold separator (5) from turning. Rotate number wheels (V) through (Y) in normal direction until desired number on wheel (U) is obtained.
- Align separator (4) with separators (5) and (6).
- Hold separator (4) from turning. Rotate number wheels (W) through (Y) in normal direction until desired number on wheel (V) is obtained.
- Align separator (3) with separators (4), (5) and (6).
- Hold separator (3) from turning. Then rotate number wheels (X) and (Y) in normal direction until desired number on wheel (W) is obtained.
- Align separator (2) with separators (3), (4), (5), and (6).

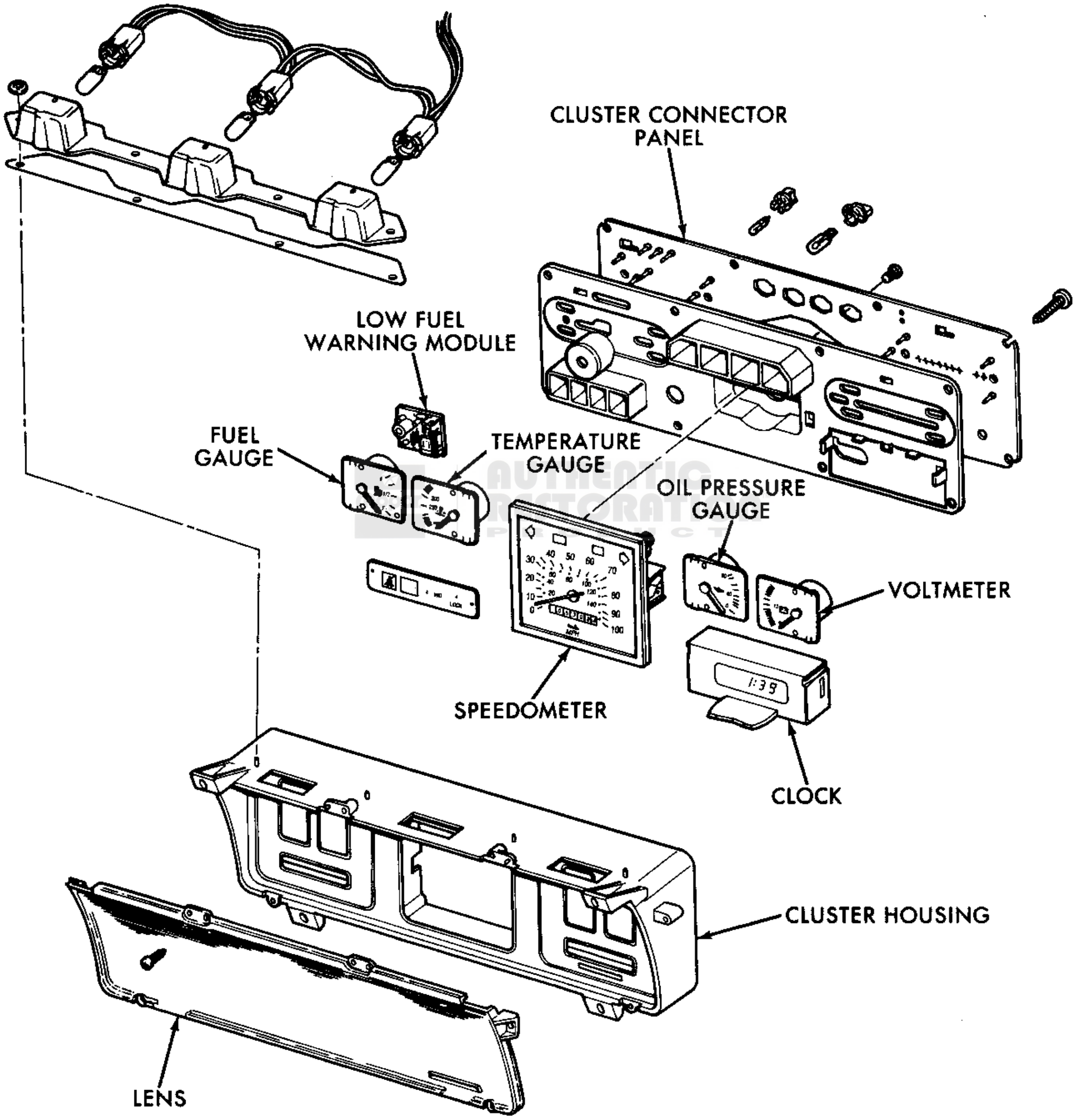


Fig. 5 Instrument Exploded View—SJ

- Hold separator (2) from turning. Then rotate number wheel (Y) in normal direction until desired number on wheel (X) is obtained.
- Align separator (1) with separators (2) through (6).
- Hold separator (1) from turning. Then rotate wheel (Y) in normal direction until desired number on wheel (Y) is obtained.
- Align separators (1) through (6) with the cross bar on the back of the speedometer face. Then carefully insert the odometer in the mounting bracket.

(4) Reengage the odometer retaining clip in the odometer and mounting bracket.

Headlight,Dome/Cluster Lights, Tailgate and Rear Defogger Control Switches—Replacement

NOTE: The control switches for the headlights, dome/cluster lights, rear defogger and tailgate are all located at the left side of the instrument panel.

(1) Remove the instrument cluster. Refer to Instrument Cluster Replacement.

(2) Disconnect the wires from the switch to be removed (Fig. 8).

(3) Use a small, thin-blade screwdriver and pry upper switch retaining tangs upward and lower tangs downward to release the switch. Remove the headlight switch and/or dome/cluster light switch.

(4) Compress the top and bottom spring clips to release the rear defogger switch and/or tailgate switch from the panel.

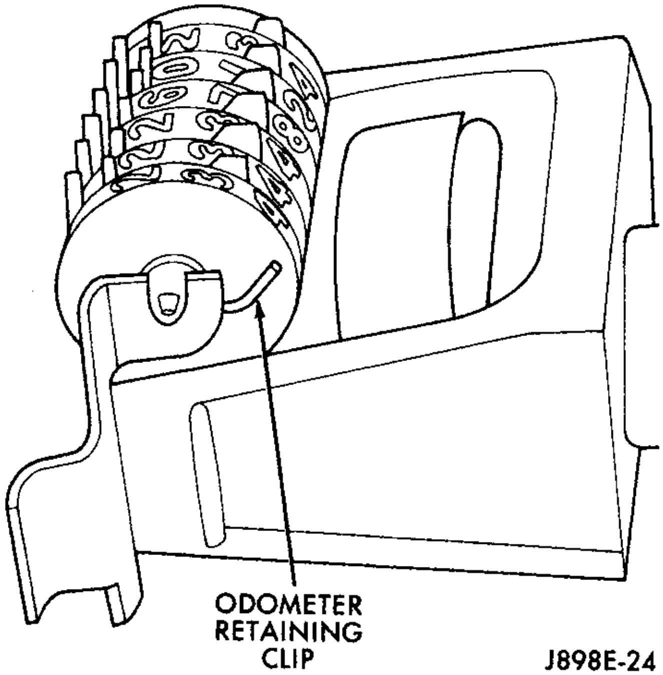


Fig. 6 Odometer Removal/Installation

(5) To install, reverse the removal procedures.

Fog Lamp Switch Replacement

(1) Disconnect the switch wires.

(2) Compress the spring clips at top and bottom of the switch to release it from the steering column cover.

(3) Remove the switch.

(4) To install, reverse the removal procedures.

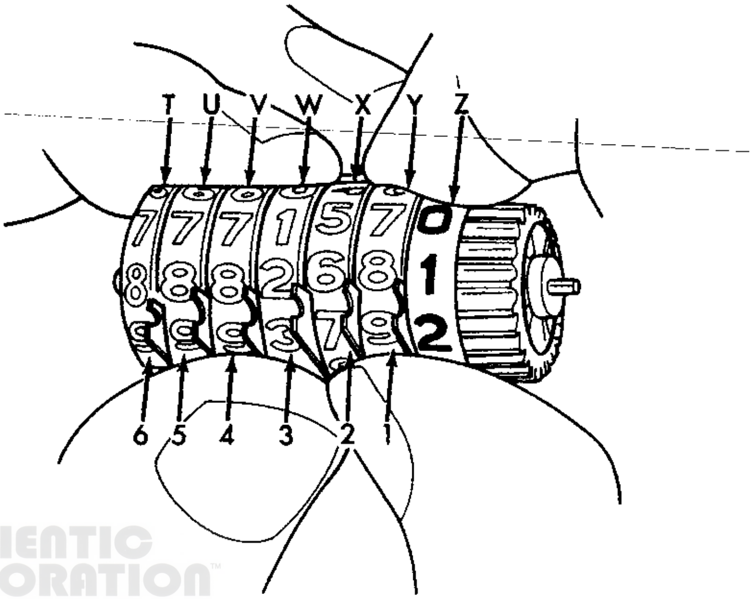


Fig. 7 Setting New Odometer

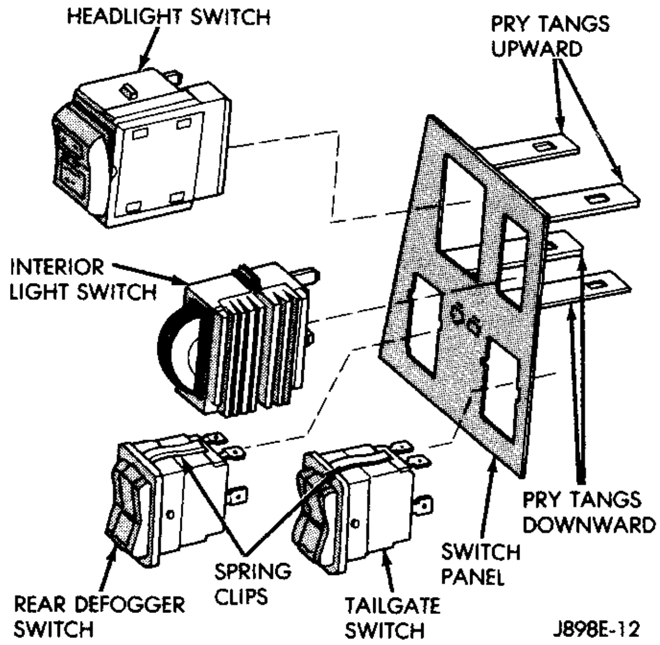
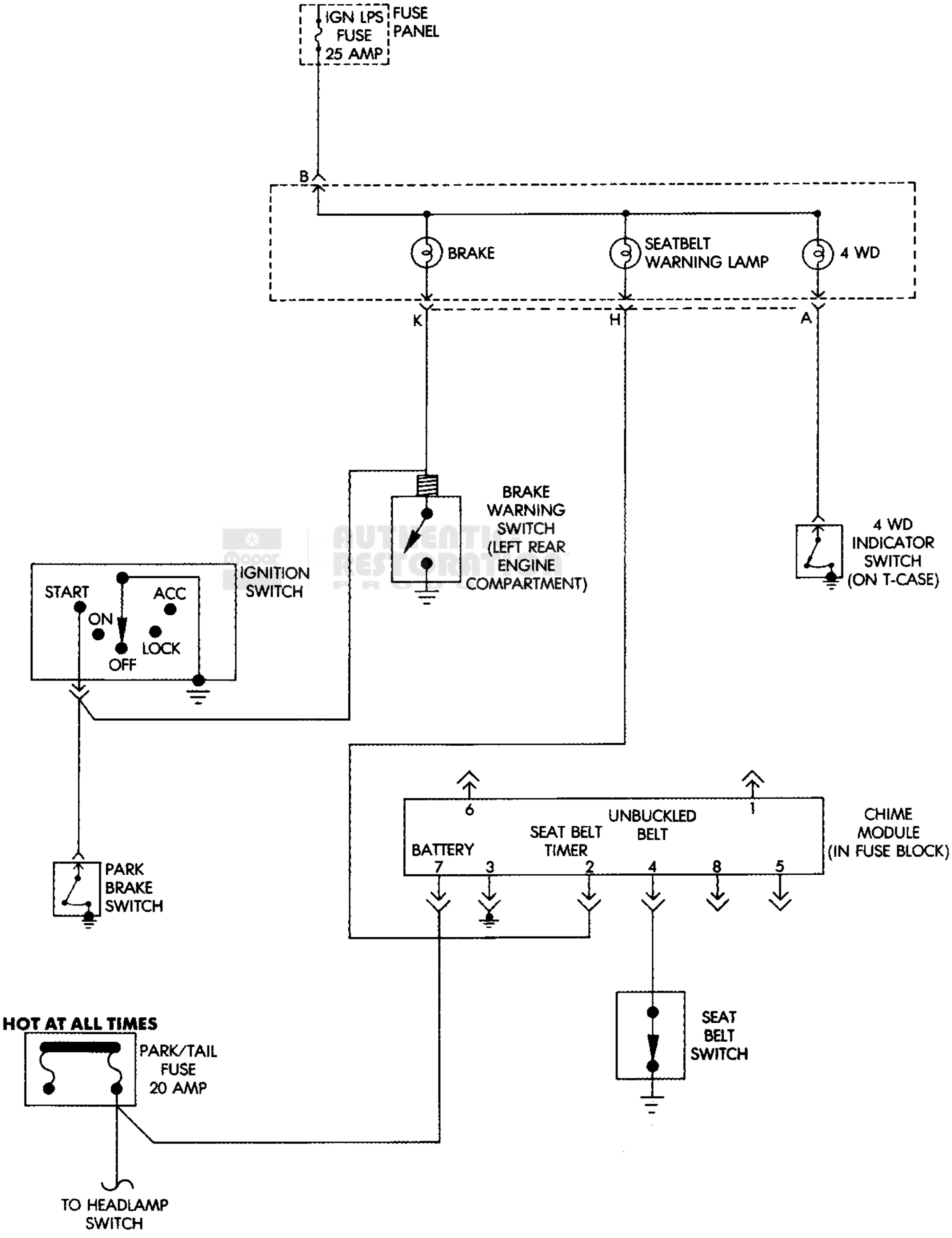


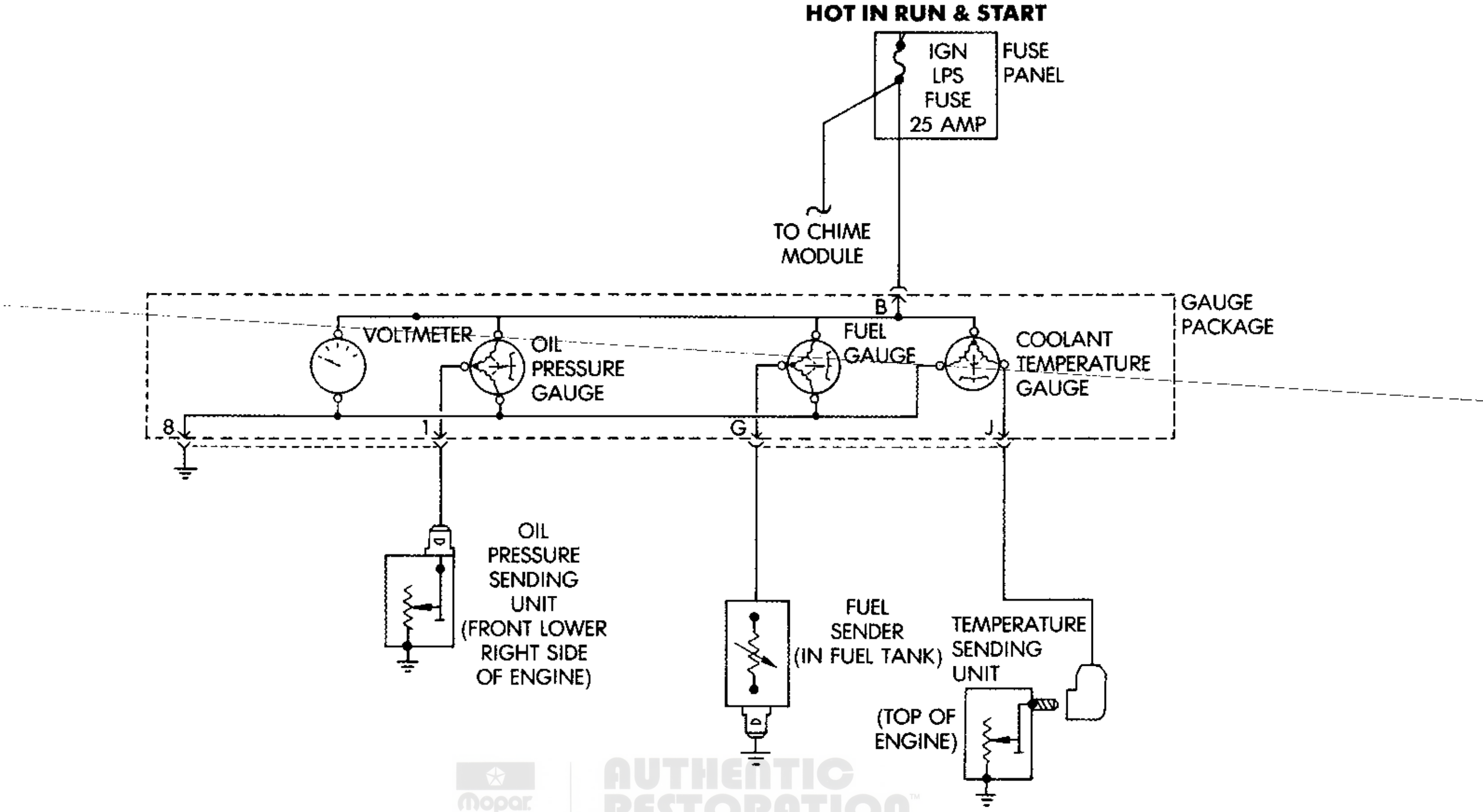
Fig. 8 Control Switch Removal/Installation

INSTRUMENT CLUSTER INDICATOR SCHEMATIC



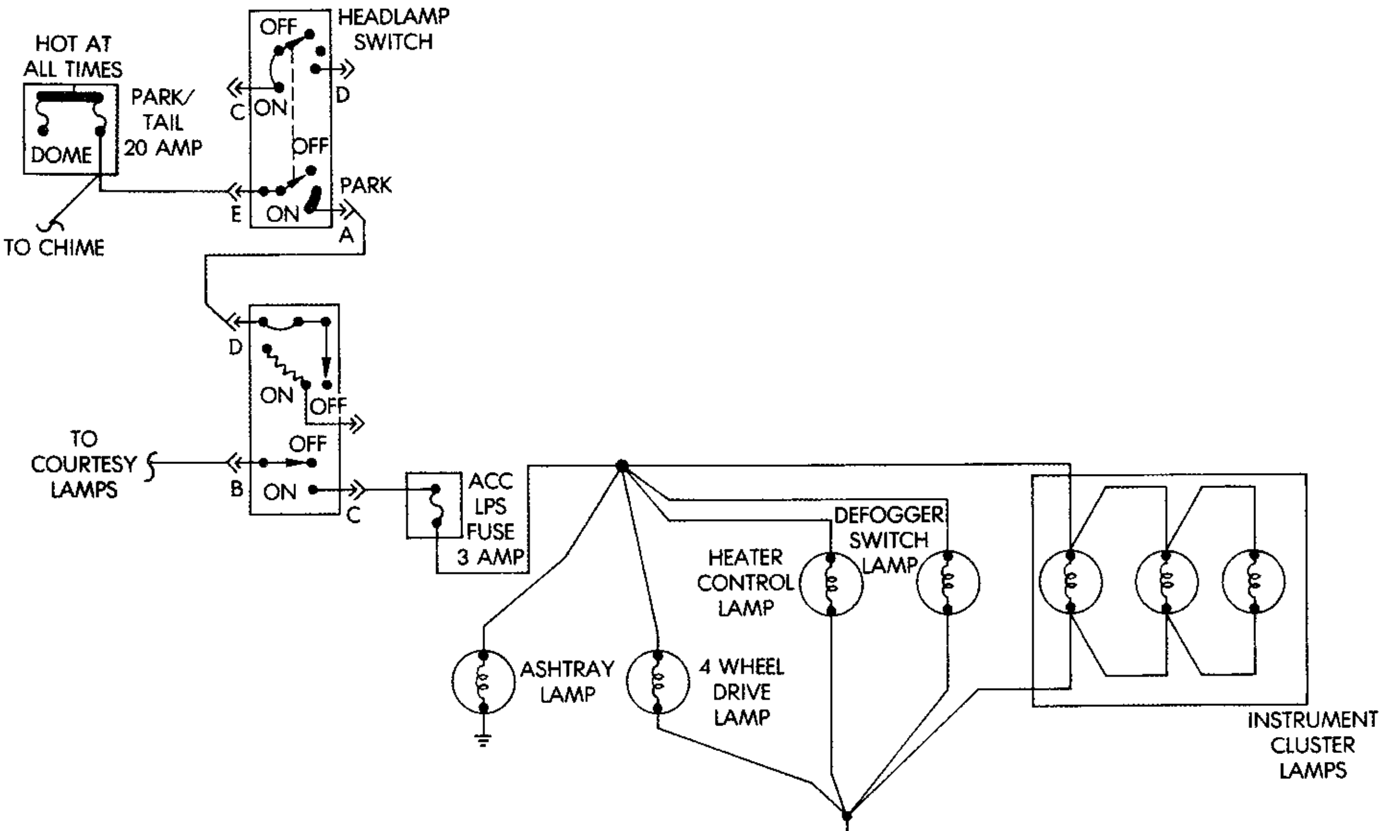
J908E-2

GAUGES SCHEMATIC



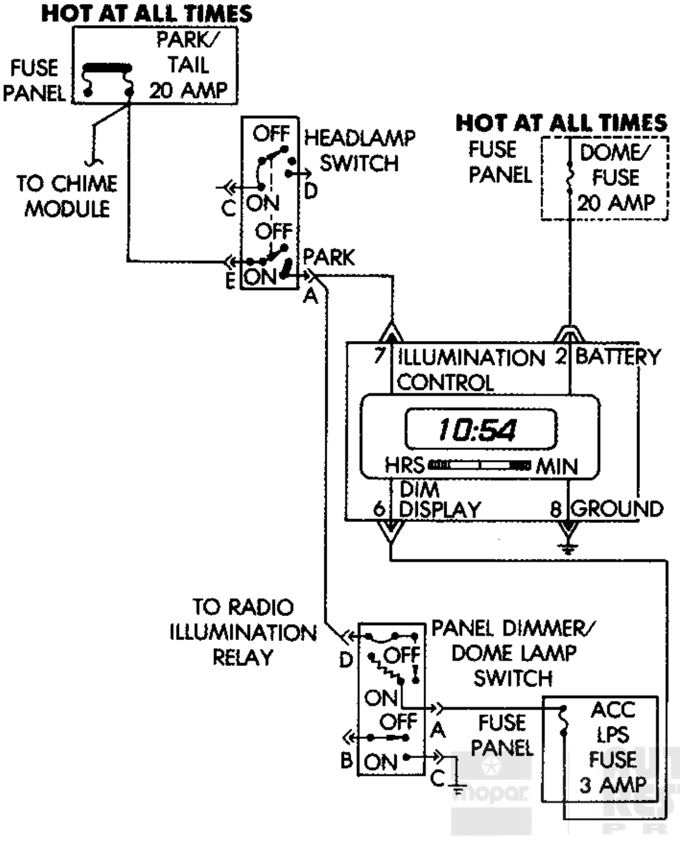
J908E-3

INSTRUMENT PANEL ILLUMINATION SCHEMATIC



J908E-4

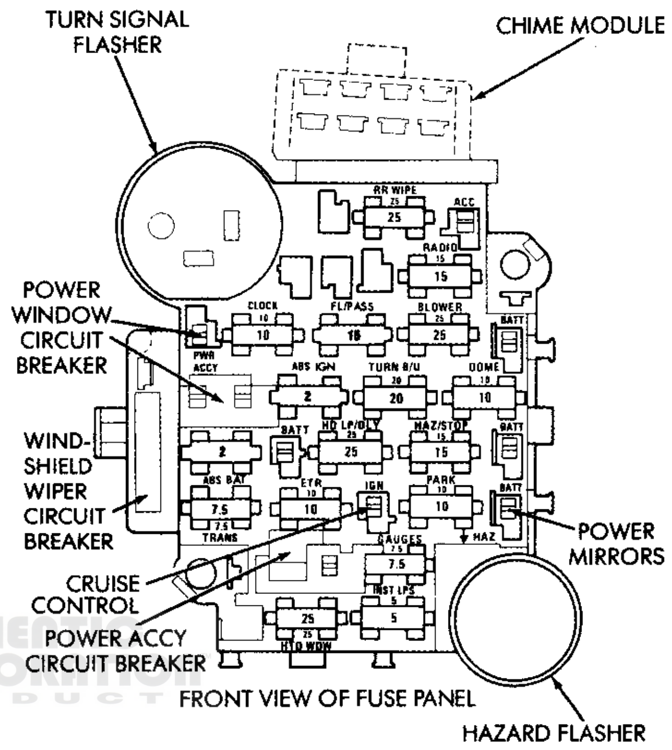
CLOCK SCHEMATIC



J908E-1

FUSE PANEL DATA

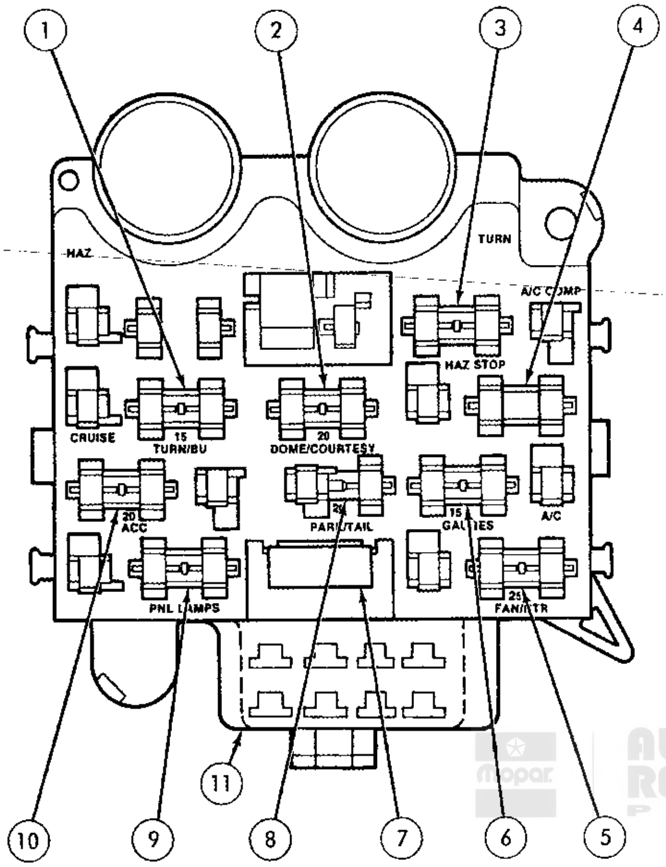
XJ AND MJ



NAME	COLOR SIZE (AMPS)	CIRCUITS PROTECTED
BLOWER	WHT (25)	BLOWER MOTOR CONTROLS
CLOCK	RED (10)	DIGITAL CLOCK, EMISSION MAINTENANCE TIMER
DOME	RED (10)	INTERIOR LAMPS, KEYLESS ENTRY, POWER MIRROR
ETR	RED (10)	RADIO, CLOCK, POWER ANTENNA
GAUGES	VIO (7.5)	CHIME MODULE, CRUISE CONTROL, INSTRUMENT CLUSTER HEADLAMP DELAY MODULE
HAZ/STOP	LT BLUE (15)	HAZARD FLASHER BRAKE LAMPS
HD LP/DLY	WHT (25)	HEAD LAMP DELAY MODULE
HTD WDW	WHT (25)	REAR DEFOGGER
INST LPS	TAN (5)	INSTRUMENT PANEL LAMPS
PARK	RED (10)	CHIME MODULE PARKING LAMPS, ILLUMINATION RELAY, CLOCK
POWER WINDOW CIRCUIT BREAKER	(30)	POWER WINDOWS
PWR ACCY CIRCUIT BREAKER	(30)	POWER DOOR LOCKS, TRAILER HARNESS POWER SEATS
RR WIPE	WHT (25)	REAR WIPER/WASHER
TRANS (TCU)	VIO (7.5)	TRANSMISSION CONTROL UNIT, BACK UP LAMPS
RADIO	LT BLUE (15)	CIGAR LIGHTER, RADIO, CLOCK, VANITY LAMPS, WASHER FLUID LEVEL
WINDHSIELD WIPER/ WASHER CIRCUIT BREAKER	(4.8)	WINDSHIELD WIPERS
TURNS B/U	YEL (20)	TURN FLASHER, REAR DEFOGGER
ABS BAT	2	ANTILOCK BRAKE
MOTOR PUMP	—	NOT USED
ABS IGN	2	ANTILOCK BRAKE

J898E-3

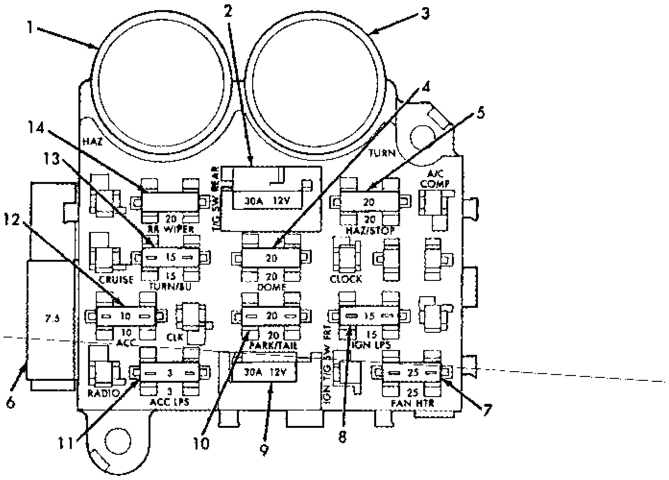
YJ



ITEM	IDENTIFER	COLOR/RATING	CIRCUITS PROTECTED
1	TURN/BLU	Light Blue/15 AMP	Turn Signal Lamps Backup Lamps
2	DOME	Yellow/20 AMP	Courtesy Lamps Cargo Lamps
3	HAZ STOP	Light Blue/15 AMP	Hazard Lamps Stop Lamps
4	HTD WDW	White/25 AMP	Rear Window Defogger Grids
5	FAN/HEATER	White/25 AMP	Heater Blower Motor
6	GAUGES	Light Blue/15 AMP	Key Buzzer Defogger Relay Gauge Pack Defogger Switch Tachometer Indicator Lamps
7	W/WIPERS	5.3 AMP Circuit Breaker	Windshield Wiper Switch and Motor
8	PARK/TAIL	Yellow/20 AMP	Turn Signal Switch Park Lamps Taillamps
9	PNL LPS	Tan/5 AMP	Instrument Panel Illumination Lamps
10	ACC	Green 30 AMP	Cigar Lighter Radio Cruise Control
11	Buzzer Module	————	————

J908E-11

SJ



1. Hazard (Emergency) Warning Flasher

2. 30 Amp Circuit Breaker (Battery)
   - Tailgate Window — Rear Switch
   - Power Door Locks
   - Power Seats
   - Rear Window Defogger

3. Turn Signal Flasher

4. 20 Amp Fuse (Battery)
   - Dome Lamps
   - Courtesy Lamps
   - Underhood Lamp
   - Glove Box Lamp
   - Radio (Memory)

5. 20 Amp Fuse (Battery)
   - Hazard Lamps
   - Cruise Control
   - Stop Lamps

6. 5.5 Amp Circuit Breaker (Ignition)
   - Wipers
   - Washer Pump

7. 25 Amp Fuse (Ignition)
   - Blower Motor Fan
   - A/C Mode Switch
   - Emission System

8. 15 Amp Fuse (Ignition)
   - Four Wheel Drive Lamp
   - Instrument Cluster Feed
   - Rear Window Defogger Switch
   - Keyless Entry
   - Electronic Compass

9. 30 Amp Circuit Breaker (Ignition)
   - Tailgate Window — Front Switch
   - Power Mirrors
   - Power Windows

10. 20 Amp Fuse (Battery)
    - Headlamp Switch Rheostat (Dimmer)
    - Park/Tail Lamps
    - Chime Module
    - Radio
    - Headlamp Switch

11. 3 Amp Fuse (Headlamp SW Battery)
    - Instrument Panel Lamps
    - Illumination Lamps

12. 20 Amp Fuse (Ignition)
    - Clock (Display)
    - Cigar Lighter
    - Radio Illumination

13. 15 Amp Fuse (Ignition)
    - Turn Signal Lamps/Backup Lamps

14. 20 Amp Fuse (Ignition)
    - Rear Wiper

J89BE-5

OVERHEAD CONSOLE

INDEX

DESCRIPTION

An overhead console is available on XJ and SJ vehicles. The console includes a compass/temperature display, map lights for the front and second seats, the receiver for the keyless entry system and storage compartments for remote garage door openers and sun glasses.

Compass

The compass will display the direction the vehicle is pointed in using the eight major compass headings (Examples: North is "N", Northeast is "NEcq). It does not display the headings in actual degrees. The display is turned on/off using the TEMP/COMP button on the left of the display.

The compass is a self calibrating unit that should not require recalibration. The only calibration that may prove necessary is to drive the vehicle in 3 complete circles, on level ground, in not less than 48 seconds to "reorient" the unit to its vehicle. The unit will also compensate for magnetism the vehicle may acquire during its life. Care should be used to avoid putting anything magnetic on the roof of the vehicle.

Although the unit can compensate for some magnetic fields in the body, the use of magnetic attachments like antenna mounts or repair order "hats" placed directly on the roof can exceed the compensation ability of the unit. Magnetic bit drivers used on the fasteners to hold the assembly to the roof header can also affect operation. If the vehicle roof should become magnetized, then the degaussing and calibration procedures may be required to restore proper operation.

If the compass functions but accuracy is suspect, it may be necessary to perform a variation adjustment. This procedure allows the unit to accommodate variations in the earth's magnetic field strength based on geographic location.

If the compass has blanked out and only CAL appears, degaussing may be necessary to remove residual magnetic fields.

Thermometer

The ambient temperature display can be changed from Fahrenheit to Celsius using the US/Metric button on the right of the display. The temperature reported is not an instant reading of conditions but an average temperature. It may take the unit several minutes to react to a major change such as driving out of a heated garage into winter temperatures.

When the ignition switch is turned off, the last displayed temperature reading stays in memory. When the ignition switch is turned on again the thermometer will display the memory temperature for one minute; then update the display to the actual temperature within five minutes.

Map And Courtesy Lamps

These lamps offer several unique features. Both the Map and Courtesy lamps can be turned on with the integral "Soft Touch" switch. Pushing this switch energizes an electrical circuit, which in turn directs power to the light. The map lamps are unaffected by the door switches, while the Courtesy lamps are turned on with the opening of any door. When any door is open, the "Soft Touch" switches are disabled, you cannot turn the lights off with these switches.

DIAGNOSTIC PROCEDURES

For complaints of erratic compass operation, illumination bulbs out, incorrect temperature readings or display is completely blank follow the appropriate diagnostic flow chart.

- Chart 1 Describes the procedures for compass and display problems.
- Chart 2 Describes the procedures for outside temperature measuring problems.
- Chart 3 Describes the procedures for illumination lamp problems.

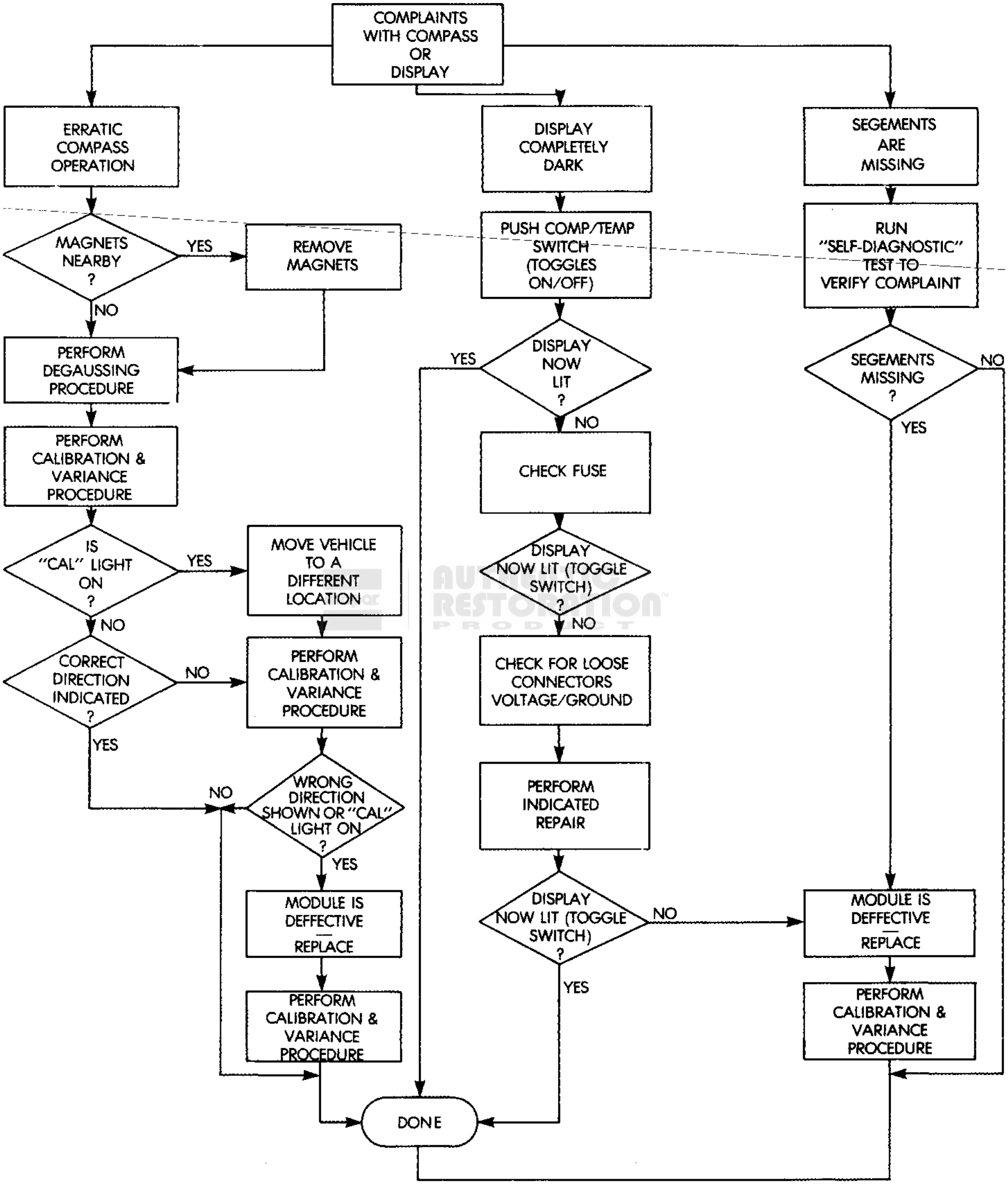

COMPLAINTS WITH COMPASS OR DISPLAY
ERRATIC COMPASS OPERATION
DISPLAY COMPLETELY DARK
SEGEMENTS ARE MISSING
MAGNETS NEARBY ?
YES
REMOVE MAGNETS
NO
PERFORM DEGAUSSING PROCEDURE
PERFORM CALIBRATION & VARIANCE PROCEDURE
IS "CAL" LIGHT ON ?
YES
MOVE VEHICLE TO A DIFFERENT LOCATION
NO
CORRECT DIRECTION INDICATED ?
NO
PERFORM CALIBRATION & VARIANCE PROCEDURE
YES
NO
WRONG DIRECTION SHOWN OR "CAL" LIGHT ON ?
YES
MODULE IS DEFFECTIVE — REPLACE
PERFORM CALIBRATION & VARIANCE PROCEDURE
PUSH COMP/TEMP SWITCH (TOGGLES ON/OFF)
YES
DISPLAY NOW LIT ?
NO
CHECK FUSE
DISPLAY NOW LIT (TOGGLE SWITCH) ?
NO
CHECK FOR LOOSE CONNECTORS VOLTAGE/GROUND
PERFORM INDICATED REPAIR
DISPLAY NOW LIT (TOGGLE SWITCH) ?
NO
YES
RUN "SELF-DIAGNOSTIC" TEST TO VERIFY COMPLAINT
SEGEMENTS MISSING ?
NO
YES
MODULE IS DEFFECTIVE — REPLACE
PERFORM CALIBRATION & VARIANCE PROCEDURE
DONE
J908E-19

Chart 1

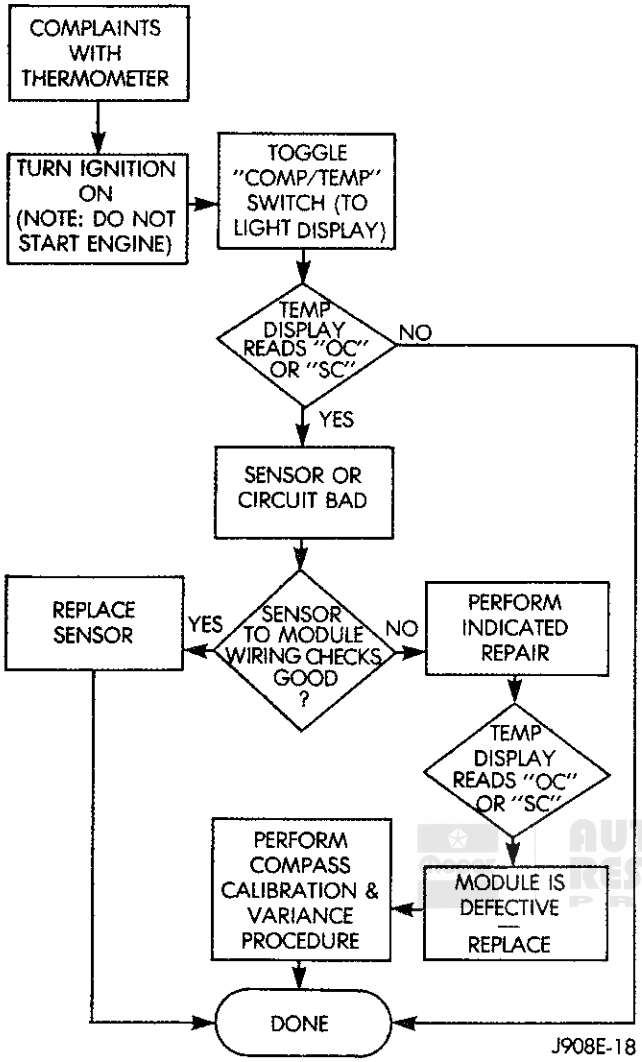

COMPLAINTS WITH THERMOMETER
TURN IGNITION ON (NOTE: DO NOT START ENGINE)
TOGGLE "COMP/TEMP" SWITCH (TO LIGHT DISPLAY)
TEMP DISPLAY READS "OC" OR "SC"
NO
YES
SENSOR OR CIRCUIT BAD
REPLACE SENSOR
YES
SENSOR TO MODULE WIRING CHECKS GOOD ?
NO
PERFORM INDICATED REPAIR
TEMP DISPLAY READS "OC" OR "SC"
PERFORM COMPASS CALIBRATION & VARIANCE PROCEDURE
MODULE IS DEFECTIVE — REPLACE
DONE
J908E-18

Chart 2

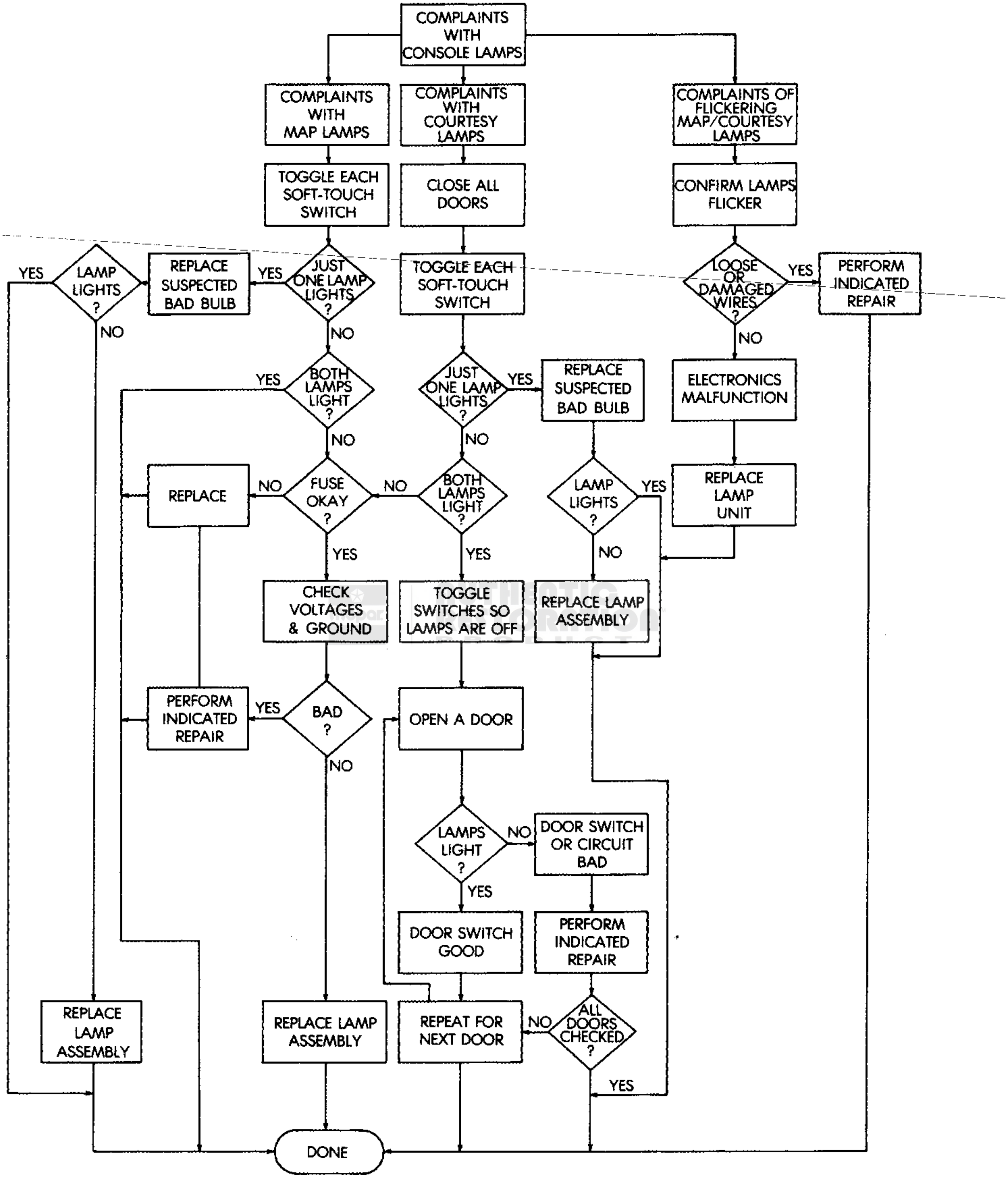

COMPLAINTS WITH CONSOLE LAMPS
COMPLAINTS WITH MAP LAMPS
COMPLAINTS WITH COURTESY LAMPS
COMPLAINTS OF FLICKERING MAP/COURTESY LAMPS
TOGGLE EACH SOFT-TOUCH SWITCH
CLOSE ALL DOORS
CONFIRM LAMPS FLICKER
YES
LAMP LIGHTS ?
REPLACE SUSPECTED BAD BULB
YES
JUST ONE LAMP LIGHTS ?
TOGGLE EACH SOFT-TOUCH SWITCH
LOOSE OR DAMAGED WIRES ?
YES
PERFORM INDICATED REPAIR
NO
NO
NO
YES
BOTH LAMPS LIGHT ?
JUST ONE LAMP LIGHTS ?
YES
REPLACE SUSPECTED BAD BULB
ELECTRONICS MALFUNCTION
NO
NO
REPLACE
NO
FUSE OKAY ?
NO
BOTH LAMPS LIGHT ?
LAMP LIGHTS ?
YES
REPLACE LAMP UNIT
YES
YES
NO
CHECK VOLTAGES & GROUND
TOGGLE SWITCHES SO LAMPS ARE OFF
REPLACE LAMP ASSEMBLY
PERFORM INDICATED REPAIR
YES
BAD ?
OPEN A DOOR
NO
LAMPS LIGHT ?
NO
DOOR SWITCH OR CIRCUIT BAD
YES
DOOR SWITCH GOOD
PERFORM INDICATED REPAIR
REPLACE LAMP ASSEMBLY
REPLACE LAMP ASSEMBLY
REPEAT FOR NEXT DOOR
NO
ALL DOORS CHECKED ?
YES
DONE
J908E-20

Chart 3

COMPASS REPAIR PROCEDURES

Variation Adjustment Procedure

Variance is the difference between magnetic North and geographic North. In some areas the difference between magnetic and geographic north is great enough to cause the compass to give false readings. If this occurs, the variance must be set.

To set the variance: turn key to the ON position. Depress both buttons and hold down until VAR light appears. This takes about 5 seconds.

Release both buttons.

Using the map (Fig. 1) find your geographic location and note the Zone Number.

Press the U.S./Metric button to sequentially go through the numbers until the zone number for your area appears in the display.

Press the COMP/TEMP button to enter this zone number.

Confirm correct directions are indicated.

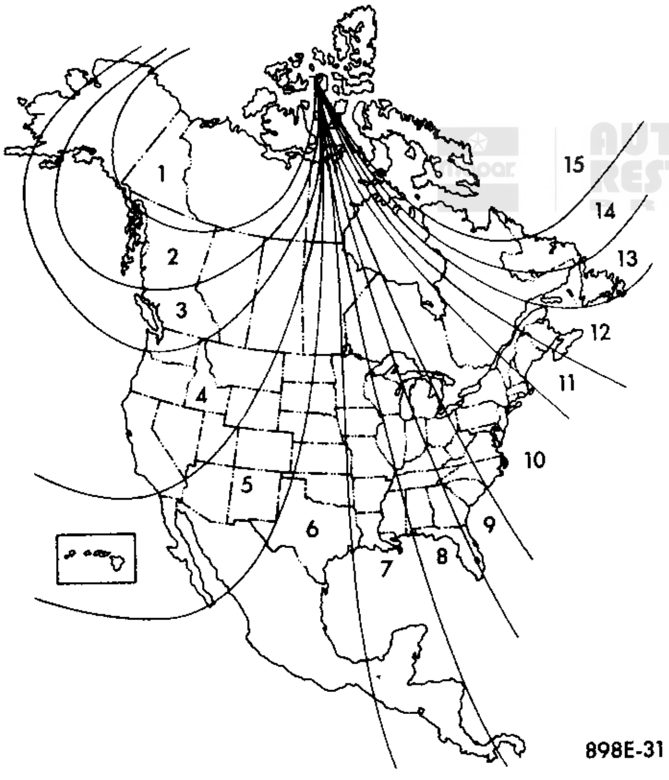


Fig. 1 Variance Settings

Compass Calibration Procedure

CAUTION: DO NOT use magnetic tools when servicing the overhead console.

CAUTION: DO NOT place any external magnets ie. magnetic roof mount antennas etc. in the vicinity of the compass.

Do not attempt to set compass near large metal objects such as other vehicles, large buildings or bridges. The compass features an "Auto-Cal" design which simplifies the calibration procedure. During normal driving this feature automatically updates the compass calibration and takes into account incremental changes in magnetism the vehicle may see over its life time.

Whenever the compass is calibrated manually, the variation number must also be reset.

Calibrate the compass as follows:

(1) Start the engine.

(2) Depress both buttons on the compass and hold down until CAL light appears. This takes about 10 seconds and appears about 5 seconds after the VAR light appears.

(3) Release buttons.

(4) Drive vehicle on a level surface away that is away from metal objects through three or more complete circles, in not less than 48 seconds. The CAL light will go off and the compass is now calibrated.

(5) Reset Variation number. This step must be done every time step 2 is performed.

If CAL light does not go off, either there is excessive magnetism near the compass or the unit is defective. Repeat the degaussing and calibration procedures at least one more time.

If the wrong direction is still indicated, the area selected may be too close to a magnetic source. Repeat the calibration procedure in another location.

Degaussing Procedure

The tool used to degauss or demagnetize the forward console attaching screw and roof panel is the Miller Tool 6029. Equivalent units are available, but must be rated as continuous duty for 110/115 volts and 60Hz with a field strength of over 350 gauss at 1/4 inch beyond the tip of the probe.

In this degaussing procedure the degaussing tool is used to demagnetize both the roof panel and console forward mounting screw.

(1) Be sure the ignition switch is in the OFF position before you begin the degaussing procedures.

(2) Plug the degaussing tool into a standard 110/115 volt AC outlet, keeping the degaussing tool at least 2 inches away from the compass area when plugging it in.

Console Forward Mounting Screw

(A) Slowly approach the head of the forward mounting screw with the plastic coated tip of the degaussing tool. Contact the head of the screw for about two seconds.

(B) With the degaussing tool still energized, slowly back it away from the screw until the tool is at least two inches from the screw head and disconnect it from the electrical outlet.

Roof Panel

(A) Place an 8 1/2 X 11 piece of paper on the center of the roof at the windshield, oriented lengthwise from front to rear. The purpose of the paper is protect the roof panel from scratches and define the area to be degaussed (Fig. 2). Figure 2 shows the recommended sweep pattern of 1/2 inch between passes in a sweeping zig-zag pattern.

(B) Plug in the degaussing tool. Keep the tool at least 2 inches away from the compass unit.

(C) Slowly approach the center of the roof panel at the windshield with the degaussing tool plugged in.

(D) Contact the roof panel with the tip of the tool (be sure template is in place to avoid scratching the roof panel). Using slow sweeping motions of 1/2 inch between sweeps, move the tool approximately 4" either side of the centerline and at least 11 inches back from the windshield.

(E) With the degaussing tool still energized, slowly back away from the roof panel until the tip is at least 2 inches from the roof and disconnect it from the outlet.

(3) Calibrate the compass and set the variance as described.

Self-Diagnostic Test

The Self-Diagnostic test is used to verify the compass is working properly electrically. This can be used to confirm that the display and all of its segments are operating properly. Initiate the self-diagnostic test as follows:

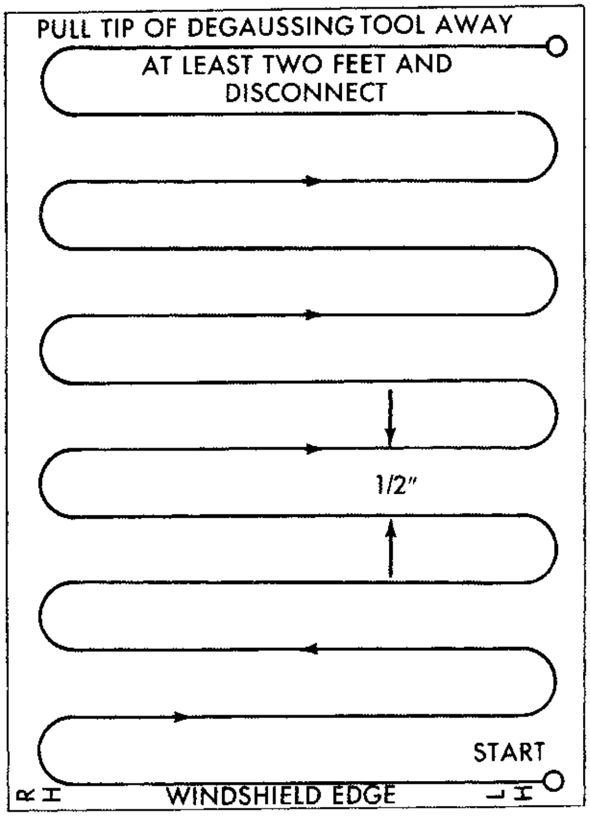


Fig. 2 Roof Degaussing Pattern

(1) With the ignition switch in the OFF position simultaneously press and hold the COMP/TEMP button and the US/METRIC button.

(2) Turn ignition switch to ON.

(3) Continue to hold both buttons until the display performs a walking segment test. In this test all of the compass points are displayed along with various number combinations. These combinations verify that all segments work. To repeat the test, press the COMP/TEMP button.

(4) Press the US/METRIC button, and all segments will light simultaneously for about 2 seconds. To repeat the test, press the COMP/TEMP button.

(5) Press the US/METRIC button to return to normal operation.

(6) Should any segment in any of the digit positions fail to light, the unit is defective and should be replaced.

THERMOMETER AND SENSOR SYSTEM REPAIR PROCEDURES

This portion of the display consists of a sensor, a pair of wires for signal and ground and that portion of the circuit and display devoted to the temperature measuring and display. The sensor is mounted on the LH side of the grille panel just behind the grille.

If an electrical component breaks it will diagnosis as an open or short circuit. The system reports SC when the sensor is exposed to temperatures in excess of 140°F or if the circuit is shorted. If the temperature is below -40°F or an open exists, the system will display OC.

To diagnose the temperature sensor perform the following procedures. If the sensor and wiring are OK then the electronic module is defective and should be replaced.

Sensor Test

(1) Turn the ignition switch to OFF.

(2) Measure resistance of sensor. At -40°F the resistance is 336K ohms. At 140°F the resistance is 2.488K ohms. If resistance is NOT between these two values, then the sensor is faulty. Replace the sensor.

Circuit Test

(1) Locate temperature sensor and disconnect harness connector.

(2) Short the pins on the harness connector by using a jumper wire.

(3) Remove the overhead console as described in Console Repair Procedures.

(4) Check continuity between pins 10 and 11 of compass/temperature harness connector (Fig. 3). If an open circuit is detected, repair as required.

(5) Remove jumper wire on temperature sensor harness connector. Check continuity between pins 10 and 11 of compass/temperature harness connector (Fig. 3). If a short is detected, repair as required.

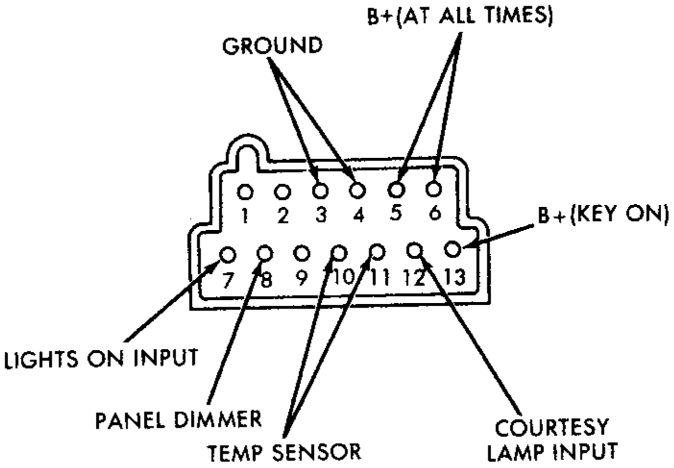


Fig. 3 Compass/Temperature Harness Connector

CONSOLE REPAIR PROCEDURES

(1) Remove screw forward of the compass unit (Fig. 4).

(2) Flex housing outward while pressing upward to disengage the housing from the rear bracket (arrow 1) (Fig. 4).

(3) Slide console rearward until the console detaches from the front mounting bracket (arrow 2) (Fig. 4).

(4) While still pressing upwards on the rear of the console (arrow 1), slide the console forward holding the front of the console away from the headliner (arrow 2) until the rear of the console detaches from the headliner and becomes free (Fig. 5).

Disconnect wire harnesses from keyless entry and compass (Fig. 6).

(4) To install the overhead console, reverse the removal procedures. Be sure to flex housing outward near the keyless entry receiver until the console snaps onto the rear mounting bracket.

Bulb Replacement

(1) With a large paper clip or wire (approximately 0.06 in. diameter) make a hook in the end. Insert into the hole in the lens and pull downward (Fig. 7).

(2) Set lens aside and replace bulb.

(3) Replace lens by inserting tab on thin portion of lens into mating slot on console and push upwards on opposite end of lens (Fig. 8).

Sunglasses Bin and Spring Assembly

(1) Open sunglasses bin door.

(2) Remove cover plate (Fig. 9).

(3) Unhook torque spring from wall and put in down position as shown by arrow 1 (Fig. 10).

(4) Remove sunglasses bin door by flexing the center panel and removing the side of the door with the gear first (Fig. 11). The gear side of the door has a short pivot rod. Slide door out of the compartment.

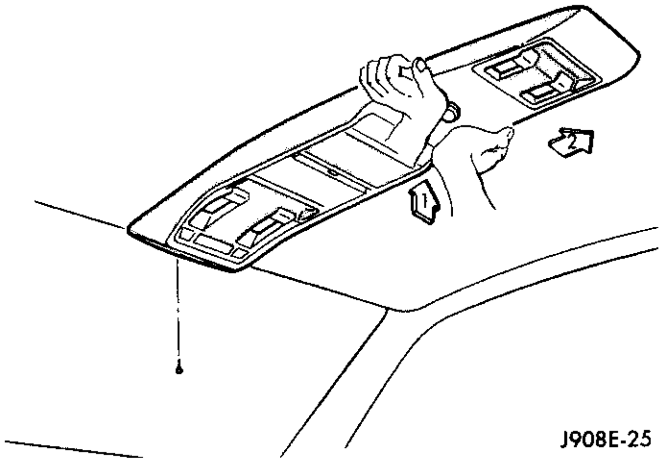


Fig. 4 Remove/Install Overhead Console

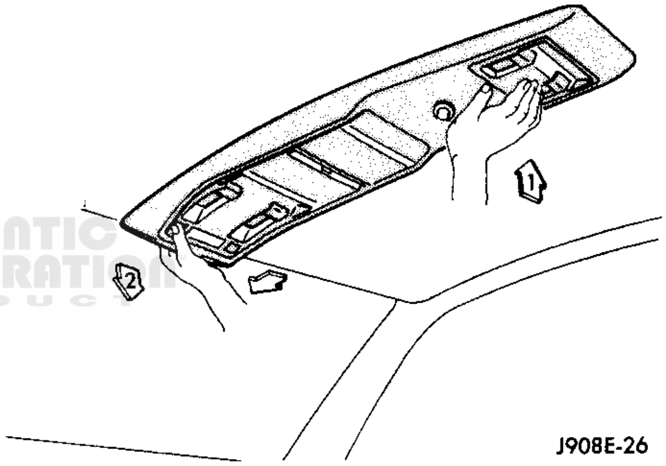


Fig. 5 Remove/Install Overhead Console

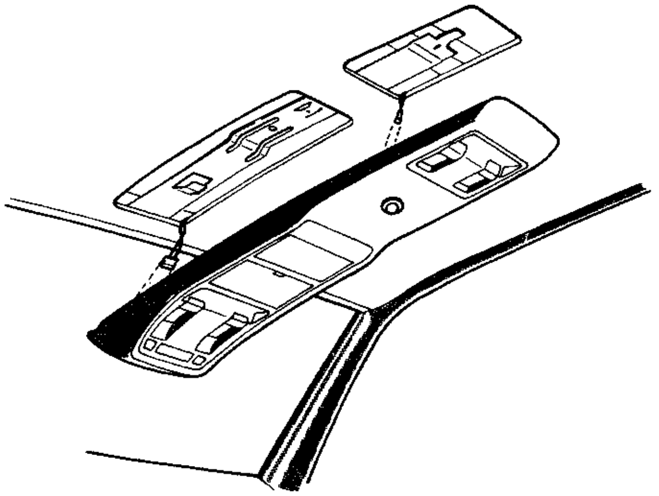


Fig. 6 Disconnect Wire Harnesses

(5) Remove and discard push push spring (Fig. 9).

(6) Install new push push spring as shown. This may require flexing the housing in that area for clearance.

(7) Install new sunglasses bin door in the open position, by first inserting the longer pivot rod making sure the torque spring lines up with the slot in the rod (Fig. 11).

(8) Flex the center panel and snap in the short pivot rod.

(9) Hook torque spring back over the wall (Fig. 9).

(10) Cycle door several times to ensure that the door functions properly.

(11) Snap cover plate back in position as shown (Fig. 9). Some pressure from the inside of the bins may be required to engage all six snaps.

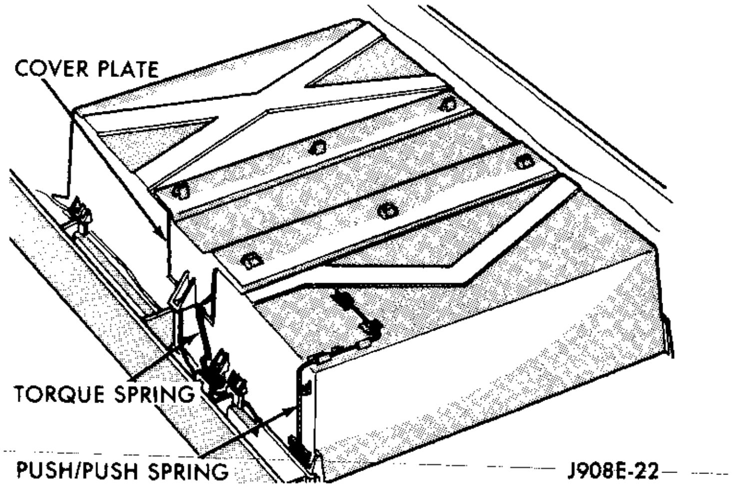


Fig. 9 Remove Cover Plate From Sunglasses Bin

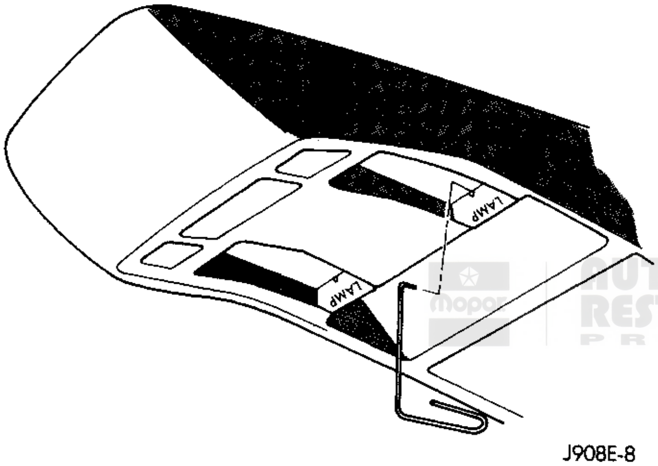


Fig. 7 Map Lamp Lens Removal

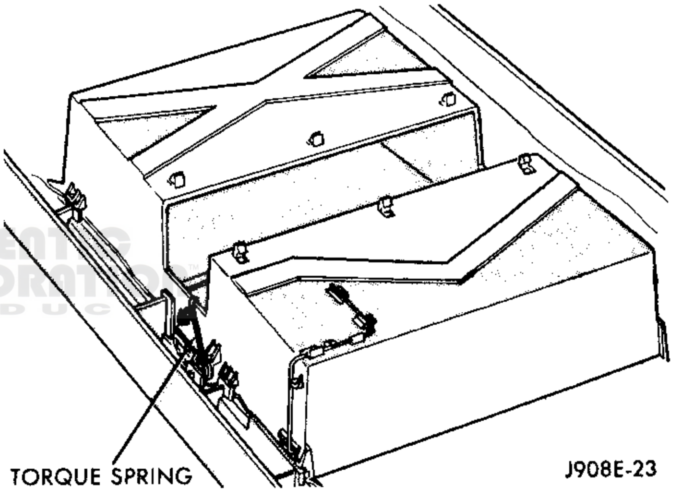


Fig. 10 Release Torque Spring

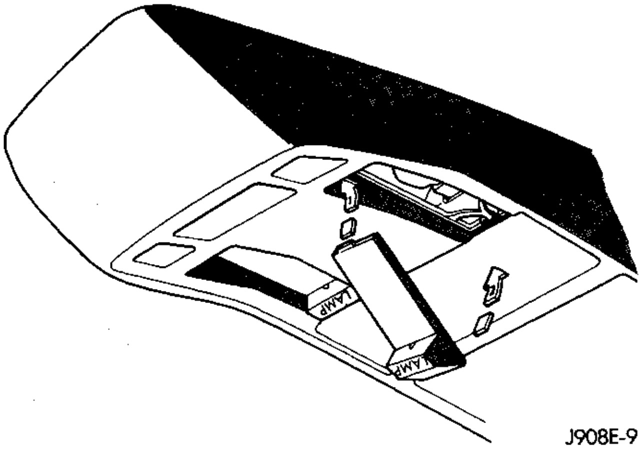


Fig. 8 Map Lamp Lens Installation

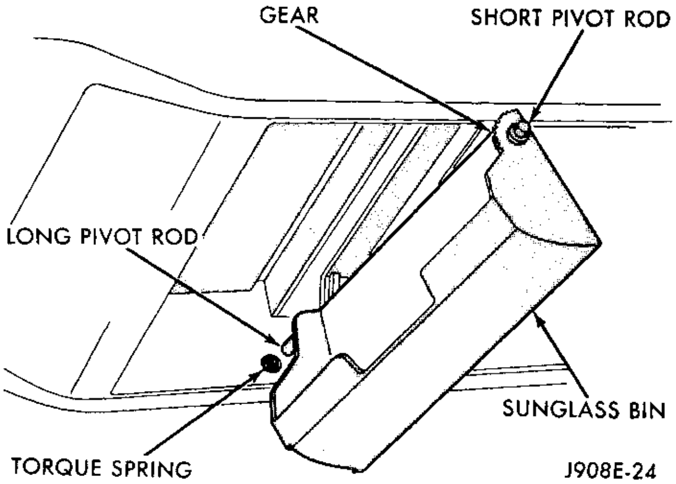


Fig. 11 Remove Sunglasses Bin

RADIO

CONTENTS

GENERAL INFORMATION

INDEX

DESCRIPTION

All radios receive IGN feed from the 20 amp ACCY fuse. There is an additional in-line fuse in the back of the radio chassis. The in-line fuse will blow in the event an internal short occurs.

The ETR cassette radios protect the vehicle in the event of a radio failure with an in-line fuse located in the rear of the radio chassis (Fig. 1).

All vehicles are equipped with an Ignition-Off Draw (IOD) connector which is used when the vehicles are originally shipped from the factory. This connector which is located near the battery, helps to prevent battery discharge during storage. For specific connector type and location refer to Group 8W - Wiring Diagrams.

The (IOD) connector is included in the radio memory circuitry and should be checked if the memory (time or radio station programming) is inoperative.

All radios are also connected to the radio illumination relay. When the ignition switch is placed in RUN or ACCY and the radio illumination relay remains de-energized, the radio receives battery voltage via the relay from the 20 amp ACCY fuse. The radio illumination relay is energized when the headlamp switch is placed in the park or headlight position. Battery voltage from the 20 amp ACCY fuse is switched to the dim display input of the radio through the relay contacts. The radio panel illumination is dimmed for night driving.

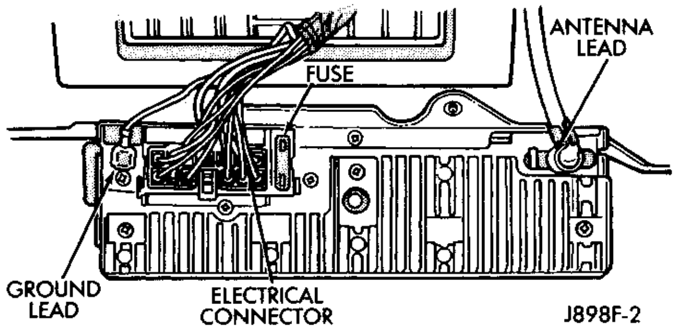


Fig. 1 In-Line Fuse Location

The electronically tuned radio requires an additional connection to the dome/courtesy fuse in order to retain the radio's memory when the ignition switch is turned to OFF.

A standard nonadjustable, whip-type antenna is used on all models.

The electronically tuned (ETR) radio is self compensating. A radio trimmer adjustment is not required.

TROUBLESHOOTING

Troubleshooting Chart Index

CHART NO.	SYMPTOM
1.	Radio Inoperative - No Audio Output, No Background Noise
2.	No Audio Output One Or More Speakers
3.	Distorted Audio Output on One or More Speakers
4.	Weak or No Reception - No Audio Output, Background Noise Present
5.	Memory Inoperative
6.	Radio Illumination
7.	Noise Interference Changes With Engine Speed

1. RADIO INOPERATIVE

a. ACCESSORY FUSE: Turn ignition switch to RUN

TEST	OK	NOT OK
Inspect fuse	Not blown	Replace fuse
Measure voltage at battery side of fuse	Battery voltage	Repair open from ignition switch

b. IN-LINE FUSE: Turn ignition switch to RUN

TEST	OK	NOT OK
Inspect fuse	Not blown	Replace fuse
Measure voltage at battery side of fuse	Battery voltage	Repair open from fuse panel

c. GROUND: Turn ignition switch to OFF; radio connector separated from radio

TEST	OK	NOT OK
Measure resistance from radio ground pin to a clean chassis ground	Zero ohms	Repair open between radio connector and ground

2. NO AUDIO OUTPUT ON ONE OR MORE SPEAKERS

a. FRONT SPEAKERS; Radio Off, radio connector disconnected

TEST	OK	NOT OK
Measure resistance between radio connector pins 2 and 12 (left); Pins 6 and 9 (right)	5 to 8 ohms If OK, remove radio for service	Repair wiring or replace speakers as required

b. REAR SPEAKERS; Radio Off, radio connector disconnected connector disconnected

TEST	OK	NOT OK
Measure resistance between radio connector pins 1 and 13 (left); Pins 7 and 8 (right)	5 to 8 ohms If OK, remove radio for service	Repair wiring or replace speakers as required

3. DISTORTED AUDIO OUTPUT ON ONE OR MORE SPEAKERS; Radio ON

TEST	OK	NOT OK
Substitute known good speaker or speakers	Non-distorted audio output	Remove radio for service

4. WEAK OR NO RECEPTION; NO AUDIO OUTPUT; BACKGROUND NOISE PRESENT; Ignition Switch in RUN, Radio ON*

TEST	OK	NOT OK
Check that antenna mast is raised - XJ ONLY	Mast raised	Go to Power Antenna testing
Inspect antenna cable and connector at radio	Not disconnected, loose or broken	Reconnect or replace antenna lead-in cable as required
Unplug coax cable from radio. Measure resistance from center conductor to coaxial shield	Infinite resistance (open)	Replace antenna assembly
Antenna mast to tip of center conductor at radio end of cable	0 to 0.5 ohms	Replace antenna lead-in cable or antenna assembly
Measure resistance from coaxial shield to chassis ground (vehicle body)	Zero ohms	Ground antenna base to vehicle body, or replace antenna assembly as required

*For all problems with no or low audio output not resolved by this test, remove radio for service.

5. MEMORY DOES NOT OPERATE

FUSE

TEST	OK	NOT OK
Inspect DOME/COURTESY fuse	Not blown	Replace fuse
Measure voltage at battery side of DOME/ COURTESY fuse	Battery voltage	Repair open from fuse link
Measure voltage at radio connector pin 4	Battery voltage If OK remove radio for service	Repair open from fuse panel

6. RADIO ILLUMINATION (PARK AND HEADLIGHTS OPERATING NORMALLY)

a. RADIO ILLUMINATION LAMP: Headlamp switch OFF

TEST	OK	NOT OK
Measure voltage at relay connector pin 4	Battery voltage	Repair open from ACCY fuse
Measure voltage at relay connector pin 3	Battery voltage	Replace radio illumination relay
Measure voltage at relay connector pin 1	Battery voltage	Repair open from radio illumination relay If battery voltage, remove radio for repair by authorized outlet

b. RADIO ILLUMINATION DIMMING CIRCUIT: Turn headlamp switch to PARK for voltage tests; turn headlamp switch to OFF for resistance tests

TEST	OK	NOT OK
Measure voltage at relay connector pin 1	Battery voltage	Repair open from headlamp switch
Separate relay connector from relay. Measure resistance from relay connector pin 2 to a clean chassis ground	Zero ohms	Repair open between relay connector and ground
Measure voltage at relay connector pin 4	Battery voltage	Repair open from ACCY fuse
Reconnect relay to connector. Measure voltage at relay connector pin 5	Battery voltage	Replace radio illumination relay
Measure voltage at radio connector pin 10.	Battery voltage	Repair open from radio illumination relay If battery voltage, remove radio for repair by authorized outlet

7. NOISE INTERFERENCE CHANGES WITH ENGINE SPEED; Radio Interference Suppression

TEST	OK	NOT OK
Inspect connections at: —Alternator —Ignition module —Antenna coaxial ground —Radio ground —Body to Engine Block (braided ground strap)	Inspection points OK	Repair connections as required
Inspect ignition secondary: —Wire routing —Condition of wire insulation —Distributor	Secondary OK	Reroute or replace wiring

XJ AND MJ

INDEX

RADIO REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove the instrument panel bezel attaching screws (Fig. 1) and remove the bezel.

(3) Remove the radio attaching screws (Fig. 2).

(4) Disconnect the radio electrical connector, ground lead and antenna lead (Fig. 3).

(5) To install radio, route the harness above and to the right of the radio cavity and install the radio making sure that the clip on top of the radio (Fig. 4) is installed on mating slot in the dash.

(6) Reverse the removal procedures to finish installing the radio.

RADIO SPEAKERS

Front Door-Mounted Radio Speakers

(1) Remove the interior door latch release assembly and control panel retaining screws (Fig. 5).

(2) Disconnect the control linkage and the wire harness connector.

(3) Remove the latch release and control panel assembly.

(4) Remove the armrest lower retaining screws.

(5) Swing the armrest downward to a vertical position. This is necessary to disconnect the armrest from the upper retainer clip (Fig. 6).

(6) Pull the armrest straight out from the trim panel.

(7) Remove the trim panel with a wide flat blade tool (Fig. 7).

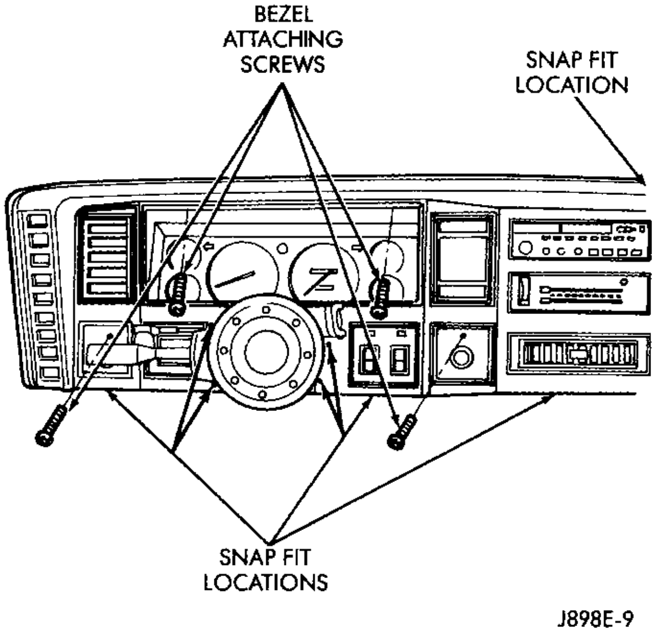


Fig. 1 Instrument Bezel Removal/Installation

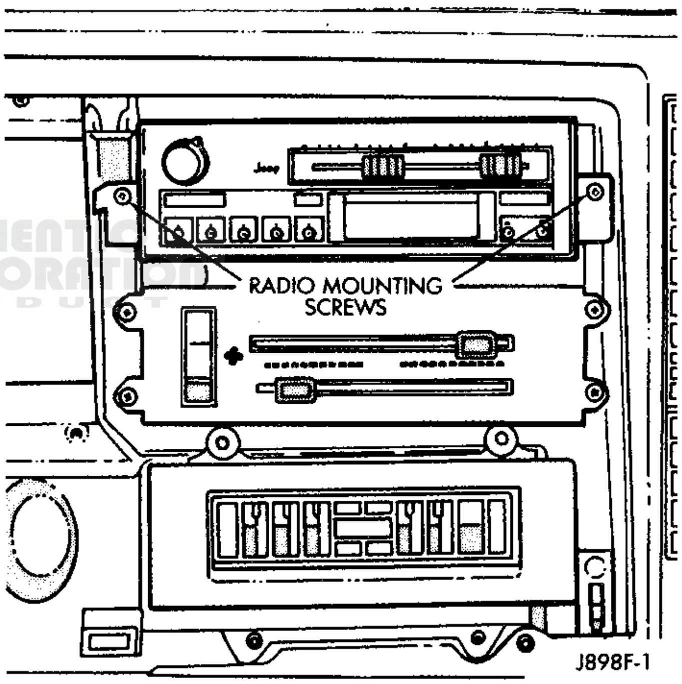


Fig. 2 Remove/Install Radio Mounting Screws

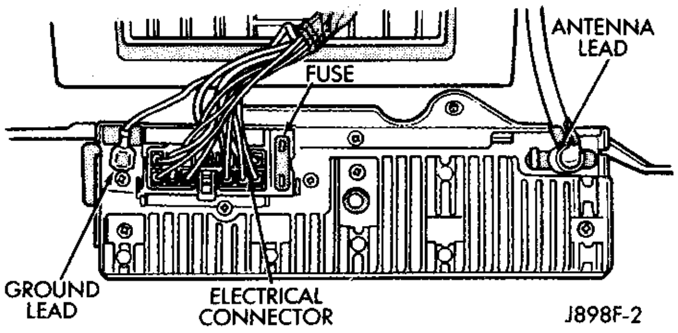


Fig. 3 Disconnect/Connect Radio Wiring Harnesses

To aid in removal of the trim panel, start at the bottom of the panel.

(8) Remove the speaker attaching screws and disconnect the speaker at the wire harness.

(9) To install a speaker, connect the speaker wire harness and reverse the removal procedure.

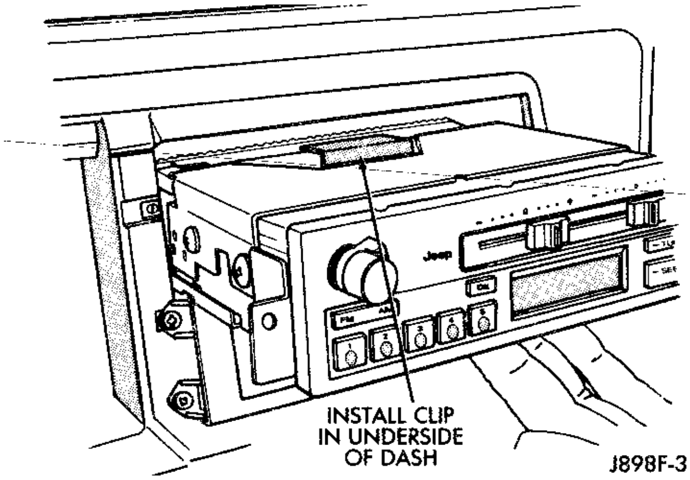


Fig. 4 Install Clip In Underside of Dash

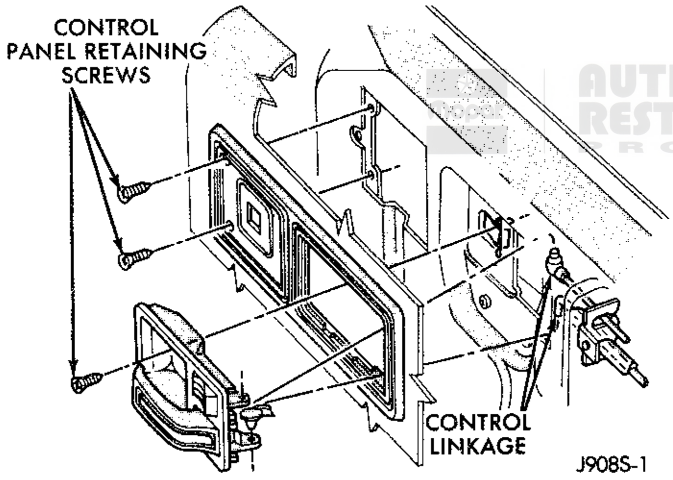


Fig. 5 Power Window Control Panel Removal/Installation

Rear Liftgate-Mounted Radio Speaker

(1) Remove two screws at the top outside edges of the liftgate trim panel.

(2) Remove the trim panel with a wide flat blade tool (Fig. 8).

To aid in removal of the trim panel, start at the bottom of the panel.

(3) Remove the speaker attaching screws (Fig. 9).

(4) Disconnect the speaker at the wiring harness and remove the speaker.

(5) To install a speaker, reverse the removal procedure.

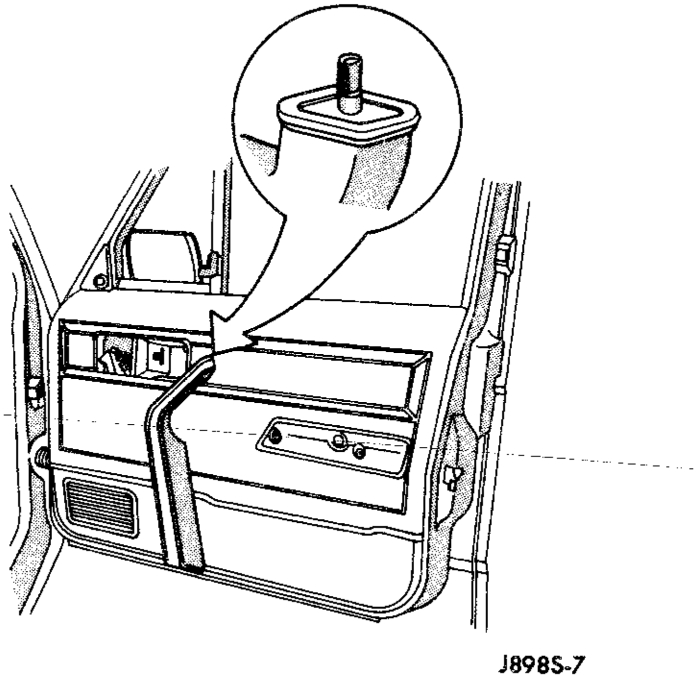


Fig. 6 Armrest Retainer Clip

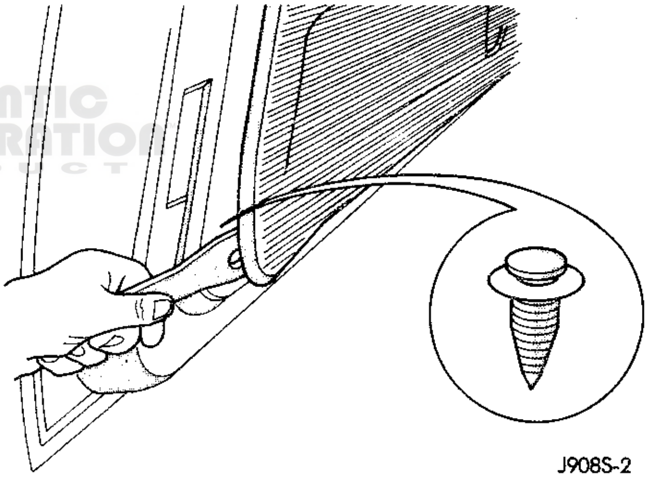


Fig. 7 Trim Panel Removal

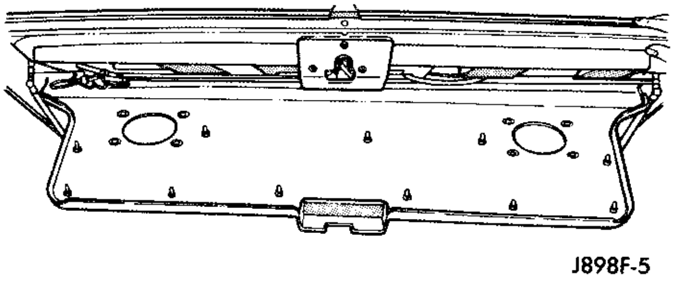


Fig. 8 Liftgate Trim Panel Removal

Rear Side Speakers (MJ)

(1) Remove seat belt anchor.

(2) Pull the trim panel outward to detach the push screws from the holes in the cab sheet metal (Fig. 10).

(3) Remove the trim panel.

(4) Remove the jack from its storage position.

(5) Remove the carpet access flaps to expose the panel retaining bolts (Fig. 11).

(6) Remove the panel retaining bolts.

(7) Pull the center of the trim panel outward to detach the retaining brackets from the cab sheet metal.

(8) Remove the trim panel.

(9) Remove the trim cover that conceals the upper shoulder/seat belt anchor bolt (Fig. 12).

(10) Remove the upper and lower shoulder/seat belt anchor bolts.

(11) Remove the trim cover that conceals the uppermost trim panel retaining screw.

(12) Remove the trim panel retaining screws.

(13) Disconnect the interior lamp wire connectors.

(14) Remove the trim panel.

(15) Remove four screws holding the speaker in place and pull the speaker out of the bracket (Fig. 13).

(16) Disconnect the speaker connector and remove the speaker.

(17) To install the speaker reverse the removal procedures. Tighten the seat belt anchor bolts to 37 N•m (27 ft.-lbs).

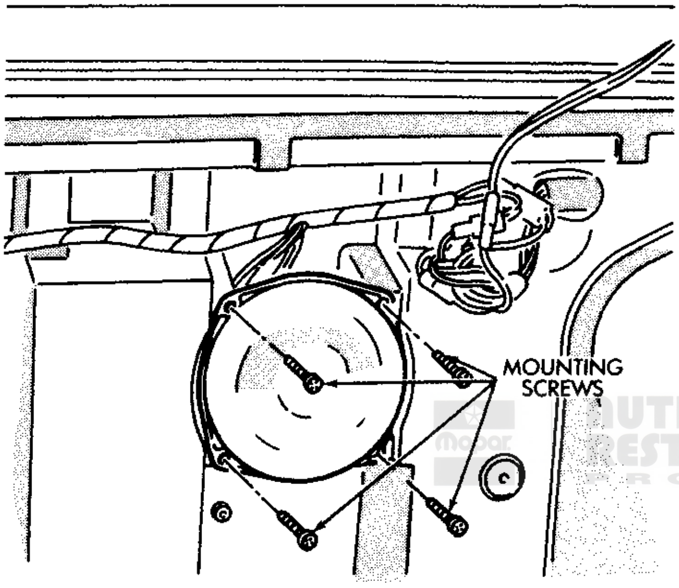


Fig. 9 Liftgate Speaker

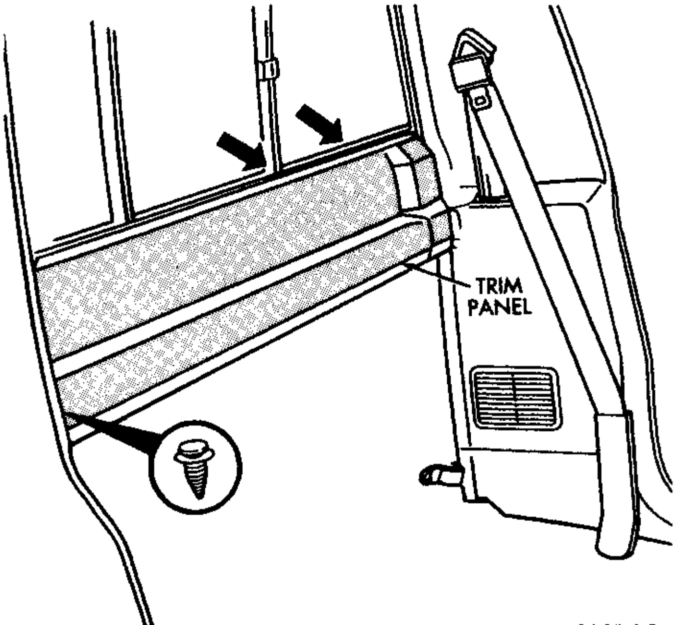


Fig. 10 Rear Cab Trim Panel Removal

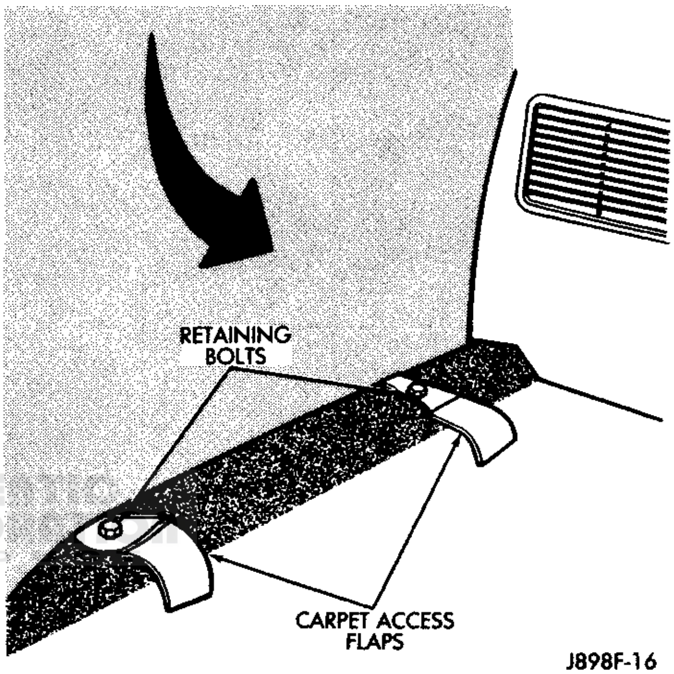


Fig. 11 Lower Rear Cab Trim Panel Removal

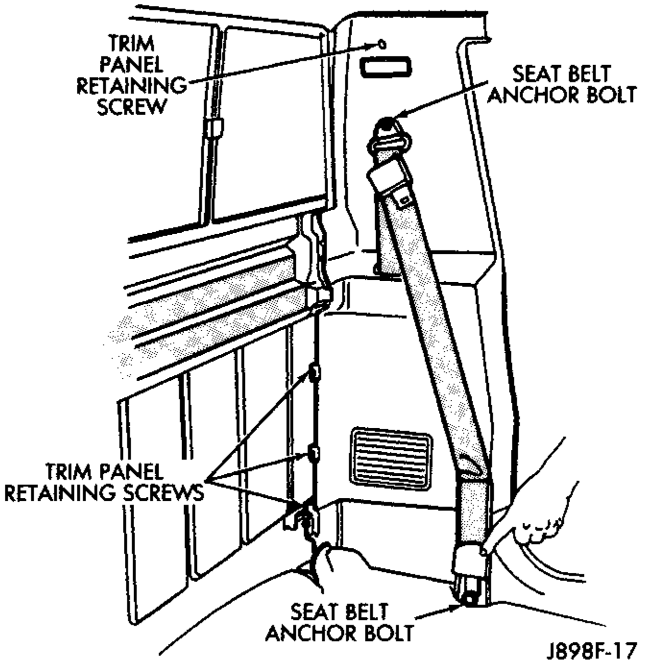


Fig. 12 Side Cab Trim Panel Removal

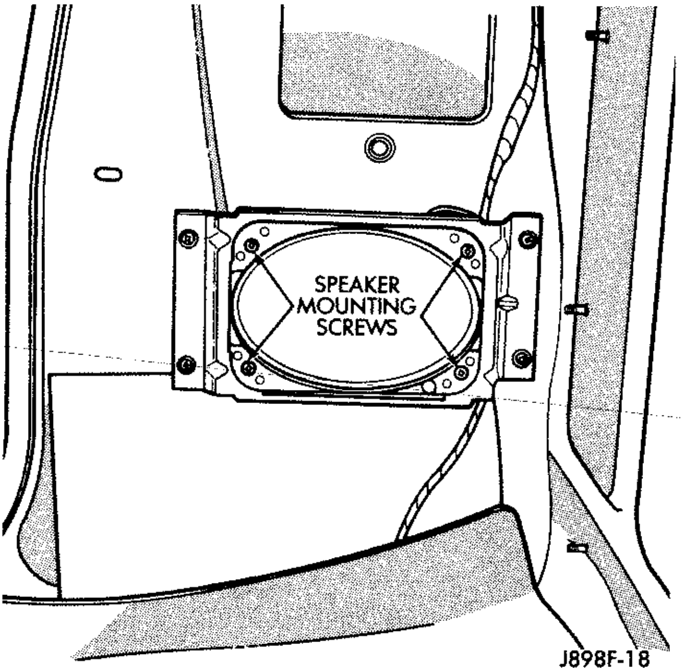


Fig. 13 Rear Side Speaker Removal/Installation

RADIO SCHEMATICS

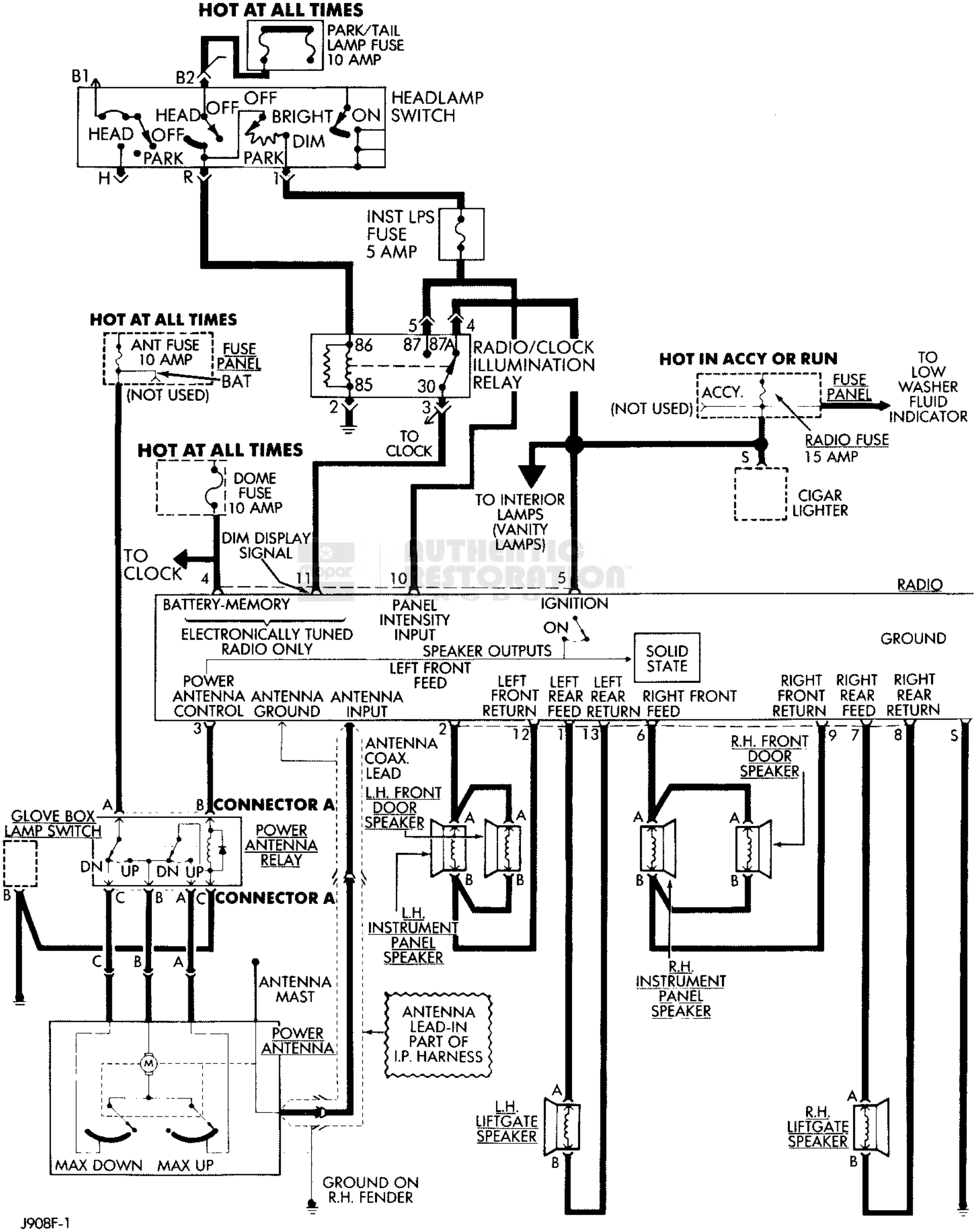


Fig. 14 XJ Radio and Power Antenna Schematic

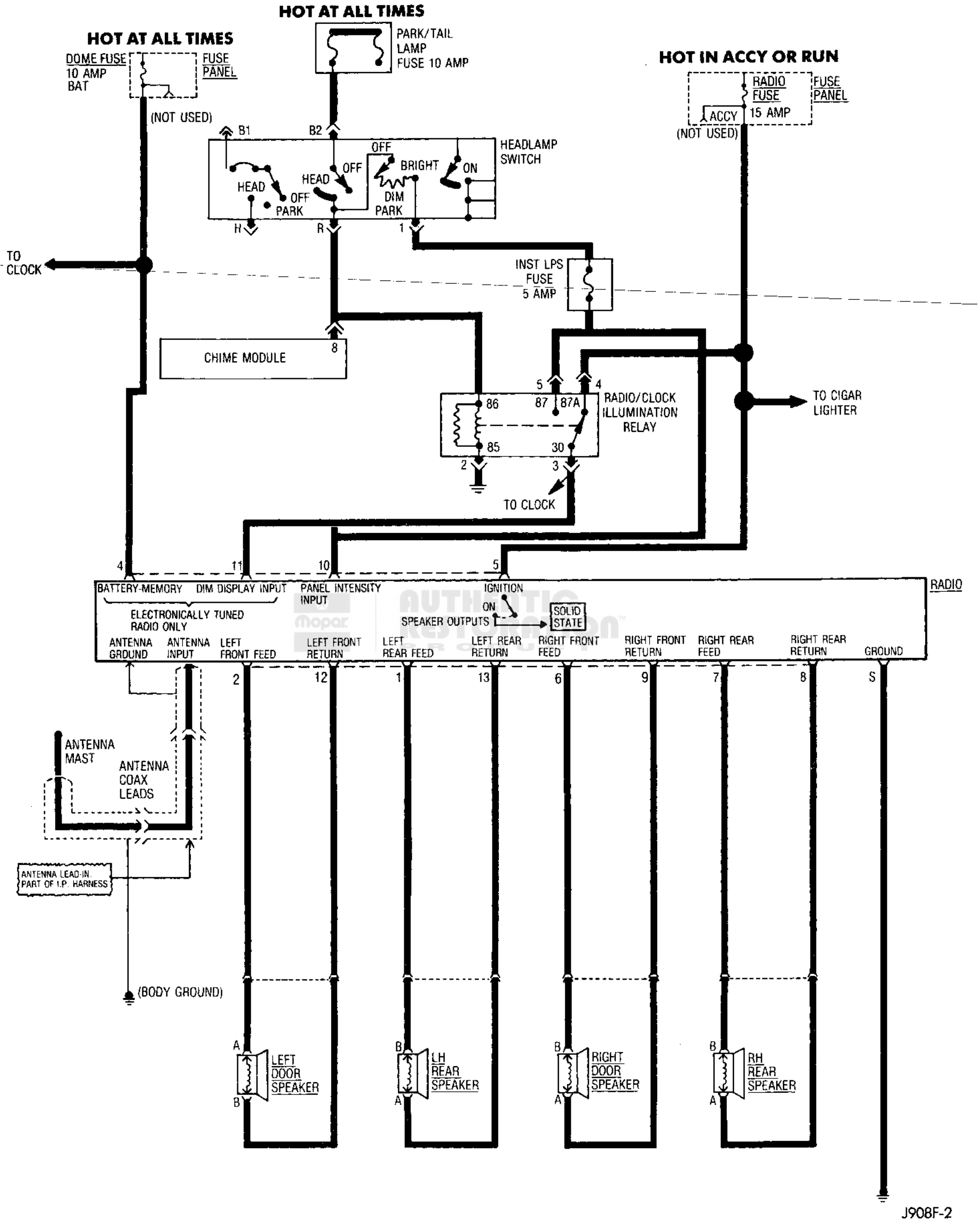


Fig. 15 MJ Radio Schematic

YJ

INDEX

RADIO REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove the gauge cluster panel bezel attaching screws (Fig. 1).

(3) Remove the radio bezel.

(4) Remove the radio attaching screws.

(5) Disconnect the radio antenna cable.

(6) Disconnect the radio wire harness.

(7) Remove the radio.

(8) To install the radio, reverse the removal procedures.

RADIO SPEAKERS

Passenger Side

The speaker is located behind the grille panel at the right end of the instrument panel.

(1) Reach up behind the instrument panel and remove four stamped nuts holding the speaker in place.

(2) Disconnect the speaker electrical connector and remove the speaker.

Drivers Side

The speaker is located behind the grille panel at the left end of the dash panel.

(1) Remove the nuts that attach the parking brake pedal assembly mounting studs to the dash panel. The nuts are accessible from the engine compartment (Fig. 2).

CAUTION: If vehicle is equipped with a rear window wiper, there is a ground wire attached to the top of the bolt that attaches the pedal assembly to the instrument panel.

(2) Remove the bolt that attaches the pedal assembly to the instrument panel and allow the pedal assembly to fall out of the way.

(3) Reach up behind the instrument panel and remove four stamped nuts holding the speaker in place.

(4) Disconnect the speaker electrical connector and remove the speaker.

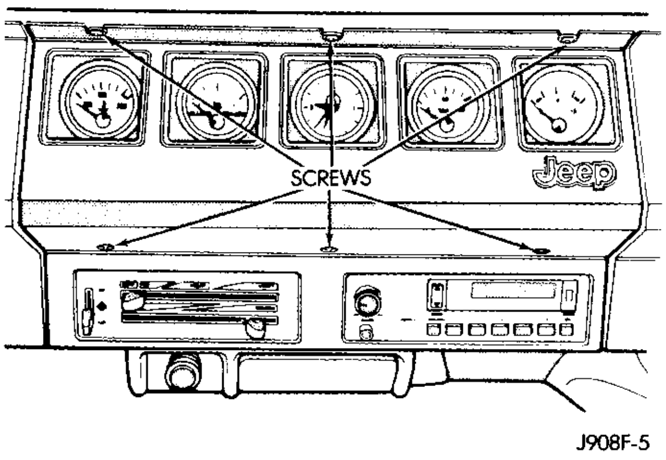


Fig. 1 Gauge Cluster Bezel Removal/Installation

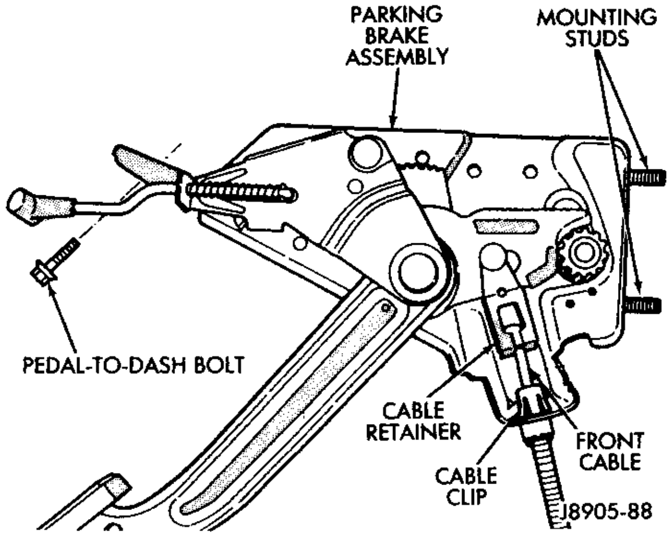
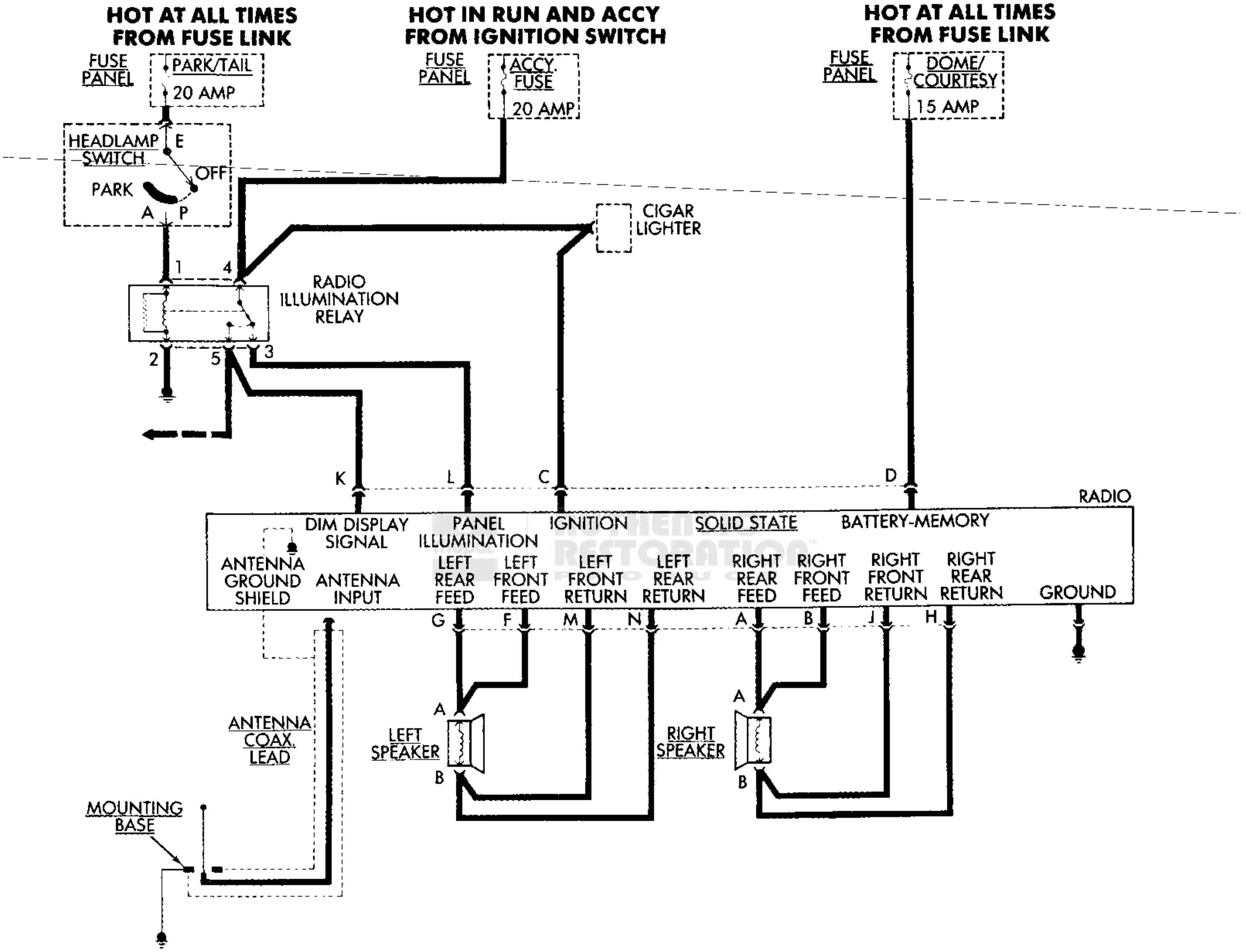


Fig. 2 Parking Brake Assembly

RADIO SCHEMATIC



J908F-3

Fig. 3 YJ Radio Schematic

SJ

INDEX

RADIO REPLACEMENT

The Grand Wagoneer is equipped with a front mount, slide-in type radio.

(1) Disconnect the battery negative cable.

(2) Remove the instrument panel bezel. Unsnap the tabs that retain the bezel in the panel and remove the bezel (Fig. 1).

(3) Remove the radio retaining screws (Fig. 2).

(4) Slide the radio out of the panel only enough for access to the antenna and wiring harness connections.

(5) Disconnect the radio wiring harness connectors and antenna cable and remove the radio.

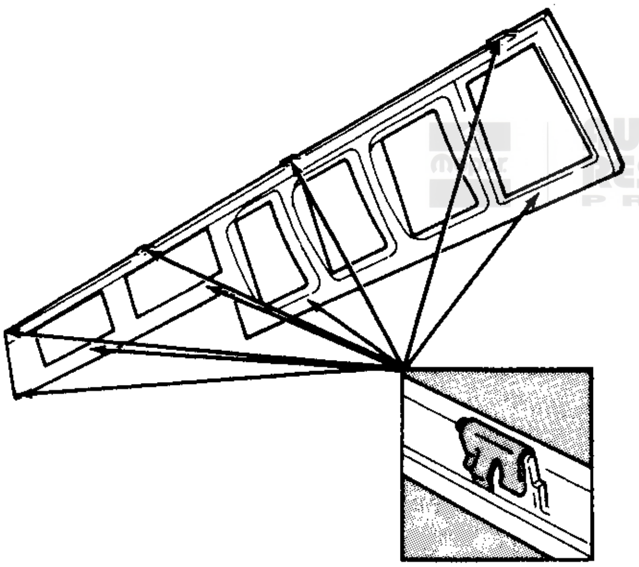


Fig. 1 Instrument Panel Bezel Retaining Clips

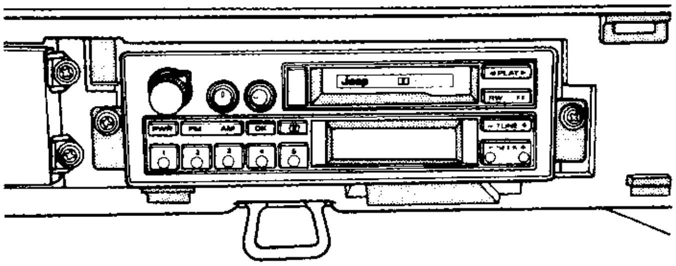


Fig. 2 Radio Removal/Installation

(6) Reverse the removal procedures to install the radio.

SPEAKERS

Front Door Speakers

The trim panels consist of fiberboard covered with a vinyl material. They are fastened to the door with plastic clips inserted into holes in the door inner panel and screws along the bottom edge.

(1) Remove two screws and the overlay on the armrest.

(2) Remove two screws and the armrest.

(3) Remove the woodgrain insert at both ends of the assist handle.

(4) Remove the attaching screws and assist handle.

(5) Remove the power door lock/window bezel.

(6) Remove the trim panel attaching screws on the bottom of the trim panel.

(7) Pry loose the trim panel-to-door clips along the sides with a wide flat blade tool and remove the panel.

(8) Remove the screws holding the speaker to the door.

(9) Remove the speaker from the door and disconnect the speaker connector.

(10) To install a speaker, reverse the removal procedures.

Rear Quarter Speakers

(1) Unsnap the rear quarter interior trim panel and remove the panel.

(2) Remove the four screws holding the speaker.

(3) Pull the speaker out and disconnect the speaker connector.

(4) To install a new speaker, reverse the removal procedures.

RADIO SCHEMATIC

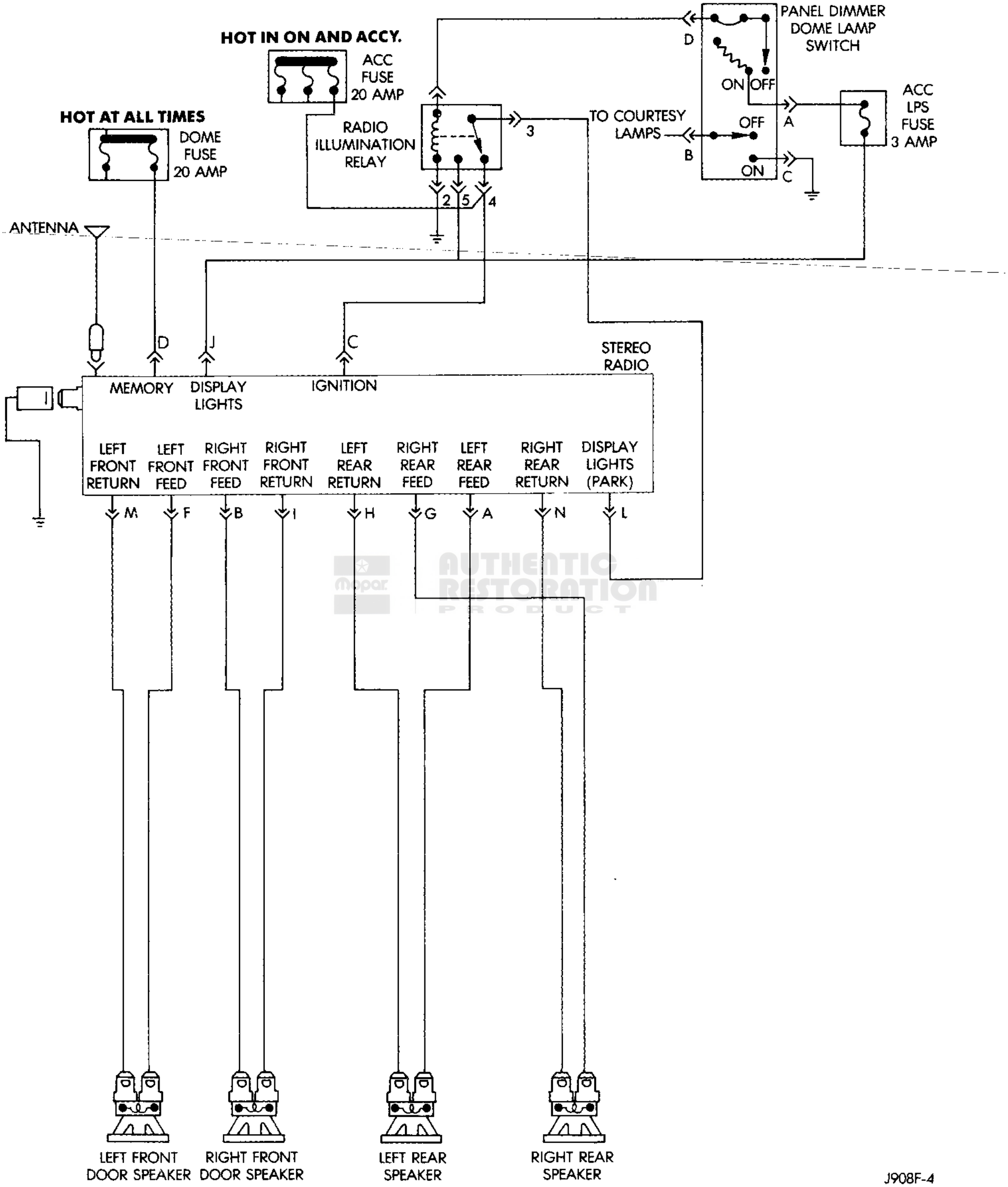


Fig. 3 Radio Schematic - SJ

RADIO INTERFERENCE DIAGNOSIS

INDEX

GENERAL

The object of this diagnosis is to present a systematic approach to troubleshooting interference (noise) problems. First, determine if the noise is normal for common radio reception characteristics. If the noise is abnormal, the following procedures outline methods of determining the interference point of entry and elimination.

There are two major ways interference enters the radio—the antenna and the A-line or power feed wire to the radio.

INTERFERENCE ENTRY

Antenna

Disconnect the antenna. If this causes the noise to stop, the problem is reduced to three possibilities:

- a defective antenna—refer to Antenna Tests
- noise radiated upward from the dash
- noise radiated from the engine compartment

Noise Radiated Upward from the Dash

This noise can be determined by fabricating a tool from a piece of aluminum or copper screen approximately 914.4 mm (36 in) by 304.8 mm (12 in) (Fig. 1).

Lay the screen across the top of the dash and attach the clips to the body grounds. If the noise is diminished or disappears, the noise is being radiated up through the dash.

To determine exactly where the noise source is, a useful noise probe can be improvised from an antenna lead-in cable.

To make the probe, cut or remove the lead-in from the antenna at the antenna, remove approximately 50.8 mm (2 in.) of the outer plastic covering and the woven wire shield (Fig. 2).

Disconnect the original antenna lead-in and plug in the noise probe.

Turn the radio on and use the probe to discover a source of noise. Do not touch the end of the probe with your hand as this would give an incorrect indication. As the probe comes closer to the noise source, loudness of the noise will increase.

If the source is found to be the switch, connect a 0.5-mfd capacitor from the power feed side of the switch to a good chassis ground.

Gauges and sender units generally can be silenced by installing 0.5-mfd capacitors at the pins.

If the source is found to be a wire, reroute the wire, or wrap a piece of wire screen around the wire or wire harness and attach one or more ground leads to the wire screen. It also may be possible to screen off the area found to be radiating noise and ground the screen.

If the noise is found to be an electric motor, install a 0.25-mfd coaxial (feed-through) capacitor in series with the motor.

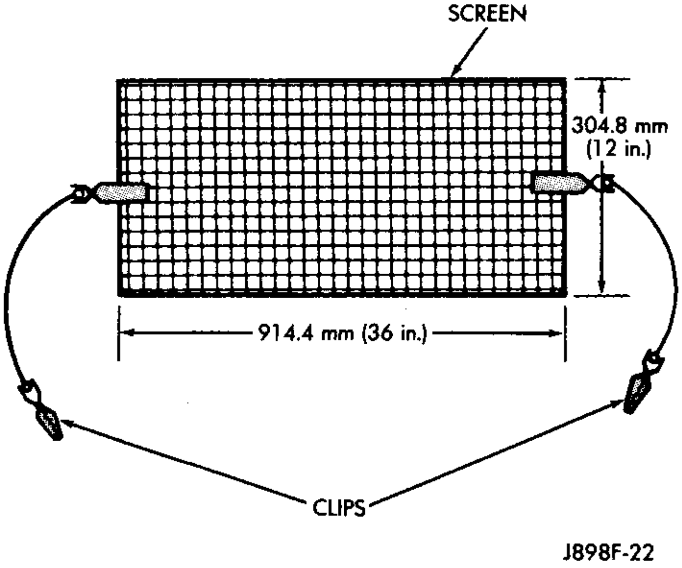


Fig. 1 Fabricate Screen

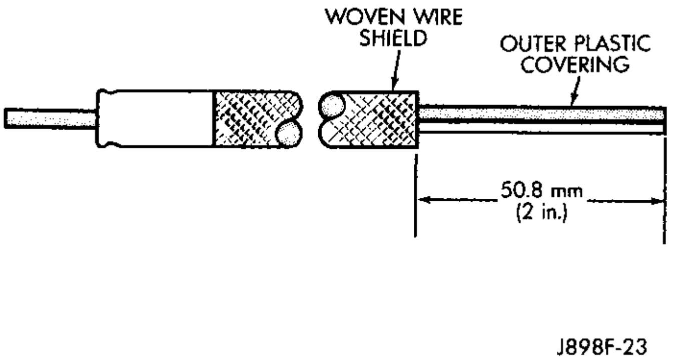


Fig. 2 Fabricate Antenna Probe

Noise Radiated from the Engine Compartment

These noises can be separated into three areas:

- primary ignition noise
- secondary ignition noise
- alternator whine (radiated)

Primary Ignition Noise

This type of noise generally affects the AM band. The noise usually appears as:

- frequency varying with the engine rpm
- loudness varying with the engine rpm
- stops instantly when the ignition is turned to the OFF position and turned to the Accessory position

The first two classifications are usually the result of poor grounds on the coil capacitors or a wire routing problem. Cleaning the grounds or rerouting the wires may solve the problem.

The extra long antenna lead-in prepared as a noise probe may be used as a probe for ignition noise.

Remove the ignition coil and its mounting bracket. Clean the paint off the bracket and the engine block, then assemble tightly. In many cases, this helps reduce the amount of interference radiated from the ignition system. Also, the installation of a hood bonding strap or device will help reduce the interference radiated from the ignition system. Be sure to check the coil polarity.

In some rare cases, extra suppression may be required if the automobile is operating in fringe areas. For those special cases, perform the following steps.

Install a 0.1-mfd coaxial capacitor as close as possible to the coil battery pin, not distributor pin. Do not use an ordinary bypass capacitor.

Install a 0.005-mfd, 1000-volt ceramic disc capacitor at the coil distributor pin.

Install a 0.5-mfd coaxial capacitor at the alternator output pin. Be sure it is rated to handle the maximum alternator voltage.

Secondary Ignition Noise

Secondary ignition noise will always affect FM and, if severe enough, may also affect AM. Normally one of two conditions will be found in the radio:

- ignition noise all across FM band (and possible on AM)
- ignition noise (loud) in between stations but not on a strong station

When these conditions exist in the radio, the problem is more than likely the result of:

- distributor cap carbon ball eroded, or cracked or loose cap
- rotor with a burned carbon contact spot
- secondary wire not seated in the coil or distributor
- defective coil
- an oil film on some of the lead pins
- copper core secondary wiring
- defective or improper spark plugs

If a wire was found not seated, remove the wire and check for a carbonated end. It is not advisable to repair an end pin on the carbon core wire; replace the entire cable.

If the noise in question sounds like one or two cylinders and definitely not all of them, then the problem is after the coil. Using the fabricated noise probe, which plugs into the radio, have someone sit in the automobile and listen to the radio. Move the probe from plug to plug. The person in the automobile should notice an appreciable increase in the noise when the defective plug is reached.

Install resistor spark plugs when experiencing spark plug noise. If the automobile has copper core secondary wiring, these wires should be replaced with original equipment, carbon-core resistor wires.

Alternator Whine (Antenna)

Alternator whine can be described as an annoying, high-pitched whistle, or a siren-type sound that increases and decreases with engine rpm.

Methods of eliminating alternator whine and engine interference noise are as follows.

Install front fender ground straps.

Install hood bonding strap or device.

Run offending wire through shielded (grounded) cable.

Clean slip rings and be sure brushes are making good contact.

A-LINE (POWER FEED WIRE TO RADIO)

If disconnecting the antenna did not eliminate the radio noise, the noise is probably on the A-line.

Motor noise on the A-line is usually the result of voltage spikes on this line being so large that the input filter circuit in the radio cannot handle them. There are two ways to handle this problem.

Locate the cause of line noise and eliminate it.

Add external filters to reduce the spikes to a point where the radio filter can handle the spikes.

A grounded capacitor touched to all hot electrical connections will often identify the offenders (Fig. 3).

The fabricated noise probe also can be used to find noise on the A-line.

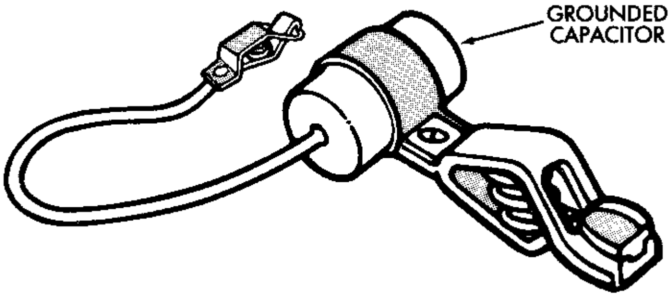


Fig. 3 Fabricate Grounded Capacitor

In general, any adjacent metal parts which are separated by mastic or paint must be connected together electrically.

Effective bonding requires more than physically clean surfaces and self-tapping screws. Tooth-type lockwashers must be used to cut into the surface layers of metal. Grounding straps must be as short and as heavy as possible.

A-line noise is normally the result of:

- alternator whine (A-line)
- wiring harness too close to the ignition wiring
- radio noise suppressor
- poor radio grounding

Alternator Whine (A-Line)

Alternator whine does not stop instantly when the key is turned quickly to the accessory position at fast idle. It is a high pitched whine which increases with rpm. Correct the alternator whine as follows.

Install a 0.5- to 2.0-mfd bypass capacitor from the alternator output pin to the ground.

Install a coaxial capacitor in alternator output wire.

Replace the alternator diodes.

Wiring Harness Close to Ignition Wiring

Noise carried to the radio can normally be corrected as follows.

Relocate the harness wiring away from the ignition wires.

Install 0.5-mfd capacitors on each fuse panel lead. Be sure the capacitor is grounded.

Poor Radio Ground

To check for a poor ground, attach a jumper wire to the radio case and connect the jumper to a good chassis ground. If there is no change in radio noise, the radio has a good ground.

If the noise changed, check for loose mounting screws and a poor ground.

Defective Radio

Exchange with known good radio to determine if the radio is defective.

Direct Entry into the Radio

Be sure the radio has a good ground.

Tighten all the radio chassis screws.

Wheel and Tire Static

Wheel static is another source of interference. This is a running noise most likely to be encountered when the automobile is in motion on a hard, dry-surfaced road. The noise will remain when the automobile is coasting with the engine and all electrical equipment turned off. The static occurs in the front wheels due to insulating film produced by the lubricant in the wheel bearings.

In some instances, static discharges take place between the tire and the road surface. An antistatic powder kit is available from radio supply houses which applies conducting material to the inside surface of the tire to eliminate noise from this source. Tire static can be checked by washing the tire with water. The water provides a conduction path to ground for the discharges. Tire static is most likely to be encountered during hot, dry seasons.

Turn Signals and Stop Lamps

The turn signal flasher and the switch in the stop lamp circuit may cause popping noises in the radio. In most cases, the noises are interference due to arcing in the contacts. The correction is a 0.5-mfd bypass capacitor installed at the battery connection of the switch or the flasher. It is less likely, but possible, that the low frequency components of the interruptions are reaching audio stages of the radio. The test is to check if the noise is present with the volume control turned down. If so, install a 1000-mfd condenser.

Horn Noise

The diagnosis and cure for a growling noise in the radio when the horn is operated is the same as for Turn Signals and Stop Lamps. The suppressor capacitors are installed at the point where the battery lead feeds the horn relay.

Be sure the horn relay cover is not loose.

Accessories

Electric windshield wipers, blower motors, window regulator motors, or any brush-type motors, generally can be suppressed by installing 0.25-mfd capacitors at the pins.

STANDARD RADIO ANTENNA

INDEX

GENERAL INFORMATION

AM/FM radio model antennas must have a good ground to eliminate static. The antenna mast is connected to the inner wire of the co-axial cable and is not grounded to any part of the vehicle. The coaxial shield (the wire mesh) surrounding the center conductor wire of the antenna lead-in cable is grounded to the radio and the antenna base.

REPLACEMENT

XJ AND MJ

(1) Remove the fender inner splash panel mounting nuts (Fig. 1) and move the panel aside to gain access to the antenna base and cable.

The splash panel screws may be covered with undercoating.

(2) Remove the antenna mast, nut and antenna pad from the top of the fender (Fig. 2).

(3) Remove the passenger side kick panel.

(4) Disconnect the antenna lead (Fig. 3) by pulling apart while twisting the metal connectors. DO NOT PULL ON THE COAX CABLE.

(5) Pull the rubber grommet out of the kick panel.

(6) Remove the antenna assembly from the inside of the wheelhouse.

(7) To install the antenna, reverse the removal procedure.

(8) Verify antenna and radio operation.

(9) Apply 3M Rubberized Undercoating, or equivalent to the splash panel screws.

YJ

(1) Remove the radio as described in Radio Replacement.

(2) Remove three screws holding the antenna base and pad to the body (Fig. 4).

(3) Pull the antenna and cable out of the vehicle.

(4) To install the antenna, make sure the antenna pad is placed over the cable and guide the cable under the instrument panel.

(5) Secure the antenna base and pad with three screws.

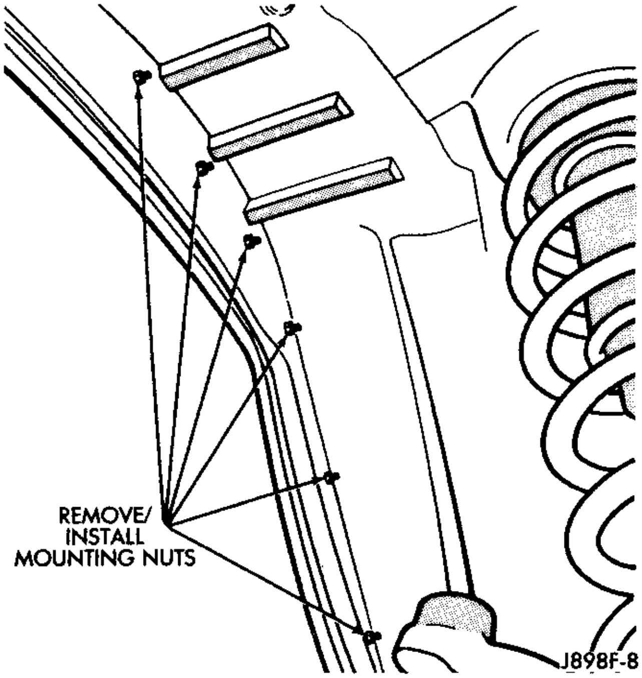


Fig. 1 Remove/Install Fender Inner Splash Panel

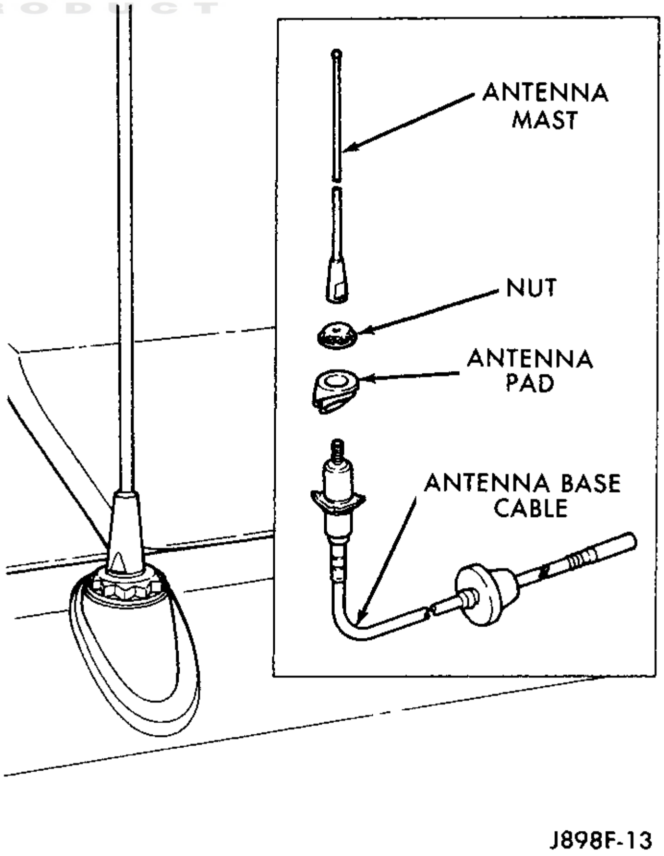


Fig. 2 Remove/Install Nut and Antenna Pad

(6) Install the antenna into the radio and install the radio.

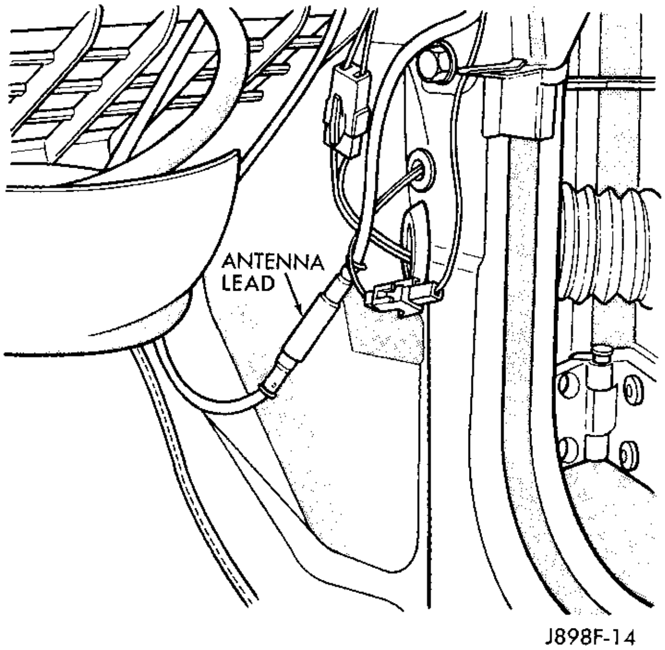


Fig. 3 Disconnect Antenna Lead

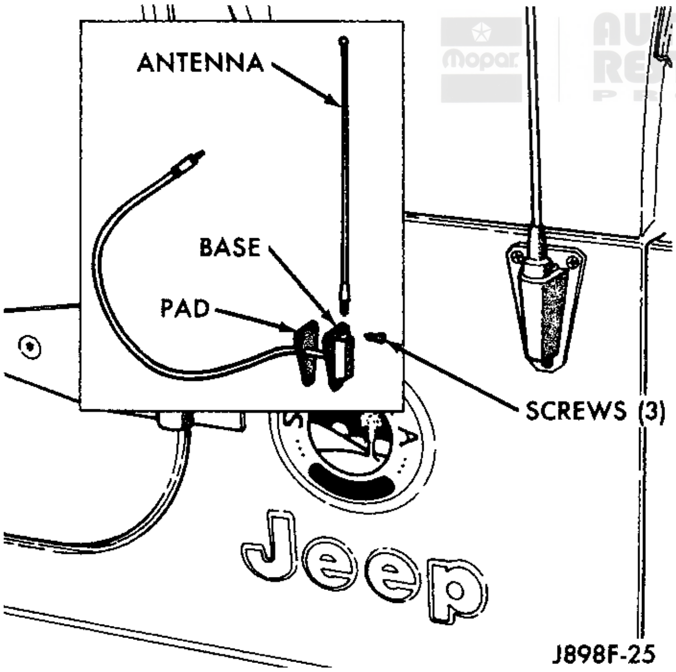


Fig. 4 Antenna Removal/Install - YJ

SJ

(1) Using a thin blade tool, pry off the antenna cap.

(2) Remove four screws holding the antenna pad to the body.

(3) Remove the radio as described in Radio Replacement.

(4) Pull the antenna cable grommet out of the kick panel and remove the antenna.

(5) To install an antenna cable, reverse the removal procedures.

ANTENNA TESTS

Antenna ground continuity is checked with an ohmmeter. The following four tests are required (Fig. 5):

- Mast-to-ground test 1.
- Tip of mast-to-tip of conductor test 2.
- Body ground-to-battery ground test 3.
- Body ground-to-coaxial shield test 4.

Ohmmeter test lead connections are shown in the following schematic.

Mast-To-Ground Test 1.

Test 1. determines if the antenna mast is insulated from the base. Procedure is as follows:

- Connect one ohmmeter lead to the tip of the antenna mast and the other lead to the antenna base.
- With the antenna disconnected from the radio, there should not be continuity.

Tip Of Mast-To-Tip Of Conductor Test 2.

Test 2. checks the antenna for an open circuit as follows:

- Disconnect the antenna cable from the radio.
- Connect one ohmmeter test lead to the tip of the mast and the other lead to the tip of the antenna cable lead-in (the part inserted into the radio).
- Continuity should exist (ohmmeter should only register a fraction of an ohm). High or infinite resistance indicates damage to the base and cable assembly which should be replaced.

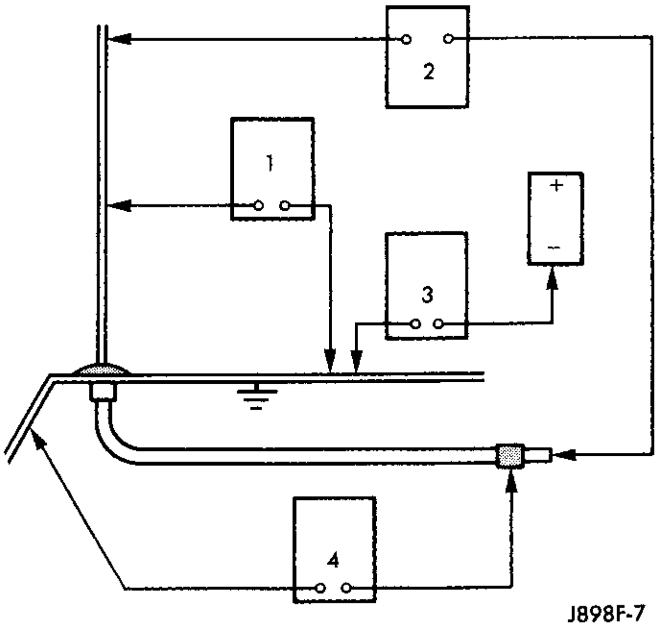


Fig. 5 Antenna Tests

Body Ground-To-Battery Ground Test 3.

Test 3. checks condition of the vehicle body ground connection as follows:

- Connect one ohmmeter test lead to the vehicle fender and the other lead to the battery negative post.
- Resistance should be less than one ohm.
- If resistance is more than one ohm, check the braided ground strap connected to the engine and vehicle body for being loose, corroded, or damaged. Repair as necessary.

Body Ground-To-Coaxial Shield Test 4.

Test 4. checks condition of the ground between the antenna base and vehicle body as follows:

- Connect one ohmmeter test lead to the fender and the other lead to the crimp on the coaxial shield.
- Resistance should be less then one ohm.
- If resistance is more then one ohm, replace the antenna base attaching screws with new cadmium plated screws.

POWER RADIO ANTENNA

INDEX

GENERAL INFORMATION

The power antenna is designed to raise automatically when both the ignition switch and the radio are turned ON. When the ignition is turned ON and the radio is turned OFF, the antenna will return to, or remain in, the retracted position.

The drive gear unit used on the power antenna system consists of two limit switches and a gear-operated cam system to activate the switches. The limit switches are used to open the motor circuits when the antenna mast reaches the full UP position.

The antenna cannot be adjusted to an intermediate position. It must be fully extended or retracted.

When the radio or ignition is turned OFF, the relay coil is de-energized which switches battery voltage to the motor through the closed lower limit switch. The antenna then retracts until the lower limit switch opens.

DESCRIPTION

When the radio is turned ON battery voltage is applied to the antenna relay coil connector A, pin B. The antenna relay contacts close, and battery voltage is applied from the ETR fuse to the relay contacts to connector B, pin B; and then to the antenna motor. The other motor pin is grounded through the up switch and the relay contacts. The motor drives the antenna up. At the end of its travel the up switch opens and the motor stops.

When the radio or ignition is turned OFF, the circuit through the power antenna relay coil relay is opened. The contacts open to the position shown in the schematic (Fig. 14) applying battery voltage to pin C. Pin B is now grounded. The voltage to the motor has reversed polarity. At the end of its travel the down switch opens and the motor stops.

REPLACEMENT

(1) Remove the fender inner splash panel mounting nuts (Fig. 1) and move the panel aside to gain access to the antenna mounting screws.

The splash panel screws may be covered with undercoating.

(2) Remove the escutcheon and antenna pad from the top of the fender (Fig. 2).

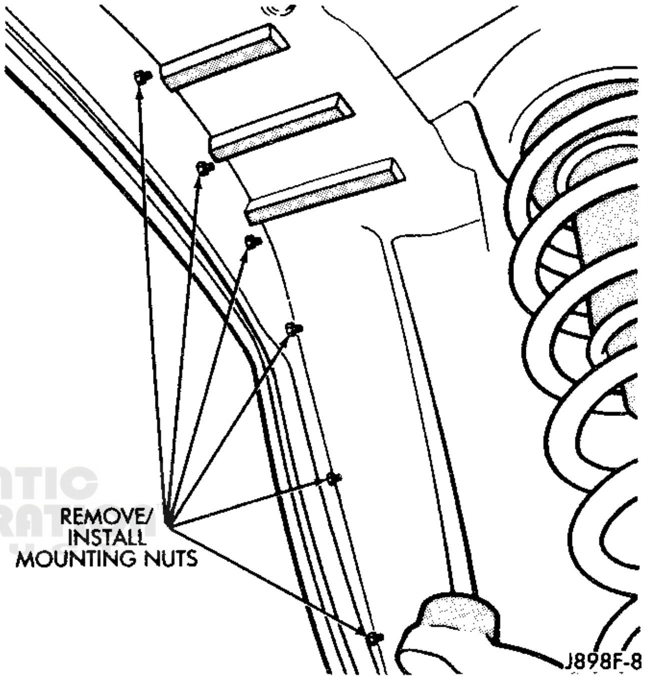


Fig. 1 Remove/Install Fender Inner Splash Panel

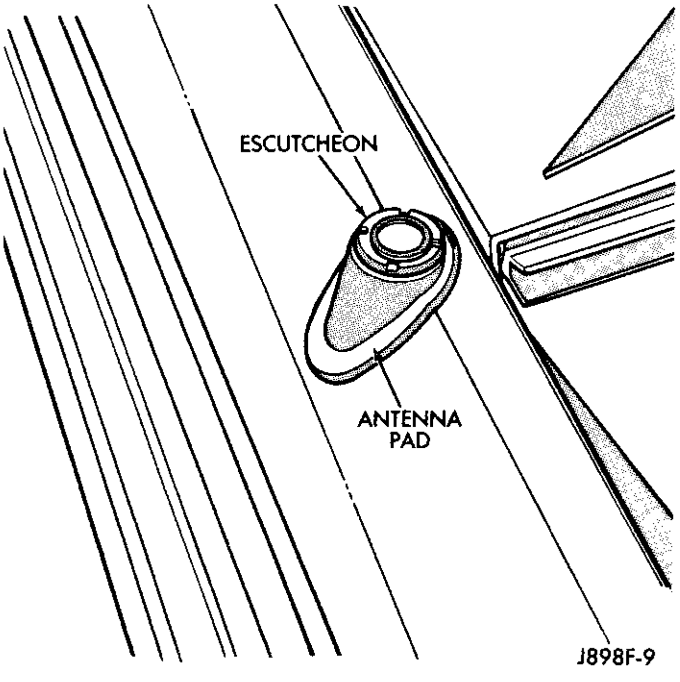


Fig. 2 Remove/Install Escutcheon and Antenna Pad

(3) Remove the passenger side kick panel.

(4) Disconnect the antenna lead (Fig. 3).

(5) Disconnect the harness from the relay.

The relay is located behind the right hand side of the dash just above the lower edge.

(6) Remove the antenna mounting bolts and washers (Fig. 4).

(7) Pull the rubber grommet out of the kick panel (Fig. 5).

(8) Pull the antenna motor harness through the hole in the kick panel.

(9) Remove the antenna assembly from the inside of the wheelhouse.

(10) To install the antenna, reverse the removal procedure.

(11) Verify antenna and radio operation.

(12) Apply 3M Rubberized Undercoating, or equivalent to the screws.

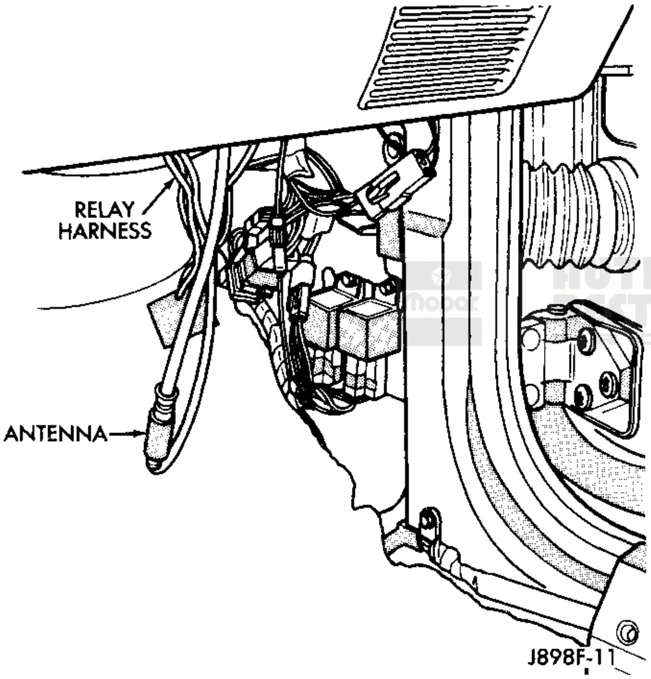


Fig. 3 Disconnect Antenna

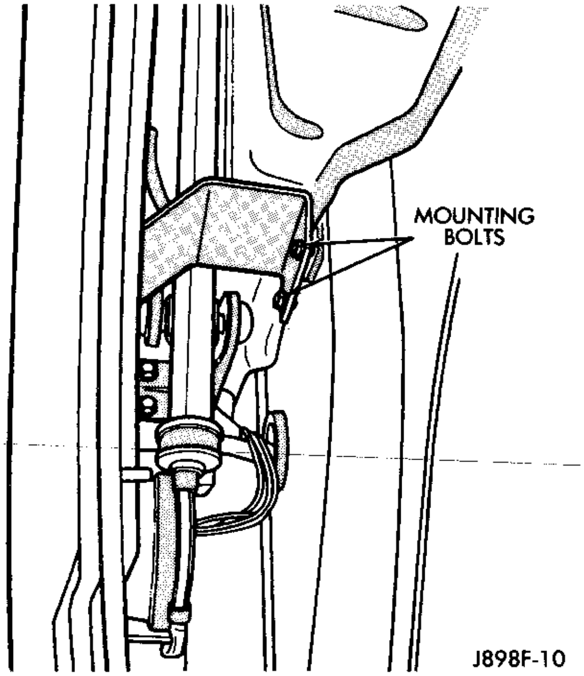


Fig. 4 Remove/Install Antenna Mounting Bolts

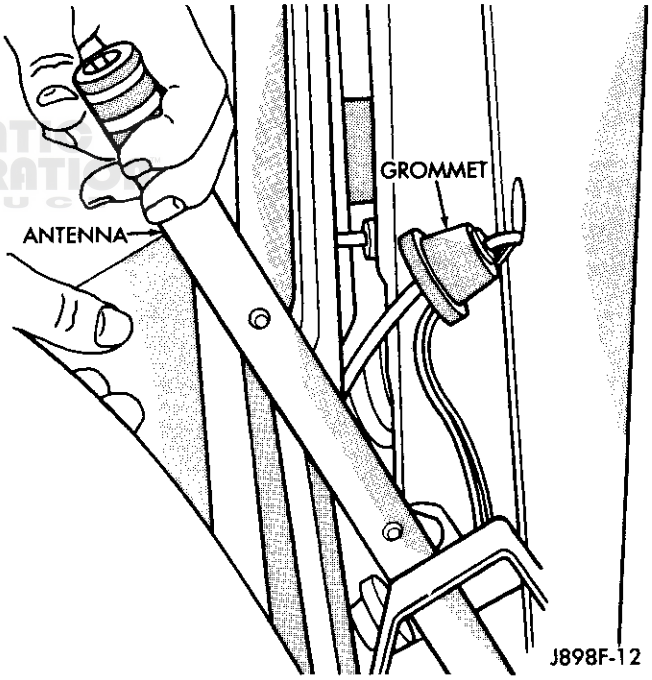


Fig. 5 Remove/Install Grommet

ANTENNA RELAY SERVICING

(1) Remove the passenger side kick panel.

(2) Disconnect the antenna harness from the relay.

(3) Remove the relay retaining screws, and remove the relay.

(4) To install the relay, reverse the removal procedures.

TROUBLESHOOTING

1. POWER ANTENNA RELAY; Radio in ON, both relay connectors disconnected

TEST	OK	NOT OK
Connector A pin A	Battery voltage	Repair open to ETR fuse
Connector A pin B	Battery voltage	Repair open to radio
Connector A pin C	Zero ohms	Repair open to ground

2. POWER ANTENNA; Connectors unplugged from relay

TEST	OK	NOT OK
Jumper test leads: Connector B pin B to connector A pin C	Next step	
Jumper test leads: Connector A pin A to connector B pin A	Antenna goes up	Replace Power Antenna
Jumper test leads: Connector A pin A to connector B pin C	Antenna goes down	Replace Power Antenna If antenna goes up and down replace Power Antenna Relay

HORNS

CONTENTS

GENERAL INFORMATION

Battery voltage is applied to the horn relay when ignition switch is in the RUN or ACCY position.

When the horn switch is depressed, the horn relay is grounded, pulling the contact closed and providing battery voltage to the horns.

A slip ring and brush arrangement in the steering wheel allows the switch circuit to maintain contact while allowing rotation of the steering wheel.

A cadmium-plated ground screw is used to attach the horn(s) to the body. Do not substitute other types of ground screws as they may become corroded and cause a loss of ground.

TORQUE SPECIFICATIONS

COMPONENT	SERVICE SET-TO TORQUE	SERVICE RECHECK TORQUE
Horn Bracket Screw	20 N•m (15 ft-lbs)	11-23 N•m (8-17 ft-lbs)

XJ AND MJ

INDEX

REPLACEMENT

(1) Raise and support the vehicle.

(2) Remove the splash shield.

(3) Remove horn mounting bolt and horn mounted on the drivers side.

(4) Remove mounting bolts holding the vacuum canister on the passenger side. DO NOT remove the vacuum hoses from the vacuum canister.

(5) Remove horn mounting bolt and remove horn.

(6) To install, reverse the removal procedures.

DIAGNOSIS AND REPAIR

Refer to Group 8W-Wiring Diagrams for a complete circuit diagram.

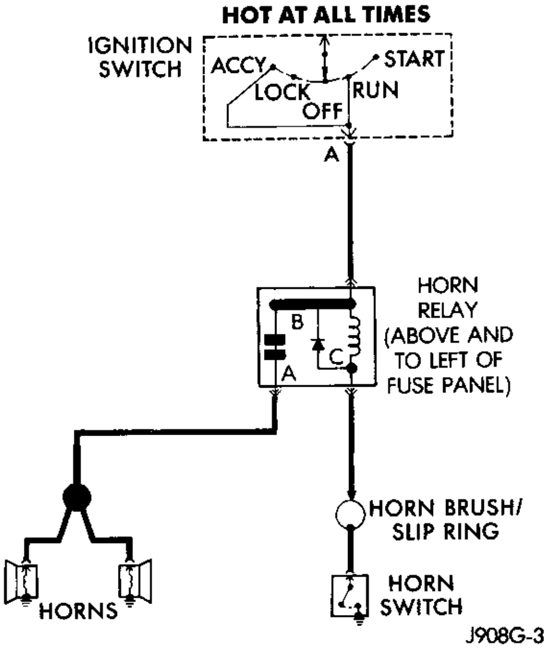


Fig. 1 Horn Circuit Schematic

1. **HORN RELAY: Ignition in ACCY**

TEST	OK	NOT OK
Depress Horn Switch	Relay contacts click If OK, go to step 2	Next step
Relay connector pin B (Remove relay)	Battery voltage	Repair open in circuit to relay
Relay connector pin A (Horn Switch depressed)	Zero ohms	Repair open to Horn Switch ground
Relay connector pin C	Almost zero ohms (horn resistance) If OK, replace relay	Repair open to in circuit between relay and horns

2. **HORNS: Ignition in ACCY, unplug horn connector, depress horn switch**

TEST	OK	NOT OK
Voltage at horn terminals	Battery voltage If OK, replace horns	Repair open to relay

YJ

INDEX

Wrangler/YJ horns are located on the inner left wheelhouse.

REPLACEMENT

(1) Remove wire harness from the horn by pulling on the hard shell connector (Fig. 2). DO NOT attempt to remove harness from horn by pulling on the wire because a special locking connector is used.

(2) Remove horn assembly screw.

(3) To install, reverse the removal procedures.

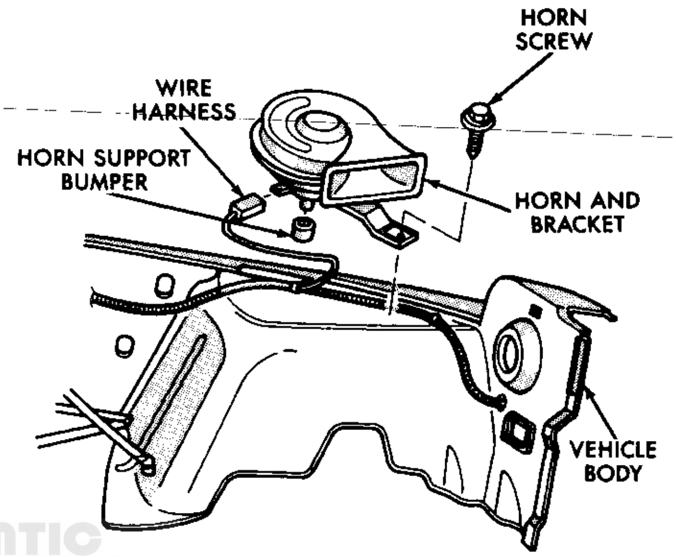


Fig. 2 YJ Horn Removal/Installation

DIAGNOSIS AND REPAIR

Refer to Group 8W-Wiring Diagrams for a complete circuit diagram.

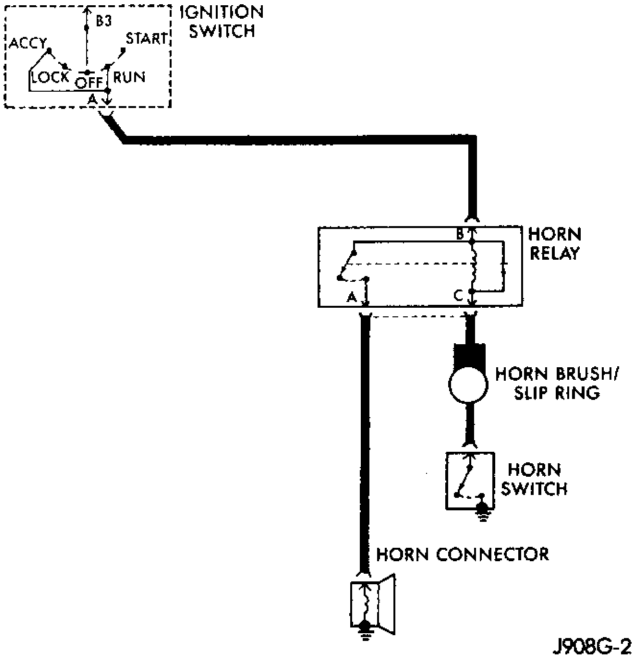


Fig. 3 Horn Circuit Schematic

1. HORN: Horn switch is depressed; ignition in RUN for voltage test only

TEST	OK	NOT OK
Horn connector	Battery voltage, horn sounds	Battery voltage; replace horn Zero volts; test relay
Horn bracket to chassis ground	Zero ohms	Check mounting screw for corrosion and replace as necessary

2. HORN RELAY: Key ON

TEST	OK	NOT OK
Relay connector pin B	Zero volts	Repair open to horn switch
Relay connector pin C	Battery voltage	Repair open from ignition switch
Relay connector pin A	Battery voltage, horn sounds	Battery voltage; repair open to horn terminal 0 volts; replace relay

SJ

INDEX

Grand Wagoneer horns are located on the radiator grille face behind the plastic grille. The grille must be removed to gain access to the horns.

REPLACEMENT

(1) Remove the plastic drive rivets attaching the grille by pulling out the small tab.

(2) Remove the grille.

(3) Remove wire harness from the horn by pulling on the hard shell connector. DO NOT attempt to remove harness from horn by pulling on the wire because a special locking connector is used (Fig. 4).

(4) Remove the attaching bolt and horn.

(5) To install, reverse the removal procedures.

DIAGNOSIS AND REPAIR

Refer to Group 8W-Wiring Diagrams for a complete circuit diagram.

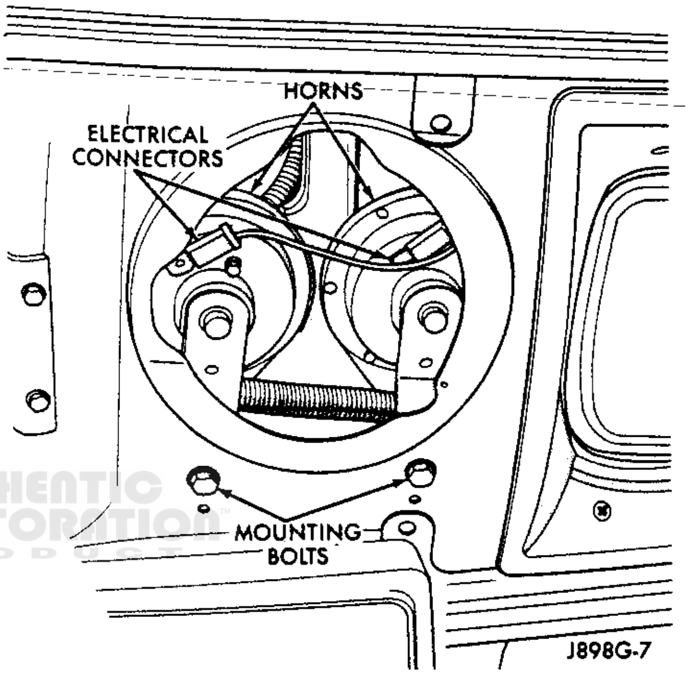


Fig. 4 SJ Horns

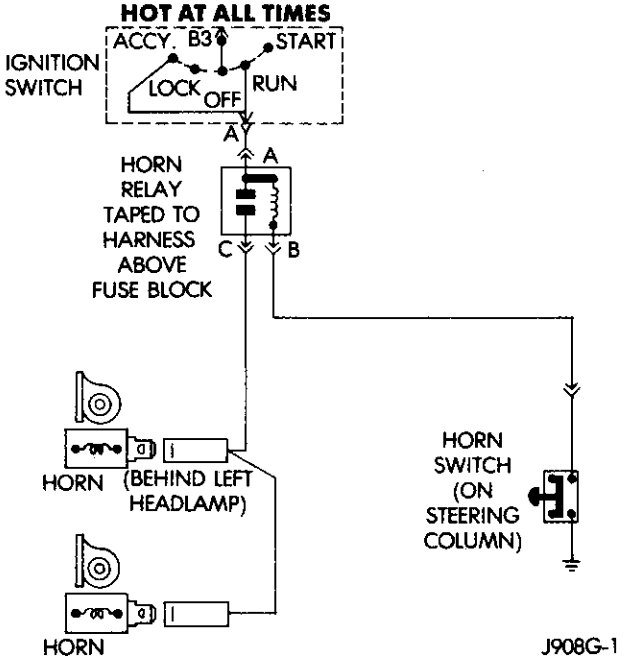
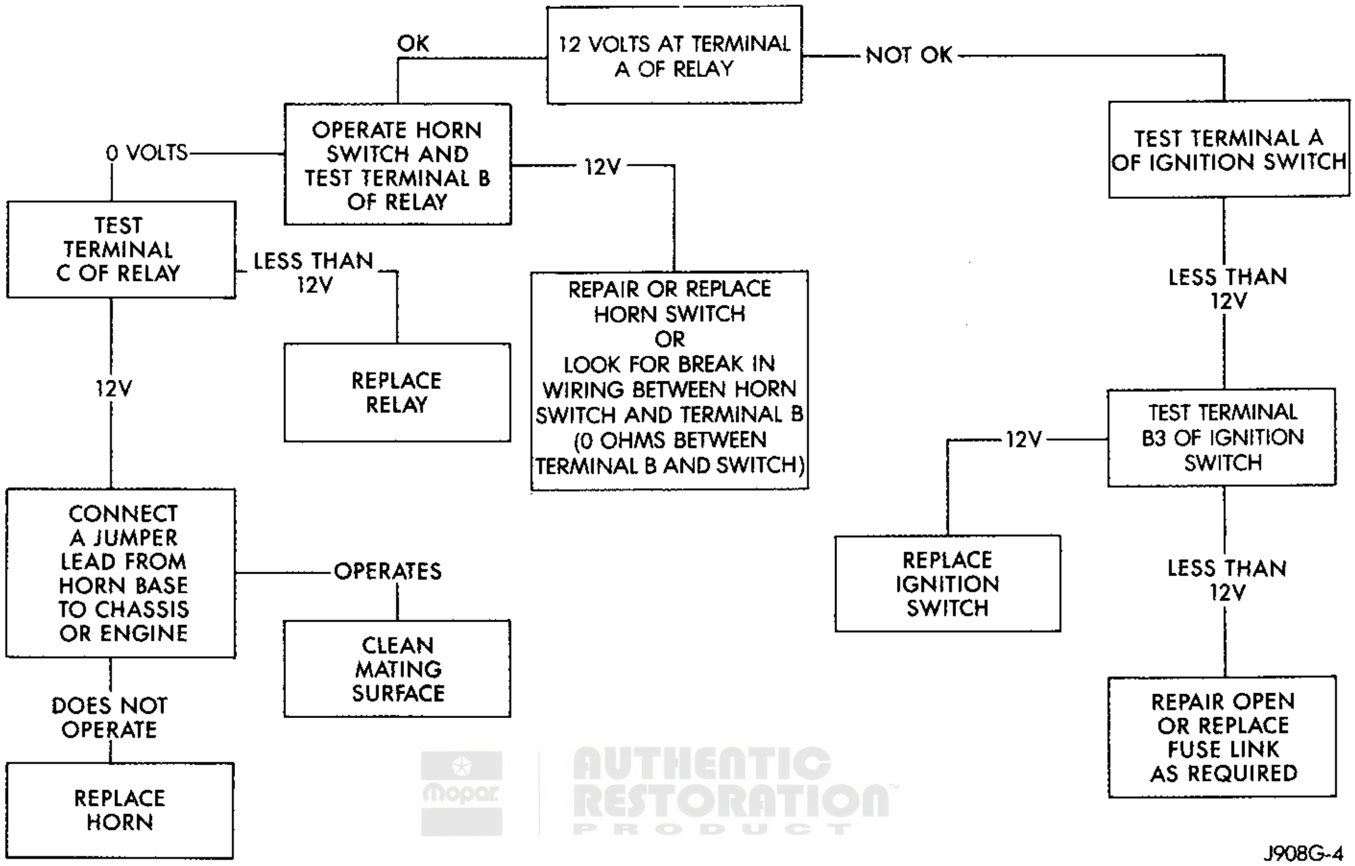


Fig. 5 Horn Circuit Schematic

HORNS DO NOT OPERATE—Key in ON or ACCY



J908G-4

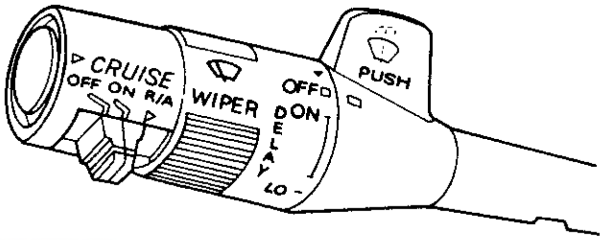
CRUISE CONTROL

CONTENTS

GENERAL

The electronic cruise control functions of Cruise, Set, On, Off, Coast, Resume Speed and Accelerate are built in the turn-signal lever.

The cruise control module automatically controls throttle position to maintain a speed set by the operator. The vehicle will keep the set speed unless the driver presses the brake, clutch or accelerator pedal.



J898H-17

COMPONENTS

The Cruise Command is a closed loop electro-mechanical servo system that consists of the following components: electronic regulator, speed sensor, servo, control switch, vacuum storage can and check valve and the release mechanisms, which consist of a mechanical vacuum vent valve and brake lamp switch.

CRUISE CONTROL MODULE

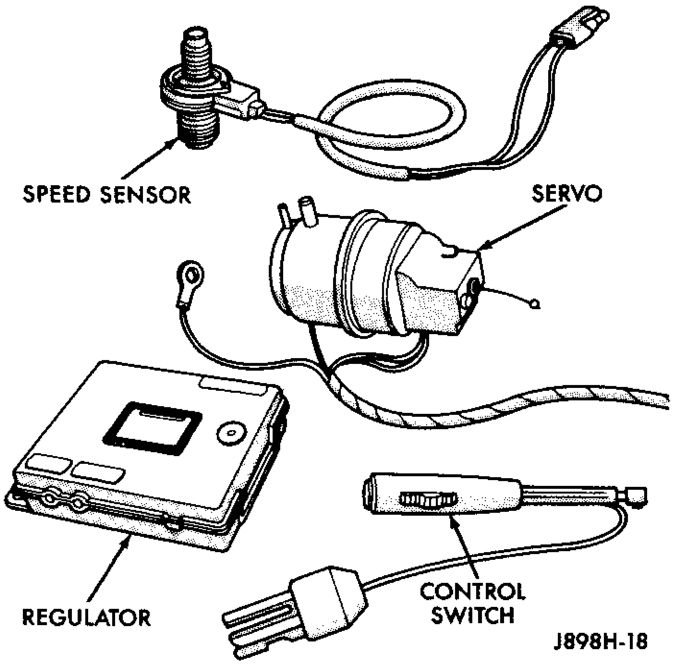
The cruise control module is the primary control unit of the cruise control system. The module contains internal circuits that regulate, amplify and convert voltage inputs received from the various system components. The module also contains the system memory feature and the low speed limit control circuit that prevents system operation at speeds below 48 km/h (30 MPH). The module is a sealed unit and is not a serviceable component.

SPEED SENSOR

The speed sensor is an electro-mechanical device (tach generator) that is driven by the speedometer cable. The sensor converts speedometer cable revolutions into voltage that represents vehicle speed. The voltage is routed directly to the cruise control module, which modifies the input into the voltage signals needed for various phases of system operation.

SERVO

The servo mounted in the engine compartment, is controlled by the cruise control module. Manifold vacuum provides the force for diaphragm motion. A cable connects the servo to the throttle linkage.



J898H-18

OPERATION

ENGAGING THE SYSTEM

To engage, push the slide switch to the ON position. After the desired cruising speed has been reached 48 km/h (30MPH) or above press the SET/COAST button. When the accelerator pedal is released, the speed will be maintained automatically.

DISENGAGING THE SYSTEM

To disengage the system, press lightly on the brake pedal, or on the clutch for manual transaxle models, or move the slide switch to OFF. To decrease the speed setting, press the SET/COAST button until the vehicle slows to the desired speed, then release the button.

MEMORY

After disengaging the cruise control by pressing on the brake or clutch pedal, return to the set speed by moving the slide switch to the RESUME/ACCEL position.

To temporarily increase the speed, move the slide switch to the RESUME/ACCEL position and hold; speed will increase. Releasing the switch will bring the vehicle back to the initial set speed. To set the cruise control at the higher speed, press the SET/COAST button after releasing the slide switch.

Acceleration is possible at any time (no matter what the position of the speed control switch) by pressing down on the accelerator pedal.

The memory is erased by turning the unit off or by turning the ignition switch off.

WARNING: DO NOT USE THE CRUISE CONTROL ON WET OR SLICK ROADS, OR IN HEAVY TRAFFIC WHERE SPEED CHANGES ARE REQUIRED FOR SAFE DRIVING.

DESCRIPTION

The (ACCY-YJ, SJ) (Gauges-XJ/MJ) fuse supplies voltage to the cruise control module with the ignition switch in the RUN position. The HAZ/STOP fuse provides battery feed to the brake switch, cruise control fuse, and the multi-function lever at all times.

When the multi-function lever is in the ON position, voltage is applied to terminal 14 (speed set signal) and terminal 5 (cruise ON input).

The driver opens the set switch when the vehicle is at the set speed. Voltage to the speed set signal stops momentarily. The cruise regulator records the vehicle's speed at the moment there is no voltage at terminal 14 (speed set signal).

The resume/accelerate switch is used after the cruise control module has been interrupted by the current path to ground through the stop lights at terminal 13. This path is broken by the use of the brake or clutch pedals or when the driver wants to accelerate. When the switch is in the R/A position, voltage is applied to the resume/accelerate input (terminal 10). The cruise control module recognizes this voltage as an instruction to accelerate. When the switch is pushed into the R/A position and released immediately, voltage is applied only momentarily to terminal 10. The cruise control module interprets this voltage as an instruction to resume the previously set speed.

The cruise control module controls the servo on the basis of these voltages, the speed signal from the speed sensor and the position feedback input from that servo. The cruise control module will energize the charge valve in the servo allowing vacuum to retract the bellow when acceleration is needed. During deceleration, the cruise control module will de-energize the vent valve and release the vacuum in the servo.

CRUISE CONTROL MODULE REPLACEMENT

(1) Remove mounting screws or tape that holds the regulator in place under the dashboard on the drivers side (Figs. 1, 2 and 3).

(2) Disconnect the electrical connector by using a screwdriver in the hole described on the case of the module.

(3) Reverse the removal procedure to install the module.

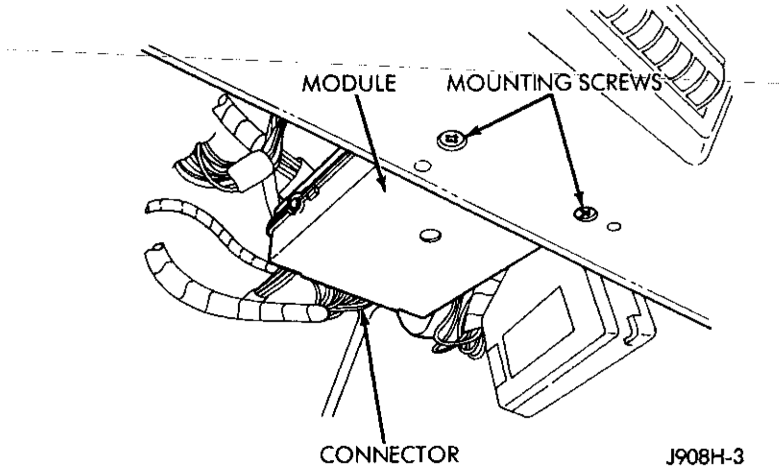


Fig. 1 Under Dashboard On Drivers Side — XJ and MJ

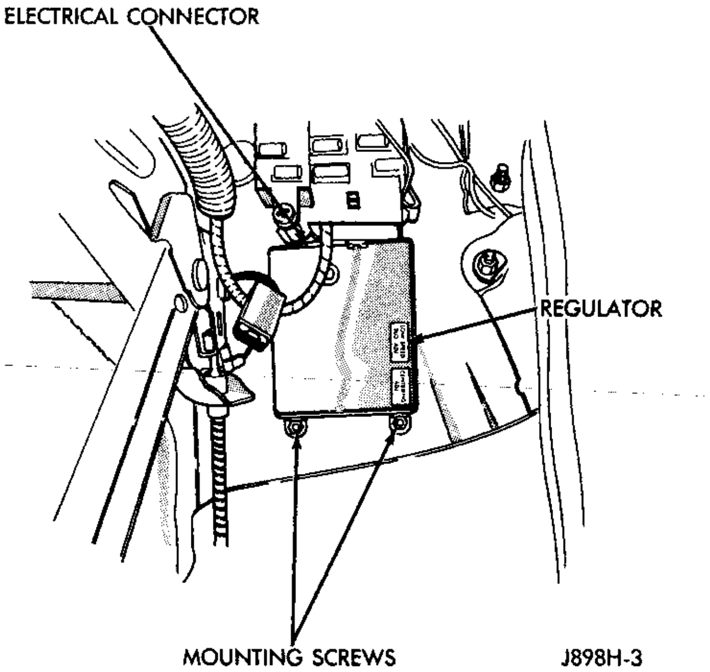


Fig. 2 Under Dashboard By Fuse Panel — YJ

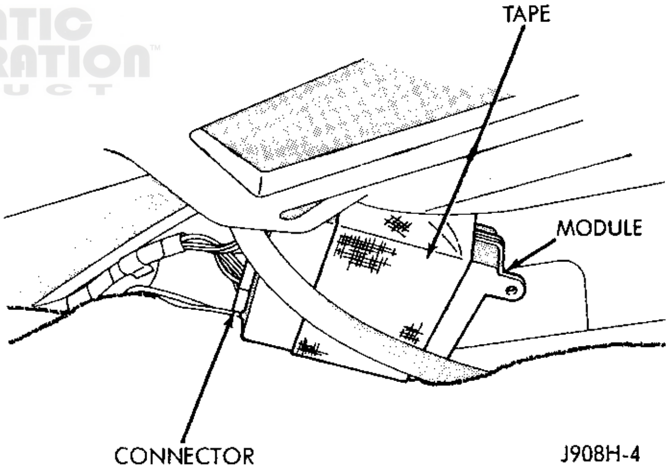


Fig. 3 Under Dashboard By Transmission Tunnel — SJ

CRUISE CONTROL SERVO REMOVAL

(1) Remove the locknut holding the servo to the mounting bracket (Figs. 4, 5 and 6).

(2) Remove two hoses from the servo.

(3) Disconnect the harness connector.

(4) Remove 2 (screws-SJ) (nuts-YJ, XJ and MJ) and cable housing from the servo.

(5) Release the cable clip from the servo cable.

(6) To install the servo, reverse the removal procedure and tighten the locknut to 7 N•m (60 in-lbs).

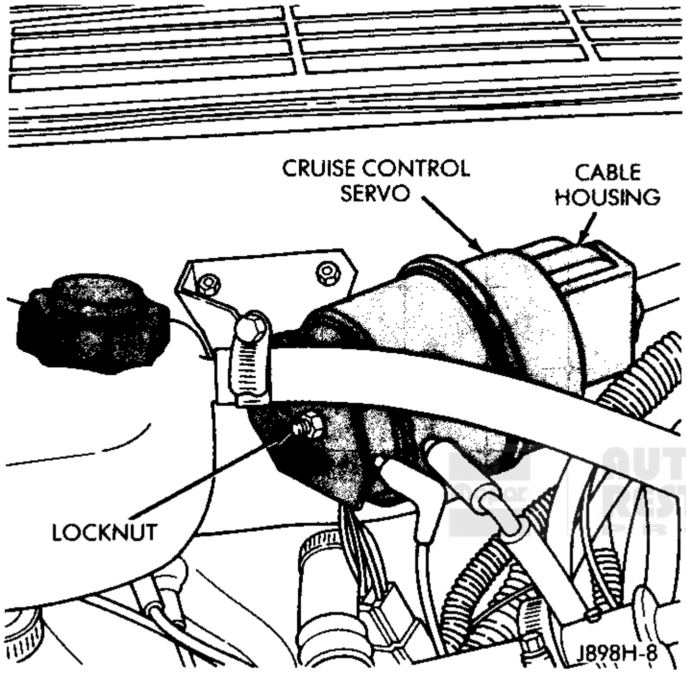


Fig. 4 Cruise Control Servo — XJ and MJ

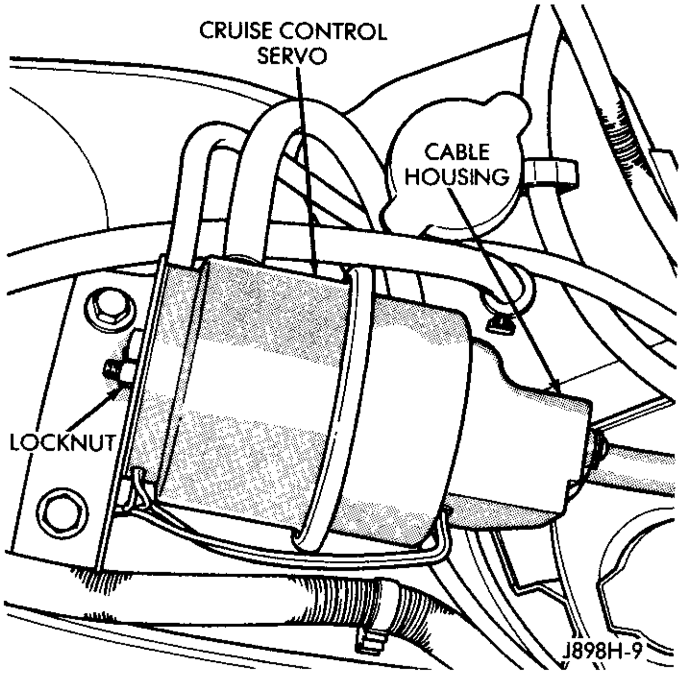


Fig. 5 Cruise Control Servo — YJ

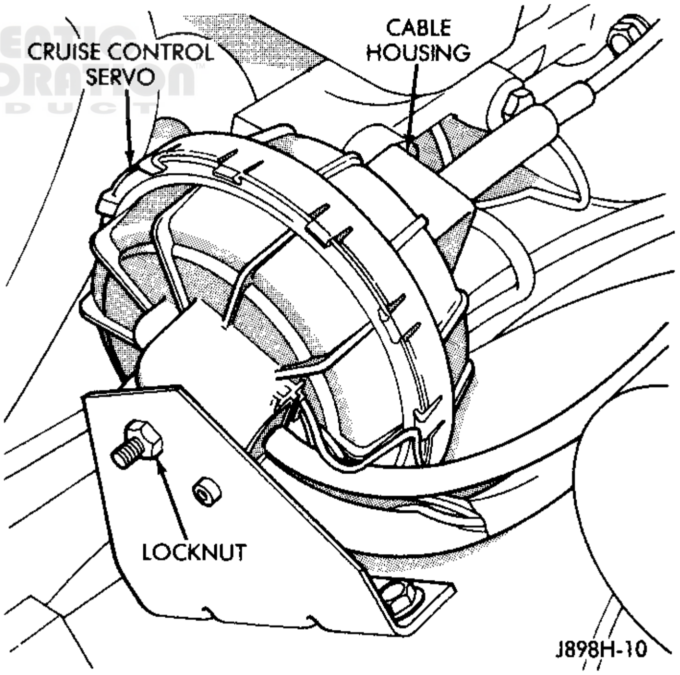


Fig. 6 Cruise Control Servo — SJ

SPEED SENSOR REPLACEMENT

XJ and MJ

On XJ and MJ vehicles, the speed sensor is located behind the instrument cluster.

(1) Raise and support vehicle.

(2) Carefully remove the spring nut holding the speedometer cable in position on the driver's side upper control arm bolt (Fig. 7).

(3) Disconnect the negative battery cable.

(4) Remove the four instrument panel bezel attaching screws and remove the instrument panel bezel (Fig. 8). Bezel is snap fit at locations shown.

(5) Remove the cigar lighter housing attaching screws (Fig. 9).

(6) Remove the switch housing attaching screws (if equipped).

(7) Remove the instrument panel cluster attaching screws.

(8) Disconnect the speedometer cable (Fig.10).

(9) Pull out the cluster assembly far enough to disconnect the two multiple plugs and remove the instrument cluster.

(10) Unscrew the two attaching nuts from the speed sensor.

(11) Disconnect the wire lead from the cruise harness (Fig. 11).

(12) To install, reverse the removal procedure.

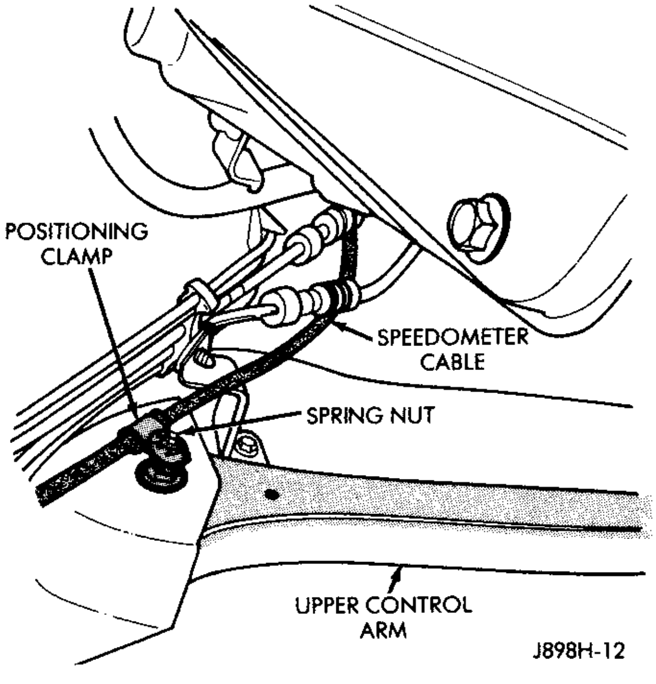


Fig. 7 Remove Cable Positioning Clamp

YJ

On YJ vehicles the speed sensor is located above the front drive shaft and is in-line with the speedometer cable.

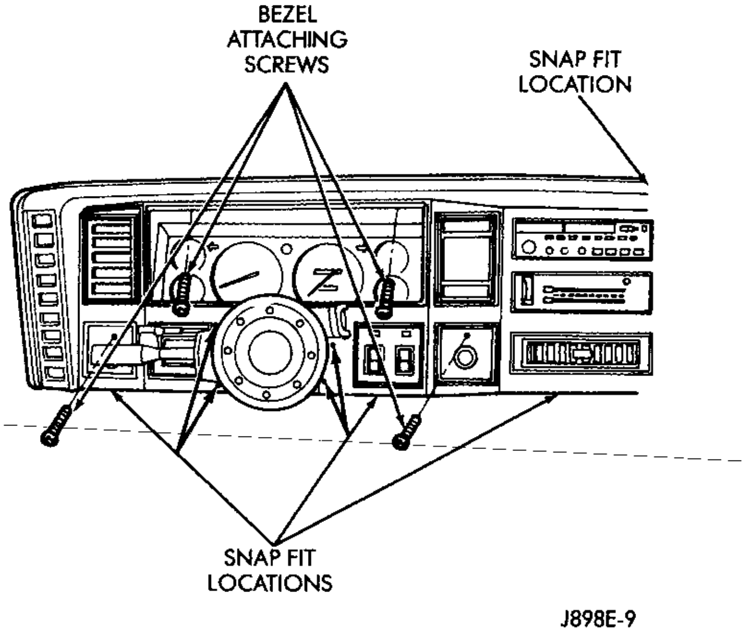


Fig. 8 Instrument Bezel Removal/Installation — XJ and MJ

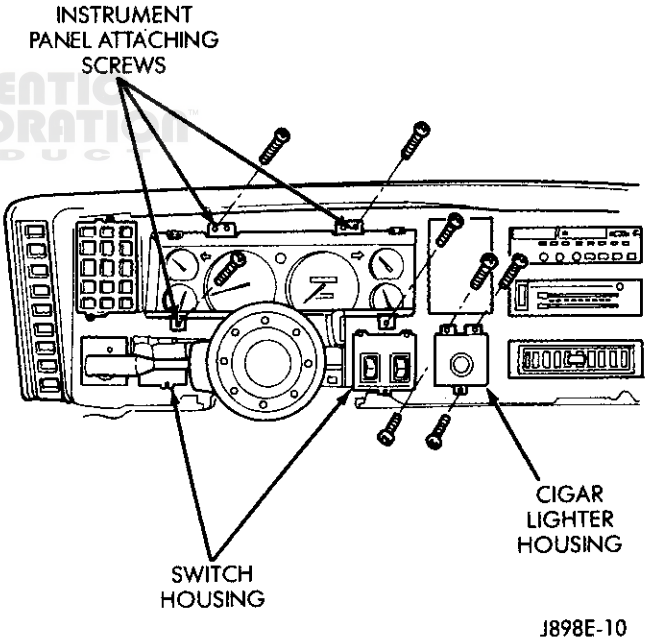


Fig. 9 Instrument Panel Removal/Installation — XJ and MJ

(1) Unscrew the two attaching nuts from the speed sensor (Fig. 11).

(2) Disconnect the wire lead from the cruise harness.

(3) To install, reverse the removal procedure.

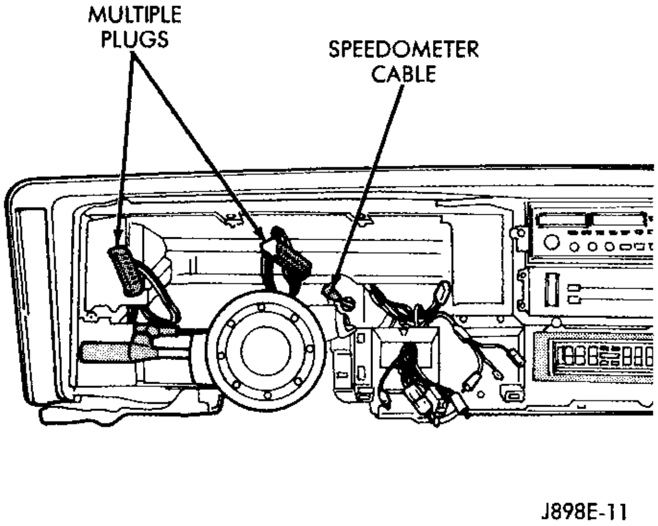


Fig. 10 Disconnect/Install Speedo Cable and Multiple Plugs

SJ

On SJ vehicles, the speed sensor is located under the power brake booster and is in-line with the speedometer cable.

(1) Remove two tie straps retaining the speedometer cable to left inner fender.

(2) Unscrew the two attaching nuts from the speed sensor (Fig. 11).

(3) Disconnect the wire lead from the cruise harness.

(4) To install, reverse the removal procedure.

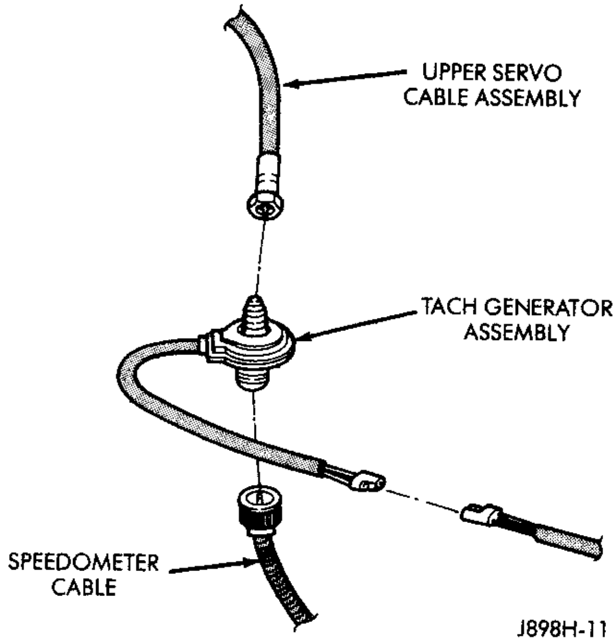


Fig. 11 Speed Sensor (Typical)

CRUISE CONTROL SWITCH REPLACEMENT

(1) Disconnect battery negative cable.

(2) Perform one of the following procedures and then continue with step (3).

STANDARD STEERING WHEEL

- Remove three screws holding the front cover of the steering wheel (Fig. 1).

CAUTION: Use a sharp pointed tool to depress the connector retainer.

- Pull horn wires off at the column side of the steering wheel. Pull gently to remove grounding pin. Be careful to not lose the spring under the grounding pin connector (Figs. 2 and 3).

OPTIONAL STEERING WHEEL

- Remove horn button with a push and turn motion.
- Remove horn button components (Fig. 4).

(3) Turn key to the lock position and remove the steering wheel nut and washer.

(4) Scribe an alignment mark on the steering in line with the mark already existing on the end of the steering column.

(5) Remove vibration damper from the steering column hub, if equipped.

(6) Remove steering wheel using a steering wheel puller.

WARNING: IN ORDER TO REMOVE THE STEERING SHAFT SNAP RING IN THE FOLLOWING STEP, THE LOCKPLATE MUST BE COMPRESSED. DO NOT ATTEMPT TO REMOVE THE LOCKPLATE WITHOUT COMPRESSOR TOOL C4156 AS THE LOCKPLATE IS UNDER HEAVY SPRING TENSION.

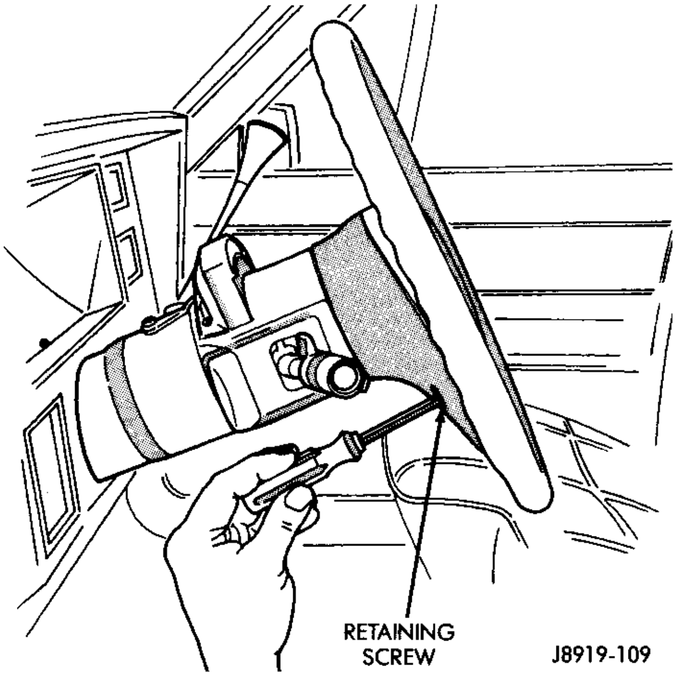


Fig. 1 Standard Steering Wheel Cover Removal/Installation

(7) Compress the lockplate with compressor tool C4156 and remove the steering shaft snap ring (Fig. 5). Discard the snap ring. It is not reusable.

(8) Remove compressor tool.

(9) Remove lockplate, cancelling cam, and upper bearing preload spring. If the vehicle is equipped with the optional steering wheel, remove the horn button components from the canceling cam.

(10) Remove the screw and hazard warning switch knob.

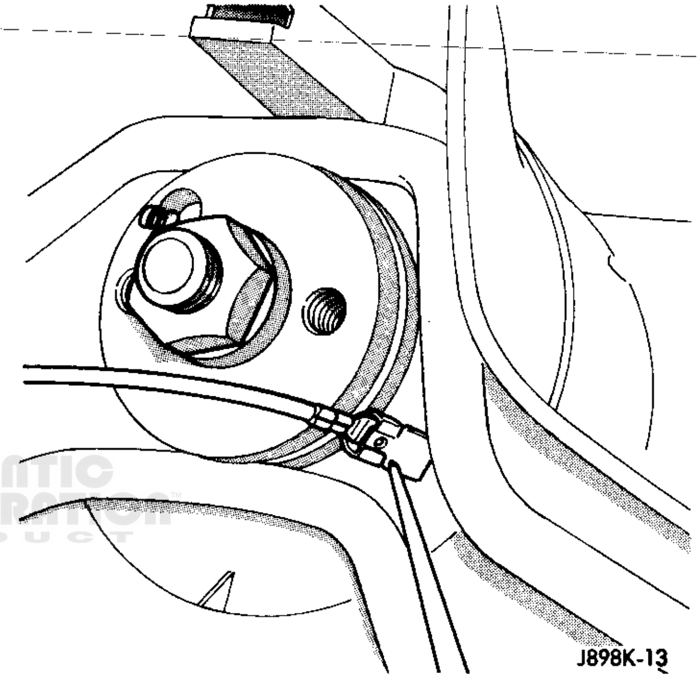


Fig. 2 Horn Wire Removal

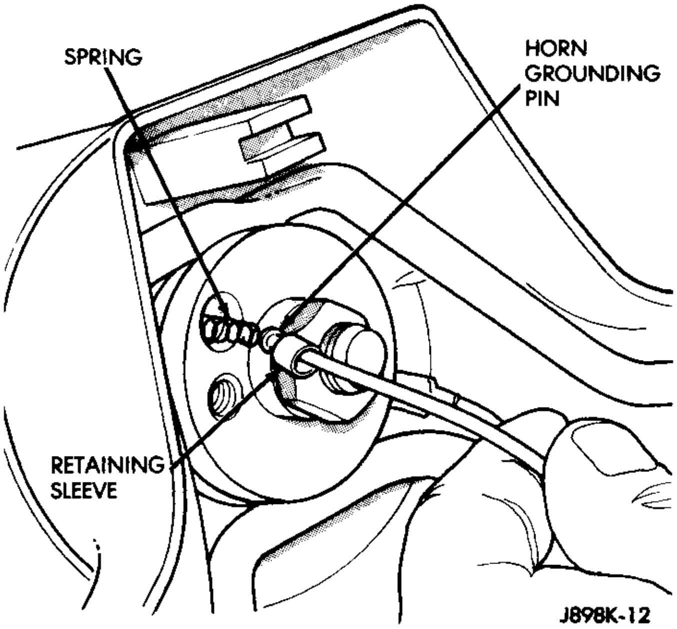


Fig. 3 Horn Grounding Pin Removal/Installation

(11) Remove actuator arm attaching screw.

(12) Remove the turn signal switch attaching screws.

(13) Unplug cruise control switch connector.

(14) Pull the cruise control harness out of the column.

(15) Insert the ignition key in the lock cylinder and turn the key to ON position.

(16) Remove the key warning buzzer switch and retaining clip with a paper clip inserted below the retainer so that the retainer is flattened (Fig. 6).

Do not attempt to remove the buzzer switch and clip separately. The clip could fall into the column jacket.

(17) Remove the ignition lock cylinder retaining screw and pull the lock cylinder out of the column housing (Fig. 7)

(18) Remove the screws that attach the housing and shroud assembly to the column jacket and carefully remove the housing and shroud assembly (Fig. 8).

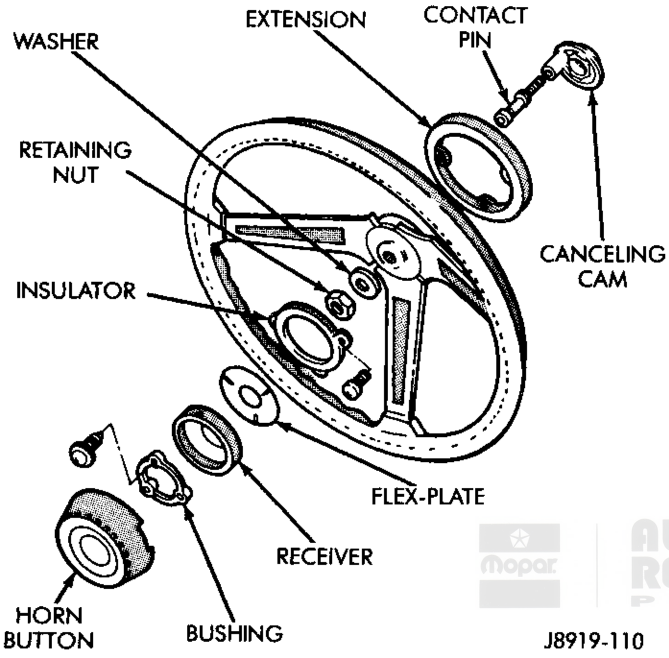


Fig. 4 Optional Steering Wheel Removal/Installation

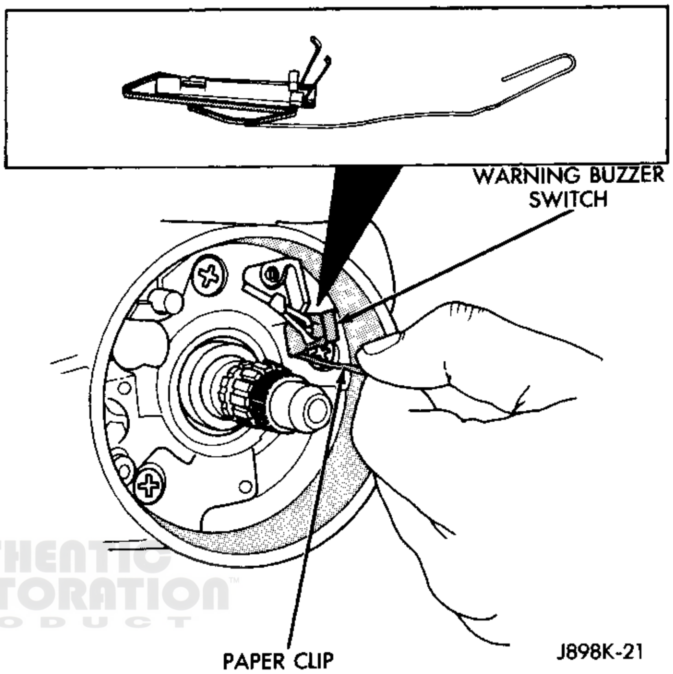


Fig. 6 Buzzer Switch Removal

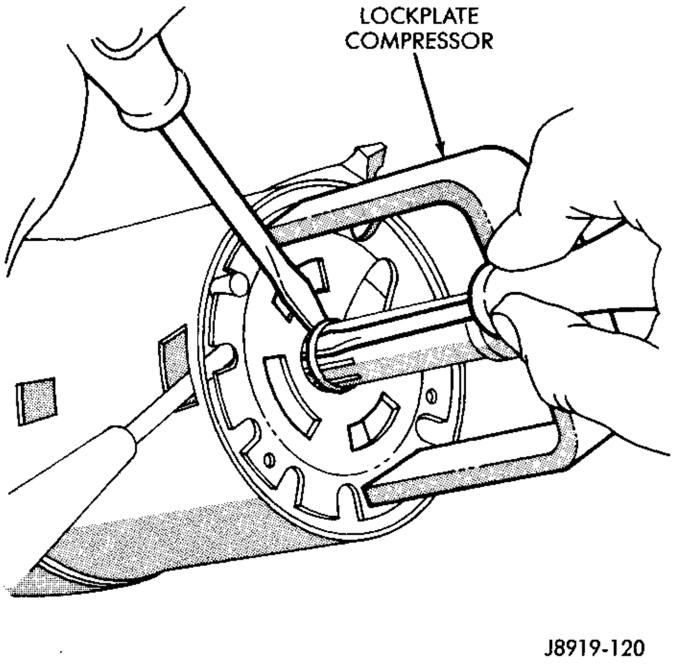


Fig. 5 Lockplate Removal

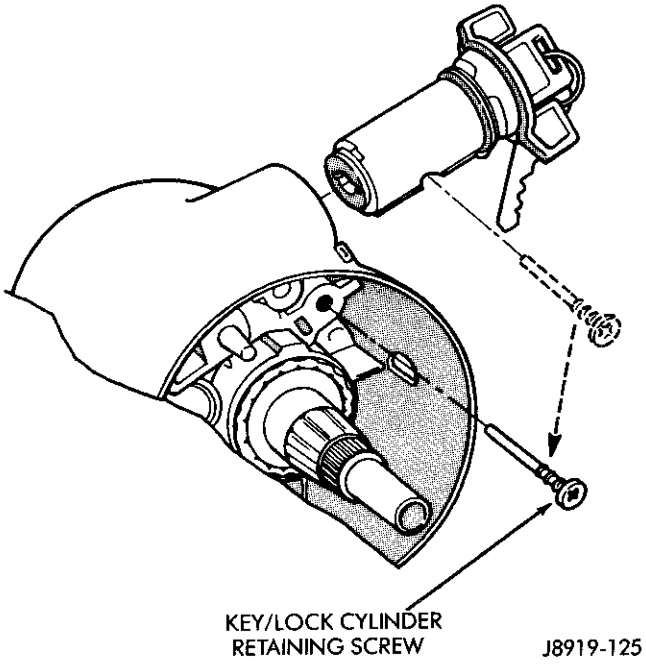


Fig. 7 Lock Cylinder Removal/Installation

Do Not let the dimmer switch rod, lock pin or lock rack fall out.

(19) Remove the turn signal/wiper lever by pulling it straight out of the column.

(20) Remove the wiper switch cover from the back of the housing and shroud assembly (Fig. 9). If equipped with column shift, remove the screw holding the cover on.

(21) Remove the pivot screw from the housing and remove the wiper switch.

(22) Install a new switch and switch cover.

(23) Push on dimmer switch rod to make sure it is connected then carefully position housing and shroud assembly to column (Fig. 10).

Make sure the nylon spring retainer on the lock pin is positioned forward of the retaining slot of the lock rack (Fig. 10).

Position the first tooth of the gear (farthest from the block tooth) with the most forward tooth of the lock rack.

(24) Install the screws that attach the housing and shroud assembly to the column jacket and carefully mate the housing and shroud assembly.

(25) Insert the key and lock cylinder and test that the lock pin extends fully when the key is moved to the lock position.

(26) To install remaining parts, reverse the removal procedures.

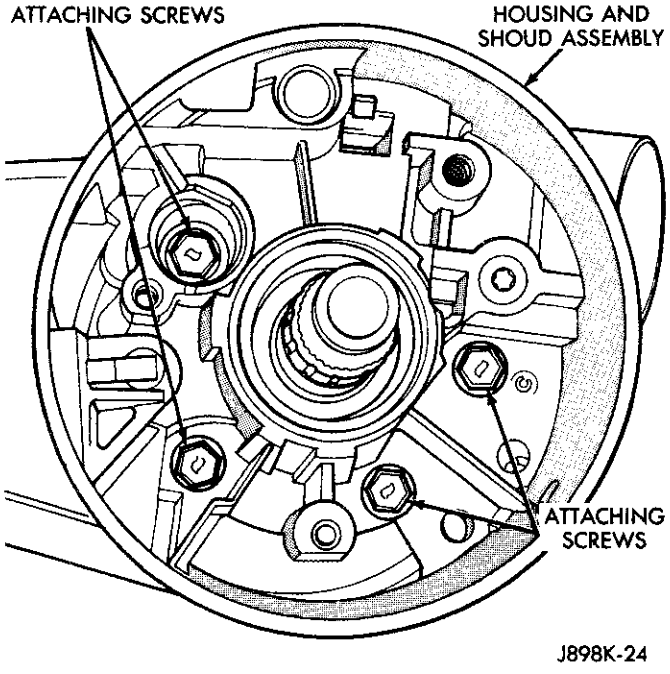


Fig. 8 Steering Column Housing Removal/Installation

CAUTION: When installing a wiper switch, make sure wires are laying flat on bottom inside of column.

On vehicles equipped with column shift, install the PRNDL cable clip with the shift indicator on N. Move the selector through the range and make sure it lines up with each letter.

(37) Install the steering wheel. Tighten the steering wheel nut to 34 N•m (25 ft-lbs) torque.

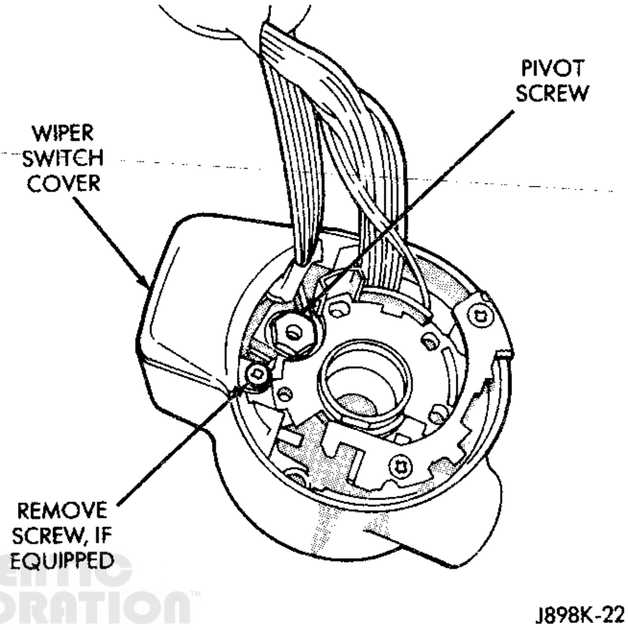


Fig. 9 Remove Pivot Screw

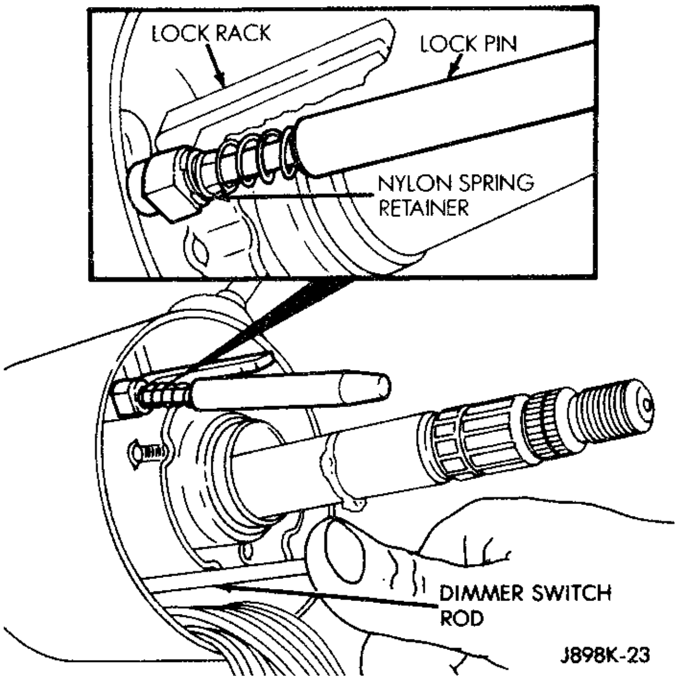


Fig. 10 Check Dimmer Switch Rod and Lock Pin

SERVO CABLE REPLACEMENT

XJ AND MJ

CAUTION: Use finger pressure only to remove the cruise control cable connector at the bell crank. Pliers or screwdriver can brake the connector requiring the complete cable replacement.

(1) Using finger pressure only, remove cruise control cable connector at bell crank by pushing connector off the bell crank (Fig. 1). DO NOT try to pull connector off perpendicular to the bell crank.

(2) Squeeze tabs on cruise control cable and lift cable out of locking plate (Fig. 2).

XJ AND MJ

- Remove two MAP sensor mounting nuts (Fig. 3).
- Slide the MAP sensor forward off of the mounting studs.

(3) Remove two nuts and cable housing from the servo.

(4) Release the cable clip from the servo cable and remove the servo cable.

(5) To install, reverse the removal procedure.

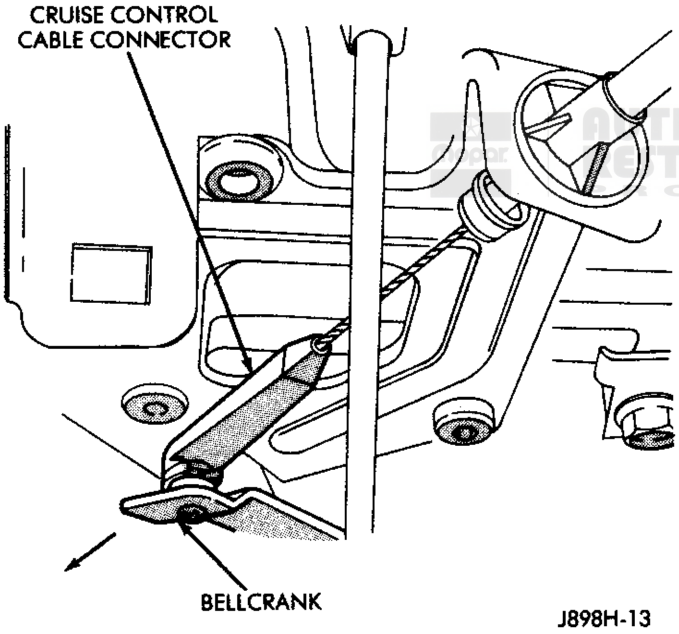


Fig. 1 Remove Bell Crank Connector

YJ

Removal

(1) Remove clip and washer from pin on bellcrank and remove lost motion link.

(2) Squeeze tabs that retain cable housing in bracket and remove cable from bracket.

(3) Remove retaining nuts and cable housing from servo.

(4) Spread clip that connects cable to servo and remove.

(5) To install, reverse the removal procedure.

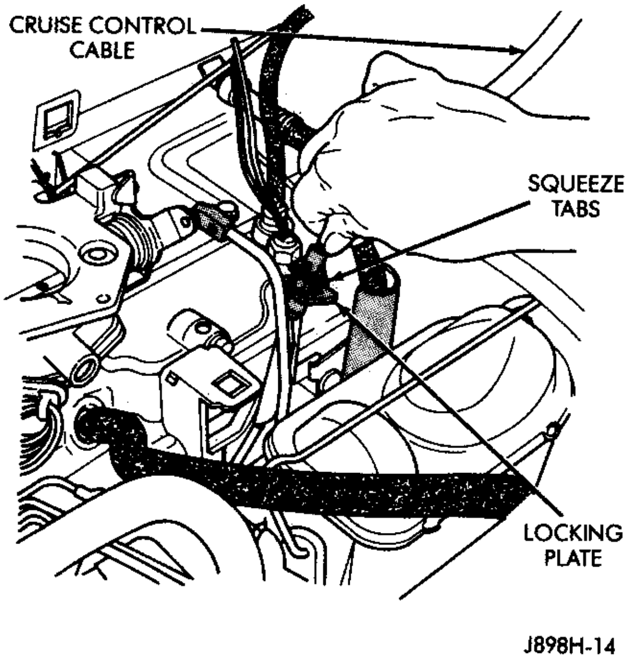


Fig. 2 Remove/Install Cruise Control Cable to Locking Plate

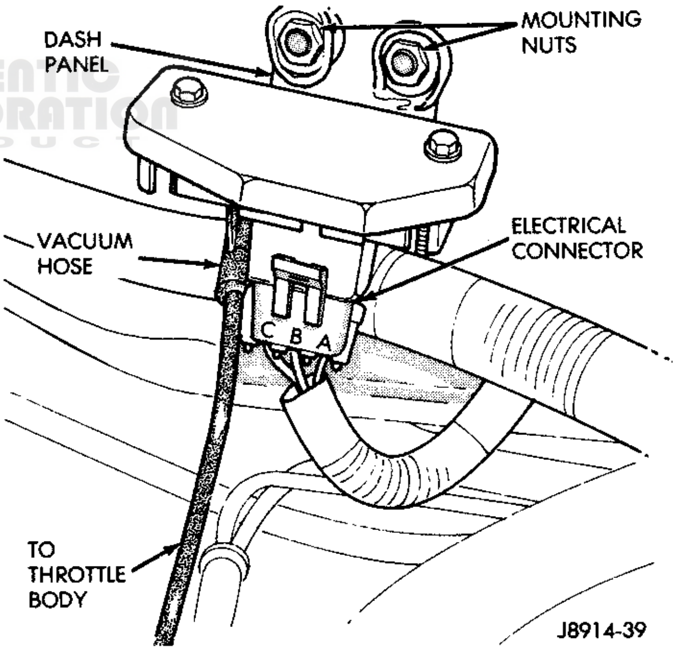


Fig. 3 MAP Sensor Removal/Installation

Installation

(1) Attach cable to servo and squeeze clip to retain cable.

(2) Install cable housing on servo.

Mounting studs are not equally spaced from hole in servo. Ensure housing is installed correctly.

(3) Attach cable housing on bracket. Ensure tabs are locked in bracket.

(4) Place lost motion link on bellcrank pin and install washer and lock clip.

SJ

(1) Remove the lock clip and washer from the clevis pin on the bellcrank (Fig. 4).

(2) Remove the chain from the clevis pin.

(3) Squeeze the tabs that retain the cable housing in the bracket.

(4) Remove two screws and cable housing from the servo and remove servo cable.

(5) To install, reverse the removal procedure.

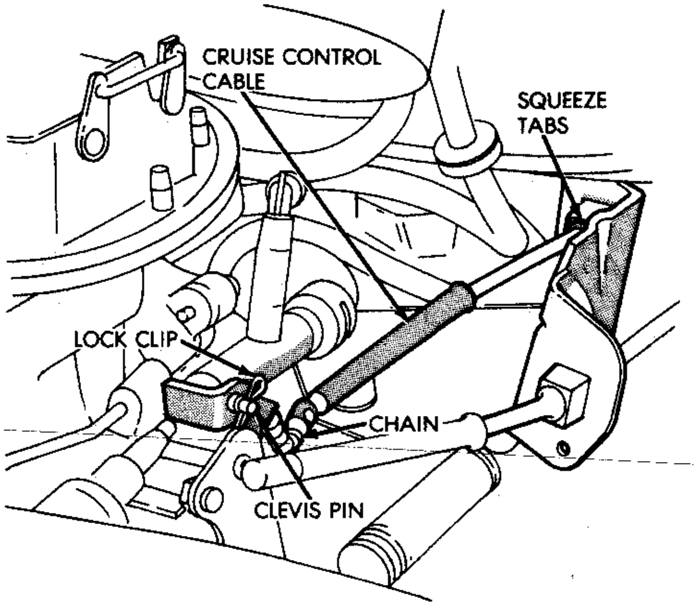


Fig. 4 Servo Cable Removal/Installation — SJ

OPERATIONAL CHECK (ROAD TEST)

The following sequential checks are performed with the cruise switch ON and vehicle speed faster than 35 mph:

1. Press the set button at the end of multi-function lever. Vehicle should maintain set speed.
2. Hold set button in, and remove foot from accelerator. Vehicle should coast to a slower speed.
3. Release set button. Cruise control will engage and hold a slower speed, provided the speed remains above 35 mph.
4. Slide cruise switch to R/A and hold it there. Vehicle should accelerate.
5. Release cruise switch back to ON. Vehicle will hold the new faster speed, if set speed button has been pressed.
6. Tap brake pedal. Vehicle will decelerate.

If vehicle has a manual transmission, repeat step 6 by depressing the clutch.

7. Slide cruise switch momentarily R/A. Vehicle will accelerator to former set speed.
8. While cruising, accelerate, then remove foot from accelerator. Vehicle will coast back to set speed.
9. While cruise is engaged, tap set speed button. Vehicle speed will increase 1 mph for each time set speed button is tapped.

CRUISE CONTROL DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTION
A. System Does Not Engage in ON Position	(1) Restricted vacuum hose or no vacuum	(1) Locate restriction or air leak and repair
	(2) Control switch defective	(2) Replace switch
	(3) Control module defective	(3) Replace control module
	(4) Speed sensor defective	(4) Replace sensor
	(5) Brake lamps defective	(5) Replace brake lamp bulbs
	(6) Brake lamp switch defective	(6) Replace switch
	(7) Brake lamp switch wire disconnected	(7) Connect wire to switch
	(8) Open circuit between brake lamp switch and brake lamps	(8) Adjust open circuit
	(9) Mechanical vent valve position improperly adjustedp	(9) Adjust vent valve position
B. Resume Feature Inoperative	(1) Defective servo ground connection	(1) Check servo ground wire connection and repair as necessary
	(2) Control switch defective	(2) Replace switch
C. Accelerate Function Inoperative	(1) Accelerate circuit in control module inoperative	(1) Replace control module
	(2) Cruise switch defective	(2) Replace switch
D. System Re-engages When Brake Pedal Or Clutch Is Released	(1) Control module defective	(1) Replace control module
	(2) Mechanical vent valve not opening	(2) Adjust position or replace valve
	(3) Kink in mechanical vent valve hose	(3) Reroute hose to remove kink
	(4) Brake lamp switch defective	(4) Adjust or replace switch
E. Throttle Does Not Return To Idle Position	(1) Improper linkage adjustment	(1) Adjust properly
	(2) No slack in lost motion link	(2) Adjust servo cable
F. Road Speed Changes More Than 2 MPH (3.2km/h)When Setting Speed	(1) Centering adjustment set wrong	(1) Adjust centering screw
G. Engine Accelerates When Started	(1) No slack in bead chain	(1) Adjust chain
	(2) Vacuum hose connections reversed at servo	(2) Check connection and correct
	(3) Servo defective	(3) Replace servo
H. System Disengages On Level Road Without Applying Brake Or Clutch	(1) Loose wire connection	(1) Repair connection
	(2) Loose vacuum hose connection	(2) Check vacuum hose connection and repair as necessary
	(3) Servo linkage broken	(3) Repair linkage
	(4) Defective brake lamp switch	(4) Replace switch
I. Erratic Operation	(1) Reverse polarity	(1) Check position of speed sensor wires at connector
	(2) Servo defective	(2) Replace servo
	(3) Control module defective	(3) Replace control module
J. Vehicle Continues to Accelerate When Set Button is Released	(1) Servo defective	(1) Replace servo
	(2) Control module defective	(2) Replace control module
K. System Engages But Slowly Loses Set Speed	(1) Air leak at vacuum hose connection or in hoses	(1) Check hoses and connections and repair as necessary
	(2) Air leak at vent release valve at brake pedal	(2) Replace vacuum vent valve

TROUBLESHOOTING WITH TOOL # 7079 (AM P-C-1R)

The following troubleshooting charts are based on the results obtained from Cruise Control Tester 7079 (AM PC-1-R).

To install the tester, remove the control module as described in Control Module Replacement. Unplug the wiring connector and plug it into the tester. Disconnect and connect all cruise control connectors before testing to remove oxidation that may have formed on the connector terminals.

CAUTION: When separating wiring harness connectors do not pull on the wires. PULL ONLY ON THE CONNECTORS.

Proceed through the diagnostic chart and its instructions. Complete the entire test sequence even though a tester lamp may not come on.

CRUISE CONTROL TESTER DIAGNOSTIC CHART

Note: Lamp No. 2 will remain lit during all tests. If no lamps light, go to Test No. 1.

MINIMUM OPERATION REQUIRED TO TURN ON LAMP	LAMP ON						TEST NUMBER
	1	2	3	4	5	6	
A. CRUISE SWITCH ON • Set Switch Depressed	X						2
B. CRUISE SWITCH ON		X					3
C. IGNITION SWITCH ON • Depress Brake or Clutch To Turn Off			X	X			4, 5
D. CRUISE SWITCH RESUME/ACCELERATE					X	X	6

J898H-5

SERVO CHECKS

E. CRUISE SWITCH RESUME/ACCELERATE • Engine Running • Parking brake fully engaged; automatic transmission in PARK; manual transmission in NEUTRAL					X	X	7A, 7B
WARNING: Servo will pull throttle wide open. Keep RPM at a safe limit by releasing the cruise switch.							

J898H-6

1. NO LAMPS WILL LIGHT: Ignition in OFF

TEST	OK	NOT OK
Module connector terminal 1 to chassis ground	Zero ohms	Repair open to Ground

2. LAMP NO.1 WILL NOT LIGHT: Remove and inspect fuse, Ignition in RUN, Cruise Switch in ON, Set Switch DEPRESSED

TEST	OK	NOT OK
HAZ/STOP fuse	Not blown	Replace fuse
In-line fuse	Not blown	Replace fuse
In-line fuse connector terminal A	Battery voltage	Repair open from Brake Switch
Backprobe cruise switch connector terminal A	Battery voltage	Repair open from In-line fuse
Backprobe cruise switch connector terminal D	Battery voltage	Replace Cruise Switch
Backprobe cruise switch connector terminal 14	Battery voltage	Repair open from Cruise Switch

3. LAMP NO.2 WILL NOT LIGHT: Ignition in ON, Cruise Switch in ON

TEST	OK	NOT OK
Cruise Switch connector terminal B	Battery voltage	Replace Cruise Switch
Module connector terminal 5	Battery voltage	Repair open from Cruise Switch
Across Module connector terminals 2 and 3	15-50 ohms	Go to next step
Across Speed Sensor terminals A and B	15-50 ohms If OK, repair open to module	Go to next step
Speed Sensor terminals A and B with rear wheels spinning	At 30 mph, 0.9v AC voltage should increase 0.1v AC per each 10 mph	Replace Speed Sensor

4. LAMP NO.3 WILL NOT LIGHT: Ignition in RUN

TEST	OK	NOT OK
Module connector terminal 7	Battery voltage	Repair open from Gauges Fuse
Jumper wire between Module connector terminals 7 and 13	Stop Lamps light	Repair open in brake/clutch switch circuit

5. LAMP NO. 4 WILL NOT LIGHT: Ignition in RUN

TEST	OK	NOT OK
Gauges fuse (XJ and MJ) ACCY fuse (YJ and SJ)	Not blown	Replace fuse
Module connector terminals 2 and 11 while moving throttle from idle to wide open	240-4K ohms	Go to next step
Cruise Control Servo connector terminals G and F while moving throttle from idle to wide open	280-430 ohms at idle, 4K ohms at wide open If both tests OK, repair open to Control Module	Replace Control Servo

6. LAMP'S 5 AND 6 WILL NOT LIGHT: Ignition in RUN, Cruise Switch in R/A

TEST	OK	NOT OK
Cruise Switch connector terminal C	Battery voltage	Replace Cruise Switch
Module connector terminal 10	Battery voltage	Repair open from Cruise Switch
Across Module connector terminals 6 and 12	30-50 ohms	Go to Servo checks
Across Module connector terminals 4 and 12	30-50 ohms	Go to Servo checks
Module connector terminal 6 to clean chassis ground	Infinite resistance (OPEN)	Replace Control Servo
Module connector terminal 4 to clean chassis ground	Infinite resistance (OPEN)	Replace Control Servo
Module connector terminal 12 to clean chassis ground	Infinite resistance (OPEN)	Replace Control Servo

7A. HOSE ROUTING AND SERVO CABLE

TEST	OK	NOT OK
Inspect the following: ● Servo cable for breaks and hook-up ● Engine vacuum can and hose connections (small hose)	Proper connection	Repair as required

7B. BRAKE VENT VALVE HOSE AND SERVO

TEST	OK	NOT OK
Pinch brake vent hose (large hose) at servo and repeat Servo Check test E	Servo operates If OK, inspect vent hose for kinks, cuts or other damage. Also check brake vent valve adjustment.	Replace Control Servo

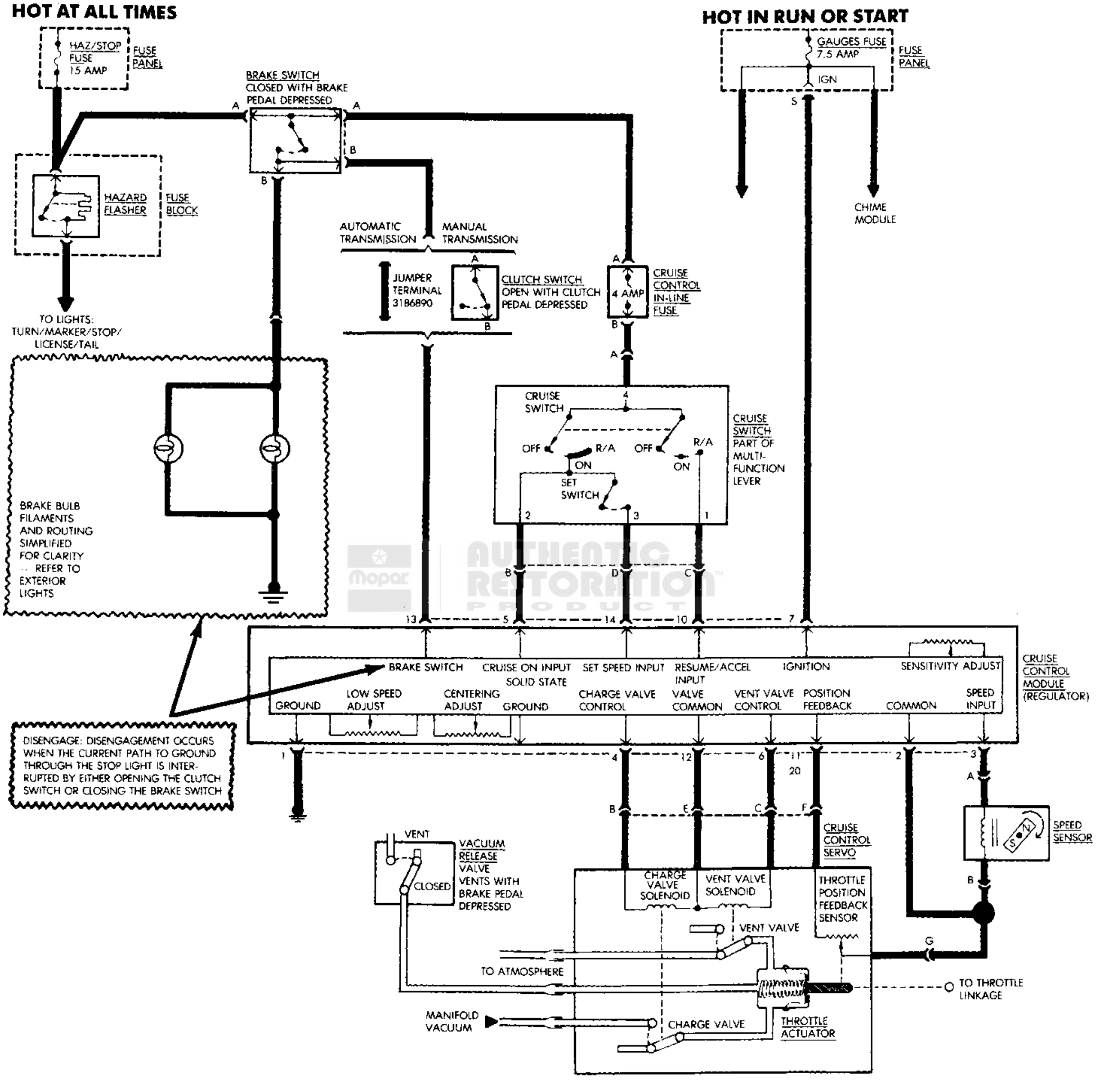
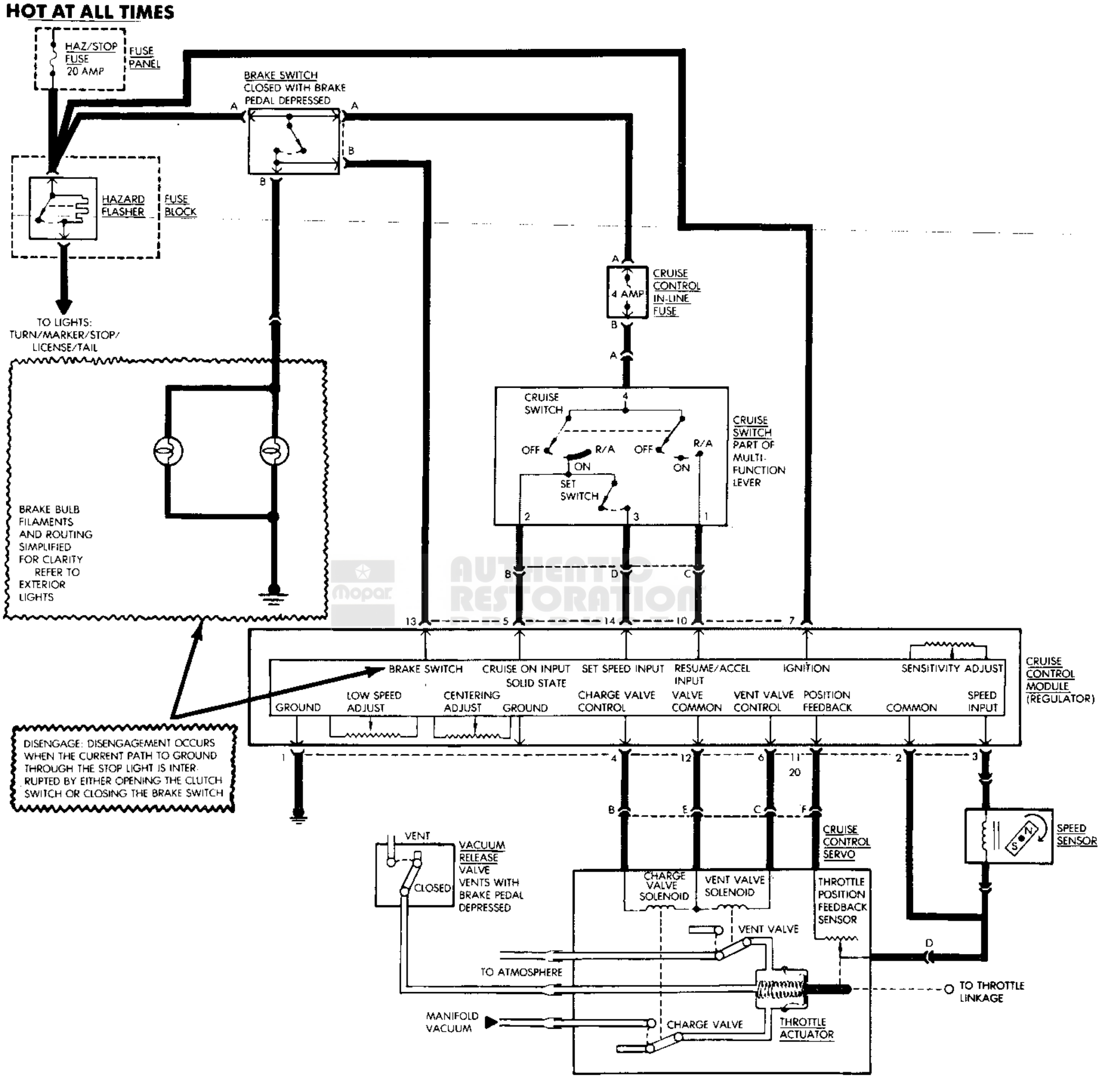


Fig. 1 Cruise Control Schematic — XJ, MJ and YJ



J908H-1

Fig. 2 Cruise Control Schematic — SJ

CRUISE CONTROL MODULE TESTS

The cruise control module adjustments are pre-set. If all other components of the system appear to be functioning normally and the cruise control remains inoperative, perform the following adjustments to determine if the module is functional.

CAUTION: The adjustment potentiometers are extremely delicate. Insert the screwdriver into the slots very carefully and do not push hard or turn hard against the stops. The potentiometer has a maximum turning angle of 270 degrees (three-quarter turn).

Verify the cruise control module is not working by using the indicated settings (Fig. 3)

(1) Turn the sensitivity adjustment full clockwise (3).

(2) Turn the low speed adjustment to the 10 o'clock position (2).

(3) Turn the centering adjustment to the 10 o'clock position (1).

The adjustments may not be precisely correct for the automobile, but will be acceptable to determine if the regulator is functioning. The need for more precise adjustments can be determined by a road test.

If the adjustments have no effect on the cruise control operation, replace the regulator.

The regulator is the only component of the system that cannot be isolated and tested separately. It must be tested while connected to the other components of the system.

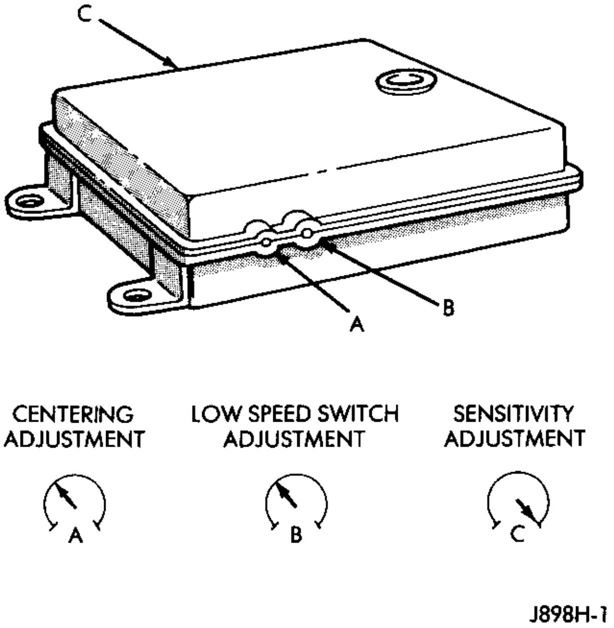


Fig. 3 Cruise Control Module Adjustments

CRUISE CONTROL MODULE ADJUSTMENTS

CENTERING ADJUSTMENT

Adjustment is made by turning the centering adjustment screw on the regulator.

If the controlled speed is more than 3 km/h (2 mph) above or below the " Set Speed", turn the CENTERING ADJ.;

- counterclockwise to decrease
- clockwise to increase

Check for proper centering adjustment by engaging the cruise control on a level road after each adjustment.

SENSITIVITY ADJUSTMENT

The SENSITIVITY ADJ. is on the opposite side of the regulator from the CENTERING ADJ. If sensitivity needs to be adjusted turn the SENSITIVITY ADJ:

- counterclockwise to decrease
- clockwise to increase

Changes in the sensitivity setting affect centering, so if sensitivity is changed, check the centering again and adjust as required.

LOW SPEED SWITCH (ENGAGEMENT) ADJUSTMENT

If the Low Speed Setting is not between 43 and 53 km/h (27 and 33 mph) turn the LOW SPEED SW.ADJ. screw:

- counterclockwise to lower or slow the speed
- clockwise to increase or raise the speed

VENT VALVE ADJUSTMENT

(1) Hold the brake pedal in the depressed position.

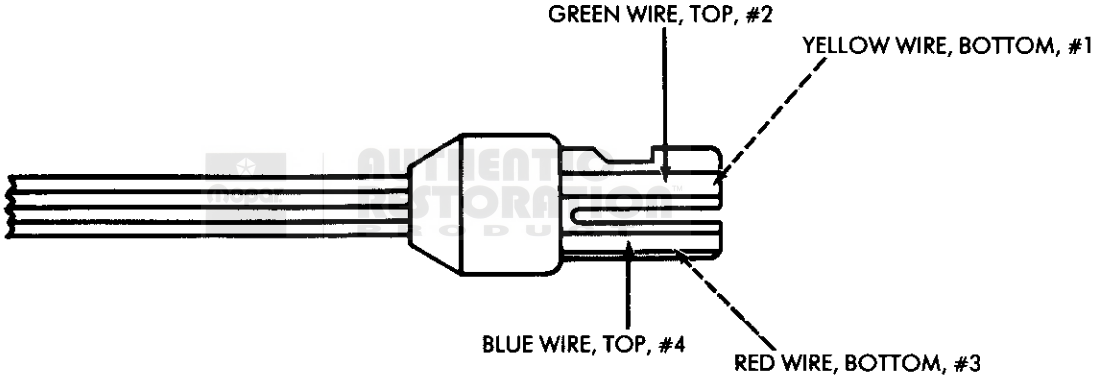
(2) Push the vent valve forward as far as possible.

(3) Release the brake pedal.

CRUISE CONTROL SWITCH TESTING

SET/COAST (S/C) SW	POSITION SLIDER	1-2	1-3	1-4	2-3	2-4	3-4
Normal	Off	○	○	○	○	○	○
Normal	On	○	○	○	○	C	○
Normal	R/A	C	○	C	○	C	○
Depressed	Off	○	○	○	C	○	○
Depressed	On	○	○	○	C	C	C
Depressed	R/A	C	C	C	C	C	C

C —CLOSED (ZERO OHMS)
○ —OPEN (∞ (INFINITE))



J898H-16

MULTI-FUNCTION SWITCH AND HAZARD

CONTENTS

HEADLAMP DIMMER SWITCH — ALL MODELS

INDEX

HEADLAMP DIMMER SWITCH CONNECTIONS

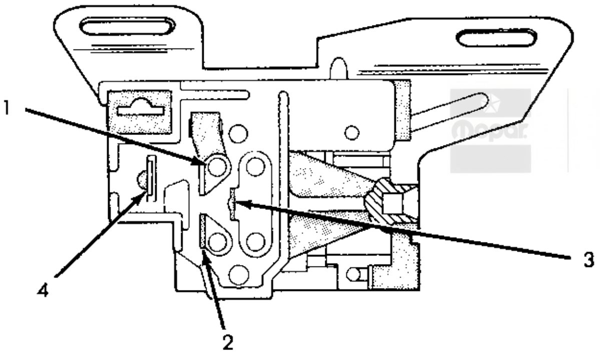


Fig. 1 Headlamp Dimmer Switch Connections—With Flash To Pass

HEADLAMP DIMMER SWITCH REMOVAL

(1) Disconnect battery negative cable.

XJ and MJ

(a) Remove the lower instrument panel cover trim panel (Fig. 2).

YJ

(a) Remove 6 instrumentation housing screws (Fig. 3).

(b) Slide the housing towards the steering wheel.

(c) Apply upward pressure to the housing and downward pressure to the indicator panel. This will release the holding tabs (Fig. 4).

(d) Remove instrumentation housing.

YJ and SJ

(a) Remove the evaporator housing-to-instrument panel attaching screws and the housing mounting bracket screw (Figs. 5,6).

(b) Lower the evaporator housing.

(2) Disconnect the dimmer switch electrical connector.

(3) Tape the dimmer switch actuator rod to the column to prevent the rod from disengaging.

(4) Remove the dimmer switch attaching hardware and remove the switch from the rod.

HEADLAMP DIMMER SWITCH INSTALLATION

(1) Push the switch onto the actuator rod and install the switch mounting screws. DO NOT tighten the screws at this time.

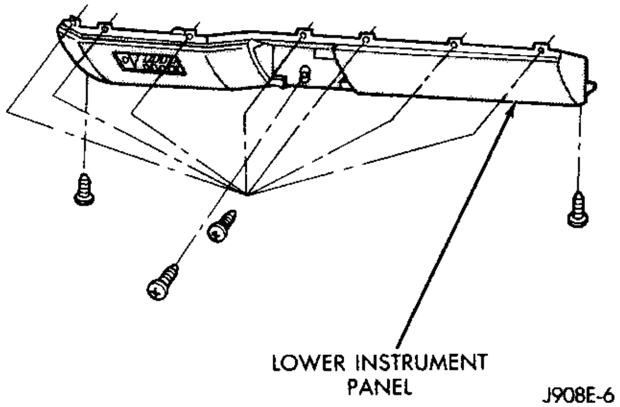


Fig. 2 Lower Instrument Panel — XJ and MJ

(2) Remove the tape, previously applied, holding the actuator rod to the column.

(3) Adjust the dimmer switch as follows:

- Compress the switch slightly and insert a 3/32 inch diameter drill into the adjustment hole (Fig. 7). The drill will prevent any horizontal movement of the switch.
- Move the switch toward the steering wheel to remove actuator rod lash.
- Tighten the screws to 4 N•m (35 in. lbs).
- Connect the battery negative cable.
- Remove the drill and check switch operation. Readjust the switch if necessary.

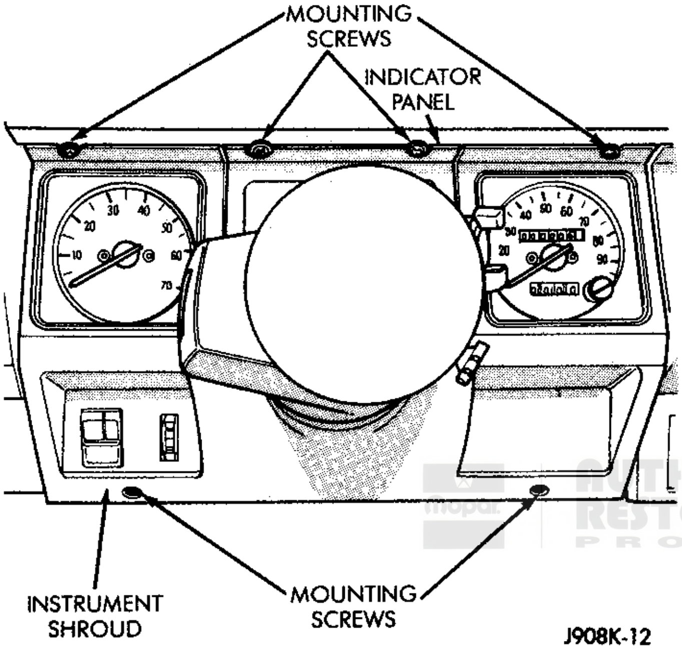


Fig. 3 Instrument Housing Removal/Installation

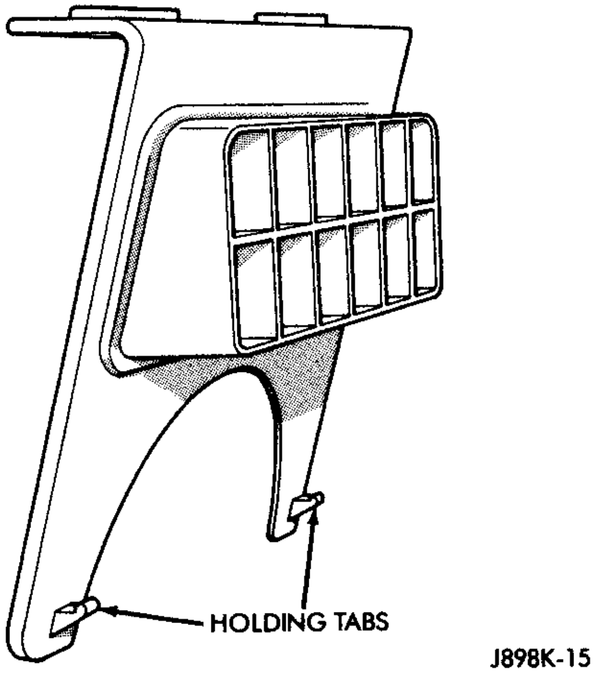


Fig. 4 Indicator Panel Holding Tabs

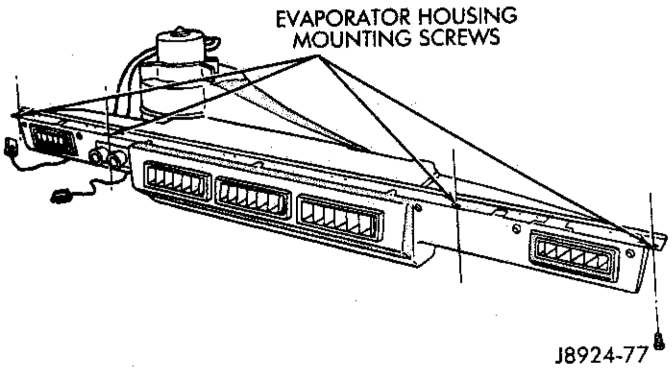


Fig. 5 Remove Evaporator Housing — YJ

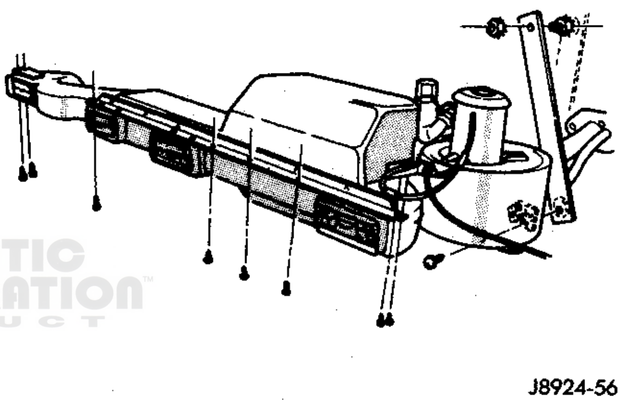


Fig. 6 Remove Evaporator Housing Mounting Screws — SJ

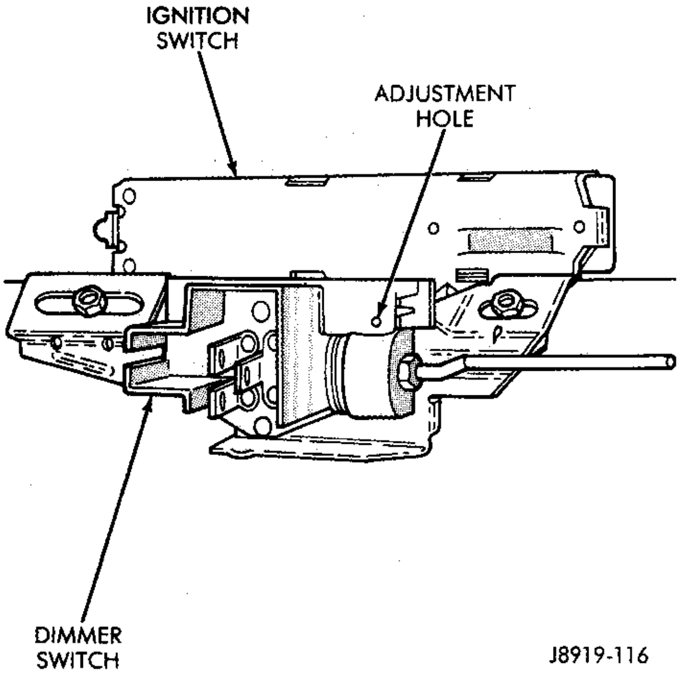


Fig. 7 Headlamp Dimmer Switch Adjustment

XJ and MJ

Install the lower instrument panel cover trim panel.

YJ

(a) Place the housing under the steering column.

(b) Slide the indicator panel tabs into the housing notches.

(c) Place the assembled housing over the indicator lamp foam gasket and install the indicator panel screws.

A fragile foam gasket is on the back of the indicator overlay. If the gasket is torn or distorted, replace with a new gasket.

(d) Install remaining 4 screws.

YJ and SJ

Raise the evaporator housing. Install the evaporator housing-to- instrument panel attaching screws and the evaporator housing mounting bracket screw.

DIRECTIONAL SIGNAL SWITCH REPLACEMENT — ALL MODELS

Refer to Section 8W - Wiring Diagrams for circuit wiring diagram.

(1) Disconnect battery negative cable.

(2) Perform one of the following procedures and then continue with the next step.

Standard Steering Wheel

- Remove 3 screws holding the front cover of the steering wheel (Fig. 1) and carefully remove the front cover.

CAUTION: Use a sharp pointed tool to depress the connector retainer.

- Pull horn wires off at the column side of the steering wheel. Pull gently to remove grounding pin. Be careful to not lose the spring under the grounding pin connector (Figs. 2,3).

Optional Steering Wheel

- Remove the horn button with a push and turn motion.
- Remove the horn button components (Fig. 4).

(3) Turn the key to the lock position and remove the steering wheel nut and washer.

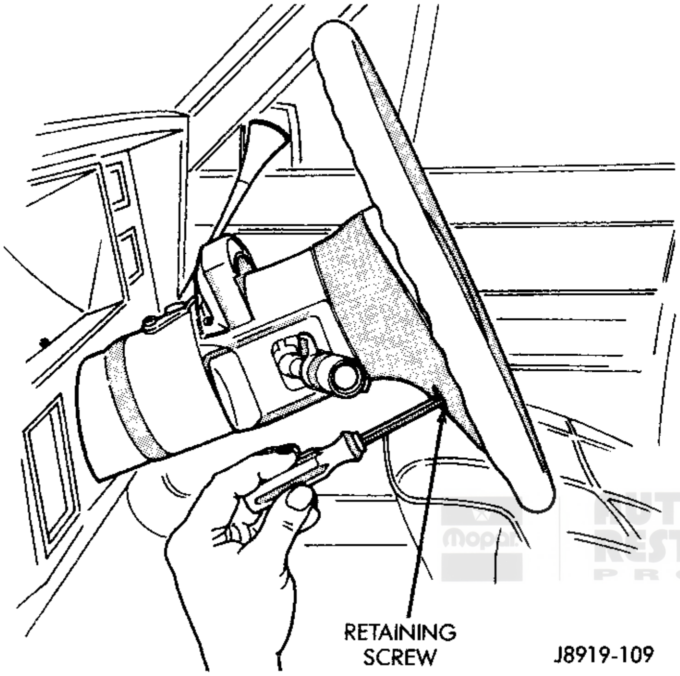


Fig. 1 Standard Steering Wheel Cover Removal/Installation

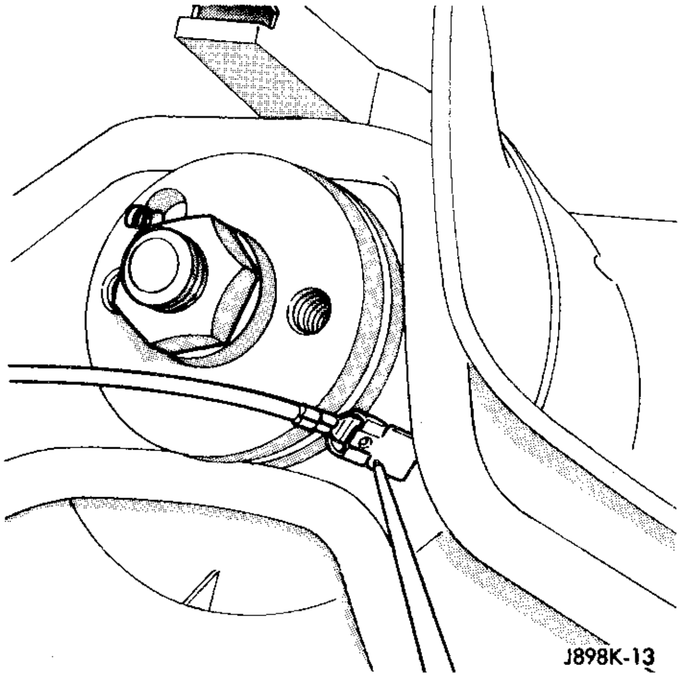


Fig. 2 Horn Wire Removal

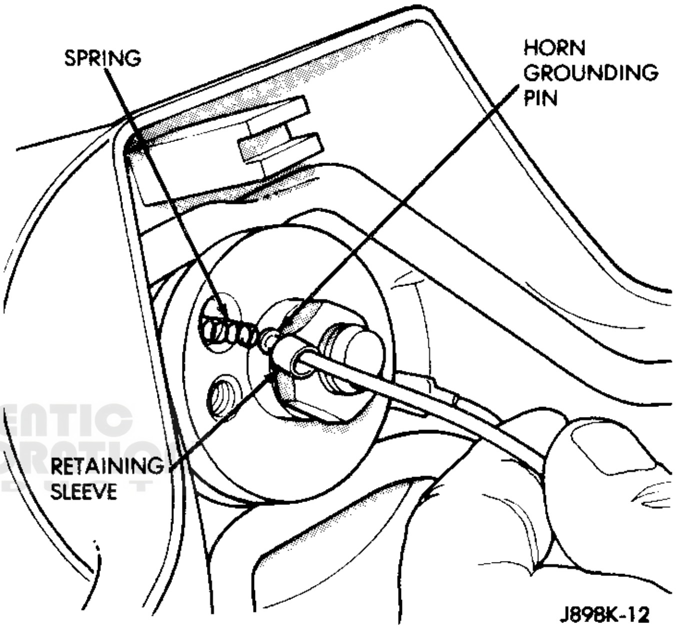


Fig. 3 Horn Grounding Pin Removal/Installation

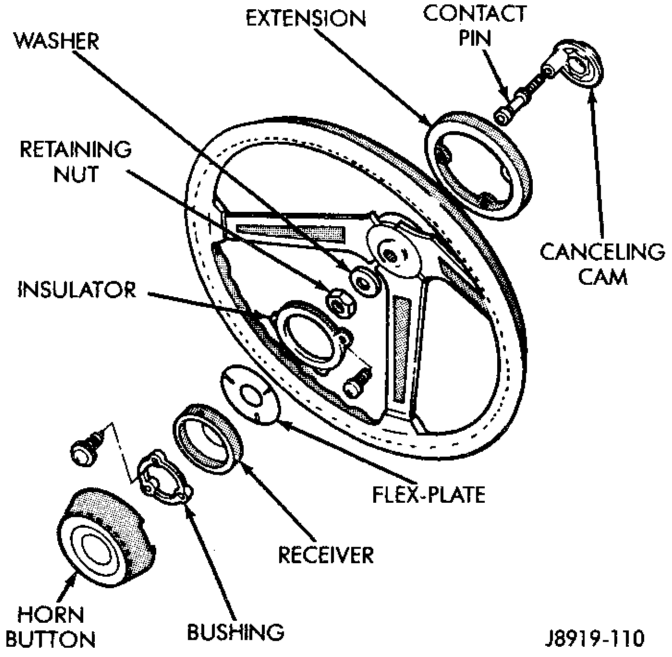


Fig. 4 Optional Steering Wheel Removal/Installation

(4) Scribe an alignment mark on the steering in line with the mark already existing on the end of the steering column.

(5) Remove vibration damper from the steering column hub, if equipped.

(6) Remove the steering wheel using a steering wheel puller. DO NOT hammer on puller or end of steering shaft.

WARNING: IN ORDER TO REMOVE THE STEERING SHAFT SNAP RING IN THE FOLLOWING STEP, THE LOCKPLATE MUST BE COMPRESSED. DO NOT ATTEMPT TO REMOVE THE LOCKPLATE WITHOUT COMPRESSOR TOOL C4156 AS THE LOCKPLATE IS UNDER HEAVY SPRING TENSION.

(7) Compress the lockplate with compressor tool C4156 (Fig. 5) and remove the steering shaft snap ring. Discard the snap ring, it is not reusable.

(8) Remove the compressor tool.

(9) Remove the lockplate, cancelling cam, and upper bearing preload spring. If the vehicle is equipped with the optional steering wheel, remove the horn button components from the canceling cam.

(10) Remove the screw and hazard warning switch knob.

(11) Remove dimmer switch actuator arm attaching screw (Fig. 6).

(12) Remove the turn signal switch attaching screws.

(13) **XJ, MJ and SJ**—Remove the lower instrument panel cover trim panel.

YJ—Remove six housing screws (Fig. 7).

- Slide housing towards the steering wheel.

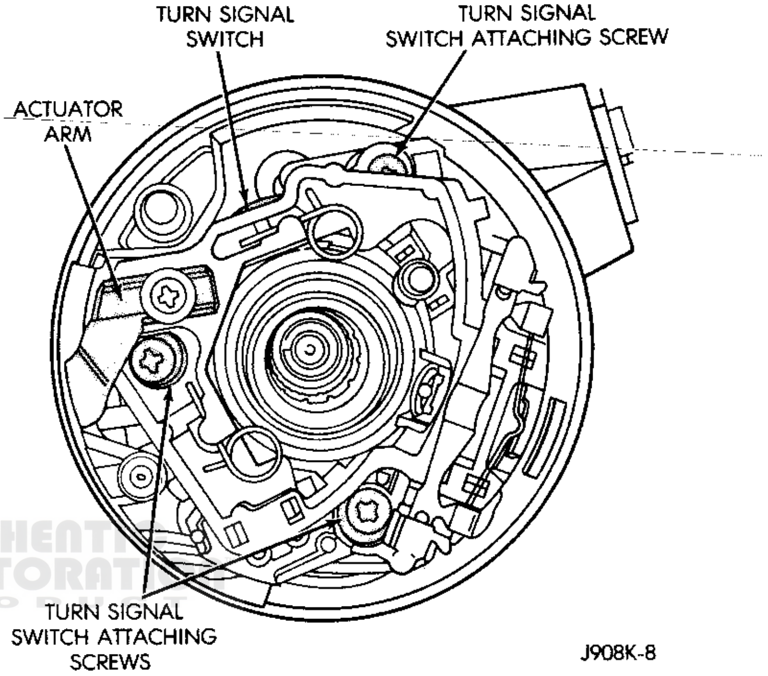


Fig. 6 Turn Signal and Dimmer Actuating Lever Screws

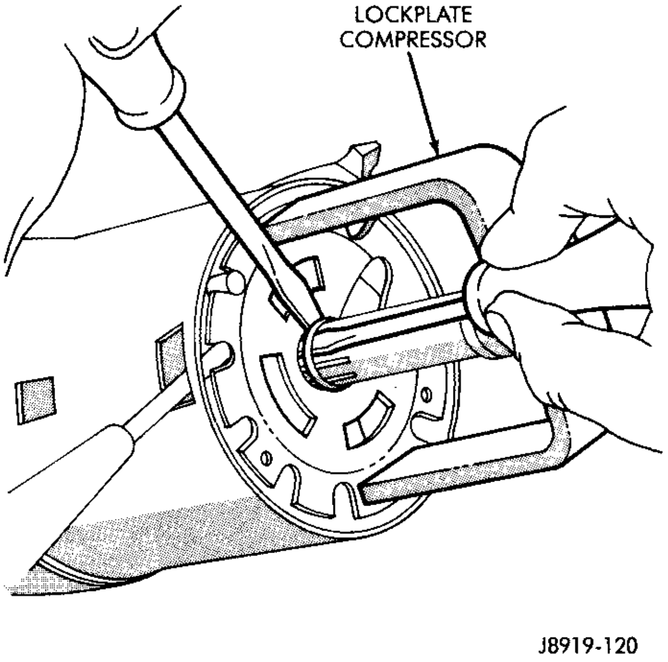


Fig. 5 Lockplate Removal

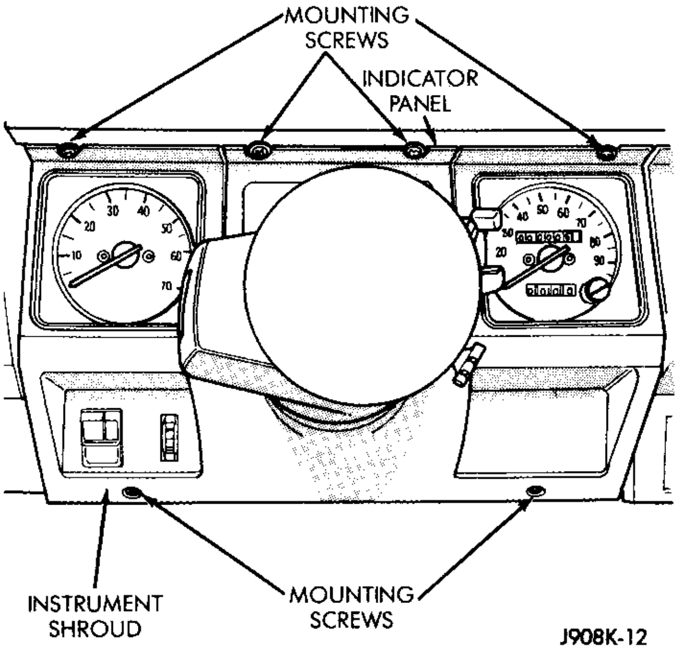


Fig. 7 Instrument Housing Removal/Installation — YJ

- Apply upward pressure to the housing and downward pressure to the indicator panel. This will release the holding tabs (Fig. 8).

(14) Remove cover under column.

(15) If vehicle is equipped with a column shift, remove PRNDL cable clip (Fig. 9).

(16) Remove two nuts holding steering column bracket to brake sled (Fig. 10).

(17) Remove four bolts holding steering column bracket to column.

(18) Loosen column brace mounting nut at drivers side kick panel. This will allow column to drop.

(19) Push upper connector up and out of turn signal connector (Fig. 11).

(20) Pry up locking tabs of turn signal connector and remove connector from column bracket.

(21) Tape connector to wires as shown (Fig. 12).

(22) Remove plastic harness cover by pulling it up and over the weld nuts then open and slide the cover off the harness (Fig. 13).

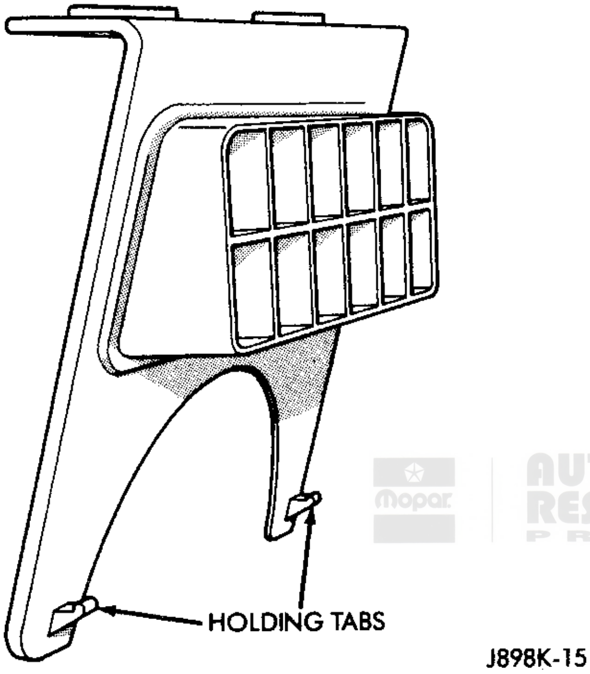


Fig. 8 Indicator Panel — YJ

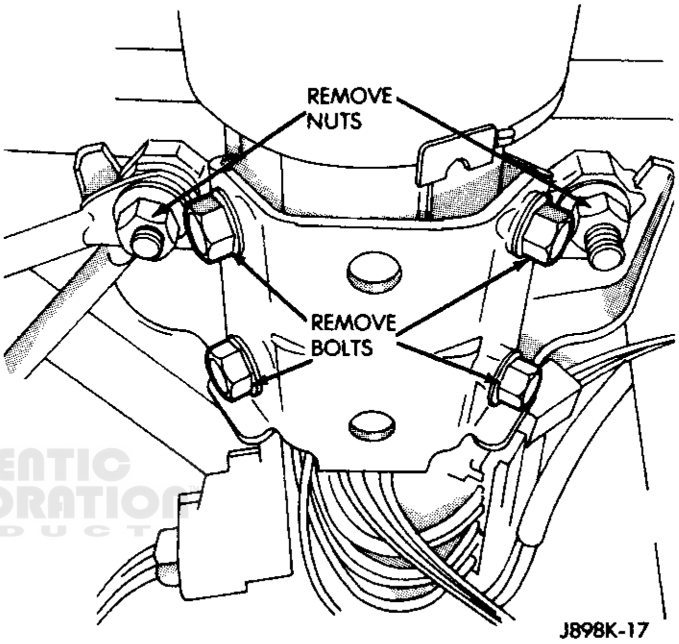


Fig. 10 Lower Steering Column

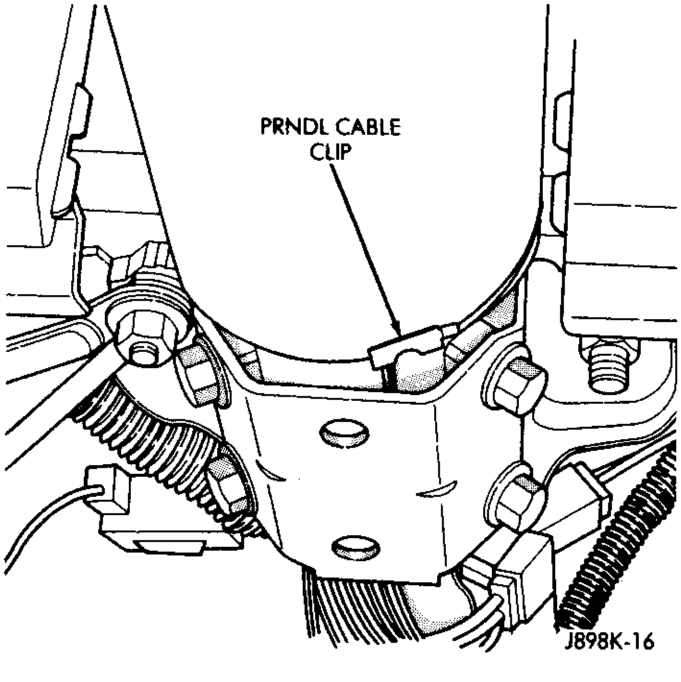


Fig. 9 PRNDL Cable Clip Removal/Installation

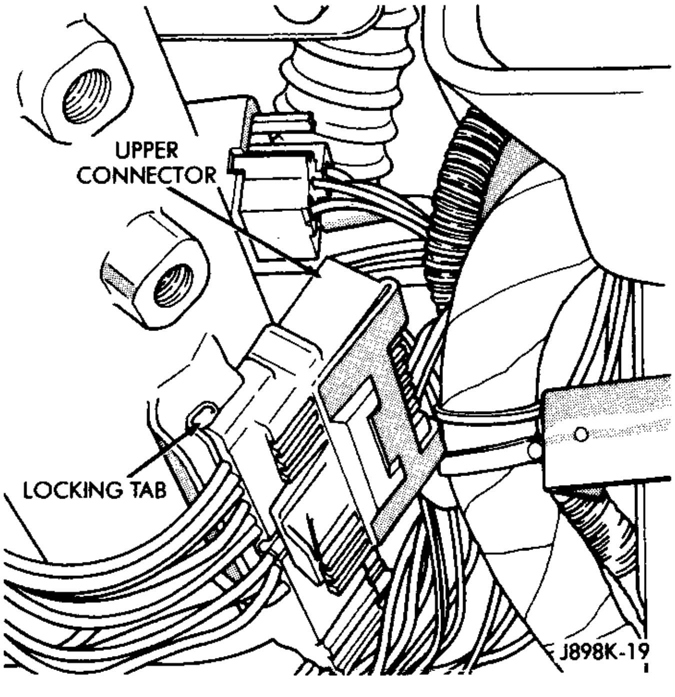


Fig. 11 Turn Signal Connector

(23) Remove the turn signal switch. Pull the switch and wire harness straight up and out of the housing.

(24) To install a new switch, reverse the removal procedure.

CAUTION: When installing a turn signal switch, make sure wires are laying flat on bottom inside of column.

On vehicles equipped with column shift, install the PRNDL cable clip with the shift indicator on N. Move the selector through the range and make sure it lines up with each letter.

(25) Adjust the headlamp dimmer switch as described in Headlamp Dimmer Switch Installation in this section.

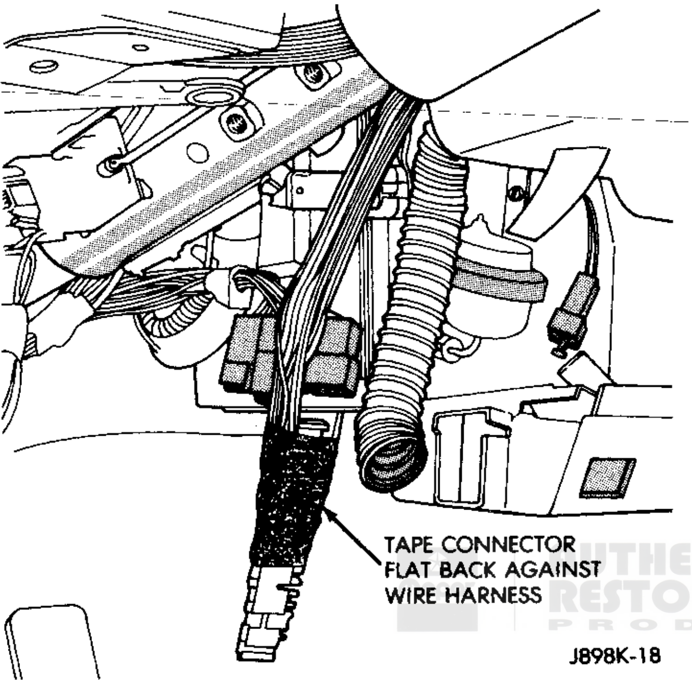


Fig. 12 Tape Wiper Switch Connector

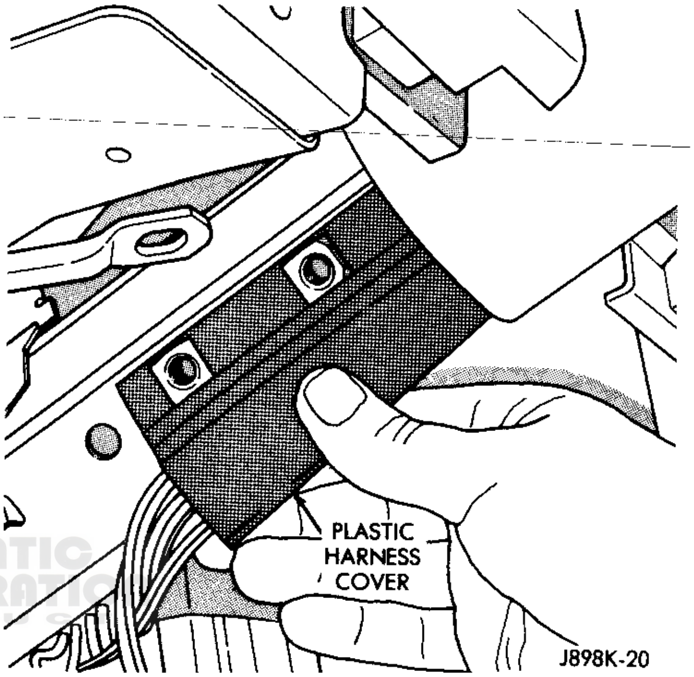


Fig. 13 Remove Plastic Harness Cover

TURN SIGNALS — XJ AND MJ

INDEX

Refer to Section 8L - Lamps for circuit schematic and Section 8W - Wiring Diagrams for circuit wiring diagram.

DESCRIPTION

With the multi-function lever in its UP or DOWN position, current flows through the normally closed turn signal flasher contact, the turn/hazard switch assembly, the select turn indicator, the front and rear bulbs and the side marker bulbs to ground. With the headlamps OFF the turn and side marker lamps go on immediately. They begin to flash when voltage is applied to the flasher causing the contacts to open and close the selected circuit. **With the headlamps ON the turn and side marker lamps flash alternately.**

TROUBLESHOOTING MJ AND CHEROKEE

High alternator output voltage can burn out lamps rapidly.

ALL TURN SIGNAL LAMPS—INOPERATIVE: Remove and inspect fuse, Ignition in ACCY, LH Turn Switch in ON, Hazard Switch pulled OUT

TEST	OK	NOT OK
Turn/Bu fuse	Stop Lamps light	Replace Haz/Stop fuse
Fuse side of Turn Flasher	Battery voltage	Repair open to fuse
Replace Turn Flasher with 2 Lamp 12 Volt rating Flasher	Lamps flash	Go to next step
Turn Hazard Switch connector terminal L	Battery voltage If OK, replace Turn/Hazard Switch Assembly	Repair open to Hazard Flasher

TROUBLESHOOTING WAGONEER

High alternator output voltage can burn out lamps rapidly.

ALL TURN SIGNAL LAMPS—INOPERATIVE: Remove and inspect fuse, Ignition in ACCY, LH Turn Switch in ON, Hazard Switch pulled OUT

TEST	OK	NOT OK
Turn/Bu fuse	Stop Lamps light	Replace Haz/Stop fuse
Fuse side of Turn Flasher	Battery voltage	Repair open to fuse
Replace Turn Flasher with 3 Lamp 12 Volt rating Flasher	Lamps flash	Go to next step
Turn Hazard Switch connector terminal L	Battery voltage If OK, replace Turn/Hazard Switch Assembly	Repair open to Hazard Flasher

HAZARD LAMPS — XJ AND MJ

INDEX

DESCRIPTION

With the hazard switch in its OUT position, current flows to the timing element in the hazard flasher, causing the flasher contacts to close and open repeatedly. When the hazard/flasher contacts are closed, current flows through hazard switches 1 and 2, both indicator bulbs, both front signal bulbs and corner lamp bulbs to ground. Current also flows through hazard switch 3, and both rear turn signal bulbs to ground. All of the turn lamps and both turn indicators flash on and off.

TROUBLESHOOTING

ALL HAZARD LAMPS INOPERATIVE; Hazard Switch in ON

TEST	OK	NOT OK
Depress Brake Pedal	Stop Lamps light	Replace Haz/Stop fuse
Fuse side of Hazard Flasher	Battery voltage	Repair open to fuse
Replace Hazard Flasher	Lamps flash	Go to next step
Turn Hazard Switch connector terminal K	Battery voltage If OK replace Turn/Hazard Switch Assembly	Repair open to Hazard Flasher

TURN SIGNALS AND HAZARD LAMPS — YJ

INDEX

Refer to Section 8L - Lamps for circuit schematic and Section 8W - Wiring Diagrams for circuit wiring diagram.

DESCRIPTION

On the battery side, the flashers and brake switch connect the turn signal switch to the turn/bu and hazard/stop fuses. The flasher circuit is on a separate fuse than the hazard and stop lamps which are hot at all times. The continuous hot feed is necessary because these circuits must be functional without the ignition on.

The turn/hazard switch, which is mounted in the steering column behind the steering wheel, contains the contacts necessary for connecting various lamp combinations to battery feed. In the neutral position, the stop lamp contacts are aligned and the circuit will be completed whenever the brake switch is closed. In the left or right turn position the appropriate exterior lamps (including front side markers) and instrument panel indicator lamp are connected to the turn signal flasher. While the switch is making the connection to the turn signal, it is also maintaining the circuit to the remaining stop and indicator lamp. In the hazard position, the turn signal lamps and side marker lamps are connected to the hazard flasher.

If the headlight switch is on, the side marker and turn signal flash alternately.

TROUBLESHOOTING FLASHER CIRCUIT

1. FUSE: Ignition in RUN

TEST	OK	NOT OK
Check operation of backup lamps	Lamps ON	Check Turn/Bu fuse
Measure voltage at battery side of TURN/BU fuse	Battery voltage	Repair open from ignition switch

2. FLASHER: Ignition in RUN for voltage tests; ignition in OFF for resistance tests

TEST	OK	NOT OK
Measure resistance across Turn Flasher terminals A and B	Zero ohms (except element resistance)	Replace Flasher
Measure voltage at Turn Flasher terminal A	Battery voltage	Repair open from fuse panel
Measure voltage at Turn/Hazard Switch terminal L	Battery voltage	Repair open from Flasher

3. SWITCH: Turn/Hazard Switch Connector separated from turn/hazard switch; switch in left or right turn position as required

TEST	OK	NOT OK
Measure resistance between Turn/Hazard switch connector terminals L and M for left turn	Zero ohms	Replace switch
Measure resistance between Turn/Hazard switch connector terminals L and N for right turn	Zero ohms	Replace switch
Measure resistance between Turn/Hazard switch connector terminals L and H for left turn	Zero ohms	Replace switch
Measure resistance between Turn/Hazard switch connector terminals L and J for right turn	Zero ohms	Replace switch

TROUBLESHOOTING TURN SIGNAL INDICATOR LAMPS

1.TURN SIGNAL INDICATOR CIRCUIT: Ignition switch in RUN for voltage tests; ignition switch in OFF for resistance tests; switch in right or left turn position as required

TEST	OK	NOT OK
Measure voltage at Indicator Lamp Panel connector A terminal 8 for left turn	Pulsing battery voltage	Repair open from turn/hazard switch
Measure voltage at Indicator Lamp Panel connector B terminal 3 for right turn	Pulsing battery voltage	Repair open from turn/hazard switch
Measure resistance between Indicator Lamp Panel connector B terminal 1 and a clean chassis ground	Zero ohms	Repair open between Indicator Lamp Panel connector B terminal 1 and ground

TROUBLESHOOTING HAZARD LAMPS—ONE LAMP OUT

1. FUSE

TEST	OK	NOT OK
Check operation of stop lamps	Lamps on	Check Hazard/Stop fuse
Measure voltage at battery side of hazard/stop fuse	Battery voltage	Repair open from fuse link

2. FLASHER CIRCUIT: Flasher removed

TEST	OK	NOT OK
Measure voltage at hazard flasher terminal A	Battery voltage	Repair open from fuse panel
Measure resistance across flasher terminals	Zero ohms (except element resistance)	Replace flasher

3. TURN/HAZARD SWITCH ASSEMBLY: Hazard switch ON; turn/hazard switch connector separated from turn/hazard switch

TEST	OK	NOT OK
Measure voltage at turn/hazard switch connector terminal K	Battery voltage	Repair open from fuse panel
Measure resistance from turn/hazard switch terminal K to switch terminals H, J, M, and N	Zero ohms	Replace turn/hazard switch

TURN SIGNALS AND HAZARD LAMPS — SJ

INDEX

Refer to Section 8L - Lamps for circuit schematic and Section 8W - Wiring Diagrams for circuit wiring diagram.

DESCRIPTION

With the multi-function lever in its UP or DOWN position, current flows to the timing element in the turn signal flasher causing the flasher contacts to close and open repeatedly. When the flasher contacts are closed, current flows through the turn signal switch assembly, select turn indicator, the front and rear bulbs and side marker bulbs to ground.

With the hazard switch in its OUT position, current flows to the timing element in the hazard flasher, causing the flasher contacts to close and open repeatedly. When the hazard flasher contacts close current flows to the turn signal switches, select turn indicators, all four turn signal bulbs and side marker bulbs to ground. All of the turn lamps, side marker lamps and both turn indicators flash on and off.

If the headlight switch is on, the side marker and turn signal flash alternately.

TROUBLESHOOTING

ALL HAZARD LAMPS INOPERATIVE; Hazard Switch in ON

TEST	OK	NOT OK
Depress Brake Pedal	Stop Lamps light	Replace Haz/Stop fuse
Fuse side of Hazard Flasher	Battery voltage	Repair open to fuse
Replace Hazard Flasher	Lamps flash	Go to next step
Turn Hazard Switch connector terminal K	Battery voltage If OK, replace Turn/Hazard Switch Assembly	Repair open to Hazard Flasher

High alternator output voltage can burn out lamps rapidly.

ALL TURN SIGNAL LAMPS—INOPERATIVE: Remove and inspect fuse, Ignition in ACCY, LH Turn Switch in ON, Hazard Switch pulled OUT

TEST	OK	NOT OK
Check operation of backup lamps	Lamps ON	Replace Turn/Backup fuse
Fuse side of Turn Flasher	Battery voltage	Repair open to fuse
Replace Turn Flasher with 2 Lamp 12 Volt rating Flasher	Lamps flash	Go to next step
Turn Hazard Switch connector terminal L	Battery voltage If OK, replace Turn/Hazard Switch Assembly	Repair open to Turn Signal Flasher

WINDSHIELD WIPERS

CONTENTS

XJ AND MJ

INDEX

FRONT WIPERS/WASHERS

General

Two-speed electric windshield wipers and electric washers are standard equipment. An optional intermittent wiper system provides a pause between wipe cycles for use during conditions of very light precipitation.

Wipers

The standard windshield wiper circuit contains three components; wiper/washer switch, motor, and front washer pump. Both standard and intermittent circuits are the same, except that the intermittent circuit requires a module and delay resistance in the wiper switch. Both circuits receive battery feed from, and are protected by a 4.8 amp circuit breaker.

In the standard wiper circuit, the switch connects the motor directly to battery feed for LO and HI speed operation. In the intermittent circuit, the switch supplies battery feed to the intermittent wiper module, which then supplies the motor. In the delay position, the module is connected with the variable resistor in the wiper switch. The value of the resistance is used by the solid state module to charge a capacitor, which triggers the amount of delay between wipes.

The wiper motor has an arrangement of brushes providing the two wiper speeds. When the wipers are turned off, the park switch maintains current to the motor until the wipers reach the park position on the windshield.

The park arm in the motor assembly is connected to the park switch and is driven by the motor. When the wiper/washer switch is turned to OFF, current flows through the contact and the module to the motor until the wipers reach the park position.

CAUTION: The wiper arms and blades must not be moved manually from side to side or damage may result.

Washers

With the washer switch in ON, current flows through the washer pump to ground, The front washer pump runs as long as the driver holds the switch in ON. On standard wipers, the washer switch automatically moves the wiper switch to LO when the washer is on. On intermittent wipers, the wiper module runs the wiper motor on LO. Turning the switch to OFF stops the wipers.

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Frt. W.W. Pivot Screws and Cowl Brkt. Nut	4 N•m (35 in. lbs.)	4-5 N•m (35-50 in. lbs.)
Rear Window Wiper Pivot—Liftgate	5 N•m (44 in. lbs.)	3-4 N•m (27-37 in. lbs.)
Rear Window Wiper Motor Mounting Bracket—Liftgate	5 N•m (40 in. lbs.)	4-5 N•m (35-50 in. lbs.)

WINDSHIELD WIPER MOTOR

Removal

(1) Remove wiper arm assemblies by lifting blade off of windshield and pulling out on the tab (Fig. 1) to lock wiper arm in UP position.

(2) Remove cowl trim panel. Disconnect the washer hose. Remove the cowl mounting bracket attaching nuts (Fig. 2) and pivot pin attaching screws.

(3) Disconnect wiring harness and remove the assembly.

The wiper motor is shrouded in a protective rubber boot. Care should be taken not to puncture the boot during removal or installation.

Installation

(1) Install wiper motor and linkage assembly into the cowl cavity.

(2) Position cowl mounting bracket and install the attaching nuts. Install pivot pin attaching screws. Tighten the screws and nuts to 4 N•m (35 in. lbs.) torque.

(3) Connect the wire harness.

(4) Connect the washer hose and install cowl trim panel.

(5) Install the wiper arm assemblies and position as shown (Fig. 3).

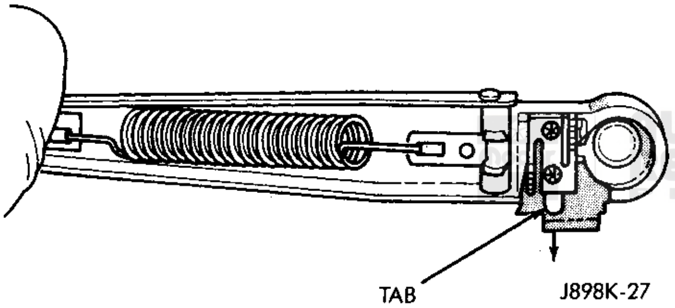


Fig. 1 Wiper Arm Removal

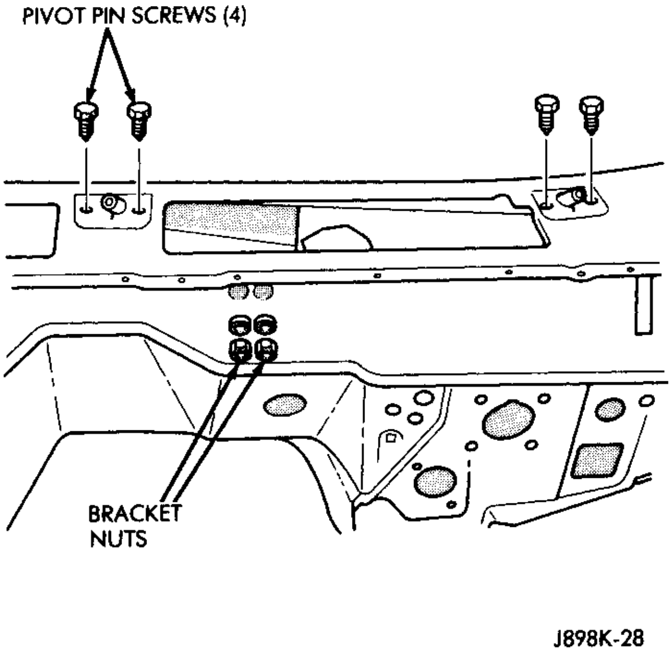


Fig. 2 Pivot Assembly Removal

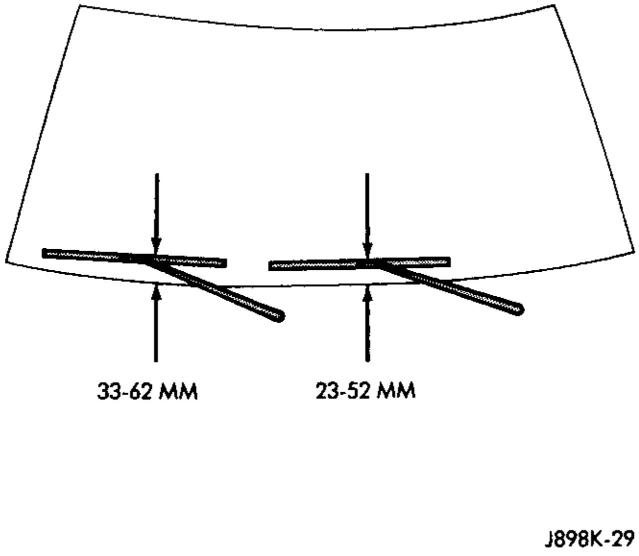


Fig. 3 Windshield Wiper Arm Installation

WASHER PUMP REPLACEMENT

(1) Remove three washer reservoir mounting screws (Fig. 4).

(2) Disconnect hose from pump(s).

(3) Drain washer reservoir.

(4) Using a deep socket, remove filter nut(s) from bottom inside of reservoir and remove pump.

(5) Reverse the removal procedure to install a new pump(s).

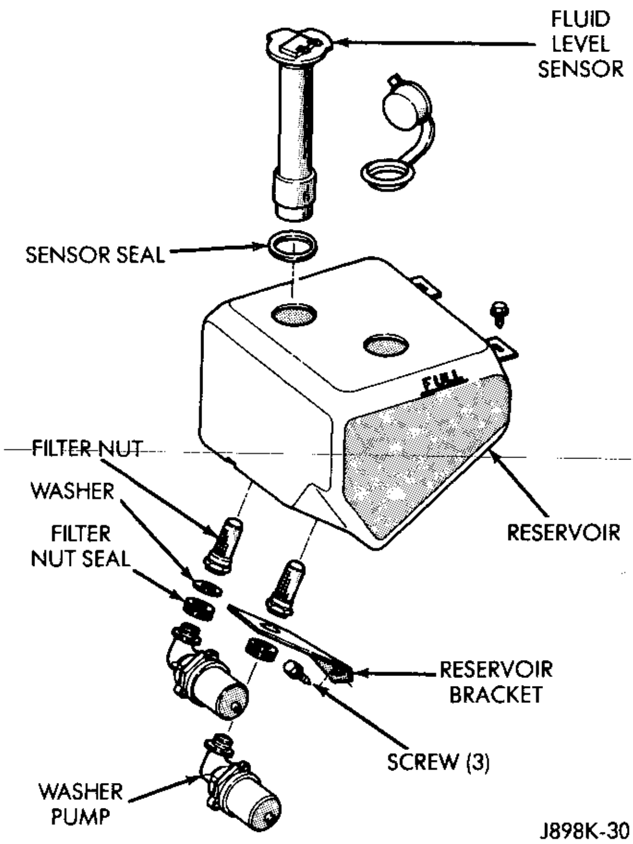


Fig. 4 Washer Reservoir and Pump

TROUBLESHOOTING — WINDSHIELD WIPERS

1. POWER INPUT: Remove circuit breaker

TEST	OK	NOT OK
Battery side of circuit breaker	Zero ohms	Repair open to splice
Across circuit breaker terminals	Battery voltage	Replace circuit breaker

2. GROUND: Connector A unplugged (Figs. 5,6)

TEST	OK	NOT OK
Terminal G	Zero ohms	Repair open to ground

3. WITH INTERMITTENT WIPERS: Ignition switch in ACCY

TEST	OK	NOT OK
Remove delay module and plug connectors together from the module	Wipers operate in LO and HI speed modes and Mist (washer) is working If wipers and Mist now operate, replace intermittent module	Go to Test 4

4. WIPER/WASHER SWITCH: Ignition in RUN, wiper switch position as indicated, back probe switch side of connector A for standard, connector B for intermittent

TEST	OK	NOT OK
Connector terminal E-wiper switch in LO and mist/intermittent	Battery voltage	Replace switch
Connector terminal C-wiper switch in HI	Battery voltage	Replace switch
Connector terminal F-wiper switch to OFF	Battery voltage until wipers park and then zero volts	Replace switch

5. WITH INTERMITTENT WIPERS: Connector B unplugged

TEST	OK	NOT OK
Across terminals A and D while rotating switch from minimum delay to maximum delay	0-500K ohms	Replace switch
Across terminals A and G while rotating switch from minimum delay to maximum delay	0-500K ohms If OK, replace wiper module	Replace switch

6. WIPER MOTOR: Ignition in ACCY, wiper switch position as indicated, probe connector D

TEST	OK	NOT OK
Connector terminal 1	Zero ohms	Repair open to ground
Connector terminal 4-wiper switch in any position	Battery voltage If OK, replace motor	Repair open from fuse panel
Connector terminal 2-wiper switch in LO	Battery voltage If OK, replace motor	Repair open from wiper switch
Connector terminal 2-wiper switch in HI	Battery voltage If OK, replace motor	Repair open from wiper switch
Connector terminal 5-wiper switch to OFF with voltmeter connected	Battery voltage until wipers park and then zero volts If OK, replace motor	Repair open from wiper switch

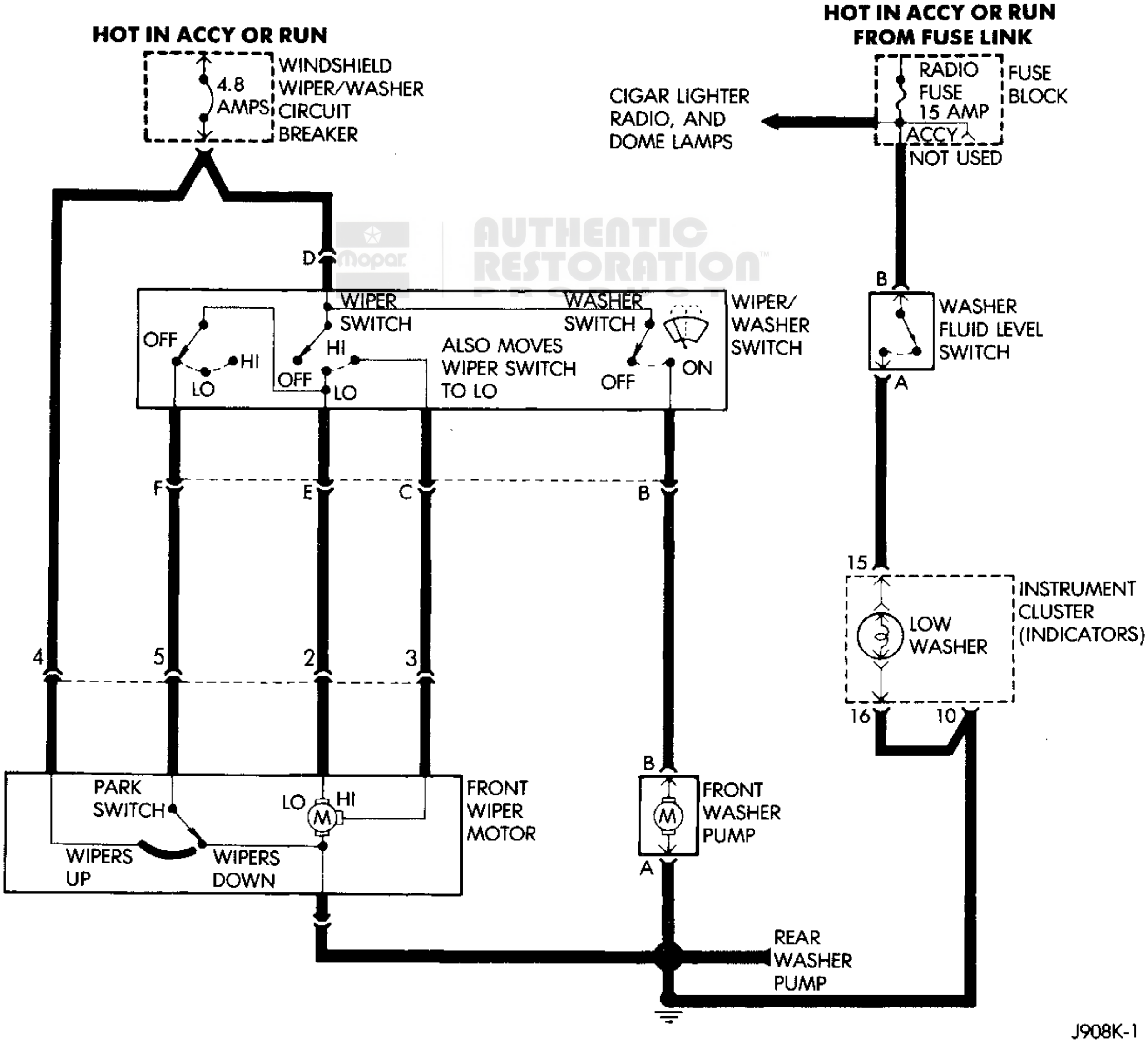


Fig. 5 Non-Intermittent Wiper Schematic—XJ And MJ

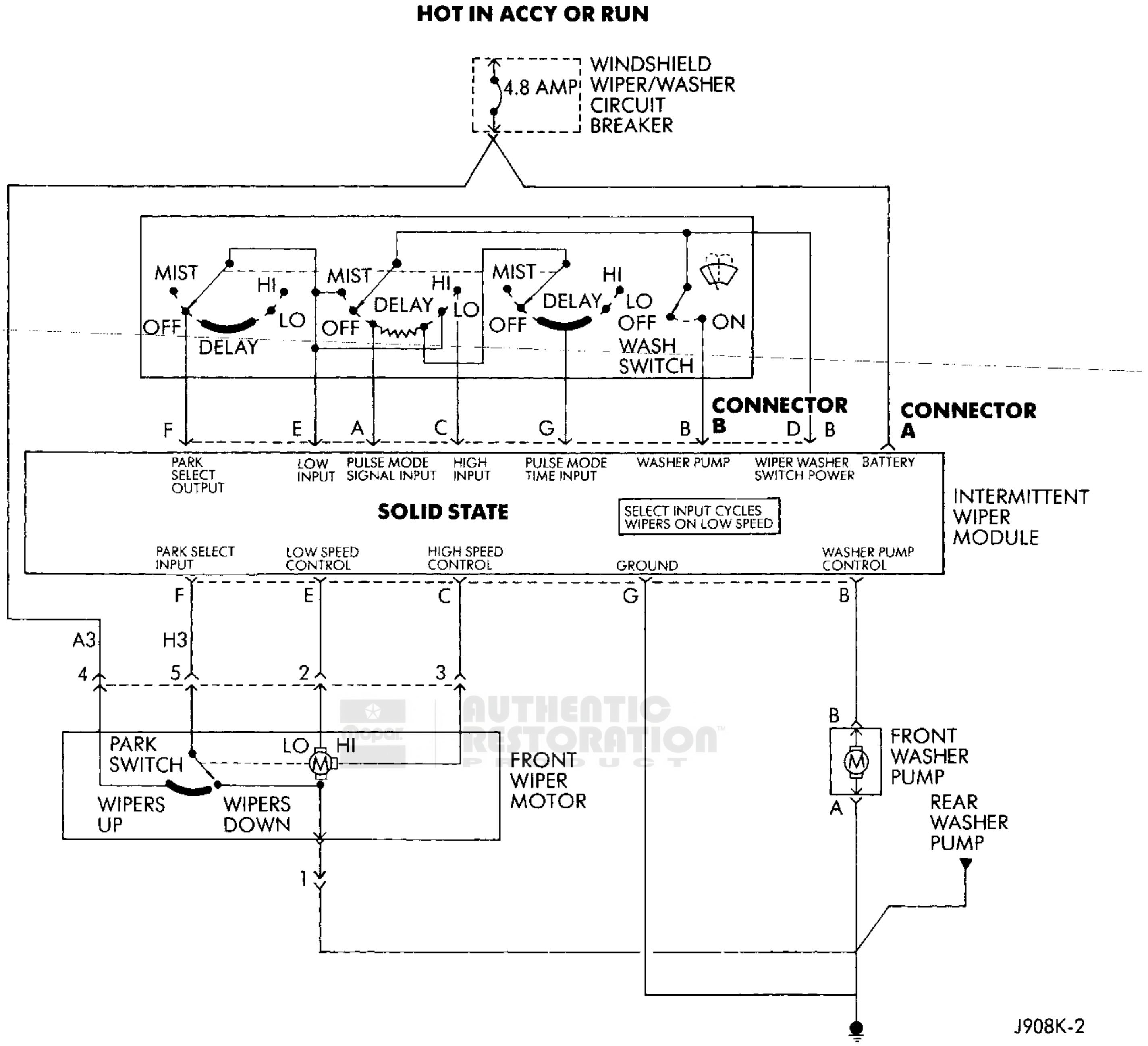


Fig. 6 Intermittent Wiper Schematic—XJ And MJ

TROUBLESHOOTING — WINDSHIELD WASHER (NON-INTERMITTENT)

1. **GROUND: Unplug Washer Pump Connector**

TEST	OK	NOT OK
Terminal A at pump to clean chassis ground	Zero ohms	Repair open to ground

2. **POWER INPUT: Ignition in ACCY, washer switch to ON**

TEST	OK	NOT OK
Washer pump connector terminal B	Battery Voltage If OK, replace washer pump	Go to Next step
Wiper washer switch connector, terminal B at switch	Battery Voltage If OK, repair open to washer pump	Replace switch

TROUBLESHOOTING — WINDSHIELD WASHER (INTERMITTENT)

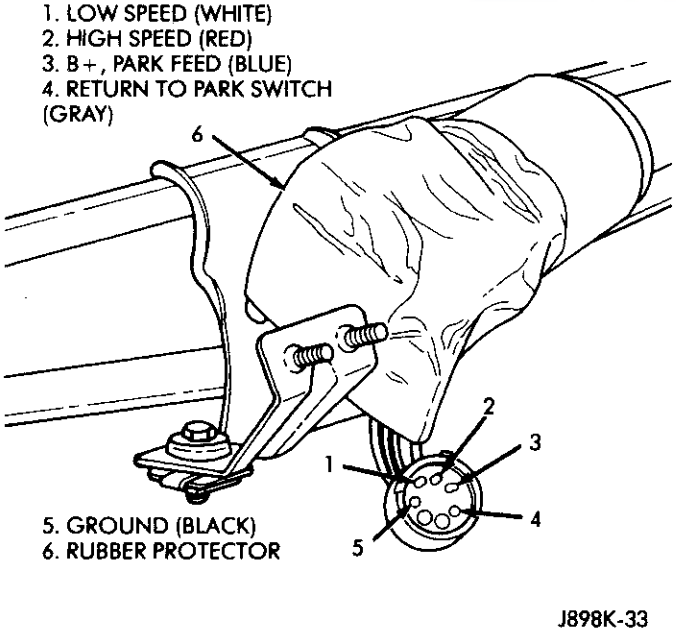
1. **GROUND: Unplug Washer Pump Connector**

TEST	OK	NOT OK
Terminal A at pump to clean chassis ground	Zero ohms	Repair open to ground

2. **POWER INPUT: Ignition switch in ACCY, washer switch to ON**

TEST	OK	NOT OK
Connector B terminal B	Battery voltage	Replace wiper switch
Connector A terminal B	Battery voltage	Replace module
Washer pump connector terminal B at pump	Battery voltage If OK, replace pump	Repair open from Wiper Module

Windshield Wiper Connector



Intermittent Wiper Module

The Intermittent Wiper Module is non-serviceable. Refer to the wiring schematic for connector call outs.

The intermittent wiper module is attached to the lower instrument panel cover near the steering column with a patch of velcro.

LIFTGATE WIPER

General

The liftgate wiper motor is a single-speed motor equipped with an automatic park feature.

With the ignition switch in ACCY or RUN, voltage is applied from the RR wipe fuse to the rear wiper/washer switch.

With the rear wiper/washer switch in WIPE, current flows to the rear wiper relay. The relay energizes and current flows to terminal H of the rear wiper motor connector to the PARK/RUN contacts of the rear wiper motor. The contact arm in the motor is driven by the motor. During a wipe cycle, current flows through terminal K of the rear wiper motor connector to the contact, the contact arm, the circuit breaker and the wiper motor to ground. If the driver turns the wipers off in mid-cycle, current to the motor is maintained through terminal K until the wipers are parked. The ground circuit (terminals 30 and 87A in the relay) and the diode in the wiper motor allows the wiper motor to park abruptly.

With the rear wiper/washer switch in WASH, current flows through the rear washer pump and the coil of the rear wiper relay. The washer pump runs as long as the driver holds the switch in WASH.

Removal

(1) Remove the wiper arm assembly from the pivot pin by depressing the tab (Fig. 1) and pulling straight out.

(2) Slide clip along hose until clip is off hose mounting.

(3) Disconnect the washer hose.

(4) Remove pivot pin retaining nut.

(5) Remove the liftgate interior trim panel.

(6) Disconnect the wiper motor at the wiring harness.

(7) Remove the wiper motor mounting screws.

(8) Remove the wiper motor.

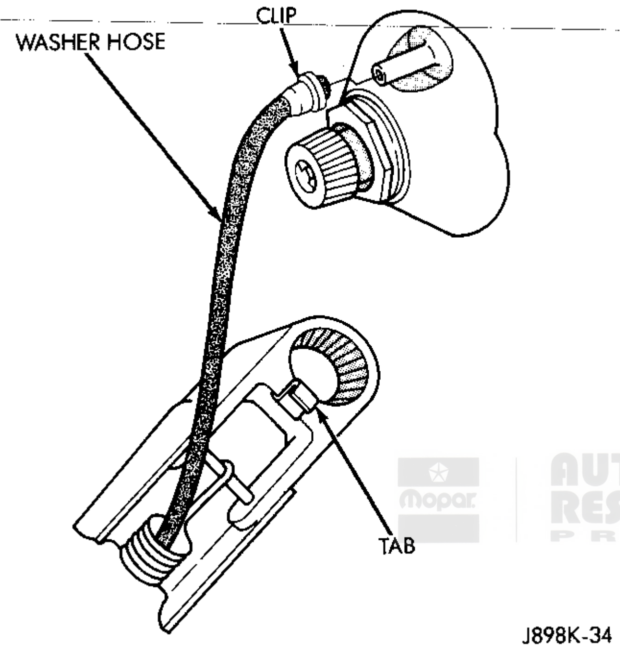


Fig. 1 Rear Wiper Arm Removal

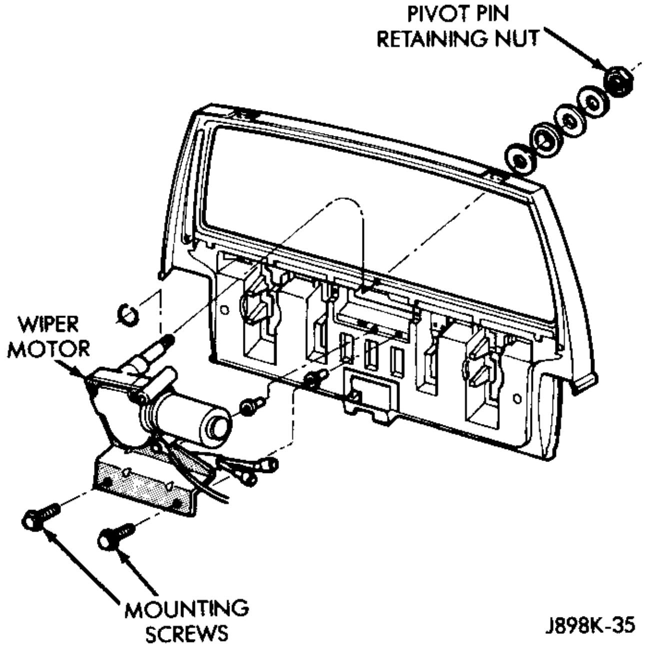


Fig. 2 Rear Wiper Motor Removal/Installation

Installation

(1) Position the motor (Fig. 2) in the liftgate cavity with the pivot pin protruding through the hole in the liftgate.

(2) Install the mounting screws.

(3) Connect the wiring harness.

(4) Install the pivot pin attaching nut (Fig. 2) and torque to 4 N•m (32 in. lbs.).

(5) Install the liftgate trim panel.

(6) Install the wiper arm assembly and connect the washer hose.

(7) Slide the clip along the hose until it is over hose mount.

Lubricate the nipple with a small amount of water and then install the washer nozzle hose prior to attaching the wiper arm to the wiper motor knurl.

The blade should be parallel to the window opening and come no closer than 5mm to the window seal when operated on a wet window (Fig. 3).

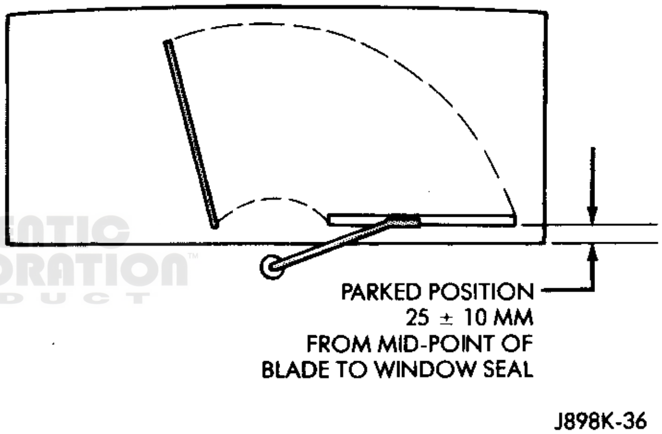


Fig. 3 Rear Wiper Arm Positioning

WASHER PUMP REPLACEMENT

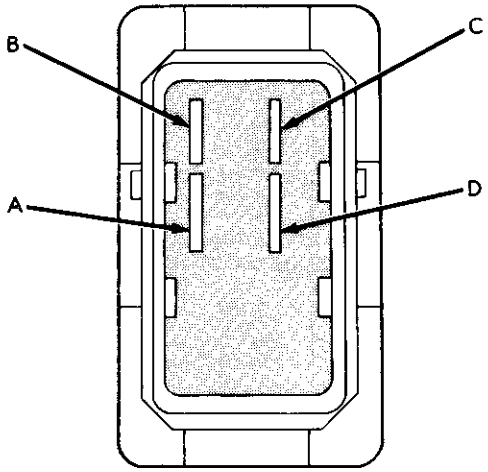
The washer pump for the liftgate is located next to the front washer pump on the washer reservoir in the engine compartment. For replacement refer to the front washer pump replacement procedure.

LIFTGATE WIPER SWITCH REPLACEMENT

(1) Remove the instrument panel bezel; see Instrument Panel and Components Section for the procedure.

(2) Remove the switch housing panel.

(3) Unplug the switch connector. Slightly depress the switch mounting tabs and remove the switch (Fig. 4).



A. WIPER MOTOR FEED (PARK) C. WASHER MOTOR FEED
B. WIPER MOTOR FEED (RUN) D. BATTERY FEED

J898K-37

Fig. 4 Rear Wiper Switch

TROUBLESHOOTING — REAR WIPER

Refer to Fig. 5.

1. POWER INPUT: Remove and inspect fuse

TEST	OK	NOT OK
RR Wipe fuse	Not blown	Replace fuse

2. REAR WIPER RELAY: Ignition in ACCY, switch in WASH, remove liftgate cover

TEST	OK	NOT OK
Rear Wiper Relay terminal 2 and terminal 4 (ignition switch off)	Zero ohms	Repair open to splice in body harness
Rear Wiper Relay terminal 1 and terminal 5	Battery voltage	Go to switch test step 4
Rear Wiper Relay terminal 3	Battery voltage	Replace relay

3. REAR WIPER MOTOR: Ignition in ACCY, switch in WASH, install relay

TEST	OK	NOT OK
Rear Wiper Motor terminal J (ignition switch off)	Zero ohms	Repair open to splice in liftgate harness
Rear Wiper Motor terminal K	Battery voltage	Go to switch test step 4
Rear Wiper Motor terminal H	Battery voltage If OK, replace motor	Repair open from rear wiper relay terminal 3

4. REAR WIPER/WASHER SWITCH: Remove switch and re-connect below Instrument panel; back probe switch connector, in ACCY

TEST	OK	NOT OK
Switch connector terminal B	Battery voltage	Repair open to fuse
Switch connector terminal D	Battery voltage If OK, repair open to Rear Wiper Motor terminal K	Replace switch
Switch connector terminal C, switch in wipe	Battery voltage If OK, repair open to Rear Wiper Relay terminals 1 and 5	Replace switch

TROUBLESHOOTING — REAR WIPER WASHER

Refer to Fig. 5.

1. POWER INPUT: Ignition in ACCY, rear wiper/washer switch in WASH

TEST	OK	NOT OK
Operate rear wiper motor	Motor operates	Check RR Wipe fuse

2. REAR WASHER PUMP: Ignition in ACCY, Rear Washer Pump connector unplugged

TEST	OK	NOT OK
Pump connector terminal A	Zero ohms	Battery voltage If OK, replace pump
Pump connector terminal B, switch in WASH	Repair open to splice	Go to switch test step 3

3. REAR WIPER/WASHER SWITCH: Remove switch and re-connect below Instrument panel; back probe switch connector, ignition in ACCY

TEST	OK	NOT OK
Switch connector terminal B	Battery voltage	Battery voltage If OK, repair open to washer pump terminal B
Switch connector terminal A, switch in WASH	Repair open to fuse	Replace switch

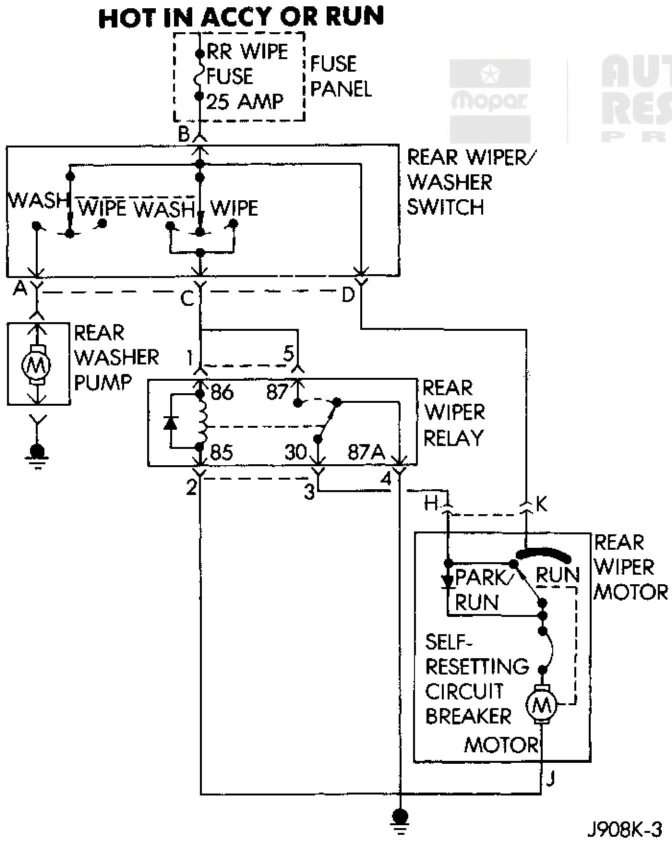
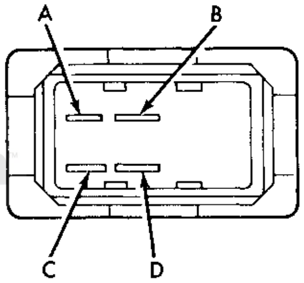
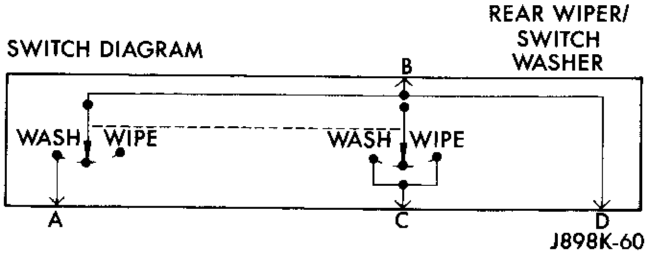


Fig. 5 Rear Wiper/Washer Schematic — XJ

REAR WIPER/WASHER SWITCH TESTING





SWITCH TEST

SWITCH POSITION	TERMINALS	ZERO OHMS
OFF (NORMAL)	B AND A	NO
	B AND C	NO
WIPE	B AND C	YES
	B AND A	NO
WASH	A AND B	YES
	B AND C	YES

J908K-17

YJ

INDEX

FRONT WIPERS/WASHERS

GENERAL INFORMATION

The non-intermittent windshield wiper circuit contains three components; control switch, motor and washer pump. The intermittent circuit contains the same components and a wiper module that provides the delay function. Both circuits receive battery feed from and are protected by a 5.3 amp circuit breaker.

In the non-intermittent wiper circuit, the switch connects the motor directly to battery feed for LO and HI speed operation. In the intermittent circuit, the switch supplies battery feed to the delay module, which then supplies the motor. In the delay position, the module is connected with the variable resistor in the wiper switch. The value of the resistance is used by the solid state module to charge a capacitor, which triggers the amount of delay between wipes.

The wiper motor has an arrangement of brushes providing the two wiper speeds. When the wipers are turned off, the park switch maintains current to the motor until the wipers reach the park position on the windshield.

The washer pump receives battery feed either directly from the wiper switch or from the intermittent module. In either case the electric motor will drive the washer pump.

The wiper motor is mounted on the lower left corner of the windshield.

FRONT WIPER BLADE REPLACEMENT

Rotate the wiper blade release (Fig. 1) clockwise. This will release the wiper blade from the pivot pin.

CAUTION: Take Care to ensure that the wiper arm does not strike the windshield after the wiper blade has been removed.

To install, place the blade assembly on the wiper arm and snap the blade assembly into position.

FRONT WIPER ARM REPLACEMENT

(1) Pull the wiper arm forward.

(2) Insert an ice pick type tool into the hole (Fig. 2).

(3) Grasp the wiper arm above the pivot nut.

(4) Pull and remove the wiper arm assembly.

(5) To install, push the wiper arm over the pivot shaft. Be sure the pivot shaft is in the PARK position and the wiper arm is positioned correctly on the windshield (Fig. 3).

FRONT WIPER ARM AND PIVOT ASSEMBLY REPLACEMENT

Removal

(1) Remove the left and right wiper arms.

(2) Remove the nuts attaching the pivots to the windshield frame.

(3) Remove the necessary hard or soft top components from the windshield frame.

(4) Remove the windshield holddown bolts in the lower corners of the instrument panel and fold the windshield forward.

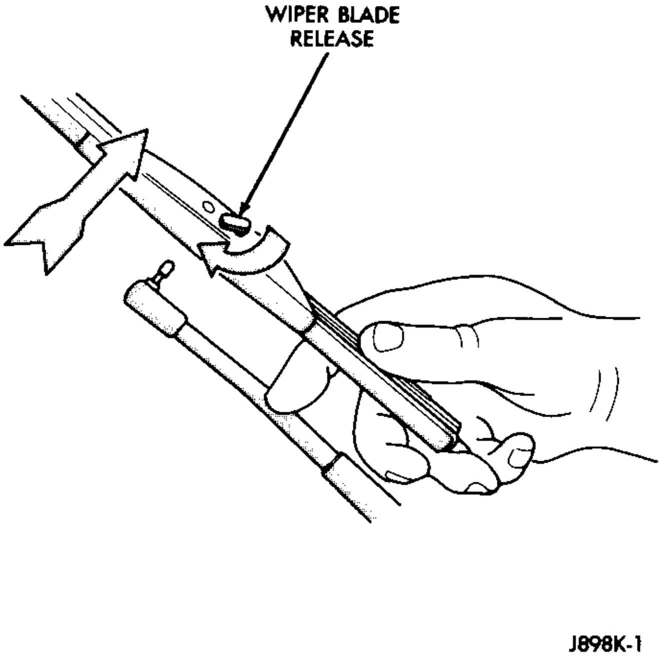


Fig. 1 Wiper Blade Removal—YJ

(5) Remove wiper motor mounting screws (Fig. 4).

(6) Disconnect the wiper linkage drive arm (Fig. 5).

(7) Remove the 4 inboard screws retaining the seal to the bottom of the windshield frame (the protruding screws ends interfere with pivot link removal and installation).

(8) Grasp the motor and pull the motor and drive arm out of the access hole (Fig. 6).

(9) Remove the pivot shaft assembly through the access hole.

(10) Pry the drive arm of the motor pivot. DO NOT remove the pivot attaching nut (Fig. 7).

Installation

(1) Install wiper linkage drive arm onto motor (Fig. 8).

(2) Install pivot shaft assembly in the windshield frame.

(3) Install motor and drive arm in the windshield frame.

(4) Install the weatherstrip screws.

(5) Connect wiper linkage drive arm to Pivot Shaft (Fig. 9).

(6) Install motor mounting screws. Tighten screws to 10.5 N•m (96 in. lbs.).

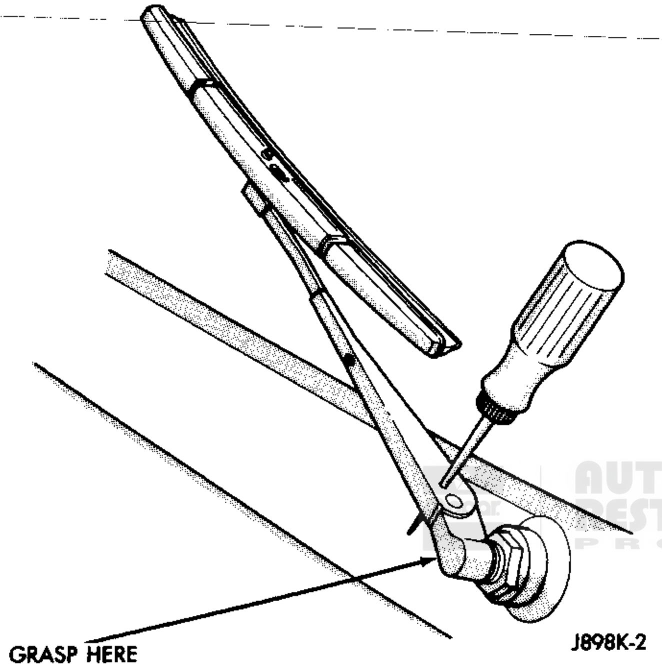


Fig. 2 Wiper Arm Removal/Installation

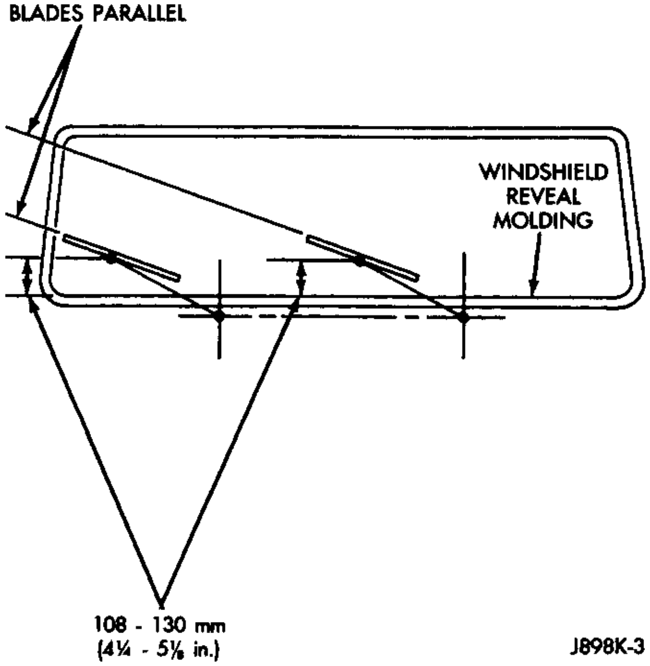


Fig. 3 Wiper Arm Positioning

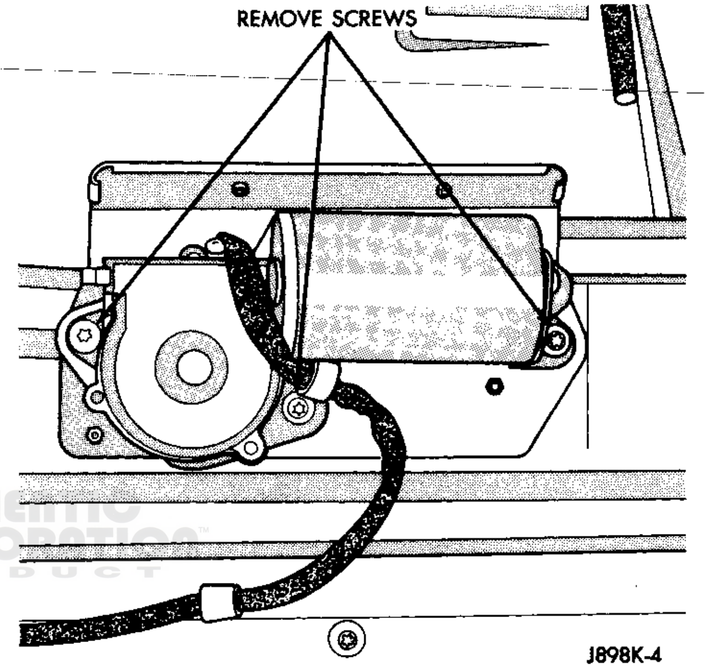


Fig. 4 Remove Wiper Motor Mounting Screws

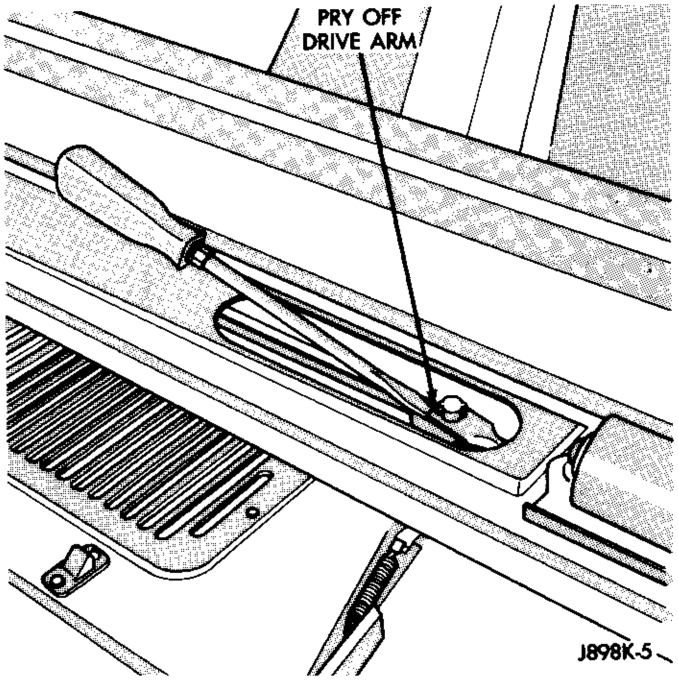


Fig. 5 Disconnect Drive Arm

Be sure wire harness is not pinched or cut when windshield frame is rotated to upright position.

(7) Raise the windshield to the upright position and install the left and right windshield holddown bolts.

(8) Install the nuts attaching the pivots to the windshield frame. Tighten nuts to 10 N•m (7.5 ft. lbs.).

(9) Turn wipers on to allow motor to cycle to Park position.

(10) Install the left and right wiper arms (Fig. 3).

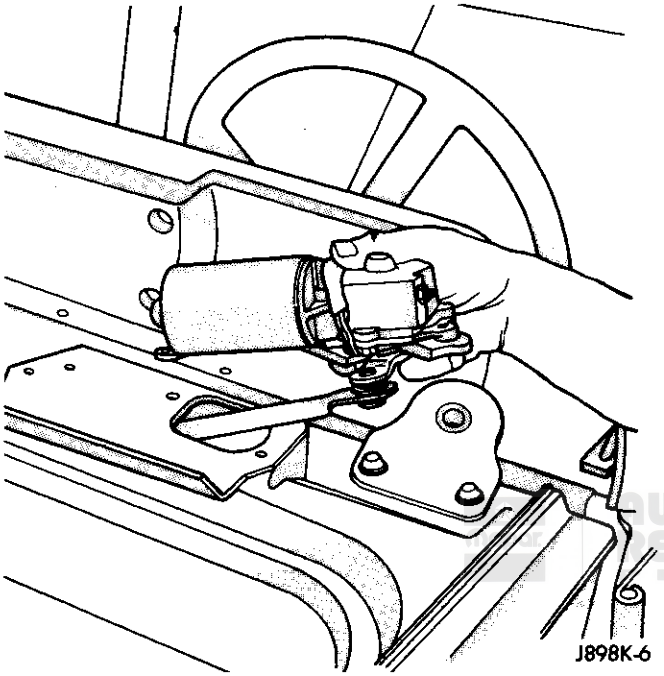


Fig. 6 Remove Wiper Motor and Drive Arm

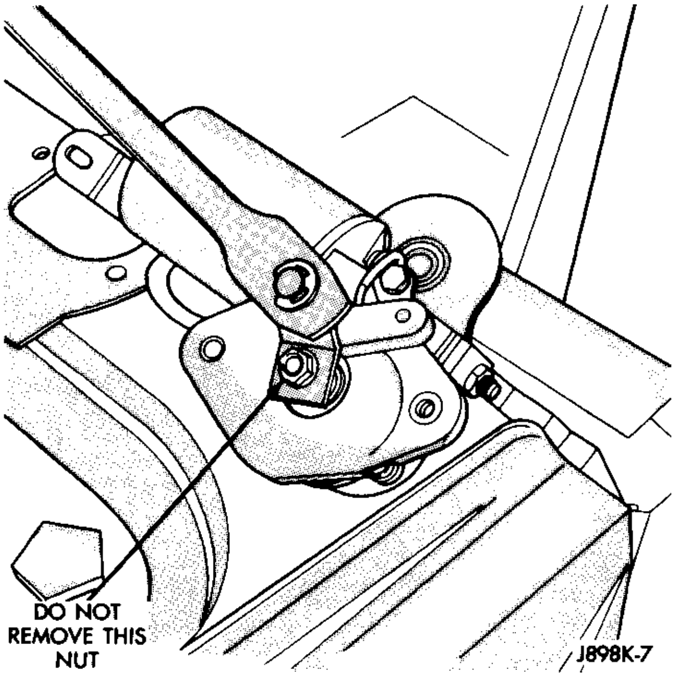


Fig. 7 Drive Arm Removal

(11) Install the necessary top components on the windshield frame.

FRONT WIPER MOTOR

Removal

(1) Remove the necessary hard or soft top components from the windshield frame.

(2) Remove the windshield holddown bolts in the lower corners of the instrument panel.

(3) Remove wiper motor mounting screws (Fig. 4).

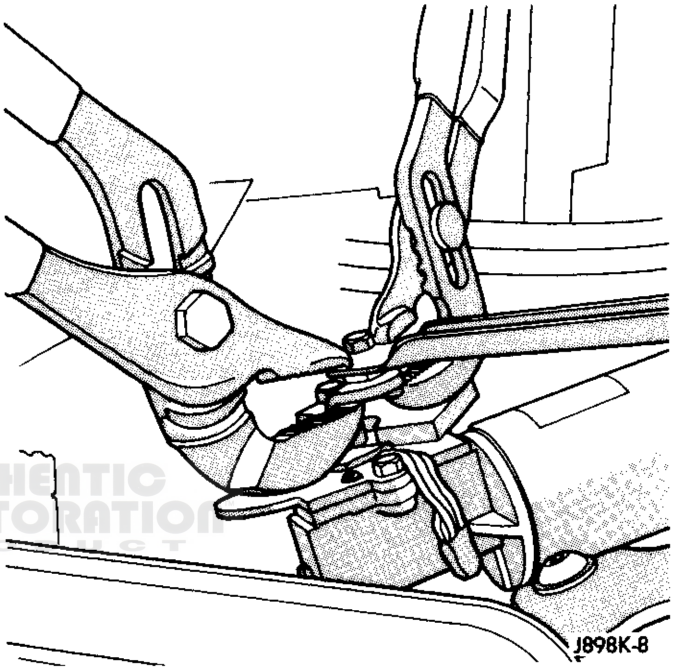


Fig. 8 Install Drive Arm On Motor

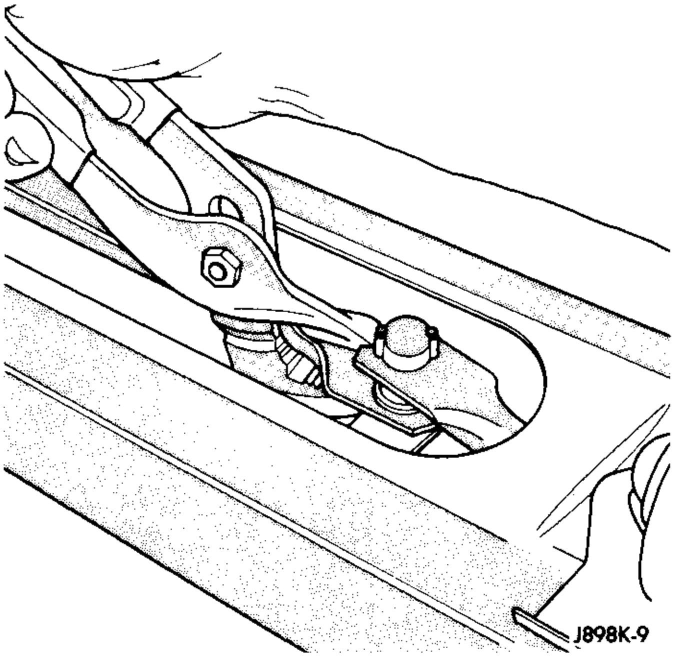


Fig. 9 Connect Drive Arm To Pivot Shaft

(4) Remove wiper motor harness retaining clip located on bottom of windshield.

(5) Disconnect the wiper linkage drive arm (Fig. 5)

(6) Grasp the motor and pull the motor and drive arm out of the access hole (Fig. 6).

(7) Pry the drive arm of the motor pivot. DO NOT remove the pivot attaching nut (Fig. 7).

(8) Remove two screws holding intermittent wiper module bracket to bottom of instrument panel.

(9) Reach up behind instrument panel and disconnect wiper motor harness.

(10) Remove wiper motor.

Installation

(1) Install wire harness through hole in top of instrument panel.

(2) Connect wiper motor connector behind instrument panel.

(3) Install intermittent wiper module bracket to bottom of instrument panel.

(4) Turn wipers on to allow motor to cycle to Park position.

(5) Install wiper linkage drive arm onto motor (Fig. 8).

(6) Install motor and drive arm in the windshield frame.

(7) Connect wiper linkage drive arm to pivot shaft (Fig. 9).

(8) Install motor mounting screws. Tighten screws to 10.5 N•m (96 in. lbs.).

(9) Install wire harness retaining clip on bottom of windshield.

Be sure wire harness is not pinched or cut when windshield frame is rotated to upright position.

(10) Raise windshield to upright position and install left and right windshield holddown bolts.

(11) Install the necessary top components on windshield frame.

WASHER PUMP REPLACEMENT

(1) Remove three washer reservoir mounting screws (Fig. 10).

(2) Disconnect hose(s) from pump.

(3) Drain washer reservoir.

(4) Using a deep socket, remove filter nut from bottom inside of reservoir and remove pump.

(5) Reverse the removal procedure to install a new pump.

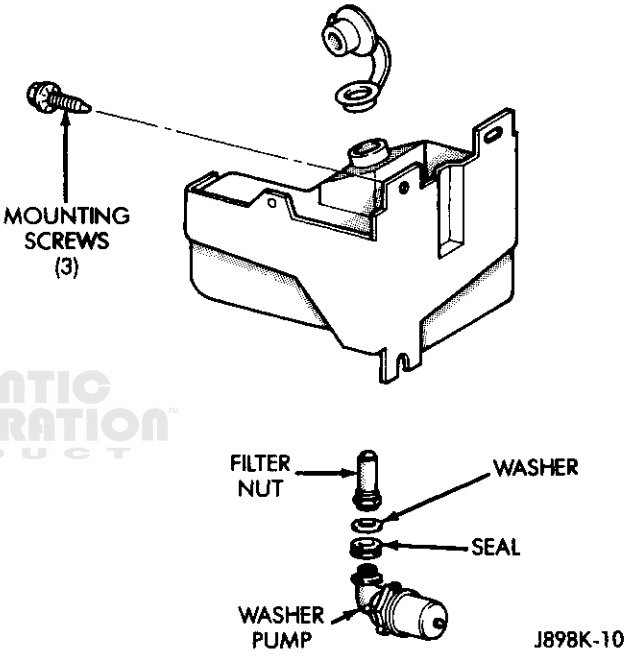


Fig. 10 Washer Reservoir and Pump

TROUBLESHOOTING—Front Windshield Wipers Inoperative

Refer to (Figs. 11,12)

1. CIRCUIT BREAKER: Turn ignition switch to RUN

TEST	OK	NOT OK
Measure voltage at battery side of circuit breaker	Battery voltage	Repair open from ignition switch
Measure voltage at wiper side of circuit breaker	Battery voltage	Replace circuit breaker

2. WIPER MOTOR GROUND

TEST	OK	NOT OK
Measure resistance between motor connector terminal E and clean chassis ground	Zero ohms	Repair open between motor connector and ground.

3. INTERMITTENT WIPER MODULE: Intermittent wipers only; if equipped with non-intermittent wipers proceed to switch tests; turn ignition switch to RUN

TEST	OK	NOT OK
Remove intermittent wiper module and plug terminals A and B together.	Wipers operate in LO and HI speed modes and mist (washer) is working	Proceed to switch test (5). If wipers and mist now operate, replace intermittent module.

4. SWITCH: Turn ignition switch to RUN; wiper switch position as indicated; tests made on switch side of wiper /washer switch connector

TEST	OK	NOT OK
Terminal E-wiper switch in LO and/or mist/intermittent	Battery voltage	Replace switch
Terminal C-wiper switch in HI	Battery voltage	Replace switch
Terminal F-wiper switch to OFF with voltmeter connected	Battery voltage until wipers park and then zero volts	Replace switch

5. WIPER SWITCH DELAY RESISTANCE: Wiper switch disconnected; intermittent wiper only; turn ignition switch to OFF

TEST	OK	NOT OK
Across terminals A and D while rotating switch from minimum delay to maximum delay	Ranges from 0-500K ohms	Replace Switch
Across terminals A and G while rotating switch from minimum delay to maximum delay	Ranges from 0-500K ohms	Replace switch If OK, replace wiper module

6. MOTOR: Turn ignition switch to RUN; wiper switch position as indicated; tests made on motor side of motor connector

TEST	OK	NOT OK
Terminal B-wiper switch in any position	Battery voltage	Repair open from fuse panel If battery voltage, replace motor
Terminal A-wiper switch in LO	Battery voltage	Repair open from wiper switch If battery voltage, replace motor
Terminal H-wiper switch in HI	Battery voltage	Repair open from wiper switch If battery voltage, replace motor
Terminal D-wiper switch to OFF with voltmeter connected	Battery voltage until wipers park and then zero volts	Repair open from wiper switch If battery voltage and zero volts, replace motor

TROUBLESHOOTING—Windshield Washer

Refer to Non-Intermittent Wipers Fig. 11

1. PUMP GROUND

TEST	OK	NOT OK
Measure resistance from washer pump connector terminal B to a clean chassis ground	Zero ohms	Repair open between terminal B and ground

2. PUMP SWITCH CIRCUIT: Turn ignition switch to RUN; press washer

TEST	OK	NOT OK
Measure voltage at switch connector terminal B	Battery voltage	Replace wiper/washer switch
Measure voltage at washer pump connector terminal A	Battery voltage	Repair open between switch connector washer and pump connector If battery voltage, replace pump

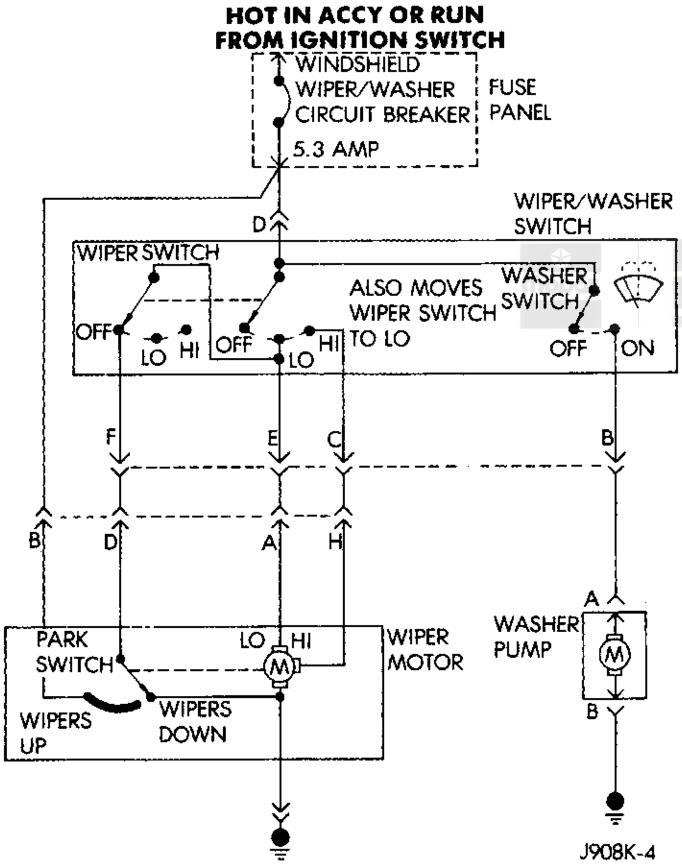


Fig. 11 Non-Intermittent Wiper Schematic—YJ

TROUBLESHOOTING—Windshield Washer

Refer to Intermittent Wipers Fig. 12

1. PUMP GROUND

TEST	OK	NOT OK
Measure resistance from washer pump connector terminal B to a clean chassis ground	Zero ohms	Repair open between washer pump connector and ground

2. PUMP SWITCH CIRCUIT: Turn ignition switch to RUN; washer switch tab rotated forward

TEST	OK	NOT OK
Measure voltage at wiper/washer switch connector terminal B located at intermittent wiper module	Battery voltage	Replace wiper switch
Measure voltage at intermittent wiper module connector terminal B (to washer pump)	Battery voltage	Replace intermittent wiper module
Measure voltage at washer pump connector terminal A	Battery voltage	Repair open from intermittent wiper module connector terminal B If battery voltage, replace pump

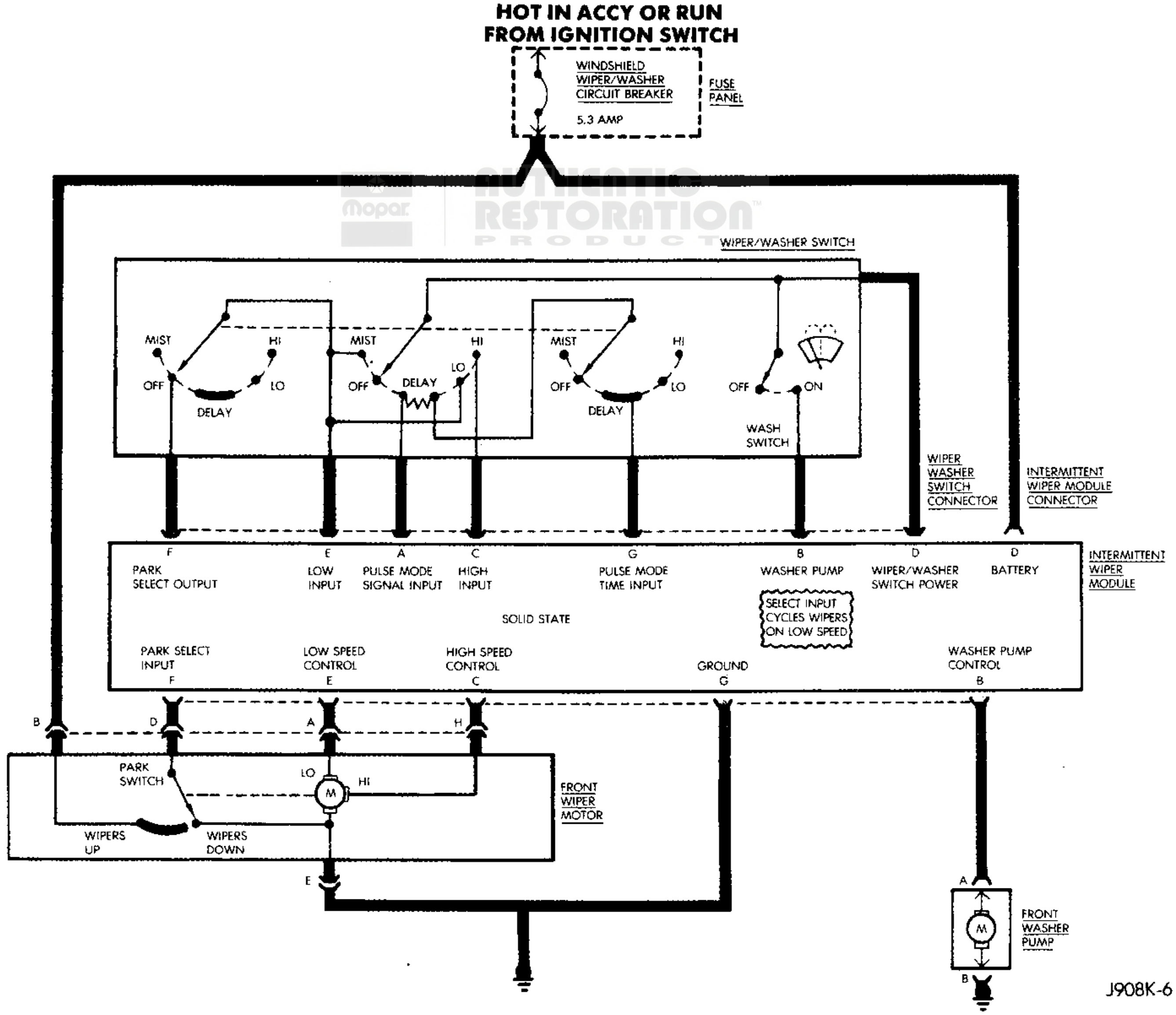


Fig. 12 Intermittent Wiper Schematic—YJ

REAR WIPER ARM REPLACEMENT

(1) Raise the blade end of the wiper arm from the window and pull tab away from the pivot shaft. Pull wiper arm from the pivot shaft.

(2) To install, be sure the pivot shaft is in the park position. Position the wiper arm over the pivot shaft then push the arm down on the pivot shaft until it bottoms. Push the tab toward the pivot shaft to lock the arm in place.

(3) Wet the window and check the PARK position by operating the wiper motor several times.

REAR WASHER PUMP REPLACEMENT

The washer pump for the rear window is located next to the front washer pump on the washer reservoir in the engine compartment (Fig. 13). For replacement refer to the front washer pump replacement procedure.

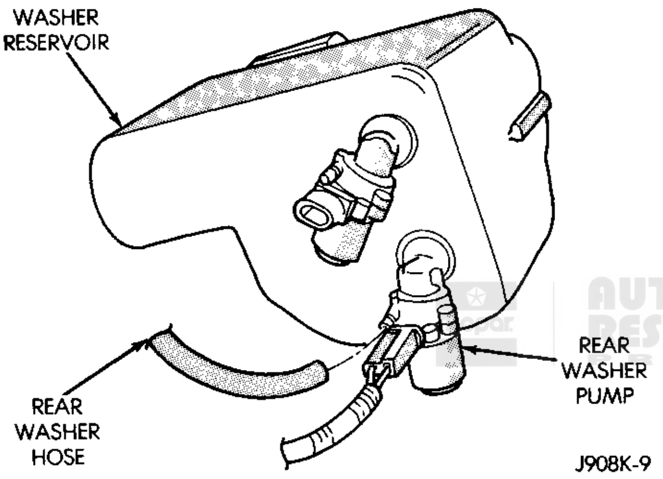


Fig. 13 Rear Washer Pump

REAR WIPER SWITCH REPLACEMENT

(1) Remove the instrumentation shroud; see Instrument Panel, Indicator Bezel Replacement.

(2) Remove the switch housing panel.

(3) Unplug the switch connector. Slightly depress the switch mounting tabs and remove the switch (Fig. 14).

REAR WIPER MOTOR REPLACEMENT

(1) Remove wiper arm from motor (refer to Wiper Arm Replacement).

(2) Remove pivot shaft retaining nut.

(3) Remove motor trim cover (Fig. 15).

(4) Disconnect electrical connector.

(5) Remove two screws holding motor to top.

(6) To install, reverse the removal procedures.

WASHER NOZZLE REPLACEMENT

(1) From inside the vehicle remove the motor trim cover.

(2) Remove the washer hose from the back of the washer nozzle.

(2) Open the liftgate.

CAUTION: Support the liftgate so that it will remain in the open position when the nuts are removed.

(3) Remove the right side window hinge bolt that attaches the glass.

(4) Lift the hinge off the glass and remove the washer nozzle.

(5) Install the new washer nozzle.

(6) Install the hinge to the glass. Tighten the bolt to 4.5-6.8 N•m (45-60 in. lbs.).

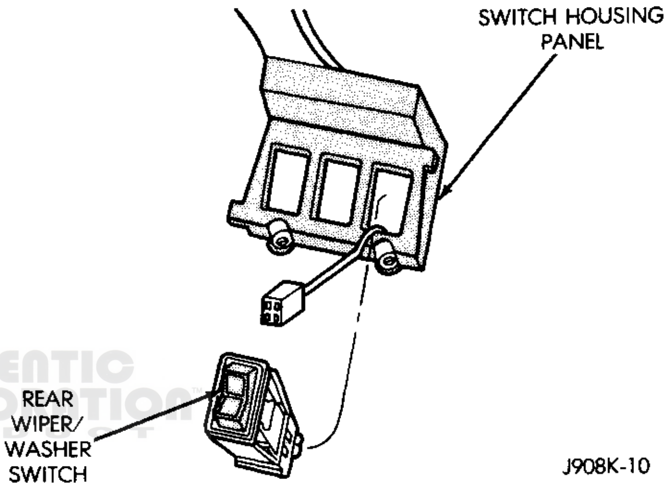


Fig. 14 Rear Wiper Switch

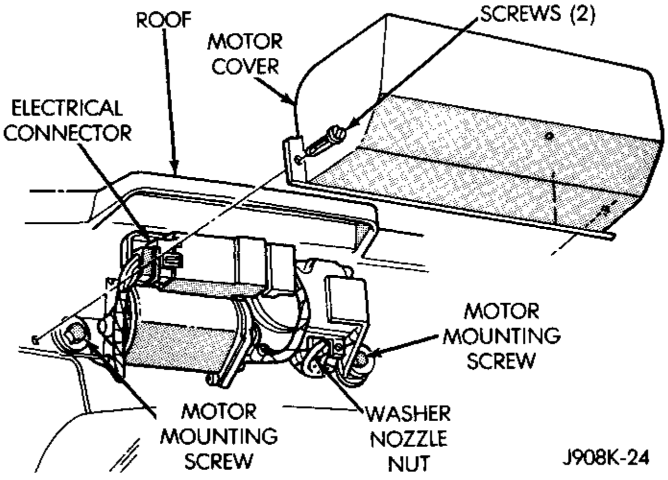


Fig. 15 Rear Wiper Motor

LOCKOUT SWITCH REPLACEMENT

(1) Remove screws holding the trim cover in place on the lower left inside of the top (Fig. 16).

(2) Remove two screws holding the lockout switch in place.

(3) Disconnect the electrical connector.

(4) To install, reverse the removal procedures.

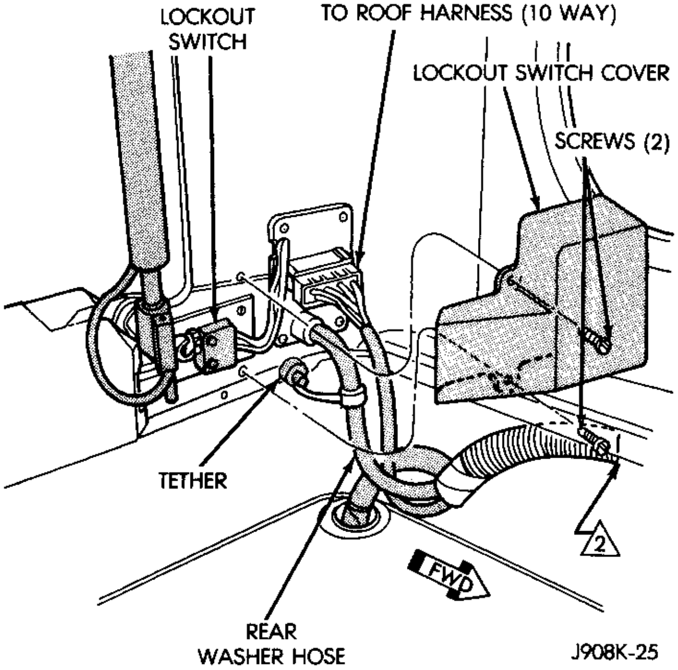


Fig. 16 Rear Wiper Lockout Switch

TROUBLESHOOTING — REAR WIPER

Refer to Fig. 17.

1. POWER INPUT: Remove and inspect fuse

TEST	OK	NOT OK
ACCY and RR Wipe fuse	Not blown	Replace fuse(s)

2. REAR WIPER MOTOR: Ignition in ACCY, switch in WASH

TEST	OK	NOT OK
Rear Wiper Motor terminal B (ignition switch off)	Zero ohms	Repair open to ground
Rear Wiper Motor terminal C	Battery voltage	Check lockout switch If OK, go to switch test
Rear Wiper Motor terminal A	Battery voltage If OK, replace motor	Repair open from R/Wipe fuse

3. REAR WIPER/WASHER SWITCH: Remove switch and re-connect below Instrument panel; back probe switch connector, in ACCY

TEST	OK	NOT OK
Switch connector terminal B	Battery voltage	Repair open to fuse
Switch connector terminal C, switch in wipe	Battery voltage If OK, repair open to Rear Wiper Motor terminal C	Replace switch

TROUBLESHOOTING — REAR WIPER WASHER

1. POWER INPUT: Ignition in ACCY, rear wiper/washer switch in WASH

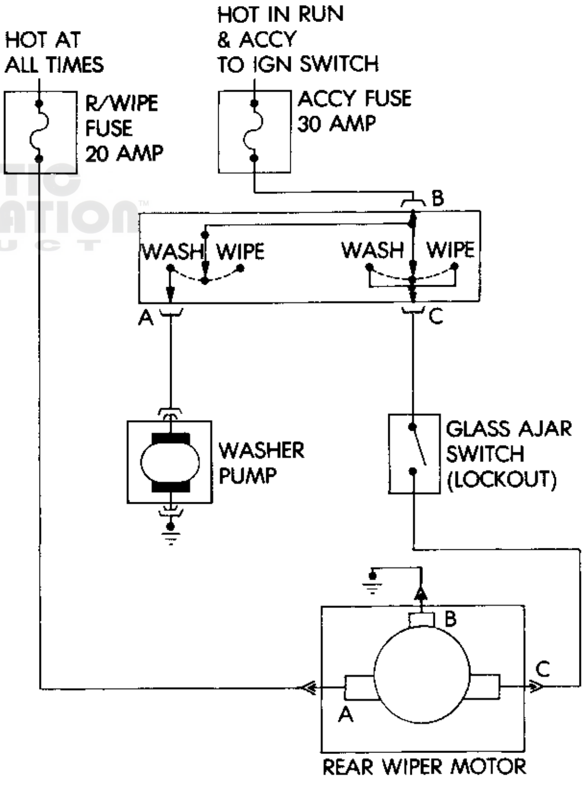
TEST	OK	NOT OK
Operate rear wiper motor	Motor operates	Check ACCY and RR Wipe fuses

2. REAR WASHER PUMP: Ignition in ACCY, Rear Washer Pump connector unplugged

TEST	OK	NOT OK
Pump connector terminal A	Zero ohms	Repair open to ground
Pump connector terminal B, switch in WASH	Battery voltage If OK, replace pump	Go to switch test step 3

3. REAR WIPER/WASHER SWITCH: Remove switch and connect below Instrument panel; back probe switch connector, ignition in ACCY

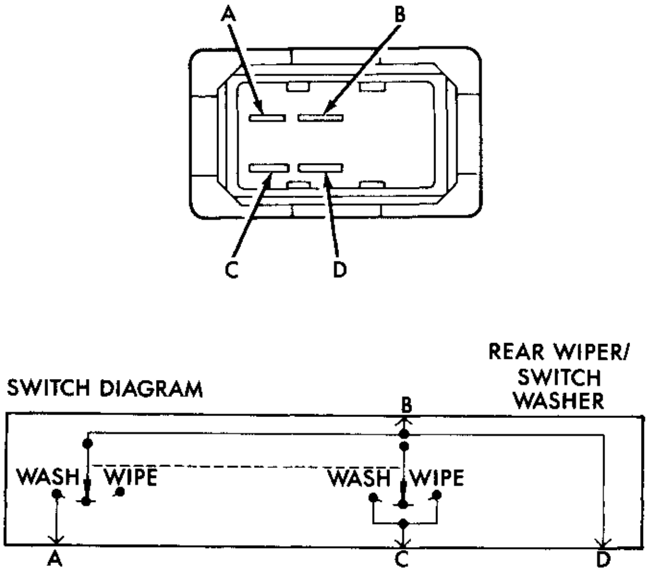
TEST	OK	NOT OK
Switch connector terminal B	Battery voltage	Replace switch
Switch connector terminal A, switch in WASH	Battery voltage If OK, repair open to washer pump terminal B	Repair open to ACCY fuse
Switch connector terminal C, switch in WASH	Battery voltage If OK, repair open to wiper motor terminal C	Replace switch



J908K-26

Fig. 17 Rear Wiper System Schematic

REAR WIPER/WASHER SWITCH TESTING



J898K-60

SWITCH TEST

SWITCH POSITION	TERMINALS	ZERO OHMS
OFF (NORMAL)	B AND A	NO
	B AND C	NO
WIPE	B AND C	YES
	B AND A	NO
WASH	A AND B	YES
	B AND C	YES

J908K-17

SJ

INDEX

FRONT WIPERS/WASHERS

General

The standard intermittent wiper system provides a pause between wipe cycles for use during conditions of very slight precipitation.

The controls for the windshield wipers are mounted on the multi-function stalk.

CAUTION: The wiper arms and blades must not be moved manually from side to side or damage could result.

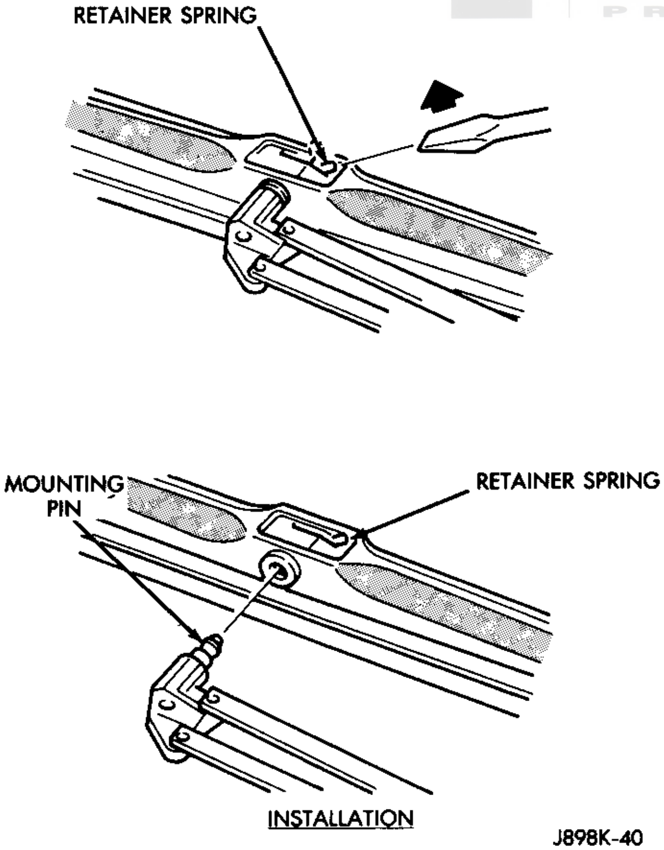


Fig. 1 Wiper Blade Removal/Installation

Wiper Blade Replacement

(1) To remove the wiper blade from the mounting pin on the wiper arm, pull up on the retainer spring (Fig. 1) and remove the wiper blade.

(2) To install, push the blade frame into the mounting pin so that the retainer spring engages the pin. Be sure the blade is securely attached to the arm.

Wiper Element Replacement

(1) Place the frame of the wiper blade on a firm surface (Fig. 2) with the notched end of the blade element backing strip as shown in the illustration.

(2) Pull up and twist counterclockwise the plastic backing strip, unlocking the backing strip from the retaining tab.

(3) Slide the backing strip down and align with the next retaining tab; twist slightly and unlock the backing strip from the retaining tab.

(4) Repeat the procedure for the remaining tabs until the blade element is detached from the frame.

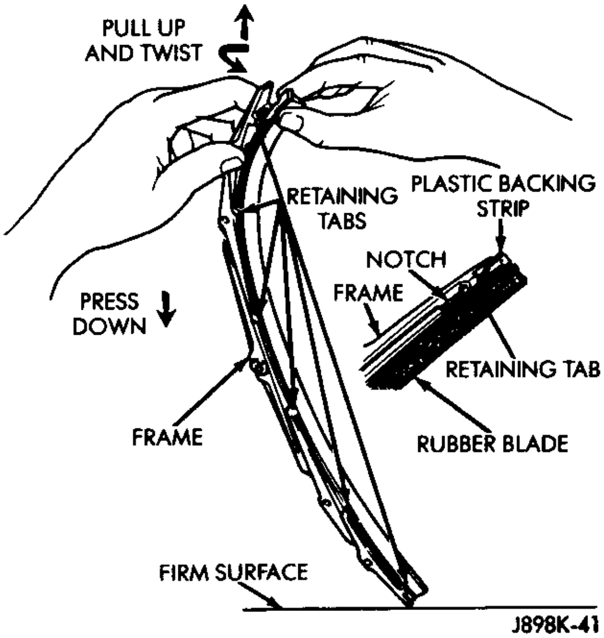
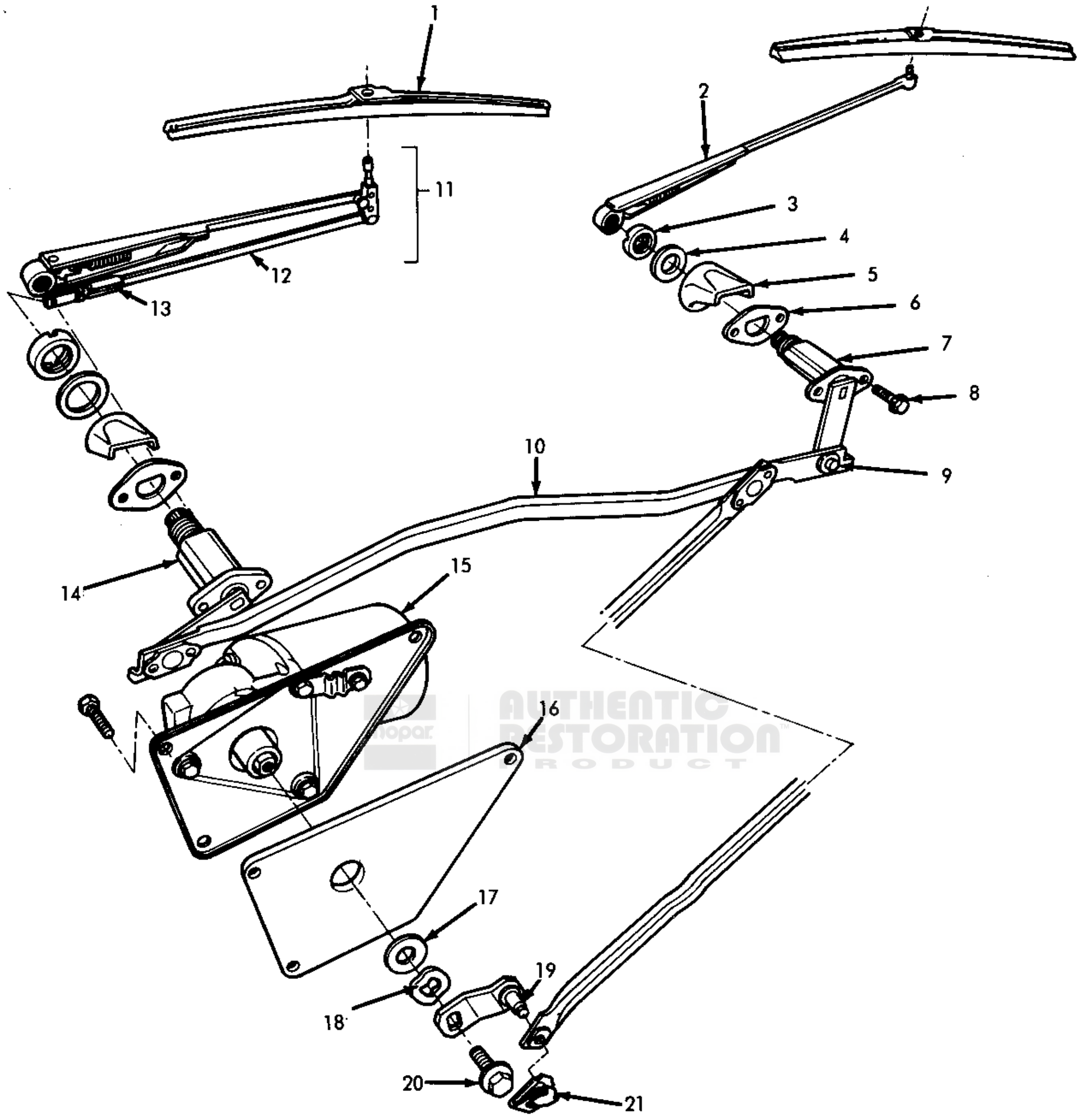


Fig. 2 Wiper Element Removal



1. BLADE
2. ARM
3. NUT
4. WASHER
5. ESCUTCHEON
6. GASKET
7. RIGHT PIVOT SHAFT BODY
8. SCREW
9. CLIP
10. CONNECTING LINK
11. ARTICULATING ARM
12. AUXILIARY ARM
13. CLIP
14. LEFT PIVOT SHAFT BODY
15. MOTOR
16. SEAL
17. WASHER
18. WAVE WASHER
19. CRANK ARM
20. BOLT
21. CLIP

J898K-39

Windshield Wiper Components

(5) To install, engage the notched end of the blade element backing strip with the first wiper blade frame retaining tab.

(6) Slide the backing strip up and align with the next backing strip.

(7) Repeat the procedure for the next three retaining tabs.

(8) For the last retaining tab, place the frame on a firm surface, pull up and twist the backing strip clockwise, locking the strip into the retaining tab.

Wiper Arm Replacement

(1) Raise the blade end of the arm from the windshield and move the spring tab away from the pivot shaft. Disengage the auxiliary arm retainer clip (driver's side only) from the pivot pin and pull the wiper arm from the pivot shaft.

(2) To install, start the wiper on the pivot shaft, position the auxiliary arm on the pivot and slide the retaining clip down to lock the arm in position. Push the wiper arm down on the pivot shaft until it bottoms. Be sure that the pivot shaft is in the Park position and the wiper arm is positioned as shown in the illustration.

(3) Wet the windshield and recheck the Park position by operating the wiper motor several times—ON and OFF (Fig. 3).

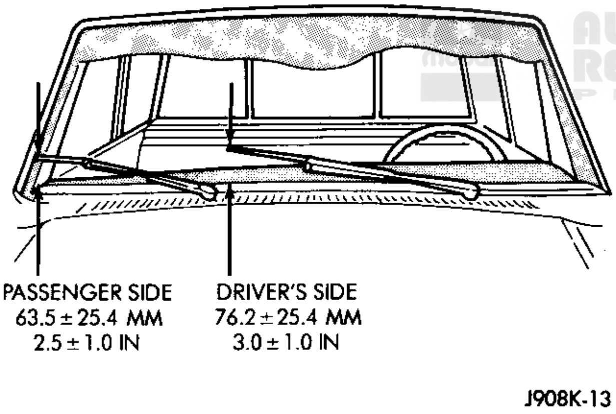


Fig. 3 Wiper Arm Positioning

FRONT WIPER PIVOT SHAFT BODY AND LINKAGE REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove the left wiper arm, pivot shaft nut, washer, escutcheon and gasket.

(3) Remove the right wiper arm, pivot shaft nut, washer, escutcheon and gasket.

(4) Unsnap the tabs that retain the instrument panel bezel and remove the bezel (Fig. 4).

(5) Remove the radio retaining screws.

(6) Slide the radio out far enough for access to the antenna and wiring harness connections.

(7) Disconnect the radio wiring harness connectors and antenna cable and remove the radio.

(8) Remove the Heat and A/C control panel retaining screws.

(9) Remove the control panel and disconnect all electrical and vacuum connections.

Tag the hoses according to their numbered locations for ease of assembly.

(10) Remove the control cable from the control panel by pressing in the retaining tab and removing the cable.

(11) Remove the 4WD Selection Switch mounting screws and lower the switch housing (Fig. 5).

(12) Remove the left A/C duct extension.

(13) Loosen the bolt holding the lower left corner of the instrument panel.

(14) Loosen the steering column mounting bolts.

(15) Remove the evaporator housing mounting screws and ground wire screw (Fig. 6).

(16) Lower the evaporator housing (Fig. 7).

(17) Remove the bolt holding the lower right corner of the instrument panel.

(18) Remove the four nuts holding the top of the defroster duct to the studs at the top of the instrument panel (Fig. 8).

(19) Carefully pry off the spring nuts holding the defroster duct to the back of the glove box (Fig. 9).

(20) Disconnect electrical connectors behind glove box.

(21) Carefully pull the bottom of the instrument panel toward the rear of the vehicle and remove the defroster duct.

(22) Raise up the lock tab of the drive link-to-crank stud retaining clip with a flat blade screwdriver (Fig.

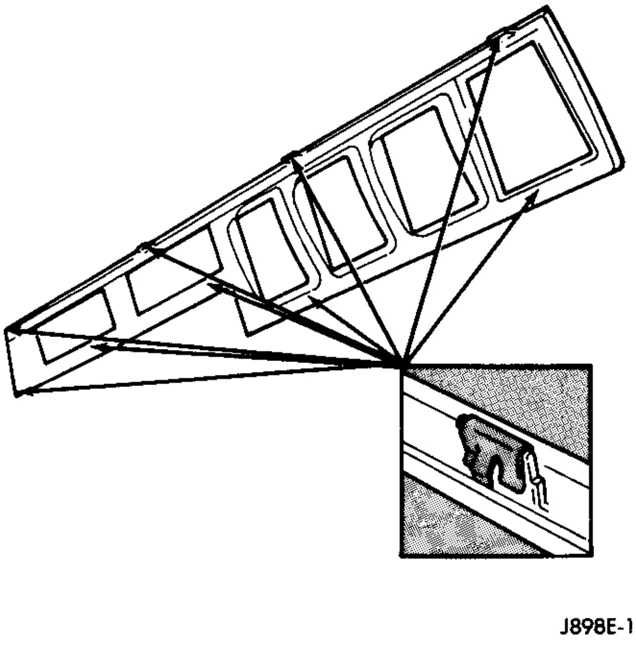


Fig. 4 Instrument Panel Bezel Retaining Clips

10). The clip is located inside the vehicle up behind the instrument panel. Slide the clip off the stud.

(23) Remove the screws attaching the left pivot shaft body to the vehicle.

(24) Remove the screws attaching the right pivot shaft body to the vehicle and remove the linkage (Fig. 11).

(25) Reverse the removal procedures to install the linkage assembly.

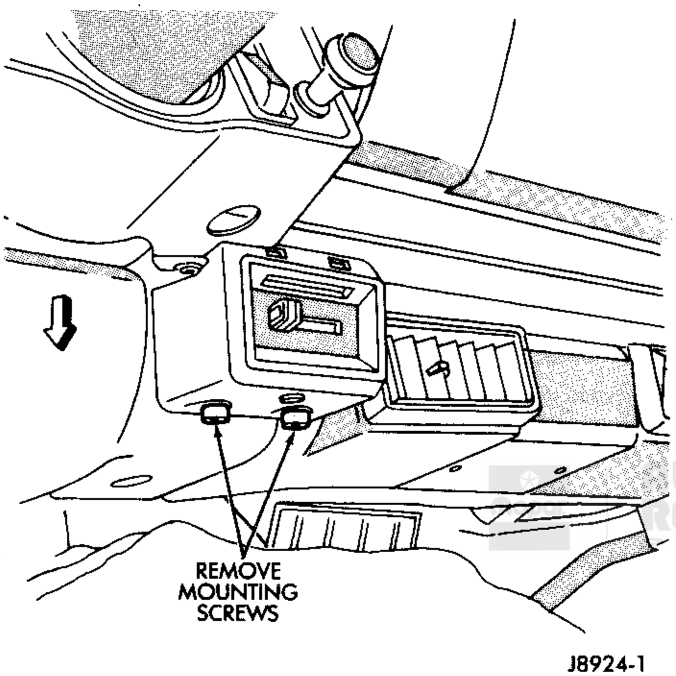


Fig. 5 Remove/Install 4WD Switch Housing

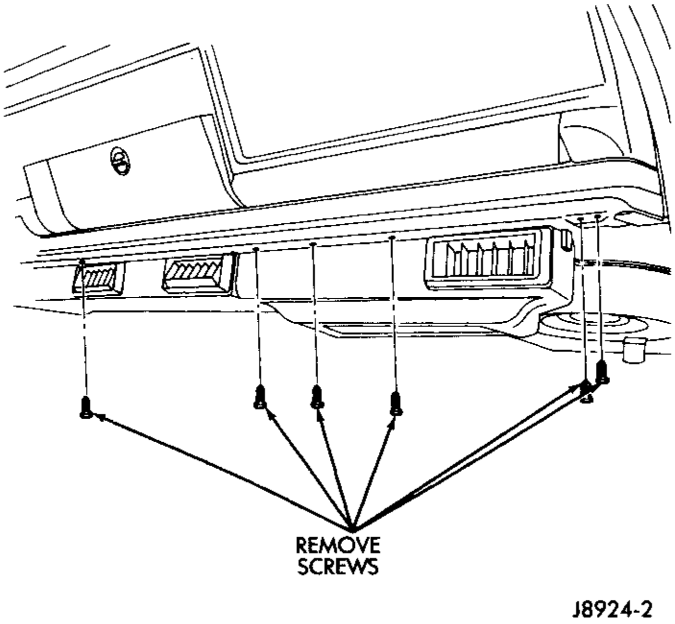


Fig. 6 Remove Evaporator Housing Screws

INTERMITTENT WIPER GOVERNOR REPLACEMENT

(1) The intermittent wiper governor is located under the left side of the instrument panel (Fig. 12).

(2) Disconnect the connectors on each end of the governor and remove it.

(3) Install two connectors on a intermittent wiper governor and install the governor under the left side of the instrument panel.

FRONT WIPER MOTOR REPLACEMENT

The windshield wiper motor is not a serviceable unit. If tests prove the motor to be bad it must be replaced.

(1) Remove the screws attaching the motor adapter plate to the dash panel.

(2) Separate the wiper wiring harness connector at the motor.

(3) Raise up the lock tab of the drive link-to-crank stud retaining clip with a flat blade screwdriver. The clip is located inside the vehicle up behind the instrument panel. Slide the clip off the stud.

(4) Remove the wiper motor assembly.

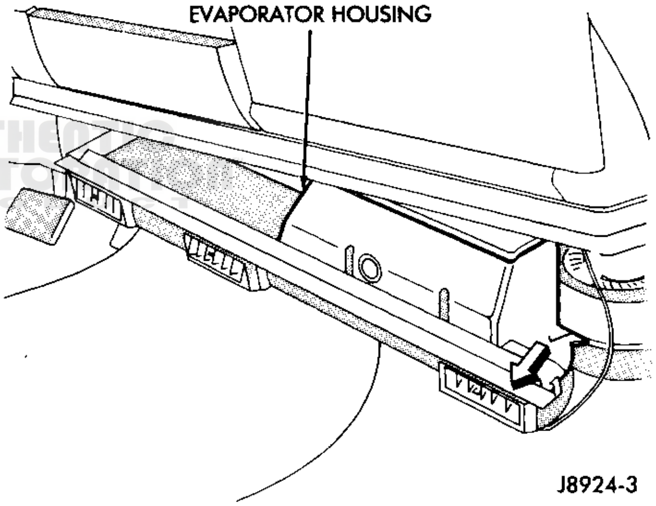


Fig. 7 Lower Evaporator Housing

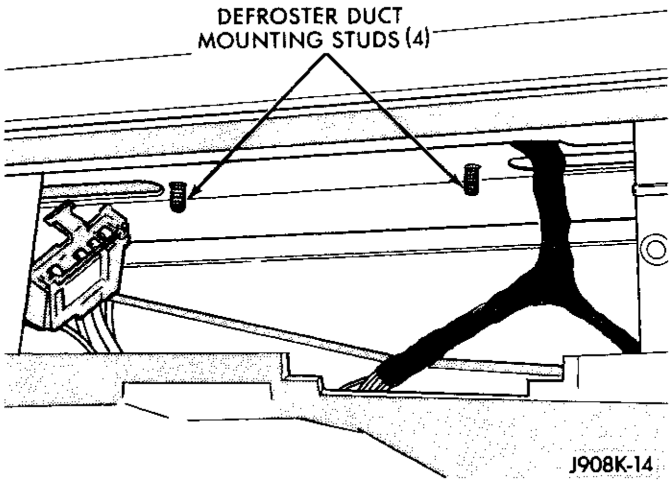


Fig. 8 Remove Defroster Duct Retaining Nuts

(5) To install the motor, position the wiper motor assembly and insert the crank stud into the drive link bushing.

(6) Press the retaining clip onto the stud and slide it in place in the stud groove (Fig. 10). Check for positive retention.

(7) Install the wiper motor attaching screws. Tighten the attaching screws to 3 N•m (25 ft. lbs.) torque.

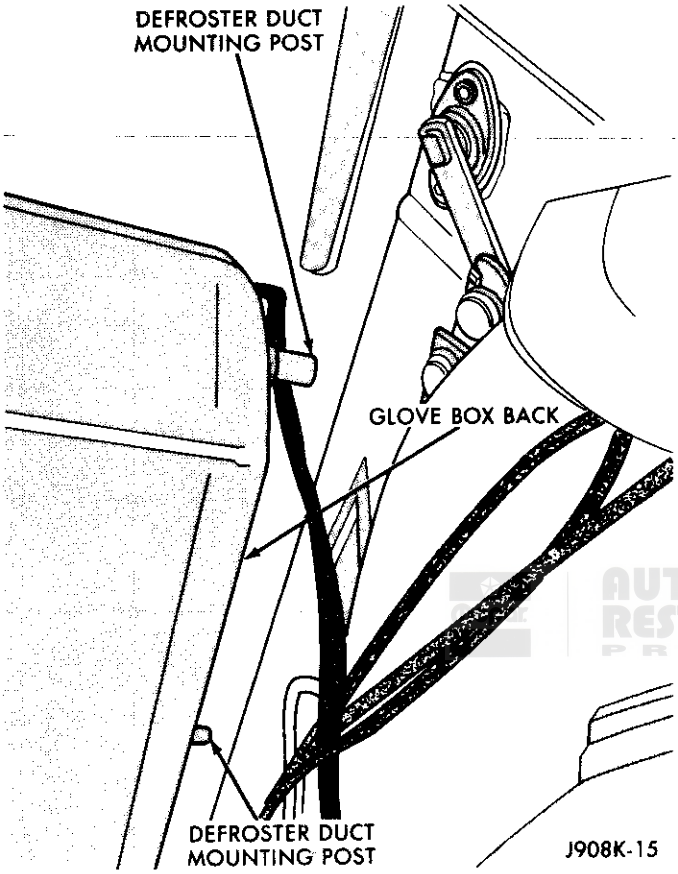


Fig. 9 Remove Defroster Duct From Rear Of Glove Box

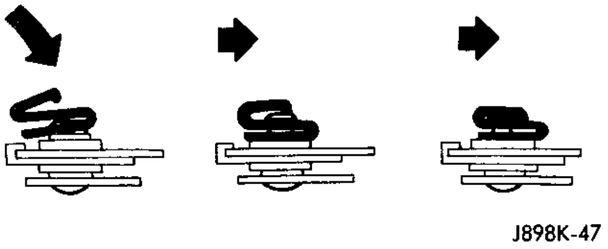


Fig. 10 Drive Link Retaining Clip Installation

FRONT WASHER PUMP

The electric pump assembly is mounted in the bottom of the water reservoir and is not replaceable. The impeller motor case is grounded to the car body by a ground wire.

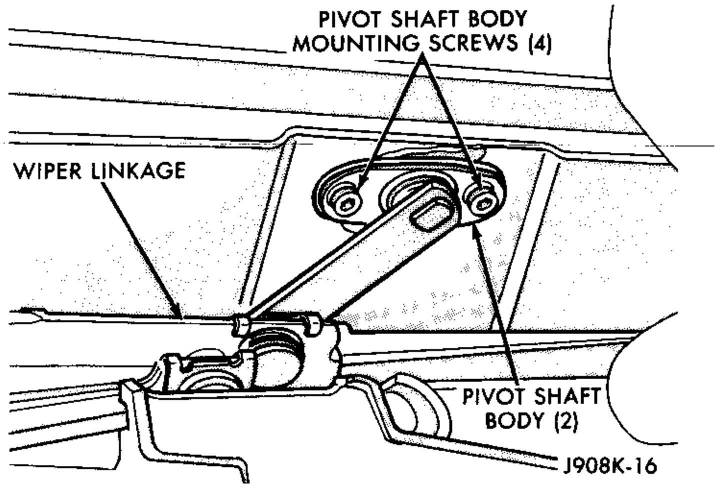


Fig. 11 Pivot Shaft Body Mounting Screws

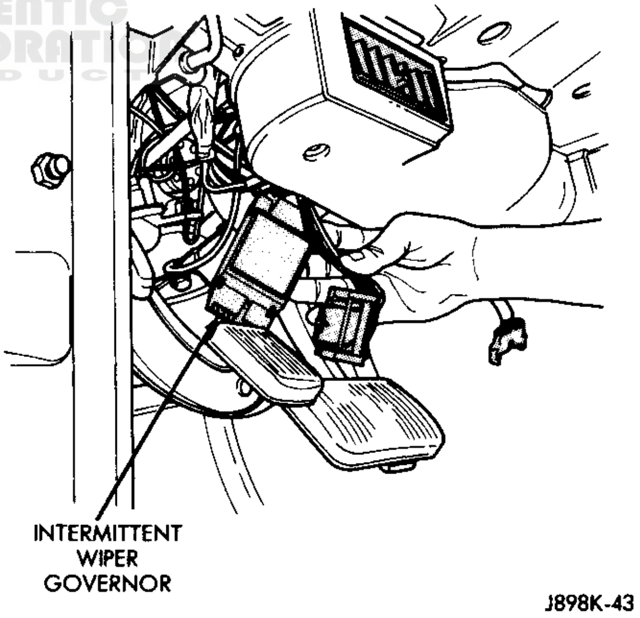
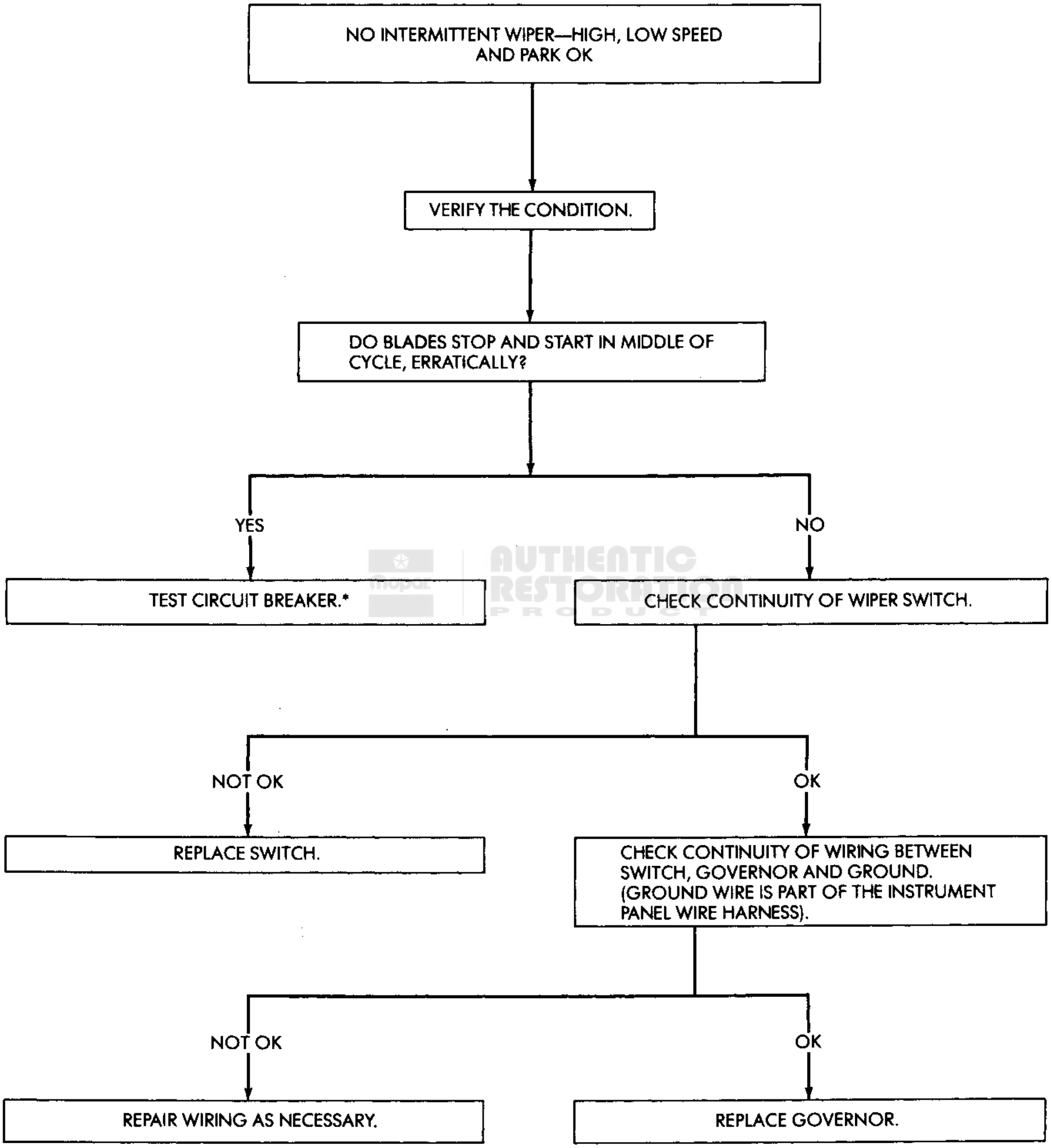


Fig. 12 Intermittent Wiper Governor Location

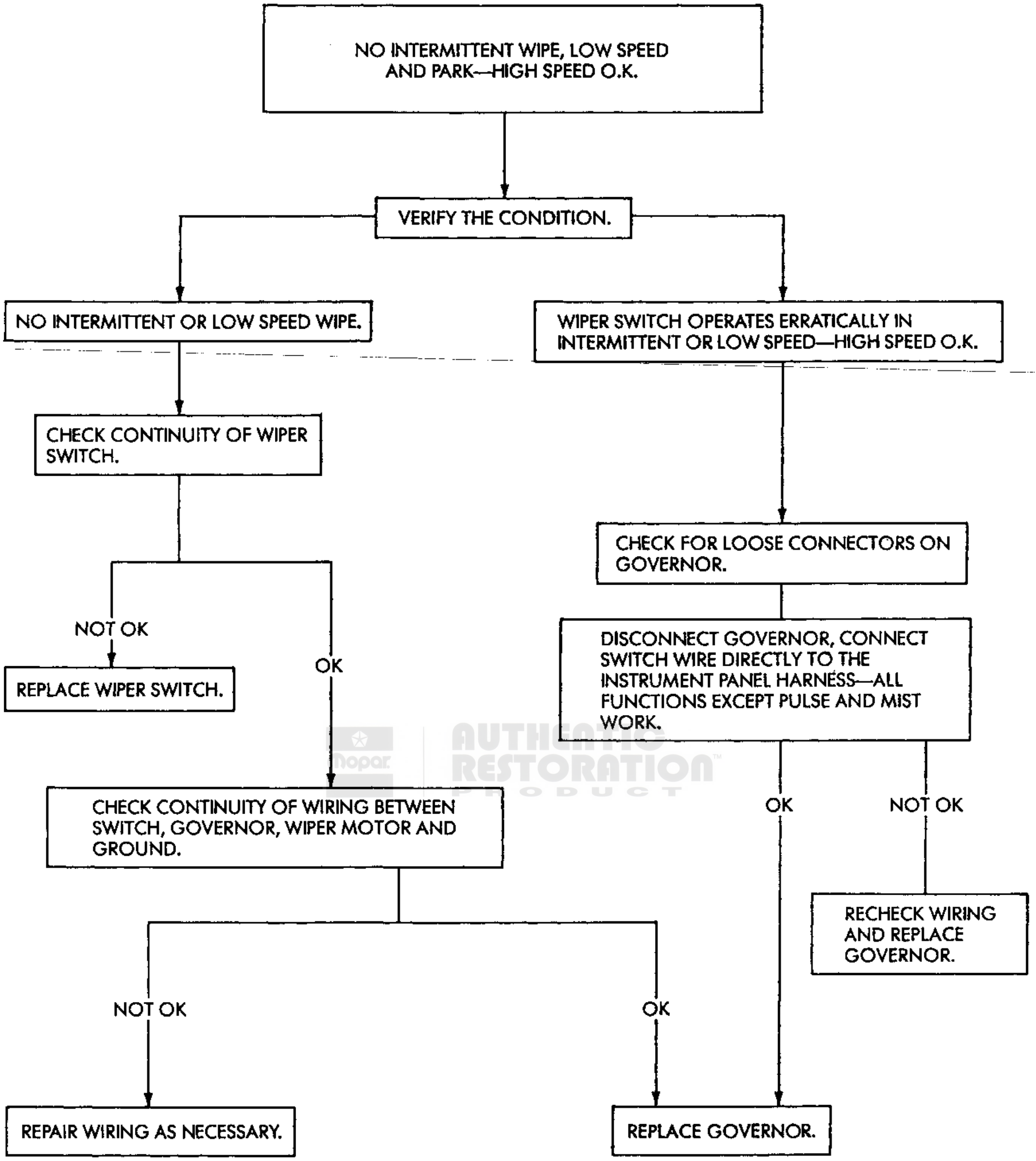
FRONT WIPER/WASHER DIAGNOSIS AND CIRCUITRY

This section is a guide to troubleshooting the windshield wiper system used on Grand Wagoneer models. It consists of two parts: Diagnosis Charts and a circuitry illustration.

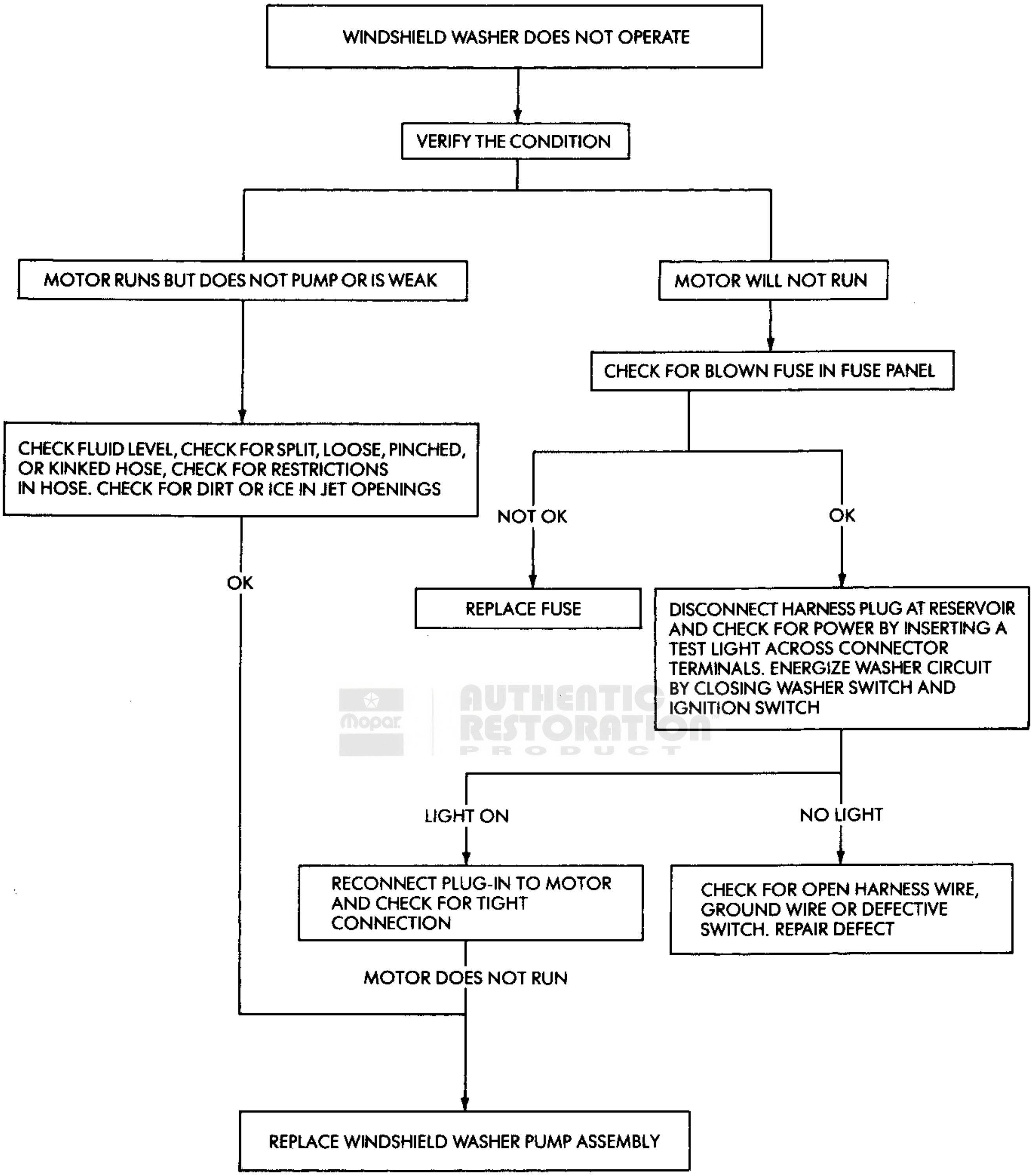


*WIPER SWITCHES HAVE INTERNAL CIRCUIT BREAKERS WHICH REQUIRE REPLACEMENT OF ENTIRE SWITCH.

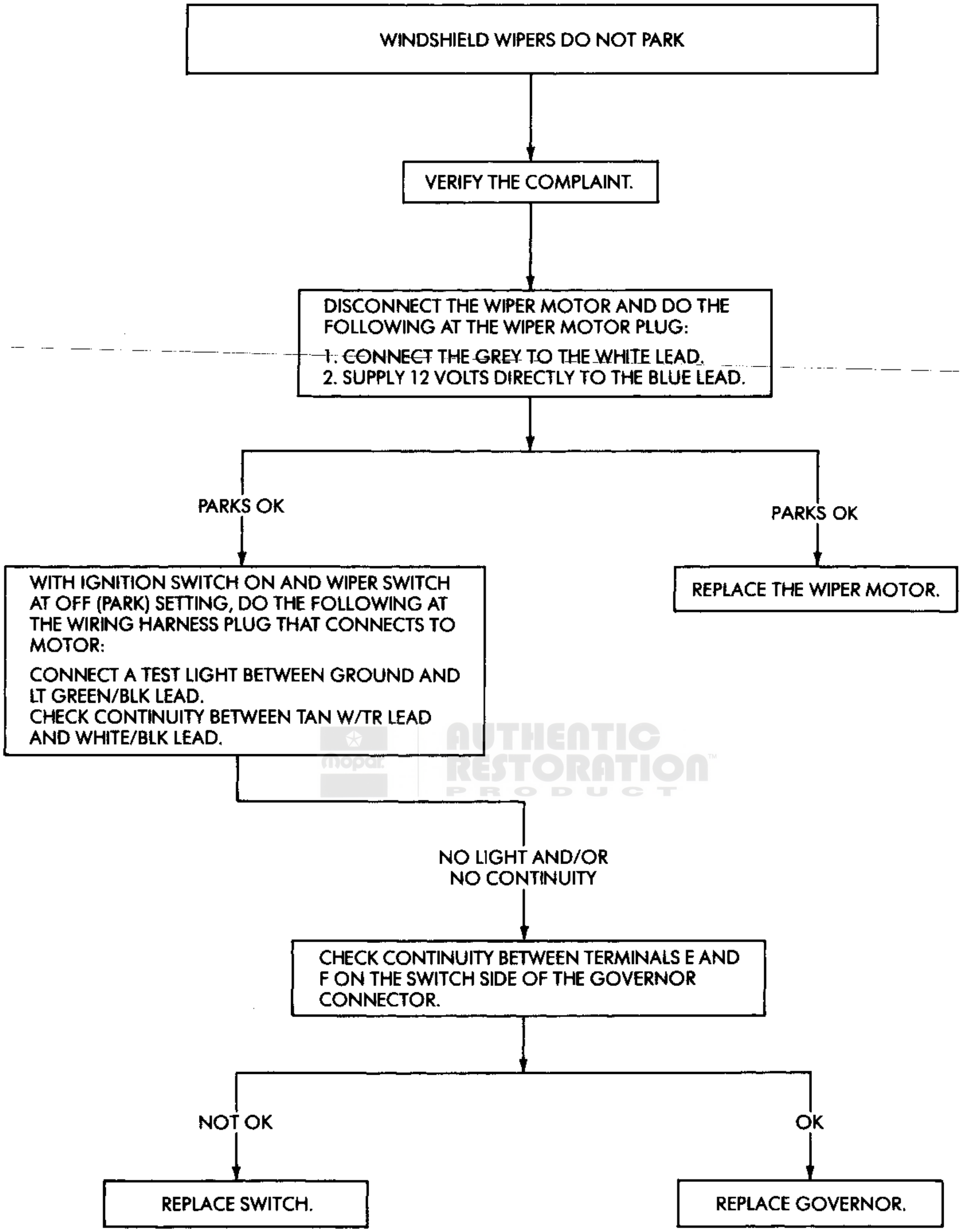
J898K-44


NO INTERMITTENT WIPE, LOW SPEED AND PARK—HIGH SPEED O.K.
VERIFY THE CONDITION.
NO INTERMITTENT OR LOW SPEED WIPE.
WIPER SWITCH OPERATES ERRATICALLY IN INTERMITTENT OR LOW SPEED—HIGH SPEED O.K.
CHECK CONTINUITY OF WIPER SWITCH.
CHECK FOR LOOSE CONNECTORS ON GOVERNOR.
NOT OK
REPLACE WIPER SWITCH.
OK
DISCONNECT GOVERNOR, CONNECT SWITCH WIRE DIRECTLY TO THE INSTRUMENT PANEL HARNESS—ALL FUNCTIONS EXCEPT PULSE AND MIST WORK.
CHECK CONTINUITY OF WIRING BETWEEN SWITCH, GOVERNOR, WIPER MOTOR AND GROUND.
OK
NOT OK
RECHECK WIRING AND REPLACE GOVERNOR.
NOT OK
OK
REPAIR WIRING AS NECESSARY.
REPLACE GOVERNOR.

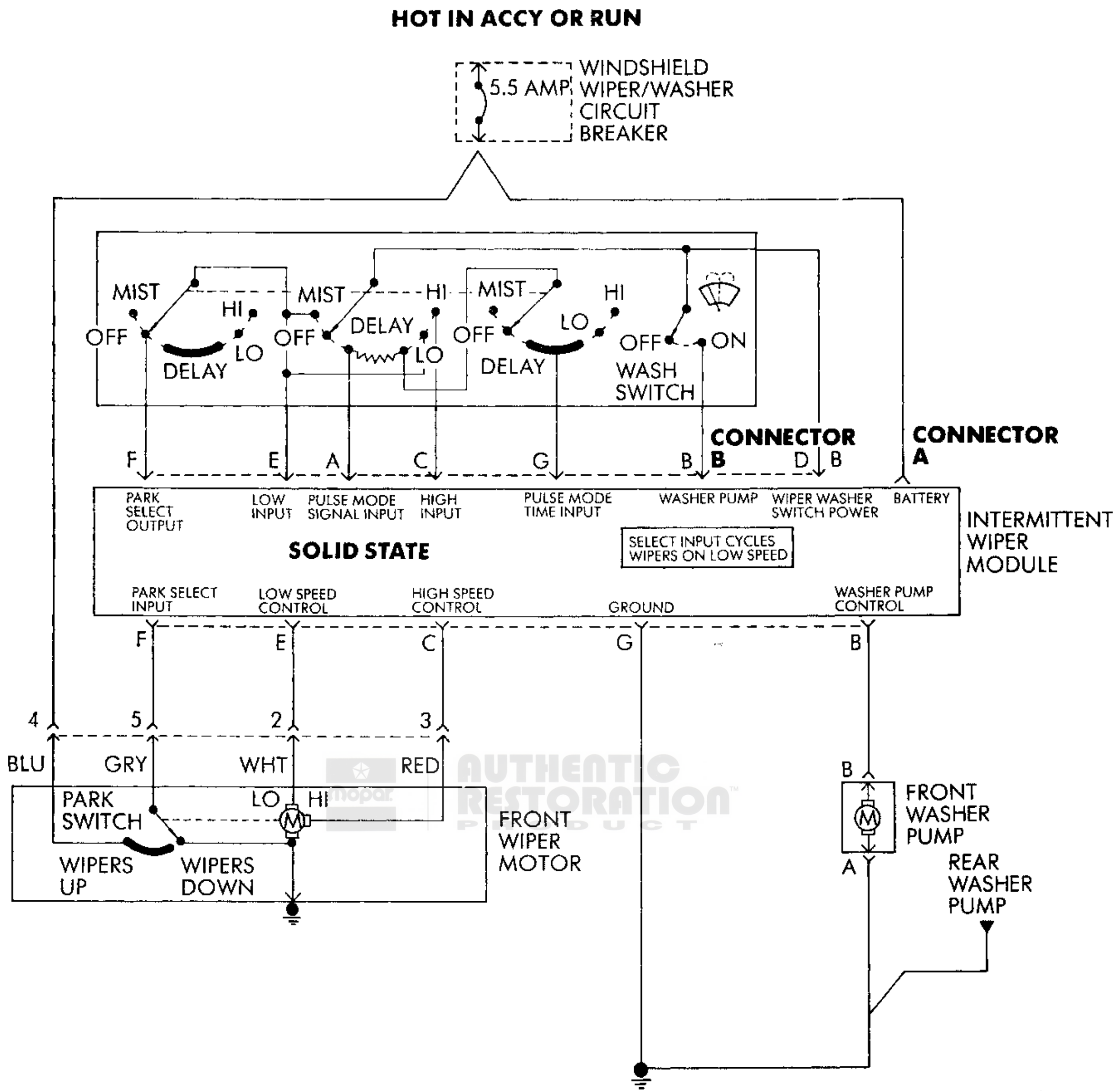
J898K-45


WINDSHIELD WASHER DOES NOT OPERATE
VERIFY THE CONDITION
MOTOR RUNS BUT DOES NOT PUMP OR IS WEAK
MOTOR WILL NOT RUN
CHECK FOR BLOWN FUSE IN FUSE PANEL
CHECK FLUID LEVEL, CHECK FOR SPLIT, LOOSE, PINCHED, OR KINKED HOSE, CHECK FOR RESTRICTIONS IN HOSE. CHECK FOR DIRT OR ICE IN JET OPENINGS
NOT OK
OK
OK
REPLACE FUSE
DISCONNECT HARNESS PLUG AT RESERVOIR AND CHECK FOR POWER BY INSERTING A TEST LIGHT ACROSS CONNECTOR TERMINALS. ENERGIZE WASHER CIRCUIT BY CLOSING WASHER SWITCH AND IGNITION SWITCH
LIGHT ON
NO LIGHT
RECONNECT PLUG-IN TO MOTOR AND CHECK FOR TIGHT CONNECTION
CHECK FOR OPEN HARNESS WIRE, GROUND WIRE OR DEFECTIVE SWITCH. REPAIR DEFECT
MOTOR DOES NOT RUN
REPLACE WINDSHIELD WASHER PUMP ASSEMBLY

J898K-46


WINDSHIELD WIPERS DO NOT PARK
VERIFY THE COMPLAINT.
DISCONNECT THE WIPER MOTOR AND DO THE FOLLOWING AT THE WIPER MOTOR PLUG:
1. CONNECT THE GREY TO THE WHITE LEAD.
2. SUPPLY 12 VOLTS DIRECTLY TO THE BLUE LEAD.
PARKS OK
PARKS OK
WITH IGNITION SWITCH ON AND WIPER SWITCH AT OFF (PARK) SETTING, DO THE FOLLOWING AT THE WIRING HARNESS PLUG THAT CONNECTS TO MOTOR:
CONNECT A TEST LIGHT BETWEEN GROUND AND LT GREEN/BLK LEAD.
CHECK CONTINUITY BETWEEN TAN W/TR LEAD AND WHITE/BLK LEAD.
REPLACE THE WIPER MOTOR.
NO LIGHT AND/OR NO CONTINUITY
CHECK CONTINUITY BETWEEN TERMINALS E AND F ON THE SWITCH SIDE OF THE GOVERNOR CONNECTOR.
NOT OK
OK
REPLACE SWITCH.
REPLACE GOVERNOR.

J898K-48


HOT IN ACCY OR RUN
5.5 AMP
WINDSHIELD WIPER/WASHER CIRCUIT BREAKER
MIST
HI
OFF
LO
DELAY
MIST
HI
OFF
DELAY
LO
MIST
HI
OFF
LO
DELAY
OFF
ON
WASH SWITCH
CONNECTOR B
CONNECTOR A
F
E
A
C
G
B
D
B
PARK SELECT OUTPUT
LOW INPUT
PULSE MODE SIGNAL INPUT
HIGH INPUT
PULSE MODE TIME INPUT
WASHER PUMP
WIPER WASHER SWITCH POWER
BATTERY
SOLID STATE
SELECT INPUT CYCLES WIPERS ON LOW SPEED
INTERMITTENT WIPER MODULE
PARK SELECT INPUT
LOW SPEED CONTROL
HIGH SPEED CONTROL
GROUND
WASHER PUMP CONTROL
F
E
C
G
B
4
5
2
3
BLU
GRY
WHT
RED
PARK SWITCH
LO
HI
M
WIPERS UP
WIPERS DOWN
FRONT WIPER MOTOR
B
M
A
FRONT WASHER PUMP
REAR WASHER PUMP

J908K-5

FRONT WIPER TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Wiper Motor Mounting Plate-to-Cowl	3 N•m (23 in. lbs.)	2-4 N•m (15-35 in. lbs.)
Windshield Wiper Pivot-to-Cowl	13 N•m (118 in. lbs.)	11-15 N•m (100-135 in. lbs.)

REAR WINDOW WIPER/WASHER

General

The rear wiper system provides three operating modes:

- Intermittent wipe with a 5 to 8 second delay between sweeps.
- Constant wipe which operates in conjunction with a washer.
- Park mode which operates when ignition or rear wiper switch is turned off, or when the tailgate window is lowered.

The rear wiper motor contains electronic controls to provide three operating modes. It receives current from the rear wiper switch for intermittent and constant wipe/wash modes and from the tailgate window switch for park.

The safety switch is located on the rear window regulator. When the tailgate window is in the UP position, the switch is closed and allows current to flow to the rear wiper switch for both intermittent and wash/wipe operation. When the tailgate window is lowered, the switch opens and cuts off the flow of current to the rear wiper switch, the wiper motor will then park.

The rear wiper switch is located in the instrument panel and is supplied current when the ignition switch is in the ON position and the safety switch is closed. The switch can be placed in the intermittent wipe position to provide current to the rear wiper motor or it can be held in the wash/wipe position to provide current to both the motor and the rear washer pump. The switch is spring loaded in the wash/wipe position.

The rear washer bottle and pump are located on the left inner fender apron. The pump is fed current from the rear wiper switch. Washer fluid is routed from the pump through a rubber hose which is run in the electrical harness to the right of the quarter panel. The discharge nozzle has an adjustable ball type outlet.

REAR WIPER MOTOR REPLACEMENT

CAUTION: When the tailgate window is raised with the tailgate lowered, the glass must be supported to avoid damage.

(1) Remove the rear wiper arm by lifting the plastic cover and removing the wiper arm nut (Fig. 1).

(2) Remove the nut that holds the pivot assembly to the tailgate panel.

(3) Remove the tailgate carpet and access cover.

(4) With the tailgate lowered, raise the window by operating the window switch and depressing the safety switch on the left side of the tailgate, being careful to support the glass as it is raised to avoid glass damage.

(5) Unplug the motor connector, remove the screw that holds the rear wiper motor to the reinforcement and remove the motor.

(6) To install the motor, reverse the removal procedure.

(7) Torque the pivot retaining nut to 11 N•m (8 ft. lbs.).

CAUTION: The rear wiper retaining must be properly torqued. If it is not torqued tight enough, the wiper will work the nut off. If it is torqued too tight, the threads will be damaged.

(8) Install the wiper arm and adjust it to park on the rubber tailgate window side just off the glass. Torque the retaining nut to 10 N•m (90 in. lbs.).

REAR WIPER SWITCH REPLACEMENT

(1) Remove four screws holding the steering column cover to the instrument panel bezel and lower the bezel.

(2) Unplug the electrical connector from the switch.

(3) Depress the plastic tangs and push the switch through the cover.

SAFETY SWITCH

CAUTION: When the tailgate window is raised with the tailgate lowered, the glass must be supported to avoid damage.

(1) Remove tailgate carpet and access cover.

(2) Raise the tailgate window to gain access to the two screws that hold the switch to the regulator.

(3) Move the tailgate window to align the hole in the regulator gear to allow for removal of the screws (Fig. 2).

(4) Remove the screws and remove the safety switch.

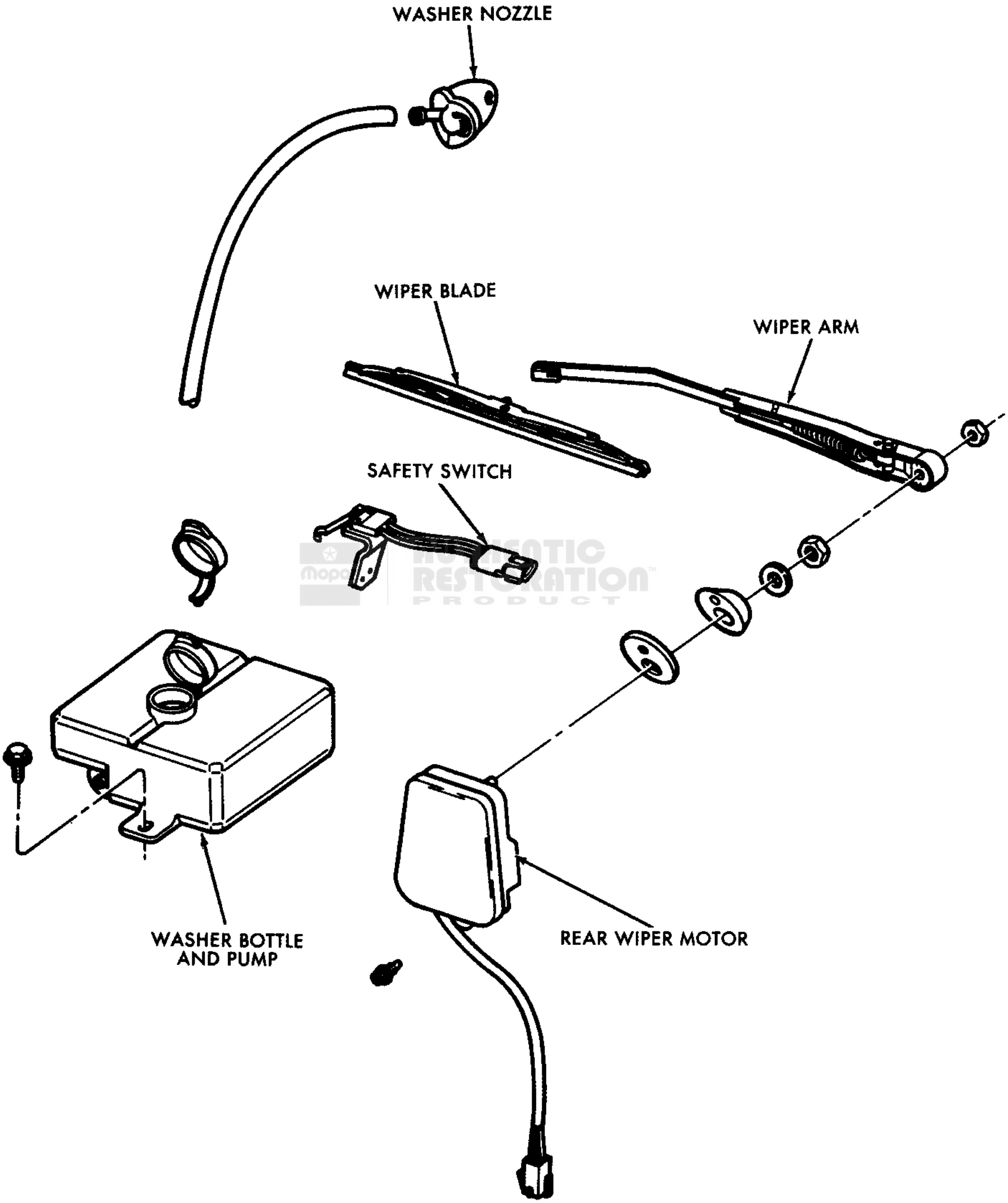
REAR WASHER DISCHARGE NOZZLE

(1) Insert small screwdriver in the slot below the outlet ball to release the locking tab (Fig. 3).

(2) Remove the nozzle being careful not to dislodge the hose from the nozzle.

(3) Remove the nozzle from the hose and secure the hose to prevent it from falling in the quarter panel.

If the hose drops in the quarter panel, it can be reached through the jack compartment by removing the trim panel. Remove the hose from the "L" connector and feed it through the nozzle hole from the outside.



J898K-52

Fig. 1 Rear Wiper Components

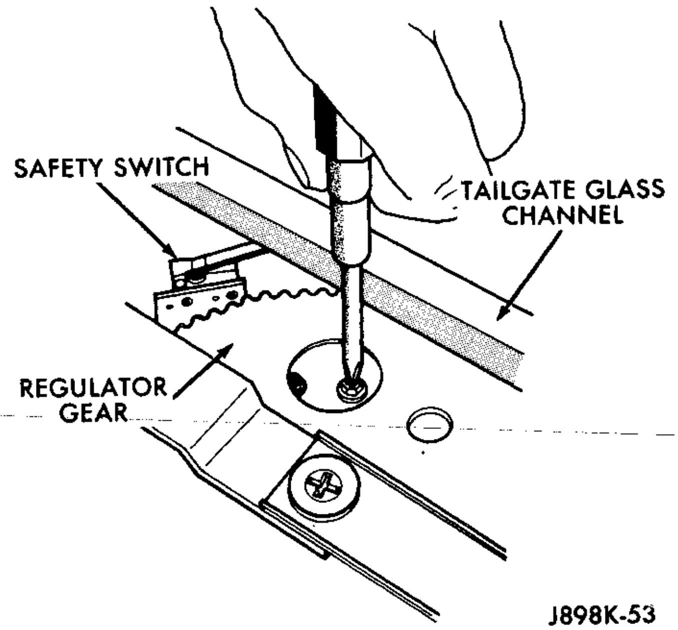


Fig. 2 Safety Switch Removal/Installation

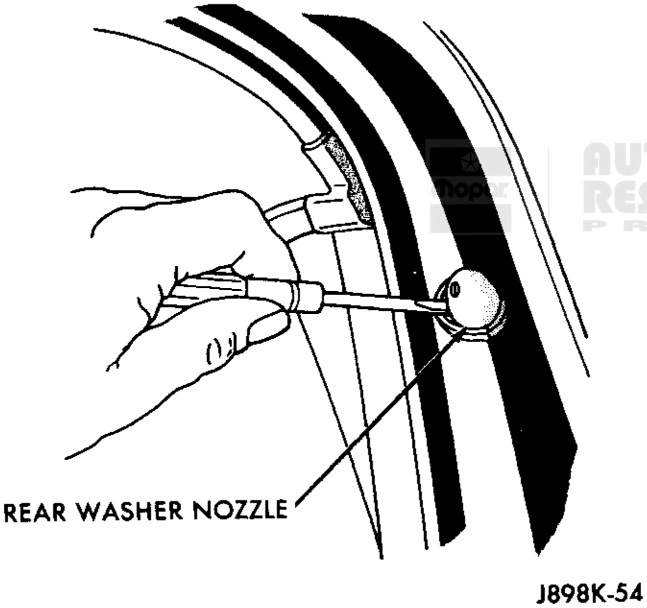


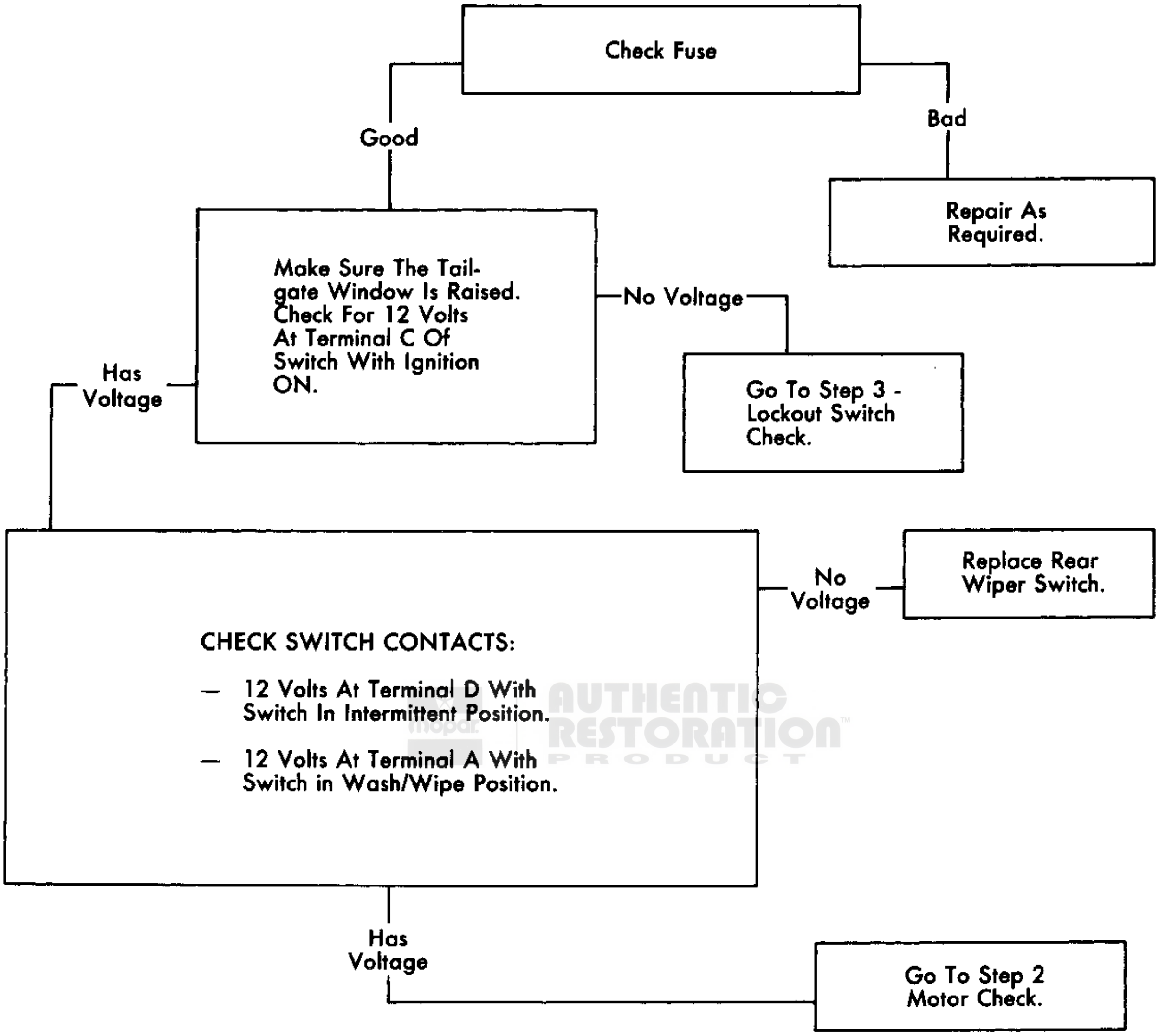
Fig. 3 Rear Washer Discharge Nozzle Removal

REAR WASHER PUMP

The electric pump assembly is mounted in the bottom of the water reservoir and is not replaceable. The impeller motor case is grounded to the car body by a ground wire.

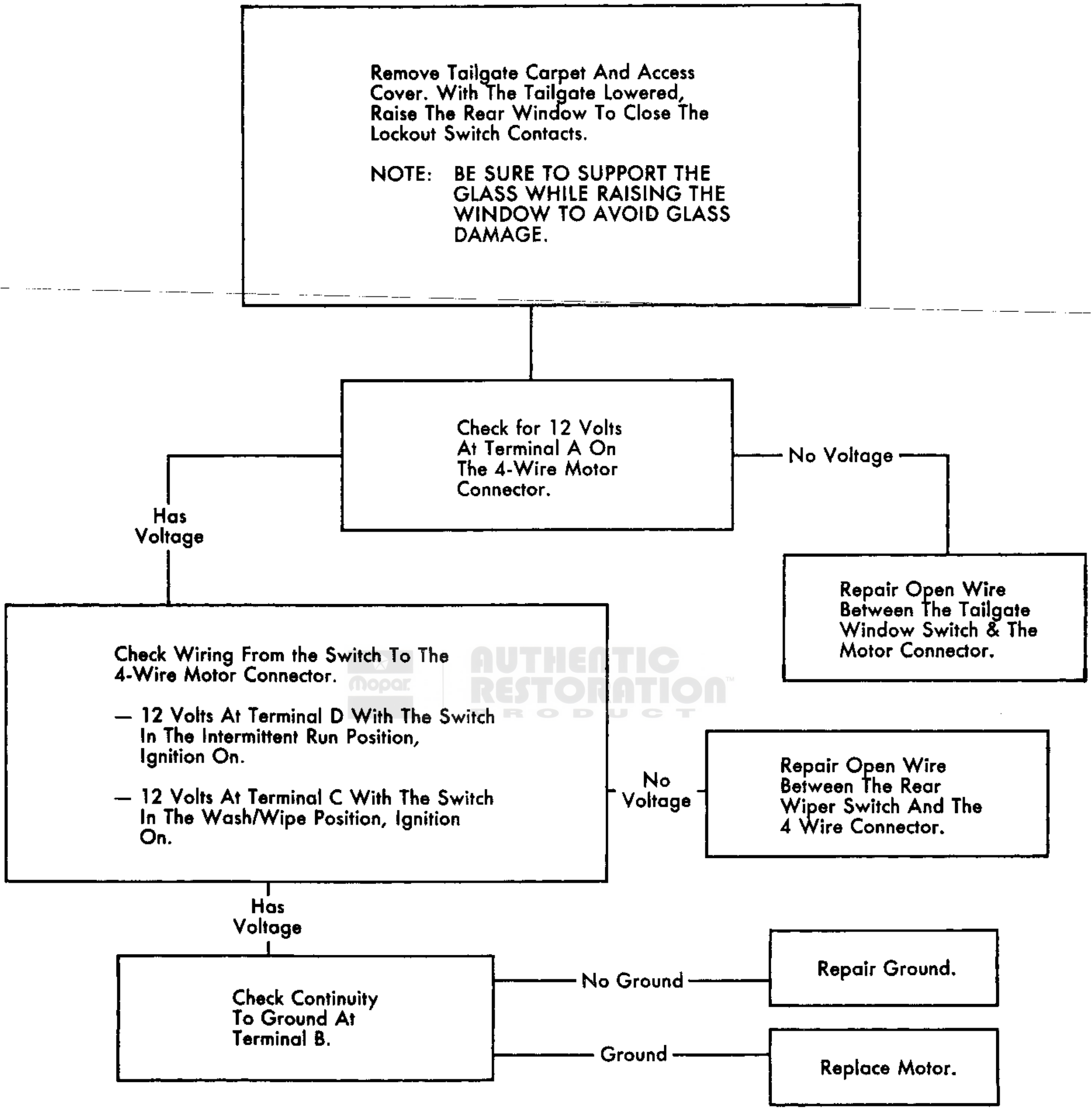
REAR WIPER/WASHER DIAGNOSIS AND CIRCUITRY

Rear Wiper Switch



J898K-55

Rear Wiper Motor



Remove Tailgate Carpet And Access Cover. With The Tailgate Lowered, Raise The Rear Window To Close The Lockout Switch Contacts.

NOTE: BE SURE TO SUPPORT THE GLASS WHILE RAISING THE WINDOW TO AVOID GLASS DAMAGE.

Check for 12 Volts At Terminal A On The 4-Wire Motor Connector.

Repair Open Wire Between The Tailgate Window Switch & The Motor Connector.

Check Wiring From the Switch To The 4-Wire Motor Connector.

- 12 Volts At Terminal D With The Switch In The Intermittent Run Position, Ignition On.
- 12 Volts At Terminal C With The Switch In The Wash/Wipe Position, Ignition On.

Repair Open Wire Between The Rear Wiper Switch And The 4 Wire Connector.

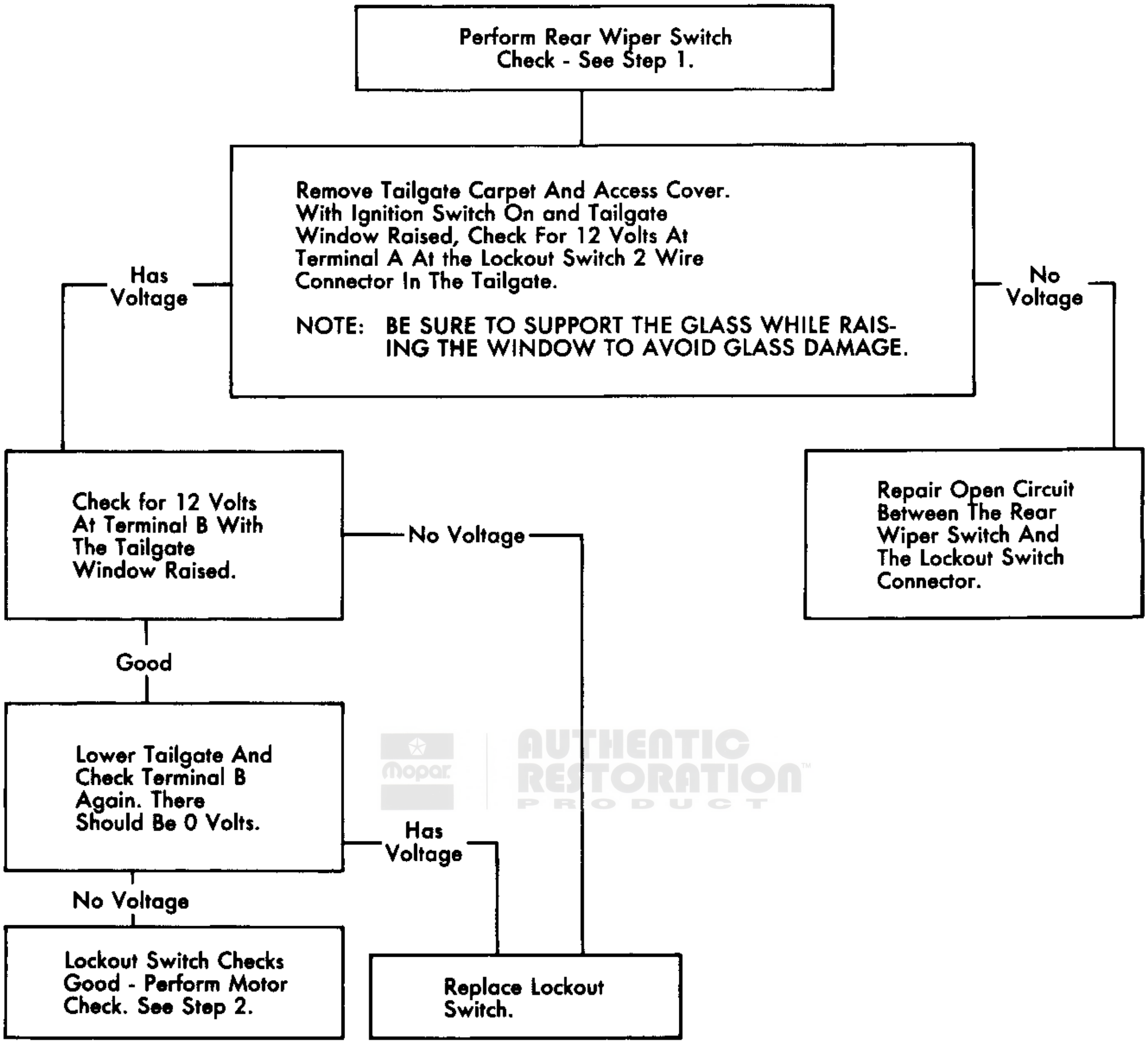
Check Continuity To Ground At Terminal B.

Repair Ground.

Replace Motor.

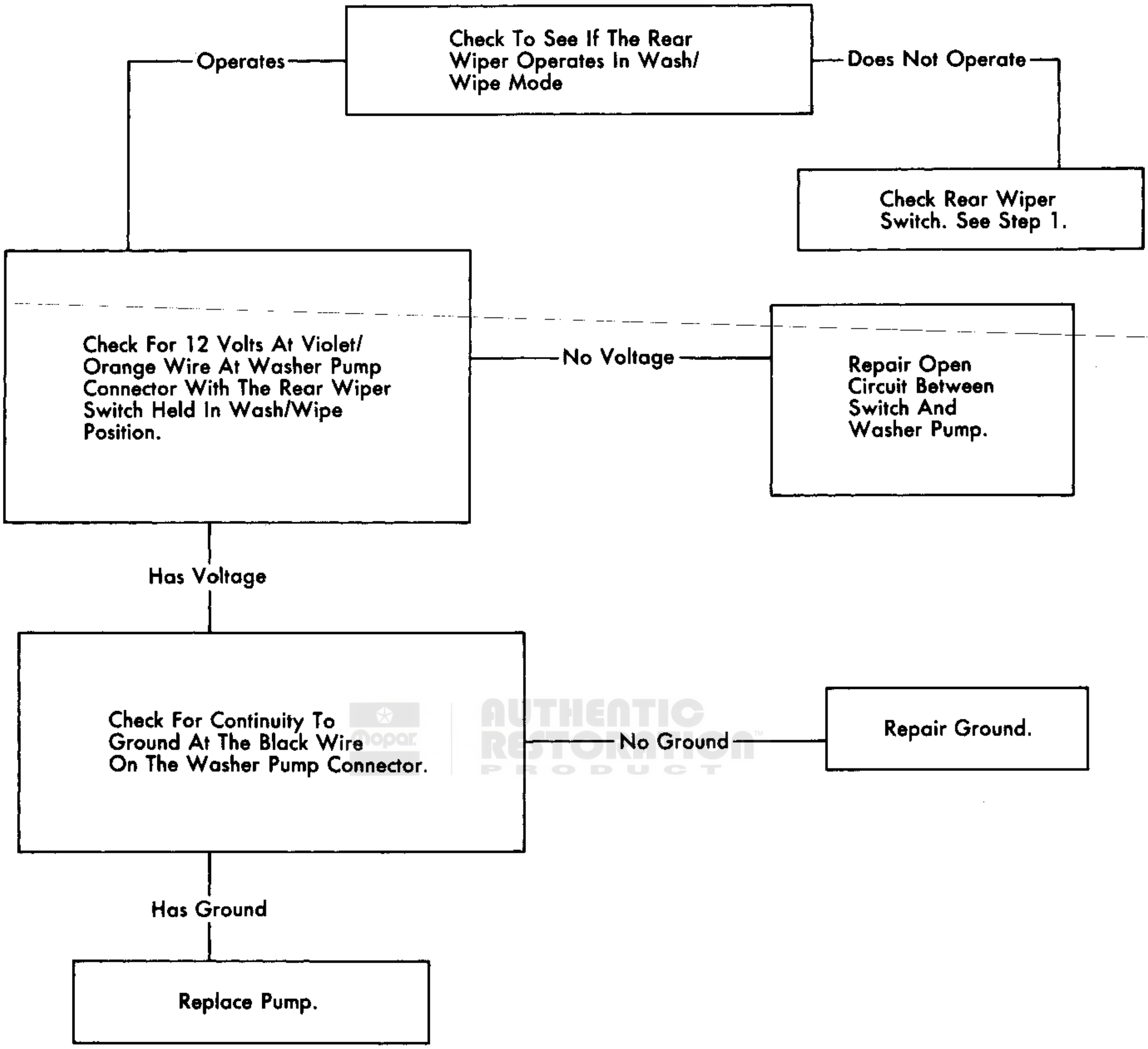
J898K-56

Safety Switch



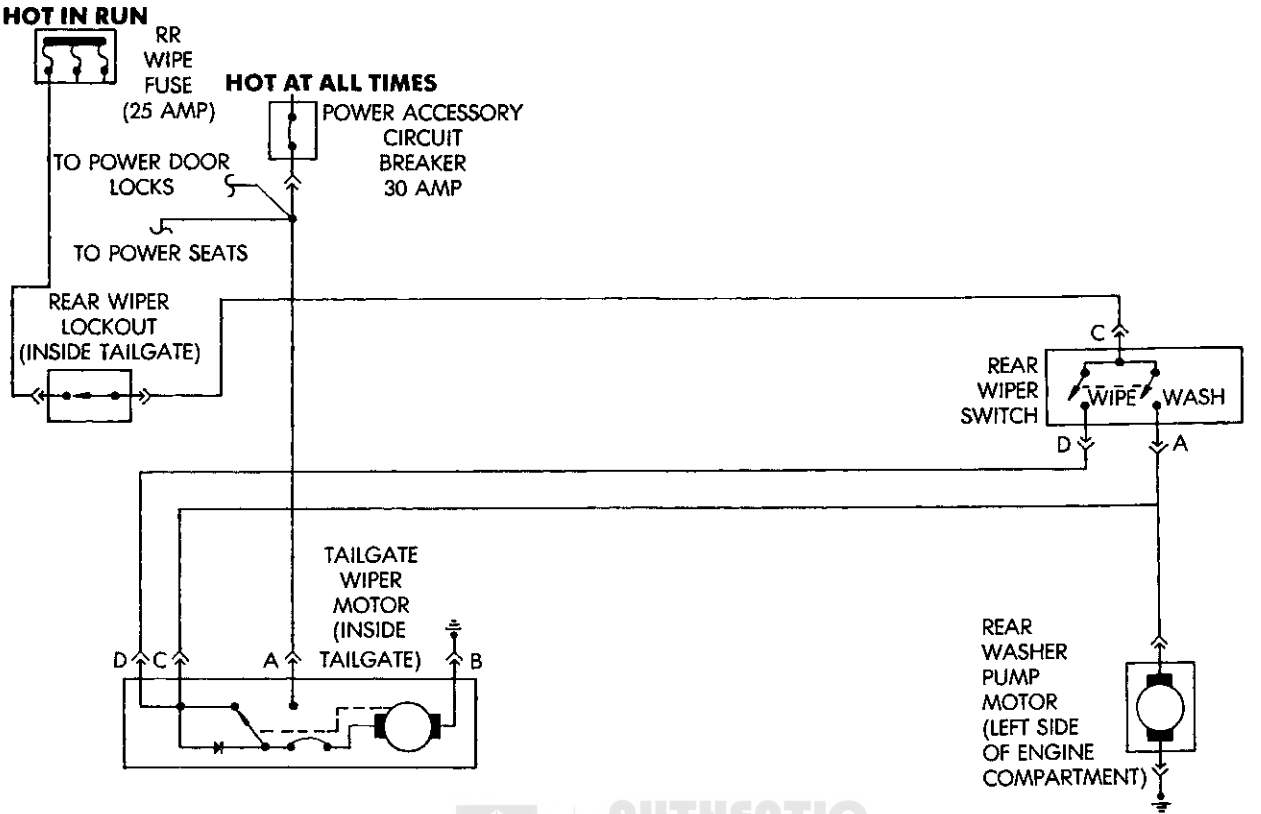
J898K-57

Rear Washer Pump



J898K-58

Rear Wiper/Washer Schematic



WIPER CONTROL SWITCH REPLACEMENT

(1) Disconnect battery negative cable.

(2) Perform one of the following procedures and then continue with the next step.

Standard Steering Wheel

- Remove three screws holding the front cover of the steering wheel (Fig. 1).

CAUTION: Use a sharp pointed tool to depress the connector retainer.

- Pull horn wires off at the column side of the steering wheel (Fig. 2). Pull gently to remove grounding pin. Be careful to not lose the spring under the grounding pin connector (Fig. 3).

Optional Steering Wheel

- Remove horn button with a push and turn motion.
- Remove horn button components (Fig. 4).

(3) Turn key to the lock position and remove the steering wheel nut and washer.

(4) Scribe an alignment mark on the steering in line with the mark already existing on the end of the steering column.

(5) Remove vibration damper from the steering column hub, if equipped.

(6) Remove steering wheel using a steering wheel puller.

WARNING: IN ORDER TO REMOVE THE STEERING SHAFT SNAP RING IN THE FOLLOWING STEP, THE LOCKPLATE MUST BE COMPRESSED. DO NOT ATTEMPT TO REMOVE THE LOCKPLATE WITHOUT COMPRESSOR TOOL C4156 AS THE LOCKPLATE IS UNDER HEAVY SPRING TENSION.

(7) Compress the lockplate with compressor tool C4156 and remove the steering shaft snap ring (Fig. 5). Discard the snap ring. It is not reusable.

(8) Remove compressor tool.

(9) Remove lockplate, cancelling cam, and upper bearing preload spring. If the vehicle is equipped with the optional steering wheel, remove the horn button components from the canceling cam.

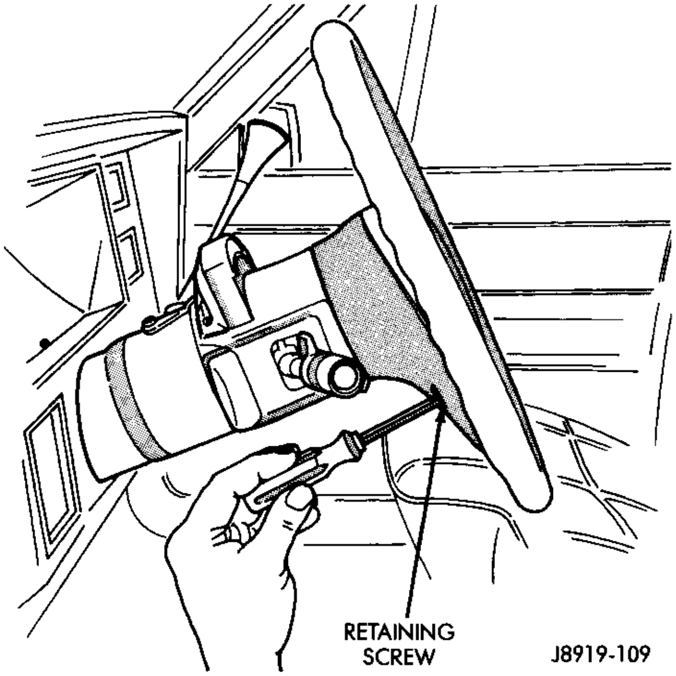


Fig. 1 Standard Steering Wheel Cover Removal/Installation

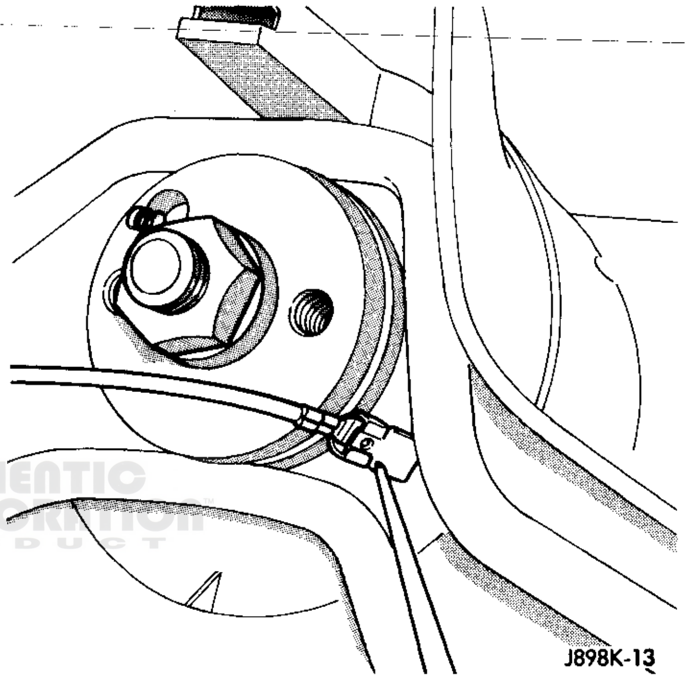


Fig. 2 Horn Wire Removal

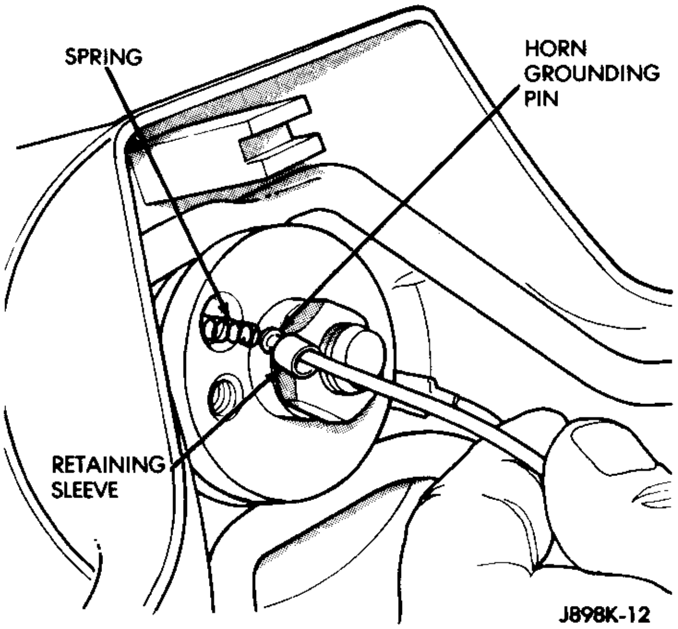


Fig. 3 Horn Grounding Pin Removal/Installation

(10) Remove the screw and hazard warning switch knob.

(11) Remove dimmer switch actuator arm attaching screw (6).

(12) Remove the turn signal switch attaching screws (Fig. 6).

(13) **XJ, MJ, and SJ**—Remove the lower instrument panel cover trim panel.

YJ—Remove six shroud screws (Fig. 7).

- Slide shroud towards the steering wheel.
- Apply upward pressure to the shroud and downward pressure to the indicator panel. This will release the holding tabs (Fig. 8).

(14) Remove cover under column.

(15) If vehicle is equipped with a column shift, remove PRNDL cable clip (Fig. 9).

(16) Remove two nuts holding steering column bracket to brake sled (Fig. 10).

(17) Remove four bolts holding steering column brake to column.

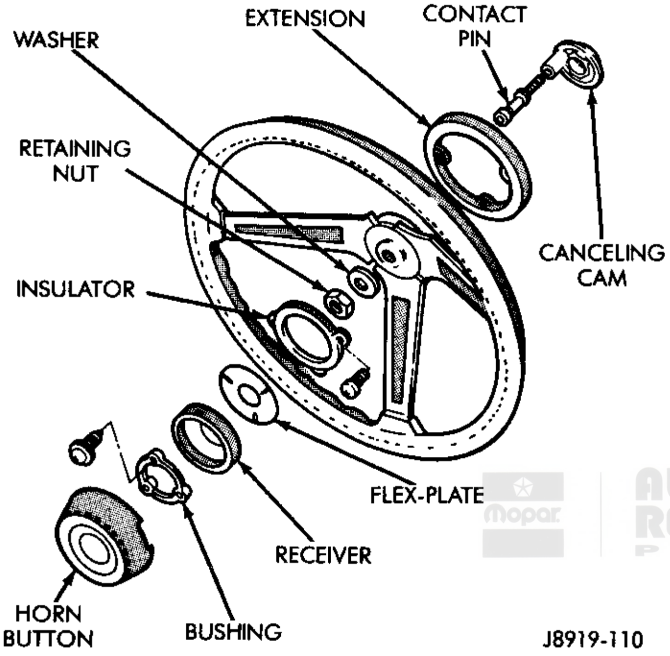


Fig. 4 Optional Steering Wheel Removal/Installation

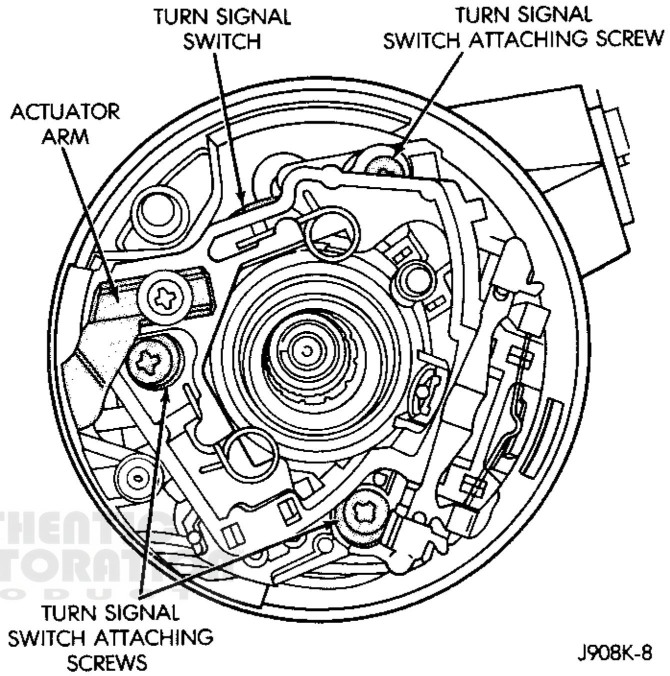


Fig. 6 Turn Signal And Dimmer Actuating Lever Screws

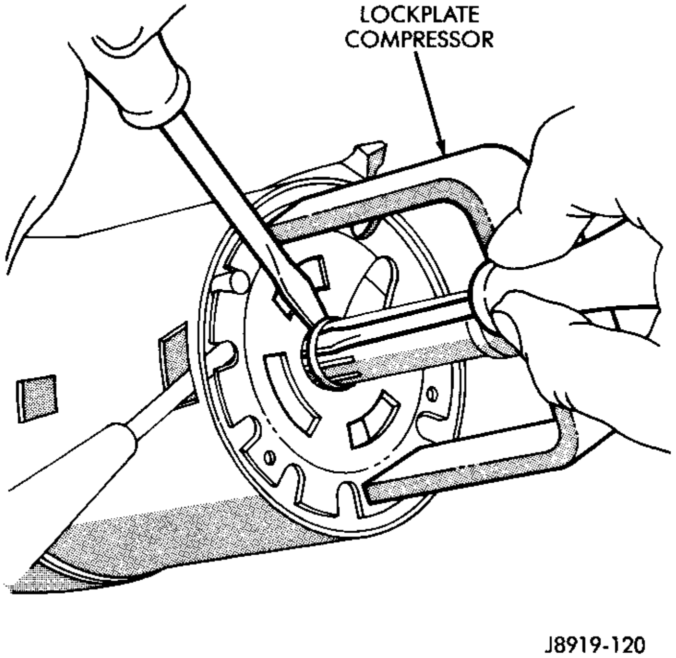


Fig. 5 Lockplate Removal

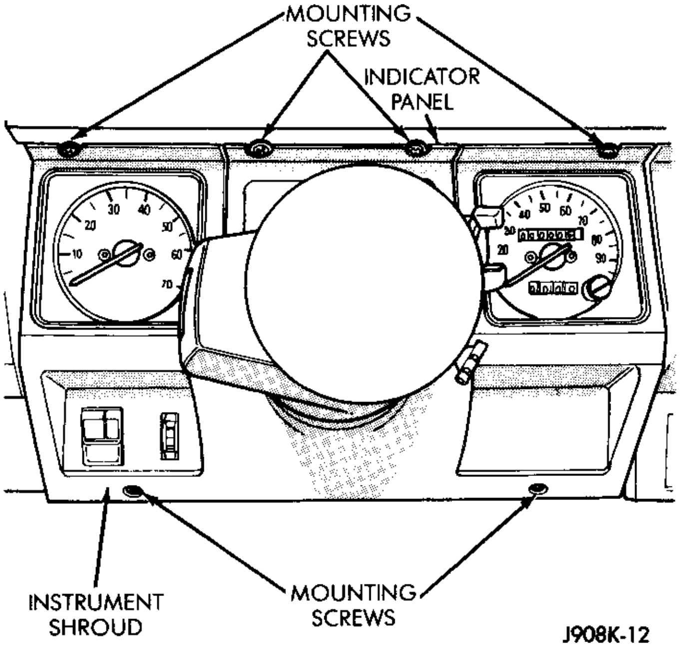


Fig. 7 Instrument Shroud Removal/Installation — YJ

(18) Loosen column brace mounting nut at drivers side kick panel. This will allow column to drop.

(19) Unplug wiper switch connector.

(20) Tape connector to wires (Fig. 11).

(21) Push upper connector up and out of turn signal connector (Fig. 12).

(22) Pry up locking tabs of turn signal connector and remove connector from column bracket.

(23) Remove plastic harness cover by pulling it up and over the weld nuts then open and slide the cover off the harness (Fig. 13).

(24) Pull the turn signal switch out of the column far enough to allow access to the remaining screws.

(25) Insert the ignition key in the lock cylinder and turn the key to ON position.

(26) Remove the key warning buzzer switch and retaining clip with a paper clip inserted below the retainer so that the retainer is flattened (Fig. 14).

Do not attempt to remove the buzzer switch and clip separately. The clip could fall into the column jacket.

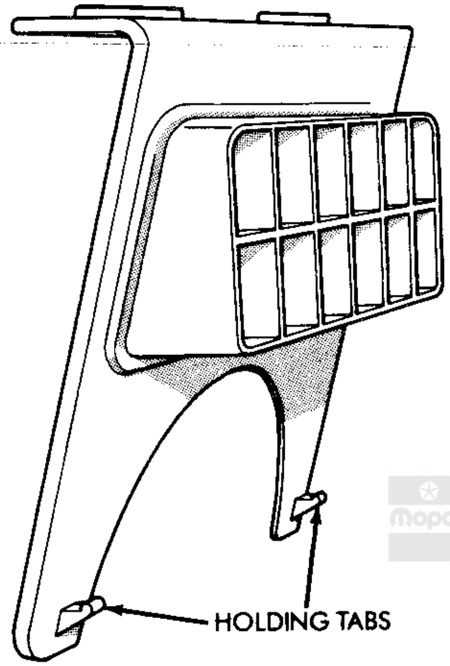


Fig. 8 Indicator Panel — YJ

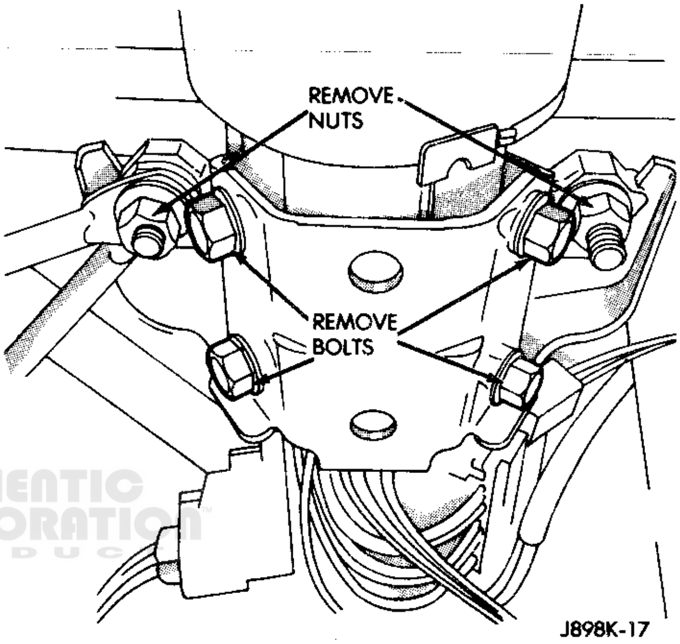


Fig. 10 Lower Steering Column Mounting

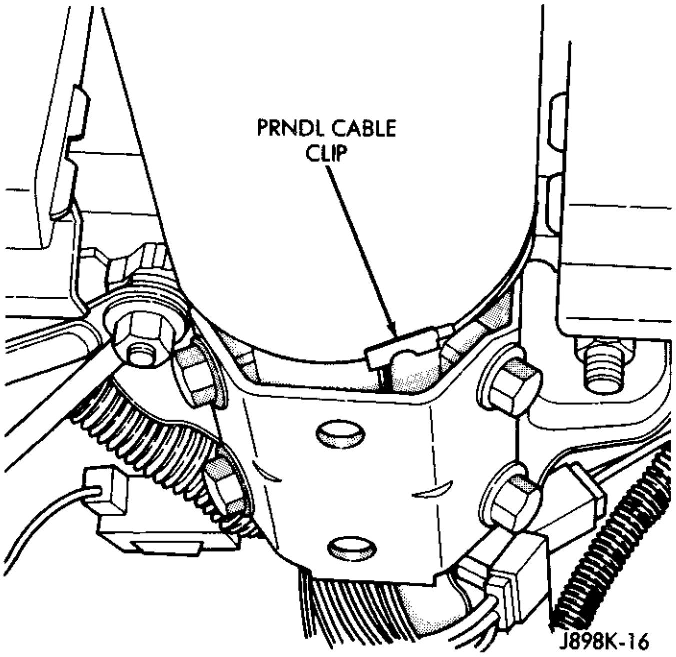


Fig. 9 PRNDL Cable Clip Removal/Installation

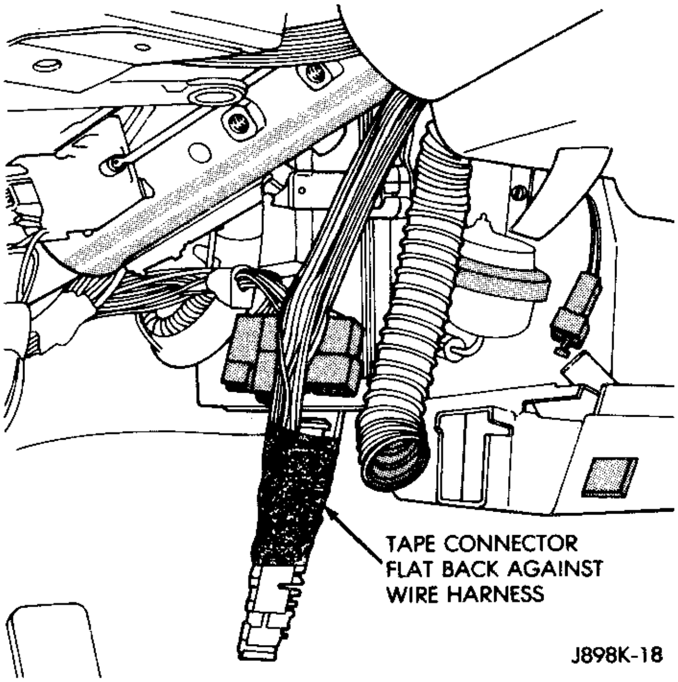


Fig. 11 Tape Wiper Switch Connector

(27) Remove the ignition lock cylinder retaining screw and pull the lock cylinder out of the column housing (Fig. 15)

(28) Remove the screws that attach the housing and shroud assembly to the column jacket and carefully remove the housing and shroud assembly (Fig. 16).

Do Not let the dimmer switch rod, lock pin or lock rack fall out.

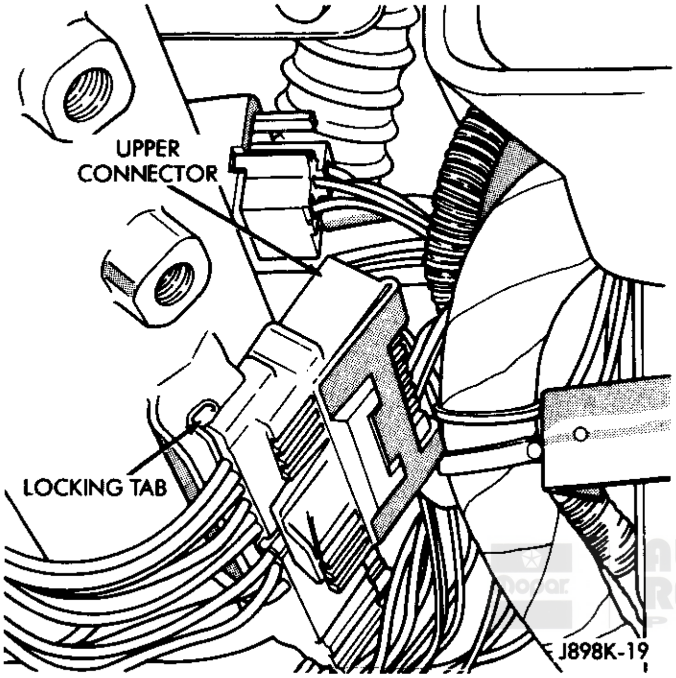


Fig. 12 Turn Signal Switch Connector Removal/Installation

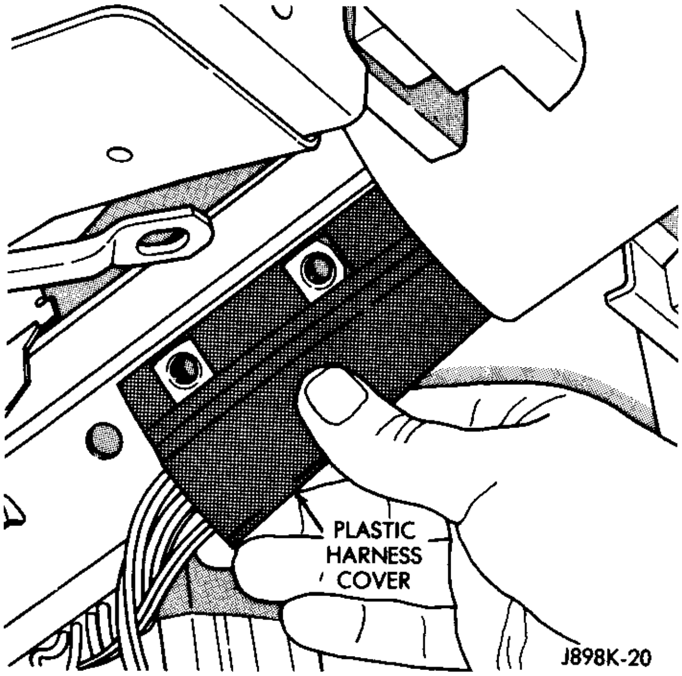


Fig. 13 Remove Plastic Harness Cover

(29) Remove the turn signal/wiper lever by pulling it straight out of the column.

(30) Remove the wiper switch cover from the back of the housing and shroud assembly (Fig. 17). If equipped with column shift, remove the screw holding the cover on.

(31) Remove the pivot screw from the housing and remove the wiper switch.

(32) Install a new switch and switch cover.

(33) Push on dimmer switch rod to make sure it is connected then carefully position housing and shroud

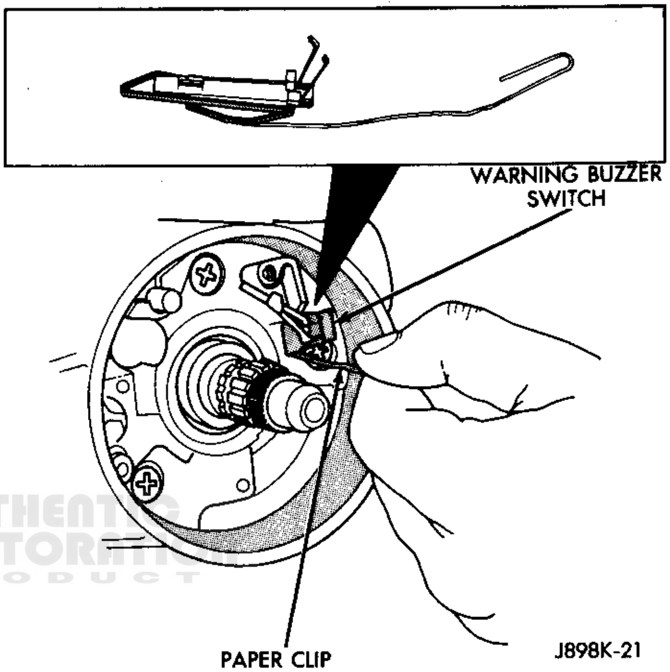


Fig. 14 Buzzer Switch Removal

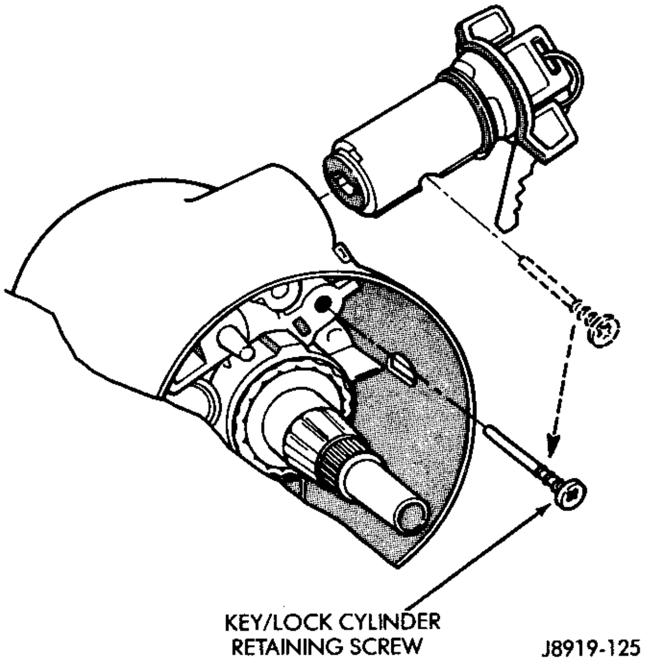


Fig. 15 Lock Cylinder Removal/Installation

assembly to column (Fig. 18).

Make sure the nylon spring retainer on the lock pin is positioned forward of the retaining slot of the lock rack (Fig. 18).

Position the first tooth of the gear (farthest from the block tooth) with the most forward tooth of the lock rack.

(34) Install the screws that attach the housing and shroud assembly to the column jacket and carefully mate the housing and shroud assembly.

(35) Insert the key and lock cylinder and test that the lock pin extends fully when the key is moved to the lock position.

(36) To install remaining parts, reverse the removal procedures.

CAUTION: When installing a wiper switch, make sure wires are laying flat on bottom inside of column.

On vehicles equipped with column shift, install the PRNDL cable clip with the shift indicator on N. Move the selector through the range and make sure it lines up with each letter.

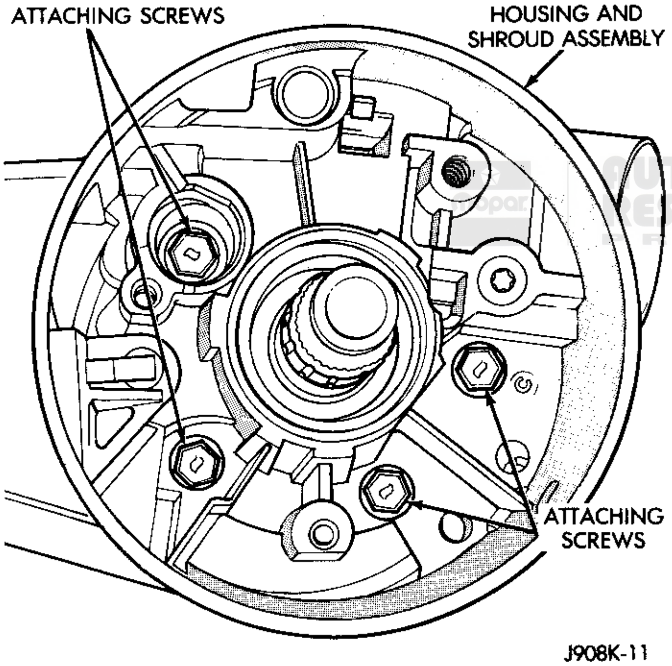


Fig. 16 Steering Column Housing Removal/Installation

(37) Install the steering wheel. Tighten the steering wheel nut to 34 N•m (25 ft. lbs.) torque.

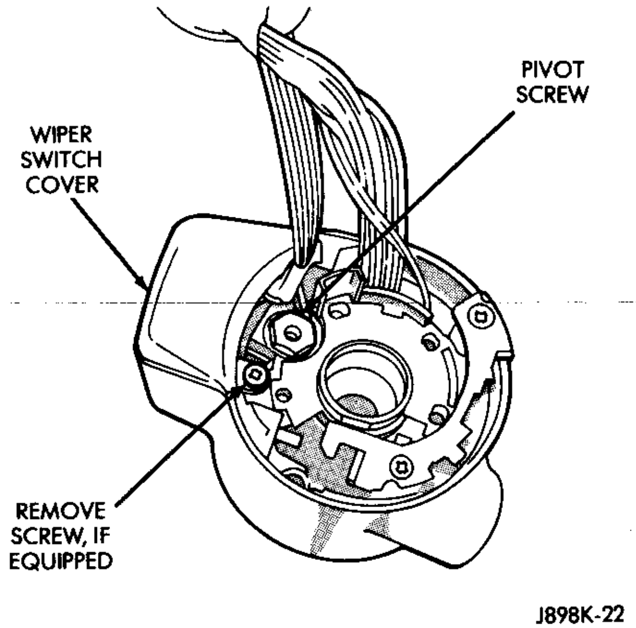


Fig. 17 Remove Pivot Screw

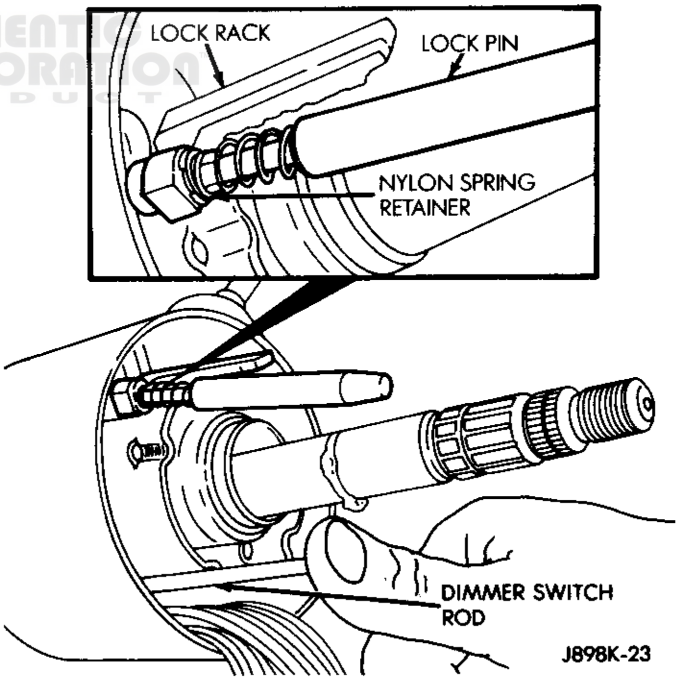
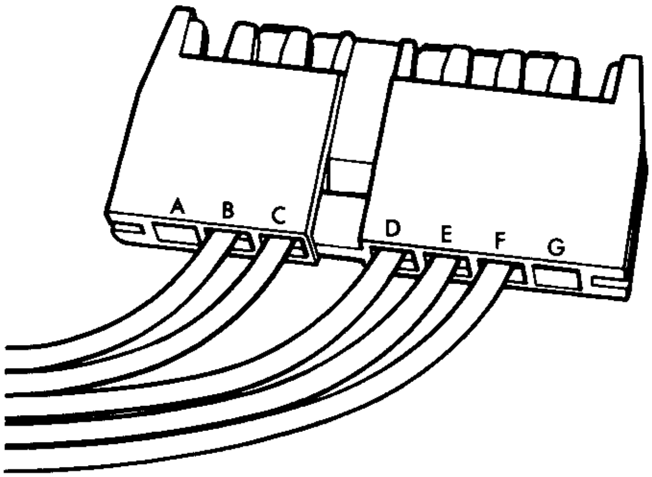
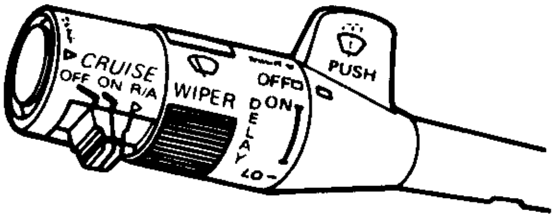


Fig. 18 Check Dimmer Switch Rod and Lock Pin

WIPER SWITCH TESTING

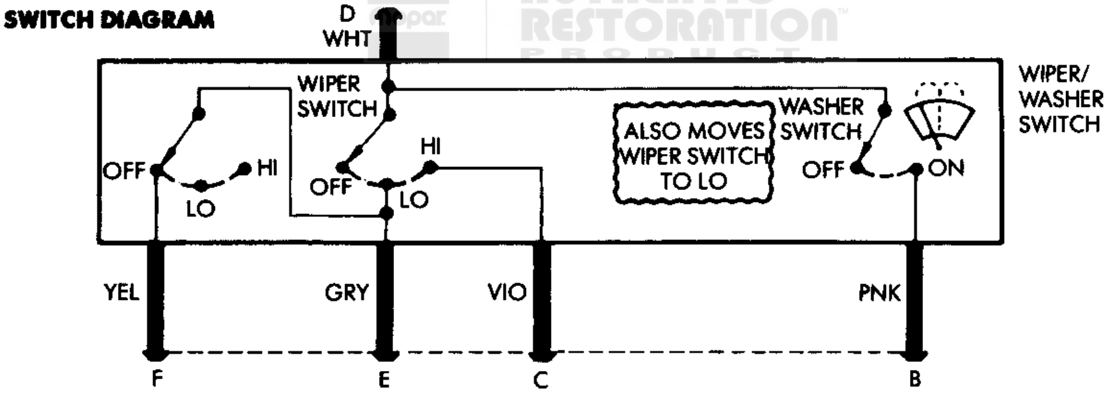
STANDARD WIPER WASHER





B - WASHER PINK
C - HI VIOLET
D - IGNITION WHITE
E - LO/PARK GRAY
F - OFF/PARK YELLOW

SWITCH DIAGRAM

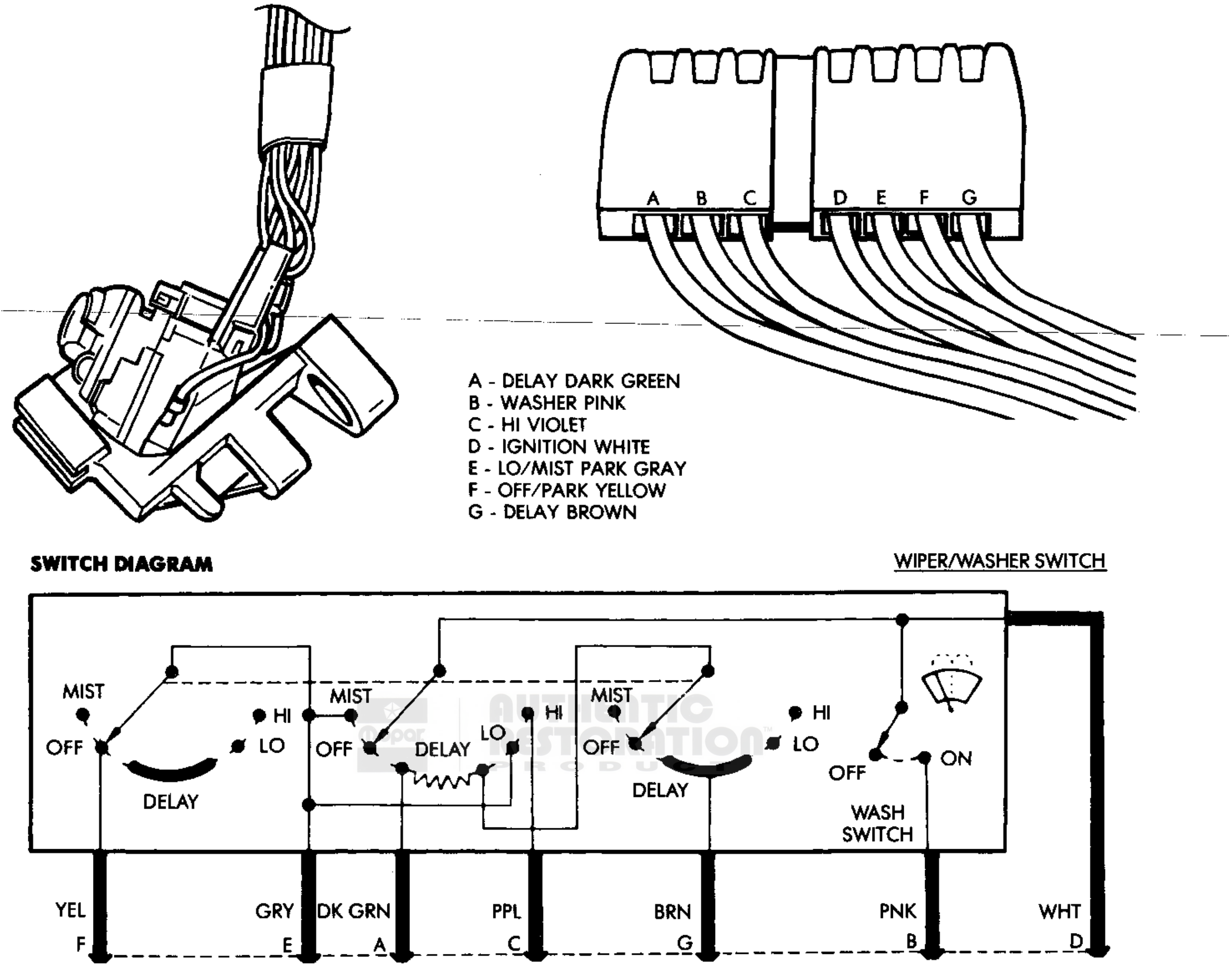


SWITCH TEST

SWITCH POSITION	TERMINALS	ZERO OHMS
Off	E and F	Yes
	All Others	No
Lo	D and E	Yes
	All Others	No
Hi	C and D	Yes
	All Others	No
Wash	B and D	Yes
	D and E	Yes
	All Others	No

J898K-49

INTERMITTENT WIPER WASHER



A - DELAY DARK GREEN
B - WASHER PINK
C - HI VIOLET
D - IGNITION WHITE
E - LO/MIST PARK GRAY
F - OFF/PARK YELLOW
G - DELAY BROWN

SWITCH TEST

SWITCH POSITION	TERMINALS	ZERO OHMS
Off	E and F	Yes
	All Others	No
Lo	D and E	Yes
	All Others	No
Hi	C and D	Yes
	All Others	No
Wash/Mist	B and D	Yes
	D and E	Yes
	All Others	No
Delay	A and G	152-480K ohms

J898K-50

LAMPS

CONTENTS

EXTERIOR LAMPS

INDEX

TURN SIGNAL SWITCH

The turn signal switch removal and installation instructions can be found in Section 8J - Multi-Function Switch and Hazard.

HEADLAMP REPLACEMENT

The headlamps are removed on all models by removing the headlamp bezel and the retaining ring. Disconnect the headlamp wiring connector and remove the headlamp (Figs. 1,2,3,4).

HEADLAMP AIMING - LOW BEAM

This procedure applies to all models, but only the upper, low beam headlamp on Wagoneer quad systems. Headlamps must be aimed on low beam. They may be aimed either with mechanical aimers or by using a screen.

The dimmer switch is located on the steering column on all models. The dimmer switch is activated by pulling the turn signal lever toward the driver.

Use Headlight Aimer J-25300-10 following the instructions supplied with the equipment for proper headlamp aiming.

If a screen is to be used, preparation for aiming is as follows:

(1) Locate the vehicle in a darkened area with a level floor and with a screen (wall) having a nonreflecting white surface.

(2) Mark a reference line on the floor 25 feet away from and parallel to the screen (Fig. 5).

(3) Position the vehicle perpendicular to the screen and with the headlamps directly over the reference line.

(4) Locate the middle tape on the screen so it is aligned with centerline of the vehicle.

(5) Equalize all tire pressures.

(6) Rock the vehicle from side to side to equalize the springs and shock absorbers.

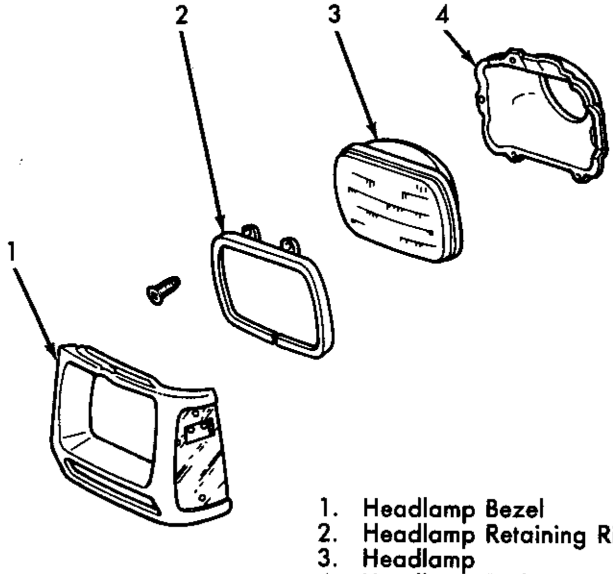


Fig. 1 Headlamp Assembly — MJ and Cherokee

(7) Measure the distance between the vehicle headlamp centers.

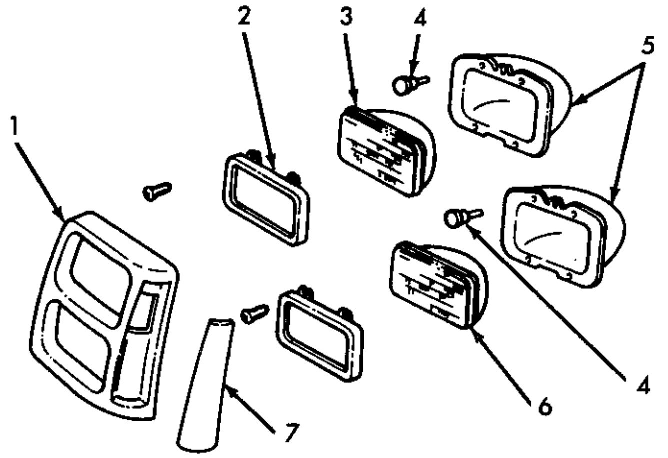
(8) Position the marker tapes vertically on the screen to the right and left of the middle tape at half this distance.

(9) Measure the distance from the center of each lamp to the surface on which the vehicle rests.

(10) Position the marker tape horizontally on the screen to cross the vertical tapes at the measured height of each lamp center respectively.

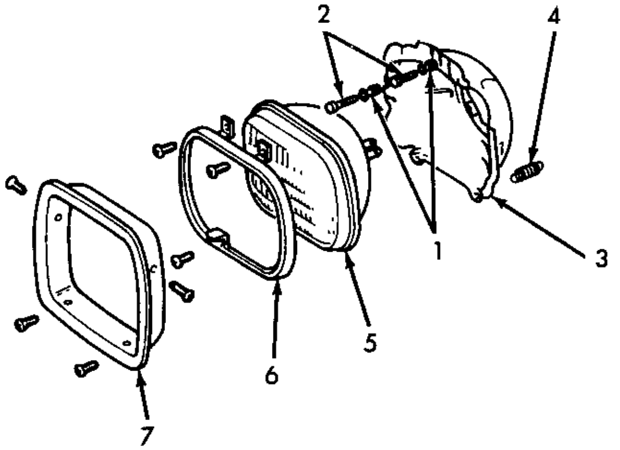
(11) Remove the headlamp bezels.

(12) Clean the headlamps.



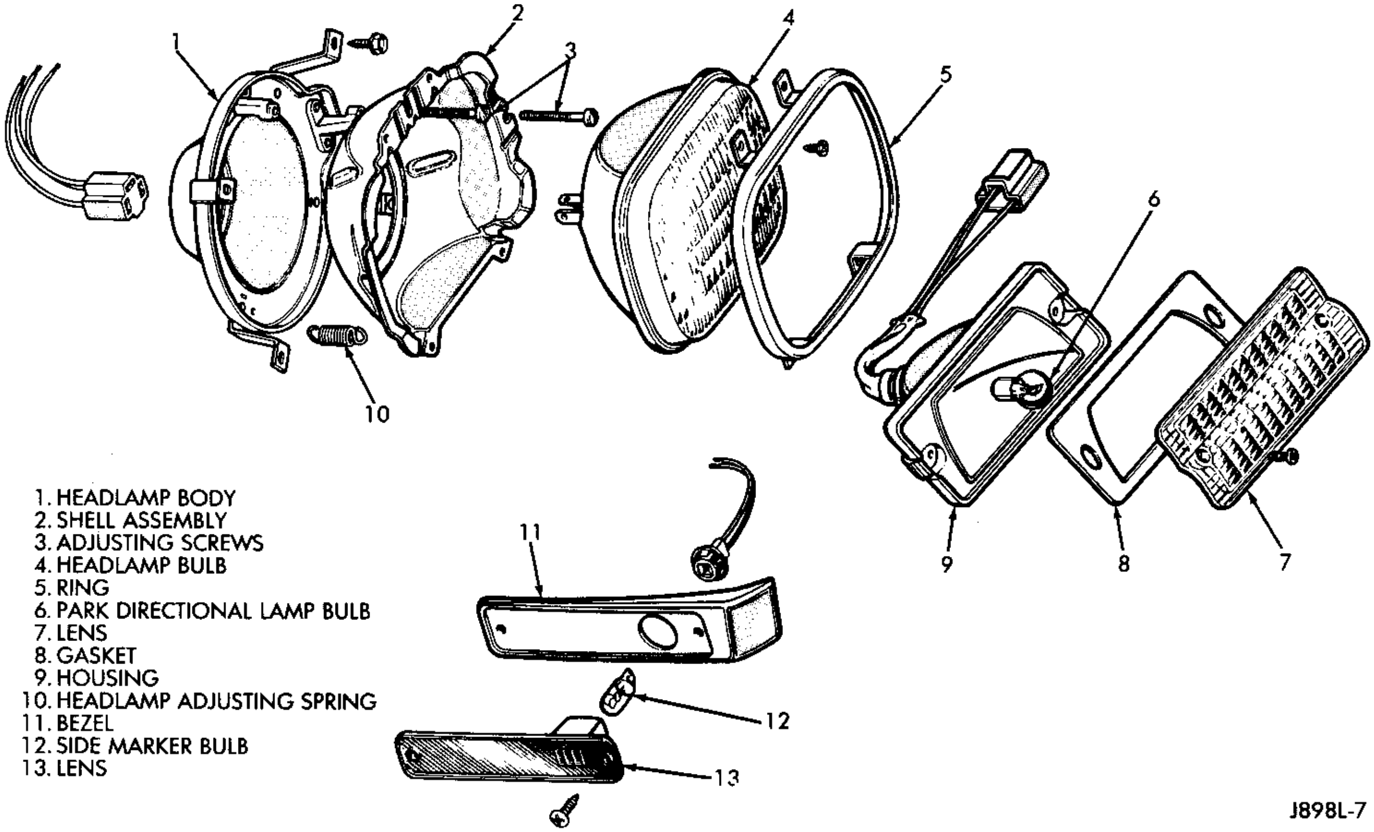
1. Headlamp Bezel
2. Retaining Ring
3. Headlamp (Low Beam)
4. Headlamp Adjustors
5. Headlamp Bracket
6. Headlamp (High Beam)
7. Side Marker

Fig. 2 Headlamp Assembly — Wagoneer



1. Plastic Adjuster Nut(s)
2. Adjusting Screw(s)
3. Headlamp Bucket
4. Adjusting Spring
5. Headlamp
6. Retaining Ring
7. Trim Ring

Fig. 3 Headlamp Assembly — YJ



1. HEADLAMP BODY
2. SHELL ASSEMBLY
3. ADJUSTING SCREWS
4. HEADLAMP BULB
5. RING
6. PARK DIRECTIONAL LAMP BULB
7. LENS
8. GASKET
9. HOUSING
10. HEADLAMP ADJUSTING SPRING
11. BEZEL
12. SIDE MARKER BULB
13. LENS

Fig. 4 Headlamp Assembly — SJ

(13) Turn the headlamps on LOW beam.

(14) Cover the lamp not being aimed.

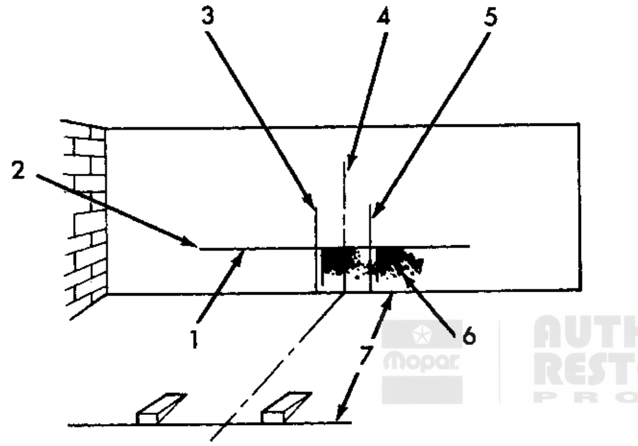
(15) Turn the vertical aiming screw (Figs. 6,7) counterclockwise until the lamp beam is considerably lower than the horizontal reference line on the screen.

(16) Turn the screw clockwise until the top edge of the high intensity area is even with the horizontal line.

(17) Turn the horizontal aiming screw counterclockwise until the beam is off the centering tape.

(18) Turn the same screw clockwise until the left edge of the high intensity area is 2 inches to the right of the lamp centerline.

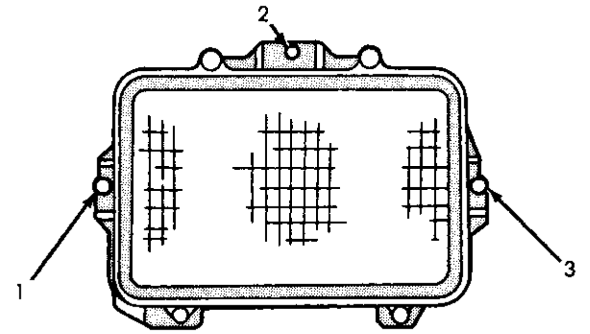
(19) Cover the lamp that has been aimed and aim the other lamp using the same procedure.



1. Height of Lamp Centers
2. Horizontal Tape
3. Vertical Tape Left Lamp Center
4. Vertical Centerline
5. Vertical Tape Right Lamp Center
6. Zone of Greatest Intensity
7. 25 Feet

J898L-8

Fig. 5 Headlamp Aiming Screen



1. HORIZONTAL ADJ. SCREW - RH
2. VERTICAL ADJ. SCREW
3. HORIZONTAL ADJ. SCREW - LH

J908L-24

Fig. 6 Headlamp Aiming — XJ, MJ and SJ

HIGH BEAM AIMING—WAGONEER QUAD-SYSTEM

After adjusting the upper, low beam headlamps, the lower, high beam lamps can be adjusted to maximize road illumination and to conform with the existing state regulations.

The dimmer switch is located on the steering column on all models. The dimmer switch is activated by pulling the turn signal lever toward the driver.

The lamps must be aimed on the **high beam**. They may be aimed either with mechanical aimer or by using a screen.

Use Headlight Aimer J-25300-10 with adapter J-25300-204 which has the proper adapters for use with the smaller rectangular headlamps used on the Quad-Headlamp System following the instructions supplied with the equipment for proper headlamp aiming.

If a screen is to be used, preparation for aiming the high beam headlamps is the same as described in Headlamp Aiming (Fig. 8).

(1) Turn the headlamps on HIGH beam.

(2) Cover the lamp not being aimed.

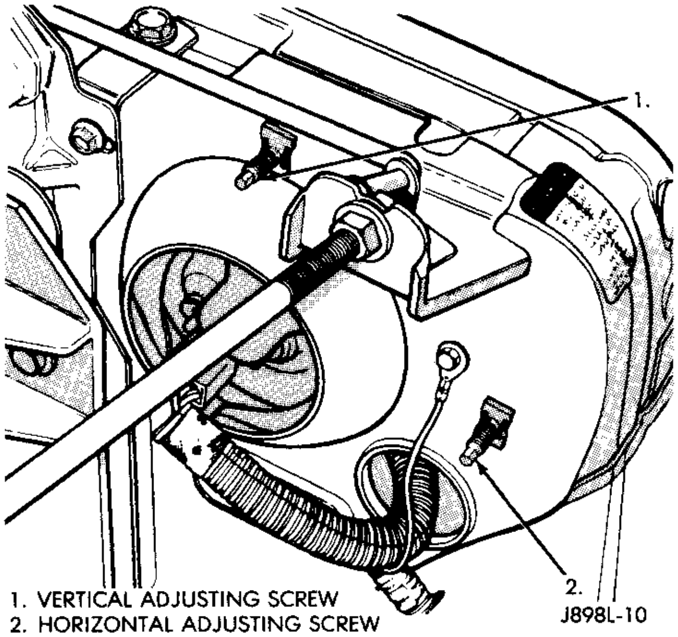
(3) Turn the vertical aiming screw counterclockwise until the lamp beam is considerably lower than the horizontal reference line on the screen (Fig. 9).

(4) Turn the same screw clockwise until the middle of the high intensity area is even with the horizontal line.

(5) Turn the horizontal aiming screw until the beam is off the centering tape.

(6) Turn the same screw clockwise until the middle of the high intensity area is even with the lamp centerline.

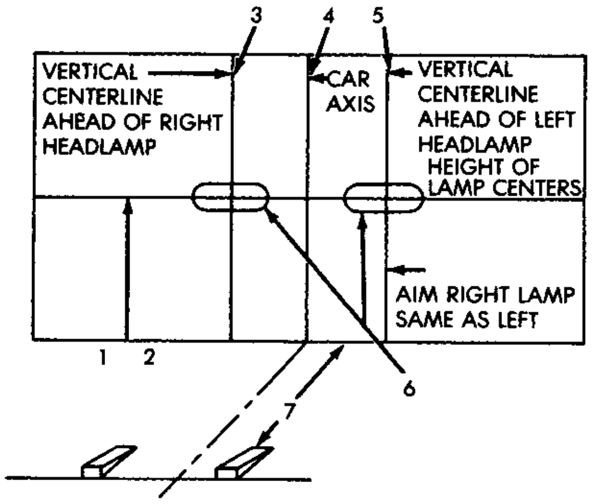
(7) Cover the lamp that has been adjusted and aim the other lamp using the same procedure.



1. VERTICAL ADJUSTING SCREW
2. HORIZONTAL ADJUSTING SCREW

J898L-10

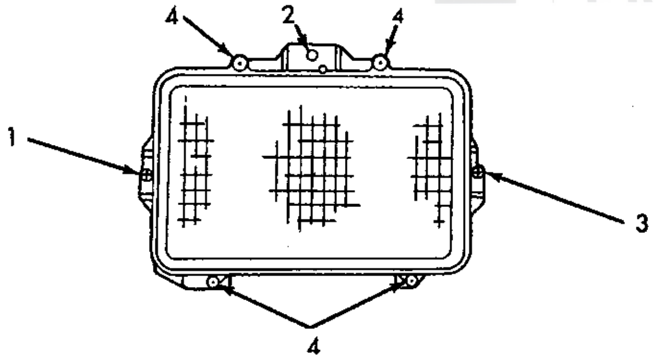
Fig. 7 Headlamp Aiming — YJ



1. HEIGHT OF LAMP CENTERS
2. HORIZONTAL TAPE
3. VERTICAL TAPE LEFT LAMP CENTER
4. VERTICAL CENTERLINE
5. VERTICAL TAPE RIGHT LAMP CENTER
6. ZONE OF GREATEST INTENSITY
7. 25 FEET

J898L-12

Fig. 8 Quad-System High Beam Aiming



1. Horizontal Adj. Screw - RH
2. Vertical Adj. Screw
3. Horizontal Adj. Screw - LH
4. Bezel Holddown Screws

J908L-25

Fig. 9 High Beam Aiming — Wagoneer

HEADLAMP SWITCH REPLACEMENT

XJ and MJ

(1) Disconnect battery negative cable.

(2) Pull the headlamp switch control knob to full ON position.

(3) Reach up under the instrument panel and depress the switch shaft retainer button (Fig. 10) while pulling the switch control shaft knob straight out.

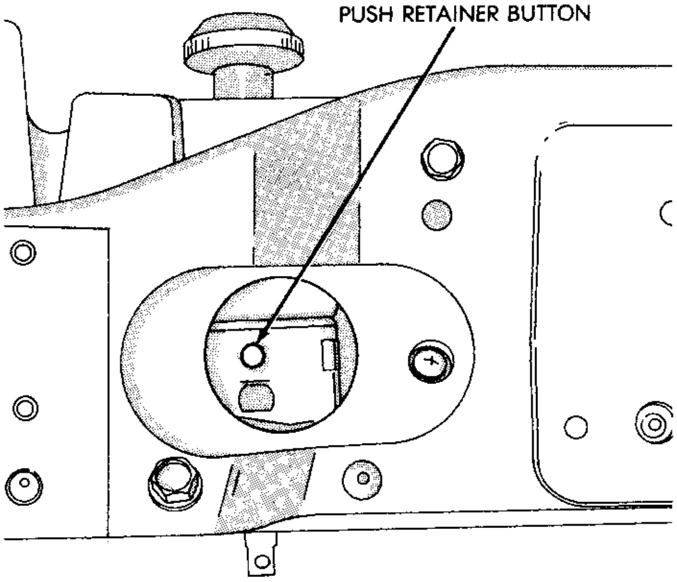
(4) Remove the light switch ferrule nut from the front of the instrument panel (Fig. 11).

(5) Disconnect the switch from the wiring harness.

(6) Install the headlamp switch in the instrument panel and connect the wiring harness.

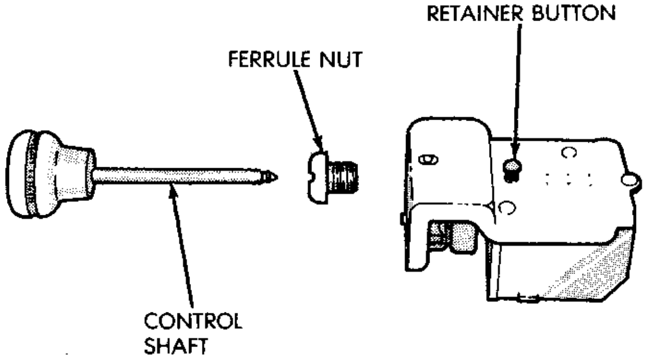
(7) Install the switch ferrule nut.

(8) Insert the switch control shaft knob and firmly press into the switch.



J898L-13

Fig. 10 Headlight Switch Shaft Removal — XJ and MJ



J898L-14

Fig. 11 Headlamp Switch Removal/Installation

YJ

(1) Disconnect battery negative cable.

(2) Remove six shroud screws (Fig. 12).

(3) Slide the shroud towards the steering wheel.

(4) Apply upward pressure to the shroud and downward pressure to the indicator panel. This will release the holding tabs (Fig. 13).

(5) Remove instrumentation shroud.

(6) Remove two headlamp switch attaching screws (Fig. 14).

(7) Remove the headlamp switch connector.

(8) To install the headlamp switch, connect the switch connector and install the switch.

(9) Place the shroud under the steering column.

(10) Slide the indicator panel tabs into the shroud notches.

(12) Place the assembled shroud over the indicator lamp foam gasket and tighten the indicator screw.

A fragile foam gasket is on the back of the indicator overlay. If the gasket is torn or distorted, replace with a new gasket.

(13) Install remaining four screws.

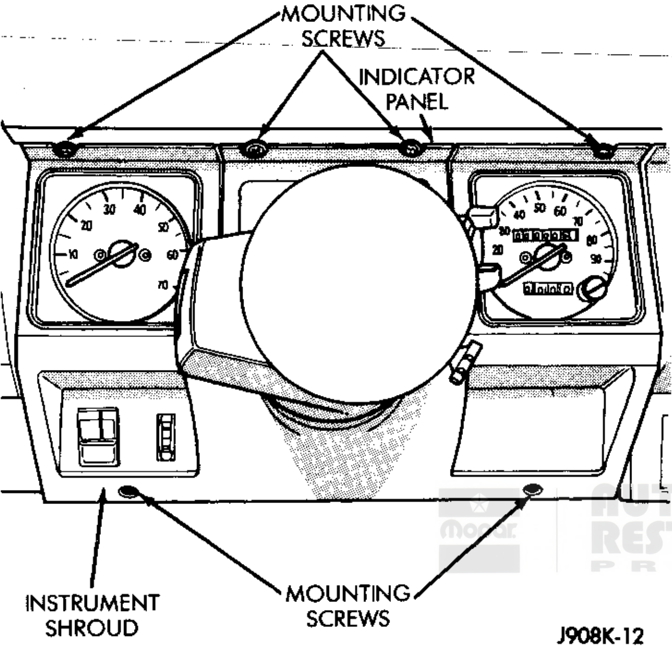


Fig. 12 Instrument Shroud Removal/Installation

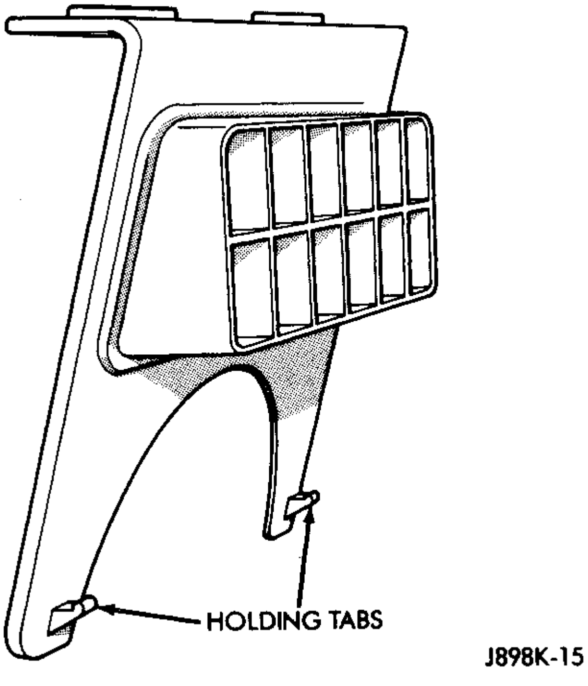


Fig. 13 Indicator Panel Holding Tabs

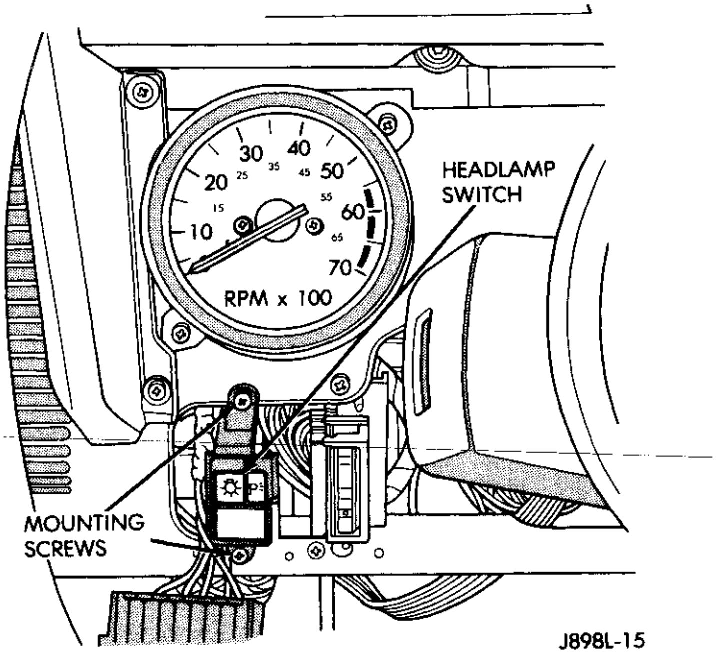


Fig. 14 Headlamp Switch Removal/Installation

SJ

The headlamp switch is located at the left side of the instrument panel.

(1) Disconnect battery negative cable.

(2) Disconnect the speedometer cable at the speed sensor which is located beneath the power brake booster.

(3) Unsnap the tabs that retain the instrument panel bezel and remove the bezel (Fig. 15).

(3) Remove the screws that attach the instrument cluster to the panel (Fig. 16).

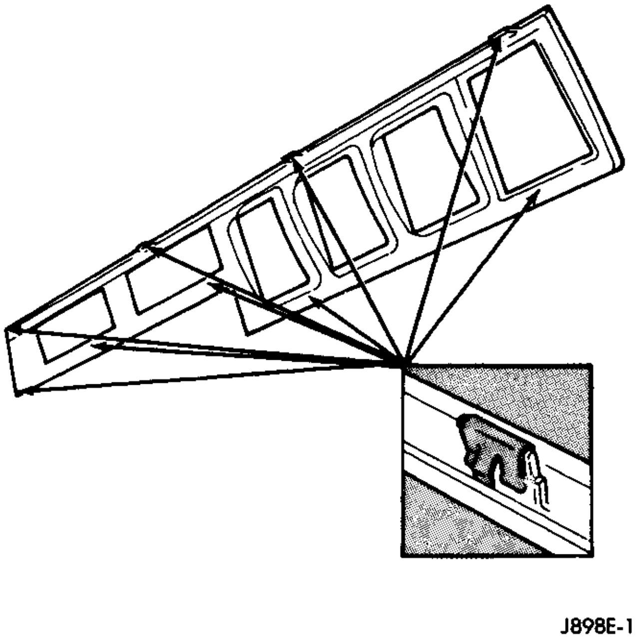


Fig. 15 Instrument Panel Bezel Retaining Clips

(4) Pull the instrument cluster outward and disconnect the speedometer and the cluster wire harness connectors.

(5) Remove the instrument cluster.

(6) Disconnect the headlight switch connector.

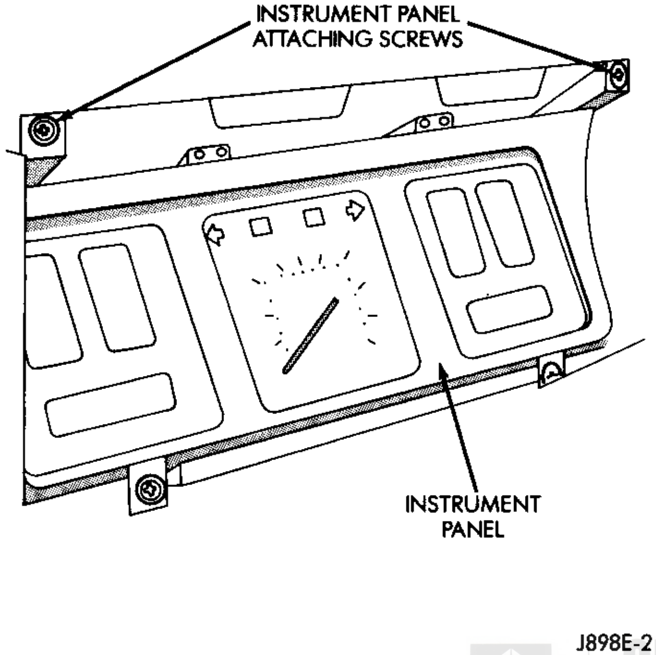


Fig. 16 Instrument Cluster Removal/Installation — SJ

(7) Using two small, thin-blade screwdrivers pry the upper switch retaining tangs upward and the lower tangs downward to release the Illumination rheostat. Repeat the procedure to remove the headlight switch (Fig. 17).

(8) To install, reverse the removal procedures.

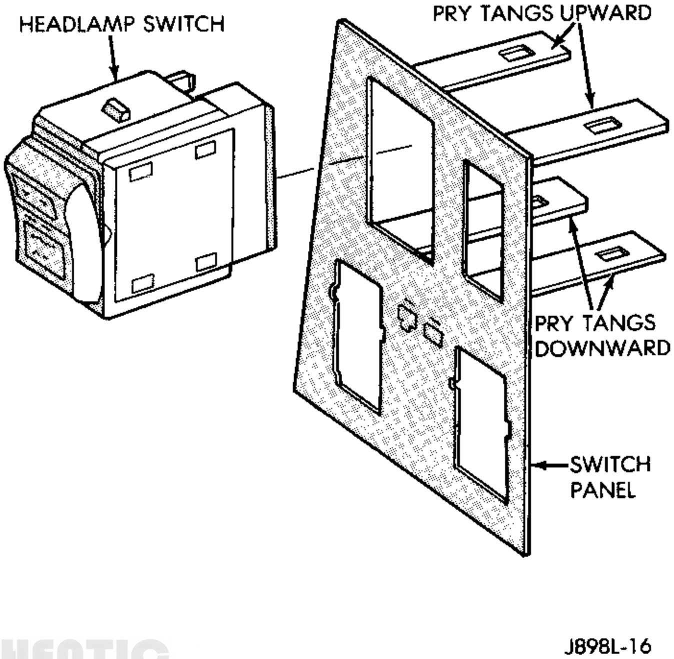


Fig. 17 Headlight Switch Removal/Installation

TROUBLESHOOTING — HEADLAMPS

XJ and MJ

1. ALL LO AND HI HEADLAMPS FILAMENTS—INOPERATIVE: Light Switch in HEAD

TEST	OK	NOT OK
Check operation of Fuse Link components	Components are functional	Check for blown fuse link If blown go to Step 2
Back probe connector A terminal 5	Zero ohms	Repair open to ground
Disconnect connector A, Front lamp Harness side of connector terminal 5 to 2 then 5 to 7	Almost zero ohms (bulb filament)	Replace Headlamps
Dimmer switch connector terminal 2	Battery voltage	Next step
Dimmer switch connector unplugged, light switch OFF, terminal 2	Infinite resistance If OK, replace light switch and go to next step	Repair short in circuit to terminal 2
Dimmer switch connector unplugged, light switch OFF, terminal 1	Almost zero ohms (bulb filament) If OK, go to next step	Repair short in circuit from terminal 1
Dimmer switch connector unplugged, light switch OFF, terminal 3	Almost zero ohms (bulb filament) If OK, test dimmer switch and connect dimmer switch connector	Repair short in circuit from terminal 3

2. ALL LO OR HI BEAMS—INOPERATIVE: Light Switch in OFF, Dimmer Switch Connector Unplugged

TEST	OK	NOT OK
Dimmer switch connector terminal 1	Almost zero ohms (bulb filament)	Repair open to Headlamps
Dimmer switch connector terminal 3	Almost zero ohms (bulb filament) If OK, replace dimmer switch	Repair open to Headlamps

YJ

Headlamp switch in HEAD; dimmer switch in HI or LO as required; headlamp connectors separated from headlamps

TEST	OK	NOT OK
Measure voltage headlamp connectors terminal B - dimmer switch in LO	Battery voltage	Repair open from dimmer switch
Measure voltage headlamp connectors terminal C - dimmer switch in HI	Battery voltage	Repair open from dimmer switch
Measure resistance from headlamp connectors terminal A to a clean chassis ground	Zero ohms	Repair open between headlamp connectors and ground

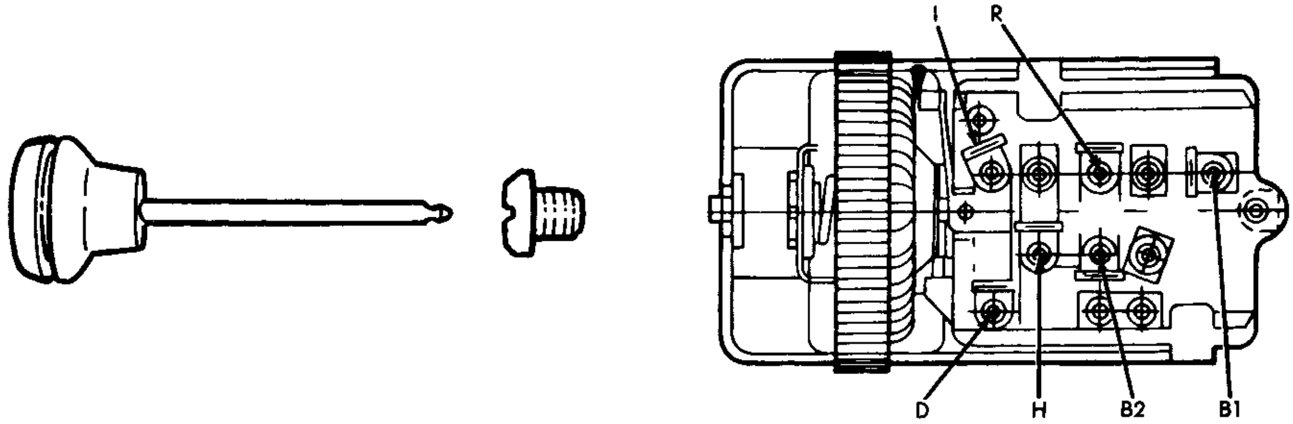
SJ

Headlamp switch in HEAD; dimmer switch in HI or LO as required; headlamp connectors separated from headlamps

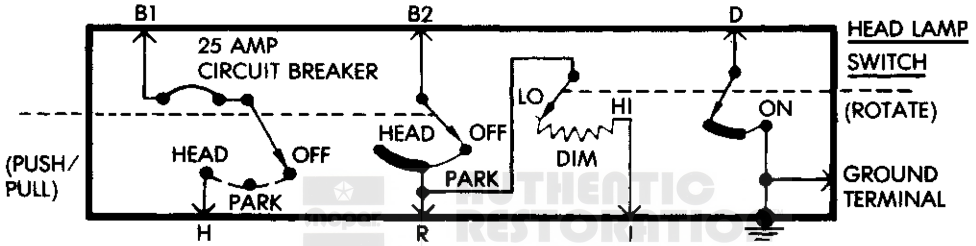
TEST	OK	NOT OK
Measure voltage at headlamp connectors terminal A - dimmer switch in LO	Battery voltage	Repair open from dimmer switch
Measure voltage at headlamp connectors terminal B - dimmer switch in HI	Battery voltage	Repair open from dimmer switch
Measure resistance from headlamp connectors terminal C to a clean chassis ground	Zero ohms	Repair open between headlamp connectors and ground

HEADLAMP SWITCH TESTING

XJ and MJ



SWITCH DIAGRAM



SWITCH TEST

SWITCH POSITION	TERMINALS	ZERO OHMS
Off	Any Terminals	No
Park	B2 and R	Yes
Head	B1 and H	Yes
	B2 and R	Yes
	All Others	No
Knob Turned C.W. and Pulled Out to Park Position	B2 and I	Yes
	B2 and R	Yes
	All Others	No
Knob Turned Fully C.W.	D and Ground Terminal	Yes
	All Others	No

J898L-18

YJ and SJ

Headlamp Switch

From the headlamp switch, the lighting circuits branch into the tail/side marker/park lamp circuits and the headlamp circuit. Before reaching the headlamps, battery feed is routed to the dimmer switch, where it branches into the head/indicator/fog lamp circuits.

HEADLAMP SWITCH: Headlamp switch in HEAD

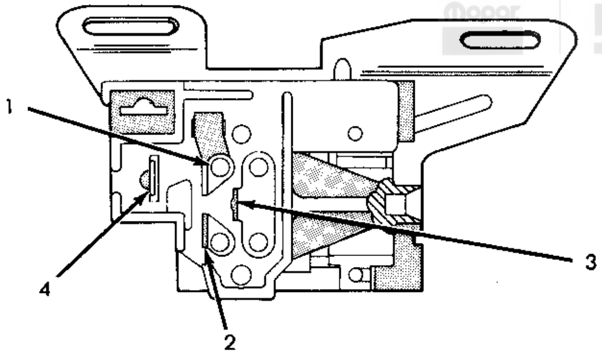
TEST	OK	NOT OK
Measure voltage at headlamp switch connector terminal C	Battery voltage	Repair open from fuse link
Measure voltage at headlamp switch connector terminal D	Battery voltage	Replace headlamp switch

Dimmer Switch

The dimmer switch transfers battery feed from the headlamp low beam filament to the high beam filament. It also serves as a fog lamp lock-out circuit. The circuit to the fog lamp switch is completed only when the dimmer switch is in the low beam position.

DIMMER SWITCH: Headlamp switch in HEAD; dimmer switch in HI or LO as required (Fig. 18)

TEST	OK	NOT OK
Measure voltage at dimmer switch connector terminal 1	Battery voltage	Repair open from headlamp switch
Measure voltage at dimmer switch connector terminal 3 - dimmer switch in LO	Battery voltage	Replace dimmer switch
Measure voltage at dimmer switch connector terminal 2 - dimmer switch in HI	Battery voltage	Replace dimmer switch



1. HIGH BEAM
2. LOW BEAM
3. HEAD LAMP FEED (FROM LAMP SWITCH)
4. FEED FROM HEADLAMP SWITCH FOR FLASH TO PASS

J898L-70

Fig. 18 Headlamp Dimmer Switch

SIDE MARKER LAMP REPLACEMENT

XJ and MJ

(1) Remove screws from side marker lens and separate lens from headlight bezel (Figs. 19, 20).

(2) Pull bulb assembly from socket in back of lens and replace bulb. Reverse procedure for installation.

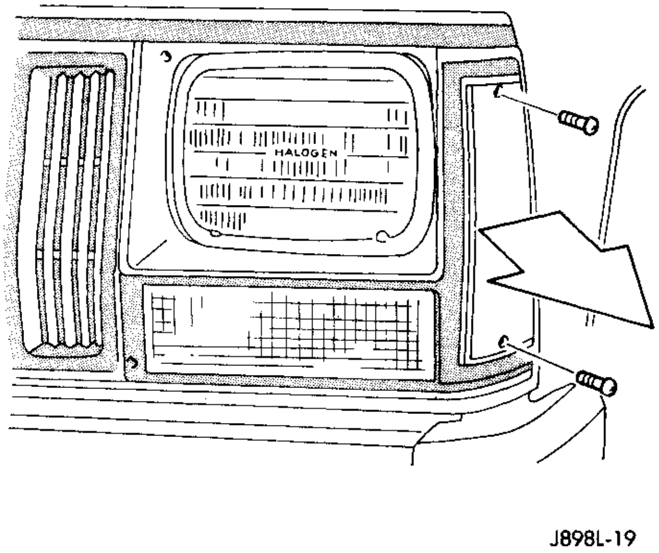


Fig. 19 Side Marker Lamp — MJ and Cherokee

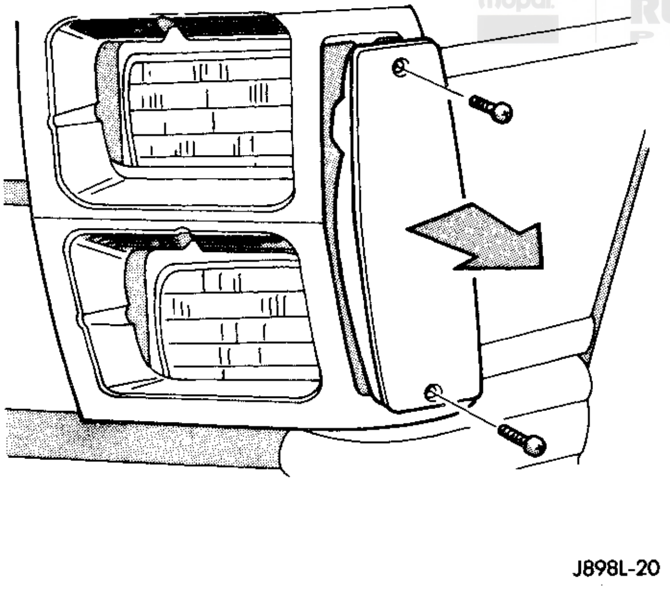


Fig. 20 Side Marker Lamp — Wagoneer

YJ

Reach beneath the fender; grasp the bulb assembly, turn 1/3 turn and pull from socket (Fig. 21).

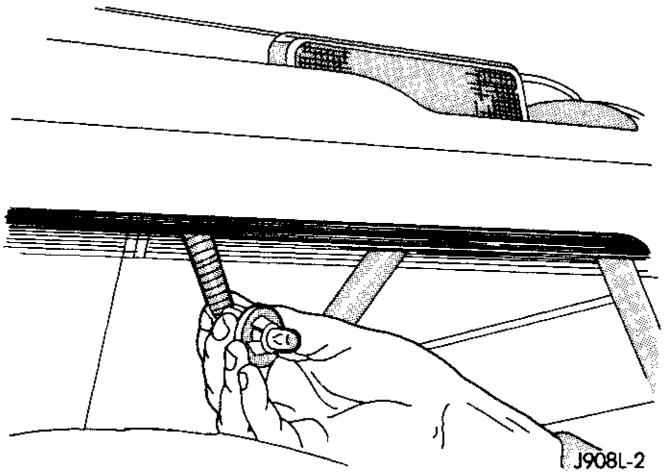


Fig. 21 Side Marker Lamp — YJ

SJ

Front Side Marker

(1) Remove screws and lamp assembly from fender (Fig. 22).

(2) Remove the bulb by pulling it straight out from the socket.

(3) Replace the bulb.

Rear Side Marker Bulb Replacement

(1) Remove the lens attaching screws, lens and gasket.

(2) Pull the side marker bulb straight out of the socket.

(3) To install the new bulb, push straight into the socket.

(4) Clean lens and reflector before installing.

(5) Position the lens gasket and lens and install the screws.

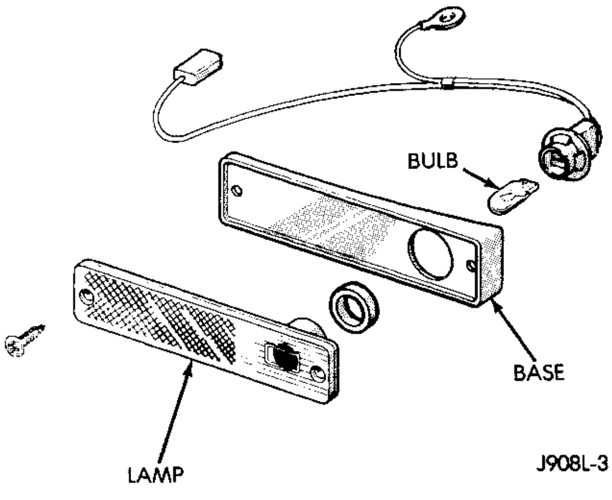


Fig. 22 Side Marker Lamp — SJ

FRONT PARK/TURN SIGNAL LAMP REPLACEMENT

MJ and Cherokee

(1) Remove screws from side marker lens and separate lens from headlight bezel (Fig. 23).

(2) Remove screws from headlight bezel.

(3) Remove screws from turn signal (Fig. 24).

(4) Turn bulb assembly 1/3 turn and pull from socket to replace bulb.

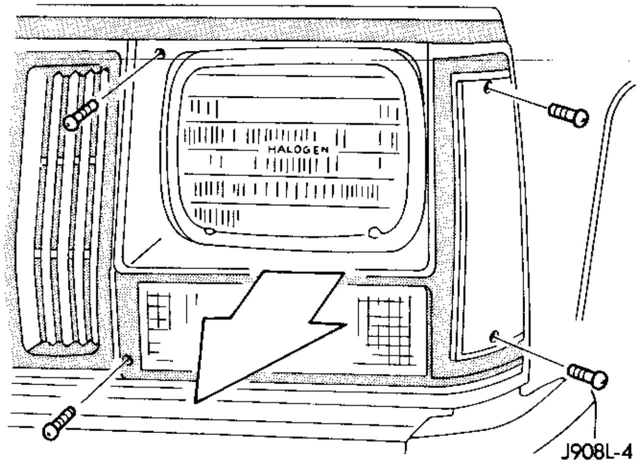


Fig. 23 Headlamp Bezel Removal

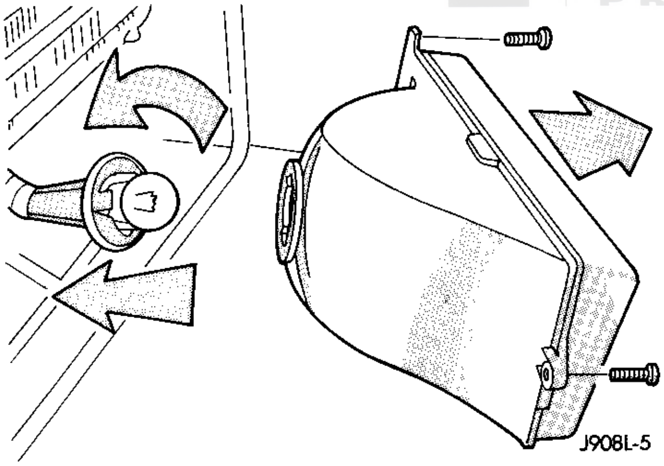


Fig. 24 Turn Signal Removal

Wagoneer

(1) Remove three screws and turn signal lamp housing (Fig. 25).

(2) Press bulb housing lock tab and twist assembly 1/3 turn counterclockwise, then pull bulb assembly from housing socket to replace bulb (Fig. 26).

YJ

(1) Remove screws.

(2) Turn bulb assembly 1/3 turn and pull from socket to replace bulb (Fig. 27).

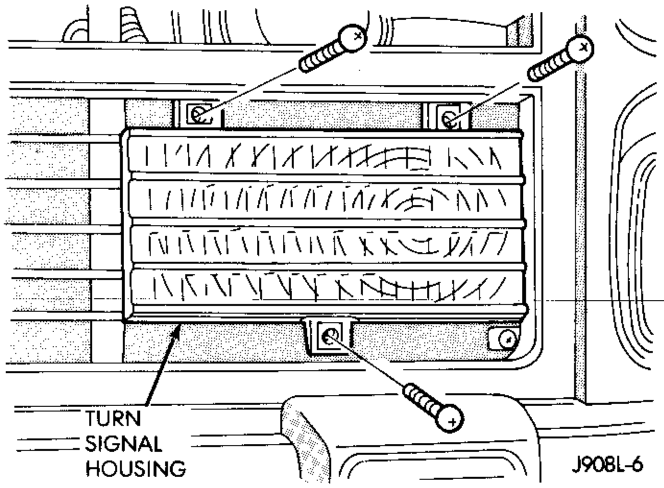


Fig. 25 Turn Signal Housing Removal

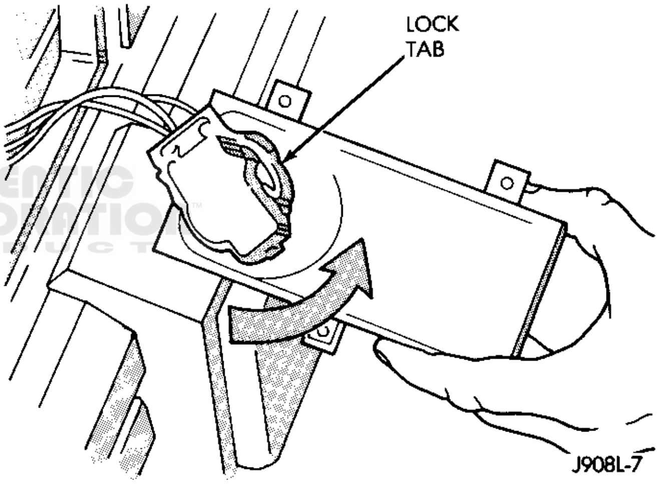


Fig. 26 Turn Signal Bulb Removal

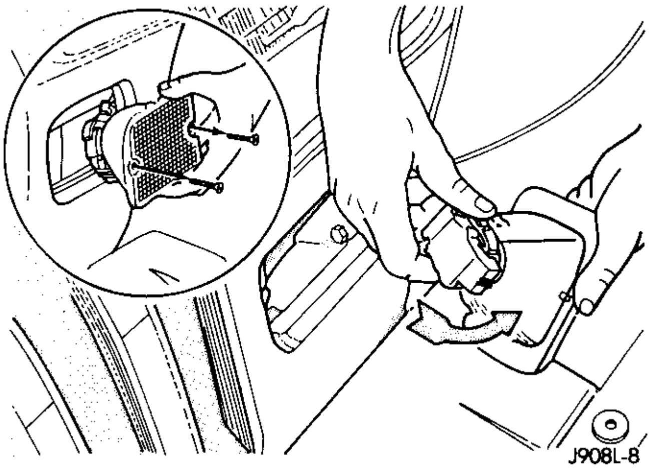


Fig. 27 Front Park/Turn Signal Lamp Replacement — YJ

SJ

Parking and Directional Lamp

(1) Remove the lens attaching screws (Fig. 28).

(2) Remove the lens.

(3) Replace the bulb.

Parking Lamp Assembly

(1) Remove the lens attaching screws.

(2) Remove the lens and gasket.

(3) Remove the housing from the front panel.

(4) Disconnect the wire connector from the harness.

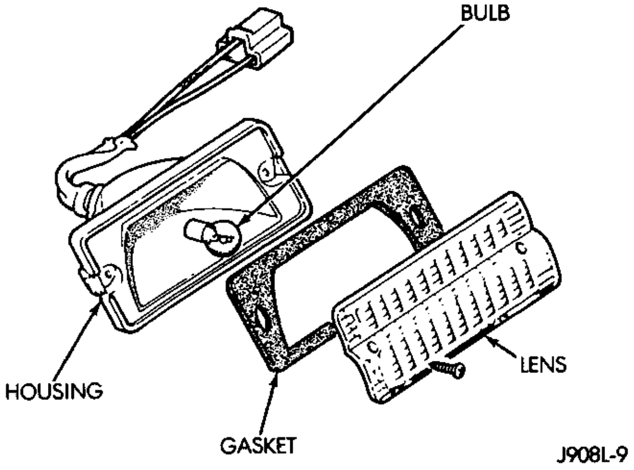


Fig. 28 Parking/Directional Lamp Replacement — SJ

TROUBLESHOOTING — XJ AND MJ EXTERIOR LAMPS

ALL PARKING LAMPS INOPERATIVE: Light switch in PARK or HEAD; Chime/Buzzer module removed; key in ignition switch

TEST	OK	NOT OK
Park fuse	Not blown	Replace fuse If fuse blows again, check circuit from terminal R for short to ground
Chime/Buzzer module connector terminal 7	Battery voltage	Repair open from Park fuse
Chime/Buzzer module connector terminal 8	Battery voltage	Go to next step
Light switch terminal R	Battery voltage If OK, repair open between light switch connector terminal R and connectors A and B	Replace Light Switch

FRONT PARKING LAMPS INOPERATIVE: Light switch OFF, back probe connector C

TEST	OK	NOT OK
Connector C terminal 5	Zero ohms	Repair open to ground
Connector C terminal 4, Light switch ON	Battery voltage	Repair open to Headlight switch terminal R
Connector C unplugged, Front Lighting Harness side of connector across terminals 4 and 5	Almost zero ohms (bulb filaments)	Repair open

TAILLIGHTS INOPERATIVE: Light Switch OFF

XJ

TEST	OK	NOT OK
Connector D terminal 7	Zero ohms	Repair open to ground
Connector D terminal 6 Light switch ON	Battery voltage	Repair open to connector B terminal 4
Connector D unplugged, Rear Crossbody harness side of connector across terminals 6 and 7	Almost zero ohms (bulb filament)	Repair open

MJ

TEST	OK	NOT OK
Any lamp black wire to ground	Zero ohms	Repair open to ground
Connector D	Battery voltage	Repair open to headlight switch termial R

ALL BRAKE LAMPS INOPERATIVE: Turn Signal Switch in NORMAL position

TEST	OK	NOT OK
Push in Hazard switch	Lamps flash	Replace Haz/Stop fuse
Brake switch terminal A	Battery voltage	Repair open to fuse
Brake switch terminal B Brake Pedal depressed	Battery voltage	Replace Brake Switch
Turn/Hazard switch connector terminal P Brake Pedal depressed	Battery voltage (MJ and Wagoneer)	Repair open to Brake Switch
Turn/Hazard switch connector terminal N Brake Pedal depressed	Battery voltage (Cherokee)	Replace Turn/Hazard Switch
Turn/Hazard switch connector terminal N then terminal M to ground	Almost zero ohms (bulb filaments)	Check lamps
BLK wire at bulb socket	Zero ohms	Repair open to ground splice of body harness
Wire at bulb socket terminal A	Battery voltage	Repair open to Turn/Hazard switch

ALL BACKUP LAMPS INOPERATIVE: Remove and inspect fuse, Parking Brake ON, Transmission in Reverse, Ignition in RUN for voltage tests

TEST	OK	NOT OK
TCU fuse	Not blown	Replace fuse
Fuse side of switch	Battery voltage	Repair open to fuse
Across switch	Zero ohms	Replace switch
Lamp side of switch	Almost zero ohms (bulb filaments)	Check lamps If OK, repair open between Lamps and switch

TROUBLESHOOTING — YJ EXTERIOR LAMPS

Tail/Side Marker/Park Lamps

1. LAMP: Headlamp switch in HEAD; lamp connector separated

TEST	OK	NOT OK
Measure voltage at battery side of lamp connector	Battery voltage	Repair open from supply side
Measure resistance from socket to a clean chassis ground	Zero ohms	Repair open between socket and ground

2. FUSE: Battery feed

TEST	OK	NOT OK
Inspect PARK/TAIL fuse	Not blown	Replace fuse
Measure voltage at battery side of fuse	Battery voltage	Repair open from fuse link

3. HEADLAMP SWITCH: Headlamp switch in HEAD

TEST	OK	NOT OK
Measure voltage at headlamp switch connector terminal E	Battery voltage	Repair open from fuse panel
Measure voltage at headlamp switch connector terminal A	Battery voltage	Repair open from fuse link If battery voltage, replace switch

Backup Lamps—One Lamp Out

LAMP: Transmission in Reverse; Socket connector separated from backup lamp; ignition switch in RUN

TEST	OK	NOT OK
Measure voltage at socket connector	Battery voltage	Repair open from supply side splice
Ignition off, measure resistance across bulb terminals	Zero ohms (except filament resistance)	Replace bulb
Measure resistance from socket to a clean chassis ground	Zero ohms	Clean or replace socket

Backup Lamps—All Lamps Out

1. BACKUP LAMP SWITCH (Manual Transmission): Ignition switch in RUN; transmission in Reverse

TEST	OK	NOT OK
Measure voltage at backup lamp switch connector terminal A	Battery voltage	Repair open from fuse panel
Measure voltage at backup lamp switch connector terminal B	Battery voltage	Replace backup lamp switch

2. BACKUP/NEUTRAL SAFETY SWITCH (Automatic Transmission): Ignition switch in RUN; transmission in Reverse

TEST	OK	NOT OK
Measure voltage at Backup/Neutral safety switch connector terminal A	Battery voltage	Repair open from fuse panel
Measure voltage at Backup/Neutral safety switch connector terminal B	Battery voltage	Replace backup/neutral safety switch

Stop Lamps—One Lamp Out

BULB: Brake pedal pressed

TEST	OK	NOT OK
Measure voltage at battery side of bulb socket	Battery voltage	Repair open from turn signal switch
Measure voltage at ground side of bulb socket	Zero ohms	Clean ground connection If zero volts, replace bulb

Stop Lamps—All Lamps Out

1. FUSE

TEST	OK	NOT OK
Check operation of hazard/stop lamps	Hazard lamps on	Check fuse
Measure voltage at battery side of hazard/stop fuse	Battery voltage	Repair open from fuse link

2. BRAKE SWITCH: Brake pedal pressed

TEST	OK	NOT OK
Measure voltage at brake switch connector terminal A	Battery voltage	Repair open from Hazard/Stop fuse
Measure voltage at brake switch connector terminal B	Battery voltage	Replace brake switch

3. TURN SIGNAL SWITCH

TEST	OK	NOT OK
Measure resistance from Turn/Hazard switch connector terminal P to terminals M and N	Zero ohms	Replace turn/hazard switch

BACKUP, REAR TURN SIGNAL, AND TAILLIGHT REPLACEMENT

XJ and MJ

(1) Remove four screws and remove taillight assembly (Figs. 1 and 3).

(2) Turn bulb assembly 1/3 turn and pull from socket to replace bulb (Figs. 2 and 4).

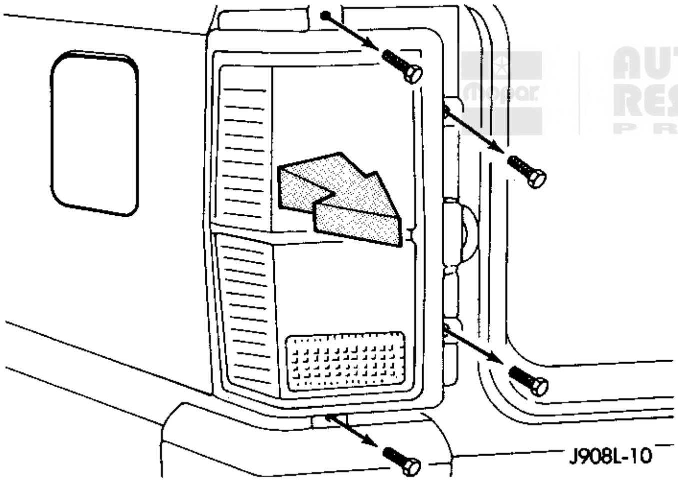


Fig. 1 Taillight Housing — XJ

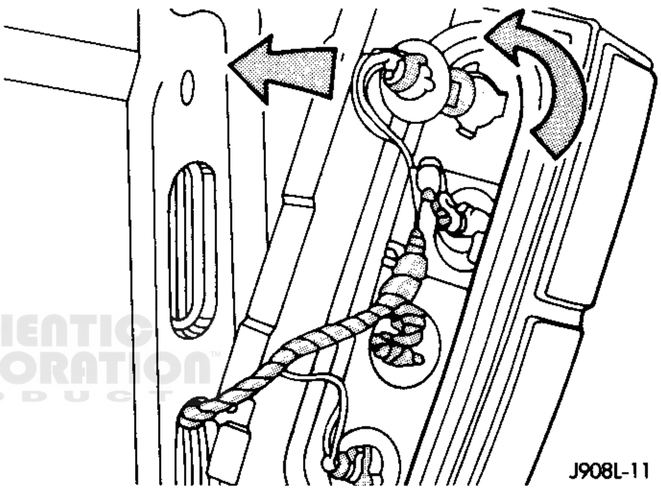


Fig. 2 Bulb Assembly Removal/Installation — XJ

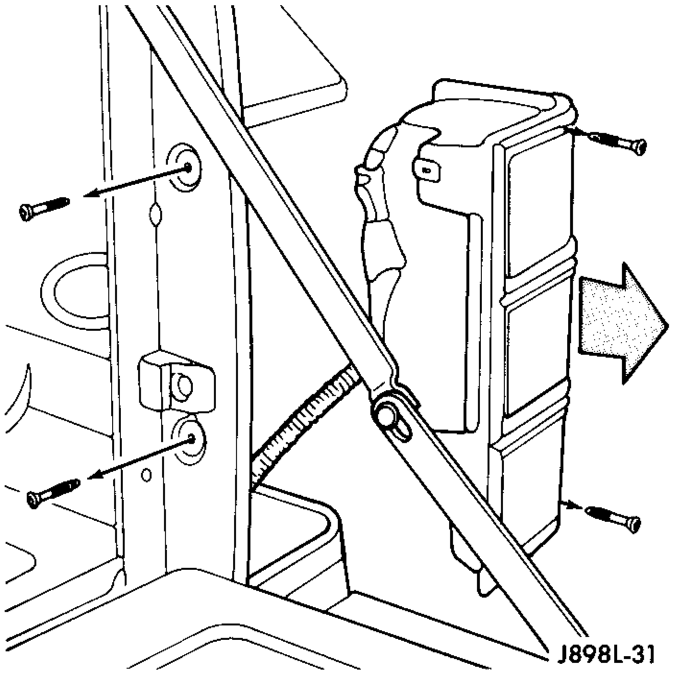


Fig. 3 Taillight Housing — MJ

YJ

(1) Remove screws and remove taillight lens (Fig. 5).

(2) Replace bulb.

SJ

Taillamp Bulb

(1) Remove the lens attaching screws, lens and gasket (Fig. 6).

(2) Remove bulb and install a replacement bulb.

(3) Clean the lens and reflector before installing.

Taillamp Housing Replacement

(1) Remove interior rear quarter trim panel. On the right side, pull the panel out at the top to remove. On the left side, the trim panel is attached with expandable clips. Use care in prying these clips out of their recesses so the panel is not bent or damaged.

(2) Disconnect the taillamp harness.

(3) Remove the two attaching nuts and push the housing out from the corner posts (Fig. 6).

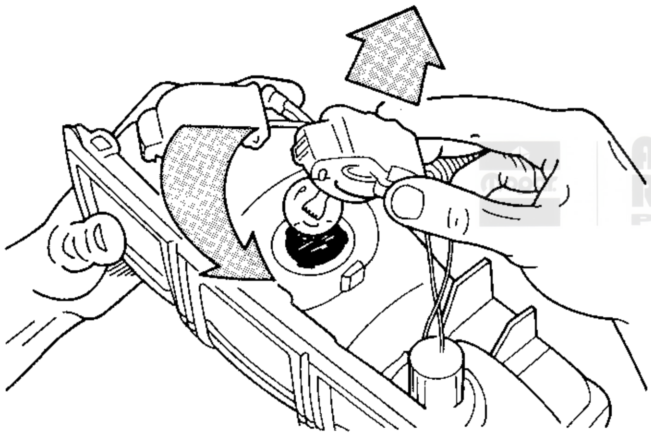


Fig. 4 Bulb Assembly Removal/Installation — MJ

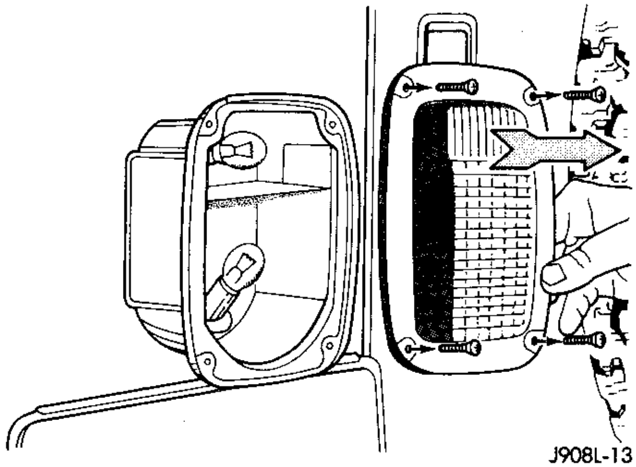


Fig. 5 Backup, Rear Turn Signal, and Taillight Replacement — YJ

Back Up Lamp

(1) To replace the bulb remove the taillamp lens.

(2) Remove old bulb and install new bulb.

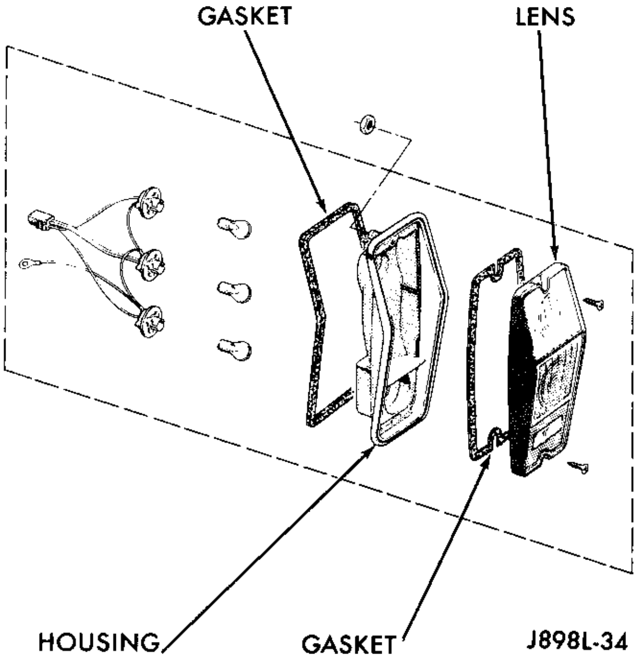


Fig. 6 Backup, Rear Turn Signal, and Taillight Replacement — SJ

LICENSE PLATE LAMP

XJ Without Swing Out Spare Tire

(1) Remove two screws and remove license plate bulb housing from liftgate (Fig. 1).

(2) Remove bulb from housing.

XJ With Swing Out Spare Tire

(1) Remove screw holding license lamp lens (Fig. 2).

(2) Carefully pry housing cover from base.

(3) Remove bulb and install new bulb.

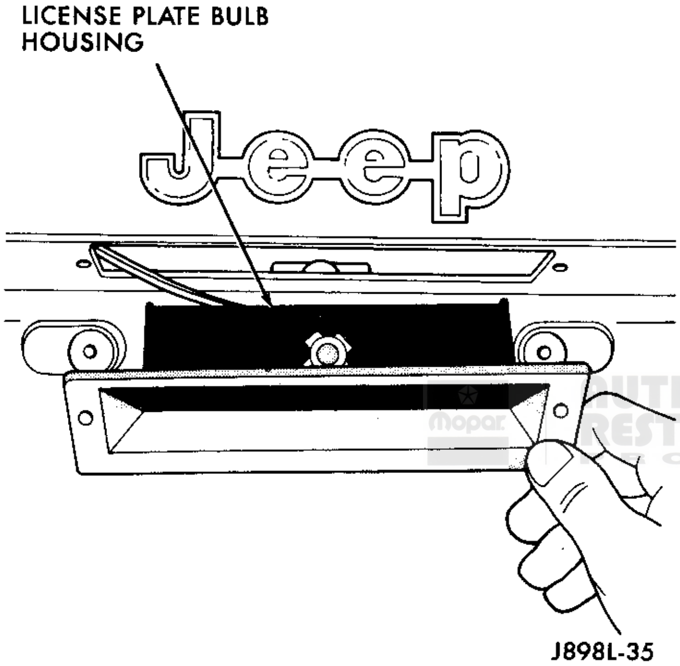


Fig. 1 License Plate Bulb and Housing Without Swing Out Spare Tire

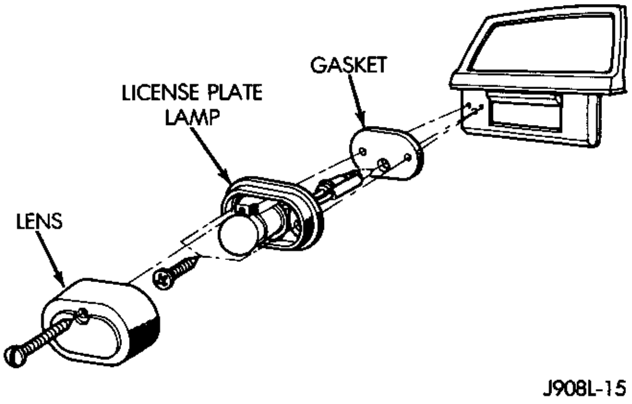


Fig. 2 License Plate Bulb and Housing With Swing Out Spare Tire

MJ

(1) Remove the clip that retains the lamp and socket in the bumper. The clip is located at the rear of the bumper (Fig. 3).

(2) Slide lamp and socket out of the bumper.

(3) Remove the bulb from the socket and install new bulb.

YJ

The left taillamp illuminates the license plate.

SJ

The license plate lamp is attached to the tailgate and is a sealed unit. The lamp is removed by removing the lamp attaching screws and disconnecting the wire harness.

FOG LAMPS

General

CAUTION: Remove the protective covers before operating fog lamps. Always replace protective covers when fog lamps are not in use.

Fog lamps are turned OFF by the circuit relay when the high beam driving lamps are turned ON.

Fog lamps may be operated ONLY when low beam headlamps are ON. If the headlamps are switched to high beam, the low beam lamps and fog lamps will turn OFF. The fog lamps will go back on when the high beams are switched OFF.

The indicator lamp on the fog lamp switch will go:

- OFF when the high beams are ON
- ON when the high beam lamps are switched OFF.

Aiming

(1) Position the vehicle on a flat surface, facing and approximately 7.5 meters (25 ft.) from the wall.

(2) Remove the lamp stone shields and/or covers.

(3) Loosen the lamp attaching hardware.

(4) Turn the headlamp and fog lamp switches on.

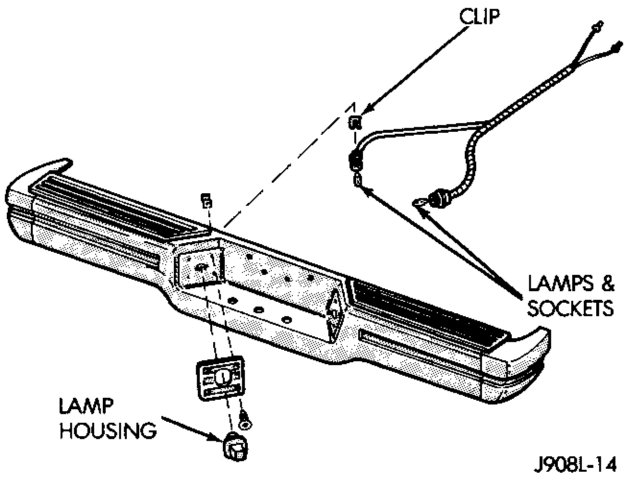


Fig. 3 License Plate Bulb and Housing — MJ

(5) Adjust the lamp beams on follows:

- The horizontal distance between the light beams on the wall should be the same size as the distance between the lamps on the front bumper.
- The vertical height of the light beams on the wall should be 10.2 cm (4 in.) less than the height of the lamps on the front bumper.

(6) Tighten the lamp attaching hardware.

(7) Install the lamp stone shields and/or covers.

Troubleshooting — Foglamps

XJ and MJ and SJ

1. FOG LAMPS—INOPERATIVE: Fog Lamp Relay unplugged, Light Switch in HEAD, Dimmer switch in LO, Fog lamp switch in ON

TEST	OK	NOT OK
Fog lamp relay connector terminal 2	Zero ohms	Repair open to ground
Fog lamp relay connector terminal 1	Battery voltage	Repair open to fuse link
Fog lamp relay connector terminal 5	Battery voltage	Repair open through Fog lamp switch to dimmer switch connector terminal 1
Jumper fused test leads across terminals 1 and 4 of fog lamp relay connector	Lamp lights If OK, replace relay	Repair open through Fog lamps to ground

YJ - One Lamp Out

LAMP: Headlamp switch in HEAD; dimmer switch in LO; fog lamp switch ON; lamp connector separated

TEST	OK	NOT OK
Measure resistance across bulb terminals	Zero ohms (except filament resistance)	Replace bulb
Measure voltage at battery side of lamp connector	Battery voltage	Repair open to battery side of wiring connector
Measure resistance from ground side of lamp connector to clean chassis ground	Zero ohms	Repair open to ground

YJ - Both Lamps Out

1. SWITCH/INDICATOR LAMP: Headlamp switch in HEAD; dimmer switch in LO; fog lamp switch ON (Headlamps operating)

TEST	OK	NOT OK
Measure voltage at fog lamp switch connector terminal B	Battery voltage	Repair open from dimmer switch
Measure voltage at fog lamp switch connector terminal C	Battery voltage	Replace switch
Measure voltage at fog lamp switch connector terminal B	Zero volts	Zero volts and indicator lamp off - replace switch Battery voltage - repair open to ground

2. Relay

TEST	OK	NOT OK
Measure voltage at Fog lamp relay connector terminal 3	Battery voltage	Repair open in wire from fuselink
Measure voltage at Fog lamp relay connector terminal 1	Battery voltage	Repair open from fog lamp switch
Measure voltage at Fog lamp relay connector terminal 2	Zero volts	Repair open to ground
Measure voltage at Fog lamp relay connector terminal 5	Battery voltage	Replace relay

Lamp Element Replacement

(1) Remove the lamp stone shields.

(2) Remove the screws attaching the bezel to the lamp body. Remove the bezel from the lamp body.

(3) Remove the lens and reflector assembly from the lamp body.

(4) Remove the bulb holder from the lens and reflector assembly.

(5) Remove the lamp element from the bulb holder.

CAUTION: Always handle new elements with a clean cloth. DO NOT handle quarts elements with your bare hands as body oil residue on the glass will cause the element to fail immediately after ignition.

(6) To install, reverse the removal procedure.

XJ and MJ Switch Replacement

The fog lamp switch is located to the left of the steering column.

(1) Remove four instrument panel bezel attaching screws and remove the instrument panel bezel (Fig. 1).

(2) Remove the switch cover.

(3) Disconnect the connector.

(4) Squeeze the tabs on the side of the switch and remove the switch.

(5) To install, reverse the removal procedure.

XJ and MJ Fog Lamp Replacement

(1) Remove the nut and washer from each side of the bracket (Fig. 2).

(2) Disconnect the electrical connector and remove the fog lamp.

(3) Reverse procedure to install.

YJ Switch Replacement

The fog lamp switch is located to the right of the steering column.

The circuit relay is located below the left headlamp.

(1) Disconnect battery negative cable.

(2) Remove five shroud screws (Fig. 3).

(3) Slide the shroud towards the steering wheel.

(4) Apply upward pressure to the shroud and downward pressure to the indicator panel. This will release the holding tabs (Fig. 4).

(5) Remove instrumentation shroud.

(6) Remove two fog lamp switch attaching screws.

(7) Remove the fog lamp switch connector.

(8) Reverse the removal procedures for installation of the switch.

(9) Place the shroud under the steering column.

(10) Slide the indicator panel tabs into the shroud notches.

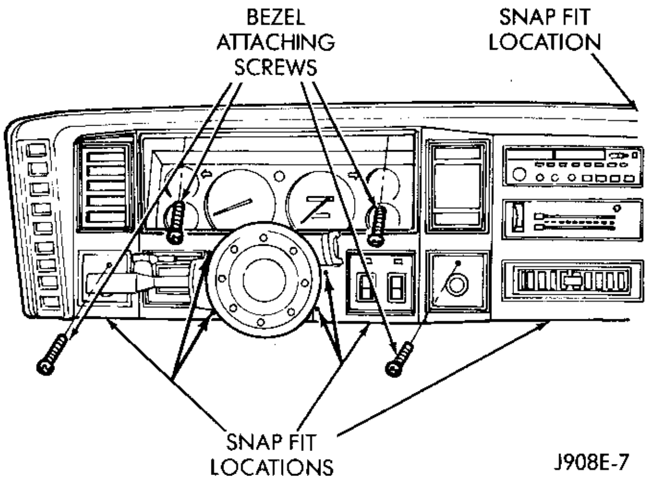


Fig. 1 Instrument Panel Bezel Removal/Installation

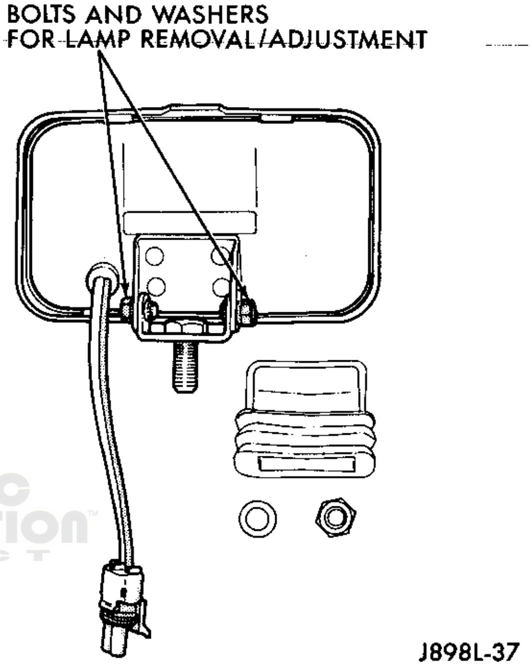


Fig. 2 Fog Lamp Removal — XJ and MJ

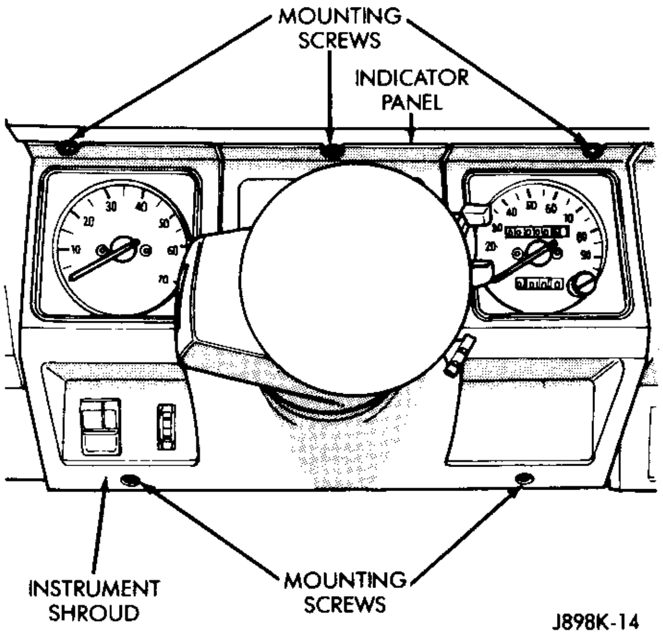


Fig. 3 Instrument Shroud Removal/Installation

(11) Place the assembled shroud over the indicator lamp foam gasket and tighten the indicator screw.

A fragile foam gasket is on the back of the indicator overlay. If the gasket is torn or distorted, replace with a new gasket.

(12) Install the remaining four screws.

YJ Fog Lamp Replacement

(1) Remove bolt(s), nut and washer(s) holding fog lamp to bracket (Figs. 5,6).

(2) Disconnect electrical connector and remove fog lamp.

(3) Reverse procedure to install.

SJ Switch Replacement

(1) Disconnect the switch wires.

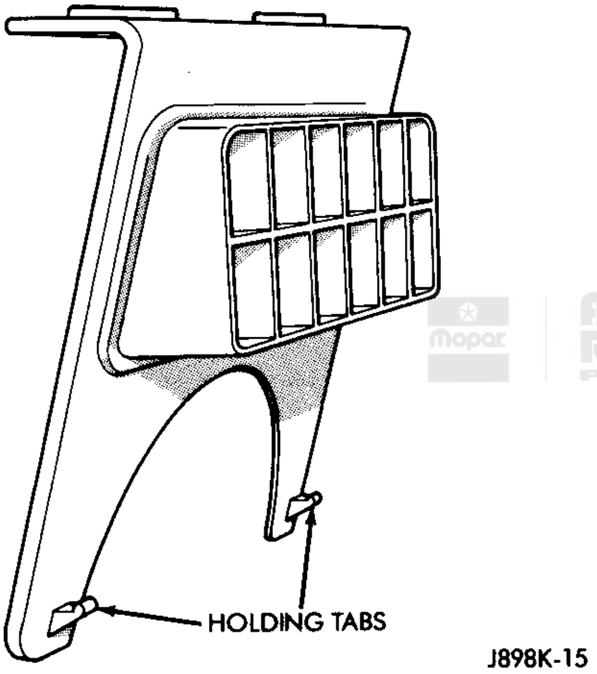


Fig. 4 Indicator Panel Holding Tabs

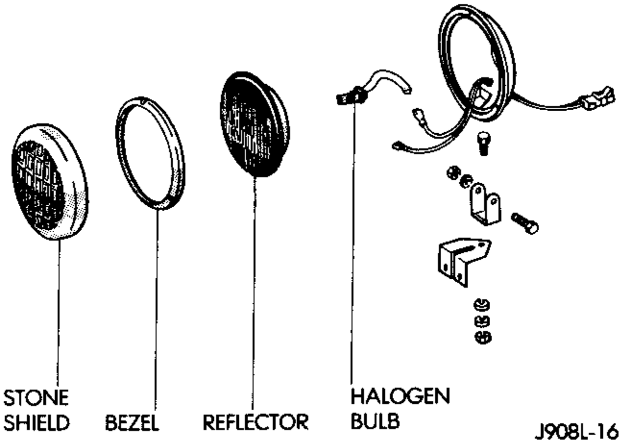


Fig. 5 Round Fog Lamp Removal — YJ

(2) Compress the spring clips at top and bottom of the switch to release it from the steering column cover.

(3) Remove the switch.

(4) To install, push the switch inward until it snaps into place.

SJ Fog Lamp Replacement

(1) Remove the nut and washer from each side of the bracket (Fig. 7).

(2) Disconnect the electrical connector and remove the fog lamp.

(3) Reverse procedure to install.

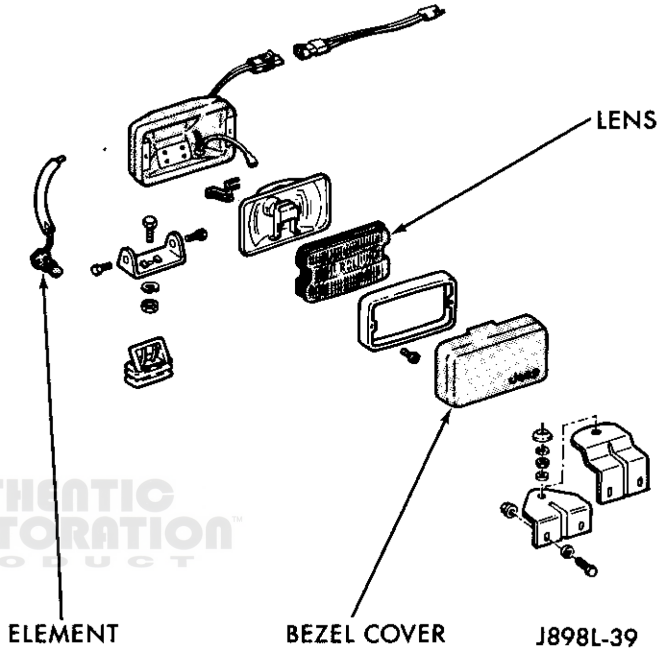


Fig. 6 Rectangular Fog Lamp Removal — YJ

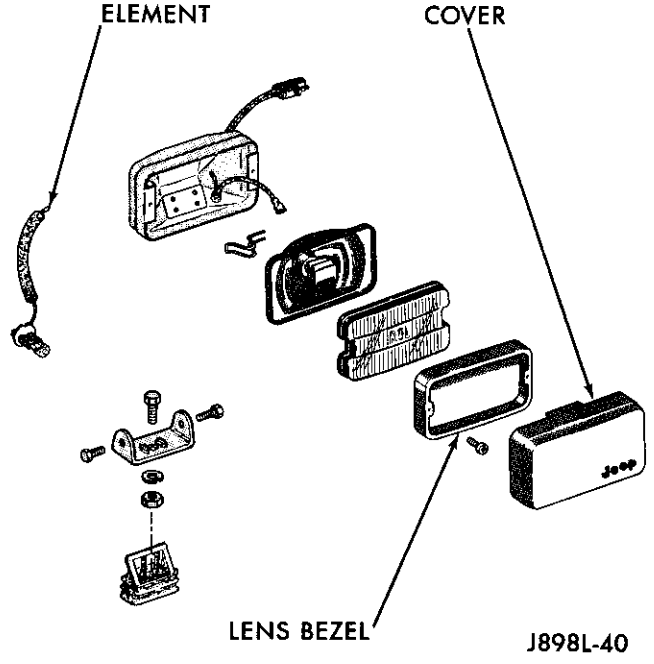


Fig. 7 Fog Lamp Removal — SJ

SENTINEL HEADLAMP - XJ AND MJ

The Sentinel Headlamp Module delays the shut-off of the headlamps for 45±15 seconds after the ignition is turned off. The driver activates the module by turning the ignition OFF, then turning the headlamps OFF.

Replacement

The Headlamp Delay Module is attached to the inner instrument panel to the right of the headlamp switch. Remove the lower trim panel.

(1) Remove the attaching screw and disconnect the module from the wiring harness.

(2) Reverse the procedure to install.

Troubleshooting — Sentinel Headlamp

When the module loses voltage at the IGN OFF signal (from Gauges Fuse) and then at the lights ON signal, it activates the relay, pulling the contact closed. Current flows from the hd lp/dly fuse through the headlamp delay module, the dimmer switch and the RH and LH headlamps. After 45 seconds, the headlamp delay module de-activates and the headlamps turn OFF.

1. POWER INPUT AND GROUND: Remove and inspect fuse

TEST	OK	NOT OK
HD LP fuse	Not blown	Replace fuse
Side of cigar lighter socket to ground	Zero ohms	Repair open to ground

2. HEADLAMP DELAY MODULE: Remove module, Ignition in RUN, Light Switch in HEAD, Ignition OFF for resistance test

TEST	OK	NOT OK
Check resistance at headlamp delay module terminal 4	Zero ohms	Repair open to ground
Headlamp delay module terminal 8	Battery voltage	Repair open to instrument cluster indicator connector terminal 14
Headlamp delay module terminal 6	Battery voltage	Repair open to headlight switch
Headlamp delay module terminal 2	Battery voltage	Repair open to fuse

UNDERHOOD LAMP

XJ and MJ (Fig. 1)

Replacement

(1) Remove the lamp assembly attaching screws and the ground wire connection (Fig. 2).

(2) Disconnect the lamp connector.

(3) To install the lamp assembly, reverse the removal procedures.

Bulb Replacement

(1) Remove the lens cover and remove the bulb.

(2) Install the replacement bulb and install the lens cover.

The replacement bulb is trade # 90.

YJ

Description

This optional lamp begins at the hazard flasher battery terminal and extends into the engine compartment. At approximately the center of the dash panel, the wire extends from the wiring harness and joins the lamp connector.

The lamp assembly has a mercury switch which completes the circuit through the hood assembly when the hood is open. When the hood is closed, the mercury within the lamp assembly opens the circuit and the lamp does not light.

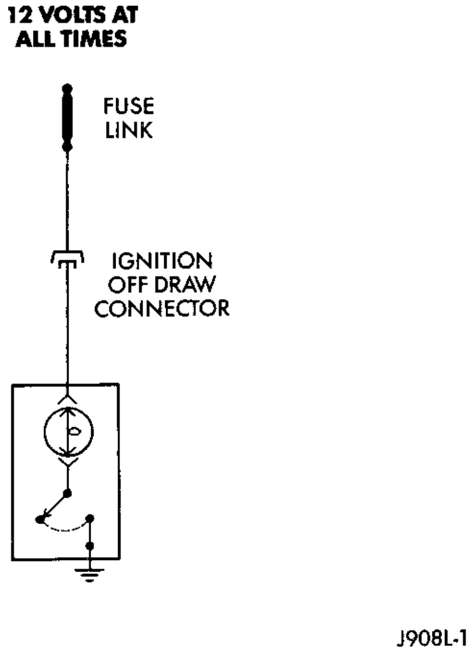


Fig. 1 Underhood Lamp — XJ and MJ

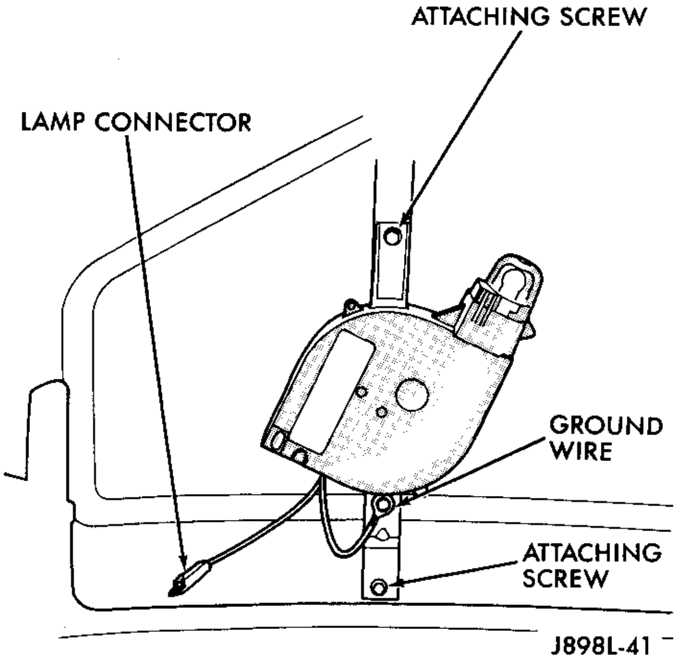


Fig. 2 Underhood Lamp Removal/Installation

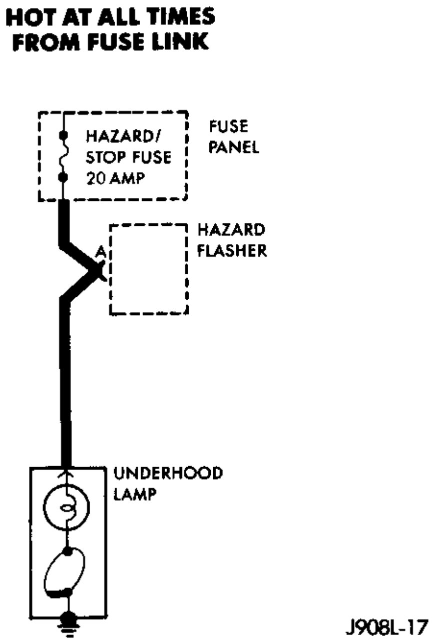


Fig. 3 Underhood Lamp — YJ

Troubleshooting — Underhood Lamp (Fig. 3)

1. FUSE

TEST	OK	NOT OK
Check operation of hazard lamps	Hazard lamps on	Check Hazard/Stop fuse

2. LAMP

TEST	OK	NOT OK
Measure resistance across bulb terminals	Zero ohms (except filament resistance)	Replace bulb If bulb is good, replace underhood lamp housing

3. BATTERY FEED

TEST	OK	NOT OK
Measure voltage at underhood lamp connector	Battery voltage	Repair open from hazard flasher

SJ

The engine compartment lamp obtains current at the battery terminal of the starter solenoid. A single wire incorporating a fusible link for protection passes current to the lamp assembly. The lamp assembly has a mercury switch which completes the circuit through the hood assembly when the hood is open. When the hood is closed, the mercury within the lamp assembly opens the circuit and the lamp does not light (Fig. 4).

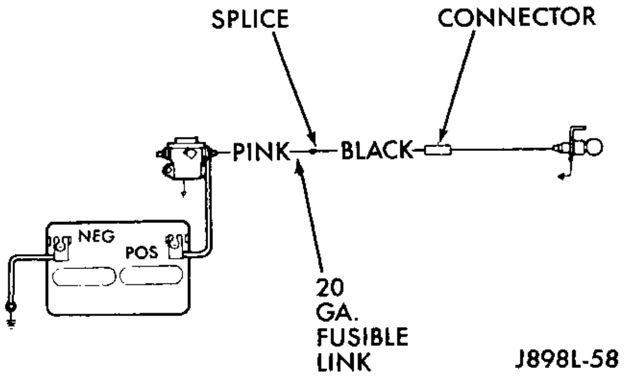
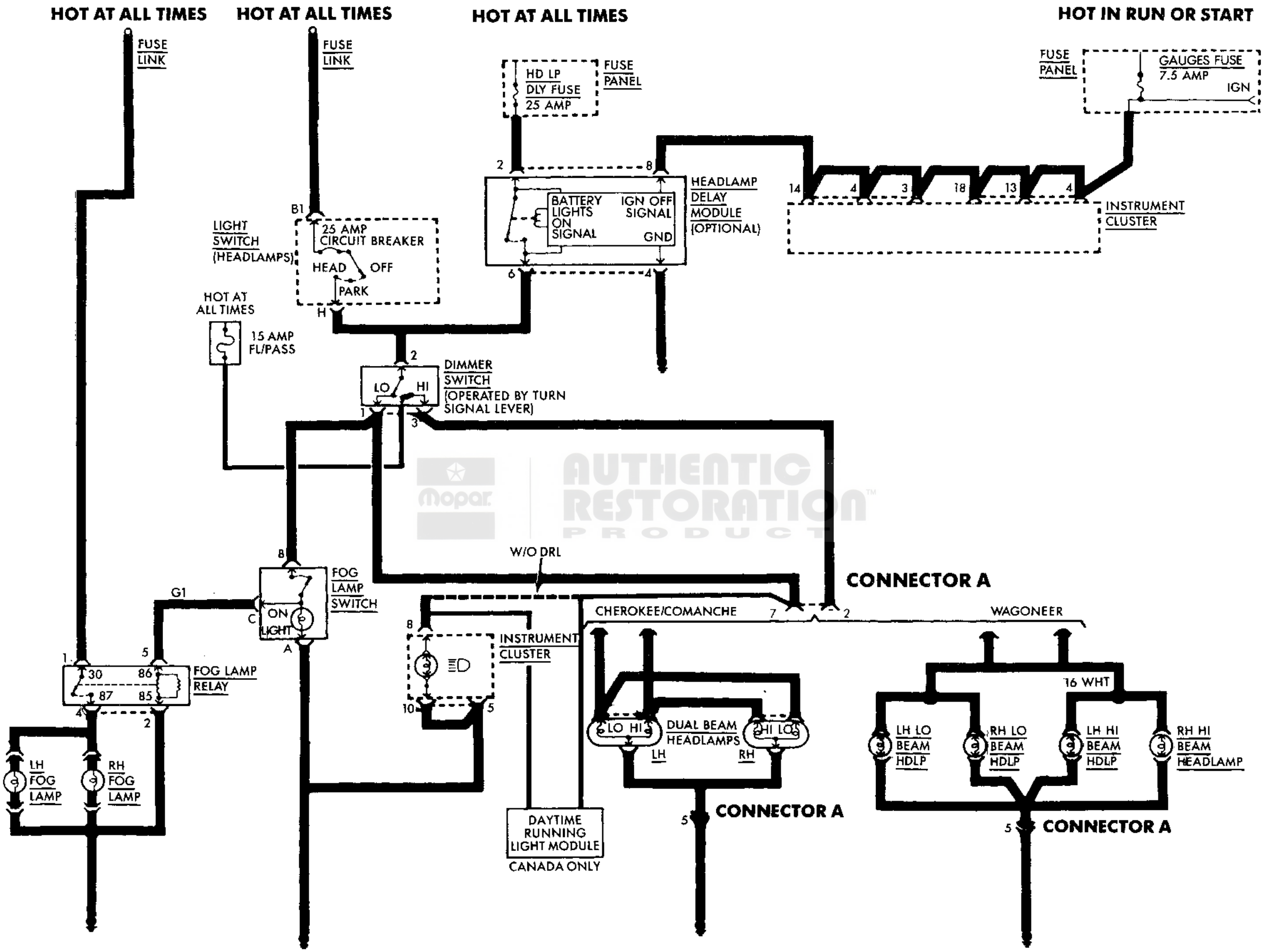


Fig. 4 Engine Compartment Light - SJ

WIRING DIAGRAMS

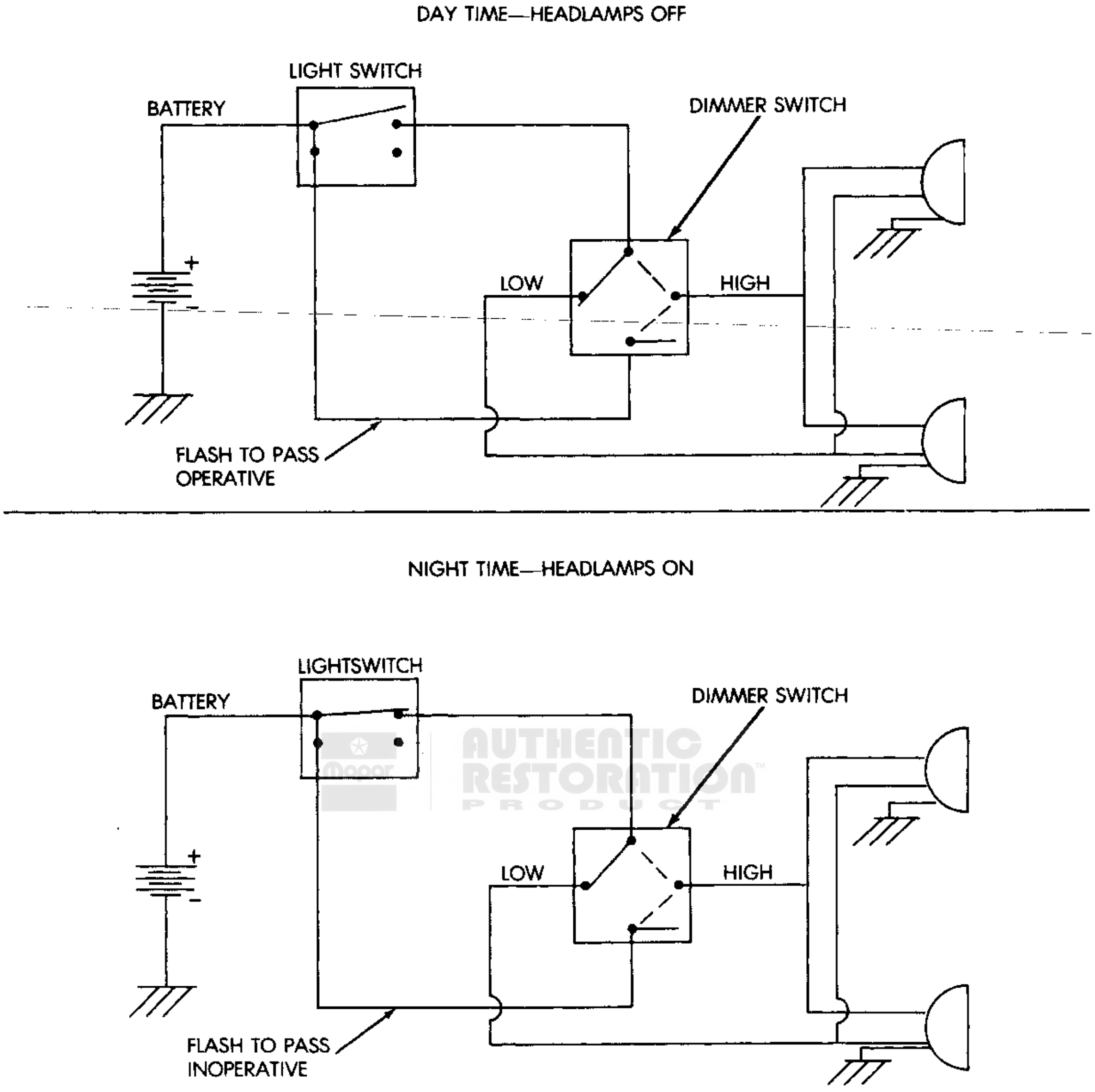
INDEX



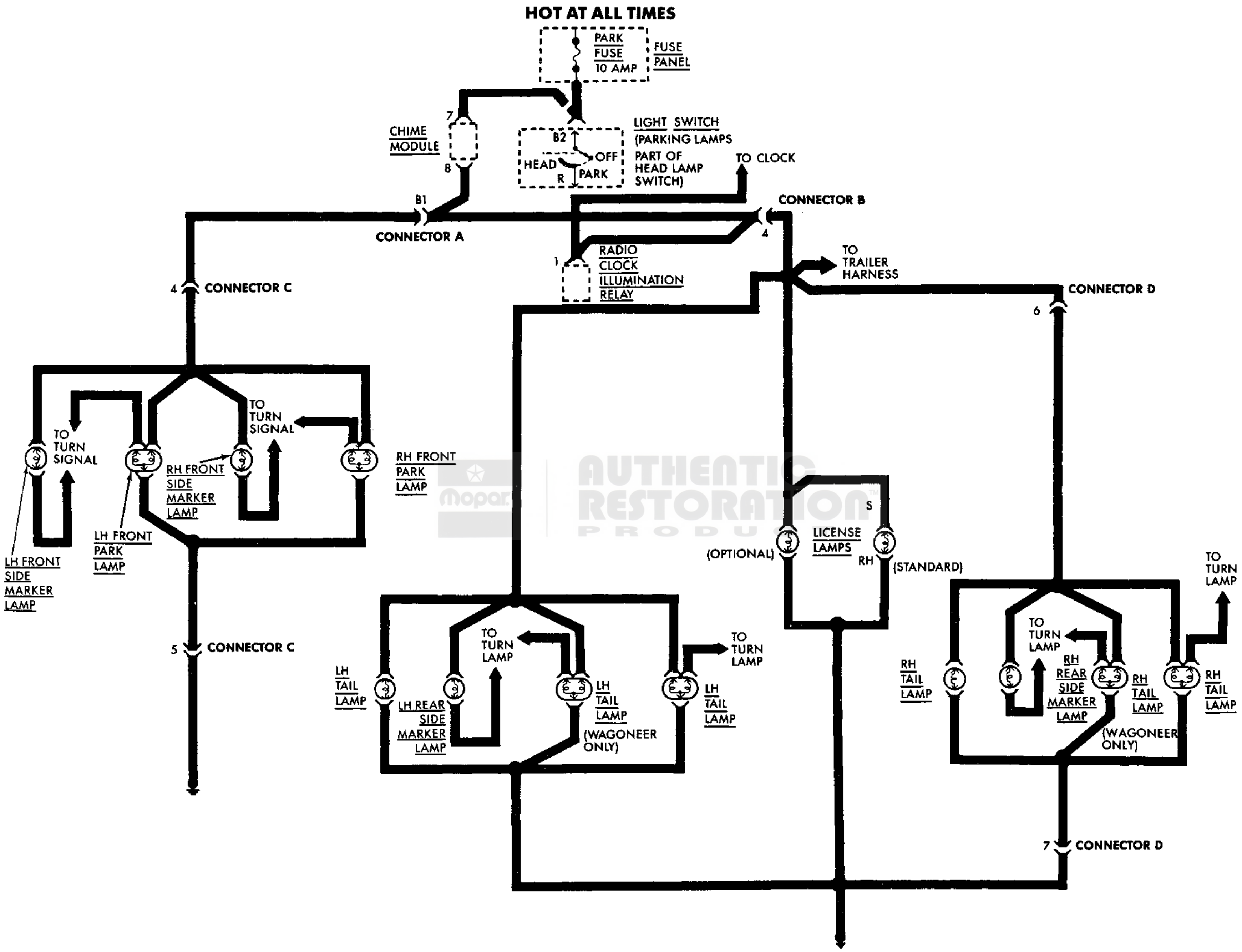
Headlamps and Fog Lamps — XJ and MJ

J908L-21

Flash To Pass

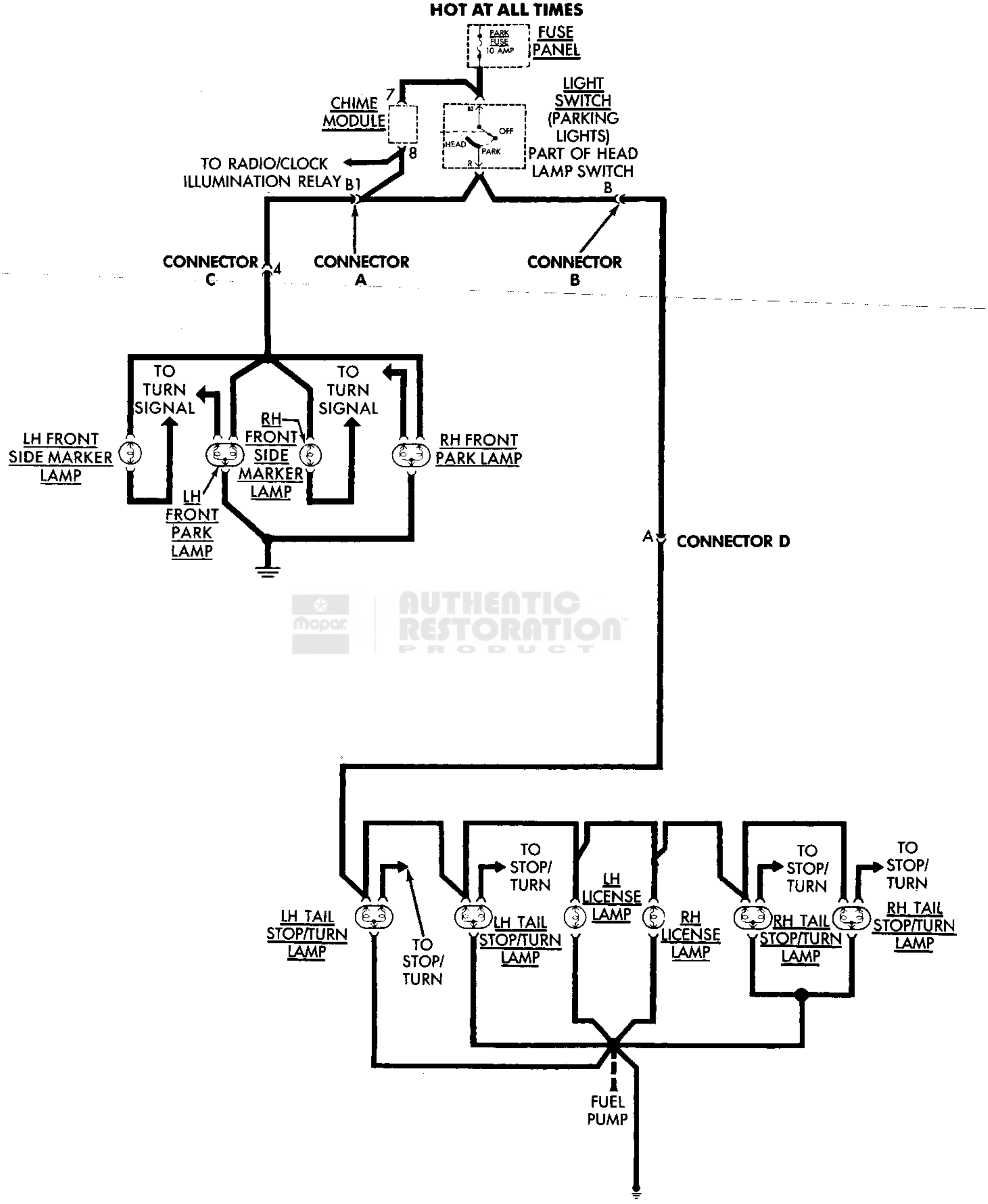


J908L-31



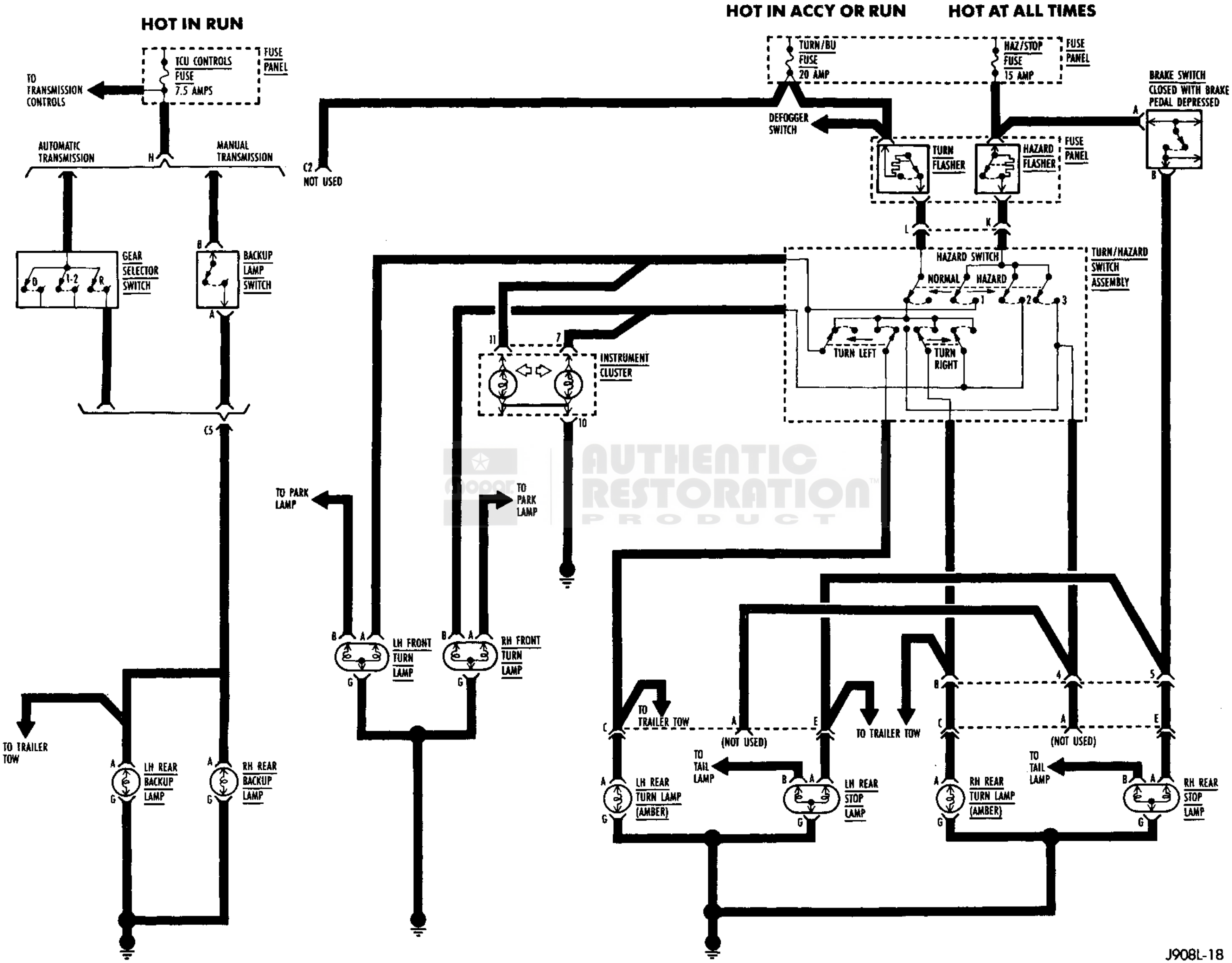
J908L-20

Side Marker/Park/Tail/License — XJ



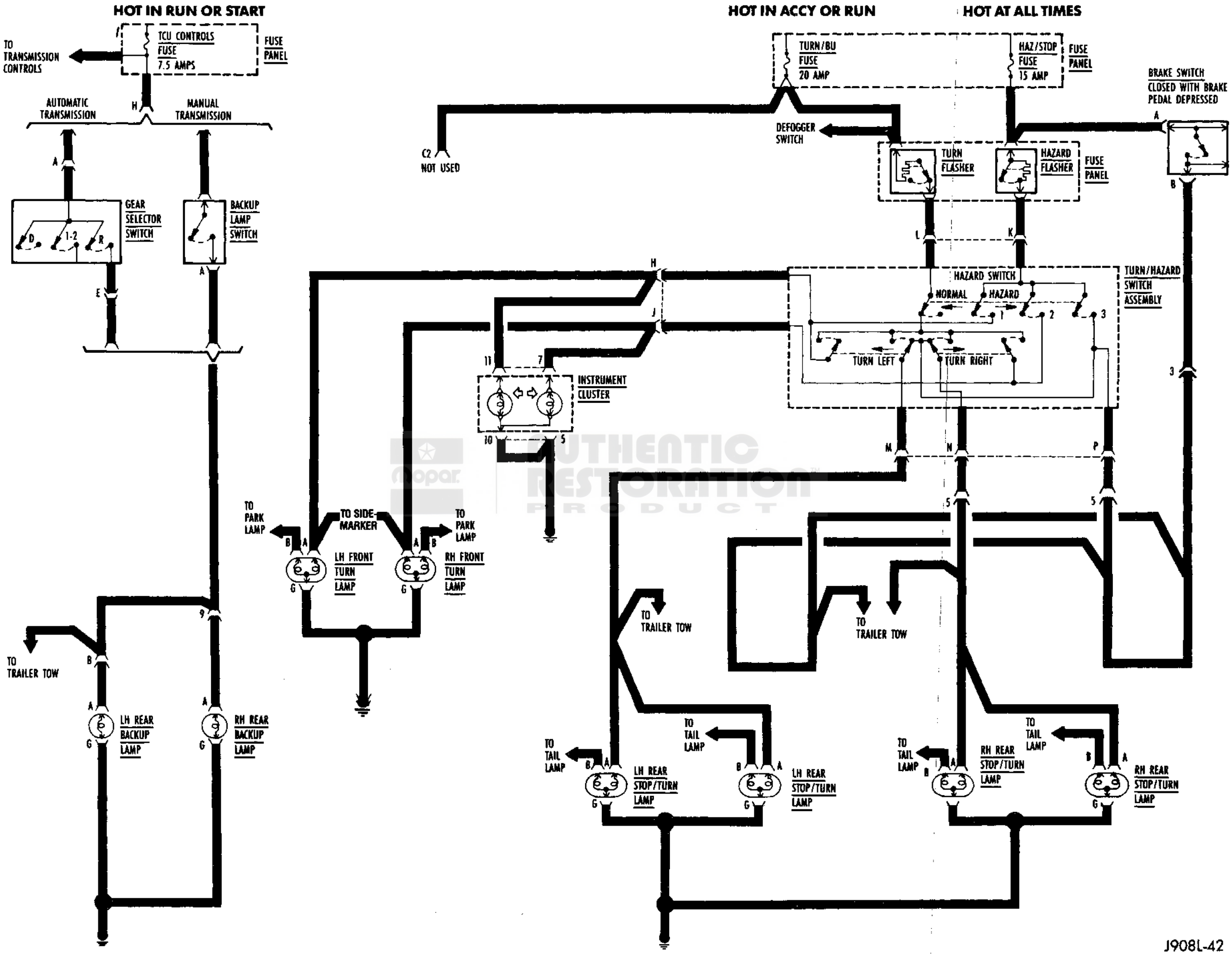
J908L-19

Side Marker/Park/Tail/License — MJ



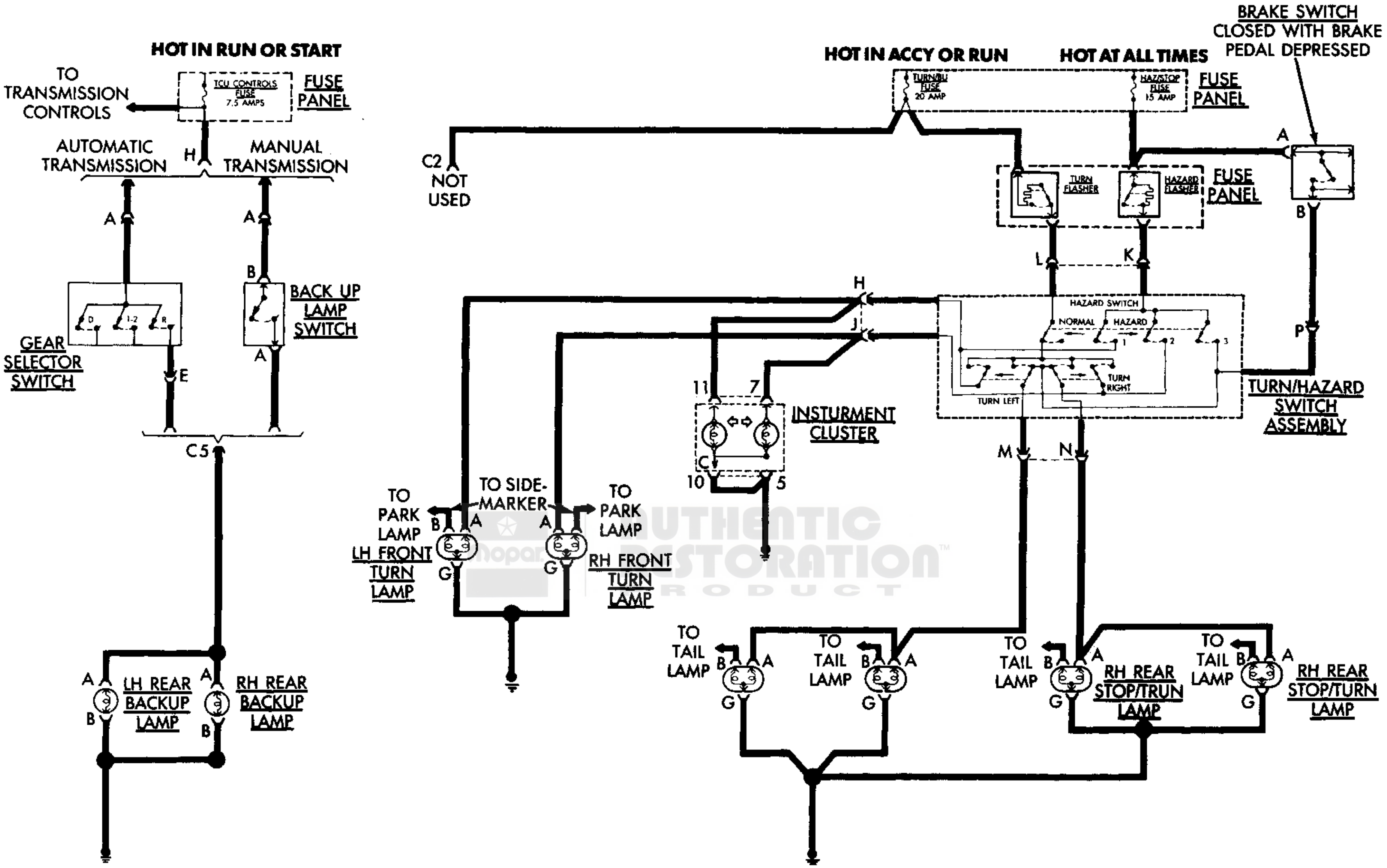
J908L-18

Turn/Stop/Backup — Cherokee



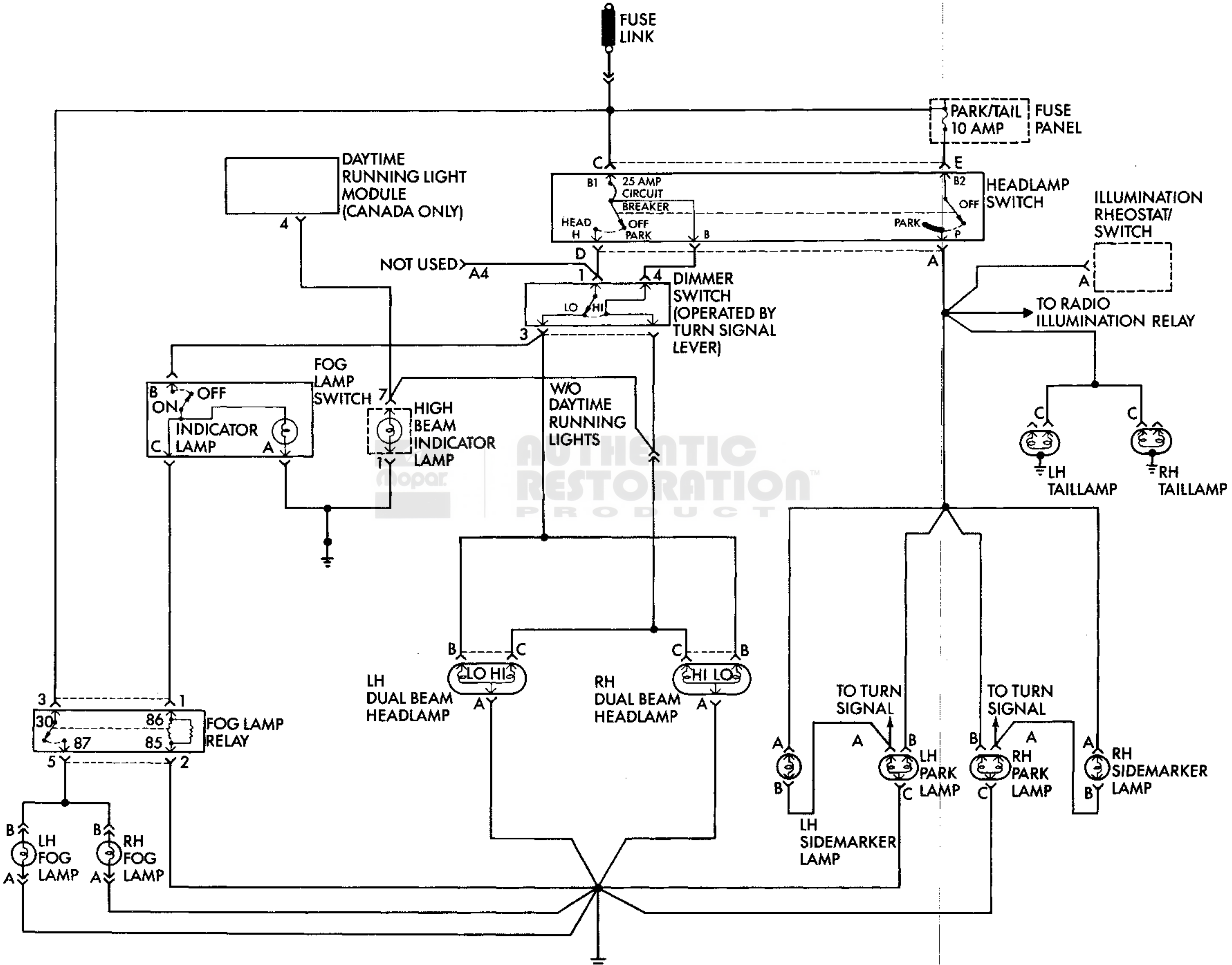
J908L-42

Turn/Stop/Backup — Wagoneer

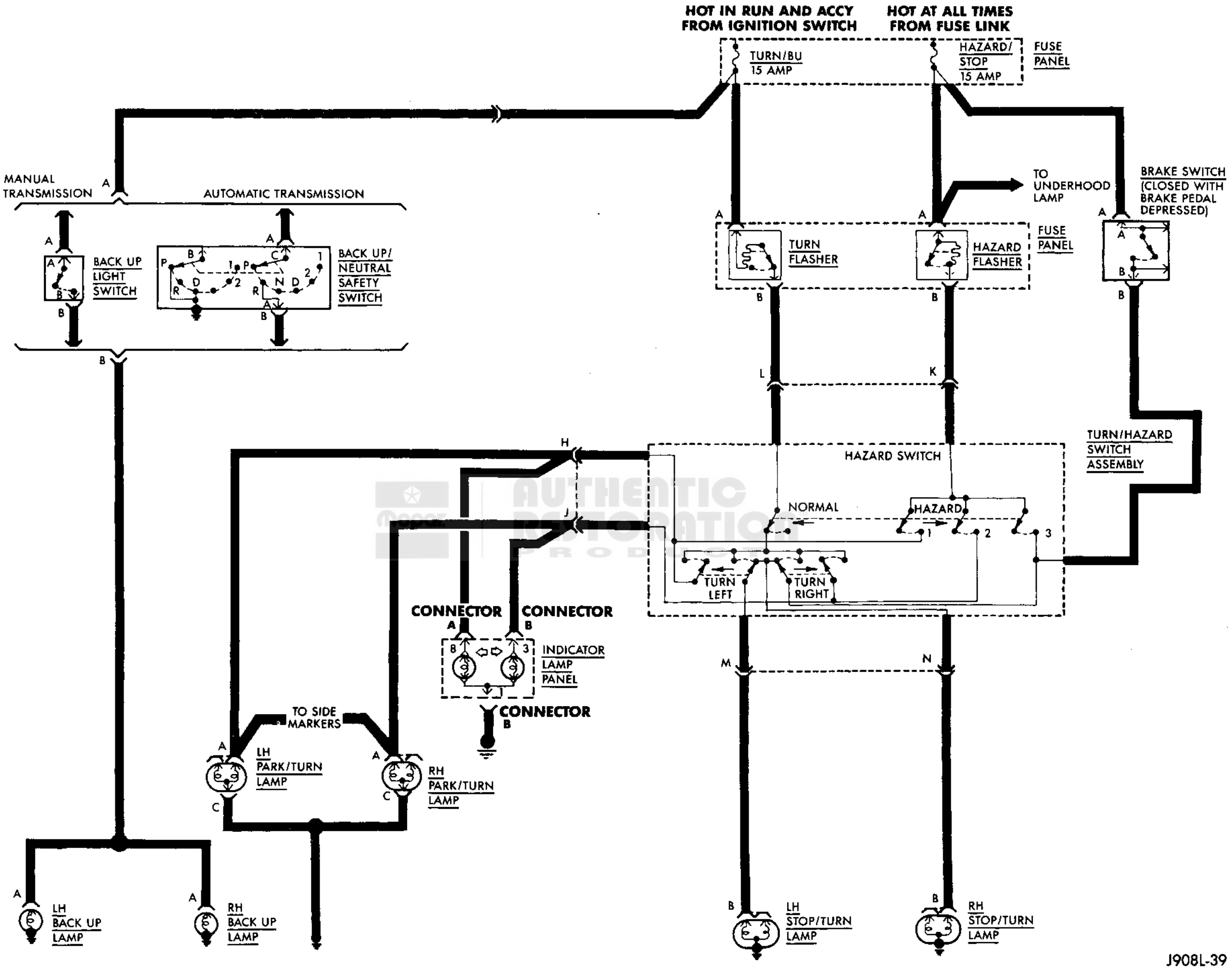


J908L-41

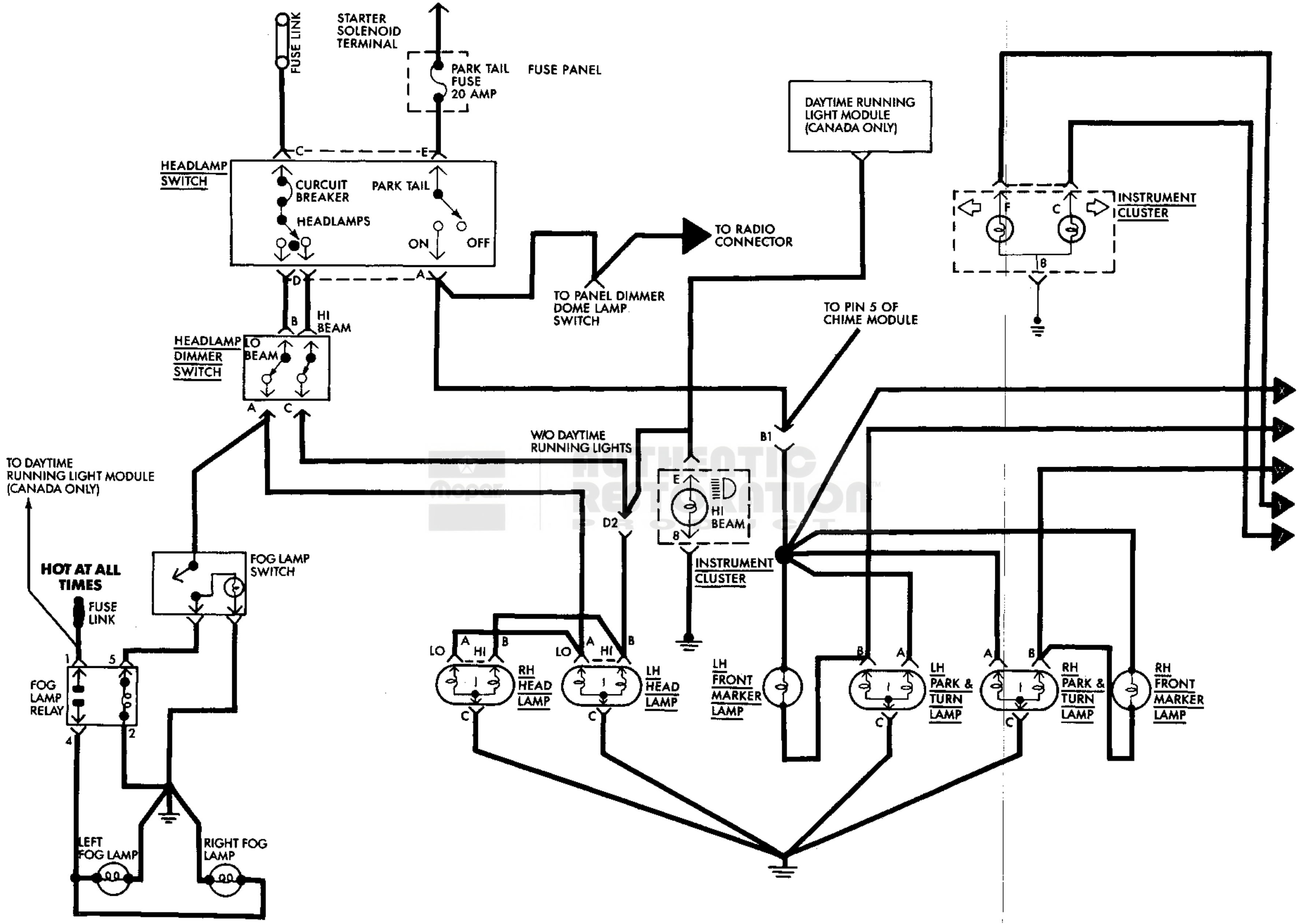
Turn/Stop/Backup — MJ



Head/Tail/Side Marker/Fog/Park — YJ

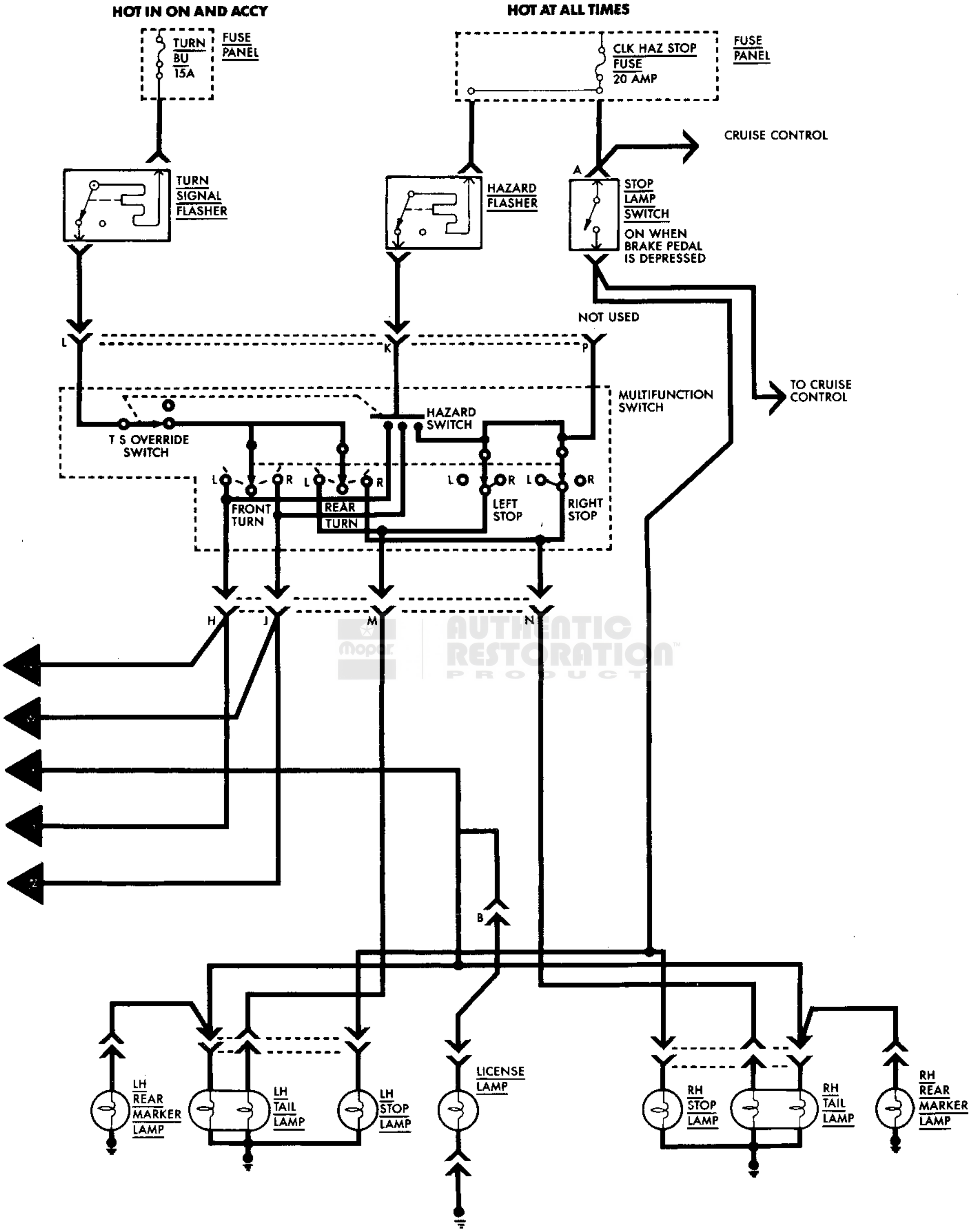


Turn Signal/Stop/Hazard/Backup — YJ



Head/Front Park/Turn Lamps — SJ

J908L-37



J908L-38

Rear Lamps — SJ

SPECIFICATIONS

XJ

Exterior Lighting	Bulb Type
Backup Lamps (2)	1156
Front Park/Turn Lamps (2)	2057NA
Front Side Marker Lamps (2)	194
Cherokee Headlights (2)	H 6052
Wagoneer Headlights	
Low Beam (2)	H4703
High Beam (2)	H4701
Rear License Plate Lamp	168
(w/Outside Spare)	67
Stop/Tail Lamps (2)	2057
Side Reflector Lamps (2)	97
Turn Signal Lamps (2)	1156
Underhood Lamp	90
Underhood Retractable Lamp	105

J898L-1

YJ

Exterior Lighting	Lamp Type
Back Up Lamps (2)	1156
Front Park/Turn Lamps (2)	2057 NA*
Front Side Marker Lamps (2)	194
Headlights (2)	H 6054
Stop/Tail/Turn Lamps (2)	1157
Underhood Lamp	90

*NA = Natural Amber

J898L-2

MJ

Exterior Lamps	Bulb Type
Backup Lamps (2)	1156
Front Park/Turn Lamps (2)	2057NA
Front Side Marker Lamps (2)	194
Headlights (2)	H 6052
Rear License Plate Lamp	67
W/Rear Step Bumper	194
Stop/Tail Lamps (2)	2057
Side Reflector Lamps (2)	97
Turn Signal Lamps (2)	1156
Underhood Lamp	90
Underhood Retractable Lamp	105

J898L-51

SJ

Exterior Lighting	Number of Bulbs / Bulb Trade Number
Backup Lights	2/1156
Front Parking and Turn Signal Lights	2/1157
Front Side Marker	2/194
Headlights	2/H6052
Rear License Plate Wagoneer Replace as a Unit	P/N J3670544
Rear Side Marker	2/194
Stop - Tail - Turn Signal	2/1157
Tail Lamp	2/1156
Engine Compartment Lamp	1/105 (GE Only)

J898L-3

INTERIOR LAMPS

INDEX

DOME - READING LAMP

Troubleshooting — XJ and MJ Interior Lamps (Figs. 1,2)

Voltage is applied at all times through the dome fuse to each of the interior lamps. The courtesy, cargo, glove box and dome lamps operate when they are connected to ground through the headlamp switch, any door jamb switch, or the liftgate switch (if the cargo lamp is on.)

1. INTERIOR LAMPS: ALL LAMPS INOPERATIVE; Remove and inspect fuses

TEST	OK	NOT OK
Dome fuse	Not blown	Replace fuse
Turn light switch on by rotating headlamp switch	Lamps light	Repair open to ground

2. INTERIOR LAMPS: ONE LAMP OUT; Lamp

TEST	OK	NOT OK
Across bulb terminals	Almost zero ohms (bulb filament)	Replace bulb
Battery side of bulb socket	Battery voltage	Repair open to splice

3. INTERIOR LAMPS: INOPERATIVE WITH ONE OR MORE DOORS OPENED; Door Jamb Switches

TEST	OK	NOT OK
Remove switch in door that is inoperative and ground switch lead	Lamps light, replace switch	Repair open in BLK w/TR wire

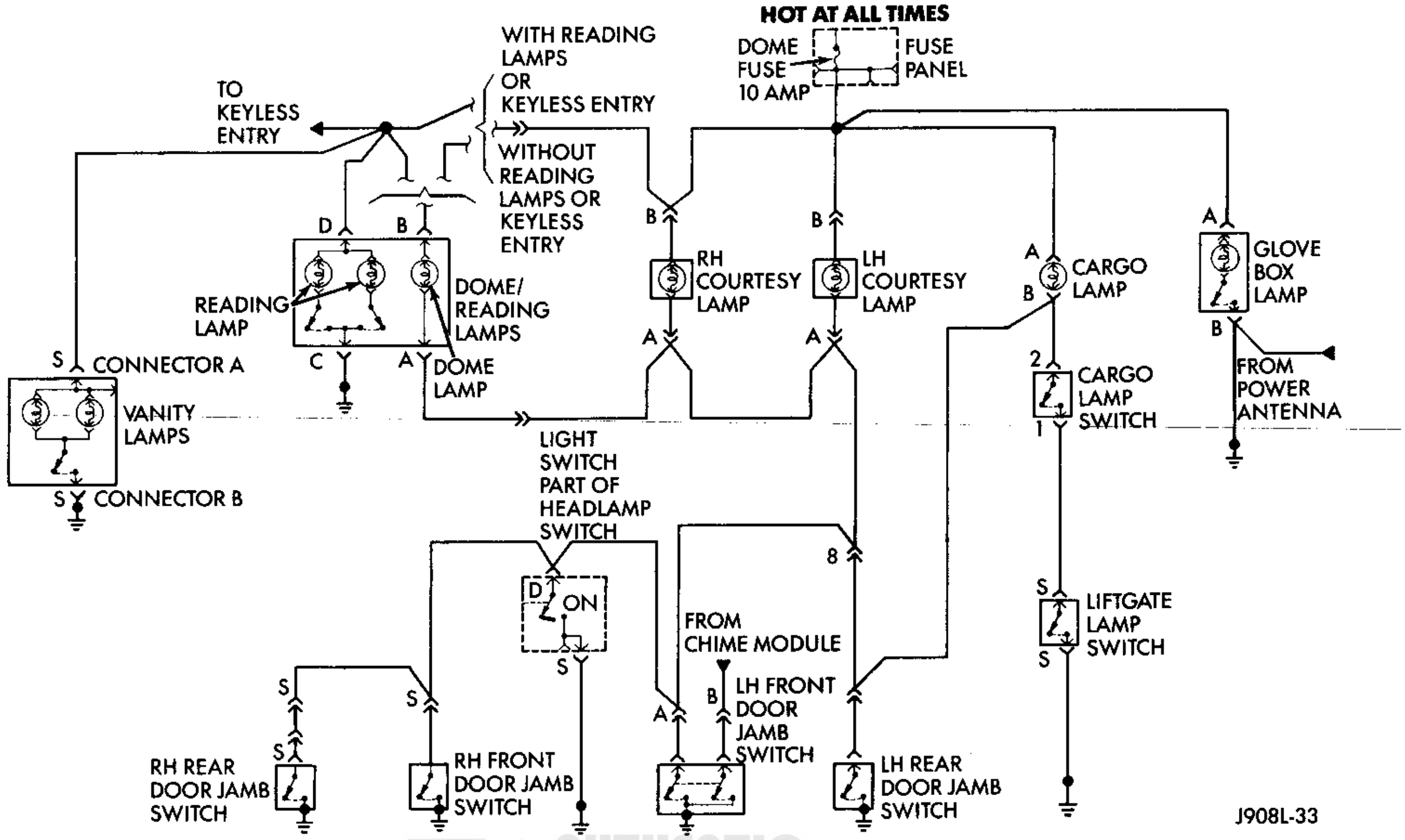


Fig. 1 Interior Lamp Wiring Schematic — XJ

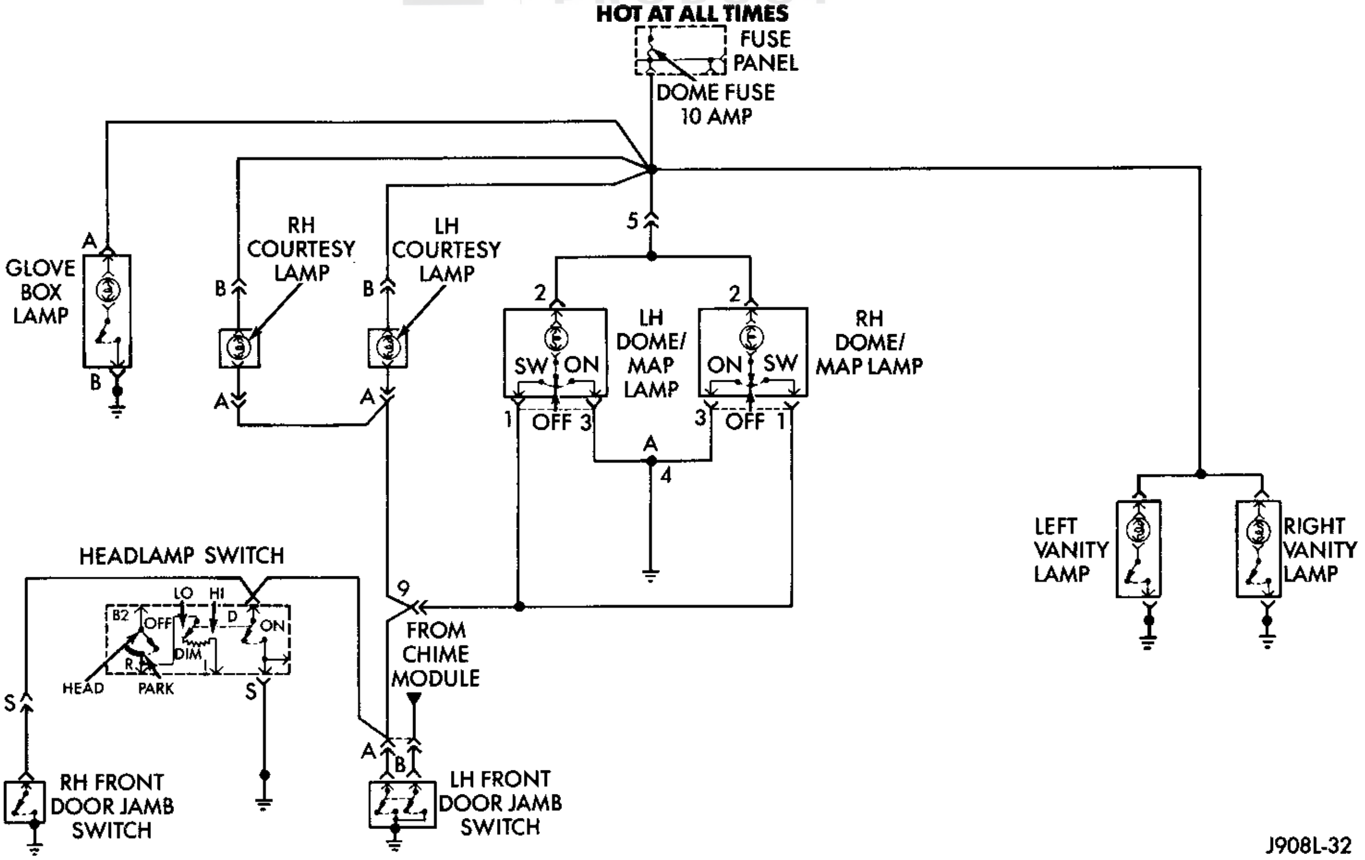


Fig. 2 Interior Lamp Wiring Schematic — MJ

XJ

(1) Remove the dome lamp lens by squeezing it on both sides. This will release the lens retaining clips.

(2) Pull the lens downward to remove.

(3) Remove the housing retaining clips (Fig. 3).

(4) Disconnect the wire harness connector.

(5) Remove the dome lamp assembly.

(6) To install the dome lamp assembly, reverse the removal procedures.

MJ

(1) Insert a thin blade tool under the edge of the interior lamp assembly and pry outward to detach the retaining clips from the side trim panel (Fig. 4).

(2) Pull the lamp assembly outward for access to the wire connectors.

(3) Disconnect the wire connectors.

(4) Remove the interior lamp assembly.

(5) To install the interior lamp assembly, reverse the removal procedures.

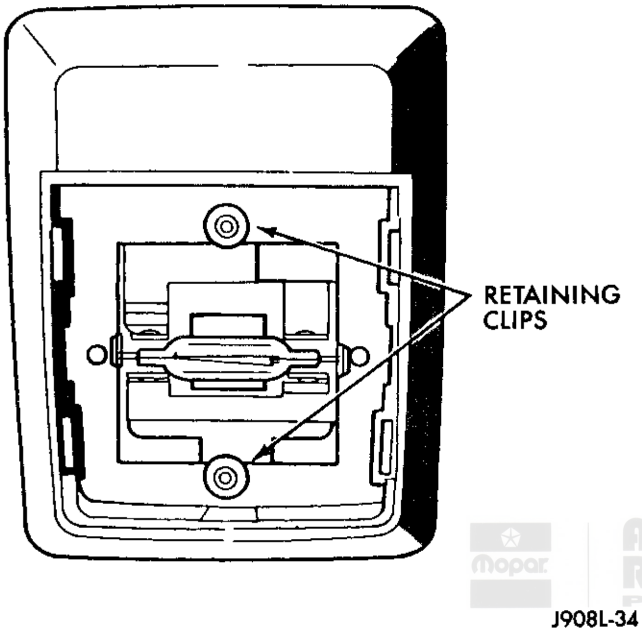


Fig. 3 Dome Lamp Removal/Installation — XJ

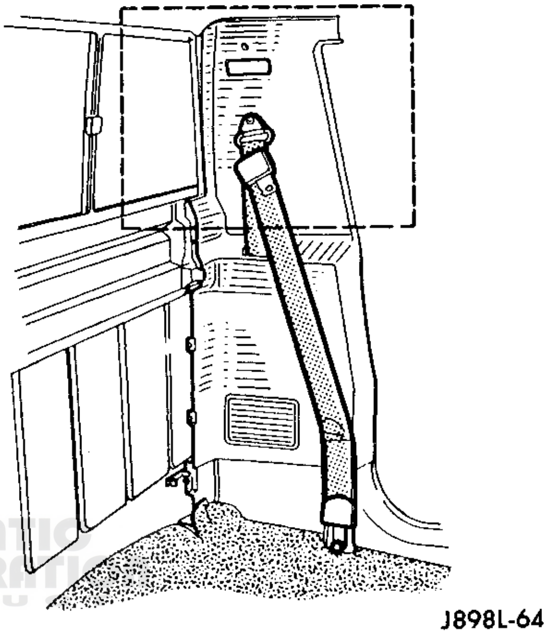


Fig. 4 Interior Lamp Removal/Installation — MJ

Troubleshooting Interior Lamps - YJ

Troubleshooting—One Lamp Out

LAMP: Lamp connector separated

TEST	OK	NOT OK
Measure resistance across bulb terminals	Zero ohms (except filament resistance)	Replace bulb
Measure voltage at battery side of lamp connector	Battery voltage	Repair open from fuse
Measure resistance from ground side of bulb terminal to a clean chassis ground	Zero ohms	Repair open from bulb socket to RH door jamb switch

Troubleshooting—All Lamps Out

1. FUSE

TEST	OK	NOT OK
Inspect DOME/COURTESY fuse	Not blown	Replace fuse
Measure voltage at battery side of DOME/ COURTESY fuse	Battery voltage	Repair open from fuse link

2. ILLUMINATION RHEOSTAT/SWITCH: Switch rotated to ON position; illumination switch connector separated from switch

TEST	OK	NOT OK
Measure resistance from illumination rheostat/switch terminals C to B	Zero ohms	Replace illumination rheostat/switch
Measure resistance from illumination switch connector terminal B to a clean chassis ground	Zero ohms	Repair open from illumination switch connector to ground

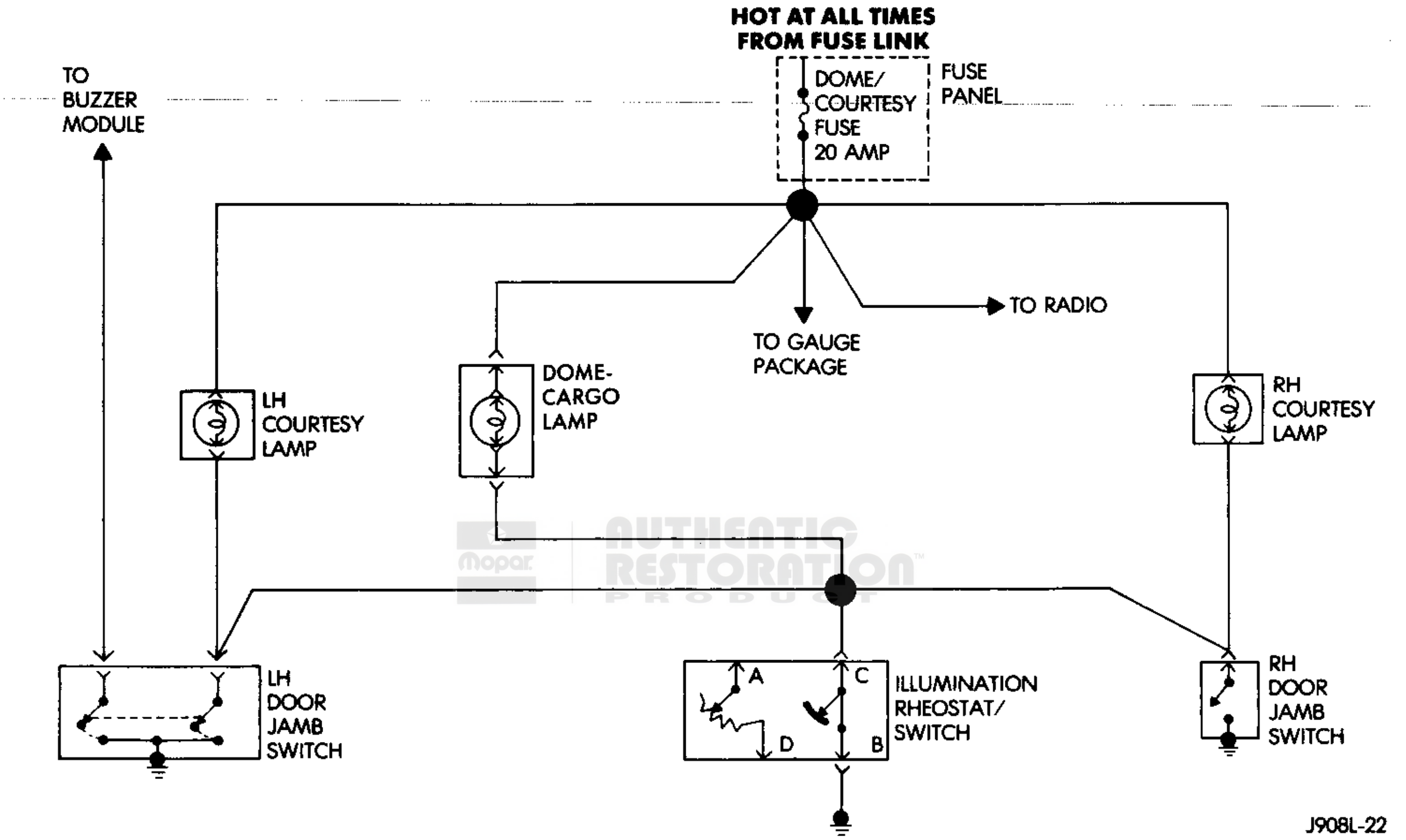


Fig. 5 Cargo/Courtesy Lamps Wiring Schematic — YJ

YJ Hardtop Dome-Cargo Lamp

(1) Remove the dome-cargo lamp lens by squeezing the sides of the lens. This will disengage the retaining tabs (Fig. 6).

(2) Pull the bulb straight out to remove.

(3) To install, reverse the removal procedure.

YJ Dome/Cargo/Courtesy Lamps (Fig. 6)

The dome/cargo and courtesy lamps are a switched ground circuit. Power feed from the dome/courtesy fuse goes directly to the lamps without passing through an ON/OFF switch. The switches are on the ground side of the circuit. When either door is opened, the door jamb switch closes and completes a path to ground.

The cargo and courtesy lamps can also be turned on at the illumination rheostat/switch.

The switch detent at the end of the maximum brightness setting also completes a path to ground for the cargo and courtesy lamps.

SJ

Cargo Lamp

(1) Remove the dome lamp lens by squeezing it on both sides. This will release the lens retaining clips.

(2) Pull the lens downward to remove.

(3) Remove the housing retaining clips (Fig. 7).

(4) Disconnect the wire harness connector.

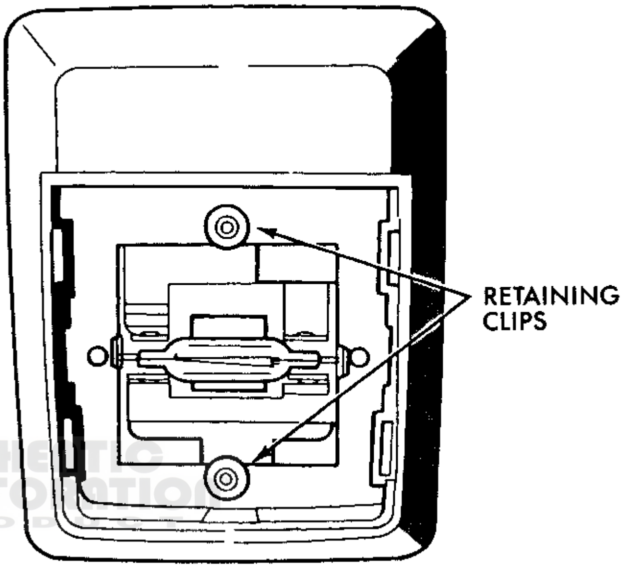
(5) Remove the dome lamp assembly.

(6) To install the dome lamp assembly, reverse the removal procedures.

Dome/Reading Lamp W/O Overhead Console

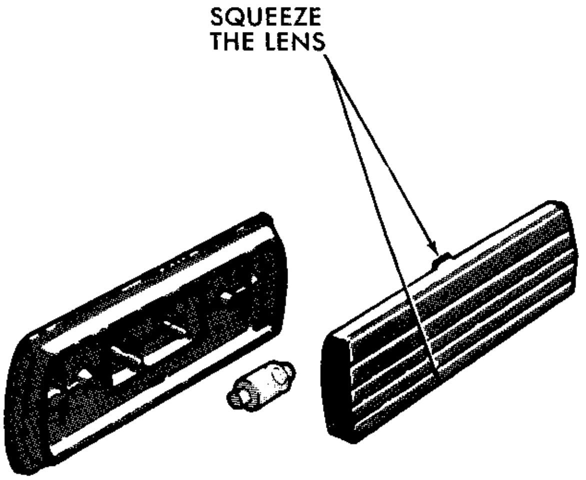
To remove the dome lamp bulb, squeeze the dome lamp lens to disengage the retaining tabs. Pull the bulbs straight out (Fig. 8).

To remove the reading lamp bulbs, remove the dome lamp lens and the housing attaching screws. Lower the housing and base assembly. Push the plastic tabs located on both sides of the dome lamp bulb toward the center of the assembly to remove the housing from the base. The reading lamp bulbs are removed by pushing the bulbs in and rotating the bulbs counterclockwise.



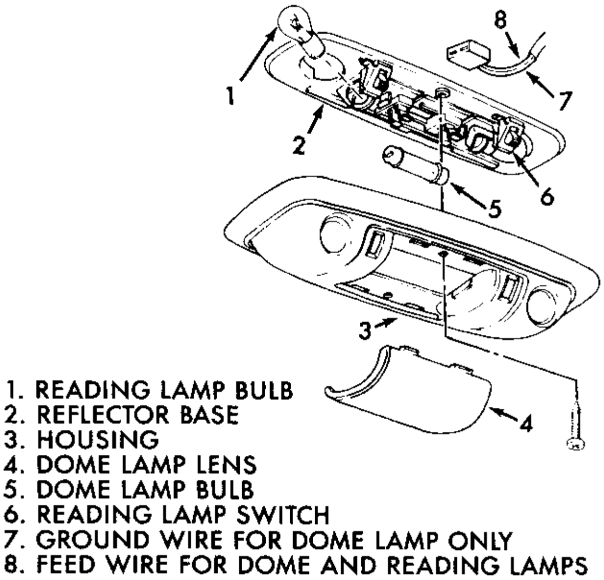
J908L-34

Fig. 7 Cargo Lamp Removal/Installation — SJ



J898L-57

Fig. 6 Dome Lamp — YJ



J898L-60

Fig. 8 Dome/Reading Lamp Removal/Installation

OVERHEAD CONSOLE

(1) With a large paper clip or wire (approximately 0.06 in. diameter) make a hook in the end. Insert into the hole in the lens and pull downward (Fig. 9).

(2) Insert tab on front of lens into hole shown in arrow 1 (Fig. 10).

(3) Push rear of lens upwards until lens snaps into place shown with arrow 2.

LIGHTED VANITY MIRROR

The lighted vanity mirror is attached to the driver and passenger sun visor. It has one lamp assembly mounted at each end of the vanity mirror. The lamps are switched on automatically when the mirror cover is lifted (Fig. 11).

Voltage is applied to the vanity lamps from the dome fuse. The vanity lamps operate when they are connected to ground through the vanity lamp switch.

Refer to Dome Lamp for schematic.

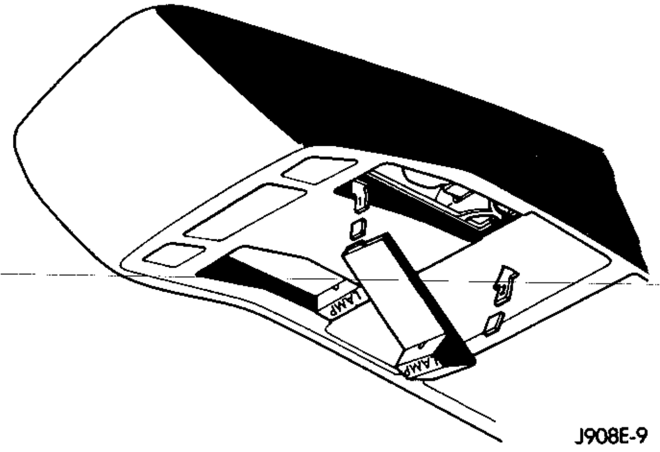


Fig. 10 Map Lens Installation

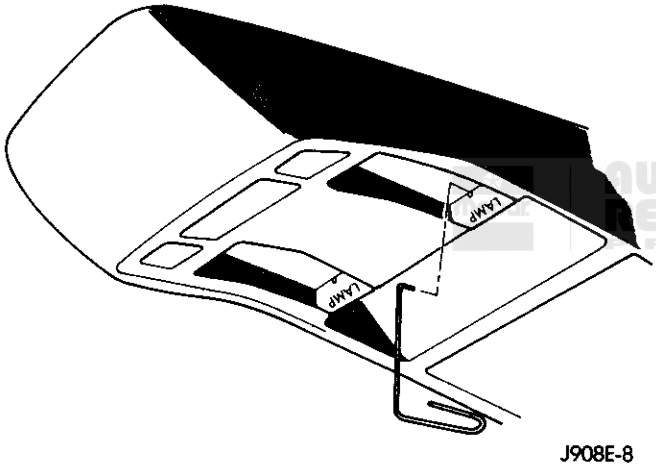


Fig. 9 Map Lamp Lens Removal

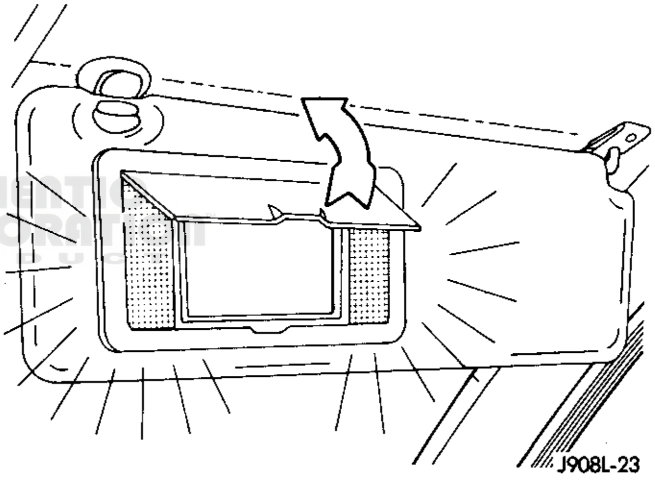


Fig. 11 Lighted Vanity Mirror

Troubleshooting Vanity Lamps Inoperative

TEST	OK	NOT OK
Dome fuse	Not blown	Repair open to ground
Dome lamp operates	Next test	Repair open from splice
Pink wire at switch connector	Battery voltage	Repair open from splice
Jumper ground side of switch to known good ground	Zero ohms	Repair open to ground
	Almost zero ohms (bulb filament)	

SPECIFICATIONS

XJ

INTERIOR LIGHTING	BULB TRADE NUMBER
Under Panel Courtesy Lamp (2)	168
Dome Lamp	561
Dome/Reading Lamp (2)	906
Dome/Reading Lamp (1)	561
Cargo Lamp	561
Lighted Vanity Mirror (2)	74
Ashtray Lamp	1891
Cigarette Lighter Lamp	53
Climate Control Lamp (2)	74
Rocker Switch Lamp	37 (As Required)
Transfer Case Lamp	658
Automatic Transmission Floor Shift Lamp	658
Glove Box Lamp	194
Overhead Console	912

J908L-30

MJ

INTERIOR LIGHTING	NUMBER OF BULBS/ BULB TRADE NUMBER
Under Panel Courtesy Light	2/168
Dome/Reading Light	2/C11-7W
Lighted Vanity Mirror	2/74
Ash Tray Light	1/1891
Cigar Lighter Light	1/53
Climate Control Panel Light	2/74
Rocker Switched Lights	1/37
Transfer Case Light	1/658
Select Drive Bezel Light	1/74
Automatic Transmission Floor Shift Light	1/658
Glove Box Light	1/194

J908L-29

SJ

INTERIOR LAMPS	NUMBER OF BULBS/ BULB TRADE NUMBER
Underpanel Courtesy Lights	2/89
Cargo Light	1/561
Dome/Reading Light	1/211 and 2/105
Lighted Vanity Mirror	2/74
Automatic Transmission Shift Indicator	1/1892
Selec-Trac Light	1/57
Glove Compartment Light	1/1891
Overhead Console	4/912

J908L-36

YJ

INTERIOR LAMPS	BULB TYPE
Courtesy Lamps, Under Dash Panel (2)	89
Dome—Cargo (Hardtop Models Only)	212
Ash Tray Lamp	1891
Cigarette Lighter Lamp	53
Heater Control Lamp	194
Rocker Switch Indicator Lamp (Fog Lamps and Rear Window Defogger)	74
Automatic Transmission Indicator Lamp	1445
Glove Box Lamp	194

J908L-35

DAYTIME RUNNING LIGHTS (Canada Only)

INDEX

OPERATION

The headlamps on Jeep vehicles sold in Canada, will illuminate when the ignition is turned ON. This provides a constant Lights On condition while the vehicle is running. The lamps illuminate at less than 50

of normal intensity. When the vehicle is not moving and the ignition is ON, the system can be turned off by applying the parking brake.

REPLACEMENT

XJ AND MJ

The daytime running light module is located on the right front wheel house behind the battery, under the relay cover (Fig. 1).

(1) Remove the relay cover.

(2) Remove two screws.

(3) Disconnect the electrical connector and remove the module.

(4) To install the module, reverse the removal procedures.

YJ

The daytime running light module is located on the windshield washer reservoir bracket (Fig. 2).

~~(1) Remove two nuts.~~

(2) Disconnect the electrical connector and remove the module.

(3) To install the module, reverse the removal procedures.

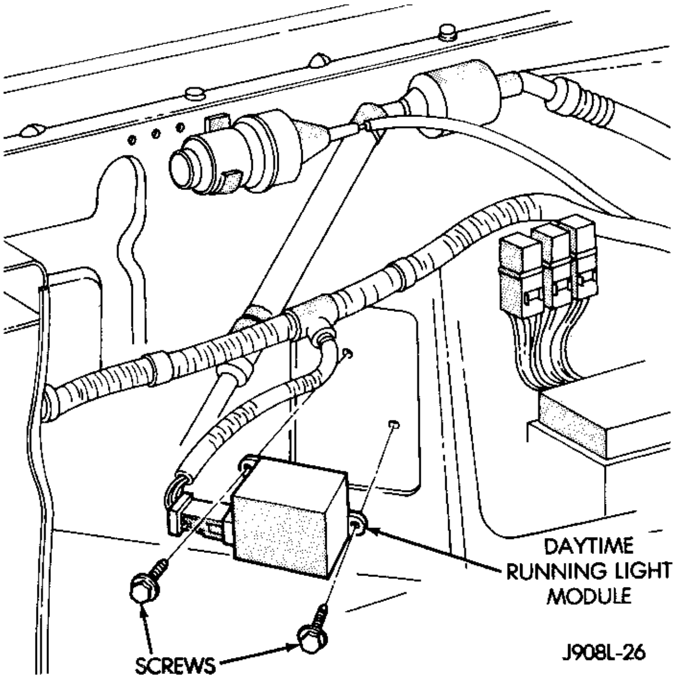


Fig. 1 Daytime Running Light Module — XJ and MJ

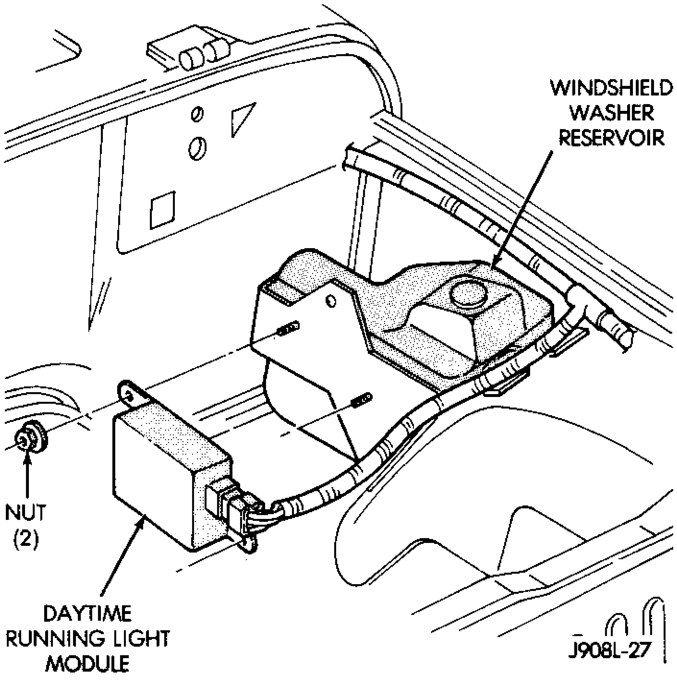


Fig. 2 Daytime Running Light Module — YJ

SJ

The daytime running light module is located on the left front wheel house between the coolant reservoir and the cruise control servo (Fig. 3).

(1) Remove two screws.

(2) Disconnect the electrical connector and remove the module.

(3) To install the module, reverse the removal procedures.

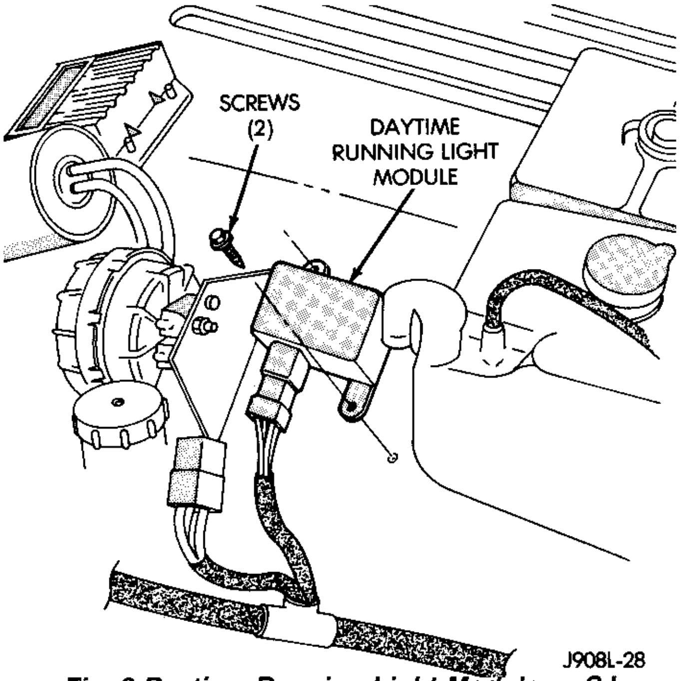


Fig. 3 Daytime Running Light Module — SJ

WARNING BUZZER/CHIME MODULE

CONTENTS

GENERAL

The buzzer/chime module is mounted on the left side of the fuse block (above and to the left of the brake/clutch pedal). The buzzer sounds an audible warning tone in any of the following conditions:

- (XJ, MJ and SJ) vehicle lights are ON when the ignition has been switched OFF and the key is removed and then the driver's door is opened. On vehicles equipped with the chime option, the chime will sound once the ignition is switched OFF while the vehicle lights are ON (without opening the driver's door).
- The key is in the ignition and the driver's door is open (On vehicles equipped with the chime option, the chime will not sound if the key is in the RUN position).
- The ignition is switched ON and the driver's seat belt is not buckled. Tone will quit after 4 to 8 seconds). In addition to the tone, a seat belt light indicator turns on as a reminder to fasten seat belt.

OPERATION/TROUBLESHOOTING XJ AND MJ

OPERATION

Battery voltage for module operation is supplied to three pins. When the key is in the ignition switch, voltage is present at pin 7. Pin 8 receives voltage from the light switch whenever the headlights or park lights are ON. Pin 1 receives voltage when the ignition switch is in the RUN or START position.

To sound the seat belt warning, the module needs:

- battery voltage at the ignition switch input
- a ground at the seat belt switch.

This occurs when the seat belt switch is closed because the driver's seat belt is not buckled. The "fasten belt" light will also turn on along with the warning sound.

To sound the "key in ignition" alarm, both the ignition key warning switch and the driver's door jamb switch must be closed. This condition grounds pin 6 of the module. These switches are closed when the driver's door is open and the key is in the ignition.

The "lights on" warning sounds when voltage is present at the "lights on" input, and not present at the ignition switch input, and the driver's door jamb switch is closed (door is open). If either of these changes, lights off or ignition on, the fast-pulsed "lights on" buzzer/chime will stop.

TROUBLESHOOTING

If the buzzer/chime unit does not operate as described, perform the following tests to determine if the module is defective or another component is defective. Before starting these tests, the module must be unplugged. Do NOT pull the module out before releasing the locking plastic clip, on the side of the module.

TEST	OK	NOT OK
Apply parking brake	Parking indicator lights	Replace Gauges fuse If light still does not work continue with voltage and resistance tests

VOLTAGE TESTS: Ignition in RUN, measure between the following pins and vehicle ground

TEST	OK	NOT OK
Buzzer/chime module connector pin 1	Battery voltage	Repair open to fuse
Buzzer/chime module connector pin 7	Battery voltage	Repair open to ignition key warning switch connector pin F
Buzzer/chime module connector pin 8	Battery voltage If OK, replace module	Repair open to front park and marker lamp connector

CAUTION:Before making resistance measurements, turn ignition switch OFF and disconnect the battery negative cable to avoid damaging the ohmmeter.

RESISTANCE TESTS: Measure between the following pins and vehicle ground

TEST	OK	NOT OK
Buzzer/chime module connector pin 2	Almost zero ohms (bulb filament)	Replace seat belt indicator bulb
Buzzer/chime module connector pin 3	Zero ohms	Repair open to ground
Buzzer/chime module connector pin 4	Zero ohms	Repair open to ground
Buzzer/chime module connector pin 6	Zero ohms	Repair open to ground side of door jamb switch

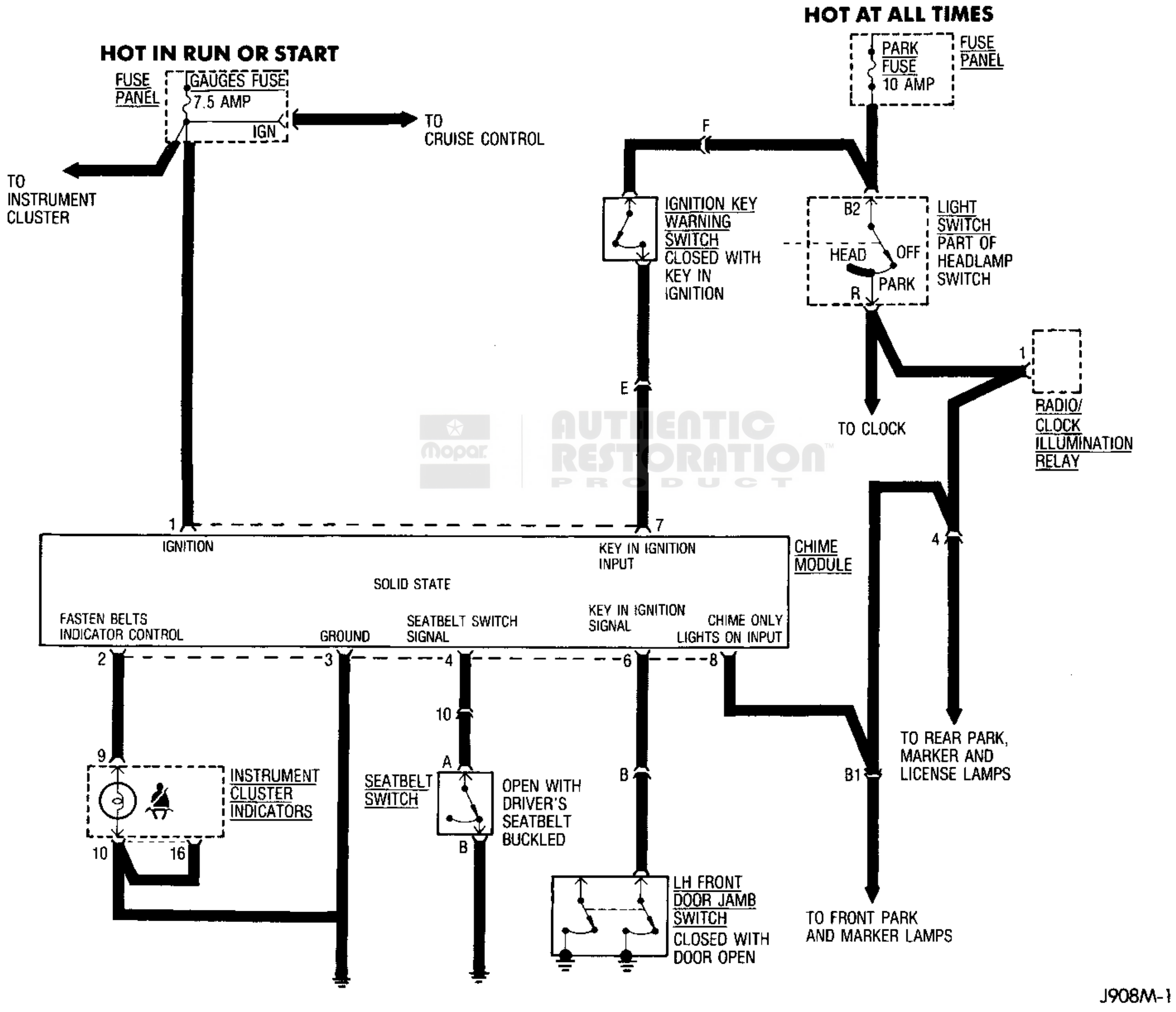


Fig. 1 Buzzer/chime module schematic — XJ and MJ

OPERATION/TROUBLESHOOTING YJ

OPERATION

Battery voltage for module operation is supplied to two pins. When the key is in the ignition switch, voltage is present at pin 7. Pin 1 receives voltage when the ignition switch is in the RUN or START position.

To sound the seat belt warning, the module needs:

- battery voltage at the ignition switch input
- a ground at the seat belt input.

This occurs when the seat belt switch is closed because the driver's seat belt is not buckled. The "fasten belt" light will also turn on along with the warning sound. Operation of seat belt portion of the circuit is limited to a specified amount of time by a timer contained in the buzzer module.

To sound the "key in ignition" alarm, both the ignition key warning switch and the driver's door jamb switch must be closed. This condition grounds pin 6 of the module. These switches are closed when the driver's door is open and the key is in the ignition.

TROUBLESHOOTING

1. BUZZER MODULE: Disconnect Buzzer Module; Open Driver's Door; Turn ignition switch to RUN for voltage tests; turn ignition switch to OFF and disconnect battery for resistance tests

TEST	OK	NOT OK
Measure voltage at buzzer module connector pin 1	Battery voltage	Repair open from IGN LPS fuse
Measure resistance between buzzer module connector pin 3 and a clean chassis ground	Zero ohms	Repair open to ground
Measure resistance between buzzer module connector pin 6 and a clean chassis ground	Zero ohms	Repair open to ground side of LH door jamb switch or replace LH door jamb switch
Measure voltage at buzzer connector module connector pin 7	Battery voltage	Repair open to "key in ignition" switch or replace switch
Connect buzzer module connector	Buzzer sounds	Replace buzzer module

2. SEAT BELT BUZZER: Disconnect Buzzer Module; Driver's Belt Buckled

TEST	OK	NOT OK
Measure resistance at Seat belt switch connector pin B and ground	Zero ohms	Repair open between seat belt switch and ground
Measure resistance at Seat belt switch connector pin A	Open circuit	Replace seat belt switch

3. SEAT BELT INDICATOR LAMP: Turn ignition switch to RUN for voltage tests; turn ignition switch to OFF and disconnect battery for resistance tests

TEST	OK	NOT OK
Measure resistance across bulb pins	Zero ohms (except filament resistance)	Replace bulb
Measure voltage at indicator lamp panel connector A pin 5	Battery voltage	Repair open from IGN LPS fuse
Measure resistance between indicator lamp panel connector B pin 6 and buzzer module connector pin 2	Zero ohms - See Test 1 for buzzer module diagnosis	Repair open between indicator lamp panel connector B pin and buzzer module connector

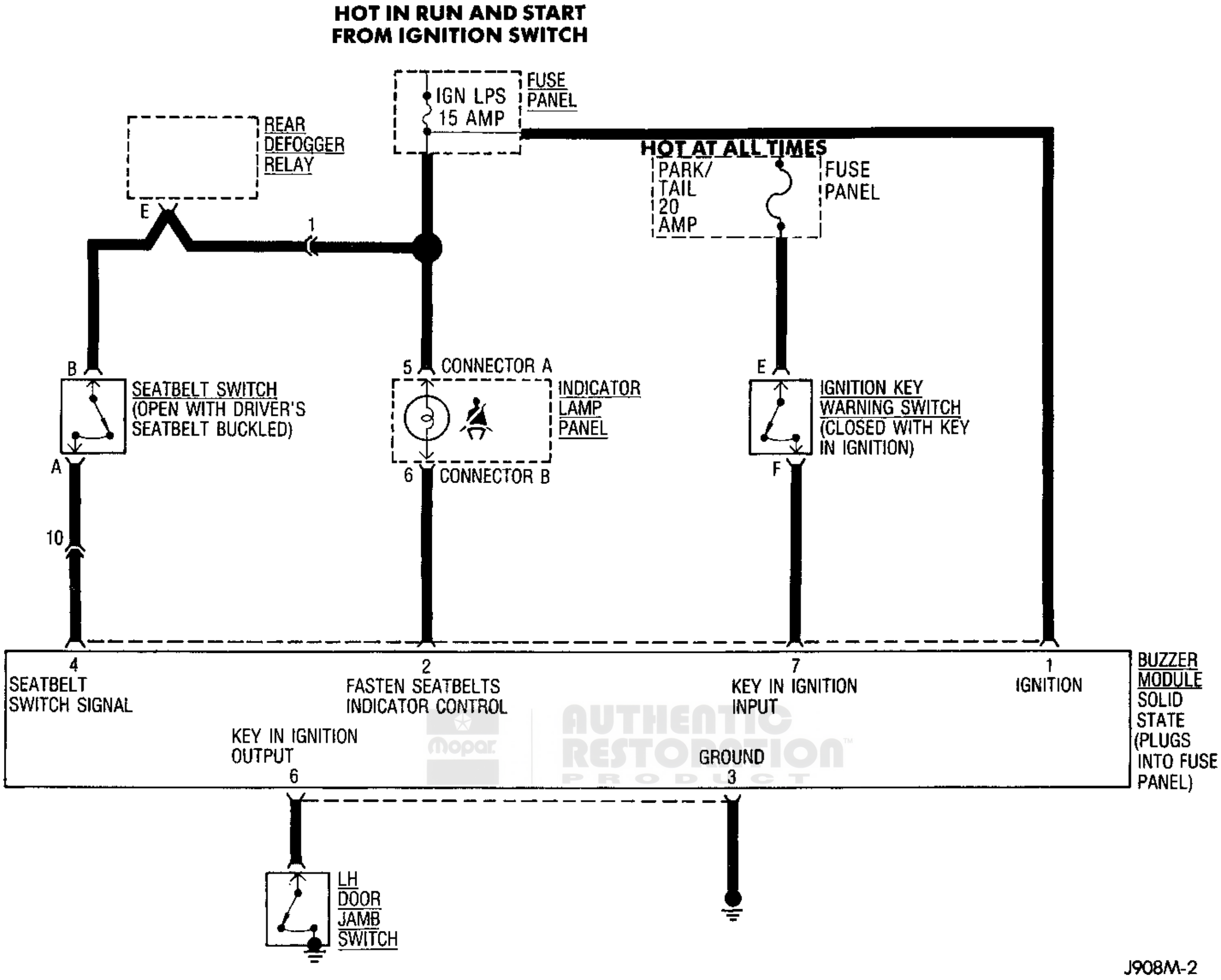


Fig. 2 Warning buzzer schematic — YJ

OPERATION/TROUBLESHOOTING SJ

OPERATION

Battery voltage for module operation is supplied to three pins. Pin 7 receives battery voltage at all times. Pin 8 receives voltage from the light switch whenever the headlights or park lights are ON. Pin 1 receives voltage when the ignition switch is in the RUN or START position.

To sound the seat belt warning, the module needs:

- battery voltage at pin 1 and 7
- a ground at the seat belt input.

This occurs when the seat belt switch is closed because the driver's seat belt is not buckled. The "fasten belt" light will also turn on along with the warning sound.

To sound the "key in ignition" alarm, both the ignition key warning switch and the driver's door jamb switch must be closed. This condition grounds pin 6 of the module. These switches are closed when the driver's door is open and the key is in the ignition while ignition switch is OFF.

The "lights on" warning sounds when voltage is present at the "lights on" input, pin 8, and not present at the ignition switch input. If either of these changes, lights off or ignition on, the fast pulsed lights on chime will stop.

TROUBLESHOOTING

If the chime unit does not operate as described, perform the following tests to determine if the module is defective or another component is defective. Before starting these tests, the module must be unplugged. Do NOT pull the module out before releasing the locking plastic clip, on the side of the module.

TEST	OK	NOT OK
Apply parking brake	Parking indicator lights	Replace Gauges fuse If light still does not work continue with voltage and resistance tests

VOLTAGE TESTS: Ignition in RUN, measure between the following pins and vehicle ground

TEST	OK	NOT OK
Chime module connector pin 1	Battery voltage	Repair open to IGN LPS fuse or replace fuse
Chime module connector pin 8	Battery voltage If OK, replace module	Repair open to front park and marker lamp connector
Chime module connector pin 7	Battery voltage	Repair open to park tail fuse

CAUTION:Before making resistance measurements, turn ignition switch OFF and disconnect the battery negative cable to avoid damaging the ohmmeter.

RESISTANCE TESTS: Measure between the following pins and vehicle ground

TEST	OK	NOT OK
Chime module connector pin 4	Zero ohms	Repair open to ground
Chime module connector pin 3	Zero ohms	Repair open to ground
Chime module connector pin 2	Almost zero ohms (bulb filament)	Replace seat belt indicator bulb
Chime module connector pin 6	Zero ohms	Repair open to ground side of door jamb switch

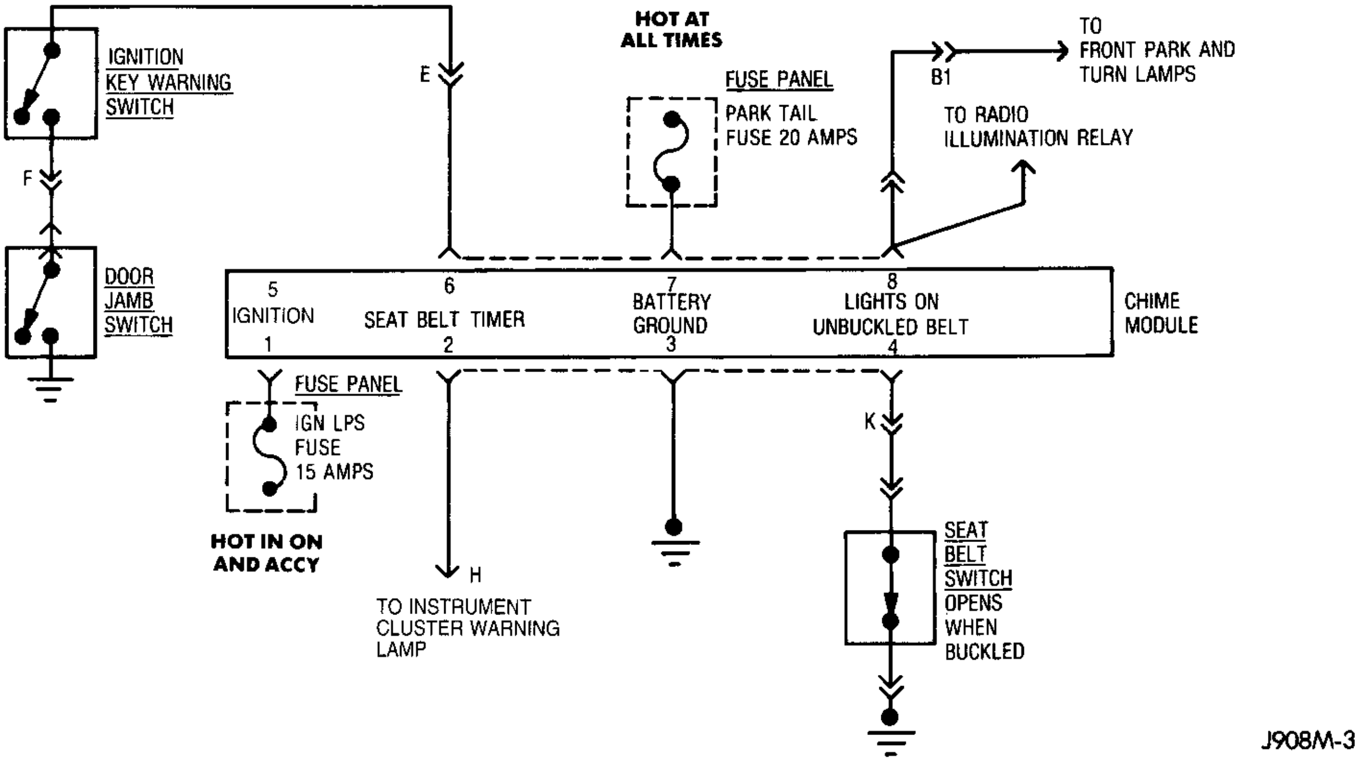


Fig. 3 Chime Module Schematic - SJ

IGNITION KEY WARNING SWITCH REPLACEMENT

(1) Disconnect battery negative cable.

(2) Perform one of the following procedures and then continue with step (3).

Standard Steering Wheel

- Remove three screws holding the front cover of the steering wheel (Fig. 1).

CAUTION: Use a sharp pointed tool to depress the connector retainer.

- Pull horn wires off at the column side of the steering wheel (Fig. 2). Pull gently to remove grounding pin. Be careful to not lose the spring under the grounding pin connector (Fig. 3).

Optional Steering Wheel

- Remove horn button with a push and turn motion.
- Remove horn button components (Fig. 4).

(3) Turn key to the lock position and remove the steering wheel nut and washer.

(4) Scribe an alignment mark on the steering wheel in line with the mark already existing on the end of the steering column.

(5) Remove vibration damper from the steering column hub, if equipped.

(6) Remove steering wheel using a steering wheel puller.

WARNING: IN ORDER TO REMOVE THE STEERING SHAFT SNAP RING IN THE FOLLOWING STEP, THE LOCKPLATE MUST BE COMPRESSED. DO NOT ATTEMPT TO REMOVE THE LOCKPLATE WITHOUT COMPRESSOR TOOL C4156 AS THE LOCKPLATE IS UNDER HEAVY SPRING TENSION.

(7) Compress the lockplate with compressor tool C4156 and remove the steering shaft snap ring (Fig. 5). Discard the snap ring. It is not reusable.

(8) Remove compressor tool.

(9) Remove lockplate, cancelling cam, and upper bearing preload spring. If the vehicle is equipped with the optional steering wheel, remove the horn button components from the canceling cam.

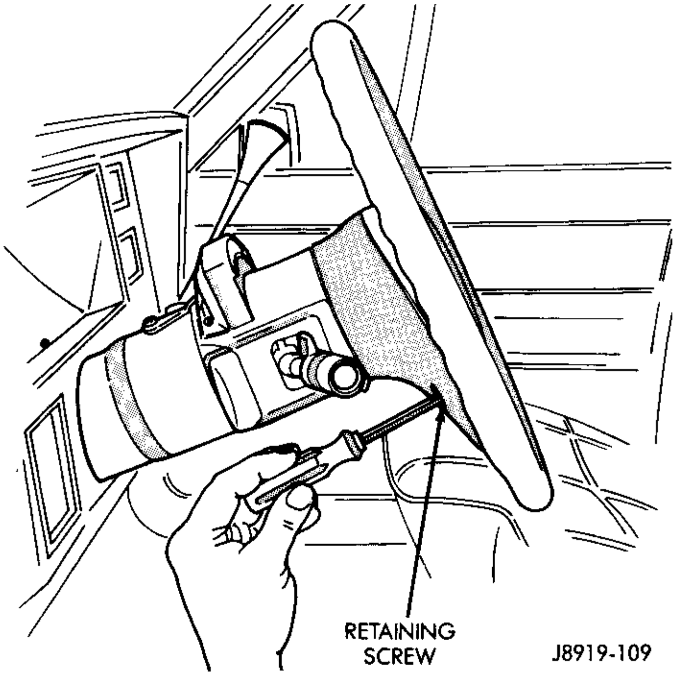


Fig. 1 Standard Steering Wheel Cover Removal/Installation

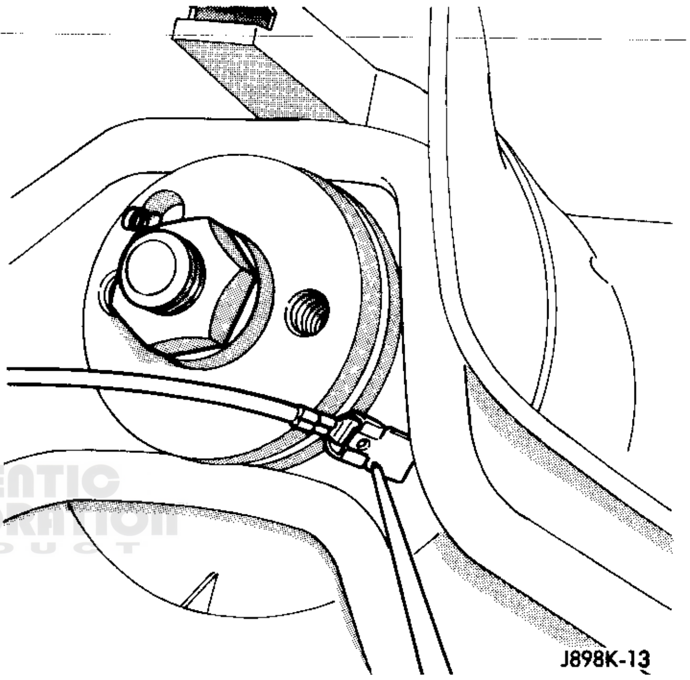


Fig. 2 Horn Wire Removal

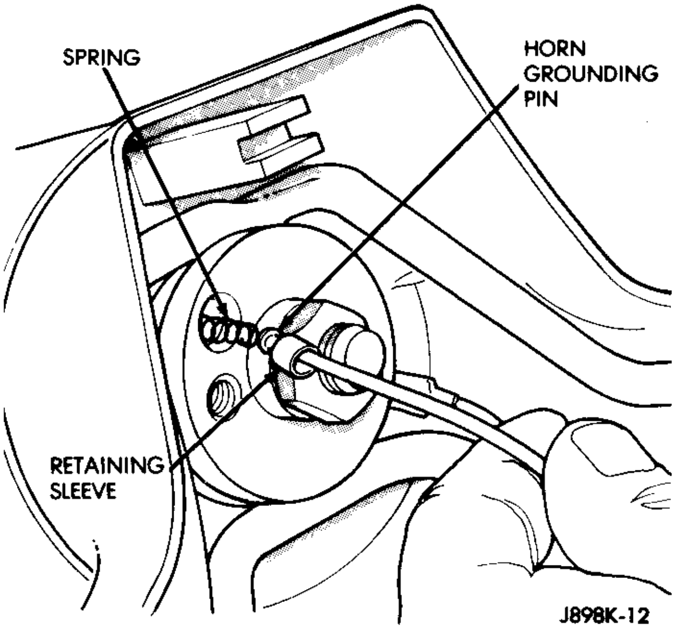


Fig. 3 Horn Grounding Pin Removal/Installation

(10) Remove the screw and hazard warning switch knob.

(11) Remove dimmer switch actuator arm attaching screw (Fig. 6).

(12) Remove the turn signal switch attaching screws (Fig. 6).

(13) Unplug wiper switch connector.

(14) Push upper connector up and out of turn signal connector (Fig. 7).

(15) Pry up locking tabs of turn signal connector and remove connector from column bracket.

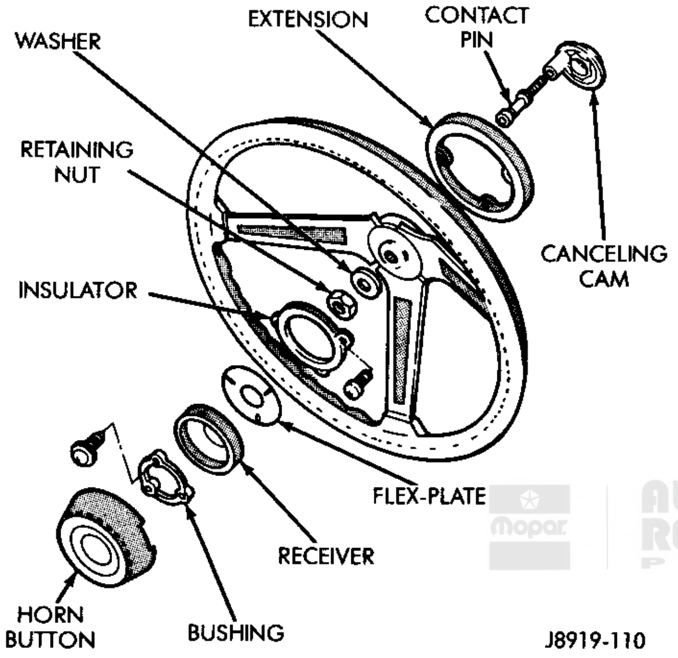


Fig. 4 Optional Steering Wheel Removal/Installation

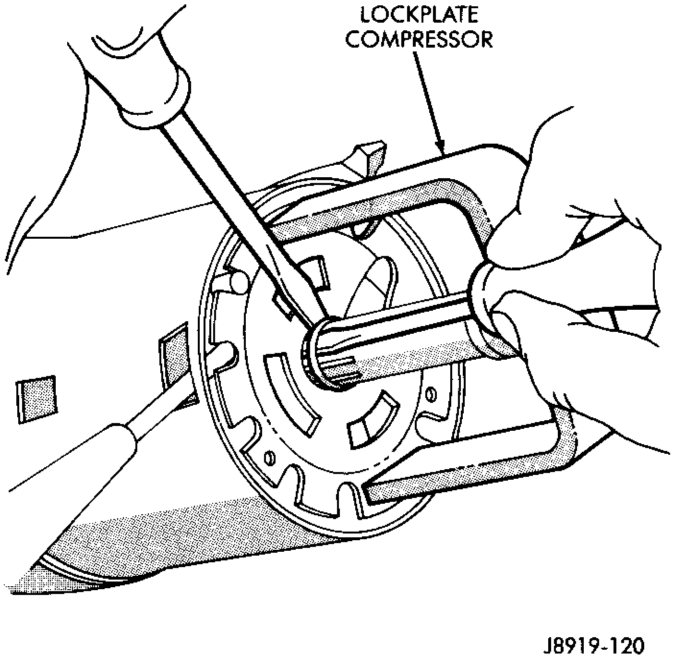


Fig. 5 Lockplate Removal

(16) Pull the turn signal switch out of the column far enough to allow access to the remaining screws.

(17) Insert the ignition key in the lock cylinder and turn the key to ON position.

(18) Remove the key warning buzzer switch and retaining clip with a paper clip inserted below the retainer so that the retainer is flattened (Fig. 8).

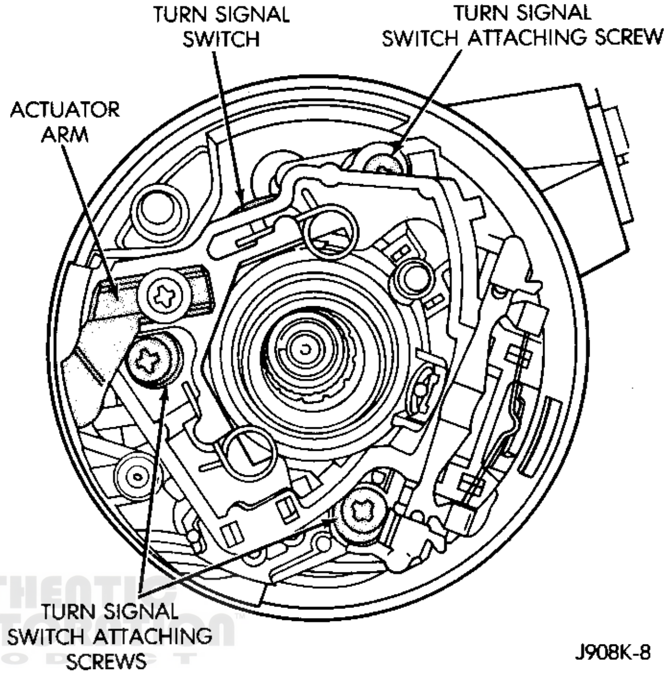


Fig. 6 Turn Signal And Dimmer Actuating Lever Screws.

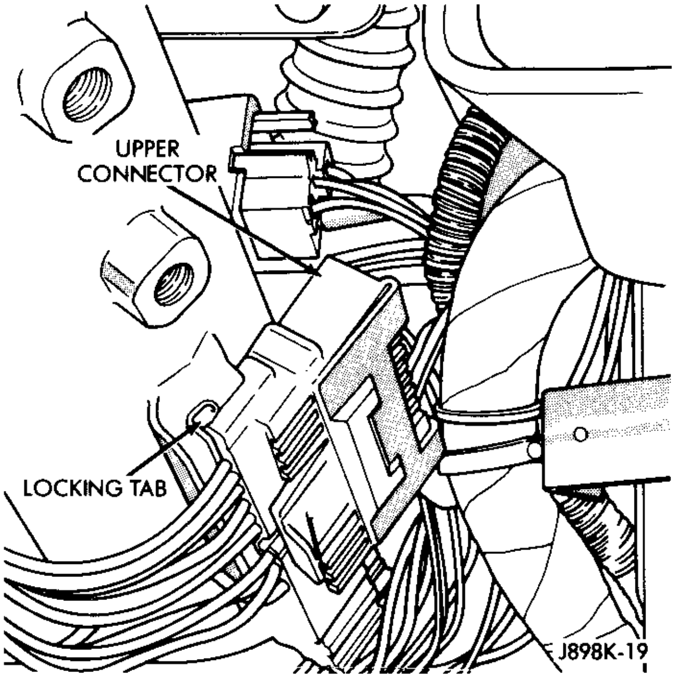


Fig. 7 Turn Signal Switch Connector Removal/Installation

Do not attempt to remove the buzzer switch and clip separately. The clip could fall into the column jacket.

(19) Reverse the removal procedures to assemble the steering column.

(20) Install the steering wheel. Tighten the steering wheel nut to 34 N•m (25 ft-lbs) torque.

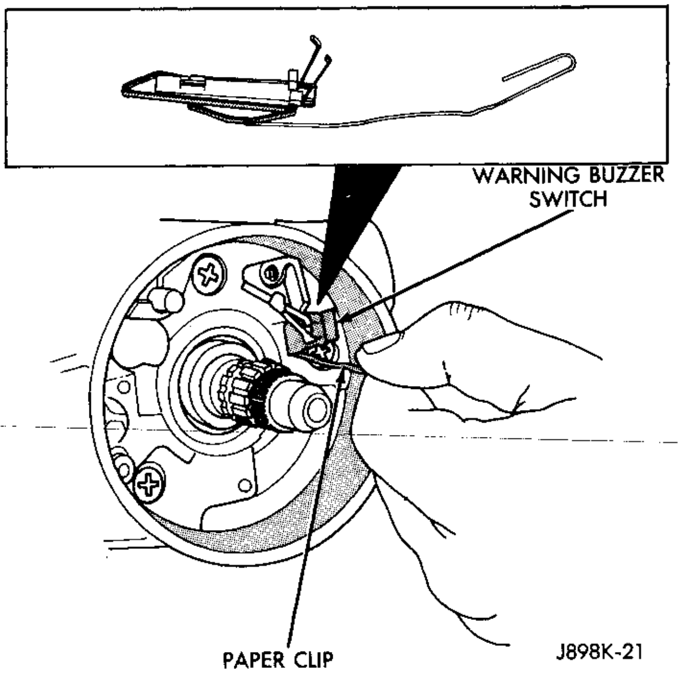


Fig. 8 Buzzer Switch Removal

REAR WINDOW DEFOGGER

CONTENTS

INDEX

GENERAL

Using heating elements bonded to the rear window glass, the rear defogger will clear condensation, frost and light snow coverings from the rear window.

The horizontal grid lines and vertical bus bar lines printed and baked on inside surface of rear window glass comprise an electrical circuit. The electrically conductive lines are composed of a silver-ceramic material which when baked on glass becomes bonded to the glass and is highly resistant to abrasion.

The electrical current required to produce the heat in the grid is supplied through a relay and driver operated switch. When the switch is closed, the relay contacts close connecting the grid to battery power. The power circuit to the grid is protected by a 25 amp fuse (XJ and YJ) or a 30 amp circuit breaker (SJ) located in the fuse panel.

To defog the rear window, press the rocker switch to the ON position. A light on the rocker switch arm will indicate that the defogger is operating.

If the ignition switch is ON the first activation of the defog/defrost feature will last for 10 minutes. Succeeding activations will last for 5 minutes unless the ignition switch is turned OFF; then it will recycle back to 10 minutes for the first activation.

To stop defogger operation, push the switch to the OFF position.

Use the defogger only when the engine is operating to prevent excessive battery drain.

CAUTION: Use care when washing the inside of the rear window to prevent damage to the defogger heating elements. Use a soft cloth and a mild washing solution. Wiping motions should be parallel to the heating elements. Also, keep all objects a safe distance from the window to prevent damaging the heating elements.

REAR WINDOW DEFOGGER GRID TEST

It is possible, that a break may exist or occur in an individual grid line resulting in no current flow through the line. When a grid is inoperable due to an open circuit, the area of glass normally cleared by that grid remains fogged or iced unless, and until it is cleared by the adjacent grids.

With the engine running at IDLE, push the rear window defogger switch to the ON position and release. The pilot lamp in the rocker switch should light, indicating defogger operation.

Use a 12vdc voltmeter and contact the positive lead of the voltmeter to the feed side vertical bus element on the inside surface of the glass and contact the negative lead to the ground side bus element. Voltage on the meter should be 11 to 13 volts. Connect the negative lead of the voltmeter to a good ground; the meter reading should be constant.

Keep the negative lead connected to ground. Use the positive lead and carefully contact each grid at the approximate centerline of the window.

A voltage drop of one-half the full amount, approximately 6 volts, indicates a good grid or closed circuit.

A voltage drop of 12 volts at the centerline indicates a break in the grid between the positive voltmeter lead and the ground.

No voltage drop (0 volts) at the centerline indicates a break in the grid between the centerline and the voltage source or lead.

The exact location of the break can then be pinpointed by moving the positive voltmeter lead to the left or right along the grid until an abrupt change in the voltage reading is noticed. The break is at that point in the grid.

REAR WINDOW DEFOGGER GRID REPAIR

Locate the broken or open grid.

Use the grid repair kit (available as a service part) in accordance with the following procedure:

(1) Mark the location of the broken or open grid on the exterior surface of the glass using a suitable marking pencil.

(2) Lightly rub the area to be repaired (inside the rear window) using fine steel wool. Clean the area with alcohol.

(3) Attach two strips of masking tape to the inside surface of the rear window (above and below the break in the grid (Fig. 1).

(4) Remove package separator clamp and mix plastic conductive epoxy thoroughly. fold in half and cut center corner to dispense epoxy.

(5) Apply conductive epoxy through slit in masking tape. Overlap both ends of the break.

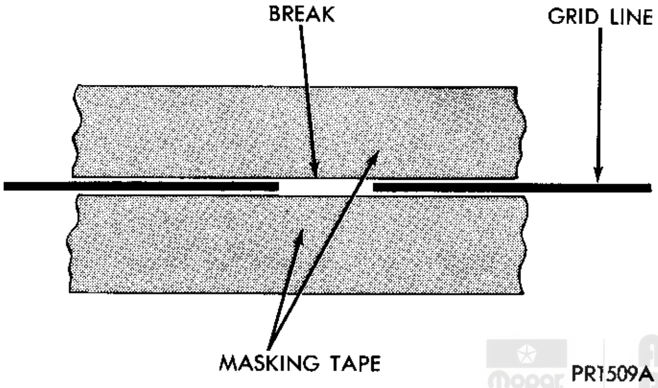


Fig. 1 Grid Line Repair (Typical)

(6) For a terminal or pigtail replacement, mask adjacent areas so epoxy can be extended onto line as well as buss bar. Apply a thin layer of epoxy to area where terminal was fastened and to adjacent line.

(7) Apply a thin layer of conductive epoxy on terminal and place terminal on desired location. To prevent terminal from moving while the epoxy is curing, it must be wedged or clamped.

(8) Carefully remove masking tape from grid line.

(9) Allow epoxy to cure 24 hours at room temperature or use heat gun with a 260°-371°C (500°-700°F) range for 15 minutes. Hold gun approximately 254mm (10 inches) from repaired area.

(10) After conductive epoxy is properly cured remove wedge from terminal and check out operation of rear window defogger. Do not attach connectors until curing is complete.

WARNING: REPAIR KIT MAY CAUSE SKIN OR EYE IRRITATION.

CONTAINS EPOXY RESIN AND AMINE TYPE HARDENER, HARMFUL IF SWALLOWED. AVOID CONTACT WITH SKIN AND EYES. FOR SKIN, WASH AFFECTED AREAS WITH SOAP AND WATER. DO NOT TAKE INTERNALLY. IF TAKEN INTERNALLY, INDUCE VOMITING; CALL A PHYSICIAN IMMEDIATELY. IF IN CONTACT WITH EYES, FLUSH WITH PLENTY OF WATER. USE WITH ADEQUATE VENTILATION. DO NOT USE NEAR FIRE OR FLAME. CONTENTS CONTAIN 3%FLAMMABLE SOLVENTS.

WARNING: KEEP OUT OF REACH OF CHILDREN.

XJ

INDEX

DESCRIPTION

With the ignition switch in the ACCY, ON, or START position, voltage is applied to the defogger switch and the solid state timer in the defogger relay. Voltage from the HTD WDW fuse is applied to the contact of the defogger relay at all times.

When the defogger switch is in the ON position, voltage is applied to the defogger relay's solid state timer from the Turn B/U fuse. The relay energizes, pulling the contact closed. When the contact is closed, voltage is applied to the defogger grid.

REAR WINDOW DEFOGGER SWITCH REPLACEMENT

(1) Remove the instrument panel bezel; see 8E-Instrument Panel and Components Section for the procedure.

(2) Remove the switch housing panel.

(3) Unplug the switch connector. Slightly depress the switch mounting tabs and remove the switch.

REAR DEFOGGER RELAY

The rear defogger relay is located behind the center of the instrument panel just below the lighter.

(1) Remove the lower instrument panel trim panel.

(2) Remove two screws holding the relay.

(3) To install the relay, reverse the removal procedures.

TROUBLESHOOTING

1. POWER INPUT: Remove and inspect fuses

TEST	OK	NOT OK
HTD WDW fuse	Not blown	Replace fuse
Turn B/U fuse	Not blown	Replace fuse

2. DEFOGGER RELAY: Ignition in ACCY

TEST	OK	NOT OK
Turn Defogger Switch ON	Relay contacts click and lamp in switch lights If OK, go to step 3	Next step
Turn Windshield Wipers ON	Wipers cycle, defogger switch ground is OK	Repair open to ground
Relay connector terminal D (Remove Defogger Relay connector by prying locking tabs)	Zero ohms	Repair open to ground
Relay connector terminal C	Battery voltage	Repair open to HTD WDW fuse
Relay connector terminal E	Battery voltage	Repair open to turn B/U fuse
Relay connector terminal B (Defogger Switch in ON)	Battery voltage	Replace switch
Relay connector terminal A	Almost zero ohms (bulb filament)	Replace switch

3. DEFOGGER GRID: Ignition in ACCY, defogger switch in ON, defogger relay connected

TEST	OK	NOT OK
LH side (driver's side) of Defogger Grid	Battery voltage	Repair open to relay
RH side of Defogger Grid	Zero ohms If OK, repair defogger grid	Repair open to defogger relay ground

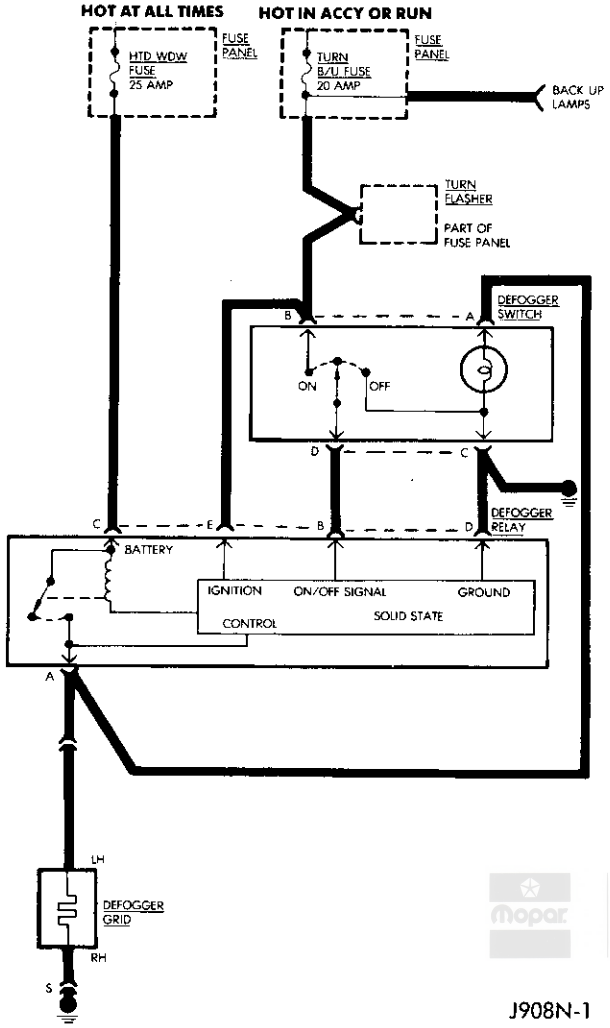
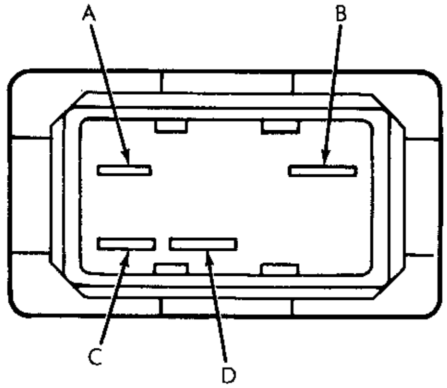
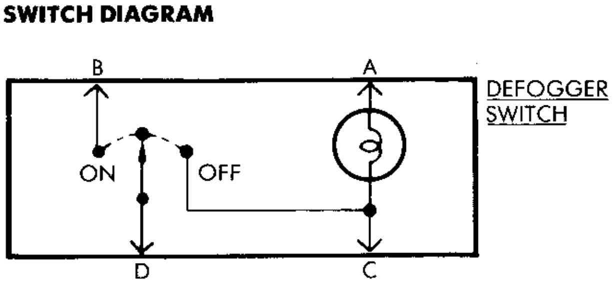


Fig. 2 Rear Defogger Schematic — XJ

SWITCH TESTING





SWITCH TEST

SWITCH POSITION	TERMINALS	ZERO OHMS
On	B and D	Yes
Off	C and D	Yes
At Rest (Normal)	A and C	Almost zero ohms (bulb filament)

J908N-4

YJ

INDEX

DESCRIPTION

Operation of the relay is prevented unless the ignition switch is in the ON position. The relay is connected to the ignition switch through a splice and the gauge fuse located in the fuse panel. Operation of the system is further limited by a timer contained in the relay. The timer is a small solid state circuit that opens the relay contacts after a specified amount of time.

The indicator lamp is connected to the output side of the defogger relay allowing it to come on only when the relay contacts are closed.

REAR WINDOW DEFOGGER SWITCH REPLACEMENT

(1) Remove six shroud screws (Fig. 3).

(2) Slide shroud towards the steering wheel.

(3) Apply upward pressure to the shroud and downward pressure to the indicator panel. This will release the holding tabs (Fig. 4).

(4) Unplug the connector from the defogger switch.

(5) Squeeze the ends of the switch to release the plastic retaining fingers and push outward.

(6) To install, depress the rear window defogger switch into the bezel until the retaining fingers lock behind the bezel.

(7) Plug the connector on the switch.

(8) Install the shroud under the steering column.

(9) Slide the indicator panel tabs into the shroud notches.

(10) Place the assembled shroud over the indicator lamp foam gasket and tighten the indicator panel screws.

A fragile foam gasket is on the back of the indicator overlay. If the gasket is torn or distorted, replace with a new gasket.

(11) Install remaining four screws.

REAR DEFOGGER RELAY

The rear defogger relay is located against the drivers side kick panel.

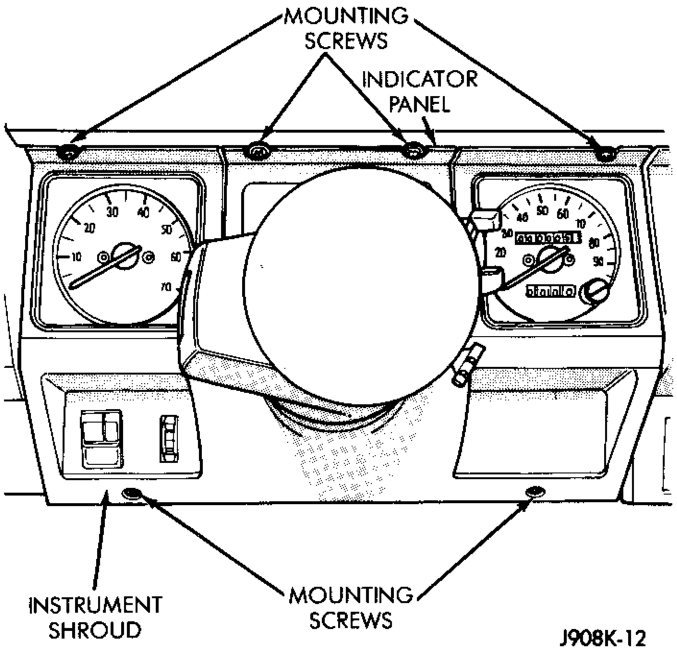


Fig. 3 Instrument Shroud Removal/Installation — YJ

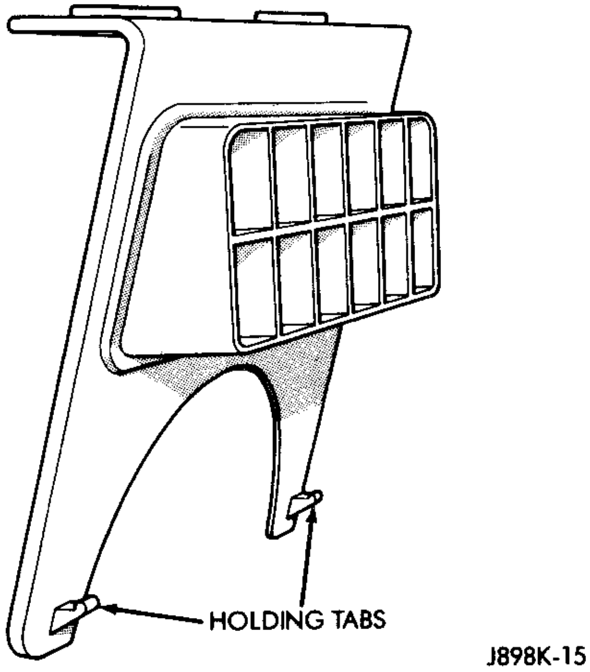


Fig. 4 Indicator Panel — YJ

TROUBLESHOOTING (Fig. 5)

1. BATTERY, IGNITION & FUSES

TEST	OK	NOT OK
HTD/WDW & IGN LPS fuses	Not blown	Replace fuses
Battery side of HTD/WDW fuse	Battery voltage	Repair open from fuse link
Ignition side of IGN LPS fuse	Battery voltage	Repair open from ignition switch NOTE: If open is before splice, seat belt buzzer will also be inoperative

2. DEFOGGER SWITCH: Defogger switch connector separated from defogger switch; turn ignition switch to RUN for voltage tests; turn ignition switch to OFF for resistance tests

TEST	OK	NOT OK
Measure voltage at defogger switch terminal B	Battery voltage	Repair open from IGN LPS fuse
Measure resistance between defogger switch connector terminal D and connector A terminal B	Zero ohms	Repair open between defogger switch connector and connector A
Turn defogger switch to ON. Measure resistance across switch terminals B and D	Zero ohms	Replace defogger switch

3. DEFOGGER RELAY: Defogger relay connector separated from defogger relay; turn defogger switch to ON; turn ignition switch to RUN for voltage tests; turn ignition switch to OFF for resistance tests

TEST	OK	NOT OK
Measure voltage at relay connector terminal C	Battery voltage	Repair open to HTD WDW fuse
Measure voltage at relay connector terminal B	Battery voltage	Repair open from defogger switch
Measure voltage at relay connector terminal E	Battery voltage	Repair open from IGN LPS fuse
Measure resistance between relay connector terminal A and LH side (driver's side) of defogger grid	Zero ohms	Repair open between relay connector and LH side of defogger grid
Measure resistance between relay connector terminal D and a clean chassis ground	Zero ohms	Repair open between relay connector and ground
Connect relay connector and measure voltage at terminal A	Battery voltage	Replace defogger relay

4. INDICATOR LAMP: Turn defogger switch to ON; turn ignition switch to RUN for voltage tests; turn ignition switch to OFF for resistance tests

TEST	OK	NOT OK
Measure resistance across bulb terminals	Zero ohms (except filament resistance)	Replace bulb
Measure voltage at defogger switch connector terminal A	Battery voltage	Repair open from defogger relay
Measure resistance from defogger switch connector terminal C to a clean chassis ground	Zero ohms	Repair open between defogger switch connector and ground

5. DEFOGGER GRID: Turn defogger switch to ON; turn ignition switch to RUN for voltage tests; turn ignition switch to OFF for resistance tests

TEST	OK	NOT OK
Measure voltage at LH side (driver's side) of Defogger Grid	Battery voltage	Repair open from defogger relay
Measure resistance for RH side of Defogger Grid to a clean chassis ground	Zero ohms	Repair open between RH side of Defogger Grid and ground

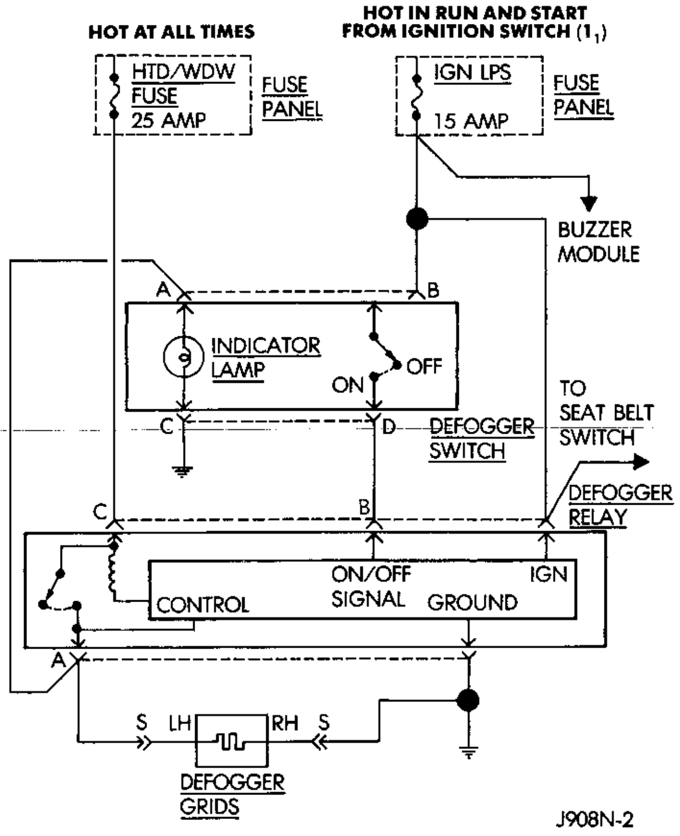


Fig. 5 Rear Defogger Schematic — YJ

SJ

INDEX

REAR WINDOW DEFOGGER SWITCH REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Unsnap the tabs that retain the instrument panel bezel and remove the bezel (Fig. 6).

(3) Remove the screws that attach the instrument cluster to the panel (Fig. 7).

(4) Pull the instrument cluster outward and disconnect the speedometer and the cluster wire harness connectors.

(5) Remove the instrument cluster.

(6) Disconnect the wires from the switch to be removed.

(7) Compress the top and bottom spring clips to release the rear defogger switch and/or tailgate switch from the panel (Fig. 8).

(8) To install, reverse the removal procedures.

REAR DEFOGGER RELAY

The rear defogger relay is located in the tailgate.

(1) Remove the trim strips and the trim panel.

(2) Remove the inspection panel.

CAUTION: When the tailgate window is raised with the tailgate lowered, the glass must be supported to avoid damage.

(3) Raise the rear window until the two screws holding the relay are accessible (Fig. 9).

(4) Remove two screws holding relay.

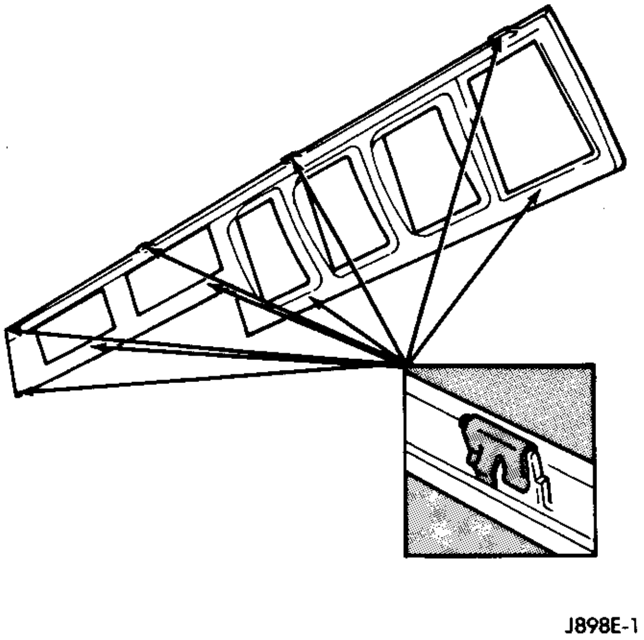


Fig. 6 Instrument Panel Retaining Tabs and Clips

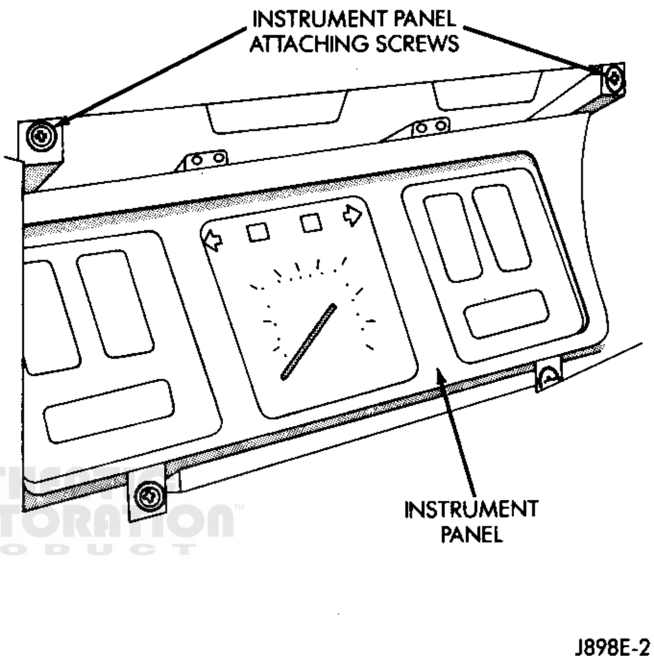


Fig. 7 Instrument Cluster Removal — SJ

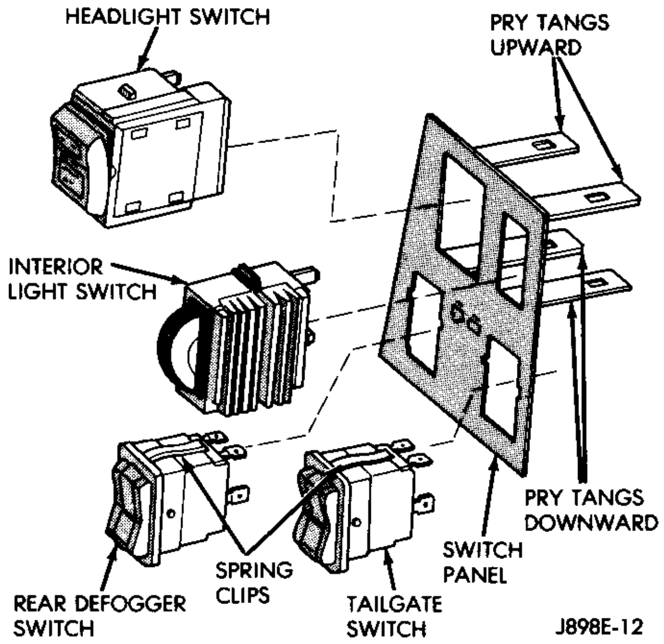


Fig. 8 Defogger Switch Removal/Installation

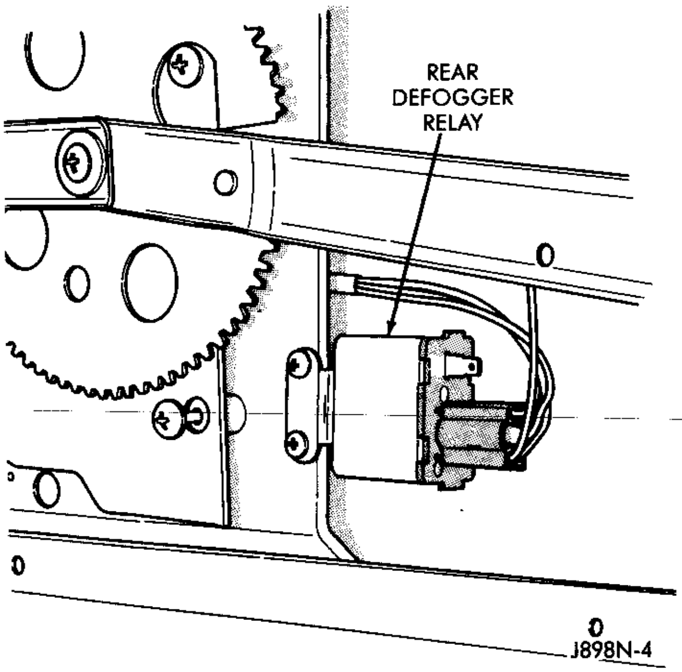


Fig. 9 Rear Defogger Relay — SJ

(5) Disconnect relay connector and remove relay.

(6) To install a new relay, reverse the removal procedures.

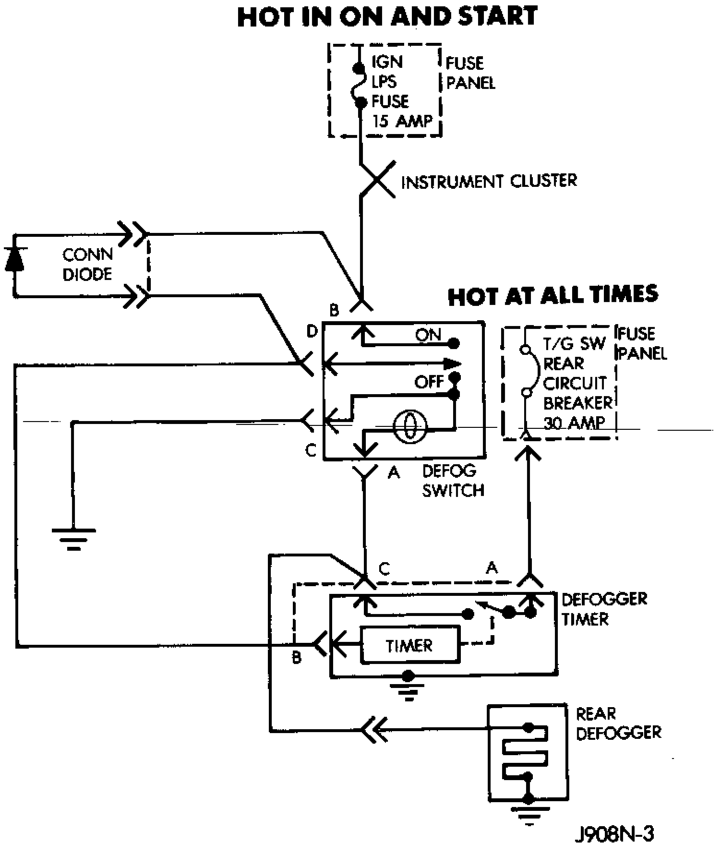


Fig. 10 Rear Defogger Schematic — SJ

POWER DOOR LOCKS

CONTENTS

XJ

INDEX

GENERAL

The door lock actuators, including liftgate, are controlled by two-way switches. To lock the doors, push down on either switch. To unlock doors from inside the vehicle push upward on either switch.

The power door locks do not lock or unlock the doors from outside the vehicle. Insert the key into the lock cylinder to lock or unlock each individual door.

CIRCUITRY

The door locks are operated by reversible motors that receive voltage from the power accy circuit breaker. Voltage is applied to the LH door lock switch and the RH door lock switch. With the LH door lock switch in LOCK, voltage is applied through switch 1 to the RH door lock switch, then from switch 3 to terminal A of each door lock motor. The ground path while switch 1 is in LOCK is through terminal B of the door lock motor, then switch 4 of the RH door lock, and to the lock contact of switch 2 to ground.

When the RH door lock window switch is in the LOCK position voltage is applied from switch 3 to terminal A of the door lock motors. The ground path is through terminal B of the door lock motors to switch 4, then switch 2 and ground. The voltage and ground paths are reversed to unlock the doors.

The power door lock operates with battery power and, therefore, is independent of the ignition switch.

A 30 amp circuit breaker mounted in the fuse block protects the circuit.

TROUBLESHOOTING POWER DOOR LOCKS (Refer To Schematics)

1. NO DOOR LOCKS OPERATE USING DOOR LOCK SWITCHES—Power ACCY circuit breaker installed

TEST	OK	NOT OK
Probe terminal S on Fuse Panel	Battery voltage	Replace circuit breaker
Remove RH kickpanel and both relays and test Lock relay terminal 4	Zero ohms	Next step
Unlock relay terminal 4	Zero ohms	Repair open to Left Hand Door Connector (refer to Switch Testing)
Unlock relay terminal 4, hold LH switch in UNLOCK position	Battery voltage	Next step
Lock relay terminal 4, hold LH switch in LOCK position	Battery voltage	Repair open to circuit breaker (refer to Switch Testing)
Lock relay terminal 3 to Unlock relay terminal 3	Almost zero ohms (motors' resistance) If ok, replace relays	Repair open through RH door lock switch (refer to Switch Testing)

2. NO DOOR LOCKS OPERATE, USING TRANSMITTER

TEST	OK	NOT OK
Aim transmitter at receiver (keyless entry module) from 1 to 3 feet away and press button	Door locks operate	Change batteries as outlined in owner's manual
Side of cigar lighter socket to ground	Zero ohms	Repair open to ground
Remove RH kickpanel and both relays and test Keyless entry module terminal 1	Zero ohms	Repair open to ground
Keyless entry module terminal 6	Battery voltage	Repair open to fuse
Jumper test leads Keyless entry module terminal 6 to terminal 2	Doors lock If OK, replace module	Go to step 3
Jumper test leads Keyless entry module terminal 6 to terminal 4	Doors unlock If OK, replace module	Go to step 4

3. LOCK RELAY—Remove RH kick panel and lock relay

TEST	OK	NOT OK
Lock relay terminal 5	Battery voltage	Repair open to circuit breaker
Lock relay terminal 2	Zero ohms	Repair open to ground
Lock relay terminal 1 and depress transmitter button twice	Battery voltage of short duration If OK, replace relay	Repair open to module

4. UNLOCK RELAY—Remove RH kick panel and unlock relay

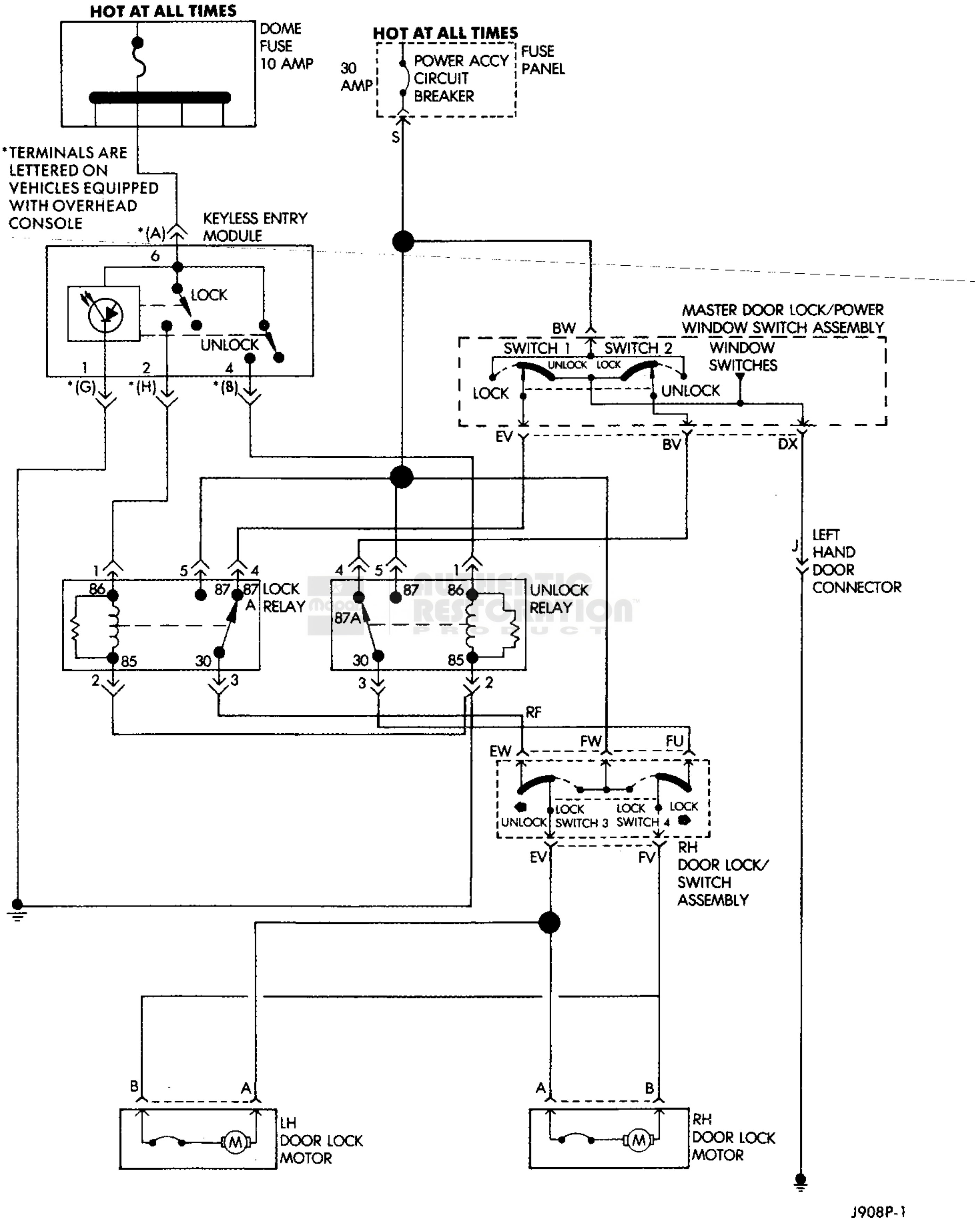
TEST	OK	NOT OK
Unlock relay terminal 5	Battery voltage	Repair open to circuit breaker
Unlock relay terminal 2	Zero ohms	Repair open to ground
Unlock relay terminal 1 and depress transmitter button twice	Battery voltage of short duration If OK, replace relay	Repair open to module

5. RH DOOR LOCK SWITCH INOPERATIVE—Remove RH switch mounting screws

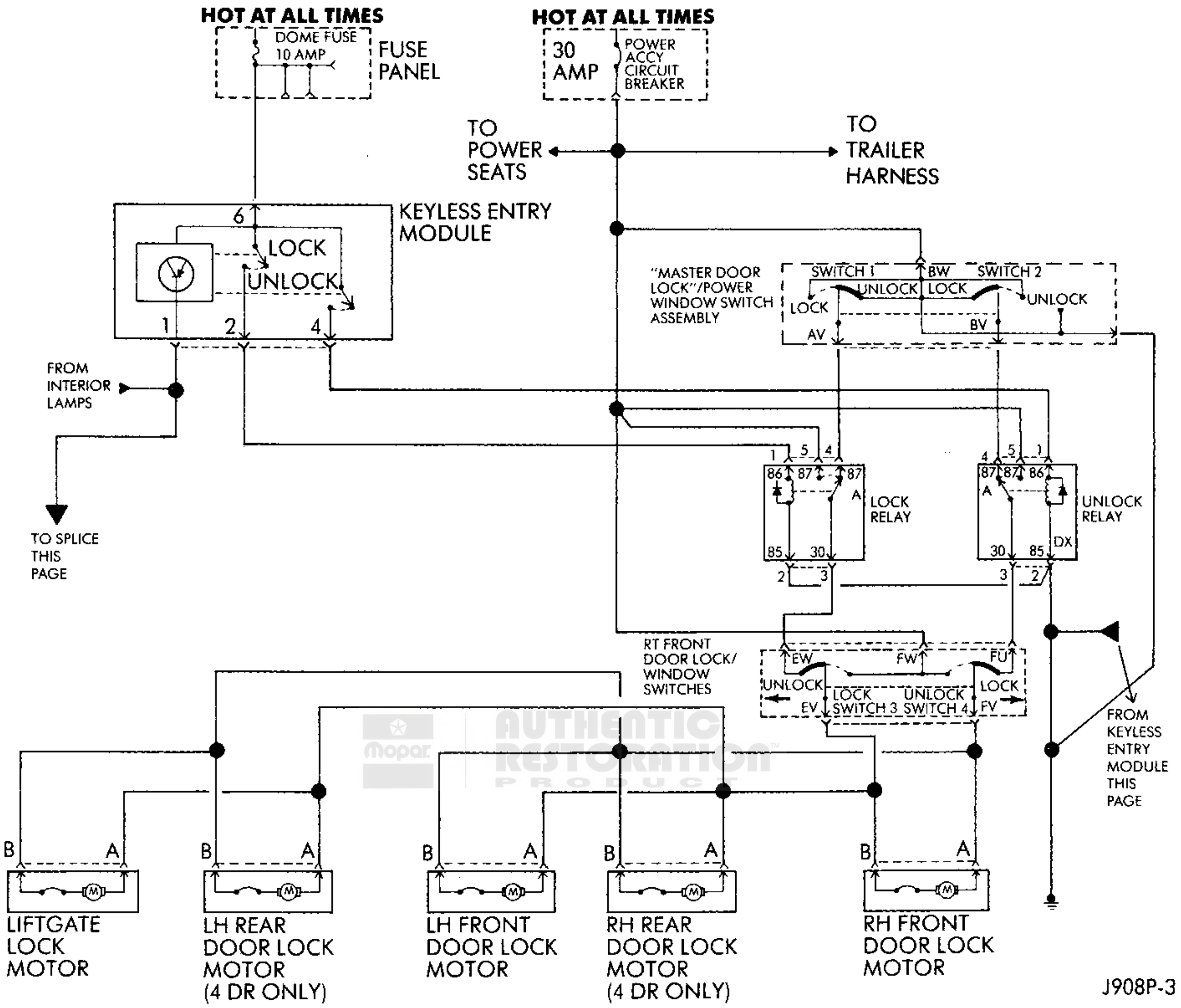
TEST	OK	NOT OK
Probe RED wire at switch	Battery voltage If OK, replace switch	Repair open to circuit breaker

6. ONE OR MORE DOOR LOCK MOTORS INOPERATIVE—Remove door panel of inoperative motor, unplug motor connector

TEST	OK	NOT OK
Harness side of motor connector terminal A	Zero ohms	Repair open to RH Door Lock Switch
Harness side of motor connector terminal B	Zero ohms If OK, replace Motor	Repair open to RH Door Lock Switch



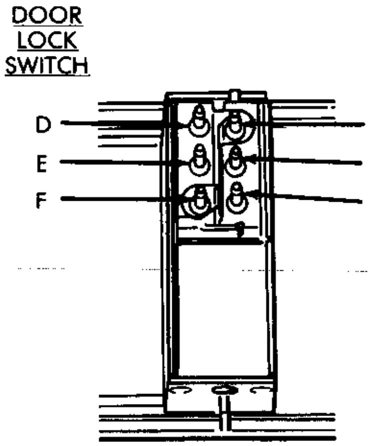
Power Door Locks (2 Door) — XJ

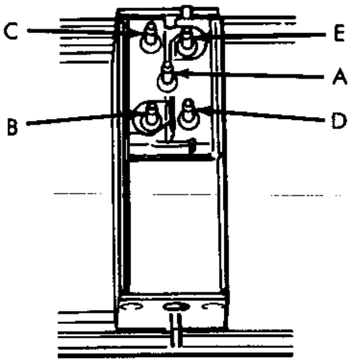


Power Door Locks (4-Door) — XJ

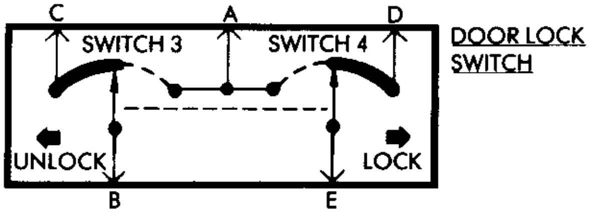
SWITCH TEST

Power Door Locks/Rear Power Windows



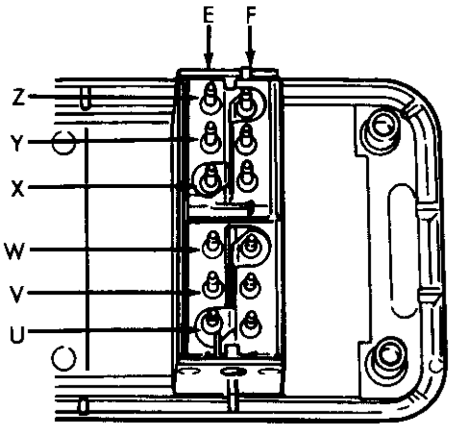


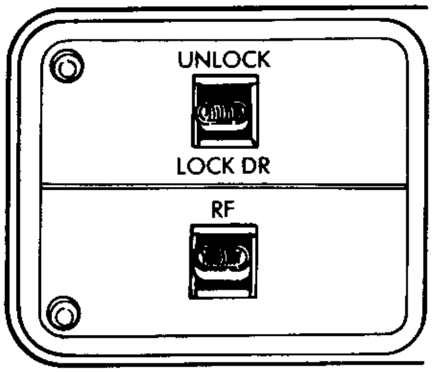
SWITCH DIAGRAM



SWITCH TEST
LH or RH Switch

SWITCH POSITION	TERMINALS	ZERO OHMS
Off (Normal)	B and C	Yes
	D and E	Yes
	All Others	No
Up (Unlock)	A and E	Yes
	B and C	Yes
	All Others	No
Down (Lock)	A and B	Yes
	D and E	Yes
	All Others	No

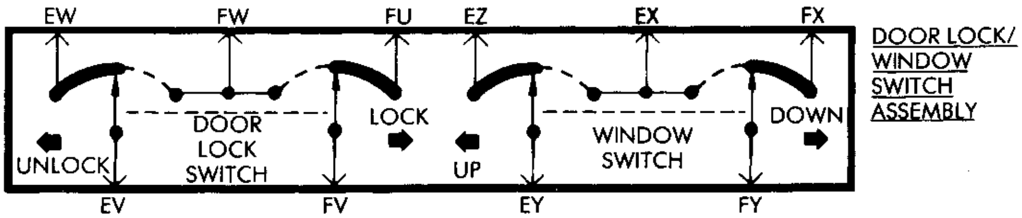




J898P-5

RH Door Lock/Window Switch Assembly

SWITCH DIAGRAM

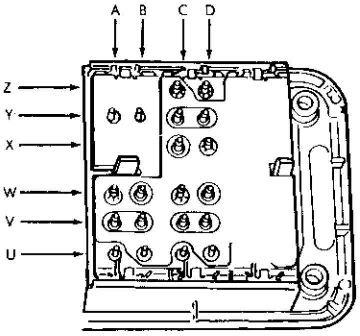


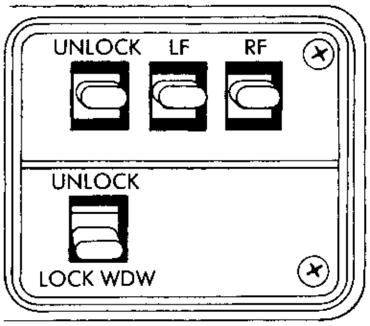
SWITCH TEST
Door Lock Switch

SWITCH POSITION	TERMINALS	ZERO OHMS
Off (Normal)	EV and EW	Yes
	FU and FV	Yes
	All Others	No
Up (Unlock)	EV and EW	Yes
	FV and FW	Yes
	All Others	No
Down (Lock)	EV and FW	Yes
	FU and FV	Yes
	All Others	No

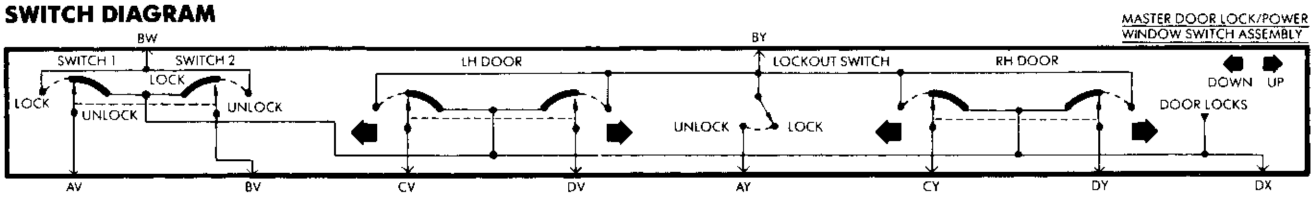
J898P-6

Master Door Lock - 2 Door





SWITCH DIAGRAM



SWITCH TEST
Switch Grounds

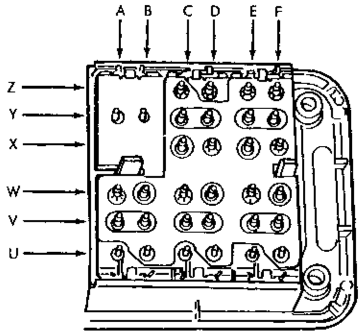
SWITCH POSITION	TERMINALS	ZERO OHMS
Off (Normal)	DX and: AV, BV, CV DV, CY, DY	Yes
	BW and DX	No
	BY and DX	No

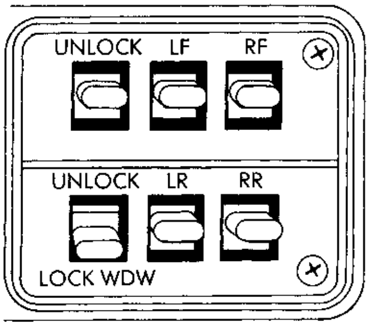
SWITCH TEST
Door Lock

SWITCH POSITION	TERMINALS	ZERO OHMS
Up (Unlock)	BV and BW	Yes
Down (Lock)	AV and BW	Yes

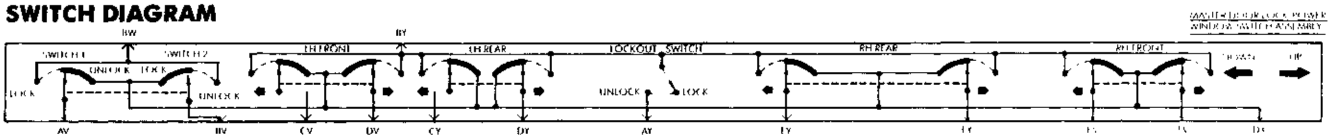
J908P-4

Master Door Lock - 4 Door





SWITCH DIAGRAM



SWITCH TEST
Switch Grounds

SWITCH POSITION	TERMINALS	ZERO OHMS
Off (Normal)	DX and: AV, BV, CV, DV, CY, DY, EY, FY, EV, FV	Yes
	BW and DX	No
	BY and DX	No

SWITCH TEST
Door Lock

SWITCH POSITION	TERMINALS	ZERO OHMS
Up (Unlock)	BV and BW	Yes
Down (Lock)	AV and BW	Yes

J908P-5

ACTUATOR MOTOR STALL TEST

To test the actuator motor, attach an ammeter to the motor terminals and operate the door switch. Replace the actuator motor if current draw exceeds 8 amps at room temperature or if the actuator does not complete its travel in less than one second. Refer to Removal procedures.

SWITCH REPLACEMENT

(1) Remove the interior door latch release assembly and control panel retaining screws (Fig. 1).

(2) Disconnect the control linkage and the wire harness connector.

(3) Remove the latch release and control panel assembly.

(4) The switch is retained to the panel with clips (Fig. 2). Push in on the retainer part of the clip and pry the clips.

(5) To install the switch, position the switch and press in the retainer clips until they snap into position.

SOLENOID AND LATCH ASSEMBLY REPLACEMENT

(1) Remove the interior door latch release assembly and control panel retaining screws (Fig. 1).

(2) Disconnect the control linkage and the wire harness connector.

(3) Remove the latch release and control panel assembly.

(4) Remove the armrest lower retaining screws.

(5) Swing the armrest downward to a vertical position. This is necessary to disconnect the armrest from the upper retainer clip (Fig. 3).

(6) Pull the armrest straight out from the trim panel.

(7) Remove the trim panel with a wide flat blade tool (Fig. 4).

To aid in removal of the trim panel, start at the bottom of the panel.

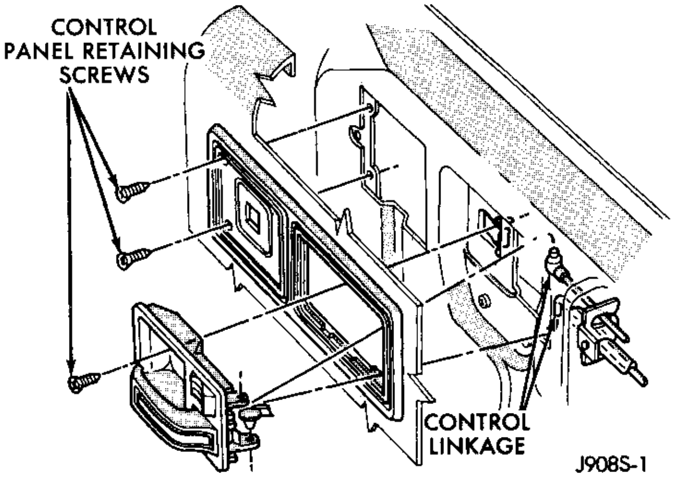


Fig. 1 Power Window/Lock Control Panel Removal/ Installation

(8) Remove the plastic water dam sheet.

(9) Remove the latch retaining screws (Fig. 5).

(10) Grind out or drill out the lock solenoid rivets and remove the solenoid with the latch assembly and remote control rods (Fig. 6).

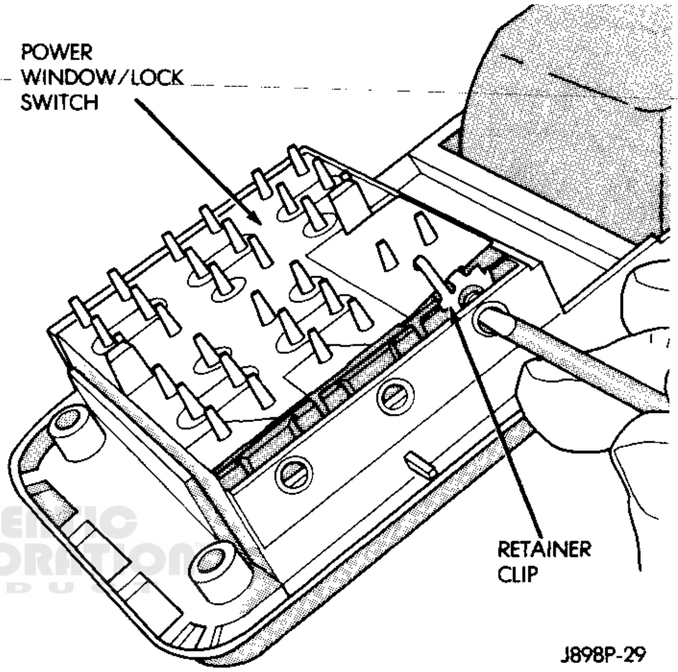


Fig. 2 Power Lock Switch Removal

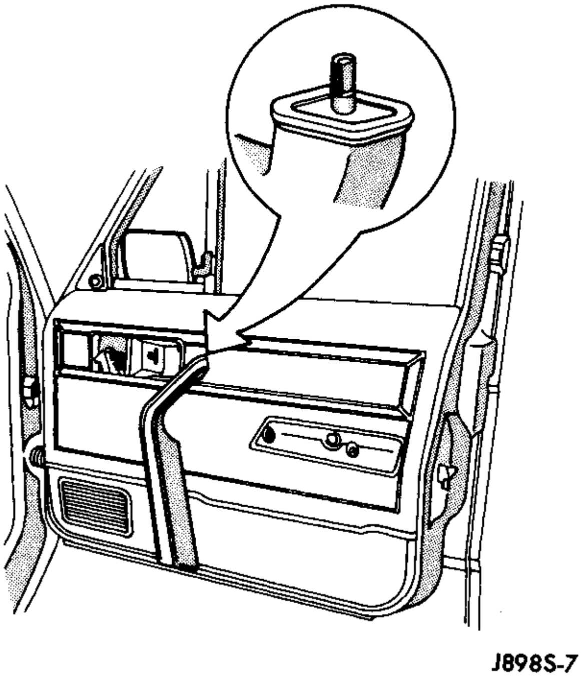


Fig. 3 Armrest Retainer Clip

(11) Place the lock solenoid, latch and remote control rods in the door.

(12) Attach the lock solenoid to the door panel with pop rivets or nuts and screws.

(13) Attach the latch. Tighten the screws to 9 N•m (7 ft. lbs.) torque.

(14) Install the door trim panel and plastic water dam sheet.

(15) Using 3M 08044 or 3M 08041 adhesive/sealant, install the plastic water dam sheet.

(16) Place the trim panel in the installation position and press in the nylon retainers.

(17) Install the armrest.

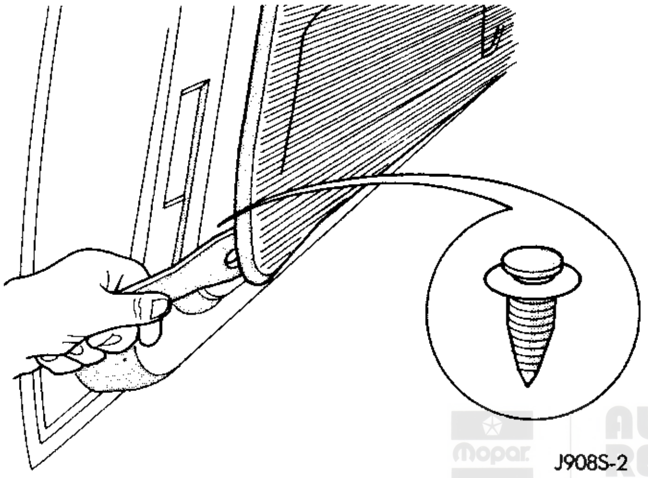


Fig. 4 Trim Panel Removal

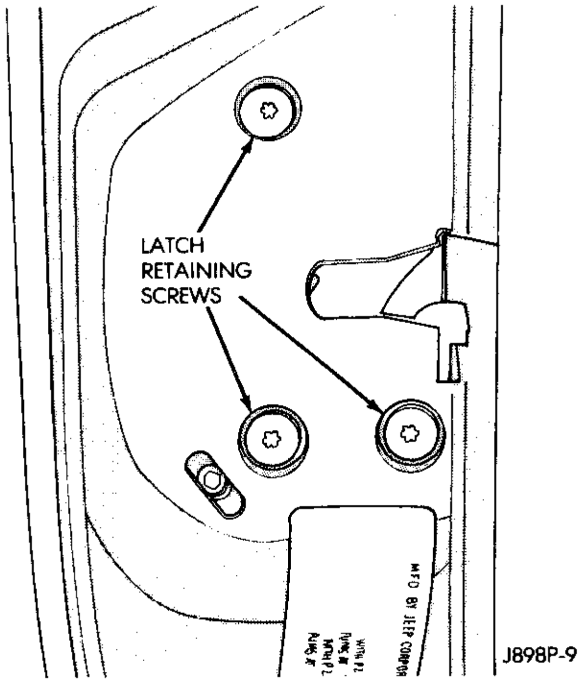


Fig. 5 Latch Removal/Installation

(18) Install the latch release assembly and control panel.

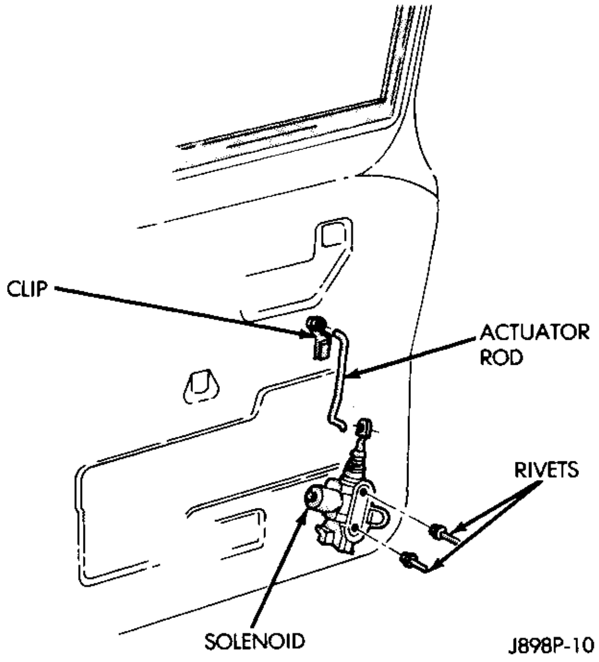


Fig. 6 Solenoid Removal/Installation

LIFTGATE LOCK CYLINDER REPLACEMENT

(1) Remove two screws at the top outside edges of the liftgate trim panel.

(2) Remove the trim panel with a wide flat blade tool (Fig. 7).

To aid in removal of the trim panel, start at the bottom of the panel.

(3) Disconnect the lock actuator linkage clip (Fig. 8).

(4) Remove three latch retaining screws (Fig. 9).

(5) Remove the latch.

(6) Drill out two rivets and remove the solenoid.

(7) To install the solenoid, reverse the removal procedures.

(8) Tighten the latch screws to 9 N•m (7 ft. lbs.) torque.

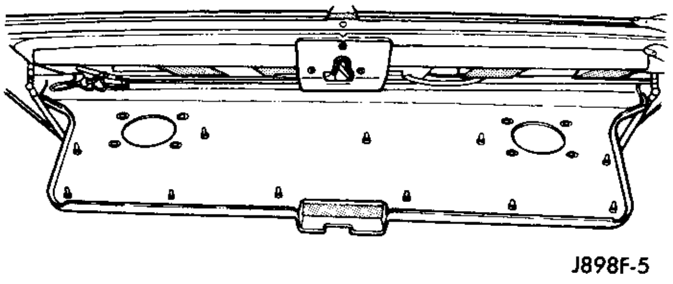


Fig. 7 Liftgate Trim Panel Removal

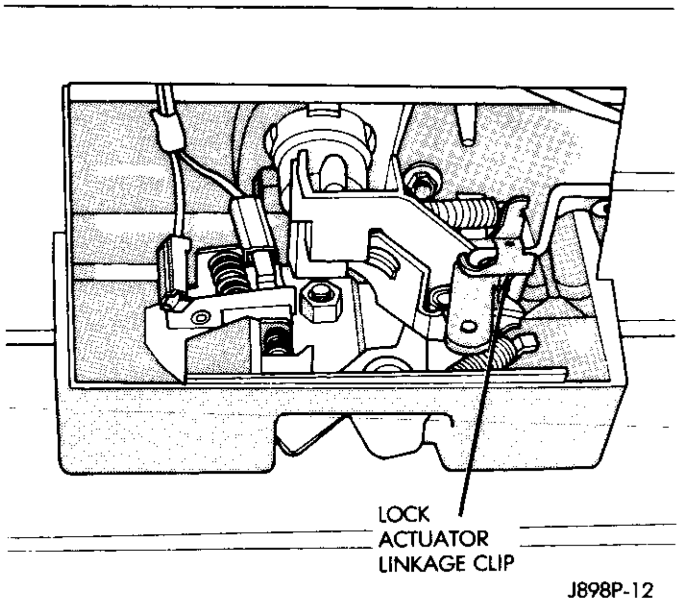


Fig. 8 Lock Actuator Linkage Clip

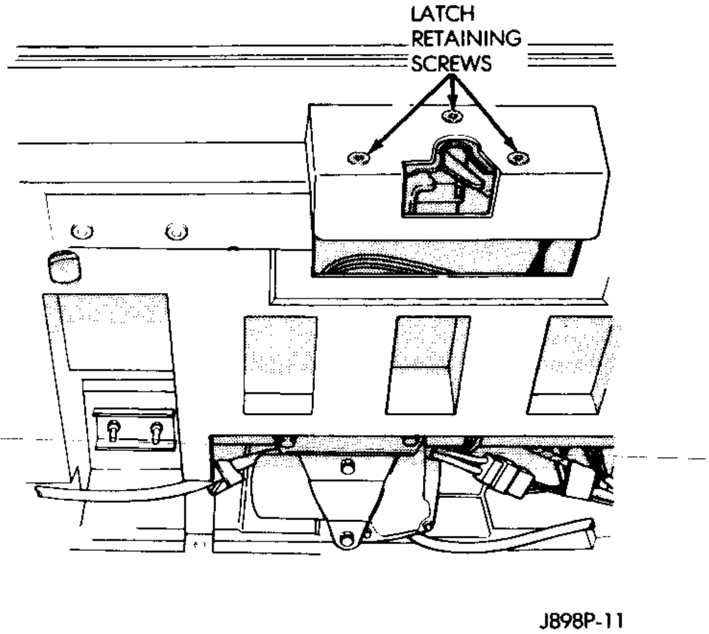


Fig. 9 Latch Assembly Removal/Installation

SJ

INDEX

GENERAL

Door lock actuators are controlled by two rocker switches. To lock the doors, push down on either switch. To unlock the doors from inside the vehicle push upward on either switch.

The power door locks do not lock or unlock the doors from outside the vehicle. Insert the key into the lock cylinder to lock or unlock each individual door.

CIRCUITRY AND TESTING

The power door lock operates with battery power and is independent of the ignition switch.

A 30 amp circuit breaker mounted in the fuse block protects the circuit. The front door harness runs from door to door and is secured to the dash panel with harness retainers.

The right and left rear door harnesses are connected to the front door harness at the top of the side-cowl panels. They are routed along the side sill to the B-pillar, then through the bottom of the B-pillar to the rear doors. The door lock wires are combined in the same harness as the power window wires.

Circuit Breaker Test

Disconnect the harness connector from the fuse panel. Test the fuse panel connection with a test lamp.

If the lamp lights, battery voltage is present. If no battery voltage is present, remove the circuit breaker and test with an ohmmeter. If the circuit breaker is OK then check for battery voltage at the circuit connection on the fuse panel. If there is no battery voltage at the fuse panel, check for failure of the fuse links in the engine compartment.

Switch Test

Test door switches for continuity with a self-powered test lamp or an ohmmeter. Continuity should exist between terminal at various switch positions: UNLOCK, OFF and LOCK (Fig. 1).

Actuator Motor Stall Test

To test the actuator motor, attach an ammeter to the motor terminals and operate the door switch (Fig. 2). Replace the actuator motor if the current draw exceeds 8 amps at room temperature or if the actuator does not complete its travel in less than one second.

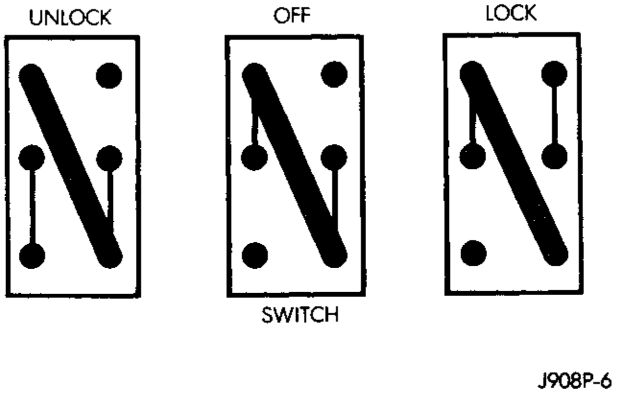


Fig. 1 Power Lock Switch Continuity

TROUBLESHOOTING POWER DOOR LOCKS (Refer To Schematic)

1. NO DOOR LOCKS OPERATE USING DOOR LOCK SWITCHES—Power ACCY circuit breaker installed

TEST	OK	NOT OK
Probe circuit breaker terminal on Fuse Panel	Battery voltage	Replace circuit breaker
Remove RH kickpanel and both relays and test Lock relay terminal 3	Zero ohms	Next step
Unlock relay terminal 3	Zero ohms	Repair open to ground
Unlock relay terminal 3, hold LH switch in LOCK position	Battery voltage	Next step
Lock relay terminal 3, hold LH switch in UNLOCK position	Battery voltage	Repair open to circuit breaker (refer to Switch Testing)
Lock relay terminal 1 to Unlock relay terminal 1	Almost zero ohms (motors' resistance) If ok, replace relays	Repair open through RH door lock switch (refer to Switch Testing)

2. NO DOOR LOCKS OPERATE, USING TRANSMITTER

TEST	OK	NOT OK
Aim transmitter at receiver (keyless entry module) from 1 to 3 feet away and press button	Door locks operate	Change batteries as outlined in owner's manual
Side of cigar lighter socket to ground	Zero ohms	Repair open to ground
Remove RH kickpanel and both relays and test Keyless entry module terminal H	Zero ohms	Repair open to ground
Keyless entry module terminal A	Battery voltage	Repair open to fuse
Jumper test leads Keyless entry module terminal A to terminal G	Doors lock If OK, replace module	Go to step 3
Jumper test leads Keyless entry module terminal A to terminal B	Doors unlock If OK, replace module	Go to step 4

3. LOCK RELAY—Remove RH kick panel and lock relay

TEST	OK	NOT OK
Lock relay terminal 4	Battery voltage	Repair open to circuit breaker
Lock relay terminal 2	Zero ohms	Repair open to ground
Lock relay terminal 5 and depress transmitter button twice	Battery voltage of short duration If OK, replace relay	Repair open to module

4. UNLOCK RELAY—Remove RH kick panel and unlock relay

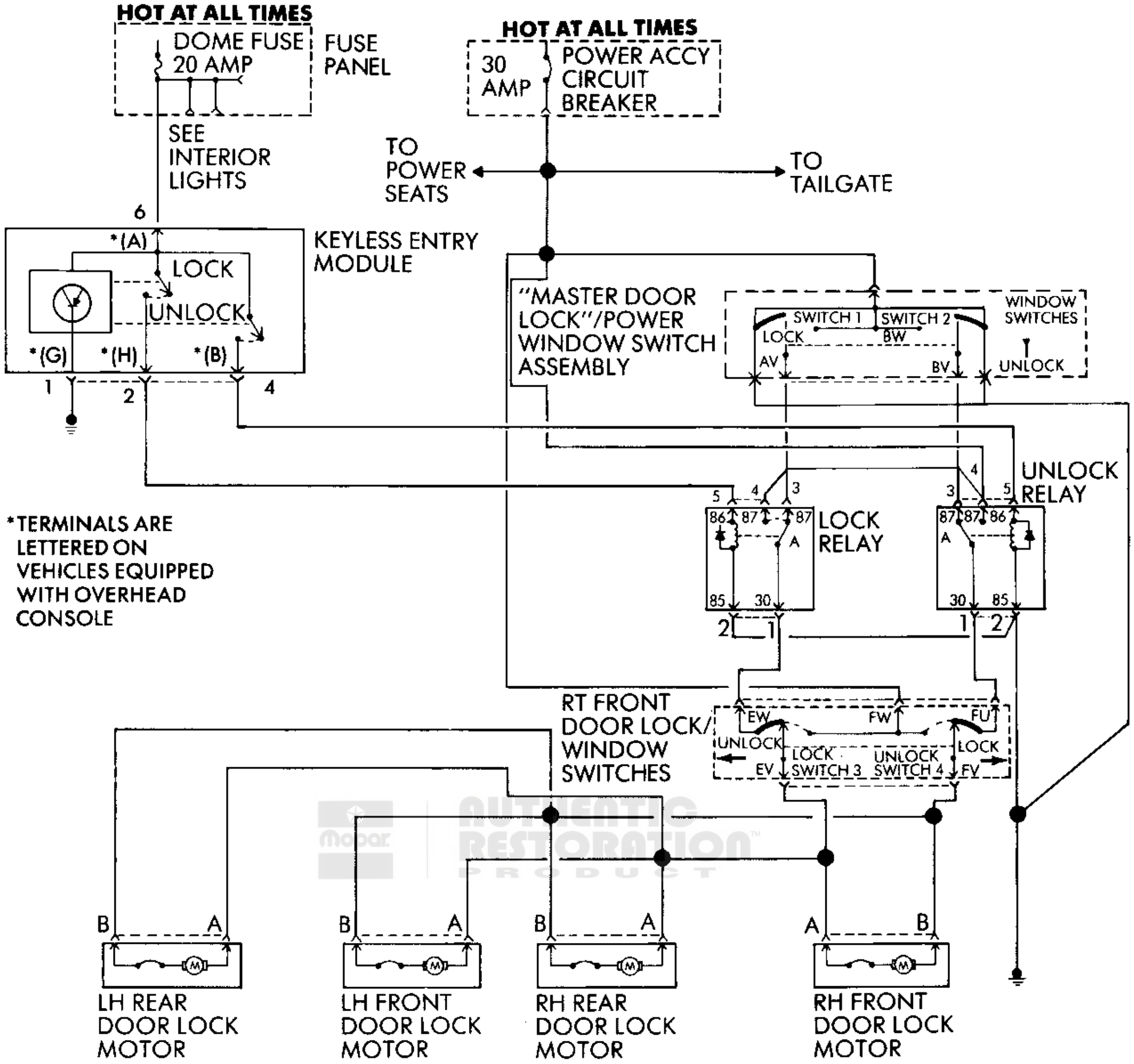
TEST	OK	NOT OK
Unlock relay terminal 4	Battery voltage	Repair open to circuit breaker
Unlock relay terminal 2	Zero ohms	Repair open to ground
Unlock relay terminal 5 and depress transmitter button twice	Battery voltage of short duration If OK, replace relay	Repair open to module

5. RH DOOR LOCK SWITCH INOPERATIVE—Remove RH switch mounting screws

TEST	OK	NOT OK
Probe RED wire at switch	**Battery voltage If OK, replace switch**	**Repair open to circuit breaker**

6. ONE OR MORE DOOR LOCK MOTORS INOPERATIVE—Remove door panel of inoperative motor, unplug motor connector

TEST	OK	NOT OK
Harness side of motor connector terminal A	Zero ohms	Repair open to RH Door Lock Switch
Harness side of motor connector terminal B	Zero ohms If OK, replace Motor	Repair open to RH Door Lock Switch



J908P-7

Fig. 2 Power Door Lock Schematic — SJ

SWITCH REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove the overlay on the armrest and remove the attaching screws and armrest.

(3) Remove the door latch remote control handle.

(4) Remove the woodgrain insert at both ends of the assist handle.

(5) Remove the attaching screws and assist handle.

(6) Remove the power door lock/window bezel.

The trim panels consist of fiberboard covered with a vinyl material. They are fastened to the door with plastic clips inserted into holes in the door inner panel and screws along the bottom edge.

(7) Remove the trim panel attaching screws on the bottom of the trim panel.

(8) Pry loose the trim panel-to-door clips along the sides with a wide blade tool and remove the trim panel.

(9) Loosen the setscrew securing the remote control mirror control cable to the escutcheon.

(10) Disconnect the power mirror switch harness after the trim panel is removed.

(11) Remove the watershield.

(12) Remove the switch housing from the inner door panel.

(13) Disconnect the wiring and remove the switch. The connector is retained to the switch with clips. Pry the clips up to disconnect.

(14) To install the switch, hold the retainer clips in position on the switch and slide the switch into the housing. Press in the retainer clips until they snap into position.

(15) Reverse the removal procedures to finish the installation.

LOCK ACTUATOR MOTOR REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove the overlay on the armrest and remove the attaching screws and armrest.

(3) Remove the door latch remote control handle.

(4) Remove the woodgrain insert at both ends of the assist handle.

(5) Remove the attaching screws and assist handle.

(6) Remove the power door lock/window bezel.

The trim panels consist of fiberboard covered with a vinyl material. They are fastened to the door with plastic clips inserted into holes in the door inner panel and screws along the bottom edge.

(7) Remove the trim panel attaching screws on the bottom of the trim panel.

(8) Pry loose the trim panel-to-door clips along the sides with a wide blade tool and remove the trim panel.

(9) Loosen the setscrew securing the remote control mirror control cable to the escutcheon.

(10) Disconnect the power mirror switch harness after the trim panel is removed.

(11) Remove the watershield.

(12) Remove the actuator motor by drilling out the rivets attaching the motor to the door panel with a 6.35 mm (1/4 in.) drill bit.

(13) Disconnect the actuator rod from the bellcrank (Fig.3).

(14) Disconnect the wire from the actuator motor and remove the actuator motor.

(15) To install the actuator, use two 1/3-20 X 1/2 in. screws and locknuts or rivets and reverse the removal procedures.

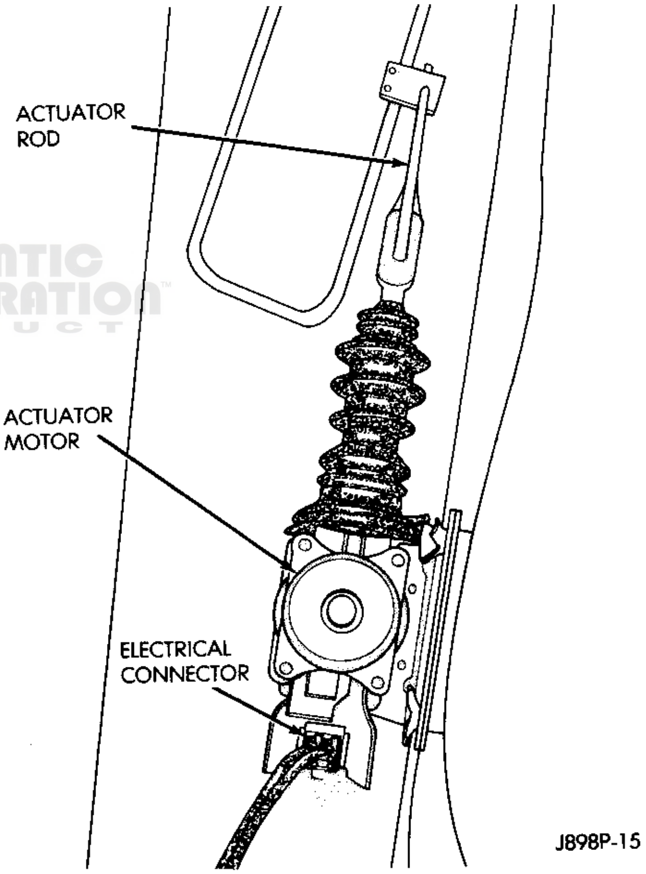


Fig. 3 Actuator Motor Removal/Installation

KEYLESS ENTRY

INDEX

SYSTEM DESCRIPTION

The keyless entry system consists of a portable remote control transmitter and a receiver mounted in the overhead console or between the sun visors. System operation is based on a coded infrared signal from the transmitter to the receiver.

When the keyless entry system is activated, the corresponding relay operates to supply voltage to the motors. The use of either relay determines the polarity of the voltage that is supplied to the door lock motors.

When the keyless entry system is used, the transmitter sends a signal to the keyless entry module. If the doors are unlocked, the module activates a transistor switch to apply voltage to the lock relay coil. The coil is energized to close the normally open contacts of the lock relay. Battery voltage from the relay is applied to the door lock motors to lock the doors. Current flows in the same path to ground as it does when the master door lock switch is used.

When the doors are locked, a transistor switch in the keyless entry module applies voltage to the unlock relay coil and a similar action takes places to unlock the doors.

TRANSMITTER

The pocket size, solid state transmitter operates on two 1.5 volt batteries and is attached to a key ring for convenient carrying (Figs. 1,2). The transmitter is activated by pressing the signal button on the side of the case. This closes the internal contacts which complete the battery circuit.

The battery voltage activates the transmitter diode which in turn generates a coded infrared signal. The signal is transmitted as pulses of infrared light.

A red LED on the side of the transmitter case will provide low battery indication by not lighting when the transmitter is activated.

RECEIVER

The receiver is in circuit with the electric door lock system. The coded infrared signal is picked up by the receiver diode and is shaped, amplified and decoded by an integrated circuit within the receiver. If the signal code received matches the code in the receiver memory circuit, the receiver triggers the door lock/unlock relays in the door lock system. The relays complete the circuit to the electric door lock solenoid to either lock or unlock the doors.

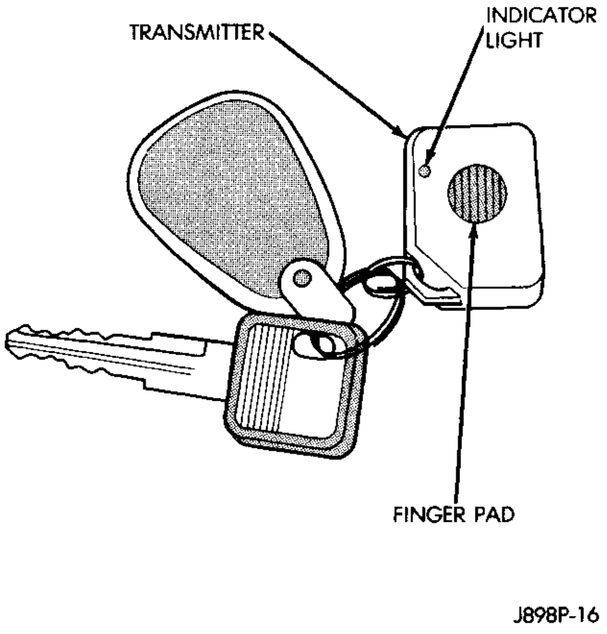


Fig. 1 Keyless Entry Transmitter

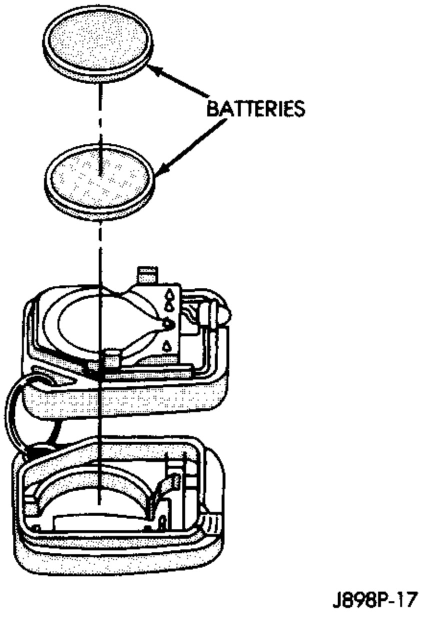


Fig. 2 Battery Replacement

The receiver and transmitter supplied with each vehicle are a matched set. Each matched set is assigned a signal code that is unique. The code is shown on both the transmitter and receiver. Neither the transmitter nor the receiver from one vehicle is interchangeable with the one of another vehicle.

SYSTEM OPERATION

To activate the system, aim the transmitter diode toward the receiver and press the transmitter signal button to lock or unlock the doors as desired.

Effective transmitter range is 1.9 meters (6 ft.) with the transmitter positioned no more than 45 degrees from the receiver centerline.

The keyless entry system can be operated conventionally with the standard door key in the event of a malfunction.

Refer to Power Door Locks for Diagnosis and Wiring Diagrams.

TRANSMITTER SERVICE

If the receiver malfunctions, it will be necessary to replace both receiver and transmitter. However, if only the transmitter is lost, be sure to supply the receiver code number so the new transmitter can be properly coded. Replacement receivers (with transmitters) and transmitters are available.

Batteries may not be supplied with some replacement transmitters. Be sure to check a replacement transmitter before attempting to activate the system.

Transmitter Battery Replacement

Separate the transmitter at the middle seam (Fig. 3).

(2) Remove and discard the old batteries (Fig. 2).

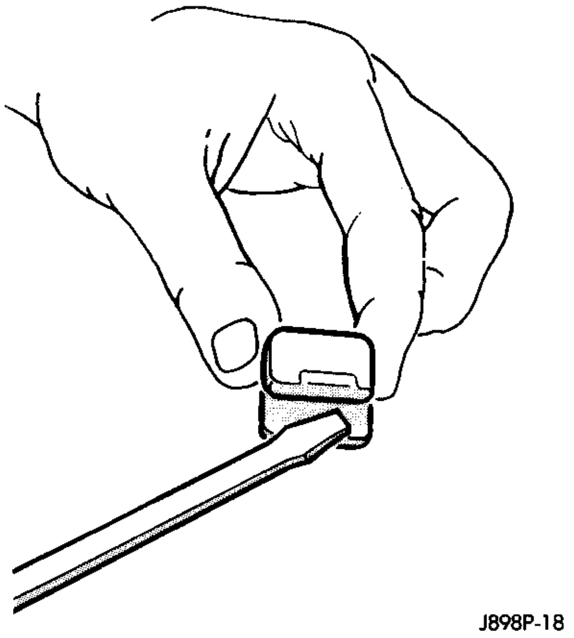


Fig. 3 Separate Transmitter Halves

(3) Install the replacement CR 2016 batteries. Be sure the batteries are positioned according to polarity as indicated on the transmitter battery receptacles.

(4) Assemble the transmitter and verify the correct battery installation. The voltage indicator light will glow when the batteries are properly installed.

Code Location

To obtain the code number required for replacement of the transmitter, inspection of the receiver will be necessary. Refer to Receiver Removal for receiver code.

(1) Separate the transmitter at the middle seam (Fig. 3).

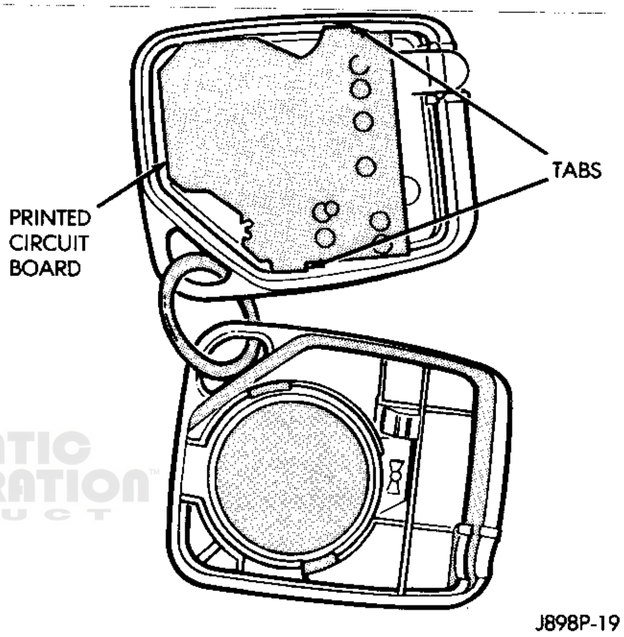


Fig. 4 Printed Circuit Board Removal/Installation

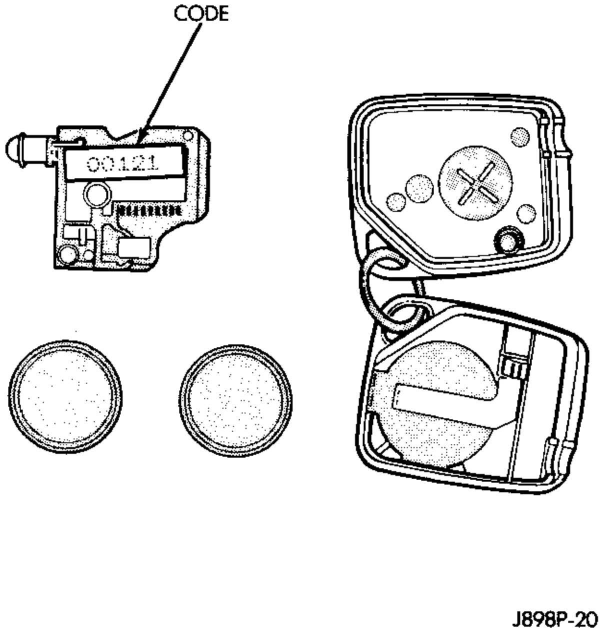


Fig. 5 Transmitter Code Location

(2) Relieve tension on tabs and remove the printed circuit board (Fig. 4).

(3) Inspect the circuit board for the code number (Fig. 5).

RECEIVER SERVICE

With Overhead Console

(1) Remove screw forward of the compass unit (Fig. 6).

(2) Flex housing outward while pressing upward to disengage the housing from the rear bracket (arrow 1) (Fig. 6).

(3) Slide console rearward until the console detaches from the front mounting bracket (arrow 2) (Fig. 6).

(4) While still pressing upwards on the rear of the console (arrow 1), slide the console forward holding the front of the console away from the headliner (arrow 2) until the rear of the console detaches from the headliner and becomes free (Fig. 7).

(3) Disconnect wire harnesses from keyless entry and compass (Fig. 8).

(4) Pinch forward area of receiver cover and release clips. Slide cover out from under rib (Fig. 9).

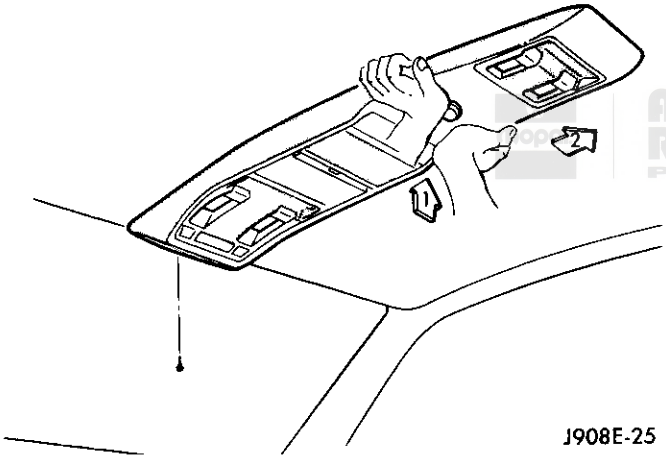


Fig. 6 Remove/Install Overhead Console

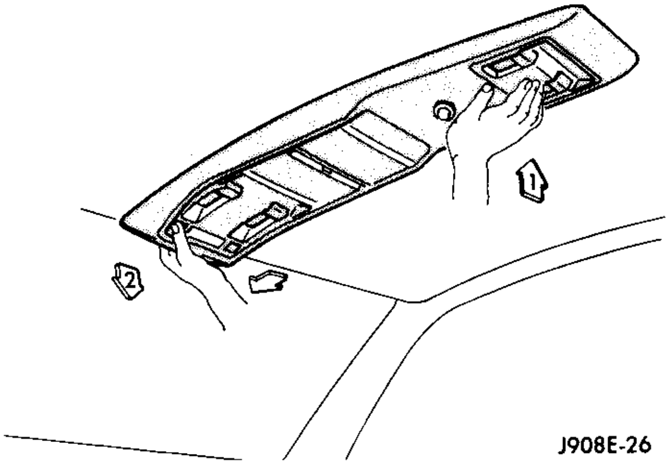


Fig. 7 Remove/Install Overhead Console

(5) Remove the screw and the printed circuit board can be removed.

(6) Inspect the printed circuit board for the code number (key) for the correct replacement transmitter (Fig. 10).

(7) To install the overhead console, reverse the removal procedures. Be sure to flex housing outward near the keyless entry receiver until the console snaps onto the rear mounting bracket.

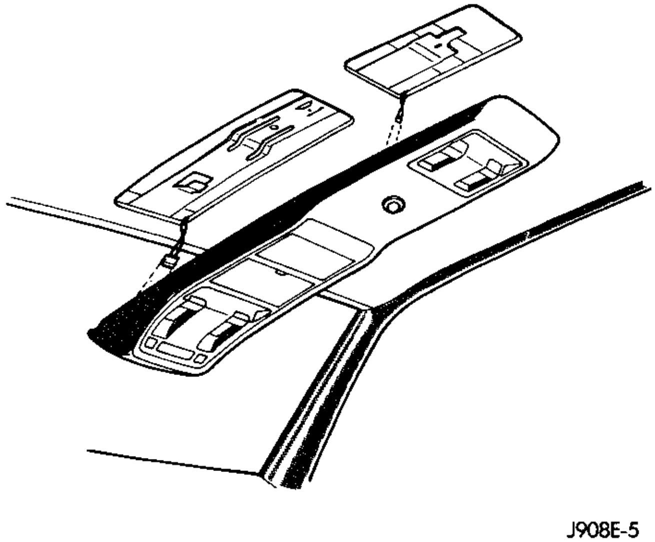


Fig. 8 Disconnect Wire Harnesses

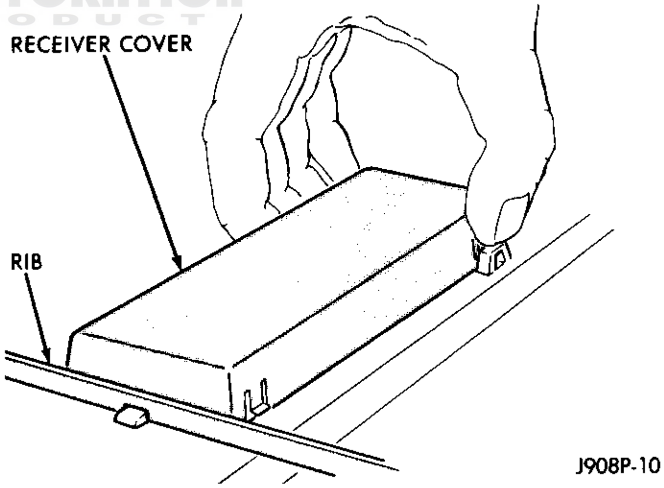


Fig. 9 Keyless Entry Receiver Cover Removal/Installation

Without Overhead Console

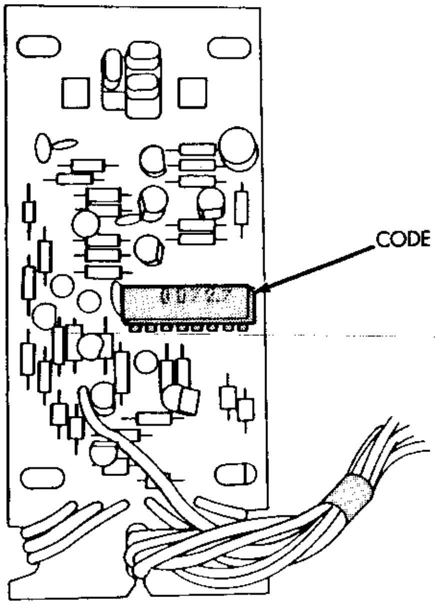
(1) Remove the screws attaching the receiver/bezel to the headlining.

(2) Remove the receiver from the bezel by depressing the retaining clips on the back of the receiver and pushing the receiver out of the bezel. Remove the receiver lens.

(3) Disconnect the receiver harness connector.

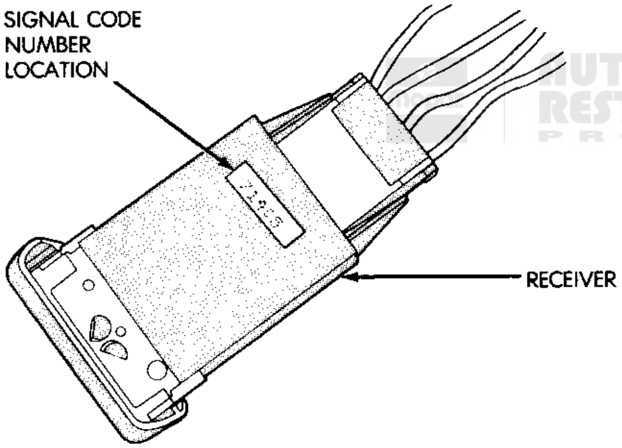
(4) Inspect the receiver housing for the code number (key) for the correct replacement transmitter (Fig. 11).

(5) Reverse the removal procedures to install the receiver.



J898P-21

Fig. 10 Receiver Code Location



J908P-8

Fig. 11 Receiver Code Location

DOOR LOCK/UNLOCK RELAY REPLACEMENT XJ

(1) Remove the right side kick panel.

(2) Remove the relay screws (Fig. 12).

(3) Disconnect the relay(s).

(4) Install the new relay(s) in the wire harness and attach the relay to the right cowl panel.

(5) Install the right kick panel.

DOOR LOCK/UNLOCK RELAY REPLACEMENT SJ

(1) Remove the 4WD Selection Switch mounting screws and lower the switch housing (Fig. 13).

(2) Remove the lower evaporator housing mounting screws and ground wire screw (Fig. 14).

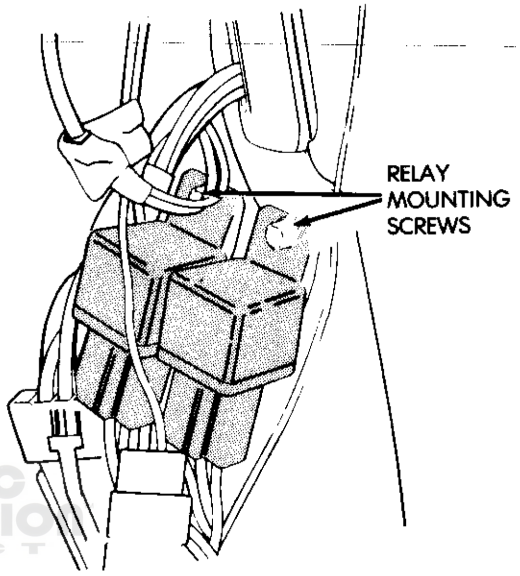
(3) Lower the evaporator housing. This will allow access to the relays mounted on the top of the heater and defroster housing (Figs. 15 and 16).

(4) Squeeze the retaining clip(s) holding the relay(s) (Fig. 16) to the bracket and remove the relay(s).

(5) Install the new relay(s) in the wire harness and attach the relay to the bracket.

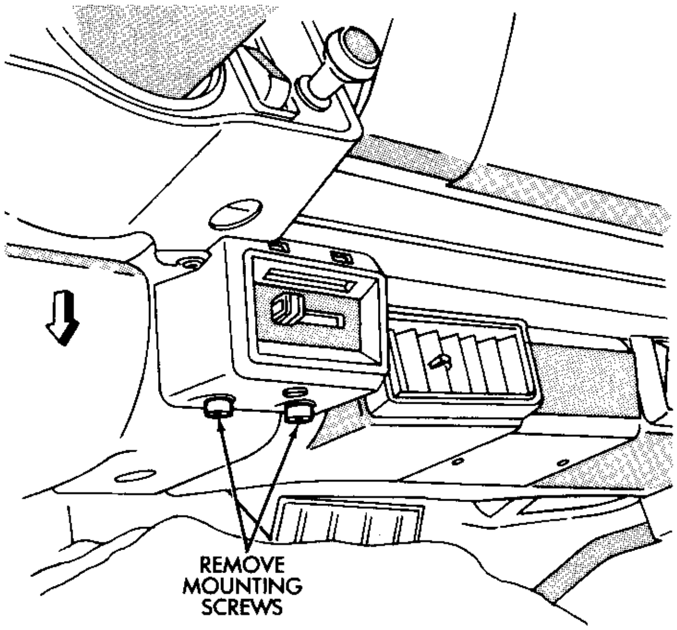
(5) Install the right kick panel.

(6) Raise the evaporator housing into position. Install the mounting screws.



J898P-26

Fig. 12 Door Lock/Unlock Relays - XJ



J8924-1

Fig. 13 Remove/Install 4WD Switch Housing

(7) Attach the ground wire (Fig. 17).

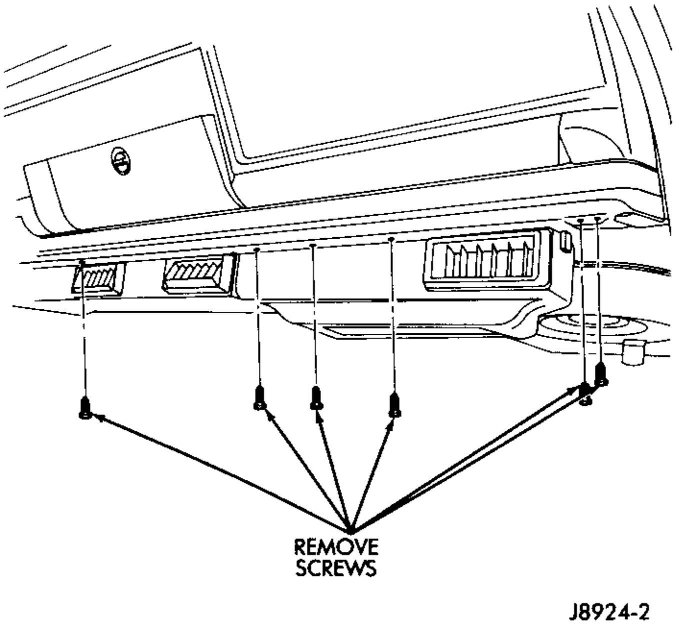


Fig. 14 Remove Lower Evaporator Housing Screws

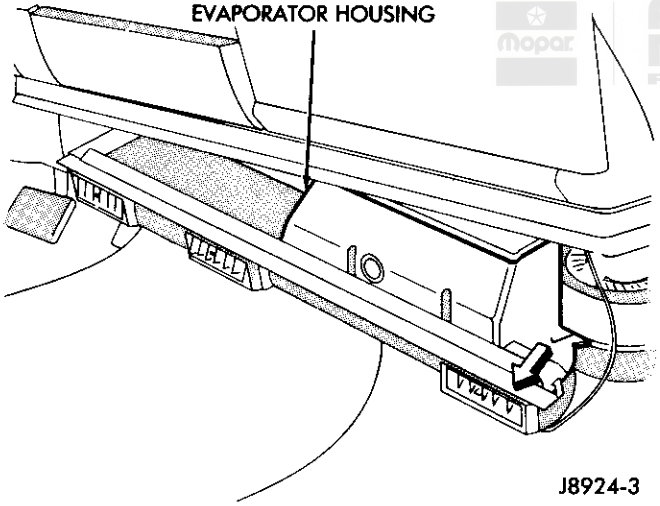


Fig. 15 Lower Evaporator Housing

(8) Install the 4WD Selection Switch. Attach the mounting screws.

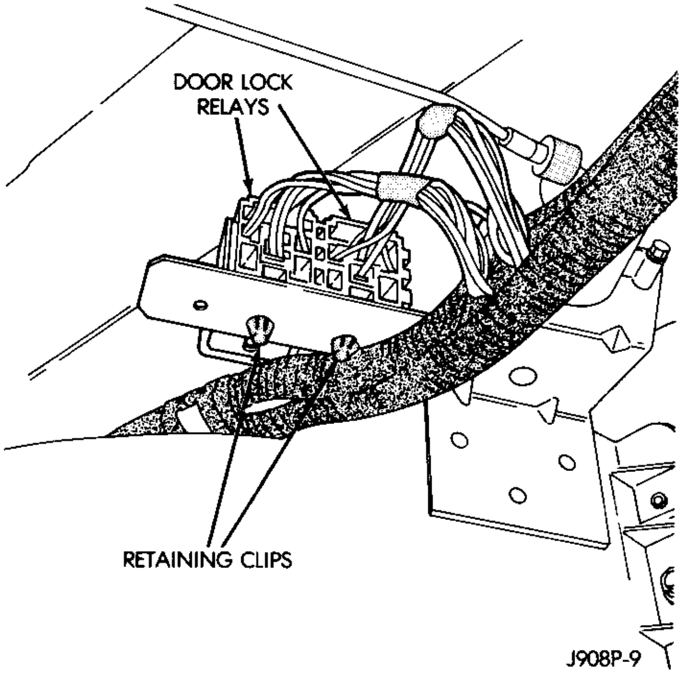


Fig. 16 Door Lock/Unlock Relays — SJ

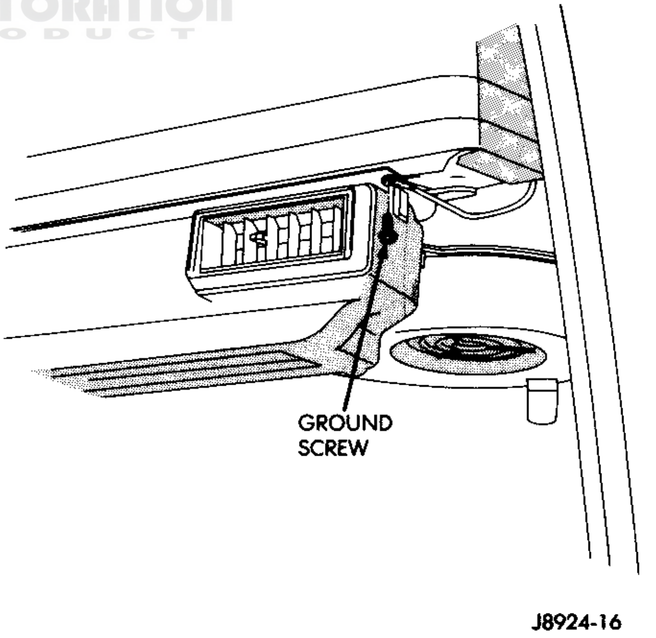


Fig. 17 Attach Ground Wire

POWER SEATS

CONTENTS

XJ

INDEX

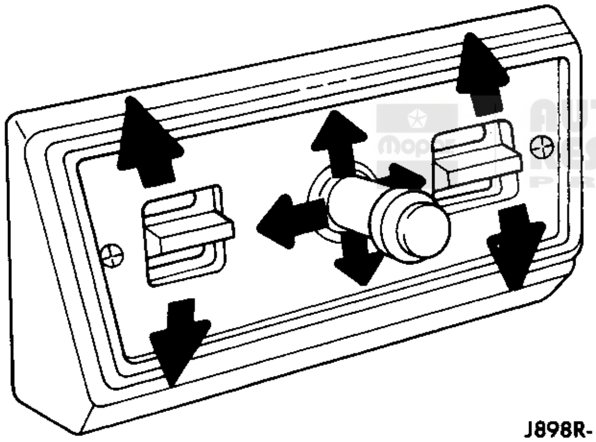


Fig. 1 Power Seat Switch — XJ

OPERATION

The power seats can be adjusted in six different directions: Up, Down, Forward, Back, Tilt Forward or Tilt Rearward.

The control switch is located on the lower outboard side of the seat (Fig. 1).

The front lever on the switch raises or lowers (tilts) the front of the seat; the center lever raises or lowers the complete seat by moving the switch up or down. It also moves it forward or rearward by moving the switch forward or rearward. The rear lever raises or lowers (tilts) the back of the seat.

DESCRIPTION

There are three reversible motors that operate the power seats. The front and back of a seat are operated by different motors. They can be raised or lowered independently of each other. When the center position seat switch is pushed to the UP or DOWN position, both rear and front motors run to move the front and back of the seat at the same time.

The forward-back motor is operated by the center position seat switch. When the switch is held in the FORWARD position, battery voltage is applied through the switch contacts to pin S3 and the forward-back motor. The motor is grounded through pin S4 and the contacts of the back switch to pin 2 and to ground. The motor runs to drive the seat forward until the switch is released.

With the switch in the BACK position, pin S4 receives battery voltage and pin S3 is grounded. This reversed polarity causes the motor to run in the opposite direction and drive the seat backward.

The front motor works in a similar way when the front height switch is operated.

To raise the entire seat, the center position seat switch is held in the UP position. This applies battery voltage to both pins S1 and S5 and the front and rear motors. Pins S2 and S6 are grounded through the down switches and the lower switch. Both motors run to drive the entire seat up. A similar action occurs to move the entire seat down.

Each motor contains a self-resetting circuit breaker to protect it from overload. Consecutive or frequent resetting must not be allowed to continue. Make necessary repairs.

TROUBLESHOOTING

Before any testing is attempted the battery should be fully charged and all connections and pins cleaned and tightened to insure proper continuity and grounds.

With the dome light on, apply switch in direction of the failure. If the dome light dims, the seat may be jamming. Check for binding. If the dome light does not dim, then proceed with the following electrical tests.

1. SEAT MOTOR ASSEMBLY

TEST	OK	NOT OK
Position Seat Switch to move all three Seat Motors	Seat moves in all directions	Go to step 2 If one or more motors operate, refer to Switch Testing
Seat Switch	Passes test	Replace defective motor

2. NO SEAT MOTORS OPERATE—Pwr ACCY breaker installed

TEST	OK	NOT OK
Probe PWR ACCY circuit breaker, on fuse panel	Battery voltage	Replace circuit breaker
Remove switch mounting screws and probe Red wire at switch	Battery voltage	Repair open to power
Probe BLK wire at switch	Zero ohms If OK, replace switch	Repair open to ground

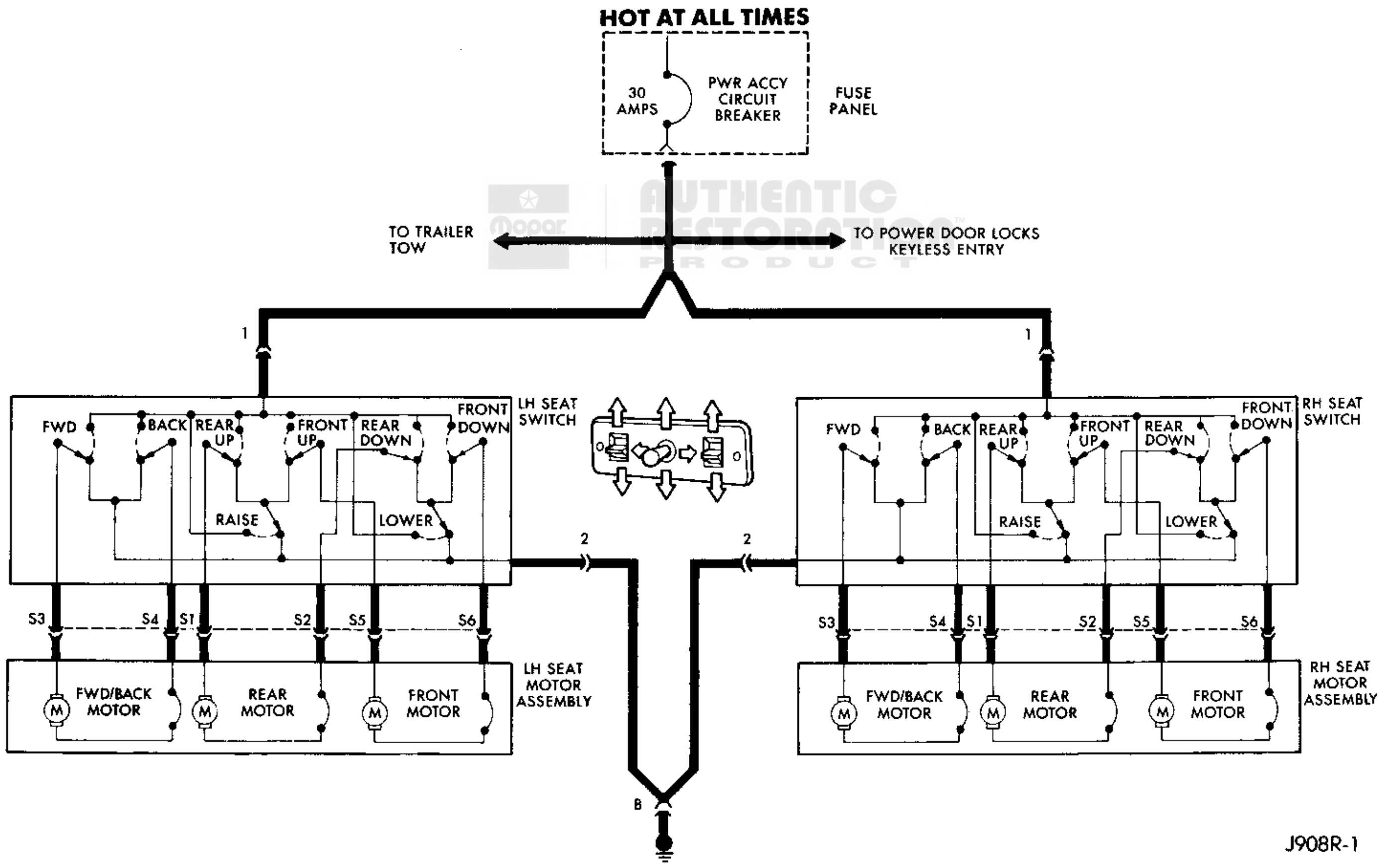
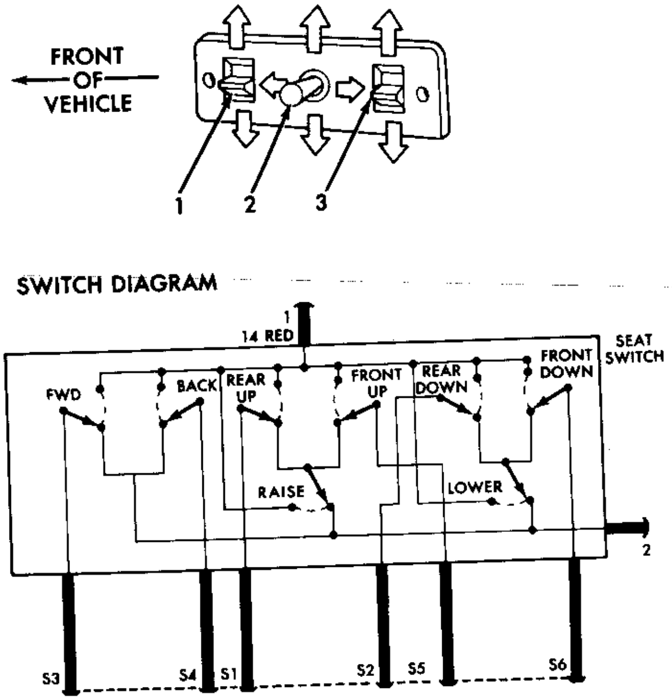


Fig. 2 Power Seat Schematic — XJ

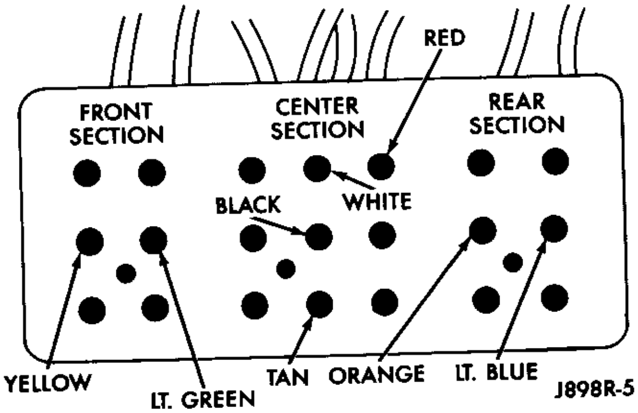
SWITCH TESTING



J898R-3

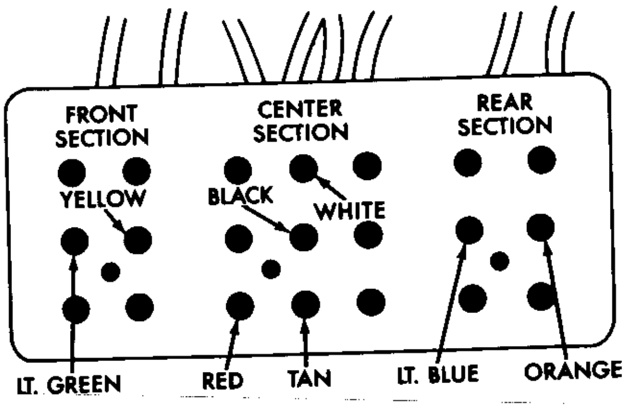
Fig. 3 Switch Diagram

Driver Side



J898R-5

Passenger Side



J898R-6

SWITCH TEST
SWITCHES 1, 2 AND 3 (GROUNDS)

SWITCH POSITION	TERMINALS	ZERO OHMS
OFF (NORMAL)	2 AND: S1, S2, S3, S4, S5 AND S6	YES
	1 AND 2	NO

SWITCH TEST
SWITCH 1

SWITCH POSITION	TERMINALS	ZERO OHMS
UP (FRONT)	1 AND S5	YES
DOWN (FRONT)	1 AND S6	YES

SWITCH TEST
SWITCH 2

SWITCH POSITION	TERMINALS	ZERO OHMS
UP (RAISE)	1 AND S1	YES
	1 AND S5	YES
DOWN (LOWER)	1 AND S2	YES
	1 AND S6	YES
FORWARD (FWD)	1 AND S3	YES
BACKWARD (BACK)	1 AND S4	YES

SWITCH TEST
SWITCH 3

SWITCH POSITION	TERMINALS	ZERO OHMS
UP (REAR)	1 AND S1	YES
DOWN (REAR)	1 AND S2	YES

J898R-4

POWER SEAT MOTOR REPLACEMENT

(1) Disconnect power seat wire harness at motor.

(2) Remove bolts attaching seat frame to floor pan and remove seat.

(3) Disconnect motor ground wire.

CAUTION: Take care to avoid excessive bending of the three drive cables when removing/installing the motor assembly.

(4) Remove screws attaching motor assembly to seat frame and remove motor assembly and mounting spacers (Fig. 4).

(5) To install the power seat motor, reverse the removal procedures.

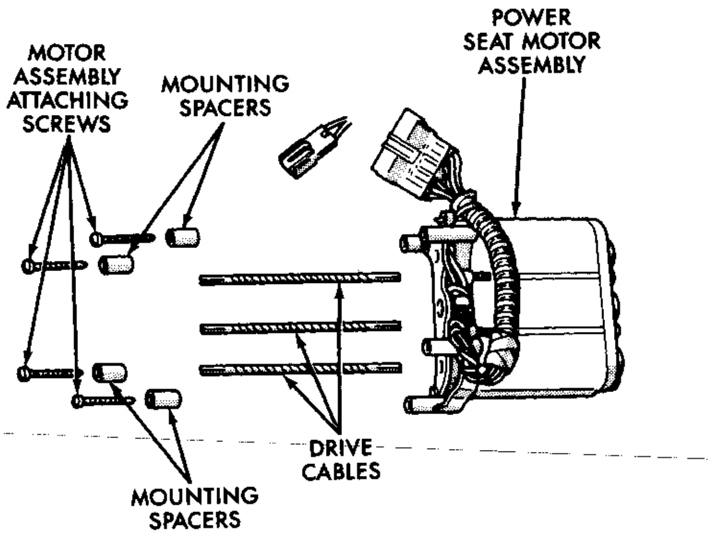


Fig. 4 Power Seat Motor Assembly

SJ

INDEX

GENERAL

The power seats can be adjusted in six different directions: Up, Down, Forward, Back, Tilt Forward or Tilt Rearward.

The control switch is located on the lower outboard side of the seat (Fig. 5).

The front lever on the switch raises or lowers (tilts) the front of the seat; the center lever raises or lowers the complete seat by moving the switch up or down. It also moves it forward or rearward by moving the switch forward or rearward. The rear lever raises or lowers (tilts) the back of the seat.

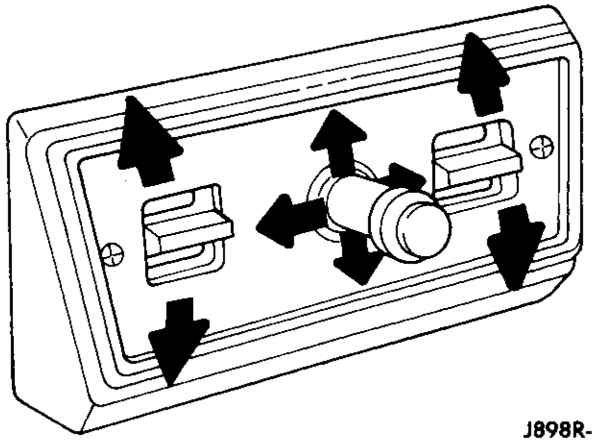


Fig. 5 Power Seat Switch

A three armature permanent magnet reversible motor is coupled through cables to the rack and pinion assemblies located in the seat tracks, providing the various seat movements.

The electrical circuit is protected by a 30 amp circuit breaker located on the fuse block.

TROUBLESHOOTING

Before any testing is attempted the battery should be fully charged and all connections and terminals cleaned and tightened to insure proper continuity and grounds.

With the dome light on, apply switch in direction of the failure. If the dome light dims, the seat may be jamming. Check for binding. If the dome light does not dim, then proceed with the following electrical tests.

Disconnect the wiring harness at the connector under the seat. Connect a 12-volt test lamp between the red and black wire in the female connector on the harness. If the test lamp lights, the harness to the seat is good. If the test lamp does not light, check as follows:

- current at the fuse panel circuit breaker
- continuity in the red wire between the fuse panel and harness connector under the seat

- continuity in the black wire and proper connection to ground

Remove the test lamp and connect the harness.

Remove the switch from the seat harness.

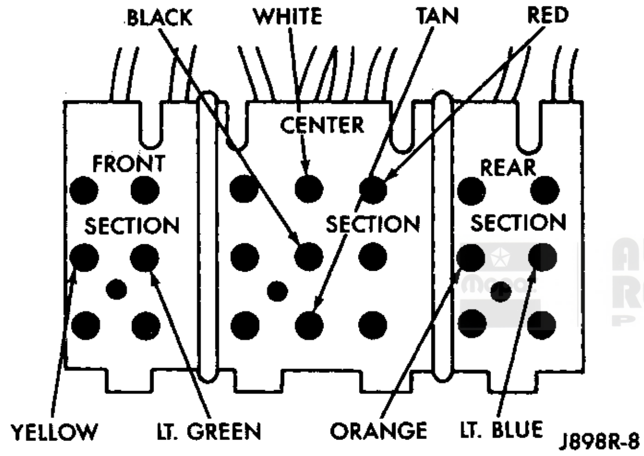
To check the rear motor, connect a covered jumper wire between the red terminal in the center section and either the light bulb or orange connection in the front section. Connect a second covered jumper wire between the black second covered jumper wire between the black terminal in the center section and the open connection in the front section. If the motor does not operate, reverse the jumpers in the front section. If the motor still does not operate, either the harness or the complete three-motor assembly may be defective.

To check the center motor, connect a covered jumper wire between the red terminal of the center section and either the white or tan connection in the center section. Connect a second covered jumper wire between the black terminal in the center section and the open connection in the center section. If the motor does not operate, reverse the white and tan jumpers. If the motor still does not operate, either the harness or the complete three-motor assembly should be replaced.

To check the front motor, connect a covered jumper wire between the red terminal in the center section and either the green or yellow connection in the rear section. Connect a second covered jumper wire between the black terminal in the center section and the open connection in the rear section. If the motor does not operate, reverse the jumpers in the section. If the motor still does not operate, either the harness or the complete three-motor assembly should be replaced.

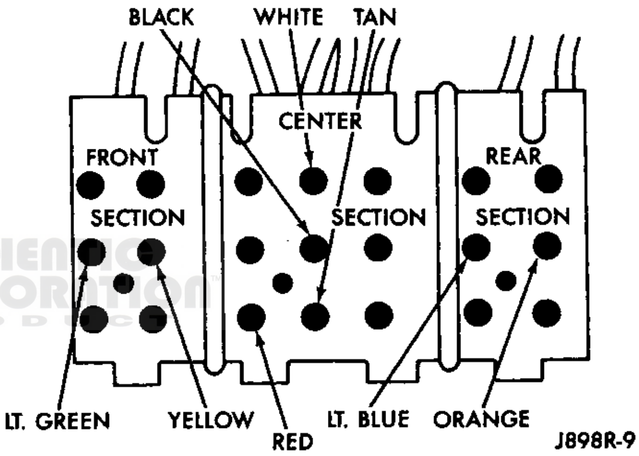
If all the motors and the seat operate properly, this indicates that the switch is bad and should be replaced.

Driver Side

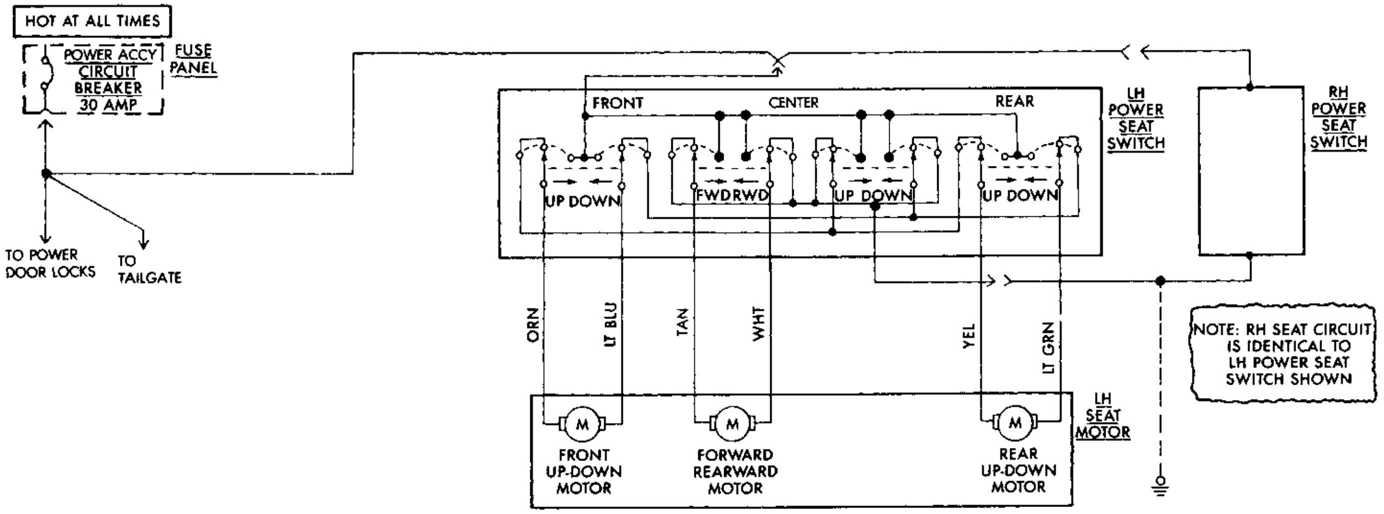


J898R-8

Passenger Side



J898R-9



J908R-2

Fig. 6 Power Seat Schematic — SJ

POWER SEAT MOTOR REPLACEMENT

Whenever maintenance is required on the motor, cable and housing assemblies, or on the front, rear or horizontal transmission assemblies (Fig. 7), the assemblies must be synchronized to ensure easy and proper operation.

(1) Disconnect the battery negative cable.

(2) Remove the attaching nuts holding the seat assembly to the floorpan.

(3) Tilt the seat and disconnect the wiring harness.

(4) Remove the seat assembly from the vehicle.

(5) Lay the seat on its back on a clean surface.

(6) Remove the motor mounting screws (Fig. 7).

(7) Carefully disconnect the housing and cables from the motor assembly.

(8) To install the motor, place the motor into position and carefully connect the cables and housings to the motor assembly.

(9) Reverse the removal procedures to finish the installation.

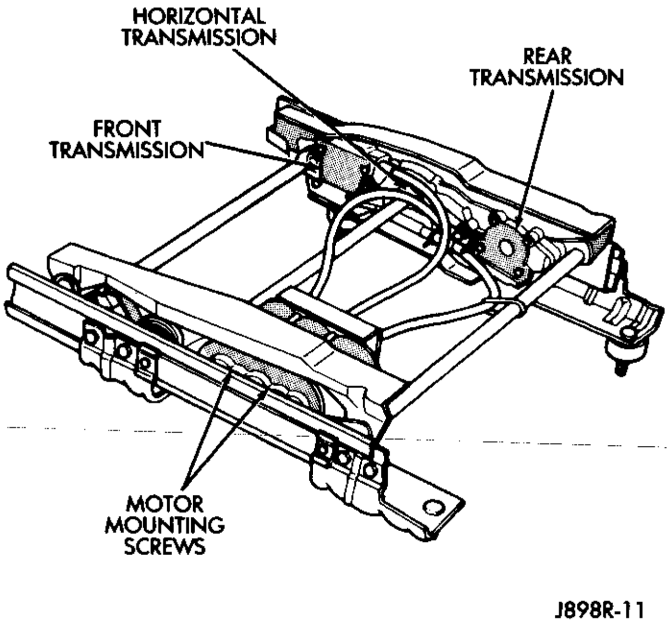


Fig. 7 Power Seat Track — SJ

POWER WINDOWS

CONTENTS

XJ

INDEX

DESCRIPTION

All XJ vehicles, equipped with power windows, have a cable driven window regulator system. A permanent magnet motor moves each of the power windows. Each motor raises or lowers the glass when voltage is supplied to the motor. The direction the motor turns depends on the polarity of the supply voltage. The control switches control the supply voltage polarity.

With the ignition switch in RUN, voltage is applied through the power window circuit breaker to the master switch assembly terminal BY and to the passenger's window switches.

When the driver's window switch is moved UP, the contacts close a current path to terminal DV, the LH front window motor, terminal CV, and the DOWN contact of the LH front window to ground. The motor moves the glass up.

Current flows in a similar way when the UP contact in one of the passenger's window switches is closed, However, current flow through the passenger's window motors must go through the driver's and the passenger's window switches before it reaches ground.

Each motor is protected by a built-in circuit breaker. If a window switch is held on too long with the window obstructed or after the window is fully up or down, the circuit breaker opens the circuit. The circuit breaker resets automatically as it cools. Do not allow frequent or consecutive resetting of the circuit breaker to continue.

TROUBLESHOOTING (Figs. 1 and 2)

No Windows Operate

Power window circuit breaker installed

TEST	OK	NOT OK
Probe terminal S on Fuse Panel	Battery voltage	Replace circuit breaker
Side of cigar lighter socket to ground	Zero ohms	Repair open to ground
Remove Master Door Lock/Power Window Switch assembly mounting screws and probe Terminal BY at LH switch	Battery voltage	Repair open to circuit breaker
Probe BLK wire (terminal DX) at LH switch	Zero ohms	Repair open to ground splice of I.P. harness
Operate Window switch	Windows move up and down	Go to Switch Testing
Master Power Window Switch	Passes test	Replace defective motors

One Window Operates

Remove door panel of inoperative window, probe harness side of unplugged motor connector

TEST	OK	NOT OK
Terminal A of connector, holding switch in the DOWN position	Battery voltage	Repair open back to Master Switch If additional switch is in circuit (not LH motor), refer to Switch Testing.
Terminal B of connector, holding switch in the DOWN position	Zero ohms, Caution, maintain DOWN position while meter lead is attached	Repair open back to Master Switch If additional switch is in circuit (not LH motor), refer to Switch Testing. If both tests are OK, replace motor.

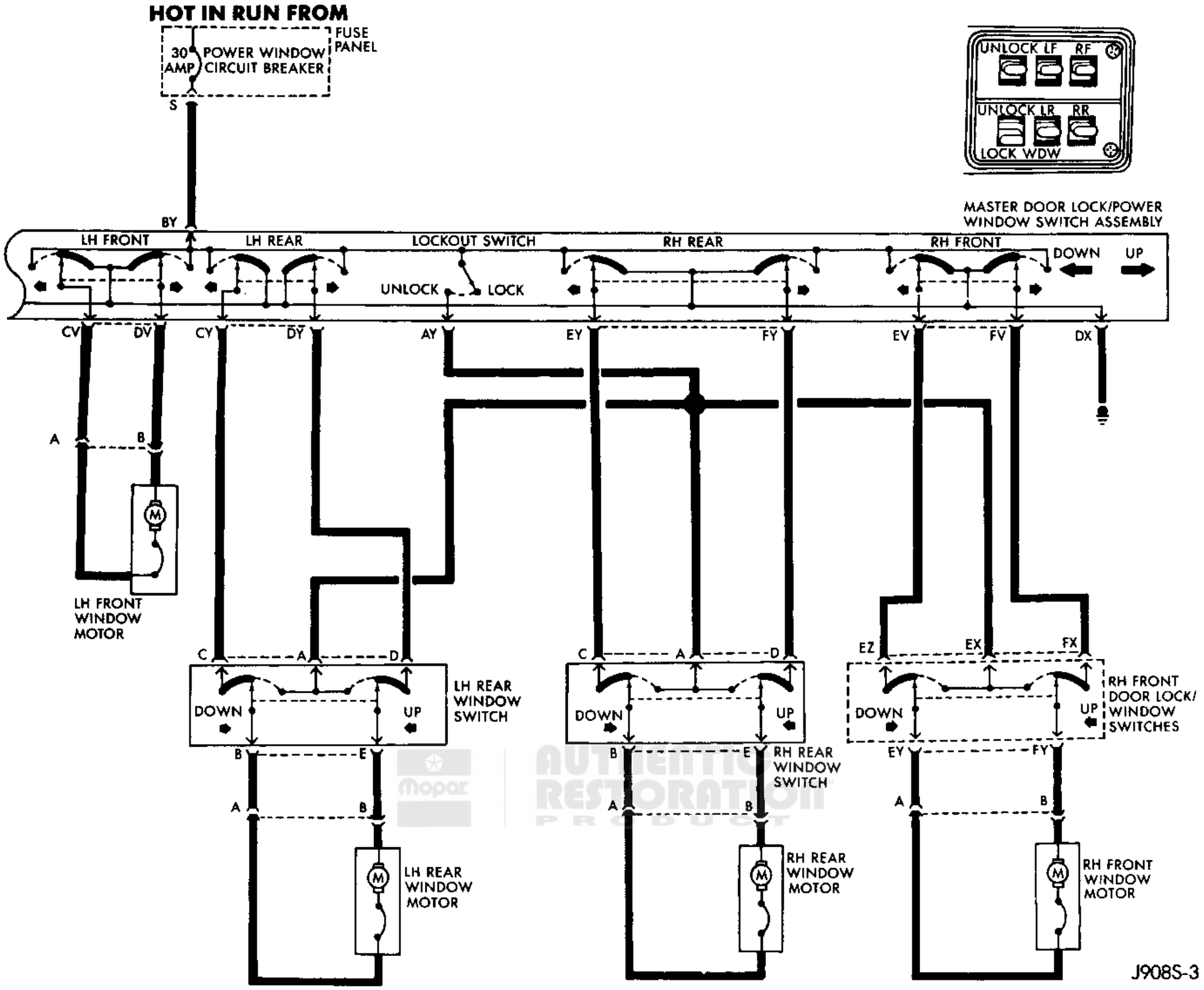


Fig. 1 Power Windows 4-Door — XJ

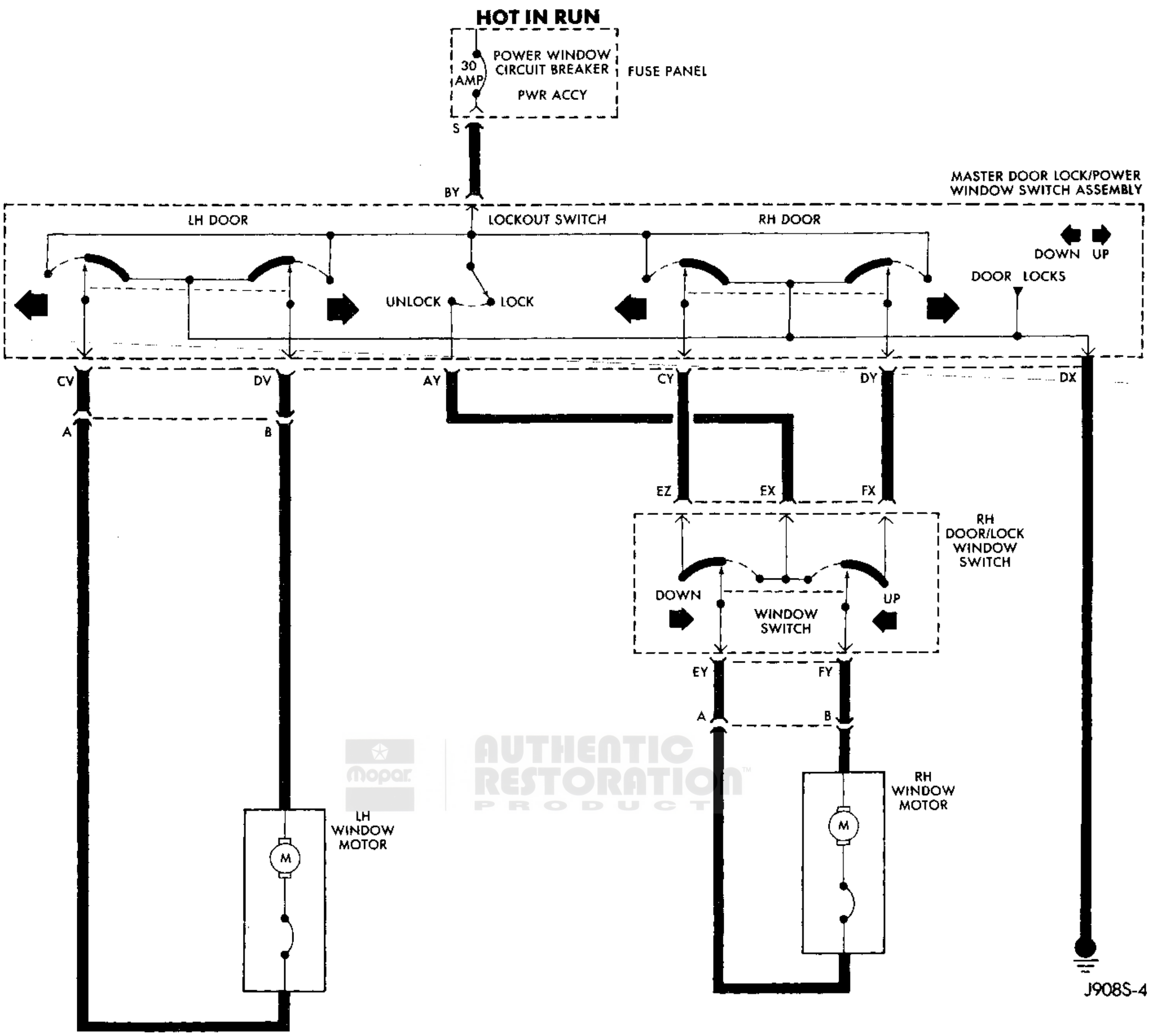
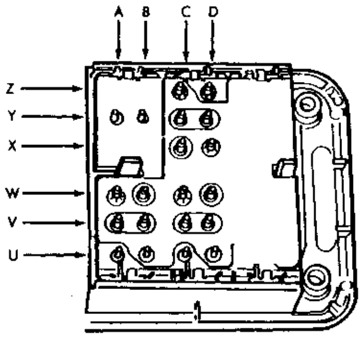
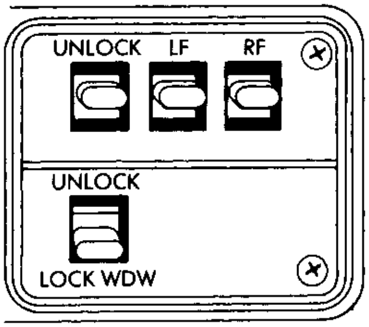


Fig. 2 Power Windows 2-Door — XJ

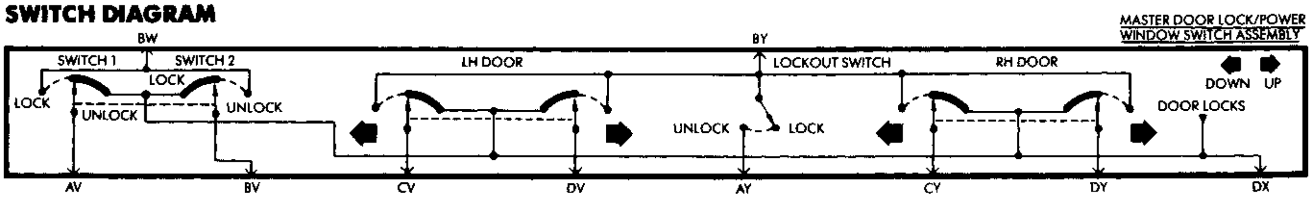
SWITCH TESTING

Master Power Window Switch Assembly 2-Door





SWITCH DIAGRAM



SWITCH TEST
Switch Grounds

SWITCH POSITION	TERMINALS	ZERO OHMS
Off (Normal)	DX and: AV, BV, CV DV, CY, DY	Yes
	BW and DX	No
	BY and DX	No

SWITCH TEST
LH Door

SWITCH POSITION	TERMINALS	ZERO OHMS
Up	BY and DV	Yes
Down	BY and CV	Yes

SWITCH TEST
RH Door

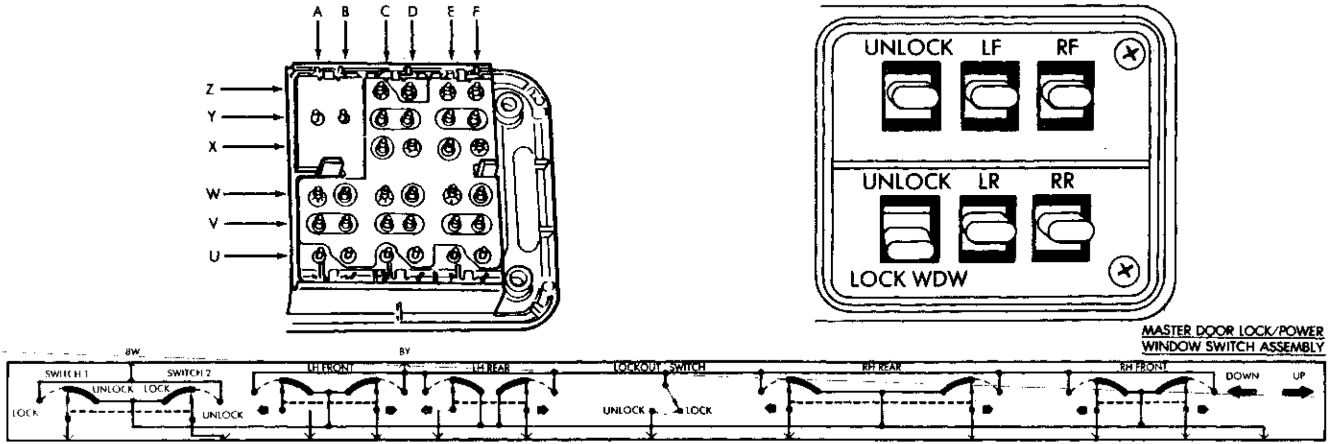
SWITCH POSITION	TERMINALS	ZERO OHMS
Up	BY and DY	Yes
Down	BY and CY	Yes

SWITCH TEST
Lockout Switch

SWITCH POSITION	TERMINALS	ZERO OHMS
Up (Unlock)	AY and BY	Yes
Down (Lock)	AY and BY	No

J898S-2

Master Power Window Switch Assembly 4-Door



SWITCH TEST
Switch Grounds

SWITCH POSITION	TERMINALS	ZERO OHMS
Off (Normal)	DX and: AV, BV, CV, DV, CY, DY, EY, FY, EV, FV	Yes
	BW and DX	No
	BY and DX	No

SWITCH TEST
LH Front

SWITCH POSITION	TERMINALS	ZERO OHMS
Up	BY and DV	Yes
Down	BY and CV	Yes

SWITCH TEST
LH Rear

SWITCH POSITION	TERMINALS	ZERO OHMS
Up	BY and DY	Yes
Down	BY and CY	Yes

SWITCH TEST
Lockout Switch

SWITCH POSITION	TERMINALS	ZERO OHMS
Up (Unlock)	AY and BY	Yes
Down (Lock)	AY and BY	No

SWITCH TEST
RH Rear

SWITCH POSITION	TERMINALS	ZERO OHMS
Up	BY and FY	Yes
Down	BY and EY	Yes

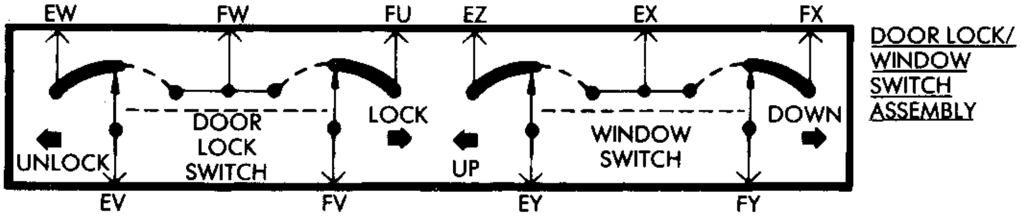
SWITCH TEST
RH Front

SWITCH POSITION	TERMINALS	ZERO OHMS
Up	BY and FV	Yes
Down	BY and EV	Yes

J898S-3

RH Door Window Switch

SWITCH DIAGRAM



SWITCH TEST
Window Switch

SWITCH POSITION	TERMINALS	ZERO OHMS
Off (Normal)	EY and EZ	Yes
	FY and FX	Yes
	All Others	No
Up	EY and EZ	Yes
	EX and FY	Yes
	All Others	No
Down	EX and EY	Yes
	FX and FY	Yes
	All Others	No

J898S-1

WINDOW REGULATOR REPLACEMENT

Removal

(1) Remove the interior door latch release assembly and control panel retaining screws (Fig. 3).

(2) Disconnect the control linkage and the wire harness connector.

(3) Remove the latch release and control panel assembly.

(4) Remove the armrest lower retaining screws.

(5) Swing the armrest downward to a vertical position. This is necessary to disconnect the armrest from the upper retainer clip (Fig. 4).

(6) Pull the armrest straight out from the trim panel.

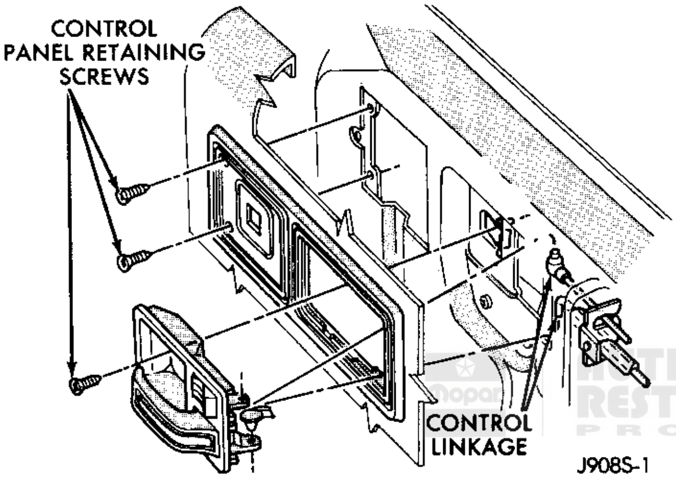


Fig. 3 Power Window Control Panel Removal/Installation

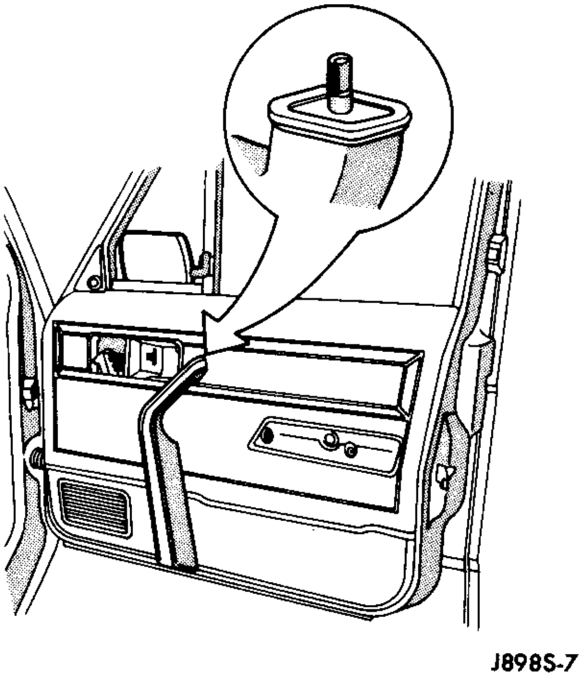


Fig. 4 Armrest Retainer Clip

(7) Remove the trim panel with a wide flat blade tool (Fig. 5).

To aid in removal of the trim panel, start at the bottom of the panel.

(8) Remove the plastic water dam sheet.

(9) Remove the two rivets holding the bottom of the regulator to the door by grinding off the heads and knocking them out with a hammer and a punch.

(10) Remove the door glass attaching stud nut and spring washer (Fig. 6).

(11) Pull the glass to the full up position and tape the glass to the door.

(12) Disconnect the wire harness connector from the window regulator.

(13) Remove the remanining window regulator rivets by grinding off the heads and knocking them out with a hammer and a punch (Fig. 7).

(14) Remove the window regulator.

Installation

(1) Place the regulator inside the door.

(2) Attach the regulator to the door using pop rivets, nuts and screws or the hardware kit supplied with a new regulator. DO NOT install the two rivets that hold the bottom of the regulator.

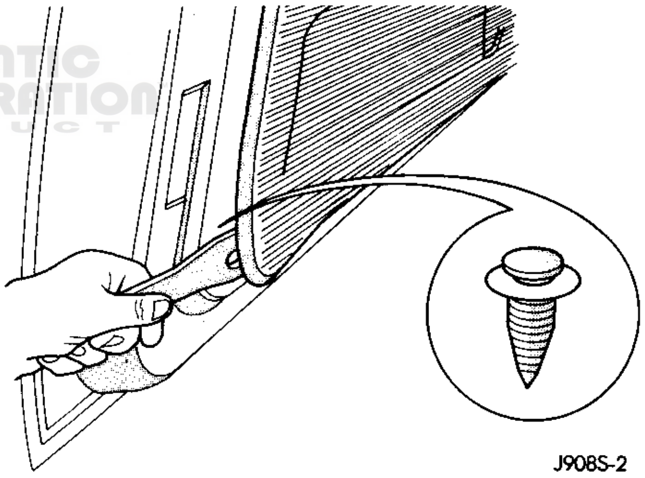


Fig. 5 Trim Panel Removal

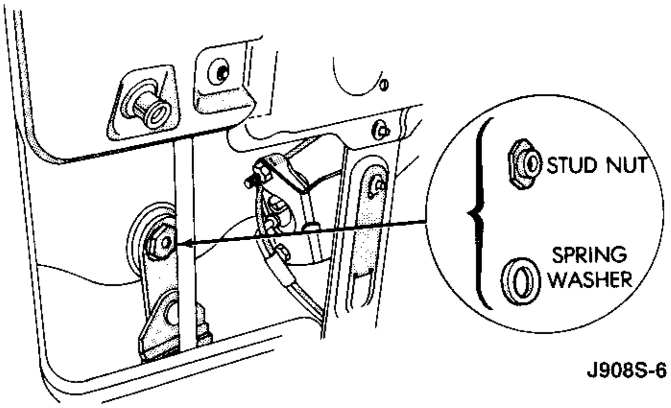


Fig. 6 Remove/Install Glass Attaching Stud Nut

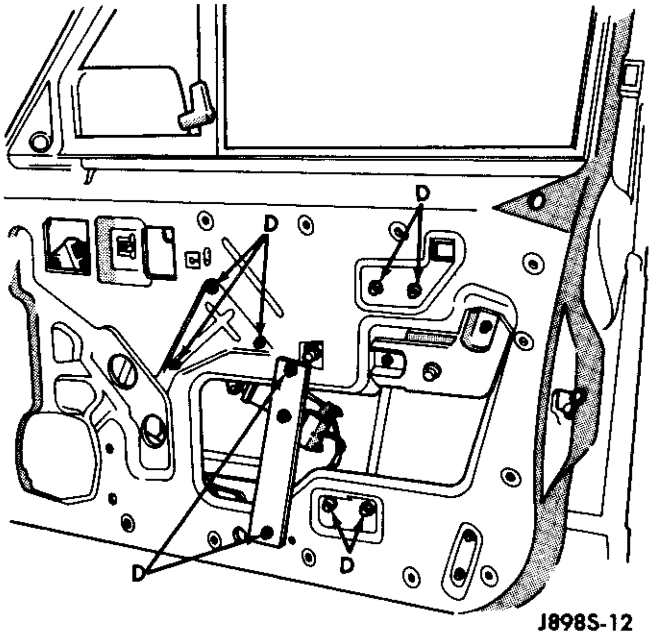


Fig. 7 Window Regulator Removal

(3) Connect the wire harness connector to the regulator.

The Spring Washer must be in place to maintain proper tension on the stud nut.

(4) Attach the door glass with the stud nut and spring washer (Fig. 6). Tighten the door glass stud nut to 6 N•m (4 ft-lbs) torque.

(5) Install the last two rivets.

(6) Using 3M 08044 or 3M 08041 adhesive/sealant, install the plastic water dam sheet.

(7) Place the trim panel in the installation position and press in the nylon retainers.

(8) Install the armrest.

(9) Install the latch release assembly and control panel.

SJ

INDEX

GENERAL

All SJ vehicles have a cable driven window regulator system (side windows). A permanent magnet motor moves each of the power windows. Each motor raises or lowers the glass when voltage is supplied to the motor. The direction the motor turns depends on the polarity of the supply voltage. The control switches control the supply voltage polarity.

CIRCUIT TESTS (Fig. 1)

A 30 amp circuit breaker, located in the fuse panel, is mounted at the far left side above the parking brake release handle.

The circuit breaker supplies power to the electric windows when the ignition switch is in the ON position. The black wires at the master control switch are the ground wires for the electric window circuits.

(1) Remove the switch bezel.

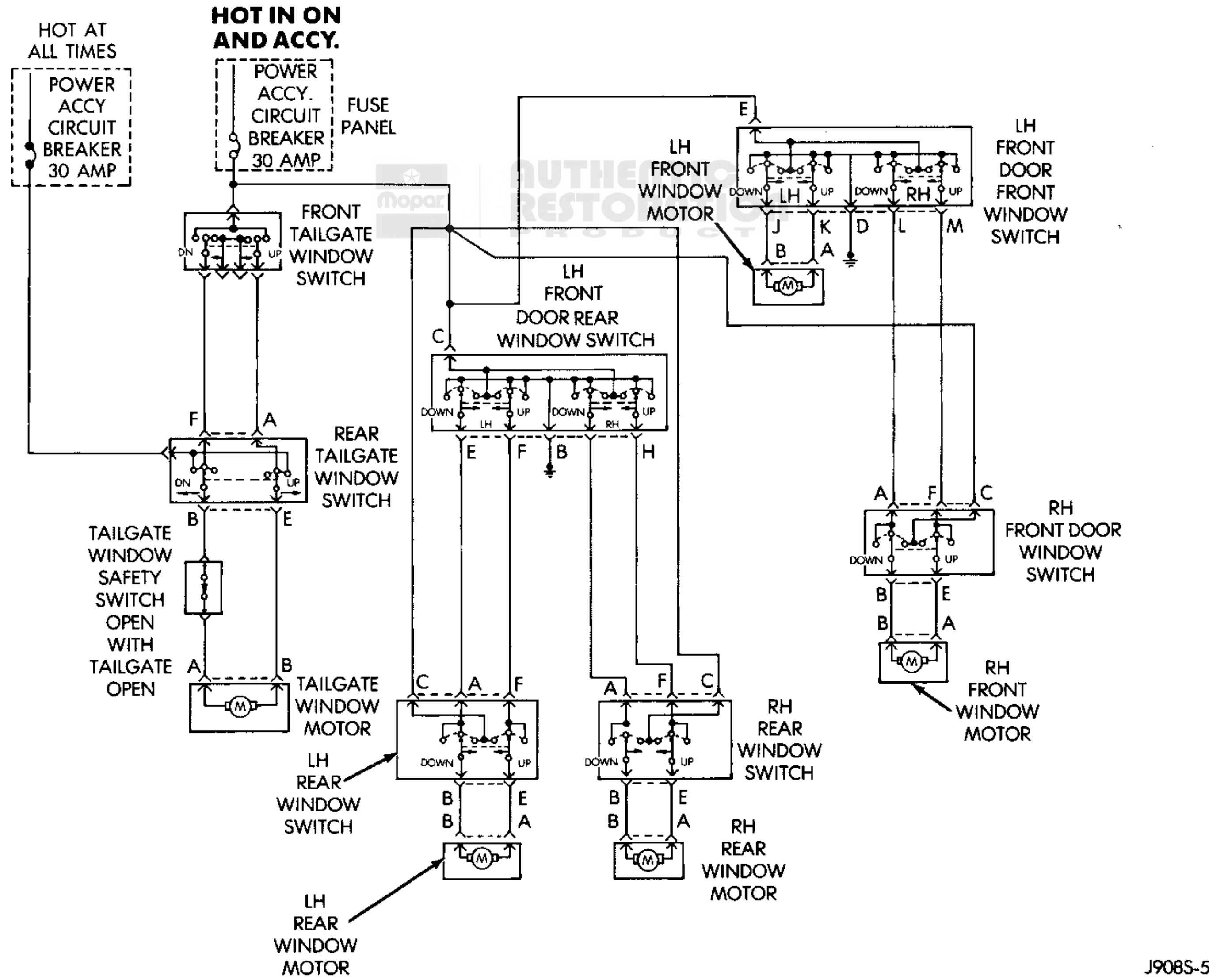


Fig. 1 Power Window Schematic — SJ

(2) Remove four screws holding the switches to the switch plate.

(3) Separate the halves of the terminal plate by releasing the barbed hooks to expose the wire terminal ends.

(4) Turn the ignition switch to the ON position.

(5) Connect one lead of the test lamp to the black wire and contact the other lead to the red terminal. Repeat this test procedure with the second black wire in the master switch.

- If the lamp does not light, remove the test lamp lead that was on the black wire terminal and connect it to the chassis ground.
- If the lamp lights at this point, an opening exists between the master switch and the ground.
- If the lamp still does not light, check for a defective circuit breaker or an opening in the red wire from the circuit breaker to the master switch.

Circuit Breaker Test

Turn the ignition switch to ON and probe the VIO/RED wire side of the circuit breaker. If the lamp lights, the circuit breaker is good. If the lamp does not light, probe the RED wire side of the circuit breaker. If the lamp lights the circuit breaker is bad. It the lamp does not light, there is an open in the circuit from the battery to the circuit breaker.

Control Switch and Motor Test

Connect the test lamp between the terminals of the yellow and orange wires.

Operate the control switch up and down for the respective window. If the lamp lights in the UP and DOWN position, the test indicates that the yellow and orange wires of the wire harness to that window and back again to the master switch are not defective. It also indicates that the individual door switch on the master control is not defective.

Disconnect the white and green motor leads at the terminal plate and connect these leads to the green and white leads respectively.

Operate the master switch. If the window goes up and down, the motor is not defective but the switch is defective. If the motor does not operate, remove the door trim panel and check the connections and leads to the motor. If the motor operates, the switch is defective.

SWITCH VOLTAGE TESTS

The following wiring test sequence determines whether or not voltage is continuous through the harness to the switch.

Leave the ignition switch in the ON position. After removing the switch from the trim panel for testing purposes, carefully separate the multiple terminal block on the wiring harness from the switch body. Connect one lead of the test lamp to the red wire terminal and the other to ground. If the test lamp lights, the wiring circuit between the battery and the switch is functional; proceed to check the continuity in the ground circuit (black wire). If the lamp does not light, check the 30 amp main circuit or for a broken wire.

Switch Up Test

Connect the jumper to the red lead and the other end of the jumper lead to the Up terminal (Fig. 2). Connect another jumper to the ground terminal of the switch. Connect the other end of the second jumper wire to the Down terminal of the switch.

If the motor runs, the test verifies that voltage is available to the motor. The switch must now be tested to make sure that voltage is passing through satisfactorily. Install the switch body back on the multiple connector and actuate the switch. If the motor fails to run, replace the switch body. Each switch is tested in the same manner.

If the motor does not run after installing the new switch, perform the Motor Test.

Switch Down Test

Connect the jumper lead to the red terminal lead and the other end of the jumper to the Down terminal (Fig. 3). Connect another jumper to the ground terminal of the switch and the other end of the jumper wire to the UP terminal of the switch.

If the motor runs, the test verifies that voltage is available to the motor. Install the switch body back on the multiple connector and actuate the switch. If the motor fails to run, replace the switch body. Each switch is tested in the same manner.

If the motor does not run after installing the new switch, perform the Motor Test.

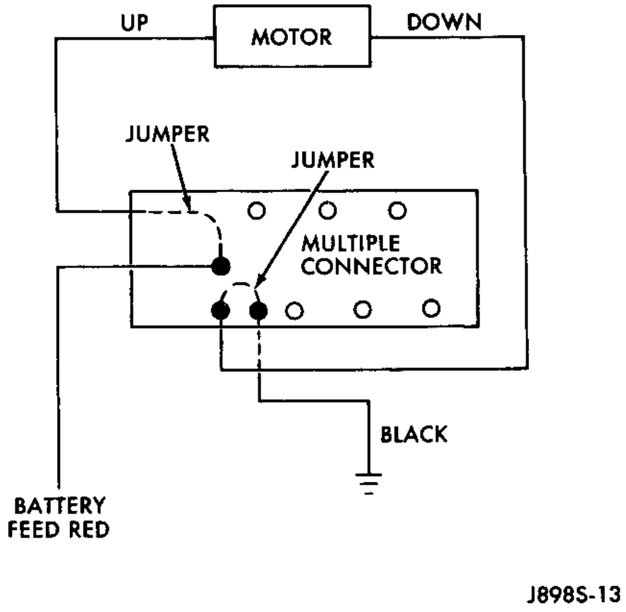
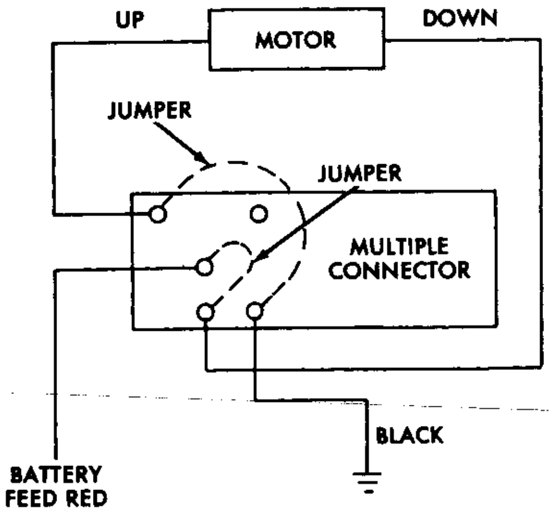


Fig. 2 Switch Up Test Jumper Connections



J898S-14

Fig. 3 Switch Down Test Jumper Connections

MOTOR TEST

(1) Remove the door trim panel as described in Regulator Replacement.

(2) Connect the positive (+) lead (from a test battery) to either terminal.

(3) Connect the negative (-) lead (from a test battery) to either terminal.

The motor should now rotate in one direction to either move the window up or down. If the window is in the full UP or DOWN position and the motor is connected so that it tries to move the window in the same direction, no movement will be observed.

Reverse the battery leads opposite to the first two steps. The window should now move. If the window does not move, replace the motor.

WINDOW REGULATOR REPLACEMENT

(1) Position the window at the mid-point position.

(2) Disconnect the battery negative cable.

The trim panels consist of fiberboard covered with a vinyl material. They are fastened to the door with plastic clips inserted into holes in the door inner panel and screws along the bottom edge.

(3) Remove two screws and the overlay on the armrest.

(4) Remove two screws and the armrest.

(5) Remove the woodgrain insert at both ends of the assist handle.

(6) Remove the attaching screws and assist handle.

(7) Remove the power door lock/window bezel.

(8) Remove the trim panel attaching screws on the bottom of the trim panel.

(9) Pry loose the trim panel-to-door clips along the sides with a wide flat blade tool and remove the panel.

(10) Disconnect the power mirror switch harness after the trim panel is removed.

(11) Remove the door speaker.

(12) Position the glass as necessary to remove the screws and plastic nuts attaching the glass to the lift bracket.

(13) Move the glass to the full up position and block or tape it in place.

(14) Remove the regulator attaching screws and disconnect the wires.

(15) Remove the regulator assembly through the opening in the bottom of the door.

(16) Reverse the removal procedure to install a regulator.

POWER TAILGATE WINDOW

The Grand Wagoneer is equipped with an electrically operated tailgate window. When checking for tailgate window motor operation, be sure the instrument panel switch black lead is properly grounded. The tailgate motor grounds through this switch.

Instrument Panel Switch

Current is supplied from the battery to the ignition switch to the fuse panel, through a 30 amp circuit breaker (located in the fuse panel), and to the instrument panel tailgate window switch.

Testing

CAUTION: When the tailgate window is raised with the tailgate lowered, the glass must be supported to avoid damage.

Be sure the instrument panel tailgate window switch black lead is properly grounded.

(1) Turn the ignition switch to the ON position.

(2) Using a 12 vdc test lamp, connect one end of the test lamp to a ground and place the probe to the VIO/RED wire of the switch. If the lamp lights, voltage is present at the switch. If the lamp does not light, repair the problem in the feed circuit before proceeding.

(3) Place the test lamp probe to the brown wire of the switch.

(4) Move the switch to the DOWN position. If the lamp lights, proceed to the next step. If the lamp does not light, replace the switch.

(5) Place the test lamp probe to the tan wire of the switch.

(4) Move the switch to the UP position. If the lamp lights, proceed to the Tailgate Window Safety Switch test. If the lamp does not light, replace the switch.

Tailgate Window Switch

Be sure the instrument panel tailgate window switch black lead is properly grounded. The tailgate motor grounds through this switch.

(1) Using a 12vdc test lamp, connect one end of the test lamp to a ground and place the probe to the red wire of the tailgate window switch. If the lamp lights, proceed to the next step. If the lamp does not light, repair the problem in the feed circuit before proceeding.

(2) Place the test lamp probe to the tan wire of the tailgate switch. Turn the tailgate window switch key to the DOWN position. If the lamp lights, proceed to the next step. If the lamp does not light, replace the switch.

(3) Place the test lamp probe to the brown wire of the switch. Turn the tailgate window switch key to the UP position. If the lamp lights proceed to the Safety Switch Test. If the lamp does not light, replace the switch.

Tailgate Window Safety Switch Test

The safety switch is mounted in the upper left side of the tailgate.

(1) Using a 12 vdc test lamp, connect one end of the test lamp to a ground and place the probe to one of the brown wires of the safety switch.

(2) Turn the ignition on and move the instrument panel tailgate switch to UP. If the lamp does not light, move the switch to DOWN.

- If the lamp does not light, there is an open in the circuit.
- If the lamp lit, note the switch position. Move the probe to the other brown wire. Move the instrument panel switch to the position noted. Manually close the safety switch, being careful to support the window glass. If the lamp does not light, replace the safety switch. If the lamp lights, proceed to tailgate Window Motor Test.

Tailgate Window Motor Test

Be sure the instrument panel tailgate window switch black lead is properly grounded.

(1) Using a 12 vdc test lamp, connect one end of the test lamp to a ground and place the probe to the TAN wire at the motor. Move the instrument panel tailgate switch to the UP position. Manually close the safety switch, being careful to support the window glass. If the lamp lights and the motor does not operate, replace the motor. If the lamp does not light, check the supply circuit to the motor and repair as necessary. If the lamp does not light, repair the open in the feed circuit before proceeding.

(2) Place the test lamp probe to the brown wire at the motor. Move the instrument panel tailgate switch to the DOWN position. Manually close the safety switch, being careful to support the window glass. If the lamp lights and the motor does not operate, replace the motor. If the lamp does not light, check the supply circuit to the motor and repair as necessary. If the lamp does not light, repair the open in the supply circuit before proceeding.

TAILGATE WINDOW MOTOR REPLACEMENT

CAUTION: When the tailgate window is raised with the tailgate lowered, the glass must be supported to avoid damage.

(1) Remove the carpeting from the tailgate.

(2) Remove the access cover.

(3) Pry off the spring nut retainers attaching the regulator arm to the channel.

(4) Disengage the regulator arm pins from the channel and raise the glass being careful to support the glass when it is in the raised position.

(5) Disconnect the wiring harness from the safety switch.

(6) If the regulator attaching screws are accessible, remove the regulator attaching screws and regulator. If the sector gears are covering the attaching screws, proceed as follows:

(a) place a jumper wire between the two terminals of the safety switch connector

(b) place the key in the tailgate switch and operate the motor until the sector gears allow access to the regulator attaching screws

(c) remove the regulator attaching screws, regulator and motor.

WARNING: A BOLT MUST BE PLACED AS DESCRIBED IN THE NEXT STEP BEFORE THE MOTOR IS REMOVED. IF IT IS NOT, THE SPRING TENSION WILL CAUSE THE REGULATOR ARMS TO CLOSE AS SOON AS THE MOTOR IS REMOVED AND COULD SERIOUSLY INJURE YOUR FINGERS.

(7) Install a bolt through a hole in the gear and a hole in the regulator plate (Fig. 4). Use a washer and nut and tighten securely.

(8) Remove the motor attaching screws and remove the motor from the regulator.

(9) To install the motor, reverse the removal procedure. Be sure the motor is installed before remove the bolt installed to lock the gear.

(10) Tighten the regulator attaching screws to 8 N•m (72 in. lbs).

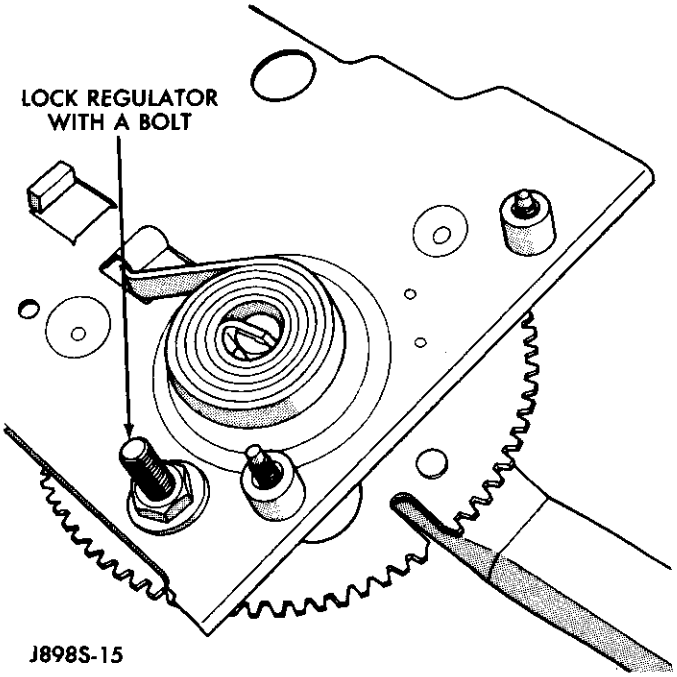


Fig. 4 Lock Regulator Gear To Plate

POWER MIRRORS

CONTENTS

XJ

INDEX

GENERAL

The mirror control switch contains two separate switches, the operating switch and the selector switch.

Each mirror has two reversible motors: one to adjust the mirror view up and down, the other to adjust the mirror view right and left. The driver operates three switches that control the polarity of the voltage to the motors. The mirror select switch directs these control voltages to either the RH or LH mirror.

With the switches in the positions shown in the schematic, neither mirror is moved (Fig. 1). The mirror select switch must be set to L or R to direct current flow. If the mirror select switch is set on R and the up-down switch is moved to the UP position, battery voltage is applied through the U contacts of switch 1 to pin E and the up-down motor in the RH mirror. The RH mirror up-down motor has a path to ground through pin D, through the mirror select switch contacts, the U contacts of switch 3 and switch 2, and pin F to ground. The RH motor runs and tilts the mirror up.

If the switch is pushed to the DOWN position, the same motor receives voltage. Now the polarity is reversed, with pin E grounded. The motor runs in the opposite direction.

The RH left-right motor operates in a similar manner when the control switch is moved to the L or R positions.

The LH mirror works in the same way as the RH mirror when the mirror select switch is moved to the LH position and the control switch is operated.

TROUBLESHOOTING

1. POWER INPUT—Fuse

TEST	OK	NOT OK
Open Door	Dome Lamps light	Check Dome fuse

2. POWER MIRROR SWITCH ASSEMBLY—Remove switch, unplug switch connector

TEST	OK	NOT OK
Mirror switch connector pin F	Zero ohms	Repair open to ground
Mirror switch connector pin G	Battery voltage	Repair open to Dome fuse
Jumper test leads pin E to pin F	—	Next step
Jumper test leads pin G to: pin A pin B pin C pin D	Mirror moves. If OK, replace switch	Repair open to motor and/or replace motor

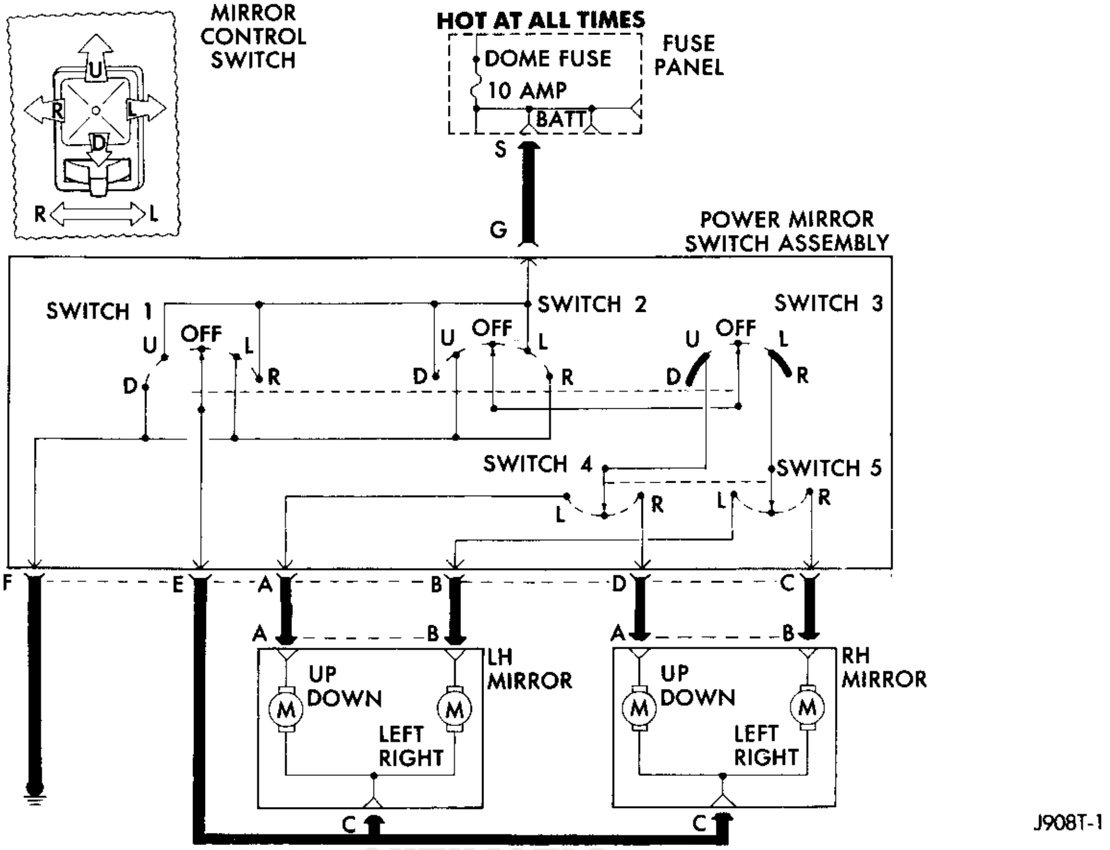
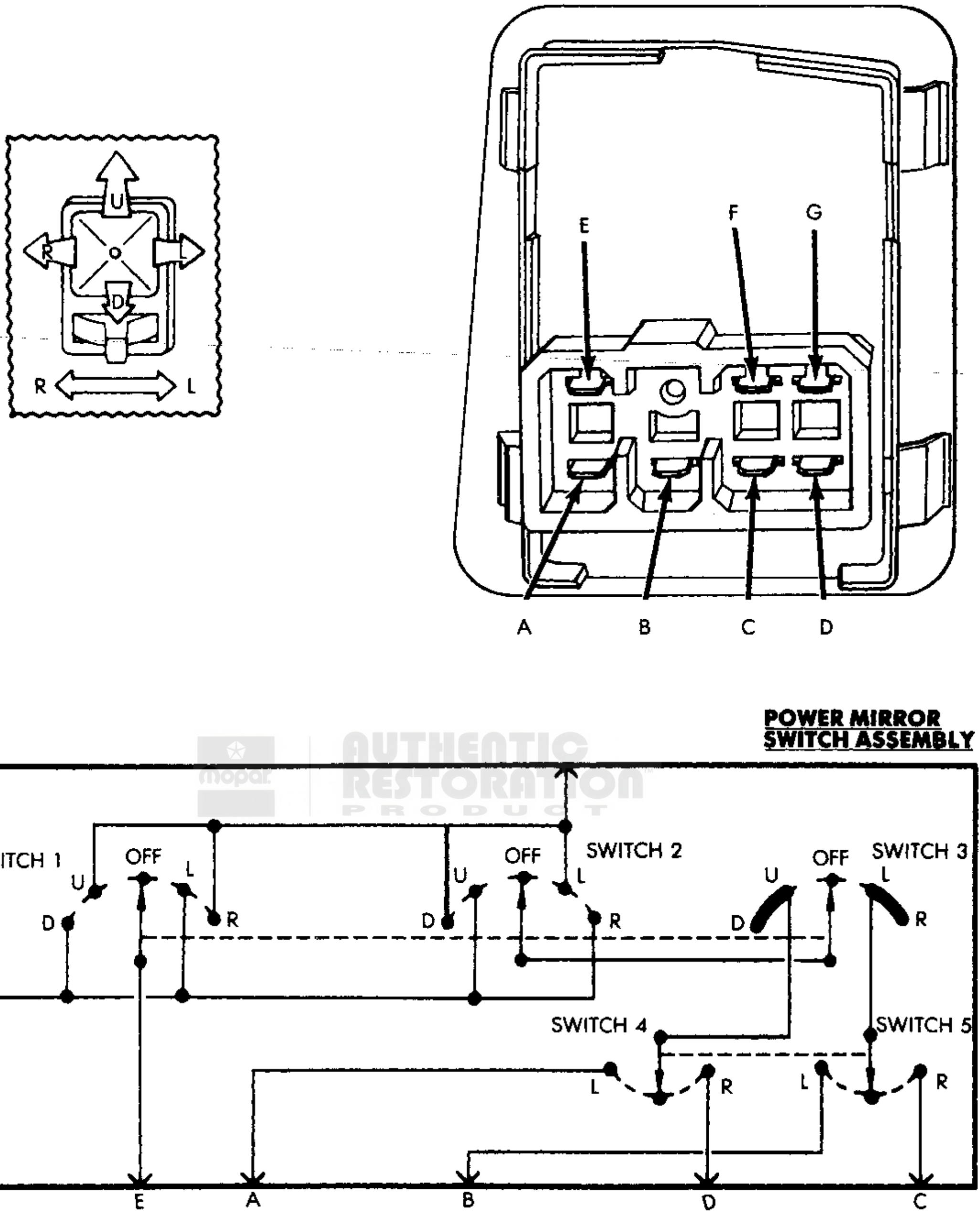


Fig. 1 Power Mirror Wiring Schematic — XJ

POWER MIRROR SWITCH TESTING



J898T-11

SWITCH TEST
Slide Switch in Left (L) Position

SWITCH POSITION	TERMINALS	ZERO OHMS
Push Down (D)	A and G	Yes
	E and F	Yes
	All Others	No
Push Up (U)	A and F	Yes
	E and G	Yes
	All Others	No
Off (Normal)	All Others	No
Push Left (L)	B and G	Yes
	E and F	Yes
	All Others	No
Push Right (R)	B and F	Yes
	E and G	Yes
	All Others	No

SWITCH TEST
Slide Switch in Right (R) Position

SWITCH POSITION	TERMINALS	ZERO OHMS
Push Down (D)	D and G	Yes
	E and F	Yes
	All Others	No
Push Up (U)	D and F	Yes
	E and G	Yes
	All Others	No
Off (Normal)	All Others	No
Push Left (L)	C and G	Yes
	E and F	Yes
	All Others	No
Push Right (R)	C and F	Yes
	E and G	Yes
	All Others	No

J898T-12

POWER MIRROR SWITCH REPLACEMENT

(1) Using a wide flat blade tool, pry the switch housing away from the center console (Fig. 2).

(2) Disconnect switch connector and remove switch.

(3) To install a new switch, reverse the removal procedure.

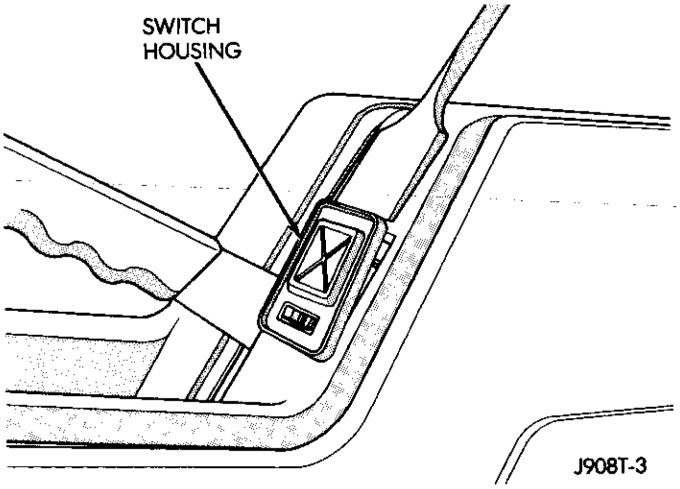


Fig. 2 Power Mirror Switch Removal/ Installation — XJ

POWER MIRROR REPLACEMENT

(1) Remove the interior door latch release assembly and control panel retaining screws (Fig. 3).

(2) Disconnect the control linkage and the wire harness connector.

(3) Remove the latch release and control panel assembly.

(4) Remove the armrest lower retaining screws.

(5) Swing the armrest downward to a vertical position. This is necessary to disconnect the armrest from the upper retainer clip (Fig. 4).

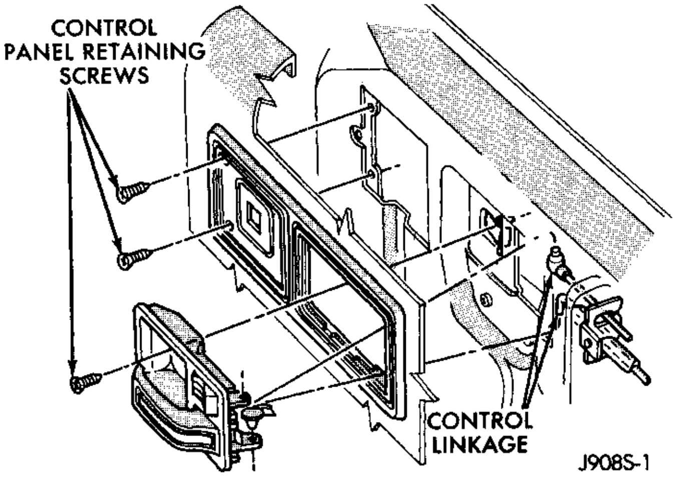


Fig. 3 Power Window Control Panel Removal/Installation

(6) Pull the armrest straight out from the trim panel.

(7) Remove the trim panel with a wide flat blade tool (Fig. 5).

To aid in removal of the trim panel, start at the bottom of the panel.

(8) Removes the screw holding the mirror trim cover (Fig. 6).

(9) Disconnect the power mirror wire harness at the connector in the door.

(10) Pull the harness up through the door.

(11) Remove three screws holding mirror to door (Fig. 7).

(12) To install a power mirror, reverse the removal procedure.

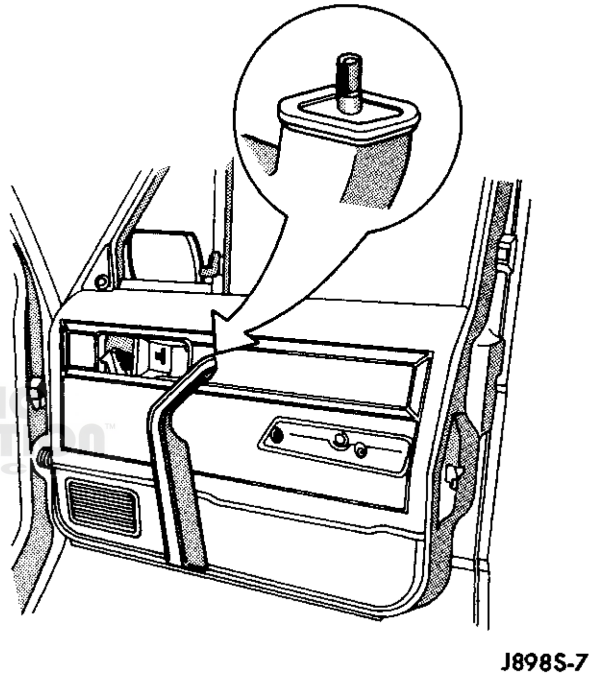


Fig. 4 Armrest Retainer Clip

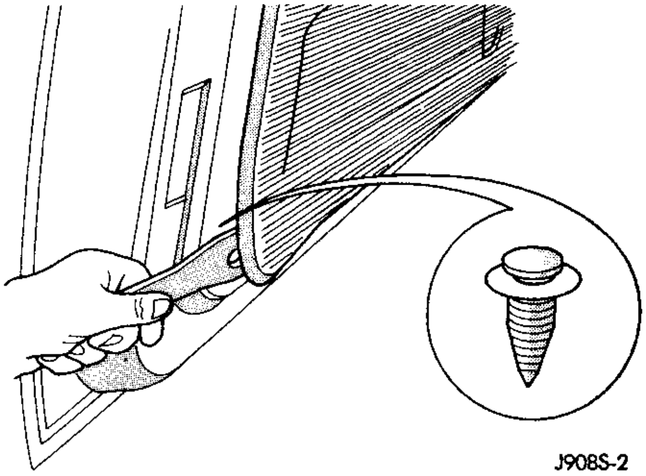


Fig. 5 Trim Panel Removal

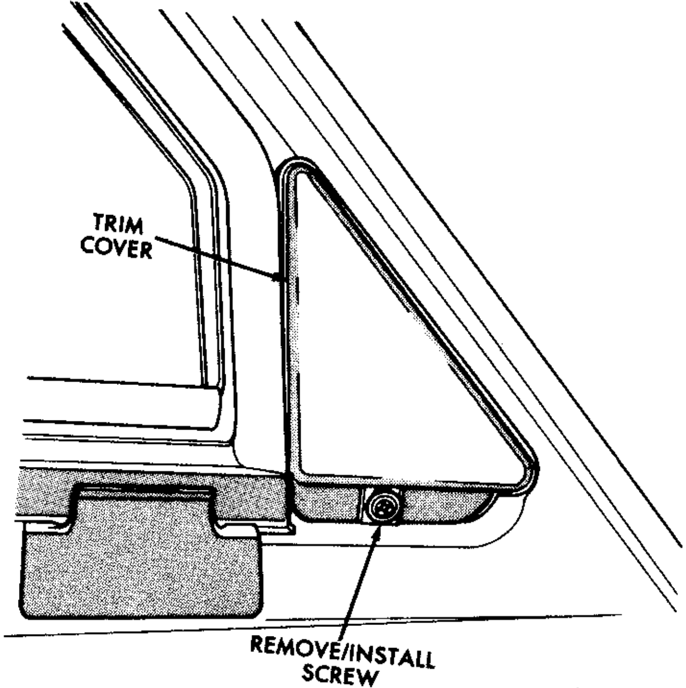


Fig. 6 Power Mirror Trim Cover — XJ

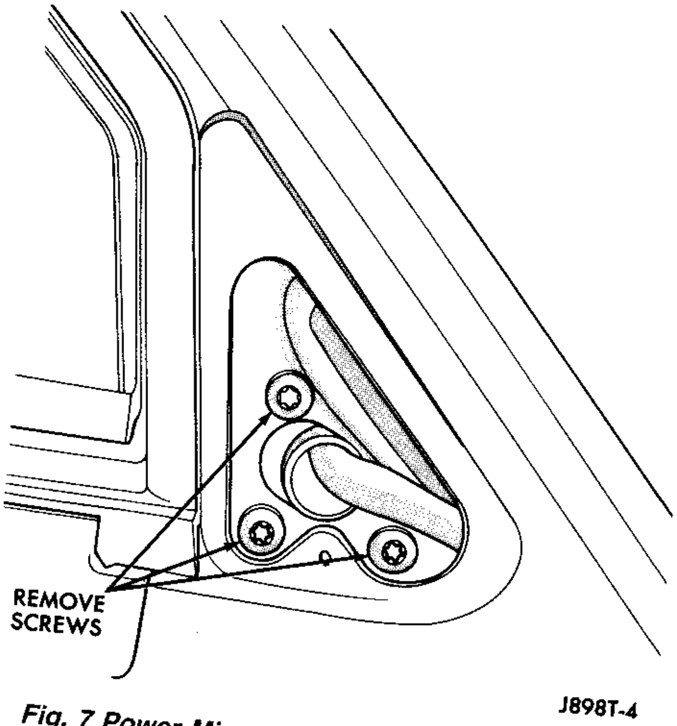


Fig. 7 Power Mirror Removal/Installation — XJ

SJ

INDEX

GENERAL

Both mirrors are controlled by a dual function switch located on the left front door panel. The left/right control switch is used for directing current to the desired mirror. The horizontal/vertical switch directs current to the motor in the mirror assembly which moves the mirror as desired.

A safety or overrun feature is designed into the mirror to prevent damage to the motor when the mirror is moved by hand or when running the mirror to the maximum limit. When the mirror is moved by hand or run to the maximum limit, a distinct snapping noise can be heard.

ELECTRICAL MOTOR/SWITCH TEST

Before conducting the electric motor/switch test, be sure the battery is fully charged and all the connections are clean and tight.

(1) Check the 30 amp circuit breaker (Fig. 1).

(2) Check for a good ground wire (black) connection located at the base of the fuse panel.

(3) Using a test light, check for current as follows:

(a) Violet input wire to switch - if no current is present, check for a broken ground (black) wire or supply wire (violet) between the switch and the fuse panel; if the violet wire checks ok, check the switch output next.

(b) Check for current at the horizontal (yellow) wire and vertical (white) wire; if current is not found in both the yellow and the white wire, replace the switch; if current is found in both the yellow and the white wire, replace the mirror.

POWER MIRROR REPLACEMENT

(1) Disconnect the battery negative cable.

The trim panels consist of fiberboard covered with a vinyl material. They are fastened to the door with plastic clips inserted into holes in the door inner panel and screws along the bottom edge.

(2) Remove two screws and the overlay on the armrest.

(3) Remove two screws and the armrest.

(4) Remove the woodgrain insert at both ends of the assist handle.

(5) Remove the attaching screws and assist handle.

(6) Remove the power door lock/window bezel.

(7) Remove the trim panel attaching screws on the bottom of the trim panel.

(8) Pry loose the trim panel-to-door clips along the sides with a wide flat blade tool and remove the panel.

(9) Disconnect the power mirror switch harness after the trim panel is removed.

(10) Remove two screws holding the mirror to the outside of the door and remove mirror.

(11) To install a power mirror, reverse the removal procedure.

POWER MIRROR SWITCH REPLACEMENT

(1) Remove the door trim panel as described in Power Mirror Replacement.

(2) Loosen the setscrew on the mirror switch escutcheon and remove the switch from the trim panel.

(3) Remove the water dam paper.

(4) Disconnect the wiring harness from the mirror and door harness.

(5) Remove the switch.

(6) To replace the switch, reverse the removal procedure.

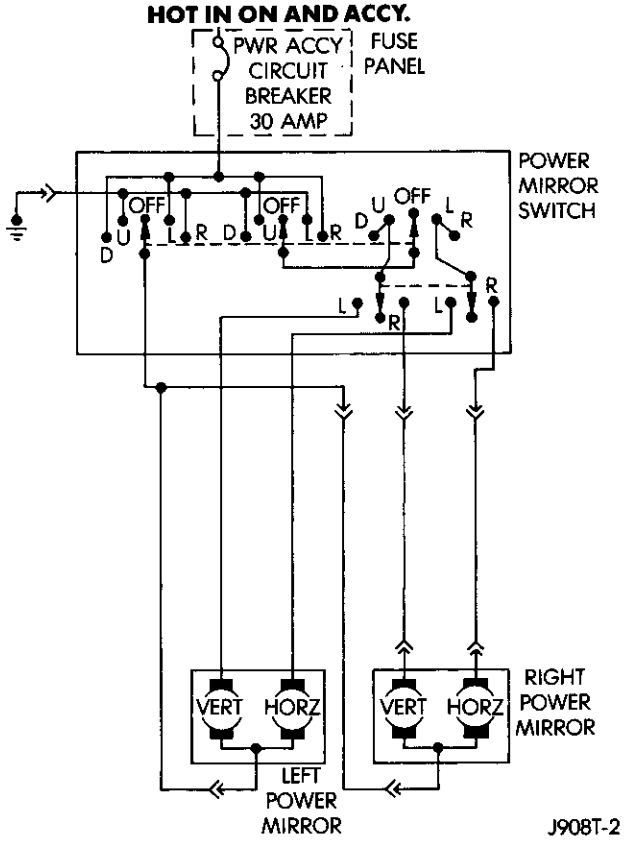


Fig. 1 Power Mirror Wiring Schematic — SJ

ELECTRICAL WIRING DIAGRAMS

INDEX

Fuse and Relay Charts

Splice Locations

Wiring and Components

Wiring Diagrams

MASTER WIRING DIAGRAMS

GENERAL INFORMATION

All Jeep master wiring diagrams are contained in this service manual in the following order, YJ, MJ/XJ, SJ.

The following master wiring diagrams contain the latest information available at time of publication. These diagrams contain various wires, wire routing, wire color codes, switches components, fuses, splices, connectors, connector cavities and other information except distributor secondary wiring. (See Figs. 1, 2 and 3). Most main wiring harnesses are identified by a main harness identification code. Some codes will not apply to all vehicles. See the main wiring harness code chart.

MAIN WIRING HARNESS CODES

Each wire also contains a code (Fig. 4) which identifies wire circuit identification (part of a circuit), color of wire which is shortened to two letters see wire color code chart and if used a colored tracer identified by a slash(/) followed by two letters or an asterisk by itself.

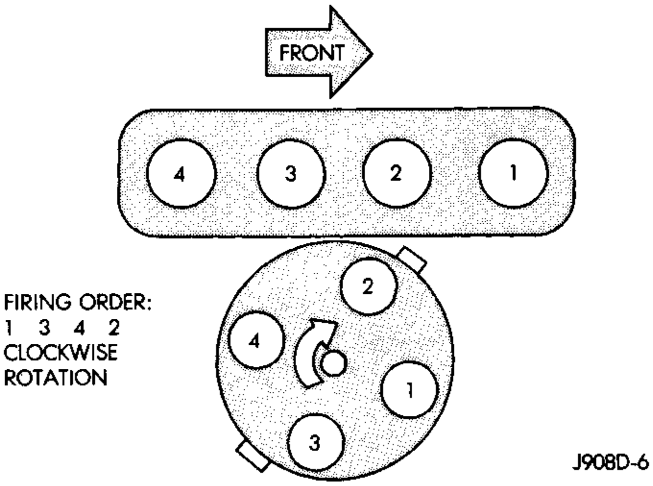


Fig. 1—Distributor Secondary Wiring 2.5L Engine

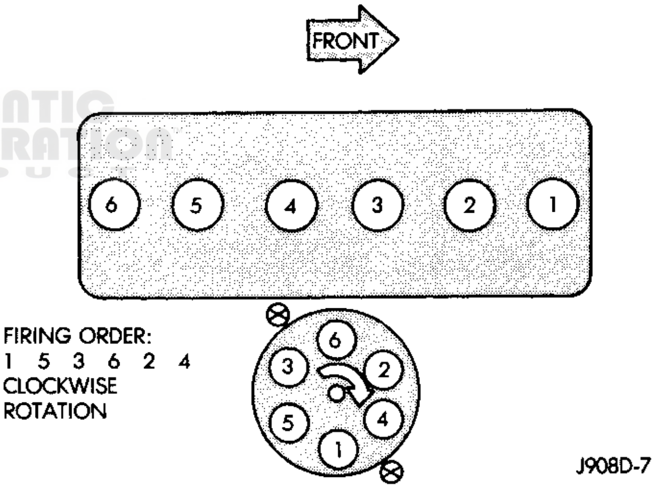


Fig. 2—Distributor Secondary Wiring 4 and 4.2L Engine

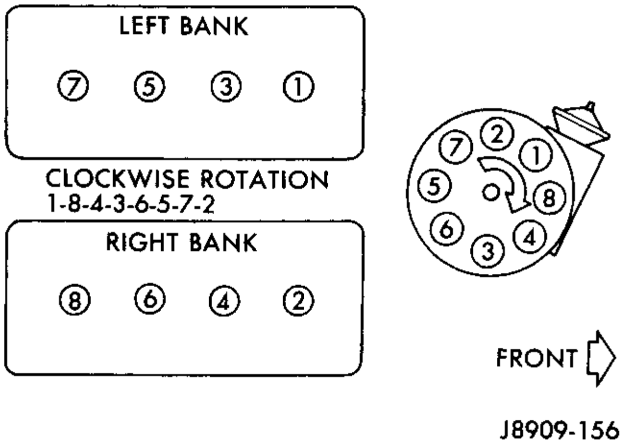


Fig. 3—Distributor Secondary Wiring 5.9L Engine

LOCATING A SYSTEM OR COMPONENT

In order to locate a system or component use alphabetical index to determine diagram sheet number.

Sheet numbers for each wiring diagram are located at lower right or left hand corner of each sheet. Page numbers at top of page do not apply to diagram sheet.

SPLICE LOCATIONS

Splice locations are indicated on master wiring diagrams by a diamond with splice harness code and number (Fig. 5).

In order to locate a particular splice determine splice number from master wiring diagram. Refer to pictorial splice index to find figure number then turn to that figure to determine splice location within a wiring harness (Fig. 6).

All connectors are viewed from terminal end.

MAIN WIRING HARNESS CODES

A	Instrument Panel
B	Engine
C	Engine Control
E	Front Lamps
F	Battery
G	Starter
H	Heater and A/C
J	Transmission
K	Cruise Control
L	Alternator
M	Front Cross Body
N	Rear Cross Body
P	Body
Q	Trailer
R	Courtesy Lamps
S	Radio
T	LH Front Door
U	RH Front Door
V	LH Rear Door
W	RH Rear Door
X	Keyless Entry/Compass
Y	Anti-Lock Braking System
Z	Tailgate
AA	Taillamp

J908W-17

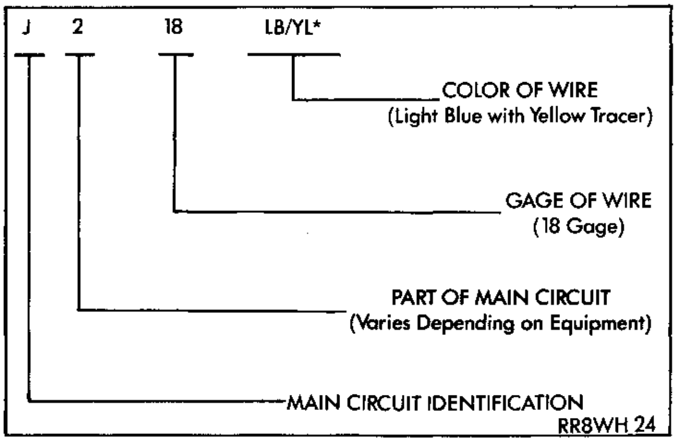


Fig. 4—Wire Color Code Identification

FUSIBLE LINKS

Vehicle wiring harnesses are equipped with fusible links to protect against harness damage in the event of a short in the electrical system.

WIRE COLOR CODE CHART

COLOR CODE	COLOR	STANDARD TRACER COLOR	COLOR CODE	COLOR	STANDARD TRACER CODE
BK	BLACK	WT	PK	PINK	BK OR WH
BR	BROWN	WT	RD	RED	WT
DB	DARK BLUE	WT	TN	TAN	WT
DG	DARK GREEN	WT	VT	VIOLET	WT
GY	GRAY	BK	WT	WHITE	BK
LB	LIGHT BLUE	BK	YL	YELLOW	BK
LG	LIGHT GREEN	BK	*	WITH TRACER	
OR	ORANGE	BK			

908W-192

Fig. 5—Wiring Splice Example

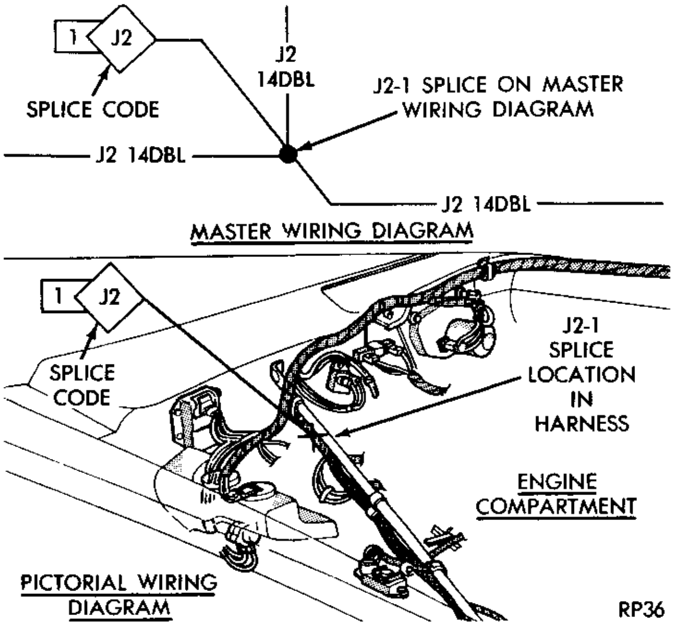


Fig. 6—Locating a Wiring Harness Splice

Fusible links are color coded as to wire gauges size. See fusible link chart.

FUSIBLE LINK REPLACEMENT

CAUTION: Do not replace blown fusible links with standard wire. Only fusible type wire with hypalon insulation can be used or damage to the electrical system will occur. Also make sure correct gauge of wiring is used. Refer to Master Wiring Diagrams for proper gauge size. Service Parts replacement fusible links are available.

(1) When a fusible link blows, it is very important to find out why it blew. They are placed in vehicle electrical systems for protection against dead shorts to ground which can be caused by electrical component failure or various wiring failures. **Do not just replace fusible link to correct problems.**

(2) When replacing fusible links that are connected to battery terminal of starter relay, they are to be serviced with the same type of prefabricated fusible link, available through the Parts Division.

All other fusible links are replaced with a piece of fusible link wire cut from bulk reels supplied through Parts Division. Care must be taken that the same gauge and color wire as the original fusible link be used (see Fusible Link Chart).

FUSIBLE LINK CHART		
Wire Gauge	Color Code	Color
12 Ga.	BL	BLUE
14 Ga.	BR	BROWN
16 Ga.	DB	DARK BLUE
18 Ga.	GN	GREEN
20 Ga.	OR	ORANGE

Multiple Fusible Link Replacement

(1) Disconnect negative battery cable.

(2) Cut off any remaining portion of blown fusible link flush with multiple connection insulator, taking care not to cut into other fusible links (Fig. 7).

(3) Remove 1 inch of insulation from main harness wire about 1 inch from multiple connection insulator (Fig. 7).

(4) Remove 1 inch of insulation from one end of new fusible link and wrap it around main harness wire that was stripped (Fig. 7).

(5) Heat splice with a high temperature soldering gun, apply rosin type solder until it flows freely, and remove soldering gun. **Do not use acid core solder.**

(6) Allow to cool and wrap new splice with a minimum of 3 layers of suitable electrical tape.

Single Fusible Link Replacement

(1) Disconnect negative battery cable.

(2) Cut fusible link including connection insulator from main harness wire (Fig. 7).

(3) Remove 1 inch of insulation from both new fusible link and main harness wire and wrap together (Fig. 7).

(4) Heat splice with a high temperature soldering gun, apply rosin type solder until it flows freely and remove soldering gun. **Do not use acid core solder.**

(5) Allow to cool and wrap new splice with a minimum of 3 layers of suitable electrical tape.

SYMBOLS, FUSES AND CONNECTORS

Various symbols are used on wiring diagrams. These symbols can be identified by referring to symbol identification (Fig. 8).

Additional fuse and connector information may be found on the backup pages of each model schematics.

CAUTION: When replacing a blown fuse, it is important to replace it with a fuse having the correct amperage rating. The use of a fuse with a rating other than indicated may result in a dangerous electrical overload. If a proper rated fuse continues to blow, it indicates a problem that should be corrected.

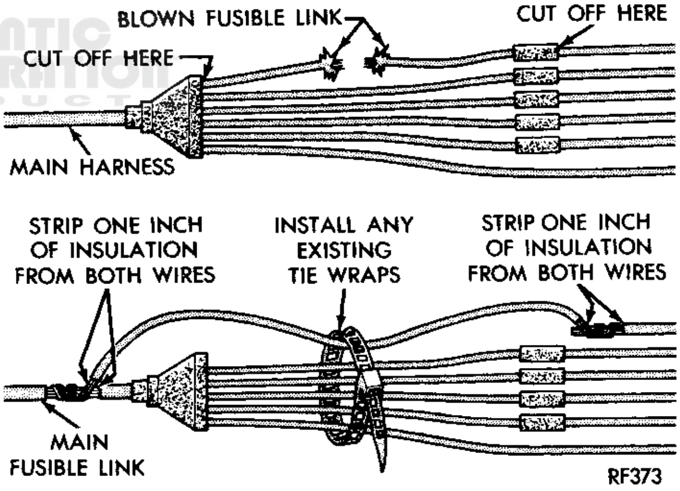


Fig. 7—Fusible Link Repair

	LEGEND OF SYMBOLS USED ON WIRING DIAGRAMS		
+	POSITIVE		CONNECTOR
−	NEGATIVE		MALE CONNECTOR
	GROUND		FEMALE CONNECTOR
	FUSE		DENOTES WIRE CONTINUES ELSEWHERE
	GANG FUSES WITH BUSS BAR		DENOTES WIRE GOES TO ONE OF TWO CIRCUITS
	CIRCUIT BREAKER		SPLICE
	CAPACITOR	J2 2	SPLICE IDENTIFICATION
Ω	OHMS		THERMAL ELEMENT
	RESISTOR	TIMER	TIMER
	VARIABLE RESISTOR		MULTIPLE CONNECTOR
	SERIES RESISTOR	◆ ◇	OPTIONAL WIRING WITH WIRING WITHOUT
	COIL		"Y" WINDINGS
	STEP UP COIL	88:88	DIGITAL READOUT
	OPEN CONTACT		SINGLE FILAMENT LAMP
	CLOSED CONTACT		DUAL FILAMENT LAMP
	CLOSED SWITCH		L.E.D. — LIGHT EMITTING DIODE
	OPEN SWITCH		THERMISTOR
	CLOSED GANGED SWITCH		GAUGE
	OPEN GANGED SWITCH		SENSOR
	TWO POLE SINGLE THROW SWITCH		FUEL INJECTOR
	PRESSURE SWITCH	#36	DENOTES WIRE GOES THROUGH BULKHEAD DISCONNECT
	SOLENOID SWITCH	#19 STRG COLUMN	DENOTES WIRE GOES THROUGH STEERING COLUMN CONNECTOR
	MERCURY SWITCH	INST PANEL #14	DENOTES WIRE GOES THROUGH INSTRUMENT PANEL CONNECTOR
	DIODE OR RECTIFIER	ENG #7	DENOTES WIRE GOES THROUGH GROMMET TO ENGINE COMPARTMENT
	BY-DIRECTIONAL ZENER DIODE		DENOTES WIRE GOES THROUGH GROMMET
	MOTOR		HEATED GRID ELEMENTS
	ARMATURE AND BRUSHES		908W-191

Fig. 8—Legend

FUSE CHARTS

INDEX

FUSE	AMP/ COLOR	ITEMS FUSED
1	15 LT/BL	TURN SIGNAL LAMPS, BACK-UP LAMPS
2	20 YL	COURTESY LAMPS, CARGO LAMPS
3	LT/BL	HAZARD LAMPS, STOP LAMPS
4	25 WT	REAR WINDOW DEFOGGER
5	25 WT	BLOWER MOTOR
6	15 LT/BL	KEY-IN BUZZER, REAR WINDOW DEFOGGER, GAUGES, TACHOMETER, INDICATOR LAMPS
7	5.3 C/BRKR	WINDSHIELD WIPERS
8	20 YL	TURN SIGNALS, PARK AND TAIL LAMPS
9	5 TN	INSTRUMENT PANEL ILLUMINATION LAMPS
10	30 GN	CIGAR LIGHTER, RADIO, CRUISE CONTROL
11		
12		
13		
14		
15		
16		

AMPS	FUSE	COLOR CODE
5	TN	TAN
15	LT BL	LIGHT BLUE
20	YL	YELLOW
25	NAT	NATURAL
30	GN	GREEN

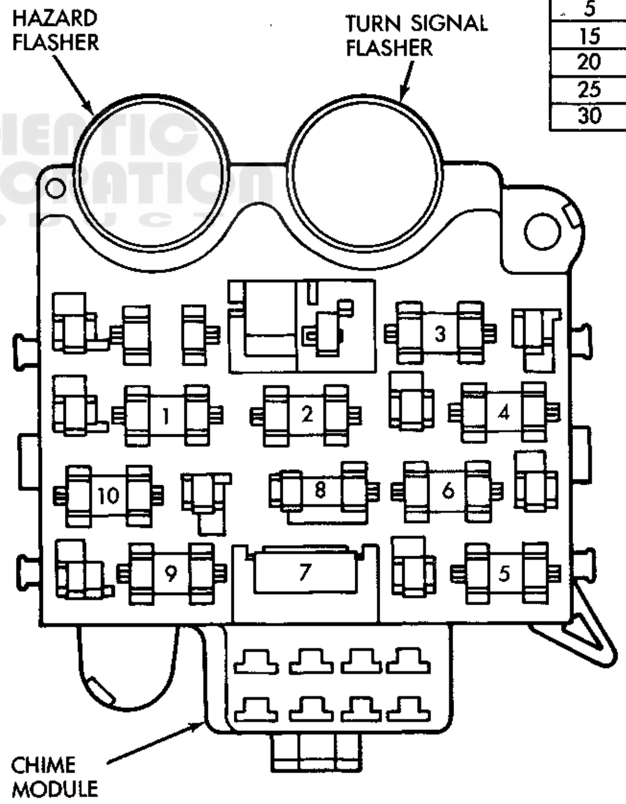
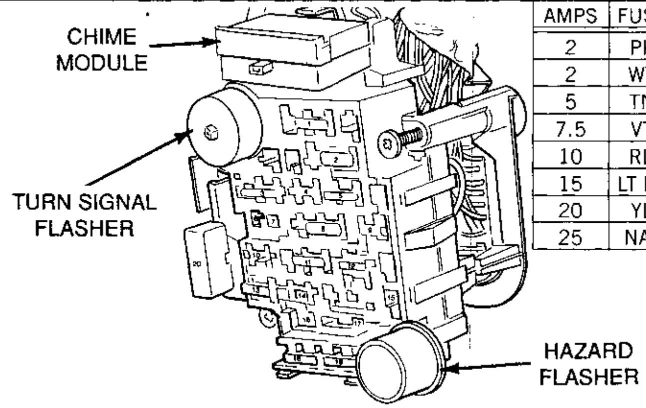


Fig. 1—Fuse Chart—YJ

FUSE	AMP/ COLOR	ITEMS FUSED
1 RR WIPE	25 WT	REAR WIPER, REAR WASHER
2 RADIO	15 LT BL	RADIO, RADIO/CLOCK ILLUMINATION, CIGAR LIGHTER, DOME LAMP, LOW WASHER FLUID
3 CLOCK	10 RD	DIGITAL CLOCK, EMISSION MAINTENANCE TIMER
4 FL/PASS	15 BL	HEADLAMP DIMMER SWITCH
5 BLOWER	25 WT	BLOWER MOTOR
6 POWER ACC	30 CIRCUIT BREAKER	POWER DOOR LOCKS, KEYLESS ENTRY, POWER SEATS, TRAILER HARNESS
7 ABS IGN	2 PK	ANTI-LOCK PUMP MOTOR
8 TURN B/U	20 YL	TURN SIGNAL FLASHER, REAR DEFOGGER
9 DOME	10 RD	COURTESY LAMPS, CARGO LAMP, DOME/MAP LAMP, GLOVE BOX LAMP, RADIO, CLOCK, KEYLESS ENTRY MODULE, POWER MIRRORS
10 ABS BAT	2 WT	ANTI-LOCK MODULE, ANTI-LOCK PUMP MOTOR, BRAKE FLUID LEVEL SWITCH
11 HD LP/DLY	25 WT	HEADLAMP DELAY MODULE
12 HAZ/STOP	15 LT BL	HAZARD FLASHER, STOPLAMP SWITCH
13 TRANS	7.5 VT	AUTOMATIC TRANSMISSION CONTROLS, BACKUP LAMPS
14 ANT	10 RD	RADIO, POWER ANTENNA
15 PARK	10 RD	HEADLAMP SWITCH, INST LPS FUSE, INSTRUMENT PANEL LAMPS, CLOCK, RADIO/CLOCK ILLUMINATION RELAY, REAR LAMPS, FRONT LAMPS
16 PWR WDW	30 CIRCUIT BREAKER	POWER WINDOWS
17 GAUGES	7.5 VT	INSTRUMENT CLUSTER, HEADLAMP DELAY MODULE, CHIME MODULE, CRUISE CONTROL
18 HTD WDW	25 WT	REAR DEFOGGER
19 INST LPS	5 TN	INSTRUMENT PANEL LAMPS
20 WINDSHIELD WIPER	4.8 CIRCUIT BREAKER	WINDSHIELD WIPER, WINDSHIELD WASHER



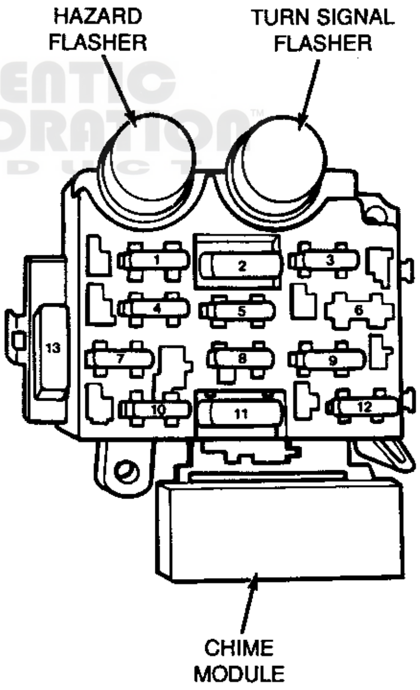
AMPS	FUSE	COLOR CODE
2	PK	PINK
2	WT	WHITE
5	TN	TAN
7.5	VT	VIOLET
10	RD	RED
15	LT BL	LIGHT BLUE
20	YL	YELLOW
25	NAT	NATURAL

J898W-86

Fig. 2—Fuse Panel—MJ/XJ

FUSE	AMP/ COLOR	ITEMS FUSED
1 RR WIPE	20 YL	REAR WIPER
2 POWER ACC	30 CIRCUIT BREAKER	POWER WINDOW, POWER MIRROR, TAILGATE WINDOW
3 HAZ STOP	20 YL	STOP LAMP SWITCH, HAZARD FLASHER, CRUISE CONTROL
4 TURN/BU	15 LT BL	TURN SIGNAL, BACKUP LAMP
5 DOME	20 YL	UNDERHOOD LAMP, COURTESY LAMP, RADIO, GLOVEBOX LAMP, INSTRUMENT CLUSTER, DOME AND READING LAMPS, COMPASS, KEYLESS ENTRY, HAZARD FLASHER, CRUISE CONTROL
6		
7 ACC	20 YL	CIGAR LIGHTER, RADIO ILLUMINATION
8 PARK/TAIL	20 YL	CHIME MODULE, HEADLAMP SWITCH, PANEL DIMMER SWITCH, ACC LPS FUSE, INSTRUMENT PANEL LAMPS, INSTRUMENT PANEL, RADIO, FRONT PARK/MARKER LAMPS, CHIME MODULE, COMPASS
9 IGN LPS	25 WT	CHIME MODULE, INSTRUMENT CLUSTER, DEFOGGER SWITCH, COMPASS
10 ACC LAMPS	3 VT	INSTRUMENT PANEL, INSTRUMENT PANEL LAMPS
11 POWER ACC	30 CIRCUIT BREAKER	POWER DOOR LOCKS, POWER SEATS, TAILGATE
12 FAN/HTR	25 WT	A/C CONTROL MODULE
13 WINDSHIELD WIPER	5.5 CIRCUIT BREAKER	WINDSHIELD WIPER
14		
15		
16		

AMPS	FUSE	COLOR CODE
3	VT	VIOLET
15	LT BL	LIGHT BLUE
20	YL	YELLOW
25	NAT	NATURAL



J898W-85

Fig. 3—Fuse Chart—SJ

WIRING AND COMPONENTS

INDEX

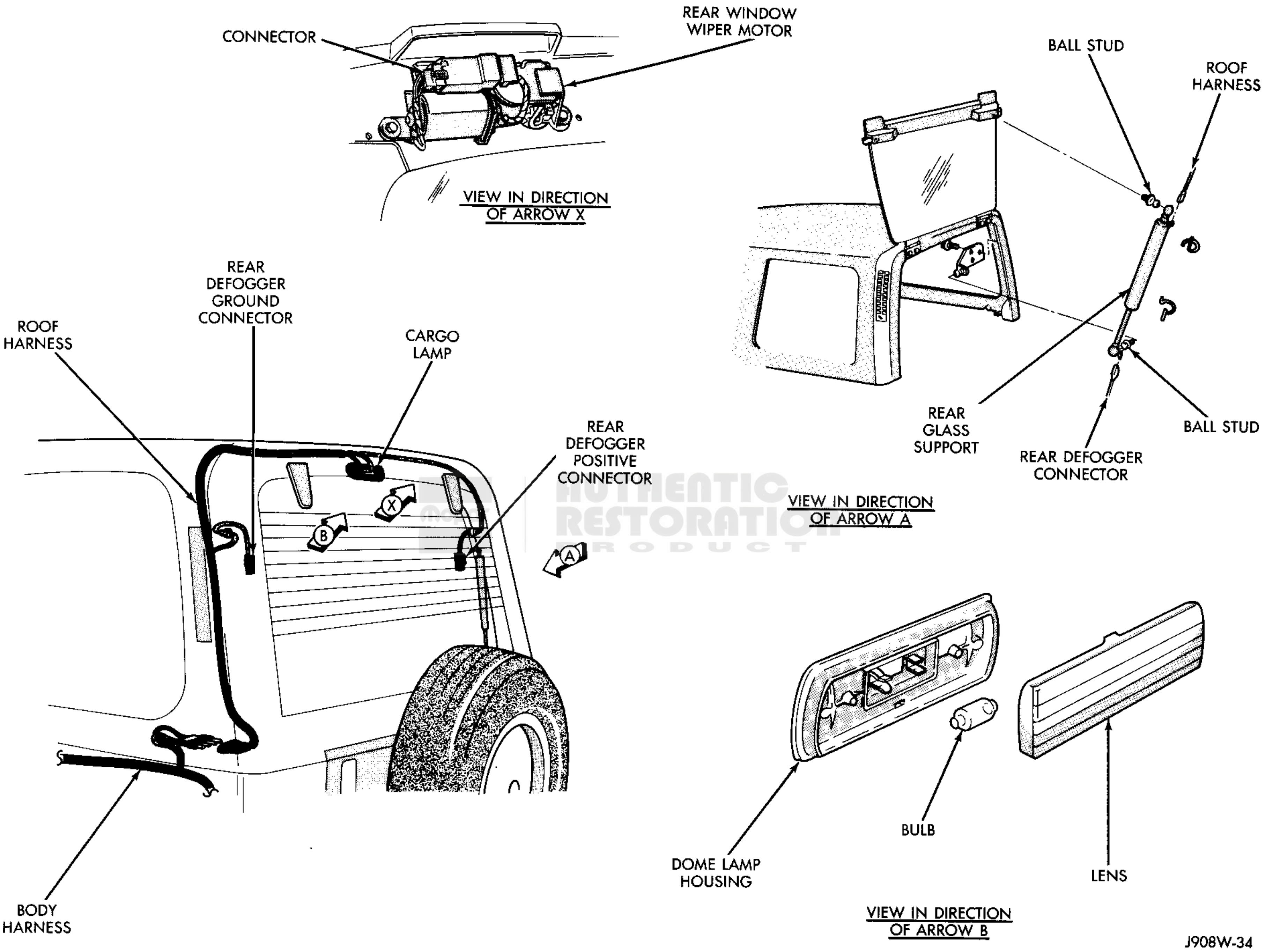


Fig. 1 — Hardtop Wiring — YJ

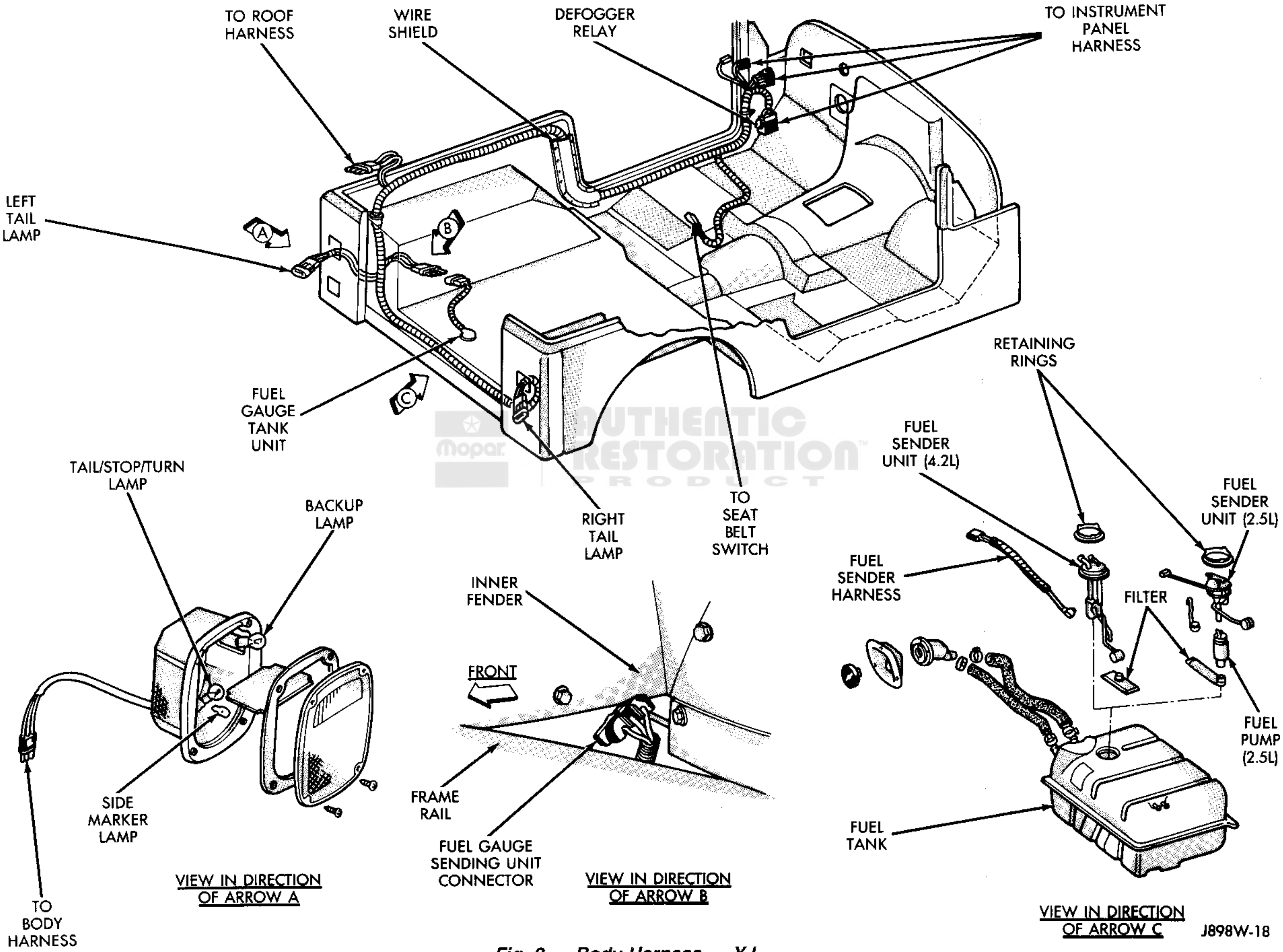


Fig. 2 — Body Harness — YJ

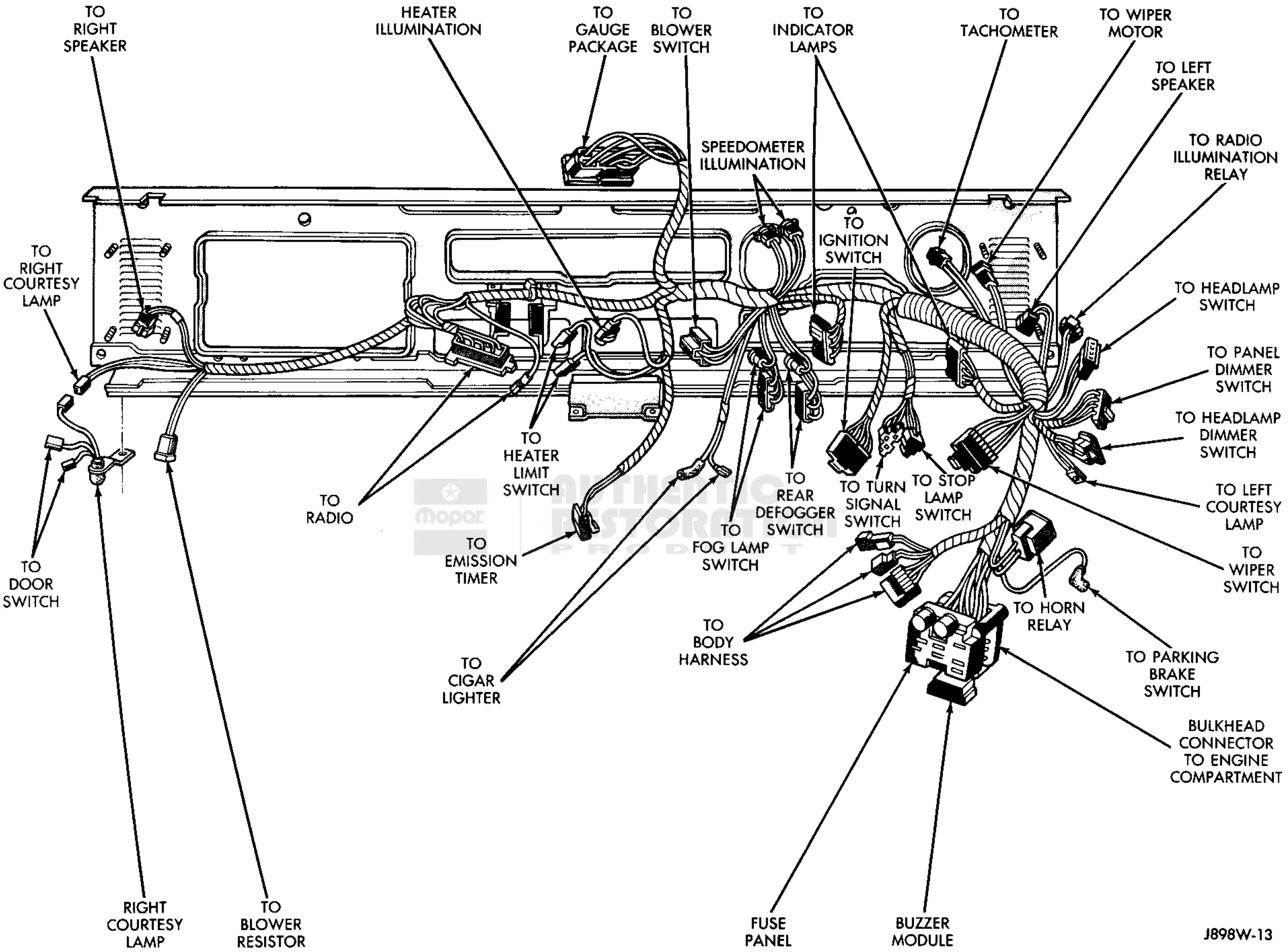


Fig. 3 — Instrument Panel Wiring — YJ

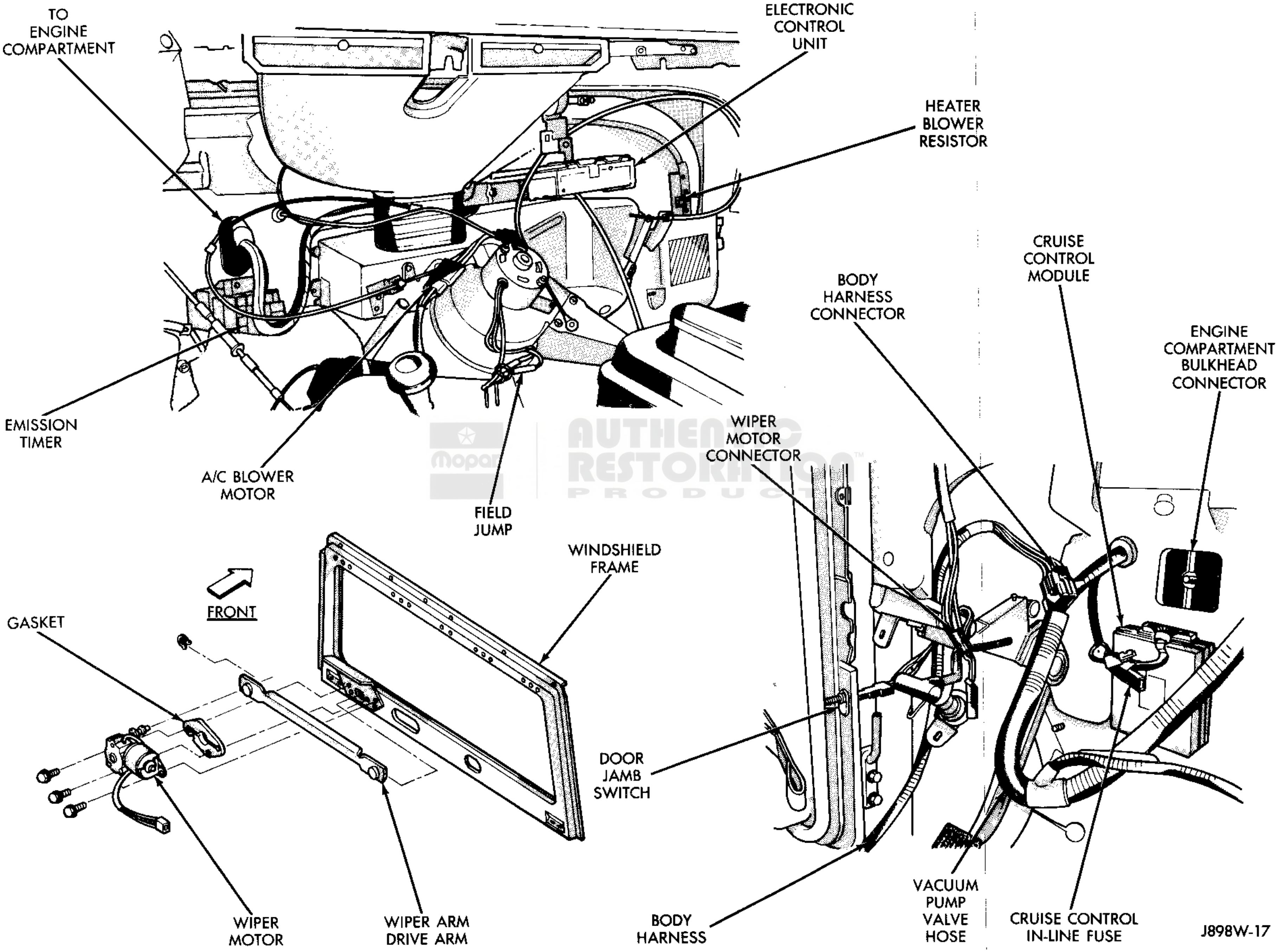


Fig. 4 — Instrument Panel Components — YJ

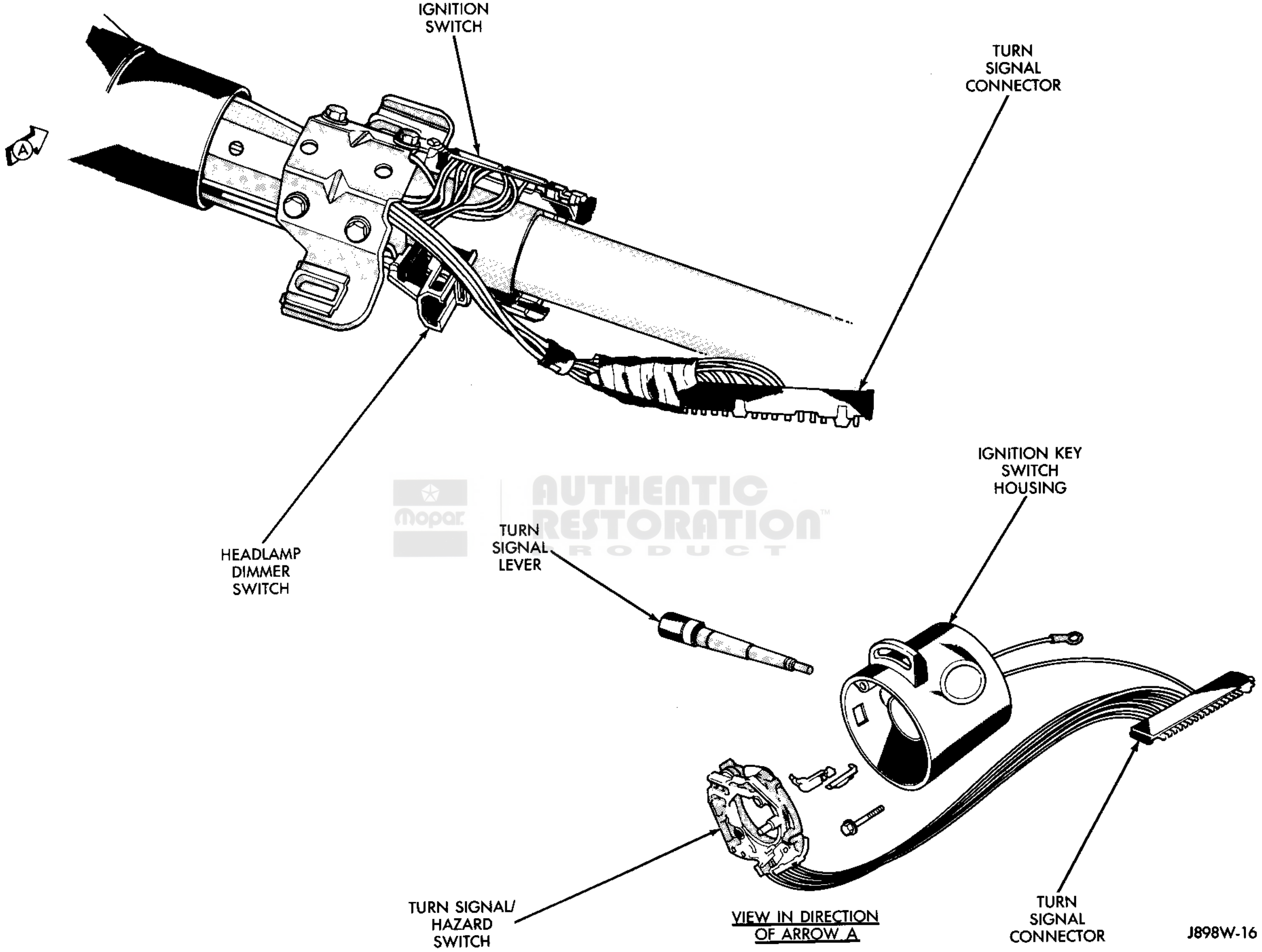


Fig. 5 — Steering Column Wiring — YJ

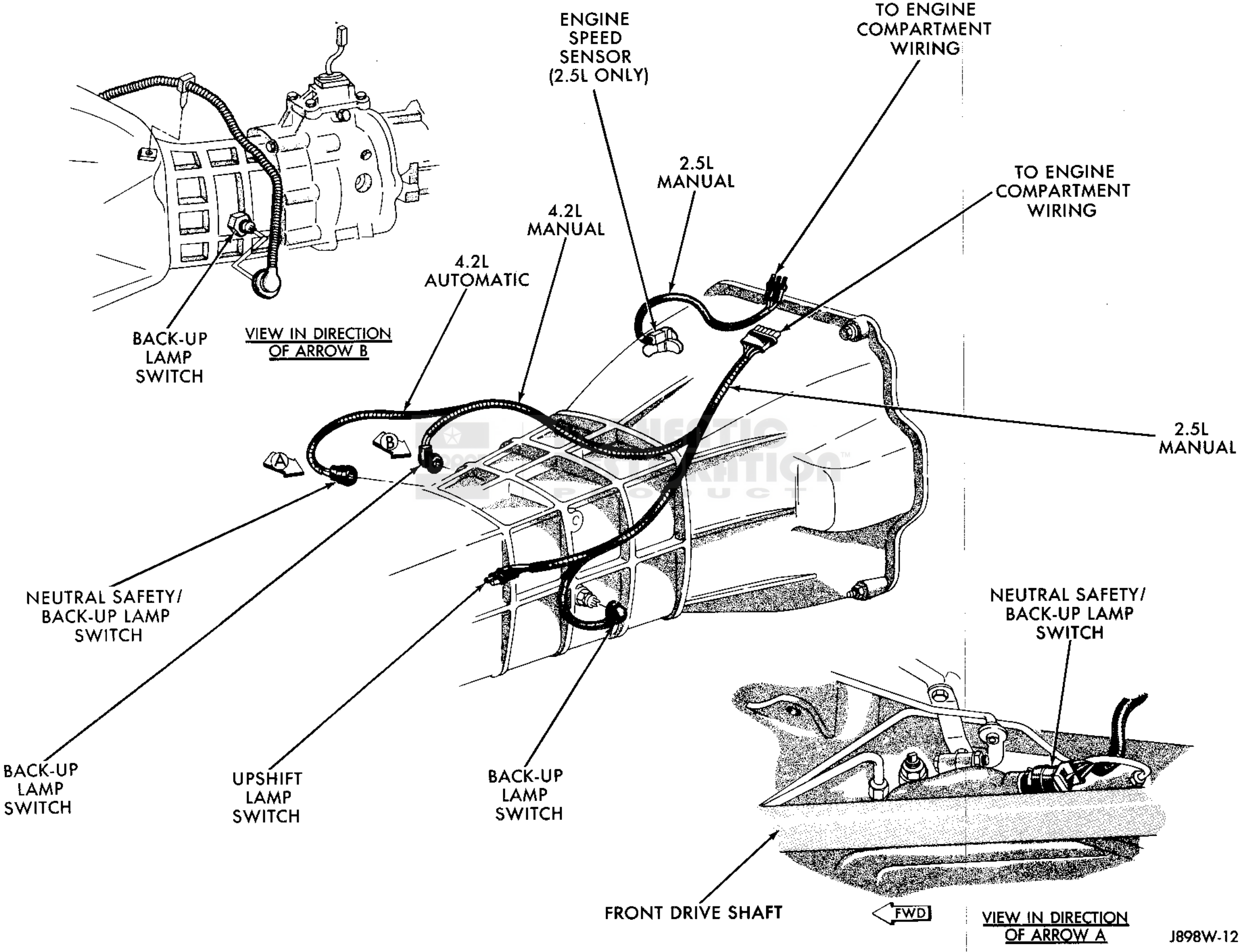
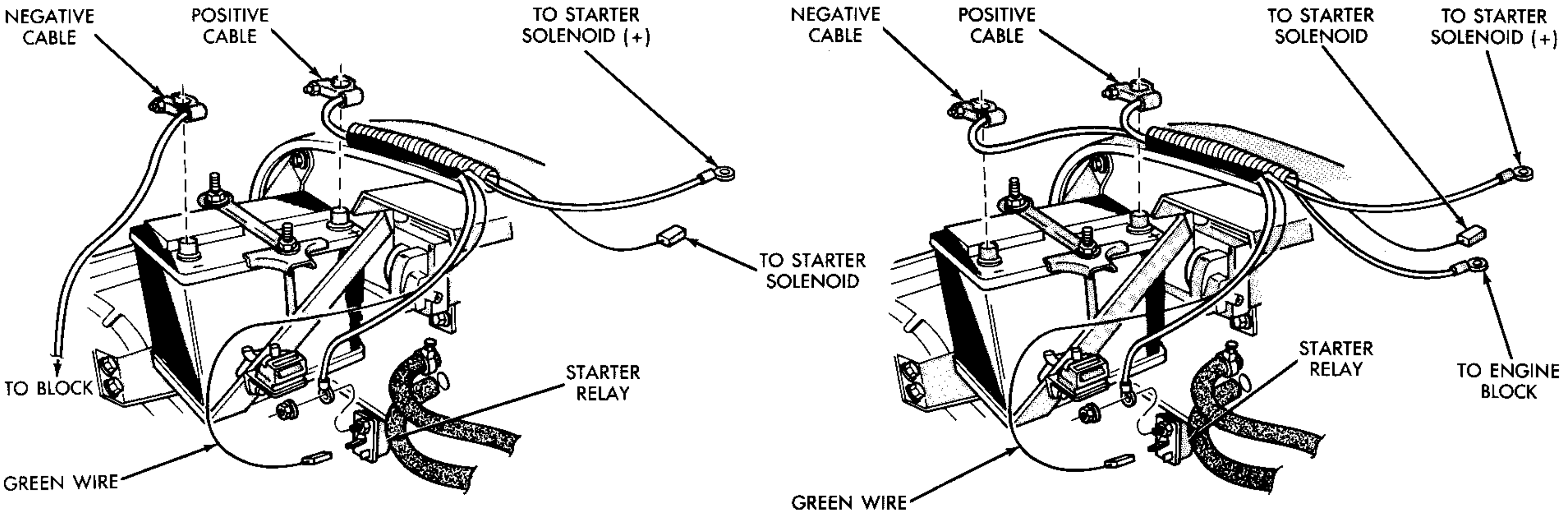


Fig. 6 — Transmission Wiring — YJ



4.2L ENGINE

2.5L ENGINE

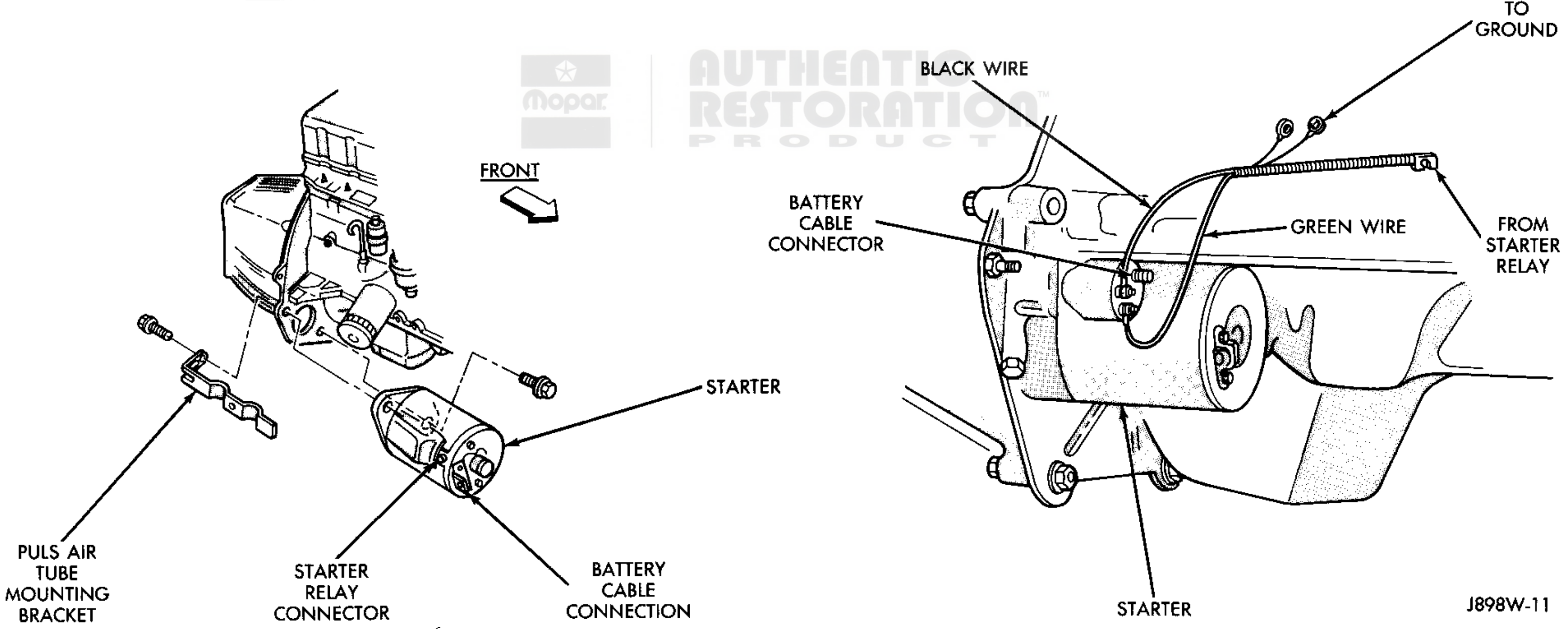


Fig. 7 — Starter System Components — YJ

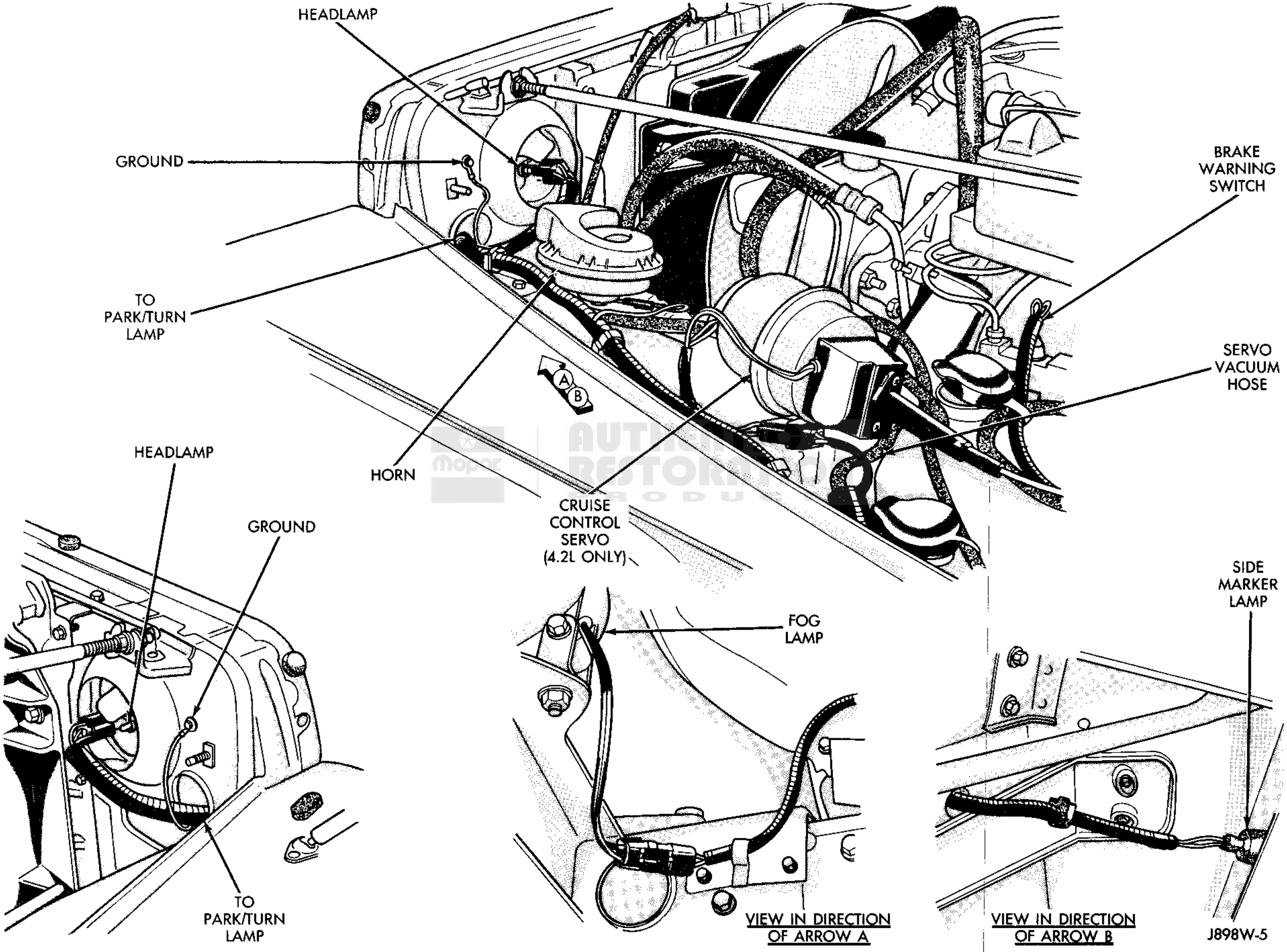


Fig. 8 — Engine Compartment Wiring 2.5L Engine — YJ

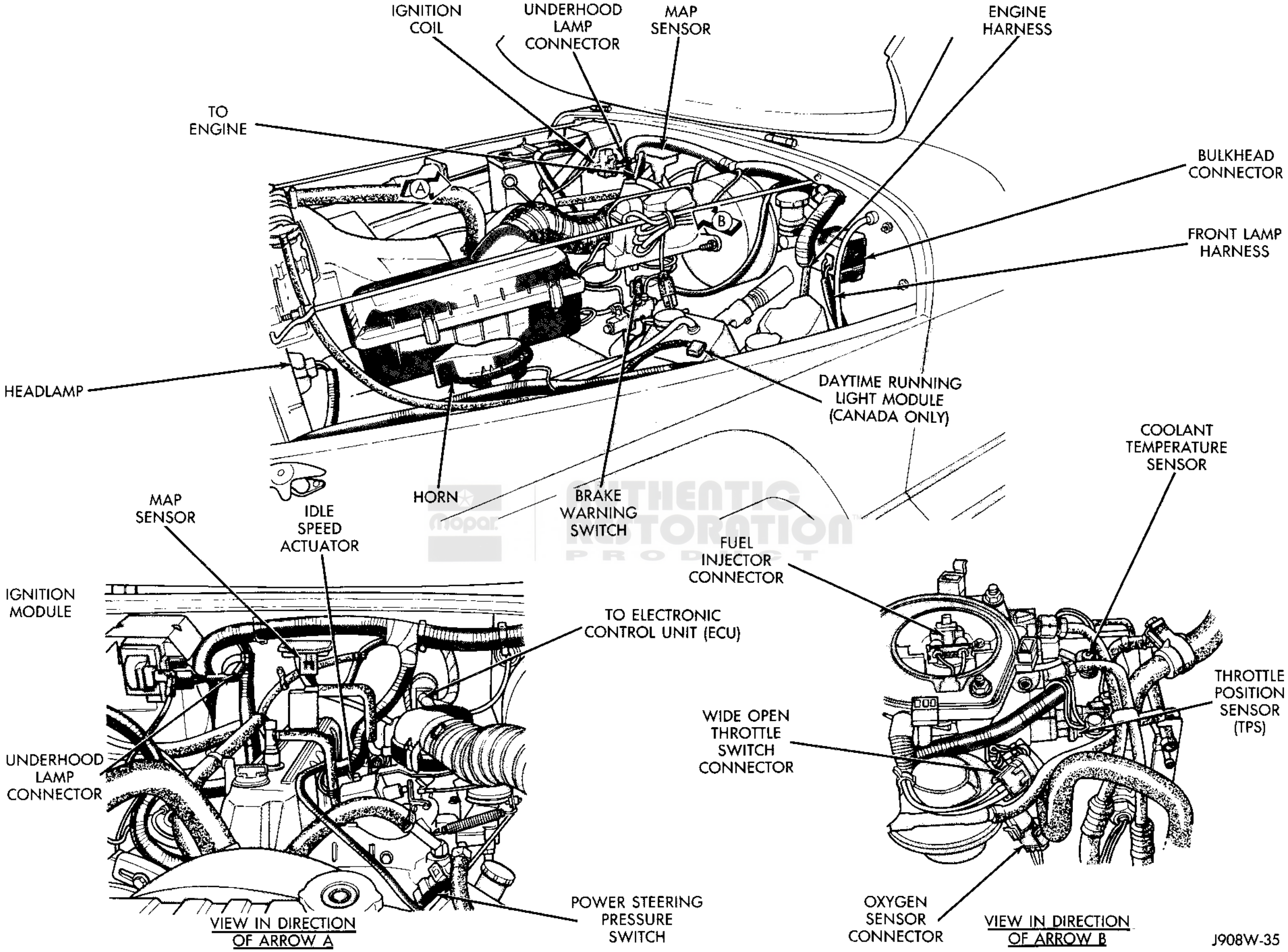


Fig. 9 — Left Side Engine Compartment Wiring 2.5L Engine — YJ

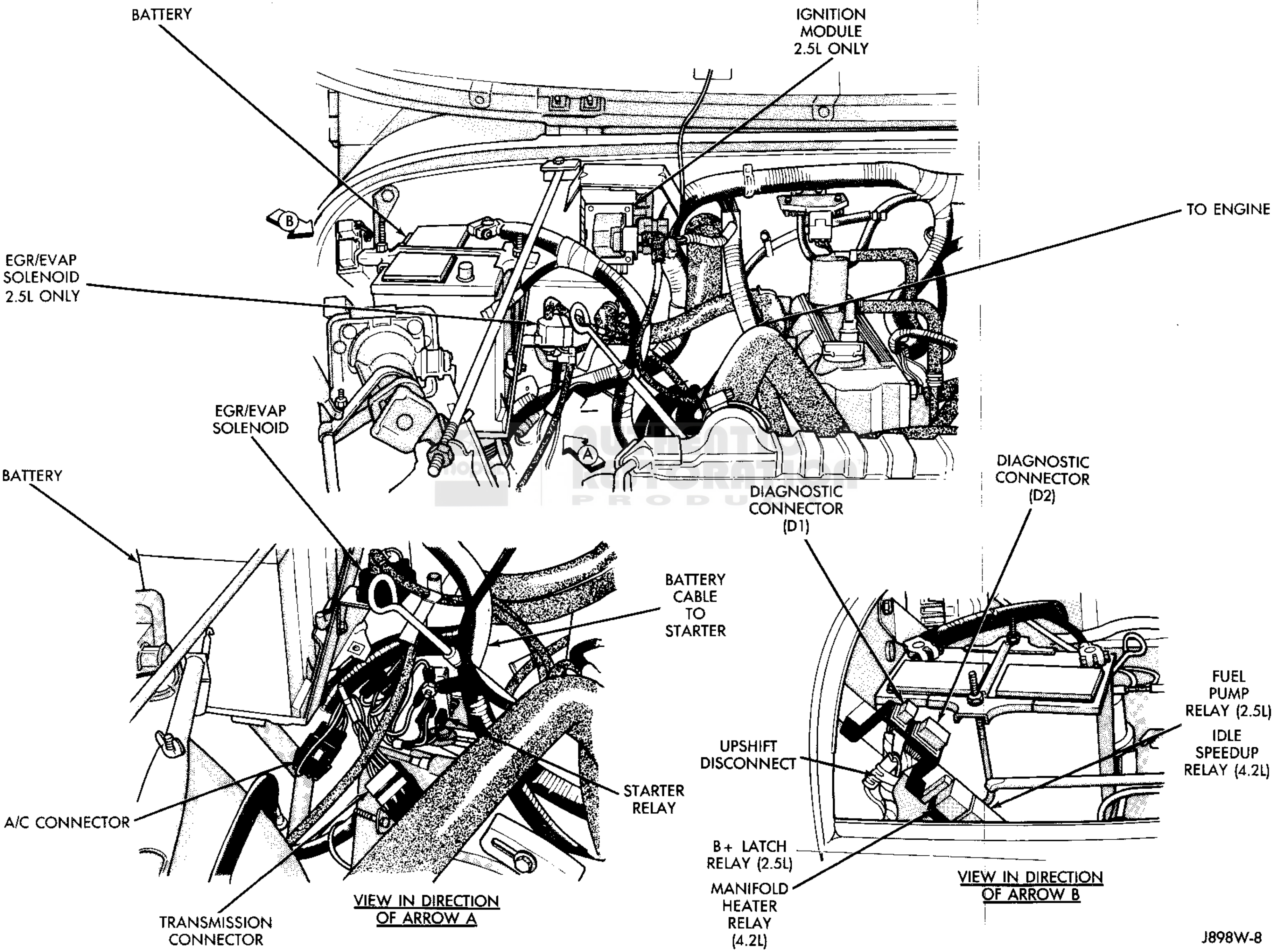


Fig. 10 — Right Side Engine Compartment Wiring 2.5L Engine — YJ

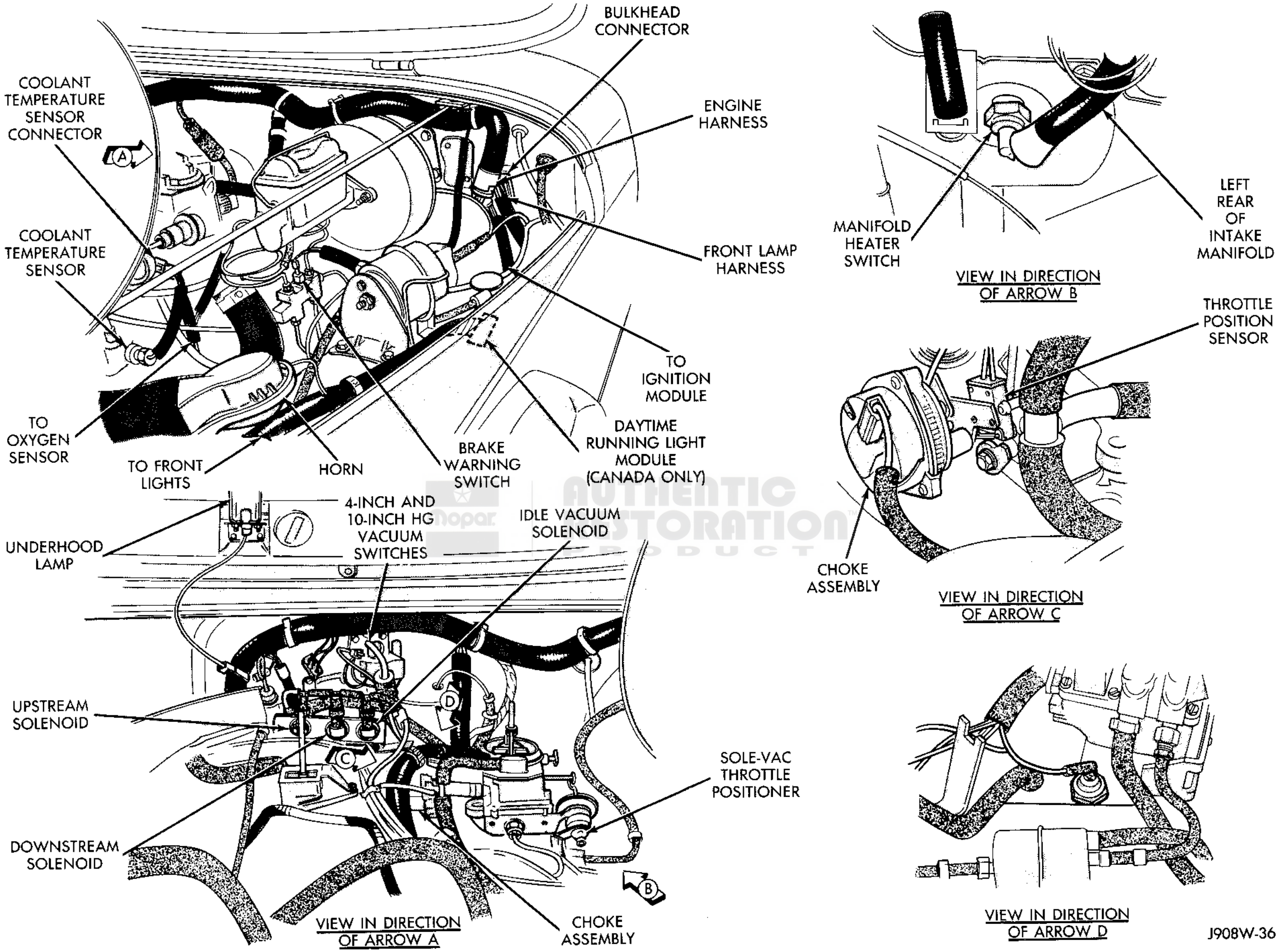


Fig. 11 — Engine Compartment Wiring 4.2L Engine — YJ

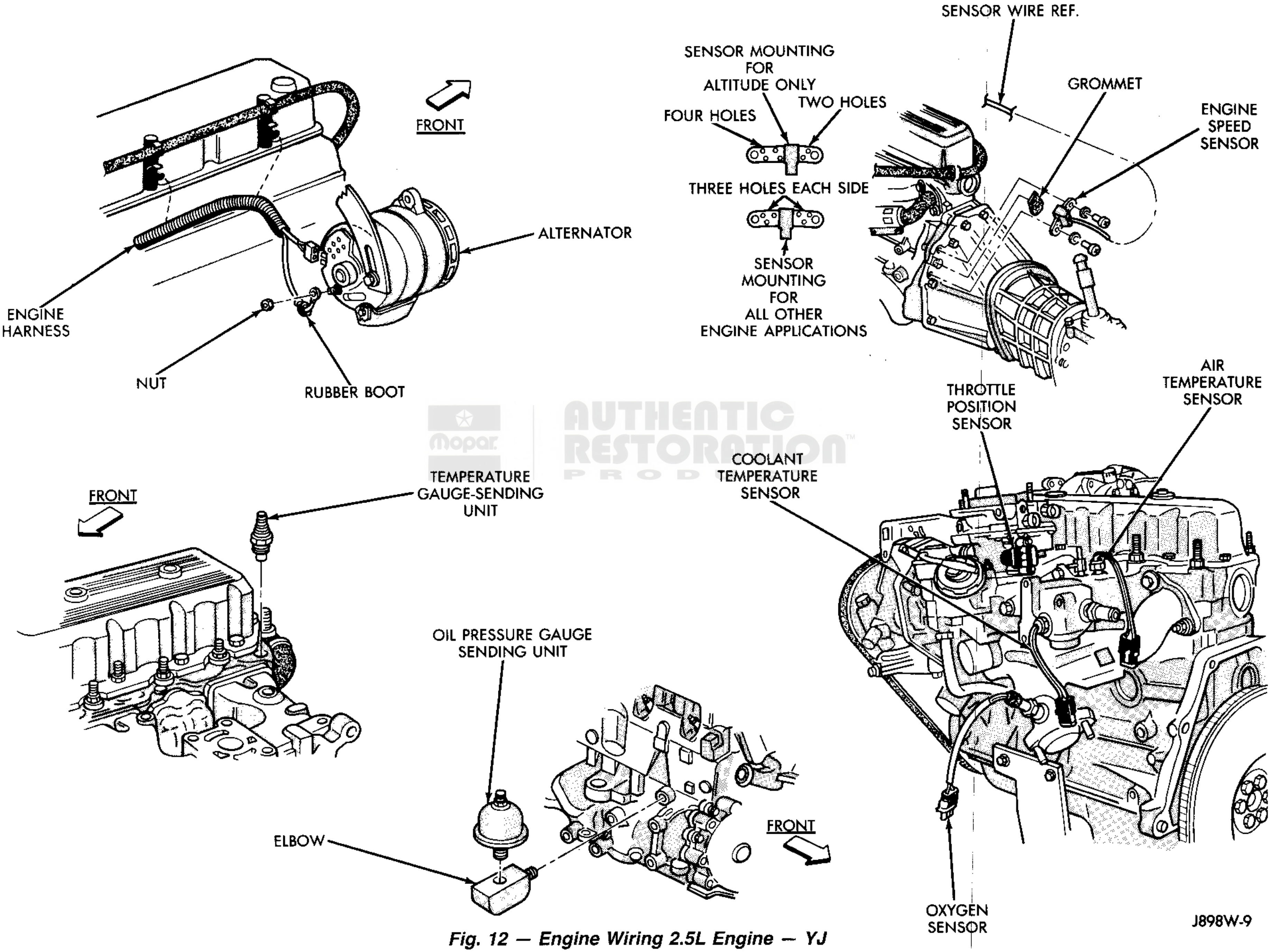


Fig. 12 — Engine Wiring 2.5L Engine — YJ

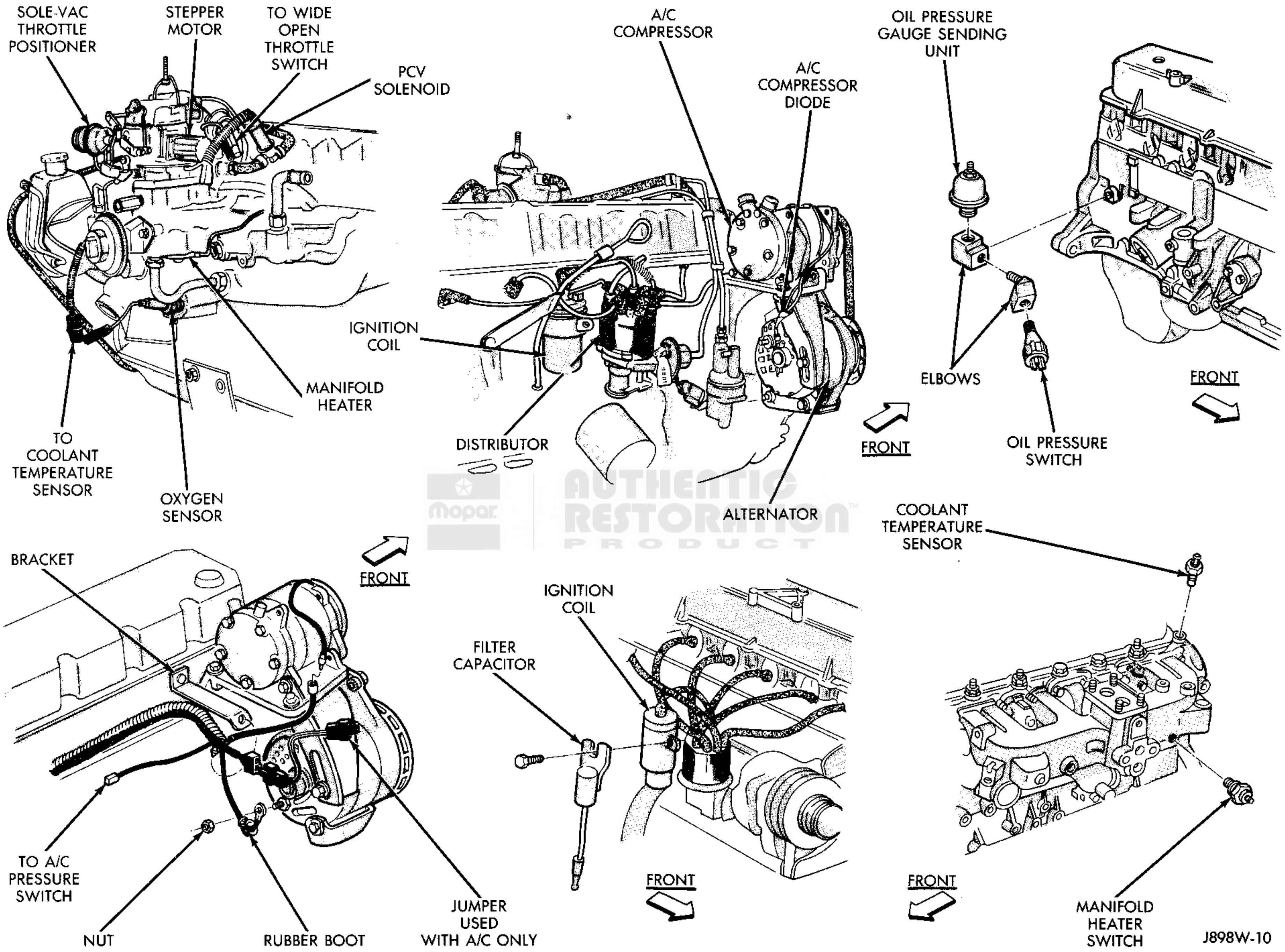


Fig. 13 — Engine Wiring 4.2L Engine — YJ

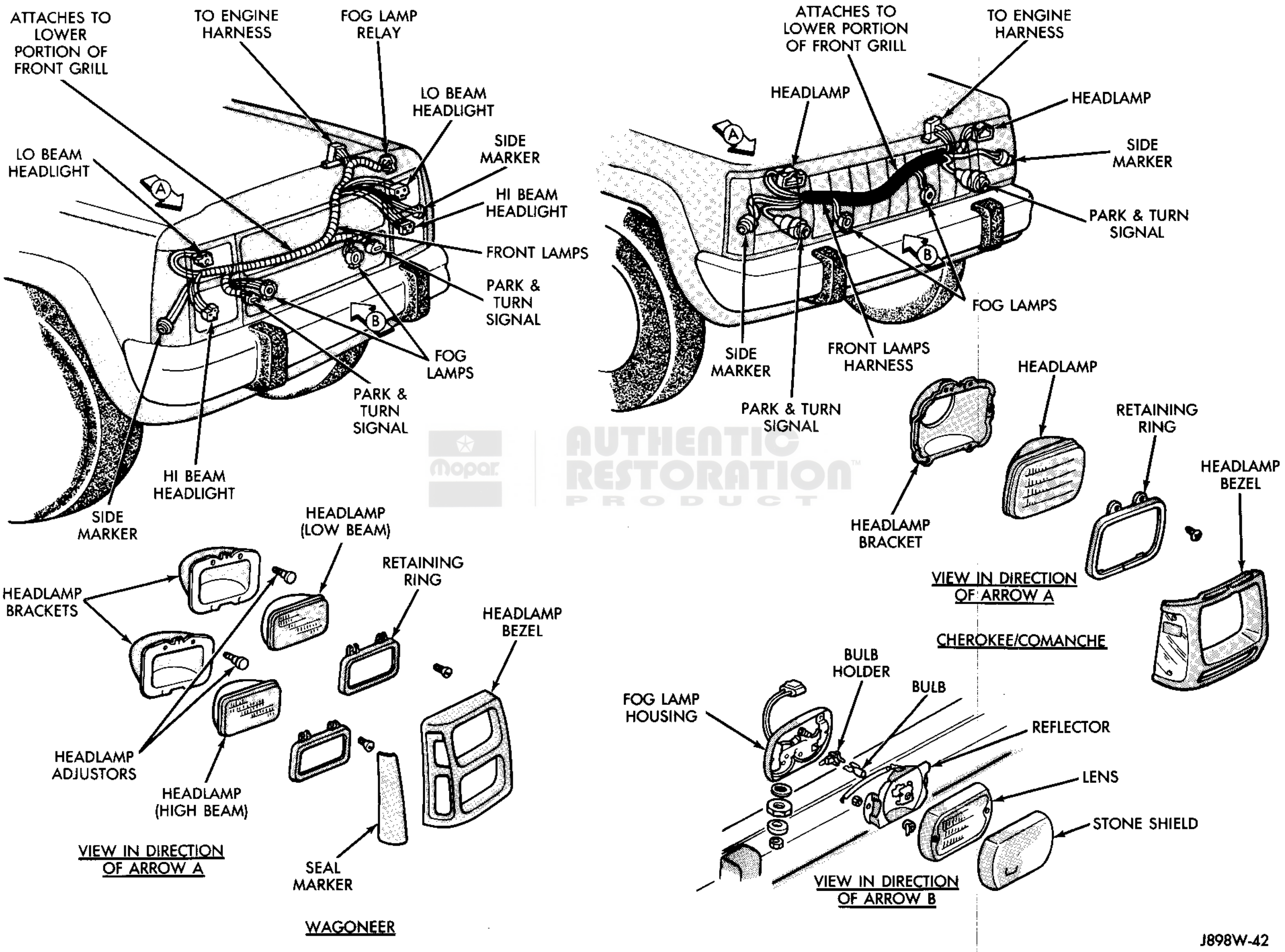


Fig. 14 — Front End Wiring — MJ, XJ

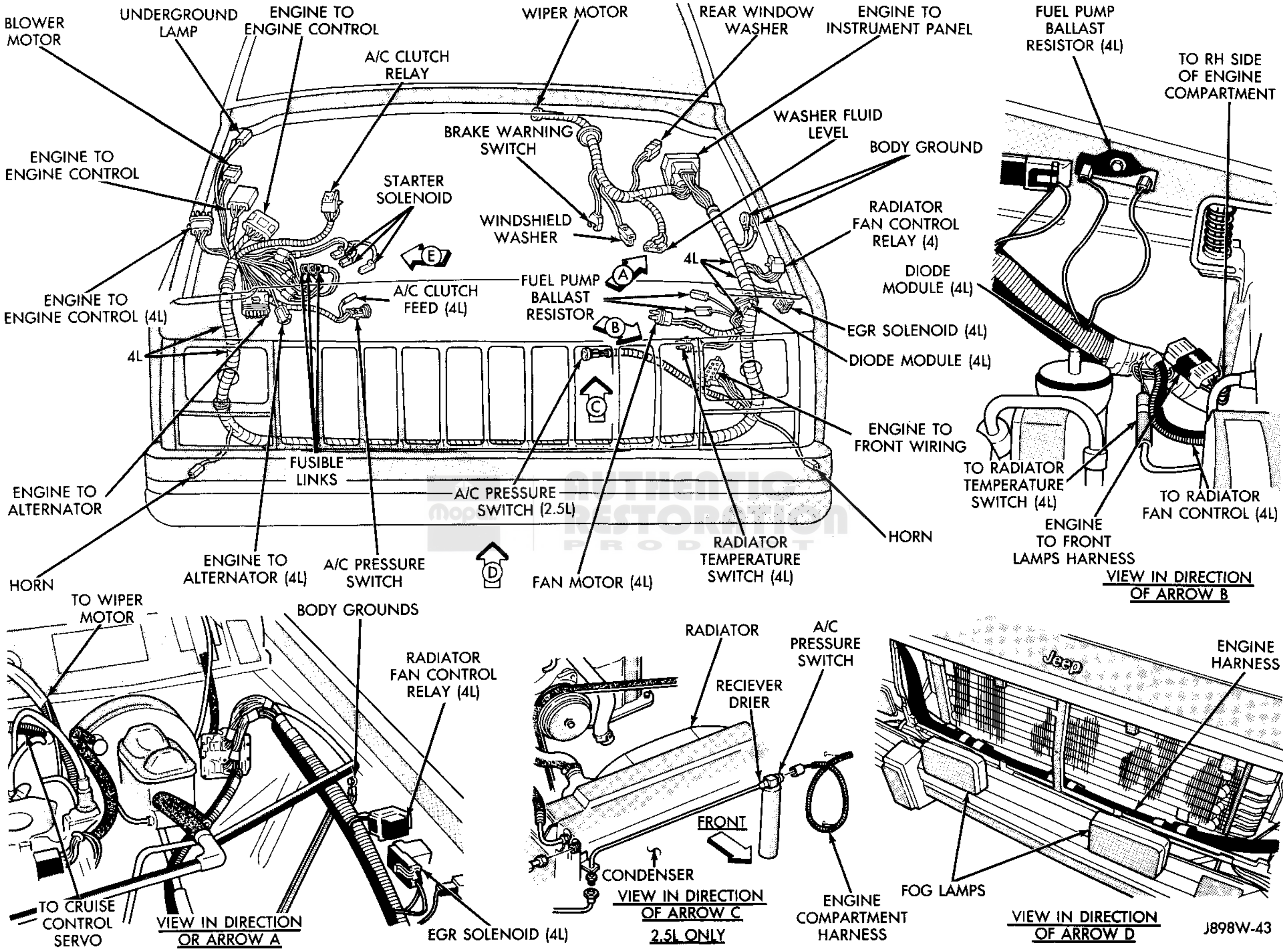


Fig. 15 — Engine Compartment Wiring — MJ, XJ

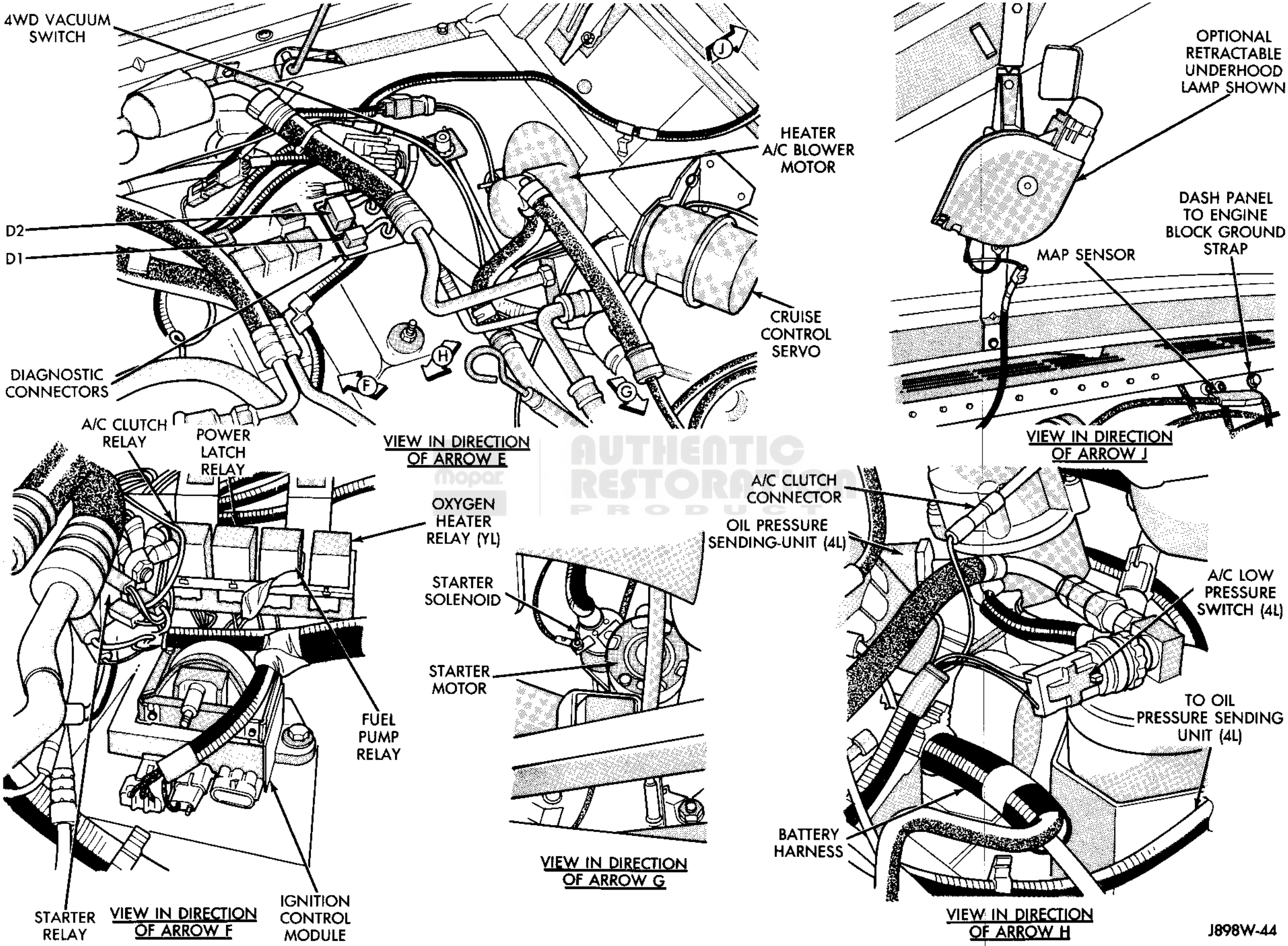


Fig. 16 — Engine Compartment Component Wiring — MJ, XJ

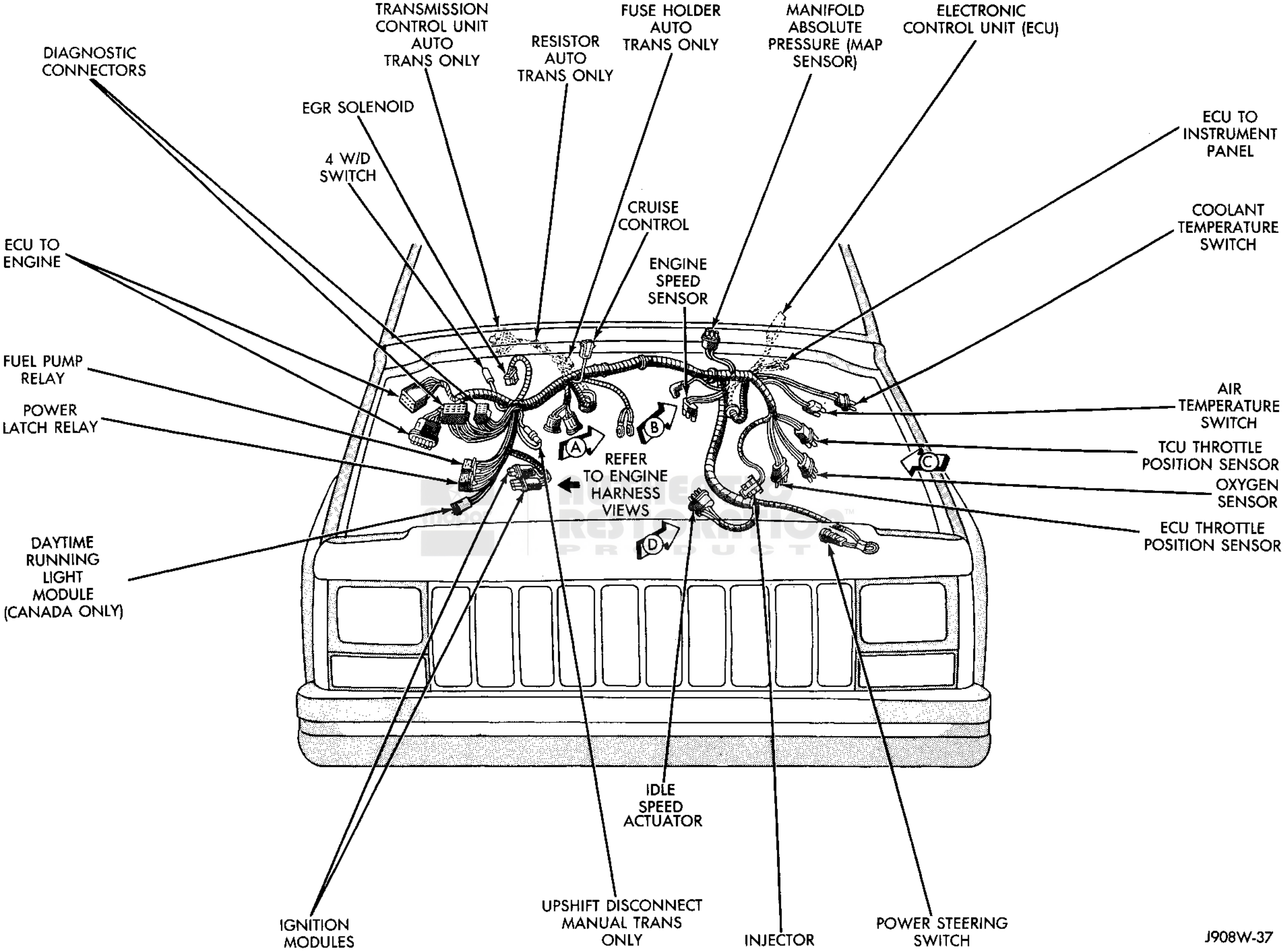
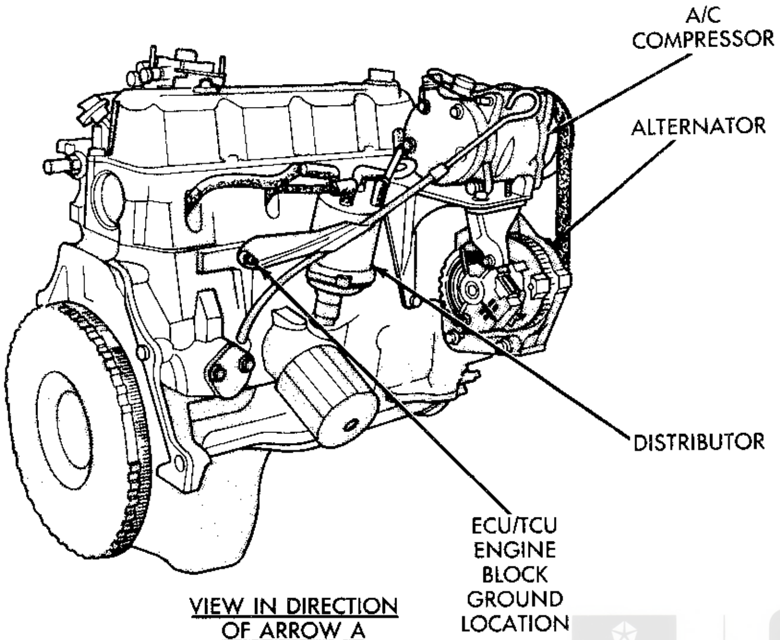
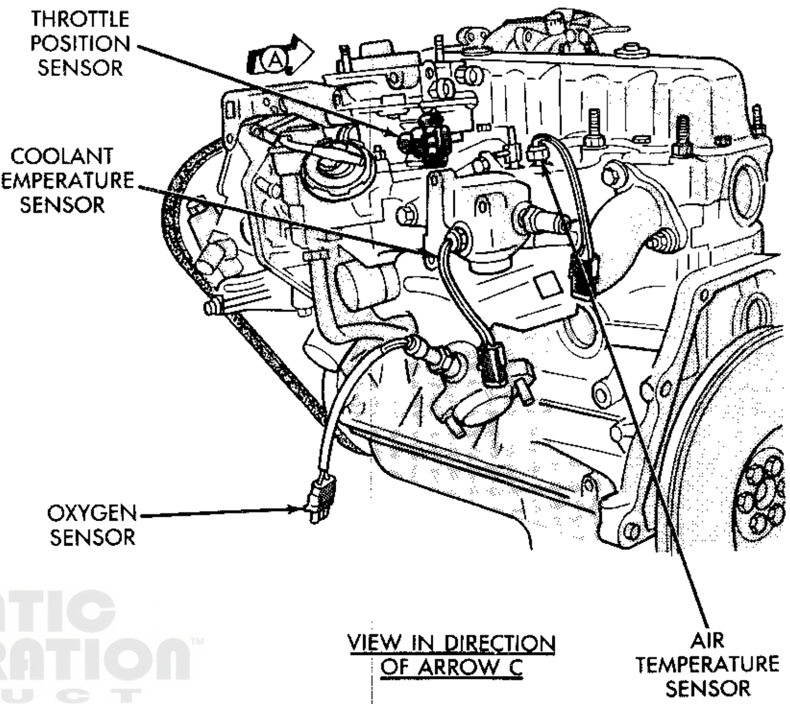


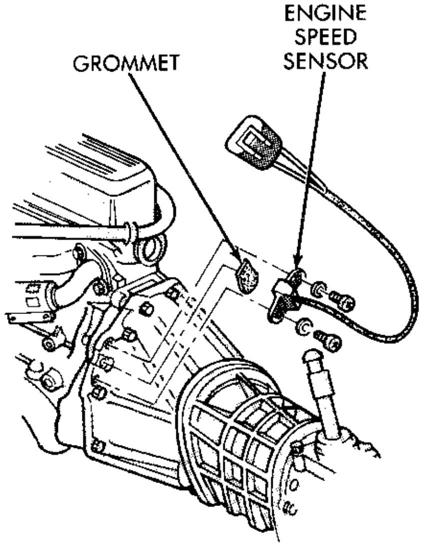
Fig. 17 — Engine Compartment Wiring 2.5L Engine — MJ, XJ

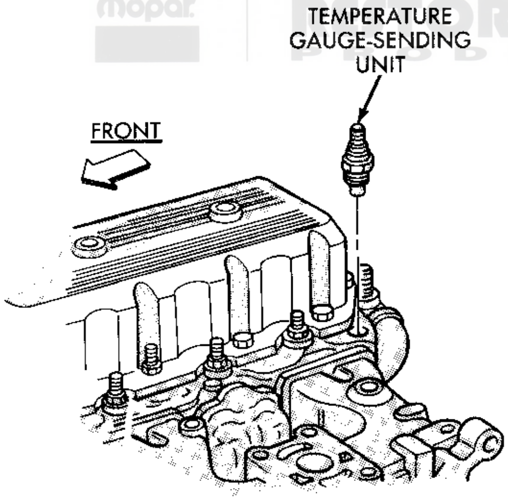


VIEW IN DIRECTION OF ARROW A

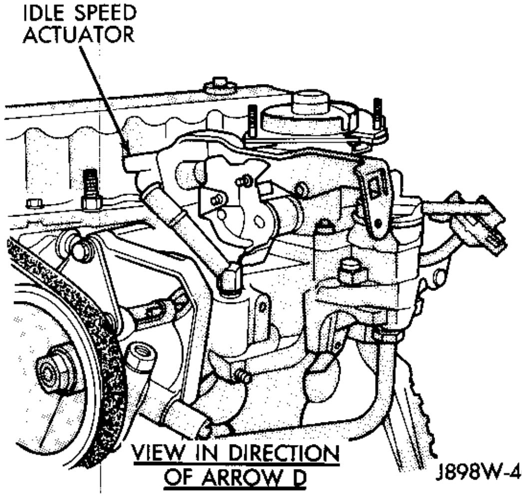


VIEW IN DIRECTION OF ARROW C





VIEW IN DIRECTION OF ARROW B



VIEW IN DIRECTION OF ARROW D

J898W-46

Fig. 18 — Engine Wiring 2.5L Engine — MJ, XJ

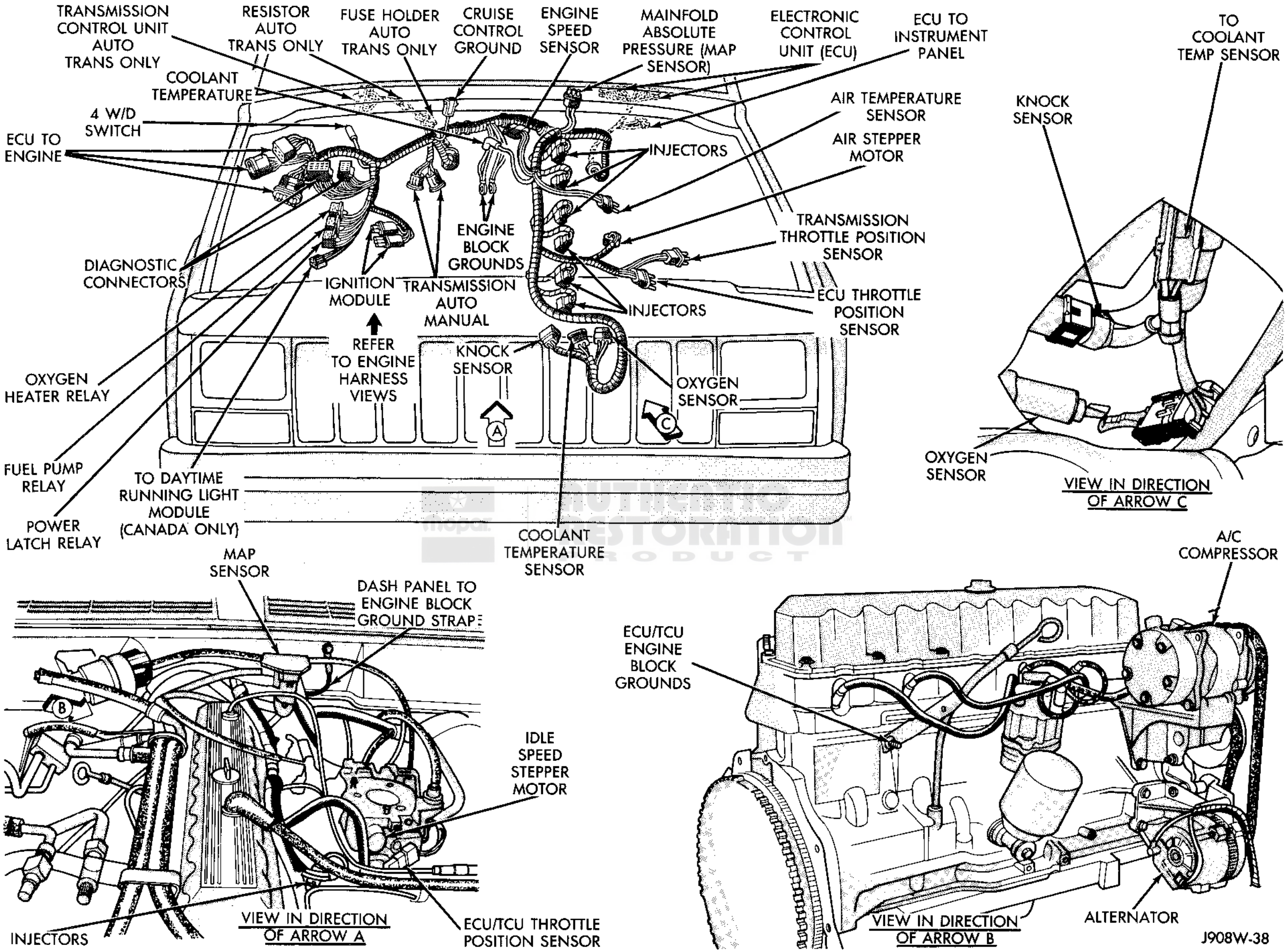


Fig. 19 — Engine Wiring 4.0L Engine — MJ, XJ

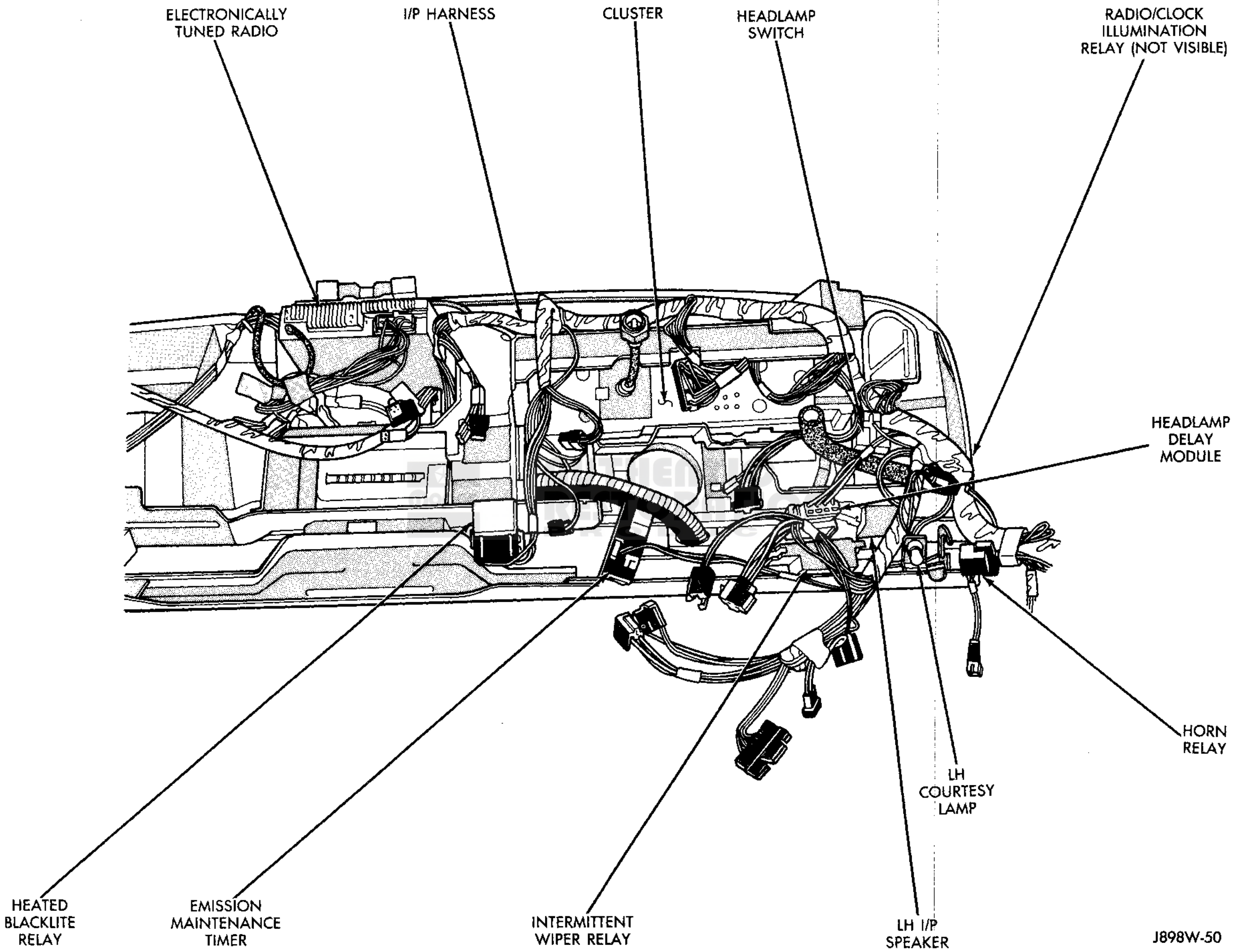


Fig. 20 — Instrument Panel Left Side Wiring — MJ, XJ

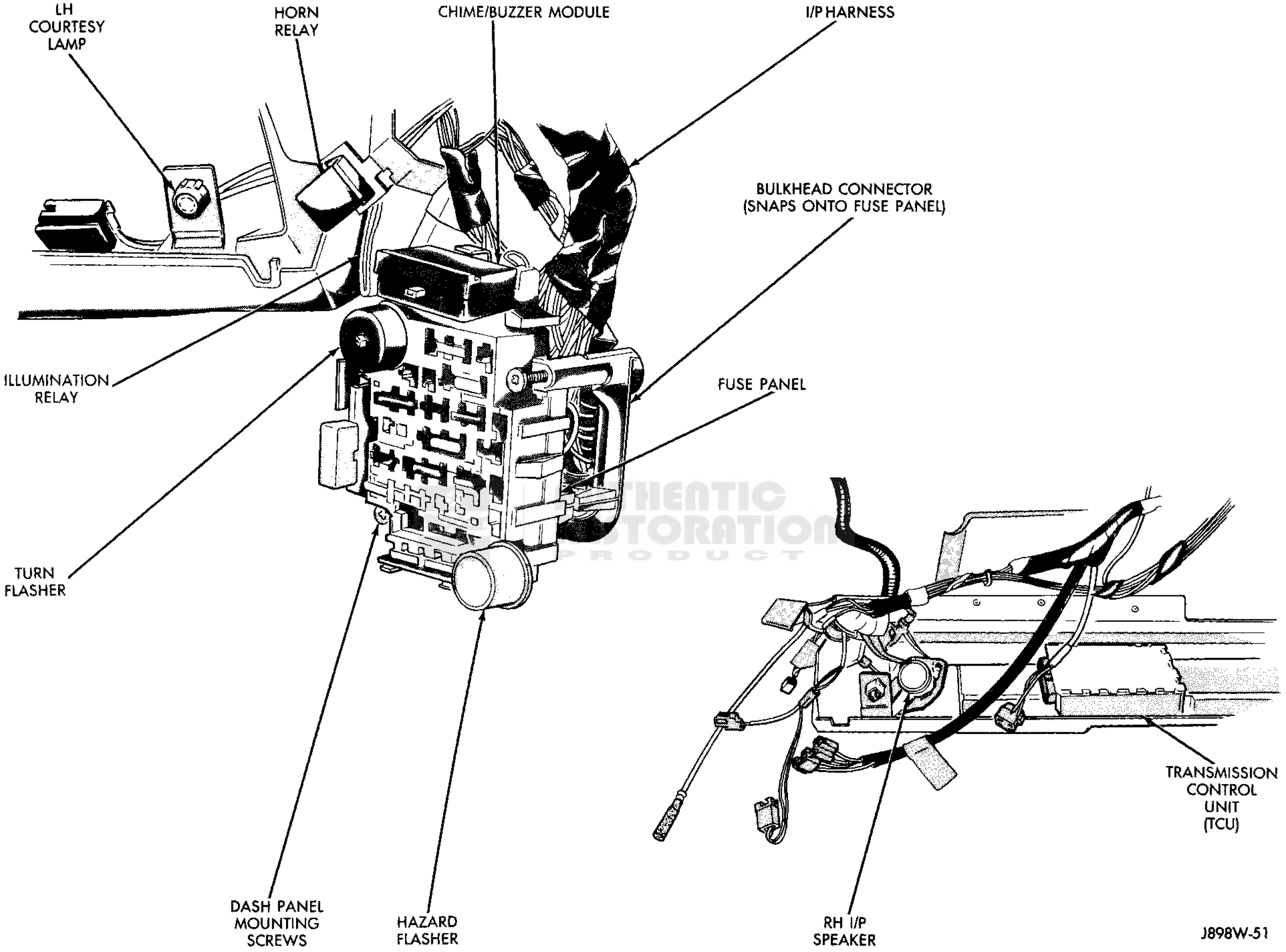


Fig. 21 — Instrument Panel Right Side Wiring — MJ, XJ

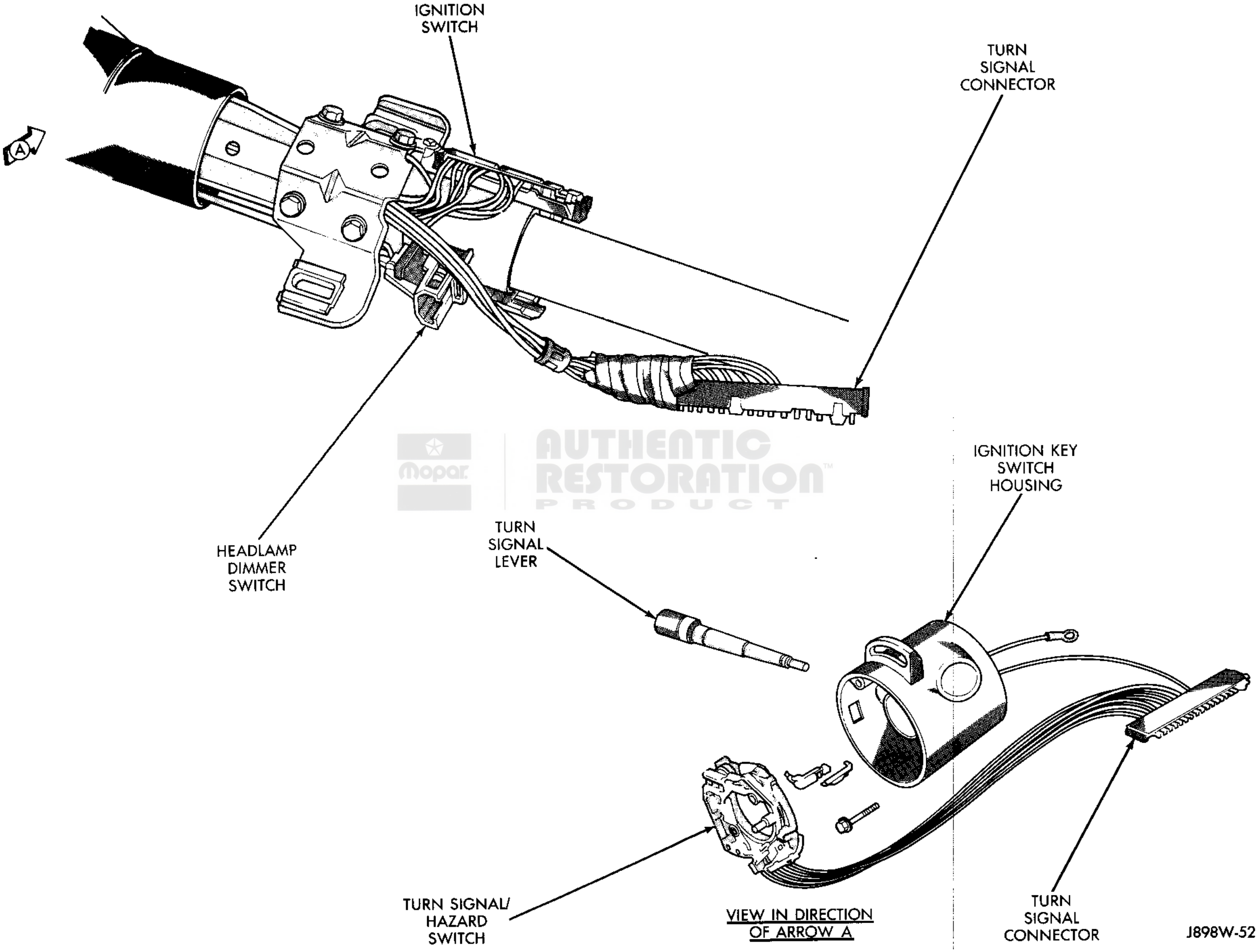


Fig. 22 — Steering Column Wiring — MJ, XJ

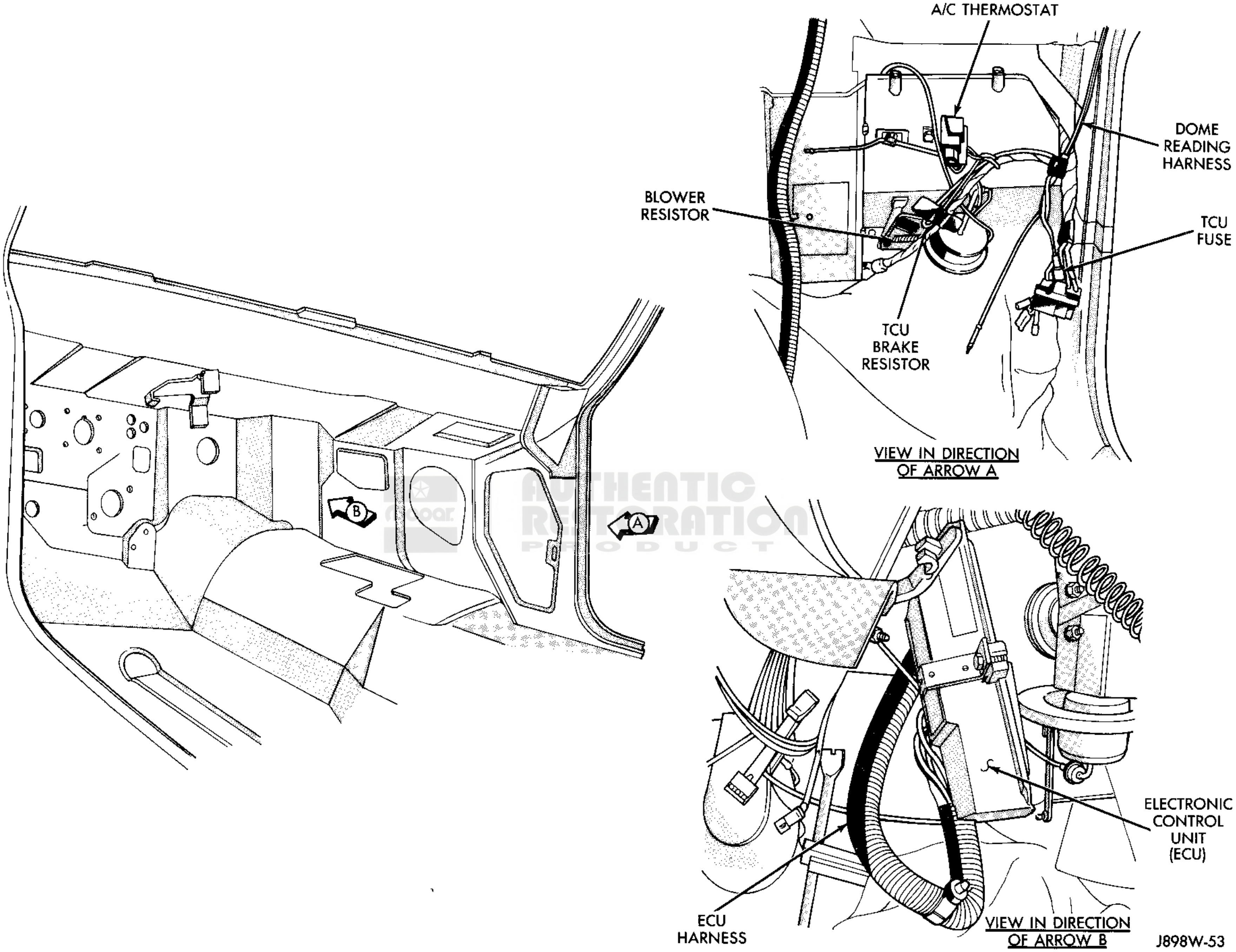


Fig. 23 — Cowl Panel Wiring — MJ, XJ

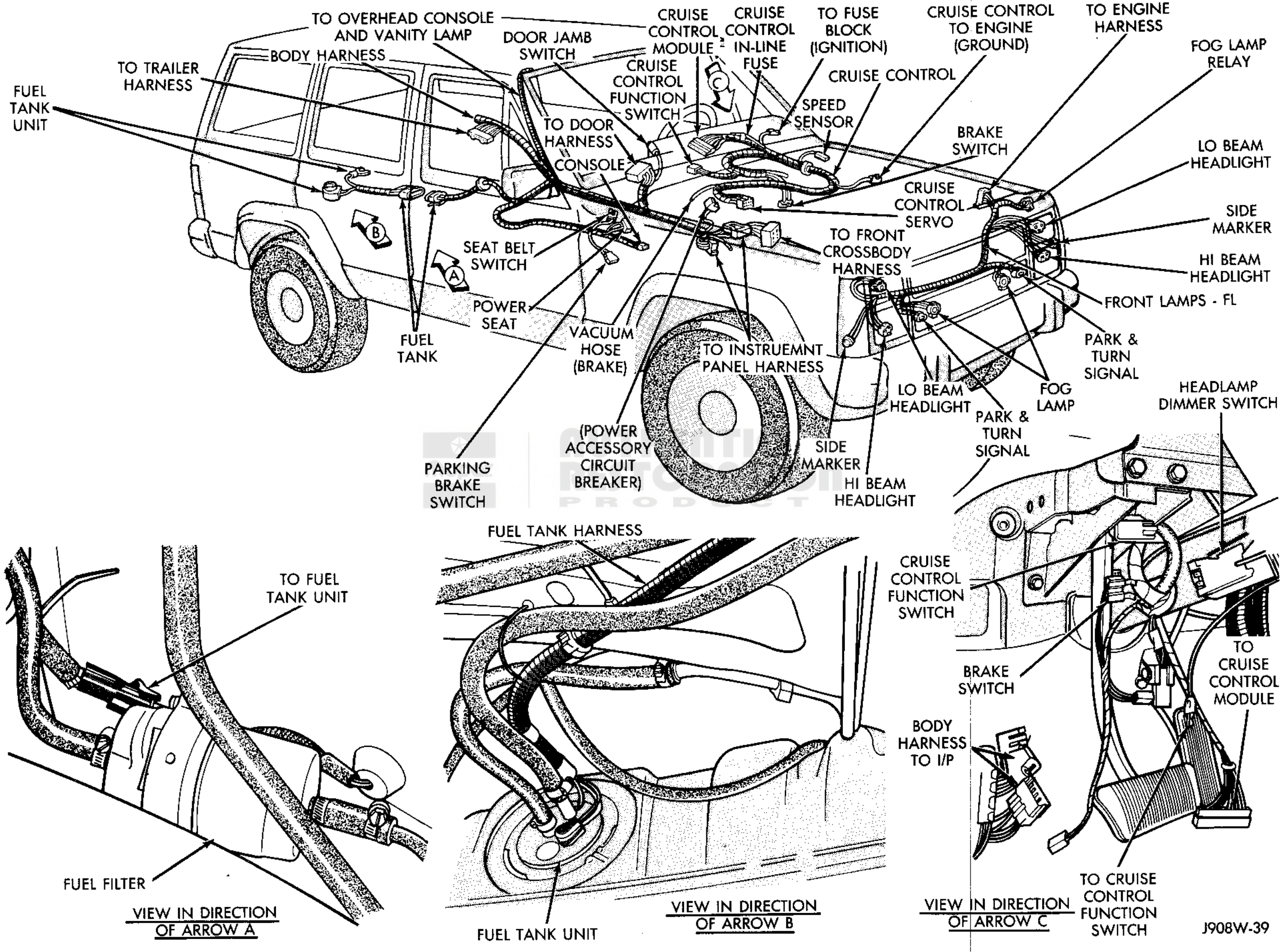


Fig. 24 — Body Wiring — XJ

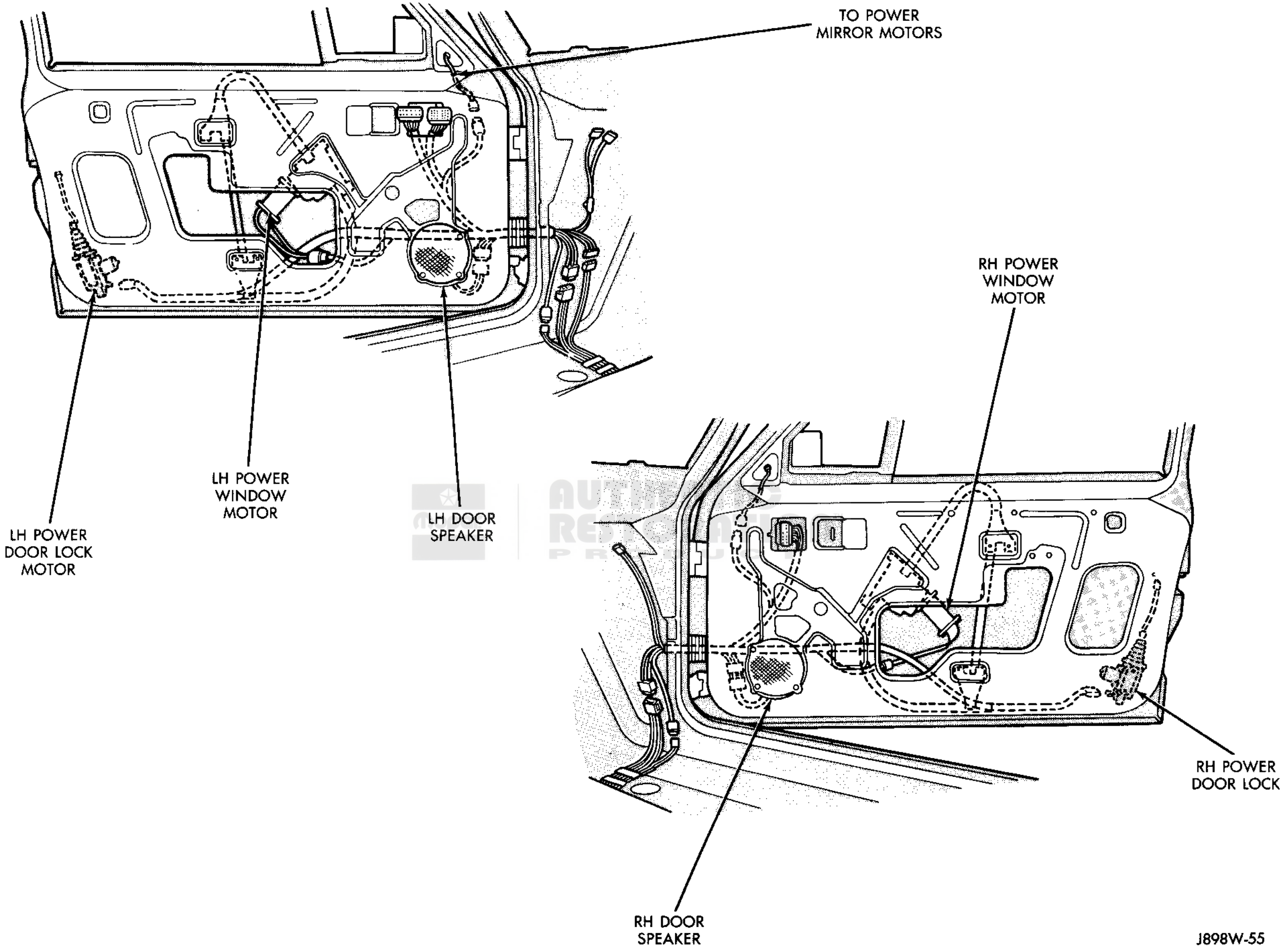


Fig. 25 — Door Wiring — XJ

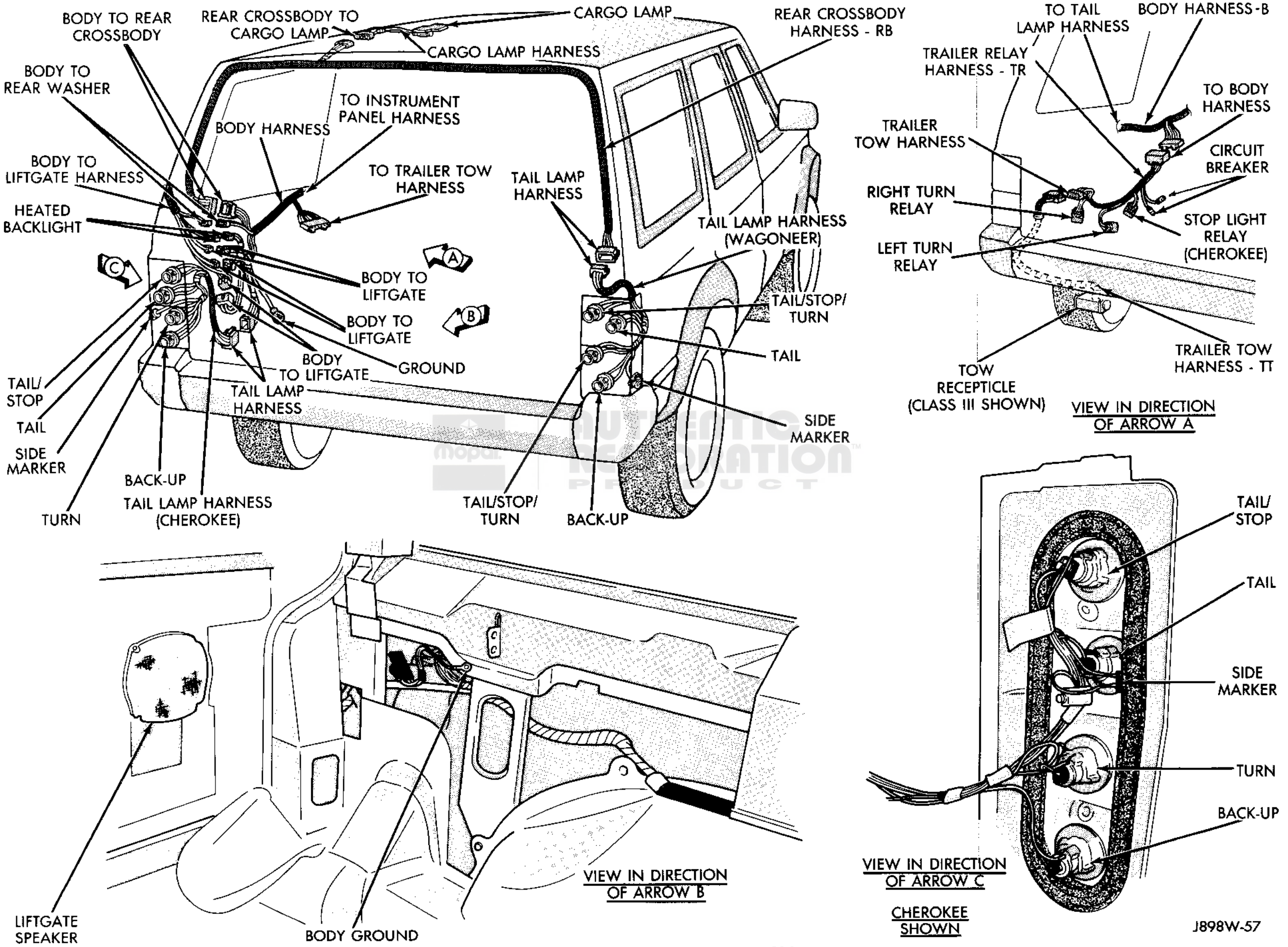


Fig. 26 — Rear End Body Wiring — XJ

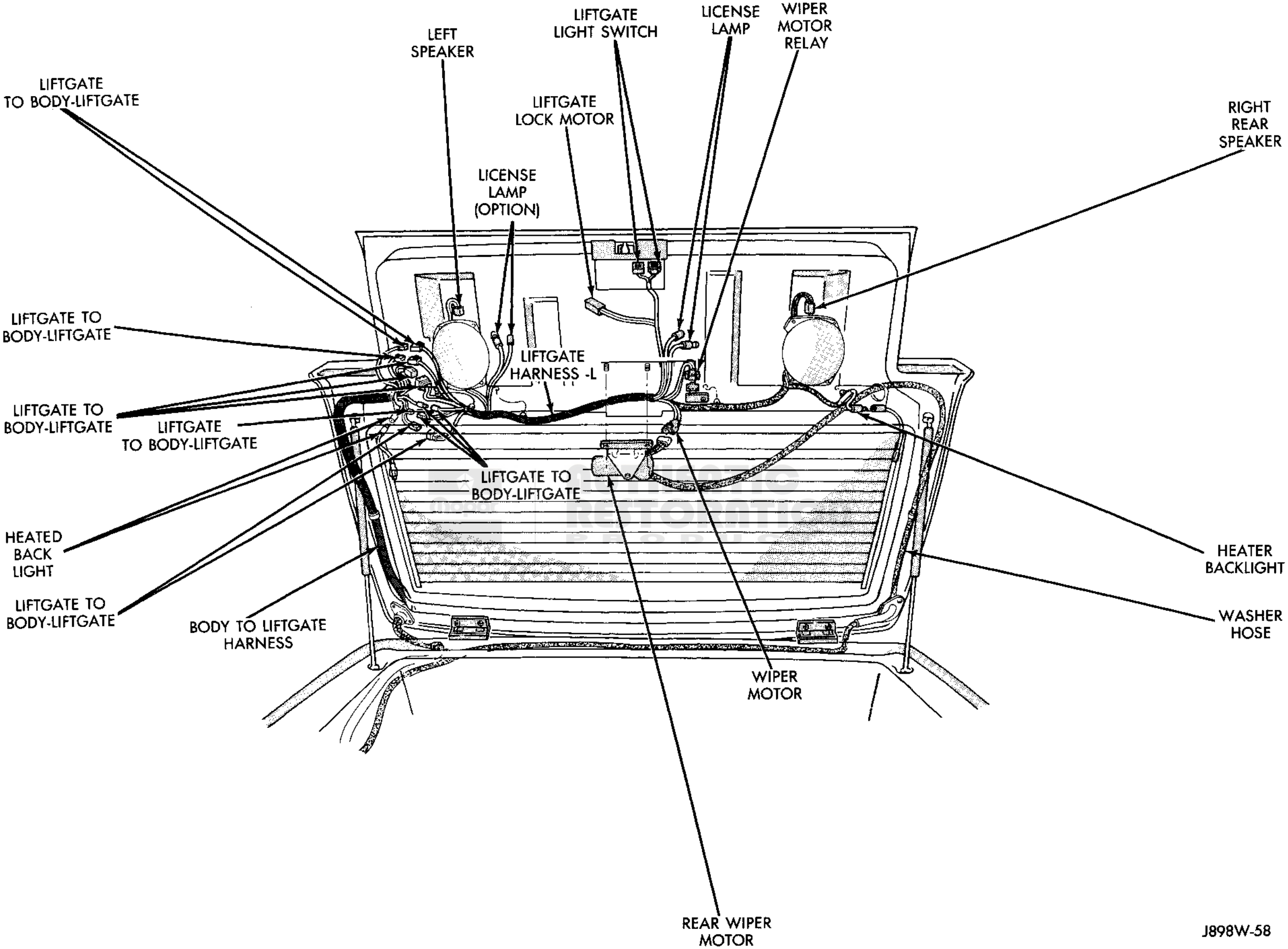
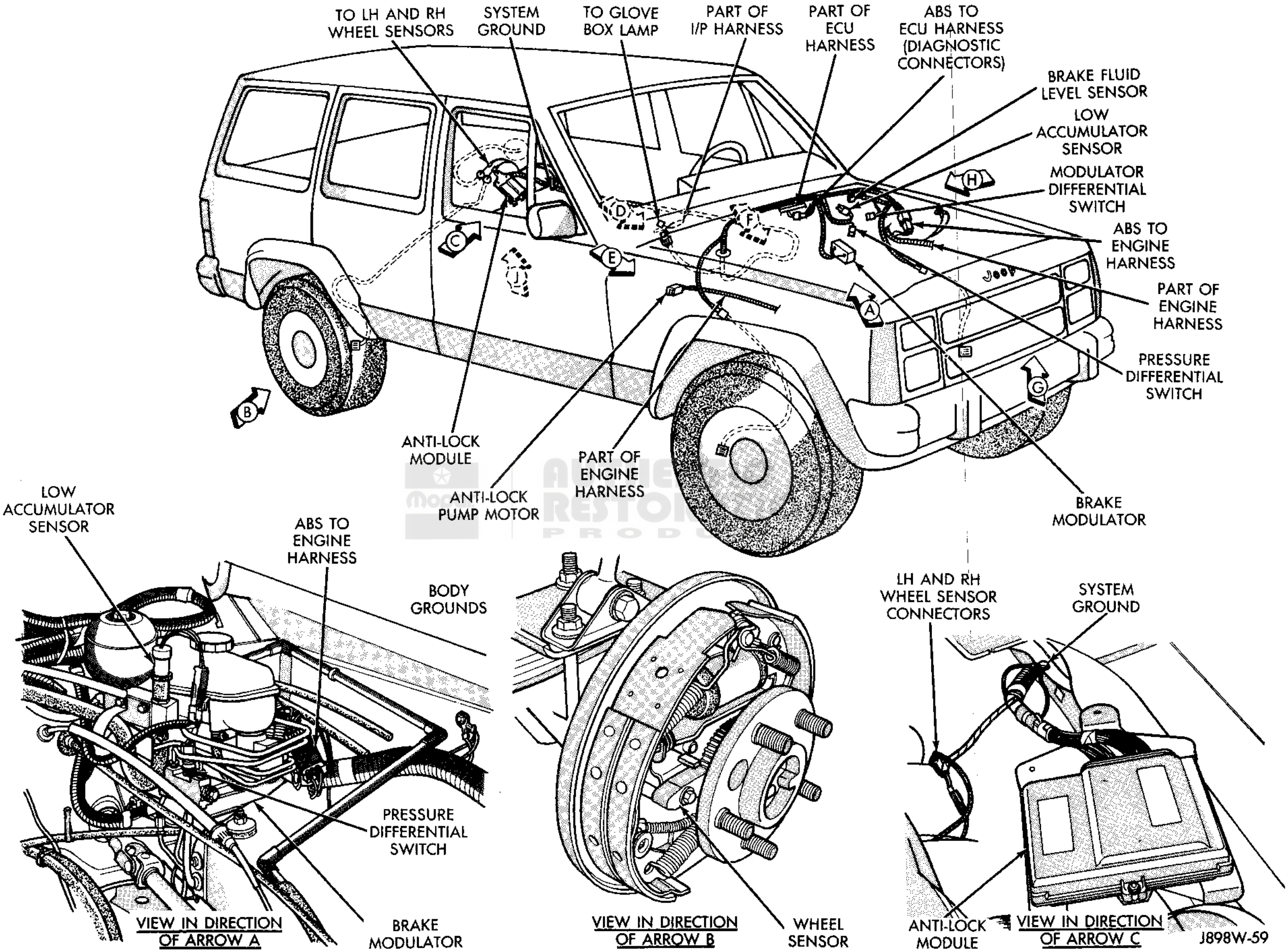


Fig. 27 — Liftgate Wiring — XJ



VIEW IN DIRECTION OF ARROW A

VIEW IN DIRECTION OF ARROW B

VIEW IN DIRECTION OF ARROW C

Fig. 28 — Antilock Brake Wiring — XJ

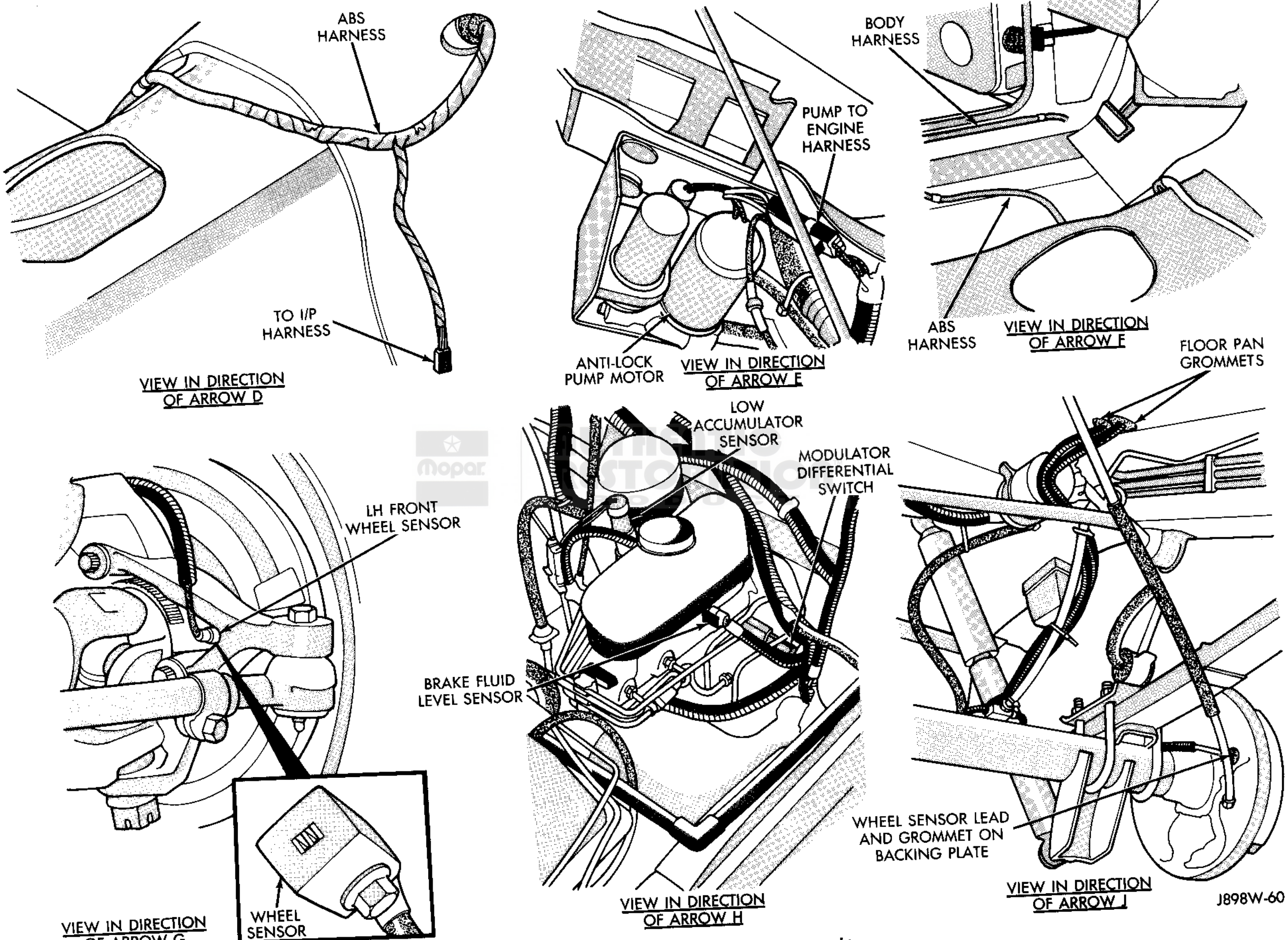


Fig. 29 — Antilock Brake System Components

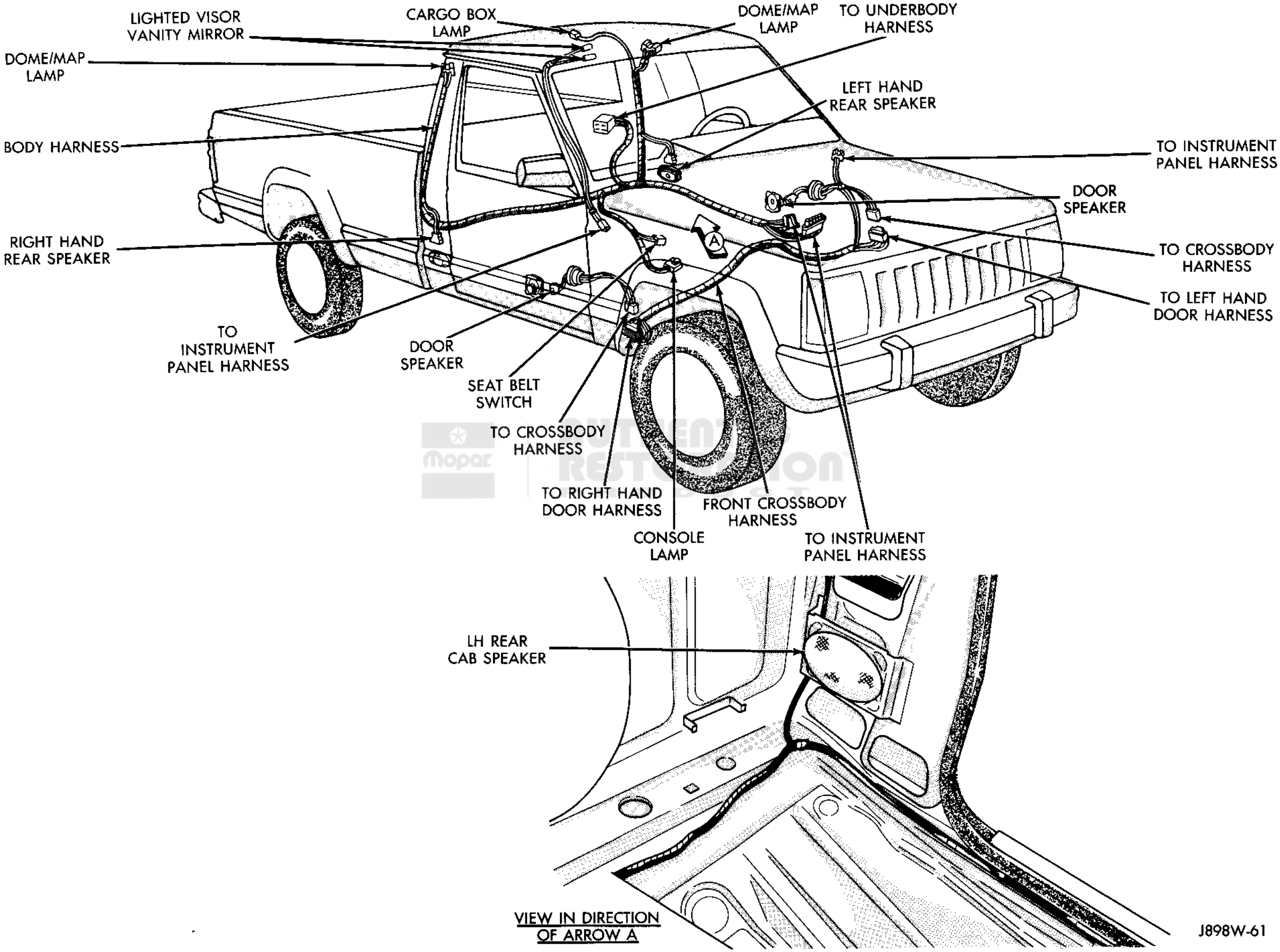
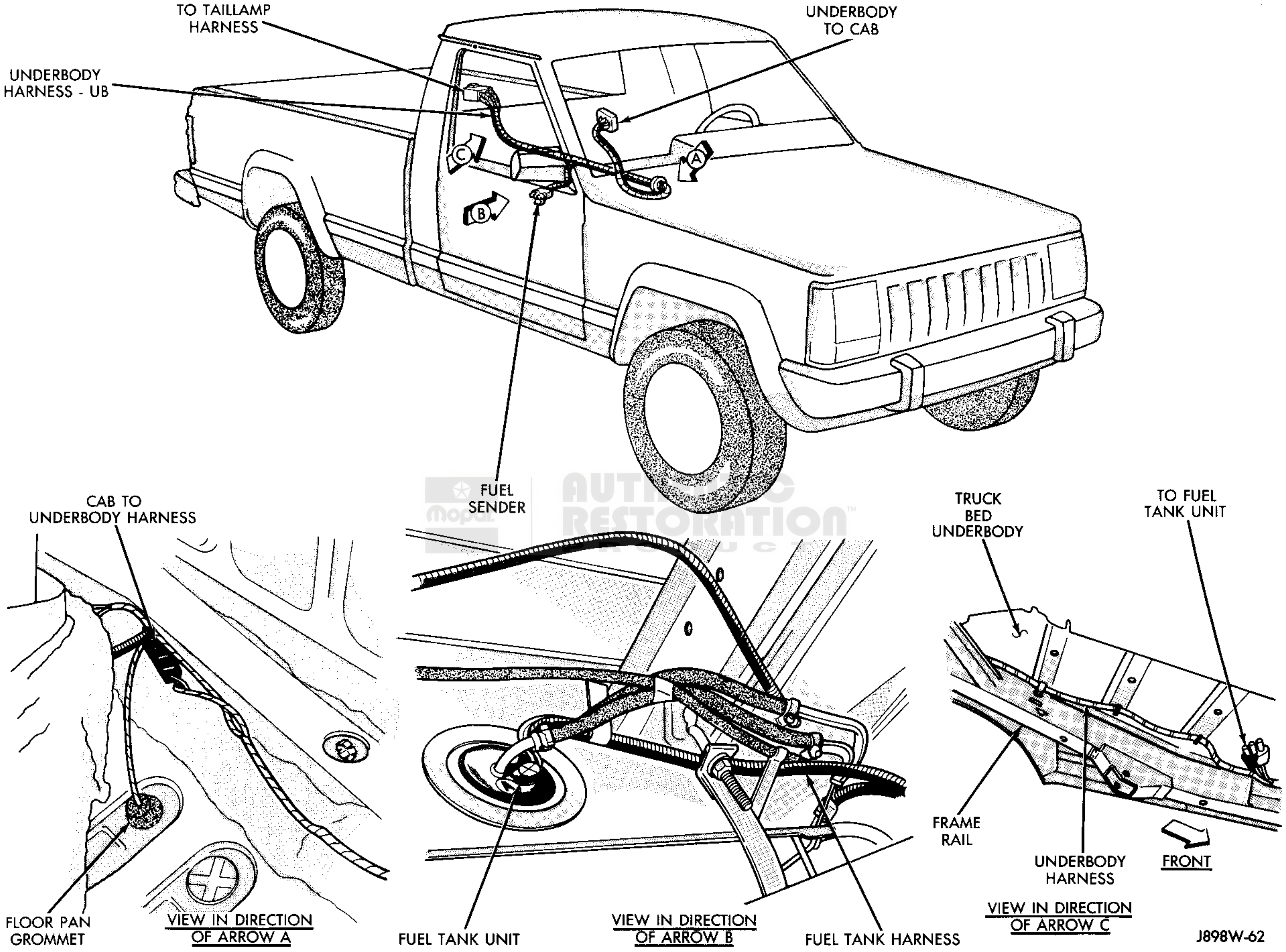


Fig. 30 — Body Wiring — MJ



VIEW IN DIRECTION OF ARROW A

VIEW IN DIRECTION OF ARROW B

VIEW IN DIRECTION OF ARROW C

Fig. 31 — Underbody Wiring — MJ

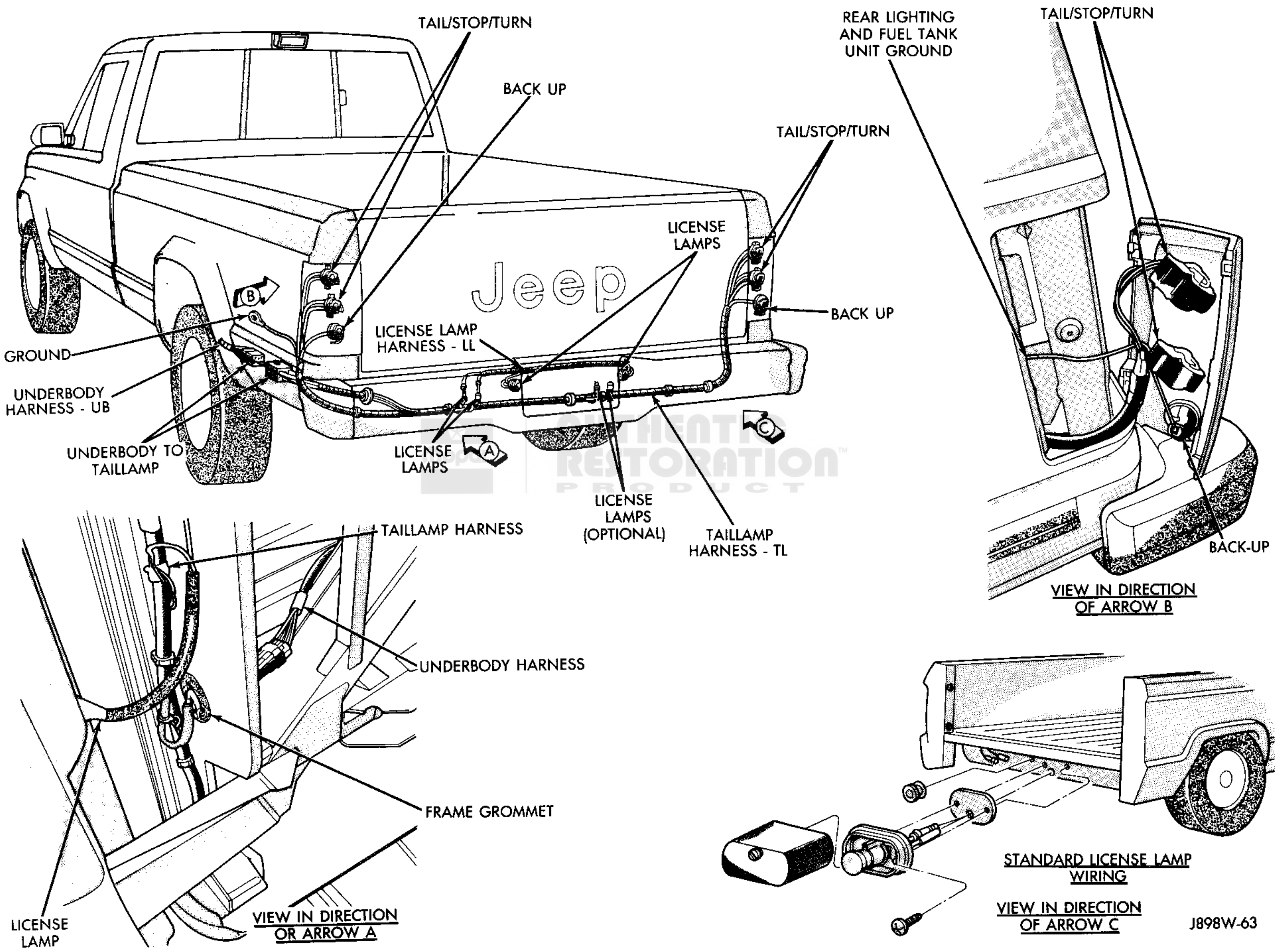


Fig. 32 — Rear End Wiring — MJ

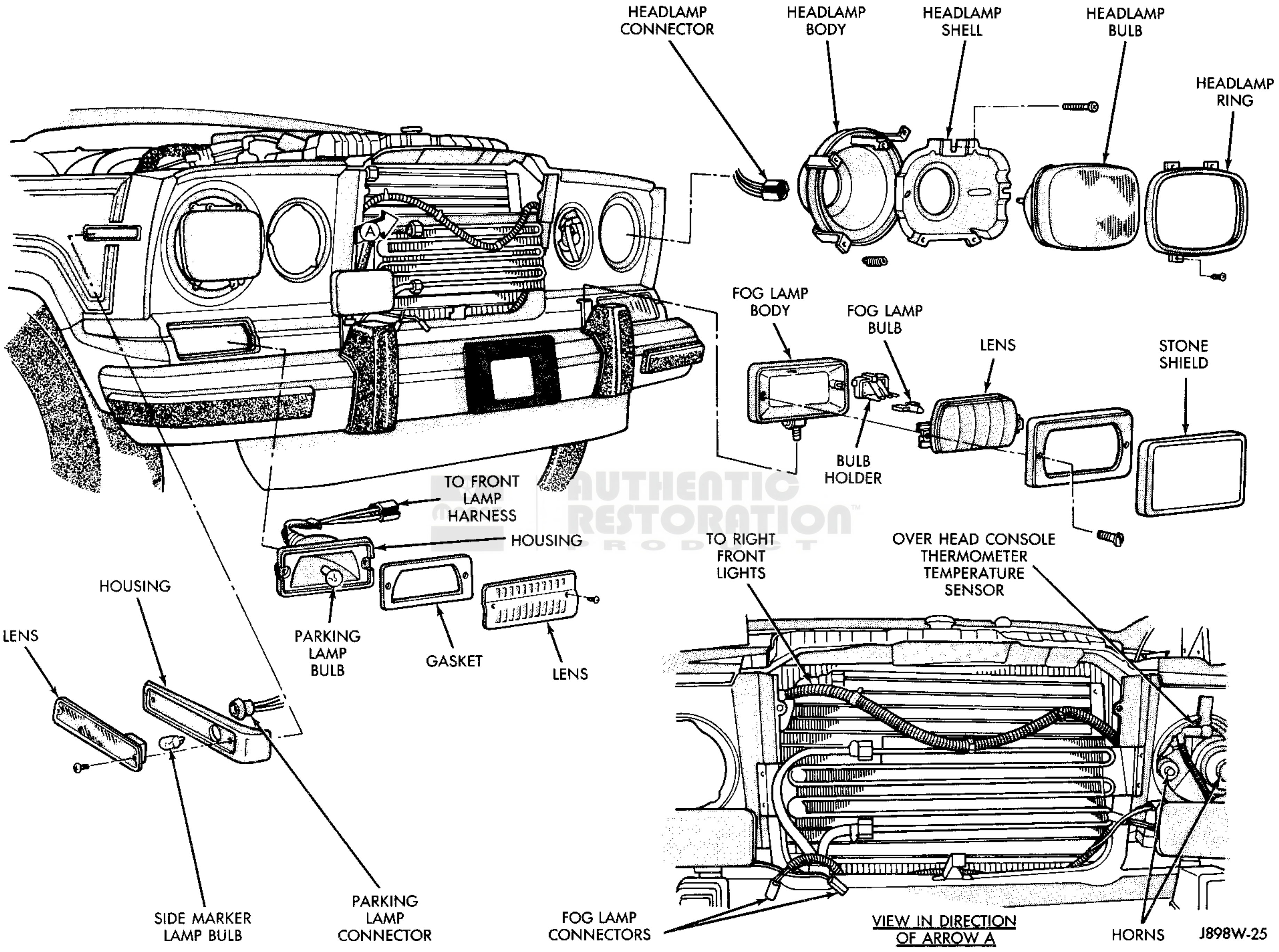


Fig. 33 — Front End LIghting Wiring — SJ

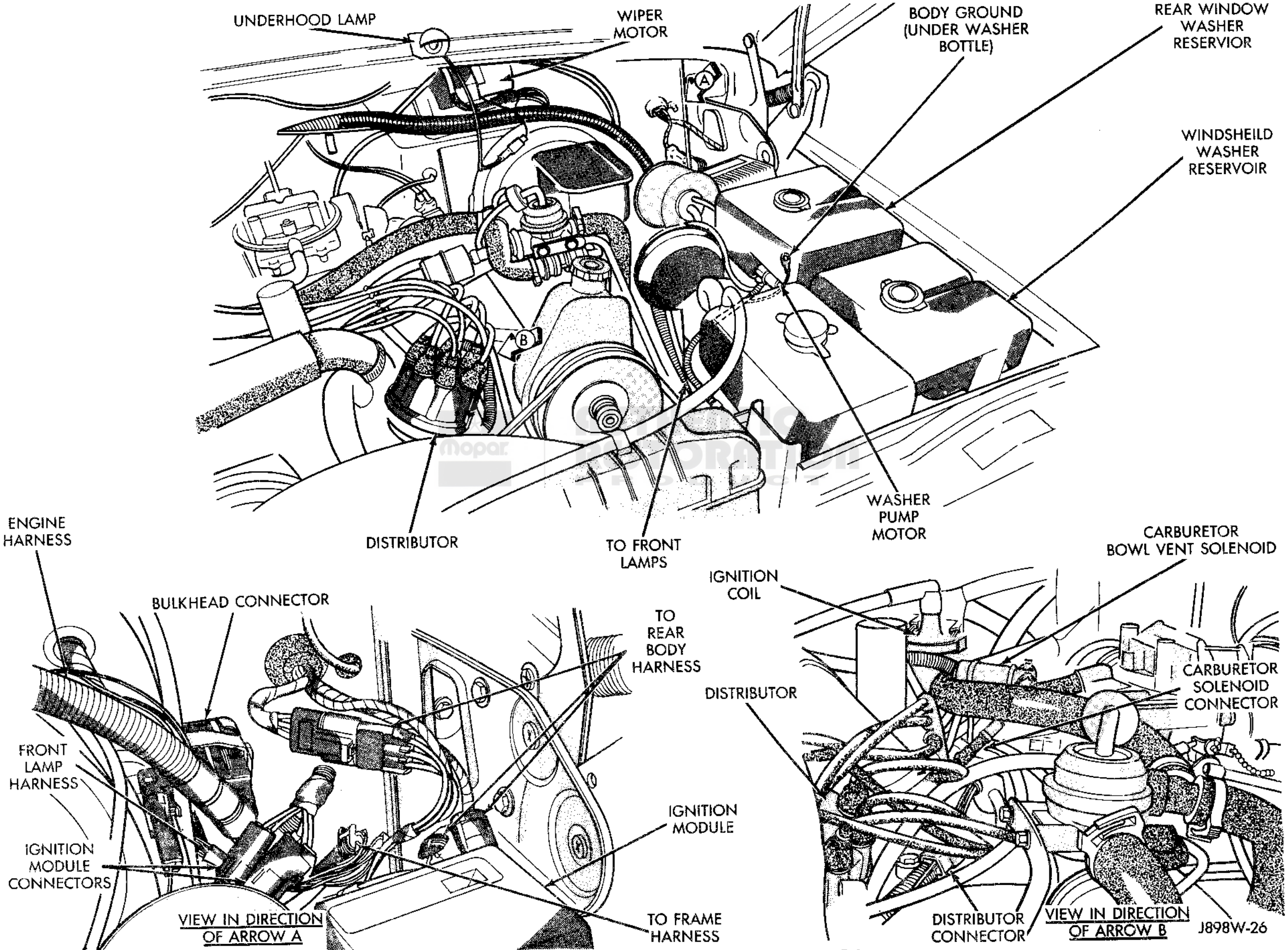


Fig. 34 — Engine Compartment Left Side Wiring — SJ

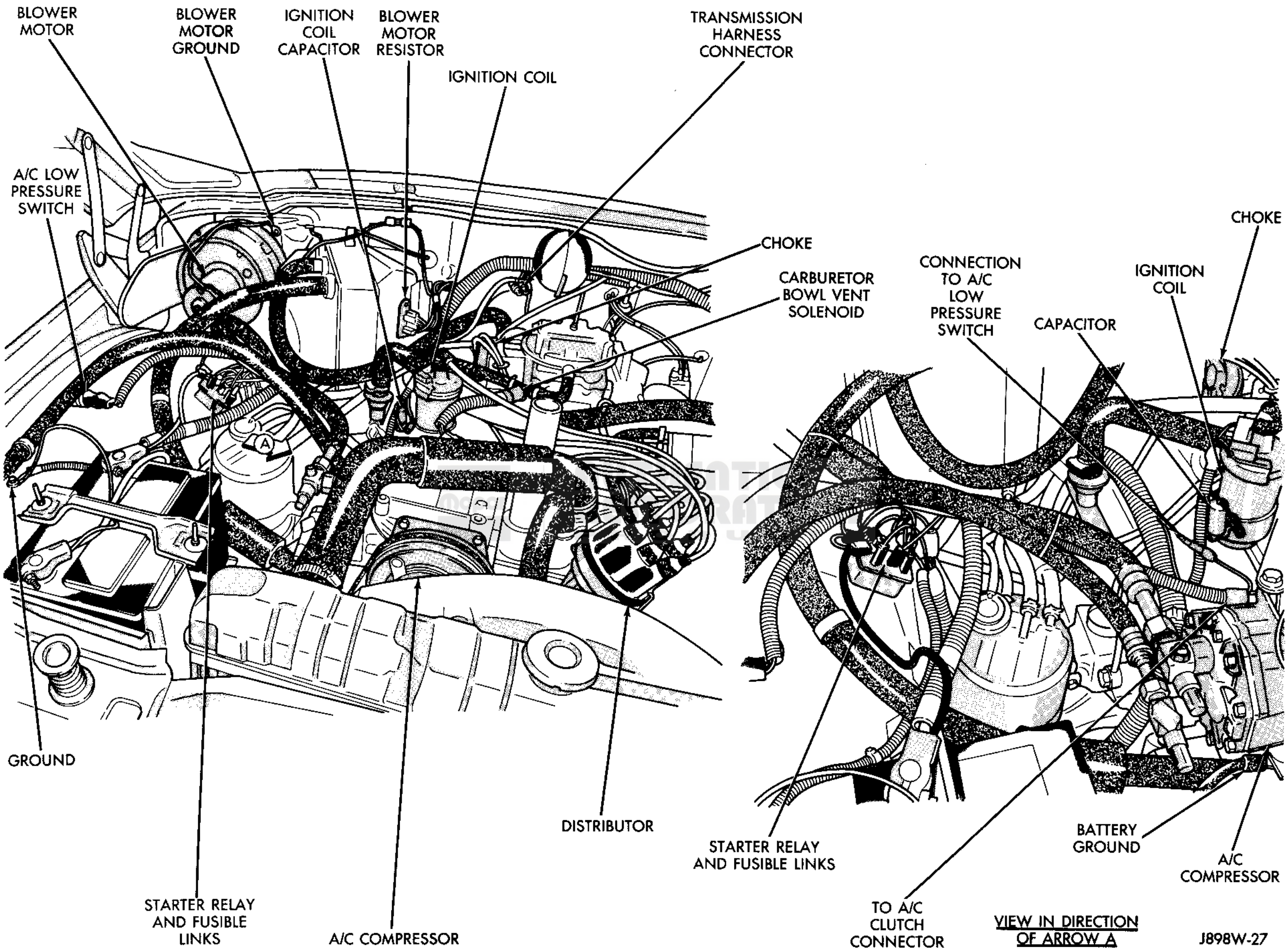


Fig. 35 — Engine Compartment Wiring — SJ

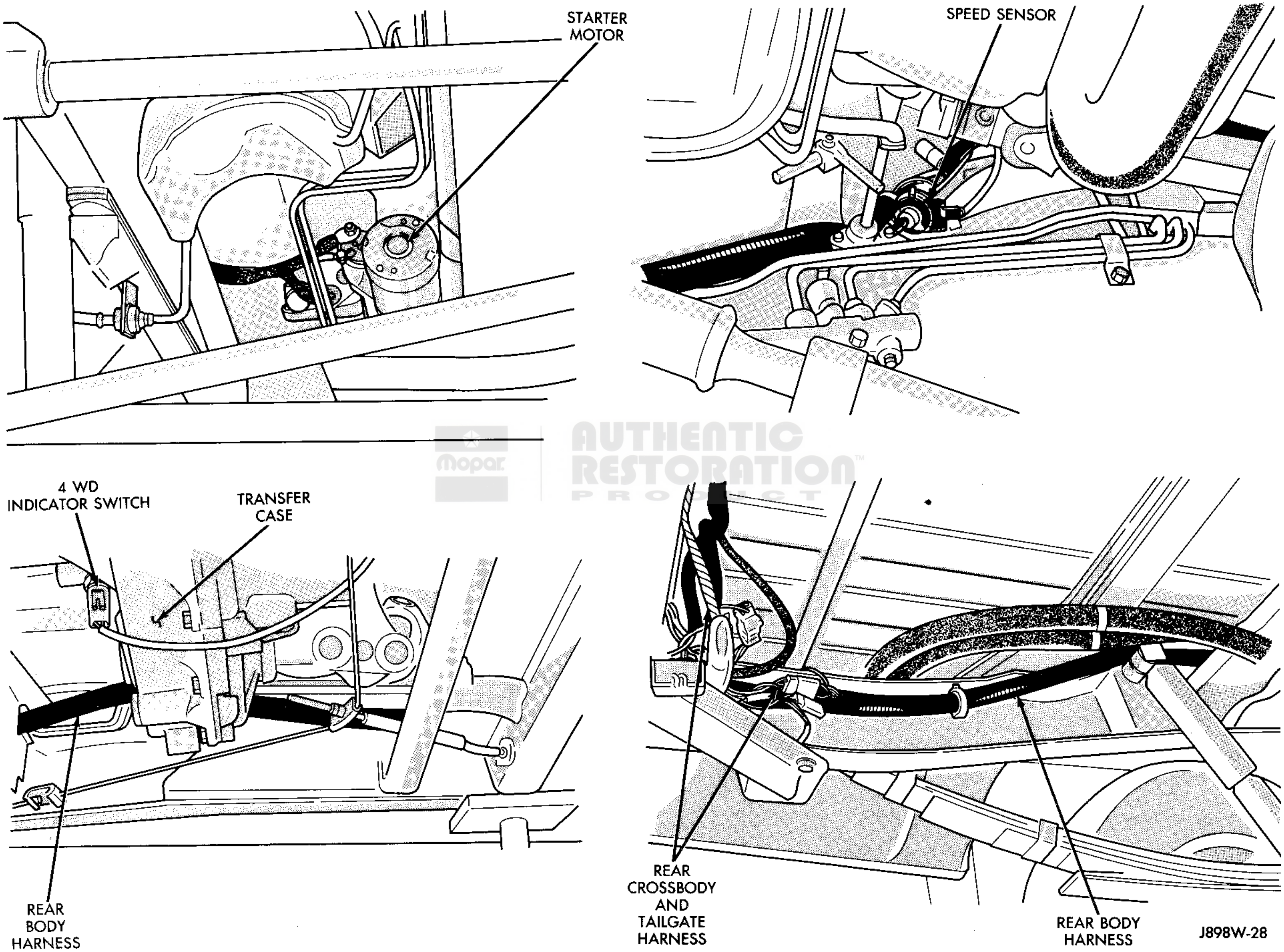


Fig. 36 — Underbody Wiring — SJ

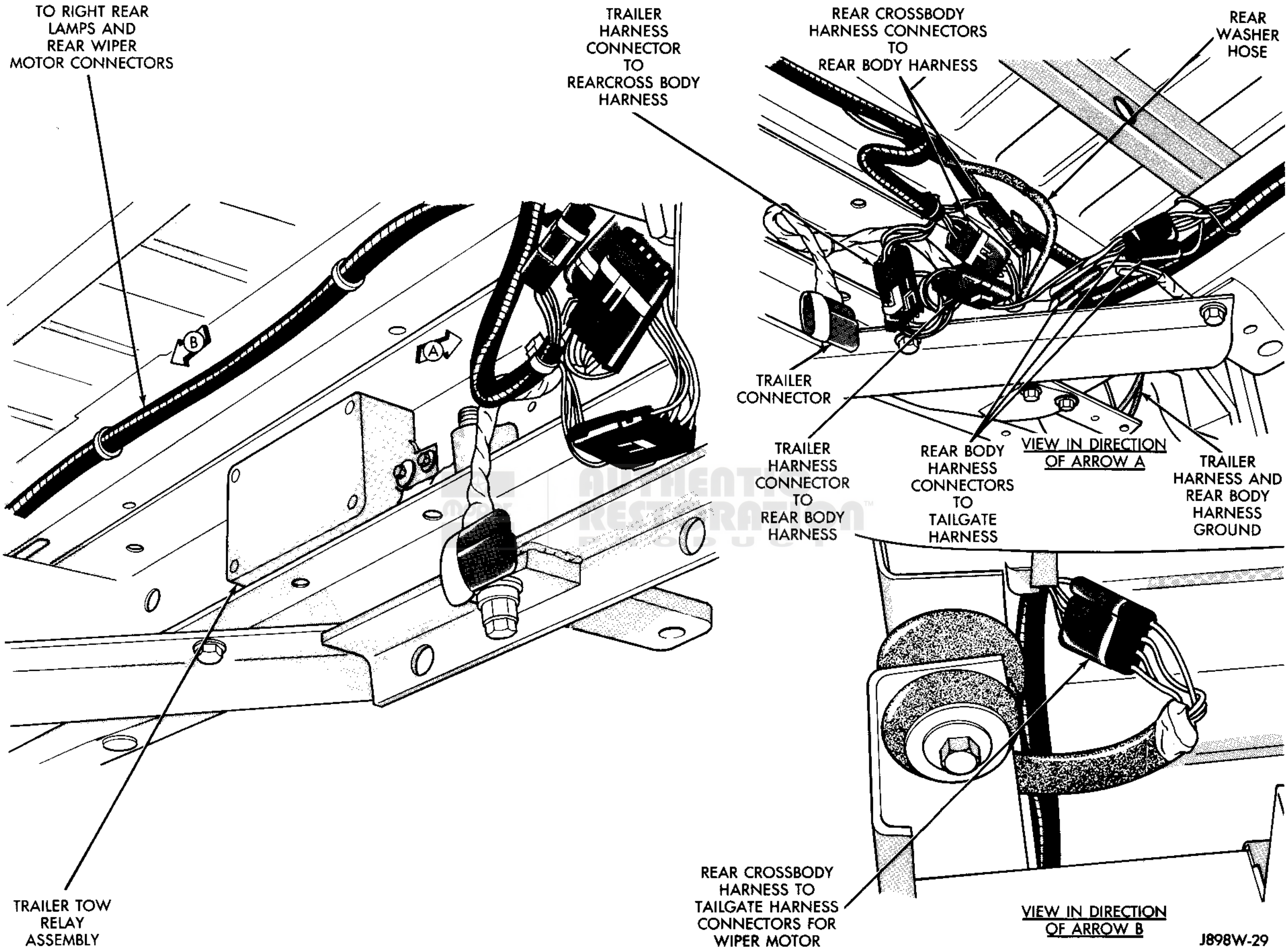


Fig. 37 — Rear Crossbody Wiring — SJ

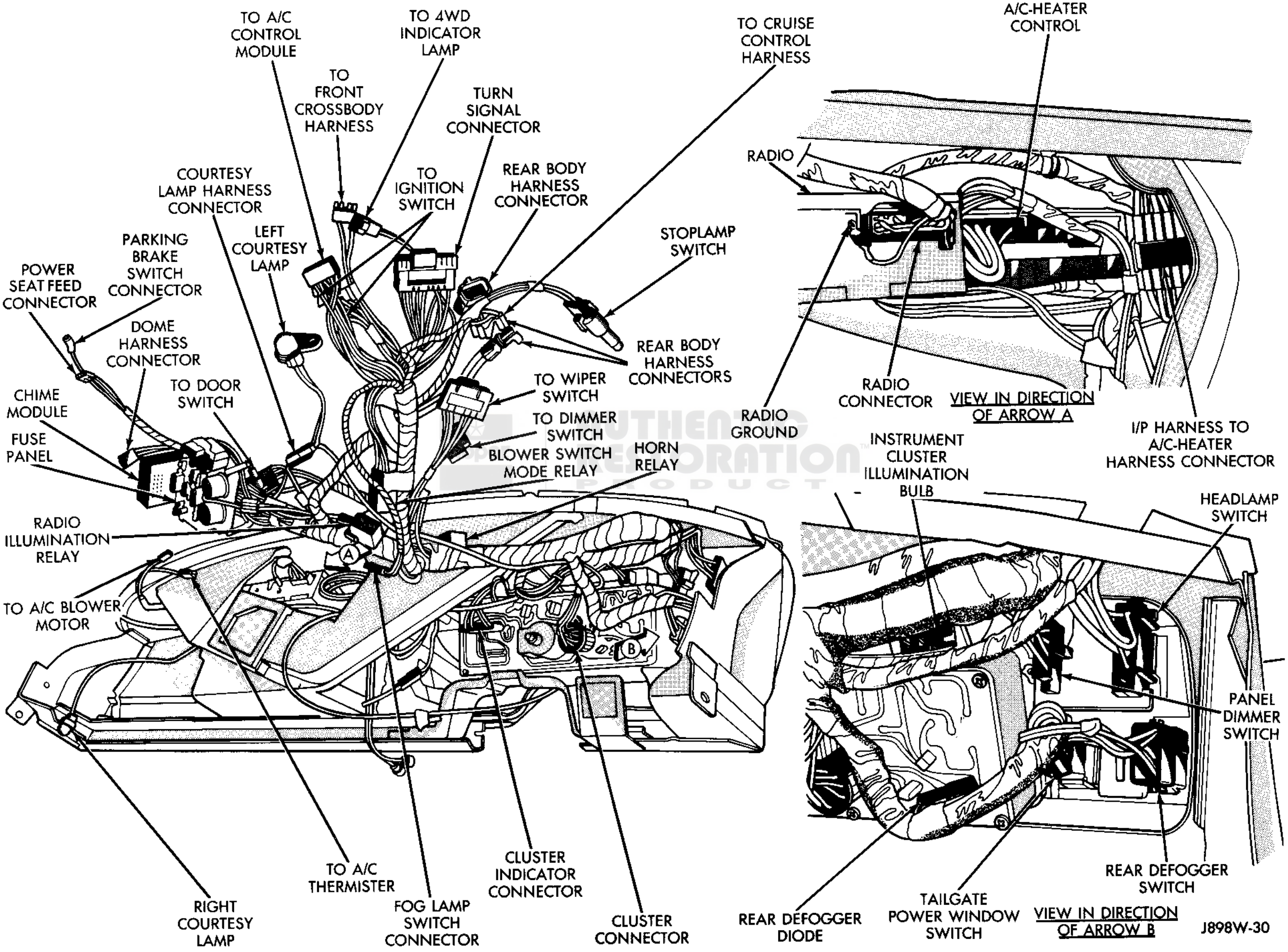


Fig. 38 — Instrument Panel Wiring — SJ

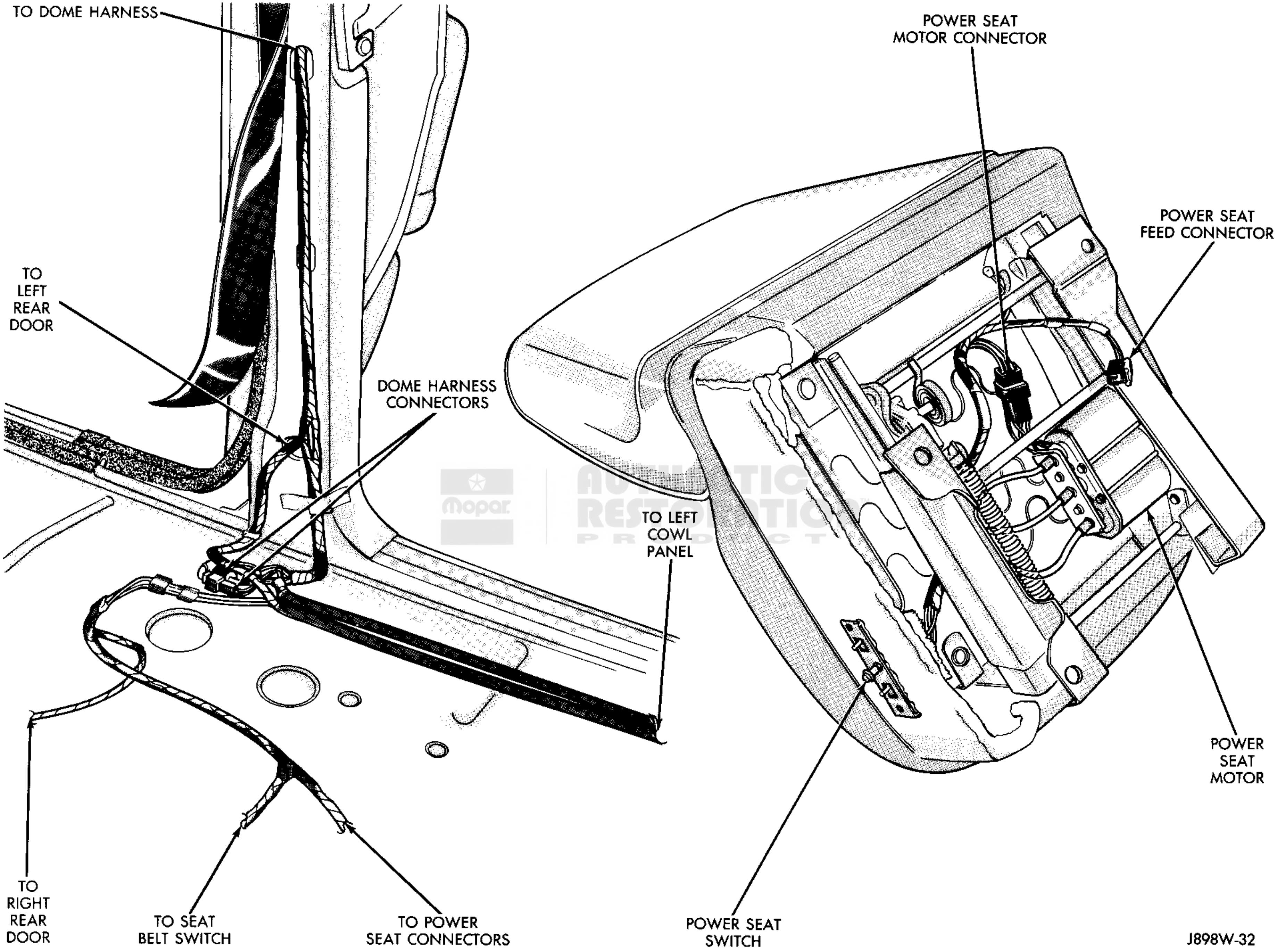


Fig. 39 — Power Seat Wiring — SJ

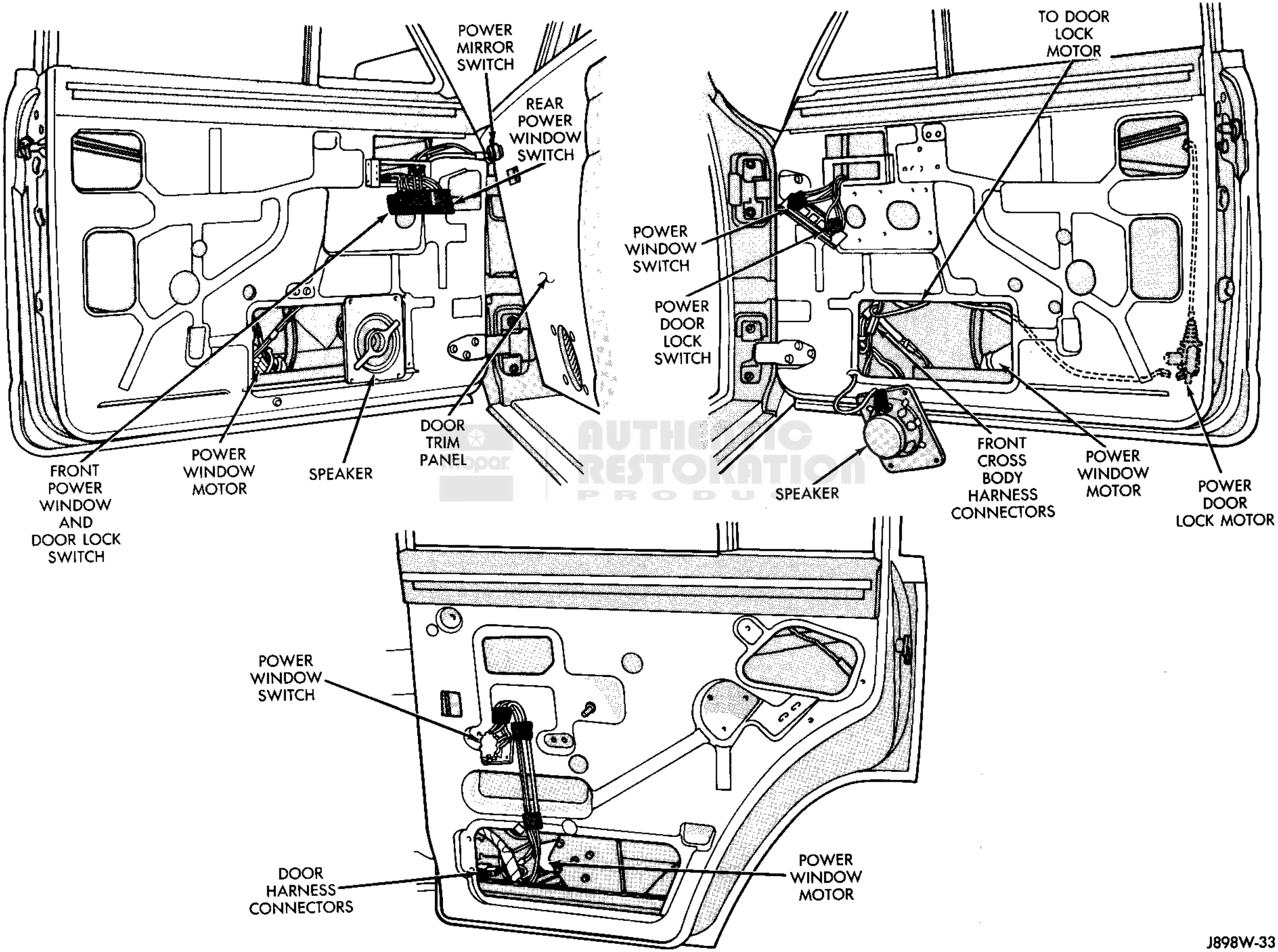


Fig. 40 — Door Wiring — SJ

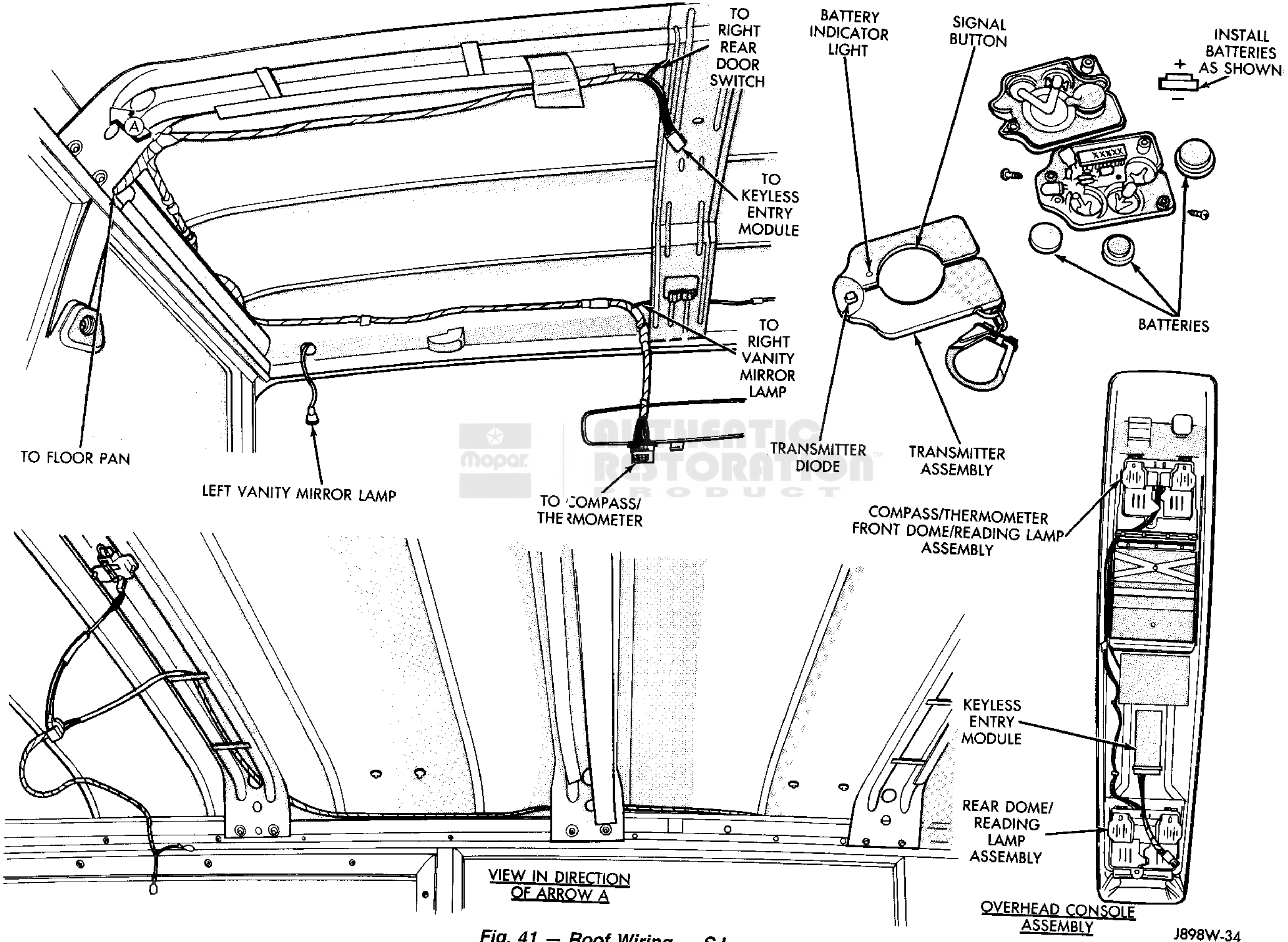


Fig. 41 — Roof Wiring — SJ

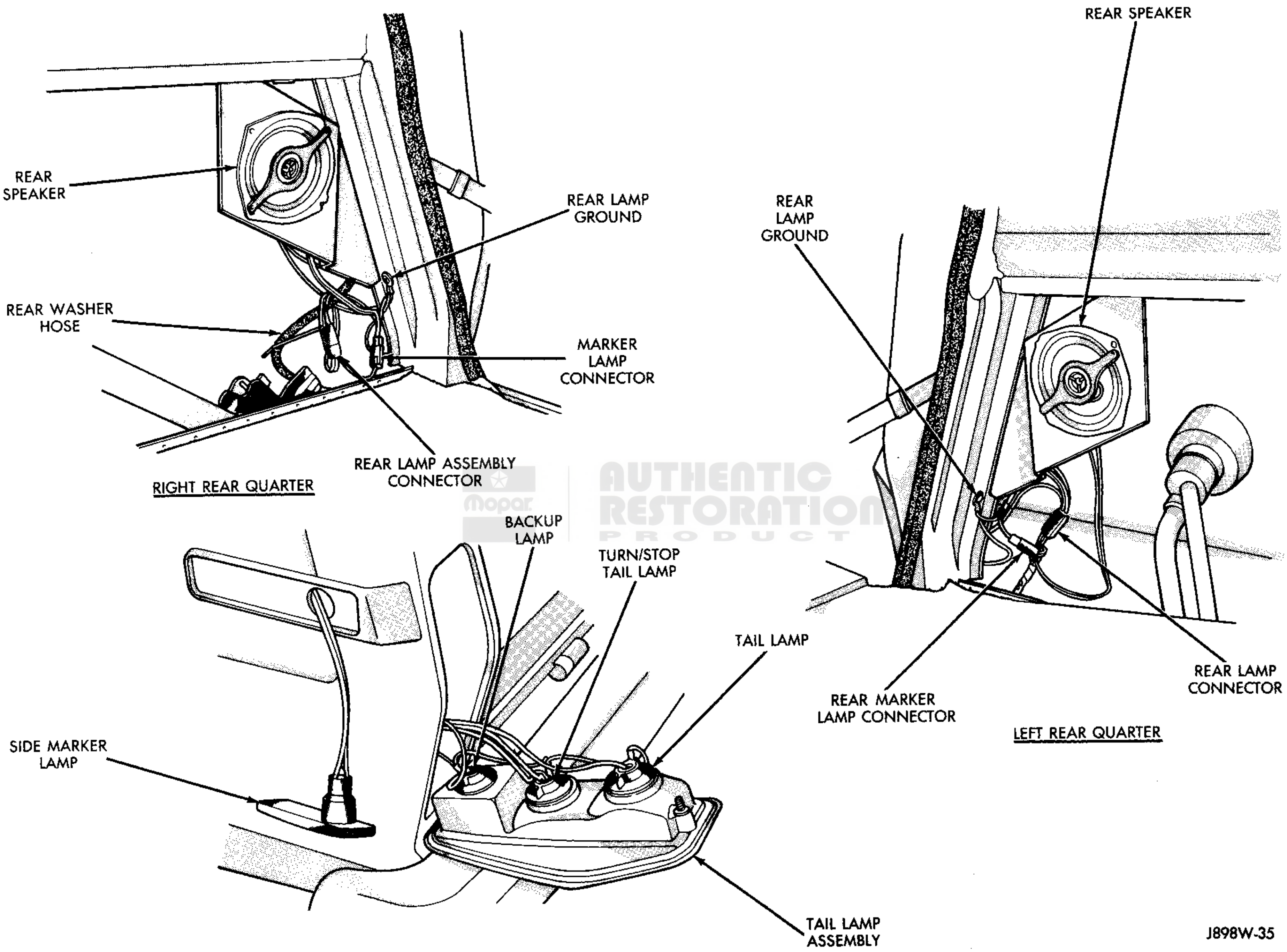


Fig. 42 — Rear Quarter Wiring — SJ

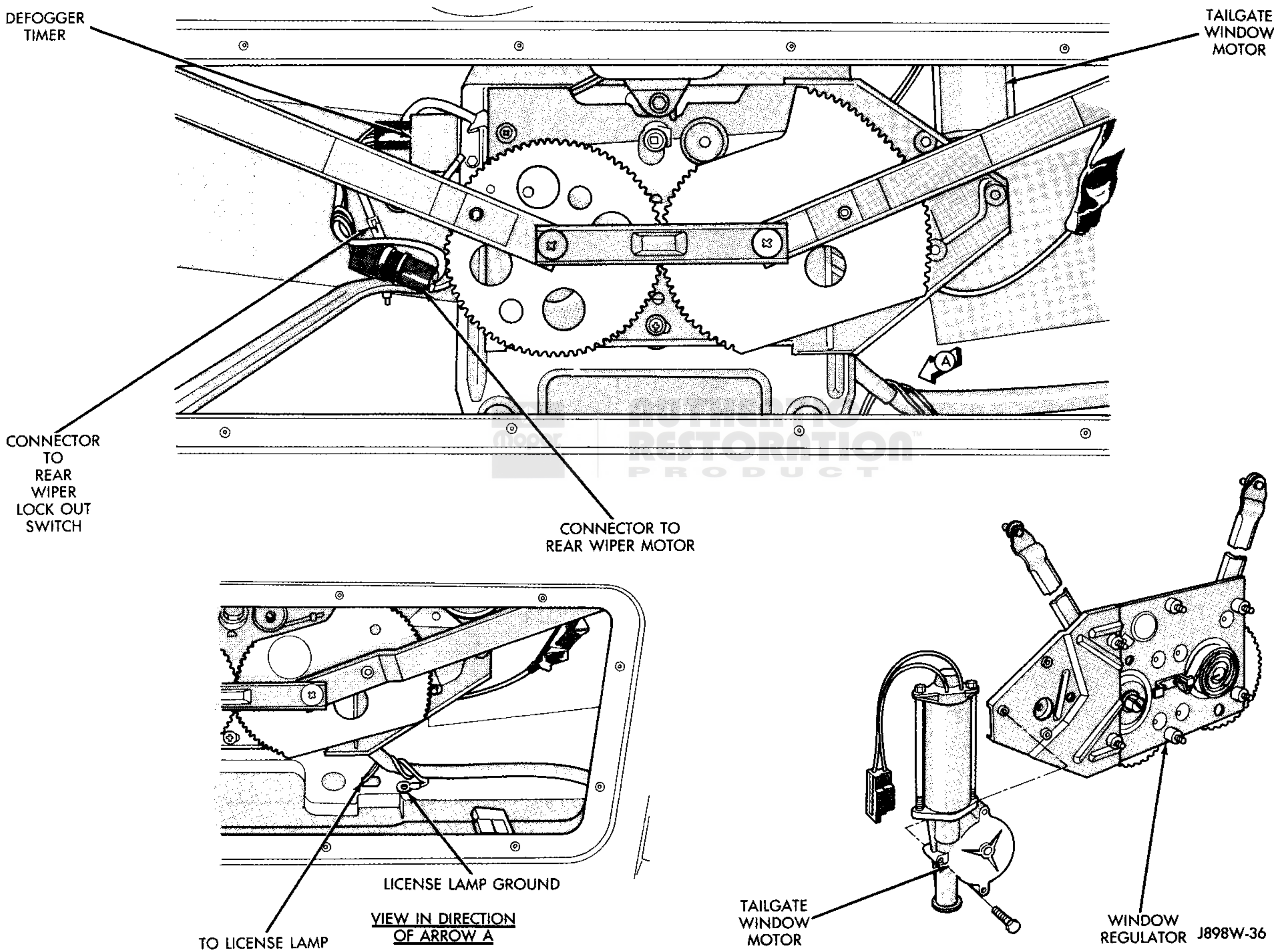
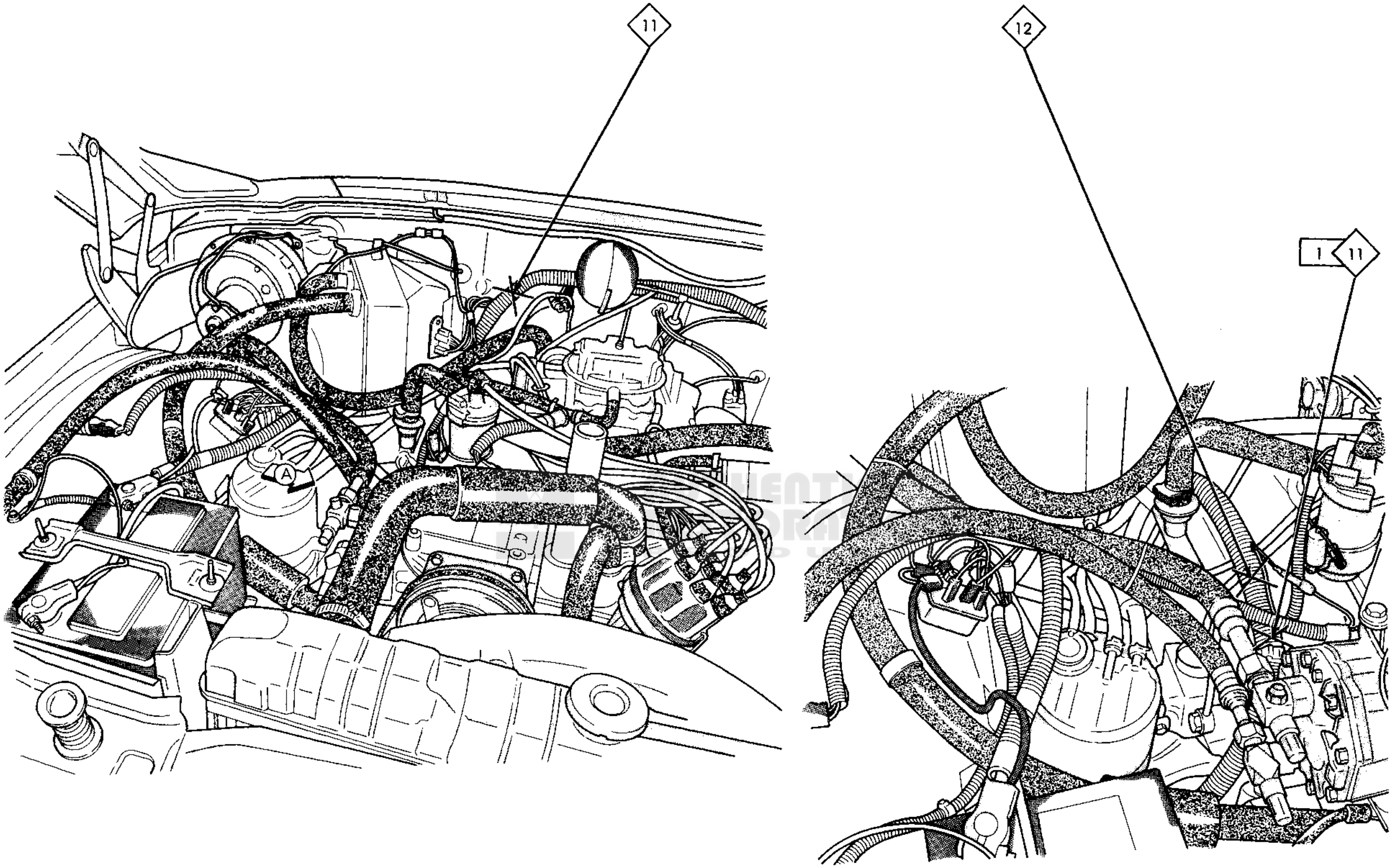


Fig. 43 — Liftgate Wiring — SJ

SPLICE INDEX

Splice Number	Fig.
SJ Splice Locations	**Figs. 1 thru 6**
10-4	4
11	1
11-1	1
12	1
15-1	4
17	4
22-4	4
33	3
51	4
51-1	5
52	4
68	4
98	5
99	4
99-3	4
99-4	5
160	3
161	3
R4	4
MJ/XJ Splice Locations	**Figs. 7 thru 18**
10	6
10-1	6
10-2	6
10-3	6
10-5	10
10-6	7
10-6	8
10-7	6
10-8	6
11	6
11-1	9
11-2	6
11-3	7,8
11-4	7,8
12	10
13	9
16	9
24	9
30	8
32	6
34	8
51	9
51-1 XJ Only	11
52	9
72 XJ Only	11
72	12
72-1 XJ Only	14
72-2 XJ Only	14
75	12,17,18
76	12
99 XJ Only	11
99	12
99-1 XJ Only	14
99-2	12,17,18
99-3	12,17,18
99-4	6
99-5	6
99-6	9
99-7 XJ Only	15
99-9	7,8
99-10	8
99-11	6
99-12 XJ Only	16
99-13 XJ Only	16
99-14 XJ Only	14
99-15	9
99-16 XJ Only	11
99-19 XJ Only	13
99-20 XJ Only	14
116	7,8
117 XJ Only	11,12
136	7
138	6,7
203 XJ Only	16
204 XJ Only	16
235 XJ Only	16
235-1 XJ Only	16
C9	12
F15	7,8
F21	8
F2	7
F21	7
F22-1	6
F22-3	7,8
F22-4	6
L1 XJ Only	11
L1-1	11,17
L2-1 XJ Only	13
L3 XJ Only	11
L3-1 XJ Only	11,13
R1 XJ Only	15
W10 XJ Only	11
YJ Splice Locations	**Figs. 19 thru 23**
10	10
10-6	20
11	21
11-1	20
33	21
51	22
52	22
72	22,23
72-2	20
75	23
88	20
98	22
99	22
99-1	21
99-2	22
99-3	22
99-5	23
99-7	20
99-9	20
99-11	20
99-12	20
168	20
F2	20
F15	20
F18	20
F21	20
F22	20
F24	21
F29	21
F34	21
F36	21
F60	21
F45	21



VIEW IN DIRECTION OF ARROW A

J908W-40

Fig. 1 — Engine Harness Splices — SJ

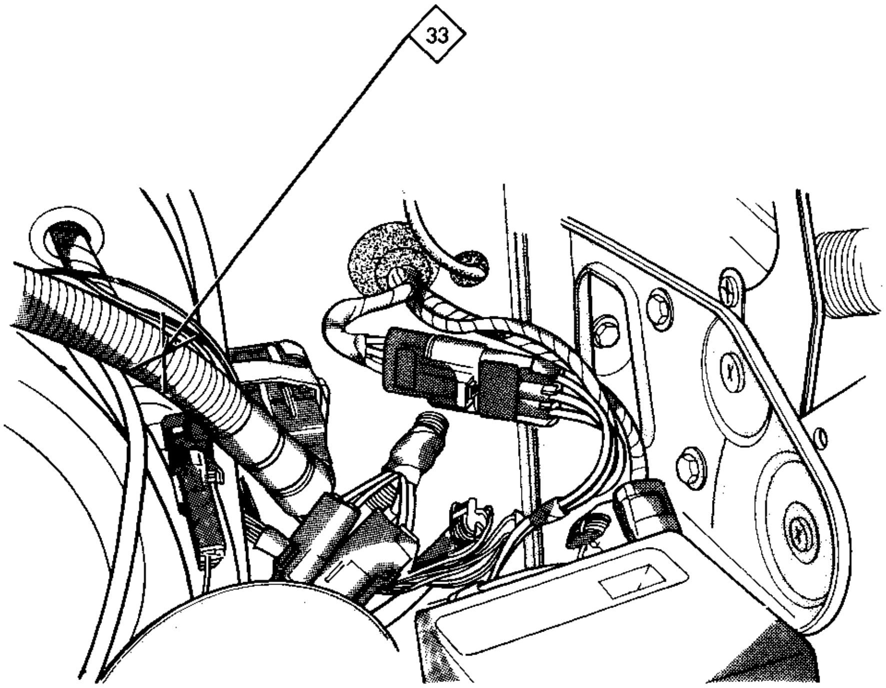


Fig. 2 — Engine Harness Splices — SJ

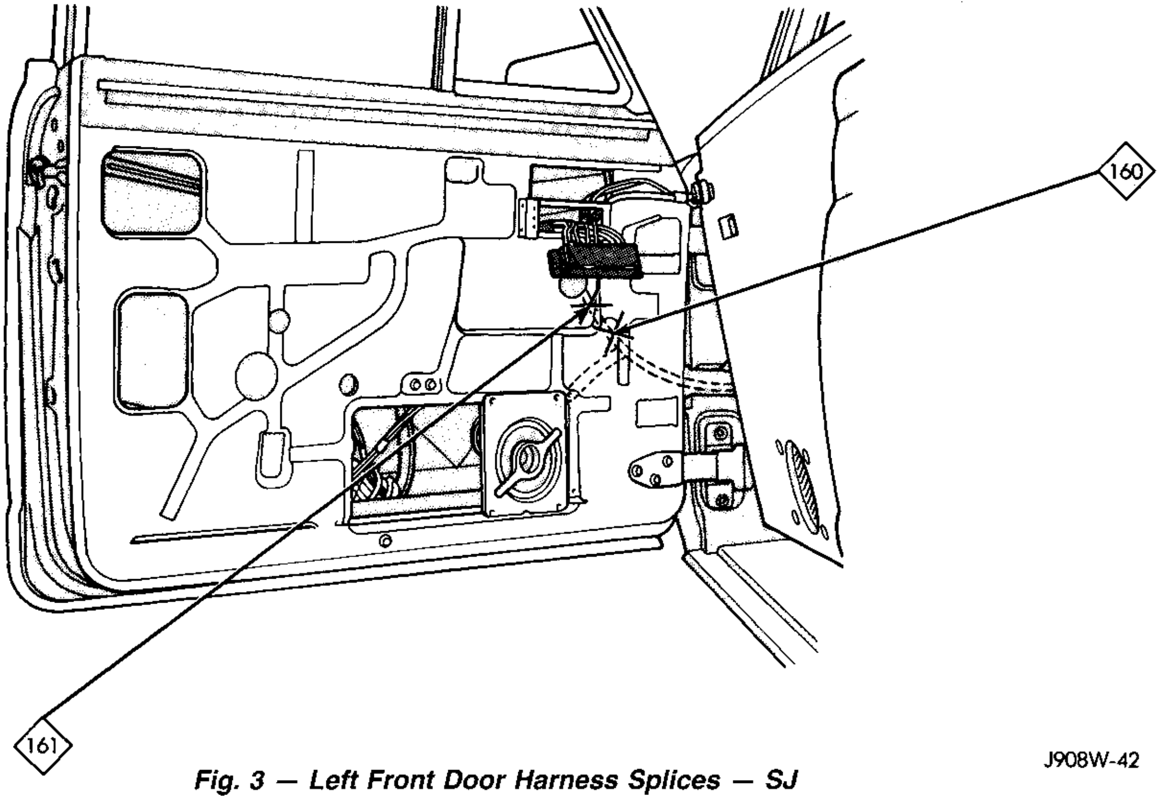


Fig. 3 — Left Front Door Harness Splices — SJ

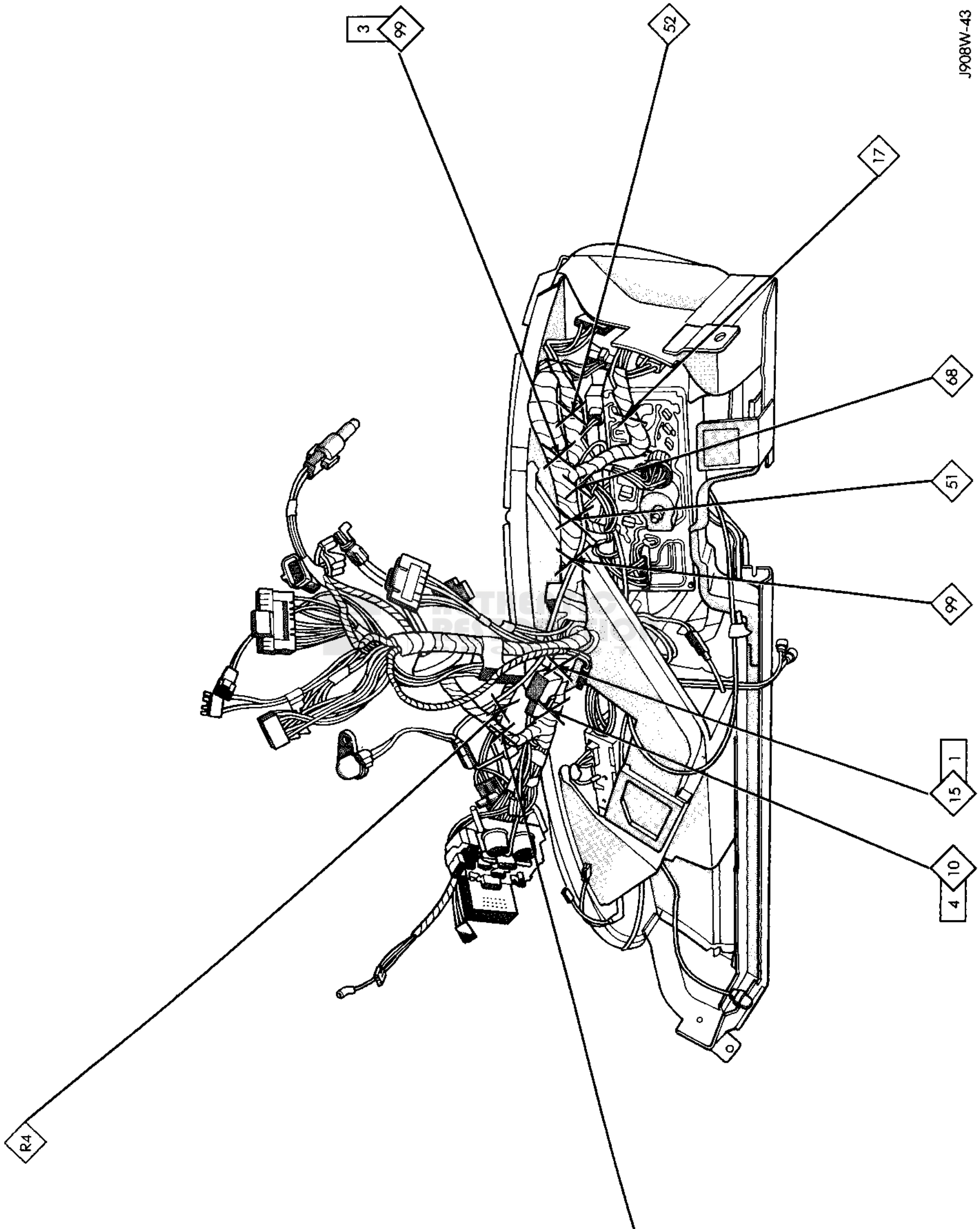


Fig. 4 — Instrument Panel Harness Splices — SJ

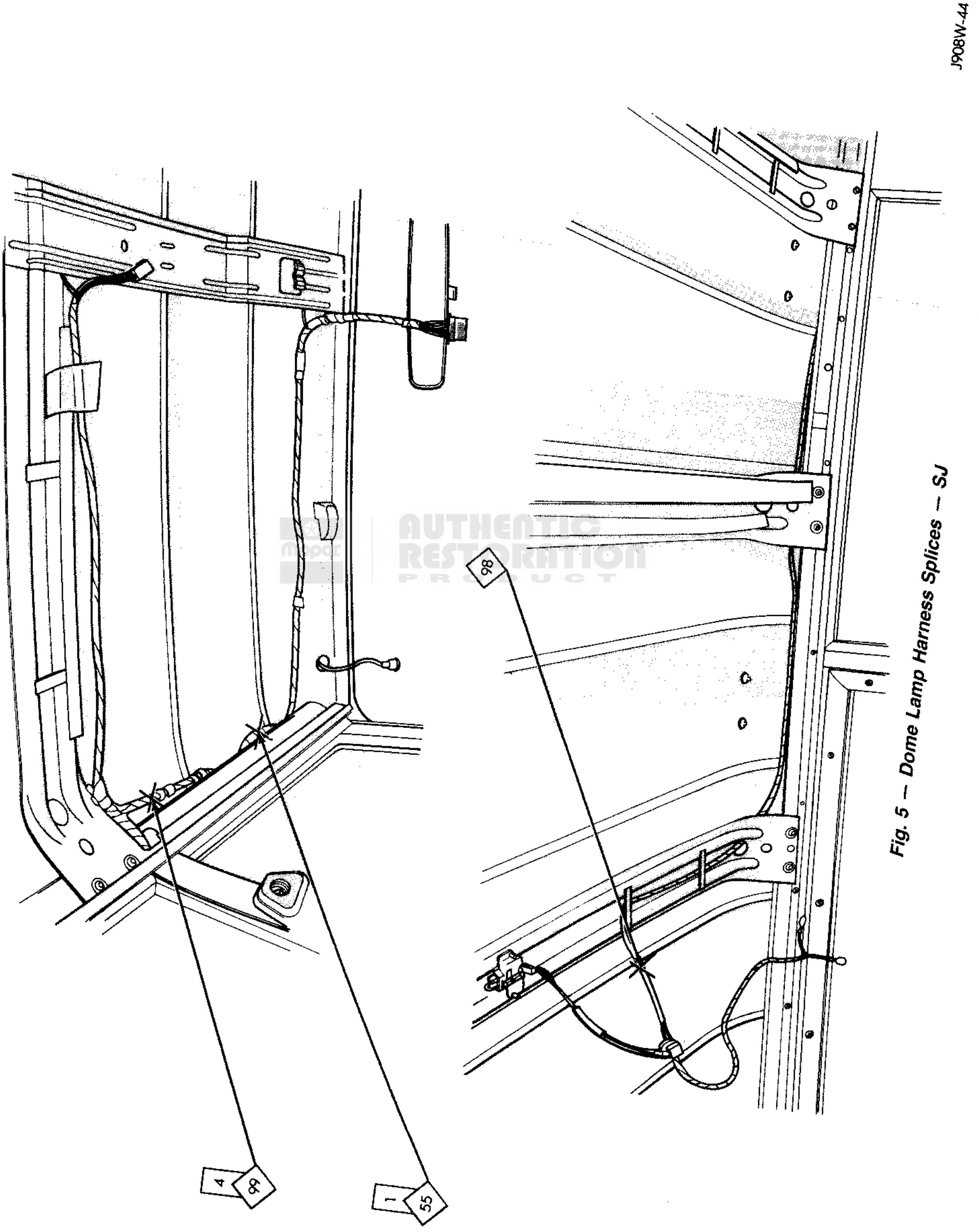


Fig. 5 — Dome Lamp Harness Splices — SJ

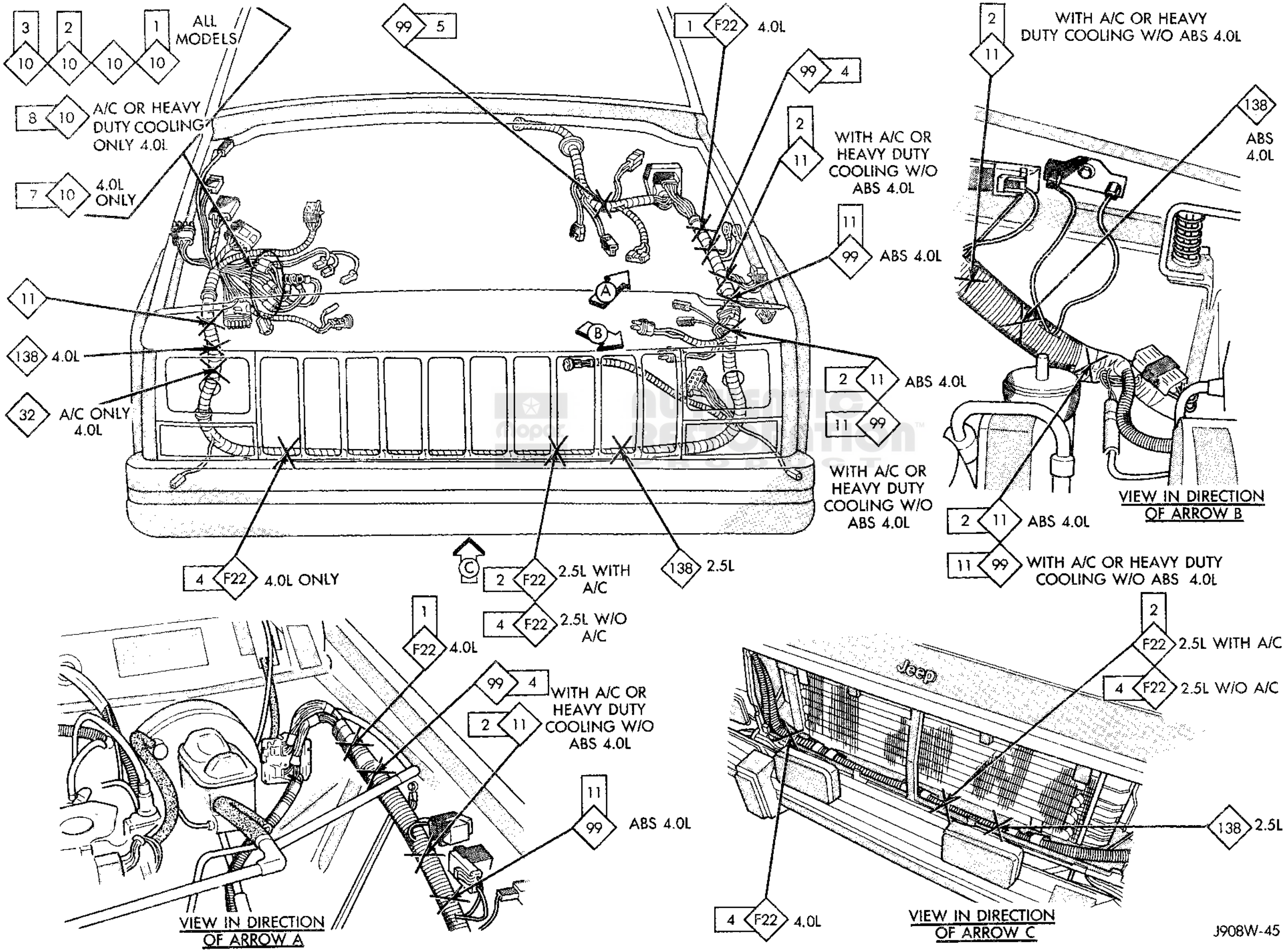


Fig. 6 — Engine Compartment Splices — MJ/XJ

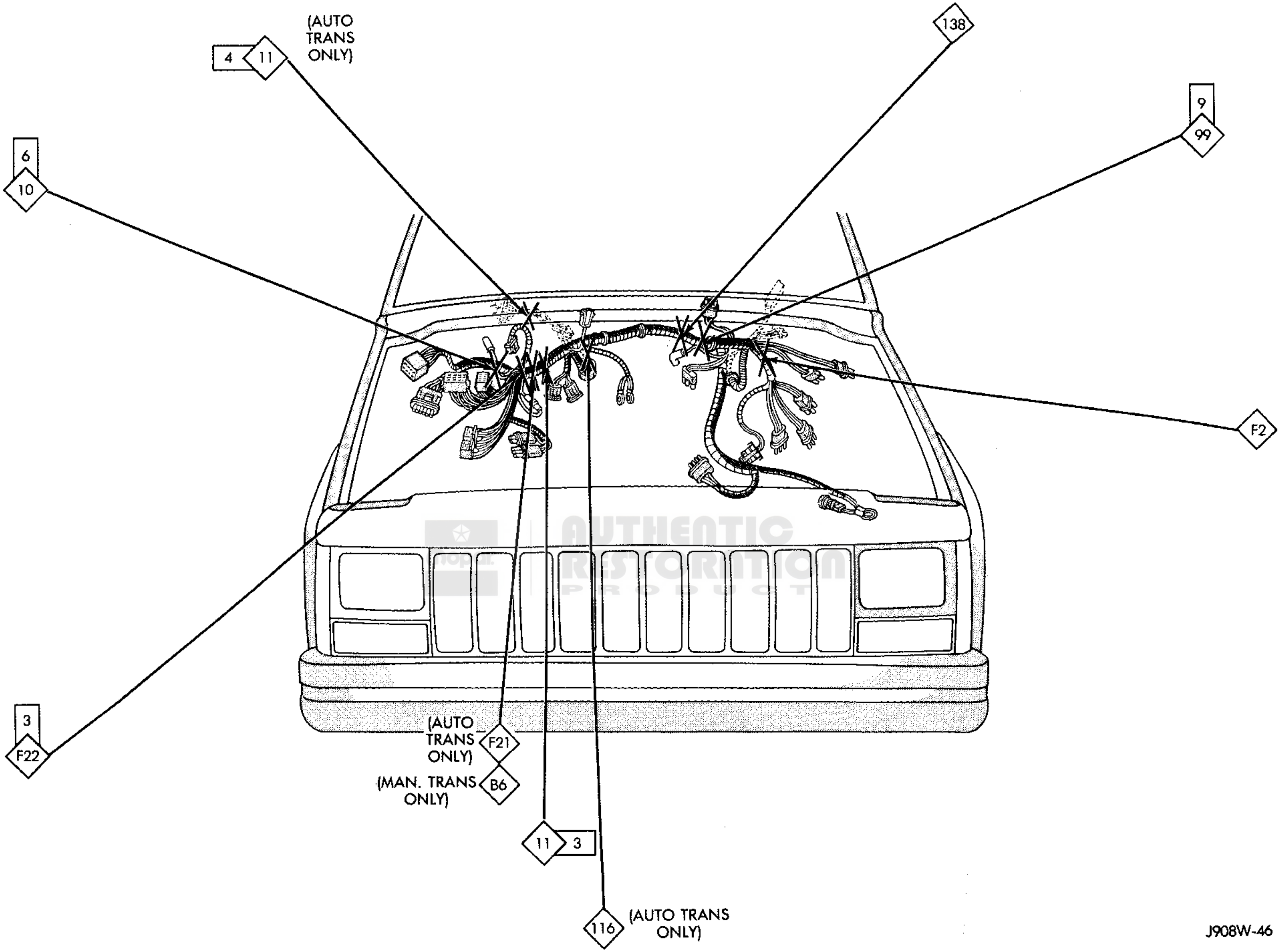


Fig. 7 — Engine Compartment Splices (2.5L) — MJ/XJ

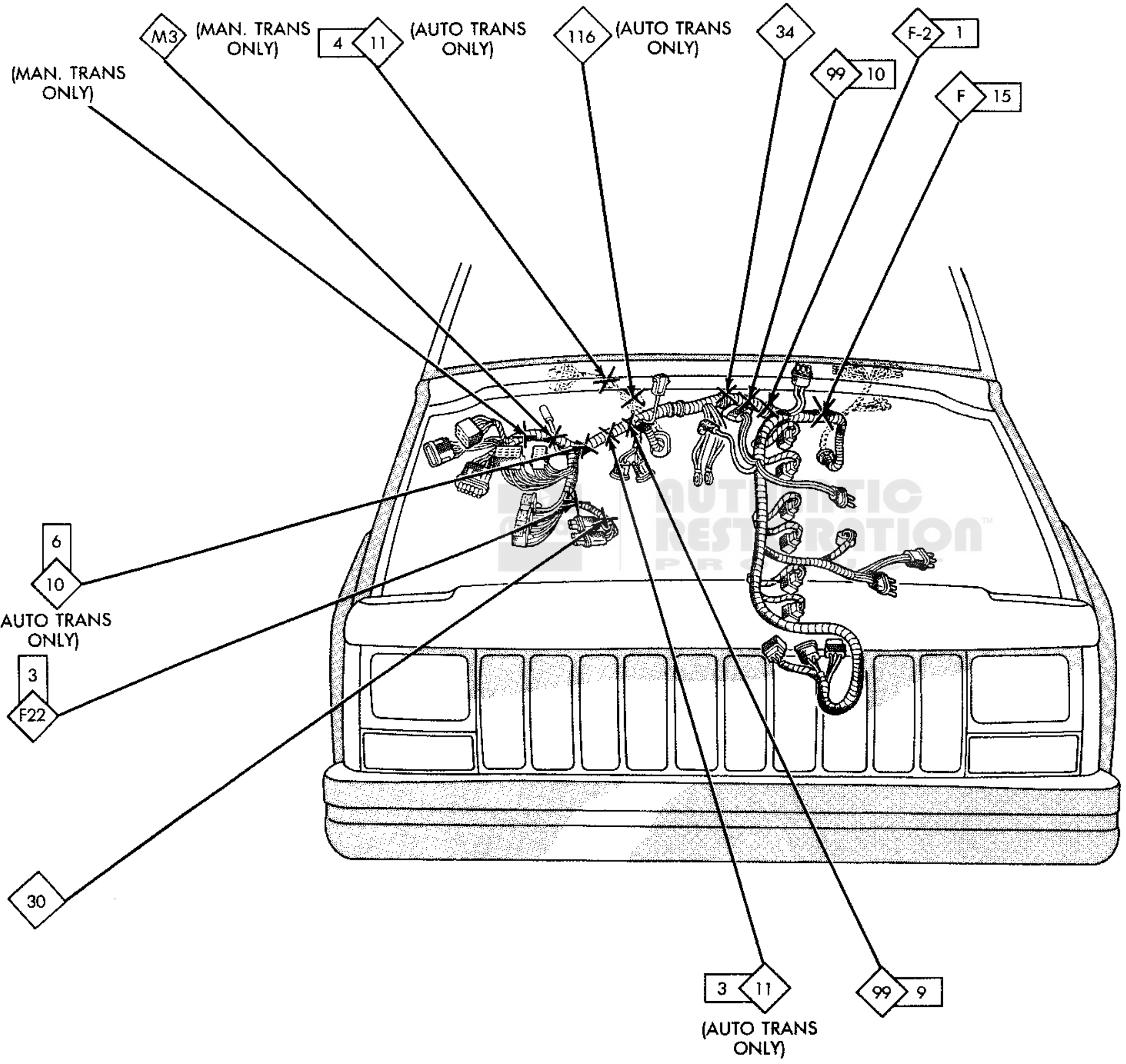


Fig. 8 — Engine Compartment Splices (4.0L)

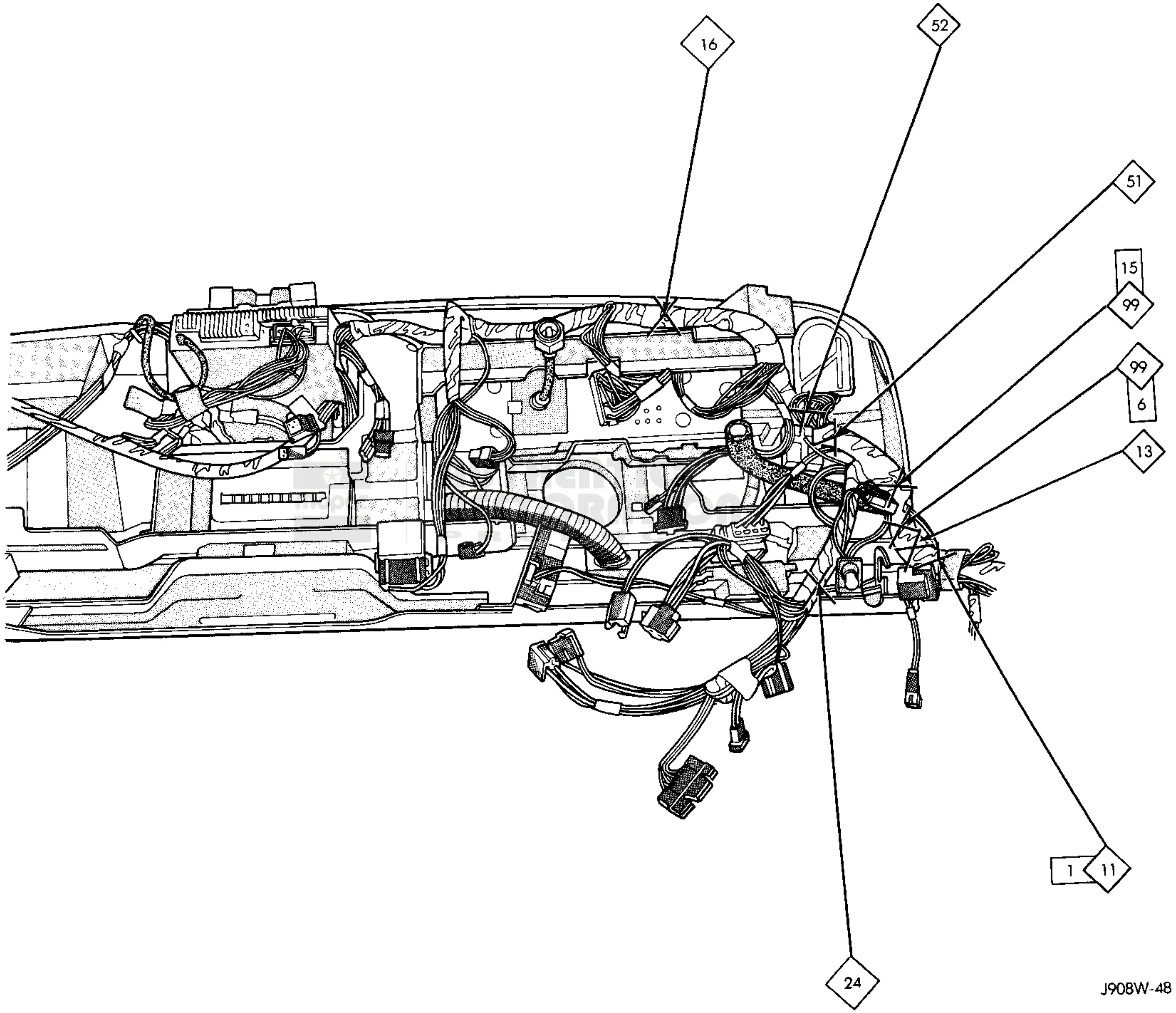
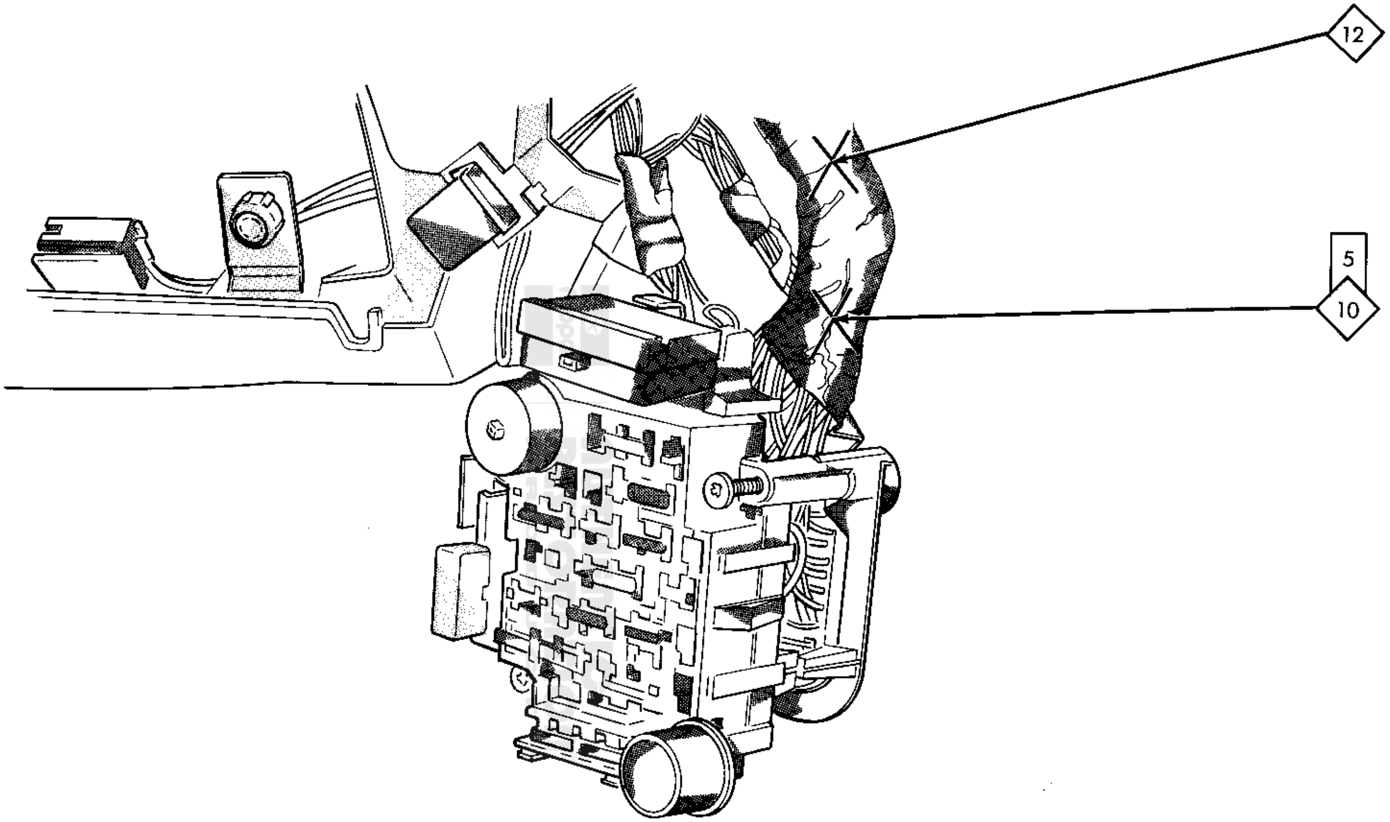


Fig. 9 — Instrument Panel Harness Splices — MJ/XJ



J908W-49

Fig. 10 — Fuse Panel Splices — MJ/XJ

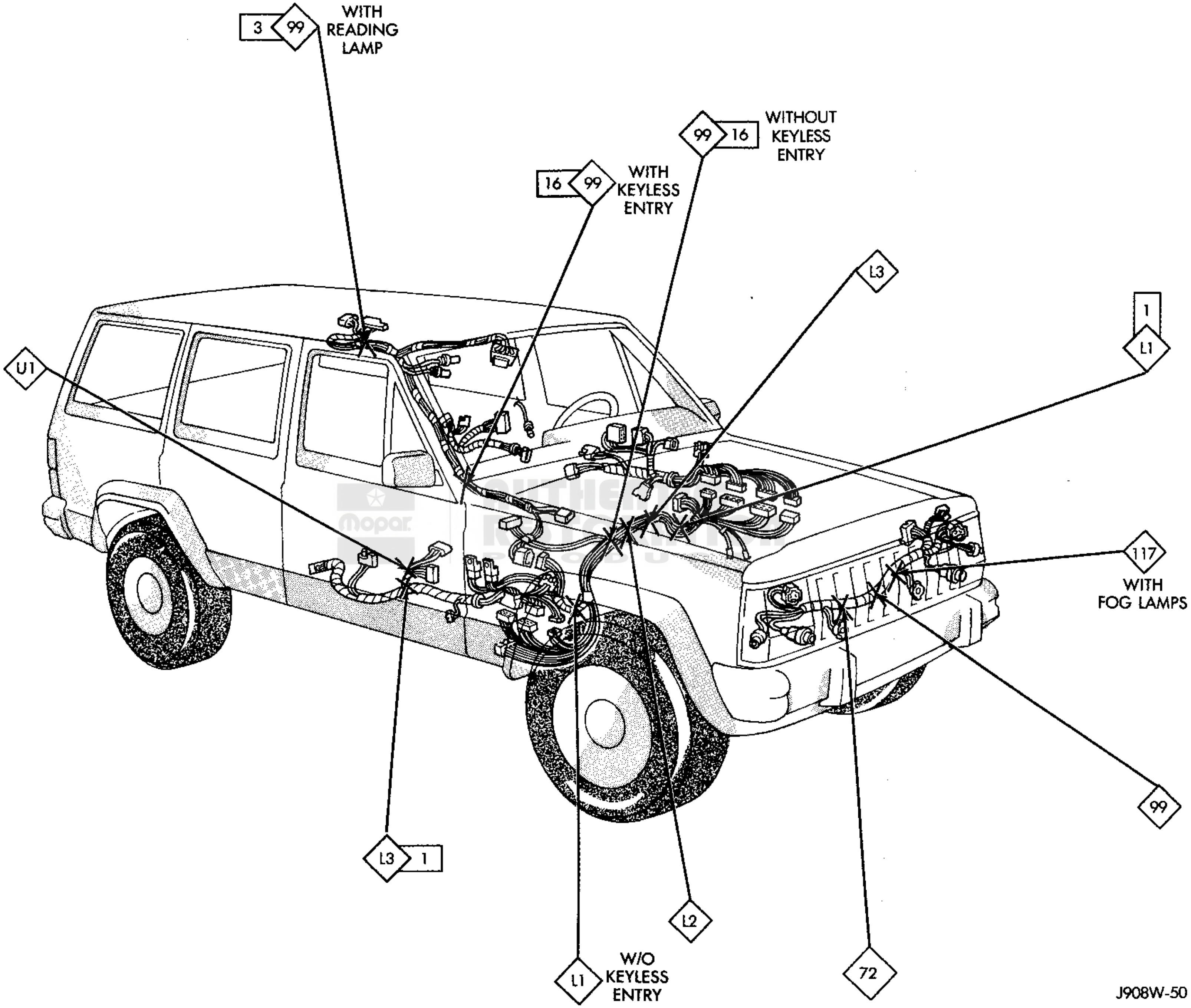


Fig. 11 — Body Harness Splices — XJ

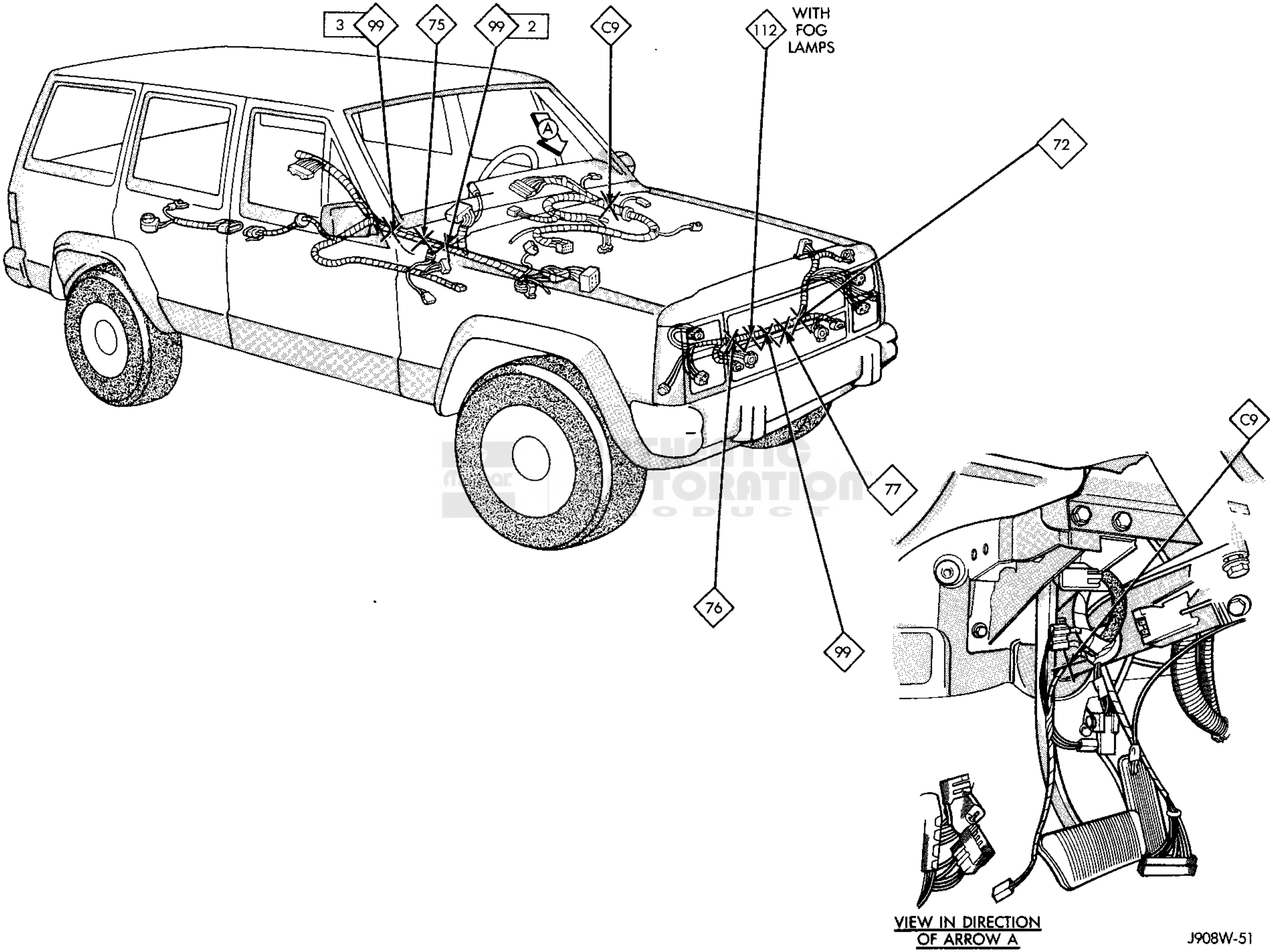


Fig. 12 — Body Harness Splices — Wagoneer

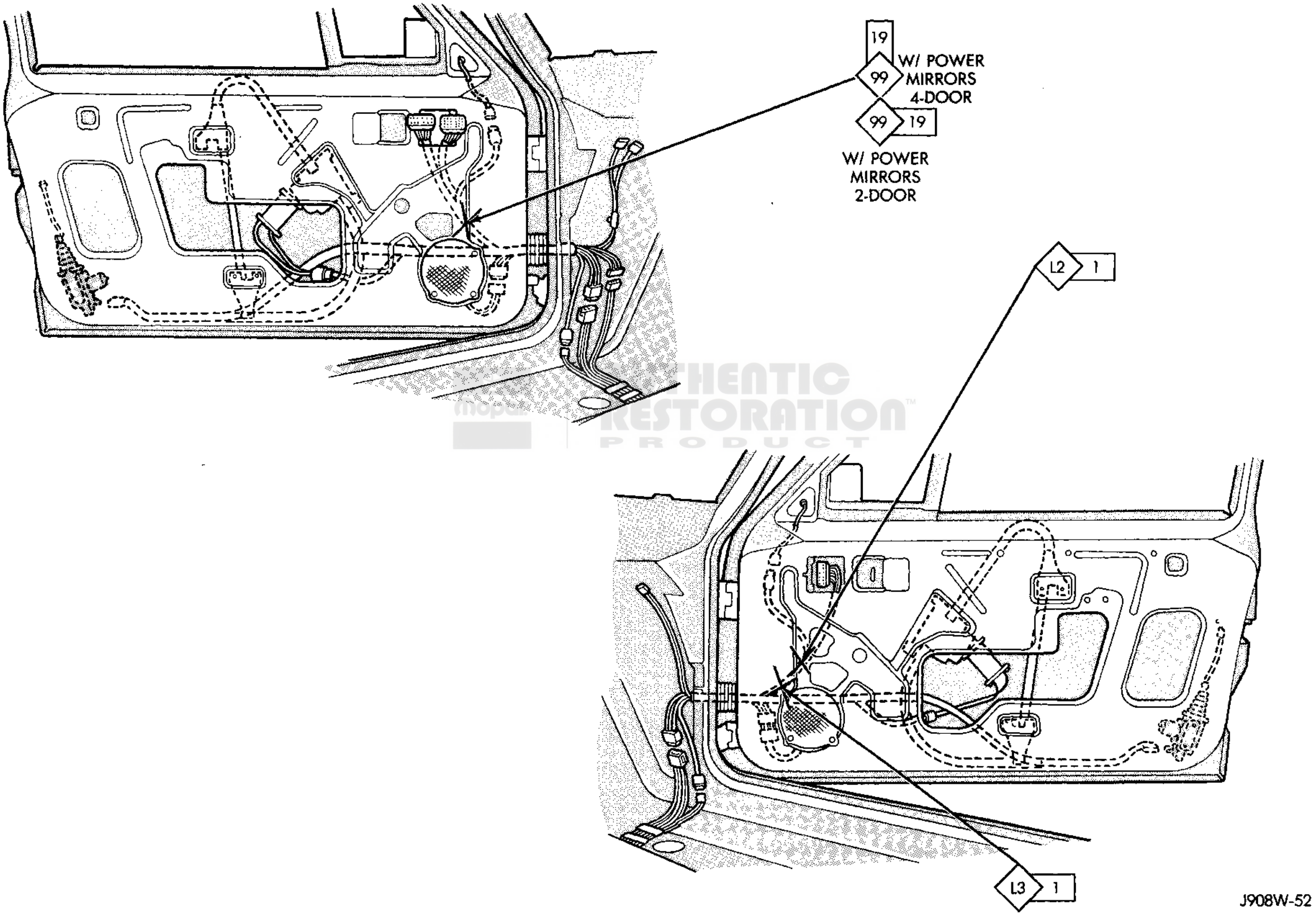


Fig. 13 — Power Window/Door Lock Splices — XJ

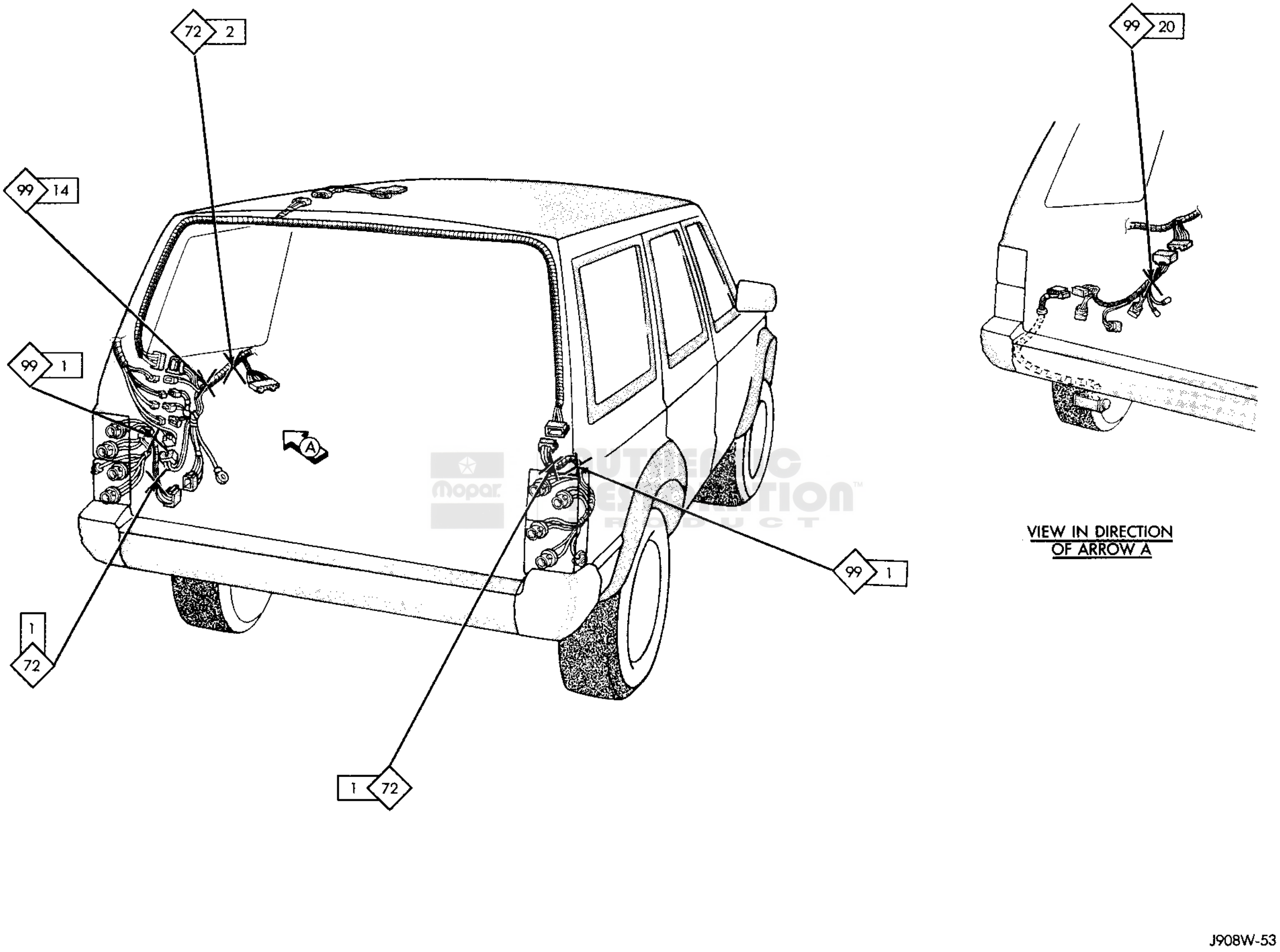


Fig. 14 — Rear Harness Splices — XJ

J908W-54

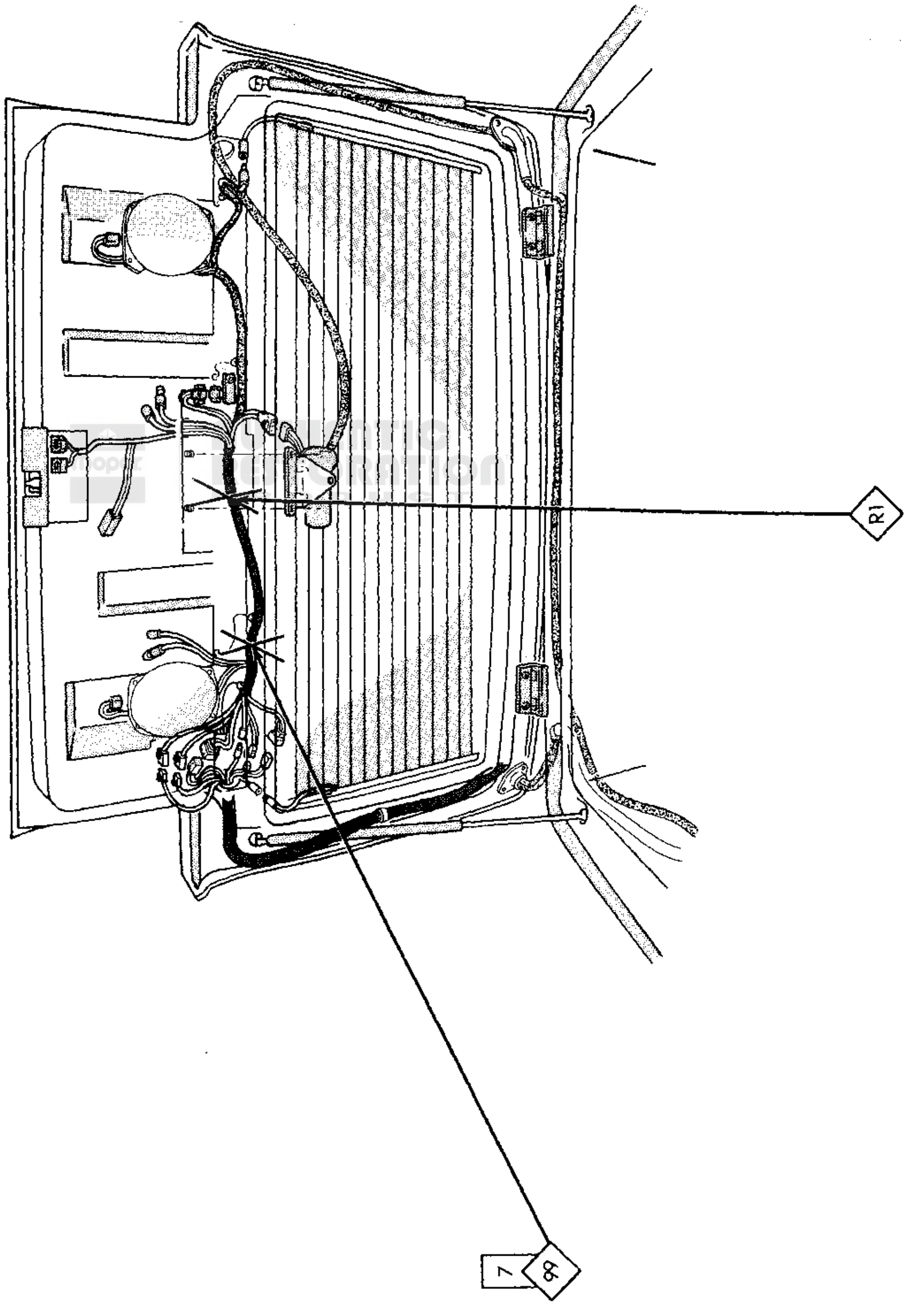


Fig. 15 — Liftgate Splices — XJ

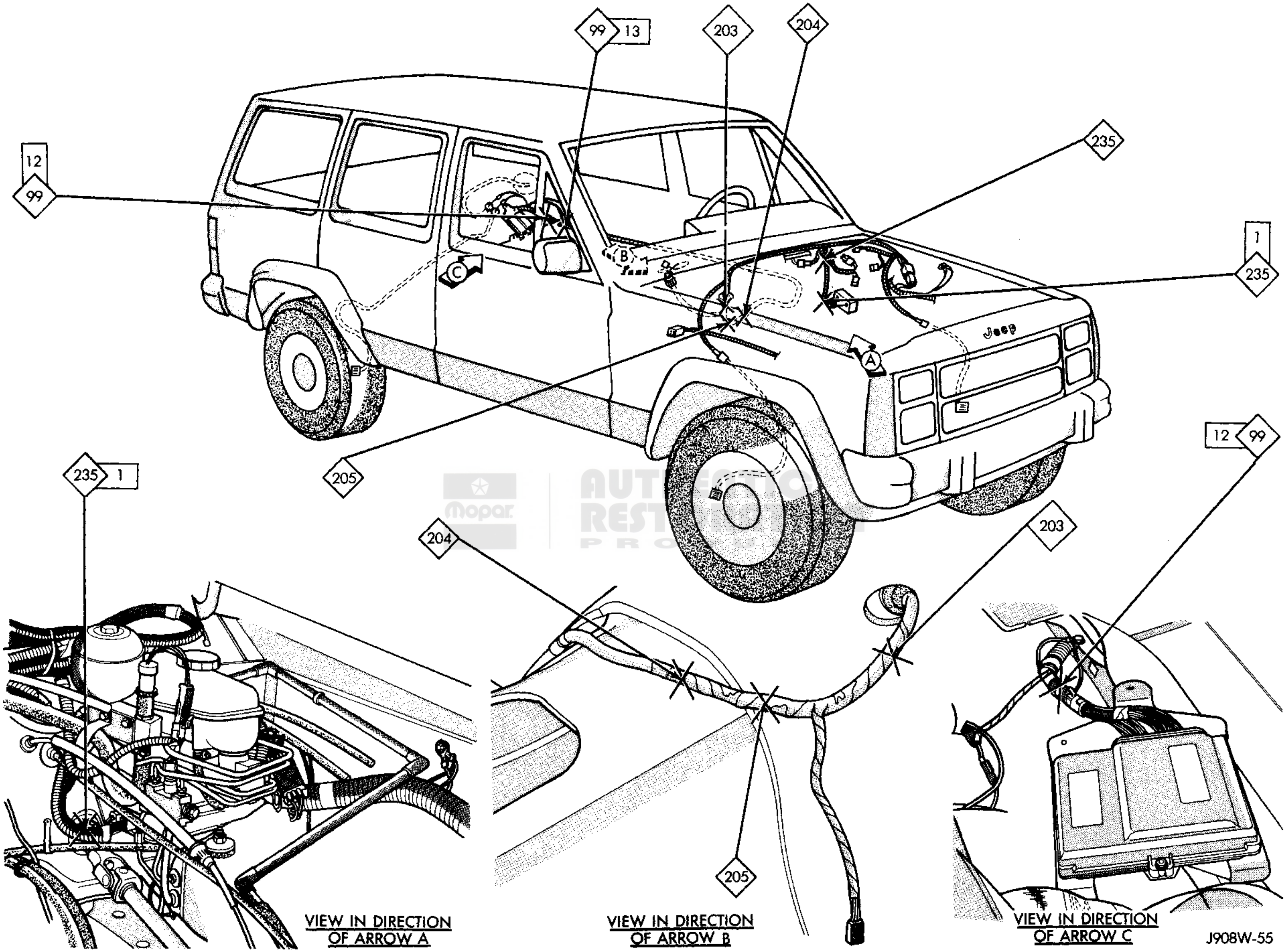


Fig. 16 —Antilock Brake System Splices — XJ

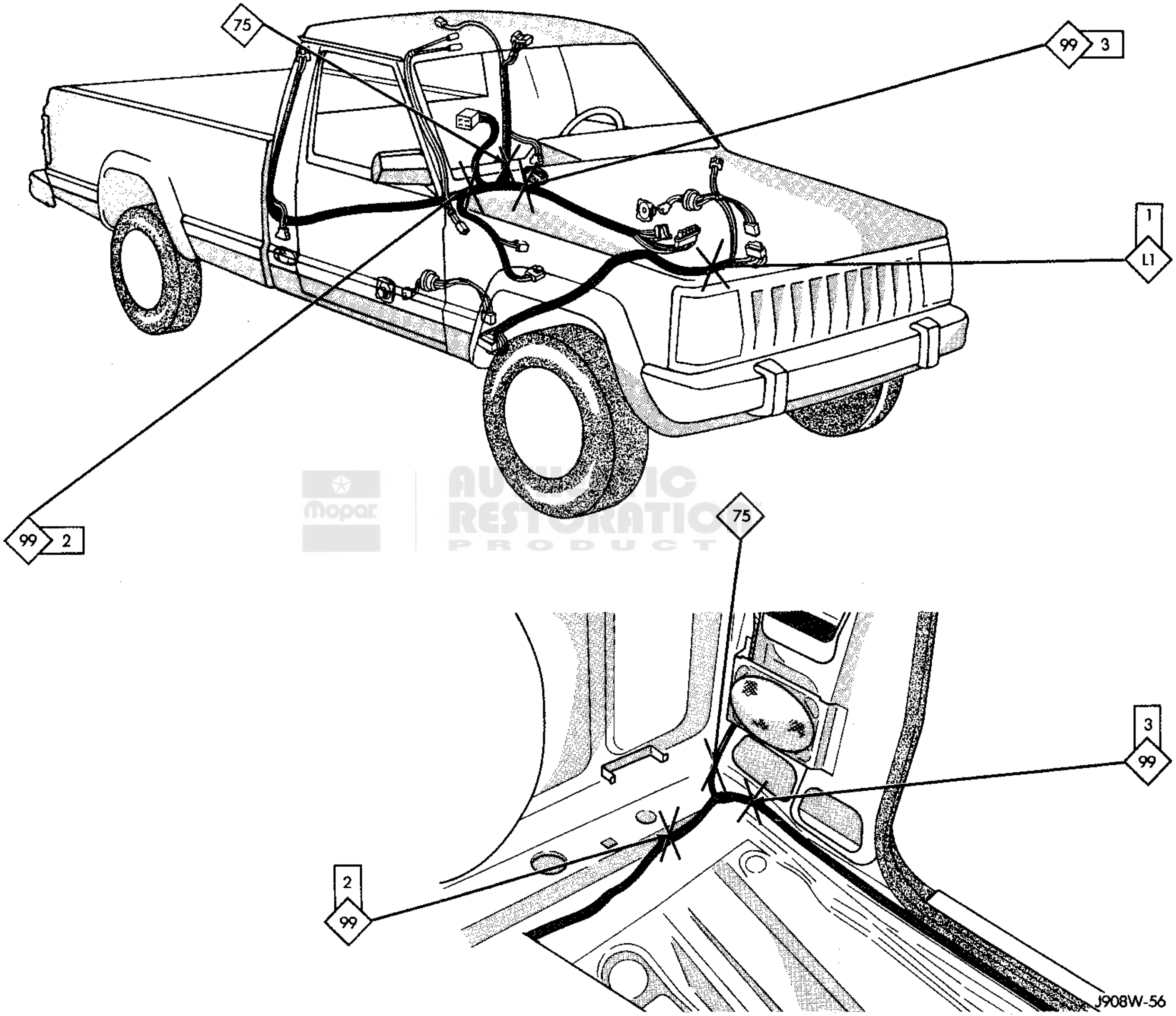


Fig. 17 — Body Harness Splices — MJ

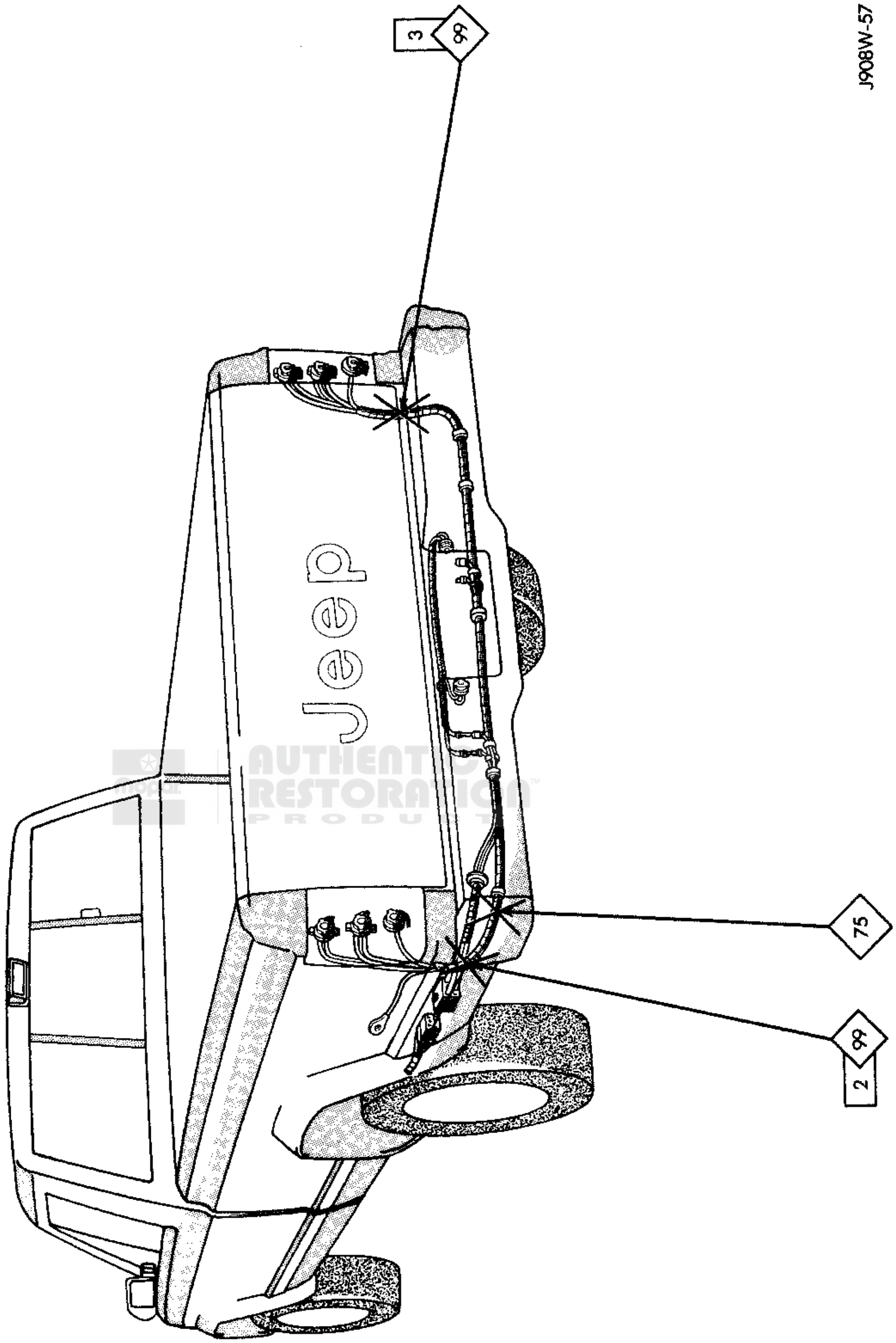
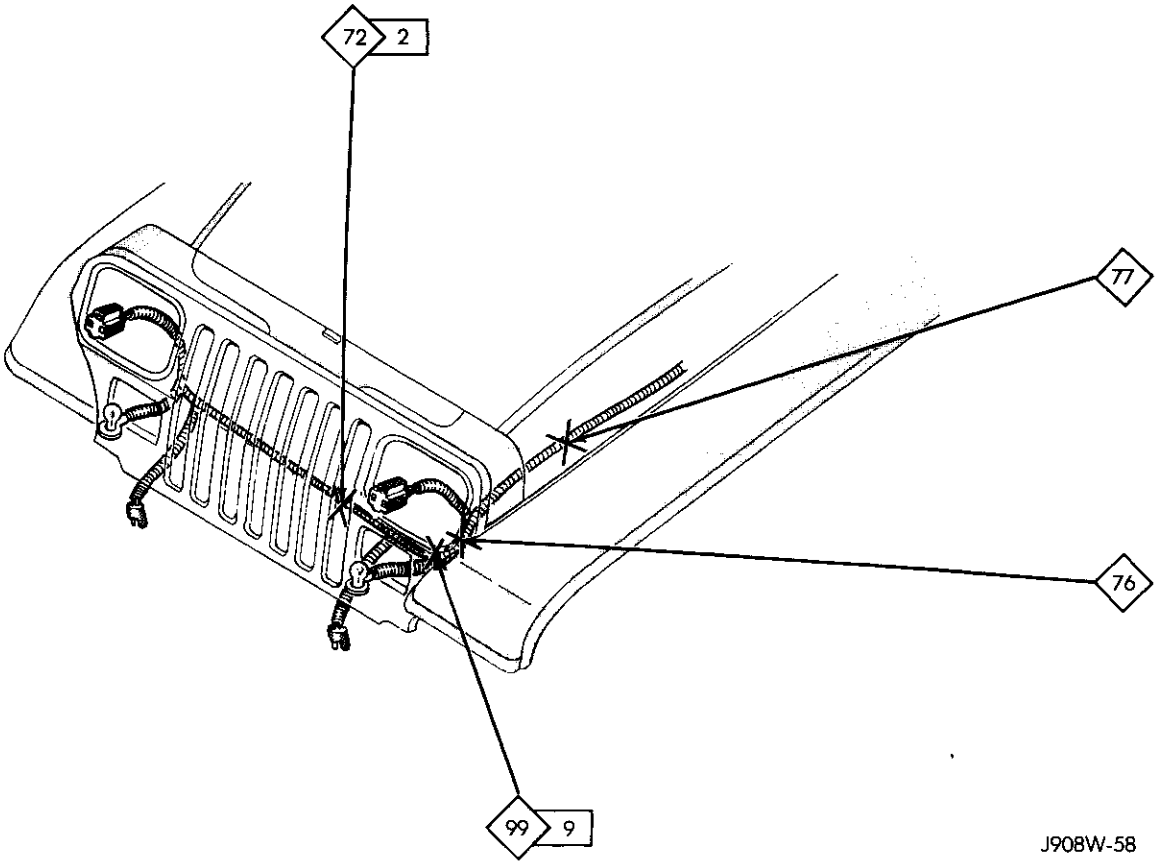
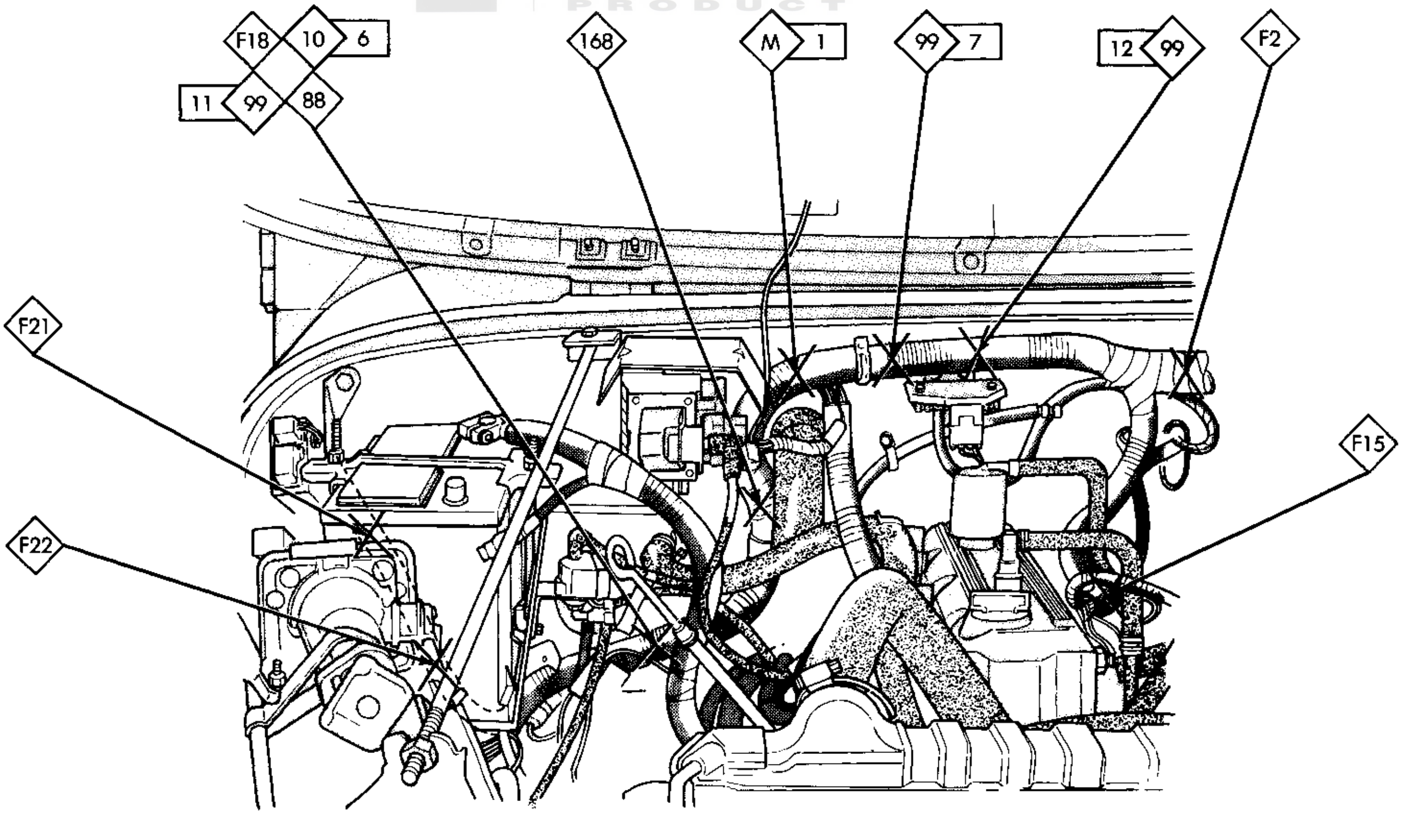


Fig. 18 — Rear Harness Splices — MJ



J908W-58

Fig. 19 — Front Lighting Harness Splices — YJ



908W-59

Fig. 20 — Engine Harness Splices (2.5L) — YJ

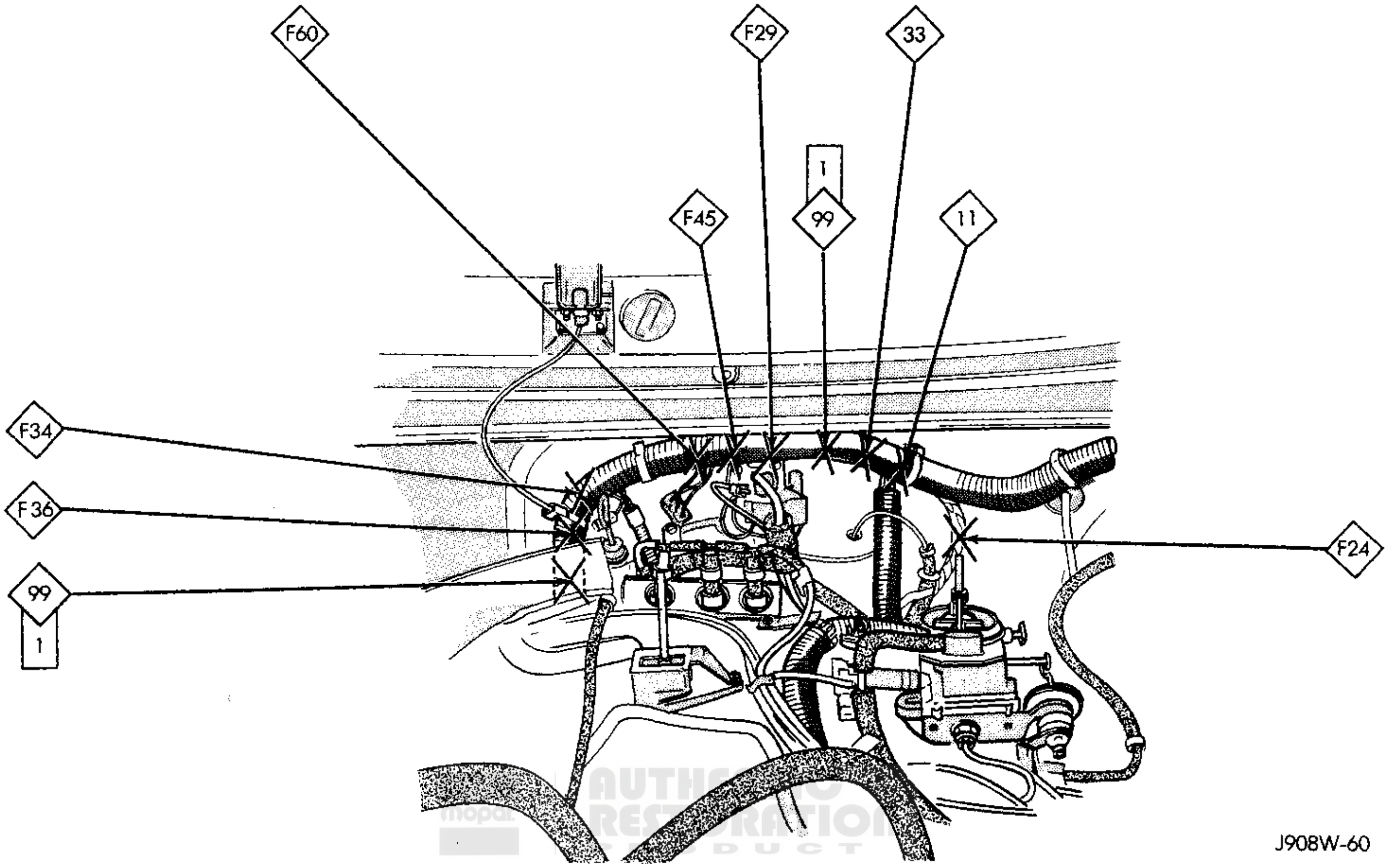


Fig. 21 — Engine Harness Splices (4.2L) — YJ

J908W-61

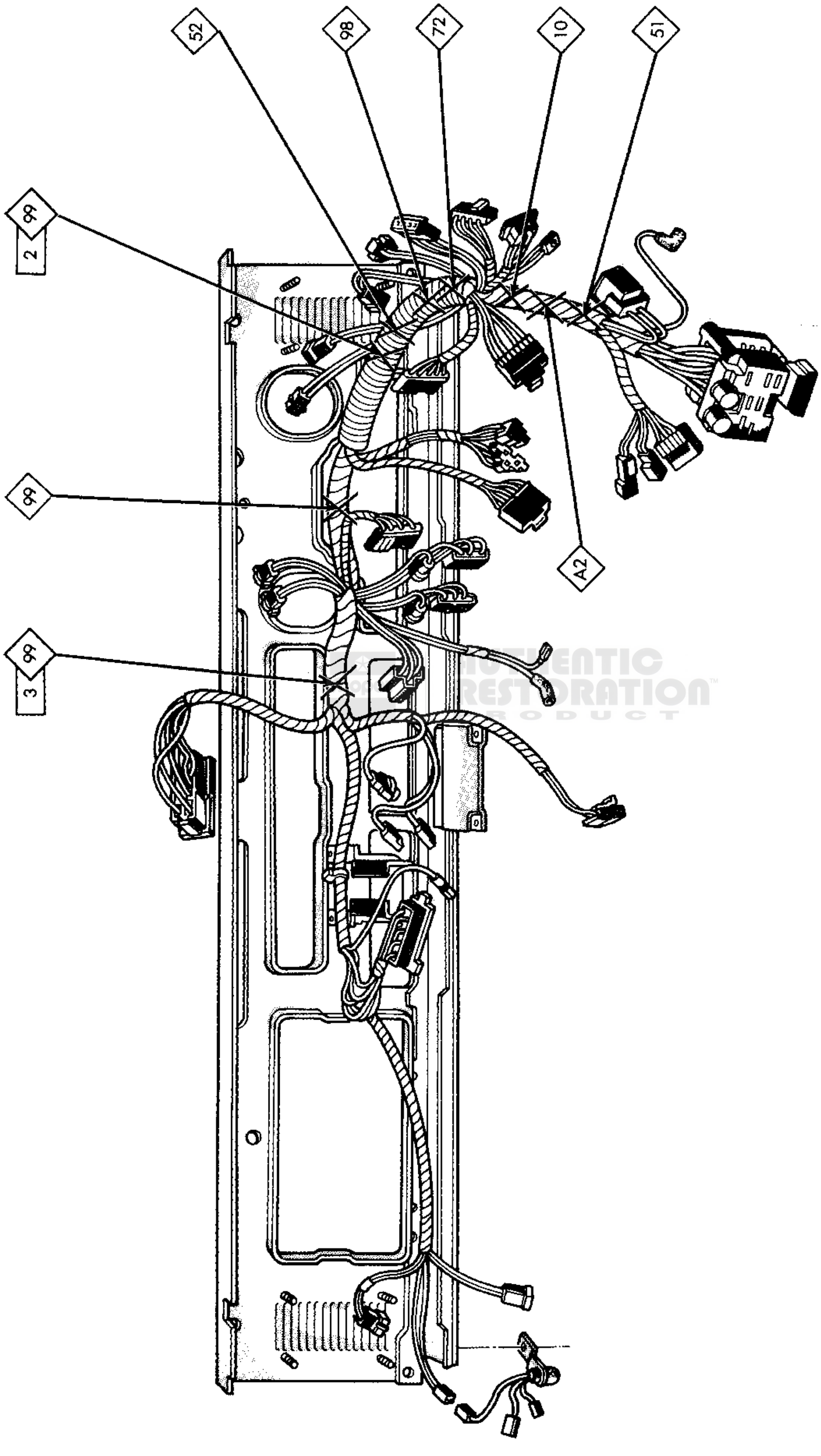


Fig. 22 — Instrument Panel Splices — YJ

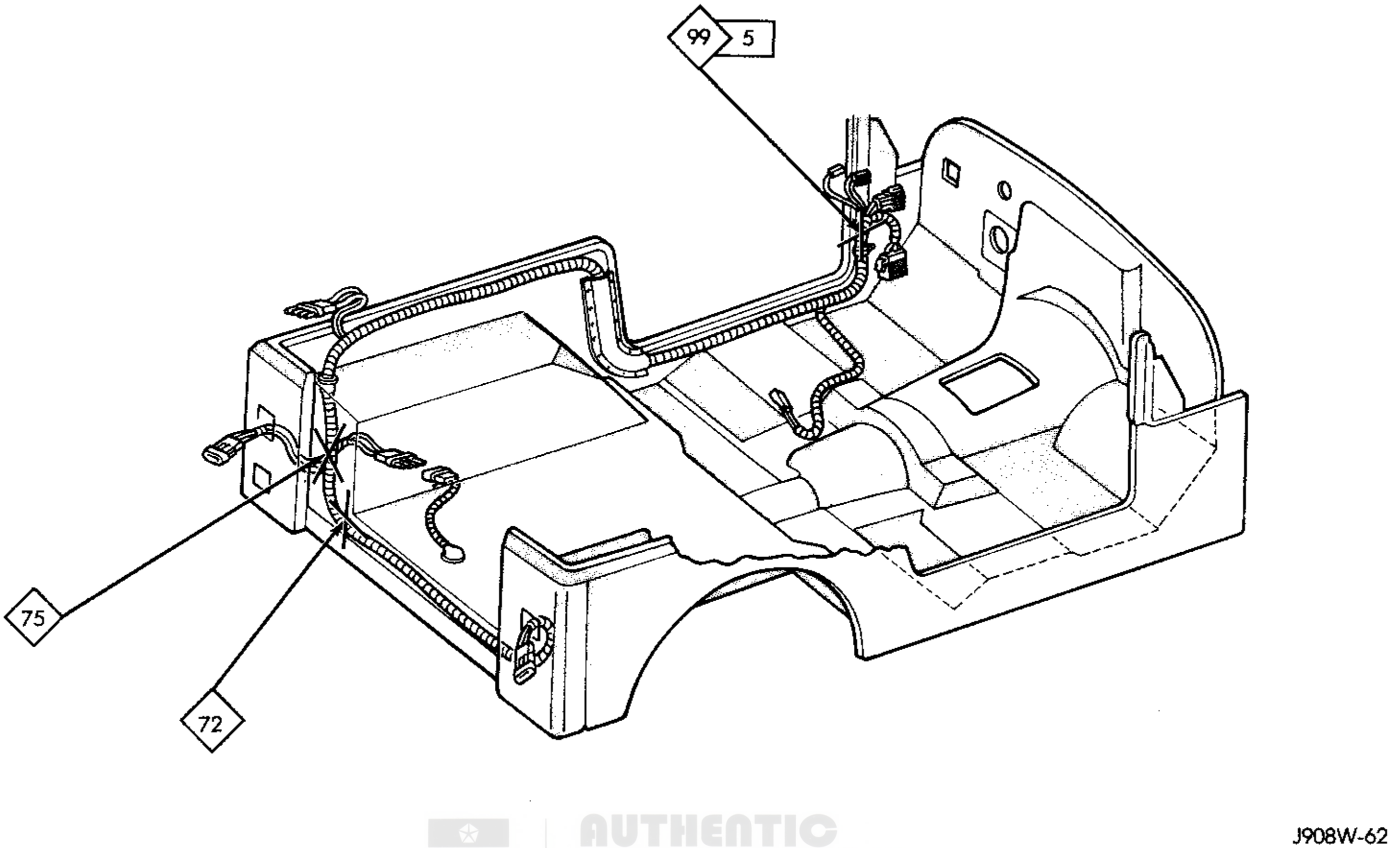
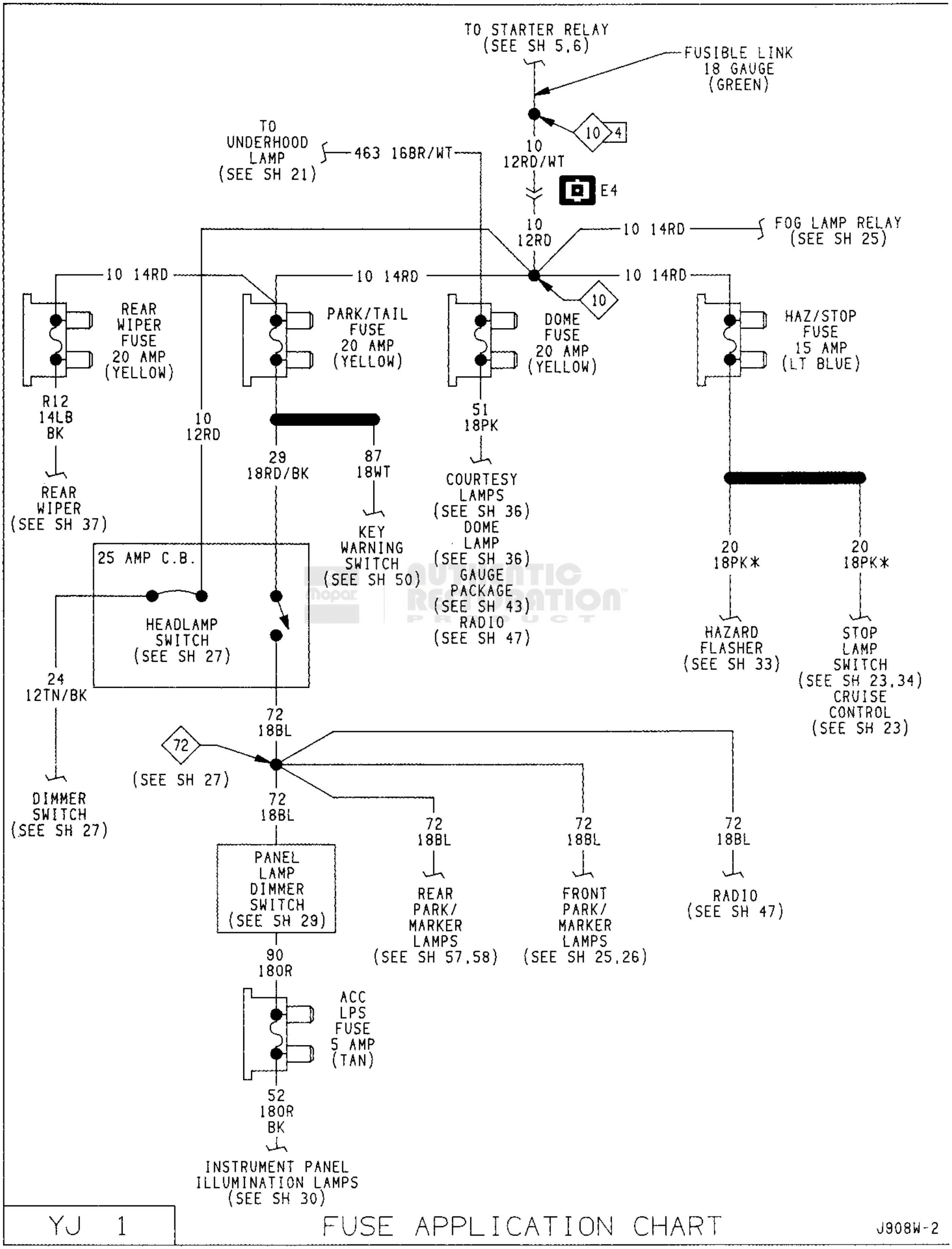


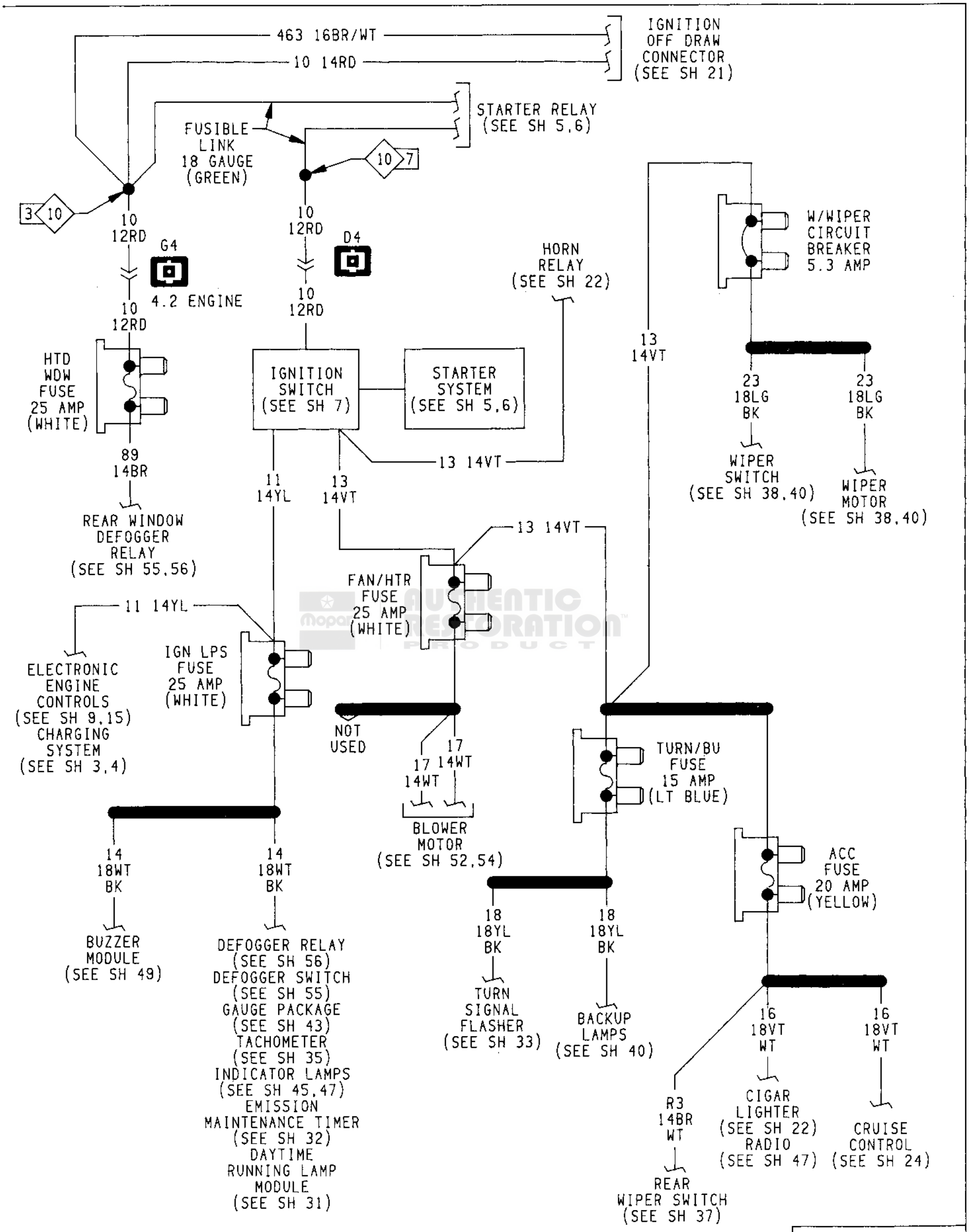
Fig. 23 — Body Harness Splices — YJ

WIRE ROUTING AND COMPONENT LOCATION ELECTRICAL WIRING DIAGRAMS YJ SERIES

ALPHABETICAL INDEX



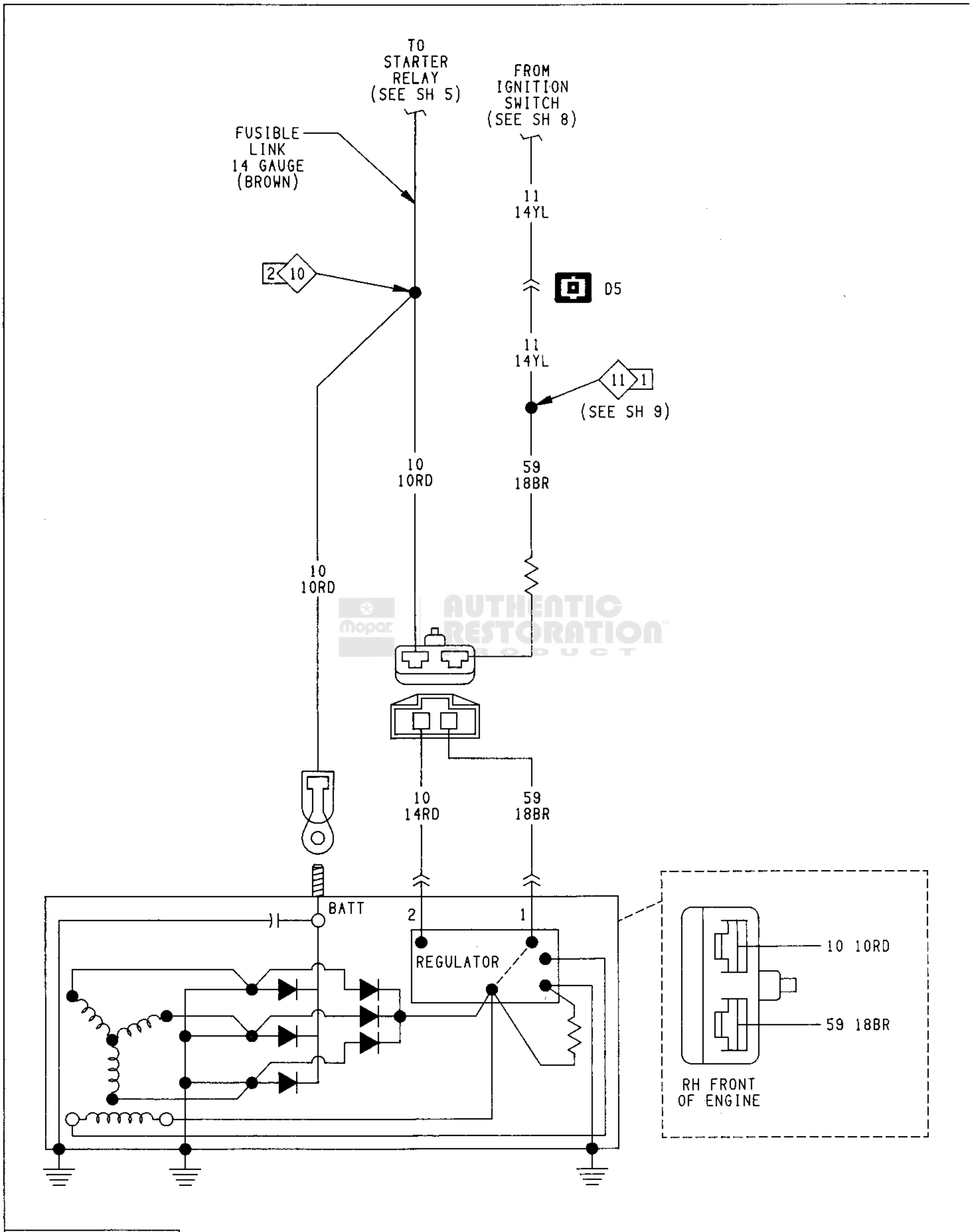
FUSE APPLICATION CHART



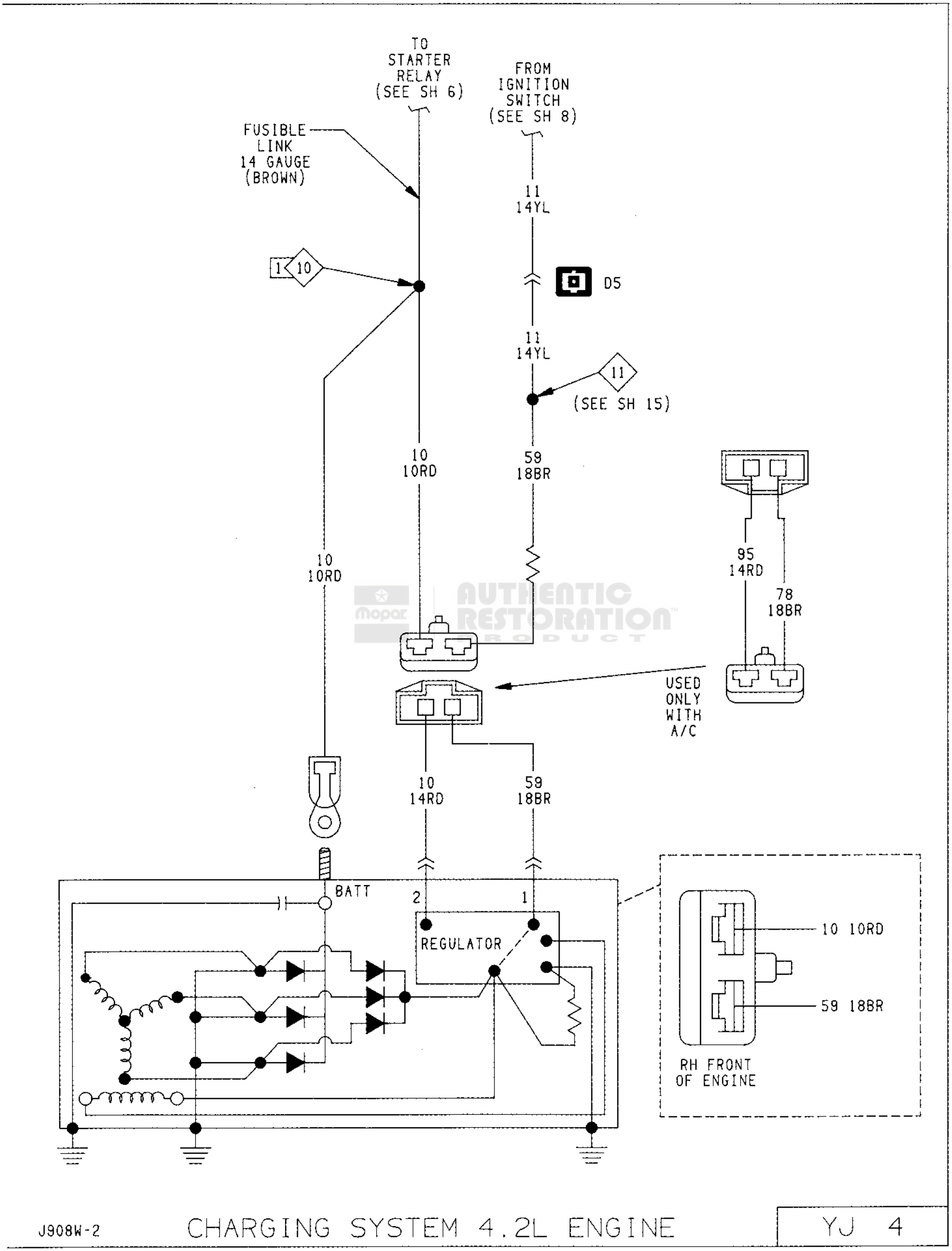
J908W-2

FUSE APPLICATION CHART

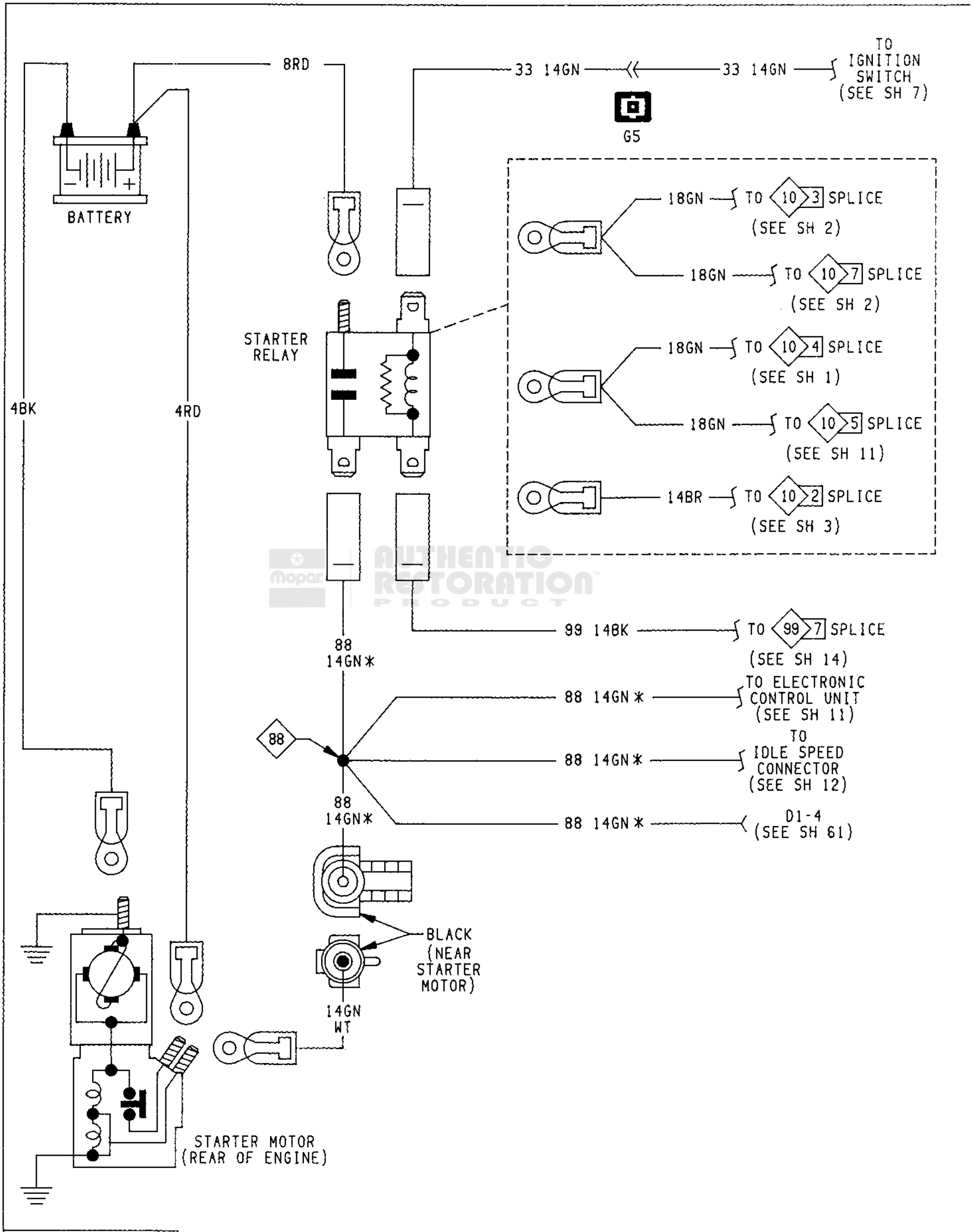
YJ 2



YJ 3 CHARGING SYSTEM 2.5L ENGINE J908W-2



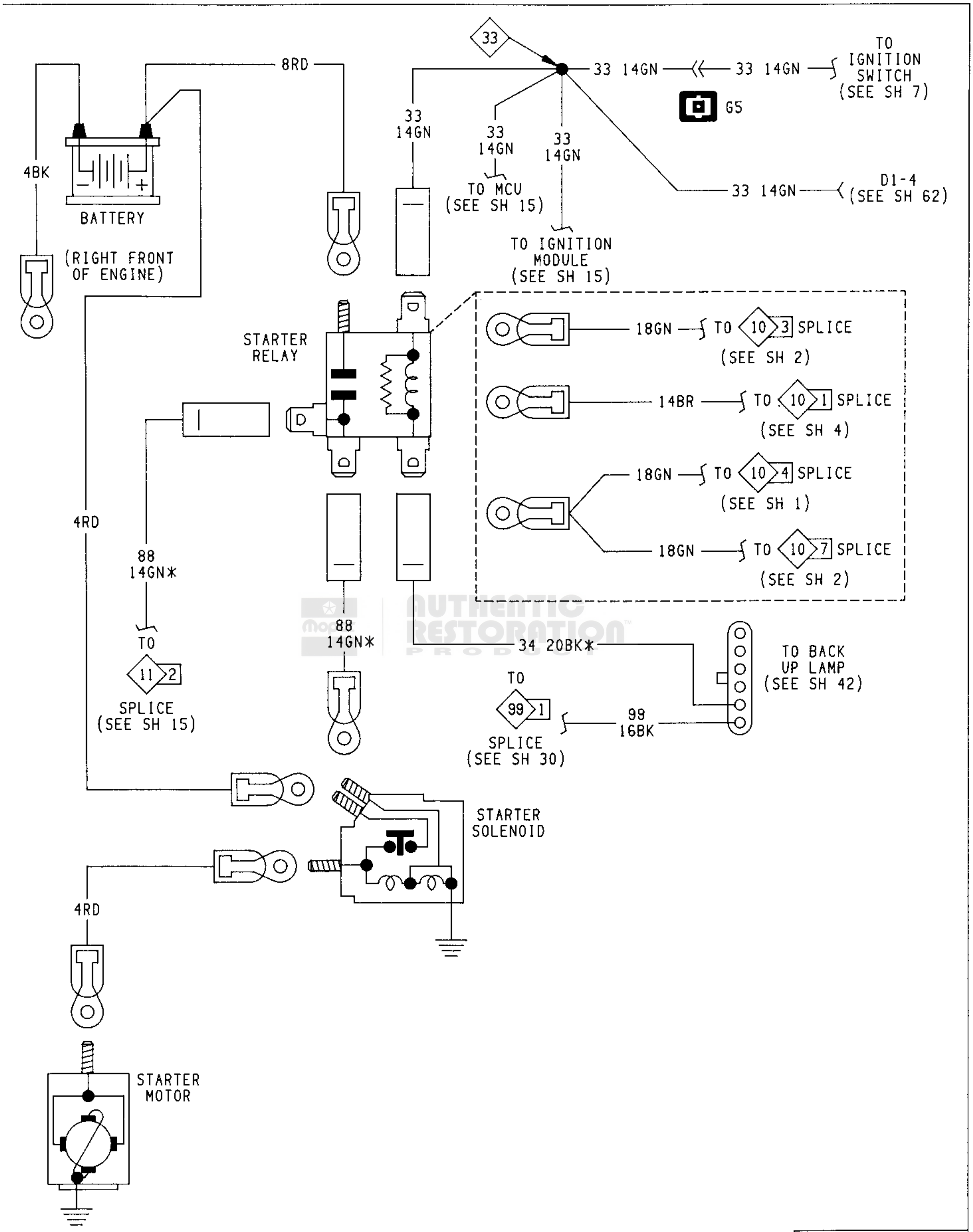
CHARGING SYSTEM 4.2L ENGINE



YJ 5

STARTER SYSTEM 2.5L ENGINE

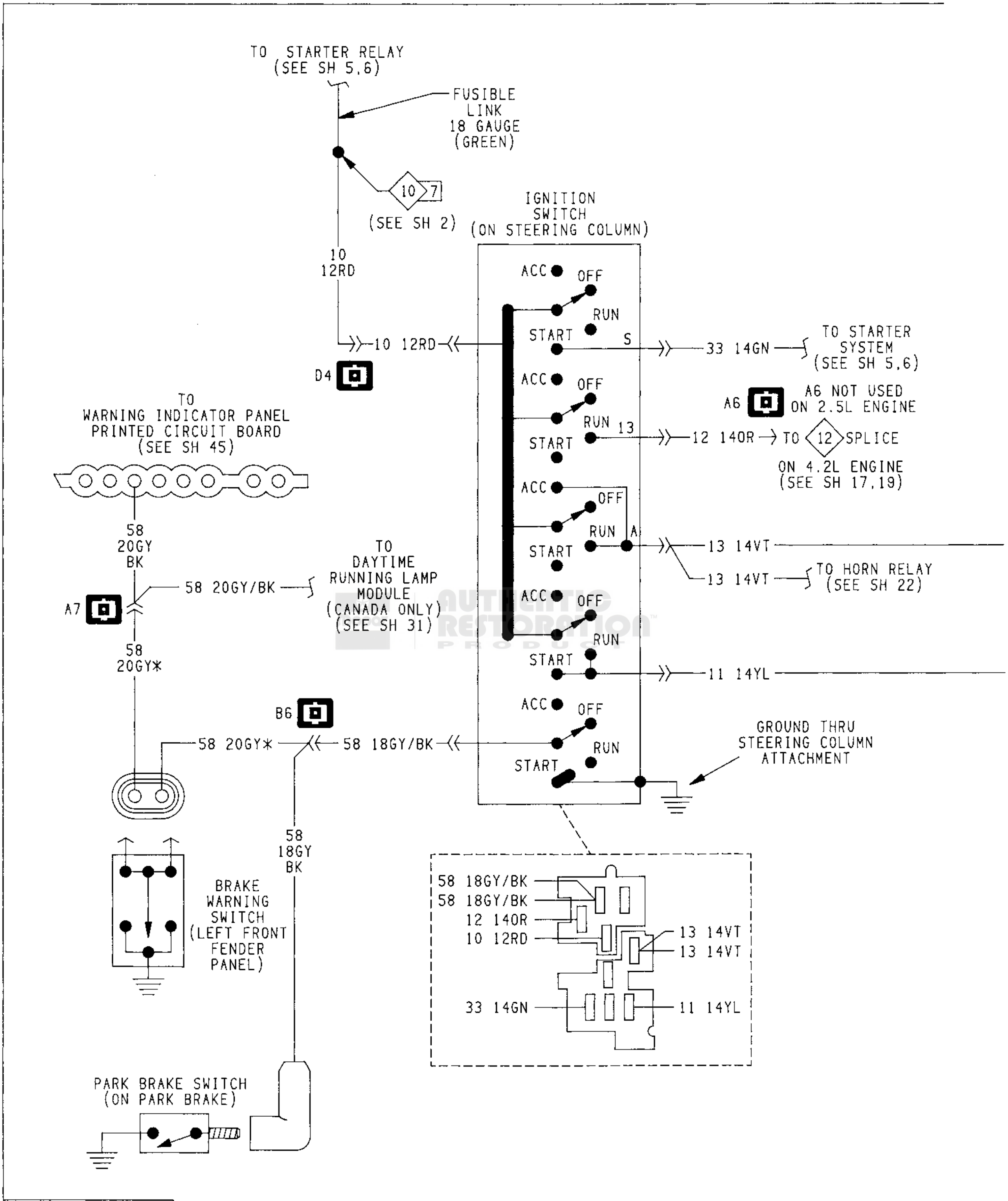
J908W-2



J908W-2

STARTER SYSTEM 4.2L ENGINE

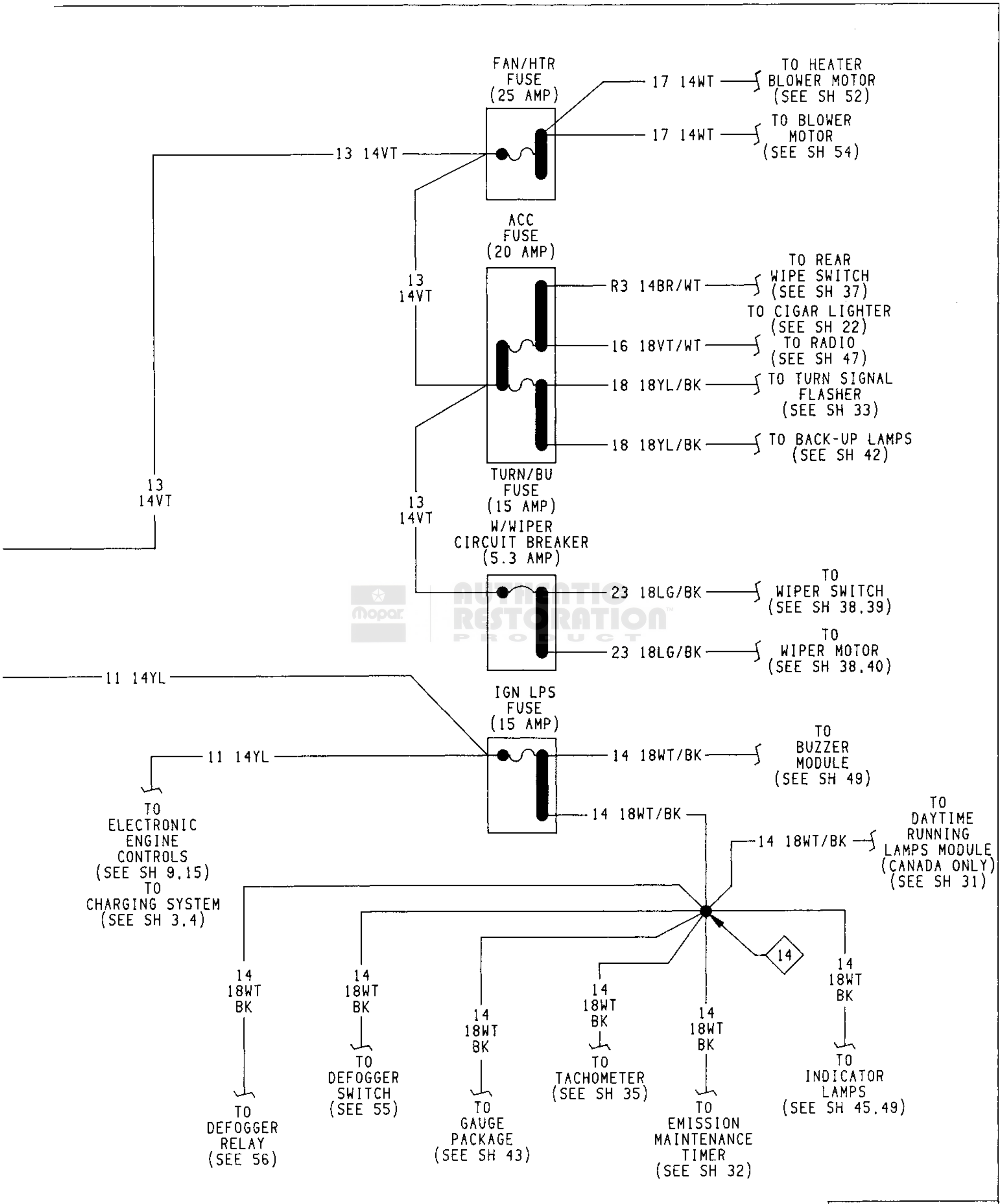
YJ 6



YJ 7

IGNITION SWITCH

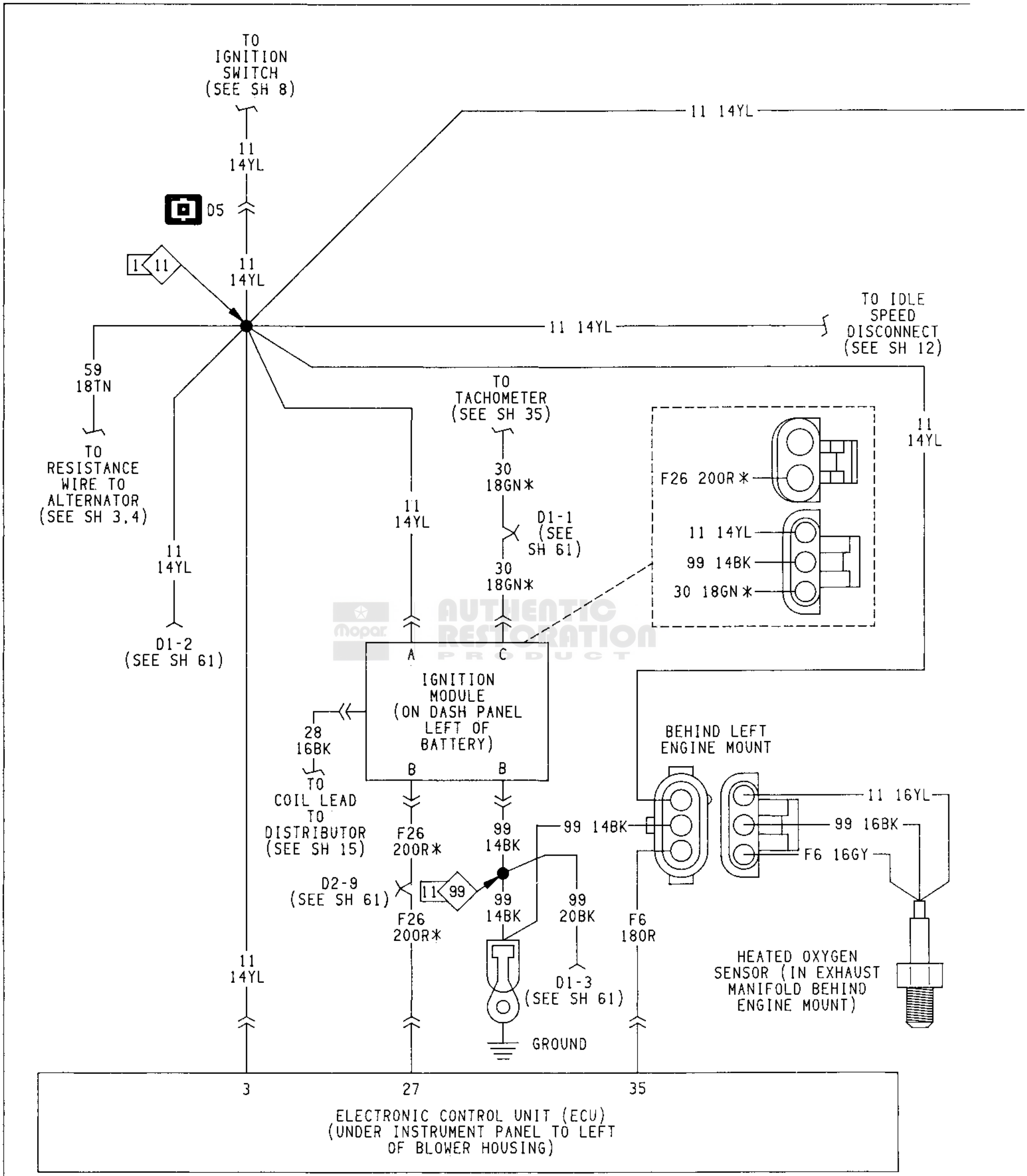
J908W-2



J908W-2

IGNITION SWITCH

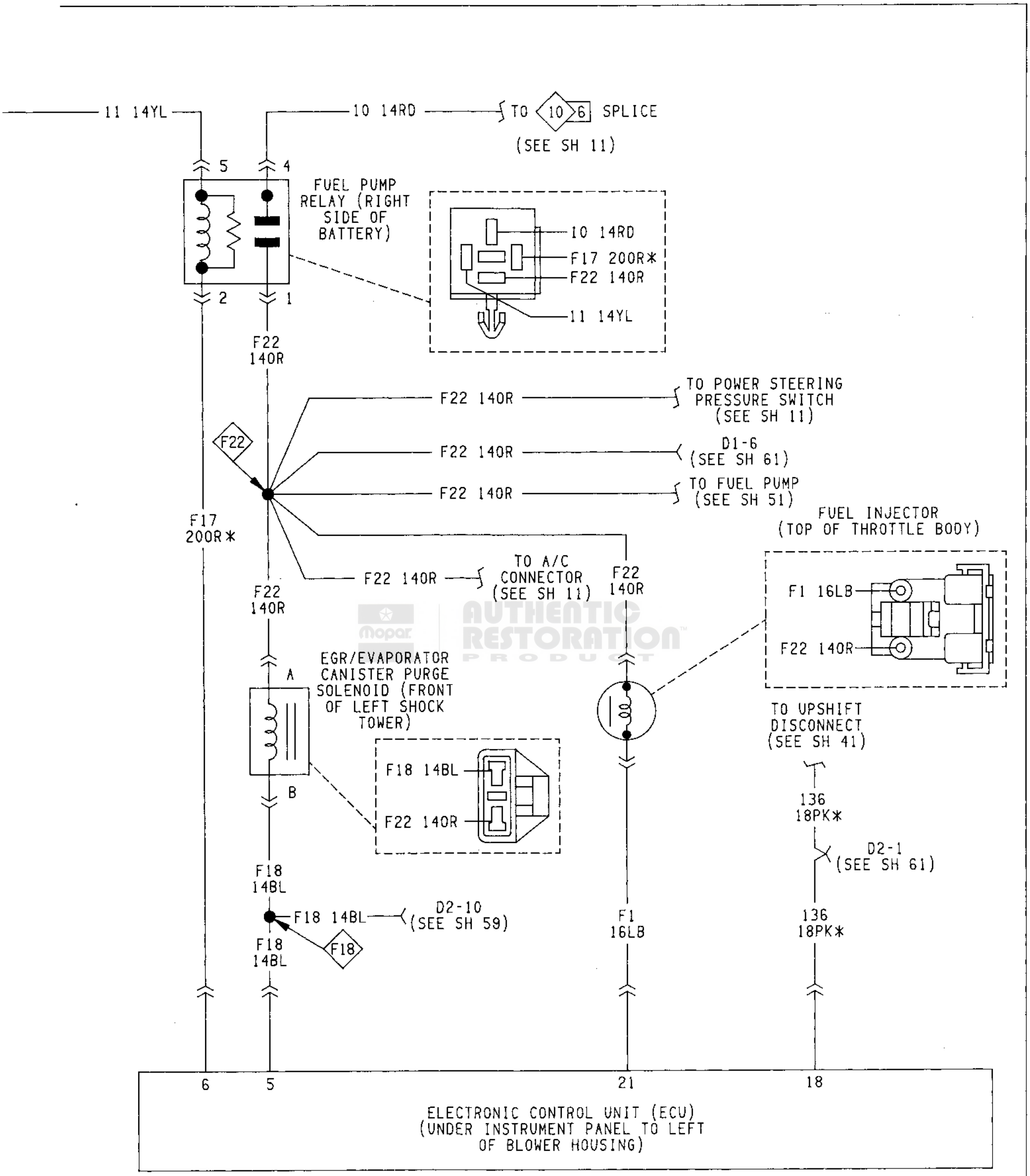
YJ 8



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

YJ 9

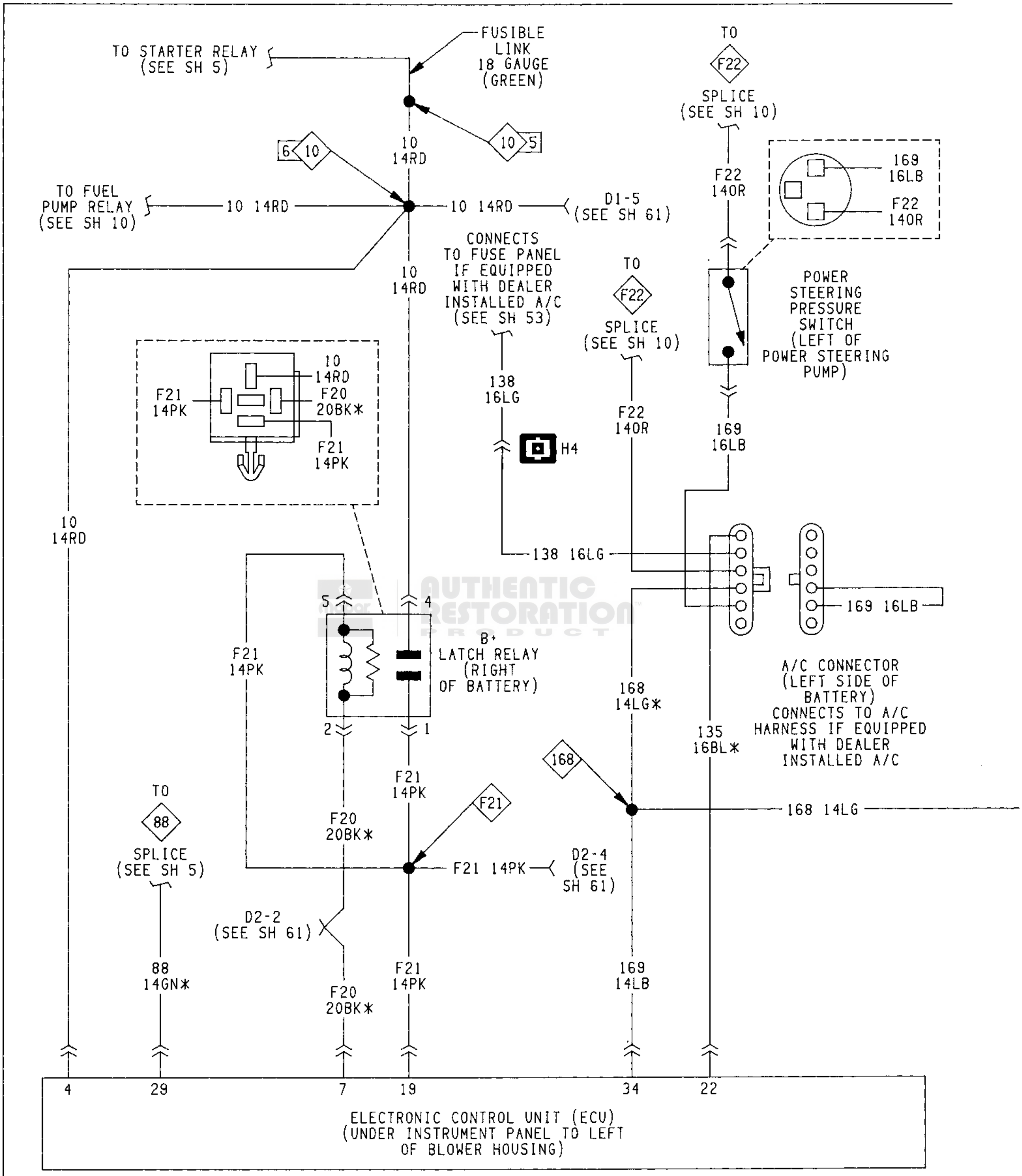
J908W-2



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

J908W-2

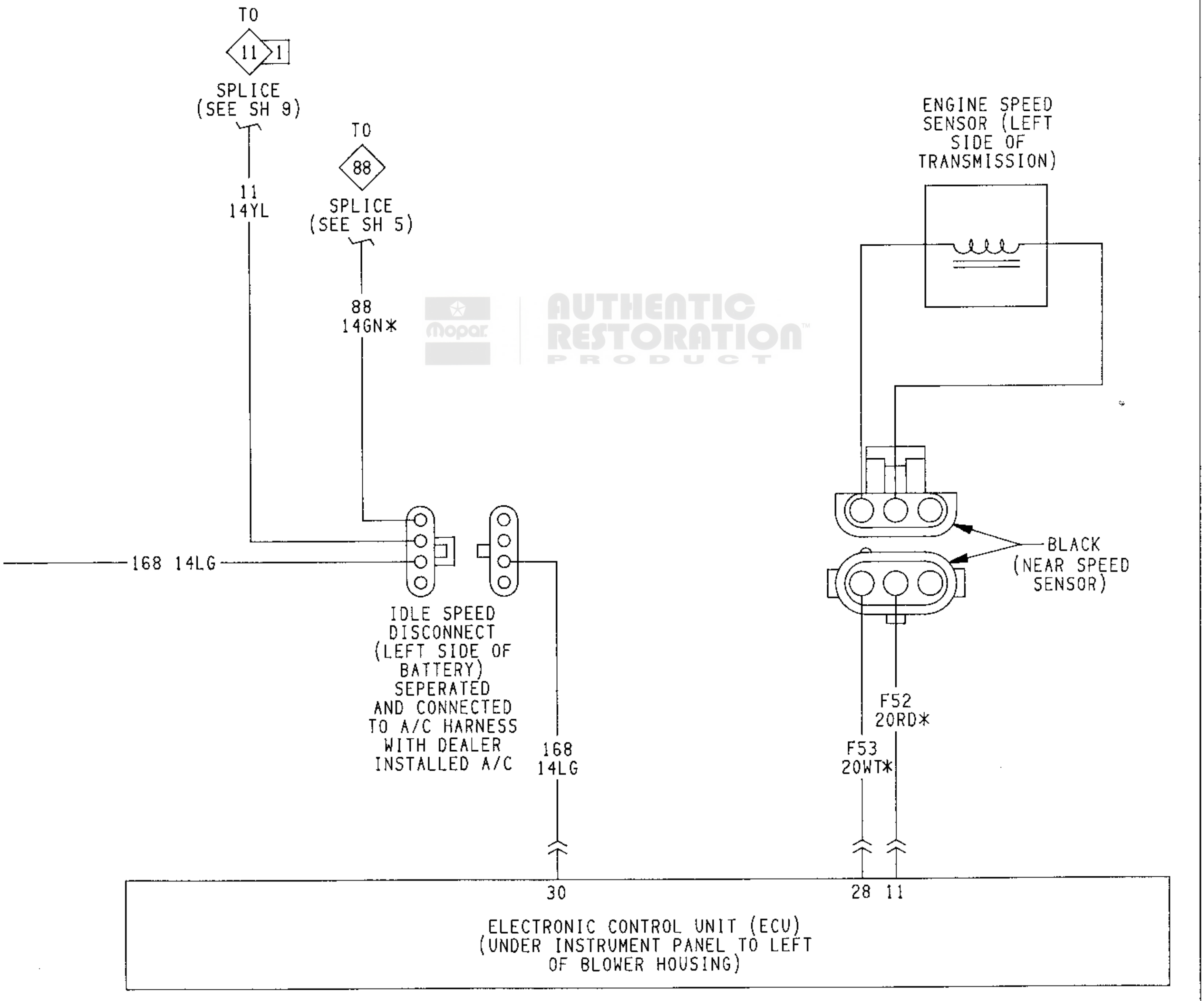
YJ 10



YJ 11

ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

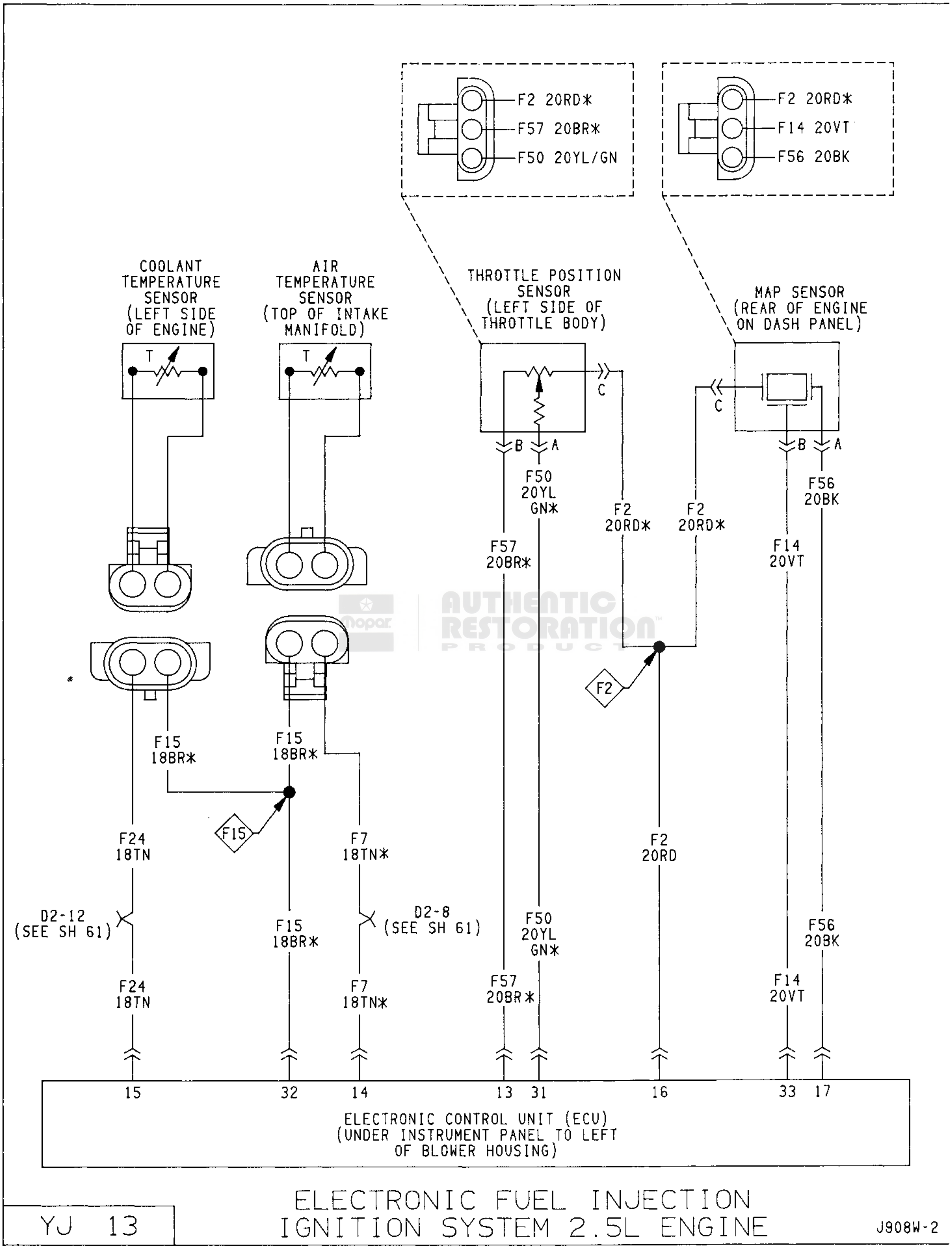
J908W-2

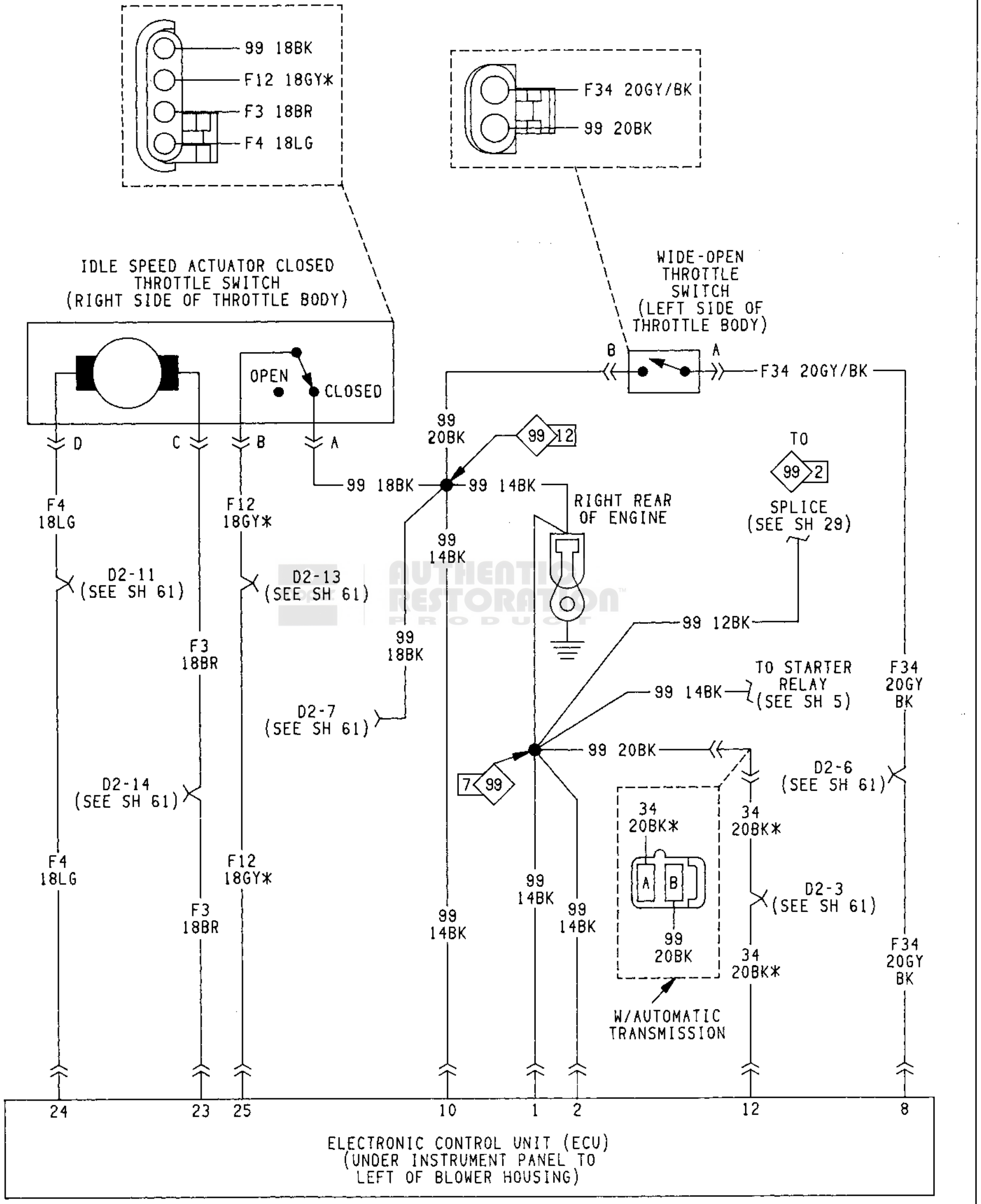


ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

J908W-2

YJ 12

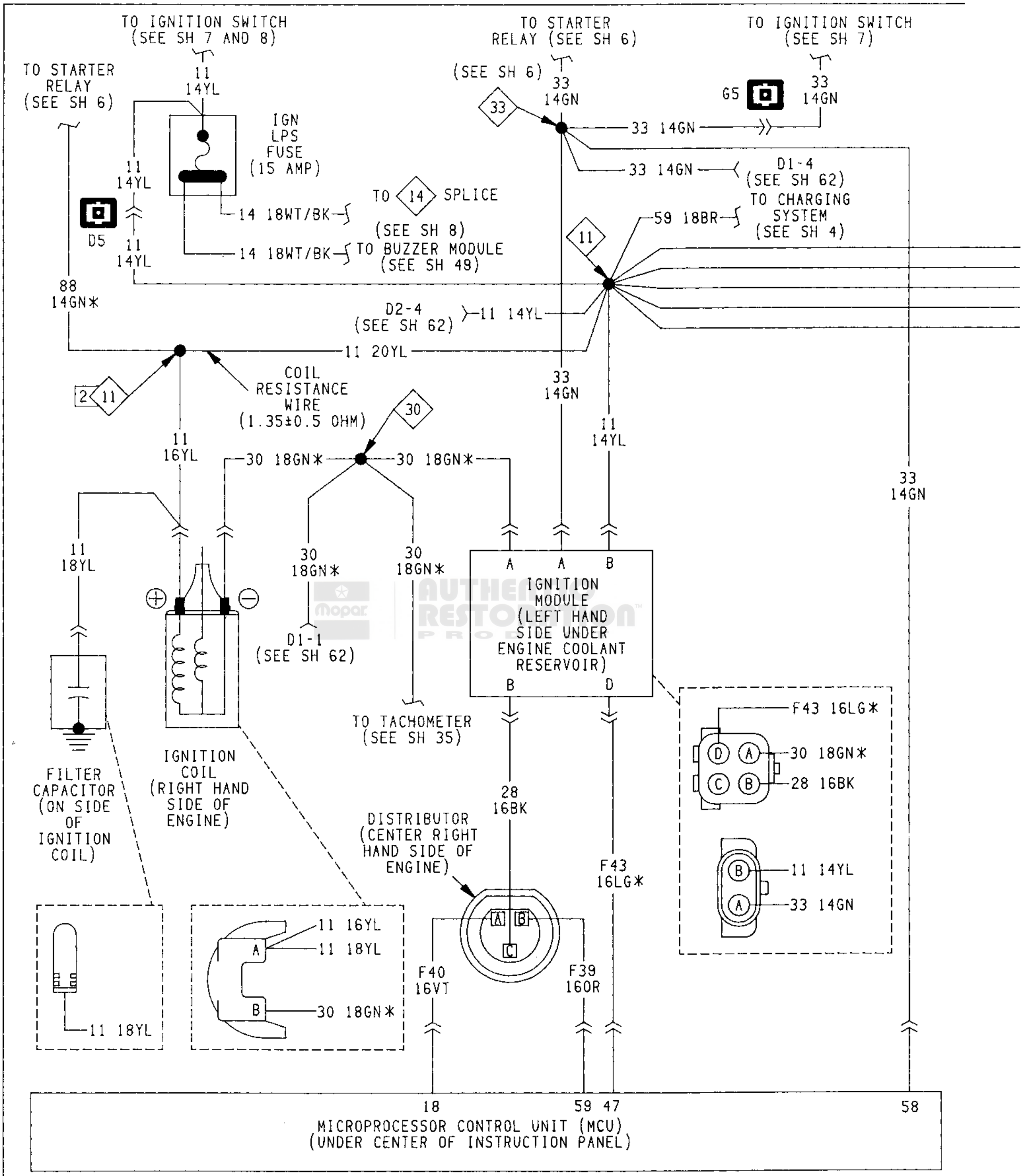

F2 20RD*
F57 20BR*
F50 20YL/GN
F2 20RD*
F14 20VT
F56 20BK
COOLANT TEMPERATURE SENSOR (LEFT SIDE OF ENGINE)
T
AIR TEMPERATURE SENSOR (TOP OF INTAKE MANIFOLD)
T
THROTTLE POSITION SENSOR (LEFT SIDE OF THROTTLE BODY)
C
B
A
MAP SENSOR (REAR OF ENGINE ON DASH PANEL)
C
B
A
F50 20YL GN*
F57 20BR*
F2 20RD*
F2 20RD*
F14 20VT
F56 20BK
F2
F15 18BR*
F15 18BR*
F15
F24 18TN
F7 18TN*
F2 20RD
D2-12 (SEE SH 61)
D2-8 (SEE SH 61)
F15 18BR*
F50 20YL GN*
F56 20BK
F24 18TN
F7 18TN*
F57 20BR*
F14 20VT
15
32
14
13
31
16
33
17
ELECTRONIC CONTROL UNIT (ECU) (UNDER INSTRUMENT PANEL TO LEFT OF BLOWER HOUSING)
YJ 13
ELECTRONIC FUEL INJECTION IGNITION SYSTEM 2.5L ENGINE
J908W-2



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

J908W-2

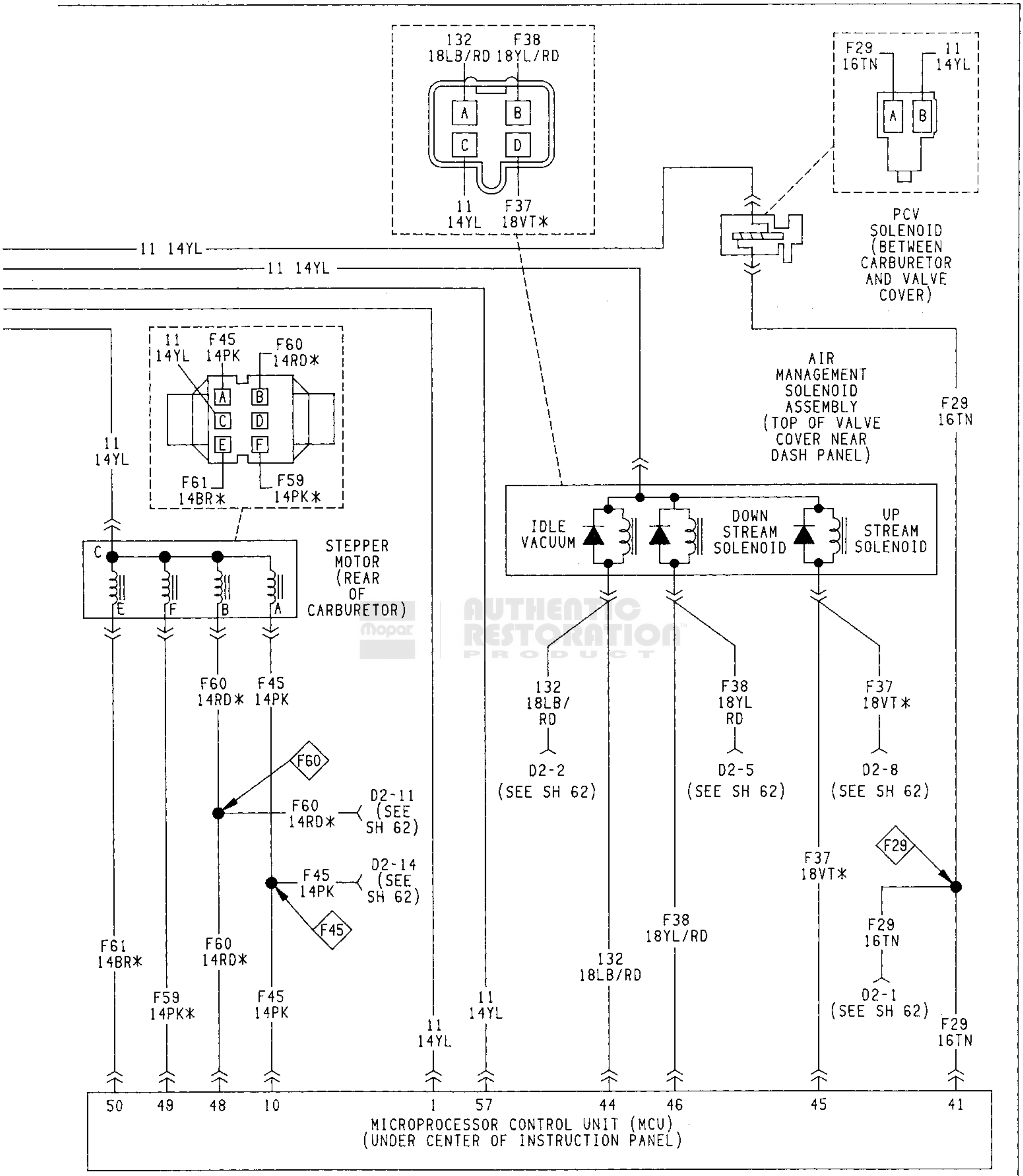
YJ 14



ELECTRONIC CONTROLS
IGNITION SYSTEM 4.2L ENGINE

YJ 15

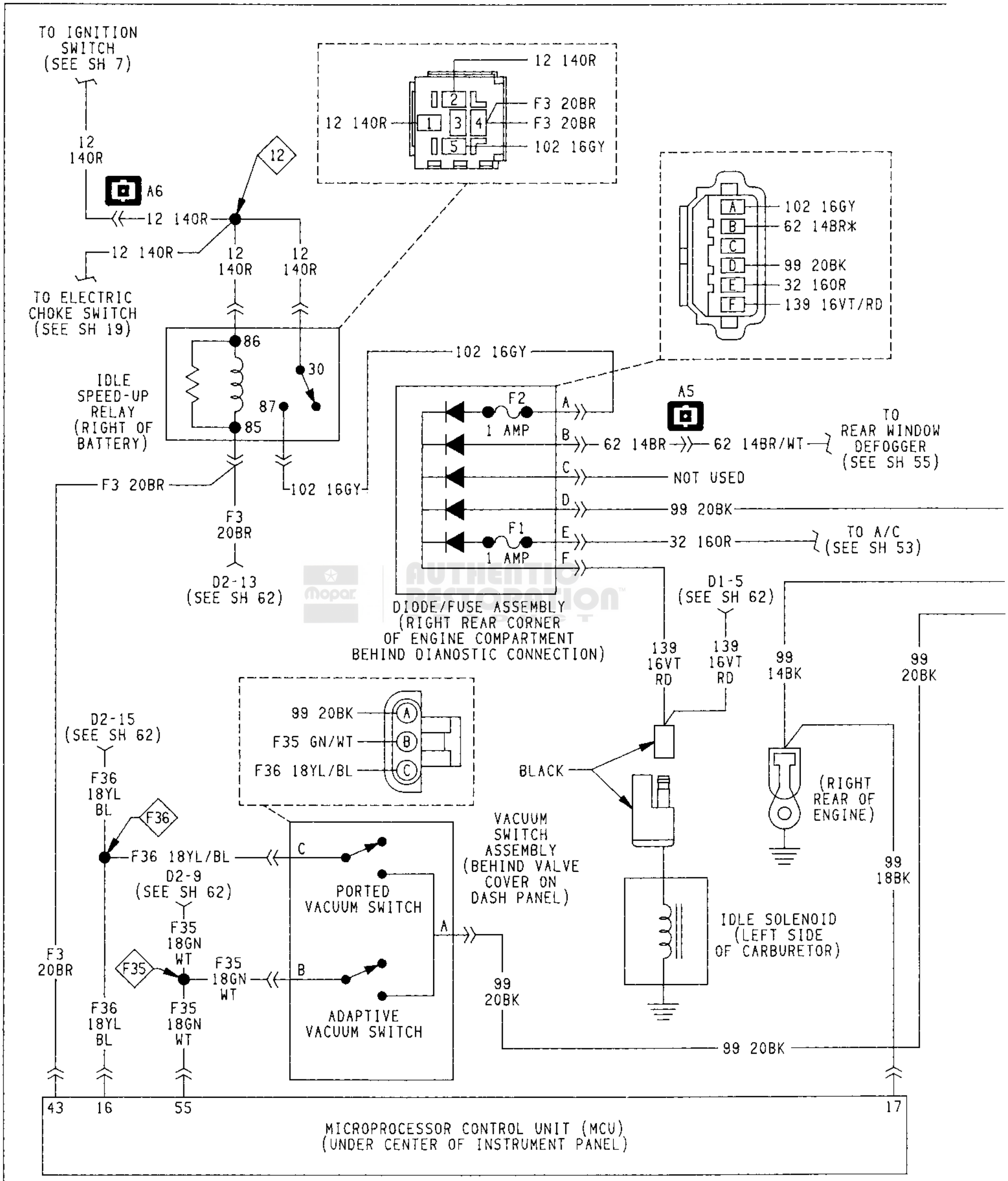
J908W-2



ELECTRONIC CONTROLS
IGNITION SYSTEM 4.2L ENGINE

J908W-2

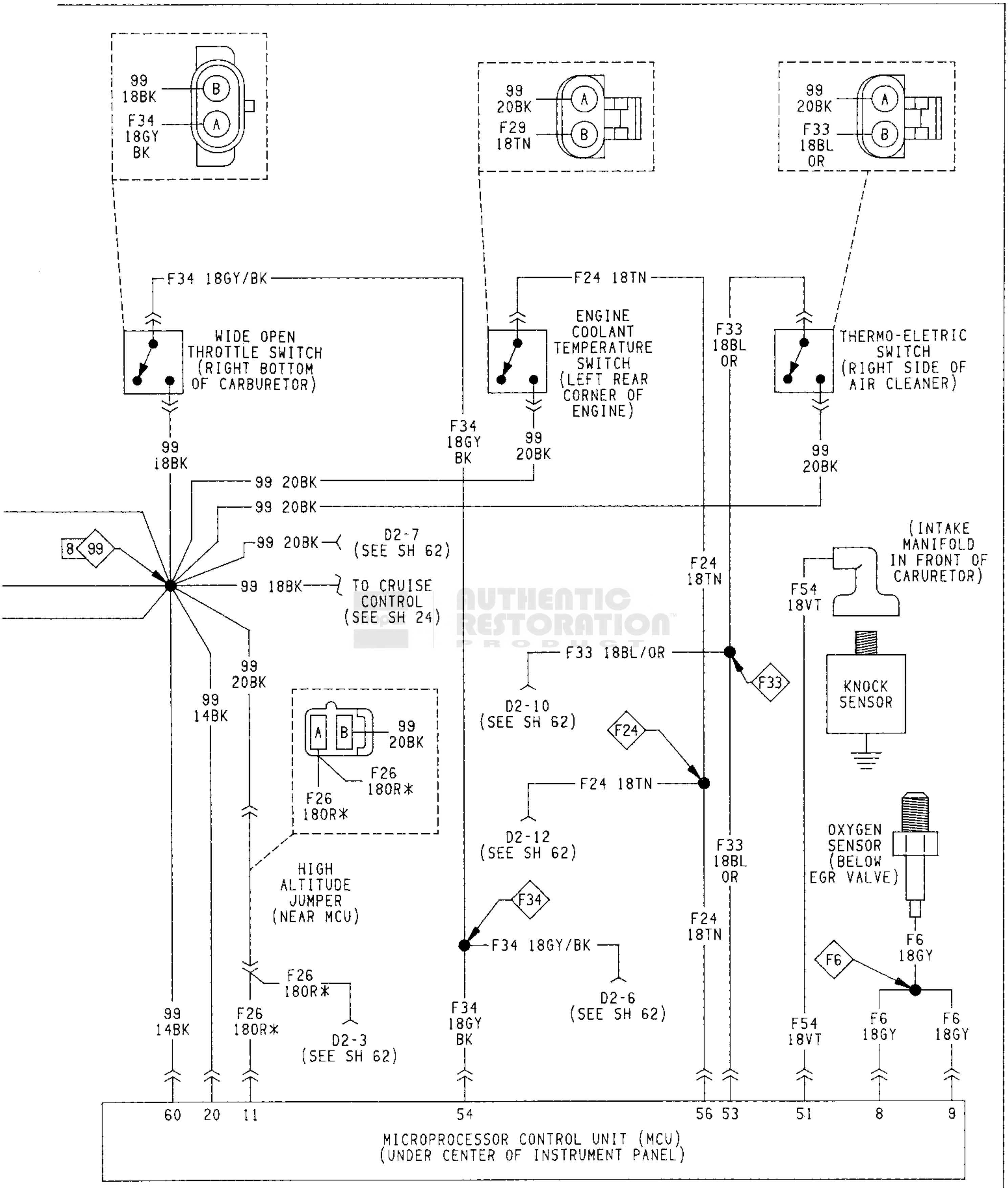
YJ 16



ELECTRONIC CONTROLS
IGNITION SYSTEM 4.2L ENGINE

YJ 17

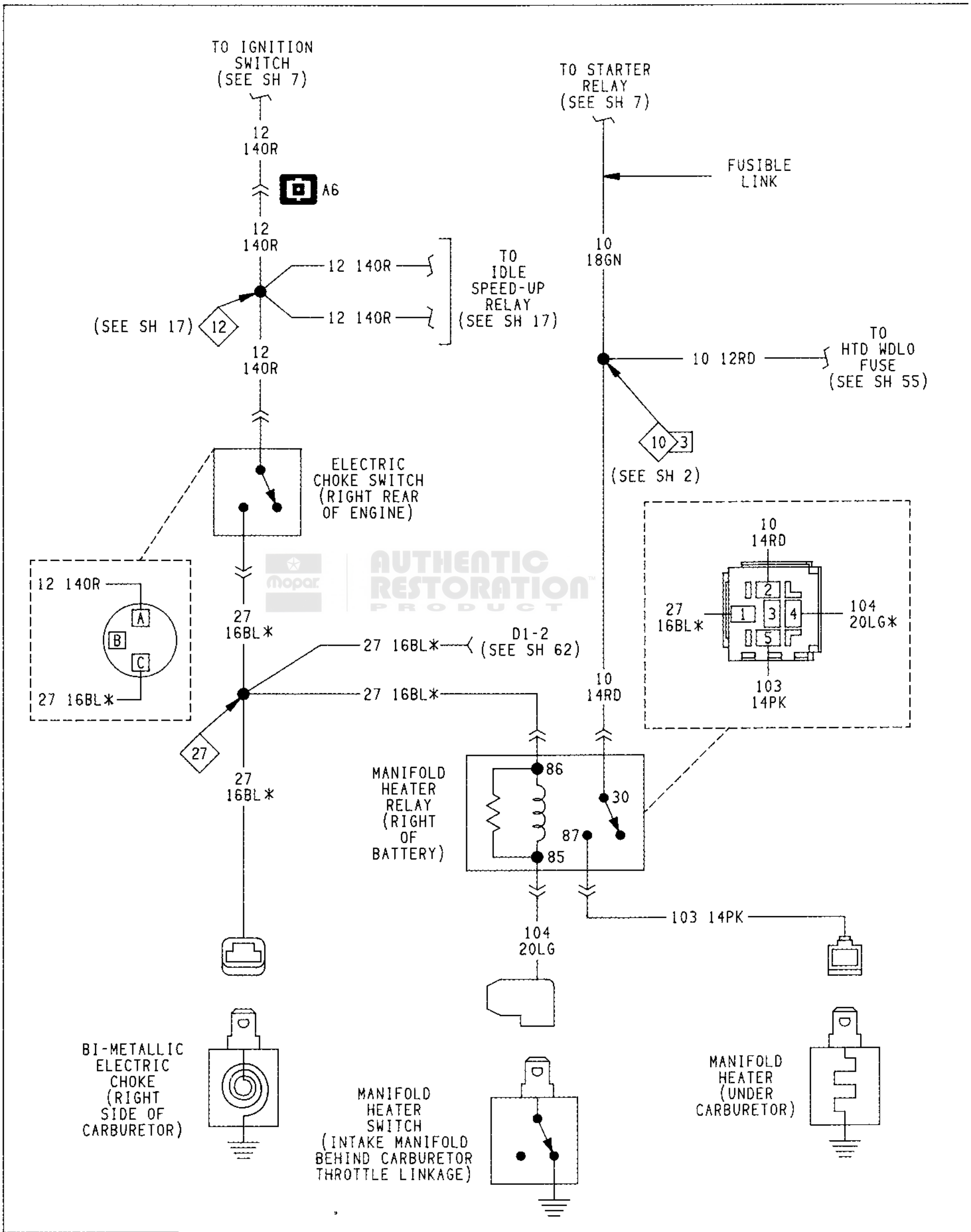
J908W-2



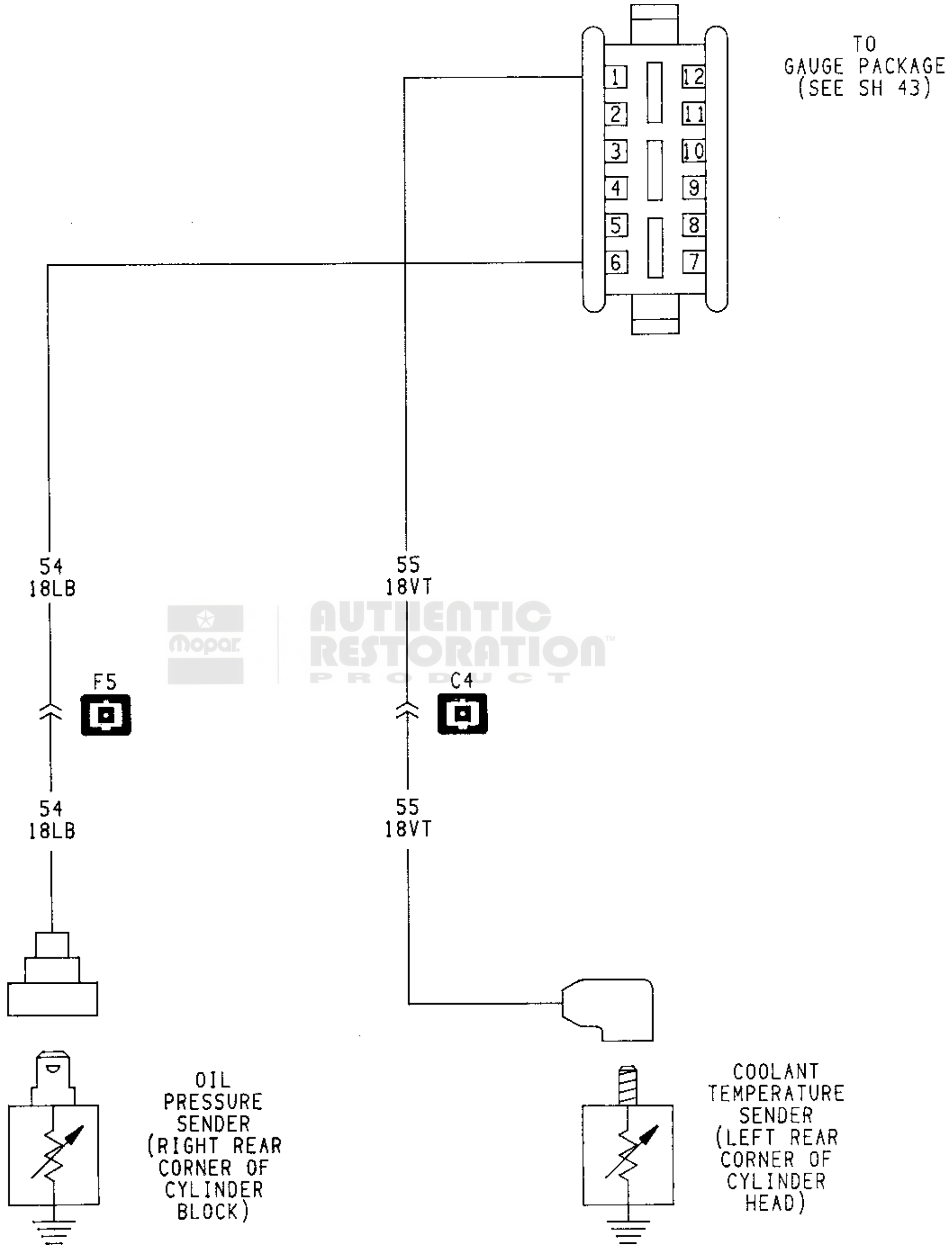
ELECTRONIC CONTROLS
IGNITION SYSTEM 4.2L ENGINE

J908W-2

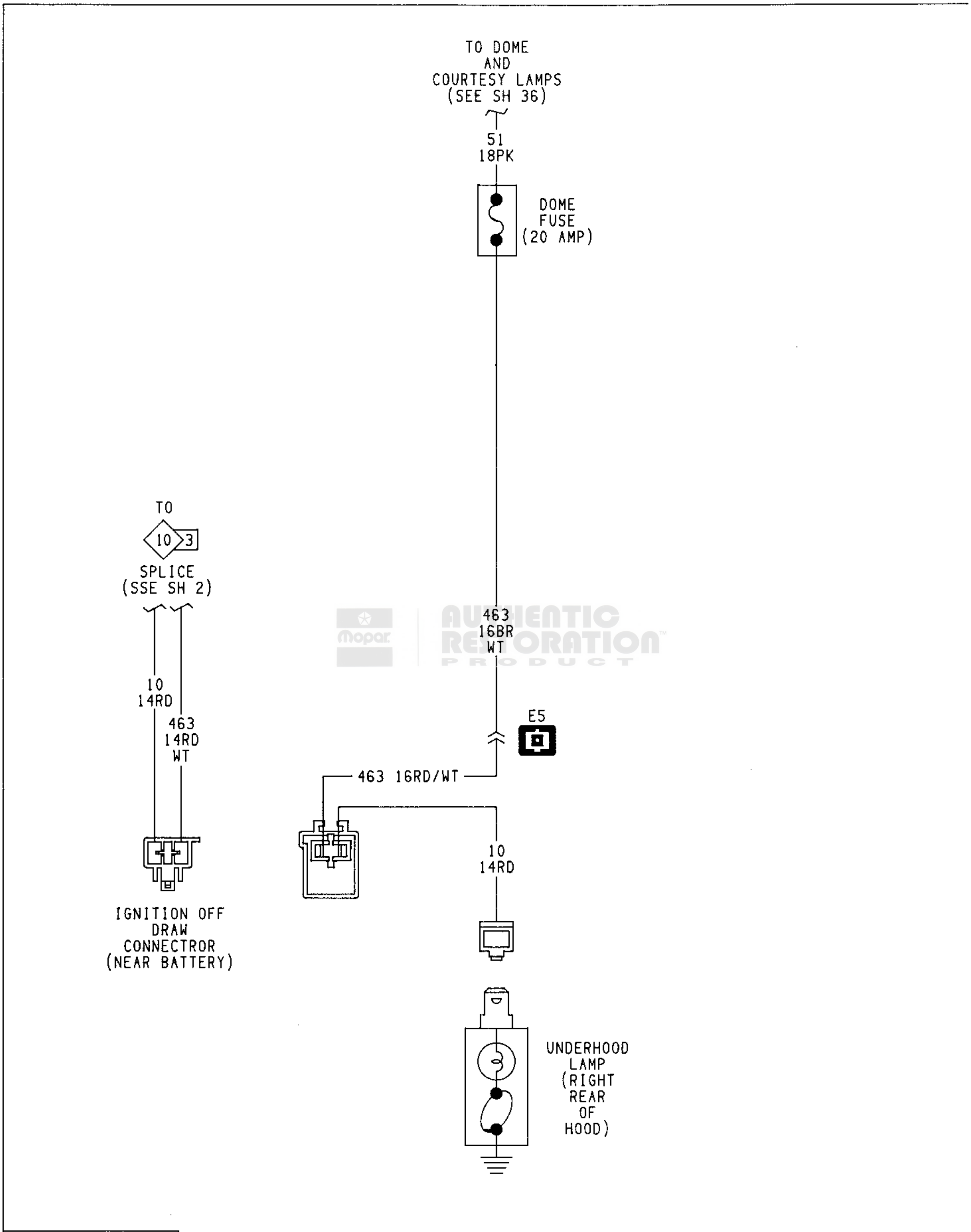
YJ 18



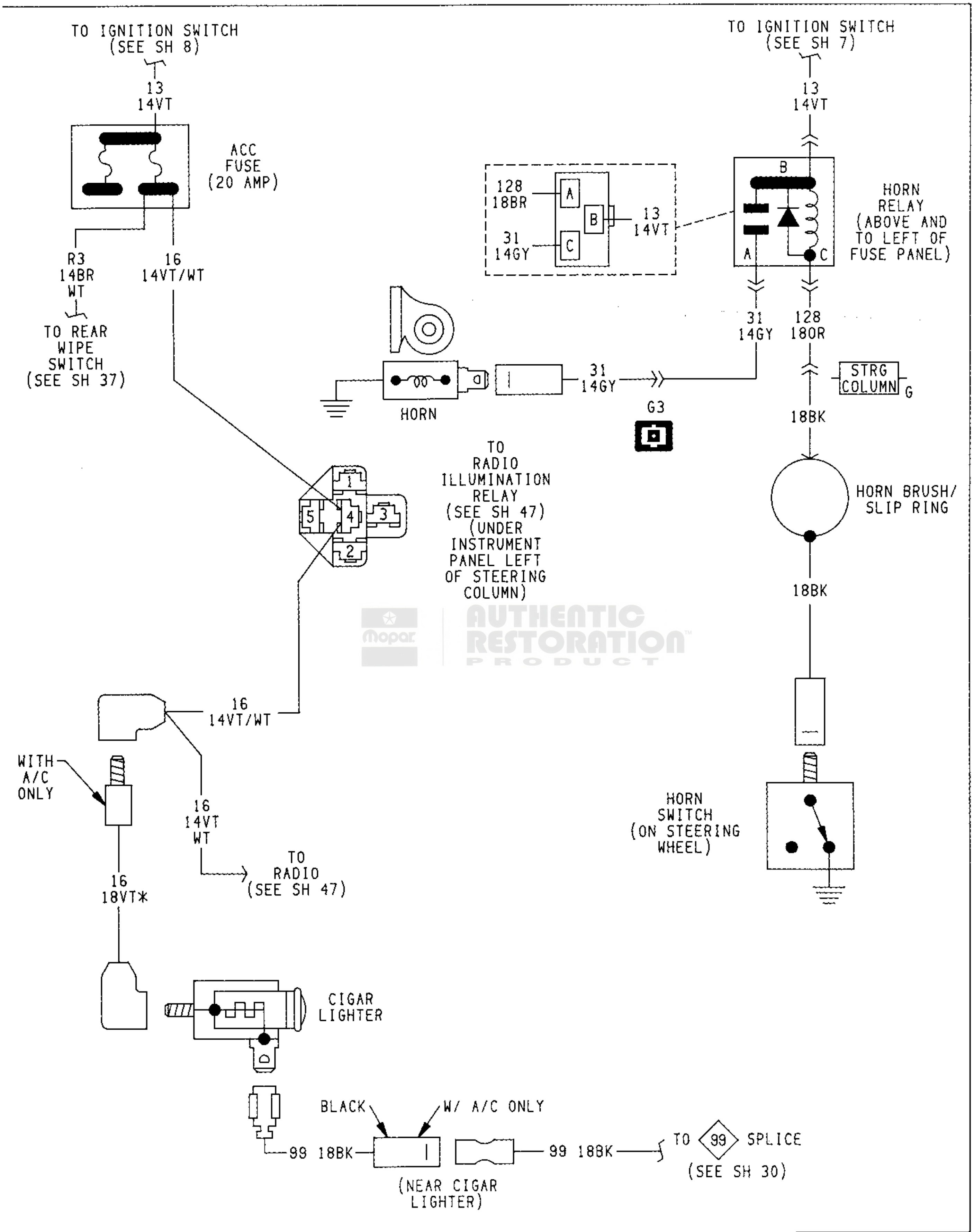
YJ 19 | CARBURETOR CIRCUITS 4.2L ENGINE | J908W-2



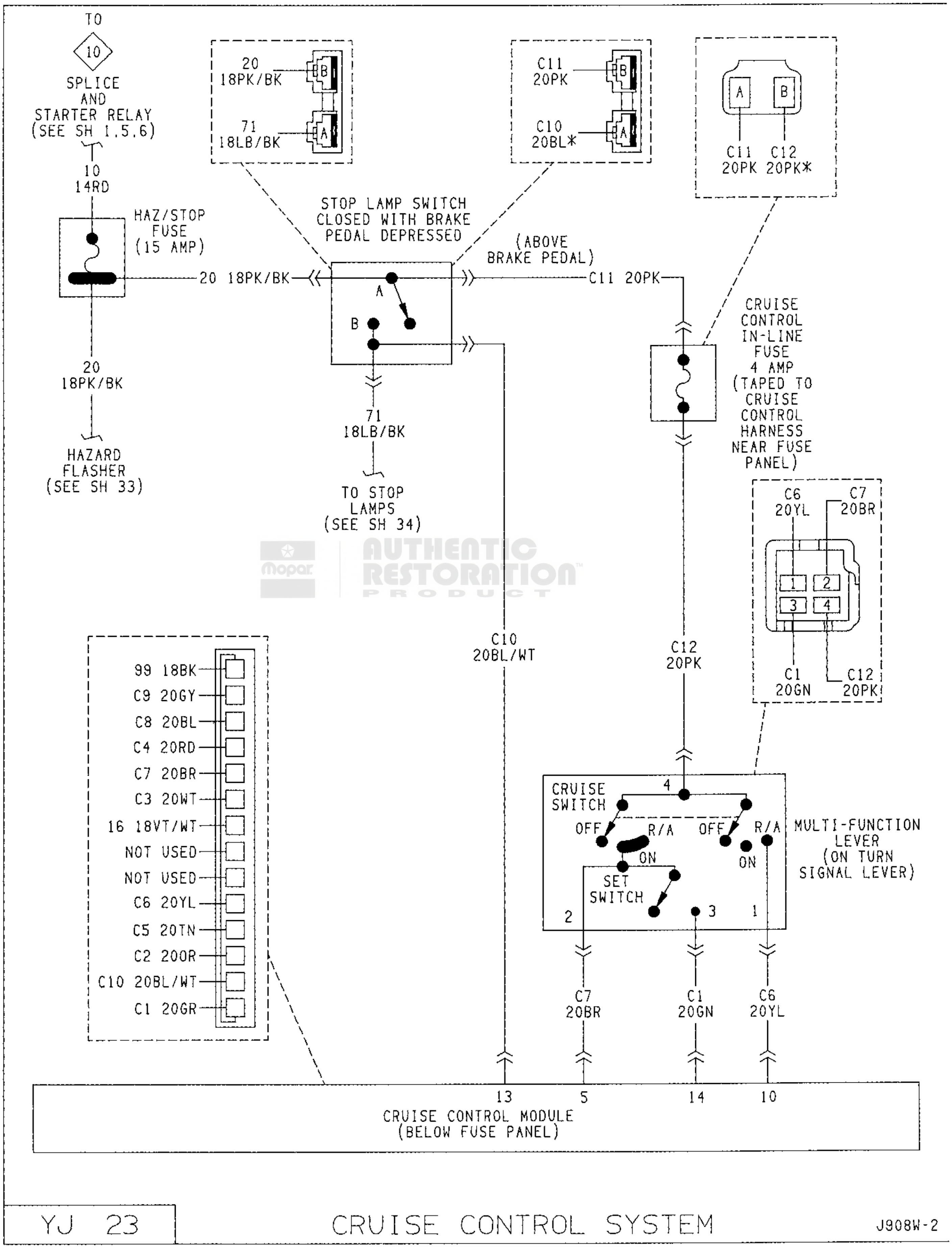
OIL PRESSURE
AND TEMPERATURE SYSTEMS

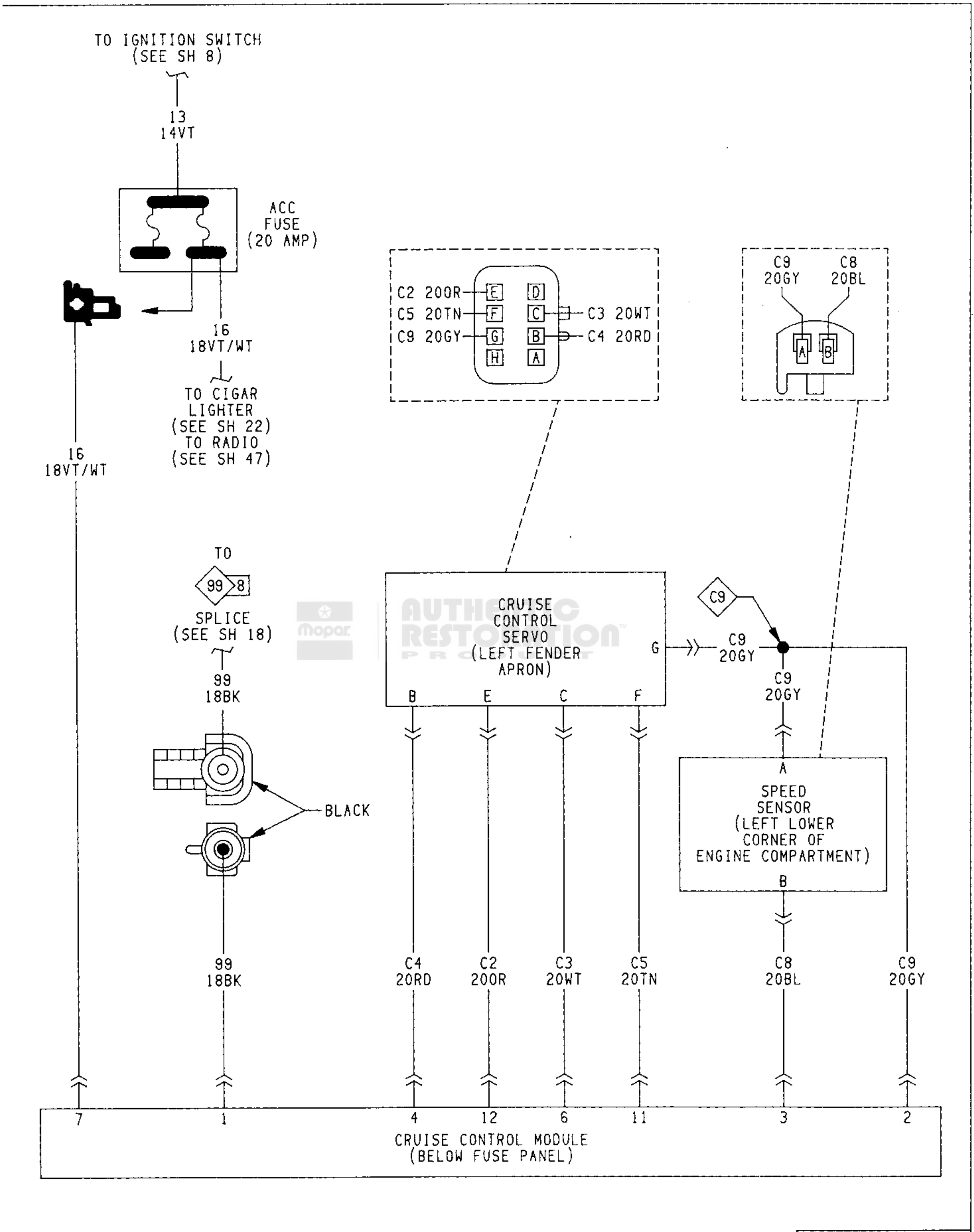


UNDERHOOD LAMP

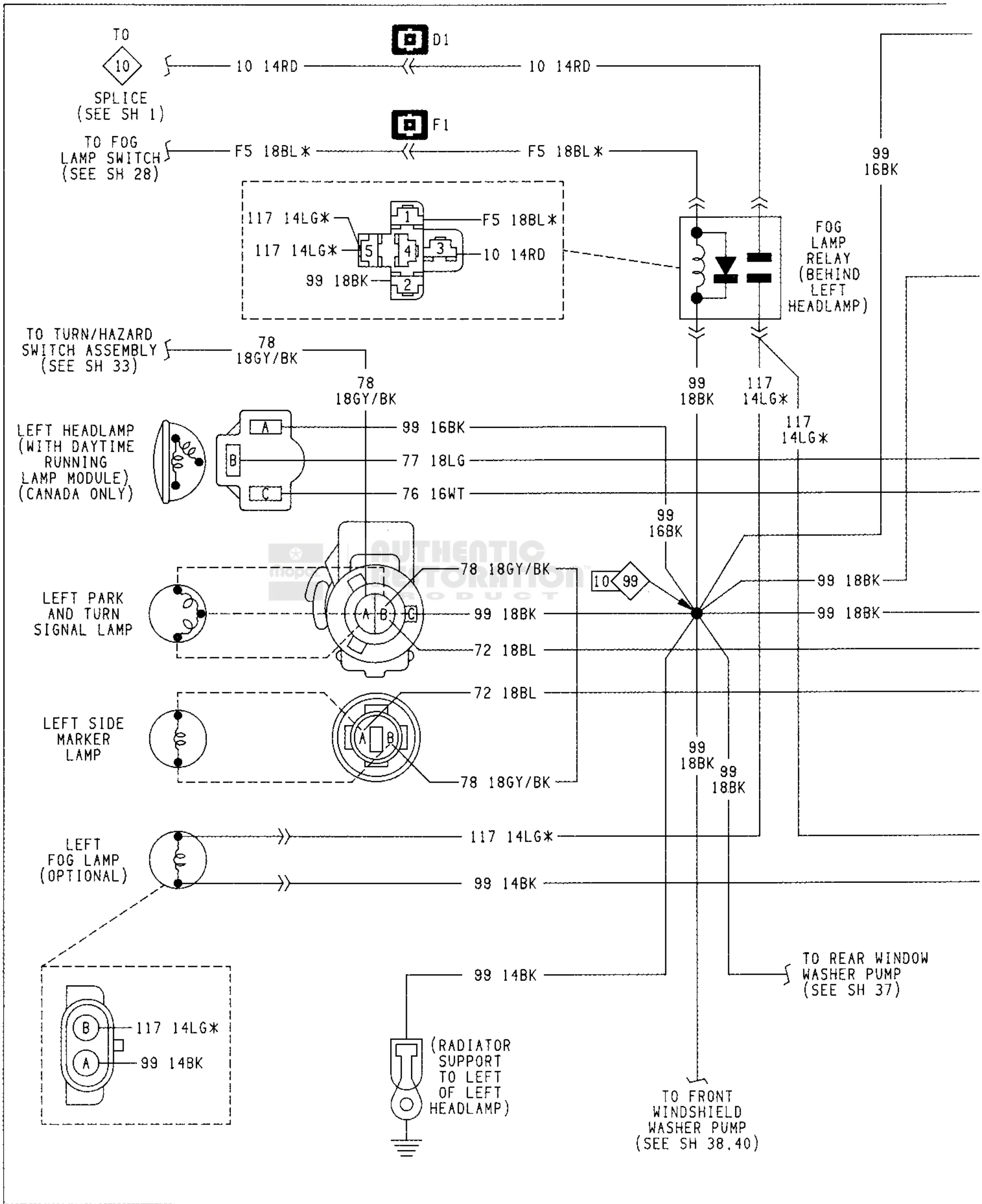


J908W-2 HORN AND CIGAR LIGHTER YJ 22


TO
10
SPLICE AND STARTER RELAY (SEE SH 1,5,6)
10 14RD
HAZ/STOP FUSE (15 AMP)
20 18PK/BK
20 18PK/BK
HAZARD FLASHER (SEE SH 33)
20 18PK/BK
71 18LB/BK
B
A
STOP LAMP SWITCH CLOSED WITH BRAKE PEDAL DEPRESSED
A
B
71 18LB/BK
TO STOP LAMPS (SEE SH 34)
C11 20PK
C10 20BL*
B
A
(ABOVE BRAKE PEDAL)
C11 20PK
C10 20BL/WT
A
B
C11 20PK
C12 20PK*
CRUISE CONTROL IN-LINE FUSE 4 AMP (TAPED TO CRUISE CONTROL HARNESS NEAR FUSE PANEL)
C12 20PK
C6 20YL
C7 20BR
1
2
3
4
C1 20GN
C12 20PK
99 18BK
C9 20GY
C8 20BL
C4 20RD
C7 20BR
C3 20WT
16 18VT/WT
NOT USED
NOT USED
C6 20YL
C5 20TN
C2 20OR
C10 20BL/WT
C1 20GR
CRUISE SWITCH
4
OFF
R/A
ON
OFF
R/A
ON
SET SWITCH
2
3
1
MULTI-FUNCTION LEVER (ON TURN SIGNAL LEVER)
C7 20BR
C1 20GN
C6 20YL
13
5
14
10
CRUISE CONTROL MODULE (BELOW FUSE PANEL)
YJ 23
CRUISE CONTROL SYSTEM
J908W-2



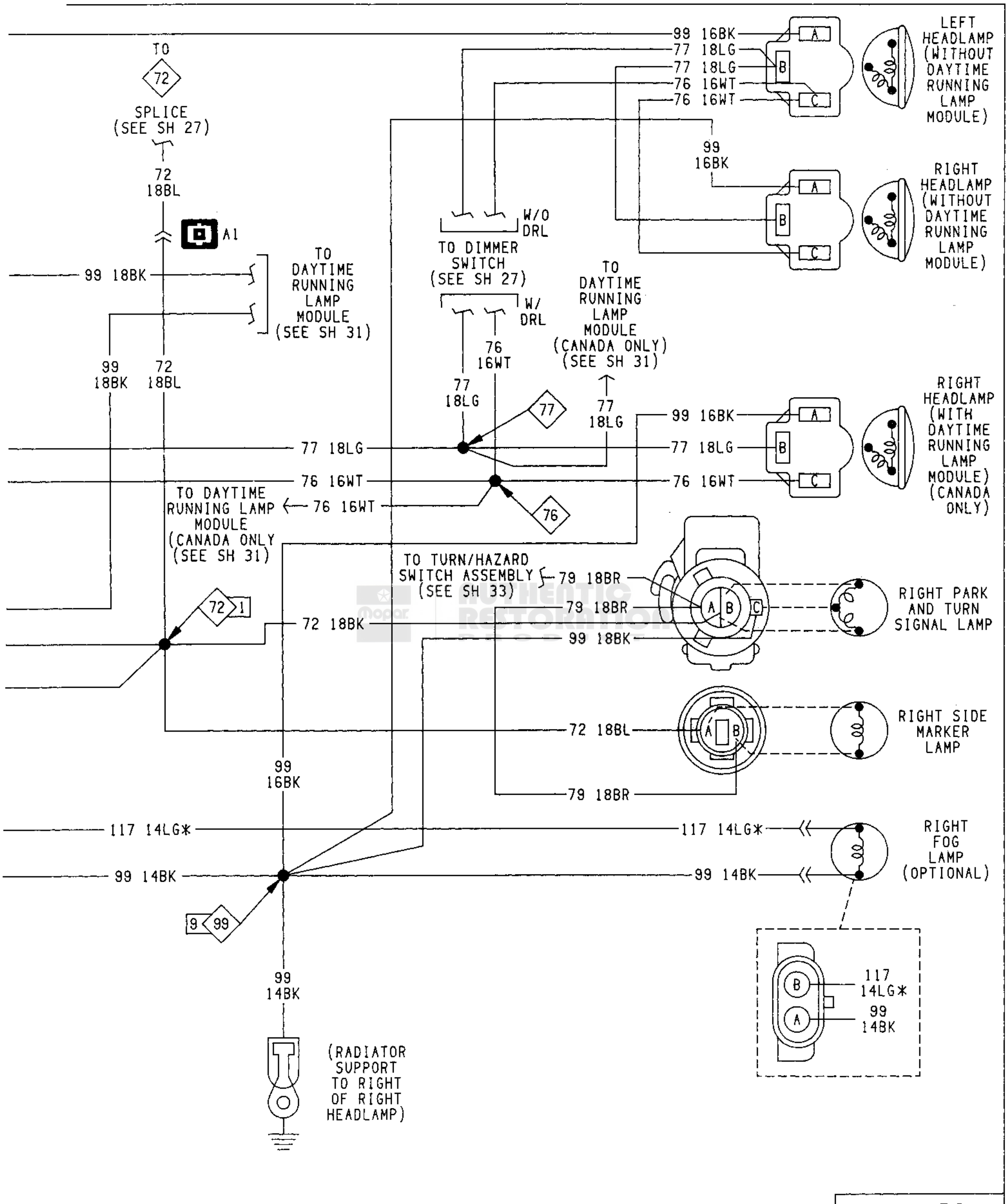
J908W-2 CRUISE CONTROL SYSTEM YJ 24



YJ 25

FRONT END LIGHTING

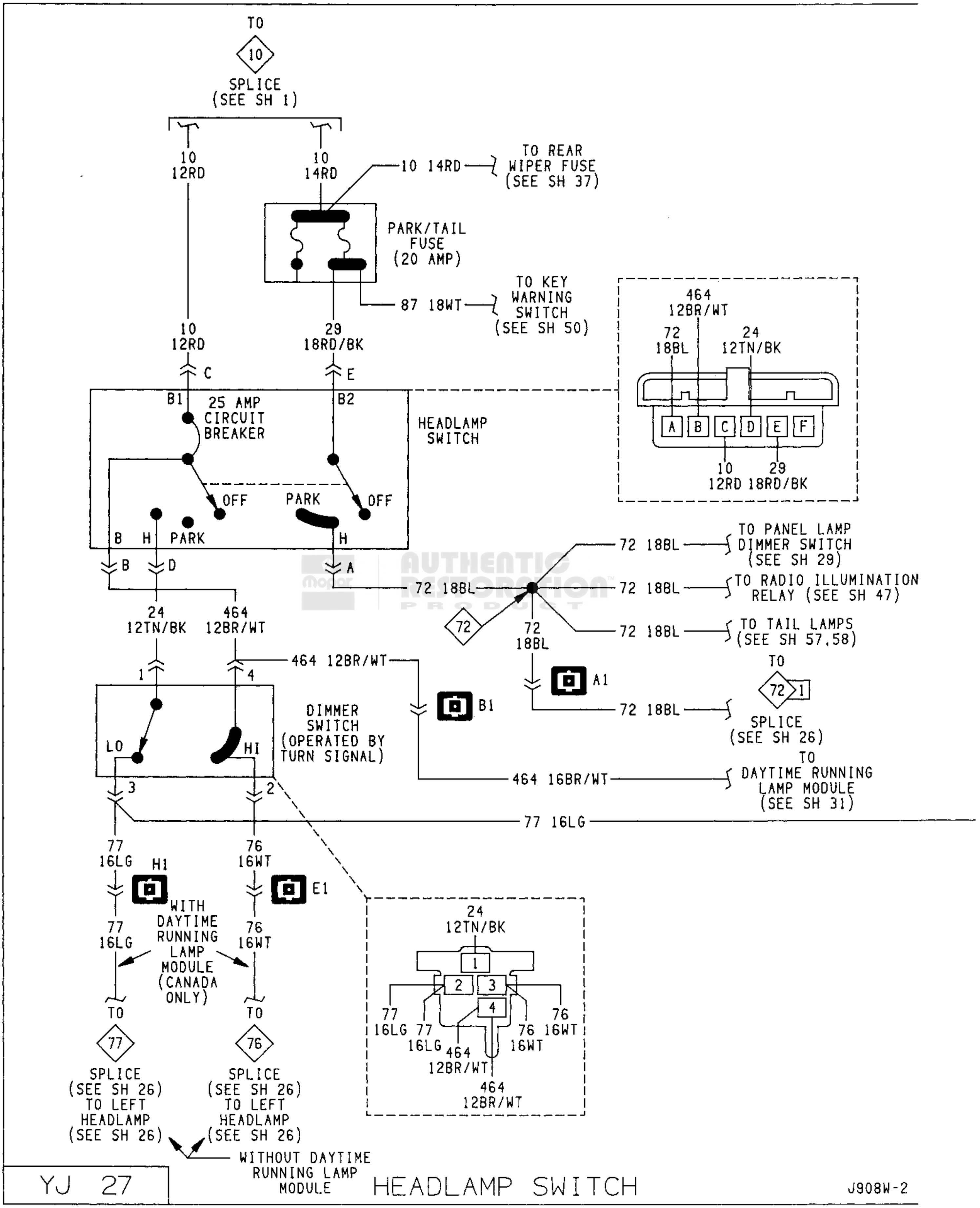
J908W-2



J908W-2

FRONT END LIGHTING

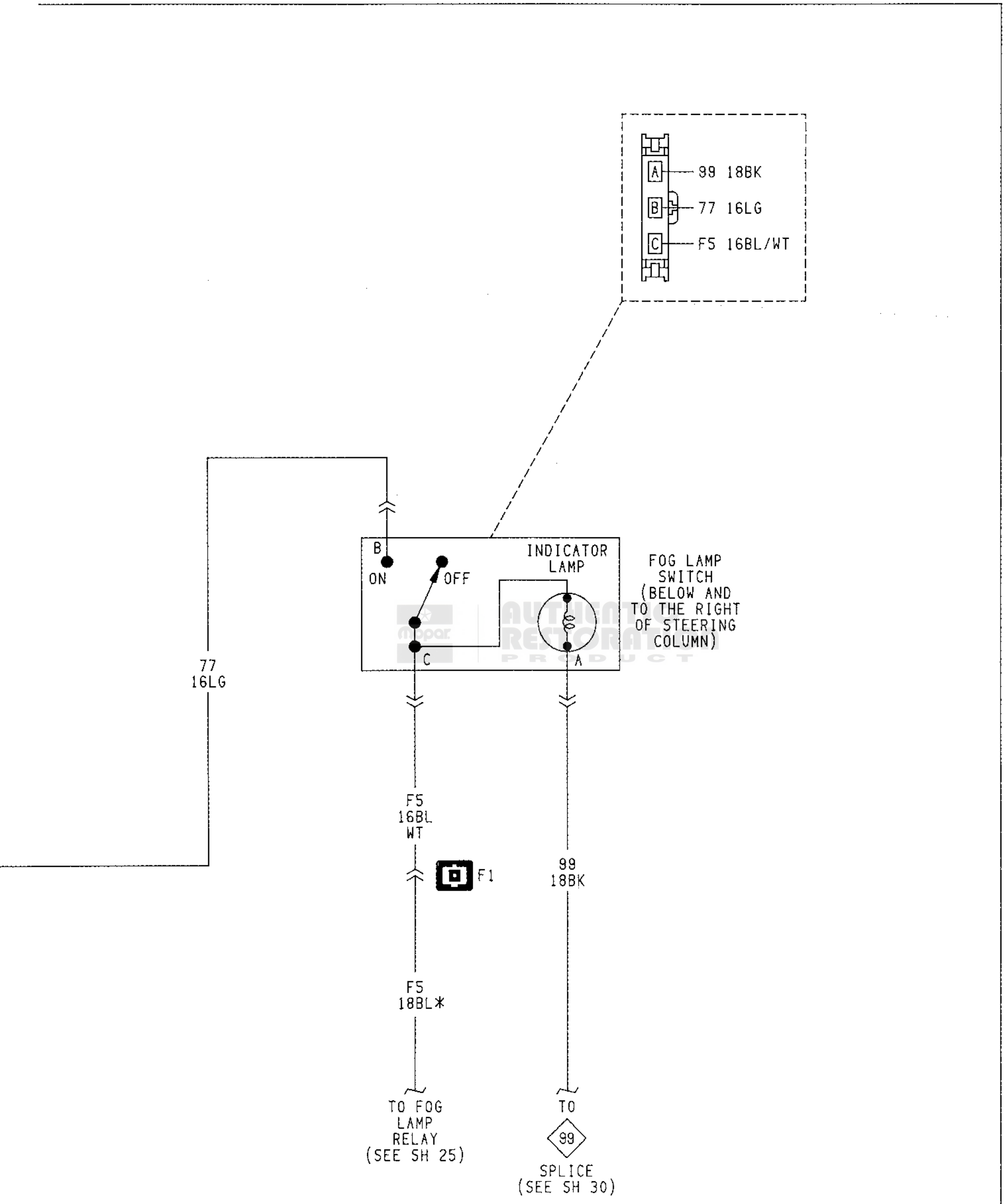
YJ 26



YJ 27

HEADLAMP SWITCH

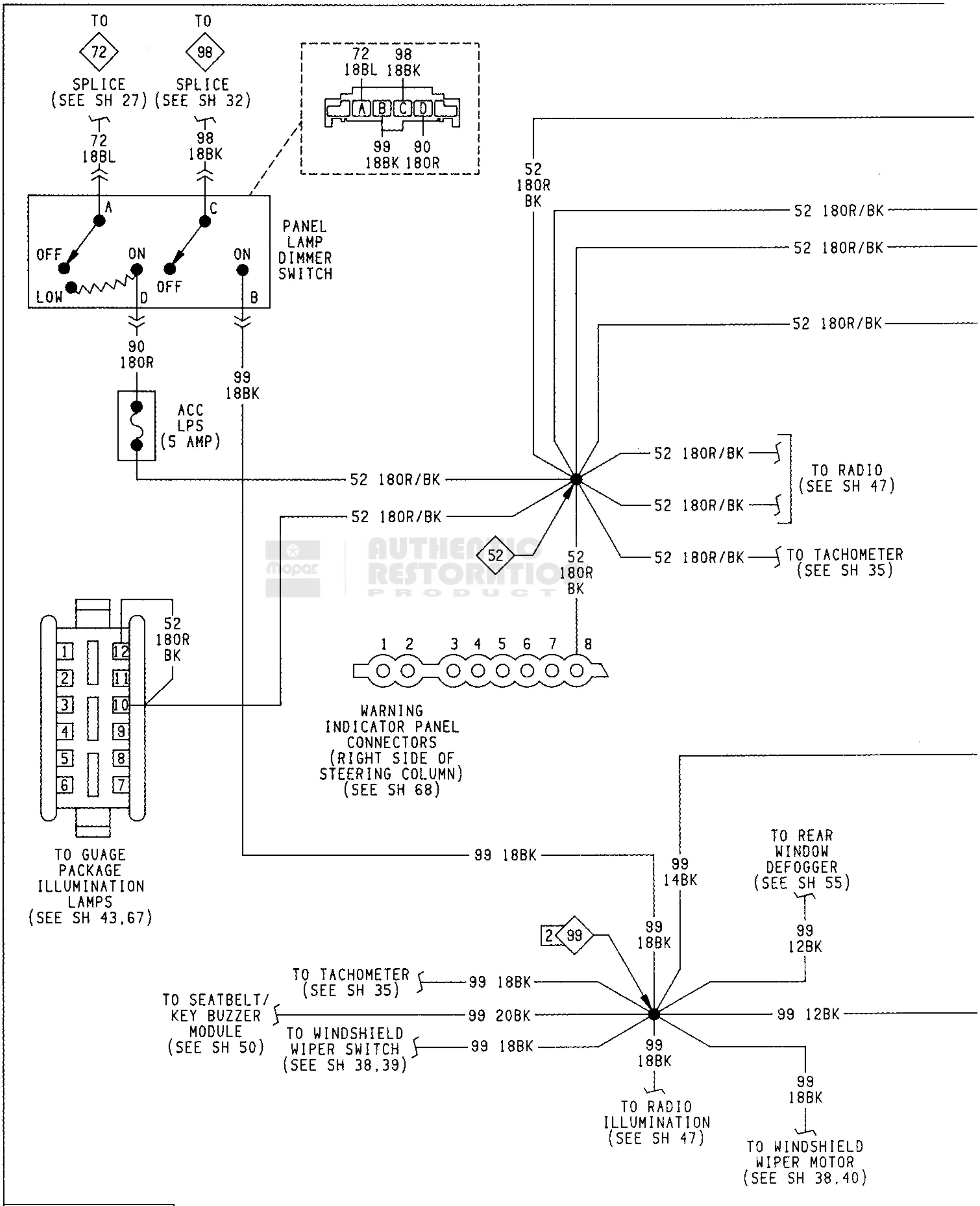
J908W-2



J908W-2

FOG LAMP SWITCH

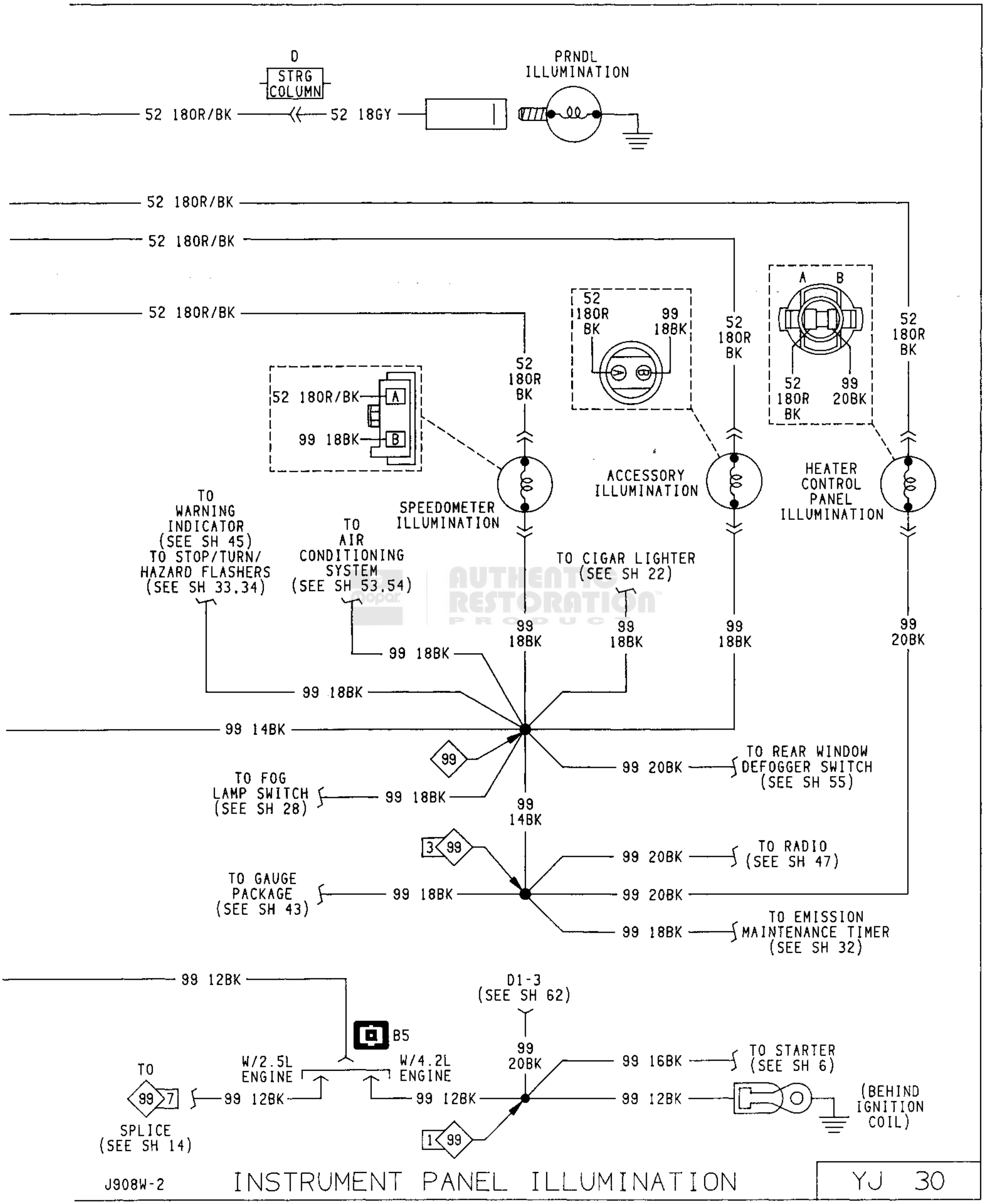
YJ 28



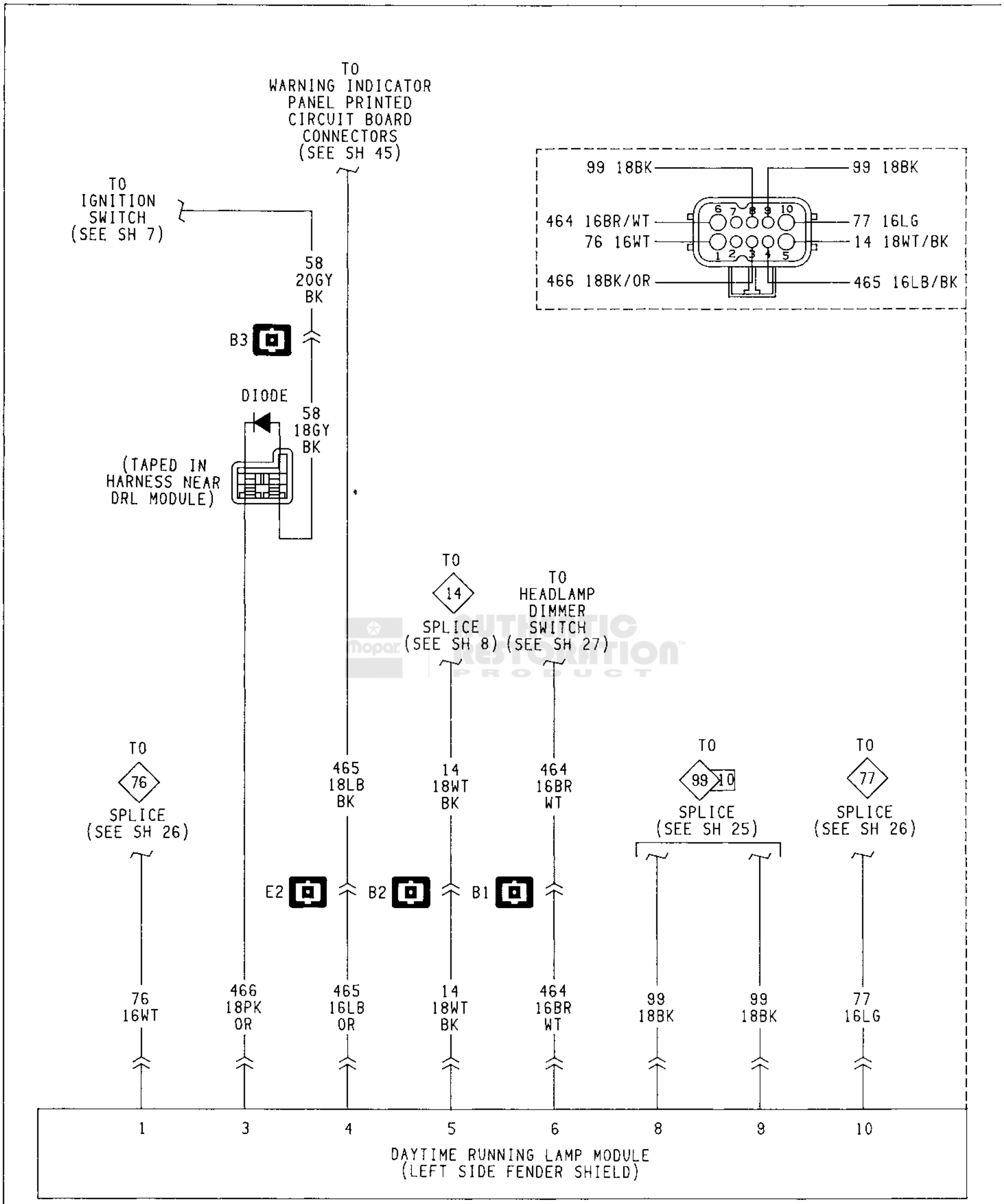
YJ 29

PANEL LAMP DIMMER SWITCH

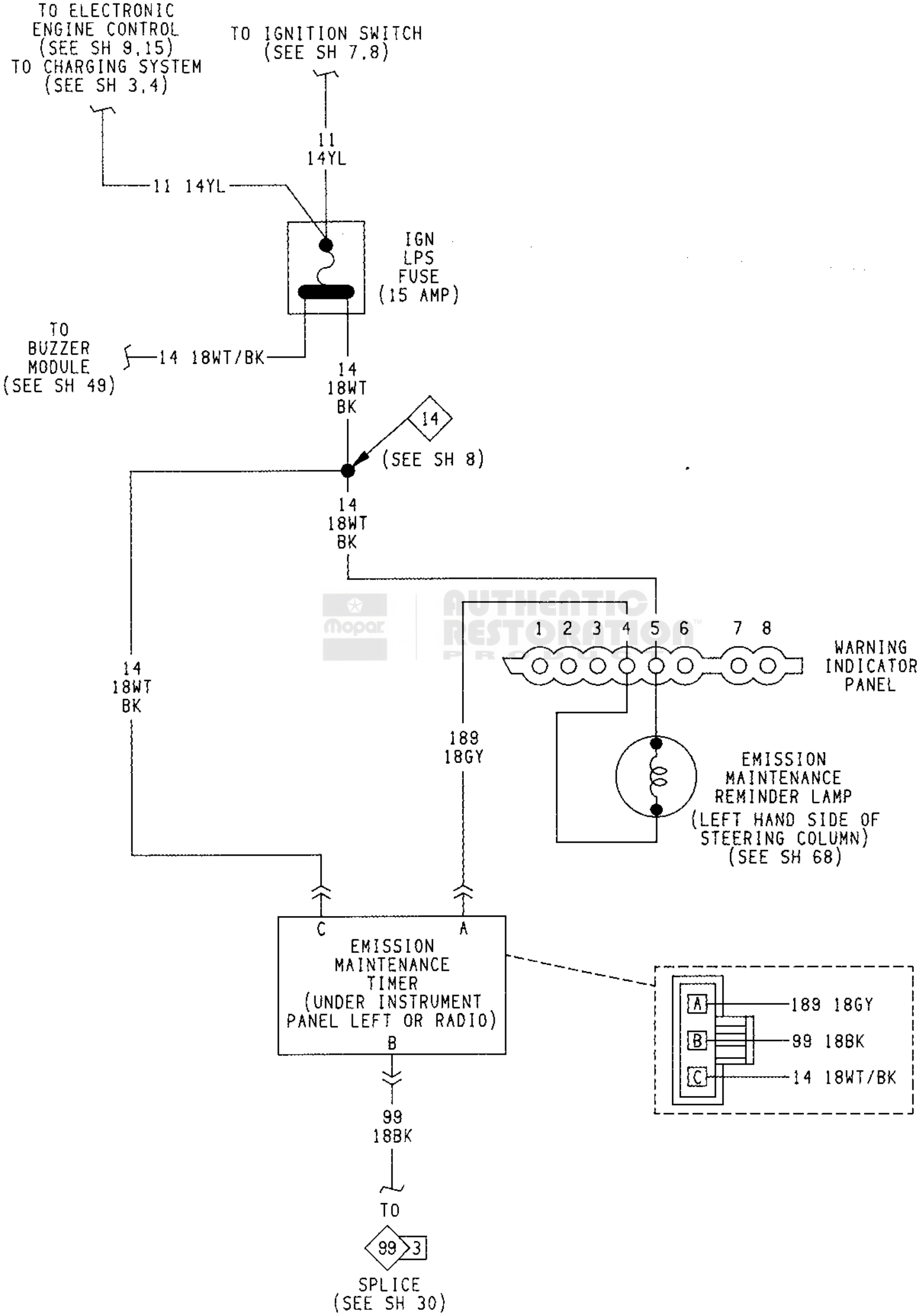
J908W-2

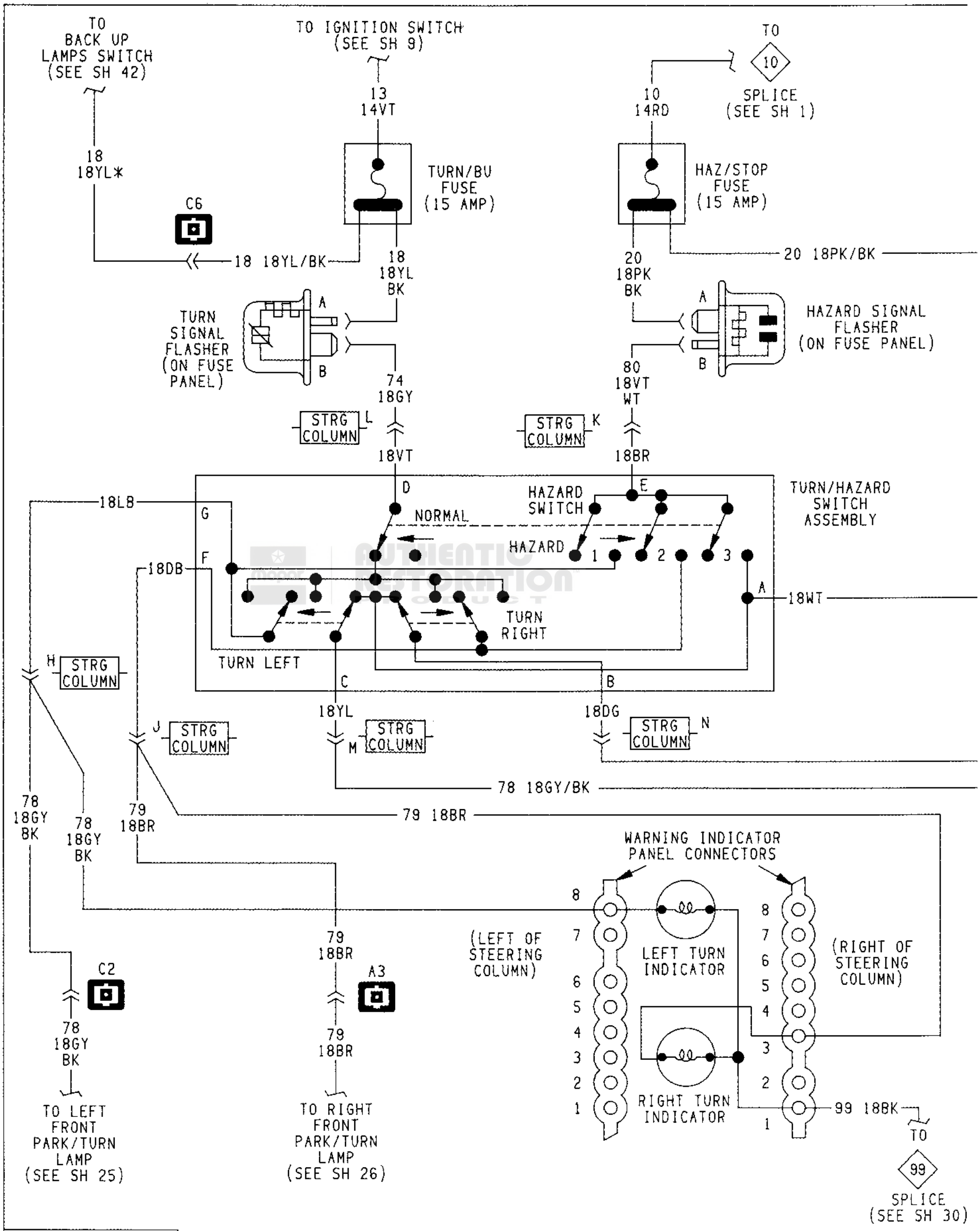


J908W-2 INSTRUMENT PANEL ILLUMINATION YJ 30

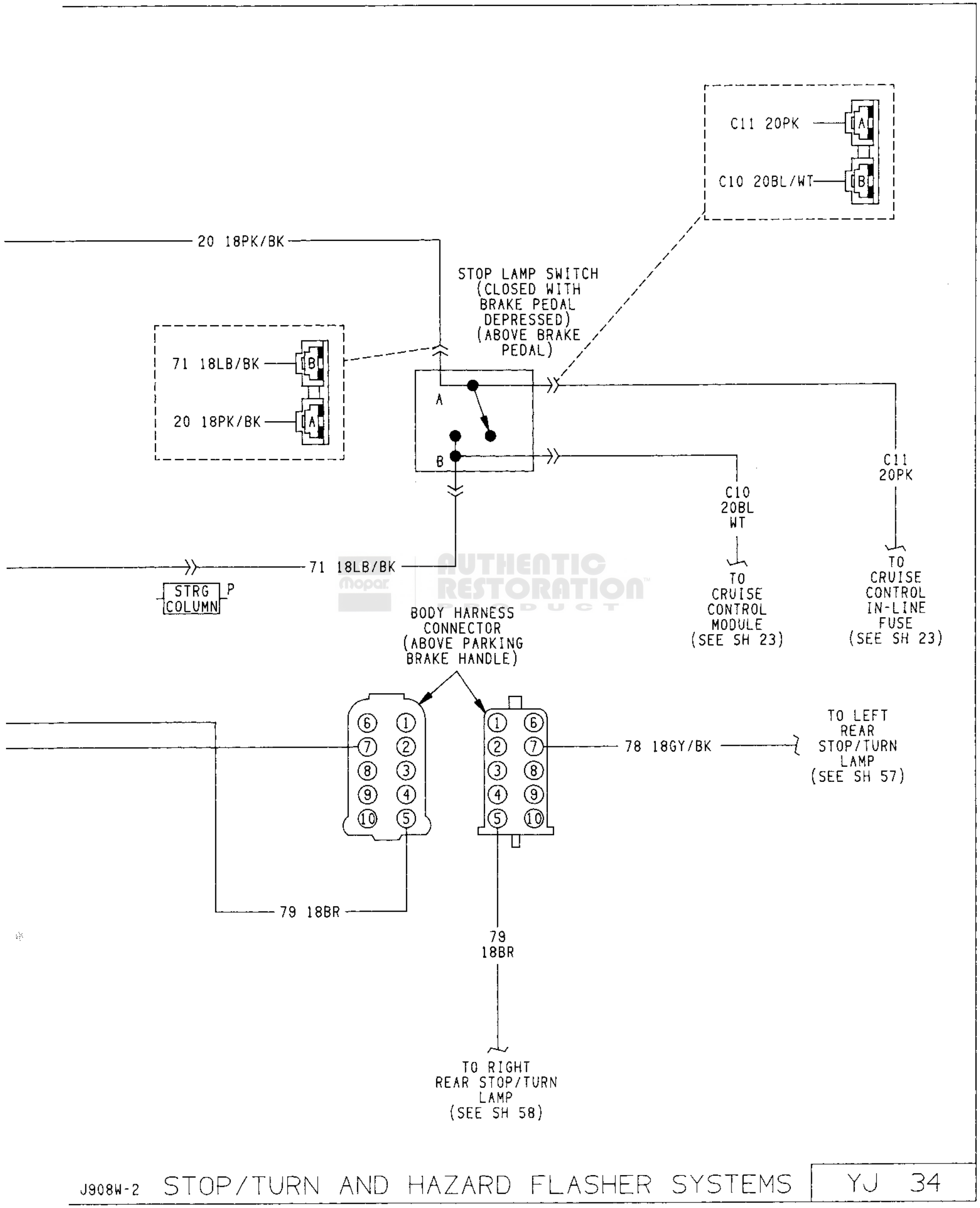


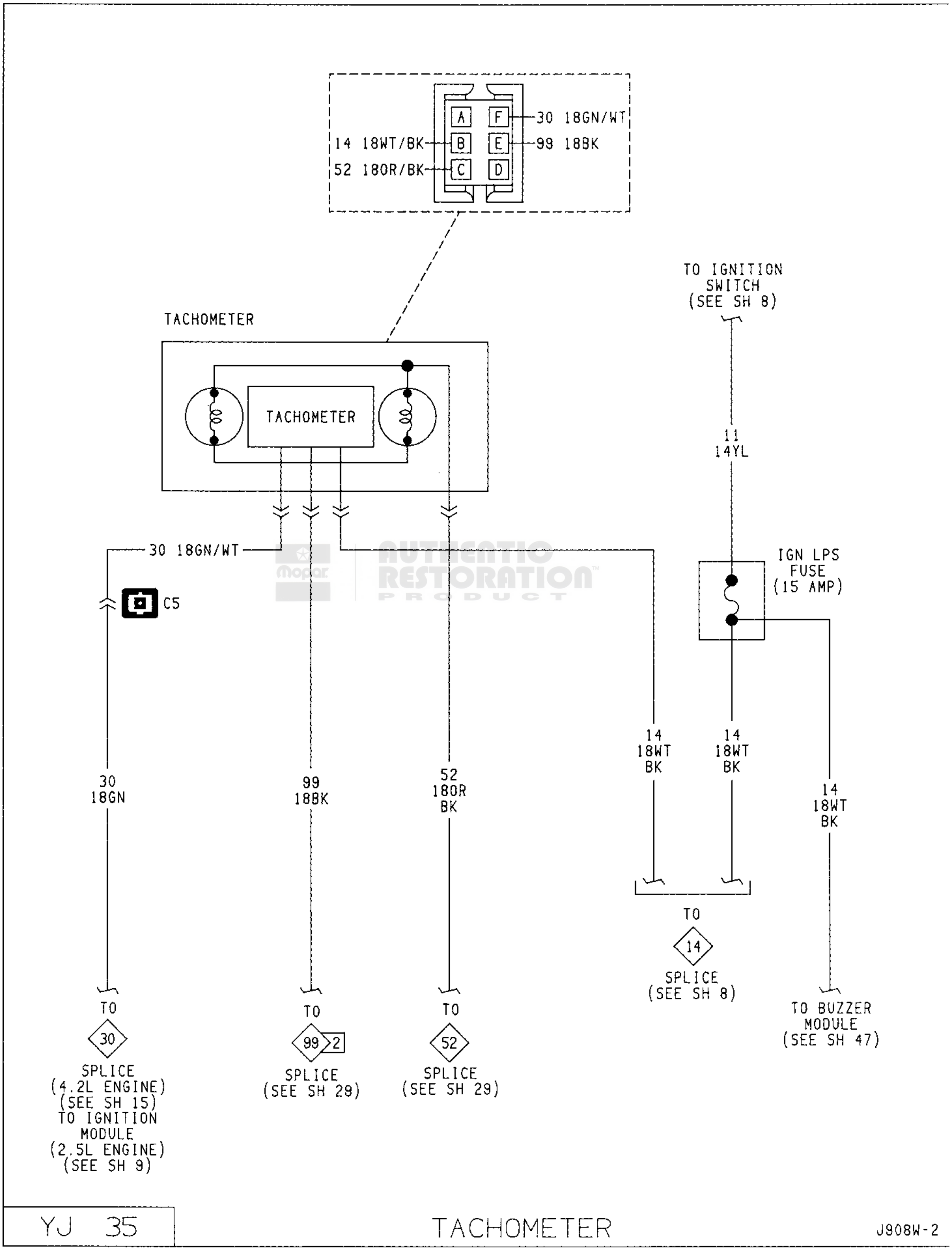
YJ 31 DAYTIME RUNNING LAMP MODULE SYSTEM J908W-2


TO ELECTRONIC ENGINE CONTROL (SEE SH 9,15) TO CHARGING SYSTEM (SEE SH 3,4)
TO IGNITION SWITCH (SEE SH 7,8)
11 14YL
11 14YL
IGN LPS FUSE (15 AMP)
TO BUZZER MODULE (SEE SH 49)
14 18WT/BK
14 18WT BK
14
(SEE SH 8)
14 18WT BK
14 18WT BK
1 2 3 4 5 6 7 8
WARNING INDICATOR PANEL
189 18GY
EMISSION MAINTENANCE REMINDER LAMP (LEFT HAND SIDE OF STEERING COLUMN) (SEE SH 68)
C
A
EMISSION MAINTENANCE TIMER (UNDER INSTRUMENT PANEL LEFT OR RADIO)
B
A 189 18GY
B 99 18BK
C 14 18WT/BK
99 18BK
TO
99 3
SPLICE (SEE SH 30)

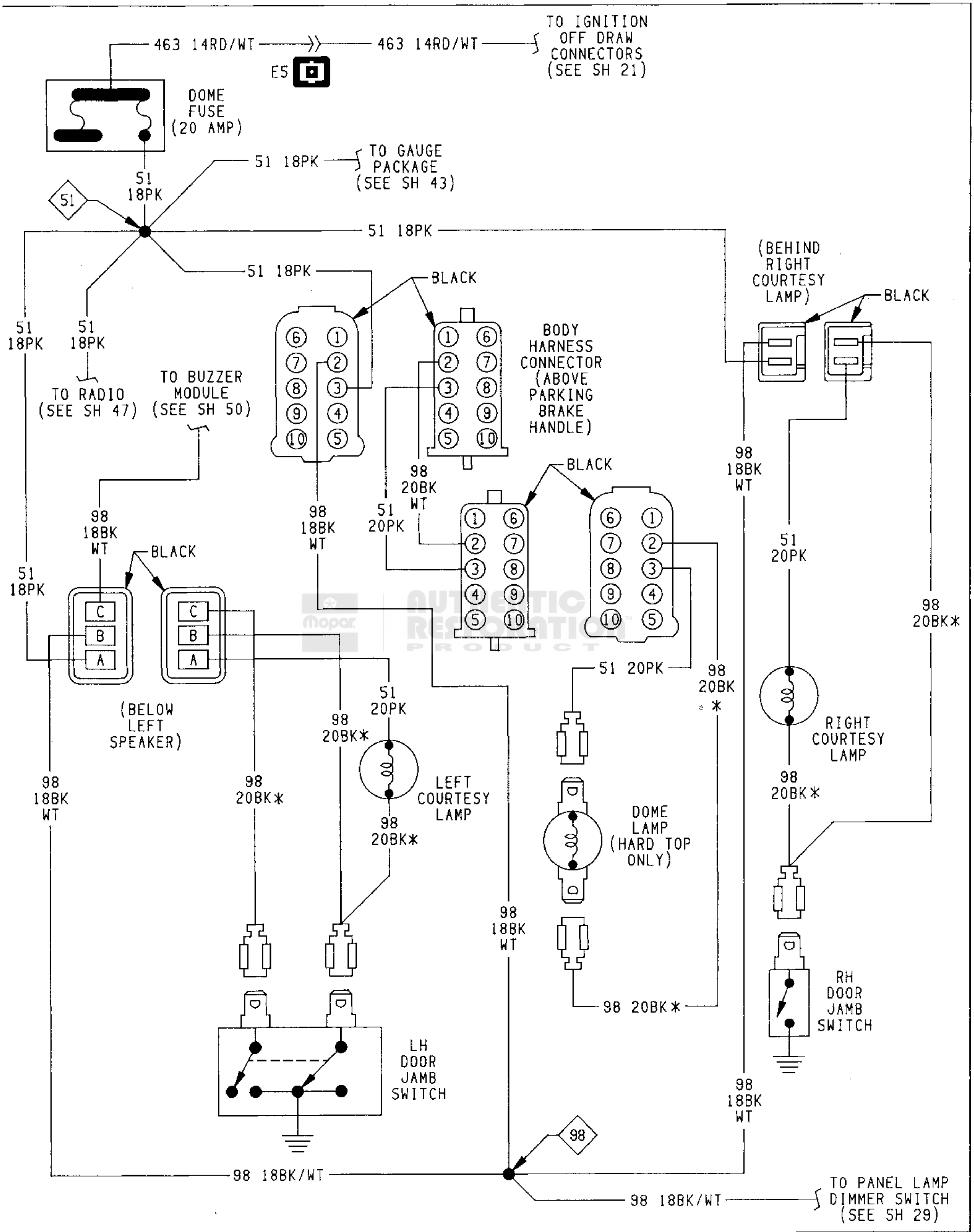


YJ 33 STOP/TURN AND HAZARD FLASHER SYSTEMS J908W-2

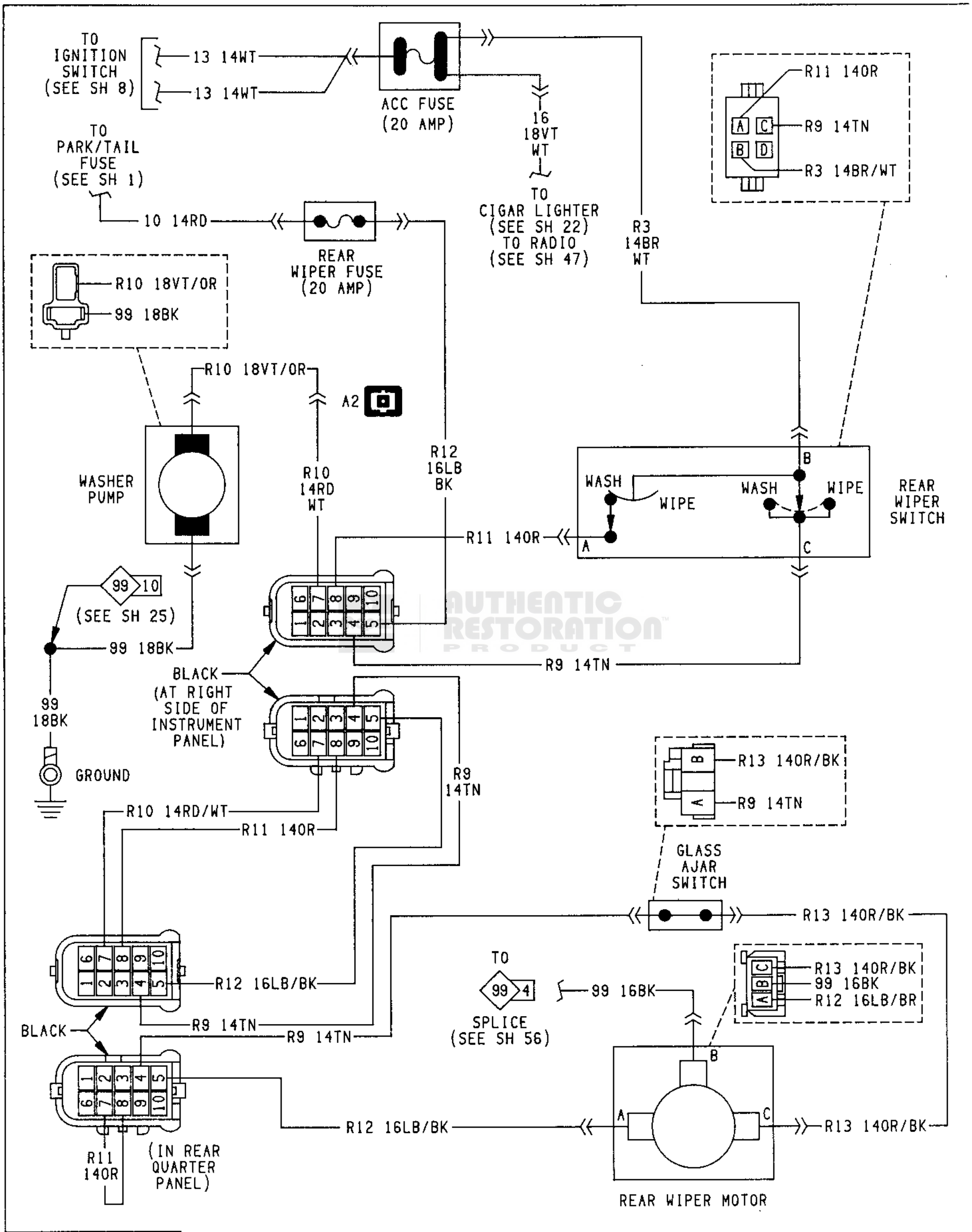

C11 20PK
A
C10 20BL/WT
B
20 18PK/BK
STOP LAMP SWITCH (CLOSED WITH BRAKE PEDAL DEPRESSED) (ABOVE BRAKE PEDAL)
71 18LB/BK
B
20 18PK/BK
A
A
B
C11 20PK
C10 20BL WT
71 18LB/BK
STRG COLUMN
P
TO CRUISE CONTROL MODULE (SEE SH 23)
TO CRUISE CONTROL IN-LINE FUSE (SEE SH 23)
BODY HARNESS CONNECTOR (ABOVE PARKING BRAKE HANDLE)
⑥ ①
⑦ ②
⑧ ③
⑨ ④
⑩ ⑤
① ⑥
② ⑦
③ ⑧
④ ⑨
⑤ ⑩
78 18GY/BK
TO LEFT REAR STOP/TURN LAMP (SEE SH 57)
79 18BR
79 18BR
TO RIGHT REAR STOP/TURN LAMP (SEE SH 58)



A
F
30 18GN/WT
14 18WT/BK
B
E
99 18BK
52 18OR/BK
C
D
TO IGNITION SWITCH (SEE SH 8)
TACHOMETER
TACHOMETER
11
14YL
30 18GN/WT
IGN LPS FUSE (15 AMP)
C5
14
18WT
BK
14
18WT
BK
30
18GN
99
18BK
52
18OR
BK
14
18WT
BK
TO
14
SPLICE (SEE SH 8)
TO BUZZER MODULE (SEE SH 47)
TO
30
SPLICE (4.2L ENGINE) (SEE SH 15) TO IGNITION MODULE (2.5L ENGINE) (SEE SH 9)
TO
99
2
SPLICE (SEE SH 29)
TO
52
SPLICE (SEE SH 29)
YJ 35
TACHOMETER
J908W-2



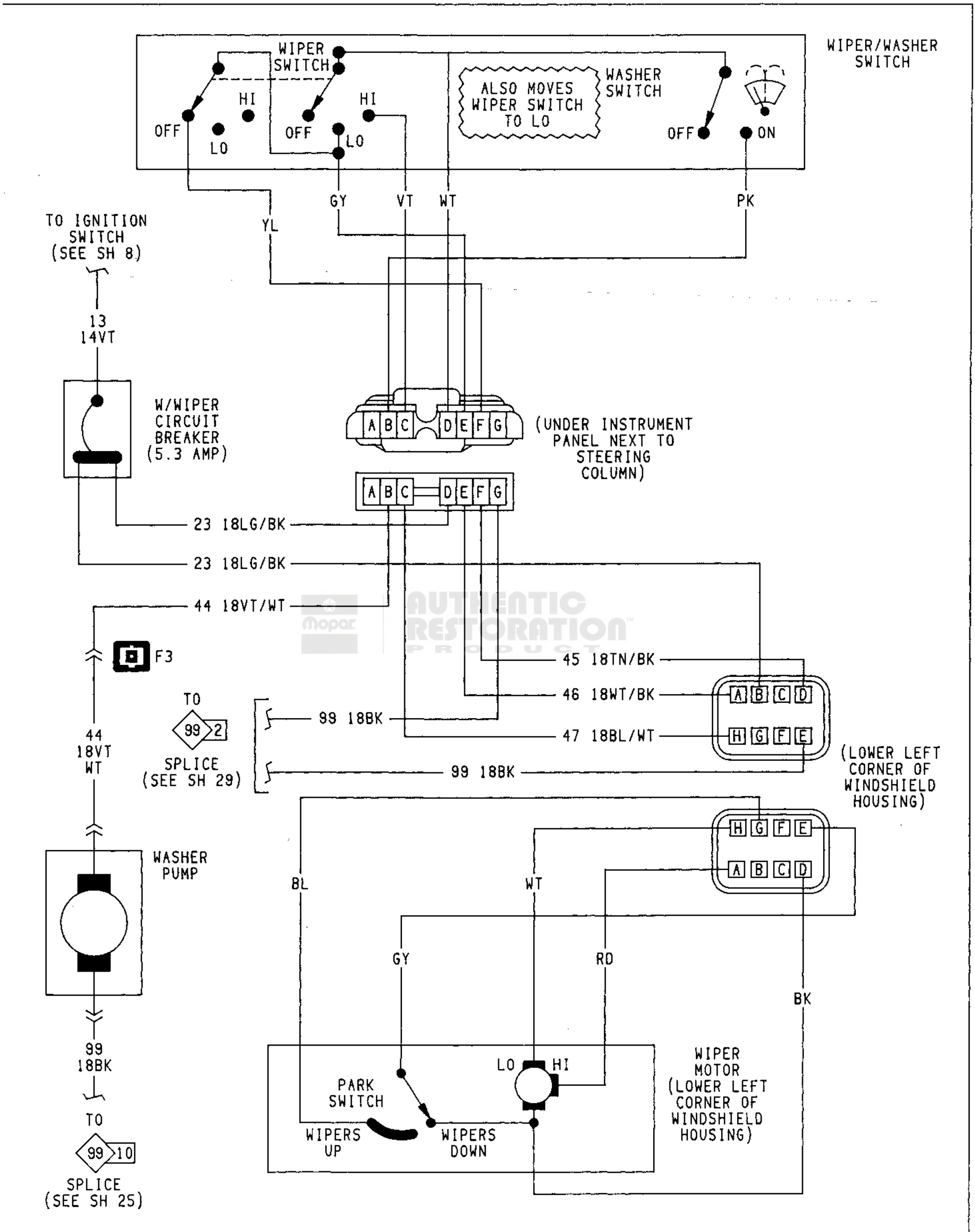
DOME AND COURTESY LAMPS



YJ 37

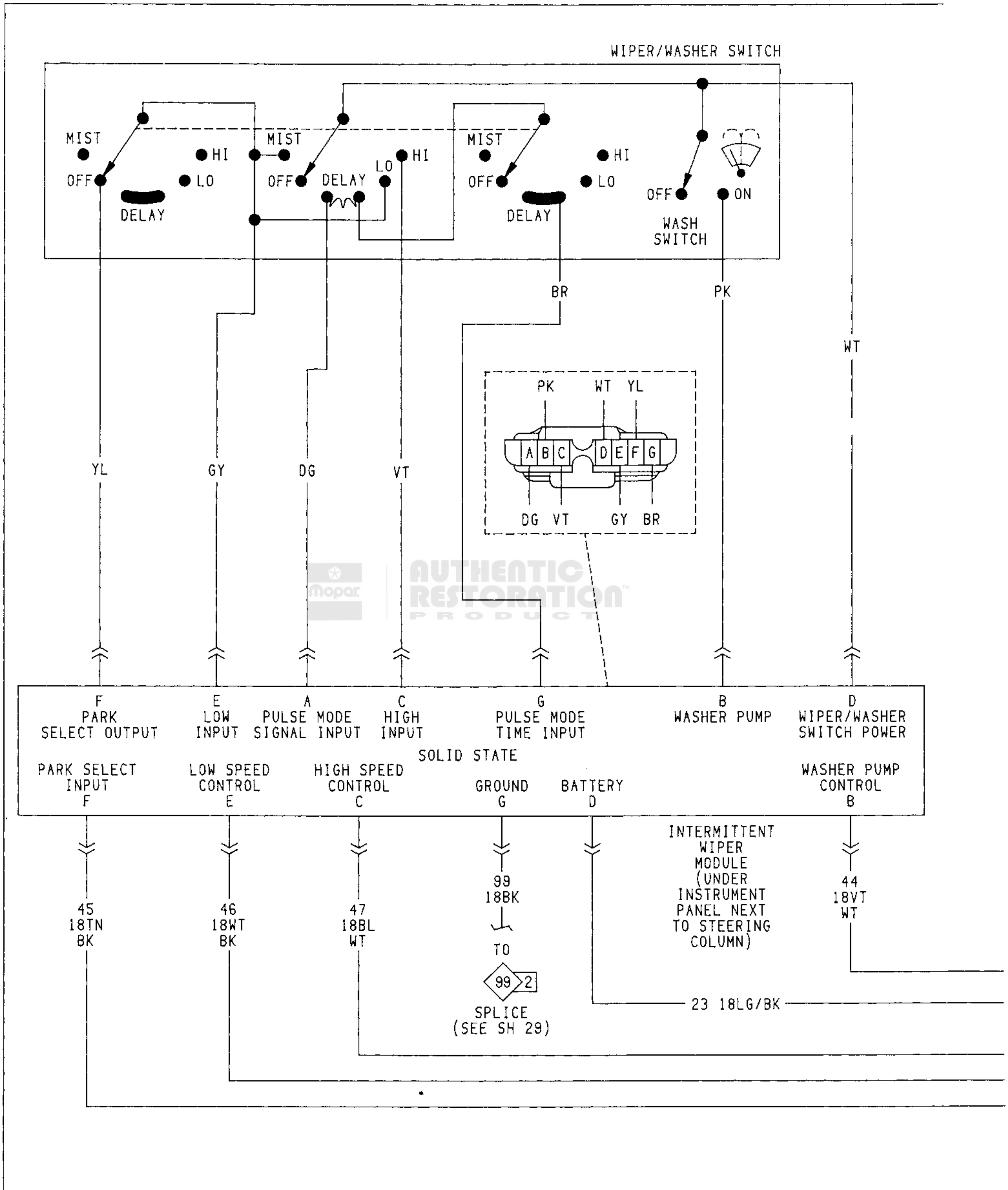
REAR WIPER/WASHER SYSTEM

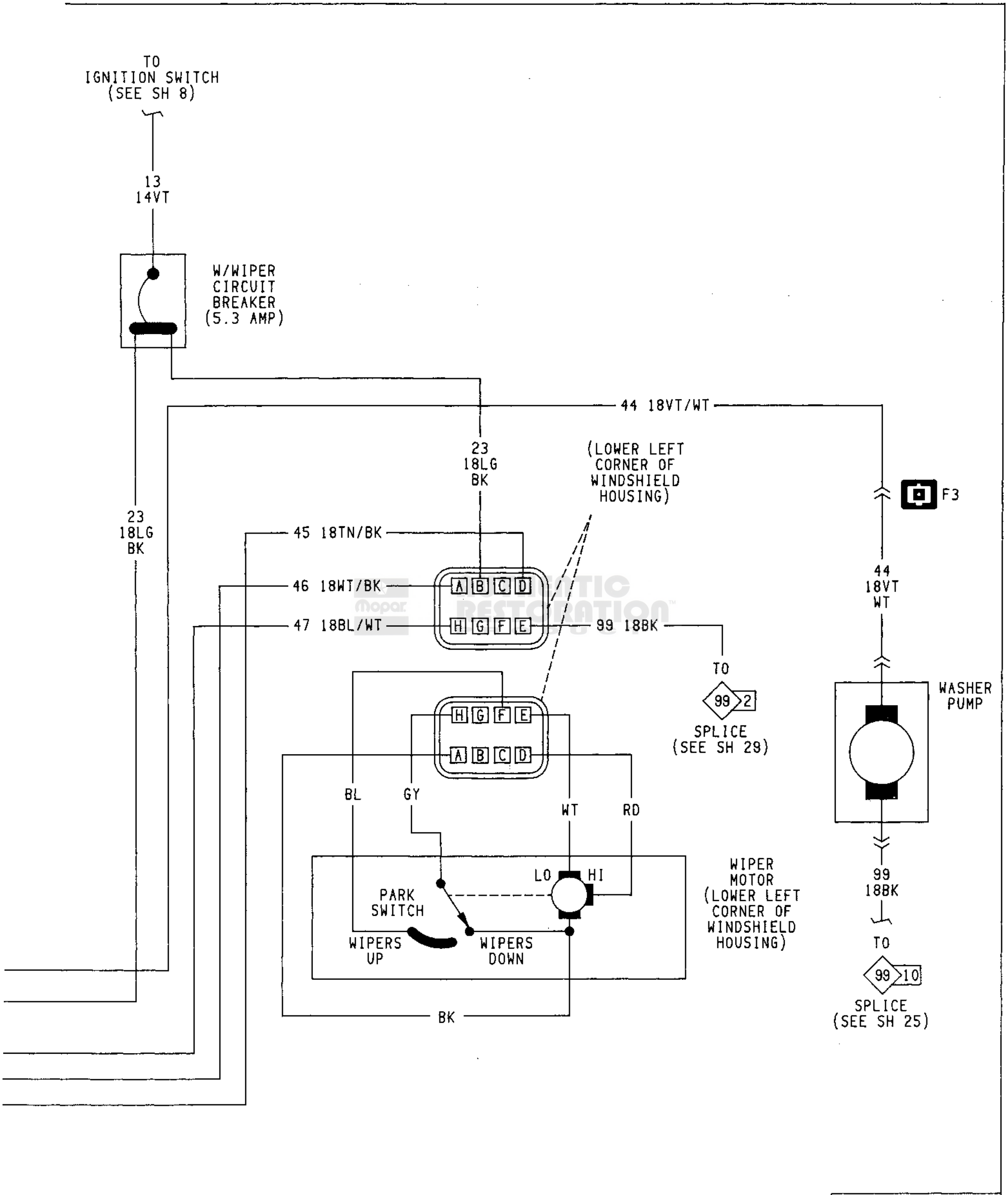
J908W-2



J908W-2 WINDSHIELD WIPER SYSTEM

YJ 38

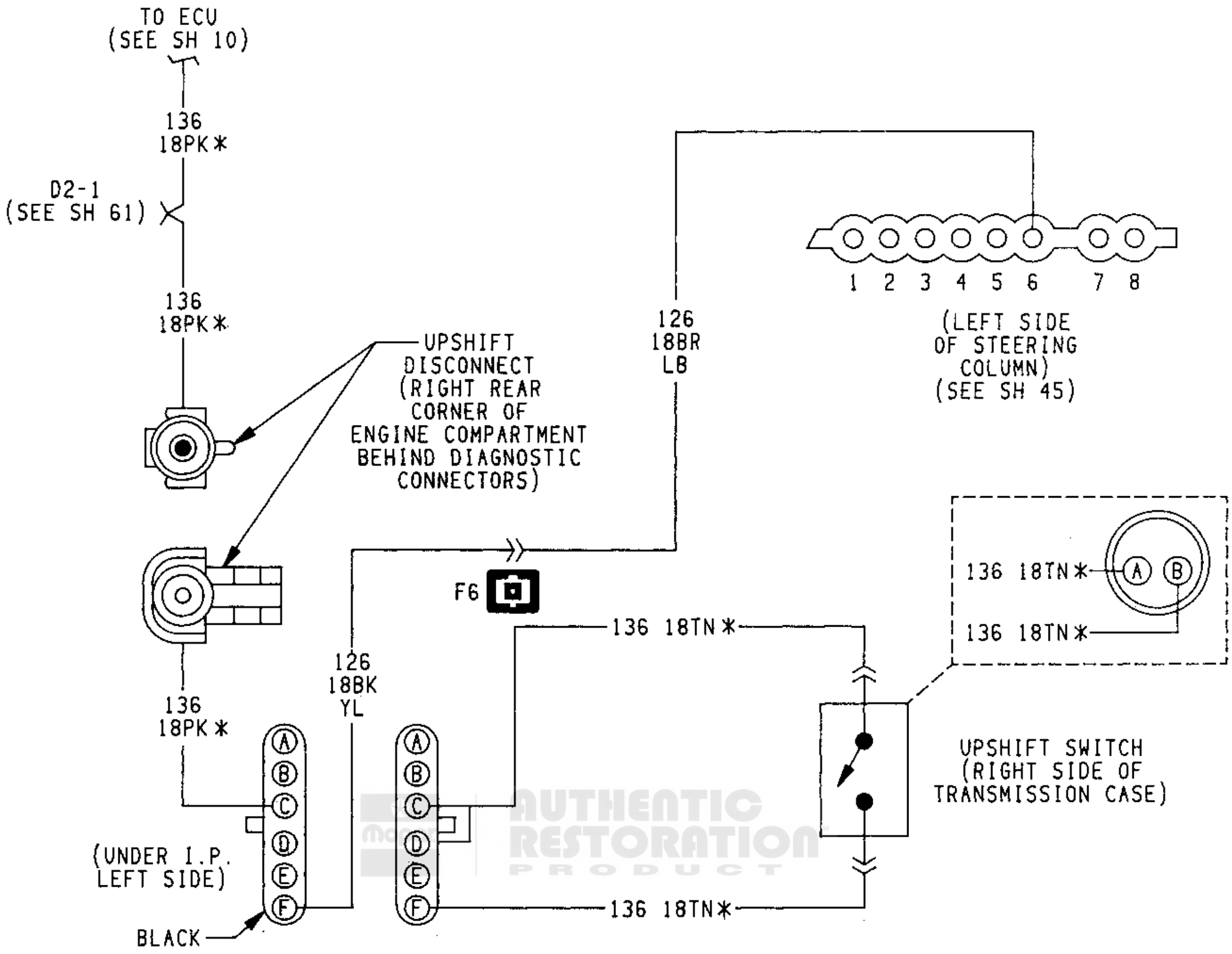

WIPER/WASHER SWITCH
MIST
OFF
DELAY
HI
LO
MIST
OFF
DELAY
LO
HI
MIST
OFF
DELAY
HI
LO
OFF
ON
WASH SWITCH
BR
PK
WT
PK WT YL
A B C D E F G
DG VT GY BR
YL
GY
DG
VT
F PARK SELECT OUTPUT
E LOW INPUT
A PULSE MODE SIGNAL INPUT
C HIGH INPUT
G PULSE MODE TIME INPUT
B WASHER PUMP
D WIPER/WASHER SWITCH POWER
SOLID STATE
PARK SELECT INPUT F
LOW SPEED CONTROL E
HIGH SPEED CONTROL C
GROUND G
BATTERY D
WASHER PUMP CONTROL B
INTERMITTENT WIPER MODULE (UNDER INSTRUMENT PANEL NEXT TO STEERING COLUMN)
45 18TN BK
46 18WT BK
47 18BL WT
99 18BK
TO
99 2
SPLICE (SEE SH 29)
44 18VT WT
23 18LG/BK



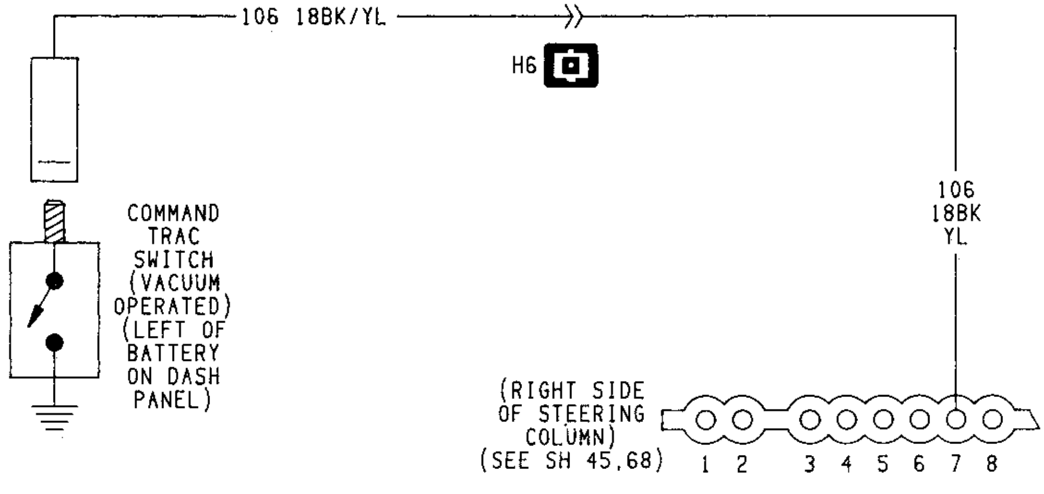
J908W-2

INTERMITTENT WIPER SYSTEM

YJ 40

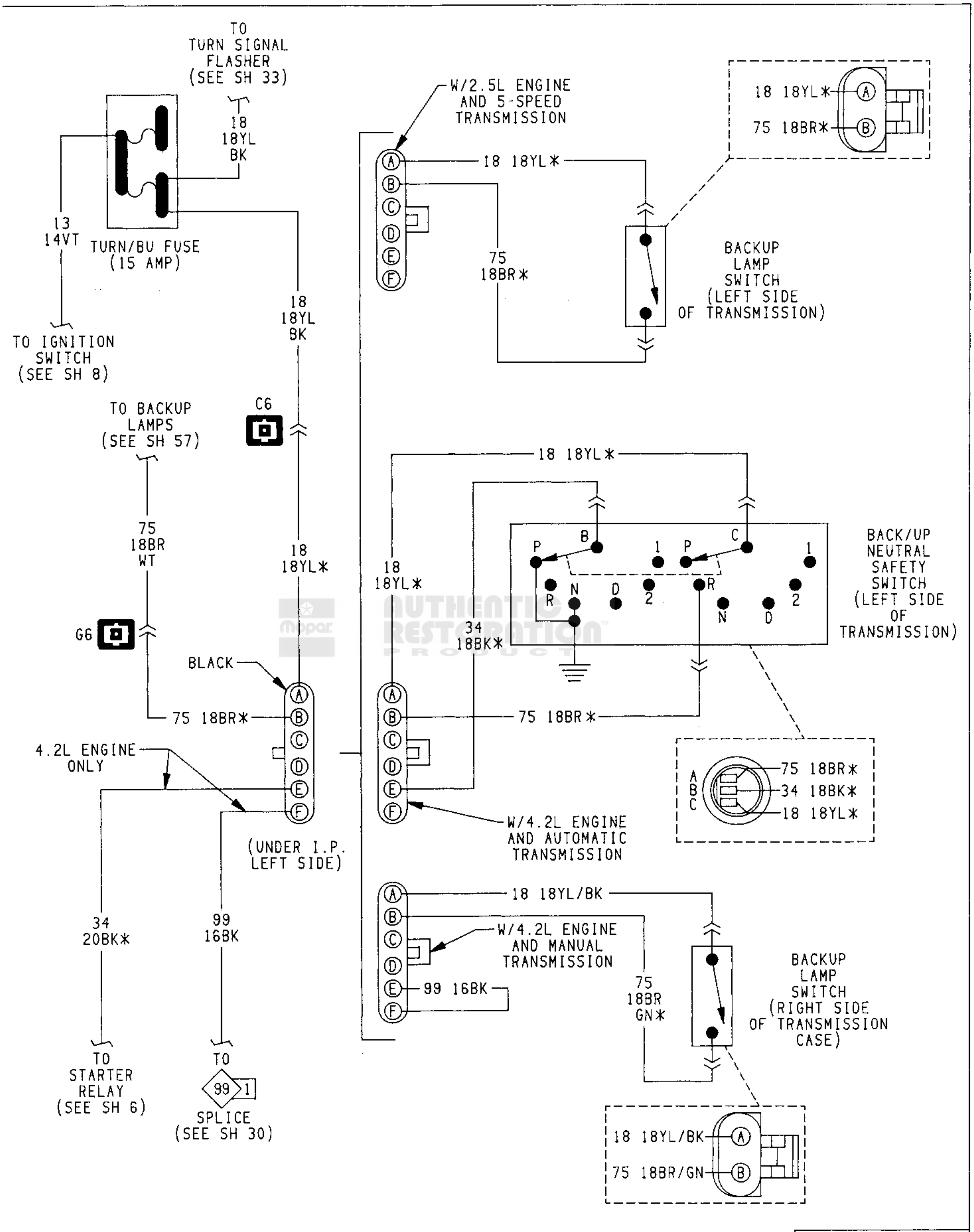


UPSHIFT SWITCH-W/2.5L ENGINE AND 5-SPEED TRANSMISSION



4 WD COMMAND TRAC SWITCH- ALL 4 WD MODELS

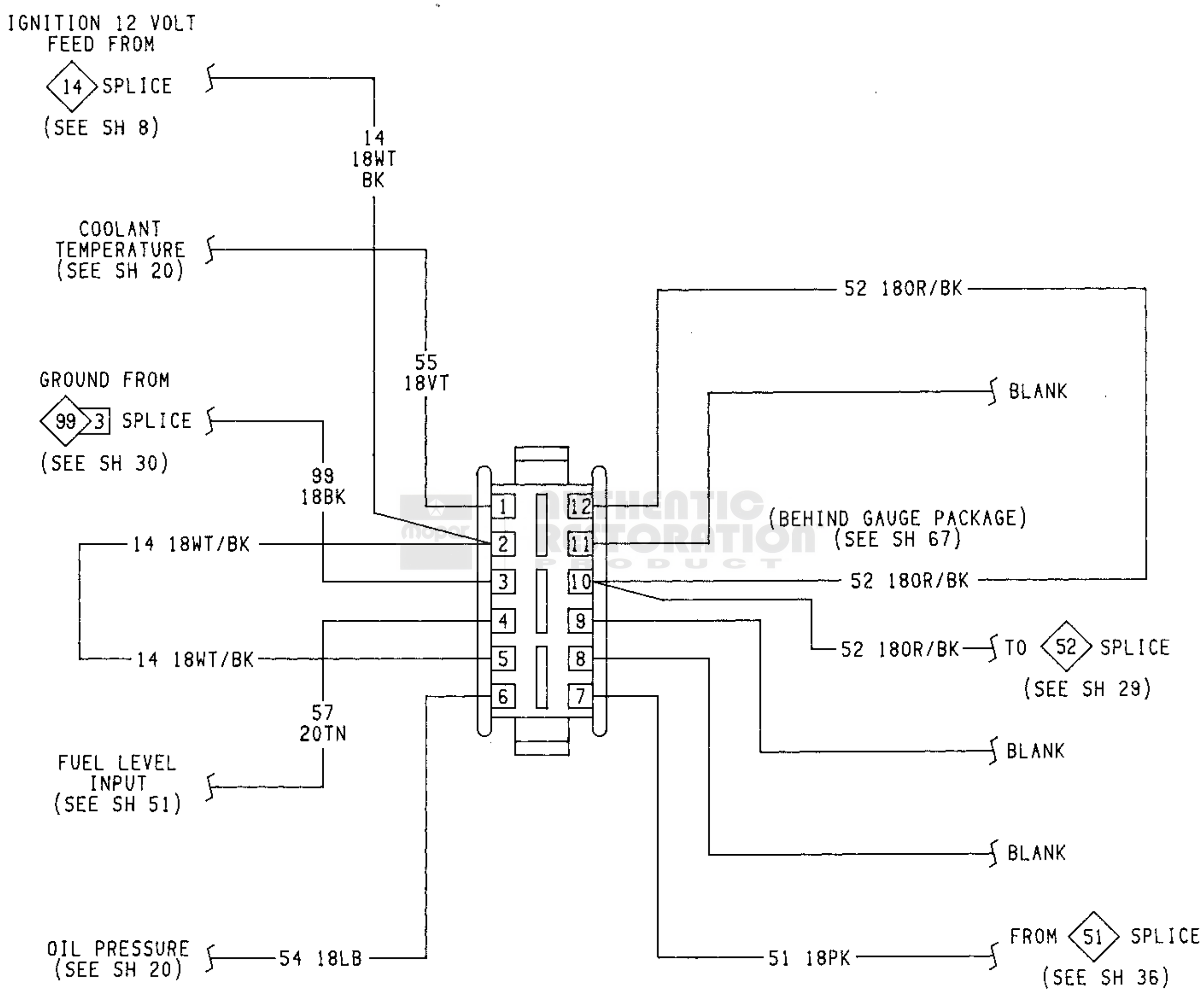
J908W-2



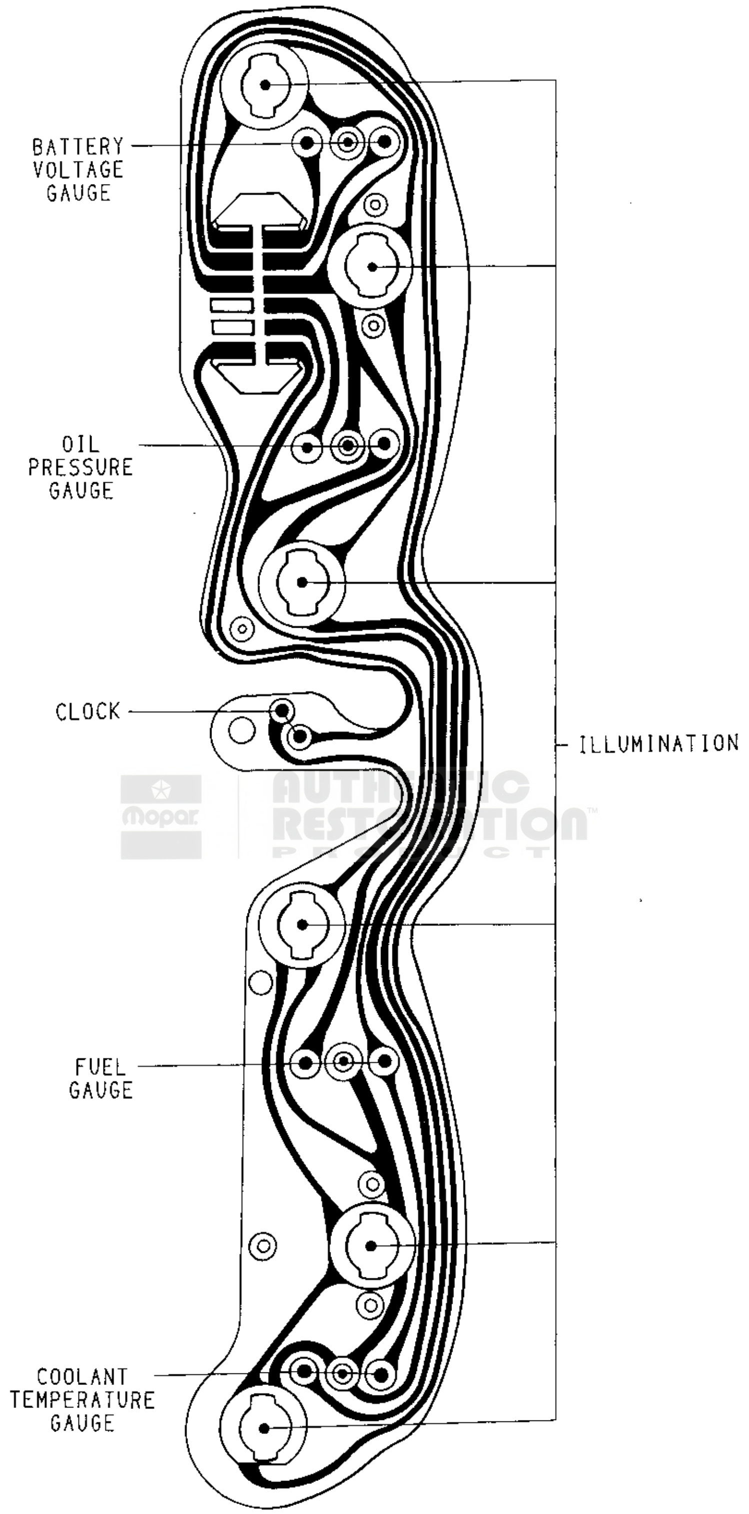
J908W-2

BACKUP LAMP SWITCH

YJ 42

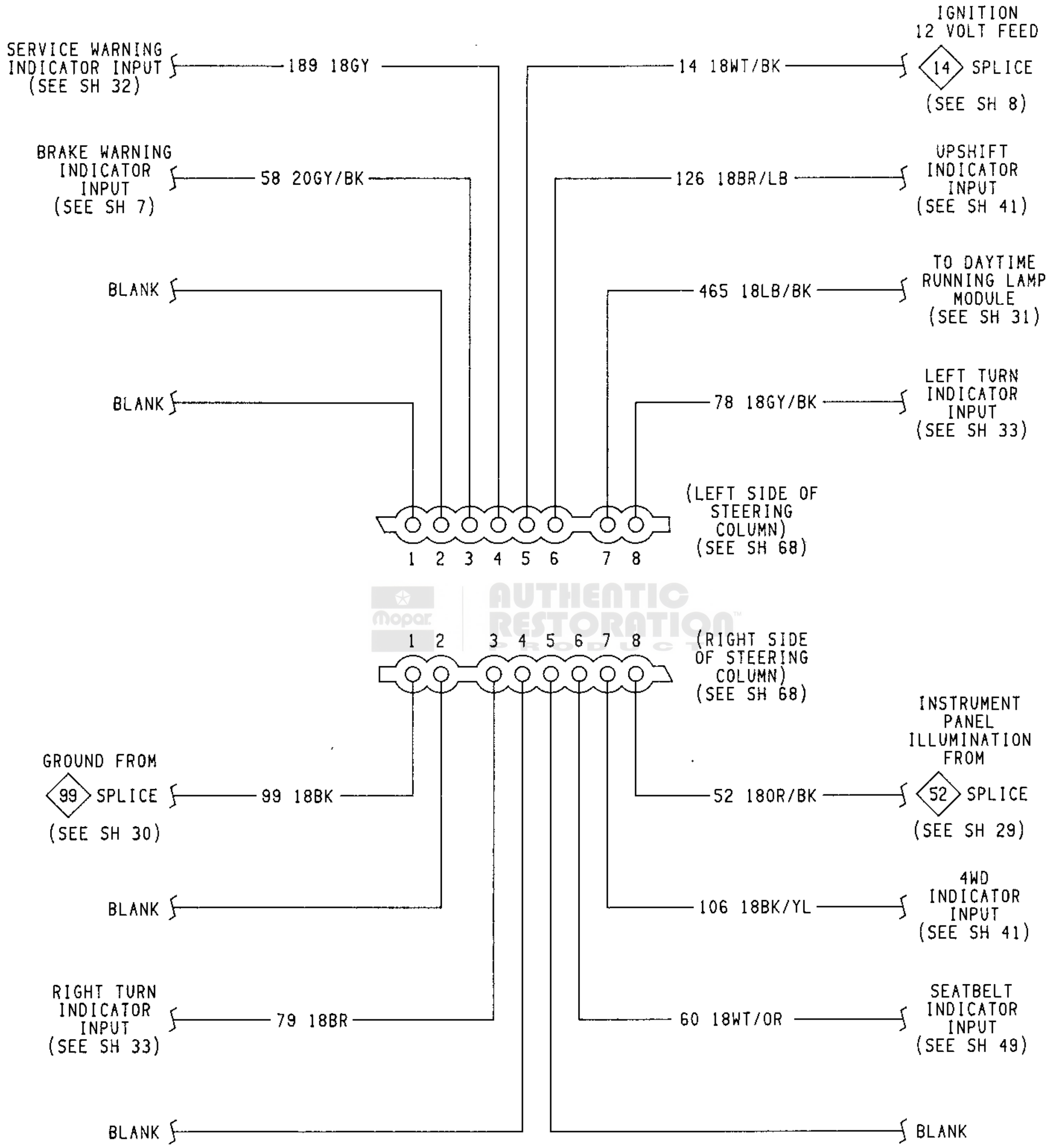


GAUGE PACKAGE PRINTED CIRCUIT BOARD



J908W-2 GAUGE PACKAGE PRINTED CIRCUIT BOARD

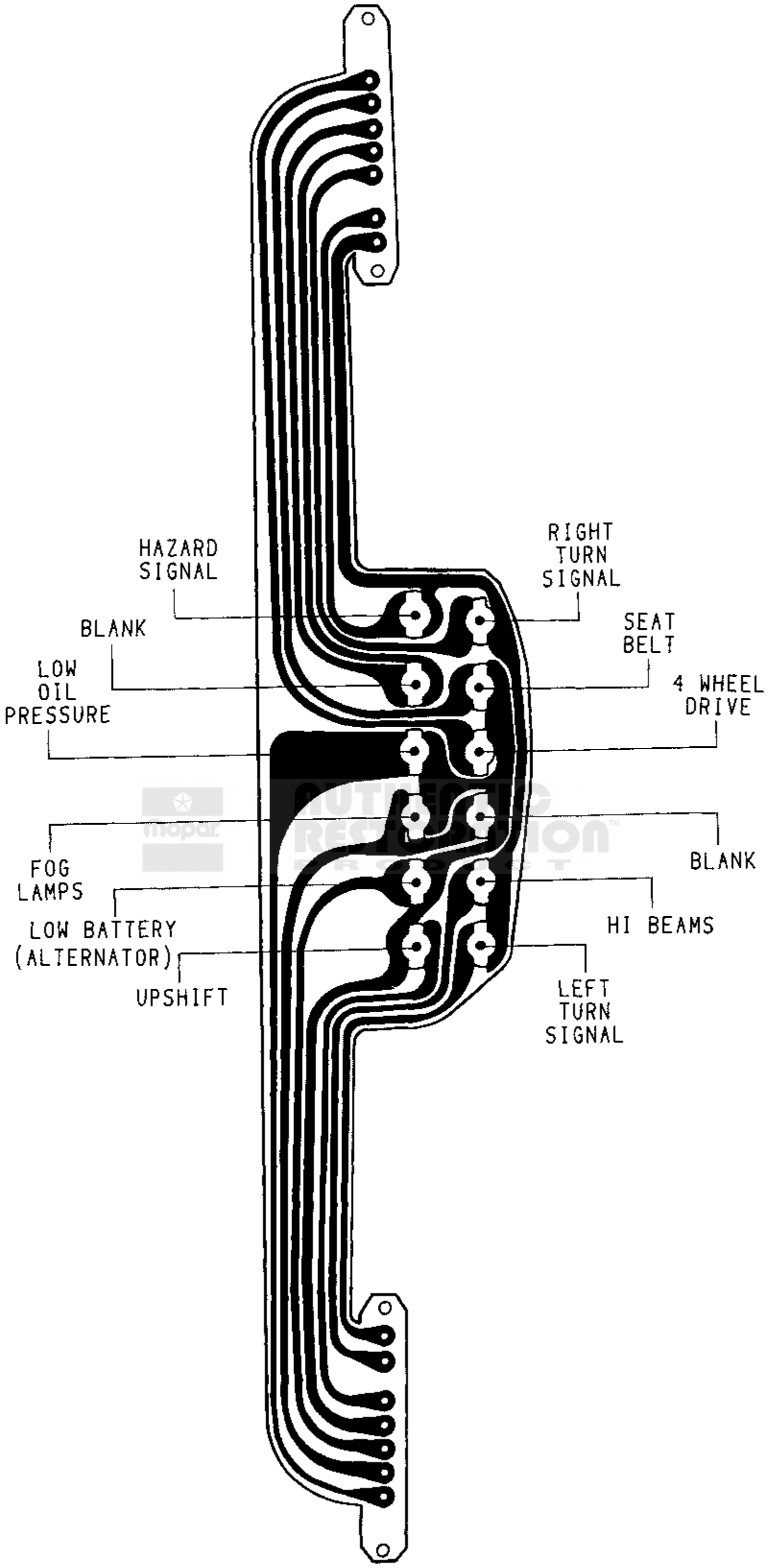
YJ 44



WARNING INDICATOR PANEL PRINTED CIRCUIT BOARD CONNECTORS

YJ 45

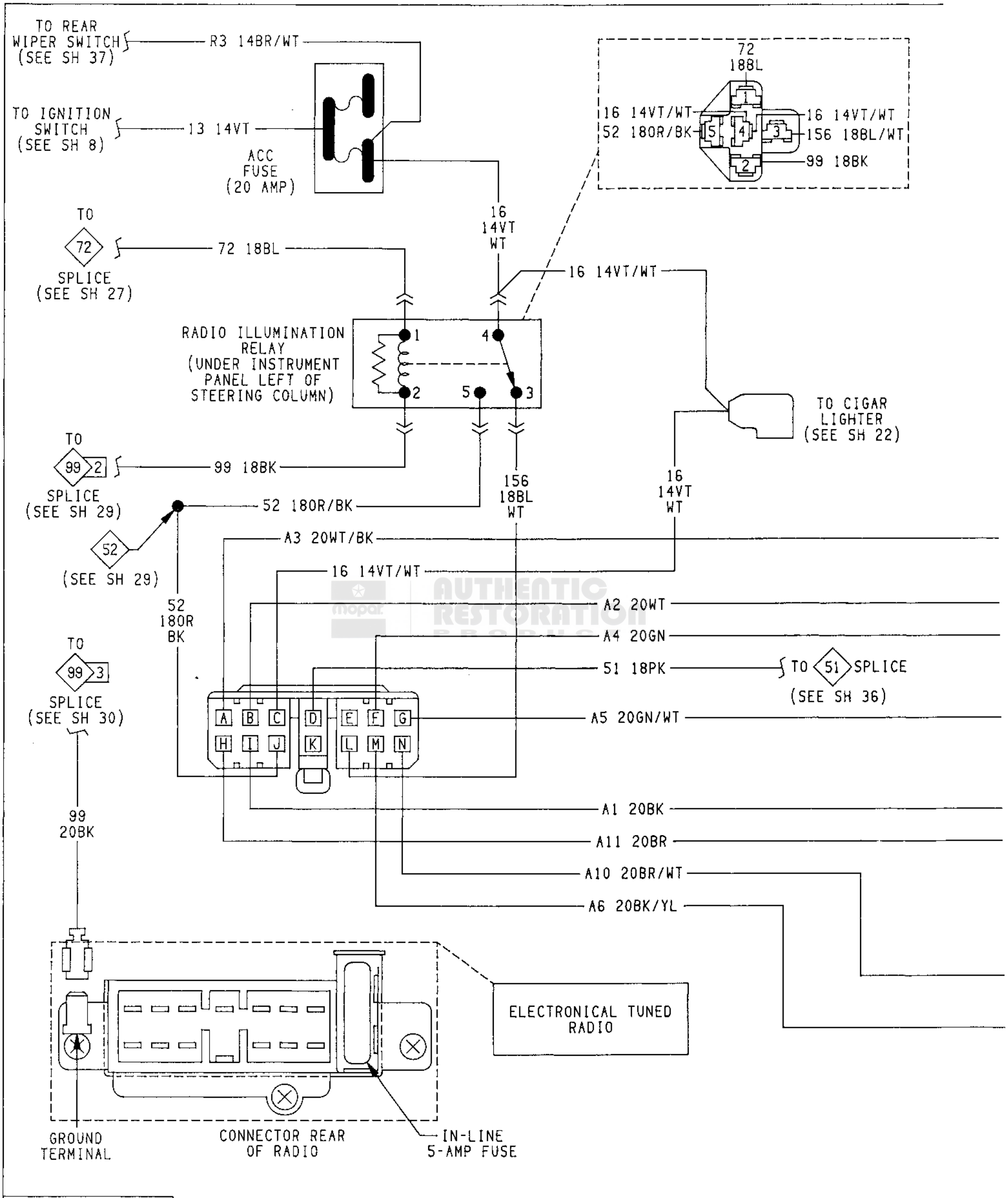
J908W-2



WARNING INDICATOR PANEL PRINTED CIRCUIT BOARD

J908W-2

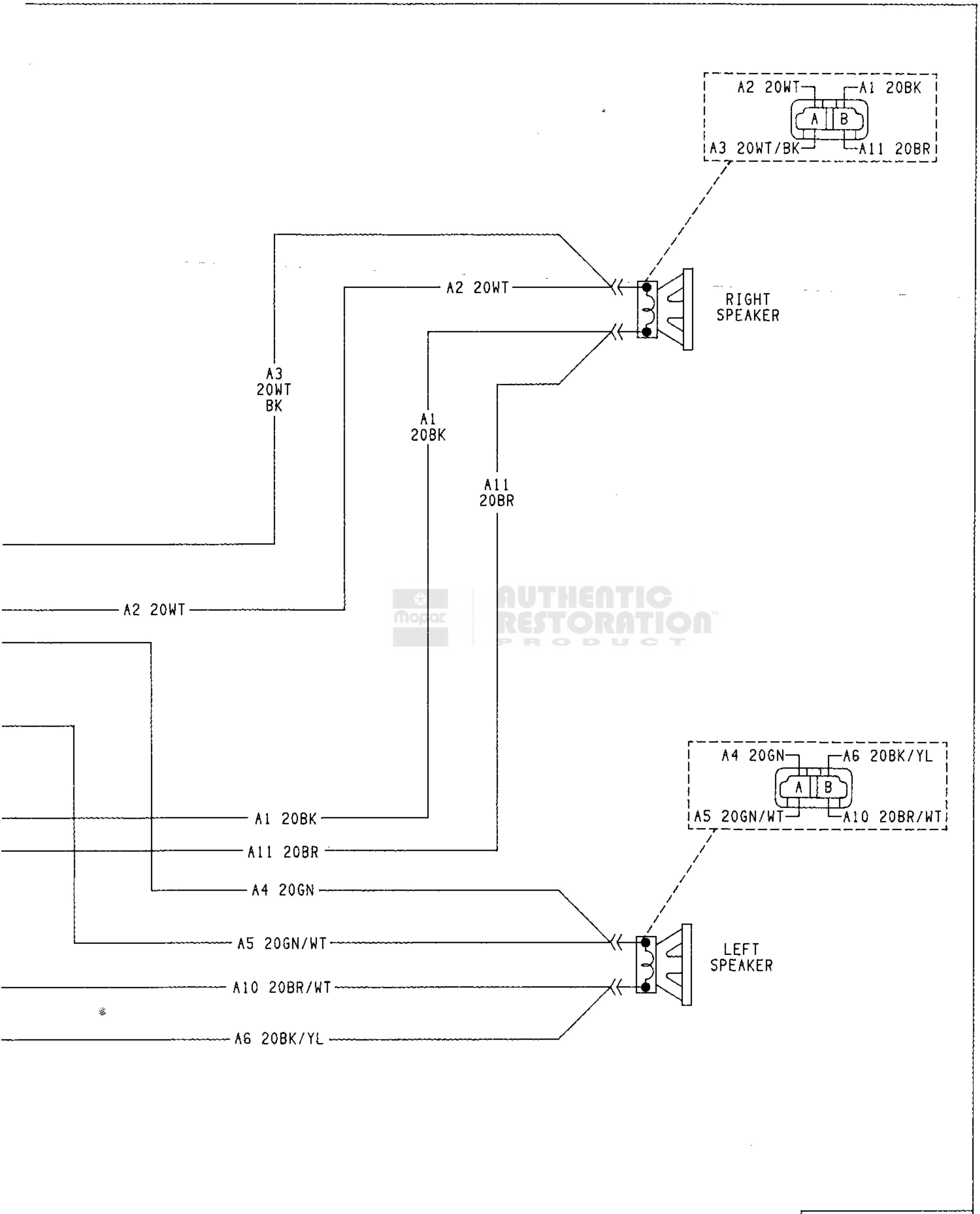
YJ 46

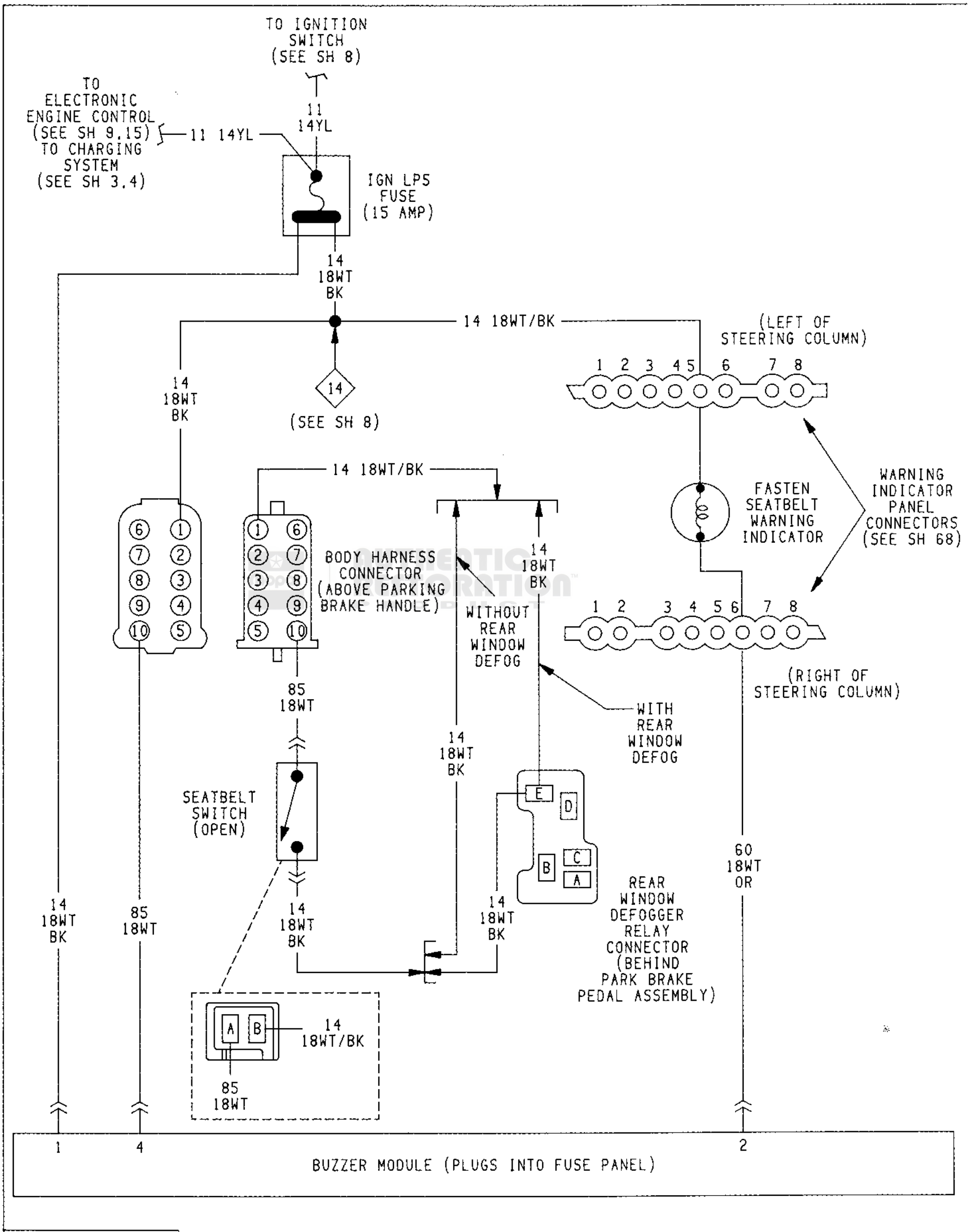


YJ 47

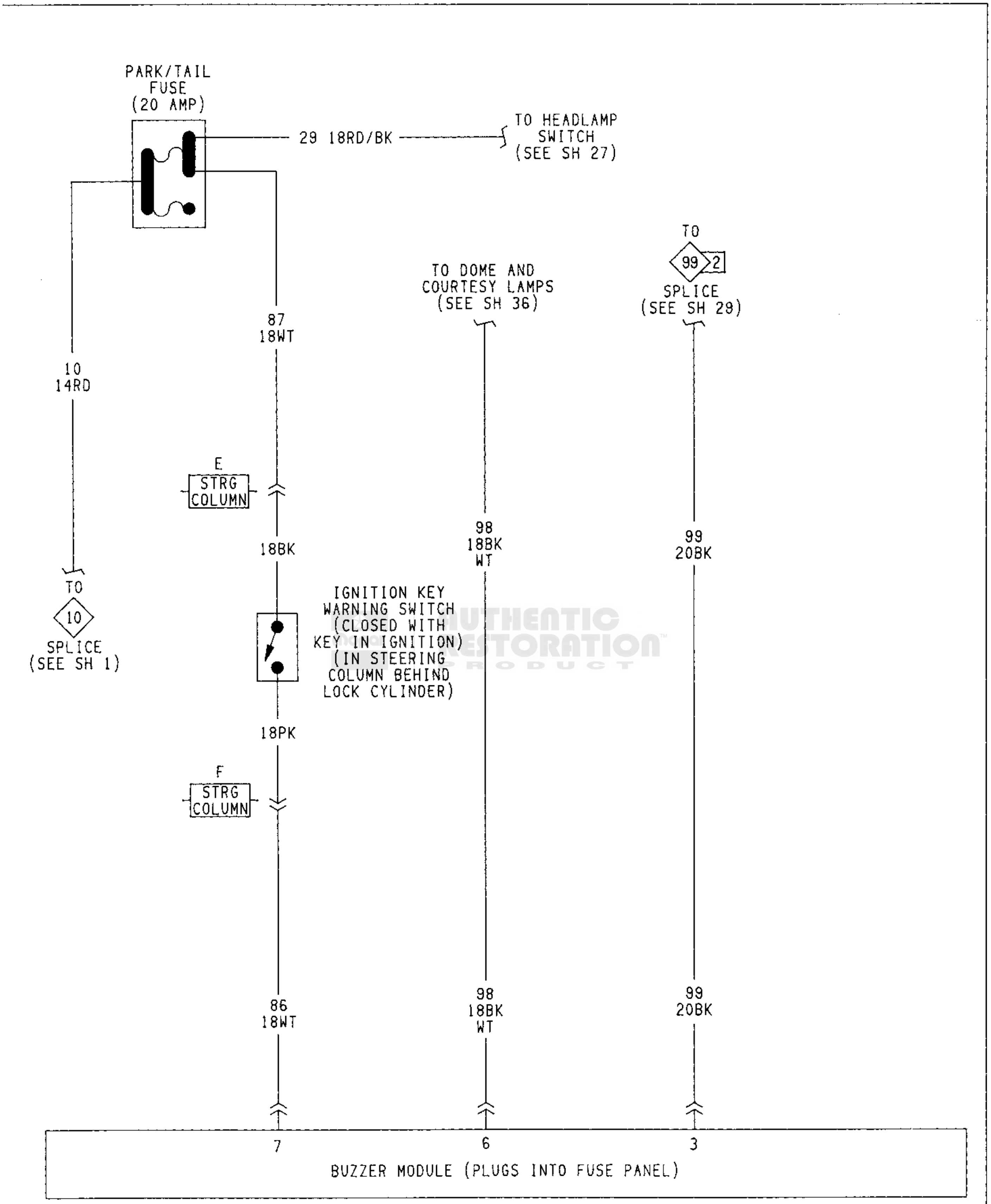
RADIO SYSTEM

J908W-2

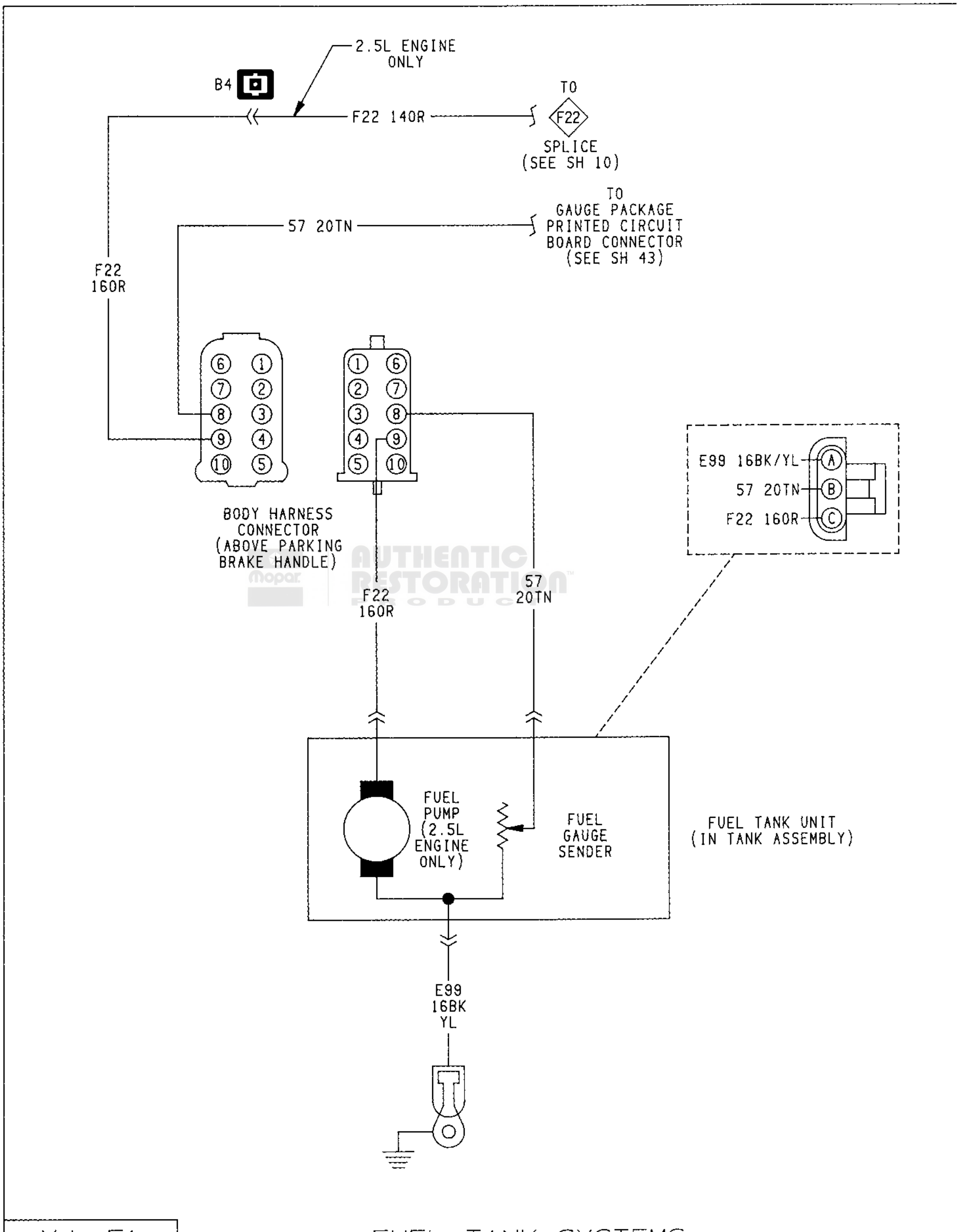

A2 20WT
A1 20BK
A
B
A3 20WT/BK
A11 20BR
RIGHT SPEAKER
A2 20WT
A3 20WT BK
A1 20BK
A11 20BR
A2 20WT
A1 20BK
A11 20BR
A4 20GN
A6 20BK/YL
A
B
A5 20GN/WT
A10 20BR/WT
A4 20GN
A5 20GN/WT
A10 20BR/WT
A6 20BK/YL
LEFT SPEAKER

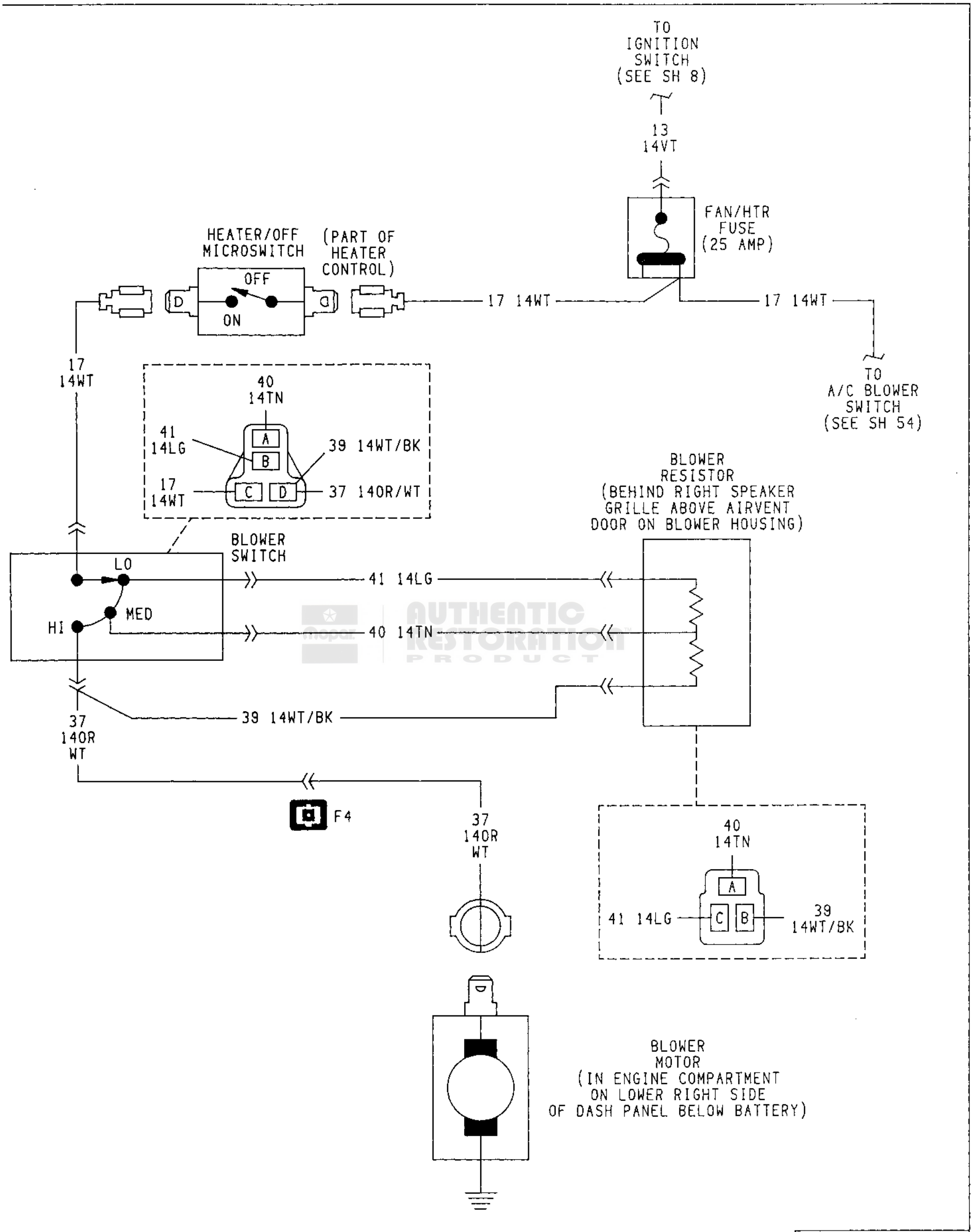


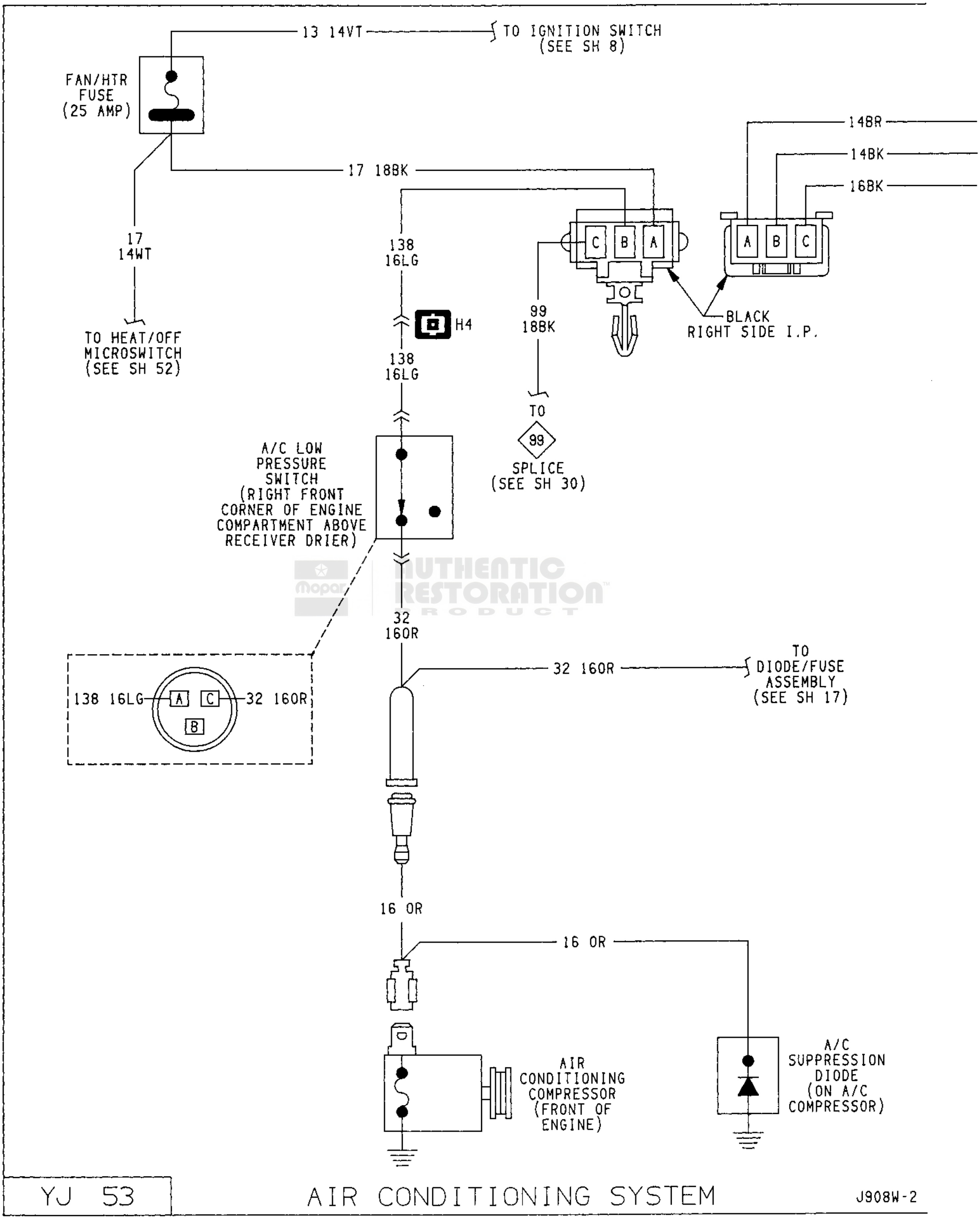
YJ 49 SEATBELT/IGNITION KEY WARNING BUZZER J908W-2



J908W-2 SEATBELT/IGNITION KEY WARNING BUZZER YJ 50


2.5L ENGINE ONLY
B4
F22 14OR
TO
F22
SPLICE (SEE SH 10)
TO GAUGE PACKAGE PRINTED CIRCUIT BOARD CONNECTOR (SEE SH 43)
57 20TN
F22 16OR
6 1 7 2 8 3 9 4 10 5
1 6 2 7 3 8 4 9 5 10
BODY HARNESS CONNECTOR (ABOVE PARKING BRAKE HANDLE)
F22 16OR
57 20TN
E99 16BK/YL
A
57 20TN
B
F22 16OR
C
FUEL PUMP (2.5L ENGINE ONLY)
FUEL GAUGE SENDER
FUEL TANK UNIT (IN TANK ASSEMBLY)
E99 16BK YL

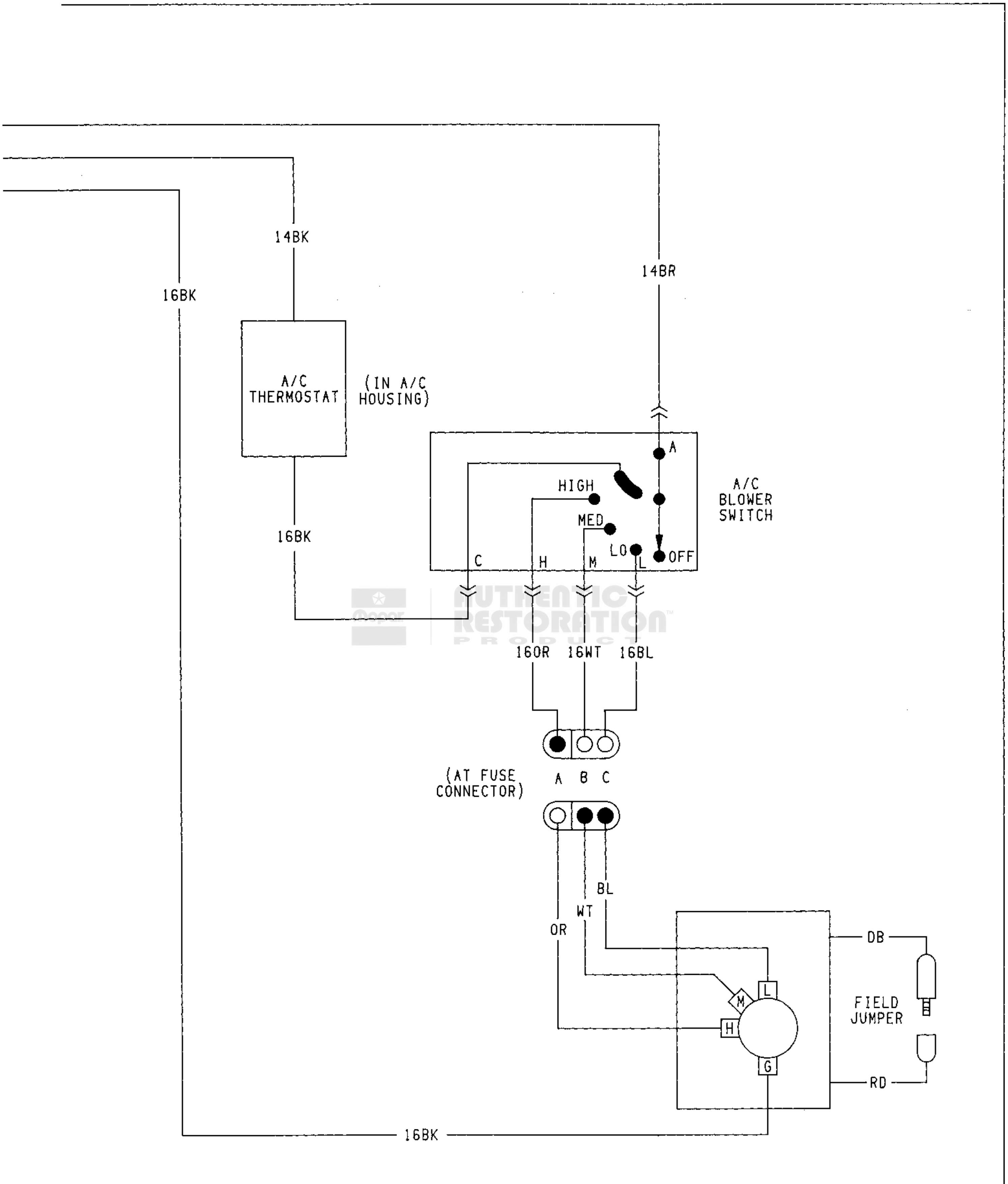

TO
IGNITION
SWITCH
(SEE SH 8)
13
14VT
FAN/HTR
FUSE
(25 AMP)
HEATER/OFF
MICROSWITCH
(PART OF
HEATER
CONTROL)
OFF
ON
D
D
17 14WT
17 14WT
TO
A/C BLOWER
SWITCH
(SEE SH 54)
17
14WT
40
14TN
41
14LG
A
B
39 14WT/BK
17
14WT
C
D
37 14OR/WT
BLOWER
SWITCH
LO
MED
HI
41 14LG
40 14TN
BLOWER
RESISTOR
(BEHIND RIGHT SPEAKER
GRILLE ABOVE AIRVENT
DOOR ON BLOWER HOUSING)
39 14WT/BK
37
14OR
WT
F4
37
14OR
WT
40
14TN
A
41 14LG
C
B
39
14WT/BK
BLOWER
MOTOR
(IN ENGINE COMPARTMENT
ON LOWER RIGHT SIDE
OF DASH PANEL BELOW BATTERY)

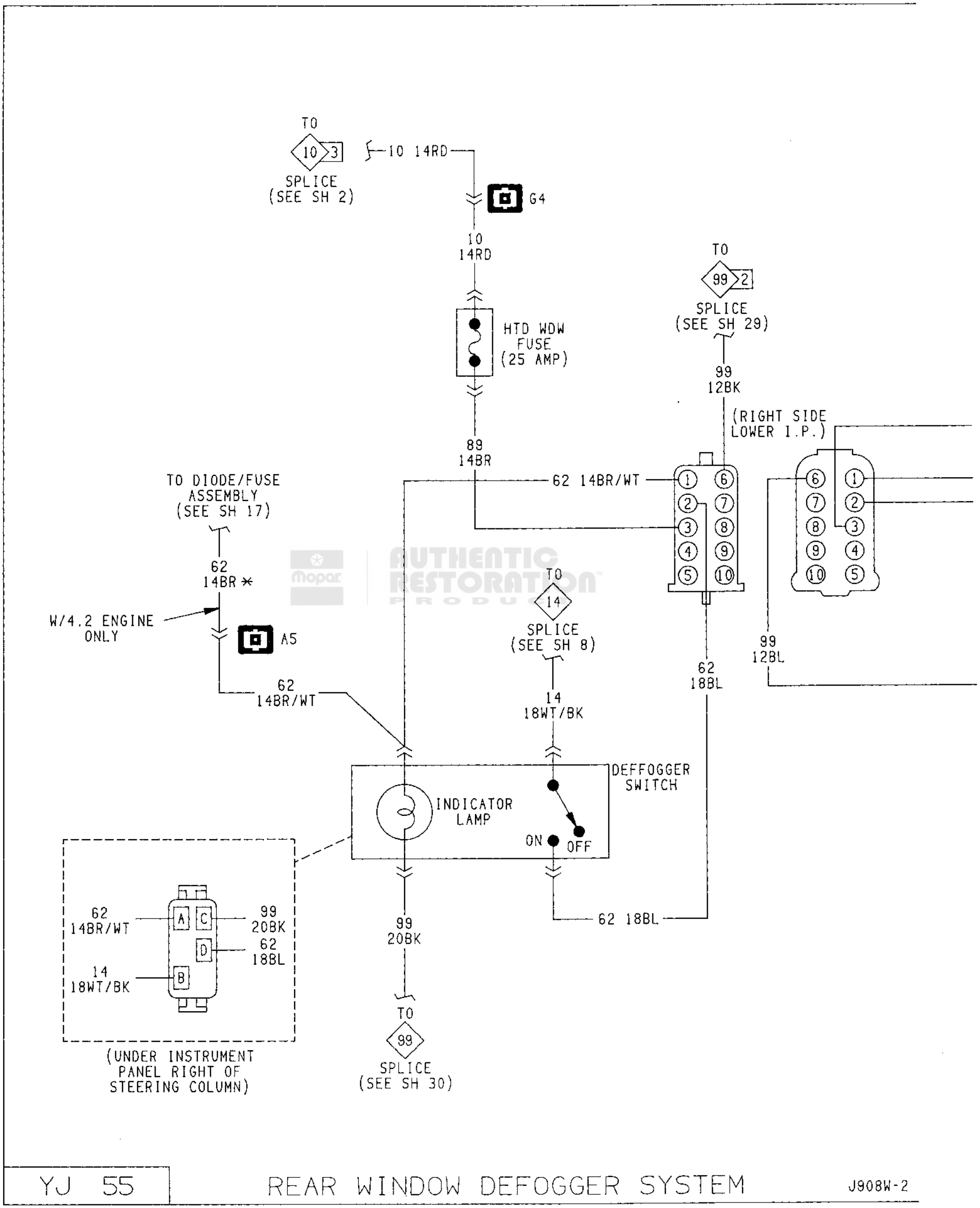


YJ 53

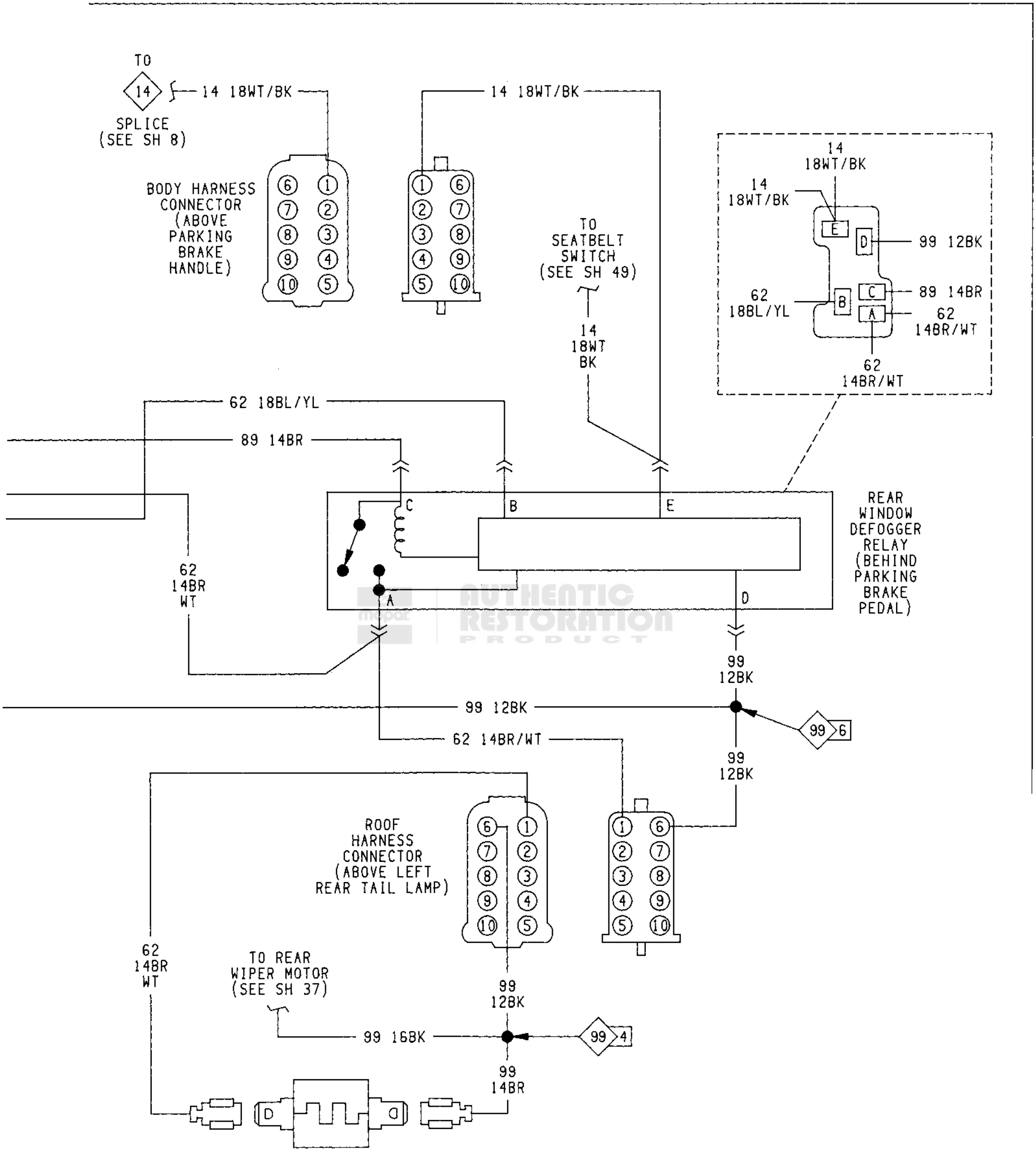
AIR CONDITIONING SYSTEM

J908W-2

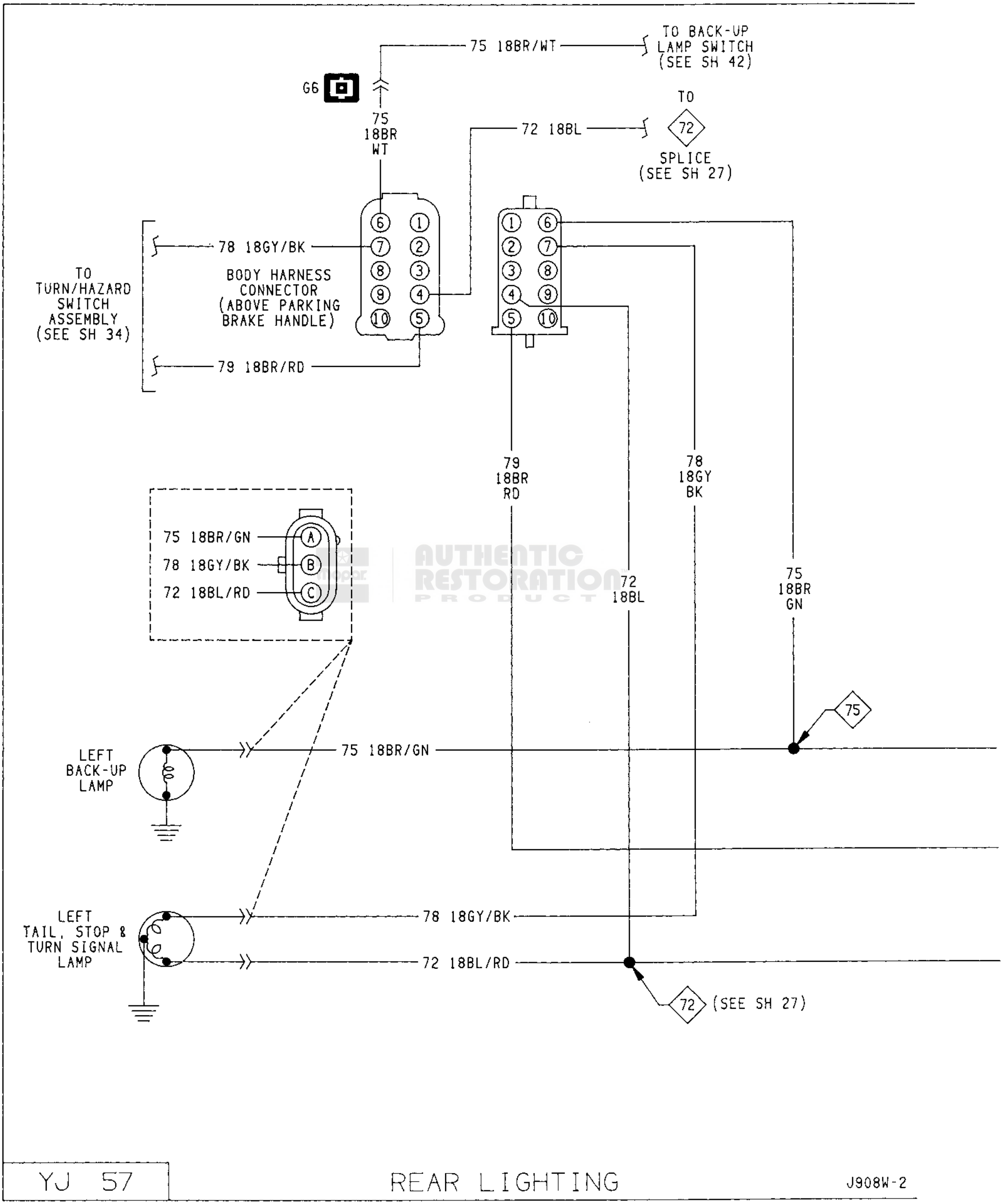

14BK
14BR
16BK
A/C THERMOSTAT
(IN A/C HOUSING)
16BK
A
HIGH
MED
LO
OFF
A/C BLOWER SWITCH
C
H
M
L
16OR
16WT
16BL
(AT FUSE CONNECTOR)
A
B
C
BL
WT
OR
DB
M
L
H
G
FIELD JUMPER
RD
16BK

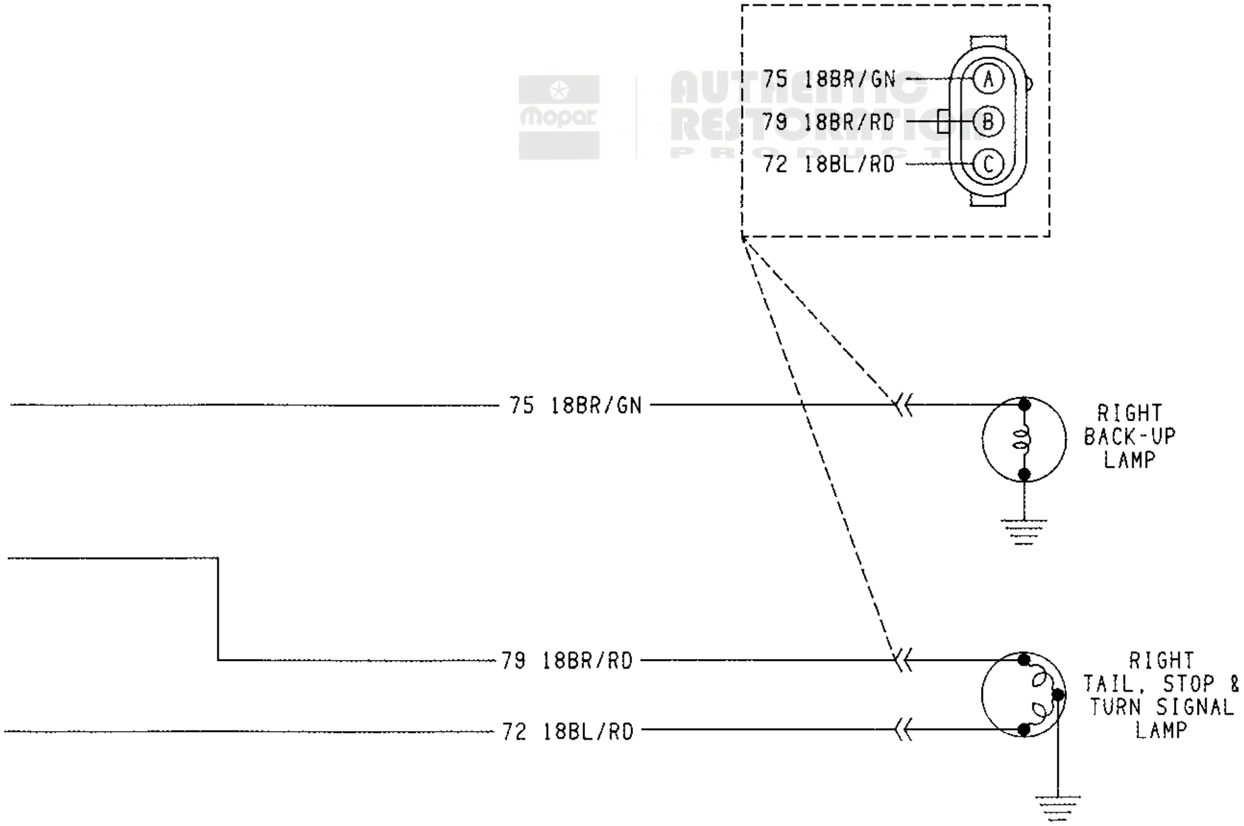


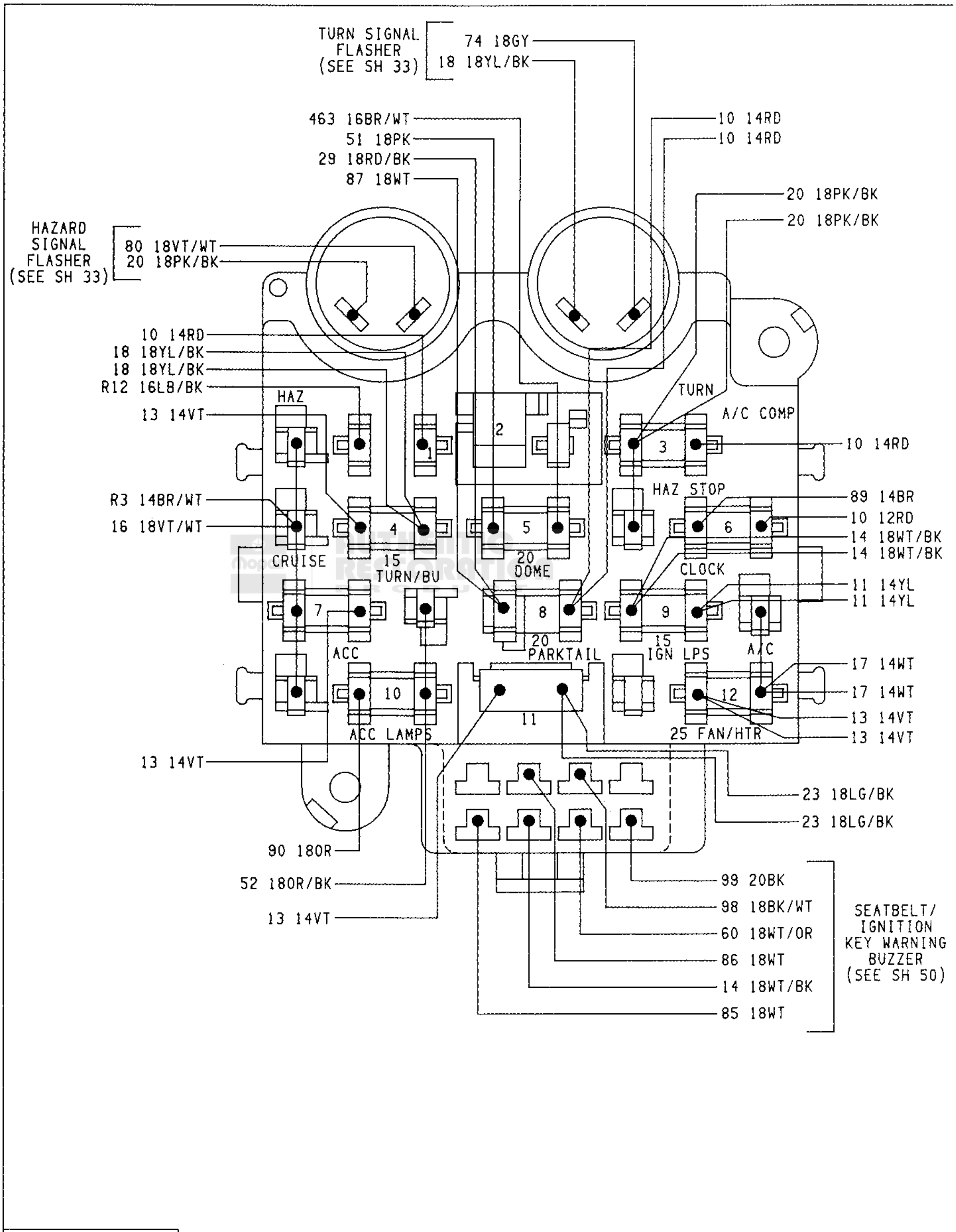
YJ 55 REAR WINDOW DEFOGGER SYSTEM J908W-2



J908W-2 REAR WINDOW DEFOGGER SYSTEM


75 18BR/WT
TO BACK-UP LAMP SWITCH (SEE SH 42)
G6
75 18BR WT
TO
72 18BL
72
SPLICE (SEE SH 27)
TO TURN/HAZARD SWITCH ASSEMBLY (SEE SH 34)
78 18GY/BK
79 18BR/RD
BODY HARNESS CONNECTOR (ABOVE PARKING BRAKE HANDLE)
6 1 7 2 8 3 9 4 10 5
1 6 2 7 3 8 4 9 5 10
79 18BR RD
72 18BL
78 18GY BK
75 18BR GN
75 18BR/GN
78 18GY/BK
72 18BL/RD
A B C
75
LEFT BACK-UP LAMP
75 18BR/GN
LEFT TAIL, STOP & TURN SIGNAL LAMP
78 18GY/BK
72 18BL/RD
72 (SEE SH 27)


75 18BR/GN
79 18BR/RD
72 18BL/RD
A
B
C
75 18BR/GN
RIGHT
BACK-UP
LAMP
79 18BR/RD
72 18BL/RD
RIGHT
TAIL, STOP &
TURN SIGNAL
LAMP



YJ 59

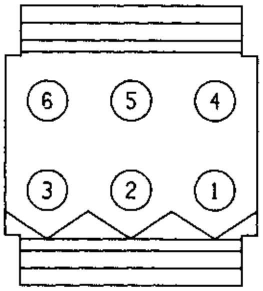
FUSE PANEL

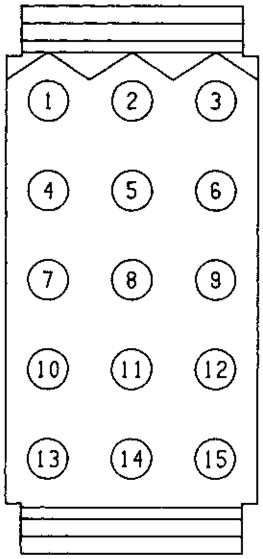
J908W-2

FUSE NUMBER	AMPS	COLOR	SHEET
1	—	—	—
2	—	—	—
3	15 HAZ STOP	LIGHT BLUE	1,23,33
4	15 TURN/BU	LIGHT BLUE	2,8,33,42
5	20 DOME	YELLOW	1,21,36
6	25 HTD WDW	WHITE	2,55
7	20 ACC	YELLOW	2,8,22,24,37,47
8	20 PARK/TAIL	YELLOW	1,27,50
9	15 IGN LPS	LIGHT BLUE	2,8,15,32,35,49
10	5 ACC LPS	TAN	1,29
11	5.3 CIRCUIT BREAKER	SILVER CAN	2,8,38,40
12	25 FAN HTR	WHITE	2,8,52,53

FUSE PANEL

CAV	DIAGNOSTIC CONNECTOR - #1	
1	30 18GN*	TACHOMETER
1	30 18GN*	TACHOMETER
2	11 14YL	I-1 IGNITION SWITCH
3	99 20BK	ECU GROUND
4	88 14GN*	START SIGNAL(−)
5	10 14RD	BATTERY
6	F22 14OR	FUEL PUMP RELAY





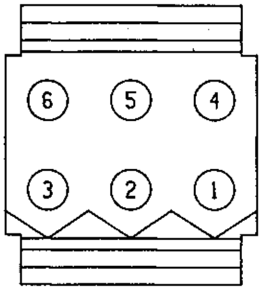
CAV	DIAGNOSTIC CONNECTOR - #2	
1	136 18PK*	UNSHIFT LAMP-MANUAL
1	136 18PK*	ECU SERIAL DATA-AUTO
2	F20 20BK*	B+ LATCH-COIL GROUND
2	F20 20BK*	B+ LATCH-COIL GROUND
3	34 20BK*	PARK/NEUTRAL-AUTO
3	34 20BK*	ECU SERIAL DATA-MANUAL
4	F21 14BK	B+ LATCH-RELAY-COIL FEED
5	—	—
6	F34 20GY/BK	WIDE OPEN THROTTLE SWITCH
6	F34 20GY/BK	WIDE OPEN THROTTLE SWITCH
7	99 18BK	SYSTEM GROUND
8	F7 18TN*	AIR TEMPERATURE SENSOR
8	F7 18TN*	AIR TEMPERATURE SENSOR
9	F26 20OR*	IGNITION TIMING
9	F26 20OR*	IGNITION TIMING
10	F18 14BL	EGR PURGE SOLENOID
11	F4 18LG	ISA-EXTENDED
11	F4 18LG	ISA-EXTENDED
12	F24 18TN	COOLANT TEMPERATURE SENSOR
12	F24 18TN	COOLANT TEMPERATURE SENSOR
13	F12 18GY*	ISA-CLOSED THROTTLE SWITCH
13	F12 18GY*	ISA-CLOSED THROTTLE SWITCH
14	F3 18BR	ISA-RETRACT
14	F3 18BR	ISA-RETRACT
15	—	—

YJ 61

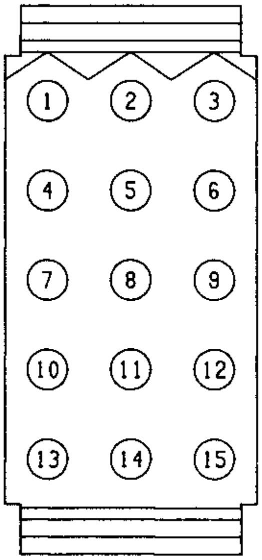
(2.5L) 6 WAY AND 15 WAY
DIAGNOSTIC CONNECTORS

J908W-2

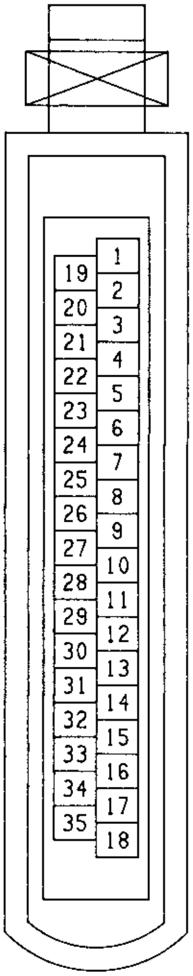
CAV	DIAGNOSTIC CONNECTOR - #1	
1	30 18GN*	TACHOMETER
2	27 16BL*	ELECTRIC CHOKE SWITCH
3	99 20BK	GROUND
4	33 14GN	START SIGNAL
5	139 16VT/RD	IDLE SOLENOID
6	—	—



CAV	DIAGNOSTIC CONNECTOR - #2	
1	F29 16TN	PCV SOLENOID
2	132 18LB/RD	IDLE VACUUM SOLENOID
3	F26 18OR*	HIGH ALTITUDE JUMPER
4	11 14YL	I-1 IGNITION SWITCH
5	F38 18YL/RD	DOWN STREAM SOLENOID
6	F34 18GY/BK	WIDE OPEN THROTTLE SWITCH
7	99 20BK	ECU GROUND
8	F37 18VT*	DOWN STREAM SOLENOID
9	F35 18GN/WT	VACUUM SWITCH
10	F33 18BL/OR	THERMO-ELECTRIC SWITCH
11	F60 14RD*	STEPPER MOTOR
12	F24 18TN	COOLANT TEMPERATURE SWITCH
13	F3 20BR	IDLE RELAY
14	F45 14PK	STEPPER MOTOR
15	F36 18YL/BL	VACUUM SWITCH



(4.2L) 6 WAY AND 15 WAY
DIAGNOSTIC CONNECTORS



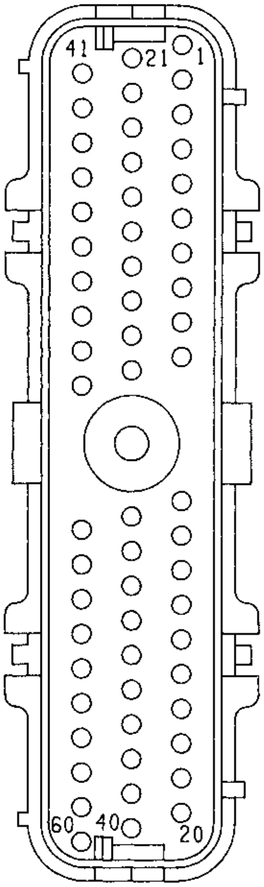
CAV	ECU SYSTEMS CIRCUITS	
1	99 14BK	POWER GROUND
2	99 14BK	POWER GROUND
3	11 14YL	IGNITION
4	10 14RD	BATTERY
5	F18 14BL	EGR CONTROL
6	F17 20OR*	FUEL PUMP RELAY
7	F20 20BK*	LATCH RELAY
8	F34 20GY/BK	WIDE OPEN THROTTLE
9	—	—
10	99 14BK	SYSTEM GROUND
11	F52 20RD*	ENGINE SPEED INPUT
12	34 20BK*	START SIGNAL (–)
13	F57 20BR*	TPS GROUND
14	F7 18TN*	AIR TEMPERATURE INPUT
15	F24 18TN	COOLANT TEMPERATURE INPUT
16	F2 20RD*	5 VOLT SUPPLY (TPS/MAP)
17	F56 20BK	MAP GROUND
18	136 18PK*	UPSHIFT INDICATOR
19	F21 14PK	B+ LATCH
20	—	—
21	F1 16LB	INJECTOR CONTROL
22	135 16BL*	A/C CLUTCH CONTROL
23	F3 18BR	ISCA (RETRACT)
24	F4 18LG	ISCA (EXTENDED)
25	F12 18GY*	CLOSED THROTTLE INPUT
26	—	—
27	F26 20OR*	TIMING OUTPUT
28	F53 20WT*	ENGINE SPEED INPUT
29	88 14GN*	START SIGNAL (+)
30	168 14LG	LOAD SWAP-A/C SELECT
31	F50 20YL/GN	TPS INPUT
32	F15 18BR*	TEMPERATURE SENSORS GROUND
33	F14 20VT	MAP INPUT
34	169 14LB	LOAD SWAP-A/C REQUEST
35	F6 18OR	OXYGEN SENSOR INPUT

YJ 63

35 WAY ENGINE CONTROLLER
CONNECTOR (2.5L ENGINE)

J908W-2

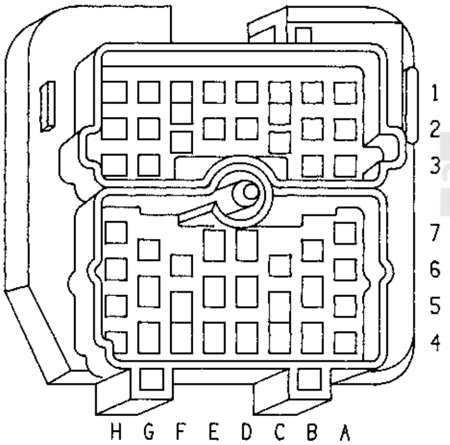
CAV	MCU SYSTEM CIRCUITS	
1	11 14YL	I-1 IGNITION SWITCH
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	—	—
8	F6 18GY	OXYGEN SENSOR
9	F6 18GY	OXYGEN SENSOR
10	F45 14PK	STEPPER MOTOR
11	F26 18OR*	HIGH ALTITUDE
12	—	—
13	—	—
14	—	—
15	—	—
16	F36 18YL/BL	4 INCH VACUUM SWITCH
17	99 18BK	OXYGEN SELECT GROUND
18	F40 16VT	MAGNETIC PICKUP (-)
19	—	—
20	99 14BK	MCU GROUND
21	—	—
22	—	—
23	—	—
24	—	—
25	—	—
26	—	—
27	—	—
28	—	—
29	—	—
30	—	—
31	—	—
32	—	—
33	—	—
34	—	—
35	—	—
36	—	—
37	—	—
38	—	—
39	—	—
40	—	—
41	F29 16TN	PCV SOLENOID
42	—	—
43	F3 20BR	IDLE SPEEDUP RELAY
44	132 18LB/RD	IDLE VACUUM SOLENOID
45	F37 18VT*	UP STREAM SOLENOID
46	F38 18YL/RD	DOWN STREAM SOLENOID
47	F43 16LG*	TIMING OUTPUT
48	F60 14RD*	STEPPER MOTOR
49	F59 14PK*	STEPPER MOTOR
50	F61 14BR*	STEPPER MOTOR
51	F54 18VT*	KNOCK SENSOR
52	—	—
53	F33 18LB/OR	THERMO-ELECTRIC SWITCH
54	F34 18GY/BK	WIDE OPEN THROTTLE
55	F35 18GN/WT	10 INCH VACUUM SWITCH
56	F24 18TN	COOLANT TEMPERATURE SWITCH
57	11 14YL	I-1 IGNITION SWITCH
58	33 14GN	START SIGNAL
59	F39 16OR	MAGNETIC PICKUP (+)
60	99 14BK	MCU GROUND



60 WAY ENGINE
CONTROLLER CONNECTOR
(4.2L ENGINE)

YJ 64

J908W-2



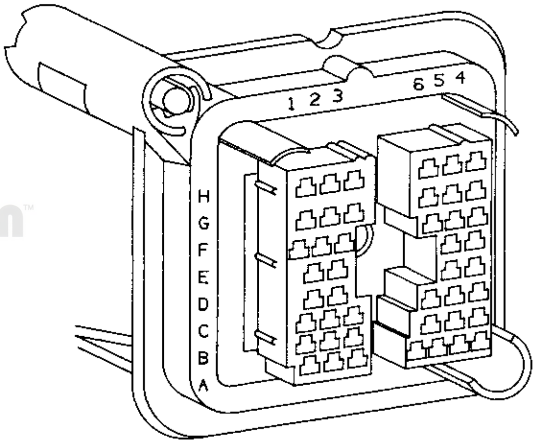
ENGINE COMPARTMENT CIRCUITS		CAV
72 18BL	PARKING LAMPS	A1
R10 18VT/OR	REAR WASHER PUMP	A2
79 18BR	RIGHT TURN SIGNAL LAMPS	A3
—	—	A4
62 14BR*	HEATED BACKLIGHT	A5
12 14OR	I-3 IGNITION (4.2L ONLY)	A6
58 20GY*	BRAKE WARNING SWITCH	A7
464 16BR/WT	DAYTIME RUNNING LIGHTS	B1
14 18WT/BK	DAYTIME RUNNING LIGHTS	B2
58 18GY/RD	DIODE	B3
F22 14OR	FUEL PUMP RELAY OUTPUT (2.5L ONLY)	B4
99 12BK	GROUND	B5
58 20GY*	BRAKE BULB CHECK	B6
—	—	C1
78 18GY*	LEFT TURN SIGNAL LAMPS	C2
—	—	C3
55 18VT	COOLANT TEMPERATURE SENSOR	C4
30 18GN*	TACHOMETER	C5
18 18YL*	BACKUP SWITCH-TRANSMISSION	C6
10 14RD	FOG LAMP RELAY-FEED	D1
—	—	D2
10 12RD	BATTERY	D4
11 14YL	I-1 IGNITION SWITCH	D5
76 16WT	HI BEAM HEADLAMPS	E1
76 18WT	W/O DAYTIME RUNNING LAMP	E1
76 18WT	W/O DAYTIME RUNNING LAMP	E2
465 18LB/BK	W/DAYTIME RUNNING LAMP	E2
10 12RD/WT	BATTERY	E4
463 14RD/WT	UNDERHOOD LAMP	E5
F5 18BL*	FOG LAMP RELAY-COIL FEED	F1
—	—	F2
44 18VT	WINDSHIELD WASHER PUMP FEED	F3
37 14OR/WT	BLOWER MOTOR	F4
54 18LG	OIL PRESSURE SENDER	F5
126 18BK/YL	UPSHIFT SWITCH	F6
—	—	G1
—	—	G2
31 14GY	HORN	G3
10 12RD	BATTERY	G4
33 14GN	STARTER RELAY-CRANK	G5
75 18BR*	BACKUP LAMPS	G6
77 16LG	LO BEAM HEADLAMPS	H1
—	—	H2
—	—	H3
138 16LG	A/C CLUTCH	H4
—	—	H5
106 18BK/YL	4 WHEEL DRIVE VACUUM SWITCH	H6

YJ 65

BULKHEAD CONNECTOR

J908W-2

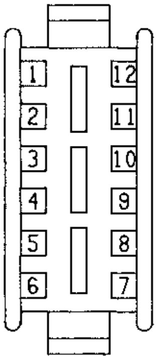
CAV	INSTRUMENT PANEL CIRCUITS	
A1	72 18BL	PARKING LAMPS FEED
A2	R10 14RD	REAR WASHER PUMP
A3	79 18BR	RIGHT TURN SIGNAL LAMPS
A4	—	—
A5	62 14BR/WT	HEATED BACKLIGHT SWITCH
A6	12 14OR	I-3 IGNITION SWITCH
A7	58 18GY/BK	LEFT WARNING INDICATOR
B1	464 16BR/WT	HEADLAMP DIMMER SWITCH
B2	14 18WT/BK	SPLICE (FUSE BLOCK)
B3	58 18GY/BK	JUMPER FROM B1
B4	F22 14OR	FUEL PUMP
B5	99 12BK	GROUND
B6	58 18GY/BK	BRAKE BULB CHECK
C1	—	—
C2	78 18GY/BK	LEFT TURN SIGNAL LAMPS
C3	—	—
C4	55 18VT	COOLANT TEMPERATURE
C5	30 18GN/WT	TACHOMETER
C6	18 18YL/BK	BACKUP LAMPS
D1	10 14RD	BATTERY
D2	—	—
D4	10 12RD	BATTERY
D5	11 14YL	I-1 IGNITION SWITCH
E1	76 16WT	DIMMER SWITCH-HI BEAM
E2	465 18LB/BK	LEFT WARNING INDICATOR
E4	10 12RD	BATTERY
E5	463 16BR/WT	FUSE BLOCK
F1	F5 16BL/WT	FOG LAMP SWITCH
F2	—	—
F3	44 18VT/WT	WINDSHIELD WIPER WASHER PUMP FEED
F4	37 14OR/WT	BLOWER MOTOR FEED
F5	54 18LB	OIL PRESSURE
F6	126 18BR/LB	UPSHIFT INDICATOR
G1	—	—
G2	—	—
G3	31 14GY	HORN RELAY
G4	10 12RD	BATTERY
G5	33 14GN	IGNITION SWITCH-START
G6	75 18BR/WT	REVERSE SWITCH
H1	77 16LG/BK	DIMMER SWITCH-LO BEAM
H2	—	—
H3	—	—
H4	138 16LG	A/C REQUEST
H5	—	—
H6	106 18BK/YL	4 WHEEL DRIVE LAMP



J908W-2

BULKHEAD CONNECTOR

YJ 66



(BEHIND GAUGE PACKAGE)

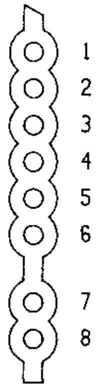
CAV	GAUGE PACKAGE CIRCUITS	
1	55 18VT	COOLANT TEMPERATURE
2	14 18WT/BK	GAUGES FUSE
2	14 18WT/BK	GAUGES FUSE
3	99 18BK	GROUND
4	57 18TN	FUEL LEVEL
5	14 18WT/BK	GAUGES FUSE
6	54 18LB	OIL PRESSURE
7	51 18PK	CLOCK FEED
8	—	—
9	—	—
10	52 18OR/BK	ILLUMINATION
10	52 18OR/BK	ILLUMINATION
11	—	—
12	52 18OR/BK	ILLUMINATION

YJ 67

12-WAY GAUGE PACKAGE CONNECTOR

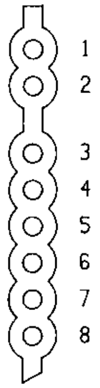
J908W-2

CAV	INDICATOR CIRCUITS	
1	—	—
2	—	—
3	58 18GY/BK	PARKING BRAKE
4	189 18GY	EMISSION MAINTENANCE WARNING INDICATOR
5	14 18WT/BK	GAUGES FUSE
6	126 18LB/BK	UPSHIFT (2.5L/5 SPD ONLY)
7	465 18LB/BK	DAYTIME RUNNING LAMP
8	78 18GY/BK	LEFT TURN SIGNAL



(LEFT OF STEERING COLUMN)

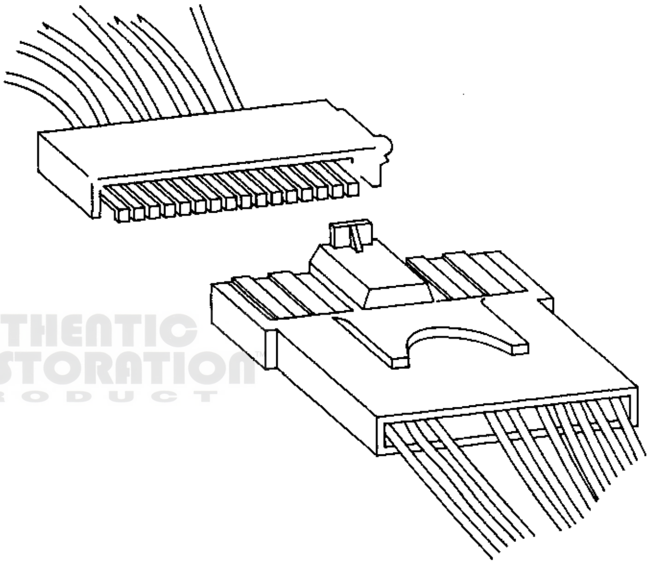
CAV	INDICATOR CIRCUITS	
1	99 18BK	GROUND
2	—	—
3	79 18BR	RIGHT TURN SIGNAL
4	—	—
5	—	—
6	60 18WT/OR	SEAT BELT INDICATOR
7	106 18BK/YL	4 WHEEL DRIVE
8	52 18OR/BK	INSTRUMENT PANEL ILLUMINATION

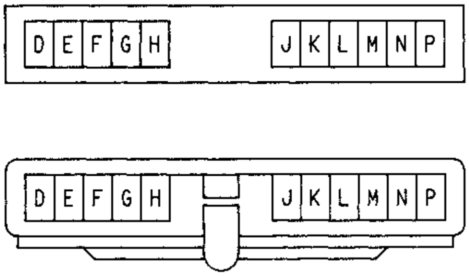


(RIGHT OF STEERING COLUMN)

8-WAY INDICATOR CONNECTORS

CAV	TURN SINGAL SWITCH CIRCUITS	
P	71 18LB/BK	STOP LAMPS
N	79 18BR/RD	RIGHT TURN-REAR
M	78 18GY/BK	LEFT TURN-REAR
L	74 18GY	TURN SIGNAL FLASHER
K	80 18VT/WT	HAZARD FLASHER
J	79 18BR	RIGHT TURN-FRONT/INDICATOR
J	79 18BR	RIGHT TURN-FRONT/INDICATOR
H	128 18GY/BK	LEFT TURN-FRONT/INDICATOR
H	78 18GY/BK	LEFT TURN-FRONT/INDICATOR
G	128 18OR	HORN SWITCH
F	86 18WT	IGNITION KEY WARNING SWITCH
E	87 18WT	IGNITION KEY WARNING SWITCH
D	52 18OR/BK	PRNDL ILLUMINATION





YJ 69

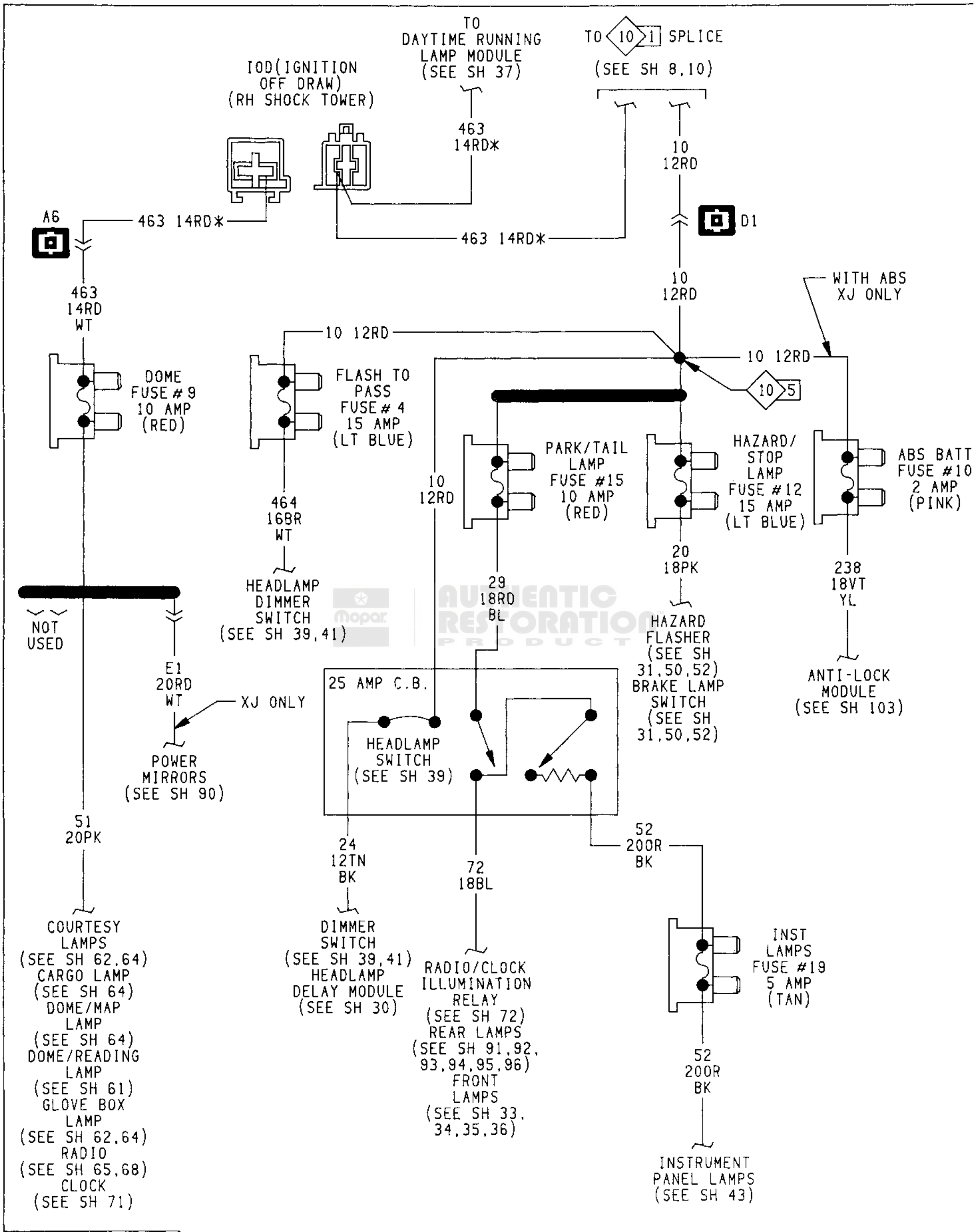
11 WAY STEERING COLUMN CONNECTOR

J908W-2

WIRE ROUTING AND COMPONENT LOCATION ELECTRICAL WIRING DIAGRAMS MJ/XJ SERIES

ALPHABETICAL INDEX

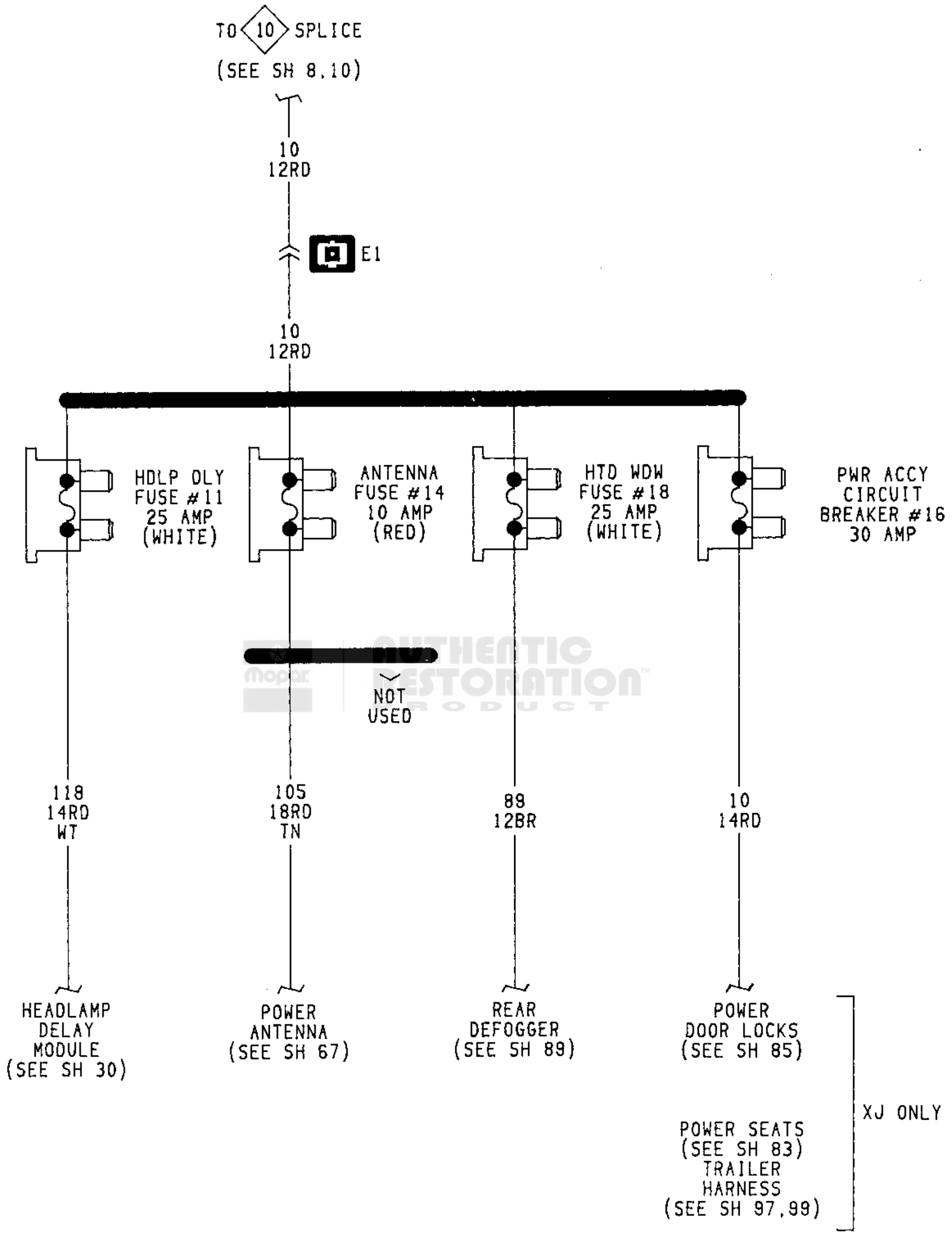
Name	Wiring Diagram Sheet Number
Coolant Temperature Sensor	17,23
Coolant Temperature Switch	28
Cooling Fan Relay	70
Cruise Control In-Line Fuse	31,106
Cruise Control Module	31,32
Cruise Control Servo	32
Cruise Control System	31,32
Brake Lamp Switch	31
Clutch Switch	31
Cruise Control In-Line Fuse	31
Cruise Control Module	31,32
Cruise Control Servo	32
Gauges Fuse	32
Hazard Flasher	31
Haz/Stop Fuse	31
Multi-Function Switch	31
Speed Sensor	32
Cruise Switch	31
Cruise/Trans Switch	25
Daytime Running Lamp Module (DRL)	37
Daytime Running Lamp System	37
Diagnostic Connectors (2.5L) 6 Way and 15 Way	112
Diagnostic Connectors (4L) 6 Way and 15 Way	113
Dome Fuse	1,62,64,90
Dome Lamp	61
Dome, Courtesy Lamps and Cigar Lighter	61,62,63,64
Cargo Box Lamp	64
Cargo Lamp	62
Cargo Lamp Switch	41,62,64
Cigar Lighter	61,63
Dome Fuse	1,62,64,90
Dome Lamp	61
Dome/Reading Lamp	61
Glove Box Lamp	62,64
Headlamp Switch	1,39,41
LH Courtesy Lamp	62,64
LH Dome/Map Lamp	64
LH Front Door Jamb Switch	62,63
LH Rear Door Jamb Switch	62
LIftgate Lamp Switch	62
Radio Fuse	61,63
RH Courtesy Lamp	62,64
RH Dome/Map Lamp	64
Vanity Lamps	61,63
Dome/Reading Lamp	61
EGR/Evaporative Canister Purge Solenoid	14,21
Electronic Control Unit (2.5L Engine)	13,14,15,16,17,18
Electronic Control Unit (4L Engine)	19,20,21,22,23,24
EFI — Ignition System 2.5L Engine	13,14,15,16,17,18
Air Temperature Sensor	17
B+ Latch Relay	15
Coolant Temperature Sensor	17
EGR/Evaporator Canister Purge Solenoid	14
Electronic Contl Unit	13,14,15,16,17,18
Engine Speed Sensor	16
Fuel Injector	14
Fuel Pump Relay	14
Heated Exhaust Gas Oxygen Sensor	13
Idle Speed Actuator	18
Ignition Module	13
MAP Sensor	17
Power Steering Pressure Switch	18
Throttle Position Sensor	17
Upshift Switch	16
EFI — Ignition System 4L Engine	19,20,21,22,23,24
Air Stepper Motor	24
Air Temperature Sensor	23
B+ Latch Relay	22
Ballast Resistor	21
Coolant Temperature Sensor	23
EGR/Evaporation Canister Purge Solenoid	21
Electronic Control Unit (ECU)	19,20,21,22,23,24
Engine Speed Sensor	21
Fuel Injectors	24
Fuel Pump Relay	20
Heated Oxygen Sensor	20
Ignition Module	19
Knock Sensor	24
MAP Sensor	23
Oxygen Sensor Heat Relay	20
Sync Sensor	19
Throttle Position Sensor	23
Emission Main Indicator Lamp	59,61
Emission Maintenance Timer	47
Emissions Maintenance	47
Engine Speed Sensor	16,21
4 Door Power Windows	77,78,79
LH Front Window Motor	77
LH Rear Window Motor	79
LH Rear Window Switch	79
Master Door Lk/Wdo Switch	77,78
PWR WDO Circuit Breaker	77
RH Front Door Lk/Wdo Switch	79
RH Rear Window Motor	79
RH Rear Window Switch	79
4 WD Indicator Lamp	59,60
4 WD Switch	46
Fan Diode Assembly	70
Flash To Pass	1,39,41
Fog Lamp Relay	33,35
Fog Lamp Switch	40,42
Fog Lamp Switch Lamp	43
Front Lighting	33,34,35,36
Fog Lamp Relay	33,35
Left Fog Lamp	33,35
Left Headlamp	33,35
Left Park/Turn Signal Lamp	33,35
Left Side Marker Lamp	33,35
Right Fog Lamp	34,36
Right Headlamp	34,36
Right Park/Turn Signal Lamp	34,36
Right Side Marker Lamp	34,36
Front Washer Pump	53,54
Front Wiper Motor	53,54



MJ-XJ 1

FUSE APPLICATION CHART

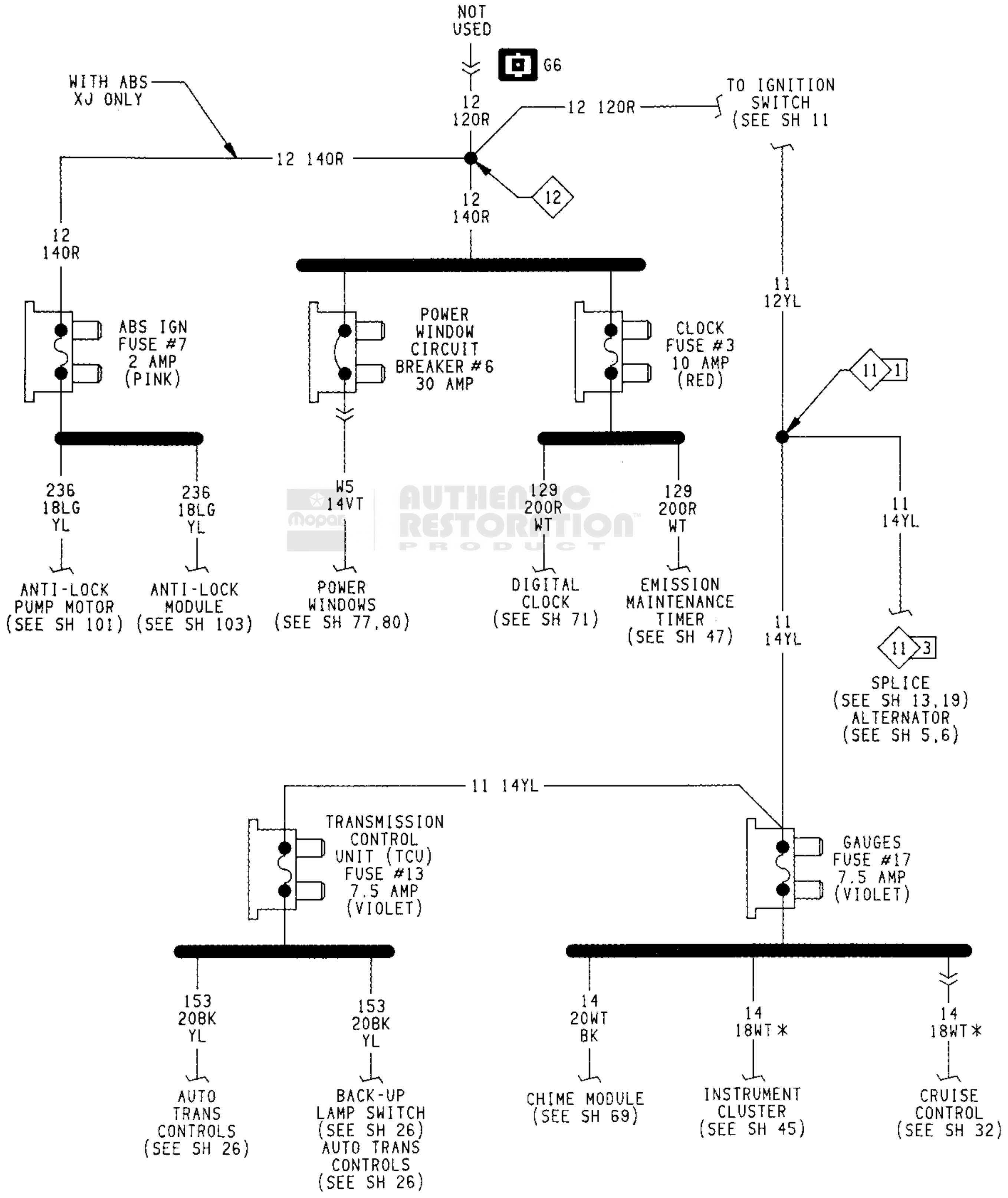
J908W-3



J908W-3

FUSE APPLICATION CHART

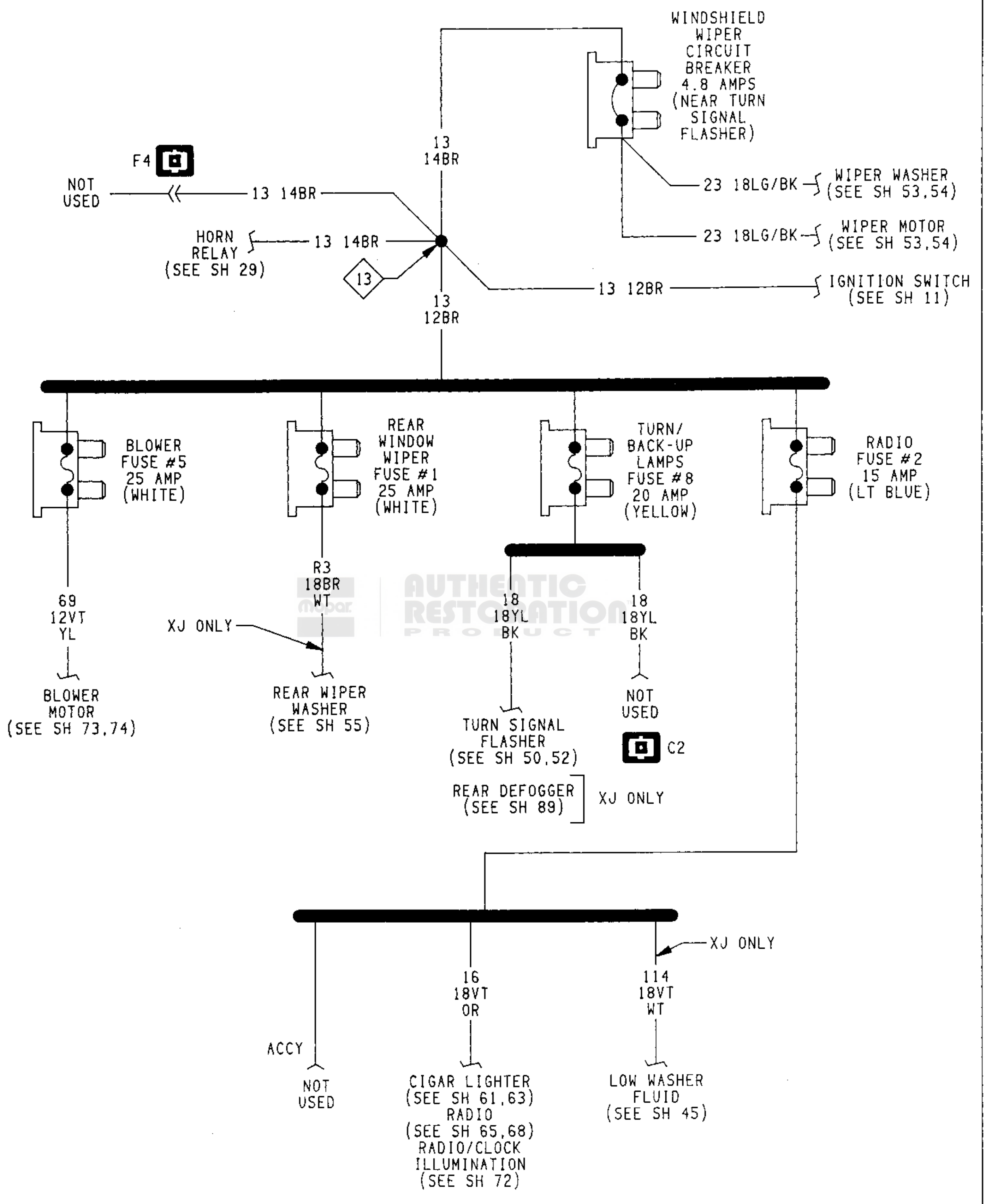
MJ-XJ 2



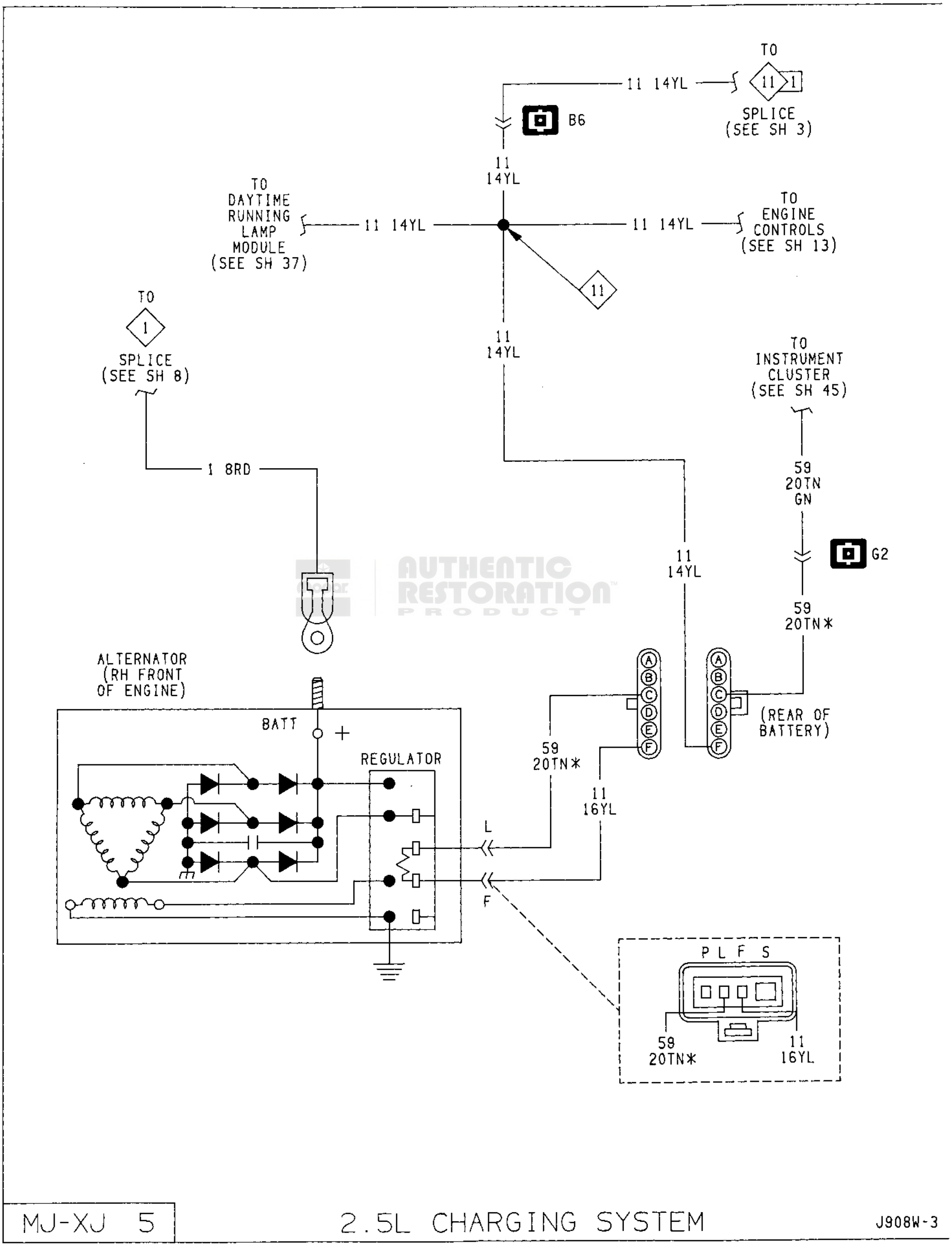
MJ-XJ 3

FUSE APPLICATION CHART

J908W-3



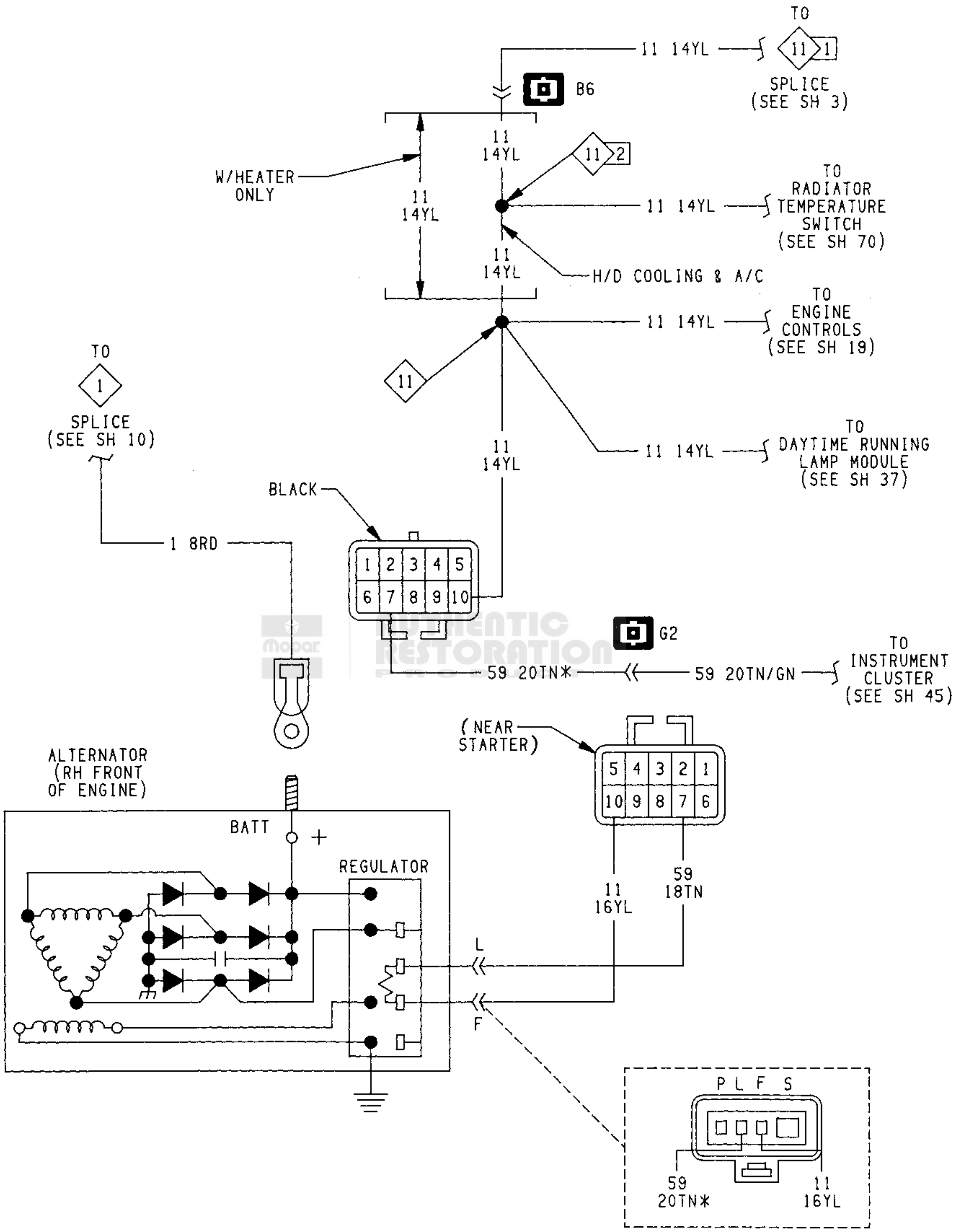
J908W-3 FUSE APPLICATION CHART MJ-XJ 4



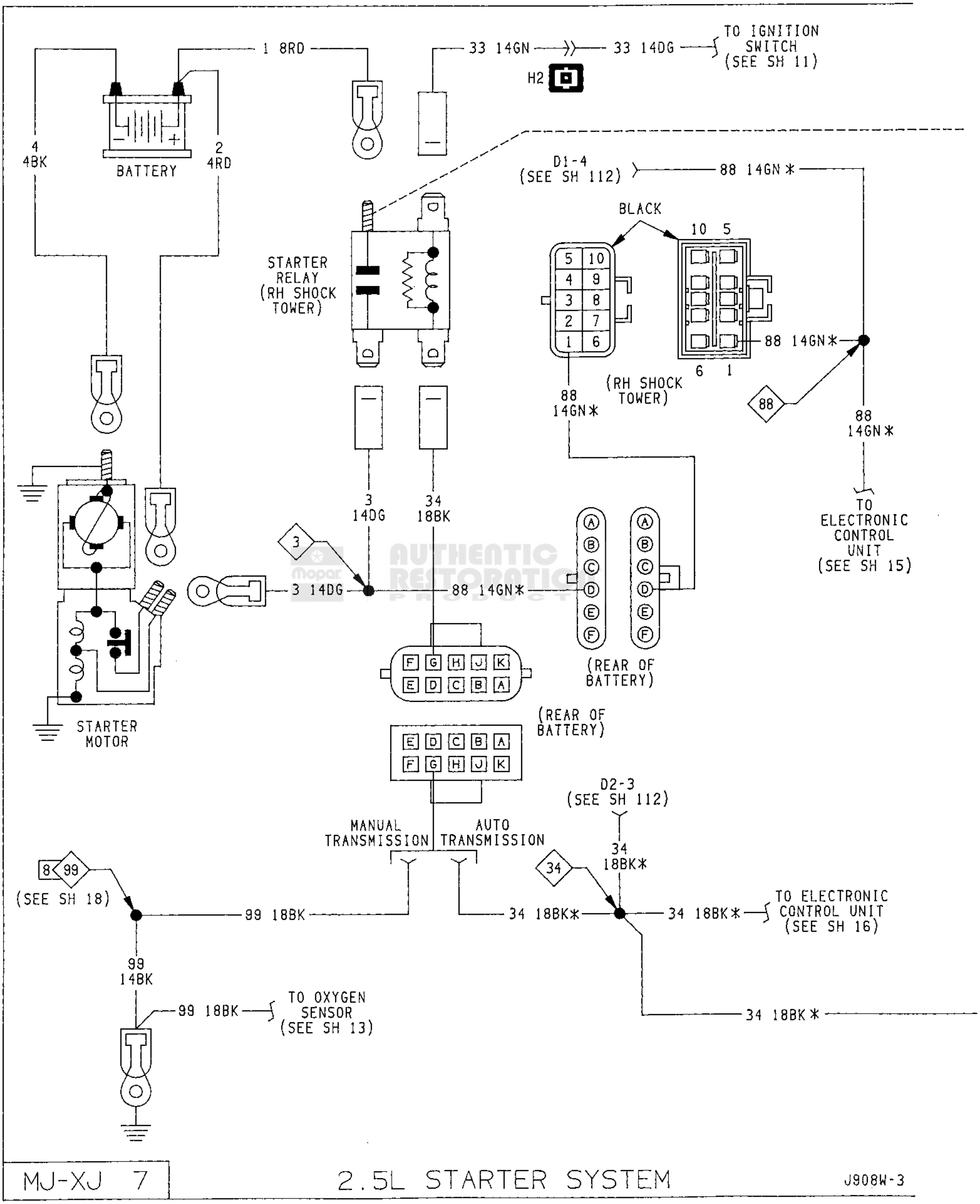
MJ-XJ 5

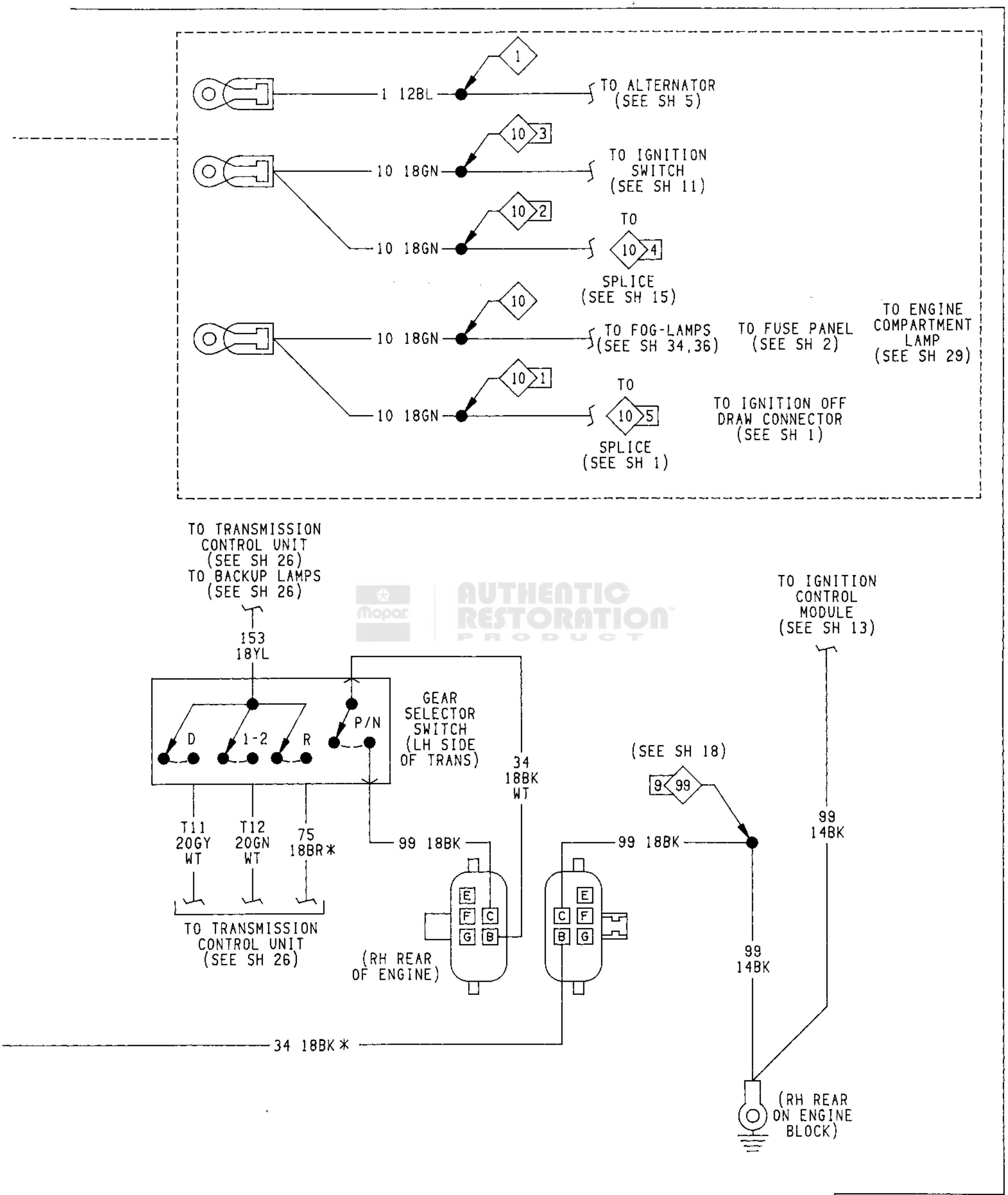
2.5L CHARGING SYSTEM

J908W-3

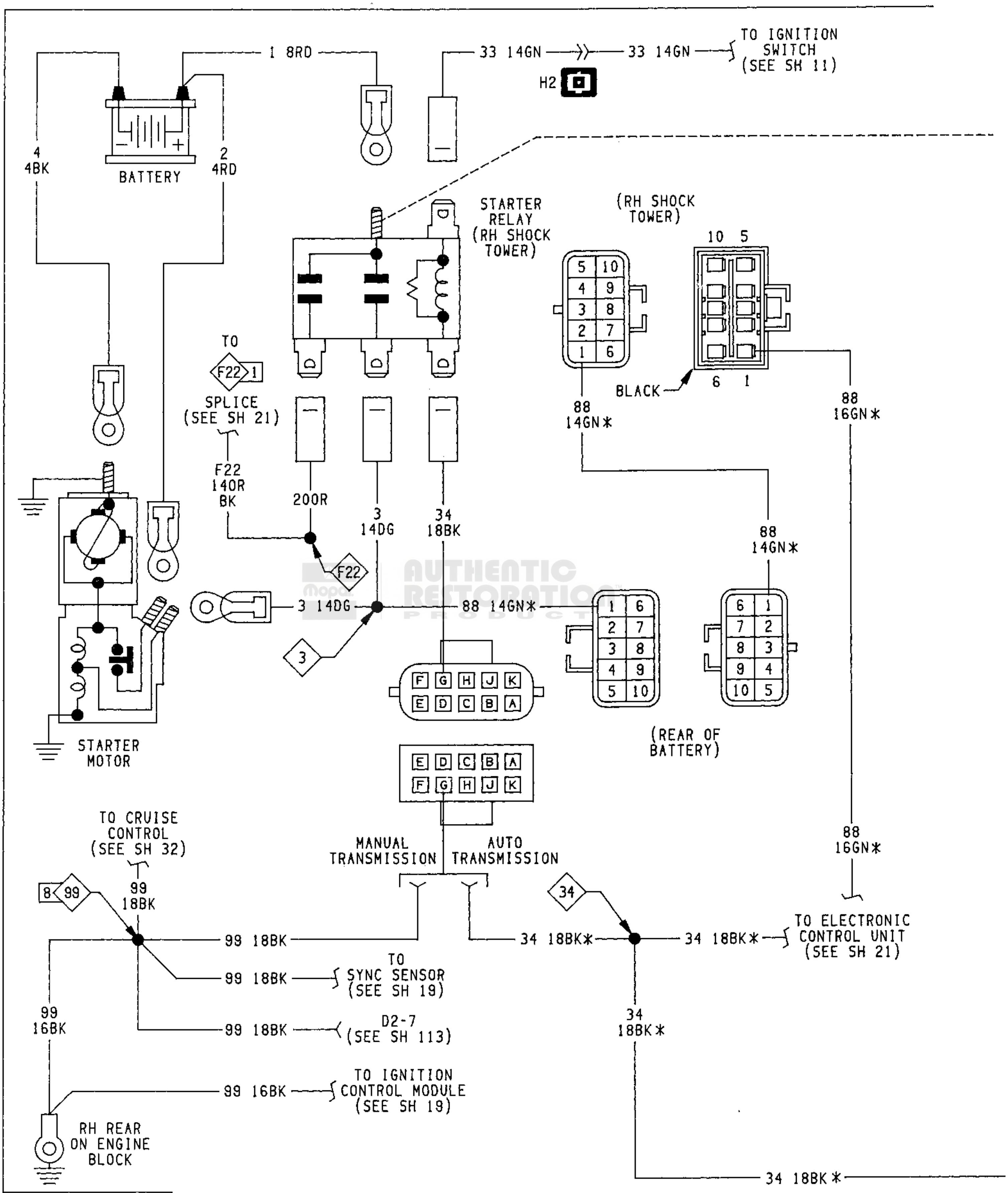


4.0L CHARGING SYSTEM


1 8RD
33 14GN
33 14DG
TO IGNITION SWITCH (SEE SH 11)
H2
4 4BK
BATTERY
2 4RD
D1-4 (SEE SH 112)
88 14GN*
BLACK
10 5
STARTER RELAY (RH SHOCK TOWER)
5 10
4 9
3 8
2 7
1 6
88 14GN*
6 1
(RH SHOCK TOWER)
88 14GN*
88
88 14GN*
TO ELECTRONIC CONTROL UNIT (SEE SH 15)
3 14DG
34 18BK
3
3 14DG
88 14GN*
A B C D E F
(REAR OF BATTERY)
F G H J K
E D C B A
STARTER MOTOR
(REAR OF BATTERY)
E D C B A
F G H J K
D2-3 (SEE SH 112)
MANUAL TRANSMISSION
AUTO TRANSMISSION
8 99
(SEE SH 18)
34
34 18BK*
99 18BK
34 18BK*
34 18BK*
TO ELECTRONIC CONTROL UNIT (SEE SH 16)
99 14BK
99 18BK
TO OXYGEN SENSOR (SEE SH 13)
34 18BK*
MJ-XJ 7
2.5L STARTER SYSTEM
J908W-3



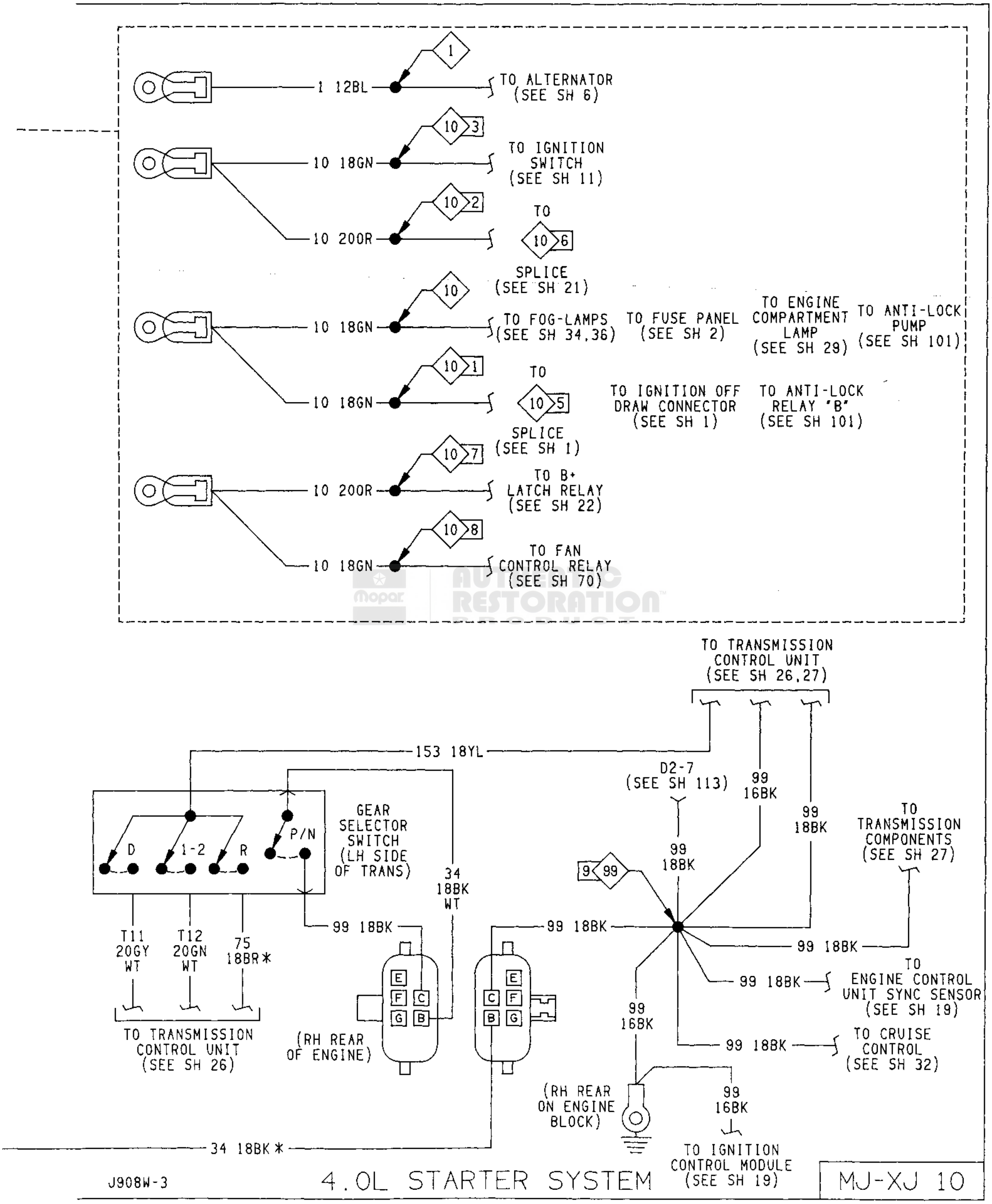
2.5L STARTER SYSTEM



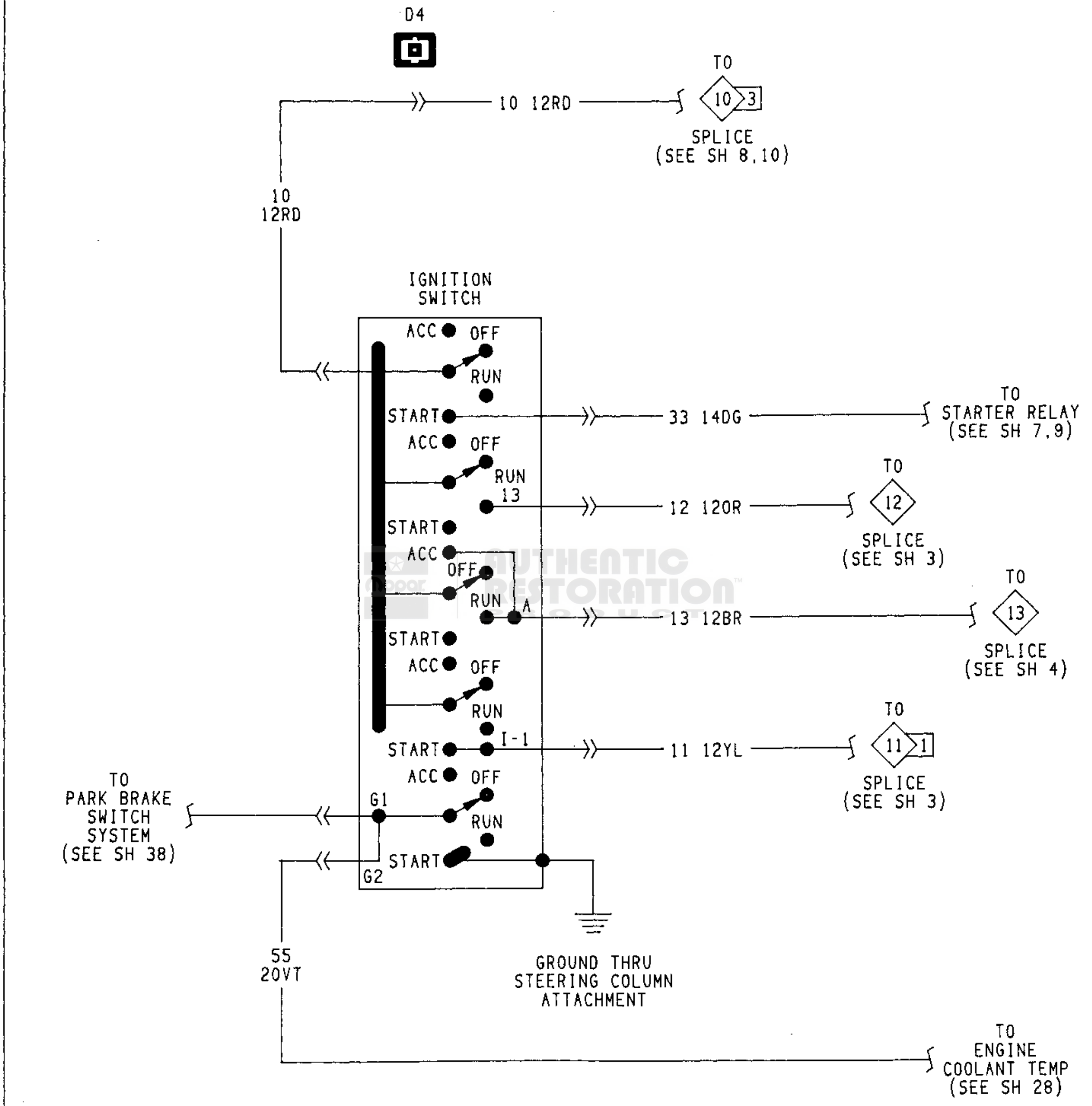
MJ-XJ 9

4.0L STARTER SYSTEM

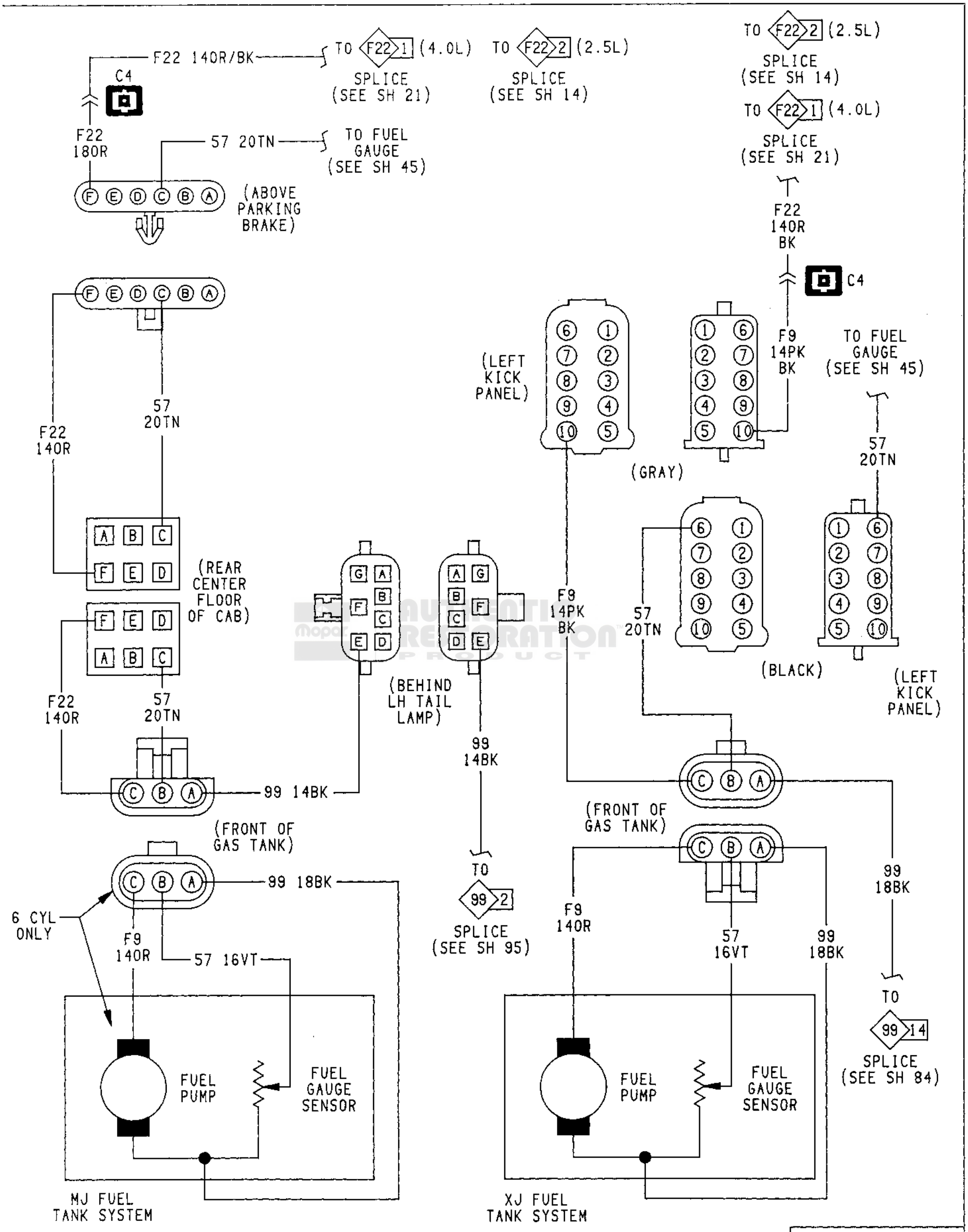
J908W-3



4.0L STARTER SYSTEM



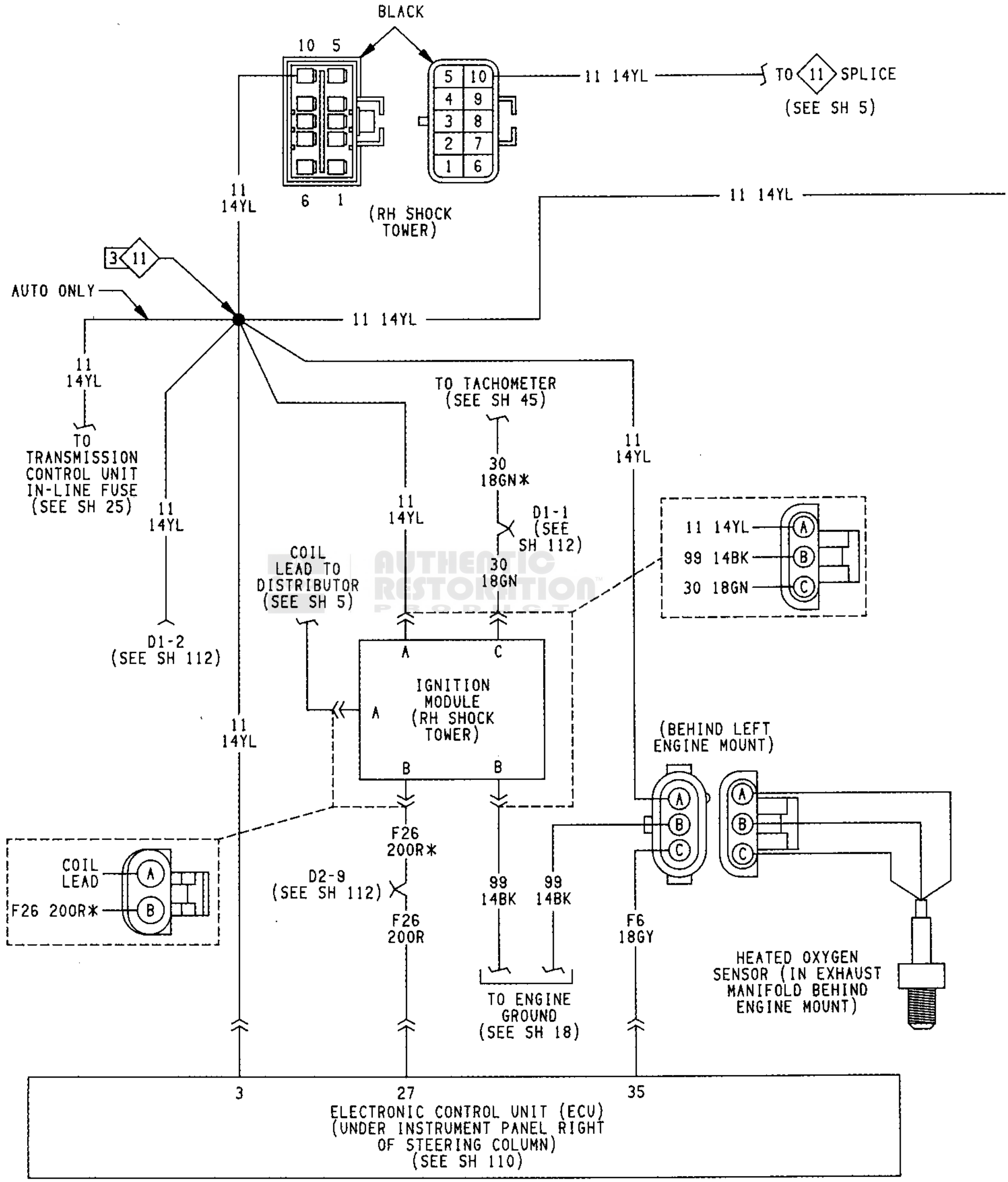
IGNITION SYSTEM



J908W-3

FUEL TANK SYSTEMS

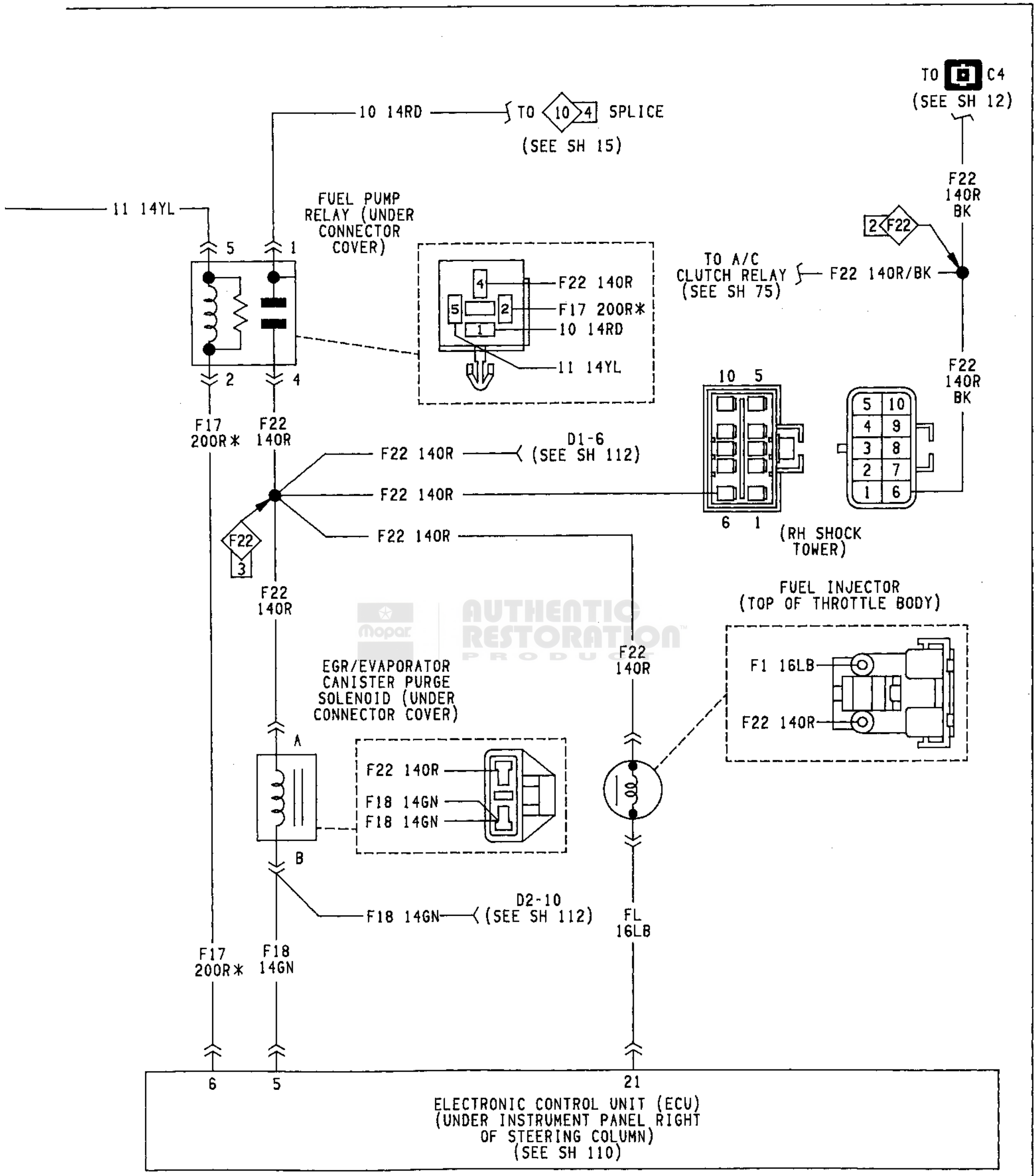
MJ-XJ 12



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

MJ-XJ 13

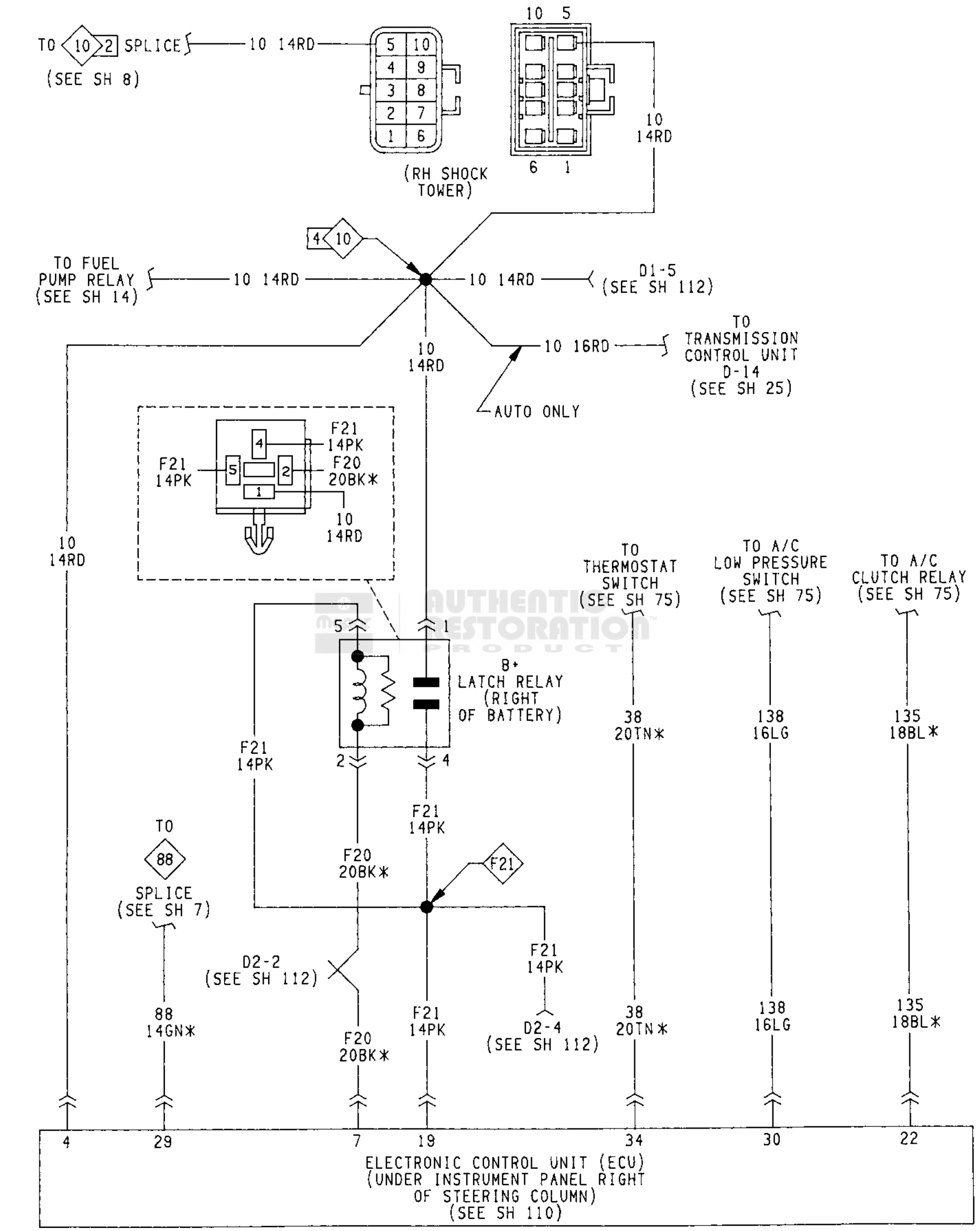
J908W-3



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

J908W-3

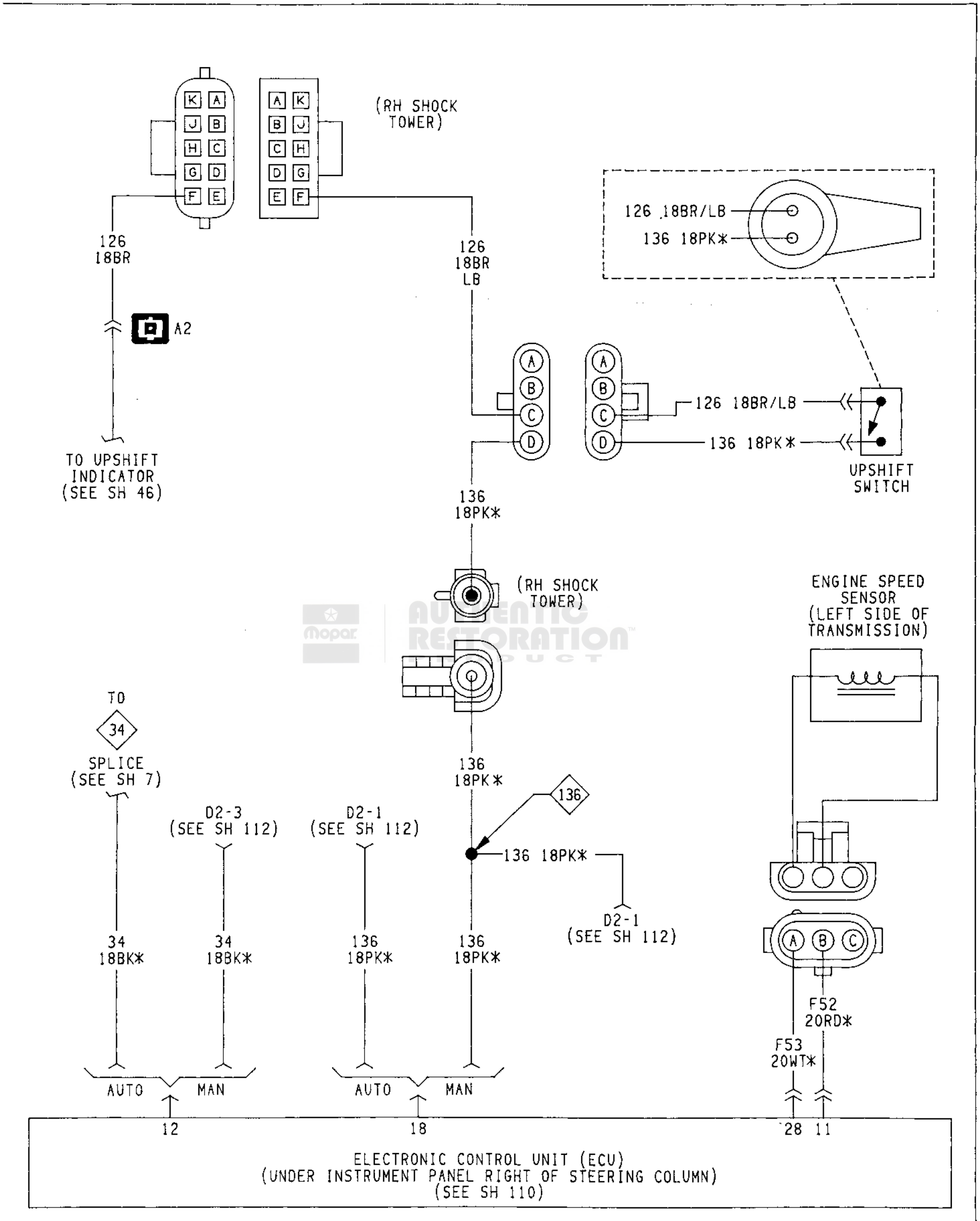
MJ-XJ 14



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

MJ-XJ 15

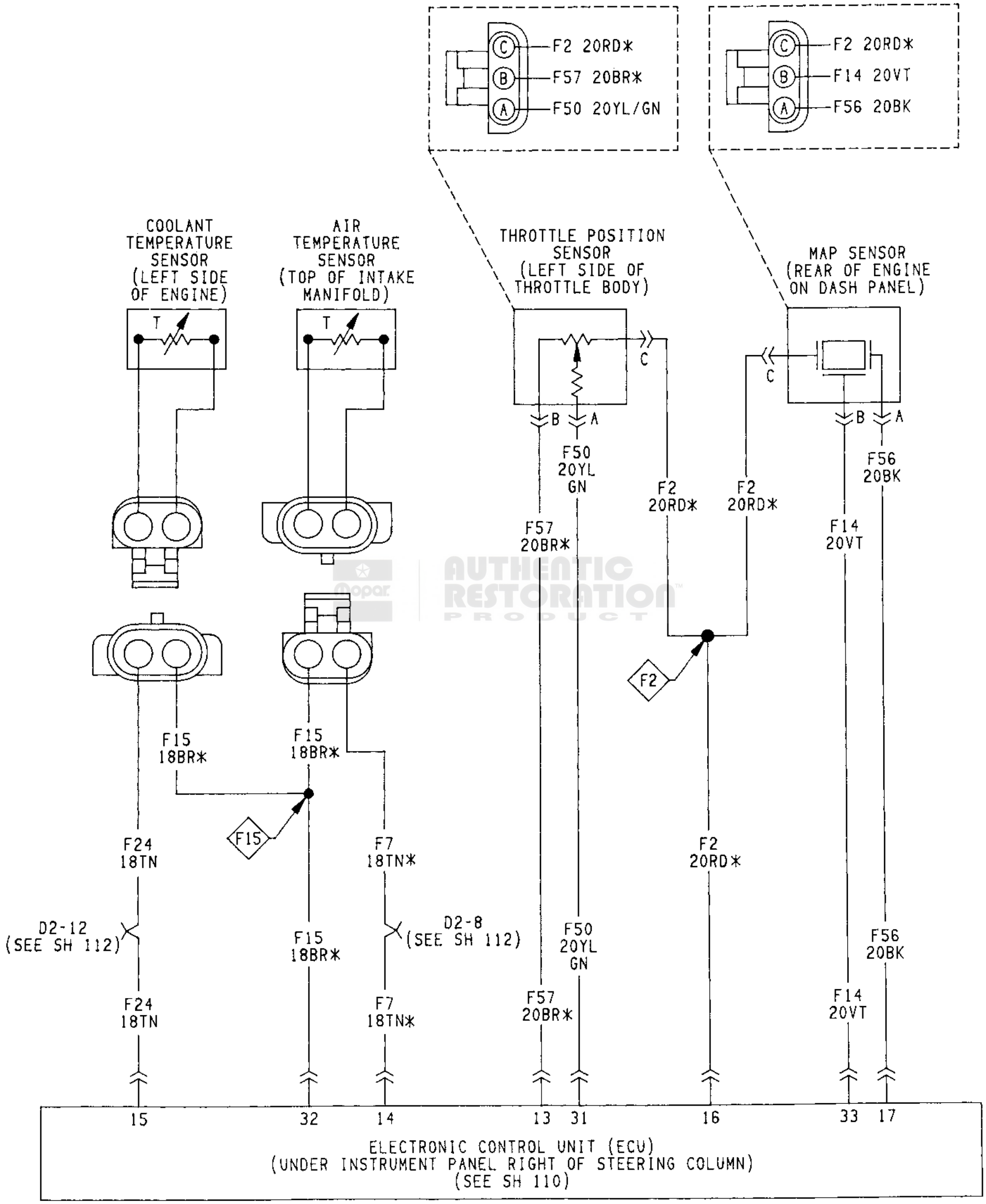
J908W-3



J908W-3

ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

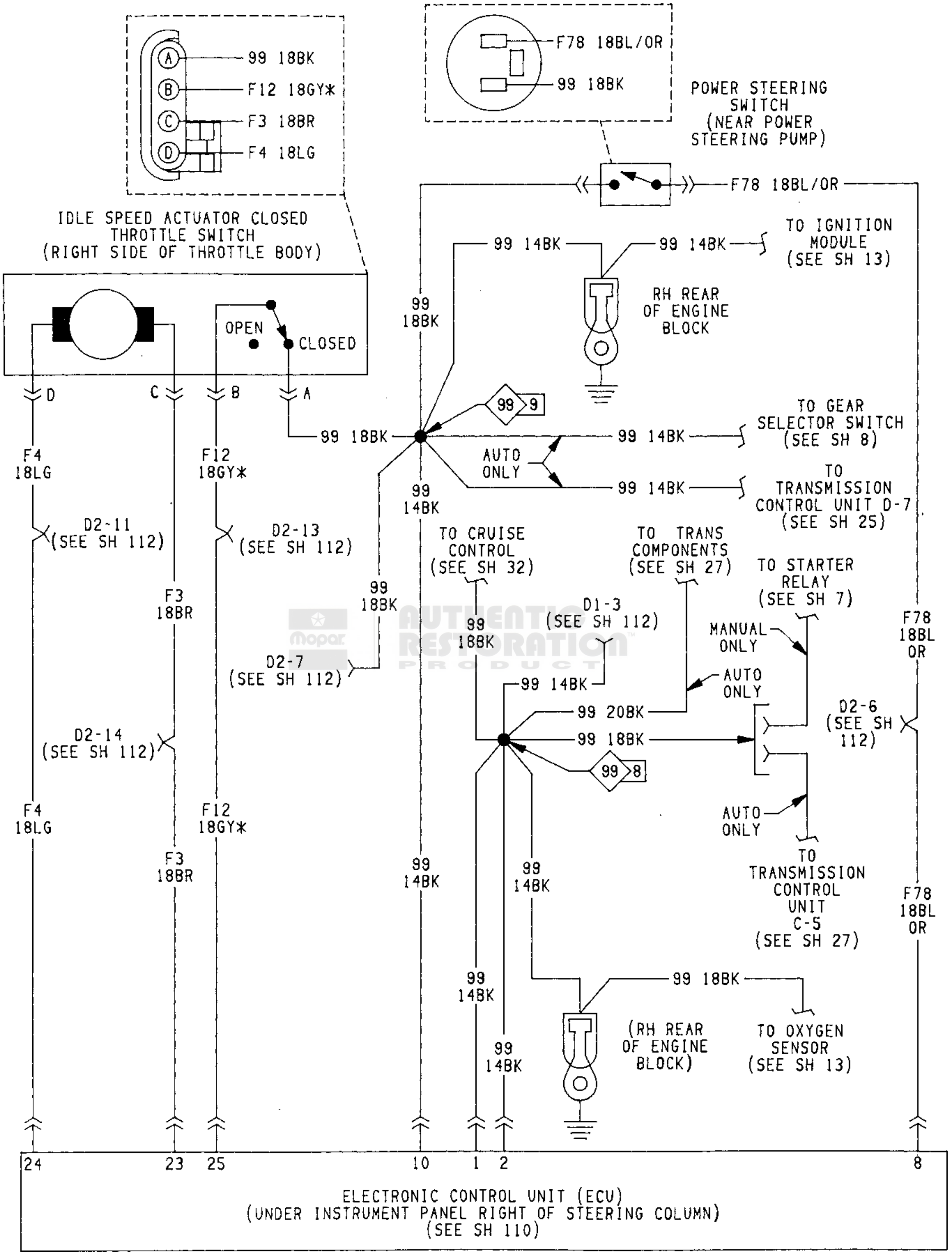
MJ-XJ 16



MJ-XJ 17

ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

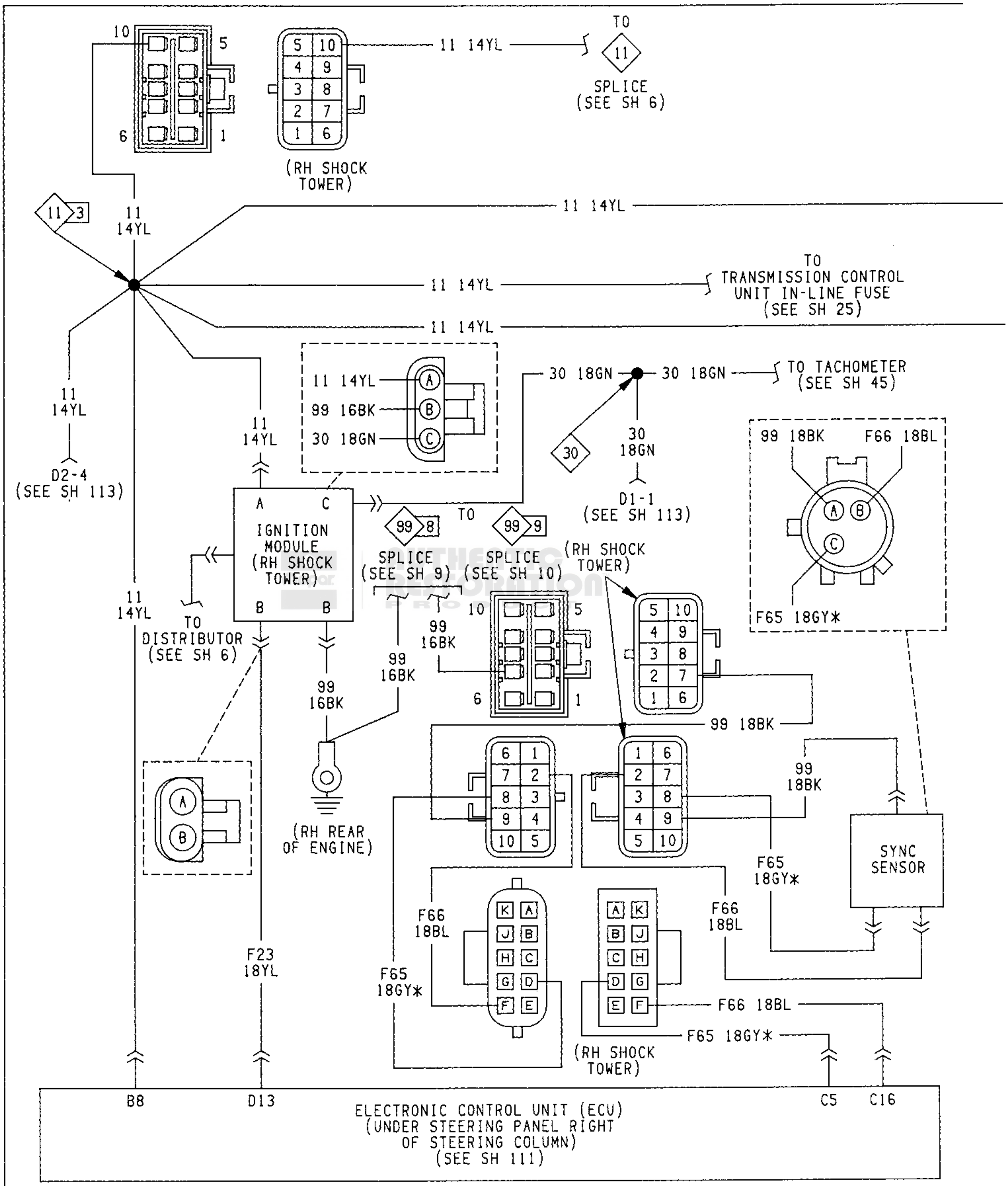
J908W-3



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 2.5L ENGINE

J908W-3

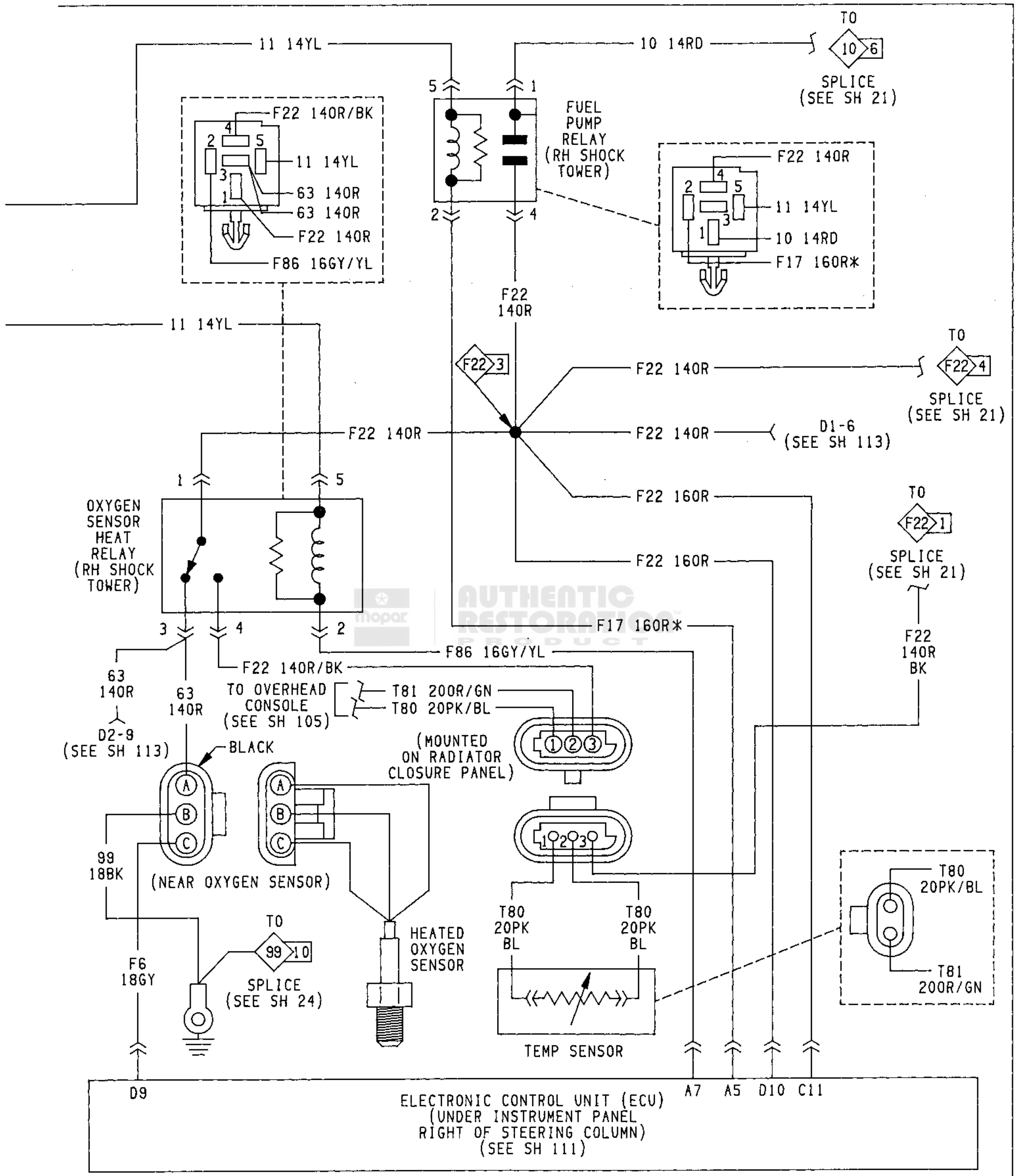
MJ-XJ 18



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 4.0L ENGINE

MJ-XJ 19

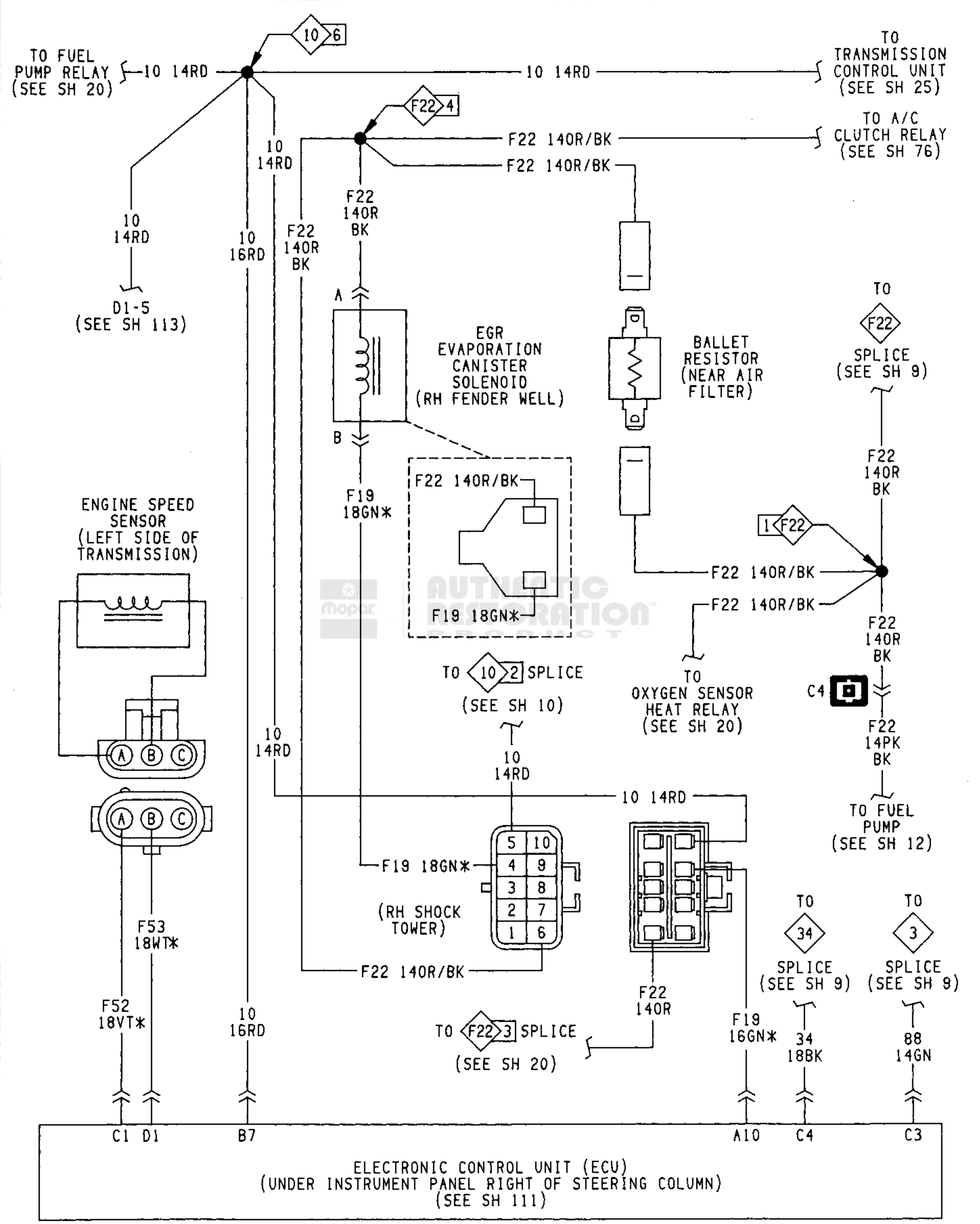
J908W-3



ELECTRONIC FUEL INJECTION IGNITION SYSTEM 4.0L ENGINE

J908W-3

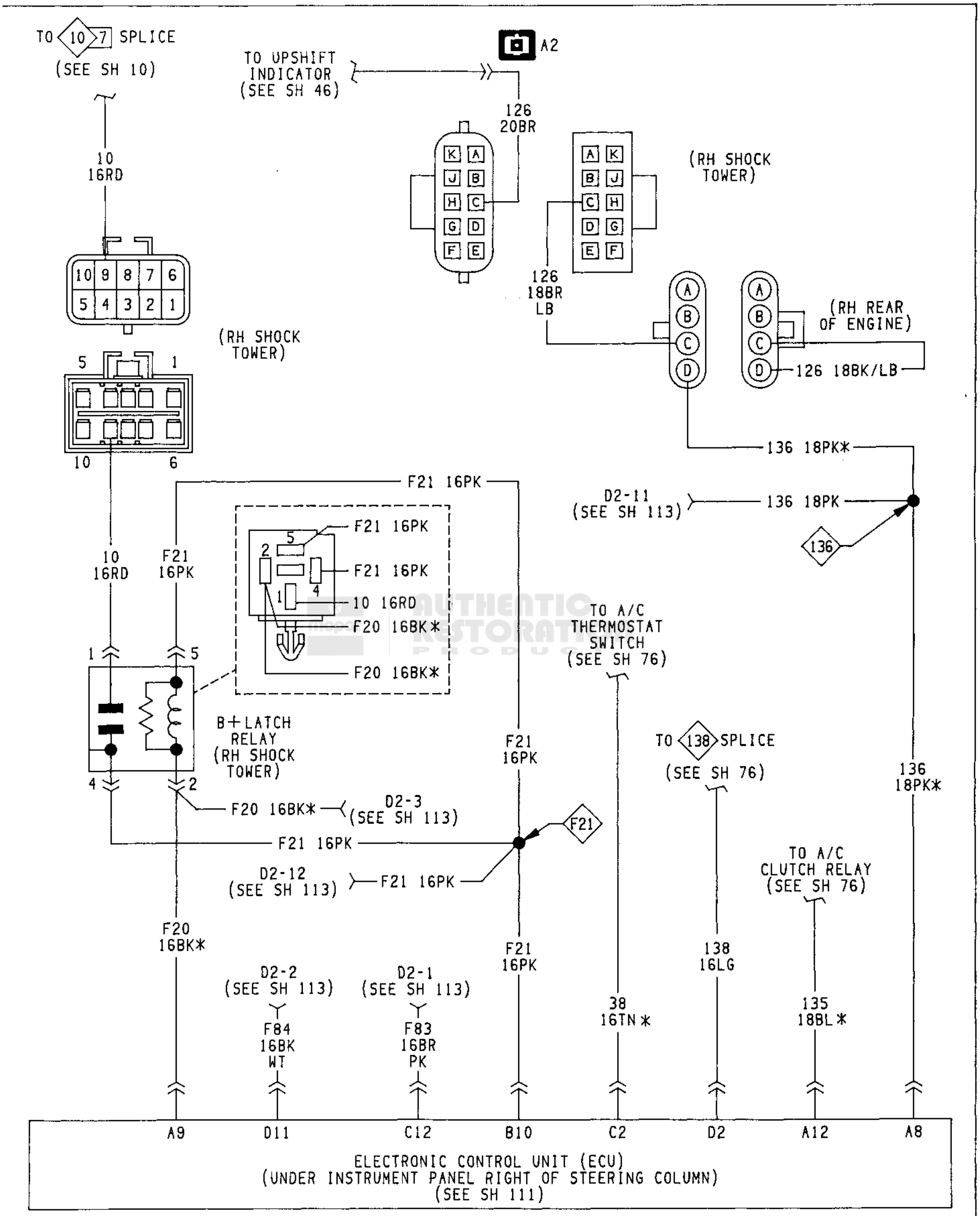
MJ-XJ 20



MJ-XJ 21

ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 4.0L ENGINE

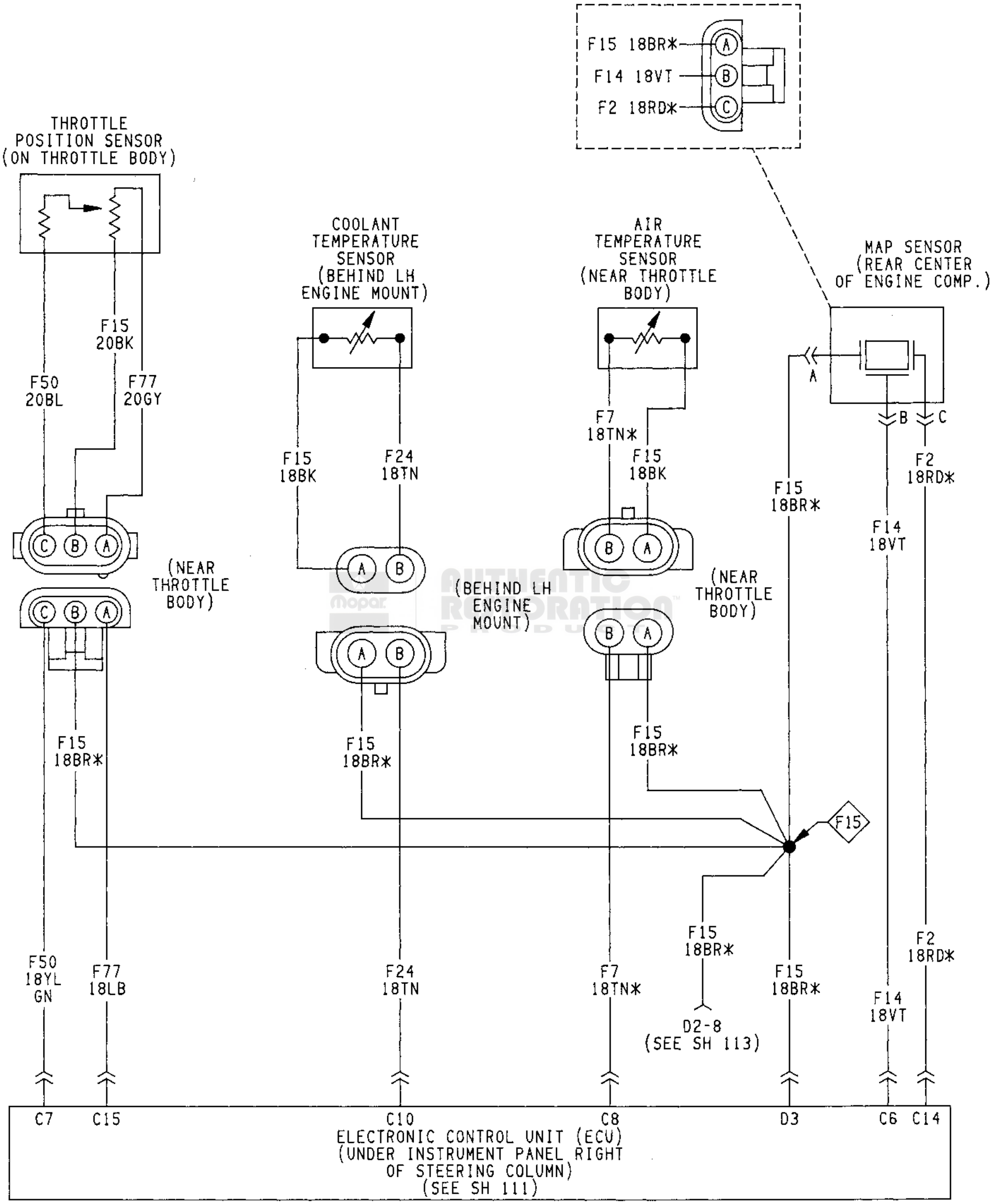
J908W-3



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 4.0L ENGINE

J908W-3

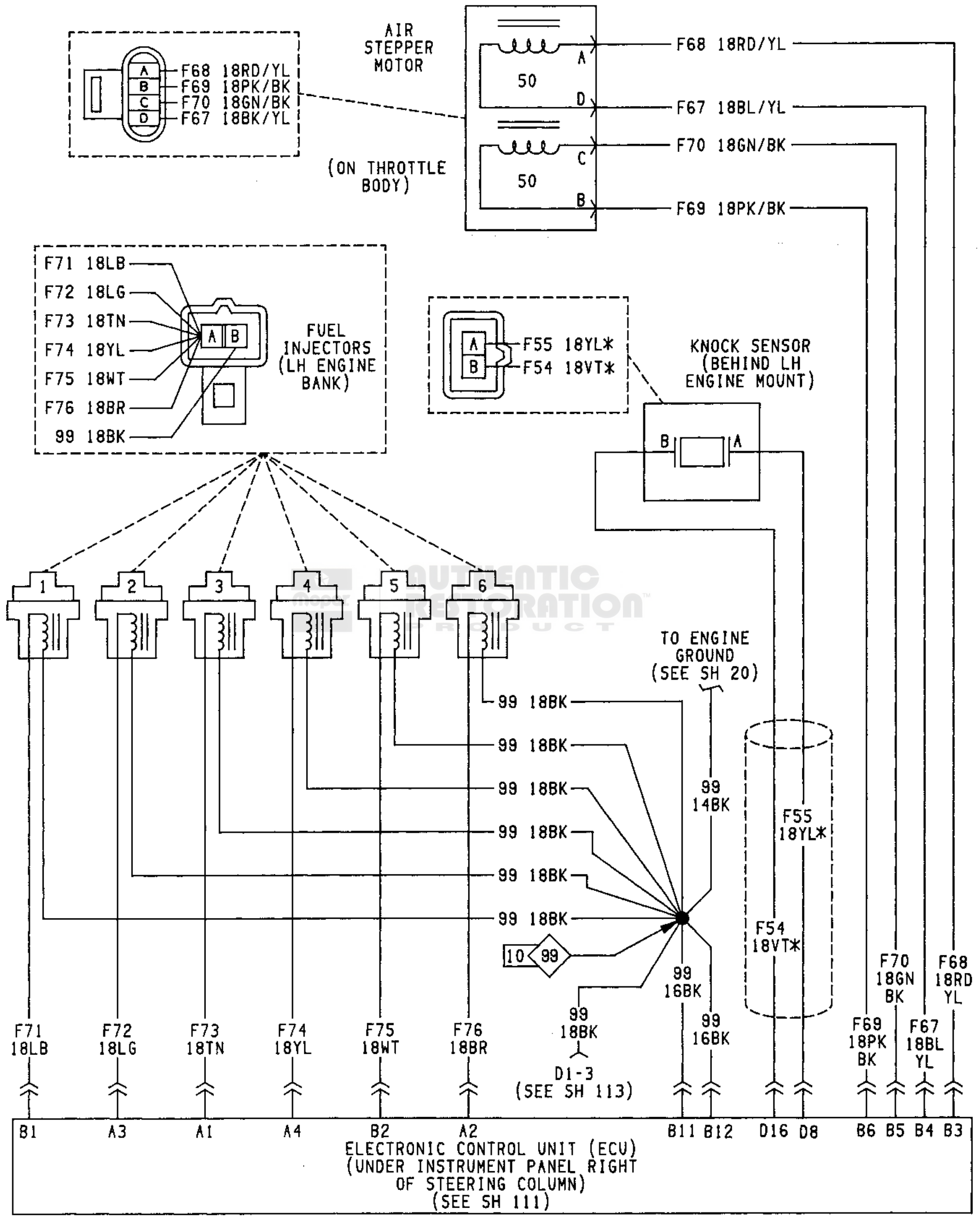
MJ-XJ 22



MJ-XJ 23

ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 4.0L ENGINE

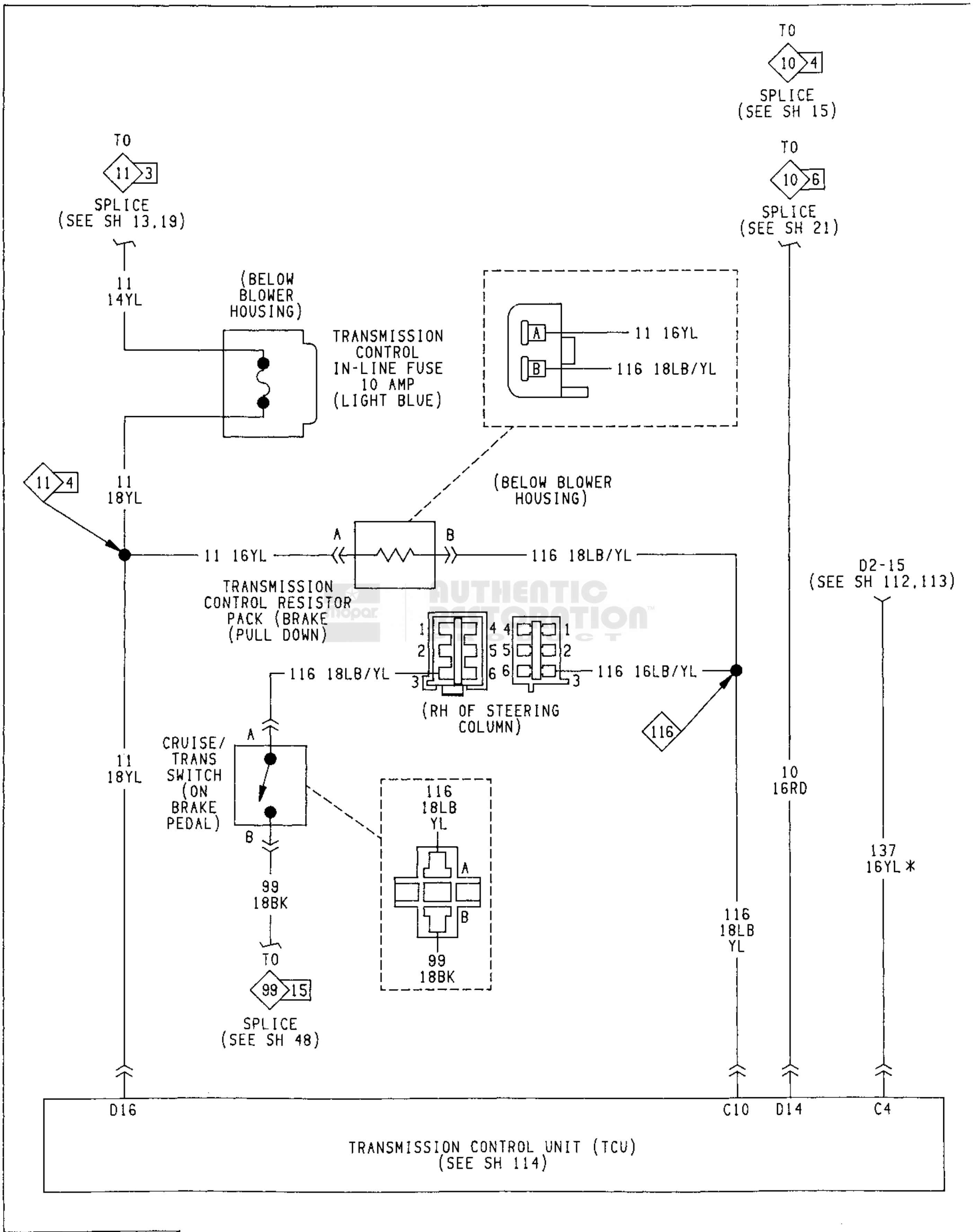
J908W-3



ELECTRONIC FUEL INJECTION
IGNITION SYSTEM 4.0L ENGINE

J908W-3

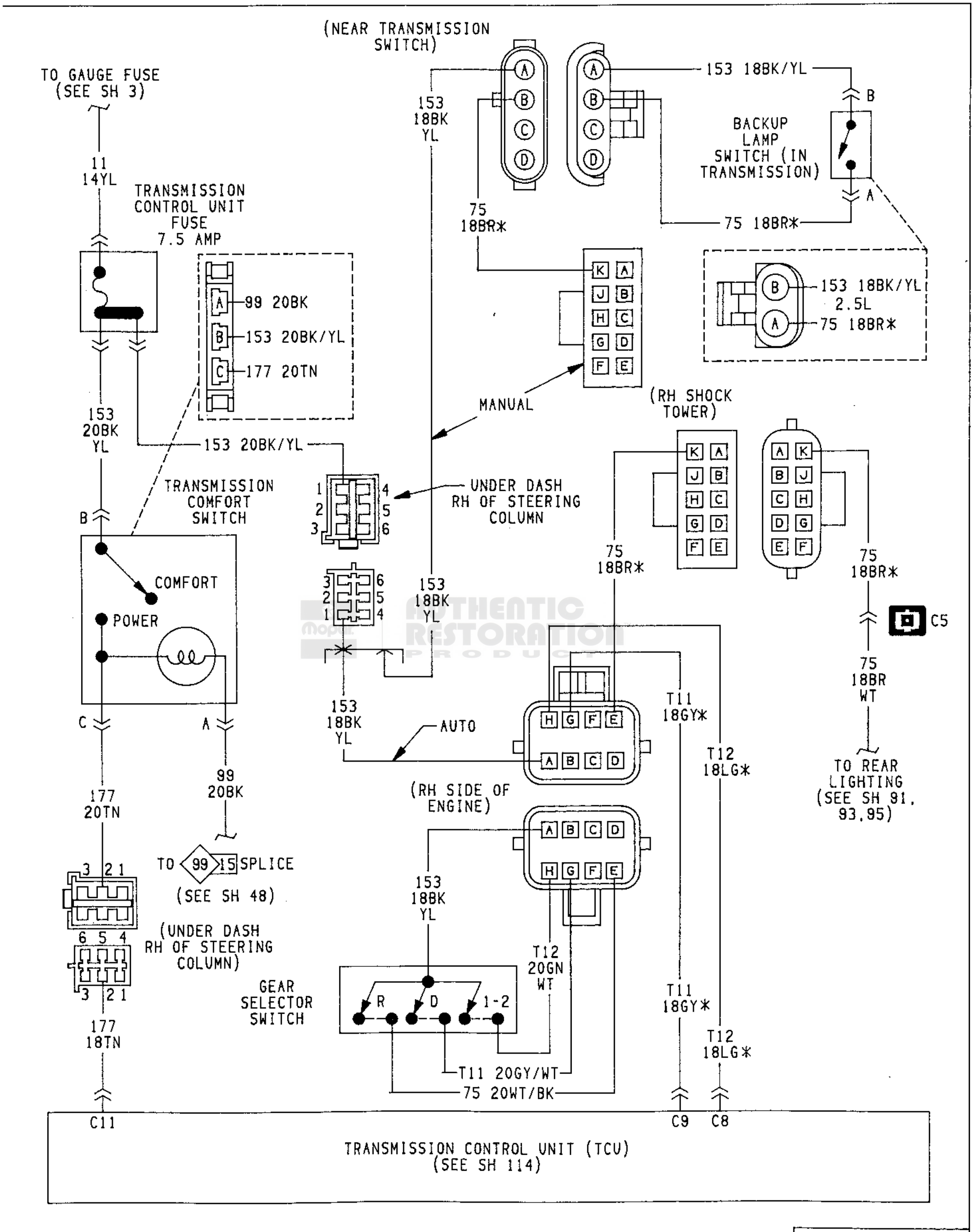
MJ-XJ 24



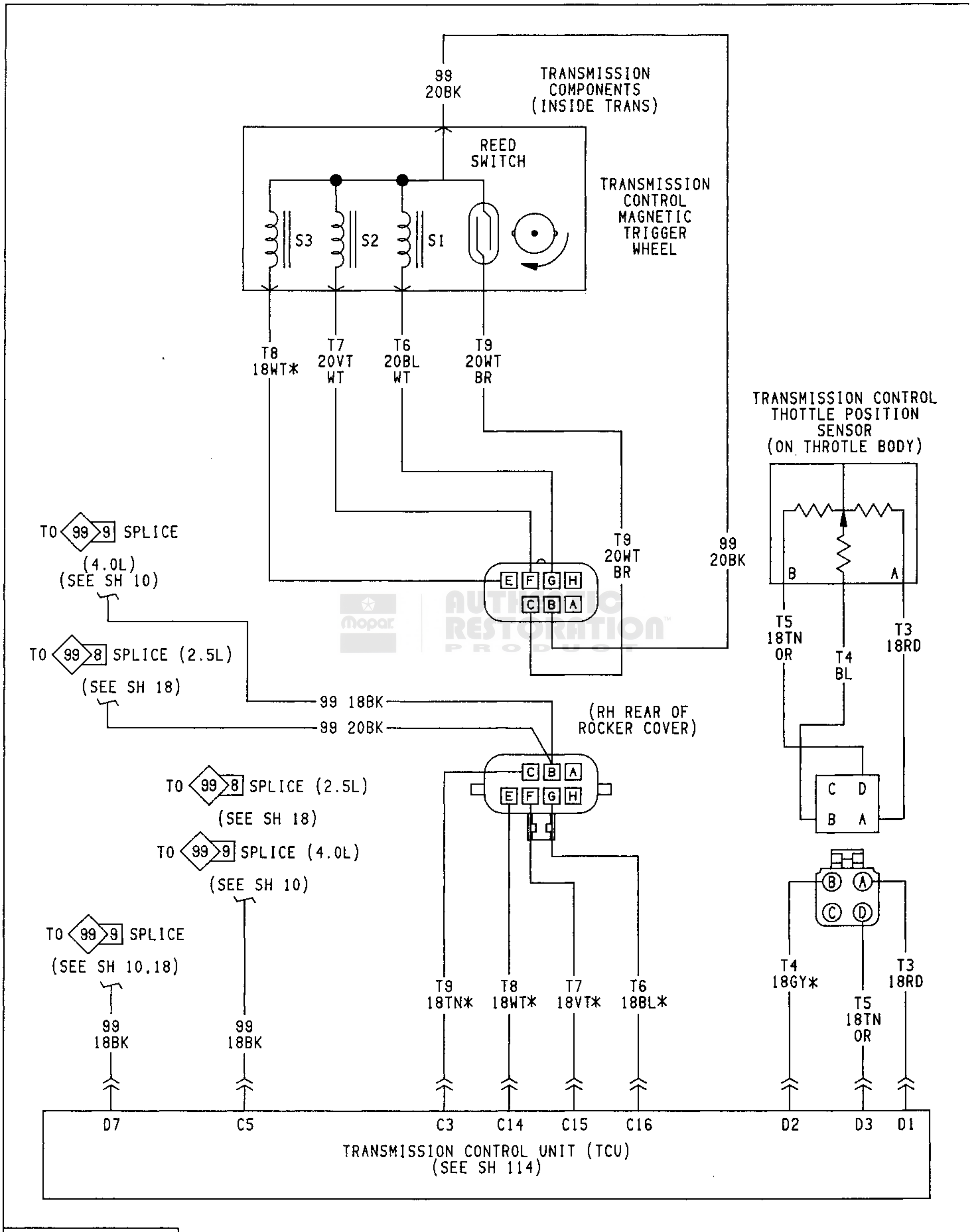
MJ-XJ 25

TRANSMISSION CONTROL SYSTEM

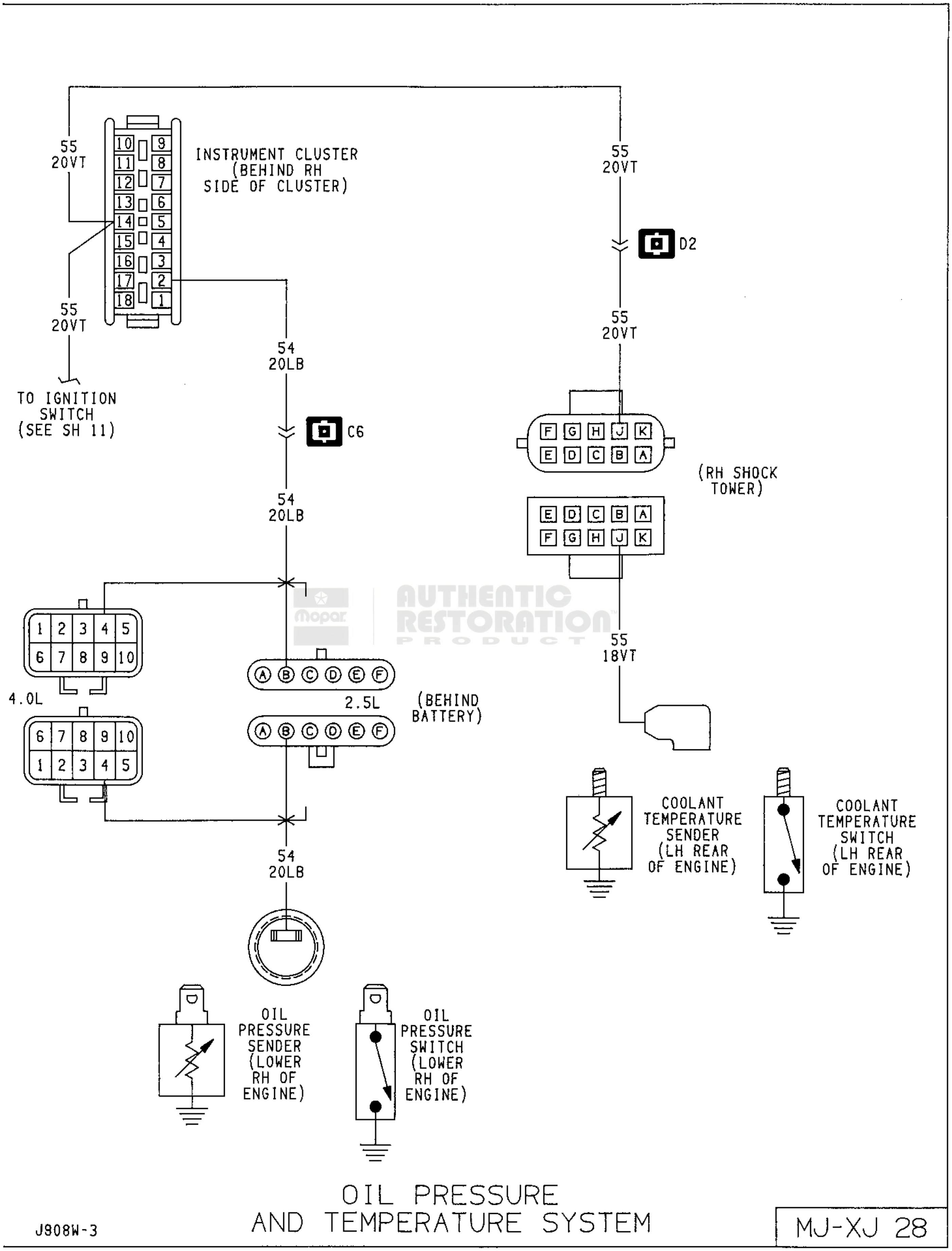
J908W-3



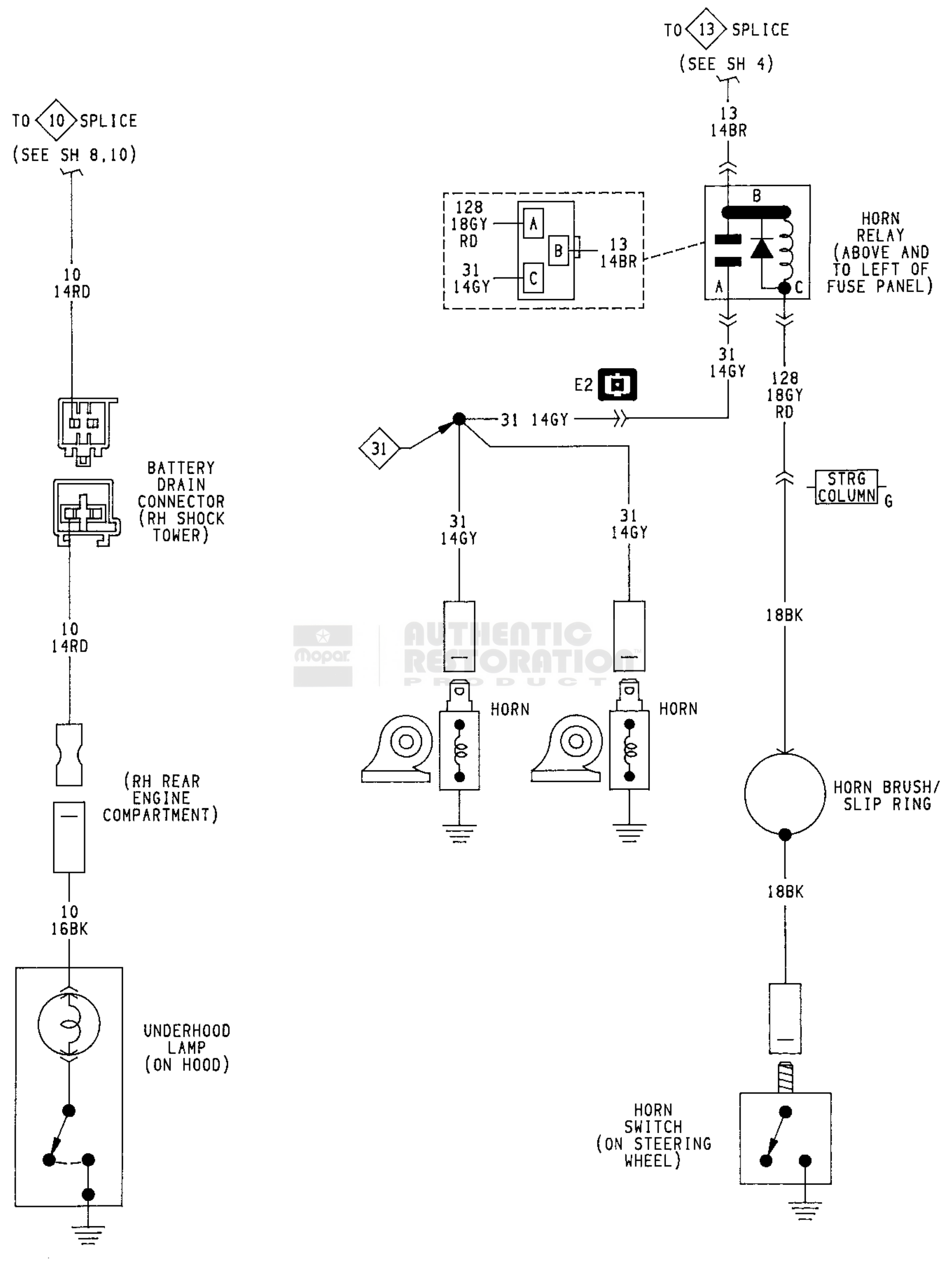
J908W-3 TRANSMISSION CONTROL SYSTEM MJ-XJ 26



TRANSMISSION CONTROL SYSTEM

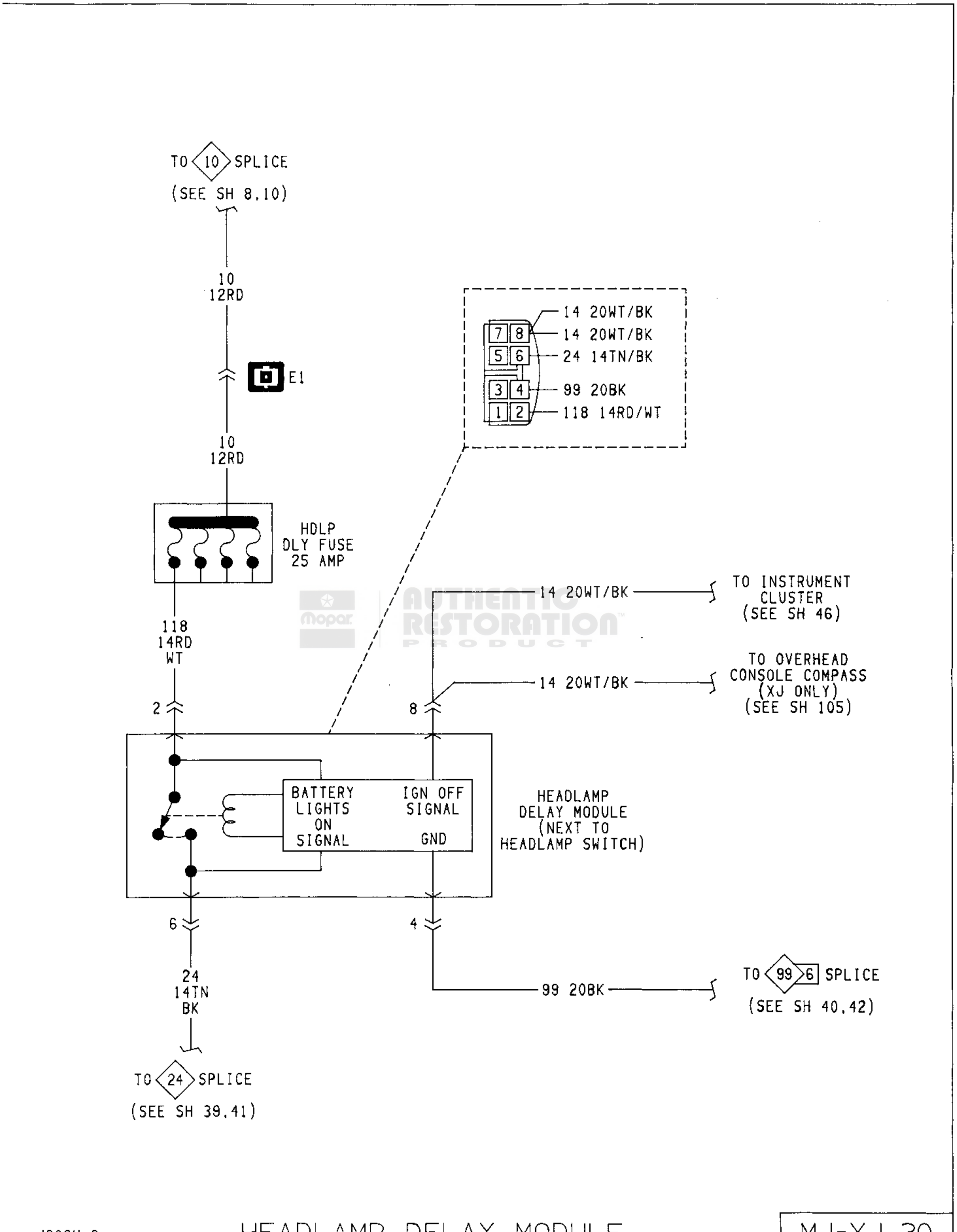


OIL PRESSURE
AND TEMPERATURE SYSTEM

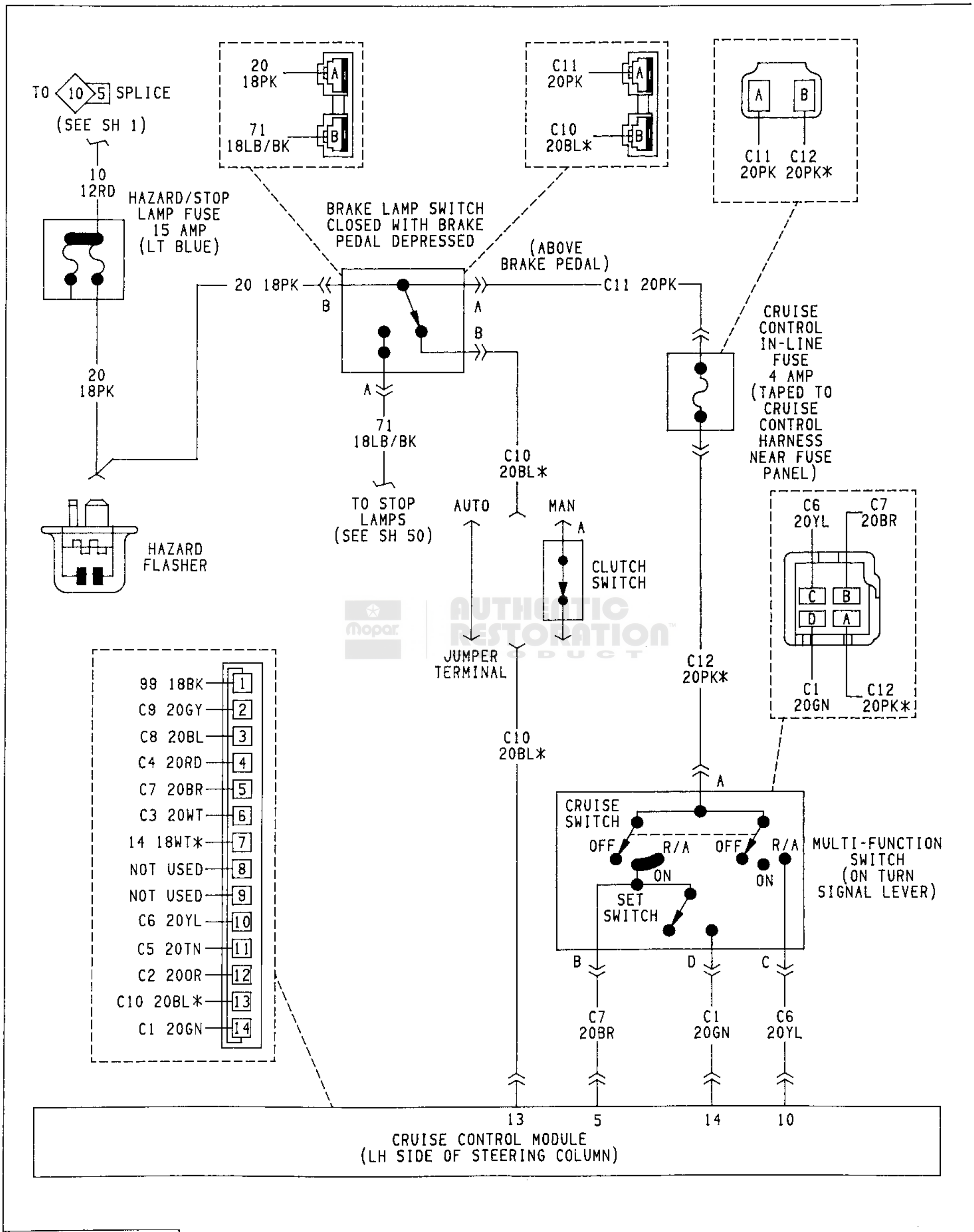


UNDERHOOD LAMP HORN SYSTEM

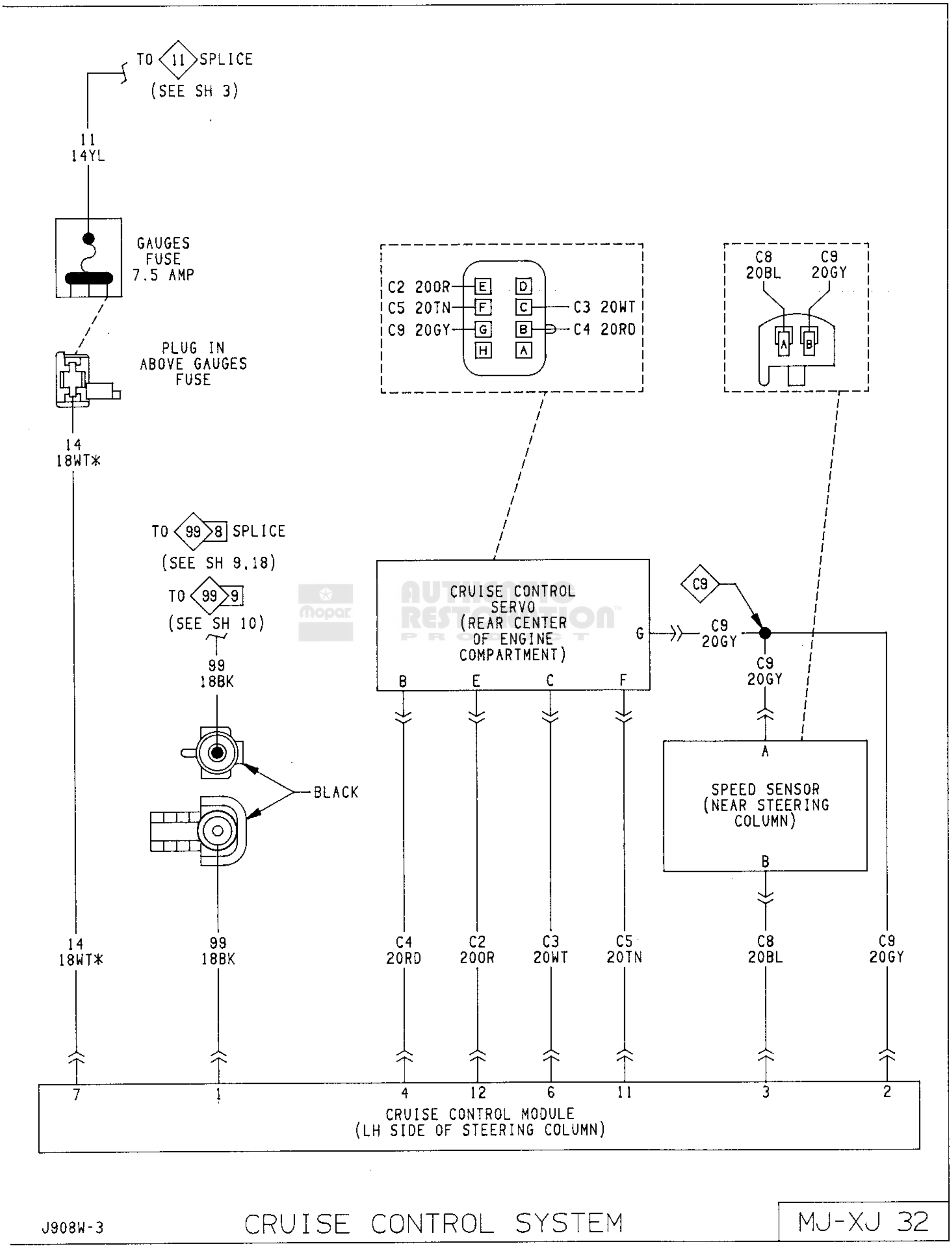
J908W-3



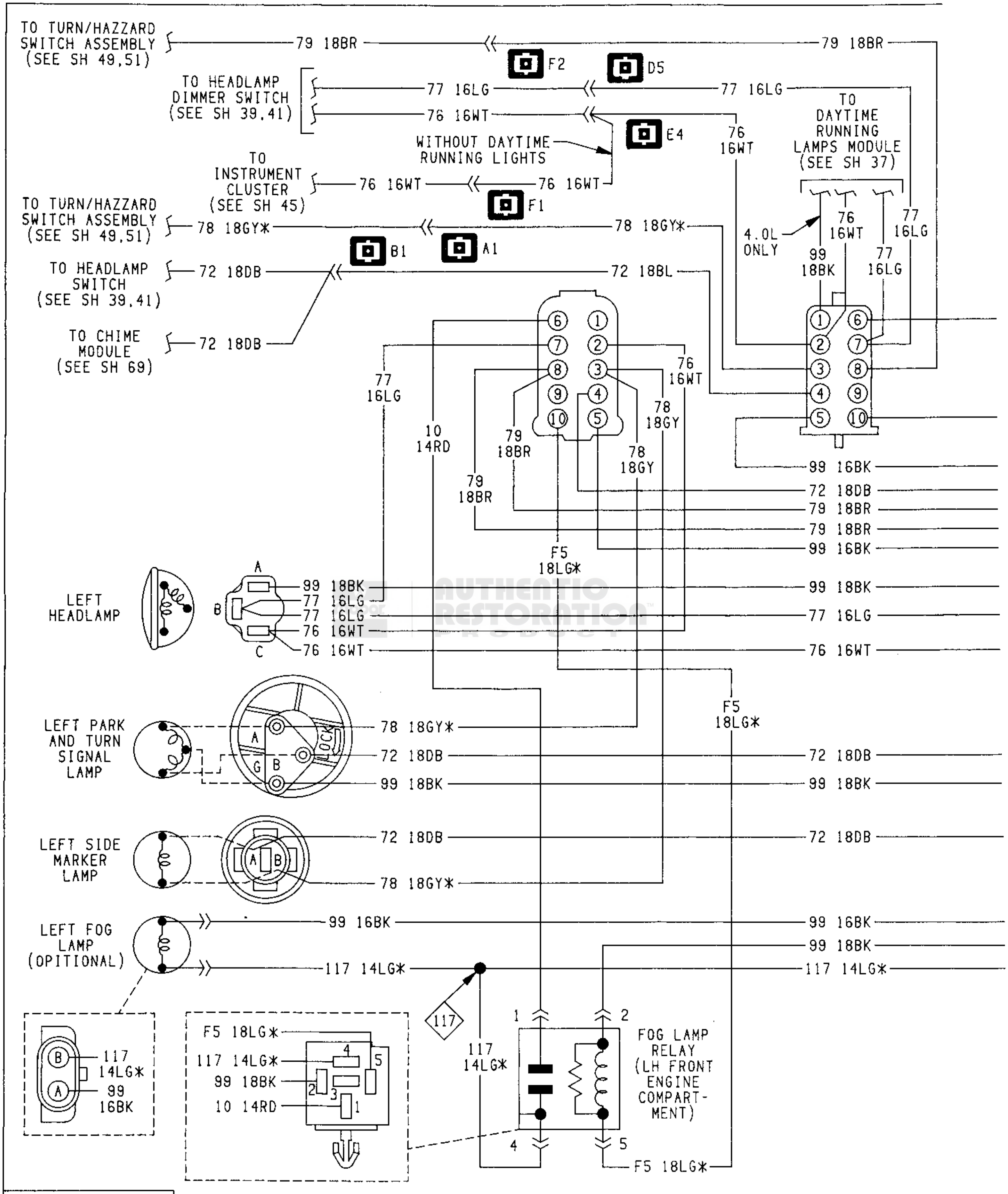
HEADLAMP DELAY MODULE



CRUISE CONTROL SYSTEM



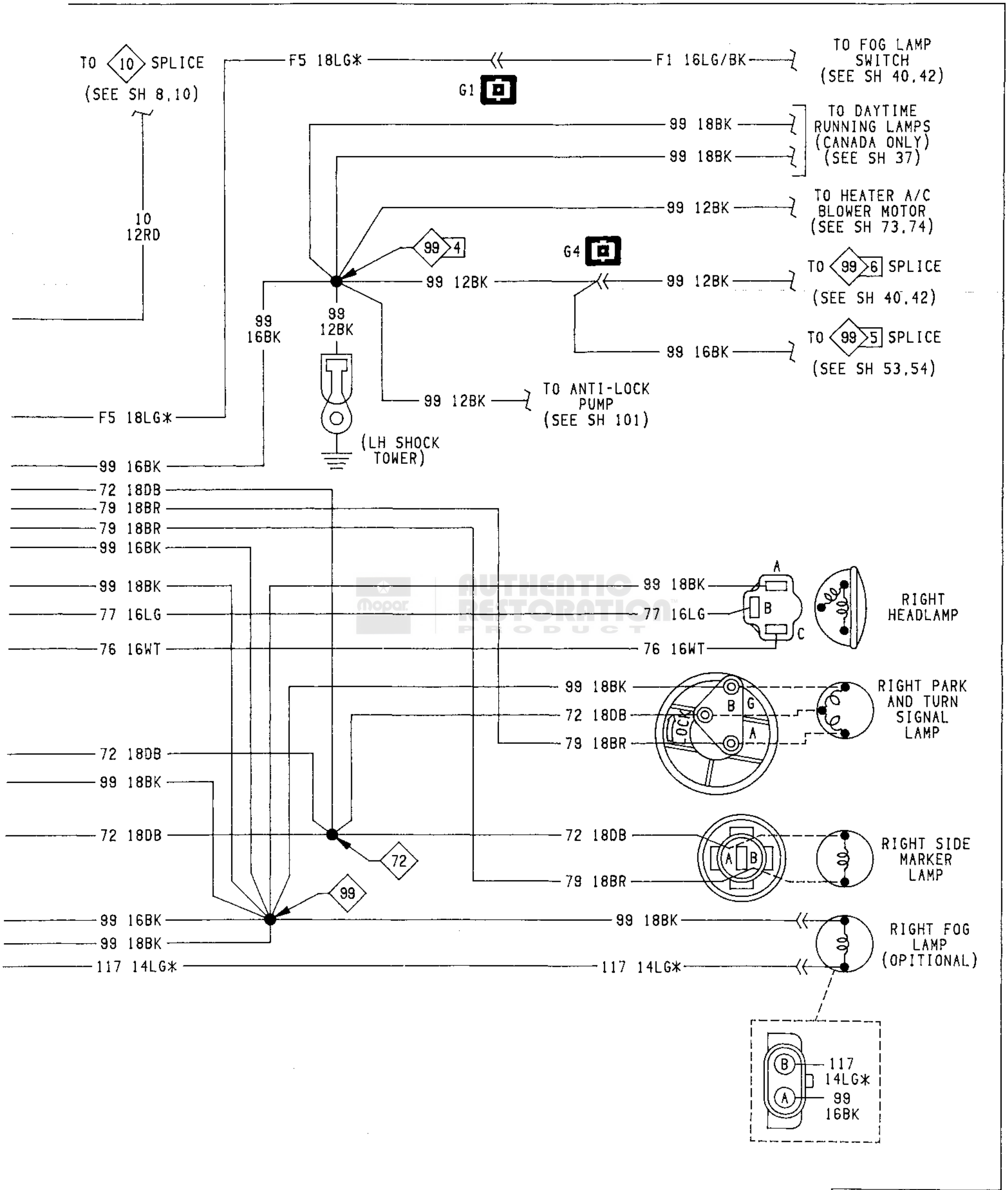
CRUISE CONTROL SYSTEM



MJ-XJ 33

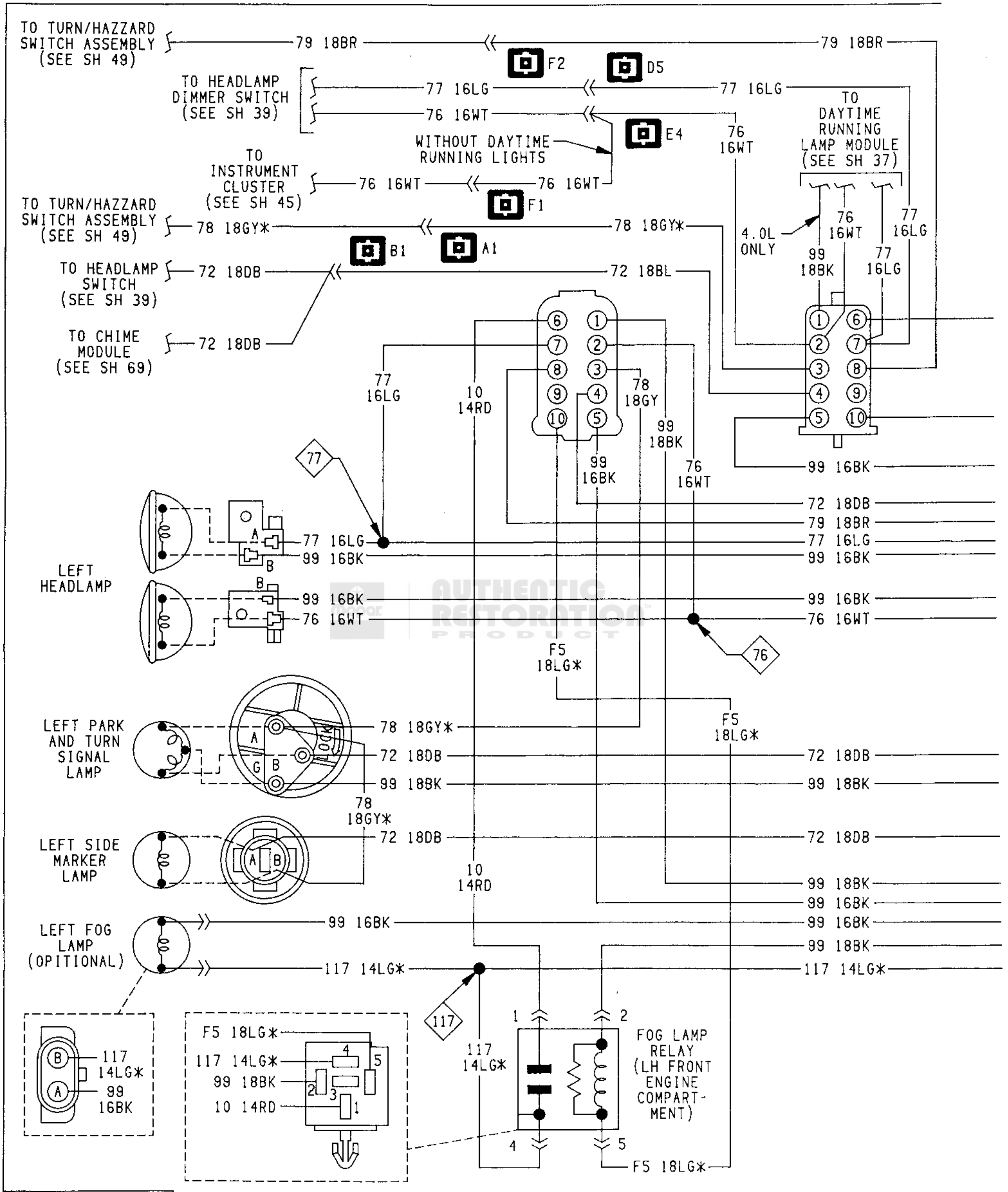
FRONT LIGHTING-DUAL

J908W-3



J908W-3

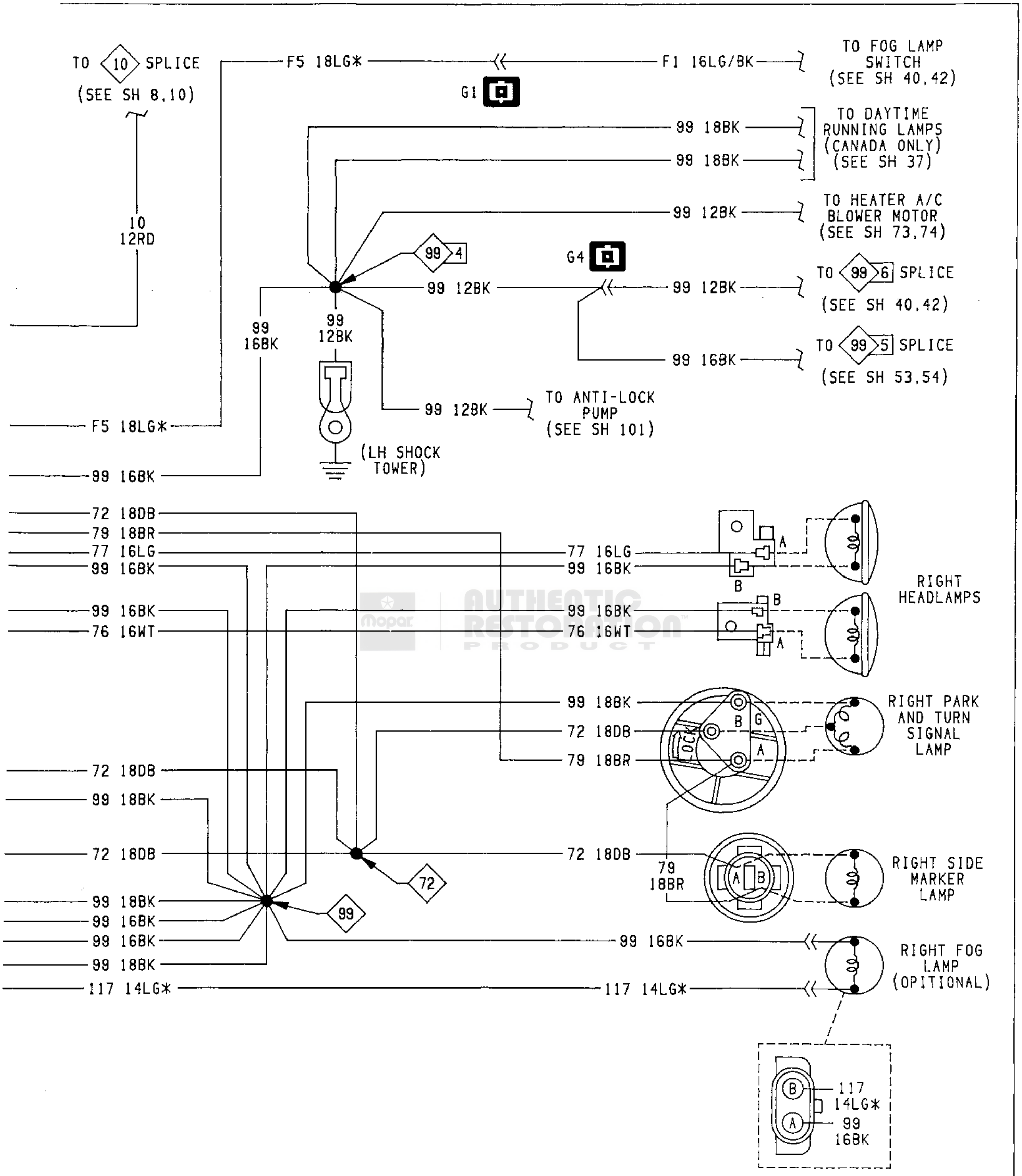
FRONT LIGHTING-DUAL



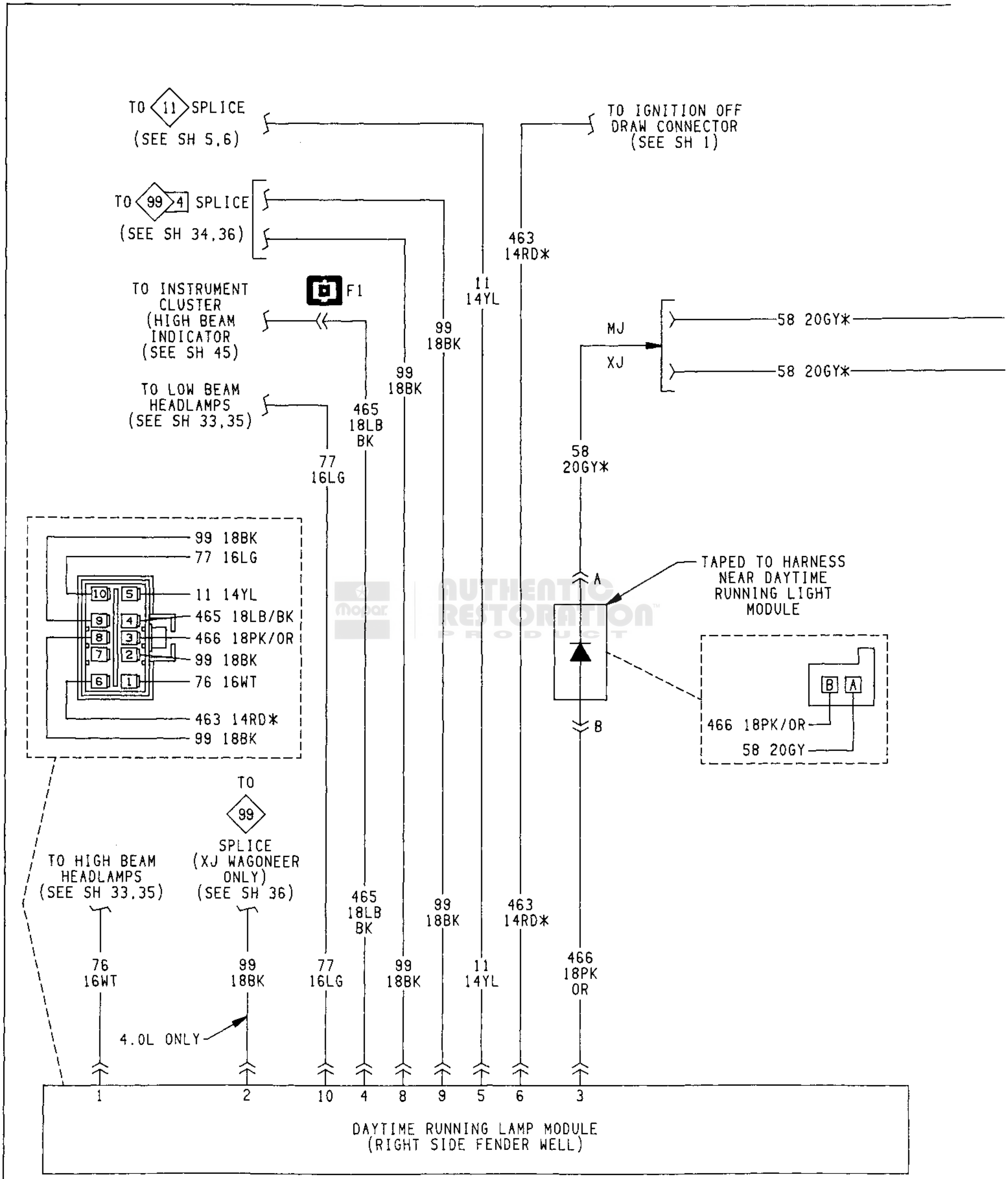
XJ 35

FRONT LIGHTING-QUAD (WAGONEER ONLY)

J908W-3



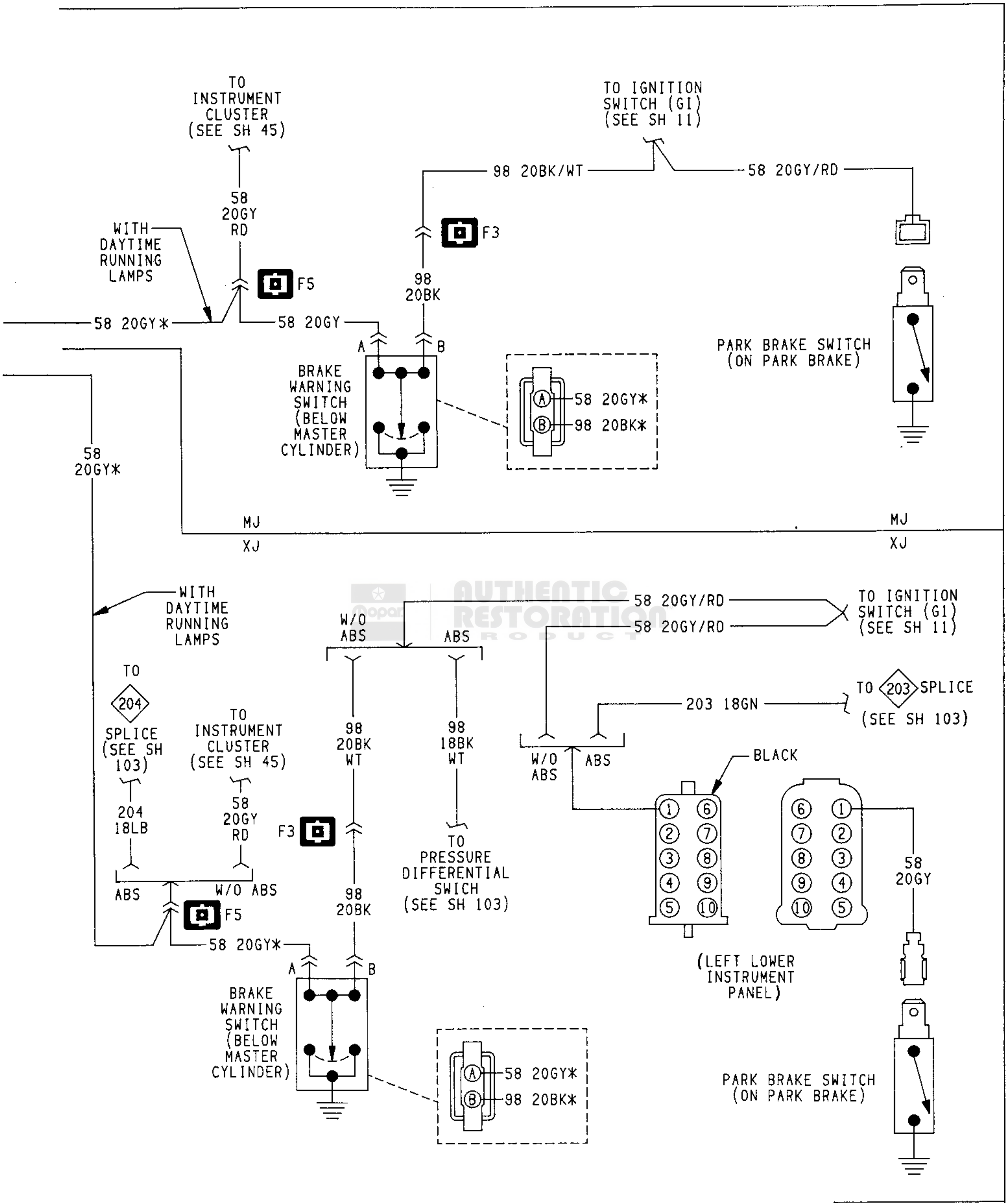
J908W-3 FRONT LIGHTING-QUAD (WAGONEER ONLY) XJ 36



MJ-XJ 37

DAYTIME RUNNING LAMP SYSTEM

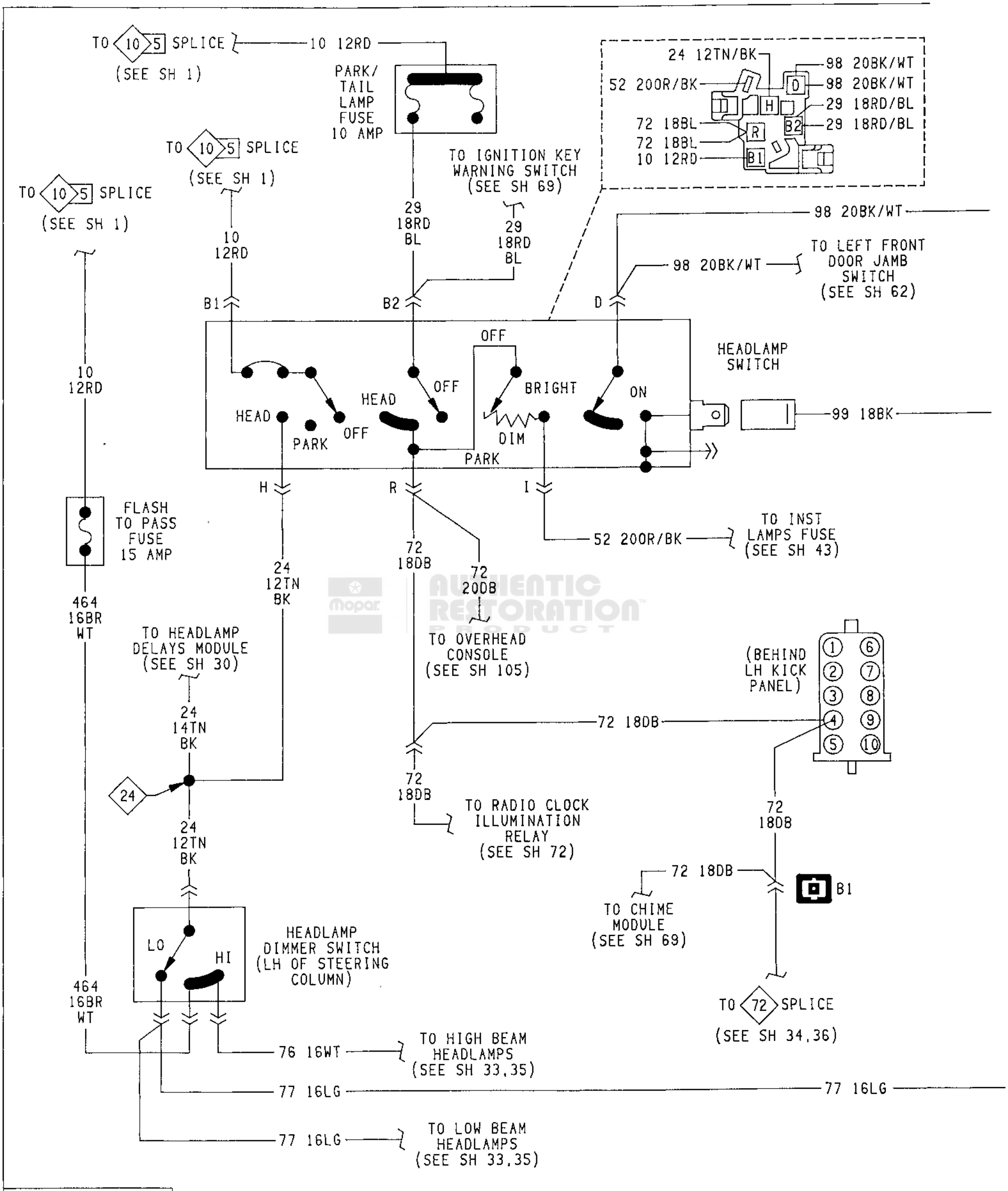
J908W-3



J908W-3

PARKING BRAKE SWITCH

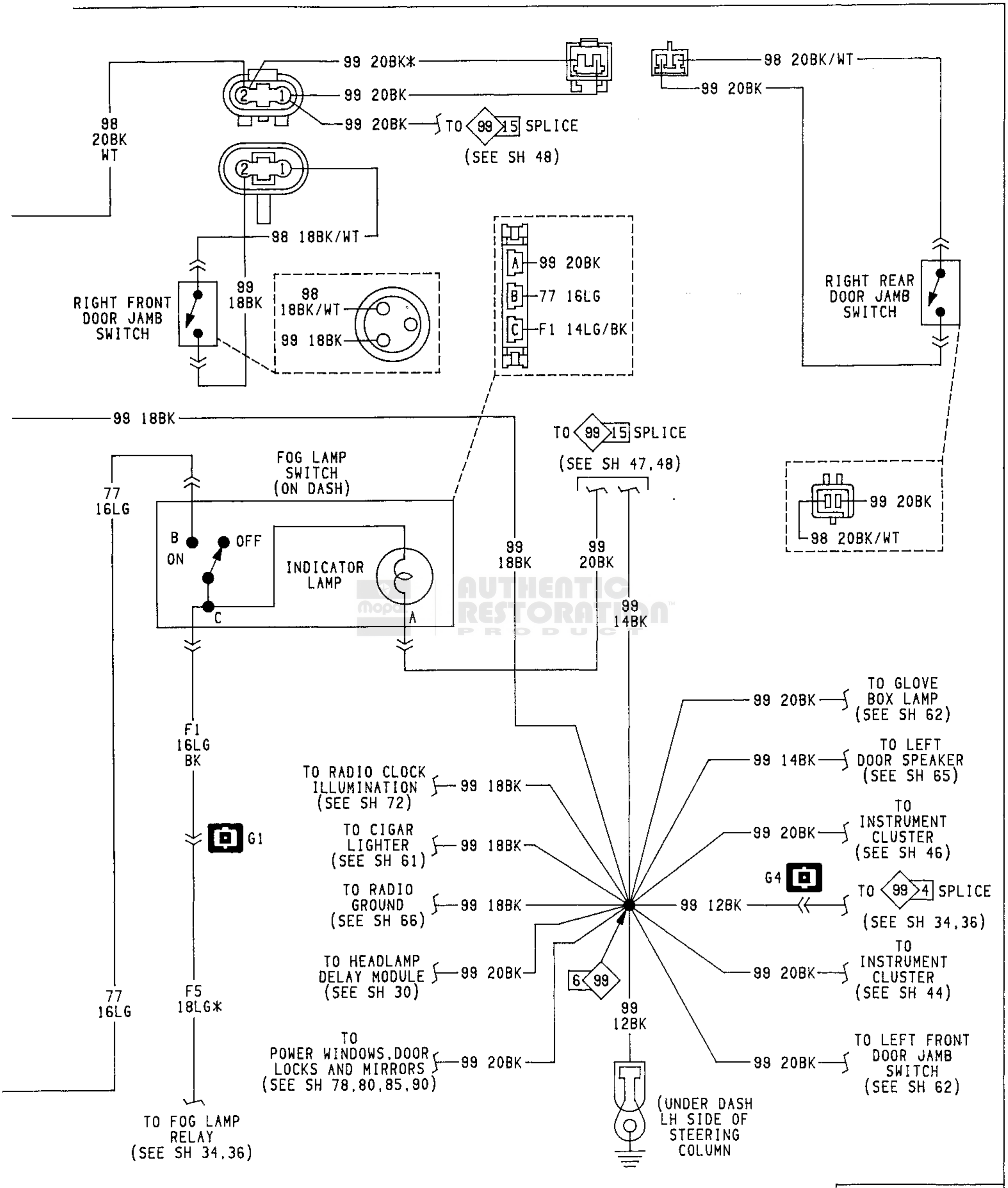
MJ-XJ 38



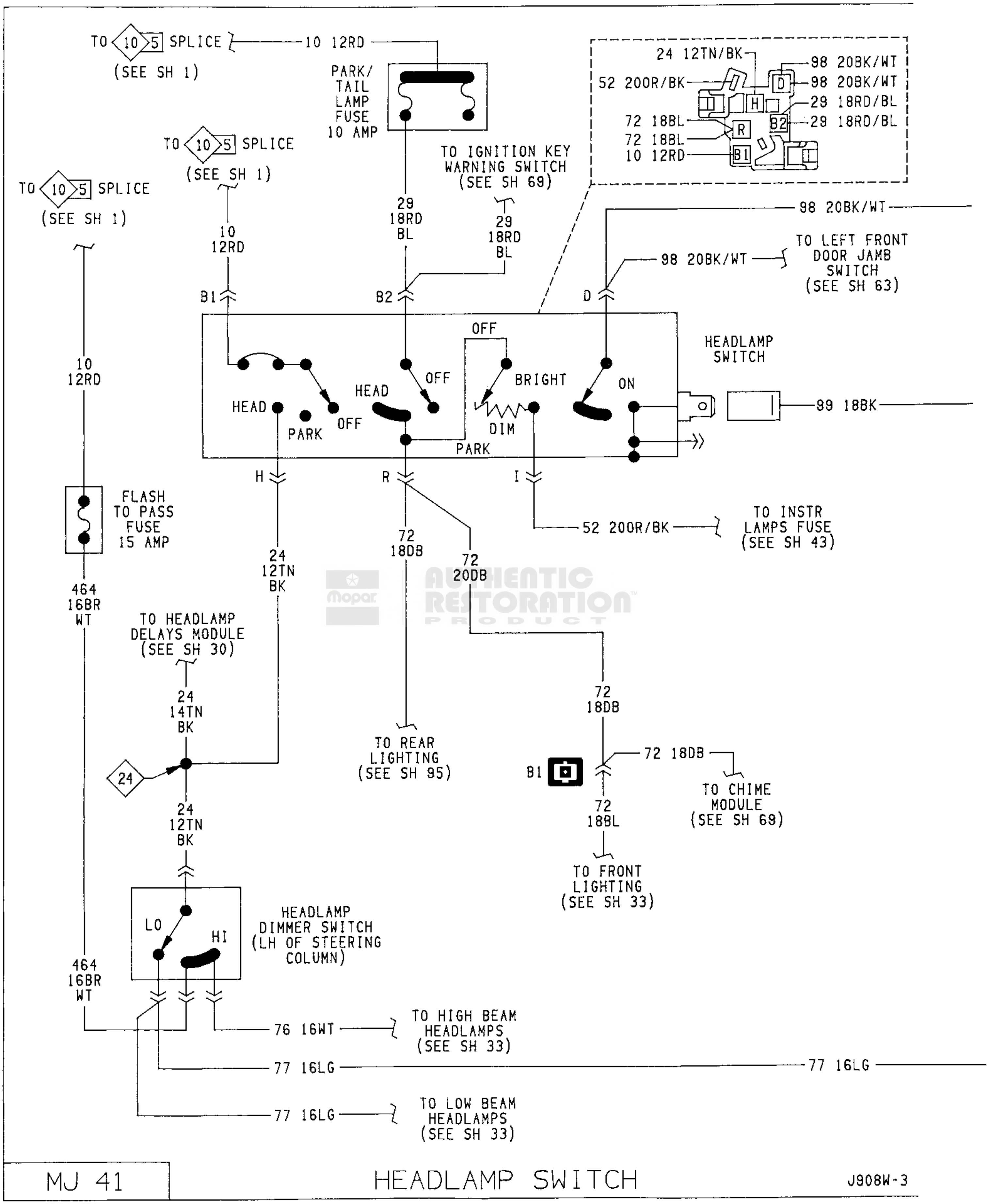
XJ 39

HEADLAMP SWITCH

J908W-3



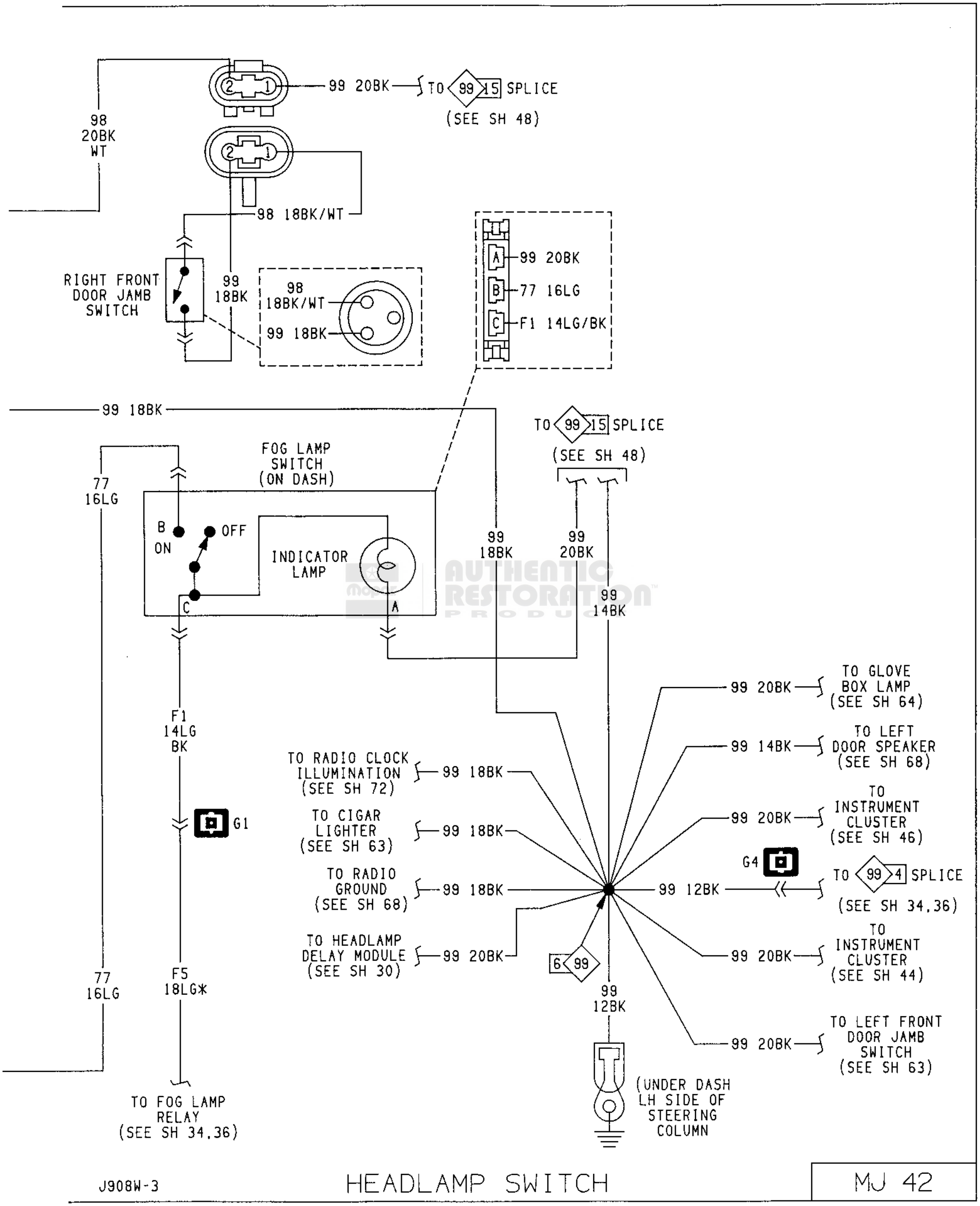
HEADLAMP SWITCH



MJ 41

HEADLAMP SWITCH

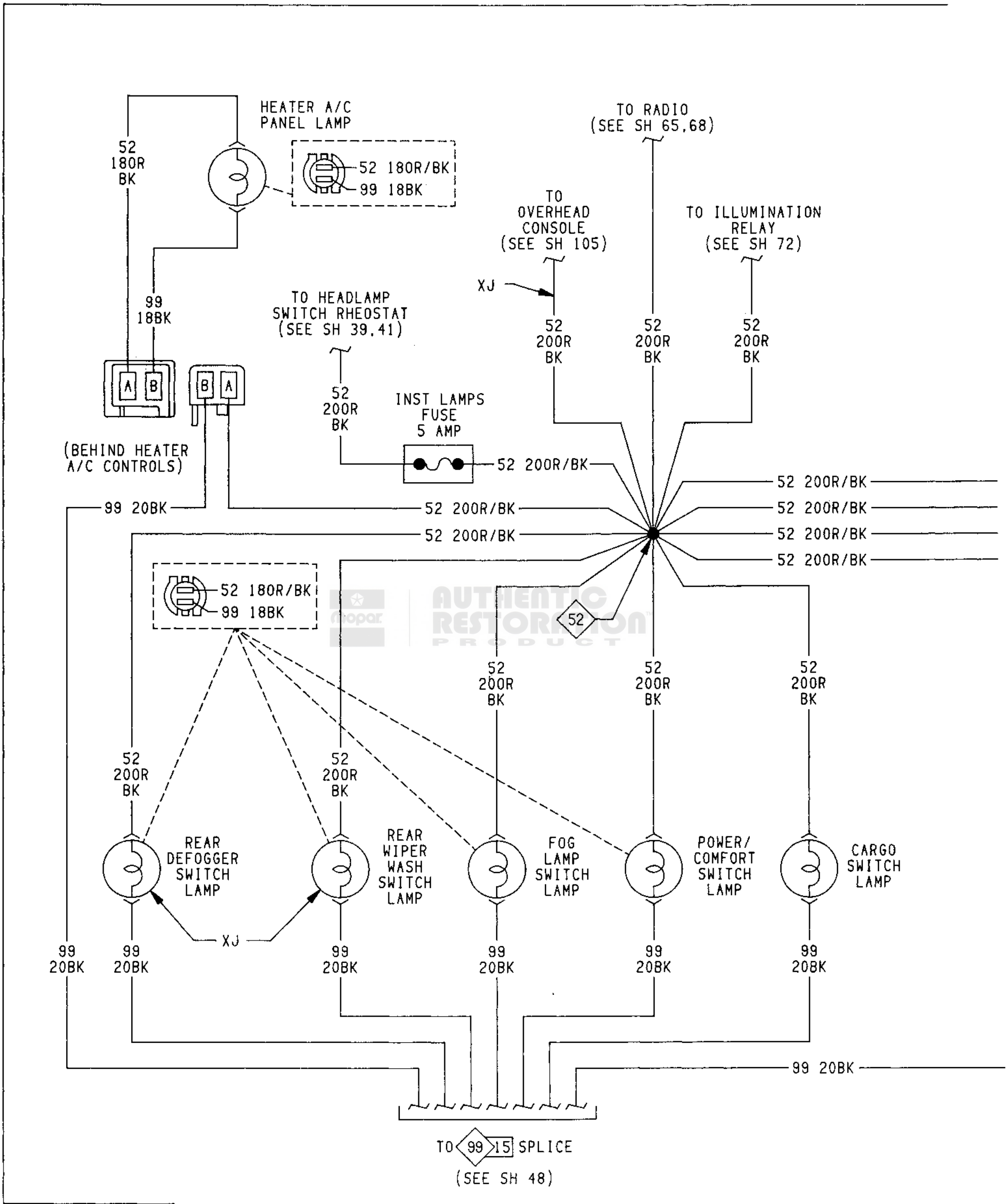
J908W-3



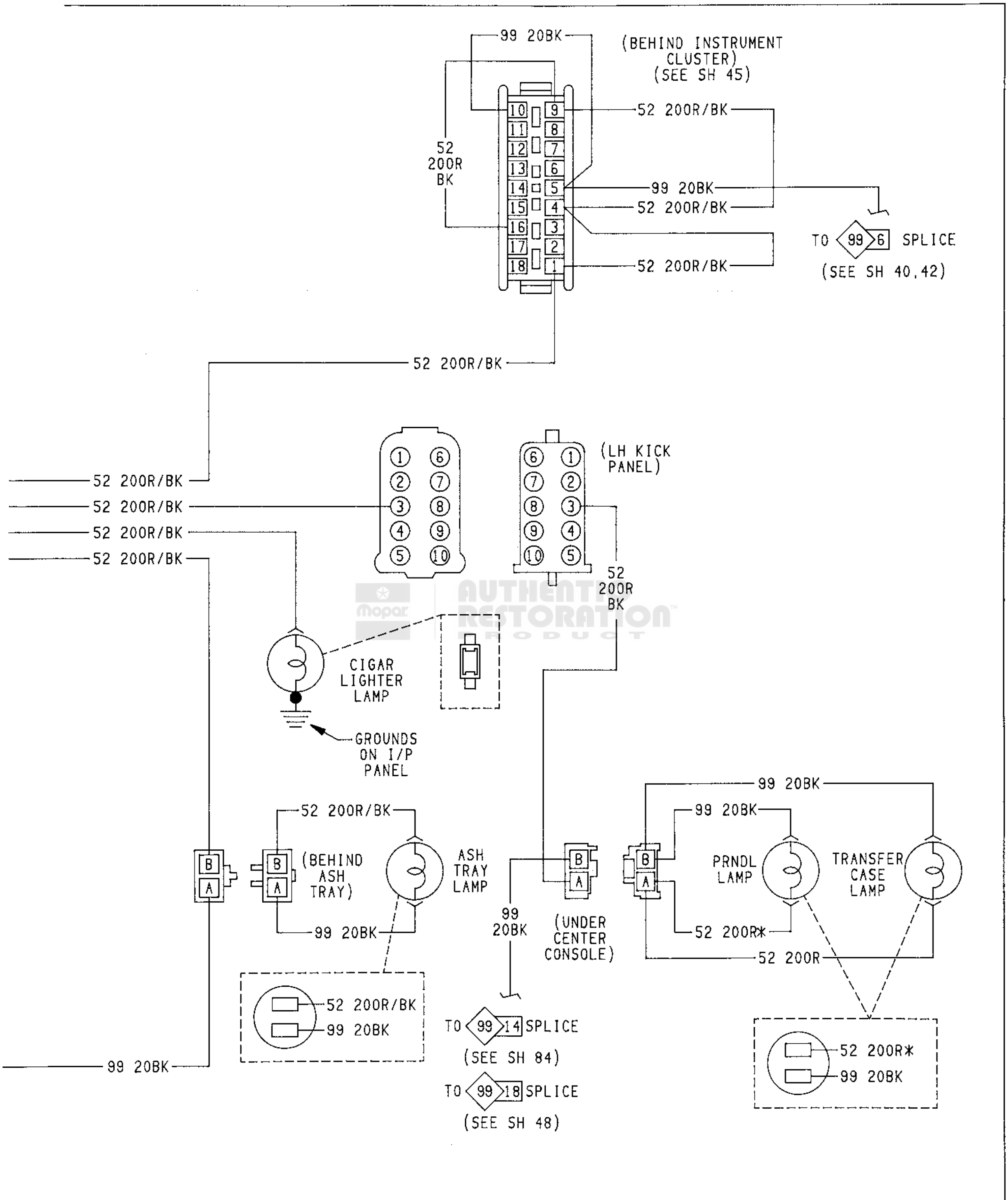
J908W-3

HEADLAMP SWITCH

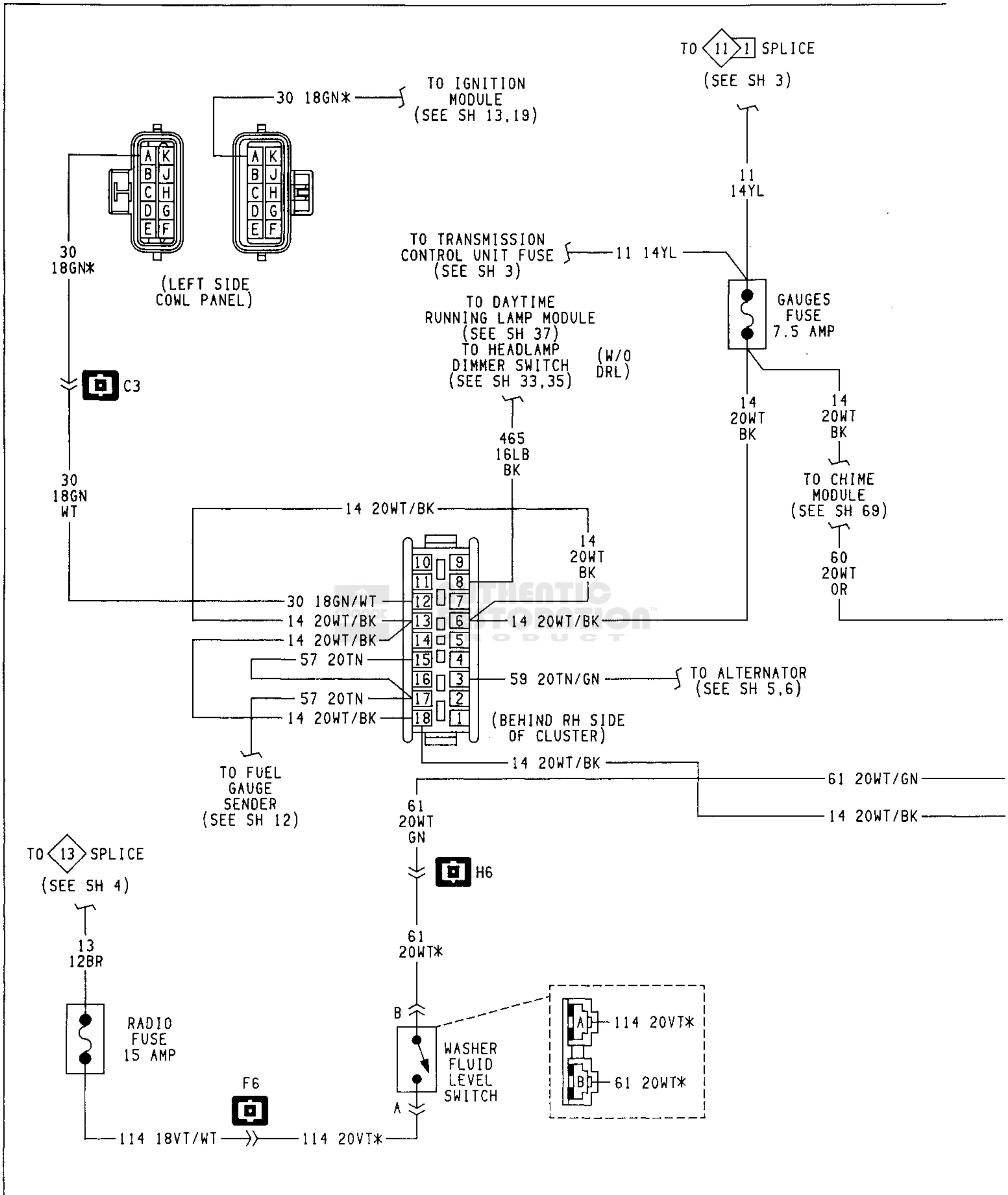
MJ 42



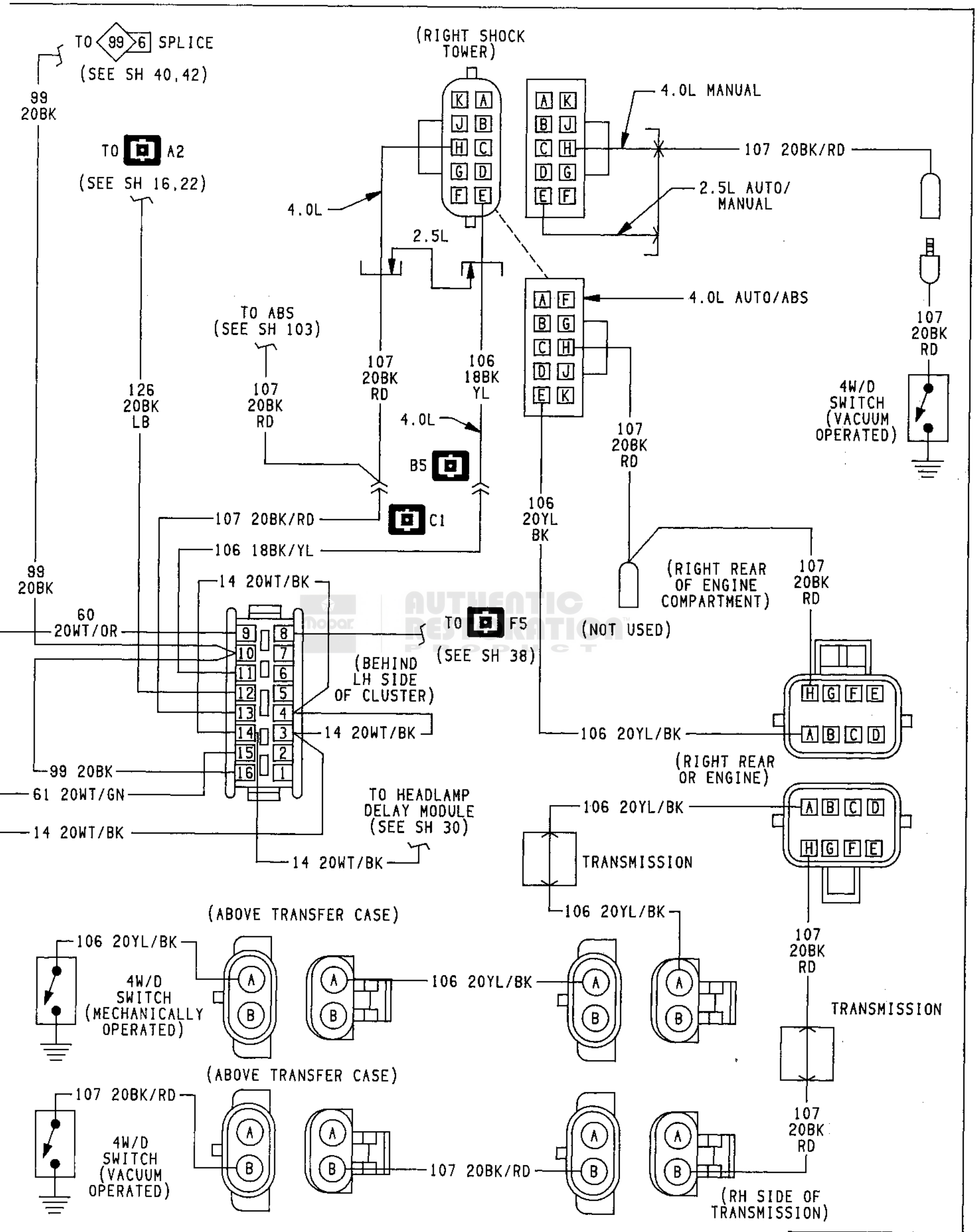
MJ-XJ 43 INSTRUMENT PANEL ILLUMINATION J908W-3



J908W-3 INSTRUMENT PANEL ILLUMINATION MJ-XJ 44

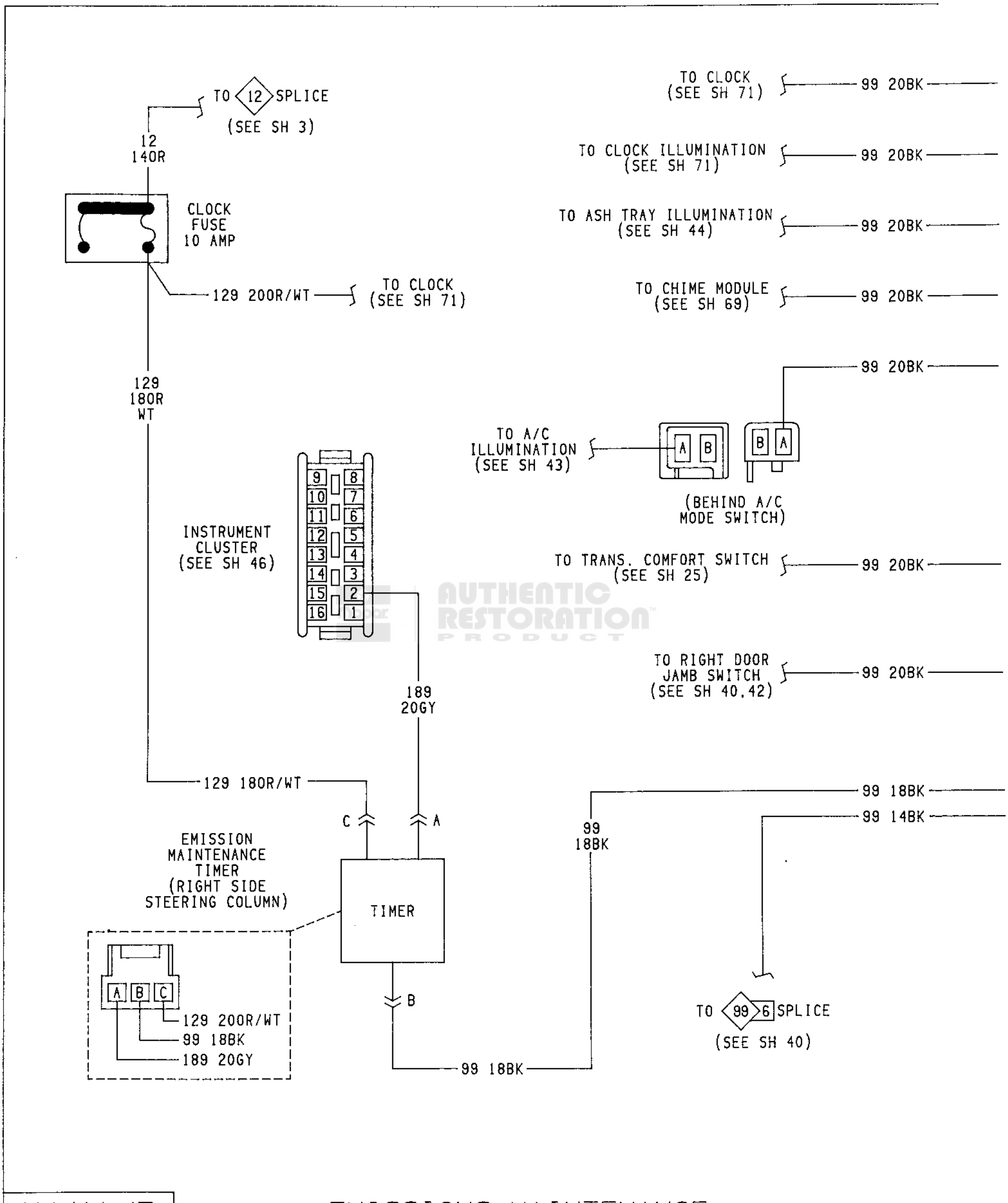


INSTRUMENT CLUSTER



J908W-3

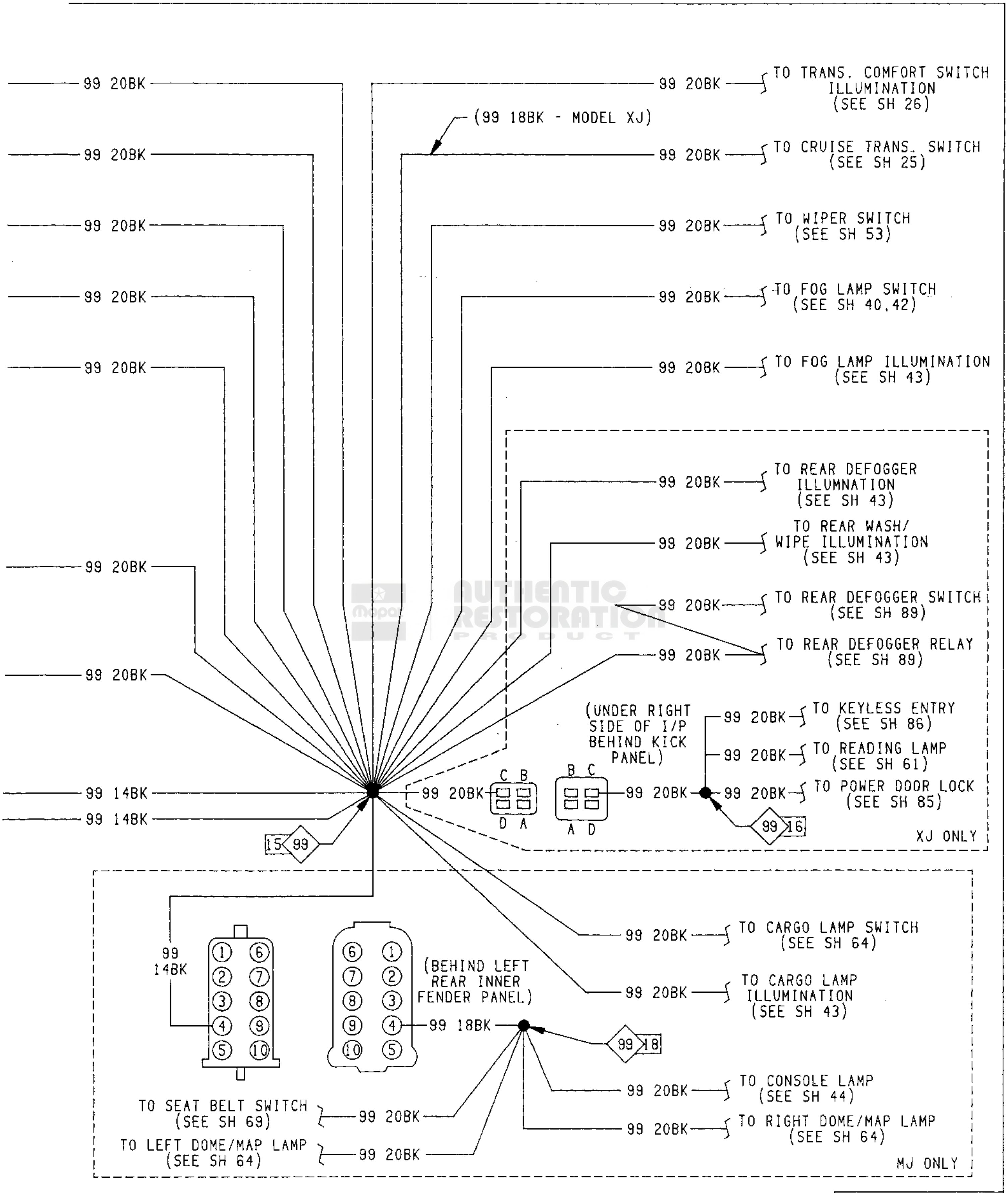
INSTRUMENT CLUSTER INDICATORS



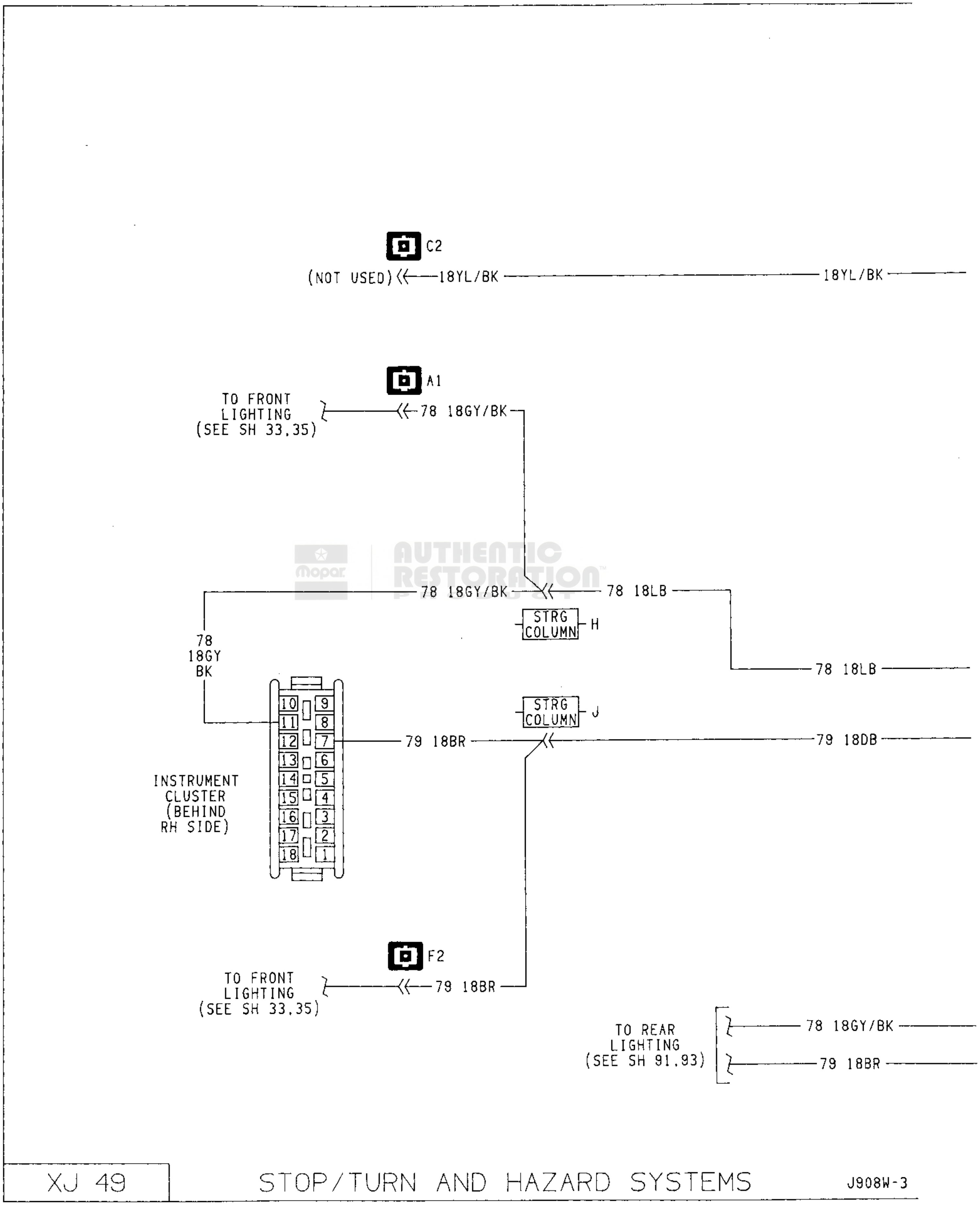
MJ-XJ 47

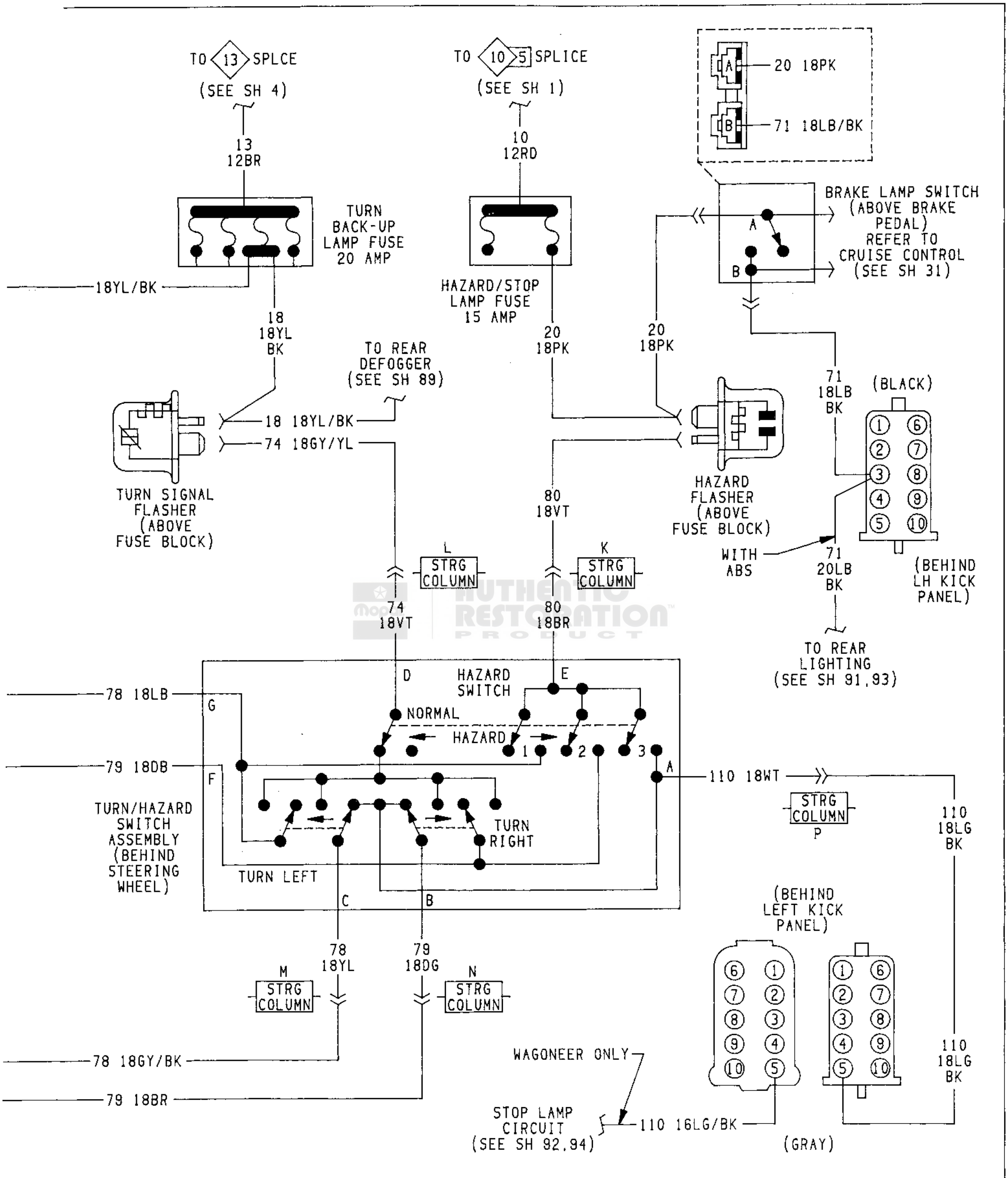
EMISSIONS MAINTENANCE

J908W-3



J908W-3 INSTRUMENT PANEL GROUND MJ-XJ 48

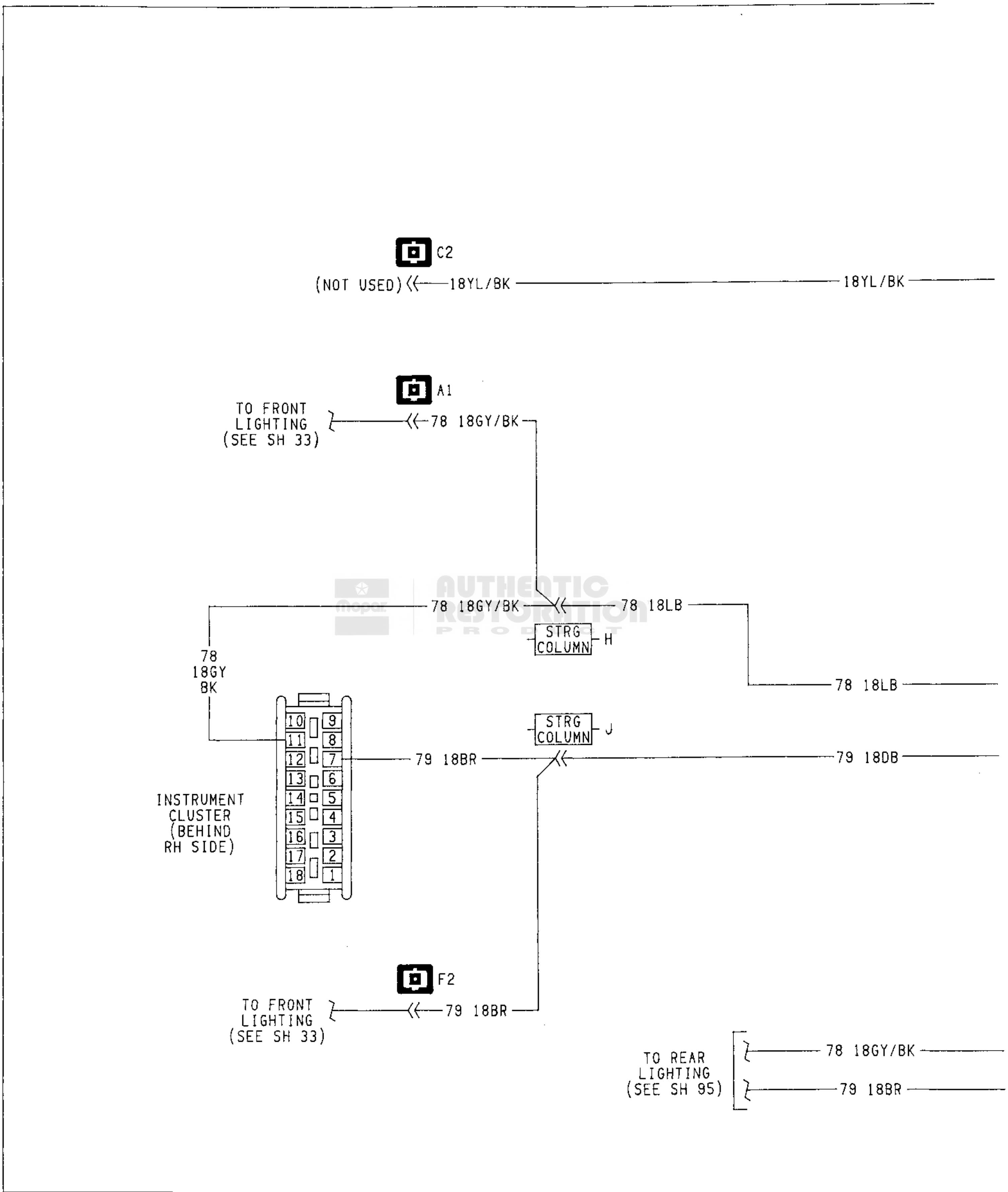

C2
(NOT USED)
18YL/BK
18YL/BK
A1
TO FRONT LIGHTING (SEE SH 33,35)
78 18GY/BK
78 18GY/BK
78 18LB
STRG COLUMN
H
78 18GY BK
78 18LB
STRG COLUMN
J
10
9
11
8
12
7
13
6
14
5
15
4
16
3
17
2
18
1
79 18BR
79 18DB
INSTRUMENT CLUSTER (BEHIND RH SIDE)
F2
TO FRONT LIGHTING (SEE SH 33,35)
79 18BR
TO REAR LIGHTING (SEE SH 91,93)
78 18GY/BK
79 18BR
XJ 49
STOP/TURN AND HAZARD SYSTEMS
J908W-3



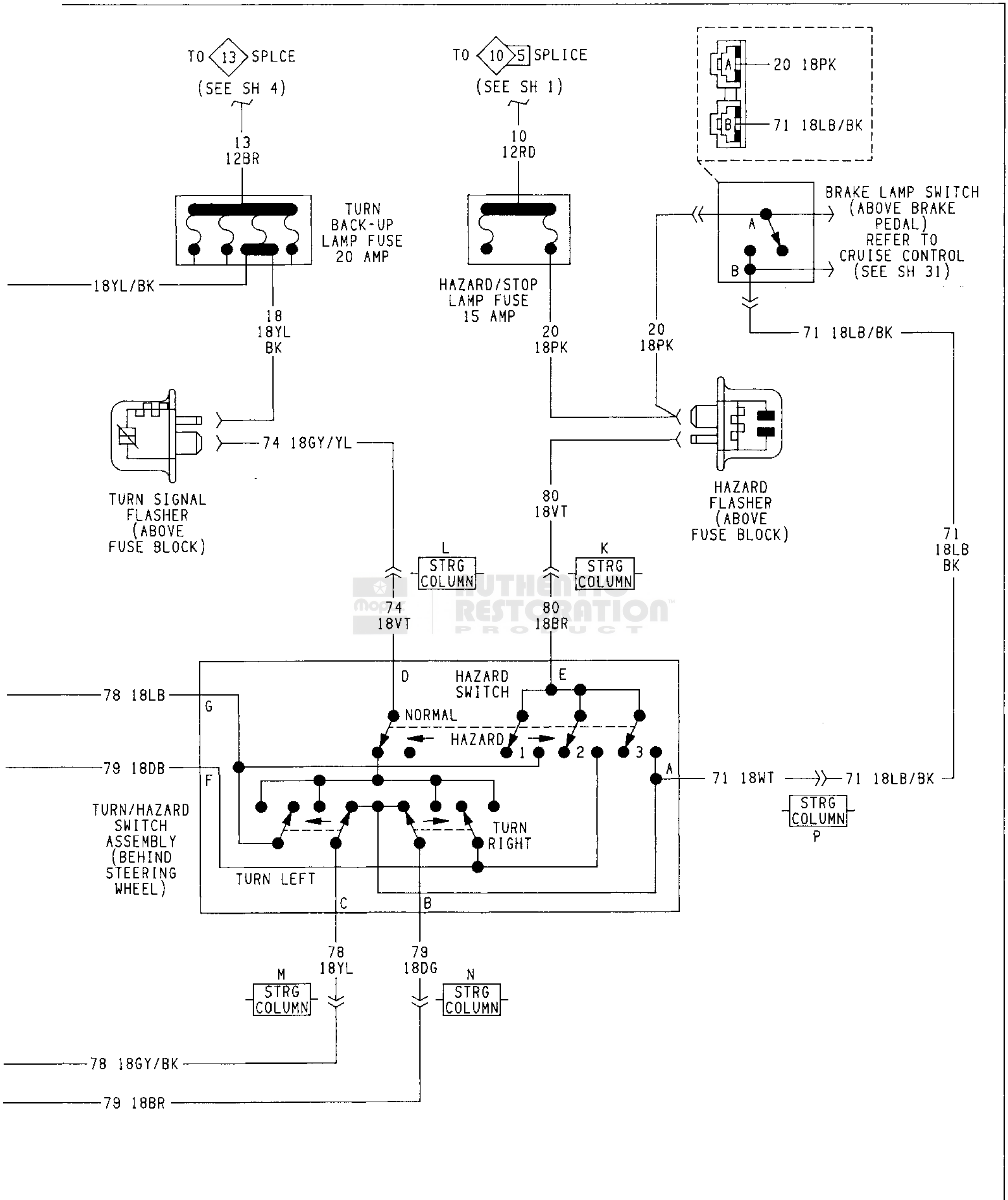
J908W-3

STOP/TURN AND HAZARD SYSTEMS

XJ 50



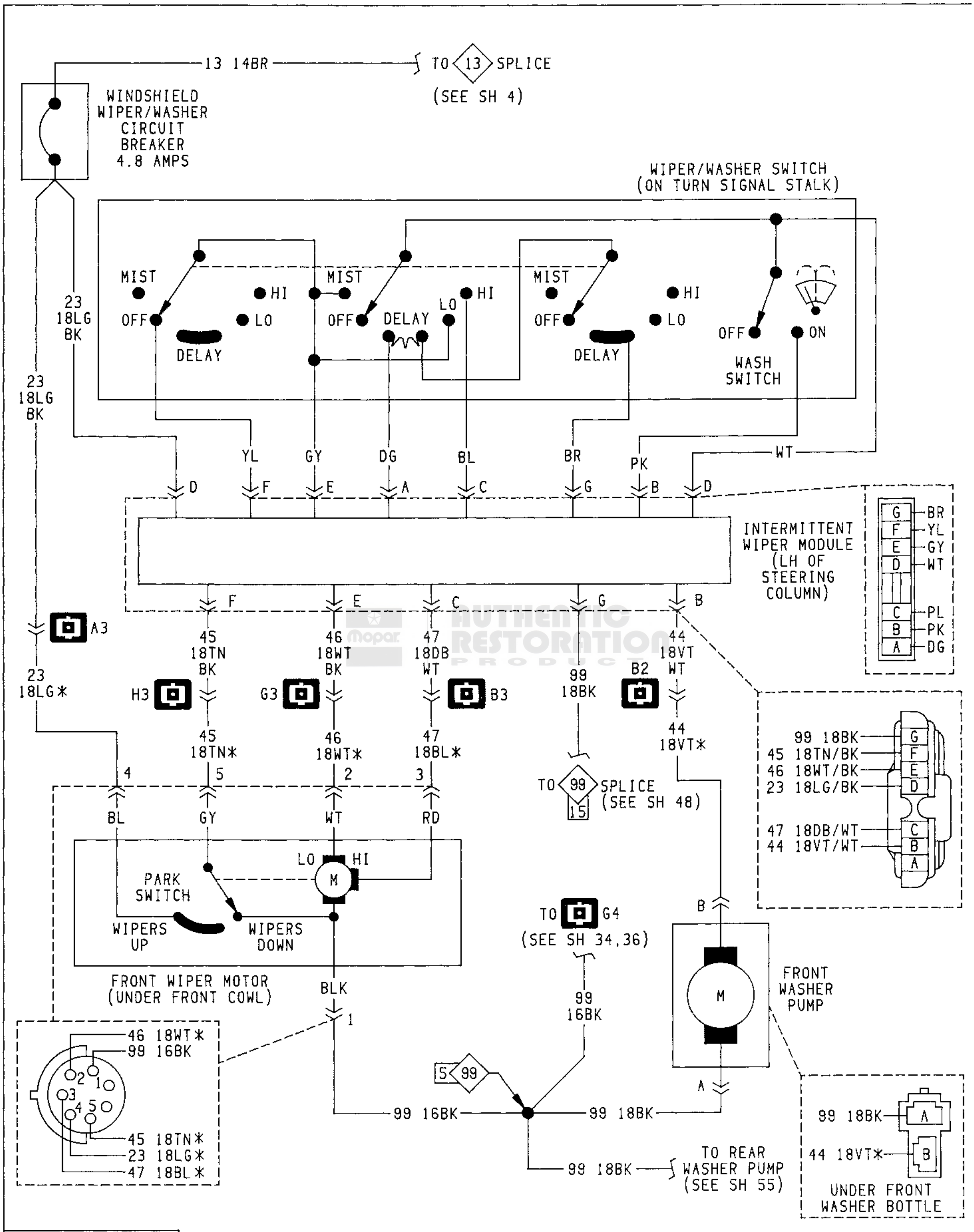
MJ 51 STOP/TURN AND HAZARD SYSTEMS J908W-3



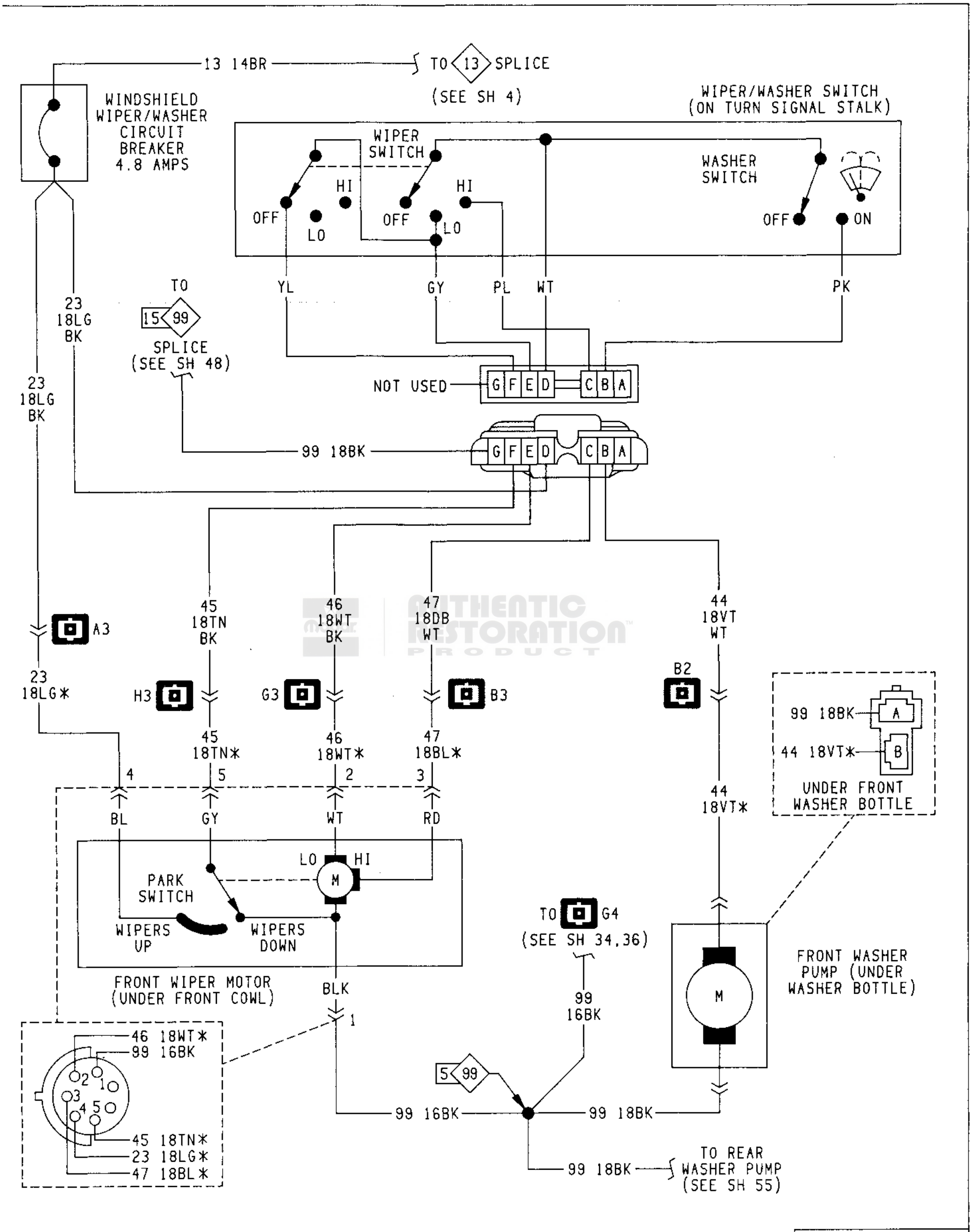
J908W-3

STOP/TURN AND HAZARD SYSTEMS

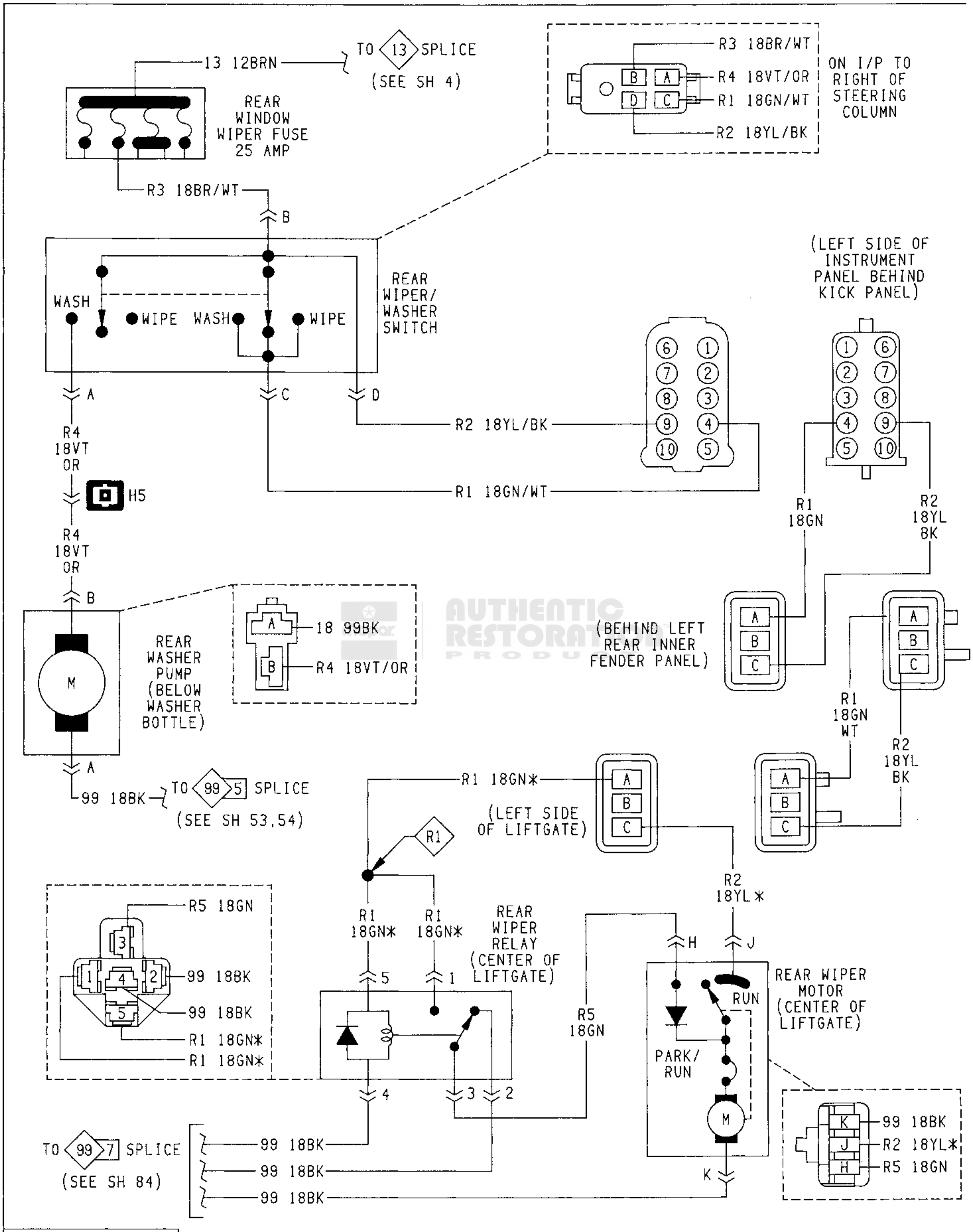
MJ 52



MJ-XJ 53 FRONT WIPERS/WASHERS-INTERMITTENT J908W-3



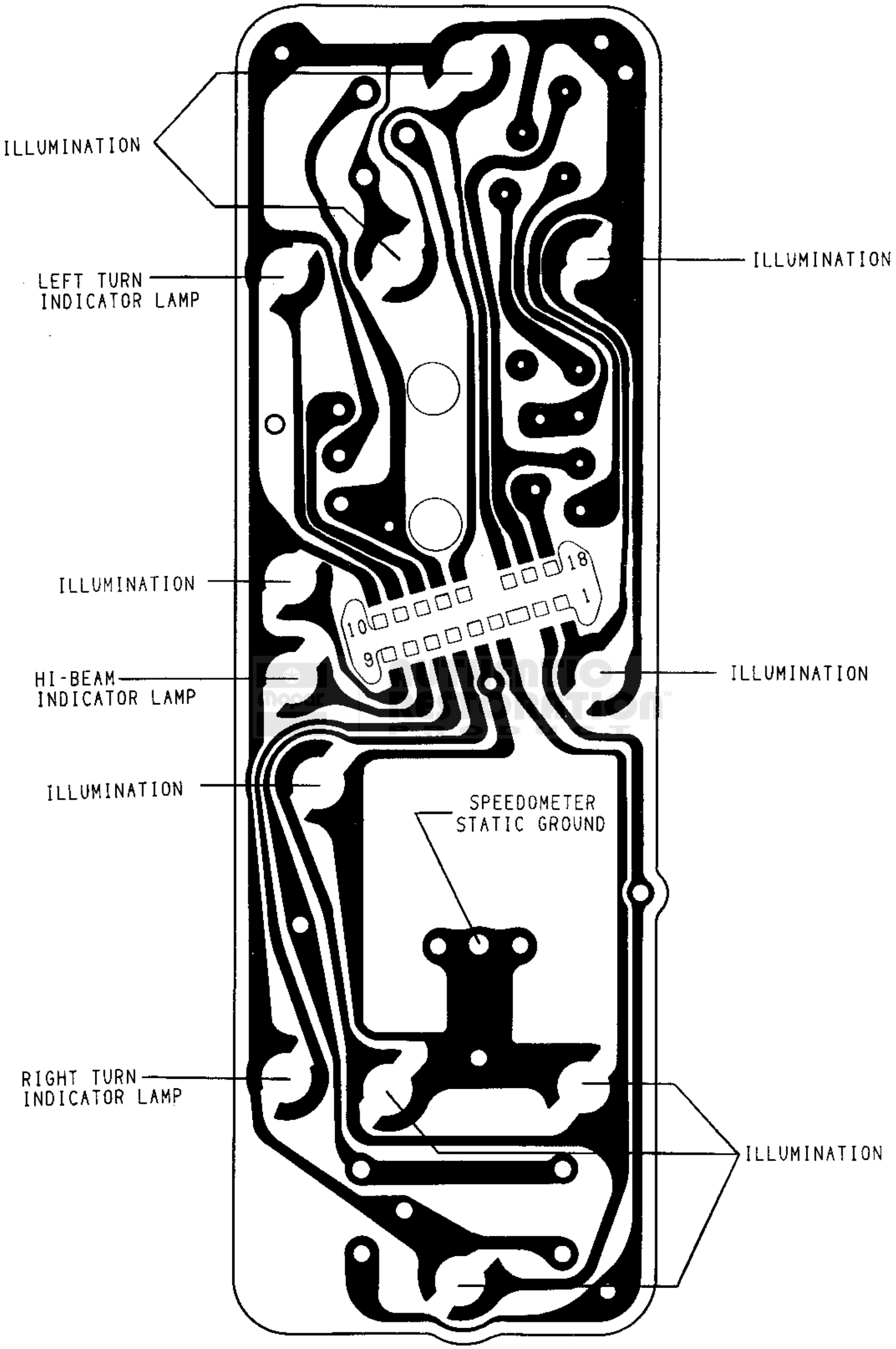
J908W-3 FRONT WIPERS/WASHERS-NON-INTERMITTENT MJ-XJ 54



XJ 55

REAR WIPER/WASHER

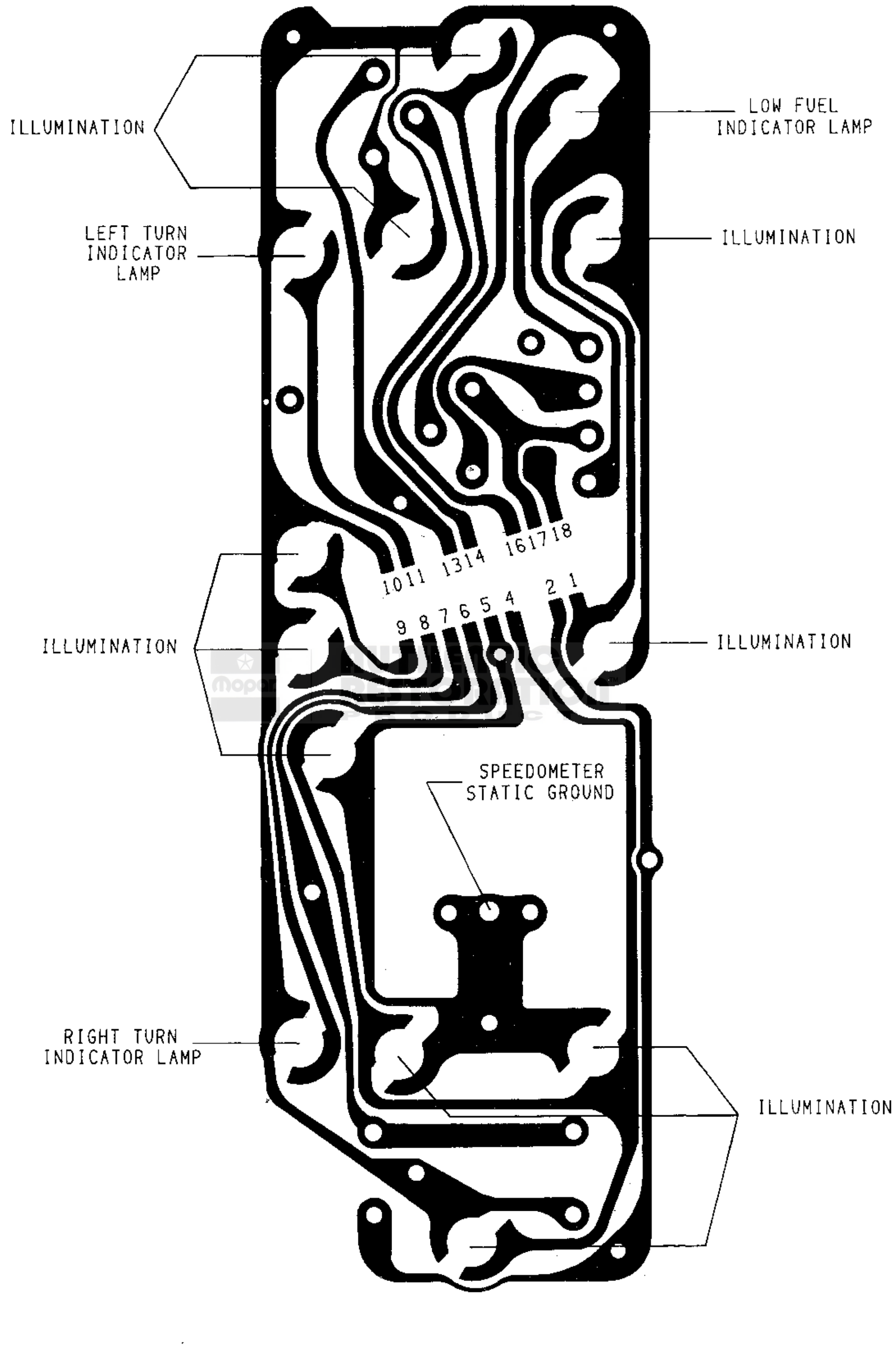
J908W-3



J908W-3

HI-LINE INSTRUMENT CLUSTER
PRINTED CIRCUIT BOARD

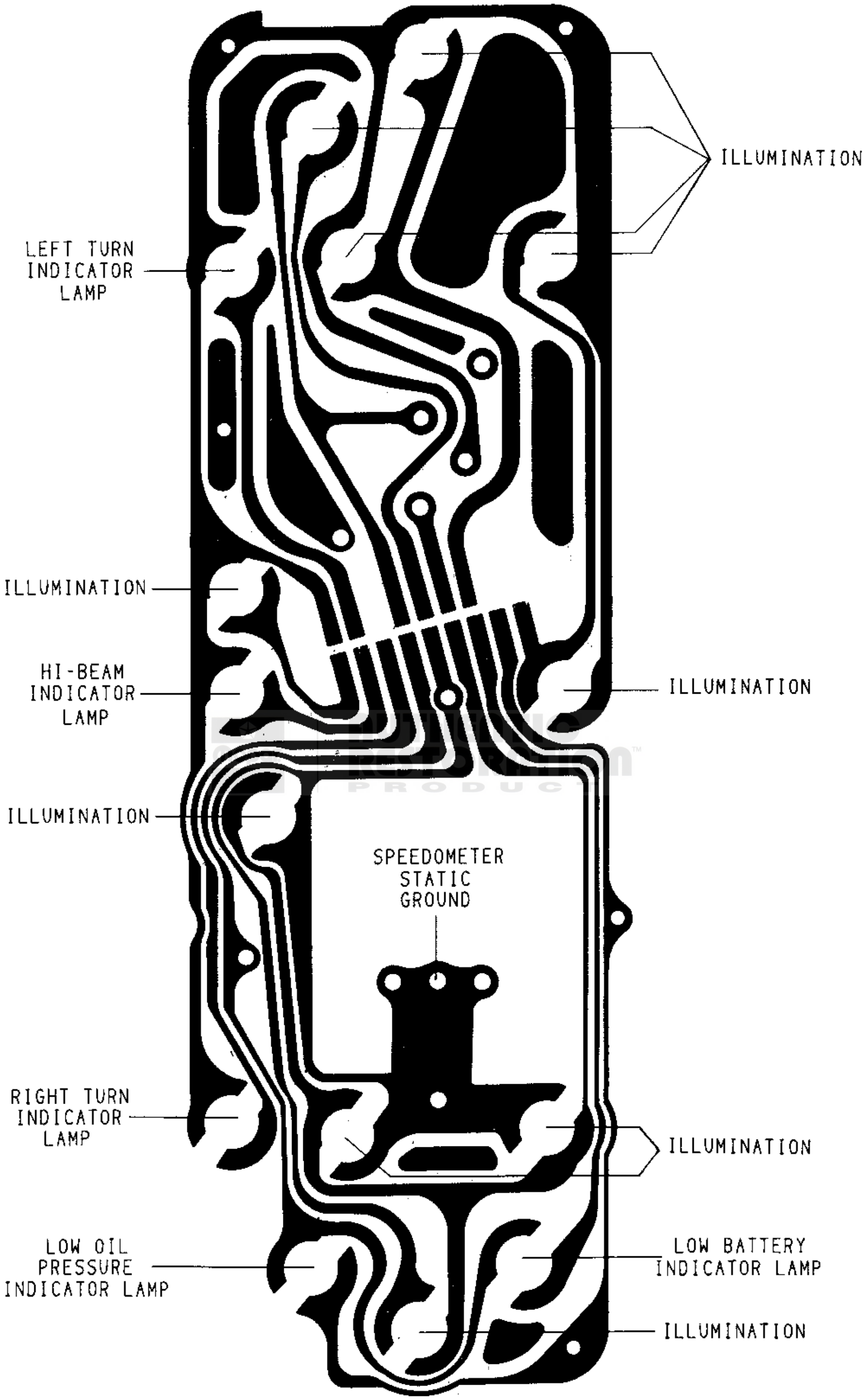
MJ-XJ 56



STANDARD INSTRUMENT CLUSTER PRINTED CIRCUIT BOARD

MJ-XJ 57

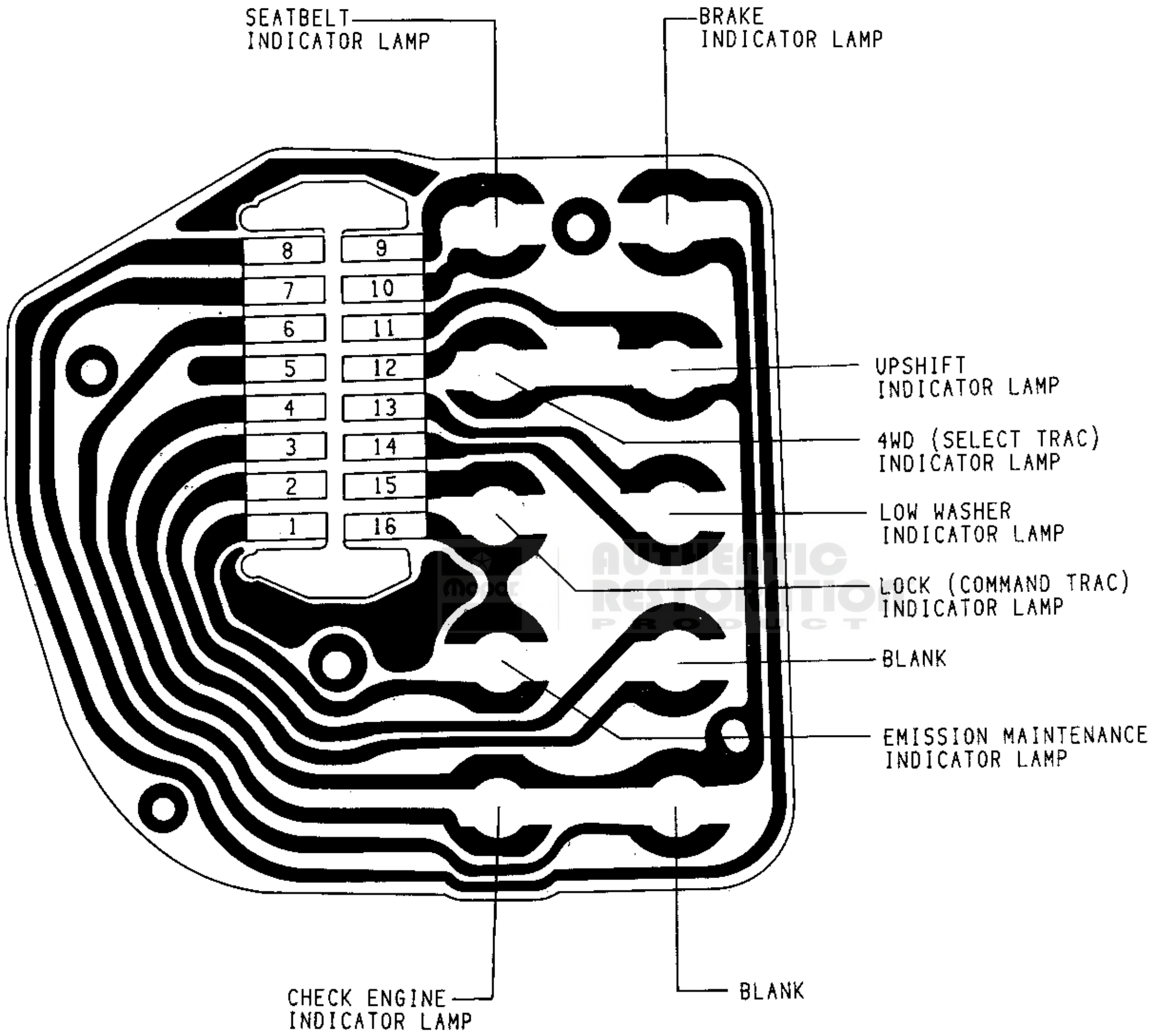
J908W-3



LO-LINE INSTRUMENT CLUSTER
PRINTED CIRCUIT BOARD

J908W-3

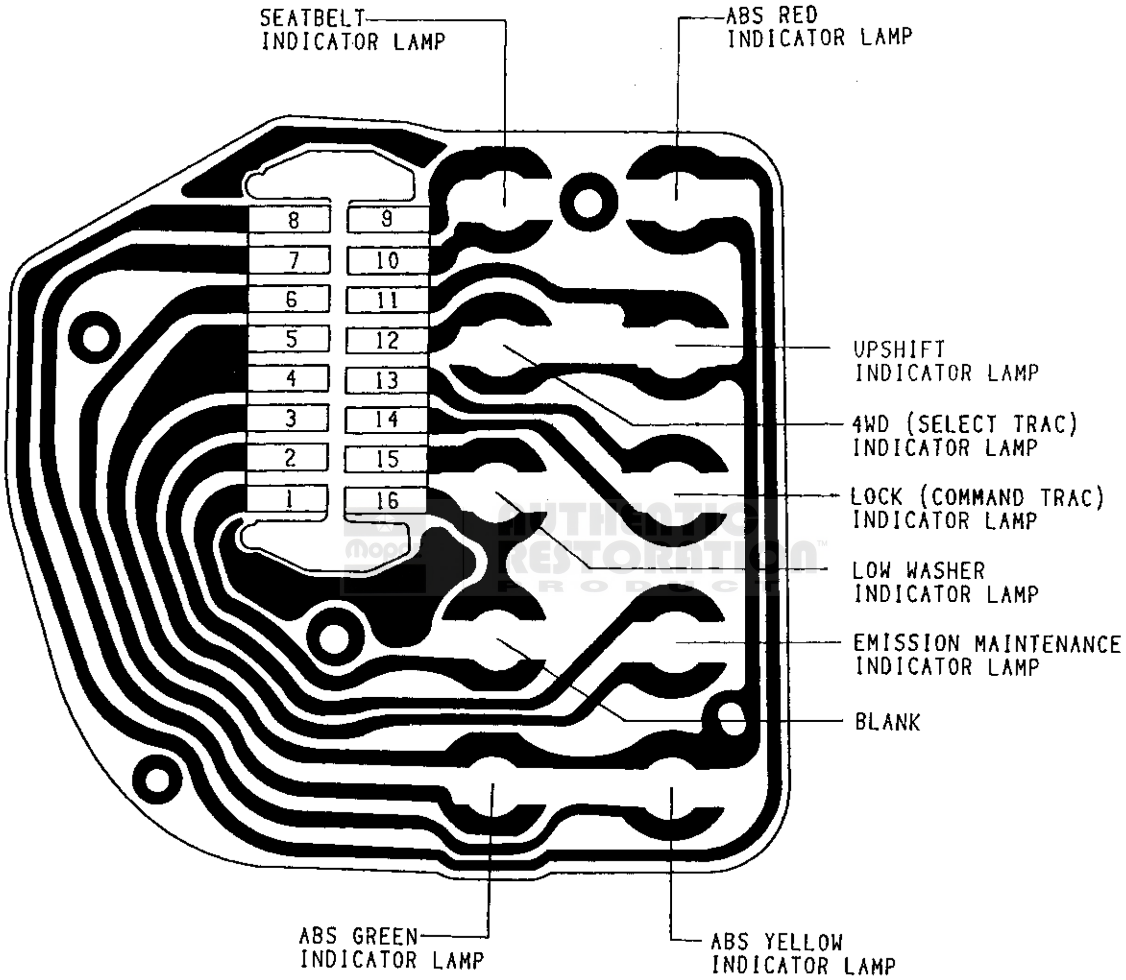
MJ-XJ 58



INSTRUMENT CLUSTER
INDICATOR PRINTED CIRCUIT BOARD
(WITHOUT ABS)

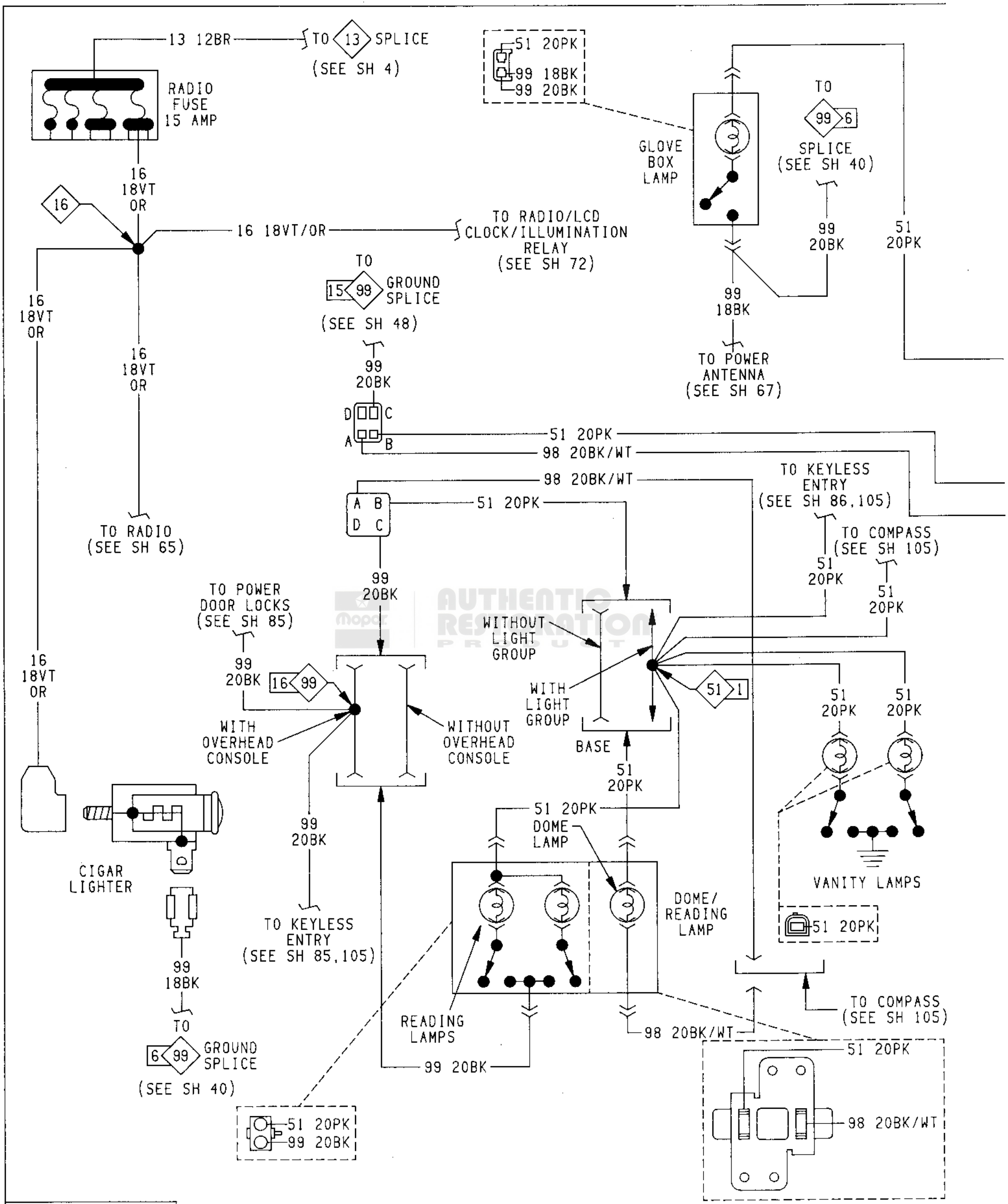
MJ-XJ 59

J908W-3

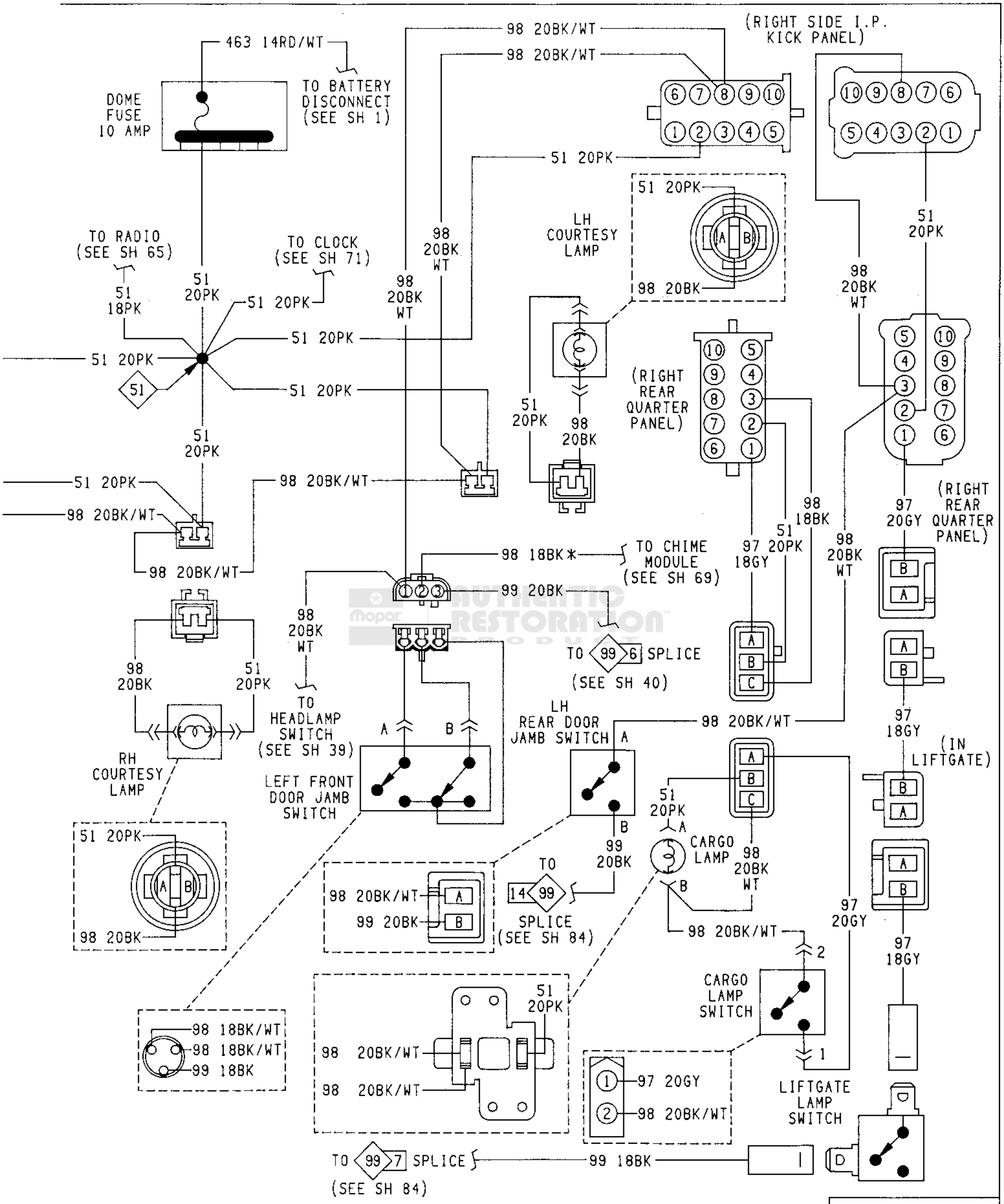


INSTRUMENT CLUSTER
INDICATOR PRINTED CIRCUIT BOARD
(WITH ABS)

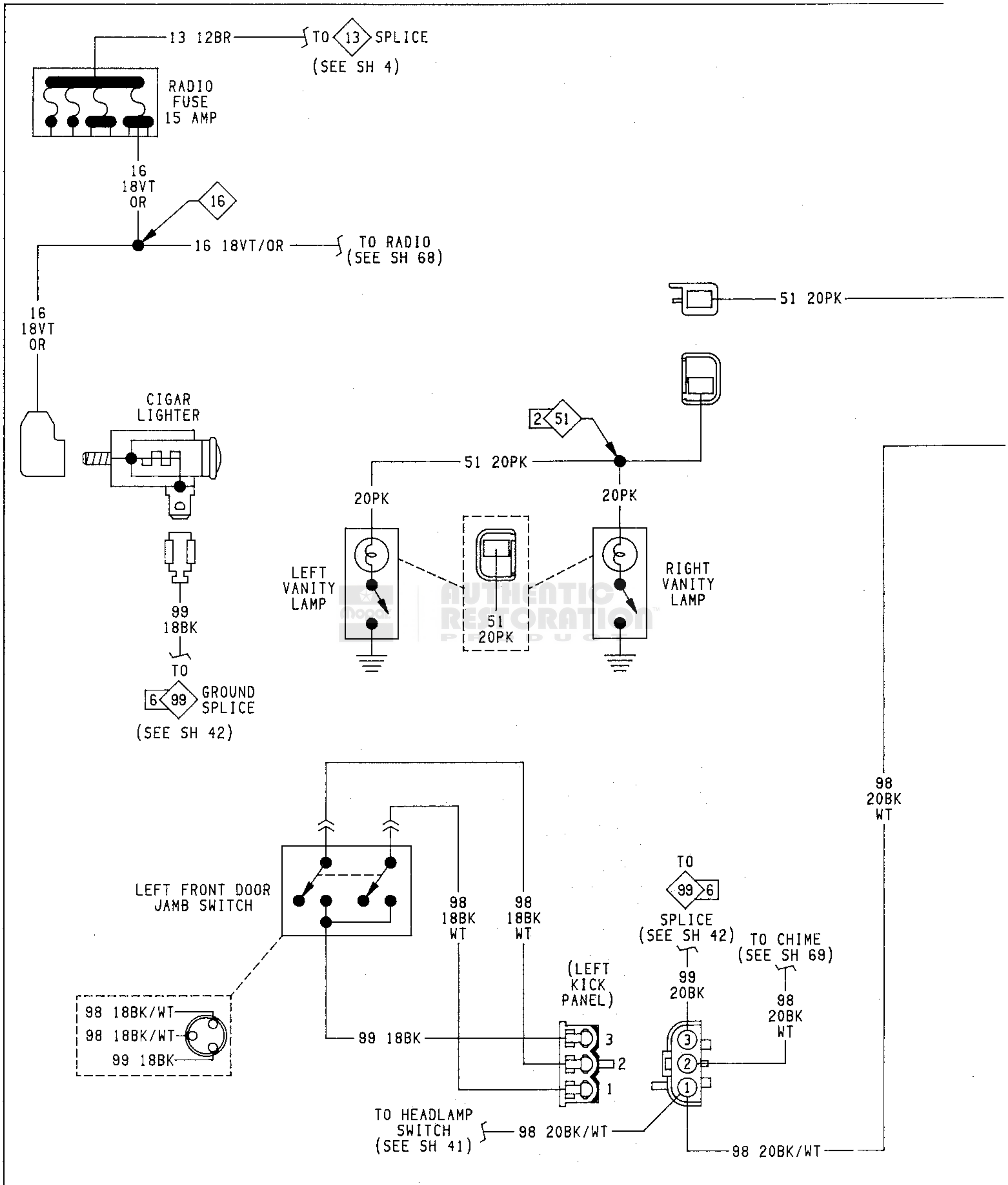
J908W-3



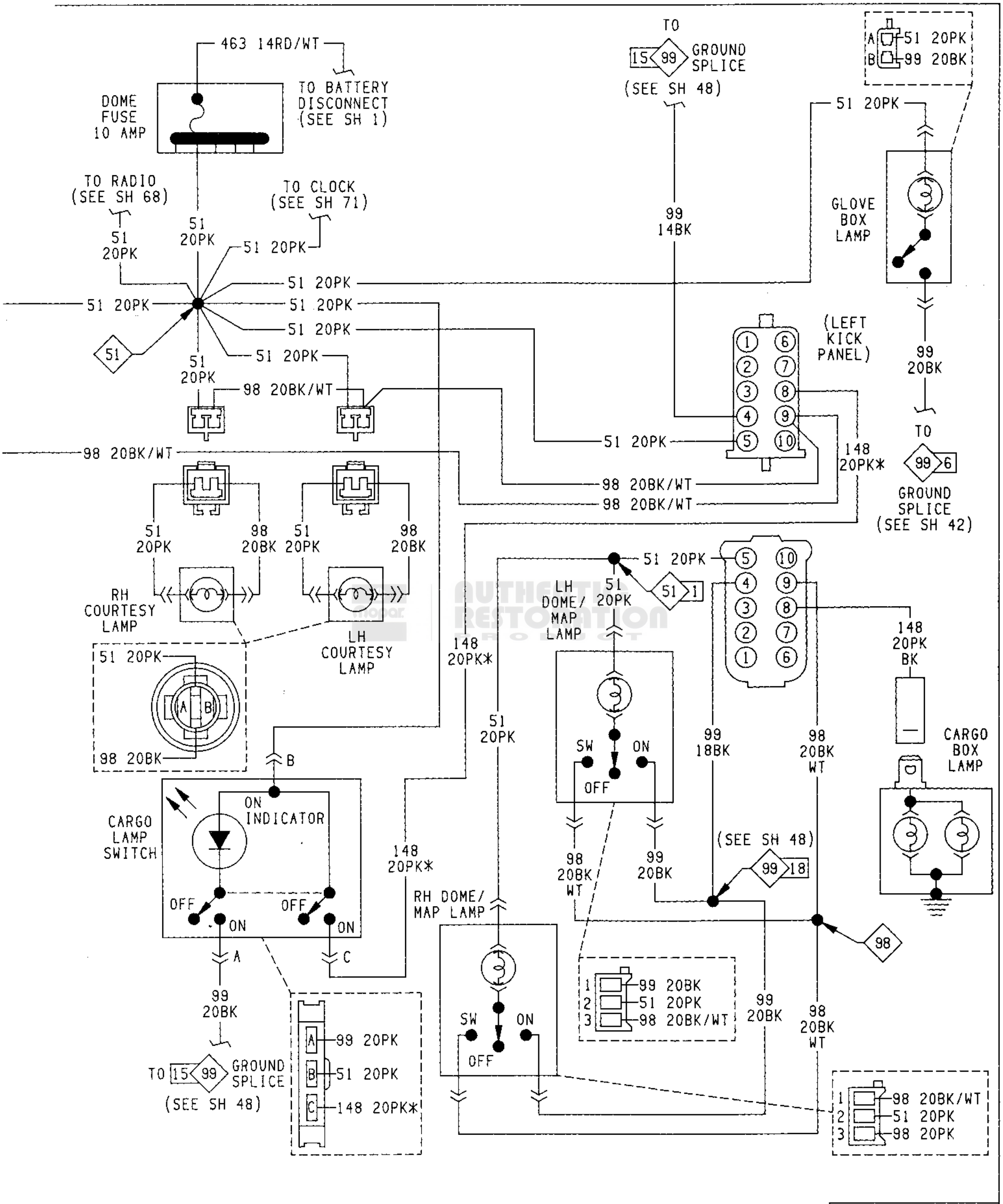
XJ 61 | DOME, COURTESY LAMPS AND CIGAR LIGHTER J908W-3



J908W-3 DOME, COURTESY LAMPS AND CIGAR LIGHTER | XJ 62

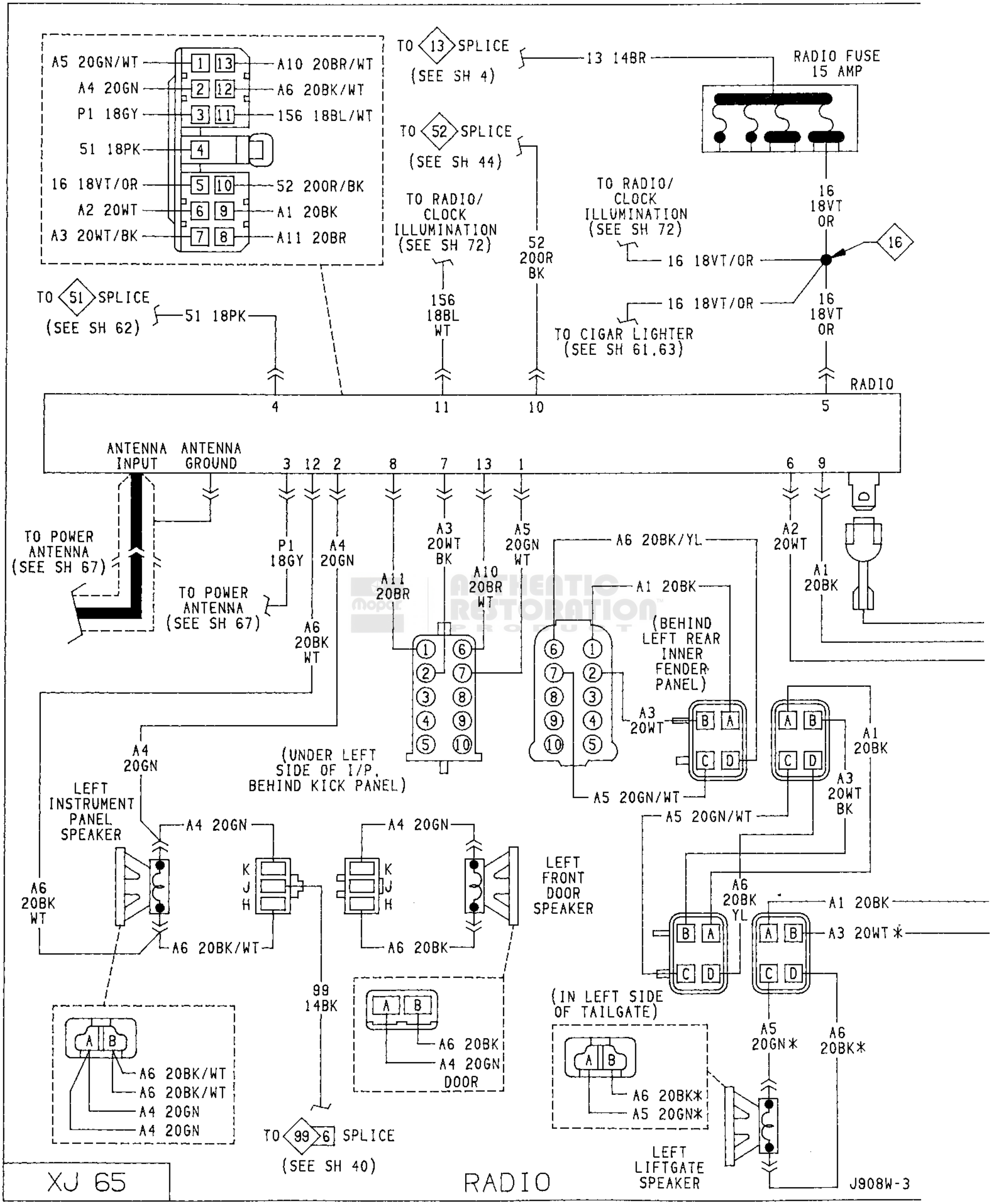


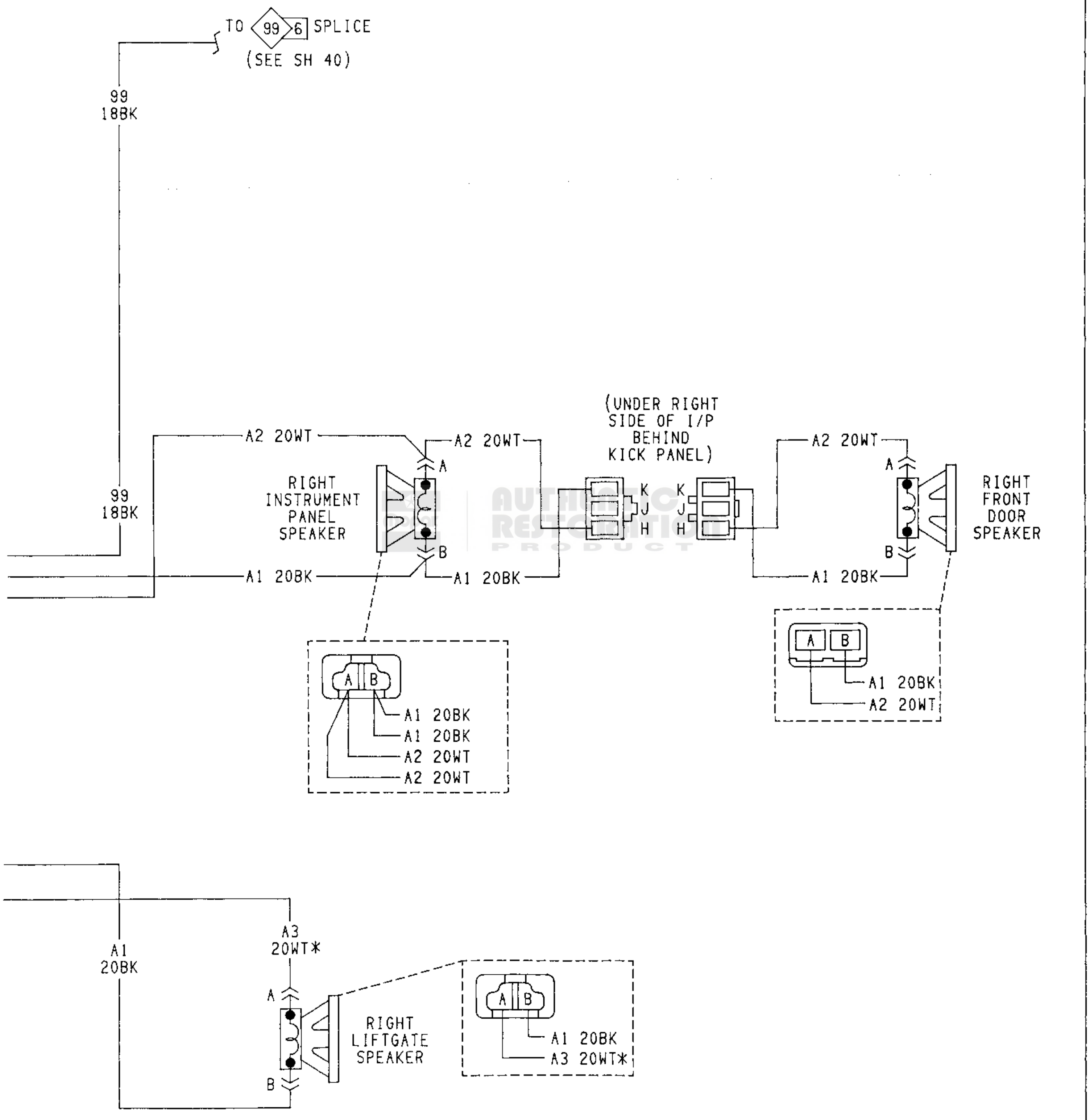
MJ 63 | DOME, COURTESY LAMPS AND CIGAR LIGHTER J908W-3

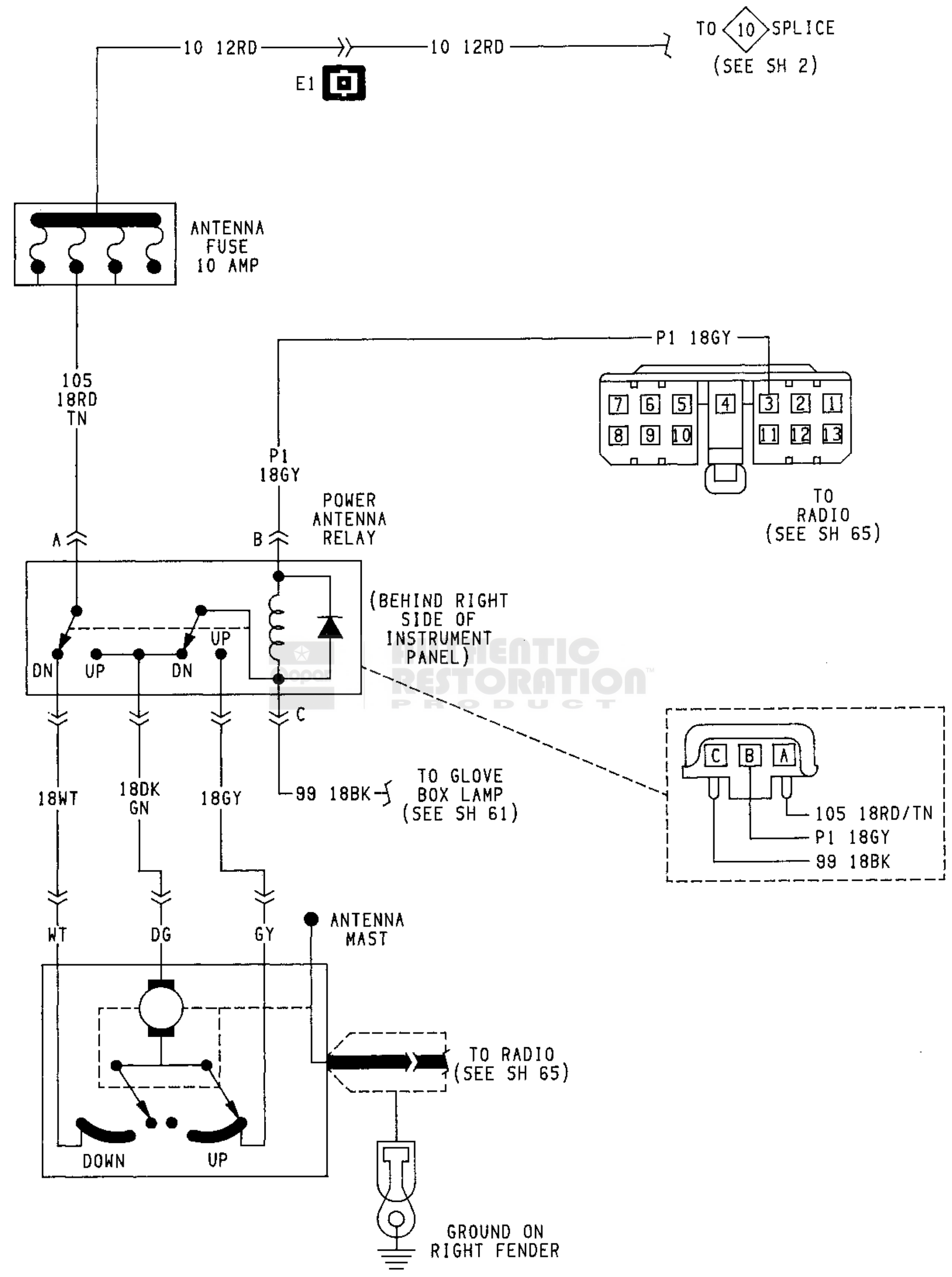


J908W-3 DOME, COURTESY LAMPS AND CIGAR LIGHTER

MJ 64


A5 20GN/WT
A4 20GN
P1 18GY
51 18PK
16 18VT/OR
A2 20WT
A3 20WT/BK
1 13
2 12
3 11
4
5 10
6 9
7 8
A10 20BR/WT
A6 20BK/WT
156 18BL/WT
52 20OR/BK
A1 20BK
A11 20BR
TO 13 SPLICE (SEE SH 4)
13 14BR
RADIO FUSE 15 AMP
TO 52 SPLICE (SEE SH 44)
TO RADIO/ CLOCK ILLUMINATION (SEE SH 72)
TO RADIO/ CLOCK ILLUMINATION (SEE SH 72)
16 18VT OR
16
16 18VT/OR
16 18VT/OR
TO CIGAR LIGHTER (SEE SH 61,63)
16 18VT OR
52 20OR BK
156 18BL WT
TO 51 SPLICE (SEE SH 62)
51 18PK
RADIO
4
11
10
5
ANTENNA INPUT
ANTENNA GROUND
3 12 2 8 7 13 1 6 9
TO POWER ANTENNA (SEE SH 67)
P1 18GY
A4 20GN
TO POWER ANTENNA (SEE SH 67)
A6 20BK WT
A11 20BR
A3 20WT BK
A10 20BR WT
A5 20GN WT
A6 20BK/YL
A1 20BK
A2 20WT
A1 20BK
(BEHIND LEFT REAR INNER FENDER PANEL)
1 6
2 7
3 8
4 9
5 10
6 1
7 2
8 3
9 4
10 5
A3 20WT
B A
C D
A B
C D
A1 20BK
A3 20WT BK
A5 20GN/WT
A5 20GN/WT
(UNDER LEFT SIDE OF I/P, BEHIND KICK PANEL)
A4 20GN
LEFT INSTRUMENT PANEL SPEAKER
A4 20GN
A4 20GN
K J H
K J H
LEFT FRONT DOOR SPEAKER
A6 20BK WT
A6 20BK/WT
A6 20BK
A6 20BK YL
A1 20BK
B A
C D
A B
C D
A3 20WT*
99 14BK
A B
A6 20BK
A4 20GN
DOOR
A B
A6 20BK/WT
A6 20BK/WT
A4 20GN
A4 20GN
TO 99 6 SPLICE (SEE SH 40)
(IN LEFT SIDE OF TAILGATE)
A B
A6 20BK*
A5 20GN*
A5 20GN*
A6 20BK*
LEFT LIFTGATE SPEAKER
XJ 65
RADIO
J908W-3

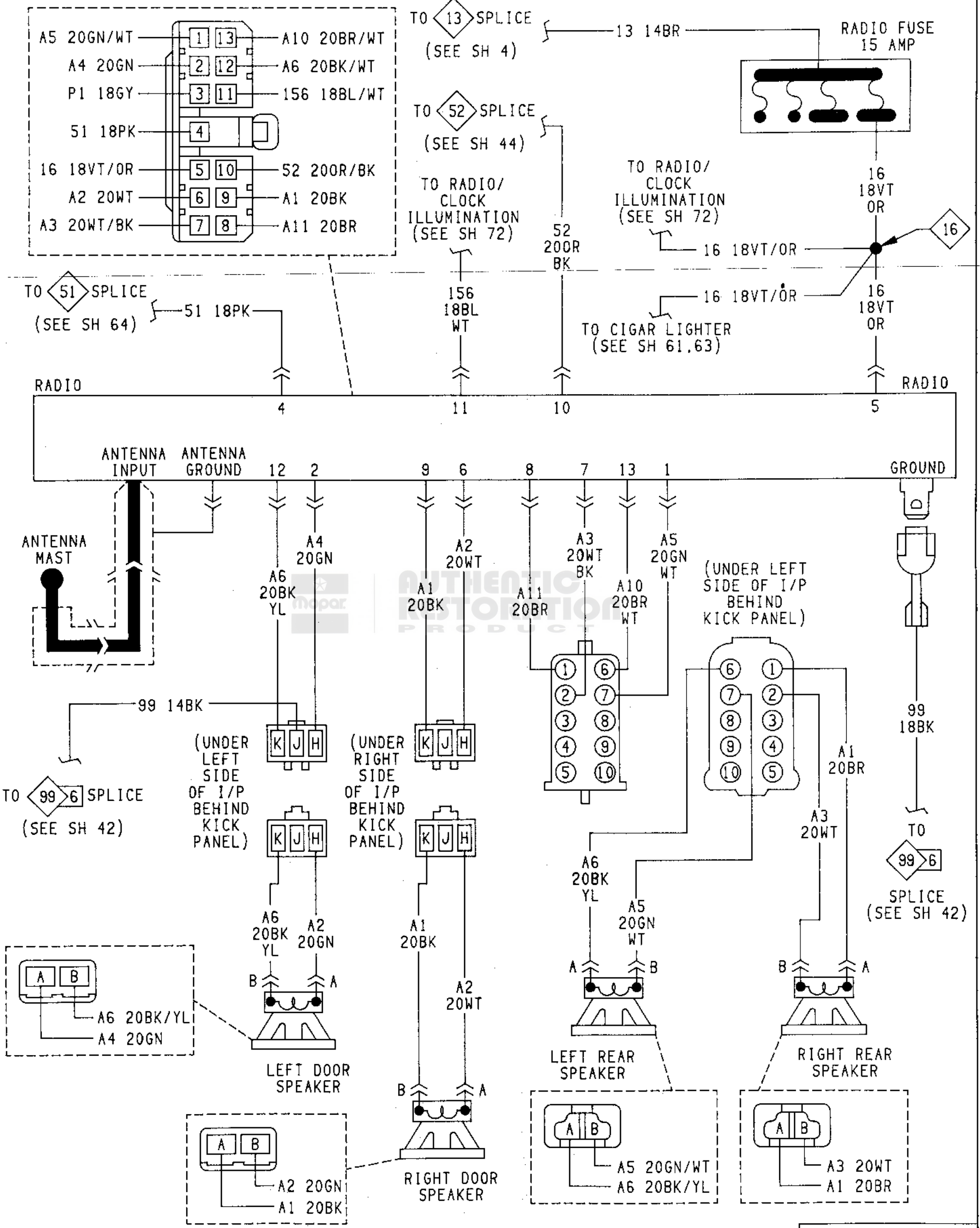

TO 99 6 SPLICE
(SEE SH 40)
99
18BK
99
18BK
A2 20WT
A2 20WT
A
B
RIGHT
INSTRUMENT
PANEL
SPEAKER
A1 20BK
A1 20BK
(UNDER RIGHT
SIDE OF I/P
BEHIND
KICK PANEL)
K
J
H
K
J
H
A2 20WT
A1 20BK
A
B
RIGHT
FRONT
DOOR
SPEAKER
A
B
A1 20BK
A1 20BK
A2 20WT
A2 20WT
A
B
A1 20BK
A2 20WT
A1
20BK
A3
20WT*
A
B
RIGHT
LIFTGATE
SPEAKER
A
B
A1 20BK
A3 20WT*



XJ 67

POWER ANTENNA

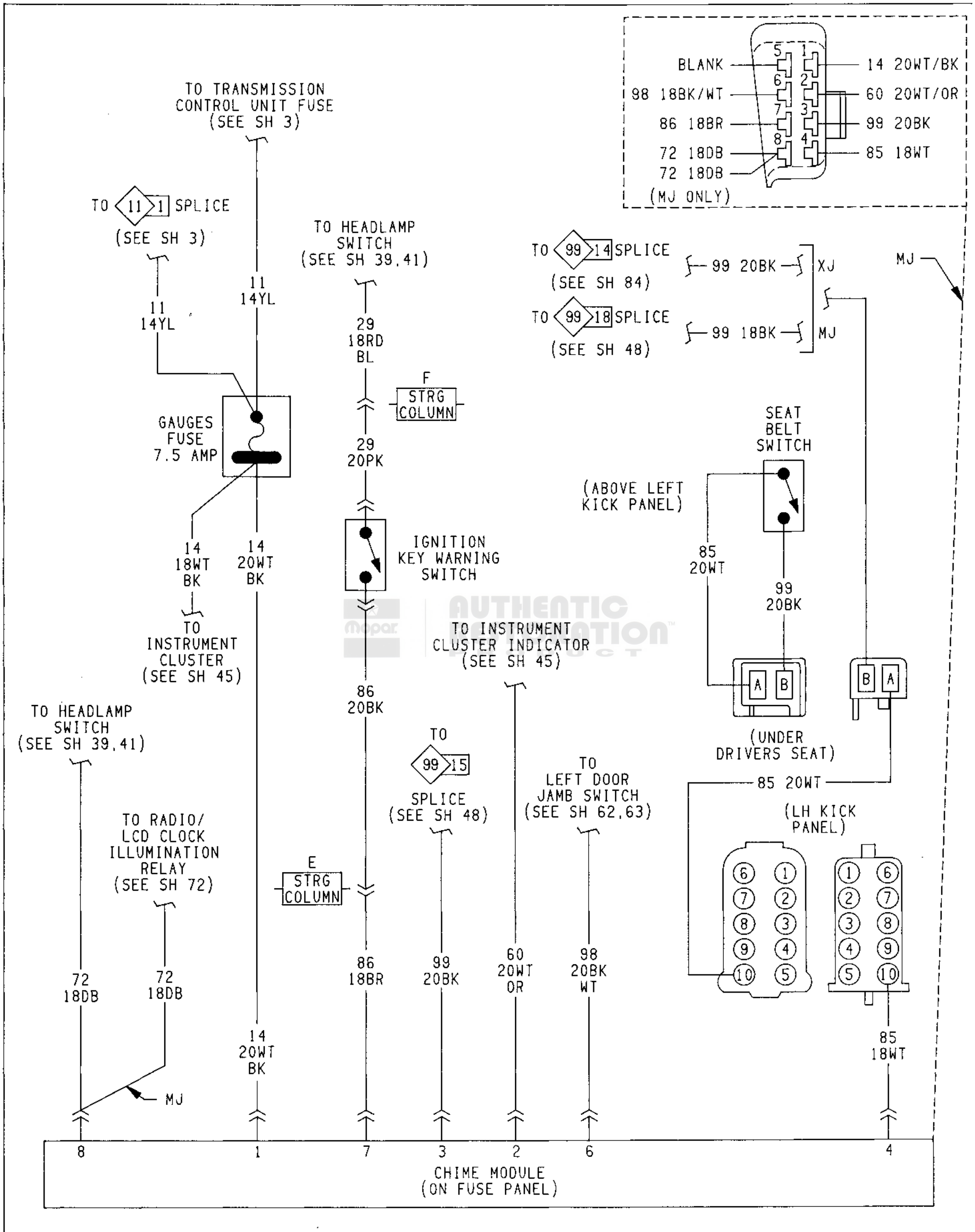
J908W-3



J908W-3

RADIO

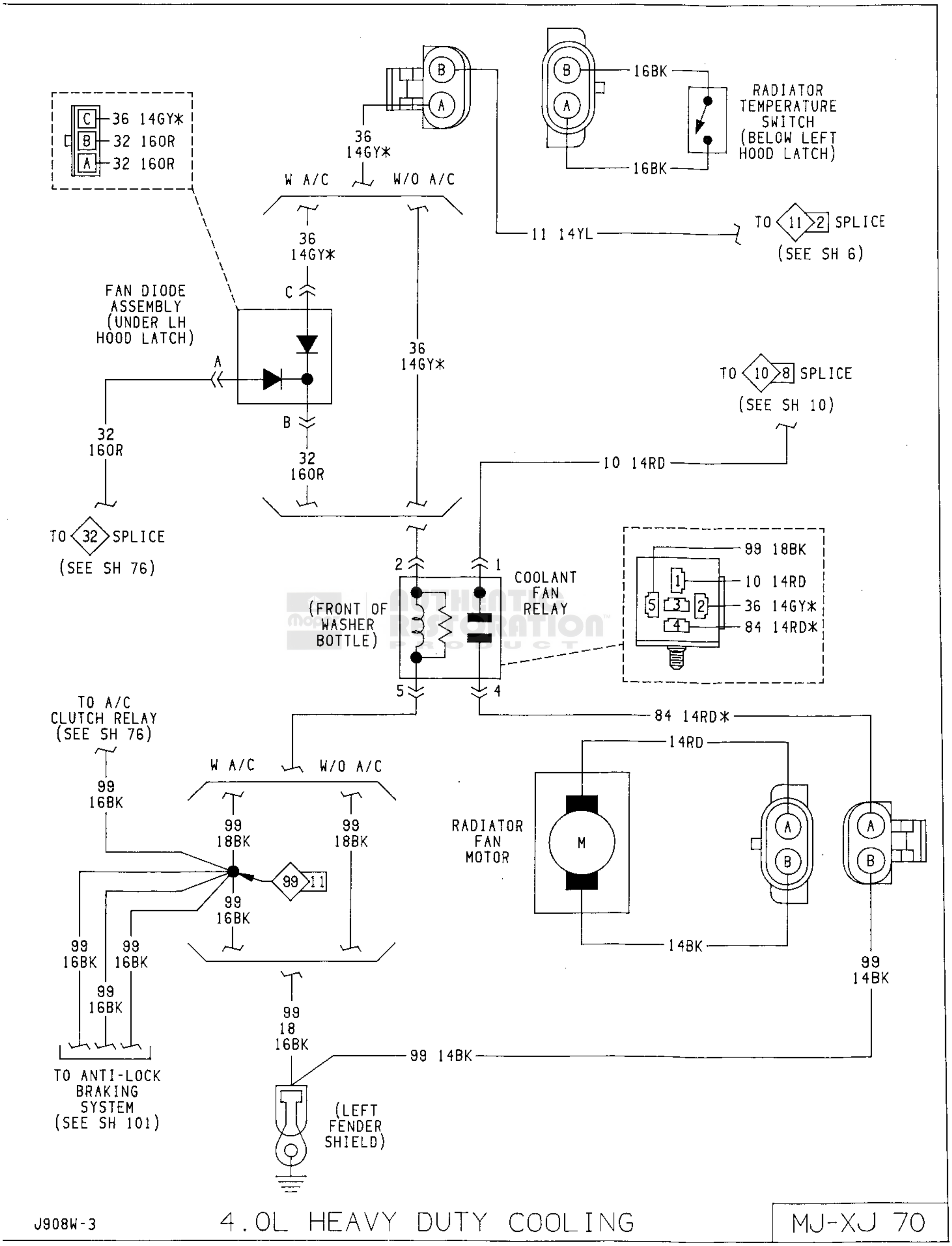
MJ 68

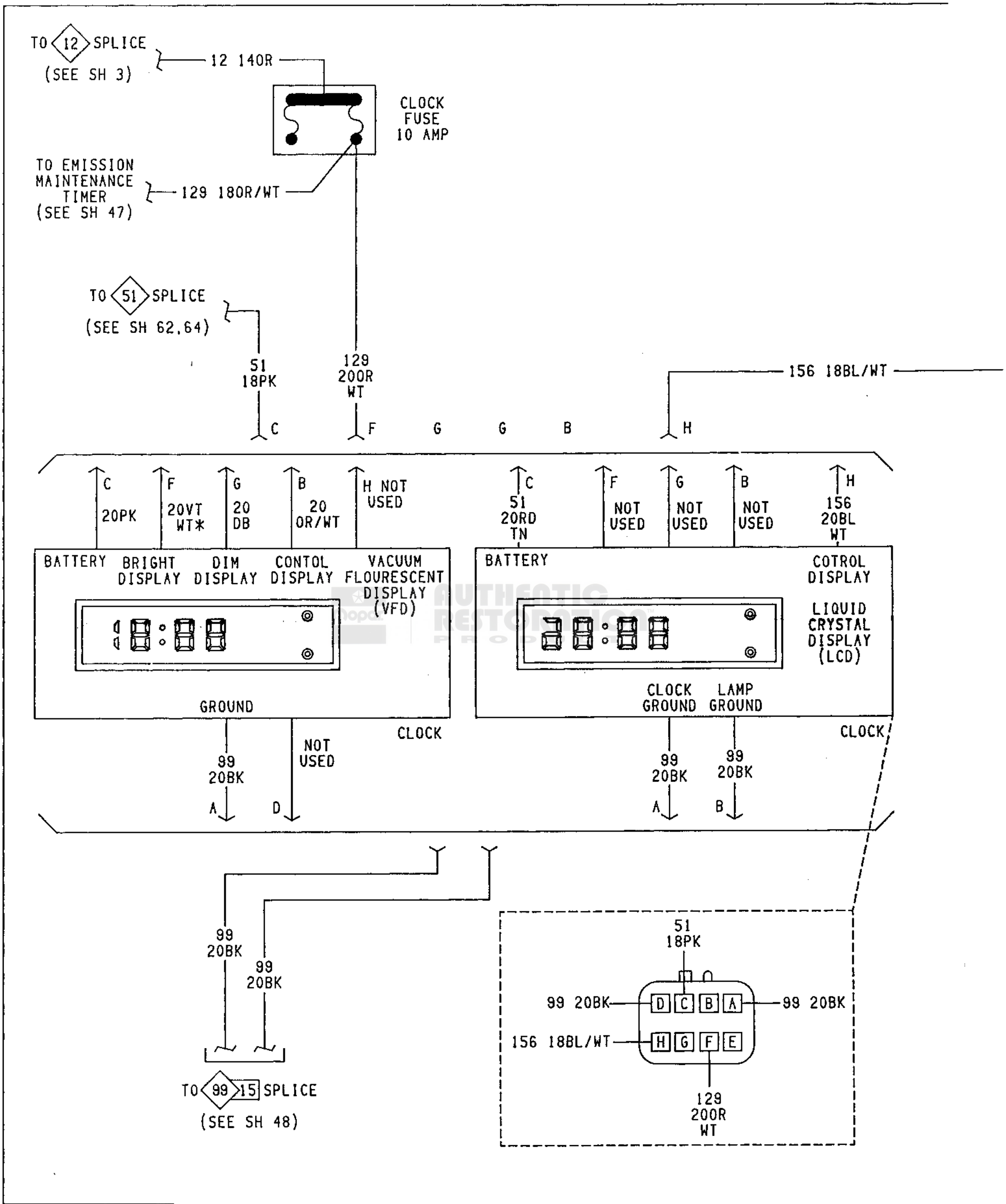


MJ-XJ 69

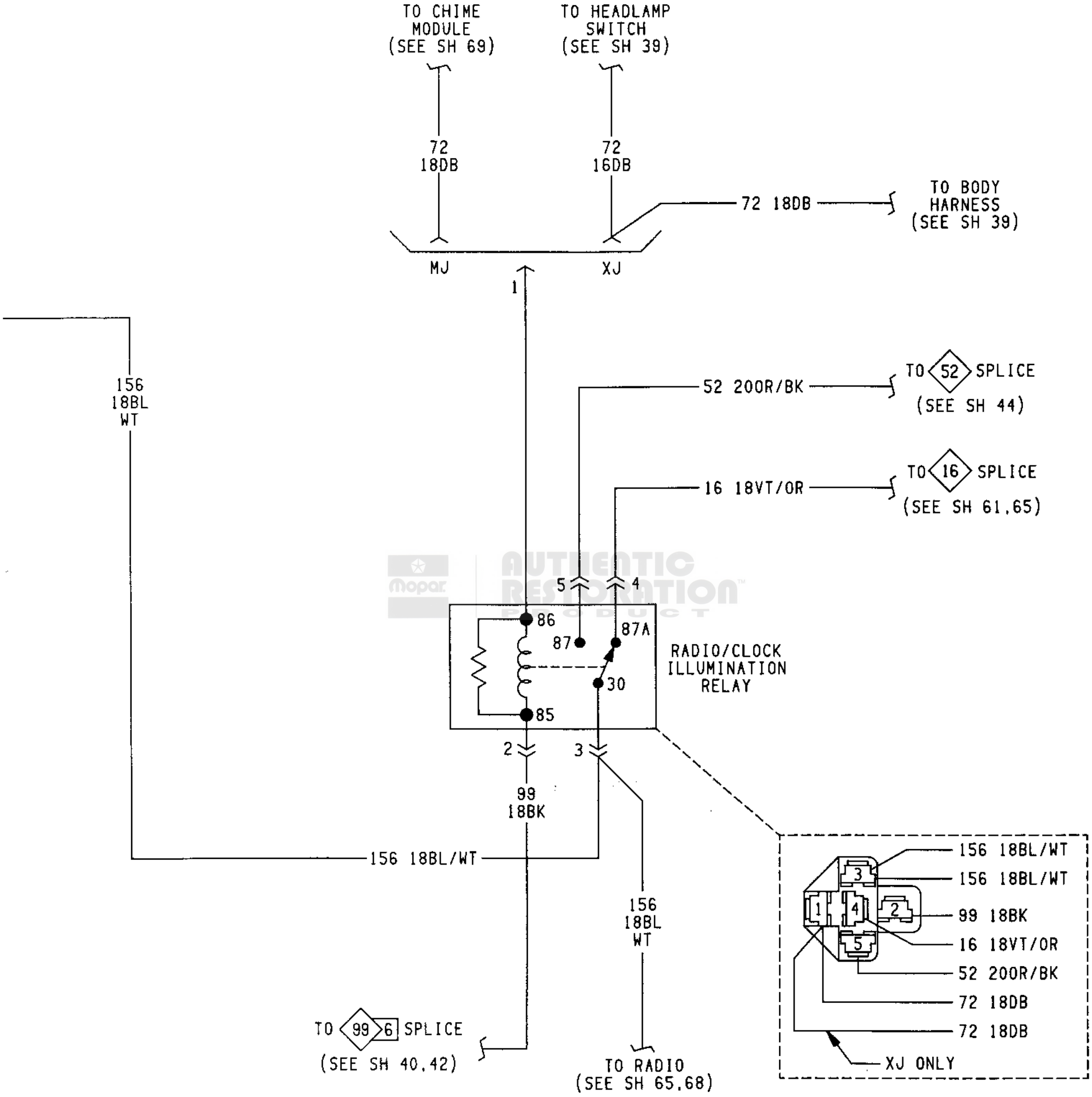
CHIME MODULE

J908W-3

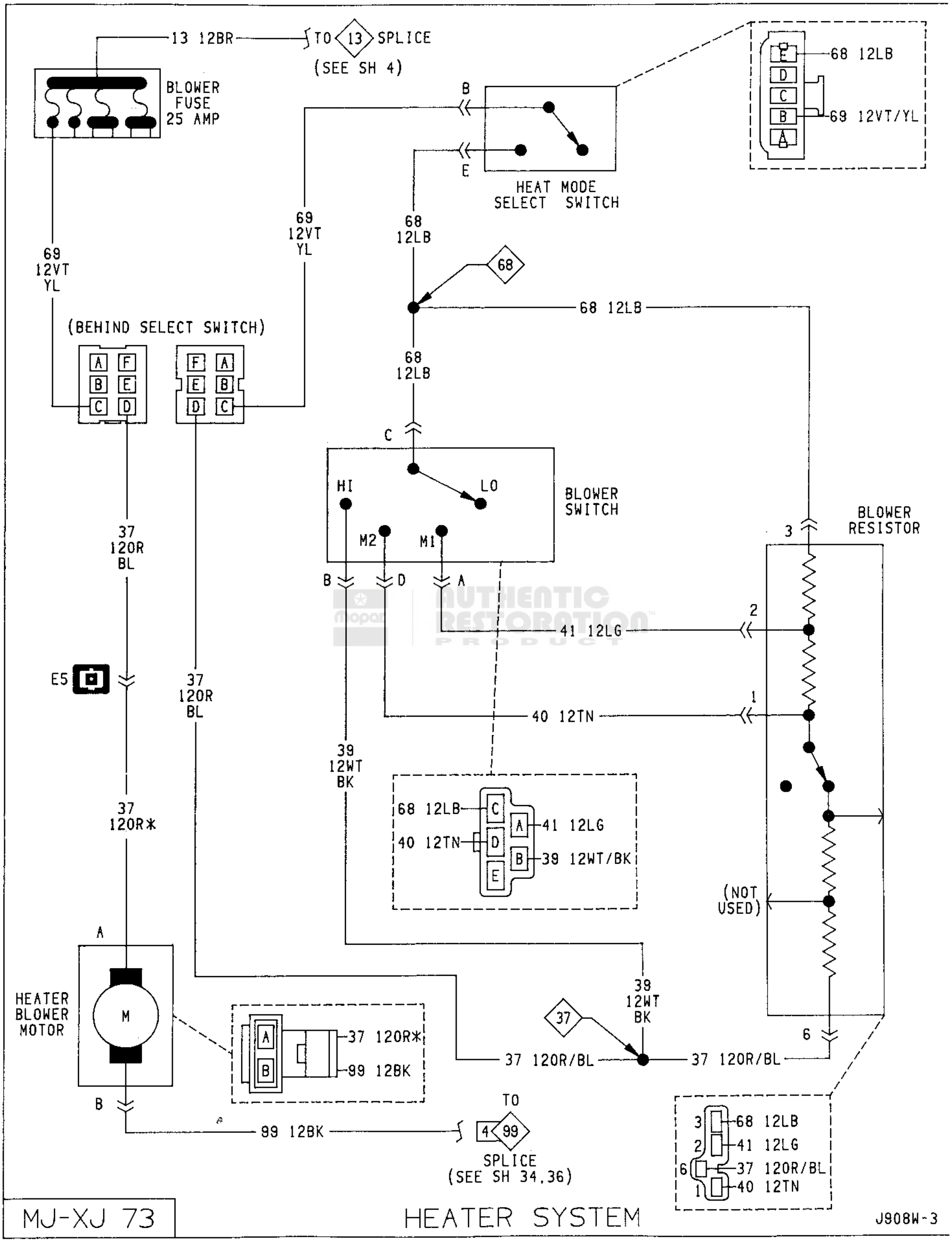

C 36 14GY*
B 32 16OR
A 32 16OR
36 14GY*
W A/C
W/O A/C
B
A
16BK
16BK
RADIATOR TEMPERATURE SWITCH (BELOW LEFT HOOD LATCH)
11 14YL
TO 11 2 SPLICE (SEE SH 6)
36 14GY*
C
FAN DIODE ASSEMBLY (UNDER LH HOOD LATCH)
A
B
36 14GY*
32 16OR
32 16OR
TO 10 8 SPLICE (SEE SH 10)
10 14RD
TO 32 SPLICE (SEE SH 76)
2
1
COOLANT FAN RELAY
(FRONT OF WASHER BOTTLE)
99 18BK
1 10 14RD
5 3 2 36 14GY*
4 84 14RD*
5
4
84 14RD*
TO A/C CLUTCH RELAY (SEE SH 76)
W A/C
W/O A/C
14RD
99 16BK
99 18BK
99 18BK
RADIATOR FAN MOTOR
M
A
B
A
B
99 11
99 16BK
99 16BK
99 16BK
99 16BK
14BK
99 14BK
99 18 16BK
99 14BK
TO ANTI-LOCK BRAKING SYSTEM (SEE SH 101)
(LEFT FENDER SHIELD)


TO 12 SPLICE
(SEE SH 3)
12 140R
CLOCK FUSE 10 AMP
TO EMISSION MAINTENANCE TIMER (SEE SH 47)
129 180R/WT
TO 51 SPLICE
(SEE SH 62,64)
51 18PK
129 200R WT
156 18BL/WT
C
F
G
G
B
H
C 20PK
F 20VT WT*
G 20 DB
B 20 OR/WT
H NOT USED
BATTERY
BRIGHT DISPLAY
DIM DISPLAY
CONTOL DISPLAY
VACUUM FLOURESCENT DISPLAY (VFD)
GROUND
CLOCK
99 20BK
NOT USED
A
D
C 51 20RD TN
F NOT USED
G NOT USED
B NOT USED
H 156 20BL WT
BATTERY
COTROL DISPLAY
LIQUID CRYSTAL DISPLAY (LCD)
CLOCK GROUND
LAMP GROUND
CLOCK
99 20BK
99 20BK
A
B
99 20BK
99 20BK
TO 99 15 SPLICE
(SEE SH 48)
51 18PK
99 20BK
D C B A
99 20BK
156 18BL/WT
H G F E
129 200R WT

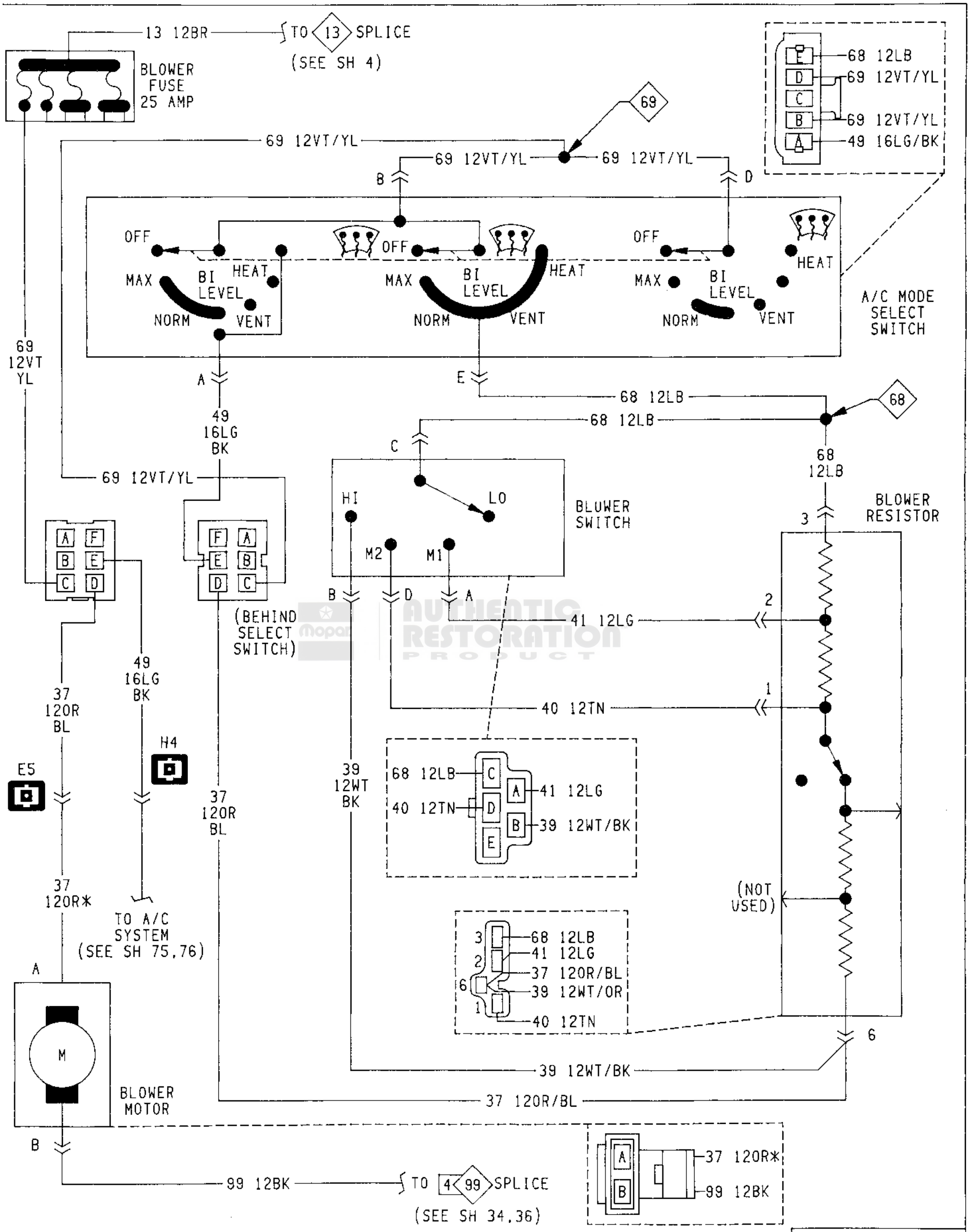
CLOCK



ILLUMINATION RELAY



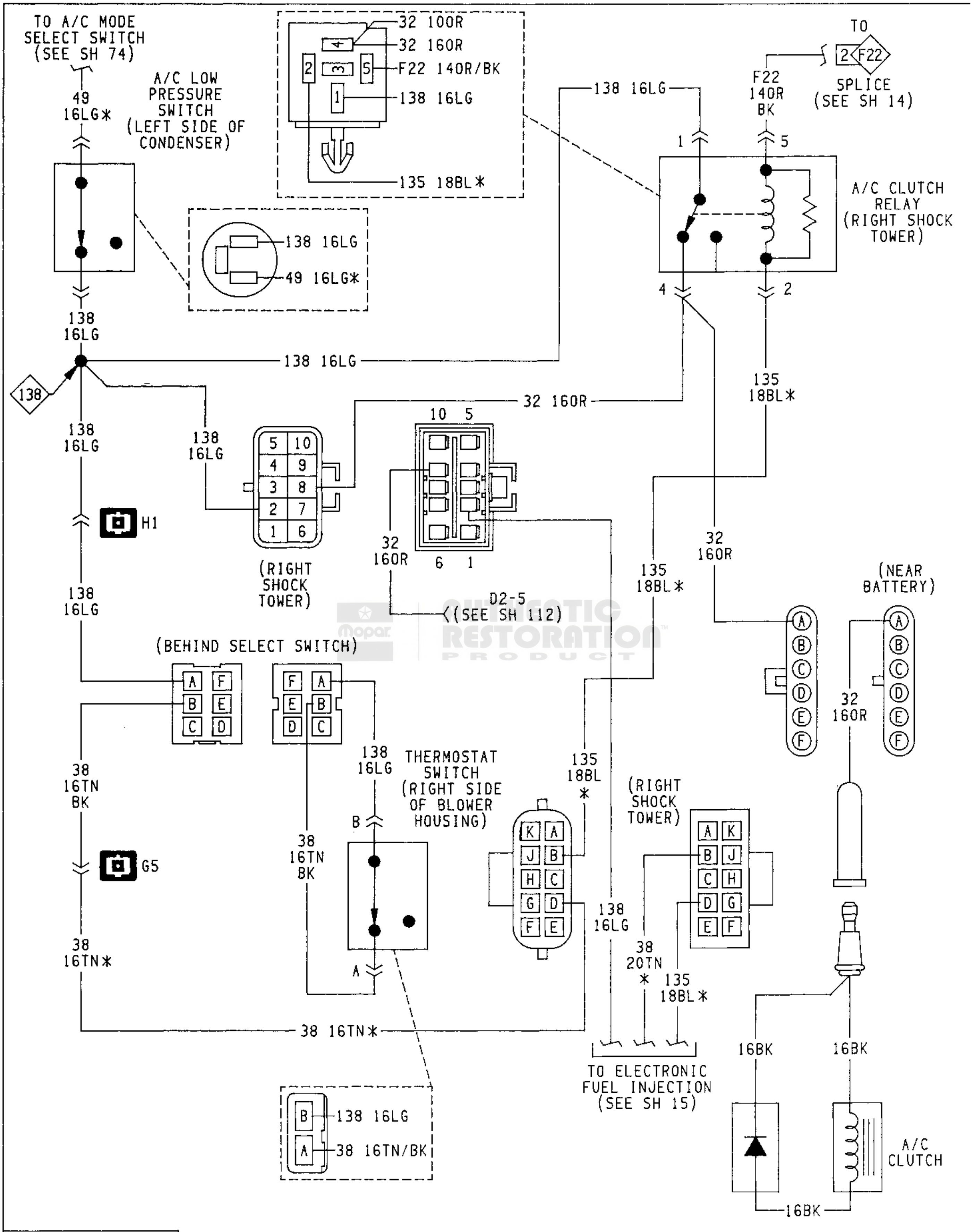
HEATER SYSTEM



J908W-3

HEATER AND A/C BLOWER SYSTEM

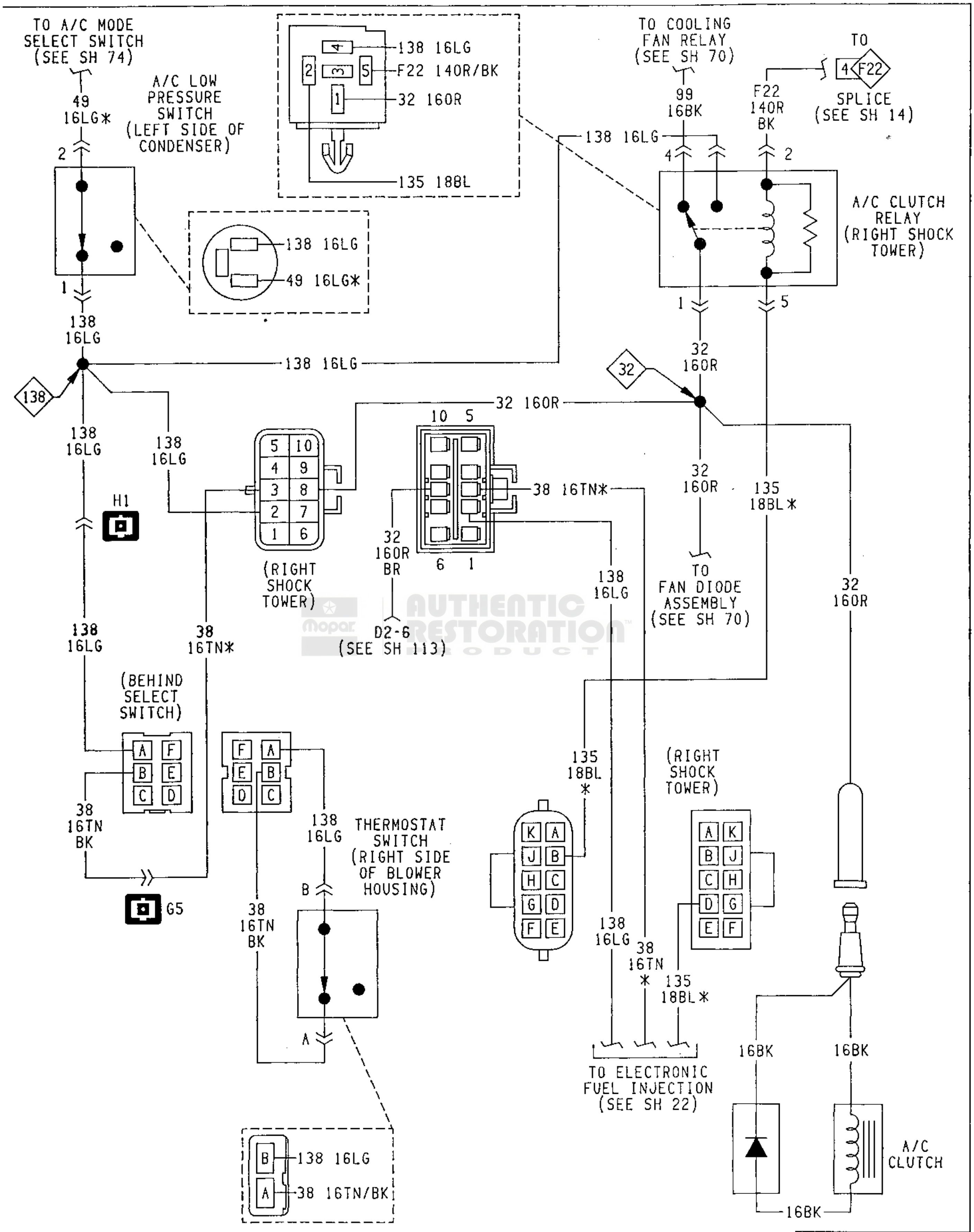
MJ-XJ 74



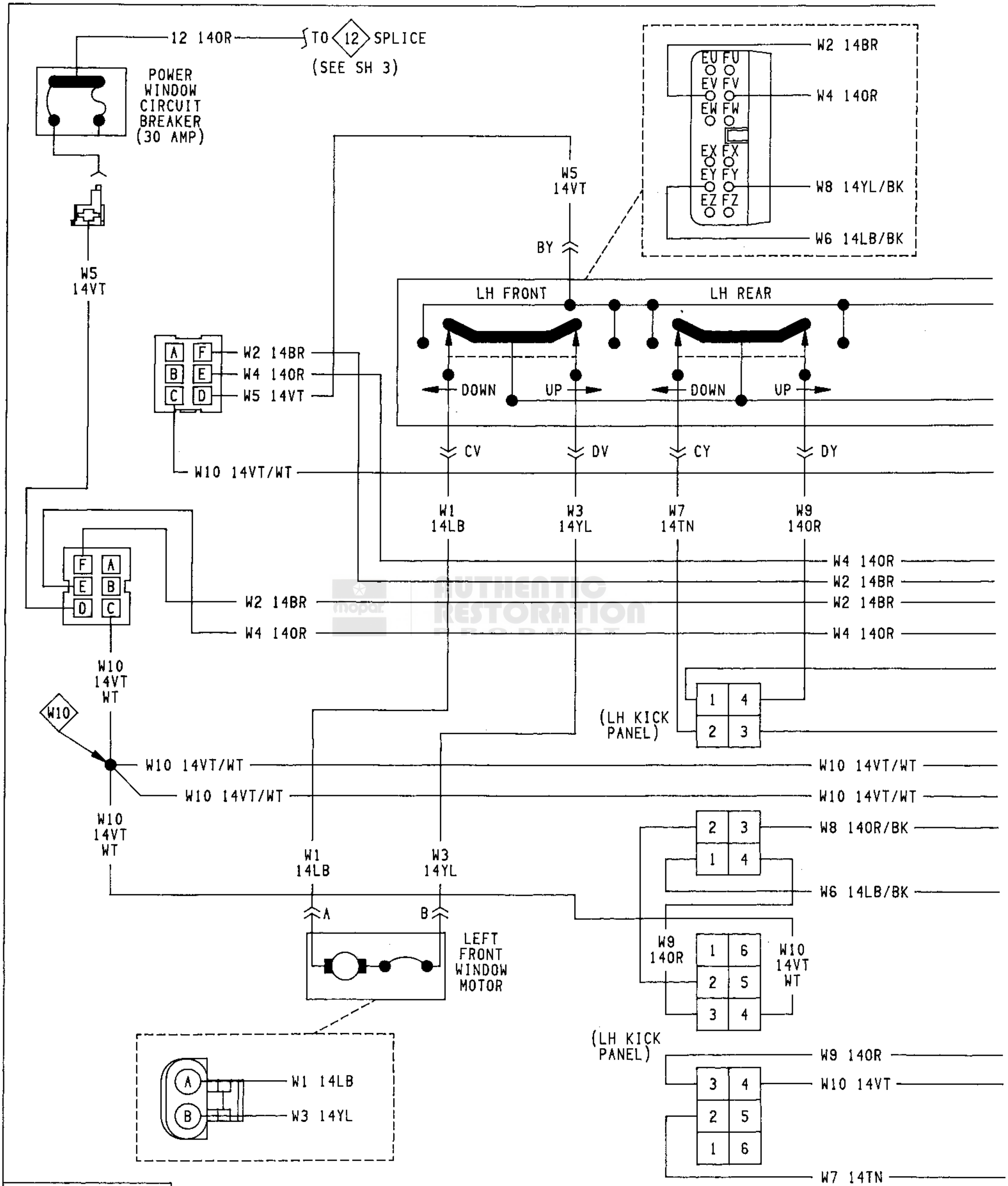
MJ-XJ 75

2.5L A/C SYSTEM

J908W-3



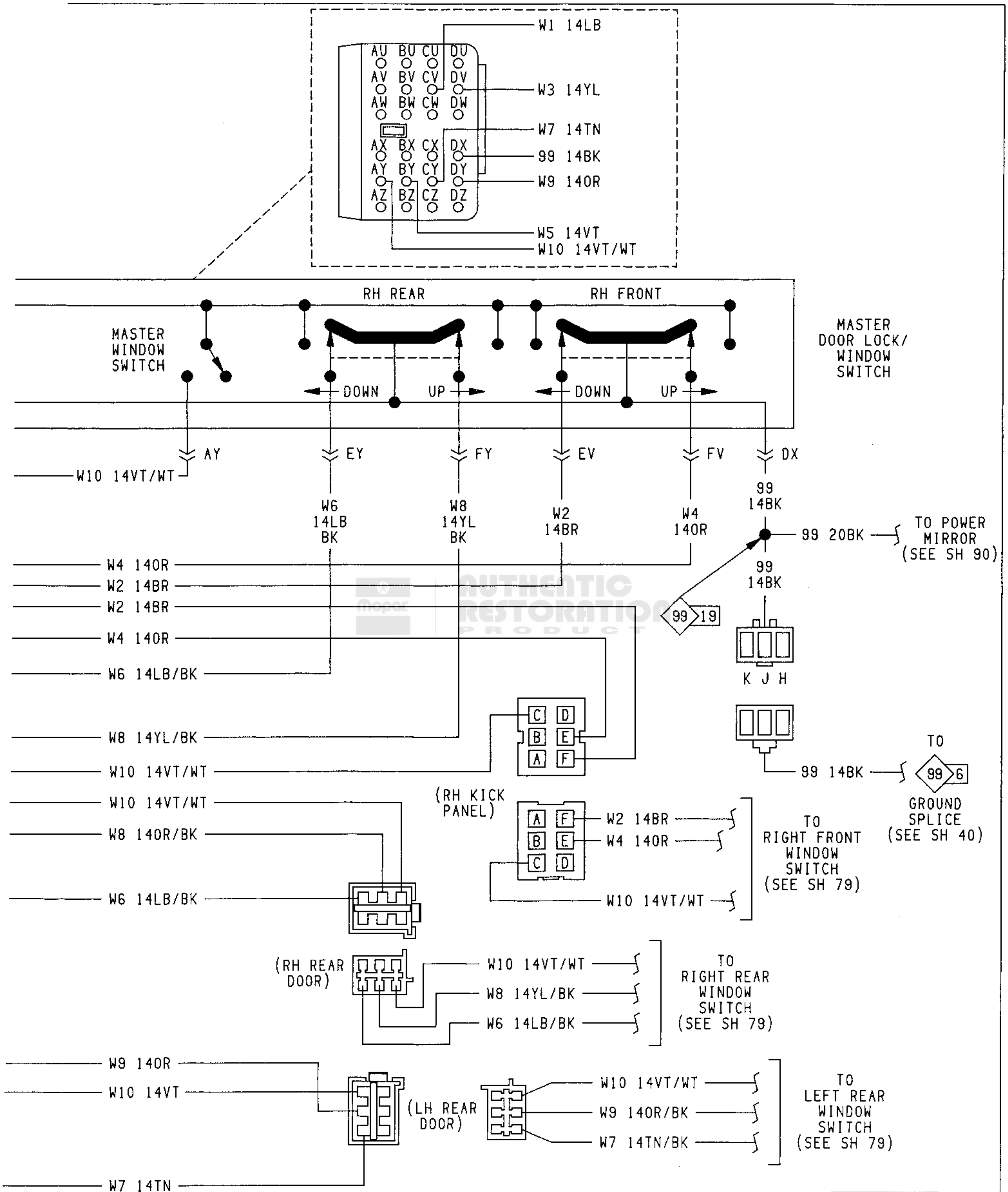
4.0L A/C SYSTEM



XJ 77

4 DOOR POWER WINDOWS

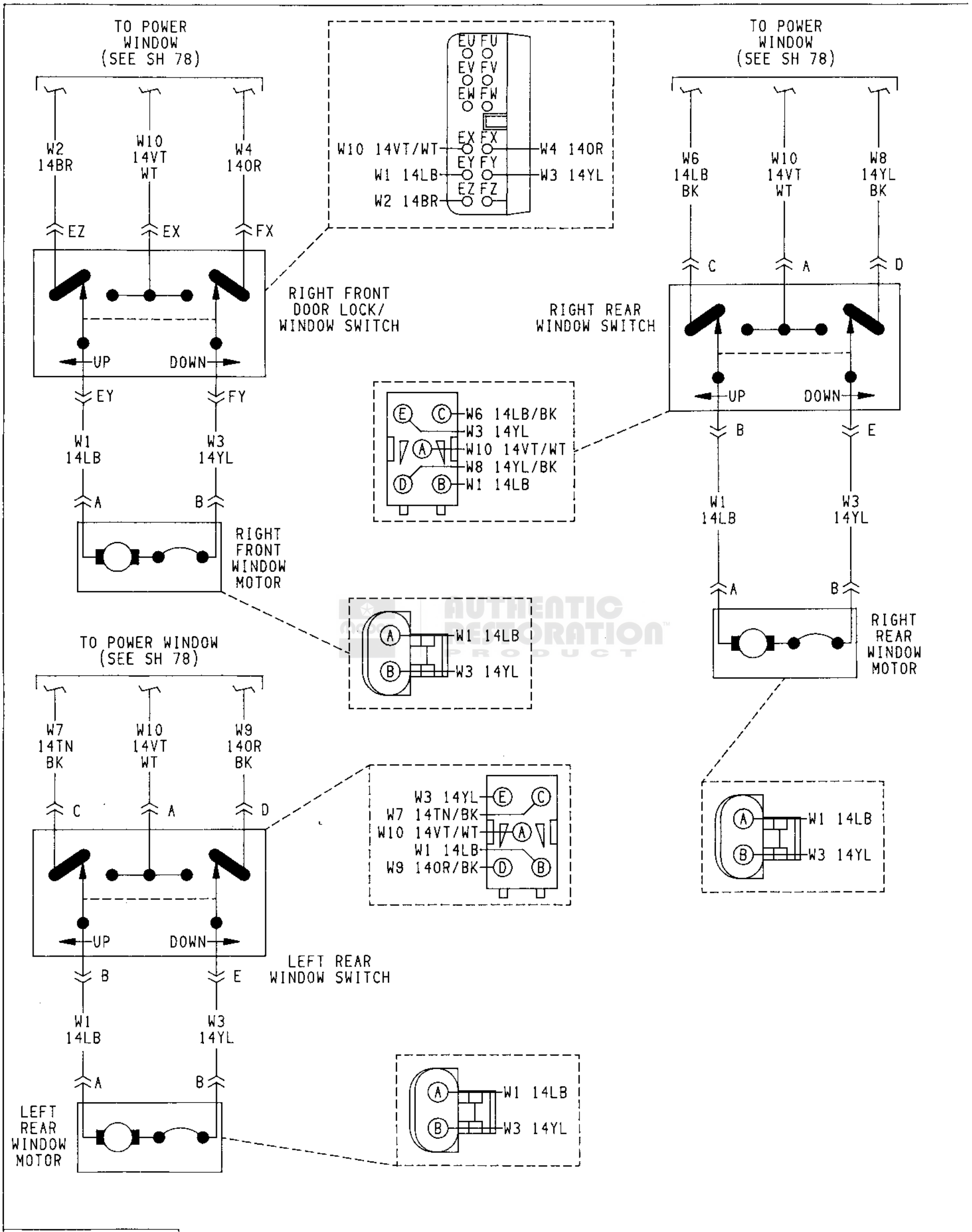
J908W-3



J908W-3

4 DOOR POWER WINDOWS

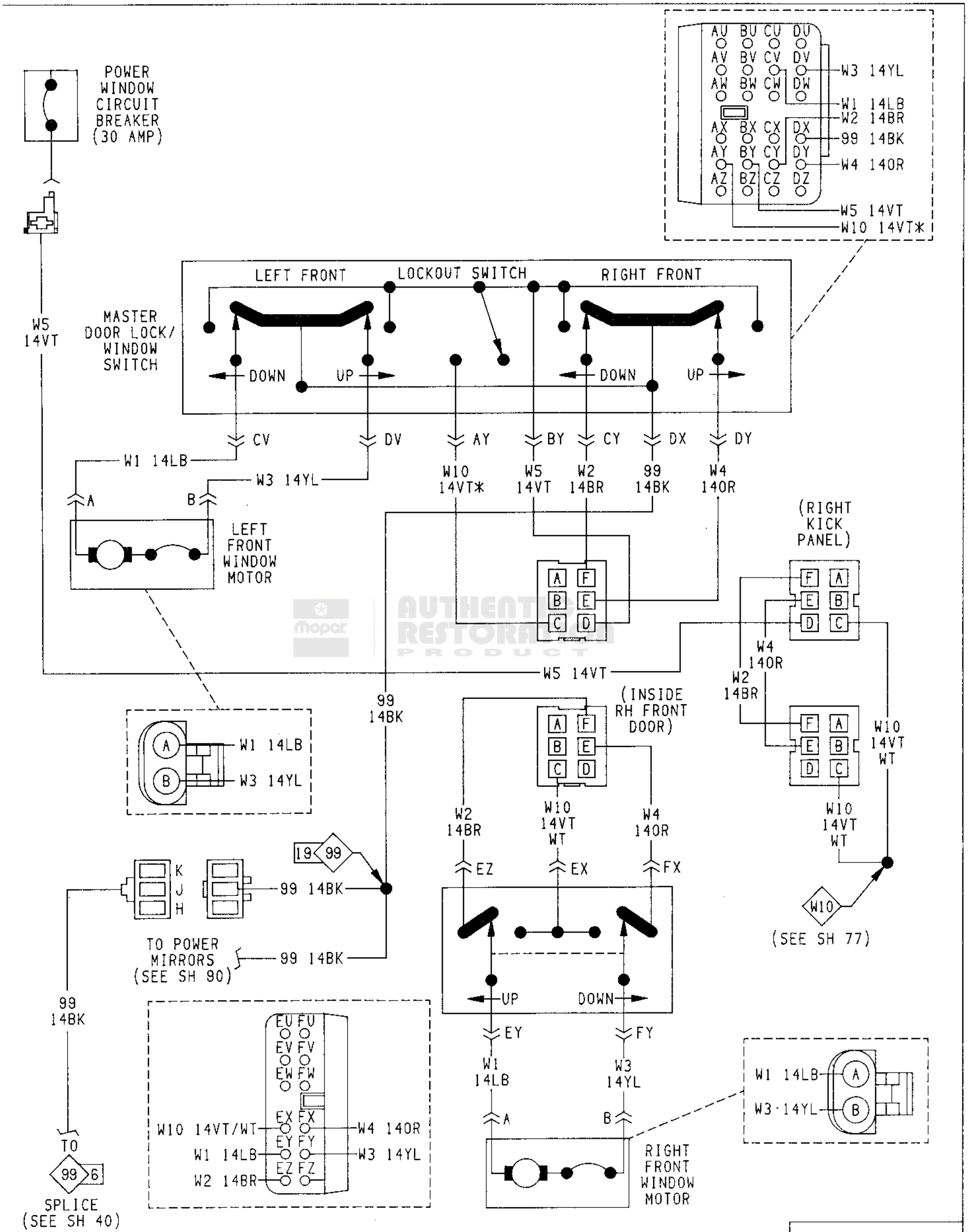
XJ 78



XJ 79

4 DOOR POWER WINDOWS

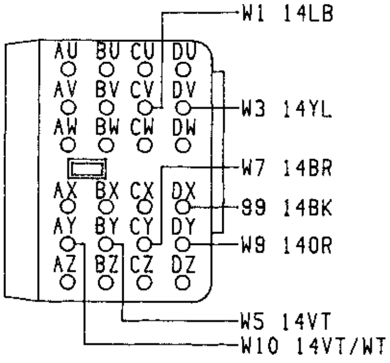
J908W-3



J908W-3

4 DOOR POWER WINDOWS

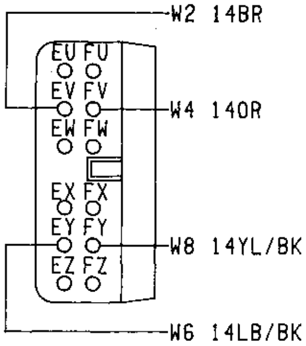
MJ-XJ 80



2 DOOR

LEFT FRONT DOOR CONNECTOR
AND WINDOW LIFT SWITCH FUNCTION

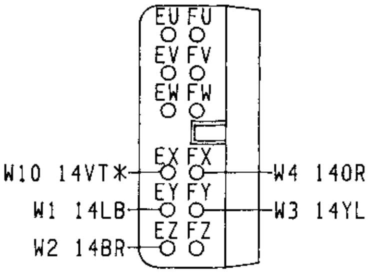
B+ POLARITY	B− POLARITY	WINDOW MOVEMENT
YL	LB	LT FRONT UP
LB	YL	LT FRONT DOWN
OR	BR	RT FRONT UP
BR	OR	RT FRONT DOWN
VT/WT	BK	FEED AND GROUND



4 DOOR

LEFT FRONT DOOR REAR WINDOW
CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

B+ POLARITY	B− POLARITY	WINDOW MOVEMENT
OR	BR	LT REAR UP
BR	OR	LT REAR DOWN
YL*	LB*	RT REAR UP
LB*	YL*	RT REAR DOWN
VT	BK	FEED AND GROUND



4 DOOR

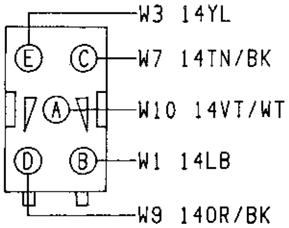
RIGHT FRONT DOOR WINDOW SWITCH
CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

B+ POLARITY	B− POLARITY	WINDOW MOVEMENT
YL	LB	RT FRONT UP (DOOR SWITCH)
LB	YL	RT FRONT DOWN (DOOR SWITCH)
OR	BR	RT FRONT UP (MASTER SWITCH)
BR	OR	RT FRONT DOWN (MASTER SWITCH)
VT*	—	FEED

J908W-3

LEFT REAR DOOR WINDOW CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

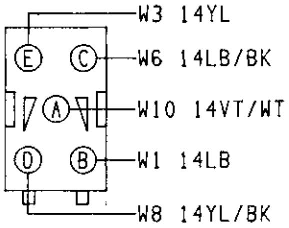
B+ POLARITY	B− POLARITY	WINDOW MOVEMENT
YL	LB	LT REAR UP (DOOR SWITCH)
LB	YL	LT REAR DOWN (DOOR SWITCH)
OR/BK	TN/BK	LT REAR UP (MASTER SWITCH)
TN/BK	OR/BK	LT REAR DOWN (MASTER SWITCH)
VT/WT	–	FEED



4 DOOR

RIGHT REAR DOOR WINDOW CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

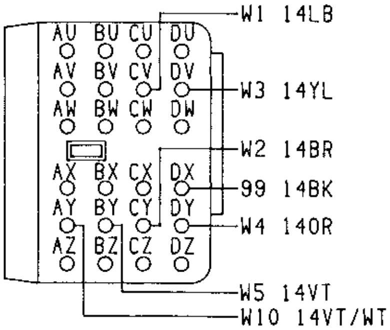
B+ POLARITY	B− POLARITY	WINDOW MOVEMENT
YL	LB	RT REAR UP (DOOR SWITCH)
LB	YL	RT REAR DOWN (DOOR SWITCH)
YL/BK	LB/BK	RT REAR UP (MASTER SWITCH)
LB/BK	YL/BK	RT REAR DOWN (MASTER SWITCH)
VT/WT	–	FEED



4 DOOR

LEFT FRONT DOOR CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

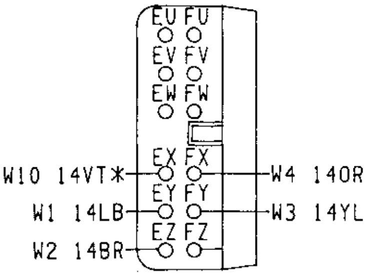
B+ POLARITY	B− POLARITY	WINDOW MOVEMENT
YL	LB	LT FRONT UP
LB	YL	LT FRONT DOWN
OR	BR	RT FRONT UP
BR	OR	RT FRONT DOWN
VT/WT	BK	FEED AND GROUND



2 DOOR

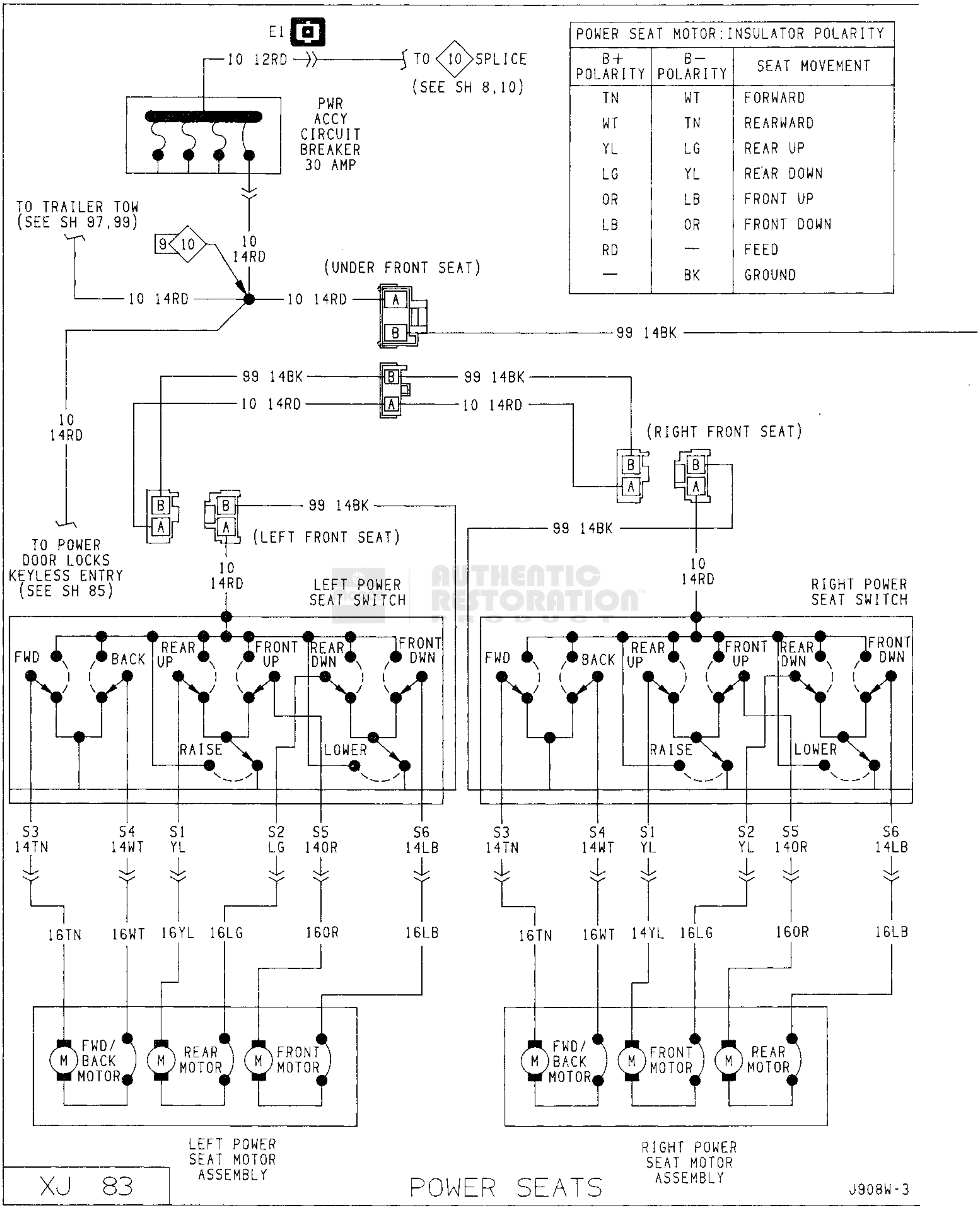
RIGHT FRONT DOOR WINDOW SWITCH CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

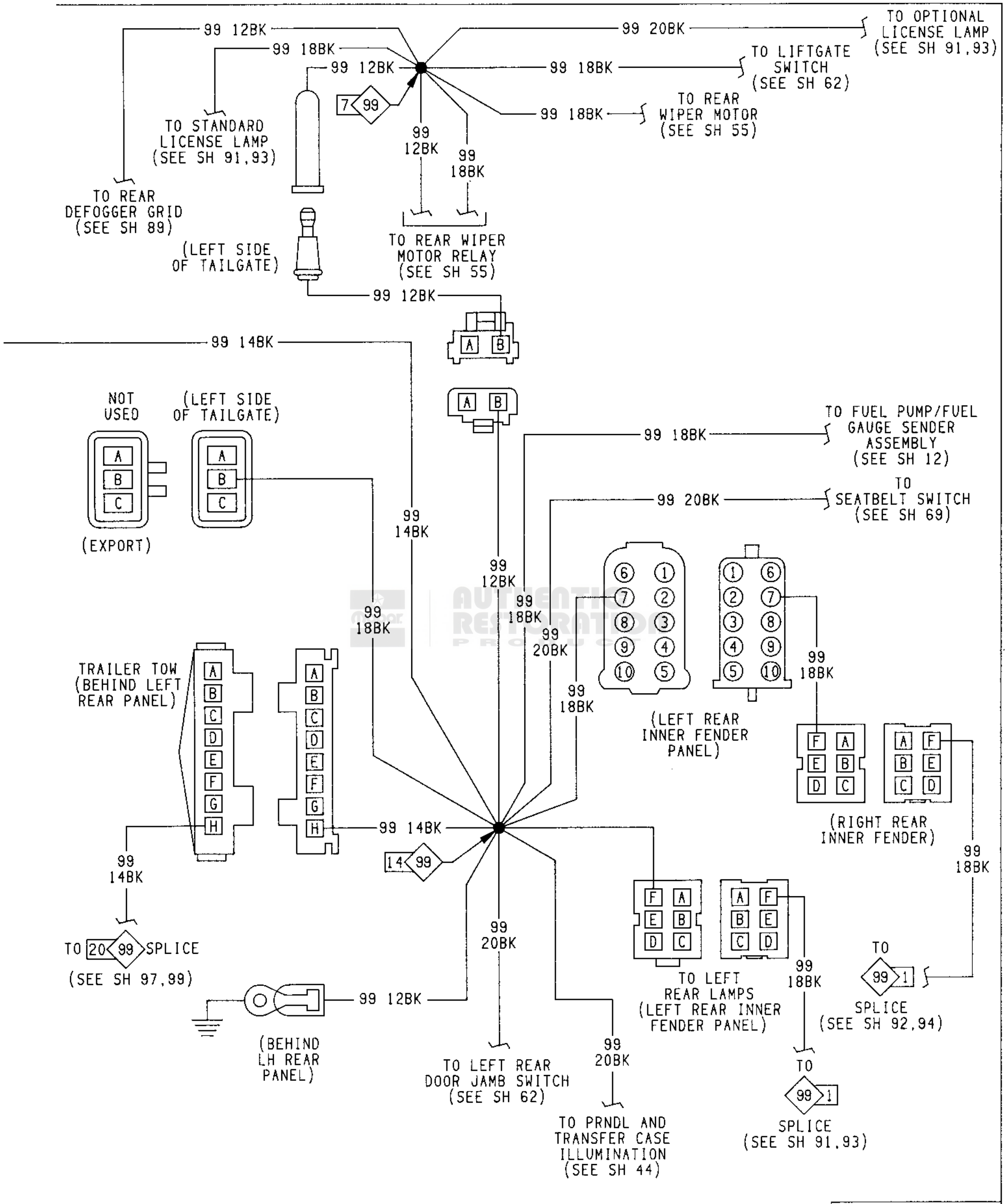
B+ POLARITY	B− POLARITY	WINDOW MOVEMENT
YL	LB	RT FRONT UP (DOOR SWITCH)
LB	YL	RT FRONT DOWN (DOOR SWITCH)
OR	BR	RT FRONT UP (MASTER SWITCH)
BR	OR	RT FRONT DOWN (MASTER SWITCH)
VT*	–	FEED



2 DOOR

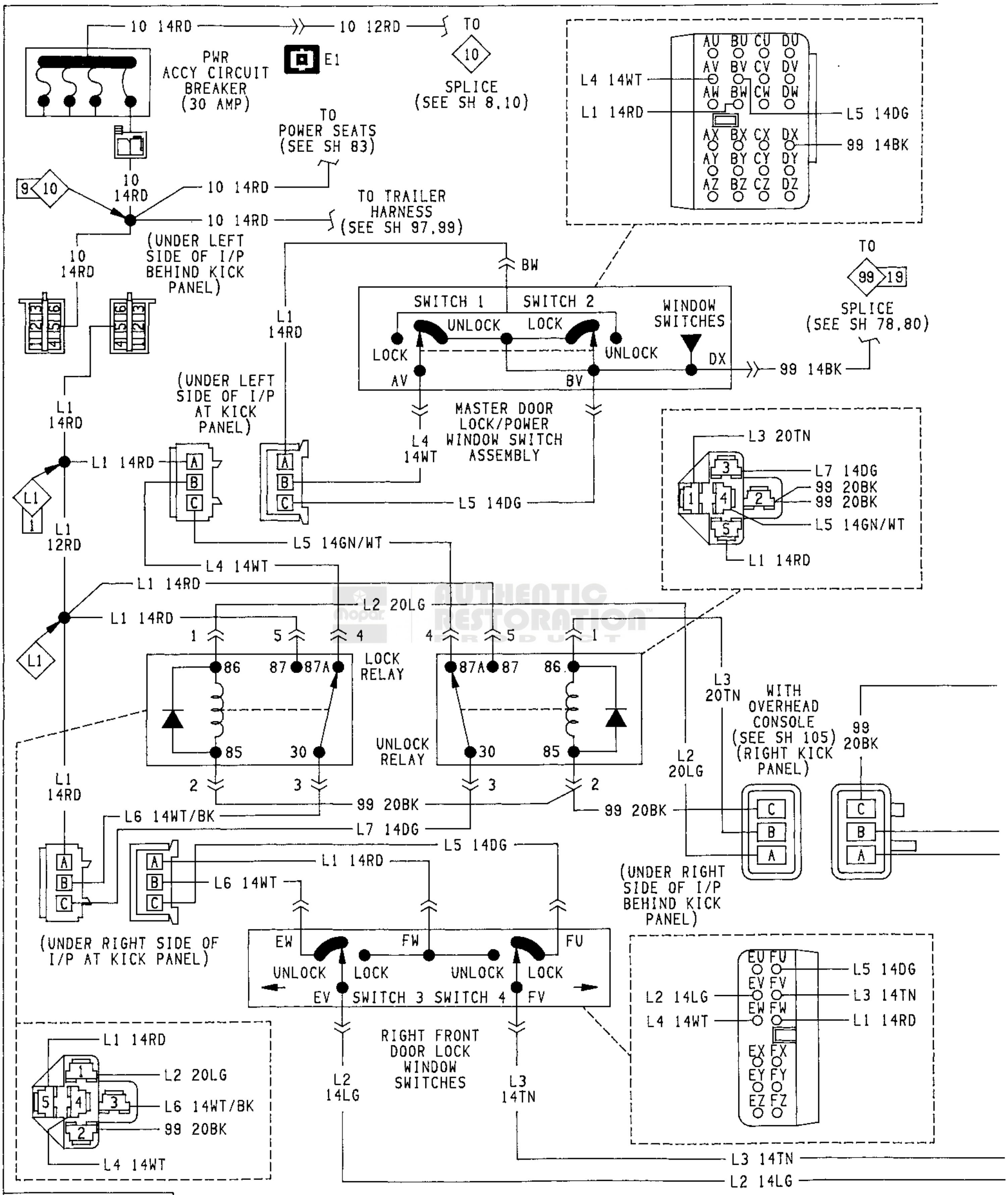
POWER SEAT MOTOR:INSULATOR POLARITY		
B+ POLARITY	B− POLARITY	SEAT MOVEMENT
TN	WT	FORWARD
WT	TN	REARWARD
YL	LG	REAR UP
LG	YL	REAR DOWN
OR	LB	FRONT UP
LB	OR	FRONT DOWN
RD	—	FEED
—	BK	GROUND





J908W-3

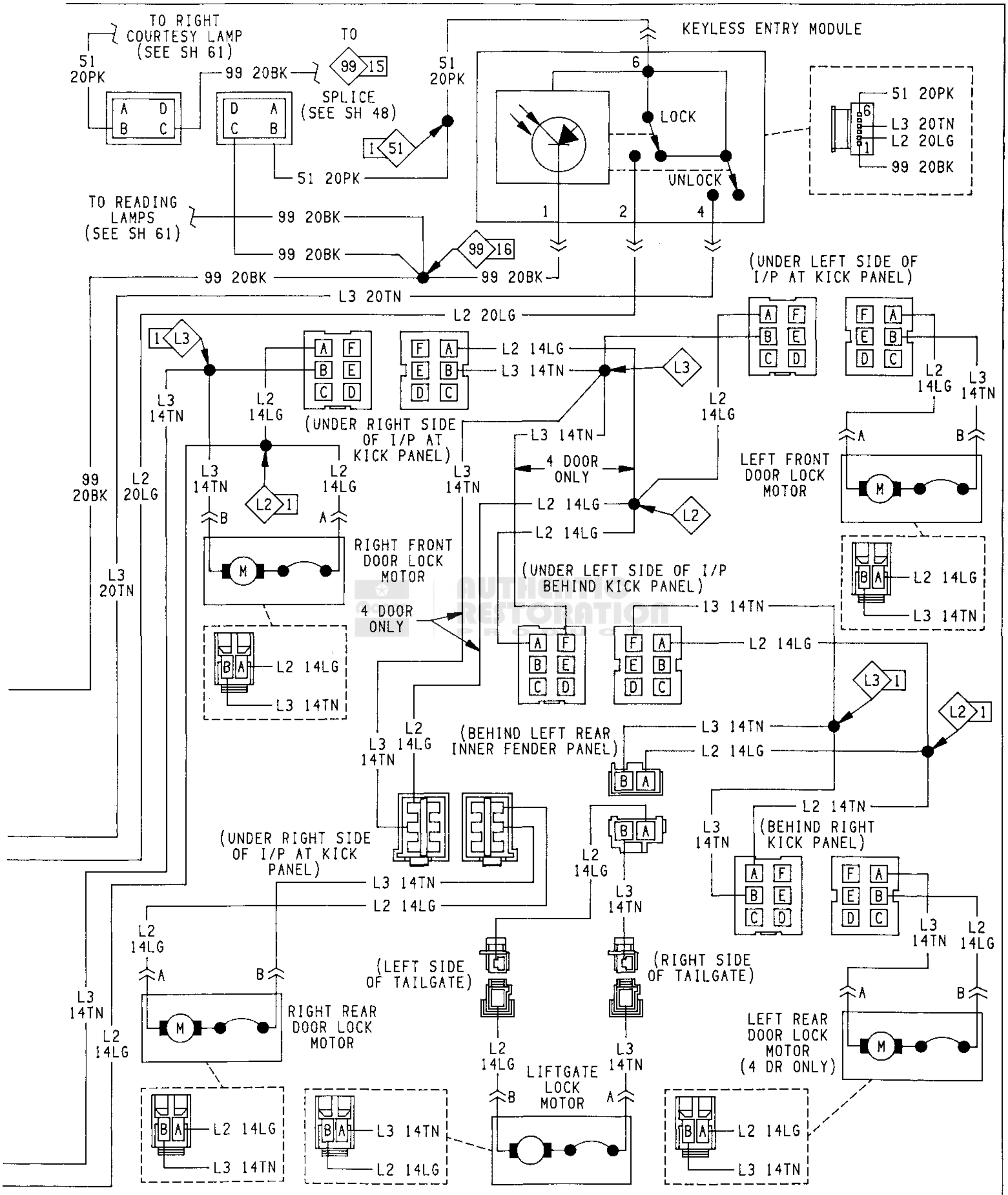
BODY GROUND



MJ-XJ 85

KEYLESS POWER DOOR LOCKS

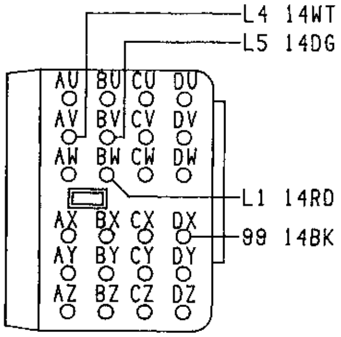
J908W-3



J908W-3

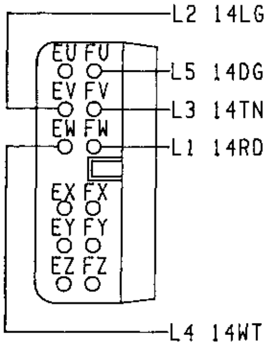
KEYLESS POWER DOOR LOCKS

MJ-XJ 86



LEFT FRONT DOOR CONNECTOR AND DOOR LOCK SWITCH FUNCTION

B+ POLARITY	B− POLARITY	DOOR LOCK FUNCTION ALL DOORS
WT	DG	LOCK
DG	WT	UNLOCK
RD	—	FEED B+
—	BK	GROUND

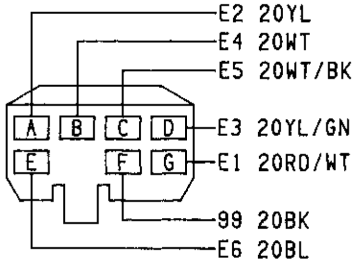


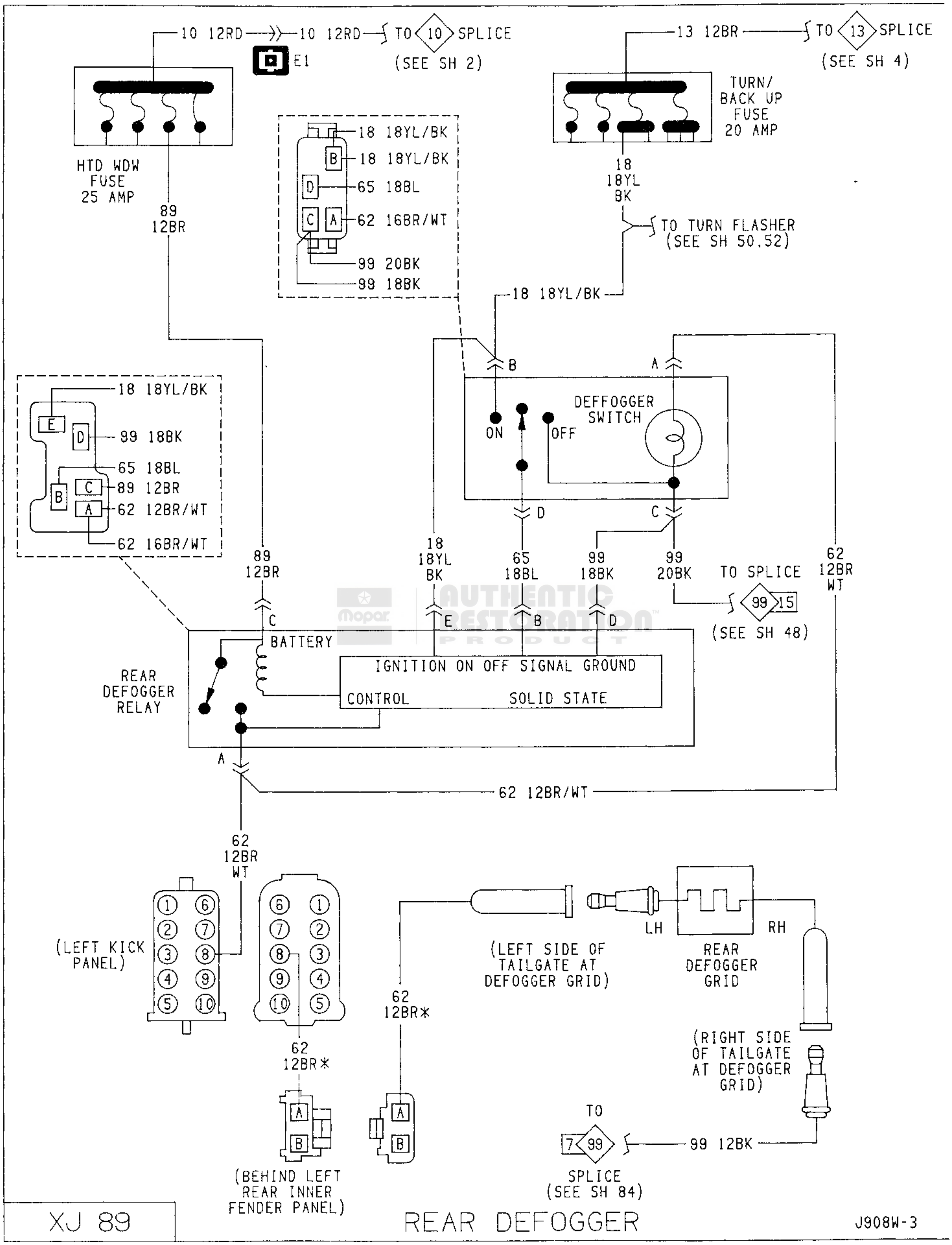
RIGHT FRONT DOOR CONNECTOR AND DOOR LOCK SWITCH FUNCTION

B+ POLARITY	B− POLARITY	DOOR LOCK FUNCTION ALL DOORS
LG	TN	LOCK FROM DOOR SWITCH
TN	LG	UNLOCK FROM DOOR SWITCH
WT	DG	LOCK FROM LEFT DOOR SWITCH
DG	WT	UNLOCK FROM LEFT DOOR SWITCH
RD	—	FEED B+

POWER MIRROR CONNECTOR
AND SWITCH FUNCTION

B+ POLARITY	B– POLARITY	MIRROR MOVEMENT
BL	YL	LEFT MIRROR UP
YL	BL	LEFT MIRROR DOWN
BL	YL/GN	RIGHT MIRROR UP
YL/GN	BL	RIGHT MIRROR DOWN
BL	WT	LEFT MIRROR RIGHT
WT	BL	LEFT MIRROR LEFT
BL	WT*	RIGHT MIRROR RIGHT
WT*	BL	RIGHT MIRROR LEFT
RD*	—	FEED
—	BK	GROUND

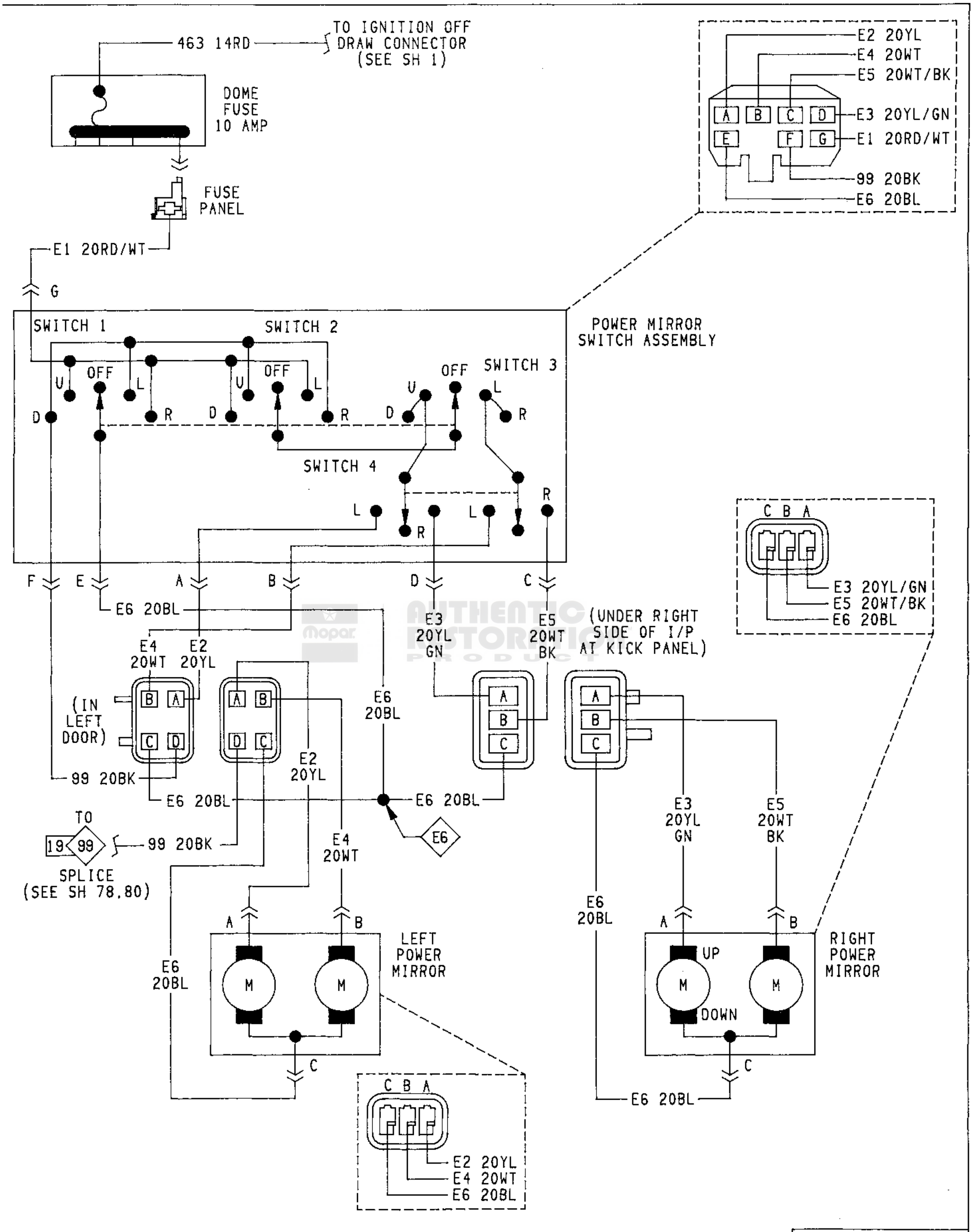




XJ 89

REAR DEFOGGER

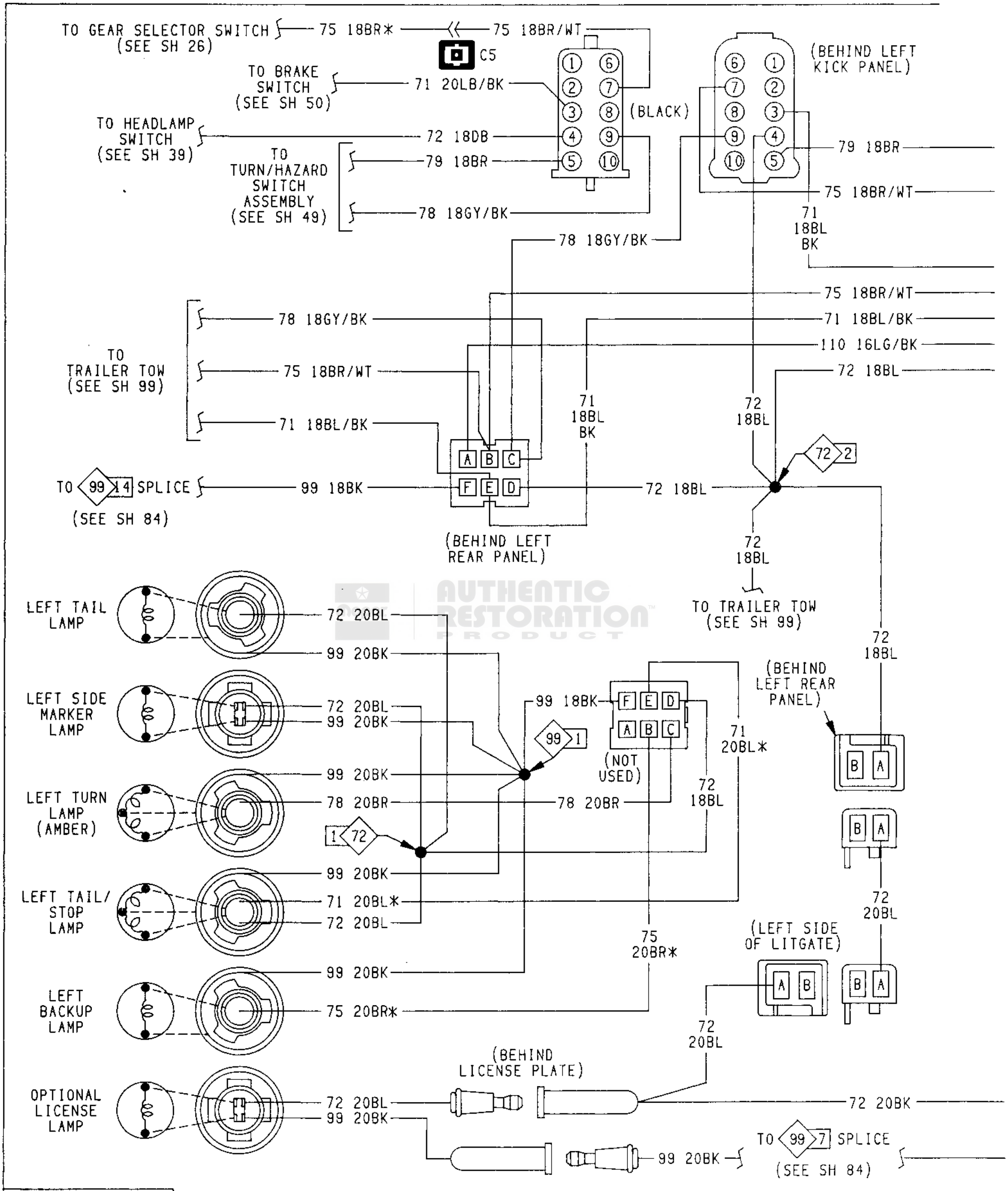
J908W-3



J908W-3

POWER MIRRORS

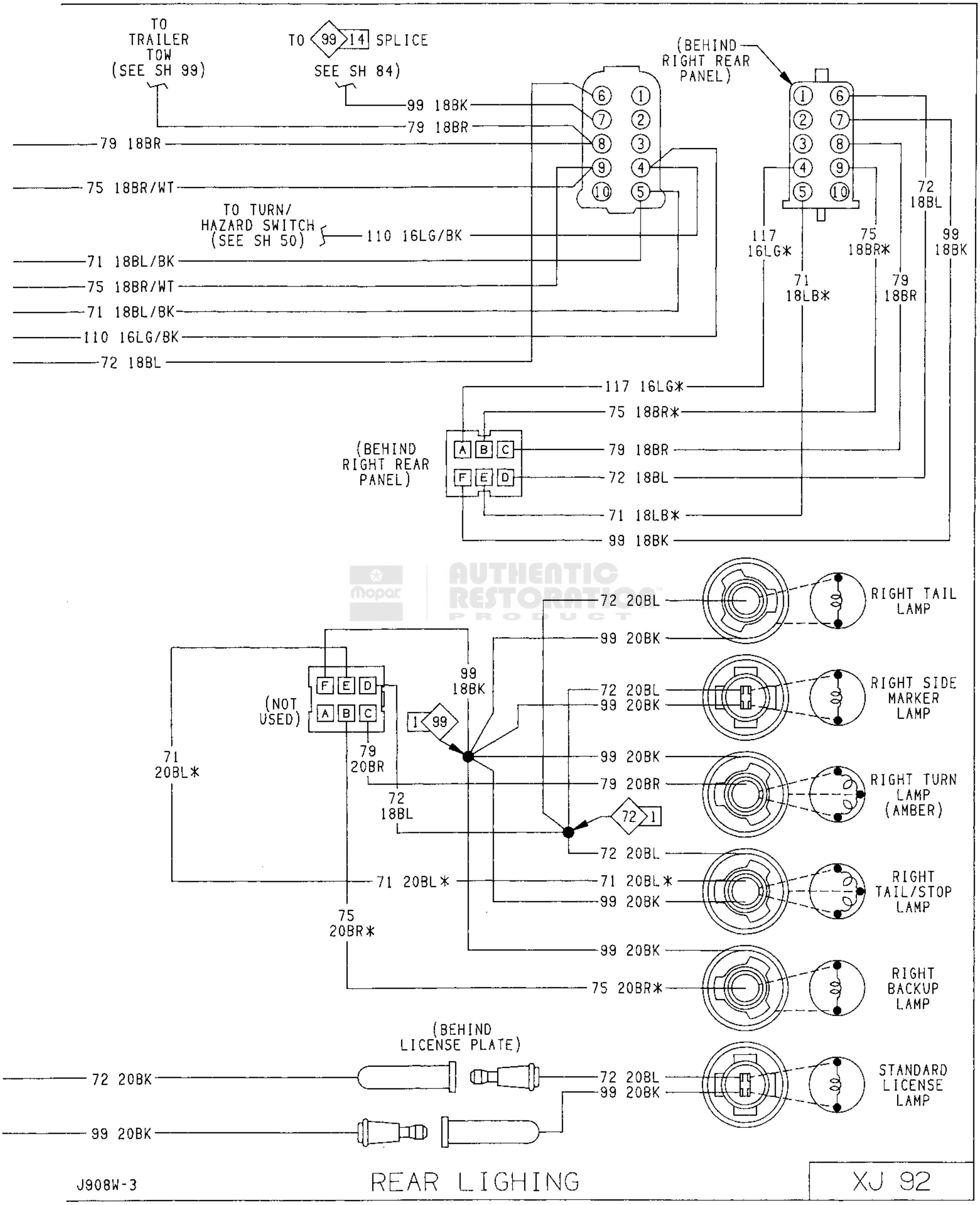
XJ 90



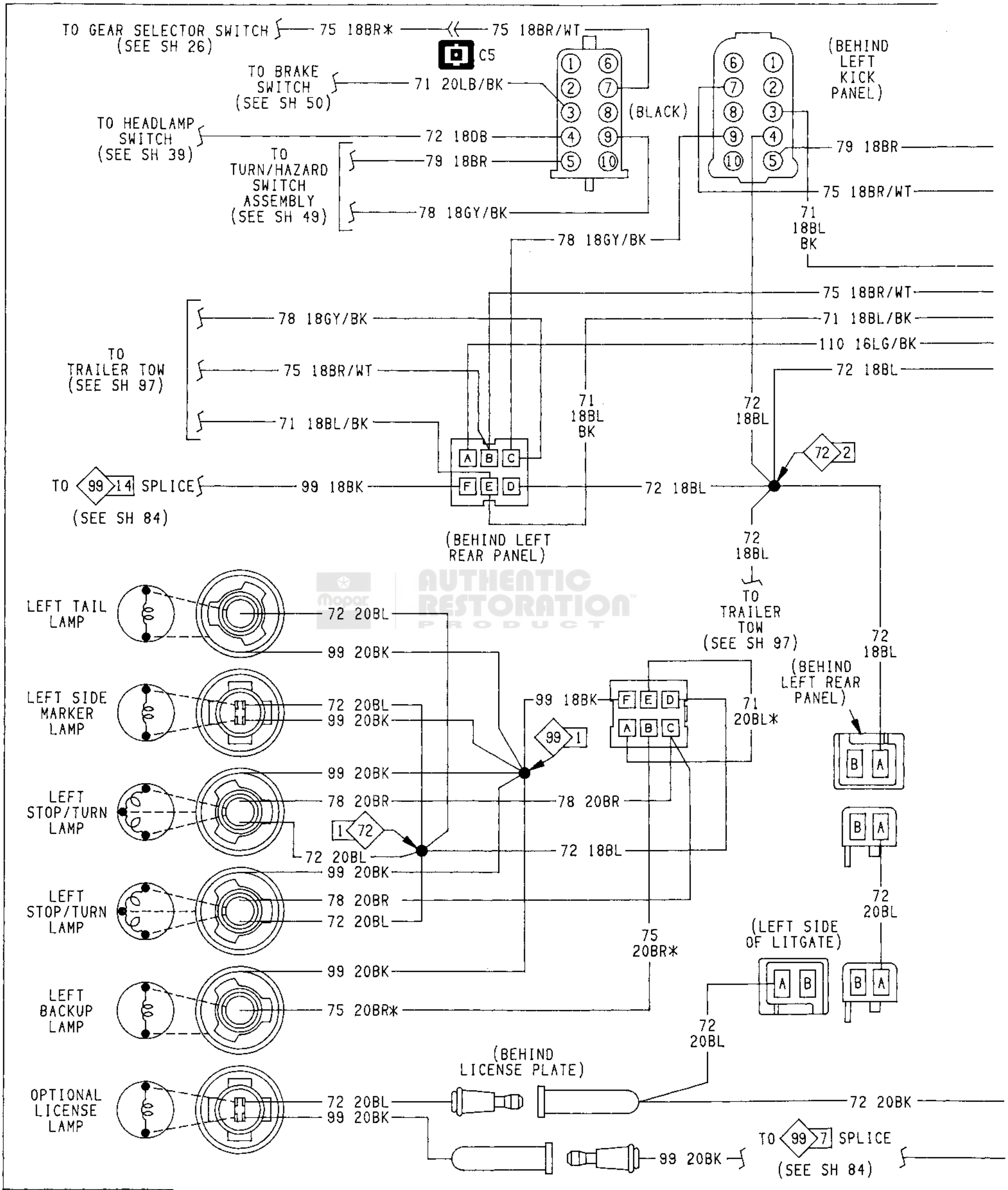
XJ 91

REAR LIGHING

J908W-3



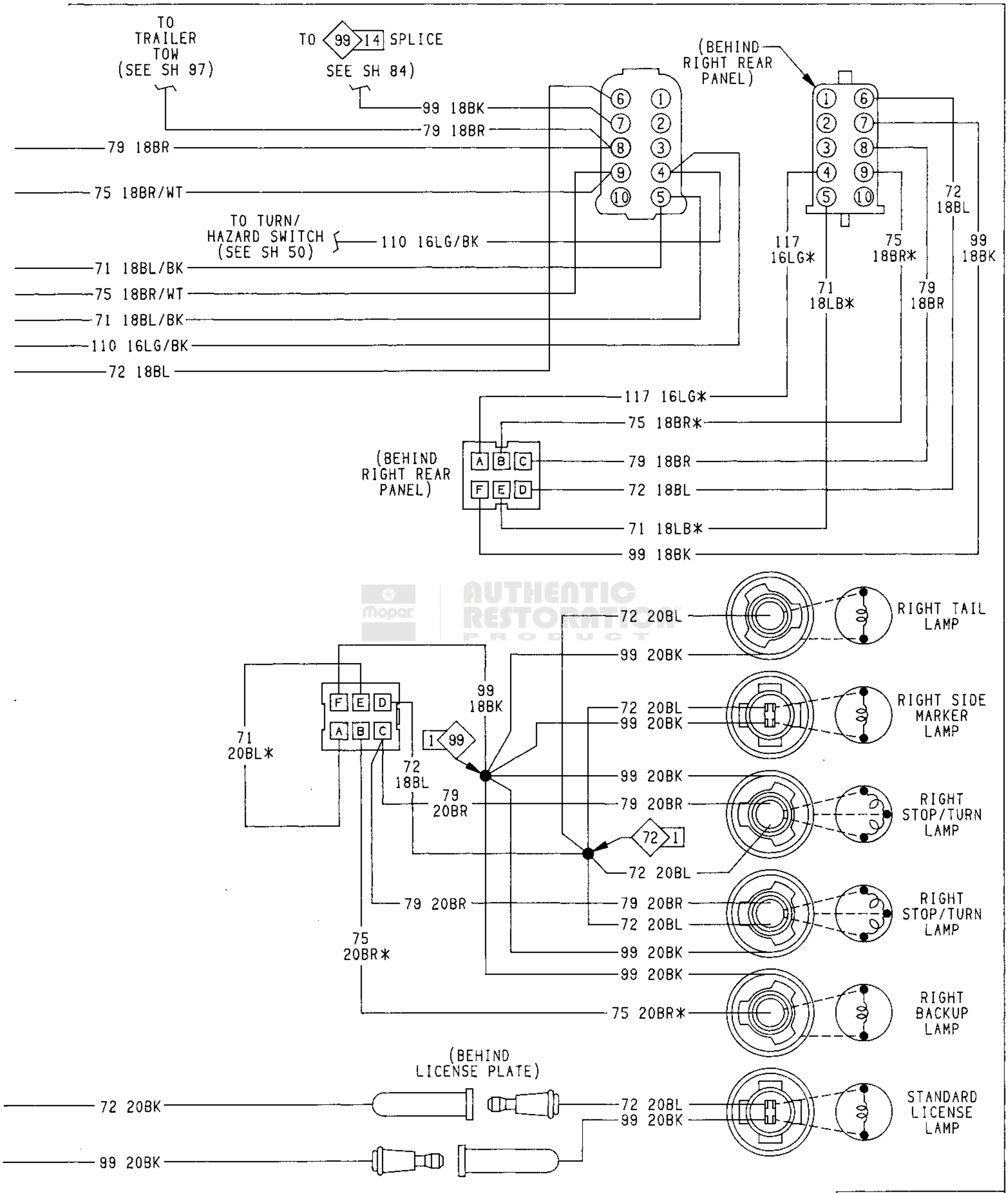
REAR LIGHING



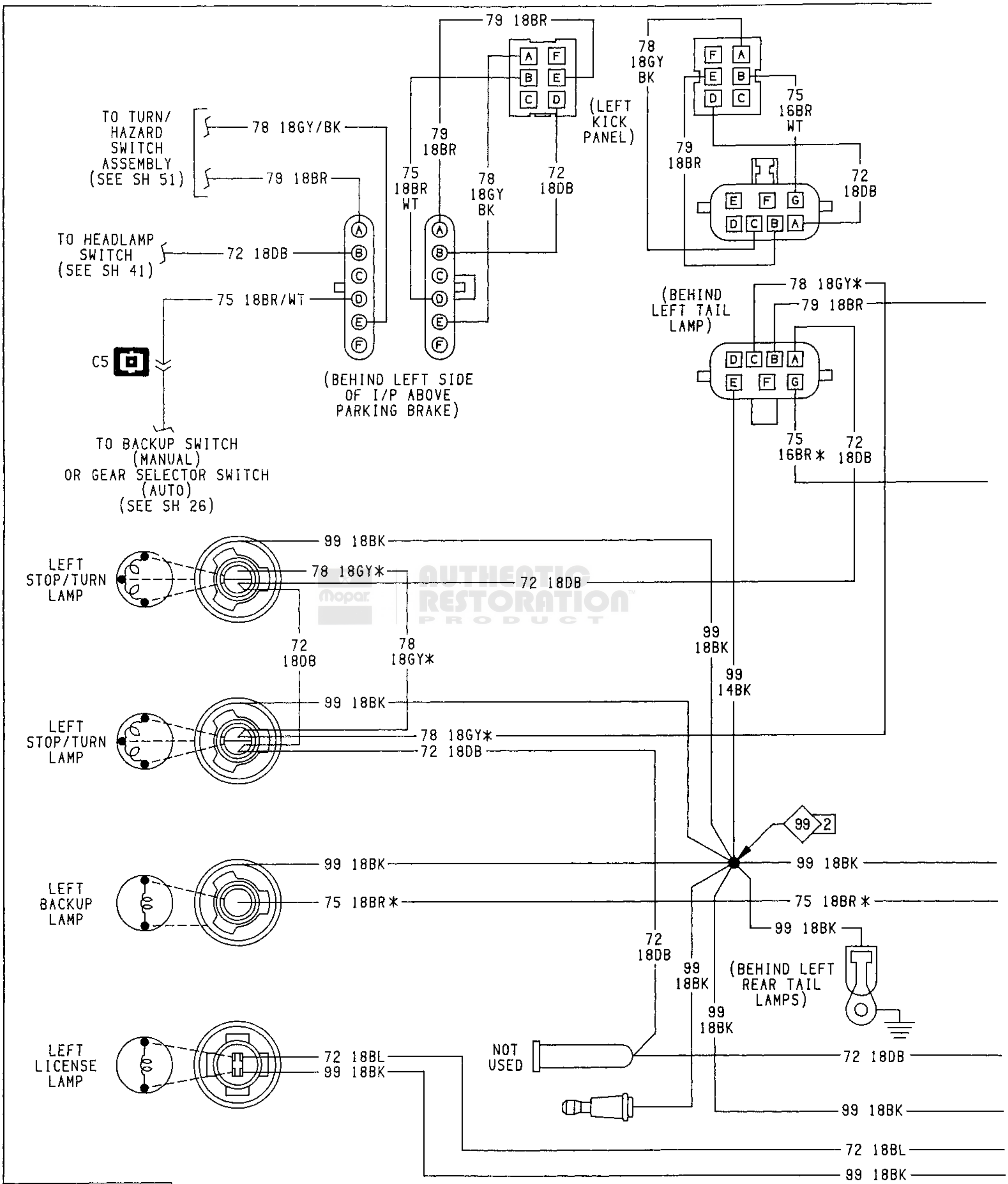
XJ 93

REAR LIGHING (WAGONEER ONLY)

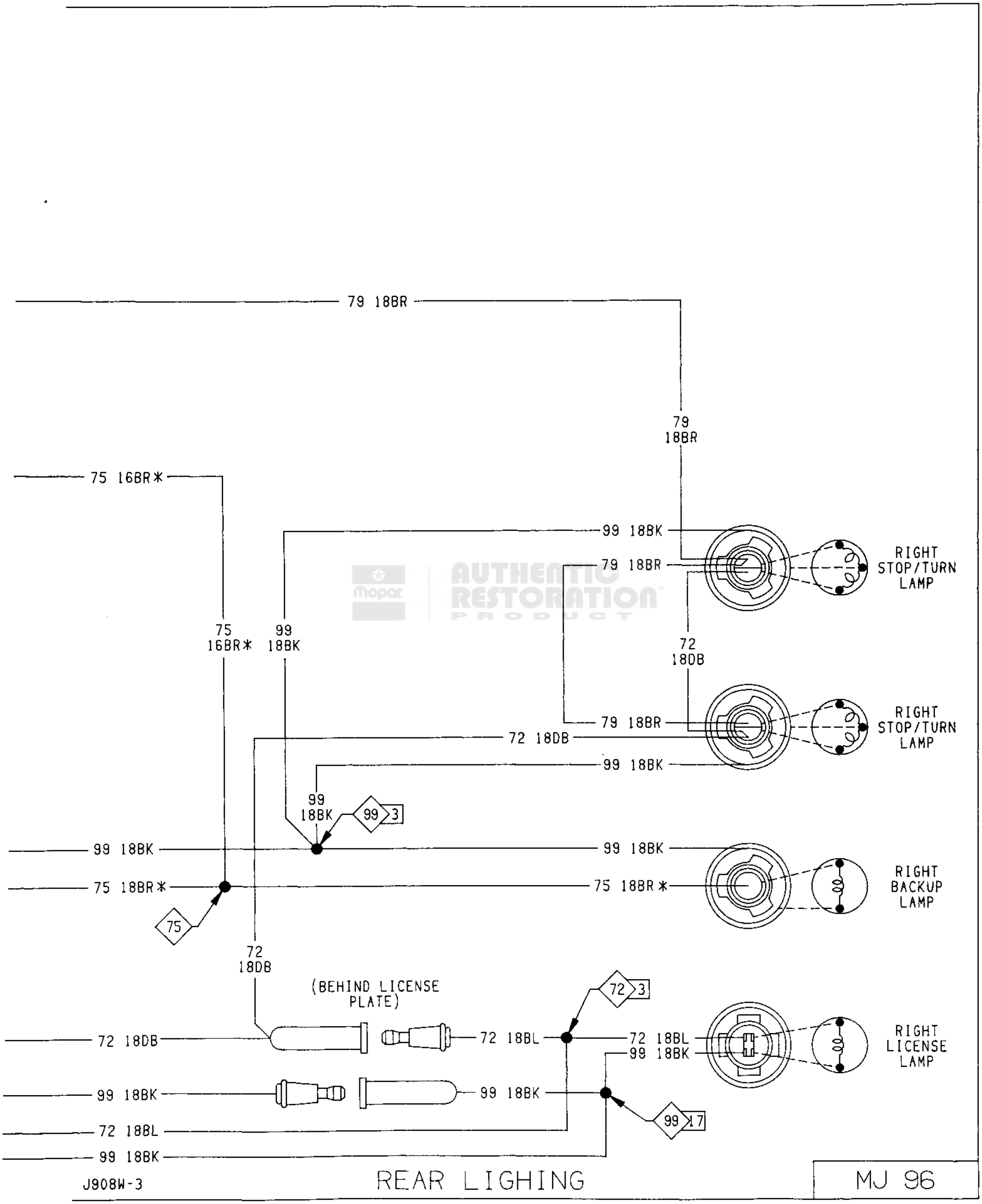
J908W-3

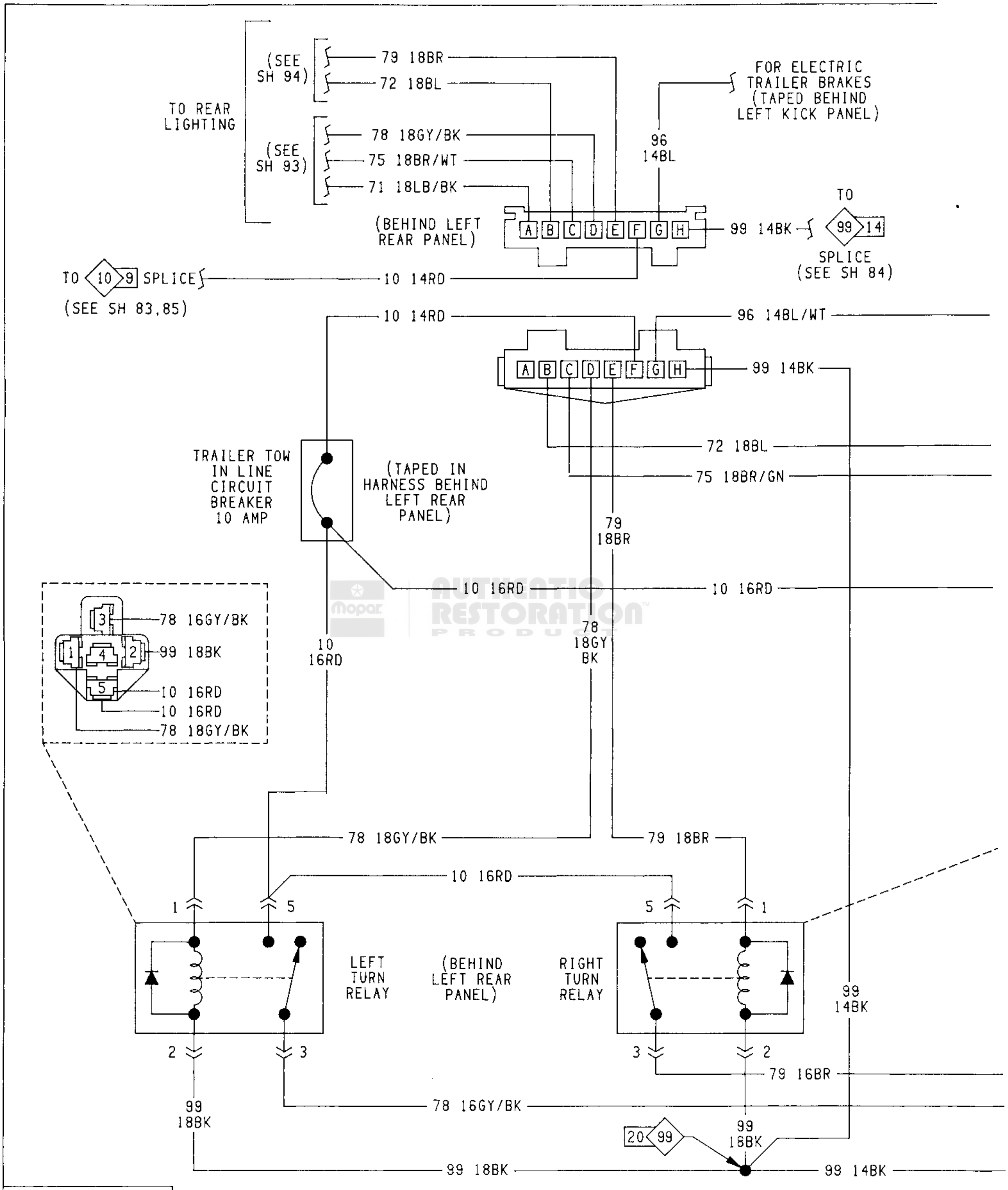


J908W-3 REAR LIGHING (WAGONEER ONLY) XJ 94



MJ 95 REAR LIGHING J908W-3

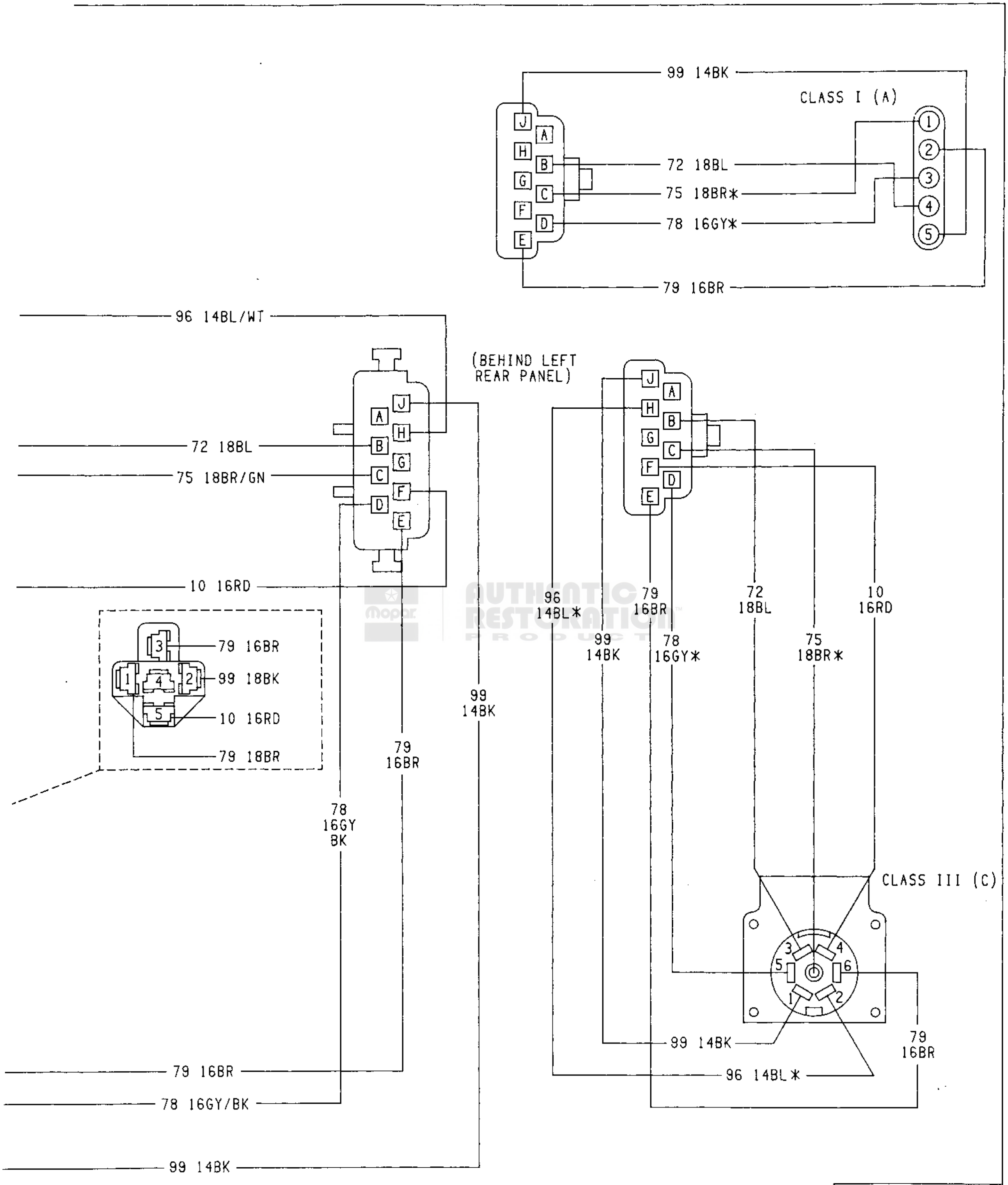

79 18BR
79
18BR
75 16BR*
99 18BK
79 18BR
RIGHT
STOP/TURN
LAMP
75
16BR*
99
18BK
72
18DB
79 18BR
72 18DB
RIGHT
STOP/TURN
LAMP
99 18BK
99
18BK
99 3
99 18BK
99 18BK
75 18BR*
75 18BR*
RIGHT
BACKUP
LAMP
75
72
18DB
(BEHIND LICENSE
PLATE)
72 3
72 18DB
72 18BL
72 18BL
99 18BK
RIGHT
LICENSE
LAMP
99 18BK
99 18BK
99 17
72 18BL
99 18BK
J908W-3
REAR LIGHING
MJ 96



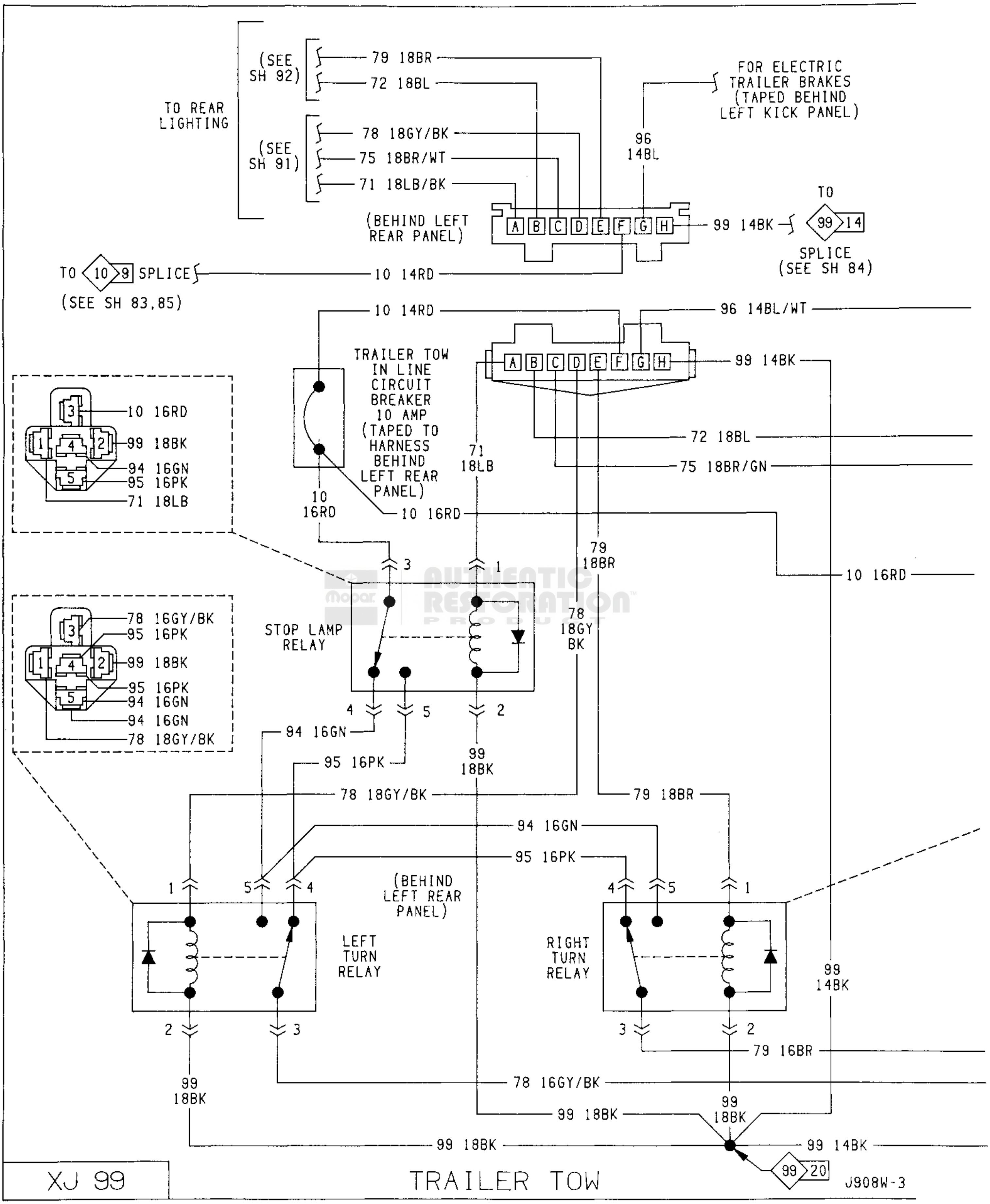
XJ 97

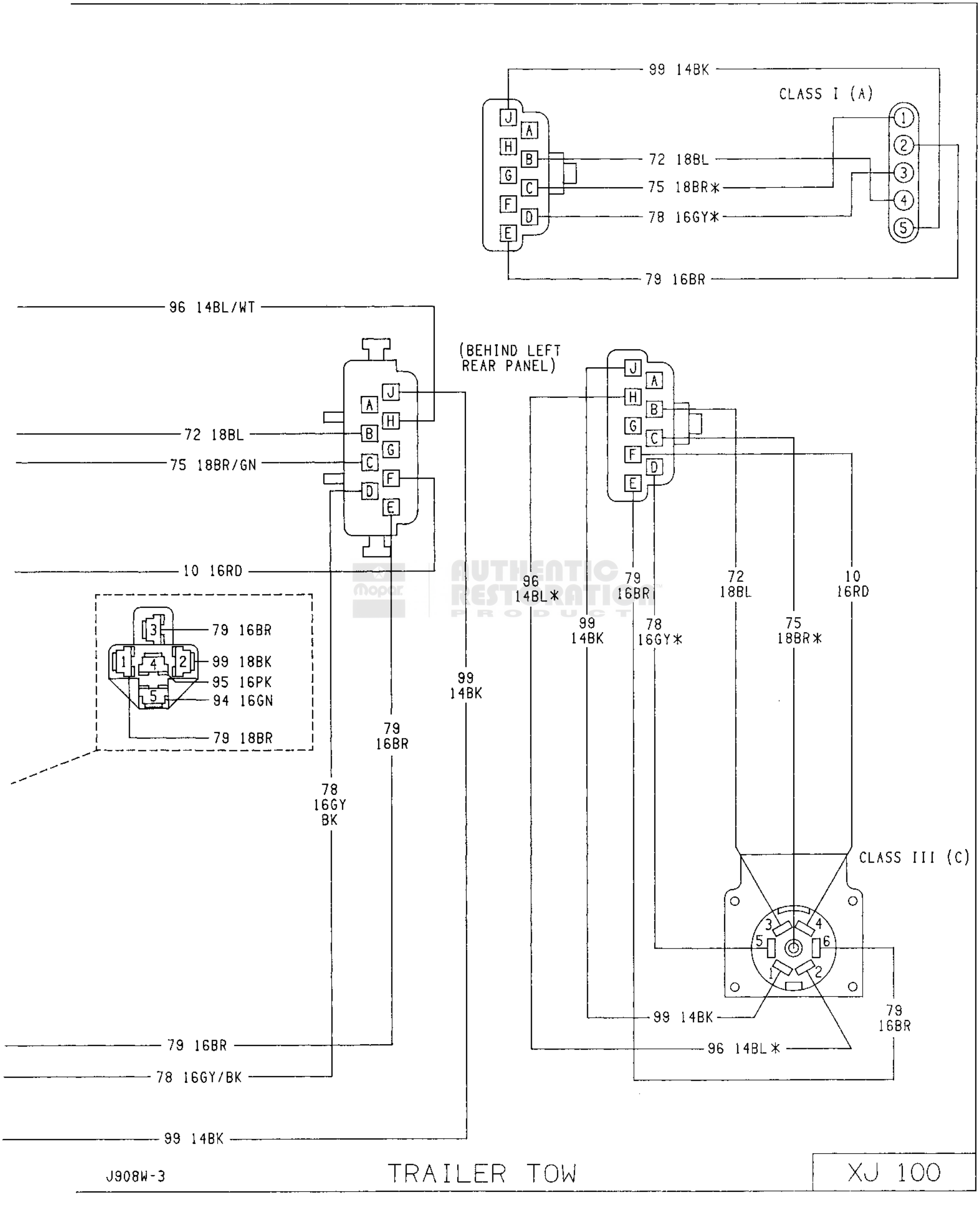
TRAILER TOW (WAGONEER ONLY)

J908W-3



J908W-3 TRAILER TOW (WAGONEER ONLY) XJ 98

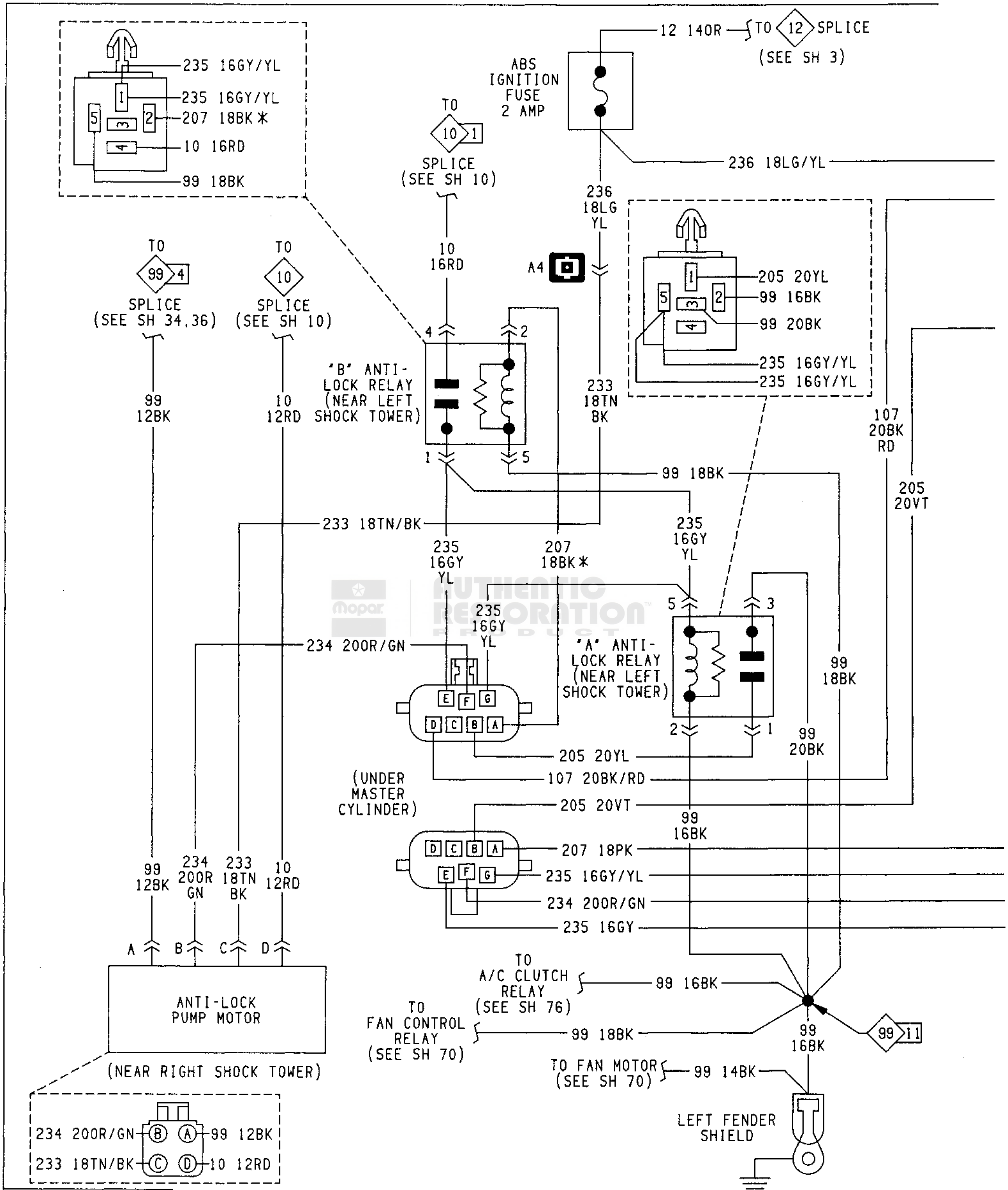

TO REAR LIGHTING
(SEE SH 92)
79 18BR
72 18BL
(SEE SH 91)
78 18GY/BK
75 18BR/WT
71 18LB/BK
FOR ELECTRIC TRAILER BRAKES (TAPED BEHIND LEFT KICK PANEL)
96 14BL
(BEHIND LEFT REAR PANEL)
A B C D E F G H
99 14BK
TO 99 14 SPLICE (SEE SH 84)
TO 10 9 SPLICE
(SEE SH 83,85)
10 14RD
10 14RD
96 14BL/WT
TRAILER TOW IN LINE CIRCUIT BREAKER 10 AMP (TAPED TO HARNESS BEHIND LEFT REAR PANEL)
A B C D E F G H
99 14BK
3
10 16RD
1
2
99 18BK
4
94 16GN
95 16PK
5
71 18LB
71 18LB
72 18BL
75 18BR/GN
10 16RD
10 16RD
10 16RD
79 18BR
3
1
STOP LAMP RELAY
78 18GY BK
3
78 16GY/BK
95 16PK
1
4
2
99 18BK
95 16PK
94 16GN
5
94 16GN
78 18GY/BK
4
5
2
94 16GN
95 16PK
99 18BK
78 18GY/BK
79 18BR
94 16GN
95 16PK
1
5
4
(BEHIND LEFT REAR PANEL)
4
5
1
LEFT TURN RELAY
RIGHT TURN RELAY
99 14BK
2
3
3
2
79 16BR
99 18BK
78 16GY/BK
99 18BK
99 18BK
99 18BK
99 18BK
99 14BK
99 20
XJ 99
TRAILER TOW
J908W-3



J908W-3

TRAILER TOW

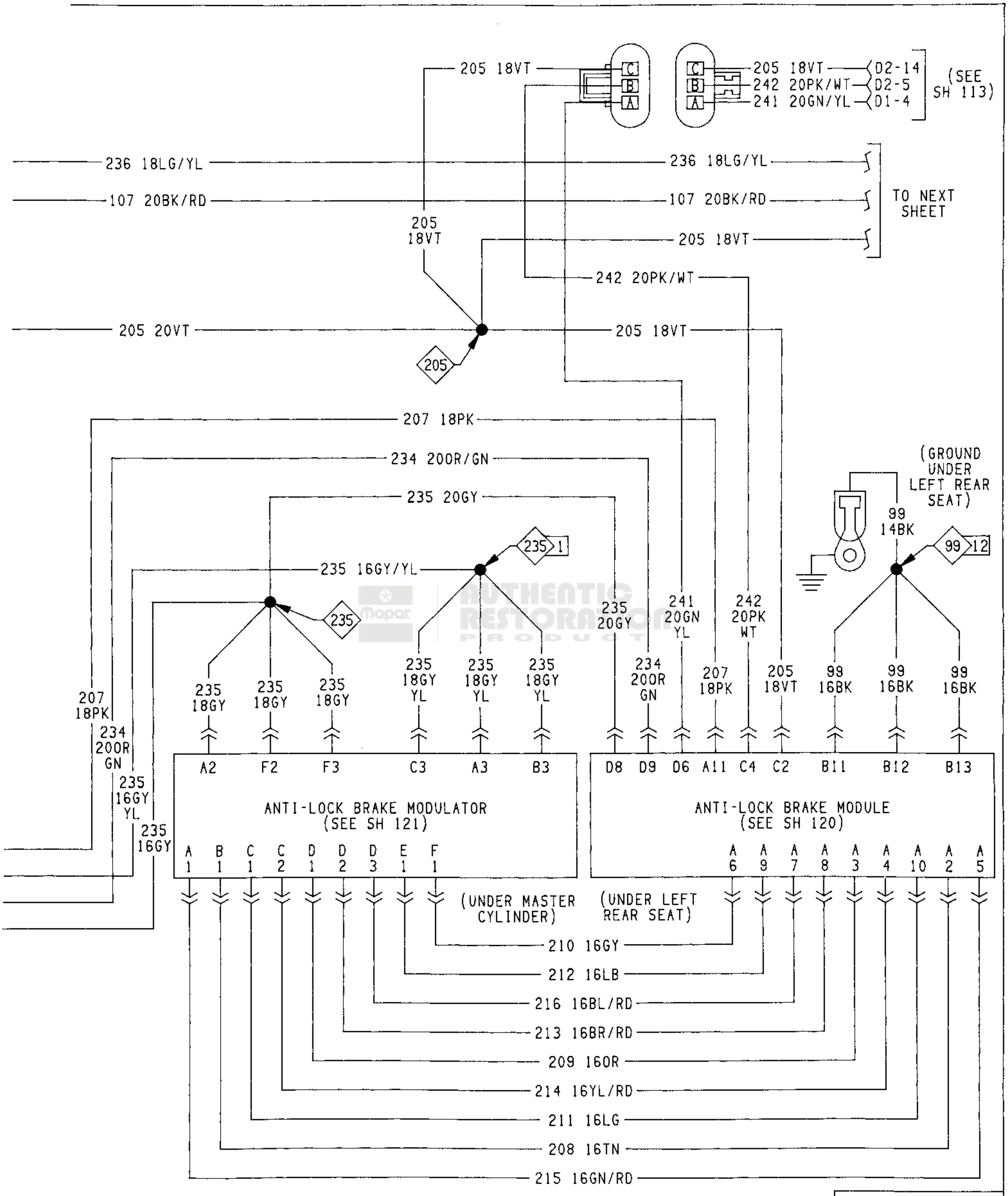
XJ 100



XJ 101

ANTI-LOCK BRAKING SYSTEM

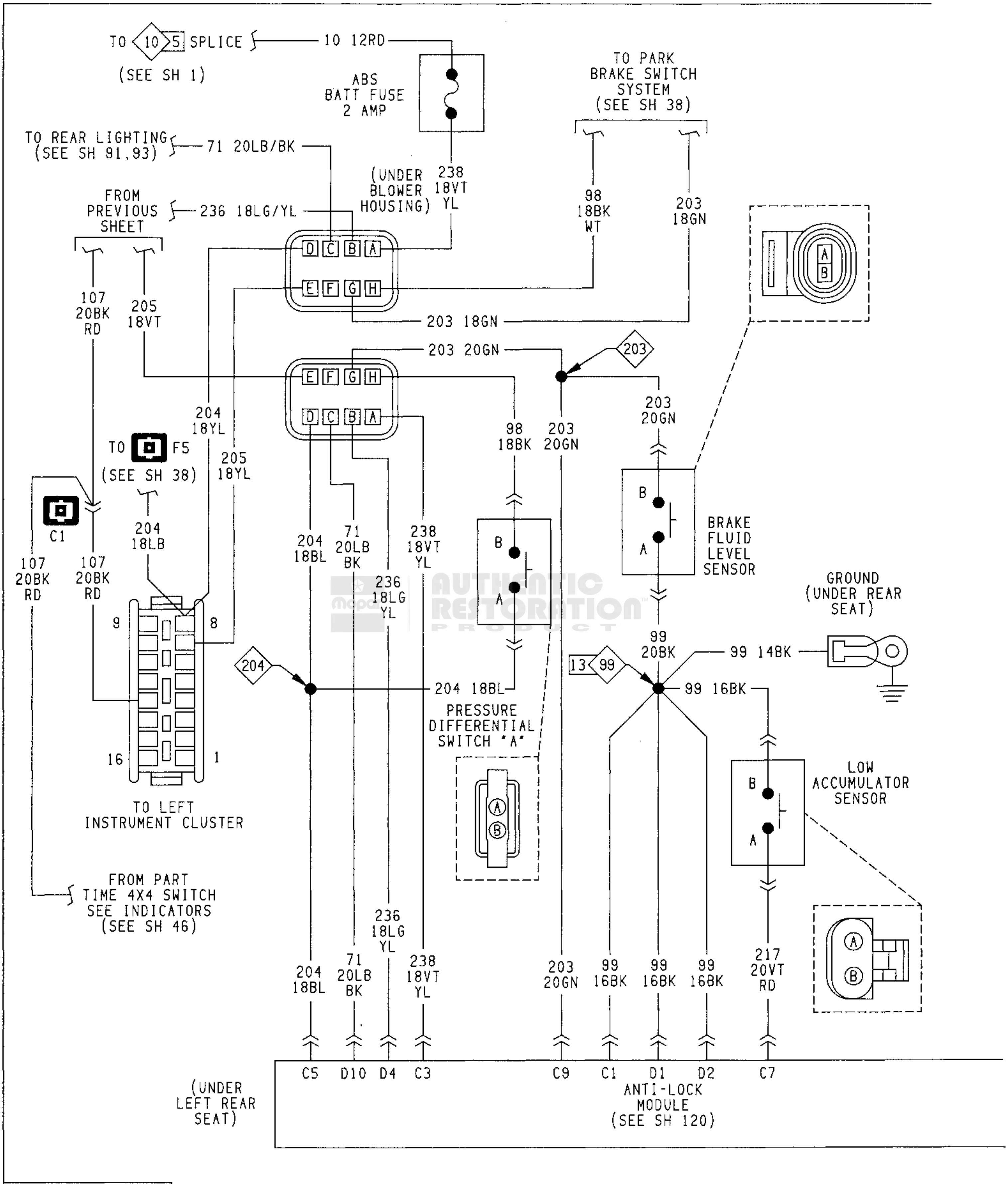
J908W-3



J908W-3

ANTI-LOCK BRAKING SYSTEM

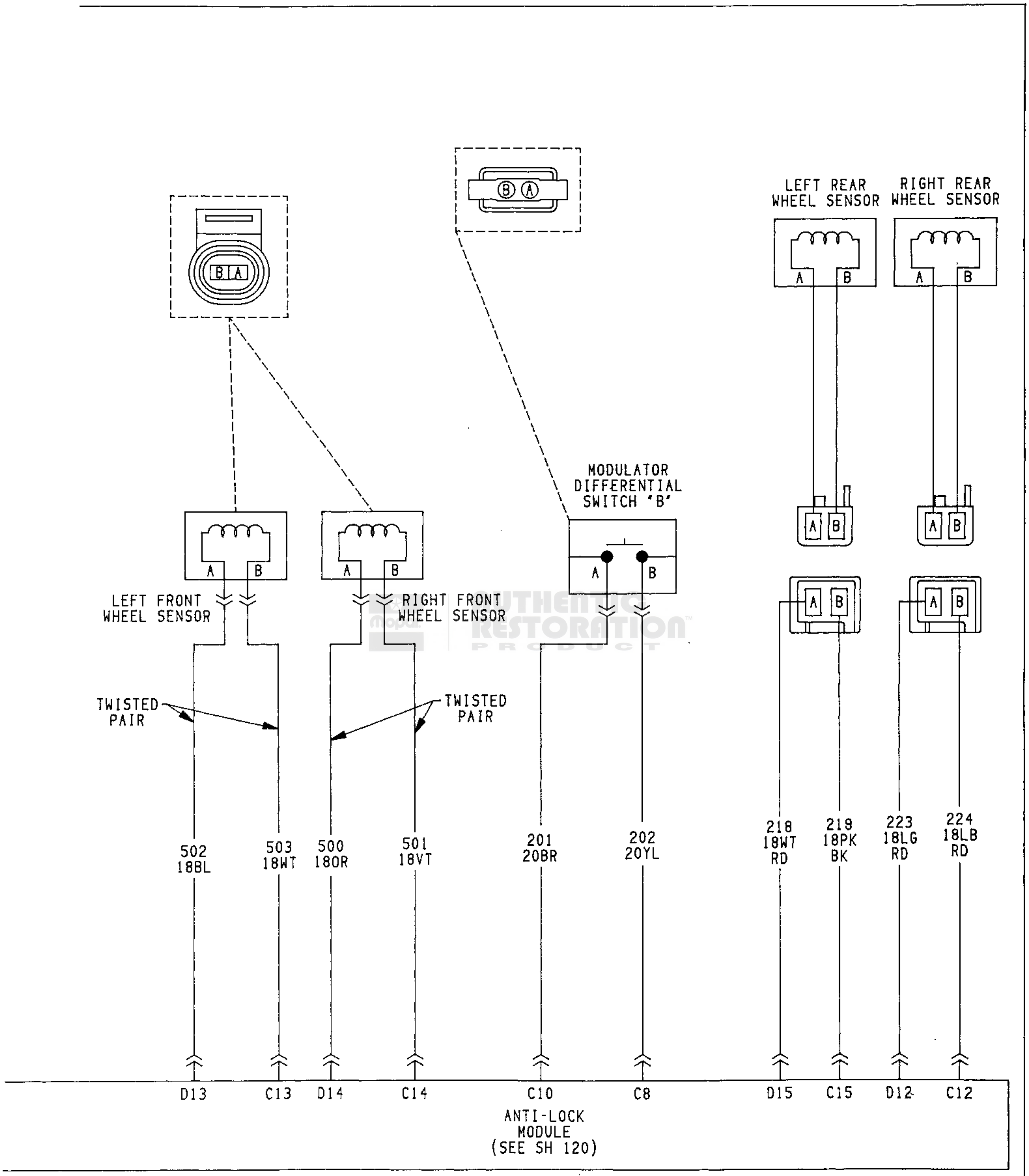
XJ 102

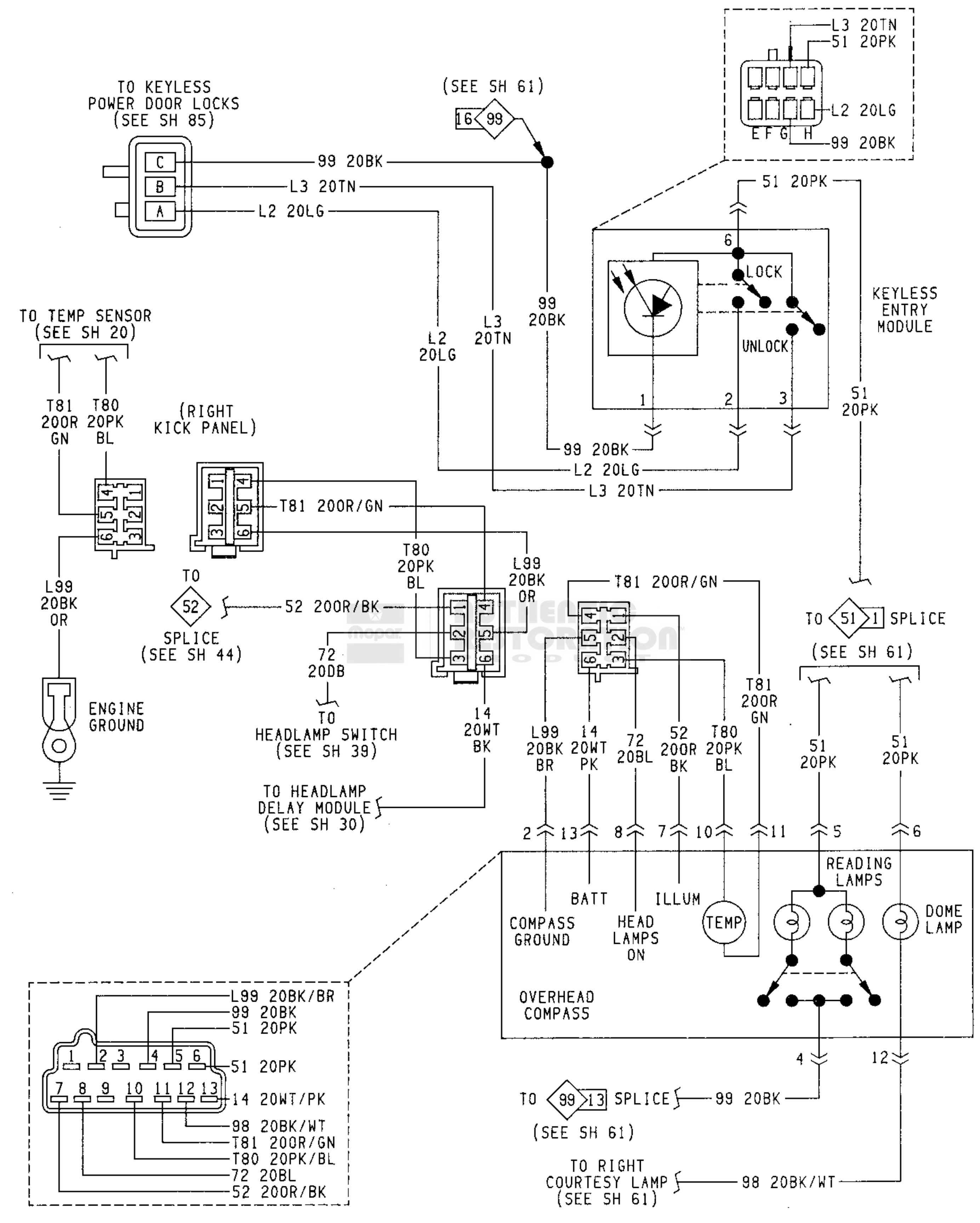


XJ 103

ANTI-LOCK BRAKING SYSTEM

J908W-3

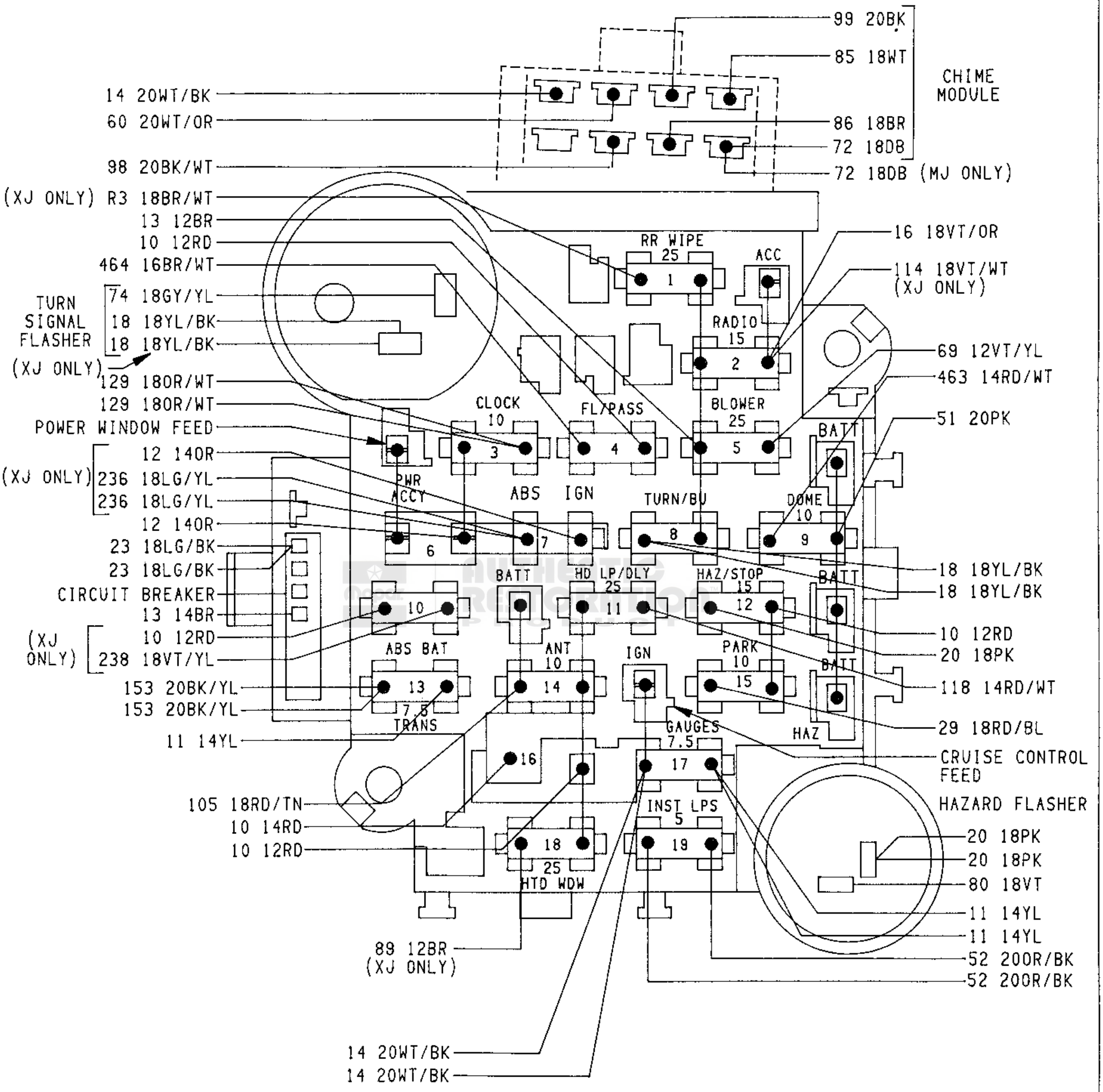

LEFT REAR WHEEL SENSOR
RIGHT REAR WHEEL SENSOR
MODULATOR DIFFERENTIAL SWITCH 'B'
LEFT FRONT WHEEL SENSOR
RIGHT FRONT WHEEL SENSOR
TWISTED PAIR
TWISTED PAIR
A
B
502 18BL
503 18WT
500 18OR
501 18VT
201 20BR
202 20YL
218 18WT RD
219 18PK BK
223 18LG RD
224 18LB RD
D13
C13
D14
C14
C10
C8
D15
C15
D12
C12
ANTI-LOCK MODULE (SEE SH 120)



XJ 105

OVERHEAD CONSOLE

J908W-3



J908W-3

FUSE PANEL

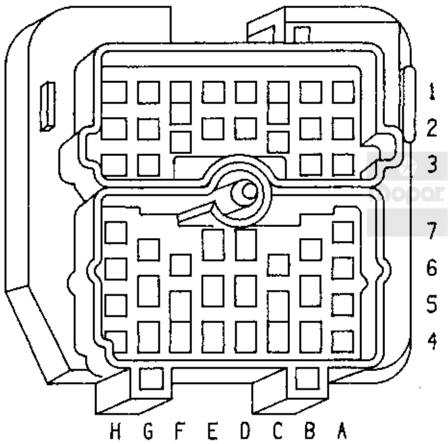
MJ-XJ 106

FUSE NUMBER	AMPS	COLOR
1	25	WHITE
2	15	LIGHT BLUE
3	10	RED
4	15	LIGHT BLUE
5	25	WHITE
6	30 CIRCUIT BREAKER	SILVER CAN
7	2	PINK
8	20	YELLOW
9	10	RED
10	2	PINK
11	25	WHITE
12	15	LIGHT BLUE
13	7.5	VIOLET
14	10	RED
15	10	RED
16	30 CIRCUIT BREAKER	SILVER CAN
17	7.5	VIOLET
18	25	WHITE
19	5	TAN

MJ-XJ 107

FUSE PANEL

J908W-3

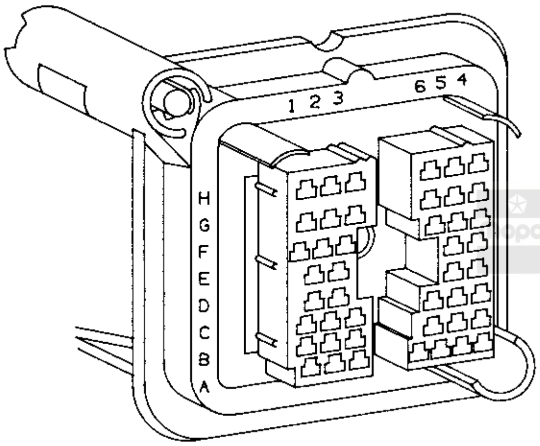


ENGINE COMPARTMENT CIRCUITS		CAV
72 18GY*	LEFT TURN SIGNAL LAMPS	A1
126 20BR	ECU UPSHIFT INDICATOR-GROUND	A2
23 18LG*	WINDSHIELD WIPER-PARK FEED	A3
233 18TN/BK	ANTI-LOCK PUMP MOTOR	A4
—	—	A5
463 14RD*	BATTERY DRAIN DISCONNECT	A6
—	—	A7
72 18BL	PARKING LAMPS-FEED	B1
44 18VT*	WINDSHIELD WASHER PUMP FEED	B2
47 18BL*	WINDSHIELD WIPER-HI SPEED	B3
—	—	B4
106 18YL/BK	4 WHEEL DRIVE SWITCH	B5
11 14YL	IGNITION CIRCUITS	B6
107 20BK/RD	4 WHEEL DRIVE SWITCH	C1
107 20BK/RD	INSTRUMENT PANEL INDICATOR	C1
18 18YL/BK	NOT USED	C2
30 18GN*	IGNITION MODULE-TACHOMETER	C3
F22 14OR/BK	FUEL PUMP FEED	C4
75 18BR*	BACKUP LAMPS	C5
54 20LB	OIL PRESSURE	C6
10 12RD	BATTERY	D1
55 20VT	COOLANT TEMPERATURE	D2
10 12RD	BATTERY	D4
77 16LG	LO-BEAM HEADLAMPS	D5
10 12RD	BATTERY	E1
31 14GY	HORNS	E2
76 16WT	HI-BEAM HEADLAMPS	E4
37 12OR*	BLOWER MOTOR FEED	E5
76 18WT	HI-BEAM INDICATOR W/O DRL	F1
465 18LB/BK	HI-BEAM INDICATOR W/DRL	F1
79 18BR	RIGHT TURN SIGNAL LAMPS	F2
98 20BK*	BRAKE WARNING SWITCH W/O ABS	F3
13 14BR	NOT USED	F4
58 20GY*	BRAKE WARNING SWITCH W/O ABS	F5
58 18LB	BRAKE WARNING SWITCH W/DRL	F5
114 20VT*	WINDSHIELD WASHER FLUID LEVEL	F6
F5 18LG*	FOG LAMP RELAY	G1
59 20TN*	ALTERNATOR-BATTERY INDICATOR	G2
46 18WT*	WINDSHIELD WIPER-LO SPEED	G3
99 12BK	GROUND	G4
99 12BK	GROUND	G4
38 16TN*	A/C REQUEST	G5
12 14OR	NOT USED	G6
138 16LG	A/C SELECT	H1
33 14GN	STARTER RELAY	H2
45 18TN*	WINDSHIELD WIPER-PARK FEED	H3
49 16LG*	A/C LOW PRESSURE SWITCH	H4
R4 18 VT/OR	REAR WIPER PUMP MOTOR	H5
61 20WT*	WASHER FLUID LEVEL SWITCH	H6

J908W-3

BULKHEAD CONNECTOR

MJ-XJ 108

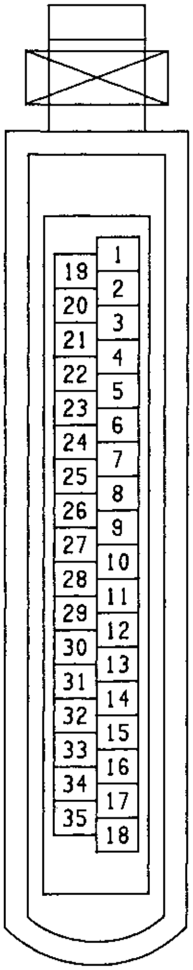


CAV	INSTRUMENT PANEL CIRCUITS	
A1	78 18GY/BK	LEFT TURN SIGNAL LAMPS
A2	126 20BK/LB	UPSHIFT INDICATOR LAMP
A3	23 18LG/BK	WINDSHIELD WIPER-PARK FEED
A4	236 18LG/YL	ANTI-LOCK PUMP FEED (MODEL XJ)
A5	—	—
A6	463 14RD/WT	BATTERY DRAIN DISCONNECT
A7	—	—
B1	72 18DB	PARKING LAMPS FEED
B1	72 18DB	CHIME/BUZZER-PARKING LAMPS ON
B2	44 18VT/WT	WINDSHIELD WASHER PUMP FEED
B3	47 18DB/WT	WINDSHIELD WIPER HI-SPEED
B4	—	—
B5	106 18BK/YL	FULL TIME INDICATOR LAMP
B6	11 14YL	IGNITION SWITCH I-1
C1	107 20BK/RD	PART TIME INDICATOR LAMP
C2	18 18YL/BK	BACKUP LAMPS FEED
C3	30 18GN/WT	TACHOMETER
C4	F9 14PK/BK	FUEL PUMP FEED (MODEL XJ)
C4	F22 14OR	FUEL INJECTOR (MODEL XJ)
C5	75 18BR/WT	REVERSE SWITCH
C6	54 20LB	OIL PRESSURE INDICATOR
D1	10 12RD	BATTERY
D2	55 20VT	COOLANT TEMPERATURE
D4	10 12RD	BATTERY
D5	77 16LG	DIMMER SWITCH-LO BEAM
E1	10 12RD	ACCESSORY POWER
E2	31 14GY	HORN RELAY
E4	76 16WT	DIMMER SWITCH-HI BEAM
E5	37 12OR/BL	BLOWER MOTOR FEED
F1	465 16LB/BR	HIGH BEAM INDICATOR W/DRL
F2	79 18BR	RIGHT TURN SIGNAL LAMPS
F3	98 20BK*	BRAKE INDICATOR W/O ABS (MODEL MJ)
F4	13 14BR	ACCESSORY IGNITION (EXPORT)
F5	58 20GY/RD	BRAKE INDICATOR (MODEL MJ)
F5	204 18BL	BRAKE WARNING W/ABS
F6	114 18VT/WT	WASHER FLUID LEVEL SWITCH FEED (MODEL XJ)
G1	F1 16LG/BK	FOG LAMP SWITCH
G2	59 20TN/GN	BATTERY INDICATOR LAMP
G3	46 18WT/BK	WINDSHIELD WIPER-LO FEED
G4	99 12BK	INSTRUMENT PANEL GROUND
G4	—	—
G5	38 16TN/BK	A/C REQUEST
G6	12 14OR	I-3 IGNITION (EXPORT)
H1	138 16LG	A/C THERMOSTAT SWITCH
H2	33 14DG	IGNITION SWITCH-START
H3	45 18TN/BK	WINDSHIELD WIPERS-PARK FEED
H4	49 16LG/BK	A/C MODE SELECTOR SWITCH
H5	R4 18VT/OR	REAR WIPER SWITCH-WASH (MODEL XJ)
H6	61 20WT/GN	LOW WASHER INDICATOR (MODEL XJ)

MJ-XJ 109

BULKHEAD CONNECTOR

J908W-3



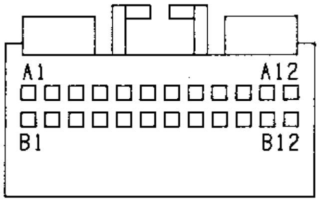
CAV	ECU SYSTEMS CIRCUITS	
1	99 14BK	POWER GROUND
2	99 14BK	POWER GROUND
3	11 14YL	IGNITION
4	10 14RD	BATTERY
5	F18 14GN	EGR CONTROL
6	F17 20OR*	FUEL PUMP RELAY
7	F20 20BK*	LATCH RELAY
8	F78 18BL/OR	POWER STEERING INPUT
9	—	—
10	99 14BK	SYSTEM GROUND
11	F52 20RD*	ENGINE SPEED INPUT
12	34 18BK*	START SIGNAL (–)
13	F57 20BR*	TPS GROUND
14	F7 18TN*	AIR TEMPERATURE INPUT
15	F24 18TN	COOLANT TEMPERATURE INPUT
16	F2 20RD*	5 VOLT SUPPLY (TPS/MAP)
17	F56 20BK*	MAP GROUND
18	136 18PK*	UPSHIFT INDICATOR
19	F21 14PK	B+ LATCH
20	—	—
21	F1 16LB	INJECTOR CONTROL
22	135 16BL*	A/C CLUTCH CONTROL
23	F3 18BR	ISCA (RETRACT)
24	F4 18LG	ISCA (EXTEND)
25	F12 18GY*	CLOSED THROTTLE INPUT
26	—	—
27	F26 20OR*	TIMING OUTPUT
28	F53 20WT*	ENGINE SPEED INPUT
29	88 14GN*	START SIGNAL (+)
30	138 16LG	A/C SELECT
31	F50 20YL/GN	TPS INPUT
32	F15 18BR*	TEMPERATURE SENSORS GROUND
33	F14 20VT	MAP INPUT
34	38 20TN*	A/C REQUEST
35	F6 18GY	OXYGEN SENSOR INPUT

(2.5L) 35 WAY
ENGINE CONTROLLER CONNECTOR

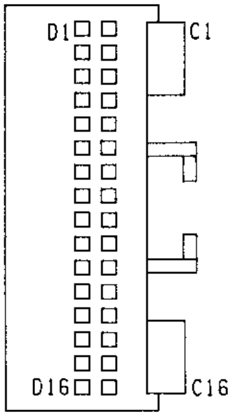
J908W-3

MJ-XJ 110

CAV	ECU SYSTEMS CIRCUITS	
A1	F37 18TN	INJECTOR 3
A2	F76 18BR	INJECTOR 6
A3	F72 18LG	INJECTOR 2
A4	F74 18YL	INJECTOR 4
A5	F17 16OR*	FUEL PUMP RELAY GROUND
A6	—	—
A7	F86 16GY/YL	OXYGEN RELAY GROUND
A8	136 18PK*	UPSHIFT LAMP-MANUAL
A9	F20 16BK*	B+ LATCH RELAY GROUND
A10	F19 16GN*	EGR CONTROL
A11	—	—
A12	135 18BL*	A/C CLUTCH CONTROL
B1	F71 18LB	INJECTOR 1
B2	F75 18WT	INJECTOR 5
B3	F68 18RD/YL	AIS MOTOR (A)
B4	F67 18BL/YL	AIS MOTOR (D)
B5	F70 18GN/BK	AIS MOTOR (C)
B6	F69 18PK/BK	AIS MOTOR (B)
B7	10 16RD	BATTERY
B8	11 14YL	IGNITION
B9	—	—
B10	F21 16PK	B+ LATCHED
B11	99 16PK	GROUND
B12	99 16PK	GROUND



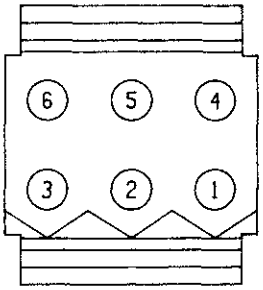
CAV	ECU SYSTEMS CIRCUITS	
C1	F52 18VT*	ENGINE SPEED INPUT
C2	38 16TN*	A/C REQUEST
C3	88 14GN*	START SIGNAL (+)
C4	34 18BK	START SIGNAL (−)
C5	F65 18GY*	SYNC SIGNAL
C6	F14 18VT	MAP INPUT
C7	F50 18YL/GN	TPS INPUT
C8	F7 18TN*	AIR TEMP INPUT
C9	—	—
C10	F24 18TN	COOLANT TEMP INPUT
C11	F22 16OR	INJECTOR FEED
C12	F83 16BR/PK	TX SERIAL DATA OUTPUT
C13	—	—
C14	F2 18RD*	MAP 5 VOLT SUPPLY
C15	F77 18LB	TPS 5 VOLT SUPPLY
C16	F66 18BL	SYNC 7.1 VOLT SUPPLY
D1	F53 18WT	ENGINE SPEED INPUT
D2	138 16LG	A/C SELECT
D3	F15 18BR	SENSOR GROUND
D4	—	—
D5	—	—
D6	—	—
D7	—	—
D8	F55 18YL*	KNOCK SENSOR GROUND
D9	F6 18GY	OXYGEN SENSOR INPUT
D10	F22 16OR	INJECTOR FEED
D11	F84 16BK/WT	RX SERIAL DATA INPUT
D12	—	—
D13	F23 18YL	TIMING OUTPUT
D14	—	—
D15	—	—
D16	F54 18VT*	KNOCK SENSOR INPUT



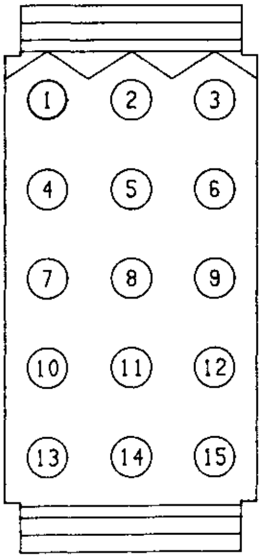
MJ-XJ 111

(4.0L) 24 WAY/32 WAY
ENGINE CONTROLLER CONNECTOR

J908W-3



CAV	DIAGNOSTIC CONNECTOR - #1	
1	30 18GN*	TACHOMETER
2	11 14YL	I-1 IGNITION SWITCH
3	99 14BK	ECU GROUND
4	88 14GN*	START SIGNAL(-)
5	10 14RD	BATTERY
6	F22 14OR	FUEL PUMP RELAY



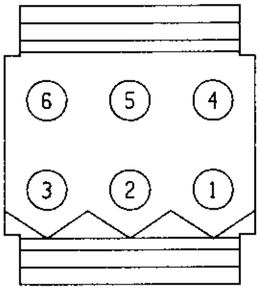
CAV	DIAGNOSTIC CONNECTOR - #2	
1	136 18PK*	UPSHIFT LAMP-MANUAL
1	136 18PK*	ECU SERIAL DATA-AUTO
2	F20 20BK*	B+ LATCH RELAY-COIL GROUND
3	34 18BK*	PARK/NEUTRAL-AUTO
3	34 18BK*	ECU SERIAL DATA-MANUAL
4	F21 14PK	B+ LATCH-RELAY-COIL FEED
5	32 16OR	A/C CLUTCH RELAY
6	F78 18BL/OR	POWER STEERING PRES SWITCH
7	99 18BK	SYSTEM GROUND
8	F7 18TN*	AIR TEMPERATURE SENSOR
9	F26 18OR*	IGNITION TIMING
10	F18 14GN	EGR PURGE SOLENOID
11	F4 18LG	ISA-EXTENDED
12	F24 18TN	COOLANT TEMPERATURE SENSOR
13	F12 18GY*	ISA-CLOSED THROTTLE SWITCH
14	F3 18BR	ISA-RETRACT
15	137 16YL*	AUTO TRANS DIAGNOSIS

(2.5L) 6 WAY AND 15 WAY DIAGNOSTIC CONNECTORS

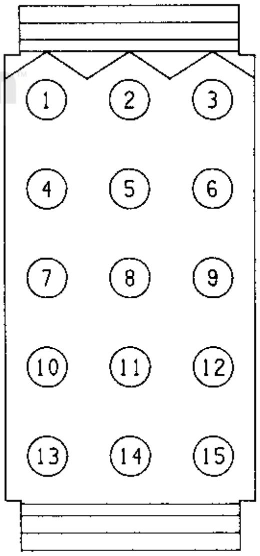
J908W-3

MJ-XJ 112

CAV	DIAGNOSTIC CONNECTOR - #1	
1	30 18GN✻	TACHOMETER
2	—	—
3	99 14BK	ECU GROUND
4	241 20GY/YL	ANTI-LOCK MODULE-DG
5	10 14RD	BATTERY
6	F22 14RD	FUEL PUMP RELAY



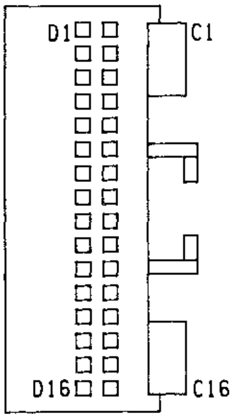
CAV	DIAGNOSTIC CONNECTOR - #2	
1	F83 16BR/PK	ECU-TX SERIAL DATA OUTPUT
2	F84 16BK/WT	ECU-RX SERIAL DATA INPUT
3	F20 16BK✻	B+ LATCH RELAY-COIL GROUND
4	11 14YL	I-1 IGNITION SWITCH
5	242 20TN/BK	ANTI-LOCK MODULE-C4
6	32 16OR/BR	A/C CLUTCH RELAY
7	99 18BK	GROUND
8	F15 18BR✻	SENSOR GROUND
9	63 14OR	OXYGEN HEATER RELAY
10	—	—
11	136 18PK✻	UPSHIFT LAMP-MANUAL
12	F21 16PK	B+ LATCH RELAY (COIL FEED)
13	—	—
14	205 18VT	BRAKE ALERT-A.L.M. C2
15	136 16YL✻	AUTO TRANS DIAGNOSIS-C4



(4.0L) 6 WAY AND 15 WAY
DIAGNOSTIC CONNECTORS

MJ-XJ 113

J908W-3



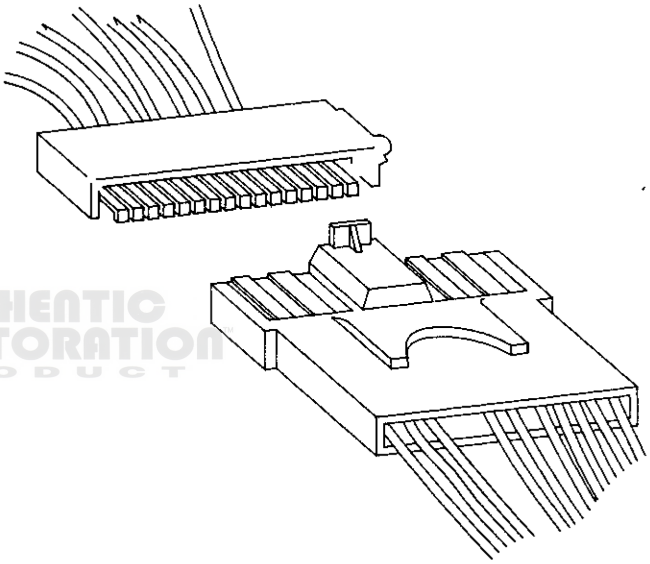
CAV	TCU SYSTEMS CIRCUITS	
C1	—	—
C2	—	—
C3	T9 18TN*	ROAD SPEED
C4	137 16YL*	TRANS DIAGNOSTIC CONNECTOR
C5	99 18BK	SHIFT POINT LOGIC GROUND
C6	—	—
C7	—	—
C8	T12 18LG	1-2 GEAR INPUT
C9	T11 18GY*	D GEAR INPUT
C10	116 18LB*	BRAKE/TORQUE CONVERTER
C11	177 18TN	POWER INPUT SIGNAL
C12	—	—
C13	—	—
C14	T8 18WT*	CONVERTER LOCKUP
C15	T7 18VT*	S2 SOLENOID
C16	T6 18BL*	S1 SOLENOID
D1	T3 18RD	TPS VOLTAGE SUPPLY
D2	T4 18GY*	TPS INPUT
D3	T5 18TN/OR	TPS GROUND
D4	—	—
D5	—	—
D6	—	—
D7	99 18BK	GROUND
D8	—	—
D9	—	—
D10	—	—
D11	—	—
D12	—	—
D13	—	—
D14	10 16RD	BATTERY
D15	—	—
D16	11 18YL	IGNITION

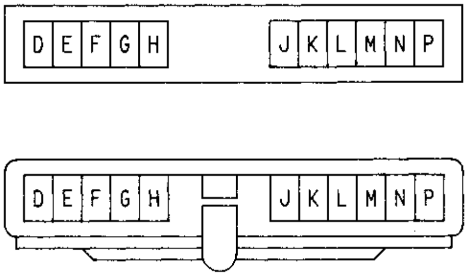
(AUTOMATIC TRANSMISSION)
32 WAY SINGLE MODULE
TRANSMISSION CONTROLLER CONNECTOR

J908W-3

MJ-XJ 114

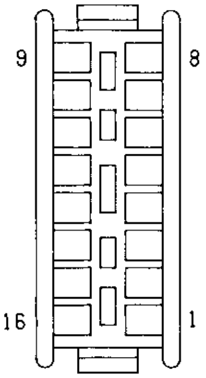
CAV	TURN SIGNAL SWITCH CIRCUITS	
P	110 18LG/BK	STOP LAMP FEED (XJ ONLY)
P	71 18LB/BK	STOP LAMP FEED (MJ ONLY)
N	79 18BR	RIGHT TURN-REAR
M	78 18GY/BK	LEFT TURN-REAR
L	74 18GY/YL	TURN SIGNAL FLASHER
K	80 18VT	HAZARD FLASHER
J	79 18BR	RIGHT TURN-FRONT/INDICATOR
J	79 18BR	RIGHT TURN LAMP
H	78 18GY/BK	LEFT TURN-FRONT/INDICATOR
H	78 18GY/BK	LEFT TURN LAMP
G	128 20OR/RD	HORN SWITCH
F	29 18RD/BL	IGNITION KEY WARNING SWITCH
E	86 18BK	IGNITION KEY WARNING SWITCH
D	—	—





MJ-XJ 115 STEERING COLUMN CONNECTOR 11 WAY J908W-3

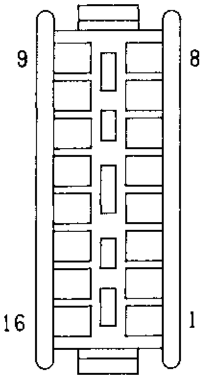
W/O ABS



LEFT HAND SIDE OF
INSTRUMENT CLUSTER

CAV	INSTRUMENT CLUSTER-INDICATOR CIRCUITS	
1	—	—
2	189 20GY	EMISSION MAINTENANCE LAMP
3	14 20WT/BK	I-1 IGNITION FEED
3	14 20WT/BK	I-1 IGNITION FEED
4	14 20WT/BK	I-1 IGNITION FEED
4	14 20WT/BK	I-1 IGNITION FEED
5	—	—
6	—	—
7	—	—
8	58 20GY/RD	BRAKE LAMP
9	60 20WT/OR	SEAT BELT LAMP
10	99 20BK	GROUND
10	99 20BK	GROUND
11	106 18BK/YL	FULL TIME LAMP
12	126 20BK/LB	UPSHIFT LAMP
13	107 20BK/RD	PART TIME LAMP
14	14 20WT/BK	I-1 IGNITION FEED
14	14 20WT/BK	I-1 IGNITION FEED
15	61 20WT/GN	LOW WASHER LAMP
16	99 20BK	GROUND

W/ABS



LEFT HAND SIDE OF
INSTRUMENT CLUSTER

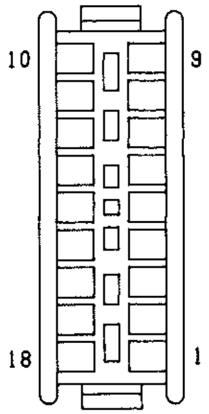
CAV	INSTRUMENT CLUSTER-INDICATOR CIRCUITS	
1	—	—
2	189 20GY	EMISSION MAINTENANCE LAMP
3	14 20WT/BK	I-1 IGNITION FEED
3	14 20WT/BK	I-1 IGNITION FEED
4	14 20WT/BK	I-1 IGNITION FEED
4	14 20WT/BK	I-1 IGNITION FEED
5	—	—
6	—	—
7	205 18YL	ABS-YELLOW LAMP
8	204 18BL	ABS-RED LAMP
8	204 18BL	PRESSURE SWITCH
9	60 20WT/OR	SEAT BELT LAMP
10	99 20BK	GROUND
10	99 20BK	GROUND
11	106 18BK/YL	FULL TIME LAMP
12	126 20BK/LB	UPSHIFT LAMP
13	107 20BK/RD	PART TIME LAMP
14	14 20WT/BK	I-1 IGNITION FEED
14	14 20WT/BK	I-1 IGNITION FEED
15	61 20WT/GN	LOW WASHER LAMP
16	99 20BK	GROUND

J908W-3

INDICATOR CONNECTOR-16 WAY

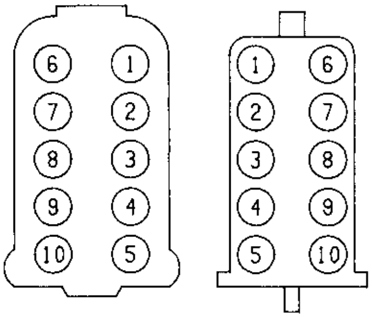
MJ-XJ 116

CAV	INSTRUMENT CLUSTER-INDICATORS/GAUGES	
1	52 200R/BK	ILLUMINATION LAMP
1	52 200R/BK	ILLUMINATION LAMP
2	54 20LB	OIL PRESSURE
3	59 20TN/GN	BATTERY LAMP
4	52 200R/BK	ILLUMINATION LAMP
4	52 200R/BK	ILLUMINATION LAMP
5	99 20BK	GROUND
5	99 20BK	GROUND
6	14 18WT/BK	I-1 IGNITION FEED
6	14 18WT/BK	I-1 IGNITION FEED
7	79 18BR	RIGHT TURN LAMP
8	465 16LB/BK	HEADLAMP HI-BEAM
9	52 200R/BK	ILLUMINATION LAMP
9	52 200R/BK	ILLUMINATION LAMP
10	99 20BK	GROUND
11	78 18GY/BK	LEFT TURN LAMP
12	30 18GN/WT	TACHOMETER
13	14 20WT/BK	I-1 IGNITION FEED
13	14 20WT/BK	I-1 IGNITION FEED
14	55 20VT	COOLANT TEMPERATURE
14	55 20VT	BULB CHECK-COOLANT
15	57 20TN	FUEL GAUGE W/O TACH
16	52 200R/BK	ILLUMINATION LAMP
17	57 20TN	FUEL GAUGE W/O TACH
17	57 20TN	FUEL GAUGE
18	14 20WT/BK	I-1 IGNITION FEED
18	14 20WT/BK	I-1 IGNITION FEED



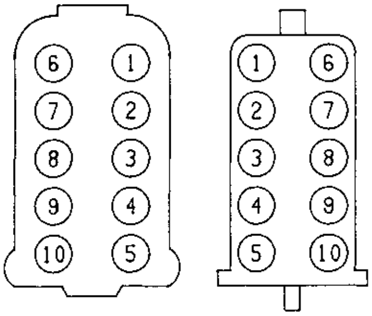
RIGHT HAND SIDE OF
INSTRUMENT CLUSTER

MJ-XJ 117 INSTRUMENT CLUSTER CONNECTOR-18 WAY J908W-3



BLACK BODY CONNECTOR (LEFT HAND KICK PANEL)

CAV	BODY CONNECTOR- #1 CIRCUITS	
1	58 20GY/RD	PARK BRAKE SWITCH
1	203 18GN	PARK BRAKE SWITCH (ABS)
2	51 20PK	CARGO LAMP FEED
3	71 18LB/BK	STOP LAMPS
4	72 18DB	ILLUMINATION RELAY
4	72 18DB	PARKING LAMPS
5	79 18BR	RIGHT TURN-REAR
6	57 20TN	FUEL GAUGE
7	75 18BR/WT	BACKUP LAMPS
8	98 20BK/WT	LEFT FRONT DOOR JAMB SWITCH
8	98 20BK/WT	COURTESY LAMPS
9	78 18GY/BK	LEFT TURN-REAR
10	85 18WT	SEAT BELT SWITCH

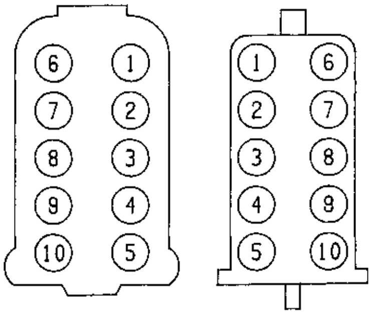


GRAY BODY CONNECTOR (LEFT HAND KICK PANEL)

CAV	BODY CONNECTOR- #2 CIRCUITS	
1	A11 20BR	SPEAKER RETURN-RIGHT REAR
2	A3 20WT/BK	SPEAKER FEED-RIGHT REAR
3	52 20OR/BK	CONSOLE ILLUMINATION
4	R1 18GN/WT	REAR WIPER MOTOR-RUN
5	110 18LG/BK	STOP LAMPS
6	A10 20BR/WT	SPEAKER RETURN-LEFT REAR
7	A5 20GN/WT	SPEAKER FEED-LEFT REAR
8	62 12BR/WT	REAR DEFOGGER FEED
9	R2 18YL/BK	REAR WIPER-PARK FEED
10	F9 14PK/BK	FUEL PUMP

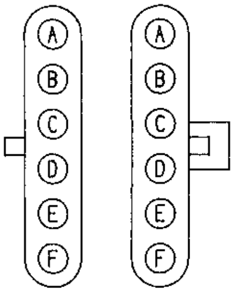
MAIN BODY CONNECTORS

CAV	BODY CONNECTOR- #3 CIRCUITS	
1	A11 20BR	SPEAKER RETURN-RIGHT REAR
2	A3 20WT/BK	SPEAKER FEED-RIGHT REAR
3	52 20OR/BK	CONSOLE ILLUMINATION
4	99 14BK	CAB GROUND
5	51 20PK	DOME LAMPS FEED
6	A10 20BR/WT	SPEAKER RETURN-LEFT REAR
7	A5 20GN/WT	SPEAKER FEED-LEFT REAR
8	148 20PK*	CARGO BOX LAMP
9	98 20BK/WT	SWITCHED GROUND
9	98 20BK/WT	COURTESY LAMPS GROUND
10	85 18WT	SEAT BELT SWITCH



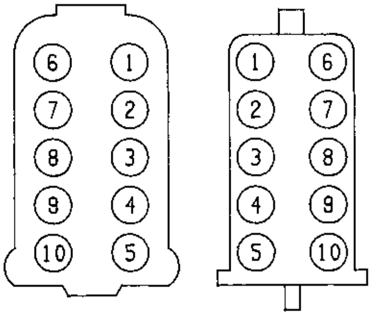
(BEHIND RIGHT
REAR PANEL)

CAV	BODY CONNECTOR- #4 CIRCUITS	
A	79 18BR	RIGHT TURN-REAR
B	72 18DB	PARKING LAMPS
C	57 20TN	FUEL GAUGE
D	75 18BR/WT	BACKUP LAMPS
E	78 18GY/BK	LEFT TURN-REAR
F	F22 14OR	FUEL PUMP



(BEHIND LEFT REAR
INNER FENDER PANEL)

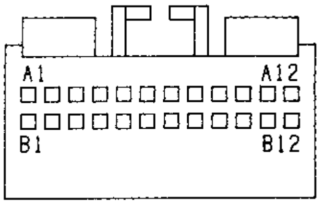
CAV	BODY CONNECTOR- #5 CIRCUITS	
1	97 20GY	SWITCHED GROUND
2	51 20PK	FUSED B+ TO COURTESY LAMPS
3	98 20BK/WT	SWITCHED GROUND
4	110 16LB/BK	TAIL LAMPS
5	71 18LB/BK	STOP LAMPS
6	72 18BL	TAIL LAMPS
7	99 18BK	GROUND
8	79 18BR	RIGHT TURN LAMPS
9	75 18BR/WT	BACKUP LAMPS
10	—	—

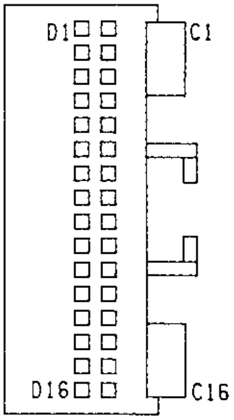


(BELOW LEFT SIDE OF I/P
ABOVE PARKING BRAKE)

MAIN BODY CONNECTORS

CAV	BODY CONNECTOR- #3 CIRCUITS	
A2	208 16TN	BRAKE MODULATOR B1
A3	209 16OR	BRAKE MODULATOR D1
A4	214 16YL/RD	BRAKE MODULATOR C2
A5	215 16GN/RD	BRAKE MODULATOR A1
A6	210 16GY	BRAKE MODULATOR F1
A7	216 16BL/RD	BRAKE MODULATOR D3
A8	213 16BR/RD	BRAKE MODULATOR D2
A9	212 16BL	BRAKE MODULATOR E1
A10	211 16LG	BRAKE MODULATOR C1
A11	207 18PK	ANTI-LOCK RELAY B
A12	99 16BK	GROUND
B11	99 16BK	GROUND
B12	99 16BK	GROUND
C1	99 16BK	GROUND
C2	205 18VT	BRAKE ALERT
C3	238 18VT/YL	BATTERY
C4	242 20PK/WT	D2-S
C5	204 18BL	LOW BRAKE PRESSURE WARNING
C7	217 20VT/RD	LOW ACCUMULATOR SENSOR
C8	202 20YL	BRAKE PUMP BOOST PRESSURE
C9	203 20GN	BRAKE FLUID LEVEL
C10	201 20BR	BRAKE PUMP BOOST PRESSURE
C12	224 18LB/RD	RH REAR WHEEL SENSOR
C13	503 18WT	LH FRONT WHEEL SENSOR
C14	501 18VT	RH FRONT WHEEL SENSOR
C15	219 18PK/BK	LH REAR WHEEL SENSOR
D1	99 16BK	GROUND
D2	99 16BK	GROUND
D4	236 18LG/YL	IGNITION FEED
D6	241 20GN/YL	D1-4
D8	235 18GY/YL	BRAKE MODULATOR A2,F2,F3
D9	234 20OR/GN	ANTI-LOCK PUMP MOTOR
D10	71 20LB/BK	PARKING BRAKE
D12	223 18LG/RD	RH REAR WHEEL SENSOR
D13	502 18BL	LH FRONT WHEEL SENSOR
D14	500 18OR	RH FRONT WHEEL SENSOR
D15	218 18WT/RD	LH REAR WHEEL SENSOR

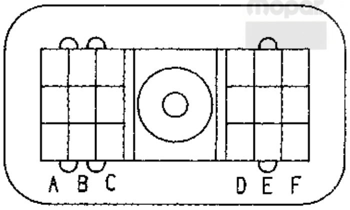




ANTI-LOCK MODULE CONNECTORS 24 WAY AND 32 WAY

J908W-3

MJ-XJ 120



CAV	BRAKE MODULE	
A1	215 16GN/RD	A.L.M. A5
A2	235 18GY	SPLICE 235
A3	235 18GY/YL	SPLICE 235-1
B1	208 16TN	A.L.M. A2
B2	—	—
B3	235 18GY/YL	SPLICE 235-1
C1	211 16LG	A.L.M. A10
C2	214 16YL/RD	A.L.M. A4
C3	235 18GY/YL	SPLICE 235-1
D1	209 16OR	A.L.M. A3
D2	213 16BR/RD	A.L.M. A8
D3	216 18BL/RD	A.L.M. A7
E1	212 16LB	A.L.M. A9
F1	210 16GY	A.L.M. A6
F2	235 18GY	SPLICE 235-1
F3	235 18GY	SPLICE 235-1

MJ-XJ 121

BRAKE MODULE 18 WAY

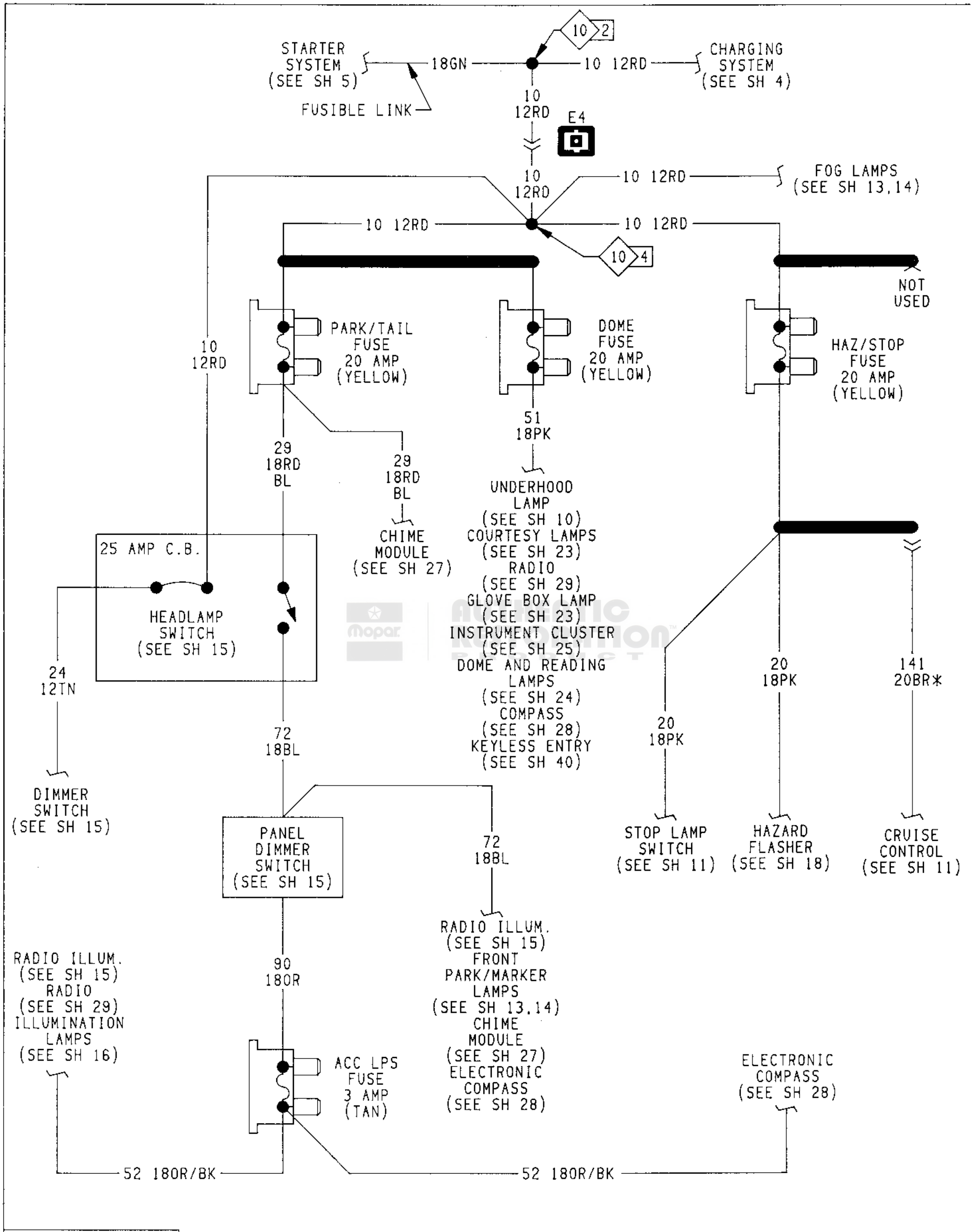
J908W-3

WIRE ROUTING AND COMPONENT LOCATION ELECTRICAL WIRING DIAGRAMS SJ SERIES

ALPHABETICAL INDEX

Name	Wiring Diagram Sheet Number
Defogger Timer	42
Distributor	7
Dome and Reading Lamp	24
Dome, Cargo and Vanity Lamps	24
Dome Fuse	1,10,23
Electric Choke Heater	8
Electric Choke Switch	8
Emission System	8
Carb Bowl Vent Solenoid	8
Carb Solenoid	8
Electric Choke Heater	8
Electric Choke Switch	8
4-WD Select Trac Gauge	26
4-Wheel Drive Lamp	16
Fan/HTR Fuse	2,6,31
Fog Lamp Relay	14
Fog Lamp Switch	14
Front End Lighting	13,14
Fog Lamp Relay	14
Fog Lamp Switch	14
Left Fog Lamp	13
Left Headlamp	13
Left Park and Turn Lamp	13
Left Side Marker Lamp	13
Right Fog Lamp	14
Right Headlamp	14
Right Park and Turn Lamp	14
Right Side Marker Lamp	14
Front Tailgate Window Switch	41
Fuel Gauge	26
Fuel Sender	43
Fuel Tank System	43
Fuses	
ACC	3
ACC LPS	1,15,16,27
Dome	1,10,23
Fan/HTR	2,6,31
Haz/Stop	1,11,18
IGN LPS	2,6,27,42,43
Park/Tail	1,15,27
RR Wipe	3,21
Turn/BU	3,18,46
Fuse Application Chart	1,2,3
Fuse Panel	49,50
Fusible Links	1,5
Glove Box Lamp	23
Haz/Stop Fuse	1,11,18
Hazard Flasher	18
Hazard Switch	18
Headlamps	13,14
Headlamp Dimmer Switch	15
Headlamp Switch	1,15
Headlamp Switch Controlled	
Interior Lighting	15,16
Ashtray Lamp	16
Defogger Switch Lamp	16
4-Wheel Drive Lamp	16

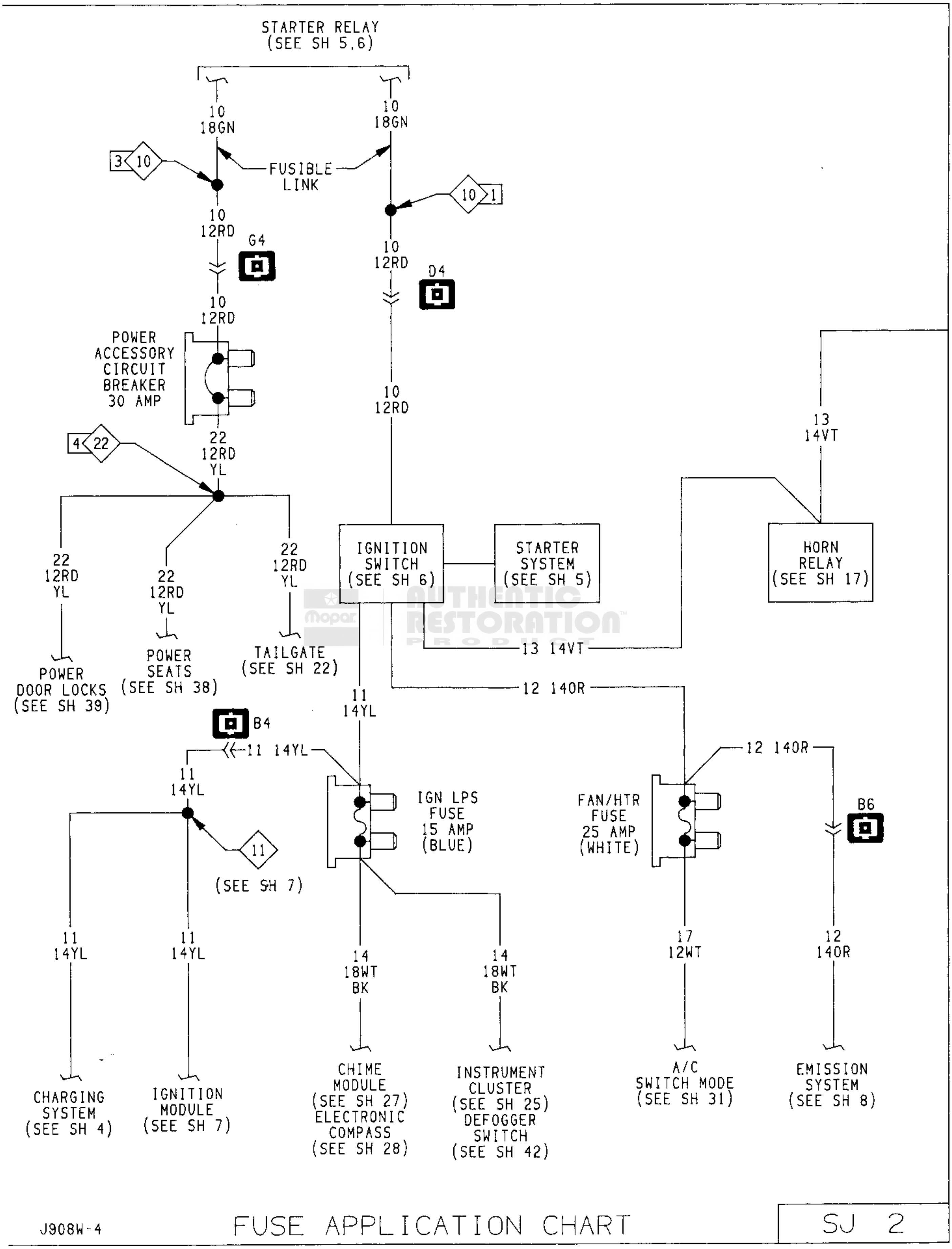
Name	Wiring Diagram Sheet Number
Headlamp Dimmer Switch	15
Headlamp Switch	15
Heater Control Lamp	16
Instrument Cluster Lamps	16
Panel Dimmer/Dome Lamp Switch	15
Radio	16
Radio Illumination Relay	15
Heater Blower Motor	32
Heater Blower Resistor	32
Heater Control Lamp	16
HI Beam Indicator	26
Horn	17
Horn Relay	2,17
Horn Switch	17
Ignition Coil	7
Ignition Key Warning Switch	27
Ignition Module	7
Ignition Switch	2,6,44
Ignition System	6,7
Ignition Coil	7
Ignition Module	7
Ignition Switch	6
IGN LPS Fuse	2,6,27,42,43
Intermittent w/Shield Wiper Governor	20
Intermittent Wiper/Washer Switch	20
Intermittent Wiper/Washer System	20
Instrument Cluster Connectors	9,15,18,25,41,43
Instrument Cluster Lamps	16
Instrument Cluster Printed Circuit	26
Keyless Entry System	40
Keyless Entry Module	40
Lamps	
Ashtray Lamp	16
Cargo Lamp	24
Defogger Switch Lamp	16
Dome and Reading Lamp	24
4-Wheel Drive Lamp	16
Glove Box Lamp	23
Heater Control Lamp	16
Instrument Cluster Lamps	16
Left Fog Lamp	13
Left Headlamp	13
Left Park and Turn Lamp	13
Left Side Marker Lamp Front	13
Left Side Marker Lamp Rear	45
Left Tail Lamps	45
LH Courtesy Lamps	23
LH Vanity Lamp	24
Rear License Lamps	45
Right Fog Lamp	14
Right Headlamp	14
Right Park and Turn Lamp	14
Right Side Marker Lamp Front	14
Right Side Marker Lamp Rear	46
Right Tail Lamps	46
RH Courtesy Lamp	23
RH Vanity Lamp	24



SJ 1

FUSE APPLICATION CHART

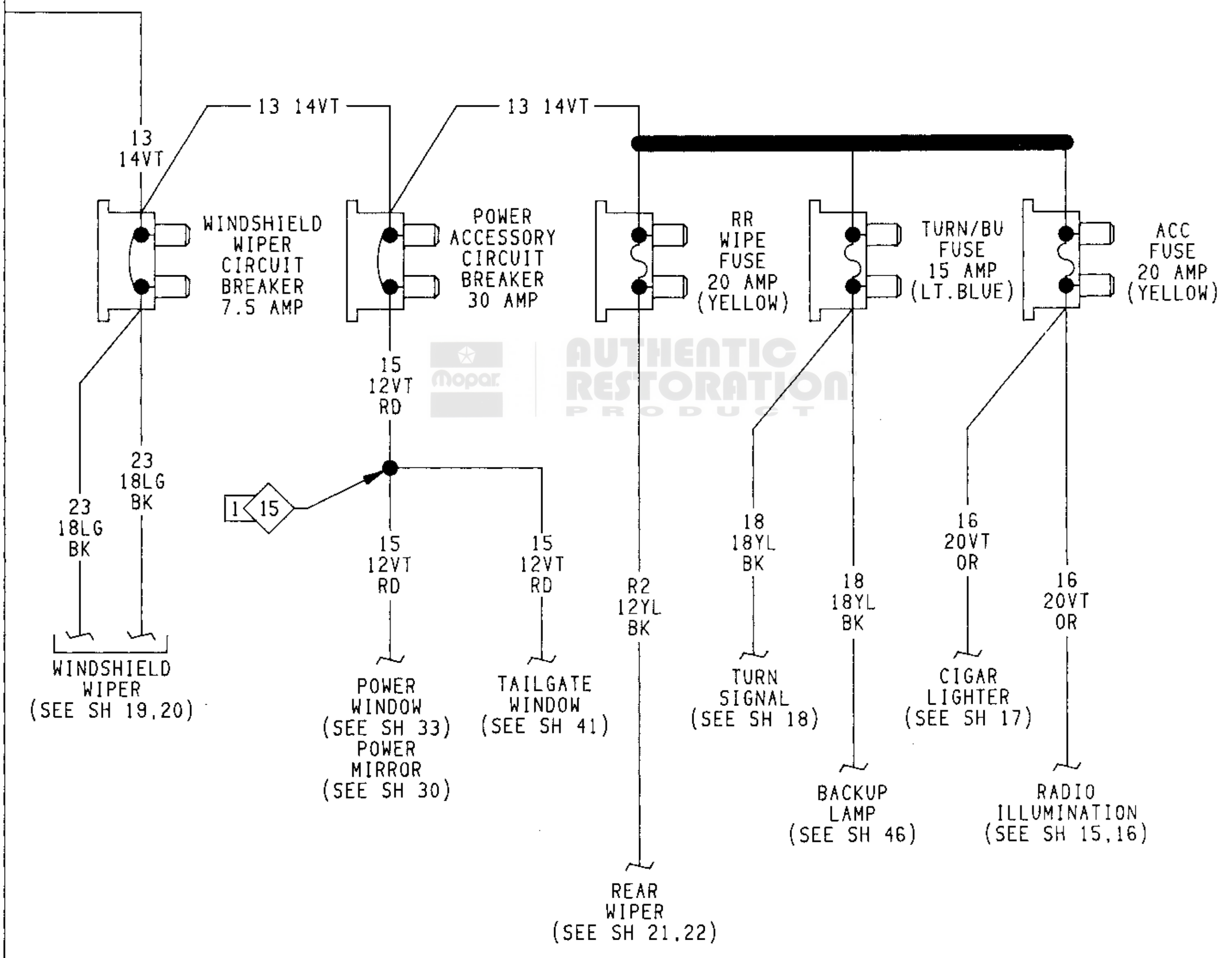
J908W-4



J908W-4

FUSE APPLICATION CHART

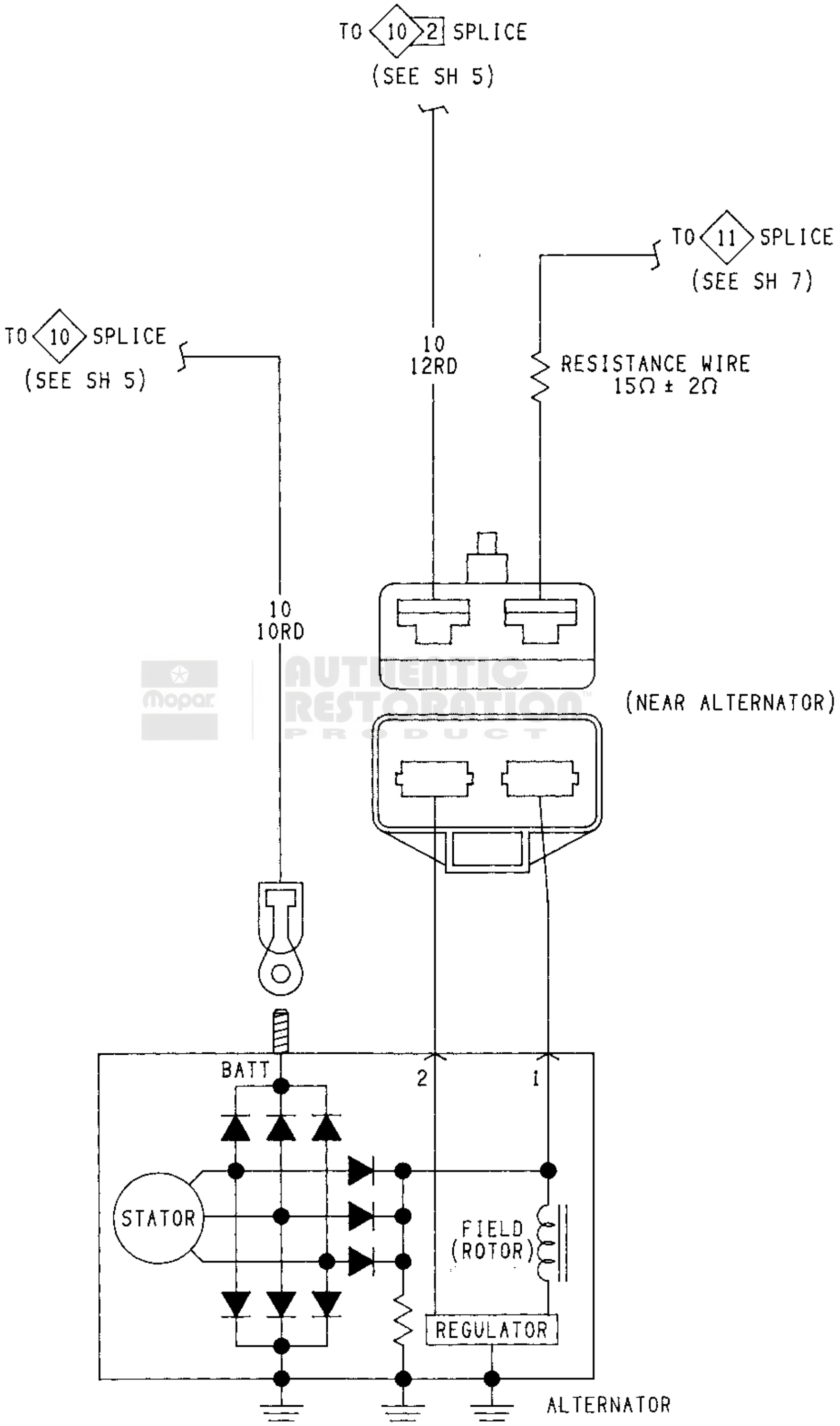
SJ 2

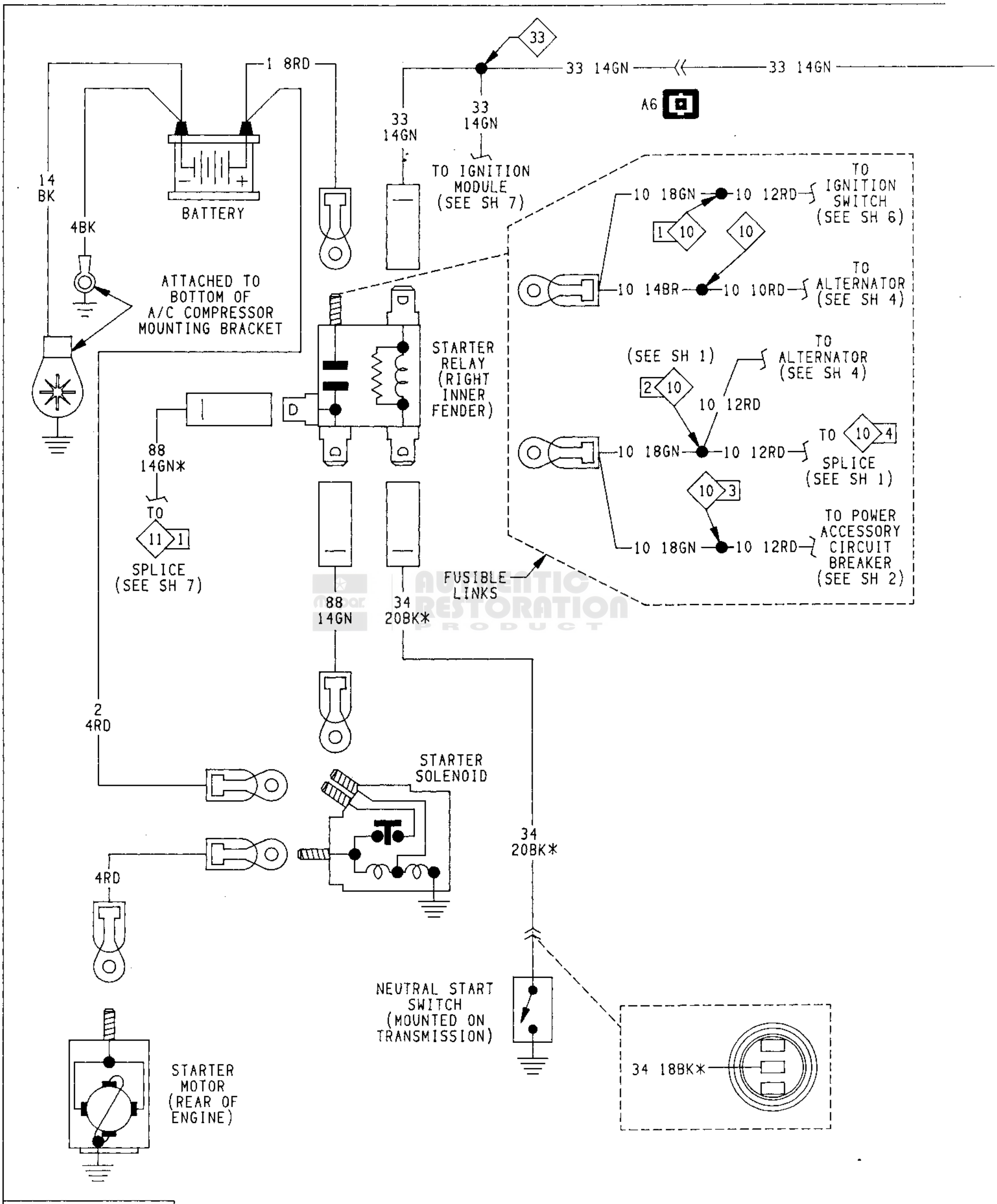


SJ 3

FUSE APPLICATION CHART

J908W-4

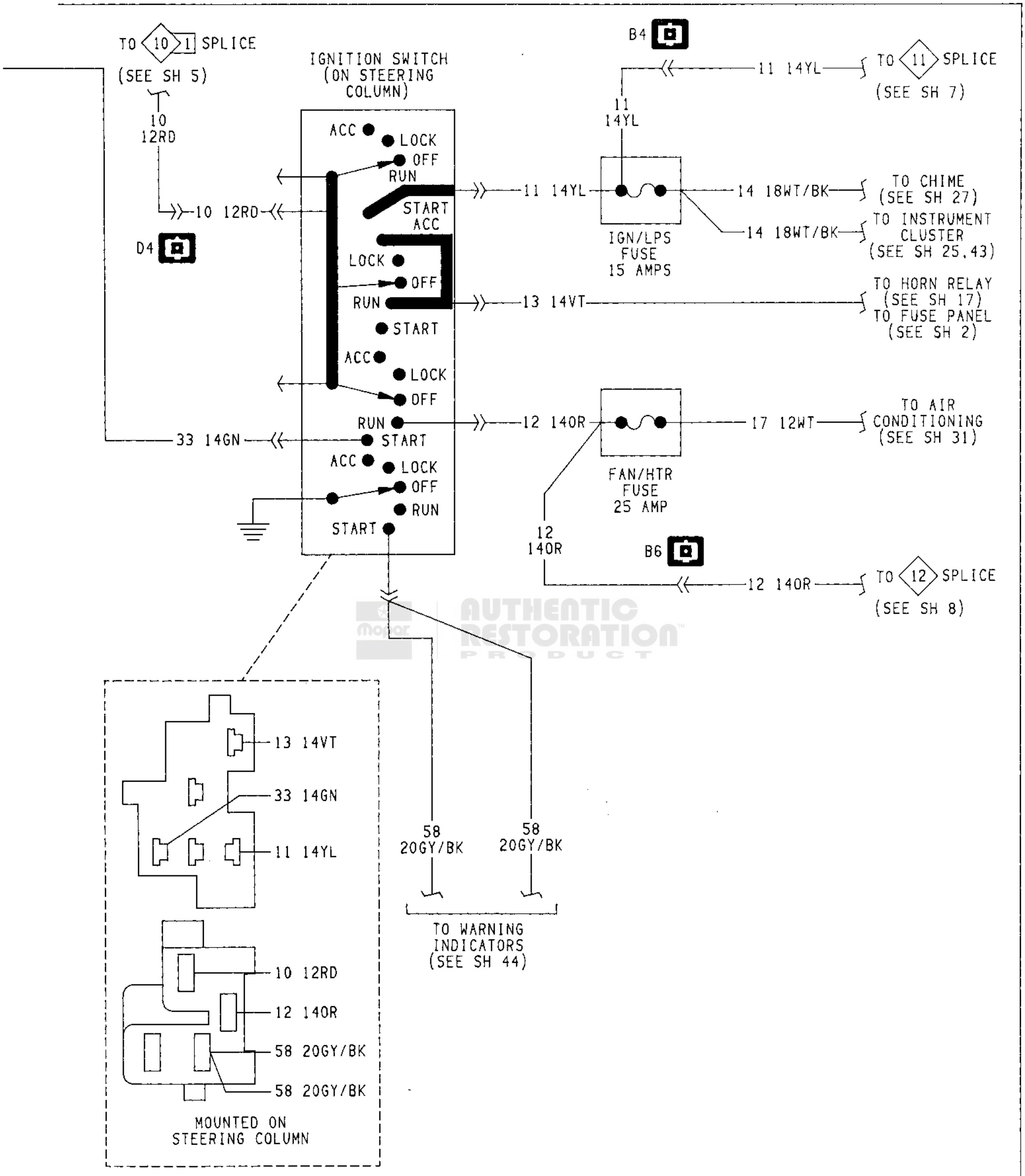

TO 10 2 SPLICE
(SEE SH 5)
TO 11 SPLICE
(SEE SH 7)
TO 10 SPLICE
(SEE SH 5)
10
12RD
RESISTANCE WIRE
15Ω ± 2Ω
10
10RD
(NEAR ALTERNATOR)
BATT
2
1
STATOR
FIELD
(ROTOR)
REGULATOR
ALTERNATOR



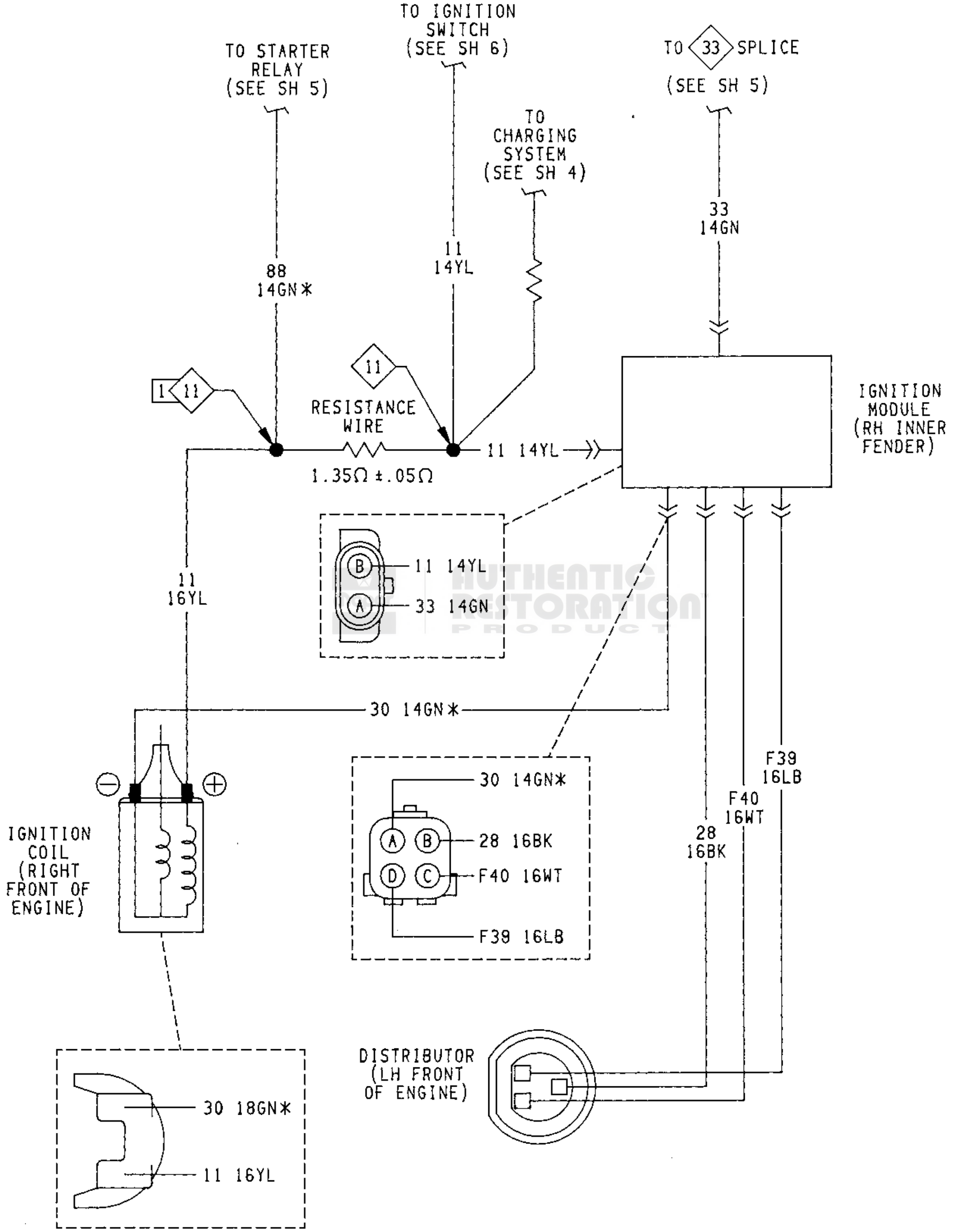
SJ 5

STARTER SYSTEM

J908W-4



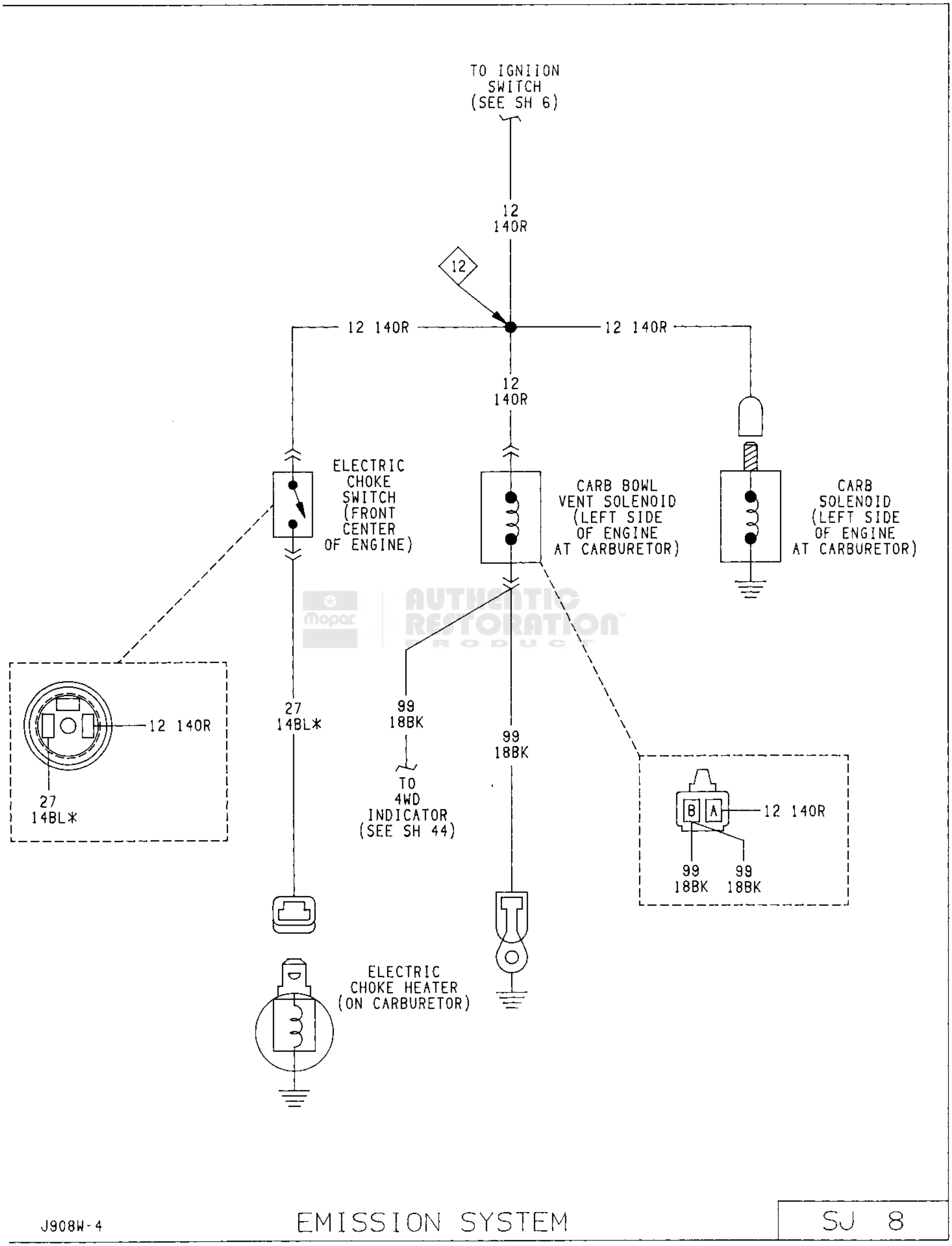
IGNITION SWITCH

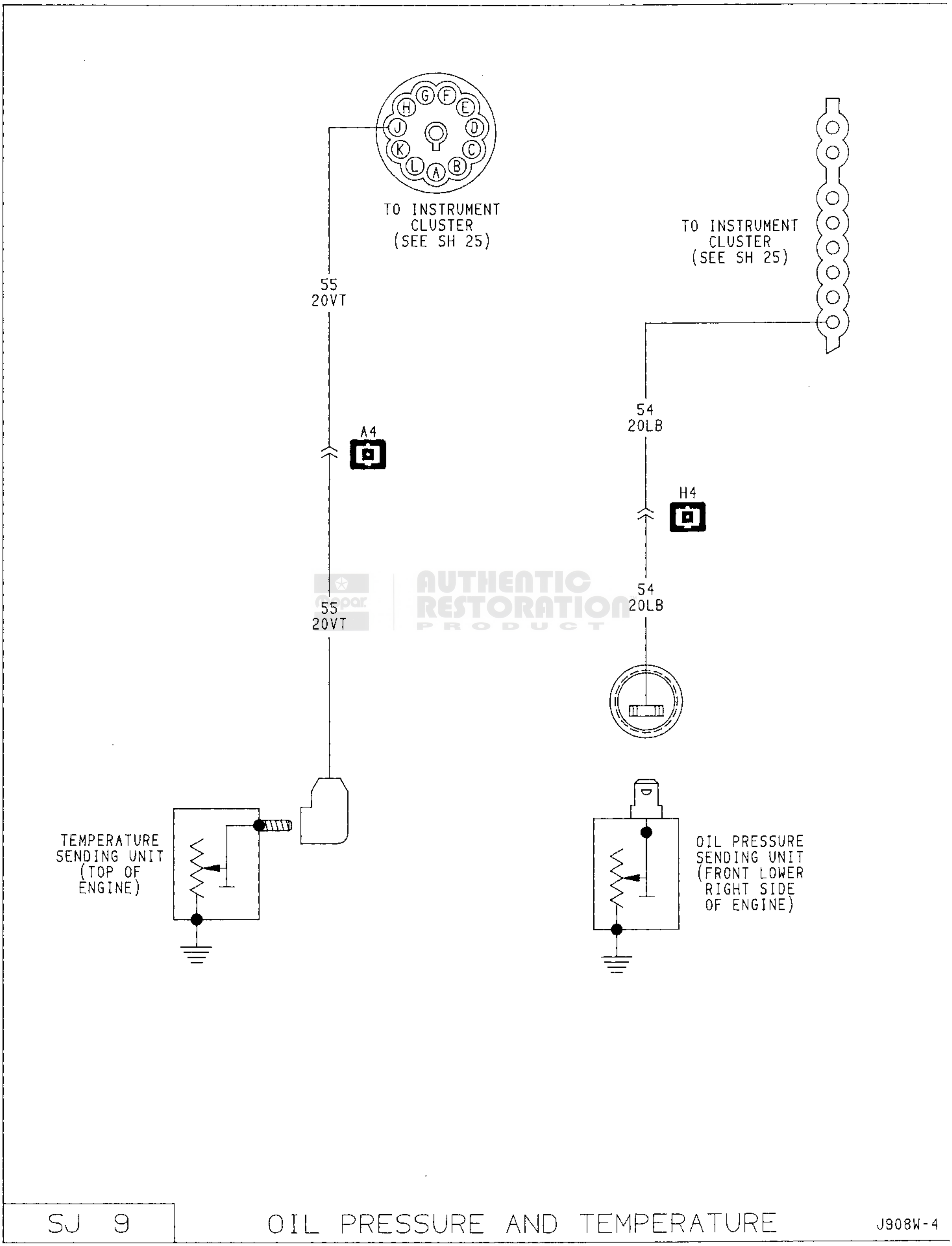


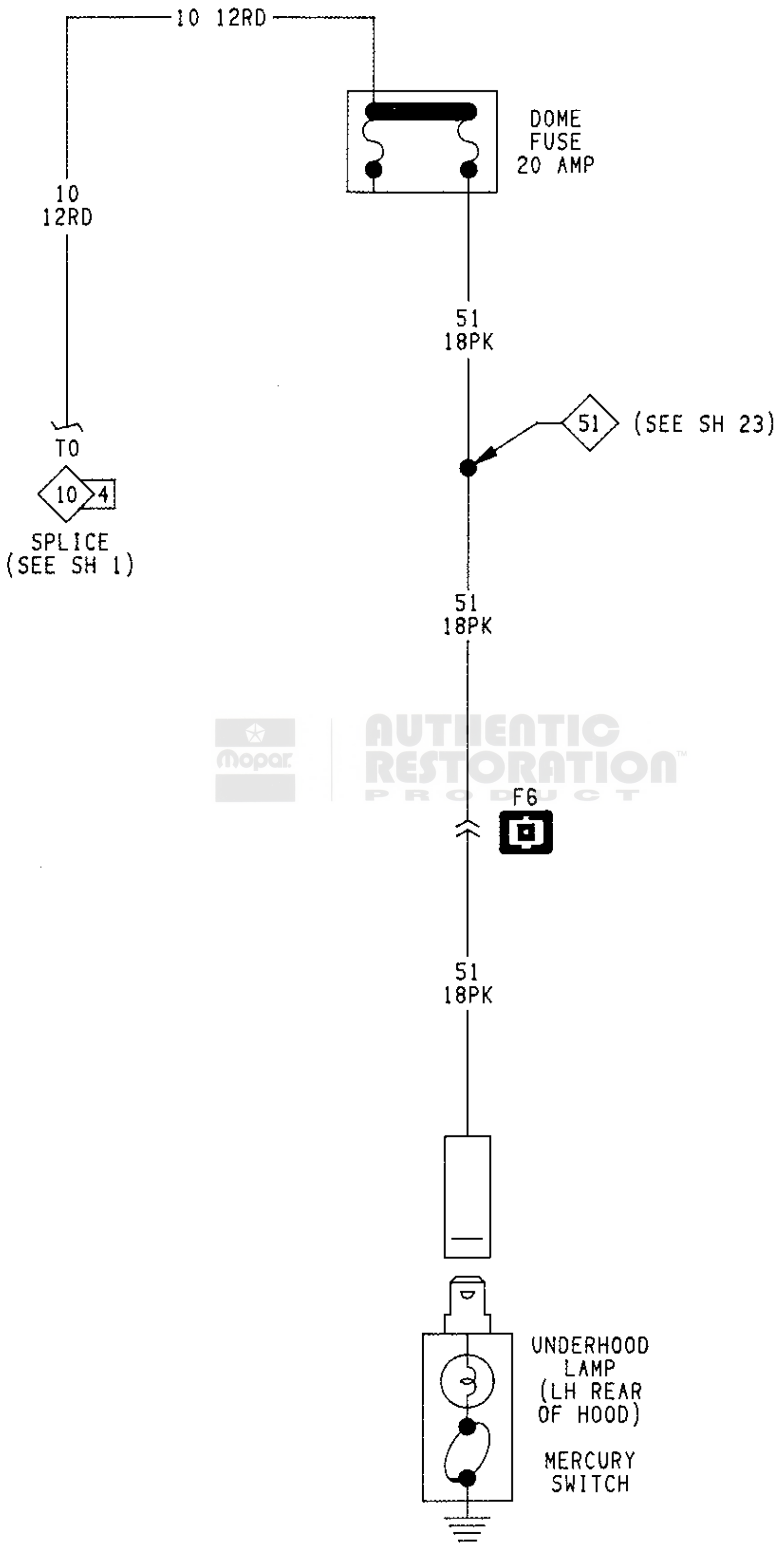
SJ 7

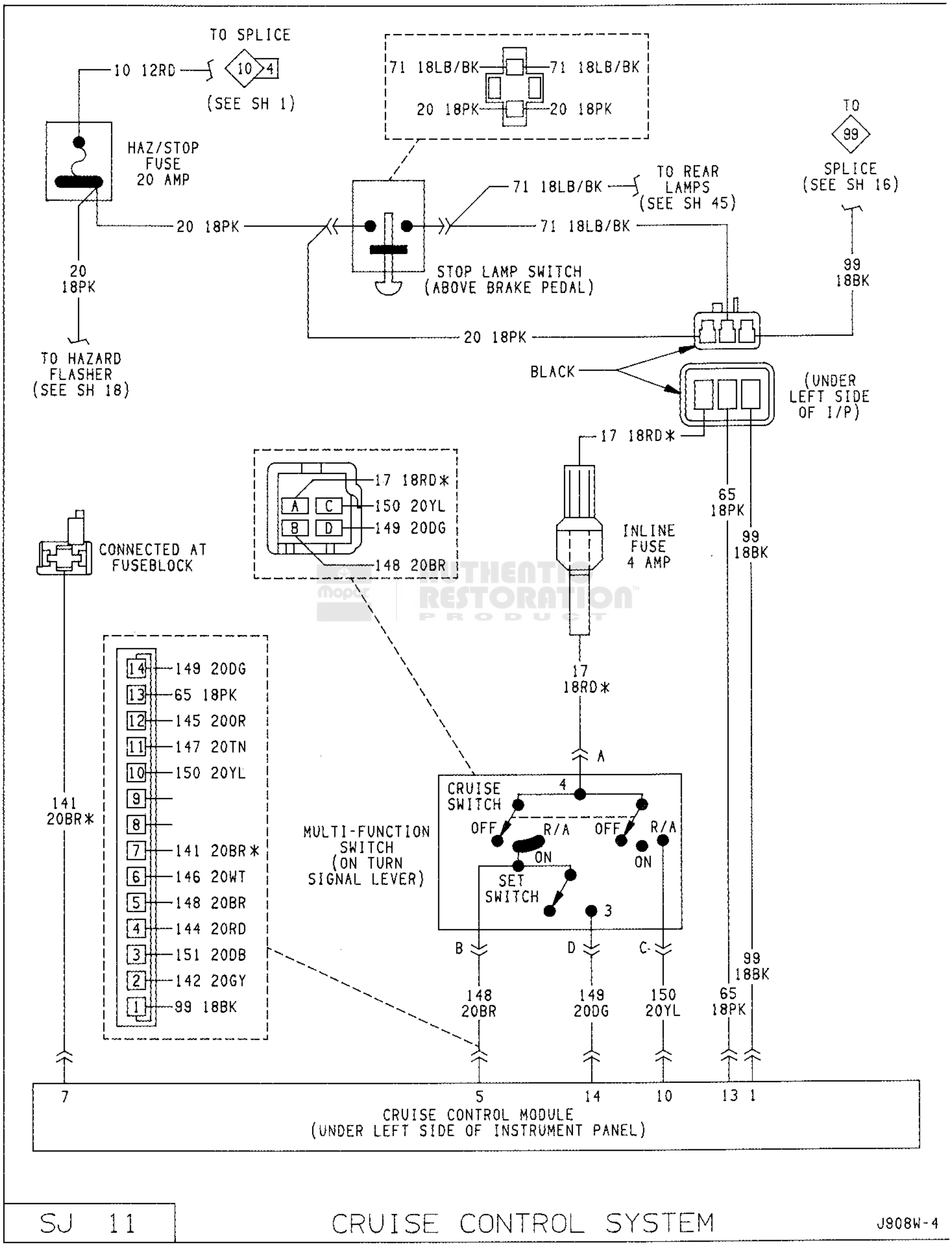
IGNITION SYSTEM

J908W-2


TO IGNIION
SWITCH
(SEE SH 6)
12
14OR
12
12 14OR
12 14OR
12
14OR
ELECTRIC
CHOKE
SWITCH
(FRONT
CENTER
OF ENGINE)
CARB BOWL
VENT SOLENOID
(LEFT SIDE
OF ENGINE
AT CARBURETOR)
CARB
SOLENOID
(LEFT SIDE
OF ENGINE
AT CARBURETOR)
12 14OR
27
14BL*
27
14BL*
99
18BK
TO
4WD
INDICATOR
(SEE SH 44)
99
18BK
B
A
12 14OR
99
18BK
99
18BK
ELECTRIC
CHOKE HEATER
(ON CARBURETOR)


G
F
H
E
J
D
K
C
L
A
B
TO INSTRUMENT CLUSTER (SEE SH 25)
TO INSTRUMENT CLUSTER (SEE SH 25)
55
20VT
A4
54
20LB
H4
55
20VT
54
20LB
TEMPERATURE SENDING UNIT (TOP OF ENGINE)
OIL PRESSURE SENDING UNIT (FRONT LOWER RIGHT SIDE OF ENGINE)
SJ 9
OIL PRESSURE AND TEMPERATURE
J908W-4

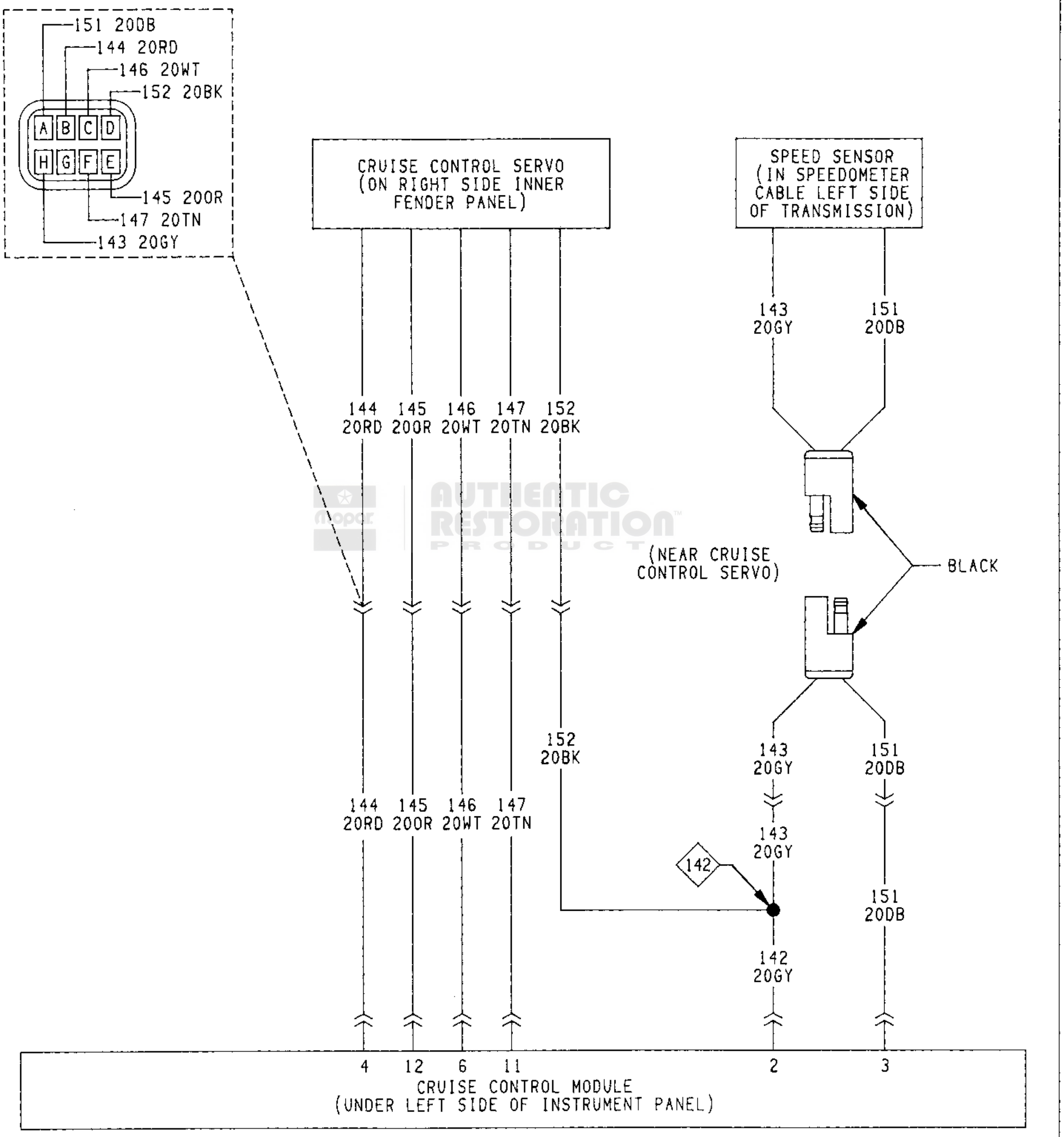

10 12RD
DOME
FUSE
20 AMP
10
12RD
51
18PK
51
(SEE SH 23)
TO
10
4
SPLICE
(SEE SH 1)
51
18PK
F6
51
18PK
UNDERHOOD
LAMP
(LH REAR
OF HOOD)
MERCURY
SWITCH



SJ 11

CRUISE CONTROL SYSTEM

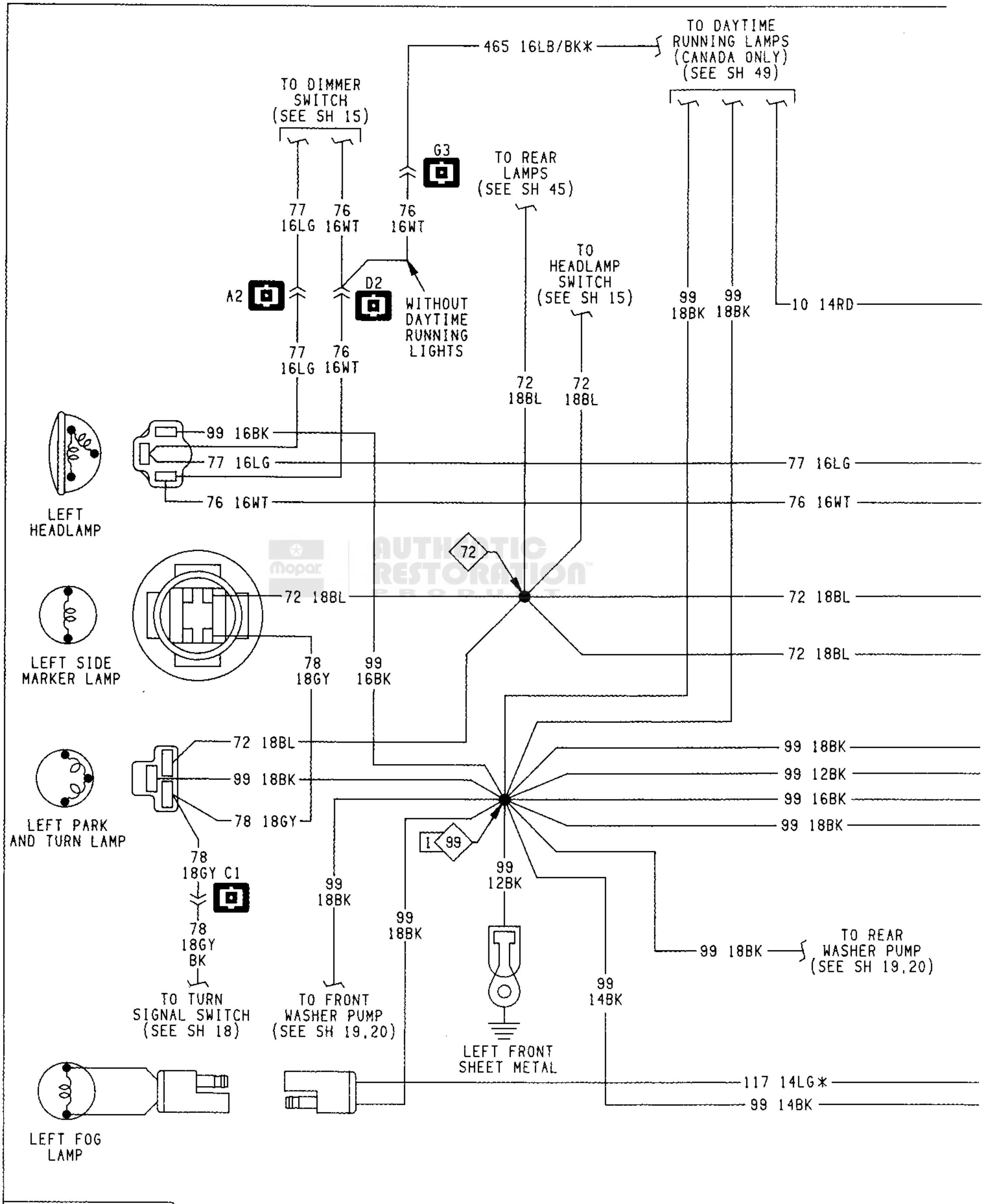
J908W-4



J908W-4

CRUISE CONTROL SYSTEM

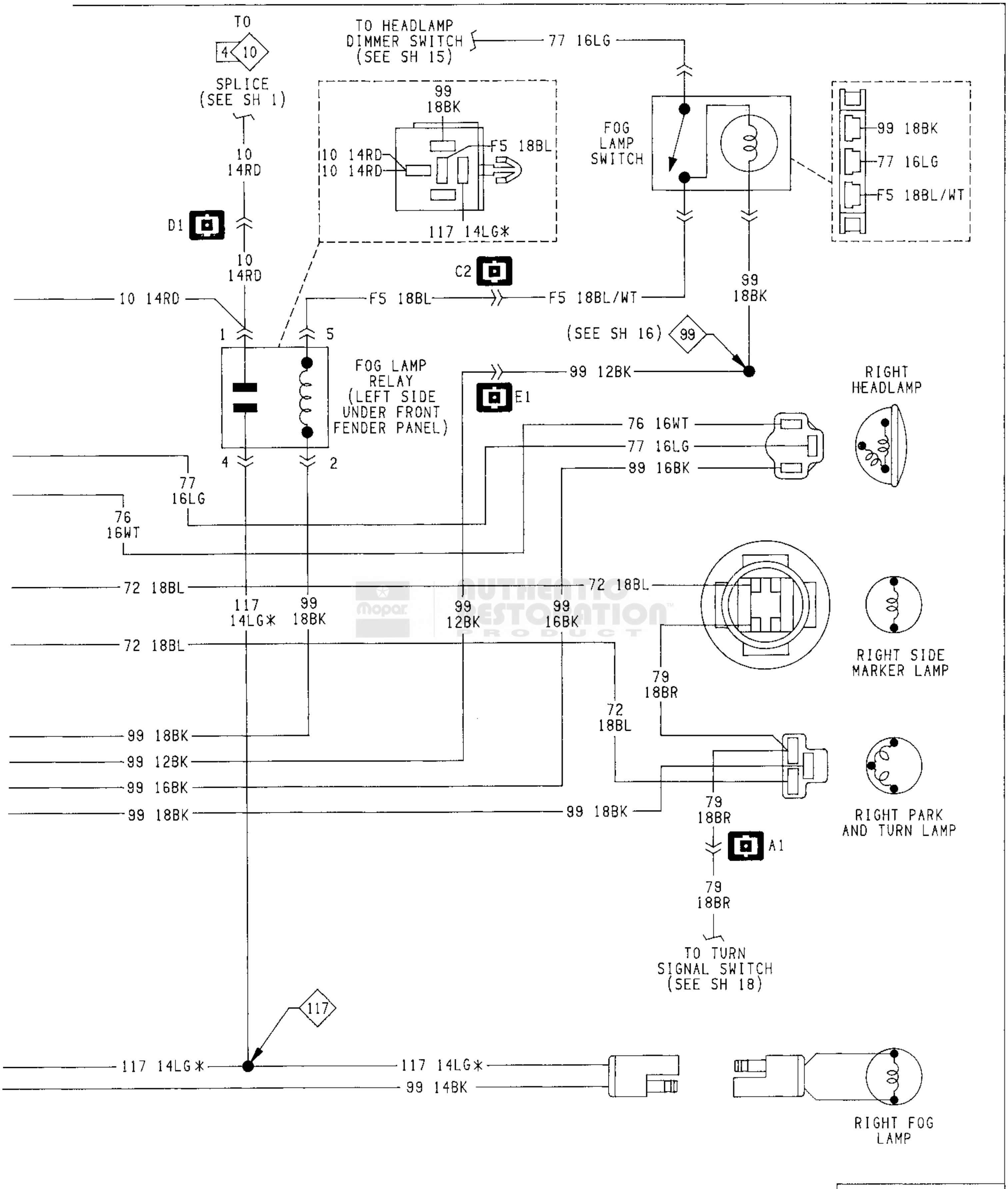
SJ 12



SJ 13

FRONT END LIGHTING

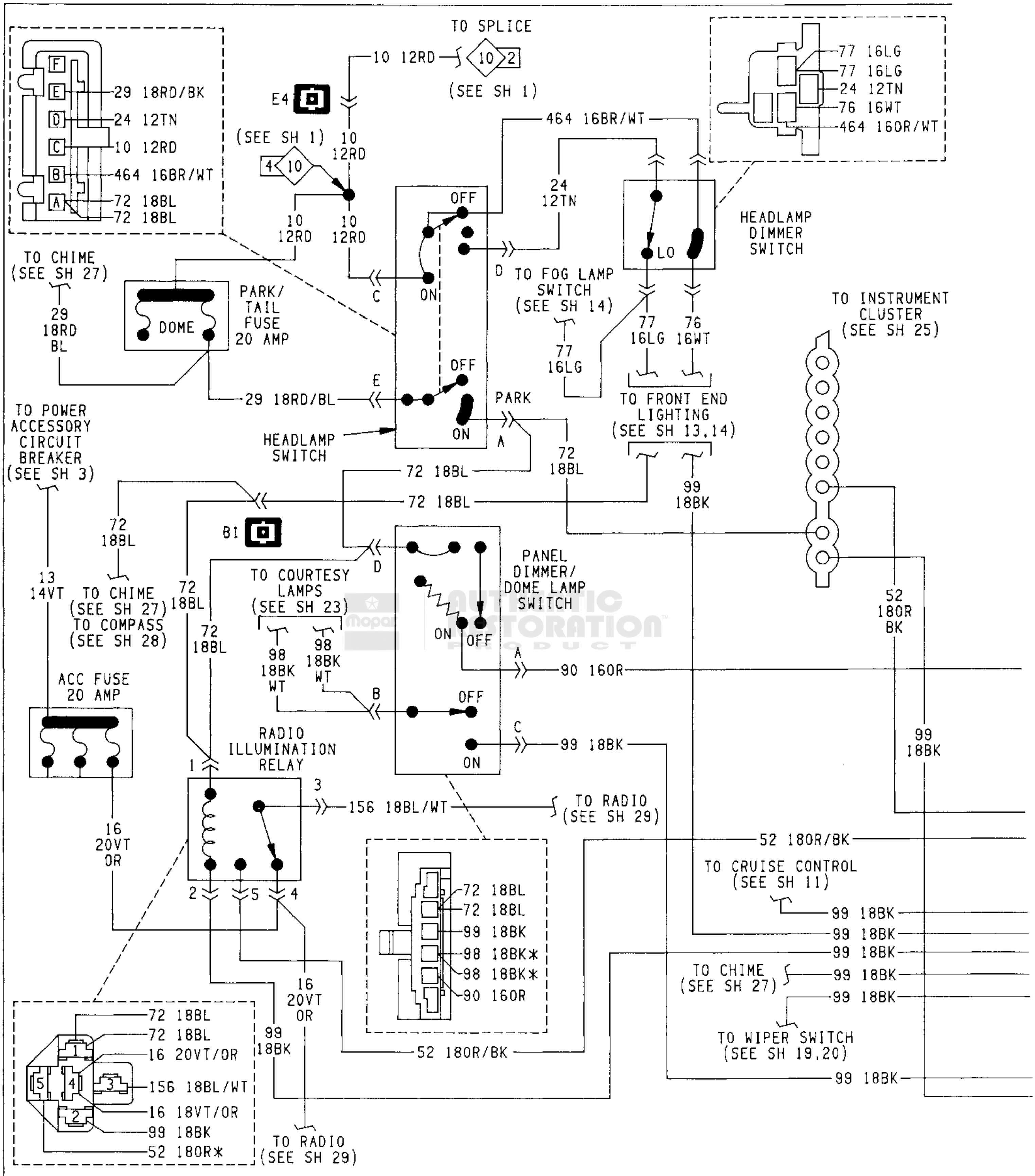
J908W-4



J908W-4

FRONT END LIGHTING

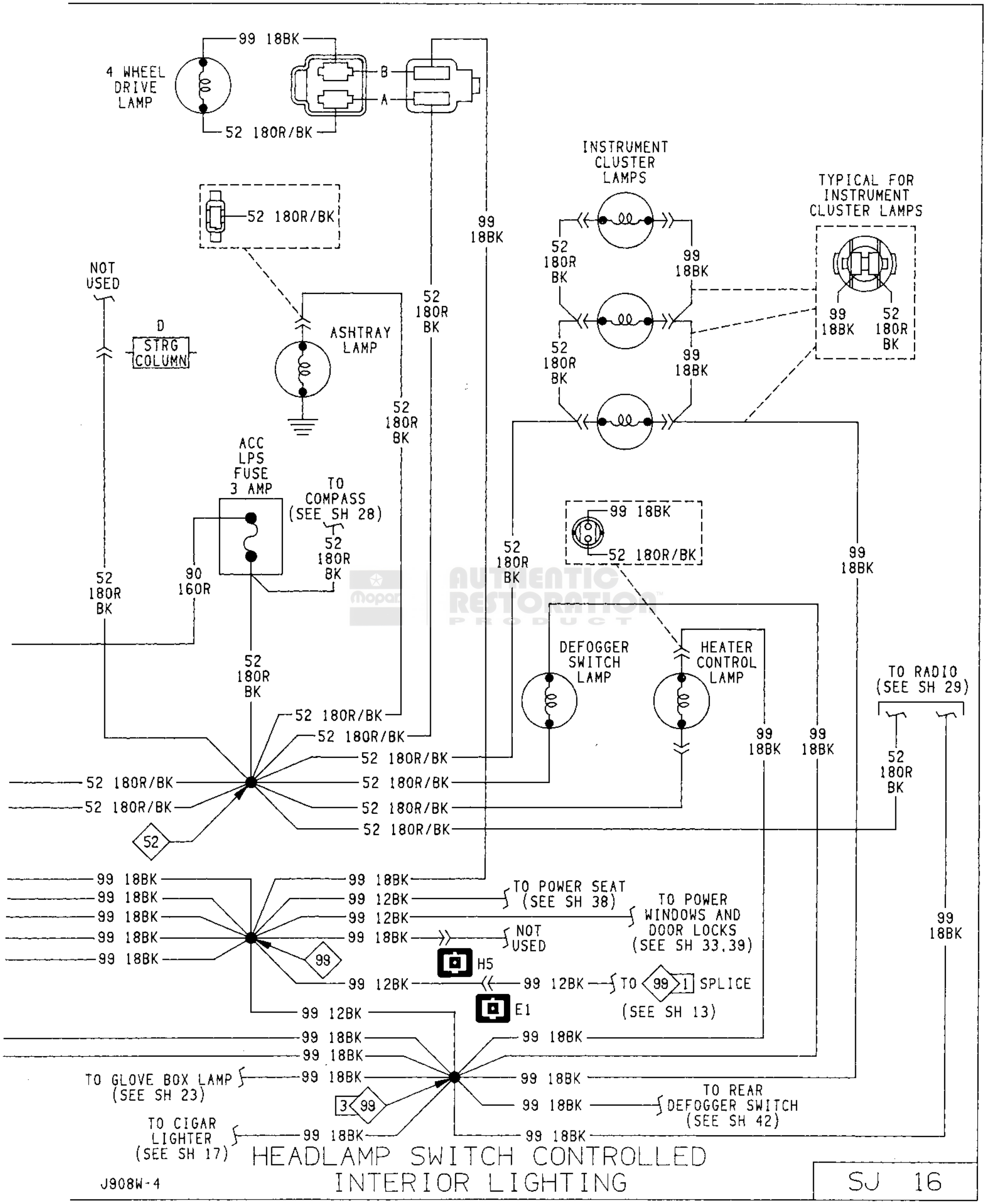
SJ 14



HEADLAMP SWITCH CONTROLLED INTERIOR LIGHTING

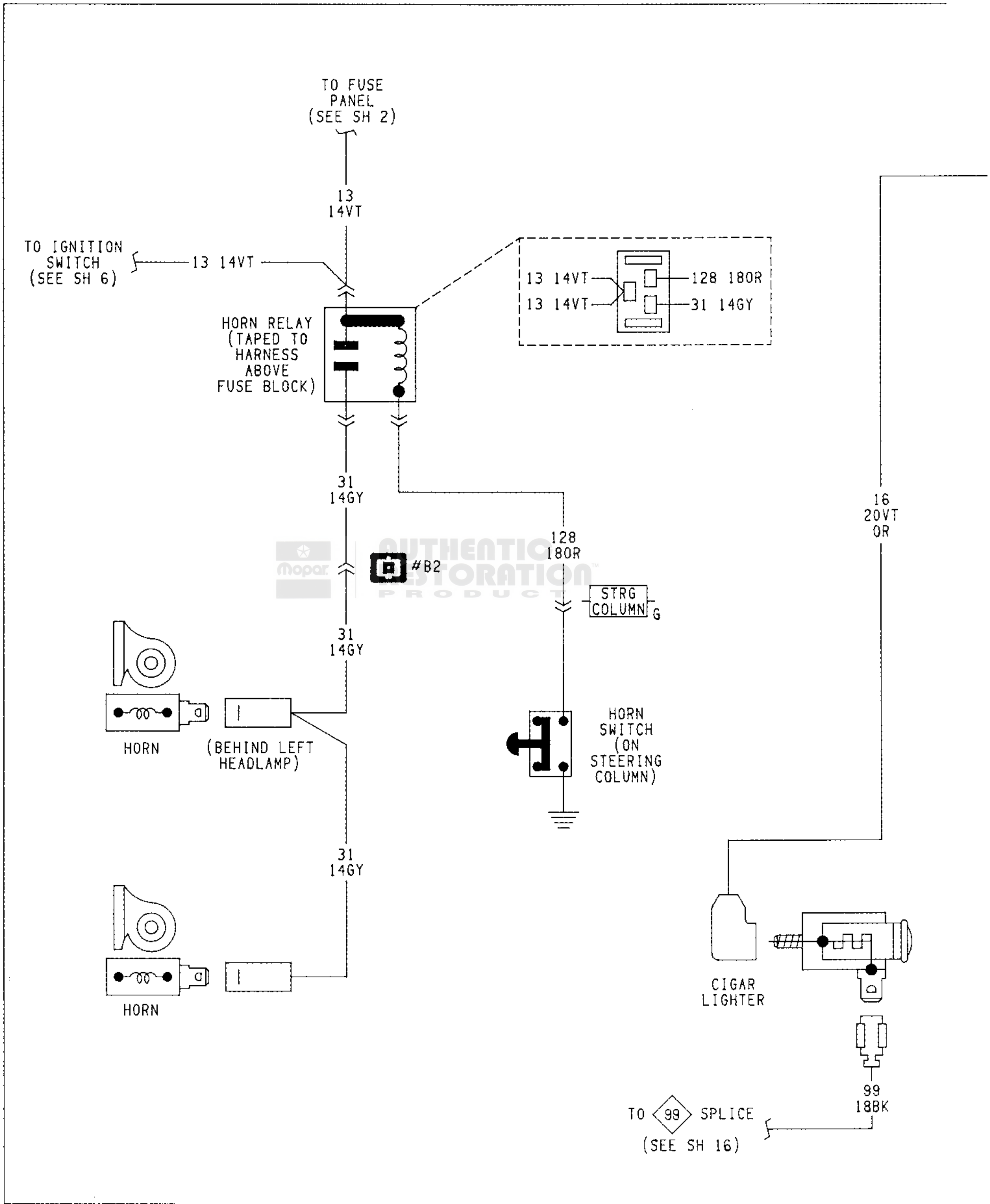
SJ 15

J908W-4

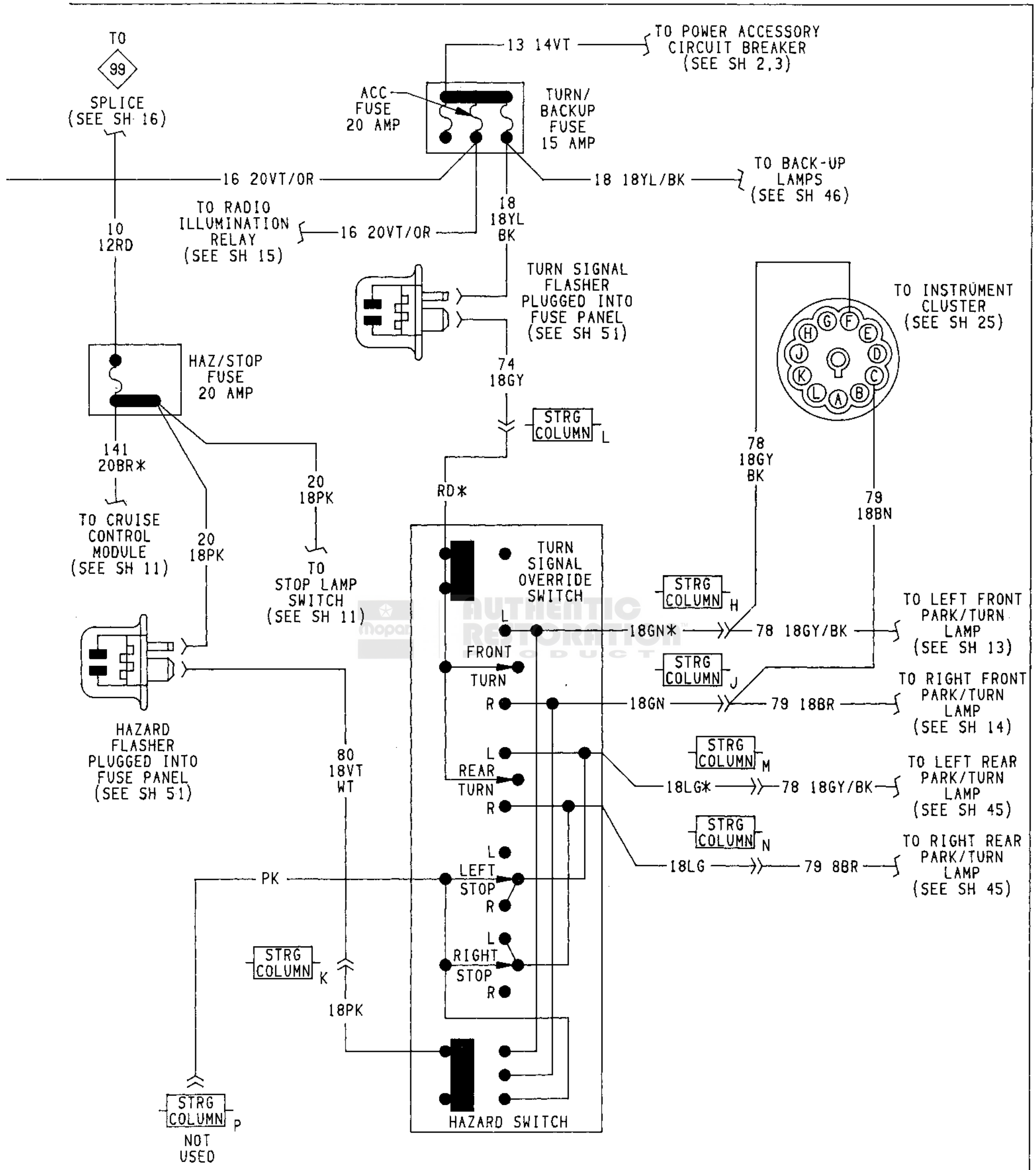


HEADLAMP SWITCH CONTROLLED
INTERIOR LIGHTING

SJ 16

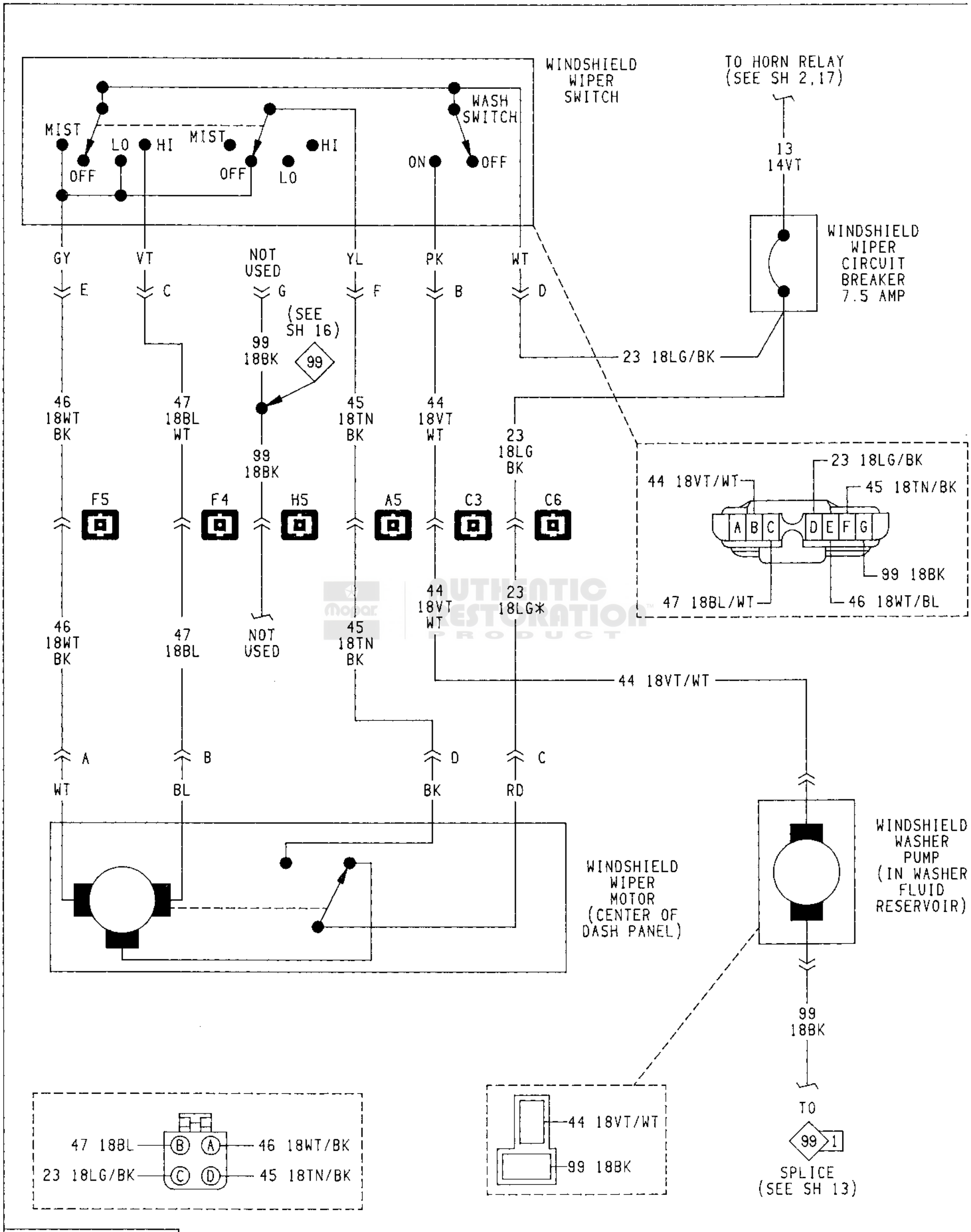


SJ 17 HORN AND CIGAR LIGHTER J908W-4

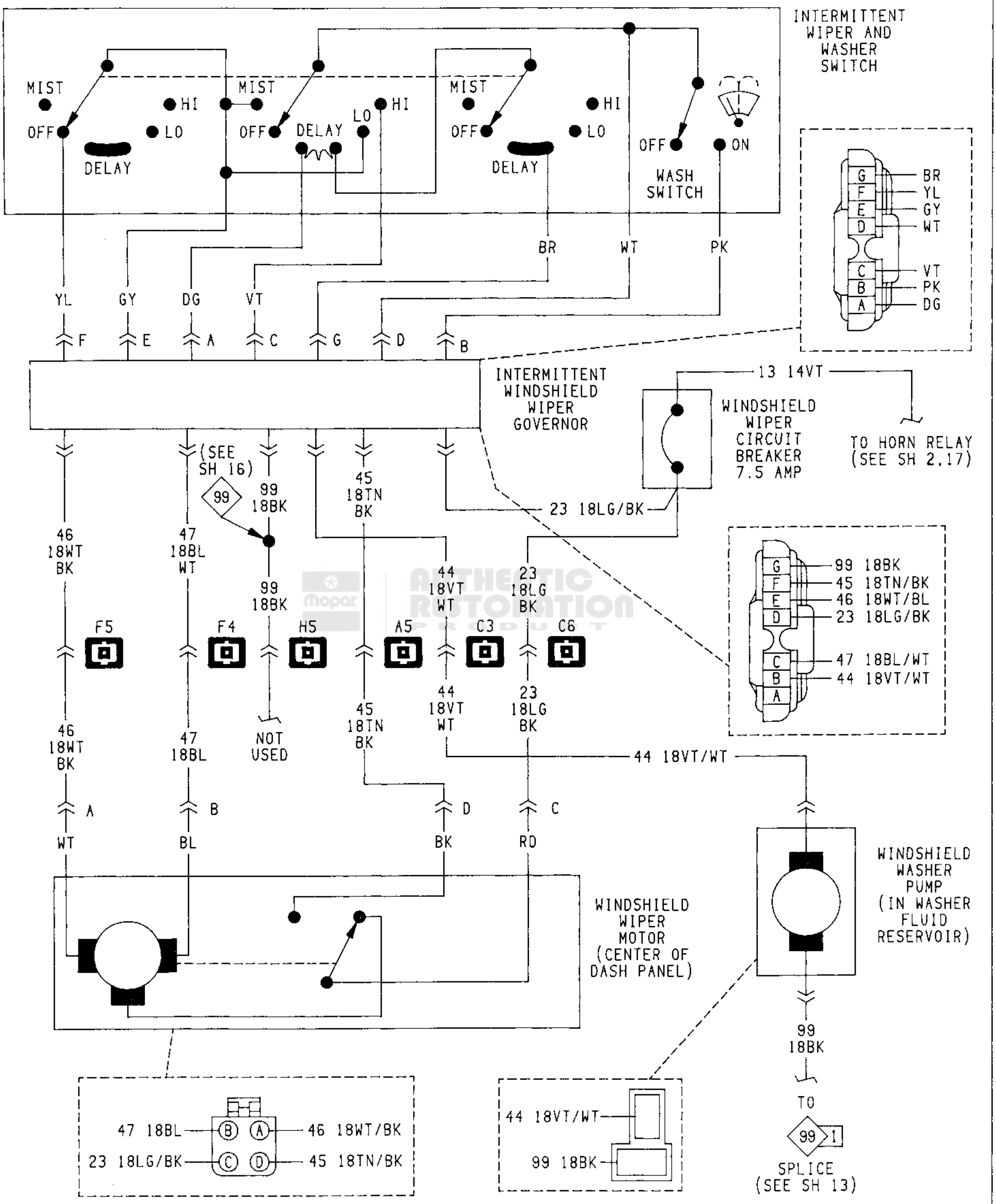


TURN SIGNAL AND HAZARD WARNING SYSTEM

J908W-4

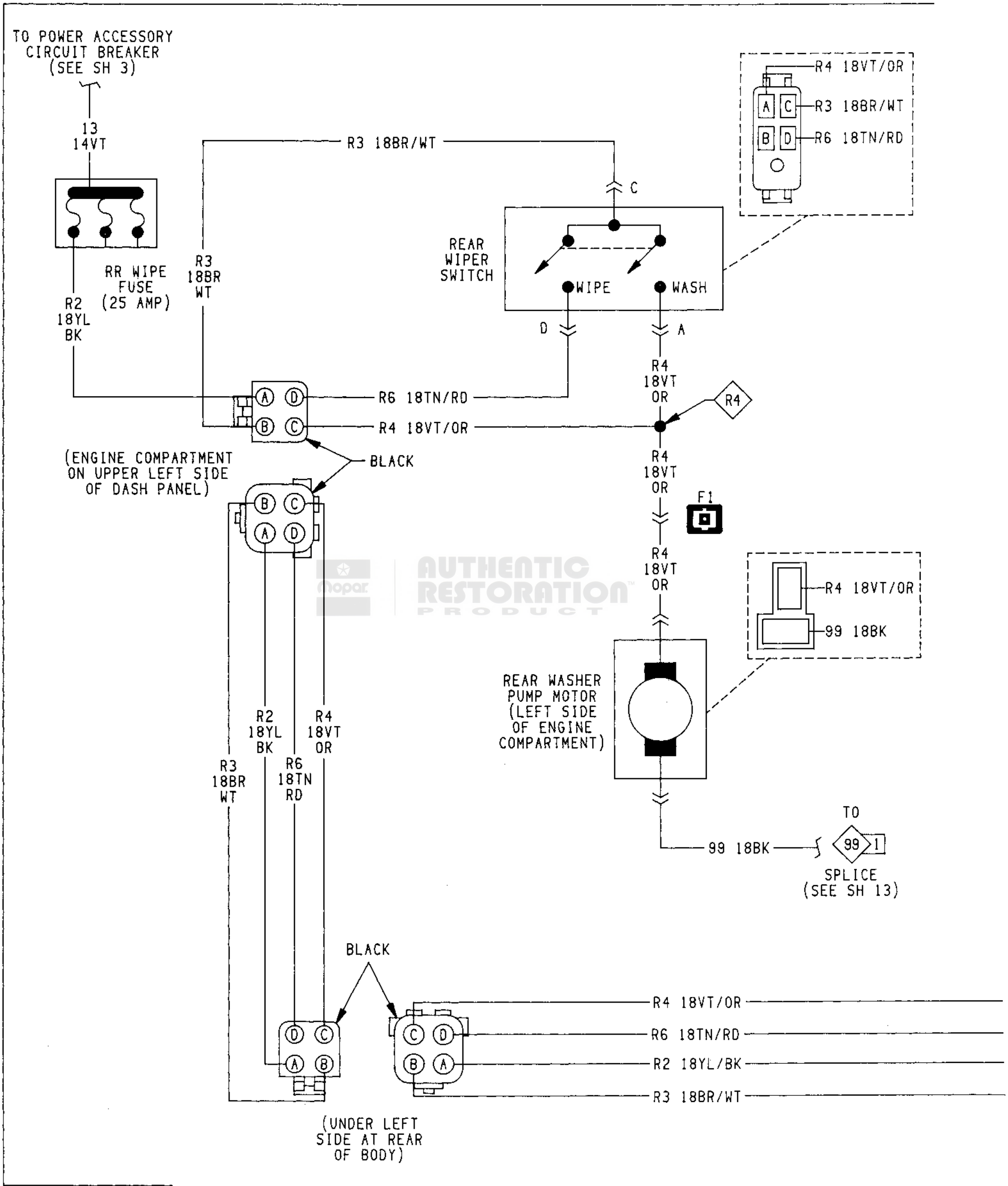


SJ 19 WINDSHIELD WIPER J908W-4



J908W-4 INTERMITTENT WINDSHIELD WIPER

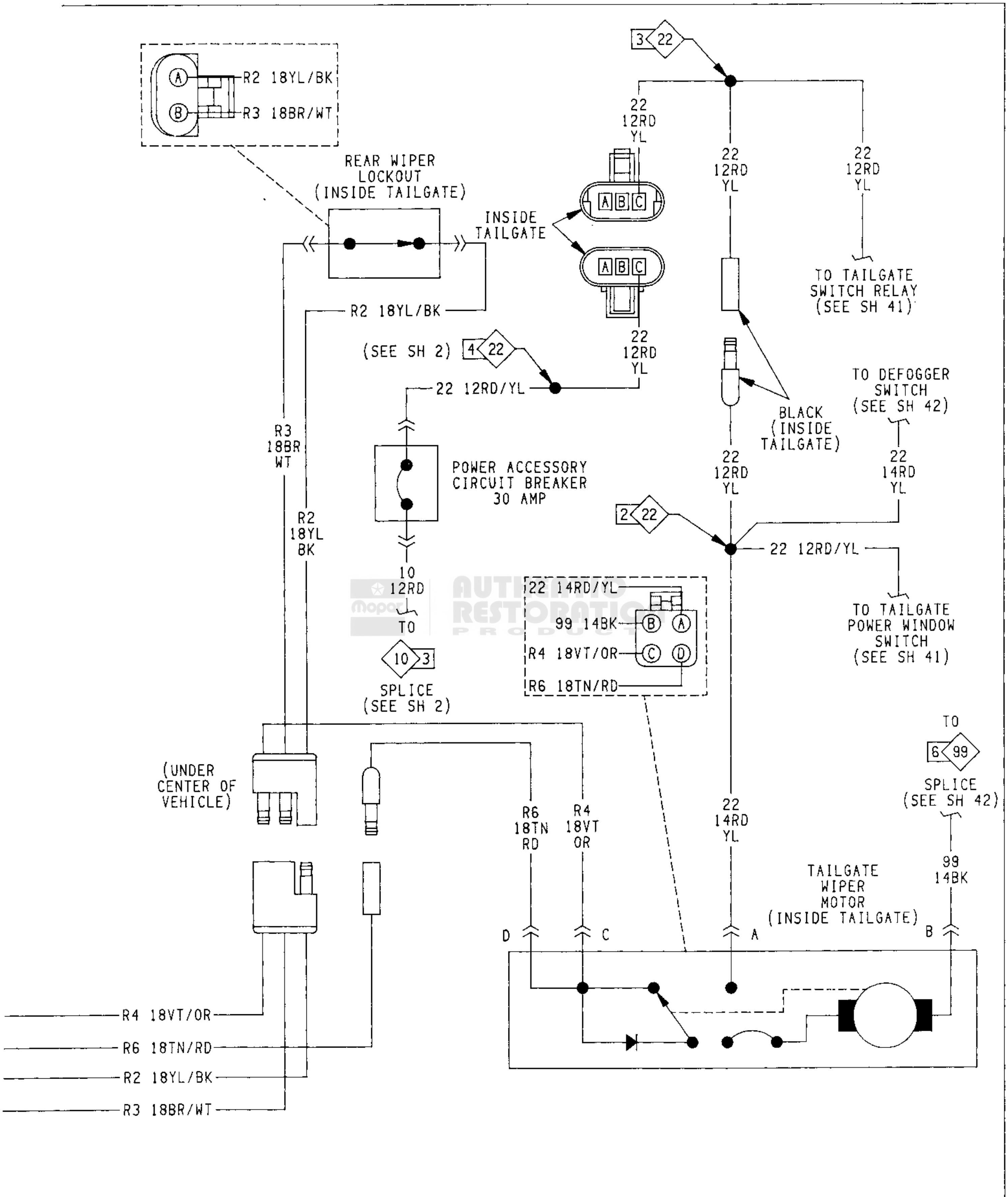
SJ 20



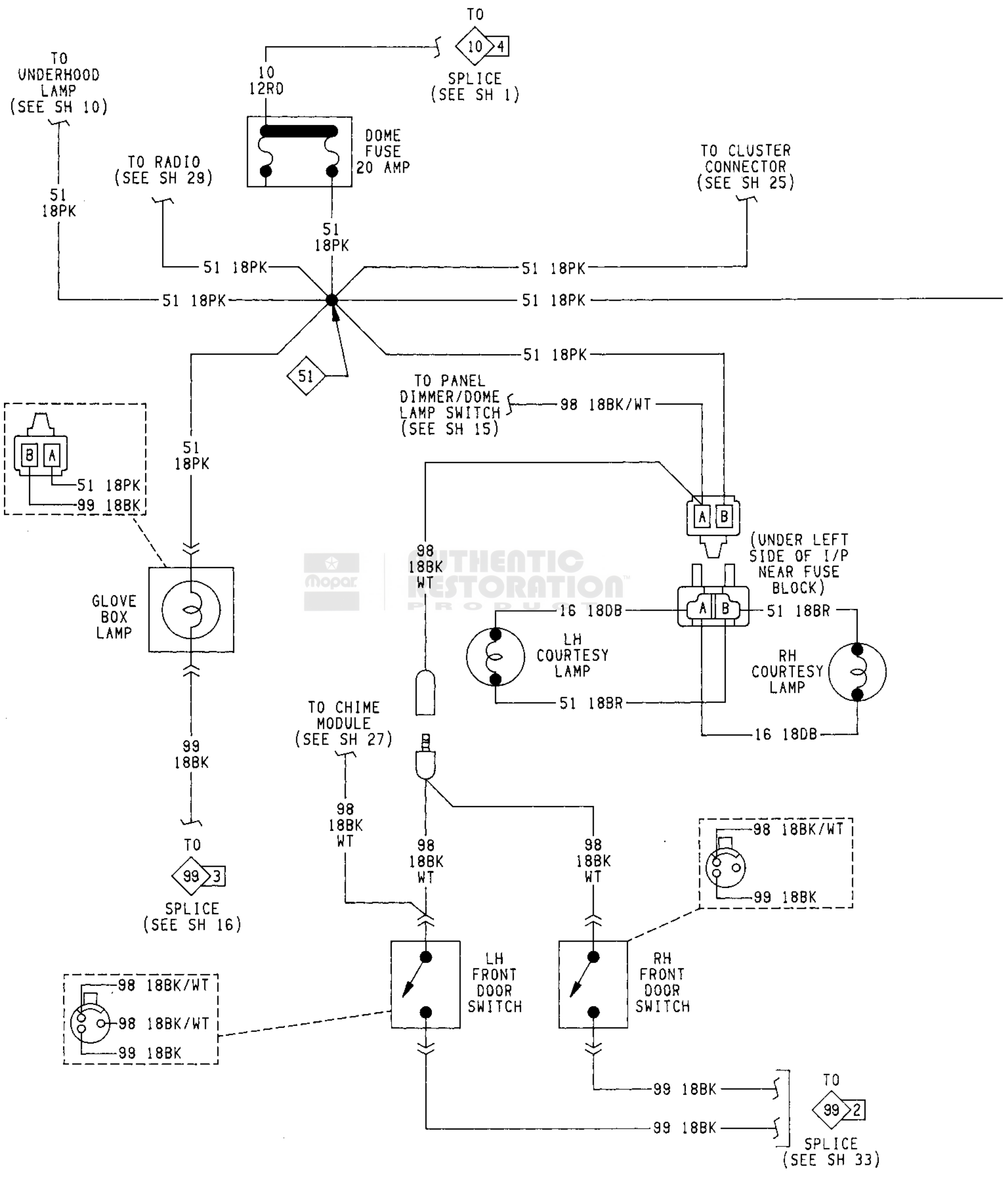
SJ 21

REAR WIPER

J908W-4


R2 18YL/BK
R3 18BR/WT
A
B
REAR WIPER LOCKOUT (INSIDE TAILGATE)
INSIDE TAILGATE
3 22
22 12RD YL
22 12RD YL
22 12RD YL
A B C
A B C
TO TAILGATE SWITCH RELAY (SEE SH 41)
R2 18YL/BK
(SEE SH 2)
4 22
22 12RD YL
22 12RD/YL
BLACK (INSIDE TAILGATE)
TO DEFOGGER SWITCH (SEE SH 42)
R3 18BR WT
POWER ACCESSORY CIRCUIT BREAKER 30 AMP
22 12RD YL
22 14RD YL
2 22
22 12RD/YL
R2 18YL BK
10 12RD
TO
10 3
SPLICE (SEE SH 2)
22 14RD/YL
99 14BK
R4 18VT/OR
R6 18TN/RD
B
A
C
D
TO TAILGATE POWER WINDOW SWITCH (SEE SH 41)
TO
6 99
SPLICE (SEE SH 42)
(UNDER CENTER OF VEHICLE)
R6 18TN RD
R4 18VT OR
22 14RD YL
TAILGATE WIPER MOTOR (INSIDE TAILGATE)
99 14BK
D
C
A
B
R4 18VT/OR
R6 18TN/RD
R2 18YL/BK
R3 18BR/WT

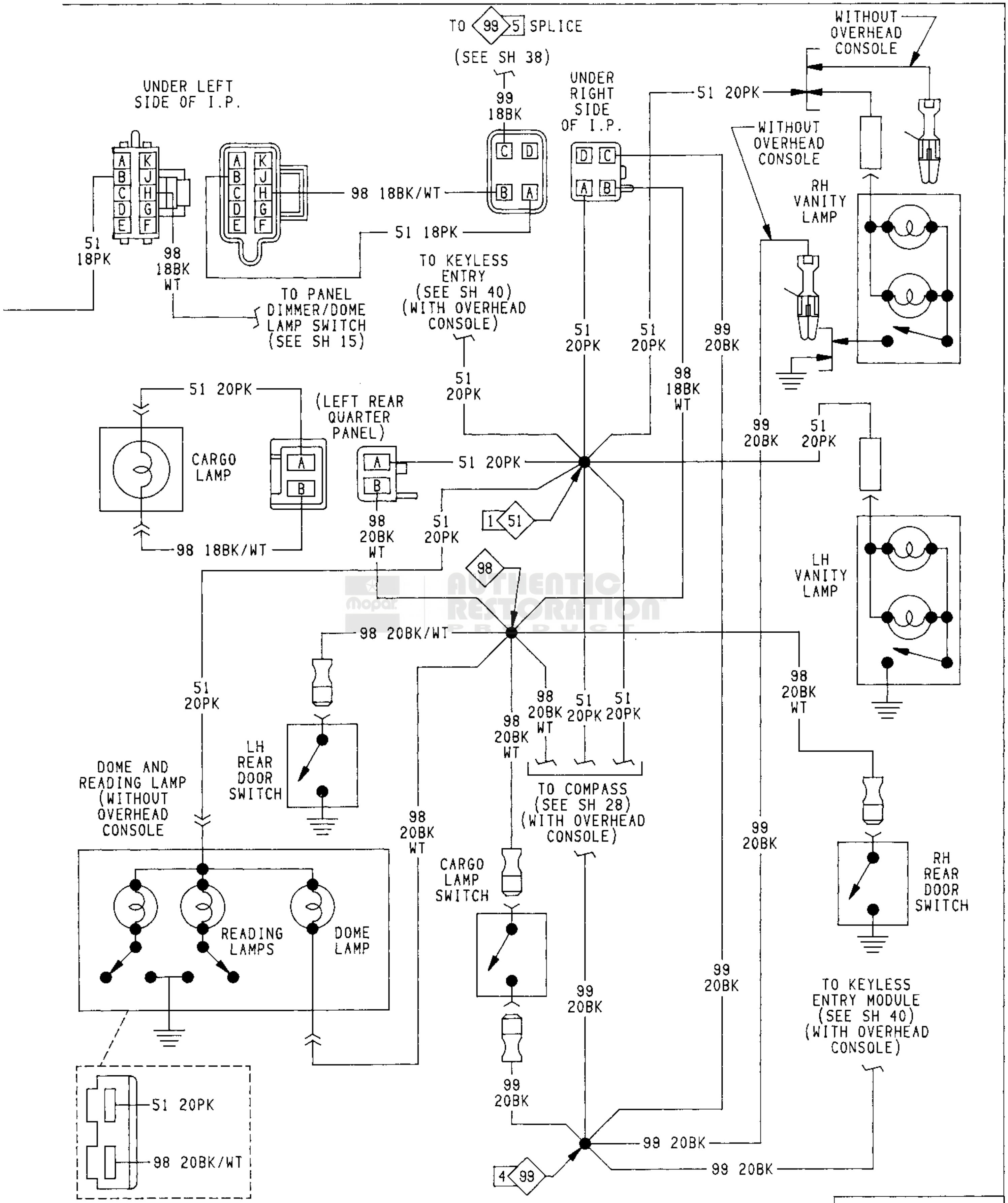
REAR WIPER



SJ 23

COURTESY LAMPS

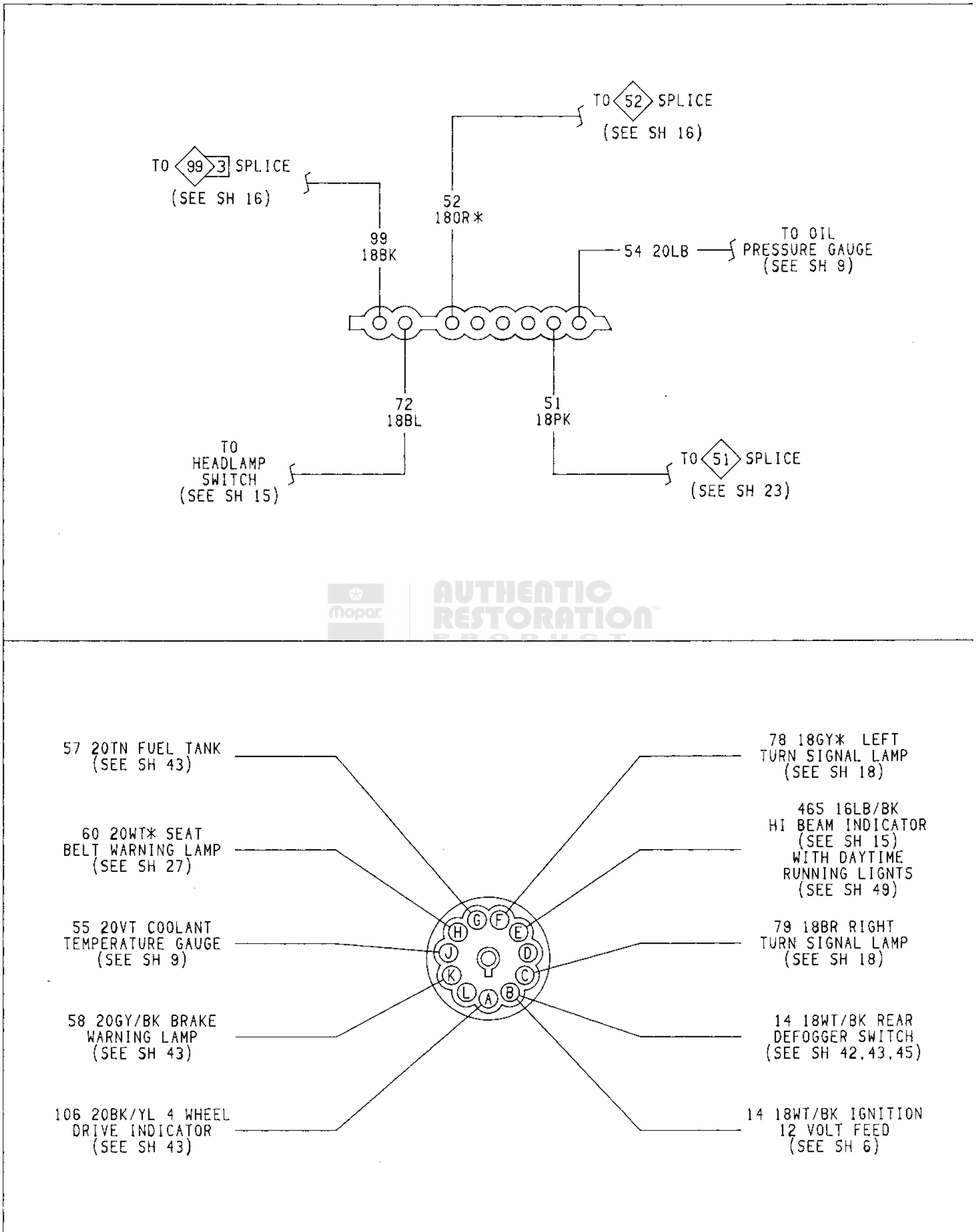
J908W-4



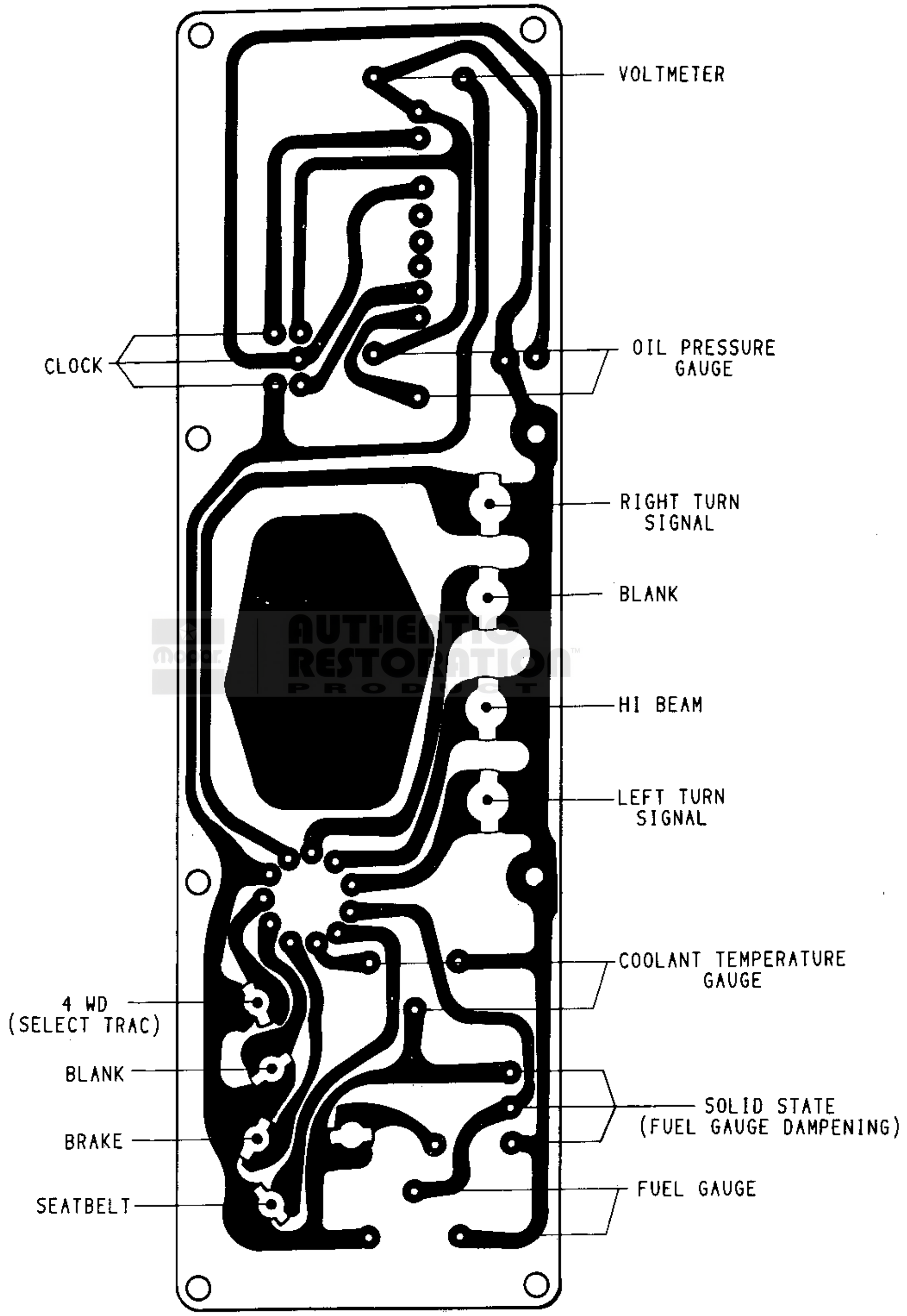
J908W-4

DOME, CARGO AND VANITY LAMPS

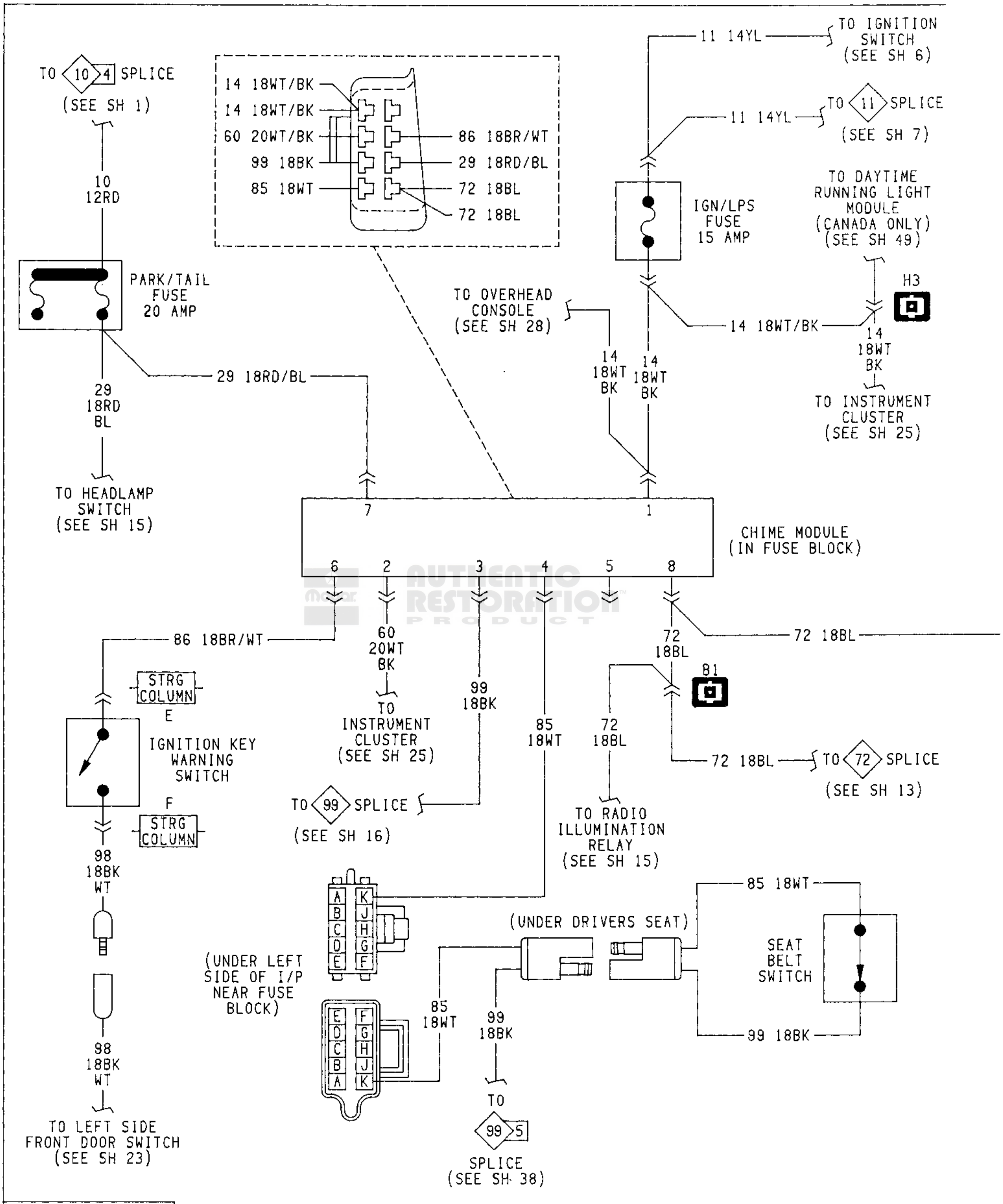
SJ 24



SJ 25 INSTRUMENT CLUSTER CONNECTORS J908W-4



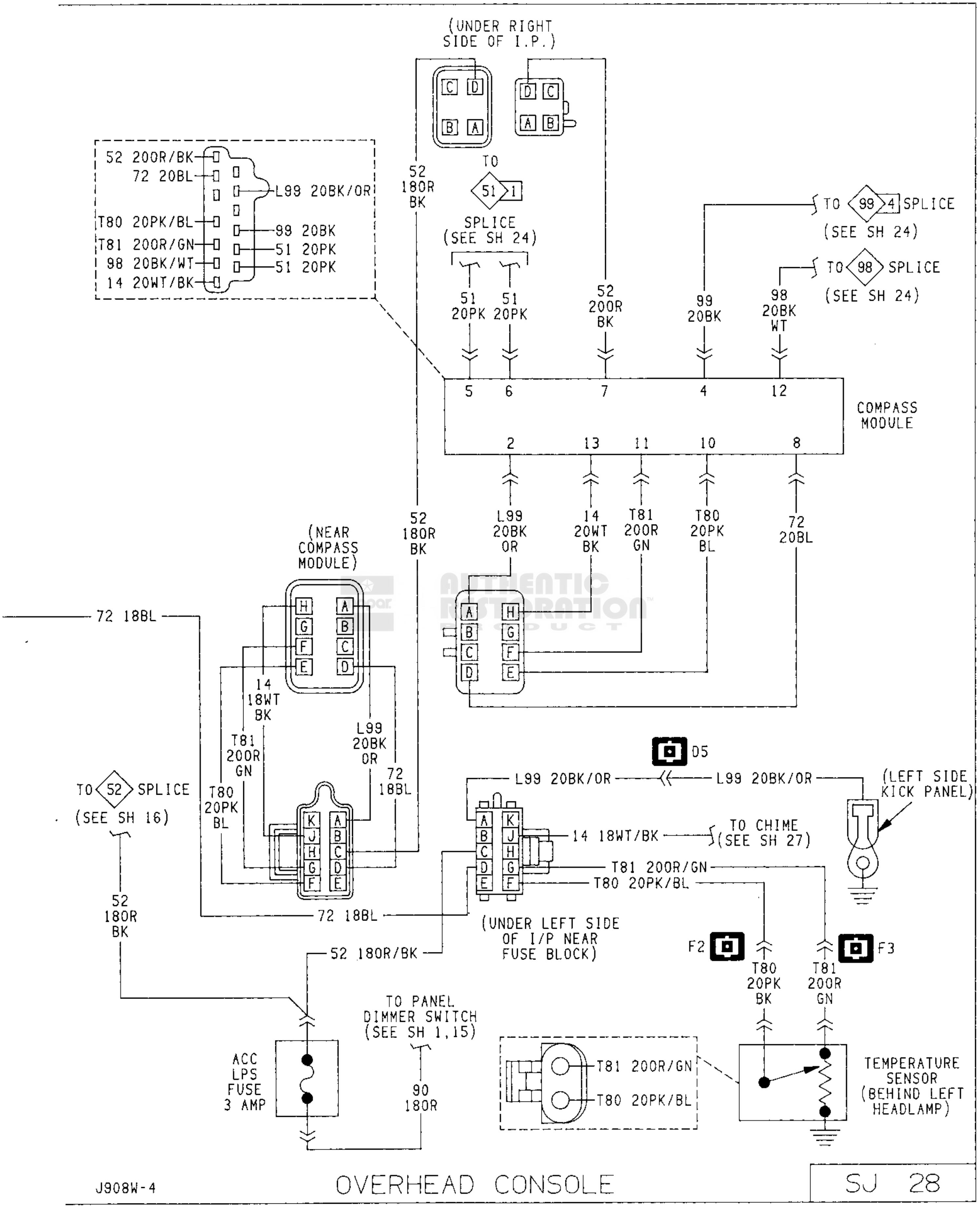
J908W-4 INSTRUMENT CLUSTER PRINTED CIRCUIT



SJ 27

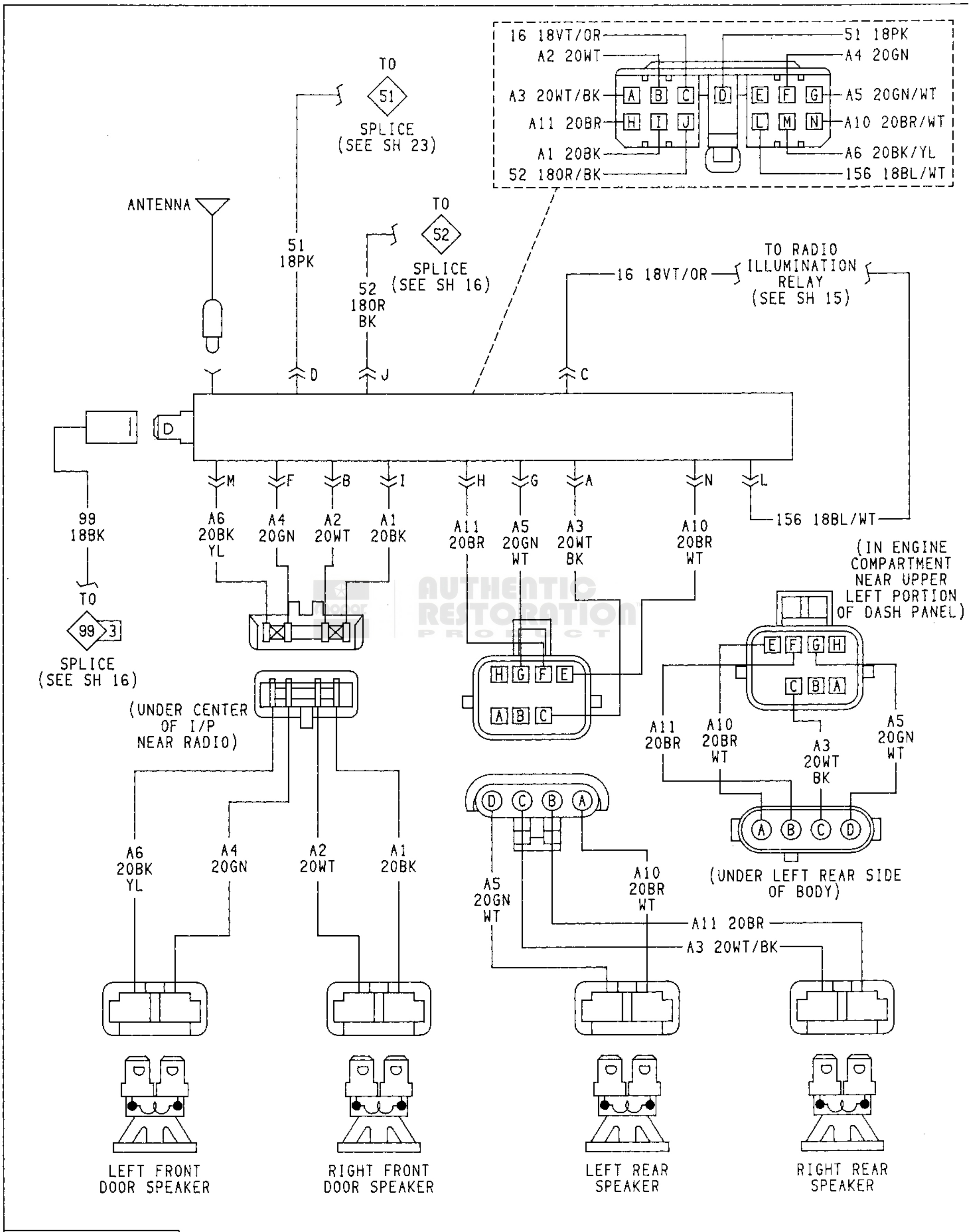
CHIME MODULE

J908W-4



J908W-4

OVERHEAD CONSOLE

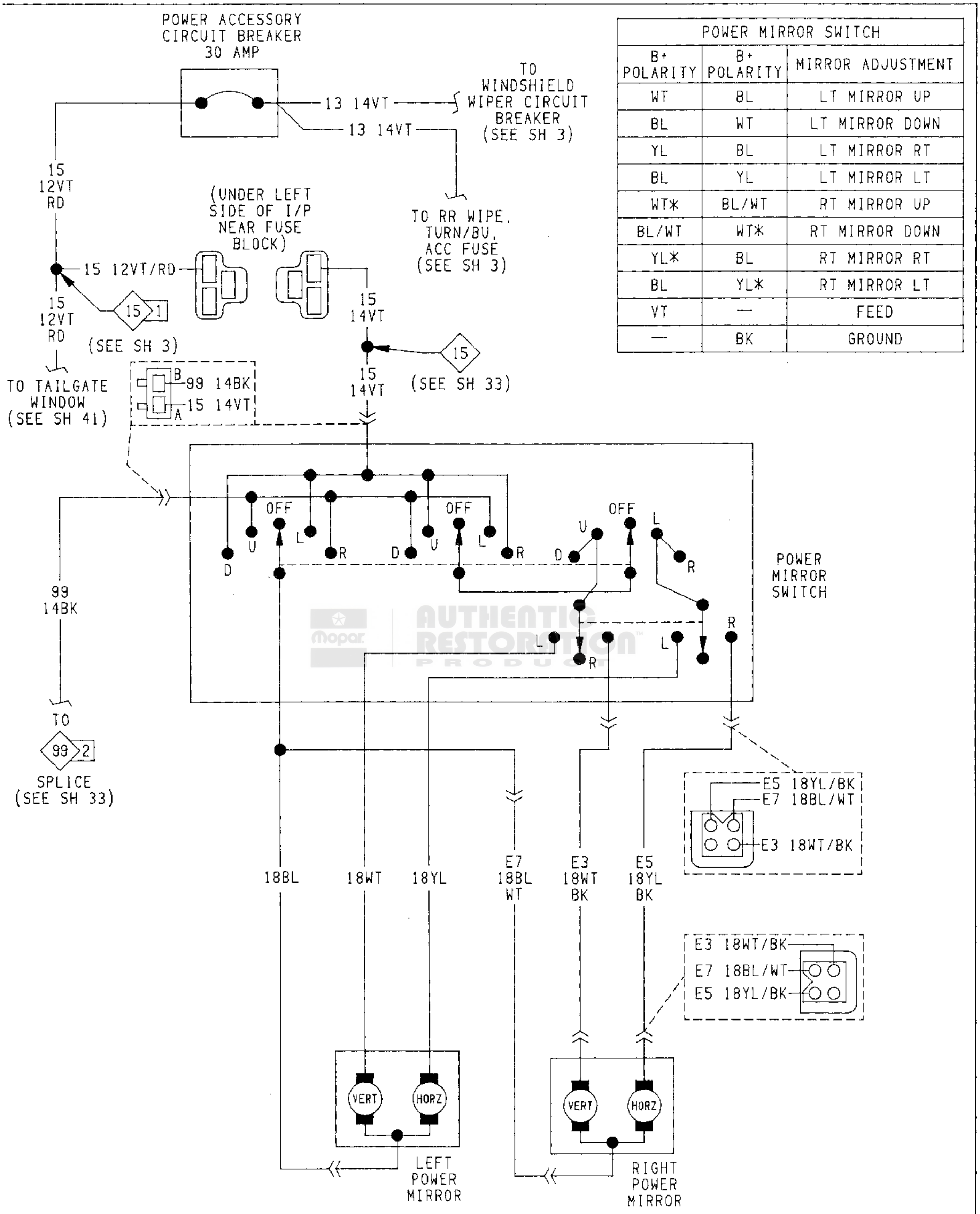


SJ 29

STEREO RADIO

J908W-4

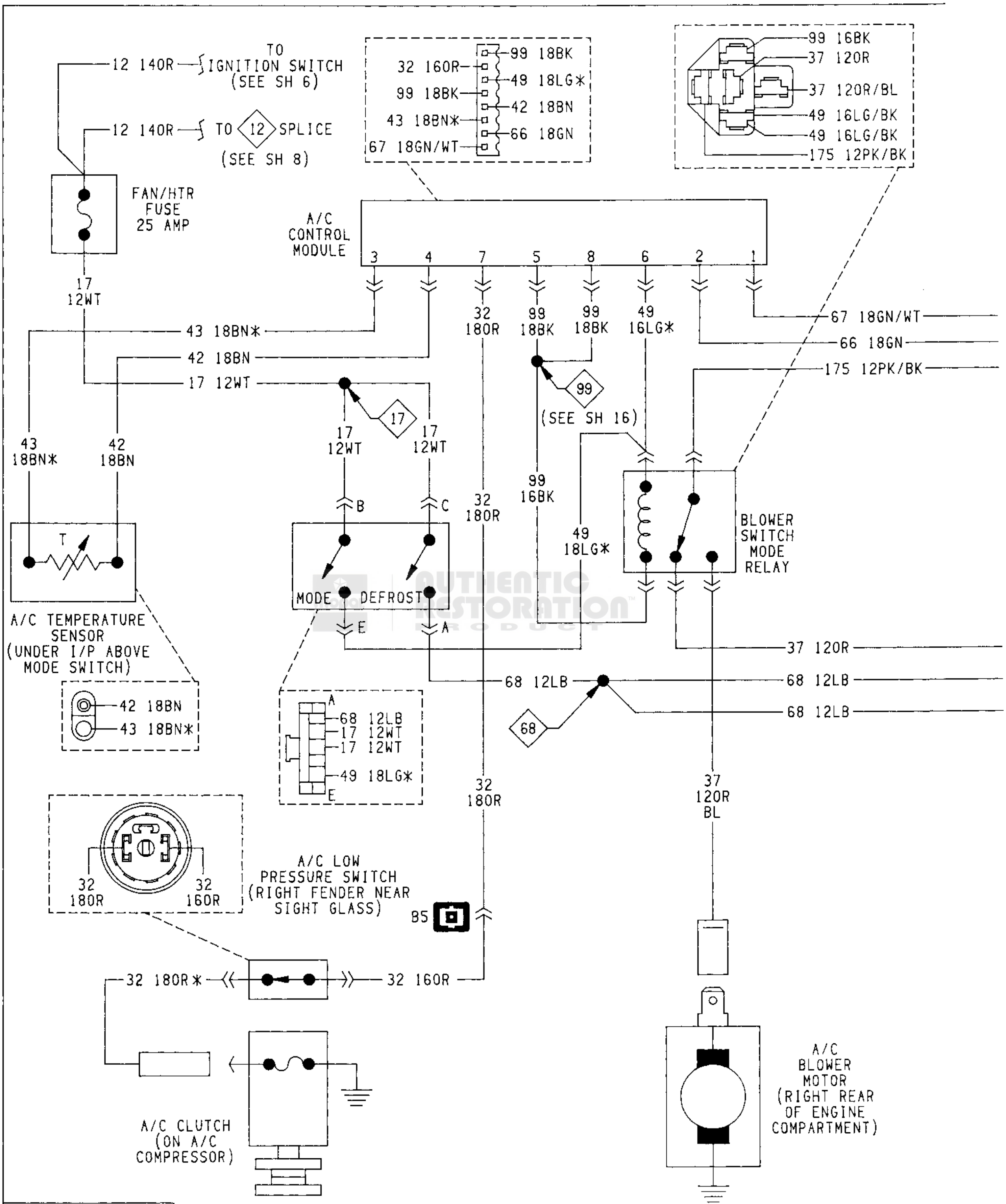
POWER MIRROR SWITCH		
B+ POLARITY	B+ POLARITY	MIRROR ADJUSTMENT
WT	BL	LT MIRROR UP
BL	WT	LT MIRROR DOWN
YL	BL	LT MIRROR RT
BL	YL	LT MIRROR LT
WT*	BL/WT	RT MIRROR UP
BL/WT	WT*	RT MIRROR DOWN
YL*	BL	RT MIRROR RT
BL	YL*	RT MIRROR LT
VT	—	FEED
—	BK	GROUND



J908W-4

POWER MIRRORS

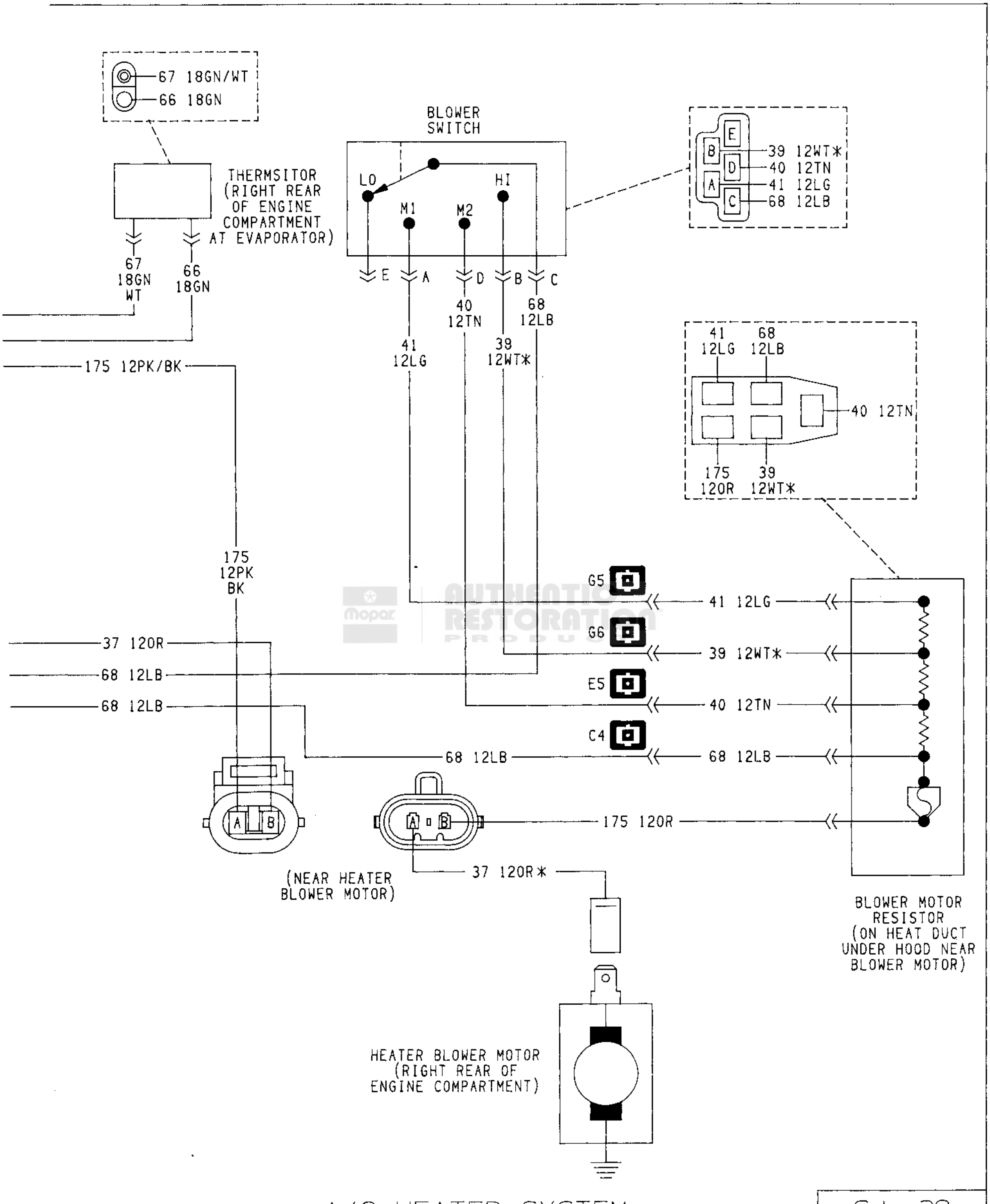
SJ 30



SJ 31

A/C HEATER SYSTEM

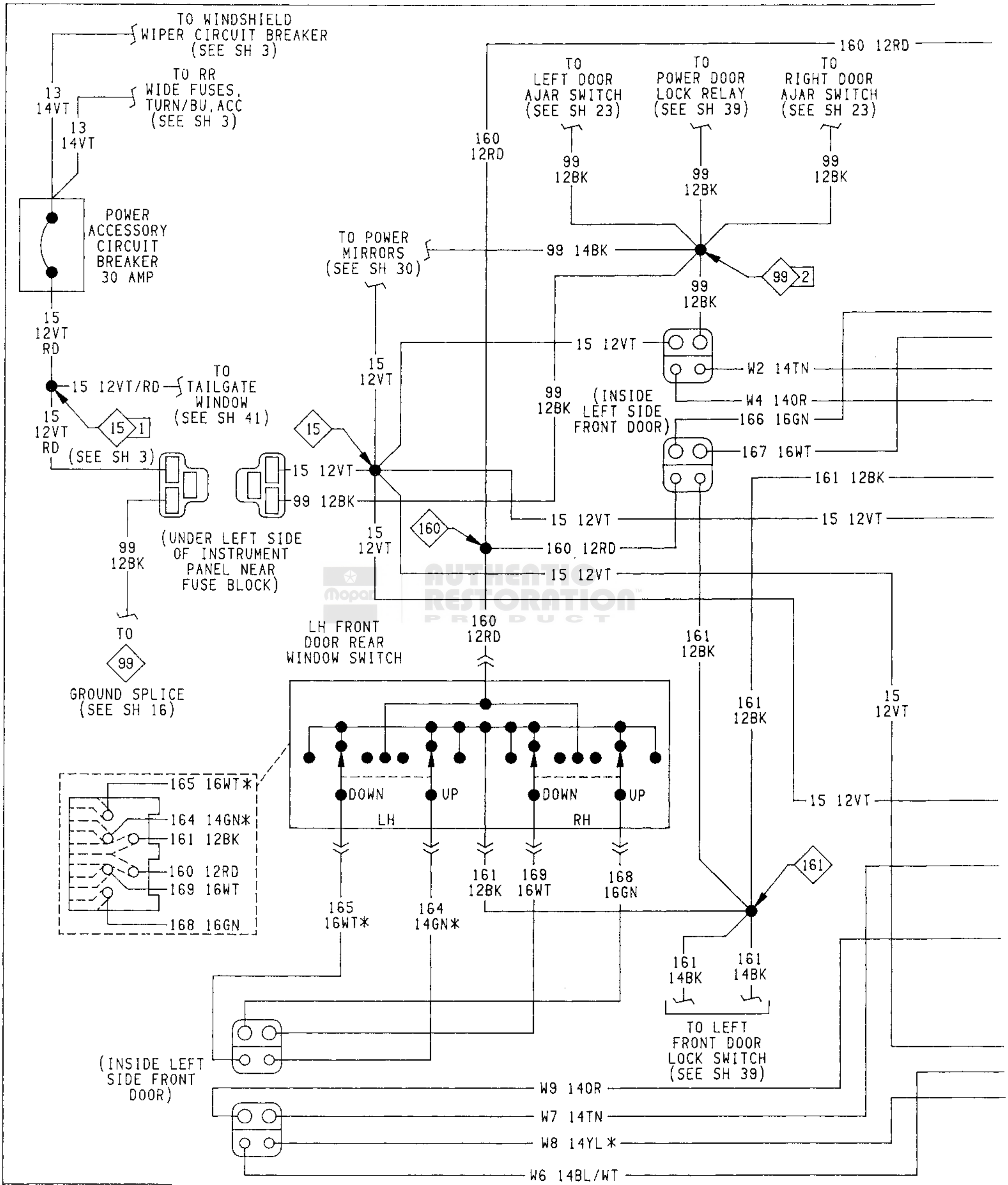
J908W-4



J908W-4

A/C HEATER SYSTEM

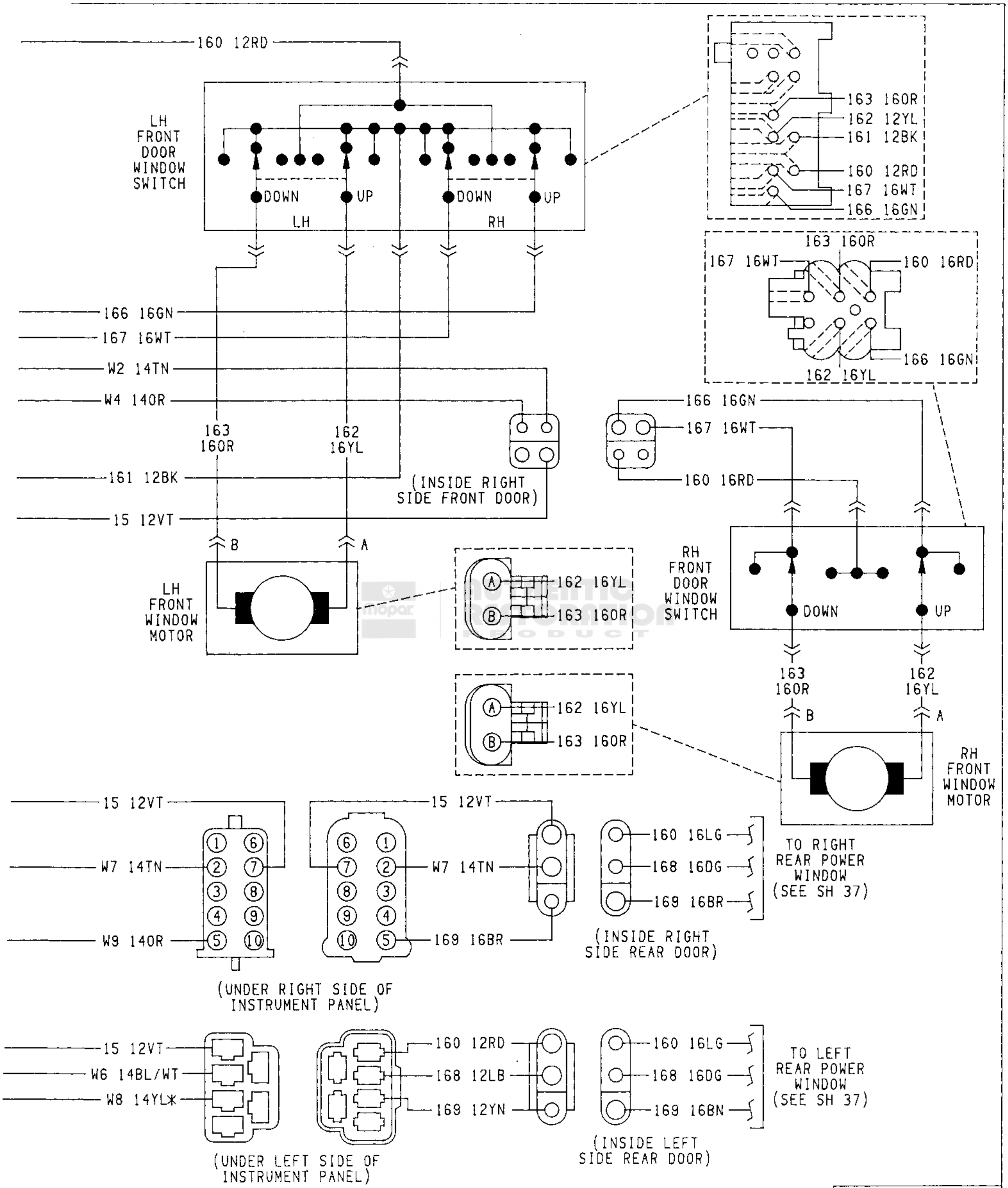
SJ 32



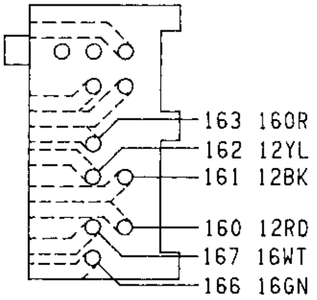
SJ 33

POWER WINDOWS

J908W-4

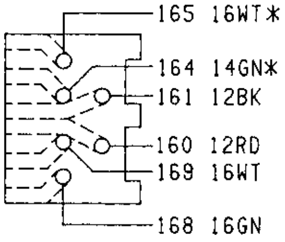

160 12RD
LH FRONT DOOR WINDOW SWITCH
DOWN
UP
DOWN
UP
LH
RH
163 16OR
162 12YL
161 12BK
160 12RD
167 16WT
166 16GN
163 16OR
167 16WT
160 16RD
166 16GN
162 16YL
166 16GN
167 16WT
W2 14TN
W4 14OR
163 16OR
162 16YL
161 12BK
15 12VT
(INSIDE RIGHT SIDE FRONT DOOR)
166 16GN
167 16WT
160 16RD
B
A
LH FRONT WINDOW MOTOR
A 162 16YL
B 163 16OR
RH FRONT DOOR WINDOW SWITCH
DOWN
UP
163 16OR
162 16YL
B
A
A 162 16YL
B 163 16OR
RH FRONT WINDOW MOTOR
15 12VT
W7 14TN
W9 14OR
1 2 3 4 5 6 7 8 9 10
15 12VT
W7 14TN
169 16BR
(UNDER RIGHT SIDE OF INSTRUMENT PANEL)
160 16LG
168 16DG
169 16BR
TO RIGHT REAR POWER WINDOW (SEE SH 37)
(INSIDE RIGHT SIDE REAR DOOR)
15 12VT
W6 14BL/WT
W8 14YL*
160 12RD
168 12LB
169 12YN
160 16LG
168 16DG
169 16BN
TO LEFT REAR POWER WINDOW (SEE SH 37)
(UNDER LEFT SIDE OF INSTRUMENT PANEL)
(INSIDE LEFT SIDE REAR DOOR)

LEFT FRONT DOOR CONNECTOR AND WINDOW LIFT SWITCH FUNCTION



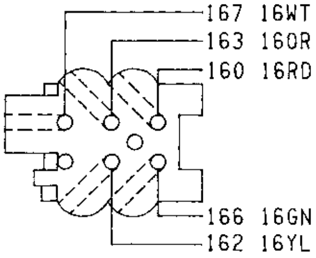
B+ POLARITY	B- POLARITY	WINDOW MOVEMENT
YL	OR	LT FRONT UP
OR	YL	LT FRONT DOWN
GN	WT	RT FRONT UP
WT	GN	RT FRONT DOWN
RD	BK	FEED AND GROUND

LEFT FRONT DOOR REAR WINDOW CONNECTOR AND WINDOW LIFT SWITCH FUNCTION



B+ POLARITY	B- POLARITY	WINDOW MOVEMENT
GN*	WT*	LT REAR UP
WT*	GN*	LT REAR DOWN
GN	WT	RT REAR UP
WT	GN	RT REAR DOWN
RD	BK	FEED AND GROUND

RIGHT FRONT DOOR WINDOW SWITCH CONNECTOR AND WINDOW LIFT SWITCH FUNCTION



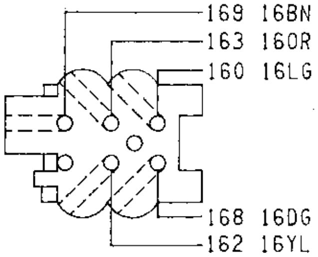
B+ POLARITY	B- POLARITY	WINDOW MOVEMENT
YL	OR	RT FRONT UP (DOOR SWITCH)
OR	YL	RT FRONT DOWN (DOOR SWITCH)
GN	WT	RT FRONT UP (MASTER SWITCH)
WT	GN	RT FRONT DOWN (MASTER SWITCH)
RD	—	FEED

SJ 35

J908W-4

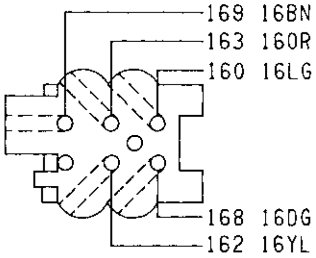
LEFT REAR DOOR WINDOW CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

B+ POLARITY	B- POLARITY	WINDOW MOVEMENT
YL	OR	LT REAR UP (DOOR SWITCH)
OR	YL	LT FRONT DOWN (DOOR SWITCH)
DG	BN	LT REAR UP (MASTER SWITCH)
BN	DG	LT REAR DOWN (MASTER SWITCH)
LG	—	FEED



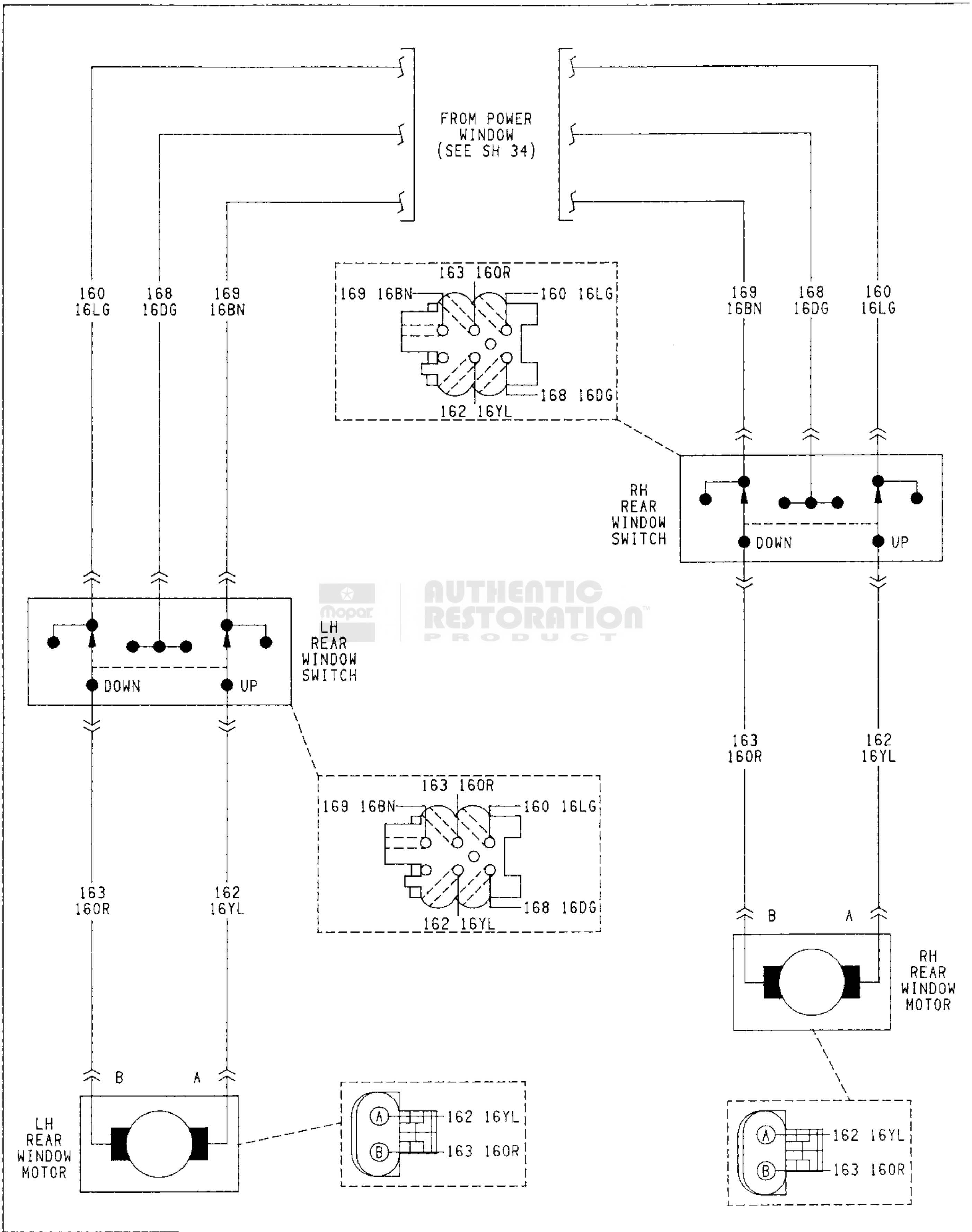
RIGHT REAR DOOR WINDOW CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

B+ POLARITY	B- POLARITY	WINDOW MOVEMENT
YL	OR	RT REAR UP (DOOR SWITCH)
OR	YL	RT REAR DOWN (DOOR SWITCH)
DG	BN	RT REAR UP (MASTER SWITCH)
BN	DG	RT REAR DOWN (MASTER SWITCH)
LG	—	FEED



POWER SEAT MOTOR INSULATOR POLARITY

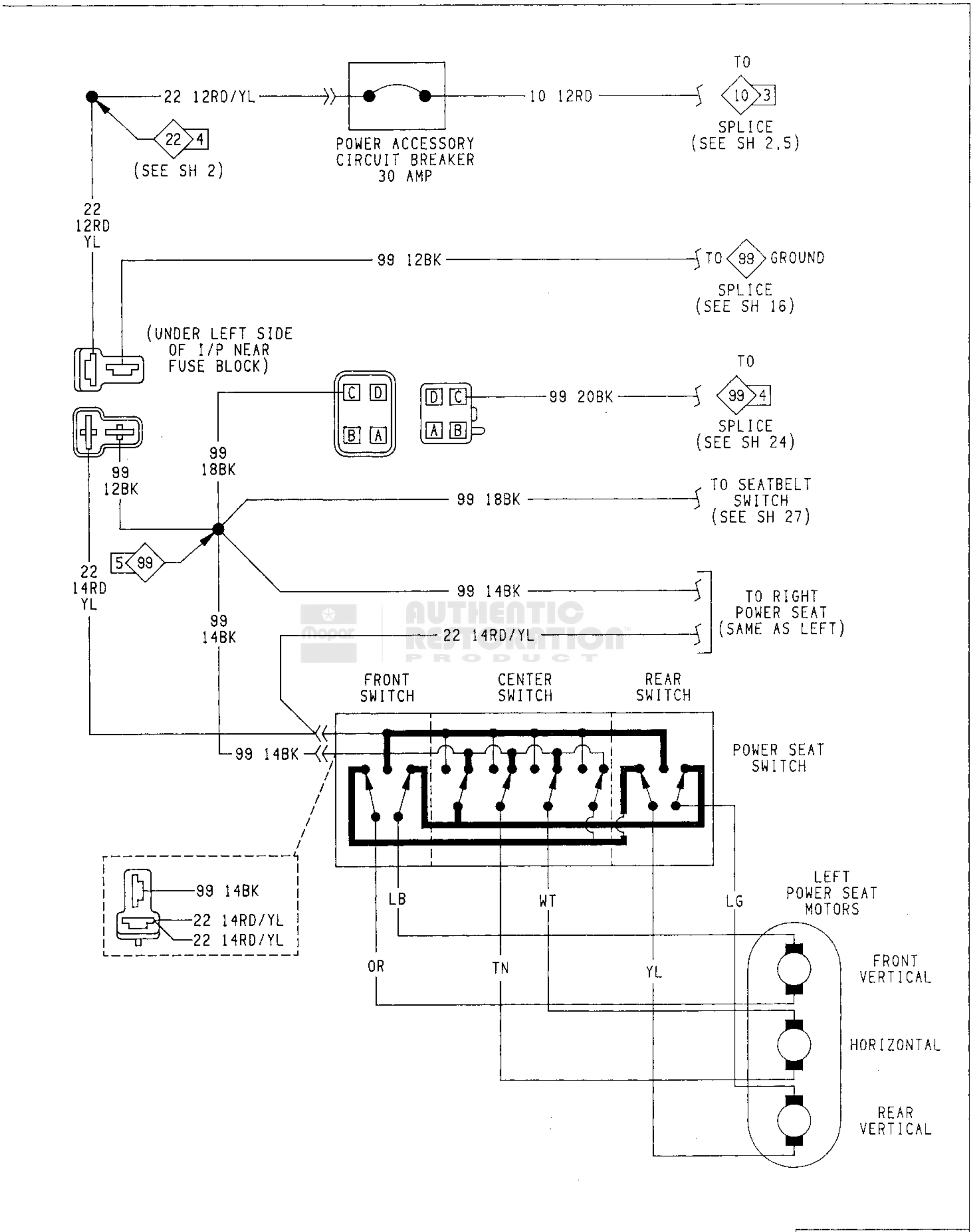
B+ POLARITY	B- POLARITY	SEAT MOVEMENT
WT	TN	FORWARD
TN	WT	REARWARD
YL	LG	REAR UP
LG	YL	REAR DOWN
OR	LB	FRONT UP
LB	OR	FRONT DOWN
RD/YL	—	FEED
—	BK	GROUND



SJ 37

POWER WINDOWS

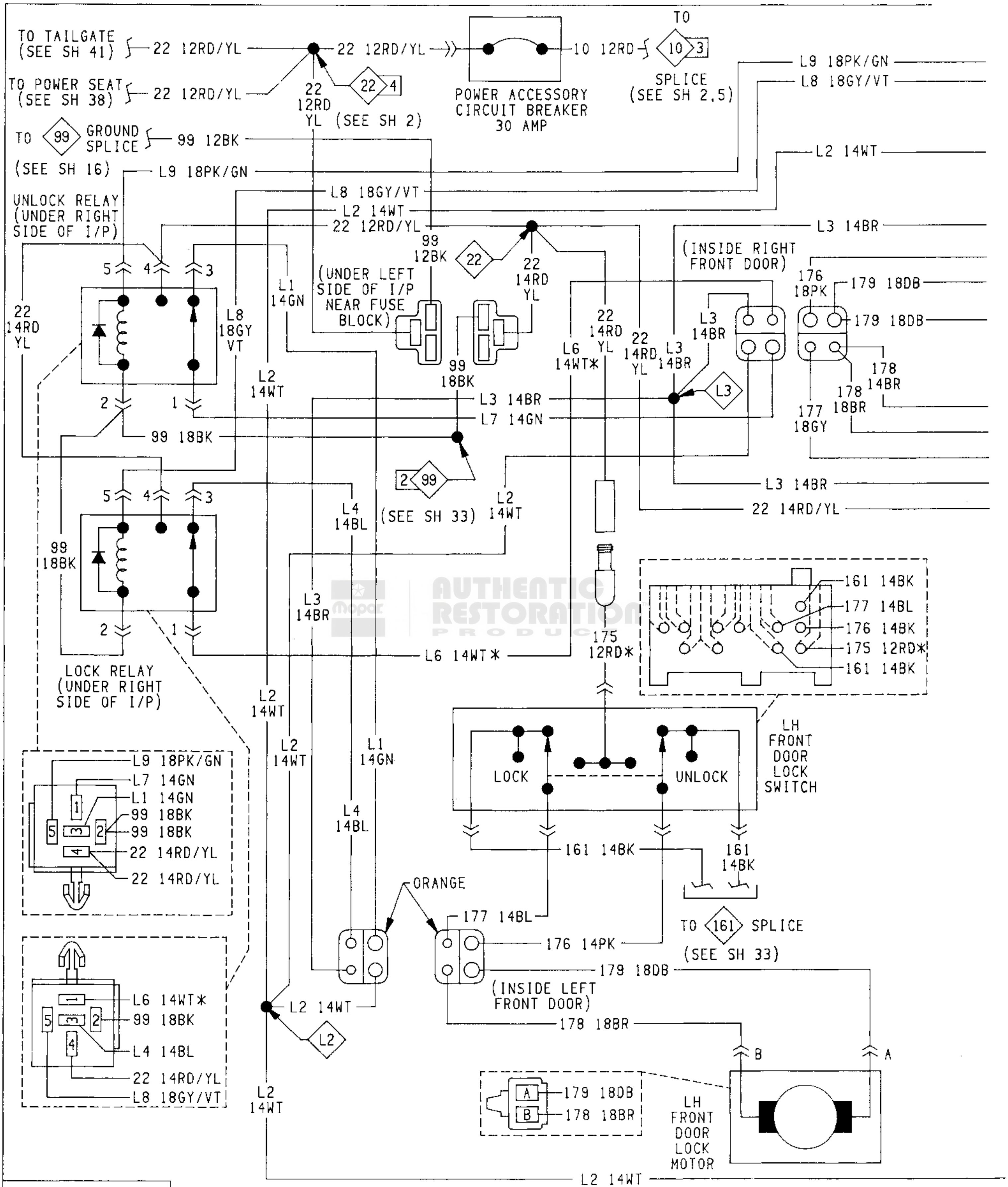
J908W-4



J908W-4

POWER SEAT

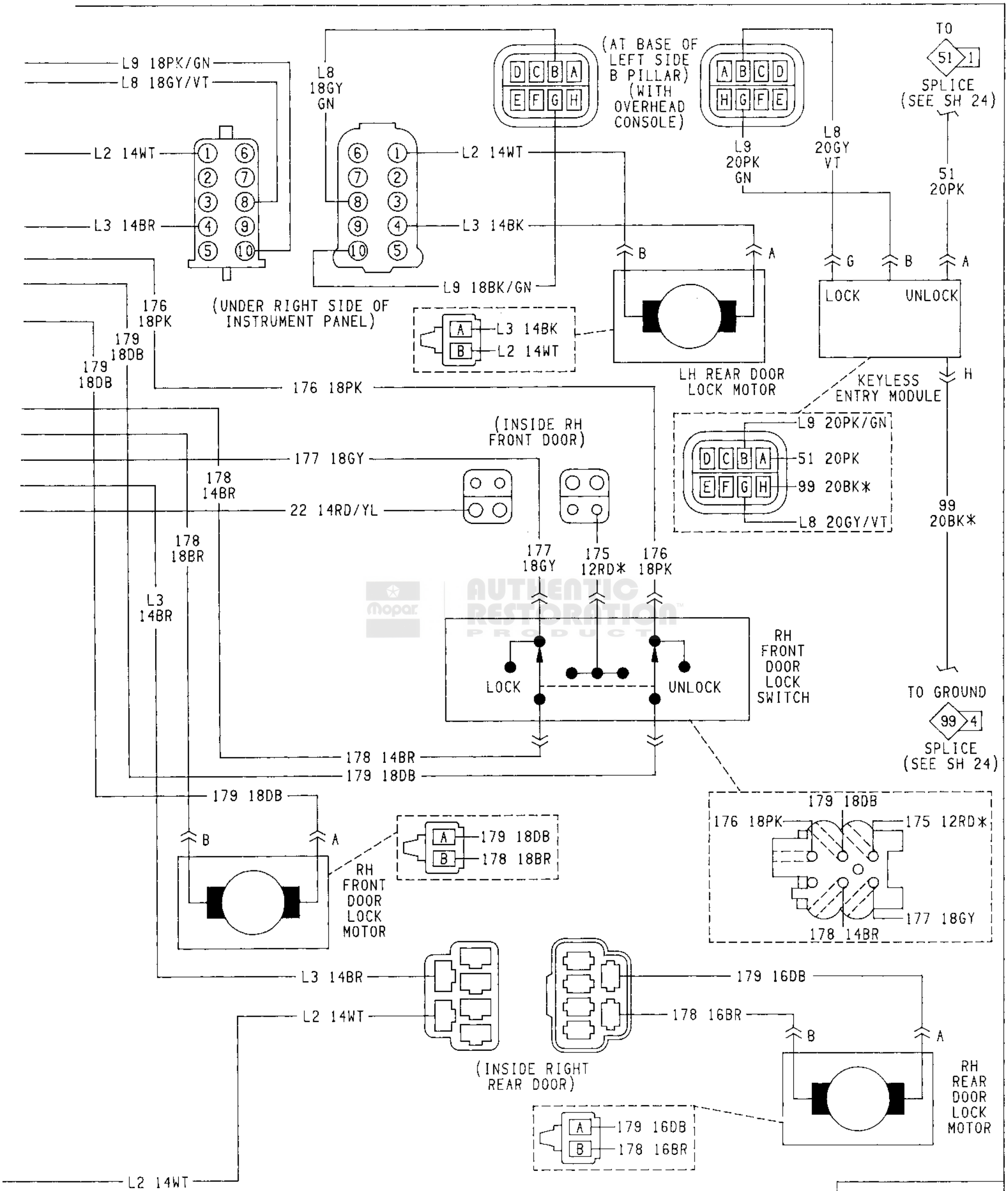
SJ 38



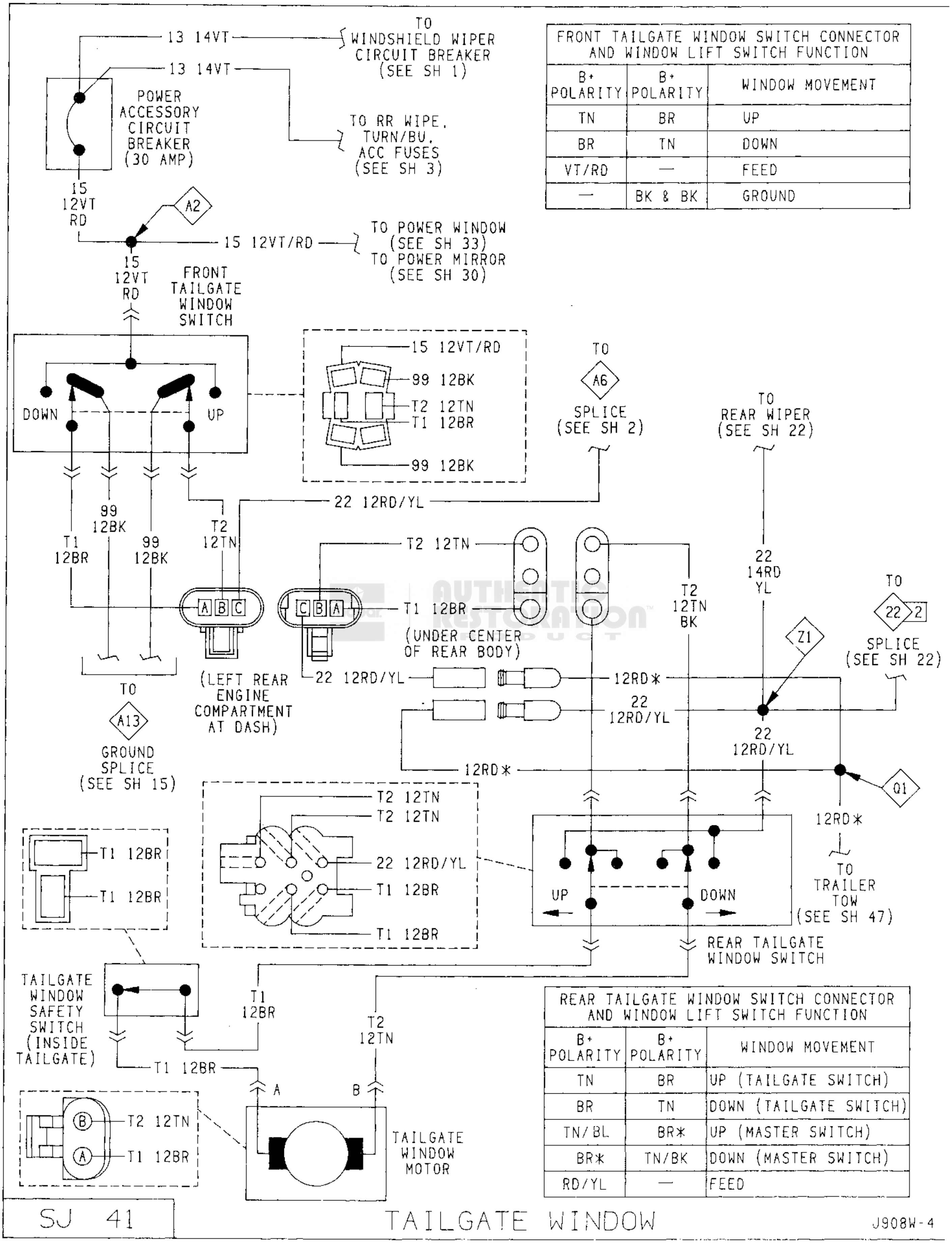
SJ 39

POWER DOOR LOCKS

J908W-4



J908W-4 POWER DOOR LOCKS/KEYLESS ENTRY SJ 40

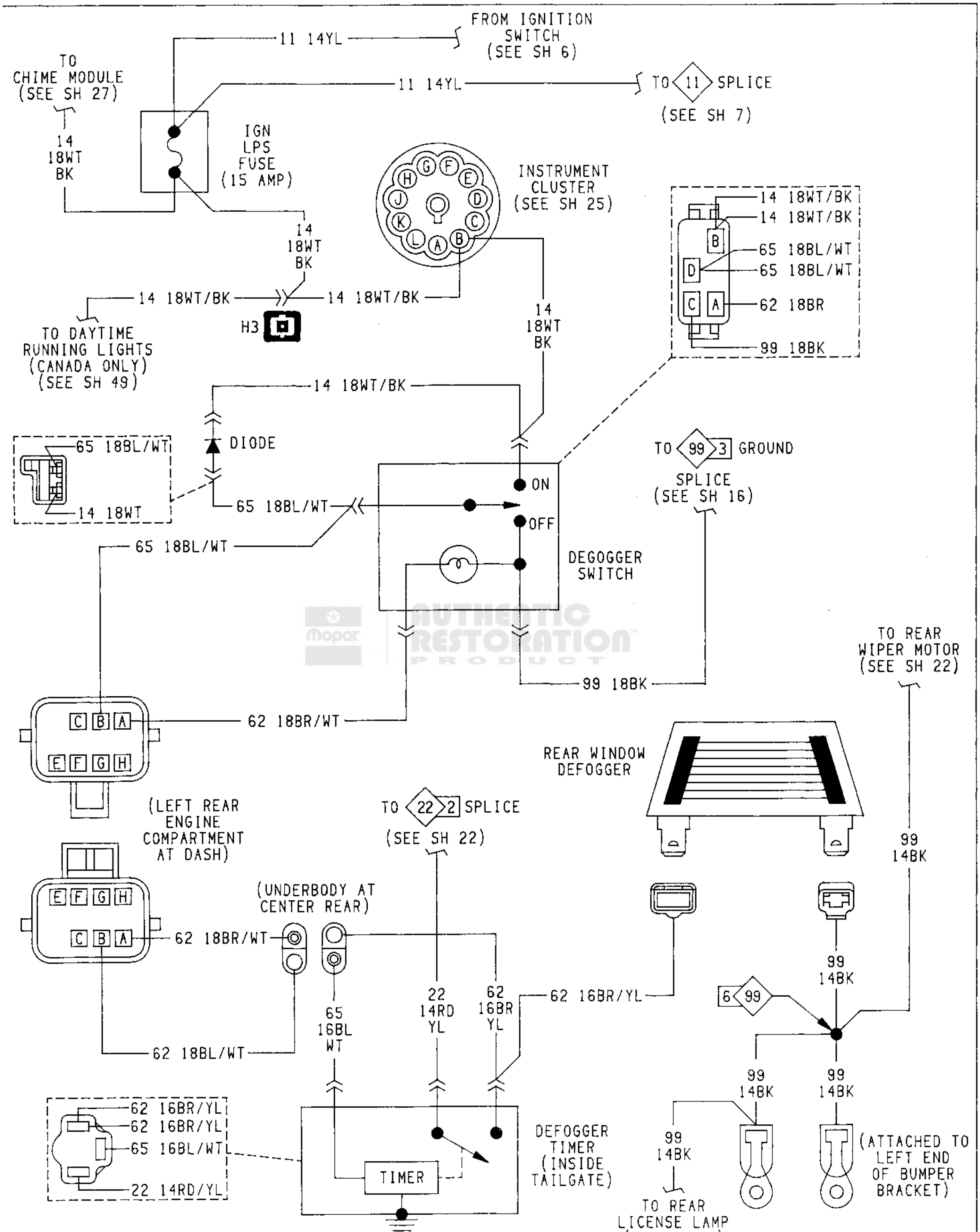


FRONT TAILGATE WINDOW SWITCH CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

B+ POLARITY	B+ POLARITY	WINDOW MOVEMENT
TN	BR	UP
BR	TN	DOWN
VT/RD	—	FEED
—	BK & BK	GROUND

REAR TAILGATE WINDOW SWITCH CONNECTOR AND WINDOW LIFT SWITCH FUNCTION

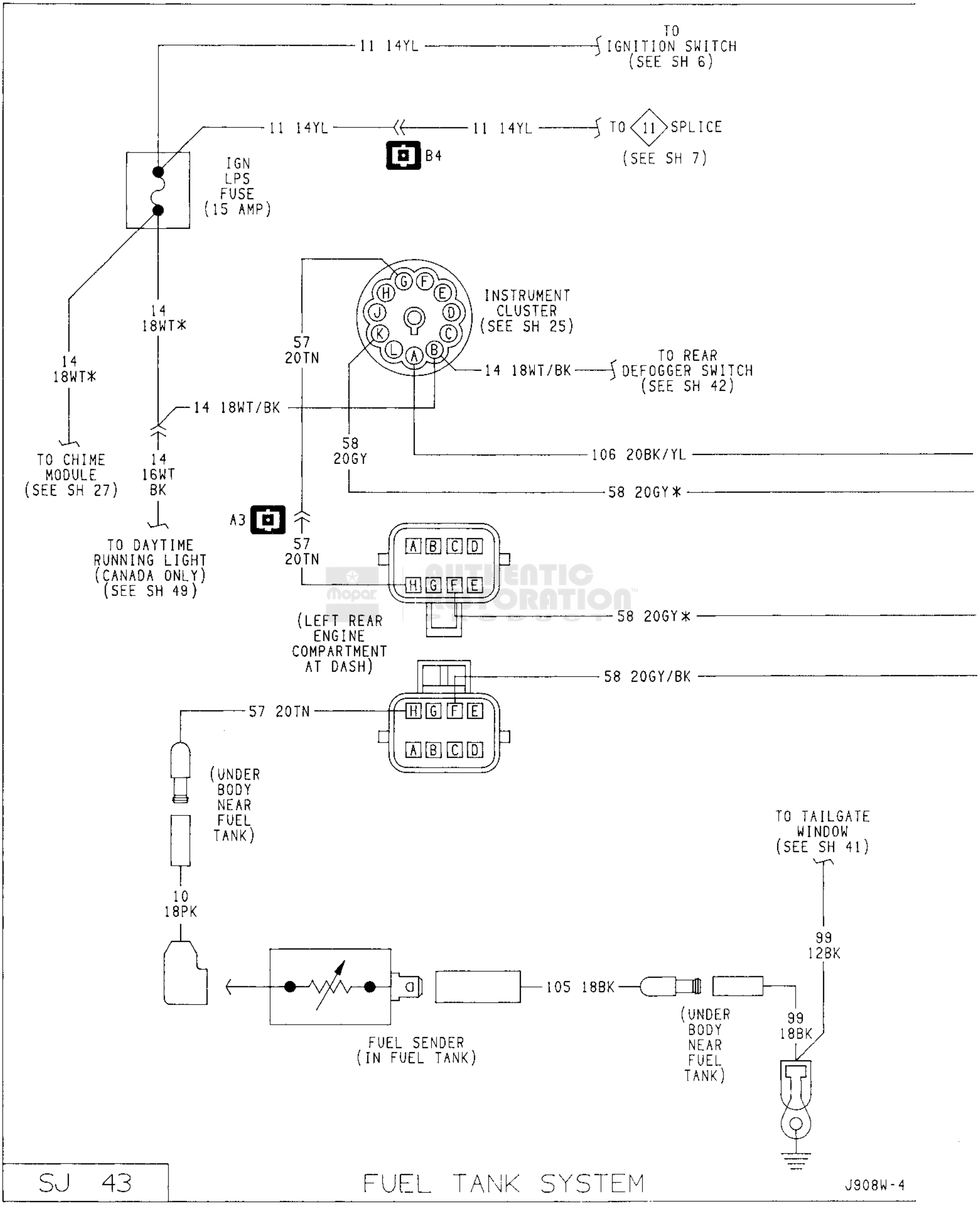
B+ POLARITY	B+ POLARITY	WINDOW MOVEMENT
TN	BR	UP (TAILGATE SWITCH)
BR	TN	DOWN (TAILGATE SWITCH)
TN/BL	BR*	UP (MASTER SWITCH)
BR*	TN/BK	DOWN (MASTER SWITCH)
RD/YL	—	FEED



J908W-4

DEFOGGER

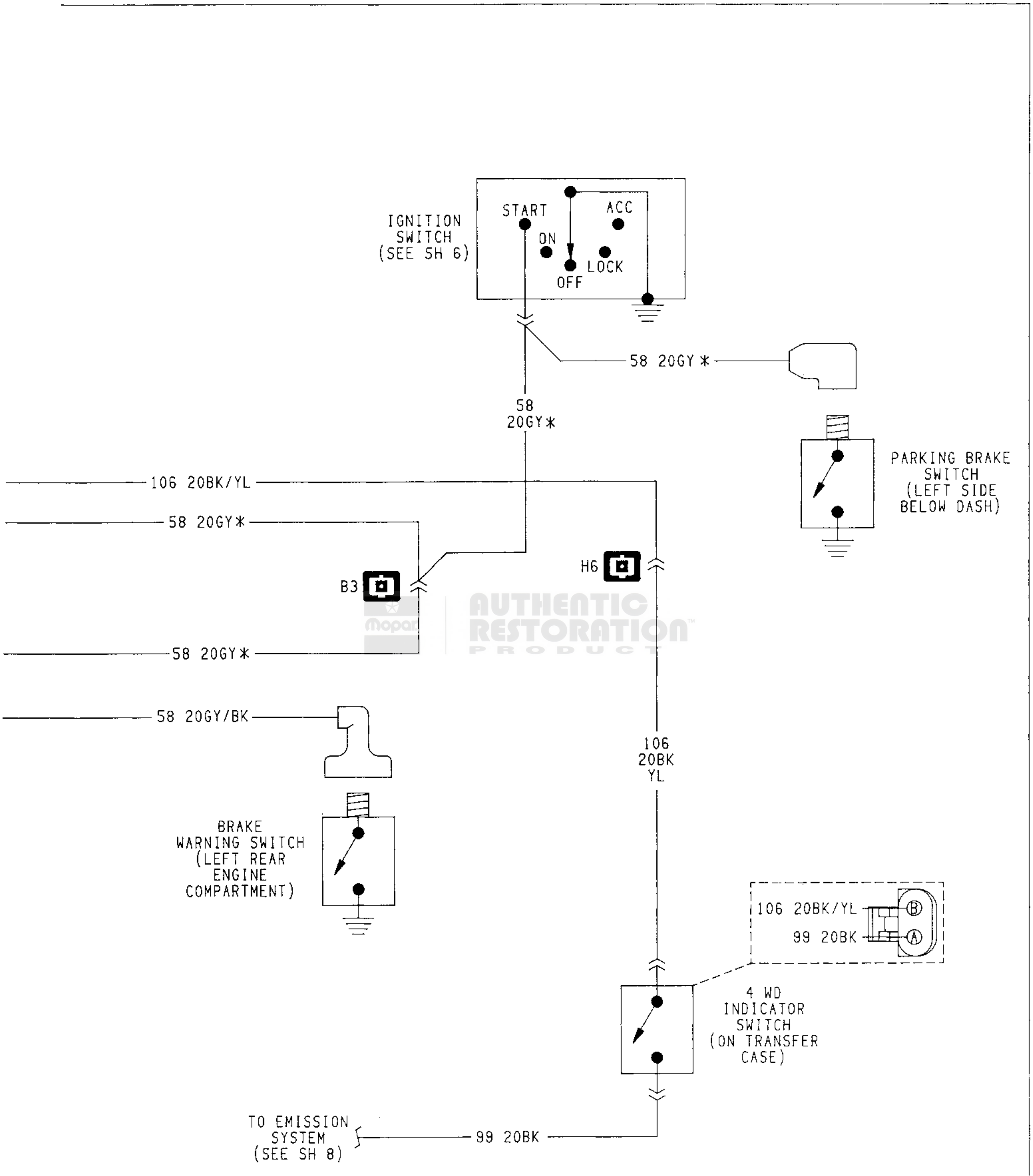
SJ 42

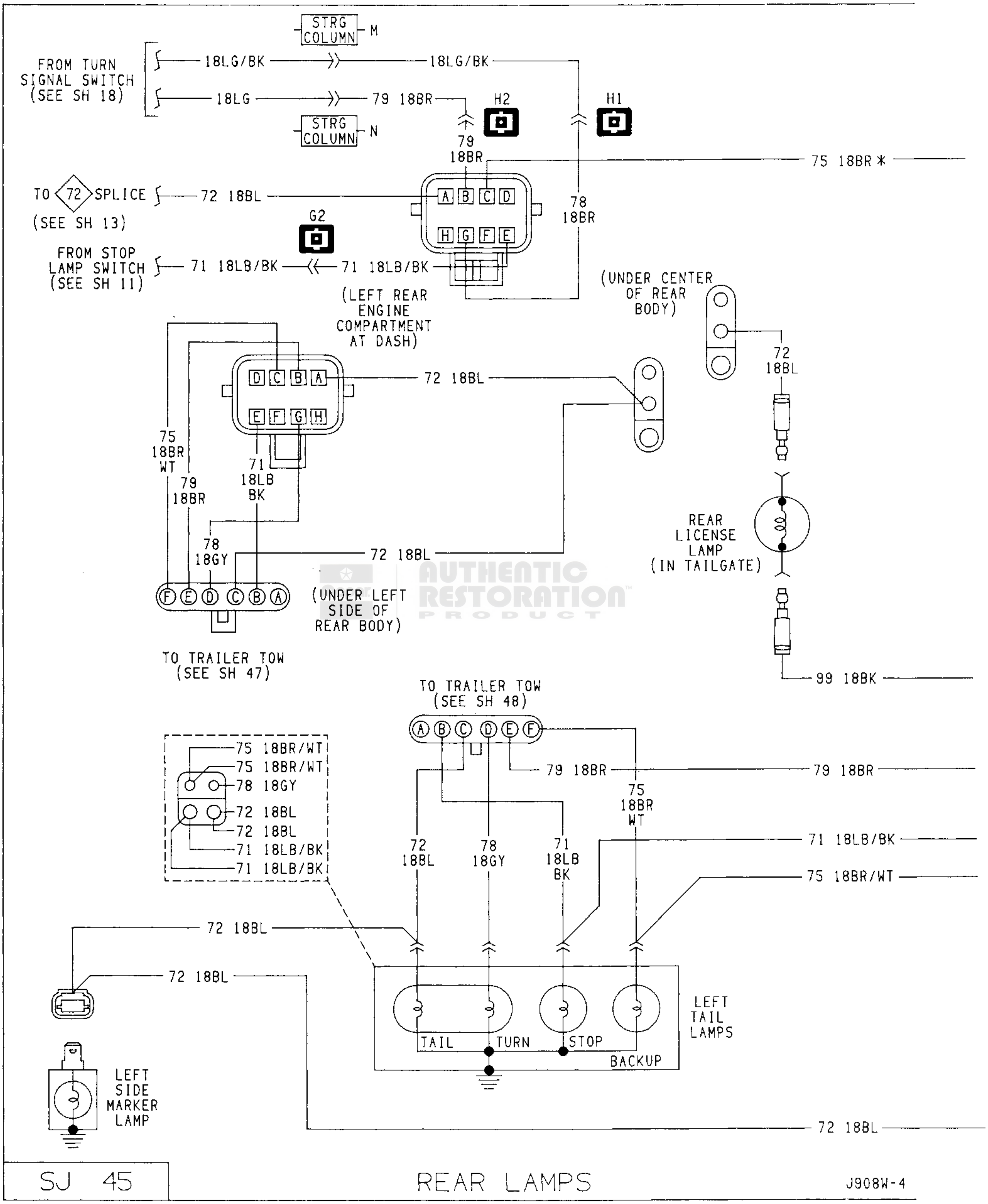


SJ 43

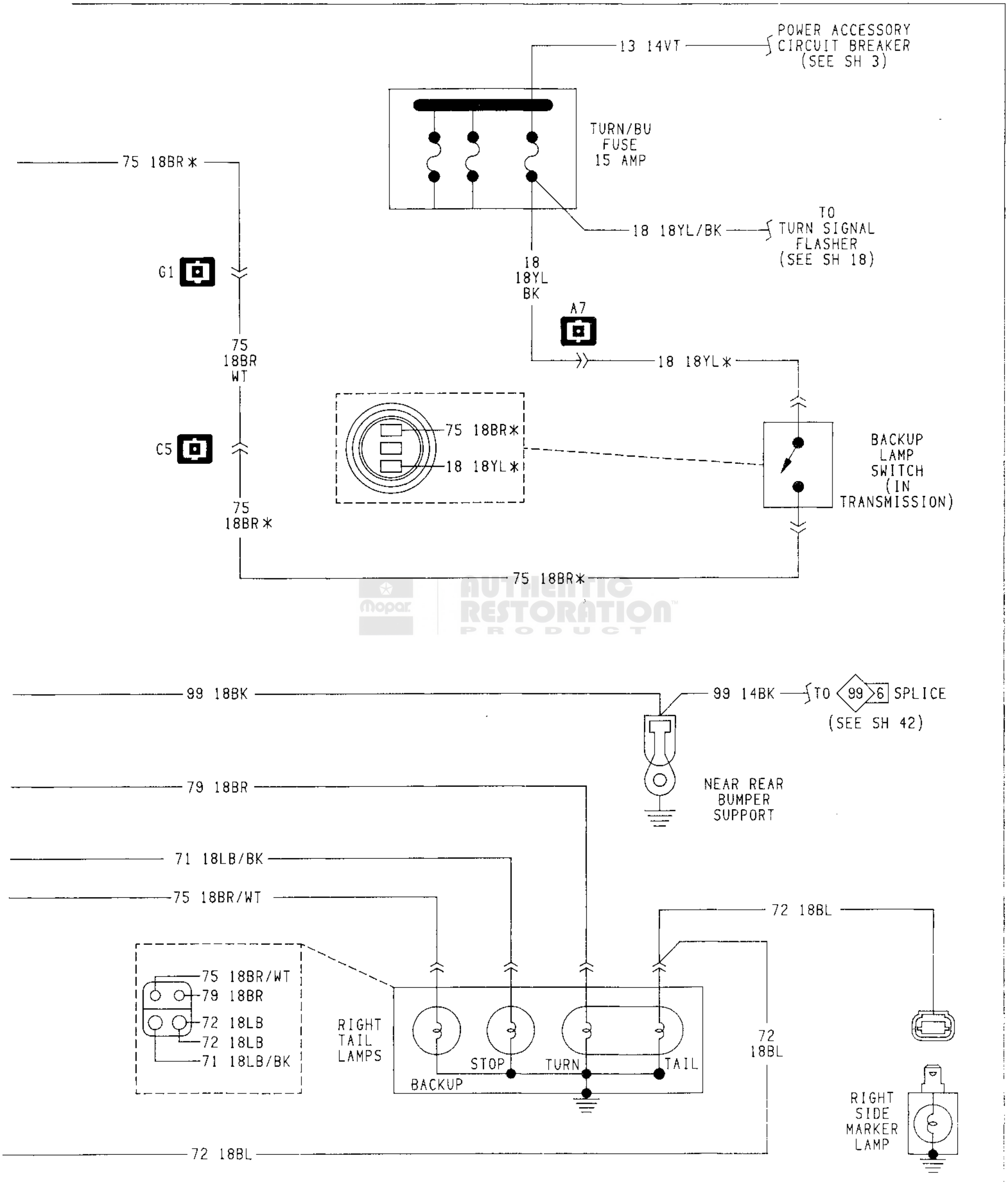
FUEL TANK SYSTEM

J908W-4


IGNITION SWITCH (SEE SH 6)
START
ACC
ON
LOCK
OFF
58 20GY*
58 20GY*
PARKING BRAKE SWITCH (LEFT SIDE BELOW DASH)
106 20BK/YL
58 20GY*
H6
B3
58 20GY*
58 20GY/BK
106 20BK YL
BRAKE WARNING SWITCH (LEFT REAR ENGINE COMPARTMENT)
106 20BK/YL
99 20BK
B
A
4 WD INDICATOR SWITCH (ON TRANSFER CASE)
TO EMISSION SYSTEM (SEE SH 8)
99 20BK


STRG COLUMN
M
FROM TURN SIGNAL SWITCH (SEE SH 18)
18LG/BK
18LG/BK
18LG
79 18BR
STRG COLUMN
N
H2
H1
79 18BR
75 18BR *
TO 72 SPLICE (SEE SH 13)
72 18BL
A B C D
H G F E
78 18BR
G2
FROM STOP LAMP SWITCH (SEE SH 11)
71 18LB/BK
71 18LB/BK
(LEFT REAR ENGINE COMPARTMENT AT DASH)
(UNDER CENTER OF REAR BODY)
D C B A
E F G H
72 18BL
72 18BL
75 18BR WT
79 18BR
71 18LB BK
78 18GY
72 18BL
REAR LICENSE LAMP (IN TAILGATE)
F E D C B A
(UNDER LEFT SIDE OF REAR BODY)
TO TRAILER TOW (SEE SH 47)
99 18BK
TO TRAILER TOW (SEE SH 48)
A B C D E F
75 18BR/WT
75 18BR/WT
78 18GY
72 18BL
72 18BL
71 18LB/BK
71 18LB/BK
79 18BR
79 18BR
75 18BR WT
72 18BL
78 18GY
71 18LB BK
71 18LB/BK
75 18BR/WT
72 18BL
72 18BL
TAIL
TURN
STOP
BACKUP
LEFT TAIL LAMPS
LEFT SIDE MARKER LAMP
72 18BL

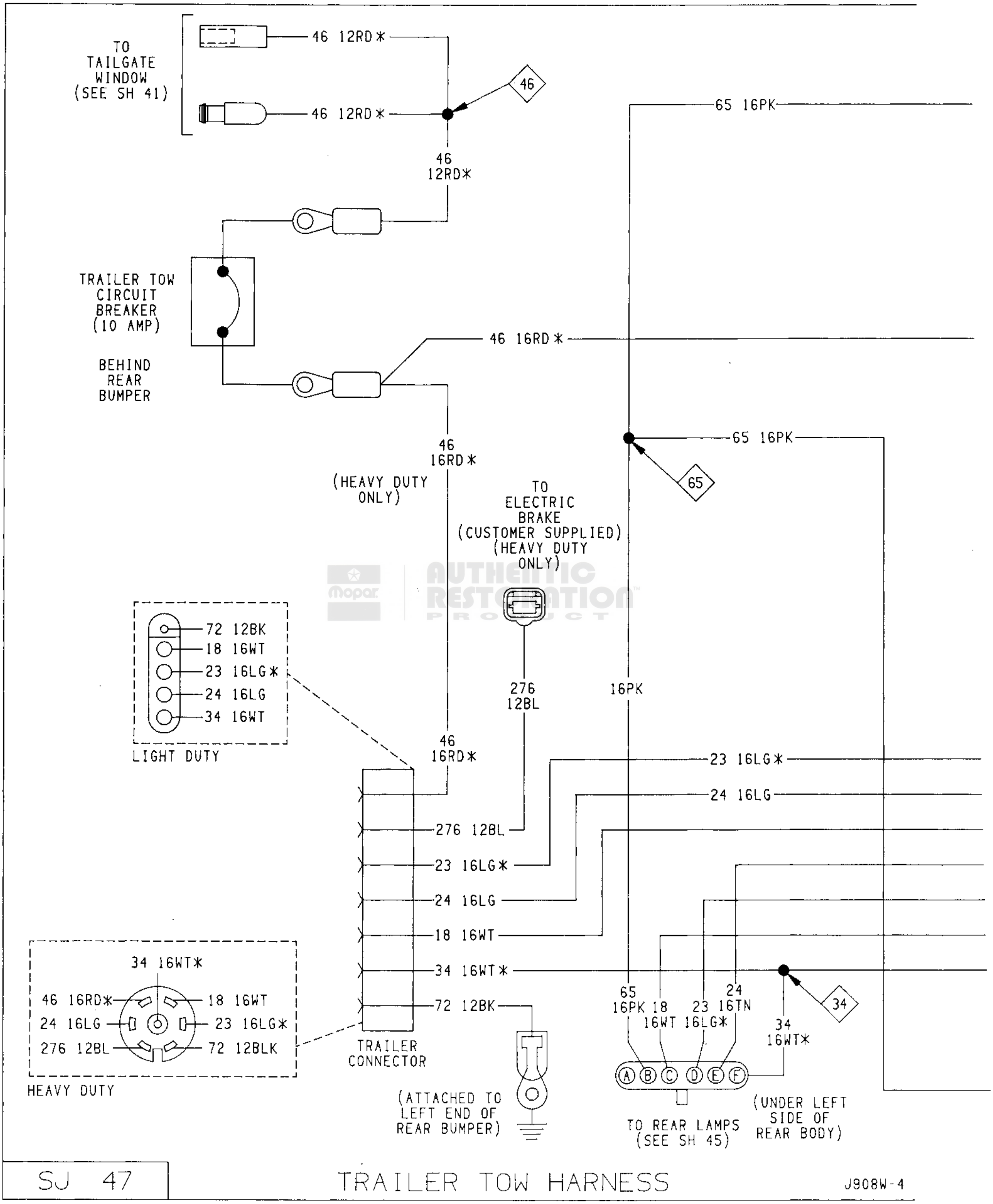
REAR LAMPS



J908W-4

REAR LAMPS

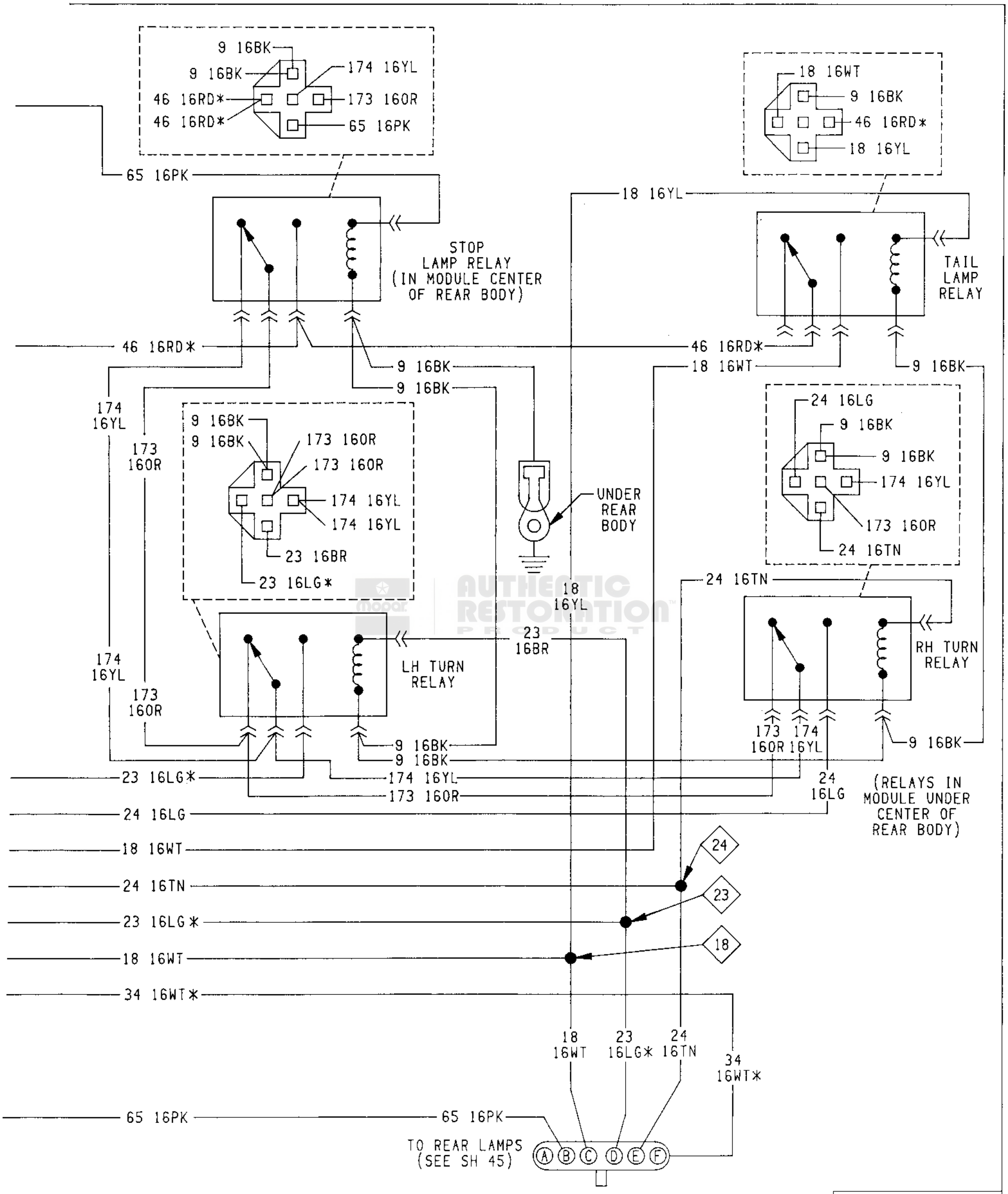
SJ 46



SJ 47

TRAILER TOW HARNESS

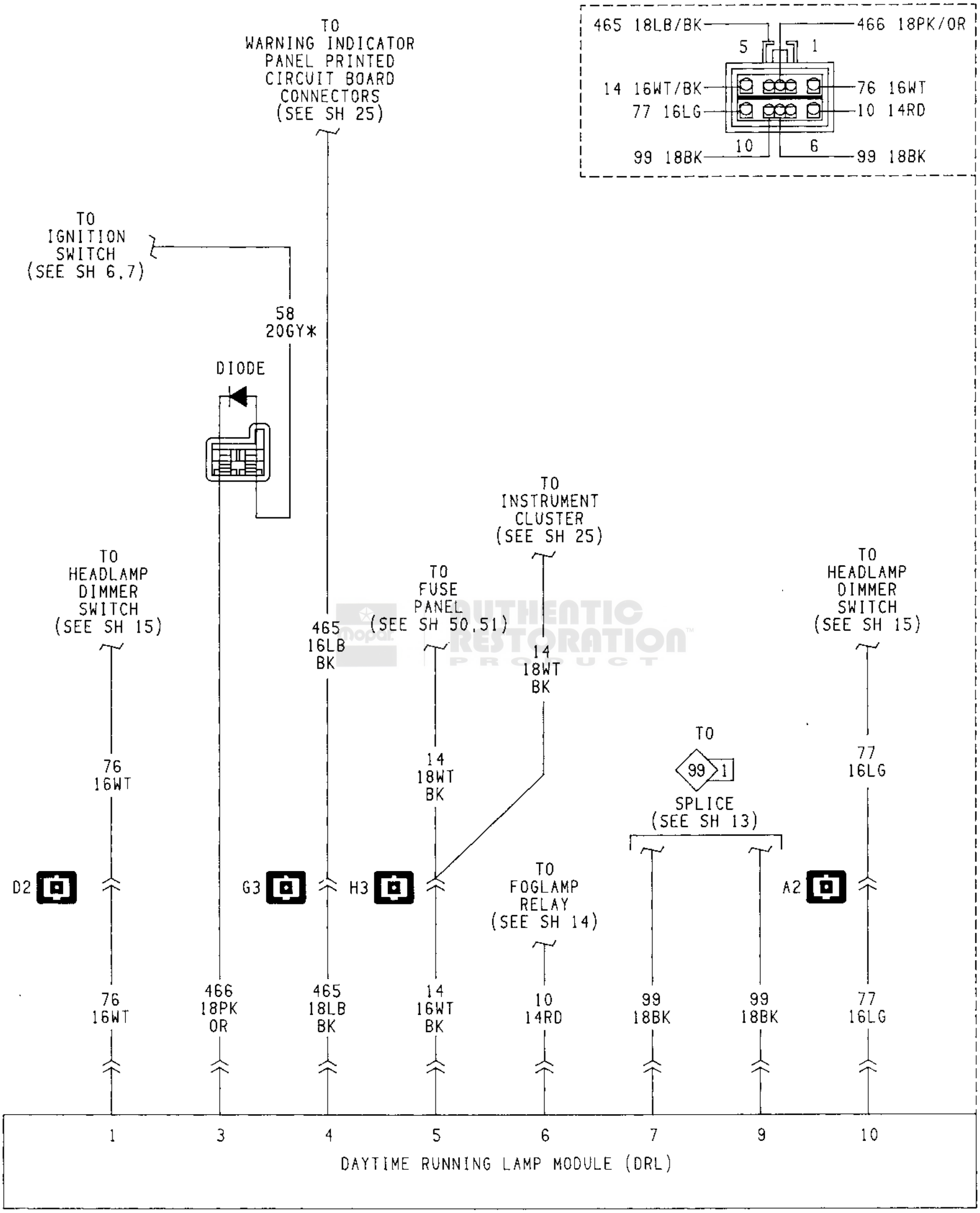
J908W-4



J908W-4

TRAILER TOW HARNESS

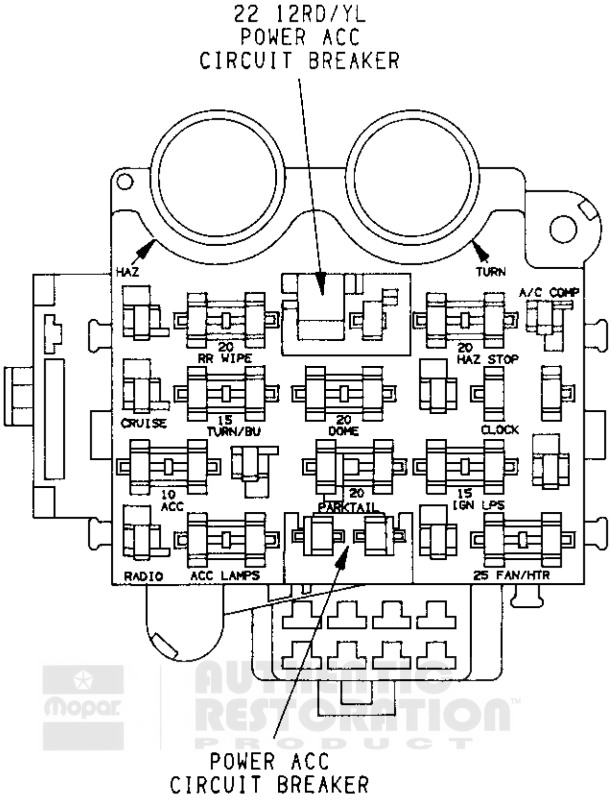
SJ 48



DAYTIME RUNNING LAMP MODULE SYSTEM (CANADA ONLY)

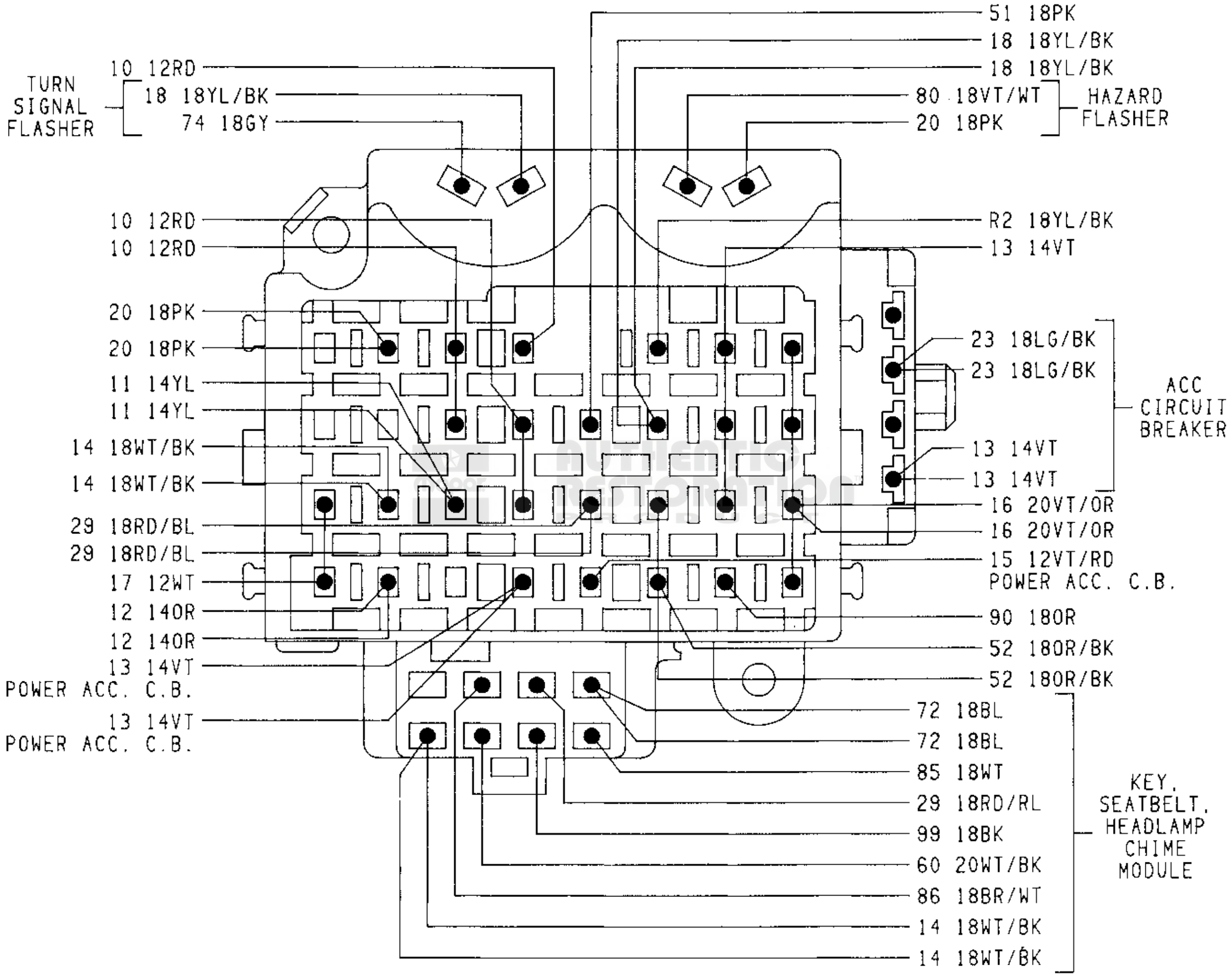
SJ 49

J908W-4



FUSE	AMPS	COLOR
RR WIPE	20 AMP	YELLOW
POWER ACC	30 AMP CIRCUIT BREAKER	
HAZ STOP	20 AMP	YELLOW
WINDSHIELD WIPER	7.5 AMP CIRCUIT BREAKER	
TURN/BU	15 AMP	LIGHT BLUE
DOME	20 AMP	YELLOW
ACC	20 AMP	YELLOW
PARK/TAIL	20 AMP	YELLOW
IGN LPS	15 AMP	BLUE
ACC LPS	3 AMP	TAN
POWER ACC	30 AMP CIRCUIT BREAKER	
FAN/HTR	25 AMP	WHITE

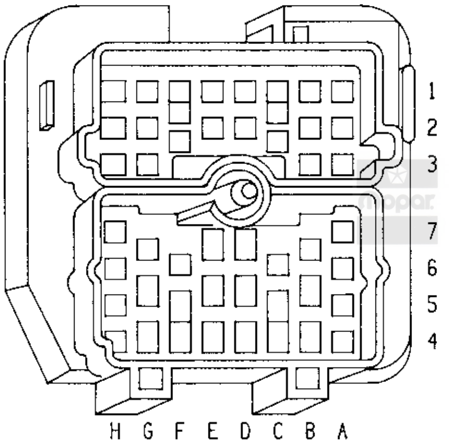
FUSE PANEL



SJ 51

FUSE PANEL

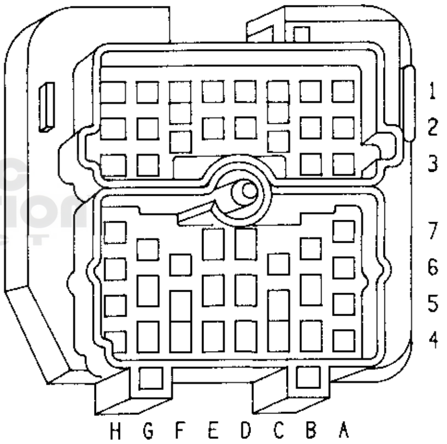
J908W-4



ENGINE COMPARTMENT CIRCUITS		CAV
55 20VT	ENGINE TEMPERATURE SENDER	A4
45 18TN*	WINDSHIELD WIPER PARK	A5
33 24GN	STARTER RELAY FEED	A6
18 18YL*	BACKUP LAMP SWITCH FEED	A7
11 14YL	ALTERNATOR AND IGNITION FEED	B4
32 16OR	A/C CLUTCH FEED	B5
12 14OR	EMISSION SYSTEM FEED	B6
68 12LB	LO HEATER BLOWER RESISTOR FEED	C4
75 18BR*	BACKUP LAMP FEED	C5
23 18LG*	WINDSHIELD WIPER PARK FEED	C6
10 12RD	IGNITION SWITCH FEED	D4
L99 18BK/OR	COMPASS GROUND	D5
10 12RD	FUSE PANEL FEED	E4
40 12TN	M2 HEATER BLOWER RESISTOR FEED	E5
47 18BL	WINDSHIELD WIPER HI FEED	F4
46 18WT*	WINDSHIELD WIPER LO FEED	F5
51 18PK	UNDERHOOD LAMP FEED	F6
10 12RD	ACCESSORY CIRCUIT BREAKER FEED	G4
41 12LG	M1 HEATER BLOWER RESISTOR FEED	G5
39 12WT*	HI HEATER BLOWER RESISTOR FEED	G6
54 20LB	OIL PRESSURE GAUGE	H4
99 20BK	INTERMITTENT WIPER GROUND	H5
106 20BK/YL	4 WD INDICATOR GROUND	H6

BULKHEAD DISCONNECT

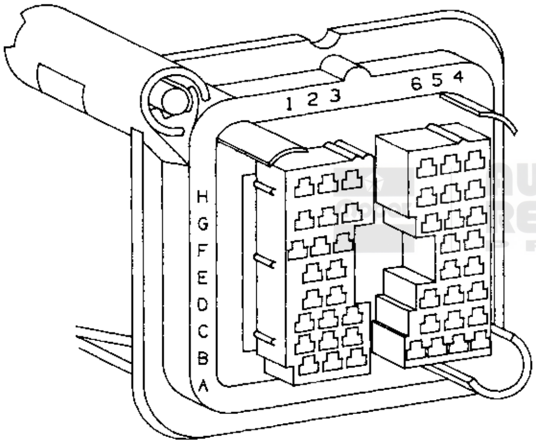
CAV	FRONT LAMP CIRCUITS	
A1	79 18BR	RIGHT PARK AND TURN FEED
A2	77 16LG	HEADLAMP LO BEAM FEED
A2	77 16LG	DAYTIME RUNNING LIGHTS(CANADA ONLY)
A3	57 20TN	FUEL SENDER
B1	72 18BL	PARK LAMPS FEED
B2	31 14GY	HORN FEED
B3	58 20GY	BRAKE INDICATOR GROUND
B3	58 20GY	DAYTIME RUNNING LIGHTS(CANADA ONLY)
C1	78 18GY	LH FRONT TURN LAMP FEED
C2	F5 18BL	FOG LAMP RELAY COIL FEED
C3	44 18VT/WT	WINDSHIELD WASHER PUMP FEED
D1	10 14RD	FOG LAMP FEED
D2	76 16WT	HEADLAMP HI BEAM FEED
D2	76 16WT	DAYTIME RUNNING LIGHTS(CANADA ONLY)
E1	99 12BK	GROUND
E2	110 18LG/BK	NOT USED
F1	R4 18VT/OR	REAR WASHER PUMP FEED
F2	T80 20PK/BL	TEMPERATURE SENSOR
F3	T81 20OR/GN	TEMPERATURE SENSOR
G1	75 18BR/WT	BACKUP LAMP FEED
G2	71 18BL/BK	STOP LAMP FEED
G3	465 18LB/BK	DAYTIME RUNNING LIGHTS(CANADA ONLY)
G3	76 16WT	HEADLAMP FEED
H1	78 18GY	LH REAR TURN LAMP FEED
H2	79 18BR	RH REAR TURN LAMP FEED
H3	14 16WT/BK	DAYTIME RUNNING LIGHTS(CANADA ONLY)



SJ 53

BULKHEAD DISCONNECT

J908W-4



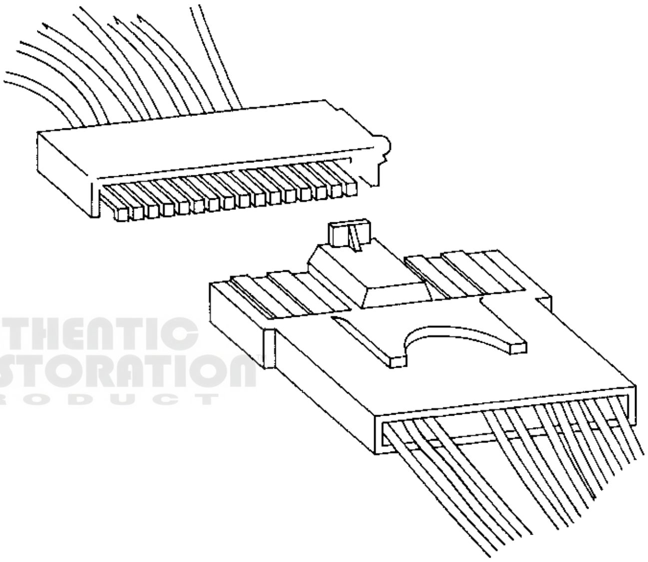
INSTRUMENT PANEL CIRCUITS		CAV
79 18BR	RIGHT PARK AND TURN FEED	A1
77 16LG	HEADLAMP LO BEAM FEED	A2
57 20TN	FUEL SENDER	A3
55 20VT	ENGINE TEMPERATURE SENDER	A4
45 18TN/BK	WINDSHIELD WIPER PARK	A5
33 14GN	STARTER RELAY FEED	A6
18 18YL/BK	BACKUP LAMP SWITCH FEED	A7
72 18BL	RADIO ILLUM. RELAY FEED	B1
72 18BL	CHIME FEED	B1
31 14GY	HORN FEED	B2
58 20GY/BK	BRAKE INDICATOR GROUND	B3
58 20GY/BK	BRAKE INDICATOR GROUND	B3
11 14YL	ALTERNATOR AND IGNITION FEED	B4
32 18OR	A/C CLUTCH FEED	B5
12 14OR	EMISSION SYSTEM FEED	B6
78 18GY/BK	LH FRONT TURN LAMP FEED	C1
F5 18BL/WT	FOG LAMP RELAY COIL FEED	C2
44 18VT/WT	WINDSHIELD WASHER PUMP FEED	C3
68 12LB	LO HEATER BLOWER RESISTOR FEED	C4
75 18BR/WT	BACKUP LAMP FEED	C5
23 18LG/BK	WINDSHIELD WASHER PUMP FEED	C6
10 14RD	FOG LAMP FEED	D1
76 16WT	HEADLAMP HI BEAM FEED	D2
10 12RD	IGNITION SWITCH FEED	D4
L99 18BK/OR	COMPASSS GROUND	D5
99 12BK	GROUND	E1
110 18LG/BK	NOT USED	E2
10 12RD	FUSE PANEL FEED	E4
40 12TN	M2 HEATER BLOWER RESISTOR FEED	E5
R4 18VT/OR	REAR WASHER PUMP FEED	F1
T80 20PK/BL	TEMPERATURE SENSOR	F2
T81 20OR/GN	TEMPERATURE SENSOR	F3
47 18BL/WT	WINDSHIELD WASHER HI FEED	F4
46 18WT/BK	WINDSHIELD WASHER LO FEED	F5
51 18PK	UNDERHOOD LAMP FEED	F6
75 18BR/WT	BACKUP LAMP FEED	G1
71 18LB/BK	STOP LAMP FEED	G2
465 16LB/BK	HI BEAM INDICATOR	G3
10 12RD	ACCESSORY CIRCUIT BREAKER FEED	G4
41 12LG	M1 HEATER BLOWER RESISTOR FEED	G5
39 12WT/BK	HI HEATER BLOWER RESISTOR FEED	G6
78 18GY/BK	LH REAR TURN LAMP FEED	H1
79 18BR	RH REAR TURN LAMP FEED	H2
14 18WT/BK	IGNITION LAMPS FUSED	H3
14 18WT/BK	REAR DEFOGGER FEED	H3
54 20LB	OIL PRESSURE GAUGE	H4
99 18BK	INTERMITTENT WIPER GROUND	H5
106 20BK/YL	4 WD INDICATOR GROUND	H6

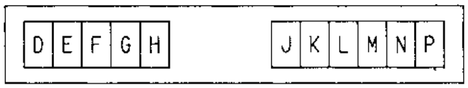
J908W-4

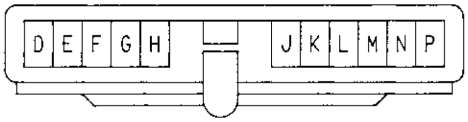
BULKHEAD DISCONNECT

SJ 54

CAV	TURN SINGAL SWITCH CIRCUITS	
P	110 18LG*	USED ON EXPORT
N	79 18BR	RIGHT TURN-REAR
M	78 18GY/BK	LEFT TURN-REAR
L	74 18GY	TURN SIGNAL FLASHER
K	80 18VT/WT	HAZARD SWITCH
J	79 18BR	RIGHT TURN/FRONT INDICATOR
J	79 18BR	RIGHT TURN/FRONT INDICATOR
H	78 18GY*	LEFT TURN/FRONT INDICATOR
H	78 18GY/BK	LEFT TURN/FRONT INDICATOR
G	128 180R	HORN SWITCH
F	98 18BK	IGNITION KEY WARNING SWITCH
E	86 18BR	IGNITION KEY WARNING SWITCH
D	52 280R	NOT USED







SJ 55

11 WAY STERRING COLUMN CONNECTOR J908W-4

COMPONENT AND SYSTEM INDEX

1990

SERVICE MANUAL

ENGINE, CHASSIS, BODY

Jeep®

CHRYSLER MOTORS

Jeep
ENGINE, CHASSIS, AND BODY SERVICE MANUAL

1990 JEEP VEHICLES

To order the special service tools used and illustrated, please refer to the instructions on inside back cover.

CHRYSLER MOTORS
SERVICE & PARTS OPERATIONS

Mopar AUTHENTIC RESTORATION PRODUCT

NO PART OF THIS PUBLICATION MAY BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM, OR TRANSMITTED, IN ANY FORM OR BY ANY MEANS, ELECTRONIC, MECHANICAL, PHOTOCOPYING, RECORDING, OR OTHERWISE, WITHOUT THE PRIOR WRITTEN PERMISSION OF CHRYSLER MOTORS.

Jeep/Eagle reserves the right to make changes in design or to make additions to or improvements in its products without imposing any obligations upon itself to install them on its products previously manufactured.

Litho in U.S.A. Copyright © 1989 Jeep/Eagle Corporation 25M889

Mopar AUTHENTIC RESTORATION PRODUCT™

MOPAR, JEEP, DODGE, HEMI, PLYMOUTH and CHRYSLER are trademarks of Chrysler LLC under license. © Chrysler LLC 2008

THIS SHOP MANUAL, OWNERS MANUAL OR PARTS BOOK IS A REPRINT OF AN ORIGINAL CHRYSLER LLC SHOP MANUAL, OWNERS MANUAL OR PARTS BOOK. IT IS REPRINTED AND PUBLISHED BY R&B HOLT ENTERPRISES, UNDER LICENSE AND WITH PERMISSION FROM CHRYSLER LLC. THE REPRESENTATIONS AND SPECIFICATIONS HAVE NOT BEEN UPDATED OR MODIFIED SINCE THE ORIGINAL PUBLICATION DATE AND SHOULD NOT BE RELIED UPON FOR CURRENT APPLICATION. CHRYSLER LLC DISCLAIMS ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS INCLUDING ANY MISLEADING INFORMATION OR INCORRECT STATEMENTS MADE HERIN. © Chrysler LLC 2008

FOREWORD

The information contained in this service manual has been prepared for the professional automotive technician involved in daily repair operations. Information in this manual is divided into groups. Each group covers a general vehicle system (brakes, steering, body, etc.). Each group is further divided to address individual components or systems within the group.

The Component and System Index, located at the back of this manual, will assist you in locating the correct group for the component or system you require.

These groups contain general information, diagnosis, testing, adjustment, removal and installation, disassembly and assembly procedures for the components.

The diagnosis charts are designed to help you locate and correct problems with a systematic approach. The tab locator at the right side of this page will help you quickly locate the first page of each group. The first page of each group contains an alphabetical index to assist in the location of the component or system.

The information, description, testing procedures and specifications were in effect at the time this manual was released for printing.

Chrysler Motors reserves the right to change testing procedures, specifications, diagnosis, or repair methods at any time without prior notice or incurring obligation.

The information describing the operation and use of standard and optional equipment is included in the Operating Instructions and Product Information manual located in the glove box.

NOTE: FOR ELECTRICAL INFORMATION, REFER TO THE "ELECTRICAL SERVICE MANUAL" - JEEP VEHICLES.

J901N-7

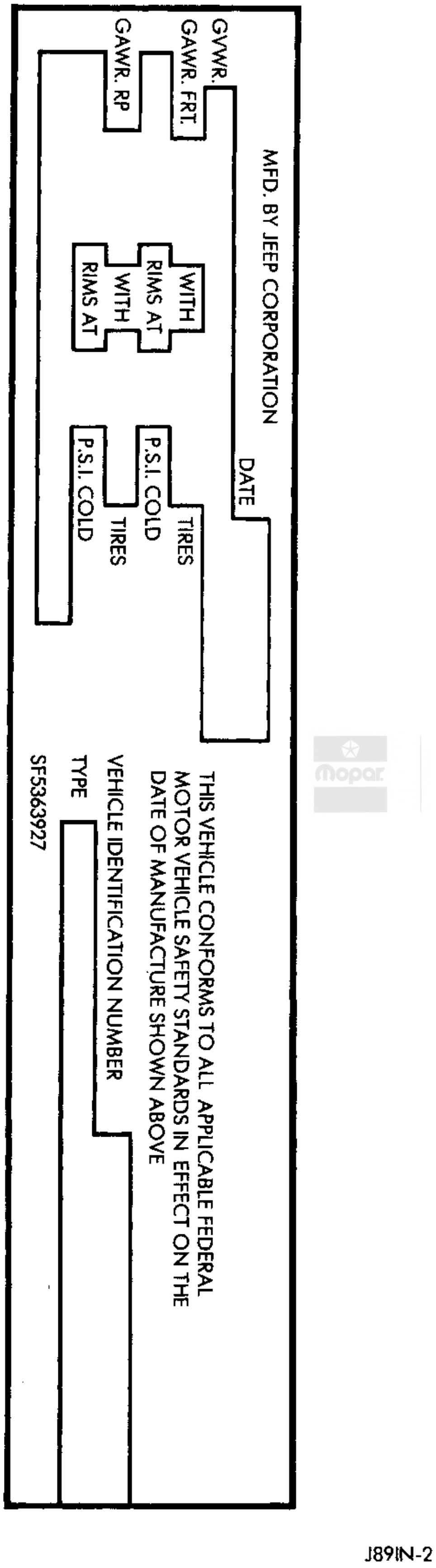


Fig. 1 Safety Certification Labels

INTRODUCTION

VEHICLE SAFETY CERTIFICATION LABELS

A safety certification label (Fig. 1) is attached to all vehicles to certify that they conform to Federal motor vehicle safety certificate standards. The label lists the month and year of manufacture, gross vehicle weight rating (GVWR) and gross axle weight rating (GAWR). The label is located on the door pillar (driver's side).

TIRE INFLATION LABEL

Check the tires for visible signs of wear which may indicate underinflation or a need for front-end alignment, tire rotation or wheel balancing. Also check for bulging, cracks or other road hazard damage. Check and adjust the inflation pressures according to the specifications. The tire pressure specification sticker is located on the glove box door (Fig. 2).

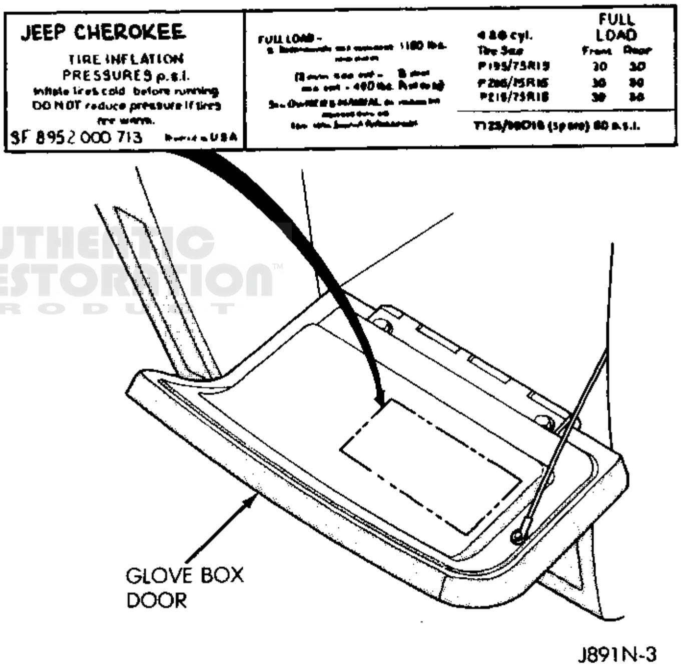


Fig. 2 Tire Inflation Pressures

VEHICLE IDENTIFICATION NUMBER (VIN)

The Vehicle Identification Number (VIN) is located on the left side of the instrument panel at the base of the windshield. All VIN's contain 17 characters in a combination of letters and numbers that provide specific information about the vehicle (Fig. 3).

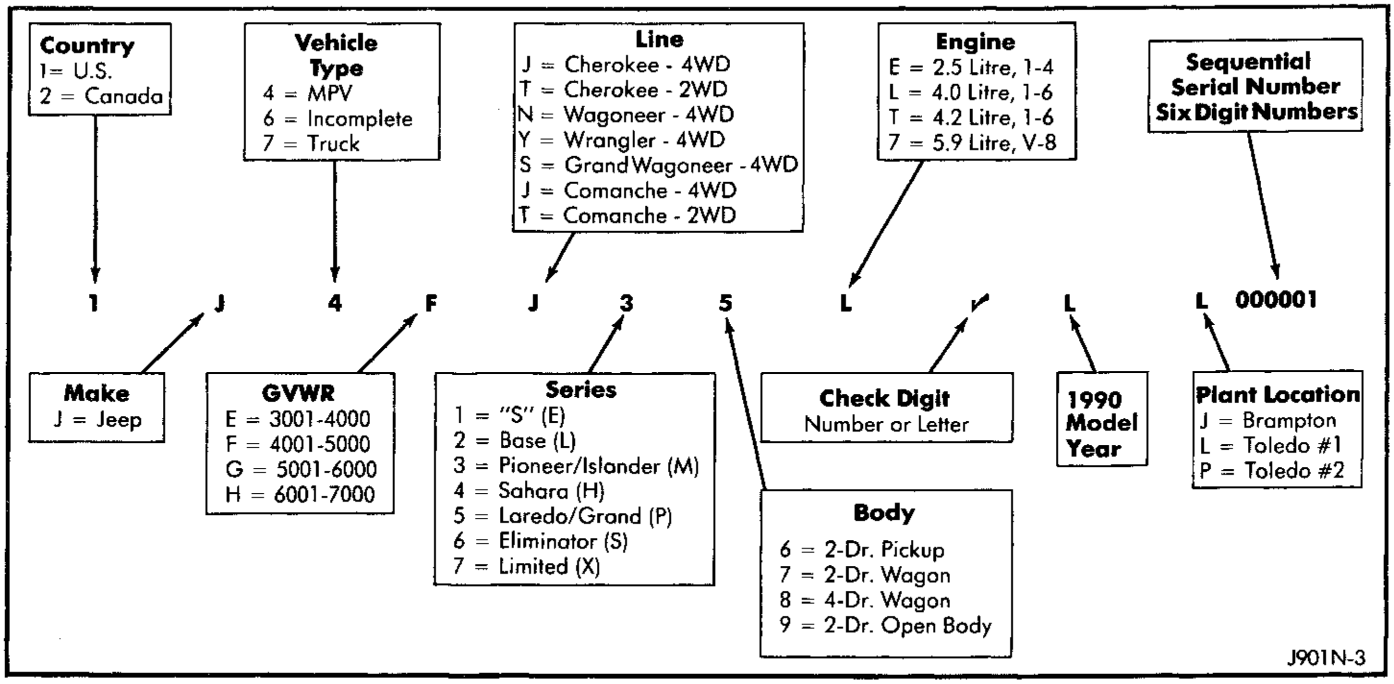


Fig. 3 Vehicle Identification Number (VIN)

BODY CODE PLATE

A metal Body Code Plate is attached to the driver's side of the dash panel in the engine compartment (Fig. 4). There are up to seven (7) lines of information on this plate. Information reads from left to right, starting with line 1 at the bottom of the plate to line 7 at the top.

Refer to the body code plate chart (lines 1 thru 3) for detailed information.

Lines 4 thru 7, of the body code plate, are sequenced on the plate as follows:

- 3 digit sales codes
- 3 digit numeric codes
- 6 digit SEC codes

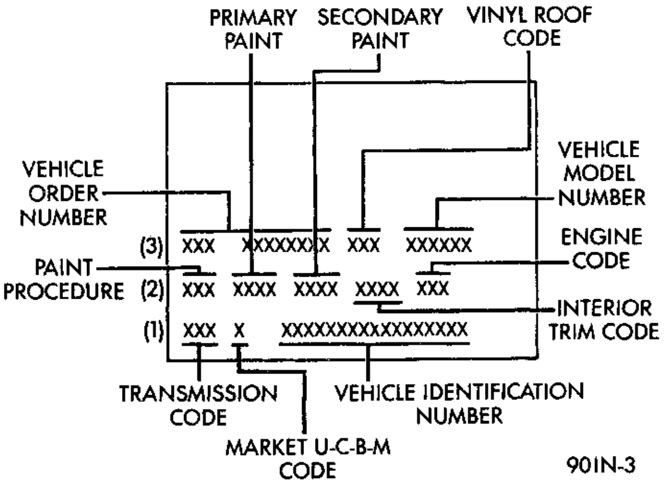


Fig. 4 Body Code Plate

Line #1	Digits 1, 2, 3	Transmission Sales Code
	Digit 4	Open Space
	Digit 5	Market Code—U-C-B-M
	Digit 6	Open Space
	Digit 7 thru 23	Vehicle Identification Number
Line #2	Digits 1, 2, 3	Paint Procedure
	Digit 4	Open Space
	Digits 5, 6, 7, 8	Primary Paint
	Digit 9	Open Space
	Digits 10, 11, 12, 13	Secondary Paint
	Digit 14	Open Space
	Digits 15, 16, 17, 18	Trim Code
	Digit 19	Open Space
	Digits 20, 21, 22	Engine Sales Code
	Digit 23	Open Space
Line #3	Digits 1 thru 12	Vehicle Order Number
	Digit 13	Open Space
	Digits 14, 15, 16	Vinyl Roof Code (Door Combo Code—Pillette)
	Digit 17	Open Space
	Digits 18 thru 23	Model

When there is an SEC code to be punched on the body code plate and there is not enough room left on a line to punch the full 6 digits, the balance of that line will be left blank and the SEC code will be punched on the next line.

The last nine positions of line #7 will contain a two digit species, when applicable, and a six digit gateline sequence number (the last six numbers of the VIN).

The last code shown on either plate will be followed by END. When two plates are required, the last code space on the first plate will show CTD (for continued).

When a second plate is required, the first four spaces of each line will not be used due to overlap of the plates.

ENGINE BUILD DATE CODE

The engine Build Date Code is located:

- 2.5L Engine - On a machined surface on the right side of the cylinder block between the No. 3 and No. 4 cylinders.
- 4.0L and 4.2L Engines - On a machined surface on the right side of the cylinder block between the No. 2 and No. 3 cylinders.
- 5.9L Engine - On a plate attached to the right bank cylinder head cover.

The digits of the code identify the year (1st), month (2nd & 3rd), engine type/fuel system/compression ratio (4th & 5th), and day (6th & 7th) of engine build (Fig. 5).

EXAMPLE: 903MXO3

1st Digit (Year)	2nd/3rd Digit (Month)	4th/5th Digit (Type)	6th/7th Digit (Day)
7-1987 8-1988 9-1989 0-1990	01-12	HX MX CX NX	01-31

Letter Code	CID Liter	Fuel System	Comp. Ratio
HX	150-2.5L	TBI	9.2:1
MX	243-4.0L	MPI	8.8:1
CX	258-4.2L	2V	9.2:1
NX	360-5.9L	2V	8.25:1

J901N-8

Fig. 5 Engine Identification and Build Date Code

1990 MODEL IDENTIFICATION CHART

The Model Identification Chart identifies descriptive codes for all Jeep vehicles (Fig. 6). These codes are used in captions and references throughout this service manual. These Model codes are not to be confused with the Vehicle Identification Number (VIN) coding or other body style references.

VEHICLE NAME	MODEL
GRAND WAGONEER - 4DR/4WD	SJ
COMANCHE (SHORT BED) - 4WD	MJ
COMANCHE (SHORT BED) - 2WD	
COMANCHE (LONG BED) - 4WD	
COMANCHE (LONG BED) - 2WD	
CHEROKEE - 2DR/4WD	XJ
CHEROKEE - 4DR/4WD	
CHEROKEE - 2DR/2WD	
CHEROKEE - 4DR/2WD	
WAGONEER - 4DR/4WD	
WRANGLER - 4WD	YJ

J901N-9

Fig. 6 Model Identification Chart

1990 EXTERIOR DIMENSIONS

MODEL NAME	MODEL	WHEEL BASE cm/in	TRACK cm/in		OVERALL cm/in		
			FRONT	REAR	LENGTH	WIDTH	HEIGTH
Grand Wagoneer	SJ	276.1	150.9	146.8	473.5	190.0	168.7
4 DR-4 WD		108.7	59.4	57.8	186.4	74.8	66.4
Comanche (Short Bed)	MJ	286.8	144.8	144.8	455.2	182.2	164.4
2 DR-4 WD/6″ Wheels		112.9	57.0	57.0	179.3	71.7	64.7
(Short Bed)		286.8	147.3	147.3	455.2	182.2	164.4
7″ Wheels		112.9	58.0	58.0	179.3	71.7	64.7
Comanche (Short Bed)	MJ	287.3	144.8	144.8	455.2	182.2	162.1
2 DR-2 WD/6″ Wheels		113.1	57.0	57.0	179.3	71.7	63.8
(Short Bed)		287.3	147.3	146.3	455.2	182.2	162.1
7″ Wheels		113.1	58.0	58.0	179.3	71.7	63.8
Comanche (Long Bed)	MJ	303.3	144.8	144.8	496.6	182.2	164.4
2 DR-4 WD/6″ Wheels		119.4	58.0	58.0	195.5	71.7	64.7
(Long Bed)		303.3	144.8	144.8	496.6	182.2	164.4
7″ Wheels		119.4	58.0	58.0	195.5	71.7	64.7
Comanche (Long Bed)	MJ	303.8	144.8	144.8	496.6	182.2	162.1
2 DR-2 WD/6″ Wheels		119.6	58.0	58.0	195.5	71.7	63.8
(Long Bed)		303.8	144.8	144.8	496.6	182.2	162.1
7″ Wheels		119.6	58.0	58.0	195.5	71.7	63.8
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
2 DR-2 WD		101.4	58.0	58.0	165.3	70.5	63.4
7″ Wheels		257.6	144.8	144.8	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
4 DR-2 WD		101.4	57.0	57.0	165.3	70.5	63.4
7″ Wheels		257.6	147.3	147.3	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Wagoneer	XJ	257.6	147.3	147.3	420.0	179.1	161.5
4 DR-4 WD		101.4	58.0	58.0	165.3	70.5	63.6
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
2 DR-4 WD		101.4	57.0	57.0	165.3	70.5	63.4
7″ Wheels		257.6	147.3	147.3	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Cherokee-6″ Wheels	XJ	257.6	144.8	144.8	420.0	179.1	161.0
4 DR-4 WD		101.4	57.0	57.0	165.3	70.5	63.4
7″ Wheels		257.6	147.3	147.3	420.0	179.1	161.0
		101.4	58.0	58.0	165.3	70.5	63.4
Wrangler	YJ	237.2	147.3	147.3	387.6	167.6	176.5
2 DR-4 WD/Hardtop		93.4	58.0	58.0	152.6	66.0	69.5

J901N-4

1990 INTERIOR DIMENSIONS

MODEL	MODEL	HEAD cm/(in)		LEG cm/(in)		SHOULDER cm/(in)		HIP cm/(in)	
		FRONT	REAR	FRONT	REAR	FRONT	REAR	FRONT	REAR
Grand Wagoneer	SJ	94.2 37.1	93.5 36.8	102.9 40.5	94.0 37.0	148.1 58.3	148.1 58.3	153.7 60.5	154.7 60.9
Comanche (Short Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Comanche (Short Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Comanche (Long Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Comanche (Long Bed)	MJ	100.1 39.4	-- --	109.2 43.0	-- --	140.5 55.3	-- --	140.5 55.3	-- --
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Wagoneer	XJ	97.3 38.3	96.5 38.0	104.4 41.1	89.7 35.3	140.5 55.3	140.5 55.3	140.5 55.3	113.0 44.5
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Cherokee	XJ	97.3 38.3	96.5 38.0	105.7 41.6	89.7 35.3	139.7 55.0	140.2 55.2	140.5 55.3	113.0 44.5
Wrangler (Hardtop)	YJ	102.1 40.2	102.9 40.5	100.1 39.4	88.9 35.0	134.8 53.1	143.0 56.3	134.8 53.1	91.4 36.0

J901N-5

TORQUE REFERENCES

Individual Torque Charts appear at the end of many Groups. Refer to the Standard Torque Specifications and Bolt Identification Chart in this Group for torques not listed in the individual torque charts (Fig. 7).

Note that the torque specifications given in the chart are based on the use of clean and dry threads. Reduce the torque by 10%when the threads are lubricated with engine oil and by 20%if new plated bolts are used.

Various sizes of internal and external hex-lobular (Torx) head fasteners are used as attaching hardware on numerous components and assemblies in Jeep vehicles. Due to the ever-changing usage and application of automotive fasteners, Torx-head fasteners may not be identified as such throughout this manual.

BOLT TORQUE

BOLT SIZE	GRADE 5		GRADE 8	
	N·m	ft-lbs (in-lbs)	N·m	ft-lbs (in-lbs)
1/4-20	11	(95)	14	(125)
1/4-28	11	(95)	17	(150)
5/16-18	23	(200)	31	(270)
5/16-24	27	20	34	25
3/8-16	41	30	54	40
3/8-24	48	35	61	45
7/16-14	68	50	88	65
7/16-20	75	55	95	70
1/2-13	102	75	136	100
1/2-20	115	85	149	110
9/16-12	142	105	183	135
9/16-18	156	115	203	150
5/8-11	203	150	264	195
5/8-18	217	160	285	210
3/4-16	237	175	305	225

J89IN-9

Fig. 7 Grade 5 and 8 Standard Torque Specifications

METRIC THREAD AND GRADE IDENTIFICATION

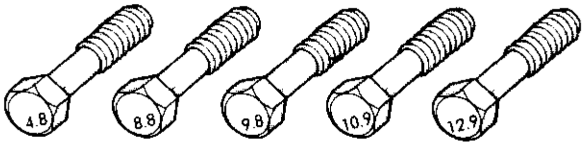
Metric and SAE thread notations differ slightly. The difference is illustrated in Fig. 8.

INCH		METRIC	
5/16-18		M8 X 1.25	
THREAD MAJOR DIAMETER IN INCHES	NUMBER OF THREADS PER INCH	THREAD MAJOR DIAMETER IN MILLIMETERS	DISTANCE BETWEEN THREADS IN MILLIMETERS

PR606B

Fig. 8 Thread Notation (Metric and SAE)

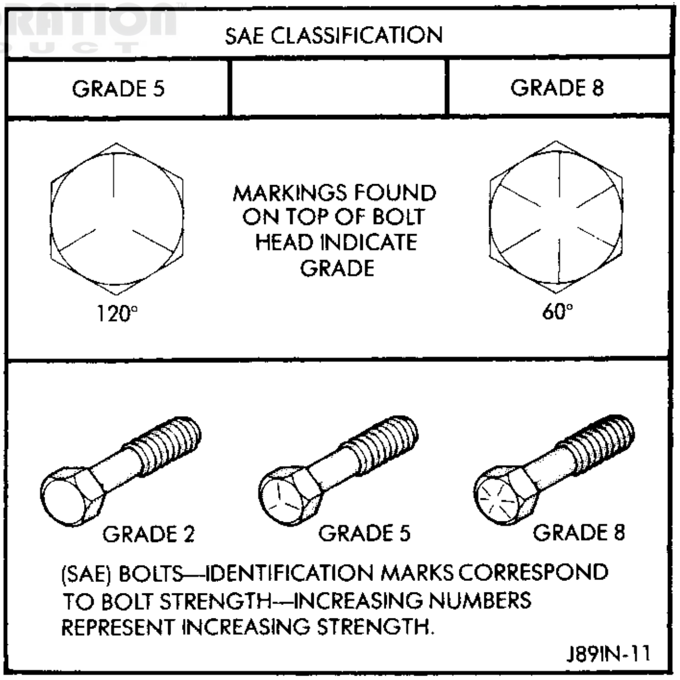
Common metric fastener strength property classes are 9.8 and 12.9 with the class identification embossed on the head of each bolt (Fig. 9). Some metric nuts will be marked with single digit strength identification numbers on the nut face.



METRIC BOLTS—IDENTIFICATION CLASS NUMBERS CORRESPOND TO BOLT STRENGTH— INCREASING NUMBERS REPRESENT INCREASING STRENGTH. J89IN-10

Fig. 9 Metric Bolt Identification

SAE strength classes range from grade 2 to 8 with line identification embossed on each bolt head. Markings corresponding to two lines less than the actual grade (Fig. 10). For Example - Grade 7 bolt will exhibit 5 embossed lines on the bolt head.



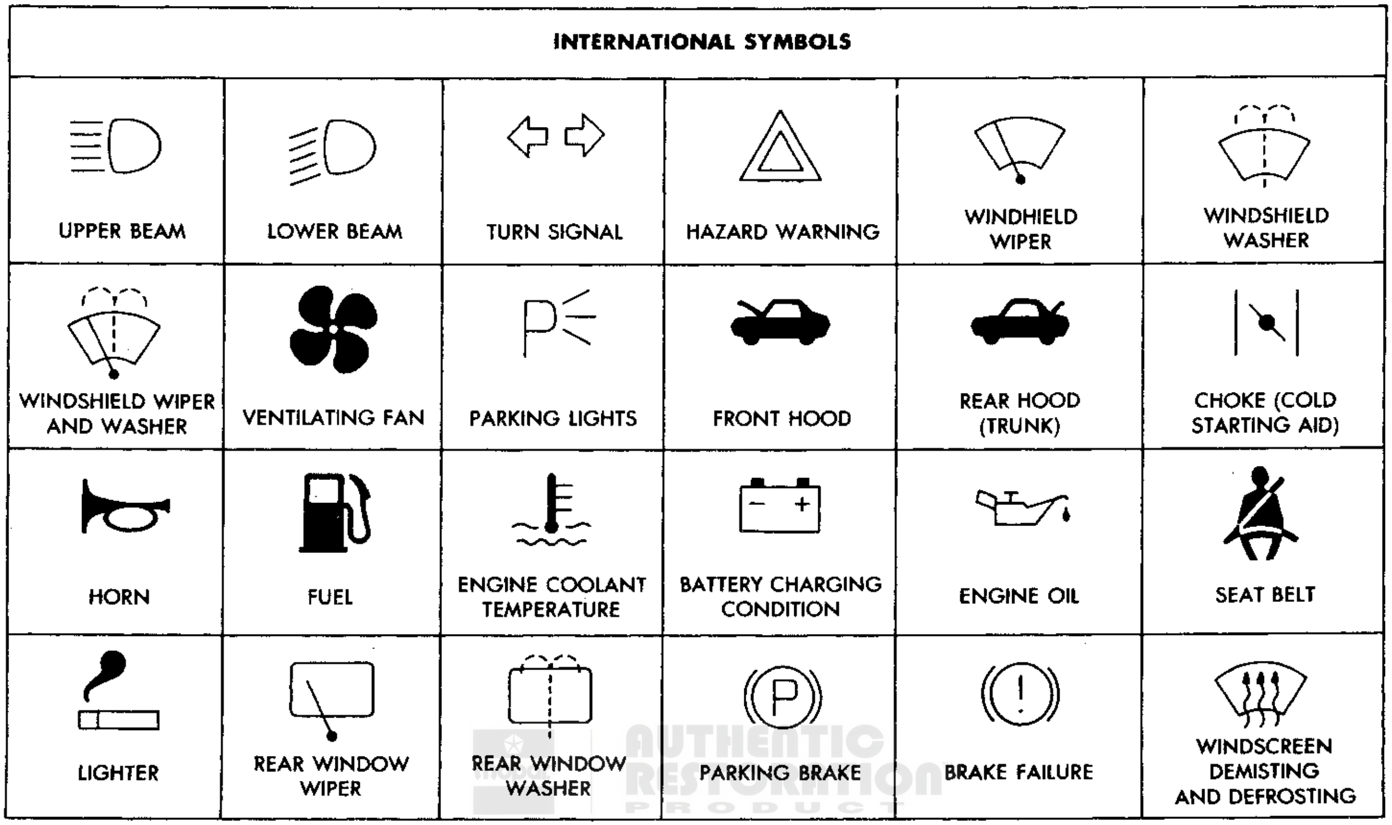
(SAE) BOLTS—IDENTIFICATION MARKS CORRESPOND TO BOLT STRENGTH—INCREASING NUMBERS REPRESENT INCREASING STRENGTH.

J89IN-11

Fig. 10 SAE Bolt Identification

INTERNATIONAL SYMBOLS

Some of the International Symbols shown below are used to identify controls and displays in this vehicle. These symbols are applicable to those controls which are displayed on the instrument panel or in the immediate vicinity of the driver (Fig. 11).



RK230

Fig. 11 International Symbols

METRIC SYSTEM

Artwork, specifications, and tightening references in this Service Manual are identified in the metric system and in the SAE system.

During any maintenance or repair procedures, it is important to salvage metric fasteners (nuts, bolts, etc.) for reassembly. If the fastener is not salvageable, a fastener of equivalent specification should be used.

WARNING: USE OF AN INCORRECT FASTENER MAY RESULT IN COMPONENT DAMAGE OR PERSONAL INJURY.

The metric system is based on quantities of one, ten, one hundred, one thousand, and one million (Fig. 12).

The following Tables will assist you in conversion procedures.

Mega - (M) Million
Deci - (D) Tenth
Kilo - (K) Thousand
Centi - (C) Hundreth
Milli - (m) Thousandth

J901N-2

Fig. 12 Metric Prefixes

CONVERSION TABLES

in-lbs to N•m

in- lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m
2	.2260	42	4.7453	82	9.2646	122	13.7839	162	18.3032
4	.4519	44	4.9713	84	9.4906	124	14.0099	164	18.5292
6	.6779	46	5.1972	86	9.7165	126	14.2359	166	18.7552
8	.9039	48	5.4232	88	9.9425	128	14.4618	168	18.9811
10	1.1298	50	5.6492	90	10.1685	130	14.6878	170	19.2071
12	1.3558	52	5.8751	92	10.3944	132	14.9138	172	19.4331
14	1.5818	54	6.1011	94	10.6204	134	15.1397	174	19.6590
16	1.8077	56	6.3270	96	10.8464	136	15.3657	176	19.8850
18	2.0337	58	6.5530	98	11.0723	138	15.5917	178	20.1110
20	2.2597	60	6.7790	100	11.2983	140	15.8176	180	20.3369
22	2.4856	62	7.0049	102	11.5243	142	16.0436	182	20.5629
24	2.7116	64	7.2309	104	11.7502	144	16.2696	184	20.7889
26	2.9376	66	7.4569	106	11.9762	146	16.4955	186	21.0148
28	3.1635	68	7.6828	108	12.2022	148	16.7215	188	21.2408
30	3.3895	70	7.9088	110	12.4281	150	16.9475	190	21.4668
32	3.6155	72	8.1348	112	12.6541	152	17.1734	192	21.6927
34	3.8414	74	8.3607	114	12.8801	154	17.3994	194	21.9187
36	4.0674	76	8.5867	116	13.1060	156	17.6253	196	22.1447
38	4.2934	78	8.8127	118	13.3320	158	17.8513	198	22.3706
40	4.5193	80	9.0386	120	13.5580	160	18.0773	200	22.5966

N•m to in-lbs

N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb
.2	1.7702	4.2	37.1747	8.2	72.5792	12.2	107.9837	16.2	143.3882
.4	3.5404	4.4	38.9449	8.4	74.3494	12.4	109.7539	16.4	145.1584
.6	5.3107	4.6	40.7152	8.6	76.1197	12.6	111.5242	16.6	146.9287
.8	7.0809	4.8	42.4854	8.8	77.8899	12.8	113.2944	16.8	148.6989
1	8.8511	5	44.2556	9	79.6601	13	115.0646	17	150.4691
1.2	10.6213	5.2	46.0258	9.2	81.4303	13.2	116.8348	17.2	152.2393
1.4	12.3916	5.4	47.7961	9.4	83.2006	13.4	118.6051	17.4	154.0096
1.6	14.1618	5.6	49.5663	9.6	84.9708	13.6	120.3753	17.6	155.7798
1.8	15.9320	5.8	51.3365	9.8	86.7410	13.8	122.1455	17.8	157.5500
2	17.7022	6	53.1067	10	88.5112	14	123.9157	18	159.3202
2.2	19.4725	6.2	54.8770	10.2	90.2815	14.2	125.6860	18.5	163.7458
2.4	21.2427	6.4	56.6472	10.4	92.0517	14.4	127.4562	19	168.1714
2.6	23.0129	6.6	58.4174	10.6	93.8219	14.6	129.2264	19.5	172.5970
2.8	24.7831	6.8	60.1876	10.8	95.5921	14.8	130.9966	20	177.0225
3	26.5534	7	61.9579	11	97.3624	15	132.7669	20.5	181.4480
3.2	28.3236	7.2	63.7281	11.2	99.1326	15.2	134.5371	21	185.8736
3.4	30.0938	7.4	65.4983	11.4	100.9028	15.4	136.3073	22	194.7247
3.6	31.8640	7.6	67.2685	11.6	102.6730	15.6	138.0775	23	203.5759
3.8	33.6342	7.8	69.0388	11.8	104.4433	15.8	139.8478	24	212.4270
4	35.4045	8	70.8090	12	106.2135	16	141.6180	25	221.2781

ft-lbs to N•m

ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m
1	1.3558	21	28.4722	41	55.5885	61	82.7049	81	109.8212
2	2.7116	22	29.8280	42	56.9444	62	84.0607	82	111.1770
3	4.0675	23	31.1838	43	58.3002	63	85.4165	83	112.5328
4	5.4233	24	32.5396	44	59.6560	64	86.7723	84	113.8888
5	6.7791	25	33.8954	45	61.0118	65	88.1281	85	115.2446
6	8.1349	26	35.2513	46	62.3676	66	89.4840	86	116.6004
7	9.4907	27	36.6071	47	63.7234	67	90.8398	87	117.9562
8	10.8465	28	37.9629	48	65.0793	68	92.1956	88	119.3120
9	12.2024	29	39.3187	49	66.4351	69	93.5514	89	120.6678
10	13.5582	30	40.6745	50	67.7909	70	94.9073	90	122.0236
11	14.9140	31	42.0304	51	69.1467	71	96.2631	91	123.3794
12	16.2698	32	43.3862	52	70.5025	72	97.6189	92	124.7352
13	17.6256	33	44.7420	53	71.8583	73	98.9747	93	126.0910
14	18.9815	34	46.0978	54	73.2142	74	100.3316	94	127.4468
15	20.3373	35	47.4536	55	74.5700	75	101.6862	95	128.8026
16	21.6931	36	48.8094	56	75.9258	76	103.0422	96	130.1586
17	23.0489	37	50.1653	57	77.2816	77	104.3980	97	131.5144
18	24.4047	38	51.5211	58	78.6374	78	105.7538	98	132.8702
19	25.7605	39	52.8769	59	79.9933	79	107.1196	99	134.2260
20	27.1164	40	54.2327	60	81.3491	80	108.4654	100	135.5820

N•m to ft-lbs

N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1	.7376	21	15.9888	41	30.2400	61	44.9913	81	59.7425
2	1.4751	22	16.2264	42	30.9776	62	45.7289	82	60.4801
3	2.2127	23	16.9639	43	31.7152	63	46.4664	83	61.2177
4	2.9502	24	17.7015	44	32.4527	64	47.2040	84	61.9552
5	3.6878	25	18.4391	45	33.1903	65	47.9415	85	62.6928
6	4.4254	26	19.1766	46	33.9279	66	48.6791	86	63.4303
7	5.1629	27	19.9142	47	34.6654	67	49.4167	87	64.1679
8	5.9005	28	20.6517	48	35.4030	68	50.1542	88	64.9545
9	6.6381	29	21.3893	49	36.1405	69	50.8918	89	65.6430
10	7.3756	30	22.1269	50	36.8781	70	51.6293	90	66.3806
11	8.1132	31	22.8644	51	37.6157	71	52.3669	91	67.1181
12	8.8507	32	23.6020	52	38.3532	72	53.1045	92	67.8557
13	9.5883	33	24.3395	53	39.0908	73	53.8420	93	68.5933
14	10.3259	34	25.0771	54	39.8284	74	54.5720	94	69.3308
15	11.0634	35	25.8147	55	40.5659	75	55.3172	95	70.0684
16	11.8010	36	26.5522	56	41.3035	76	56.0547	96	70.8060
17	12.5386	37	27.2898	57	42.0410	77	56.7923	97	71.5435
18	13.2761	38	28.0274	58	42.7786	78	57.5298	98	72.2811
19	14.0137	39	28.7649	59	43.5162	79	58.2674	99	73.0187
20	14.7512	40	29.5025	60	44.2537	80	59.0050	100	73.7562

in. to mm

in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
.01	.254	.21	5.334	.41	10.414	.61	15.494	.81	20.574
.02	.508	.22	5.588	.42	10.668	.62	15.748	.82	20.828
.03	.762	.23	5.842	.43	10.922	.63	16.002	.83	21.082
.04	1.016	.24	6.096	.44	11.176	.64	16.256	.84	21.336
.05	1.270	.25	6.350	.45	11.430	.65	16.510	.85	21.590
.06	1.524	.26	6.604	.46	11.684	.66	16.764	.86	21.844
.07	1.778	.27	6.858	.47	11.938	.67	17.018	.87	22.098
.08	2.032	.28	7.112	.48	12.192	.68	17.272	.88	22.352
.09	2.286	.29	7.366	.49	12.446	.69	17.526	.89	22.606
.10	2.540	.30	7.620	.50	12.700	.70	17.780	.90	22.860
.11	2.794	.31	7.874	.51	12.954	.71	18.034	.91	23.114
.12	3.048	.32	8.128	.52	13.208	.72	18.288	.92	23.368
.13	3.302	.33	8.382	.53	13.462	.73	18.542	.93	23.622
.14	3.556	.34	8.636	.54	13.716	.74	18.796	.94	23.876
.15	3.810	.35	8.890	.55	13.970	.75	19.050	.95	24.130
.16	4.064	.36	9.144	.56	14.224	.76	19.304	.96	24.384
.17	3.318	.37	9.398	.57	14.478	.77	19.558	.97	24.638
.18	4.572	.38	9.652	.58	14.732	.78	19.812	.98	24.892
.19	4.826	.39	9.906	.59	14.986	.79	20.066	.99	25.146
.20	5.080	.40	10.160	.60	15.240	.80	20.320	1.00	25.400

mm to in.

mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
.01	.00039	.21	.00827	.41	.01614	.61	.02402	.81	.03189
.02	.00079	.22	.00866	.42	.01654	.62	.02441	.82	.03228
.03	.00118	.23	.00906	.43	.01693	.63	.02480	.83	.03268
.04	.00157	.24	.00945	.44	.01732	.64	.02520	.84	.03307
.05	.00197	.25	.00984	.45	.01772	.65	.02559	.85	.03346
.06	.00236	.26	.01024	.46	.01811	.66	.02598	.86	.03386
.07	.00276	.27	.01063	.47	.01850	.67	.02638	.87	.03425
.08	.00315	.28	.01102	.48	.01890	.68	.02677	.88	.03465
.09	.00354	.29	.01142	.49	.01929	.69	.02717	.89	.03504
.10	.00394	.30	.01181	.50	01969	.70	.02756	.90	.03543
.11	.00433	.31	.01220	.51	.02008	.71	.02795	.91	.03583
.12	.00472	.32	.01260	.52	.02047	.72	.02835	.92	.03622
.13	.00512	.33	.01299	.53	.02087	.73	.02874	.93	.03661
.14	.00551	.34	.01339	.54	.02126	.74	.02913	.94	.03701
.15	.00591	.35	.01378	.55	.02165	.75	.02953	.95	.03740
.16	.00630	.36	.01417	.56	.02205	.76	.02992	.96	.03780
.17	.00669	.37	.01457	.57	.02244	.77	.03032	.97	.03819
.18	.00709	.38	.01496	.58	.02283	.78	.03071	.98	.03858
.19	.00748	.39	.01535	.59	.02323	.79	.03110	.99	.03898
.20	.00787	.40	.01575	.60	.02362	.80	.03150	1.00	.03937

J901N-10

CONVERSION TABLES (CONT.)

Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
in.-lbs.	x 0.11298	= Newton-Metres (N•m)	(N•m)	x 8.851	= in.-lbs.
ft.-lbs.	x 1.3558	= Newton-Metres (N•m)	(N•m)	x 0.7376	= ft.-lbs.
Inches Hg. (60°F)	x 3.377	= Kilopascals (kPa)	(kPa)	x 0.2961	= Inches Hg.
Pounds/Sq. In.	x 6.895	= Kilopascals (kPa)	(kPa)	x 0.145	= Pounds/Sq. In.
Inches	x 25.4	= Millimetres (mm)	(mm)	x 0.03937	= Inches
Feet	x 0.3048	= Metres (M)	(M)	x 3.281	= Feet
Yards	x 0.9144	= Metres (M)	(M)	x 1.0936	= Yards
Miles	x 1.6093	= Kilometres (Km)	(Km)	x 0.6214	= Miles
Miles/Hr.	x 1.6093	= Kilometres/Hr. (Km/h)	(Km/h)	x 0.6214	= Miles/Hr.
Feet/Sec.	x 0.3048	= Metres/Sec. (M/S)	(M/S)	x 3.281	= Feet/Sec.
Kilometres/Hr.	x 0.27778	= Metres/Sec. (M/S)	(M/S)	x 3.600	= Kilometres/Hr.
Miles/Hr.	x 0.4470	= Metres/Sec. (M/S)	(M/S)	x 2.237	= Miles/Hr.

COMMON METRIC EQUIVALENTS

1 Inch = 25 Millimeters
1 Foot = 0.3 Meter
1 Yard = 0.9 Meter
1 Mile = 1.6 Kilometers

1 Cubic Inch = 16 Cubic Centimeters
1 Cubic Foot = 0.03 Cubic Meter
1 Cubic Yard = 0.8 Cubic Meter

J901N-11

LUBRICATION AND MAINTENANCE

CONTENTS

GENERAL INFORMATION

INDEX

INTRODUCTION

Maintenance and lubrication service recommendations have been compiled to provide maximum protection for the owner's investment against all reasonable types of driving conditions.

Since these conditions vary with the individual operator's driving habits, the area in which the vehicle is operated and the type of service to which the vehicle is subjected, it is necessary to prescribe lubrication and maintenance service on a time schedule as well as a mileage interval basis.

Additional information can be found in the Owner's Manual provided with the vehicle.

It is the owner's responsibility to determine driving conditions (normal or severe service operation), to have the vehicle serviced according to the Maintenance Schedule and to pay for the necessary parts and labor.

SEVERE SERVICE

If your vehicle is subjected to severe service operation, maintenance should be performed twice as frequently, for example, every 3 1/2 months instead of every 7 months, or every 6 000 km (3,750 miles) instead of every 12 000 km (7,500 miles). Severe service operation is defined as:

- Frequent starting and stopping.
- Frequent long periods of engine idling.
- Frequent short trips of less than 24 km (15 miles).
- Frequent driving in dusty conditions.
- Cold climate operation (temperature of -12°C or +10°F or less).
- Sustained high speed operation (speeds over 112 km/h or 70 mph).
- Trailer towing.
- Commercial service.
- Frequent operation on dusty roads.
- Off-road driving.

After extended operation in mud, sand, water, or similar dirty conditions, have your brake drums, brake linings, and axle joints inspected and cleaned as soon as possible. This will prevent any abrasive wear or unpredictable braking action.

Following off-road usage, completely inspect the underbody of your vehicle. Check tires, body structure, steering, suspension, and exhaust system for damage. Check threaded fasteners for looseness, particularly on the chassis, drivetrain components, steering and suspension. Tighten, if required, to the torque values in the Service Manuals. Also check for accumulations of vegetation or brush that could become a fire hazard or conceal damage to fuel lines, brake hoses, axle pinion seals, and propeller shafts.

Under frequent severe service driving conditions, change all lubricants and lubricate body components, all driveline joints and steering linkage more often than in normal service to prevent excessive wear.

FUEL USAGE

All engines require the use of unleaded fuel to reduce exhaust emissions, and to protect the catalytic converters. Use a fuel with an octane rating of at least 87, (R + M)/2.

UNLEADED GASOLINE ONLY must be used in ve hicles equipped with catalyst emission control systems. All vehicles have labels located on the instrument panel under fuel gauge (Fig. 1) and on the fuel filler door (Fig. 2) that state UNLEADED FUEL ONLY. These vehicles also have fuel filler tubes specially designed to accept the smaller diameter unleaded gasoline dispensing nozzles only.

The exhaust emission system of your vehicle is designed to meet all emission regulations while, at the same time, provide excellent fuel economy.

CLASSIFICATION OF LUBRICANTS

Oils, lubricants, and greases are classified and graded according to standards recommended by the Society of Automotive Engineers (SAE), American Petroleum Institute (API) and National Lubricating Grease Institute (NLGI).

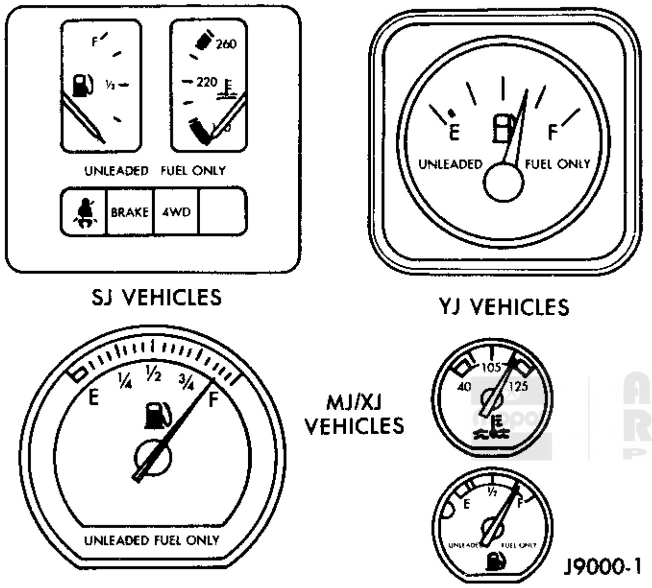


Fig. 1 UNLEADED FUEL ONLY - Fuel Gauge

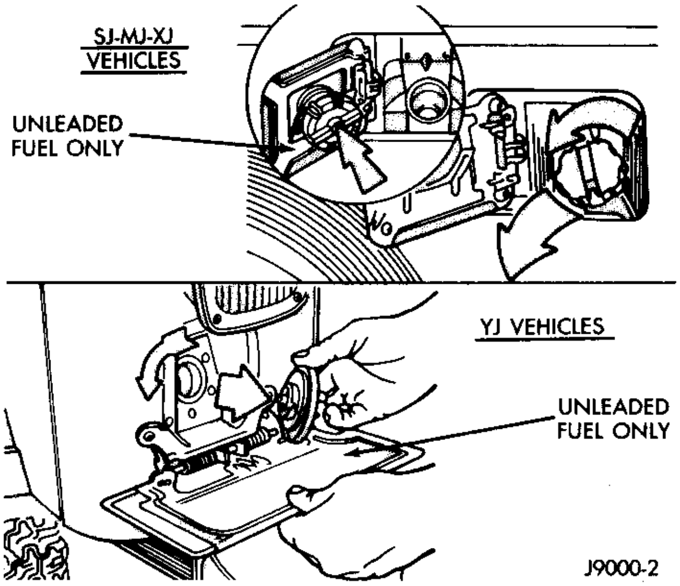


Fig. 2 UNLEADED FUEL ONLY - Fuel Filler Door

Engine Oil

The SAE grade number indicates the viscosity of engine oils, for example, SAE 30, which is a single grade oil. Engine oils are also identified by a dual number, for example, SAE 5W-30, which indicates a multi-grade oil.

Gear Lubricants

The SAE grade number also indicates the viscosity of Multipurpose Gear Lubricants.

The API classification system defines gear lubricants in terms of usage such as API GL-4 or API GL-5, etc.

Lubricants and Greases

Semisolid lubricants, bear the NLGI designation and are further classified as grades 0, 1, 2, 3, etc.

PARTS AND LUBRICATION RECOMMENDATION

Your Jeep vehicle has been engineered to perform for you for years to come. You will occasionally require service and maintenance for your vehicle and **Chrysler Motors recommends the use of MOPAR brand parts and accessories.** Each MOPAR part has been specifically designed to maintain top efficiency and quality by the same team of engineers who designed your vehicle. Only MOPAR can make this claim.

Remember, whenever your Jeep requires a new part, always request the brand name MOPAR - it's worth the effort.

PARTS REQUIRING NO LUBRICATION

There are many points that should not be lubricated; some because they are permanently lubricated, some because lubricants will be detrimental to their operating characteristics, and some because lubricants will cause component failures. In particular, rubber bushings should not be lubricated since this not only will cause them to fail, but will destroy their necessary frictional characteristics. Parts that should not be lubricated are as follows:

- Air Pumps
- Alternator Bearings
- Drive Belts
- Fan Belt Idler Pulley
- Front Wheel Bearings
- Rubber Bushings
- Starter Bearings
- Suspension Strut Bearing
- Throttle Control Cable
- Throttle Linkage
- Water Pump Bearings

LUBRICATION AND MAINTENANCE SCHEDULES

MJ AND XJ VEHICLES

● = Required x = Recommended Miles (Thousand)	7½	15	22½	30	37½	45	52½	60	67½	75	82½	90	97½	105	112½	120
Kilometers (Thousands)	12	24	36	48	60	72½	84½	96½	108½	120½	133	145	157	169	181	193
1. Oil—Change	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2. Oil Filter—Change	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
3. Exhaust System—Check (Except California)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Exhaust System—Check (California)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4. Prop Shafts—Lube U-Joints — Inspect Seals	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5. Steering Linkage—Check and Lubricate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
6. Manual Steering Gear—Check	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
7. Automatic Transmission Fluid—Replace				x				x				x				x
8. Manual Transmission Fluid—Check	x	x	x		x	x	x		x	x	x		x	x	x	
Manual Transmission Fluid—Replace				x				x				x				x
9. Axles/Transfer Case Fluid—Check	x	x	x		x	x	x		x	x	x		x	x	x	
Axles/Transfer Case Fluid—Replace				x				x				x				x
10. Spark Plugs—Replace[2]				●				●				●				●
11. Air Filter—Replace				●				●				●				●
12. Drive Belts—Inspect and Adjust				●				●				●				●
Drive Belts—Replace								●								●
13. Fuel Filter—Replace				●				●				●				●
14. Coolant—Replace[1]							x				x				x	
15. Brakes—Check (Wheel Brgs. 2WD only)				x				x				x				x
16. Body Components—Lubricate				x				x				x				x
17. Emission System Vacuum Hoses—Replace[2]								●								●
18. Ignition Wires—Replace[2]								●								●
19. Distributor Cap and Rotor—Replace								●								●
20. Oxygen Sensor—Replace[3]											●					
21. Battery—Replace								x								x

INSPECTION AND SERVICE SHOULD ALSO BE PERFORMED ANYTIME A MALFUNCTION IS OBSERVED OR SUSPECTED. RETAIN ALL RECEIPTS.

1. Or 36 months (24 months thereafter).
2. Required EPA designed emission-related maintenance item.
3. Required EPA designated critical emission-related item.

J9000-29

YJ VEHICLES

● = Required x = Recommended — Miles (Thousand)	7½	15	22½	30	37½	45	52½	60	67½	75	82½	90	97½	105	112½	120
Kilometers (Thousands)	12	24	36	48	60	72½	84½	96½	108½	120½	133	145	157	169	181	193
1. Oil—Change	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2. Oil Filter—Change	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
3. Exhaust System—Check (Except California)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Exhaust System—Check (California)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4. Prop Shafts—Lube U-Joints Inspect Seals	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5. Steering Linkage—Check and Lubricate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
6. Manual Steering Gear—Check	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
7. Automatic Transmission Fluid—Replace				x				x				x				x
8. Manual Transmission Fluid—Check	x	x	x		x	x	x		x	x	x		x	x	x	
Manual Transmission Fluid—Replace				x				x				x				x
9. Axles/Transfer Case Fluid—Check	x	x	x		x	x	x		x	x	x		x	x	x	
Axles/Transfer Case Fluid—Replace				x				x				x				x
10. Spark Plugs—Replace[2]				●				●				●				●
11. Air Filter—Replace				●				●				●				●
12. Drive Belts—Inspect/Adjust				●				●				●				●
V-Belts—Inspect/Adjust (Except Calif.)		●		●		●		●				●				●
6-Cyl. Belts—Inspect/Adjust (California)		x		●		x		●				●				●
Drive Belts—Replace								●								●
13. Idle Speed (Curb./Fast Idle)—Check/Adjust[4]							●							●		
14. Choke Linkage—Clean				●			●				●			●		
15. Fuel Filter—Replace				●				●				●				●
16. Coolant—Replace[1]							x				x				x	
17. Brakes—Check				x				x				x				x
18. Front Wheel Bearings—Lubricate				x				x				x				x
19. Body Components—Lubricate				x				x				x				x
20. Emission System Vacuum Hoses—Replace[3]								●								●
21. Ignition Wires—Replace[2]								●								●
22. Ignition Timing—Check							●							●		
23. Distributor Cap and Rotor—Replace								●								●
24. PCV Filter—Clean and Oil				●				●				●				●
25. PCV Valve—Replace[3]											●					
26. Oxygen Sensor—Replace[3]											●					
27. Battery—Replace								x								x

INSPECTION AND SERVICE SHOULD ALSO BE PERFORMED ANYTIME A MALFUNCTION IS OBSERVED OR SUSPECTED. RETAIN ALL RECEIPTS.

1. Or 36 months (24 months thereafter).
2. Required EPA designed emission-related maintenance item.
3. Required EPA designated critical emission-related item.
4. At 8 000 km (5,000 miles), check and adjust (no charge to owner).

J9000-30

SJ VEHICLES

● = Required x = Recommended Miles (Thousand)	7½	15	22½	30	37½	45	52½	60	67½	75	82½	90	97½	105	112½	120
Kilometers (Thousands)	12	24	36	48	60	72½	84½	96½	108½	120½	133	145	157	169	181	193
1. Oil—Change	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2. Oil Filter—Change	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
3. Exhaust System—Check (Except California)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Exhaust System—Check (California)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4. Prop Shafts—Double Cardan Joint—Lubricate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Prop Shaft Seals—Inspect	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5. Steering Linkage—Check and Lubricate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
6. Automatic Transmission Fluid—Replace				x				x				x				x
7. Axles/Transfer Case Fluid—Check	x	x	x		x	x	x		x	x	x		x	x	x	
Axles/Transfer Case Fluid—Replace				x				x				x				x
8. Spark Plugs—Replace[2]				●				●				●				●
9. Air Filter—Replace (Except California)				●				●				●				●
Air Filter—Replace (California)		x		●		x		●				●				●
10. Drive Belts—Inspect/Adjust		●		●		●		●		●		●		●		●
Drive Belts—Replace							●							●		
11. Idle Speed—Check/Adjust[4] (Except California)							●							●		
Idle Speed—Check/Adjust[4] (California)		x					●							●		
12. Choke Linkage—Clean				●			●				●			●		
13. Fuel Filter—Replace				●				●				●				●
14. Coolant—Replace[1]			x			x			x			x			x	
15. Brakes—Check				x				x				x				x
16. Front Wheel Bearings—Lubricate				x				x				x				x
17. Body Components—Lubricate				x				x				x				x
18. Emission System Vacuum Hoses—Replace[2]							●							●		
Vacuum Fitting Hoses/Conn—Inspect (Cal.)				x			●							●		
19. Ignition Wires—Replace[2]							●							●		
20. Ignition Timing—Check (Except California)							●							●		
Ignition Timing—Check (California)				x			●							●		
21. Dist. Cap Rotor—Replace (Except Calif.)							●							●		
Dist. Cap/Rotor—Replace (Calif.)				x			●							●		
22. Exhaust Heat Valve—Lubricate				●				●				●				●
23. PCV Filter—Clean and Oil				●				●				●				●
24. PCV Valve—Replace[3] [4]											●					
25. PCV Hoses—Inspect (California)				x				x				x				x
26. Dist. Vacuum/Centrifugal Adv—Check (Calif.)				x				x				x				x
27. Therm Air Cleaner Ctrl Valve—Inspect (Cal.)				x				x				x				x
28. Fuel Sys, Cap, Tank, Lines/Conn—Inspect (Cal.)				x				x				x				x
29. Battery—Replace								x								x

INSPECTION AND SERVICE SHOULD ALSO BE PERFORMED ANYTIME A MALFUNCTION IS OBSERVED OR SUSPECTED. RETAIN ALL RECEIPTS.

1. Or 36 months (24 months thereafter).
2. Required EPA designed emission-related maintenance item.
3. Required EPA designated critical emission-related item.
4. At 8 000 km (5,000 miles), check and adjust (no charge to owner).

J9000-31

FLUID CAPACITIES

ENGINE OIL	QUARTS	LITERS	OIL GRADES
2.5L Engine	4.0	3.8	SG or SG/CD
4.0L/4.2L Engine	6.0	5.7	SG or SG/CD
5.9L Engine	5.0	4.7	SG or SG/CD

COOLING SYSTEM	QUARTS	LITERS	RESERVE BOTTLE
2.5L (except YJ Vehicles)	10.0	9.5	2.3 QT (2.1L)
2.5L (YJ Vehicles)	9.0	8.5	1.0 QT (0.9L)
4.0L	12.0	11.4	2.3 QT (2.1L)
4.2L	10.5	9.9	1.0 QT (0.9L)
5.9L	15.5	14.7	1.5 QT (1.4L)

TRANSMISSIONS (Dry Refill)		PINTS	LITERS	TYPE
AX-4	2 WD	7.8	3.7	Man. 4 Speed
AX-5	4 WD	7.0	3.3	Man. 5 Speed
AX-15	4 WD	6.6	3.12	Man. 5 Speed
AX-5	2 WD	7.4	3.5	Man. 5 Speed
AX-15	2 WD	6.7	3.17	Man. 5 Speed
AW-4		17.0	8.0	Automatic
727		8 to 10	3.8 to 4.8	Automatic
999		16.0	7.6	Automatic

Use API GL5 75W-90 grade lubrication for the Manual Transmissions. Use MERCON® or DEXRON II® grade lubrication for the Automatic Transmissions.
Quantity may vary depending on service operation performed.

FRONT/REAR AXLES	PINTS	LITERS	GRADE
XJ Vehicles (1)	2.5	1.2	API GL5 75W-90
MJ/YJ Vehicles (3) (2)	2.5	1.2	API GL5 75W-90
Heavy Duty Axle (3) (2)	3.0	1.4	API GL5 75W-90
SJ Vehicles (3) (2)	3.8	1.8	API GL5 75W-90

(1) With Trailer Towing Package III (5000 lbs) use 75W-140 Synthetic Gear Oil
(2) With Trailer Towing Package use API GL5 80W-140
(3) With Limited Slip Differential, Add 2 ounces of Friction Modifier

TRANSFER CASE	PINTS	LITERS	GRADE
SELEC-TRAC 242	3.0	1.4	MERCON® or DEXRON II®
COMMAND-TRAC 231	2.2	1.0	MERCON® or DEXRON II®
COMMAND-TRAC 231 (YJ Vehicles)	3.3	1.5	MERCON® or DEXRON II®
MODEL 229	6.0	2.8	MERCON® or DEXRON II®

FUEL TANK	GALLONS	LITERS
SJ Vehicles	20.3	76.8
MJ Vehicles (Short Bed)	18.5	70.0
MJ Vehicles (Long Bed)	23.5	89.0
XJ Vehicles	20.2	76.4
YJ Vehicles	20.0	75.7

J9000-33

ASSIST (JUMP) STARTING

WARNING: DO NOT ATTEMPT TO PUSH OR TOW A VEHICLE TO GET IT STARTED. UNBURNED FUEL COULD ENTER THE CONVERTER AND, ONCE THE ENGINE HAS STARTED, IGNITE AND CAUSE THE CONVERTER TO OVERHEAT AND RUPTURE.

Booster Battery

WARNING: TO PREVENT PERSONAL INJURY OR DAMAGE TO CLOTHING, DO NOT ALLOW BATTERY FLUID TO CONTACT EYES, SKIN OR FABRICS. DO NOT LEAN OVER A BATTERY WHEN CONNECTING JUMPER CABLES OR ALLOW CABLE CLAMPS TO TOUCH EACH OTHER. KEEP OPEN FLAMES OR SPARKS AWAY FROM BATTERY VENT HOLES. ALWAYS WEAR EYE PROTECTION WHEN WORKING WITH BATTERIES.

If it becomes necessary to use a booster battery, with jumper cables, to start a vehicle's engine because its battery is discharged, the following procedure should be followed:

(1) Set parking brake and place automatic transmission in PARK (NEUTRAL for manual transmission).

(2) Turn off lights, heater, and other electrical loads.

(3) Raise vent caps from discharged battery with a flat, nonmetallic tool and remove the caps. It may be necessary to loosen the battery holddown clamp to remove the caps. Check fluid level. If low, fluid must be brought to proper level before jump starting is attempted.

WARNING: WHEN TEMPERATURES ARE BELOW THE FREEZING POINT, ELECTROLYTE IN A DISCHARGED BATTERY MAY FREEZE. DO NOT ATTEMPT JUMP STARTING BECAUSE BATTERY COULD RUPTURE OR EXPLODE.

(4) Check fluid condition. If slushy or frozen, battery must be brought up to 40°F (4°C) before it can be safely jump started or charged.

(5) Install vent caps on discharged battery vent wells A relief valve in the cap prevents pressure build-up.

CAUTION: Do not permit the vehicles to touch each other as this could establish a ground connection and counteract the benefits of this procedure.

(6) Attach one end of one jumper cable to the positive (+) terminal of the booster battery and other end of the same cable to the positive terminal of the discharged battery (Fig. 3).

WARNING: DO NOT CONNECT JUMPER CABLE TO THE NEGATIVE POST OF THE DISCHARGED BATTERY.

(7) Connect one end of other jumper cable to negative (-) terminal of the booster battery. Connect the other end of jumper cable to a good ground on the vehicle with the discharged battery. Make sure the ground area is free of dirt and grease and that a good connection is made. The negative connection must provide good electrical conductivity and current carrying capacity.

(8) After engine is started or if engine fails to start, cables must be disconnected in the following order:

(a) Negative cable at engine ground.

(b) Negative cable at negative post on booster battery.

(c) Cable between positive post of both batteries.

WARNING: ANY PROCEDURE OTHER THAN THE ABOVE COULD RESULT IN:

1) PERSONAL INJURY CAUSED BY ELECTROLYTE SQUIRTING OUT BATTERY VENT.

2) PERSONAL INJURY OR PROPERTY DAMAGE DUE TO BATTERY EXPLOSION.

3) DAMAGE TO CHARGING SYSTEM OF BOOSTER VEHICLE OR OF IMMOBILIZED VEHICLE.

Portable Starting Unit

There are many types of these units available. Follow instructions of their manufacturer for necessary precautions and operations.

CAUTION: It is very important that their operating voltage does not exceed 15 volts because damage to battery, starter motor, alternator or electrical system may occur.

HOISTING RECOMMENDATIONS

See the Owner's Manual for Emergency Jacking procedures.

Floor Jack

The vehicle can be raised with a floor jack and supported with jack stands at the front and rear ends of the sub frame rails (Fig. 4).

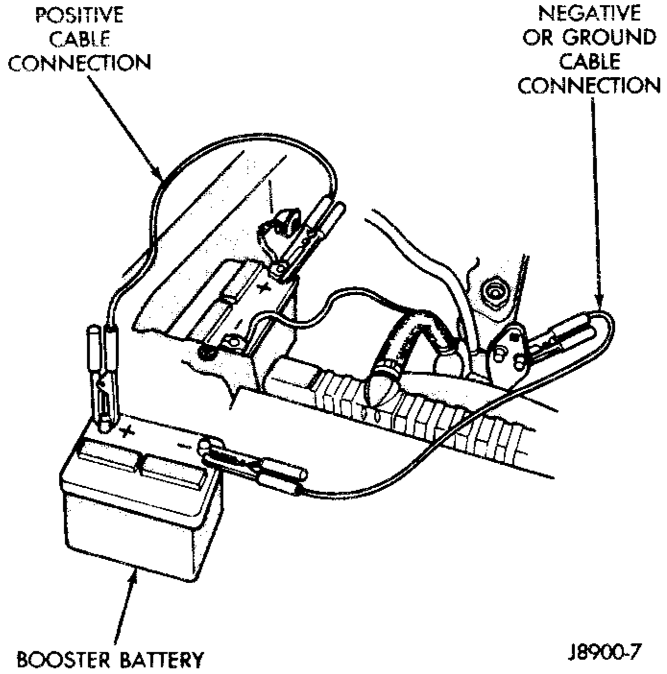


Fig. 3 Jumper Cable Hook-Up

CAUTION: Do not attempt to lift a vehicle with a floor jack positioned under the axle tubes, body side sills, steering linkage components, propeller shafts, engine/transmission oil pans, fuel tank, or front suspension arms. Use the sub frame rail lift locations only.

Hoist

The vehicle can be raised on a swiveling arm-type hoist, a wheel lift twin post or a ramp-type drive hoist.

If a swiveling arm hoist is to be used, be sure the lifting pads are positioned at sub frame rail lift points (Fig. 4).

TOWING RECOMMENDATIONS

Towing Equipment

When towing a Chrysler Motors vehicle a SAE approved sling-type towing device may be used (Fig. 5).

When a vehicle has to be rear towed, use the wheel-lift towing method with a dolly under the front wheels. A flat-bed towing device can always be used to transport a disabled vehicle (Fig. 5).

A crossbeam and spacer blocks may be required for proper attachment (Fig. 6).

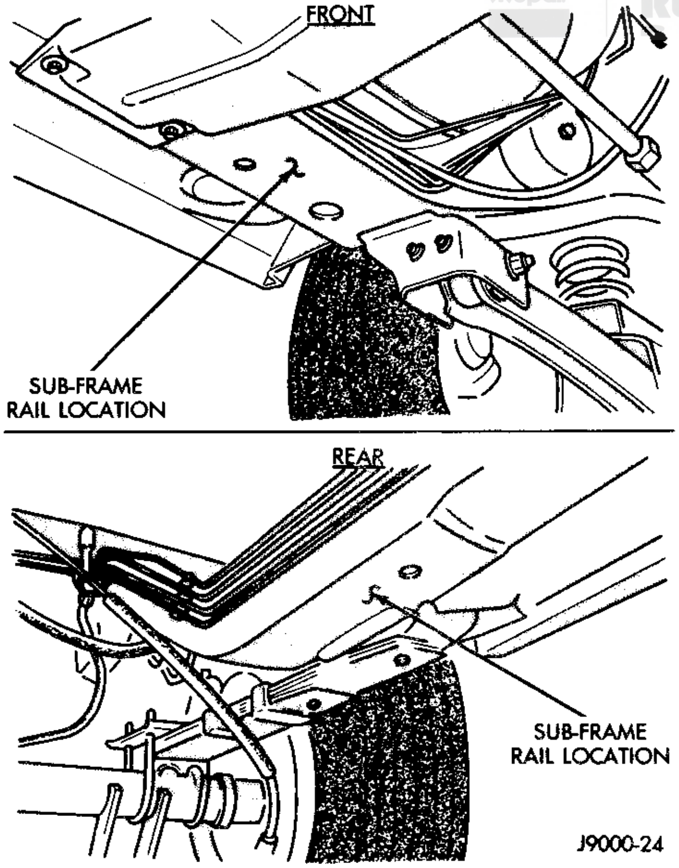


Fig. 4 Hoisting and Jacking Points

Safety Precautions

The following safety precautions must be considered when preparing for and during a vehicle towing operation:

- Secure loose and protruding parts from a disabled vehicle.
- Always use a safety chain system that is independent of the lifting and towing equipment.
- Do not allow any of the towing equipment to contact the fuel tank of the vehicle being towed.
- Do not go under the vehicle while it is lifted by the towing equipment.
- Do not allow passengers to ride in a vehicle being towed.
- Always observe all state and local laws pertaining to warning signals, night illumination, speed, etc.
- Do not attempt a towing operation that could jeopardize the operator, bystanders or other motorists.
- Do not exceed a towing speed of 48 km/h (30 mph).
- Avoid towing distances of more than 24 km (15 miles), whenever possible.

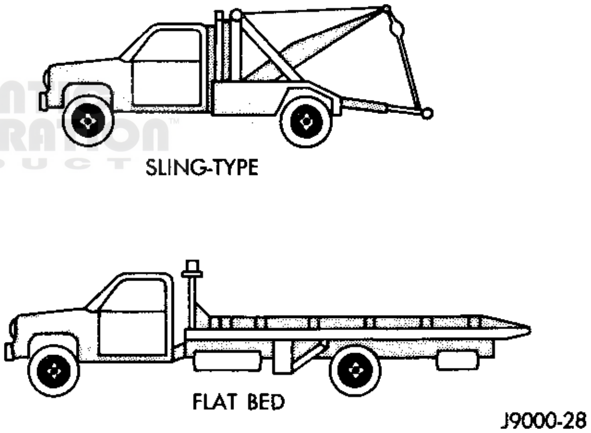


Fig. 5 Towing Devices

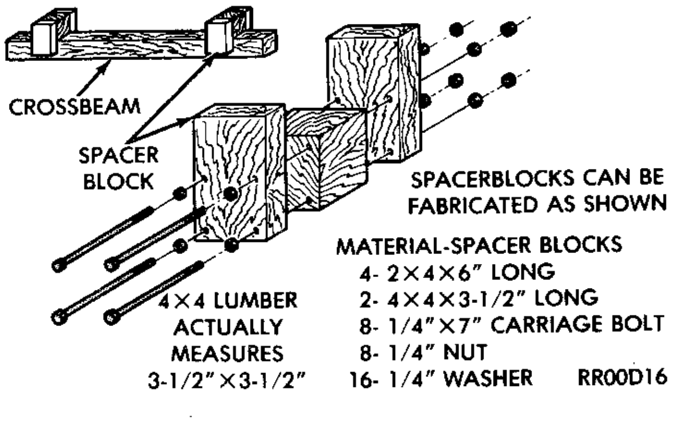


Fig. 6 Crossbeam and Spacer Block Construction

- Never attach tow chains or a tow sling to the bumper, steering linkage, universal joints, constant velocity (CV) joints, or propeller shaft.

Lifting Clearance

Ground Clearance

The end of the vehicle that is attached to the tow vehicle should be lifted a minimum of four (4) inches off the ground. Check that the opposite end has adequate ground clearance.

Ramp Angle - Flat-Bed Towing

If a flat-bed towing device is used, the approach ramp angle should not exceed 15°.

Sling-Type Towing - Front End Lift

MJ and XJ Vehicles

Follow these guidelines when the tow vehicle is attached to the front of a disabled vehicle:

(1) Always tow with the front wheels lifted off the ground and with the front wheels turned all the way to the right.

(2) Attach a J-hook to the disabled vehicle at the left side of the axle. Position the sling tow bar close to the hooks and below the front bumper (Fig. 7).

(3) Attach a chain to the right side of the disabled vehicle by positioning it over the axle and attaching it to the structural member (Fig. 8).

(4) Attach safety chains.

TWO-WHEEL DRIVE WITH MANUAL AND AUTOMATIC TRANSMISSION

(5) Turn the ignition switch to the OFF position to unlock the steering wheel.

(6) Shift the transmission into Neutral, mark the drive shaft and axle yoke for installation reference, and remove the drive shaft.

(7) Cover the exposed end of the transmission extension housing and the universal joints. Store the drive shaft in a safe place.

PART TIME (231) TRANSFER CASE WITH MANUAL TRANSMISSION

(5) Turn the ignition switch to the OFF position to unlock the steering wheel.

(6) Shift the manual transmission into a Forward Gear and the transfer case into Neutral.

PART TIME (231) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

(5) Turn the ignition switch to the OFF position to unlock the steering wheel.

(6) Shift the automatic transmission into Park and the transfer case into Neutral.

FULL TIME (242) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

(5) Turn the ignition switch to the OFF position to unlock the steering wheel.

(6) Shift the automatic transmission into Park and the transfer case into Neutral.

YJ Vehicles

Follow these guidelines when the tow vehicle is attached to the front of a disabled vehicle:

(1) Always tow with the front wheels lifted off the ground and with the front wheels turned all the way to the right.

CAUTION: Use tow chains with T-hooks for attachment to the frame rails (Fig. 9). Do not use J-hooks under any circumstances.

(2) Attach the T-hooks to the slots in the front end of each frame rail (Fig. 10).

(3) Position each chain over the top of each front spring shackle.

(4) Double wrap each chain.

(5) Position the tow bar under the front bumper.

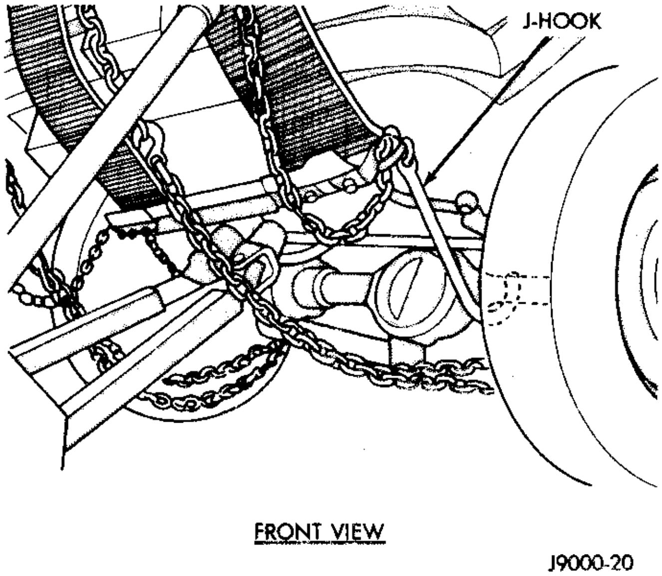


Fig. 7 Sling-Type Front Towing—Front View

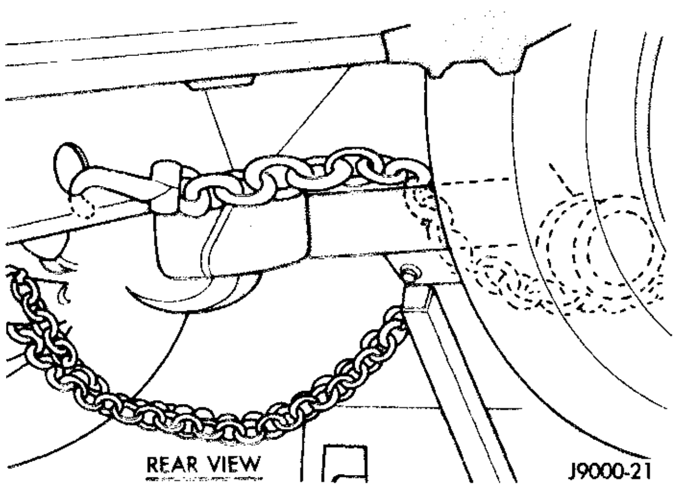


Fig. 8 Sling-Type Front Towing—Rear View

(6) Attach the safety chains to the lower half of the front spring shackles (Fig. 10).

PART TIME (231) TRANSFER CASE WITH MANUAL TRANSMISSION

(7) Turn the ignition switch to the OFF position to unlock the steering wheel.

(8) Shift the manual transmission into a Forward Gear and the transfer case into Neutral.

PART TIME (231) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

(7) Turn the ignition switch to the OFF position to unlock the steering wheel.

(8) Shift the automatic transmission into Park and the transfer case into Neutral.

SJ Vehicles

Follow these guidelines when the tow vehicle is attached to the front or rear of a disabled vehicle:

(1) Always tow with the front wheels lifted off the ground and with the front wheels turned all the way to the right.

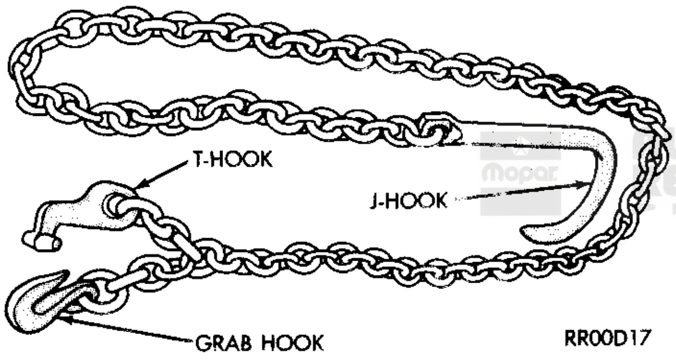


Fig. 9 Towing Chains and Hooks

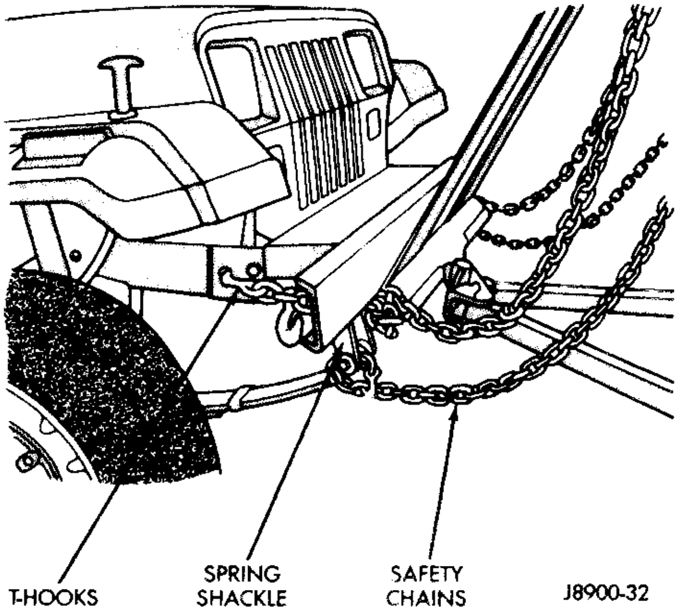


Fig. 10 Sling-Type Front Towing—YJ Vehicles

(2) Attach a J-hook around the axle outboard of the shock absorbers (Fig. 11).

(3) Place a tow bar under the spring shackles.

(4) Attach safety chains around the spring shackles (Fig. 11).

FULL TIME (229) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

When the transfer case range selector is in the neutral position both axles are disconnected from the powertrain. This allows the vehicle to be towed without removing the propeller shafts.

(5) Shift mode switch to 4WD position.

(6) With the vehicle moving slowly (3-5 km/h or 2-3 mph), shift the transmission to the Neutral (N) position.

(7) Using a firm, positive hand movement, shift the range selector lever to the Neutral (N) position.

(8) Turn ignition key switch to the unlock (OFF) position.

(9) Shift automatic transmission to the Park (P) position.

Sling-Type Towing - Rear End Lift

MJ VEHICLES - If the vehicle does not have a rear bumper, do not tow with the rear of the vehicle attached to the tow vehicle. If rear towing is absolutely necessary, place the rear wheels on a dolly and tow with front end raised.

YJ VEHICLES - Use wheel-lift equipment ONLY when rear towing is necessary.

Follow these guidelines for MJ, XJ, and SJ vehicles when the tow vehicle is attached to the rear of a disabled vehicle (Fig. 12).

(1) Attach J-hooks around the axle outboard of the shock absorber.

(2) Place a tow bar under the bumper.

(3) Attach safety chains around the frame rails.

TWO-WHEEL DRIVE WITH MANUAL AND AUTOMATIC TRANSMISSION

(4) Turn the ignition switch to the OFF position to unlock the steering wheel.

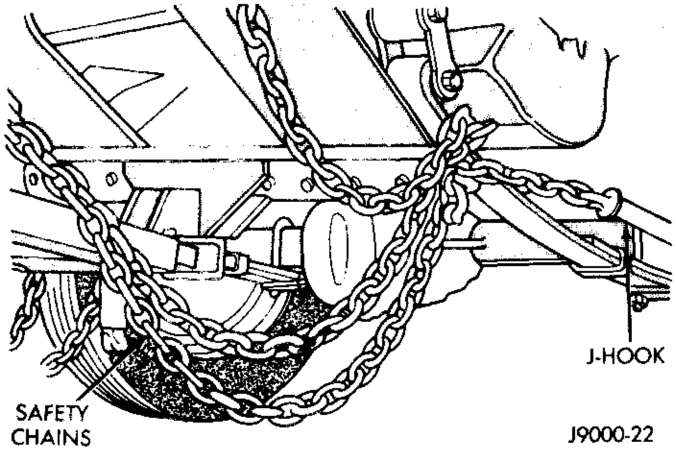


Fig. 11 Sling-Type Front Towing—SJ Vehicles

(5) Clamp the steering wheel with the front wheels in the straight ahead position. Do not use the steering column lock as a substitute for a clamping device.

(6) Shift the transmission into Neutral.

PART TIME (231) TRANSFER CASE WITH MANUAL TRANSMISSION

(4) Turn the ignition switch to the OFF position to unlock the steering column.

(5) Clamp the steering wheel with the front wheels in the straight ahead position. Do not use the steering column lock as a substitute for a clamping device.

(6) Shift the transmission into a Forward Gear and the transfer case into Neutral.

PART TIME (231) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

(4) Turn the ignition switch to the OFF position to unlock the steering column.

(5) Clamp the steering wheel with the front wheels in the straight ahead position. Do not use the steering column lock as a substitute for a clamping device.

(6) Shift the transmission into Park and the transfer case into Neutral.

FULL TIME (242) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

(4) Turn the ignition switch to the OFF position to unlock the steering column.

(5) Clamp the steering wheel with the front wheels in the straight ahead position. Do not use the steering column lock as a substitute for a clamping device.

(6) Shift the transmission into Park and the transfer case into Neutral.

FULL TIME (229) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

When the transfer case range selector is in the neutral position both axles are disconnected from the powertrain. This allows the vehicle to be towed without removing the propeller shafts.

(5) Shift mode switch to 4WD position.

(6) With the vehicle moving slowly (3-5 km/h or 2-3 mph), shift the transmission to the Neutral (N) position.

(7) Using a firm, positive hand movement, shift the range selector lever to the Neutral (N) position.

(8) Turn ignition key switch to the unlock (OFF) position.

(9) Shift automatic transmission to the Park (P) position.

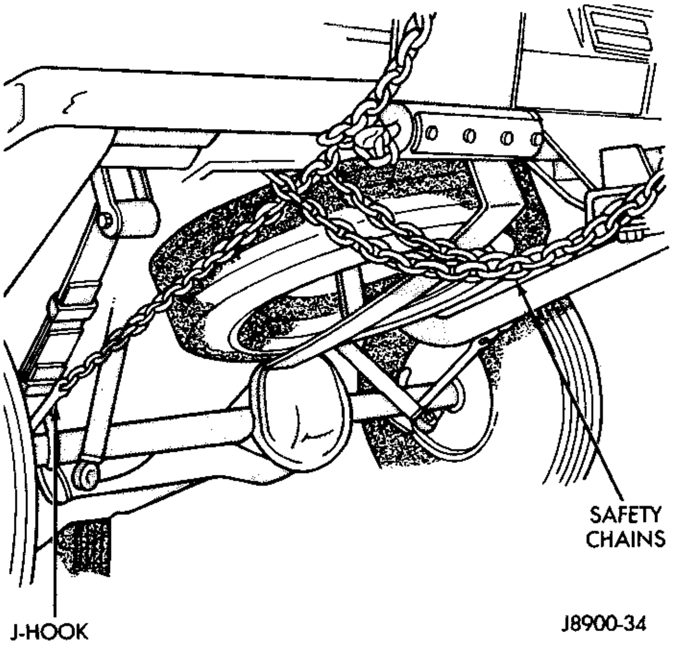


Fig. 12 Hook-Up on Sling-Type Rear Towing—Typical

Towing When Keys are not Available

Vehicle Unlocked

TWO WHEEL DRIVE VEHICLES

One of two methods can be used:

(1) Tow the vehicle with the drive shaft removed (see Sling-Type Towing - Front End Lift).

(2) Place a dolly under the rear wheels and tow with the front wheels raised.

PART TIME (231) TRANSFER CASE WITH MANUAL TRANSMISSION

(1) Shift the manual transmission into a Forward Gear.

(2) Shift the transfer case into Neutral.

(3) The vehicle may now be towed with the front wheels raised.

PART TIME (231) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

(1) Check that the automatic transmission is in Park.

(2) Shift the transfer case into Neutral.

(3) The vehicle may now be towed with the front wheels raised.

FULL TIME (242) TRANSFER CASE WITH AUTOMATIC TRANSMISSION

(1) Check that the automatic transmission is in Park.

(2) Shift the transfer case into Neutral.

(3) The vehicle may now be towed with the front wheels raised.

Vehicle Locked

Place a dolly under the rear wheels and tow with the front end raised (Fig. 13).

Flat Towing (4 Wheels on Ground)

Tow in this manner when all four wheels rotate freely. Prepare the vehicle as follows:

Two-Wheel Drive Vehicles

(1) Mark the propeller shaft and axle yoke for assembly alignment.

(2) Remove the propeller shaft. Install a protective covering over the propeller shaft U-joints to keep them assembled and protected.

(3) Cover the open end of the transmission extension housing.

Four-Wheel Drive Vehicles

(1) Mark the propeller shafts and axle yokes for assembly alignment.

(2) Remove the propeller shafts. Install a protective covering over the propeller shaft U-joints to keep them assembled and protected.

(3) Cover the open ends of the transmission extension housing and the transfer case.

CAUTION: Whenever the propeller shaft has been removed and installed, check the transmission fluid level and add fluid, if necessary. Driving the vehicle with insufficient transmission fluid may damage the transmission.

Emergency Towing - Transfer Case Not in Neutral

Whenever an emergency situation arises and the transfer case cannot be shifted to neutral, one of the following methods can be used to tow a Jeep vehicle:

- If the propeller shafts are not removed, the rear wheels must be placed on a dolly and the front end of the vehicle raised.
- If the propeller shafts are not removed, the front wheels must be placed on a dolly and the rear end of the vehicle raised.

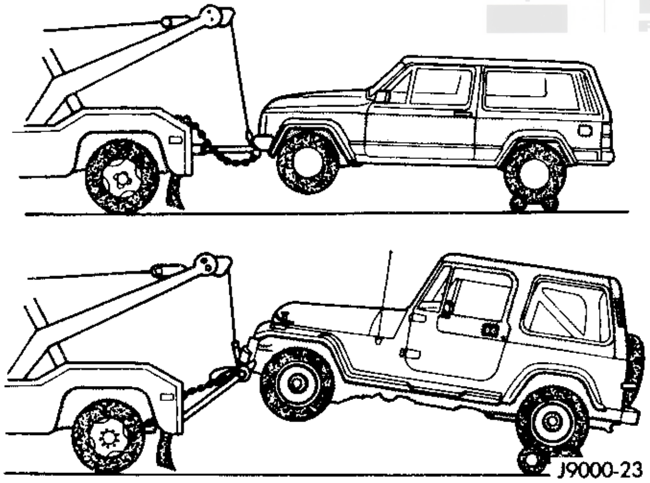


Fig. 13 Sling-Type Front Towing—Rear Wheels on Dolly

- With the rear propeller shaft removed, the vehicle can be towed with the front of the vehicle raised.
- With the front propeller shaft removed, the vehicle can be towed with the rear of the vehicle raised.
- With both propeller shafts removed, the vehicle can be towed with all four wheels on the road surface.

(1) Turn ignition key switch to the unlocked (OFF) position.

(2) Shift the transmission to the Neutral position.

(3) Determine the method of towing the vehicle and prepare the vehicle for towing.

(4) Connect the vehicle to the tow vehicle.

Emergency Tow Hooks

WARNING: STAND CLEAR OF VEHICLE WHEN PULLING WITH TOW HOOKS. TOW STRAPS AND CHAINS MAY BREAK, CAUSING SERIOUS INJURY.

Some vehicles are equipped with two hooks mounted in the front (Fig. 14). Some XJ Vvehicles also have one hook mounted in the rear.

Tow hooks are for emergency use only, such as, to rescue a vehicle stranded off the road.

CAUTION: DO NOT use tow hooks for tow truck hook-up or highway towing.

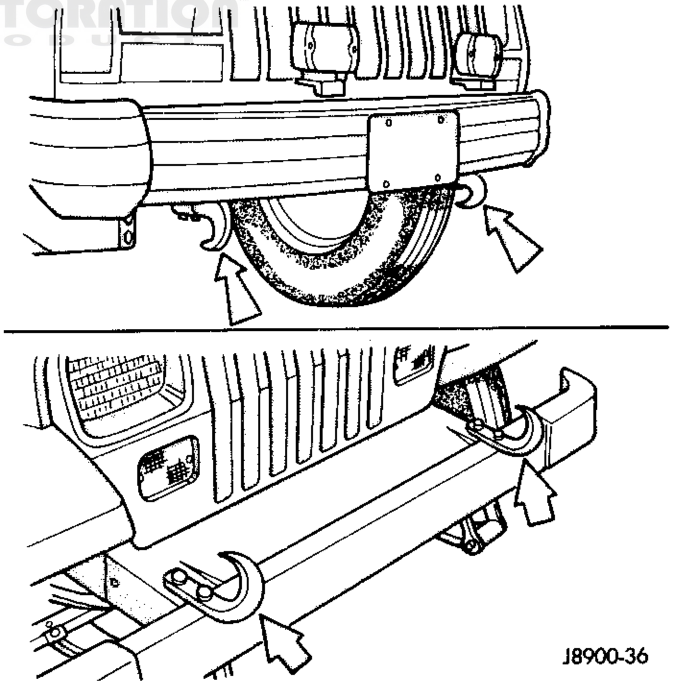


Fig. 14 Emergency Tow Hooks

ENGINE

INDEX

ENGINE OIL

During Break-In

After starting a cold engine, let it warm up for 15 seconds or so before shifting into gear.

Drive at varying speeds below 80 km/h (50 mph) for the first 160 km (100 miles) and below 88 km/h (55 mph) for the first 800 km (500 miles). Avoid driving at full throttle or top speed, steady speeds, or excessive idling during this period. Avoid fast starts and quick stops.

A break-in oil is not used. The original engine oil is the same type specified for regular oil changes. There is no need to have it changed or the oil filter replaced until the first scheduled maintenance interval, except for severe service operation. Don't add anti-friction compounds or special break-in oils during the first few thousand kilometers (or miles) of operation, since these additives might interfere with proper piston ring seating.

Check the fluid and engine oil levels regularly and be alert for indications of overheating in any component of the vehicle. Engines tend to use more fuel and oil until they are broken in, so don't expect top economy for the first 1 900 km (1,200 miles).

Allow proper break-in, at least 1 900 km (1,200 miles), before requesting engine adjustments, if needed.

Selecting Engine Oil

Oil Quality

For maximum engine protection under all driving conditions, use only engine oils that conform to API Service Catagories "SG" or "SG/CD".

Viscosity

Multi-viscosity oils protect the engine over a wide range of operating temperatures and driving conditions. Therefore these oils can be used all year round. Select oil viscosity according to the lowest air temperature expected before the next oil change (see Fig. 1).

Energy Conserving

There are many engine oils currently available that could increase the fuel economy of your vehicle. They are marketed as ENERGY CONSERVING, or ENERGY CONSERVING II. Those oils identified as ENERGY CONSERVING II provide greater fuel economy benefits than those identified as ENERGY CONSERVING. In addition to selecting the proper API quality category and viscosity grade, use of ENERGY CONSERVING type engine oils are preferred.

Engine Oil Identification Symbol

A symbol has been developed to aid the vehicle owner in the proper selection of engine oil. This symbol is located on the oil container and is composed of three distinct areas for identifying various aspects of the oil (Fig. 2).

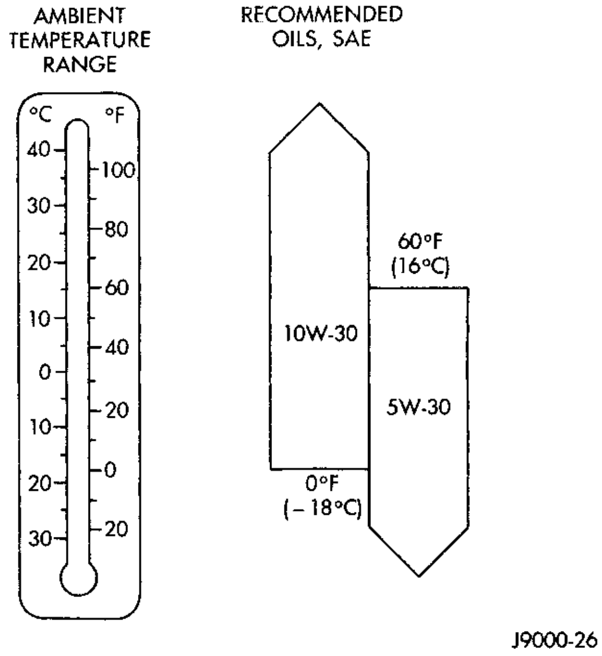


Fig. 1 Recommended Viscosity Grades

(1) The top portion will indicate the quality of the oil, such as “SG” or “SG/CD”.

(2) The center portion will show the SAE viscosity grade of the oil, such as SAE 5W-30 or 10W-30.

(3) The lower portion will show only ENERGY CONSERVING or ENERGY CONSERVING II, if it is applicable to that oil.

Energy conserving when shown, indicates, that oil, offers fuel economy benefits in gasoline engines.

Engine Oil Level Indicator

The engine oil level indicator (dipstick), is located on the right rear of the 2.5L, 4.0L and 4.2L engines (Fig. 3) and left rear of the 5.9L engine (Fig. 4).

Checking Engine Oil Level

To assure proper lubrication of your vehicle’s engine, the engine oil must be maintained at the correct level. The correct level is between the ADD and FULL marks on the engine dipstick (Fig. 3). Check the oil level at regular intervals, such as every fuel stop. Add oil only when the level on the dipstick is at or below the ADD mark.

CAUTION: Do not overfill crankcase. This will cause oil aeration and loss of oil pressure.

Materials Added to Engine Oils

It is not necessary to add any material to crankcase oils for most types of vehicle operation. In some instances, such as infrequent operation or short trips only and during break-in after a major engine overhaul and/or new piston installation, addition of special materials containing anti-rust and anti-scuff additives are beneficial. MOPAR Engine Oil Supplement, or equivalent, is a suitable product for this purpose.

ENGINE OIL FILTER SELECTION

All engines are equipped with full-flow, throw-away oil filters. The same type of replacement filter, depending on engine size is recommended as a replacement filter in service on these vehicles.

The quality of replacement filters varies considerably. Be sure that any replacement oil filter used is a high quality filter, and is capable of withstanding pressure of 1764 kPa (256 psi) - manufacturer’s specification - to avoid filter and engine damage.

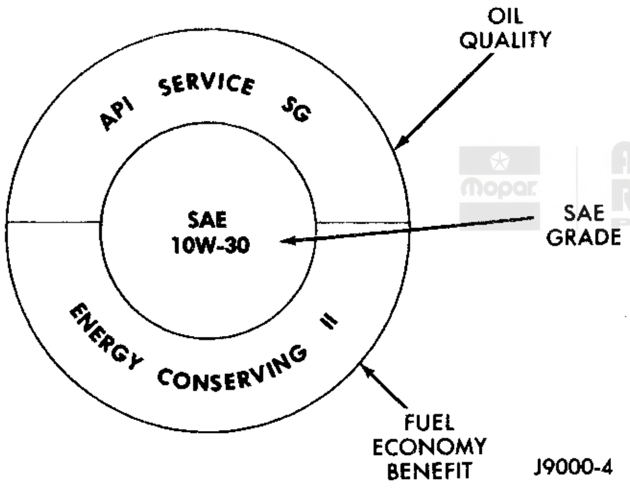


Fig. 2 Oil Container Symbol

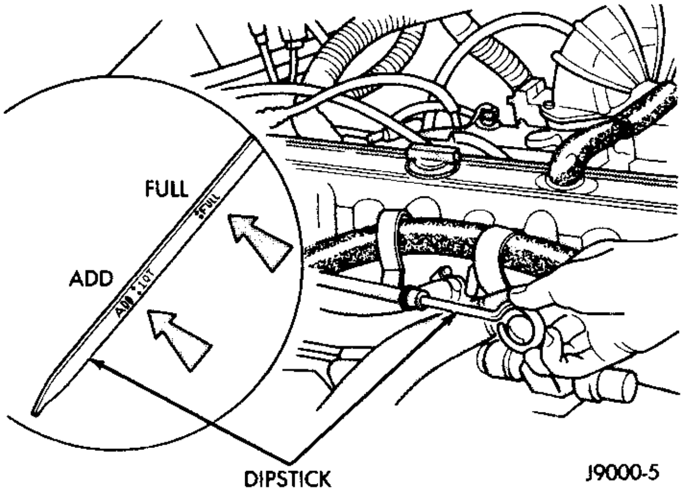


Fig. 3 Dipstick Location—4.0L Shown

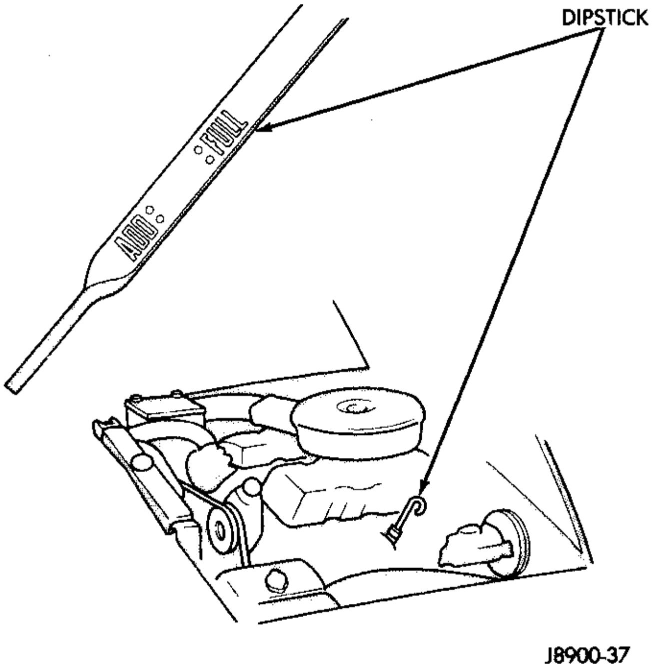


Fig. 4 Dipstick Location—5.9L Engine

ENGINE OIL AND FILTER CHANGES

Oil and Filter Changes

WARNING: TEST RESULTS SUBMITTED TO EPA HAVE SHOWN THAT LABORATORY ANIMALS DEVELOP SKIN CANCER AFTER PROLONGED CONTACT WITH USED ENGINE OIL. ACCORDINGLY, THE POTENTIAL EXISTS FOR HUMANS TO DEVELOP A NUMBER OF SKIN DISORDERS, INCLUDING CANCER, FROM SUCH EXPOSURE TO USED ENGINE OIL. CARE SHOULD BE TAKEN WHEN CHANGING ENGINE OIL, TO MINIMIZE THE AMOUNT AND LENGTH OF EXPOSURE TIME TO USED ENGINE OIL ON YOUR SKIN. PROTECTIVE CLOTHING AND GLOVES, THAT CANNOT BE PENETRATED BY OIL, SHOULD BE WORN. THE SKIN SHOULD BE THOROUGHLY WASHED WITH SOAP AND WATER, OR USE WATERLESS HAND CLEANER, TO REMOVE ANY USED ENGINE OIL. DO NOT USE GASOLINE, THINNER, OR SOLVENTS.

Engine oil should be changed at the following intervals:

(1) Every 12 000 km (7,500 mile) or 7 month intervals, whichever occurs first. If the vehicle is driven under severe service conditions, every 6 000 km (3,750 mile) or 3 1/2 month intervals, whichever occurs first.

(2) Drain the crankcase only after the engine has reached the normal operating temperature to ensure complete drainage of the used oil.

(3) Install the drain plug with a new gasket.

(4) The oil filter should be changed at every engine oil change. Change the oil filter as follows:

(a) Turn the filter counterclockwise to remove (Figs. 5, 6, 7 and 8).

(b) Clean the engine block filter mount.

(c) Lightly coat the rubber seal on the filter with engine oil.

(d) HAND TIGHTEN the filter 1/2 to 3/4 of a turn clockwise past the point of gasket contact with the engine mount.

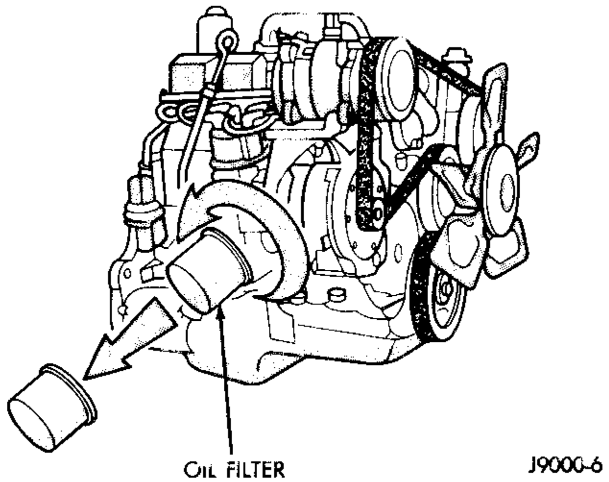


Fig. 5 Oil Filter Removal/Installation—2.5L Engine

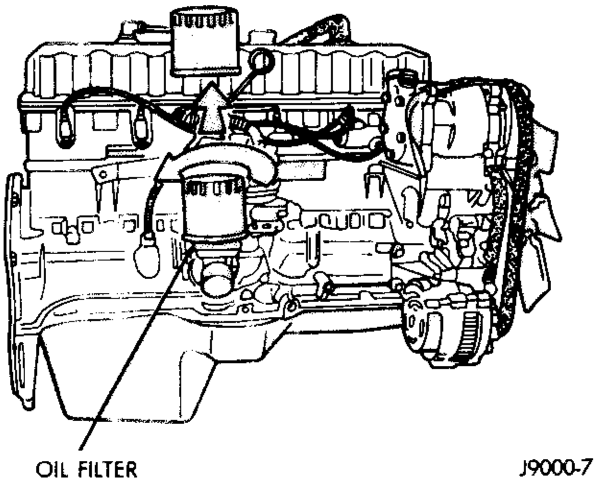


Fig. 6 Oil Filter Removal/Installation—4.0L Engine

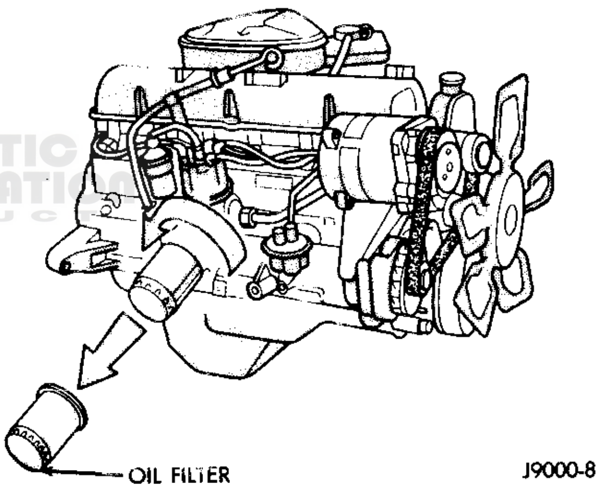


Fig. 7 Oil Filter Removal/Installation—4.2L Engine

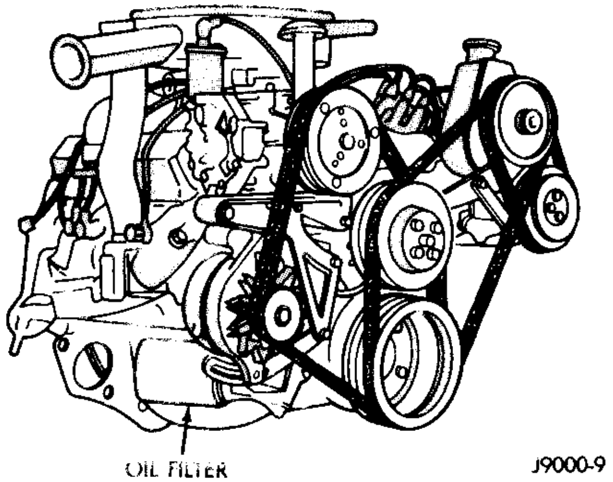


Fig. 8 Oil Filter Removal/Installation—5.9L Engine

CAUTION: The engine oil filter mount has metric threads. Use of a filter with improper threads can result in oil leakage and possible engine damage. Look for the symbol M20x1.5 on the filter.

(5) Add oil at the filler hole on top of the engine (Fig. 9). Keep the engine clean by wiping up any spilled oil.

CAUTION: Do not overfill the crankcase. This will cause oil aeration and loss of oil pressure.

Disposing of Used Engine Oil

Care should be taken in disposing of the used engine oil from your vehicle. See WARNING above. Used oil, indiscriminately discarded, can present a problem to the environment. Contact your dealer, service station or governmental agency to find out where used oil can be properly discarded in your area.

COOLING SYSTEM

WARNING: TAKE CARE TO AVOID THE RADIATOR COOLING FAN WHENEVER THE VEHICLE HOOD IS RAISED.

Inspection

With the engine cold, check the coolant level in the coolant reserve bottle every 12 000 km (7,500 mile) or 7 month intervals. Add coolant to the coolant reserve bottle, if necessary.

WARNING: WHEN REMOVING THE RADIATOR CAP, CARE SHOULD BE TAKEN TO PREVENT SCALDING FROM HOT PRESSURIZED COOLANT.

Coolant protection checks should be made every 12 months (prior to the onset of freezing weather, where applicable). If coolant is dirty or rusty in appearance, the system should be drained, flushed and refilled with fresh coolant.

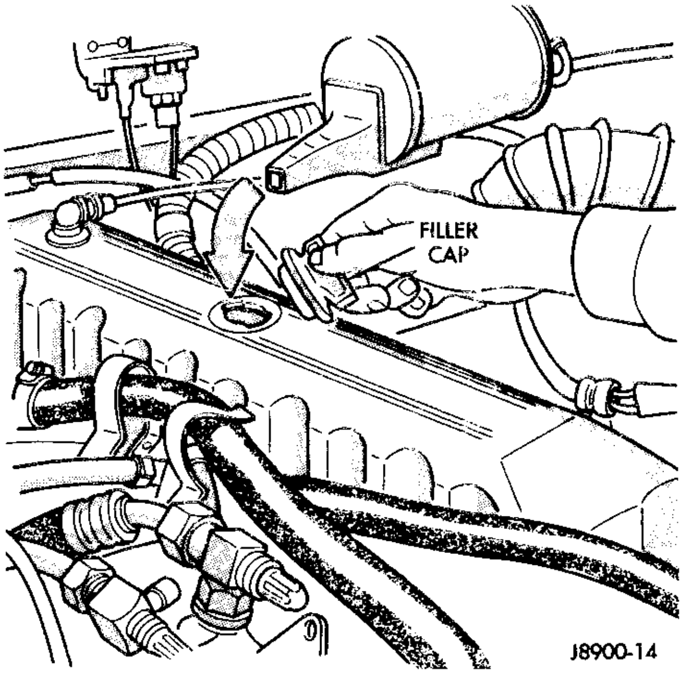


Fig. 9 Adding Oil to Engine—4.0L Shown

Check radiator cap for proper vacuum sealing and operation. Use caution when removing the radiator cap to avoid contact with hot coolant or steam. Place a heavy rag or towel over the cap and turn to the first stop. Do not press down. Pause to allow pressure to release through the overflow tube, then press down and turn counterclockwise to remove cap. Check face of radiator and air conditioning condenser for any accumulation of bugs, leaves, etc. Check reserve tank tubing for condition and tightness of connection at coolant reserve bottle and radiator. Inspect entire system for leaks.

Your cooling system has a 50/50 solution of anti-freeze and water from the factory. This is the recommended solution for most operating temperatures and provides good corrosion protection.

Failure to follow anti-freeze concentration and replacement recommendations or failure to use anti-freeze formulated to prevent corrosion of all cooling system metals, may result in radiator plugging. The result is engine overheating or cooling system leaks, such as at core hole plugs, resulting in loss of coolant.

Radiator Cap

The radiator cap must be fully tightened in order to provide a good seal with the radiator filler neck. This prevents loss of coolant and ensures that coolant will return to the radiator from the coolant reserve bottle. The vent valve and its seat can become contaminated with coolant sediment, etc. The valve and seat should be carefully cleaned if:

(1) The system will not go under pressure.

(2) The coolant reserve bottle gains coolant abnormally.

(3) The top radiator hose collapses on cool-down.

Drain, Flush and Fill

Drain, flush, and fill the cooling system at the mileage or time intervals specified in the Maintenance Schedule in this Group. If the solution is dirty or rusty or contains a considerable amount of sediment, clean and flush with a reliable cooling system cleaner. Care should be taken in disposing of the used engine coolant from your vehicle. Used coolant, indiscriminately discarded, can present a problem to the environment. Contact your dealer, service station or governmental agency to find out where used coolant can be properly discarded in your area.

Refer to Group 7, Cooling System for the proper drain, flush and fill procedures.

HOSES AND FITTINGS

Inspect the hose fittings for looseness and corrosion. Inspect the hoses for brittleness and cracks.

Thoroughly inspect the hose ends that are slipped onto nipples.

Engine performance may be adversely affected by air leaks into such unlikely places as the heater and air conditioner control vacuum hoses, coolant hoses or the power brake booster vacuum hose.

ENGINE AIR CLEANER

The engine air cleaner filter element should be replaced every 48 000 km (30,000 mile) or 30 month intervals under normal driving conditions. When the vehicle is frequently operated in dusty conditions, the filter element should be replaced every 24 000 km (15,000 mile) or 15 month intervals.

Service

(1) Remove the air cleaner cover.

(2) Remove the air cleaner filter element (Figs. 10 and 11).

(3) Clean the filter element by blowing dirt out gently with compressed air. Direct the air in the opposite direction of the normal air flow keeping the nozzle two inches away from the element to avoid damage.

(4) If the filter element is 1/2 saturated with oil, replace the element and check the crankcase ventilating system for proper operation.

CAUTION: Do not tap or immerse the paper filter element in liquid.

(5) Wash the air cleaner cover and body with cleaning solvent and wipe dry.

(6) Install the paper filter element and attach the cover.

Thermostatic Air Cleaner Control Valve

Inspect the thermostatic air cleaner control valve at the mileage or time intervals specified in the Maintenance Schedule in this Group.

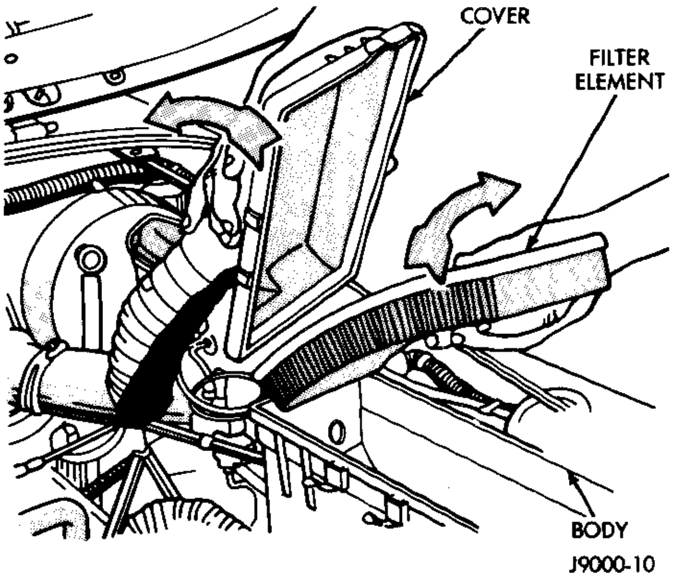


Fig. 10 Air Cleaner—2.5L and 4.0L Engines

CARBURETOR CHOKE VALVE SHAFT

4.2L and 5.9L ENGINES - To prevent the choke from sticking due to gum deposits on the shaft, spray MOPAR Combustion Chamber Conditioner, or equivalent solvent onto the choke shaft where it passes through the air horn (Fig. 12). Move choke blade back and forth to distribute the solvent. This service should be performed at the mileage or time intervals specified in the Maintenance Schedule in this Group. Apply solvent to the fast idle cam and pivot pin to remove dirt, oil, and other deposits that may have collected which could cause sticking or erratic motion.

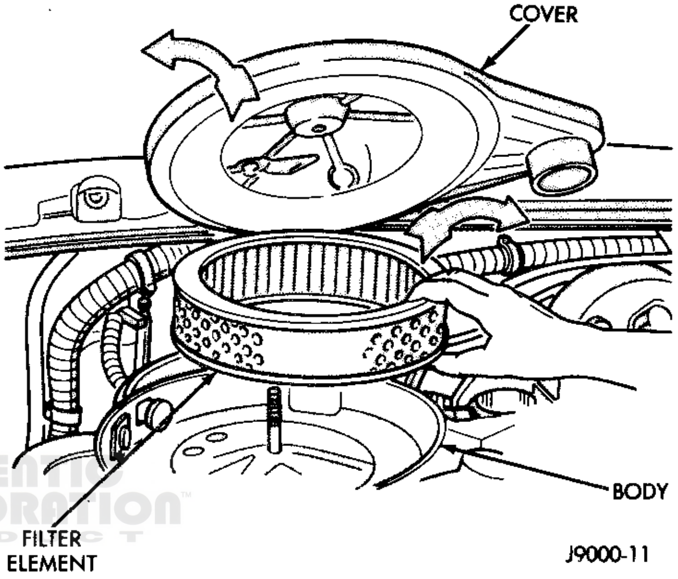


Fig. 11 Air Cleaner—4.2L and 5.9L Engines

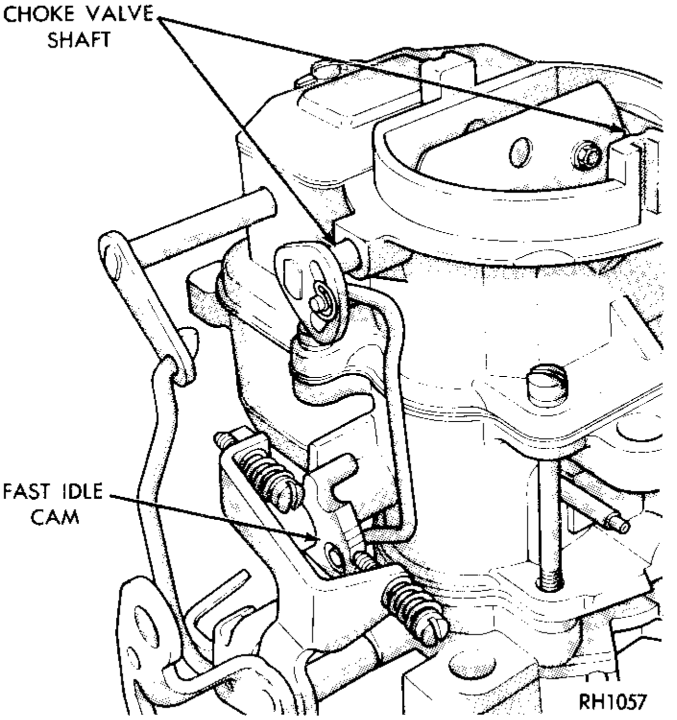


Fig. 12 Choke Valve Shaft and Fast Idle Cam—4.2L

EXHAUST MANIFOLD HEAT CONTROL VALVE

5.9L ENGINES - Check the exhaust heat valve (Fig. 13) for free movement and lubricate with MOPAR Manifold Heat Control Valve Solution, or equivalent at the mileage or time intervals specified in the Maintenance Schedule in this Group.

CRANKCASE VENTILATION SYSTEM

All models with gasoline operated engines are equipped with a closed crankcase ventilation system designed to eliminate emission of residual fumes and vapors from the crankcase by directing these fumes back through the engine combustion chamber.

Ventilation System Operation

2.5L and 4.0L Engines

The crankcase ventilation (CCV) system mixes crankcase vapors and fresh air in the cylinder head cover. The fresh air is drawn into the cylinder head cover from the air cleaner. This mixture is then drawn into the intake manifold via a metered orifice inside a fitting at the cylinder head cover.

The crankcase ventilation (CCV) system consists of a fitting with a metered orifice inside it that is connected to the cylinder head cover. A molded vacuum hose connects the intake manifold to this fitting. The air cleaner is connected to the cylinder head cover by a fresh air hose (Figs. 14 and 15).

4.2L and 5.9L Engines

The ventilation system operates by manifold vacuum. Air is drawn from the carburetor air cleaner, through the air cleaner hose to the cylinder head cover (4.2L engines) or the oil filler cap (5.9L engines). The air then is circulated through the engine and drawn out through the PCV valve, through the PCV valve hose and into a passage in the carburetor throttle body.

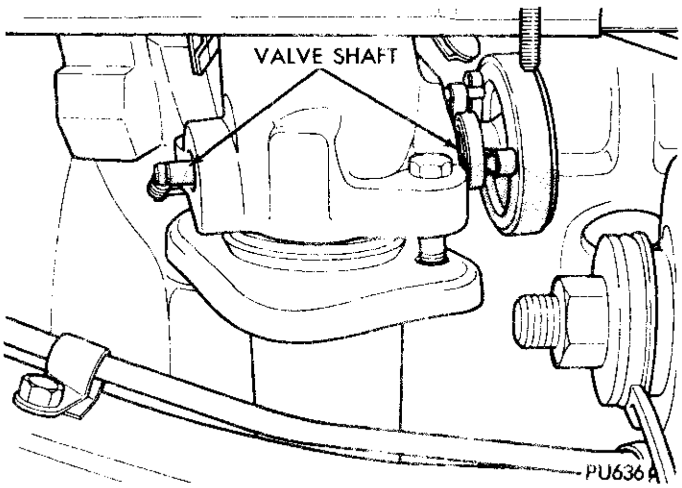


Fig. 13 Manifold Heat Control Valve

The positive crankcase ventilation (PCV) system consists of an air inlet filter, a flow-control (PCV) valve, associated hoses and a PCV solenoid (4.2L engine only). The air inlet filter is located inside the air cleaner housing (4.2L engine - Fig. 16) and is located in the oil filler cap (5.9L engine - Fig. 17).

Frequency of Service

The crankcase ventilation system must be kept clean to maintain good performance and durability.

Periodic service is required to remove combustion products from the valve, hoses, and carburetor or intake manifold passages. The components should be inspected and serviced at the mileage or time intervals specified in the Maintenance Schedule in this Group. If a vehicle

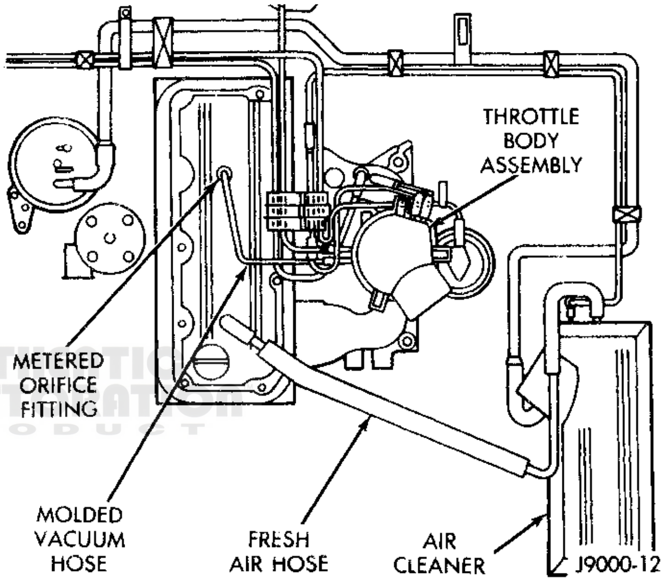


Fig. 14 Crankcase Ventilation—2.5L

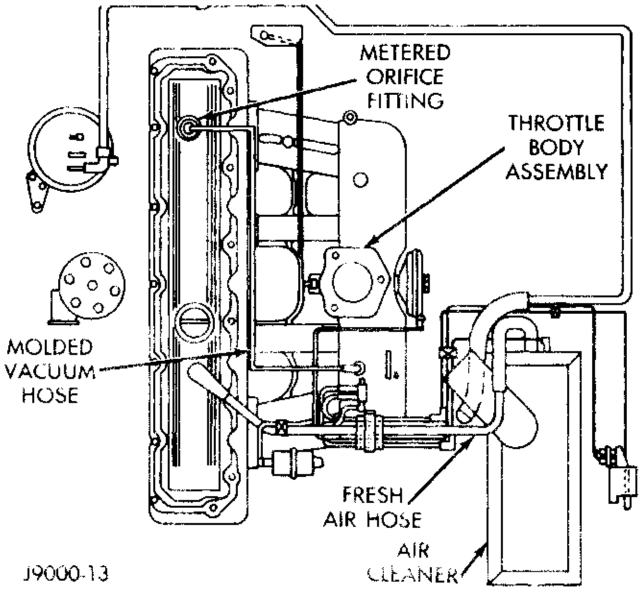


Fig. 15 Crankcase Ventilation—4.0L

is used excessively for short trips with frequent idling, the crankcase ventilation system may require servicing more frequently.

Inspection and Service Procedure

(1) With the engine running, remove the CCV fitting (2.5L and 4.0L engines) or the PCV valve (4.2L and 5.9L engines).

(a) If the fitting or valve is not plugged, a hissing noise will be heard as air passes through the valve. A strong vacuum should also be felt when a finger is placed over the fitting or valve inlet.

(b) Install the CCV fitting or the PCV valve.

(c) Remove the fresh air hose from the air cleaner assembly and loosely hold a piece of paper over the open end of the hose. After allowing about a minute for the crankcase pressure to reduce, the paper should be sucked against the opening with a noticeable amount of force.

(2) Turn the engine off. Remove the metered orifice fitting on the 2.5L or 4.0L engine, and check for a plugged condition. Remove the PCV valve from the 4.2L or 5.9L engine and shake. A clicking noise should be heard to indicate that the valve mechanism is free.

(3) If the crankcase ventilation system meets the tests in (1) and (2) above, no further service is required. If not, the CCV fitting must be cleaned or the PCV valve should be replaced and the system checked again. Install a new MOPAR PCV valve, or equivalent. **Do not attempt to clean an old PCV valve.**

(4) If test (1c) fails when the CCV fitting is cleaned or when a new PCV valve has been installed, it will be necessary to replace the molded vacuum hose and clean the metered orifice port or to replace the PCV hose and clean the PCV hose intake port.

(5) On the 4.2L and 5.9L engines, clean the air inlet filter. See Air Inlet Filter in this Group.

(6) Clean or replace the engine air cleaner. See Engine Air Cleaner in this Group.

AIR INLET FILTER

Clean or replace the air inlet cleaner at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Service - 4.2L Engine

A polyester, non-woven felt PCV system air filter is located in the filter retainer in the air cleaner housing (Fig. 18).

(1) Rotate the retainer and remove the retainer and filter from the air cleaner housing.

(2) Replace or clean the filter and retainer with kerosene.

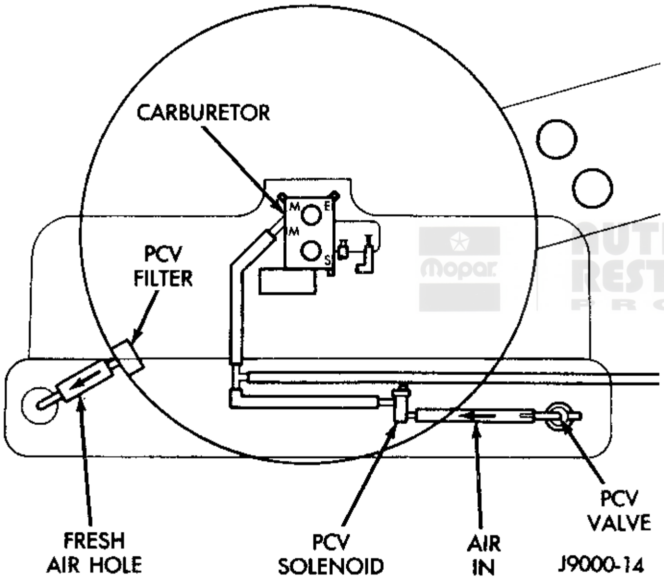


Fig. 16 Positive Crankcase Ventilation—4.2L

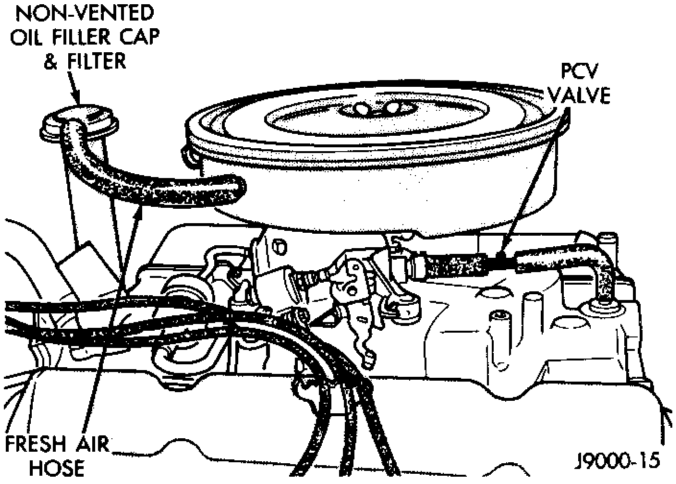


Fig. 17 Positive Crankcase Ventilation—5.9L

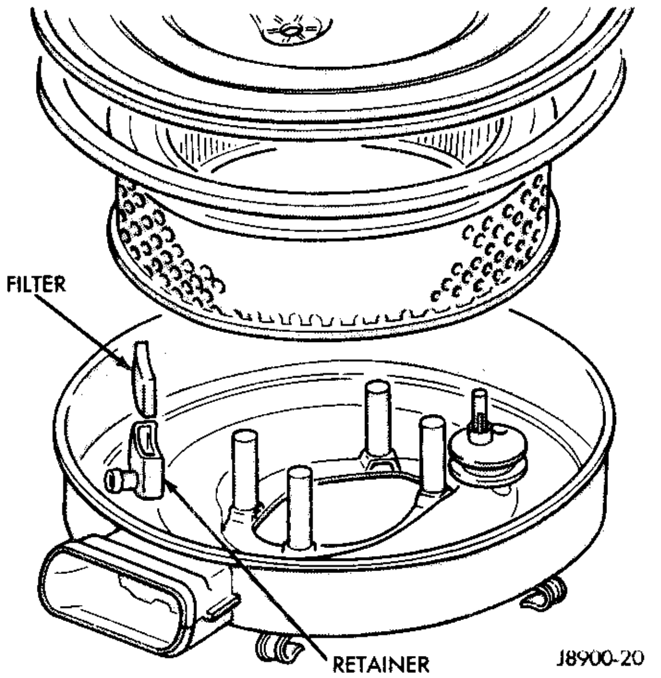


Fig. 18 Air Inlet Filter and Retainer—4.2L

(3) Install the filter and retainer in the air cleaner housing.

Service - 5.9L Engine

A polyester, non-woven felt PCV system air filter is located in the sealed oil filter cap (Fig. 17).

(1) Remove the oil filter cap from the engine.

(2) Disconnect the hose from the oil filter cap.

(3) To clean the filter, apply light air pressure in the reverse direction of the normal airflow (through the filler tube opening in the cap). Replace the filler cap if the filter has deteriorated.

(4) Install the oil filler cap and connect the hose from the air cleaner to the oil filler cap.

FUEL SYSTEM

Inspect the fuel system cap, lines, hoses, and connections at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Use gasoline having a minimum octane rating of 87 (R + M)/2.

Gasoline Containing Alcohol

Some gasolines sold at service stations contain alcohol, although they may not be so identified. Use of fuels containing alcohol is not recommended, unless the nature of the blend can be determined as being satisfactory.

GASOHOL - A mixture of 10% ethanol (grain alcohol) and 90% unleaded gasoline may be used in your vehicle. If driveability problems are experienced as a result of using GASOHOL, it is recommended that the vehicle be operated on unleaded gasoline, only.

METHANOL - Do not use gasoline containing methanol (wood alcohol). Use of this type of alcohol can result in vehicle performance deterioration and damage to critical parts in the fuel pump, carburetor/injector, and other fuel system components. Fuel system damage and vehicle performance problems, resulting from the use of gasoline containing methanol alcohol, may not be covered by the new vehicle warranty.

Gasolines Containing MTBE

Gasoline and MTBE blends are a mixture of unleaded gasoline and up to 15% MTBE (Methyl Tertiary Butyl Ether). Gasoline blended with MTBE may be used in your vehicle.

Materials Added to Fuel

Indiscriminate use of fuel system cleaning agents should be avoided. Many of these materials intended for gum and varnish removal may contain highly active solvents or similar ingredients that can be harmful to gasket and diaphragm materials used in fuel system component parts.

Fuel Filter

Replace the fuel filter at 48 000 km (30,000 mile) or 30 month intervals.

A plugged fuel filter can be caused by contaminants in the fuel. This can limit the speed at which a vehicle can be driven and cause hard starting. If these conditions occur, the filter should be replaced.

VACUUM OPERATED COMPONENTS

It is recommended to inspect all vacuum operated, emission related, components at the mileage or time intervals specified in the Maintenance Schedule in this Group to ensure components are not cracked or broken. Replace component(s), as necessary. Refer to Group 25, Emission Control System, for additional information.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

Check the EGR valve and hoses at the mileage or time intervals specified in the Maintenance Schedule in this Group. See Group 25, Emission Control System, for additional information.

IGNITION CABLES, DISTRIBUTION CAP AND ROTOR

Replace the ignition cables, distributor cap, and rotor at 84 500 km (52,500 mile) or 52 month intervals. Check the distributor for excessive wear and proper component clearances. Replace, if necessary.

The ignition cables should be kept clean and properly connected. Terminals should be fully seated and the nipple assemblies should not be removed from the distributor or coil towers.

OXYGEN (O_2) SENSOR

Replace the oxygen sensor and disconnect the emissions timer on the 2.5L, 4.0L and 4.2L Engines at 133 000 km (82,500 mile) or 82 month intervals. Refer to Group 25, Emission Control System, for additional information.

SPARK PLUGS

Replace the spark plugs at 48 000 km (30,000 mile) or 30 month intervals (Fig. 19). Refer to Group 8D, Ignition - Service Procedures, and the Owners Manual for additional information.

ENGINE	PLUG	GAP	TORQUE
2.5L	RC-12LYC	0.88 mm 0.035 in	37 N•m 27 ft-lbs
4.0L	RC-9YC	0.88 mm 0.035 in	37 N•m 27 ft-lbs
4.2L	RFN-14LY	0.88 mm 0.035 in	37 N•m 27 ft-lbs
5.9L	RN-12YC	0.84 mm 0.033 in	37 N•m 27 ft-lbs

J9000-27

Fig. 19 Spark Plug Replacement

IGNITION TIMING

Check and adjust the ignition timing according to the specifications shown on the Engine Emission Control Information Label, located in the engine compartment. Refer to Group 25, Emission Control System, for additional information.

BATTERY

WARNING: WEAR SAFETY GLASSES, RUBBER GLOVES AND PROTECTIVE CLOTHING WHEN SERVICING THE BATTERY. BATTERY FLUID CONTAINS SULFURIC ACID AND MUST BE KEPT AWAY FROM SKIN, EYES, CLOTHING AND THE PAINTED SURFACES OF THE VEHICLE. IF ACID CONTACTS ANY OF THESE, FLUSH IMMEDIATELY WITH LARGE AMOUNTS OF WATER. IF ACID CONTACTS THE SKIN OR EYES, GET MEDICAL ATTENTION. DO NOT SMOKE WHILE CHECKING OR SERVICING THE BATTERY AND KEEP OPEN FLAMES OR SPARKS AWAY FROM THE BATTERY FILLER CAPS SINCE EXPLOSIVE GAS IS ALWAYS PRESENT.

Check the electrolyte level at the mileage or time intervals specified in the Maintenance Schedule in this Group. Lift the battery cell caps and look into each filler well. It may be necessary to loosen the battery holddown clamp to remove the caps. Maintain the fluid level above the battery plates to the bottom of the filler well ring. Add distilled water or drinking water free of high mineral content. In freezing weather, add water before driving to assure mixing with acid and to prevent freezing.

In addition to regular fluid checks, inspect the overall battery condition before every winter season as follows:

(1) Disconnect the battery negative cable and then the positive cable.

(2) Clean the cables and terminal posts with a wire brush and a terminal cleaner.

(3) Check the battery fluid level and replenish, if necessary.

(4) Remove the battery holddown and clean the battery case and battery tray, if necessary, with a solution of baking soda and water; then rinse thoroughly.

(5) Position the battery in the tray and fasten the holddown. Do not overtighten.

(6) Attach the battery positive cable and then the negative cable.

(7) Apply a small amount of grease or protective coating to the cable ends to minimize corrosion.

RUBBER AND PLASTIC COMPONENT INSPECTION

Variables such as type of vehicle service, geographic area of vehicle operation, and length of exposure time to heat and contaminants are factors affecting the life of rubber and plastic components. To provide best vehicle performance and avoid adverse effect on component life, it is recommended that the following components be inspected when performing other underhood services. **Components should be replaced immediately it there is any evidence of degradation.**

Hoses (Except Emission Hoses)

Refer to Group 25, Emission Control System, for inspection of emission hoses.

Inspect surface of hoses and nylon tubing for evidence of heat and mechanical damage. Hard and brittle rubber, cracking, checking, tears, cuts, abrasion, and excessive swelling indicate deterioration of the rubber. Hose and nylon tubing located close to the exhaust manifold or any source of intense heat should receive special attention. Be certain that nylon tubing in these areas is not melted or collapsed.

Inspect hose routing to ensure hose does not come in contact with any heat source or moving component which will cause heat damage or mechanical wear.

Inspect all hose connections such as clamps and couplings to make sure they are secure and no leaks are present. **In many instances, fluids such as oil, power steering fluid, and brake fluid are used during assembly of hoses to couplings. Therefore, oil wetness at the hose-coupling area is not necessarily an indication of leakage.** Actual dripping of hot fluid when systems are under pressure (during vehicle operation), should be noted and clamps tightened before hose is replaced based on leakage.

Drive Belts

Check the driving fan, air pump, alternator, power steering pump and air conditioning compressor drive belts for cracks, fraying, wear and general condition at the mileage or time intervals specified in the Maintenance Schedule in this Group. Replace the drive belts every 84 500 km (52,500 mile) or 52 month intervals. Refer to Group 7, Cooling System, for replacement and/or adjustment specifications and procedures.

Engine Mounts

Inspect the connecting fasteners between the block and the engine mount bracket and those holding the mount to the frame for correct torque as specified in Group 9, Engines. The rubber in the mount should be inspected for excessive softening and/or swelling caused by oil and/or gasoline contamination. Slight surface deterioration and wear at the ends will not adversely affect performance. If, however, excessive engine movement, rubber softening or swelling, or noise caused by metal-to-metal contact is observed, the engine mount assembly should be replaced.

CAUTION: Avoid continuous contamination with oil or gasoline. Such contamination will result in reduced engine mount life.

EXHAUST SYSTEM

The exhaust system must be properly aligned to prevent stress, leakage, and body contact. If the system contacts any panel, it may amplify objectionable noises originating from the engine or the body.

Inspect the exhaust system at the mileage or time intervals specified in the Maintenance Schedule in this Group for the following conditions. Correct as required.

(1) Exhaust system leaks, damage, misalignment.

(2) Grounding against body sheet metal or frame.

(3) Catalytic converter "bulging" or heat damage.

When inspecting an exhaust system, critically inspect for cracked or loose joints, stripped screws/bolt threads, corrosion damage, and worn or broken hangers. Replace all components that are badly corroded or damaged. Do not attempt repair.

CAUTION: The catalytic converter(s) will become contaminated if leaded gas is used, or if the engine or emission controls are not maintained as scheduled. If this occurs, the catalyst (the alumina-coated beads in the converter) or the entire converter must be replaced.

AIR CONDITIONING COMPRESSOR

The lubricant level in the air conditioning compressor should be checked if there are signs that oil was lost (oily shaft seal area, oil covered fittings, etc.). Loss of oil usually accompanies loss of refrigerant charge. The presence of gas bubbles (white foam) as viewed through the filter drier sight glass, while the system is in operation, indicates some loss of refrigerant charge has occurred.

For compressor oil level check or recharging system, see Group 24, Heater and Air Conditioning.

DRIVETRAIN

INDEX

CLUTCH LEVER AND LINKAGE

Check the clutch at the mileage or time intervals specified in the Maintenance Schedule in this Group. If needed, apply multi-purpose chassis lubricant (lithium base) to the one lube fitting on the clutch bellcrank.

HYDRAULIC CLUTCH FLUID LEVEL

Check the fluid level of the clutch cylinder reservoir at the mileage or time intervals specified in the Maintenance Schedule in this Group. Fluid level is indicated by the MAX and MIN indicators on the cylinder reservoir. Check and top off the fluid level to the MAX mark. Do not allow level to fall below the MIN mark.

The only fluid recommended for use in the clutch hydraulic system is MOPAR brake fluid, or equivalent marked SAE J-1703 or DOT 3. Do not use any other type of fluid.

CAUTION: Never use reclaimed brake fluid or fluid from an unsealed container. In addition, do not use fluid from a container that has been opened and allowed to stand for any length of time. Moisture in the air can be absorbed by the fluid, causing dilution and loss of effectiveness.

MANUAL TRANSMISSION

Lubrication Selection

If it becomes necessary to add fluid to the transmission, use 75W-90, API Grade GL-5 gear lubricant or equivalent.

Fluid Level Check

Check lubricant level at the mileage or time intervals specified in the Maintenance Schedule in this Group. Fill plugs for all manual transmissions are located on the right side of the assembly (Fig. 1). To check the lubricant level:

(1) Remove the transmission fill plug. Lubricant should be level with the fill plug hole.

(2) If not, bring the fluid up to the bottom of the fill plug hole (Fig. 1). Use SAE 75W-90, API Grade GL-5 quality lubricant.

(3) Install the fill plug.

Frequency of Oil Change

Change the lubricant at the mileage or time intervals specified in the Maintenance Schedule in this Group:

(1) Remove the fill plug (Fig. 1).

(2) Place a drain container under the transmission drain plug.

(3) Remove the drain plug and drain fluid from the transmission (Fig. 1).

(4) Install the drain plug.

(5) Fill the transmission to the bottom edge of the fill plug hole (Fig. 1). Use gear lubricant SAE 75W-90, API Grade GL-5 quality lubricant.

(6) Install the fill plug.

AUTOMATIC TRANSMISSION

Selection of Lubricant

If it becomes necessary to add fluid to the transmission, use Mercon™, Dexron II™ or equivalent automatic transmission fluid.

Special Additives

Chrysler Motors does not recommend the addition of any fluids to the transmission, other than the automatic transmission fluid listed above. An exception to this policy is the use of special dyes to aid in detecting fluid

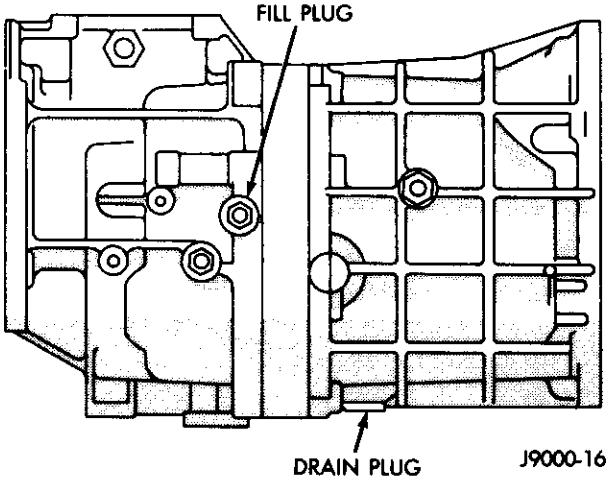


Fig. 1 Check Manual Transmission Fluid Level—2.5L Engine

leaks. The use of transmission sealers should be avoided, since they may adversely affect seals.

Fluid Level Check

WARNING: TO GUARD AGAINST INJURY, STAY CLEAR OF THE FAN AND DRIVE BELTS WHEN THE ENGINE IS RUNNING.

Check the fluid level at the mileage or time intervals specified in the Maintenance Schedule in this Group. Perform the following steps to check the fluid level:

(1) Bring the transmission up to the normal operating temperature.

(2) Place the vehicle on a level surface.

(3) Have the engine running at idle speed.

(4) Apply the parking brake.

(5) Move the gearshift lever through all positions, leaving it in Park (MJ and XJ Vehicles) or Neutral (YJ and SJ Vehicles).

(6) Remove the dipstick, and wipe it clean.

(7) Insert the dipstick until the cap seats.

(8) Remove the dipstick and note the reading (Fig. 2). The fluid level should be between the ADD and FULL marks.

(9) If it is at or below the ADD mark, add sufficient fluid to raise the level to the FULL mark. Use Mercon™ or Dexron II™ automatic transmission fluid or equivalent. With a long-necked funnel inserted into the dipstick tube, add just enough fluid to fill the transmission to the proper level. It takes only 0.5L (1.0 Pint) of fluid to raise the level from ADD to FULL.

CAUTION: Do not overfill. Overfilling can cause foaming which can lead to overheating, fluid oxidation or varnish formation.

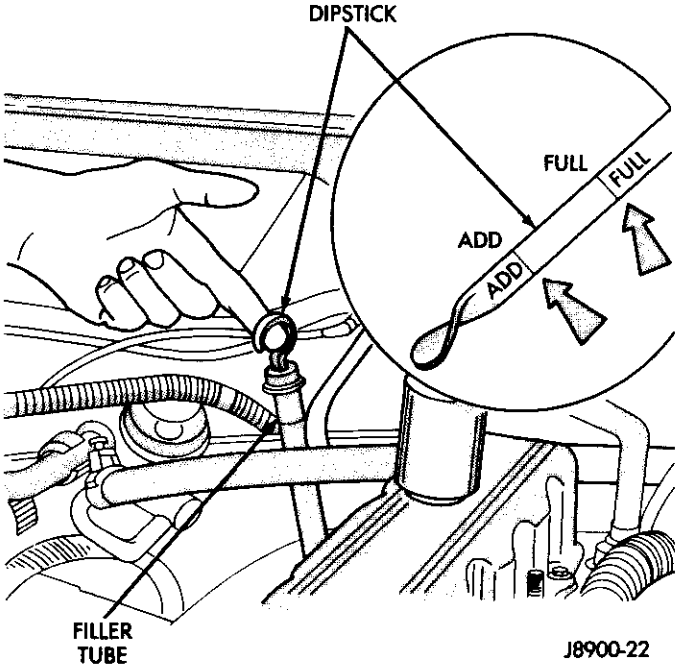


Fig. 2 Check Automatic Transmission Fluid Level

(10) When checking the fluid level, also check the fluid condition. If the fluid smells burned or is full of metal or friction material particles, a complete transmission overhaul may be needed. Examine the fluid closely. If doubtful about its condition, drain out a sample for a double check.

(11) Install the dipstick into the filler tube.

(12) Check for leaks.

Fluid and Filter Changes

Change the automatic transmission fluid and filter at 48 000 km (30,000 mile) or 30 month intervals. If the transmission is disassembled for any reason, the fluid and filter should be changed and the bands adjusted (see Group 21, Transmission, for service procedures).

Draining

Change the fluid immediately after vehicle operation, before it cools.

(1) Raise the vehicle.

(2) Loosen the transmission oil pan bolts and drain the old transmission fluid. Remove the oil pan bolts, pan, and gasket.

(3) Remove the oil filter bolts and discard the oil filter (Fig. 3).

Filling

(1) Install a replacement filter. Tighten the bolts to 4 N•m (35 in-lbs) torque.

(2) Clean the pan thoroughly. Install a new gasket on the pan. Install the pan with attaching bolts. Tighten the bolts to 17 N•m (150 in-lbs) torque.

(3) Lower the vehicle.

(4) Pour approximately 4.7 liters (5 quarts) of Mercon™ or Dexron II™ automatic transmission fluid into the filler pipe. Be sure the container spout, funnel or other items in contact with the fluid are clean.

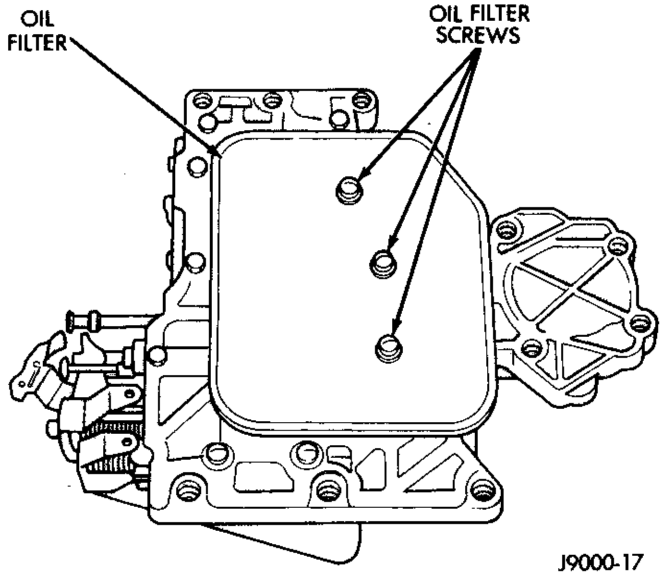


Fig. 3 Automatic Transmission Oil Filter

(5) Start the engine and allow it to idle a few minutes.

(6) Apply the brake pedal and parking brake. Shift the transmission into all positions then place the selector lever in Park (MJ and XJ Vehicles) or Neutral (YJ and SJ Vehicles).

(7) With the transmission at operating temperature, check the fluid level. Add fluid, if necessary, to bring the level to the FULL mark.

TRANSFER CASE

Lubrication Selection

If it becomes necessary to add fluid to the transfer case, use Mercon™, Dexron II™ or equivalent.

Fluid Level Check

Check lubricant level at the mileage or time intervals specified in the Maintenance Schedule in this Group. Fill plugs for all transfer cases are located at the rear of the assembly (Fig. 4).

Check the lubricant level as follows:

(1) Remove the transfer case fill plug. Lubricant should be level with the fill plug hole.

(2) If not, bring the fluid up to the bottom of the fill plug hole. Use automatic transmission fluid Mercon™, Dexron II™ or equivalent.

(3) Install the fill plug.

Frequency of Oil Change

Change the lubricant at the mileage or time intervals specified in the Maintenance Schedule in this Group.

(1) Remove the fill plug.

(2) Place a drain container under the transmission drain plug.

(3) Remove the drain plug and drain fluid from the transfer case.

CAUTION: Do not overtighten the fill and drain plugs. Overtightening can strip the threads or break the aluminum case.

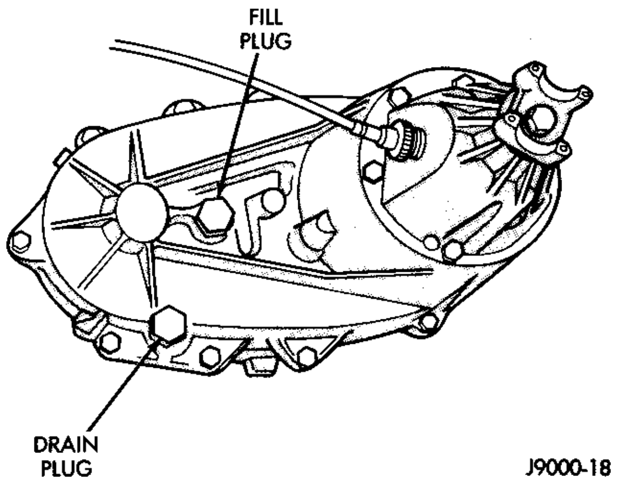


Fig. 4 Transfer Case—Typical

(4) Install the drain plug. Tighten the drain plug to 27 N•m (20 ft. lbs.) torque.

(5) Fill the transfer case to the bottom edge of the fill plug hole (Fig. 4). Use automatic transmission fluid Mercon™, Dexron II™ or equivalent.

(6) Install the fill plug. Tighten the fill plug to 27 N•m (20 ft. lbs.) torque.

FRONT AND REAR AXLES

Lubrication Selection

Fluid Type - MJ, YJ and SJ Vehicles

Jeep Gear Lubricant or equivalent SAE 75W-90 API-GL5 grade. For trailer towing applications, use SAE 80W-140 API-GL5.

Fluid Type - XJ Vehicles

Jeep Gear Lubricant or equivalent SAE 75W-90 API-GL5 grade. Vehicles with Class III Trailer Towing Package use 75W-140 Synthetic Gear Lubricant in the rear axle. Models equipped with Trac-Loc require an additive.

Fluid Level Check

Check lubricant level at the mileage or time intervals specified in the Maintenance Schedule in this Group. Check the lubricant level as follows:

(1) Remove the axle fill plug. Lubricant should be level with the fill plug hole.

(2) If not, bring the fluid up to the bottom of the fill plug hole (Fig. 5).

(3) Install the fill plug.

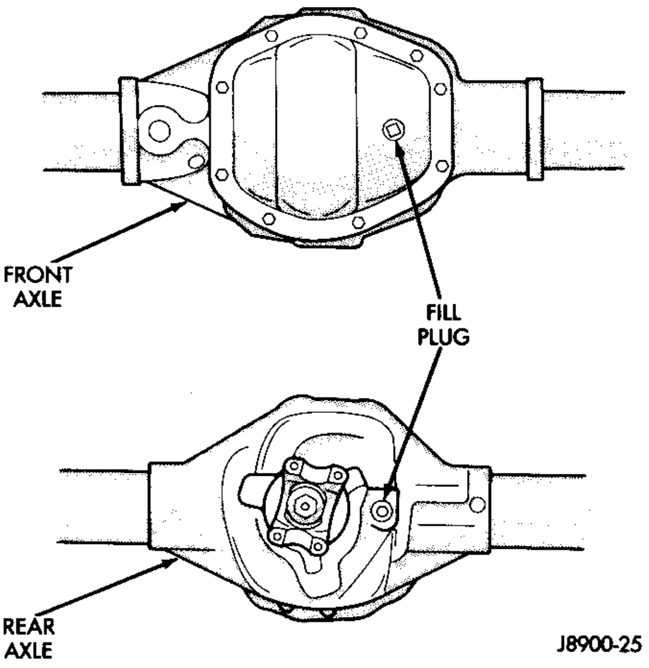


Fig. 5 Front and Rear Axle—Typical

Frequency of Lubricant Change

Change the front and rear axle lubricant at the mileage or time intervals specified in the Maintenance Schedule in this Group.

(1) Place a drain container under the axle.

(2) Remove the axle differential housing cover bolts. Remove the housing cover.

(3) Allow the lubricant to drain completely.

(4) On all differentials except Trac-Loc, flush the differential with a flushing oil or light engine oil to clean out the housing (do not use water, steam, kerosene or gasoline for flushing). Trac-Loc differentials may be cleaned only by disassembling the unit and wiping with clean, lint-free rags. Do not flush the Trac-Loc unit.

(5) Check the condition of the differential housing cover gasket. Replace it, if necessary.

(6) Install the gasket and axle differential housing cover.

(7) Tighten the cover bolts to 27 N•m (20 ft. lbs.) torque.

(8) Remove the fill plug and add new lubricant to the fill hole level.

(9) Install the fill plug.

PROPELLER SHAFTS

Lubricant Type

When lubricating the slip yokes and universal joints, use lithium-base chassis grease only.

Lubrication Intervals

CAUTION: It is important that the recommended lubricant and lubrication schedule be adhered to. Failure to comply with lubrication requirements may result in premature wear of propeller shaft components.

The propeller shaft slip yoke and universal joints on all Jeep vehicles require lubrication at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Lubrication— Sleeve Yokes (Splines)

Apply grease gun pressure to the sleeve yoke grease fitting until the lubricant appears at the pressure relief hole in the expansion plug at the sleeve yoke end of the spline. At this point, cover the pressure relief hole with a finger and continue to apply pressure until the grease appears at the sleeve yoke seal. This will ensure complete lubrication of the spline.

CHASSIS AND BODY

INDEX

STEERING LINKAGE

Lubrication Intervals

Lubricate the steering linkage at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Clean the four lube fittings on the tie-rod ends and connecting rod ends. Lubricate with multi-purpose lithium base chassis lubricant or equivalent.

Inspection

Inspect and replace as needed; torn or ruptured grease seals, damaged steering components and lubricate the ball joints.

Check the steering tie rods and connecting rod for bending, looseness or wear.

FRONT WHEEL BEARINGS

YJ AND SJ VEHICLES - Lubricate the front wheel bearings every 48 000 km (30,000 mile) or 30 month intervals using a high quality lithium base chassis lubricant. Be sure to force grease between the rollers. Check the bearing races for signs of pitting, brinelling or overheating. Wipe the spindle clean and apply a small amount of grease to prevent rust. Wipe the wheel hub clean and apply a small amount of grease inside the hub.

CAUTION: Do not overfill the wheel hub. Too much grease can cause overheating and bearing damage, or it can leak and contaminate brake linings.

Install the inner bearing and a new grease seal. Assemble the hub assembly and adjust the bearings.

Inspect the bearings, and clean and repack, if necessary, when they are removed for other services.

POWER STEERING

Checking Fluid Level

Check the fluid at the mileage or time intervals specified in the Maintenance Schedule in this Group. Lubricant level can be checked with the fluid either hot or cold. If the fluid level is below the FULL HOT or FULL COLD marking on the dipstick, add MOPAR power steering fluid, or equivalent. The dipstick is attached to the reservoir cap (Fig. 1).

Inspection

Check the power steering gear assembly for leaks, housing cracks or loose frame mounting. Inspect the steering damper for leaks or loose mounting.

MANUAL STEERING GEAR

YJ VEHICLES - Check for evidence of damage or loose frame mounting at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Repair as required (see Group 19, Steering for the proper procedures).

BRAKES

Recommended Fluid

Check the fluid level at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Use only MOPAR Heavy-Duty brake fluid, or equivalent, identified as FMVSS No. 116, DOT-3 and SAE J-1703.

Use new brake fluid only when adding fluid, filling the system, or to lubricate parts. NEVER use reclaimed

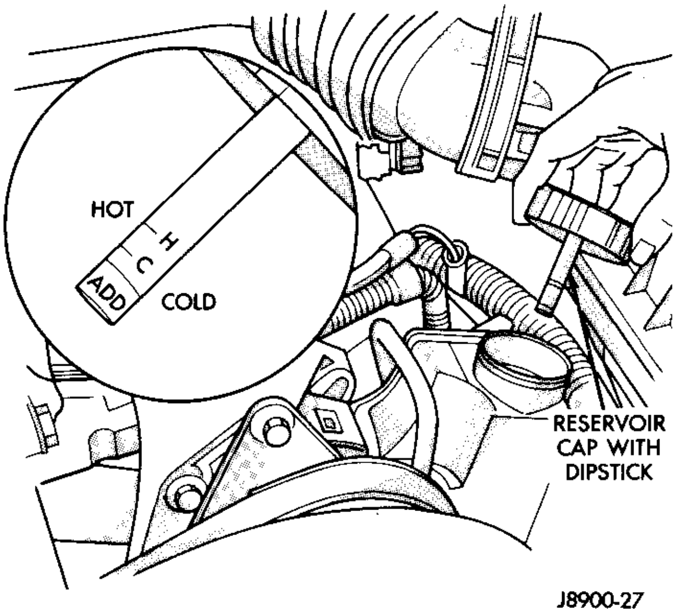


Fig. 1 Checking Power Steering Fluid Level

fluid, fluid not meeting the SAE/DOT standards, or fluid from a container that has been left open for any length of time.

Standard Brake System

Clean the top of the cover and surrounding housing area. If not cleaned, dirt from the cover could enter the fluid. Unsnap the bail and remove the cover. The fluid should be 6 mm (1/4 inch) below the rim of each well in the reservoir (MJ, XJ, and YJ Vehicles) or to the full mark on the reservoir (SJ Vehicles). If not, add brake fluid as required (Fig. 2).

Inspect the cover bail for the proper tension and fit. The cover should maintain a tight seal. Check the rubber diaphragm seal for cracks, cuts or distortion. Check the fittings and housing for signs of leakage. If internal leaks are suspected or if fluid loss occurs but a leak is not evident, check for leaks at the rear of the master cylinder. Correct as required. Install the brake reservoir cover.

ABS Brake System

The ABS fluid reservoir is located beside the windshield washer fluid bottle. Clean the cover before opening. If not cleaned, dirt from the cover could enter the fluid. Fluid should be at the marked level on the reservoir (Fig. 3). If not, add brake fluid as required. Add fluid to the V-shaped MAX indicator mark only. Do not overfill.

CAUTION: Overfilling could cause overflow and possible reservoir damage when the pump begins cycling.

Brake and Chassis Inspection

Check the brake and chassis at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Inspect the linings for wear, cracks, charred surfaces or broken rivets.

Check for contamination by brake fluid, axle lubricant or other contaminants.

Replace the front and rear brake linings if worn to within .78 mm (1/32 inch) of the rivet head.

Operate the rear self-adjuster lever and pivot. Check for ease of operation of the adjuster screw assembly. Check the condition of the adjuster components for bending, frayed cables, loose or overheated springs or binding.

Check the disc brake caliper dust boot for correct installation, tears or signs of leakage. Check bushings and pins for binding, corrosion or tears.

Pull the rear wheel cylinder dust boot back and inspect for leaks. Check the condition of the pistons and cylinder bores.

Check the differential warning valve and housing for signs of leaks, kinked lines or loose fittings.

Brake Hoses

Check for cracks, swelling, kinks, distortion or leaks. Also inspect the position to be sure no lines are rubbing against the exhaust system parts or other components.

Parking Brake

Operate the parking brake pedal and release it. Then check it for smooth operation and brake-holding ability. Inspect the cables for binds, kinks or frays. With the brake released, the rear wheels should turn freely. Adjust the parking brake, if necessary.

Overall Brake Condition and Action

Check for improper brake action, performance complaints or signs of overheating, dragging or pulling. Correct as required (see Group 5, Brakes for the proper procedure).

TIRES

Check the tires for wear, damage, etc. at the mileage or time intervals specified in the Maintenance Schedule in this Group.

Check the Owner's Manual for tire pressure, tire

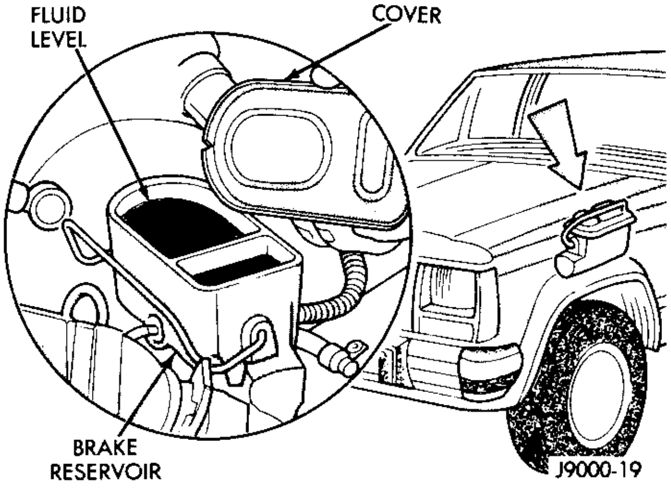


Fig. 2 Checking Brake Reservoir Fluid Level

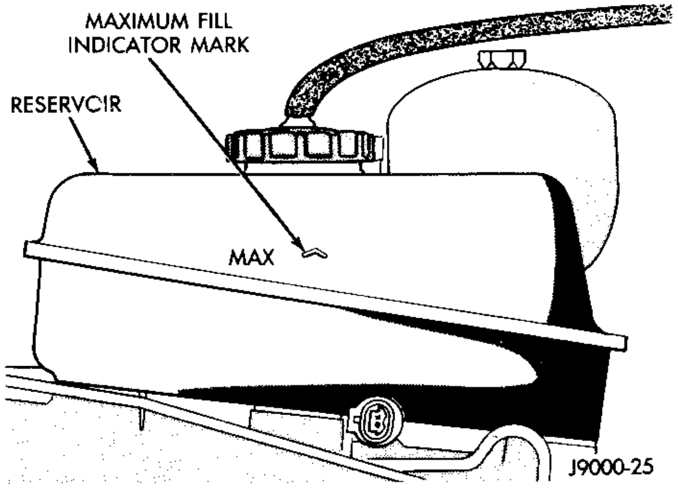


Fig. 3 Checking Brake Reservoir Fluid Level—ABS

warnings, tire replacement, treadwear indicators, or tire rotation.

BODY LUBRICATION

Lubricate the body components with the lubricant specified at the mileage or time intervals specified in the Maintenance Schedule in this Group. When lubricating the weatherstrips and seals, apply the lubricant to a rag and wipe it on the seal to avoid dust-collecting over-spray which can soil passenger clothing.

Prior to the application of any lubricant, the parts concerned should be wiped clean to remove dust and grit. After lubrication, excess oil or grease should be removed.

Particular attention should be given to external lock cylinders during fall and winter months to ensure protection from water and ice.

Particular attention should also be given to hood latching components to ensure proper function. When performing other underhood services, the hood latch, release mechanism and safety catch should be cleaned and lubricated.

BODY MECHANISMS

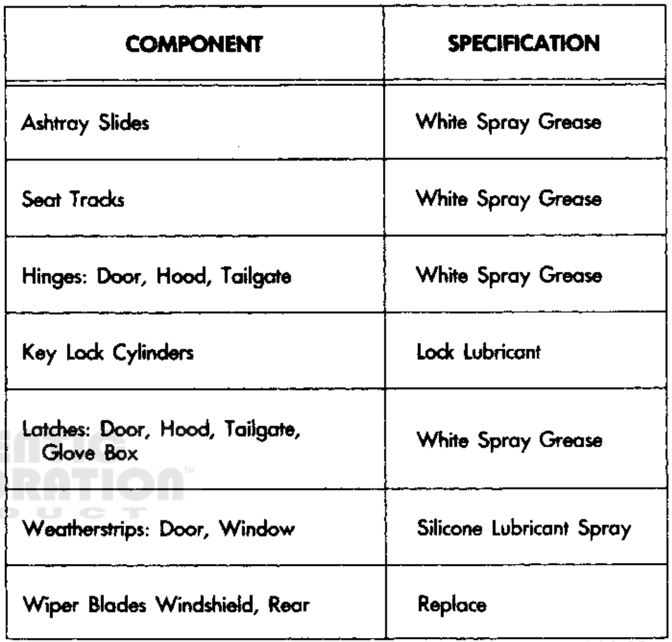
The following mechanisms should be inspected, cleaned and all pivot and sliding contact areas of these components lubricated at the mileage or time intervals specified in the Maintenance Schedule in this Group. Refer to Fig. 4 for the proper lubricant.

HEADLIGHTS

To assure correct adjustment of headlight aiming, it is recommended that the headlights be checked and, if necessary, reaimed properly every six months.

Changes in front and rear suspension, such as suspension height and/or deflection of rear springs due to heavy load, will change the headlight beam pattern and may cause unsafe night time driving conditions.

If a vehicle is to be loaded abnormally, such as for a vacation trip, or with a salesman's products, the headlight aiming should be checked and adjusted to serve the new conditions. Refer to Group 8L, Lamps for adjusting the procedures.



COMPONENT	SPECIFICATION
Ashtray Slides	White Spray Grease
Seat Tracks	White Spray Grease
Hinges: Door, Hood, Tailgate	White Spray Grease
Key Lock Cylinders	Lock Lubricant
Latches: Door, Hood, Tailgate, Glove Box	White Spray Grease
Weatherstrips: Door, Window	Silicone Lubricant Spray
Wiper Blades Windshield, Rear	Replace

J8900-29

Fig. 4 Body Mechanism Maintenance

ACCESSORIES

CONTENTS

GENERAL INFORMATION

This group (1) provides service procedures for the most common accessory equipment installed on Jeep vehicles. Service procedures for certain other dealer-installed accessory equipment are not included and, if required, the manufacturer of the applicable equipment should be consulted for the service procedures.

BRUSH GUARD

REPLACEMENT

Removal

(1) Disconnect and remove the fog lamps, if equipped.

(2) Remove the bolts and washers that attach the brush guard (Fig. 1) to the frame rails.

(3) Remove the nuts, washers and bolts that attach the brush guard to the bumper and remove the brush guard.

Installation

(1) Position and support the brush guard on the bumper. Install the attaching bolts, washers and nuts. **Do not tighten the attaching nuts and bolts until the brush guard is properly positioned on the vehicle and correctly aligned.**

(2) Install the bolts and washers that attach the brush guard to the frame rails.

(3) Align the brush guard and tighten the attaching hardware.

(4) Install and connect the fog lamps, if equipped.

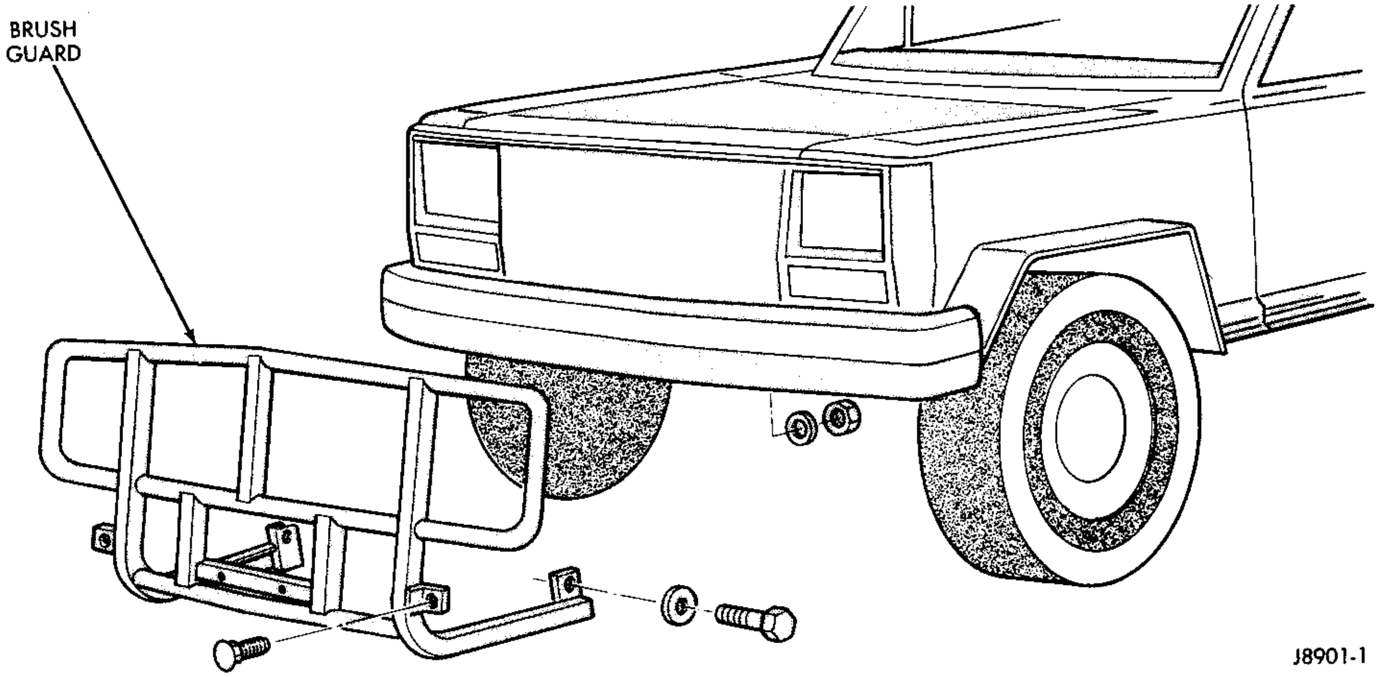


Fig. 1 Brush Guard Removal/Installation

BUMPER EXTENSION AND BUMPERETTE

REPLACEMENT—YJ VEHICLES

Front Bumper Extension Removal

(1) Remove the bumper extension retaining nuts (Fig. 2).

(2) Remove the bumper extension from the front bumper rail (Fig. 2).

Front Bumper Extension Installation

(1) Position the bumper extension on the front bumper rail (Fig. 2).

(2) Install and tighten the bumper extension retaining nuts (Fig. 2).

Rear Bumperette Removal

(1) Remove the bumperette retaining nuts, bolts and washers (Fig. 3).

(2) Remove the bumperette and spacer from the rear crossmember (Fig. 3).

Rear Bumperette Installation

(2) Position the bumperette and spacer on the rear crossmember (Fig. 3).

(2) Install the bumperette retaining bolts, washers and nuts (Fig. 3). Tighten the retaining nuts.

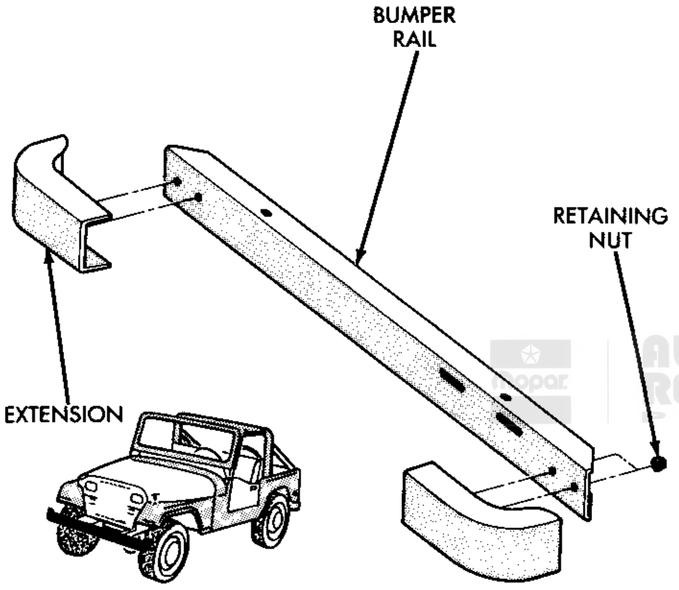


Fig. 2 Bumper Extension Removal/Installation

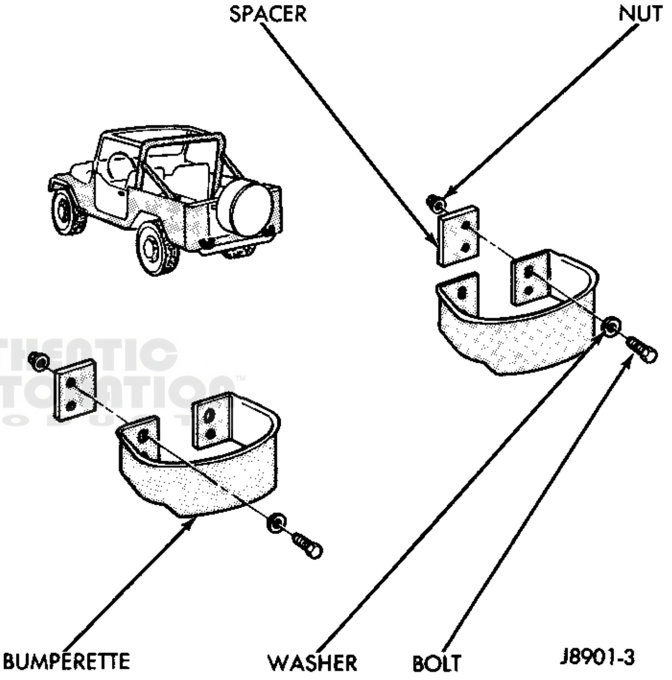


Fig. 3 Rear Bumperette Removal/Installation.

LOW PROFILE MIRROR

REPLACEMENT

Removal

(1) Remove the mirror bracket retaining bolts (Fig. 4).

(2) Remove the bracket with the mirror and the gaskets (Fig. 4).

Installation

(1) Clean the mirror bracket mating surfaces on the door.

(2) Apply 3M 08646, or an equivalent sealant, to the threads of the retaining bolts (Fig. 4).

(3) Position the gaskets on the bracket and install the bracket (with mirror) on the door (Fig. 4).

(4) Install and tighten the retaining bolts securely.

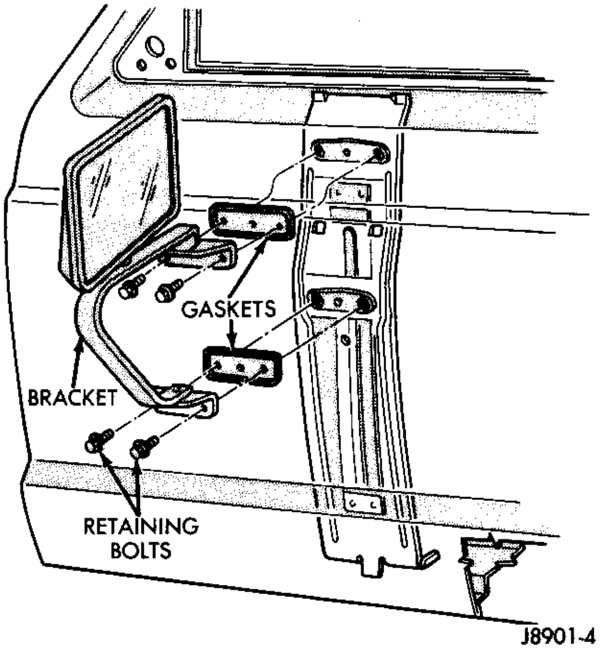


Fig. 4 Mirror Removal/Installation

LUGGAGE RACK

REPLACEMENT

Removal—XJ Vehicles

(1) Remove the cross rail adjustment wheels and remove the cross rails from the slide rails via the rear (open) end pieces (Fig. 5).

(2) Remove the slide rail attaching screws and remove the slide rails and pads (Fig. 5).

(3) Remove the skid strip inserts, the attaching screws, the skid strips and the pads (Fig. 5).

Installation—XJ Vehicles

To prevent water leaks, apply 3M Drip-Chek Sealant (or an equivalent product) to the underside of the slide rail screw heads before installation.

(1) Position the pads on the roof and install the skid strips with the attaching screws. Install the end pieces (Fig. 5).

(2) Tighten the skid strip attaching screws with 3 N•m (28 in-lbs) torque.

(3) Install the skid strip inserts (Fig. 5).

(4) Position the slide rail pads on the roof and install the slide rails and the end pieces (Fig. 5).

The slide rail pads must be installed with the thick portion of the pad facing upward (Fig. 5).

(5) Install and tighten the slide rail attaching screws with 3 N•m (28 in-lbs) torque.

(6) Insert the cross rails in the slide rails, position them at the desired location and secure them by tightening the adjustment wheels (Fig. 5).

Removal—SJ Vehicles

(1) Remove the screws that attach the end supports to the side rails (Fig. 6).

CAUTION: Do not apply excessive pressure to the end support attaching screws during removal because this could cause the well-type nuts to detach and drop between the roof panel and the headliner.

(2) Remove the end support attaching screws from the roof (Fig. 6).

(3) Remove the end supports and gaskets from the roof (Fig. 6).

(4) Remove the side rail support attaching screws (Fig. 6).

(5) Remove the side rails with the end rails attached (Fig. 6).

(6) Loosen the adjustment wheels and remove the end rails from the side rails (Fig. 6).

If necessary, remove the screws that attach the skid strips to the roof and the skid strips.

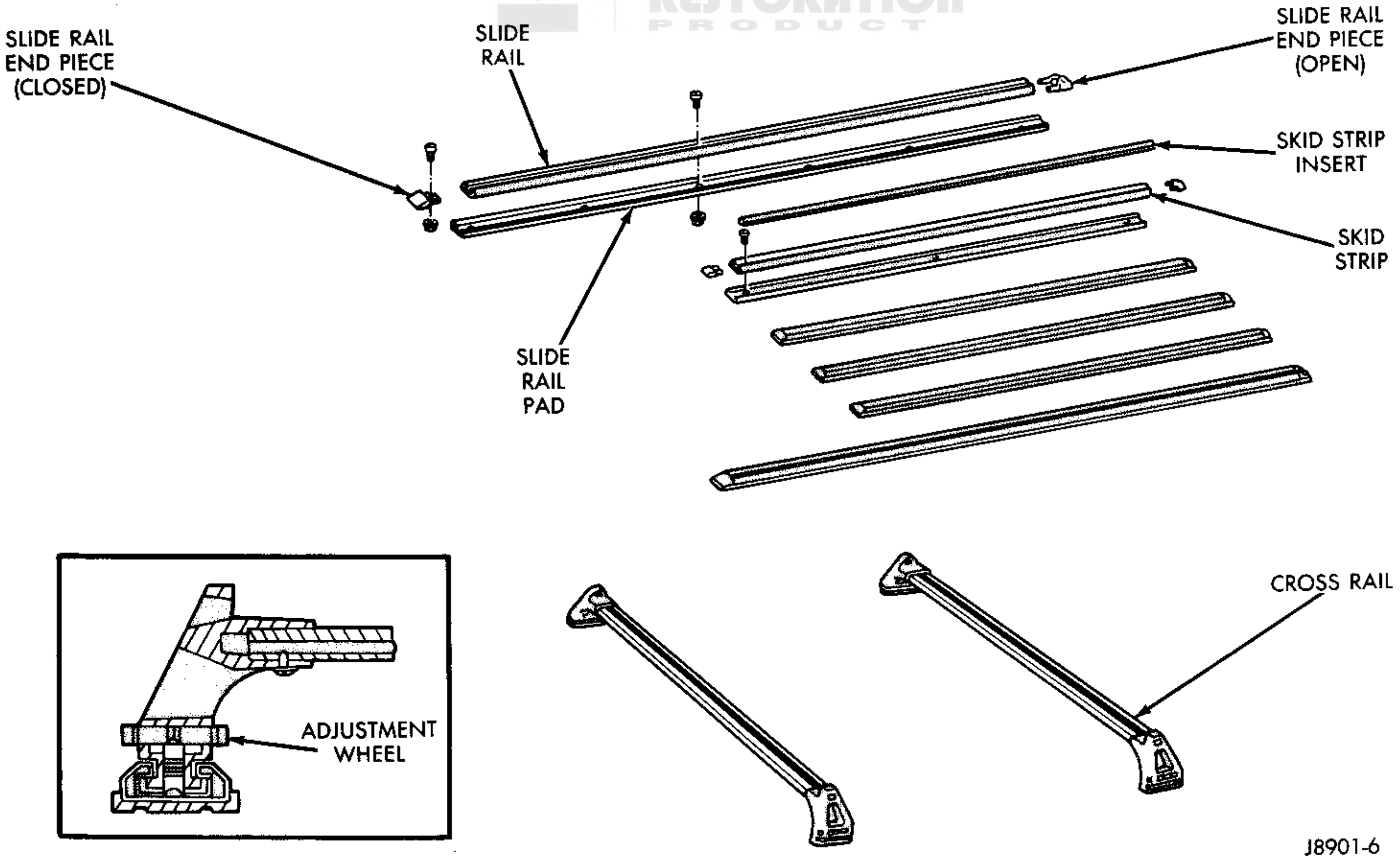


Fig. 5 Luggage Rack—XJ Vehicles

Installation—SJ Vehicles

To prevent water leaks, apply 3M Drip-Chek Sealant (or an equivalent product) to the underside of the slide rail screw heads before installation. Tighten all the attaching screws with 3 N·m (28 in-lbs) torque.

(1) If removed, install the skid strips on the roof with the attaching screws (Fig. 6).

(2) Position the end rails on the side rails and tighten the adjustment wheels (Fig. 6).

(3) Position the gaskets and the side rails (with the end rails attached) on the roof (Fig. 6).

(4) Install the side rail support attaching screws in the roof (Fig. 6).

(5) Position the gaskets and end supports on the roof with the side rails inserted in the end supports (Fig. 6).

CAUTION: Do not apply excessive pressure to the end support attaching screws during installation because this could cause the well-type nuts to detach and drop between the roof panel and the headliner.

(6) Install the end support attaching screws in the roof (Fig. 6).

(7) Install the screws that attach the side rails to the end supports (Fig. 6).

(8) Position the end rails at the desired positions.

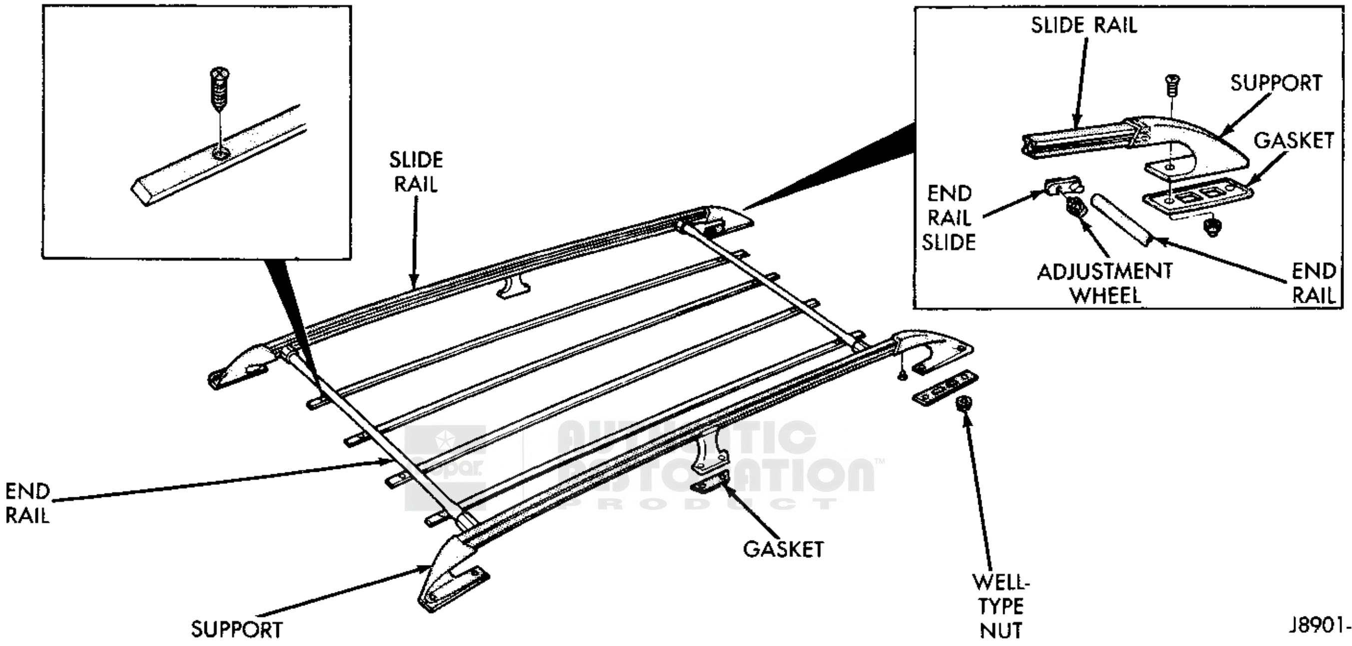


Fig. 6 Luggage Rack—SJ Vehicles

SPARE TIRE CARRIER

REPLACEMENT—XJ VEHICLES

Removal

(1) Remove the spare tire from the carrier (Fig. 7).

(2) Remove the hinge pin bolts from the upper and lower hinges (Fig. 7).

(3) Disconnect the restraint cable (Fig. 7) from the rear bumper.

(4) Release the latch lever from the latch plate (Fig. 7) and remove the carrier.

Installation

(1) Position the carrier in the latch plate (Fig. 7) and install the hinge pin bolts.

(2) Connect the restraint cable (Fig. 7) to the bumper.

(3) Install the spare tire on the carrier (Fig. 7).

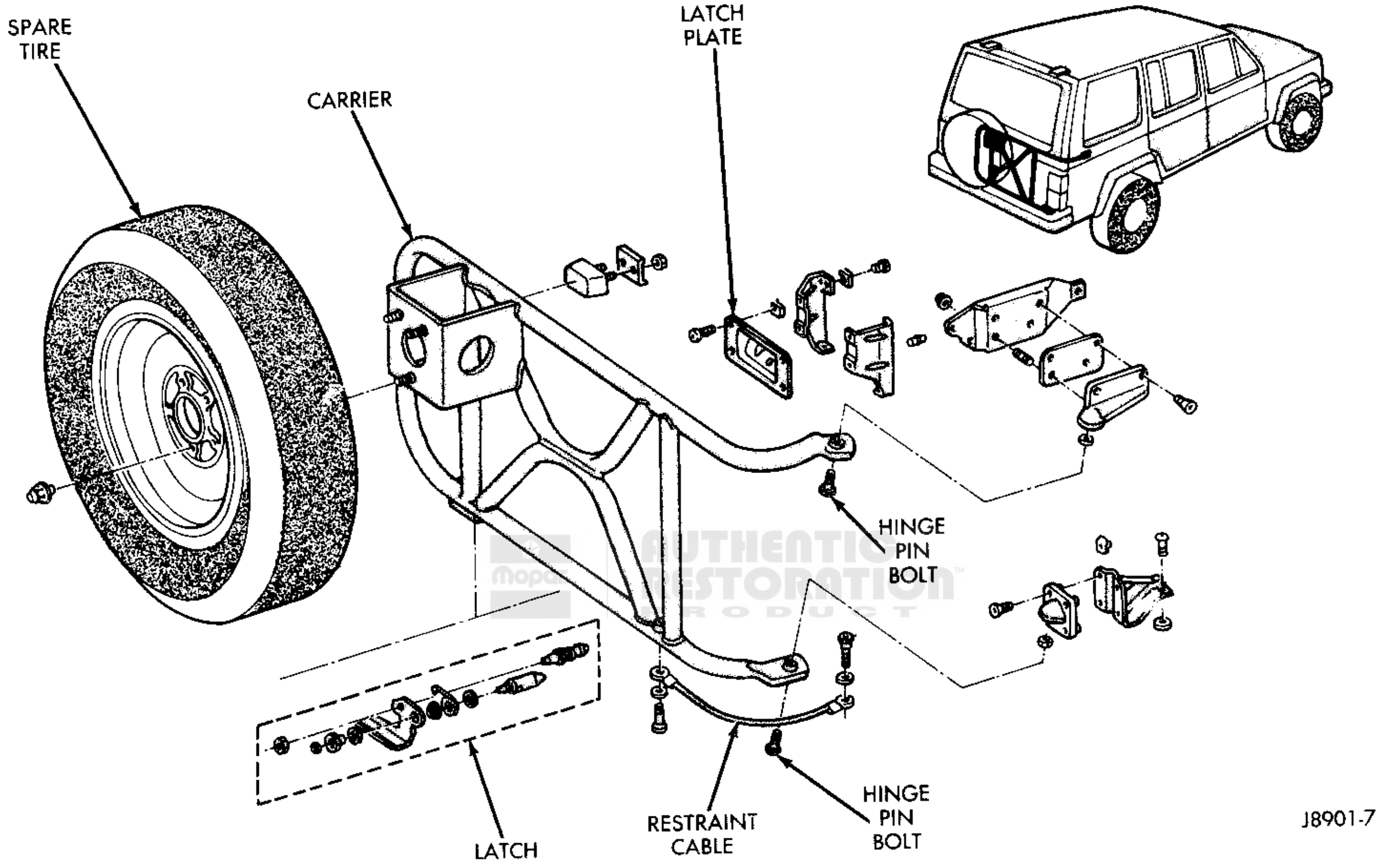


Fig. 7 Spare Tire Carrier—XJ Vehicles

STEP BUMPER

GENERAL INFORMATION—MJ VEHICLES

The rear step bumper includes the bumper rail and the end caps, the support brackets, the anti-skid pads, and the license plate lamps. Each of the step bumper components can be serviced separately.

REPLACEMENT—MJ VEHICLES

Bumper Removal

(1) Remove the retaining clips and disconnect the bulb sockets from each license plate lamp (Fig. 8).

(2) Support the step bumper with a jack or other appropriate device.

(3) Remove the bolts that attach each of the bumper support brackets to the frame (Fig. 8). Lower the step bumper and remove it and the brackets as a unit.

(4) Remove the bolts that attach each of the support brackets to the bumper and remove the brackets (Fig. 8).

Bumper Installation

(1) Attach the support brackets to the replacement bumper (Fig. 8) with the attaching bolts.

(2) Use a jack or similar lifting device and position the step bumper and brackets at the rear of the vehicle. Align the support brackets with holes in the frame and install the bracket attaching bolts (Fig. 8).

(3) Connect the license plate lamp bulb sockets to the lamps with the retaining clips (Fig. 8).

Anti-Skid Pad Removal/Installation

The step bumper anti-skid pads (Fig. 8) can be replaced individually without removing the bumper.

(1) Lift the pad upward to disengage the molded retainers from the bumper slots and remove the pad from the bumper.

(2) Position the replacement pad on the bumper and press downward on the molded retainers to engage them with the bumper slots (Fig. 8).

End Cap Removal/Installation

The step bumper end caps can be replaced without removing the bumper. The end caps are attached to the bumper with two plastic retainers and two bolts/nuts.

(1) Remove the two plastic retainers from the top of the end cap (Fig. 8).

(2) Remove the two attaching nuts and bolts (accessible at the inside of the bumper) and remove the end cap.

(3) Position the replacement end cap at the end of the bumper and install the two attaching bolts and nuts (accessible at the inside of the bumper).

(4) Insert the two plastic retainers in the top of the end cap and in the bumper (Fig. 8).

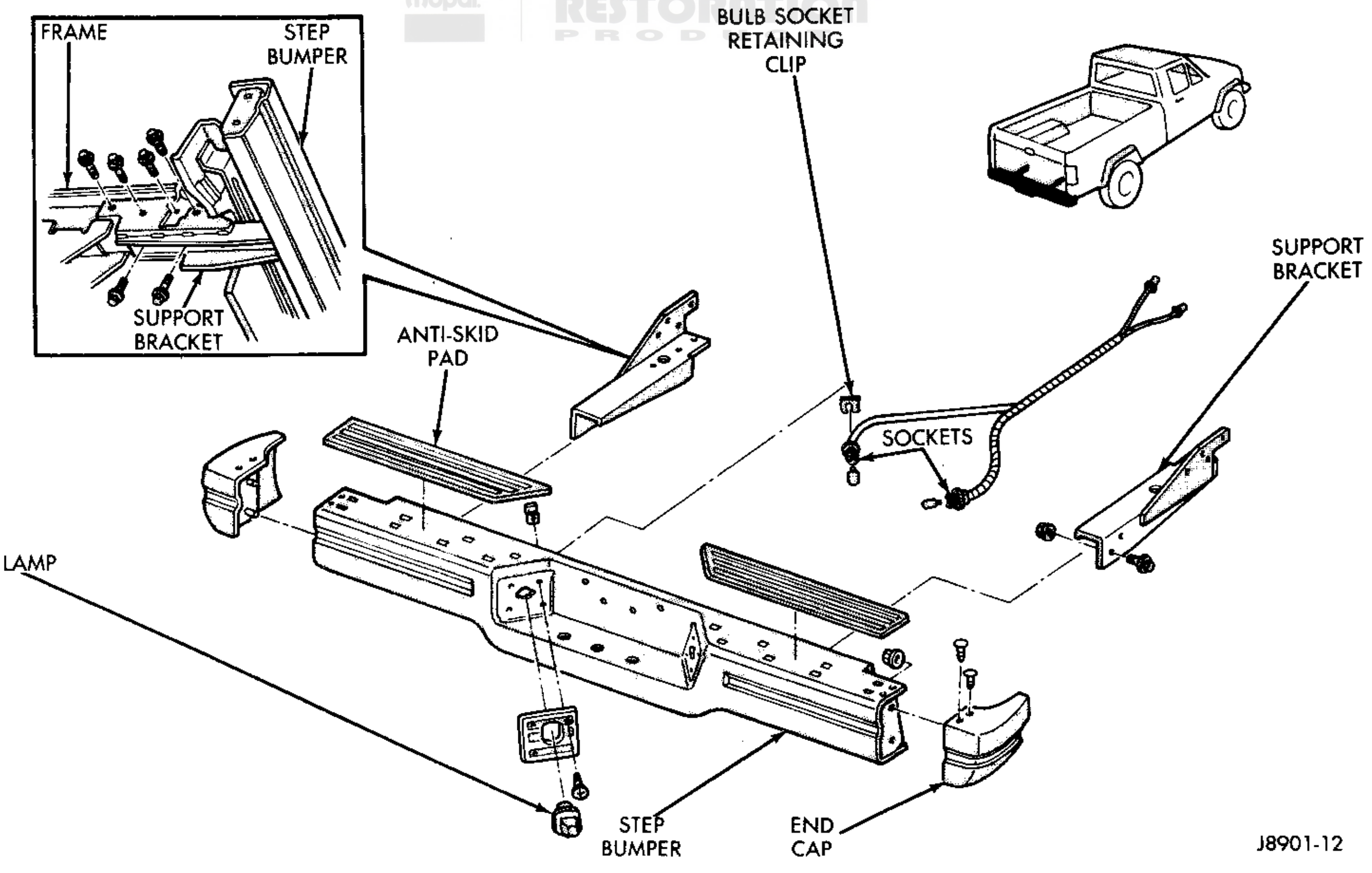


Fig. 8 Rear Step Bumper—MJ Vehicles

SIDE RAILS

GENERAL INFORMATION—MJ VEHICLES

Side rails are available with either a chrome or a matte black finish. Each side rail is comprised of the end stanchions, the rails, the center stanchion, and the stanchion gaskets. The rails are attached to stanchions with self-tapping screws (Fig. 9). The stanchions are attached to the cargo box with Allen head screws, which are threaded into inserts installed in the side of the cargo box. The attaching screws require an Allen (hexagon shaped) wrench (i.e., either a hex key or a hex-socket wrench) for both removal and installation.

REPLACEMENT—MJ VEHICLES

Removal

(1) Remove the Allen head screws that attach the stanchions to the side of the cargo box (Fig. 9).

(2) Lift the side rails up and off the side of the cargo box as a unit.

(3) Remove the stanchion gaskets (Fig. 9) from the stanchions.

If the rails and the stanchions must be separated, remove the self-tapping screws (Fig. 9) that attach the rails to the stanchions and separate them.

Installation

(1) Clean the gaskets and the gasket contact surfaces on the stanchion and on the side of the cargo box.

(2) If separated, attach the rails to the stanchions with self-tapping screws (Fig. 9).

(3) Position the stanchion gaskets on the side of the cargo box.

(4) Position and align the stanchions with the gaskets and the screw holes.

(5) Install and tighten the attaching screws (Fig. 9) with an Allen (hexagon shaped) wrench (i.e., either a hex key or a hex-socket wrench).

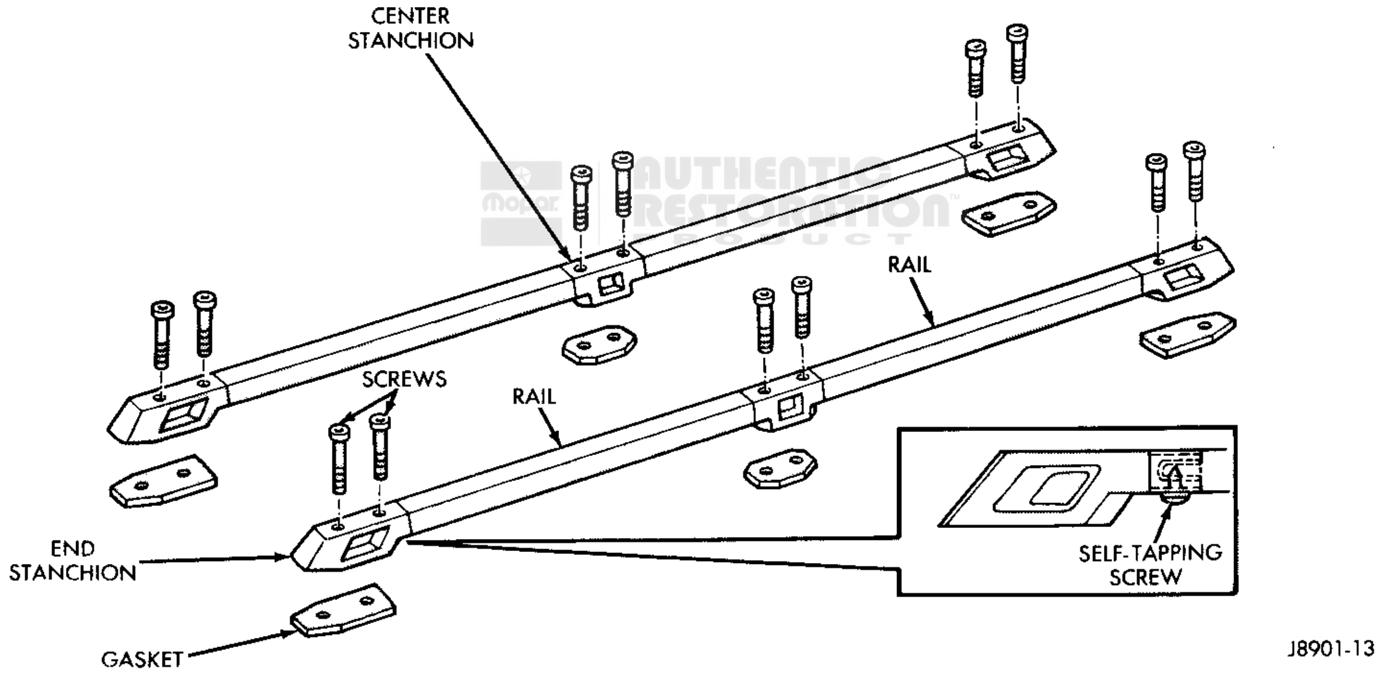


Fig. 9 Side Rails—MJ Vehicles

SPORT BAR

REPLACEMENT—MJ/YJ VEHICLES

Removal

(1) Remove the screws that attach the sport bar base plates to the vehicle (Fig. 10, Fig. 11).

(2) For YJ vehicles, remove the attaching screws and bolts, and remove the side bars from the windshield frame and the sport bar (Fig. 11).

(3) Carefully lift the sport bar upward and remove it from the vehicle.

(4) For MJ vehicles, remove and retain the four base plate gaskets and the left and right wheelhouse reinforcement plates (Fig. 10).

For MJ vehicles, it is not necessary to remove the inner and outer front support brackets (Fig. 10) unless the sport bar is being removed in preparation for vehicle damage repairs.

Installation

(1) For MJ vehicles, clean the base plate gasket mating areas at each side of the cargo box floor and at each wheelhouse.

(2) For YJ vehicles, clean the base plate mating areas on the floor panels.

(3) Apply epoxy chromate primer to the attaching screw hole edges for protection against corrosion.

(4) For MJ vehicles, position the base plate gaskets on the cargo floor and at each wheelhouse.

(5) Position the sport bar base plates:

- MJ vehicles on the gaskets (Fig. 10), and
- YJ vehicles on the floor panels (Fig. 11).

To prevent water seepage, apply 3M Drip-Chek Sealant (or an equivalent product) to the underside of all the screw heads before installation.

(6) Apply sealant to the underside of each base plate attaching screw head. Install and tighten the screws securely (Fig. 10, Fig. 11).

(7) For YJ vehicles, position the side bars at the windshield frame and the sport bar. Install the attaching screws and bolts in the windshield frame and sport bar and tighten them securely (Fig. 11).

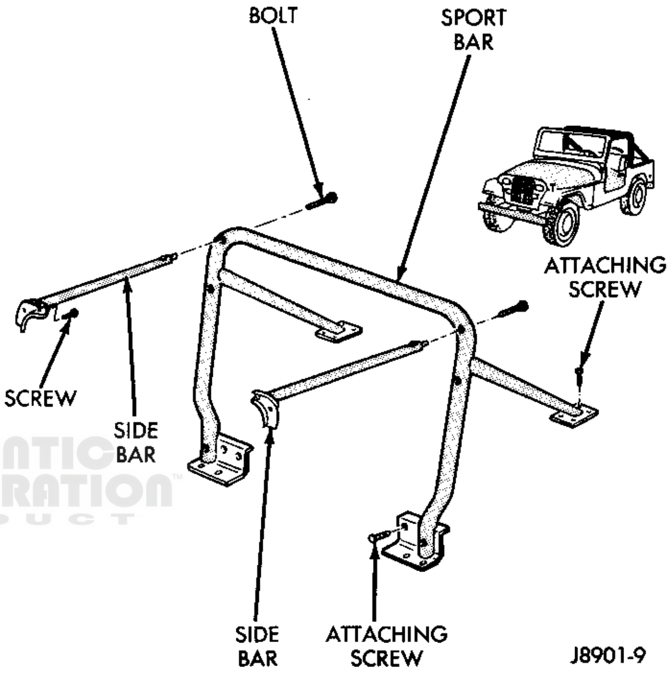


Fig. 11 Sport Bar—YJ Vehicles

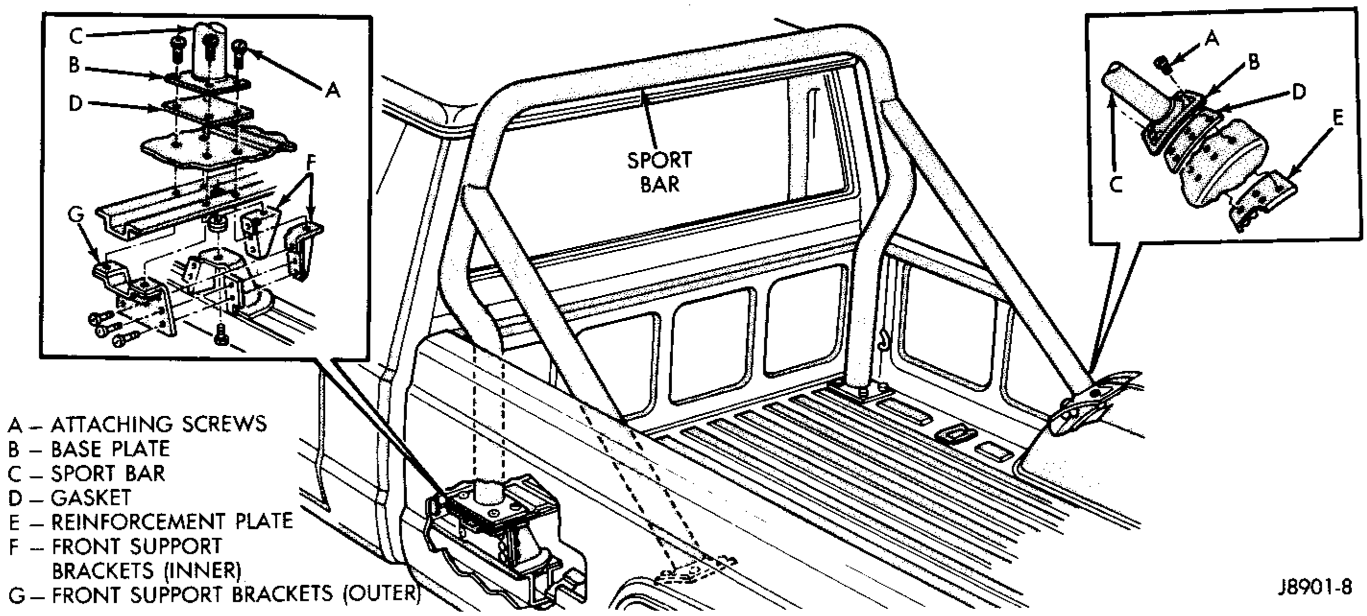


Fig. 10 Sport Bar—MJ Vehicles

TOW HOOKS

GENERAL INFORMATION—MJ/XJ VEHICLES

If a tow hook must be replaced or removed only for service access, remove the two nuts and bolts that attach tow hook to the reinforcement bracket and the support bracket (Fig. 12).

If either the tow hook reinforcement bracket or support bracket must be replaced, refer to the following removal and installation procedures.

REPLACEMENT

Removal—MJ/XJ vehicles

(1) Remove the front bumper and the valence panel. Refer to the removal procedures.

(2) Remove the two nuts and bolts that attach the tow hook to the lower reinforcement bracket and to the support bracket (Fig. 12).

(3) Remove the tow hook.

(4) Remove the nut and Torx-head bolt that attach the lower reinforcement bracket to the front sill (Fig. 12).

The retaining screws and the steering gear skid plate must be removed before the left lower reinforcement bracket can be removed.

(5) Remove the lower reinforcement bracket.

(6) Remove the bolts and washers that attach the support bracket to the side sill and to the upper reinforcement bracket (Fig. 12).

(7) Remove the support bracket (Fig. 12).

(8) Remove the two bolts and washers that attach the upper reinforcement bracket to the front sill (Fig. 12).

(9) Remove the upper reinforcement bracket (Fig. 12).

Installation—MJ/XJ Vehicles

(1) Position the upper reinforcement bracket and the support bracket on the front sill and on the side sill, respectively (Fig. 12).

(2) Align the brackets and install the bracket retaining washers and bolts (Fig. 12).

(3) Position the lower reinforcement bracket on the front sill and install the bracket attaching Torx-head bolt and nut (Fig. 12).

Install the steering gear skid plate and the retaining screws after the left lower reinforcement bracket has been installed.

(4) Position and align the tow hook with the brackets and install the attaching bolts and nuts (Fig. 12). Tighten the nuts securely.

(5) Install the front bumper and valance panel. Refer to the installation procedures.

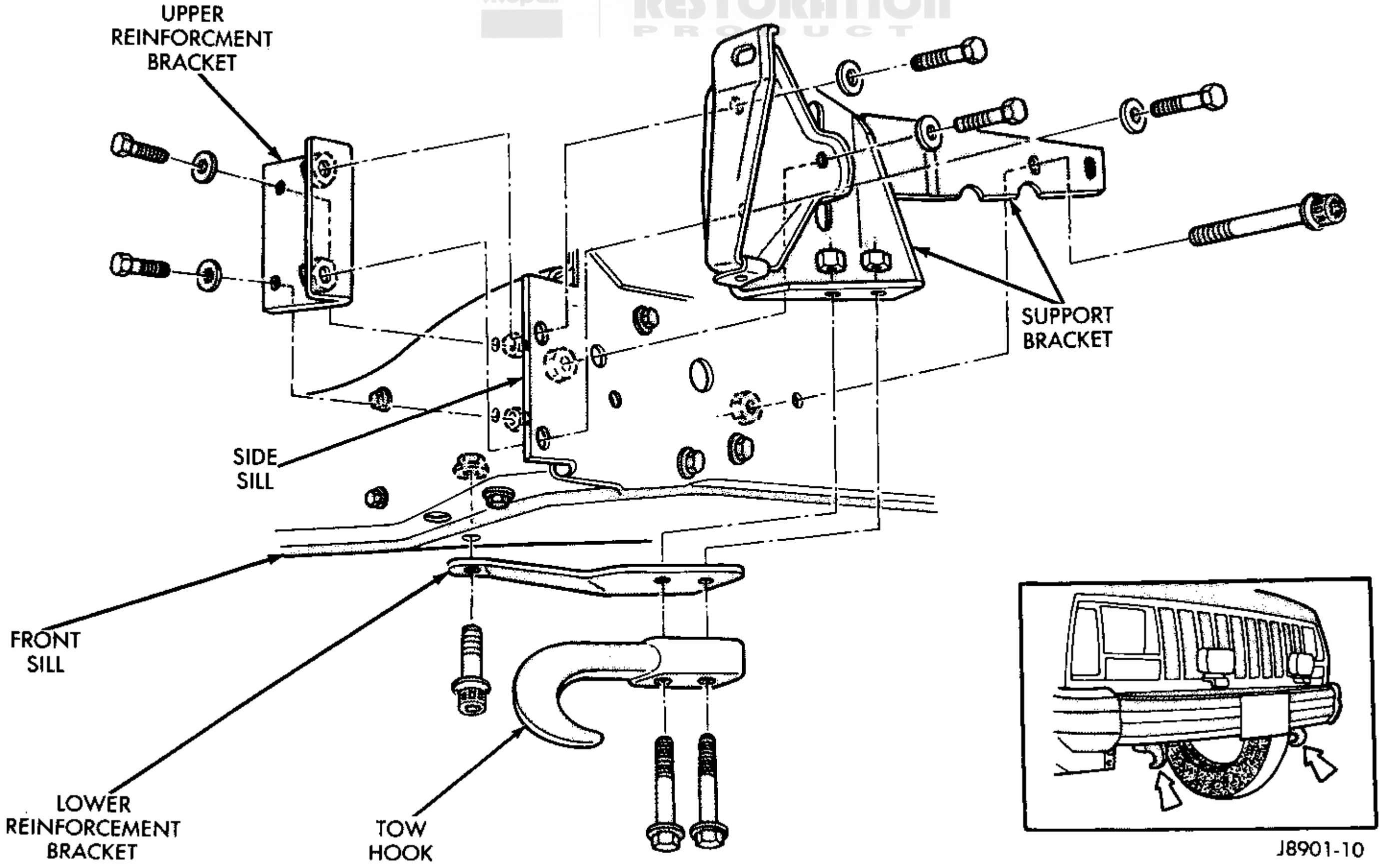


Fig. 12 Tow Hooks—MJ/XJ Vehicles

Removal—YJ Vehicles

(1) Remove the two nuts and bolts that attach the tow hook to the bumper rail and to the frame (Fig. 13).

(2) Remove the tow hook.

Installation—YJ Vehicles

(1) Position the tow hook on the bumper rail and frame (Fig. 13).

(2) Install the two bolts and nuts that attach the tow hook to the bumper rail and to the frame (Fig. 13).

(3) Tighten the nuts securely.

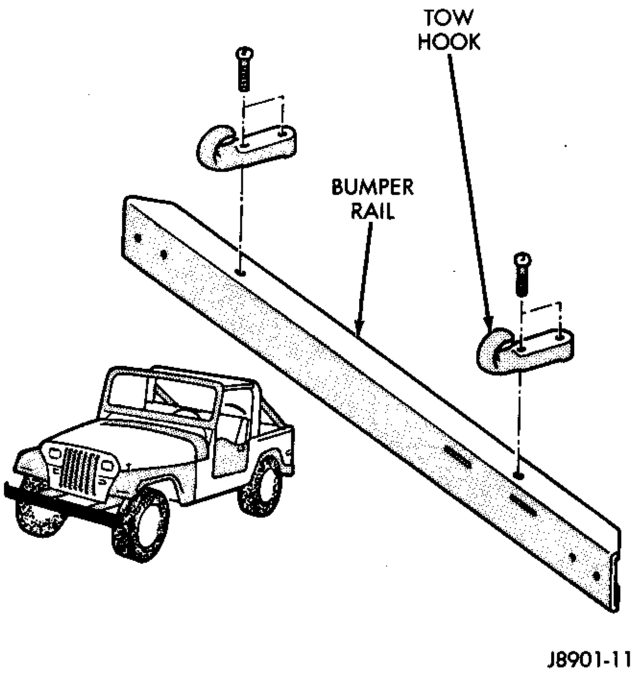


Fig. 13 Tow Hooks—YJ Vehicles

TRAILER HITCHES

INDEX

EQUIPMENT REQUIREMENTS

Class I Hitch—XJ Vehicles

The following vehicle configuration/basic equipment is required for class I (light duty) trailer towing applications (i.e., frame mounted, dead-weight type hitch with a trailer having a maximum gross weight of 2,000 lbs/900 kg and a maximum tongue weight of 300 lbs/133 kg):

- P205/75R15 or larger tires
- I-4, 2.5L engine with automatic transmission or I-6, 4.0L engine; and
- trailer wire harness.

Low profile mirrors are recommended but not required.

Class II Hitch—SJ Vehicles

The following vehicle configuration/basic equipment is required for class II (medium duty) trailer towing applications (i.e., frame mounted, dead-weight type hitch with a trailer having a maximum gross weight of 3,500 lbs/1575 kg and a maximum tongue weight of 350 lbs/155 kg):

- P205/75R15 or larger tires;
- trailer wire harness;
- heavy duty flasher;
- 3.31 axle ratio;
- heavy duty cooling system;
- heavy duty alternator/battery; and
- auxiliary automatic transmission fluid cooler.

Low profile mirrors are recommended but not required.

Class III Hitch—SJ Vehicles

The following vehicle configuration/basic equipment is required for class III (heavy duty) trailer towing applications (i.e., weight-distributing/equalizer type hitch with a trailer having a maximum gross weight of 5,000 lbs/2250 kg and a maximum tongue weight of 750 lbs/332 kg):

- P205/75R15 or larger tires;
- full size spare tire;
- low profile mirrors;
- trailer wire harness;
- heavy duty flasher;
- 3.31 axle ratio;
- heavy duty cooling system;
- heavy duty alternator/battery; and
- auxiliary automatic transmission fluid cooler.

Class III Hitch—XJ Vehicles

The following vehicle configuration/basic equipment is required for class III (heavy duty) trailer towing applications (i.e., weight-distributing/equalizer type hitch with a trailer having a maximum gross weight of 5,000 lbs/2250 kg and a maximum tongue weight of 750 lbs/332 kg):

- P205/75R15 or larger tires;
- full size spare tire;
- trailer sway control;
- trailer wire harness;
- heavy duty flasher;
- heavy duty axle (with synthetic lubricant);
- heavy duty cooling system;
- heavy duty alternator/battery;
- auxiliary automatic transmission fluid cooler; and
- 4.0L engine.

Low profile mirrors are recommended but not required.

WIRE HARNESS CONNECTORS

Class I And II Hitch Connector

The trailer wire harness connector for class I and II trailer hitches is a 5-terminal, in-line type connector (Fig. 14). This type of connector provides voltage to the trailer for tail/side/license plate lamps, backup lamps and turn/stop lamps. Terminal 5 is the source for vehicle ground.

Class III Hitch Connector

The trailer wire harness connector for class III trailer hitches is a 7-terminal, circular type connector (Fig. 14). This type of connector provides voltage to the trailer for tail/side/license plate lamps, backup lamps, turn/stop lamps and electric brakes. Terminal 4 provides battery voltage (12 volts) at all times and can be used for any 12-volt trailer application with a maximum 10 amp load (i.e., 120 watts). Terminal 1 is the source for vehicle ground.

HITCH REPLACEMENT

General Information—SJ Vehicles

The frame-mounted, dead-weight type hitch installed on SJ vehicles is comprised of a draw bar and a hitch frame that is attached to the frame rails and rear crossmember with bolts (Fig. 15).

The frame-mounted, weight-distributing/equalizer type hitch installed on SJ vehicles is comprised of a towing tube with a ball mount receptacle and support brackets that are attached to the frame rails and rear crossmember with bolts (Fig. 16).

Removal—SJ Vehicles

(1) If attached, remove the trailer wire harness connector receptacle from the hitch.

(2) Remove the retaining bracket and the spare tire.

(3) Support the hitch.

(4) For dead-weight type hitches, remove the nuts, mashers and bolts that attach the hitch frame to the vehicle frame rails and rear crossmember (Fig. 15).

(5) For equalizer type hitches, remove the nuts and bolts that attach the towing tube to the vehicle frame rails, support brackets and rear crossmember (Fig. 16). Remove the spacers.

(6) Lower the hitch.

(7) For equalizer type hitches, if necessary, remove the attaching nuts, washers and bolts from the vehicle frame rails and remove the supports.

Installation—SJ Vehicles

(1) For equalizer type hitches, if removed, install the bolts, support brackets, washers and nuts (Fig. 16).

(2) Place the hitch on a lifting device. Raise, position the hitch at the proper location for installation on the vehicle and support it.

(3) For dead-weight type hitches, install the bolts, washers and nuts that attach the hitch frame to the vehicle frame rails and rear crossmember (Fig. 15). Tighten the nuts with 102 N•m (75 ft-lbs) torque.

(4) For equalizer type hitches, install the bolts, spacers and nuts that attach the towing tube to the vehicle frame rails, rear crossmember and support brackets (Fig. 16). Tighten the nuts with 102 N•m (75 ft-lbs) torque.

(5) Remove the support and, if applicable, attach the trailer wire harness connector receptacle to the hitch.

(6) Install the spare tire and the retaining bracket.

General Information—XJ Vehicles

The frame-mounted, dead-weight type hitch installed on XJ vehicles is comprised of a draw bar, towing tube and various reinforcement/support brackets that are attached to the vehicle frame sills and rear crossmember with bolts (Fig. 17).

The frame-mounted, weight-distributing/equalizer type hitch installed on XJ vehicles is comprised of a towing tube with a ball mount receptacle and various reinforcement/support brackets that are attached to the vehicle frame sills and rear crossmember with bolts (Fig. 18).

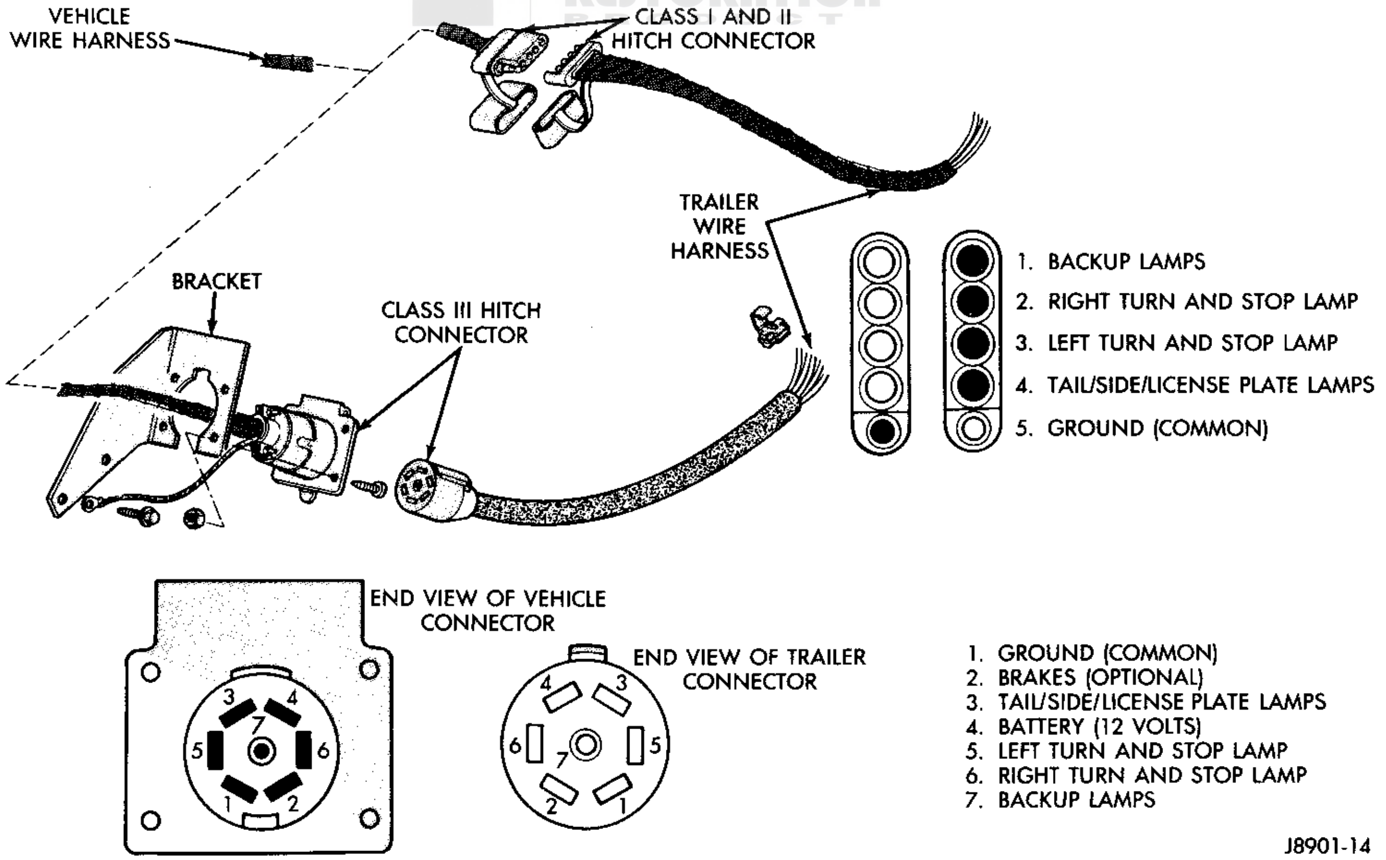


Fig. 14 Trailer Wire Harness Connectors

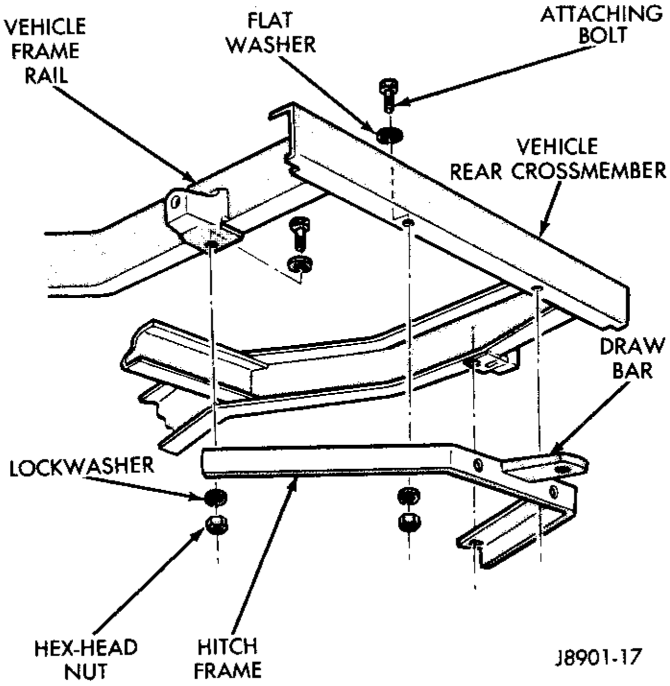


Fig. 15 Dead-Weight Type Hitch—SJ Vehicles

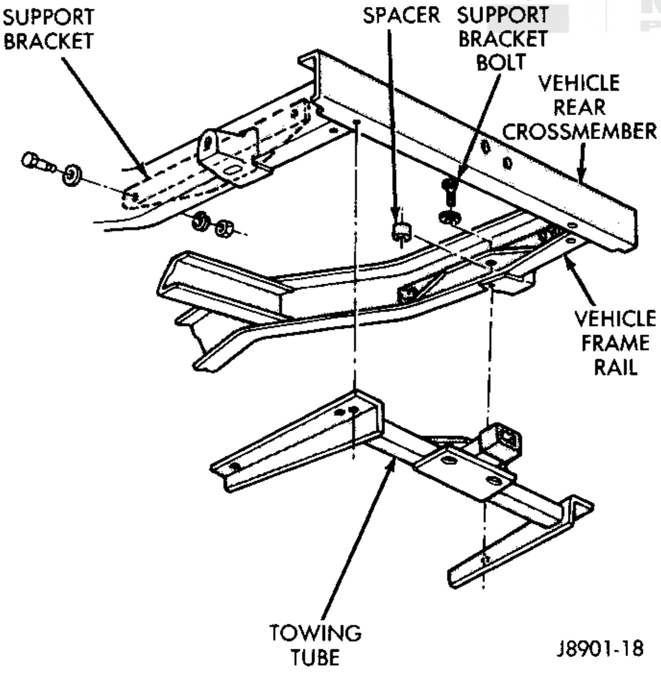


Fig. 16 Equalizer Type Hitch—SJ Vehicles

Removal—XJ Vehicles

(1) If attached, remove the trailer wire harness connector receptacle from the hitch.

(2) Support the hitch.

(3) Remove the bolts that attach the towing tube to the frame sills and reinforcement bracket (Fig. 17, Fig. 18). If equipped, remove the fuel tank skid plate.

The reinforcement brackets are retained on the frame sills by two blind rivets.

(4) For dead-weight type hitches, remove the three T-bolt nuts and washers. Guide the T-bolts up and out of the towing tube and rear crossmember (Fig. 17). Lower the towing tube, rear bumper and draw bar as a unit.

(5) For weight-distributing, equalizer type hitches, remove the bolts from the plate bracket and vehicle rear crossmember (Fig. 18) and lower the hitch.

(6) For dead-weight type hitches, disassemble the bumper, towing tube, reinforcement plate, brackets and draw bar as necessary.

Installation—XJ Vehicles

(1) For dead-weight type hitches, assemble the bumper, towing tube, reinforcement plate, brackets and draw bar as necessary (Fig. 19).

(2) Install the frame reinforcement brackets, if removed (Fig. 17), Fig. 18, Fig. 20). Slide the brackets through the vehicle rear sill openings and retain in position on the frame sills with blind rivets (Fig. 17, Fig. 18, Fig. 20).

(3) For dead-weight type hitches, place the bumper and hitch on a lifting device. Raise and position the bumper and hitch at the proper location for installation on the vehicle. Support the bumper and hitch.

(4) For equalizer type hitches, place the hitch on a lifting device. Raise, position the hitch at the proper location for installation on the vehicle (Fig. 20) and support it.

(5) If equipped, position the fuel tank skid plate (Fig. 19, Fig. 20) on the vehicle frame sills.

(6) Loosely install the bolts that attach the towing tube (and skid plate) to the vehicle frame sills and the reinforcement brackets (Fig. 17, Fig. 18, Fig. 20).

(7) For dead-weight type hitches, install the T-bolts, washers and nuts (Fig. 17).

(8) For equalizer type hitches, position the plate bracket and install the attaching bolts through the vehicle rear crossmember (Fig. 18, Fig. 20).

(9) Tighten all the attaching bolts/nuts with the specified torque. Refer to the Torque Specifications chart.

(10) Remove the support and, if applicable, attach the trailer wire harness connector receptacle to the hitch.

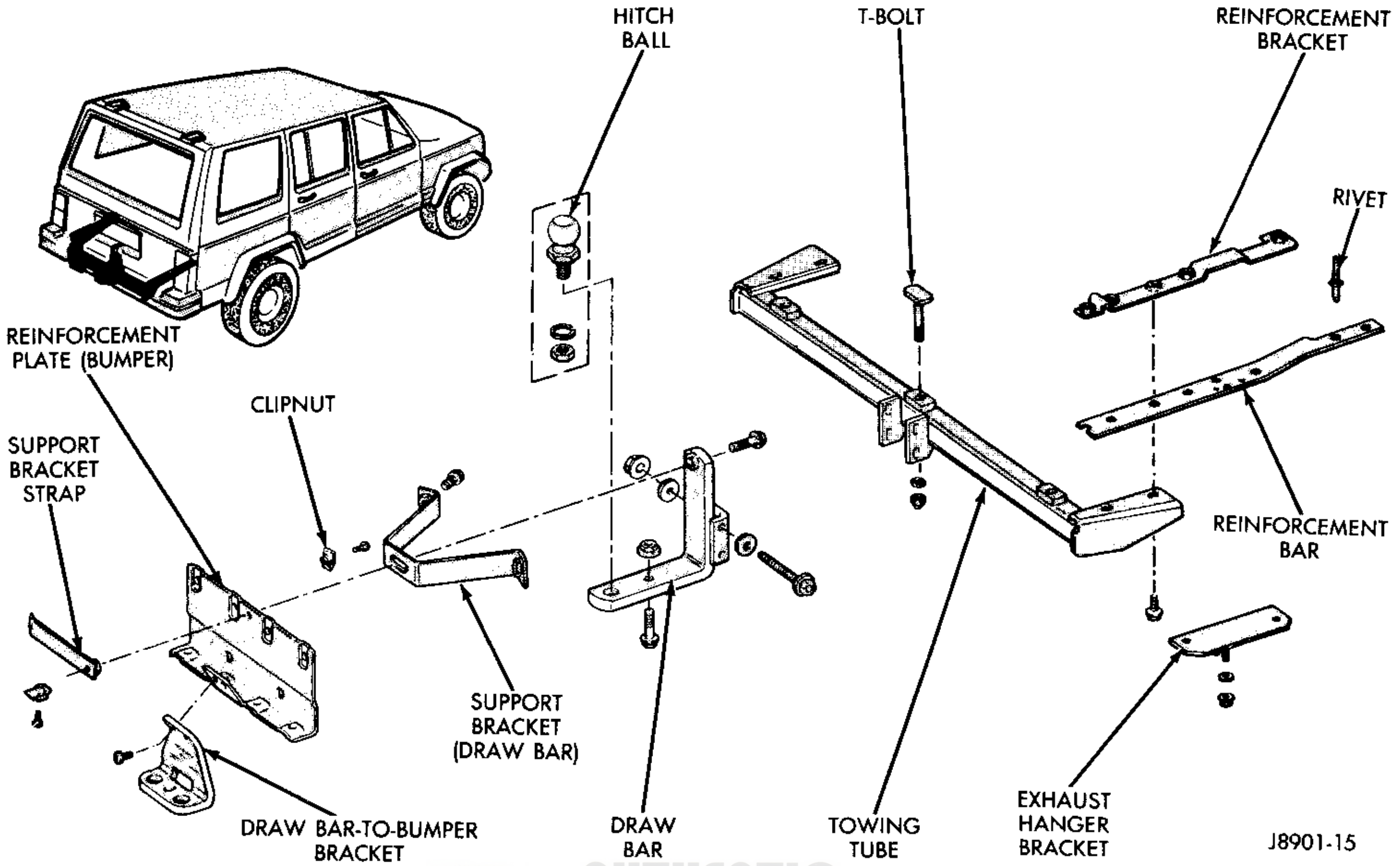


Fig. 17 Dead-Weight Type Hitch—XJ Vehicles

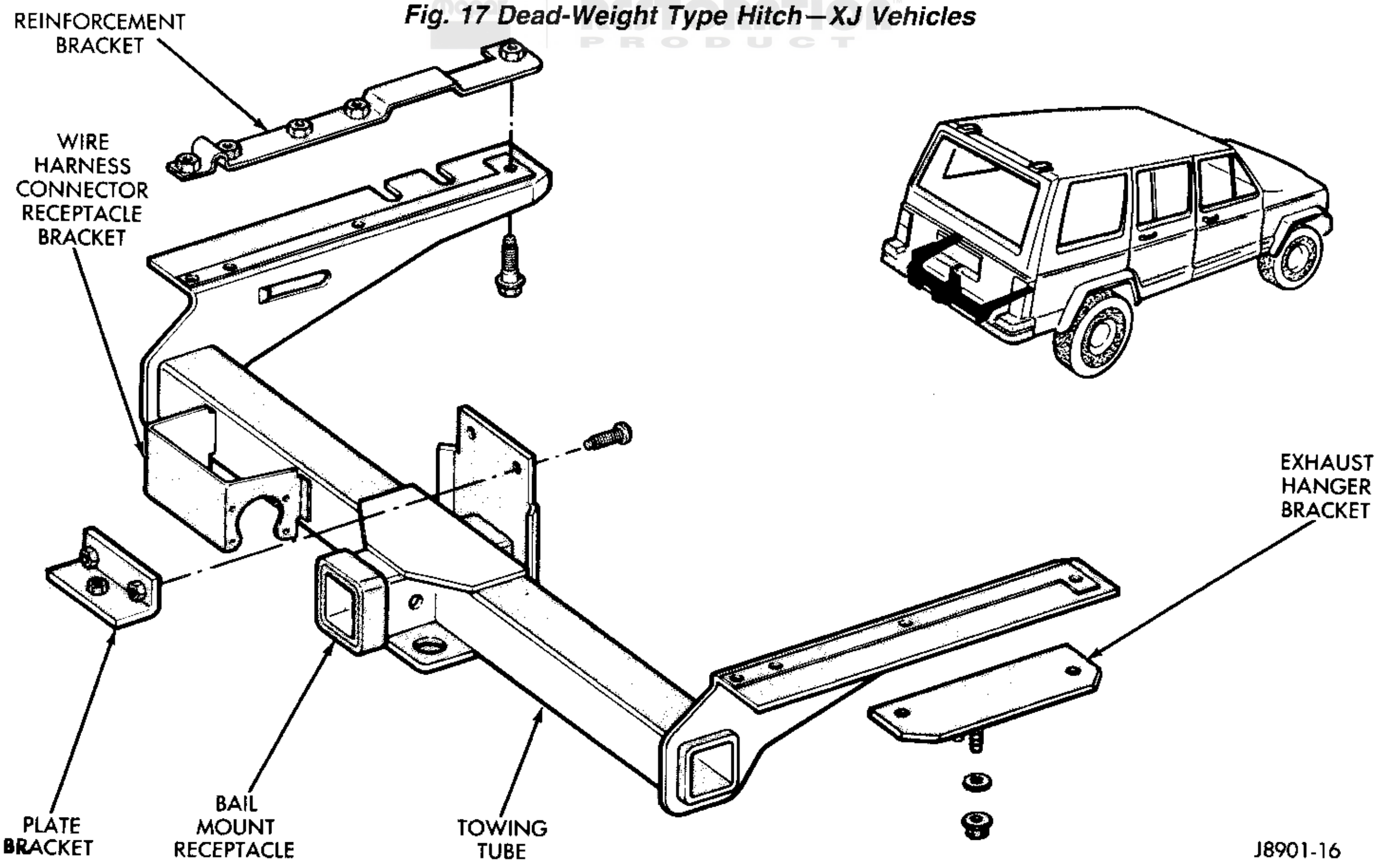


Fig. 18 Equalizer Type Hitch—XJ Vehicles

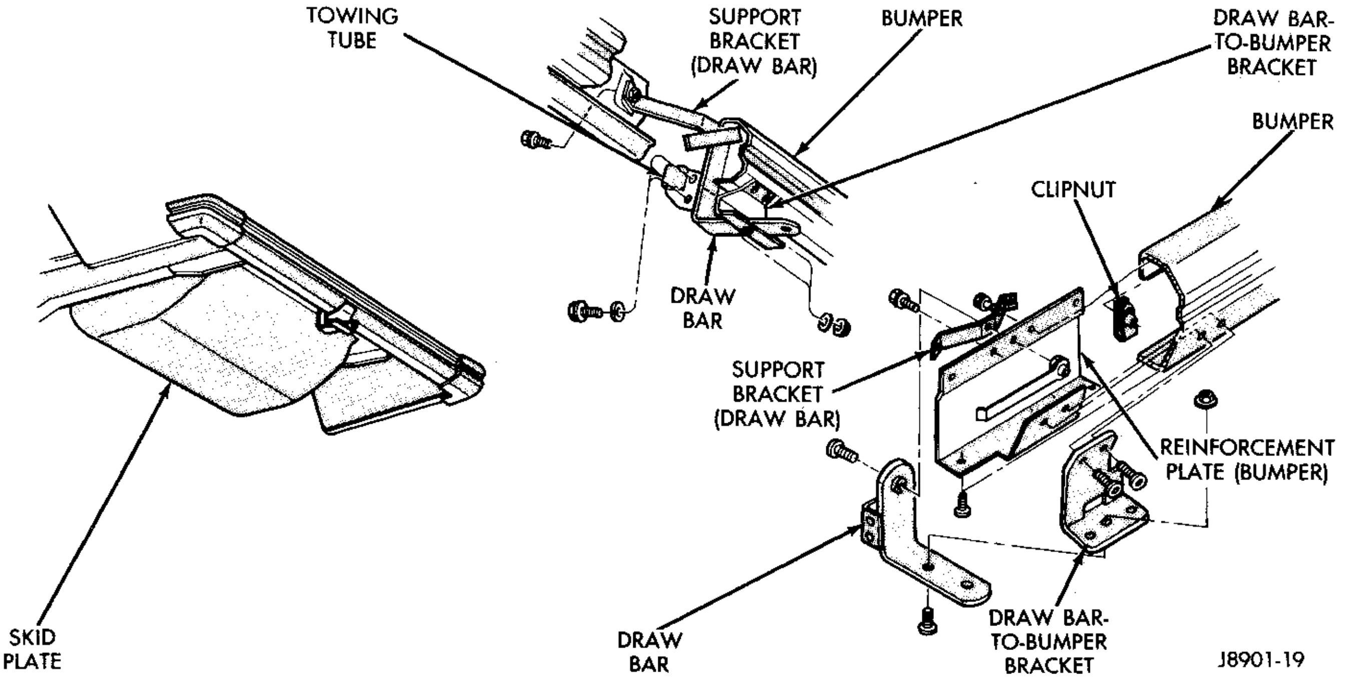


Fig. 19 Draw Bar & Support Bracket

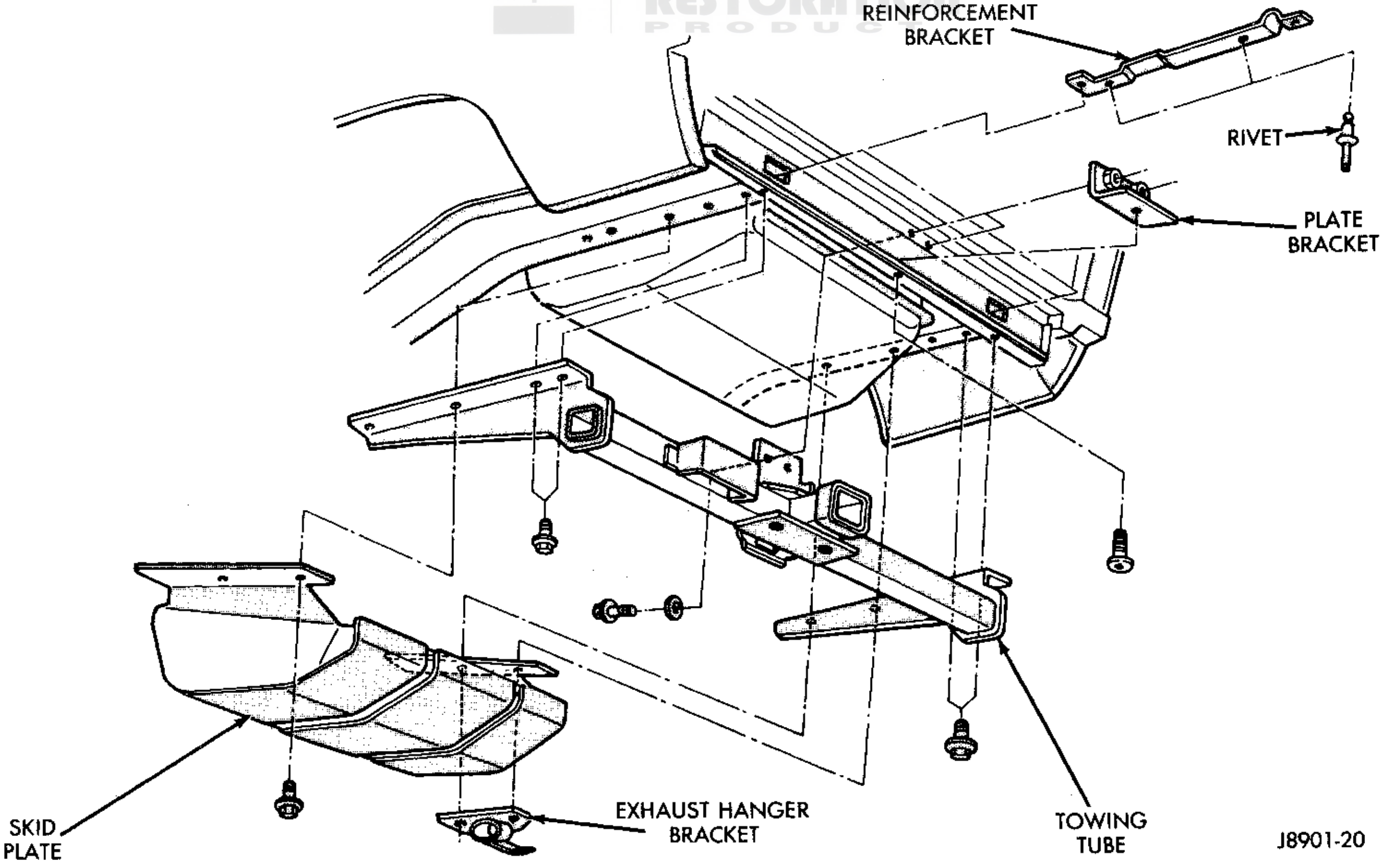


Fig. 20 Reinforcement Bracket & Hitch Installation

SUNROOF

GENERAL INFORMATION—XJ VEHICLES

The following procedure can be used to either repair or replace a pop-up sunroof (Fig. 21) installed in a XJ vehicle.

REPAIR/REPLACEMENT—XJ VEHICLES

Disassembly

(1) Turn the handle and completely open the glass (Fig. 22).

(2) Push the red disengagement/engagement levers inward, push upward on the glass to disengage it from the adjuster and release the levers (Fig. 22).

(3) Continue pushing upward on the glass until the safety latch contacts the top plate (Fig. 23).

(4) Release the safety latch and tilt the glass upward and away from the frame (Fig. 23).

(5) Press firmly inward on both of the glass hinge-halves to release them from the hinge pivots (Fig. 24). Remove the glass and store it in a safe place.

(6) Hold the handle to prevent it from turning and remove the retaining screw (Fig. 25).

(7) Remove the screws that attach the top plate to the adjuster (Fig. 26).

(8) Remove the screws that attach the adjuster to the sunroof frame and remove the adjuster (Fig. 26).

(9) If it is necessary to remove the sunroof frame from the roof panel, pull the flange seal upward and away from the frame to expose the retainer attaching screws (Fig. 27).

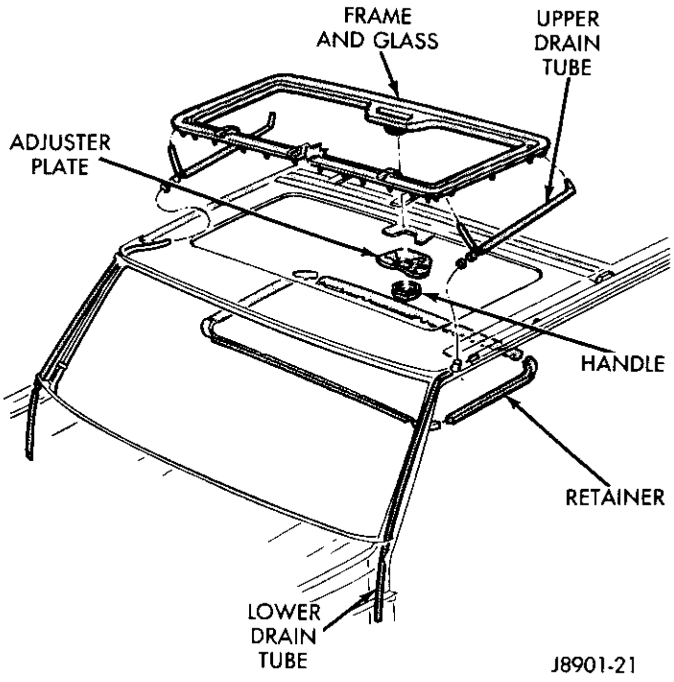


Fig. 21 Sunroof (Exploded View)

(10) Disconnect the upper drain tubes from the lower drain tubes. Remove the attaching screws and the retainers (Fig. 28).

(11) Remove the screws that attach the reinforcement to the frame, cut the seal with a hot knife or wire, and remove the reinforcement (Fig. 28).

(12) Pull the lower drain tubes up through the roof rail and A-pillars (Fig. 28).

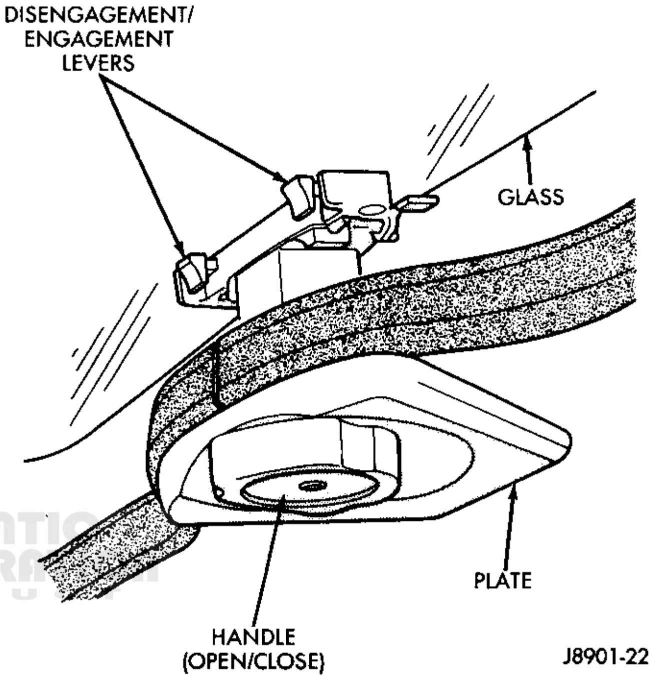


Fig. 22 Glass Disengagement/Engagement

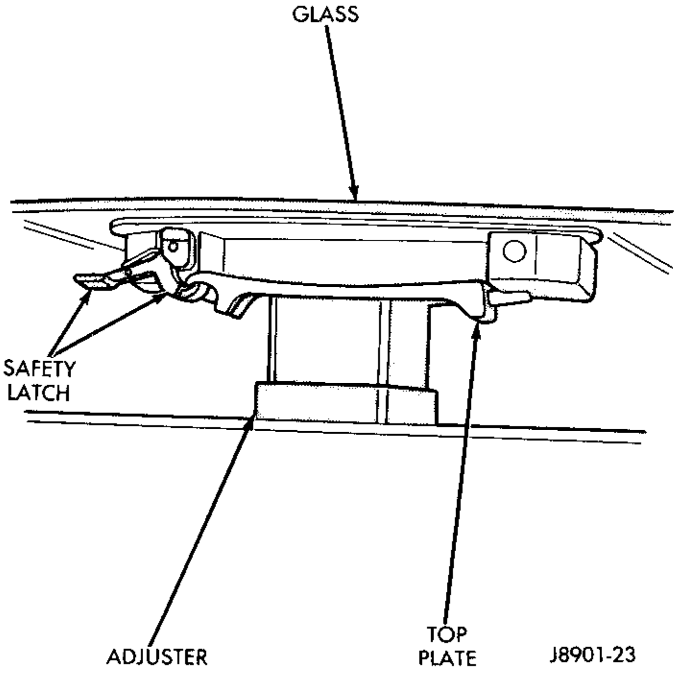


Fig. 23 Safety Latch

(13) Remove the sunroof frame from the roof panel (Fig. 28).

(14) Remove the sealant from the flange seal and the roof panel.

Assembly

(1) Position the sunroof frame in the roof panel opening (Fig. 28).

(2) Insert and guide the lower drain tubes through the roof rail and down the A-pillars (Fig. 28).

(3) Attach the reinforcement to the frame with the attaching screws. Install the upper drain tubes and connect them to the lower drain tubes (Fig. 28).

(4) Position the retainers against the frame and install the attaching screws (Fig. 28, Fig. 27).

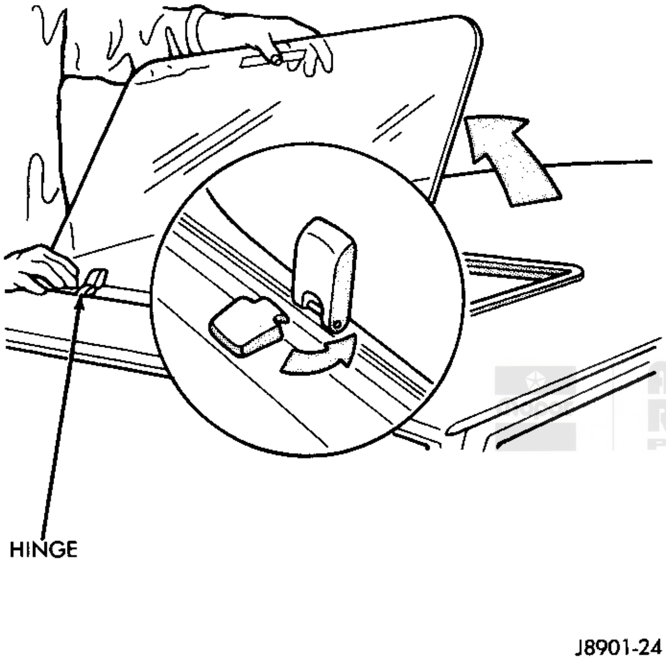


Fig. 24 Hinge Separation

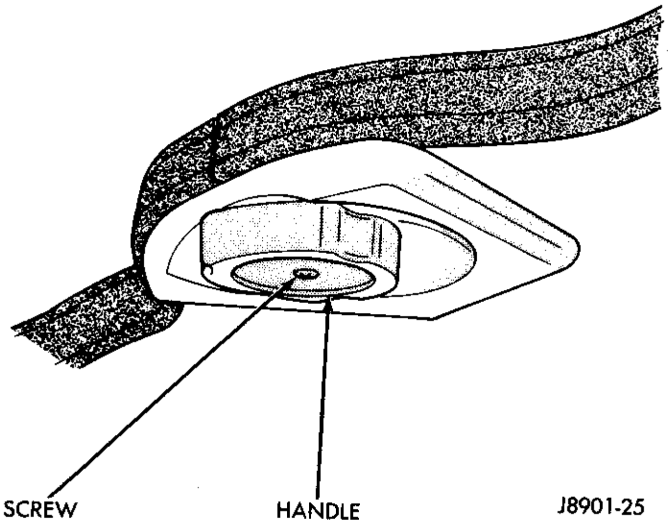


Fig. 25 Handle Removal/Installation

(5) Apply sealant to the flange seal and roof panel. Install the flange seal (Fig. 27).

(6) Position the adjuster on the sunroof frame and install the attaching screws (Fig. 26).

(7) Position the top plate on the adjuster and install the attaching screws (Fig. 26).

(8) Position the handle on the adjuster, hold it to prevent it from turning and install the retaining screw (Fig. 25).

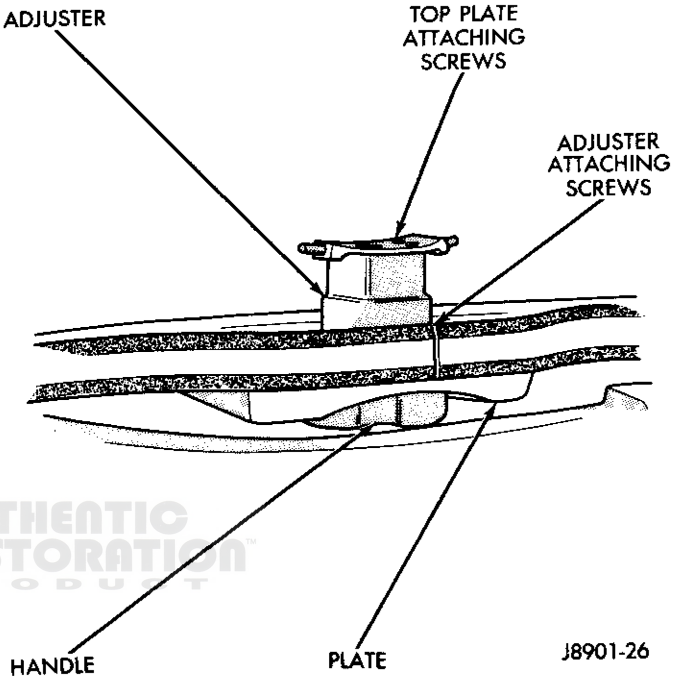


Fig. 26 Adjuster Removal/Installation

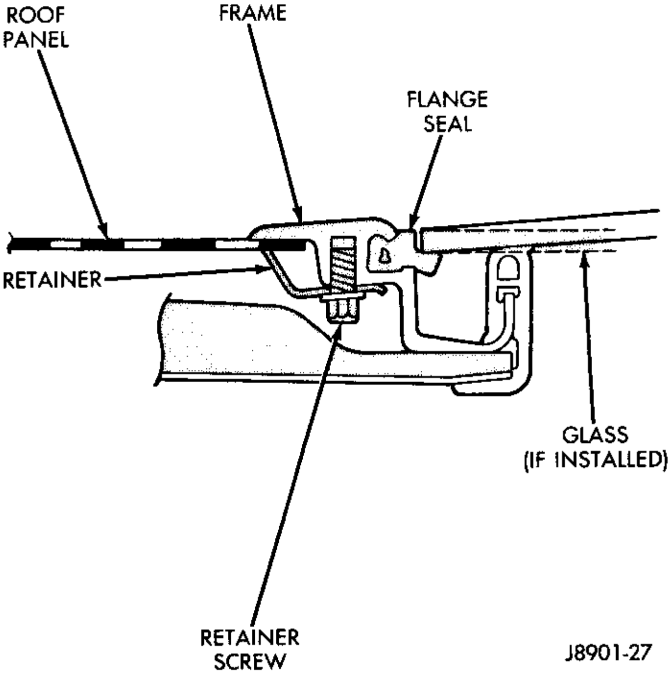


Fig. 27 Flange Seal Removal/Installation

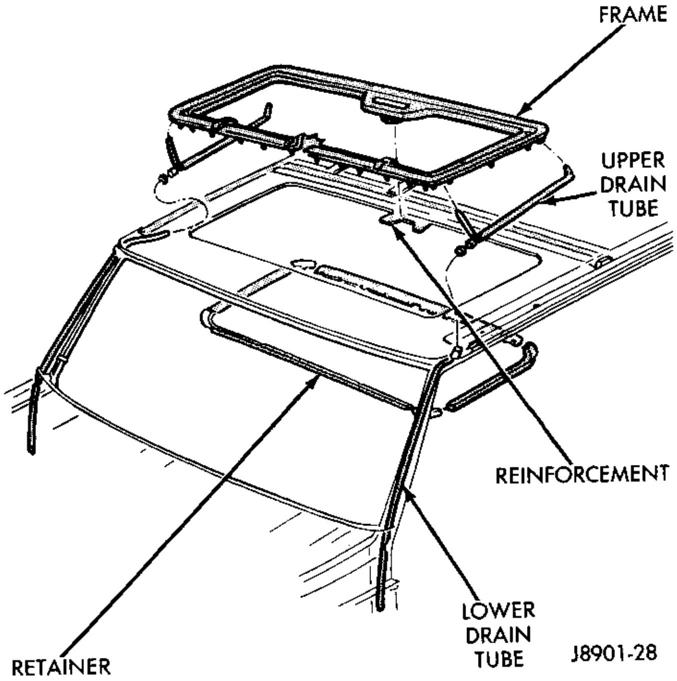


Fig. 28 Retainers & Frame Removal/Installation

(9) Position the glass so that the hinge-halves mate with their respective counterparts on the sunroof frame and join the hinge-halves at the pivots (refer to Fig. 24). Lower the glass.

(10) Release the safety latch, lower the glass to the top plate and engage the safety latch (Fig. 23).

(11) Push the red disengagement/engagement levers inward, push downward on the glass to engage it with adjuster, and release levers (Fig. 22).

(12) Turn the handle and completely close the glass (Fig. 22).

SPECIFICATIONS

Torque Specifications

COMPONENT	SERVICE SET-TO TORQUE	SERVICE RECHECK TORQUE
Towing tube-to-reinforcement bolt	50 N•m (37 ft-lbs)	40-60 N•m (30-44 ft-lbs)
T-bolt nut (M12 × 1.75)	85 N•m (63 ft-lbs)	75-95 N•m (56-70 ft-lbs)
Draw bar-to-towing tube bolt/nut (M12 × 1.75)	85 N•m (63 ft-lbs)	75-95 N•m (56-70 ft-lbs)
Rear crossmember-to-plate bracket bolt	52 N•m (40 ft-lbs)	42-62 N•m (34-46 ft-lbs)
Hitch ball-to-draw bar nut	217 N•m (160 ft-lbs)	—
Draw bar-to-draw bar bumper bracket bolt (M12 X 1.75)	85 N•m (63 ft-lbs)	75-95 N•m (56-70 ft-lbs)
Rear bumper-to-rear bumper reinforcement plate torx head bolt	20 N•m (15 ft-lbs)	15-25 N•m (11-18 ft-lbs)
Draw bar support bracket bolt (M12 × 1.75)	85 N•m (63 ft-lbs)	75-95 N•m (56-70 ft-lbs)
Trailer Hitch Bolts (Model 15)		
1/2 inch	102 N•m (75 ft-lbs)	—
5/8 inch	203 N•m (150 ft-lbs)	—
Luggage Rack Support Screws	3 N•m (28 in-lbs)	2-5 N•m (15-40 in-lbs)

J8901-29

FRONT SUSPENSION

CONTENTS

GENERAL INFORMATION

DESCRIPTION

Front Suspension

A Jeep front suspension is comprised of an axle, steering knuckles, steering linkage, a track bar, a stabilizer bar, suspension arms (MJ/XJ vehicles only), springs and shock absorbers. **Refer to Group 17—Springs/Shock Absorbers for service information involving springs and shock absorbers.**

Front Axles

4WD Axles

The Model 30 axle (MJ/XJ and YJ vehicles) is a "semi-floating" axle-shaft type, four-wheel drive front axle. The Model 44 axle (SJ vehicles) is a "full-floating" axle-shaft type, four-wheel drive front axle. Both axle housings consist of a nodular cast iron differential housing (center section) and two steel axle shaft tubes that are pressed into the differential housing (center section).

One of the axle shaft tubes has a fitting for a vent hose that is used to relieve the internal pressure caused by lubricant vaporization and internal expansion.

2WD Axle

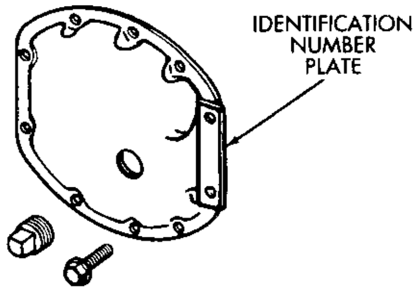
The front axle used with two-wheel drive MJ/XJ vehicles is a one-piece, tubular axle.

Identification

For MJ/XJ (4WD) vehicles and YJ vehicles, the Model 30 axle ratio, ring gear and pinion gear teeth combination, production date and manufacturer's identification number are stamped on a plate attached to the differential housing cover (Fig. 1). For SJ vehicles, the Model 44 axle code is cast in the left side of the differential housing (Fig. 2).

Refer to the axle code chart to decode a Model 44 axle code.

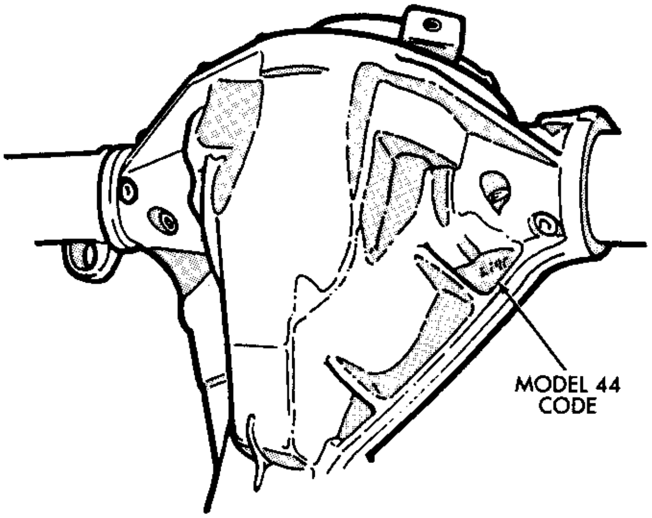
For SJ vehicles, the Model 44 axle production date and the manufacturer's identification number are stamped on the right-side axle shaft tube adjacent to the differential housing cover. The axle production date is decoded as follows: the first number represents the month, the second number represents the day of the month, the third number represents the year, the letter represents the work "shift", and the last number represents the production assembly line. If there are two



Axle Ratio	Ring/Pinion Gear Tooth Combinations
3.07:1	43/14
3.31:1	43/13
3.55:1	39/11
3.73:1	41/11
4.10:1	41/10
4.56:1	41/9

J9002-59

Fig. 1 Model 30 Axle ID Plate Location & Chart



Differential Type	Gear Ratio	Code Letter	Pinion-to-Drive Gear Teeth
Standard	2.73	D	15/41
Standard	3.31	B	13/43
Standard	3.54	A	11/39
Standard	3.73	GG	11/41
Standard	4.10	C	10/41

J8902-2

Fig. 2 Model 44 Axle Code Location & Chart

production dates, the latter date will indicate when the brake components were installed.

The tag attached to the left side of the Model 44 axle differential housing cover indicates the Jeep manufacturing reference part number and the numerical teeth combination of the ring and drive pinion gears.

Model 30 Axle Specifications

Axle Type	Drive-type, semi-floating with yoke-type steering knuckles and ball studs
Application	MJ/XJ/YJ Vehicles
Ring Gear Diameter	7.125 in. (18.09 cm)
Lubricant	MOPAR Gear Lubricant or equivalent SAE 75W-90, API Grade GL-5 quality, MIL-L-2105C
Lubricant Capacity*	2.5 pts. (1.2 liters)

*Command-Trac — add 5 ounces (148 ml) to shift motor housing opening.

J9002-18

Model 44 Axle Specifications

Axle Type	Drive-type full-floating axle with open-end housing type steering knuckles and ball studs
Application	SJ (Grand Wagoneer)
Ring Gear Diameter	8.50 in. (21.59 cm)
Lubricants	MOPAR Gear Lubricant or equivalent SAE 75W-90, API Grade GL5, MIL-L-2105C
Lubricant Capacity	3.0 pts. (1.41 liters)
Outside Wheel Turning Angle	36-37 degrees

J9002-56

Lubricant

The standard lubricant for the Model 30 and the Model 44 front axles is SAE 75W-90, API grade GL 5 hypoid gear lubricant.

Axle Shaft Inner Oil Seals

The Model 30 **Selec-Trac** (i.e., non-disconnect axle) and Model 44 axle differential housings both have two axle shaft inner oil seals that are accessible via the differential housing opening. The seals are installed in counterbores machined into the shaft bores located at each side of the housing. The Model 30 **Command-Trac** axle (i.e., disconnect axle) has only one axle shaft inner oil seal located in the differential housing. The other axle shaft inner oil seal is located in the right-side axle shaft tube outboard of the shift motor housing opening.

All the axle shaft inner oil seals are replacable but the seals in the differential housing require that the differential case and the drive pinion gear shaft be removed for replacement accessibility. Refer to Axle/ Differential Service Procedures for the replacement procedure.

4WD Systems

Two different types of 4WD drive systems are used in Jeep vehicles:

- Command-Trac, and
- Selec-Trac.

Command-Trac

The Command-Trac system employs a Model 30 front axle (Fig. 3, Fig. 4) with a two-wheel/four-wheel drive axle disconnect/connect feature. This, along with the transfer case synchronized shift feature, allows the system to be manually ("on-demand") shifted between two- and four-wheel drive (and vice-versa) **high** range from inside the vehicle while the vehicle is in motion (any speed). The only time the vehicle speed must be reduced

(2 - 3 mph or 3 - 5 km/h) is to shift into or out of four-wheel drive **low** range.

All YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** 4WD system have a two-piece axle shaft (i.e., a disconnect axle) on the right side of the differential housing that is comprised of an outer axle shaft and an intermediate axle shaft. For four-wheel drive operation, the two shafts are coupled together by a shift collar. The collar engages matching splines that are located on the end of each axle shaft. For two-wheel drive operation, the vacuum shift motor and shift fork move the shift collar out of engagement with the outer axle shaft splines.

The outer splines of the outer axle shaft mesh with splines in the wheel hub and the shaft is retained in place by an E-ring. The intermediate shaft is retained in the right-side, differential side gear by an internal expanding retaining "snap" ring.

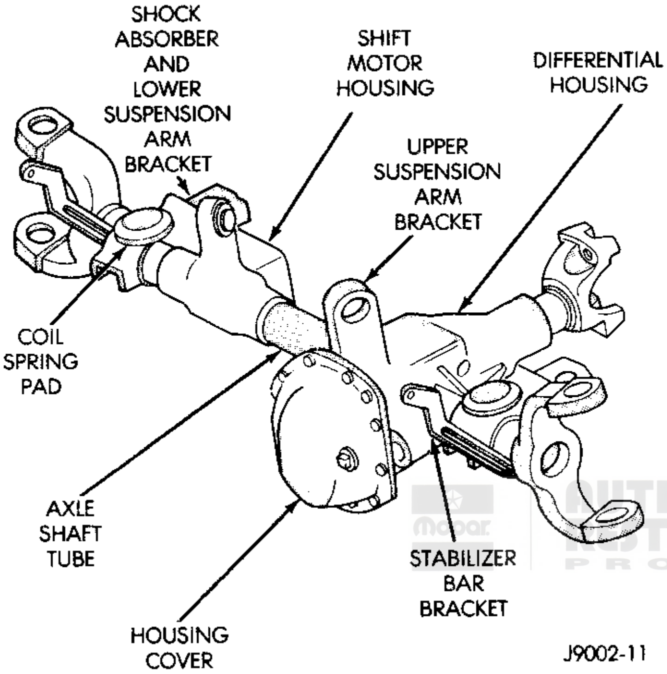


Fig. 3 Command-Trac Front Axle — MJ/XJ

Selec-Trac

The Selec-Trac system offers either full-time or part-time (manual "on-demand" selection) four-wheel drive operation. The Selec-Trac system employs either a Model 30 (MJ/XJ vehicles) or a Model 44 (SJ vehicles) front axle and can be shifted into either two- or four-wheel drive operation from inside the vehicle while the vehicle is in motion (any speed).

All SJ vehicles and MJ/XJ vehicles that are equipped with a **Selec-Trac** 4WD system (Fig. 5, Fig. 6) have a standard one-piece axle shaft (i.e., non-disconnect axle) on either side of the differential housing because shifting from two-wheel to four-wheel drive (and vice-versa) is accomplished only at the transfer case.

For XJ vehicles equipped with a **Selec-Trac** axle (i.e., a non-disconnect axle) and also with an ABS brake system, refer to Group 5—Brakes for additional service information.

2WD Front Axle

MJ/XJ vehicles that are equipped only for two-wheel drive (i.e., rear wheel drive only) operation have a one-piece, tubular front axle (Fig. 7).

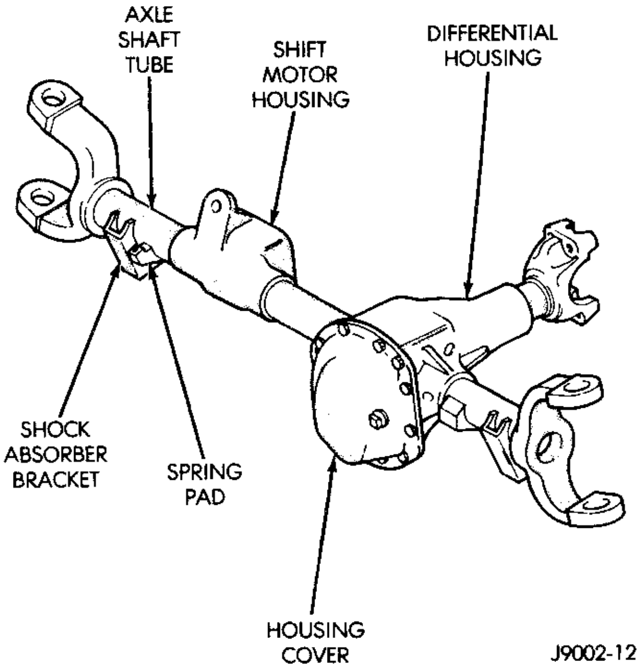


Fig. 4 Command-Trac Front Axle — YJ

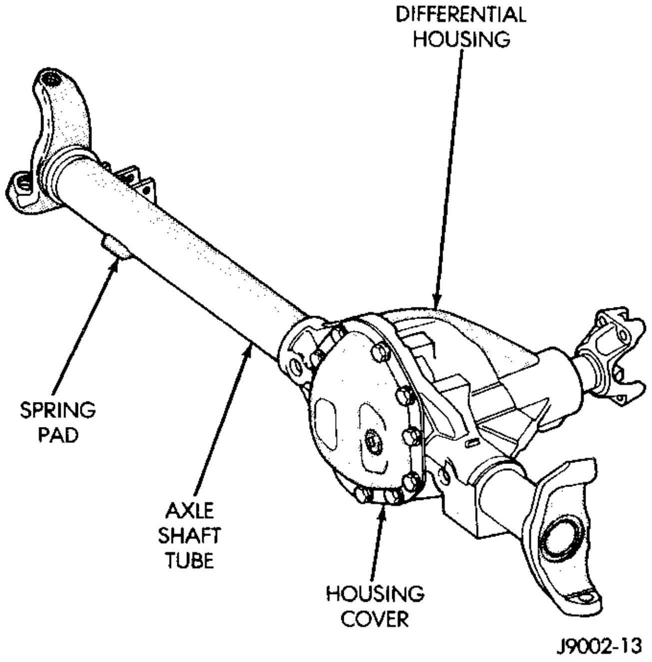


Fig. 5 Selec-Trac Front Axle — SJ

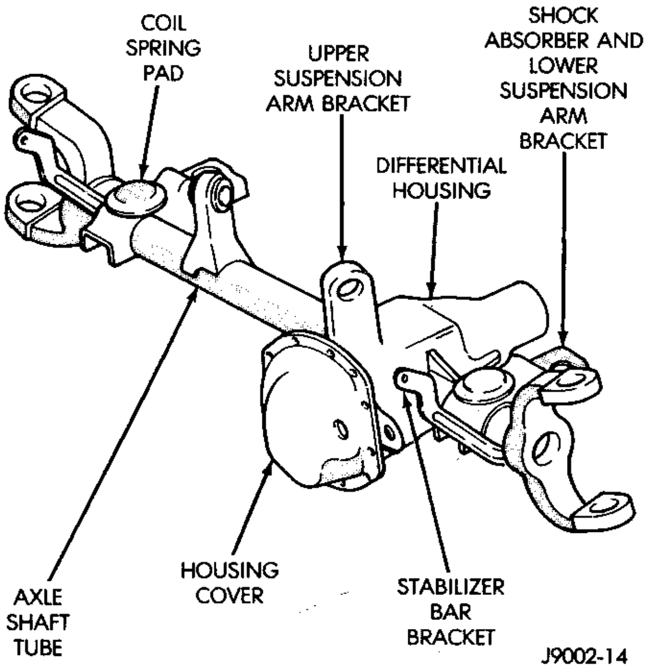


Fig. 6 Selec-Trac Front Axle — MJ/XJ

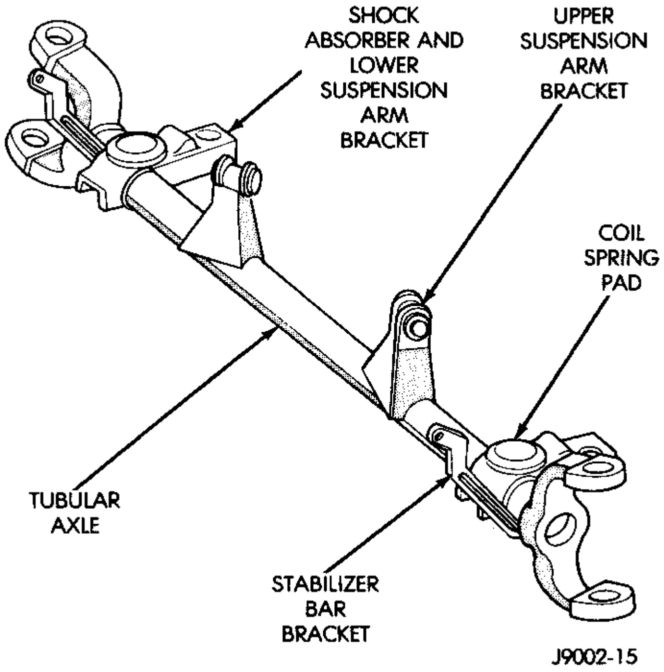


Fig. 7 2WD Front Axle — MJ/XJ

Steering Linkage

The steering linkage consists of a steering gear pitman arm, a drag link, a tie rod, and a steering dampener (Fig. 8, Fig. 9, Fig. 10). Ball stud ends and adjustment sleeves are used on the tie rod and drag link for toe adjustment and steering wheel alignment.

For SJ and YJ vehicles, the drag link is attached to the pitman arm at one end and to the tie rod at the opposite end. The tie rod ends are connected to the steering knuckle arms (Fig. 8, Fig. 10). The steering dampener is attached to the tie rod on one end and attached to the left spring bracket at the opposite end.

For MJ/XJ vehicles, the drag link is attached to the pitman arm at one end and to the right steering knuckle arm on the opposite end. The tie rod is attached to the drag link at one end and to the left steering knuckle arm on the opposite end (Fig. 9).

For SJ and YJ vehicles, the tie rod consists of a solid rod that is threaded on one end and has an integral ball stud at the opposite end that is attached to the steering

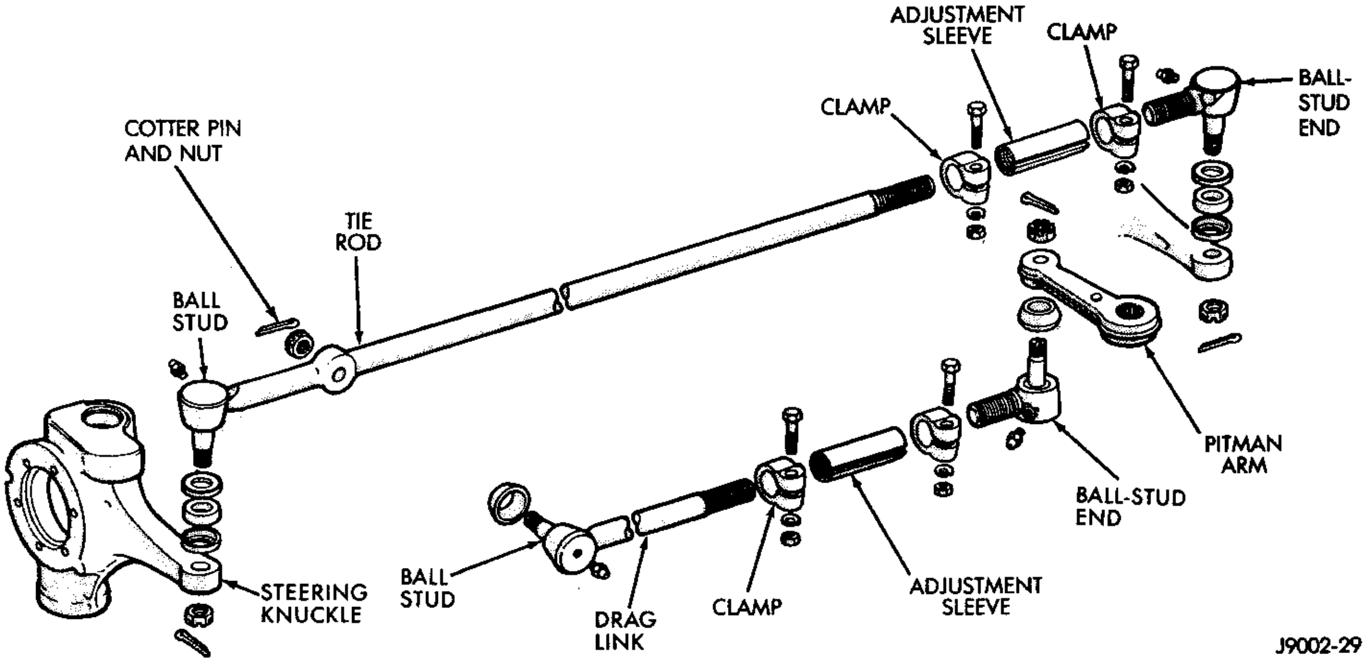


Fig. 8 Steering Linkage—SJ Vehicles

knuckle arm (Fig. 8, Fig. 10). An adjustment sleeve and the removable ball-stud end complete the tie rod. The tie rod threaded-end has right-hand threads to accept the adjustment sleeve.

For MJ/XJ vehicles, the tie rod consists of a solid rod that is threaded on one end and has an integral ball stud at the opposite end that is attached to the drag link (Fig. 9). An adjustment sleeve and the removable ball-stud

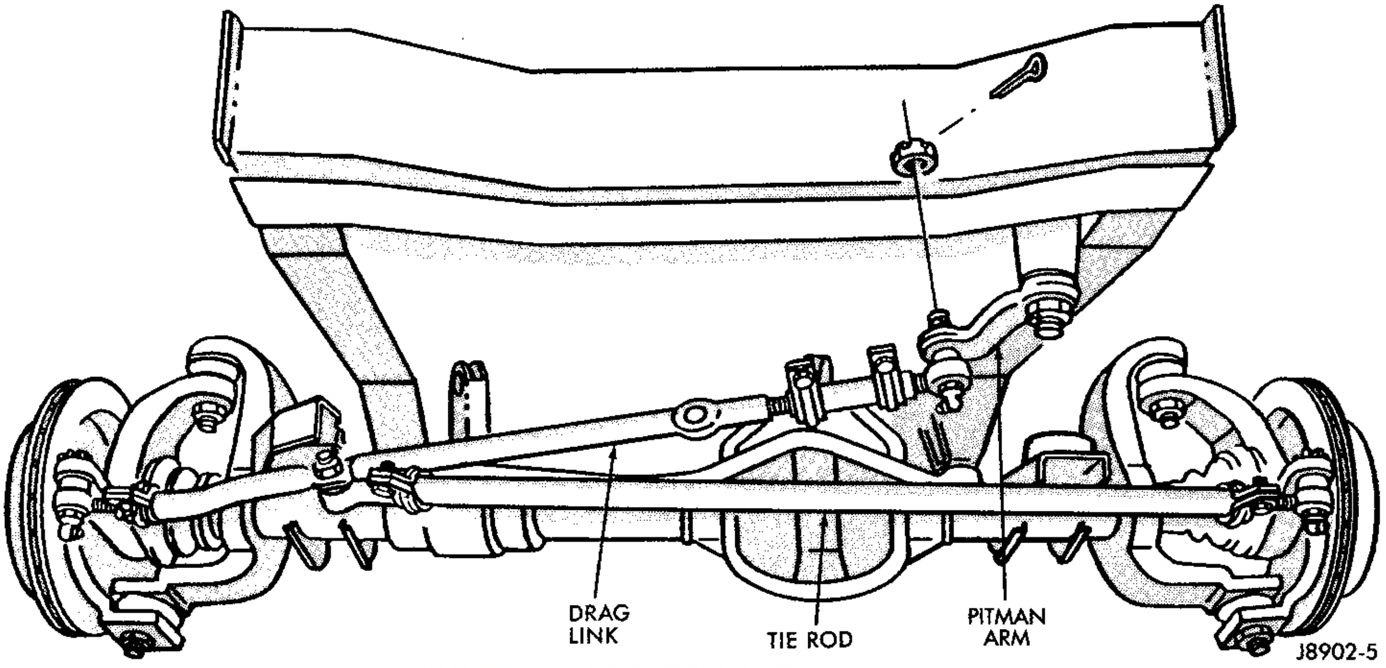


Fig. 9 Steering Linkage—MJ/XJ Vehicles

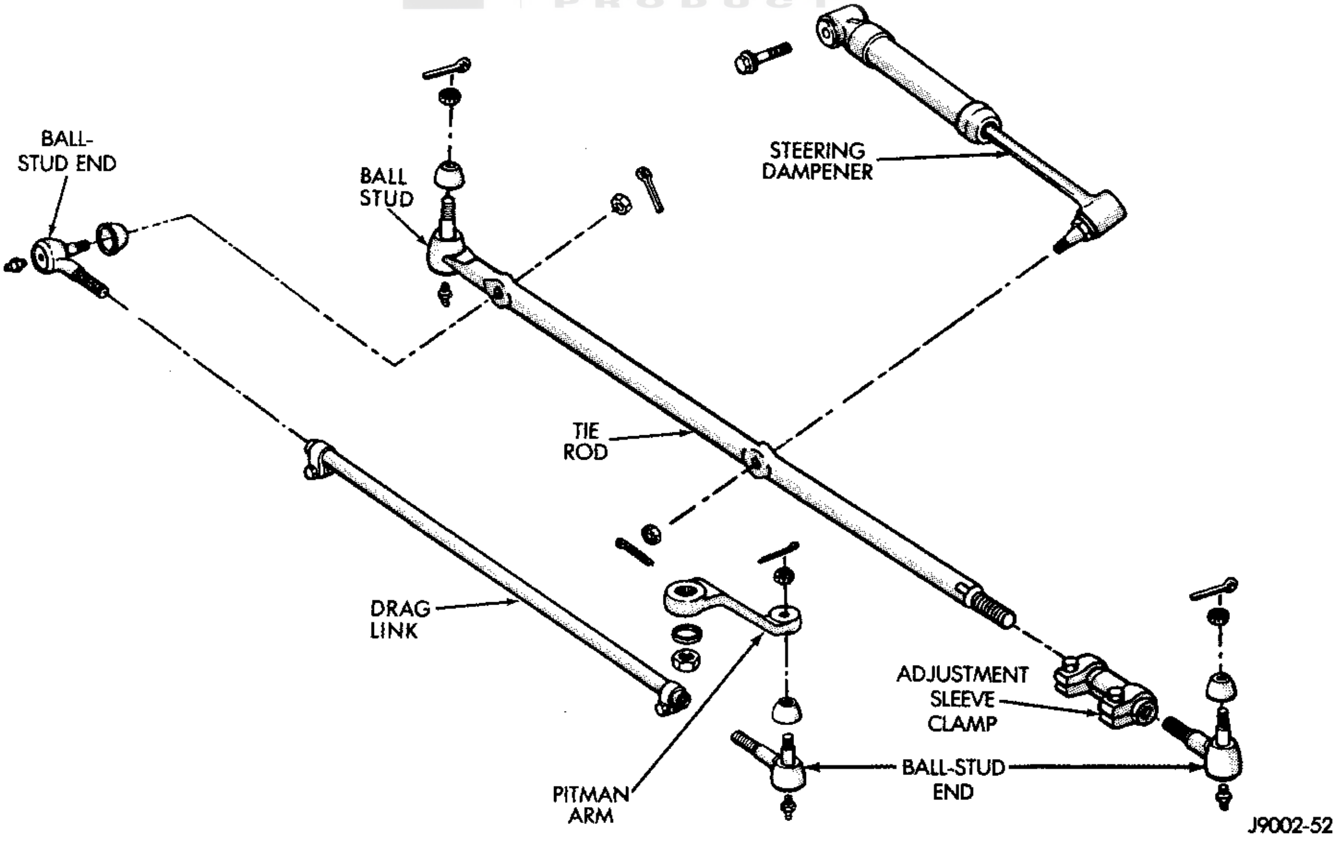


Fig. 10 Steering Linkage—YJ Vehicles

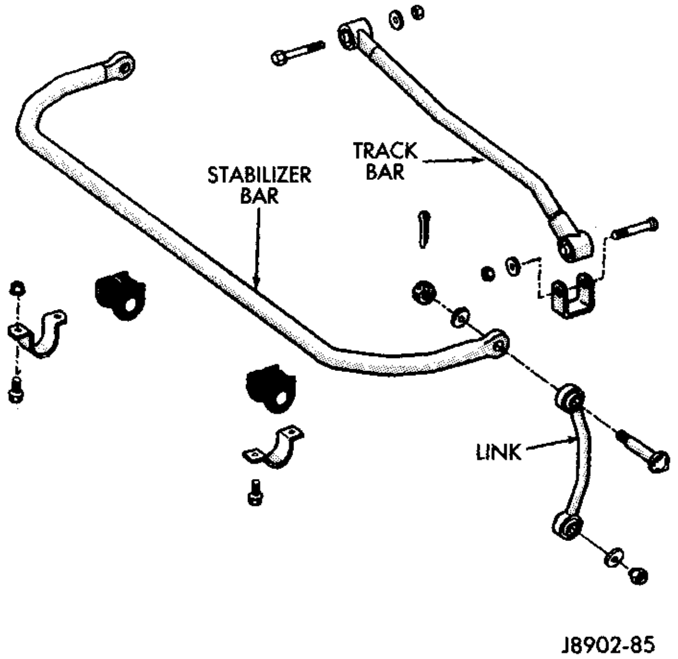


Fig. 11 Track & Stabilizer Bars—SJ & YJ Vehicles

end complete the tie rod. The tie rod threaded-end has right-hand threads to accept the adjustment sleeve.

Track Bar

The front track bar (Fig. 11) installed on all Jeep vehicles is used to minimize front axle lateral (side-to-side) movement. It is attached to the frame rail bracket by either a ball stud and nut (MJ/XJ vehicles) or a bolt, bushing and nut (SJ and YJ vehicles). The opposite end of the bar has a bushing and is retained in the axle shaft tube bracket with a bolt and nut. Refer to Group 17—Springs/Shock Absorbers for SJ and YJ vehicle rear track bar service information.

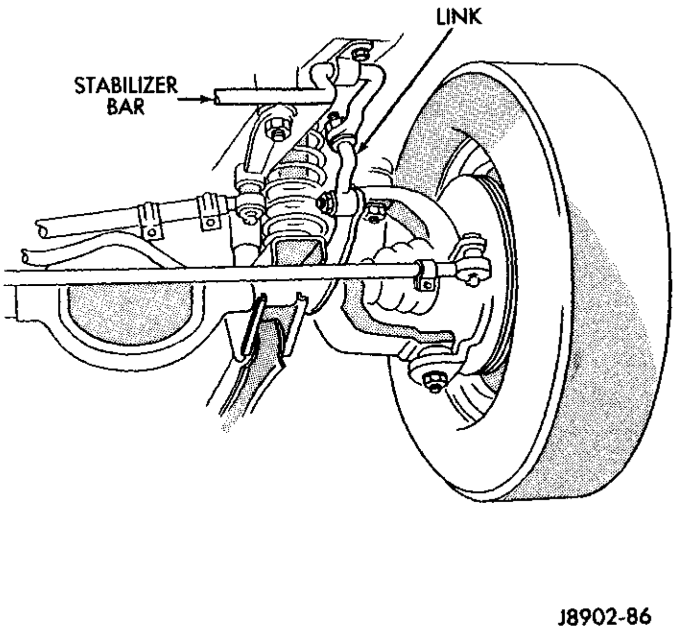


Fig. 12 Stabilizer Bar—MJ/XJ Vehicles

Stabilizer Bar

The stabilizer bar (Fig. 11, Fig. 12) extends across the front underside of the chassis. The stabilizer bar connects to the frame rails/frame and to the stabilizer bar links, which are connected to a front axle bracket.

All Jeep vehicles are equipped with a front stabilizer bar.

AXLE/DIFFERENTIAL SERVICE

INDEX

AXLE/DIFFERENTIAL NOISE DIAGNOSIS

General Information

Axle bearing problem conditions are usually caused by:

- insufficient or incorrect lubricant;
- foreign matter/water contamination; or
- incorrect bearing "preload" adjustment.

Also, when serviced, the bearings must be cleaned thoroughly and dried only with lint-free shop towels. **Never dry bearings with compressed air. This will overheat them and "brinell" the bearing surfaces, which will result in noisy operation after repair.**

Axle gear problem conditions are usually the result of:

- insufficient lubrication;
- incorrect or contaminated lubricant;
- overloading (excessive engine torque); or
- incorrect clearance or "backlash" adjustment.

Insufficient lubrication is usually the result of a housing cover leak; worn (or defective) axle shaft or drive pinion gear shaft seals; or cracks/porous areas in the housing or axle shaft tubes.

Using a lubricant that is not acceptable for axle gear use can result in overheating and the failure of gear and bearing surfaces. Gear tooth "cracking" and bearing "spalling" are two prime indicators of this situation.

Axle component breakage is most often the result of:

- severe "overloading" (engine torque);
- insufficient lubricant;
- incorrect lubricant; or
- improperly tightened components.

A common cause of "overloading" is frequent full-throttle acceleration (from a standing start). In addition, component breakage can also occur when the wheels are "spun" excessively in mud, sand, snow, or on "icy" pavement. Insufficient or incorrect lubricants contribute to breakage through overheating and consequential metal fatigue. Loose differential bearing cap bolts and a loose drive pinion gear shaft nut can also cause component breakage.

Generally, an incorrect bearing "preload" or gear "backlash" adjustment will not result in component breakage. In most instances, mis-adjustment will produce enough noise to cause service/repair before a failure occurs. However, if a mis-adjustment condition is not corrected within a reasonable period of time, component failure can result.

General Diagnosis Information

When diagnosing a front axle noise condition, obtain a complete description of the noise and the driving conditions during which the noise occurred. A preliminary road test with the owner demonstrating the complaint condition is recommended.

Whenever axle noise is caused by worn or damaged axle/differential bearings (Fig. 1), do not replace the axle/differential gears unless they are also worn or damaged. Similarly, if the axle/differential gears are causing noise, do not replace the bearings unless they are also worn or damaged.

The mechanical action that transfers engine torque to the wheels will cause a small amount of noise in all axles. Slight axle noise confined to a limited speed range or a specific time period are considered normal.

Noise produced by the engine, transfer case, transmission, tires, wheel bearings, exhaust system, drive shafts or the action of wind on the body or grille can be incorrectly diagnosed as axle noise. It is important to test the vehicle thoroughly to isolate the problem component and avoid unnecessary repair.

Before road testing, check and correct the tire inflation pressures and the differential housing lubricant level.

During the road test, stop the vehicle, shift the transmission into neutral, and operate the engine at a variety of speeds (rpm). If the noise is heard during this phase of the test, the noise is being produced by either the engine, exhaust system, clutch, transmission, transfer case or by engine driven accessory equipment.

Refer to Group 22—Tires And Wheels for additional information involving audible vibration (noise) and mechanical vibration.

Tire Noise

Because certain types of tires, unusual tread wear or tread patterns can produce objectionable noises, drive the vehicle on a variety of road surfaces and listen for a change in the noise. If the noise varies with the type of road surface, the tires may be causing the noise.

Wheel Bearing Noise

The noise caused by worn, loose, or damaged wheel bearings can be confused with axle noise. Wheel bearing noise is usually more noticeable when coasting at low speeds. Applying the brakes gently while the vehicle is moving will usually change the amplitude of wheel bearing noise. Another test involves turning the vehicle alternately left and right while moving straight ahead at a relatively low speed. This maneuver "sideloads" the bearings and should cause the noise amplitude from the problem bearing to increase.

Differential Gear And Bearing Noise

Differential gear (Fig. 1) noise is often described as a whine or a high-pitched resonating sound. It is usually more pronounced at specific vehicle speeds and within a limited speed range whether the vehicle is in a "drive" (accelerating load), a "coast" (decelerating load), or a "float" (constant speed) operating condition.

Differential bearing (Fig. 1) noise amplitude is usually constant and the pitch is relative to vehicle speed. Because the drive pinion gear rotates faster than the differential ring gear, the drive pinion gear shaft bearings produce a higher pitch sound than the differential bearings. Drive pinion gear shaft bearing noise is usually more pronounced at lower vehicle speeds in the range of 20 - 30 mph (32 - 48 km/h).

Differential bearings produce a lower noise pitch (frequency) because they are rotating at the same speed as the wheels. Differential bearing noise does not vary when the vehicle wheels are turned alternately left and right or when the brakes are gently applied.

Road Test

Before testing an axle/differential, drive the vehicle a distance that will sufficiently ensure that the axle/differential and the lubricant are at normal operating temperature. During the test drive, operate the transmission and the transfer case in every gear combination.

Axle and differential (Fig. 1) noises are usually relative to vehicle speed rather than engine speed (rpm) or transmission gear range. Axle and differential noises are classified as two types: **gear noise and bearing noise.**

Axle/differential (Fig. 1) noise produced during a **"drive" or "coast"** operating condition can be caused by:

- excessive ring gear "backlash";
- excessive drive pinion gear "end-play";
- damaged or worn drive pinion gear shaft bearings;
- incorrect drive pinion gear depth adjustment; or
- incorrect lubricant.

Axle/differential (Fig. 1) noise produced during a **"drive"** operating condition can be caused by:

- incorrect ring gear "backlash" or drive pinion gear depth adjustment;
- damaged or worn drive pinion gear shaft bearings; or
- incorrect drive pinion gear shaft bearing "preload".

Axle/differential (Fig. 1) noise produced during a **"coast"** operating condition can be caused by:

- excessive ring gear "backlash";
- excessive drive pinion gear "end-play";
- worn or damaged drive pinion gear shaft or differential bearings; or
- excessive differential bearing "preload" torque.

Driveline Backlash

Excessive driveline "backlash" can be the result of "backlash" existing in the:

- transmission;
- transfer case;
- drive shaft yokes and slip joint splines;
- universal joints;
- ring and drive pinion gears;
- differential side and pinion gears;
- front axle shaft splines and universal joints (4WD); or
- rear axle shaft splines.

Other Axle/Differential Noise Conditions

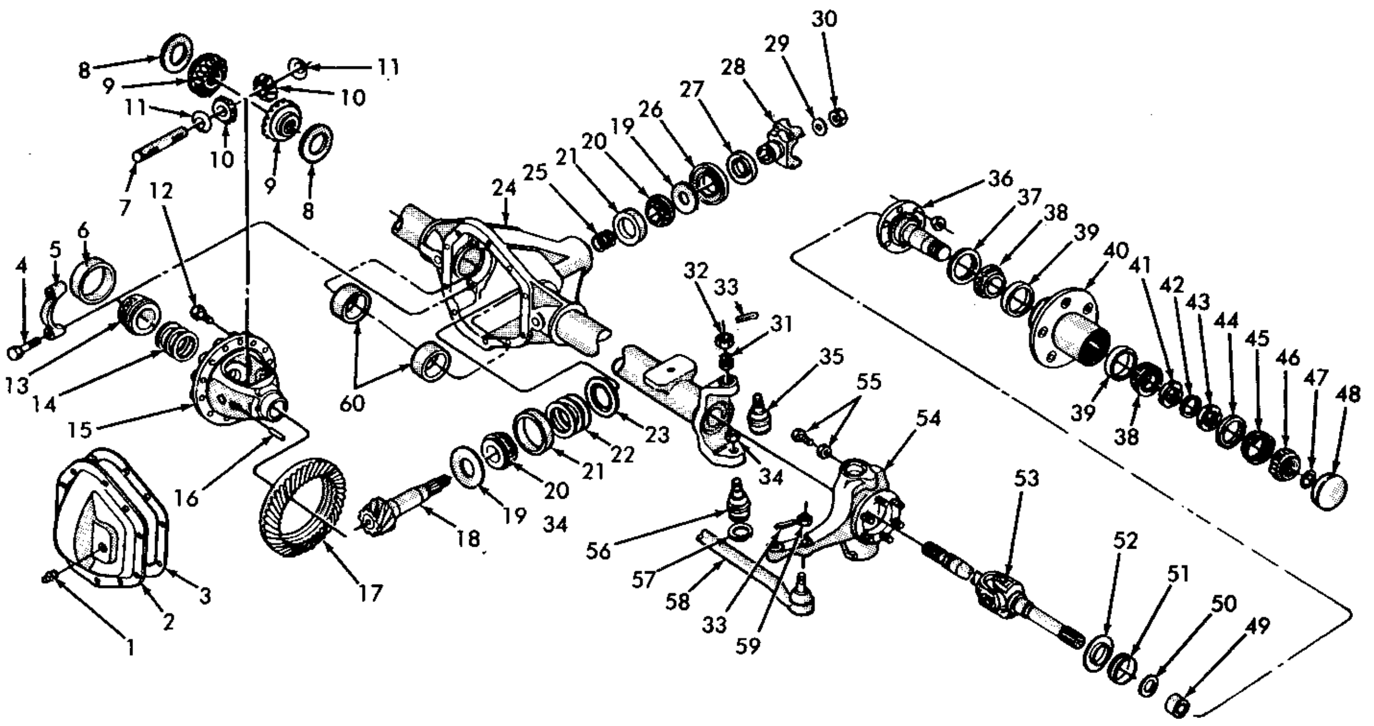
A knocking noise heard at low speed or when coasting may be caused by loose fitting differential side gears (Fig. 1). If this condition is encountered, operate the vehicle at the speed where the noise is the loudest and apply the brakes lightly. If loose fitting gears are causing the problem, the noise level will usually decrease when the brakes are applied.

Differential gear noise is considered normal when spinning a wheel with an "on-the-vehicle" type wheel balance machine, or when the wheels are spinning on "icy" or other types of low traction surfaces.

AXLE/DIFFERENTIAL INSPECTION

The axle shaft tubes and differential housing should be inspected periodically for weld cracks or other damage that could cause loss of lubricant, affect driving characteristics, or result in front-end misalignment.

If a vehicle is driven through water that is deep enough to cover the front hubs, the steering knuckles and brake components should be disassembled and inspected for foreign object contamination and water damage. All the components should be cleaned thoroughly, examined carefully, and lubricated as necessary before assembly. During the inspection, closely observe the axle shaft bearings, spindle bearings and brake components. Damaged or contaminated components should be replaced.



1. FILL PLUG
2. DIFFERENTIAL HOUSING COVER
3. DIFFERENTIAL HOUSING COVER GASKET
4. DIFFERENTIAL BEARING CAP BOLT
5. DIFFERENTIAL BEARING CAP
6. DIFFERENTIAL BEARING CUP (2)
7. PINION MATE SHAFT
8. THRUST WASHER
9. DIFFERENTIAL SIDE GEAR
10. DIFFERENTIAL PINION GEAR
11. THRUST WASHER
12. RING GEAR MOUNTING BOLTS
13. DIFFERENTIAL BEARING (2)
14. DIFFERENTIAL BEARING PRELOAD SHIMS
15. DIFFERENTIAL CASE
16. PINION MATE SHAFT PIN
17. RING GEAR
18. PINION DRIVE GEAR
19. SLINGER
20. PINION BEARING
21. DRIVE PINION BEARING CUP
22. DRIVE PINION DEPTH SHIMS
23. BAFFLE
24. DIFFERENTIAL HOUSING
25. DRIVE PINION PRELOAD SHIMS
26. OIL SEAL
27. DUST CAP
28. YOKE
29. WASHER
30. DRIVE PINION NUT
31. UPPER BALL STUD SPLIT RING SEAT
32. UPPER BALL STUD NUT
33. COTTER PIN
34. LOWER BALL STUD JAMNUT
35. UPPER BALL STUD
36. SPINDLE
37. SEAL
38. BEARING
39. BEARING CUP
40. HUB
41. INNER LOCKNUT
42. WASHER
43. OUTER LOCKNUT
44. SPRING CUP
45. PRESSURE SPRING
46. DRIVE GEAR
47. SNAP RING
48. HUB CAP
49. SPINDLE BEARING
50. WASHER
51. SEAL
52. SEAL SEAT
53. AXLE SHAFT
54. STEERING KNUCKLE
55. STEERING STOP BOLT
56. LOWER BALL STUD
57. SNAP RING
58. TIE ROD
59. TIE ROD END NUT
60. INNER OIL SEAL

J8902-6

Fig. 1 Model 44 Front Axle

AXLE LUBRICANT

Drain And Refill—All Vehicles

(1) Shift to 4WD and drive the vehicle until the axle lubricant attains the normal operating temperature.

(2) Raise and support the vehicle.

(3) Remove the lubricant fill plug from the differential housing.

(4) Remove the original lubricant with a "suction gun".

(5) For MJ/XJ and YJ vehicles (Model 30 axles), refill the differential housing with 2.5 pints (1.2 liters) of the recommended gear lubricant. For SJ vehicles (Model 44 axles), refill the differential housing with 3.75 pints (1.77 liters) of the recommended lubricant.

(6) Install and tighten the fill plug with 34 N•m or 25 ft-lbs torque.

(7) Remove the supports and lower the vehicle.

COMPLETE AXLE AND DIFFERENTIAL REMOVAL/INSTALLATION

Removal—SJ Vehicles

(1) Raise and support the front end of the vehicle. Position the support stands under the frame rails at the rear of the front springs.

(2) Remove the wheels/tires.

(3) Mark the front drive shaft and the drive pinion gear shaft (axle) yoke for installation alignment reference.

(4) Disconnect the front drive shaft from the axle yoke. Attach the drive shaft to the frame rail with wire.

(5) Remove the cotter pins, the retaining nuts, and disconnect the tie-rod ends from the steering knuckles. Discard the cotter pins.

(6) Remove the retaining nut and bolt from the axle shaft tube bracket and remove the lower end of the track bar from the axle shaft tube bracket.

(7) Remove the retaining nuts and bolts and remove the shock absorbers from the axle shaft tube brackets.

(8) Remove the nuts that attach the stabilizer bar connecting links to the spring bracket studs.

(9) Remove the stabilizer bar connecting links from the spring bracket studs.

(10) Disconnect the vent hose from the axle shaft tube fitting.

(11) Remove the disc brake calipers, the disc brake rotors and the brake shields. If necessary, refer to the applicable removal procedures within Group 5—Brakes.

(12) Remove the nuts and the U-bolts from the spring brackets and the axle shaft tubes.

(13) Position a floor jack under the axle and raise the jack slightly to reduce the load on the springs and relieve the spring tension.

(14) Loosen the nuts that attach the spring rear eyes to the spring hanger brackets.

(15) Remove the nuts and bolts that attach the spring front shackles to the spring eyes and lower the front of the springs to the floor.

(16) Remove the floor jack and the axle from beneath the vehicle.

Installation—SJ Vehicles

(1) Support the axle with a floor jack and position the axle under the vehicle.

(2) Raise the front of the springs and align the spring eyes with the shackles. Insert the shackle bolts through the spring front eyes and the shackles. Install and tighten the shackle bolt retaining nuts "finger-tight" only.

(3) Lower the floor jack until the axle is supported by the front springs and correctly align the axle on the spring brackets.

(4) Install the spring U-bolts over the axle shaft tubes and into the spring brackets. Install and tighten the U-bolt retaining nuts with 136 N•m (100 ft-lbs) torque.

(5) Tighten the spring front shackle bolt retaining nuts with 136 N•m (100 ft-lbs) torque.

(6) Tighten the nuts that attach the spring rear eyes to the spring hanger brackets with 136 N•m (100 ft-lbs) torque.

(7) Position the stabilizer bar connecting links on the spring bracket studs. Install and tighten the retaining nuts with 75 N•m (55 ft-lbs) torque.

(8) Install the brake shields, the disc brake rotors and the disc brake calipers. If necessary, refer to the applicable installation procedures within Group 5—Brakes.

(9) Connect the axle vent hose to the fitting on the axle shaft tube.

(10) Position the shock absorbers at the axle shaft tube brackets and install the bolts and the retaining nuts. Tighten the nuts with 61 N•m (45 ft-lbs) torque.

It is important that the front springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the track bar is connected to the axle shaft tube bracket, otherwise it will be difficult to align it with the bracket holes. In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(11) Position the lower end of the track bar in the axle shaft tube bracket and install the retaining bolt and nut. Tighten the retaining nut with 100 N•m (74 ft-lbs) torque.

(12) Insert the tie-rod ends in the steering knuckles and install the retaining nuts. Tighten the nuts with 81 N•m (60 ft-lbs) torque (minimum). Use replacement cotter pins to secure the nuts.

(13) Align the installation reference marks on the drive shaft and the axle yoke. Connect the drive shaft to the axle yoke. Tighten the shaft-to-yoke attaching bolts/nuts with 22 N•m (16 ft-lbs) torque.

(14) Install the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(15) Remove the supports and lower the vehicle.

(16) Check the front wheel alignment. Adjust as necessary.

(17) Measure and adjust (if necessary) the outside-wheel turning angles. Refer to the adjustment procedure.

Removal—MJ/XJ Vehicles (4WD)

(1) Raise and support the vehicle.

(2) Remove the wheels/tires, disc brake calipers and pads, and the disc brake rotors. If necessary, refer to the applicable removal procedures within Group 5—Brakes.

(3) If equipped with a **Command-Trac** axle (i.e., a disconnect axle), disconnect the vacuum harness from the shift motor. Disconnect the vent hose from the axle shaft tube.

(4) Mark the front drive shaft and drive pinion gear shaft (axle) yoke for installation alignment reference.

(5) Disconnect the following components from the axle:

- stabilizer bar link;
- tie rod and drag link;
- front drive shaft (discard the U-joint straps);
- shock absorbers;
- steering dampener;
- ABS brake sensor (if equipped); and
- track bar.

(6) Position a floor jack under the axle.

(7) Disconnect the upper and lower suspension arms at the axle.

(8) Lower the axle with the jack.

Installation—MJ/XJ Vehicles (4WD)

(1) Raise the axle with a floor jack and align it with the coil springs.

(2) Connect the upper and lower suspension arms to the axle and tighten with the specified torque. Lower: 180 N•m (133 ft-lbs) torque. Upper: 75 N•m (55 ft-lbs) torque.

It is important that the front springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the track bar is connected to the axle shaft tube bracket, otherwise it will be difficult to align the holes with the bracket holes. In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(3) Connect the following components to the axle:

- track bar nut — 100 N•m (74 ft-lbs) torque;
- steering dampener nut — 75 N•m (55 ft-lbs) torque;
- shock absorber nut — 19 N•m (14 ft-lbs) torque;
- stabilizer bar link nut — 95 N•m (70 ft-lbs) torque;
- tie rod and drag link nuts — 47 N•m (35 ft-lbs) torque;
- ABS brake sensor (if equipped);
- axle vent hose; and
- front drive shaft nut — 19 N•m (14 ft-lbs or 70 in-lbs) torque.

(4) If equipped with a **Command-Trac** axle (i.e., a disconnect axle), connect the axle shift motor vacuum harness.

(5) Install the disc brake rotors, pads, calipers, and the wheels/tires. If necessary, refer to the applicable installation procedures within Group 5—Brakes. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(6) Remove the jack and the supports, and lower the vehicle.

(7) Check the front wheel alignment and the outside-wheel turning angles.

Removal—YJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the front wheels/tires.

(3) Remove the disc brake calipers and pads but do not disconnect the brake hoses from the calipers. Tie the calipers to the body or a suspension component. **Do not allow the brake hose to support the weight of the calipers.**

(4) Remove the disc brake rotors.

(5) Disconnect the vacuum harness (Fig. 2) from the shift motor and the vent hose from the axle shaft tube.

(6) Mark the front drive shaft and the drive pinion gear shaft (axle) yokes (Fig. 2) for installation alignment reference and disconnect the drive shaft from the axle. Discard the U-joint straps.

(7) Disconnect the following:

- drag link (at the right-side of the tie rod);
- shock absorbers from the axle (Fig. 2);
- steering dampener; and
- track bar from the axle shaft tube bracket.

(8) Loosen the stabilizer bar links at the stabilizer bar.

(9) Disconnect the stabilizer bar links (Fig. 2) from the spring brackets.

(10) Loosen the nuts/bolts (Fig. 2) that attach the spring rear eyes to the frame brackets.

(11) Loosen the nuts/bolts (Fig. 2) that attach the front springs to the shackles.

(12) Support the axle (Fig. 2) with a floor jack and remove the nuts from the U-bolts. Remove the U-bolts from the axle shaft tubes and the spring brackets (Fig. 2).

(13) Raise the jack enough to relieve the axle weight from the springs.

(14) Remove the spring shackle nuts and bolts and lower the front of the springs to the floor.

(15) Remove the axle (Fig. 2) with the floor jack.

Installation—YJ Vehicles

(1) Place the axle on a floor jack and roll the axle into position beneath the vehicle.

(2) Raise the axle with the floor jack. Raise the springs, align the front eyes with the shackles and install the shackle bolts and nuts. **Do not tighten the bolts at this time.**

(3) Lower the floor jack and align the axle on the spring brackets. Ensure that the spring bracket center bolts are correctly aligned on the axle pads.

(4) Install the U-bolts on the axle shaft tubes and in the spring brackets (Fig. 2). Install and tighten the U-bolt retaining nuts with 122 N•m (90 ft-lbs) torque.

It is important that the front springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the track bar is connected to the axle shaft tube bracket, otherwise it will be difficult to align the holes with the bracket holes. In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(5) Connect the following components (Fig. 2):

- track bar (do not tighten at this time);
- steering dampener — 71 N•m (53 ft-lbs) torque;
- shock absorbers — 61 N•m (45 ft-lbs) torque;
- stabilizer bar links — 61 N•m (45 ft-lbs) torque;
- drag link — 47 N•m (35 ft-lbs) torque; and
- front drive shaft — 19 N•m (14 ft-lbs) torque.

(6) Connect the axle vent hose and the axle shift motor vacuum harness (Fig. 2).

(7) Install the disc brake rotors, pads, calipers and the wheels/tires. If necessary, refer to the applicable installation procedures within Group 5—Brakes. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(8) Remove the floor jack and the supports.

(9) Lower the vehicle.

(10) Tighten the front spring shackle retaining bolts/nuts, the track bar retaining bolt/nut and the front spring eye-to-frame bracket retaining bolts/nuts with the specified torque. Sping shackle bolt/nut: 129 N•m (95 ft-lbs) torque; track bar-to-frame bracket bolt/nut: 168 N•m (125 ft-lbs) torque; track bar-to-axle shaft tube bracket bolt/nut: 100 N•m (74 ft-lbs) torque; and spring eye-to-frame bracket bolt/nut: 142 N•m (105 ft-lbs) torque.

(11) Check the front wheel alignment and the outside-wheel turning angles. Adjust the front wheel alignment, if necessary.

DRIVE PINION GEAR SHAFT SEAL REPLACEMENT

Removal—SJ Vehicles

(1) Raise and support the vehicle.

(2) Mark the front drive shaft and the drive pinion gear shaft (axle) yoke for installation alignment reference and disconnect the drive shaft from the yoke.

(3) Remove the drive pinion gear shaft (axle) yoke retaining nut (Fig. 3) with a socket wrench, a rachet/breaker bar and Flange Removal/Installation Tool 8023 (J8614-1). Remove the washer. Discard the nut.

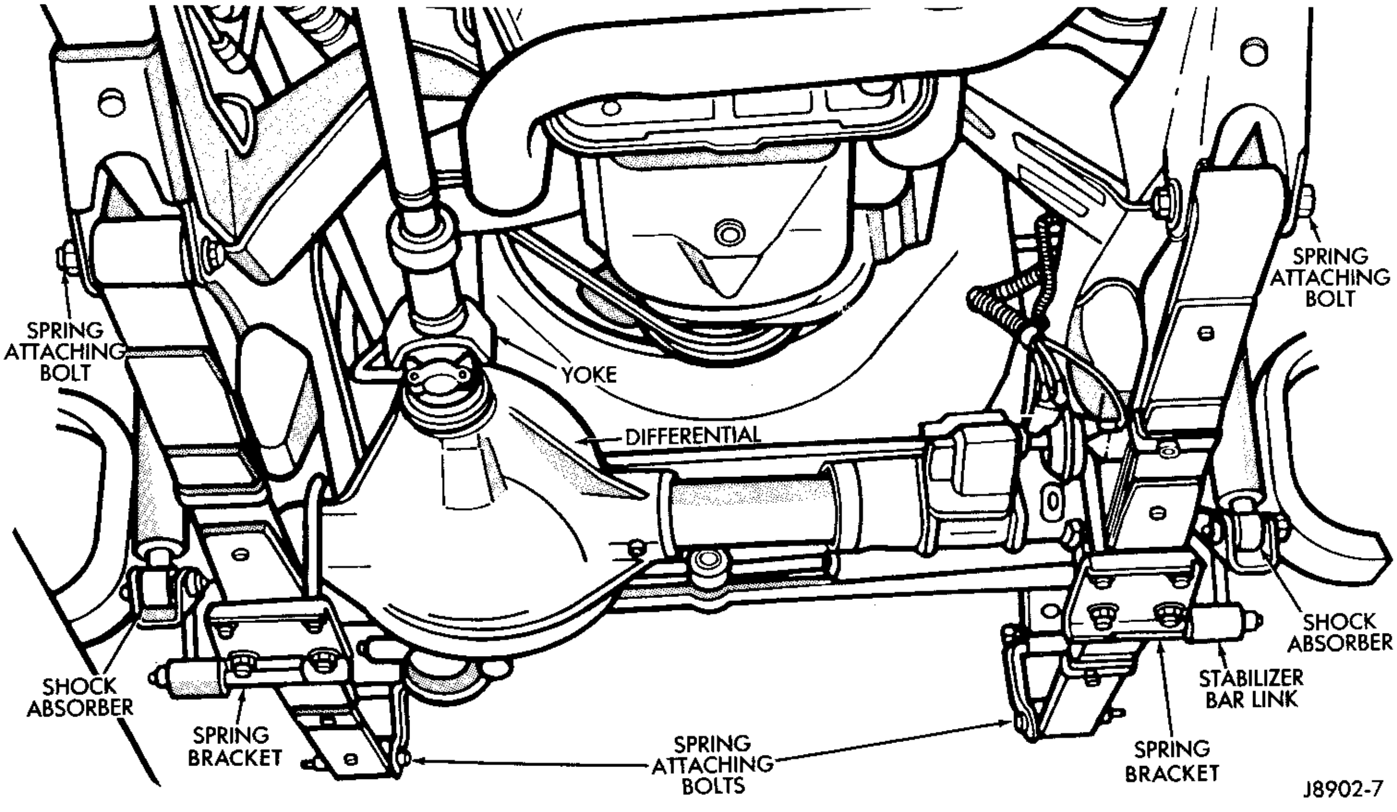


Fig. 2 Front Axle Removal/Installation—YJ Vehicles

(4) Remove the drive pinion gear shaft (axle) yoke. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke (Fig. 4).

(5) Remove the drive pinion gear shaft dust cap and the seal with an appropriate seal removal tool (Fig. 5).

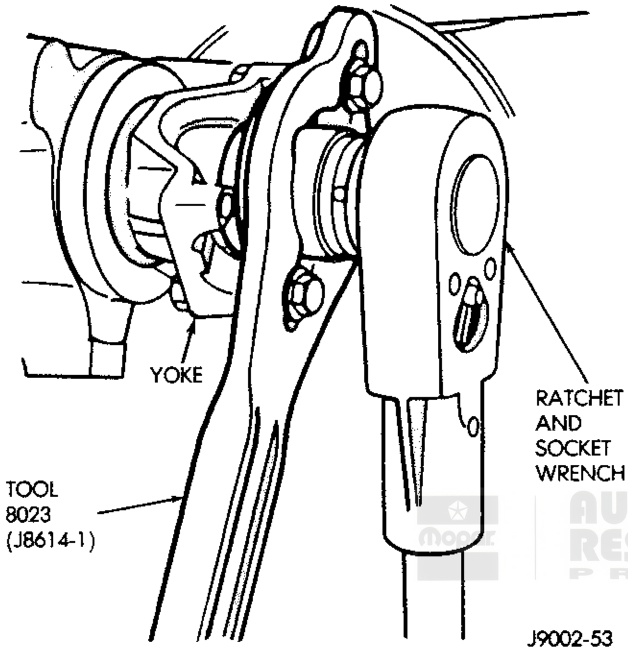


Fig. 3 Yoke Retaining Nut Removal

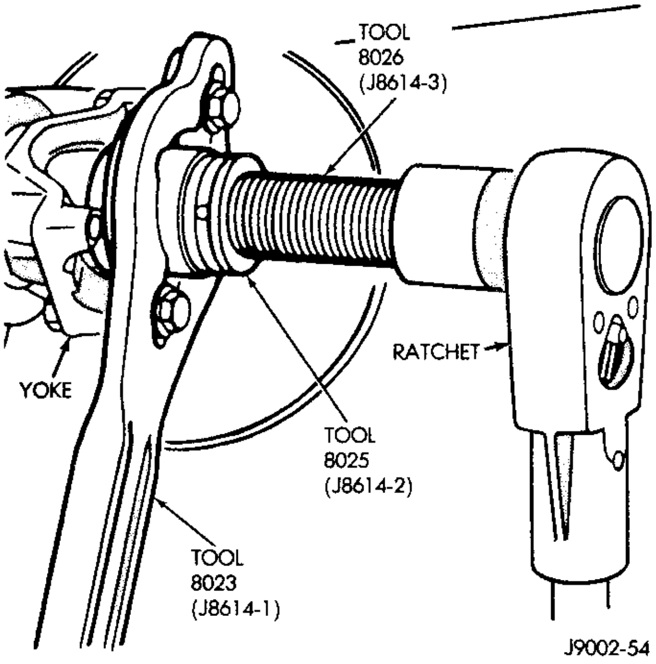


Fig. 4 Drive Pinion Shaft (Axle) Yoke Removal

Installation—SJ Vehicles

(1) Apply gear lubricant to the lip and install the replacement drive pinion gear shaft seal (Fig. 6) with Seal Installation Tool 6272 (J22661). Install the dust cap.

(2) Install the drive pinion gear shaft (axle) yoke.

(3) Install the yoke washer and a replacement retaining nut. Tighten the nut with 271 N•m (200 ft-lbs) torque (minimum). Use Flange Installation Tool 8023 (J8614-1) to retain the yoke and shaft while tightening the retaining nut.

(4) Measure the amount of torque (in Newton-meters or inch-pounds) necessary to rotate the drive pinion gear shaft with a torque wrench. This is the drive pinion gear shaft bearing "preload" torque and it should be 1 - 2 N•m or 10 - 20 in-lbs.

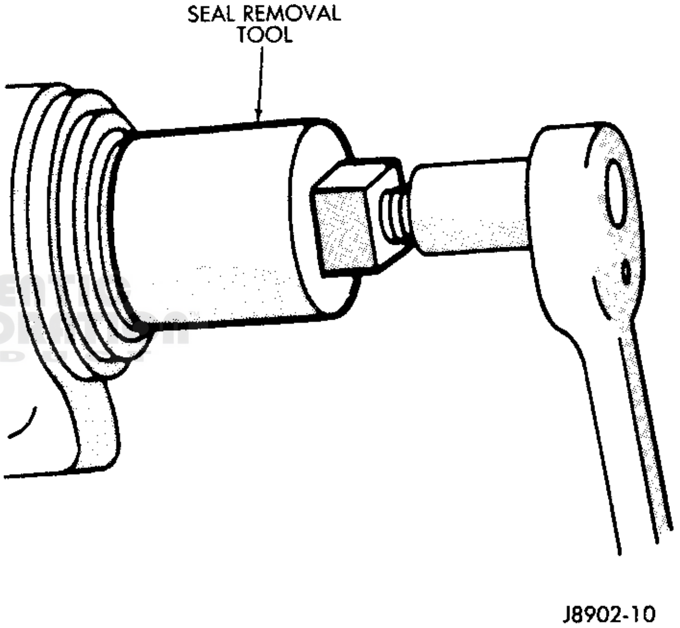


Fig. 5 Drive Pinion Gear Shaft Seal Removal

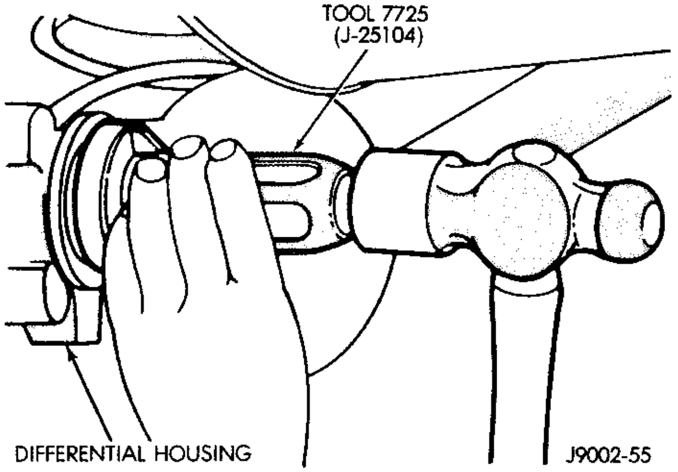


Fig. 6 Drive Pinion Gear Shaft Seal Installation

(5) Align the installation reference marks on the drive shaft and on the yoke. Connect the drive shaft to the drive pinion gear shaft (axle) yoke. Tighten the shaft-to-yoke attaching bolts/nuts with 22 N•m (16 ft-lbs) torque.

(6) Add SAE 75W-90, API grade GL 5 hypoid gear lubricant to the differential housing, if necessary.

(7) Remove the supports and lower the vehicle.

Removal—MJ/XJ And YJ Vehicles

(1) Raise and support the vehicle.

(2) Mark the drive shaft yoke and the drive pinion gear shaft (axle) yoke for installation alignment reference. Remove and discard the U-joint straps.

(3) Disconnect and remove the drive shaft from the yoke.

(4) Rotate the drive pinion gear shaft three or four times.

(5) Measure the amount of torque (in Newton-meters or inch-pounds) necessary to rotate the drive pinion gear shaft with a torque wrench. Note the torque for installation reference. **It must be known to properly adjust the drive pinion gear shaft bearing "preload" torque after seal installation.**

(6) Remove the pinion gear shaft (axle) yoke retaining nut (Fig. 3) with a socket wrench, a rachet/breaker bar and Flange Removal/Installation Tool 8023 (J8614-1). Remove the washer. Discard the nut.

(7) Remove the pinion gear shaft (axle) yoke. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke (Fig. 4).

(8) Mark the positions of the yoke and the drive pinion gear shaft for installation alignment reference.

(9) Remove the drive pinion gear shaft seal (Fig. 5).

Installation—MJ/XJ And YJ Vehicles

(1) Apply gear lubricant to the lip of the replacement seal.

(2) Install the replacement seal on the drive pinion gear shaft with Pinion Shaft Seal Installation Tool D-163.

(3) Align the installation reference marks and position the yoke on the drive pinion gear shaft.

(4) Install the washer and a replacement nut on the drive pinion gear shaft. **Tighten the nut only enough to remove the shaft "end play".**

CAUTION: Exercise care during the bearing "preload" torque adjustment. Do not over-tighten, or loosen and then re-tighten the drive pinion gear shaft nut. If the specified bearing "preload" torque is exceeded, the collapsible "preload" torque spacer will have to be replaced and the bearing "preload" torque readjusted afterward.

(5) Adjust the drive pinion gear shaft bearing "preload" torque according to the following instructions:

- install a socket wrench with a Newton-meter or an inch-pound torque wrench on the shaft nut;
- rotate the shaft with the torque wrench and note the torque;

The required drive pinion gear shaft bearing "preload" torque is equal to the amount noted during removal, plus an additional 0.56 N•m or 5 in-lbs torque.

- use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and shaft and tighten the shaft nut in very small increments; and
- measure the shaft rotating torque frequently and continue tightening the shaft nut in small increments until the correct bearing "preload" torque is attained.

(6) Align the installation reference marks and attach the drive shaft to the yoke. Install replacement U-joint straps and tighten the retaining screws with 19 N•m or 170 in-lbs/14 ft-lbs torque.

(7) Add SAE 75W-90, API grade GL 5 hypoid gear lubricant to the differential housing, if necessary.

(8) Remove the supports and lower the vehicle.

HUB AND BEARING SERVICE (4WD)

If the hub is equipped with ball bearings, it can not be serviced and, if defective, the complete unit must be replaced. If the hub is equipped with tapered roller bearings, its internal components can be serviced or replaced as necessary.

Removal—MJ/XJ And YJ Vehicles

(1) Raise and support the front of the vehicle.

(2) Remove the wheel/tire, the disc brake caliper and the disc brake rotor. If necessary, refer to the applicable removal procedure within Group 5—Brakes.

(3) Remove the cotter pin, the nut retainer and the axle hub nut.

(4) Remove the the three hub-to-steering knuckle attaching bolts and remove the hub from the steering knuckle.

(5) Remove the axle shaft dust "slinger" and the disc brake rotor shield from the bearing carrier (Fig. 7).

Disassembly—MJ/XJ And YJ Vehicles

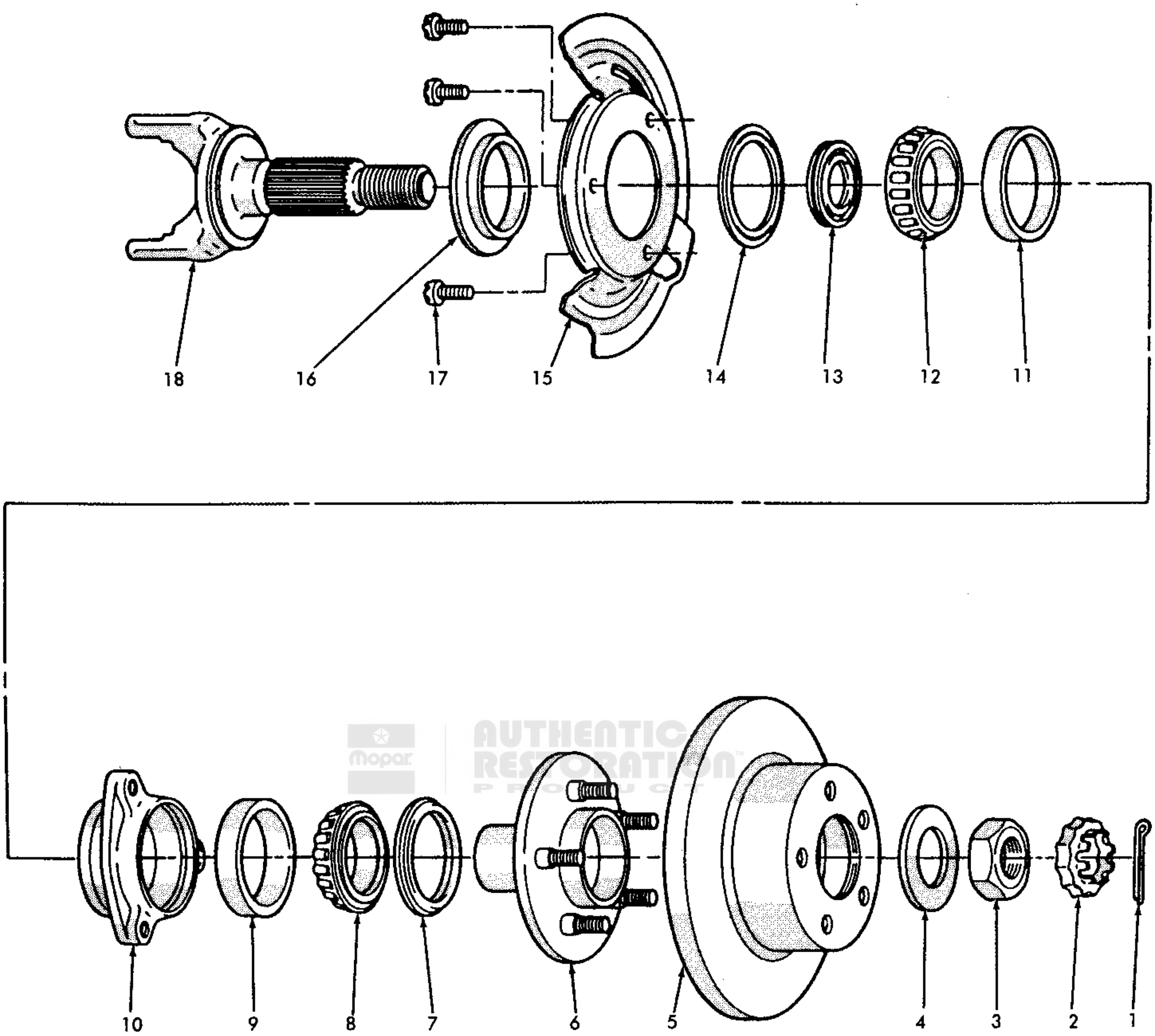
Hub With Tapered Roller Bearings

Refer to Group 22—Tires And Wheels for more detailed service procedures for the hub, the tapered roller bearings and the carrier.

(1) Press the hub out of the carrier, and remove the seals and the tapered roller bearings (Fig. 7).

(2) Replace all worn and damaged components as necessary.

(3) Replace the bearings and the bearing races as "matched sets" only (if replacement is required).



1. COTTER PIN
2. NUT RETAINER
3. NUT
4. WASHER
5. BRAKE ROTOR
6. HUB
7. OUTER BEARING SEAL
8. OUTER BEARING
9. OUTER BEARING RACE
10. BEARING CARRIER
11. INNER BEARING RACE
12. INNER BEARING
13. INNER BEARING SEAL
14. CARRIER SEAL
15. ROTOR SHIELD
16. AXLE SHAFT DUST SLINGER
17. BEARING CARRIER BOLTS
18. AXLE SHAFT

J8902-12

Fig. 7 Hub & Tapered Roller Bearings (4WD)

(4) If the carrier bearing races are to be replaced (Fig. 7), remove the existing races and install the replacement races in the carrier with an arbor press or a brass drift.

Assembly—MJ/XJ And YJ Vehicles

(1) Apply a coating of EP-type (extreme pressure), lithium base, waterproof wheel bearing lubricant to the interior of the hub and the bearing carrier, and to the lips of the seals.

(2) "Pack" the tapered roller bearings with EP-type, lithium base, waterproof wheel bearing lubricant and place the bearings in the bearing carrier. Install the outer bearing seal in the bearing carrier (Fig. 7).

(3) Press the hub through the bearings and into the carrier. Install the inner bearing seal and the carrier seal (Fig. 7).

Installation—MJ/XJ And YJ Vehicles

(1) Position the disc brake rotor shield and the axle shaft dust "slinger" on the bearing carrier (Fig. 7).

(2) Thoroughly clean the axle shaft (Fig. 7) and apply a thin film of EP-type (extreme pressure), lithium base, waterproof wheel bearing lubricant to the shaft splines and seal contact surface.

(3) Apply a coating of EP-type (extreme pressure), lithium base, waterproof wheel bearing lubricant to the hub bore in the steering knuckle and install the hub and bearings.

(4) Apply Loctite (or an equivalent product) to the threads, install and tighten the steering knuckle-to-hub bolts with 102 N•m (75 ft-lbs) torque.

(5) Install the hub washer and nut. Tighten the hub nut with 237 N•m (175 ft-lbs) torque. Install the nut retainer and a replacement cotter pin (Fig. 7).

Clean the disc brake rotor contact surfaces, if necessary.

(6) Install the disc brake rotor, the disc brake caliper and the wheel/tire. If necessary, refer to the applicable installation procedure within Group 5—Brakes. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(7) Remove the supports and lower the vehicle.

HUB AND BEARING SERVICE (2WD)

Removal—MJ/XJ Vehicles

(1) Raise and support the front of the vehicle.

(2) Remove the wheel/tire and the disc brake caliper. **Do not disconnect the caliper hose unless the caliper must also be removed for service. Suspend the caliper with a fabricated hanger to prevent brake hose damage.**

(3) Remove the dust cap, the cotter pin, the nut retainer, the adjustment nut, and the thrust washer from the spindle (Fig. 8). Discard the cotter pin.

(4) Remove the wheel outer bearing from the hub (Fig. 8).

(5) Remove the hub and disc brake rotor from the spindle (Fig. 8).

Installation—MJ/XJ Vehicles

(1) Partially fill the brake rotor/hub cavity with wheel bearing lubricant.

(2) "Pack" the wheel bearings with wheel bearing lubricant.

(3) Install the wheel inner bearing in the disc brake rotor and install a replacement seal (Fig. 8).

(4) Clean the disc brake rotor contact surfaces, if necessary.

(5) Install the hub and the disc brake rotor on the spindle.

(6) Install the wheel outer bearing, the thrust washer, and the spindle nut (Fig. 8).

(7) Tighten the spindle nut with 28 N•m (21 ft-lbs) torque while rotating the disc brake rotor to "seat" the bearings.

(8) Loosen the spindle nut 1/2 of-a-turn and, while rotating the disc brake rotor, tighten the spindle nut with 2 N•m (19 in-lbs) torque.

(9) Install the nut retainer and a replacement cotter pin (Fig. 8).

(10) Clean the dust cap and apply wheel bearing lubricant to the inside surface. **Do not fill the dust cap with lubricant.**

(11) Install the dust cap.

(12) Install the disc brake caliper. If necessary, refer to the installation procedure within Group 5—Brakes.

(13) Install the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(14) Remove the supports and lower the vehicle.

AXLE SHAFT (4WD) REMOVAL/INSTALLATION

Removal—SJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the disc brake caliper.

(3) Remove the disc brake rotor/hub cap.

(4) Remove the axle shaft retaining "snap" ring, the drive gear, the pressure spring and the spring retainer.

(5) Remove the outer locknut, the washer and the inner locknut with Wheel Bearing Nut Wrench Tool 8000 (J6893D).

(6) Remove the disc brake rotor. The spring retainer and outer bearing will be retained with the disc brake rotor.

(7) Remove the nuts and bolts that attach the spindle and the support shield, and remove them from the steering knuckle. If necessary, tap the spindle with a rawhide mallet to remove it from the steering knuckle.

(8) Remove the axle shaft.

Installation—SJ Vehicles

(1) Insert the splined end of the axle shaft into the axle shaft tube and into the differential side gear. Gently force the shaft into the side gear.

(2) Position the spindle on the steering knuckle and install the retaining nuts. Tighten the retaining nuts with 38 N•m (28 ft-lbs) torque.

(3) Install the support shield and the disc brake rotor.

(4) Install the inner wheel bearing locknut (the nut has a peg on one side). Tighten the locknut just enough to remove the "end-play".

(5) Install the wheel/tire but do not tighten the wheel lug nuts completely.

(6) Tighten the inner locknut with 68 N•m (50 ft-lbs) torque; then "back-off" the locknut 1/6 of-a-turn (45°-65°). Rotate the wheel while tightening the locknut to "seat" the bearings evenly.

(7) Install the washer so that the inner tab is aligned with the spindle keyway. Also, ensure that the peg on the inner locknut engages in the nearest hole in the washer.

(8) Install and tighten the outer locknut with a minimum of 68 N•m (50 ft-lbs) torque.

(9) Remove the wheel/tire.

CAUTION: Install the spring retainer with the cupped side of the retainer facing toward the center of the vehicle.

(10) Install the spring retainer, the pressure spring and the drive gear.

(11) Force the drive gear inward to provide sufficient clearance for the axle shaft retaining "snap" ring. Install the retaining "snap" ring.

(12) Apply a coating of Permatex Adhesive-Sealant number 3 (or an equivalent sealant) to the disc brake rotor/hub cap rim and install the hub cap in the disc brake rotor.

(13) Install the disc brake caliper. If necessary, refer to the installation procedure within Group 5—Brakes.

(14) Install the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(15) Remove the supports and lower the vehicle.

Axle Shaft Seal Replacement—SJ Vehicles

Removal

(1) Remove the axle shaft. Refer to the axle shaft removal procedure.

(2) Remove the seal from the axle shaft (Fig. 9).

(3) Remove the bronze thrust washer (Fig. 9) from the axle shaft. If the washer is worn, replace it.

Installation

(1) Clean all the foreign matter from the seal contact area in the axle shaft tube and on the axle shaft.

(2) Install the bronze thrust washer on the axle shaft (Fig. 9) so that the chamfered side will face **inward** toward the axle shaft seal.

(3) Install the replacement seal on the axle shaft with the seal lip facing **outward** toward the spindle yoke.

(4) "Pack" wheel bearing lubricant around the thrust (inner) face of the axle shaft and the seal. Also, apply wheel bearing lubricant to the seal outer perimeter area (adjacent to the thrust washer and the spindle yoke).

(5) Install the axle shaft. Refer to the axle shaft installation procedure.

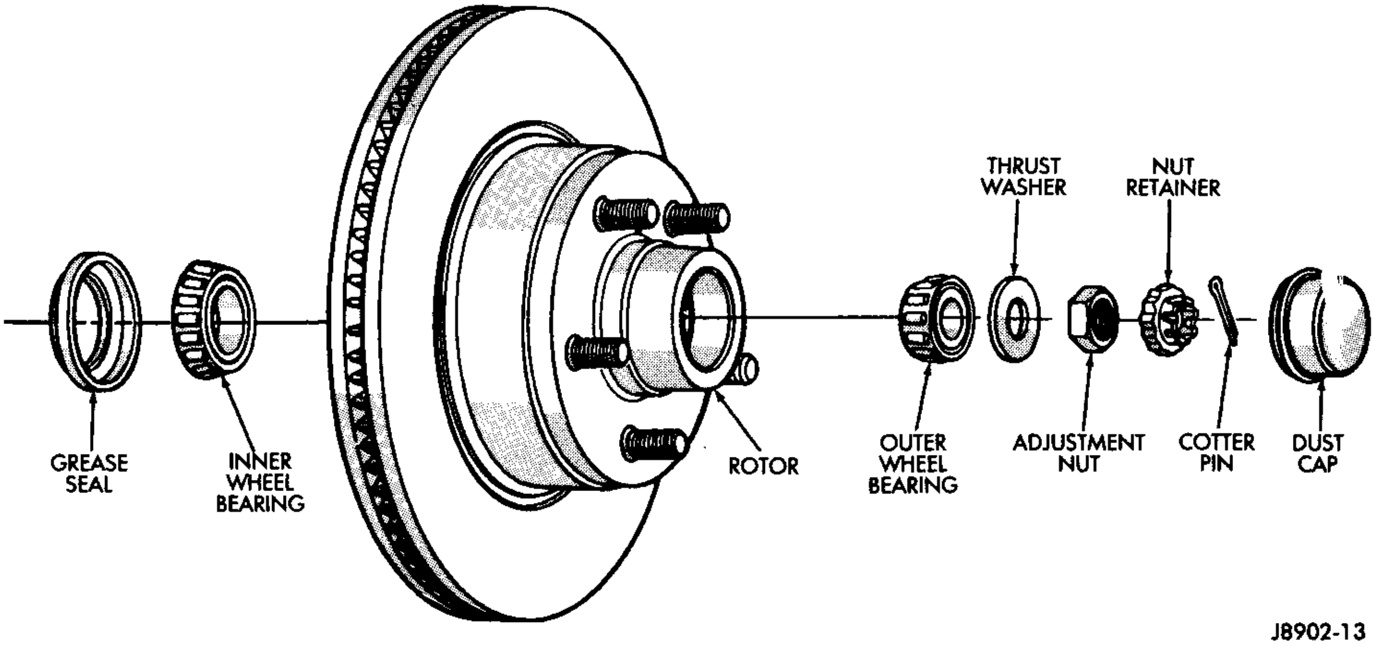


Fig. 8 Hub & Bearings (2WD)

Removal—MJ/XJ And YJ Vehicles

For XJ vehicles equipped with a Selec-Trac axle (i.e., a non-disconnect axle) and an ABS brake system, also refer to Group 5—Brakes for additional service information.

(1) Remove the wheel/tire, disc brake caliper and disc brake rotor. If necessary, refer to the removal procedures within Group 5—Brakes.

(2) Remove the cotter pin, nut retainer and axle hub nut.

(3) Remove the hub-to-steering knuckle attaching bolts.

(4) Remove the hub and disc brake rotor shield from the steering knuckle.

(5) Remove the left axle shaft from the axle shaft tube.

(6) On the right side:

- if equipped with a **Command-Trac** axle (i.e., a disconnect axle), disconnect the vacuum harness from the shift motor, and;
- if equipped with a Command-Trac/disconnect axle, remove the shift motor and housing from the axle shaft tube (Fig. 10).

(7) Remove the right-side axle shaft from the axle shaft tube. If equipped with a Command-Trac/disconnect axle, ensure that the shift collar (Fig. 10) remains on the intermediate shaft.

Installation—MJ/XJ And YJ Vehicles

For XJ vehicles equipped with a Selec-Trac axle (i.e., a non-disconnect axle) and an ABS brake system, also refer to Group 5—Brakes for additional service information.

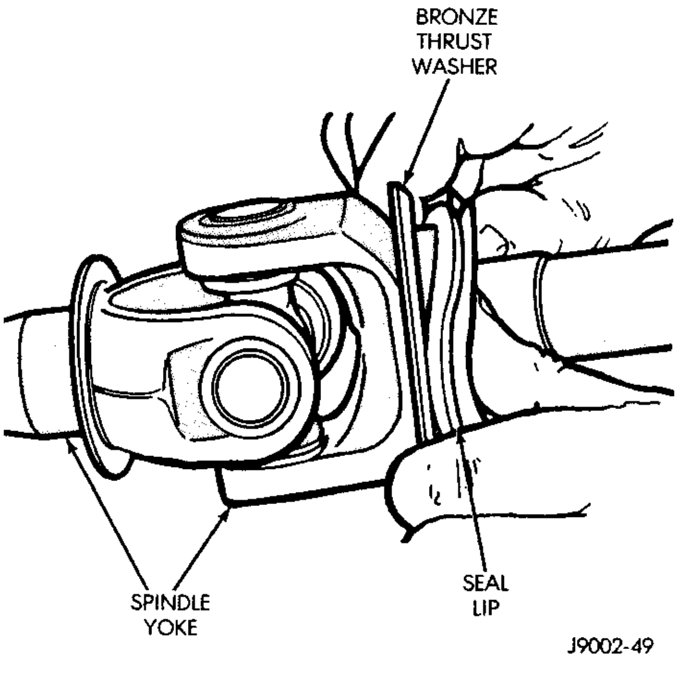


Fig. 9 Axle Shaft Seal Removal/Installation

(1) Insert the left- and right-side axle shafts into the axle shaft tubes. **Insert the axle shafts carefully through the seals in the axle shaft tubes.**

(2) On the right side:

- if equipped with a **Command-Trac** axle (i.e., a disconnect axle), ensure that the shift collar is correctly positioned on the intermediate axle shaft (Fig. 10), that the outer axle shaft will engage with the shift collar and that the pilot bushing is correctly mated with the small-diameter tip at the end of the intermediate axle shaft; and
- if equipped with a Command-Trac/disconnect axle, install the shift motor and housing (ensure that the fork engages with the shift collar) and tighten the bolts with 11 N•m (8.5 ft-lbs) torque.

(3) Apply a coating of EP-type (extreme pressure), lithium base, waterproof wheel bearing lubricant to the hub bore in the steering knuckle and install the disc brake rotor shield and the hub.

(4) Tighten the hub bolts with 101 N•m (75 ft-lbs) torque.

(5) Install the hub washer and nut on the shaft. Tighten the hub-to-shaft nut with 237 N•m (175 ft-lbs). Install the nut retainer and a replacement cotter pin.

(6) Install the disc brake rotor, the disc brake caliper and the wheel/tire. If necessary, refer to the installation procedures within Group 5—Brakes. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(7) Remove the supports and lower the vehicle.

AXLE SHAFT OUTER U-JOINT SERVICE

For XJ vehicles equipped with a Selec-Trac axle (i.e., a non-disconnect axle) and an ABS brake system, also refer to Group 5—Brakes for additional service information.

Disassembly—All Vehicles

(1) Remove the axle shaft. Refer to the removal procedure.

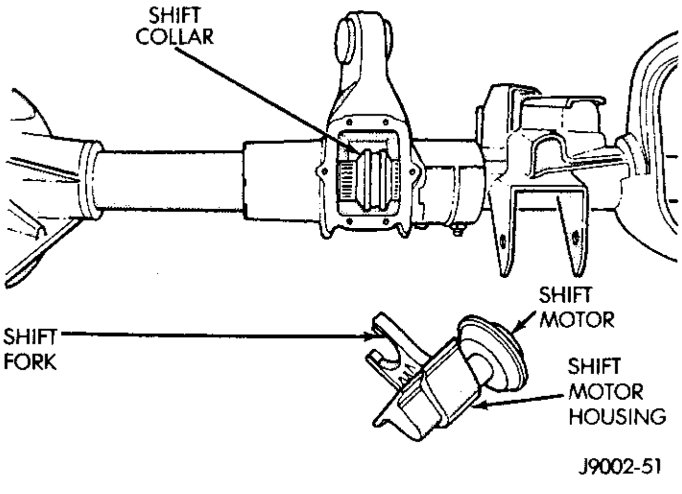


Fig. 10 Shift Motor & Housing Removal

(2) Remove the bearing cap retaining "snap" rings (Fig. 11).

(3) Force the bearing caps (Fig. 11) out of the spindle yoke and shaft yoke with an appropriate size small diameter socket wrench (press tool), an appropriate size large diameter socket wrench (receiver) and a vise according to the following instructions:

- position a U-joint yoke in a vise with socket wrenches at each bearing cap;
- position the small diameter socket wrench (press tool) on the bearing cap that is opposite the cap to be removed (Fig. 12);
- ensure that the socket wrench outer diameter is smaller than the bearing cap diameter;
- position the large socket wrench (receiver) over the bearing cap that is to be removed (Fig. 12);
- ensure that the large socket wrench inner diameter is larger than the bearing cap diameter;
- tighten the vise to force the cap out of the yoke (Fig. 12);
- clamp the opposite bearing cap in the vise and tap the yoke with a mallet or rotate it back and forth to remove the cap; and
- repeat the procedure to remove the bearing caps from the other yoke and the spider.

(4) Clean all the components in cleaning solvent. Inspect the components after cleaning. Replace any component that exhibits excessive wear or damage.

Assembly—All Vehicles

(1) "Pack" the replacement bearing caps 1/3 full of wheel bearing lubricant.

(2) Position the spider either in the shaft yoke or the spindle yoke and insert two bearing caps in the yoke (Fig. 11). Tap the caps in the yokes just far enough to hold the spider in place.

(3) Install the remaining bearing caps in the other yoke (Fig. 11).

(4) "Seat" all the bearing caps and install the retaining "snap" rings (Fig. 11). Use a vise to "seat" the caps, if necessary.

(5) Tap the yokes lightly to relieve any pressure on the bearing caps.

(6) Install the axle shaft. Refer to the installation procedure.

INTERMEDIATE AXLE SHAFT REMOVAL/ INSTALLATION

The following procedures are applicable only to YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).

Removal—MJ/XJ And YJVehicles

(1) Raise and support the vehicle.

(2) Remove the differential housing cover and drain the lubricant.

(3) Remove the right-side axle shaft according to the removal procedure.

(4) Remove the intermediate axle shaft retaining clip (adjacent to the side gear) from the end of the shaft inside the differential case (Fig. 13).

(5) Remove the intermediate axle shaft from the axle shaft tube.

Installation—MJ/XJ And YJVehicles

(1) Insert the intermediate axle shaft into and through the right-side axle shaft tube, into the differential housing and engage it with the differential side gear splines.

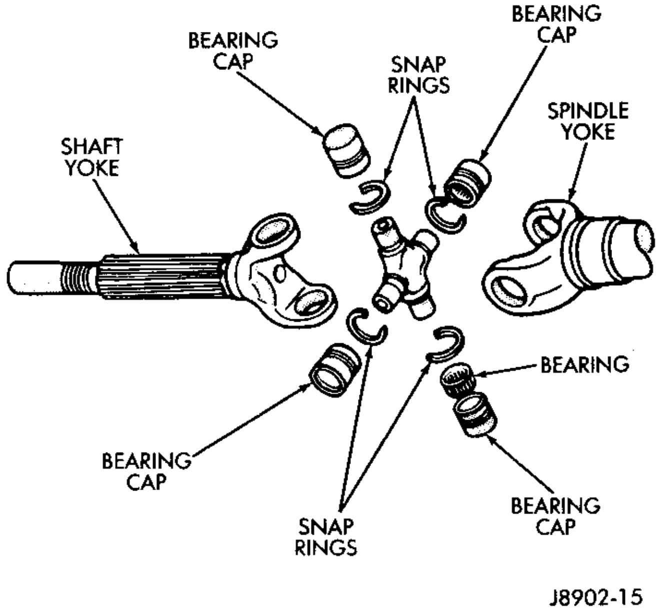


Fig. 11 Axle Shaft Outer U-Joint

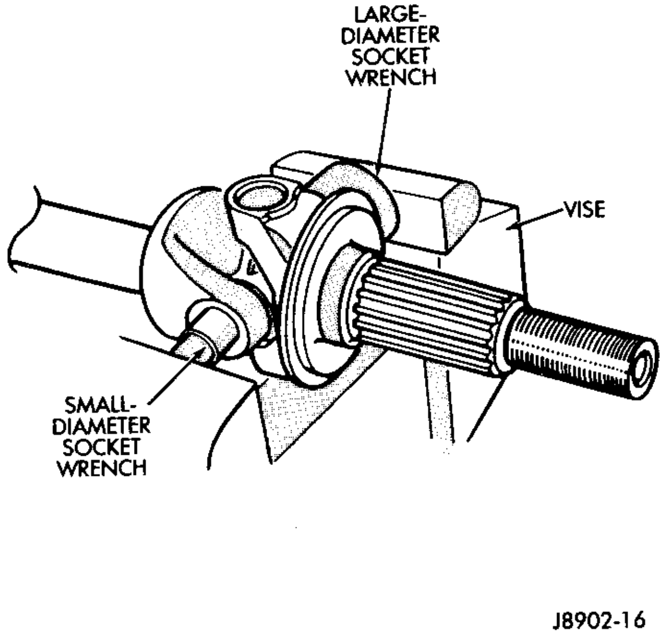


Fig. 12 Yoke Bearing Cap Removal

(2) Install the retaining clip on the end of the intermediate axle shaft (Fig. 13).

(3) Clean the differential housing and the housing cover mating surfaces thoroughly.

(4) Apply a thin bead of MOPAR RTV sealant (or an equivalent sealant) around the perimeter of the differential housing opening and to the cover. Install the cover. Tighten the cover bolts with 27 N•m (20 ft-lbs) torque.

(5) Install the shift collar and the outer axle shaft, but do not install the axle shift motor and housing at this time.

(6) Fill the differential housing with 1.2 liters (2.5 pints) of SAE 75W 90, API grade GL 5 hypoid gear lubricant. Add an additional 148 milliliters (5 ounces) to the shift motor housing opening (Fig. 14).

(7) Install the axle shift motor and housing, and complete the installation according to the axle shaft installation procedure.

STEERING KNUCKLE SERVICE

High Steering Effort—SJ Vehicles

High steering effort or slow return of the steering wheel after turns can be the result of excessive steering knuckle ball -stud "preload" torque. If this condition occurs and all the other components that involve the steering effort are functioning normally, the ball-stud "preload" torque should be measured according to the following instructions.

Ball-Stud Preload Torque Measurement

(1) Raise and support the vehicle.

(2) Remove the front wheels/tires.

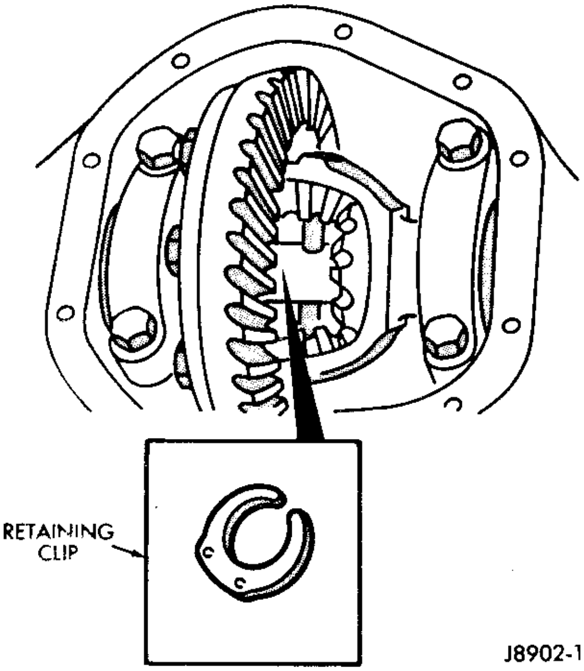


Fig. 13 Intermediate Shaft Retaining Clip

(3) Disconnect the steering dampener from the tie rod and move the dampener aside.

(4) Release the steering column lock.

(5) Disconnect the drag link from the right-side of the tie rod.

(6) Remove the cotter pin from the nut retaining the tie rod to the right-side steering knuckle. Discard the cotter pin.

(7) From the right side of the vehicle, rotate both the steering knuckles through a complete arc several times.

(8) Assemble a socket wrench and a 0 - 68 N•m (0 - 50 ft-lbs) capacity torque wrench. Install the wrench on the right-side tie rod retaining nut.

The torque wrench must be positioned at a 90 degree angle to the steering knuckle arm to obtain an accurate "preload" torque measurement.

(9) Rotate the steering knuckles slowly and steadily through a complete arc. Measure and note the torque required to rotate the steering knuckles:

- if the torque measurement is less than 34 N•m (25 ft-lbs), the required turning effort is within the torque specification limit and the fault is not in the steering knuckles;
- inspect the steering gear, the P/S pump and the steering column;
- if the torque measurement is more than 34 N•m (25 ft-lbs), the required turning effort is excessive; and
- further diagnosis is necessary — proceed to the next step.

(10) Disconnect the tie rod from both steering knuckles.

(11) Install a 12.7 x 25.4-mm (1/2 x 1-in) bolt, a flat washer, and a nut in one of the steering knuckle tie-rod end stud connecting holes.

(12) Tighten the bolt and nut securely.

(13) Assemble and install a socket wrench and a 0 - 68 N•m (0 - 50 ft-lbs) capacity torque wrench on the bolt that was just installed in the steering knuckle hole.

The torque wrench must be positioned at a 90 degree angle to the steering knuckle arm.

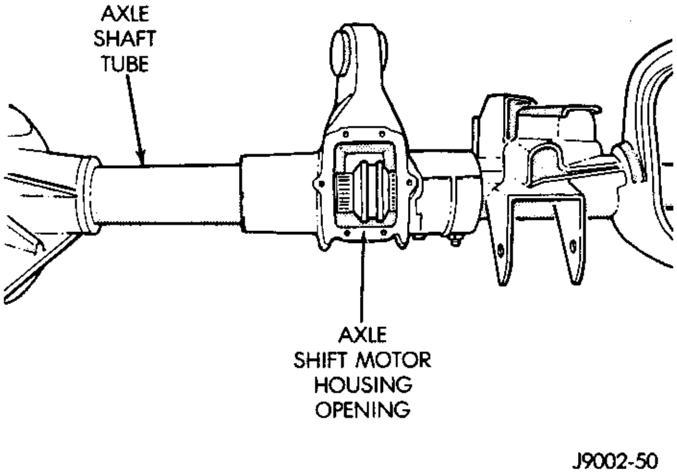


Fig. 14 Shift Motor & Housing

(14) Rotate the steering knuckle slowly and steadily through a complete arc. Measure and note the torque required to rotate the steering knuckle. Remove the nut, the washer and the bolt.

(15) Install the bolt, the flat washer, the nut, the socket wrench and the torque wrench on the opposite steering knuckle. Measure and note the torque required to rotate the steering knuckle:

- if the torque at each steering knuckle is less than 14 N•m (10 ft-lbs), the steering effort is within the torque specification limit and the fault is not in the steering knuckle ball studs;
- inspect for "tight" or damaged tie-rod ends, lubricate or replace them as necessary; and
- if the torque at one (or both) steering knuckle(s) is more than 14 N•m (10 ft-lbs), the turning effort is excessive — proceed to Ball-Stud Preload Torque Correction.

(16) Install the tie rod. Tighten the tie-rod end stud retaining nuts with 81 N•m (60 ft-lbs) torque (minimum) and install replacement cotter pins.

(17) Attach the drag link to the tie rod. Tighten the drag- link end stud retaining nut with 95 N•m (70 ft-lbs) torque (minimum) and install a replacement cotter pin.

(18) Connect the steering dampener to the tie rod and tighten the retaining nut with 41 N•m (30 ft-lbs) torque.

(19) Install the front wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(20) Remove the supports and lower the vehicle.

Ball-Stud Preload Torque Correction

(1) Raise and support the vehicle.

(2) Remove the front axle shafts according to the removal procedure.

(3) Loosen the lower ball-stud jamnut.

(4) Remove the cotter pin and the "slotted" retaining nut from the upper ball stud.

(5) "Unseat" the upper and lower ball studs by striking the studs with a lead hammer.

(6) Remove the upper ball-stud split-ring seat with Upper Ball Stud Locknut Wrench Tool 6291 (J23447). Discard the seat after removal.

(7) Remove the lower ball-stud jamnut and remove the steering knuckle. Discard the jamnut after removal.

(8) Clean the upper ball-stud split-ring seat threads, the lower ball stud tapered cavity in the steering knuckle, the threads and tapered surfaces on the ball studs, and the upper ball stud retaining nut threads.

(9) Position the steering knuckle on the axle and install the replacement lower ball-stud jamnut "finger-tight" only.

(10) Install and tighten the upper ball-stud "slotted" retaining nut with 13 - 27 N•m (10 - 20 ft-lbs) torque to force the lower ball stud into the tapered cavity in the axle yoke. **Do not install the upper ball-stud split-ring seat at this time.**

(11) Tighten the replacement lower ball-stud jamnut with 108 N•m (80 ft-lbs) torque.

(12) Remove the upper ball-stud "slotted" retaining nut and install the replacement split-ring seat with Ball Stud Locknut Wrench Tool 6291 (J23447). Tighten the seat with 68 N•m (50 ft-lbs) torque.

(13) Install the "slotted" retaining nut on the upper ball stud. Tighten the nut with 136 N•m (100 ft-lbs) torque. Align and install a replacement cotter pin without loosening the "slotted" retaining nut.

If the cotter pin holes in the nut and stud are not aligned, tighten the nut (only) to align the holes. Never loosen the nut to align the holes.

(14) Install the front axle shafts and the spindles loosely and measure the turning effort (torque) at each steering knuckle as instructed in Ball-Stud Preload Torque Measurement:

- if the turning effort is 14 N•m (10 ft-lbs) torque or less, proceed to step (15); and
- if the turning effort is greater than 14 N•m (10 ft-lbs) torque, replace the upper and lower ball studs, and repeat the Ball-Stud Preload Torque Correction procedure.

If the Ball-Stud Preload Torque Correction procedure is repeated, ensure that the split-ring seat is tightened with 68 N•m (50 ft-lbs) torque. Also, ensure that the "slotted" retaining nut on the upper ball stud is tightened with 136 N•m (100 ft-lbs) torque.

(15) Install the front axle shafts and the spindles according to the installation procedure.

(16) Connect the tie rod to the steering knuckle arms. Tighten the tie-rod stud retaining nuts with 81 N•m (60 ft-lbs) torque (minimum) and install replacement cotter pins.

(17) Attach the drag link to the tie rod. Tighten the drag- link stud retaining nut with 95 N•m (70 ft-lbs) torque (minimum).

(18) Connect the steering dampener to the tie rod and tighten the retaining nut with 41 N•m (30 ft-lbs) torque.

(19) Install the front wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(20) Remove the supports and lower the vehicle.

Steering Knuckle Ball Stud Replacement—SJ Vehicles

SJ vehicles are equipped with "open-end" housing type steering knuckles that pivot on ball studs. Ball stud replacement requires removal of the applicable axle shaft and steering knuckle (Fig. 15).

Steering Knuckle Removal

(1) Remove the axle shaft. Refer to the removal procedure.

(2) Disconnect the tie-rod end stud from the steering knuckle arm. If necessary, use a puller tool.

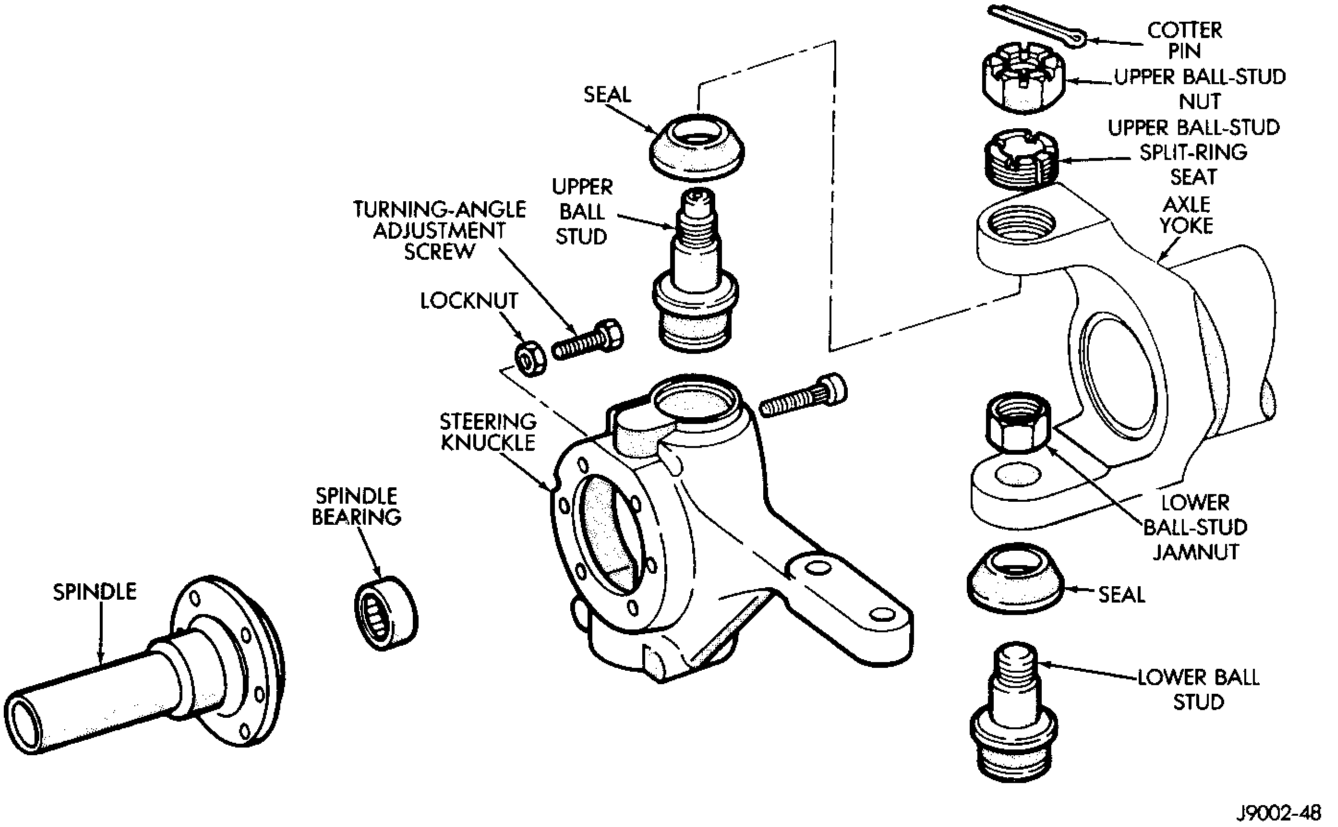


Fig. 15 Steering Knuckle — Exploded View

(3) Remove and discard the lower ball-stud jamnut (Fig. 16).

(4) Remove the cotter pin from the upper ball stud and loosen the nut (Fig. 16) until the top edge of the nut is flush with the top of the stud.

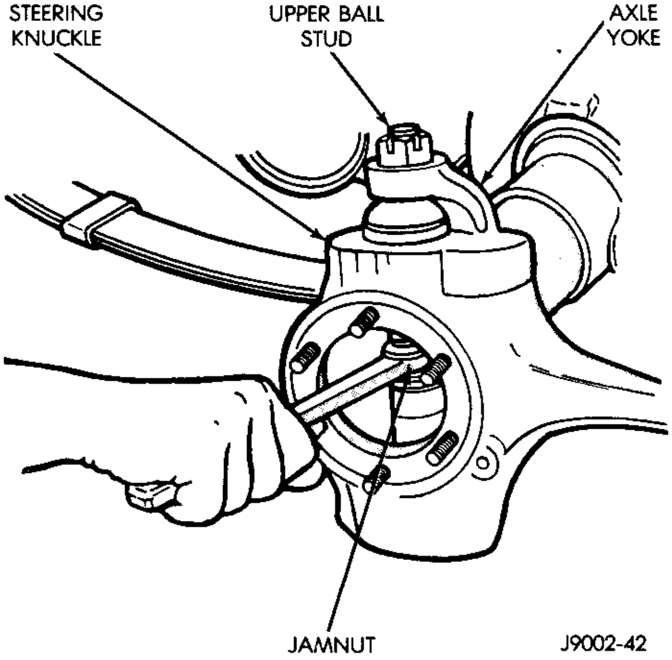


Fig. 16 Lower Ball-Stud Jamnut Removal

(5) “Unseat” the upper and lower ball studs with a lead hammer.

(6) Remove the upper ball-stud nut and the steering knuckle.

(7) Remove the upper ball-stud split-ring seat with Upper Ball Stud Locknut Wrench Tool 6291 (J23447).

Lower Ball Stud Removal

(1) Remove the lower ball stud retaining “snap” ring.

(2) Clamp the steering knuckle securely in a vise with the upper ball stud facing downward.

(3) Attach the plate tool from Ball Stud Removal/ Installation Tool Kit 6290 (J25211-1) to the spindle mating surface on the steering knuckle (Fig. 17).

(4) Position the button tool from Ball Stud Removal/ Installation Tool Kit 6290 (J25211-3) on the lower ball stud (Fig. 17).

(5) Assemble and install a puller tool on the steering knuckle. “Hook” one puller arm jaw in the plate tool from Tool Kit 6290 (J25211-1) and “hook” the opposite arm jaw in the steering knuckle (Fig. 17).

(6) Tighten the puller tool screw to force the lower ball stud out of the steering knuckle bore.

(7) Remove the tools from the steering knuckle.

Upper Ball Stud Removal

(1) Remove both of the puller arms from the frame of a puller tool (Fig. 18).

(2) Place the button tool from Tool Kit 6290 (J25211-3) on the upper ball stud (Fig. 18).

(3) Thread the puller tool frame halfway onto the puller tool screw. Insert the nut-end of the puller tool screw up, into and through the lower ball-stud bore in the steering knuckle (Fig. 18). Position the puller tool frame up against the steering knuckle and the bottom of the puller tool screw against the button tool from Tool Kit 6290 (J25211-3).

(4) Tighten the puller tool screw to force the upper ball stud out of the steering knuckle bore.

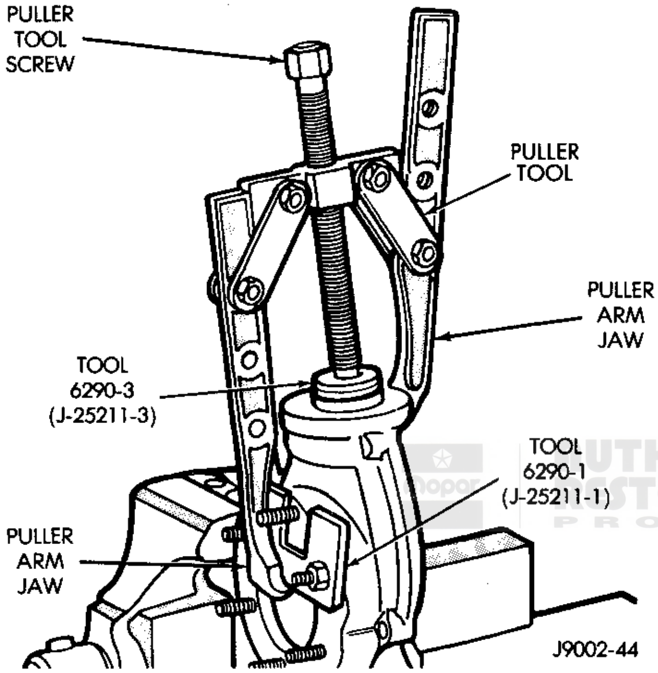


Fig. 17 Lower Ball Stud Removal

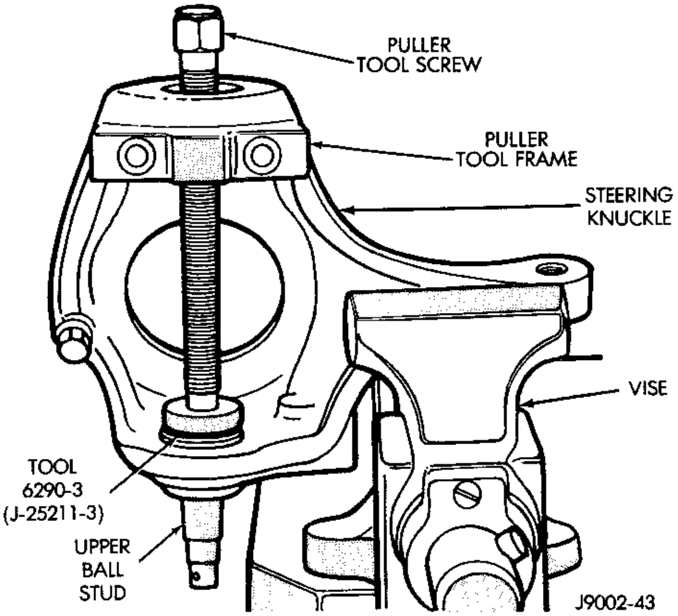


Fig. 18 Upper Ball Stud Removal

(5) Remove the tools from the steering knuckle. Do not disassemble the puller tool screw and frame at this time. The tool will be used, as assembled, to install the lower ball stud.

Lower Ball Stud Installation

(1) Clamp the steering knuckle in a vise.

(2) Position the replacement lower ball stud in the steering knuckle.

(3) Place the adapter tool from Tool Kit 6290 (J25211-4) over the nut-end of the puller tool screw and against the puller tool frame (Fig. 19).

(4) Insert the nut-end of the puller tool screw through the upper ball stud bore in the steering knuckle and retain the adapter tool and puller tool frame against the steering knuckle (Fig. 19).

(5) Place the installation cup tool from Tool Kit 6290 (J25211-2) on the ball stud (Fig. 19).

(6) Tighten the puller tool screw to force the lower ball stud into the steering knuckle.

(7) Install the replacement lower ball-stud retaining "snap" ring.

(8) Remove the lower ball stud installation tools.

Upper Ball Stud Installation

(1) Attach both of the puller arms to the puller tool frame.

(2) Position the replacement upper ball stud in the steering knuckle.

(3) Install the plate tool from Tool Kit 6290 (J25211-1) on the steering knuckle studs (Fig 20).

(4) Position the installation cup tool from Tool Kit 6290 (J25211-2) on the upper ball stud (Fig. 20).

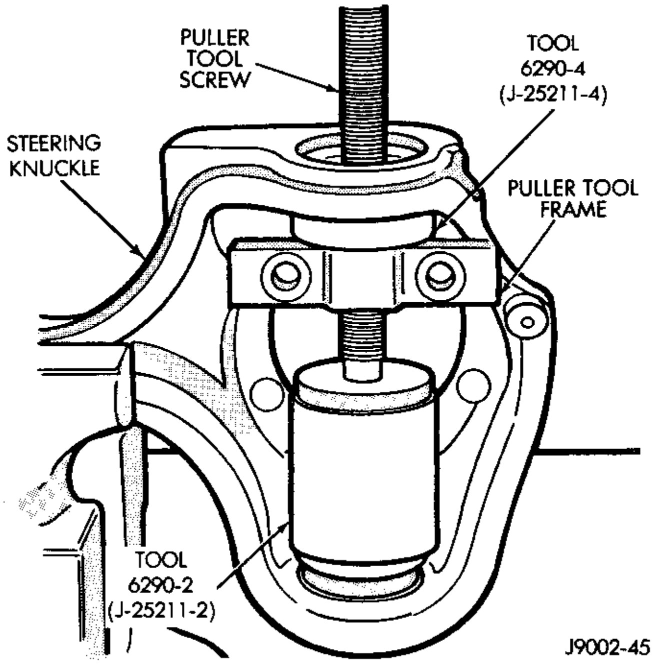


Fig. 19 Lower Ball Stud Installation

(5) Install the assembled puller tool on the steering knuckle. "Hook" one puller arm jaw in the plate tool and "hook" the opposite arm jaw in the steering knuckle. Ensure that the puller tool screw is centered on the installation cup tool (Fig. 20).

(6) Tighten the puller tool screw to force the ball stud into the steering knuckle.

(7) Remove the upper ball stud installation tools.

Steering Knuckle Installation

(1) Install the upper ball-stud split-ring seat in the axle yoke threaded bore. The top of the seat should be flush with the top of the yoke.

(2) Position the steering knuckle ball studs in the axle yoke bores and install the lower ball-stud jamnut "finger-tight" only.

(3) Position and align Locknut Wrench Tool 6291 (J23447), the button tool from Tool Kit 6290 (J25211-3), the plate tool from Tool Kit 6290 (J25211-1) and a puller tool on the steering knuckle (Fig. 21).

(4) Tighten the puller tool screw until the lower ball stud is firmly "seated" in the axle yoke bore and tighten the jamnut with 108 N•m (80 ft-lbs) torque.

(5) Remove the puller tool and the plate tool.

(6) Tighten the upper ball-stud split-ring seat (Fig. 22) with 68 N•m (50 ft-lbs) torque. Use Locknut Wrench Tool 6291 (J23447).

(7) Install the upper ball-stud retaining nut. Tighten the nut with 136 N•m (100 ft-lbs) torque and install a replacement cotter pin.

If the cotter pin holes do not align, tighten the nut (only) until the holes are aligned. Never loosen the nut to align the holes.

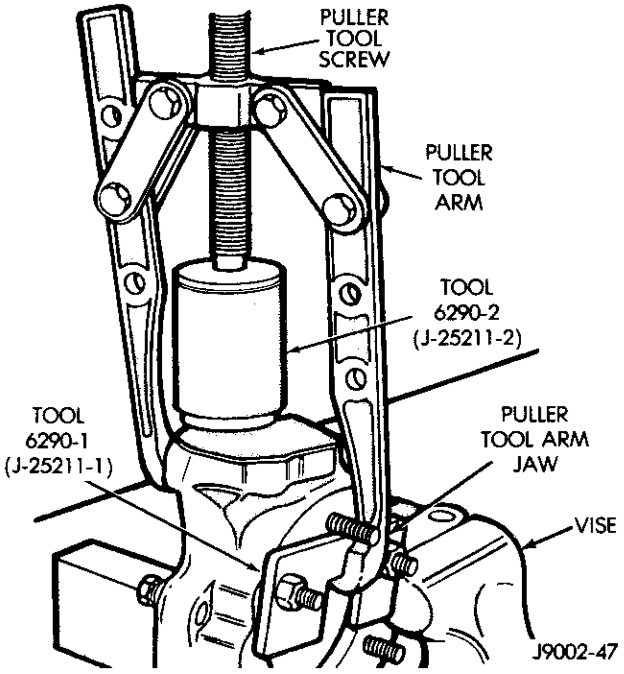


Fig. 20 Upper Ball Stud Installation

(8) Connect the tie rod to the steering knuckle. Tighten the tie-rod end stud nut with 81 N•m (60 ft-lbs) torque (minimum) and install a replacement cotter pin.

(9) Measure and, if necessary, adjust the outside-wheel turning angle. Refer to the adjustment procedure.

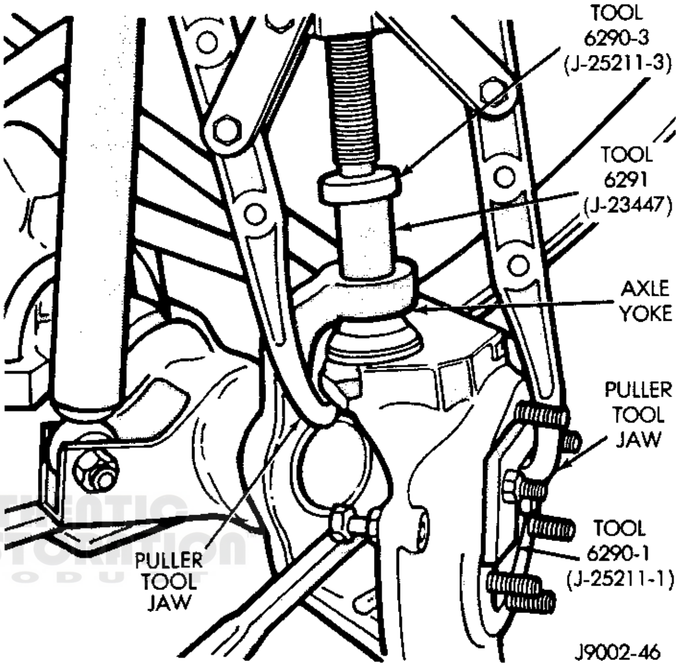


Fig. 21 Steering Knuckle Installation

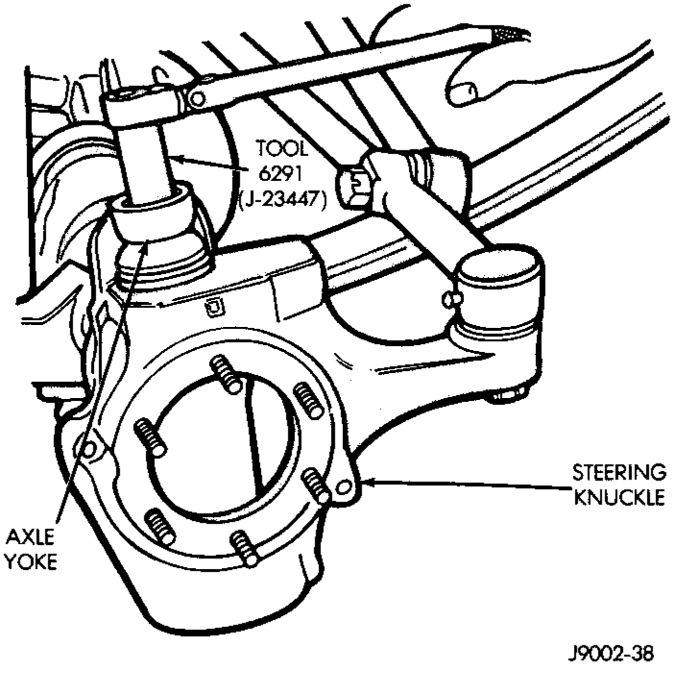


Fig. 22 Tightening The Split-Ring Seat

Steering Knuckle Ball Stud Replacement—MJ/XJ And YJ Vehicles

MJ/XJ and YJ vehicles are equipped with yoke-type steering knuckles that pivot on ball studs. Ball stud replacement requires removal of the applicable axle shaft and steering knuckle.

For XJ vehicles equipped with a Selec-Trac axle (i.e., a non-disconnect axle) and an ABS brake system, also refer to Group 5—Brakes for additional service information.

Steering Knuckle Removal

(1) Remove the axle shaft according to the removal procedure (4WD vehicles only).

(2) Remove the disc brake caliper from the steering knuckle. If necessary, refer to Group 5—Brakes for the removal procedure.

(3) Remove the ball stud-to-steering knuckle cotter pins and retaining nuts.

(4) Strike the steering knuckle with a brass hammer to loosen it and then remove it.

Upper Ball Stud Removal

(1) Position Ball Stud Receiver Tool 7903 (J34503-1) on top of the yoke upper arm and over the upper ball stud (Fig. 23).

(2) Position Ball Stud Removal Adapter Tool 7907 (J34503-3) on a C-clamp jaw and position the adapter tool under the yoke upper arm (Fig. 23).

(3) With the C-clamp screw head positioned on the receiver tool, tighten the C-clamp screw to remove the ball stud from the yoke upper arm bore (Fig. 23).

Upper Ball Stud Installation

(1) Insert the replacement upper ball stud into the yoke upper arm bore and place Ball Stud Installation Adapter Tool 7909 (J34503-5) over the ball stud (Fig. 24).

(2) Position a C-clamp with the screw head located on Ball Stud Installation Adapter Tool 7909 (J34503-5) and position Ball Stud Installation Adapter Tool 7904 (J34503-12) between the C-clamp jaw and the lower side of the yoke upper arm (Fig. 24).

(3) Tighten the C-clamp screw and completely "seat" the ball stud in the yoke upper arm bore (Fig. 24).

Lower Ball Stud Removal

(1) Position Ball Stud Receiver Tool 7903 (J34503-1) over the lower ball stud and between the underside of the yoke lower arm and a C-clamp screw head. Position Ball Stud Removal Adapter Tool 7907 (J34503-3) between the top side of the yoke lower arm and the C-clamp jaw (Fig. 25).

(2) Remove the lower ball stud from the yoke lower arm bore by tightening the C-clamp screw.

Lower Ball Stud Installation

(1) Insert the replacement lower ball stud into the yoke lower arm bore and place Ball Stud Installation Adapter Tool 7908 (J34503-4) over the ball stud (Fig. 26).

(2) Position a C-clamp with the screw head located on Ball Stud Installation Adapter Tool 7908 (J34503-4) and position Ball Stud Installation Adapter Tool 7906 (J34503-2) between the C-clamp jaw and the upper side of the yoke lower arm (Fig. 26).

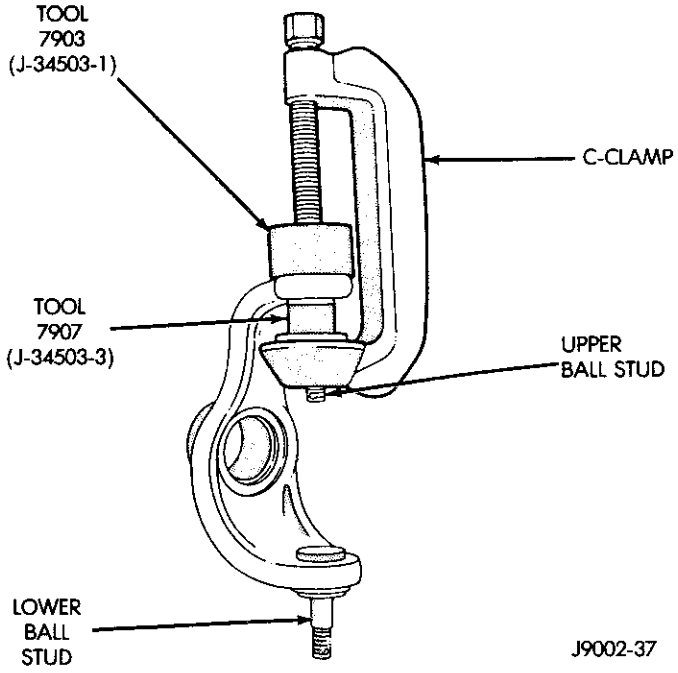


Fig. 23 Upper Ball Stud Removal

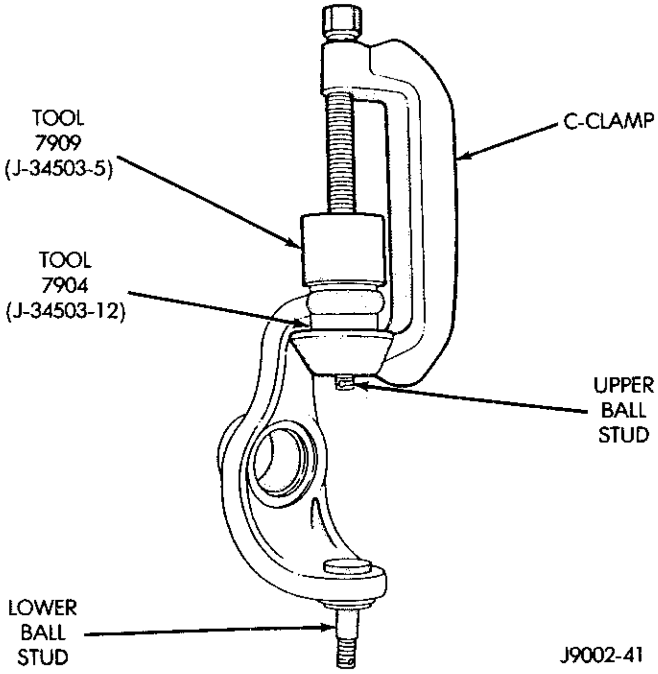


Fig. 24 Upper Ball Stud Installation

(3) Install the lower ball stud by tightening the C-clamp screw until the stud is completely “seated” in the yoke lower arm bore.

(4) Install the steering knuckle according to the installation procedure.

Steering Knuckle Installation

(1) Position the steering knuckle over the ball studs and install the retaining nuts.

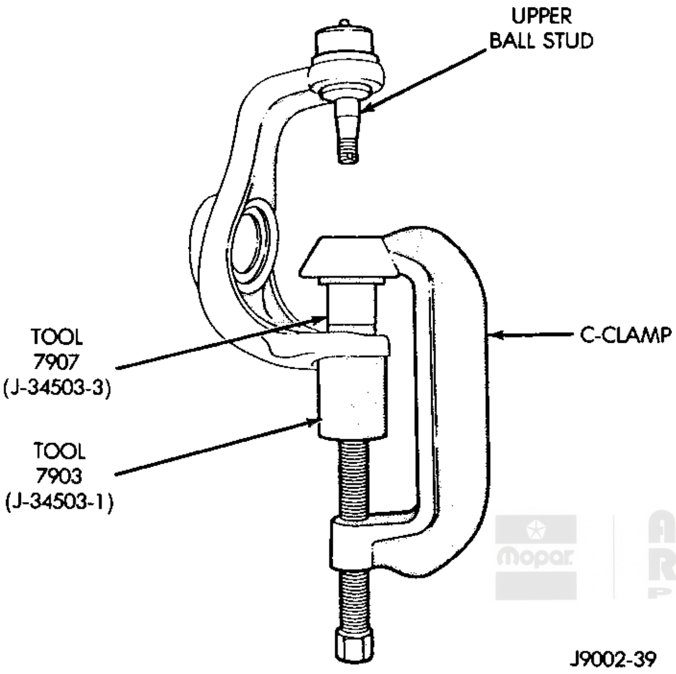


Fig. 25 Lower Ball Stud Removal

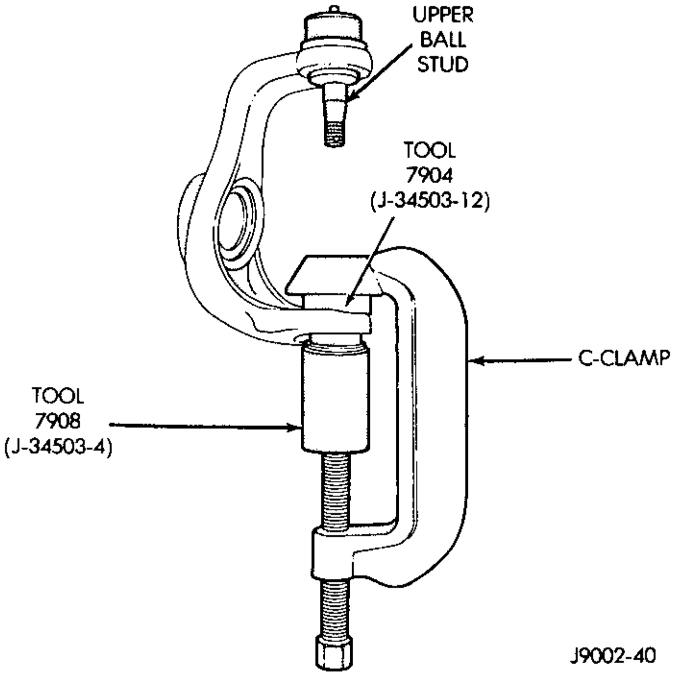


Fig. 26 Lower Ball Stud Installation

(2) Tighten the retaining nuts with 101 N•m (75 ft-lbs) and install replacement cotter pins.

(3) Install the disc brake caliper on the steering knuckle. If necessary, refer to Group 5—Brakes for the installation procedure.

(4) Install the axle shaft according to the installation procedure.

SPINDLE BEARING REPLACEMENT—SJ VEHICLES

The front axle spindles are equipped with a needle roller bearing that is located in the spindle flange bore (Fig. 27).

Spindle Removal

(1) Raise and support the vehicle.

(2) Remove the disc brake caliper.

(3) Remove the disc brake rotor/hub cap.

(4) Remove the axle shaft retaining “snap” ring, the drive gear, the pressure spring and the spring retainer.

(5) Remove the outer locknut, washer and inner locknut with Wheel Bearing Nut Wrench Tool 8000 (J6893D).

(6) Remove the disc brake rotor. The spring retainer and outer bearing will be retained with the disc brake rotor.

(7) Remove the nuts that attach the spindle and the bolts that attach the support shield, and remove them from the steering knuckle. If necessary, tap the spindle with a rawhide mallet to remove it from the steering knuckle.

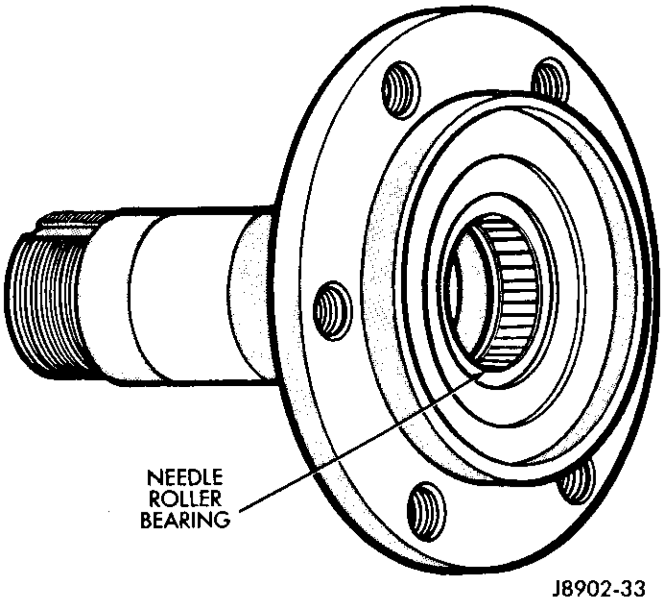


Fig. 27 Spindle Bearing

Bearing Removal

(1) Wrap the machined surfaces of the spindle with tape and clamp the spindle in a vise. **Do not clamp the spindle in a vise unless protective tape covers the spindle surfaces.**

(2) Remove the needle bearing with an internal-type jaw puller tool.

(3) Clean all foreign matter from the spindle bearing surface.

Bearing Installation

(1) Install the replacement needle bearing with an appropriate bearing driver tool.

(2) "Pack" the replacement needle bearing with wheel bearing lubricant.

(3) Remove the spindle from the vise and remove the protective tape from the spindle.

Spindle Installation

(1) Position the spindle on the steering knuckle and install the retaining nuts. Tighten the retaining nuts with 38 N•m (28 ft-lbs) torque.

(2) Install the support shield and the disc brake rotor.

(3) Install the inner wheel bearing locknut (the nut has a peg on one side). Tighten the locknut just enough to remove the "end-play".

(4) Install the wheel/tire but do not tighten the wheel lug nuts completely.

(5) Tighten the inner locknut with 68 N•m (50 ft-lbs) torque; then "back-off" the locknut 1/6 of-a-turn (45°-65°). Rotate the wheel while tightening the locknut to "seat" the bearings evenly.

(6) Install the washer so that the inner tab is aligned with the spindle keyway. Also, ensure that the peg on the inner locknut engages in the nearest hole in the washer.

(7) Install and tighten the outer locknut with a minimum of 68 N•m (50 ft-lbs) torque.

(8) Remove the wheel/tire.

CAUTION: Install the spring retainer with the cupped side of the retainer facing toward the center of the vehicle.

(9) Install the spring retainer, the pressure spring and the drive gear.

(10) Force the drive gear inward to provide sufficient installation clearance for the axle shaft retaining "snap" ring. Install the retaining "snap" ring.

(11) Apply a coating of Permatex Adhesive-Sealant number 3 (or an equivalent sealant) to the disc brake rotor/hub cap rim and install the hub cap in the disc brake rotor.

(12) Install the disc brake caliper. If necessary, refer to Group 5—Brakes for the installation procedure.

(13) Install the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(14) Remove the supports and lower the vehicle.

INTERMEDIATE AXLE SHAFT BUSHING REPLACEMENT

The following procedures are applicable only to YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).

Removal—MJ/XJ And YJ Vehicles

(1) Remove the right-side (outer) axle shaft and the intermediate axle shaft according to the removal procedures.

(2) Clean the outer edge and the inside perimeter of the axle shaft tube with fine crocus cloth.

(3) Slide Support Guide Tool 7919 (J34659-4) over Threaded Rod Tool 7918 (J34659-3) and position it near the nut. Apply all-purpose lubricant to the non-threaded half of the threaded rod so that it will slide easily through the axle shaft seal.

If the axle shaft inner seal has been removed for replacement, the intermediate shaft bushing removal tool can be threaded onto the threaded rod tool prior to insertion into the axle shaft tube. If the seal has not been removed, the bushing removal tool cannot be threaded onto the threaded rod at this time.

(4) Insert the threaded rod tool (with the support guide tool) into the outer end, through the right-side axle shaft tube and **carefully** through the axle shaft seal (if installed) until the threaded end of the rod is visible at the shift motor housing opening in the axle shaft tube (Fig. 28).

(5) Thread Axle Shaft Bushing Removal Tool 7916 (J34659-1) tightly onto the end of the threaded rod tool via the shift motor housing opening in the axle shaft tube (Fig. 29). Pivot the end (i.e., the "foot") of the removal tool so that it is parallel with the bracket.

(6) Continue inserting the threaded rod tool and the bushing removal tool into the axle shaft tube until the end (i.e., the "foot") of the removal tool is located at the differential housing side of the intermediate shaft bushing. Pivot the end (i.e., the "foot") of the bushing re-

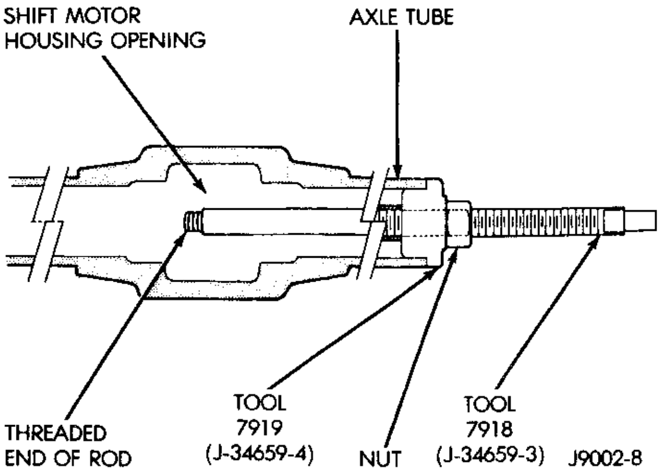


Fig. 28 Threaded Rod Tool In The Axle Shaft Tube

moval tool 90° (so that it is perpendicular to the bracket) with an appropriate device.

(7) Ensure that the support guide tool is "seated" in the end of the axle shaft tube. Position an open-end wrench on the "flat" area at the outer end of the threaded rod tool to prevent it from turning and tighten the nut (at the outer end of the threaded rod tool) against the support guide tool to force the intermediate shaft bushing from the axle shaft tube bore and into the shift motor housing opening (Fig. 29).

(8) Unthread the bushing removal tool from the threaded rod and remove the tool and the bushing via the shift motor housing opening in the axle shaft tube. **Do not remove the threaded rod tool from the axle shaft tube.**

Installation—MJ/XJ And YJ Vehicles

(1) Thread Bushing And Seal Installation Tool 7917 (J34659-2) tightly onto the end of the threaded rod tool via the shift motor housing opening in the axle shaft tube.

(2) Position the replacement bushing on the bushing installation tool.

(3) Insert the threaded rod tool (with the installation tool and the replacement bushing) into the intermediate axle shaft tube as far as possible (Fig. 30).

(4) Position the threaded rod tool nut 51 mm or 2 inches away from the support guide tool (Fig. 30).

(5) With the support guide tool "seated" in the end of the axle shaft tube, tap the end of the threaded rod tool with a brass hammer to "seat" the intermediate axle shaft bushing in the axle shaft tube bore (Fig. 30).

(6) Withdraw the threaded rod tool and the installation tool from the bushing. Unthread the installation tool from the threaded rod and remove it via the shift motor housing opening.

(7) Remove the threaded rod tool (with the support guide tool) from the axle shaft tube.

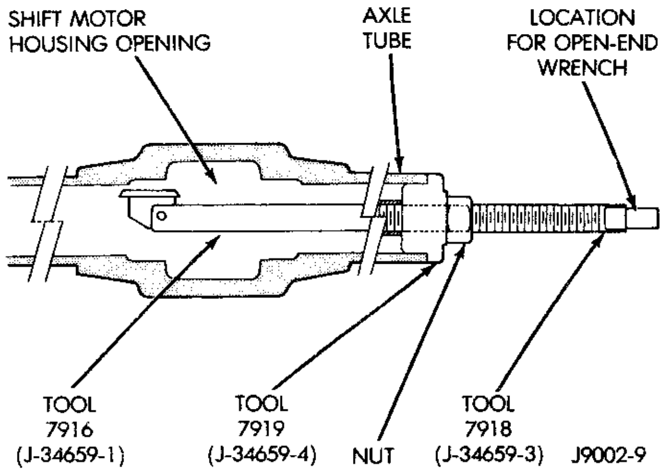


Fig. 29 Axle Shaft Bushing Removal Tool Installed

(8) Install the intermediate axle shaft and the right-side (outer) axle shaft according to the installation procedures.

RIGHT-SIDE AXLE SHAFT PILOT BUSHING REPLACEMENT

The following procedures are applicable only to YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).

Removal—MJ/XJ And YJ Vehicles

(1) Remove the right-side (outer) axle shaft from the axle shaft tube according to the removal procedure.

(2) Pry the pilot bushing from the axle shaft bore with a small pry bar or another appropriate device.

(3) Clean the axle shaft bore.

Installation—MJ/XJ And YJ Vehicles

(1) Insert the replacement bushing in the axle shaft bore and "seat" it with a rawhide mallet.

(2) Install the right-side (outer) axle shaft in the axle shaft tube according to the installation procedure.

Insert the axle shaft carefully through the seal and engage the splined-end of the shaft with the shift collar. Ensure that the small-diameter "tip" at the end of the intermediate shaft inserts and mates properly with the "pilot" bushing in the end of the axle shaft.

RIGHT-SIDE AXLE SHAFT INNER SEAL REPLACEMENT

The following procedures are applicable only to YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).

Removal—MJ/XJ And YJ Vehicles

(1) Remove the right-side (outer) axle shaft according to the removal procedure.

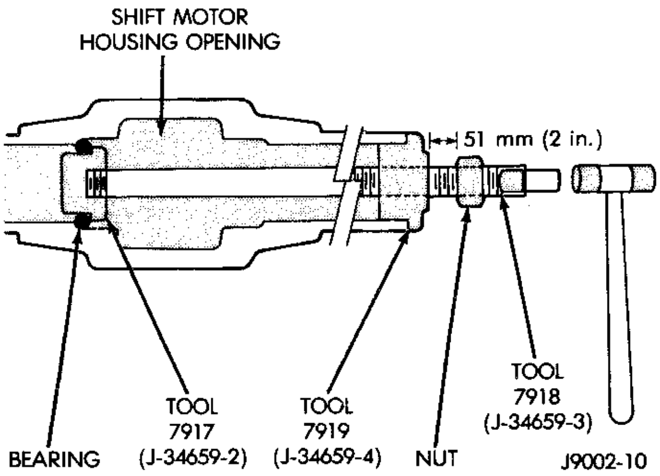


Fig. 30 Intermediate Shaft Bushing Installation

(2) Remove the vacuum shift motor and housing from the axle shaft tube (Fig. 31). If necessary, refer to the removal procedure.

(3) Remove the shift collar from the intermediate shaft (Fig. 31).

(4) Clean the outer edge and the inside perimeter of the axle shaft tube with fine crocus cloth.

(5) Slide Support Guide Tool 7919 (J34659-4) over Threaded Rod Tool 7918 (J34659-3) and position it near the nut.

(6) Thread Axle Shaft Seal Removal Tool 7920 (J34659-5) onto the opposite end of Threaded Rod Tool 7918 (J34659-3).

(7) Insert the threaded rod tool (with the support guide tool and the removal tool) into the outer end and through the right-side axle shaft tube until the axle shaft seal is contacted (Fig. 32).

(8) Position the threaded rod tool nut 51 mm or 2 inches away from the support guide tool (Fig. 32).

(9) With the support guide tool "seated" in the outer end of the axle shaft tube, strike the end of the threaded rod tool with a brass hammer to force the axle shaft seal from the axle shaft tube and into the shift motor housing opening. Remove the seal via the housing opening in the axle shaft tube.

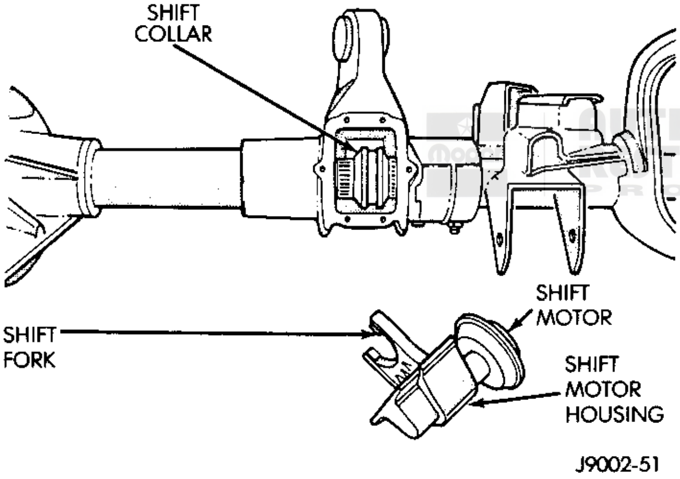


Fig. 31 Shift Motor Housing & Shift Collar

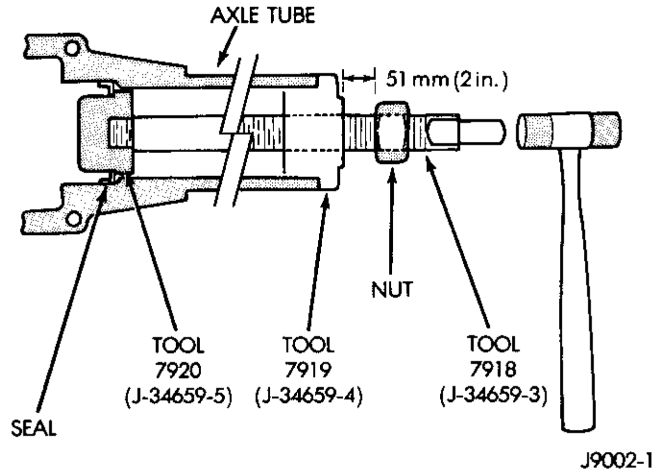


Fig. 32 Axle Shaft Inner Seal Removal

(10) Remove the threaded rod tool (with the support guide tool and the seal removal tool) from the axle shaft tube.

(11) Remove the seal removal tool from the end of the threaded rod tool.

If applicable, (for convenience) do not install a replacement axle shaft inner seal until after the intermediate axle shaft bushing has been replaced.

Installation—MJ/XJ And YJ Vehicles

(1) Ensure that the seal contact area in the axle shaft tube bore is clean (Fig. 33).

(2) Slide Support Guide Tool 7919 (J34659-4) and Spacer Sleeve Tool 6228-2 over Threaded Rod Tool 7918 (J34659-3).

(3) Insert the threaded rod tool (with the support guide tool and the spacer sleeve tool) into the outer end and through the right-side axle shaft tube until the end is visible in the shift motor housing opening. Ensure that the support guide tool is "seated" in the end of the axle shaft tube.

(4) Apply a light film of oil to the inside lip of the replacement axle shaft seal.

(5) Position the replacement seal on Axle Shaft Seal Primary Installation Tool 6228-1 (Fig. 34). Ensure that the seal lip has sufficient clearance from the edge of the tool.

(6) Thread the axle shaft seal primary installation tool (with the replacement seal) onto the threaded rod tool (Fig. 35) via the shift motor housing opening in the

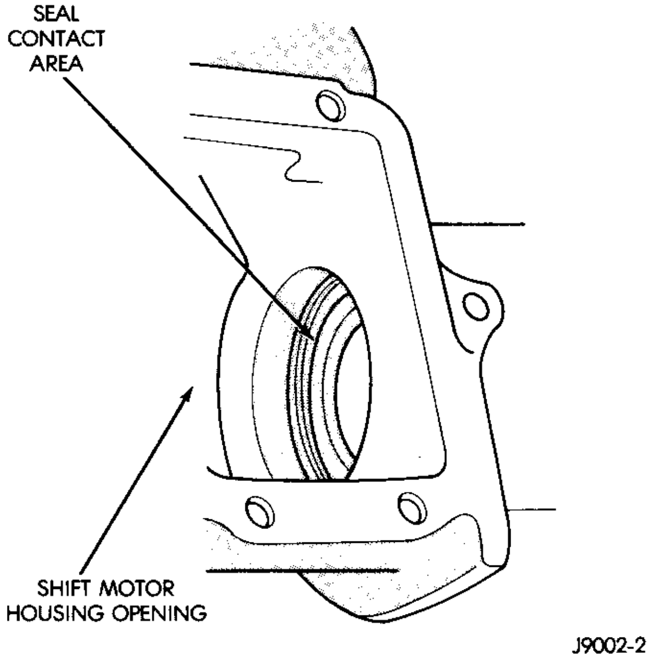


Fig. 33 Axle Shaft Tube Bore Seal Contact Area

axle shaft tube. **Ensure that the seal primary installation tool is tightly threaded onto the threaded rod tool.**

(7) Position an open-end wrench on the "flat" area at the outer end of the threaded rod tool to prevent it from turning and tighten the nut (at the outer end of the threaded rod tool) against the support guide tool to force the replacement axle shaft seal into the axle shaft tube bore (Fig. 35).

The axle shaft seal primary installation tool will only force the replacement seal partially into the axle shaft tube bore. The axle shaft seal secondary installation tool must be used to completely "seat" the replacement seal in the axle shaft tube bore.

(8) Loosen the threaded rod tool nut (Fig. 35).

(9) Insert a drift punch into the hole in the edge of the axle shaft seal primary installation tool (Fig. 36). While retaining the punch to prevent the installation tool from turning, unthread the threaded rod tool from the axle shaft seal primary installation tool.

(10) Remove the seal primary installation tool via the shift motor housing opening in the axle shaft tube.

(11) Thread Axle Shaft Seal Secondary Installation Tool 6228-3 onto the threaded rod tool (Fig. 37) via the shift motor housing opening in the axle shaft tube. **Ensure that the seal installation tool is tightly threaded onto the threaded rod tool.**

(12) Position an open-end wrench on the "flat" area at the outer end of the threaded rod tool to prevent it from turning and tighten the nut (at the outer end of the threaded rod tool) against the support guide tool to "seat" the replacement axle shaft seal in the axle shaft tube bore (Fig. 37).

(13) Loosen the threaded rod tool nut (Fig. 37).

(14) Insert a drift punch into the hole in the seal secondary installation tool (Fig. 37). While retaining

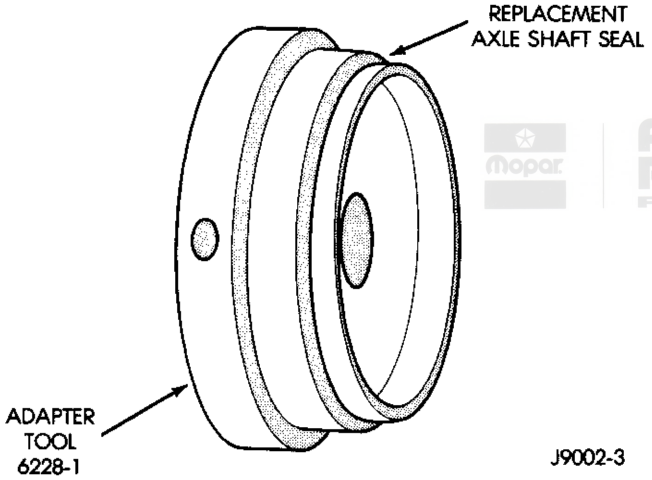


Fig. 34 Replacement Axle Shaft Seal & Tool 6228-1

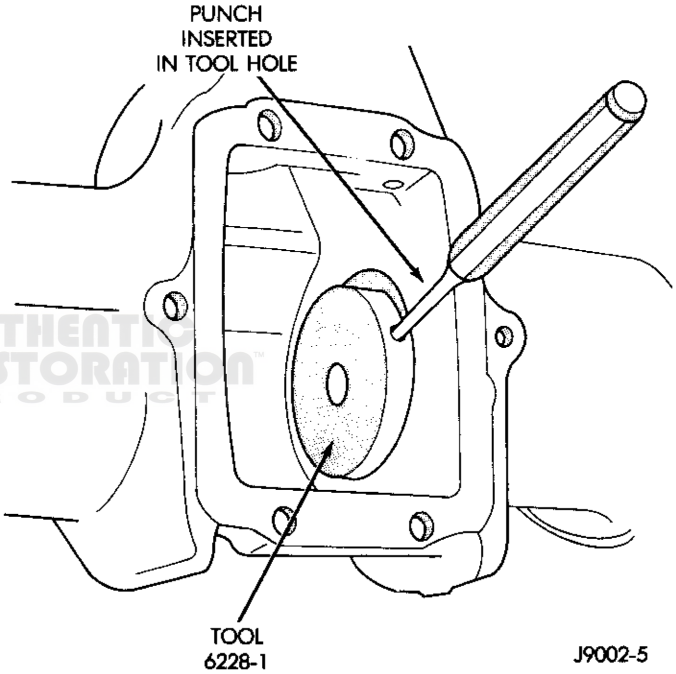


Fig. 36 Seal Primary Installation Tool Removal

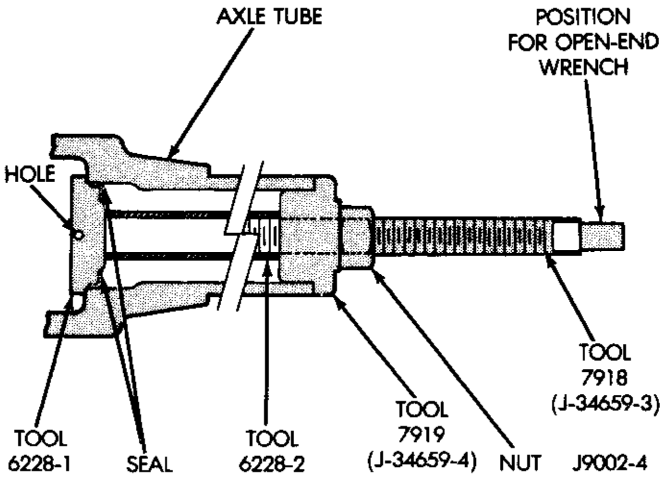


Fig. 35 Axle Seal Primary Installation

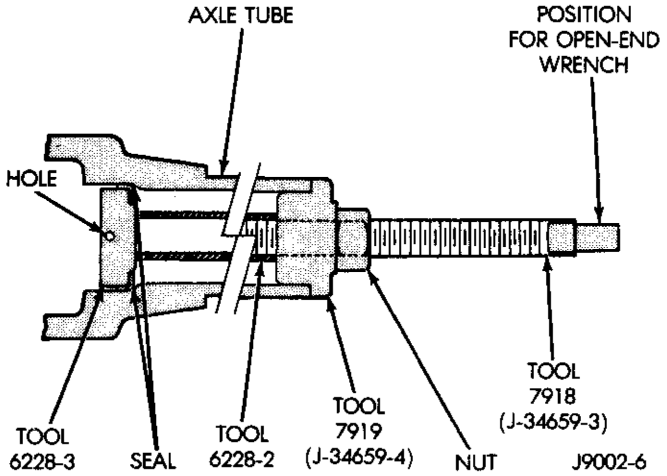


Fig. 37 Axle Shaft Seal Secondary Installation

the punch to prevent the installation tool from turning, unthread the threaded rod tool from the seal secondary installation tool.

(15) Remove the seal secondary installation tool via the shift motor housing opening. Remove the remaining installation tools from the axle shaft tube.

(16) Position the shift collar on the end of the intermediate shaft (in the shift motor housing opening) and slide it as far as possible to the left; **i.e., completely on the shaft** (Fig. 38).

CAUTION: Apply all-purpose lubricant to the axle shaft splines to prevent damage to the replacement seal during axle shaft installation.

(17) Insert the axle shaft into the axle shaft tube (carefully through the seal) and engage the splined-end of the shaft with the shift collar. **Ensure that the small-diameter "tip" at the end of the intermediate shaft inserts and mates properly with the "pilot" bushing in the end of the outer axle shaft.**

(18) Center the shift collar over the ends of both axle shafts.

(19) Position a replacement gasket around the perimeter of the shift motor housing opening and install the shift motor and housing with the fork inserted into the shift collar groove (Fig. 31). Tighten the retaining bolts with 11 N•m or 101 in-lbs torque.

(20) Refer to the applicable installation procedures and install the disc brake rotor shield, the hub and bearing, the disc brake rotor, the disc brake caliper and the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(21) Remove the supports and lower the vehicle.

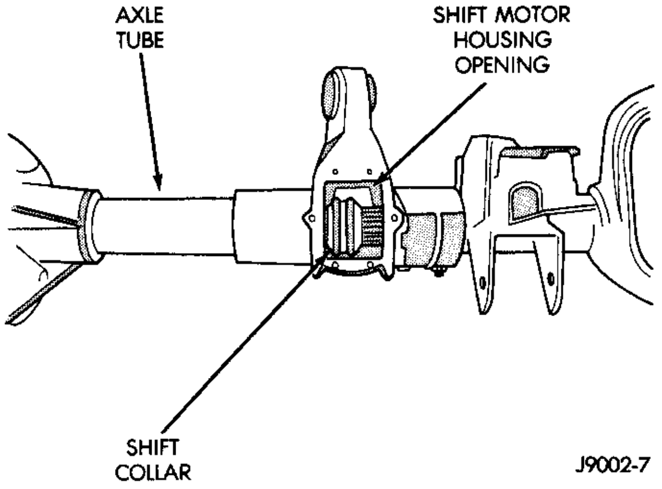


Fig. 38 Shift Collar Installation

DIFFERENTIAL SERVICE

General Service Information

For XJ vehicles equipped with a **Selec-Trac** axle (i.e., a non-disconnect axle) and an ABS brake system, also refer to Group 5—Brakes for additional service information.

Model 30 Axle Differential Specifications

	USA	Metric
Differential Bearing Preload Shim	0.004 in.	0.1 mm
Differential Side Gear-to-Case Clearance	0.000-0.006 in.	0.00-0.15 mm
Ring Gear Backlash..............	0.005-0.010 in.	0.12-0.25 mm
Drive Pinion Gearshaft Bearing Break-Away Preload Torque		
Original Bearings	15-25 in-lbs	2-3 N·m
Replacement Bearings	20-40 in-lbs	2-5 N·m
Drive Pinion Gear Depth Standard Setting	2.25 in.	57.1 mm
Lubricant Capacity*	2.5 pts.	1.2 liters
Lubricant Type	SAE 75W-90, API GL5	

*Command-Trac—add 5 ounces (148 ml) to front axle shift motor housing opening.

J9002-57

Model 44 Axle Differential Specifications

	USA	Metric
Differential Bearing Preload Shim	0.15 in.	0.38 mm
Differential Side Gear-to-Case Clearance	0.000-0.006 in.	0.00-0.15 mm
Ring Gear Backlash..............	0.005-0.010 in.	0.12-0.25 mm
Drive Pinion Gearshaft Bearing Break-Away Preload Torque		
Original Bearings..............	10-20 in-lbs	1-2 N·m
Replacement Bearings..........	20-40 in-lbs	2-5 N·m
Drive Pinion Gear Depth Standard Setting	2.625 in.	66.6 mm
Lubricant Capacity...............	3.0 pts.	1.41 liters
Lubricant Type	SAE 75W-90, API GL5	

J9002-35

Differential Case Removal—All Vehicles

(1) Raise and support the vehicle.

(2) Remove the differential housing cover and drain the lubricant.

(3) Score installation alignment reference marks on the yokes and disconnect the front drive shaft from the drive pinion gear shaft (axle) yoke.

(4) Refer to the applicable removal procedures (if necessary) and remove the:

- front wheels/tires,
- disc brake rotors,
- hubs and bearings,
- shift motor and housing (if equipped with a Command-Trac/disconnect axle), and
- axle shafts.

(5) If equipped with a **Command-Trac** axle (i.e., a disconnect axle), remove the intermediate axle shaft retaining clip (Fig. 39) and disengage the shaft from the right-side differential side gear.

(6) Mark the differential bearing caps with a center-punch for installation reference.

(7) Loosen the differential bearing cap bolts until only 2 or 3 threads are engaged.

(8) Disconnect the tie rod from the left steering knuckle and disconnect the track bar from the frame rail bracket.

(9) Install Differential Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing (Fig. 40).

(10) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing (Fig. 40).

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(11) Separate the differential housing only enough to remove the differential case. For MJ/XJ/YJ vehicles, separate the differential housing a **maximum distance of 0.50 mm (0.02 in)** with the spreader tool. For SJ vehicles, separate the differential housing a **maximum distance of 0.38 mm (0.015 in)** with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated (Fig. 40).

(12) Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the differential bearing caps.

(13) Remove the differential case with two pry bars. Position one bar under the ring gear bolt head, one under the differential case and pry the differential case upward to remove it.

(14) Remove the spreader tool and the holddown clamps immediately after removing the differential case. **This is important to avoid the possibility of the housing acquiring a different "set".**

Differential Disassembly—All Vehicles

(1) Clamp the differential case in a vise.

(2) Remove and discard the ring gear attaching bolts.

CAUTION: Do not attempt to pry or chisel the ring gear off of the differential case because the case could be damaged during the process.

(3) Remove the ring gear. Use a brass punch and tap it with a hammer to remove the gear from the differential case (Fig. 41).

(4) Remove the differential pinion gear mate shaft lockpin with a small pin punch (Fig. 42).

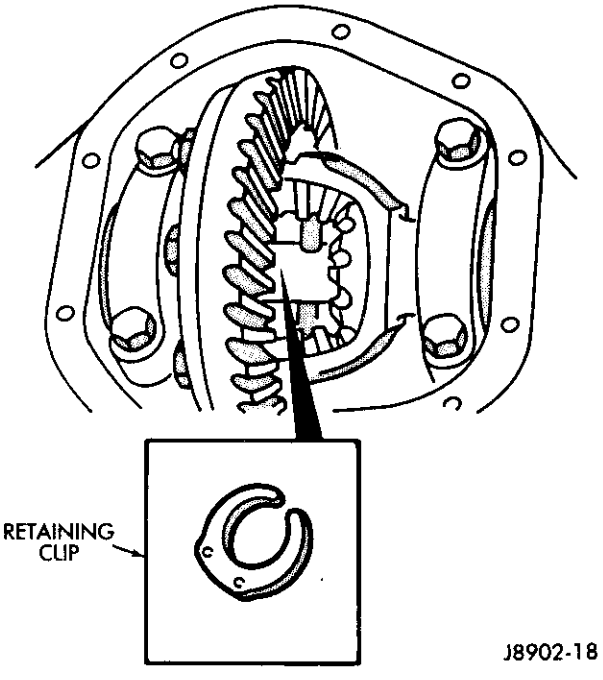


Fig. 39 Intermediate Shaft Retaining Clip

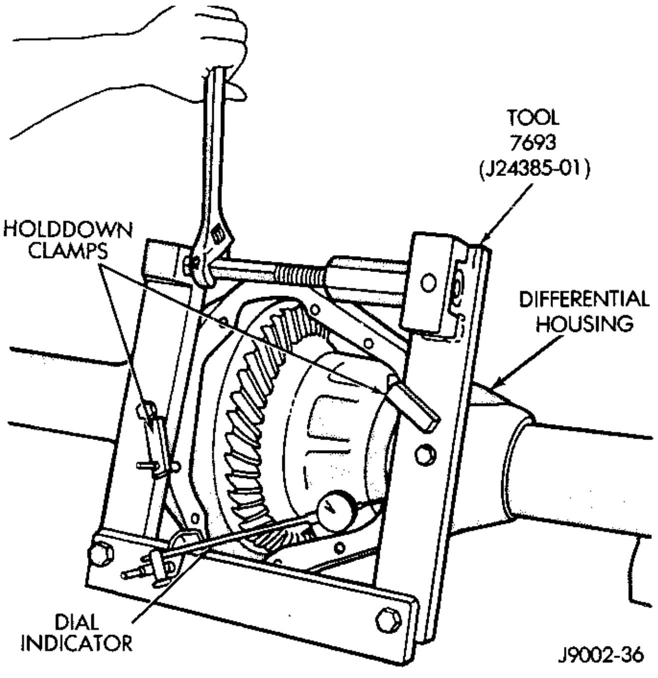


Fig. 40 Differential Housing Separation

(5) Remove the differential pinion gear mate shaft (Fig. 43).

(6) Rotate the differential pinion gears until the gears are aligned with the case opening, then remove the differential pinion gears and the thrust washers (Fig. 43).

(7) Measure the side gear clearance with two feeler gauges (Fig. 44). Insert a gauge blade between each thrust washer and the differential case. Vary the feeler gauge blade thickness until each gauge blade fits "tight". The clearance should not exceed 0.007 inch or 0.18 mm between either of the washers and the case. Replace both thrust washers if the clearance exceeds the clearance specification.

(8) Remove the differential side gears and the thrust washers (Fig. 43).

Differential Bearing Removal—All Vehicles

(1) Mark the differential bearing cups for installation reference and remove them.

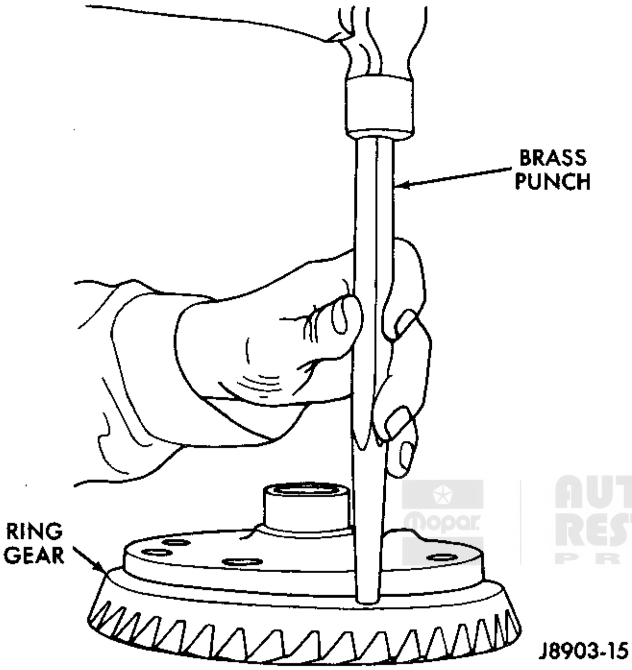


Fig. 41 Ring Gear Removal

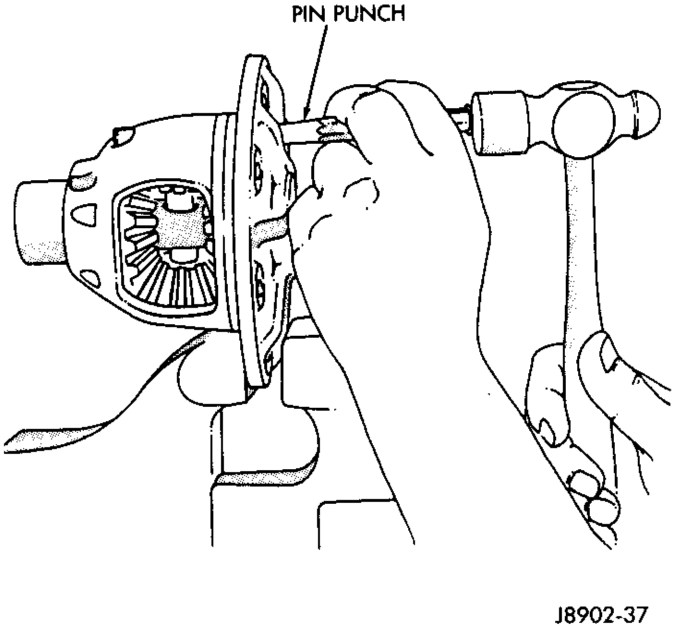


Fig. 42 Lockpin Removal

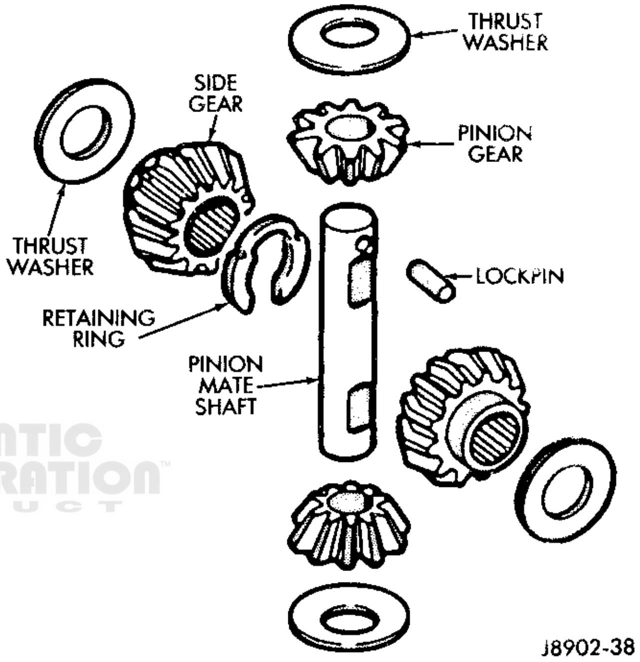


Fig. 43 Pinion Gear & Side Gear Removal

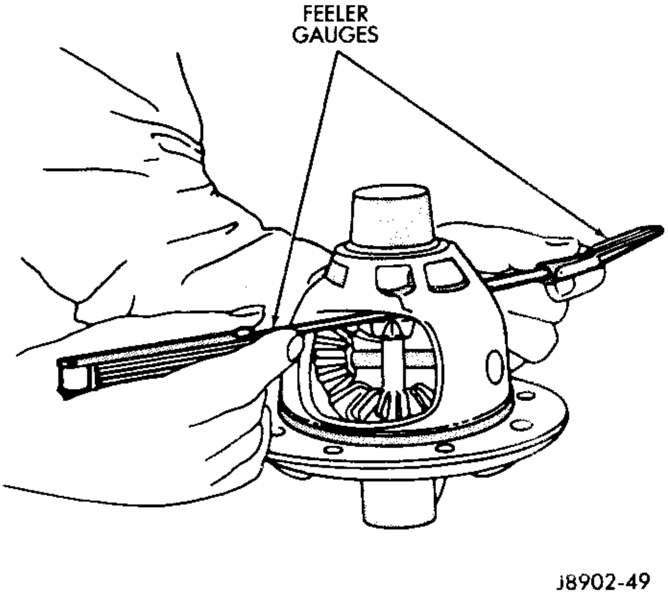


Fig. 44 Side Gear Clearance Measurement

CAUTION: When removing a differential bearing, ensure that the differential case is securely clamped or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

(2) Install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and bearing (Fig. 45). If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(3) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(4) Tighten the puller tool or removal tool screw (Fig. 45) and remove the bearing from the differential case hub.

(5) Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

Drive Pinion Gear Shaft Removal—All Vehicles

(1) Remove the drive pinion gear shaft (axle) yoke retaining nut and washer. Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke while removing the nut (Fig. 46). Retain the nut for ring gear and drive pinion gear adjustment during assembly.

(2) Remove the drive pinion gear shaft (axle) yoke. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke (Fig. 47).

(3) If equipped, remove the dust cap from the drive pinion gear shaft (Model 44 axles only).

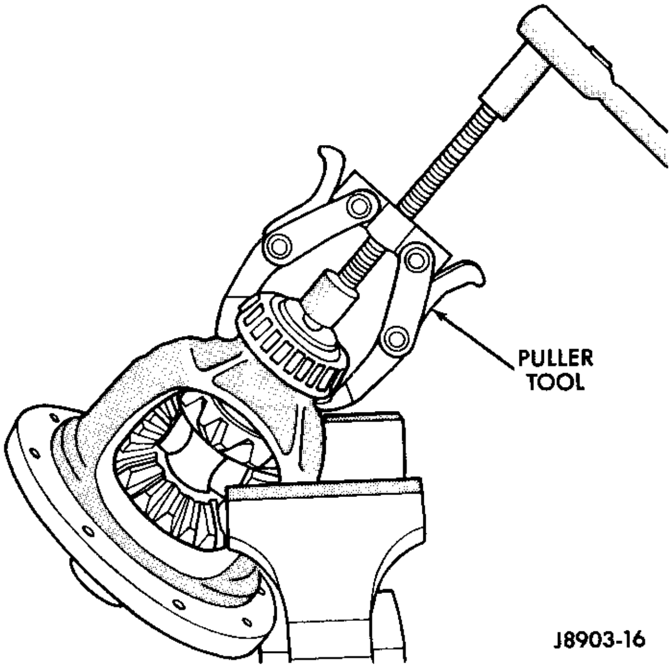


Fig. 45 Differential Bearing Removal

(4) Remove the drive pinion gear shaft. Strike the end of the shaft with a rawhide hammer to force it out of the drive pinion gear shaft rear bearing and the housing.

(5) Remove the drive pinion gear shaft front bearing, the bearing "preload" torque spacer/shim(s), the oil slinger, and the seal from the differential housing. Use a 2 x 2-inch or 5 x 5-cm piece of wood, or length of pipe to drive the bearing, the spacer/shim(s), the oil slinger, and the seal out of the housing.

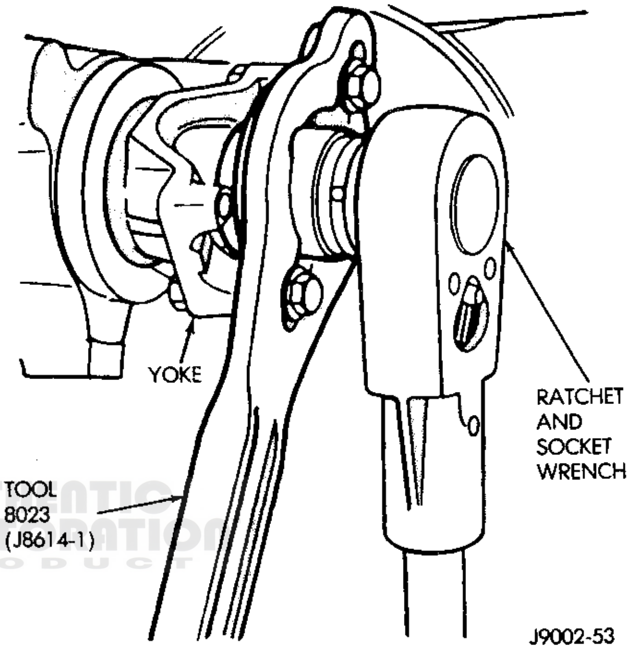


Fig. 46 Pinion Gear Shaft (Axle) Yoke Nut Removal

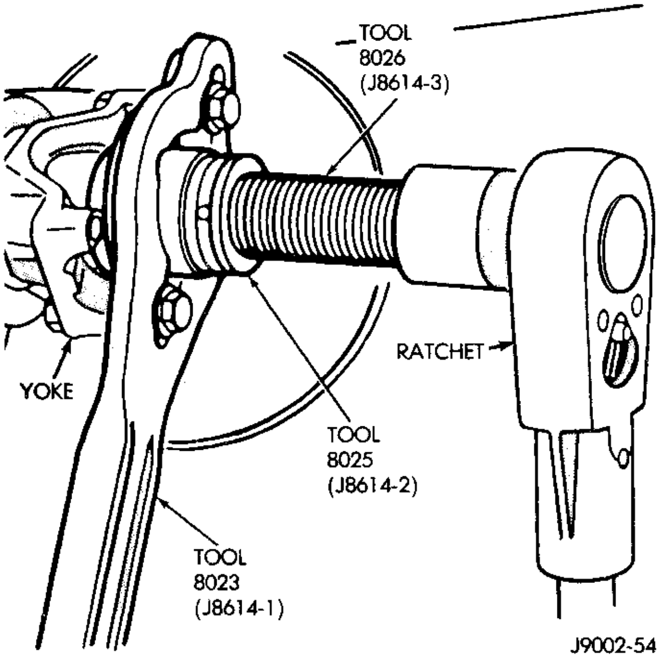


Fig. 47 Pinion Gear Shaft (Axle) Yoke Removal

(6) Discard the seal and the spacer (Model 30 axles) after removal. If reusable, retain the "preload" torque shim(s) for installation during the bearing "preload" torque adjustment.

Drive Pinion Gear Shaft Rear Bearing Removal—All Vehicles

(1) Assemble and install a bearing removal tool set (Fig. 48) on the rear bearing and the drive pinion gear shaft.

(2) Insert the bearing removal tool set adapters (Fig. 48) into the removal tool base from the top and position them 180° opposite each other.

(3) Tighten the removal tool screw (Fig. 48) and remove the bearing.

Drive Pinion Gear Shaft Bearing Cup Removal—All Vehicles

(1) Remove the drive pinion gear shaft rear bearing cup. Use a brass drift and a hammer to tap the cup out of the housing.

(2) Remove the drive pinion gear shaft depth shim(s) from the rear bearing cup bore in the differential housing. Retain the depth shim(s) for installation reference (even if they are bent or distorted).

(3) Remove the drive pinion gear shaft front bearing cup. Use a brass drift and a hammer to tap the cup out of the differential housing.

Cleaning And Inspection—All Vehicles

(1) Clean all of the differential components in cleaning solvent (Fig. 49, Fig. 50). Allow the bearings to either air dry or dry them with a lint-free cloth. Dry the other components with compressed air.

(2) Inspect all of the bearings and cups for pitting, galling, flat spots, and cracks (Fig. 49, Fig. 50).

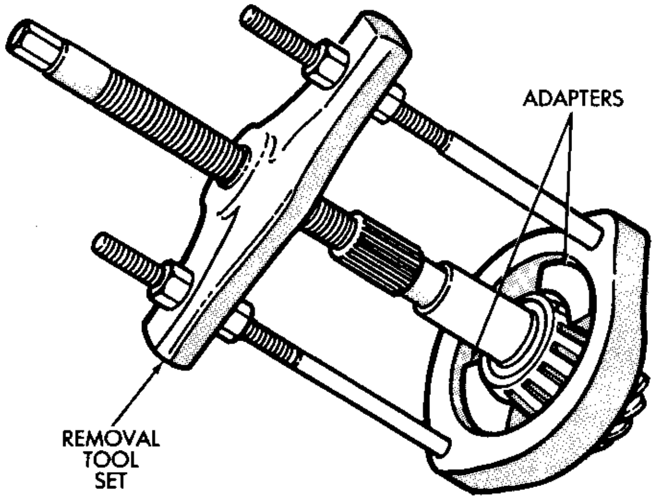


Fig. 48 Drive Pinion Gear Shaft Rear Bearing Removal

(3) Replace any bearing or cup that has any of the defective conditions described above.

(4) Inspect the differential case (Fig. 49, Fig. 50) for an elongated or enlarged differential pinion gear mate shaft bore. The machined thrust washer surface areas and counterbores must be smooth and free of nicks, gouges, cracks, and burrs.

(5) Inspect the differential case for cracks, worn shaft and pin bores, and other damage that could necessitate replacement. If the metal was raised on the bearing cup bore shoulders during bearing cup removal, flatten the raised area with a blunt punch.

(6) Replace the differential case if defective.

(7) Inspect the differential pinion gear mate shaft (Fig. 49, Fig. 50) for excessive wear, scoring, and galling. The shaft must be smooth and concentric. Replace the shaft if it is either worn, damaged or defective.

(8) Inspect the differential side gears and pinion gears (Fig. 49, Fig. 50). All the gear teeth must have a uniform contact pattern. Inspect the gears and gear teeth for cracks, scoring, excessive wear, and galling.

(9) Replace all the gears if any **one gear** has any of the defective conditions described above.

(10) Inspect the differential side gear and pinion gear thrust washers for wear, scoring, galling and distortion (Fig. 49, Fig. 50).

(11) Replace the washers if they have any of the defective conditions described above.

(12) Inspect the differential pinion gear mate shaft lockpin (Fig. 49, Fig. 50) for damage or for a loose fit in the differential case.

(13) Replace the lockpin or the differential case as necessary.

(14) Inspect the differential ring gear and the drive pinion gear and shaft (Fig. 49, Fig. 50) for worn or chipped teeth, cracks, damaged bearing journals and damaged attaching bolt threads.

(15) If replacement is necessary, both gears must be replaced as a **"matched set" only.**

(16) Inspect the drive pinion gear shaft (axle) yoke (Fig. 49, Fig. 50) for cracks, worn splines, and pitted, rough or corroded seal contact surfaces.

(17) Repair or replace the yoke as necessary.

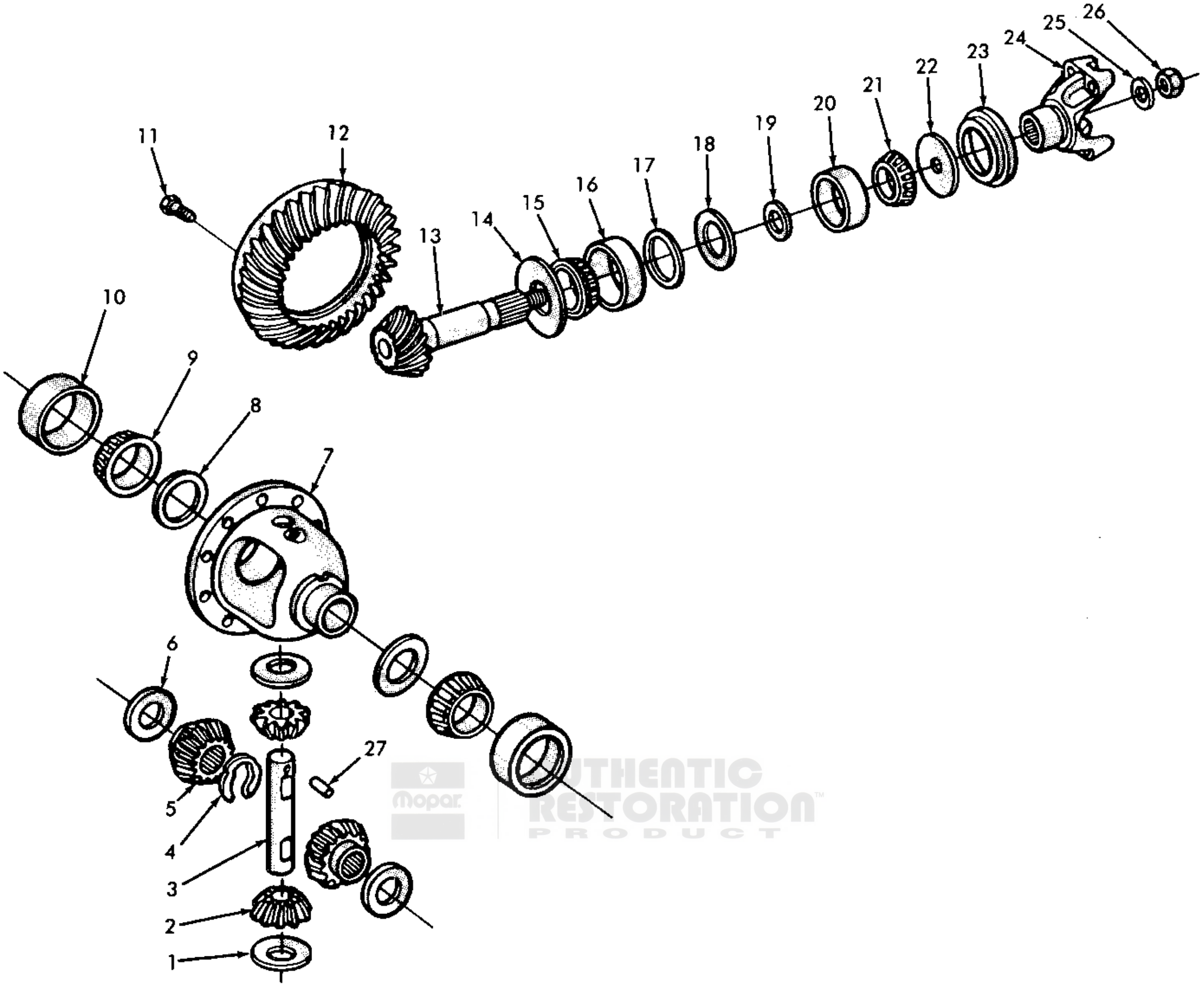
(18) Inspect the drive pinion gear shaft bearing shims (Fig. 49, Fig. 50) for damage and distortion.

(19) Replace any defective shims as necessary during assembly.

Axle Shaft Inner Seal And Bushing Replacement

Right-Side Axle Shaft Inner Seal—Command-Trac

The following **right-side** axle shaft inner seal replacement procedure is applicable only to YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).



1. DIFFERENTIAL PINION GEAR THRUST WASHER
2. DIFFERENTIAL PINION GEAR
3. PINION MATE SHAFT
4. RETAINING CLIP
5. SIDE GEAR
6. SIDE GEAR THRUST WASHER
7. DIFFERENTIAL CASE
8. BEARING SHIM
9. DIFFERENTIAL BEARING
10. BEARING CUP
11. RING GEAR BOLT
12. RING GEAR
13. DRIVE PINION GEAR SHAFT
14. OIL SLINGER
15. DRIVE PINION GEAR SHAFT REAR BEARING
16. REAR BEARING CUP
17. DRIVE PINION GEAR DEPTH SHIM
18. BAFFLE
19. DRIVE PINION GEAR SHAFT BEARING PRELOAD SPACER
20. FRONT BEARING CUP
21. DRIVE PINION GEAR SHAFT FRONT BEARING
22. DUST SLINGER
23. DRIVE PINION GEAR SHAFT SEAL
24. DRIVE PINION GEAR SHAFT YOKE
25. WASHER
26. PINION YOKE NUT
27. PINION MATE SHAFT LOCKPIN

J9002-34

Fig. 49 Model 30 Axle Differential — Exploded View

(1) Clean the edge and the inside perimeter of the outer end of the right-side axle shaft tube with fine crocus cloth.

(2) Slide Support Guide Tool 7919 (J34659-4) over Threaded Rod Tool 7918 (J34659-3) and position it near the nut.

(3) Thread Axle Shaft Seal Removal Tool 7920 (J34659-5) onto the opposite end of Threaded Rod Tool 7918 (J34659-3).

(4) Insert the threaded rod tool (with the support guide tool and the removal tool) into the outer end and through the right-side axle shaft tube until the axle shaft seal is contacted (Fig. 51).

(5) Position the threaded rod tool nut 51 mm or 2 inches away from the support guide tool (Fig. 51).

(6) With the support guide tool "seated" in the outer end of the axle shaft tube, strike the end of the threaded rod tool with a brass hammer to force the axle shaft seal from the axle shaft tube bore and into the shift motor housing opening. Remove the seal via the housing opening.

(7) Remove the threaded rod tool (with the support guide tool and the removal tool) from the axle shaft tube.

(8) Remove the seal removal tool from the end of the threaded rod tool.

If applicable, (for convenience) do not install a replacement axle shaft inner seal until after the intermediate axle shaft bushing has been replaced.

(9) Ensure that the seal contact area in the axle shaft tube bore is clean (Fig. 52).

(10) Slide Support Guide Tool 7919 (J34659-4) and Spacer Sleeve Tool 6228-2 over Threaded Rod Tool 7918 (J34659-3).

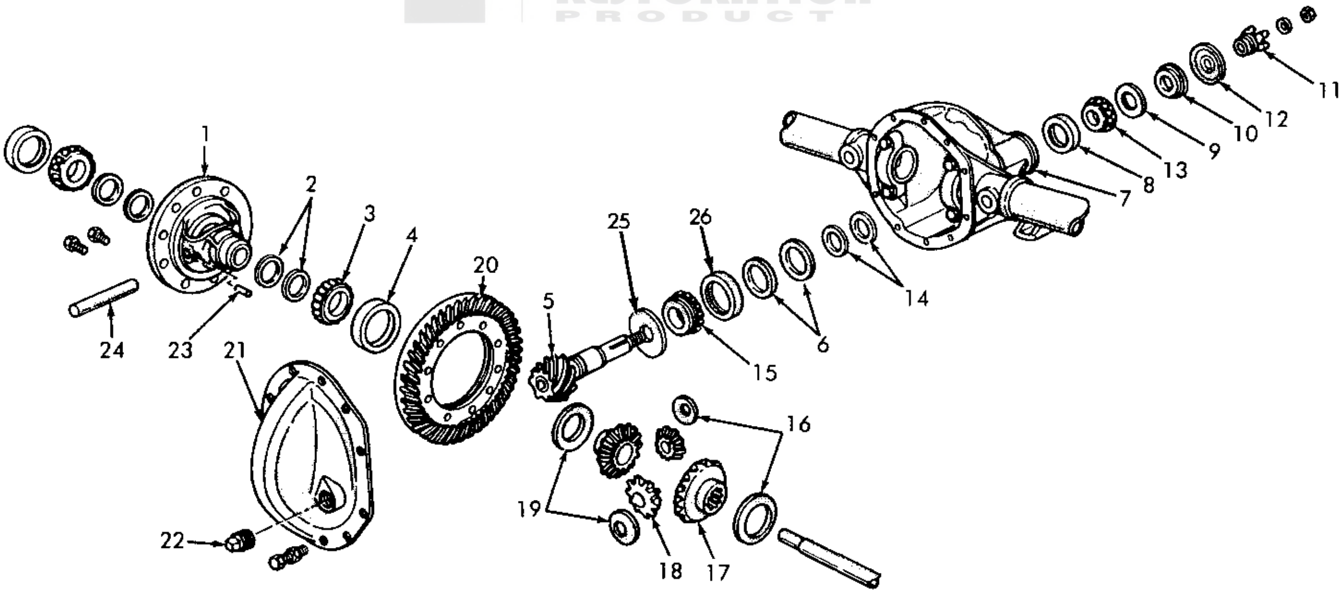
(11) Insert the threaded rod tool (with the support guide tool and the spacer sleeve tool) into the outer end and through the right-side axle shaft tube until the end is visible in the shift motor housing opening in the axle shaft tube. Ensure that the support guide tool is "seated" in the outer end of the axle shaft tube.

(12) Apply a light film of oil to the inside lip of the replacement axle shaft seal.

(13) Position the replacement seal on Axle Shaft Seal Primary Installation Tool 6228-1 (Fig. 53). Ensure that the seal lip has sufficient clearance from the edge of the tool.

(14) Thread the axle shaft seal primary installation tool (with the replacement seal) onto the threaded rod tool (Fig. 54) via the shift motor housing opening in the axle shaft tube. **Ensure that the seal installation tool is tightly threaded onto the threaded rod tool.**

(15) Position an open-end wrench on the outer end of the threaded rod tool to prevent it from turning and



1. DIFFERENTIAL CASE
2. DIFFERENTIAL BEARING SHIMS
3. DIFFERENTIAL BEARING
4. BEARING CUP
5. DRIVE PINION GEAR SHAFT
6. DRIVE PINION GEAR DEPTH SHIMS
7. DIFFERENTIAL HOUSING
8. DRIVE PINION GEAR SHAFT FRONT BEARING CUP
9. SLINGER
10. SEAL
11. YOKE
12. DUST CAP
13. DRIVE PINION GEAR SHAFT FRONT BEARING
14. DRIVE PINION GEAR BEARING PRELOAD SHIMS
15. DRIVE PINION GEAR SHAFT REAR BEARING
16. THRUST WASHERS
17. DIFFERENTIAL SIDE GEAR
18. DIFFERENTIAL PINION GEAR
19. THRUST WASHERS
20. RING GEAR
21. COVER
22. PLUG
23. LOCKPIN
24. PINION MATE SHAFT
25. SLINGER
26. REAR BEARING CUP

J9002-33

Fig. 50 Model 44 Axle Differential — Exploded View

tighten the nut (at the outer end of the threaded rod tool) against the support guide tool to force the replacement axle shaft seal into the axle shaft tube bore (Fig. 54).

The axle shaft seal primary installation tool will only force the replacement seal partially into the axle shaft tube bore. The axle shaft seal secondary installation tool must be used to completely "seat" the replacement seal in the axle shaft tube bore.

(16) Loosen the threaded rod tool nut (Fig. 54).

(17) Insert a drift punch into the hole in the edge of the seal primary installation tool (Fig. 55). While retaining the punch to prevent the installation tool from turning, unthread the threaded rod tool from the seal primary installation tool.

(18) Remove the seal primary installation tool via the shift motor housing opening in the axle shaft tube.

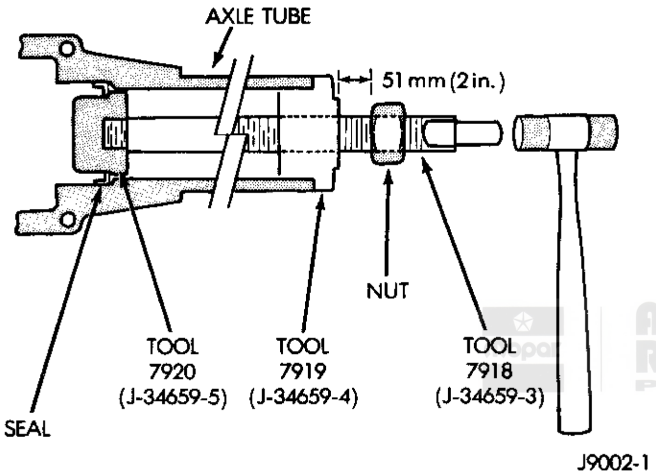


Fig. 51 Axle Shaft Inner Seal Removal

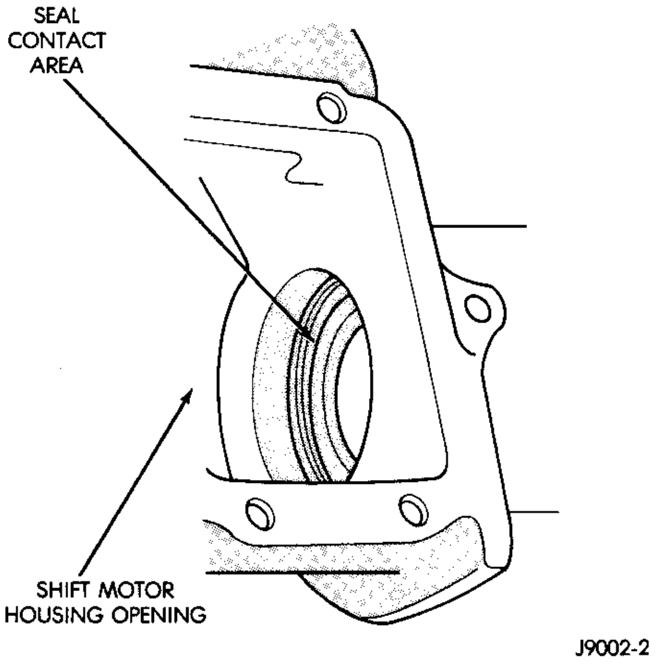


Fig. 52 Axle Shaft Tube Bore Seal Contact Area

(19) Thread Axle Shaft Seal Secondary Installation Tool 6228-3 onto the threaded rod tool (Fig. 56) via the shift motor housing opening in the axle shaft tube. **Ensure that the seal installation tool is tightly threaded onto the threaded rod tool.**

(20) Position an open-end wrench on the outer end of the threaded rod tool to prevent it from turning and tighten the nut (at the outer end of the threaded rod tool) against the support guide tool to "seat" the replacement axle shaft seal in the axle shaft tube bore (Fig. 56).

(21) Loosen the threaded rod tool nut (Fig. 56).

(22) Insert a drift punch into the hole in the seal secondary installation tool (Fig. 56). While retaining the punch to prevent the seal installation tool from turning, unthread the threaded rod tool from the seal secondary installation tool.

(23) Remove the seal secondary installation tool via the shift motor housing opening. Remove the remaining installation tools from the axle shaft tube.

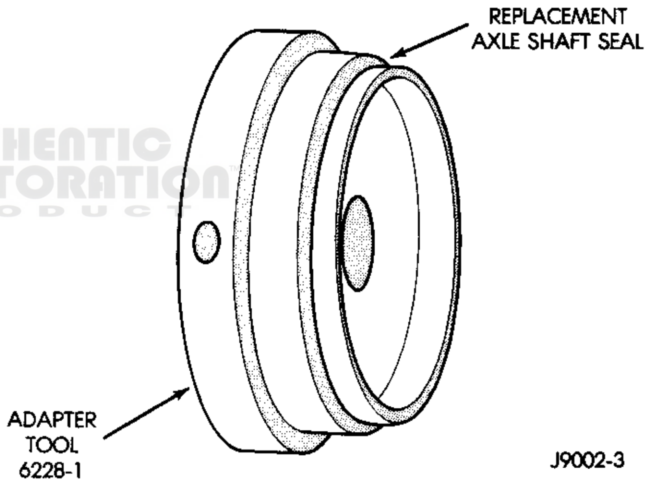


Fig. 53 Replacement Axle Shaft Seal & Tool 6228-1

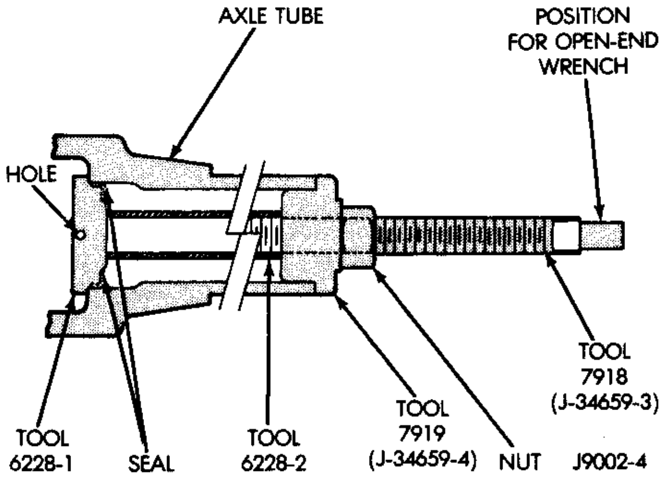


Fig. 54 Axle Shaft Seal Primary Installation

Intermediate Axle Shaft Bushing—Command-Trac

The following bushing replacement procedure is applicable only to YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).

(1) Clean the edge and the inside perimeter of the outer end of the right-side axle shaft tube with fine crocus cloth.

(2) Slide Support Guide Tool 7919 (J34659-4) over Threaded Rod Tool 7918 (J34659-3) and position it near the nut. If the axle shaft inner seal has not been removed, apply all-purpose lubricant to the non-threaded half of the threaded rod so that it will slide easily through the axle shaft seal.

If the axle shaft inner seal has been removed for replacement, the intermediate shaft bushing removal tool can be threaded onto the threaded rod tool prior to insertion into the axle shaft tube. If the seal has not been removed, the bushing removal tool cannot be threaded onto the threaded rod at this time.

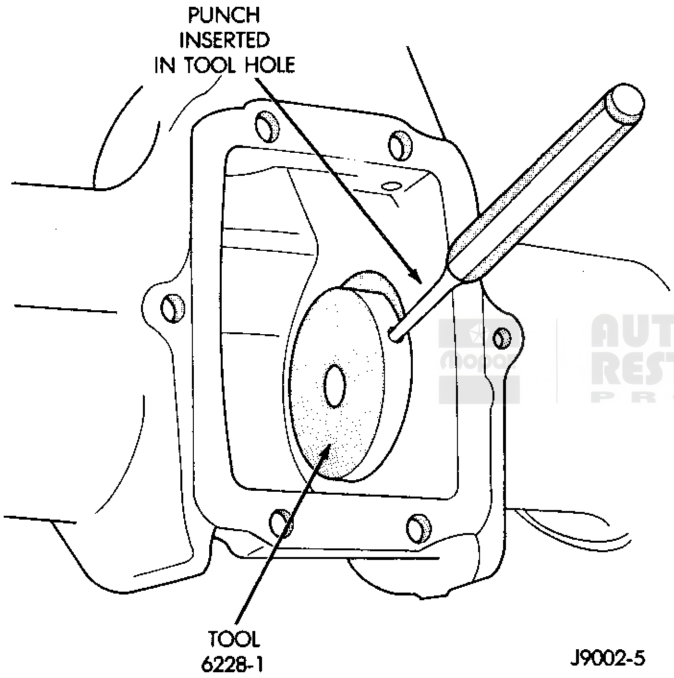


Fig. 55 Seal Primary Installation Tool Removal

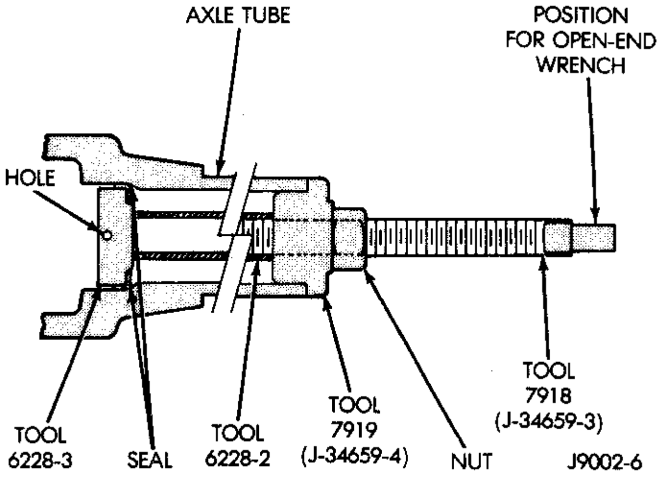


Fig. 56 Axle Shaft Seal Secondary Installation

(3) Insert the threaded rod tool (with the support guide tool) into the outer end, through the right-side axle shaft tube and **carefully** through the axle shaft seal (if installed) until the threaded end of the rod is visible at the shift motor housing opening in the axle shaft tube (Fig. 57).

(4) Thread Axle Shaft Bushing Removal Tool 7916 (J34659-1) tightly onto the end of the threaded rod tool via the shift motor housing opening in the axle shaft tube (Fig. 58).

(5) Continue inserting the threaded rod tool and the bushing removal tool into the axle shaft tube until the removal tool is located at the differential housing side of the intermediate shaft bushing. Pivot the end (i.e., the "foot") of the bushing removal tool 90° (i.e., so that it is perpendicular to the tool bracket) with an appropriate device.

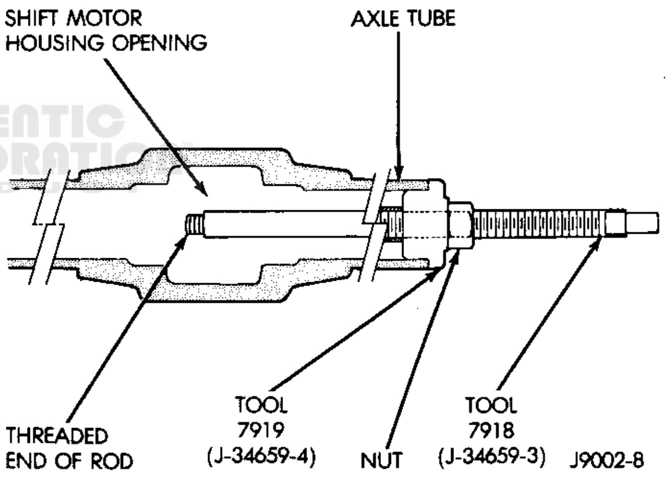


Fig. 57 Threaded Rod Tool In Axle Shaft Tube

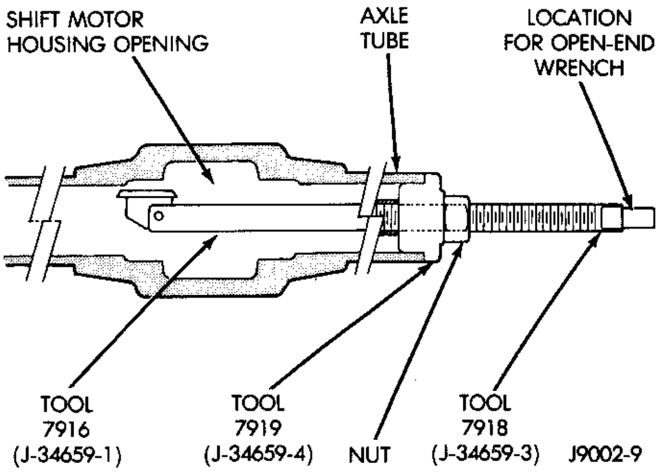


Fig. 58 Axle Shaft Bushing Removal Tool Installed

(6) Ensure that the support guide tool is "seated" in the outer end of the axle shaft tube. Position an open-end wrench on the outer end of the threaded rod tool to prevent it from turning and tighten the nut (at the outer end of the threaded rod tool) against the support guide tool to force the intermediate shaft bushing from the axle shaft tube bore (Fig. 58).

(7) Unthread the bushing removal tool from the threaded rod and remove the tool and the bushing via the shift motor housing opening. **Do not remove the threaded rod tool from the axle shaft tube.**

(8) Thread Bushing And Seal Installation Tool 7917 (J34659-2) tightly onto the end of the threaded rod tool via the shift motor housing opening.

(9) Position the replacement bushing onto the bushing installation tool.

(10) Insert the threaded rod tool (with the installation tool and the replacement bushing) into the intermediate axle shaft tube as far as possible (Fig. 59).

(11) Position the threaded rod tool nut 51 mm or 2 inches away from the support guide tool (Fig. 59).

(12) With the support guide tool "seated" in the outer end of the axle shaft tube, tap the end of the threaded rod tool with a brass hammer to "seat" the intermediate axle shaft bushing in the axle shaft tube bore (Fig. 59).

(13) Withdraw the threaded rod tool and the installation tool from the bushing.

(14) Unthread the installation tool from the threaded rod and remove it via the shift motor housing opening.

(15) Remove the threaded rod tool (with the support guide tool) from the axle shaft tube.

Left-Side Axle Shaft Inner Seal—Command-Trac

The following front axle shaft inner seal replacement procedure is applicable to the **left-side** inner seal for YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).

(1) Pry the original left, inner seal from the axle shaft tube bore in the differential housing and remove it from the differential housing cavity. Clean the seal contact area in the axle shaft tube bore.

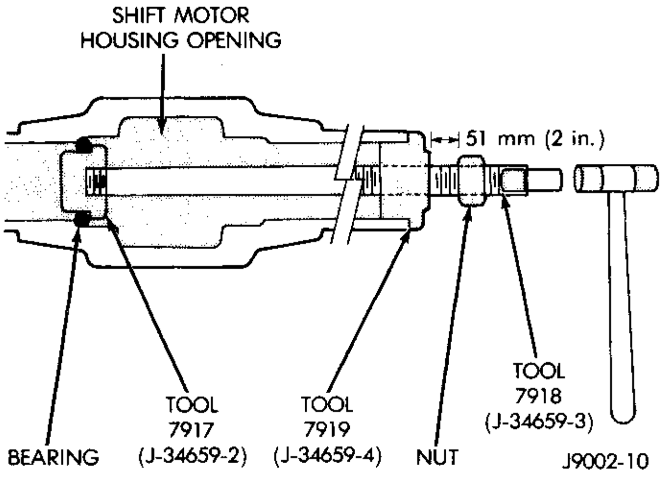


Fig. 59 Intermediate Axle Shaft Bushing Installation

(2) Clean the edge and the inside perimeter of the outer end of the left-side axle shaft tube with fine crocus cloth.

(3) Slide Support Guide Tool 7919 (J34659-4) over Threaded Rod Tool 7918 (J34659-3) and position it near the nut.

(4) Insert the threaded rod tool (with the support guide tool) into the outer end and through the left-side axle shaft tube until the threaded end of the rod is visible at the differential housing opening. Ensure that the support guide tool is "seated" in the outer end of the axle shaft tube.

(5) Apply a light film of lubricant to the inside lip of the replacement axle shaft inner seal.

(6) Position the replacement seal over the threaded rod and in the axle shaft tube bore.

(7) Thread the **reverse** side of Seal Installation Tool 6228-1 onto the threaded rod tool via the differential housing opening. **Ensure that the installation tool is tightly threaded onto the threaded rod tool and that the seal lip has sufficient clearance from the edge of the tool.**

(8) Position an open-end wrench on the outer end of the threaded rod tool to prevent it from rotating and tighten the nut (at the outer end of the threaded rod tool) against the support guide tool to force the replacement axle shaft inner seal into the axle shaft tube bore.

(9) Loosen the threaded rod tool nut.

(10) Insert a drift punch into the hole in the edge of the seal installation tool. While retaining the punch to prevent the seal installation tool from rotating, unthread the threaded rod tool from the seal installation tool.

(11) Remove the seal installation tool via the differential housing opening.

(12) Remove the remaining installation tools from the axle shaft tube.

Left- And Right-Side Axle Shaft Inner Seals—Selec-Trac

The following axle shaft inner seal replacement procedure is applicable to **both** (i.e., left and right) inner seals for MJ/XJ/SJ vehicles equipped with a **Selec-Trac** axle (i.e., a non-disconnect axle).

(1) Pry the original inner seals from the axle shaft tube bores in the differential housing and remove them from the differential housing cavity. Clean the seal contact areas in the axle shaft tube bores.

(2) For MJ/XJ vehicles (Model 30 **Selec-Trac** axles), position the replacement inner seals on Seal Installation Adapter Tools D-112-4. For SJ vehicles (Model 44 Axles), position the replacement seals on Seal Installation Adapter Tools 6473.

(3) Position an installation adapter tool (with seal) over each axle shaft tube bore (Fig. 60).

(4) For MJ/XJ vehicles (Model 30 **Selec-Trac** axles), position Installation Spreader (Turnbuckle) Tool D-112 between the two Seal Installation Aadapter Tools D-112-4 (Fig. 61). For SJ vehicles (Model 44 axles), position Installation Spreader (Turnbuckle) Tool D-112-44 between the two Seal Installation Adapter Tools 6473 (Fig. 61).

(5) Turn the turnbuckle spreader tool with a wrench and force the seals into the axle shaft tube bores until properly "seated".

(6) Remove the installation tools.

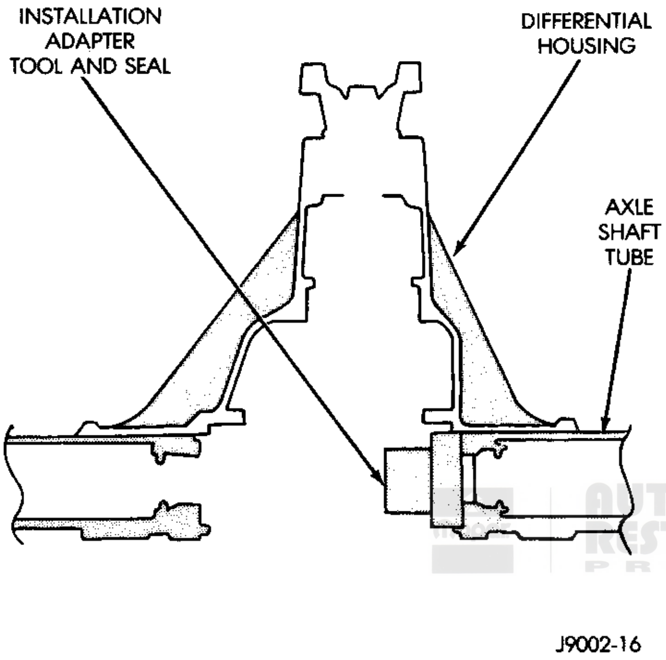


Fig. 60 Adapter Tool & Seal

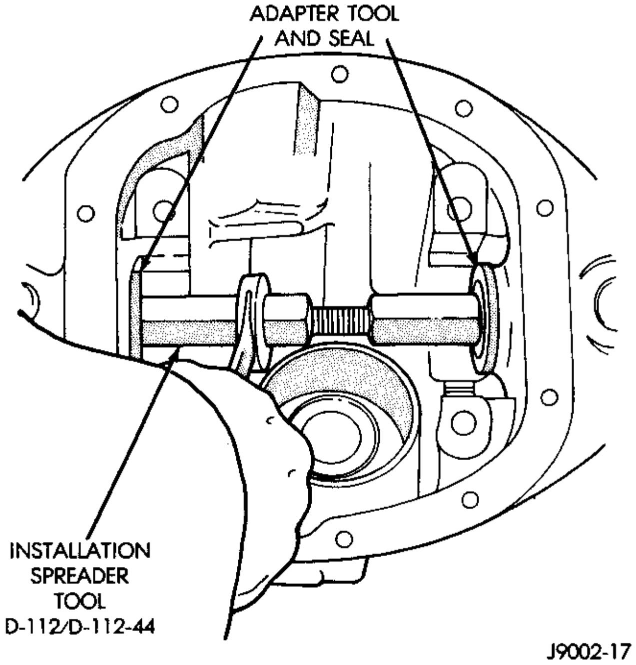


Fig. 61 Inner Seal Installation With Spreader Tool

Differential Assembly And Adjustment Information—All Vehicles

The differential ring and drive pinion gears in Model 30 and Model 44 front axles must be adjusted for the best possible **gear teeth contact patterns.** The drive pinion gear depth cannot be initially measured and "set" precisely with shims. If the original gear set is installed with the original depth shim(s), the **best possible gear teeth contact patterns** are achieved by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If a replacement gear set must be installed, the **best possible gear teeth contact patterns** are achieved by using the Pinion Variance chart to determine the shims necessary to "initially" establish the replacement drive pinion gear depth and then by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If necessary, the differential ring gear and drive pinion gear shaft must be replaced as a "matched set" only. They are identified as a "matched set" by the numbers etched into each gear (Fig. 62).

The identical first two "ID" numbers (Fig. 62) etched into each gear identify them as a "matched set". The second number etched into the drive pinion gear is the depth variance. It indicates the amount (in thousandths of an inch) that the set varied from the standard "setting" of 2.250 inches (57.1 mm) for Model 30 axles and 2.625 inches (66.6 mm) for Model 44 axles. The depth variance can be either a plus (+), zero (0) or a minus (-) value.

If the original gear set is not used, the replacement drive pinion gear **initial** depth shim thickness must be determined before installing the differential in the housing. The depth shim (Fig. 63) is positioned adjacent to the drive pinion gear shaft rear bearing cup.

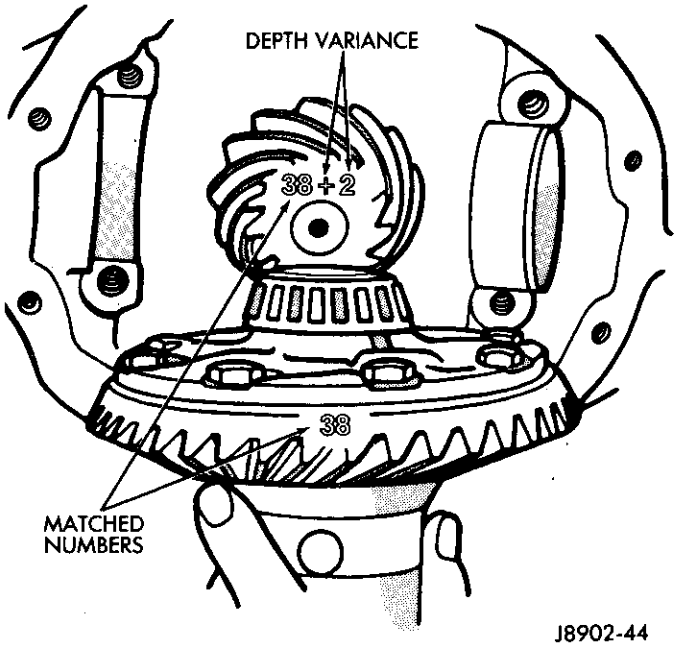


Fig. 62 Matched Ring Gear & Drive Pinion Gear Set

Refer to the Pinion Gear Depth Variance chart for the required initial depth of a replacement drive pinion gear shaft. The chart will aide in determining the depth shim thickness needed for establishing the **initial** depth. **The chart will only help determine the required shim thickness for the initial depth. It will not provide the exact shim thickness necessary to precisely position the pinion gear for the best possible gear teeth contact patterns and must not be used as a substitute for actually analyzing the gear teeth contact patterns and adjusting the drive pinion gear depth and the ring gear "backlash" accordingly.**

To use the chart, proceed according to the following instructions:

- measure the thickness of the original drive pinion gear shaft depth shim(s);
- note the depth variance values etched in the original and the replacement drive pinion gears;
- refer to the Original and Replacement Pinion Gear Depth Variance columns in the chart; and
- locate the chart box where the Original and Replacement Pinion Gear Depth Variance columns intersect for the approximate amount of "change" from the original shim thickness that is required to establish the initial pinion gear depth for the replacement shaft.

For example, if the original drive pinion gear is etched **-3** and the replacement drive pinion gear is etched **+2,** the "initial" shim selection procedure is accomplished according to the following instructions:

- refer to the Original Pinion Gear Depth Variance column at the left side of the chart and locate the **-3** value in this column;
- move to the right across the chart until at the **+2** value in the Replacement Pinion Gear Depth Variance column;
- the box where the two columns intersect will provide the amount of **change** in shim thickness required (i.e., -0.005 inch) for the replacement gear set;
- the value in the intersecting box is -0.005 inch (-0.12 mm), which represents the amount of thickness to be **subtracted** from the original drive pinion gear shaft shim(s);
- if the value was zero (0), the initial shim thickness would be the **same** as the original drive pinion gear shaft shim(s); and
- if the value was positive (+), this amount of thickness would be **added** to the original drive pinion gear shaft shim(s).

CAUTION: Front axle differentials require an oil slinger to be located between the drive pinion gear shaft rear bearing and the drive pinion gear head (Fig. 49, Fig. 50). The slinger must be installed on the shaft to correctly adjust the drive pinion gear shaft depth for the best possible gear teeth contact patterns.

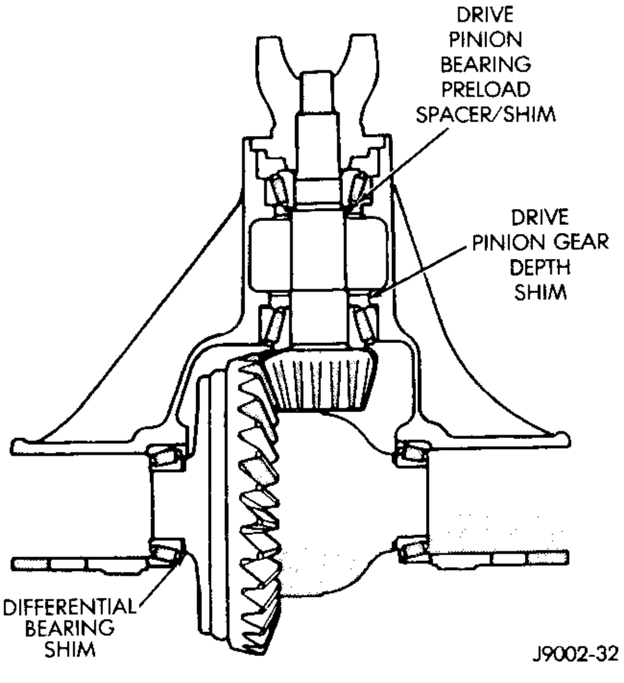


Fig. 63 Depth Shim & Preload Torque Spacer/Shim Locations

Pinion Gear Depth Variance

Original Pinion Gear Depth Variance	Replacement Pinion Gear Depth Variance								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

J8902-46

Differential Assembly—MJ/XJ And YJ Vehicles (Model 30 Axle)

Drive Pinion Gear Shaft—Assembly And Installation

(1) If applicable, verify that the replacement ring gear and drive pinion gear shaft are a "matched set" before proceeding.

(2) If the original ring gear and drive pinion gear shaft set is being installed, use the original depth shim(s).

(3) If a replacement ring gear and drive pinion gear set is being installed, determine the amount of "thickness" that must be either added to or subtracted from the original depth shim(s) to initially establish the drive pinion gear depth:

- note the depth variance etched in the original and the replacement drive pinion gear;
- refer to the Pinion Gear Depth Variance chart and move to the box where the Original and Replacement Pinion Gear Depth Variance columns intersect; and
- note the value in the box, it will be either a plus (+), zero (0) or a minus (-) value of **change** required from the original shim thickness so that it can be used with the replacement gear set.

(4) Clean the bearing cup bores in the differential housing.

(5) Install the "initial" depth shim(s) in the housing rear bearing cup bore (Fig. 49).

If a depth shim is chamfered on one side, position the chamfered side so that it faces the bottom of the bearing cup bore.

(6) Install the drive pinion gear shaft rear bearing cup in the housing and adjacent to the initial depth shim (Fig. 49).

(7) Install the drive pinion gear shaft front bearing cup in the housing (Fig. 49).

(8) Install the oil slinger on the drive pinion gear shaft (Fig. 49).

(9) Install the rear bearing on the drive pinion gear shaft (Fig. 49) with Bearing Installation Tool 7699 (J24433).

(10) Install the drive pinion gear shaft in the housing (Fig. 49).

Do not install the bearing "preload" torque spacer at this time.

(11) Install the front bearing on the drive pinion gear shaft (Fig. 49). "Seat" the bearing on the shaft and in the cup.

Do not install the drive pinion gear shaft replacement seal at this time.

(12) Install the drive pinion gear shaft (axle) yoke and the original nut on the drive pinion gear shaft (Fig. 49). Tighten the nut only enough to remove the shaft "end play".

(13) Proceed to Differential Case Flange Runout Measurement.

Differential Case Flange Runout Measurement

(1) Install the bearings on the differential case hubs with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092). Do not install the bearing shims at this time (Fig. 64).

(2) Observe the reference marks and install the bearing cups on the bearings.

(3) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(4) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(5) Separate the differential housing only enough to install the differential case. Separate the differential housing a **maximum distance of 0.50 mm (0.02 in)** with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated.

(6) Remove the dial indicator when the differential housing has been separated sufficiently to remove the case.

(7) Position the differential case in the housing.

(8) Remove the spreader tool and the holddown clamps immediately after removing the differential case. **This is important to avoid the possibility of the housing acquiring a different "set".**

(9) Insert enough spare shims between one of the differential bearings and the housing to eliminate all differential case "side play".

(10) Observe the installation reference marks and install the differential bearing caps and bolts (Fig. 65). Tighten the bolts securely (no specified torque).

(11) Attach a dial indicator to the housing. Position the dial indicator plunger so that it contacts the ring gear mating face on the differential case (Fig. 65).

(12) Pry the differential case to one side and "zero" the dial indicator pointer.

(13) Rotate the differential case several times and note the dial indicator pointer position as the case rotates.

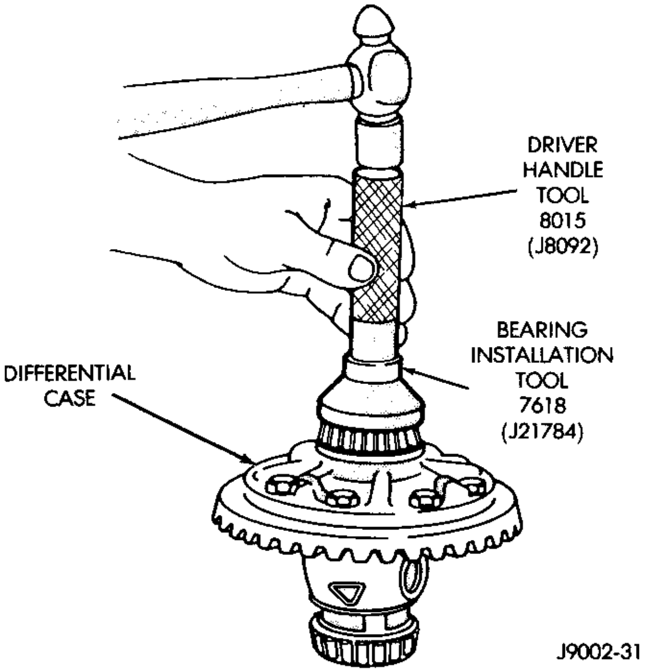


Fig. 64 Differential Bearing Installation

(14) The differential case flange "runout" should not exceed 0.002 inch or 0.05 mm. Replace the case if the "runout" exceeds the specified limit.

(15) Retain the dial indicator at this position and proceed to differential bearing Zero End-Play Adjustment.

Zero End-Play Adjustment

(1) Loosen the differential bearing cap bolts at both sides of the differential case.

(2) Remove the spare shims that were used to eliminate the differential case "side play" and retain the differential case in the same position as it was for the "runout" measurement.

(3) Install a 0.142-inch or 3.6-mm thick shim between each differential bearing and the housing (Fig. 66). These shims will provide an "end-play" "coarse" adjustment.

(4) Pry the differential case to one side of the housing and "zero" the dial indicator pointer while at this location.

(5) Pry the differential case to the opposite side of the housing and record the dial indicator "end-play" (distance) measurement. The distance measurement is the **additional** shim thickness required for differential bearing "zero" "end play".

(6) For example, if the "end play" (distance) measurement is 0.008 inch or 0.20 mm, an additional 0.004-inch or 0.10-mm thick shim will be necessary at each side of the housing for differential bearing "zero" "end play".

(7) Obtain the necessary differential bearing "zero" "end-play" shims, set them aside and reserve them for installation later.

(8) Remove the dial indicator from the housing.

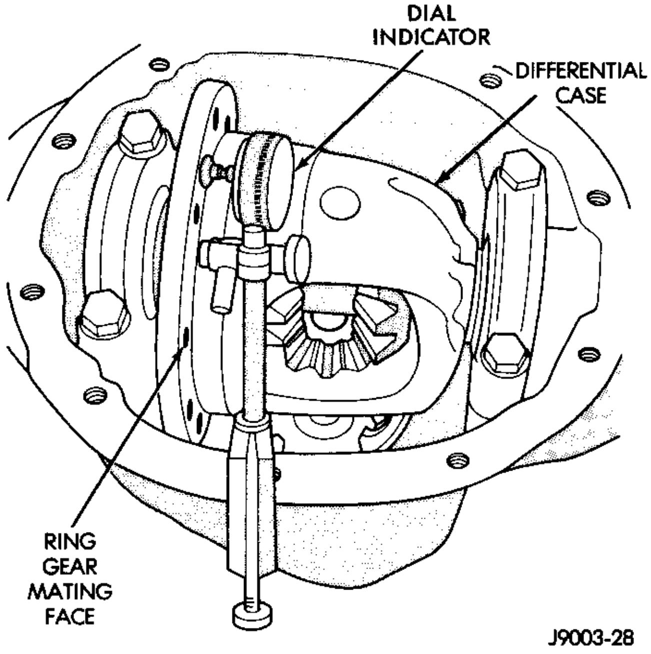


Fig. 65 Differential Case Flange Runout Measurement

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.50 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the spreader tool and the holddown clamps immediately after removing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(9) Install the spreader tool and remove the differential case from the housing and proceed to Differential Case Component—Assembly.

Differential Case Component—Assembly

(1) Install the side gears with their thrust washers and the pinion gears with their thrust washers in the differential case (Fig. 49). **Install replacement side-gear thrust washers if the measurement during disassembly or the inspection after disassembly indicated that they were not within tolerance or otherwise non-usable.**

(2) Measure the side-gear clearance (Fig. 67). If the clearance exceeds 0.007 inch or 0.18 mm per side with the original thrust washers installed, replace the thrust washers. If the clearance exceeds 0.007 inch or 0.18 mm per side with replacement thrust washers installed, replace the side gears.

(3) Install the pinion gear mate shaft and the lockpin (Fig. 49) in the differential case.

(4) Mark the differential bearing cups for installation reference and remove them.

CAUTION: When removing a differential bearing, ensure that the differential case is securely clamped or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

(5) Install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and bearing (Fig. 68). If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(6) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(7) Tighten the puller tool or removal tool screw (Fig. 68) and remove the bearing from the differential case hub.

Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

(8) Install the previously reserved "zero" "end-play" shims on each of the differential case hubs.

(9) Observe the installation reference marks and install the differential bearings and cups on the case hubs (Fig. 64).

(10) Align and position the ring gear on the differential case (Fig. 49).

Do not reuse the original ring gear bolts, install replacement bolts only.

(11) Install **replacement** ring gear bolts. Tighten the bolts alternately and evenly with 75 N•m (55 ft-lbs) torque.

(12) Proceed to Ring Gear Backlash And Drive Pinion Gear Depth Adjustment.

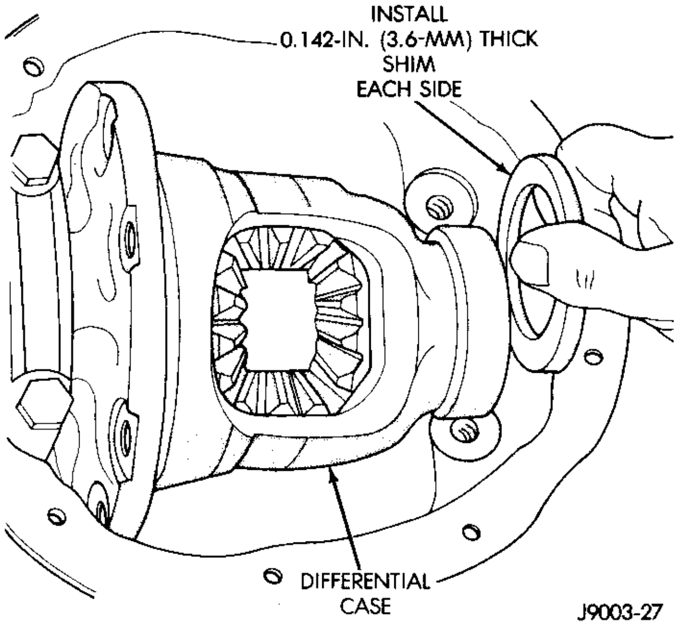


Fig. 66 Differential Bearing Shim Installation

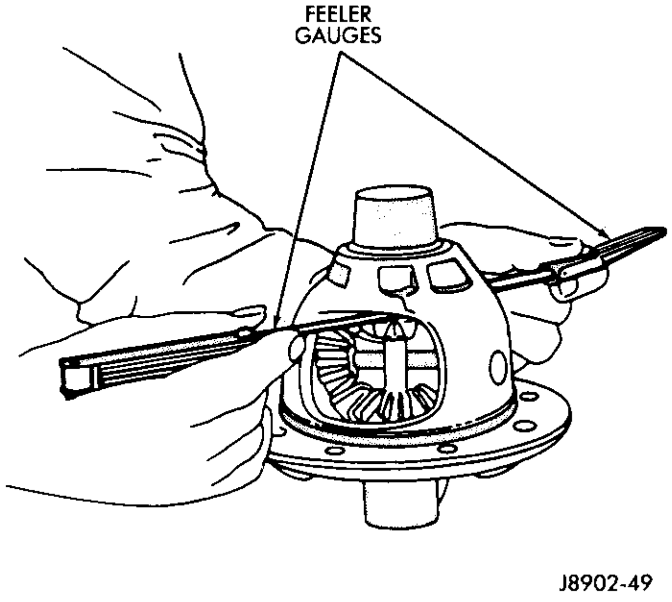


Fig. 67 Differential Side-Gear Clearance Measurement

Ring Gear Backlash And Drive Pinion Gear Depth Adjustment

The ring and the drive pinion gears must be adjusted for the **best possible teeth contact patterns**. The gear tooth nomenclature is illustrated in Figure 69.

The "toe" is the part of the gear tooth that is the closest to the inside perimeter of the gear. The "heel" is the part of the gear tooth that is the closest to the outside perimeter of the gear (Fig. 69).

The "drive" side of the ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin engagement and then mesh. The "coast" side of ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin disengagement and continues until they exit.

Obtaining the best possible gear teeth contact patterns involves adjusting the depth position of the drive pinion gear "in-or-out" (in respect to the ring gear) and adjusting the position of the ring gear "in-or-out" (in respect to the drive pinion gear) until the ring gear "backlash" is acceptable and the best possible teeth contact patterns are achieved.

The drive pinion gear depth position is adjusted by changing the size (i.e., thickness) of the depth shim(s) located beneath the rear bearing cup (Fig. 70). The ring gear position (i.e., the gear "backlash") is adjusted by changing the side-to-side thickness of the differential bearing shims.

When replacing shims to adjust the ring gear "backlash" and the drive pinion gear depth position, restrict the increment of each size change to within the range of 0.002 - 0.004 inch or 0.05 - 0.10 mm. Also, remember that the two adjustment variables are interdependent (i.e., simultaneously involved); consequently, they interact. For example, if the ring gear "backlash" is acceptable but the pinion gear depth position is then changed to obtain better teeth contact patterns, the ring gear "backlash" will probably have to be readjusted because of the interaction.

(1) Apply yellow ferrous (iron) oxide compound to both (drive and coast) sides of the ring gear teeth.

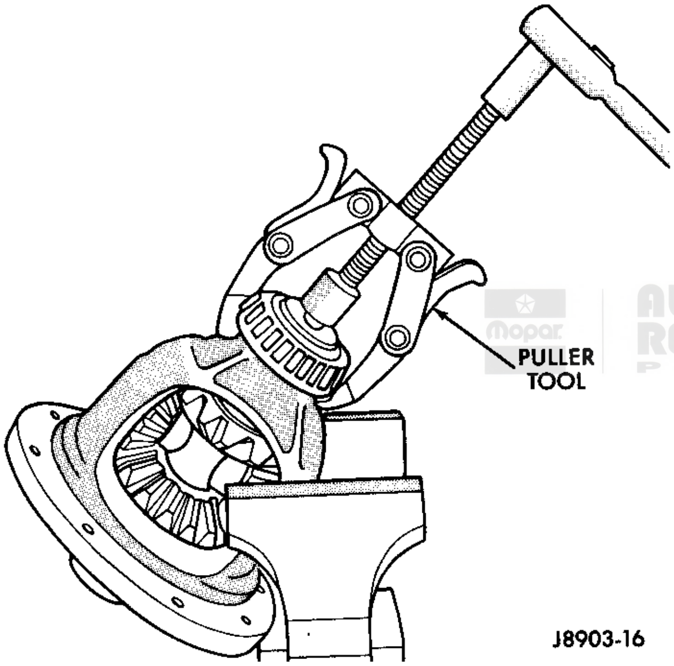


Fig. 68 Differential Bearing Removal

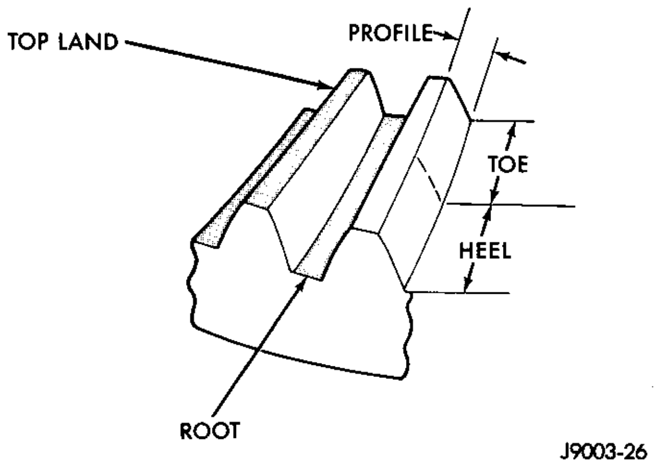


Fig. 69 Gear Tooth Nomenclature

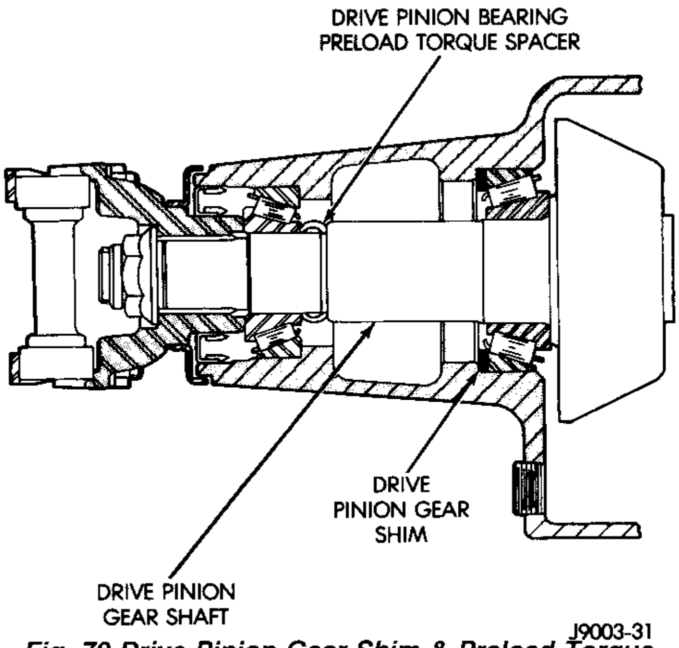


Fig. 70 Drive Pinion Gear Shim & Preload Torque Spacer

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/ install the differential case. Separate the differential housing a maximum distance of 0.50 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the spreader tool and the holddown clamps immediately after installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(2) Install the differential case in the housing (with the spreader tool). Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them (Fig. 71). Observe the installation reference marks and install the bearing caps. Tighten the bolts securely.

(3) Attach a dial indicator to the housing. Position the indicator plunger against the "drive" side of one ring gear tooth. Ensure that the plunger is at a right angle (90°) to the tooth (Fig. 72).

(4) Pry the ring gear toward the dial indicator and "zero" the dial indicator pointer while at this position.

(5) Pry the ring gear away from the drive pinion gear until the gear "backlash" indicated on the dial indicator is 0.005 - 0.009 inch or 0.13 - 0.23 mm.

(6) Temporarily insert shims between one differential bearing (nearest to the ring gear) and the housing to maintain the established gear "backlash" during the remainder of the adjustment.

(7) Move the dial indicator aside and, if necessary, apply yellow ferrous (iron) oxide compound to the ring gear teeth.

(8) Rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(9) Note the teeth contact patterns imprinted in the ferrous (iron) oxide compound. Refer to Figure 73 for interpretation of the gear teeth contact patterns and proceed to the next step.

(10) Analyze the gear teeth contact patterns for corrective action and, if necessary, use the following information to correct the gear positions:

- decreasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly lower and toward the "toe" (Fig. 69) of the gear tooth;
- increasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly higher and toward the "heel" (Fig. 69) of the gear tooth;
- inserting a **thicker** depth shim will move the pinion gear closer to the ring gear;
- this will cause the "drive" side teeth contact patterns to move lower and slightly toward the "toe" (Fig. 69) of the tooth and cause the "coast" side teeth contact patterns to move lower and slightly toward the "heel" (Fig. 69) of the tooth;
- inserting a **thinner** depth shim will move the pinion gear away from ring gear; and
- this will cause the "drive" side teeth contact patterns to move higher and toward the "heel" (Fig. 69) of the tooth and cause the "coast" side teeth contact patterns to move higher and toward the "toe" (Fig. 69) of the tooth.

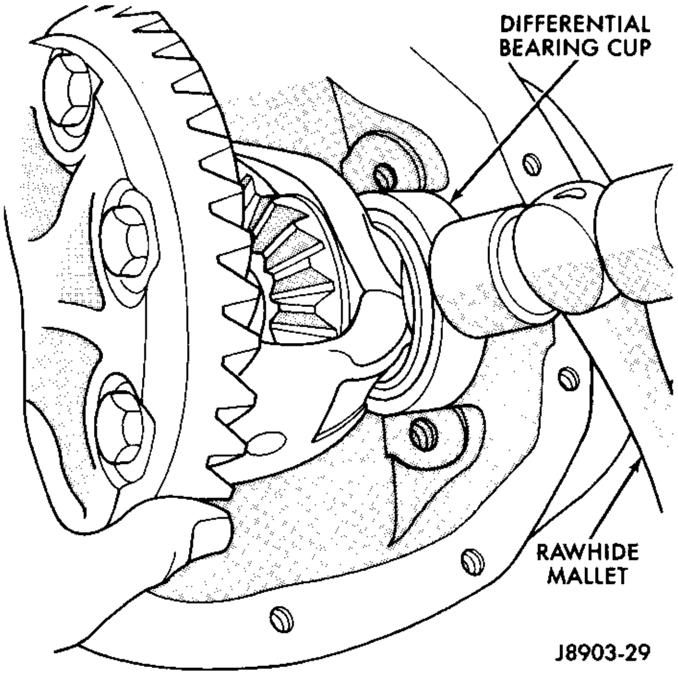


Fig. 71 Seating Differential Bearing Cups

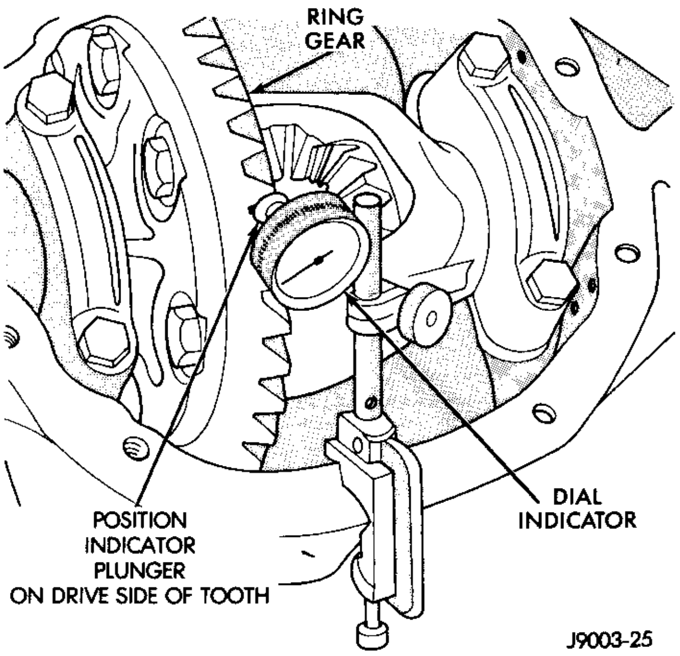
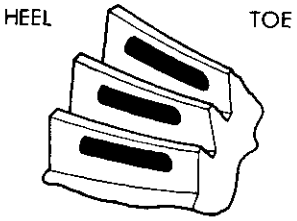
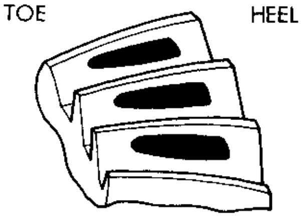
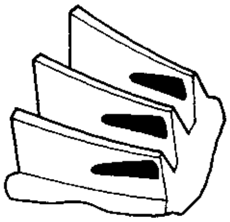
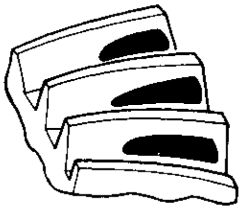
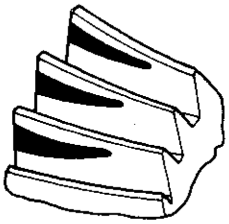
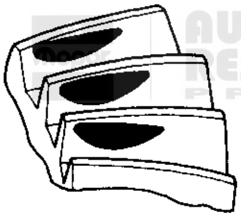
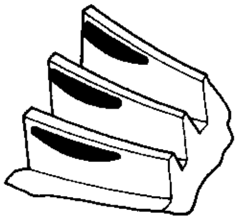
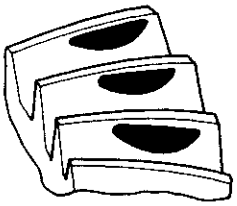
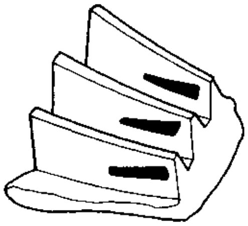
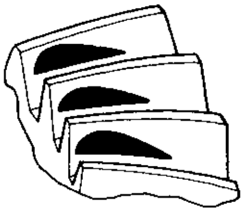


Fig. 72 Ring Gear Backlash Measurement

DRIVE SIDE OF RING GEAR TEETH	COAST SIDE OF RING GEAR TEETH	
		DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.
		RING GEAR BACKLASH CORRECT. **THINNER** PINION GEAR DEPTH SHIM REQUIRED.
		RING GEAR BACKLASH CORRECT. **THICKER** PINION GEAR DEPTH SHIM REQUIRED.
		PINION GEAR DEPTH SHIM CORRECT. **DECREASE** RING GEAR BACKLASH.
		PINION GEAR DEPTH SHIM CORRECT. **INCREASE** RING GEAR BACKLASH.

J9003-24

Fig. 73 Gear Teeth Contact Patterns

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.50 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the spreader tool and the holddown clamps immediately after removing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(11) Install the spreader tool, remove the differential case and remove the drive pinion gear shaft. Replace the shims as necessary to adjust the gear positions for the best possible gear teeth contact patterns and an acceptable ring gear "backlash".

To increase the ring gear "backlash", decrease the shim thickness at the ring gear side of the housing. To decrease the ring gear "backlash", increase the shim thickness at the ring gear side of the housing.

(12) Install the drive pinion gear shaft and the differential case (with the spreader tool). Refer to the **CAUTION** listed above.

(13) Re-apply yellow ferrous (iron) oxide compound to both sides of the ring gear teeth and rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(14) Analyze the gear teeth contact patterns and, if necessary, re-adjust the gear positions.

(15) Proceed to Drive Pinion Gear Bearing Preload Torque Adjustment.

Drive Pinion Gear Bearing Preload Torque Adjustment

A tension-type spacer maintains the drive pinion gear bearing "preload" torque (Fig. 70). The "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft. The drive pinion gear shaft/axle yoke nut is used to adjust the "preload" torque. The spacer is designed to compress and maintain the "preload" torque after it is established by adjustment.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.50 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the spreader tool and the holddown clamps immediately after removing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(1) Install Differential Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing and remove the differential case (Fig. 49). Remove the ferrous (iron) oxide compound from the ring gear.

(2) Remove the differential bearing cups, the bearings and the shims (Fig. 49). Install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and bearing to remove the bearings. **Do not intermix the shims. Mark or tag them for installation reference.**

(3) If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(4) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(5) Tighten the puller tool or removal tool screw and remove the bearing from the differential case hub.

(6) Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

(7) Remove the drive pinion gear shaft (Fig. 49).

(8) Install a replacement bearing "preload" torque spacer on the drive pinion gear shaft (Fig. 49).

(9) Install the drive pinion gear shaft in the housing (Fig. 49).

(10) Apply gear lubricant to the lip and install a replacement seal on the drive pinion gear shaft (Fig. 49) with Seal Installation Tool D-163.

(11) Install the axle yoke on the drive pinion gear shaft.

The correct drive pinion gear bearing "preload" torque with replacement bearings is 2 - 5 N·m or 20 - 40 in-lbs. The correct drive pinion gear bearing "preload" torque with original bearings is 2 - 3 N·m or 15 - 25 in-lbs. The "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft (with a Newton-meter or an inch-pound torque wrench).

(12) Install a replacement nut on the drive pinion gear shaft. **Tighten the nut only enough to remove the "end play". Do not over-tighten it.**

(13) Place a socket wrench on the nut. Rotate the shaft with a Newton-meter or an inch-pound torque wrench and note the indicated torque.

CAUTION: The bearing "preload" torque spacer will permanently compress and maintain the established "preload" torque. If the specified "preload" torque is exceeded, do not attempt correction by loosening and re-tightening the drive pinion gear shaft/axle yoke nut. If the nut is over-tightened, the drive pinion gear shaft must be removed, the "preload" spacer replaced, the drive pinion gear shaft installed and the "preload" torque adjusted again.

(14) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and slowly tighten the nut in small increments until the torque required to rotate the drive pinion gear shaft is in the range of 2 - 3 N•m or 15 - 25 in-lbs. Measure the "preload" torque frequently to avoid over-tightening the nut.

(15) Proceed to Differential Bearing Preload Shim Installation.

Differential Bearing Preload Shim Installation

Before installing the differential case, the differential bearings must be "preloaded" with additional shims to compensate for the heat accumulation and the engine torque load during vehicle operation.

(1) Note the installation reference marks (or tags) and install the originally selected differential bearing shims on each case hub.

(2) Add an additional 0.004-inch or 0.1-mm thick shim to **each** case hub.

(3) Install the differential bearings on the case hubs (Fig. 74) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092).

Differential Case Installation

(1) Lubricate the bearings, gears and thrust washers with axle lubricant.

(2) Install Differential Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(3) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified 0.5-mm (0.02-in) separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) Separate the differential housing only enough to install the differential case. Separate the differential housing a **maximum distance of 0.5 mm (0.02 in)** with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated.

(5) Remove the dial indicator when the differential housing has been separated sufficiently to remove the case.

(6) Observe the installation reference marks and install the bearing cups on the differential bearings.

(7) Install the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them (Fig. 75).

(8) Remove Differential Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(9) Observe the reference marks and install the differential bearing caps. Tighten the cap bolts with 77 N•m or 57 ft-lbs torque.

(10) Measure the ring gear "backlash". If it has changed, it must be readjusted.

Differential Assembly—SJ Vehicles (Model 44 Axle)

Differential Case Component—Assembly

(1) Install the side gears with their thrust washers and the pinion gears with their thrust washers in the differential case (Fig. 50). **Install replacement side-gear thrust washers if inspection after disassem-**

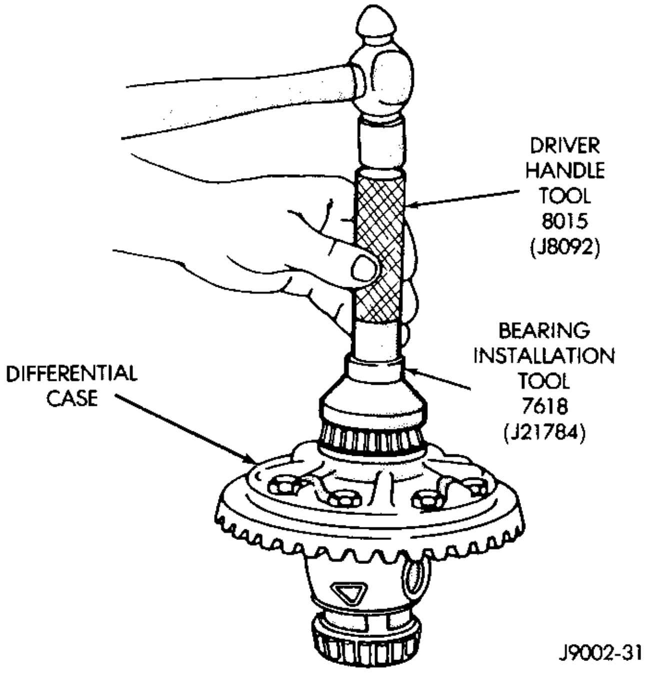


Fig. 74 Differential Bearing Installation

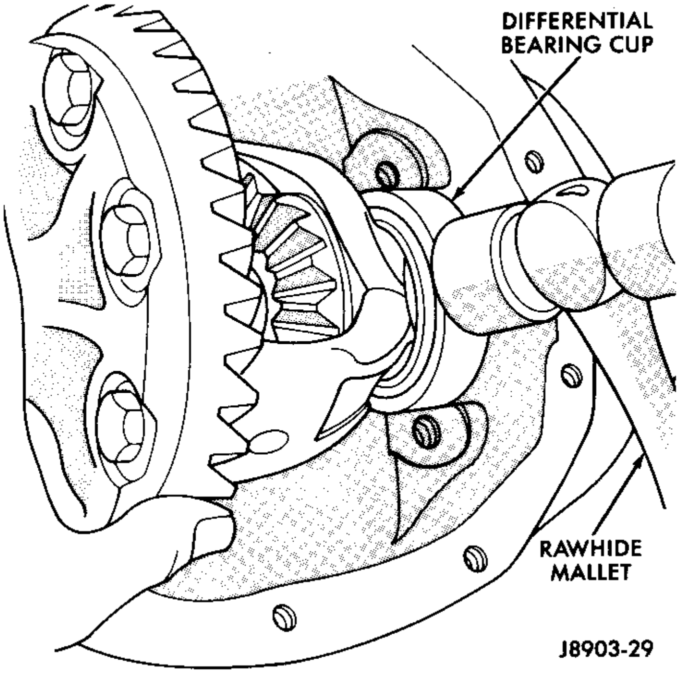


Fig. 75 Seating Differential Bearing Cups

bly indicated that they were not within tolerance or otherwise non-usable.

(2) Measure the side-gear clearance (Fig. 76). If the clearance exceeds 0.007 inch or 0.18 mm per side with the original thrust washers installed, replace the thrust washers. If the clearance exceeds 0.007 inch or 0.18 mm per side with replacement thrust washers installed, replace the side gears.

(3) Install the pinion gear mate shaft and the lockpin (Fig. 50) in the differential case.

(4) Assemble the original differential bearing shim set and remove 0.02 inch (0.5 mm) shim thickness from each set. The shims remaining in each set will be used as the "initial" sets.

(5) Install an "initial" shim set and the bearing on each differential case bearing hub. Use Differential Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092) to install the bearings.

(6) Observe the installation reference marks and install the differential bearing cups on the case hubs.

(7) Align and position the ring gear on the differential case (Fig. 50).

Do not reuse the original ring gear bolts, install replacement bolts only.

(8) Install **replacement** ring gear bolts. Tighten the bolts alternately and evenly with 75 N•m (55 ft-lbs) torque.

Drive Pinion Gear Shaft—Assembly And Installation

(1) If applicable, verify that the replacement ring gear and drive pinion gear shaft are a "matched set" before proceeding. **The depth variance with replacement gear sets can range from plus-to-minus 0.004 inch (0.1 mm). A replacement gear set with a variance that is not within this range, or a set with mismatched gears, must not be installed.**

(2) If the original ring gear and drive pinion gear shaft set is being installed, use the original depth shim(s).

(3) If a replacement ring gear and drive pinion gear set is being installed, determine the amount of "thickness" that must be either added to or subtracted from the original depth shim(s) to **initially** establish the drive pinion gear depth:

- note the depth variance etched in the original and the replacement drive pinion gear;
- refer to the Pinion Gear Depth Variance chart and move to the box where the Original and Replacement Pinion Gear Depth Variance columns intersect; and
- note the value in the box, it will be either a plus (+), zero (0) or a minus (-) value of **change** required from the original shim thickness so that it can be used with the replacement gear set.

(4) Clean the bearing cup bores in the differential housing.

(5) Install the initial depth shim(s) in the housing rear bearing cup bore (Fig. 50).

If a depth shim is chamfered on one side, position the chamfered side so that it faces the bottom of the bearing cup bore.

(6) Install the drive pinion gear shaft rear bearing cup in the housing and adjacent to the initial depth shim(s) (Fig. 77). Use an appropriate tool.

(7) Install the drive pinion gear shaft front bearing cup in the housing (Fig. 50).

(8) Install the rear bearing on the drive pinion gear shaft with an appropriate bearing installation tool (Fig. 78).

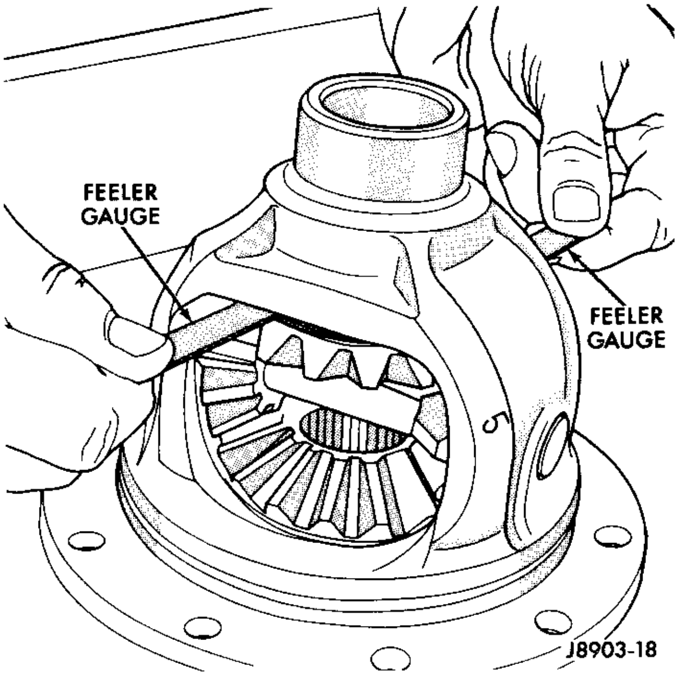


Fig. 76 Differential Side-Gear Clearance Measurement

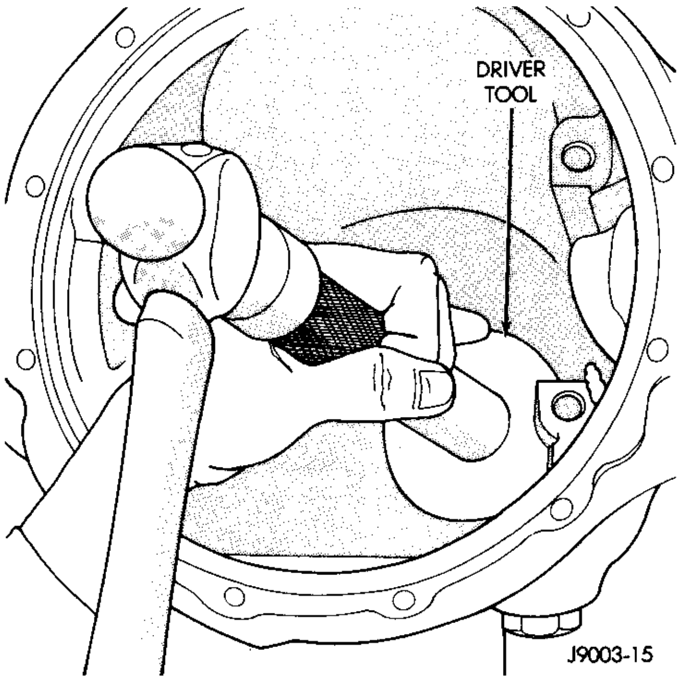


Fig. 77 Rear Bearing Cup Installation

(9) Install the drive pinion gear shaft in the housing (Fig. 50).

Do not install the bearing "preload" torque shims at this time.

(10) Install the front bearing on the drive pinion gear shaft (Fig. 50). "Seat" the bearing on the shaft and in the cup.

Do not install the drive pinion gear shaft replacement seal and the oil slinger at this time.

(11) Install the dust cap (Fig. 50).

(12) Install the drive pinion gear shaft (axle) yoke, the washer and the original nut on the drive pinion gear shaft (Fig. 50). Tighten the nut only enough to remove the shaft "end play".

(13) Proceed to Ring Gear Backlash And Drive Pinion Gear Depth Adjustment.

Ring Gear Backlash And Drive Pinion Gear Depth Adjustment

The ring and the drive pinion gears must be adjusted for the **best possible teeth contact patterns**. The gear tooth nomenclature is illustrated in Figure 79.

The "toe" is the part of the gear tooth that is the closest to the inside perimeter of the gear. The "heel" is the part of the gear tooth that is the closest to the outside perimeter of the gear (Fig. 79).

The "drive" side of the ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin engagement and then mesh. The "coast" side of ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin disengagement and continues until they exit.

Obtaining the best possible gear teeth contact patterns involves adjusting the depth position of the drive pinion gear "in-or-out" (in respect to the ring gear) and adjusting the position of the ring gear "in-or-out" (in respect to the drive pinion gear) until the ring gear "backlash" is acceptable and the best possible teeth contact patterns are achieved.

The drive pinion gear depth position is adjusted by changing the size (i.e., thickness) of the depth shim(s) located beneath the rear bearing cup (Fig. 80). The ring gear position (i.e., the gear "backlash") is adjusted by changing the side-to-side thickness of the differential bearing shims.

When replacing shims to adjust the ring gear "backlash" and the drive pinion gear depth position, restrict the increment of each size change to within the range of 0.002 - 0.004 inch or 0.05 - 0.10 mm. Also, remember that the two adjustment variables are interdependent (i.e., simultaneously involved); consequently, they interact. For example,

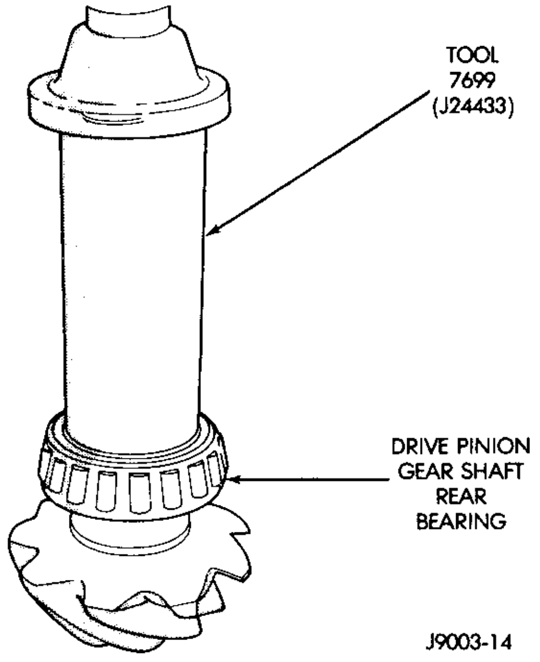


Fig. 78 Rear Bearing Installation

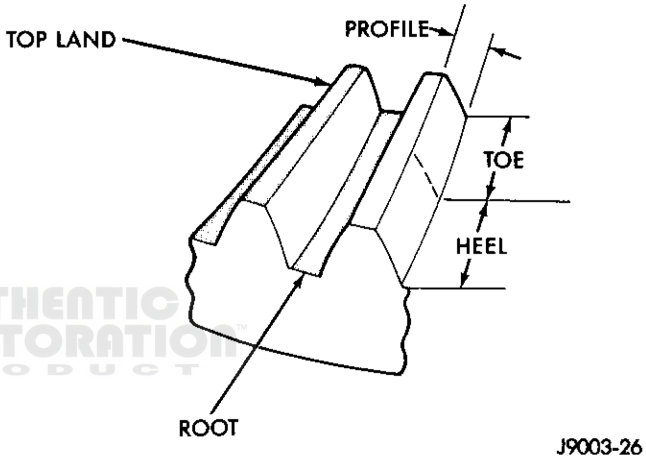


Fig. 79 Gear Tooth Nomenclature

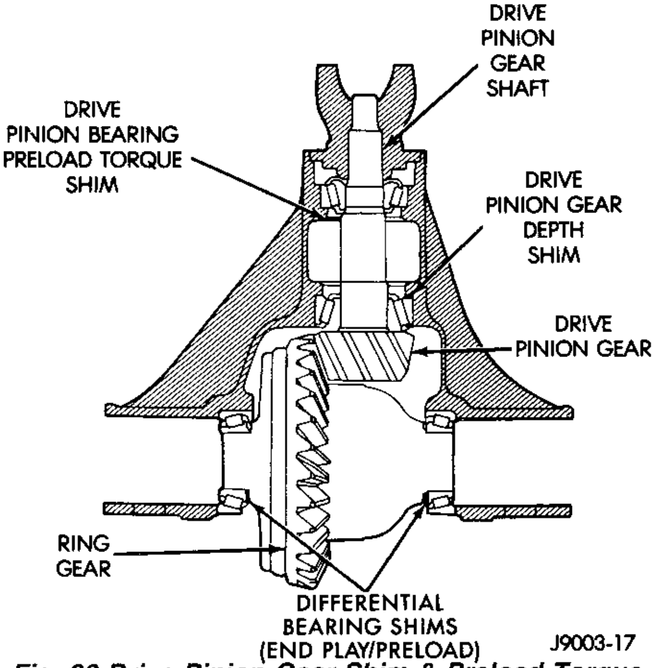


Fig. 80 Drive Pinion Gear Shim & Preload Torque Shim

if the ring gear "backlash" is acceptable but the pinion gear depth position is then changed to obtain better teeth contact patterns, the ring gear "backlash" most likely will have to be re-adjusted because of the interaction.

(1) Apply yellow ferrous (iron) oxide compound to both (drive and coast) sides of the ring gear teeth.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/ install the differential case. Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the spreader tool and the holddown clamps immediately after installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(2) Install the differential case in the housing with Differential Spreader Tool 7693 (J24385-01) and the holddown clamps. Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them (Fig. 81). Observe the installation reference marks and install the bearing caps. Tighten the bolts securely.

(3) Attach a dial indicator to the housing. Position the indicator plunger against the "drive" side of one ring gear tooth. Ensure that the plunger is at a right angle (90°) to the tooth (Fig. 82).

(4) Pry the ring gear toward the dial indicator and "zero" the dial indicator pointer while at this position.

(5) Pry the ring gear away from the drive pinion gear until the gear "backlash" indicated on the dial indicator is 0.005 - 0.009 inch or 0.13 - 0.23 mm.

(6) Temporarily insert shims between one differential bearing (nearest to the ring gear) and the housing to maintain the established gear "backlash" during the remainder of the adjustment.

(7) Move the dial indicator aside and, if necessary, apply yellow ferrous (iron) oxide compound to the ring gear teeth.

(8) Rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(9) Note the teeth contact patterns imprinted in the ferrous (iron) oxide compound. Refer to Figure 83 for interpretation of the gear teeth contact patterns and proceed to the next step.

(10) Analyze the gear teeth contact patterns for corrective action and, if necessary, use the following information to correct the gear positions:

- decreasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly lower and toward the "toe" (Fig. 79) of the gear tooth;
- increasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly higher and toward the "heel" (Fig. 79) of the gear tooth;
- inserting a **thicker** depth shim will move the pinion gear closer to the ring gear;
- this will cause the "drive" side teeth contact patterns to move lower and slightly toward the "toe" (Fig. 79) of the tooth and cause the "coast" side teeth contact patterns to move lower and slightly toward the "heel" (Fig. 79) of the tooth;

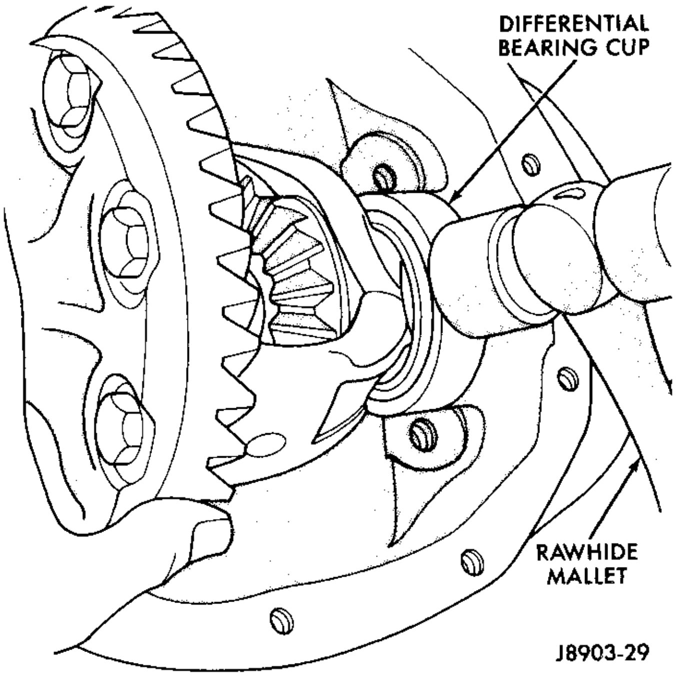


Fig. 81 Seating Differential Bearing Cups

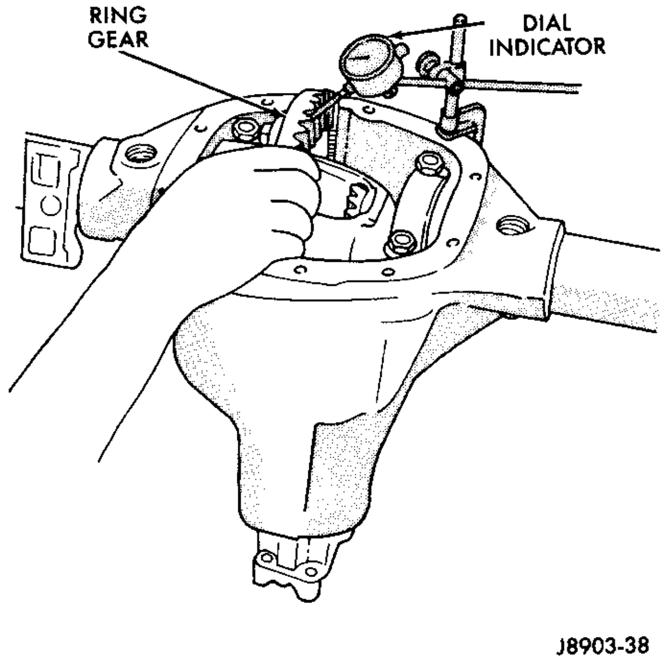
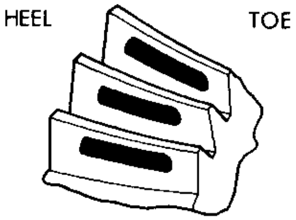
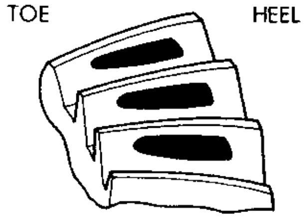
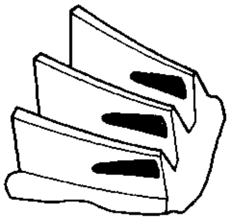
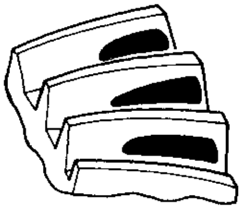
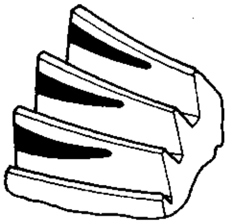
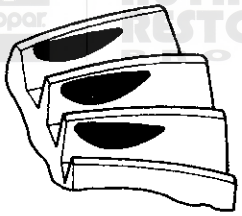
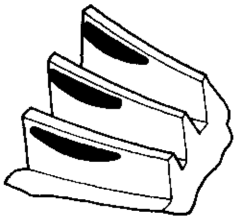
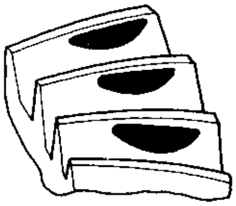
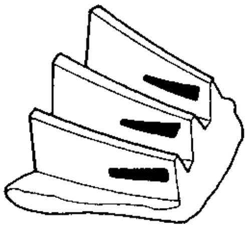
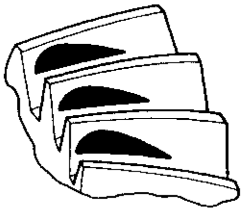


Fig. 82 Ring Gear Backlash Measurement

DRIVE SIDE OF RING GEAR TEETH	COAST SIDE OF RING GEAR TEETH	
		DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.
		RING GEAR BACKLASH CORRECT. **THINNER** PINION GEAR DEPTH SHIM REQUIRED.
		RING GEAR BACKLASH CORRECT. **THICKER** PINION GEAR DEPTH SHIM REQUIRED.
		PINION GEAR DEPTH SHIM CORRECT. **DECREASE** RING GEAR BACKLASH.
		PINION GEAR DEPTH SHIM CORRECT. **INCREASE** RING GEAR BACKLASH.

J9003-24

Fig. 83 Gear Teeth Contact Patterns

- inserting a **thinner** depth shim will move the pinion gear away from ring gear; and
- this will cause the "drive" side teeth contact patterns to move higher and toward the "heel" (Fig. 79) of the tooth and cause the "coast" side teeth contact patterns to move higher and toward the "toe" (Fig. 79) of the tooth.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the spreader tool and the holddown clamps immediately after removing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(11) Install the spreader tool, remove the differential case and remove the drive pinion gear shaft. Replace the shims as necessary to adjust the gear positions for the best possible gear teeth contact patterns and an acceptable ring gear "backlash".

To increase the ring gear "backlash", decrease the shim thickness at the ring gear side of the housing. To decrease the ring gear "backlash", increase the shim thickness at the ring gear side of the housing.

(12) Install the drive pinion gear shaft and the differential case. Use the spreader tool to separate the housing. Refer to the **CAUTION** listed above.

(13) Re-apply yellow ferrous (iron) oxide compound to both sides of the ring gear teeth and rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(14) Analyze the gear teeth contact patterns (Fig. 83) and, if necessary, re-adjust the gear positions.

(15) Proceed to Drive Pinion Gear Bearing Preload Torque Adjustment.

Drive Pinion Gear Bearing Preload Torque Adjustment

Shims are used to maintain the drive pinion gear bearing "preload" torque (Fig. 80). The "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the case. Remove the spreader tool and the holddown clamps immediately after removing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(1) Install Differential Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case (Fig. 50). Remove the ferrous (iron) oxide compound from the ring gear.

(2) Remove the drive pinion gear shaft (Fig. 50).

(3) Install the original "preload" torque shim(s) on the shaft (Fig. 50).

(4) Install the drive pinion gear shaft in the housing (Fig. 50).

(5) Install the front bearing, the oil slinger, the dust cap, the yoke, the washer and the original shaft nut (Fig. 50).

(6) Use a holding tool and tighten the shaft nut with 271 N•m or 200 ft-lbs torque (minimum).

The correct drive pinion gear bearing "preload" torque with replacement bearings is 2 - 5 N•m or 20 - 40 in-lbs. The correct drive pinion gear bearing "preload" torque with original bearings is 1 - 2 N•m or 10 - 20 in-lbs. The bearing "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft (with a Newton-mwter or an inch-pound torque wrench).

(7) Place a socket wrench on the shaft nut. Rotate the shaft with a Newton-meter or an inch-pound torque wrench and note the indicated "preload" torque.

(8) If not correct, add shims to increase the "preload" torque and remove shims to decrease the "preload" torque.

(9) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and remove the original shaft nut and the washer from the shaft. Remove the yoke from the shaft. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke from the shaft. Remove the dust cap and the seal from the shaft. Discard the original nut and the seal.

(10) Lubricate the drive pinion gear shaft replacement seal lip with gear lubricant.

(11) Install the replacement seal on the drive pinion gear shaft with Seal Installation Tool 6272 (J22661).

(12) Install the dust cap, the yoke, the washer and the replacement shaft nut (Fig. 50).

(13) Place Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and tighten the shaft nut with 271 N•m or 200 ft-lbs torque (minimum).

(14) Proceed to Differential Bearing Preload Shim Installation.

Differential Bearing Preload Shim Installation

Before installing the differential case, the differential bearings must be "preloaded" with additional shims to compensate for the heat accumulation and the engine torque "load" during vehicle operation.

(1) Remove the differential bearing cup and bearing that are located on the **opposite** side of the case from the ring gear (Fig. 84):

CAUTION: When removing a differential bearing, ensure that the differential case is securely clamped or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

- install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and bearing (Fig. 84);
- if used, position the chamfered edge of the removal tool adapters between the bearing race and the case;
- if used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race; and
- tighten the puller tool or removal tool screw (Fig. 84) and remove the bearing from the differential case hub.

(2) Place an additional 0.015-inch or 0.38-mm thick shim on the differential case hub (Fig. 85).

(3) Install the differential bearing on the case hub (Fig. 85). Use Differential Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092) to install the bearing.

(4) Install the differential bearing cup on the case hub.

Differential Case Installation

(1) Lubricate the bearings, the gears and the thrust washers with axle lubricant.

(2) Install Differential Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing (Fig. 86).

(3) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing (Fig. 86).

CAUTION: Do not exceed the specified 0.38-mm (0.015-in) separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) Separate the differential housing only enough to install the differential case. Separate the differential housing a **maximum distance of 0.38 mm (0.015 in)** with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated (Fig. 86).

(5) Remove the dial indicator when the differential housing has been separated sufficiently to remove the case.

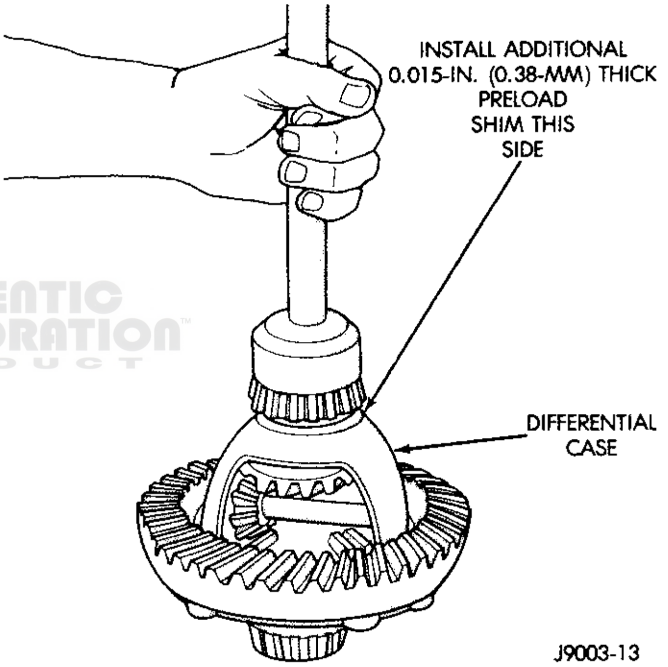


Fig. 85 Differential Bearing & Shim Installation

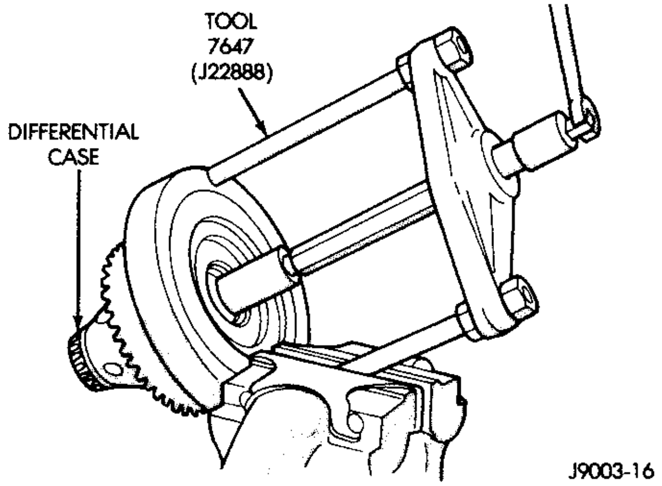


Fig. 84 Differential Bearing Removal

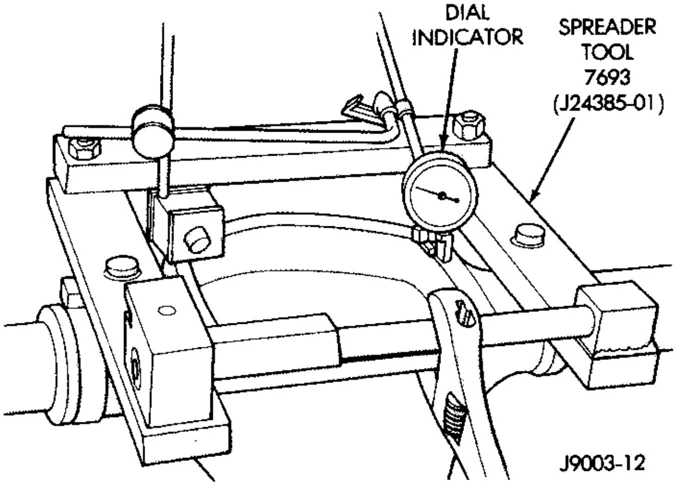


Fig. 86 Differential Housing Separation

(6) Install the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them.

(7) Remove Differential Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing (Fig. 86).

(8) Observe the installation reference marks and install the differential bearing caps. Tighten the cap bolts with 108 N•m or 80 ft-lbs torque.

(9) Measure the ring gear "backlash". The "backlash" should be 0.005 to 0.009 inch or 0.13 to 0.23 mm. If necessary, readjust the ring gear "backlash".

Installation — All Vehicles

(1) If equipped, install the intermediate axle shaft and the shaft retaining ring (Command-Trac/disconnect axle). If necessary, refer to the installation procedure.

(2) Install the axle shafts. If necessary, refer to the applicable installation procedure.

(3) Clean the differential housing and the housing cover mating surfaces thoroughly.

(4) Apply a thin bead of MOPAR RTV sealant (or an equivalent sealant) to the differential housing and to the cover. Install the cover. Tighten the cover bolts with 27 N•m (20 ft-lbs) torque.

It is important that the front springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the track bar is connected to the frame rail bracket, otherwise it will be difficult to align it with the bracket hole(s). In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(5) Connect the track bar to the frame/frame rail bracket and tighten the nut with 85 N•m (63 ft-lbs) for MJ/XJ vehicles and 168 N•m (125 ft-lbs) for SJ and YJ vehicles.

(6) Connect the tie rod to the steering knuckle. For MJ/XJ and YJ vehicles, tighten the nut with 47 N•m (35 ft-lbs) torque. For SJ vehicles, tighten the nut with 81 N•m (60 ft-lbs) torque.

(7) If equipped with a **Command-Trac** axle (i.e., a disconnect axle), install the axle shift motor and housing. If necessary, refer to the installation procedure.

(8) Align the installation reference marks on the drive shaft yoke and the axle yoke. Install replacement U-joint straps (MJ/XJ and YJ vehicles) and connect the drive shaft to the axle yoke. Tighten the U-Joint strap bolts with 19 N•m (14 ft-lbs) torque (MJ/XJ and YJ vehicles). Tighten the shaft-to-yoke attaching bolts/nuts with 22 N•m (16 ft-lbs) torque (SJ vehicles).

(9) Fill the differential housing with the specified amount of SAE 75W-90, API grade GL 5 hypoid gear lubricant.

(10) Install the hubs and bearings, the disc brake rotors and calipers, and the wheels/tires. If necessary, refer to the applicable installation procedure. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(11) Remove the supports and lower the vehicle.

AXLE SHIFT MOTOR AND HOUSING SERVICE

Command-Trac Axle Vacuum Control System

The Command-Trac axle vacuum control system (i.e., disconnect axle control system), consists of a vacuum control switch on the transfer case, an air vent filter, a vacuum shift motor (located on the front axle), a four-wheel drive indicator light and vacuum switch, two vacuum check valves and an interconnecting vacuum harness (Fig. 87). **Refer to Group 21 for information involving the Selec-Trac vacuum control system (i.e., non-disconnect axle control system) and additional service information for the Command-Trac system.**

Axle Shift Motor Functional Test

(1) Raise and support the vehicle. Disconnect the vacuum harness from the axle shift motor and connect a vacuum pump to the vacuum shift motor front port (Fig. 88).

(2) Apply 51 kPa (15 in. Hg) of vacuum to the front port and rotate the right front wheel to fully disengage the outer and intermediate axle shafts (i.e., shift to two-wheel drive operation).

(3) The shift motor should maintain the vacuum applied to the front port for a minimum of 30 seconds. If the motor does not maintain the vacuum, replace it. If the motor does maintain the vacuum, proceed to the next step.

(4) Disconnect the vacuum pump from the vacuum shift motor front port (Fig. 88). Connect the vacuum

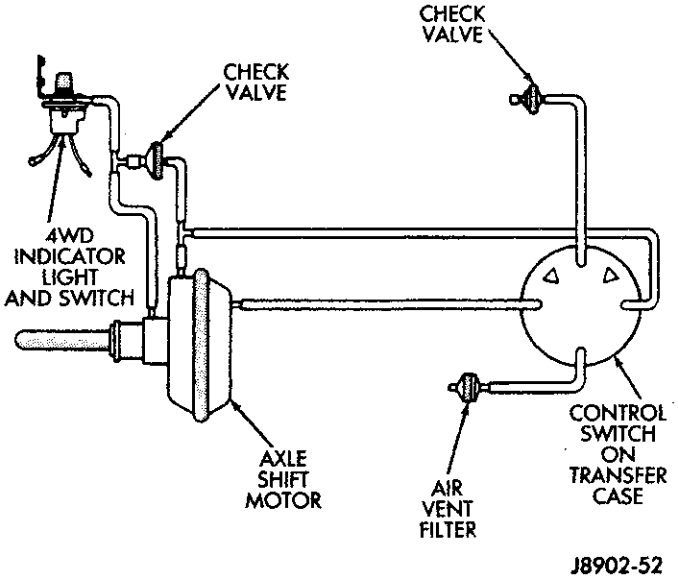


Fig. 87 Command-Trac Axle Vacuum Control System

pump to the vacuum shift motor rear port, cap the port for the indicator lamp switch, and apply 51 kPa (15 in. Hg) of vacuum to the rear port.

(5) The shift motor should maintain the vacuum applied to the rear port for a minimum of 30 seconds. If the shift motor does not maintain the vacuum, replace it. If the motor does maintain the vacuum, proceed to the next step.

(6) Remove the cap from the port for the indicator lamp switch and determine if vacuum was present at this port. If vacuum was present, the shift motor functions normally. If vacuum was not present, proceed to the next step.

(7) Apply 51 kPa (15 in. Hg) of vacuum to the shift motor rear port. Rotate the right front wheel as necessary and ensure that the outer and intermediate axle shafts are completely engaged. The axles must be completely engaged (i.e., shifted to four-wheel drive operation) to open the port for the indicator lamp switch.

(8) Determine if vacuum is present at the port for the indicator lamp switch again. If vacuum was present at the port, the shift motor functions normally. If vacuum was not present at the port, replace the shift motor.

(9) Connect the vacuum harness to the shift motor, remove the supports and lower the vehicle.

Axle Shift Motor And Housing—Removal/ Installation

The following procedures are applicable to YJ vehicles and MJ/XJ vehicles that are equipped with a **Command-Trac** front axle (i.e., a disconnect axle).

Removal—MJ/XJ And YJ Vehicles

(1) Raise and support the vehicle. Position a drain pan under the shift motor housing.

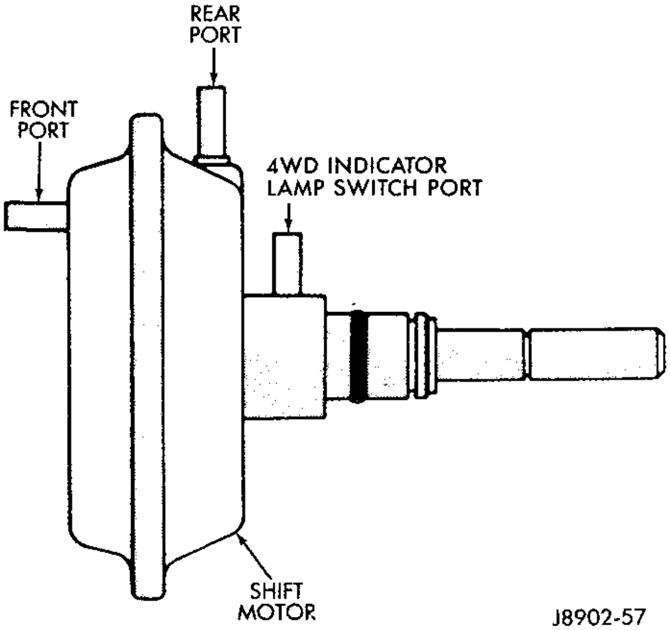


Fig. 88 Axle Vacuum Shift Motor

(2) Disconnect the vacuum harness.

(3) Remove the housing attaching bolts. Remove the housing, the motor and the shift fork as a unit (Fig. 89).

(4) Mark the shift fork and housing for installation reference.

(5) Rotate the shift motor and remove the shift fork and motor retaining "snap" rings.

(6) Remove the shift motor from the housing.

(7) Remove the O-ring seal from the shift motor shaft (Fig. 90). Discard the O-ring seal.

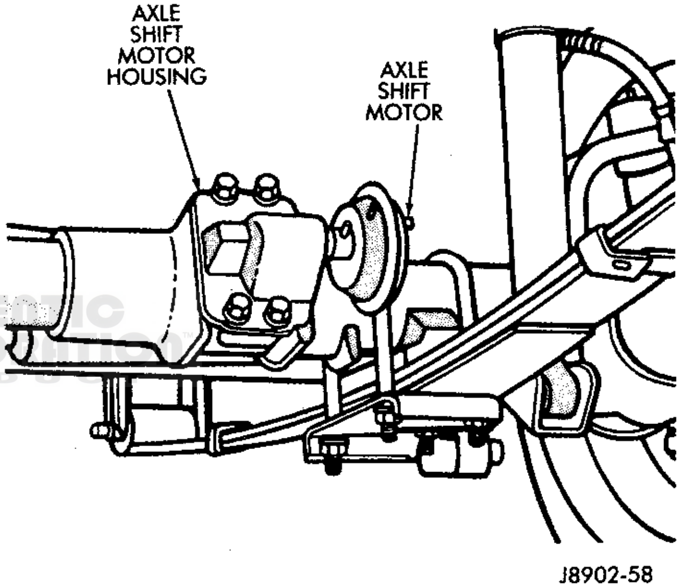


Fig. 89 Axle Vacuum Shift Motor & Housing

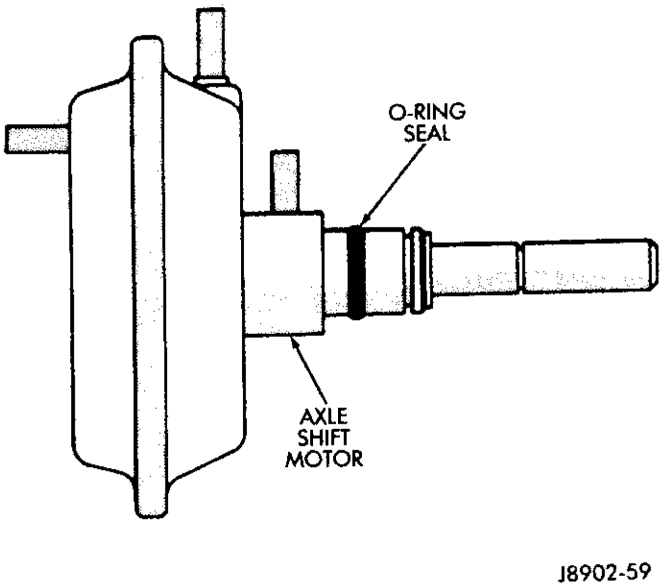


Fig. 90 Axle Vacuum Shift Motor Shaft O-Ring Seal

Installation—MJ/XJ And YJ Vehicles

(1) Add 148 ml (5 ounces) of SAE 75W-90, API grade GL 5 hypoid gear lubricant to the axle through the shift motor housing opening.

(2) Install a replacement O-ring seal (Fig. 90) on the shift motor shaft.

(3) Install the shift motor in the housing with the retaining "snap" rings and slide the shift fork onto the shaft with the reference mark aligned.

(4) Engage the shift fork with the shift collar and install the housing attaching bolts (Fig. 89). Tighten the bolts with 11 N•m (101 in-lbs) torque.

(5) Connect the vacuum harness to the shift motor, remove the supports and lower the vehicle.

SUSPENSION ARM SERVICE

COMPONENT REPLACEMENT

Upper Suspension Arm Removal—MJ/XJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the upper suspension arm attaching nut and Torx-head bolt at the axle (Fig. 1).

(3) Remove the attaching nut and bolt (Fig. 1) at the frame rail and remove the upper suspension arm.

Upper Suspension Arm Installation—MJ/XJ Vehicles

(1) Position the replacement upper suspension arm at the axle and at the frame rail (Fig. 1).

(2) Install the attaching bolts and nuts and tighten the nuts "finger tight" (Fig. 1).

(3) Remove the supports and lower the vehicle.

It is important to have the front springs supporting the weight of the vehicle (i.e., with the springs at their usual position) when the upper suspension arm attaching nuts are tightened with the specified torque because (if the springs are not at their usual position when the suspension arm attaching nuts are tightened) the vehicle "ride comfort" could be adversely affected. Do not tighten via the Torx-head bolts, use only the nuts to tighten the suspension arm bolts.

(4) Tighten the attaching nuts with 75 N•m (55 ft-lbs) torque at the axle and 90 N•m (66 ft-lbs) torque at the frame rail (Fig. 1).

Axle Bracket Bushing Replacement—MJ/XJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the upper suspension arm. If necessary, refer to the removal procedure.

CAUTION: Do not attempt to remove the bushing installed on two-wheel drive front axles without inserting Spacer Tool 7932-3 (J35581-3) around the bushing because, otherwise, the axle bracket will become distorted during bushing removal.

(3) For two-wheel drive front axles, insert Spacer Tool 7932-3 (J35581-3) around the bushing in the suspension arm axle bracket (Fig. 2).

Spacer Tool 7932-3 (J35581-3) is not necessary for four-wheel drive front axles because the axle bracket is solid metal.

(4) Assemble and install Bushing Removal/Installation Tools (Fig. 2) 7932-1 (J35581-1), 7932-2 (J35581-2), 7603 (J21474-18) and 7604 (J21474-19).

(5) Remove the bushing by tightening the hex-head on tool 7603 (J21474-18). Press Tool 7932-2 (J35581-2) will force the bushing out of the bracket and into Receiver Tool 7932-1 (J35581-1).

(6) Remove the bushing and the tools.

For two-wheel drive front axles, do not remove Spacer Tool 7932-3 (J35581-3) at this time.

(7) Position the replacement bushing on Press Tool 7932-2 (J35581-2) and Long Nut Tool 7603 (J21474-18). Position the tools and the replacement bushing at the axle bracket (Fig. 3).

(8) Refer to Figure 3 and install Receiver Tool 7932-1 (J35581-1) and Bolt Tool 7604 (J21474-19).

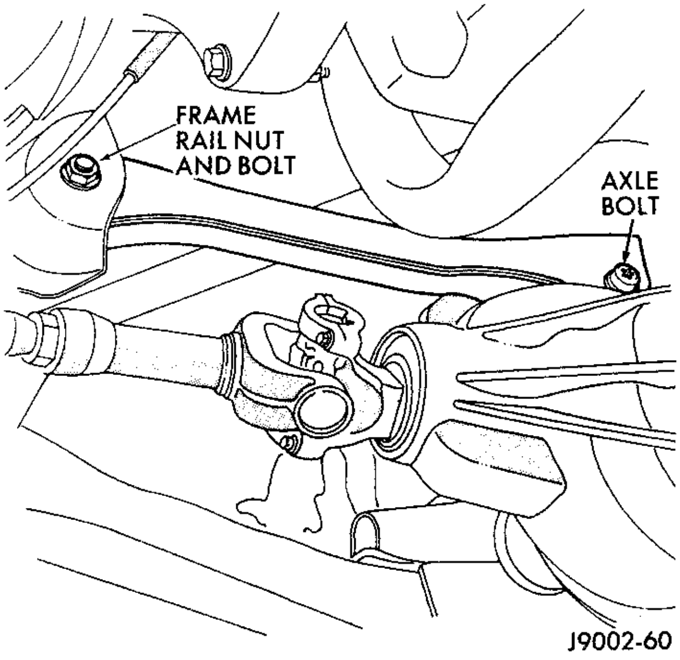


Fig. 1 Upper Suspension Arm Removal/Installation

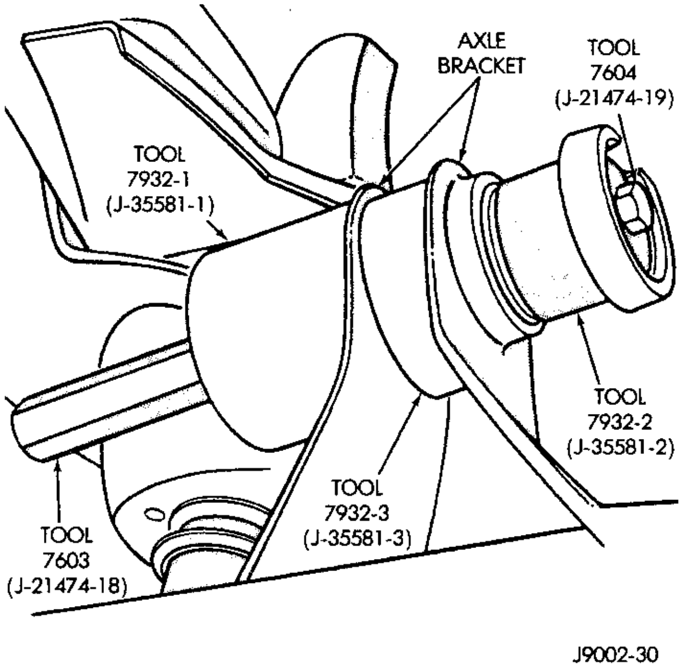


Fig. 2 Axle Bracket Bushing Removal

(9) Position the replacement bushing in the bracket Fig. 3) by tightening the hex-head on Long Nut Tool 7603 (J21474-18).

(10) Disassemble and remove the bushing installation tools, including Spacer Tool 7932-3 (J35581-3), if used.

(11) Remove the supports and lower the vehicle.

Lower Suspension Arm Removal—MJ/XJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the lower suspension arm attaching nut and bolt from the axle bracket (Fig. 4).

(3) Remove the attaching nut and bolt (Fig. 4) from the rear bracket and remove the lower suspension arm.

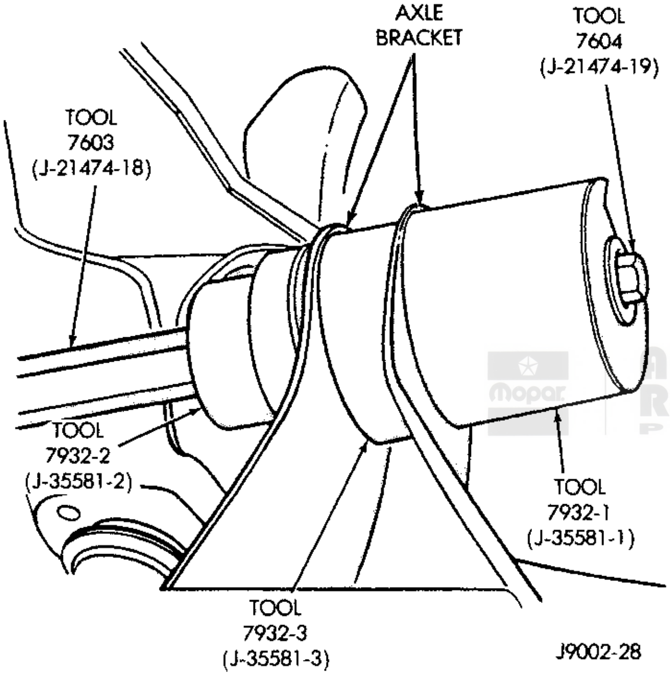


Fig. 3 Axle Bracket Bushing Installation

Lower Suspension Arm Installation—MJ/XJ Vehicles

(1) Position the replacement lower suspension arm at the axle bracket and at the rear bracket (Fig. 4).

(2) Install the attaching bolts and nuts and tighten the nuts “finger tight” (Fig. 4).

(3) Remove the supports and lower the vehicle.

It is important to have the front springs supporting the weight of the vehicle (i.e., with the springs at their usual position) when the lower suspension arm attaching nuts are tightened with the specified torque because (if the springs are not at their usual position when the suspension arm attaching nuts are tightened) the vehicle “ride comfort” could be adversely affected. Do not tighten via the Torx-head bolts, use only the nuts to tighten the suspension arm bolts.

(4) Tighten the attaching nuts with 180 N•m (133 ft-lbs) torque (Fig. 4).

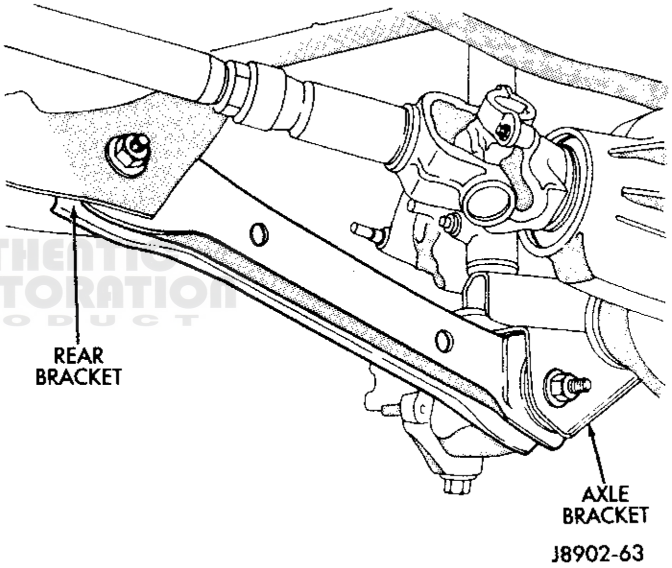


Fig. 4 Lower Suspension Arm Removal/Installation

STEERING LINKAGE SERVICE

COMPONENT REPLACEMENT

SJ Vehicles

The steering linkage (Fig. 1) is comprised of the following components:

- drag link with integral ball stud,
- drag link ball-stud end,
- tie rod with integral ball stud,
- adjustment sleeves,
- tie rod ball-stud end,
- clamps, and
- steering dampener.

The primary tie rod consists of a solid rod that is threaded on one end and has an integral ball stud at the opposite end. An adjustment sleeve (with clamps) and a non-integral ball-stud end complete the tie rod. The tie rod ball-stud ends are connected to the steering knuckle arms (Fig. 1). The threaded end of the primary tie rod has right-hand threads to accept the adjustment sleeve.

The drag link is attached to the pitman arm at one end and to the tie rod at the opposite end. The integral drag link ball-stud is connected to the tie rod (Fig.1).

The non-integral ball-stud ends and the adjustment sleeves are used with the tie rod and the drag link to provide wheel "toe" position adjustment and steering wheel alignment (Fig. 1).

The steering dampener, the tie rod and its non-integral ball-stud end, and the drag link and its non-integral ball-stud end are serviceable by replacement only. The tie rod and the drag link must be replaced if their integral ball stud becomes worn or damaged (Fig. 1).

The steering dampener is attached to the tie rod at one end and to the left spring bracket at the opposite end (Fig. 3).

Tie Rod Replacement

(1) Raise and support the vehicle.

(2) Remove the cotter pins and retaining nuts from both tie rod ball studs and from the drag link ball stud that attaches to the tie rod (Fig. 1).

(3) Remove the nut that attaches the steering dampener piston rod to the tie rod bracket (Fig. 3) and move the steering dampener aside.

(4) Use a puller tool to remove the tie rod ball studs from the steering knuckle arms and the drag link ball stud from the tie rod.

After removal, the non-integral tie-rod ball-stud end can be removed from the tie rod by loosening the adjustment sleeve clamp bolts and removing it from the sleeve (Fig. 1). The tie rod ball stud cannot be disassembled for service. During installation, position the tie rod adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and are angled upward (Fig. 2).

(5) Attach the replacement tie rod ball studs to the steering knuckle arms (Fig. 1). Install and tighten the retaining nuts with 81 N•m (60 ft-lbs) torque. Install replacement cotter pins.

(6) Attach the drag link ball stud to the tie rod (Fig. 1). Install and tighten the retaining nut with 95 N•m (70 ft-lbs) torque. Install a replacement cotter pin in the retaining nut.

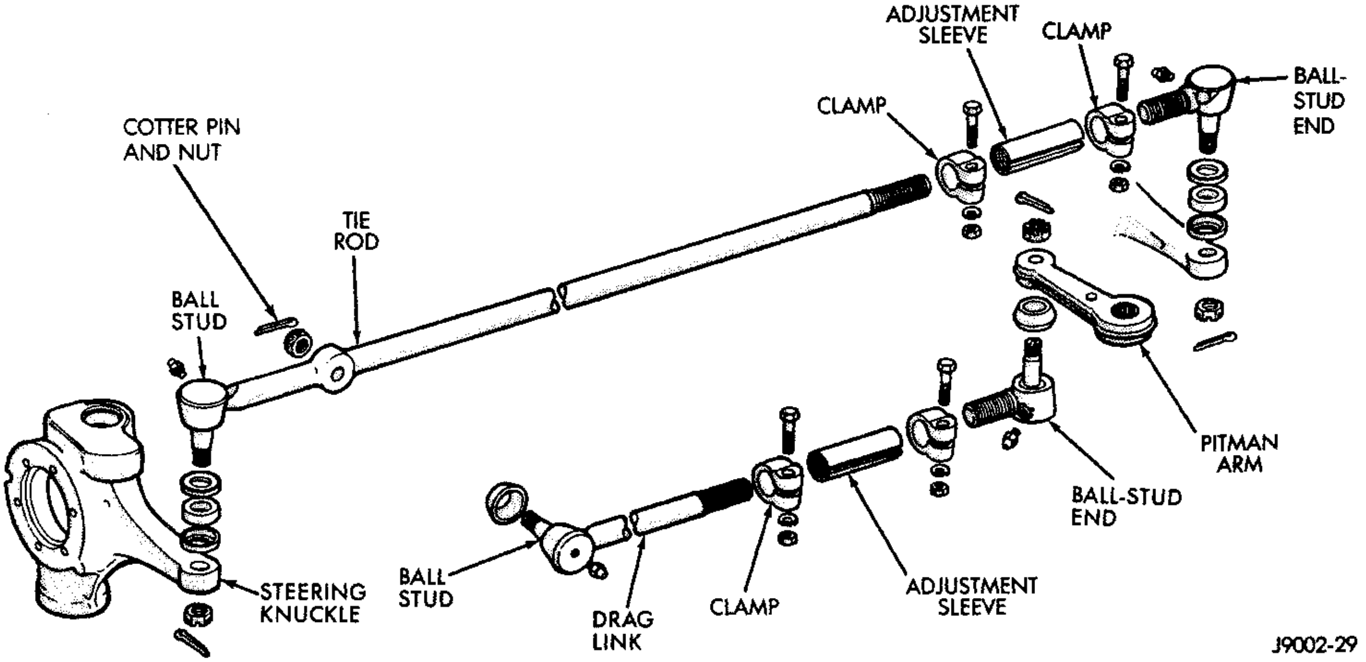


Fig. 1 Steering Linkage—SJ Vehicles

(7) Attach the steering dampener to the tie rod bracket (Fig. 3) and tighten the retaining nut with 41 N•m (30 ft-lbs) torque.

(8) If necessary, adjust the wheel "toe" position and center the steering wheel.

(9) Remove the supports and lower the vehicle.

Drag Link Replacement

(1) Raise and support the vehicle.

(2) Remove the cotter pins and retaining nuts from both drag link ball studs (Fig. 1). Remove the ball studs from the tie rod and the pitman arm with a puller tool.

After removal, the non-integral drag link ball-stud end can be removed from the drag link by loosening the adjustment sleeve clamp bolts and removing it from the sleeve (Fig. 1). The drag link ball stud cannot be disassembled for service. During installation, position the drag link adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and are angled upward (Fig. 2).

(3) Before installing the replacement drag link, place the front wheels in the straight-ahead position with the steering knuckle arms parallel to the centerline of the vehicle. The steering gear shaft and the steering gear must be centered.

(4) With the pitman arm correctly positioned, install the drag link and the retaining nuts. Tighten the retaining nut at the pitman arm with 81 N•m (60 ft-lbs) torque and the retaining nut at the tie rod with 95 N•m (70 ft-lbs) torque.

(5) Install replacement cotter pins.

(6) If necessary, adjust the wheel "toe" position and center the steering wheel.

(7) Remove the supports and lower the vehicle.

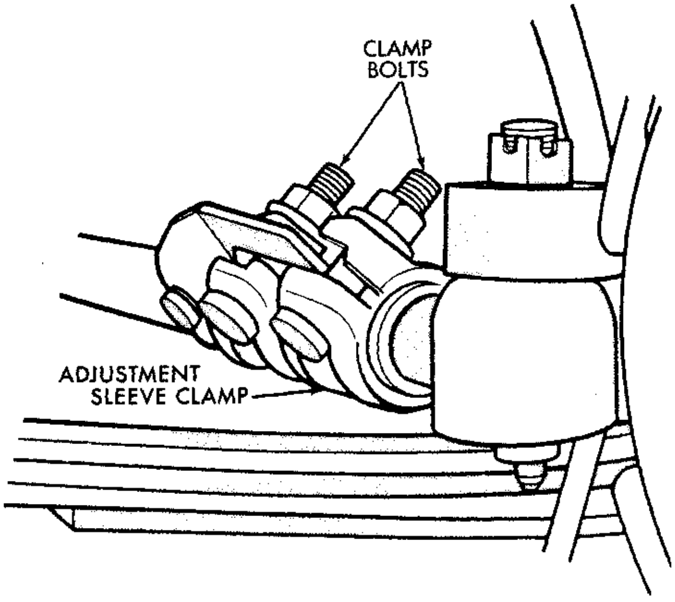


Fig. 2 Adjustment Sleeve Clamp Bolts

Steering Dampener Replacement

The steering dampener is replaceable as a complete unit only. If damaged or leaking, replace the complete dampener. However, the two rubber bushings located in each dampener eyelet can be replaced individually as necessary (Fig. 2).

(1) Raise and support the vehicle.

(2) Place the front wheels in the straight-ahead position.

(3) Remove the locknut that attaches the dampener to the spring-bracket stud (Fig. 3) and lift the dampener from the stud.

(4) Remove the locknut that attaches the dampener piston-rod end to the tie-rod bracket stud (Fig. 3) and remove the dampener.

(5) Insert the inner rubber bushings (Fig. 3) either into the replacement dampener eyelets or over the bracket studs.

(6) Position the replacement dampener piston-rod eyelet on the tie rod bracket stud and install the outer rubber bushing, the washer and the locknut (Fig. 3).

(7) Extend the replacement dampener piston rod (by pulling back on the dampener body) and position the dampener body eyelet over the spring bracket stud (Fig. 3).

(8) Install the outer rubber bushing, the washer and the locknut on the spring bracket stud (Fig. 3).

(9) Tighten both locknuts with 41 N•m (30 ft-lbs) torque.

(10) Remove the supports and lower the vehicle.

MJ/XJ Vehicles

The steering linkage (Fig. 4) is comprised of the following components:

- drag link with integral ball stud,
- drag link ball-stud end,
- adjustment sleeve,
- tie rod,

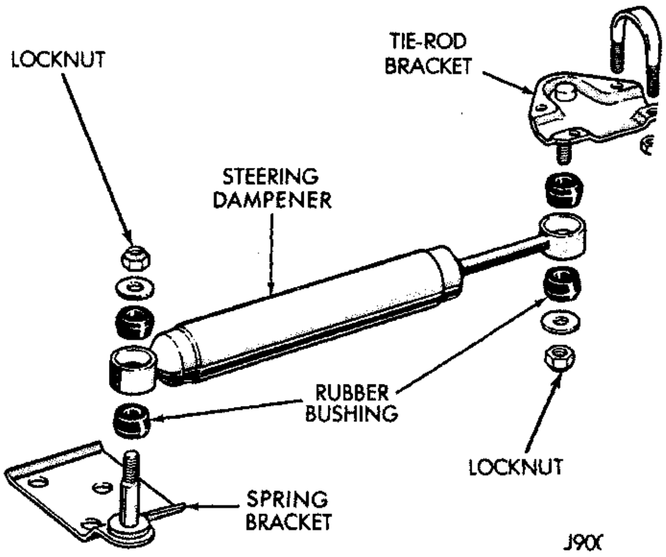


Fig. 3 Steering Dampener

- tie rod ball-stud ends, and
- steering dampener.

The steering dampener, the tie rod and its non-integral ball-stud ends, and the drag link and its non-integral ball-stud end are serviceable by replacement only. The drag link must be replaced if the integral ball stud becomes worn or damaged.

Tie Rod Replacement

(1) Raise and support the vehicle.

(2) Remove the cotter pins and the nuts that attach the tie rod ball studs to the drag link and to the steering knuckle (Fig. 4).

(3) Loosen the ball studs with a puller tool and remove the tie rod.

It is not necessary to completely remove the tie rod if only one of the ball-stud ends requires replacement.

(4) Loosen the ball-stud end clamp bolts and remove the ball-stud ends from the tie rod (Fig. 4).

(5) Install the replacement tie rod components (Fig. 4). Position the tie rod clamp bolts so that the bolt heads face the rear of the vehicle (Fig. 5). Tighten the ball-stud end clamp bolts with 49 N•m (36 ft-lbs) torque.

(6) Position the tie rod at the drag link and at the steering knuckle (Fig. 4) and install the retaining nuts.

(7) Tighten the ball stud retaining nuts with 47 N•m (35 ft-lbs) torque and install replacement cotter pins.

(8) If necessary, adjust the front wheel "toe" position and center the steering wheel.

(9) Remove the supports and lower the vehicle.

Drag Link Replacement

(1) Raise and support the vehicle.

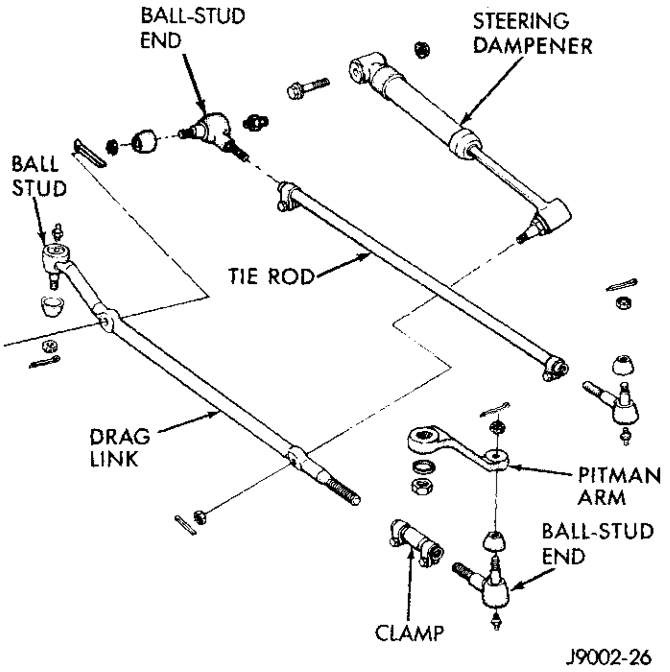


Fig. 4 Steering Linkage—MJ/XJ Vehicles

(2) Remove the cotter pin and the retaining nut, and remove the steering dampener ball stud from the drag link (Fig. 4). If necessary, use a puller tool.

(3) Remove the cotter pins and nuts that attach the drag link to the steering knuckle, the tie rod and the pitman arm (Fig. 4).

(4) Loosen all the ball studs with a puller tool and remove the drag link.

(5) Remove the adjustment sleeve and non-integral ball-stud end from the drag link (Fig. 4). **The drag link ball stud cannot be disassembled for service.**

(6) Install the drag link replacement components. During installation, position the drag link adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and are angled upward (Fig. 2).

(7) Position the drag link at the steering linkage (Fig. 4).

Install the nuts that attach the drag link to the steering knuckle, the tie rod and the pitman arm (Fig. 4).

(8) Tighten the nuts with 47 N•m (35 ft-lbs) and install replacement cotter pins.

(9) Attach the steering dampener ball stud to the drag link with the retaining nut (Fig. 4). Tighten the retaining nut with 47 N•m (35 ft-lbs) torque. Install a replacement cotter pin.

(10) If necessary, adjust the front wheel "toe" position and center the steering wheel.

(11) Remove the supports and lower the vehicle.

Steering Dampener Replacement

The steering dampener is replaceable as a complete unit only. If damaged or leaking, the complete dampener must be replaced (Fig. 4).

(1) Raise and support the vehicle.

(2) Place the front wheels in a straight-ahead position.

(3) Remove the steering dampener retaining nut and bolt from the axle bracket (Fig. 4).

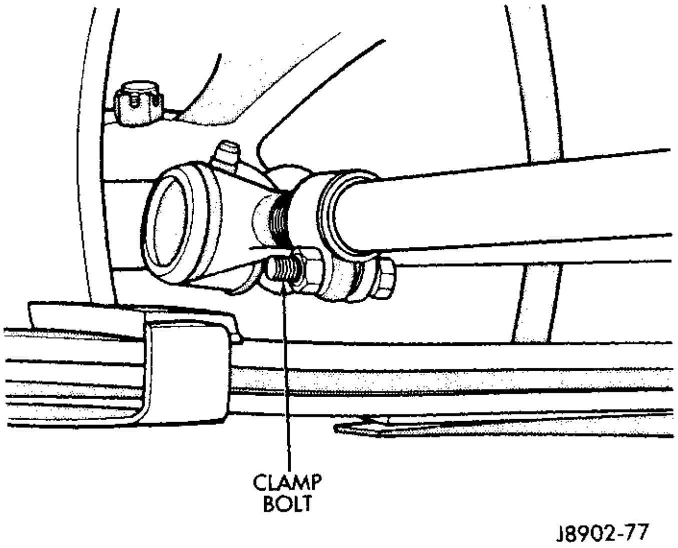


Fig. 5 Tie Rod/Drag Link Clamp Bolt

(4) Remove the cotter pin and nut from the piston rod ball stud at the drag link (Fig. 4).

(5) Remove the steering dampener ball stud from the drag link with a puller tool.

(6) Extend the replacement steering dampener piston enough to align the dampener eyelet and ball stud with the axle bracket and the drag link.

(7) Position the steering dampener eyelet in the axle bracket and the ball stud in the drag link (Fig. 4).

(8) Install the steering dampener retaining bolt in the axle bracket and install and tighten the nut with 75 N•m (55 ft-lbs) torque.

(9) Install the steering dampener retaining nut on the ball stud at the drag link and tighten it with 47 N•m (35 ft-lbs) torque. Install a replacement cotter pin.

(10) Remove the supports and lower the vehicle.

YJ Vehicles

The steering linkage (Fig. 6) is comprised of the following components:

- drag link,
- drag link ball-stud ends,
- tie rod with integral ball stud,
- adjustment sleeve,
- tie rod ball-stud end,
- clamps, and
- steering dampener.

The primary tie rod consists of a solid rod that is threaded on one end and has an integral ball stud at the opposite end. An adjustment sleeve and non-integral ball-stud end complete the tie rod. The tie rod ends are connected to the steering knuckle arms (Fig. 6). The threaded end of the tie rod has right-hand threads to accept the adjustment sleeve.

The drag link is attached to the pitman arm at one end and to the tie rod at the opposite end. The right-side end of the drag link is connected to the tie rod (Fig. 6).

The non-integral ball-stud ends and the adjustment sleeve are used with the tie rod and the drag link to provide "toe" position adjustment and steering wheel alignment (Fig. 6).

The steering dampener (Fig. 6) is attached to the tie rod at one end and to a frame bracket at the opposite end.

The steering dampener, the tie rod and its non-integral ball-stud end, and the drag link and its non-integral ball-stud ends are serviceable by replacement only. The tie rod must be replaced if the integral ball stud becomes worn or damaged (Fig. 6).

Tie Rod Replacement

(1) Raise and support the vehicle.

(2) Remove the cotter pins and the retaining nuts from both ball studs on the tie rod and from the drag link ball stud that is attached to the tie rod (Fig. 6).

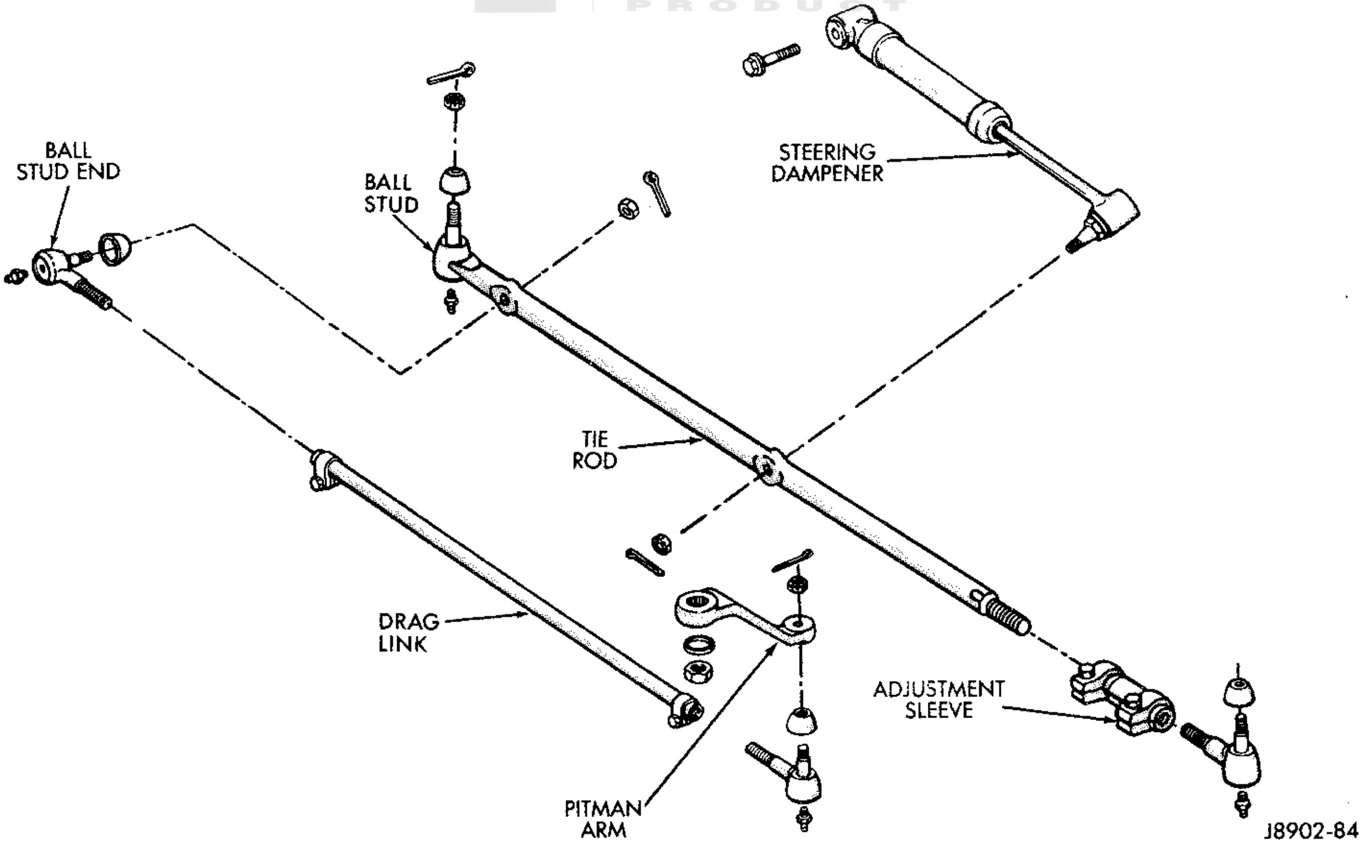


Fig. 6 Steering Linkage—YJ Vehicles

(3) Remove the cotter pin and the nut that attach the steering dampener piston-rod ball stud to the tie rod (Fig. 6) and move the steering dampener aside. If necessary, use a puller tool to loosen the ball stud.

(4) Use a puller tool to loosen the tie rod ball studs from the steering knuckle arms and the drag link ball stud from the tie rod.

After removal, the non-integral tie rod ball-stud end can be removed from the tie rod by loosening the adjustment sleeve clamp bolts and removing it from the sleeve (Fig. 6). The tie-rod ball stud cannot be disassembled for service. During installation, position the tie rod adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and are angled upward (Fig. 2).

(5) Attach the replacement tie rod to the steering knuckle arms (Fig. 6). Install and tighten the retaining nuts with 47 N•m (35 ft-lbs) torque. Install replacement cotter pins.

(6) Attach the drag link ball stud to the tie rod (Fig. 6). Install and tighten the retaining nut with 47 N•m (35 ft-lbs) torque. Install a replacement cotter pin in the retaining nut.

(7) Attach the steering dampener ball stud to the tie rod with the retaining nut (Fig. 6). Tighten the retaining nut with 71 N•m (53 ft-lbs) torque and install a replacement cotter pin.

(8) If necessary, adjust the wheel "toe" position and center the steering wheel.

(9) Remove the supports and lower the vehicle.

Drag Link Replacement

It is not necessary to completely remove the drag link if only one of the ball-stud ends requires replacement.

(1) Raise and support the vehicle.

(2) Remove the cotter pins and the retaining nuts from both drag link ball studs (Fig. 6) and remove the studs from the tie rod and the pitman arm with a puller tool.

(3) If necessary, loosen the ball-stud end clamp bolts and remove the ball-stud ends from the drag link (Fig. 6).

The drag link ball studs cannot be disassembled for service.

(4) If necessary, install the replacement drag link components (Fig. 6). Position the drag link clamp bolts so that the bolt heads face the rear of the vehicle (Fig. 5). Tighten the ball-stud end clamp bolts with 49 N•m (36 ft-lbs) torque.

(5) Before installing the replacement drag link, place the front wheels in the straight-ahead position with the steering knuckle arms parallel to the centerline of the vehicle. The steering gear shaft and the steering gear must be centered.

(6) With the pitman arm correctly positioned, install the drag link and the retaining nuts. Tighten the retaining nut on the ball stud in the pitman arm and the retaining nut on the ball stud in the tie rod with 81 N•m (60 ft-lbs) torque.

(7) Install replacement cotter pins.

(8) Remove the supports and lower the vehicle.

Steering Dampener Replacement

The steering dampener is replaceable as a complete unit only. If damaged or leaking, the complete dampener must be replaced (Fig. 6).

(1) Raise and support the vehicle.

(2) Place the front wheels in the straight-ahead position.

(3) Remove the nut and the bolt that attach the dampener to the axle bracket.

(4) Remove the cotter pin and the nut that attach the dampener piston rod ball stud to the tie rod (Fig. 6) and loosen the ball stud with a puller tool.

(5) Position the replacement dampener piston rod ball stud in the tie rod and install the retaining nut (Fig. 6). Tighten retaining nut with 71 N•m (53 ft-lbs) torque.

(6) Extend the replacement dampener piston rod (by pulling back on the dampener body) and position the dampener body eyelet in the axle bracket.

(7) Install the retaining bolt and nut in the axle bracket. Tighten the retaining nut with 75 N•m (55 ft-lbs) torque.

(8) Remove the supports and lower the vehicle.

TRACK BAR SERVICE

COMPONENT REPLACEMENT

SJ and YJ vehicles are equipped with both a front and a rear track bar. Refer to Group 17—Springs/Shock Absorbers for SJ and YJ vehicle rear track bar service information.

Track Bar Removal

(1) Raise and support (if applicable) the vehicle.

Lift the vehicle either with the arms of a hoist positioned under the axle tubes or with a platform-type lifting device under the wheels/tires. It is important that the front springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the replacement track bar is installed, otherwise it will be difficult to align the bolt holes (and stud) with the bracket bolt holes. In addition, if the springs are not at their usual position when the track bar retaining nuts are tightened, the vehicle "ride comfort" could be adversely affected.

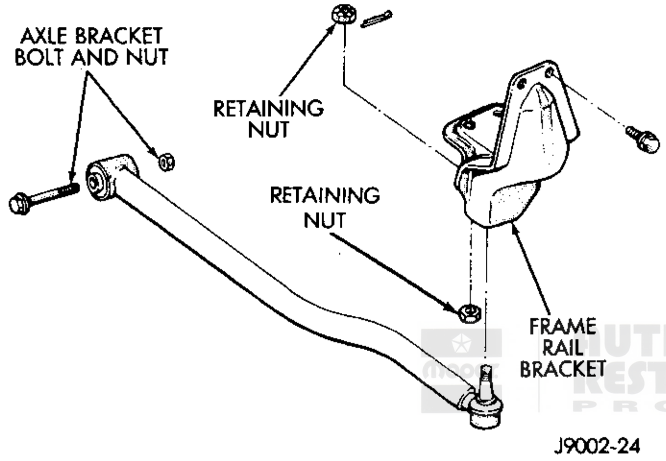


Fig. 1 Track Bar—MJ/XJ Vehicles

(2) Remove the cotter pin (MJ/XJ vehicles only), the retaining nut (MJ/XJ vehicles only) or the retaining nut and bolt (SJ and YJ vehicles only) from the frame rail/frame bracket (Fig. 1, Fig. 2).

(3) Remove the retaining nut and bolt (Fig. 1, Fig. 2) from the axle shaft tube bracket and remove the track bar.

For MJ/XJ vehicles, a puller tool may be necessary to separate the ball stud from the frame rail bracket.

Track Bar Installation

(1) Position the replacement track bar at the axle shaft tube bracket and loosely install the retaining bolt and nut (Fig. 1, Fig. 2).

(2) Position the replacement track bar at the frame/frame rail bracket (Fig. 1, Fig. 2) and install the retaining bolt and nut (SJ and YJ vehicles only) or the retaining nut on the stud (MJ/XJ vehicles only).

If the front springs are not at their usual position (i.e., supporting the weight of the vehicle) when the replacement track bar retaining nuts are tightened, the vehicle "ride comfort" could be adversely affected.

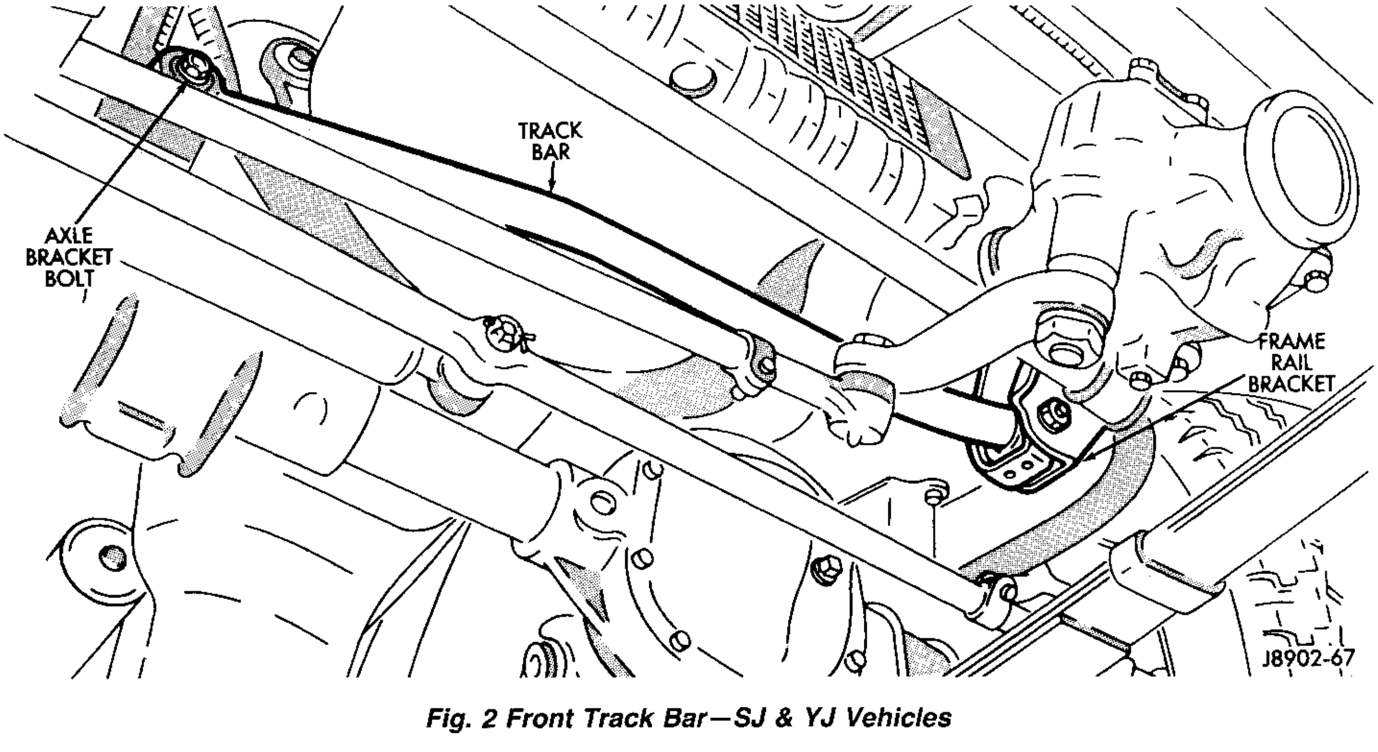


Fig. 2 Front Track Bar—SJ & YJ Vehicles

(3) Tighten the retaining nut at the axle shaft tube bracket with 100 N•m (74 ft-lbs) torque.

(4) For MJ/XJ vehicles, tighten the retaining nut at the frame rail bracket with 85 N•m (63 ft-lbs) torque and install a replacement cotter pin. For SJ and YJ vehicles, tighten the retaining nut at the frame bracket with 168 N•m (125 ft-lbs) torque.

(5) Remove the supports (if applicable) and lower the vehicle.

Frame Rail Bracket Removal—MJ/XJ Vehicles

(1) Raise and support (if applicable) the vehicle.

Lift the vehicle either with the arms of a hoist positioned under the axle tubes or with a platform-type lifting device under the wheels/tires. It is important that the front springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the track bar is installed, otherwise it could be difficult to align the stud with the frame rail bracket hole. In addition, if the springs are not at their usual position when the track bar retaining nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(2) Remove the cotter pin and the track bar retaining nut from the frame rail bracket (Fig. 1).

(3) Loosen the track bar retaining nut (Fig. 1) at the front axle bracket. Lower the ball stud and pivot the track bar away from the frame rail bracket.

A puller tool may be necessary to separate the track bar ball stud from the frame rail bracket.

(4) Remove the bracket-to-frame rail nuts and bolts (Fig. 3). Remove the frame rail bracket.

Frame Rail Bracket Installation—MJ/XJ Vehicles

(1) Clean the bracket mating surface on the frame rail.

(2) Position the replacement bracket at the frame rail and install the bracket-to-frame rail bolts and nuts (Fig. 3).

(3) Tighten the bracket-to-frame rail bolts with 121 N•m or 90 ft-lbs torque. Tighten the bracket-to-frame rail nuts with 100 N•m or 74 ft-lbs torque.

(4) Pivot the track bar, raise the ball stud and insert it into the frame rail bracket hole (Fig. 1). Install the retaining nut.

If the front springs are not at their usual position (i.e., supporting the weight of the vehicle) when the track bar retaining nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(5) Tighten the retaining nut at the axle shaft tube bracket with 100 N•m or 74 ft-lbs torque.

(6) Tighten the retaining nut at the frame rail bracket with 85 N•m or 63 ft-lbs torque and install a replacement cotter pin.

(7) Remove the supports (if applicable) and lower the vehicle.

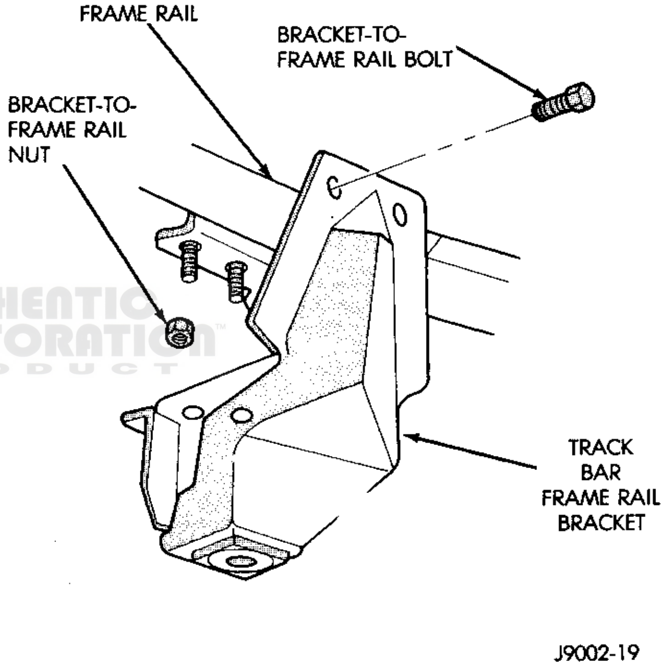


Fig. 3 Frame Rail Bracket—MJ/XJ Vehicles

FRONT STABILIZER BAR SERVICE

REPLACEMENT

Removal—SJ Vehicles

The stabilizer bar (Fig. 1) extends across the front underside of the frame and is attached to the frame by brackets and rubber bushings.

The ends of the stabilizer bar extend rearward to a location above the front springs and are connected to the axle and springs by connecting links (Fig. 2).

(1) Raise and support the vehicle.

(2) Remove the retaining nut from the connecting link bolt (Fig. 2) at each side of the vehicle.

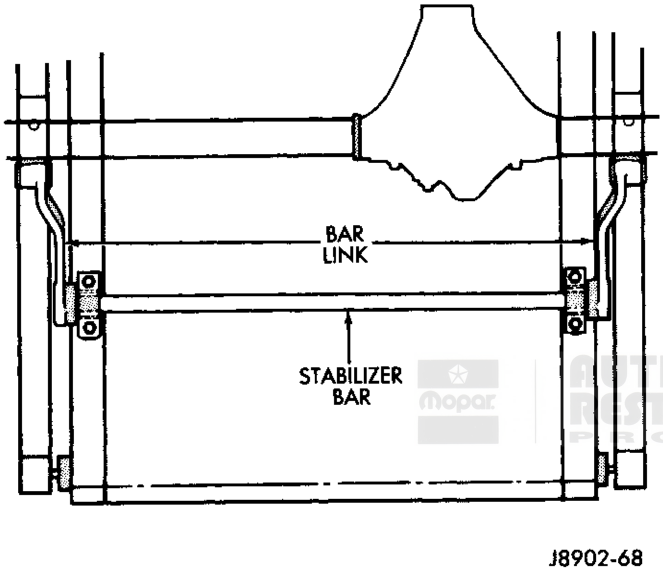


Fig. 1 Stabilizer Bar—SJ Vehicles

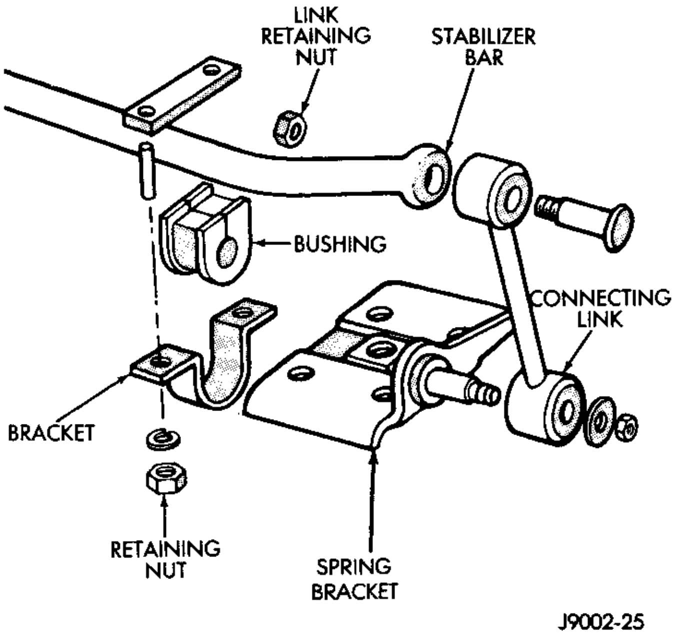


Fig. 2 Stabilizer Bar Removal/Installation

(3) Remove the bracket retaining nuts and brackets (Fig. 2) at each side of the vehicle.

(4) Remove the stabilizer bar.

Installation—SJ Vehicles

(1) Inspect the stabilizer bar bushings (Fig. 2). Replace the bushings if cracked, cut, distorted, or worn.

(2) Position the replacement stabilizer bar on the frame and install the retaining brackets and nuts (Fig. 2) at each side of the vehicle. Tighten the nuts with 47 N•m or 35 ft-lbs torque.

(3) Install the connecting link bolts and retaining nuts (Fig. 2) at each side of the vehicle. Tighten the nuts with 75 N•m or 55 ft-lbs torque.

(4) Remove the supports and lower the vehicle.

Removal—MJ/XJ And YJ Vehicles

In addition to a front stabilizer bar, MJ/XJ vehicles are equipped with a rear stabilizer bar. Refer to Group 17 for rear stabilizer bar service information.

(1) Raise and support the vehicle.

(2) Remove the nuts that attach the stabilizer bar to the connecting links at each side of the vehicle (Fig. 3, Fig. 4).

For YJ vehicles, use vise-grip pliers to retain the link bolt heads (Fig. 3) when removing the nuts.

(3) Remove the bolts that retain the stabilizer bar attaching brackets at the frame rail and the steering gear bracket (Fig.3, Fig. 4).

(4) Remove the stabilizer bar.

(5) If required, disconnect the connecting links from the axle brackets.

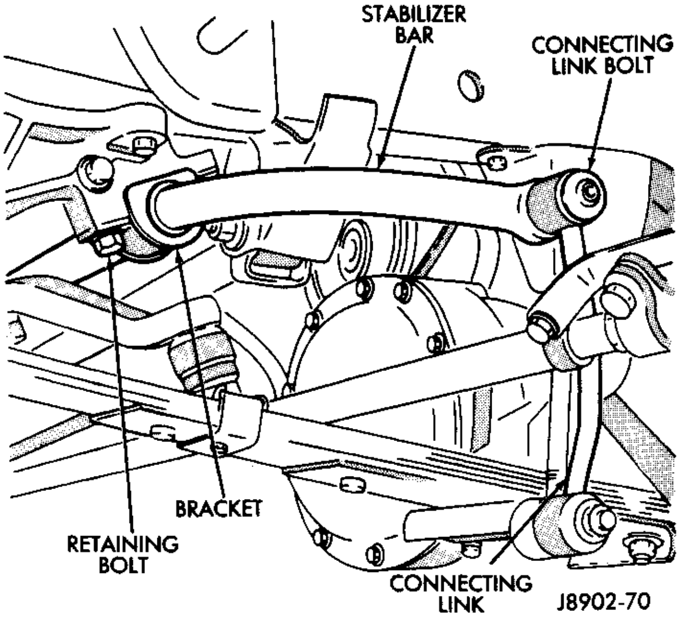


Fig. 3 Stabilizer Bar—YJ Vehicles

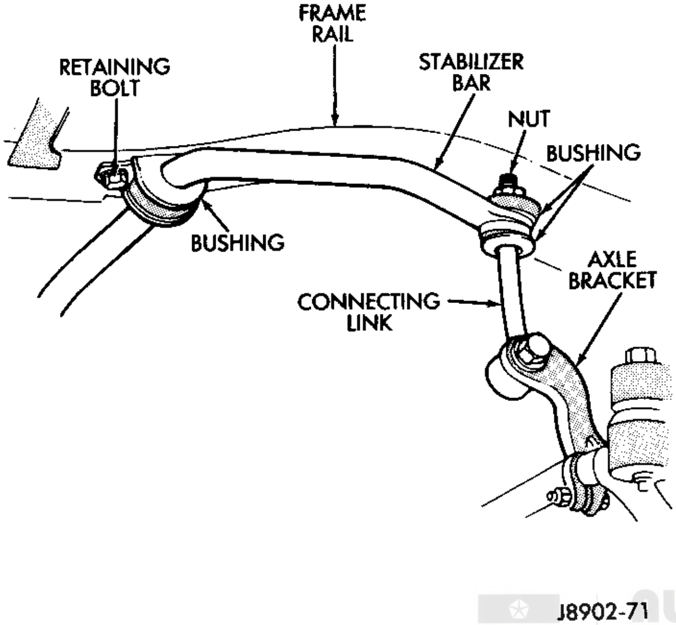


Fig. 4 Stabilizer Bar—MJ/XJ Vehicles

Installation—MJ/XJ And YJ Vehicles

(1) Inspect and lubricate the bushings in the stabilizer bar attaching brackets (Fig. 3, Fig. 4). Replace the bushings if cracked, cut, distorted, or worn.

(2) If removed, install the connecting links at the axle brackets (Fig. 3, Fig. 4).

(3) For MJ/XJ vehicles, tighten the connecting link attaching bracket bolts with 95 N•m or 70 ft-lbs torque.

(4) For YJ vehicles, tighten the connecting link attaching bracket bolts with 61 N•m or 45 ft-lbs torque.

(5) Install the attaching brackets and bushings on the replacement stabilizer bar.

(6) Position the stabilizer bar attaching brackets on the frame rails.

(7) Align the stabilizer bar attaching brackets and install the retaining bolts (Fig. 3, Fig. 4). Do not tighten the bolts at this time.

(8) Align the stabilizer bar with the connecting links and install the retaining bolts and nuts.

(9) For MJ/XJ vehicles, tighten the stabilizer bar attaching bracket bolts with 75 N•m or 55 ft-lbs torque.

(10) For YJ vehicles, tighten the stabilizer bar attaching bracket bolts with 41 N•m or 30 ft-lbs torque.

(11) For MJ/XJ vehicles, tighten the stabilizer bar-to-connecting link bolt nuts with 36 N•m or 27 ft-lbs torque.

(12) For YJ vehicles, tighten the stabilizer bar-to-connecting link bolt nuts with 61 N•m or 45 ft-lbs torque.

(13) Remove the supports and lower the vehicle.

FRONT WHEEL ALIGNMENT SERVICE

INDEX

GENERAL INFORMATION

The front wheel alignment should be measured and adjusted with the vehicle on an accurate alignment rack. To ensure correct alignment, the following inspection is also recommended:

- equalize the tire pressures and place the vehicle on a level surface,
- inspect the steering gear-to-steering column shaft alignment,
- inspect the steering knuckle pivots, spindle and wheel bearings for looseness,
- inspect for spring sag,
- inspect the brakes and shock absorbers for proper operation,
- inspect and determine if the steering gear is properly centered,
- inspect the front and rear wheels for proper tracking,
- inspect for broken spring center bolts, and
- measure the caster angle, the camber angle and the toe position, as applicable to the vehicle.

Ensure that all the front suspension and steering system nuts and bolts are tight before measuring the caster/camber angles and the toe position.

Alignment Specifications—SJ Vehicles

Adjustment	Set-To	OK Range
TOE:	PER WHEEL	TOTAL TOE-IN
Right Wheel	5/64 IN. (1.98 MM.) (0.17°)	0 TO 5/32 IN. (0 TO 3.97 MM.) (0 TO 0.34°)
Left Wheel	5/64 IN. (1.98 MM.) (0.17°)	0 TO 5/32 IN. (0 TO 3.97 MM.) (0 TO 0.34°)
CAMBER	0°	0° to +1/2°
CASTER	4°	4° to 5°
OUTSIDE WHEEL TURN ANGLE	37°	36° to 37°

J9002-22

Alignment Specifications—MJ/XJ Vehicles

Adjustment	Set-To	OK Range
TOE:		
Right Wheel	0°	1/32 inch IN to 1/32 inch OUT
Left Wheel	0°	1/32 inch IN to 1/32 inch OUT
CAMBER	0°	+1/2° to −3/4°
CASTER	6°	5° to 9°
OUTSIDE WHEEL TURN ANGLE*	33° MAX.	33° to 32°

J9002-23

*STEERING STOPS ARE NOT ADJUSTABLE.

Alignment Specifications—YJ Vehicles

Adjustment	Set-To	OK Range
TOE:		
Right Wheel	0°	1/32 inch IN to 0 inch OUT
Left Wheel	0°	1/32 inch IN to 0 inch OUT
CAMBER	0°	−1/2° to +1/2°
CASTER:		
Manual Trans.	8°	7½° to 8½°
Auto. Trans.	6½°	6° to 7°
OUTSIDE WHEEL TURN ANGLE*	33°	32° to 33°

*Steering stops are not adjustable.

J8902-74

DIAGNOSIS

Front wheel shimmy can be caused by one or more of the following conditions:

- loose front wheel bearings,
- worn, unbalanced or out-of-round front tires,
- loose steering dampener or bracket,
- steering dampener malfunction,
- worn or loose tie-rod/drag-link ball-stud ends,
- loose or incorrectly "preloaded" steering knuckle ball studs, and/or
- incorrect tire inflation pressures.

The following procedure involves a method for determining and correcting the cause(s) of front wheel shimmy.

(1) Raise and support the vehicle front end.

(2) Inspect the front tire condition, and measure and correct the inflation pressures. Examine the tires for evidence of unbalance; such as cupping, scalloping, flat spots and bald spots. Balance or replace any tire or tires that has/have any of these conditions.

(3) Check and correct the front wheel bearing adjustment, if necessary. Refer to Group 22—Tires And Wheels.

(4) Inspect the steering dampener attaching brackets and retaining nuts/bolts for looseness. If they are loose, tighten the nuts and/or the bracket. Tighten all retaining nuts and bolts.

(5) Inspect the steering dampener operation. Disconnect the piston-rod end of the dampener and alternately compress and extend the dampener piston fully. The piston action should be smooth and uniform throughout each stroke. Higher resistance on the extension stroke than the compression stroke is a normal condition. Replace the dampener if a lack of resistance to movement is evident.

(6) Inspect the tie-rod and drag-link ball studs. Replace any tie rod or drag link with a ball stud that has excessive play.

(7) Inspect the steering knuckle ball studs. Insert a pry bar between the knuckle and the yoke (adjacent to the ball stud) and pry against each ball stud. If the ball studs do not move or do not appear to be loose in the stud socket, proceed to the next procedure. For MJ/XJ and YJ vehicles, if any ball stud moves or appears loose, refer to the replacement procedure. For SJ vehicles, if any ball stud moves or appears loose, "reseat" both of the ball studs at that side of the axle according to the following instructions:

- remove the wheels/tires and the axle shafts;
- loosen the lower ball-stud jamnut and remove the cotter pin and the "slotted" retaining nut from the upper ball stud;
- "unseat" both of the ball studs by striking them with a lead hammer, remove the upper ball-stud split-ring seat with Locknut Wrench Tool 6291 (J23447) and discard the seat after removal;
- remove the lower ball-stud jamnut and remove the steering knuckle (discard the jamnut after removal);
- clean the split-ring seat threads and the lower ball-stud tapered cavity in the steering knuckle;
- clean the threads and tapered surfaces of both the ball studs and clean the threads in the upper ball-stud "slotted" retaining nut;
- position the steering knuckle on the axle yoke and install the replacement lower ball-stud jamnut "finger-tight" (only);
- install and tighten the upper ball-stud "slotted" retaining nut with 13 - 27 N•m (10 - 20 ft-lbs) torque to force the lower ball stud into the tapered hole in the axle yoke (do not install the upper ball-stud split-ring seat at this time);
- tighten the replacement lower ball-stud jamnut with 108 N•m or 80 ft-lbs torque (minimum);
- remove the upper ball-stud "slotted" retaining nut and install the replacement split-ring seat with Locknut Wrench Tool 6291 (J23447);
- tighten the split-ring seat with 68 N•m or 50 ft-lbs torque;
- install and tighten the upper ball-stud "slotted" retaining nut with 136 N•m or 100 ft-lbs torque;
- align and install the cotter pin without loosening the "slotted" retaining nut;
- loosely install the axle shafts and the spindles;
- measure the turning effort required for each steering knuckle;
- if the turning effort is less than 14 N•m or 10 ft-lbs torque, this is acceptable — continue with the installation;
- if the turning effort is greater than 14 N•m or 10 ft-lbs torque, replace the upper and lower ball studs (refer to the replacement procedure); and
- install the wheels/tires (tighten the wheel lug nuts with 102 N•m or 75 ft-lbs torque, remove the supports and lower the vehicle.

(8) Road test the vehicle to verify the effectiveness of the repairs.

MEASUREMENTS AND ADJUSTMENTS

Front Toe Position Measurement And Adjustment

SJ Vehicles

Accurate alignment equipment is recommended to measure the toe position.

(1) Measure the toe position. The distance between outside edges (Fig. 1) at the rear of the tires should be greater than the distance at the front of the tires by 0 - 5/32 inch (0 - 3.97 mm). Refer to the Alignment Specifications chart.

(2) To adjust for the correct toe-in position, loosen the adjustment sleeve clamp bolts and move the tie rod (and

wheels) in or out by turning the adjustment sleeve **CC or CCW** with an appropriate turning tool.

The tie rod and the adjustment sleeve have both right- and left-hand threads to provide equal adjustment for each wheel.

(3) After the adjustment is completed, position the tie rod adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and are angled upward (Fig. 2).

(4) Tighten the adjustment sleeve clamp bolts with 41 N•m or 30 ft-lbs torque.

(5) If necessary, the steering wheel can be centered by adjusting the drag link adjustment sleeve. When the adjustment is completed, position the drag link adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and they are angled upward (Fig. 2) and tighten them with 41 N•m or 30 ft-lbs torque.

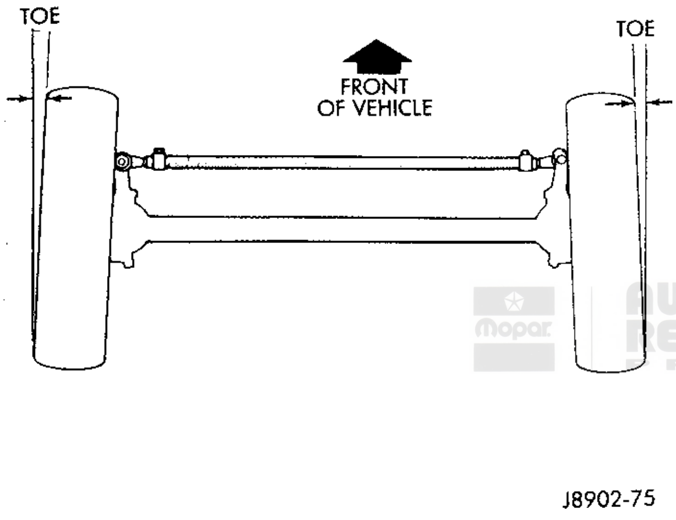


Fig. 1 Toe Position Measurement

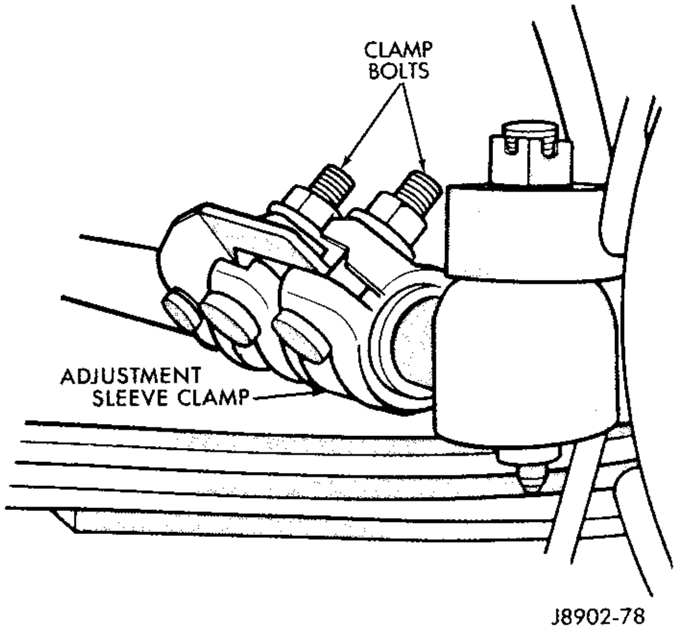


Fig. 2 Tie Rod/Drag Link Adjustment Sleeve Clamp Bolts

MJ/XJ Vehicles

Accurate alignment equipment is recommended to measure the toe position.

(1) Measure the toe position. The acceptable range is from 1/32 inch (0.79 mm) toe-in, to 1/32 inch (0.79 mm) toe-out. The desired toe position is zero (0). Refer to the Alignment Specifications chart.

The front wheel toe position is adjusted with the drag link adjustment sleeve and with the tie rod (Fig. 3). The drag link adjustment sleeve adjusts the right wheel toe position and the tie rod the left wheel toe position.

(2) Center the steering gear according to the following instructions:

- turn the steering wheel to the right until the right-side steering stop is contacted;
- turn the steering wheel to the left and count the number of turns required to contact the left-side steering stop; and
- turn the steering wheel back to the right one-half the number of "stop-to-stop" turns and lock the steering wheel at that position.

(3) Adjust the right wheel toe position:

- loosen the drag link adjustment sleeve clamp bolts (Fig. 3);
- turn the drag link adjustment sleeve (Fig. 3) **CC or CCW** with an appropriate turning tool until the right wheel toe is at the zero (0) position;
- position the drag link adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and they are angled upward (Fig. 2); and

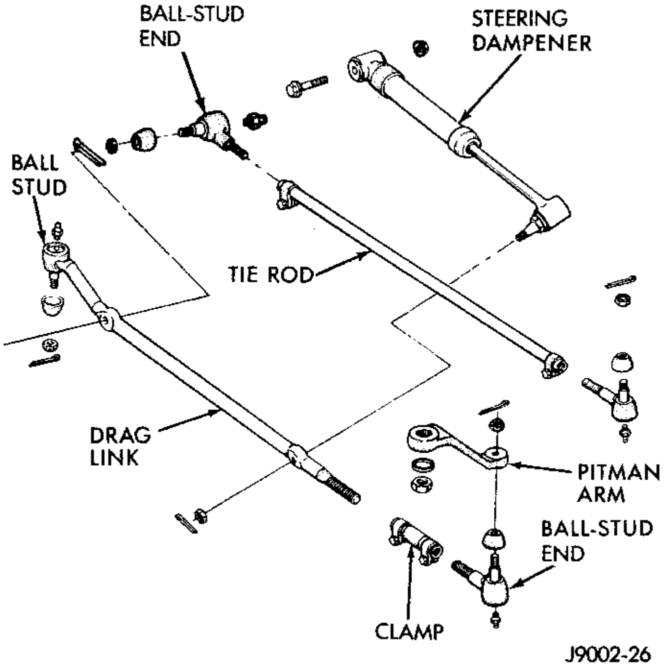


Fig. 3 Toe Adjustment—MJ/XJ Vehicles

- tighten the drag link adjustment sleeve clamp bolts (Fig. 3) with 19 N•m or 14 ft-lbs torque.

(4) Adjust the left wheel toe position:

- loosen the clamp bolts at each end of the tie rod (Fig. 3);
- turn the tie rod (Fig. 3) **CC or CCW** with an appropriate turning tool until the left wheel toe is at the zero (0) position;
- position the tie rod clamp bolts so that the bolt heads face the rear of the vehicle (Fig. 4); and
- tighten the tie rod clamp bolts with 49 N•m or 36 ft-lbs torque.

YJ Vehicles

Accurate alignment equipment is recommended to measure the toe position.

(1) Measure the toe position. The acceptable range is from 1/32 inch (0.79 mm) toe-in, to 1/32 inch (0.79 mm) toe-out. The desired toe position is zero (0). Refer to the Alignment Specifications chart.

(2) To adjust for the correct toe position, loosen the tie rod adjustment sleeve clamp bolts and move the tie rod (and wheels) in or out by turning the adjustment sleeve **CC or CCW** with an appropriate turning tool (Fig. 5).

The tie rod and the adjustment sleeve (Fig. 5) have both right- and left-hand threads to provide equal adjustment for each wheel.

(3) After the adjustment is completed, position the tie rod adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and they are angled upward (Fig. 2).

(4) Tighten the adjustment sleeve clamp bolts with 19 N•m or 14 ft-lbs torque.

(5) If necessary, the steering wheel can be centered by loosening the clamps and adjusting the drag link (Fig. 5). When the adjustment is completed, position the drag link clamp bolts so that the bolt heads face the rear of the vehicle (Fig. 4) and tighten them with 49 N•m or 36 ft-lbs torque.

Camber Measurement—All Vehicles

The correct wheel camber (vertical tilt) angle (Fig. 6) is factory "preset" at zero degrees (0°) for all Jeep vehicles and cannot be altered by adjustment. It is important that the camber (vertical tilt) angle be the same for both front wheels. The camber angle should be measured with accurate wheel alignment equipment. Refer to the applicable specification chart.

CAUTION: Do not attempt to adjust the camber angle by heating or bending the axle or any suspension component. If the camber angle is incorrect, the component(s) causing an incorrect camber angle must be replaced.

Caster Measurement And Adjustment

If the caster angle appears to be correct and the axle is not bent or twisted, a satisfactory test for assurance can be made by road testing the vehicle and observing the steering wheel "return-to-center" position.

Before road testing, check and correct the tire inflation pressures. Be particularly careful to inflate both of the front tires with exactly the same pressure.

During the road test, turn the steering wheel from side-to-side and make vehicle turns to both the left and right. If the wheels turn easily to either side and the steering wheel returns toward the center position unassisted, the caster angle is correct. However, if the wheels turn to either side easily but the steering wheel does not return toward the center position unassisted, an incorrect caster angle is probable.

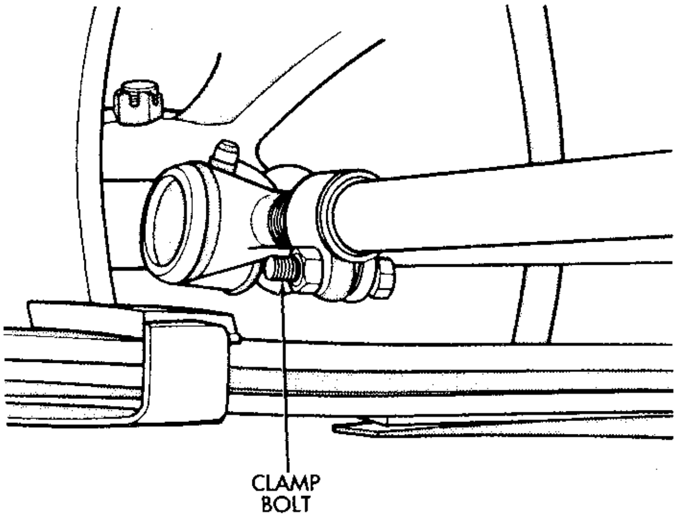


Fig. 4 Tie Rod/Drag Link Clamp Bolt

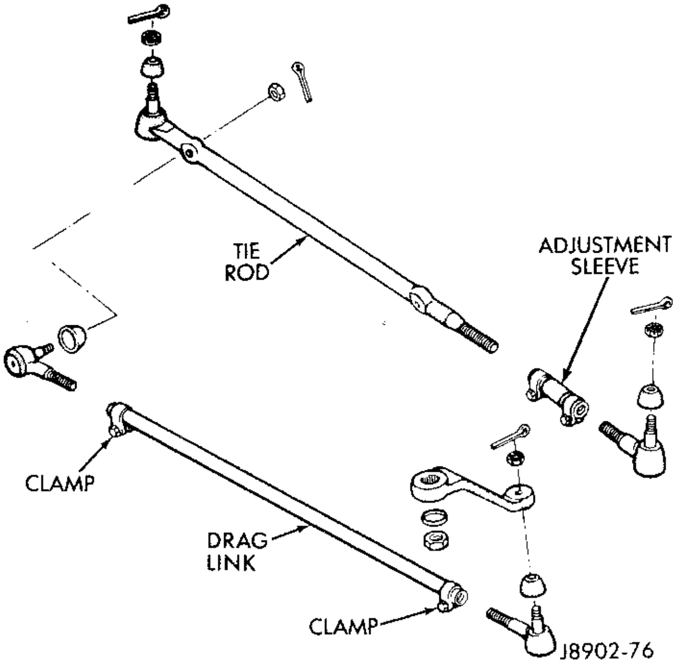


Fig. 5 Toe Adjustment—YJ Vehicles

SJ Vehicles

The caster angle is factory "preset" at positive four degrees (+4°). The acceptable range is +4° to +5°.

The caster angle should be measured with accurate wheel alignment equipment. If the caster angle is incorrect, it can be adjusted by installing appropriate size, tapered shims between the front axle pads and the spring brackets.

MJ/XJ Vehicles

The caster angle is factory "preset" at positive six degrees (+6°). The acceptable range is +5° to +9°.

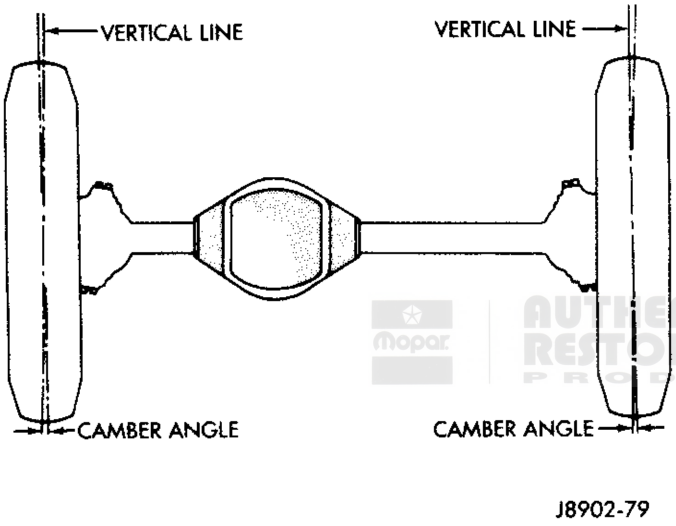


Fig. 6 Camber Angle

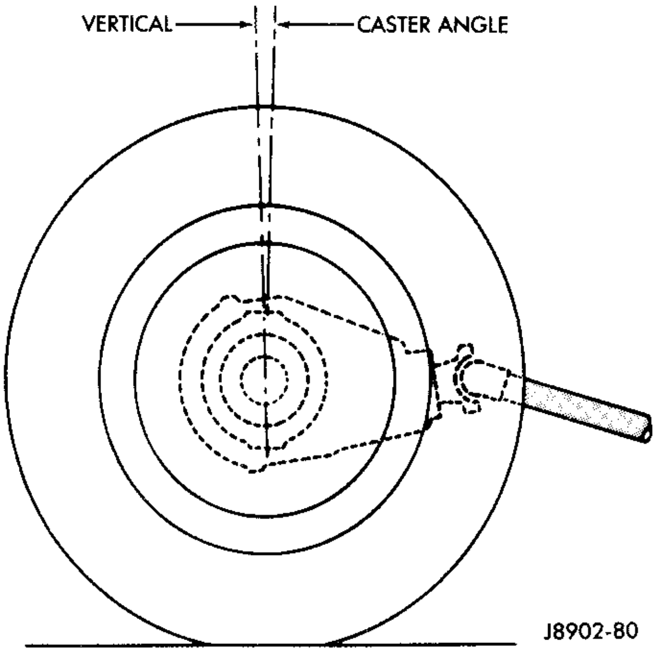


Fig. 7 Caster Angle

The caster angle should be measured with accurate wheel alignment equipment and adjusted to six degrees (6°) only if the angle is less than five degrees (5°). It can be adjusted by adding or removing shims at the rear of the lower suspension arms.

The shim adjustment will change both the caster angle and the front drive shaft angle (four-wheel drive vehicles only). If both angles cannot be adjusted to be within the applicable specified limits, the drive shaft angle has priority and should be adjusted for its specified angle. Refer to Group 16 for additional service information.

YJ Vehicles

The caster angle is factory "preset". For vehicles equipped with a manual transmission, the caster angle is "set" at positive eight degrees (+8°). The acceptable range is +7-1/2° to +8-1/2°. For vehicles equipped with an automatic transmission, the caster angle is "set" at positive six and one-half degrees (+6-1/2°). The acceptable range is +6° to +7°.

The caster angle should be measured with accurate wheel alignment equipment. It can be adjusted by installing appropriate size, tapered shims between the front axle pads and the spring brackets. The shims must have center slots machined in them to allow clearance for the spring center bolt.

The shim caster angle adjustment will change both the caster angle and front drive shaft angle. If both angles cannot be adjusted to be within the applicable specified limits, the drive shaft angle has priority and should adjusted for its specified angle. Refer to Group 16 for additional service information.

TURNING ANGLE ADJUSTMENT

SJ Vehicles

The acceptable outside-wheel turning angle is 36 to 37 degrees for SJ vehicles. The turning angle adjustment screws are located at the rear of each steering knuckle and slightly above the axle centerline. If an adjustment is necessary, proceed with the following instructions.

(1) Loosen the locknuts on the turning angle adjustment screws.

(2) Using a turntable to measure the angle, adjust the adjustment screws to obtain the correct outside turning angle for each wheel. Adjust the outside turning angle for 37 degrees.

Turning the adjustment screw inward increases the turning angle. Turning the adjustment screw outward decreases the turning angle.

(3) Tighten the adjustment screw locknuts.

STEERING WHEEL ALIGNMENT

SJ And YJ Vehicles

After measuring and correcting the front wheel alignment, the steering wheel can be centered, if necessary, according to the following instructions.

(1) Turn the steering wheel until the spokes are in the centered position and clamp the steering wheel in place.

(2) For SJ vehicles, loosen the drag link adjustment sleeve clamps and turn the sleeve with a turning tool until the front wheels are in the straight-ahead position.

(3) For YJ vehicles, loosen both drag link clamps and turn the drag link **CC or CCW** with a turning tool until the front wheels are in the straight-ahead position.

(4) For SJ vehicles, after the adjustment is completed, position the drag link adjustment sleeve clamp bolts so that the threaded ends of the bolts face rearward and they are angled upward (Fig. 2).

(5) For SJ vehicles, tighten the adjustment sleeve clamp nuts with 41 N•m or 30 ft-lbs torque.

(6) For YJ vehicles, after the adjustment is completed, position the drag link clamp bolts so that the bolt heads face the rear of the vehicle (Fig. 4).

(7) For YJ vehicles, tighten the drag link clamp bolts with 49 N•m or 36 ft-lbs torque.

(8) Road test the vehicle and observe the steering wheel alignment.

SPECIFICATIONS

Torque Specifications—SJ Vehicles

Component	Service Set-To Torque	Service Recheck Torque
Drag Link Clamp Bolt	41 N•m (30 ft-lbs)	34-47 N•m (25-35 ft-lbs)
Drag Link End-to-Tie Rod Nut (5/8-18)	95 N•m min. (70 ft-lbs min.)	
Drag Link End-to-Pitman Arm Nut (9/16-18)	81 N•m min. (60 ft-lbs min.)	
Pitman Arm-to-Pitman Shaft Nut	251 N•m (185 ft-lbs)	217-285 N•m (160-210 ft-lbs)
Steering Dampener Locknut	41 N•m (30 ft-lbs)	33-49 N•m (24-36 ft-lbs)
Upper Ball-Stud Retaining Nut	136 N•m (100 ft-lbs)	
Upper Ball-Stud Split-Ring Seat	68 N•m (50 ft-lbs)	
Tie-Rod Clamp Bolt (7/16-14)	41 N•m (30 ft-lbs)	34-47 N•m (25-35 ft-lbs)
Tie-Rod End Stud Nut	81 N•m min. (60 ft-lbs min.)	
Wheel Lug Nut	102 N•m (75 ft-lbs)	88-108 N•m (65-80 ft-lbs)
Differential Housing Cover Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Drag-Link End Nut	95 N•m min. (70 ft-lbs min.)	
Differential Bearing Cap Bolt	108 N•m (80 ft-lbs)	95-122 N•m (70-90 ft-lbs)
Disc Brake Shield Bolt	11 N•m (8 ft-lbs)	7-14 N•m (5-10 ft-lbs)
Spindle Nut	38 N•m (28 ft-lbs)	34-41 N•m (25-30 ft-lbs)
Disc Brake Shield Nut	47 N•m (35 ft-lbs)	41-54 N•m (30-40 ft-lbs)
Lower Ball Stud Jamnut	108 N•m min. (80 ft-lbs min.)	
Drive Pinion Gear Shaft Yoke Nut	271 N•m (200 ft-lbs)	265-278 N•m (195-205 ft-lbs)
Ring Gear-to-Case Bolt	75 N•m (55 ft-lbs)	61-81 N•m (45-65 ft-lbs)
Support Plate Bolt/Nut	41 N•m (30 ft-lbs)	34-47 N•m (25-35 ft-lbs)
Shock Absorber Lower Nut	61 N•m (45 ft-lbs)	109-163 N•m (80-120 ft-lbs)
Spring Rear Eye-to-Hanger Nut	136 N•m (100 ft-lbs)	109-163 N•m (80-120 ft-lbs)
Spring Shackle Bolt/Nut	136 N•m (100 ft-lbs)	
Spring U-Bolt Nut (9/16-18)	136 N•m (100 ft-lbs)	115-142 N•m (85-105 ft-lbs)
Universal Joint Flange Bolt	47 N•m (35 ft-lbs)	34-61 N•m (25-45 ft-lbs)
Drive Shaft U-Joint Strap Bolt	22 N•m (16 ft-lbs)	20-26 N•m (15-19 ft-lbs)
Track Bar Axle Bracket Nut	100 N•m (74 ft-lbs)	90-110 N•m (67-81 ft-lbs)
Track Bar Frame Bracket Nut	168 N•m (125 ft-lbs)	122-214 N•m (90-156 ft-lbs)
Stabilizer Bar Frame Bracket Nut	47 N•m (35 ft-lbs)	41-54 N•m (30-40 ft-lbs)
Stabilizer Bar Connecting Link Nut	75 N•m (55 ft-lbs)	61-81 N•m (45-65 ft-lbs)

J9002-21

Torque Specifications—MJ/XJ Vehicles

Component	Service Set-To Torque	Service Recheck Torque
Pitman Arm-to-Steering Gear Nut	251 N•m (185 ft-lbs)	217-285 N•m (160-210 ft-lbs)
Drag Link-to-Pitman Arm Nut	81 N•m (60 ft-lbs)	67-100 N•m (50-75 ft-lbs)
Drag Link-to-Steering Knuckle Nut	47 N•m (35 ft-lbs)	34-61 N•m (25-45 ft-lbs)
Tie Rod-to-Steering Knuckle Nut	47 N•m (35 ft-lbs)	34-61 N•m (25-45 ft-lbs)
Drag-Link Adjustment Sleeve Clamp Bolt	19 N•m (14 ft-lbs)	16-22 N•m (12-16 ft-lbs)
Steering Dampener-to-Axle Bracket Nut	75 N•m (55 ft-lbs)	60-90 N•m (44-66 ft-lbs)
Steering Dampener-to-Drag-Link Nut	47 N•m (35 ft-lbs)	34-61 N•m (25-45 ft-lbs)
Steering Knuckle Ball Stud-to-Axle Yoke Nut	102 N•m (75 ft-lbs)	88-115 N•m (65-85 ft-lbs)
Tie-Rod Clamp Bolt	49 N•m (36 ft-lbs)	40-58 N•m (30-42 ft-lbs)
Steering Gear-to-Frame Rail Bolt	88 N•m (65 ft-lbs)	75-102 N•m (55-75 ft-lbs)
Front Stabilizer Bar-to-Frame Sill	75 N•m (55 ft-lbs)	65-85 N•m (48-63 ft-lbs)
Front Stabilizer Bar-to-Link Nut	36 N•m (27 ft-lbs)	31-42 N•m (23-31 ft-lbs)
Upper Suspension Arm at Axle Nut	75 N•m (55 ft-lbs)	65-85 N•m (48-62 ft-lbs)
Upper Suspension at Frame Rail Nut	90 N•m (66 ft-lbs)	80-100 N•m (59-75 ft-lbs)
Lower Suspension Arm at Axle and Rear Bracket Nut	180 N•m (133 ft-lbs)	160-200 N•m (118-148 ft-lbs)
Front Shock Lower Bolt	19 N•m (14 ft-lbs)	16-22 N•m (12-16 ft-lbs)
Track Bar-to-Axle Bracket Nut	100 N•m (74 ft-lbs)	90-110 N•m (67-81 ft-lbs)
Drive Shaft U-Joint Strap Bolt	19 N•m (14 ft-lbs)	16-23 N•m (12-17 ft-lbs)
Stabilizer Bar Link-to-Axle Bracket Nut	95 N•m (70 ft-lbs)	80-110 N•m (59-81 ft-lbs)
Wheel Lug Nut	102 N•m (75 ft-lbs)	81-122 N•m (60-90 ft-lbs)
Pinion Gear Shaft Yoke Nut	271 N•m (200 ft-lbs)	265-278 N•m (195-205 ft-lbs)
Brake Caliper Mounting Pin	40 N•m (30 ft-lbs)	34-47 N•m (25-35 ft-lbs)
Brake Caliper Mounting Bolt	105 N•m (77 ft-lbs)	95-115 N•m (70-85 ft-lbs)
Axle Hub-to-Shaft Nut	237 N•m (175 ft-lbs)	203-271 N•m (150-200 ft-lbs)
Wheel Bearing and Hub Assembly-to-Knuckle Bolt	101 N•m (75 ft-lbs)	95-108 N•m (70-80 ft-lbs)
Differential Housing Cover Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Steering Knuckle Slotted Nut	136 N•m (100 ft-lbs)	118-153 N•m (87-113 ft-lbs)
Differential Bearing Cap Bolt	77 N•m (57 ft-lbs)	70-91 N•m (52-67 ft-lbs)
Ring Gear-to-Case Bolt	75 N•m (55 ft-lbs)	61-88 N•m (45-65 ft-lbs)
Axle Shift Motor Housing Bolt	11 N•m (101 in-lbs)	9.5-12.2 N•m (94-108 in-lbs)
Track Bar-to-Frame Rail Bracket Nut	85 N•m (63 ft-lbs)	68-102 N•m (50-75 ft-lbs)
Track Bar Bracket-to-Frame Rail Stud Nut	100 N•m (74 ft-lbs)	90-110 N•m (67-81 ft-lbs)
Track Bar Bracket-to-Frame Rail Bolt	121 N•m (90 ft-lbs)	110-130 N•m (81-96 ft-lbs)

J9002-58

Torque Specifications—YJ Vehicles

Component	Service Set-To Torque	Service Recheck Torque
Pitman Arm Nut	251 N•m (185 ft-lbs)	217-285 N•m (160-210 ft-lbs)
Drag Link-to-Pitman Arm Nut	81 N•m (60 ft-lbs)	67-100 N•m (50-75 ft-lbs)
Drag Link-to-Tie Rod Nut	47 N•m (35 ft-lbs)	34-61 N•m (25-45 ft-lbs)
Tie Rod-to-Steering Knuckle Nut	47 N•m (35 ft-lbs)	34-61 N•m (25-45 ft-lbs)
Tie-Rod Adjustment Sleeve Clamp Bolt	19 N•m (14 ft-lbs)	16-22 N•m (12-16 ft-lbs)
Steering Dampener-to-Axle Bracket Bolt	75 N•m (55 ft-lbs)	60-90 N•m (44-66 ft-lbs)
Steering Knuckle Slotted Nut	136 N•m (100 ft-lbs)	118-153 N•m (87-113 ft-lbs)
Drag-Link Clamp Bolts	49 N•m (36 ft-lbs)	40-58 N•m (30-42 ft-lbs)
Steering Dampener-to-Tie Rod Nut	71 N•m (53 ft-lbs)	61-81 N•m (45-60 ft-lbs)
Front Shock Absorber Upper Nut	13 N•m (9 ft-lbs)	7-19 N•m (5-14 ft-lbs)
Front Shock Absorber Lower Eye Bolt	61 N•m (45 ft-lbs)	47-75 N•m (35-55 ft-lbs)
Track Bar Frame Bracket Nut Bolt	168 N•m (125 ft-lbs)	122-214 N•m (90-156 ft-lbs)
Stabilizer Bar-to-Link Bolt	61 N•m (45 ft-lbs)	48-75 N•m (35-55 ft-lbs)
Stabilizer Bar Frame Bracket Bolt	41 N•m (30 ft-lbs)	34-48 N•m (25-35 ft-lbs)
Stabilizer Bar Link-to-Spring Bracket Bolt	61 N•m (45 ft-lbs)	48-75 N•m (35-55 ft-lbs)
Front/Rear Spring Eye-to-Schackle Bolt	129 N•m (95 ft-lbs)	115-142 N•m (85-105 ft-lbs)
Front/Rear Spring Eye-to-Frame Bracket Bolt	142 N•m (105 ft-lbs)	129-156 N•m (95-115 ft-lbs)
Spring Bracket U-Bolt Nut	122 N•m (90 ft-lbs)	108-136 N•m (80-100 ft-lbs)
Wheel Lug Nut	102 N•m (75 ft-lbs)	81-122 N•m (60-90 ft-lbs)
Track Bar-to-Axle Bracket Nut	100 N•m (74 ft-lbs)	90-110 N•m (67-81 ft-lbs)
Drive Shaft U-Joint Strap Bolt	19 N•m (14 ft-lbs)	16-23 N•m (12-17 ft-lbs)
Brake Caliper Mounting Pin	40 N•m (30 ft-lbs)	34-47 N•m (25-35 ft-lbs)
Brake Caliper Mounting Bolt	105 N•m (77 ft-lbs)	95-115 N•m (70-85 ft-lbs)
Axle Hub-to-Shaft Nut	237 N•m (175 ft-lbs)	203-271 N•m (150-200 ft-lbs)
Wheel Bearing and Hub Assembly-to-Knuckle Bolt	101 N•m (75 ft-lbs)	95-108 N•m (70-80 ft-lbs)
Differential Housing Cover Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Differential Bearing Cap Bolt	77 N•m (57 ft-lbs)	70-91 N•m (52-67 ft-lbs)
Ring Gear-to-Differential Case Bolt	75 N•m (55 ft-lbs)	61-88 N•m (45-65 ft-lbs)
Axle Shift Motor Housing Bolt	11 N•m (101 ft-lbs)	9.5-12.2 N•m (94-108 in-lbs)
Slip Yoke Nut	74 N•m (55 ft-lbs)	68-81 N•m (50-60 ft-lbs)
Drive Pinion Gear Shaft Yoke Nut	271 N•m (200 ft-lbs)	265-278 N•m (195-205 ft-lbs)

J9002-20

REAR AXLES

CONTENTS

GENERAL SERVICE INFORMATION

INDEX

DESCRIPTION

The Model 35 axle and the Model 44 axle are both "semi-floating" axle shaft type rear axles. The axle housings consist of a nodular cast iron differential housing (center section) and two steel axle shaft tubes that are pressed into the differential housing (center section).

One of the axle shaft tubes has a fitting for a vent hose that is used to relieve the internal pressure caused by lubricant vaporization and internal component expansion. The oil seals and the axle shaft bearings are located within the axle shaft tubes.

APPLICATIONS

The Model 35 axle is the standard rear axle for MJ/XJ and YJ vehicles. The Model 44 axle is the standard rear axle for SJ vehicles and is also used for MJ vehicles that are equipped with a "Metric Ton" package.

IDENTIFICATION

For both the Model 35 rear axle and the Model 44 rear axle, the axle production date and the manufacturer's identification number are stamped on the right-side axle shaft tube near the housing cover (Fig. 1). The axle assembly part number and the axle gear ratio are listed on a tag attached to the left side of the housing cover (Fig. 1).

The Model 35 axle has a 7 and 9/16-inch (19.2-cm) diameter ring gear. The Model 44 axle has an 8 and 1/2-inch (21.59-cm) diameter ring gear.

AXLE RATIOS

The rear axle gear ratios for both the Model 35 and the Model 44 axles installed in Jeep vehicles are listed in

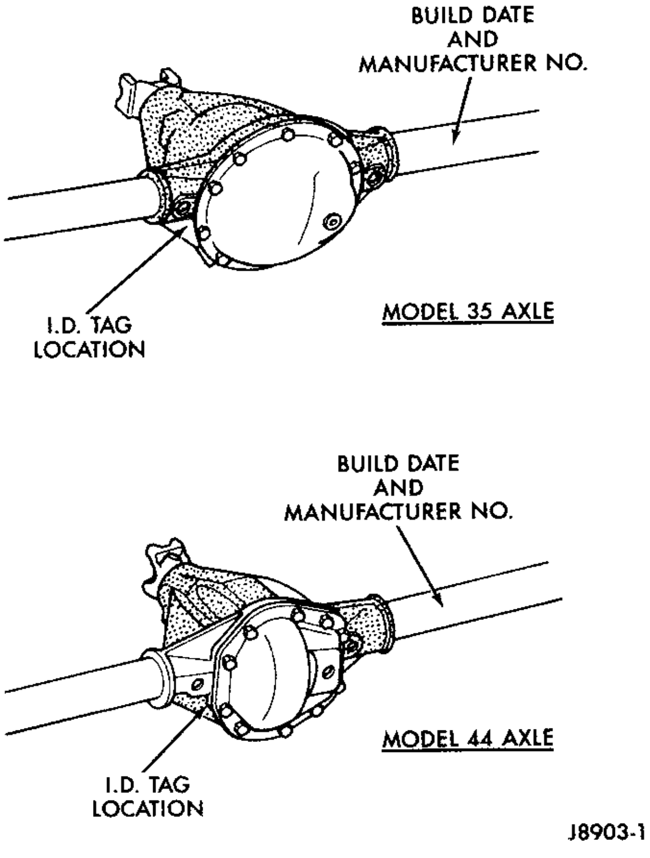


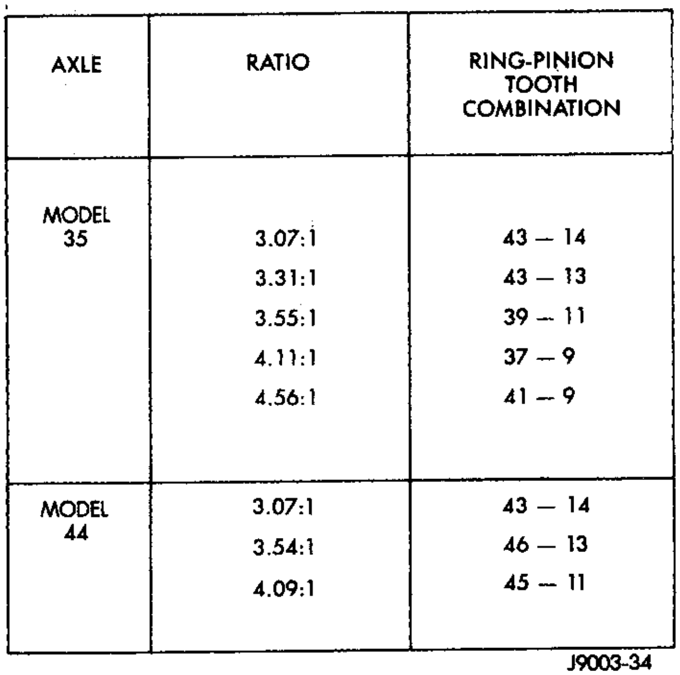
Fig. 1 Rear Axle Identification

the Axle Gear Ratios chart (Fig. 2). The chart also lists the ring gear-pinion gear tooth combinations for identification purposes.

LUBRICANTS

The standard lubricant for the Model 35 and the Model 44 rear axles is SAE 75W-90, API grade GL 5 hypoid gear lubricant. For 5000-pound trailer towing applications with a Model 35 rear axle, replace the standard lubricant with MOPAR (synthetic-type) 80W-140 Hypoid Gear Lubricant.

When refilling a **Trac-Lok** (i.e., a limited-slip) rear differential housing after repair service or a lubricant change, also add MOPAR Trac-Lok Lubricant. This friction modifier additive is compatible with both standard and synthetic-type gear lubricants.



AXLE	RATIO	RING-PINION TOOTH COMBINATION
MODEL 35	3.07:1	43 — 14
	3.31:1	43 — 13
	3.55:1	39 — 11
	4.11:1	37 — 9
	4.56:1	41 — 9
MODEL 44	3.07:1	43 — 14
	3.54:1	46 — 13
	4.09:1	45 — 11

J9003-34

Fig. 2 Axle Gear Ratios

SERVICE DIAGNOSIS

INDEX

GENERAL DIAGNOSIS INFORMATION

Axle bearing problem conditions are usually caused by:

- insufficient or incorrect lubricant;
- foreign matter/water contamination; or
- incorrect bearing "preload" torque adjustment.

Also, when serviced, the bearings must be cleaned thoroughly and dried only with lint-free shop towels. **Never dry bearings with compressed air. This will overheat them and "brinell" the bearing surfaces, which will result in noisy operation after repair.**

Axle gear problem conditions are usually the result of:

- insufficient lubrication;
- incorrect or contaminated lubricant;
- overloading (excessive engine torque); or
- incorrect clearance or "backlash" adjustment.

Insufficient lubrication is usually the result of a housing cover leak; worn (or defective) axle shaft or drive pinion gear shaft seals; or cracks/porous areas in the housing or axle shaft tubes.

Using a lubricant that is not acceptable for axle gear use can result in overheating and the failure of gear and bearing surfaces. Gear tooth "cracking" and bearing "spalling" are two prime indicators of this situation.

Axle component breakage is most often the result of:

- severe "overloading" (engine torque);
- insufficient lubricant;
- incorrect lubricant; or
- improperly tightened components.

Two common causes of "overloading" are frequent full-throttle acceleration (from a standing start) and towing heavier-than-recommended boats, trailers, etc. In addition, component breakage can also occur when the wheels are "spun" excessively in mud, sand, snow, or on "icy" pavement. Insufficient or incorrect lubricants contribute to breakage through overheating and consequential metal fatigue. Loose differential case bolts, loose axle shaft seal retainer nuts, and a loose drive pinion gear shaft nut can also cause component breakage.

Generally, an incorrect bearing "preload" torque or gear "backlash" adjustment will not result in component breakage. In most instances, mis-adjustment will produce enough noise to cause service repair before a failure occurs. However, if a mis-adjustment condition is not corrected within a reasonable period of time, component failure can result.

TIRE NOISE

Tires that are damaged, unbalanced, incorrectly inflated, or have extremely deep mud/snow treads can emit noise that is often mistaken for axle noise. An informed, alert listener can usually differentiate between tire and axle noise during a road test.

The amplitude of tire noise will usually vary according to the type of road surface but axle noise will not. Tire noise amplitude is also somewhat sensitive to changes in inflation pressure. However, the pitch (frequency) of tire noise is constant and only changes when the vehicle speed is varied. Axle noise will usually stop when the vehicle speed drops below the peak-noise speed range or if the transmission is shifted into neutral.

During a road test, drive the vehicle over different road surfaces (concrete, asphalt, gravel) and note the changes in the noise. If the noise changes noticeably, or even ceases and then resumes on a different road surface, the tires are the source of the noise.

Refer to Group 22—Tires And Wheels for additional information involving tire noise.

AXLE GEAR AND BEARING NOISE

Gear Noise

Axle gear noise is most often caused by either insufficient lubricant, incorrect ring gear "backlash" or incorrect ring/drive pinion gear tooth contact, or worn/damaged gears.

Axle gear noise is usually confined to a specific speed range such as 30 to 40 mph, or above 50 mph. The noise can also occur during a specific type of driving condition (e.g., acceleration, deceleration, coast, or constant load).

When road testing, accelerate the vehicle to the speed range where the noise volume is the greatest; then shift out-of-gear and coast through the peak-noise speed range. If the noise stops or changes greatly, the condition could be caused by insufficient axle lubricant, excessive or insufficient ring gear "backlash", or gear damage.

Differential side and pinion gears usually do not cause noise in straight-ahead driving because these gears are only "loaded" when the rear wheels travel at different speeds during vehicle turns. However, if gear noise does occur during vehicle turns, the side or pinion gears could be worn or damaged. A worn pinion gear mate shaft can also cause a "snapping" or a "knocking" noise along with the gear noise.

Bearing Noise

The axle shaft, differential and drive pinion gear shaft bearings can all produce noise when worn or damaged. Bearing noise can be either a "whining", a "grating", or a "growling" sound.

Drive pinion gear shaft bearings usually emit a constant-pitch noise that changes only with vehicle speed. Because these bearings rotate at speeds higher than the differential bearings, drive pinion gear shaft bearing noise is almost always higher in pitch than noise produced by differential bearings. If the bearing noise is most pronounced when the differential is "loaded", the drive pinion gear shaft rear bearing is the source of the noise. If the bearing noise is most pronounced during a "coast" condition, the drive pinion gear shaft front bearing is the source of the noise.

Worn, damaged differential bearings usually produce noise that is lower in pitch than that produced by drive pinion gear shaft bearings. Differential bearing noise is similar to drive pinion gear shaft bearing noise because the pitch of differential bearing noise is also constant and varies only with vehicle speed.

Axle shaft bearings can produce both noise and vibration when worn or damaged. The noise generally changes when the bearings are "loaded". Turning the vehicle sharply to the left and to the right or lightly applying the brakes, will "load" the bearings and change the noise level. In instances where axle bearing damage is slight, the noise is usually not noticeable at speeds above 30 mph.

LOW SPEED KNOCK

Low speed knock is generally caused by a worn U-joint or by worn side-gear thrust washers. A worn pinion gear shaft bore will also cause low speed knock. If the side-gear thrust washer mating surfaces on the differential case are severely worn, it will be necessary to replace the case, the thrust washers and, possibly, the side gears.

VIBRATION

Vibration at the rear of the vehicle is usually caused by a:

- damaged drive shaft;
- missing drive shaft balance weight;
- worn, out-of-balance wheels/tires;
- loose wheel lug nuts;
- worn U-joint;
- loose spring U-bolts;
- loose/broken rear springs or shackles;
- damaged axle shaft bearings;
- loose drive pinion gear shaft nut;
- excessive drive pinion gear shaft (axle) yoke "run out"; or
- bent axle shaft.

In some situations, loose or damaged front-end components or engine/transmission mounts can also contribute to what appears to be a rear-end vibration. In addition, do not overlook engine accessories, brackets and drive belts. All of these components can cause vibration that appears to be located at the rear of the vehicle.

When diagnosing a vibration condition, if the actual cause is not readily apparent, all driveline components should be examined before starting any repair.

Refer to Group 22—Tires And Wheels for additional information involving vibration diagnosis.

DRIVELINE SNAP

A "snap" or "clunk" noise when the vehicle is shifted into gear (or the clutch engaged), can be caused by:

- high engine idle speed;
- loose engine/transmission/transfer case mounts;
- worn U-joints;
- loose spring shackles or U-bolts;
- loose drive pinion gear shaft nut and yoke;
- excessive ring gear "backlash"; and
- excessive differential side gear-to-case clearance.

With 2WD vehicles, a worn bushing in the transmission extension housing can also cause noise.

In many instances, the source of a "snap" or a "clunk" noise can be determined on a hoist with the assistance of a helper. Raise the vehicle on a hoist with the wheels free to rotate. Instruct the helper to shift the transmission into gear. If the cause of the noise is not readily apparent, a mechanics stethoscope is frequently helpful in isolating the source of a noise.

TRAC-LOK DIFFERENTIAL DIAGNOSIS

With normal tire traction conditions, engine torque is divided evenly. With low-traction surfaces, engine torque is transferred to the wheel with the most tire traction. When diagnosing a suspected **Trac-Lok** (i.e., limited-slip) differential problem condition, it is important to remember: **if the tire traction is unequal (or low) at both wheels, both wheels will "slip" or "spin"**. When extreme differences in wheel-to-wheel tire traction exist, the wheel with the least tire traction can continue "spinning" regardless of the fact that maximum torque was transferred to the opposite wheel.

Generally, the most common **Trac-Lok** differential problem condition encountered is a "chatter" noise when turning corners. A common cause of this is incorrect or contaminated lubricant. Changing the axle gear lubricant (and adding MOPAR Trac-Lok Lubricant friction modifier additive) will correct the condition in most instances. However, if the "chatter" persists, clutch disc damage could have occurred.

After changing the lubricant in a **Trac-Lok** differential, drive the vehicle and make 10 to 12 slow, figure-eight turns. This type of maneuver ensures that the replacement lubricant is pumped through the clutch discs.

MODEL 35 AXLE SERVICE

INDEX

GENERAL SERVICE INFORMATION

The service procedures contained within this section can be utilized with the complete axle either installed or removed from the vehicle.

The ring gear and the drive pinion gear in Model 35 axles are supplied as a "matched set" and must not be individually interchanged or replaced. **Verify that the "ID" numbers etched into a replacement gear set are identical before installation.**

The ring gear and the differential case in current Model 35 rear axles are also a "matched set" and they **are not** interchangeable with a ring gear and a differential case set that was manufactured for 1987 and earlier Model 35 axles.

LUBRICANT

Drain And Refill—MJ/XJ And YJ Vehicles

(1) Drive the vehicle until the axle lubricant attains the normal operating temperature.

(2) Raise and support the vehicle.

(3) Clean all the foreign material from the area where the differential housing cover mates with the differential housing.

(4) Remove the lubricant fill hole plug from the differential housing cover.

(5) Loosen the differential housing cover bolts and allow the original lubricant to completely drain from the housing and the axle shaft tubes.

(6) Remove the housing cover.

CAUTION: DO NOT FLUSH Trac-Lok differentials. Trac-Lok differentials may be cleaned only by disassembling the unit and wiping with clean, lint-free cloths.

(7) Flush standard differentials and the housing cavity with a *flushing* oil (or light engine oil) to remove residual lubricant and foreign material. **Do not use water, steam, kerosene or gasoline for flushing.**

(8) Remove any residual RTV sealant/gasket material from the differential housing and cover, thoroughly clean the contact surfaces with mineral spirits (or an equivalent solution) and dry the surfaces completely.

(9) Apply a thin *bead* of MOPAR RTV Sealant, or an equivalent sealant, around the bolt circle on the housing and on the cover.

If for any reason the housing cover is not installed within 20 minutes after applying the sealant, the sealant must be removed and another *bead* of sealant applied.

(10) Install the housing cover on the differential housing with the attaching bolts. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

(11) Refill the differential housing with 2.5 pints (1.2 liters) of SAE 75W-90, API grade GL 5 hypoid gear lubricant (or, if applicable, synthetic-type MOPAR 80W-140 Hypoid Gear Lubricant). With **Track-Lok** (i.e., limited-slip) differentials, a container of Track-Lok Lubricant additive (a friction modifier) can also be added.

(12) Install and tighten the fill hole plug with 34 N•m (25 ft-lbs) torque.

(13) Remove the supports and lower the vehicle.

(14) With **Trac-Lok** differentials, drive the vehicle and make 10 to 12 slow, figure-eight turns. This type of maneuver will ensure that the replacement lubricant is pumped through the clutch discs.

AXLE SHAFT, SEAL AND BEARING

Axle Shaft Removal—MJ/XJ And YJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the wheel/tire.

(3) Remove the brake drum.

(4) Clean all the foreign material from the area where the differential housing cover mates with the differential housing.

(5) Loosen the differential housing cover bolts and drain the lubricant from the housing and the axle shaft tubes. Remove the housing cover.

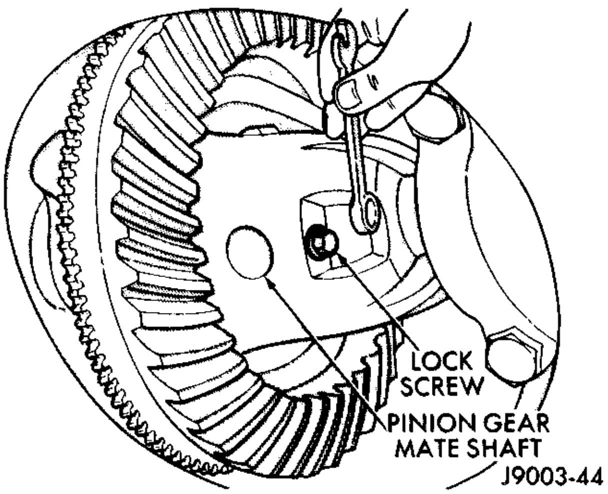


Fig. 1 Pinion Gear Mate Shaft Lock Screw

(6) Rotate the differential case so that the differential pinion gear mate shaft lock screw is accessible. Remove the lock screw and the pinion gear mate shaft from the differential case (Fig. 1).

Removing the pinion gear mate shaft will allow clearance for the axle shaft to be moved inward to provide accessibility to the C-clip "lock".

(7) Force the applicable axle shaft toward the center of the vehicle and remove the axle shaft C-clip "lock" from the recessed groove in the axle shaft (Fig. 2) with two screwdrivers or another appropriate tool. Place the screwdriver blade ends simultaneously against the C-clip ends and force the C-clip off the shaft.

(8) Remove the axle shaft from the differential side gear and the axle shaft tube. Use care to prevent damage to the axle shaft bearing and seal, which will remain in the axle tube.

(9) Inspect the bearing contact surface on the axle shaft for evidence of "brinelling", "spalling" and "pitting".

(10) If any of these conditions exist, both the axle shaft and the bearing must be replaced.

The normal appearance from bearing contact on the shaft will be a dull gray area that could appear slightly dented.

(11) If necessary, remove the axle shaft seal to inspect the exposed end of the axle shaft bearing for damage.

Axle Shaft Seal And Bearing Removal—MJ/XJ And YJ Vehicles

(1) With the axle shaft removed from the axle shaft tube, remove the axle shaft seal from the end of the axle shaft tube with a small pry bar.

(2) Remove the bearing if it appears damaged or if the axle shaft exibits any of the conditions described above.

If bearing inspection prior to removal is not necessary, the seal and the bearing can be removed simultaneously with the bearing removal tool.

(3) Remove the axle shaft bearing from the axle tube (Fig. 3) with Bearing Removal Tool Set 6310 (T.Ar 960-02):

- select the adapter tool with the smallest "foot" from the removal tool set;
- thread the adapter onto the threaded rod;
- with the "foot" parallel with the adapter bracket, insert it through the bearing bore and pivot it 90° (i.e., pivot it perpendicular to the bracket) with an appropriate device; and
- position the guide against the axle shaft tube and turn the nut against the guide plate to remove the bearing.

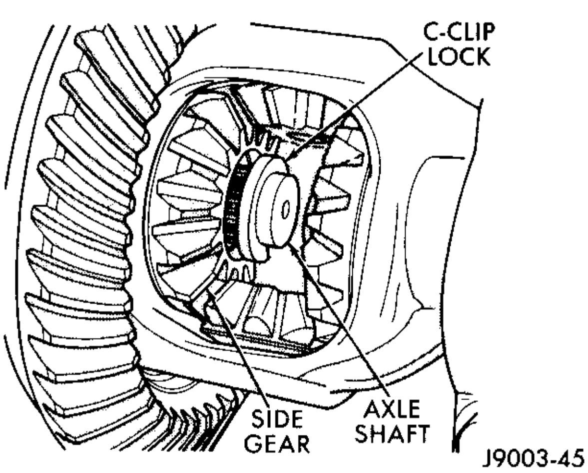


Fig. 2 Axle Shaft C-Clip Lock

Axle Shaft Seal And Bearing Installation—MJ/XJ And YJ Vehicles

Do not install the original axle shaft seal or bearing. Always install a replacement seal and bearing.

(1) Wipe the axle shaft bearing bore in the axle shaft tube clean.

(2) Attach Driver Handle Tool C-4171 to Bearing Installation Tool 6436.

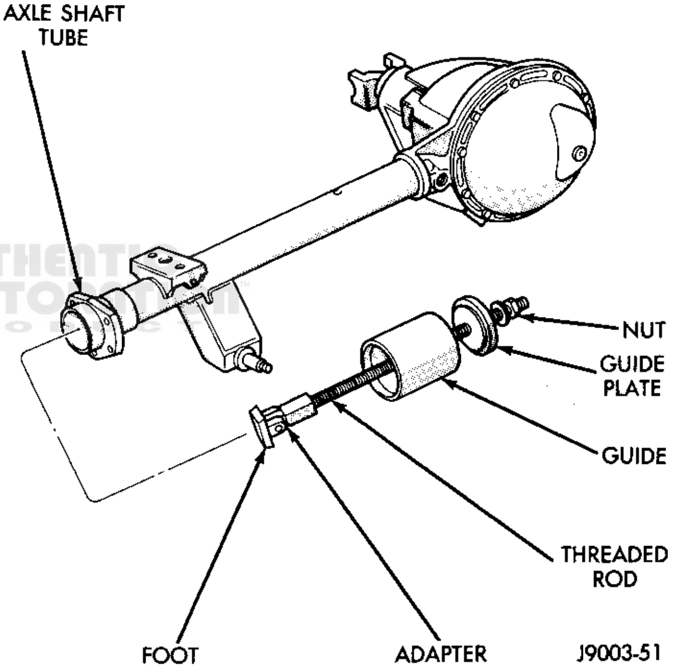


Fig. 3 Axle Shaft Bearing Removal Tool

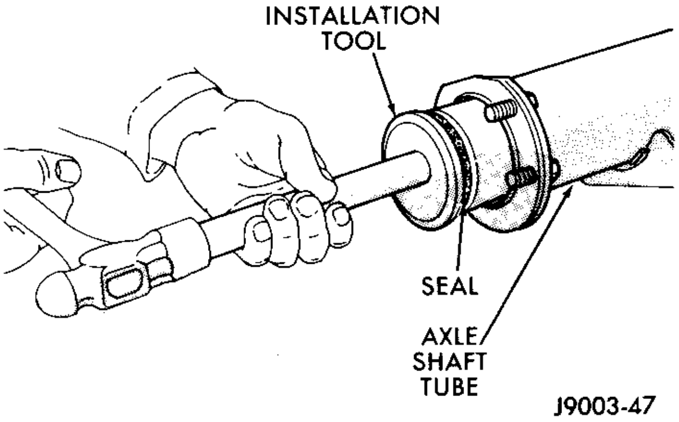


Fig. 4 Axle Shaft Seal Installation

(3) Position the replacement axle shaft bearing on the "pilot" of Bearing Installation Tool 6436.

(4) Insert the axle shaft bearing into the axle shaft tube bore. Ensure that the bearing is not "cocked" in the bore and tap the driver handle tool until the bearing is "seated" firmly against the "shoulder" in the axle tube.

CAUTION: DO NOT use the replacement axle shaft seal to position or "seat" the bearing in the axle shaft bore because this will damage the seal and cause lubricant leakage from the axle shaft tube.

(5) Install the replacement axle shaft seal (Fig. 4) in the axle shaft tube with Seal Installation Tool 6437 and Driver Handle Tool C-4171. The flat side of the installation tool must face the seal.

(6) When the installation tool contacts the axle tube "face", the seal will be positioned at the proper depth in the bore.

Axle Shaft Installation—MJ/XJ And YJ Vehicles

(1) Lubricate the bearing bore and the seal lip, insert the axle shaft into the axle shaft tube and engage its splines with the differential side gear splines. **Use care to prevent the shaft splines from damaging the axle shaft seal lip.**

(2) With the axle shaft in place, install the C-clip "lock" in the recessed groove at the end of the axle shaft (Fig. 2). Force the axle shaft outward to "seat" the C-clip "lock" in the differential side gear counterbore.

(3) Insert the differential pinion gear mate shaft into the case, and through the thrust washers and the pinion gears. Align the hole in the shaft with the lock screw hole in the case and install the lock screw (Fig. 1). Tighten the screw with 19 N•m (14 ft-lbs) torque.

(4) Remove any residual RTV sealant/gasket material from the differential housing and cover, thoroughly clean the contact surfaces with mineral spirits (or an equivalent solution) and dry the surfaces completely.

(5) Apply a thin "bead" of MOPAR RTV Sealant, or an equivalent sealant, around the bolt circle on the housing and on the cover.

If for any reason the housing cover is not installed within 20 minutes after applying the sealant, the sealant must be removed and another "bead" of sealant applied.

(6) Install the housing cover on the differential housing with the attaching bolts. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

(7) Install the brake drum and the wheel/tire. Tighten the wheel lug nuts in the proper sequence with 102 N•m (75 ft-lbs).

(8) Remove supports and raise or lower the hoist until the vehicle is level.

(9) Remove the fill hole plug and fill the differential housing and the axle tubes with 1.2 liters (2.5 pints) of SAE 75W-90, API grade GL 5 hypoid gear lubricant (or, if applicable, synthetic-type MOPAR 80W-140 Hypoid Gear Lubricant) and, if applicable, a container of Trac-Lok Lubricant additive (a friction modifier). Install the fill hole plug and tighten with 34 N•m (25 ft-lbs).

(10) Lower the vehicle and test the brakes and the axle for proper operation.

(11) For **Trac-Lok** (i.e., limited-slip) differentials, drive the vehicle and make 10 to 12 slow, figure-eight turns. This type of maneuver will ensure that the replacement lubricant is pumped through the clutch discs.

DRIVE PINION GEAR SHAFT SEAL REPLACEMENT

Removal—MJ/XJ And YJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the rear wheels/tires and the brake drums.

(3) Mark the rear drive shaft yoke and the drive pinion gear shaft (axle) yoke for installation alignment reference (Fig. 5).

(4) Disconnect and remove the drive shaft from the drive pinion gear shaft (axle) yoke.

(5) Rotate the drive pinion gear shaft three or four times.

(6) Measure the amount of torque (in inch-pounds or Newton-meters) necessary to rotate the drive pinion gear shaft. Record the torque for installation reference. **It must be known to properly adjust the drive pinion gear shaft bearing "preload" torque.**

(7) Remove the drive pinion gear shaft nut (Fig. 6) with Flange Removal/Installation Tool 8023 (J8614-1) and a wrench. Discard the nut, it is not reusable.

(8) Mark the positions of the yoke and the drive pinion gear shaft for installation alignment reference.

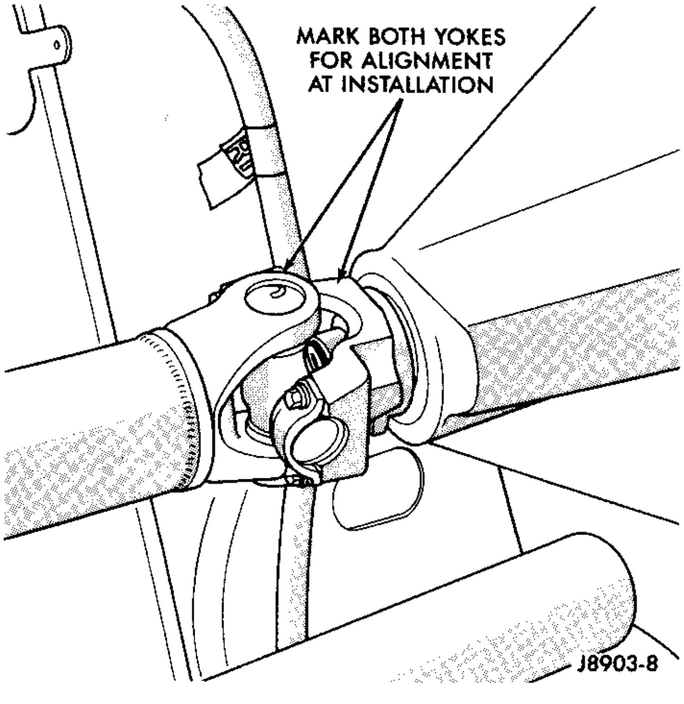


Fig. 5 Yoke Alignment Marks

(9) Remove the drive pinion gear shaft (axle) yoke. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke (Fig. 7).

(10) Remove the drive pinion gear shaft seal (Fig. 8).

Installation—MJ/XJ And YJ Vehicles

(1) Apply gear lubricant to the lip of the replacement seal.

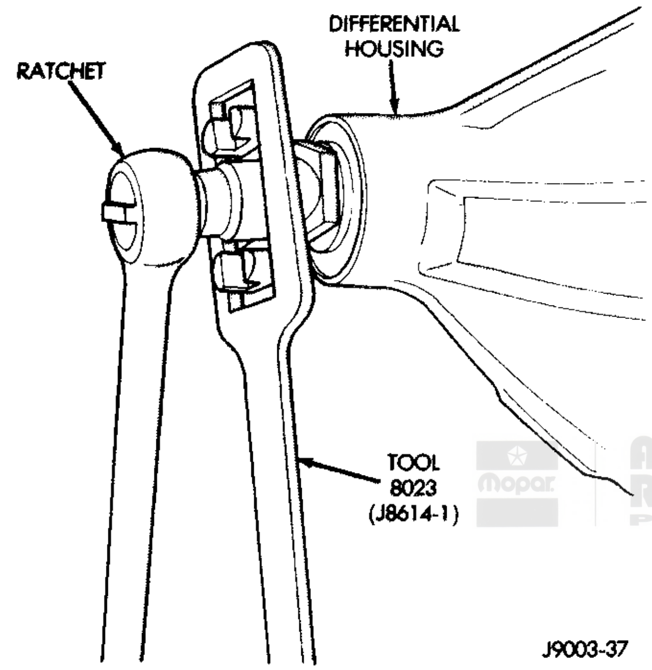


Fig. 6 Drive Pinion Gear Shaft Nut Removal

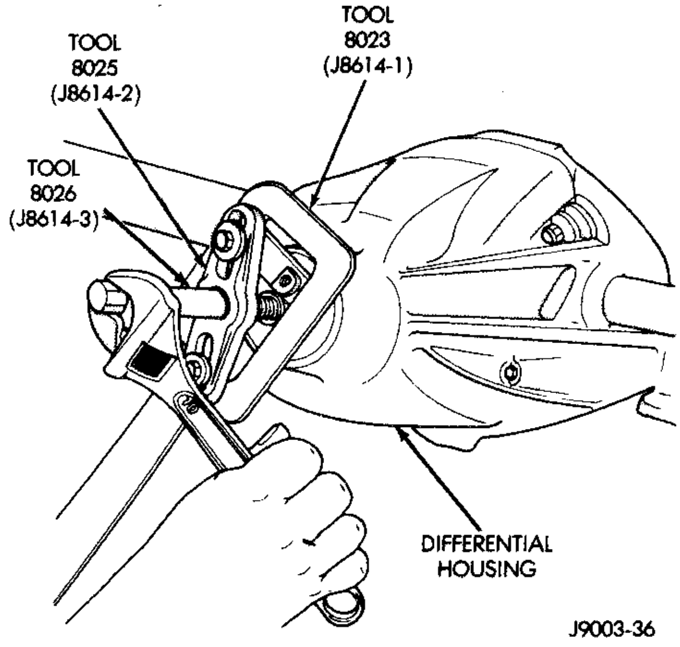


Fig. 7 Axle Yoke Removal

(2) Install the replacement seal on the drive pinion gear shaft (Fig. 9) with Seal Installation Tool 6272 (J22661).

(3) Align the installation reference marks and install the yoke on the drive pinion gear shaft.

(4) Install a replacement nut on the drive pinion gear shaft. **Tighten the nut only enough to remove the shaft "end play".**

CAUTION: Exercise care during the bearing "preload" torque adjustment. Do not over-tighten, or loosen and then re-tighten the drive pinion gear shaft nut. If the required bearing "preload" torque is exceeded, the collapsible "preload" torque spacer on the shaft will have to be replaced and the bearing "preload" torque readjusted afterward.

(5) Adjust the drive pinion gear shaft bearing "preload" torque according to the following instructions:

- place a socket wrench with a Newton-meter or an

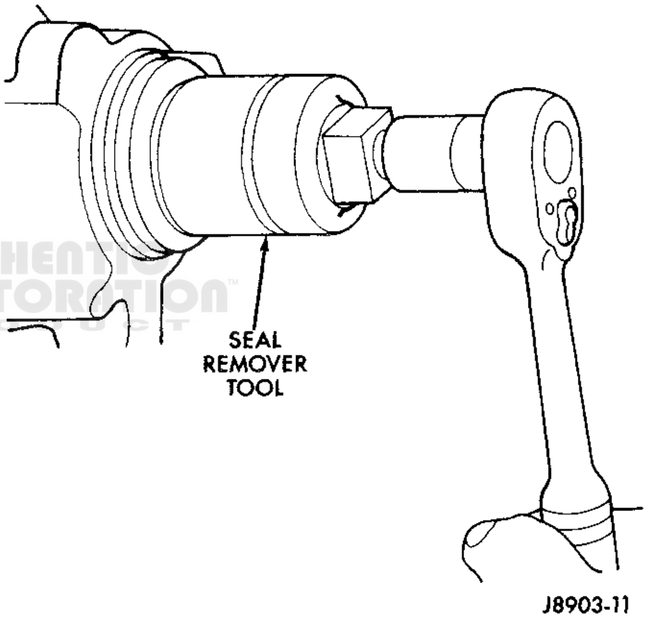


Fig. 8 Shaft Seal Removal

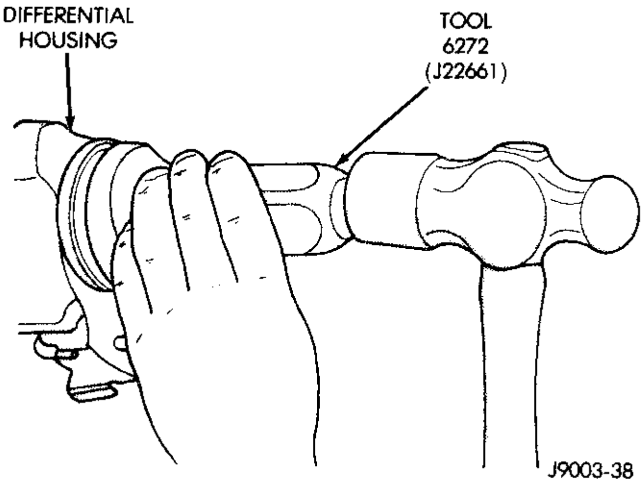


Fig. 9 Shaft Seal Installation

inch-pound torque wrench on the shaft nut;

- rotate the shaft with the torque wrench and note the torque;

The required drive pinion gear shaft bearing "preload" torque is equal to the amount recorded during removal, plus an additional 0.56 N•m (5 in-lbs) torque.

- use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and shaft and tighten the shaft nut in very small increments; and
- measure the "preload" torque frequently and continue tightening the shaft nut in small increments until the correct bearing "preload" torque is attained.

(6) Align the installation reference marks and attach the drive shaft to the yoke. Tighten the U-joint clamp bolts with 19 N•m (170 in-lbs/14 ft-lbs) torque.

(7) Install the brake drums and the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(8) Check the lubricant level in the differential housing. Add lubricant, if necessary.

(9) Remove the supports and lower the vehicle.

DIFFERENTIAL CASE REMOVAL/INSTALLATION

The following procedures apply to either a standard or a **Trac-Lok** (i.e., limited-slip) differential.

Removal—MJ/XJ And YJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the differential housing cover and drain the lubricant.

(3) Mark the drive pinion gear shaft (axle) yoke and the drive shaft yoke for installation alignment reference (Fig. 10) and disconnect the drive shaft.

(4) If the drive pinion gear shaft, the bearings or the seal are also being serviced, measure and record the drive pinion gear shaft bearing "preload" torque according to the following instructions:

- rotate drive pinion gear shaft three or four times;
- measure and note the amount of "preload" torque in Newton-meters or inch-pounds that is necessary to rotate the drive pinion gear shaft; and
- retain the amount of measured "preload" torque for installation reference (it is required for the drive pinion gear shaft bearing "preload" torque adjustment).

(5) Remove the rear wheels/tires and the brake drums.

(6) Remove the axle shafts. If necessary, refer to the removal procedure.

(7) Mark the differential bearing caps for installation reference.

(8) Loosen the bearing cap bolts until only two or three bolt threads are engaged.

(9) If necessary for differential case removal, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(10) If the spreader tool is being used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(11) If necessary, separate the differential housing only enough to remove the differential case from the housing. **Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated.

(12) If installed, remove the dial indicator when the differential housing has been separated sufficiently to remove the case from the housing.

(13) Pry the differential case loose from the housing.

(14) Remove the bearing cap bolts and the bearing caps.

(15) Remove the differential case from the housing.

(16) Mark (or tag) the differential bearing cups for installation reference.

(17) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(18) Remove the drive pinion gear shaft, the shaft bearings and the seal if they are to be serviced.

Installation—MJ/XJ And YJ Vehicles

(1) Install the drive pinion gear shaft, the bearings and the seal, if removed. If necessary, refer to the applicable installation and adjustment procedures.

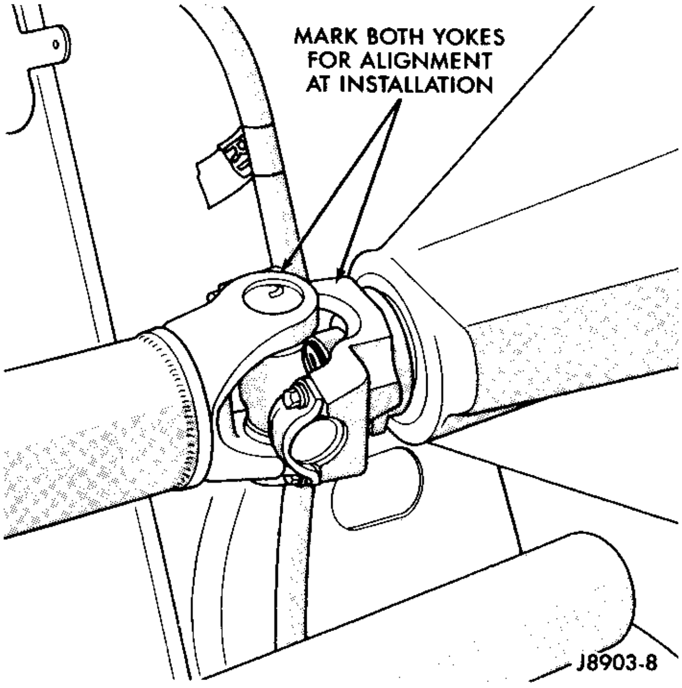


Fig. 10 Yoke Installation Reference

(2) If necessary for differential case installation, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(3) If the spreader tool is being used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) If necessary, separate the differential housing only enough to install the differential case in the housing. **Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated.

(5) If installed, remove the dial indicator when the differential housing has been separated sufficiently to remove the case from the housing.

(6) Observe the installation reference marks and install the bearing cups on the differential bearings.

(7) Install the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them.

(8) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(9) Observe the reference marks and install the differential bearing caps. Tighten the cap bolts with 77 N•m (57 ft-lbs) torque.

(10) If applicable, adjust the ring gear "backlash" and the drive pinion gear depth for the best teeth contact pattern. If necessary, refer to the adjustment procedure within Drive Pinion Gear Shaft Seal Replacement.

(11) If the drive pinion gear shaft, the bearings or the seal were serviced, adjust the bearing "preload" torque. If necessary, refer to the adjustment procedure within Drive Pinion Gear Shaft Seal Replacement.

(12) Align the installation reference marks and connect the drive shaft to the drive pinion gear shaft (axle) yoke. Tighten the U-joint clamp bolts with 19 N•m (170 in-lbs/14 ft-lbs) torque.

(13) Install the axle shafts. If necessary, refer to the installation procedure.

(14) Apply a thin "bead" of MOPAR RTV Sealant (or an equivalent sealant) to the differential housing and cover mating surfaces.

(15) Install the differential housing cover. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

(16) Fill the housing with 2.5 pints (1.2 liters) of the recommended lubricant. With **Trac-Lok** (i.e., limited-slip) differentials, also add a container of Trac-Lok Lubricant additive (a friction modifier).

(17) Install the brake drums and the wheels/tires.

(18) Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(19) Remove the supports and lower the vehicle.

(20) With **Trac-Lok** differentials, drive the vehicle and make 10 to 12 slow, figure-eight turns. This type of maneuver will ensure that the replacement lubricant is pumped through the clutch discs.

COMPLETE AXLE AND DIFFERENTIAL REMOVAL/INSTALLATION

Removal—MJ/XJ And YJ Vehicles

(1) Raise the vehicle.

(2) Position support stands under the frame rails. Place the stands either adjacent to, or slightly in front of the rear spring front eyes.

(3) Remove the rear wheels/tires.

(4) Mark the rear drive shaft yoke and the drive pinion gear shaft (axle) yoke for installation alignment reference.

(5) Disconnect the drive shaft from the drive pinion gear shaft (axle) yoke.

(6) Disconnect the rear track bar (YJ vehicles only) from the axle shaft tube bracket and disconnect the axle vent tube from the axle fitting.

(7) Disconnect the parking brake cables at the equalizer.

(8) Disconnect the shock absorbers from the axle shaft tube brackets.

(9) Disconnect the brake hose from the floorpan fitting. Cap the hose end to prevent foreign matter entry.

(10) Loosen — **but do not remove** — the bolts that attach the spring eyes to the frame brackets and shackles.

(11) Remove the spring U-bolts and the brackets.

(12) Support the axle with a hydraulic jack.

(13) Raise the axle just enough to relieve the axle weight from the springs.

(14) Remove the bolts that attach the springs to the shackles and lower the springs to the floor.

(15) Lower the jack and remove the axle from the vehicle.

Installation—MJ/XJ And YJ Vehicles

(1) Support the axle on a hydraulic jack and move it into position under the rear of the vehicle.

(2) Raise the springs and install the bolts that attach the springs to the shackles. **Do not tighten the bolts at this time.**

(3) Align the center bolts on the springs with the bolt locating holes on the axle.

(4) Lower the axle onto the springs. Install the spring U-bolts and the brackets.

(5) Tighten the U-bolt nuts with 122 N•m (90 ft-lbs) torque.

(6) Connect the axle vent hose, the parking brake cables, and the brake hose.

(7) Align the installation reference marks and connect the drive shaft. Tighten the U-joint clamp bolts with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

It is important that the rear springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the rear track bar is connected to the axle shaft tube bracket, otherwise it will be difficult to align it with the bracket holes. In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(8) Attach the rear track bar (YJ vehicles only) and the shock absorbers to the axle shaft tube brackets.

(9) Tighten the shock absorber-to-axle shaft tube bracket bolts with 60 N•m (44 ft-lbs) torque.

(10) Check and add, if necessary, lubricant to the differential housing.

(11) Install the wheels/tires.

(12) Bleed the brakes.

(13) Remove the supports and lower the vehicle.

(14) Tighten the spring shackle bolts with 129 N•m (95 ft-lbs) torque.

(15) Tighten the spring front eye bolts with 142 N•m (105 ft-lbs) torque.

(16) For YJ vehicles, tighten the track bar-to-axle shaft tube bracket nut with 168 N•m (125 ft-lbs) torque.

STANDARD DIFFERENTIAL SERVICE

Model 35 Axle Differential Specifications

	USA	METRIC
Differential Bearing Preload		
Torque Shims	0.008 in.	0.20 mm
Each Side	0.004 in.	0.10 mm
Differential Side Gear-to-Case Clearance (Max. Each Side)	0.000-0.007 in.	0.00-0.18 mm
Ring Gear Backlash	0.005-0.009 in.	0.13-0.23 mm
Pinion Gear Shaft Bearing Preload Torque	15-25 in-lbs	2-3 N•m
Pinion Gear Depth Standard Setting	2.095 in.	53.21 mm
Lubricant Capacity	2.5 pts.	1.2 liters
Lubricant Type		
Standard	SAE 75W-90, API GL-5	
Trailer Tow	Synthetic Type 80W-140	

J9003-40

Differential Case Removal—MJ/XJ And YJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the differential housing cover and drain the lubricant.

(3) Score installation alignment reference marks on the yokes and disconnect the rear drive shaft from the drive pinion gear shaft (axle) yoke.

(4) Remove the:

- rear wheels/tires,
- brake drums, and
- axle shafts (refer to the removal procedure).

(5) Mark the differential bearing caps with a center-punch for installation reference. Loosen the bearing cap bolts.

(6) If necessary for differential case removal, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(7) If the spreader tool is being used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(8) If necessary, separate the differential housing only enough to remove the differential case from the housing. **Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated.

(9) If used, remove the dial indicator when the differential housing has been separated sufficiently to remove the case from the housing.

(10) Pry the differential case loose from the housing.

(11) Remove the bearing cap bolts and the bearing caps.

(12) Remove the differential case from the housing.

(13) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

Differential Disassembly—MJ/XJ And YJ Vehicles

(1) Clamp the differential case in a vise.

(2) Remove and discard the ring gear attaching bolts.

CAUTION: Do not attempt to pry or chisel the ring gear off of the differential case because the case could be damaged during the process.

(3) Remove the ring gear. Use a brass punch and tap it with a hammer to remove the ring gear from the differential case (Fig. 11).

(4) If not removed, remove the differential pinion gear mate shaft lock screw (Fig. 12).

(5) Remove the differential pinion gear mate shaft (Fig. 12).

(6) Rotate the differential pinion gears until the gears are aligned with the case opening, then remove the differential pinion gears and thrust washers (Fig. 13).

(7) Remove the differential side gears (Fig. 13) and thrust washers.

Differential Bearing Removal

(1) Mark or tag the differential bearing cups for installation reference and remove them.

CAUTION: When removing the differential bearing, ensure that the differential case is securely clamped in a vise or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

(2) Install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and bearing (Fig. 14). If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(3) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(4) Tighten the puller tool or removal tool screw (Fig. 14) and remove the bearing from the differential case hub.

(5) Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

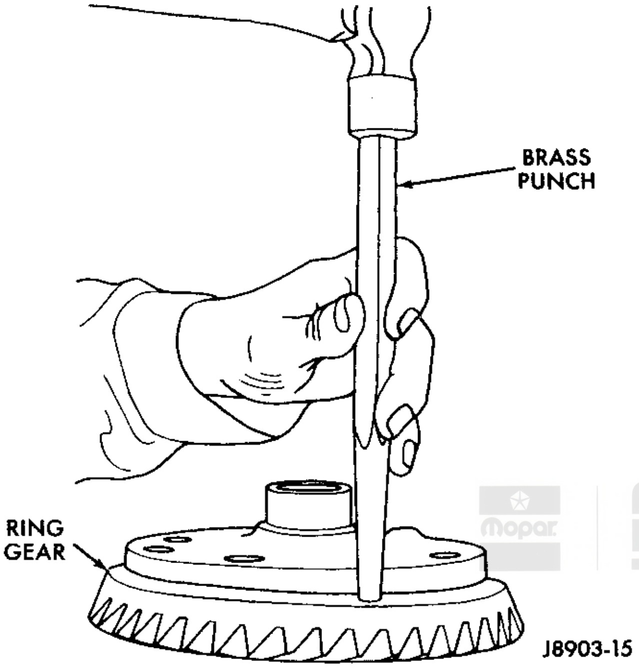


Fig. 11 Ring Gear Removal

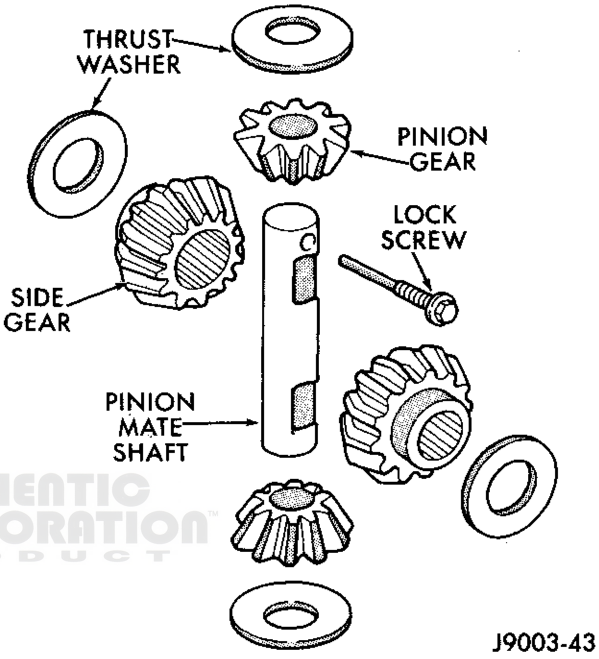


Fig. 13 Pinion Gear & Side Gear Removal

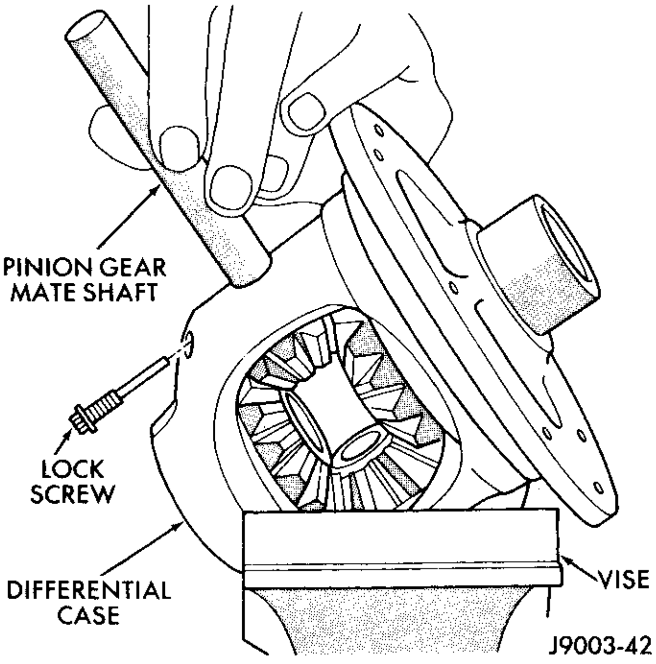


Fig. 12 Pinion Gear Mate Shaft Lock Screw

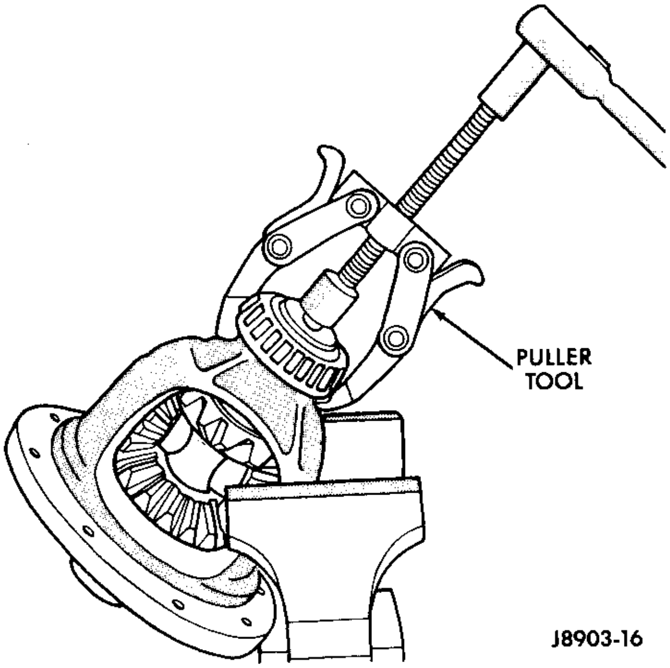


Fig. 14 Differential Bearing Removal

Drive Pinion Gear Shaft Removal

(1) Remove the drive pinion gear shaft (axle) yoke retaining nut and washer. Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke while removing the nut (Fig. 15). Retain the nut for ring gear and drive pinion gear adjustment during assembly.

(2) Remove the drive pinion gear shaft (axle) yoke. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke (Fig. 16).

(3) Remove the drive pinion gear shaft. Strike the exposed end of the shaft with a rawhide hammer to loosen it from the drive pinion gear shaft rear bearing and the differential housing.

(4) Remove the drive pinion gear shaft front bearing, the bearing "preload" torque spacer and the seal from the differential housing. Use a 2 x 2-inch or 5 x 5-cm piece of wood, or length of pipe to drive the bearing, the spacer and the seal out of the housing.

(5) Discard the seal and the spacer after removal.

Drive Pinion Gear Shaft Rear Bearing Removal

(1) Assemble and install a bearing removal tool set (Fig. 17) on the rear bearing and the drive pinion gear shaft.

(2) Insert the bearing removal tool set adapters (Fig. 17) into the removal tool base from the top and position them 180° opposite each other.

(3) Tighten the bearing removal tool screw (Fig. 17) and remove the bearing.

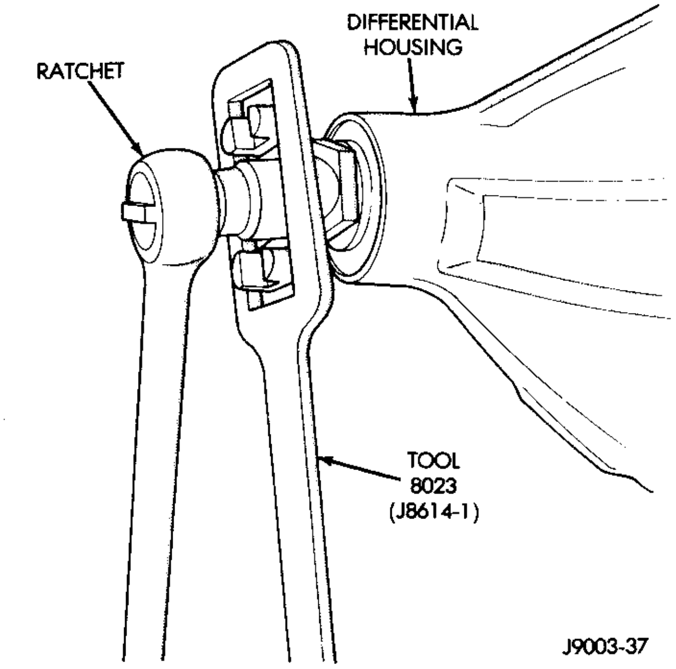


Fig. 15 Pinion Gear Shaft (Axle) Yoke Nut Removal

Drive Pinion Gear Shaft Bearing Cup Removal

(1) Remove the drive pinion gear shaft rear bearing cup. Use a brass drift and a hammer to tap the cup out of the housing.

(2) Remove the drive pinion gear depth shim(s) from the rear bearing cup bore in the differential housing. Retain the depth shim(s) for installation reference (even if they are bent or distorted).

(3) Tap the drive pinion gear shaft front bearing cup from the differential housing with a brass drift and a hammer.

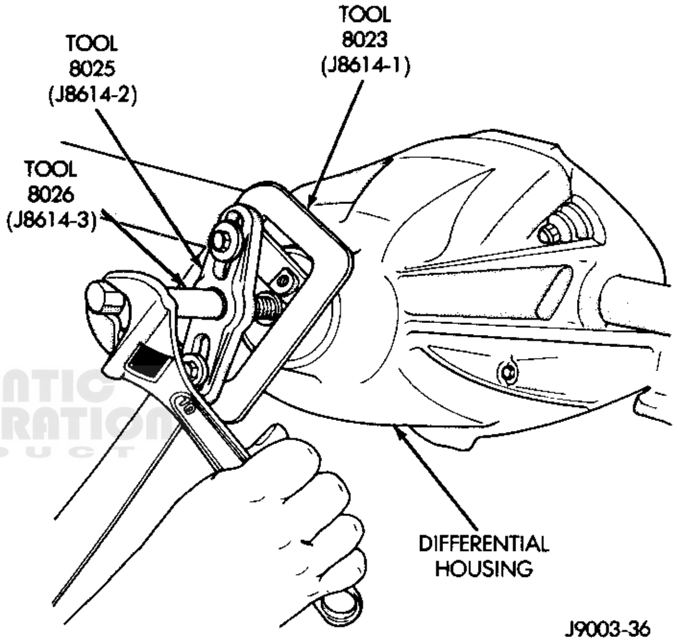


Fig. 16 Pinion Gear Shaft (Axle) Yoke Removal

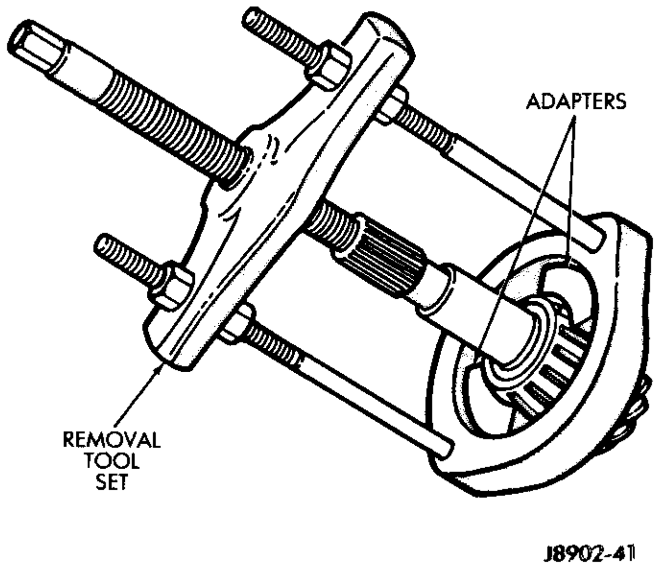
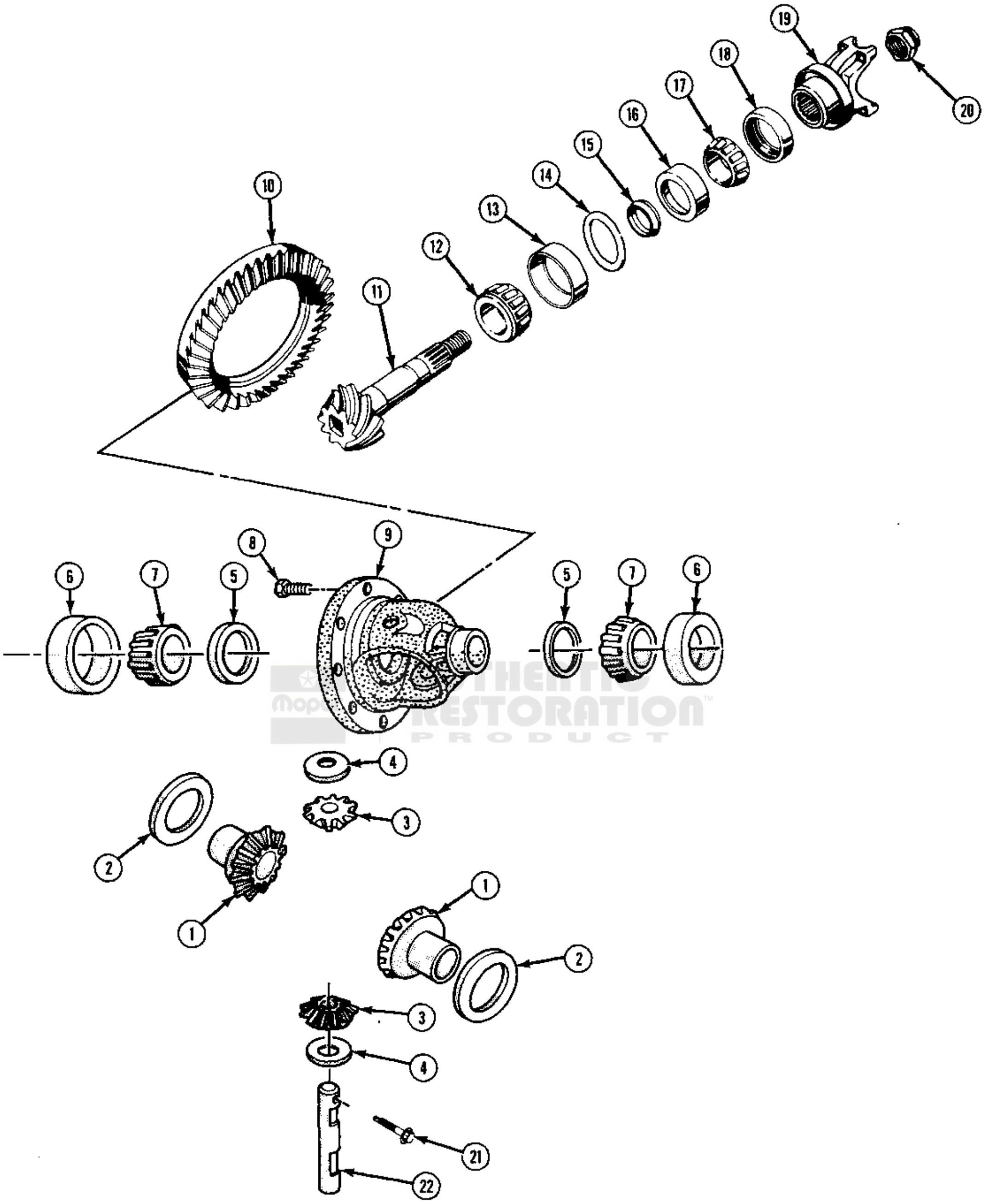


Fig. 17 Pinion Gear Shaft Rear Bearing Removal



1. DIFFERENTIAL SIDE GEAR	12. PINION GEAR REAR BEARING
2. SIDE GEAR THRUST WASHER	13. REAR BEARING CUP
3. DIFFERENTIAL PINION	14. PINION DEPTH SHIM
4. PINION THRUST WASHER	15. PINION BEARING PRELOAD SPACER
5. DIFFERENTIAL BEARING SHIM	16. FRONT BEARING CUP
6. DIFFERENTIAL BEARING CUP	17. PINION GEAR FRONT BEARING
7. DIFFERENTIAL BEARING	18. PINION SEAL
8. REAR GEAR BOLT	19. PINION YOKE
9. DIFFERENTIAL CASE	20. PINION NUT
10. RING GEAR	21. PINION SHAFT LOCK SCREW
11. PINION GEAR	22. DIFFERENTIAL PINION SHAFT

J9003-39

Fig. 18 Model 35 Axle Differential — Exploded View

Cleaning And Inspection—MJ/XJ And YJ Vehicles

(1) Clean all of the differential components in cleaning solvent (Fig. 18). Allow the bearings to either air dry or dry them with a lint-free cloth. Dry the other components with compressed air.

(2) Inspect all of the bearings and cups for "pitting", "galling", "flat spots", and "cracks" (Fig. 18).

(3) Replace any bearing or cup that has any of the defective conditions listed above.

(4) Inspect the differential case (Fig. 18) for an elongated or enlarged differential pinion gear mate shaft bore. The machined thrust washer surface areas and counterbores must be smooth and free of "nicks", "gouges", "cracks", and "burrs".

(5) Inspect the differential case for "cracks", worn shaft and pin bores, and other damage that could necessitate replacement (Fig. 18). If the metal was raised on the bearing cup bore shoulders during bearing cup removal, flatten the raised area with a blunt punch.

(6) Replace the differential case if it is defective.

(7) Inspect the differential pinion gear mate shaft (Fig. 18) for "excessive wear", "scoring", and "galling". The shaft must be smooth and concentric. Replace the shaft if it is either worn, damaged or defective.

(8) Inspect the differential side gears and the pinion gears (Fig. 18). All the gear teeth must have a uniform contact pattern. Inspect the gears and gear teeth for "cracks", "scoring", "excessive wear", and "galling".

(9) Replace all the gears if any **one gear** has any of the defective conditions described above.

(10) Inspect the differential side gear and pinion gear thrust washers for "excessive wear", "scoring", "galling" and "distortion" (Fig. 18).

(11) Replace the washers if they have any of the defective conditions listed above.

(12) Inspect the differential pinion gear mate shaft lock screw (Fig. 18) for damage or for a loose fit in the differential case.

(13) Replace the lock screw or the differential case as necessary.

(14) Inspect the differential ring gear and the drive pinion gear and shaft (Fig. 18) for worn or "chipped" teeth, "cracks", damaged bearing journals and damaged attaching bolt threads.

(15) If replacement is necessary, both gears must be replaced as a **"matched set" only.**

(16) Inspect the drive pinion gear shaft (axle) yoke (Fig. 18) for "cracks", worn splines, and "pitted", rough or corroded seal contact surfaces.

(17) Repair or replace the yoke as necessary.

(18) Inspect the drive pinion gear shaft shims (Fig. 18) for damage and distortion.

(19) Replace any defective shims as necessary during assembly.

Assembly And Adjustment Information—MJ/XJ And YJ Vehicles

The differential ring and drive pinion gears in Model 35 axles must be adjusted for the best possible **gear teeth contact patterns.** The drive pinion gear depth cannot be initially measured and "set" precisely with shims. If the original gear set is installed with the original depth shim(s), the **best possible gear teeth contact patterns** are achieved by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If a replacement gear set must be installed, the best possible gear teeth contact pattern is achieved by using the Pinion Gear Depth Variance chart to "initially" establish the drive pinion gear depth with shim(s) and then by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If necessary, the differential ring gear and drive pinion gear shaft must be replaced as a "matched set" only. They are identified as a "matched set" by the numbers etched into each gear.

The identical first two numbers (Fig. 19) etched into each gear identify them as a "matched set". The second number etched into the drive pinion gear is the depth variance. It indicates the amount (in thousandths of an inch) that the set varied from the standard "setting" of 2.095 inches (53.21 mm) for Model 35 axles. The depth variance can be either a plus (+), zero (0) or a minus (-) value.

If the original gear set is not used, the replacement drive pinion gear **initial** depth shim thickness must be determined before installing the differential in the housing. The depth shim (Fig. 20) is positioned adjacent to the drive pinion gear shaft rear bearing cup.

Refer to the Pinion Gear Depth Variance chart for the required initial depth of a replacement drive pinion

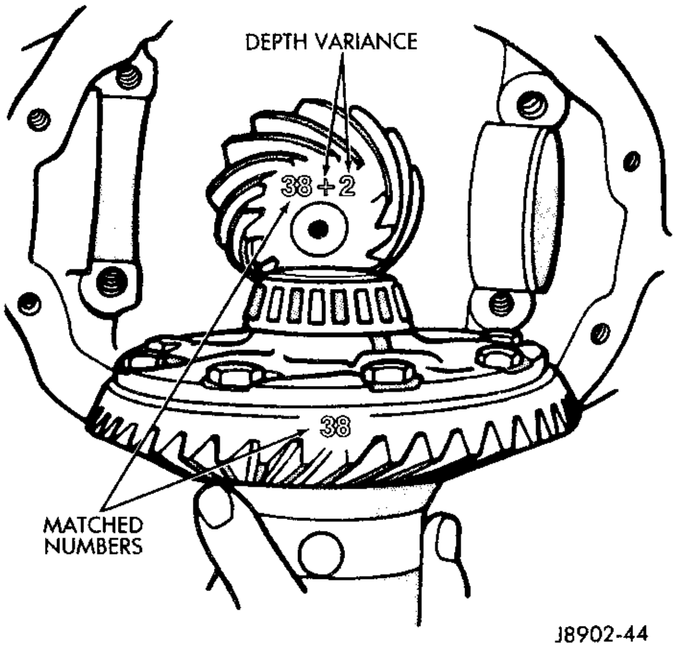


Fig. 19 Matched Ring Gear & Drive Pinion Gear Set

gear shaft. The chart will aide in determining the depth shim thickness needed for establishing the initial depth. **The chart will only help determine the required shim thickness for the initial depth. It will not provide the exact shim thickness necessary to precisely position the pinion gear for the best possible gear teeth contact patterns and must not be used as a substitute for actually analyzing the gear teeth contact patterns and adjusting the drive pinion gear depth and the ring gear "backlash" accordingly.**

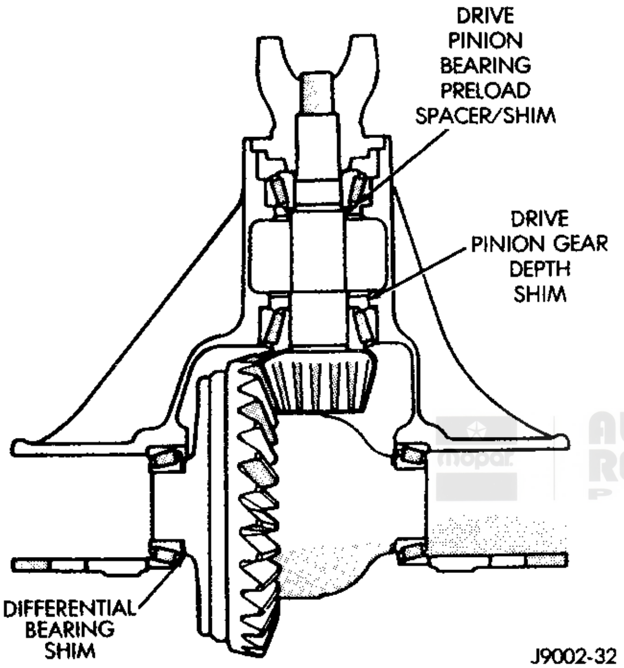


Fig. 20 Depth Shim & Preload Spacer Locations

To use the chart, proceed according to the following instructions:

- measure the thickness of the original drive pinion gear depth shim(s);
- note the depth variance values etched in the original and the replacement drive pinion gears;
- refer to the Original and Replacement Pinion Gear Depth Variance columns in the chart; and
- locate the chart box where the Original and Replacement Pinion Gear Depth Variance columns intersect for the approximate amount of "change" from the original shim thickness that is required to establish the "initial" pinion gear depth for the replacement shaft.

For example, if the original drive pinion gear is etched **-3** and the replacement drive pinion gear is etched **+2,** the initial shim selection procedure is accomplished according to the following instructions:

- refer to the Original Pinion Gear Depth Variance column at the left side of the chart and locate the **-3** value in this column;
- move to the right across the chart until at the **+2** value in the Replacement Pinion Gear Depth Variance column;
- the box where the two columns intersect will provide the amount of **change** in shim thickness required (i.e., -0.005 inch) for the replacement set;
- the value in the intersecting box is -0.005 inch (-0.12 mm), which represents the amount of thickness to be **subtracted** from the original drive pinion gear depth shim(s);
- if the value was zero (0), the initial shim thickness would be the **same** as the original drive pinion gear depth shim(s); and
- if the value was positive (+), this amount of thickness would be **added** to the original drive pinion gear depth shim(s).

Pinion Gear Depth Variance

Original Pinion Gear Depth Variance	Replacement Pinion Gear Depth Variance								
	−4	**−3**	**−2**	**−1**	**0**	**+1**	**+2**	**+3**	**+4**
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

J8902-46

Assembly—MJ/XJ And YJ Vehicles

Drive Pinion Gear Shaft—Assembly And Installation

(1) If applicable, verify that the replacement ring gear and drive pinion gear shaft are a "matched set" before proceeding.

(2) If the original ring gear and drive pinion gear shaft set is being installed, use the original depth shim(s).

(3) If a replacement ring gear and drive pinion gear set is being installed, determine the amount of "thickness" that must be either added to or subtracted from the original depth shim(s) to initially establish the drive pinion gear depth:

- note the depth variance etched in the original and the replacement drive pinion gear;
- refer to the Pinion Gear Depth Variance chart and move to the box where the Original and Replacement Pinion Gear Depth Variance columns intersect; and
- note the value in the box, it will be either a plus (+), zero (0) or a minus (-) value of **change** required from the original shim thickness so that it/they can be used with the replacement gear set.

(4) Clean the drive pinion gear shaft bearing cup bores in the differential housing.

(5) Install the "initial" depth shim(s) in the housing rear bearing cup bore (Fig. 18).

If a depth shim is chamfered on one side, position the chamfered side so that it faces the bottom of the bearing cup bore.

(6) Install the drive pinion gear shaft rear bearing cup in the housing and adjacent to the "initial" depth shim(s) (Fig. 18).

(7) Install the drive pinion gear shaft front bearing cup in the housing (Fig. 18).

(8) Install the rear bearing on the drive pinion gear shaft (Fig. 18) with Bearing Installation Tool 7699 (J24433).

(9) Install the drive pinion gear shaft in the housing (Fig. 18).

Do not install the "preload" torque spacer at this time.

(10) Install the front bearing on the drive pinion gear shaft (Fig. 18). "Seat" the bearing on the shaft and in the cup.

Do not install the drive pinion gear shaft replacement seal at this time.

(11) Install the drive pinion gear shaft (axle) yoke and the original nut on the drive pinion gear shaft (Fig. 18). Tighten the nut only enough to remove the shaft "end play".

(12) Proceed to Differential Case Runout Measurement.

Differential Case Runout Measurement

(1) Install the differential bearings on the case hubs (Fig. 21) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092). **Do not install the bearing shims at this time.**

(2) Observe the installation reference marks and install the bearing cups on the bearings.

(3) If necessary for differential case installation, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(4) If the spreader tool is used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(5) If necessary, separate the differential housing only enough to install the differential case in the housing. **Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated.

(6) If used, remove the dial indicator when the differential housing has been separated sufficiently to install the case in the housing.

(7) Position the differential case in the housing.

(8) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(9) Insert enough spare shims between one of the differential bearings and the housing to eliminate all differential case "side play".

(10) Observe the installation reference marks and install the differential bearing caps and the bolts (Fig. 21). Tighten the bolts securely (no specified torque).

(11) Attach a dial indicator to the housing. Position the dial indicator plunger so that it contacts the ring gear mating face on the differential case (Fig. 22).

(12) Pry the differential case to one side and "zero" the dial indicator pointer.

(13) Rotate the differential case several times and note the dial indicator pointer position as the case rotates.

(14) The differential case "runout" should not exceed 0.002 inch or 0.05 mm. Replace the case if the "runout" exceeds the specified limit.

(15) Retain the dial indicator at this position and proceed to the differential bearing Zero End-Play Adjustment.

Zero End-Play Adjustment

(1) Loosen the differential bearing cap bolts at each side of the differential case.

(2) Remove the spare shims that were used to eliminate the differential case "side play" and retain the differential case in the same position as it was for the "runout" measurement.

(3) Install a 0.142-inch or 3.6-mm thick shim between each differential bearing and the housing (Fig. 23). These shims will provide an "end-play" "coarse" adjustment.

(4) Pry the differential case to one side of the housing and "zero" the dial indicator pointer while at this location.

(5) Pry the differential case to the opposite side of the housing and record the dial indicator "end-play" (distance) measurement. The distance measurement is the **additional** shim thickness required for differential bearing "zero" "end play".

(6) For example, if the "end play" (distance) measurement is 0.008 inch or 0.20 mm, an additional 0.004-inch or 0.10-mm thick shim will be necessary at each side of the housing for differential bearing "zero" "end play".

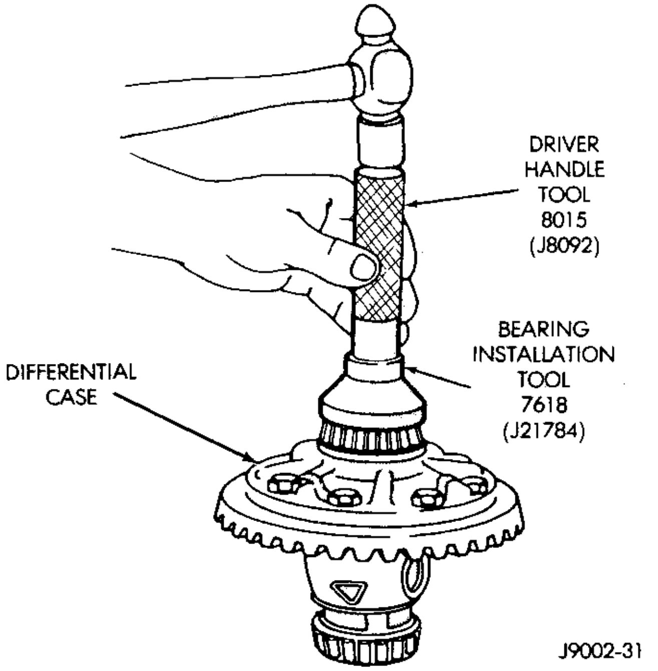


Fig. 21 Differential Bearing Installation

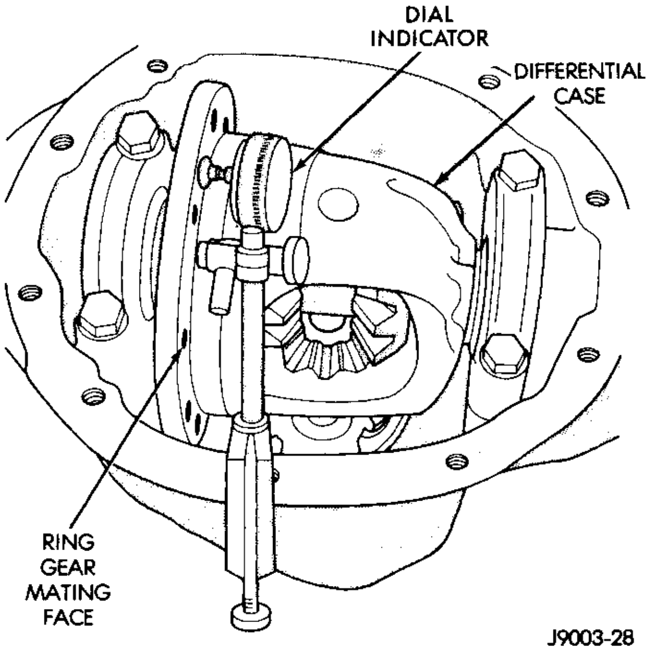


Fig. 22 Differential Case Runout Measurement

(7) Obtain the necessary differential bearing "zero" "end-play" shims, set them aside and reserve them for installation later.

(8) Remove the dial indicator from the housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove the differential case from the housing. Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the differential case from the housing. Remove the spreader tool and the hold-down clamps immediately after removing the differential case from the housing. This is important to avoid the possibility of the housing acquiring a different "set".

(9) If necessary, use the spreader tool and the hold-down clamps to remove the differential case from the housing. Proceed to Differential Case Components—Assembly.

Differential Case Components—Assembly

(1) Install the side gears with their thrust washers and the pinion gears with their thrust washers in the differential case (Fig. 18). **Install replacement side-gear thrust washers if inspection after disassembly indicated that they were not within tolerance or otherwise non-usable.**

(2) Measure the side-gear clearance (Fig. 24). If the clearance exceeds 0.007 inch or 0.18 mm per side with the original thrust washers installed, replace the thrust washers. If the clearance exceeds 0.007 inch or 0.18 mm per side with replacement thrust washers installed, replace the side gears.

(3) Install the pinion gear mate shaft and the lock screw (Fig. 18) in the differential case.

(4) Remove the differential bearing cups and install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and bearing (Fig. 25). If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(5) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(6) Tighten the puller tool or removal tool screw (Fig. 25) and remove the bearing from the differential case hub.

(7) Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

(8) Install the previously reserved "zero" "end-play" shims on each of the differential case hubs.

(9) Install the differential bearings on the case hubs (Fig. 21) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092). Observe the installation reference marks and install the differential bearing cups on the case hubs.

(10) Align and position the ring gear on the differential case (Fig. 18).

Do not reuse the original ring gear bolts, install replacement bolts only.

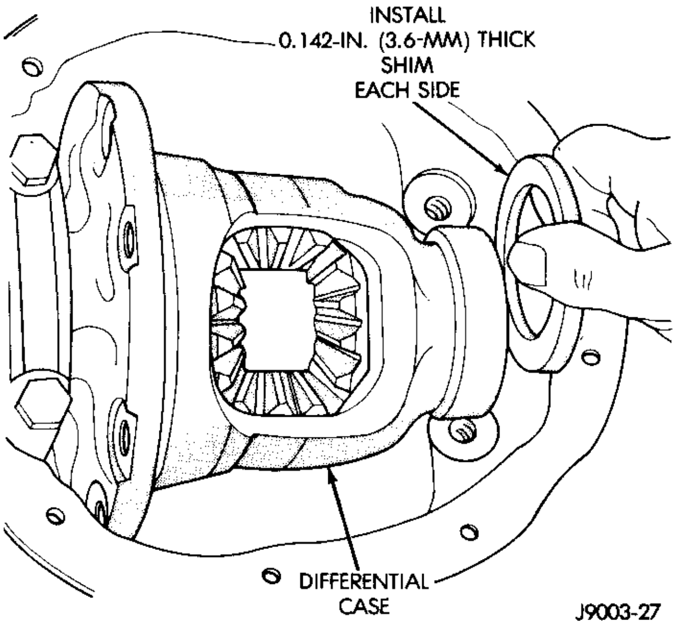


Fig. 23 Differential Bearing Shim Installation

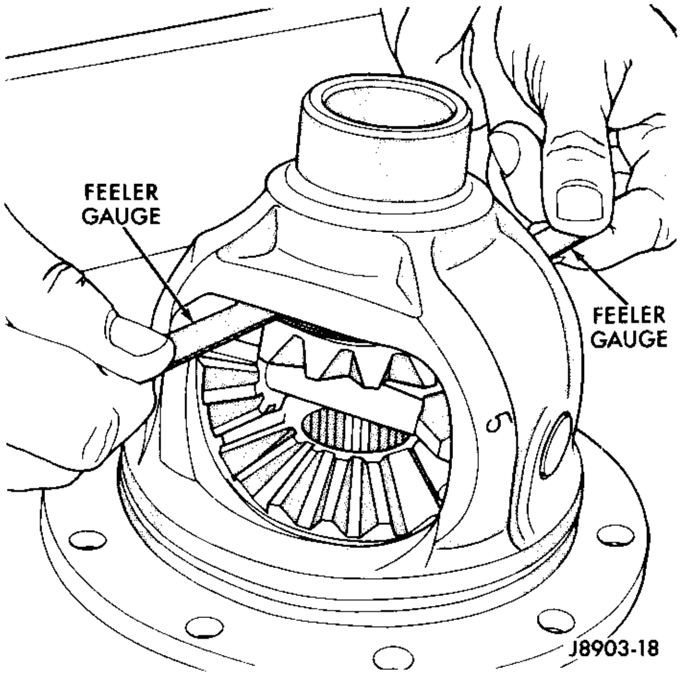


Fig. 24 Side-Gear Clearance Measurement

(11) Install **replacement** ring gear bolts. Tighten the bolts alternately and evenly with 75 N•m (55 ft-lbs) torque.

(12) Proceed to Ring Gear Backlash And Drive Pinion Gear Depth Adjustment.

Ring Gear Backlash And Drive Pinion Gear Depth Adjustment

The ring and drive pinion gears must be adjusted for the **best possible teeth contact patterns**. The gear tooth nomenclature is illustrated in Figure 26.

The "toe" is the part of the gear tooth that is the closest to the inside perimeter of the gear. The "heel" is the part of the gear tooth that is the closest to the outside perimeter of the gear (Fig. 26). The "drive" side of the ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin engagement and then mesh. The "coast" side of ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin disengagement and continues until they exit.

Obtaining the best possible gear teeth contact patterns involves adjusting the depth position of the drive pinion gear "in-or-out" (in respect to the ring gear) and adjusting the position of the ring gear "in-or-out" (in respect to the drive pinion gear) until the ring gear "backlash" is acceptable and the best possible teeth contact patterns are achieved.

The drive pinion gear depth position is adjusted by changing the size (i.e., thickness) of the depth shim(s) located beneath the rear bearing cup (Fig. 27). The ring gear position (i.e., the gear "backlash") is adjusted by changing the side-to-side thickness of the differential bearing shims.

When replacing shims to adjust the ring gear "backlash" or the drive pinion gear depth position, restrict the increment of each size change to within the range of 0.002 - 0.004 inch or 0.05 - 0.10 mm. Also, remember that the two adjustment variables are interdependent (i.e., simultaneously involved); consequently, they interact. For example, if the ring gear "backlash" is acceptable but the pinion gear depth position is then changed to obtain better teeth contact patterns, the ring gear "backlash" will probably have to be readjusted because of the interaction.

(1) Apply yellow ferrous (iron) oxide compound to both (drive and coast) sides of the ring gear teeth.

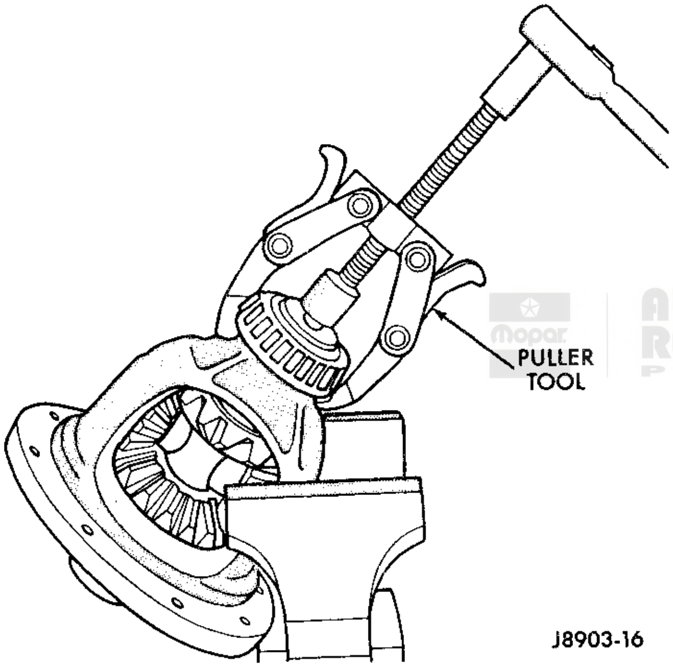


Fig. 25 Differential Bearing Removal

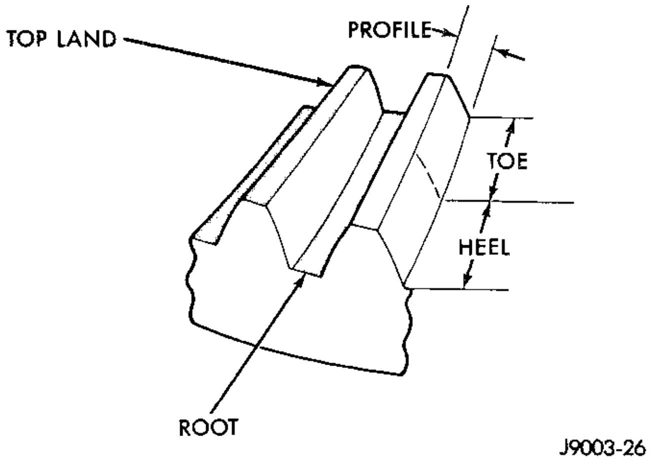


Fig. 26 Gear Tooth Nomenclature

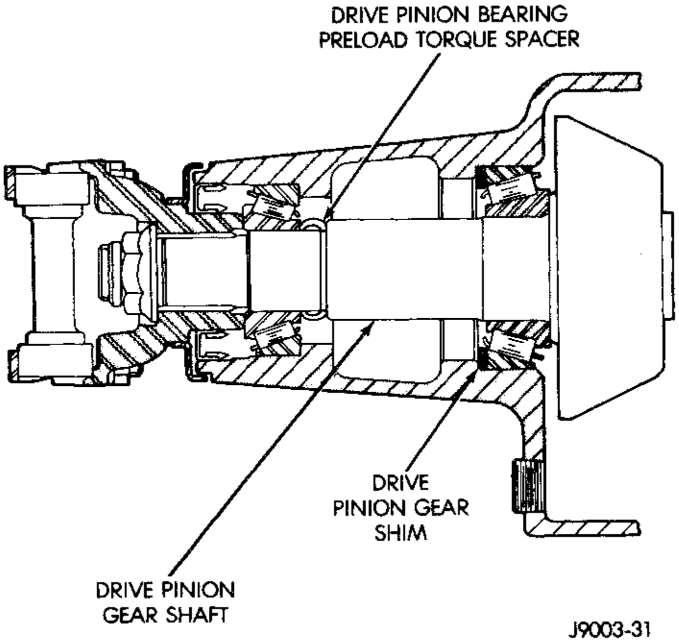


Fig. 27 Drive Pinion Gear Shim & Preload Spacer

(2) If necessary for differential case installation, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(3) If the spreader tool is used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) If necessary, separate the differential housing only enough to install the differential case in the housing. **Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated.

(5) If installed, remove the dial indicator when the differential housing has been separated sufficiently to install the case in the housing.

(6) Position the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them (Fig. 28). Observe the installation reference marks and install the bearing caps. Tighten the bolts securely.

(7) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(8) Attach a dial indicator to the housing. Position the indicator plunger against the "drive" side of one ring gear tooth. Ensure that the plunger is at a right angle (90°) with the tooth (Fig. 29).

(9) Pry the ring gear toward the dial indicator and "zero" the dial indicator pointer while at this position.

(10) Pry the ring gear away from the drive pinion gear until the gear "backlash" indicated on the dial indicator is 0.005 - 0.009 inch or 0.13 - 0.23 mm.

(11) Temporarily insert shims between one differential bearing (nearest to the ring gear) and the housing to maintain the established gear "backlash" during the remainder of the adjustment.

(12) Move the dial indicator aside and, if necessary, re-apply yellow ferrous (iron) oxide compound to the ring gear teeth.

(13) Rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(14) Note the teeth contact patterns imprinted in the ferrous (iron) oxide compound. Refer to Figure 30 for interpretation of the gear teeth contact patterns and proceed to the next step.

(15) Analyze the gear teeth contact patterns for corrective action and, if necessary, use the following information to correct the gear positions:

- decreasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly lower and toward the "toe" (Fig. 26) of the gear tooth;
- increasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly higher and toward the "heel" (Fig. 26) of the gear tooth;
- inserting a **thicker** depth shim will move the pinion gear closer to the ring gear;
- this will cause the "drive" side teeth contact patterns to move lower and slightly toward the "toe" (Fig. 26) of the tooth and cause the "coast" side teeth contact pat-

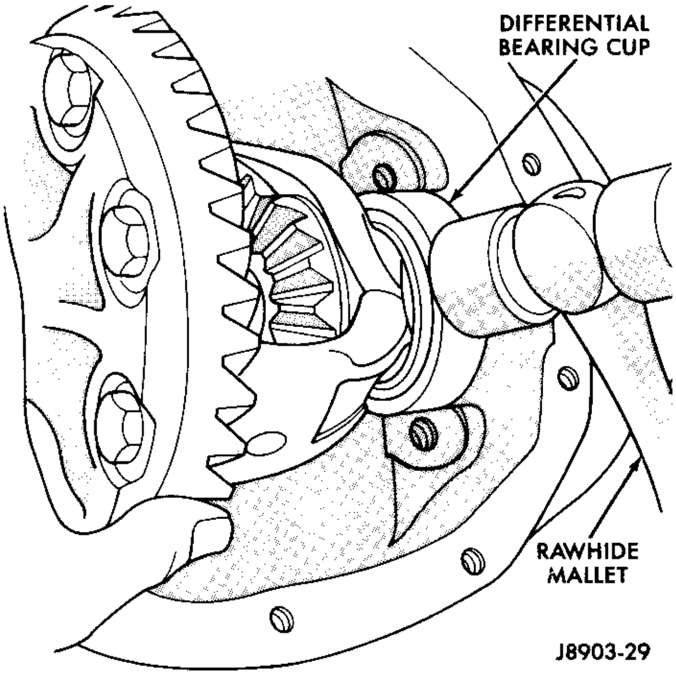


Fig. 28 Seating The Differential Bearing Cups

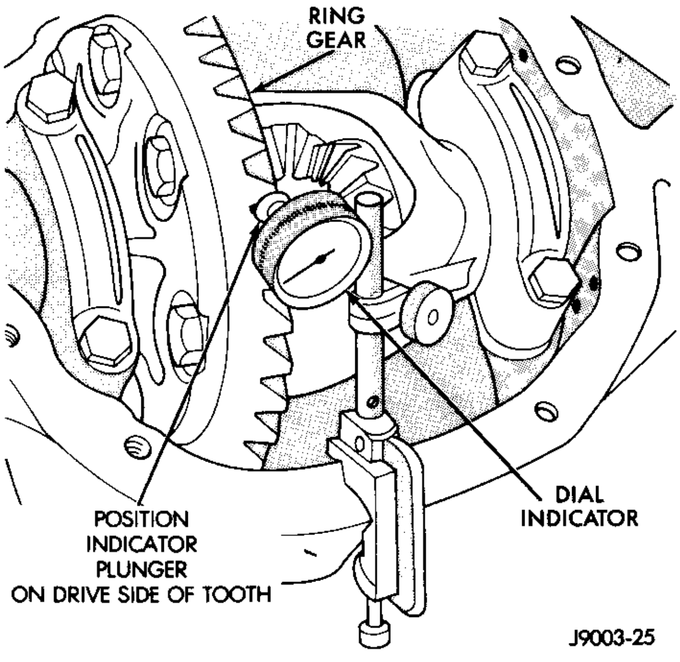
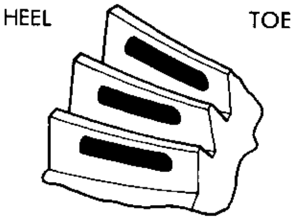
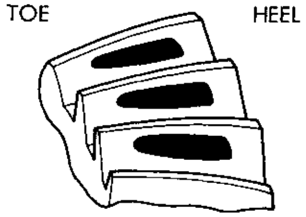
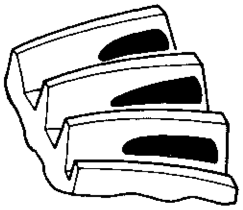
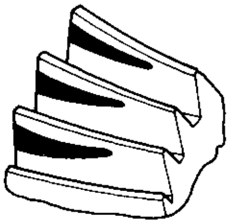
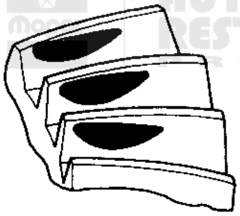
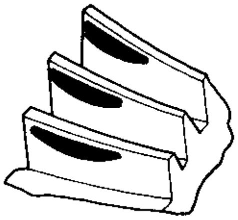
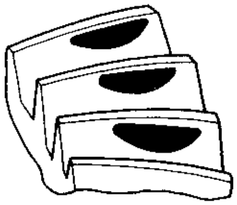
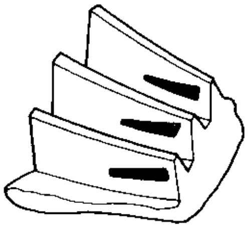
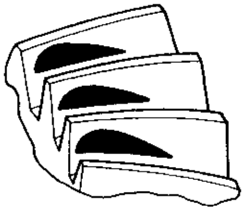


Fig. 29 Ring Gear Backlash Measurement

DRIVE SIDE OF RING GEAR TEETH	COAST SIDE OF RING GEAR TEETH	
		DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.
		RING GEAR BACKLASH CORRECT. **THINNER** PINION GEAR DEPTH SHIM REQUIRED.
		RING GEAR BACKLASH CORRECT. **THICKER** PINION GEAR DEPTH SHIM REQUIRED.
		PINION GEAR DEPTH SHIM CORRECT. **DECREASE** RING GEAR BACKLASH.
		PINION GEAR DEPTH SHIM CORRECT. **INCREASE** RING GEAR BACKLASH.

J9003-24

Fig. 30 Gear Teeth Contact Patterns

terns to move lower and slightly toward the "heel" (Fig. 26) of the tooth;

- inserting a **thinner** depth shim will move the pinion gear away from ring gear; and
- this will cause the "drive" side teeth contact patterns to move higher and toward the "heel" (Fig. 26) of the tooth and cause the "coast" side teeth contact patterns to move higher and toward the "toe" (Fig. 26) of the tooth.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the differential case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(16) If necessary, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case from the housing. Remove the drive pinion gear shaft. Replace the depth and the differential bearing shims as necessary to adjust the gear positions for the best possible gear teeth contact patterns and an acceptable ring gear "backlash".

To increase the ring gear "backlash", decrease the differential bearing shim thickness at the ring gear side of the housing. To decrease the ring gear "backlash", increase the differential bearing shim thickness at the ring gear side of the housing.

(17) Install the drive pinion gear shaft and the differential case. If applicable, observe the **CAUTION** listed above.

(18) Re-apply yellow ferrous (iron) oxide compound to both sides of the ring gear teeth and rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(19) Analyze the gear teeth contact patterns and, if necessary, readjust the gear positions.

(20) Proceed to Drive Pinion Gear Bearing Preload Torque Adjustment.

Drive Pinion Gear Bearing Preload Torque Adjustment

A "tension-type" collapsible spacer maintains the drive pinion gear bearing "preload" torque (Fig. 27). The bearing "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft. The drive pinion gear shaft (axle) yoke nut is used to adjust the "preload" torque. The spacer is designed to compress and maintain the "preload" torque after it is established by adjustment.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the differential case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(1) If necessary for differential case removal, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case (Fig. 18). Remove the ferrous (iron) oxide compound from the ring gear.

(2) Remove the differential bearing cups, the bearings and the shims (Fig. 18). Use Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) to remove the bearings (Fig. 25). **Do not intermix the shims. Mark or tag them for installation reference.**

(3) Remove the drive pinion gear shaft (Fig. 18).

(4) Install a replacement bearing "preload" torque spacer on the drive pinion gear shaft (Fig. 18).

(5) Install the drive pinion gear shaft in the housing (Fig. 18).

(6) Apply axle lubricant to the lip and install a replacement seal on the drive pinion gear shaft (Fig. 18) with Seal Installation Tool 6272 (J22661).

(7) Install the axle yoke on the drive pinion gear shaft.

The correct drive pinion gear bearing "preload" torque is 2 - 3 N·m (15 - 25 in-lbs). The bearing "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft (with a Newton-meter or an inch-pound torque wrench).

(8) Install a replacement nut on the drive pinion gear shaft. **Tighten the nut only enough to remove the "end play". Do not over-tighten it.**

(9) Place a socket wrench on the nut. Rotate the shaft with a Newton-meter or an inch-pound torque wrench and note the indicated torque.

CAUTION: The bearing "preload" torque spacer will permanently compress and maintain the established "preload" torque. If the specified "preload" torque is exceeded, do not attempt correction by loosening and re-tightening the drive pinion gear shaft (axle) yoke nut. If the nut is over-tightened, the drive pinion gear shaft must be removed, the "preload" spacer replaced, the drive pinion gear shaft installed and the "preload" torque adjusted again.

(10) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and slowly tighten the nut in small increments until the torque required to rotate the drive pinion gear shaft is in the range of 2 - 3 N•m (15 - 25 in-lbs). Measure the "preload" torque frequently to avoid over-tightening the nut.

(11) Proceed to Differential Bearing Preload Shim Installation.

Differential Bearing Preload Shim Installation

Before installing the differential case, the differential bearings must be "preloaded" with additional shims to compensate for the heat accumulation and the engine torque "load" during vehicle operation.

(1) Note the installation reference marks (or tags) and install the originally selected differential bearing shims on each case hub.

(2) Add an additional 0.004-inch or 0.1-mm thick shim to **each** case hub.

(3) Install the differential bearings on the case hubs (Fig. 31) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092).

(4) Observe the installation reference marks and install the differential bearing cups on the case hubs.

Differential Case Installation

(1) Lubricate the bearings, the gears and the thrust washers with axle lubricant.

(2) If necessary for differential case installation, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(3) If the spreader tool is used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified 0.5-mm (0.02-in) separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) If necessary, separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated.

(5) If used, remove the dial indicator when the differential housing has been separated sufficiently to install the case in the housing.

(6) Observe the installation reference marks and install the bearing cups on the differential bearings.

(7) Install the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them (Fig. 32).

(8) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(9) Observe the installation reference marks and install the differential bearing caps. Tighten the cap bolts with 77 N•m (57 ft-lbs) torque.

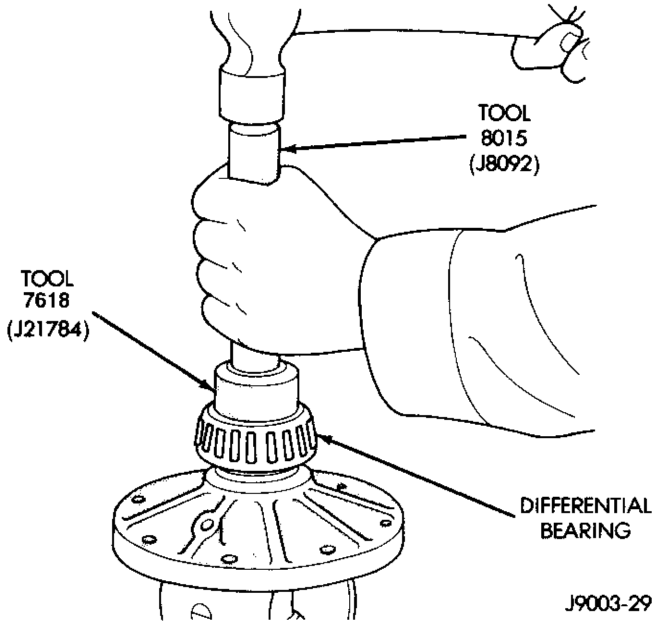


Fig. 31 Differential Bearing Installation

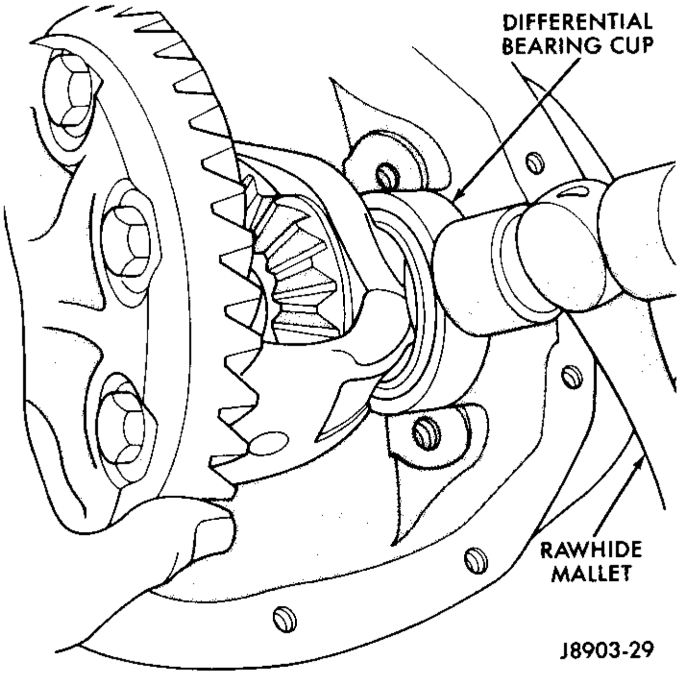


Fig. 32 Seating The Bearing Cups

(10) Measure the ring gear “backlash”. If it has changed, it must be readjusted.

Installation—MJ/XJ And YJ Vehicles

(1) Install the axle shafts. If necessary, refer to the installation procedure.

(2) Clean the differential housing and the housing cover mating surfaces thoroughly.

(3) Apply a thin “bead” of MOPAR RTV sealant (or an equivalent sealant) to the housing and to the cover. Install the cover. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

(4) Align the installation reference marks on the drive shaft yoke and the drive pinion gear shaft (axle) yoke. Connect the drive shaft to the axle yoke. Tighten the U-joint clamp screws with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

(5) Fill the differential housing with 2.5 pints (1.2 liters) of SAE 75W-90, API grade GL 5 hypoid gear lubricant or, if applicable, MOPAR (synthetic-type) 80W-140 Hypoid Gear Lubricant.

(6) Install the brake drums and the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(7) Remove the supports and lower the vehicle.

MODEL 44 AXLE SERVICE

INDEX

GENERAL SERVICE INFORMATION

The service procedures described within this section can be utilized with the axle either installed or removed from the vehicle.

The ring gear and the drive pinion gear in Model 44 axles are supplied as a "matched set" and must not be individually interchanged or replaced. **Verify that the "ID" numbers etched into a replacement gear set are identical before installation.**

LUBRICANTS

Drain And Refill

(1) Drive the vehicle until the axle lubricant attains the normal operating temperature.

(2) Raise and support the vehicle.

(3) Clean all the foreign material from the area where the differential housing cover mates with the differential housing.

(4) Remove the lubricant fill hole plug from the differential housing cover.

(5) Loosen the differential housing cover bolts and allow the original lubricant to completely drain from the housing and the axle shaft tubes.

(6) Remove the housing cover.

CAUTION: DO NOT FLUSH Trac-Lok differentials. Trac-Lok differentials may be cleaned only by disassembling the unit and wiping with clean, lint-free cloths.

(7) Flush standard differentials and the housing cavity with a "flushing" oil (or light engine oil) to remove residual lubricant and foreign material. **Do not use water, steam, kerosene or gasoline for flushing.**

(8) Remove any residual RTV sealant/gasket material from the differential housing and cover, thoroughly clean the contact surfaces with mineral spirits (or an equivalent solution) and dry the surfaces completely.

(9) Apply a thin "bead" of MOPAR TRV Sealant, or an equivalent sealant, around the bolt circle on the housing and on the cover.

If for any reason the housing cover is not installed within 20 minutes after applying the sealant, the sealant must be removed and another "bead" of sealant applied.

(10) Install the housing cover on the differential housing with the attaching bolts. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

(11) Refill the differential housing with 3.75 pints (1.77 liters) of SAE 75W-90, API grade GL 5 hypoid gear lubricant (or, if applicable, synthetic-type MOPAR 80W-140 Hypoid Gear Lubricant). With **Trac-Lok** (ie., limited-slip) differentials, a container of Trac-Lok Lubricant additive (a friction modifier) can also be added.

(12) Install and tighten the fill hole plug with 34 N•m (25 ft-lbs) torque.

(13) Remove the supports and lower the vehicle.

(14) With **Trac-Lok** differentials, drive the vehicle and make 10 to 12 slow, figure-eight turns. This type of maneuver will ensure that the replacement lubricant is pumped through the clutch discs.

AXLE SHAFT REMOVAL/INSTALLATION

Removal

(1) Raise and support the vehicle.

(2) Remove the wheel/tire and the brake drum.

(3) Remove the nuts that attach the outer seal retainer (and the brake support plate) to the axle shaft tube flange (Fig. 1). **Discard the nuts, they are not reusable.**

(4) Remove the axle shaft with a flange-type puller tool and a slide hammer (Fig. 2).

Installation

(1) Clean and then apply a thin coating of wheel bearing lubricant to the bearing and the outer seal contact surfaces in the axle shaft tube.

(2) Lubricate the lip of the axle shaft outer seal with wheel bearing lubricant (Fig. 1).

(3) "Pack" the axle shaft bearing with wheel bearing lubricant (Fig. 1).

(4) Insert the axle shaft into the axle shaft tube.

(5) Position and align the seal retainer and the brake support plate on the axle shaft tube flange studs. Install the replacement attaching nuts and tighten them with 43 N•m (32 ft-lbs) torque.

(6) Install the brake drum and the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(7) Remove the supports and lower the vehicle.

AXLE SHAFT BEARING AND SEAL REPLACEMENT

Removal

(1) Remove the axle shaft. If necessary, refer to the removal procedure.

(2) Remove the axle shaft inner seal. Discard the seal.

(3) Clamp the axle shaft in a vise.

(4) Centerpunch and then drill a 1/4-inch or 6-mm diameter hole in the bearing retaining ring outer surface (Fig. 1). Drill approximately three-quarters (3/4) through the retaining ring.

(5) Cut the retaining ring with a chisel (Fig. 3) and remove it from the axle shaft.

(6) "Press" the original bearing off the axle shaft (Fig. 4) with a press and Bearing Removal/Installation Tool 7650 or 7671 (J22912-1 or J23674).

(7) Remove the outer seal and the seal retainer from the axle shaft (Fig. 3). Discard the seal. Replace the seal retainer if it is worn or damaged.

Installation

(1) Clean and then apply a thin coating of wheel bearing lubricant to the bearing and the seal contact surfaces in the axle shaft tube.

(2) Apply wheel bearing lubricant to the lips of the replacement axle shaft inner and outer seals.

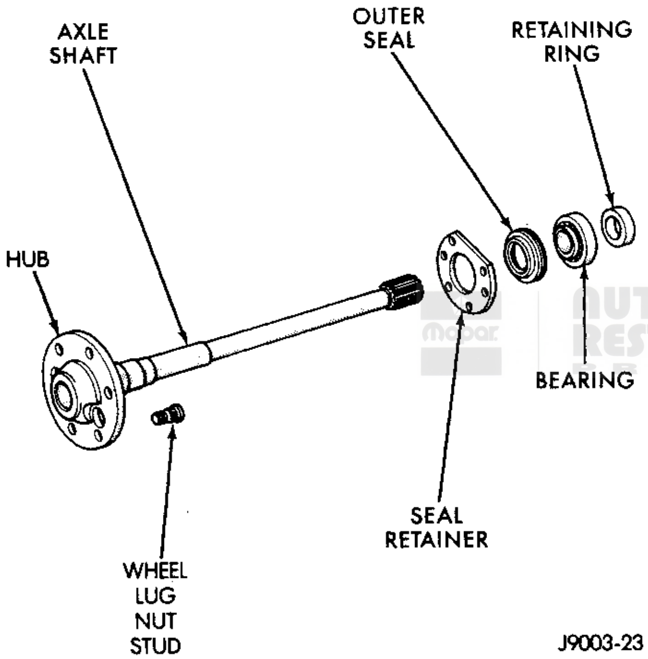


Fig. 1 Axle Shaft Components

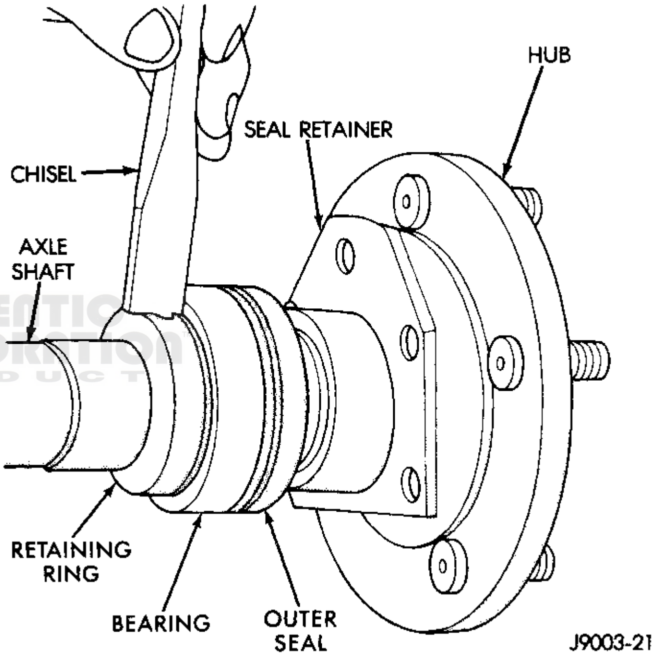


Fig. 3 Bearing Retaining Ring Removal

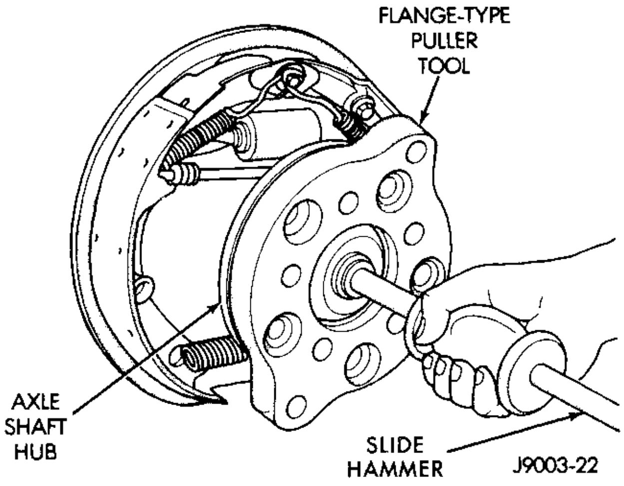


Fig. 2 Axle Shaft Removal

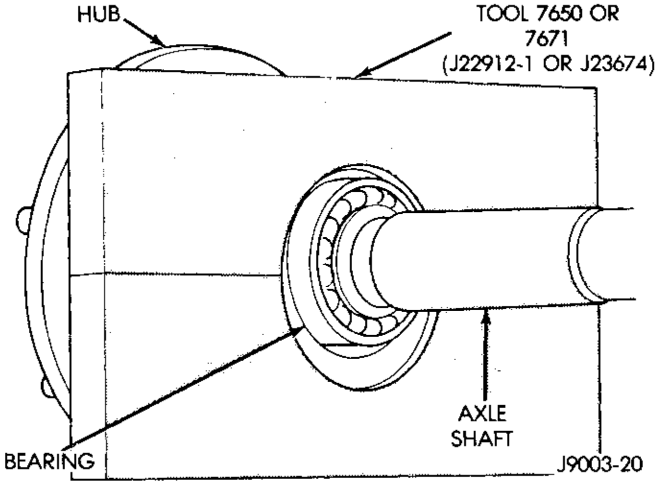


Fig. 4 Axle Shaft Bearing Removal

(3) Install the replacement inner seal in the axle shaft tube (Fig. 5). Ensure that the **open end** of the seal faces **inward** and that the seal is completely "seated" in the axle shaft tube bore.

(4) Install the retainer plate and the outer seal on the axle shaft. Ensure that the **open end** of the seal faces **toward the axle shaft bearing**.

(5) "Pack" the replacement axle shaft bearing with wheel bearing lubricant and position it on the axle shaft.

(6) "Press" the replacement bearing onto the axle shaft with a press and Bearing Removal/Installation Tool 7650 or 7671 (J22912-1 or J23674). When the bearing is completely "seated" on the axle shaft, "press" a replacement bearing retaining ring onto the axle shaft and against the bearing (Fig. 1).

(7) Install the axle shaft. If necessary, refer to the installation procedure.

DRIVE PINION GEAR SHAFT SEAL REPLACEMENT

Removal

(1) Raise and support the vehicle.

(2) Remove the rear wheels/tires and the brake drums.

(3) Mark the rear drive shaft yoke and the drive pinion gear shaft (axle) yoke for installation alignment reference (Fig. 6).

(4) Disconnect the rear drive shaft yoke from the drive pinion gear shaft (axle) yoke.

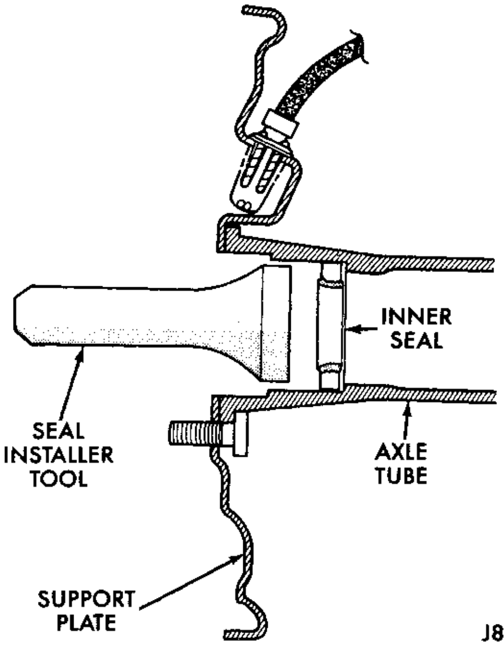


Fig. 5 Axle Shaft Inner Seal Installation

(5) Remove the drive pinion gear shaft nut. Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke while removing the nut (Fig. 7). Discard the nut, it is not reusable.

(6) Remove the washer from the drive pinion gear shaft.

(7) Mark the yoke and the shaft for installation alignment reference.

(8) Remove the drive pinion gear shaft (axle) yoke from the shaft. If the yoke cannot be removed easily by

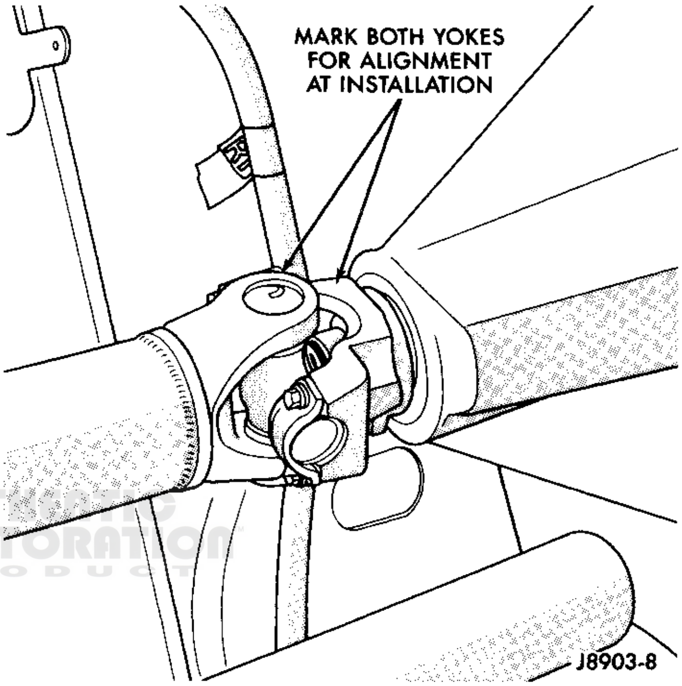


Fig. 6 Drive Shaft & Drive Pinion Gear Shaft Yokes

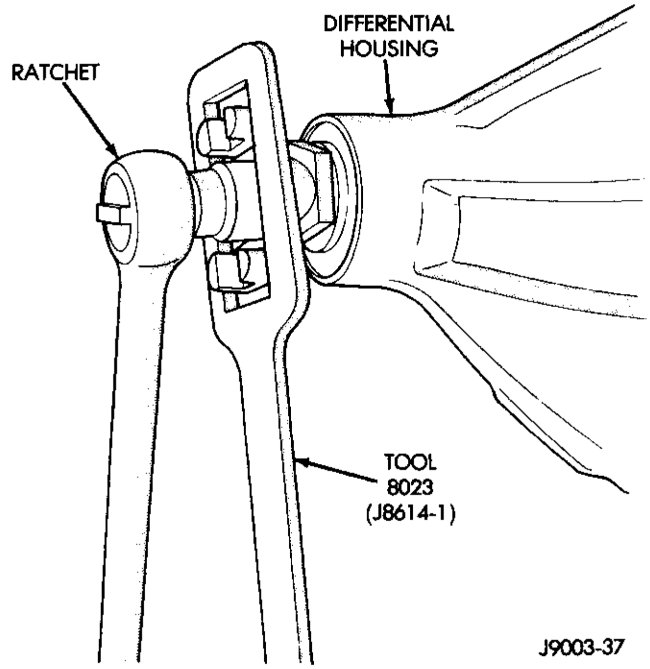


Fig. 7 Drive Pinion Gear Shaft Nut Removal

hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke (Fig. 8).

(9) Remove the drive pinion gear shaft seal. Use a punch to remove the seal or use an external thread-type, seal removal tool (Fig. 9)

Installation

(1) Apply axle lubricant to the lip of the replacement seal.

(2) Install the replacement seal on the drive pinion gear shaft (Fig. 10) with Seal Installation Tool 6272 (J22661).

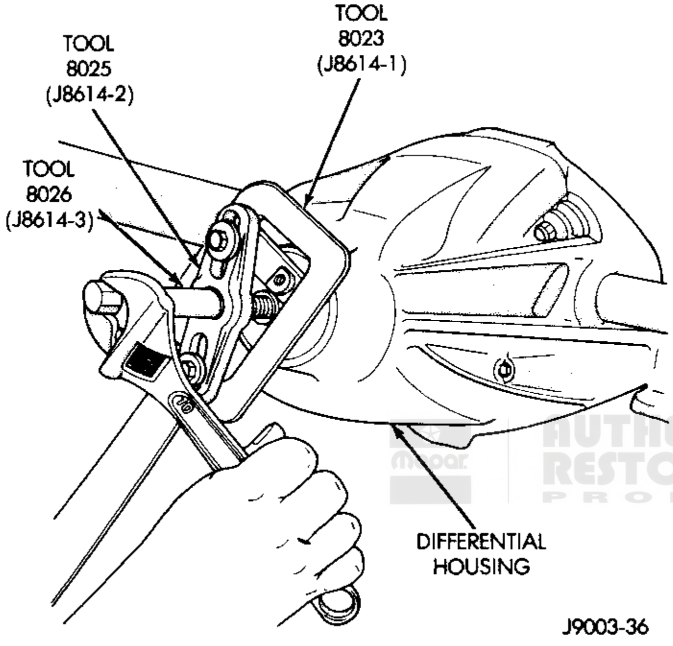


Fig. 8 Drive Pinion Gear Shaft Yoke Removal

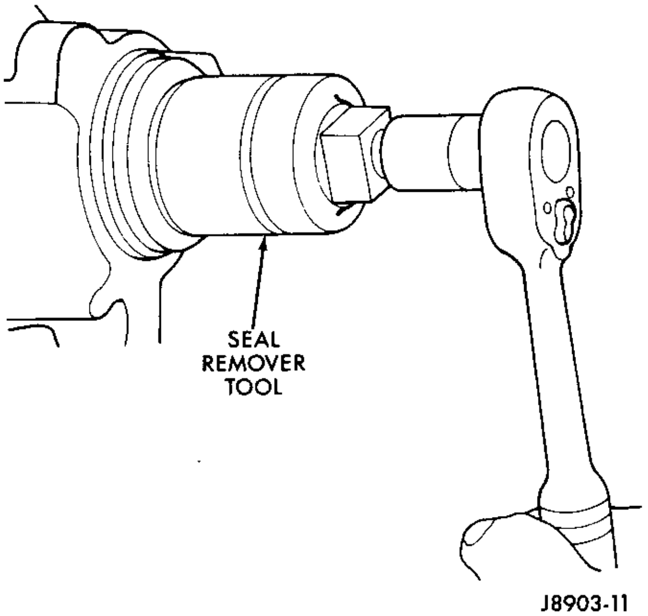


Fig. 9 Drive Pinion Gear Shaft Seal Removal

(3) Position and align the yoke installation reference mark with the reference mark on the drive pinion gear shaft.

(4) Install the washer and a replacement nut on the shaft.

(5) Tighten the nut with 271 N•m (200 ft-lbs) torque (minimum). Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and the shaft while tightening the nut.

(6) Align the yoke installation reference marks and install the drive shaft (Fig. 6). Tighten the U-joint clamp screws with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

(7) Install the brake drums and the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(8) Check the lubricant level in the differential housing. Add lubricant, if necessary.

(9) Remove the supports and lower the vehicle.

DIFFERENTIAL CASE REMOVAL/INSTALLATION

The following procedures apply to both a standard and a **Trac-Lok** (i.e., limited-slip) differential case.

Removal

(1) Raise and support the vehicle.

(2) Remove the differential housing cover and drain the lubricant.

(3) Mark the drive pinion gear shaft (axle) yoke and the drive shaft yoke for installation alignment reference (Fig. 6) and disconnect the drive shaft yoke from the axle yoke.

(4) Remove the wheels/tires and the brake drums.

(5) Remove the axle shafts. If necessary, refer to the removal procedure.

(6) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing (Fig. 11).

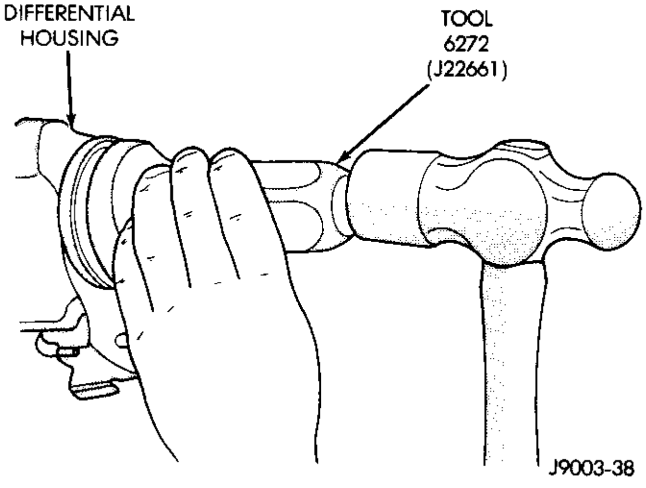


Fig. 10 Seal Installation

(7) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing (Fig. 11).

(8) Loosen the differential bearing cap bolts until only two or three bolt threads are engaged.

(9) Mark the differential bearing caps for installation reference.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(10) Separate the differential housing only enough to remove the differential case from the housing. **Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated (Fig. 11).

(11) Pry the differential case loose from the housing.

(12) Remove the bearing caps and the differential case from the housing. Mark or tag the differential bearing cups for installation reference.

(13) Remove the spreader tool from the differential housing.

(14) Remove the drive pinion gear shaft (axle) yoke, the seal, the dust cap, the shaft and the remaining components if they also require service. Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke while removing the shaft nut. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke.

Installation

(1) Install the drive pinion gear shaft with all its components. Apply axle lubricant to the lip and install the replacement seal on the drive pinion gear shaft with Seal Installation Tool 6272 (J22661). Adjust the drive pinion gear depth and the bearing "preload" torque, if necessary. Refer to the instructions within Differential Service.

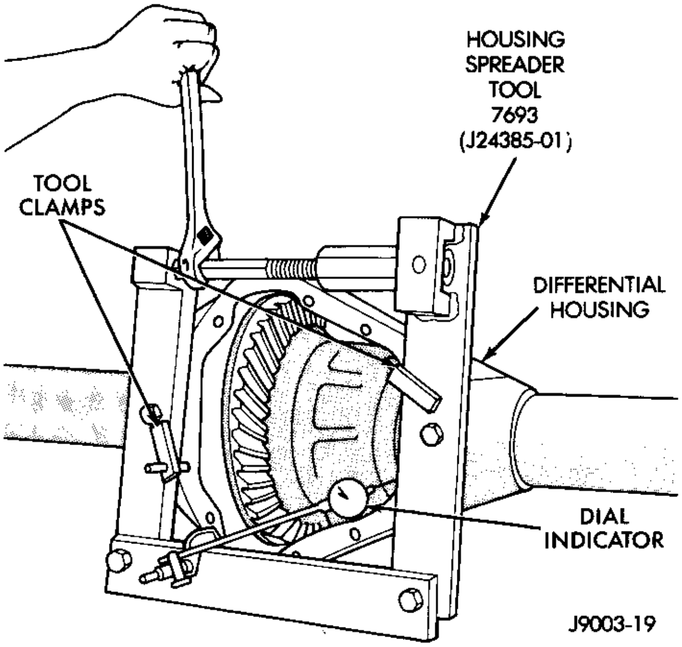


Fig. 11 Differential Housing Separation

(2) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing (Fig. 11).

(3) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing (Fig. 11).

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) Separate the differential housing only enough to install the differential case in the housing. **Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated (Fig. 11).

(5) With the differential bearing cups properly installed, install the differential case in the housing. If necessary, tap the bearing cups with a rawhide mallet to "seat" them.

(6) Observe the installation reference marks and install the differential bearing caps. Tighten the cap bolts with 108 N•m (80 ft-lbs) torque.

(7) Remove the dial indicator and the spreader tool from the differential housing.

(8) Align the installation reference marks and connect the drive shaft. Tighten the U-joint clamp screws with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

(9) Install the axle shafts. If necessary, refer to the installation procedure.

(10) Apply a thin "bead" of MOPAR RTV Sealant (or an equivalent sealant) to the differential housing cover and to the mating surface on the housing. Install the cover. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

(11) Fill the differential housing with 3.75 pints (1.77 liters) of the recommended lubricant. With **Trac-Lok** (i.e., limited-slip) differentials, also add a container of Trac-Lok Lubricant additive (a friction modifier).

(12) Install and tighten the fill plug with 34 N•m (25 ft-lbs) torque.

(13) Install the brake drums and the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(14) Remove the supports and lower the vehicle.

(15) With **Trac-Lok** differentials, drive the vehicle and make 10 to 12 slow, figure-eight turns. This type of maneuver will ensure that the replacement lubricant is pumped through the clutch discs.

COMPLETE AXLE AND DIFFERENTIAL REMOVAL/INSTALLATION

Removal

(1) Raise and support the vehicle.

(2) Position support stands under the frame rails. Place the stands slightly ahead of the rear spring front eyes.

(3) Remove the rear wheels/tires.

(4) Mark the rear drive shaft yoke and drive pinion gear shaft (axle) yoke for installation alignment reference.

(5) Disconnect the rear drive shaft from the axle.

(6) For SJ vehicles, disconnect the rear track bar from the axle shaft tube bracket.

(7) Disconnect the axle vent hose from the axle fitting and disconnect the parking brake cables at the equalizer.

(8) Disconnect the shock absorbers from the axle shaft tube brackets.

(9) Disconnect the brake hose at the axle junction block or at the floorpan bracket. **Do not disconnect the wheel cylinder tubing fittings.**

(10) Loosen — **but do not remove** — the bolts that attach the spring front eyes to the frame brackets.

(11) Remove the spring U-bolts and the brackets.

(12) Support the axle with a hydraulic jack.

(13) Raise the axle just enough to relieve the axle weight from the springs.

(14) Remove the bolts that attach the springs to the shackles and lower the springs to the floor.

(15) Lower the jack and remove the axle.

Installation

(1) Support the axle on a hydraulic jack and move the axle into position under the vehicle.

(2) Raise the springs and install the spring shackle bolts. **Do not tighten the bolts at this time.**

(3) Align the spring center bolts with the locating holes in the axle pads.

(4) Lower the axle onto the springs and install the spring U-bolts and the brackets.

(5) Tighten the U-bolt nuts:

- for MJ vehicles, tighten the nuts with 122 N•m (90 ft-lbs) torque; and
- for SJ vehicles, tighten the nuts with 136 N•m (100 ft-lbs) torque.

(6) Connect the axle vent hose, the parking brake cables, and the brake hose.

(7) Align the installation reference marks and connect the drive shaft. Tighten the U-joint clamp screws with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

It is important that the rear springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the track bar is connected to the axle shaft tube bracket, otherwise it will be difficult to align it with the bracket holes. In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(8) For SJ vehicles, attach the track bar to the axle shaft tube bracket.

(9) Attach the shock absorbers to the axle shaft tube brackets. Tighten the attaching nuts with 61 N•m (45 ft-lbs) torque.

(10) Check and add, if necessary, lubricant to the differential housing.

(11) Bleed the brakes.

(12) Install the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(13) Remove the supports and lower the vehicle.

(14) Tighten the spring eye and shackle bolts with 136 N•m (100 ft-lbs) torque.

(15) For SJ vehicles, tighten the track bar-to-bracket nut with 168 N•m (125 ft-lbs) torque.

(7) Measure the side gear clearance with two feeler gauges (Fig. 15). Insert a gauge blade between each thrust washer and the differential case. Vary the feeler gauge blade thickness until each gauge blade fits "tight". The clearance should not exceed 0.007 inch or 0.18 mm between either washer and the case. Replace both thrust washers if the clearance exceeds the clearance specification.

(8) Remove the differential side gears (Fig. 14) and the thrust washers.

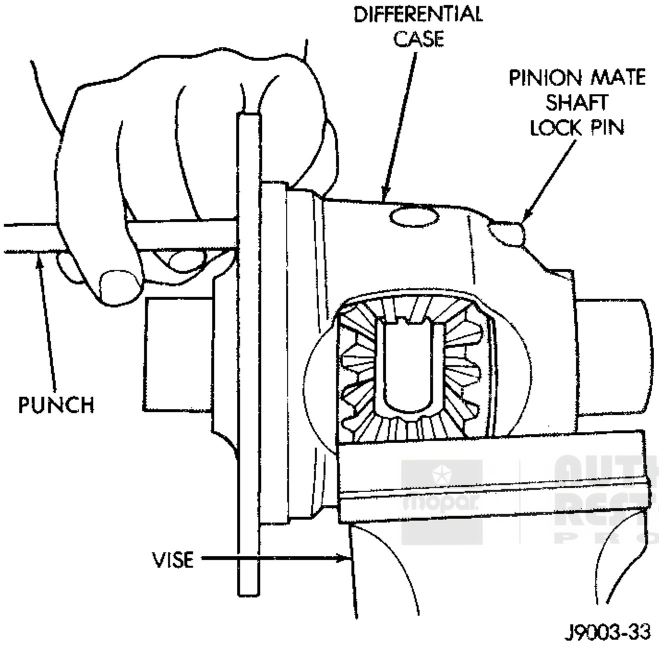


Fig. 13 Lockpin Removal

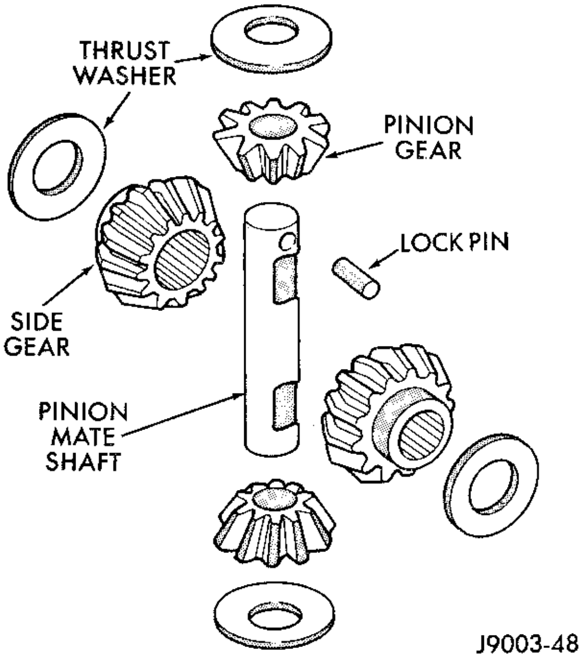


Fig. 14 Pinion Gears & Side Gears

Differential Bearing Removal—SJ And MJ Vehicles

(1) Mark the bearing cups for installation reference and remove them.

CAUTION: When removing a differential bearing, ensure that the differential case is securely clamped or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

(2) Install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and bearing (Fig. 16). If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(3) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(4) Tighten the puller tool or removal tool screw (Fig. 16) and remove the bearing from the differential case hub.

(5) Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

Drive Pinion Gear Shaft Removal—SJ And MJ Vehicles

(1) Remove the drive pinion gear shaft (axle) yoke retaining nut and washer. Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke while removing the shaft nut (Fig. 17).

(2) Remove the drive pinion gear shaft (axle) yoke. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke (Fig. 18).

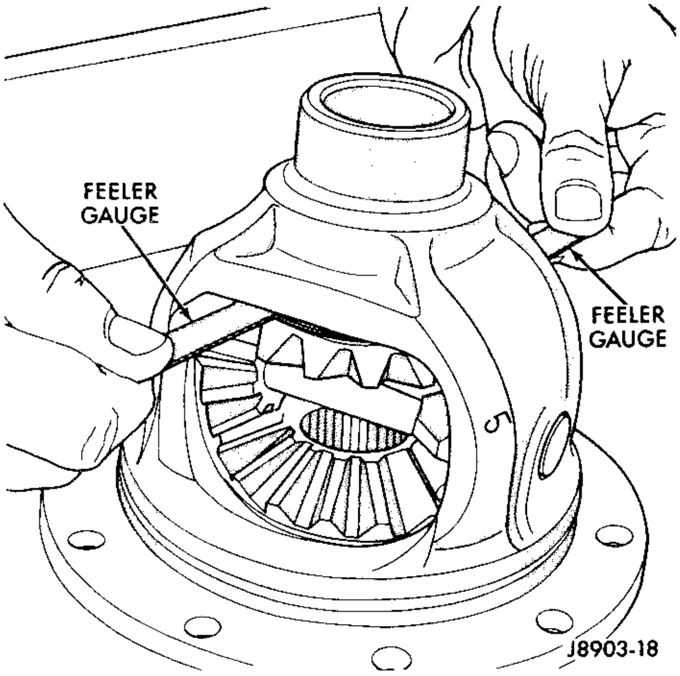


Fig. 15 Side Gear Clearance Measurement

(3) Remove the dust cap from the drive pinion gear shaft.

(4) Remove the drive pinion gear shaft. Strike the end of the shaft with a rawhide hammer to force it out of the drive pinion gear shaft rear bearing and the housing.

(5) Remove the drive pinion gear shaft front bearing, the bearing "preload" torque shim(s), the oil slinger, and the seal. Use a 2 x 2-inch or 5 x 5-cm piece of wood, or length of pipe to drive the bearing, the shim(s), the oil slinger, and the seal out of the housing.

(6) Discard the seal after removal. Retain the "preload" torque shim(s) for installation during the "preload" torque adjustment.

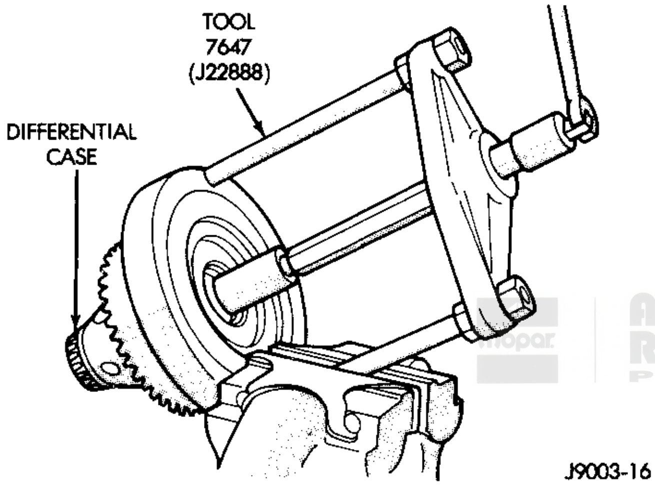


Fig. 16 Differential Bearing Removal

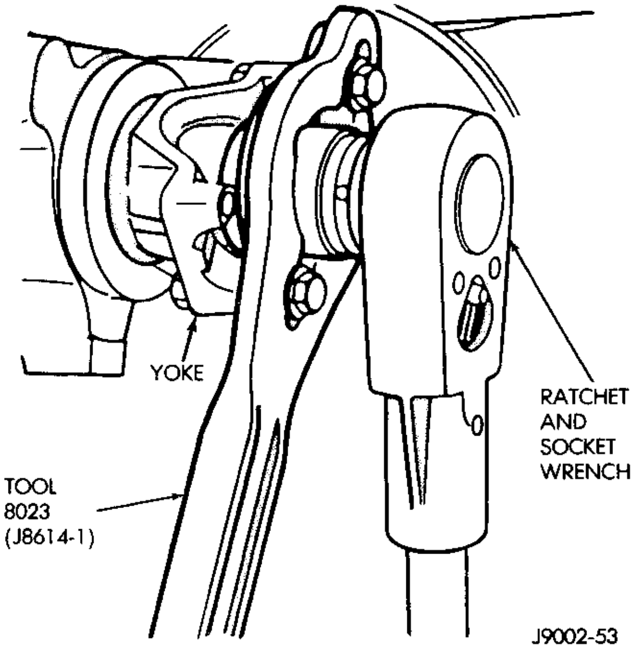


Fig. 17 Pinion Shaft (Axle) Yoke Nut Removal

Drive Pinion Gear Shaft Rear Bearing Removal—SJ And MJ Vehicles

(1) Install Bearing Removal/Installation Tool 7650 or 7671 (J22912-1 or J23674) between the rear bearing and the drive pinion gear shaft (Fig. 19).

(2) Remove the rear bearing (Fig. 19) with a press and Bearing Removal/Installation Tool 7650 or 7671 (J22912-1 or J23674).

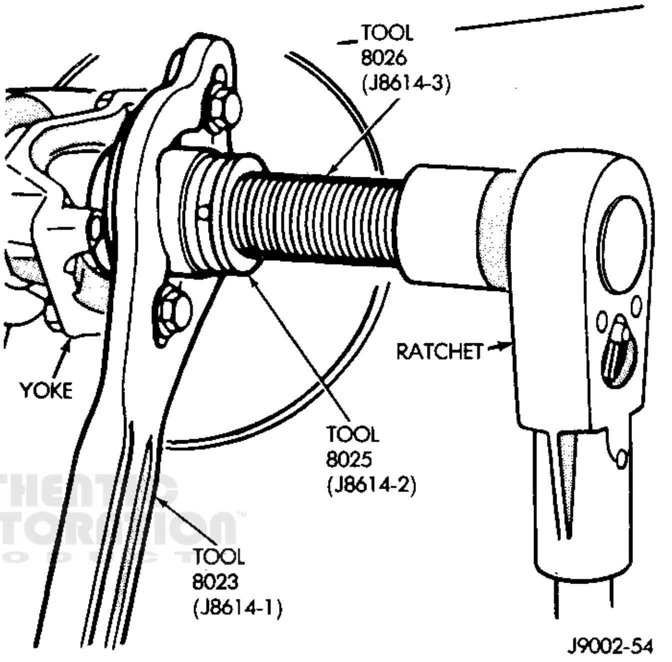


Fig. 18 Drive Pinion Gear Shaft (Axle) Yoke Removal

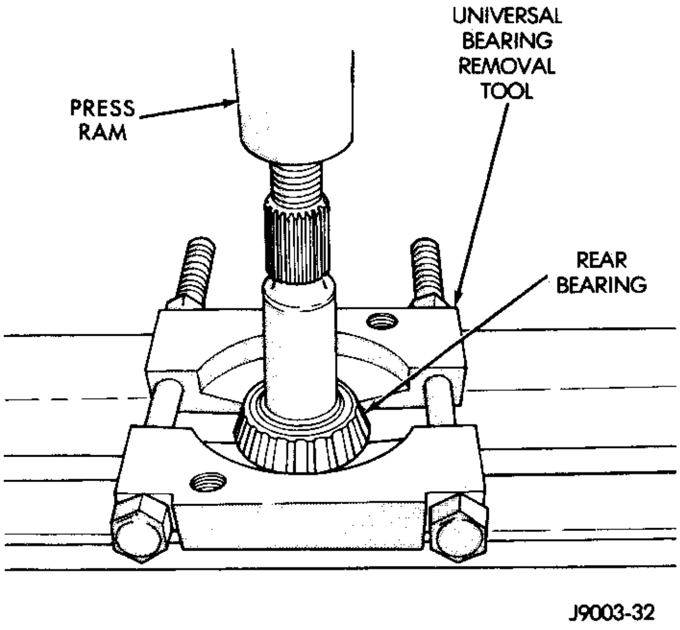


Fig. 19 Pinion Gear Shaft Rear Bearing Removal

Drive Pinion Gear Shaft Bearing Cup Removal—SJ And MJ Vehicles

(1) Remove the drive pinion gear shaft rear bearing cup. Use a brass drift and a hammer to tap the cup out of the differential housing.

(2) Remove the drive pinion gear depth shim(s) from the rear bearing cup bore in the differential housing. Retain the depth shim(s) for installation reference (even if they are bent or distorted).

(3) Remove the drive pinion gear shaft front bearing cup. Use a brass drift and a hammer to tap the cup out of the differential housing.

Cleaning And Inspection—SJ And MJ Vehicles

(1) Clean all of the differential components in cleaning solvent (Fig. 20). Allow the bearings to either air dry or dry them with a lint-free cloth. Dry the other components with compressed air.

(2) Inspect all of the bearings and cups for “pitting”, “galling”, “flat spots”, and “cracks” (Fig. 20).

(3) Replace any bearing or cup that has any of the defective conditions described above.

(4) Inspect the differential case (Fig. 20) for an elongated or enlarged differential pinion gear mate shaft bore. The machined thrust washer surface areas and counterbores must be smooth and free of “nicks”, “gouges”, “cracks”, and “burrs”.

(5) Inspect the differential case for “cracks”, worn shaft and pin bores, and other damage that could necessitate replacement. If the metal was raised on the bearing cup bore shoulders during bearing cup removal, flatten the raised area with a blunt punch.

(6) Replace the differential case if defective.

(7) Inspect the differential pinion gear mate shaft (Fig. 20) for “excessive wear”, “scoring”, and “galling”. The shaft must be smooth and concentric. Replace the shaft if it is either worn, damaged or defective.

(8) Inspect the differential side gears and pinion gears (Fig. 20). All the gear teeth must have a uniform contact pattern. Inspect the gears and gear teeth for “cracks”, “scoring”, “excessive wear”, and “galling”.

(9) Replace all the gears if any **one gear** has any of the defective conditions described above.

(10) Inspect the differential side gear and pinion gear thrust washers for “excessive wear”, “scoring”, “galling” and “distortion” (Fig. 20).

(11) Replace the washers if they have any of the defective conditions described above.

(12) Inspect the differential pinion gear mate shaft lockpin (Fig. 20) for damage or for a loose fit in the differential case.

(13) Replace the lockpin or the differential case as necessary.

(14) Inspect the differential ring gear and the drive pinion gear and shaft (Fig. 20) for worn or “chipped” teeth, “cracks”, damaged bearing journals and damaged attaching bolt threads.

(15) If replacement is necessary, both gears must be

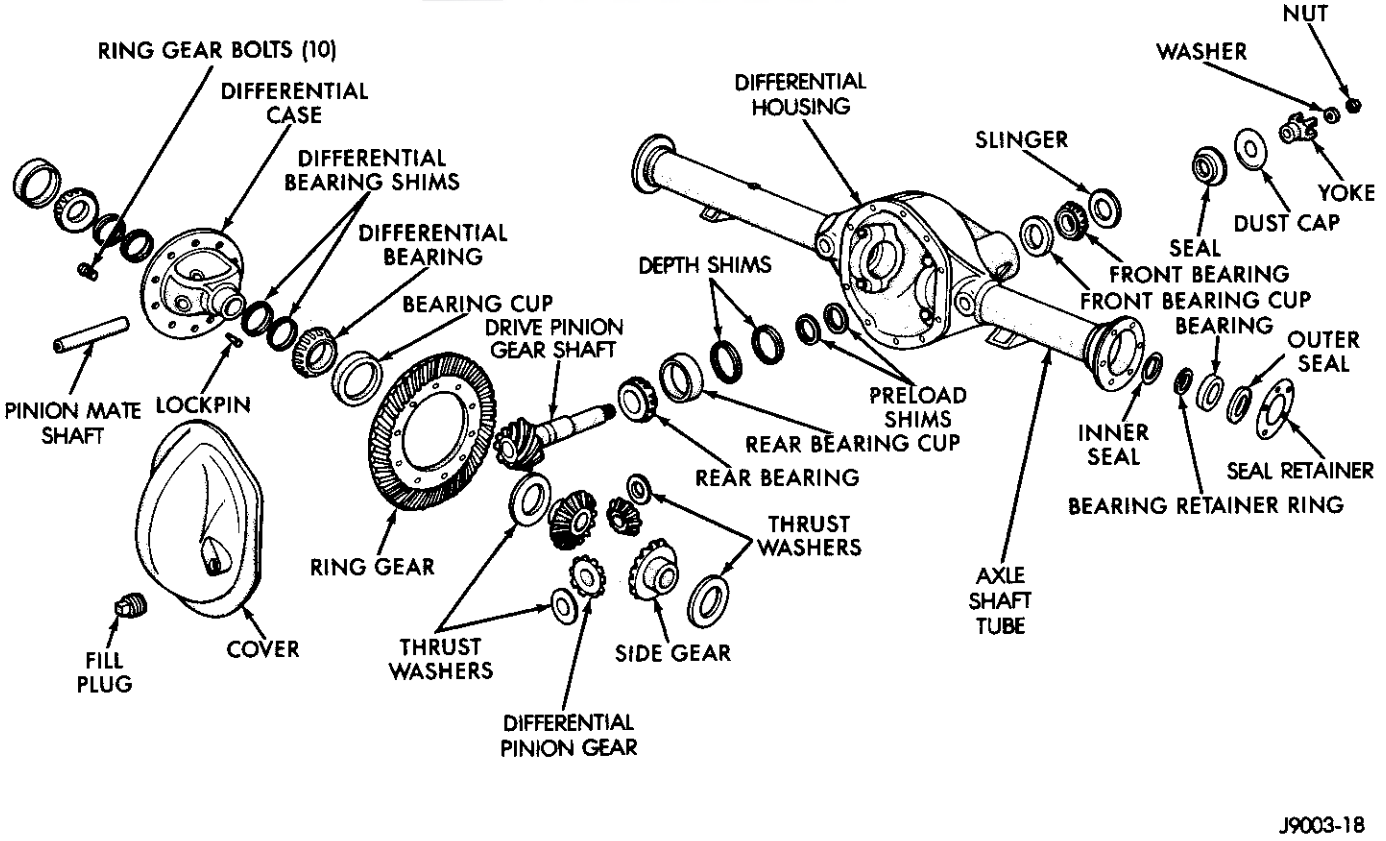


Fig. 20 Model 44 Differential — Exploded View

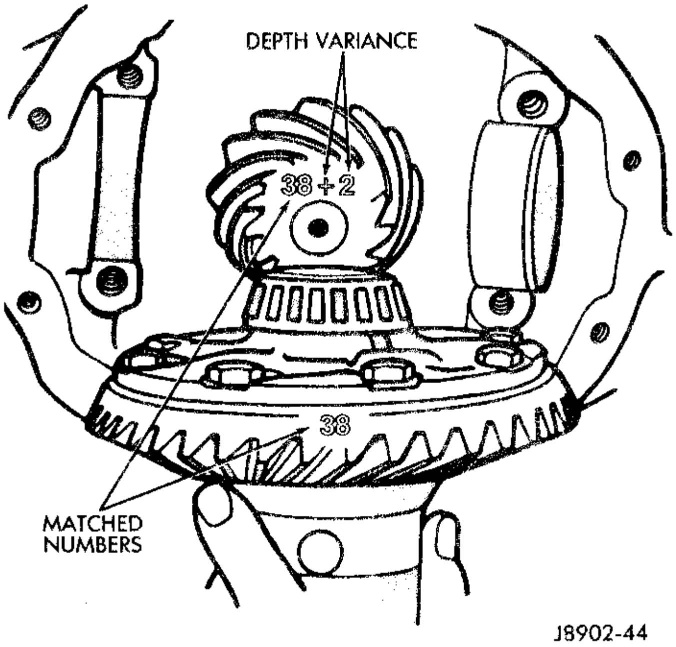


Fig. 21 Matched Ring Gear & Drive Pinion Gear Set

replaced as a **"matched set" only.**

(16) Inspect the drive pinion gear shaft (axle) yoke (Fig. 20) for "cracks", worn splines, and "pitted", rough or corroded seal contact surfaces.

(17) Repair or replace the yoke as necessary.

(18) Inspect the drive pinion gear shaft bearing "preload" torque shims and the depth shims (Fig. 20) for damage and distortion.

(19) Replace any defective shims as necessary during assembly.

Differential Assembly And Adjustment Information—MJ And SJ Vehicles

The differential ring and drive pinion gears in Model 44 rear axles must be adjusted for the best possible **gear teeth contact patterns.** The drive pinion gear depth cannot be initially measured and "set" precisely with shims. If the original gear set is installed with the original depth shim(s), the **best possible gear teeth contact patterns** are achieved by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If a replacement gear set must be installed, the **best possible gear teeth contact patterns** are achieved by using the Pinion Gear Depth Variance chart to determine the shims necessary to "initially" establish the replacement drive pinion gear depth and then by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If necessary, the differential ring gear and drive pinion gear shaft must be replaced as a "matched set" only. They are identified as a "matched set" by the numbers etched into each gear (Fig. 21).

The identical first two "ID" numbers (Fig. 21) etched into each gear identify them as a "matched set". The second number etched into the drive pinion gear is the depth variance. It indicates the amount (in thousandths of an inch) that the set varied from the standard "setting" of 2.625 inches (66.68 mm) for Model 44 axles. The depth variance can be either a plus (+), zero (0) or a minus (-) value.

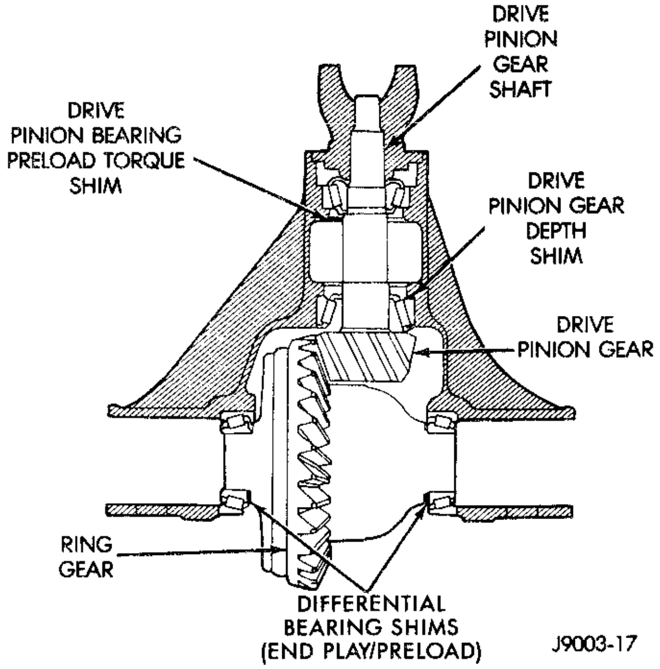


Fig. 22 Depth Shim & Preload Shim Locations

If the original gear set is not used, the replacement drive pinion gear **initial** depth shim thickness must be determined before installing the differential in the housing. The depth shim (Fig. 22) is positioned adjacent to the drive pinion gear shaft rear bearing cup.

Refer to the Pinion Gear Depth Variance chart for the required initial depth of a replacement drive pinion gear shaft. The chart will aide in determining the depth shim thickness needed for establishing the **initial** depth. **The chart will only help determine the required shim thickness for the initial depth. It will not provide the exact shim thickness necessary to precisely position the pinion gear for the best possible gear teeth contact patterns and must not be used as a substitute for actually analyzing the gear teeth contact patterns and adjusting the drive pinion gear depth and the ring gear "backlash" accordingly.**

To use the chart, proceed according to the following instructions:

- measure the thickness of the original drive pinion gear depth shim(s);
- note the depth variance values etched in the original and the replacement drive pinion gears;
- refer to the Original and Replacement Pinion Gear Depth Variance columns in the chart; and
- locate the chart box where the Original and Replacement Pinion Gear Depth Variance columns intersect for the approximate amount of "change" from the original

shim thickness that is required to establish the initial pinion gear depth for the replacement shaft.

For example, if the original drive pinion gear is etched -3 and the replacement drive pinion gear is etched +2, the "initial" shim selection procedure is accomplished according to the following instructions:

- refer to the Original Pinion Gear Depth Variance column at the left side of the chart and locate the **-3** value in this column;
- move to the right across the chart until at the **+2** value in the Replacement Pinion Gear Depth Variance column;
- the box where the two columns intersect will provide the amount of **change** in shim thickness required (i.e., -0.005 inch) for the replacement gear set;
- the value in the intersecting box is -0.005 inch (-0.12 mm), which represents the amount of thickness to be **subtracted** from the original drive pinion gear depth shim(s);
- if the value was zero (0), the initial shim thickness would be the **same** as the original drive pinion gear depth shim(s); and
- if the value was positive (+), this amount of thickness would be **added** to the original drive pinion gear depth shim(s).

Pinion Gear Depth Variance

Original Pinion Gear Depth Variance	Replacement Pinion Gear Depth Variance								
	−4	**−3**	**−2**	**−1**	**0**	**+1**	**+2**	**+3**	**+4**
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

J8902-46

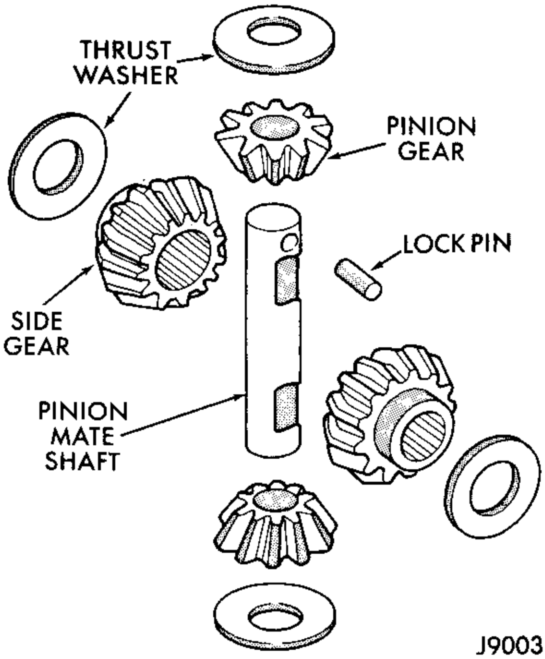
Differential Assembly—SJ And MJ Vehicles

DIFFERENTIAL CASE COMPONENTS—ASSEMBLY

(1) Install the side gears with their thrust washers and the pinion gears with their thrust washers in the differential case (Fig. 23). **Install replacement side-gear thrust washers if the measurement during disassembly or if the inspection after disassembly indicated that they were not within tolerance or otherwise non-usable.**

(2) Measure the side-gear clearance (Fig. 24). If the clearance exceeds 0.007 inch or 0.18 mm per side with the original thrust washers installed, replace the thrust washers. If the clearance exceeds 0.007 inch or 0.18 mm per side with replacement thrust washers installed, replace the side gears.

(3) Install the pinion gear mate shaft and the lockpin (Fig. 23) in the differential case.



J9003-48

Fig. 23 Pinion Gears & Side Gears

(4) Assemble the original differential bearing shim set and remove 0.02 inch (0.5 mm) shim thickness from each set. The shims remaining in each set will be used as the "initial" sets.

(5) Install an "initial" shim set and the bearing on each differential case bearing hub. Use Differential Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092) to install the bearings.

(6) Observe the installation reference marks and install the differential bearing cups on the case hubs.

(7) Align and position the ring gear on the differential case (Fig. 20).

Do not reuse the original ring gear bolts, install replacement bolts only.

(8) Install **replacement** ring gear bolts. Tighten the bolts alternately and evenly with 75 N•m (55 ft-lbs) torque.

Drive Pinion Gear Shaft—Assembly And Installation

(1) If applicable, verify that the replacement ring gear and drive pinion gear shaft are a "matched set" before proceeding. **The depth variance with replacement gear sets can range from plus-to-minus 0.004 inch (0.1 mm). A replacement gear set with a variance that is not within this range, or a set with mismatched gears, must not be installed.**

(2) If the original ring gear and drive pinion gear set is being installed, use the original depth shim(s).

(3) If a replacement ring gear and drive pinion set is being installed, determine the amount of "thickness" that must be either added to or subtracted from the original depth shim(s) to **initially** establish the drive pinion gear depth:

- note the depth variance etched in the original and the replacement drive pinion gear;
- refer to the Pinion Gear Depth Variance chart and move to the box where the Original and Replacement Pinion Gear Depth Variance columns intersect; and
- note the value in the box, it will be either a plus (+), zero (0) or a minus (-) value of **change** required from the original shim thickness so that it can be used with the replacement gear set.

(4) Clean the bearing cup bores in the differential housing.

(5) Install the "initial" depth shim(s) in the housing rear bearing cup bore (Fig. 20).

If a depth shim is chamfered on one side, position the chamfered side so that it faces the bottom of the bearing cup bore.

(6) Install the drive pinion gear shaft rear bearing cup in the housing and adjacent to the initial depth shim(s) (Fig. 25). Use an appropriate installation tool.

(7) Install the drive pinion gear shaft front bearing cup in the housing (Fig. 20). Use an appropriate installation tool.

(8) Install the rear bearing on the drive pinion gear shaft (Fig. 26) with Bearing Installation Tool 7699 (J24433) and a press.

Do not install the bearing "preload" torque shim(s) at this time.

(9) Install the drive pinion gear shaft in the housing (Fig. 20).

(10) Install the front bearing on the drive pinion gear shaft (Fig. 20). "Seat" the bearing correctly on the shaft and in the cup.

Do not install the drive pinion gear shaft replacement seal and the oil slinger at this time.

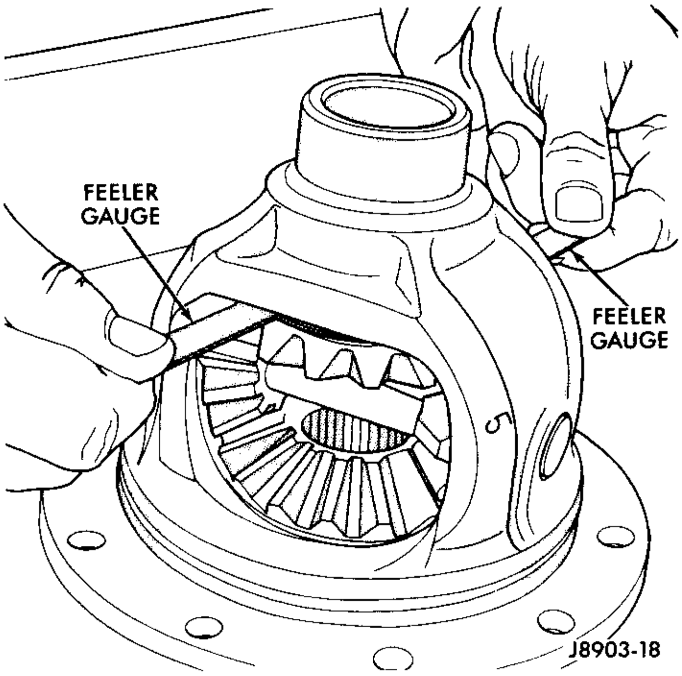


Fig. 24 Side-Gear Clearance Measurement

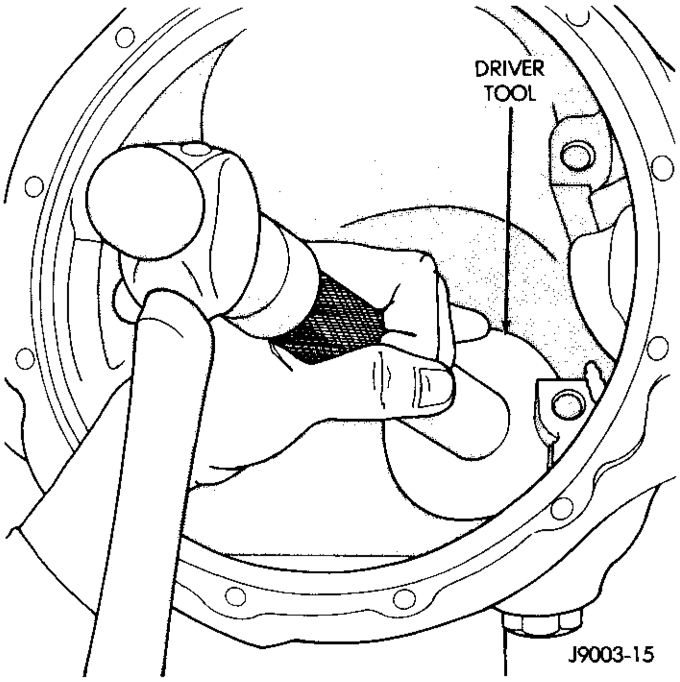


Fig. 25 Rear Bearing Cup Installation

(11) Install the dust cap (Fig. 20).

(12) Install the drive pinion gear shaft (axle) yoke, the washer and the original nut on the drive pinion gear shaft (Fig. 20). Tighten the nut only enough to remove the shaft "end play".

(13) Proceed to Ring Gear Backlash And Drive Pinion Gear Depth Adjustment.

Ring Gear Backlash And Drive Pinion Gear Depth Adjustment

The ring and the drive pinion gears must be adjusted for the **best possible gear teeth contact patterns**. The gear tooth nomenclature is illustrated in Figure 27.

The "toe" is the part of the gear tooth that is the closest to the inside perimeter of the gear. The "heel" is the part of the gear tooth that is the closest to the outside perimeter of the gear (Fig. 27).

The "drive" side of the ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin engagement and then mesh. The "coast" side of ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin disengagement and continues until they exit.

Obtaining the best possible gear teeth contact patterns involves adjusting the depth position of the drive pinion gear "in-or-out" (in respect to the ring gear) and adjusting the position of the ring gear "in-or-out" (in respect to the drive pinion gear) until the ring gear "backlash" is acceptable and the best possible teeth contact patterns are achieved.

The drive pinion gear depth position is adjusted by changing the size (i.e., thickness) of the depth shim(s) located beneath the rear bearing cup (Fig. 28). The ring gear position (i.e., the gear "backlash") is adjusted by changing the side-to-side thickness of the differential bearing shims.

When replacing shims to adjust the ring gear "backlash" and the drive pinion gear depth position, restrict the increment of each size change to within the range of 0.002 - 0.004 inch or 0.05 - 0.10 mm. Also, remember that the two adjustment variables are interdependent (i.e., simultaneously involved); consequently, they interact. For example, if the ring gear "backlash" is acceptable but the pinion gear depth position is then changed to obtain better teeth contact patterns, the ring gear "backlash" most likely will have to be readjusted because of the interaction.

(1) Apply yellow ferrous (iron) oxide compound to both (drive and coast) sides of the ring gear teeth.

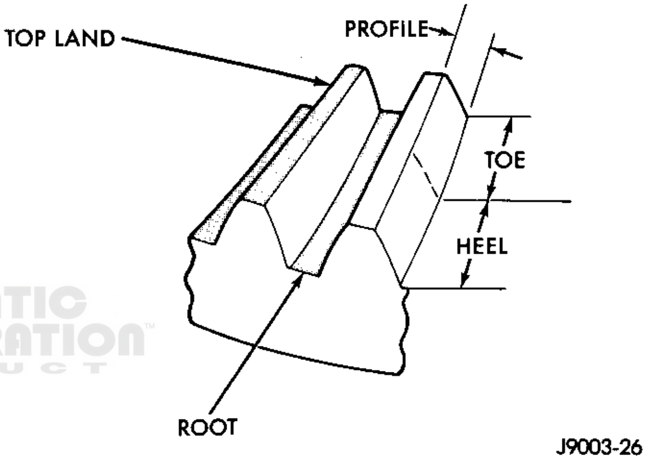


Fig. 27 Gear Tooth Nomenclature

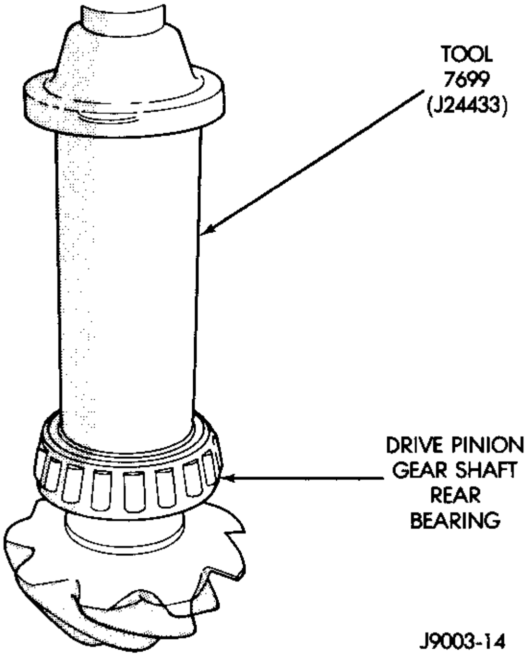


Fig. 26 Rear Bearing Installation

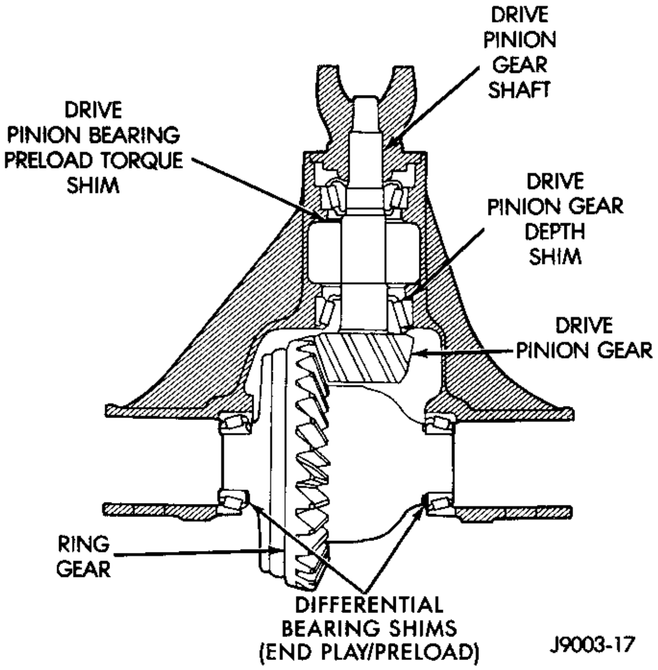


Fig. 28 Drive Pinion Gear Shim(s) & Preload Shim(s)

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the differential case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(2) Install the differential case in the housing with Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps (Fig. 29). Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them in the housing (Fig. 30). Observe the installation reference marks and install the bearing caps. Tighten the bolts securely.

(3) Attach a dial indicator to the housing. Position the indicator plunger against the "drive" side of one ring gear tooth. Ensure that the plunger is at a right angle (90°) with the tooth (Fig. 31).

(4) Pry the ring gear toward the dial indicator and "zero" the dial indicator pointer while at this position.

(5) Pry the ring gear away from the drive pinion gear until the gear "backlash" indicated on the dial indicator is 0.005 - 0.008 inch or 0.12 - 0.20 mm.

(6) Temporarily insert shims between one differential bearing (nearest to the ring gear) and the housing to maintain the established gear "backlash" during the remainder of the adjustment.

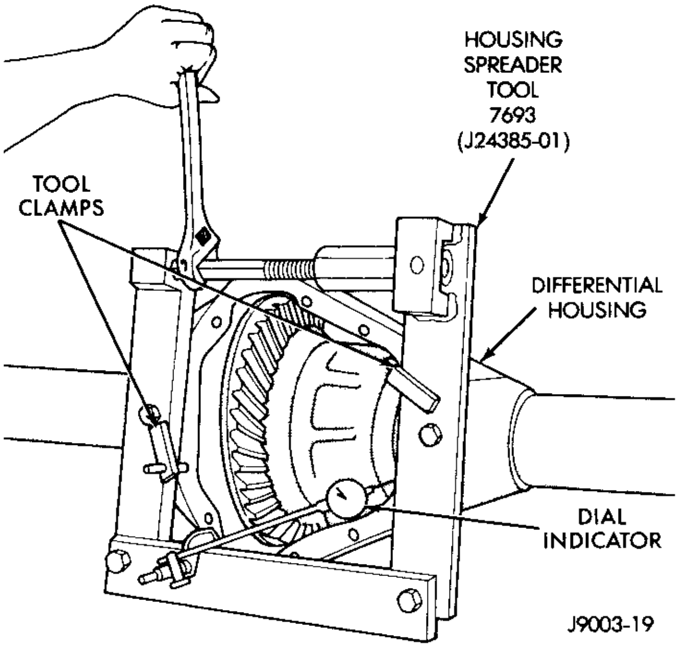


Fig. 29 Differential Housing Separation

(7) Move the dial indicator aside and, if necessary, re-apply yellow ferrous (iron) oxide compound to the ring gear teeth.

(8) Rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(9) Note the teeth contact patterns imprinted in the ferrous (iron) oxide compound. Refer to Figure 32 for interpretation of the gear teeth contact patterns and proceed to the next step.

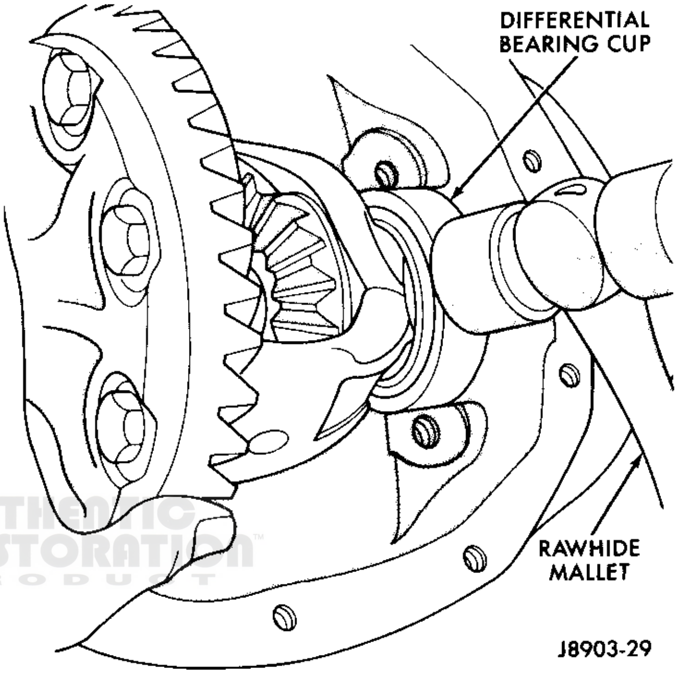


Fig. 30 Seating The Differential Bearing Cups

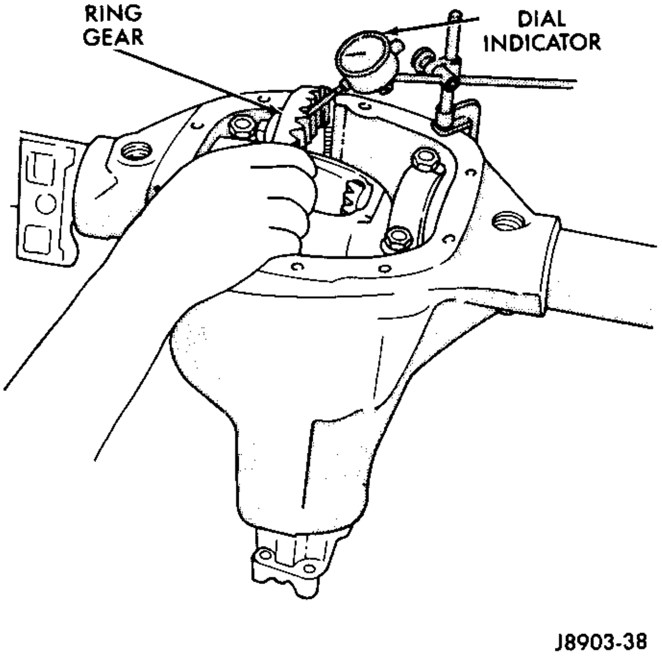
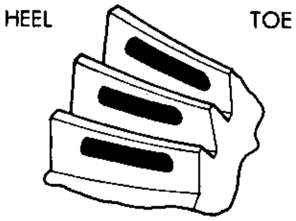
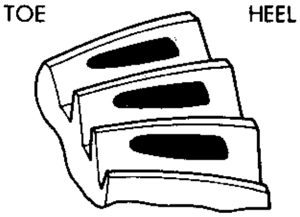
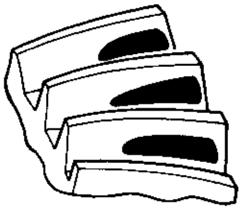
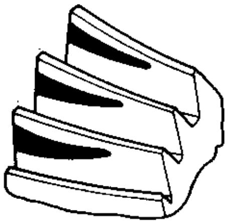
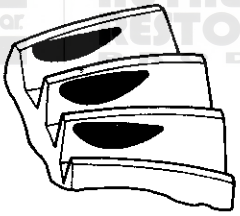
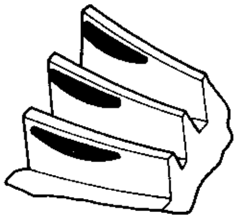
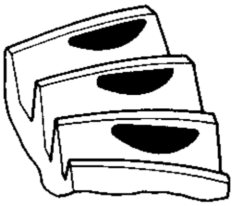
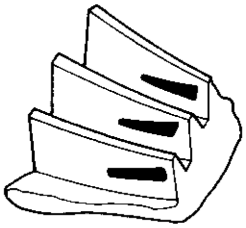
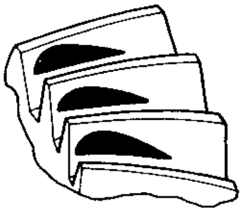


Fig. 31 Ring Gear Backlash Measurement

DRIVE SIDE OF RING GEAR TEETH	COAST SIDE OF RING GEAR TEETH	
		DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.
		RING GEAR BACKLASH CORRECT. **THINNER** PINION GEAR DEPTH SHIM REQUIRED.
		RING GEAR BACKLASH CORRECT. **THICKER** PINION GEAR DEPTH SHIM REQUIRED.
		PINION GEAR DEPTH SHIM CORRECT. **DECREASE** RING GEAR BACKLASH.
		PINION GEAR DEPTH SHIM CORRECT. **INCREASE** RING GEAR BACKLASH.

J9003-24

Fig. 32 Gear Teeth Contact Patterns

STANDARD DIFFERENTIAL SERVICE

Model 44 Axle Differential Specifications

Differential Bearing Preload Torque Shim	0.15 in.	0.38 mm
Differential Side Gear-to-Case Clearance (Max. Each Side)	0.000-0.007 in.	0.00-0.18 mm
Ring Gear Backlash	0.005-0.008 in.	0.12-0.20 mm
Pinion Gear Shaft Bearing Preload Torque		
Original Bearings	10-20 in-lbs	1-2 N•m
Replacement Bearings	20-40 in-lbs	2-5 N•m
Pinion Gear Depth Standard Setting	2.625 in.	66.68 mm
Lubricant Capacity	3.75 pts.	1.77 liters
Lubricant Type		
Standard	SAE 75W-90, API GL5	
Trailer Tow	Synthetic Type 80W-140	

J9003-41

Differential Case Removal—SJ And MJ Vehicles

(1) Raise and support the vehicle.

(2) Remove the differential housing cover and drain the lubricant.

(3) Score installation alignment reference marks on the yokes and disconnect the rear drive shaft from the drive pinion gear shaft (axle) yoke.

(4) Refer to the axle shaft removal procedure (if necessary) and remove the:

- rear wheels/tires,
- brake drums, and
- axle shafts.

(5) Mark the differential bearing caps with a centerpunch for installation reference.

(6) Loosen the differential bearing cap bolts until only 2 or 3 threads are engaged.

(7) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing (Fig. 11).

(8) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing (Fig. 11).

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(9) Separate the differential housing only enough to remove the differential case from the housing. Separate the differential housing a **maximum distance of 0.38 mm (0.015 in)** with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated (Fig. 11).

(10) Remove the dial indicator when the differential housing has been separated sufficiently to remove the case from the housing. Remove the differential bearing caps. Mark the caps for installation reference.

(11) Remove the differential case with two pry bars. Position one bar under the ring gear bolt head, one under the differential case and pry the differential case upward to remove it.

(12) Remove the spreader tool and the holddown clamps immediately after removing the differential case from the housing. **This is important to avoid the possibility of the housing acquiring a different "set".**

Differential Disassembly—SJ And MJ Vehicles

(1) Clamp the differential case in a vise.

(2) Remove and discard the ring gear retaining bolts.

CAUTION: Do not attempt to pry or chisel the ring gear off of the differential case because the case could be damaged during the process.

(3) Remove the ring gear. Use a brass punch and tap it with a hammer to remove the gear from the differential case (Fig. 12).

(4) Remove the differential pinion gear mate shaft lockpin with a small pin punch (Fig. 13).

(5) Remove the differential pinion gear mate shaft (Fig. 14).

(6) Rotate the differential pinion gears until the gears are aligned with the case opening, then remove the differential pinion gears and the thrust washers (Fig. 14).

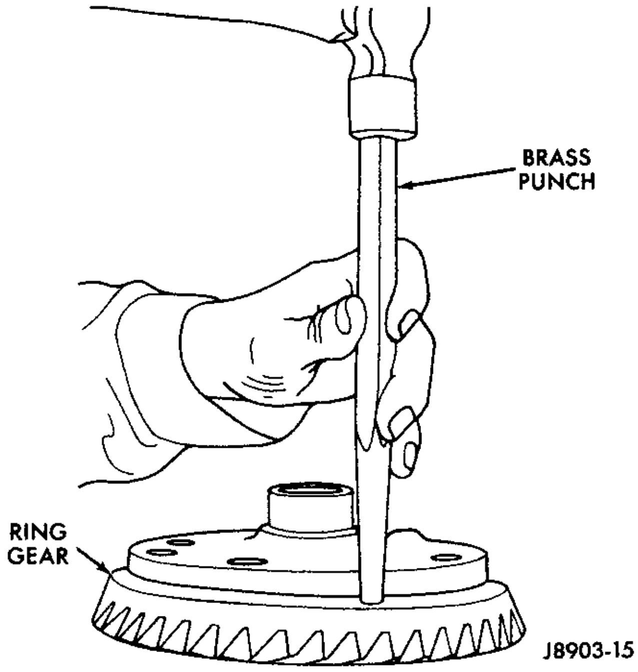


Fig. 12 Ring Gear Removal

(10) Analyze the gear teeth contact patterns for corrective action and, if necessary, use the following information to correct the gear positions:

- decreasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly lower and toward the "toe" (Fig. 27) of the gear tooth;
- increasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly higher and toward the "heel" (Fig. 27) of the gear tooth;
- inserting a **thicker** depth shim will move the pinion gear closer to the ring gear;
- this will cause the "drive" side teeth contact patterns to move lower and slightly toward the "toe" (Fig. 27) of the tooth and cause the "coast" side teeth contact patterns to move lower and slightly toward the "heel" (Fig. 27) of the tooth;
- inserting a **thinner** depth shim will move the pinion gear away from ring gear; and
- this will cause the "drive" side teeth contact patterns to move higher and toward the "heel" (Fig. 27) of the tooth and cause the "coast" side teeth contact patterns to move higher and toward the "toe" (Fig. 27) of the tooth.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the differential case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(11) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case from the housing (Fig. 33). Remove the drive pinion gear shaft. Replace the depth and the differential bearing shims as necessary to adjust the gear positions for the best possible gear teeth contact patterns and an acceptable ring gear "backlash".

To increase the ring gear "backlash", decrease the differential bearing shim thickness at the ring gear side of the housing. To decrease the ring gear "backlash", increase the differential bearing shim thickness at the ring gear side of the housing.

(12) Install the drive pinion gear shaft and the differential case with the spreader tool. Refer to the **CAUTION** listed above.

(13) Re-apply yellow ferrous (iron) oxide compound to both sides of the ring gear teeth and rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(14) Analyze the gear teeth contact patterns and, if necessary, re-adjust the gear positions.

(15) Proceed to Drive Pinion Gear Bearing Preload Torque Adjustment.

Drive Pinion Gear Bearing Preload Torque Adjustment

Shims are used to maintain the drive pinion gear shaft bearing "preload" torque (Fig. 28). The "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the differential case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(1) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case (Fig. 33). Remove the ferrous (iron) oxide compound from the ring gear teeth.

(2) Remove the drive pinion gear shaft (Fig. 20).

(3) Install the original drive pinion gear shaft bearing "preload" torque shim(s) on the shaft (Fig. 20).

(4) Install the drive pinion gear shaft in the housing (Fig. 20).

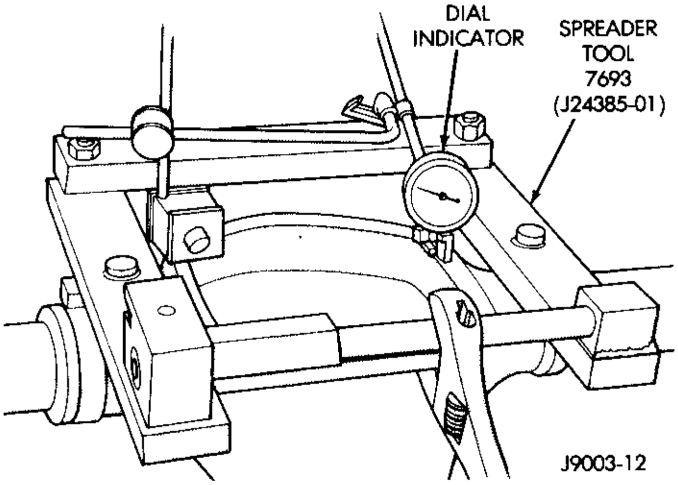


Fig. 33 Differential Housing Separation

(5) Install the front bearing, the oil slinger, the dust cap, the yoke, the washer and the **original** shaft nut (Fig. 20).

(6) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and tighten the shaft nut (Fig. 34) with 271 N•m (200 ft-lbs) torque (minimum).

The correct drive pinion gear shaft bearing "preload" torque with the original bearings installed is 1 - 2 N•m (10 - 20 in-lbs). The correct drive pinion gear shaft bearing "preload" torque with replacement bearings installed is 2 - 5 N•m (20 - 40 in-lbs). The bearing "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft (with a Newton-meter or an inch-pound torque wrench).

(7) Place a socket wrench on the drive pinion gear shaft nut. Rotate the shaft with a Newton-meter or an inch-pound torque wrench and note the indicated "preload" torque.

(8) If not correct, increase the shim thickness to increase the "preload" torque and decrease the shim thickness to decrease the "preload" torque.

(9) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and remove the original shaft nut and the washer from the shaft (Fig. 34). Remove the yoke from the shaft. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke from the shaft (Fig. 35). Remove the dust cap and the seal from the shaft (Fig. 36). Discard the original nut and the seal.

(10) Lubricate the replacement seal lip with gear lubricant.

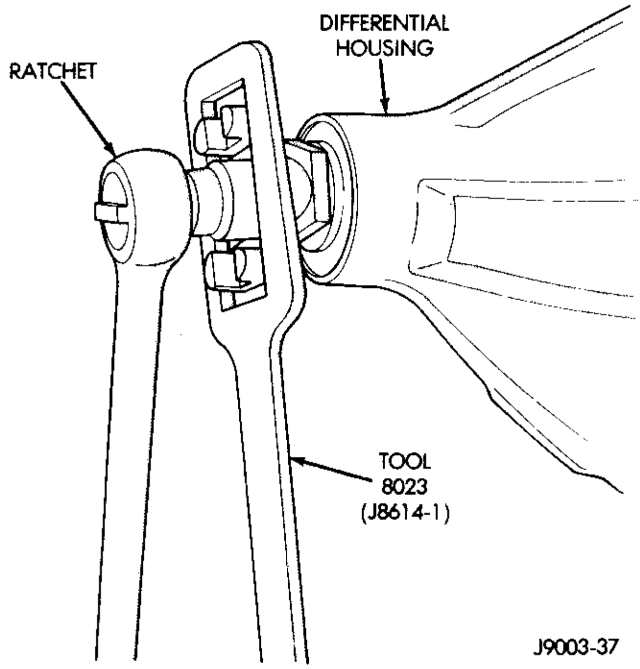


Fig. 34 Pinion Gear Shaft Nut Removal/Installation

(11) Install the replacement seal on the drive pinion gear shaft (Fig. 37) with Seal Installation Tool 6272 (J22661).

(12) Install the dust cap, the yoke, the washer and the replacement shaft nut on the shaft (Fig. 20).

(13) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and tighten the shaft nut (Fig. 34) with 271 N•m (200 ft-lbs) torque (minimum).

(14) Proceed to Differential Bearing Preload Shim Installation.

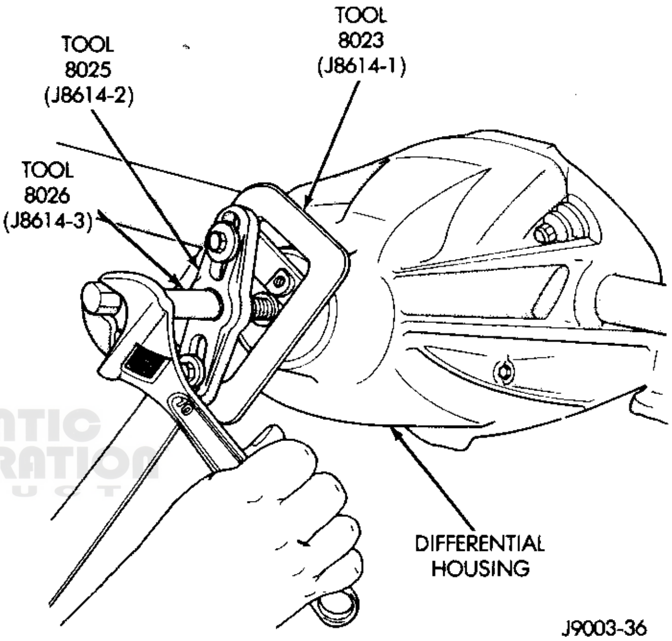


Fig. 35 Drive Pinion Gear Shaft Yoke Removal

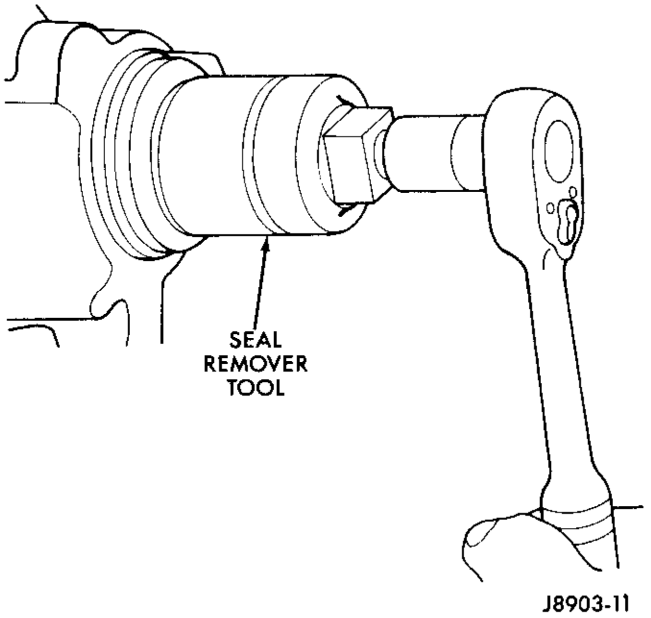


Fig. 36 Drive Pinion Gear Shaft Seal Removal

Differential Bearing Preload Shim Installation

Before installing the differential case, the differential bearings must be “preloaded” with additional shims to compensate for the heat accumulation and the engine torque “load” during vehicle operation.

(1) Remove the differential cup and bearing that are located at the **opposite** side of the case from the ring gear. Use Bearing Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) to remove the bearing (Fig. 38).

(2) If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(3) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(4) Tighten the puller tool or the removal tool screw (Fig. 38) and remove the bearing from the differential case hub.

(5) Place an additional 0.015-inch or 0.38-mm thick shim on the differential case hub (Fig. 39).

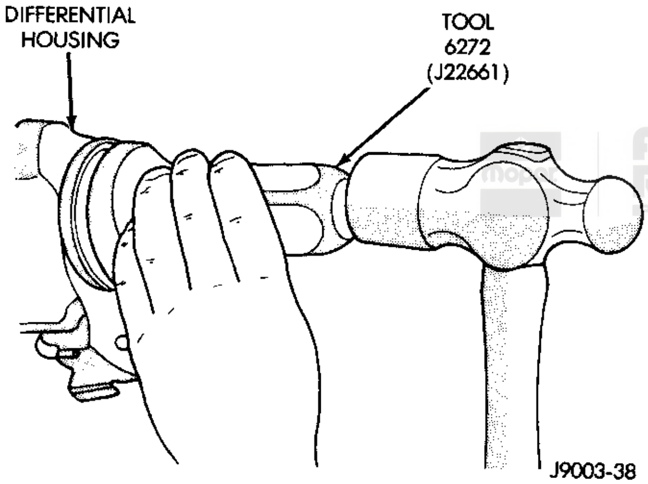


Fig. 37 Drive Pinion Gear Shaft Seal Installation

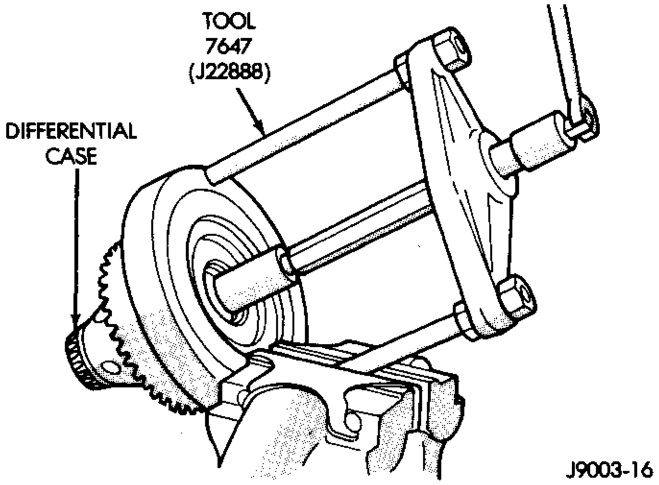


Fig. 38 Differential Bearing Removal

(6) Install the differential bearing on the case hub (Fig. 39) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092).

(7) Install the bearing cup on the case hub.

Differential Case Installation

(1) Lubricate the bearings, the gears and the thrust washers with axle lubricant.

(2) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing (Fig. 40).

(3) Attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing (Fig. 40).

CAUTION: Do not exceed the specified 0.38-mm (0.015-in) separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) Separate differential housing only enough to install the differential case in the housing. Separate the differential housing a **maximum distance of 0.38 mm (0.015 in)** with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated (Fig. 40).

(5) Remove the dial indicator when the differential housing has been separated sufficiently to install the case in the housing.

(6) Install the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to “seat” them (Fig. 41).

(7) Remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing (Fig. 40).

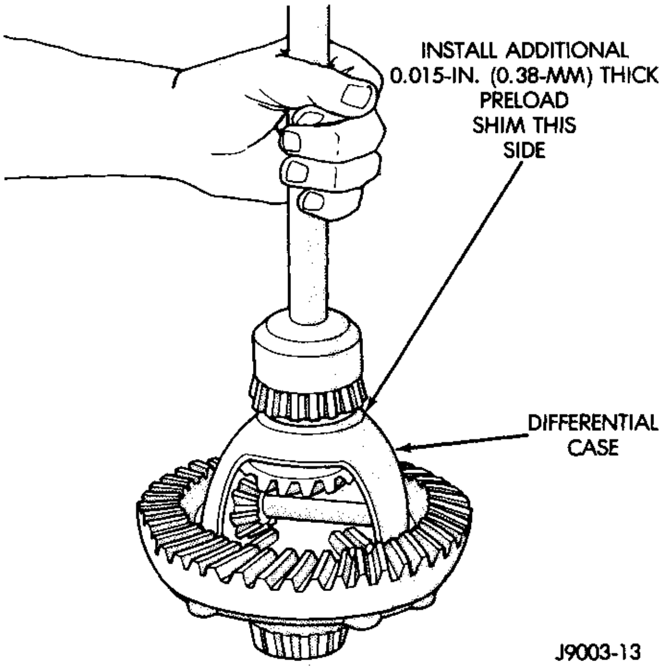


Fig. 39 Differential Bearing & Shim Installation

(8) Observe the installation reference marks and install the differential bearing caps. Tighten the cap bolts with 108 N•m (80 ft-lbs) torque.

(9) Measure the ring gear "backlash". The "backlash" should be 0.005 to 0.008 inch or 0.12 to 0.20 mm. If necessary, readjust the ring gear "backlash".

Installation—SJ and MJ Vehicles

(1) Install the axle shafts. If necessary, refer to the installation procedure.

(2) Clean the housing and the housing cover mating surfaces thoroughly.

(3) Apply a thin "bead" of MOPAR RTV sealant (or an equivalent sealant) to the housing and to the cover. Install the cover. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

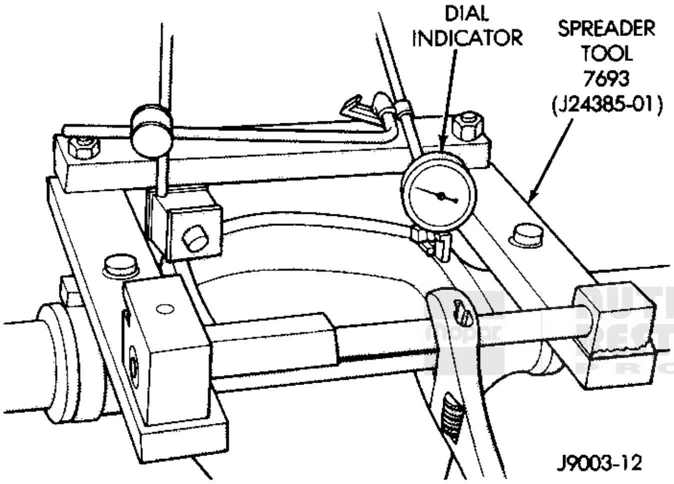


Fig. 40 Differential Housing Separation

(4) Align the installation reference marks on the drive shaft yoke and the axle yoke. Install the clamps and the screws. Tighten the clamp screws with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

(5) Fill the differential housing with 3.75 pints (1.77 liters) of SAE 75W-90, API grade GL 5 hypoid gear lubricant.

(6) Install the brake drums and the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(7) Remove the supports and lower the vehicle.

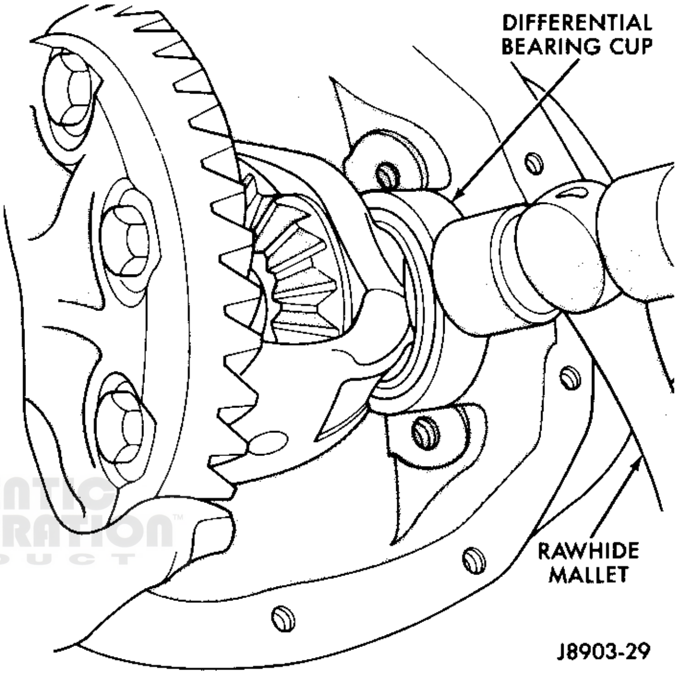


Fig. 41 Seating The Differential Bearing Cups

TRAC-LOK DIFFERENTIAL SERVICE

INDEX

GENERAL SERVICE INFORMATION

The service procedures described within this section can be utilized with the axle either installed or removed from the vehicle.

LUBRICANTS

The lubricants recommended for a **Trac-Lok** (i.e., limited-slip) differential are SAE 75W-90, API grade GL 5 hypoid gear lubricant and a container of Trac-Lok Lubricant (a friction modifier) additive (when refilling the differential housing after repair service or a lubricant change).

COMPONENTS

The **Trac-Lok** (i.e., limited-slip) differential components are illustrated in Figure 1. Refer to this illustration during repair service for component detail and their location.

SERVICE PROCEDURES

Differential Case Removal—Model 35 And 44 Axles

(1) Raise and support the vehicle.

(2) Remove the differential housing cover and drain the lubricant.

(3) Score installation alignment reference marks on the yokes and disconnect the drive shaft rear yoke from the drive pinion gear shaft (axle) yoke.

(4) Refer to the axle shaft removal procedure (if necessary) and remove the:

- rear wheels/tires,
- brake drums, and
- axle shafts.

(5) Mark the differential bearing caps with a center-punch for installation reference.

(6) Loosen the differential bearing cap bolts until only 2 or 3 threads are engaged.

(7) If necessary, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing (Fig. 2).

(8) If a spreader tool is used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing (Fig. 2).

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(9) Separate the differential housing only enough to remove the differential case from the housing. Separate the differential housing a **maximum distance of 0.38 mm (0.015 in)** for Model 44 axles and a **maximum distance of 0.5 mm (0.02 in)** for Model 35 axles. Measure the separation distance with the dial indicator as the housing is being separated (Fig. 2).

(10) Remove the dial indicator when the differential housing has been separated sufficiently to remove the case from the housing.

(11) Remove the differential bearing caps.

(12) Remove the differential case with two pry bars. Position one bar under a ring gear bolt head, one under the differential case and pry the differential case upward to remove it.

Remove the spreader tool and the holddown clamps immediately after removing the differential case from the housing. This is important to avoid the possibility of the housing acquiring a different "set".

Disassembly—Model 35 And 44 Axles

Differential Case—Disassembly

(1) Clamp one of the axle shafts in a vise (with protective jaws) with the splined end upward. Allow no more than 2-3/4 inches (or 7 cm) of the shaft to extend above the vise jaws (Fig. 3). The axle shaft will be used as a fixture to hold the differential case stationary for repair service.

If the axle shaft extends more than 2-3/4 inches (or 7 cm) above the vise jaws, it will prevent installation of the clutch disc removal tools.

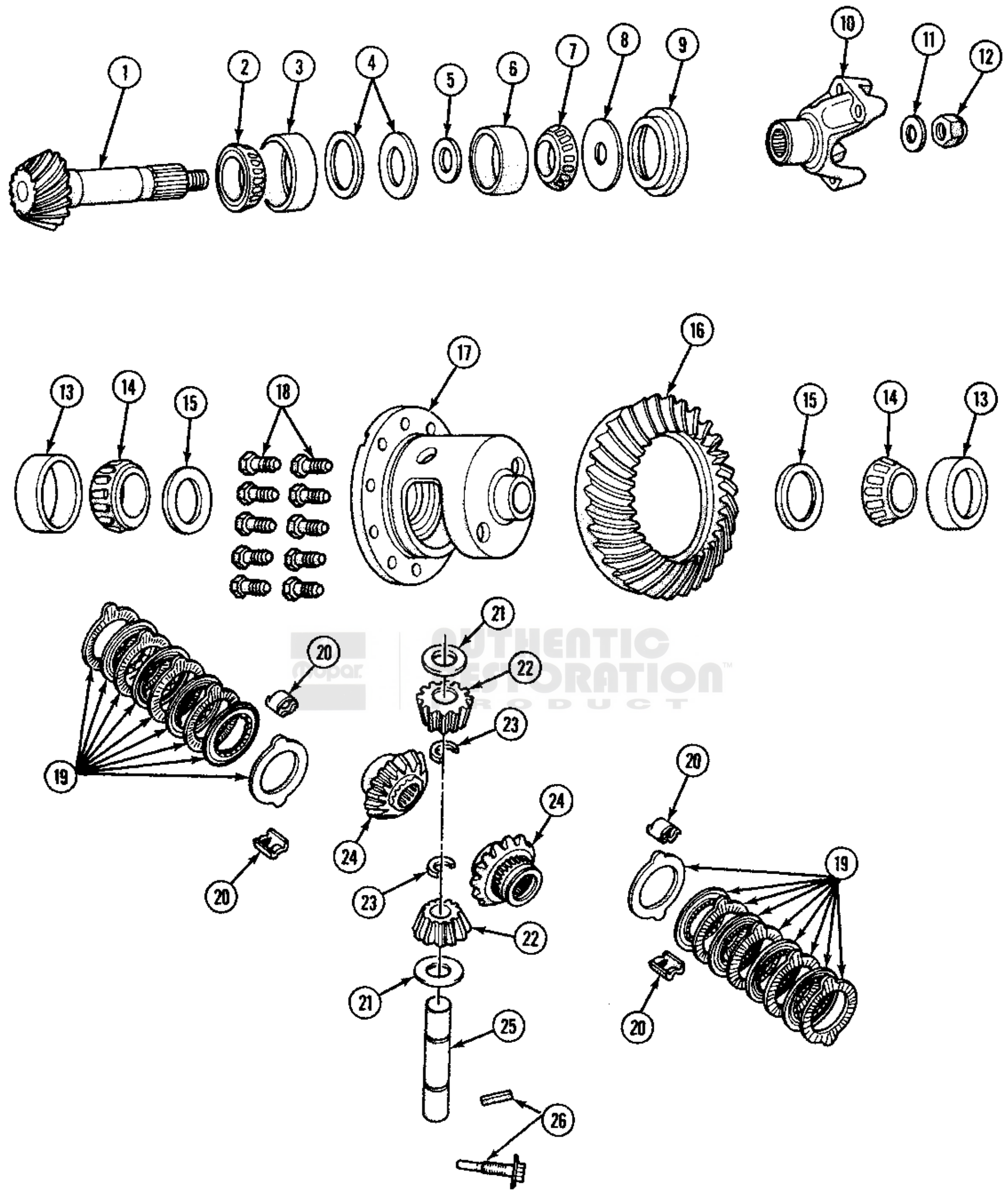
(2) Place shop towels under the differential gear to avoid gear damage during removal of the ring gear (Fig. 4).

(3) Position the differential case on the axle shaft with the ring gear bolts facing upward (Fig. 4).

(4) Remove and discard the ring gear bolts. They are not reusable.

(5) Remove the differential case from the axle shaft and remove the ring gear from the case by tapping it with brass drift and a hammer.

(6) Position the differential case on the axle shaft.



1. PINION GEAR
2. PINION REAR BEARING
3. BEARING CUP
4. PINION DEPTH SHIMS
5. PINION PRELOAD SHIM/SPACER
6. BEARING CUP
7. PINION FRONT BEARING
8. SLINGER
9. PINION SEAL
10. YOKE
11. WASHER
12. PINION NUT
13. BEARING CUP
14. DIFFERENTIAL BEARING
15. BACKLASH/PRELOAD SHIM
16. RING GEAR
17. DIFFERENTIAL CASE
18. RING GEAR BOLTS
19. CLUTCH PACKS
20. CLUTCH PACK RETAINERS
21. PINION THRUST WASHER
22. DIFFERENTIAL PINIONS
23. PINION SHAFT SNAP RINGS (MODEL 44 ONLY)
24. DIFFERENTIAL SIDE GEARS
25. PINION SHAFT
26. PINION SHAFT LOCK PIN OR SCREW

J9003-10

Fig. 1 Trac-Lok Differential — Exploded View

(7) For Model 44 axles, drape a shop towel around the case to prevent losing the pinion gear mate shaft retaining "snap" rings during removal (Fig. 5).

(8) For Model 44 axles, remove the pinion gear mate shaft retaining "snap" rings with two small pry bars. Place the pry bar blade ends simultaneously against the ring ends and force the ring off the shaft (Fig. 5).

(9) For Model 44 axles, remove the pinion gear mate shaft from the differential case by tapping it with a brass drift and a hammer.

(10) Install Step Plate Tool 7676-7 (J23781-7) in the differential lower side gear bore (Fig. 6).

(11) Apply gear lubricant to the centering hole in the step plate tool.

(12) Position Gear Rotating Tool 7676-3 (J23781-3) on the step plate tool (Fig. 7).

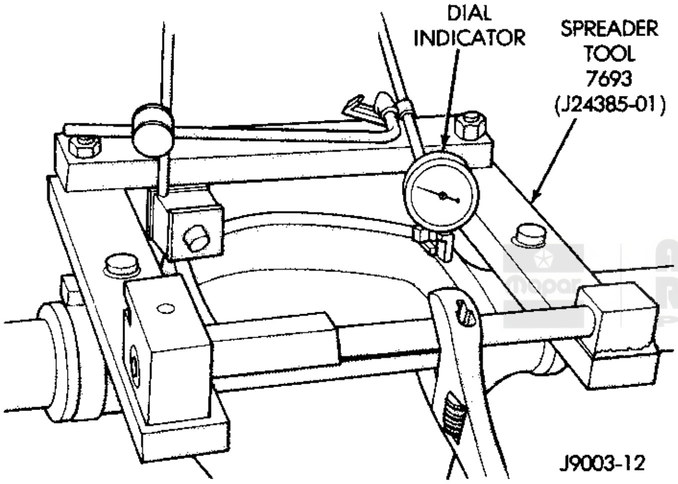


Fig. 2 Differential Housing Separation

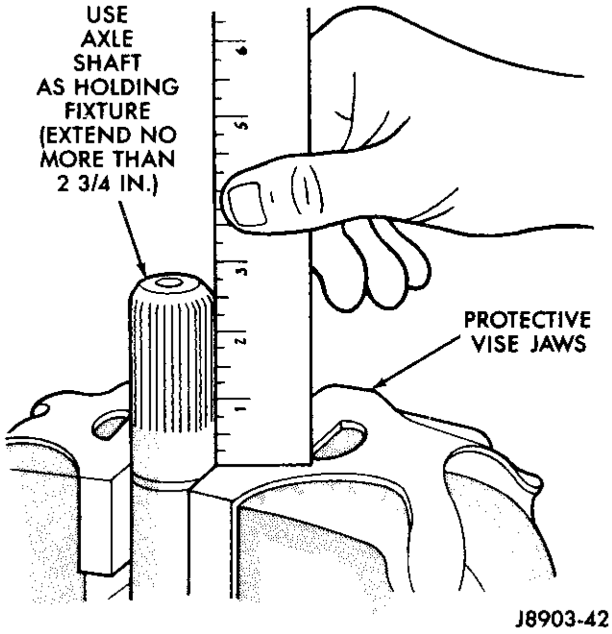


Fig. 3 Axle Shaft As A Holding Fixture

(13) Apply gear lubricant to the threads of Forcing Screw Tool 8027 (J8646-2).

(14) Insert the forcing screw tool through the differential case and thread it into the gear rotating tool. Continue threading the forcing screw tool through the gear rotating tool and into the step plate tool centering hole (Fig. 8).

(15) Tighten the forcing screw tool just enough to relieve the clutch disc tension. Remove the differential pinion gear thrust washers (Fig. 8).

(16) Continue tightening the forcing screw tool until all the clutch disc tension is relieved.

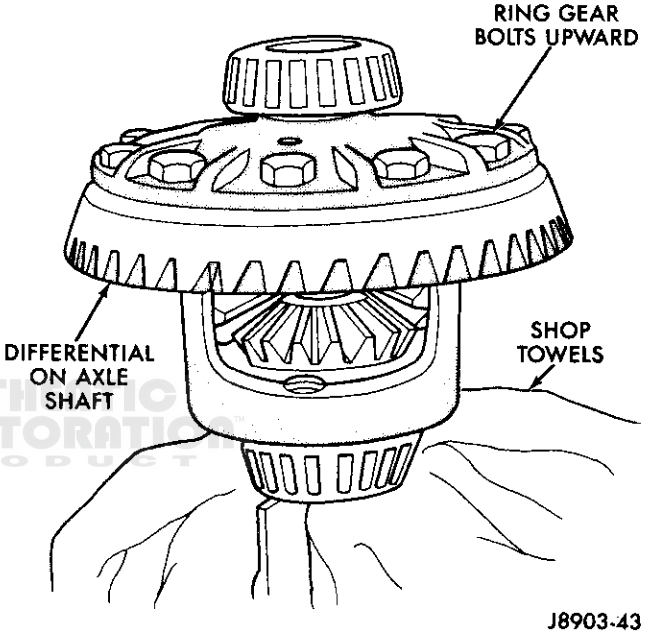


Fig. 4 Differential Case On An Axle Shaft

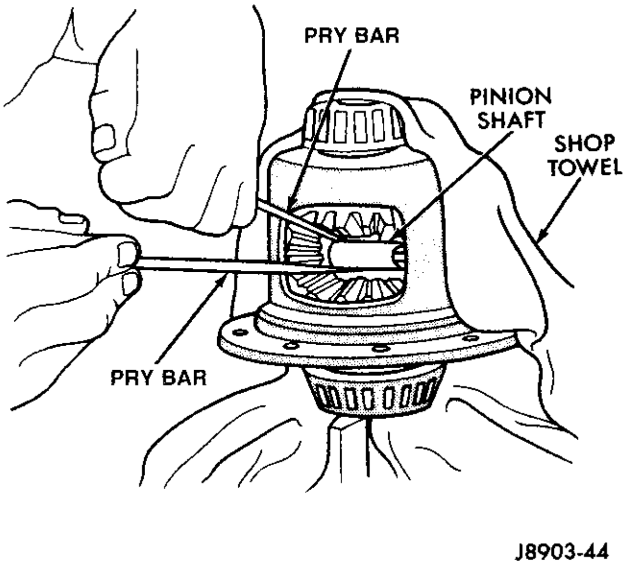


Fig. 5 Pinion Gear Mate Shaft Retaining Ring Removal

(17) Slide the gear rotating tool pawl into engagement with the differential side gear teeth (Fig. 9).

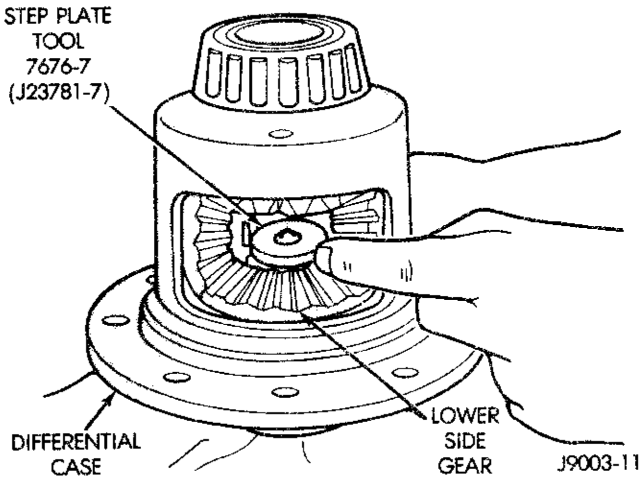


Fig. 6 Step Plate Tool Installation

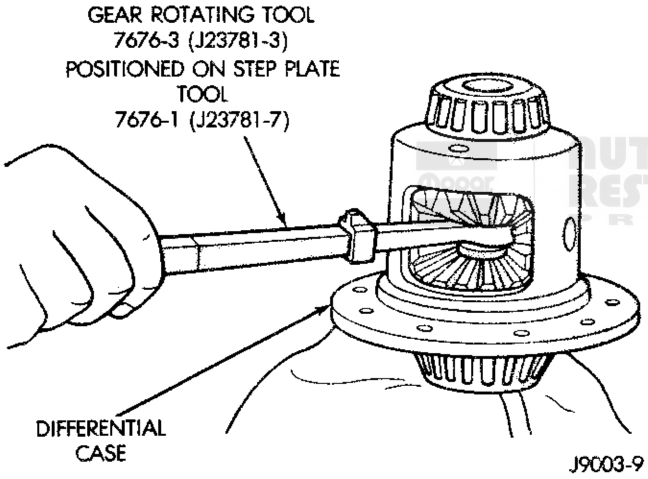


Fig. 7 Gear Rotating Tool Installation

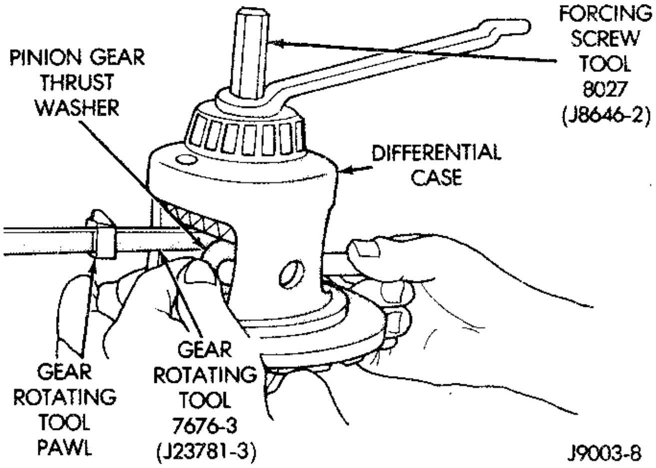


Fig. 8 Differential Pinion Gear Thrust Washer Removal

(18) Rotate the side gears with the gear rotating tool until the pinion gears can be removed via the differential case opening (Fig. 9).

(19) Remove the forcing screw tool, the gear rotating tool, and the upper differential side gear with the clutch discs (Fig. 10).

(20) Remove the differential case from the axle shaft and remove the step plate tool and the lower side gear with the clutch discs (Fig. 10).

(21) Remove the clutch disc retaining clips and mark/tag each clutch disc pack for installation reference.

Differential Bearing—Removal

(1) Mark the bearing cups for installation reference and remove them.

CAUTION: When removing a differential bearing, ensure that the differential case is securely clamped or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

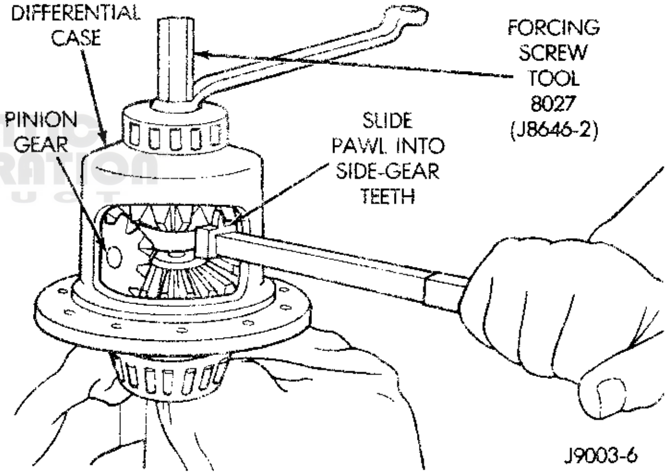


Fig. 9 Differential Pinion Gear Removal

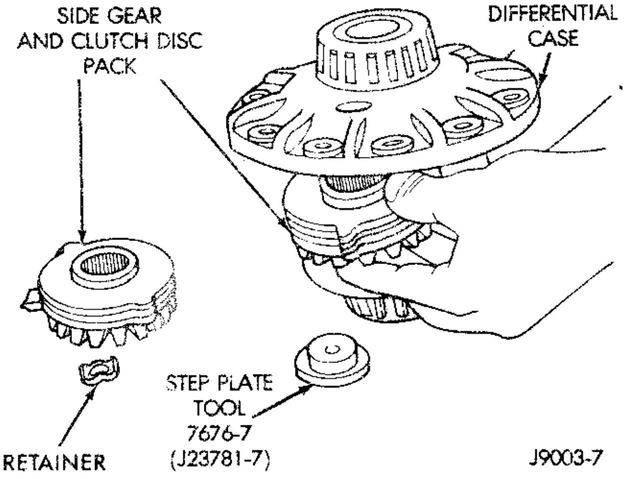


Fig. 10 Side Gear & Clutch Disc Removal

(2) Install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and the bearing (Fig. 11).

(3) If used, position the chamfered edge of the removal tool adapters between the bearing race and the case.

(4) If used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race.

(5) Tighten the puller tool or removal tool screw (Fig. 11) and remove the bearing from the differential case hub.

(6) Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

Drive Pinion Gear Shaft—Removal

(1) Remove the drive pinion gear shaft (axle) yoke retaining nut and washer. Use a socket and Flange Removal Tool 8023 (J8614-1) to remove the shaft nut (Fig. 12).

(2) Remove the drive pinion gear shaft (axle) yoke (Fig. 13) with Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3).

(3) If equipped, remove the dust cap from the drive pinion gear shaft (Model 44 axles only).

(4) Remove the drive pinion gear shaft. Strike the exposed end of the shaft with a rawhide hammer to force it out of the drive pinion gear shaft rear bearing and the housing.

(5) Remove the drive pinion gear shaft front bearing, the bearing "preload" torque spacer/shim(s), the oil slinger, and the seal. Use a 2 x 2-inch or 5 x 5-cm piece of wood, or length of pipe to drive the bearing, the spacer/shim(s), the oil slinger, and the seal out of the housing.

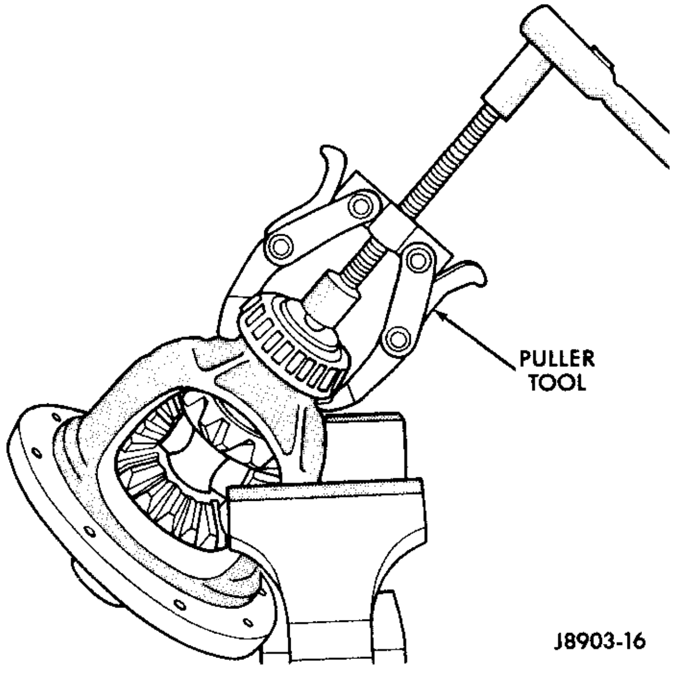


Fig. 11 Differential Bearing Removal

(6) Discard the seal and the spacer (Model 35 axles) after removal. If reusable, retain the "preload" torque shim(s) (Model 44 axles).

Drive Pinion Gear Shaft Rear Bearing—Removal

(1) Install Bearing Removal Tool 7650 (J22912-1) around the shaft rear bearing (Fig. 14).

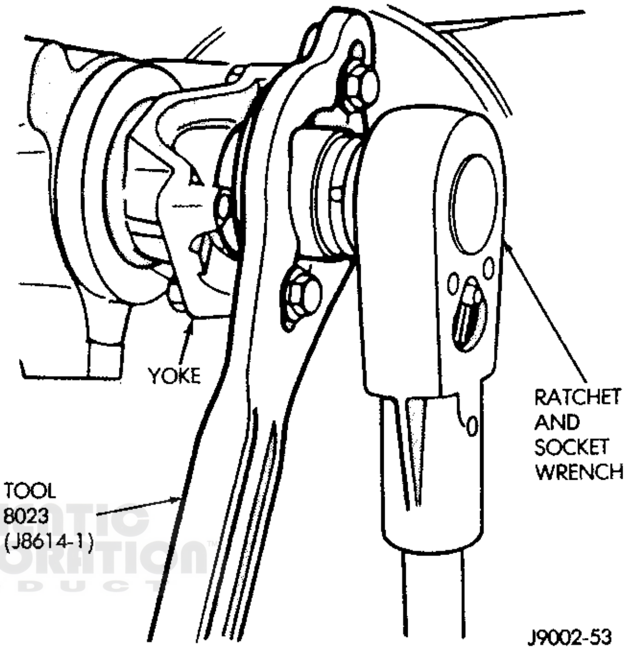


Fig. 12 Pinion Shaft (Axle) Yoke Nut Removal

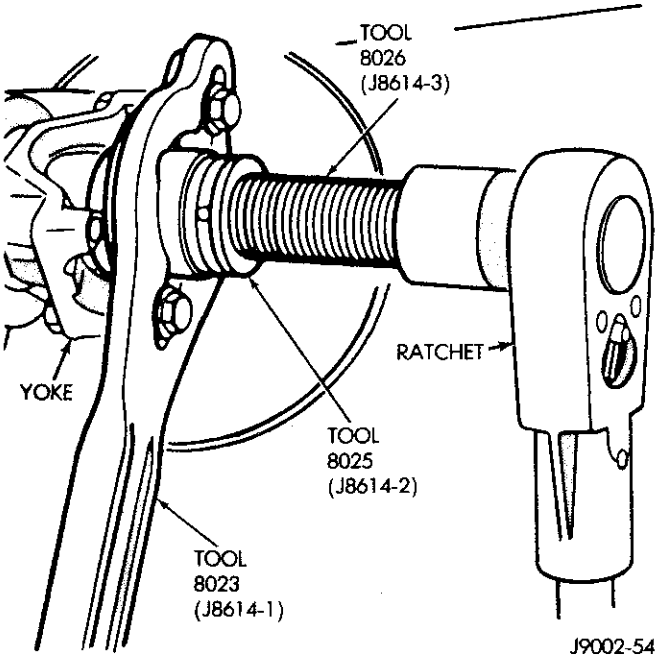


Fig. 13 Drive Pinion Gear Shaft (Axle) Yoke Removal

(2) Tighten the removal tool screws (Fig. 14) and remove the bearing.

Drive Pinion Gear Shaft Bearing Cup — Removal

(1) Remove the drive pinion gear shaft rear bearing cup. Use a brass drift and a hammer to tap the cup out of the housing.

(2) Remove the drive pinion gear depth shim(s) from the rear bearing cup bore in the differential housing. Retain the depth shim(s) for installation reference (even if they are bent or distorted).

(3) Remove the drive pinion gear shaft front bearing cup. Use a brass drift and a hammer to tap the cup out of the differential housing.

Cleaning And Inspection—Model 35 And 44 Axles

(1) Clean all of the differential components (Fig. 1) in cleaning solvent. Allow the bearings to either air dry or dry them with a lint-free cloth. Dry the other components with compressed air.

(2) Inspect all of the bearings and cups for "pitting", "galling", "flat spots", and "cracks" (Fig. 1).

(3) Replace any bearing or cup that has any of the defective conditions described above.

(4) Inspect the differential case (Fig. 1) for an elongated or enlarged differential pinion gear mate shaft bore. The machined thrust washer surface areas and counterbores must be smooth and free of "nicks", "gouges", "cracks", and "burrs".

(5) Inspect the differential case for "cracks", worn shaft and pin bores, and other damage that could necessitate replacement. If the metal was raised on the bearing cup bore shoulders during bearing cup removal, flatten the raised area with a blunt punch.

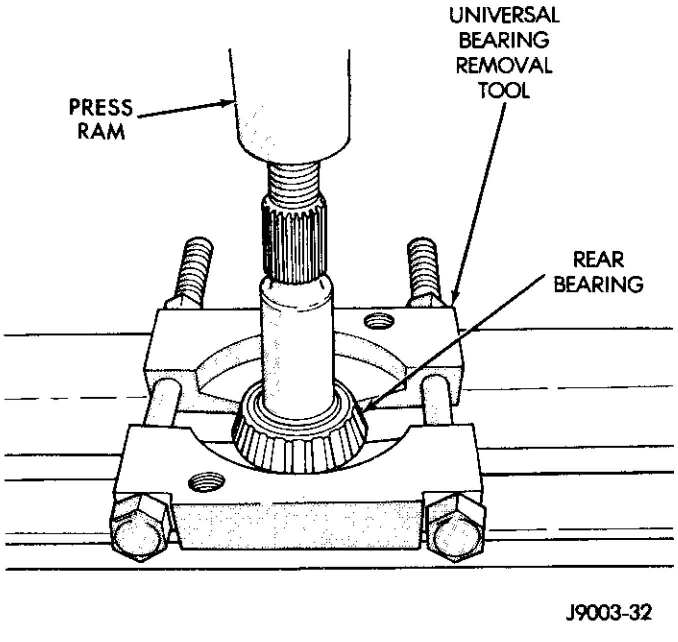


Fig. 14 Drive Pinion Gear Shaft Rear Bearing Removal

(6) Replace the differential case if defective.

(7) Inspect the differential clutch discs for "excessive wear", "scoring" or other damage (Fig. 1). Both clutch disc packs must be replaced if any **one** component in either pack is damaged.

(8) Inspect the differential pinion gear mate shaft (Fig. 1) for "excessive wear", "scoring", and "galling". The shaft must be smooth and concentric. Replace the shaft if it is either worn excessively, damaged or defective.

(9) Inspect the differential side gears and the pinion gears (Fig. 1). All the gear teeth must have uniform contact patterns. Inspect the gears and gear teeth for "cracks", "scoring", "excessive wear", and "galling".

(10) Replace all the gears if any **one gear** has any of the defective conditions described above.

(11) Inspect the differential pinion gear thrust washers for "excessive wear", "scoring", "galling" and "distortion" (Fig. 1).

(12) Replace the washers if they have any of the defective conditions described above.

(13) Inspect the differential pinion gear mate shaft lockpin or lock screw (Fig. 1) for damage or for a loose fit in the differential case.

(14) Replace the lockpin/lock screw or the differential case as necessary.

(15) Inspect the differential ring gear and the drive pinion gear and shaft (Fig. 1) for worn or "chipped" teeth, "cracks", damaged bearing journals and damaged attaching bolt threads.

(16) If replacement is necessary, both gears must be replaced as a **"matched set" only.**

(17) Inspect the drive pinion gear shaft (axle) yoke (Fig. 1) for "cracks", worn splines, and "pitted", rough or corroded seal contact surfaces.

(18) Repair or replace the yoke as necessary.

(19) Inspect the drive pinion gear depth shims and the bearing "preload" torque shims (Model 44 axles only) for damage and distortion (Fig. 1).

(20) Replace any defective shims as necessary during assembly.

Assembly And Adjustment Information—Model 35 And 44 Axles

The differential ring and drive pinion gears in Model 35 and Model 44 axles must be adjusted for the best possible **gear teeth contact patterns.** The drive pinion gear depth cannot be initially measured and "set" precisely with shims. If the original gear set is installed with the original depth shim(s), the **best possible gear teeth contact patterns** are achieved by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If a replacement gear set must be installed, the best possible gear teeth contact patterns are achieved by using the Pinion Gear Depth Variance chart to "initially" establish the drive pinion gear depth with shim(s) and then by adjusting the pinion gear depth and the ring gear "backlash" as necessary.

If necessary, the differential ring gear and drive pinion gear shaft must be replaced as a "matched set" only. They are identified as a "matched set" by the numbers etched into each gear.

The identical, first two numbers (Fig. 15) etched into each gear identify them as a "matched set". The second number etched into the drive pinion gear is the depth variance. It indicates the amount (in thousandths of an inch) that the set varied from the standard "setting" of 2.095 inches (53.21 mm) for Model 35 axles and 2.625 inches (66.6 mm) for Model 44 axles. The depth variance can be either a plus (+), zero (0) or a minus (-) value.

If the original gear set is not used, the replacement drive pinion gear **initial** depth shim thickness must be determined before installing the differential in the housing. The depth shim(s) (Fig. 16) is (are) positioned adjacent to the drive pinion gear shaft rear bearing cup.

Refer to the Pinion Gear Depth Variance chart for the required initial depth of a replacement drive pinion gear shaft. The chart will aide in determining the depth shim thickness needed for establishing the initial depth. **The chart will only help determine the required shim thickness for the initial depth. It will not provide the exact shim thickness necessary to precisely position the pinion gear for the best possible gear teeth contact patterns and must not be used as a substitute for actually analyzing the gear teeth contact patterns and adjusting the drive pinion gear depth and the ring gear "backlash" accordingly.**

To use the chart, proceed according to the following instructions:

- measure the thickness of the original drive pinion gear depth shim(s);
- note the depth variance values etched in the original and the replacement drive pinion gears;
- refer to the Original and Replacement Pinion Gear Depth Variance columns in the chart; and
- locate the chart box where the Original and Replacement Pinion Gear Depth Variance columns intersect for the approximate amount of "change" from the original shim thickness that is required to establish the "initial" pinion gear depth for the replacement shaft.

For example, if the original drive pinion gear is etched **-3** and the replacement drive pinion gear is etched **+2**, the initial shim selection procedure is accomplished according to the following instructions:

- refer to the Original Pinion Gear Depth Variance column at the left side of the chart and locate the **-3** value in this column;
- move to the right across the chart until at the **+2** value in the Replacement Pinion Gear Depth Variance column;
- the box where the two columns intersect will provide the amount of **change** in shim thickness required (i.e., -0.005 inch) for the replacement set;
- the value in the intersecting box is -0.005 inch (-0.12 mm), which represents the amount of thickness to be **subtracted** from the original drive pinion gear shaft shim(s);
- if the value was zero (0), the initial shim thickness would be the **same** as the original drive pinion gear shaft shim(s); and
- if the value was positive (+), this amount of thickness would be **added** to the original drive pinion gear shaft shim(s).

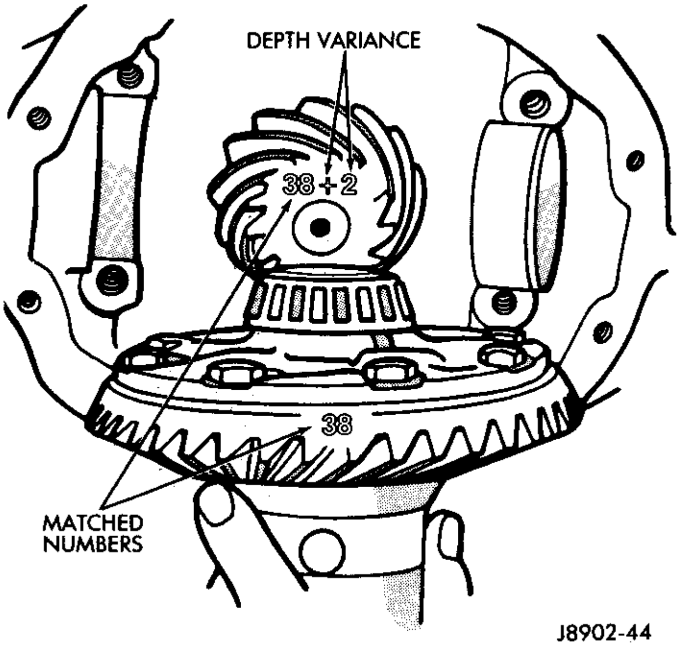


Fig. 15 Matched Ring Gear & Drive Pinion Gear Set

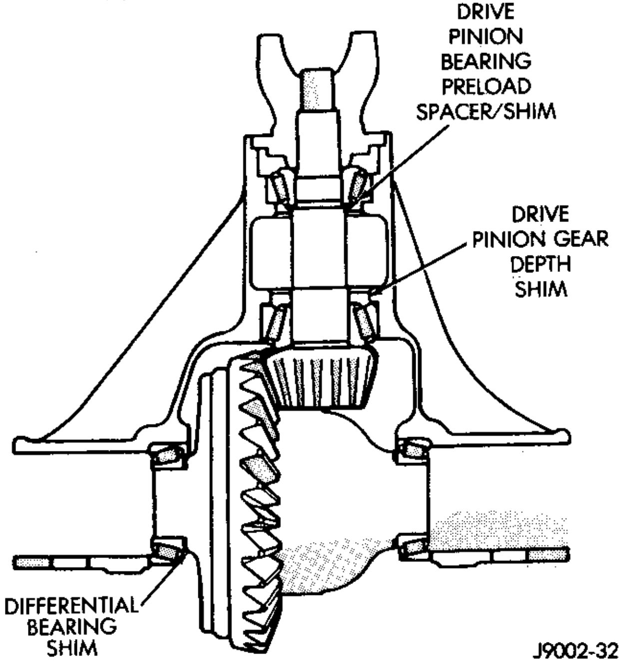


Fig. 16 Depth Shim & Preload Spacer/Shim Locations

Pinion Gear Depth Variance

Original Pinion Gear Depth Variance	Replacement Pinion Gear Depth Variance								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

J8902-46

Assembly—Model 35 And 44 Axles

Drive Pinion Gear Shaft—Assembly And Installation

(1) If applicable, verify that the replacement ring gear and drive pinion gear shaft are a "matched set" before proceeding.

(2) If the original ring gear and drive pinion gear shaft set is being installed, use the original depth shim(s).

(3) If a replacement ring gear and drive pinion gear set is being installed, determine the amount of "thickness" that must be either **added to or subtracted from** the original depth shim(s) to **initially** establish the drive pinion gear depth:

- note the depth variance etched in the original and the replacement drive pinion gear;
- refer to the Pinion Gear Depth Variance chart and move to the box where the Original and Replacement Pinion Gear Depth Variance columns intersect; and
- note the value in the box, it will be either a plus (+), zero (0) or a minus (-) value of **change** required from the original shim thickness so that it/they can be used with the replacement gear set.

(4) Clean the drive pinion gear shaft bearing cup bores in the differential housing.

(5) Install the "initial" depth shim(s) in the housing rear bearing cup bore (Fig. 1).

If a depth shim is chamfered on one side, position the chamfered side so that it faces the bottom of the bearing cup bore.

(6) Install the drive pinion gear shaft rear bearing cup in the housing and adjacent to the "initial" depth shim(s) (Fig. 1).

(7) Install the drive pinion gear shaft front bearing cup in the housing (Fig. 1).

(8) Install the rear bearing on the drive pinion gear shaft (Fig. 1) with Bearing Installation Tool 7699 (J24433).

(9) Install the drive pinion gear shaft in the housing (Fig. 1).

Do not install the bearing replacement "preload" torque spacer (Model 35 axles) or the shim(s) (Model 44 axles) at this time.

(10) Install the front bearing on the drive pinion gear shaft (Fig. 1). "Seat" the bearing on the shaft and in the cup.

Do not install the drive pinion gear shaft replacement seal at this time.

(11) Install the dust cap (Model 44 axle only), the drive pinion gear shaft (axle) yoke and the original nut on the drive pinion gear shaft (Fig. 1). **Tighten the nut only enough to remove the shaft "end play".**

(12) For Model 35 axles, proceed to Differential Case Runout Measurement. For Model 44 axles, proceed to Differential Case Components Assembly—Model 35 And 44 Axles

Differential Case Runout Measurement—Model 35 Axles Only

(1) Install the differential bearings on the case hubs (Fig. 17) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092). **Do not install the bearing shims at this time.**

(2) Install the bearing cups on the bearings.

(3) If necessary, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

(4) If the spreader tool is used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(5) If necessary, separate the differential housing only enough to install the differential case in the housing. **Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated.

(6) If used, remove the dial indicator when the differential housing has been separated sufficiently to install the case in the housing.

(7) Position the differential case in the housing.

(8) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(9) Insert enough spare shims between one of the differential bearings and the housing to eliminate all differential case "side play".

(10) Observe the installation reference marks and install the differential bearing caps and bolts (Fig. 18). Tighten the bolts securely (no specified torque).

(11) Attach a dial indicator to the housing. Position the dial indicator plunger so that it contacts the ring gear mating face on the differential case (Fig. 18).

(12) Pry the differential case to one side and "zero" the dial indicator pointer.

(13) Rotate the differential case several times and note the dial indicator pointer position as the case rotates.

(14) The differential case "runout" should not exceed 0.002 inch or 0.05 mm. Replace the case if the "runout" exceeds the specified limit.

(15) Retain the dial indicator at this position and proceed to the differential bearing Zero End-Play Adjustment.

Zero End-Play Adjustment—Model 35 Axles Only

(1) Loosen the differential bearing cap bolts at each side of the differential case.

(2) Remove the spare shims that were used to eliminate the differential case "side play" and retain the differential case in the same position as it was for the "runout" measurement.

(3) Install a 0.142-inch or 3.6-mm thick shim between each differential bearing and the housing (Fig. 19). These shims will provide an "end-play" "coarse" adjustment.

(4) Pry the differential case to one side of the housing and "zero" the dial indicator pointer while at this location.

(5) Pry the differential case to the opposite side of the housing and record the dial indicator "end-play" (distance) measurement. The distance measurement is the **additional** shim thickness required for differential bearing "zero" "end play".

(6) For example, if the "end play" (distance) measurement is 0.008 inch or 0.20 mm, an additional 0.004-inch or 0.10-mm thick shim will be necessary at each side of the housing for differential bearing "zero" "end play".

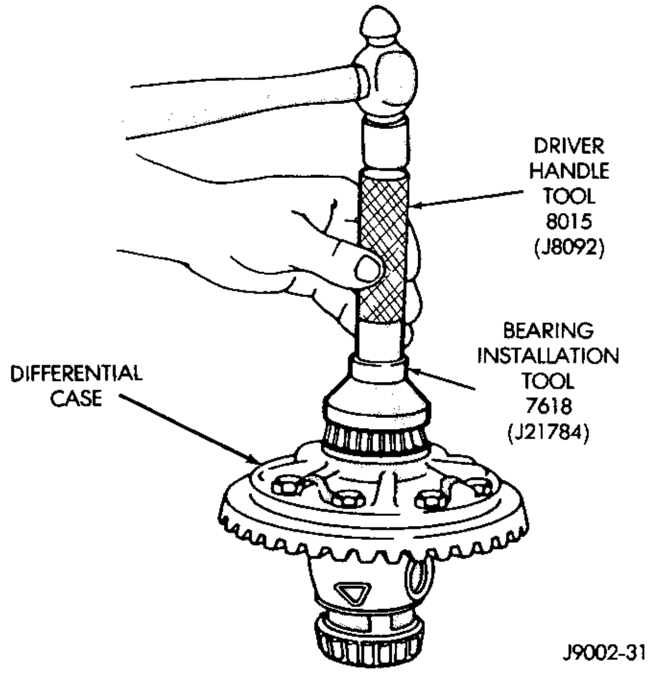


Fig. 17 Differential Bearing Installation

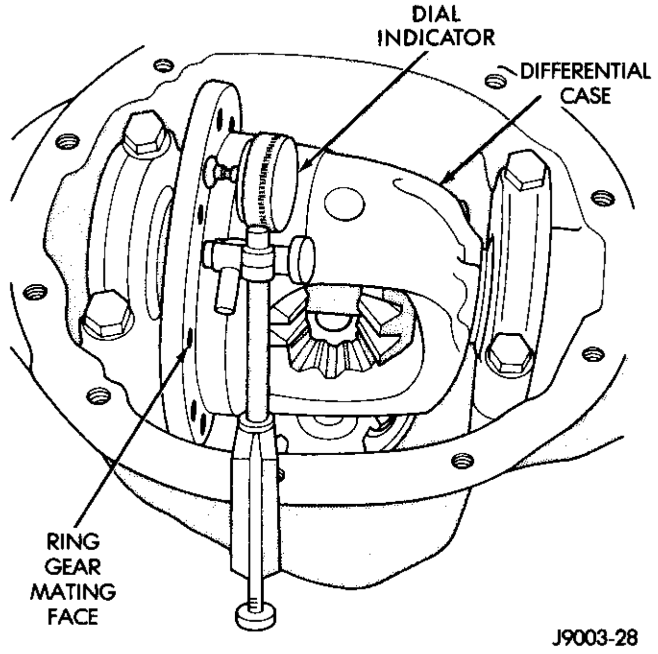


Fig. 18 Differential Case Runout Measurement

(7) Obtain the necessary differential bearing "zero" "end-play" shims, set them aside and reserve them for installation later.

(8) Remove the dial indicator from the housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove the differential case from the housing. Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove the differential case from the housing. Remove the spreader tool and the holddown clamps immediately after removing the differential case from the housing. This is important to avoid the possibility of the housing acquiring a different "set".

(9) If necessary, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case from the housing. Proceed to Differential Case Components Assembly.

Differential Case Components Assembly—Model 35 And 44 Axles

(1) The **Trac-Lok** (i.e., limited-slip) clutch disc packs are replaceable as complete sets only. **If one clutch disc pack is damaged, both clutch disc packs must be replaced.**

(2) Lubricate the side gears and the clutch discs with gear lubricant.

(3) Assemble the clutch discs into "packs" (Fig. 20).

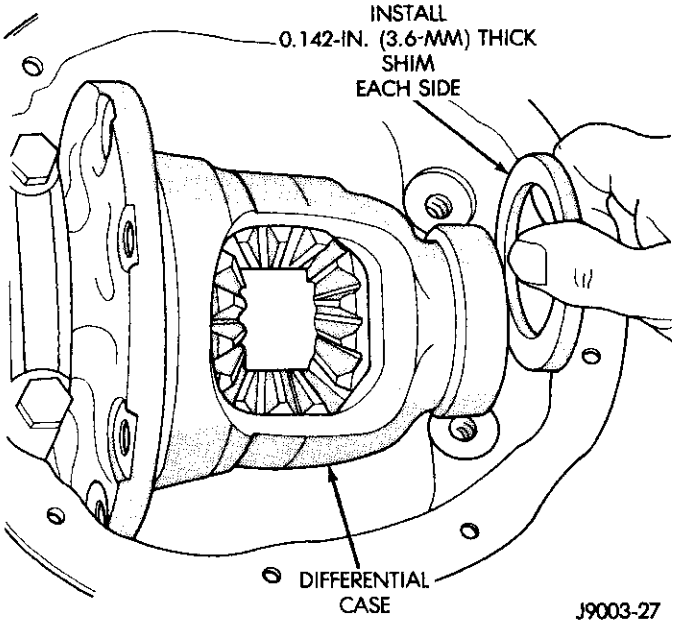


Fig. 19 Differential Bearing Shim Installation

(4) Secure the assembled clutch disc packs with the retaining clips (Fig. 20). Install the clips on the clutch disc ears.

(5) Position the assembled clutch disc packs on the side gear hubs.

(6) Position the differential case on an axle shaft (Fig. 21).

(7) Install the clutch discs and side gear in the lower bore of the differential case (Fig. 22). **Ensure that the clutch disc retaining clips remain correctly positioned and are "seated" in the case pockets.**

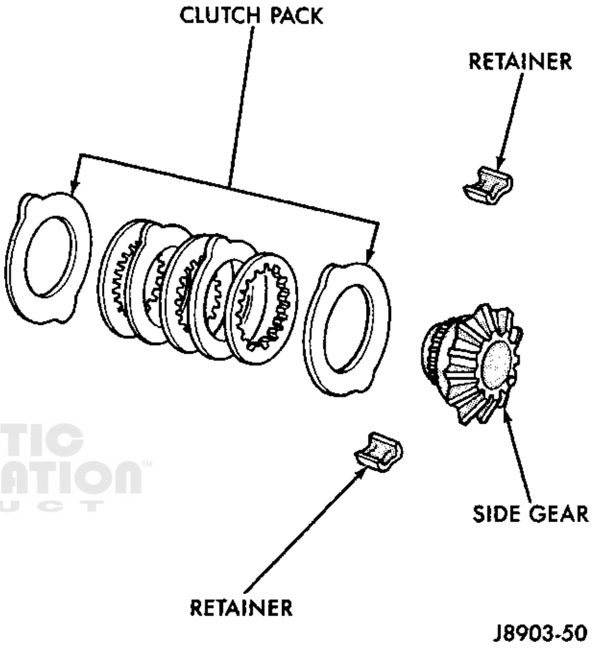


Fig. 20 Trac-Lok Clutch Disc Pack

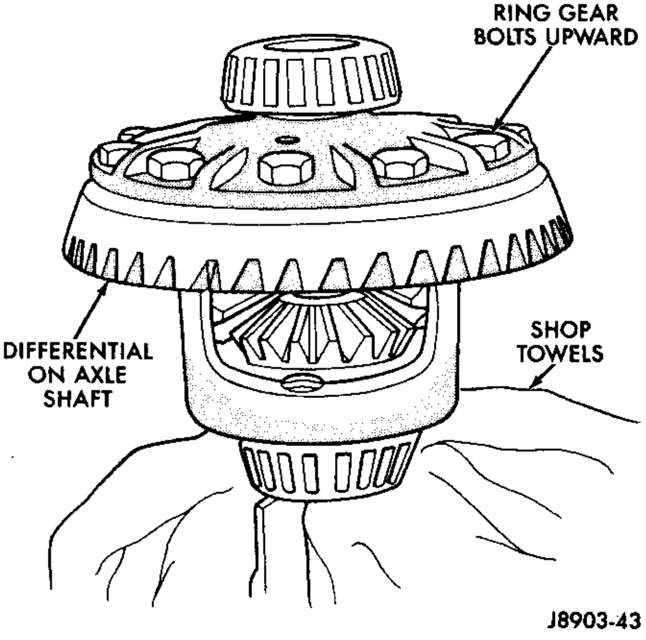


Fig. 21 Differential Case On An Axle Shaft

(8) Install Step Plate Tool 7676-7 (J23781-7) in the lower side gear bore (Fig. 23).

(9) Apply gear lubricant to the centering hole in the step plate tool.

(10) Install the upper side gear and the clutch discs in the differential case (Fig. 23).

(11) Hold the upper side gear and position Gear Rotating Tool 7676-3 (J23781-3) on the step plate tool (Fig. 24).

(12) Apply gear lubricant to the threads of Forcing Screw Tool 8027 (J8646-2).

(13) Insert the forcing screw tool through the differential case and thread it into the gear rotating tool. Continue threading the forcing screw tool through the gear rotating tool and into the step plate tool centering hole (Fig. 24).

(14) Tighten the forcing screw tool and compress the clutch discs.

(15) Install the pinion gears (Fig. 24). Rotate the side gears with the gear rotating tool pawl until each pinion gear is aligned with the pinion gear mate shaft bore.

(16) Install the pinion gear thrust washers (Fig. 25).

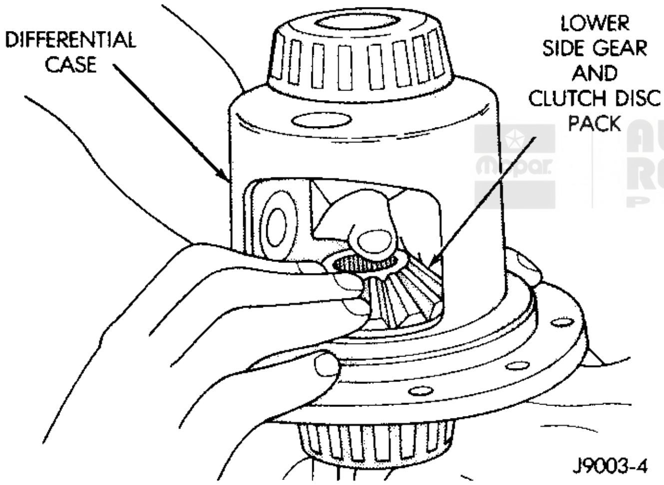


Fig. 22 Clutch Discs & Lower Side Gear Installation

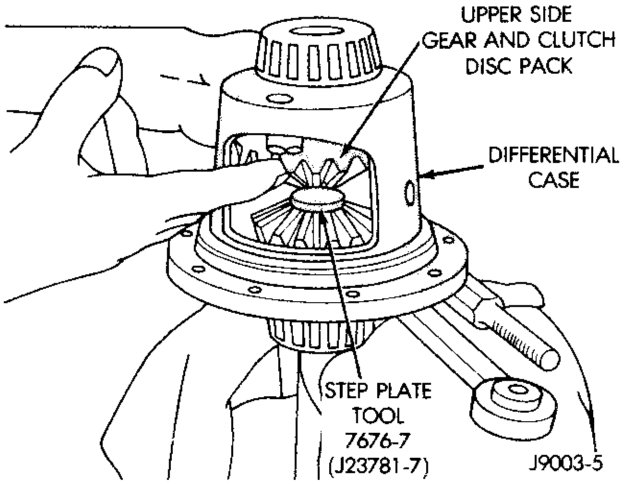


Fig. 23 Upper Side Gear & Clutch Disc Installation

(17) Insert and tap the pinion gear mate shaft into the bores in the differential case (Fig. 26).

(18) For Model 44 axles, secure the pinion gear mate shaft with replacement retaining "snap" rings.

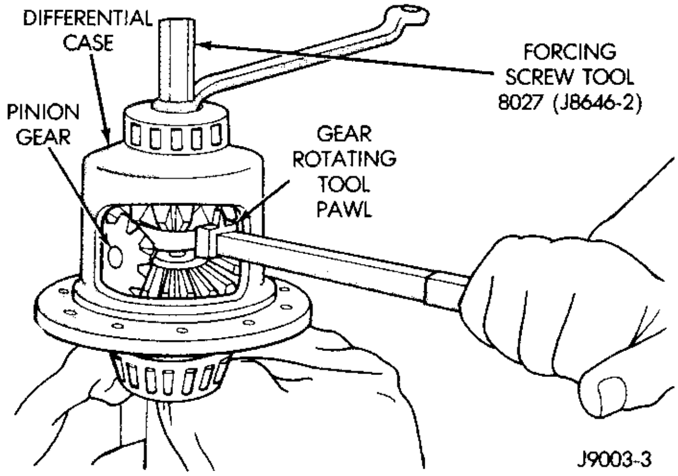


Fig. 24 Gear Rotating & Forcing Screw Tool Installation

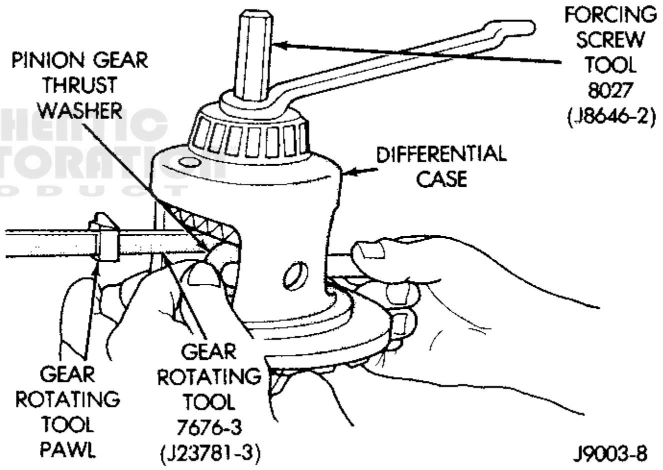


Fig. 25 Pinion Gear Thrust Washer Installation

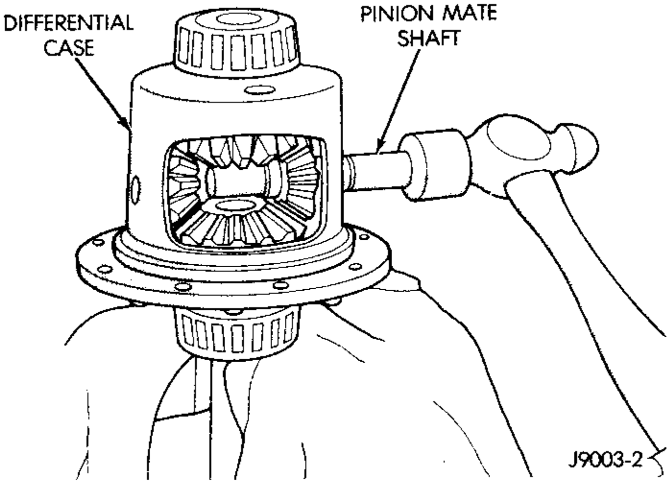


Fig. 26 Pinion Gear Mate Shaft Installation

(19) Remove the differential case and the axle shaft om the vise.

AUTION: When removing a differential bearing, enure that the differential case is securely clamped or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

(20) For Model 35 axles, remove the differential bearing cups and the bearings from the case hubs:

- mark the bearing cups for installation reference and remove them;
- install Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and the bearing (Fig. 27);
- if used, position the chamfered edge of the removal tool adapters between the bearing race and the case;
- if used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race; and
- tighten the puller tool or removal tool screw (Fig. 27) and remove the bearing from the differential case hub.

(21) For Model 35 axles, repeat the instructions to remove the other differential bearing from the opposite differential case hub.

(22) For Model 35 axles, install the previously reserved "zero" "end-play" shims on each of the differential case hubs.

(23) For Model 35 axles, observe the installation reference marks and install the differential bearings and cups on the case hubs. Install the differential bearings (Fig. 28) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092).

(24) Align and position the ring gear on the differential case (Fig. 1).

Do not reuse the original ring gear bolts, install replacement bolts only.

(25) Install **replacement** ring gear bolts. Tighten the bolts alternately and evenly with 75 N•m (55 ft-lbs) torque.

(26) Proceed to Ring Gear Backlash And Drive Pinion Gear Depth Adjustment.

Ring Gear Backlash And Drive Pinion Gear Depth Adjustment—Model 35 And 44 Axles

The ring and drive pinion gears must be adjusted for the **best possible teeth contact patterns**. The gear tooth nomenclature is illustrated in Figure 29.

The "toe" is the part of the gear tooth that is the closest to the inside perimeter of the gear. The "heel" is the part of the gear tooth that is the closest to the outside perimeter of the gear (Fig. 29).

The "drive" side of the ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin engagement and then mesh. The "coast" side of ring gear teeth is the side where the most surface contact exists as the drive pinion gear teeth begin disengagement and continues until they exit.

Obtaining the best possible gear teeth contact patterns involves adjusting the depth position of the drive pinion gear "in-or-out" (in respect to the ring gear) and adjusting the position of the ring gear "in-or-out" (in respect to the drive pinion gear) until the ring gear "backlash" is acceptable and the best possible teeth contact patterns are achieved.

The drive pinion gear depth position is adjusted by changing the size (i.e., thickness) of the depth shim(s) located beneath the rear bearing cup (Fig. 30). The ring

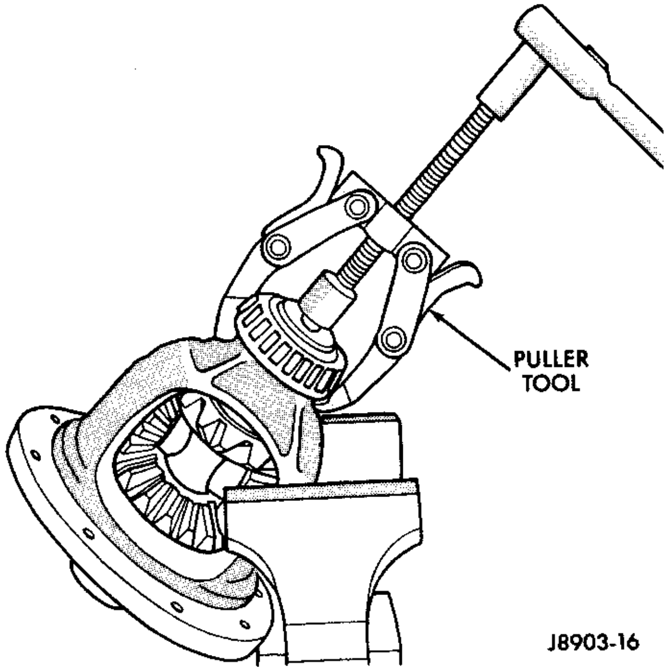


Fig. 27 Differential Bearing Removal

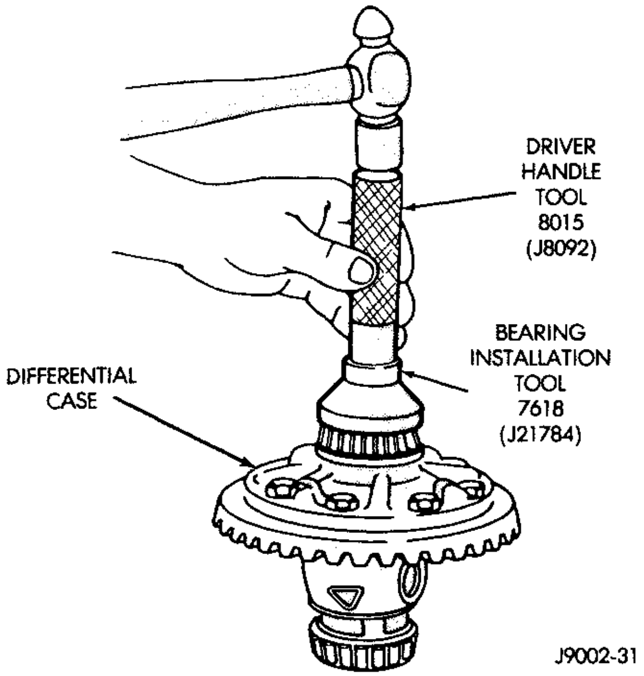


Fig. 28 Differential Bearing Installation

gear position (i.e., the gear "backlash") is adjusted by changing the side-to-side thickness of the differential bearing shims (Fig. 30).

When replacing shims to adjust the ring gear "backlash" or the drive pinion gear depth position, restrict the increment of each shim size change to within the range of 0.002 - 0.004 inch or 0.05 - 0.10 mm. Also, remember that the two adjustment variables are interdependent (i.e., simultaneously involved); consequently, they interact. For example, if the ring gear "backlash" is acceptable but the pinion gear depth position is then changed to obtain better teeth contact patterns, the ring gear "backlash" will probably have to be readjusted because of the interaction.

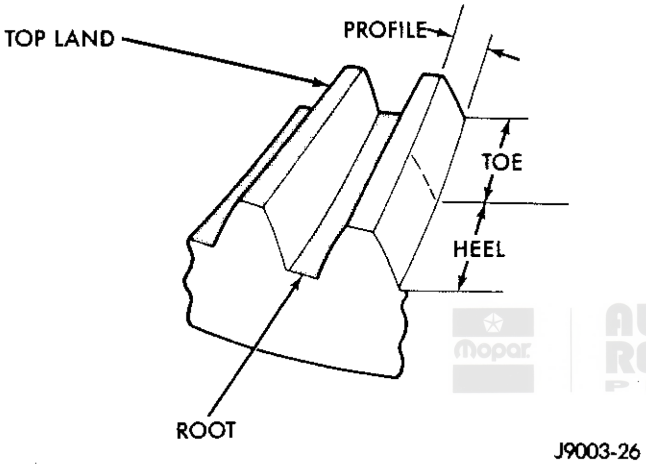


Fig. 29 Gear Tooth Nomenclature

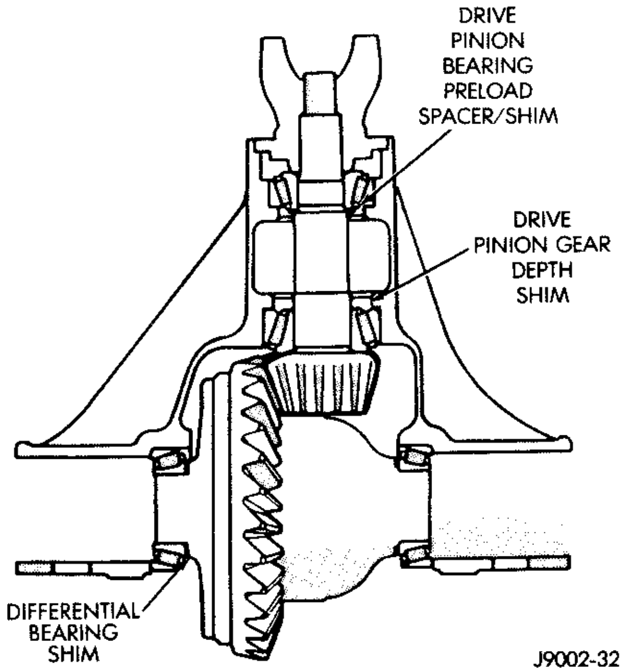


Fig. 30 Drive Pinion Gear Shim(s) & Preload Spacer/ Shim(s)

(1) Apply yellow ferrous (iron) oxide compound to bo (drive and coast) sides of the ring gear teeth.

(2) If necessary for differential case installation, i stall Differential Housing Spreader Tool 7693 (J2438 01) and the holddown clamps on the differentia housing.

(3) If the spreader tool is used, attach a dial indicato with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) If necessary, separate the differential housing only enough to install the differential case in the housing. **For Model 35 axles, separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. For Model 44 axles, separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool.** Measure the separation distance with the dial indicator as the housing is being separated.

(5) If used, remove the dial indicator when the differential housing has been separated sufficiently to install the case in the housing.

(6) Position the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to "seat" them (Fig. 31). Observe the installation reference marks and install the bearing caps. Tighten the bolts securely.

(7) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

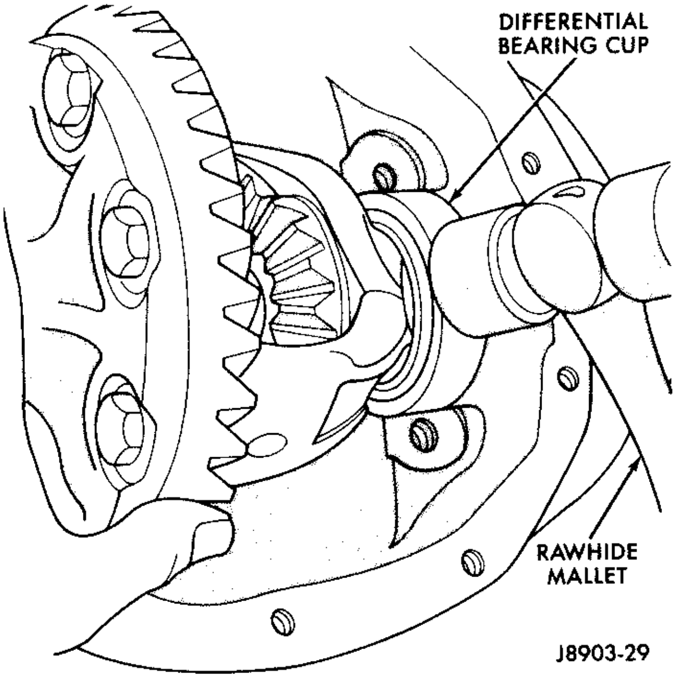


Fig. 31 Seating The Differential Bearing Cups

(8) Attach a dial indicator to the housing. Position the indicator plunger against the "drive" side of one ring gear tooth. Ensure that the plunger is at a right angle (90°) with the tooth (Fig. 32).

(9) Pry the ring gear toward the dial indicator and "zero" the dial indicator pointer while at this position.

(10) Pry the ring gear away from the drive pinion gear until the gear "backlash" indicated on the dial indicator is 0.005 - 0.009 inch or 0.13 - 0.23 mm.

(11) Temporarily insert shims between one differential bearing (nearest to the ring gear) and the housing to maintain the established gear "backlash" during the remainder of the adjustment.

(12) Move the dial indicator aside and, if necessary, re-apply yellow ferrous (iron) oxide compound to the ring gear teeth.

(13) Rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(14) Examine the teeth contact patterns imprinted in the ferrous (iron) oxide compound. Refer to Figure 33 for interpretation of the gear teeth contact patterns and proceed to the next step.

(15) Analyze the gear teeth contact patterns for corrective action and, if necessary, use the following information to correct the gear positions:

- decreasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly lower and toward the "toe" (Fig. 29) of the gear tooth;
- increasing the ring gear "backlash" will move the "drive" and the "coast" side teeth contact patterns slightly higher and toward the "heel" (Fig. 29) of the gear tooth;
- inserting a **thicker** depth shim will move the pinion gear closer to the ring gear;
- this will cause the "drive" side teeth contact patterns to move lower and slightly toward the "toe" (Fig. 29) of the tooth and cause the "coast" side teeth contact patterns to move lower and slightly toward the "heel" (Fig. 29) of the tooth;
- inserting a **thinner** depth shim will move the pinion gear away from ring gear; and
- this will cause the "drive" side teeth contact patterns to move higher and toward the "heel" (Fig. 29) of the tooth and cause the "coast" side teeth contact patterns to move higher and toward the "toe" (Fig. 29) of the tooth.

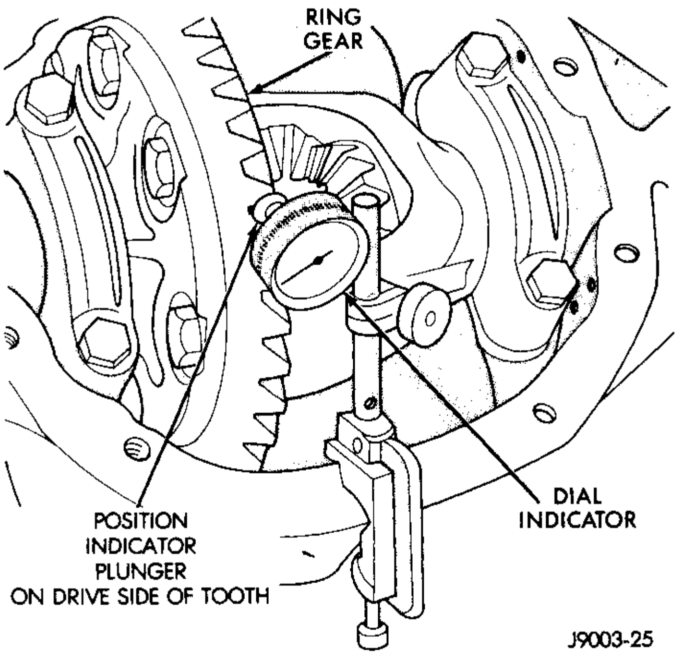


Fig. 32 Ring Gear Backlash Measurement

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. For Model 35 axles, separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. For Model 44 axles, separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the differential case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(16) If necessary for differential case removal, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case from the housing. Remove the drive pinion gear shaft. Replace the drive pinion gear depth shims and the differential bearing shims as necessary to adjust the gear positions for the best possible gear teeth contact patterns and an acceptable ring gear "backlash".

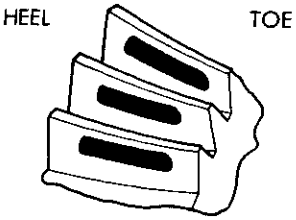
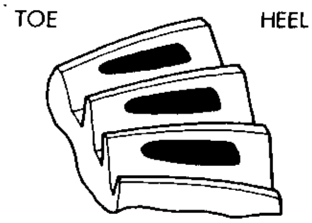
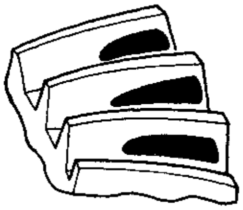
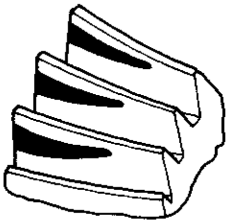
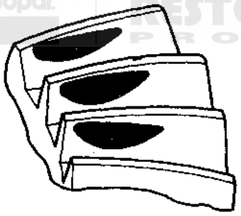
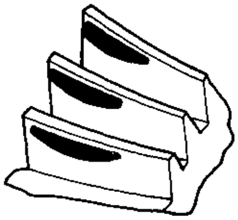
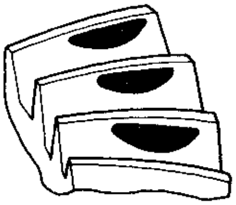
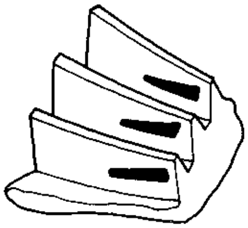
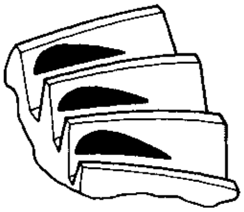
To increase the ring gear "backlash", decrease the differential bearing shim thickness at the ring gear side of the housing. To decrease the ring gear "backlash", increase the differential bearing shim thickness at the ring gear side of the housing.

(17) Install the drive pinion gear shaft and the differential case in the housing. If applicable, observe the **CAUTION** listed above.

(18) Re-apply yellow ferrous (iron) oxide compound to both sides of the ring gear teeth and rotate the ring gear one complete revolution in both directions to imprint the gear teeth contact patterns in the compound.

(19) Analyze the gear teeth contact patterns and, if necessary, readjust the gear positions.

(20) Proceed to the applicable Drive Pinion Gear Shaft Bearing Preload Torque Adjustment.

DRIVE SIDE OF RING GEAR TEETH	COAST SIDE OF RING GEAR TEETH	
		DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.
		RING GEAR BACKLASH CORRECT. **THINNER** PINION GEAR DEPTH SHIM REQUIRED.
		RING GEAR BACKLASH CORRECT. **THICKER** PINION GEAR DEPTH SHIM REQUIRED.
		PINION GEAR DEPTH SHIM CORRECT. **DECREASE** RING GEAR BACKLASH.
		PINION GEAR DEPTH SHIM CORRECT. **INCREASE** RING GEAR BACKLASH.

J9003-24

Fig. 33 Gear Teeth Contact Patterns

Drive Pinion Gear Shaft Bearing Preload Torque Adjustment—Model 35 Axles

A tension-type spacer maintains the drive pinion gear bearing "preload" torque (Fig. 30). The bearing "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft. The drive pinion gear shaft/axle yoke nut is used to adjust the "preload" torque. The spacer is designed to compress and maintain the "preload" torque after it is established by adjustment.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(1) If necessary for differential case removal, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case from the housing (Fig. 1, Fig. 34). Remove the ferrous (iron) oxide compound from the ring gear.

CAUTION: When removing a differential bearing, ensure that the differential case is securely clamped or otherwise supported. When the bearing is removed, the differential case could drop if not properly supported.

(2) Remove the differential bearing cups, the bearings and the shims (Fig. 1). **Do not intermix the shims. Mark or tag them for installation reference.** Install Bearing Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters) on the differential case and the bearing to remove the bearings from the case hubs:

- if used, position the chamfered edge of the removal tool adapters between the bearing race and the case;
- if used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race; and
- tighten the puller tool or removal tool screw to remove the bearing from the differential case hub.

(3) Repeat the instructions to remove the other differential bearing from the opposite differential case hub.

(4) Remove the drive pinion gear shaft (Fig. 1).

(5) Install a replacement bearing "preload" torque spacer on the drive pinion gear shaft (Fig. 1).

(6) Install the drive pinion gear shaft in the housing (Fig. 1).

(7) Apply axle lubricant to the lip and install the replacement seal (Fig. 1) on the drive pinion gear shaft with Seal Installation Tool 6272 (J22661).

(8) Install the axle yoke (Fig. 1) on the drive pinion gear shaft.

The correct drive pinion gear shaft bearing "preload" torque is 2 - 3 N•m (15 - 25 in-lbs). The bearing "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft (with a Newton-meter or an inch-pound torque wrench).

(9) Install a replacement nut on the drive pinion gear shaft. **Tighten the nut only enough to remove the "end play". Do not over-tighten it.**

(10) Place a socket wrench on the nut. Rotate the shaft with a Newton-meter or an inch-pound torque wrench and note the indicated torque.

CAUTION: The bearing "preload" torque spacer will permanently compress and maintain the established "preload" torque. If the specified "preload" torque is exceeded, do not attempt correction by loosening and re-tightening the drive pinion gear shaft (axle) yoke nut. If the nut is over-tightened, the drive pinion gear shaft must be removed, the "preload" torque spacer replaced, the drive pinion gear shaft installed and the "preload" torque adjusted again.

(11) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke (Fig. 35) and slowly tighten the nut in small increments until the torque required to rotate the drive pinion gear shaft is in the range of 2 - 3 N•m (15 - 25 in-lbs). Measure the torque frequently to avoid over-tightening the nut.

(12) Proceed to Differential Bearing Preload Shim Installation.

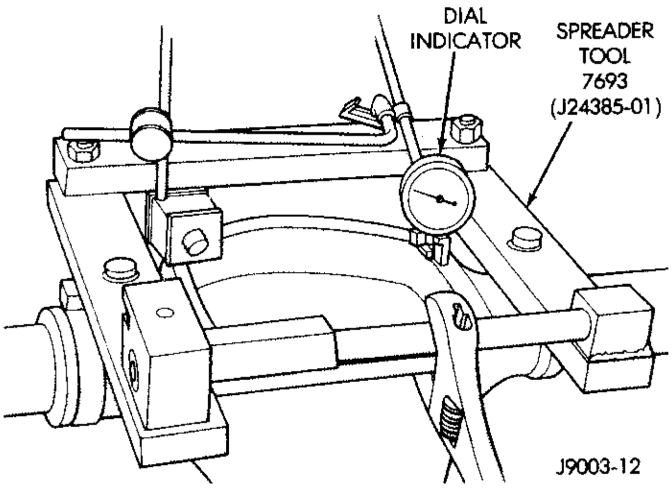


Fig. 34 Differential Housing Separation

Drive Pinion Gear Shaft Bearing Preload Torque Adjustment—Model 44 Axles

Shims are used to maintain the drive pinion gear shaft bearing "preload" torque (Fig. 30). The "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft.

CAUTION: Do not exceed the specified separation distance when separating the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement. Separate the differential housing only enough to remove/install the differential case. Separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated. Remove the dial indicator when the differential housing has been separated sufficiently to remove/install the case. Remove the spreader tool and the holddown clamps immediately after removing/installing the differential case. This is important to avoid the possibility of the housing acquiring a different "set".

(1) Install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps and remove the differential case from the housing (Fig. 34, Fig. 1)). Remove the ferrous (iron) oxide compound from the ring gear.

(2) Remove the drive pinion gear shaft (Fig. 1).

(3) Install the original drive pinion gear shaft bearing "preload" torque shims on the shaft (Fig. 1).

(4) Install the drive pinion gear shaft in the housing (Fig. 1).

(5) Install the front bearing, the oil slinger, the dust cap, the yoke, the washer and the **original** shaft nut (Fig. 1).

(6) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and tighten the shaft nut (Fig. 34) with 271 N•m (200 ft-lbs) torque (minimum).

The correct drive pinion gear shaft bearing "preload" torque is 2 - 5 N•m (20 - 40 in-lbs). The bearing "preload" torque is equivalent to the amount of torque necessary to rotate the drive pinion gear shaft (with a Newton-meter or an inch-pound torque wrench).

(7) Place a socket wrench on the drive pinion gear shaft nut. Rotate the shaft with a Newton-meter or an inch-pound torque wrench and note the indicated "preload" torque.

(8) If not correct, increase the shim thickness to increase the "preload" torque and decrease the shim thickness to decrease the "preload" torque.

(9) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and remove the original shaft nut and the washer from the shaft (Fig. 36). Remove the yoke from the shaft. If the yoke cannot be removed easily by hand, use Flange Removal Tool 8023 (J8614-1), Adaptor Tool 8025 (J8614-2) and Screw Tool 8026 (J8614-3) to remove the yoke from the shaft (Fig. 37). Remove the dust cap and the seal from the shaft (Fig. 38). Discard the original nut and the seal.

(10) Lubricate the replacement seal lip with axle lubricant and install it on the drive pinion gear shaft (Fig. 39) with Seal Installation Tool 6272 (J22661).

(11) Install the dust cap, the yoke, the washer and the replacement shaft nut on the shaft (Fig. 1).

(12) Use Flange Removal/Installation Tool 8023 (J8614-1) to retain the yoke and tighten the shaft nut (Fig. 36) with 271 N•m (200 ft-lbs) torque (minimum). Proceed to Differential Bearing Preload Torque Shim Installation.

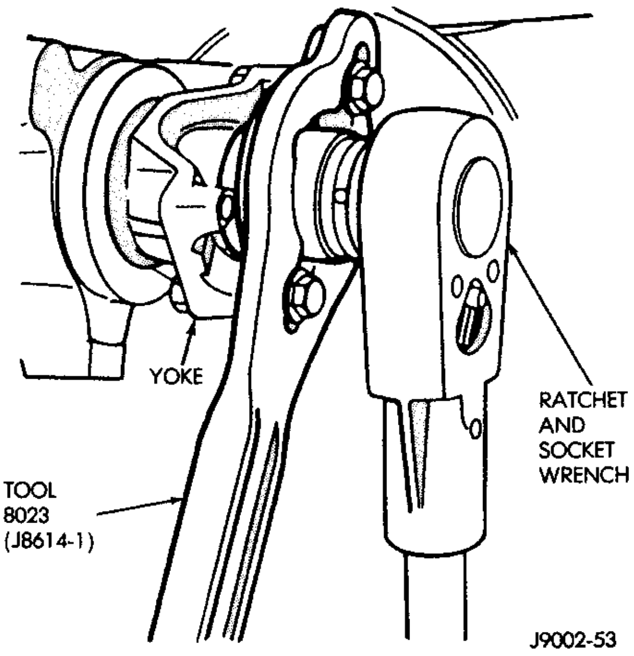


Fig. 35 Tightening Nut For Preload Adjustment

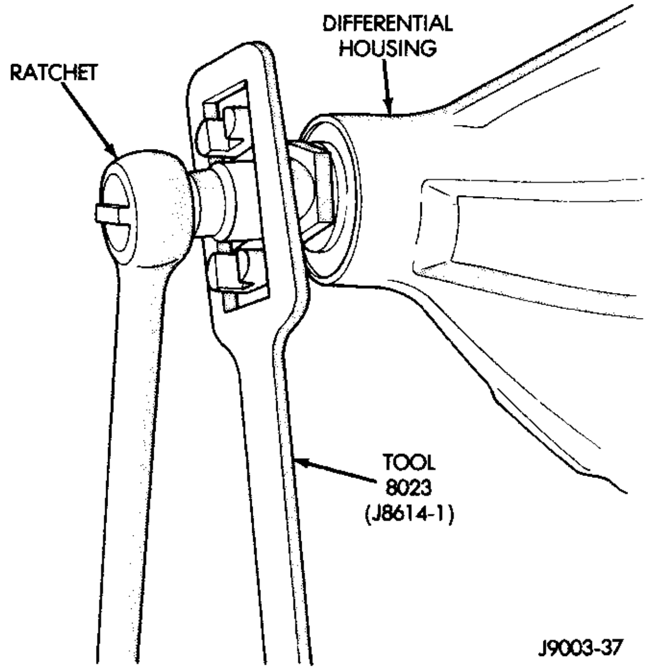


Fig. 36 Pinion Gear Shaft Nut Removal/Installation

Differential Bearing Preload Torque Shim Installation—Model 35 And 44 Axles

Before installing the differential case, the differential bearings must be “preloaded” with additional shims to compensate for the heat accumulation and the engine torque “load” during vehicle operation.

(1) For Model 35 axles:

- note the reference marks (or tags) and install the originally selected differential bearing shims on each case hub;
- add an additional 0.004-inch or 0.1-mm thick shim to **each** case hub;
- install the differential bearings (Fig. 40) with Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092); and
- observe the reference marks and install the bearing cups on the case hubs.

(2) For Model 44 axles:

- remove the differential cup and bearing that are located on the **opposite** side of the case from the ring gear (Fig. 41) with Bearing Puller Tool 7647 (J22888) or a universal bearing removal tool set (with adapters);
- if used, position the chamfered edge of the removal tool adapters between the bearing race and the case;
- if used, tighten the bearing removal tool nuts until the chamfered edge of the adapters are thoroughly beneath the bearing race;

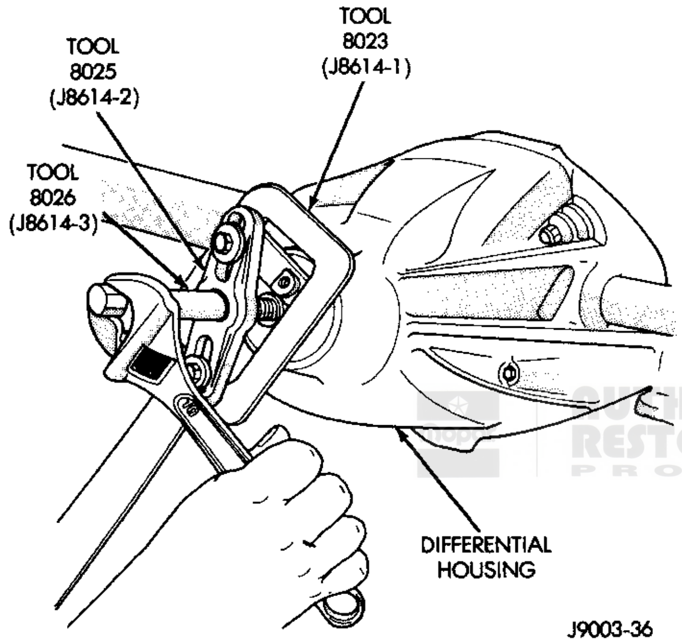


Fig. 37 Drive Pinion Gear Shaft Yoke Removal

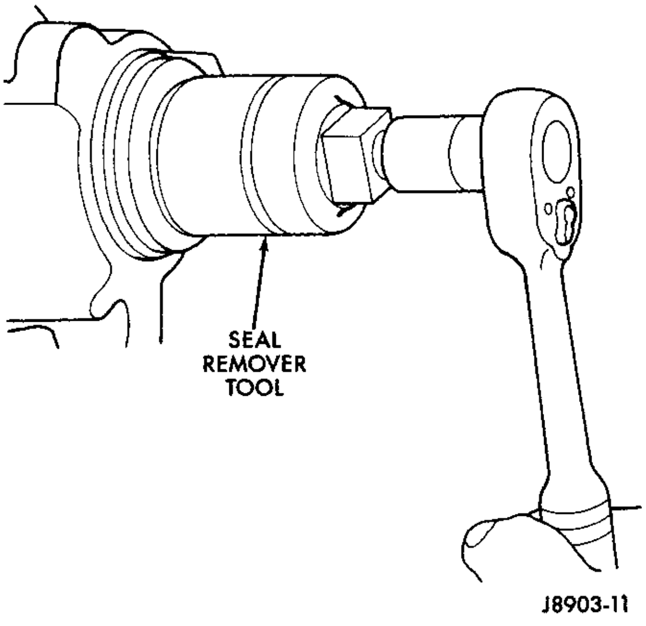


Fig. 38 Drive Pinion Gear Shaft Seal Removal

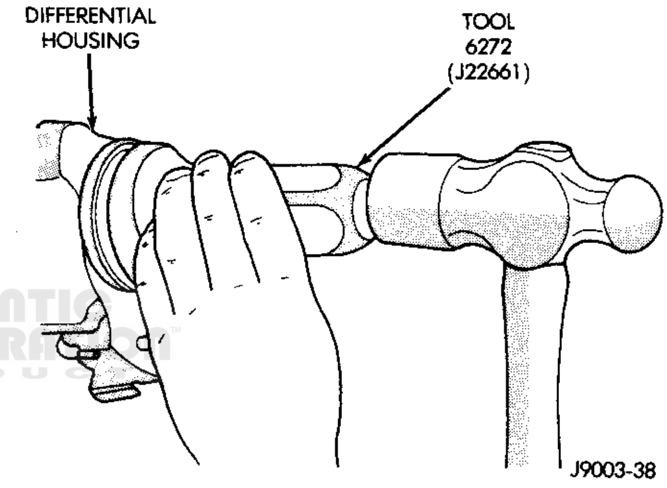


Fig. 39 Drive Pinion Gear Shaft Seal Installation

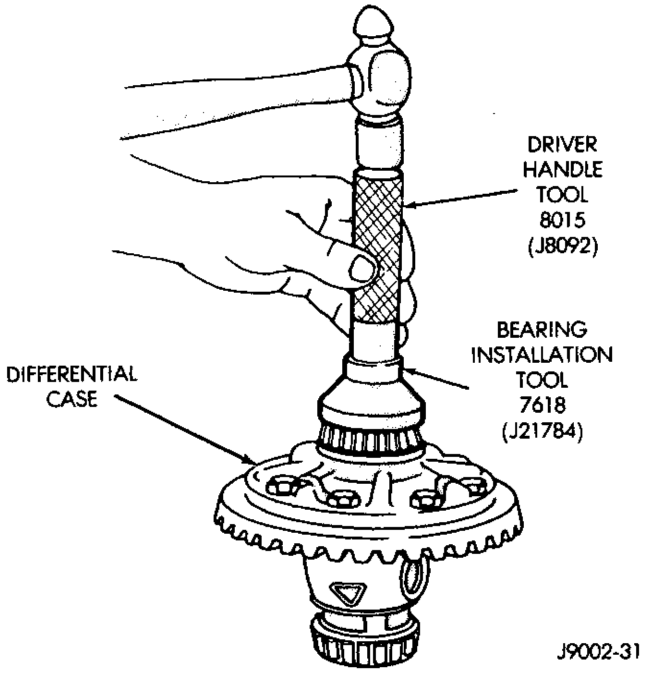


Fig. 40 Differential Bearing Installation

- tighten the puller tool or the removal tool screw (Fig. 41) to remove the bearing from the differential case hub;
- place an additional 0.015-inch or 0.38-mm thick shim on the differential case hub (Fig. 42); and
- install the differential bearing on the case hub (Fig. 42) with Differential Bearing Installation Tool 7618 (J21784) and Threaded Driver Handle Tool 8015 (J8092).

Differential Case Installation—Model 35 And 44 Axles

(1) Lubricate the bearings, the gears, the thrust washers and the clutch discs with axle lubricant.

(2) If necessary for differential case installation, install Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps on the differential housing.

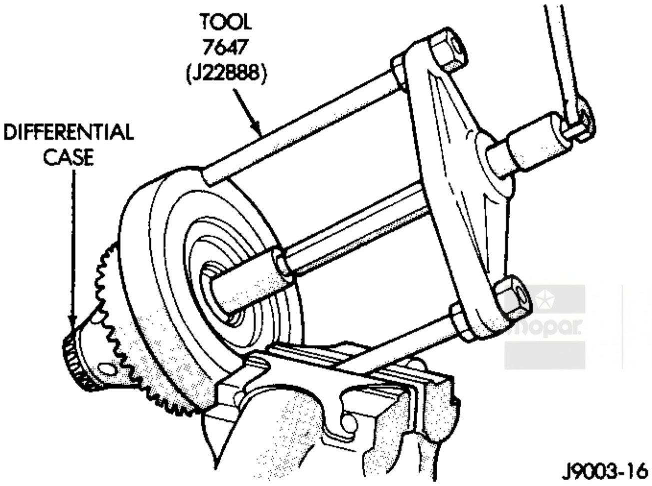


Fig. 41 Differential Bearing Removal

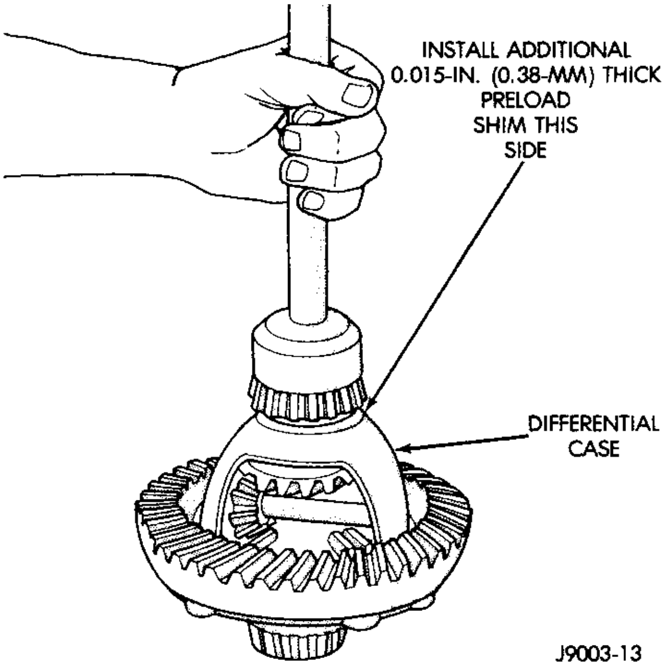


Fig. 42 Differential Bearing & Shim Installation

(3) If the spreader tool is used, attach a dial indicator with the indicator plunger contacting one side of the opening in the differential housing.

CAUTION: Do not exceed the specified separation distance if it is necessary to separate the differential housing. If the housing is over-separated, it could be distorted or damaged, which would necessitate replacement.

(4) If necessary, for Model 35 axles, separate the differential housing a maximum distance of 0.5 mm (0.02 in) with the spreader tool. For Model 44 axles, separate the differential housing a maximum distance of 0.38 mm (0.015 in) with the spreader tool. Measure the separation distance with the dial indicator as the housing is being separated.

(5) If used, remove the dial indicator when the differential housing has been separated sufficiently to install the differential case in the housing.

(6) Observe the installation reference marks and install the bearing cups on the differential bearings.

(7) Install the differential case in the housing. Tap the outer edges of the bearing cups with a rawhide mallet to “seat” them (Fig. 42).

(8) If installed, remove Differential Housing Spreader Tool 7693 (J24385-01) and the holddown clamps from the differential housing.

(9) Observe the installation reference marks and install the differential bearing caps. For Model 35 axles, tighten the cap bolts with 77 N•m (57 ft-lbs) torque. For Model 44 axles, tighten the cap bolts with 108 N•m (80 ft-lbs) torque.

(10) Measure the ring gear “backlash”. If it has changed, it must be re-adjusted.

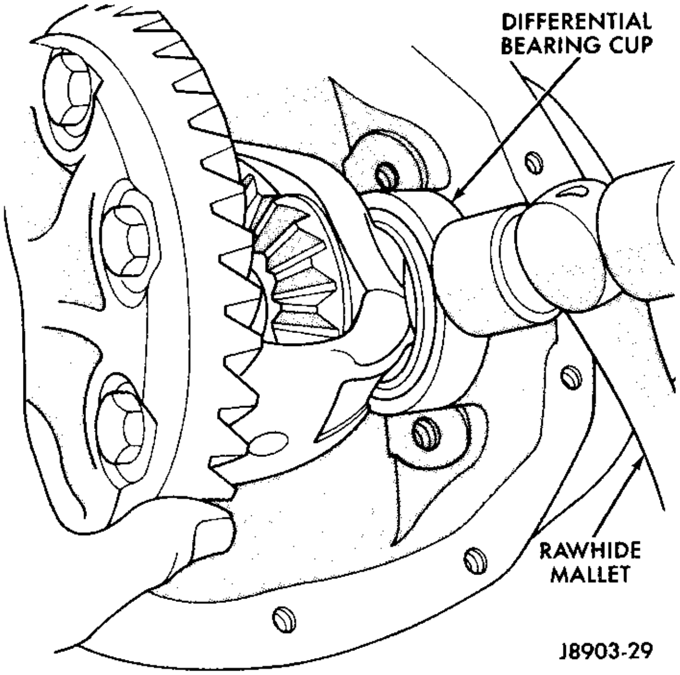


Fig. 42 Seating The Bearing Cups

Installation—Model 35 and 44 Axles

(1) Install the axle shafts. If necessary, refer to the installation procedure.

For Model 35 axles, remove the pinion gear mate shaft before installing the axle shafts.

(2) Clean the differential housing and the housing cover mating surfaces thoroughly.

(3) Apply a thin "bead" of MOPAR RTV Sealant (or an equivalent sealant) to the housing and to the cover. Install the cover. Tighten the cover bolts with 47 N•m (35 ft-lbs) torque.

(4) Align the installation reference marks on the drive shaft yoke and the drive pinion gear shaft (axle) yoke. Connect the drive shaft to the axle yoke. Tighten the U-joint clamp screws with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

(5) For Model 35 axles, fill the differential housing with 2.5 pints (1.2 liters) of SAE 75W-90, API grade GL 5 hypoid gear lubricant (or, if applicable, synthetic-type MOPAR 80W-140 Hypoid Gear Lubricant) and a container of Trac-Lok Lubricant additive (a friction modifier). For Model 44 axles, fill the differential housing with 3.75 pints (1.77 liters) of SAE 75W-90, API grade GL 5 hypoid gear lubricant and a container of Trac-Lok Lubricant additive (a friction modifier).

(6) Install and tighten the fill hole plug with 34 N•m (25 ft-lbs) torque.

(7) Install the brake drums and the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(8) Remove the supports and lower the vehicle.

(9) Drive the vehicle and make 10 to 12 slow, figure-eight turns. This type of maneuver will ensure that the replacement lubricant is pumped through the clutch discs.

SPECIFICATIONS

MODEL 35 AXLE	FOOT POUNDS	N•M	INCH POUNDS	N•M
BRAKE SUPPORT PLATE NUT	32	43		
DIFFERENTIAL HOUSING COVER BOLT	35	47		
COVER FILL PLUG	25	34		
WHEEL LUG NUT	75	102		
U-JOINT CLAMP SCREW			170	19
RING GEAR BOLT	55	75		
DIFFERENTIAL BEARING CAP BOLT	57	77		
SPRING EYE BOLT	105	142		
SPRING SHACKLE BOLT	95	129		
SHOCK ABSORBER NUT	44	60		
SPRING U-BOLT NUT	90	122		
TRACK BAR BOLTS/NUTS	125	168		
AXLE JOUNCE BUMPER	20	27		
WHEEL CYLINDER BRAKE LINE FITTING			132	15
BRAKE HOSE JUNCTION BLOCK SCREW			70	8

MODEL 44 AXLE	FOOT POUNDS	N•M	INCH POUNDS	N•M
BRAKE SUPPORT PLATE NUT	32	43		
DIFFERENTIAL COVER BOLT	35	47		
COVER FILL PLUG	25	34		
WHEEL LUG NUT	80	108		
U-JOINT CLAMP SCREW			170	19
RING GEAR BOLT	55	75		
DIFFERENTIAL BEARING CAP BOLT	80	108		
SPRING EYE BOLT	100	136		
SPRING SHACKLE BOLT	100	136		
SHOCK ABSORBER NUT	45	61		
TRACK BAR BOLT/NUT	125	168		
AXLE JOUNCE BUMPER	20	27		
WHEEL CYLINDER BRAKE LINE FITTING			132	15
BRAKE HOSE JUNCTION BLOCK SCREW			70	8
PINION GEAR SHAFT NUT	200 MIN.	271 MIN.		
SPRING U-BOLT NUT (1/2-20)	90	122		
SPRING U-BOLT NUT (9/16-18)	100	136		

RING GEAR DIAMETER:	
MODEL 35	7.5625 IN (19.21 CM)
MODEL 44	8.5 IN (21.59 CM)
STANDARD PINION GEAR DEPTH SETTING:	
MODEL 35	2.095 IN (53.21 MM)
MODEL 44	2.625 IN (66.68 MM)
PINION BEARING PRELOAD TORQUE:	
MODEL 35	15-25 IN-LBS (2-3 N•m)
MODEL 44 (REPLACEMENT BEARINGS)	20-40 IN-LBS (2-5 N•m)
MODEL 44 (ORIGINAL BEARINGS)	10-20 IN-LBS (1-2 N•m)
RING GEAR BACKLASH:	
MODEL 35	0.005-0.009 IN (0.13-0.23 MM)
MODEL 44	0.005-0.008 IN (0.12-0.20 MM)
DIFFERENTIAL BEARING PRELOAD:	
MODEL 35	0.008 IN (0.20 MM)
MODEL 44	0.015 IN (0.38 MM)
SIDE GEAR CLEARANCE (MAX. ALLOWABLE):	
MODEL 35	0.007 IN (0.18 MM) EACH SIDE
MODEL 44	0.006 IN (0.15 MM) EACH SIDE
CASE RUNOUT:	
MODEL 35	0.002 IN (0.5 MM) MAX.
MODEL 44	0.006 IN (0.15 MM) MAX.
LUBRICANT CAPACITY:	
MODEL 35	2.5 PINTS (1.2 L)
MODEL 44	3.75 PINTS (1.77 L)
LUBRICANT TYPE (ALL):	
STANDARD USE	SAE 75W-90, API GRADE GL5
TRAILER TOW APPLICATIONS	SYNTHETIC TYPE 80W-140

J9003-1

BRAKES

CONTENTS

GENERAL SERVICE INFORMATION

INDEX

BRAKE COMPONENTS

Wheel Brake Units

Front disc brakes and rear drum brakes are used on all models. The front disc brakes consist of single piston brake calipers and ventilated cast iron rotors. The rear brakes are dual shoe, internal expanding units with cast iron brake drums. The parking brake mechanism is connected to the trailing shoes.

The parking brakes are operated by a foot pedal assembly on SJ, MJ and YJ models. A hand lever assembly is used on XJ models. The pedal or lever assembly is attached to the rear brake trailing shoes by cables.

Power Brakes

Power brakes are standard on all models. A vacuum operated power booster is used on models with standard brakes. A hydraulic booster and pump are used on XJ models with anti-lock brakes.

Hydraulic Components

A dual reservoir master cylinder is used for all applications. A combination proportioning valve/pressure differential switch is used on all models. MJ models are equipped with a rear brake height sensing proportioning valve. The valve adjusts front-rear brake proportioning to maintain brake balance when the vehicle is loaded.

Brakelining Material

The brakelining on all except SJ models consists of an organic base material combined with metallic particles. The lining on these models does not contain asbestos.

Brake Indicator Lights

A red, brake indicator and warning light is used to alert the driver if a pressure differential exists between the front and rear hydraulic systems. The light also alerts the driver when the parking brakes are applied. The light is located at the left side of the instrument cluster.

On models equipped with anti-lock brakes, an additional indicator light is used. This light is yellow and is located in the same side of the instrument cluster as the red indicator light. The yellow anti-lock light alerts the driver if an anti-lock system fault occurs.

ANTI-LOCK BRAKE SYSTEM

The anti-lock, all wheel brake control system is available on XJ models with Selec-Trac four wheel drive. It is an electronically operated, power assisted, all wheel brake control system. The system is designed to retard wheel lockup during periods of high wheel slip when braking. Refer to the Anti-Lock Brake section for operation and service information.

BRAKE FLUID/LUBRICANTS/CLEANING SOLVENTS

Recommended fluid for all Jeep vehicles with standard or anti-lock brakes is Mopar brake fluid or equivalent meeting SAE J1703 and DOT 3 standards.

Use Mopar multi purpose grease to lubricate caliper slide surfaces, drum brake pivot pins and rear brakeshoe contact points on the support plates. Use GE 661 or Dow 111 silicone grease on caliper bushings and slide pins.

Use fresh brake fluid or Mopar brake cleaner to clean or flush brake system components. These are the only cleaning materials recommended.

CAUTION: Never use gasoline, kerosene, alcohol, motor oil, transmission fluid, or any fluid containing mineral oil to clean the system components. These fluids damage rubber cups and seals. If system contamination is suspected, check the fluid for dirt, discoloration, or separation into distinct layers. Drain and flush the system with new brake fluid if contamination is suspected.

BRAKE SAFETY PRECAUTIONS

WARNING: EXTREME CARE MUST BE EXERCIZED WHEN SERVICING WHEEL BRAKE COMPONENTS. DUST AND DIRT THAT ACCUMULATES ON BRAKE PARTS DURING NORMAL USE MAY CONTAIN ASBESTOS FIBERS. BREATHING EXCESSIVE CONCENTRATIONS OF THESE FIBERS CAN CAUSE SERIOUS BODILY HARM. WEAR A RESPIRATOR WHEN CLEANING WHEEL BRAKE COMPONENTS. NEVER CLEAN WHEEL BRAKE COMPONENTS WITH COMPRESSED AIR OR WITH A DRY BRUSH. USE A VACUUM CLEANER SPECIFICALLY DESIGNED FOR REMOVING ASBESTOS FIBERS AND DUST. IF A VACUUM CLEANER IS NOT AVAILABLE, CLEAN THE PARTS WITH WATER DAMPENED SHOP RAGS. DO NOT CREATE DUST BY SANDING BRAKELINING. IF THE LINING SURFACE IS DAMAGED OR CONTAMINATED, REPLACE THE LINING. DISPOSE OF ALL DUST AND DIRT SUSPECTED OF CONTAINING ASBESTOS FIBERS OR DUST IN SEALED BAGS OR CONTAINERS. THIS WILL HELP MIMINIZE EXPOSURE TO YOURSELF AND TO OTHERS. FOLLOW ALL RECOMMENDED SAFETY PRACTICES PRESCRIBED BY THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) AND THE ENVIRONMENTAL SAFETY AGENCY (EPA), FOR THE HANDLING AND DISPOSAL OF PRODUCTS CONTAINING ASBESTOS.

SERVICE DIAGNOSIS

INDEX

DIAGNOSIS PROCEDURES

Brake diagnosis involves determining if the problem is related to a mechanical, hydraulic or vacuum operated component. A preliminary check, road testing and component inspection are needed to determine a problem cause.

Road testing will either verify proper brake operation or confirm the existence of a problem. Component inspection will, in most cases, identify the actual part causing a problem.

The first diagnosis step is the preliminary check. This involves inspecting fluid level, parking brake action, wheel and tire condition, checking for obvious leaks or component damage and testing brake pedal response. A road test will confirm or deny the existence of a problem. The final diagnosis procedure involves road test analysis and a visual inspection of brake components.

Preliminary Brake Check

(1) Check condition of tires and wheels. Damaged wheels and worn, damaged, or underinflated tires can cause pull, shudder, tramp and a condition similiar to grab.

(2) If complaint was based on noise when braking, check suspension components. Jounce front and rear of vehicle and listen for noise that might be caused by loose, worn, or damaged suspension or steering components.

(3) Inspect brake fluid level and condition. Remember that fluid level in the front disc brake reservoir will decrease in proportion to normal lining wear.

(a) If fluid level is abnormally low, look for evidence of leaks at calipers, wheel cylinders, brakelines and master cylinder.

(b) If fluid appears contaminated, drain out a sample. If fluid is separated into layers, or obviously contains oil or a substance other than brake fluid, the system seals and cups will have to be replaced and the hydraulic system flushed.

(4) Check parking brake operation. Verify free movement and full release of cables and foot pedal or hand lever. Also note if vehicle was being operated with parking brake partially applied.

(5) Check brake pedal operation. Verify that pedal does not bind and has adequate free play. If pedal lacks free play, check pedal and power booster for being loose or for bind condition. Do not road test until condition is corrected.

(6) If components checked appear OK, road test the vehicle.

Road Testing

(1) If complaint involved low brake pedal, make several low speed stops and note if the brake pedal comes back up to normal height.

(2) Check brake pedal response with transmission in Neutral and engine running. Pedal should remain firm under steady foot pressure.

(3) During road test, make normal and firm brake stops in 25-40 mph range. Note faulty brake operation such as pull, grab, drag, noise, low pedal, hard pedal, fade, pedal pulsation, etc.

(4) Inspect suspect brake components and refer to problem diagnosis information for causes of various brake conditions.

Component Inspection

Fluid leak points and dragging brake units can usually be located without removing any components. The area around a leak point will be wet with fluid. The components at a dragging brake unit (wheel, tire, rotor) will be quite warm or hot to the touch.

Other brake problem conditions will require component removal for proper inspection. Raise the vehicle and remove the necessary wheels for better visual access.

DIAGNOSING BRAKE PROBLEMS

Pedal Falls Away

A brake pedal that falls away under steady foot pressure is generally the result of a system leak. The leak point could be at a brakeline, fitting, hose, wheel cylinder, or caliper. Internal leakage in the master cylinder caused by worn or damaged piston cups, may also be the problem cause.

If leakage is severe, fluid will be evident at or around the leaking component. However internal leakage in the master cylinder will not be physically evident. Refer to the cylinder test procedure in this section.

Low Pedal

If a low pedal is experienced, pump the pedal several times. If the pedal comes back up, worn lining and worn rotors or drums are the likely causes.

A decrease in fluid level in the master cylinder reservoirs may only be the result of normal lining wear. Fluid level can be expected to decrease in proportion to normal wear. It is a result of the outward movement of caliper and wheel cylinder pistons to compensate for normal wear. Top off the reservor fluid level and check brake operation to verify proper operation.

Spongy Pedal

A spongy pedal is most often caused by air in the system. Thin brake drums or substandard brake lines and hoses can also cause a condition similar to a spongy pedal. The proper course of action is to bleed the system and replace thin drums or suspect quality brake lines and hoses.

Hard Pedal Or High Pedal Effort

A hard pedal or high pedal effort may be due to lining that is water soaked, contaminated, glazed, or badly worn. The power booster or check valve could also be faulty. Test the booster and valve as described in this section.

Brake Drag

Brake drag occurs when the lining is in constant contact with the rotor or drum. Drag can occur at one wheel, all wheels, fronts only, or rears only. It is a product of incomplete brakeshoe release. Drag can be minor or severe enough to overheat the linings, rotors and drums.

Brake drag also has a direct effect on fuel economy. If undetected, minor brake drag can be misdiagnosed as an engine or transmission/torque converter problem.

Minor drag will usually cause slight surface charring of the lining. It can also generate hard spots in rotors and drums from the overheat-cool down process. In most cases, the rotors, drums, wheels and tires are quite warm to the touch after the vehicle is stopped.

Severe drag can char the brake lining all the way through. It can also distort and score rotors and drums to the point of replacement. The wheels, tires and brake components will be extremely hot. In severe cases, the lining may generate smoke as it chars from overheating.

Some common causes of brake drag are: loose or damaged wheel bearing, seized or sticking caliper or wheel cylinder piston, caliper binding on bushings or slide surfaces, loose caliper mounting bracket, distorted brake drum or shoes, rear brakeshoes binding on worn or damaged support plates, or misassembled components.

If brake drag occurs at all wheels, the problem may be related to a blocked master cylinder return port or faulty power booster (binds-does not release).

Brake Fade

Brake fade is a product of overheating caused by brake drag. However, brake overheating and subsequent fade can also be caused by riding the brake pedal, making repeated high deceleration stops in a short time span, or constant braking on steep roads. Refer to the Brake Drag information in this section for causes.

Pedal Pulsation

Pedal pulsation is caused by components that are loose, or beyond tolerance limits.

Disc brake rotors with excessive lateral runout or thickness variation, or out of round brake drums are the primary causes of pulsation. Other causes are loose wheel bearings or calipers and worn, damaged tires.

Pull

A front pull condition could be the result of contaminated lining in one caliper, seized caliper piston, binding caliper, loose caliper, loose or corroded slide pins, improper brakeshoes, or a damaged rotor.

A worn, damaged wheel bearing or suspension component are further causes of pull. A damaged front tire (bruised, ply separation) can also cause pull.

A common and frequently misdiagnosed pull condition is where direction of pull changes after a few stops. The cause is a combination of brake drag followed by fade at the dragging brake unit.

As the dragging brake overheats, efficency is so reduced that fade occurs. If the opposite brake unit is still functioning normally, its braking effect is magnified. This causes pull to switch direction in favor of the brake unit that is functioning normally.

When diagnosing a change in pull condition, remember that pull will return to the original direction if the dragging brake unit is allowed to cool down (and is not seriously damaged).

Rear Brake Grab

Rear grab (or pull) is usually caused by contaminated lining, bent or binding shoes and support plates, or improperly assembled components. This is particularly true when only one rear wheel is involved. However, when both rear wheels are affected, the master cylinder or proportioning valve could be at fault.

Brakes Do Not Hold After Driving Through Deep Water Puddles

This condition is generally caused by water soaked lining. If the lining is only wet, it can be dried by driving with the brakes lightly applied for a mile or two. However, if the lining is both wet and dirty, disassembly and cleaning will be necessary.

Brake Noise

Squeak/Squeal

Brake squeak or squeal may be due to linings that are wet or contaminated with brake fluid, grease, or oil. Glazed linings and rotors with hard spots can also contribute to squeak. Dirt and foreign material embedded in the brake lining can also cause squeak/squeal.

A very loud squeak or squeal is frequently a sign of severely worn brake lining. If the lining has worn through to the brakeshoes in spots, metal-to-metal contact occurs. If the condition is allowed to continue, rotors can become so scored that replacement is necessary.

Thump/Clunk

Thumping or clunk noises during braking are frequently **not** caused by brake components. In many cases, such noises are caused by loose or damaged steering, suspension, or engine components. However, calipers that bind on the slide surfaces can generate a thump or clunk noise. In addition, worn out, improperly adjusted, or improperly assembled rear brakeshoes can also produce a thump noise.

Chatter

Brake chatter is usually caused by loose or worn components, or glazed/burnt lining. Rotors with hard spots can also contribute to chatter. Additional causes of chatter are out-of-tolerance rotors, brake lining not securely attached to the shoes, loose wheel bearings and contaminated brake lining.

Brakelining Contamination

Brakelining contamination is usually a product of leaking calipers or wheel cylinders, driving through deep water puddles, or lining that has become covered with grease and grit during repair.

Wheel and Tire Problems

Some conditions attributed to brake components may actually be caused by a wheel or tire problem.

A damaged wheel can cause shudder, vibration and pull. A worn or damaged tire can also cause pull.

Severely worn tires with very little tread left can produce a grab-like condition as the tire loses and recovers traction.

Flat-spotted tires can cause vibration and wheel tramp and generate shudder during brake operation.

A tire with internal damage such as a severe bruise or ply separation can cause pull and vibration.

MASTER CYLINDER/POWER BOOSTER TEST

(1) Start engine and check booster vacuum hose connections. Hissing noise indicates vacuum leak. Correct any vacuum leak before proceeding.

(2) Stop engine and shift transmission into Neutral.

(3) Pump brake pedal until all vacuum reserve in booster is depleted.

(4) Press and hold brake pedal under light foot pressure.

(a) If pedal holds firm, proceed to step (5).

(b) If pedal does not hold firm and falls away, master cylinder is faulty (internal leakage).

(5) Start engine and note pedal action.

(a) If pedal falls away slightly under light foot pressure then holds firm, proceed to step (6).

(b) If no pedal action is discernible, power booster or vacuum check valve is faulty. Install known good check valve and repeat steps (2) through (5).

(6) Rebuild booster vacuum reserve as follows: Release brake pedal. Increase engine speed to 1500 rpm, close the throttle and immediately turn off ignition.

(7) Wait a minimum of 90 seconds and try brake action again. Booster should provide two or more vacuum assisted pedal applications. If vacuum assist is not provided, perform booster and check valve vacuum tests.

POWER BOOSTER CHECK VALVE TEST

(1) Disconnect the vacuum hose from check valve.

(2) Remove check valve and valve seal from booster (Fig. 1).

(3) Hand operated vacuum pump can be used for test (Fig. 2).

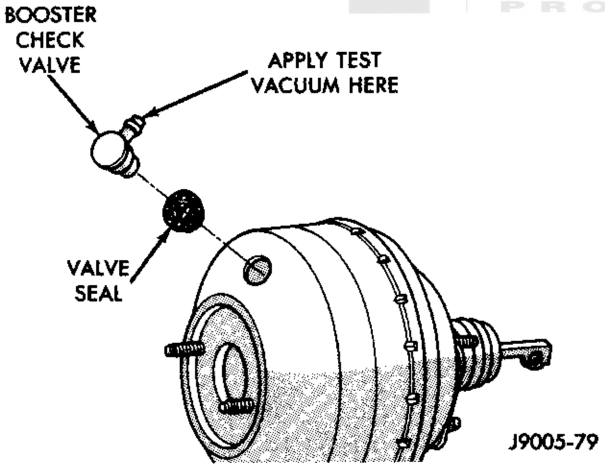


Fig. 1 Vacuum Check Valve And Seal—Typical

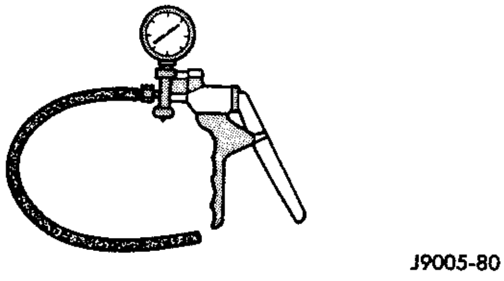


Fig. 2 Hand Operated Vacuum Pump—Typical

(4) Apply 15-20 inches vacuum at large end of check valve (Fig. 1).

(5) Vacuum should hold steady. If gauge on pump indicates any vacuum loss, valve is faulty and must be replaced.

POWER BOOSTER VACUUM TEST

(1) Connect a vacuum gauge to the booster check valve with a short length of hose and a T-fitting (Fig. 3).

(2) Start and run engine at idle speed for one minute.

(3) Clamp hose shut between vacuum source and check valve (Fig. 3).

(4) Stop engine and observe vacuum gauge.

(5) If vacuum drops more than one inch HG (33 millibars) within 15 seconds, booster diaphragm or check valve is faulty.

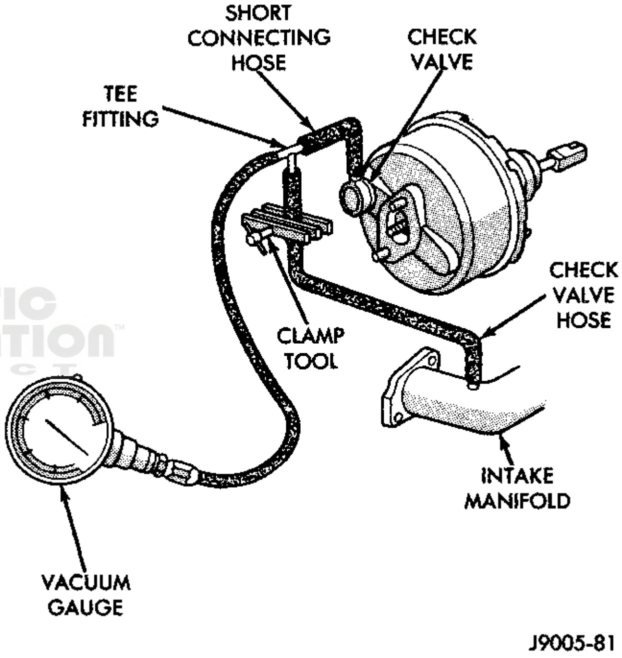


Fig. 3 Booster Vacuum Test Connections

SERVICE ADJUSTMENTS

INDEX

BRAKE FLUID AND LEVEL

Recommended Fluid

The only brake fluid recommended for Jeep vehicles with standard or anti-lock brakes is Mopar brake fluid, or an equivalent fluid meeting SAE J1703 and DOT 3 standards.

Use new brake fluid only to top off the master cylinder or refill the system. Never use reclaimed fluid, fluid not meeting the SAE/DOT standards, or fluid from a container that has been left open for any length of time.

Brake Fluid Level

Always clean the master cylinder and cover before checking fluid level. If not cleaned, dirt from the cover could enter the fluid. Also check the cover seal and replace it if torn or distorted.

Correct fluid level is to within 1/4 inch (6 mm) of each reservoir rim on XJ/MJ/YJ models. On SJ models, correct level is to the fill mark on the plastic reservoir. Refer to the Anti-Lock Brake section for fluid levels on models equipped with anti-lock brakes.

BRAKE FLUID CONTAMINATION

Oil in the fluid will cause brake system rubber seals to soften and swell. The seals may also become porous and begin to deteriorate.

If fluid contamination is suspected, drain off a sample from the master cylinder. A suction gun or similar device can be used for this purpose.

Empty the drained fluid into a glass container. Contaminants in the fluid will cause the fluid to separate into distinct layers. If contamination has occurred, the system rubber seals, hoses and cups must be replaced and the system thoroughly flushed with clean brake fluid.

REAR BRAKE ADJUSTMENT

The rear drum brakes are equipped with a self-adjusting mechanism. Under normal circumstances, the only time adjustment is required is when the shoes are replaced; removed for access to other parts; or when one or both drums are replaced.

The only tool needed for adjustment is a standard brake gauge.

Adjustment is performed with the brakeshoes installed on the support plate. Procedure is as follows:

Adjustment Procedure

(1) If necessary, raise the rear of the vehicle and remove the wheels and brake drums.

(2) Verify that the left/right automatic adjuster lever and cable are properly connected.

(3) Insert the brake gauge in the drum. Expand the gauge until the gauge inner legs contact the drum braking surface. Then lock the gauge in position (Fig. 1).

(4) Reverse the gauge and install it on the brakeshoes (Fig. 2). Position the gauge legs at the shoe centers as shown. If the gauge does not fit (too loose/too tight), adjust the shoes.

(5) Pull the shoe adjuster star wheel away from the automatic adjuster lever.

(6) Turn the adjuster star wheel (by hand) to expand or retract the brakeshoes. Continue adjustment until the gauge outside legs are a light drag-fit on the shoes (Fig. 2).

(7) Repeat adjustment at the opposite brakeshoe assembly.

(8) Install the brake drums and wheels and lower the vehicle.

(9) Make final adjustment as follows: Drive vehicle and make one forward stop followed by one reverse stop. Repeat procedure 8-10 times to actuate self adjuster

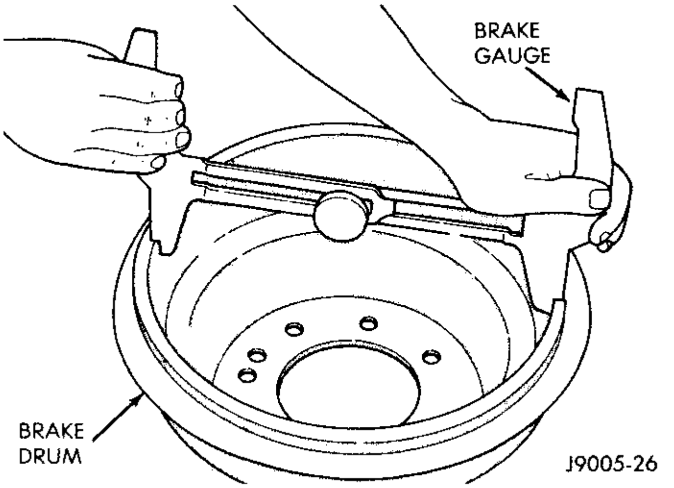


Fig. 1 Adjusting Gauge To Brake Drum

components and equalize adjustment. Bring vehicle to complete standstill at each stop. Incomplete, rolling stops will not activate the adjuster mechanism.

PARKING BRAKE CABLE ADJUSTMENT

Parking Brake Cable Adjustment—SJ

(1) Adjust rear brakes. Refer to procedure in this section.

(2) Apply and release parking brakes 2-3 times.

(3) Raise and support vehicle so rear wheels are free to rotate.

(4) Loosen both equalizer locknuts (Fig. 3) and rotate the wheels.

(5) Tighten the equalizer adjusting nuts (Fig. 3) evenly until a slight drag is produced at both rear wheels.

(6) Loosen the adjusting nuts until drag is eliminated and the rear wheels rotate freely.

(7) Tighten both equalizer locknuts securely.

(8) Lower the vehicle and verify correct parking brake operation.

Parking Brake Cable Adjustment—XJ

(1) Adjust rear brakes. Refer to procedure in this section.

(2) Fully apply and release parking brake hand lever four or five times.

(3) Place hand lever in fifth notch.

(4) Raise vehicle.

(5) Loosen equalizer locknut (Fig. 4).

(6) Install cable adjustment gauge on an inch-pound torque wrench (Fig. 5).

(7) Position adjustment gauge on one rear cable (Fig. 4).

(8) Apply and hold torque of 45 to 50 inch-pounds (5 to 6 N•m) on adjustment gauge and note position of gauge pointer.

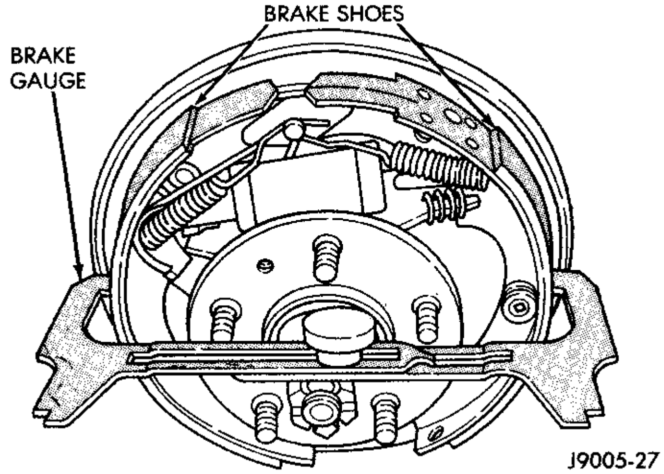


Fig. 2 Adjusting Brakeshoes To Gauge

(9) If adjustment gauge pointer is not in OK band, turn equalizer locknut in or out until pointer is within OK band.

(10) Remove tools and lower vehicle.

(11) Apply and release parking brakes four or five times and check adjustment again. If adjustment changed, readjust cable.

Parking Brake Cable Adjustment—MJ

(1) Adjust rear brakes. Refer to procedure in this section.

(2) Fully apply and release parking brakes four or five times.

(3) Place parking brake pedal in fifth notch.

(4) Raise vehicle.

(5) Loosen equalizer locknut (Fig. 6).

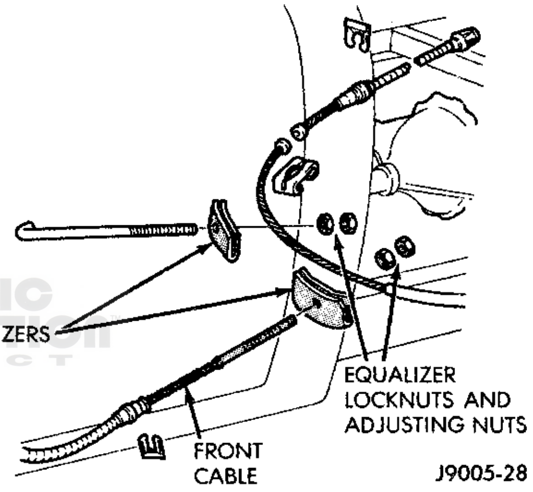


Fig. 3 Parking Brake Equalizers And Cables—SJ

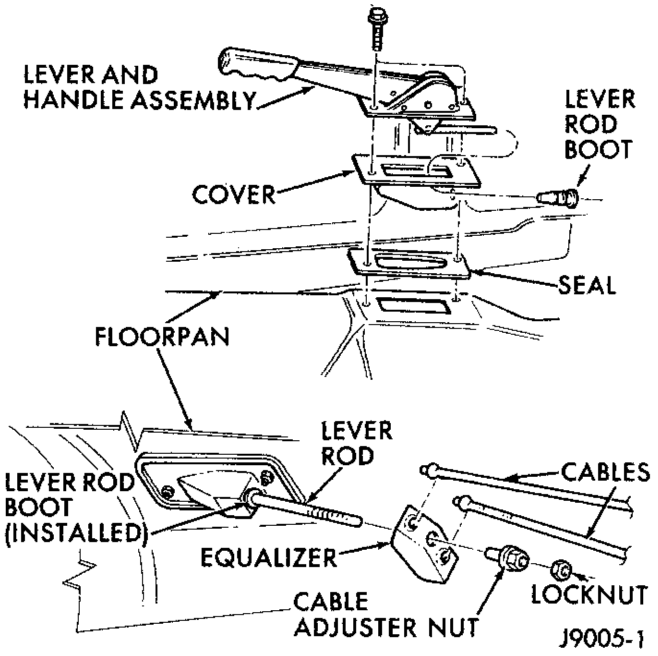


Fig. 4 Parking Brake Components—XJ

(6) Install cable adjustment gauge on inch-pound torque wrench (Fig. 5).

(7) Position adjustment gauge on front cable (Fig. 5).

(8) Apply torque of 45 to 50 inch-pounds (5 to 6 N•m) to adjustment gauge and note position of gauge pointer.

(9) If adjustment gauge pointer is not in OK band, turn equalizer locknut in-or-out until pointer is within OK band.

(10) Remove tools and lower vehicle.

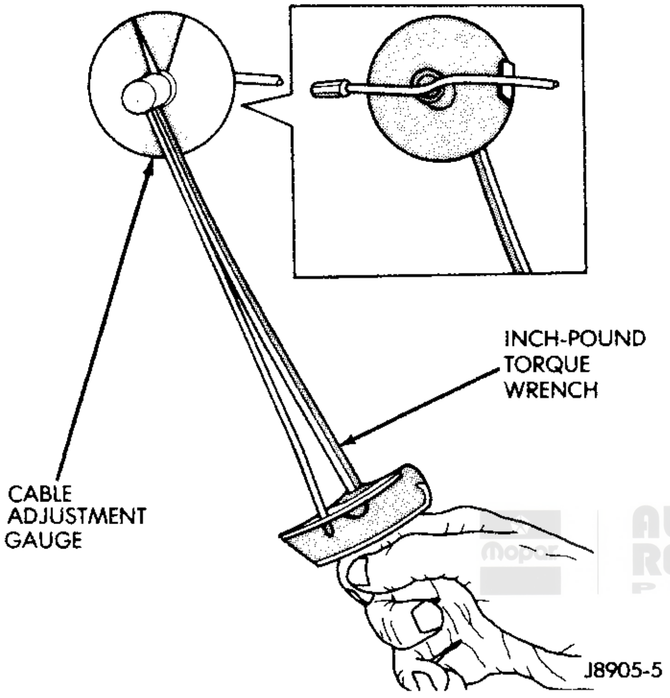


Fig. 5 Checking Cable Adjustment—XJ/MJ

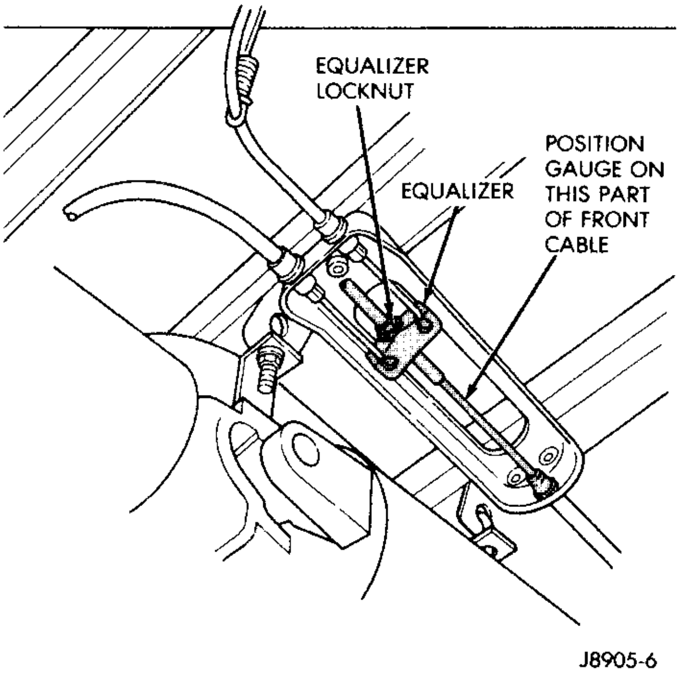


Fig. 6 Parking Brake Equalizer And Cables—MJ

(11) Apply and release parking brakes 4-5 times and check adjustment again. If adjustment changed, readjust cable.

Parking Brake Cable Adjustment—YJ

(1) Adjust rear brakes. Refer to procedure in this section.

(2) Fully apply and release parking brakes five times.

(3) Raise vehicle.

(4) Loosen equalizer locknut and adjusting nut (Fig. 7).

(5) Install adjusting gauge on inch-pound torque wrench (Fig. 8).

(6) Place adjusting gauge on parking brake front cable (Fig. 8)).

(7) Apply and hold 50 in-lb (6 N•m) rotating torque on cable (Fig. 8). Note position of adjusting gauge pointer.

(8) If adjustment gauge pointer is not in OK band, turn equalizer locknut in or out until pointer is within OK band.

(9) Remove tools and lower vehicle.

(10) Apply and release parking brake pedal 4-5 times and check adjustment again. If adjustment changed, readjust cable.

HEIGHT SENSING REAR PROPORTIONING VALVE—MJ

A height sensing rear proportioning valve is used on MJ models (Figs. 9 and 10). The valve must be adjusted if replaced, removed for access to other components, if the rear springs are changed, rear axle removed, or if the valve link, lever or bracket are removed or replaced.

The method of adjusting the valve is different for

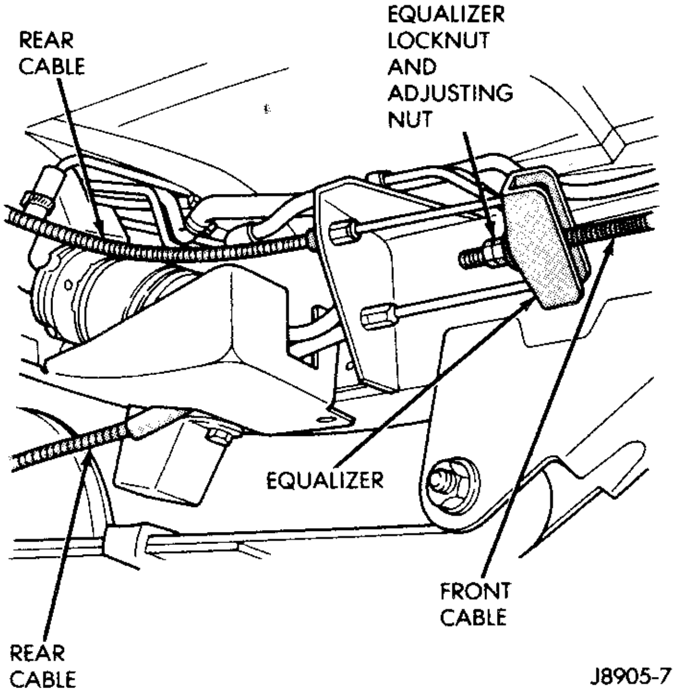


Fig. 7 Parking Brake Equalizer And Cables—YJ

1990 models. Follow the procedure and use the new adjustment gauge described in this section when servicing 1990 models. Do not attempt to use the gauges or procedures outlined for previous MJ models.

Valve adjustment on 1990 models requires gauge 6439 and a bushing installer tool. The gauge and installer tool are included in calibration kit 6229.

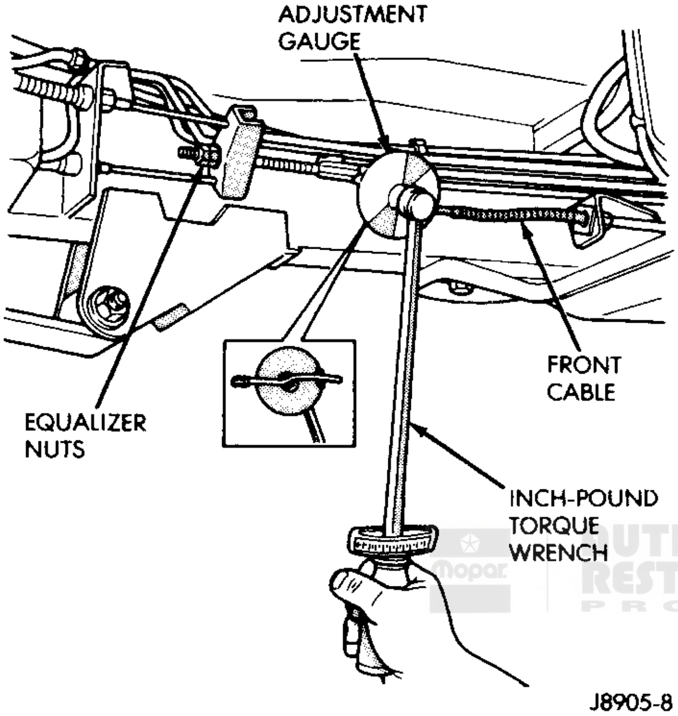


Fig. 8 Checking Cable Adjustment—YJ

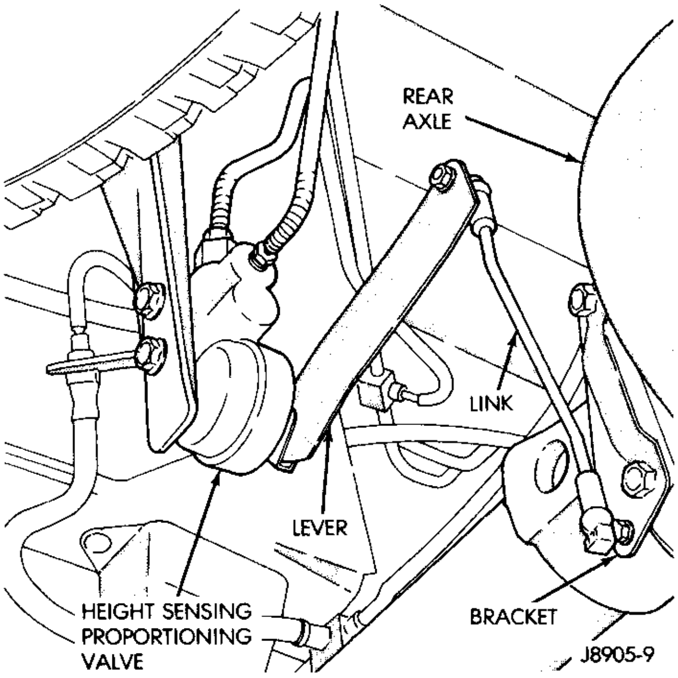


Fig. 9 Height Sensing Proportioning Valve—MJ

Height Sensing Valve Adjustment—MJ

WARNING: THE VEHICLE MUST BE UNLOADED AND ON A LEVEL SURFACE FOR ACCURATE VALVE ADJUSTMENT. THE VALVE BUSHING MUST ALSO BE REPLACED DURING ADJUSTMENT. FAILURE TO OBSERVE THESE PRECAUTIONS AND FOLLOW THE ADJUSTMENT PROCEDURE CAN RESULT IN UNSATISFACTORY BRAKE ACTION. IN ADDITION, MAKING MODIFICATIONS OR ADDING ACCESSORIES THAT CHANGE AXLE-TO-FRAME DISTANCE CAN ALSO RESULT IN UNSATISFACTORY BRAKE ACTION. ACCESSORIES SUCH AS LIFT KITS, LOAD LEVELERS, AIR SHOCKS, AND EXTRA SPRING LEAVES CAN CHANGING AXLE-TO-FRAME DISTANCE CAUSING FALSE READINGS TO THE VALVE.

(1) The vehicle must be unloaded. Remove load items from the vehicle and cargo bed if necessary.

(2) Position the vehicle on a level surface. **If a hoist will be used for adjustment, it must be a single post or drive-on hoist. Do not use a twin-post hoist.**

(3) Remove nut attaching lever to valve shaft (Fig. 11).

(4) Pull lever and retainer off valve shaft and remove old bushing (Fig. 11). **Discard the bushing, it is not reusable.**

(5) Clean threads and splines on valve shaft.

(6) If valve link was disconnected from axle bracket or lever, reconnect link before continuing. **Do not attempt adjustment with the link disconnected. The link must be connected to avoid false readings to the valve after installation.**

(7) Loosen valve mounting bolts two full turns.

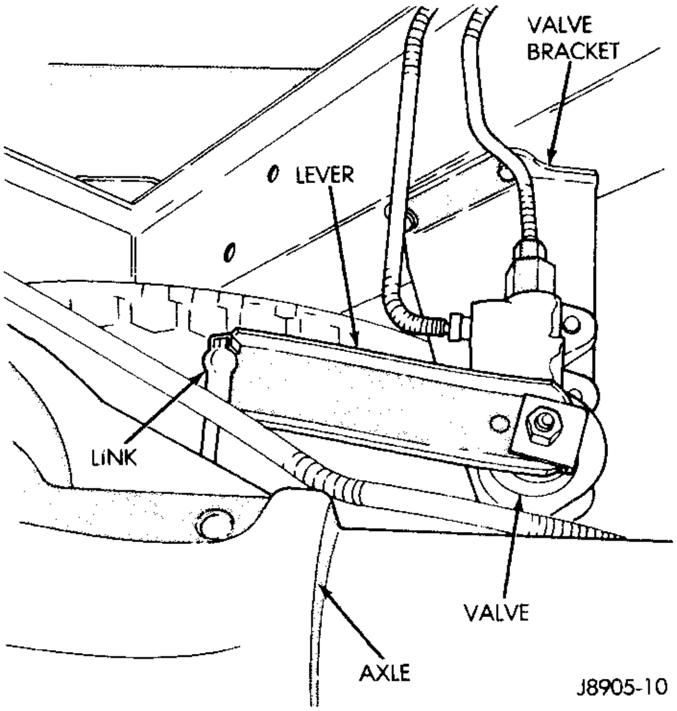


Fig. 10 Height Sensing Valve Mounting—MJ

(8) Turn valve shaft until shaft flat is approximately at 5:50 o-clock (10 minutes to six) position (Fig. 12).

(9) Use 85° adjusting gauge 6439 (from calibration tool kit 6229). This gauge is used for both Model 35 and Model 44 rear axles on 1990 models.

(10) Install valve adjusting gauge. Position gauge on mounting bolts and shaft (Fig. 13). There should be no clearance between gauge, shaft and bolts. Gauge must also be seated on shaft flat.

(11) Install retainer in lever, if removed.

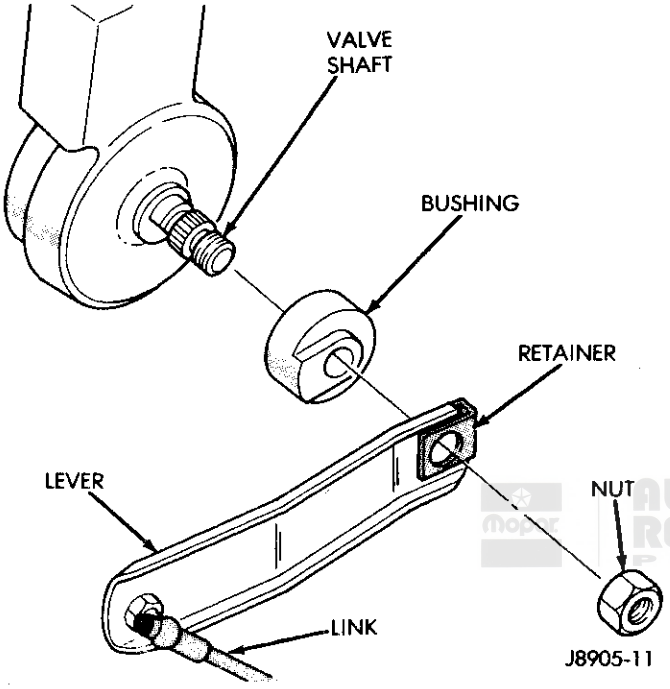


Fig. 11 Proportioning Valve Lever, Link And Bushing—MJ

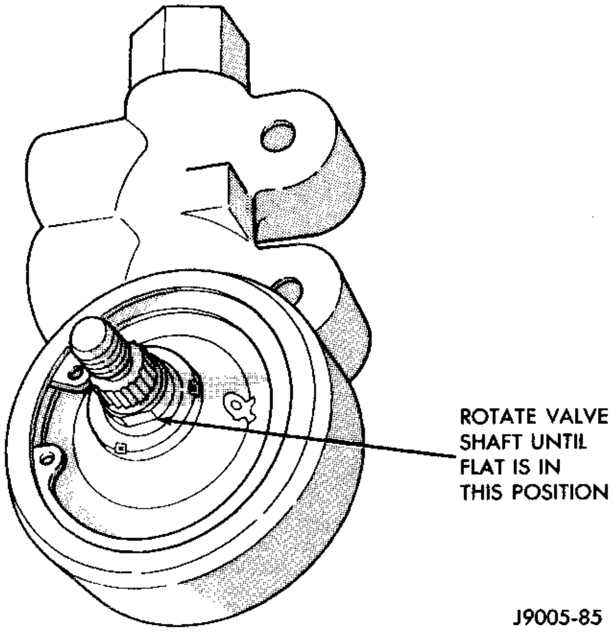


Fig. 12 Positioning Flat On Valve Shaft—MJ

(12) Insert new bushing in retainer and lever.

(13) Start bushing and lever on valve shaft.

(14) Press bushing and lever onto shaft with installer tool from kit 6229, or use C-clamp and suitable size socket (Fig. 14).

(15) Remove adjustment gauge and bushing installer tool.

(16) Tighten valve mounting bolts to 118 in-lbs (13 N•m) torque.

(17) Install and tighten lever attaching nut to 100 in-lbs (11 N•m) torque.

WHEEL NUT TIGHTENING

The wheel attaching nuts must be tightened properly to ensure efficient brake operation. Overtightening the nuts or tightening them in the wrong sequence can cause distortion of the brake rotors and drums.

Impact wrenches are not recommended for tightening wheel nuts. A torque wrench should be used for this purpose at all times.

The correct tightening sequence is important in avoiding rotor and drum distortion. The correct sequence is in a diagonal crossing pattern (Fig. 15).

Seat the wheel and install the wheel nuts finger tight. Tighten the nuts in the sequence to 1/2 required torque. Then repeat the tightening sequence to final specified torque.

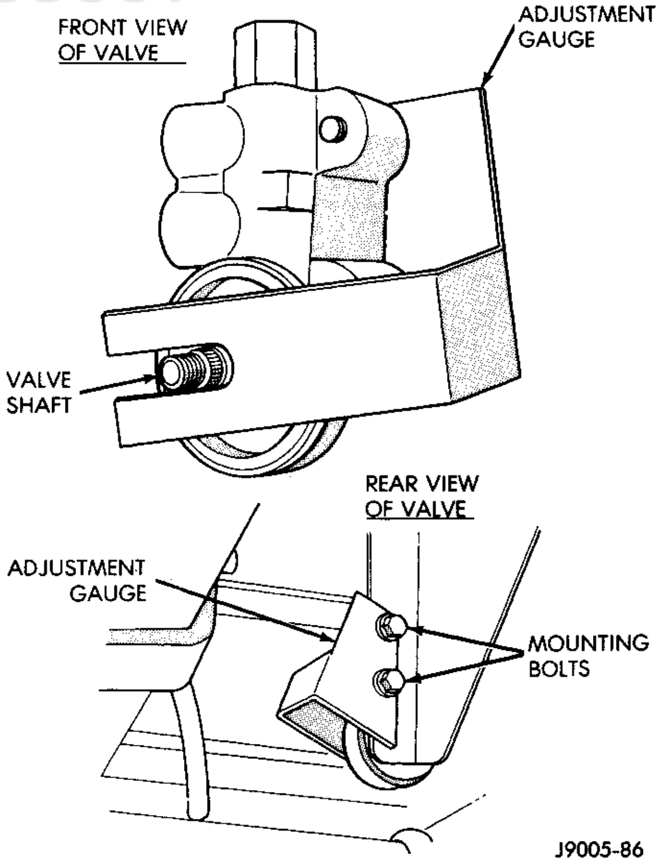


Fig. 13 Installing Valve Adjustment Gauge—MJ

BRAKE BLEEDING

The brake bleeding procedures in this section are for models with standard brakes. Bleeding procedures for models with anti-lock brakes are described in the Anti-Lock Brake section.

Bleed the hydraulic system whenever diagnosis indicates air has entered the system. If the fluid is also contaminated, flush the system completely with fresh brake fluid

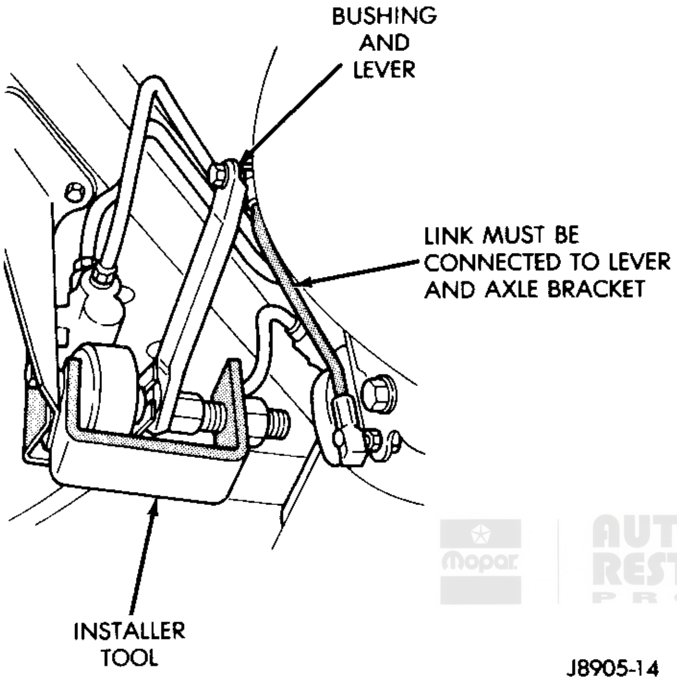


Fig. 14 Installing Bushing And Lever—MJ

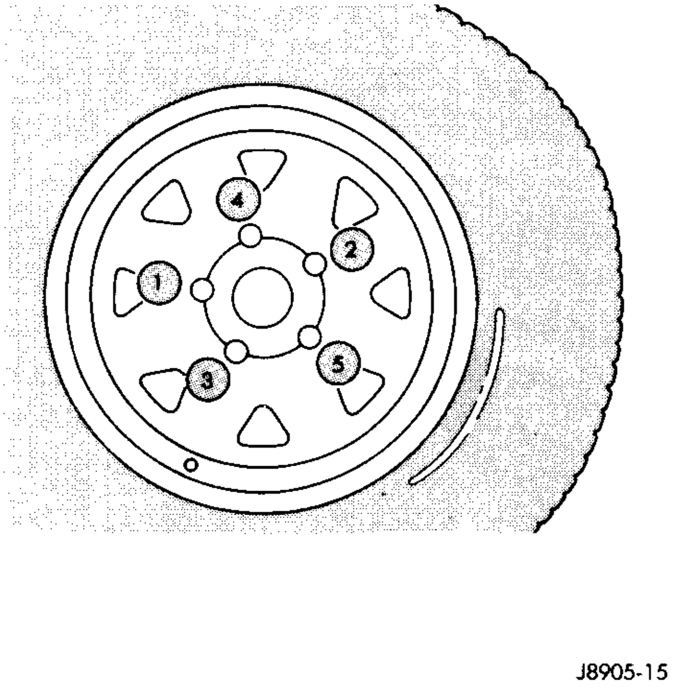


Fig. 15 Wheel Nut Tightening Sequence

Use Mopar brake fluid or equivalent meeting DOT and SAE standards J1703F and DOT 3 to fill the bleeding apparatus and system.

The brake hydraulic system can be bled manually or with pressure equipment. When using pressure equipment, follow the manufacturers instructions carefully.

Pressure Bleeding

(1) Release air from bleeder pressure tank.

(2) Fill bleeder supply tank with brake fluid.

(3) Close tank-to-master cylinder fluid supply valve.

(4) Charge bleeder pressure tank to 15 to 20 psi (103 to 138 kPa).

(5) Install bleeder adapter cover on master cylinder. Refer to Figures 16 and 17 for typical adapter covers.

(6) Connect adapter cover fluid supply hose to fluid supply valve in tank.

(7) Remove hose fitting from master cylinder adapter and install it in quick-disconnect fitting on fluid supply hose.

(8) Place end of fluid supply hose in clean container. Then slowly open tank fluid supply valve to purge any air from tank and hose.

(9) Close valve when fluid flows clear and free of air bubbles.

(10) Recharge tank if pressure falls below 15-20 psi.

(11) Remove adapter fitting from hose and install it in master cylinder adapter.

(12) Connect fluid supply hose to adapter fitting and open tank fluid supply valve.

(13) Use following bleed sequence:
  (a) right rear
  (b) left rear
  (c) right front
  (d) left front

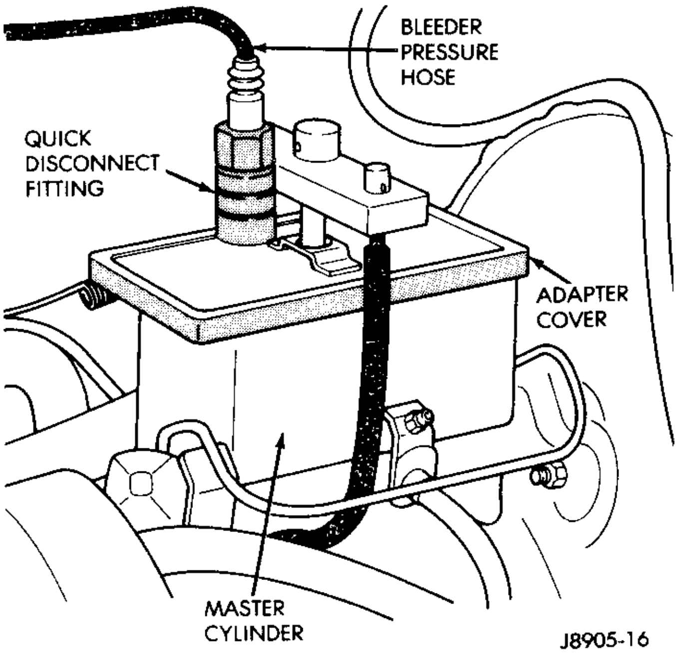


Fig. 16 Integral Master Cylinder Adapter—Typical

(14) Bleed only one wheel brake unit at a time.

(15) Install rubber hose on caliper or cylinder bleed fitting. Submerge end of hose in container partially filled with brake fluid (Fig. 18).

(16) Open caliper or cylinder bleed fitting 3/4 turn. Close fitting when fluid flows clear and free of air bubbles.

(17) After bleeding all wheels, disconnect fluid supply hose and remove master cylinder adapter cover.

(18) Discard fluid removed during bleeding.

(19) Top off master cylinder reservoirs.

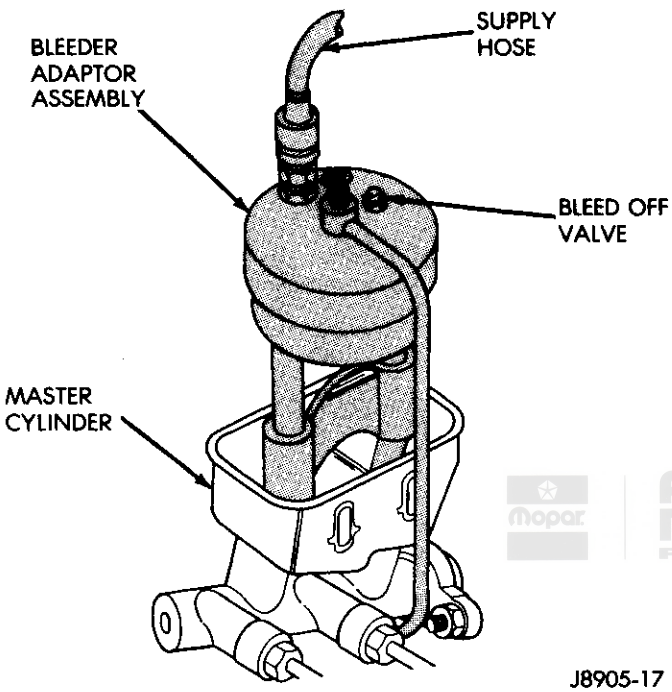


Fig. 17 Two-Piece Master Cylinder Adapter—Typical

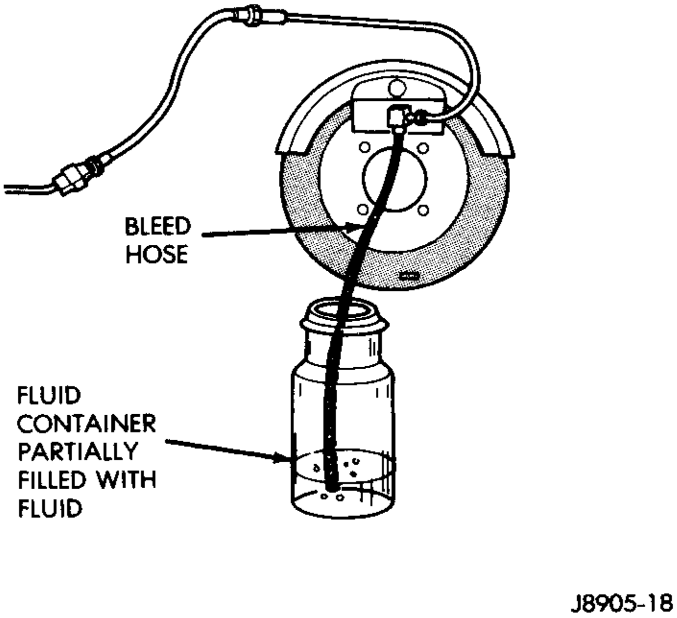


Fig. 18 Bleed Hose And Fluid Container

(20) Release bleeder tank air pressure and close fluid supply valve.

(21) Verify proper brake operation.

Manual Bleeding

(1) Fill master cylinder reservoirs.

(2) Use following bleed sequence:

  (a) right rear

  (b) left rear

  (c) right front

  (d) left front

(3) Bleed only one wheel brake unit at a time.

(4) Install bleed hose on caliper or cylinder bleed fitting. Submerge free end of hose in container partially filled with brake fluid (Fig. 18).

CAUTION: Do not allow the master cylinder to run out of fluid when bleeding the brakes manually. An empty cylinder will allow additional air to be drawn into the system. Check the cylinder fluid level frequently and add fluid as needed.

(5) Open caliper or cylinder bleed fitting 3/4 turn.

(6) Have helper press and hold brake pedal to floor. Tighten bleed fitting and have helper release brake pedal. Continue this operation until fluid from fitting is clear and free of bubbles.

(7) Repeat bleeding operation at remaining wheel brake units.

(8) Discard all fluid removed during bleeding operation.

(9) Top off master cylinder reservoirs.

(10) Verify proper brake operation.

BRAKELIGHT SWITCH ADJUSTMENT—SJ MODELS

(1) Press and release brake pedal.

(2) Remove brakelight switch wire connector from switch (Fig. 19).

(3) Press brake pedal and check switch plunger travel. Plunger should be fully extended to ON position after 3/8 to 5/8 inch of pedal travel (Fig. 19).

(4) If adjustment is required, turn switch in or out to adjust plunger travel.

(5) Connect wires to switch.

(6) Verify correct brakelight operation.

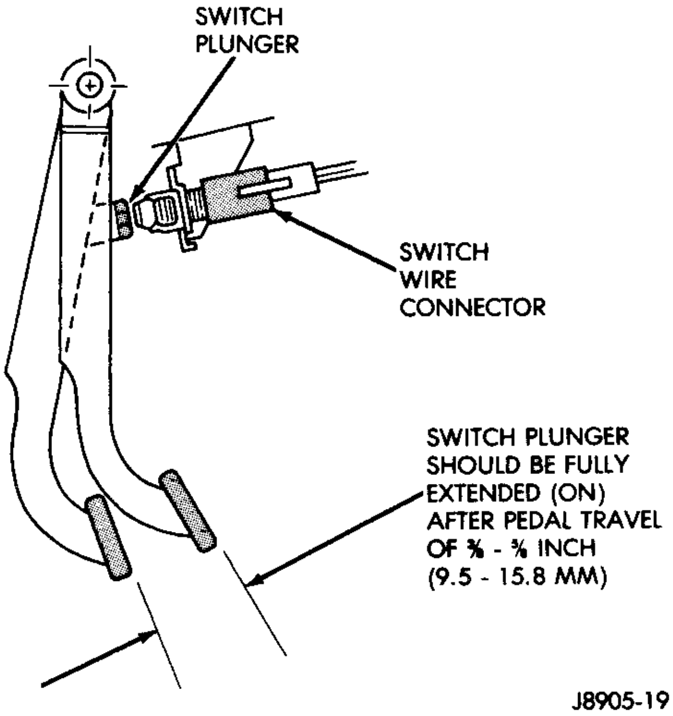


Fig. 19 Brakelight Switch Adjustment—SJ

POWER BRAKE BOOSTER

INDEX

SERVICE INFORMATION

The vacuum operated power brake booster is not a serviceable component. If a booster malfunction occurs, the booster must be replaced as an assembly.

The booster in SJ and YJ models requires spacers for attachment to the dash panel (Figs. 1 and 2). The booster in XJ/MJ models (Fig. 3) is attached to the dash panel and pedal support. The three booster assemblies are different sizes and capacities and are not interchangeable.

POWER BRAKE BOOSTER REMOVAL

(1) Loosen but do not remove nuts attaching master cylinder to booster (Fig. 4).

(2) Remove instrument panel lower trim cover. On SJ models, remove A/C duct and lower trim panel.

(3) On all except SJ models, disconnect brakelight switch wires and remove nuts attaching booster push rod to brake pedal.

(4) On SJ models, remove cotter pin, washer and bushing attaching booster push rod to pedal.

(5) Remove bolts/nuts attaching booster to dash panel (Fig. 5).

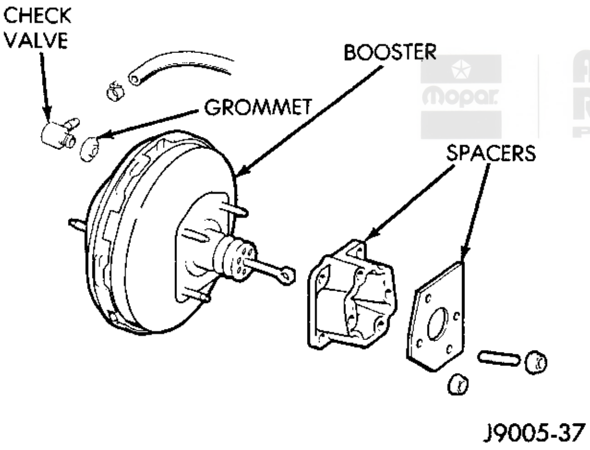


Fig. 1 Power Brake Booster—SJ

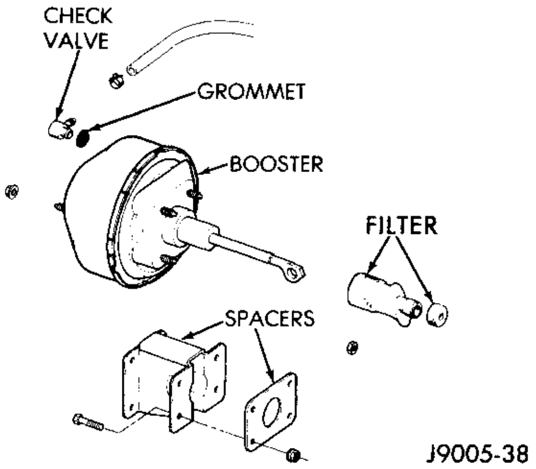


Fig. 2 Power Brake Booster—YJ

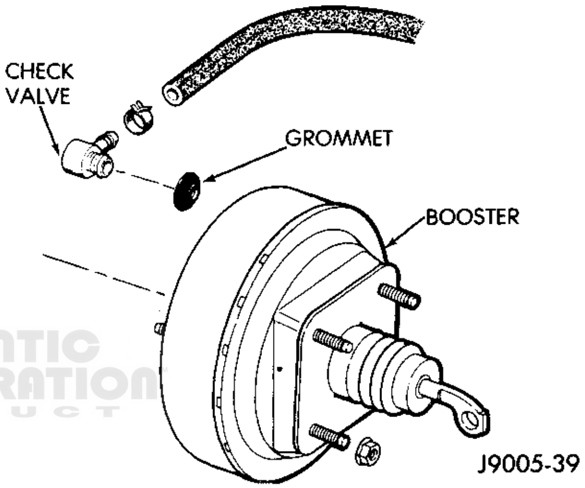


Fig. 3 Power Brake Booster—XJ/MJ

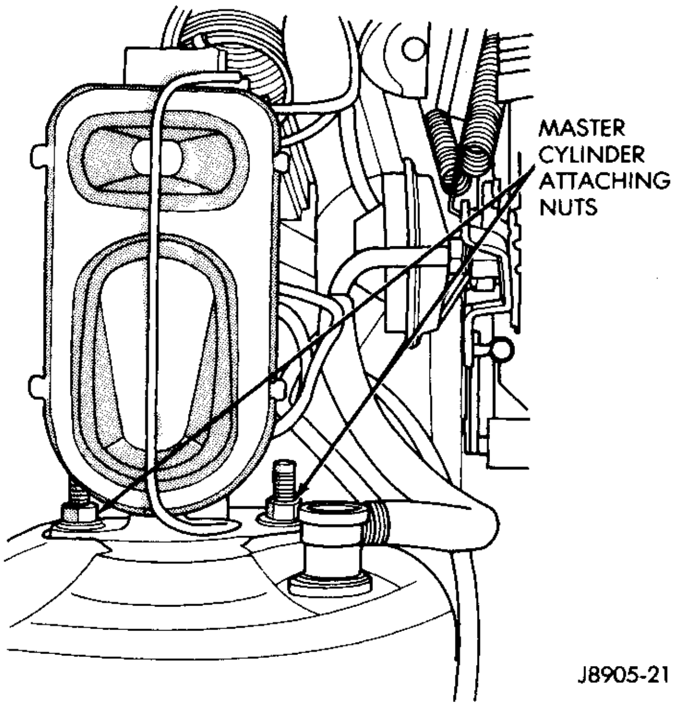


Fig. 4 Master Cylinder Attachment

(6) In engine compartment, loosen vacuum hose clamp and remove vacuum hose from booster check valve (Fig. 6).

(7) Remove master cylinder attaching nuts and remove cylinder from booster studs.

(8) Carefully move master cylinder aside and remove booster. On models with cruise control, remove brakelight switch and switch bushings and spacers (Fig. 7).

POWER BRAKE BOOSTER INSTALLATION

(1) Install check valve and grommet in booster. On SJ/YJ models, also install spacers on booster.

(2) Install brakelight switch on all except SJ models (Fig. 7).

(3) Position booster on dash panel and install booster mounting bolts.

(4) Inside vehicle, install nuts on booster mounting bolt or studs.

(5) Attach booster push rod to brake pedal. On all except SJ models, secure push rod with a new bolt and nuts. On SJ Models, secure push rod with a new washer and cotter pin.

(6) Tighten booster mounting bolts/stud nuts to following torque: SJ - 22 ft-lbs (30 N•m); XJ/MJ - 30 ft-lbs (41 N•m); YJ- 25 ft-lbs (34 N•m).

(7) On all except SJ models, tighten push rod bolt inner nut to 25 ft-lbs (34 N•m) torque. Then tighten outer locknut to 75 in-lbs (8 N•m) torque.

(8) Connect brakelight switch wires and install trim panels and A/C ducts.

(9) Install master cylinder on booster studs. Tighten attaching nuts to 25 ft-lbs (34 N•m) on SJ models and 15 ft-lbs (21 N•m) on all other models.

(10) Connect vacuum hose to booster, top off master cylinder fluid level and check brake operation.

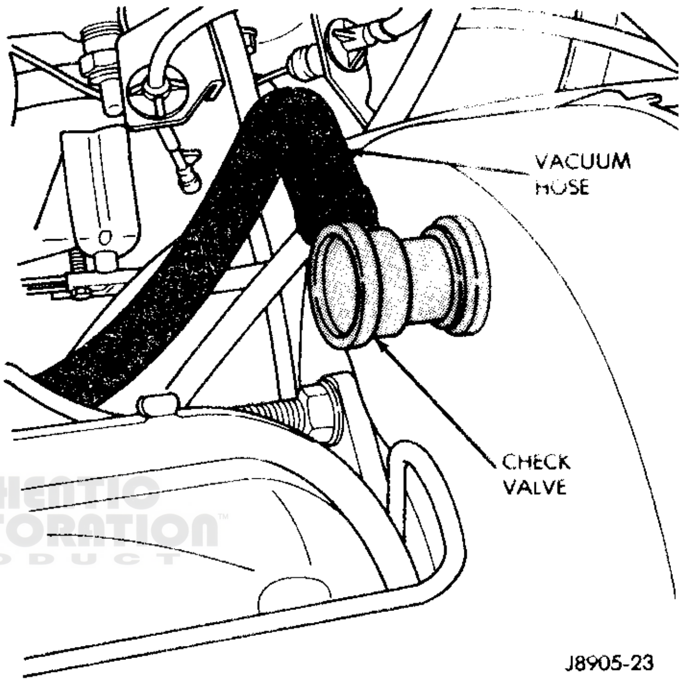


Fig. 6 Booster Check Valve And Hose

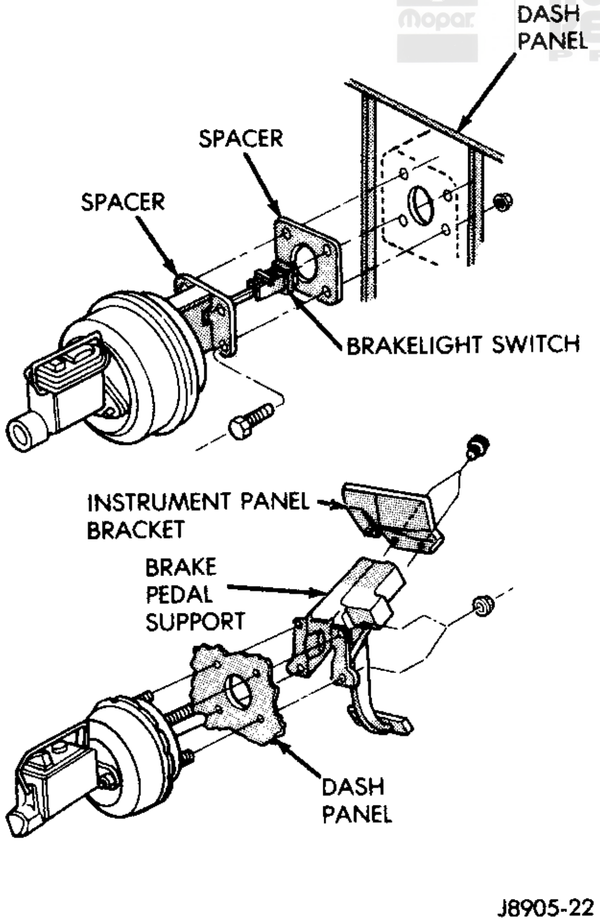


Fig. 5 Power Brake Booster Mounting

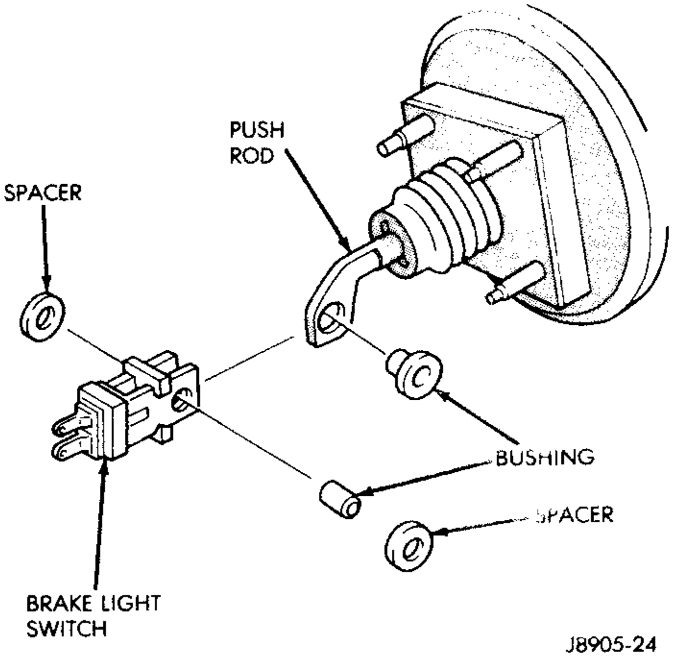


Fig. 7 Brakelight Switch—With Cruise Control

MASTER CYLINDER

INDEX

MASTER CYLINDER REMOVAL

(1) Disconnect brake lines at master cylinder.

(2) Remove cylinder mounting nuts and remove master cylinder.

(3) Remove cylinder cover and drain fluid.

MASTER CYLINDER INSTALLATION

(1) Install cylinder on brake booster studs and install cylinder attaching nuts. Tighten nuts to 25 ft-lbs (34 N•m) on SJ models and 15 ft-lbs (21 N•m) on all other models.

(2) Connect brakelines to cylinder.

(3) Fill and bleed brake system.

MASTER CYLINDER OVERHAUL—XJ/MJ/YJ

Disassembly

(1) Remove cylinder cover and drain fluid.

(2) Examine cylinder cover seal. Discard seal if torn or distorted.

(3) Clamp cylinder in vise (Fig. 1).

(4) Press primary piston inward with philips screwdriver and remove snap ring (Fig. 2).

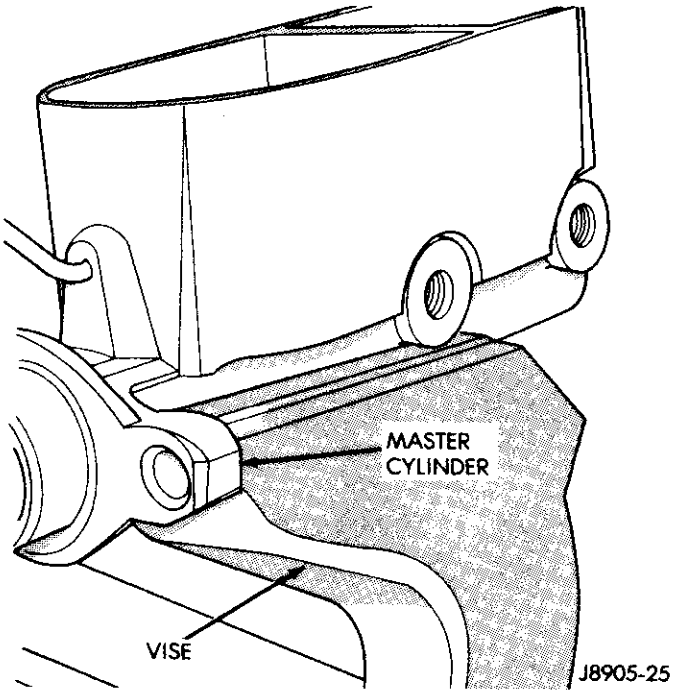


Fig. 1 Cylinder Mounted In Vise

(5) Remove primary piston (Fig. 3). Discard piston. It is serviced only as an assembly.

(6) Remove secondary piston (Fig. 4). Apply air pressure through rear outlet port to ease piston out of bore. Cover small ports at bottom of rear reservoir with towel to prevent air leakage.

(7) Discard secondary piston. Do not disassemble piston as components are only serviced as assembly.

Cleaning And Inspection

Clean the cylinder with Mopar brake cleaning solvent or clean brake fluid. Remove cleaning residue with compressed air.

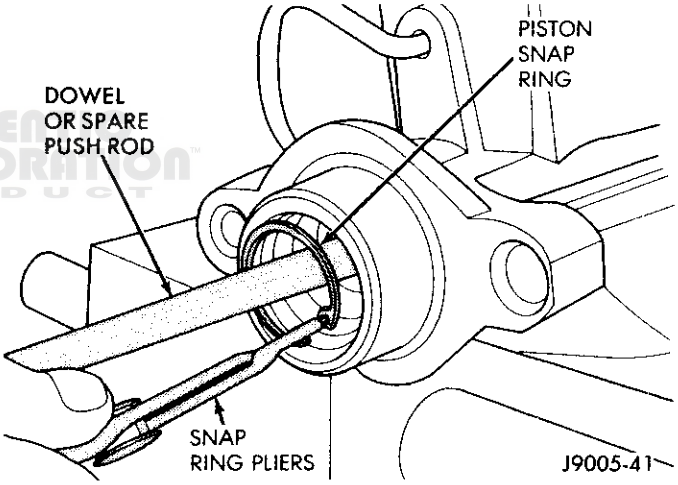


Fig. 2 Removing/Installing Piston Snap Ring

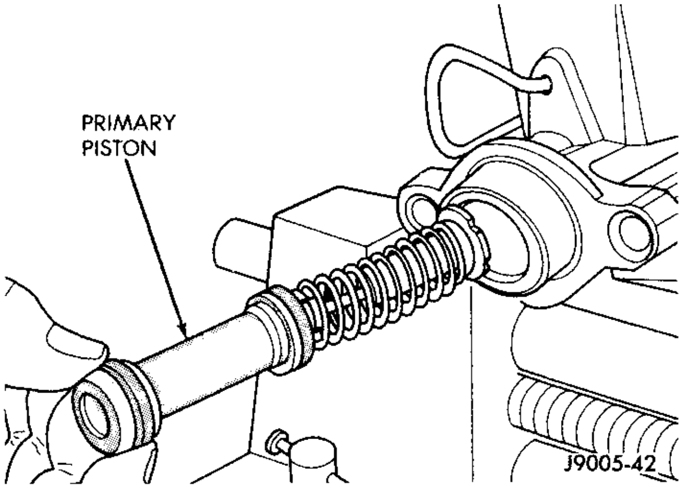


Fig. 3 Removing/Installing Primary Piston

Inspect the cylinder bore. A light discoloration of the bore surface is normal and acceptable but only if the surface is in good condition.

Replace the cylinder if the bore is scored, corroded, or pitted. **Do not hone the cylinder bore in an attempt to restore the surface. Replace the cylinder if the bore is corroded or if doubt exists about cylinder bore condition.**

Check the outer and inner surfaces of the cylinder for cracks or porosity, especially if wet spots were noted on the cylinder outer surface during removal and disassembly.

Inspect the cylinder cover, seal and retainer spring. Replace the seal if torn or distorted and replace the cover and spring if either part is bent or damaged in any way.

Cylinder Assembly

(1) Coat cylinder bore and new piston assemblies with brake fluid.

(2) Install secondary piston in bore with push and turn motion (Fig. 5). **Do not use any tools to start seals into bore. Sharp edged tools will cut the seal and scratch the bore.**

(3) Insert primary piston in bore (Fig. 3).

(4) Push primary piston inward and install snap ring (Fig. 2).

(5) Fill master cylinder reservoirs with brake fluid.

(6) Fabricate and install bleed tubes in master cylinder (Fig. 6). Be sure tube ends are submerged in brake fluid. Tubes can be fabricated from copper tubing and spare brakeline fittings.

(7) Using push rod or a wooden dowel (Fig. 6), press pistons into bore; then allow them to return under spring pressure. Repeat this operation until air bubbles cease to appear in the fluid.

(8) Remove bleed tubes. Cap outlet ports and install reservoir cover and seal.

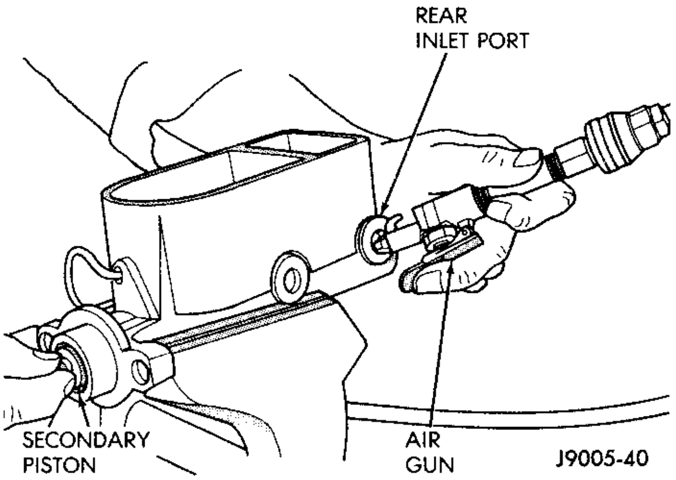


Fig. 4 Removing Secondary Piston Assembly

MASTER CYLINDER OVERHAUL—SJ

(1) Remove reservoir cover and seal (Fig. 7) and drain fluid.

(2) Mount cylinder in vise. Clamp vise jaws on cylinder mounting ear (Fig. 8).

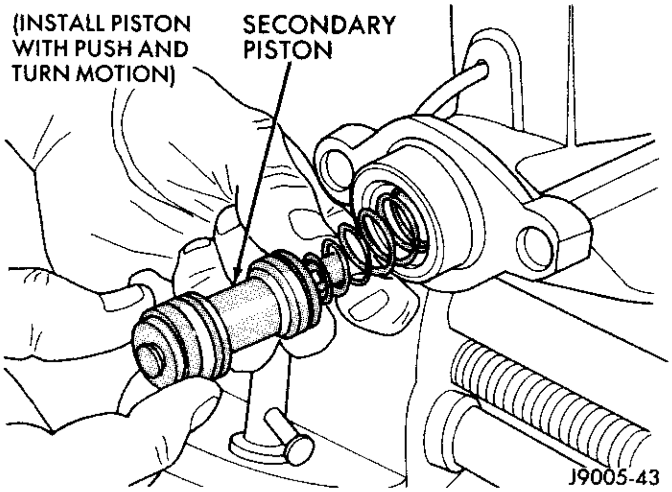


Fig. 5 Installing Secondary Piston

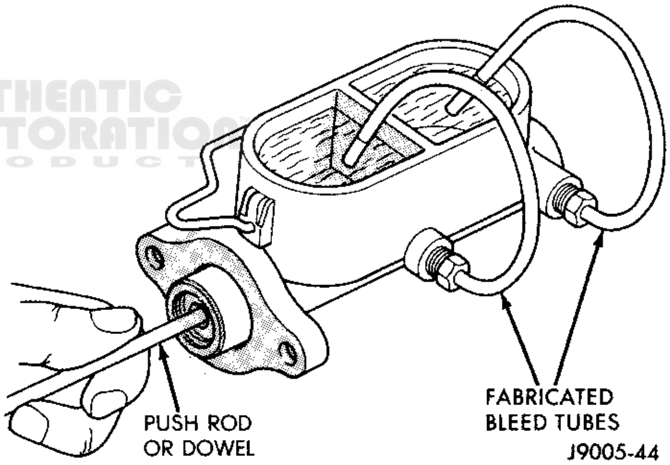


Fig. 6 Bleeding Master Cylinder

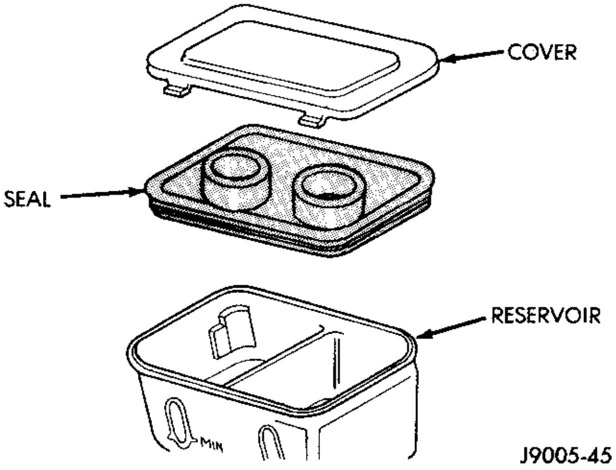


Fig. 7 Removing Reservoir Cover And Seal

(3) Remove reservoir with rocking motion. Use pry bar to help ease reservoir off cylinder if necessary (Fig. 8).

(4) Remove grommets from reservoir (Fig. 9).

(5) Remove piston snap ring with pointed tool and small flat blade screwdriver (Fig. 10).

(6) Remove primary piston (Fig. 10). Discard piston. It is serviced only as an assembly.

(7) Remove secondary piston and spring (Fig. 10). Apply air pressure through rear outlet port to ease piston out of bore.

(8) Tilt cylinder downward and remove secondary piston spring (Fig. 10).

(9) Disassemble secondary piston (Fig. 11). Discard piston seals, retainer and spring.

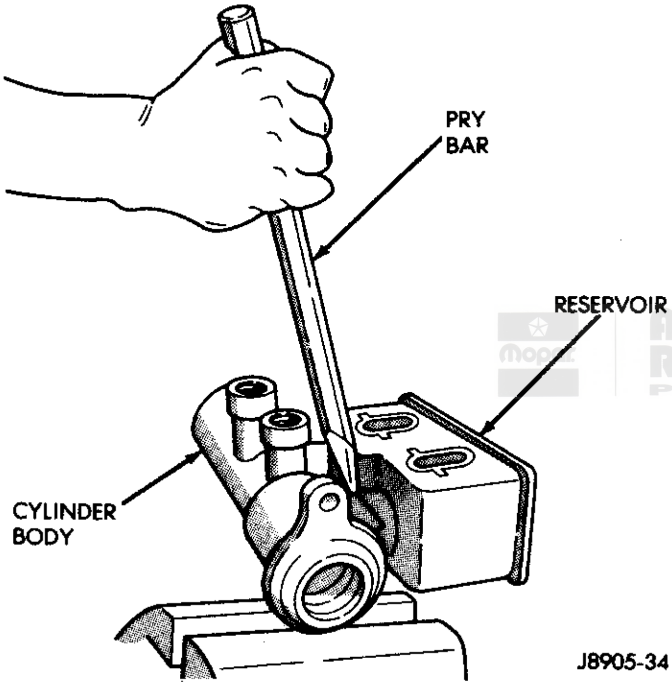


Fig. 8 Removing Master Cylinder Reservoir

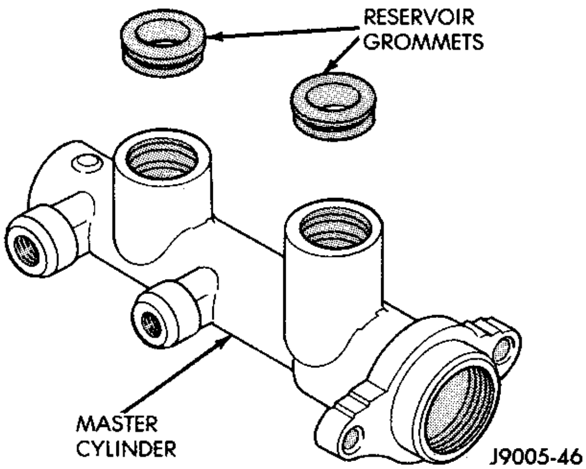


Fig. 9 Remove Reservoir Grommets

Cleaning And Inspection

Clean the cylinder with brake cleaning solvent or clean brake fluid. Remove cleaning residue with compressed air.

Inspect the cylinder bore. A light discoloration of the bore surface is normal and acceptable but only if the surface is in good condition.

Replace the cylinder if the bore is scored, corroded, or pitted. **Do not hone the cylinder bore in an attempt to restore the surface. Replace the cylinder if doubt exists about cylinder bore condition.**

Check the outer and inner surfaces of the cylinder for cracks or porosity, especially if wet spots were noted on the cylinder outer surface during removal and disassembly.

Inspect the cylinder cover and seal. Replace the seal if torn or distorted and replace the cover if damaged in any way.

Inspect the reservoir. Replace it if cracked, distorted or damaged in any way. Inspect the cylinder check valve (Fig. 12). Remove the valve snap ring and replace the valve if necessary.

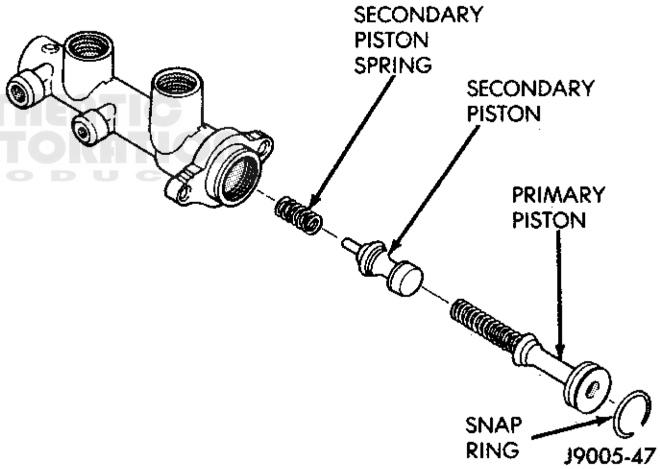


Fig. 10 Removing Master Cylinder Pistons

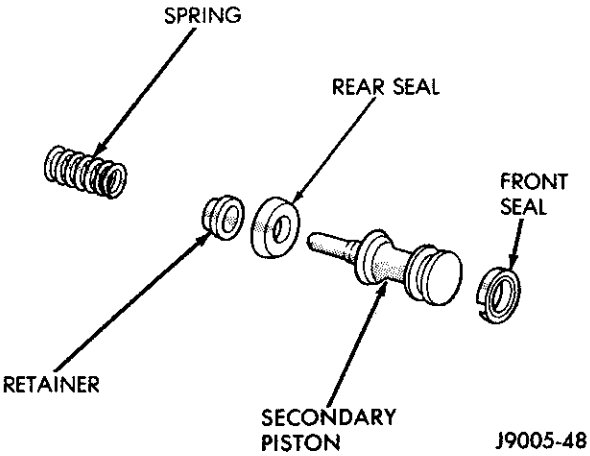


Fig. 11 Secondary Piston Components

Also inspect the outlet port tube seats (Fig. 12). Replace the tube seats if cracked, scored, or loose. Remove the seats with a hardened self tapping screw. Thread the screw into the tube seat. Then pry upward on the screw with two screwdrivers to remove the seat. Remove any chips with brake cleaner.

Cylinder Assembly

(1) Install new check valve and tube seats (if removed). Use spare brakeline fittings to press tube seats into the cylinder ports.

(2) Coat master cylinder bore, pistons, seals and reservoir grommets with brake fluid.

(3) Assemble secondary piston (Fig. 11). Lips on both piston seals face away from piston

(4) Install secondary piston in bore with twist and turn motion. **Do not use any tools to start seals into bore. Sharp edged tools will cut the seals and scratch the bore.**

(5) Insert primary piston in bore and install snap ring (Fig. 10).

(6) Install new reservoir grommets in master cylinder (Fig. 9). Be sure grommets are fully seated in cylinder.

(7) Turn reservoir upside down and place on flat surface (Fig. 13).

(8) Press master cylinder onto reservoir with rocking motion (Fig. 13). Be sure reservoir is fully seated in grommets.

(9) Mount master cylinder in vise and fill reservoir with brake fluid.

(10) Install bleed tubes in master cylinder and bleed cylinder until bubbles no longer appear in fluid.

(11) Install new seal on reservoir cover and install cover on reservoir.

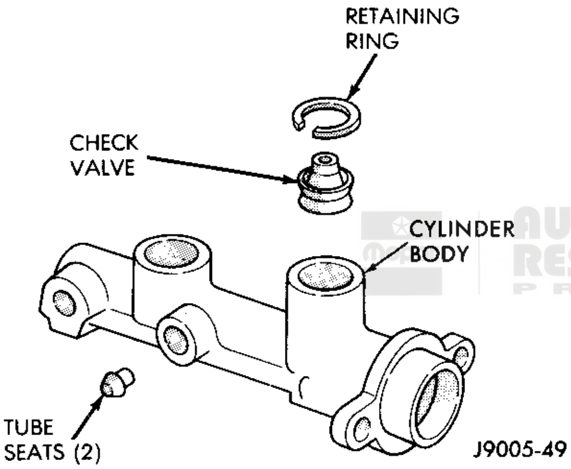


Fig. 12 Check Valve And Tube Seats

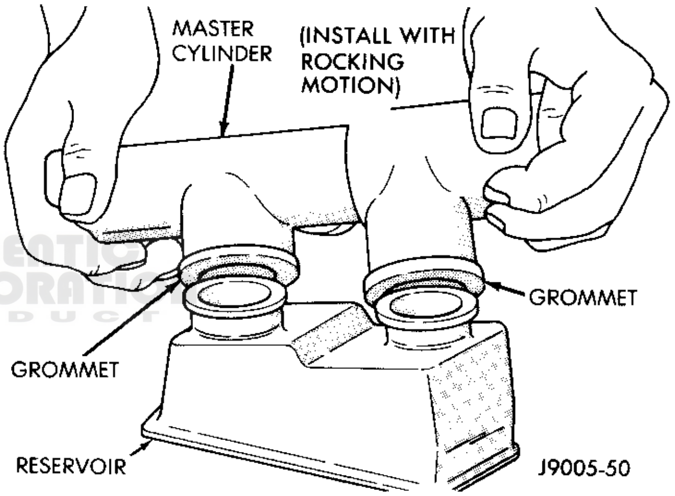


Fig. 13 Installing Master Cylinder Reservoir

DISC BRAKES

INDEX

DISC BRAKESHOE REPLACEMENT-FOUR WHEEL DRIVE—XJ/MJ/YJ

Disc Brakeshoe Removal

(1) Raise vehicle and remove front wheels.

(2) Drain small amount of fluid from master cylinder front brake reservoir with suction gun.

(3) Bottom caliper piston with C-clamp. Position clamp screw on outboard brakeshoe and frame of clamp on rear of caliper. A typical C-clamp set up is shown in Figure 1. **Do not allow the clamp screw to bear directly on the outboard shoe retainer spring. Use a wood or metal spacer between the shoe and clamp screw if necessary.**

(4) Remove caliper pins (Fig. 2).

(5) Tilt top of caliper caliper outward. Use pry tool if necessary (Fig. 3).

(6) Lift caliper off steering knuckle (Fig. 4).

(7) **If original brakeshoes will be used, keep them in sets (left and right as they are not interchangeable.**

(8) Remove outboard shoe. Press one end of shoe inward to disengage shoe lug and rotate shoe upward until retainer spring clears caliper. Then press opposite end of shoe inward to disengage opposite shoe lug and rotate shoe up and out of caliper (Fig. 5).

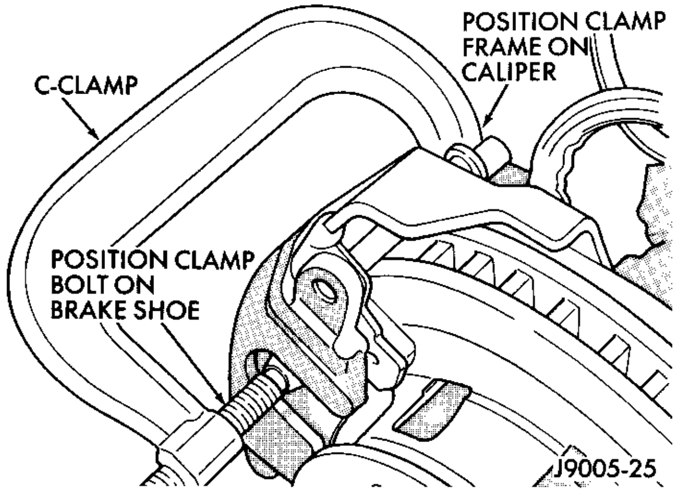


Fig. 1 Bottoming Caliper Piston With C-Clamp—Typical

(9) Remove inboard shoe. Grasp ends of shoe and tilt shoe outward to release springs from caliper piston (Fig. 6). Then remove shoe from caliper.

(10) Support caliper on box, mechanics stool, or similar device. **Do not allow brake hose to support caliper weight.**

(11) Wipe caliper off with shop rags or towels. **Do not use compressed air. Compressed air can unseat dust boot and force dirt into piston bore.**

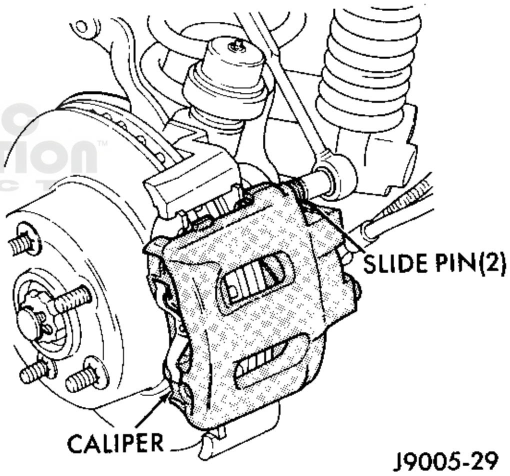


Fig. 2 Removing/Installing Caliper Slide Pins

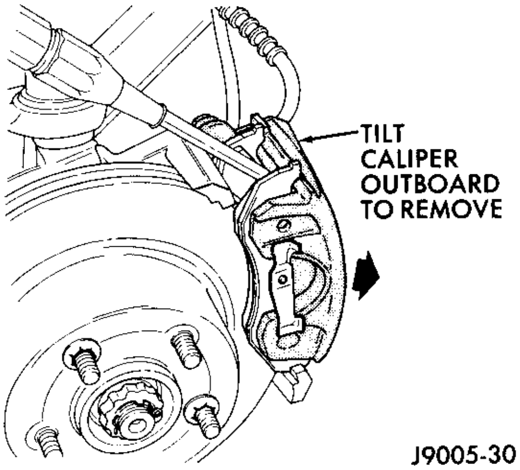


Fig. 3 Tilting Caliper Outward

(12) Inspect condition of caliper piston dust boot (Fig. 7). Overhaul caliper if there is evidence of leakage past piston and dust boot. Then inspect caliper slide bushings and bushing boots (Fig. 7). Replace boots if torn or cut. If bushings or boots are damaged, replace them.

Disc Brakeshoe Installation

(1) Clean brakeshoe mounting ledges of steering knuckle with wire brush. Then apply light coat of Mopar multi-purpose grease to slide surfaces (Fig. 8).

(2) Lubricate caliper pins and bushings (Fig. 7) with GE 661 or Dow 111 silicone grease.

(3) **Keep new or original brakeshoes in sets. They are not interchangeable from side to side.**

(4) Install inboard shoe in caliper (Fig. 9). Be sure shoe retaining springs are fully seated in caliper piston.

(5) Install outboard shoe in caliper (Fig. 10). Start one end of shoe in caliper and rotate shoe downward and into place until shoe locating lugs and shoe spring are seated in caliper.

(6) Verify that locating lugs on outboard shoe are seated in caliper (Fig. 4).

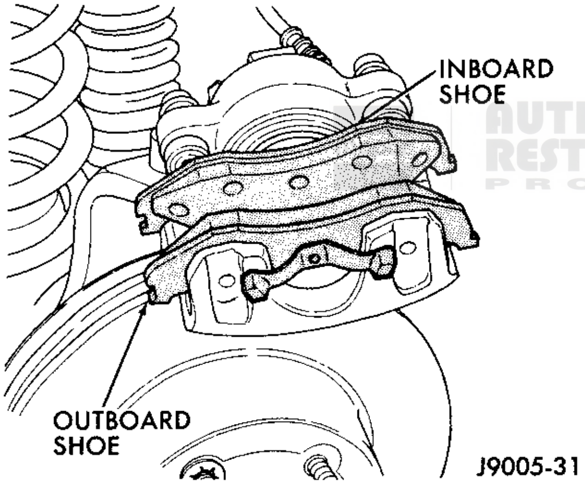


Fig. 4 Caliper Removal

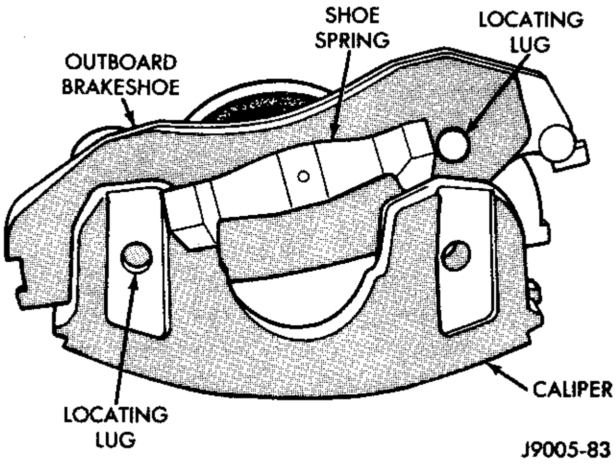


Fig. 5 Removing Outboard Brakeshoe

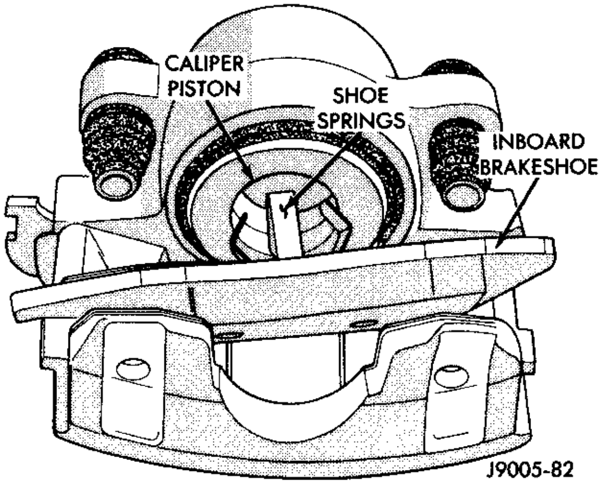


Fig. 6 Removing Inboard Brakeshoe

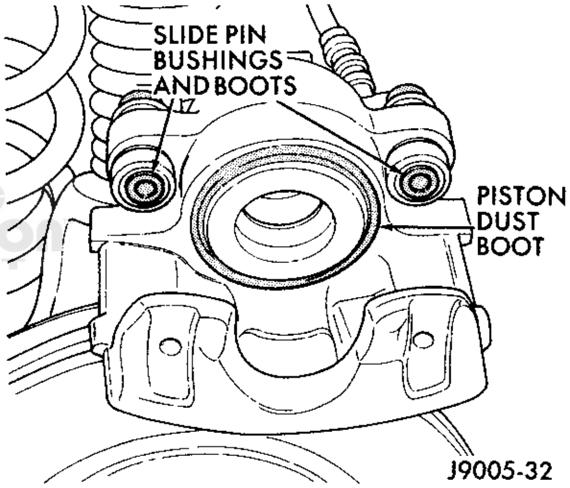


Fig. 7 Inspect Caliper Dust Boots And Slide Bushings

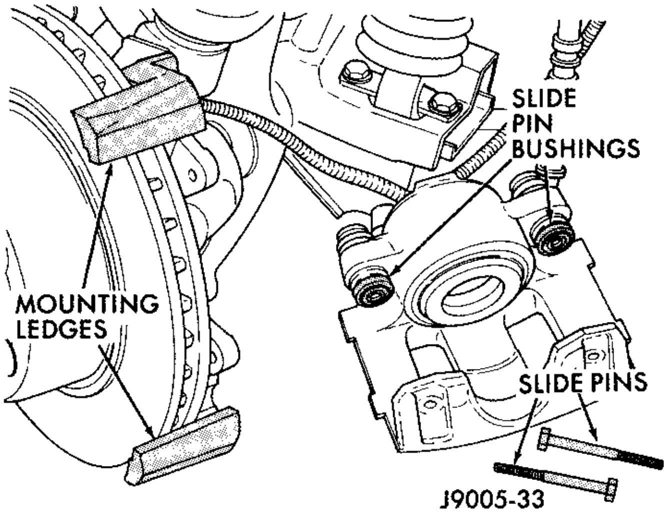


Fig. 8 Caliper Lubrication Points

(7) Install caliper. Position notches at lower end of brakeshoes on bottom mounting ledge (Fig. 110). Then

install caliper over rotor and seat upper ends of brakeshoes on top mounting ledge (Fig. 9).

CAUTION: Before securing the caliper, be sure the caliper brake hose is not twisted, kinked or touching any chassis components.

(8) Install and tighten slide pins to 10-20 N•m (7-15 ft-lbs) torque.

(9) Install wheels. Tighten lug nuts to 102 N•m (75 ft-lbs) torque.

(10) On models with standard brakes, pump brake pedal until caliper pistons and brakeshoes are seated. On models with anti-lock brakes, turn ignition On and run booster pump for 5-6 seconds. Then pump brake pedal until shoes are seated and indicator lights go out.

(11) Top off brake fluid level if necessary. Use Mopar brake fluid or equivalent meeting SAE J1703 and DOT 3 standards only.

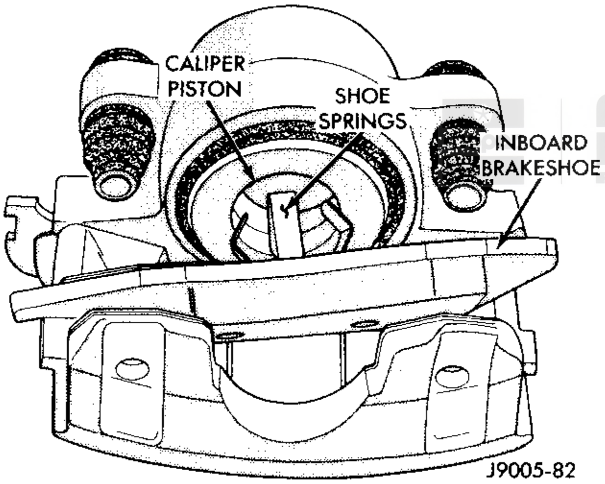


Fig. 9 Installing Inboard Brakeshoe

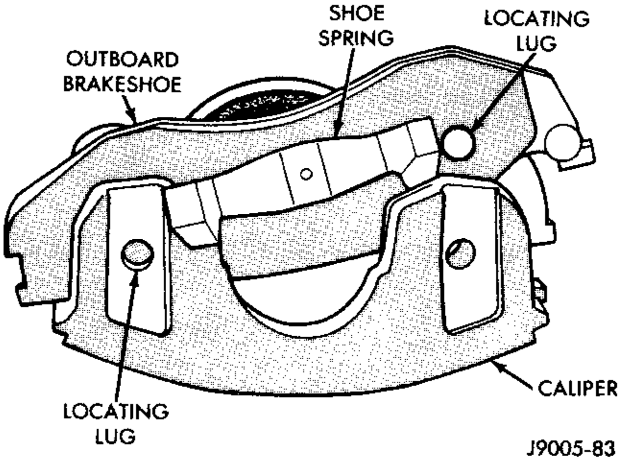


Fig. 10 Installing Outboard Brakeshoe

CALIPER OVERHAUL-FOUR WHEEL DRIVE—XJ/MJ/YJ

Caliper Removal

(1) Raise vehicle and remove front wheels.

(2) Remove caliper slide pins (Fig. 2).

(3) Rotate caliper rearward by hand or with pry tool (Fig. 3). Then rotate caliper and brakeshoes off mounting ledges.

(4) Remove caliper fitting bolt and disconnect front brakeline at caliper. Discard fitting bolt washers. They are not reusable and must be replaced.

(5) Remove caliper from vehicle.

Caliper Disassembly

(1) Remove brakeshoes from caliper.

(2) Pad interior of caliper with one or two inch thickness of shop towels (Fig. 12). Towels are needed to protect caliper piston during removal.

(3) Remove caliper piston with one or two **short bursts** of low pressure compressed air. Direct air through fluid inlet port and ease piston out of bore (Fig. 13).

CAUTION: Do not blow the piston out of the bore with sustained air pressure. This could result in a cracked piston. Use only enough air pressure to ease the piston out. In addition, never attempt to catch the piston as it leaves the bore. This could result in personal injury.

(4) Remove caliper piston dust boot (Fig. 14). Collapse boot with suitable tool and remove and discard boot.

(5) Remove and discard caliper piston seal with pencil, toothpick, or plastic tool (Fig. 15). Do not use metal tools as they will scratch piston bore.

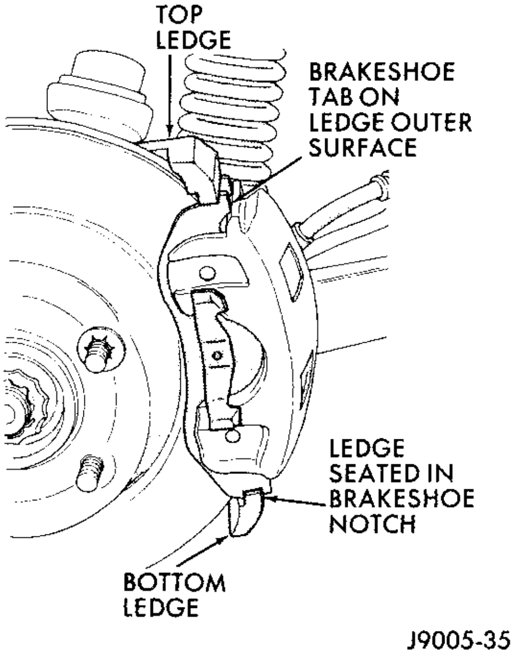


Fig. 11 Caliper Installation

(6) Remove caliper slide bushings and and boots (Fig. 15).

Cleaning And Inspection

Clean the caliper and piston with clean brake fluid or Mopar brake cleaning solvent only. Do not use gasoline, kerosene, thinner, or any similar type of solvent. These products may leave a residue that could damage the piston and seal.

Wipe the caliper and piston dry with lint free towels or use low pressure compressed air.

Inspect the piston and piston bore. Replace the caliper if the bore is corroded, rusted, or scored. Do not hone the caliper piston bore. Replace the caliper if the bore is damaged.

Inspect the caliper piston. The piston is made from a phenolic resin (plastic material) and should be smooth and clean. Replace the piston if cracked or scored. Do not attempt to restore a scored piston surface by sanding or polishing. The piston must be replaced if damaged.

Inspect the caliper bushings and boots. Replace the boots if cut or torn. Clean and relubricate the bushings with GE 661 or Dow 111 silicone grease if necessary.

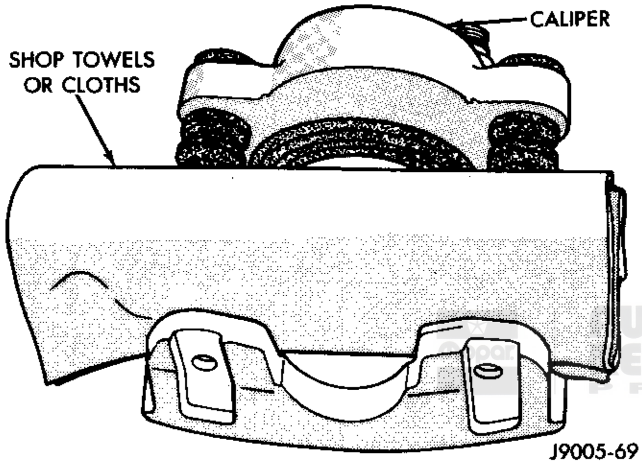


Fig. 12 Padding Caliper Interior

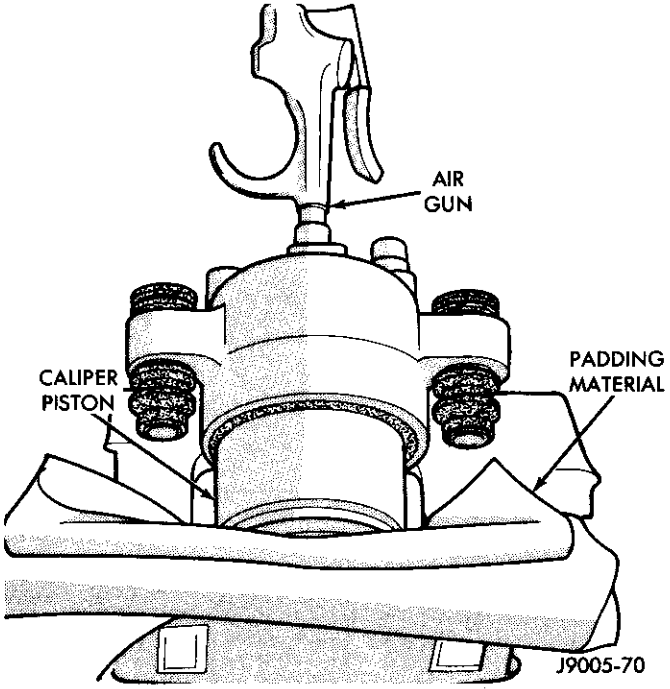


Fig. 13 Removing Caliper Piston

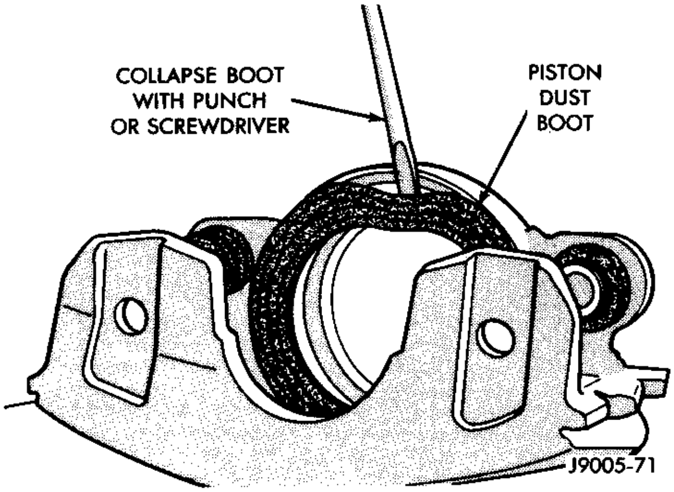


Fig. 14 Removing Caliper Piston Dust Boot

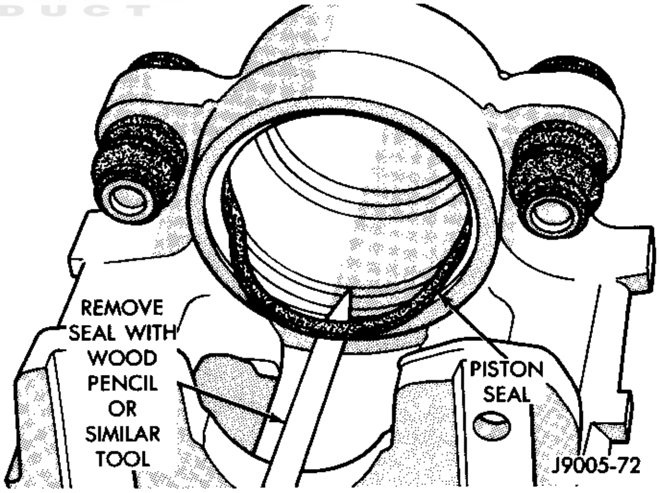


Fig. 15 Removing Caliper Piston Seal

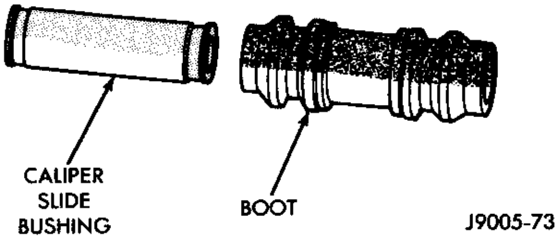


Fig. 16 Caliper Slide Bushing And Boot

Caliper Assembly

(1) Coat caliper piston bore, new piston seal and piston with clean, fresh brake fluid.

(2) Lubricate caliper slide bushings and interior of bushing boots with GE 661 or Dow 111 silicone grease.

(3) Install bushing boots in caliper first. Then insert bushing into boot and push bushing into place (Fig. 17).

(4) Install new piston seal in caliper bore. Press seal into seal groove with finger (Fig. 18).

(5) Install dust boot on caliper piston (Fig. 19). Slide boot over piston and seat boot in piston groove.

(6) Start caliper piston in bore by hand (Fig. 20). Use a turn and push motion to work piston into seal. Once piston is started in seal, press piston **only part way** into bore.

(7) Apply light coat of GE 661 or Dow 111 silicone grease to indicated areas (circumference) of piston and caliper boot groove (Fig. 21). Grease acts as corrosion protection for these areas.

(8) Press caliper piston to bottom of bore.

(9) Seat dust boot in caliper with installer tool C-4842 and tool handle C-4171 (Fig. 22).

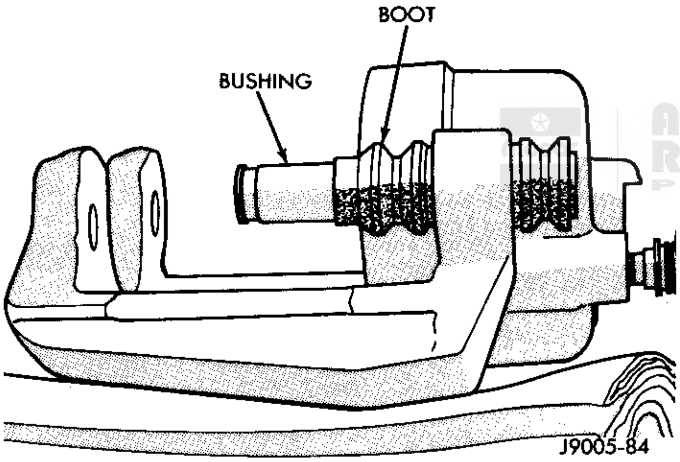


Fig. 17 Installing Slide Bushings And Boots

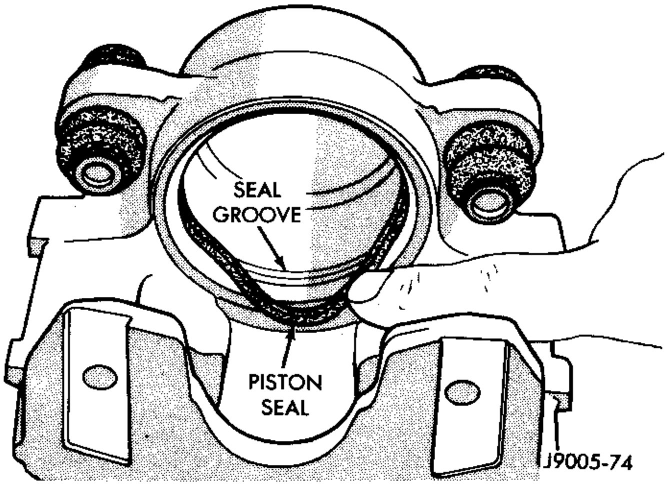


Fig. 18 Installing Piston Seal

(10) Install caliper bleed screw if removed.

Caliper Installation

(1) Install brakeshoes in caliper (Figs. 9, 10).

(2) Connect brake hose fitting to caliper but do not tighten fitting bolt completely at this time. **Be sure to use new washers on fitting bolt to avoid leaks (Fig. 23).**

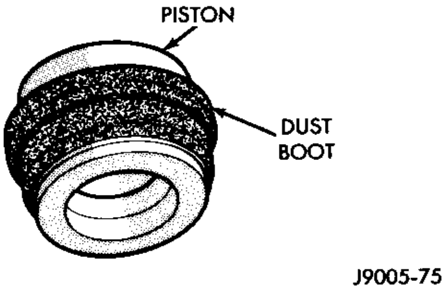


Fig. 19 Installing Dust Boot On Piston

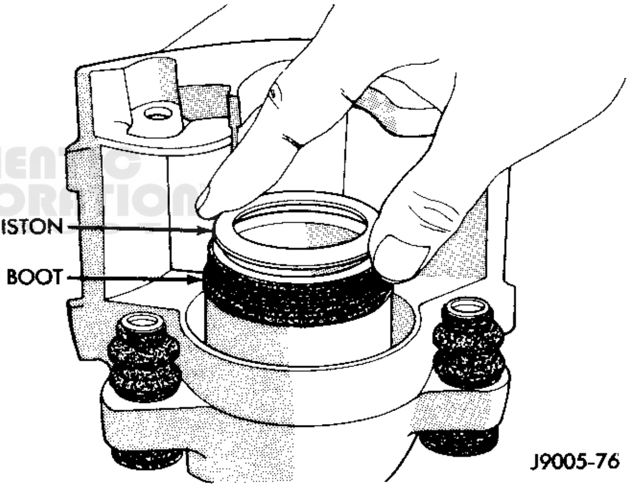


Fig. 20 Installing Caliper Piston

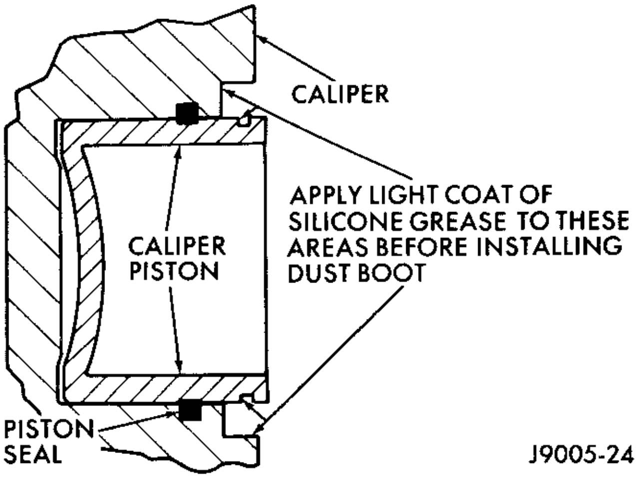


Fig. 21 Caliper And Piston Areas To Be Lightly Coated With Silicone Grease

(3) Install caliper. Position mounting notches at lower end of brakeshoes on bottom mounting ledge (Fig. 11). Then rotate caliper over rotor and seat notches at upper end of shoes on mounting ledge (Fig. 11).

(4) Coat caliper slide pins with GE 661 or Dow 111 silicone grease. Then install and tighten pins to 10-20 N•m (7-15 ft-lbs) torque.

(5) Position front brake hose clear of all chassis components and tighten caliper fitting bolt to 31 N•m (23 ft-lbs) torque.

(6) Install wheels. Tighten lug nuts to 102 N•m (75 ft-lbs) torque.

(7) Bleed brake system. Refer to procedures in Service And Adjustments section.

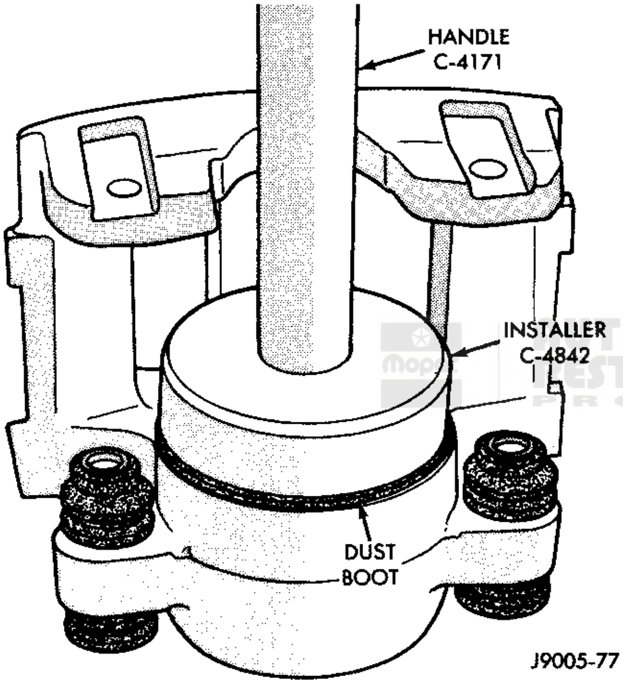


Fig. 22 Seating Dust Boot In Caliper

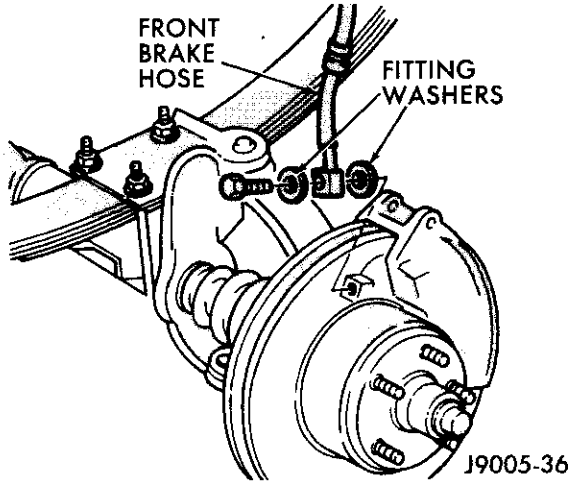


Fig. 23 Front Brake Hose And Fitting Components

DISC BRAKESHOE REPLACEMENT—TWO WHEEL DRIVE—XJ/MJ

Brakeshoe Removal

(1) Partially drain master cylinder reservoirs with suction gun. Do not drain reservoirs completely.

(2) Loosen wheel lug nuts and raise vehicle front end.

(3) Press caliper piston to bottom of piston bore with C-clamp (Fig. 1).

(4) Remove caliper slide pins (Fig. 2).

(5) Remove caliper from support bracket (Fig. 3).

(6) Support caliper on box or suspend caliper from body or suspension component with wire. Do not allow brake hose to support caliper weight.

(7) Hold lower anti-rattle clip against support bracket and remove outboard brake shoe (Fig. 4).

(8) Remove inboard brakeshoe and both anti-rattle clips (Fig. 5).

(9) Wipe caliper off with shop towel only. **Do not use compressed air to remove dirt from caliper exte-**

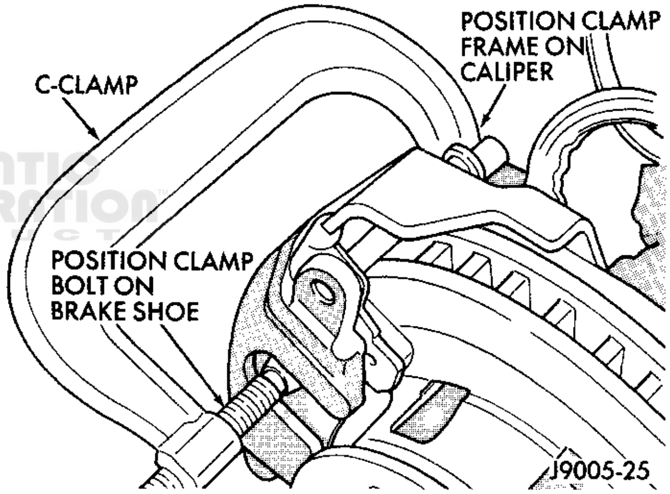


Fig. 1 Bottoming Caliper Piston With C-Clamp—Typical

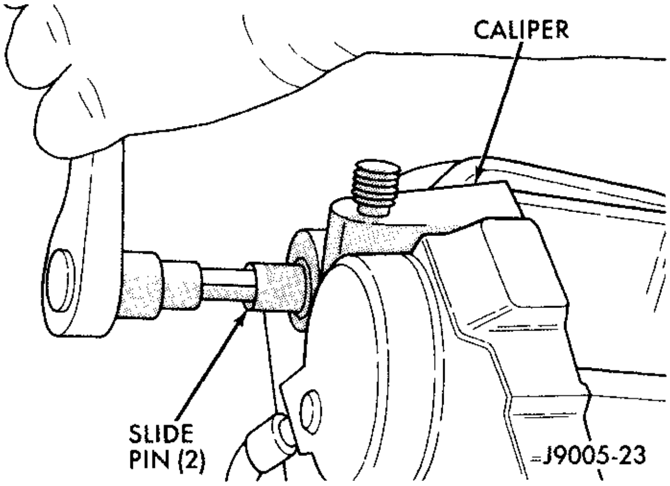


Fig. 2 Removing Caliper Slide Pins

rior. This could unseat the caliper dust boot or force grit into the piston bore.

(10) Inspect the caliper. If leakage is evident, remove and overhaul the caliper.

Brakeshoe Installation

(1) Clean slide surfaces of caliper and support bracket with wire brush and emery cloth (Fig. 6).

(2) Lubricate caliper and bracket slide surfaces wit chassis grease (Fig. 6).

(3) Install anti-rattle clip on trailing end of suppor bracket. Split end of clip faces away from rotor (Fig. 5).

(4) Install inboard brakeshoe (Fig. 5). Be sure shoe is engaged in anti-rattle clip and support bracket.

(5) Install outboard brakeshoe (Fig. 4). Be sure shoe is engaged in clip and support bracket.

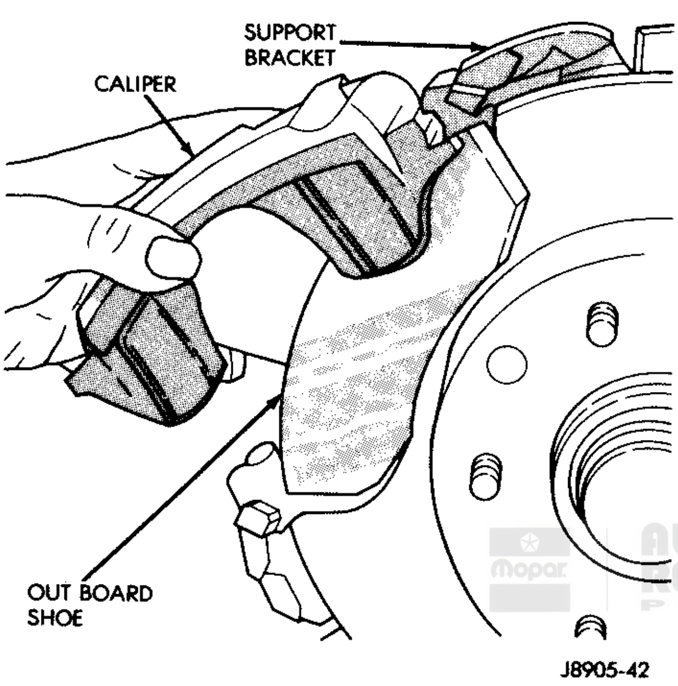


Fig. 3 Removing Caliper From Support Bracket

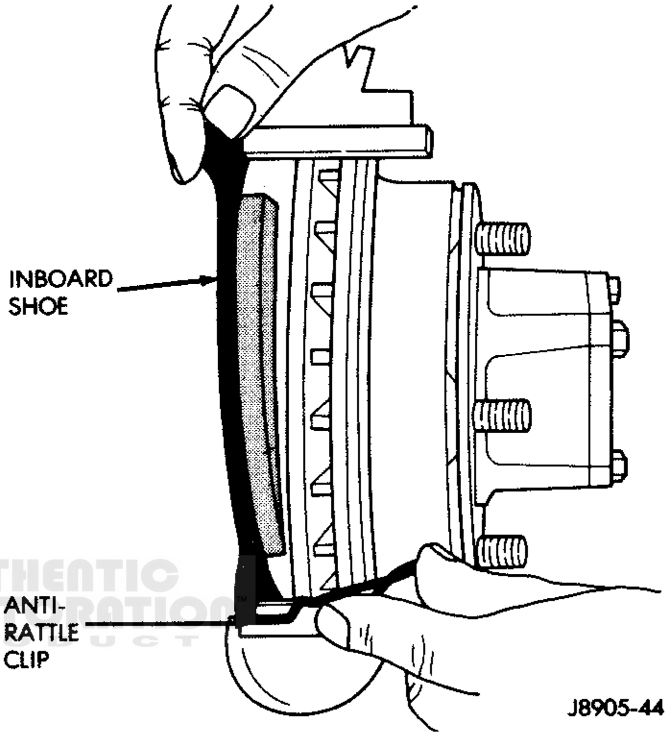


Fig. 5 Removing Inboard Brakeshoe

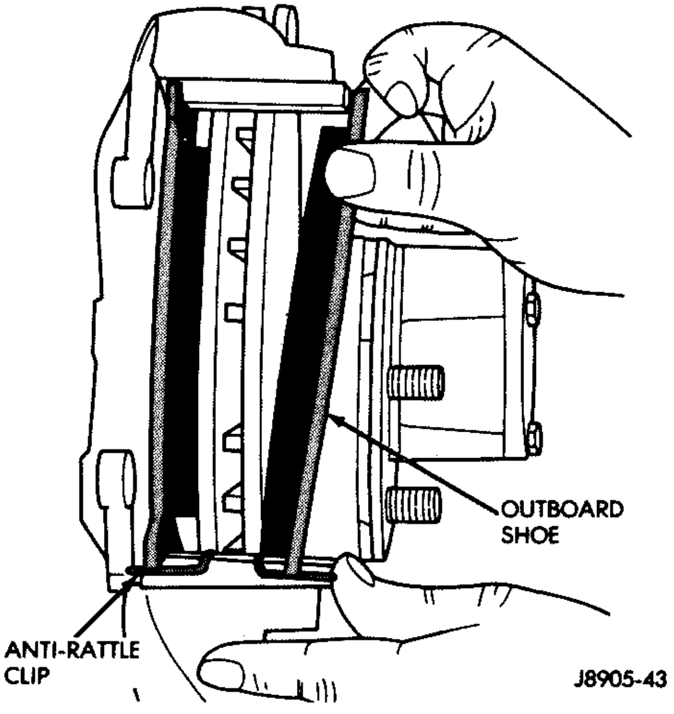


Fig. 4 Removing Outboard Brakeshoe

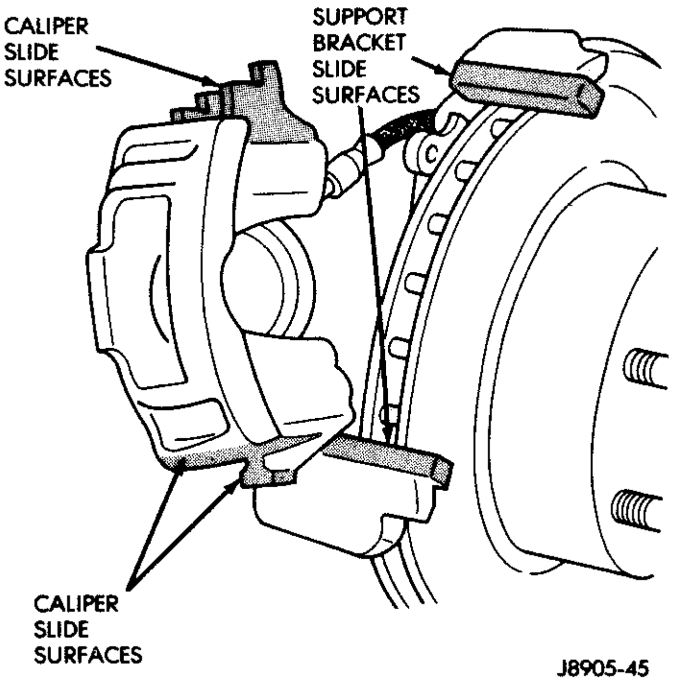


Fig. 6 Clean And Lubricate Slide Surfaces

(6) Install remaining anti-rattle clip.

(7) Install caliper in support bracket.

CAUTION: Before securing the caliper, be sure the caliper brake hose is not twisted, kinked or touching any chassis components.

(8) Install and tighten caliper slide pins (Fig. 2). Tighten pins to 30 ft-lbs (41 N•m) torque.

(9) Install wheels and lower vehicle.

(10) Pump brake pedal until caliper pistons and brakeshoes are seated.

(11) Top off master cylinder fluid level if necessary.

CALIPER OVERHAUL—TWO WHEEL DRIVE—XJ/MJ

Caliper Removal

(1) Raise vehicle and remove front wheels.

(2) Remove caliper slide pins (Fig. 2).

(3) Remove caliper from support bracket.

(4) Press brake pedal just enough to move caliper piston part way out of bore.

(5) Remove brake line bolt and remove brakeline (Fig. 7). Retain bolt but discard washers which are not reusable.

Caliper Disassembly

(1) Pad interior of caliper with shop towels to protect piston during removal (Fig. 8).

(2) Remove caliper piston with low pressure compressed air (Fig. 8). **Use only enough air pressure to ease piston out of bore. Do not blow piston out of bore.**

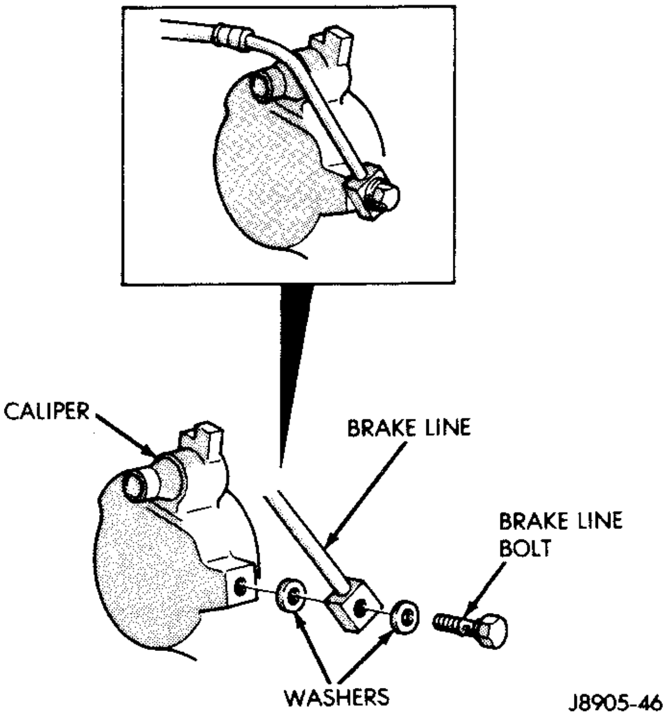


Fig. 7 Caliper Brakeline Connection

(3) Remove and discard piston seal and dust boot (Fig. 9).

(4) Remove caliper inner and outer bushings (Fig. 9).

(5) Replace mounting pins and bushings (Fig. 9) if corroded or damaged.

(6) Remove caliper bleed screw and cap (Fig. 9).

Cleaning And Inspection

Replace the caliper piston if damaged or corroded. Also replace the caliper if the piston bore is damaged or corroded.

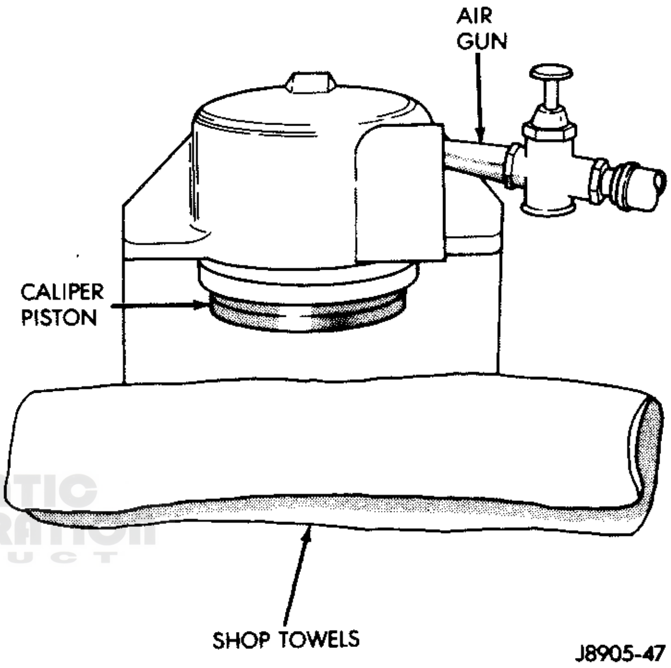


Fig. 8 Removing Caliper Piston

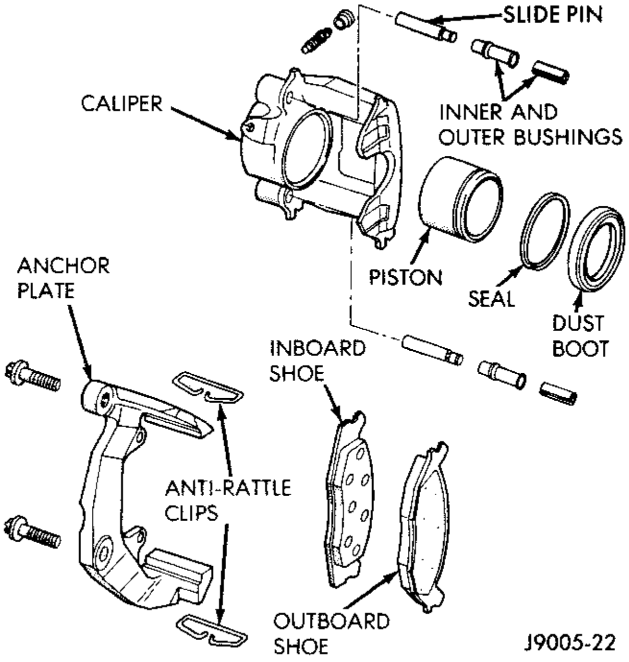


Fig. 9 Caliper Components—2WD

CAUTION: Do not attempt to restore a damaged bore by honing. If the caliper bore is corroded or scored, replace the caliper. Also do not use any type of abrasive on the piston. Abrasives will ruin the piston plating and cause it to corrode and bind. Replace the piston and/or caliper if damaged in any way.

Caliper Assembly

(1) Coat caliper piston bore, piston and new piston seal with brake fluid.

(2) Install new seal in piston bore groove by hand. Do not use any tools to install seal.

(3) Apply light coat of GE 661 or Dow 111 silicone grease to indicated areas (circumference) of piston and caliper boot groove (Fig. 10). Grease acts as corrosion protection for coated areas.

(4) Slide metal retainer part of new dust boot over open end of piston (Fig. 11).

(5) Pull retainer rearward until boot lip seats in groove at open end of piston (Fig. 11).

(6) Push metal retainer part of boot forward until flush with rim at open end of piston. Then snap boot folds in place (Fig. 12).

(7) Install piston in caliper bore with a twisting motion. **Do not unseat the piston seal during installation.**

(8) Press piston to bottom of bore.

(9) Seat metal retainer part of dust boot in caliper (Fig. 13).

(10) Install bleeder screw and cap.

(11) Install new inner and outer bushings in caliper (Fig. 9).

Caliper Installation

(1) Lubricate slide surfaces of caliper with Mopar multi purpose grease (Fig. 6).

(2) Clean support plate slide surfaces with wire brush and coat with Mopar multi purpose grease.

(3) Install caliper.

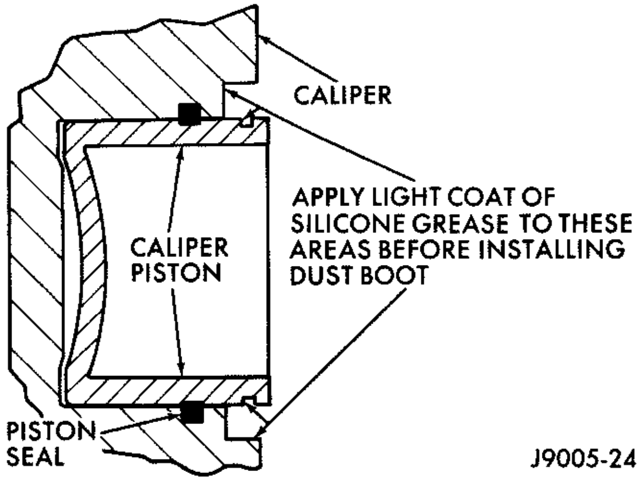


Fig. 10 Caliper And Piston Areas To Be Coated With Silicone Grease

(4) Install and tighten caliper slide pins to 30 ft-lbs (N•m) torque.

(5) Connect brakeline to caliper (Fig.7). **To avoi leaks, use new washers only to secure line fitting**

(6) Tighten brakeline fitting bolt to 23 ft-lbs (31 N•m torque.

CAUTION: Be sure to position the caliper brakeline away from all suspension components before tightening the brakeline bolt (Fig. 14).

(7) Install wheel and lower vehicle.

(8) Apply brakes several times to seat caliper pistons.

(9) Top off master cylinder fluid level with Mopar brake fluid.

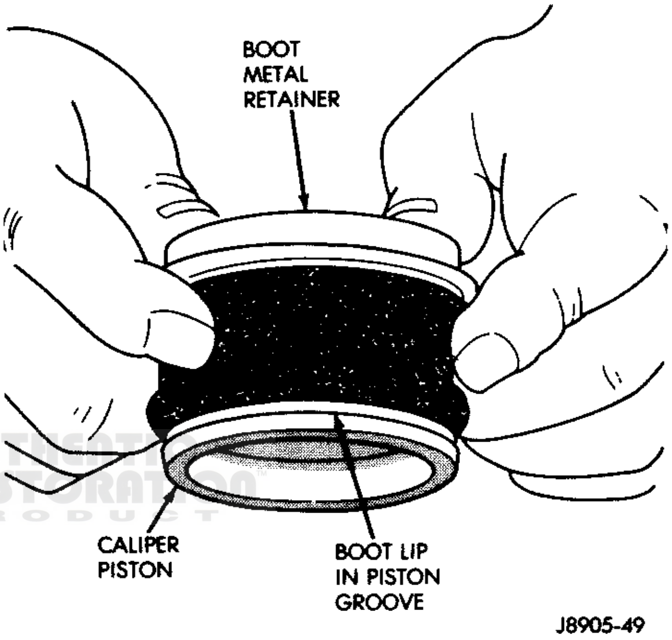


Fig. 11 Installing Dust Boot On Piston

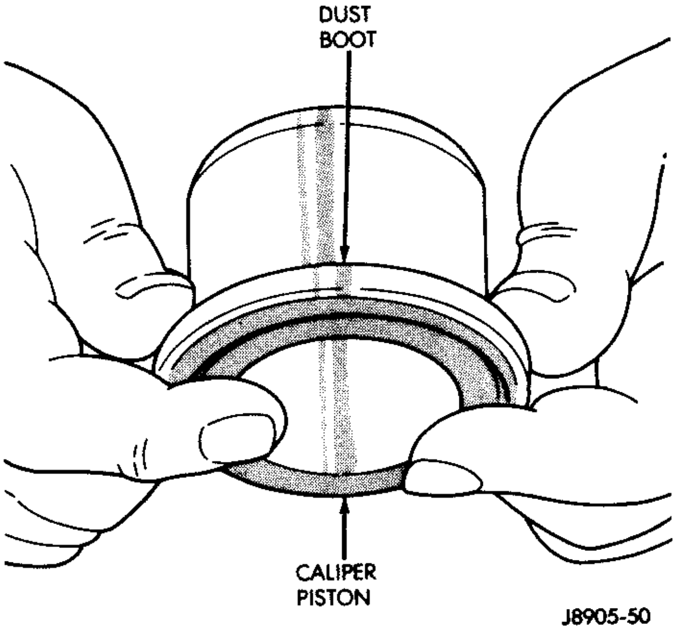


Fig. 12 Snapping Dust Boot Folds In Place

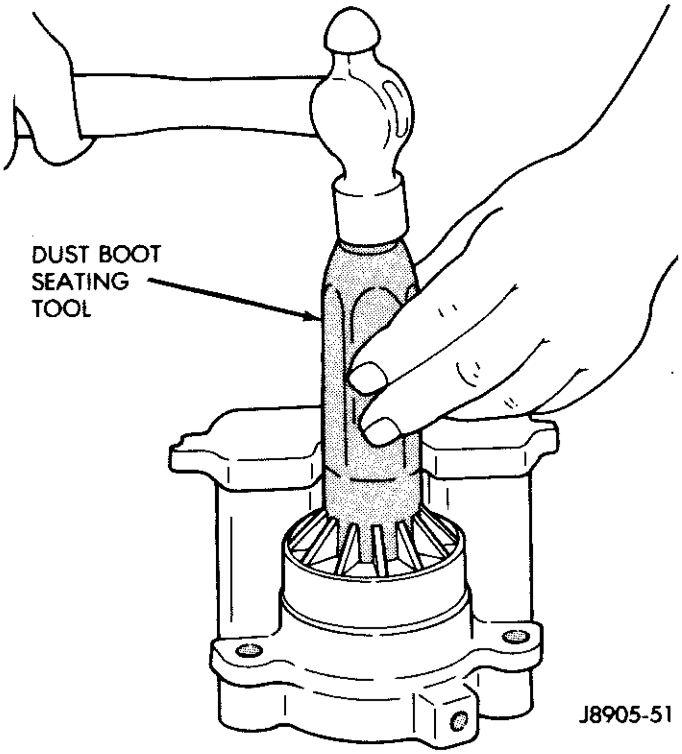


Fig. 13 Seating Piston Dust Boot

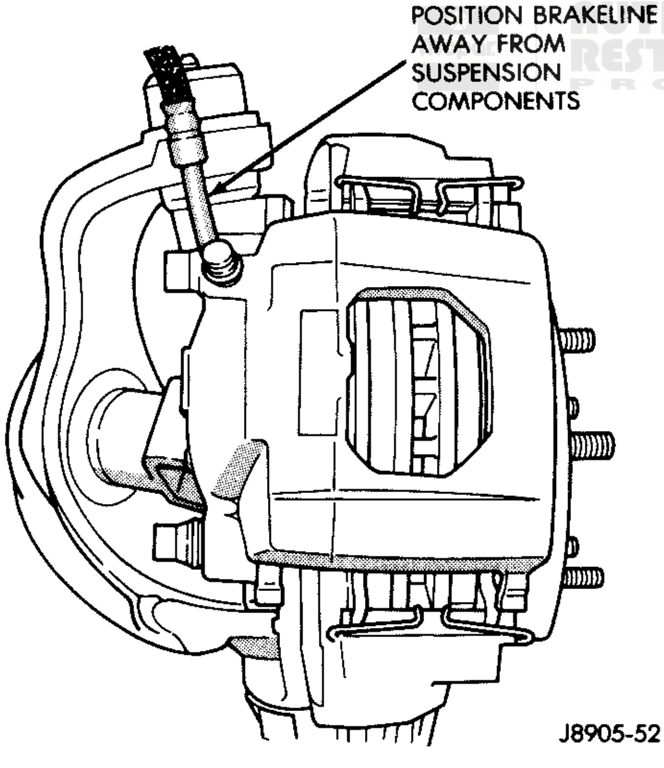


Fig. 14 Caliper Brakeline Position

DISC BRAKESHOE REPLACEMENT—SJ MODELS

Brakeshoe Removal

(1) Drain small amount of fluid from master cylinder front reservoir with suction gun.

(2) Raise vehicle and remove front wheels.

(3) Bottom caliper piston with C-clamp (Fig. 1).

(4) Remove caliper slide pins (Fig. 2).

(5) Lift caliper off rotor and support bracket (Fig. 3).

(6) Remove brakeshoes and inboard shoe retaining clip (Fig. 3).

(7) Suspend caliper from spring or other suspension component with wire. Do not allow brake hose to support caliper weight.

(8) Remove caliper mounting bushings, seals and O-rings (Fig. 4).

(9) Inspect caliper slide pins (Fig. 4). **Replace pins if scored, corroded, or damaged. Do not attempt to clean or polish pins. Protective plating on pins is easily damaged by abrasives.**

(10) Wipe caliper interior clean with shop towels. **Do not use compressed air. Air pressure can unseat the dust boot making complete disassembly necessary.**

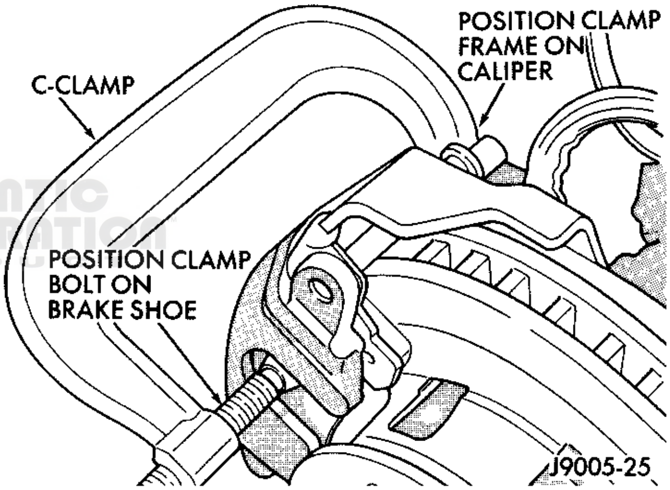


Fig. 1 Bottoming Caliper Piston With C-Clamp—Typical

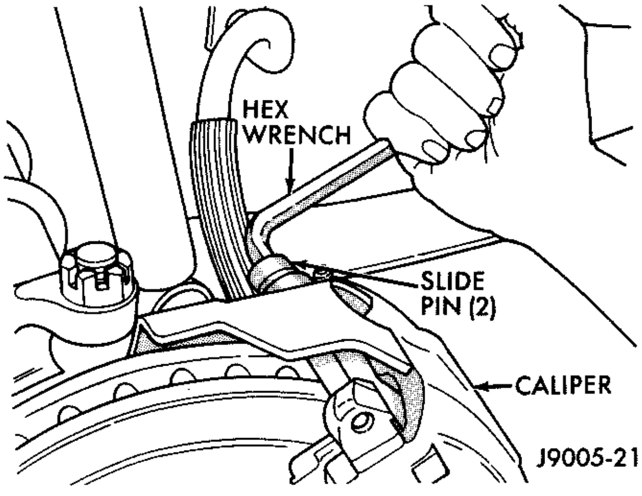


Fig. 2 Removing/Installing Caliper Slide Pins

(11) Check caliper piston dust boot for cuts or tears. If boot is damaged, or evidence of leakage is noted, overhaul caliper.

Brakeshoe Installation

(1) Lubricate caliper mounting bolts, bushings, seals and seal rings with Mopar silicone lubricant.

(2) Install mounting components in caliper (Fig. 4). Bushings go in inboard mounting ears.

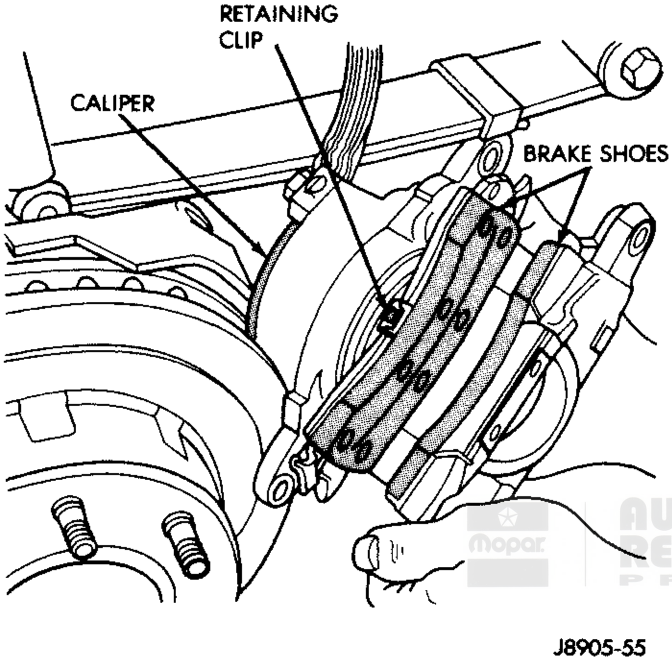


Fig. 3 Caliper And Brakeshoes

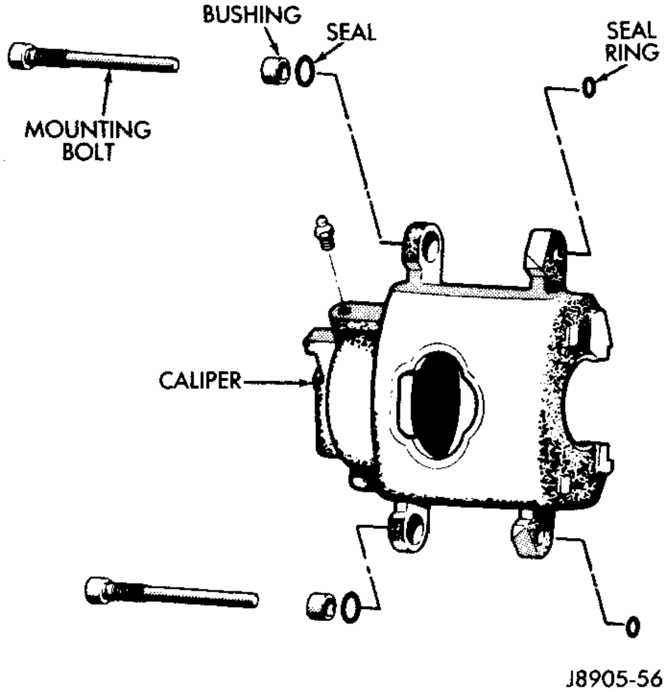


Fig. 4 Caliper Mounting Components

(3) Install retaining clip on inboard brakeshoe (l 5).

(4) Install inboard shoe and clip in caliper. Press taining clip into piston until it snaps into place (Fig.

(5) Install outboard shoe in caliper (Fig. 3). Crin shoe flanges to caliper with channel-lock type pliers

(6) Install caliper.

CAUTION: Before securing caliper, be sure calipe brake hose is not twisted, kinked, or touching an chassis components.

(7) Apply light coat of silicone grease to slide pins. Then install and tighten pins to 35 ft-lbs (47 N•m) torque.

(8) Lower vehicle.

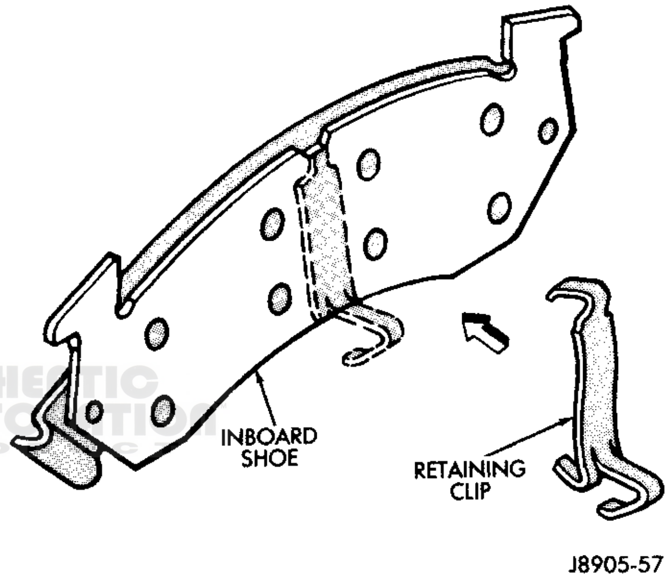


Fig. 5 Installing Inboard Shoe Retaining Clip

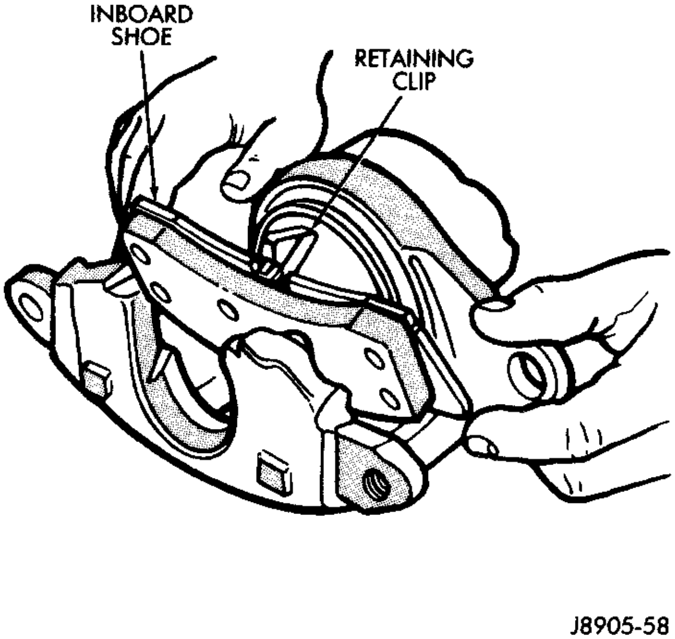


Fig. 6 Installing Inboard Shoe

(9) Apply brakes several times to seat brakeshoes.
(10) Top off master cylinder fluid level.

CALIPER OVERHAUL—SJ MODELS

Caliper Removal

(1) Drain about half the fluid from the master cylinder front reservoir with a suction gun.
(2) Raise vehicle and remove front wheels.
(3) Bottom caliper piston with C-clamp (Fig. 1).
(4) Remove caliper slide pins (Fig. 2).
(5) Lift caliper off rotor and support bracket (Fig. 3).
(6) Remove brakeshoes and inboard shoe retaining clip (Fig. 3).
(7) Remove caliper.
(8) Disconnect brake hose at caliper.

Caliper Disassembly

(1) Drain the caliper.
(2) Pad caliper interior with shop towels (Fig. 7).
(3) Remove caliper piston with one or two **short bursts** of low pressure compressed air. Direct air through fluid inlet port and ease piston out of bore (Fig. 7).

CAUTION: Do not blow the piston out of the bore with sustained air pressure. This could result in a cracked piston. Use only enough air pressure to ease the piston out. In addition, never attempt to catch the piston as it leaves the bore. This could result in personal injury.

(4) Remove piston dust boot with a screwdriver (Fig. 8).

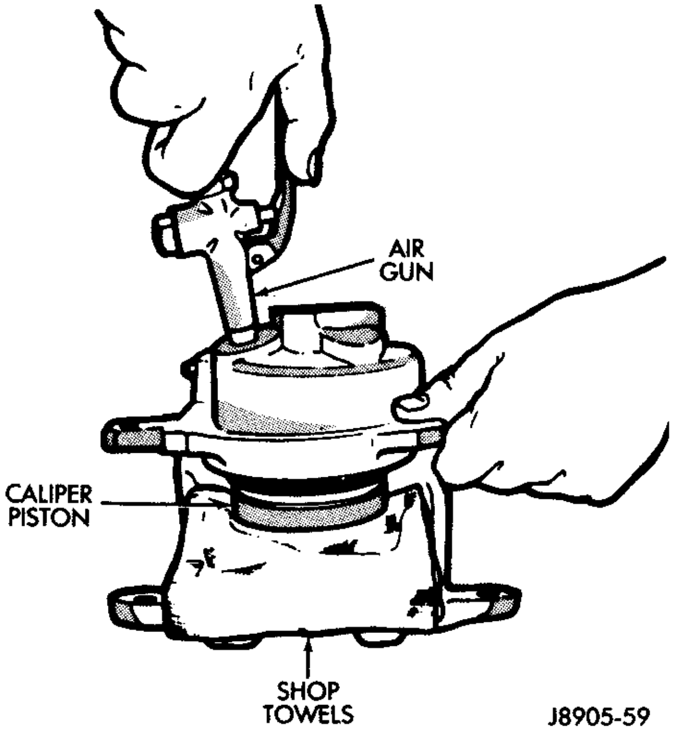


Fig. 7 Removing Caliper Piston

(5) Remove piston seal from caliper bore (Fig. 9)

Cleaning And Inspection

Clean the caliper and piston with Mopar brake cleaner or fresh brake fluid only. Dry the parts with compressed air.

Replace the caliper piston if damaged or corroded and replace the caliper if the piston bore is damaged or corroded, or the caliper itself is damaged.

CAUTION: Do not attempt to restore a damaged bore by honing. If the caliper bore is corroded or scored, replace the caliper. Do not use any type of abrasive on the piston. Abrasives will ruin the piston plating and cause it to corrode and bind. Replace the piston if damaged in any way.

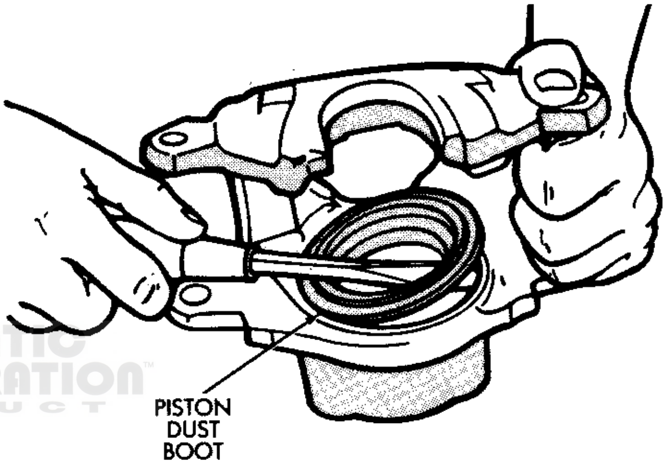


Fig. 8 Removing Caliper Piston Dust Boot

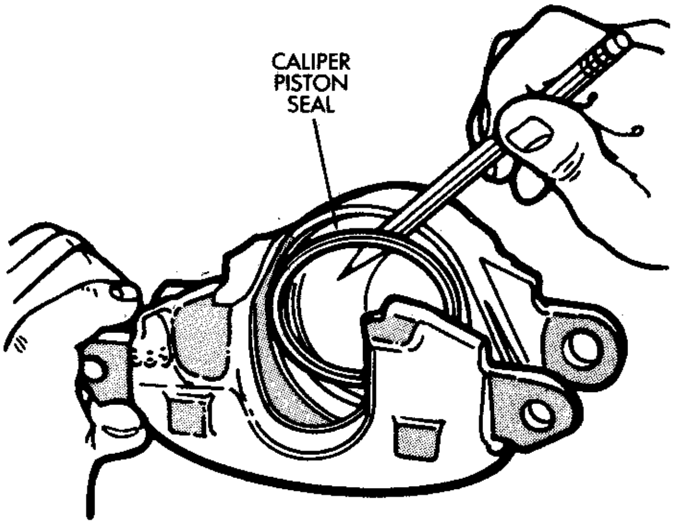


Fig. 9 Removing Caliper Piston Seal

Caliper Assembly

(1) Coat caliper bore, piston and seal with brake fluid.

(2) Install new seal in caliper bore. Be sure seal is fully seated in bore groove.

(3) Apply light coat of GE 661 or Dow 111 silicone grease to indicated areas (circumference) of piston and caliper boot groove (Fig. 10). Grease acts as corrosion protection for coated areas.

(4) Slide metal retainer part of boot over open end of piston. Then pull boot rearward until boot lip seats in piston groove (Fig. 11).

(5) Push metal retainer part of boot forward until flush with end of piston (Fig. 12). Be sure rubber boot folds into position as shown.

(6) Start piston in bore and through seal with a twisting motion.Use hammer handle or wood dowel to bottom piston in bore.

(7) Seat metal retainer part of dust boot in calipei (Fig. 13).

(8) Install caliper bleed screw.

Caliper Installation

(1) Install brakeshoes in caliper (Fig. 3).

(2) Connect but do not tighten caliper brake hose.

(3) Install caliper.

(4) Install and tighten caliper slide pins to 35 ft-lbs (47 N•m) torque.

(5) Position caliper brake hose so it is clear of all chassis components then tighten hose fitting.

(6) Fill master cylinder and bleed brakes.

(7) Install wheels.

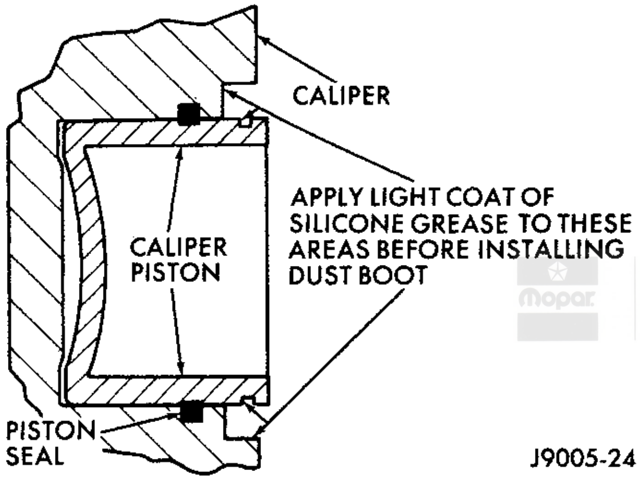


Fig. 10 Caliper And Piston Areas To Be Coated With Silicone Grease

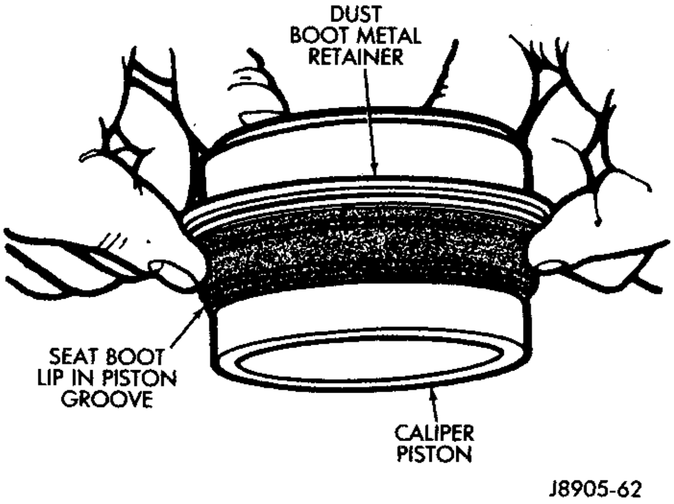


Fig. 11 Installing Piston Dust Boot

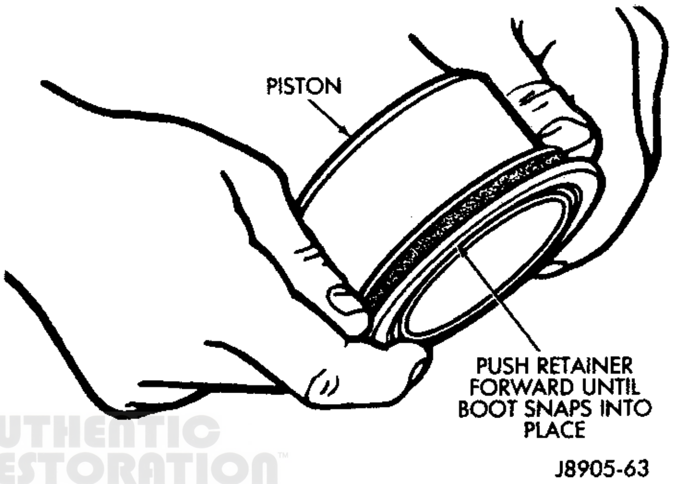


Fig. 12 Snap Dust Boot Folds Into Place

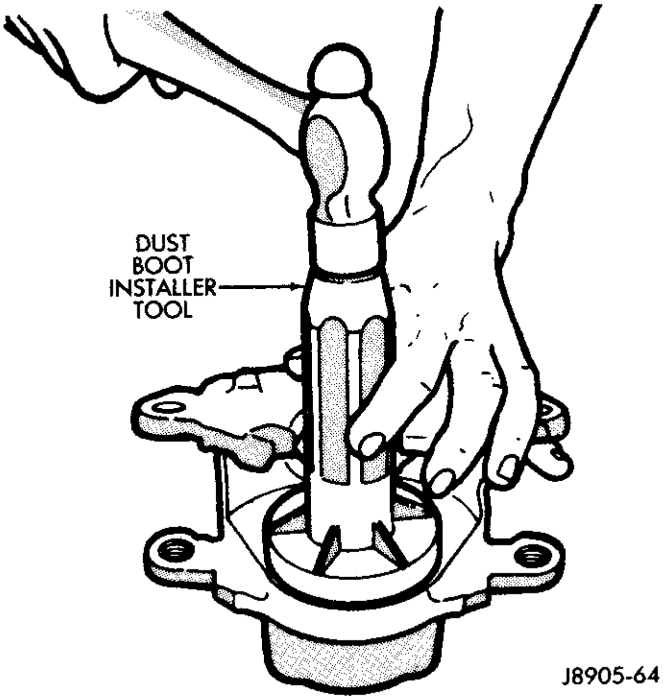


Fig. 13 Seating Dust Boot In Caliper

DISC BRAKE ROTOR SERVICE-ALL

Rotor Removal-Two Wheel Drive—XJ/MJ

(1) Raise vehicle and remove wheels.

(2) Remove the caliper.

(3) Remove grease cap (Fig. 1).

(4) Remove cotter pin and nut retainer (Fig. 1).

(5) Remove nut lock, bearing nut and front bearing (Fig. 1).

(6) Remove rotor from spindle (Fig. 1).

(7) Remove grease seal and rear bearing (Fig. 1).

(8) Remove rotor shield if necessary.

Rotor Installation-Two Wheel Drive—XJ/MJ

(1) Clean and repack bearings with Mopar or equivalent wheel bearing grease. Then coat spindle, bearing races and rotor hub cavity with bearing grease.

(2) Install rear bearing and new grease seal in rotor.

(3) Install rotor on spindle.

(4) Install front bearing, washer and bearing nut.

(5) Install the wheel.

(6) Tighten bearing nut to 17-25 ft-lbs (23-34 N•m) torque while rotating the wheel. Then loosen bearing nut 1/2 turn and retighten to 19 in-lbs (2 N•m) torque.

(7) Install nut lock and new cotter pin.

(8) Cover interior of grease cap with bearing grease and install it in rotor hub.

(9) Remove wheel.

(10) Install caliper and reinstall wheel.

(11) Lower vehicle.

Rotor Removal-Four Wheel Drive—XJ/MJ/YJ

(1) Raise vehicle and remove wheel.

(2) Remove caliper.

(3) Remove retainers securing rotor to hub studs (Fig. 2).

(4) Remove rotor from hub (Fig. 2).

(5) If rotor shield requires service, remove front hub and bearing assembly.

Rotor Installation-Four Wheel Drive—XJ/MJ/YJ

(1) Install rotor on hub.

(2) Install caliper.

(3) Install new spring nuts on wheel studs.

(4) Install wheel and lower vehicle.

Rotor Removal—SJ

(1) Raise vehicle and remove wheel.

(2) Remove caliper.

(3) Remove hub cap and snap ring (Fig. 3).

(4) Remove drive gear, pressure spring and spring cup (Fig. 3).

(5) Remove outer nut, nut washer and inner nut (Fig. 3).

(6) Remove rotor.

(7) Remove grease seal and rear bearing (Fig. 3).

(8) Remove rotor shield if necessary.

Rotor Installation—SJ

(1) Clean and repack bearings with Mopar or equivalent wheel bearing grease.

(2) Apply wheel bearing grease to rotor hub cavity and spindle.

(3) Install rear bearing and new grease seal in rotor.

(4) Install rotor on spindle.

(4) Install inner nut. **The inner nut has a locating peg on one side. Be sure this peg is facing outward.**

(5) Install wheel but do not tighten wheel nuts completely at this time.

(6) Tighten inner nut to 50 ft-lbs (68 N•m) torque while rotating wheel to seat bearings.

(7) Continue rotating wheel and back off inner nut 1/6 turn (45-65 degrees).

(8) Install nut washer and outer nut. **Be sure the locating peg on the inner nut is seated in one of the washer holes before installing the outer nut.**

(9) Tighten outer nut to miminum of 50 ft-lbs (68 N•m) torque.

(10) Install spring cup and pressure spring.

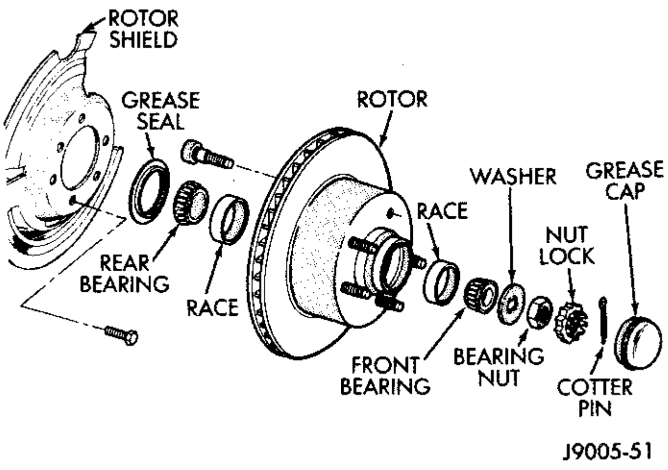


Fig. 1 Two Wheel Drive Rotor And Bearings—XJ/MJ

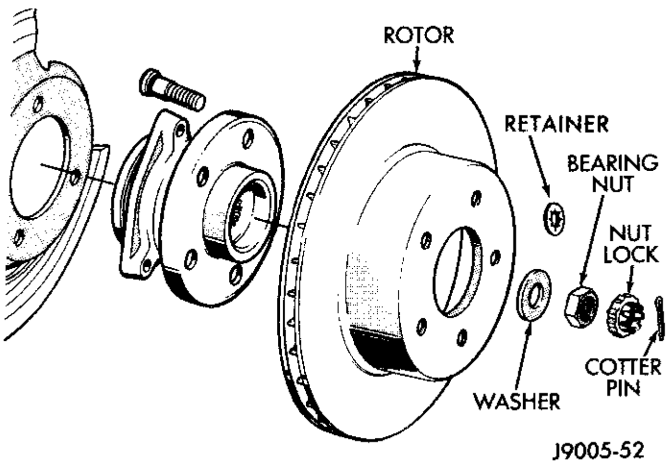


Fig. 2 Four Wheel Drive Rotor And Hub—XJ/MJ/YJ

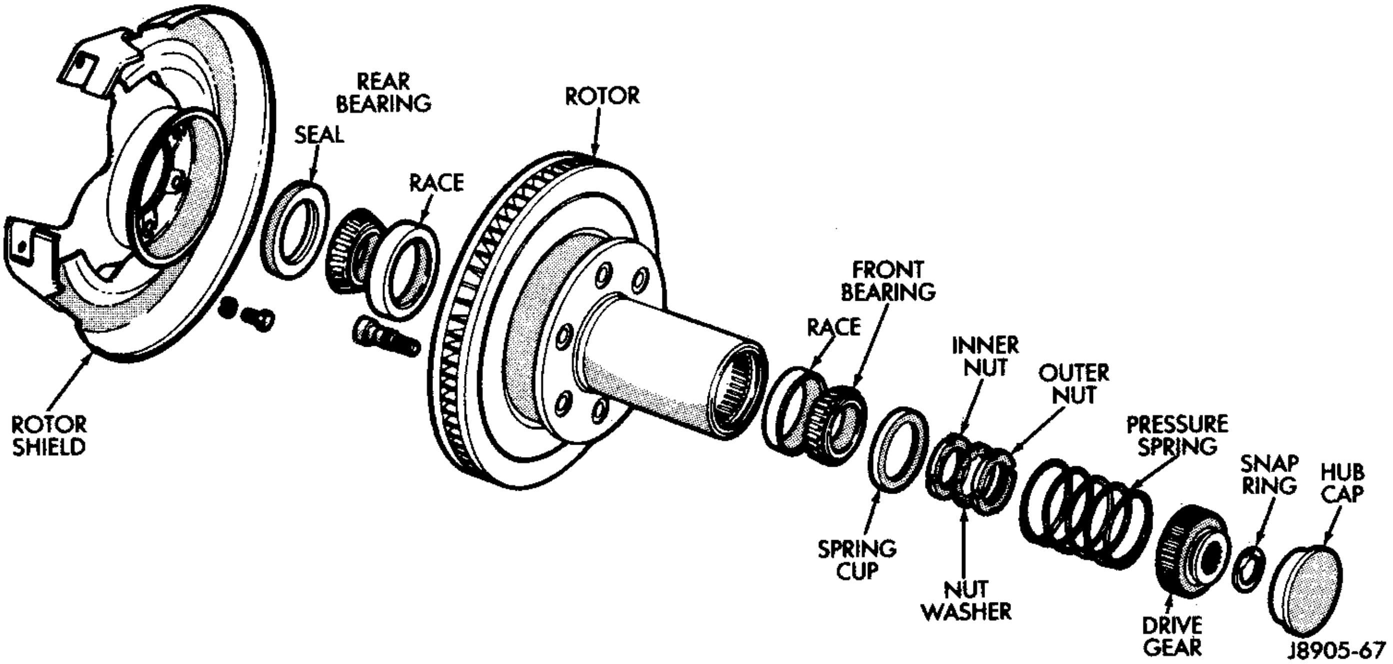


Fig. 3 Rotor And Bearings—SJ

(11) Install drive gear. Then push gear inward and install snap ring.

(12) Remove the wheel.

(13) Install the caliper.

(14) Install the wheel.

(15) Lower the vehicle and tighten the wheel nuts to 75 ft-lbs (102 N•m) torque.

Rotor Inspection

Rotor Thickness

Measure rotor thickness at the center of the brakeshoe contact surface. Replace the rotor if it is worn below minimum thickness, or if refinishing would reduce thickness below the allowable minimum.

Rotor minimum thickness for YJ and four wheel drive XJ/MJ models is 24 mm (.94 in). Minimum rotor thickness for two wheel drive XJ/MJ models is 22 mm (.866 in). Minimum rotor thickness for SJ models is 30.86 mm (1.215 in).

Rotor Runout

Check rotor lateral runout with a dial indicator (Fig. 4). Excessive lateral runout will cause brake pedal pulsation and rapid, uneven wear of the brakeshoes.

Maximum allowable rotor runout for all models is .005 inch (.12 mm).

Rotor Thickness Variation

Variations in rotor thickness will cause pedal pulsation, noise and shudder.

Measure rotor thickness at four to six points around the rotor face. Position the micrometer approximately 3/4 inch from the rotor outer circumference for each measurement (Fig. 5).

Thickness should not **vary** by more than .013 mm (.0005 inch) from point to point on the rotor. Refinish or replace the rotor if necessary.

Rotor Refinishing

Rotor brake surfaces can be refinished by sanding and/or machining in a disc brake lathe. The lathe must be capable of machining both rotor surfaces simultaneously with dual (two) cutter heads (Fig. 6). **Equipment capable of machining only one side at a time**

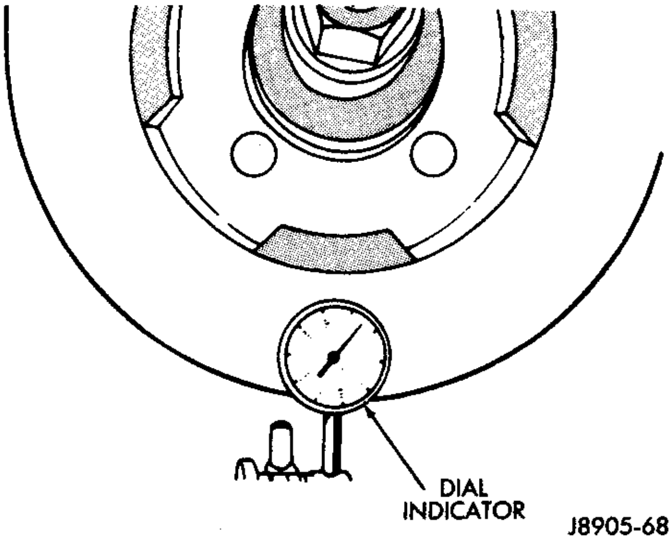


Fig. 4 Checking Rotor Lateral Runout

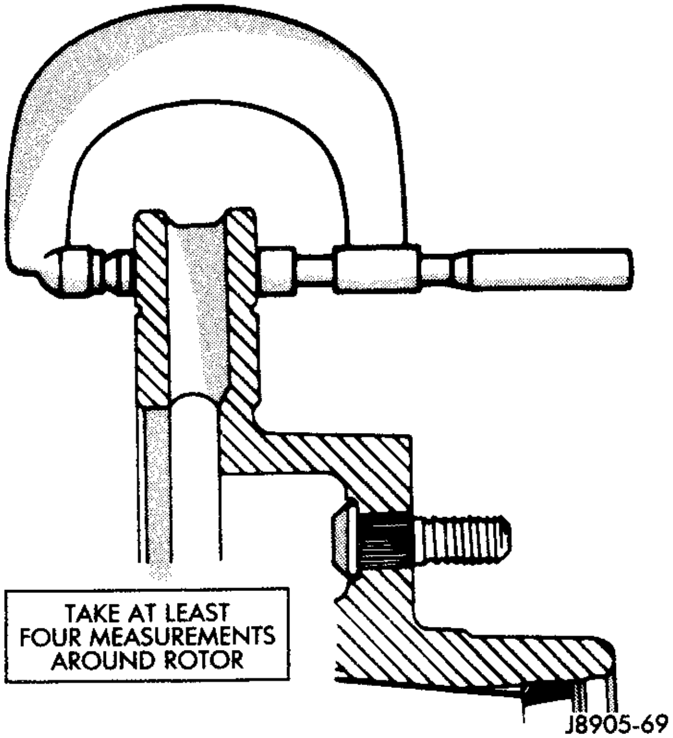


Fig. 5 Measuring Rotor Taper And Thickness Variation

will produce a tapered rotor. The lathe should also be equipped with a grinder attachment or dual sanding discs for final cleanup or light refinishing (Fig. 6).

If the rotor surfaces only need minor cleanup of rust, scale, or minor scoring, use abrasive discs to clean up the rotor surfaces. However, when a rotor is scored or worn, machining with cutting tools will be required.

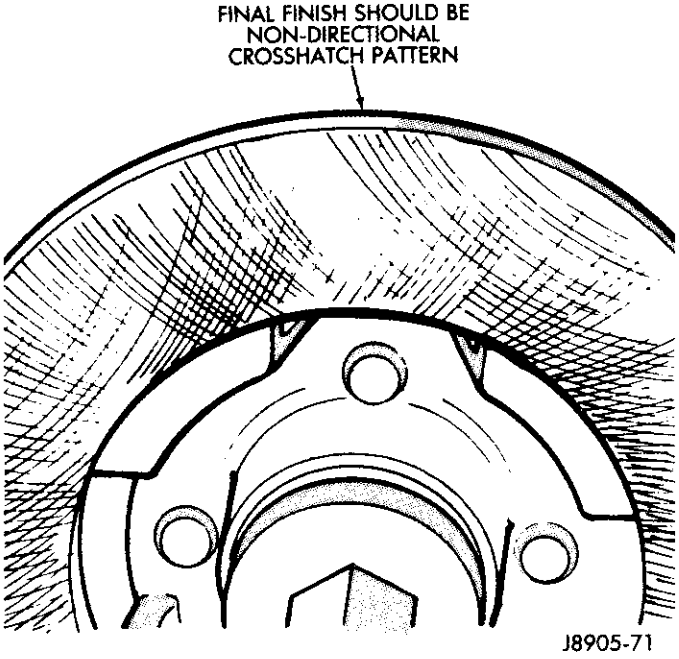


Fig. 7 Correct Final Surface Finish

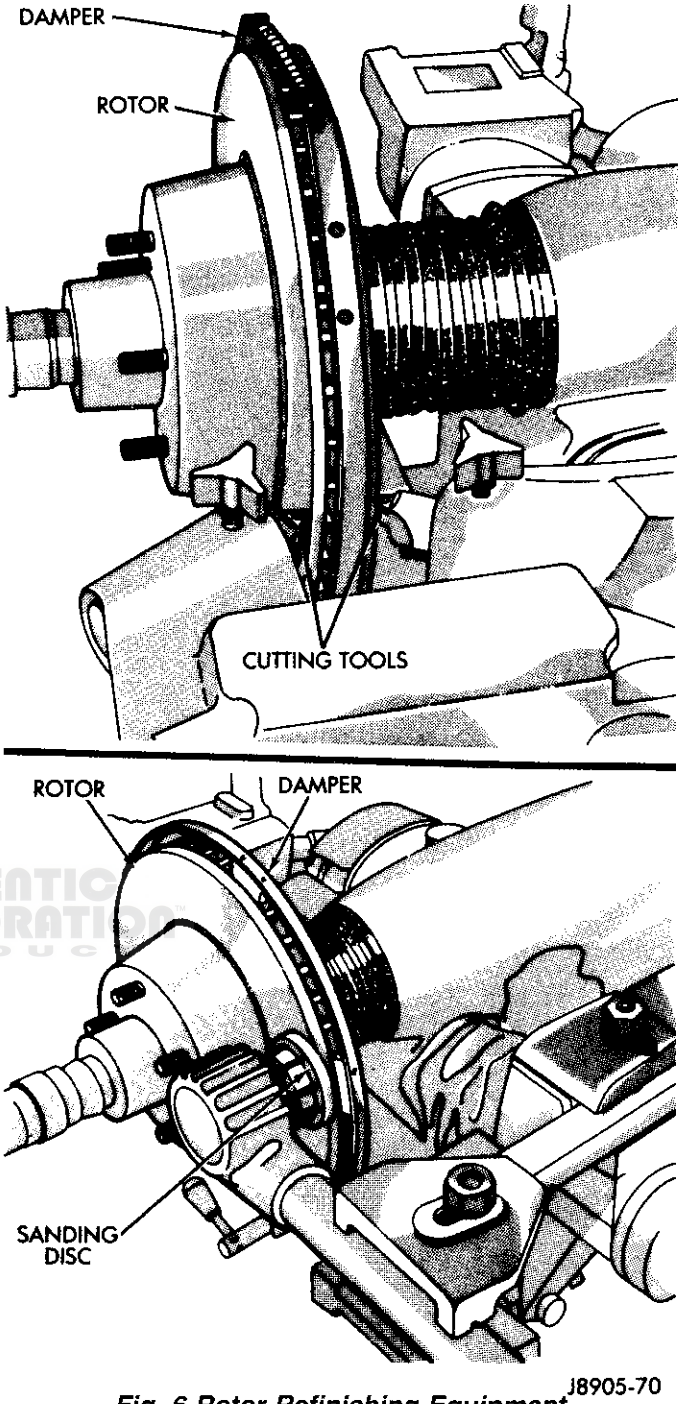


Fig. 6 Rotor Refinishing Equipment

CAUTION: Do not refinish a rotor if machining would cause the rotor to fall below minimum allowable thickness.

The final finish on the rotor should be a non-directional, cross hatch pattern (Fig. 7). Use sanding discs to produce this finish.

DRUM BRAKES

INDEX

DRUM BRAKESHOE REPLACEMENT—XJ/MJ/YJ

Brakeshoe Removal (Figs. 1 and 2)

(1) Raise vehicle and remove rear wheels.

(2) Remove and discard spring nuts securing drums to wheel studs.

(3) Remove brake drums. If drums prove difficult to remove, retract brakeshoes. Remove access plug at the rear of backing plate and back off adjuster screw with brake tool and screwdriver.

(4) Remove U-clip and washer securing adjuster cable to parking brake lever.

(5) Remove primary and secondary return springs from anchor pin with brake spring tool.

(6) Remove holddown springs, retainers and pins.

(7) Install clamps on wheel cylinders to hold pistons in place.

(8) Remove adjuster lever, adjuster screw and spring.

(9) Remove adjuster cable and cable guide.

(10) Remove brakeshoes and parking brake strut.

(11) Disconnect cable from parking brake lever and remove lever.

Brakeshoe Installation

(1) Clean and lubricate anchor pin with Mopar multi purpose grease.

(2) Clean and lubricate support plate shoe contact surfaces with Mopar multi purpose grease (Figs. 3 and 4).

(3) Lubricate ajuster cable guides, adjuster screw and pivot, parking brake lever and lever pivot pin with Mopar multi purpose grease.

(4) Attach parking brake lever to secondary brakeshoe with washer and new U-clip.

(5) Remove wheel cylinder clamps.

(6) Attach parking brake cable to lever.

(7) Install brakeshoes on support or backing plate. Secure shoes with new holddown springs, pins and retainers.

(8) Install parking brake strut and spring.

(9) Install guide plate and adjuster cable on anchor pin.

(10) Install primary and secondary return springs.

(11) Install adjuster cable guide on secondary shoe.

(12) Lubricate and assemble adjuster screw (Fig. 5).

(13) Install adjuster screw, spring and lever and connect to adjuster cable.

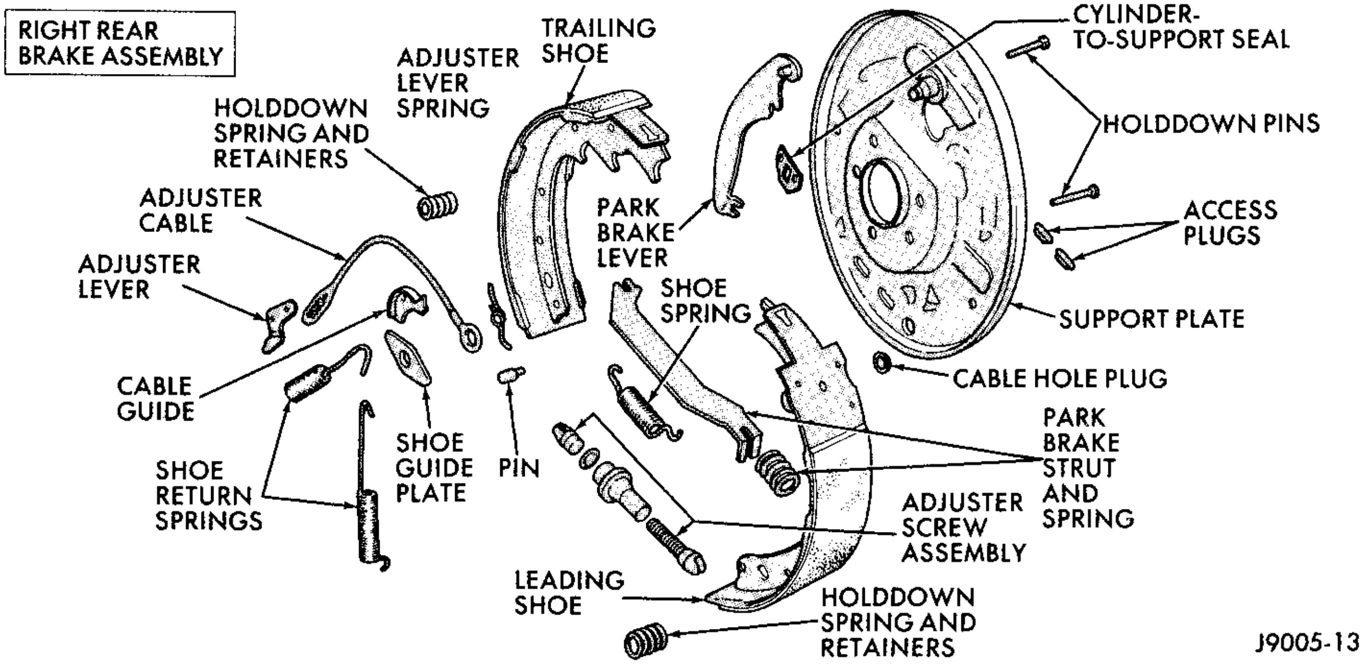


Fig. 1 Nine Inch Drum Brake Components—XJ/MJ/YJ

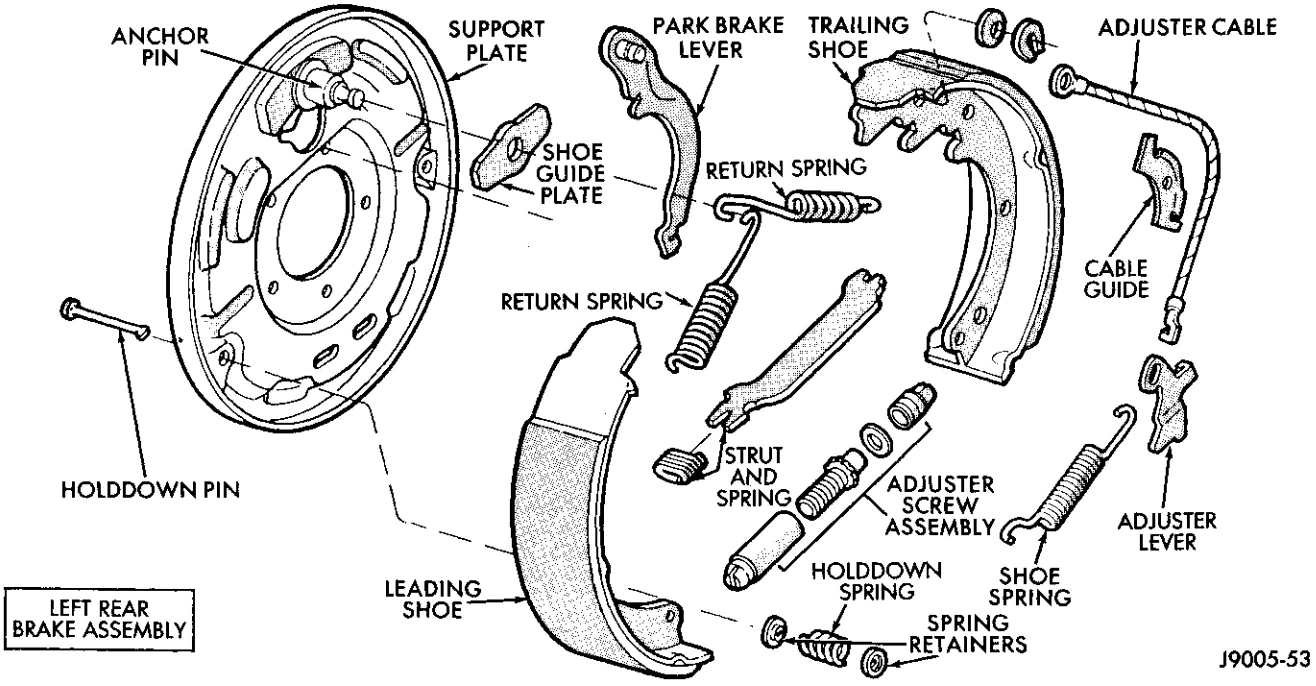


Fig. 2 Ten Inch Drum Brake Components—MJ Metric Ton

(14) Adjust shoes to drum with brake gauge and install brake drum.

DRUM BRAKESHOE REPLACEMENT—SJ MODELS

Brakeshoe Removal

(1) Raise vehicle and remove rear wheels.

(2) Remove brake drums.

(3) Remove shoe return springs (Fig. 6) with brake spring tool.

(4) Remove primary shoe holddown spring, retainers and pin (Fig. 6).

(5) Disconnect shoe spring and remove primary shoe and strut (Fig. 6).

(6) Disconnect parking brake cable from lever.

(7) Remove the secondary brakeshoe, parking brake lever, adjuster lever, actuator lever and spring, adjuster spring and adjuster screw (Fig. 6).

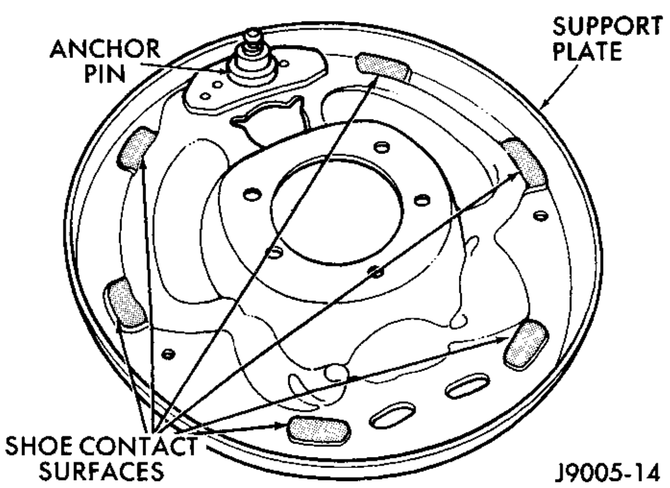


Fig. 3 Shoe Contact Surfaces-9 Inch Brake Support Plate

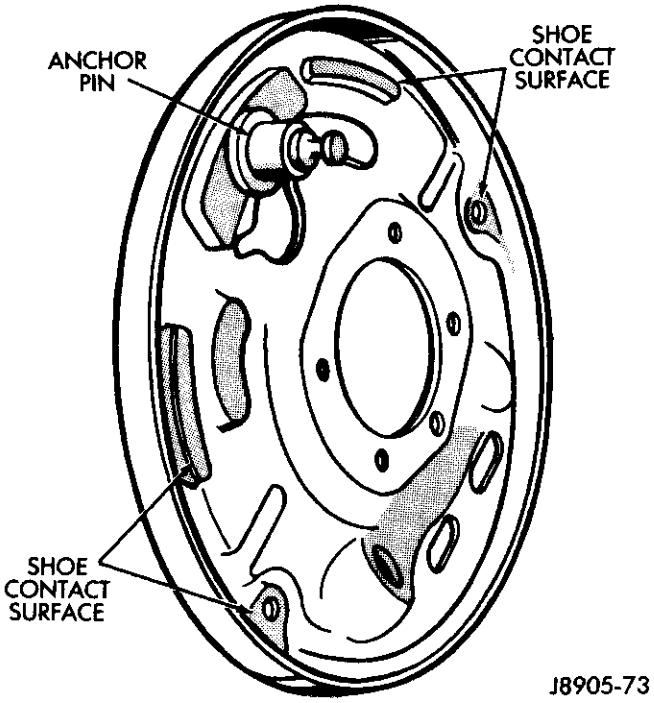


Fig. 4 Shoe Contact Surfaces-10 Inch Brake Support Plate

Brakeshoe Installation

(1) Lubricate the anchor pin and shoe contact surfaces of the backing plate with molydisulphide grease (Fig. 7).

(2) Lubricate adjuster screw threads, adjuster lever pivot points, parking brake lever pin, and actuator lever with lithium grease.

(3) Install parking brake lever on secondary shoe. Attach lever with new C-clip. Pinch clip closed to secure it.

(4) Attach parking brake cable to lever.

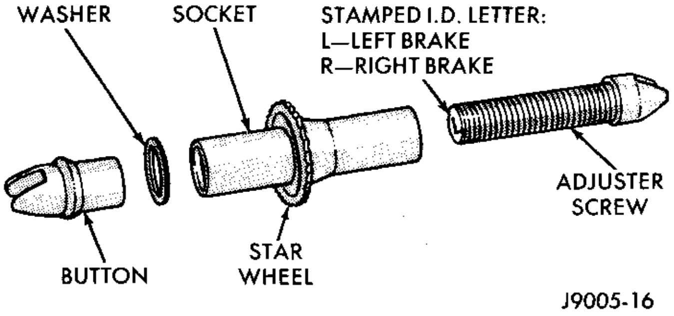


Fig. 5 Adjuster Screw Components-9 Inch Brake

(5) Position adjuster lever and pivot on secondary shoe. Then install shoe on backing plate. Secure shoe and lever with new holddown spring, retainers and pin.

(6) Attach shoe spring to secondary shoe. Long end of spring goes on secondary shoe.

(7) Install primary shoe on backing plate. Secure shoe with new holddown spring, pin and retainers.

(8) install actuator lever and lever spring. Hook actuator lever under adjuster lever as shown (Fig. 8).

(9) Install adjuster screw assembly and attach shoe spring to primary shoe.

(10) Install guide plate on anchor pin.

(11) Install strut and spring.

(12) Attach adjuster spring to adjuster lever.

(13) Attach adjuster spring to secondary shoe return spring. Then install adjuster spring on anchor pin (Fig. 8).

(14) Install primary shoe return spring on shoe and anchor pin.

(15) Verify that adjuster components are installed correctly (Fig. 6). Actuating lever should contact adjuster screw star wheel and be hooked under adjuster lever as shown.

(16) Adjust shoes to drums with brake gauge.

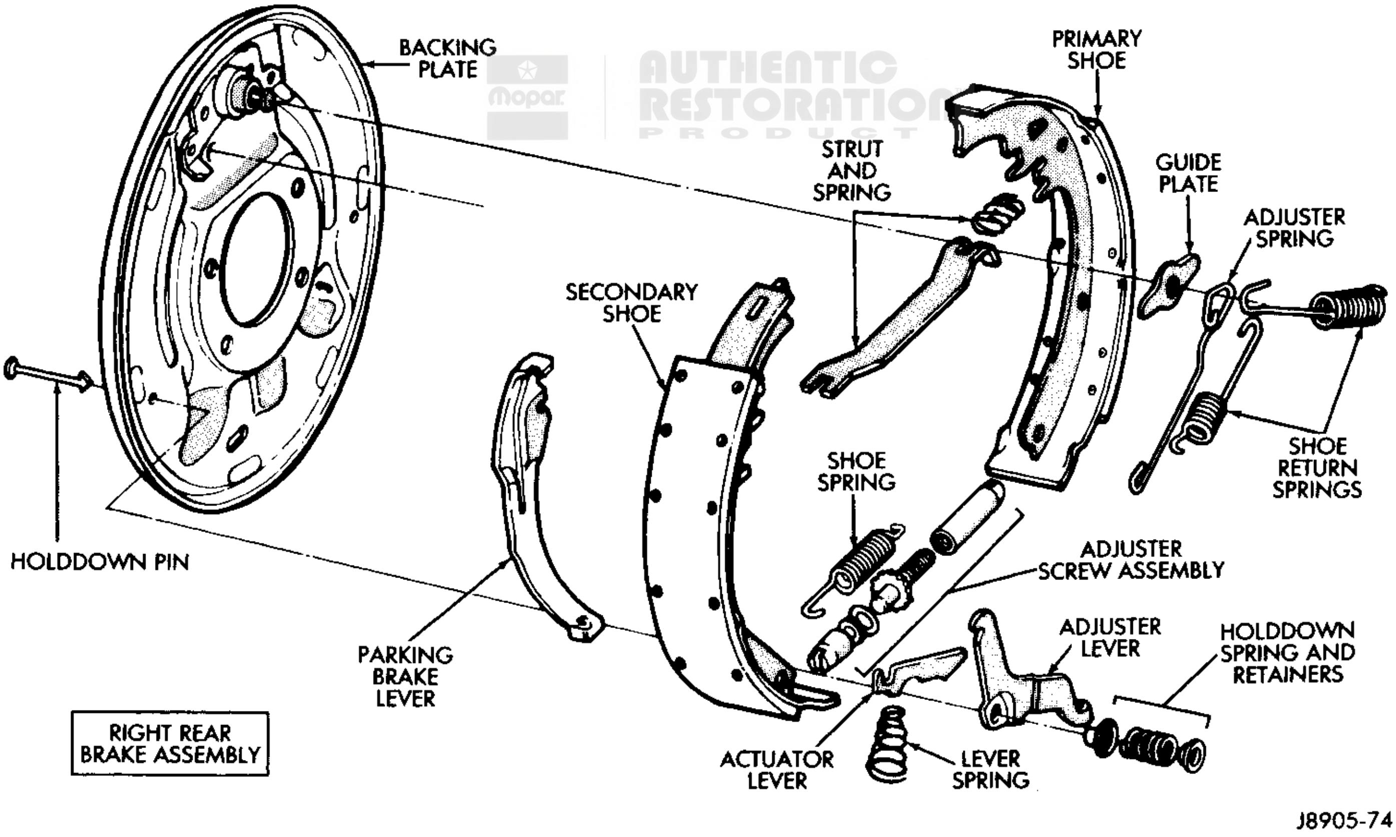


Fig. 6 Eleven Inch Drum Brake Components—SJ

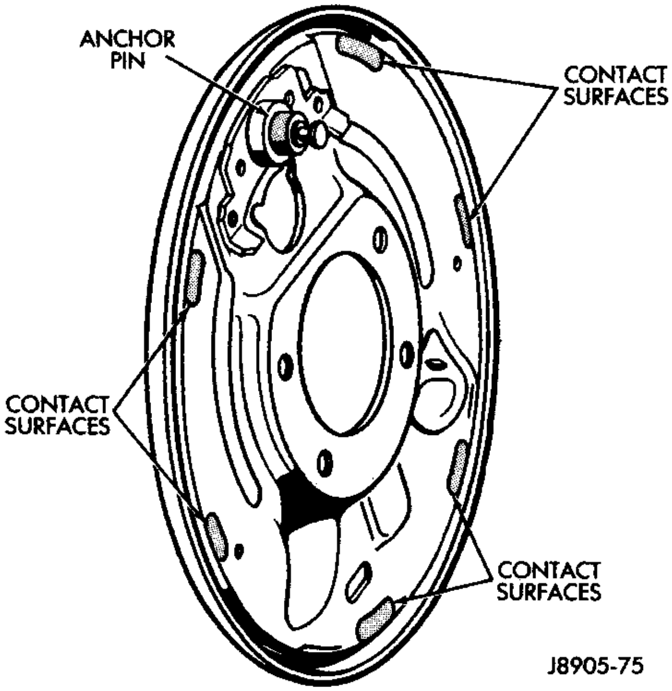


Fig. 7 Shoe Contact Surfaces—SJ Support Plate

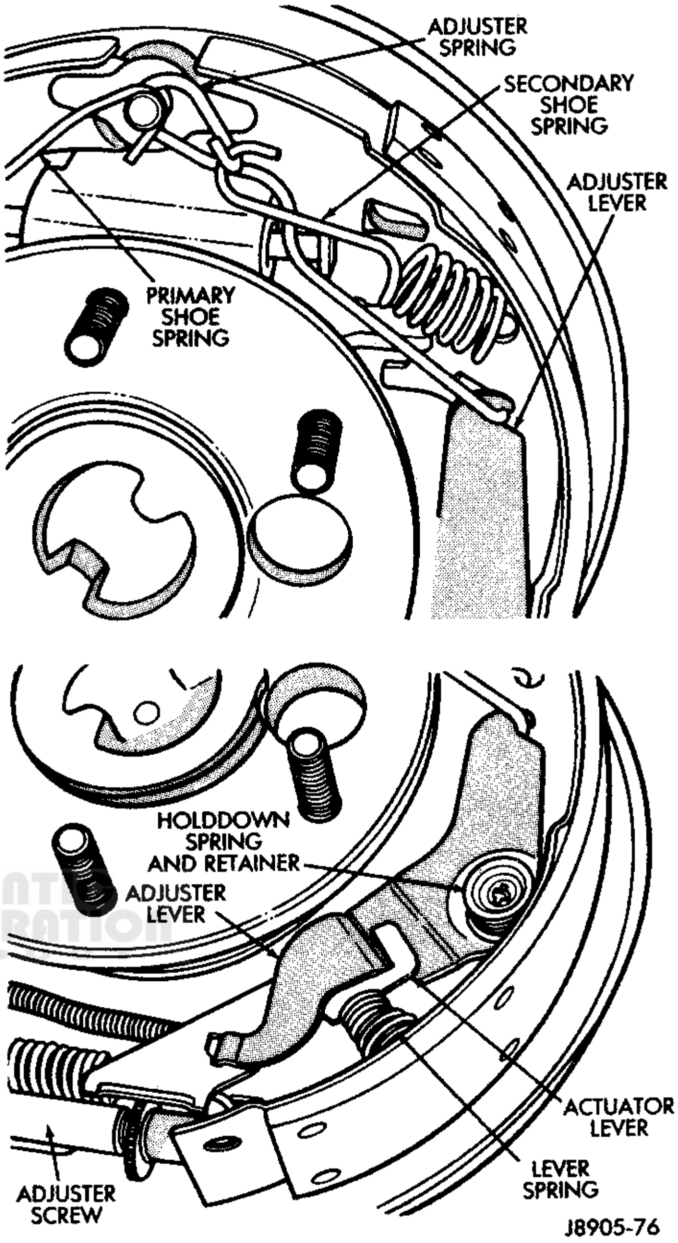


Fig. 8 Shoe Adjuster Components—SJ Models

WHEEL CYLINDER OVERHAUL—ALL

Cylinder Removal

(1) Raise vehicle and remove wheel.

(2) Disconnect brakeline at wheel cylinder.

(3) Remove brakeshoes.

(4) Remove bolts attaching wheel cylinder to backing plate and remove cylinder.

Cylinder Overhaul (Figs. 1, 2, 3)

(1) Remove links.

(2) Remove dust boots.

(3) Remove cups and pistons.

(4) Remove spring and expander.

(5) Remove bleed screw.

(6) Clean cylinder, pistons and links with Mopar brake cleaner. Discard cups, boots and expander.

(7) Inspect cylinder bore and pistons. Light discoloration of bore is acceptable. However, replace cylinder if bore and pistons are scored, pitted, or corroded. **Do not hone cylinder bores or polish pistons. Replace cylinder as an assembly if bore is damaged.**

(8) Install bleed screw.

(9) Coat cylinder bore, pistons, cups and expander with brake fluid and reassemble cylinder components. Be sure piston cup lips face expander.

Cylinder Installation

(1) Position wheel cylinder on backing plate (Fig. 4).

(2) Start brakeline in wheel cylinder fitting.

(3) Install cylinder mounting bolts (Fig. 4). On all except SJ models, tighten bolts to 90 in-lbs (10 N•m) torque. On SJ models, tighten bolts to 18 ft-lbs (24 N•m) torque.

(4) Tighten brakeline fitting to 160 in-lbs (18 N•m) on SJ and to 132 in-lbs (15 N•m) on all other models.

(5) Install brakeshoes. Adjust shoes to drum with brake gauge.

(6) Install brake drums and lower vehicle.

(7) Fill master cylinder and bleed brakes.

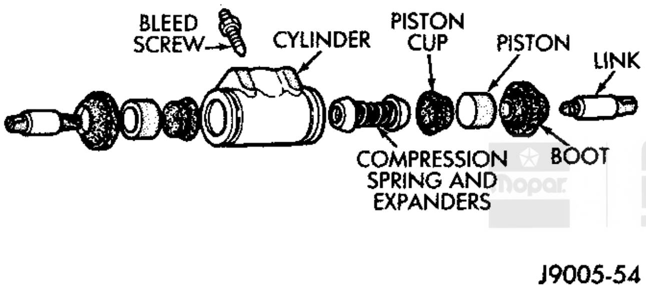


Fig. 1 Wheel Cylinder—XJ/MJ/YJ—9-Inch Brake

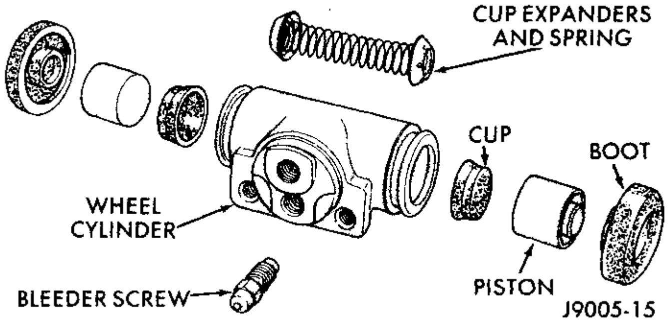


Fig. 2 Wheel Cylinder—MJ—10-Inch Brake

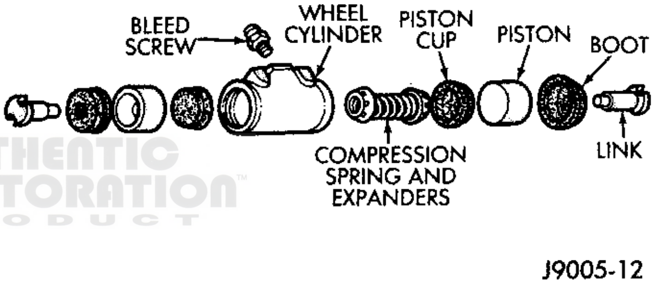


Fig. 3 Wheel Cylinder—SJ—11-Inch Brake

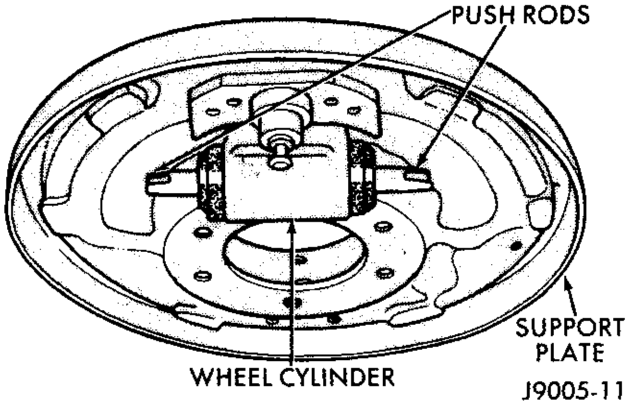


Fig. 4 Wheel Cylinder Mounting

BRAKE DRUM REFINISHING

Brake drums can be machined to restore the braking surface. Use a brake lathe to clean up light scoring and wear.

CAUTION: Never refinish a brake drum if machining will cause the drum to exceed maximum allowable brake surface diameter.

Brake drums that are warped, distorted, or severely tapered should be replaced. Do not refinish drums exhibiting these conditions. Brake drums that are heat checked or have hard spots should also be replaced.

The maximum allowable diameter for the drum braking surface is usually indicated on the periphery of the drum outer face (Fig. 5). Refer to the specifications section if this information is either illegible or not provided.

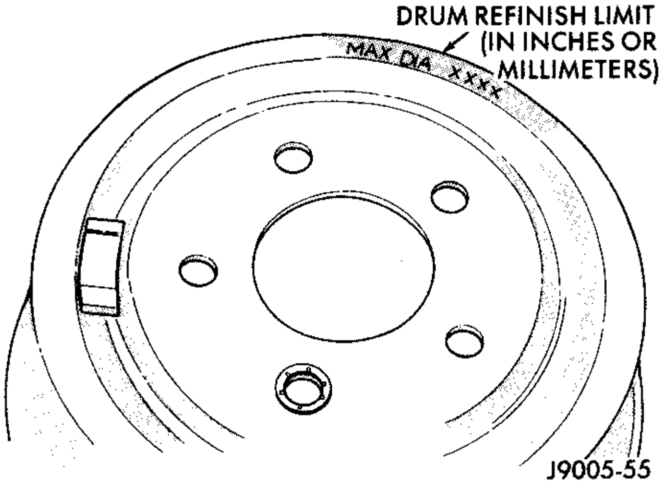


Fig. 5 Brake Drum Refinish Limit

PARKING BRAKE SERVICE

INDEX

PARKING BRAKE LEVER—XJ

Lever Removal-With Console

(1) Release parking brakes.

(2) Raise vehicle and remove equalizer nut and washer from operating rod (Fig. 1).

(3) Lower vehicle.

(4) On models with manual transmission, remove shift knob, boot and bezel.

(5) On models with automatic transmission, remove shift handle cap and remove plunger, spring and T-lock (Fig. 2).

(6) Remove shift handle and shift bezel (Fig. 2).

(7) Remove console cover screws (Fig. 3).

(8) On models with power mirror switch, pry switch out of console cover and disconnect switch connector (Fig. 3).

(9) Remove console cover from base (Fig. 4).

(10) Remove console base.

(11) Disconnect brake warning light wire connector at lever (Fig. 5).

(12) Remove lever attaching bolts and remove lever (Fig. 6).

Lever Installation-With Console

(1) Position the lever on the floorpan and install the lever attaching bolts (Fig. 6).

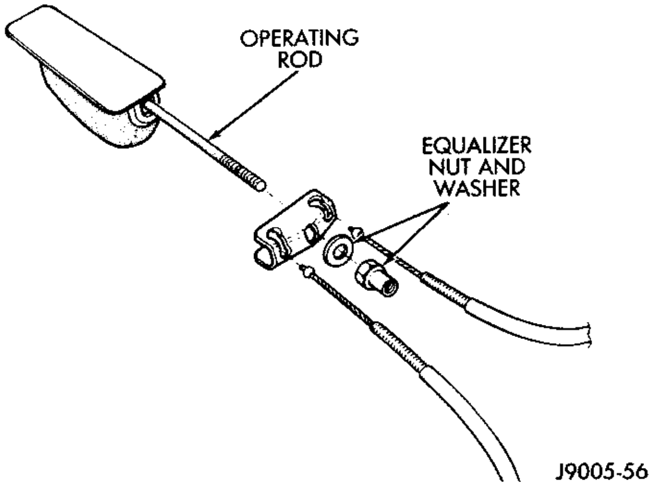


Fig. 1 Disconnect Lever Operating Rod

(2) Connect the brake warning light wire connector (Fig. 5).

(3) Install the console base and cover (Fig. 4).

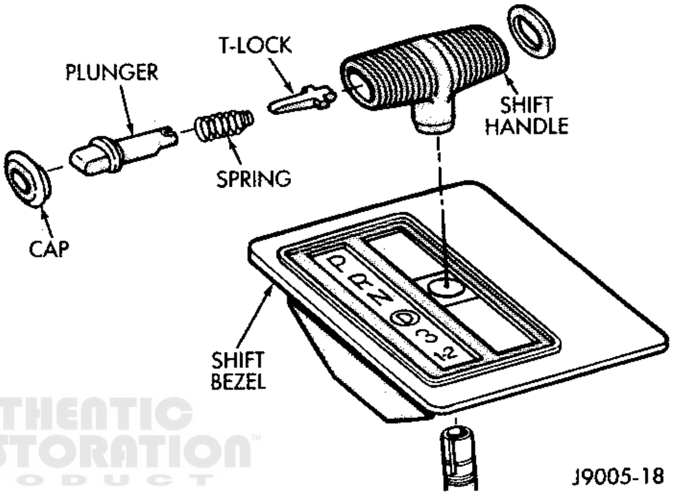


Fig. 2 Automatic Transmission Shift Handle

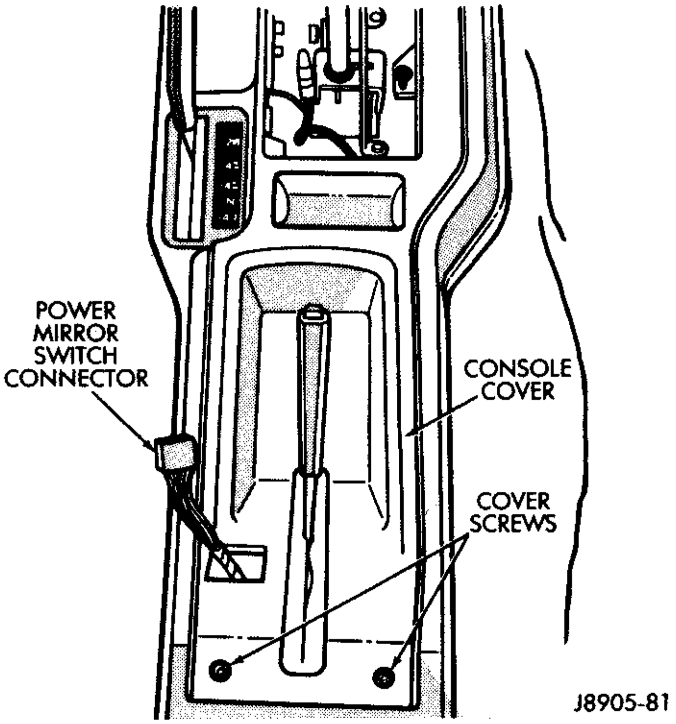


Fig. 3 Console Cover Screws And Power Mirror Switch Connector

(4) Connect power mirror switch wire to switch and install switch in console cover.

(5) On automatic transmission models, install shift bezel and shift handle (Fig. 2).

(6) On manual transmission models, install boot, bezel and shift knob.

(7) Raise vehicle and connct equalizer to lever operating rod.

(8) Adjust parking brakes as described in Service Adjustments section.

Lever Removal-Without Console

(1) Raise vehicle and disconnect equalizer from lever operating rod (Fig. 1).

(2) Lower vehicle.

(3) Raise lever cover at rear and tilt it forward (Fig. 7).

(6) Drill out cover retaining rivets and remove cover (Fig. 7).

(4) Disconnect brake warning light wire at lever (Fig. 5).

(5) Remove lever retaining bolts (Fig. 6) and remove lever.

Lever Installation-Without Console

(1) Position lever on floorpan and install mounting bolts.

(2) Connect brake warning light wire to lever.

(3) Install lever cover. Secure cover with new rivets.

(4) Raise vehicle.

(5) Connect lever operating rod to equalizer.

(6) Adjust parking brakes as described in Service Adjustment section.

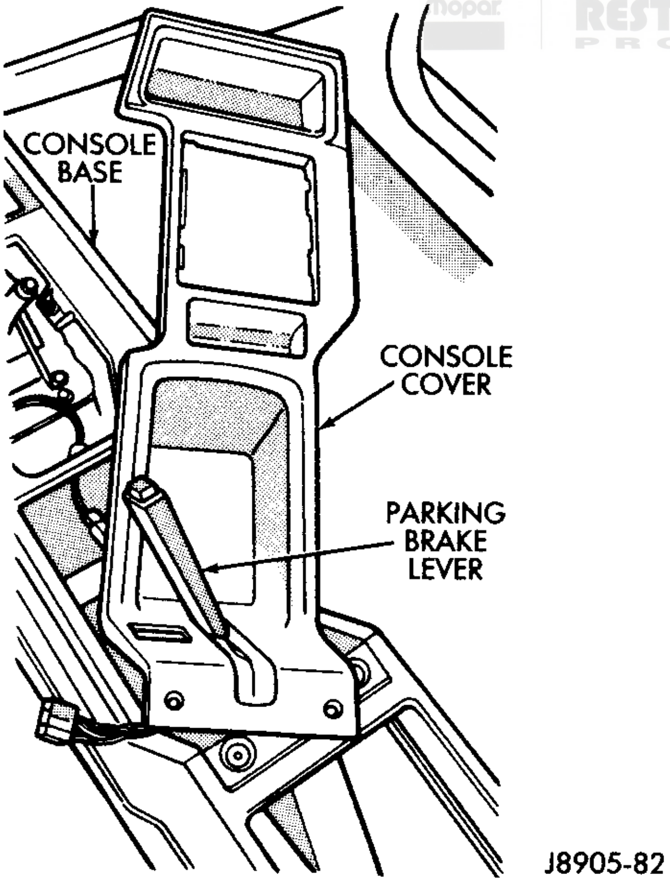


Fig. 4 Remove Console Cover And Base

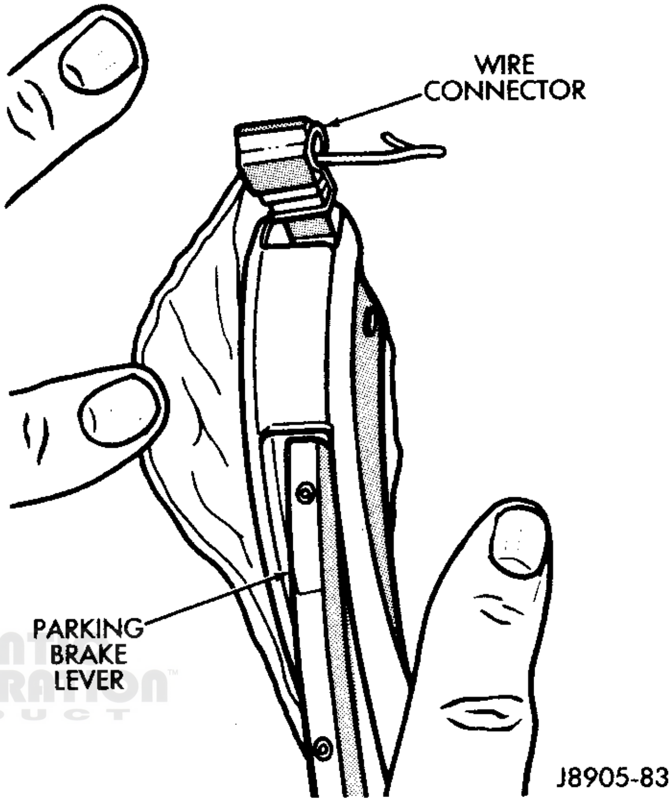


Fig. 5 Brake Warning Light Wire Connector

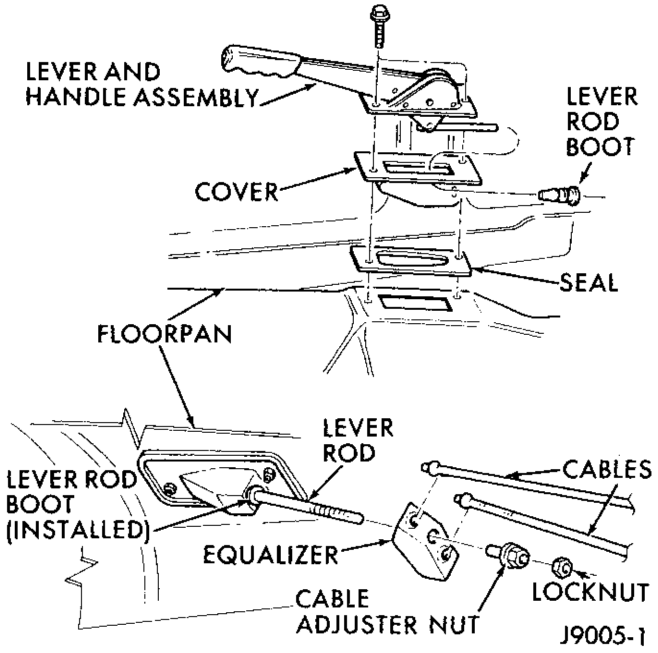


Fig. 6 Removing Parking Brake Lever

PARKING BRAKE PEDAL—MJ

Pedal Removal

(1) Raise vehicle and loosen equalizer nut until front cable is slack (Fig. 8)

(2) Lower vehicle.

(3) Remove kick panel trim and release handle screws (Fig. 9).

(4) Disengage front cable retaining clip (Fig. 9).

(5) Disconnect warning light wire (Fig. 9).

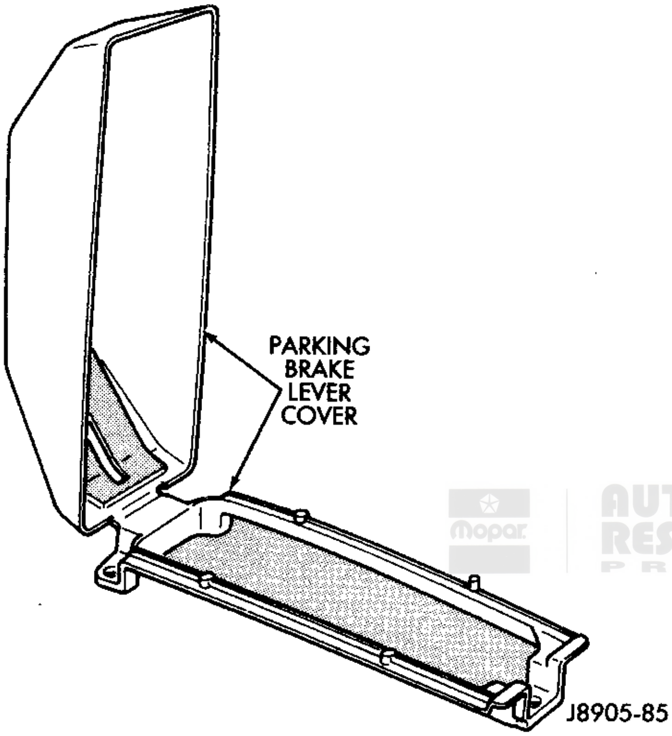


Fig. 7 Lever Cover—XJ

(6) Remove pedal attaching bolts.

(7) Disengage front cable from retainer and remove pedal assembly.

Pedal Installation

(1) Connect front cable to pedal retainer.

(2) Position pedal on panel and install pedal attaching bolts.

(3) Install cable retaining clip.

(4) Connect warning light wire.

(5) Install kick panel trim. Position release handle on dash and install handle attaching screws.

(6) Adjust parking brake cable as described in Service Adjustment section.

PARKING BRAKE PEDAL—SJ/YJ

Pedal Removal

(1) Raise vehicle.

(2) Loosen equalizer nuts until front cable is slack (Figs. 10 and 11).

(3) Lower the vehicle.

(4) On SJ, remove dash-to-instrument panel brace rod.

(5) Disconnect warning light switch wire from pedal assembly.

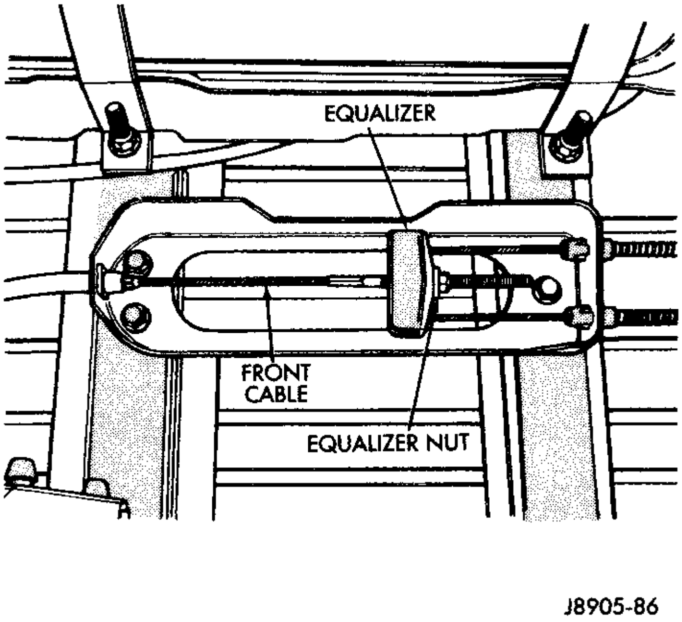


Fig. 8 Front Cable And Equalizer—MJ

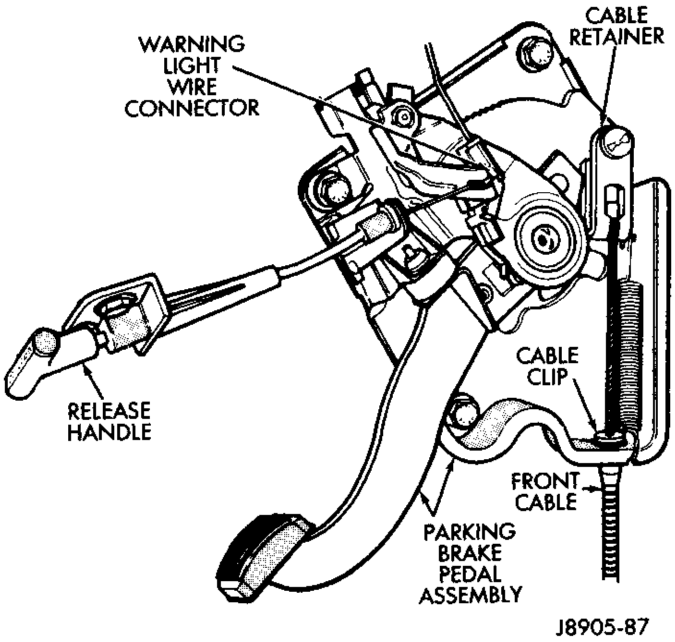


Fig. 9 Parking Brake Pedal—MJ

CAUTION: On YJ models, there is a ground wire attached to the upper end of the bolt that secures the parking brake pedal to the instrument panel. The wire is retained on the bolt with a nut. Be sure to remove the nut and detach the ground wire before proceeding. If the wire is not removed beforhand, the wire and harness could be damaged when the pedal assembly bolt is removed. The ground wire and attaching nut are accessible from under the instrument panel.

(6) Remove bolt securing pedal assembly to instrument panel (Fig. 12).

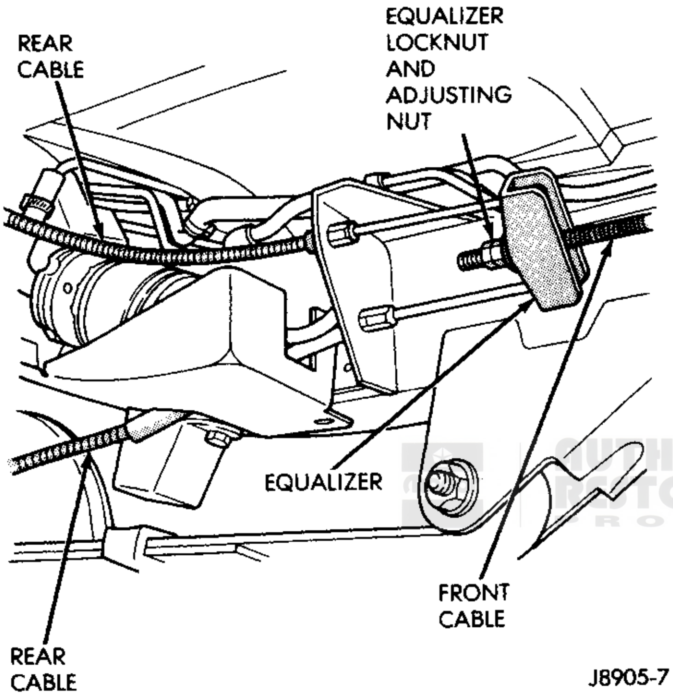


Fig. 10 Front Cable And Equalizer—YJ

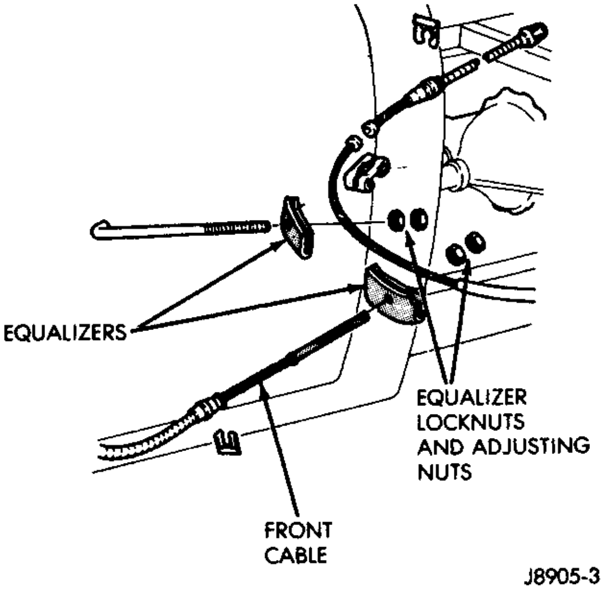


Fig. 11 Front Cable And Equalizers—SJ

(7) In engine compartment, remove pedal mounting stud nuts.

(8) Remove pedal assembly from panel.

(9) Disengage front cable from retainer (Fig. 12).

(10) Squeeze cable clip (Fig. 12) and pull cable out of pedal frame.

(11) Remove pedal assembly.

Pedal Installation—SJ/YJ

(1) Connect front cable to pedal retainer.

(2) Position pedal assembly on panel and install mounting stud nuts and pedal-to-dash bolt.

(3) Install ground wire on upper end of pedal-to-dash bolt and secure wire with attaching nut.

(3) Connect warning light switch wire to pedal connector.

(4) On Grand Wagoneer, install dash-to-instrument panel brace rod.

(5) Raise vehicle and adjust brake cables. Refer to procedure in Service Adjustment section.

PARKING BRAKE CABLES—MJ

Rear Cable Replacement

(1) Raise vehicle.

(2) Remove rear wheel and brake drum.

(3) Remove secondary brakeshoe.

(4) Disengage cable from lever on brakeshoe.

(5) Compress cable retainer with worm drive hose clamp (Fig. 13).

(6) Remove cable from backing plate.

(6) Remove cable mounting clips (Fig. 14).

(7) Disengage cable from equalizer (Fig. 14) and remove cable.

(8) Install new cable in backing plate. Be sure cable retainer is seated.

(9) Engage cable in equalizer (Fig. 14).

(10) Install cable mounting clips (Fig. 14).

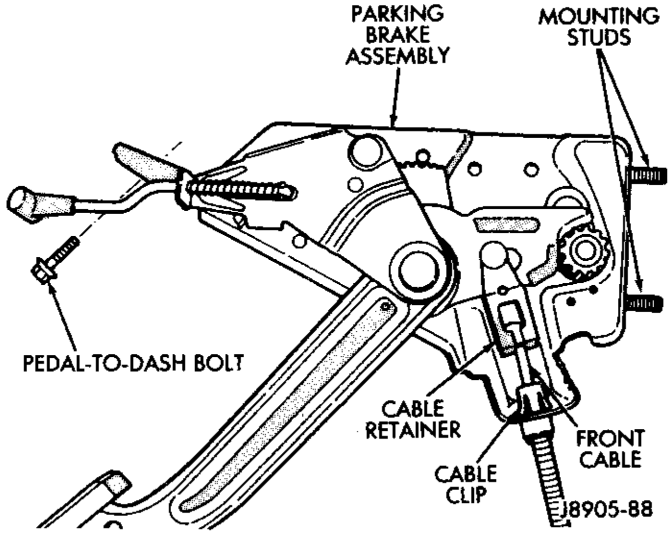


Fig. 12 Pedal Assembly—SJ/YJ

(11) Connect cable to lever on secondary brakeshoe.

(12) Install secondary brakeshoe on backing plate.

(13) Adjust brakshoes to drum with brake gauge.

(14) Install brake drum and wheel.

(15) Adjust parking brakes as described in Service Adjustment section.

Front Cable Replacement—MJ

(1) Raise vehicle.

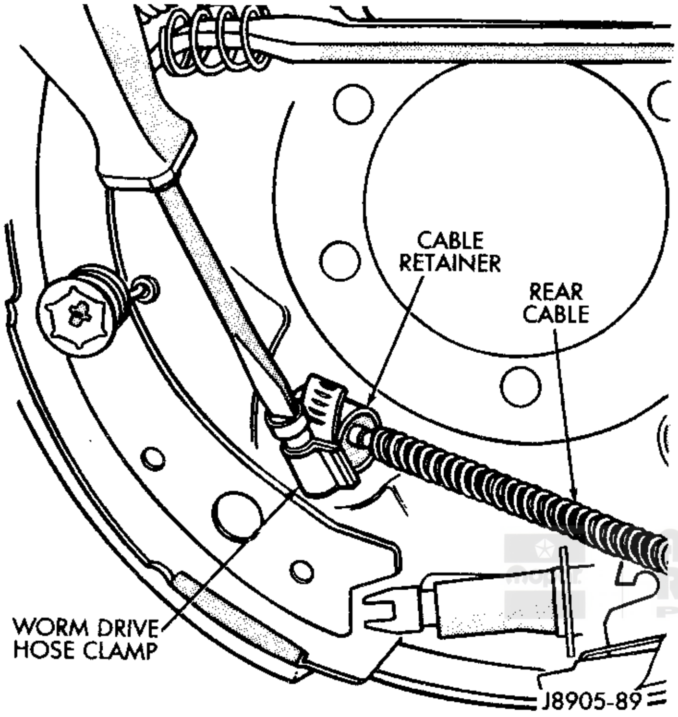


Fig. 13 Compressing Rear Cable Retainer

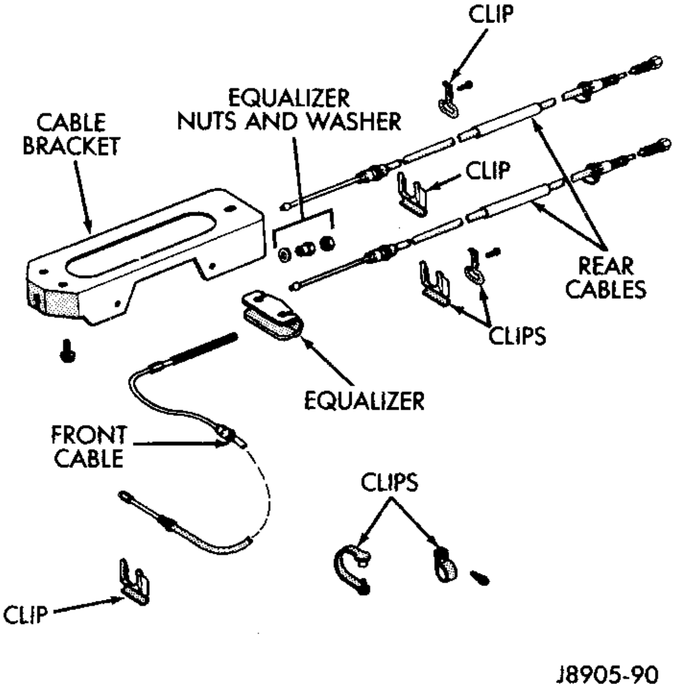


Fig. 14 Parking Brake Cables—MJ

(2) Remove equalizer nuts and remove front cable from equalizer and cable bracket (Fig. 14).

(3) Lower vehicle.

(4) Move carpet away from pedal assembly. Then remove pedal mounting bolts and move pedal assembly away from kick panel

(5) Disconnect front cable from pedal assembly.

(6) Move carpet at driver side and rear of cab aside for access to cable floorpan clamps (Fig. 15).

(7) Remove cable clamps, unseat cable grommet and remove cable through floorpan (Fig. 15).

(8) Insert new cable through floorpan and connect it to the pedal assembly.

(9) Install pedal assembly on kick panel.

(10) Secure cable grommet in cab rear and install cable floorpan clamps (Fig. 15).

(11) Reposition carpeting on floorpan.

(12) Raise vehicle.

(13) Install cable in bracket and in equalizer (Fig. 14).

(14) Install equalizer nuts and washer on cable (Fig. 14).

(15) Adjust parking brakes as described in Service Adjustment section.

PARKING BRAKE CABLES—XJ

Rear Cable Replacement

(1) Raise vehicle and loosen equalizer nuts until rear cables are slack.

(2) Disengage cable from equalizer and remove cable clip and spring (Fig. 16).

(3) Remove rear wheel and brake drum.

(4) Remove secondary brakeshoe and disconnect cable from lever on brakeshoe.

(5) Compress cable retainer with worm drive hose clamp (Fig. 13) and remove cable from backing plate.

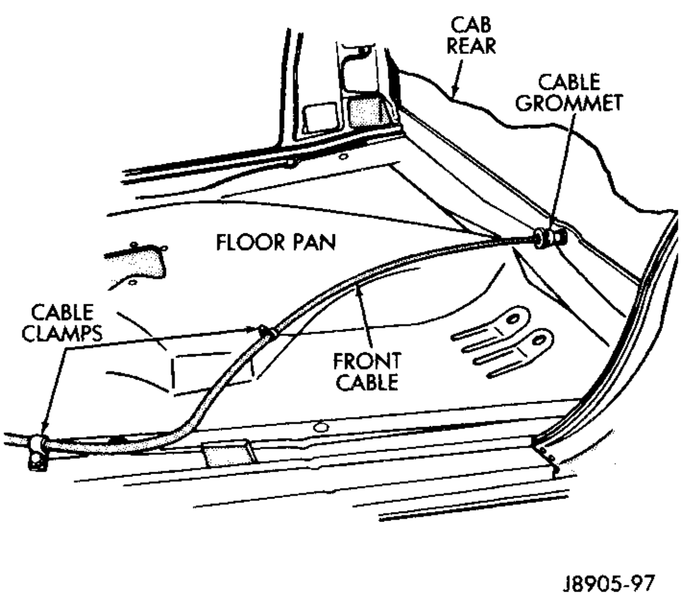


Fig. 15 Front Cable Floorpan Attachment—MJ

(6) Install new cable in backing plate. Be sure cable retainer is seated.

(7) Attach cable to lever on brakeshoe and install brakeshoe on backing plate.

(8) Adjust brakeshoes to drum with brake gauge.

(9) Install brake drum and wheel.

(10) Engage cable in equalizer and install equalizer nuts (Fig. 16).

(11) Adjust parking brakes as described in Service Adjustment section.

PARKING BRAKE CABLES—YJ

Front Cable Replacement

(1) Raise vehicle.

(2) Remove equalizer nuts (Fig. 17).

(3) Remove front cable from equalizer (Fig. 17).

(4) Remove the cable-to-frame bracket clip.

(5) Lower the vehicle.

(6) Move front carpeting away from pedal.

(7) Using hose clamp, compress clip securing cable to pedal frame (Fig. 13).

(8) Disconnect cable from pedal retainer and remove cable.

(9) Remove grommet (Fig. 17) from old cable and transfer it to new cable.

(10) Install new cable in floorpan and connect it to pedal assembly.

(11) Seat cable grommet in floorpan.

(12) Raise the vehicle.

(13) Install cable-to-frame retaining clip.

(14) Insert cable in equalizer and install equalizer washer and nuts.

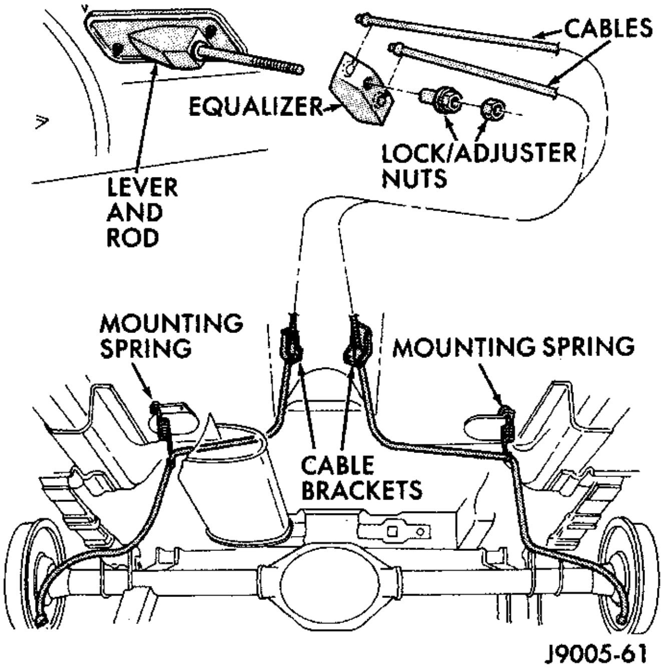


Fig. 16 Parking Brake Cables—XJ

(15) Adjust parking brakes as described in Service Adjustment section.

Rear Cable Replacement—YJ

(1) Raise vehicle and loosen equalizer nuts (Fig. 17).

(2) Remove clamp and cotter pin attaching rear cable to equalizer and remove cable.

(3) Remove cable clips.

(4) Remove rear wheel and brake drum.

(5) Remove secondary brakeshoe and disconnect cable from lever on brakeshoe.

(6) Compress cable retainer with hose clamp (Fig. 13) and remove cable from backing plate.

(7) Install new cable in backing plate. Be sure cable retainer lock tabs are engaged in plate.

(8) Install secondary brakeshoe.

(9) Adjust brakeshoes to brake drum and install drum and wheel.

(10) Install cable in equalizer. Secure cable with retainer and cotter pin.

(11) Install cable clips.

(12) Adjust parking brakes as described in Service Adjustment section.

PARKING BRAKE CABLES—SJ

Front Cable Replacement

(1) Raise vehicle.

(2) Remove equalizer from front cable and remove cable-to-crossmember clip (Fig. 18).

(3) Lower vehicle.

(4) Move carpet aside and remove cable-to-pedal retainer (Fig. 18). Also disengage cable return spring if equipped.

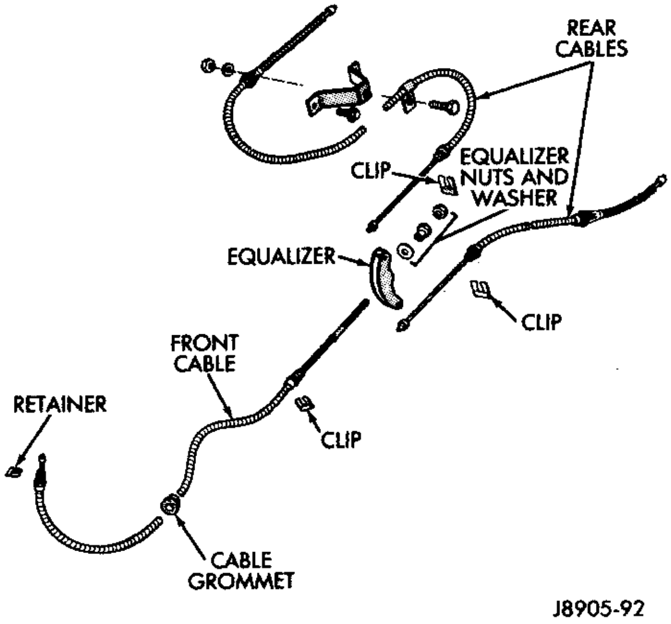


Fig. 17 Parking Brake Cables—YJ

(5) Disengage cable from pedal assembly and remove cable.

(6) Transfer insulator or grommet to new cable.

(7) Connect cable to pedal assembly and insert cable through floorpan. Reconnect cable return spring if equipped and reposition carpet.

(8) Raise vehicle.

(9) Connect front cable to equalizer and equalizer cable (Fig. 18).

(10) Install cable clips.

(11) Adjust parking brakes as described in Service Adjustment section.

Rear Cable Replacement—SJ

(1) Raise vehicle.

(2) Loosen locknuts at both equalizers (Fig. 18). Remove locknuts and both equalizers if equalizer cable is being replaced.

(3) Disengage cable from left or right connector (Fig. 18).

(4) Remove fuel tank skid plate if left cable is being replaced.

(5) Remove cable clips.

(6) Remove wheel and brake drum.

(7) Remove secondary brakeshoe and disconnect cable from lever on shoe.

(8) Compress lock tabs on cable retainer with hose clamp (Fig. 13) and remove cable from backing plate.

(9) Install new cable in backing plate. Be sure cable retainer lock tabs are engaged in plate.

(10) Connect cable to lever on secondary brakeshoe and install brakeshoe on backing plate.

(11) Assemble the three cables (Fig. 18). Be sure the cables are seated in the connectors.

(12) Position both equalizers on the equalizer cable.

(13) Insert the front cable and cable rod in the equalizers and install the equalizer nuts.

(14) Install the fuel tank skid plate if removed.

(15) Install cable clips.

(16) Adjust parking brakes as described in Service Adjustment section.

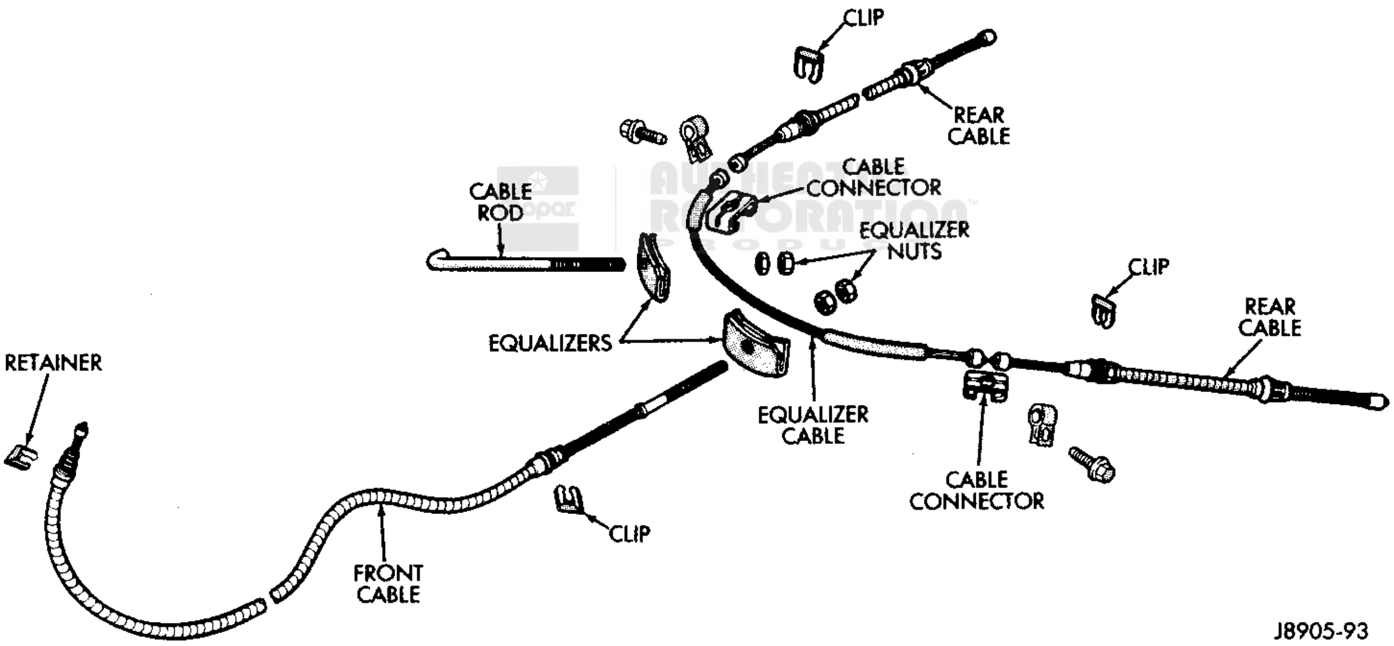


Fig. 18 Parking Brake Cables—SJ

BRAKE PEDAL AND SWITCH

INDEX

GENERAL INFORMATION

A suspended-type brake pedal is used on all models (Figs. 1,2,3).

The pedal pivots on a pin mounted in a pedal bracket. The bracket is attached to the dash and instrument panels on all models.

The brakelight switch on XJ, MJ, YJ models is not adjustable. It is attached to the pedal and push rod with a bolt. The switch on SJ models is adjustable and is attached to the pedal bracket.

The various brake pedal assemblies are shown in Figures 1, 2 and 3.

BRAKE PEDAL SERVICE

The brake pedal is a serviceable component. The pedal, pivot pin, sleeve, pedal bushings, spacers/washers, and the push rod bolt and nuts on XJ, MJ, YJ models are all replaceable parts. The pedal bracket can also be replaced when necessary.

Brake Pedal Removal

(1) Remove lower trim panel and necessary A/C ducts.

(2) On SJ models, remove the steering column lower trim panel and bezel.

(3) On all except SJ models, disconnect the brakelight switch wires.

(4) On SJ models, remove the push rod cotter pin, spacer washer and spring washer. Then disconnect the pedal spring.

(5) On all except SJ models, remove the push rod bolt and nuts. Note position of the bolt, brakelight switch and push rod for installation reference.

(6) Remove necessary dash panel-to-instrument panel brace rods.

(7) Remove the nut from the pedal pivot pin and remove the pin, pedal and sleeve.

(8) Remove the pedal bushings if they are to be replaced.

Brake Pedal Installation

The nuts for the pedal pivot pin and the push rod bolt on XJ, MJ and YJ models are specially formed and not reusable. Use new nuts only to secure the pin and bolt during pedal installation.

(1) Install new bushings in the pedal. Lubricate the bushings and pivot pin with Mopar multi-purpose grease.

(2) Position pedal, sleeve and spacer(s) in bracket and install pivot pin. Tighten pivot pin nut to 20 ft-lbs (27 N•m) on models with manual transmission and 26 ft-lbs (35 N•m)

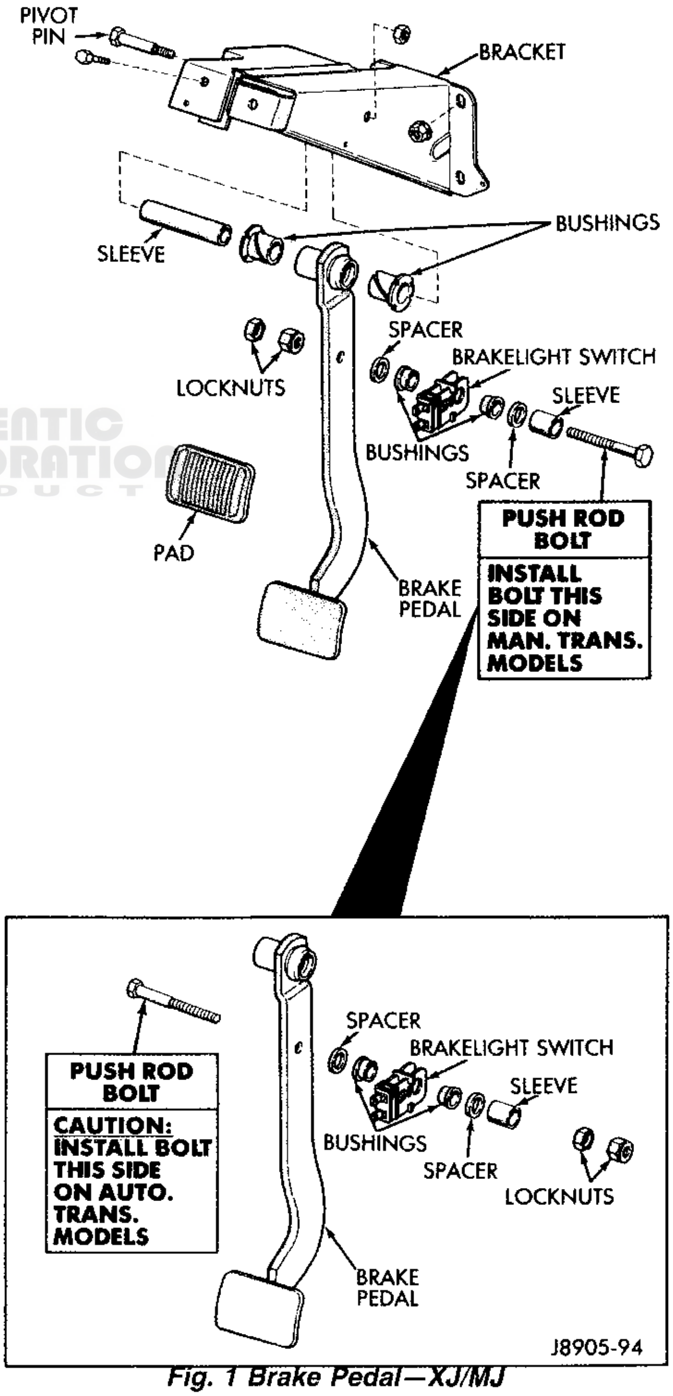


Fig. 1 Brake Pedal—XJ/MJ

on models with automatic transmission.

Caution: On XJ and MJ models, push rod bolt position is different for manual and automatic transmission models (Fig. 1). The push rod bolt must be installed from the left side on models with automatic transmission. On models with manual transmission, install the bolt from the right side (Fig. 1).

(3) Install the brakelight switch, bushings and push rod bolt. Install new nuts on the push rod bolt. Tighten the inner nut to 25 ft-lbs (34 N•m) torque and the outer nut to 75 in-lbs (8.5 N•m) torque.

(4) On SJ models, install the push rod on the pedal. Secure the push rod with a new spring washer, retainer washer and cotter pin.

(5) Install the dash brace rod, if removed.

(6) Connect the brakelight switch wires.

(7) Install the A/C ducts and trim panels.

(8) On SJ models, check and adjust the brakelight switch if necessary.

BRAKELIGHT SWITCH

Only the SJ model brakelight switch is adjustable. Refer to the Service Adjustment section for the adjustment procedure.

On SJ models, the switch and retainer are mounted in the pedal bracket. On all other models, the switch is mounted on the push rod.

Switch Replacement

On SJ models, the switch is mounted in the pedal bracket Fig. 3). Disconnect the switch wires and thread the switch out of the plastic retainer. Also remove the retainer if worn, loose or damaged. Install the new switch and retainer and connect the switch wires. Adjust the switch as described in the Service Adjustment section.

On all except SJ models (Figs. 1 and 2), disconnect the switch wires, remove the push rod bolt and remove the switch from the push rod. Note position of the switch bushings and spacers for reference. Install the bushings and spacers in the new switch and position the switch on the push rod. Secure the push rod to the pedal with the bolt and new lock nuts. Tighten the inner nut to 25 ft-lbs (34 N•m) torque and the outer nut to 75 in-lbs (8.5 N•m) torque. Connect the switch wires and verify switch operation.

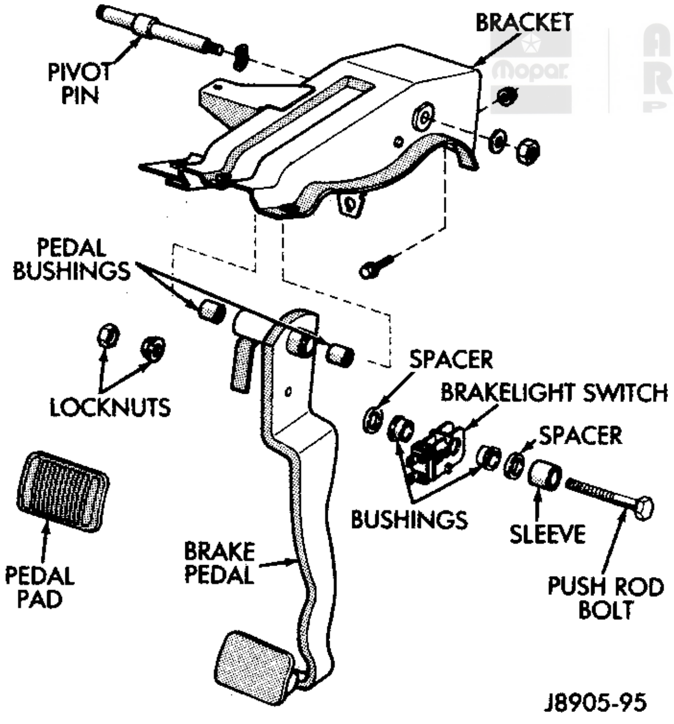


Fig. 2 Brake Pedal—YJ

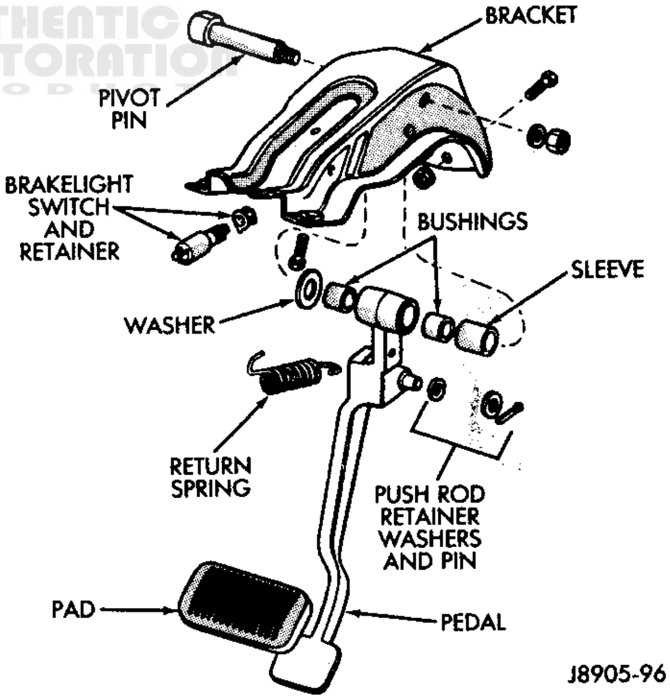


Fig. 3 Brake Pedal—SJ

BRAKELINES AND VALVES

INDEX

BRAKELINES AND HOSES

Metal brakelines and rubber brake hoses should be inspected periodically and replaced if damaged. However, a minor leak in a metal brakeline can be corrected with one of the repair fittings available through the parts division. Only one repair fitting should be used on any single brakeline. Replace the line if damage is extensive or has more than one leak point.

Rubber brake hoses should be replaced if cut, cracked, swollen, or leaking. Rubber hoses must only be replaced. They are not repairable parts.

When installing new, or reconnecting original brakelines and hoses, lubricate the fitting threads with brake fluid before connection.

COMBINATION AND PROPORTIONING VALVES

The standard combination valve is not a serviceable part. The valve must be replaced if it malfunctions.

The rear height sensing rear proportioning valve on MJ models is also not a serviceable part. The valve must be replaced if it malfunctions. In addition, the height sensing valve must be adjusted whenever one or both rear springs are changed or when the valve is removed during service operations. Refer to the Service Adjustments section for valve adjustment procedure.

BRAKELINE CHARTS

Brakeline charts are provided in Figures 1 through 7. The chart illustrations show typical brakeline routing, hose connections and component position.

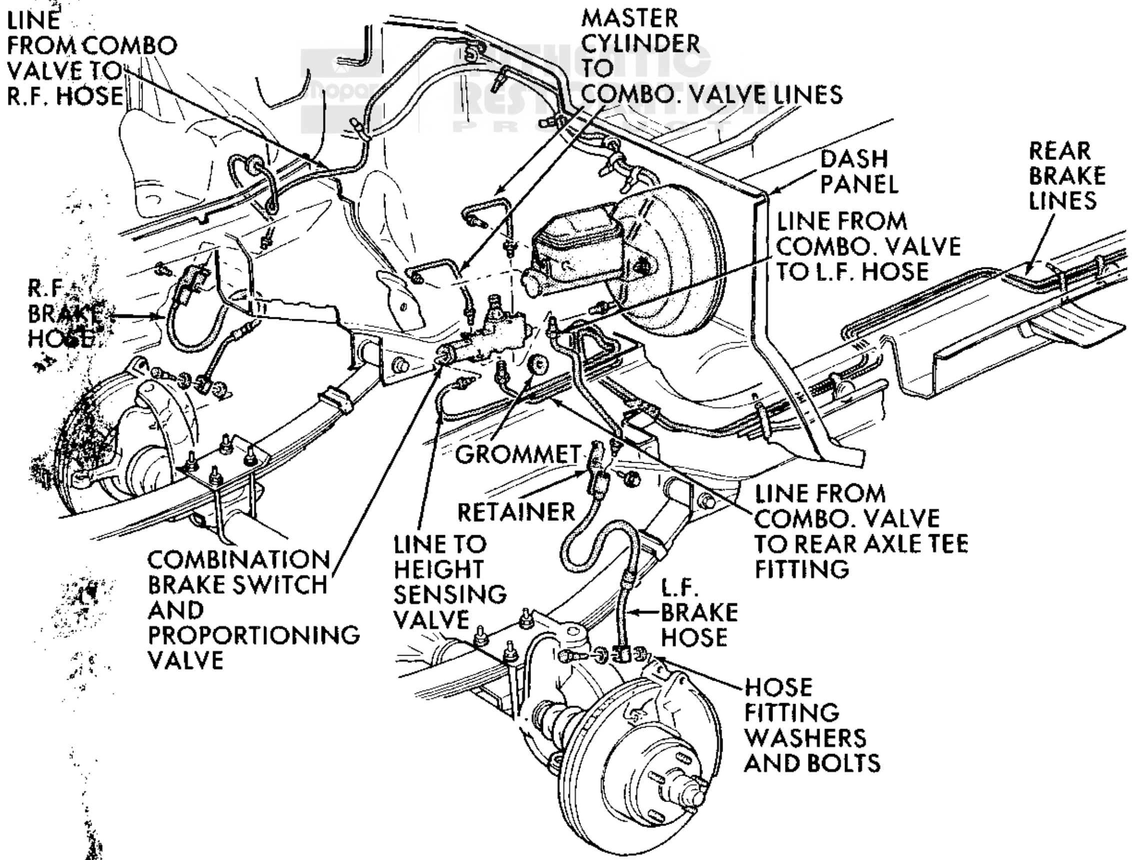


Fig. 1 Brakeline Routing—MJ

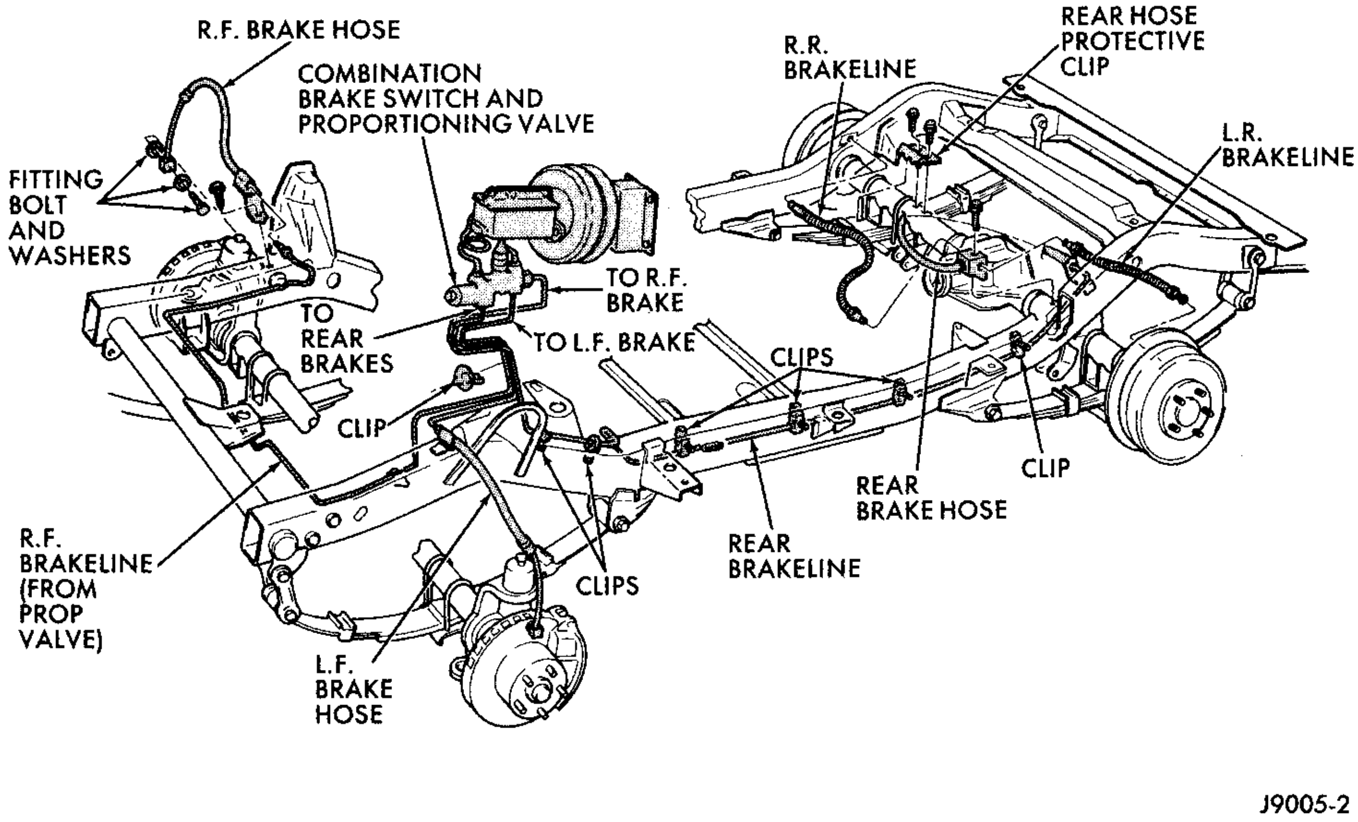


Fig. 2 Brakeline Routing—YJ

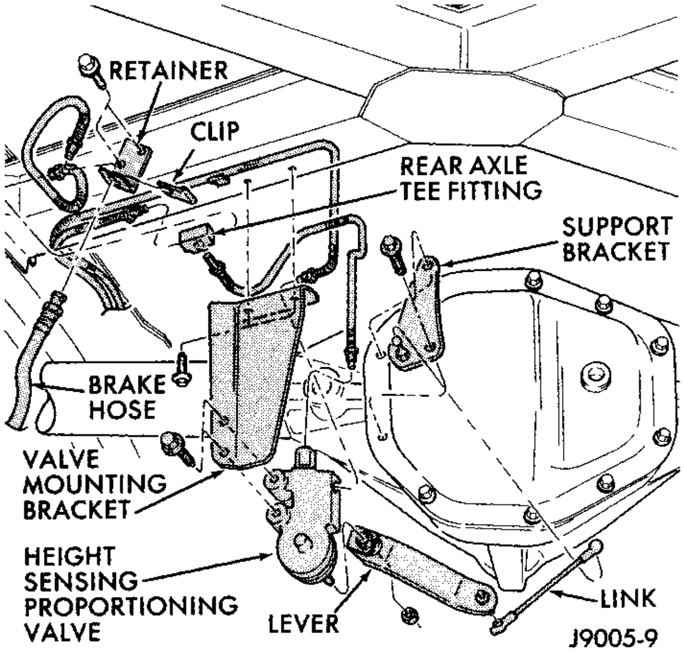


Fig. 3 Height Sensing Valve—MJ With Model 35 Rear Axle

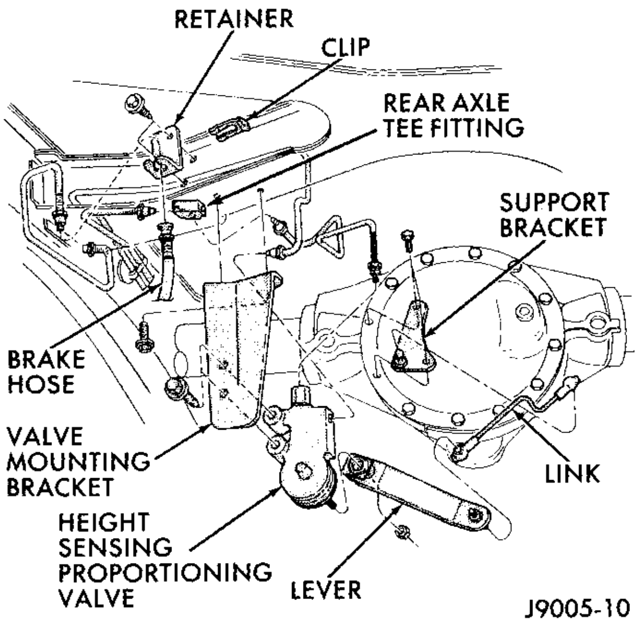


Fig. 4 Height Sensing Valve—MJ With Model 44 Rear Axle

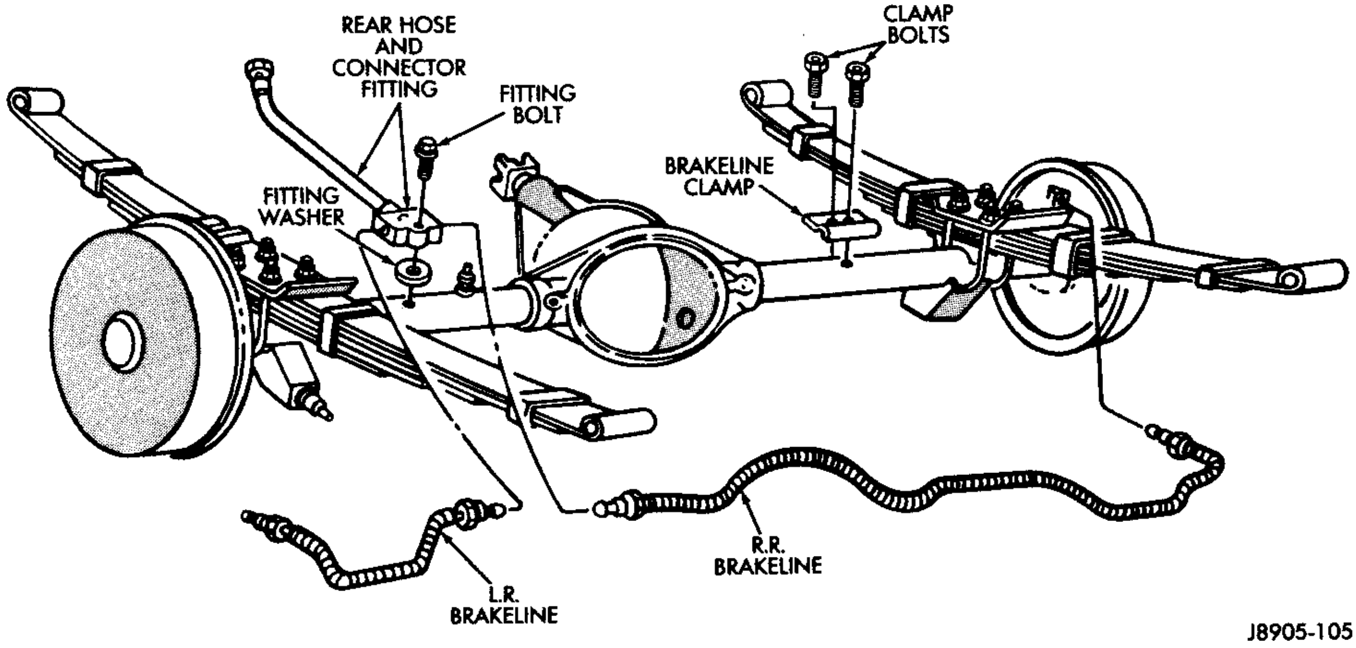


Fig. 5 Rear Brakeline Connections—Typical

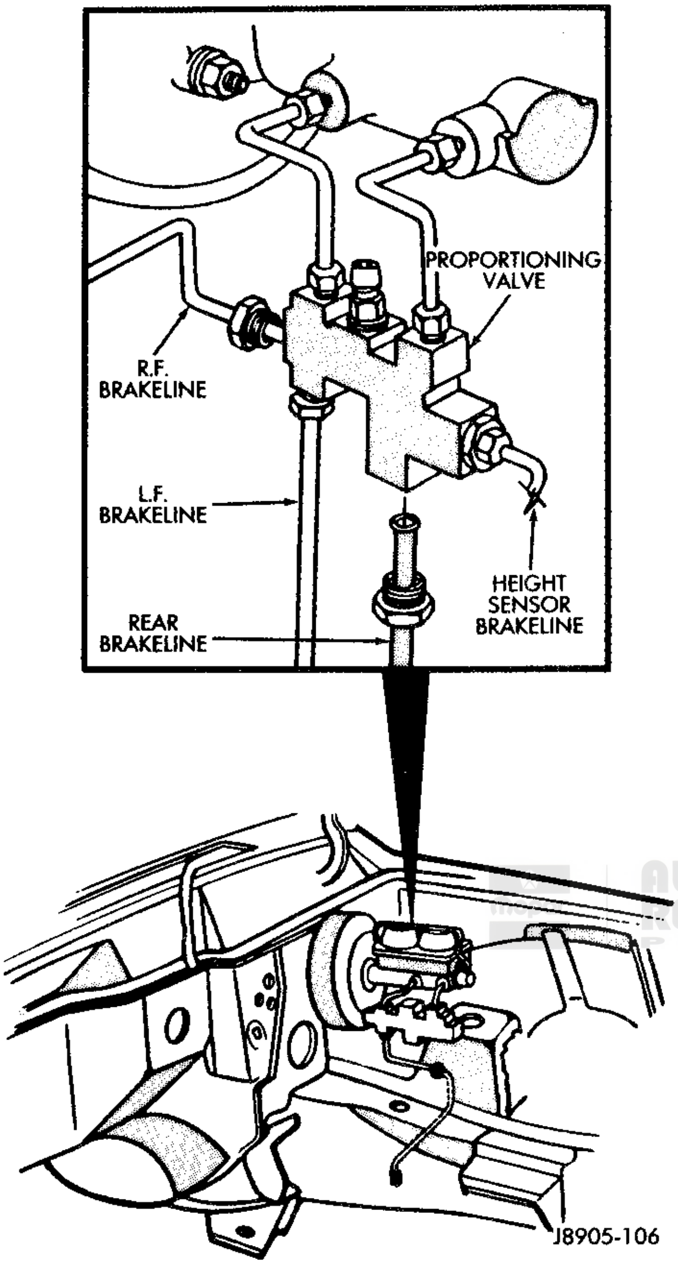


Fig. 6 Proportioning Valve Connection

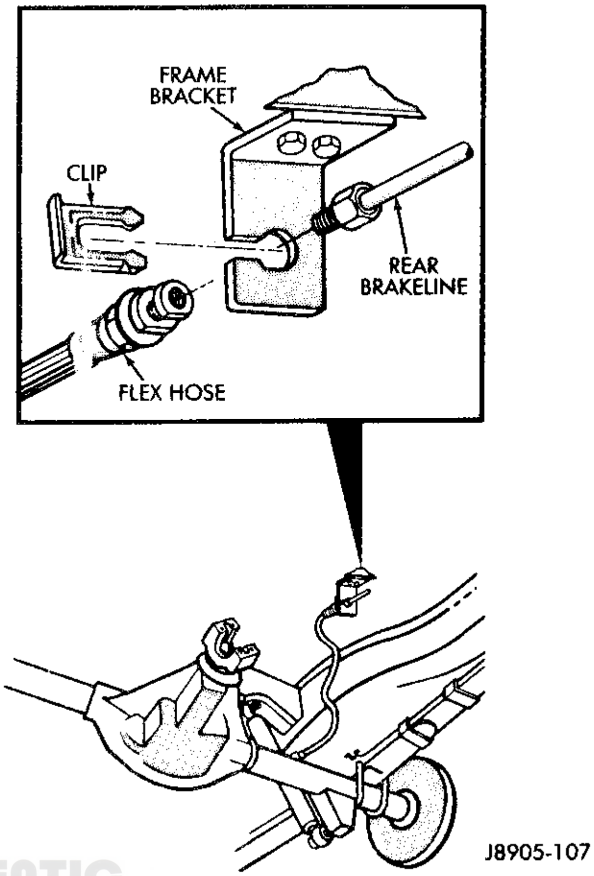


Fig. 7 Rear Hose Connection

ANTI-LOCK BRAKE SYSTEM

INDEX

GENERAL INFORMATION

SYSTEM APPLICATION

The anti-lock brake system is available on XJ models with Selec-Trac four wheel drive. It is an electronically operated, power assisted, all wheel brake control system. The system is designed to retard wheel lockup during periods of high wheel slip when braking. Retarding wheel lockup is accomplished by modulating fluid pressure to the wheel brake units.

The anti-lock system is a three channel design. The front wheel brakes are controlled individually and the rear wheel brakes in tandem.

System pressure is modulated according to wheel speed, degree of wheel slip and rate of deceleration. A sensor at each wheel converts wheel speed into electronic signals. The signals are transmitted to the brake system control unit for processing and determination of deceleration rate and wheel slip.

Basic system components include wheel sensors, fluid level and pressure switches, a pressure modulator, an accumulator, an electric booster pump, a master cylinder/power boost unit and an electronic control unit (Fig. 1). Two instrument cluster indicator lights (one red-one yellow) are used to signal system condition and operating status.

The anti-lock electronic control system is separate from other electrical circuits in the vehicle. A specially programmed ECU is used for operational control.

SERVICE SAFETY PRECAUTIONS

WARNING: THE NORMAL WORKING PRESSURE OF THE ANTI-LOCK BOOST SYSTEM IS 1650-2050 PSI. SYSTEM PRESSURE MUST BE PUMPED DOWN BEFORE ANY PRESSURE LINES ARE LOOSENED/DISCONNECTED. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY. TO REDUCE SYSTEM PRESSURE, TURN THE IGNITION SWITCH OFF. THEN APPLY THE BRAKES 45-50 TIMES (UNTIL PEDAL IS FIRM) TO REDUCE FLUID PRESSURE IN THE ACCUMULATOR, BOOSTER, PUMP AND LINES. WEAR SAFETY GOGGLES WHEN DISCONNECTING FLUID LINES.

THE ACCUMULATOR TANK AND THE SMALL ACCUMULATOR IN THE BOOSTER PUMP BOTH CONTAIN HIGH PRESSURE GAS CHARGES WHICH ASSIST IN MAINTAINING BOOST PRESSURE. DO NOT PUNCTURE OR ATTEMPT TO DISASSEMBLE EITHER OF THESE COMPONENTS AT ANY TIME.

WHEN SERVICING THE ANTI-LOCK SYSTEM, KEEP SYSTEM COMPONENTS CLEAN. DO NOT ALLOW ANY DIRT OR FORIEGN MATERIAL TO ENTER THE SYSTEM. CLEAN THE RESERVOIR CAP AND EXTERIOR THOROUGHLY BEFORE REMOVING THE CAP TO ADD FLUID. DIRT OR FOREIGN MATERIAL IN THE SYSTEM COULD RESULT IN POOR BRAKE SYSTEM PERFORMANCE AND POSSIBLE COMPONENT FAILURE.

USE MOPAR BRAKE FLUID OR EQUIVALENT MEETING SAE J1703 AND DOT 3 STANDARDS ONLY. NEVER USE RECLAIMED FLUID, FLUID FROM A CONTAINER THAT HAS BEEN ALLOWED TO STAND OPEN FOR ANY LENGTH OF TIME, OR FLUID NOT MEETING THE SAE AND DOT STANDARDS

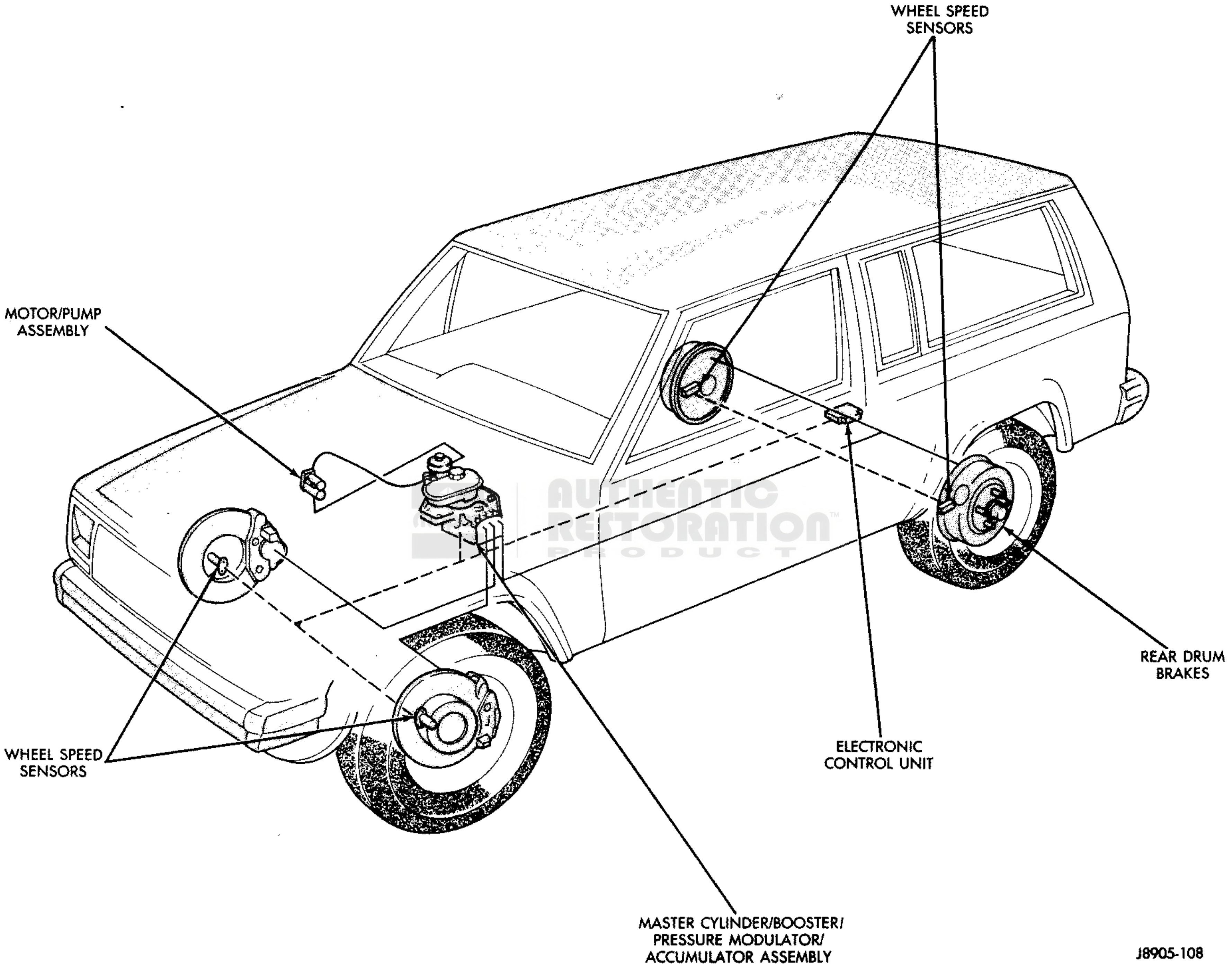


Fig. 1 Anti-Lock Brake System

ANTI-LOCK SYSTEM COMPONENTS

INDEX

MASTER CYLINDER/POWER BOOSTER UNIT

The master cylinder and power booster pistons are located in a single, cast aluminum, cylinder body. A fluid reservoir is attached to the body with rubber seals.

The fluid reservoir is internally separated into three sections by bulkheads (Fig. 2). A common fluid fill is used for the three sections.

The power booster is a demand type component. Power assist occurs only when the brakes are applied. Power assist is from high pressure brake fluid supplied by the electric motor driven booster pump. The pump is connected to the system accumulator. The accumulator is connected to the booster unit in the master cylinder.

PUMP AND MOTOR ASSEMBLY

The booster pump is powered by an electric motor (Fig. 3). The motor and pump are combined in a common housing. The pump piston operates off an eccentric drive. An internal relief valve and a pressure switch control pump output. The housing contains a small accumulator which operates in tandem with the main accumulator.

The pump supplies fluid boost pressure for both standard and anti-lock brake operation. Pump operating pressure range is 1650 - 2050 psi. The pump motor is equipped with a thermal fuse which stops the pump if operating temperatures approach overheat range. The fuse does not reset once it is tripped.

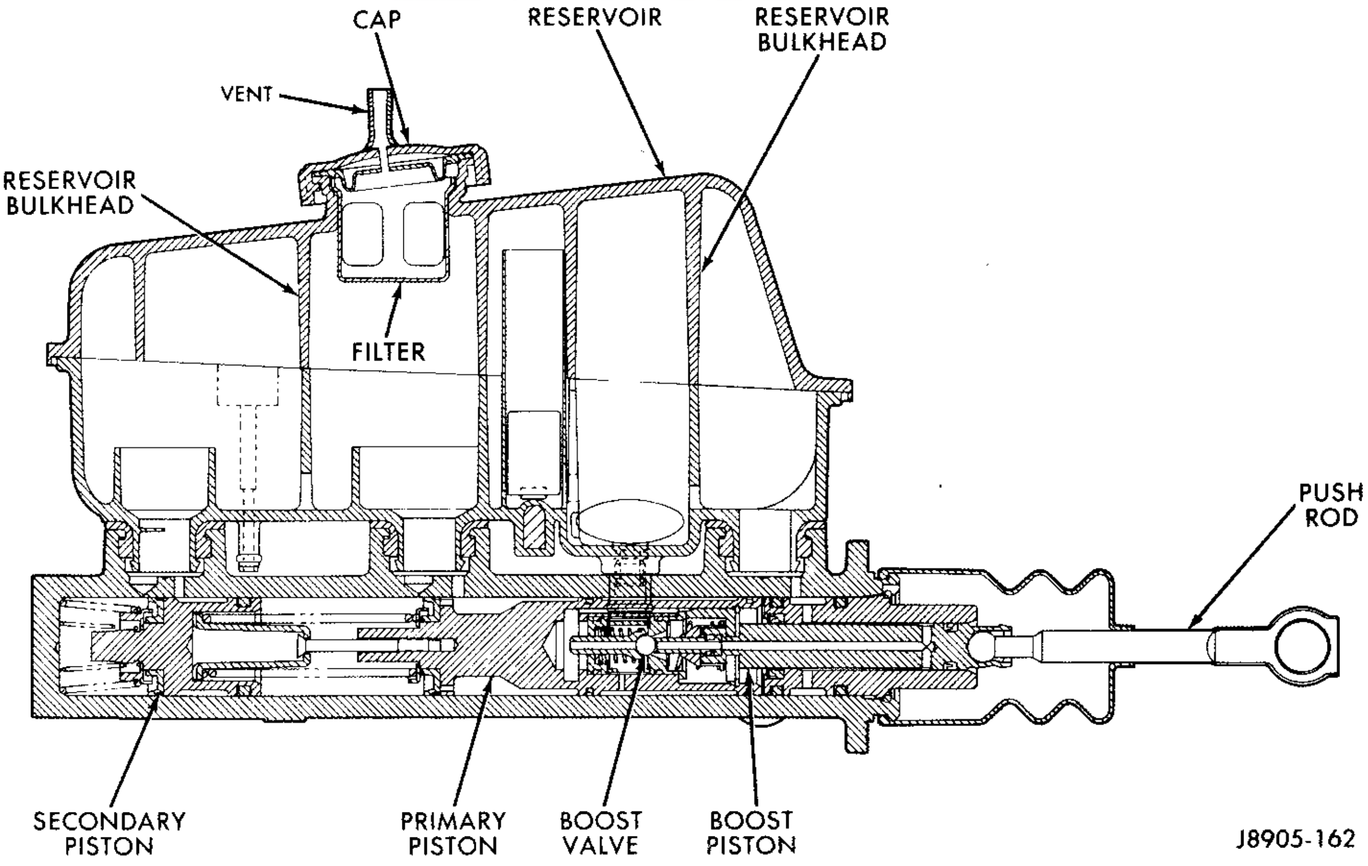


Fig. 2 Master Cylinder/Power Booster Unit

PRESSURE MODULATOR

The pressure modulator is a hydro-electric component. It provides three channel pressure control to the front/rear brakes. One channel controls the rear wheel brakes in tandem. The two remaining channels control the front wheel brakes individually. Modulator inputs are both hydraulic and electronic.

The modulator contains a total of nine solenoid valves. Three valves are assigned to each control channel. One channel section of the modulator is shown in Figure 4.

The three solenoid valves in each control channel have separate functions. The isolation solenoid valves isolate the master cylinder line to a caliper or wheel cylinder. The decay solenoid valves provide a controlled decrease (drop) in pressure to wheel brakes in anti-lock mode. The build solenoid valves provide controlled pressure build (increase) to the wheel brakes in anti-lock mode.

ACCUMULATOR AND LOW PRESSURE SWITCH

The accumulator stores fluid under pressure for power brake and anti-lock operation (Fig. 5). The low pressure switch monitors fluid pressure and is connected to the ECU.

If pressure falls below a minimum value of approximately 1050 psi, the switch triggers the ECU which stops cycling the modulator solenoids. The yellow indicator light illuminates when the solenoids cease operation in anti-lock mode.

The pressure switch is grounded through the vehicle body during normal operation but reverts to an open circuit if a pressure drop occurs. An open circuit wil trigger the instrument cluster indicator lights.

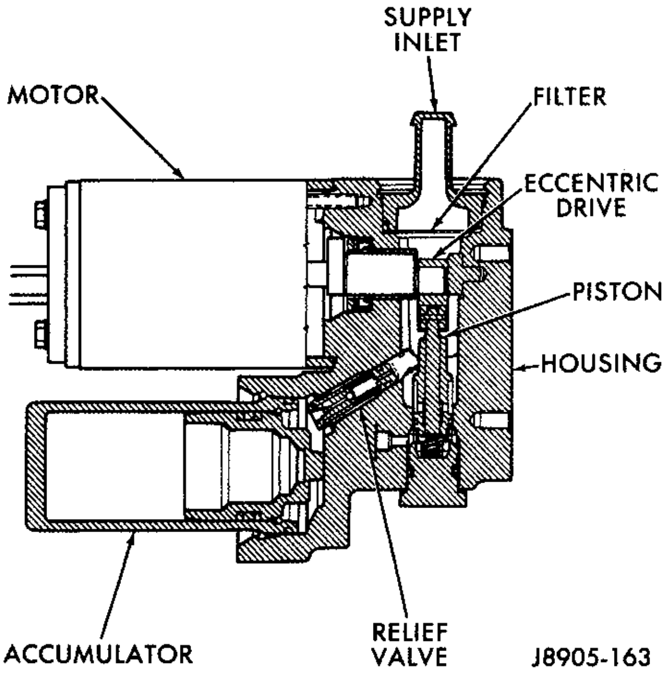


Fig. 3 Pump And Motor Assembly

The accumulator is connected to the pump and power booster unit respectively.

WHEEL SENSORS

A sensor is used at each wheel. The sensors convert wheel speed into an electronic signal which is transmitted to the anti-lock ECU. A toothed-type tone wheel serves as the trigger mechanism for each sensor. The tone wheels are mounted at the outboard ends of the front and rear axle shafts.

Refer to Figure 6 for front wheel sensor/tone wheel location and to Figure 7 for rear wheel sensor/tone wheel location.

BOOST PRESSURE DIFFERENTIAL SWITCH

The boost pressure differential switch is mounted in the pressure modulator (Fig. 8). The switch checks the pressure differential between modulated boost pressure and master cylinder primary system pressure.

The switch is in circuit with the ECU and instrument panel indicator lights. The switch is open when pressure differential is normal. The switch will ground (through the vehicle body) if a pressure differential problem is detected. Once grounded, the switch signals the ECU to illuminate the indicator lights.

FLUID LEVEL SWITCH

A fluid level switch is located in the master cylinder reservoir (Fig. 8). The switch activates the red indicator light if fluid level falls below required level. The yellow light also illuminates if vehicle speed is above approximately 2.5 mph (4 kph).

ANTI-LOCK ECU

A separate electronic control unit (ECU) is used to monitor and control the entire anti-lock system (Fig. 9). The ECU is attached to a bracket located under the rear seat. The power up voltage source for the ECU is through the ignition switch in the On and Run positions.

The anti-lock ECU is separate from the other vehicle electronic systems. It contains a self-diagnostic program which triggers the indicator lights when a system fault is detected. Faults are stored in a diagnostic program memory. Faults remain in memory until cleared. However, if the battery is disconnected, stored faults are erased.

The ECU is also equipped with a mercury switch. The switch monitors the degree of vehicle deceleration to determine what type of surface the vehicle is on. The switch provides input to the ECU for improved operation in 4WD mode on low traction (slippery) road surfaces. **Proper mounting angle of the ECU is critical to correct and accurate operation of the mercury switch.**

SYSTEM RELAYS

There are three system relays. The yellow indicator light and modulator power relays are located on the driver side inner fender panel (Fig. 10). The relay wires are in the engine compartment wire harness.

The pump/motor relay is part of the pump motor harness and is located at the passenger side of the engine compartment (Fig. 11).

The modulator power relay is connected to the pressure modulator solenoids and the ECU. When the system is powered up, the ECU supplies operating voltage (12 volts) to the solenoids through the relay.

The indicator light relay is connected to the modulator solenoid relay and the indicator light. The relay turns the yellow light on when the modulator power relay is off. The yellow light is turned off when the modulator power relay is energized.

The pump motor relay starts/stops the pump motor when signaled by the pump switch.

IGNITION SWITCH

The anti-lock ECU and indicator lights are in standby mode with the ignition switch in Off or Accessory position. No operating voltage is supplied.

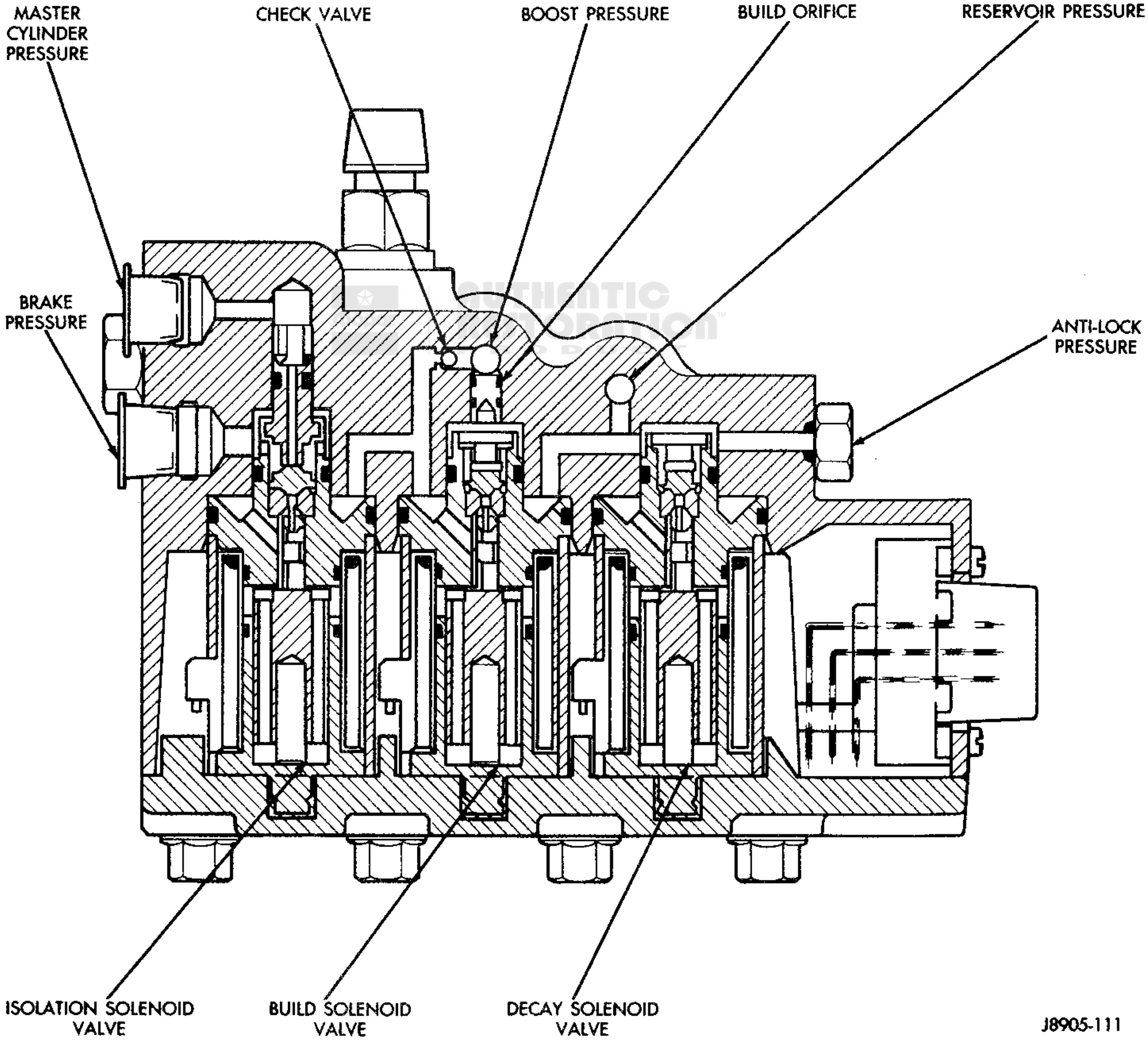


Fig. 4 Typical Pressure Modulator Channel

In On and Run positions, the switch supplies the ECU, pump motor and indicator lights with a 12 volt power supply.

In Start position, only the indicator lights are supplied with operating voltage. The remaining system components are in standby mode.

SYSTEM INDICATOR LIGHTS

Two indicator lights are used with the anti-lock system. One light is red and the other yellow. Both are in the instrument cluster. The lights are in circuit with the self diagnostic program in the ECU and signal both normal operation and system faults.

The yellow light indicates anti-lock system condition. It is in circuit with the modulator solenoids and relay. The light illuminates at start-up and goes out when the self-diagnostic program determines system operation is normal.

If a fault occurs, the yellow light remains on until the fault is either corrected, the battery is disconnected, or the ignition switch is cycled (turned off then on). Cycling the ignition switch may not turn the light off after some faults.

The yellow light illuminates in tandem with the red warning light to indicate certain types of faults. The pressure modulator solenoids are in circuit with the yellow indicator light. When the yellow light is on (system fault occurred), the solenoids are disabled.

The red light serves as the system warning light (low fluid, parking brake on, system pressure differential,

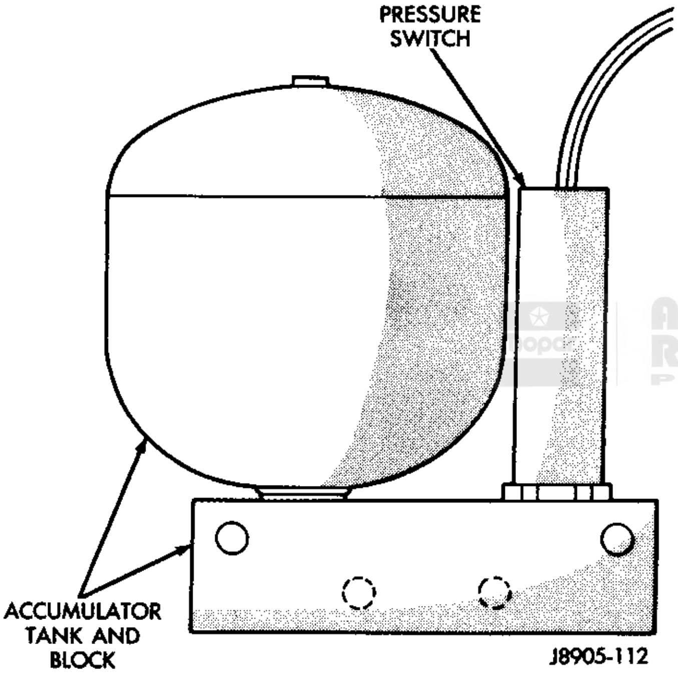


Fig. 5 Accumulator And Low Pressure Switch

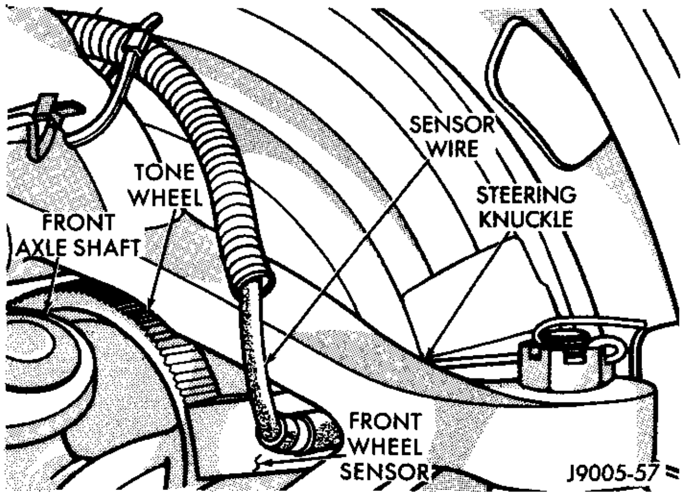


Fig. 6 Front Wheel Sensor And Tone Wheel

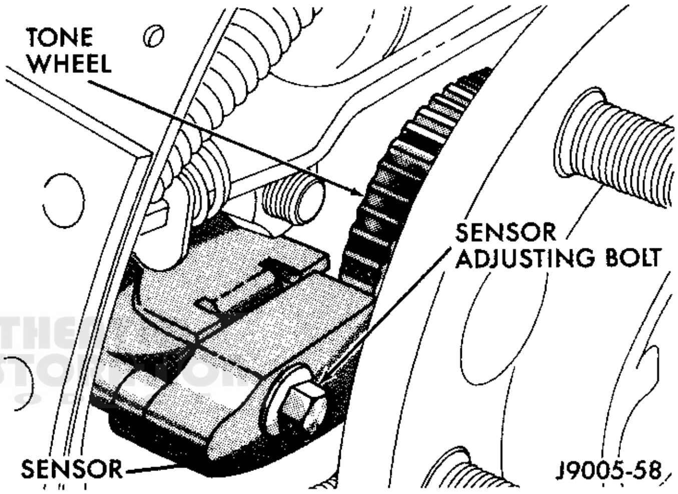


Fig. 7 Rear Wheel Sensor And Tone Wheel

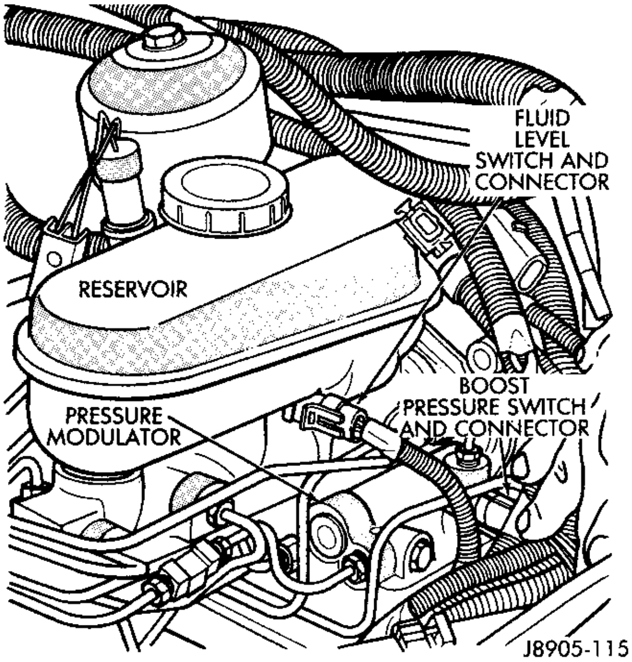


Fig. 8 Boost Pressure Differential And Low Fluid Switch Locations

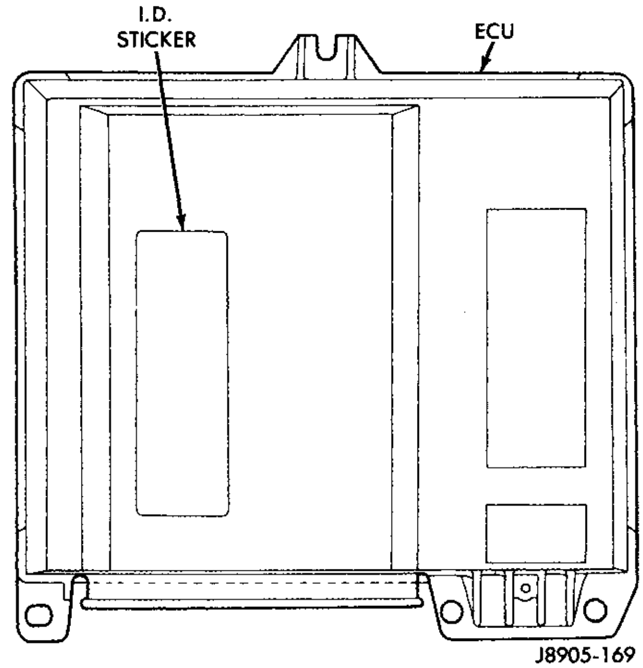


Fig. 9 Anti-Lock ECU

etc.). The light illuminates in tandem with the yellow anti-lock light when certain system faults occur.

There are time delays built into indicator light illumination. The delays are provided as a means of identifying some system faults.

COMBINATION VALVE

The combination front/rear brake pressure switch and proportioning valve is connected between the master cylinder and modulator. The switch and valve operate normally in standard braking mode. In anti-lock mode, the proportioning valve is isolated to enable brake pressure modulation during anti-lock system operation. The pressure differential switch is only activated by a difference in pressure between the front and rear (primary and secondary) brake circuits.

PARKING BRAKE SWITCH

The switch is connected to the ECU low fluid circuit. When the switch is activated, the red indicator light illuminates. If vehicle speed is above approximately 2.5 mph (4 kph), the yellow light will also illuminate.

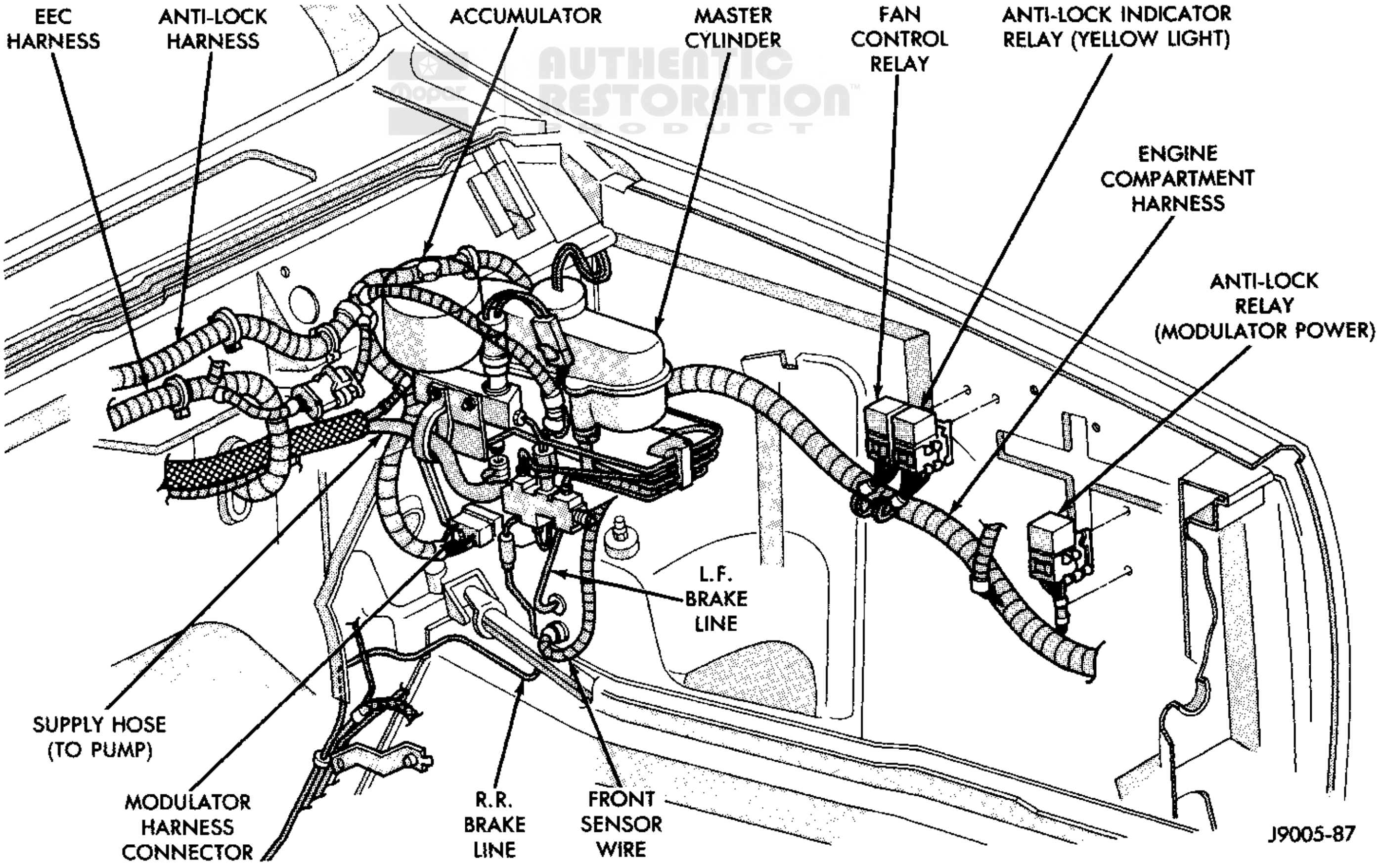


Fig. 10 Modulator And Indicator Light Relays And Harness Locations

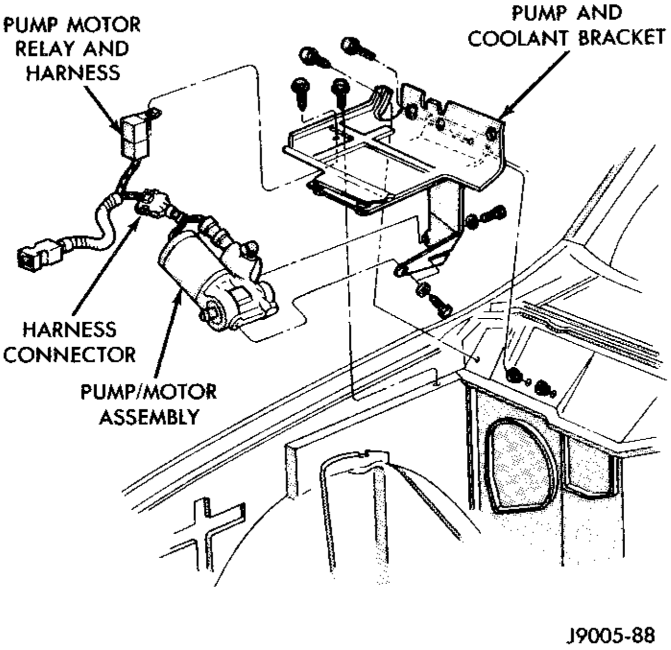


Fig. 11 Pump Motor Relay And Harness

SYSTEM OPERATION

INDEX

COMPONENT CONNECTIONS

The booster pump and accumulator provide the fluid pressure needed for power assist.

The accumulator is connected to the pump by a high pressure feed line. A second high pressure line connects the accumulator to the booster section of the master cylinder. A low pressure supply line connects the reservoir to the booster pump.

Fluid from the master cylinder is channeled to the calipers and wheel cylinders through the pressure modulator. The three solenoid valves (isolation-decay-build) in each modulator control channel are contained within the modulator body.

The wheel sensors are connected directly to the ECU. The sensor triggering devices (tone wheels), are mounted on the axle shafts.

SYSTEM POWER UP

The anti-lock system is in standby mode with the ignition switch in Off or Accessory position. When the switch is moved to Start position, voltage through the switch activates the indicator lights only. The ECU and other system components are still in standby mode.

The indicator lights illuminate as part of the self test feature and remain on until the switch is in Run position.

In On and Run position, 12 volts are supplied through the ignition switch to power up the ECU and system components.

When the vehicle is motionless (no wheel speed inputs) and the ignition switch is in On or Run position, the modulator solenoids are activated and briefly exercised. This serves two purposes: It checks solenoid function as part of the self diagnostic feature and ensures proper solenoid operation after periods of inactivity.

BOOST PRESSURE AND FLUID SUPPLY

The system main fluid supply is contained in the master cylinder reservoir and the accumulator. Additional fluid is also contained in the booster pump accumulator. The pump and main accumulator provide the reserve fluid pressure needed for power brake assist.

Fluid stored in the accumulator is at normal working pressure of 1650-2050 psi. The accumulator contains enough pressurized fluid for 25-30 power assisted brake applications if a pump fault should occur.

The main accumulator and the smaller accumulator in the booster pump, each contain a high pressure gas charge. The charge maintains system reserve pressure. Initial charge pressure is approximately 1000 psi (Fig. 12).

The gas charge and brake fluid are separated by a piston in the booster pump and by a diaphragm in the main accumulator tank (Fig. 12).

In operation, brake fluid pumped into the accumulators, fills the area below the pump piston and accumulator tank diaphragm (Fig. 13). The fluid presses the diaphragm (and piston) upward compressing the gas charge. This causes charge pressure to increase proportionately exerting a counterpressure against the brake fluid. When the booster pump is not running, gas charge counterpressure is enough to provide reserve pressure for system operation.

Booster pump motor operation is controlled by the pump relay and by a pressure switch within the pump/motor assembly. The pump operates only when the ignition switch is in On or Run position.

The pump does not run continously. It cycles on/off with the pump pressure switch. The pump is capable of running with or without connection to the ECU. Pressurized fluid from the pump is transmitted to the accumulator and power booster unit.

The booster pump motor is equipped with thermal protection. If the motor approaches an overheat condi-

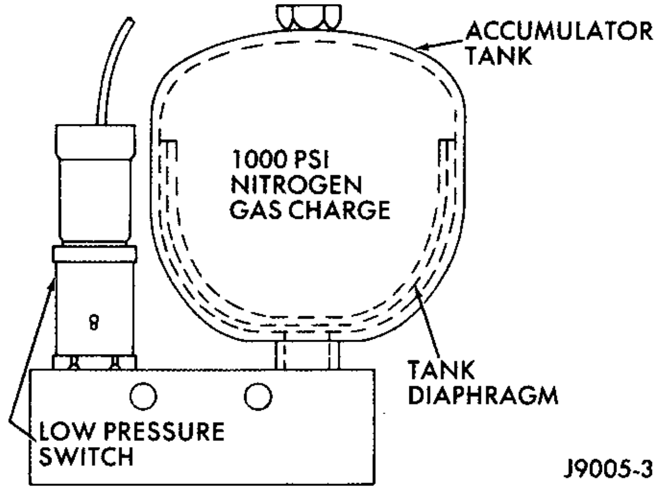


Fig. 12 Accumulator Charge Pressure-System Off

tion, a thermal fuse inside the pump will blow and shut off the motor. The fuse is not a reset-type and is not serviceable.

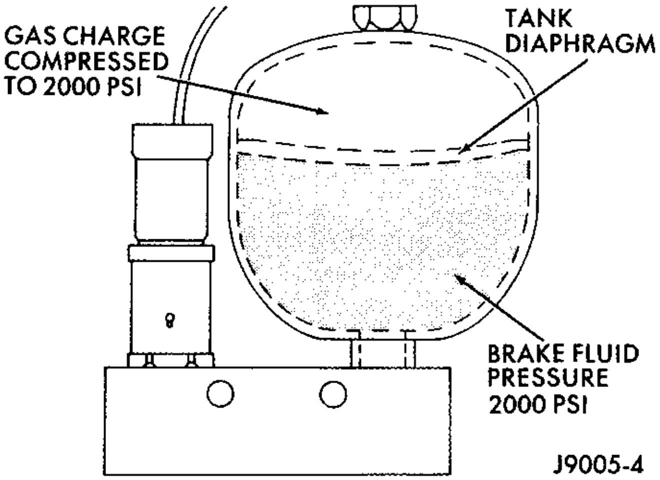


Fig. 13 Accumulator Charge Pressure-System Running

SENSOR INPUTS AND PRESSURE MODULATION

The wheel sensors and tone wheels supply wheel speed inputs to the ECU whenever the vehicle is in motion.

The ECU determines the degree of deceleration and wheel slip and provides optimum brake pressures for each control channel based on this data. The anti-lock system provides three channel control. The front wheels are controlled individually. The rear wheels are controlled in tandem (Fig. 14).

The ECU activates the pressure modulator solenoids which either build (increase), decay (decrease), or hold (maintain) fluid pressure as dictated by the ECU. The isolation solenoids isolate normal fluid pressure from the master cylinder to the rear wheels or to the left or right front wheel as needed. Wheel brake isolation occurs prior to build/decay solenoid operation.

Solenoid operation is not entirely constant in anti-lock mode. Operation occurs in brief, rapid cycles front-to-rear and side-to-side. Rapid changes in input data will produce equally rapid changes in pressure modulation. The isolation, decay, and build functions are capable of function changes and cycle times measured in milliseconds.

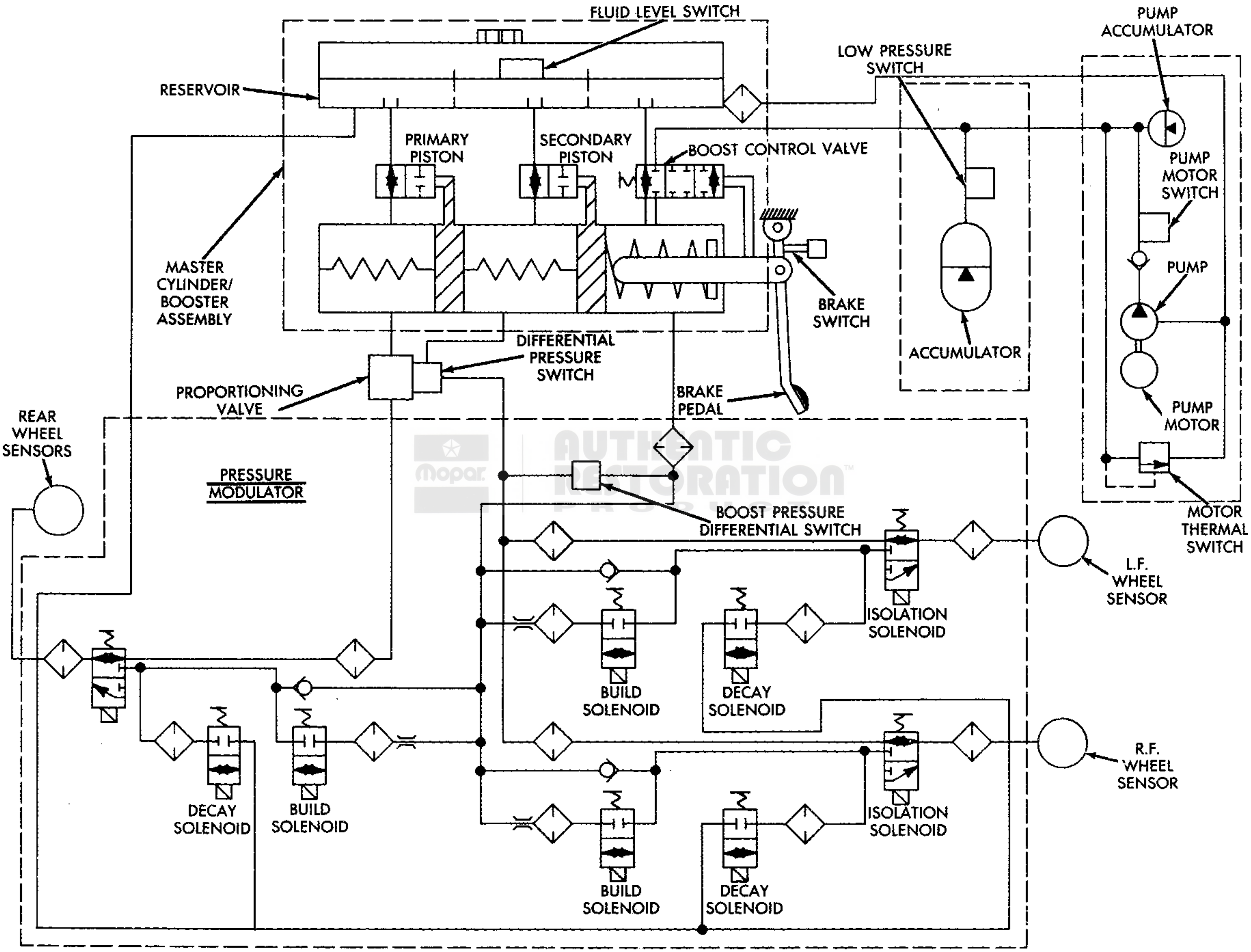


Fig. 14 Three Channel Anti-Lock System

J8905-167

SERVICE DIAGNOSIS

INDEX

WHEEL/TIRE SIZE AND INPUT SIGNALS

Anti-lock system operation is dependant on speed signals from the wheel sensors. The vehicle wheels and tires must all be the same size and type in order to generate accurate signals. Variations in wheel/tire size will produce inaccurate input signals resulting in incorrect pressure modulation.

OPERATIONAL SOUND LEVELS

The booster pump and/or relay may produce a clicking sound as they cycle on and off. In addition, the booster pump and motor and the pressure modulator solenoids may generate a buzzing-type sound when operating. The sound is due to normal pump motor and system operaton and is not indicative of a system fault. Under most conditions, the sound should not be audible.

VEHICLE RESPONSE IN ANTI-LOCK MODE

During anti-lock braking, the pressure modulator solenoids cycle rapidly in response to ECU inputs.

As the solenoids in each channel isolate, build and decay pressure as needed, the driver may experience a slight pulsing sensation within the vehicle. A firmer brake pedal and some pedal pulsation may also be noted during anti-lock mode braking.

The pulsing sensation occurs as the individual brake units apply or release during anti-lock mode braking. Pulsing is a result of normal front-to-rear and side-to-side pressure modulation.

INDICATOR LIGHT OPERATION

The red warning light and the yellow anti-lock indicator light both go on at start-up and go off when the engine is running. The one or two second illumination is part of a system self-test feature and indicates normal operation. System faults are indicated when one or both of the lights illuminate after the initial start up check. Refer to the diagnosis and indicator light display information.

DRIVER INDUCED SYSTEM FAULTS

Some driving or operational situations can induce faults in an anti-lock system that is actually operating correctly.

Induced faults are not true faults; a component malfunction has not actually occurred. Instead, they are a result of driver actions recognized by the diagnostic program as improper operation.

Improper parking brake use can induce faults in the self-diagnostic program. If a driver attempts to move the vehicle with the parking brakes applied, a system fault will register. Or, if the parking brake is applied while the vehicle is still in motion, a system fault will also register. One or both indicator lights will illuminate in either situation. The red light illuminates for parking brake faults. The yellow light illuminates if a fault is sensed.

Faults can be induced in the system through excessive wheel spin. Wheel spin due to low traction surfaces or high speed acceleration can induce a fault in a system that is operating normally. In addition, if system pressure is not restored after repair, a fault will register when the vehicle is driven.

Pumping or riding the brake pedal may also induce a fault causing the indicator light to go on.

STEERING RESPONSE

A modest amount of steering input is required during extremely high deceleration braking, or when braking on differing traction surfaces. An example of differing traction surfaces would be when the left side wheels are on ice and the right side wheels are on dry pavement.

LOSS OF SENSOR INPUT

Sensor malfunctions will most likely be due to loose connections, damaged sensor wires, or incorrect sensor-to-tone wheel air gap adjustment. Additional causes of sensor faults would be sensor and tone wheel misalignment or a damaged tone wheel.

SYSTEM DIAGNOSIS PROCEDURES

Anti-lock system diagnosis involves three basic procedures. The first requires observation of indicator light display sequence. The second is a visual examination of system components for low fluid levels, leak points, or visible damage. The third involves use of the DRB II tester to check operation and locate a malfunctioning circuit.

The two indicator lights will illuminate separately, simultaneously, or with varying delays depending on the fault. The lights signal low fluid levels, pressure drops and other hydro-electrical faults. Refer to the Service Diagnosis charts for indicator light display modes when a fault is detected.

The visual examination requires a check of reservoir fluid level and all system components to confirm or rule out leaks, loose connections, or mechanical component failures as a problem cause.

The final diagnosis step requires the use of the DRB II tester to determine the specific circuit at fault. The tester is connected to the diagnostic connectors on the passenger side of the engine compartment (Fig. 15). Refer to the DRB II Tester Manual section on anti-lock system diagnosis for procedures.

Faults read by the DRB II tester at initial tester reading should be used as a diagnosis guide only. Initial faults should be cleared and the vehicle road tested to reset any faults that remain in the system. Faults can be cleared by disconnecting the 2 amp, ABS BAT fuse for five or six seconds (Fig. 16).

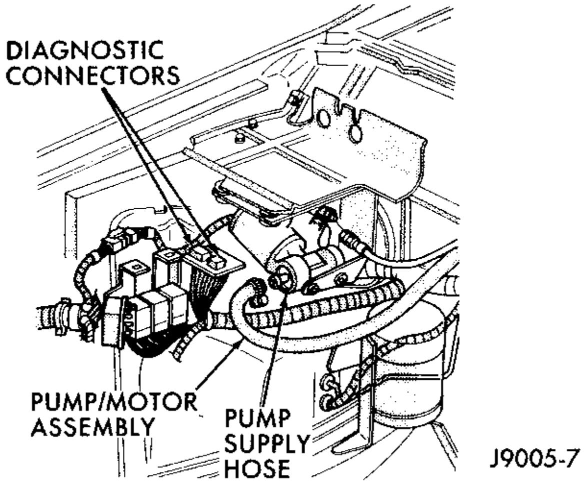


Fig. 15 Anti-Lock Diagnostic Connector Location

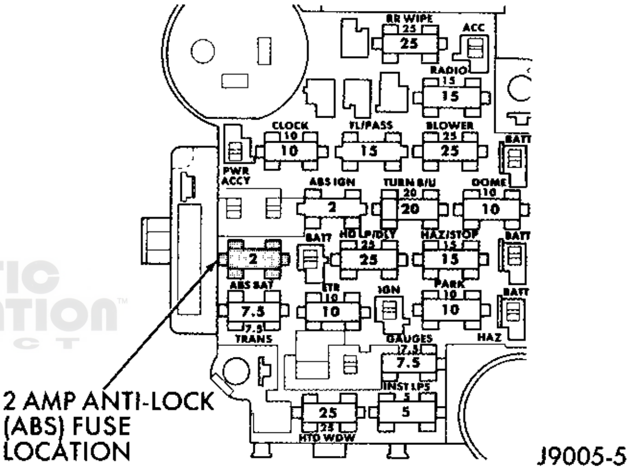


Fig. 16 Anti-Lock System Fuse Location

SERVICE DIAGNOSIS

SYSTEM FAULT	POSSIBLE CAUSE	INDICATOR LIGHT DISPLAY
LOW FLUID	SYSTEM LEAK. ACCUMULATOR CHARGE LOW OR LOST.	RED LIGHT ON. YELLOW LIGHT ON WITHIN 1/2 SECOND WHEN VEHICLE SPEED EXCEEDS 2.5 MPH.
PARKING BRAKES APPLIED	PARKING BRAKES NOT RELEASED BEFORE DRIVING VEHICLE.	RED LIGHT ON. YELLOW LIGHT ON IF VEHICLE SPEED EXCEEDS 2.5 MPH.
PRESSURE DROP AT ACCUMULATOR	ACCUMLATOR GAS CHARGE LOST. SYSTEM LEAK. PUMP/MOTOR MALFUNCTION. PROLONGED STOP ON ICY SURFACE WITH TRANSMISSION IN GEAR.	YELLOW LIGHT ON. RED LIGHT WILL ALSO COME ON WITHIN 20 SECONDS.
DIFFERENTIAL PRESSURE SWITCH (IN PROPORTIONING VALVE) ACTUATED	SYSTEM LEAK. MASTER CYLINDER MALFUNCTION (SECONDARY PISTON). AIR IN SYSTEM.	RED LIGHT ON. YELLOW LIGHT COMES ON AT VEHICLE SPEED OF 3 MPH.
PRESSURE DROP AT BOOST PRESSURE SWITCH AND PRESSURE DIFFERENTIAL SWITCH	MASTER CYLINDER MALFUNCTION (PRIMARY PISTON). SYSTEM LEAK. AIR IN SYSTEM.	RED LIGHT ON. YELLOW LIGHT COMES ON AT VEHICLE SPEED OF 3 MPH.
WHEEL SENSOR FAULT (FRONT ONLY)	SENSOR-TO-TONE WHEEL SPACING INCORRECT (SPACE TOO LARGE). DAMAGED SENSOR WIRE, SENSOR, OR TONE WHEEL. SENSOR AND TONE WHEEL MISALIGNED. SENSOR DISCONNECTED.	YELLOW LIGHT ON. (AFTER 15 MPH)
WHEEL SENSOR FAULT (FRONT OR REAR ONE OR TWO MISSING SIGNALS)	DAMAGED SENSOR, WIRE, OR CONNECTOR. SENSOR DISCONNECTED. EXCESSIVE WHEEL SPIN. MISALIGNED OR DAMAGED TONE WHEEL. OPEN SENSOR OR WIRE.	YELLOW LIGHT ON AT 15 MPH IF FAULT OCCURRED BEFORE VEHCLE DRIVE-OFF. OR, YELLOW LIGHT ON AT 8 MPH IF FAULT OCCURRED AFTER VEHICLE DRIVE-OFF.
EXCESSIVE DECAY SOLENOID OPERATION	MODULATOR/SOLENOID FAULT. WHEEL SENSOR FAULT. EXTREMELY LOW AMBIENT TEMPERATURES. VEHICLE ON ICE COVERED SURFACE. TIRES HYDROPLANING ON WATER COVERED ROAD SURFACE.	YELLOW LIGHT ON WITHIN 1-2 SECONDS.
PRESSURE MODULATOR SOLENOID FAULT	SOLENOID SHORTED OR OPEN. DECAY AND BUILD SOLENOID ON AT SAME TIME. OPEN/SHORT IN MODULATOR HARNESS.	YELLOW LIGHT ON.
PUMP/MOTOR RUN-ON	EXCESSIVE RUN TIME. RELAY SHORTED, MOTOR SWITCH SHORTED.	RED LIGHT ON IF PUMP RUNS MORE THAN 4 MINUTES WITH NO BRAKE.
PUMP/MOTOR INOPERATIVE	PUMP RELAY FAULT. NO VOLTAGE TO MOTOR. DAMAGED PUMP OR MOTOR. PUMP GAS CHARGE LOST.	YELLOW LIGHT ON. RED LIGHT ON AFTER 20 SECONDS.
LOW VOLTAGE	SYSTEM VOLTAGE BELOW 9V. SHORT, OPEN IN FEED WIRES OR RELAY. FUSE BAD. POOR GROUND. LOOSE, DISCONNECTED WIRE IN SYSTEM. BATTERY LOW OR DISCHARGED	YELLOW LIGHT ON.
NO BRAKE SIGNAL	SYSTEM LEAK. MASTER CYLINDER MALFUNCTION. PUMP/MOTOR MALFUNCTION. ACCUMULATOR OR MODULATOR FAULT.	RED LIGHT ON DURING BRAKING.
RELAY FAULT	RELAY SHORTED OR OPEN.	YELLOW LIGHT ON.
ECU SELF DIAGNOSTIC FEATURE INOPERATIVE (SOLENOIDS NOT TEST-EXERCISED AT START-UP)	IGNITION SWITCH IN OFF POSITION. PARKING BRAKES ON (NOT RELEASED AT DRIVE-OFF). SYSTEM COMPONENT HAS MALFUNCTIONED. LOW FLUID LEVEL/LEAK IN SYSTEM.	YELLOW LIGHT ON.

J9005-6

COMPONENT SERVICE

INDEX

COMPONENT SERVICEABILITY

The master cylinder/power booster unit, pressure modulator, accumulator, pump/motor and proportioning valve (Fig. 1) are not repairable components. If diagnosis indicates a malfunction has occured, these components are to be replaced as a complete assembly.

The fluid level switch in the master cylinder and the boost pressure switch in the modulator are also not serviceable. The switches cannot be removed from their respective components.

The electrical harnessess, pump bracket, pump high pressure and supply hose, system relays, and wheel sensors can be serviced individually.

The tone wheels are permanently attached to the axle shafts and are not replaceable. If a tone wheel becomes damaged, it will be necessary to replace the tone wheel and axle shaft as an assembly.

The wheel brake components such as the calipers, brakeshoes, wheel cylinders, rotors and drums are all serviced the same as standard brake system components.

WHEEL SENSORS

The wheel sensors have a polyethylene spacer strip attached to the sensor contact face. When installing a sensor, be very sure this spacer strip actually touches the tone wheel. The strips are made in the exact thickness needed for correct sensor-to-tone wheel spacing

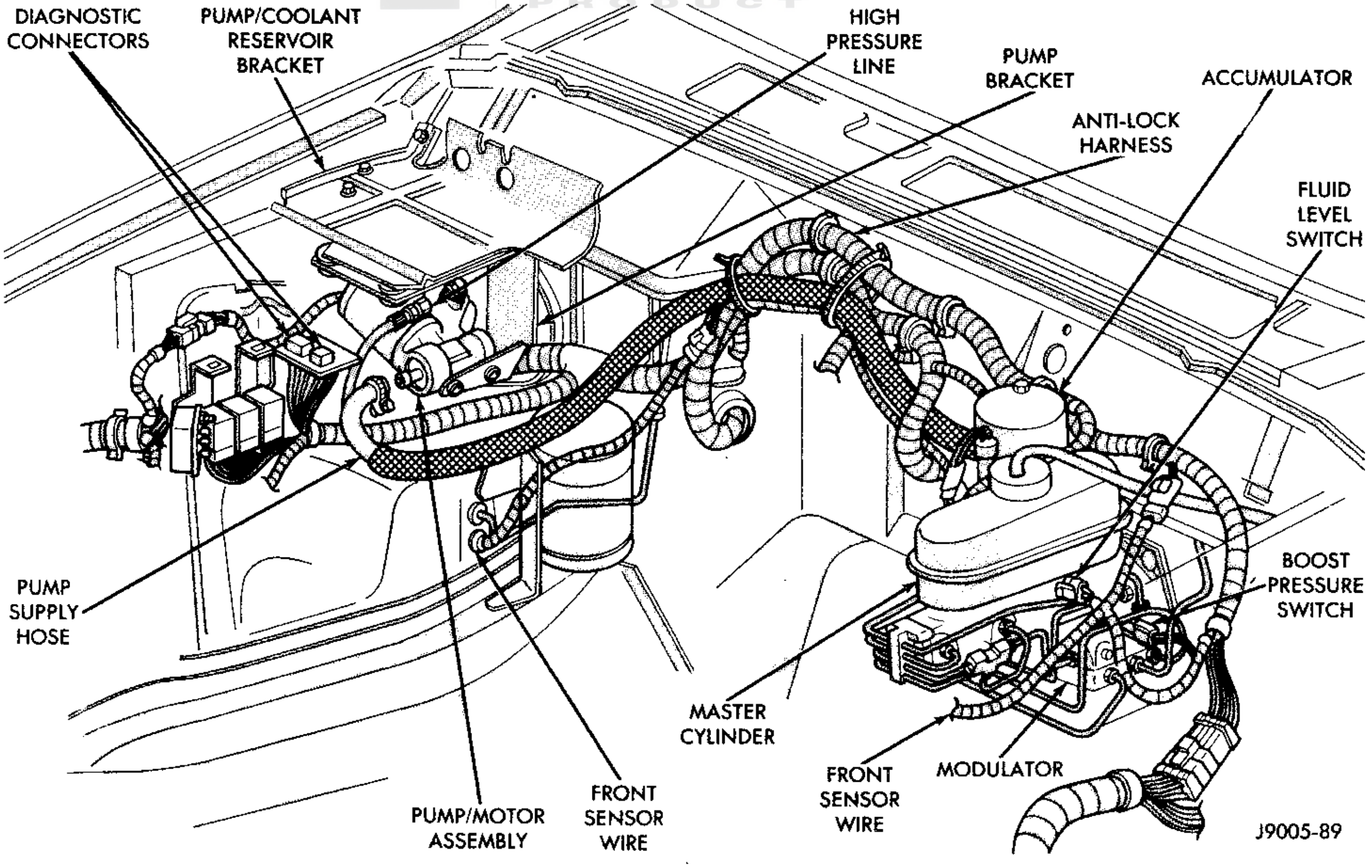


Fig. 1 System Components And Location

(air gap). **If the spacing (air gap) is too great, the sensors will not transmit accurate speed signals to the ECU.**

If the spacer strip is missing from an original (or new) sensor, the correct sensor-to-tone wheel air gap will have to established with a brass feeler gauge. **A brass feeler gauge must be used to avoid disrupting sensor polarity.**

If the spacer strip is missing from a reusable sensor, set sensor-to-tone wheel air gap as follows:

- front sensor air gap is .013 - .019 inch (.33 - .48 mm)
- rear sensor air gap is .030 - .036 inch (.76 - .91 mm)

Front Wheel Sensor Removal

(1) Raise vehicle and turn wheel outward for easier access to sensor.

(2) Cut tie straps securing sensor wire to steering knuckle and front brake hose and line.

(3) If sensor is covered with heavy accumulations of dirt, mud, or road splash, clean the sensor and surrounding area before proceeding. This is necessary to avoid possible damage when removing the sensor.

(4) Remove bolt attaching sensor to steering knuckle and remove sensor (Fig. 2).

(5) Unseat grommet retaining sensor wire in wheel house panel.

(6) In engine compartment, disconnect sensor wire connector at anti-lock harness plug. Then remove sensor and wire.

Front Wheel Sensor Installation

(1) Inspect new, or original sensor and note condition of spacer strip (Fig. 3). If strip is securely attached and in good condition, a spacing (air gap) adjustment will not be needed. However, if the strip is loose or damaged, correct air gap will have to established with a brass feeler gauge.

(2) Feed sensor wire through grommet hole in wheelhouse panel.

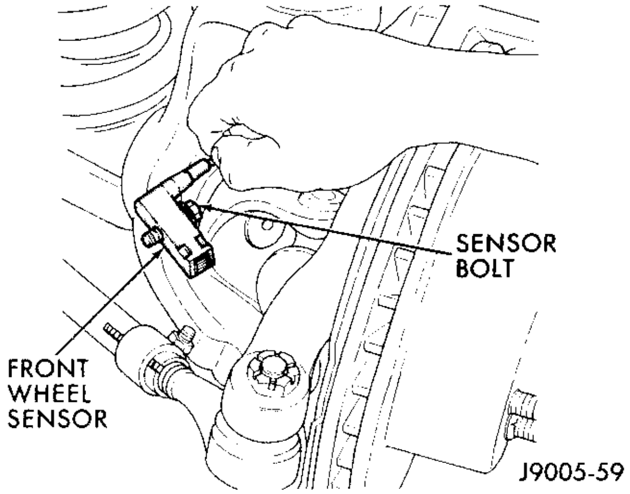


Fig. 2 Front Sensor Removal/Installation

(3) Connect sensor to harness plug.

(4) Seat sensor wire grommet in wheel house panel.

(5) Position sensor on steering knuckle and install sensor attaching bolt finger-tight.

(6) If sensor spacer strip was in good condition and securely attached, lightly press sensor **against** tone wheel. Then tighten sensor bolt to 11 ft-lbs (14 N•m) torque.

(7) If sensor spacer strip is missing, loose or damaged and sensor contacts are exposed (Fig. 4), perform steps (a), (b) and (c):

(a) Remove spacer strip completely if loose or torn. Then wipe sensor contacts clean with a shop towel (Fig. 4).

(b) Set sensor-to-tone wheel air gap at .013 - .019 inch (.33 - .48 mm) with brass feeler gauge (Fig. 5).

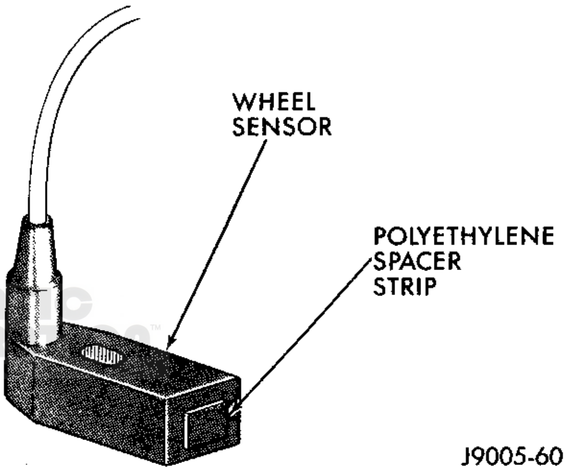


Fig. 3 Sensor Spacer Strip

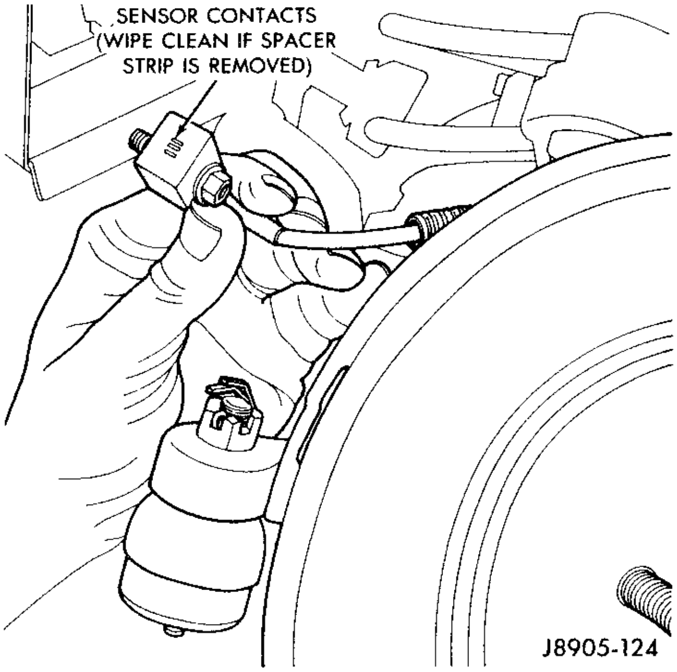


Fig. 4 Sensor Contacts—Spacer Strip Removed

(c) Tighten sensor bolt to 11 ft-lbs (14 N•m) torque and recheck spacing.

(8) Secure sensor wire to brake line and steering knuckle with new tie straps.

Rear Sensor Removal

(1) Raise and fold rear seat forward for access to rear sensor connectors (Fig. 6).

(2) Disconnect sensors at harness connectors (Fig. 6).

(3) Push sensor grommets and sensor wires through floorpan (Fig. 6).

(4) Raise vehicle.

(5) Remove wheel and brake drum.

(6) Cut and remove tie straps securing sensor wires to axle and rear brake hose (Fig. 7).

(7) Unseat sensor support plate grommet.

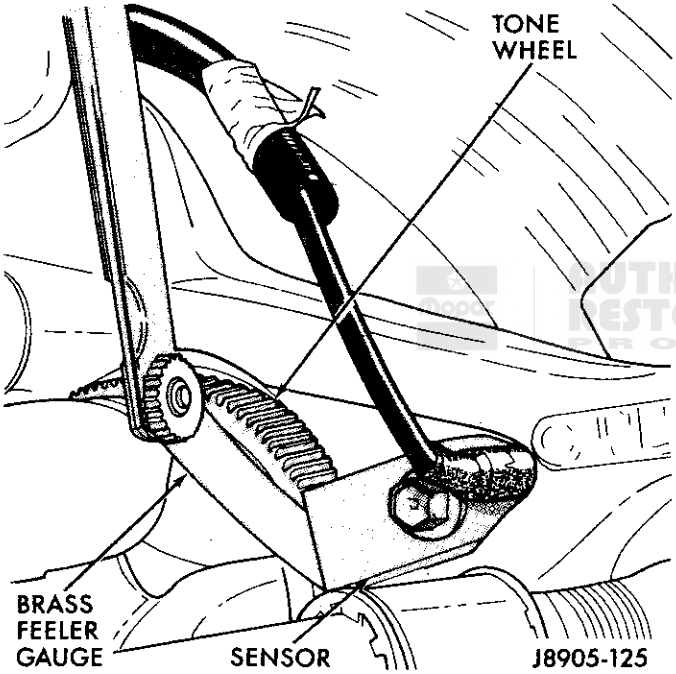


Fig. 5 Adjusting Sensor-To-Tone Wheel Air Gap

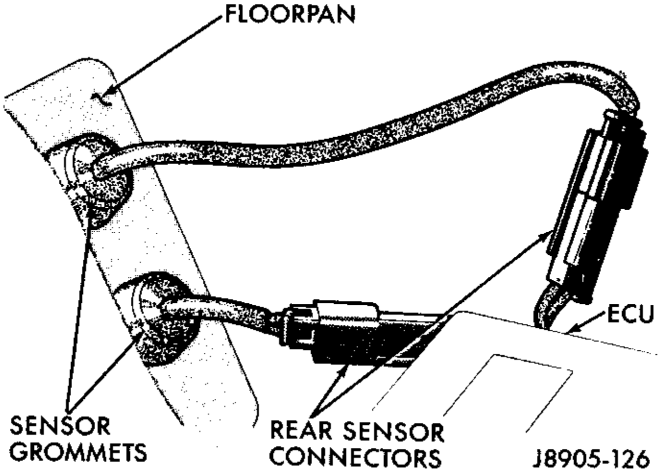


Fig. 6 Rear Sensor Connectors

(8) Remove bolt attaching sensor to bracket (Fig. 9) and remove sensor by pulling wire through grommet hole in support plate.

Rear Sensor Installation

(1) Inspect new, or original sensor and note condition of spacer strip (Fig. 3). If strip is securely attached and in good condition, a spacing (air gap) adjustment will not be needed. However, if the strip is loose or damaged, correct air gap will have to established with a brass feeler gauge.

(2) Insert sensor wire through support plate hole and seat sensor grommet in backing plate.

(3) If sensor spacer strip is in good condition and securely attached, lightly press sensor **against** tone wheel. Then tighten sensor bolt to 11 ft-lbs (14 N•m) torque.

(4) If sensor spacer strip is missing, loose or damaged, perform steps (a), (b) and (c):

(a) Remove spacer strip completely if loose or torn. Then wipe sensor contact face clean with shop towel.

(b) Set sensor-to-tone wheel air gap at .030 - .036 inch (.76 - 91 mm) with brass feeler gauge.

(c) Tighten sensor adjusting bolt to 11 ft-lbs (14 N•m) torque and recheck spacing (Fig. 8).

(5) Route sensor wires to rear seat area.

(6) Feed sensor wires through floorpan access hole and seat sensor grommets in floorpan.

(7) Secure sensor wire to rear brake hose and axle with new tie straps (Fig. 25). Verify that wire is clear of rotating components.

(8) Install brake drum and wheel. Then lower vehicle.

(9) Connect sensors to harness connectors (Fig. 6).

(10) Reposition carpet and fold rear seat down.

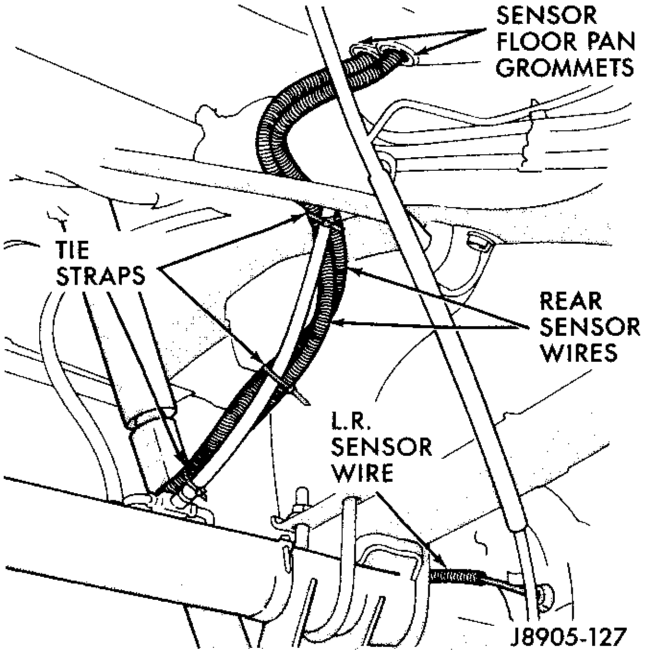


Fig. 7 Rear Sensor Wire Routing And Attachment

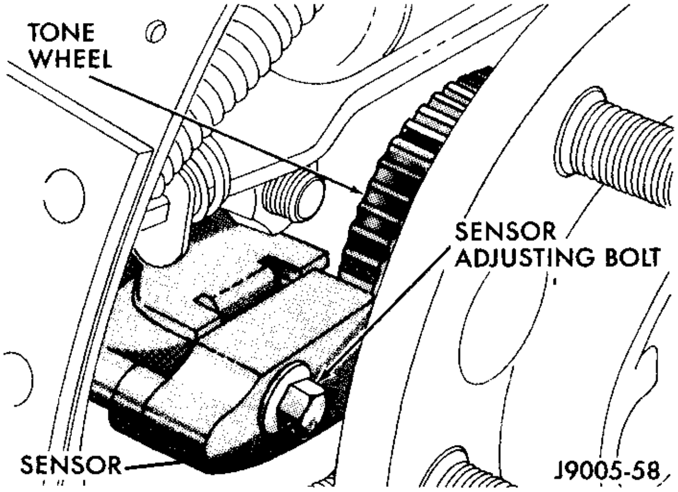


Fig. 8 Rear Sensor Installation

HARNESS REPLACEMENT

Harness Removal

(1) Disconnect the battery.

(2) Disconnect the harness from the modulator, boost switch, low fluid switch, low pressure switch and engine (EEC) harness.

(3) Disconnect the front and rear sensor wires from the anti-lock harness connectors.

(4) Disconnect anti-lock connector from instrument panel connector.

(5) Unseat harness grommet in dash panel.

(6) Feed the harness through the dash panel and into the passenger compartment.

(7) Loosen the seat mounting bolts/nuts.

(8) Remove the sill trim.

(9) Move the front and rear carpeting aside.

(10) Remove the harness tie straps, clips and retainers (Fig. 9).

(11) Tilt the rear seat cushion forward for access to the ECU.

(12) Disconnect the harness rear ground wires (Fig. 9).

(13) Disconnect the rear sensor wires (Fig. 9).

(14) Remove the ECU mounting bracket screws and remove the bracket and ECU.

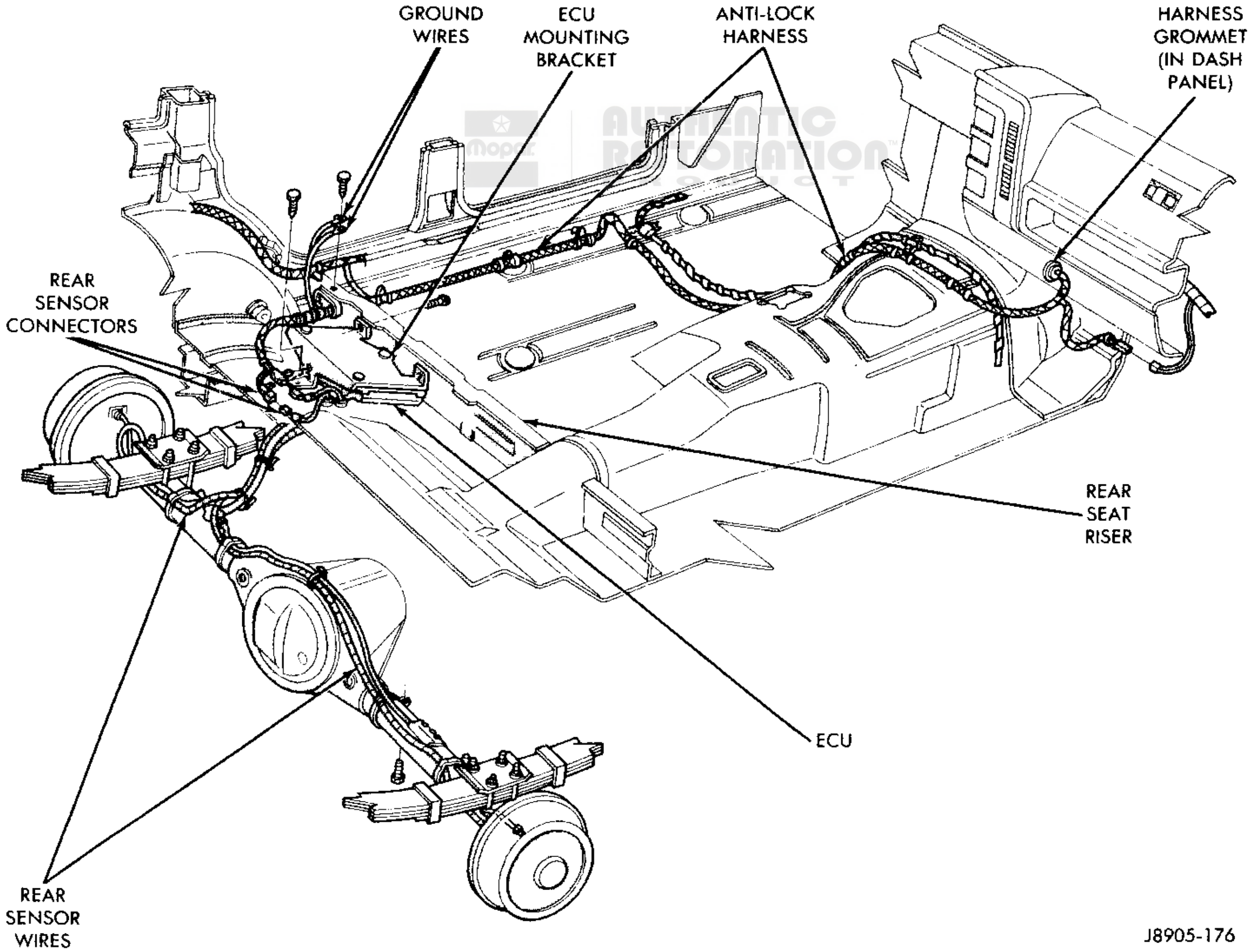


Fig. 9 Anti-Lock Harness Routing

(15) Disconnect the harness at the ECU.

(16) Remove the harness from the vehicle.

Harness Installation

(1) position the harness in the vehicle.

(2) Connect the harness to the ECU and install the ECU and mounting bracket (Fig. 9).

(3) Connect the harness rear ground wires and connect the rear sensor wires (Fig. 9).

(4) Secure the harness to the sill and floorpan with the necessary tie straps, clips and retainers.

(5) Connect the anti-lock harness to the instrument panel connector.

(6) Reposition the carpeting, install the sill trim and tighten the seat bolts.

(7) Tilt the rear seat cushion into place.

(8) Route the harness over the transmission tunnel and to the dash panel opening. Feed the harness through the dash and into the engine compartment. Seat the harness grommet in the dash.

(9) Connect the harness to the sensors, switches, modulator and connect the ground wires.

(10) Connect the battery.

BOOSTER PUMP AND MOTOR

Pump And Motor Removal

WARNING: THE NORMAL WORKING PRESSURE OF THE ANTI-LOCK BOOST SYSTEM IS 1650-2050 PSI. SYSTEM PRESSURE MUST BE PUMPED DOWN BEFORE ANY PRESSURE LINES ARE LOOSENED/DISCONNECTED. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY. TO REDUCE SYSTEM PRESSURE, TURN THE IGNITION SWITCH OFF. THEN APPLY THE BRAKES 45-50 TIMES (UNTIL BRAKE PEDAL BECOMES FIRM ON INITIAL APPLY) TO REDUCE FLUID PRESSURE IN THE ACCUMULATOR, BOOSTER, PUMP AND LINES. WEAR SAFETY GOGGLES WHEN DISCONNECTING SYSTEM FLUID LINES.

(1) Turn ignition switch to Off position and apply brakes (pump pedal) 45-50 times (until pedal is firm on initial apply) to reduce system fluid pressure. **When reserve pressure is depleted, the reservoir fluid level will rise above the MAX fill mark but will not overflow unless the reservoir was overfilled to begin with.**

(2) Disconnect battery negative cable.

(3) Remove coolant pressure bottle retaining strap and move reservoir aside (Fig. 10). It is not necessary to disconnect pressure bottle hoses. Just move bottle aside for working clearance.

(4) Remove bolts attaching two-piece mounting bracket to dash and inner fender panels (Fig. 10).

(5) Rotate bracket and pump/motor assembly to one side for access to wires and hoses.

(6) Disconnect pump motor harness from engine harness (Fig. 11).

(7) Slowly loosen pump pressure line at pump (Fig. 12) and allow any residual fluid pressure to bleed off. Then disconnect line from pump.

(8) Position drain container under pump return line. Then loosen return line hose clamp and remove line from pump (Fig. 12). Discard fluid that drains from line.

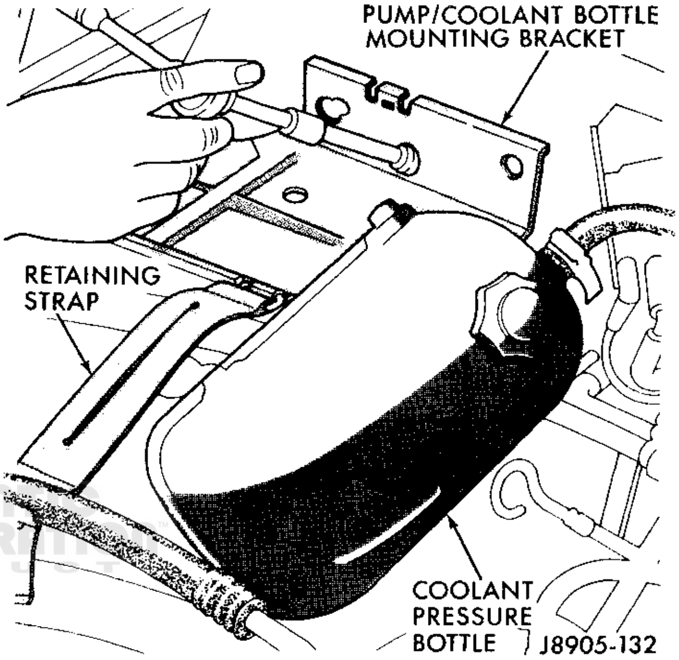


Fig. 10 Removing/Installing Coolant Bottle And Mounting Bracket

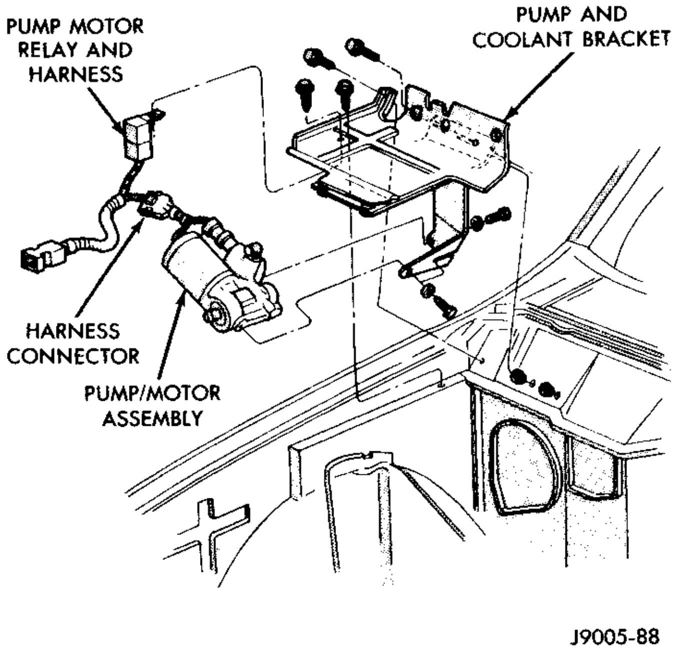


Fig. 11 Pump Motor Relay And Harness Location

(9) Remove pump/motor and bracket as assembly.

(10) Remove screw attaching relay to mounting bracket.

(11) Remove screws attaching pump/motor assembly to bracket and separate components (Fig. 11).

Pump/Motor Installation

(1) Position pump/motor assembly on bracket and install assembly attaching screws.

(2) Attach pump/motor assembly to bracket (Fig. 11).

(3) Attach pump relay to mounting bracket (Fig. 13).

(4) Connect pressure and return lines to pump.

(5) Connect pump motor harness.

(6) Position mounting bracket on dash panel and install bracket attaching bolts and screws (Fig. 13).

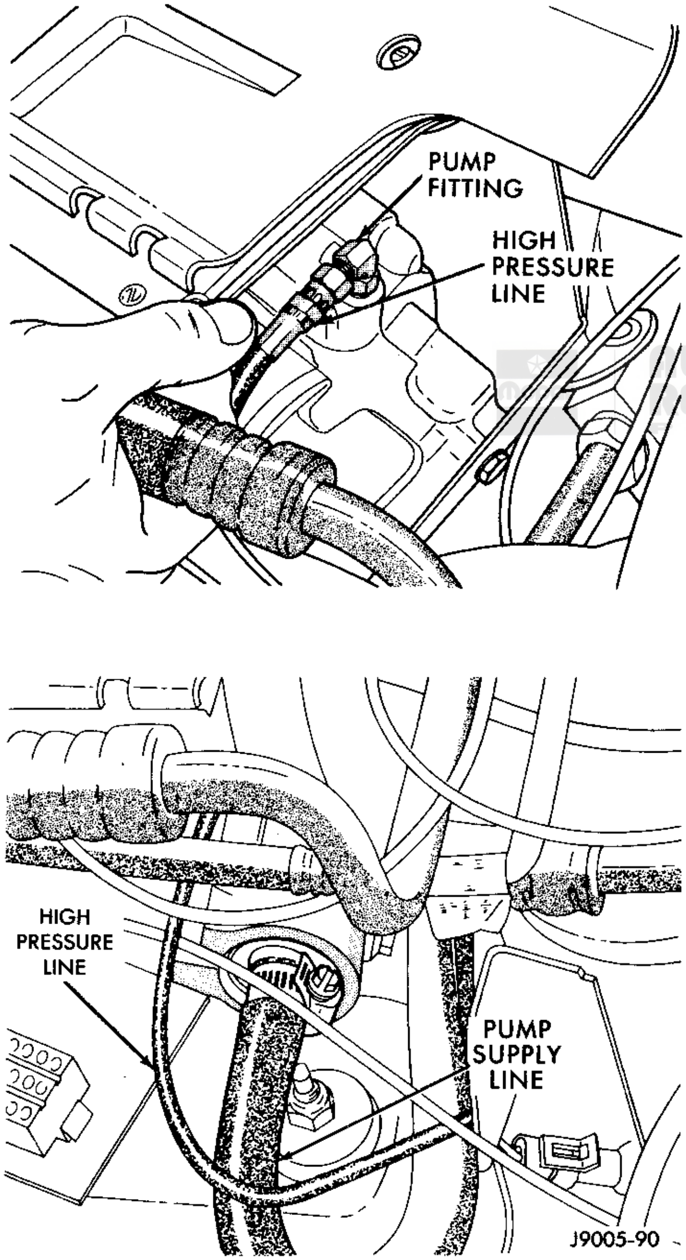


Fig. 12 Pump Pressure And Supply Line Connections

(7) Check pump high pressure and supply (return) line routing. Be sure lines are not kinked or touching engine.

(8) Clean master cylinder exterior and cap. Fill master cylinder reservoir to top of V-shaped Max indicator mark. Use Mopar brake fluid or equivalent with SAE J1703 and DOT 3 rating only.

CAUTION: Do not overfill the reservoir. Overfilling will cause overflow and could damage the reservoir. Add fluid to the V-shaped Max indicator mark only.

(9) Connect the battery.

(10) Turn ignition switch to On position to start pump running. While pump is running, listen for rpm drop which indicates pump is pressurizing. If pump rpm does not drop after 20 seconds, immediately turn ignition switch to Off position and check pump hydraulic connections.

CAUTION: Do not allow the pump to run if it does not pressurize. If pump rpm does not drop after 20 seconds run time, turn the ignition switch off immediately to avoid pump damage.

(11) Add fluid to master cylinder reservoir if necessary.

MASTER CYLINDER/MODULATOR/ ACCUMULATOR

The master cylinder, modulator and accumulator are serviced as as an assembly only. Do not attempt to disassemble or repair these components.

WARNING: THE NORMAL WORKING PRESSURE OF THE ANTI-LOCK BOOST SYSTEM IS 1650-2050 PSI. SYSTEM PRESSURE MUST BE

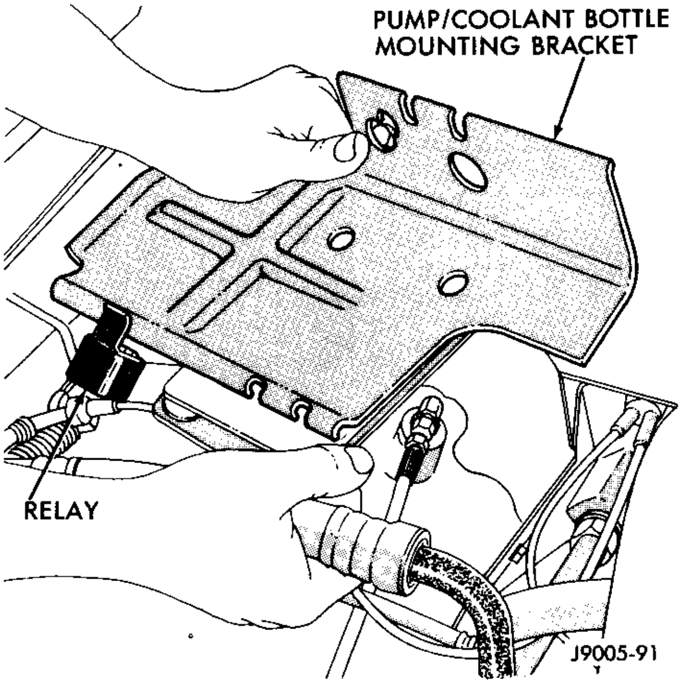


Fig. 13 Installing Relay And Pump Mounting Bracket

PUMPED DOWN BEFORE ANY PRESSURE LINES ARE LOOSENED/DISCONNECTED. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY. TO REDUCE SYSTEM PRESSURE, TURN THE IGNITION SWITCH OFF. THEN APPLY THE BRAKES 45-50 TIMES (UNTIL PEDAL BECOMES FIRM) TO REDUCE FLUID PRESSURE IN THE ACCUMULATOR, BOOSTER, PUMP AND LINES. WEAR SAFETY GOGGLES WHEN DISCONNECTING SYSTEM FLUID LINES.

Master Cylinder/Modulator/Accumulator Removal

(1) Pump system pressure down by turning ignition Off and applying brake pedal 45-50 times until pedal becomes firm.

(2) Disconnect battery.

(3) Remove windshield washer fluid reservoir attaching screws. Disconnect reservoir hoses and wires and remove reservoir (Fig. 14).

(4) Remove air cleaner assembly.

(5) Disconnect ECU harness wire connectors at pressure modulator (Fig. 15).

(6) Disconnect wires at proportioning valve differential switch (Fig. 15).

(7) Disconnect brakeline at underside of proportioning valve at coupling (Fig. 15).

(8) Disconnect high pressure line at accumulator block (Fig. 16). Cap line to prevent dirt entry.

(9) Disconnect supply line at reservoir (Fig. 16). Cap line to prevent dirt entry. Discard fluid that drained from line.

(10) Disconnect low pressure switch wires (Fig. 32).

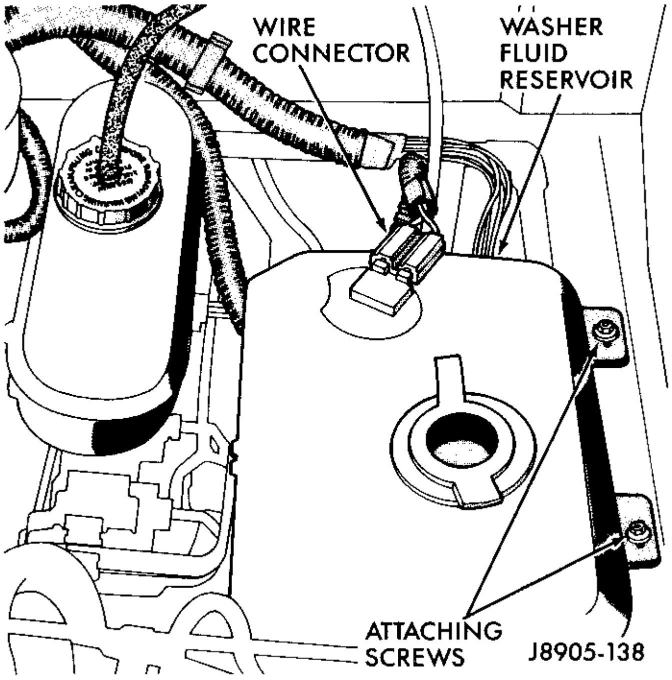


Fig. 14 Removing Washer Fluid Reservoir

(11) Disconnect wires at modulator boost pressure and fluid level switches (Fig. 17).

(12) Disconnect front brakelines at outboard side of pressure modulator.

(13) If necessary, remove instrument panel lower trim cover for access to brake pedal.

(14) Disconnect brakelight switch wires (Fig. 18).

(15) Remove master cylinder push rod bolt and disconnect push rod from pedal (Fig. 18). Discard push rod bolt nuts. They are not reusable.

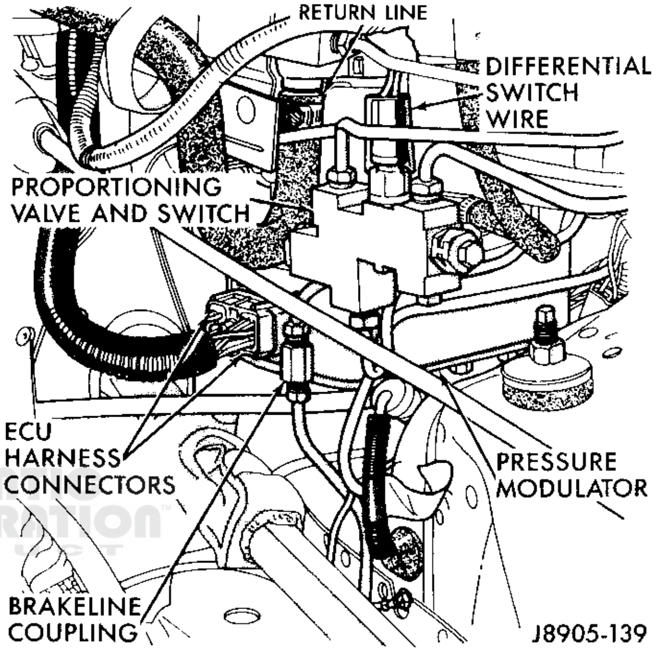


Fig. 15 ECU Harness And Fluid Connections

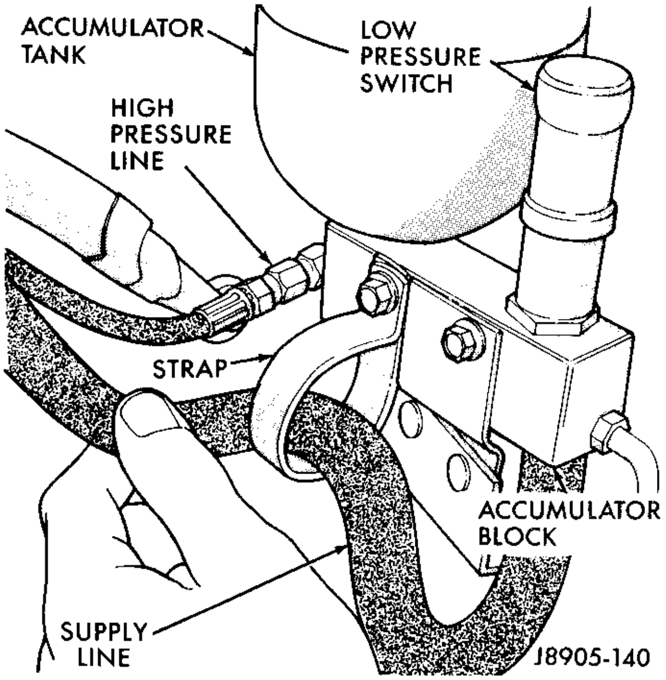


Fig. 16 Fluid Line Connections

(16) Remove brake mounting bracket stud nuts (Fig. 19).

(17) In engine compartment, pull brake hydraulic components and mounting bracket forward until bracket studs are clear of dash. Then lift assembly up and out of engine compartment (Fig. 19).

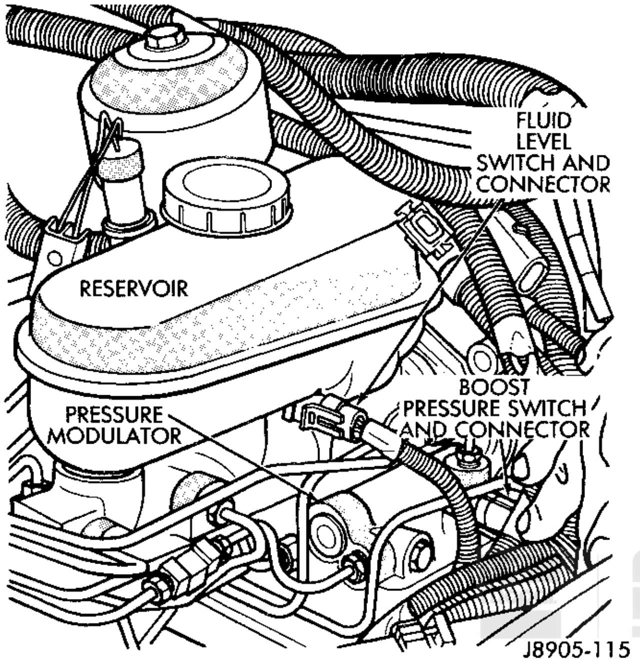


Fig. 17 Boost Pressure Differential And Fluid Level Switch Connections

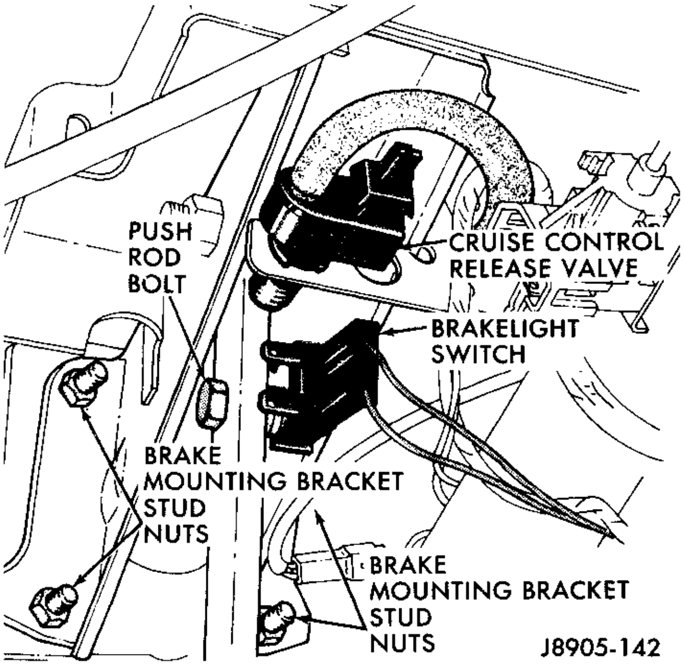


Fig. 18 Brakelight Switch And Mounting Bracket Stud Nut Location

Master Cylinder/Modulator/Accumulator Installation

(1) Install pad on mounting bracket and position assembled bracket and brake components on dash panel. Be sure bracket studs are seated in dash panel holes.

(2) Position master cylinder/modulator/accumulator assembly on dash panel (Fig. 19).Tighten mounting bracket stud nuts to 27 ft-lbs (36 N•m) torque.

(3) Connect harness wires to pressure modulator, low pressure switch, differential switch (on proportioning valve) and the low fluid and boost pressure switches.

(4) In passenger compartment, install nuts on mounting bracket studs (Fig. 18). Tighten nuts to 31 ft-lbs (42 N•m) torque.

(5) Align brake pedal, brakelight switch, master cylinder push rod and install the push rod bolt.

CAUTION: The push rod bolt must be installed correctly to avoid interference with the dash bracket. The bolt must be installed with the bolt head at the left side of the pedal as shown in Figure 18.

(6) Install new nuts on push rod bolt. Tighten inner lock nut to 25 ft-lbs (34 N•m) torque. Tighten outer jam nut to 75 in-lbs (8.5 N•m) torque.

(7) Connect brake light switch wires.

(8) Install instrument panel lower trim cover, if removed.

(9) In engine compartment, connect brake lines to proportioning valve and connect pressure and return lines to accumulator.

(10) Install air cleaner assembly.

(11) Connect hoses and wires to windshield washer reservoir and install reservoir on inner fender panel.

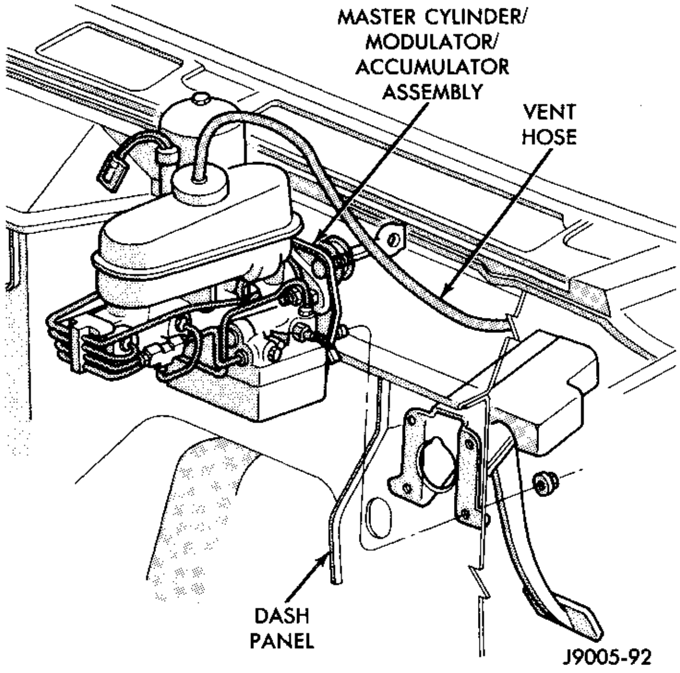


Fig. 19 Removing/Installing Master Cylinder, Modulator And Accumulator Assembly

(12) Fill master cylinder reservoir to V-shaped Max fill mark with Mopar brake fluid or equivalent meeting SAE 1703 and DOT 3 standards.

(13) Connect battery.

(14) Turn ignition switch On position to start pump. While pump is running, listen for rpm drop which indicates pump is pressurizing. If pump rpm does not drop after 20 seconds, immediately turn ignition switch to Off position and check pump hydraulic connections.

CAUTION: Do not allow the pump to run if it does not pressurize. If pump rpm does not drop after 20 seconds run time, turn ignition switch off immediately to avoid pump damage.

(15) Add fluid to master cylinder reservoir if necessary.

(16) Bleed brake system. Refer to procedure in this section.

ECU REPLACEMENT

(1) Verify that ignition switch is Off. Then fold rear seat cushion forward for access to ECU.

(2) Remove screws attaching ECU mounting bracket to floorpan riser (Fig. 20).

(3) Remove screw attaching mounting bracket tab to floorpan (Fig. 20).

(4) Remove screws attaching ECU to mounting bracket (Fig. 20-21).

(5) Unplug ECU harness and remove ECU (Fig. 21).

(6) Connect harness to replacement ECU.

(7) Install replacement ECU on mounting bracket and install ECU attaching screws.

(8) Position mounting bracket on floorpan and install attaching screws.

(9) Fold rear seat down.

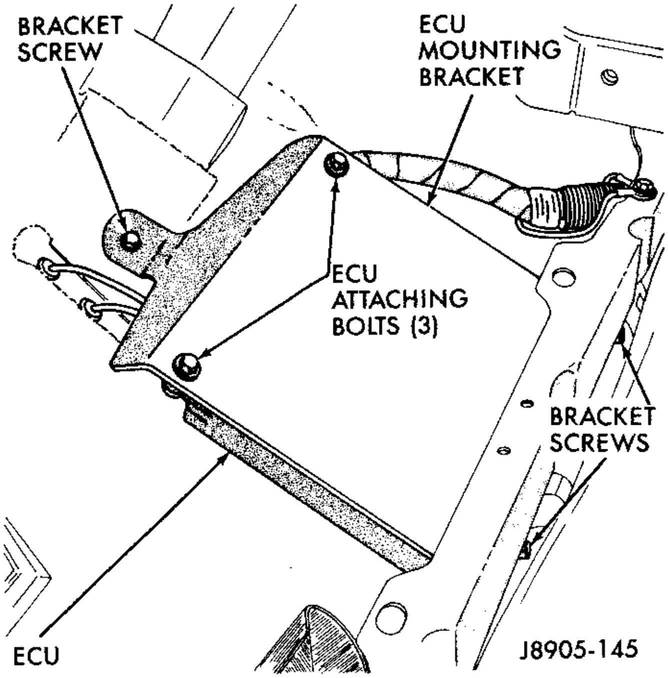


Fig. 20 ECU Mounting Bracket

BRAKE FLUID AND LEVEL

Recommended Fluid

The only brake fluid recommended for use with the anti-lock system is Mopar brake fluid, or an equivalent fluid meeting SAE and DOT standards J-1703 and DOT 3.

Use new brake fluid only when adding fluid, refilling the system, or to lubricate parts. Never use reclaimed fluid, fluid not meeting the SAE/DOT standards, or fluid from a container that has been left open for any length of time.

Fluid Level

The fluid level indicator mark is on the driver side of the reservoir (Fig. 22). Fill the reservoir only to the top of the V-shape MAX indicator mark. Do not fill the reservoir above this mark. Overfilling could cause overflow and possible reservoir damage when the pump begins cycling.

Importance of Clean Fluid

Clean the reservoir cap and exterior thoroughly before removing the cap to add fluid. Any dirt or foreign material entering the hydraulic system through the reservoir could result in poor brake system performance and possible component failure.

Also check the reservoir filter when servicing the system. Remove and clean the filter with clean brake fluid if necessary.

BRAKE BLEEDING

(1) Fill reservoir to V-shaped MAX fill mark.

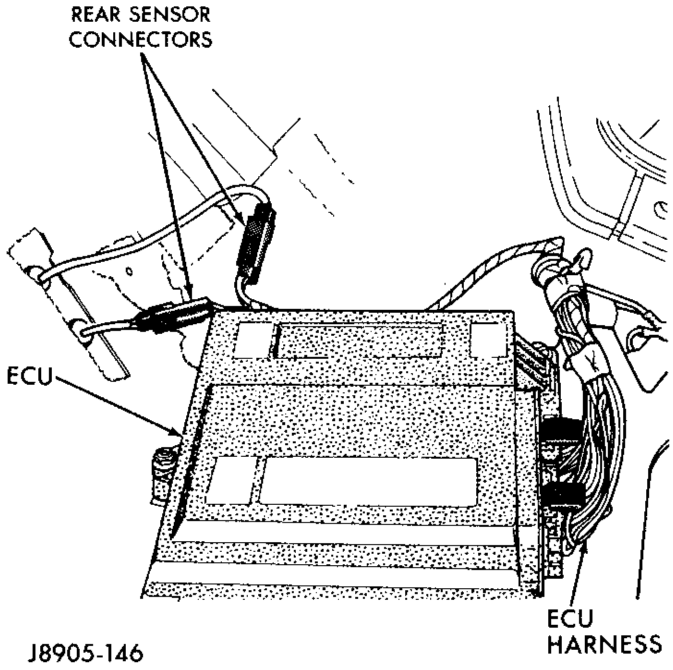


Fig. 21 ECU Connections

(2) Bleed brakes in following sequence: right rear; left rear; right front; left front.

(3) Attach bleed hose to caliper or wheel cylinder bleed fitting.

(4) Immerse end of bleed hose in glass container partially filled with brake fluid. Be sure hose end is submerged in fluid.

(5) Turn ignition switch On to cycle pump.

(6) Have helper apply brake pedal to pressurize system.

(7) Open bleed screw 1/2 turn.

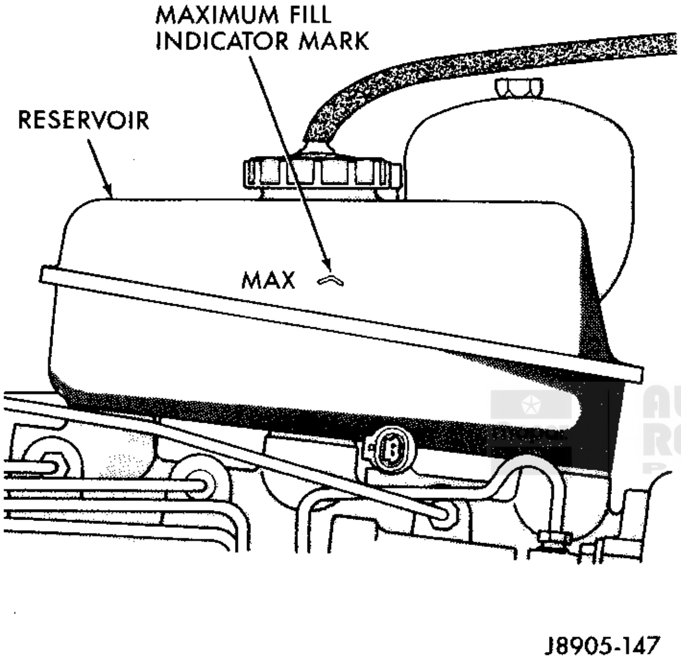


Fig. 22 Reservoir Fluid Level

(8) Close bleed screw when fluid entering glass container is free of bubbles.

(9) Check reservoir fluid level and add fluid to Max fill mark.

CAUTION: Do not allow the master cylinder reservoir to run dry while bleeding the brakes. Running dry will allow air to re-enter the system making a second bleeding operation necessary. More importantly, if air re-enters the system, it could damage the pump seriously enough to require replacement.

(10) Repeat bleeding operation at remaining wheels.

ELECTRICAL CONNECTIONS AND SCHEMATICS

Anti-lock electrical system ground locations and ECU circuitry are provided in the following illustrations.

System grounds are shown in Figures 23 and 24. The rear chassis ground is at the rear seat riser next to the ECU (Fig. 23). ECU circuits (pin-outs) are shown in Figure 24.

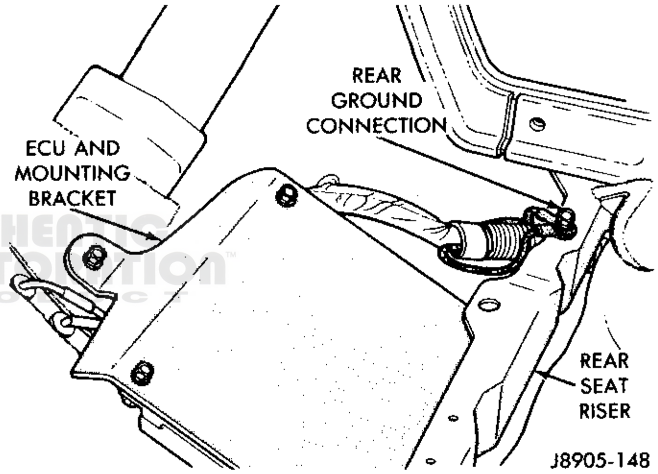
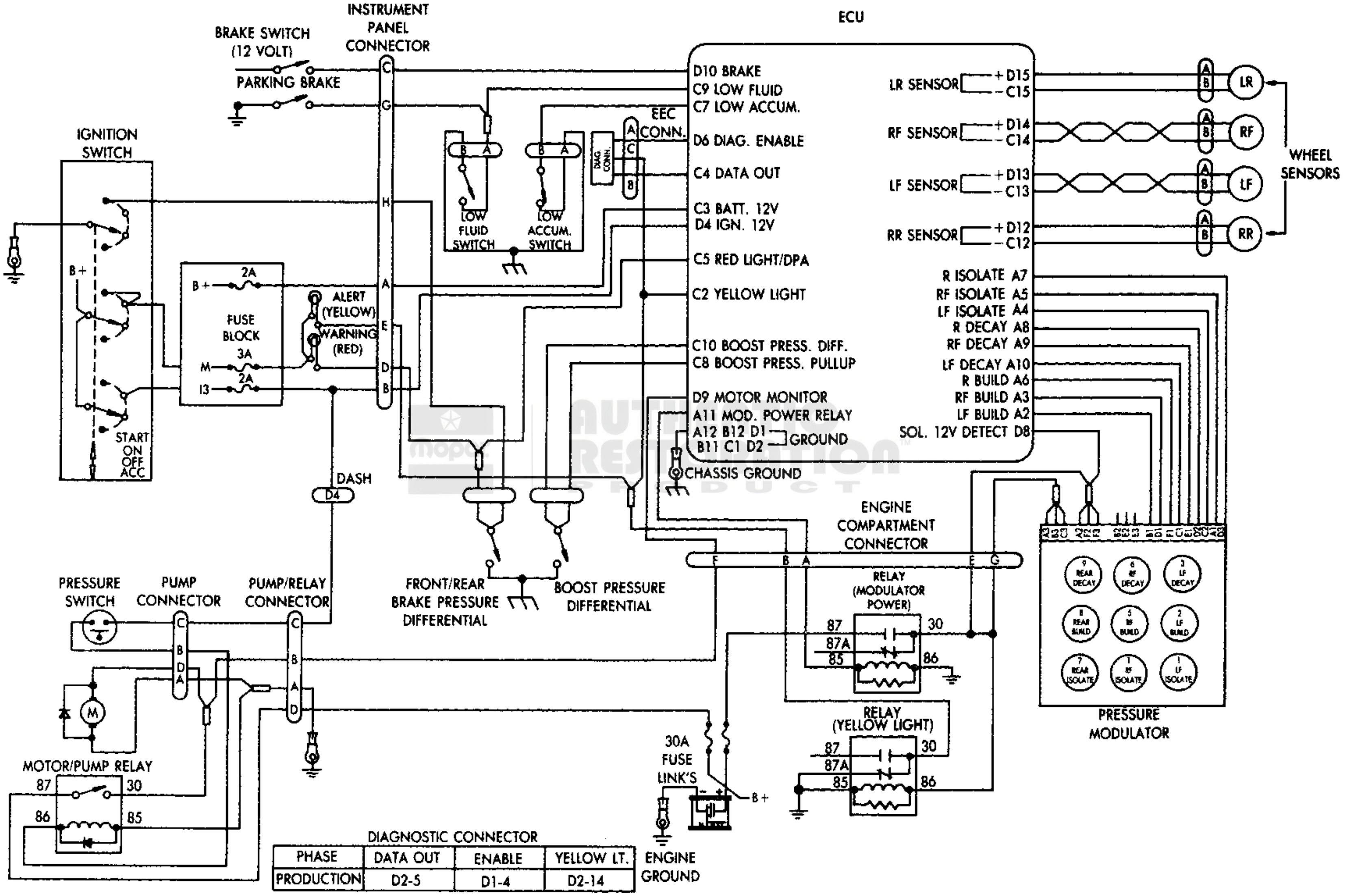


Fig. 23 Anti-Lock Rear Ground Wires



DIAGNOSTIC CONNECTOR

PHASE	DATA OUT	ENABLE	YELLOW LT.
PRODUCTION	D2-5	D1-4	D2-14

J8905-170

Fig. 24 ECU Circuitry

BRAKE SPECIFICATIONS

Recommended brake fluid (standard and anti-lock)	Mopar brake fluid or equivalent meeting SAE J1703 and DOT3 standards
Rotor diameter:	
XJ-MJ-YJ	280 mm (11.02 in.)
SJ	305 mm (12.0 in.)
Brake drum diameter:	
XJ-MJ-YJ	228.6 mm (9 in.)
Metric ton MJ	254 mm (10 in.)
SJ	279.4 mm (11 in.)
Rotor runout (max. allowable)	.12 mm (.005 in.)
Rotor thickness variation (max. allowable)	.013 mm (.0005 in.)
Minimum rotor thickness (refinish limit):	
SJ	30.8 mm (1.215 in.)
2-wheel drive XJ-MJ	22 mm (.86 in.)
4-wheel drive XJ-MJ-YJ	24 mm (.94 in.)
Brake drum max. diameter (refinish limit):	
SJ	280.9 mm (11.060 in.)
Metric ton MJ	255.5 mm (10.060 in.)
XJ-MJ-YJ	230 mm (9.050 in.)
Rear brake drum and shoe size:	
SJ	11 x 2 in.
Metric ton MJ	10 x 2½ in.
XJ-MJ-YJ	9 x 2½ in.
Disc brake pad wear limit	Replace when lining is 1/32" from rivet heads
Drum brakeshoe wear limit:	
bonded lining	Replace when lining is 1/16" thick
riveted lining	Replace when lining is 1/32" from rivet heads

J9005-20

BRAKE TORQUE SPECIFICATIONS

COMPONENT	SERVICE SET-TO TORQUE
Front brake hose fitting bolt at caliper:	
XJ-MJ-YJ	31 N·m (276 in-lbs)
SJ	18 N·m (160 in-lbs)
Brakeline fitting at master cylinder	20 N·m (180 in-lbs)
Brakeline fitting at wheel cylinder	18 N·m (160 in-lbs)
Brakeline fitting at proportioning valve:	
XJ-MJ-YJ	15 N·m (132 in-lbs)
SJ	18 N·m (160 in-lbs)
Rear brake support plate bolts:	
XJ-MJ-YJ	43 N·m (32 ft-lbs)
SJ	61 N·m (45 ft-lbs)
Brake pedal push rod bolt nuts:	
inner nut	34 N·m (25 ft-lbs)
outer nut	8.5 N·m (75 in-lbs)
Brake pedal pivot bolt nuts:	
XJ-MJ-YJ Man. Trans.	27 N·m (20 ft-lbs)
XJ-MJ-YJ Auto. Trans.	35 N·m (26 ft-lbs)
SJ	35 N·m (26 ft-lbs)
Caliper slide pins:	
4 wheel drive XJ-MJ-YJ	10-20 N·m (7-15 ft-lbs)
2 wheel drive XJ-MJ	34-47 N·m (25-35 ft-lbs)
SJ	47 N·m (35 ft-lbs)
Caliper anchor bracket bolts (SJ and 2WD models)	105 N·m (77 ft-lbs)
Master cylinder mounting stud nuts:	
All except SJ	13-25 N·m (115-220 in-lbs)
SJ	34 N·m (25 ft-lbs)
Power booster bolts/nuts:	
XJ-MJ	41 N·m (30 ft-lbs)
YJ	34 N·m (25 ft-lbs)
SJ	30 N·m (22 ft-lbs)
Parking brake pedal assembly nuts/bolts:	
YJ (nuts)	15 N·m (11 ft-lbs)
YJ (bolts)	10 N·m (7 ft-lbs)
SJ	20 N·m (15 ft-lbs)
MJ	22 N·m (16 ft-lbs)
Parking brake cable clamp bolts (SJ)	14 N·m (10 ft-lbs)
Wheel lug nuts	102 N·m (75 ft-lbs)
Wheel speed sensor adjusting bolt	14 N·m (11 ft-lbs)
Wheel bearing nuts:	
XJ-MJ-YJ	237 N·m (175 ft-lbs)
SJ inner	68 N·m (50 ft-lbs)
SJ outer	Tighten to 68 N·m (50 ft-lbs) and back nut off 1/6 turn
Rear brake hose T-fitting retainer bolt	7-9 N·m (60-80 in-lbs)
Disc brake shield bolts—SJ	
bolts	11 N·m (8 ft-lbs)
nuts	47 N·m (35 ft-lbs)
Wheel cylinder mounting bolts:	
SJ/metric ton MJ	15-25 N·m (130-230 in-lbs)
XJ-MJ-YJ	8-18 N·m (6-13 ft-lbs)

J9005-19

CLUTCH

CONTENTS

GENERAL INFORMATION

INDEX

CLUTCH COMPONENTS

A hydraulically operated clutch mechanism is used on all Jeep models with manual transmission. Basic clutch components consist of the: disc; clutch cover; hydraulic concentric bearing; and pilot bushing (Fig. 1).

The clutch disc is a single, dry-disc unit with cushion springs in the disc hub. The clutch disc friction material is riveted to the hub.

The clutch cover is a diaphragm type unit with a one-piece diaphragm spring and multiple release fingers.

Clutch disc diameter is 266 mm (10.5 inch) on six-cylinder models and 232 mm (9.28 inch) on four-cylinder models.

CLUTCH HYDRAULIC SYSTEM

The clutch hydraulic system consists of the clutch master cylinder; the hydraulic concentric bearing; and the fluid lines (Fig. 2).

The clutch master cylinder is mounted on the drivers side of the dash panel adjacent to the brake master cylinder. The cylinder is operated by a suspended type clutch pedal (Fig. 2).

The hydraulic concentric bearing is a unique design; It incorporates the release bearing and slave cylinder in a single assembly. The bearing is permanently attached to the cylinder piston. The hydraulic lines are permanently attached to the cylinder and bearing assembly and are not removable.

The hydraulic concentric bearing completely encircles the transmission input shaft. In operation, piston movement causes the bearing to move in a linear (straight line) direction.

CLUTCH FLUID

Clutch system fluid level is checked at the clutch master cylinder (Fig. 3). Fluid level is indicated by the MAX and MIN indicators on the cylinder reservoir. Check and top off fluid level to the MAX mark. Do not allow level to fall below the MIN mark.

The only fluid recommended for use in the clutch hydraulic system is Mopar Brake Fluid, or an equivalent meeting SAE J-1703 and DOT 3 standards. Do not use any any other type of fluid.

Never use reclaimed brake fluid or fluid from an unsealed container. In addition, do not use fluid from a container that has been opened and allowed to stand for any length of time. Moisture in the air can be absorbed by the fluid causing dilution and loss of effectiveness.

GENERAL SERVICE INFORMATION

The hydraulic concentric bearing is serviced as an assembly. It cannot be disassembled for repair. The hydraulic lines are permanently attached to the assembly. They will leak if loosened or if removal is attempted.

Nylon retaining straps are installed on the concentric bearing during manufacture. The straps hold the bearing piston in place during shipment and installation. It is not necessary to cut or remove the straps after bearing installation. The straps are designed to disconnect the first time piston movement occurs.

The clutch master cylinder can be disassembled for repair. A service kit containing a replacement plunger and seal assembly is available for overhaul purposes.

The clutch disc, cover, pilot bushing and hydraulic fluid lines are all serviced as assemblies.

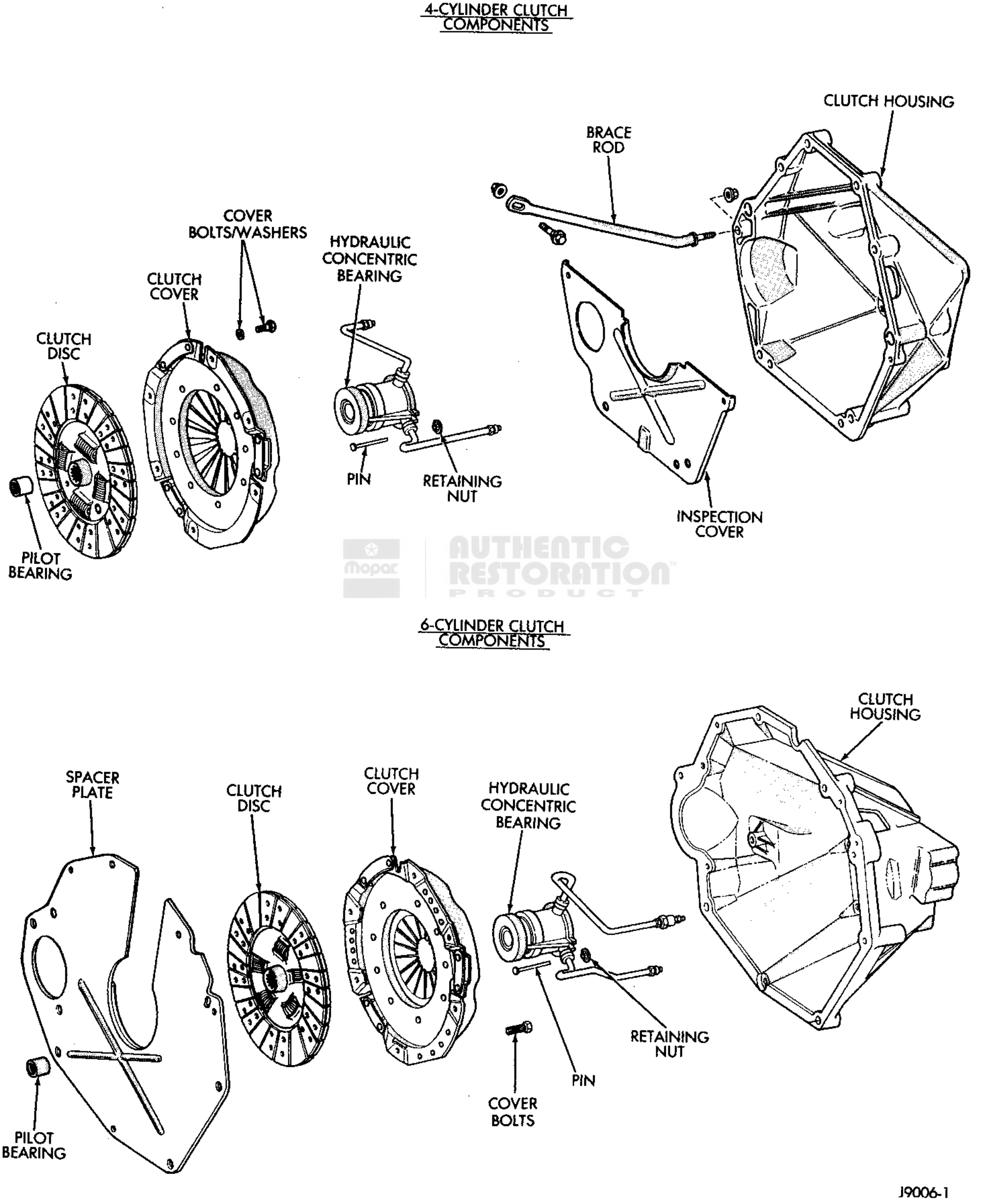
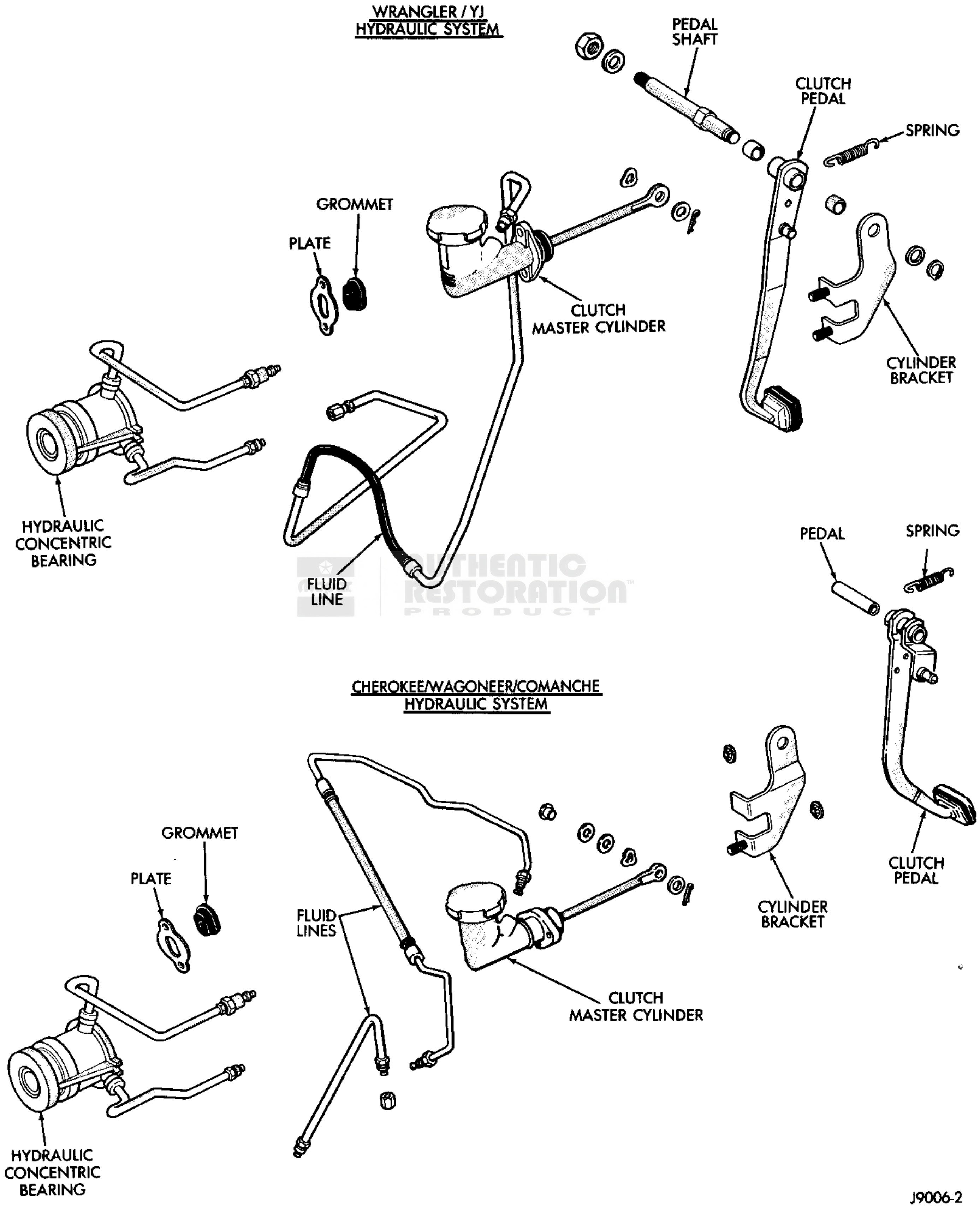


Fig. 1 Clutch Components



J9006-2

Fig. 2 Clutch Hydraulic System

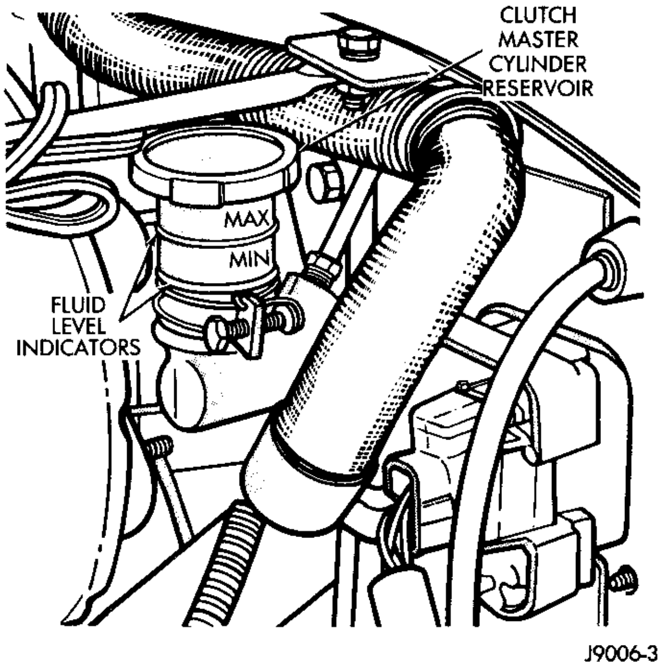


Fig. 3 Clutch Fluid Level

SERVICE DIAGNOSIS

INDEX

GENERAL DIAGNOSIS INFORMATION

Unless the cause of a clutch problem is extremely obvious, accurate problem diagnosis will require a road test to verify a a clutch problem followed by component inspection to determine the actual problem cause.

During a road test, drive the vehicle at normal speeds. Shift the transmission through all gear ranges and observe clutch action. If chatter, grab, slip, or improper release is experienced, remove and inspect the clutch components. However, if the problem is noise or hard shifting, further diagnosis may be needed as the transmission or another driveline component may be at fault. Careful observation during the test will help narrow the problem area.

CLUTCH PROBLEM CAUSES

Contamination

Fluid contamination is the most frequent cause of clutch malfunctions. Oil, water, or clutch fluid on the clutch contact surfaces will result in faulty operation. The usual result is chatter, slip and grab.

During inspection, note if any components are contaminated with oil, hydraulic fluid, or water/road splash.

Oil contamination indicates a leak at either the rear main seal or transmission input shaft. Oil leakage produces a residue of oil on the housing interior and on the clutch cover and flywheel. Heat buildup caused by slippage between the cover, disc and flywheel, can sometimes bake the oil residue onto the components. The glaze-like residue ranges in color from amber to black.

Road splash contamination means dirt/water is entering the clutch housing due to loose bolts, housing cracks, or through hydraulic line openings. Driving through deep water puddles can force water/road splash into the housing through such openings.

Clutch fluid leaks are from loose or damaged concentric bearing lines or connections. However, clutch fluid leaks will usually be noted and corrected before severe contamination occurs.

Clutch Misalignment

Clutch components must be in proper alignment with the crankshaft and transmission input shaft. Misalignment caused by excessive runout or warpage of any clutch component will cause grab, chatter and improper clutch release.

Flywheel Runout

Check flyweel runout whenever misalignment is suspected. Flywheel runout should not exceed .08 mm (.003 inch). Measure runout at the outer edge of the flywheel face with a dial indicator. Mount the dial indicator on a stud installed in place of one of the flywheel attaching bolts.

Common causes of runout are heat warpage, improper machining, mounting the flywheel on a dirty crankshaft flange, incorrect bolt tightening and improper seating on the crankshaft flange shoulder.

Cleanup of minor flywheel scoring should be performed with surface grinding equipment. Remove only enough material to reduce scoring (approximately .001 - .003 inch). Heavy stock removal is **not recommended.** Replace the flywheel if scoring is severe and deeper than .003 inch. Excessive stock removal can result in flywheel cracking or warpage after installation; it can also weaken the flywheel and interfere with proper clutch release.

Clean the crankshaft flange before mounting the flywheel. Dirt and grease on the flange surface may cock the flywheel causing excessive runout. Use new bolts when remounting a flywheel and secure the bolts with Mopar Lock And Seal. Tighten flywheel bolts to specified torque only. Overtightening can distort the flywheel hub causing runout.

Clutch Cover And Disc Runout

Check the clutch disc before installation. Axial (face) runout of a **new** disc should not exceed .5 mm (.020 inch). Measure runout about 1/4 inch from the outer edge of the disc facing. Obtain another disc if runout is excessive.

Check condition of the clutch before installation. A warped cover or diaphragm spring will cause grab and incomplete release or engagement. Be careful when handling the cover and disc. Impact can distort the cover, diaphragm spring, release fingers and the hub of the clutch disc.

Use an alignment tool when positioning the disc on the flywheel. The tool prevents accidental misalignment which could result in cover distortion and disc damage.

A frequent cause of clutch cover distortion (and consequent misalignment) is improper bolt tightening. To avoid warping the cover, the bolts must tightened alternately (diagonal pattern) and evenly (2-3 threads at a time) to specified torque.

Clutch Housing Misalignment And Runout

Clutch housing alignment is important to proper clutch operation. The housing maintains alignment between the crankshaft and transmission input shaft. Misalignment can cause noise, incomplete release and chatter; It can also result in premature wear of the pilot bearing, cover release fingers and clutch disc. In severe cases, misalignment can also cause premature wear of the transmission input shaft and the shaft bearing.

Housing misalignment is generally caused by incorrect seating on the engine or transmission, loose housing bolts, missing alignment dowels or housing damage. Infrequently, misalignment may also be caused by housing mounting surfaces that are not parallel.

Installation Methods And Parts Usage

Distortion of clutch components during installation and the use of non-standard components are additional causes of clutch malfunction.

Improper clutch cover bolt tightening can distort the cover. The usual result is clutch grab, chatter and rapid wear. Tighten the cover bolts as described in Clutch Service section.

Improperly seated flywheels and clutch housings are other causes of clutch failure. Improper seating will produce misalignment and subsequent clutch problems.

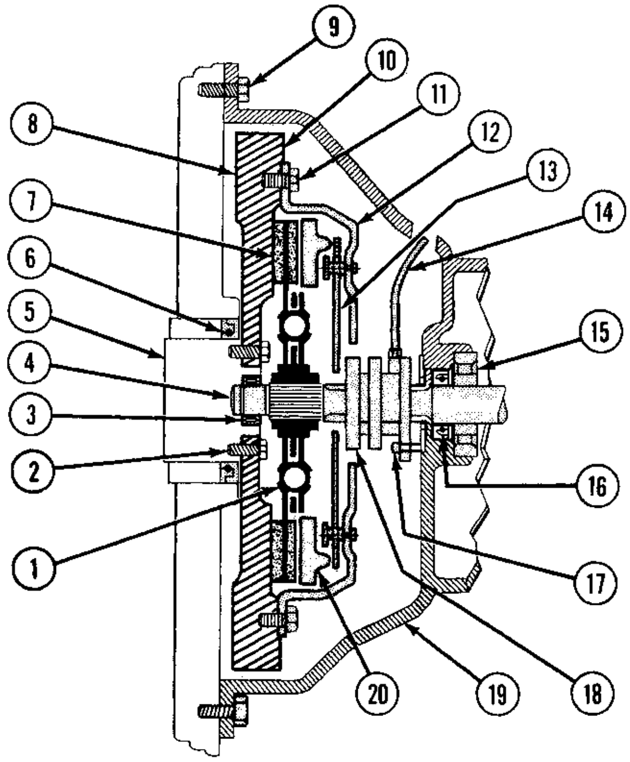
The use of non-standard or low quality parts can also lead to problems and wear. Use the recommended factory quality parts to avoid comebacks.

INSPECTION AND DIAGNOSIS CHARTS

The clutch inspection chart (Fig. 4) outlines items to be checked before and during clutch installation. Use the chart as a check list to help avoid overlooking potential problem sources during service operations.

The diagnosis charts describe common clutch problems, causes and correction. Fault conditions are listed at the top of each chart. Conditions, causes and corrective action are outlined in the indicated columns.

The charts are provided as a convenient reference when diagnosing faulty clutch operation.



1 Make sure side of clutch disc marked "flywheel side" is toward flywheel.

2 Check flywheel bolt torque. If bolts are loose, replace them. Use Mopar Lock and Seal to secure new bolts.

3 Check pilot bearing. Replace bearing if brinnelled, seized, or noisy. Lube bearing with wheel bearing grease before installation.

4 Check transmission input shaft. Clutch disc must slide freely on shaft splines. Lightly grease splines before installation. Replace shaft if splines or pilot bearing hub are damaged.

5 Check crankshaft flange (if flywheel is removed). Be sure flange is clean and flywheel bolt threads are in good condition.

6 Check rear main seal if clutch disc and cover were oil covered. Replace seal if necessary.

7 Check clutch disc facing. Replace disc if facing is charred, scored, flaking off, or worn. Also check runout of new disc. Runout should not exceed .5 mm (.02 in.).

8 Check flywheel condition and runout. Scuff sand flywheel face to remove glaze. Clean surface with a wax and grease remover afterward. Replace flywheel if severely scored, worn or cracked. Secure flywheel with new bolts (if removed). Do not reuse old bolts. Use Lock and Seal on bolts.

9 Check clutch housing bolts. Tighten if loose. Be sure housing is fully seated on engine block. Also be sure locating dowels are in place.

10 Check flywheel face runout if chatter or grab was encountered. Runout should not exceed .08 mm (.003 in.).

11 Tighten clutch cover bolts 2-3 threads at a time, alternately and evenly (in a diagonal pattern) to specified torque. Failure to do so could warp the cover.

12 Check clutch cover. Replace if warped, cracked, bent. Be sure cover is correct size and properly aligned on disc and flywheel.

13 Check clutch cover diaphragm spring and release fingers. Replace cover if spring or fingers are bent, warped, broken, cracked. Do not tamper with factory clutch spring setting. Clutch problems will result.

14 Inspect concentric bearing hydraulic lines. Be sure connections are tight and not cross threaded. Replace bearing assembly **only** if lines are loose, or leaking.

15 Transmission input shaft bearing will cause noise, chatter, or improper release if damaged. Check condition before installing transmission.

16 Check input shaft seal if clutch cover and disc were oil covered. Replace seal if worn, or cut.

17 Check concentric bearing mounting pin and retaining nut. Never reuse old retaining nut. Use new part only. Be sure pin is secure and in good condition.

18 Do not replace hydraulic concentric bearing unless actually faulty. Replace bearing only if it leaks, is seized, or damaged.

19 Inspect clutch housing. Be sure locating dowels are in position and bolts are tight. Replace housing if cracked, or damaged. If clutch problems ocurred, check runout, to be sure housing is square with flywheel and transmission input shaft.

20 Check condition of pressure plate surface. Replace clutch cover if plate surface is deeply scored, warped, worn, or cracked.

Fig. 4 Clutch Inspection Points

J9006-11

CLUTCH SLIPS

Condition Found	Cause	Correction
1. Disc facing worn out	a) Normal wear b) Driver frequently "rides" (slips) clutch. Results in rapid wear overheating. c) Insufficient clutch cover diaphragm spring tension.	Replace clutch disc. Also replace cover if spring is weak or pressure plate surface is damaged.
2. Clutch disc facing contaminated with oil, grease, or clutch fluid.	a) Leak at rear main seal or at transmission input shaft seal. b) Excessive amount of grease applied to input shaft splines. c) Leak from concentric bearing or bearing hydraulic line fittings.	Replace leaking seals. Apply less grease to input shaft splines. Replace concentric bearing only if actually leaking. Replace clutch disc (do not clean and reuse). Clean clutch cover and reuse only if cover is in good condition.
3. Clutch is running partially disengaged.	Concentric bearing sticking–binding. Does not return to normal running position.	Verify that bearing is actually binding, then replace bearing.
4. Flywheel height incorrect.	Flywheel surface improperly machined. Too much stock removed or surface is tapered.	Replace flywheel.
5. Wrong disc or pressure plate installed.	Incorrect parts order or model number.	Replace with correct parts. Compare old and new parts before installation.
6. Clutch disc, cover and/or diaphragm spring, warped, distorted.	a) Rough handling (impact) bent cover, spring, or disc. b) Incorrect bolt tightening sequence and method caused warped cover.	Install new disc or cover as needed. Follow installation/tightening instructions.
7. Facing on flywheel side of disc torn, gouged, worn.	Flywheel surface scored and nicked.	Reduce scores and nicks by sanding or surface grinding. Replace flywheel if scores–nicks are deeper than .002-.004 inch.
8. Clutch disc facing burnt (charred). Flywheel and cover pressure plate surfaces heavily glazed.	a) Frequent operation under high loads or hard acceleration conditions. b) Driver frequently "rides" (slips) clutch. Results in rapid wear and overheating of disc and cover.	Scuff sand flywheel. Replace clutch cover and disc. Alert driver to problem cause.

J9006-13

IMPROPER CLUTCH RELEASE

Condition Found	Cause	Correction
1. Clutch disc warped.	New disc not checked for axial runout before installation.	Replace disc. Be sure runout of new disc is less than .5 mm (.020 in.).
2. Clutch disc binds on input shaft splines.	a) Clutch disc hub splines damaged during installation. b) Input shaft splines rough, damaged. c) Corrosion, rust formations on splines of disc and input shaft.	Clean, smooth and lubricate disc and shaft spines. Replace disc and/or input shaft if splines are severely damaged.
3. Clutch disc rusted to flywheel and/or pressure plate.	Occurs in vehicles stored, or not driven for extended periods of time.	Remove clutch cover and disc. Sand rusted surfaces clean with 180 grit paper.
4. Clutch disc facing sticks to flywheel.	Vacuum may form in pockets over rivet heads in clutch disc. Occurs as clutch cools down after use.	Drill 1/16 inch diameter hole through rivets and scuff sand disc facing with 180 grit paper.
5. Clutch disc too thick.	Wrong disc installed.	Replace disc.
6. Pilot bearing seized.	a) Bearing cocked during installation. b) Bearing defective. c) Bearing not lubricated. d) Clutch misalignment.	Lubricate and install new bearing. Check and correct any misalignment.
7. Clutch will not disengage properly.	a) Low fluid level in cutch master cylinder. b) Air in clutch hydraulic system. c) Clutch cover loose. d) Wrong clutch disc. e) Disc bent, distorted during installation. f) Clutch cover diaphragm spring bent or warped during transmission installation. g) Clutch disc installed backwards.	a) Top off cylinder and check for leaks. b) Bleed and refill system. c) Tighten bolts. d) Install correct disc. e) Replace disc. f) Replace cover. g) Remove and reinstall disc correctly. Be sure disc side marked "to flywheel" is actually toward flywheel.

J9006-14

CLUTCH GRAB/CHATTER

Condition Found	Cause	Correction
1. Clutch disc facing covered with oil, grease, or clutch fluid.	a) Oil leak at rear main or input shaft seal.	a) Correct leak and replace disc (do not clean and reuse the disc).
	b) Too much grease applied to splines or disc and input shaft.	b) Apply lighter grease coating to splines and replace disc (do not clean and reuse the disc).
	c) Concentric bearing, line or fittings leaking fluid.	c) Replace concentric bearing and replace disc (do not clean and reuse the disc).
2. Clutch disc and/or cover warped, or disc facings exhibit unusual wear or appear to be wrong type.	Incorrect or substandard parts.	Replace disc and/or cover with correct parts.
3. Clutch master cylinder plunger or concentric bearing dragging–binding.	a) Cylinder components worn or corroded.	a) Overhaul or replace clutch master cylinder.
	b) Concentric bearing is faulty.	b) Replace the bearing.
4. No fault found with clutch components.	a) Problem actually related to suspension or driveline component.	a) Further diagnosis required. Check engine/transmission mounts, propeller shafts and U-joints, tires, suspension attaching parts and other driveline components as needed.
	b) Engine related problem.	b) Check EFI and igniton systems.
5. Partial engagement of clutch disc (one side worn–opposite side glazed and lightly worn).	a) Clutch pressure plate position setting incorrect or modified.	a) Replace clutch cover and disc.
	b) Clutch cover, spring, or release fingers bent, distorted (rough handling, improper assembly).	b) Replace clutch cover and disc.
	c) Clutch disc damaged or distorted.	c) Replace disc.
	d) Clutch misalignment.	d) Check alignment and runout of flywheel, disc, or cover. Correct as necessary.

J9006-15

CLUTCH NOISE

Condition Found	Cause	Correction
1. Clutch components damaged or worn out prematurely.	Incorrect or sub-standard clutch parts.	Replace with parts of correct type and quality.
2. Pilot bearing seized or bearing rollers are brinneled.	a) Bearing cocked or scored during installation. b) Bearing not lubricated prior to installation. c) Bearing defect. d) Clutch misalignment.	a), b), c) Replace bearing. Be sure it is properly seated and lubricated before installing clutch. d) Check and correct misalignment caused by excessive runout of flywheel, disc, or cover. Replace input shaft if bearing hub is damaged.
3. Loose components.	Attaching bolts loose at flywheel, cover, or clutch housing.	Tighten bolts to specified torque. Replace any clutch bolts that are damaged.
4. Components appear overheated. Hub of disc cracked or torsion damper springs are distorted or broken.	Frequent high load, full throttle operation.	Replace parts as needed. Alert driver to condition causes.
5. Contact surface of concentric bearing damaged.	a) Clutch cover incorrect, or release fingers are bent or distorted causing damage. b) Concentric bearing defect. c) Concentric bearing misaligned.	a) Replace clutch cover and concentric bearing. b) Replace concentric bearing. c) Check and correct runout of clutch components. Also check input shaft and bearing condition. Replace shaft and bearing if worn or damaged.
6. Concentric bearing is noisy.	Concentric bearing defect.	Replace concentric bearing.
7. Clutch pedal squeak.	a) Pivot pin loose. b) Pedal bushings worn out or cracked.	Tighten pivot pin. Replace bushings if worn or damaged. Lubricate pin and bushings with silicone base lubricator chassis grease.

J9006-16

CLUTCH SERVICE

INDEX

CLUTCH SAFETY PRECAUTIONS

WARNING: EXTREME CARE MUST BE EXERCIZED WHEN SERVICING CLUTCH COMPONENTS. DUST AND DIRT THAT ACCUMULATES ON CLUTCH PARTS DURING NORMAL USE MAY CONTAIN ASBESTOS FIBERS. BREATHING EXCESSIVE CONCENTRATIONS OF THESE FIBERS CAN CAUSE SERIOUS BODILY HARM. WEAR A RESPIRATOR WHEN CLEANING CLUTCH COMPONENTS AND NEVER CLEAN CLUTCH COMPONENTS WITH COMPRESSED AIR OR WITH A DRY BRUSH. USE A VACUUM CLEANER SPECIFICALLY DESIGNED FOR REMOVING ASBESTOS FIBERS AND DUST. IF A VACUUM CLEANER IS NOT AVAILABLE, CLEAN THE PARTS WITH WATER DAMPENED SHOP RAGS. DO NOT CREATE DUST BY SANDING A CLUTCH DISC. IF THE DISC FRICTION SURFACE IS DAMAGED OR CONTAMINATED, REPLACE THE DISC. DISPOSE OF ALL DUST AND DIRT SUSPECTED OF CONTAINING ASBESTOS FIBERS OR DUST IN SEALED BAGS OR CONTAINERS. THIS WILL HELP MIMINIZE EXPOSURE TO YOURSELF AND TO OTHERS. FOLLOW ALL RECOMMENDED SAFETY PRACTICES PRESCRIBED BY THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) AND THE ENVIRONMENTAL SAFETY AGENCY (EPA), FOR THE HANDLING AND DISPOSAL OF PRODUCTS CONTAINING ASBESTOS.

CLUTCH COVER AND DISC REMOVAL

(1) Remove the clutch housing/transmission/transfer case as an assembly. See Group 21 Manual Transmission for procedure.

(2) Loosen the clutch cover bolts evenly and in rotation to relieve spring tension. Loosen the bolts a few threads at a time only.

(3) Remove the cover bolts and remove the cover and disc (Fig. 9).

CLUTCH COVER AND DISC INSTALLATION

(1) Check runout and free operation of the new clutch disc. Install the disc on the transmission input shaft splines. The disc should slide freely on the splines. Leave the disc on the shaft and check runout with a dial indicator. Check at the disc hub and about 1/4 inch from the outer edge of the facing. Runout should not exceed .5 mm (.020 inch). Obtain another clutch disc if runout exceeds specified limit.

(2) Insert a clutch alignment tool in the clutch disc.

(3) Insert the alignment tool in the pilot bearing and position the disc on the flywheel. Be sure the disc hub is positioned correctly. Side of hub marked Flywheel Side should face toward flywheel (Fig. 9).

(4) Position the clutch cover over the disc and on the flywheel.

(5) Install all of the clutch cover bolts finger tight.

(6) Tighten the cover bolts evenly (and in rotation) a few threads at atime. **The cover bolts must be tightened evenly and to specified torque to avoid distorting the cover. Correct tightening torques are: 31 N·m (23ft-lbs) on four-cylinder models and 54 N·m (40 ft-lbs) on six-cylinder models.**

(7) Apply a light coating of chassis grease to the splines of the transmission input shaft. **Do not overlubricate the shaft splines. This can result in grease contamination of the disc.**

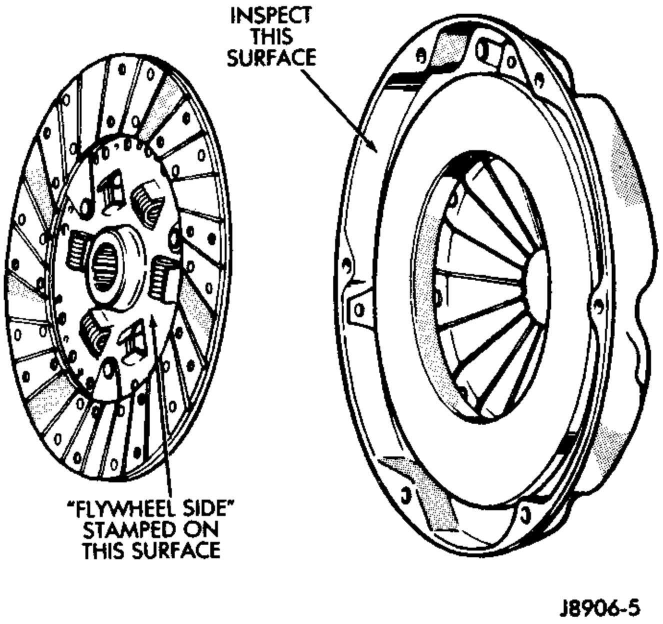


Fig. 9 Positioning Clutch Disc — Typical

(8) Install the clutch housing/transmission/transfer case as an assembly. See Group 21 Manual Transmission.

PILOT BEARING REPLACEMENT

(1) Remove the transmission/transfer case as an assembly. See Group 21 Manual Transmission.

(2) Remove the clutch cover and disc.

(3) Remove the pilot bearing. Use an internal puller and slide hammer if the bearing proves difficult to remove.

(4) Lubricate the new bearing with Mopar high temperature wheel bearing grease.

(5) Insert the new bearing into the crankshaft by hand, or with a clutch alignment tool or spare input shaft (Fig. 10).

(6) Install the clutch disc and cover as outlined in this section.

(7) Install the transmission/transfer case assembly. See Group 21 Manual Transmission.

CLUTCH MASTER CYLINDER REMOVAL

(1) Remove the master cylinder reservoir cap and drain the fluid with a suction gun.

(2) Disconnect the hydraulic line at the cylinder (Fig. 11). Cap the line and cylinder to prevent dirt entry.

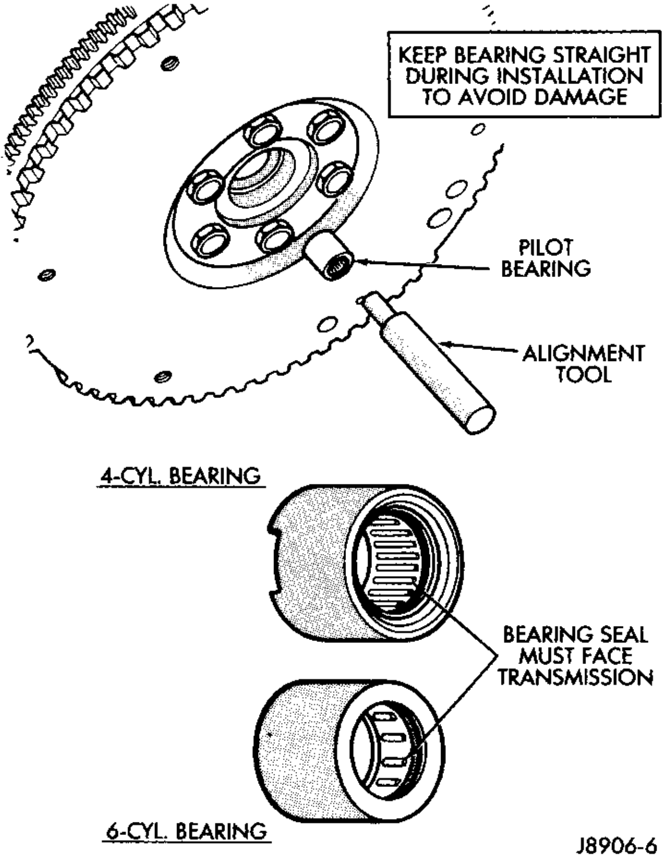


Fig. 10 Pilot Bearing Installation

(3) On XJ/MJ models, remove the instrument panel lower trim cover for access to the cylinder push rod (Fig. 12).

(4) On YJ models, remove the cotter pin and washer securing the cylinder push rod to the clutch pedal.

(5) On XJ/MJ models, remove the cotter pin and washer securing the push rod to the pivot arm and slide the rod off arm (Fig. 13).

(6) Remove the cylinder mounting bolts and nuts and remove the cylinder. **The cylinder bolts are reversed**

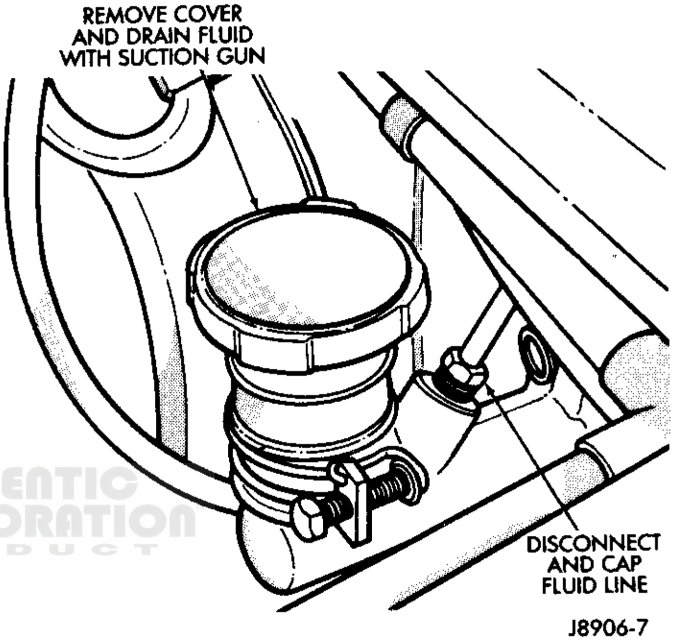


Fig. 11 Drain And Disconnect Clutch Master Cylinder

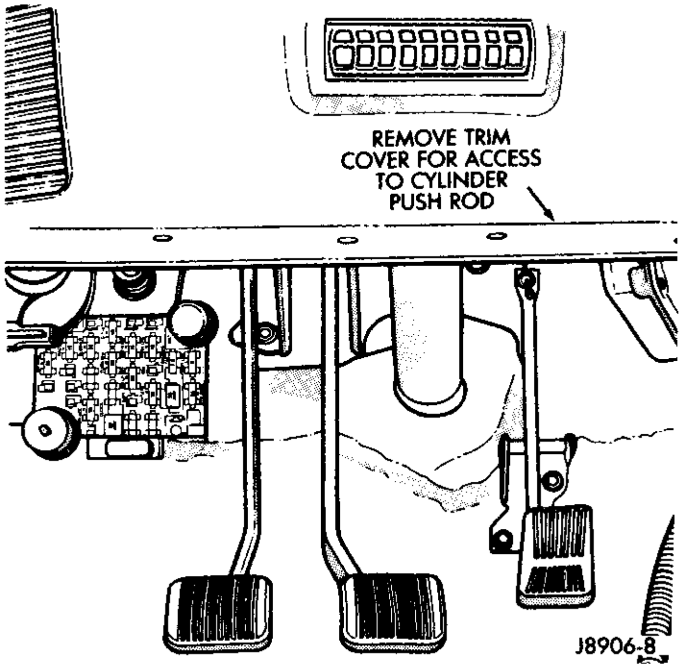


Fig. 12 Lower Trim Cover Position

(Fig. 14). Top bolt is installed from engine compartment. Bottom bolt is installed from passenger compartment.

CLUTCH MASTER CYLINDER INSTALLATION

(1) Position the clutch master cylinder on the dash panel and install the top attaching bolt.

(2) Install the cylinder bottom attaching bolt and the both of the attaching bolt nuts. Tighten the nuts to 26 N•m(19 ft-lbs) torque.

(3) Connect the cylinder hydraulic line (Fig. 12). Tighten the line fitting to15 N•m (11 ft-lbs) torque.

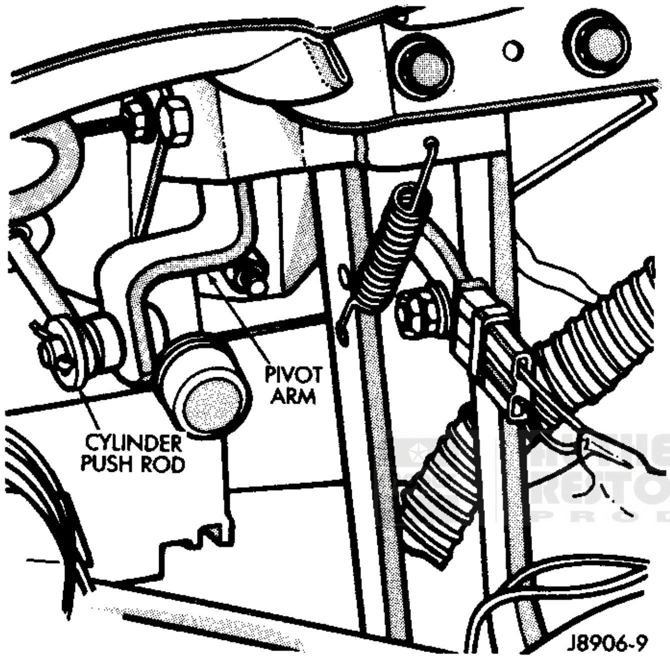


Fig. 13 Push Rod Removal/Installation — XJ/MJ

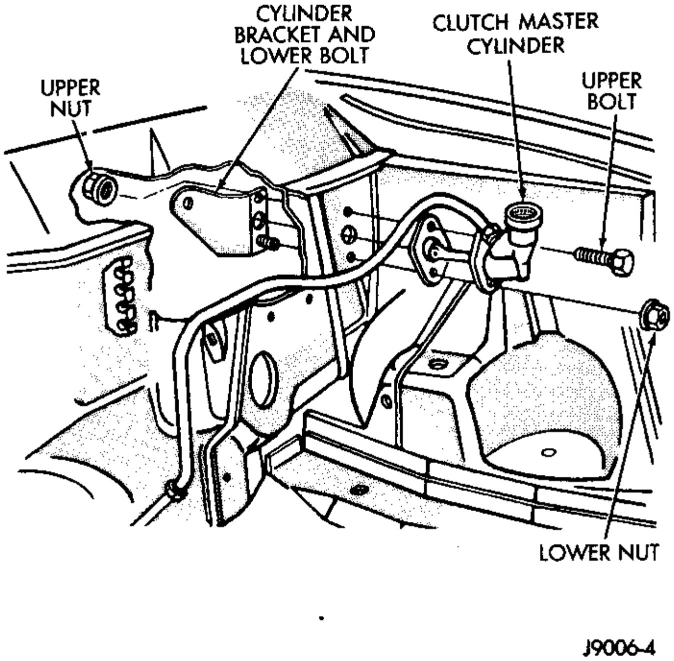


Fig. 14 Clutch Master Cylinder Mounting Bolts

(4) Install the cylinder push rod on the brake pedal or pivot arm and install the retaining washer and a new cotter pin.

(5) Fill the cylinder reservoir with Mopar brake fluid, or equivalent labeled SAE J-1703 or DOT 3 only.

(6) Install the reservoir cap and bleed the hydraulic system.

CLUTCH MASTER CYLINDER OVERHAUL

Cylinder Disassembly and Cleaning

(1) Remove the reservoir cap.

(2) Pull the dust boot out of the cylinder groove.

(3) Press the cylinder plunger inward with the push rod and unseat the push rod snap ring. Discard the snap ring after removal. A new ring is included in the overhaul kit.

(4) Remove the push rod, washer and dust boot (Fig. 15). Retain the push rod and washer but discard the dust boot. A new boot is included in the overhaul kit.

(5) Remove the plunger, spring and valve stem assembly (Fig. 15). Lightly tap the cylinder on a wood block to dislodge the assembly. Discard the assembly after removal.

(6) Clean the cylinder thoroughly with fresh brake fluid or brake system cleaner only.

Cylinder Inspection and Assembly

(1) Inspect the cylinder bore for cracks, pitting, corrosion, wear or scoring. Replace the cylinder if it exhibits any of these conditions.

(2) Lubricate the cylinder bore with clean brake fluid.

(3) Lubricate the replacement valve, plunger and spring assembly with clean brake fluid.

(4) Install the new valve, plunger and spring assembly in the cylinder bore.

(5) Install the washer, snap ring and new dust boot on the push rod.

(6) Lubricate ball end of the push rod with chassis grease.

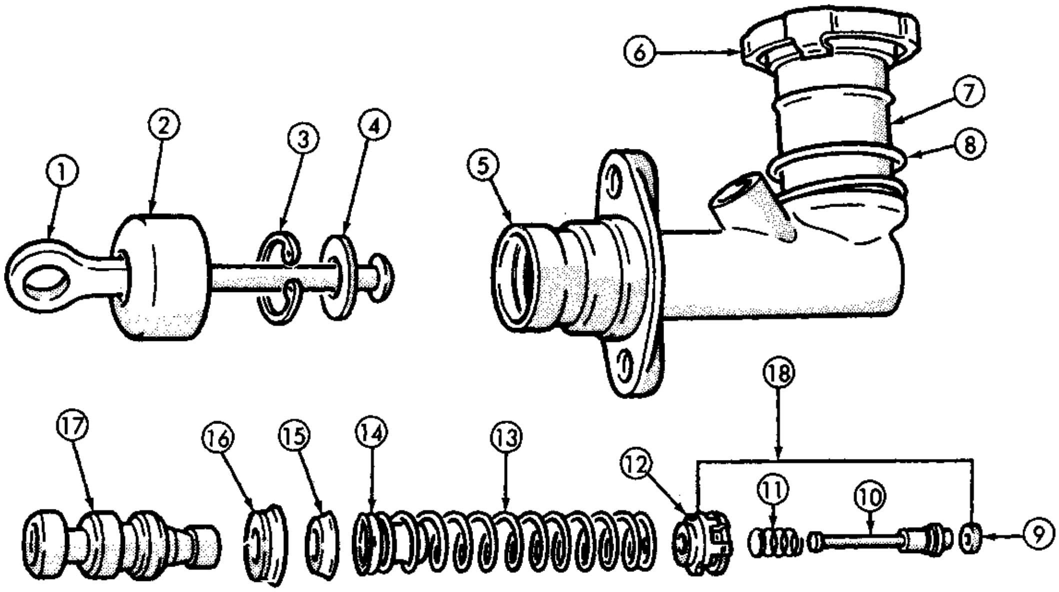
(7) Insert the push rod in the plunger. Press the plunger inward and seat the washer and snap ring in the cylinder bore.

(8) Install the dust boot on the cylinder. Be sure the boot is seated in the cylinder boot groove.

HYDRAULIC CONCENTRIC BEARING REPLACEMENT

The hydraulic concentric bearing is serviced as an assembly only. The release bearing portion of the assembly is permanently attached to the piston. The hydraulic lines are also permanently attached.

The only time the concentric bearing assembly should be replaced is when it is either leaking or obviously damaged. The bearing should never be



① PUSH ROD
② DUST BOOT
③ SNAP RING
④ WASHER
⑤ CLUTCH MASTER CYLINDER
⑥ RESERVOIR CAP
⑦ RESERVOIR
⑧ RETAINING CLAMP
⑨ STEM TIP SEAL
⑩ VALVE STEM
⑪ RETAINER SPRING
⑫ SPRING RETAINER
⑬ PLUNGER SPRING
⑭ VALVE STEM RETAINER
⑮ PLUNGER REAR SEAL
⑯ PLUNGER FRONT SEAL
⑰ PLUNGER
⑱ VALVE STEM ASSEMBLY

NOTE: ITEMS ⑨ THROUGH ⑱ ARE SUPPLIED AS AN ASSEMBLY.

J9006-5

Fig. 15 Clutch Master Cylinder Components

replaced just because the clutch disc or cover are being serviced. Replace the bearing only when it has actually failed.

Concentric Bearing Removal

(1) Remove the clutch master cylinder reservoir cover and drain the fluid with a suction gun. Reinstall the cap afterward.

(2) Disconnect the clutch master cylinder line (Fig. 11). Cap the line to prevent dirt entry.

(3) Remove the clutch housing/transmission/transfer case as an assembly. See Group 21 Manual Transmission.

(4) Disconnect the clutch master cylinder feed line.

(5) Remove the insulator plate bolts and slide the plate and rubber insulator off the bleed line (Figs. 16 and 17).

(6) Remove the throwout bearing retaining nut (Fig. 18). Pry the nut up and off the mounting pin on the transmission case.

(7) Remove the concentric bearing from the transmission input shaft. If the bearing will be reused, secure the

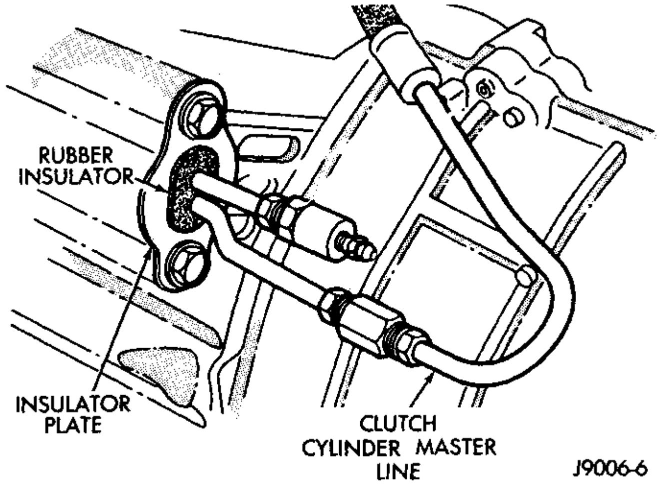


Fig. 16 Insulator, Plate And Bleed Screw — 6-Cyl

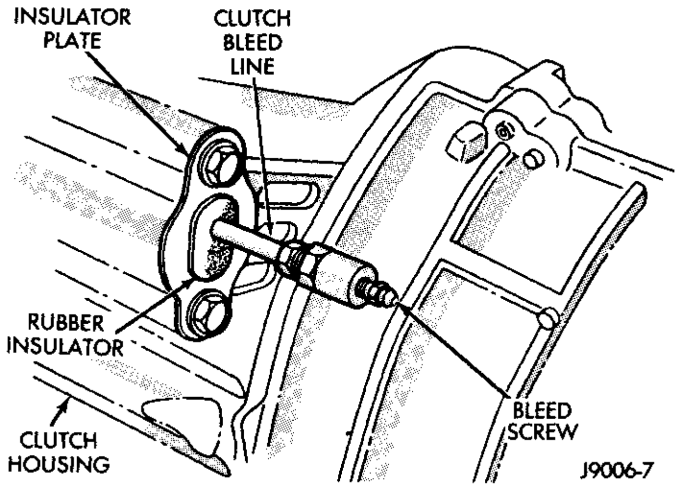


Fig. 17 Insulator, Plate And Bleed Screw — 4-Cyl

bearing and piston with tape or rubber bands. Or reconnect the nylon straps if they are still usable.

Concentric Bearing Installation

(1) New concentric bearings are equipped with nylon retaining straps (Fig. 19).The straps hold the bearing piston in place during shipment. It is not necessary to cut the straps. Simply unhook the T-shaped ends from the bearing before installation.

(2) Inspect the bearing mounting pin (Fig. 20). Replace the pin if damaged.

(3) Install the bearing assembly on the transmission input shaft (Fig. 18).

(4) Guide the bearing inlet and bleed lines through the openings in the clutch housing.

(5) Position the bearing boss on the mounting pin and seat the bearing against the transmission case (Fig. 21).

(6) Secure the bearing to the mounting pin with a new retaining nut (Fig. 21).

(7) Unhook the nylon straps that secure the bearing piston.

(8) Install the insulator and plate (Figs. 16, 17).

(9) Install the clutch housing/transmission/transfer case assembly.

(10) Connect the clutch master cylinder fluid line.

(11) Fill and bleed the clutch hydraulic system.

CLUTCH SYSTEM BLEEDING

(1) Fill the clutch master cylinder with brake fluid.

(2) Raise the vehicle.

(3) Attach a bleed hose to the bleed screw on the concentric bearing bleed line (Figs. 16, 17).

(4) Insert the opposite end of the bleed hose in a glass container partially filled with brake fluid. Be sure the hose end is completely submerged in fluid.

(5) Carefully loosen the bleed screw. Hold the bleed screw fitting firmly to prevent it from turning while loosening the screw. **Do not allow the bleed line to bend or flex when loosening the screw.**

(6) Have a helper press and hold the clutch pedal to the floor.

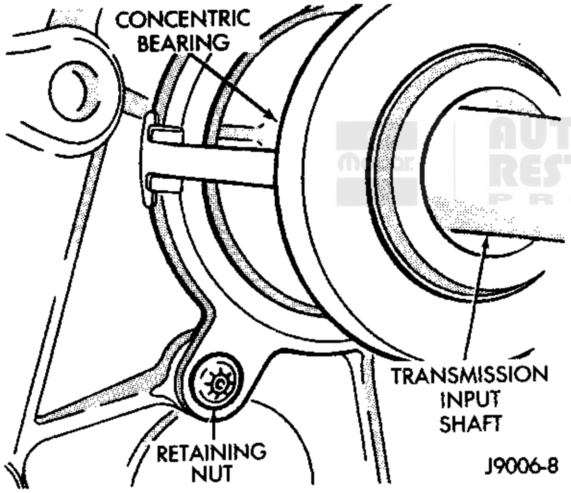


Fig. 18 Retaining Nut Removal/Installation

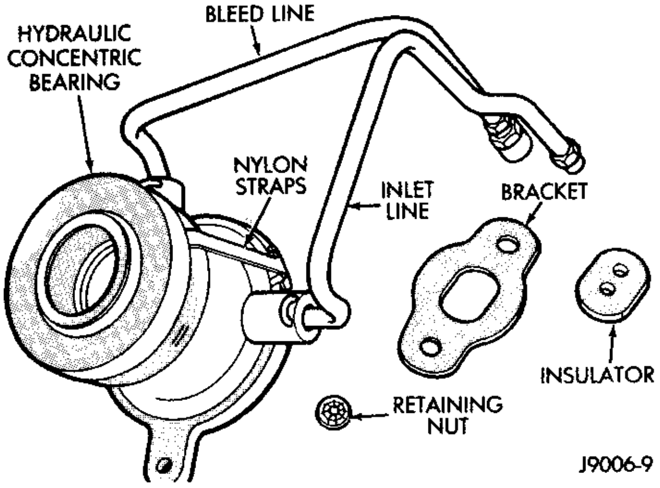


Fig. 19 Concentric Bearing Components

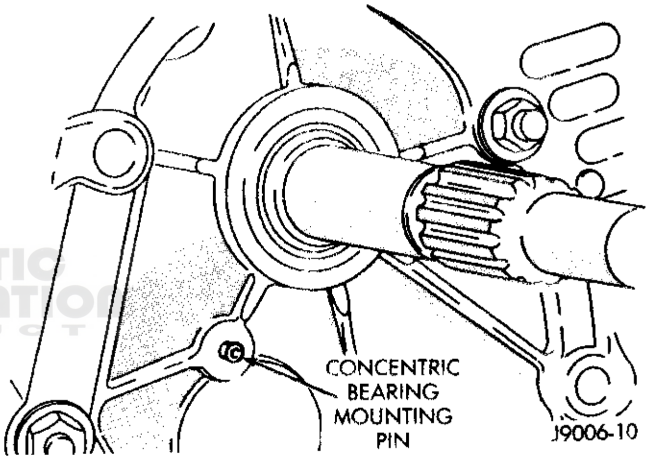


Fig. 20 Concentric Bearing Mounting Pin

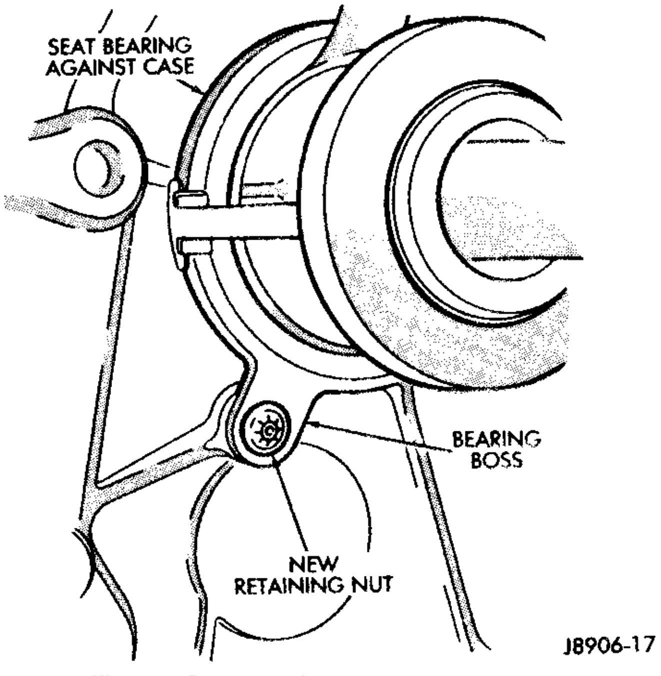


Fig. 21 Concentric Bearing Installation

(7) Tighten the bleed screw and have helper release the clutch pedal.

(8) Check clutch master cylinder fluid level. Add fluid if necessary. Do not allow the cylinder reservoir to run out of fluid during bleedingoperations.

(9) Repeat the bleeding process until fluid entering the glass container is free of bubbles. **Be sure the bleed hose end remains submerged in brake fluid during bleeding operations.**

(10) Lower the vehicle.

(11) Top off the clutch master cylinder reservoir to MAX indicator mark.

CLUTCH FLUID LEVEL

Fluid level is checked at the clutch master cylinder reservoir (Fig. 3). Fluid level is indicated by the MAX and MIN indicators on the cylinder reservoir. Check and top off fluid level to the MAX mark. Do not allow level to fall below the MIN mark.

The only fluid recommended for use in the clutch hydraulic system is Mopar Brake Fluid, or equivalent meeting SAE J-1703 and DOT 3 standards. Do not use any any other type of fluid.

Never use reclaimed brake fluid or fluid from an unsealed container. In addition, do not use fluid from a container that has been opened and allowed to stand for any length of time. Moisture in the air can be absorbed by the fluid causing dilution and loss of effectiveness.

TORQUE SPECIFICATIONS

Component	Foot Pounds	N·m	Inch Pounds	N·m
Clutch Cover Bolts:				
4-Cylinder	23	31		
6-Cylinder	40	54		
Concentric Bearing Fluid Fitting			132	15
Clutch Cylinder Mounting Bolts/Nuts	19	26		
Clutch Cylinder Hydraulic Line Fitting:				
4-Cylinder			132	15
6-Cylinder			190	21
Clutch Housing-to-Engine Bolts:				
M12 × 1.75	55	75		
3/8-16	27	37		
7/16-14	43	58		
Clutch Housing Cover (4-Cylinder):				
Upper Bolt	16	22		
Lower Bolt	55	75		
Clutch Housing-to-Transmission Bolt:				
AX 15	28	38		
AX 5	28	38		
Starter Motor Dowel Bolt	33	45		
U-Joint Clamp Bolts			170	19
Rear Support-to-Crossmember Bolt	33	45		
Crossmember-to-Frame Rail Bolt	30	41		

J9006-18

COOLING SYSTEM

CONTENTS

GENERAL INFORMATION

INDEX

Throughout this group references are made to particular vehicle models by alphabetical designation or by the particular model nameplate. A chart showing a breakdown of the alphabetical designations is included in the Introduction section of this manual.

COOLING SYSTEM

The cooling system regulates the engine operating temperature by allowing the engine to reach normal operating temperature as quickly as possible, maintaining normal operating temperature and preventing overheating.

The cooling system also provides a means of heating the passenger compartment and cooling the automatic transmission fluid (if equipped). The cooling system is pressurized and uses a centrifugal water pump to circulate coolant throughout the system.

An optional factory installed heavy duty cooling package is available on most models. Generally the package consists of a radiator which has an increased number of cooling fins and two rows of cooling tubes instead of one. MJ and XJ vehicles equipped with a 4.0L engine and heavy duty cooling and/or air conditioning also have an auxiliary electric cooling fan.

System Coolant Routing

For cooling system routings refer to Figures 1 through 5.

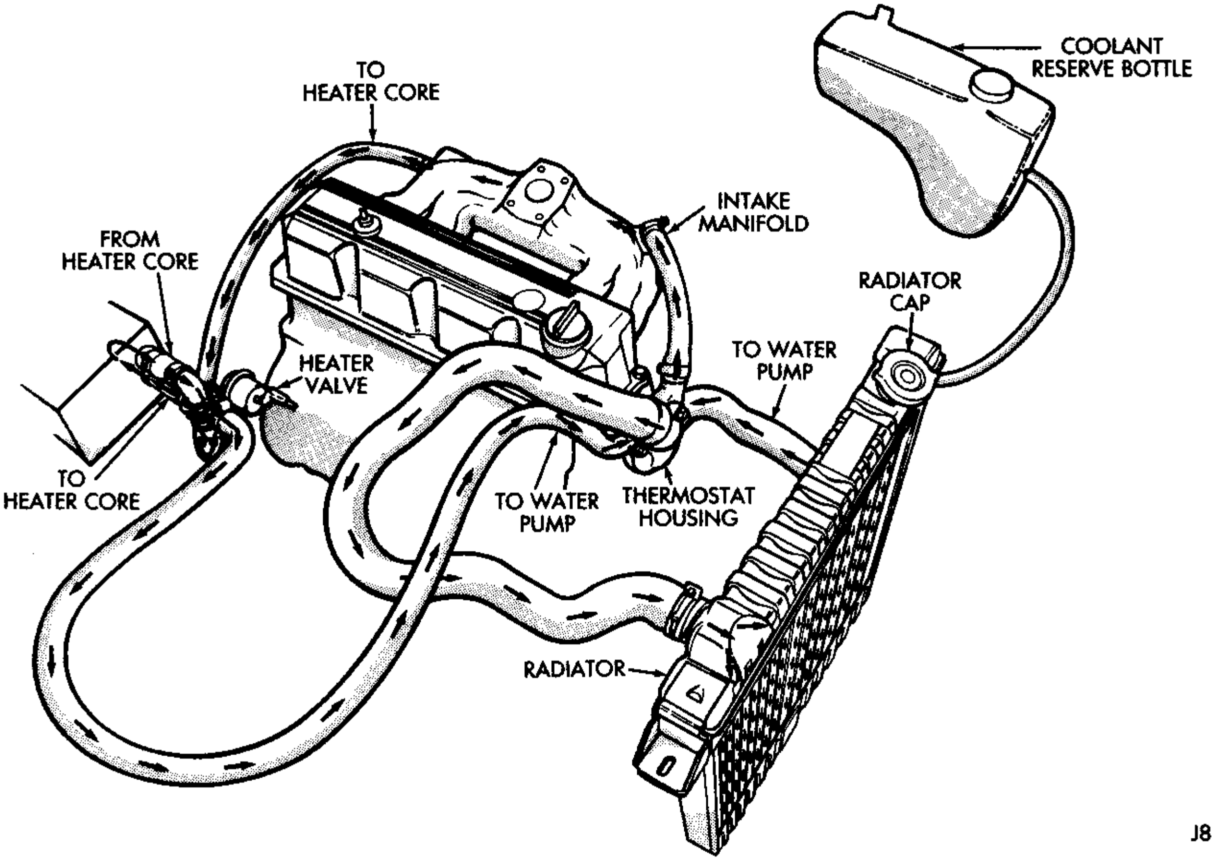


Fig. 1 Coolant Flow—MJ and XJ Vehicles with 2.5L Engine

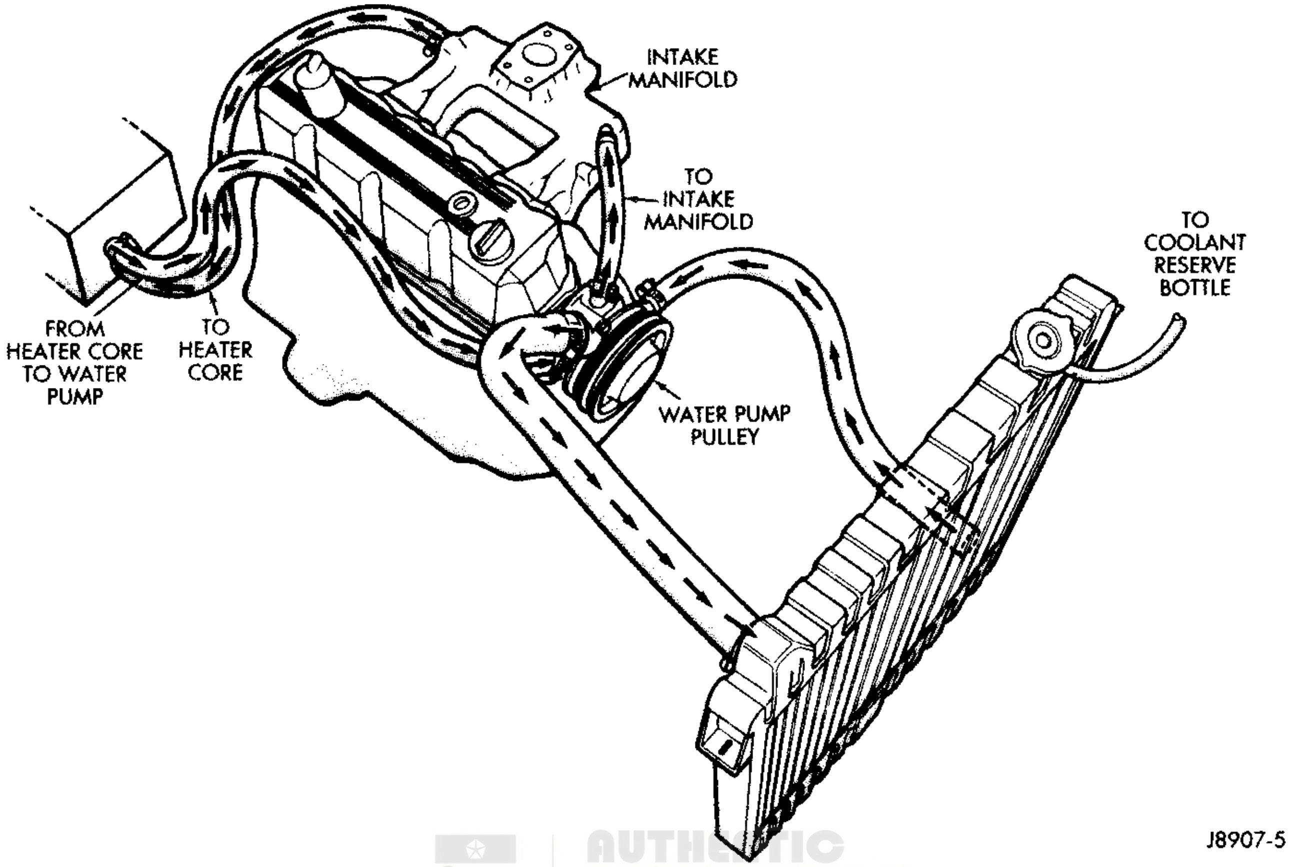


Fig. 2 Coolant Flow—YJ Vehicles with 2.5L Engine

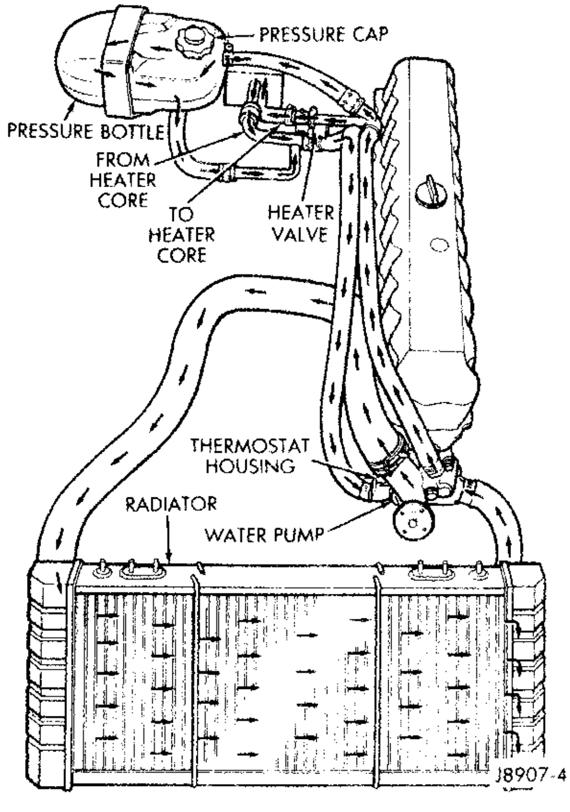


Fig. 3 Coolant Flow— MJ and XJ Vehicles with 4.0L Engine

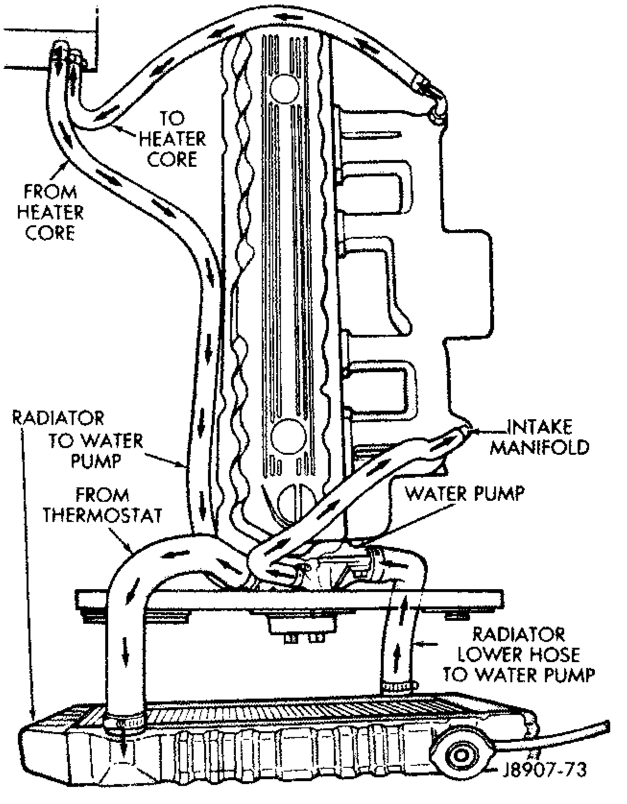


Fig. 4 Coolant Flow—YJ Vehicles with 4.2L Engine

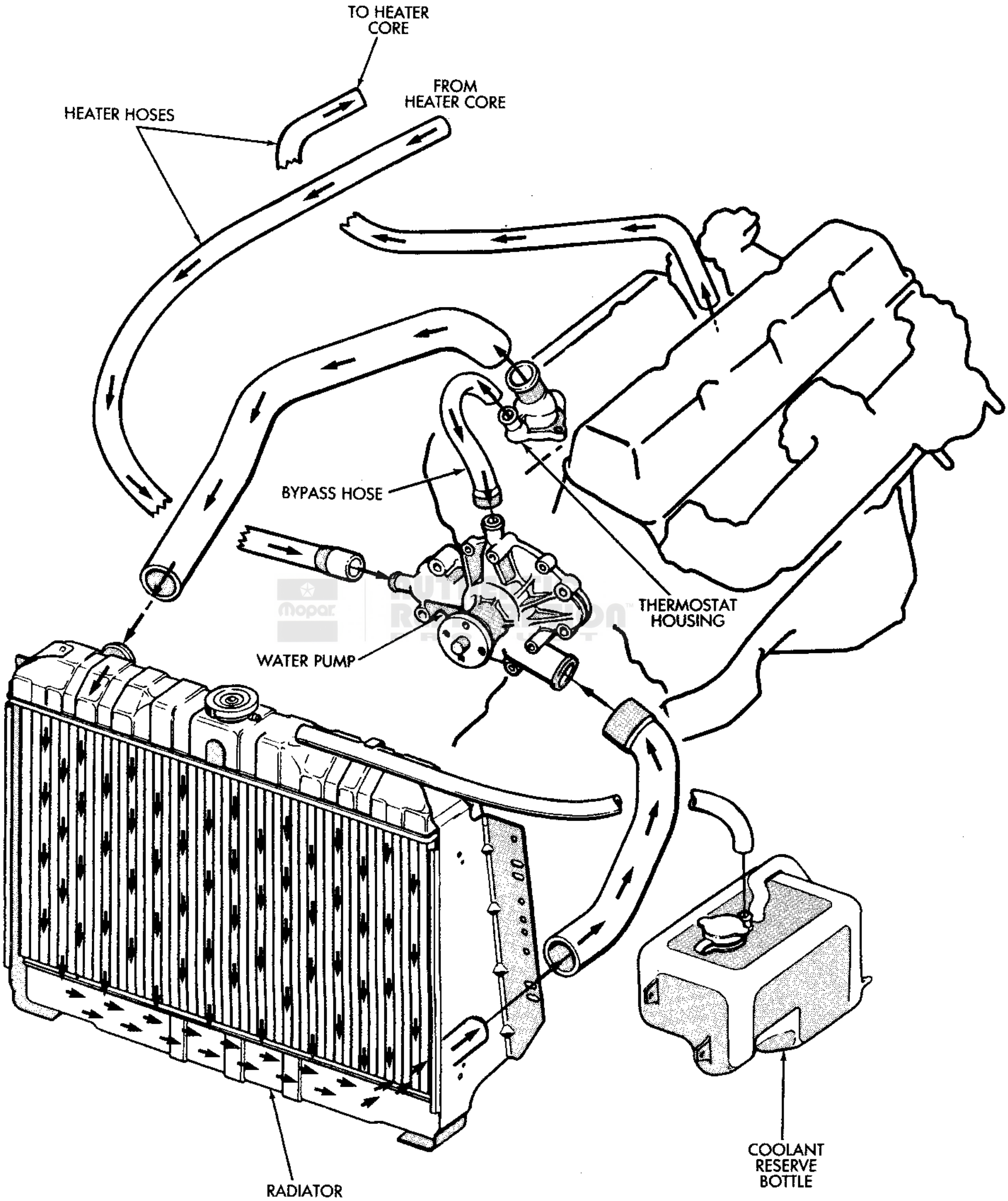


Fig. 5 Coolant Flow—SJ Vehicles with 5.9L Engine

DIAGNOSIS

PRELIMINARY DIAGNOSIS

Engine Cooling System Overheat Diagnosis

Establish what "driving" conditions caused the complaint. Abnormal loads on the cooling system such as the following may be the cause:

1. PROLONGED IDLE, VERY HIGH AMBIENT TEMPERATURE, SLIGHT TAIL WIND AT IDLE, SLOW TRAFFIC, TRAFFIC JAMS, HIGH SPEED, STEEP GRADES:

Driving techniques that avoid overheating are:

(a) Idle with A/C off when temperature gauge is at end of normal range.

(b) Increasing engine speed for more air flow is recommended.

2. TRAILER TOWING:

Consult owner's manual—Trailer Towing. Do not exceed limits.

3. AIR CONDITIONING; ADD-ON OR AFTER MARKET:

A heavy duty cooling package should have been ordered with the vehicle if add-on or after market A/C is installed. If not, heavy duty cooling system components must be installed for the model involved per manufacturer's specifications.

4. RECENT SERVICE OR ACCIDENT REPAIR:

Determine if any recent service has been performed on the vehicle that may affect the cooling system such as: engine adjustments (incorrect timing), slipping accessory drive belt(s), brakes (possibly dragging), changed parts (incorrect water pump—rotating in wrong direction), recored radiator or cooling system refilling (possibly under filled or trapped air).

If investigation reveals none of the above as a cause for engine overheating complaint refer to the following symptom and action chart.

SYMPTOM and ACTION

(See Preliminary FIRST)

Symptom	**Action**
Blinking Engine Temperature Warning Light Or High GaugeIndication-Without Coolant Loss	Normal with temporary operation with heavy load, towing a trailer, high outdoor temperatures, and/or on a steep grade.
Coolant Loss	Improper refilling procedures can result in trapped air in the system. Subsequent operation of the pressure cap and coolant reserve system will deaereate the cooling system. A low coolant level will then result in the Coolant Reserve Bottle. Add coolant.If condition persists see System Diagnosis.
Hot Vehicle (Not Engine) Heat Damage, Hot Carpet, Seat, Hot Catalytic Converter, Smoke, Burnt Odor	Check heat shielding, exhaust system, engine emission controls, ignition timing, engine misfiring.
Hot Engine Crackling Noise Hot Smell Severe Local Hot Spots	A moderate amount of sound from heating metal can be expected with any vehicle. However, a crackling sound from the thermostat housing, a hot smell and/or severe local hot spots on an engine can indicate blocked coolant passages, bad casting, core sand deposits and subsequent blockage, cracked cylinder block or head, or blown cylinder head gasket.
Coolant Reserve Bottle Level Changes	Level changes are to be expected as coolant volume fluctuates with engine temperature. During operation at higher temperatures and/or under heavy loads the coolant level in the reserve bottle may increase above the Maximum level indicated on the bottle. If the level in the bottle is between the Maximum and Minimum marks when the engine is at normal operating temperature, the level should return to within that range when the engine returns to normal operating conditions.
Coolant Not Returning To Radiator	Coolant will not return to the radiator if the radiator cap vent valve does not function, if an air leak destroys vacuum, or if the overflow passage is blocked or restricted. Inspect all portions of the overflow passage, pressure cap, filler neck nipple, hose, and passages within the bottle for vacuum leak only. Coolant return failure will be evident by a low level in the radiator. Reserve bottle level should increase during heat-up.
4.0L Engine Only: Auxiliary Cooling Fan Never Runs	Consult Inoperative Auxiliary Cooling Fan section of this group.
Auxiliary Cooling Fan	The Fan will run when the air conditioning compressor is engaged regardless of coolant temperature. If fan runs when compressor is not engaged and coolant temperature in the radiator outlet tank is below 88°C (190°F) Consult Group 8 Electrical Section.

SYSTEM DIAGNOSIS

Condition	Possible Cause	Correction
NOISE	(1) Fan contacting shroud. (2) Loose water pump impeller. (3) Glazed fan belt. (4) Loose fan belt. (5) Rough surface on drive pulley. (6) Water pump bearing worn. (7) Belt alignment.	(1) Reposition shroud and inspect engine mounts. (2) Replace pump. (3) Replace Belt. (4) Adjust fan belt tension. (5) Replace pulley. (6) Remove belt to isolate. Replace pump. (7) Check pulley alignment. Repair as necessary.
COOLANT LOSS – BOILOVER	**Refer to Overheating Causes in addition to the following items.**	
	(1) Overfilled cooling system. (2) Quick shutdown after hard (hot) run. (3) Air in system, resulting in occasional "burping" of coolant. (4) Insufficient antifreeze, allowing coolant boiling point to be too low. (5) Antifreeze deteriorated because of age of contamination. (6) Leaks due to loose hose clamps, loose nuts, bolts, drain plugs, faulty hoses, or defective radiator. (7) Faulty head gasket. (8) Cracked head, manifold, or block. (9) Faulty radiator cap.	(1) Reduce coolant level to proper specification. (2) Allow engine to run at fast idle prior to shutdown. (3) Purge system. (4) Add antifreeze to raise boiling point. (5) Replace coolant. (6) Pressure test system to locate source of leak(s), then repair as necessary. (7) Replace head gasket. (8) Replace as necessary. (9) Replace cap.
COOLANT ENTRY INTO CRANKCASE OR CYLINDER(S)	(1) Low cylinder head bolt torque. (2) Faulty head gasket. (3) Crack in head, manifold or block.	(1) Replace gasket, retorque head. (2) Replace head gasket. (3) Replace as necessary.
COOLANT RESERVE SYSTEM INOPERATIVE	(1) Coolant level low. (2) Leak in system. (3) Pressure cap not tight or seal missing, or leaking. (4) Pressure cap defective. (5) Overflow tube clogged or leaking. (6) Recovery bottle vent restricted.	(1) Replenish coolant to FULL mark. (2) Pressure test to isolate leak and repair as necessary. (3) Repair as necessary. (4) Replace cap. (5) Repair as necessary. (6) Remove restriction.

J8907-71

Condition	Possible Cause	Correction
HIGH TEMPERATURE GAUGE INDICATION – OVERHEATING	(1) Coolant level low.	(1) Replenish coolant.
	(2) Fan belt loose.	(2) Adjust fan belt tension.
	(3) Radiator hose(s) collapsed.	(3) Replace hose(s).
	(4) Radiator airflow blocked.	(4) Remove restriction (bug screen, fog lamps, etc.).
	(5) Faulty coolant expansion bottle cap.	(5) Replace coolant expansion bottle cap.
	(6) Air trapped in cooling system.	(6) Purge air.
	(7) Heavy-traffic driving.	(7) Operate at fast idle in neutral intermittently to cool engine.
	(8) Incorrect cooling system component(s) installed.	(8) Install proper component(s).
	(9) Faulty thermostat.	(9) Replace thermostat.
	(10) Water pump shaft broken or impeller loose.	(10) Replace water pump.
	(11) Radiator tubes clogged.	(11) Flush radiator.
	(12) Cooling system clogged.	(12) Flush system.
	(13) Casting flash in cooling passages	(13) Repair or replace as necessary. Flash may be visible by removing cooling system components or removing core plugs.
	(14) Brakes dragging.	(14) Repair brakes.
	(15) Excessive engine friction.	(15) Repair engine.
	(16) Antifreeze concentration over 68%.	(16) Lower antifreeze concentration percentage.
	(17) Faulty gauge or sending unit.	(17) Repair or replace faulty component.
	(18) Loss of coolant flow caused by leakage or foaming.	(18) Repair or replace leaking component, replace coolant.
	(19) Faulty cooling fan operation.	(19) Check cooling fan operation.
LOW TEMPERATURE GAUGE INDICATION – UNDERCOOLING	(1) Thermostat stuck open.	(1) Replace thermostat.
	(2) Faulty gauge or sending unit.	(2) Repair or replace faulty component.

J8907-70

Condition	Possible Cause	Correction
NO COOLANT FLOW THROUGH HEATER CORE	(1) Restricted return inlet in water pump.	(1) Remove restriction.
	(2) Heater hose collapsed or restricted.	(2) Remove restriction or replace hose.
	(3) Restricted heater core.	(3) Remove restriction or replace core.
	(4) Restricted outlet in thermostat housing.	(4) Remove flash or restriction.
	(5) Intake manifold bypass hole in cylinder head restricted.	(5) Remove restriction.
	(6) Intake manifold coolant passage restricted.	(6) Remove restriction or replace intake manifold.
	(7) Heater valve controls not functioning.	(7) Repair controls (see Heating and Air Conditioning Group 24).
	(8) Heater valve stuck in closed position.	(8) Repair or replace as necessary.

J8907-72

SERVICE PROCEDURES

INDEX

WATER PUMPS

A centrifugal water pump circulates the coolant through the water jackets, passages, intake manifold, radiator core, cooling system hoses and heater core. The pump is driven from the engine crankshaft by a serpentine or "V" drive belt .

The water pump impeller is pressed onto the rear of a shaft that rotates in bearings pressed into the housing. The housing has a small hole to allow seepage to escape. The water pump seals are lubricated by the antifreeze in the coolant mixture. No additional lubrication is necessary.

CAUTION: Engines with a serpentine accessory drive belt (single, 6 ribbed belt) have a reverse (counterclockwise) rotating water pump and viscous fan drive assembly. The components are identified by the words "REVERSE" stamped or imprinted on the cover of the viscous drive and inner side of the fan, and "REV" cast into the water pump body. An "R" is also stamped into the back of the water pump impeller (Fig. 6).

Do not install components that are intended for non-serpentine drive belts when servicing an engine with a serpentine drive belt. Engines with "V" type accessory drive belts have a forward (clockwise) rotating water pump (Fig. 7). Installation of the wrong water pump will cause engine over heating.

Depending upon application, 2.5L and 4.2L engines can have either serpentine or "V" type accessory drive belts. All 4.0L engines have serpentine accessory drive belts and reverse rotating water pumps. All 5.9L engines have "V" type accessory drive belts.

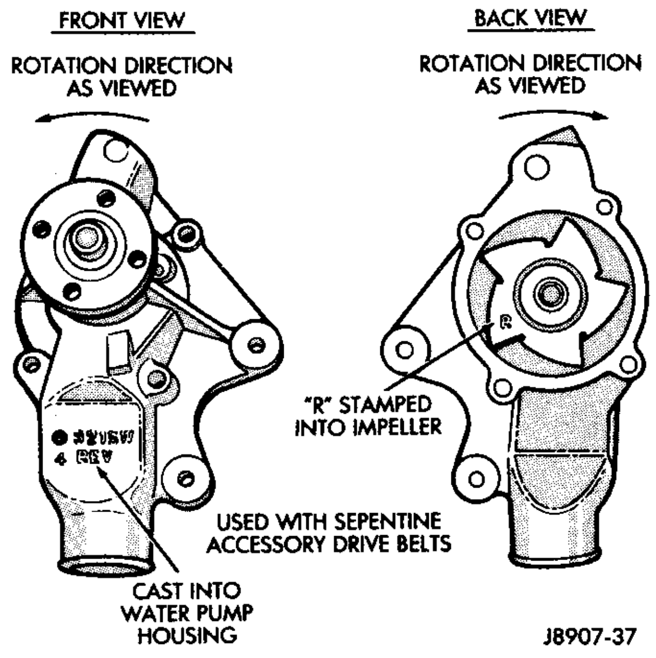


Fig. 6 Reverse Rotating Water Pump—2.5L, 4.0L and 4.2L (Typical)

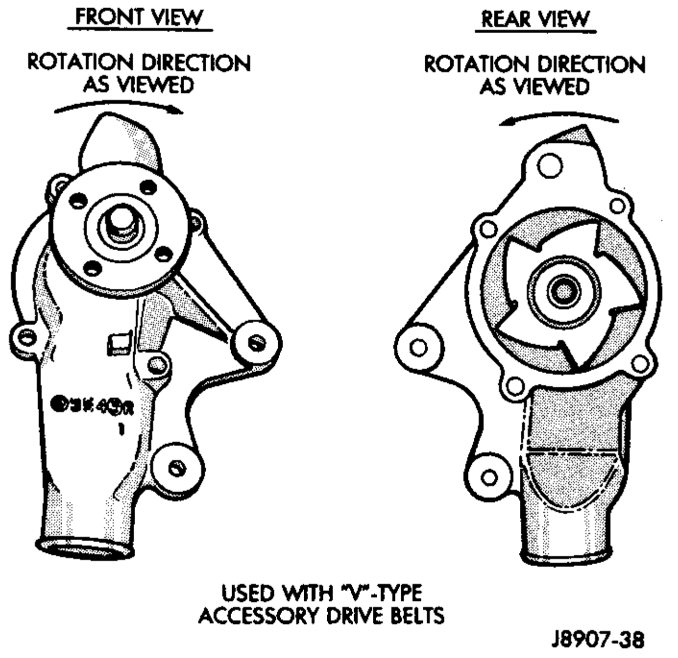


Fig. 7 Forward Rotating Water Pump—2.5L and 4.2L (Typical)

Water Pump Tests

Loose Impeller

DO NOT WASTE reusable coolant. If solution is clean and is being drained only to service the cooling system, drain coolant into a clean container for reuse.

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

(1) Drain the cooling system.

(2) Loosen the fan belt(s).

(3) Disconnect the lower radiator hose from the water pump.

(4) Bend a stiff clothes hanger or welding rod as shown (Fig. 8).

(5) Position the rod in the water pump inlet and attempt to hold the impeller while turning the fan blades. If equipped with a Tempatrol fan, turn the water pump shaft with a breaker bar and socket attached to a mounting flange nut. If the impeller is loose and can be held with the rod while the fan blades are turning, the pump is defective. If the impeller turns, the pump is OK.

Connect the hose and install the coolant, or proceed with repairs.

Inspecting for Inlet Restrictions

With 2.5L, 4.0L and 4.2L engines, inadequate heater performance may be caused by a casting restriction in the water pump heater hose inlet.

DO NOT WASTE reusable coolant. If solution is clean and being drained only to service the cooling system, drain the coolant into a clean container for reuse.

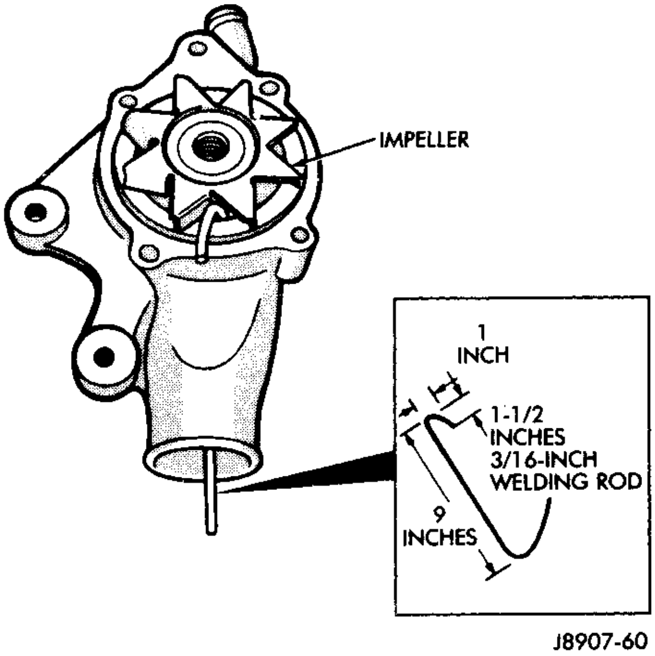


Fig. 8 Impeller Test—2.5L, 4.0L and 4.2L

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

(1) Drain sufficient coolant from the radiator to decrease the level below the water pump heater hose inlet.

(2) Remove the heater hose.

(3) Inspect the inlet for casting flash or other restrictions.

Remove the pump from the engine before removing restriction to prevent contamination of the coolant with debris. Refer to Water Pump Removal.

Intake Manifold Coolant Flow Test—4.2L Engine

If a restricted coolant flow is suspected, perform the following test procedure.

DO NOT WASTE reusable coolant. If solution is clean and being drained only to service the cooling system, drain coolant into a clean container for reuse.

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

(1) Drain the coolant from the radiator to a level below the intake manifold and remove the coolant hoses from the front and rear fittings on the intake manifold.

(2) Install a 30 cm (12 in) length of 16 mm (5/8 in) inside diameter (ID) heater hose on the intake manifold front fitting and place the funnel in the hose. The funnel must have a minimum outlet size of 9.5 mm (3/8 in) inside diameter (ID).

(3) Fill a clean container with 1/2 gallon of water.

(4) Begin pouring the water into the funnel and, time the water flow through the manifold when the water starts flowing down the funnel.

Continue pouring the water into the funnel until the container is empty and continue timing the water flow until the funnel is empty. If the water flows through the intake manifold coolant passage in 25 seconds or less, the flow interval is correct and the passage is not restricted. If the water takes longer than 25 seconds to flow through the intake manifold, inspect the manifold coolant inlet for casting flash or other restrictions. Correct as necessary and proceed to the next step.

Check the length of the hose fitting extending into the intake manifold coolant passages. The extension must not be so excessive in length that the coolant flow is restricted. Replace the fitting if the length is excessive.

If the intake manifold coolant passages are restricted and cannot be cleared, replace the intake manifold. Refer to the replacement procedure in Group 9.

Removal—2.5L, 4.0L and 4.2L Engines.

The water pump impeller is pressed on the rear of the pump shaft and bearing assembly. The water pump is serviced only as a complete assembly.

WARNING: DO NOT REMOVE THE BLOCK DRAIN PLUG(S) OR LOOSEN RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

Do not waste reusable coolant. If the solution is clean and is being drained only for service, drain coolant into a clean container for reuse.

(1) Disconnect battery negative cable.

(2) Drain the cooling system.

(3) Disconnect the radiator and heater hoses from the water pump.

(4) Remove the fan shroud attaching screws.

CAUTION: The accessory drive belts must be removed prior to removing the fan.

(5) Remove the accessory drive belt(s).

(6) Remove the fan assembly and shroud. On some models, fan removal may be easier if the fan shroud is rotated 1/2 turn.

(7) If equipped, remove the power steering bracket from the water pump boss.

(8) If equipped, remove the fan assembly and radiator shroud.

CAUTION: Engines with a serpentine accessory drive belt (single, 6 ribbed belt) have a reverse (counterclockwise) rotating water pump which is identified by "REV" cast into the front of the water pump body and an "R" stamped into the back of the water pump impeller. Engines with standard V-belt accessory drive belts have a forward (clockwise) rotating water pump. Installation of the wrong water pump will cause engine over heating.

(9) Remove the water pump and gasket (Fig. 9).

Installation—2.5L, 4.0L and 4.2L Engines

(1) Clean the gasket mating surfaces. If the original pump is used, remove any deposits or other foreign material. Inspect the cylinder block and water pump mating surfaces for erosion or damage from cavitation.

(2) Install the gasket and water pump, the gasket is installed dry. Tighten mounting bolts to 18 N•m (13 ft-lbs) torque. Rotate the shaft by hand to ensure it turns freely.

(3) Connect the radiator and heater hoses to the water pump.

(4) Position the fan assembly and shroud in place.

(5) Tighten fan drive mounting nuts to 24 N•m (18 ft-lbs).

(6) Tighten fan shroud mounting screws.

(7) Install the accessory drive belt(s) and tighten to the specified tension. Refer to Accessory Drive Belt section of this group.

CAUTION: When installing a serpentine accessory drive belt, the belt MUST be routed correctly. If not, the engine may overheat due to the water pump rotating in the wrong direction. Refer to appropriate accessory drive belt schematic for correct belt routing.

(8) Adjust the belt tension to the specified tension.

(9) Fill cooling system with coolant and check for leaks. On 2.5L and 4.2L engines remove coolant temperature sensor switch located in intake manifold to permit air to escape from the block. Install coolant temperature sensor switch when system is filled.

(10) Connect battery negative cable.

(11) Operate the engine with the heater control valve open (Heater Select in the HEAT position) until the thermostat opens to purge air from the cooling system. Check the coolant level and add as required.

Removal—5.9L Eight-Cylinder Engine

The water pump impeller is pressed on the rear of the pump shaft and bearing assembly. The water pump is serviced only as a complete assembly. DO NOT WASTE reusable coolant. If the solution is clean and being drained only to service the cooling system, drain it into a clean container for reuse.

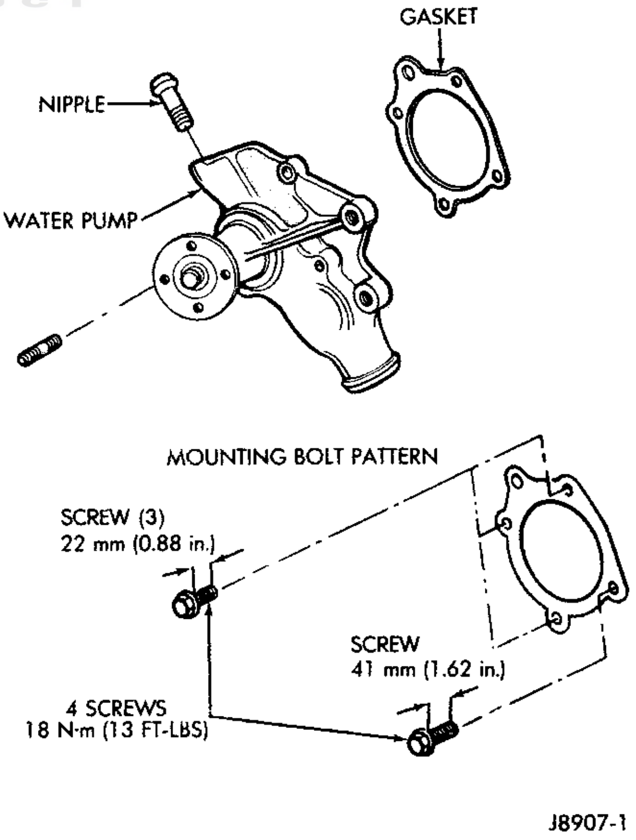


Fig. 9 Water Pump Remove/Install—2.5L, 4.0L and 4.2L

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

(1) Disconnect the battery negative cable.

(2) Drain the cooling system.

(3) Disconnect radiator upper hose at radiator.

(4) Loosen all accessory drive belts.

(5) Separate fan shroud from radiator. Install one radiator/shroud screw to hold radiator in place.

(6) Remove fan assembly from water pump.

(7) Remove water pump pulley.

(8) Remove fan shroud.

(9) Remove alternator front mounting bracket.

(10) If equipped with air conditioning, remove the three compressor mounting screws and slightly loosen stud nut (located behind and below heater hose nipple of water pump).

(11) Pivot air conditioning compressor and bracket away from water pump (Fig. 10). **It is not necessary to discharge air conditioning compressor.**

(12) If equipped with power steering, remove stud nut from power steering pump front mounting bracket. Remove power steering pump rear mounting bracket screws. Pull power steering pump/air pump assembly forward until front bracket is clear of water pump stud. Pivot assembly away from water pump and install rear bracket lower screw to hold assembly in place.

(13) Disconnect heater hose at water pump.

(14) Disconnect bypass hose at water pump.

(15) Disconnect radiator lower hose at water pump.

(16) Remove water pump and gasket.

Installation 5.9L Eight-Cylinder Engine

(1) Clean the gasket mating surfaces. If the original pump is used, remove any deposits or other foreign material. Inspect the timing case cover and water pump mating surfaces for erosion or damage from cavitation.

(2) Install the water pump and a replacement gasket on the timing case cover.

(3) Tighten the water pump mounting screws.

(a) water pump to timing case cover to 5 N•m (48 in-lbs) torque.

(b) water pump to cylinder block bolts to 38 N•m (28 ft-lbs)

(4) Install power steering pump, air pump, and brackets assembly.

(5) Connect the heater hose, bypass hose and radiator lower hose to the water pump.

CAUTION: Ensure the wire coil (spring) is installed in the lower heat radiator hose. Failure to install this coil will result in the hose collapsing when the engine is operating at high RPM.

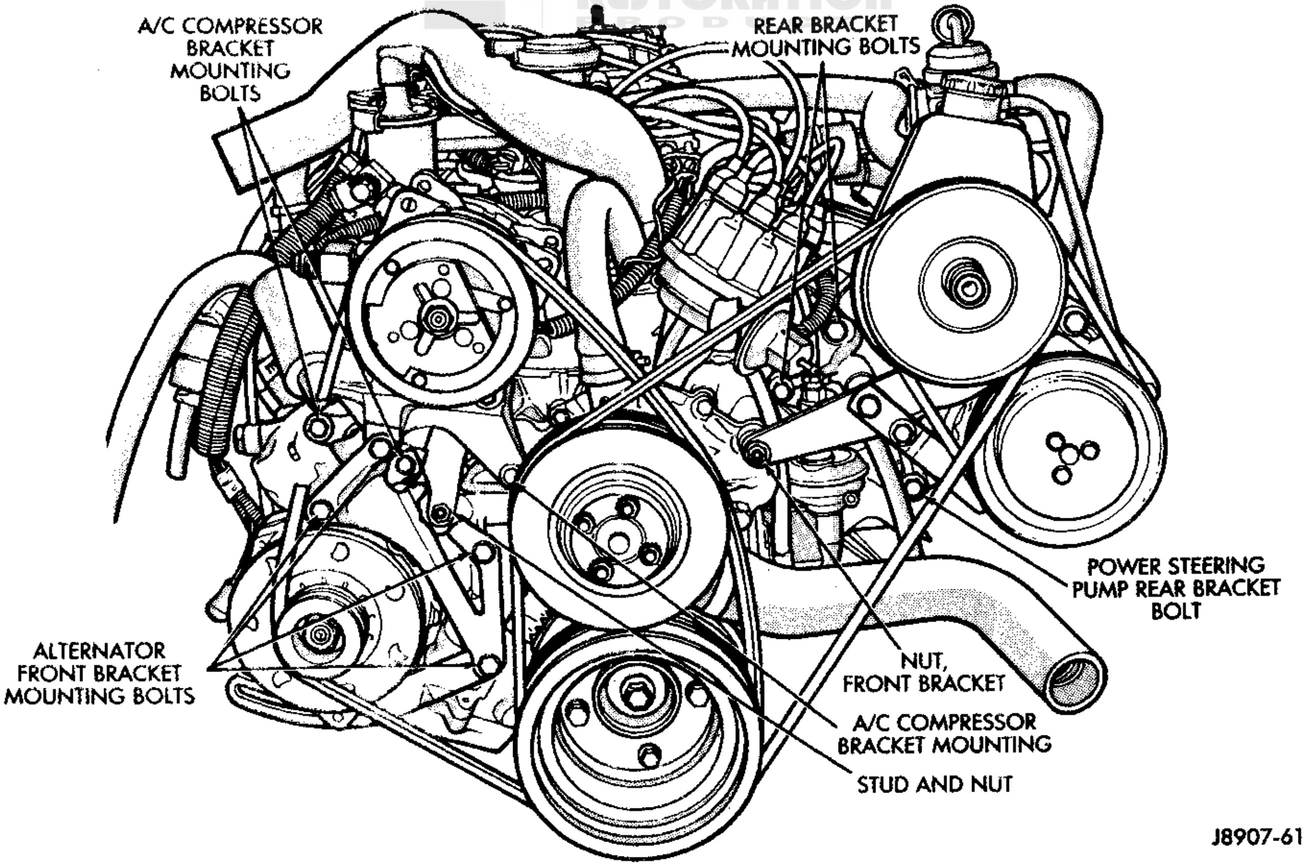


Fig. 10 Water Pump Remove/Install—5.9L

(6) Pivot air conditioning compressor into position. Tighten mounting screws and stud nut to 38 N•m (28 ft-lbs).

(7) Install alternator front mounting bracket. Tighten mounting screws to 38 N•m (28 ft-lbs).

(8) Position the shroud against the front of the engine and install fan and viscous drive assembly.

(9) Tighten the retaining nuts to 24 N•m (18 ft-lbs) torque.

(10) Position the shroud on the radiator and install it with the attaching screws.

(11) Install accessory drive belts and tighten to the specified tension. Refer to Accessory Drive Belt section of this group.

(12) Connect radiator upper hose to the radiator.

(13) Connect battery negative cable.

(14) Fill cooling system with correct mixture of Mopar All-Season Coolant, or equivalent, and water.

(15) Operate the engine with the heater control valve open until the thermostat opens. Shut the engine off. Recheck the coolant level and add as necessary.

ENGINE THERMOSTAT

Description and Operation

A pellet-type thermostat controls the operating temperature of the engine by controlling the amount of coolant flow to the radiator. On all engines the thermostat is closed below 195°F (90°C). Above this temperature, coolant is allowed to flow to the radiator. This provides quick engine warmup and overall temperature control. An arrow plus the word **UP** stamped on the front flange next to the air bleed and the words **TO RAD** stamped on one arm of the thermostat, indicate the proper installed position. The same thermostat is used for winter and summer seasons. An engine should not be operated without a thermostat, except for servicing or testing. Operating without a thermostat causes longer engine warmup time, unreliable warmup performance, increased exhaust emissions, and crankcase condensation that can result in sludge formation.

CAUTION: Do not operate an engine without a thermostat, except for servicing or testing.

Thermostat Testing

Remove the thermostat. Refer to Thermostat Removal. Insert a 0.076mm (0.003-in) feeler gauge, with a wire or string attached, between the thermostat valve and seat (Fig. 11).

WARNING: ANTIFREEZE IS POISONOUS. KEEP OUT OF THE REACH OF CHILDREN.

Submerge the thermostat in a container of pure antifreeze and suspend it so that it does not touch the sides or the bottom of the container.

Suspend a thermometer in the antifreeze so that it does not contact the container or thermostat.

WARNING: DO NOT BREATHE THE VAPOR. ENSURE THE TEST AREA IS PROPERLY VENTILATED.

Heat the antifreeze. Apply a slight tension on the feeler gauge while the antifreeze is heated. When the valve opens the feeler gauge will slip free from the valve. Note the temperature (Fig. 11). If defective, replace the thermostat.

Install the thermostat. Refer to Thermostat Removal.

Thermostat Removal

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

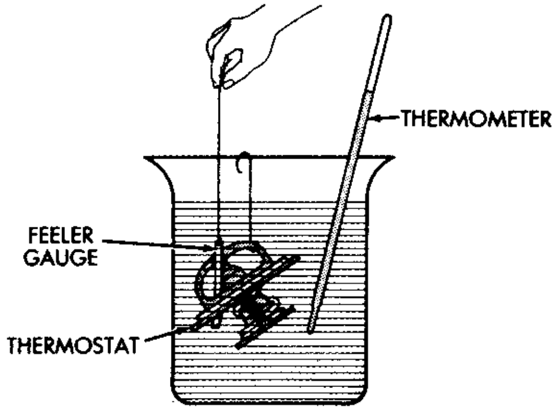
Do not waste reusable coolant. If the solution is clean and being drained only to service the cooling system, drain the coolant into a clean container for reuse.

(1) Drain the coolant from the radiator until the level is below the thermostat housing.

(2) 5.9L engine: remove radiator upper hose, thermostat housing cover, gasket and thermostat.

2.5L and 4.2L engines: remove radiator upper and intake manifold hoses, thermostat housing, gasket, and thermostat.

4.0L engine: remove radiator upper hose, thermostat housing, gasket, and thermostat.



Must Be Open 0.076 mm (0.003 inch)	90°C (195°F)
Must Be Fully Open	103°C (218°F)

J8907-6

Fig. 11 Thermostat Calibrations

(3) Clean the gasket mating surfaces.

Thermostat Installation

(1) Install the replacement thermostat so that the pellet, which is encircled by a coil spring, faces the engine. All thermostats are marked on the outer flange to indicate the proper installed position.

(a) 2.5L, 4.0L and 4.2L engines: Observe the recess groove in the cylinder head (Fig. 12).

(b) 5.9L Engines: Observe the recess groove in the intake manifold (Fig. 13).

(c) On 2.5L, 4.0L and 4.2L Engines: Position thermostat in groove with arrow and air bleed hole on outer flange pointing up (Fig. 14).

(d) On 5.9L Engines: position thermostat in groove with pellet end down and the arrow on the outer flange facing up (Fig. 15).

(2) Install replacement gasket and thermostat housing.

CAUTION: Tightening the housing unevenly or with the thermostat out of its recess may result in a cracked housing.

(3) Tighten the housing bolts to 18 N•m (13 ft-lbs) torque.

(4) Install hoses.

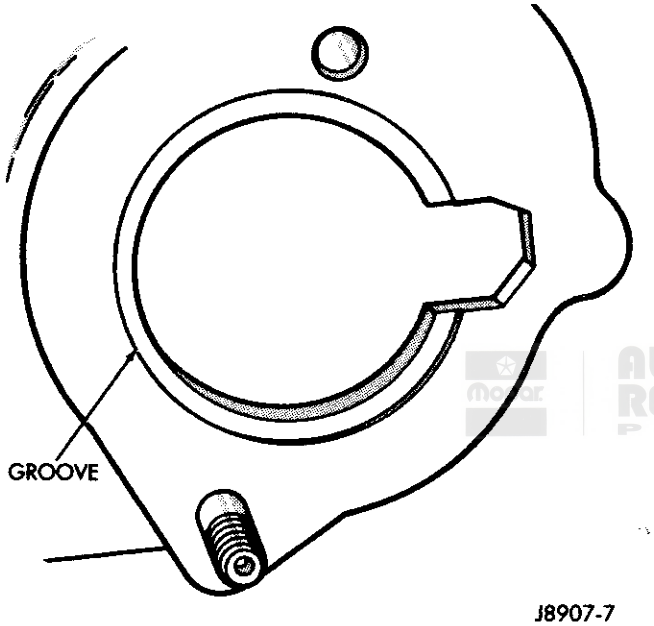


Fig. 12 Thermostat Recess—2.5L, 4.0L and 4.2L

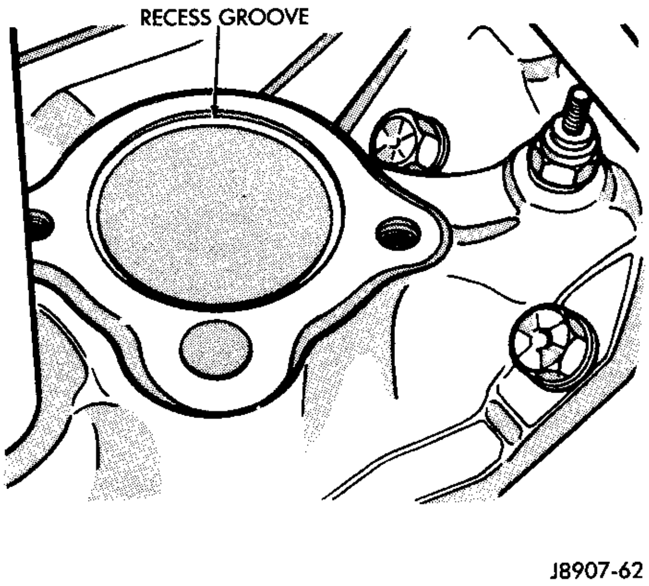


Fig. 13 Thermostat Recess—5.9L

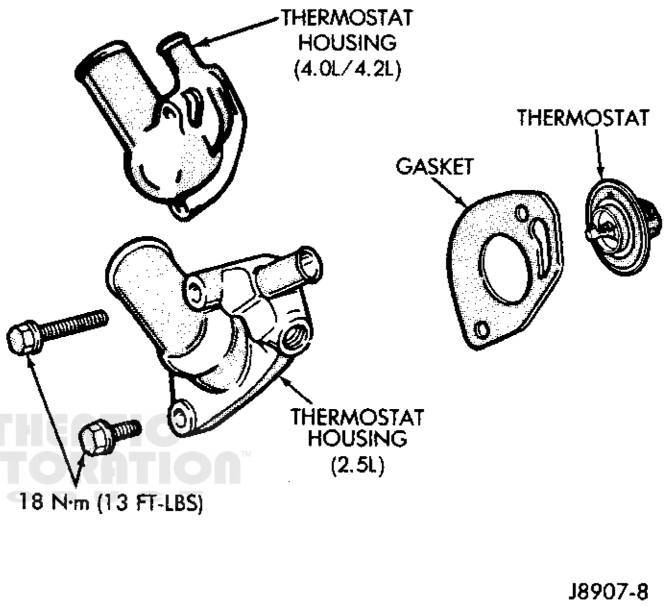


Fig. 14 Thermostat Installation—2.5L, 4.0L and 4.2L

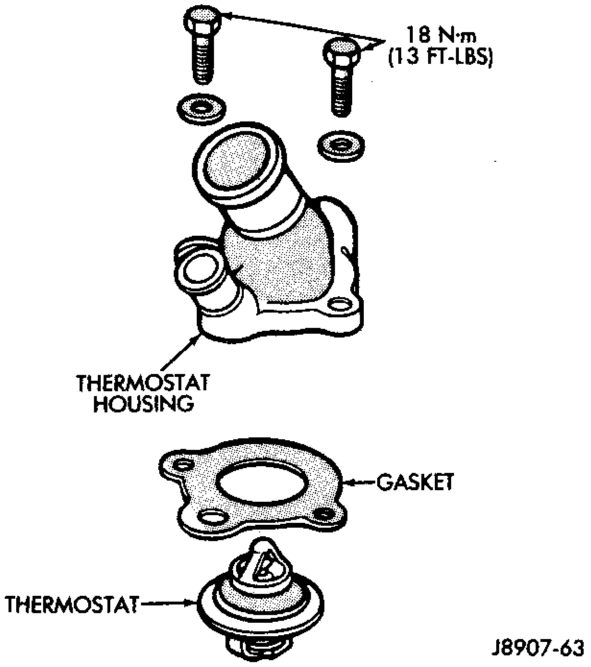


Fig. 15 Thermostat Installation—5.9L

(5) Ensure that the radiator draincock is tightly closed. Fill the cooling system to the correct level with the required coolant mixture. Refer to Coolant.

COOLANT

Coolant flows through the engine and absorbs heat produced during engine operation. The coolant carries the heat to radiator and heater core where it is transferred to the ambient air passing through the radiator and heater core fins. The coolant also removes heat from automatic transmission fluid in vehicles equipped with an automatic transmission.

Coolant Performance

The required ethylene-glycol (anti-freeze) and water mixture depends upon climate and vehicle operating conditions. The coolant performance of various mixtures follows.

Pure Water — For the purpose of heat transfer only, water is able to absorb more heat than a mixture of water and ethylene-glycol. But, water freezes at a higher temperature and allows corrosion.

100 percent Ethylene-Glycol — The corrosion inhibiting additives in ethylene-glycol need the presence of water to dissolve, without water they form deposits in the system which act as insulation causing the temperature to rise. In addition, 100 percent ethylene-glycol freezes at -22°C (-8°F).

50/50 Ethylene-Glycol and Water — Is the recommended mixture, it provides protection against freezing to -37°C (-35°F). The antifreeze concentration **MUST ALWAYS** be a minimum of 44 percent, year-round in all climates. If the percentage is lower, engine parts may be eroded by cavitation. Maximum protection against freezing is provided with a 68 percent antifreeze concentration, which prevents freezing down to -67.7°C (-90°F). A higher percentage will freeze at a warmer temperature. Also, a higher percentage of antifreeze can cause the engine to overheat because the specific heat of antifreeze is lower than that of water.

CAUTION: Richer mixtures cannot be measured with normal field equipment and can cause problems associated with 100 percent ethylene-glycol.

Coolant Selection-Additives

Maintain the coolant at the specified level with a mixture of ethylene glycol- based antifreeze (containing ALUGARD 340-2 ™) and low mineral content water.

CAUTION: Do not use coolant additives that are claimed to improve engine cooling.

Coolant Service

It is recommended that the cooling system be drained and flushed every 36,000 kilometers (22,500 miles) or 22 months.

Coolant Level Check-Routine

For all Jeep vehicles, check the coolant level at the reserve bottle with engine cold. The correct coolant level is between the ADD and FULL marks on the reserve bottle for all Jeep vehicles except those equipped with the 4.0L engine.

To check the coolant level in vehicles equipped with a 4.0L engine, **with the engine cold**, remove the reserve bottle cap and look down into the bottle. The coolant level is correct when it is at the top of the post inside the reserve bottle.

Adding Additional Coolant-Routine

Do not remove the radiator cap to add coolant to the system. Only add coolant when the engine is cold. When adding coolant to maintain the correct level, do so at the coolant reserve bottle. Remove the radiator cap only for testing or when refilling the system after service. Removing the cap unnecessarily can cause loss of coolant and allow air to enter the system, which produces corrosion.

Coolant Level Check-Service

The cooling system in all vehicles, except those equipped with the 4.0L engine, is closed and designed to maintain coolant level to the top of the radiator.

In vehicles equipped with 4.0L engines the system is pressurized and designed to maintain coolant level to the top of the post located inside the pressure bottle.

WARNING: DO NOT REMOVE THE COOLANT PRESSURE BOTTLE CAP WHEN THE ENGINE IS HOT AND UNDER PRESSURE AS SERIOUS BURNS FROM HOT COOLANT CAN OCCUR.

Coolant level in vehicles equipped with a 4.0L engine is checked at the pressure bottle **with engine off and cold**. The coolant level should be at top of post in bottle. The notch on the post is the ADD mark. If coolant level is low in a warm, running engine, allow engine to cool before adding coolant. Since the system is always under pressure open the pressure bottle cap slowly to relieve pressure. Fill system as necessary.

Low Coolant Level-Aeration

Low coolant level can cause the thermostat pellet to be suspended in air instead of coolant. This will cause the thermostat to open later which in turn causes higher coolant temperature. Air trapped in cooling system also reduces the amount of coolant circulating in the heater core resulting in low heat output.

Deaeration

2.5L, 4.2L, and 5.9L Engines

As engine operates, air trapped in the cooling system gathers under the radiator cap. The next time engine is operated thermal expansion of coolant will push trapped air past radiator cap into coolant reserve bottle where it escapes to atmosphere in the bottle. When engine cools down coolant will be drawn from reserve bottle into radiator to replace removed air.

4.0L Engine

As the engine operates air trapped in the system gathers in the pressure bottle and is released to atmosphere through the pressure valve in the bottle cap when system pressure reaches approximately 124 kPa (18 psi). The air is replaced with coolant from the pressure bottle. The radiator does not have a pressure cap. The cap on the pressure bottle is the only cap used in the system.

DRAINING COOLING SYSTEM

Vehicle without 4.0L Engine

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

DO NOT WASTE reusable coolant. If the solution is clean and is being drained only to service the engine or cooling system, drain the coolant into a clean container for reuse.

Do not remove the radiator cap when draining the coolant from the reserve bottle. Open the radiator draincock and when the bottle is empty, remove the radiator cap. The coolant need not be removed from the bottle unless the system is being refilled with a fresh mixture.

(1) Drain the coolant from the radiator by loosening the draincock on the bottom tank.

(2) Drain coolant from engine:

(a) On 2.5L engines by removing drain plug at left rear side of block.

(b) On 4.2L engines by removing the two drain plugs located on the left side of the block (the plugs may have been replaced by one or two CTO valves).

(c) On 5.9L engines by removing the centrally located plugs on each side of the block.

MJ and XJ Vehicles With 4.0L Engine.

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

DO NOT WASTE reusable coolant. If the solution is clean and is being drained only to service the engine or cooling system, drain the coolant into a clean container for reuse.

(1) Remove pressure bottle cap.

(2) For access to radiator draincock:

(a) remove left park/turn signal lamp on Wagoneer vehicles (Fig. 16).

(b) remove radiator grille on Comanche and Cherokee vehicles (Fig. 17).

(3) Attach one end of a 24 in. long 1/4 in ID hose to the radiator draincock, put the other end into a clean container. Open draincock and drain coolant from radiator.

(4) Drain coolant from engine by removing the drain plug and coolant temperature sensor on left side of block (Fig. 18).

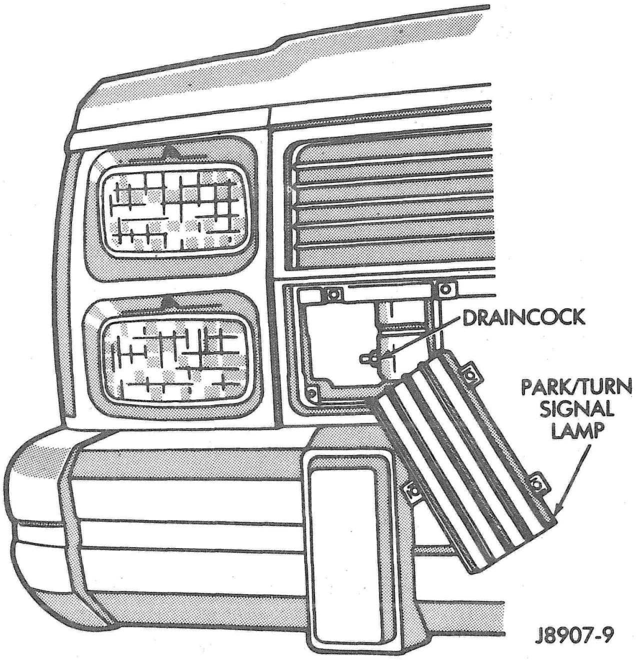


Fig. 16 Draincock Access—Wagoneer with 4.0L Engine

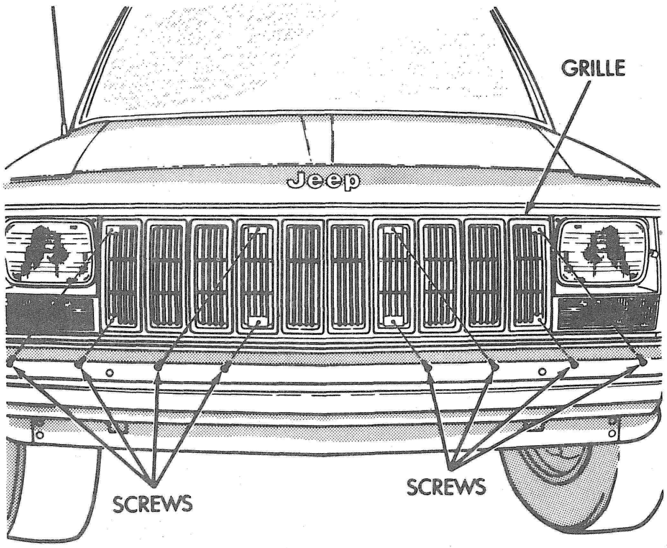


Fig. 17 Draincock Access—MJ and XJ Vehicles with 4.0L

REFILLING COOLING SYSTEM

SJ and YJ Vehicles

(1) Remove draining hose and tighten the radiator draincock and the cylinder block drain plug(s).

(2) Fill system, using a 50/50 mixture of water and anti-freeze as described in "Coolant". Fill the radiator to the top and install the radiator cap. Add sufficient coolant to the reserve bottle to raise the level to the FULL mark.

(3) Operate the engine with the radiator and reserve bottle caps in place. After the engine has reached the normal operating temperature, shut the engine off and allow it to cool.

(4) Add coolant to the reserve bottle as necessary. **Only add coolant when the engine is cold. Coolant level in a warm engine will be higher due to thermal expansion.**

MJ and XJ Vehicles with 2.5L Engine

(1) Tighten the radiator draincock and the cylinder block drain plug.

(2) Fill system, using a 50/50 mixture of water and anti-freeze as described in the "Coolant" section of this group. Fill radiator to top and install radiator cap. Add sufficient coolant to reserve bottle to raise level to FULL mark.

(3) With heater control unit in "HEAT" position, operate engine with radiator and reserve bottle caps in place.

(4) After engine has reached normal operating temperature, shut engine off and allow it to cool.

(5) Add coolant to reserve bottle as necessary. **Only add coolant when the engine is cold. Coolant level in a warm engine will be higher due to thermal expansion.**

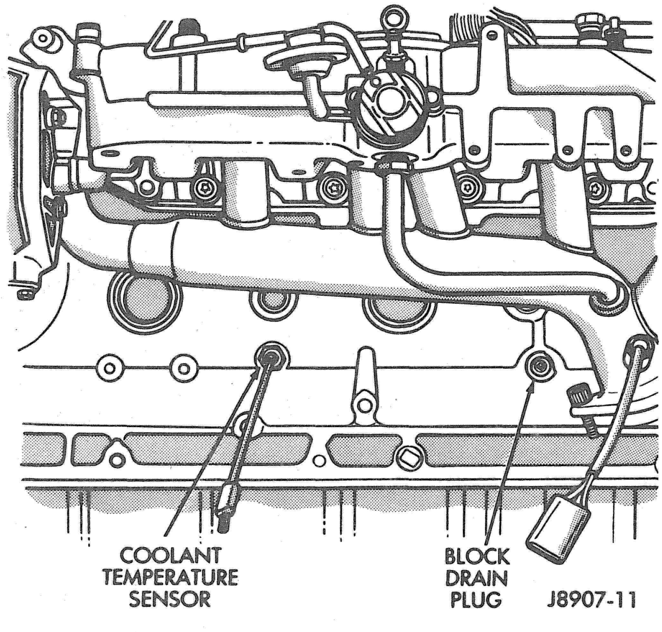


Fig. 18 Draining Coolant—4.0L Engine

MJ and XJ Vehicles with 4.0L Engine

(1) Tighten the radiator draincock and cylinder block drain plugs.

(2) Slowly fill the system at the pressure bottle with a 50/50 mixture of water and anti-freeze as described in "Coolant". **Fill until the coolant level is at the top of the post inside the bottle. The top of the post is the full mark. The notch on the post is the add mark.**

(3) With heater control unit in "HEAT" position, start engine and operate until the radiator upper hose is warm to the touch.

(4) Shut engine off.

(5) After the engine has cooled down check the coolant level in the pressure bottle. **Only add coolant to the pressure bottle when the engine is cold. Coolant level in a warm engine will be higher due to thermal expansion.** Add coolant, if necessary, until coolant level is to the top of the post inside the bottle.

COOLING SYSTEM CLEANING, REVERSE FLUSHING

CAUTION: The cooling system normally operates at 82.7 - 103.4 kPa (12 - 15 psi) pressure. Exceeding this pressure may damage the radiator or hoses.

Cleaning

Drain cooling system and refill with water. Run engine with radiator cap installed until upper radiator hose is hot. Stop engine and drain water from system. If water is dirty, fill system with water, run engine, and drain system. Repeat until water drains clean.

Reverse Flushing

Reverse flushing of the cooling system is the forcing of water through the cooling system, using air pressure, in the opposite direction of normal coolant flow. This is usually only necessary with very dirty systems with evidence of partial plugging.

Reverse Flushing Radiator

Disconnect the radiator hoses from the radiator fittings. Attach a section of radiator hose to the radiator bottom outlet fitting and insert the flushing gun. Connect a water supply hose and air supply hose to the flushing gun.

CAUTION: The cooling system normally operates at 82.7 - 103.4 kPa (12 - 15 psi) pressure. Exceeding this pressure may damage the radiator or hoses.

Allow the radiator to fill with water. When the radiator is filled, apply air in short blasts, allowing the radiator to refill between blasts. Continue this reverse flushing until clean water flows out through rear the radiator cooling tube passages. Have the radiator cleaned more extensively by a radiator repair shop.

Reverse Flushing Engine

Drain the cooling system. Remove the thermostat housing cover (eight-cylinder engine) or housing (2.5L four-cylinder, 4.0L and 4.2L six-cylinder engines) and thermostat. Install the thermostat housing cover or housing. Disconnect the radiator upper hose from the radiator and attach the flushing gun to the hose. Disconnect the radiator lower hose from the water pump and attach a lead away hose to the water pump inlet fitting.

CAUTION: Ensure the heater control valve is closed (heat off). This will prevent coolant flow with scale and other deposits from entering the heater core.

Connect the water supply hose and air supply hose to the flushing gun. Allow the engine to fill with water. When the engine is filled, apply air in short blasts, allowing the system to fill between air blasts. Continue until clean water flows through the lead away hose.

Remove the lead away hose, flushing gun, water supply hose and air supply hose. Remove the thermostat housing cover or housing and install the thermostat. Install the thermostat housing cover or housing with a replacement gasket. Refer to Thermostat Replacement. Connect the radiator hoses. Refill the cooling system with the correct antifreeze/water mixture.

Chemical Cleaning

In some instances, the use of a radiator cleaner (Mopar Radiator Kleen, or equivalent) before flushing will soften scale and other deposits and aid the flushing operation.

CAUTION: Ensure instructions on the container are followed.

TESTING COOLING SYSTEM FOR LEAKS

Ultraviolet Light Method

All models have a leak detection additive added to the cooling system before they leave the factory. The additive is highly visible under ultraviolet light (black light). If the factory original coolant has been drained, poor one ounce of additive into the cooling system. The additive is available through the parts department. Place the heater control unit in "HEAT" position. Start and operate the engine until the radiator upper hose is warm to the touch. Aim the black light, tool 7138 or an equivalent, at the components to be checked. If leaks are present, the black light will cause the additive to glow a bright green color.

The black light can be used in conjunction with a pressure tester to determine if any external leaks exist (Fig. 19).

Pressure Tester Method

2.5L, 4.2L, and 5.9L engines

The engine should be at the normal operating temperature. Recheck the system cold if the cause of coolant loss is not located during warm engine examination.

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING.

Carefully remove the radiator pressure cap from the filler neck and check the coolant level. Push down on the cap to disengage it from the stop tabs. Wipe the inside of the filler neck and examine the lower inside sealing seat for nicks, cracks, paint, dirt and solder residue. Inspect the reserve bottle tube for internal obstructions. Insert a wire through the tube to ensure it is not obstructed.

Inspect the cams on the outside of the filler neck. If the cams are bent, seating of pressure cap valve and tester seal will be affected. Bent cams can be reformed if done carefully. Attach pressure tester 7700-A or an equivalent to the radiator filler neck (Fig. 20).

Operate the tester pump to apply 103.4 kPa (15 psi) pressure to the system. If the hoses enlarge excessively or bulge while testing, replace as necessary. Observe the gauge pointer and determine the condition of the cooling system according to following criteria.

Holds Steady: If the pointer remains steady for two minutes, there are no serious coolant leaks in the system. However, there could be an internal leak that does not appear with normal system test pressure. If it is certain that coolant is being lost and no leaks can be detected, inspect for interior leakage or perform the Internal Leakage Test.

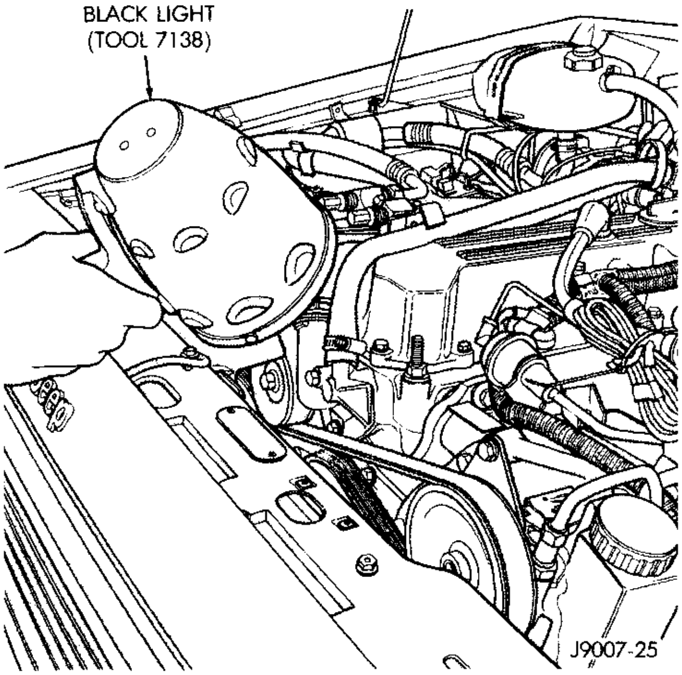


Fig. 19 Leak Detection Using Black Light

Drops Slowly: Indicates a small leak or seepage is occurring. Examine all connections for seepage or slight leakage with a flashlight. Inspect the radiator, hoses, gasket edges and heater. Seal small leak holes with a Sealer Lubricant, or equivalent. Repair leak holes and reinspect the system with pressure applied.

Drops Quickly: Indicates that a serious leakage is occurring. Examine the system for serious external leakage. If no leaks are visible, inspect for internal leakage. Large radiator leak holes should be repaired by a reputable radiator repair shop.

4.0L Engine

Remove cap from pressure bottle and install pressure tester adapter 7294 or an equivalent in place. Connect pressure tester to adapter (Fig. 21).

Start and operate engine until radiator upper hose is warm. Stop engine. Pump pressure tester 7295 or an equivalent until pressure reading on tool gauge is 124 kPa (18 psi). Pressure should remain steady. If a pressure drop occurs, inspect cooling system for leaks.

Correct any leaks and test system again. Disconnect tester tools from pressure bottle and test pressure cap. Refer to pressure cap testing.

Internal Leakage Inspection

Remove the oil pan drain plug and drain a small amount of engine oil. Coolant, being heavier, will drain first, or operate the engine to churn the oil, then examine the dipstick for water globules. Inspect the transmission dipstick for water globules. Inspect the transmission fluid cooler for leakage. Operate the engine without the pressure cap on the radiator until the thermostat opens.

Attach a Pressure Tester to the filler neck. If the pressure builds up quickly, a leak exists as result of a faulty cylinder head gasket or crack in the engine. Repair as necessary.

WARNING: DO NOT ALLOW PRESSURE TO EXCEED 103.4 KPA (15 PSI). TURN THE ENGINE OFF. TO RELEASE THE PRESSURE, ROCK THE TESTER FROM SIDE TO SIDE. WHEN REMOVING THE TESTER, DO NOT TURN THE TESTER MORE THAN 1/2 TURN IF THE SYSTEM IS UNDER PRESSURE.

If there is no immediate pressure increase, pump the Pressure Tester until the indicated pressure is within the system range. Vibration of the gauge pointer indicates compression or combustion leakage into the cooling system.

WARNING: DO NOT DISCONNECT THE SPARK PLUG WIRES WHILE THE ENGINE IS OPERATING.

CAUTION: Do not operate the engine with a spark plug shorted for more than a minute, otherwise the catalytic converter may be damaged.

Isolate the compression leak by shorting each spark plug to the cylinder block. The gauge pointer should stop or decrease vibration when the spark plug for the leaking cylinder is shorted because of the absence of combustion pressure.

Combustion Leakage Test (without Pressure Tester)

DO NOT WASTE reusable coolant. If the solution is clean and is being drained only to service the cooling system, drain the coolant into a clean container for reuse.

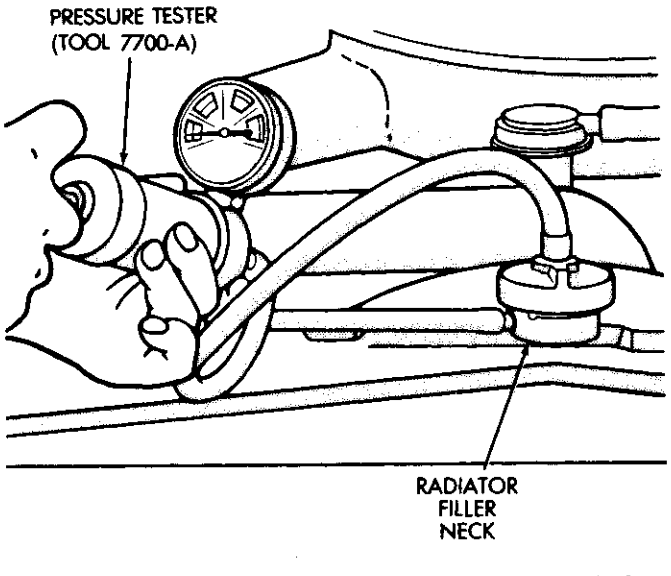


Fig. 20 Pressurizing System—2.5L, 4.2L and 5.9L

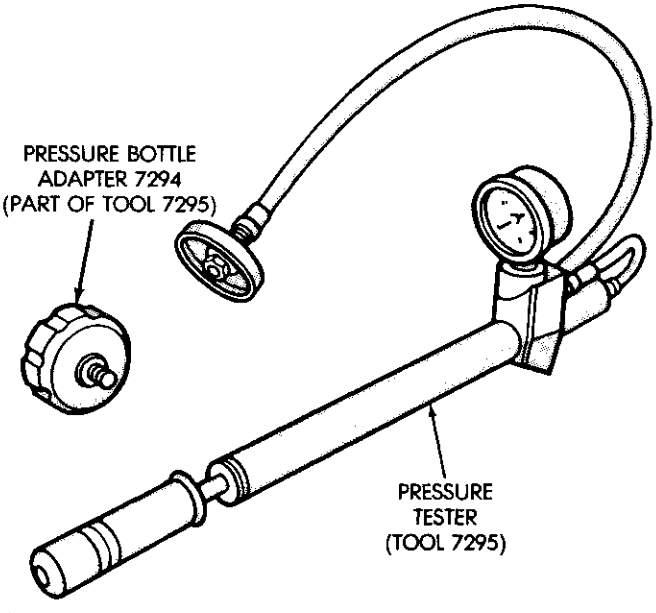


Fig. 21 Pressure Bottle System Pressure Tester

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

Drain sufficient coolant to allow the thermostat removal. Refer to Thermostat Replacement. Disconnect the water pump drive belt.

Eight-cylinder engine: remove the thermostat housing cover and remove the thermostat.

2.5L four-cylinder and 4.2L Six-cylinder engines: Disconnect the upper radiator hose from the thermostat housing. Remove the housing and thermostat. Install the thermostat housing on the cylinder head.

Add coolant to the radiator to bring the level to within 6.3 mm (1/4 in) of the top of the thermostat housing.

CAUTION: Avoid overheating. Do not operate the engine for an excessive period of time. Open the draincock immediately after the test to eliminate boilover.

Start the engine and accelerate rapidly three times, to approximately 3000 rpm while observing the coolant. If internal engine combustion gases are leaking into the cooling system, bubbles will appear in the coolant. If bubbles do not appear, there is no internal combustion gas leakage.

COOLANT RESERVE SYSTEM (CRS)

2.5L, 4.2L, and 5.9L Engines

This system works in conjunction with the radiator pressure cap to utilize thermal expansion and contraction of the coolant to keep the coolant free of trapped air. It provides a volume for expansion and contraction, provides a convenient and safe method for checking coolant level and adjusting level at atmospheric pressure without removing the radiator pressure cap. It also provides some reserve coolant to cover minor leaks and evaporation or boiling losses.

The coolant reserve system consists of a pressure radiator cap, an overflow tube, and a plastic coolant reserve bottle (Fig. 22).

PRESSURE BOTTLE SYSTEM

4.0L Engine

This system does not have a radiator pressure cap. Instead the pressure cap is mounted on the coolant pressure bottle. System coolant flows directly through a fully pressurized Hot-Type expansion bottle. Coolant flows through the pressure bottle at all times during engine operation whether the engine is cold or at normal operating temperatures (Fig. 23).

Larger coolant volume caused by thermal expansion during engine operation is absorbed by the expansion chamber in the bottle. Air trapped in the system is purged through the pressure cap vent valve during maximum coolant expansion.

The cooling system remains pressurized when the coolant contracts during engine cool-down. Coolant volume in the pressure bottle returns to the normal cold engine level during this period.

RADIATOR PRESSURE CAP

MJ Vehicles without 4.0L Engine

Radiators are equipped with a pressure cap which releases pressure at some point within a range of 83-110 kPa (12-16 psi). The pressure relief point (in pounds) is engraved on top of the cap.

The cooling system will operate at pressures slightly above atmospheric pressure. This results in a higher coolant boiling point allowing increased radiator cooling capacity. The cap (Fig. 24) contains a spring-loaded

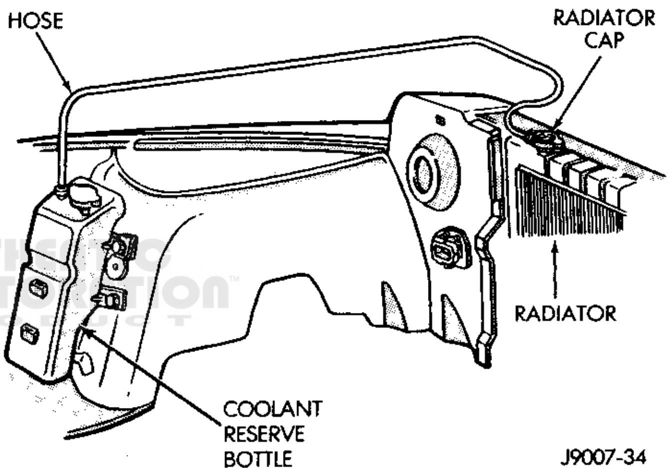


Fig. 22 Coolant Reserve System—Typical

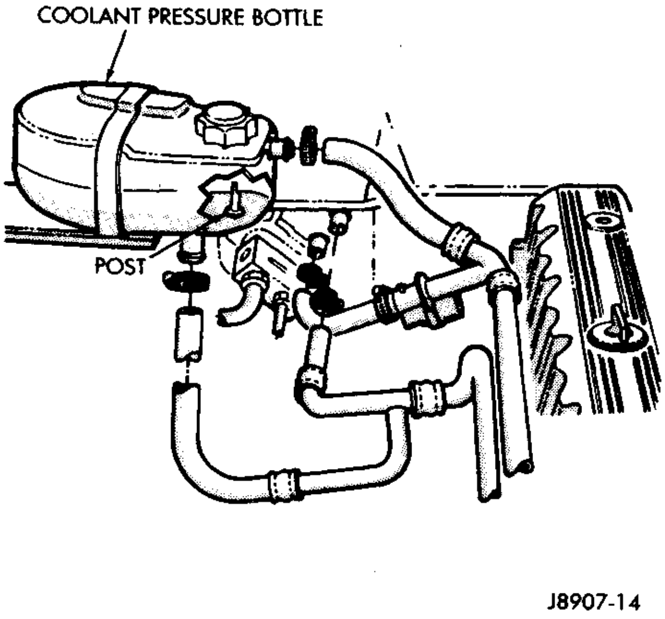


Fig. 23 Pressure Bottle System—4.0L Engine

pressure relief valve that opens when system pressure reaches the release range of 83-110 kPa (12-16 psi).

A vent valve in the center of the cap allows a small coolant flow through the cap when coolant is below boiling temperature. The valve is completely closed when boiling point is reached. As coolant cools it contracts and creates a vacuum in the cooling system. This causes the vacuum valve to open and coolant in reserve bottle to be drawn through connecting hose into radiator. If the vacuum valve is stuck shut radiator hoses will collapse on cool down.

A rubber gasket seals the radiator filler neck to maintain vacuum during coolant cool down and to prevent leakage when system is under pressure.

Radiator Cap to Filler Neck Seal, Pressure Relief Check

With radiator cap installed on filler neck, remove coolant reserve bottle hose from nipple on filler neck. Connect a hand operated vacuum pump to nipple. Operate pump until a reading of 47-61 kPa (14-18 in. Hg) appears on gauge. If the reading stays steady, or drops slightly and then remains steady, the pressure valve seal is good. Replace radiator cap if reading does not hold.

WARNING: THE WARNING WORDS "DO NOT OPEN HOT" ON THE RADIATOR PRESSURE CAP ARE A SAFETY PRECAUTION. WHEN HOT, PRESSURE BUILDS UP IN COOLING SYSTEM. TO PREVENT SCALDING OR INJURY, THE RADIATOR CAP SHOULD NOT BE REMOVED WHILE THE SYSTEM IS HOT AND/OR UNDER PRESSURE.

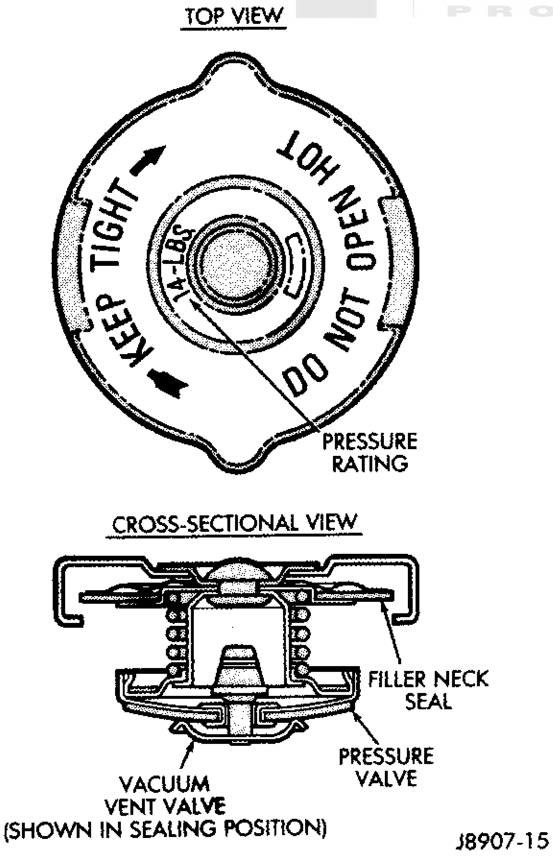


Fig. 24 Radiator Pressure Cap

There is no need to remove the radiator cap at any time **except** for the following purposes:

(1) Check and adjust anti-freeze freeze point.
(2) Refill system with new anti-freeze.
(3) Conducting service procedures.
(4) Checking for vacuum leaks.

WARNING: IF VEHICLE HAS BEEN RUN RECENTLY, WAIT AT LEAST 15 MINUTES BEFORE REMOVING RADIATOR CAP. WITH A RAG, SQUEEZE RADIATOR UPPER HOSE TO CHECK IF SYSTEM IS UNDER PRESSURE. PLACE A RAG OVER THE CAP AND WITHOUT PUSHING CAP DOWN ROTATE IT COUNTER-CLOCKWISE TO THE FIRST STOP. ALLOW FLUID TO ESCAPE THROUGH OVERFLOW HOSE INTO COOLANT RESERVE BOTTLE. SQUEEZE RADIATOR UPPER HOSE TO DETERMINE WHEN PRESSURE HAS BEEN RELEASED. WHEN COOLANT AND STEAM STOP BEING PUSHED INTO BOTTLE AND SYSTEM PRESSURE DROPS REMOVE RADIATOR CAP COMPLETELY.

PRESSURE TESTING RADIATOR CAPS

Remove cap from radiator. Ensure that sealing surfaces are clean. Moisten rubber gasket with water and install the cap on pressure tester 7700-A or an equivalent (Fig. 25).

Operate the tester pump and observe the gauge pointer at its highest point. The cap release pressure should be 83 - 110 kPa (12 - 16 psi). The cap is satisfactory when the pressure holds steady or holds within

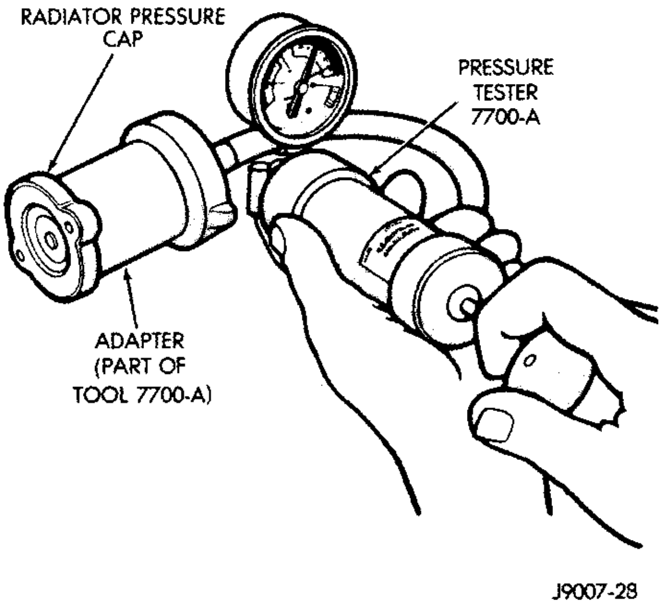


Fig. 25 Pressure Testing Radiator Pressure Cap

the 83 - 110 kPa (12 - 16 psi) range for 30 seconds or more. If the pointer drops quickly, replace the cap.

Inspection

Visually inspect pressure valve gasket. Replace cap if the gasket is swollen, torn or worn. Inspect the area around radiator filler neck for white deposits that indicate a leaking cap.

PRESSURE BOTTLE CAP

Vehicles with 4.0L Engine

The pressure bottle is equipped with a pressure cap which releases pressure at some point within a range of 110-124 kPa (16 - 18 psi).

The cooling system will operate at pressures slightly above atmospheric pressure. This results in a higher coolant boiling point allowing increased radiator cooling capacity. The cap contains a spring-loaded pressure relief valve that opens when system pressure reaches the release range of 110-124 kPa (16 - 18 psi).

PRESSURE TESTING PRESSURE BOTTLE CAP

Vehicles with 4.0L Engine

Install cap adapter 7296 or equivalent on pressure tester (Fig. 26). Connect pressure bottle cap to adapter and pressurize cap to 128 kPa (18.6 psi). Cap pressure should stabilize within 6.89-10.4 kPa (1-1/2 psi) of this setting. Replace cap if pressure does not stabilize within specified limits.

Inspection

Visually inspect pressure bottle cap gasket. Replace cap if gasket is swollen, torn, or worn. Inspect pressure bottle in area around cap for white deposits which indicate a leaking cap.

RADIATORS

Radiators used in vehicles with either 2.5L four-cylinder, 4.2L six-cylinder, or 5.9L eight-cylinder engines are down flow types and have brass tanks. Radiators in vehicles with the 4.0L six-cylinder engine are cross flow type and have plastic and brass tanks.

Radiator Draincock Service

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

Radiators Used with All Engines Except 4.0L Engine

All radiator draincocks are replaceable. However the threaded fitting in the radiator outlet tank is not replaceable. Unscrew draincock until it is removed from radiator tank (Fig. 27). Replace with new draincock and tighten.

Radiators Used with 4.0L Engines

Radiators used with 4.0L engines have a plastic draincock with an integral O-ring seal. Two arms hold the draincock in place once it has been completely unscrewed. Pull draincock out of radiator tank once it has been completely loosened (Fig. 28). Push the replacement draincock into the radiator tank and tighten.

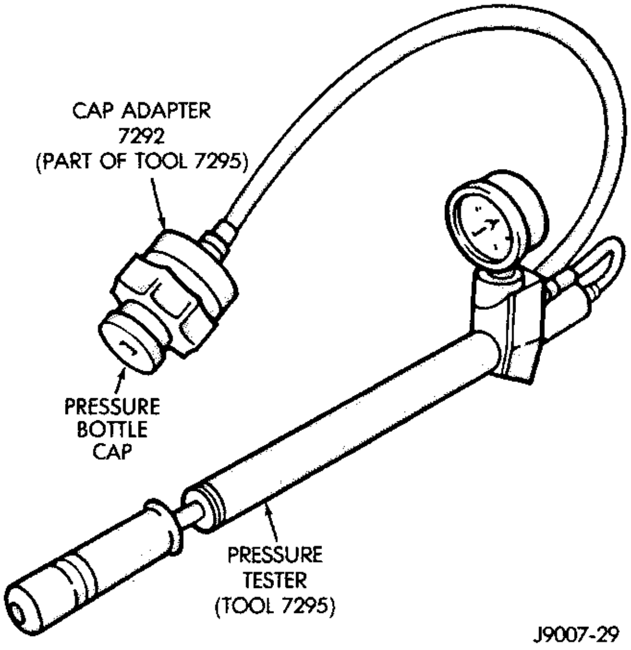


Fig. 26 Pressure Testing Pressure Bottle Cap

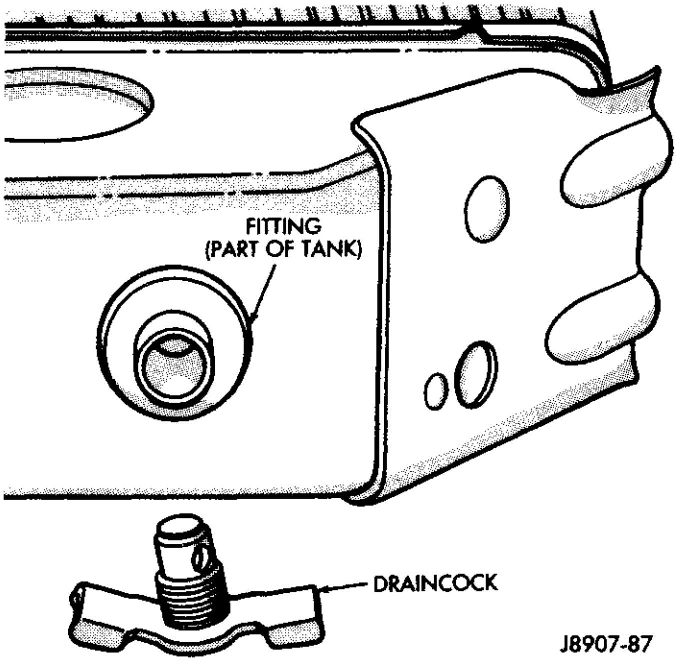


Fig. 27 Draincock Service—2.5L, 4.2L and 5.9L

Radiator Removal: MJ and XJ Vehicles with 2.5L Engine

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS, RADIATOR CAP, OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

Do not waste reusable coolant. If the solution is clean and is being drained only to service the cooling system, drain the coolant into a clean container for reuse.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING THIS TYPE OF CLAMP, ONLY USE TOOLS SUCH THAT ARE DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS TOOL 6094.

Perform following steps to remove radiator.

(1) Disconnect battery negative cable.

(2) Observe **WARNINGS** above. Remove radiator cap.

(3) Position drain pan under draincock. Open radiator draincock. Drain radiator.

(4) Remove radiator upper and lower hose clamps and hoses.

(5) Remove alignment dowel E-clip from radiator lower mounting bracket (Fig. 29).

(6) Disconnect coolant reserve bottle hose from radiator.

(7) Remove radiator fan shroud mounting screws (Fig. 30). Push shroud back against front of engine.

(8) If equipped, disconnect and plug automatic transmission fluid cooler lines.

(9) Remove radiator top mounting bolts (Fig. 30).

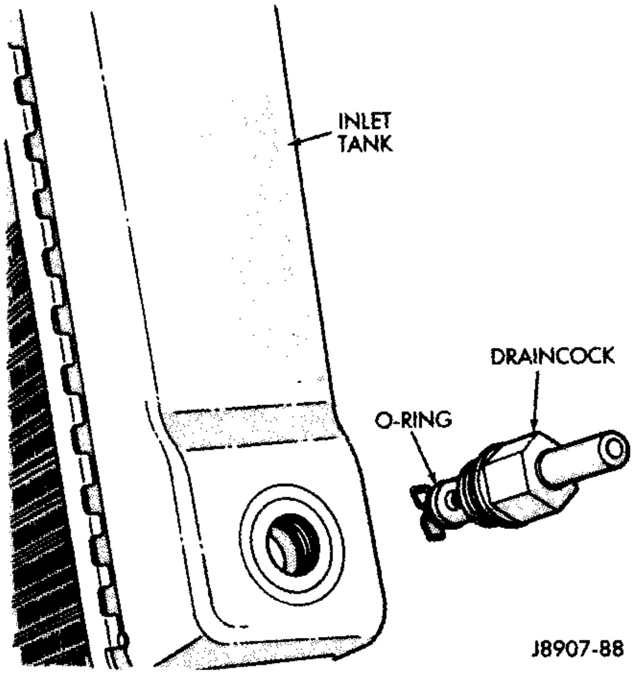


Fig. 28 Draincock Service—4.0L

(10) Remove the radiator grille mounting screws. Remove grille (Fig. 31).

(11) Remove the air-conditioning condenser to radiator mounting screw using open end wrench to remove bottom 2 (Fig. 32).

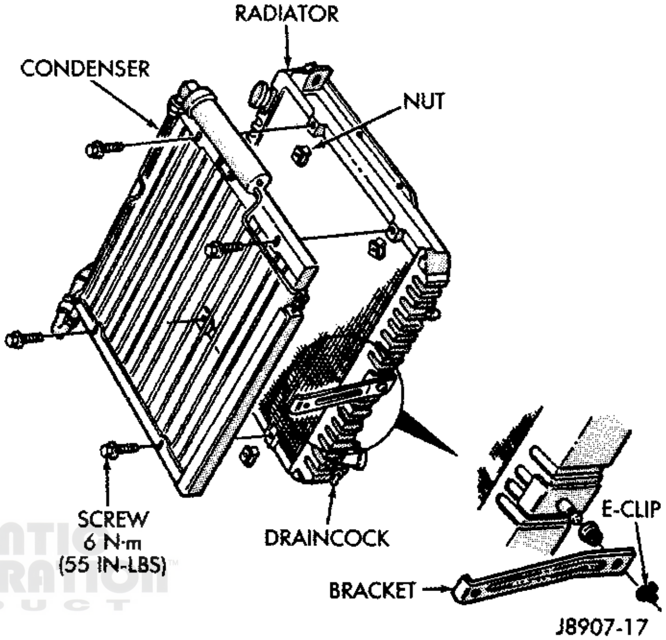


Fig. 29 Radiator Remove/Install MJ and XJ Vehicles— 2.5L

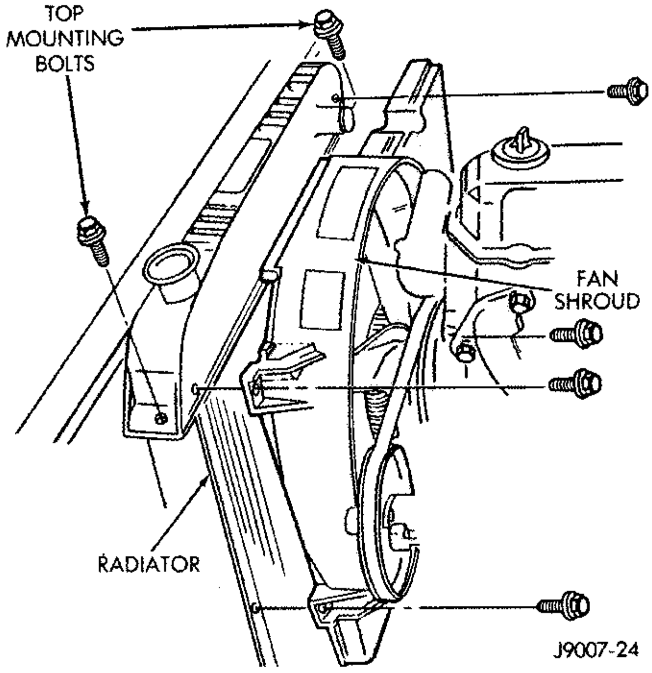


Fig. 30 Shroud Remove/Install MJ and XJ Vehicles—2.5L

(12) Lift radiator straight up, out of vehicle. Take care not to damage radiator fins.

Radiator Installation: MJ and XJ Vehicles with 2.5L Engine

(1) Install radiator behind air-conditioning condenser with bottom alignment dowel inserted into radiator lower mounting bracket.

(2) Install E-clip to alignment dowel.

(3) Tighten the 4 condenser to radiator mounting bolts to 6.2 N•m (55 in-lbs) torque.

(4) Install radiator grille.

(5) Tighten radiator top mounting bolts to 6 N•m (55 in-lbs) torque.

(6) If equipped, connect automatic transmission fluid cooler lines to radiator.

(7) Install the radiator fan shroud. Connect the coolant reserve tank hose.

(8) Connect radiator hoses and install hose clamps.

(9) Connect battery negative cable.

(10) Close the draincock.

(11) Fill cooling system with correct coolant.

(12) Install radiator cap.

Radiator Removal: MJ and XJ Vehicles with 4.0L Engine

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

Do not waste reusable coolant. If the solution is clean and is being drained only to service the cooling system, drain the coolant into a clean container for reuse.

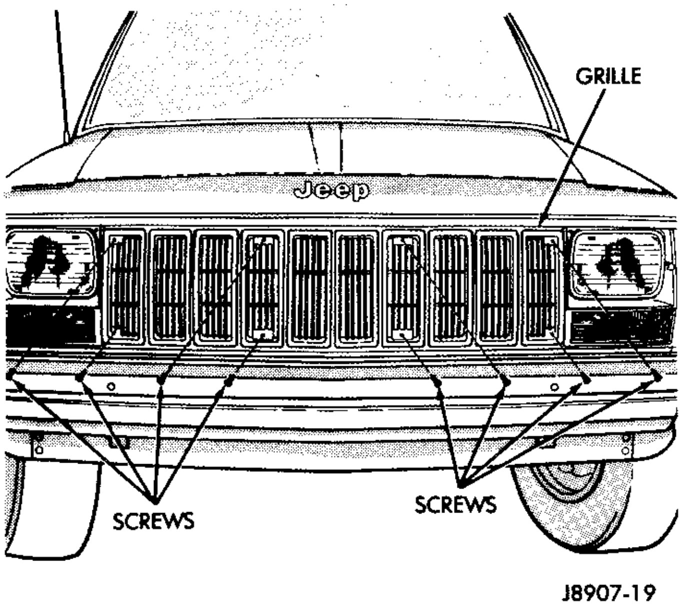


Fig. 31 Grille Remove/Install— Comanche and Cherokee Vehicles—2.5L

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING THIS TYPE OF CLAMP, ONLY USE TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP SUCH AS TOOL 6094.

Perform the following to remove the radiator.

(1) Disconnect battery negative cable.

(2) Observe **WARNINGS** above.

(3) Remove pressure bottle cap.

(4) For access to radiator draincock:

(a) On Comanche and Cherokee vehicles remove radiator grille.

(b) On Wagoneer vehicles remove right front park/turn signal lamp (Fig. 33).

(5) Attach one end of a 24 in long 1/4 in. ID to the radiator draincock, put the other end into a clean container. Open Draincock. Drain radiator.

(6) If equipped with air-conditioning or heavy duty cooling, disconnect auxiliary electric cooling fan thermal switch electrical connector (Fig. 34).

(7) Disconnect electric cooling fan electrical connector (Fig. 35).

(8) Remove electric fan mounting screws. Lift fan straight up, out of engine compartment.

(9) Remove Mechanical fan shroud mounting screws. Lift shroud up until alignment tabs at the bottom are clear of slots in bracket at bottom of radiator (Fig. 36). Place shroud over mechanical fan.

(10) If equipped, disconnect and plug automatic transmission fluid cooler lines. If equipped with remote cooler, remove line to cooler from bracket at bottom of radiator.

(11) Disconnect radiator upper and lower hoses.

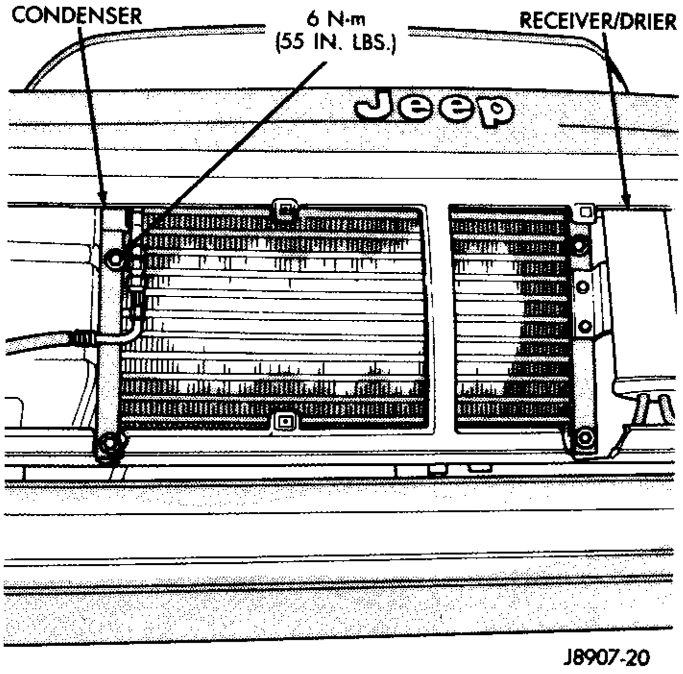


Fig. 32 Condenser Mounting Screws MJ and XJ Vehicles—2.5L

(12) Remove hood striker.

(13) Remove radiator upper crossmember bracket.

(14) Remove radiator upper crossmember.

(15) If equipped with air-conditioning separate radiator from condenser by removing condenser to radiator mounting brackets (Fig. 37).

(16) Lift radiator straight up out of engine compartment taking care not to damage fins.

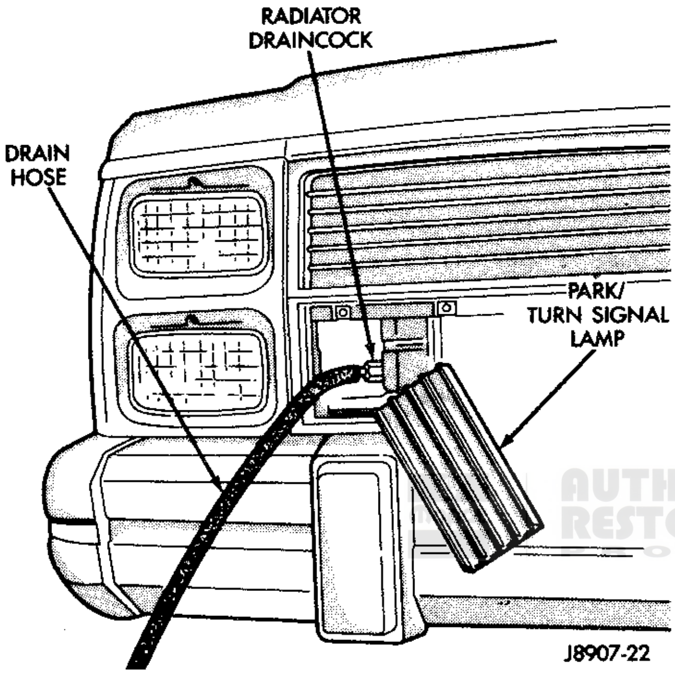


Fig. 33 Grille Remove/Install —Wagoneer Vehicles

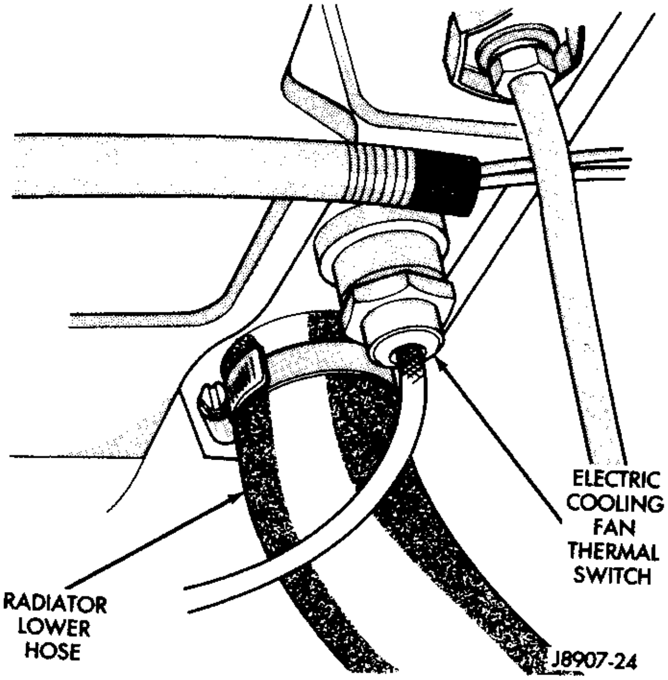


Fig. 34 Auxiliary Fan Thermal Switch

Radiator Installation: MJ and XJ Vehicles with 4.0L Engine

The radiator has two (2) alignment dowels on the bottom tank that fit into rubber grommets in the radiator lower crossmember.

(1) Lower radiator into engine compartment, position alignment dowels into grommets in radiator lower crossmember (Fig. 38).

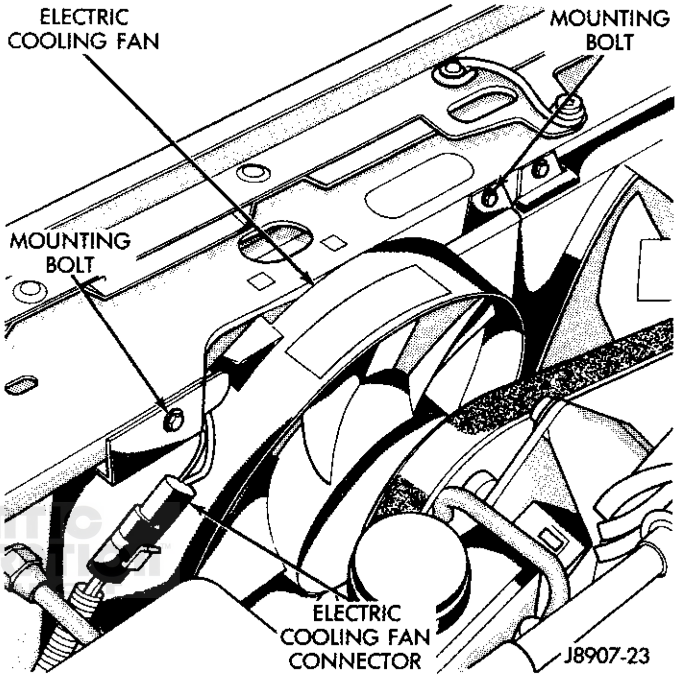


Fig. 35 Auxiliary Fan Remove/Install

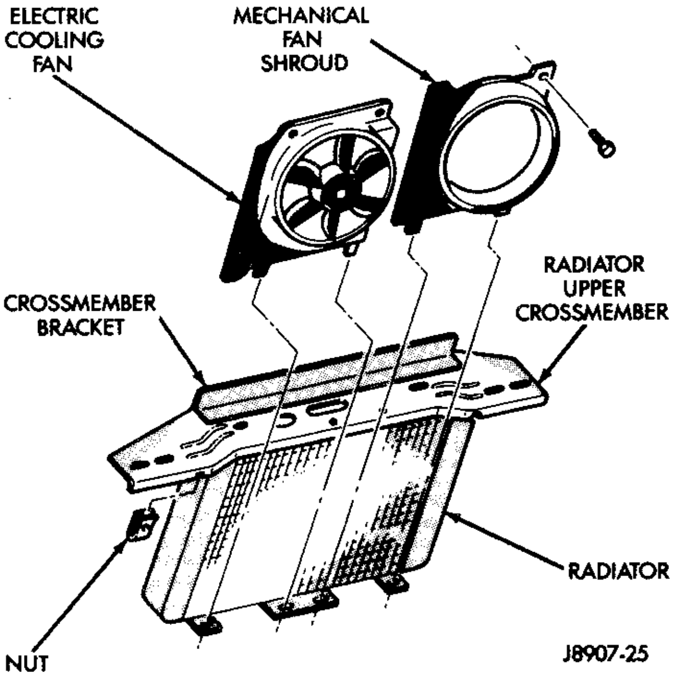


Fig. 36 Auxiliary Fan, Mechanical Fan Shroud Remove/Install

(2) If equipped with air-conditioning, attach condenser to radiator with mounting brackets (Fig. 37).

(3) Install radiator upper crossmember.

(4) Install radiator upper crossmember bracket.

(5) Install hood striker.

(6) Connect radiator upper and lower hoses.

(7) If equipped, connect automatic transmission fluid cooler lines. If equipped with remote cooler, attach cooler line to bracket at bottom of radiator.

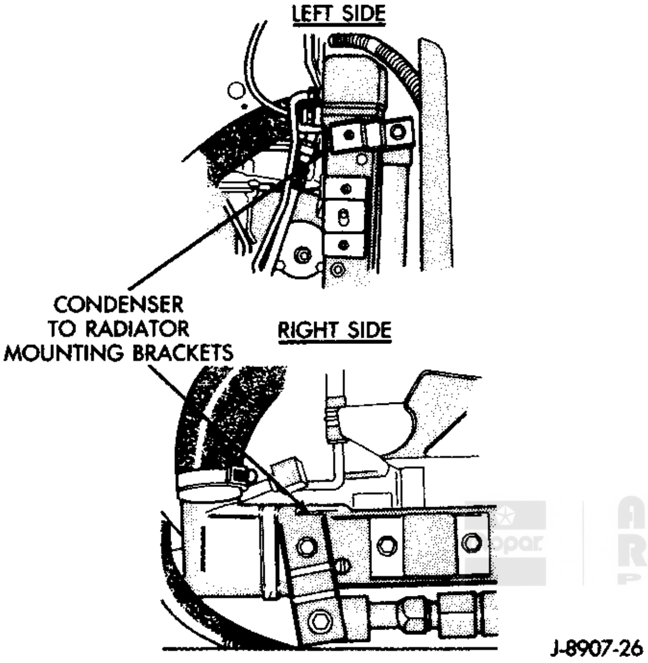


Fig. 37 Condenser to Radiator Mounting Brackets—4.0L

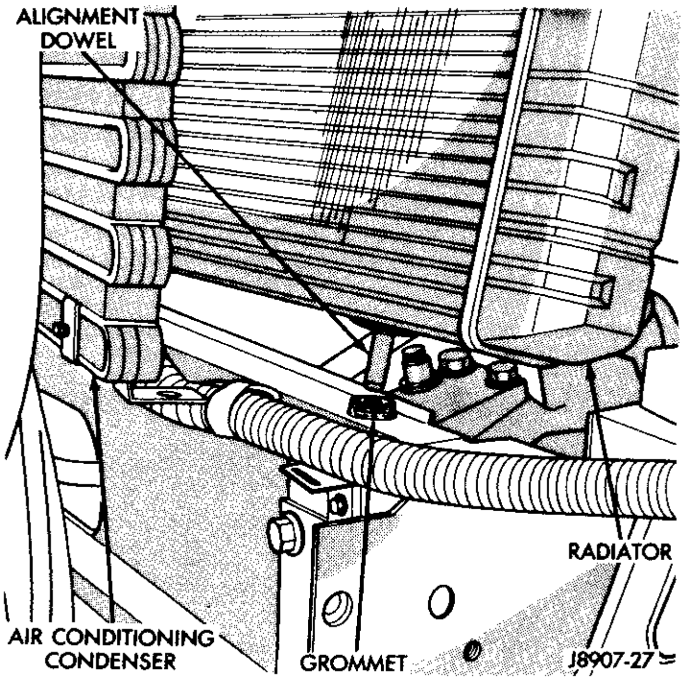


Fig. 38 Radiator Installation—4.0L

(8) Install electric cooling fan thermal switch electrical connector.

(9) Install electric cooling fan. Insert alignment tabs at bottom of fan shroud into slots in bracket at bottom of radiator. Tighten mounting screws to 4.07 N•m (36 in-lbs) torque (Fig. 36).

(10) Connect electric cooling fan electrical connector.

(11) Install mechanical cooling fan shroud. Insert alignment tabs at bottom of shroud into slots in bracket at bottom of radiator. Tighten mounting screws to 4.07 N•m (36 in-lbs) torque (Fig. 36).

(12) Close radiator draincock.

(13) Depending upon vehicle application, install grille or park/turn signal lamp.

(14) Connect battery negative cable.

(15) Fill cooling system with correct coolant. Refer to "COOLANT".

(16) Install pressure bottle cap.

Radiator Removal: YJ Vehicles

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

Do not waste reusable coolant. If the solution is clean and is being drained only to service the cooling system, drain the coolant into a clean container for reuse.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING THIS TYPE OF CLAMP, ONLY USE TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP.

Perform the following to remove the radiator.

(1) Disconnect battery negative cable.

(2) Observe the **WARNINGS** above. Remove the radiator cap.

(3) Position drain pan under draincock. Open radiator draincock. Drain radiator.

(4) Remove radiator upper and lower hose clamps and hoses.

(5) Disconnect coolant reserve bottle hose from radiator.

(6) Remove fan shroud screws, push shroud back onto fan (Fig. 39).

(7) If equipped, disconnect and plug automatic transmission fluid cooler lines.

(8) Remove radiator attaching screws.

(9) Lift radiator straight up, out of vehicle taking care not to damage radiator fins.

Radiator Installation: YJ Vehicles

(1) Install the radiator. Tighten the mounting screws to 8 N•m (6 ft-lbs) torque (Fig. 39).

(2) Close radiator draincock.

(3) Install fan shroud. Tighten mounting screws to 16N•m (11 ft-lbs) torque.

(4) If equipped, remove plugs and connect automatic transmission fluid cooler lines.

(5) Connect radiator hoses and install hose clamps.

(6) Connect battery negative cable.

(7) Fill cooling system with correct coolant. Refer to Coolant.

(8) Connect reserve bottle hose.

(9) Install radiator cap.

Radiator Removal: SJ Vehicles

DO NOT WASTE reusable coolant. If the solution is clean and is being drained only to service the cooling system, drain the coolant into a clean container for reuse.

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

(1) Position drain pan under radiator and open draincock.

(2) Remove radiator cap.

(3) Disconnect radiator upper hose.

(4) Disconnect coolant reserve bottle hose.

(5) Remove fan shroud.

(6) Remove attaching screws at top of radiator.

(7) Disconnect radiator lower hose.

(8) Disconnect and plug automatic transmission fluid cooler tubes.

(9) Remove attaching screws at bottom of radiator.

(10) Remove radiator.

Radiator Installation: SJ Vehicles

(1) Install radiator.

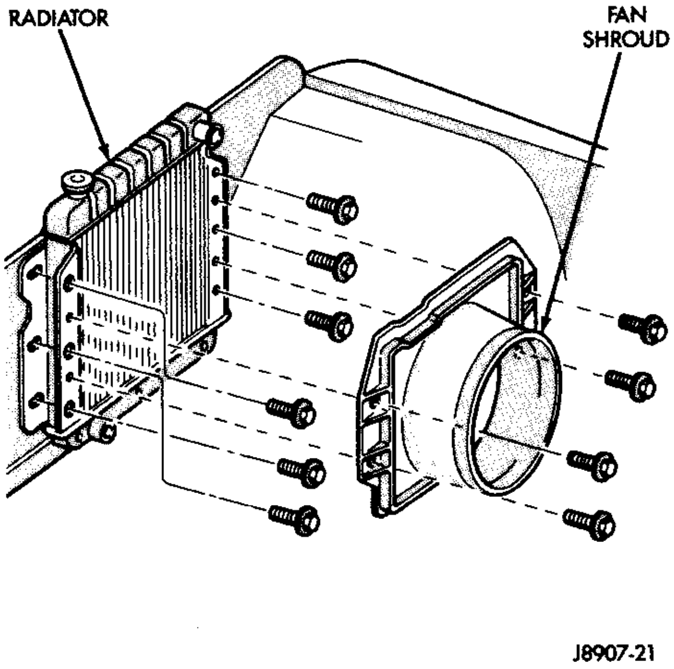


Fig. 39 Radiator Remove/Install—YJ Vehicles

(2) Install radiator attaching screws.

(3) Install fan shroud.

(4) Close draincock.

(5) Remove plugs and connect automatic transmission fluid cooler tubes.

(6) Connect radiator lower hose using a replacement clamp.

(7) Connect radiator upper hose using a replacement clamp.

(8) Connect coolant reserve hose.

(9) Fill cooling system. Use correct mixture. Refer to Coolant.

(10) Install radiator cap.

Radiator Coolant Flow Check

The following procedure will determine if coolant is flowing through the cooling system.

If engine is cold, idle engine until normal operating temperature is reached. Then feel upper radiator hose. If hose is hot, the thermostat is open and water is circulating through cooling system.

COOLING SYSTEM HOSES

Rubber hoses route coolant to and from the radiator, intake manifold and heater core. All MJ and XJ vehicles equipped with air conditioning have a coolant control valve located In-line with the heater core inlet and outlet hoses which controls coolant flow to the heater core when the A/C system is in operation.

Radiator lower hoses are spring-reinforced to prevent collapse from water pump suction at moderate and high engine speeds.

Inspect the hoses at regular intervals. Replace hoses that are cracked, feel brittle when squeezed or swell excessively when the system is pressurized.

In areas where specific routing clamps are not provided, ensure that the hoses are positioned with sufficient clearance from the exhaust manifold and pipe, fan blades, drive belts and sway bars. Otherwise, improperly positioned hoses will be damaged, resulting in coolant loss and overheating.

When performing a hose inspection, inspect the radiator lower hose for proper position and condition of the spring.

FANS

All vehicles are equipped with a temperature controlled fan. The viscus fan drive is a torque-and temperature-sensitive clutch unit that automatically increases or decreases fan speed to provide proper engine cooling. All MJ and XJ vehicles equipped with a 4.0L engine and that have air conditioning and/or heavy duty cooling also have an auxiliary electrical fan.

Viscus Fan Operation

The viscus fan drive clutch is essentially a silicone-fluid-filled coupling connecting the fan assembly to the fan/water pump pulley (Fig. 40). The coupling allows the fan to be driven in a normal manner at low engine speeds while limiting the top speed of the fan to a predetermined maximum level at higher engine speeds. A bimetallic spring coil is located on the front face. This spring coil reacts to the temperature of the radiator discharge air and engages the drive clutch for higher fan speed if the air temperature from the radiator rises above a certain point. Until additional engine cooling is necessary, the fan will remain at a reduced rpm regardless of engine speed. Only when sufficient heat is present in the air flowing through the radiator core to cause a reaction from the bimetallic coil will the viscus drive clutch engage and increase fan speed to provide the necessary additional engine cooling.

Regardless of increased engine speed, once the fan has reached its maximum operating speed it will not rotate any faster. When the necessary engine cooling has been accomplished causing a reduction in the temperature of the radiator discharge air, the bimetallic coil again reacts and the fan speed is reduced to the previous disengaged speed.

CAUTION: Engines equipped with serpentine drive belts have reverse rotating fans and viscous fan drives. They are marked with "REVERSE" to designate their usage. Installation of the wrong fan or fan drive can result in engine overheating.

Viscous Fan Replacement

(1) Disconnect fan shroud from radiator.
(2) Remove accessory drive belts.
(3) Remove fan flange to pulley mounting nuts.
(4) Remove fan and viscous drive as an assembly.
(5) Remove fan blade to viscous drive mounting bolts.
(6) Assemble fan to viscous drive. Tighten mounting bolts to 24 N•m (18 ft-lbs) torque.
(6) Position mounting flange of fan/viscous drive assembly onto pulley. Tighten mounting nuts to 24 N•m (18 ft-lbs) torque.
(7) Install accessory drive belts. Tension belts to specifications. Refer to Accessory Drive Belt Service in this section.

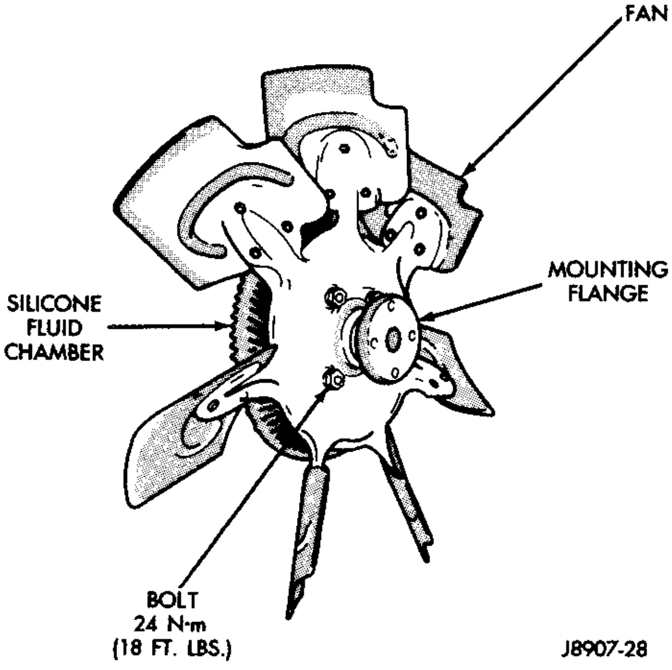


Fig. 40 Viscous Fan—Typical

Viscous Fan Test

The cooling system must be in good condition prior to performing the test outlined below to ensure against excessively high coolant temperature.

CAUTION: Ensure that there is adequate fan blade clearance before drilling.

(1) Drill a 3.18-mm (1/8-in) diameter hole in the top center of the fan shroud.

(2) Insert a dial thermometer -18° to 105°C (0° to 220° F) with an 8 inch stem, or equivalent, through the hole in the shroud. Ensure that there is adequate clearance from the fan blades.

(3) Connect a tachometer and an engine ignition timing light (to be used as strobe light).

(4) Block the air flow through the radiator by securing a sheet of plastic in front of the radiator (or air conditioner condenser). Use tape at the top to secure the plastic and ensure that the air flow is blocked.

(5) Ensure that the air conditioner, if equipped, is turned off.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(6) Start the engine and operate at 2400 rpm with the timing light (strobe light) aimed at the fan blades. Within ten minutes the air temperature (indicated on the dial thermometer) should be 88° C (190°F). Satisfactory operation of the fan drive requires that it engage before or at 88° C (190°F). Engagement is distinguishable by a definite increase in flow noise. The timing light will also indicate an increase in the speed of the fan.

(7) When the air temperature reaches 88° C (190°F), remove the plastic sheet. Satisfactory operation of the viscous fan requires the air temperature to drop 20° F (11° C) or more. A definite decrease of audible fan air flow noise should be noticed. Replace defective fan assemblies.

Auxiliary Electric Cooling Fan Operation

All MJ and XJ vehicles equipped with a 4.0L engine that have air-conditioning and/or heavy duty cooling are also are equipped with an auxiliary electrical fan. The fan is controlled by a relay mounted on the left inner fender panel. A switch attached to the radiator outlet tank above the radiator lower hose senses engine coolant temperature. When coolant temperature is above 88°C (190°F) the switch closes allowing current from the ignition switch to flow through the fan relay to ground activating the relay. When the relay is activated battery voltage is supplied to the fan causing it to operate. When coolant temperature is below 88°C (190°F) the switch is open preventing the relay from being grounded and the cooling fan from being energized.

When the air-conditioning is used the engine ECU grounds the A/C relay coil allowing current to flow through it. This activates the A/C relay which then supplies current to the A/C clutch, fan diode assembly and cooling fan relay. The cooling fan relay is activated and the fan operates. When ever the air-conditioning is used, regardless of engine coolant temperature, the auxiliary electric cooling fan operates.

Auxiliary Electric Cooling Fan Removal

The auxiliary fan is attached to the radiator upper crossmember behind the radiator.

(1) Remove fan retaining screws from radiator upper crossmember (Fig. 41).

(2) Disconnect the electric fan connector.

(3) Lift fan straight up out of vehicle.

Auxiliary Cooling Fan Installation

(1) Align lower retaining tabs of fan shroud with slots in bracket at bottom of radiator and push fan down into position.

(2) Tighten the mounting screws to 4.07 N•m (36 in-lbs).

(3) Connect auxiliary cooling fan electrical connector.

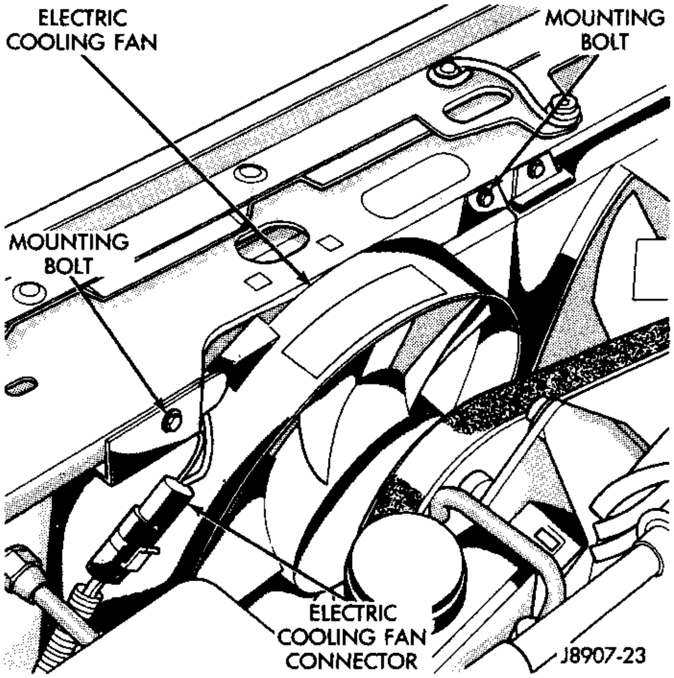


Fig. 41 Auxiliary Fan Remove/Install

AUXILIARY ELECTRIC COOLING FAN MOTOR INOPERATIVE

Equipment Required

(1) Volt/Ohm Meter

(2) Jumper wire with In-line 25 amp fuse

(3) Figures 42, 43, and 44

Test Procedures

Vehicle Equipped With Air Conditioning

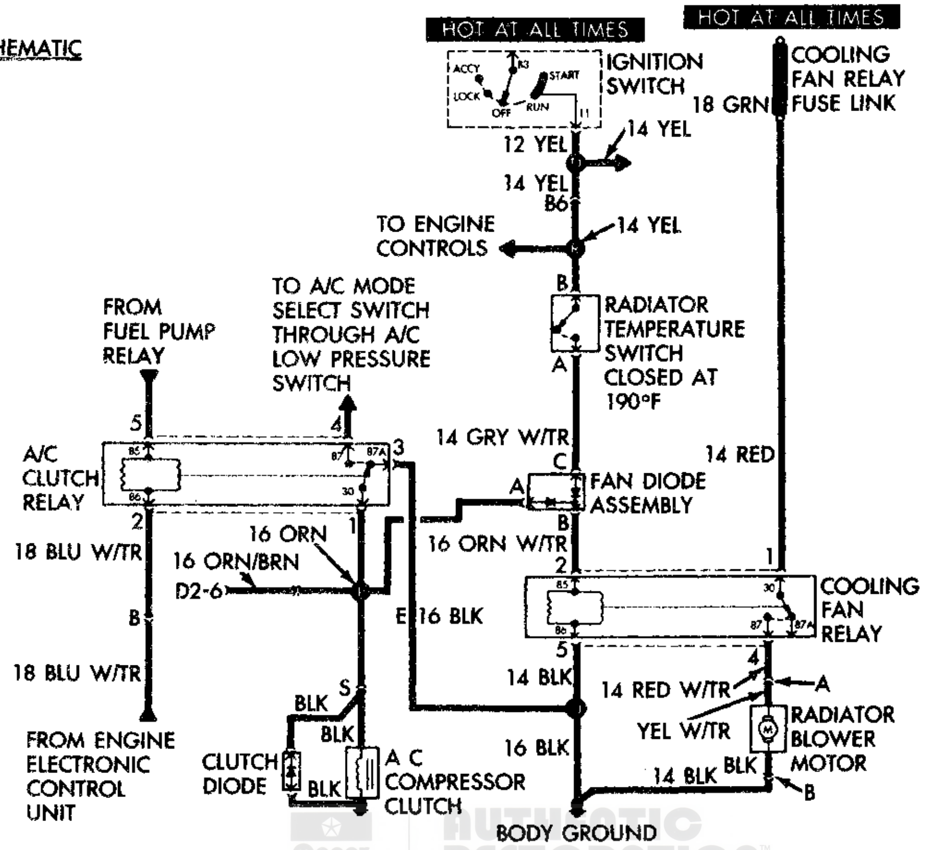
(1) Auxiliary Fan Operation:

(a) Remove fan relay which is mounted to left inner fender panel (Fig. 42).

(b) Using a jumper wire with an In-line 25 amp fuse, supply battery voltage to terminal 4 of the relay connector (Fig. 43):

- If fan operates, the motor is good. Proceed to (2).
- If fan motor does not operate, check continuity between terminal 4 of the relay connector (Fig. 43) and body ground connections on the fender panel back from the relay connector (Fig. 42). If continuity exists replace the fan motor. If continuity is not found repair open and retest.

CIRCUIT SCHEMATIC



COMPONENT LOCATION

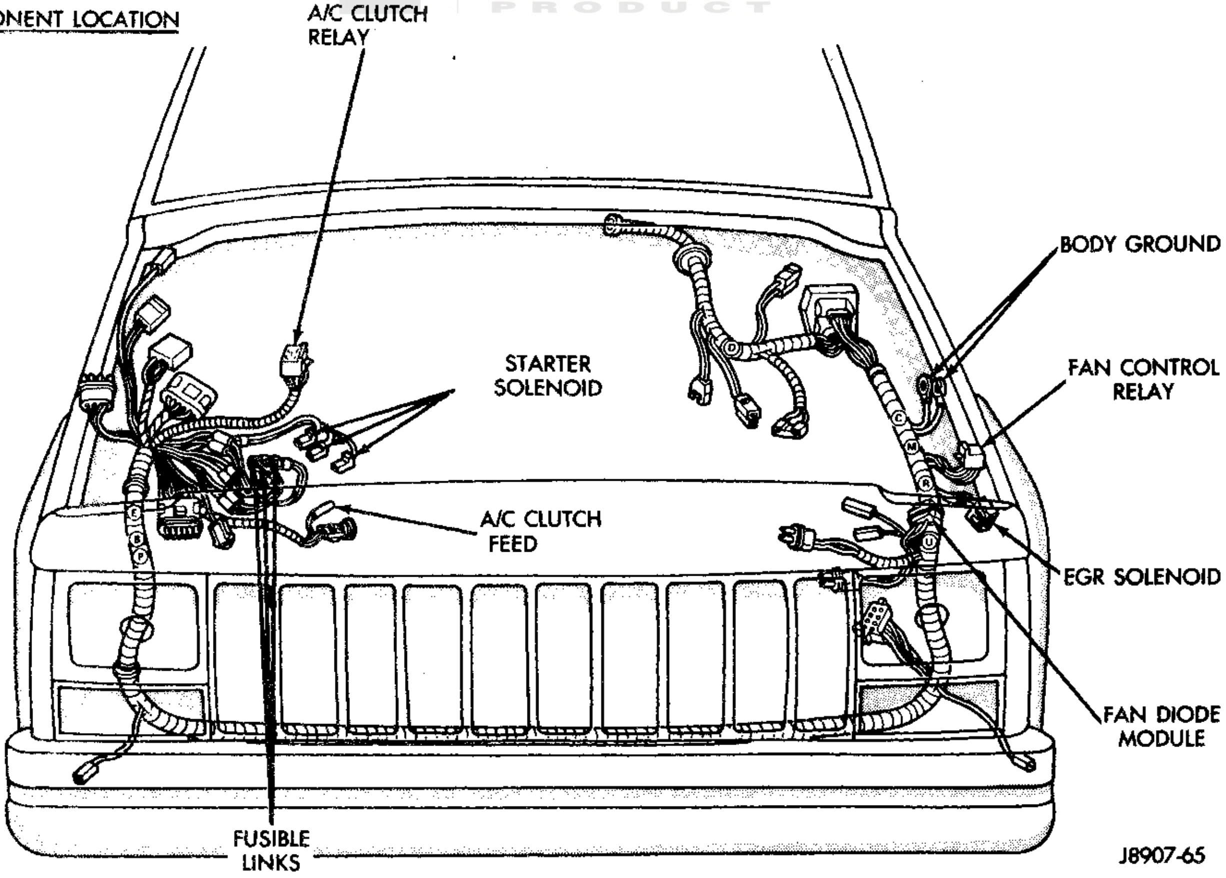


Fig. 42 Auxiliary Fan Controls—with A/C

(2) Cooling Fan Relay:

(a) With fan relay removed turn the ignition switch to the RUN position.

(b) Check continuity between terminal 5 of the relay connector (Fig. 43) and the body ground connections on the fender panel back from the relay connector (Fig. 42). If continuity exists proceed to (c). If continuity is not found repair open.

(c) Using jumper wire with In-line 25 amp fuse, jump across terminals 1 and 4 of the relay connector. If the fan motor operates proceed to (d) leaving the jumper wire in place. If the fan motor does not operate repair fan relay fuse link. Refer to Wiring diagrams for circuit diagram.

(d) Check for battery voltage at terminal 2 of fan relay connector (Fig. 43).

(e) Connect a jumper wire across the radiator temperature switch harness connector. If fan operates proceed to (f). If fan does not operate replace radiator temperature switch once the engine has cooled down.

(f) Check for battery voltage at terminal 2 of the fan relay connector (Fig. 43). If battery voltage is not present replace the fan diode assembly.

Fan Inoperative When Air Conditioning Compressor Operates

With engine running, A/C on, and fan relay removed, check for battery voltage at terminal 2 of fan relay connector (Fig. 43). Replace fan diode assembly (Fig. 42) if battery voltage is not present. If battery voltage is not present perform (1) and (2) above.

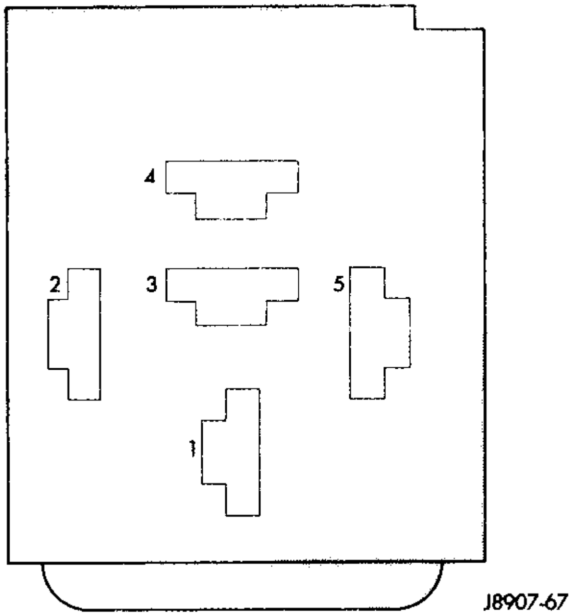


Fig. 43 Auxiliary Fan Relay Connector

Vehicle Not Equipped With Air Conditioning

(1) Auxiliary Fan Operation:

(a) Remove fan relay which is mounted to left inner fender panel (Fig. 44).

(b) Using a jumper wire with an In-line 25 amp fuse, supply battery voltage to terminal 4 of the relay connector (Fig. 43):

- If fan operates, the motor is good. Proceed to (2).
- If fan motor does not operate, check continuity between terminal 4 of the relay connector (Fig. 43) and body ground connections on the fender panel back from the relay connector (Fig. 44). If continuity exists replace the fan motor. If continuity is not found repair open and retest.

(2) Cooling Fan Relay:

(a) With fan relay removed turn the ignition switch to the RUN position.

(b) Check continuity between terminal 5 of the relay connector (Fig. 43) and body ground connections on the fender panel back from the relay connector (Fig. 44). If continuity exists proceed to (c). If continuity is not found repair open.

(c) Using jumper wire with In-line 25 amp fuse, jump across terminals 1 and 4 of the relay connector (Fig. 43). If the fan motor operates proceed to (d) leaving the jumper wire in place. If the fan motor does not operate repair fan relay fuse link. Refer to Wiring diagrams for circuit diagram.

(d) Check for battery voltage at terminal 2 of fan relay connector (Fig. 43).

(e) Connect a jumper wire across the radiator temperature switch harness connector. If fan operates proceed to (f). If fan does not operate replace radiator temperature switch once the engine has cooled down.

Fan Shroud

All vehicles are equipped with a fan shroud to improve fan air flow efficiency. The shrouds are attached to the engine side of the radiator. For removal and installation of fan shrouds refer to Radiator Removal.

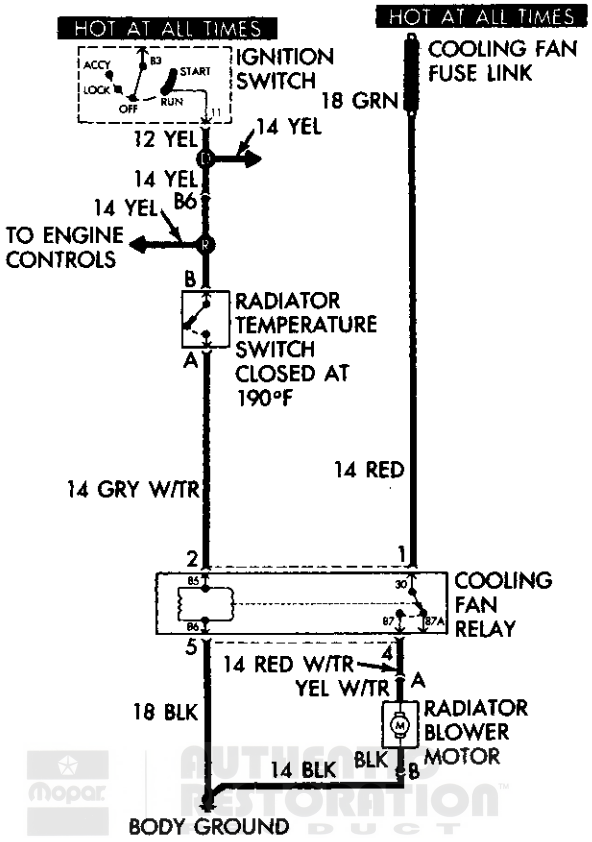
AUTOMATIC TRANSMISSION OIL COOLERS

There are two types of automatic transmission oil coolers, an oil to coolant type which is mounted in the radiator outlet tank or an external auxiliary oil to air cooler mounted in front of the radiator and air conditioning condenser, behind the grille.

An auxiliary automatic transmission oil cooler is standard equipment on all MJ and XJ vehicles (Fig. 45) with the 4.0L engine that are equipped with factory installed optional heavy duty cooling and/or trailer towing package "B", and all SJ vehicles (Fig. 46) equipped with a factory installed trailer towing package.

Serpentine Drive Belts Diagnosis

CIRCUIT SCHEMATIC



COMPONENT LOCATION

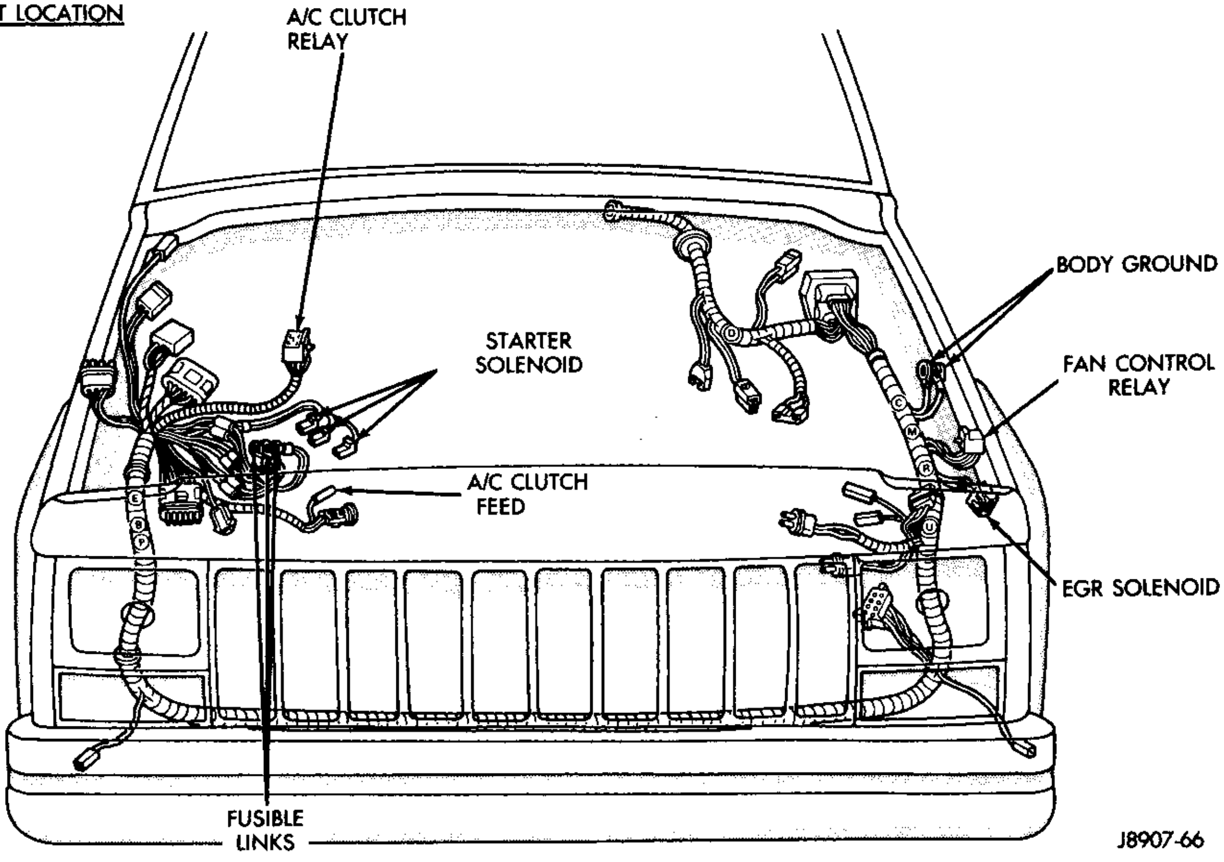


Fig. 44 Auxiliary Fan Controls—without A/C

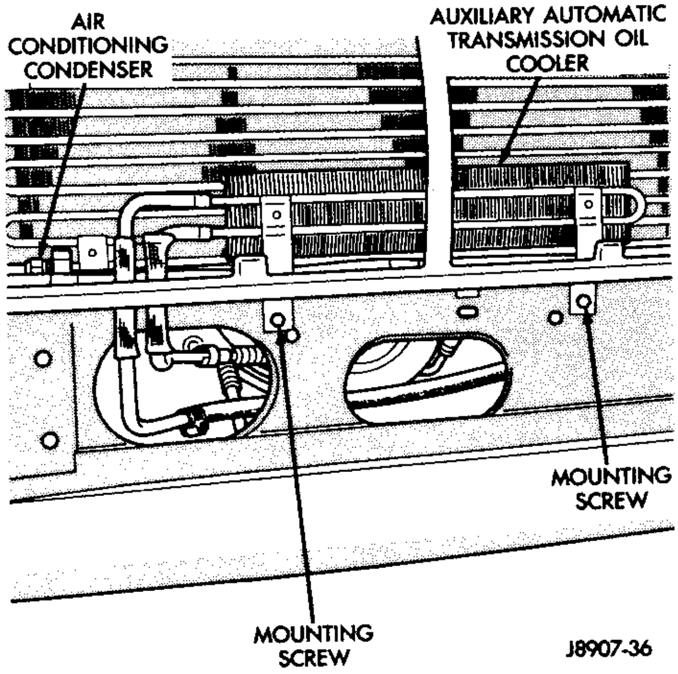


Fig. 45 Auxiliary Auto. Trans. Oil Cooler—MJ and XJ Vehicles

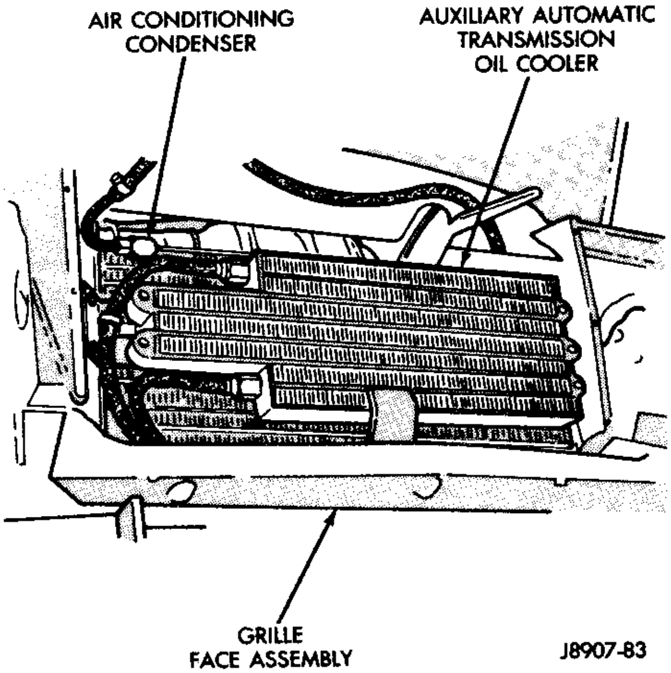


Fig. 46 Auxiliary Auto. Trans. Oil Cooler—SJ Vehicles

ACCESSORY DRIVE BELTS

INDEX

DIAGNOSIS

V-Belt Diagnosis

Condition	Possible Cause	Correction
INSUFFICIENT ACCESSORY OUTPUT DUE TO BELT SLIPPAGE	(a) Belt too loose.	(a) Adjust belt tension
	(b) Belt excessively glazed or worn.	(b) Replace and tighten as specified.
BELT SQUEAL WHEN ACCELERATING	(a) Belt too loose.	(a) Adjust belt tension.
	(b) Belt glazed.	(b) Replace belt.
BELT SQUEAK AT IDLE	(a) Belt too loose.	(a) Adjust belt tension.
	(b) Dirt and/or paint imbedded in belt.	(b) Replace belt.
	(c) Non-uniform belt.	(c) Replace belt.
	(d) Misaligned pulleys.	(d) Align accessory drive pulleys.
	(e) Non-uniform groove or eccentric pulley.	(e) Replace pulley.
BELT ROLLED OVER IN GROOVE OR BELT JUMPS OFF	(a) Broken cord in belt.	(a) Replace belt.
	(b) Belt too loose or too tight.	(b) Adjust belt tension.
	(c) Misaligned pulley.	(c) Adjust belt tension.
	(d) Non-uniform groove or eccentric pulley.	(d) Replace pulley.

J8907-76

Serpentine Drive Belt Diagnosis

Condition	Possible Cause	Correction
RIB CHUNKING (ONE OR MORE RIBS HAS SEPARATED FROM BELT BODY)	(1) Foreign objects imbedded in pulley grooves.	(1) Remove foreign objects from pulley grooves. Replace belt.
	(2) Installation damage.	(2) Replace belt.
RIB OR BELT WEAR	(1) Pulley(s) misaligned.	(1) Align pulley(s).
	(2) Abrasive environment.	(2) Clean pulley(s). Replace belt if necessary.
	(3) Rusted pulley(s).	(3) Clean rust from pulley(s).
	(4) Sharp or jagged pulley groove tips.	(4) Replace pulley.
	(5) Rubber deteriorated.	(5) Replace belt.
LONGITUDINAL BELT CRACKING (CRACKS BETWEEN TWO RIBS)	(1) Belt has mistracked from pulley groove.	(1) Replace belt.
	(2) Pulley groove tip has worn away rubber to tensile member.	(2) Replace belt.
BELT SLIPS	(1) Belt slipping because of insufficient tension.	(1) Adjust tension.
	(2) Belt or pulley subjected to substance (belt dressing, oil, ethylene glycol) that has reduced friction.	(2) Replace belt and clean pulleys.
	(3) Driven component bearing failure.	(3) Replace faulty component bearing.
	(4) Belt glazed and hardened from heat and excessive slippage.	(4) Replace belt.
"GROOVE JUMPING" (BELT DOES NOT MAINTAIN CORRECT POSITION ON PULLEY)	(1) Belt tension either too high or too low.	(1) Adjust belt tension.
	(2) Pulley(s) not within design tolerance.	(2) Replace pulley(s).
	(3) Foreign object(s) in grooves.	(3) Remove foreign objects from grooves.
	(4) Pulley misalignment.	(4) Align pulley(s).
	(5) Belt cordline is broken.	(5) Replace belt.
BELT BROKEN (NOTE: IDENTIFY AND CORRECT PROBLEM BEFORE NEW BELT IS INSTALLED)	(1) Excessive tension.	(1) Replace belt and adjust tension to specification.
	(2) Tensile members damaged during belt installation.	(2) Replace belt.
	(3) Severe misalignment.	(3) Align pulley(s).
	(4) Bracket, pulley, or bearing failure.	(4) Replace defective component and belt.
NOISE (OBJECTIONAL SQUEAL, SQUEAK, OR RUMBLE IS HEARD OR FELT WHILE DRIVE BELT IS IN OPERATION)	(1) Belt slippage.	(1) Adjust belt.
	(2) Bearing noise.	(2) Locate and repair.
	(3) Belt misalignment.	(3) Align belt/pulley(s).
	(4) Belt-to-pulley mismatch.	(4) Install correct belt.

E8907-143

Condition	Possible Cause	Correction
NOISE (OBJECTIONAL SQUEAL, SQUEAK, OR RUMBLE IS HEARD OR FELT WHILE DRIVE BELT IS IN OPERATION) (Continued)	(5) Driven component induced vibration.	(5) Locate defective driven component and repair.
	(6) System resonant frequency induced vibration.	(6) Vary belt tension within specifications. Replace belt.
TENSION SHEETING FABRIC FAILURE (WOVEN FABRIC ON OUTSIDE CIRCUMFERENCE OF BELT HAS CRACKED OR SEPARATED FROM BODY OF BELT)	(1) Tension sheeting contacting stationary object.	(1) Correct rubbing condition.
	(2) Excessive heat causing woven fabric to age.	(2) Replace belt.
	(3) Tension sheeting splice has fractured.	(3) Replace belt.
CORD EDGE FAILURE (TENSILE MEMBER EXPOSED AT EDGES OF BELT OR SEPARATED FROM BELT BODY)	(1) Excessive tension.	(1) Adjust belt tension.
	(2) Belt contacting stationary object.	(2) Correct as necessary.
	(3) Pulley(s) out of tolerance.	(3) Replace pulley.
	(4) Insufficient adhesion between tensile member and rubber matrix.	(4) Replace belt and adjust tension to specifications.

E8907-144

ACCESSORY DRIVE BELT SERVICE

There are two types of accessory drive belts, a single "V" belt or a six ribbed serpentine belt.

CAUTION: When installing a serpentine accessory drive belt, the belt MUST be routed correctly. If not, the engine may overheat due to the water pump rotating in the wrong direction. Refer to the appropriate accessory drive belt schematic for the correct belt routing.

Proper Belt Tension

Correct accessory drive belt tension is required to ensure optimum performance of the belt driven engine accessories. There are different gauges for checking serpentine and V type belts. Use the correct gauge when checking belt tension. Place gauge in the middle of the section of belt being used to check tension. Do not allow gauge to contact anything but belt.

CAUTION: When installing a serpentine accessory drive belt, the belt MUST be routed correctly. If not, the engine may overheat due to the water pump rotating in the wrong direction. Refer to the appropriate accessory drive belt schematic for the correct belt routing.

Belt Tension Specifications

Proper belt tension for a new serpentine accessory drive belt is 800-900 N (180-200 lbs-f). For a used serpentine accessory drive belt, proper belt tension is 623-712 N (140-160 lbs-f).

Proper belt tension for a new V-Belt is 533-711 N (120-160 lbs-f). For a used V-belt, proper belt tension is 400-511 N (90-115 lbs-f).

Accessory Drive Belt Schematics

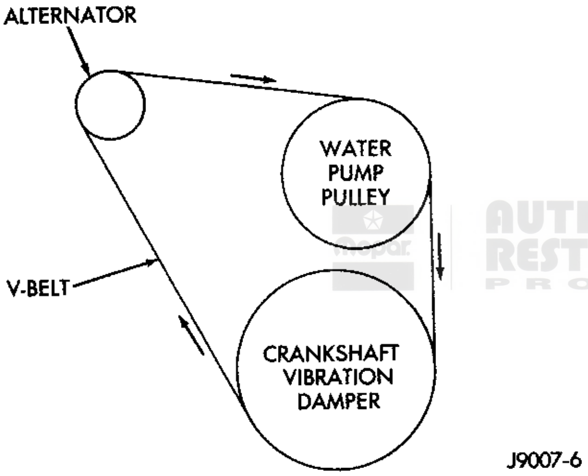


Fig. 1 YJ with Alternator Only—All 2.5L, and 4.2L Except California

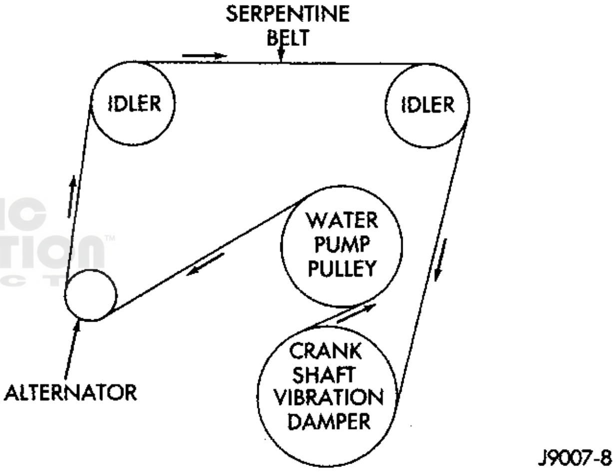


Fig. 3 Alternator only—California YJ with 4.2L

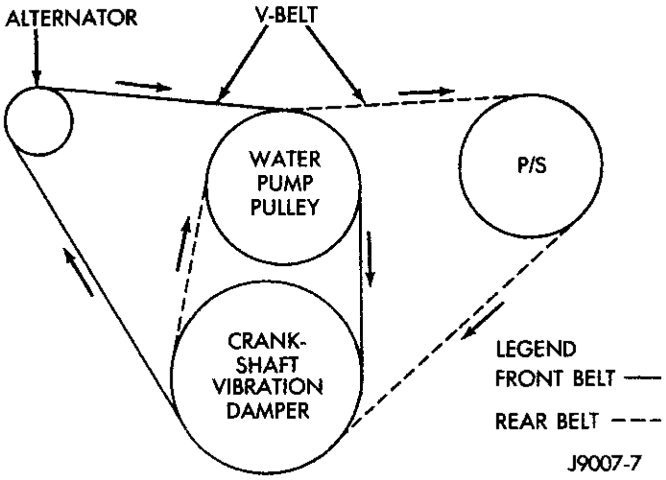


Fig. 2 YJ with Alternator, P.S.— All 2.5L, and 4.2L Except California

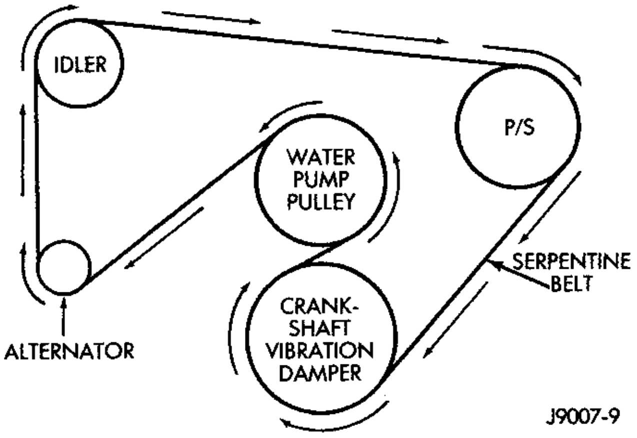


Fig. 4 Alternator and Power Steering—California YJ with 4.2L

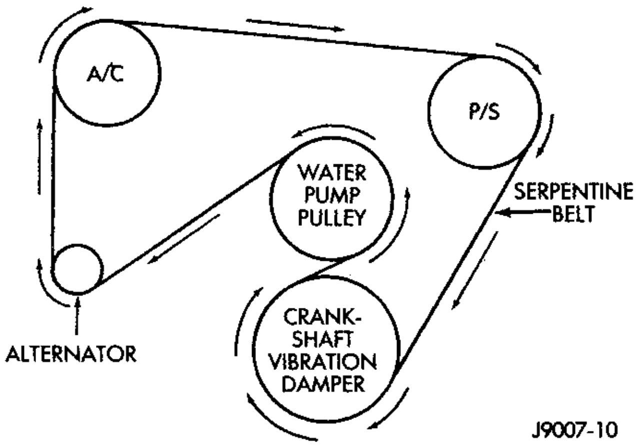


Fig. 5 Alternator, A/C, and Power Steering—YJ with 4.2L

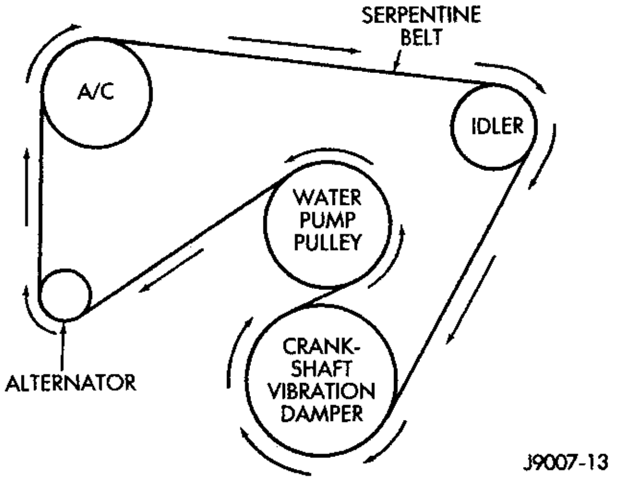


Fig. 8 Alternator and A/C—MJ and XJ Vehicles with 2.5L

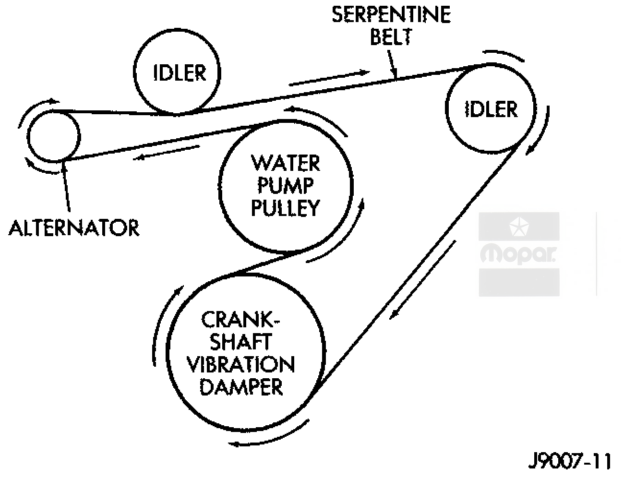


Fig. 6 Alternator Only—MJ and XJ Vehicles with 2.5L

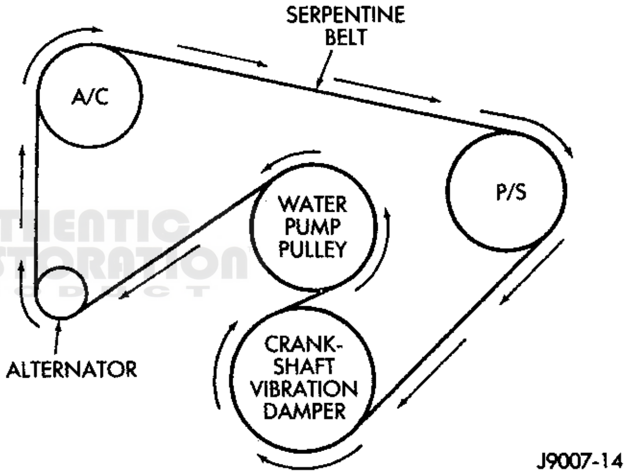


Fig. 9 Alternator, A/C and Power Steering—MJ and XJ Vehicles with 2.5L

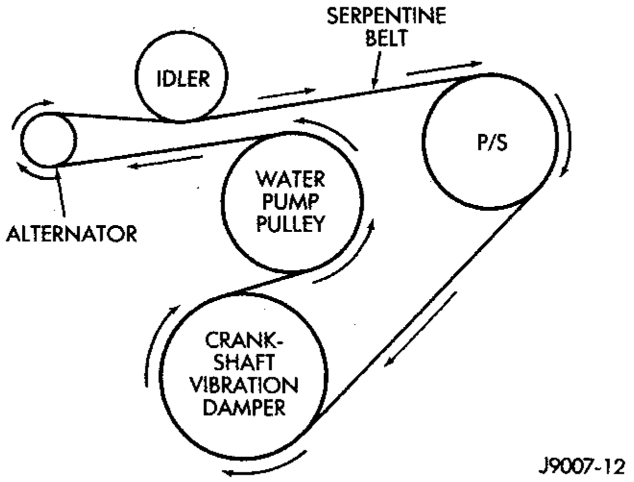


Fig. 7 Alternator and Power Steering—MJ and XJ Vehicles with 2.5L

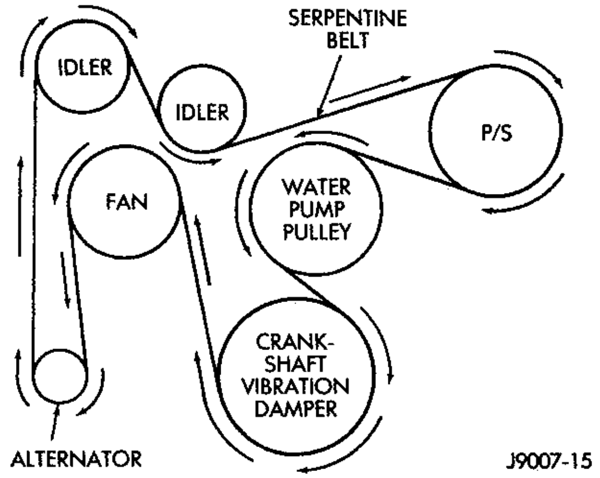


Fig. 10 Alternator and Power Steering—MJ and XJ Vehicles with 4.0L

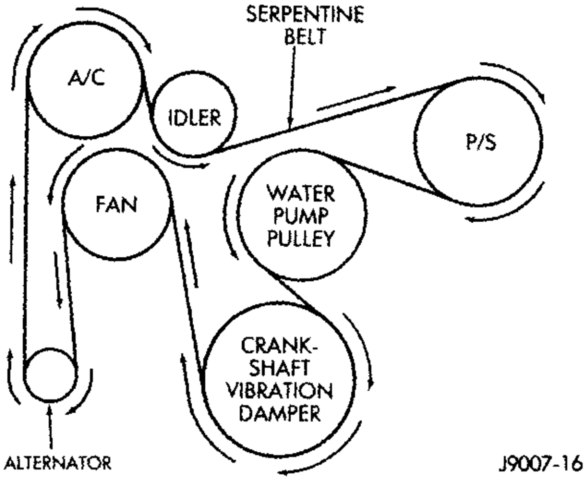


Fig. 11 Alternator, A/C, and Power Steering—MJ and XJ Vehicles 4.0L

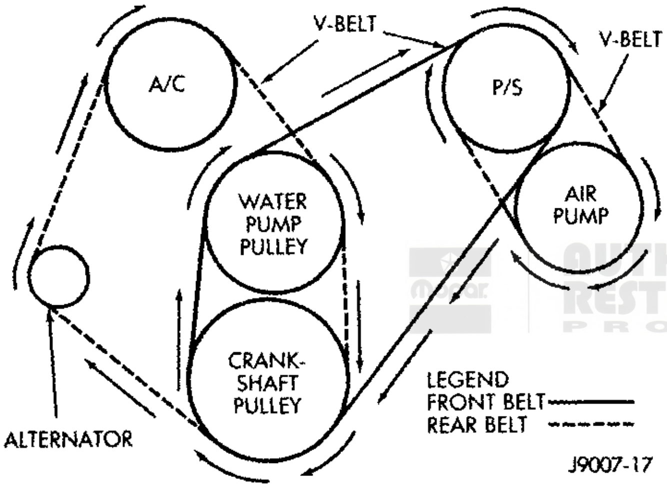


Fig. 12 Alternator, A/C, Air Pump, and Power Steering—SJ Vehicles

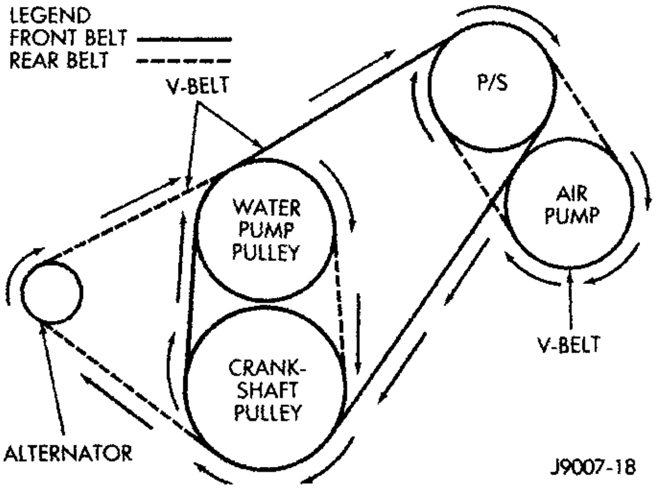


Fig. 13 Alternator, Air Pump, and Power Steering—SJ Vehicles

2.5L Engine, Alternator Drive Belt Adjustment—V-belt

(1) Disconnect battery negative cable.
(2) Loosen alternator front and rear adjusting bolts.
(3) Loosen alternator pivot bolt (Fig. 14).
(4) Pry alternator away from engine to tension belt.
(5) Tighten adjusting bolts to 27N•m (20 ft-lbs) torque.
(6) Tighten pivot bolt to 38N•m (28 ft-lbs) torque.
(7) Connect battery negative cable.

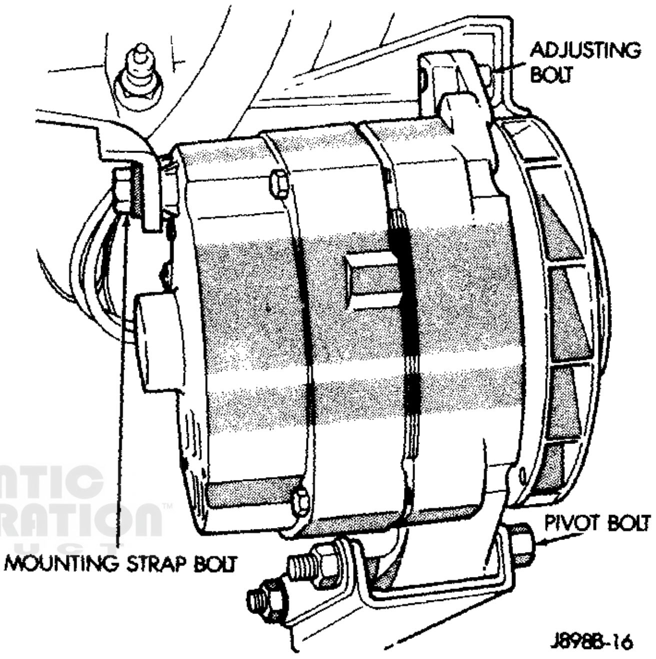


Fig. 14 Alternator V-Belt Adjustment—2.5L

4.2L Engine, Alternator Drive Belt Adjustment—V-belt

(1) Disconnect battery negative cable.

(2) Loosen alternator adjusting bolt.

(3) Loosen alternator pivot bolt (Fig. 15).

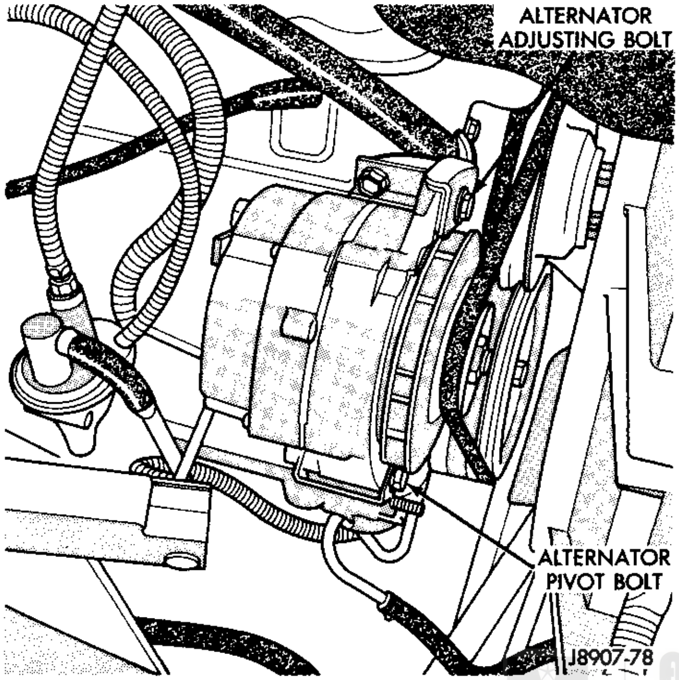


Fig. 15 Alternator V-Belt Adjustment—4.2L

(4) Pry alternator away from engine to tension belt.

(5) Tighten adjusting bolt to 27N•m (20 ft-lbs) torque.

(6) Tighten pivot bolt to 38N•m (28 ft-lbs) torque.

(7) Connect battery negative cable.

Power Steering Pump Belt Adjustment—V-belt 2.5L and 4.2L Engines

(1) Loosen power steering pump front and rear pivot bolts.

(2) Loosen adjusting bolt.

(3) Insert a 1/2 inch breaker bar into adjusting hole of rear pivot bracket (Fig. 16). Tighten belt to correct tension.

(4) Tighten adjusting bolt to 38 N•m (28 ft-lbs) torque.

(5) Tighten front and rear pivot bolts to 38 N•m (28 ft-lbs) torque.

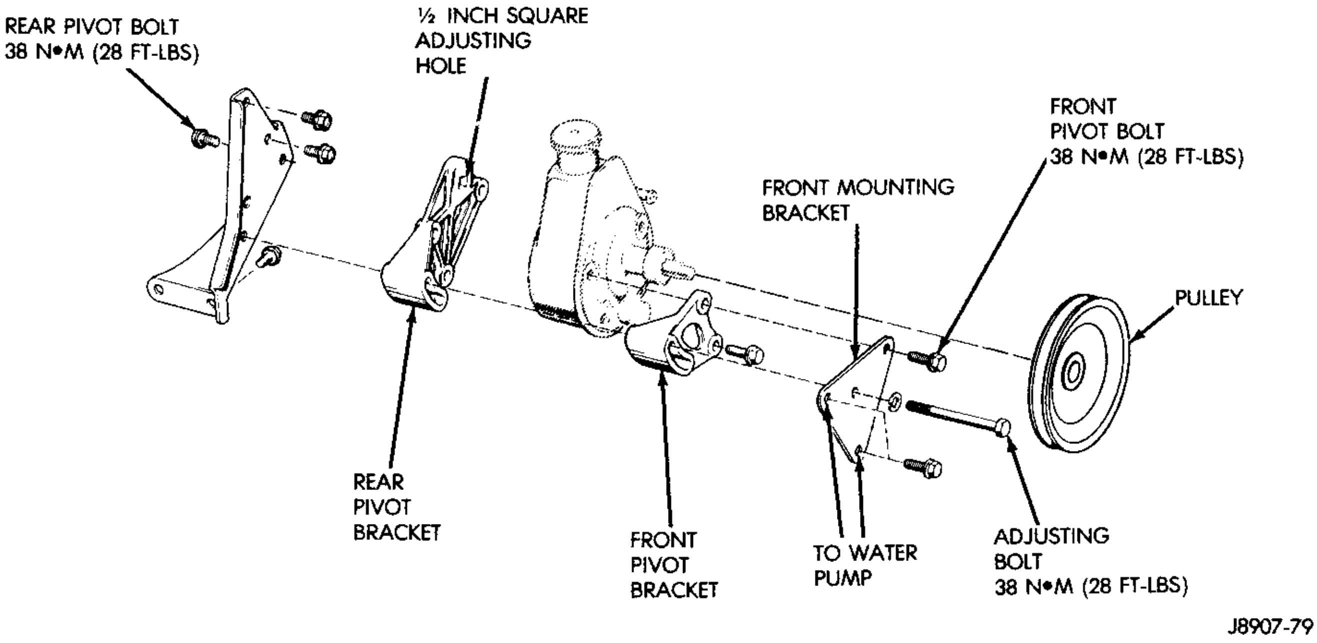


Fig. 16 Power Steering Pump Drive V-Belt Adjustment—2.5L and 4.2L

2.5L and 4.0L Engines with Serpentine Drive Belts and Power Steering

Belt tension is adjusted at the power steering pump. To adjust belt tension or to replace belt:

(1) Loosen power steering pump rear mounting bolts (Fig. 18).

(2) Loosen power steering pump pivot bolt and lock nut (Fig. 17).

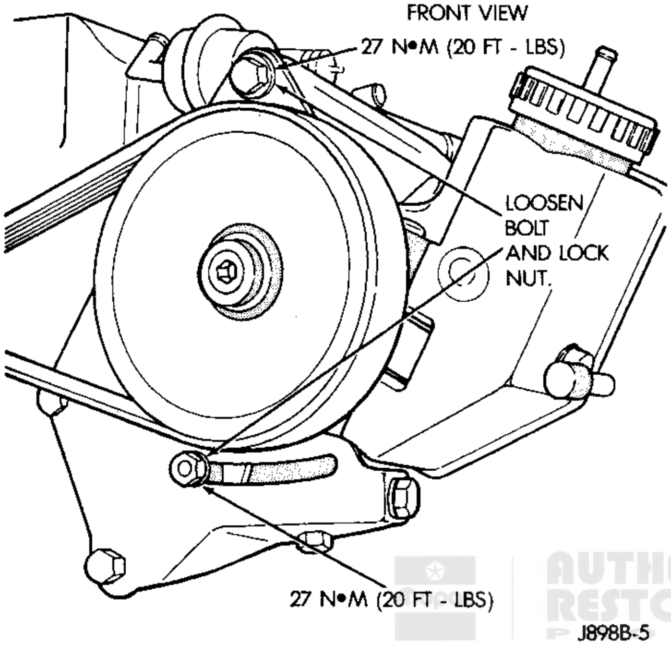


Fig. 17 Serpentine Drive Belt Adjustment 2.5L and 4.0L with P.S.—Front View

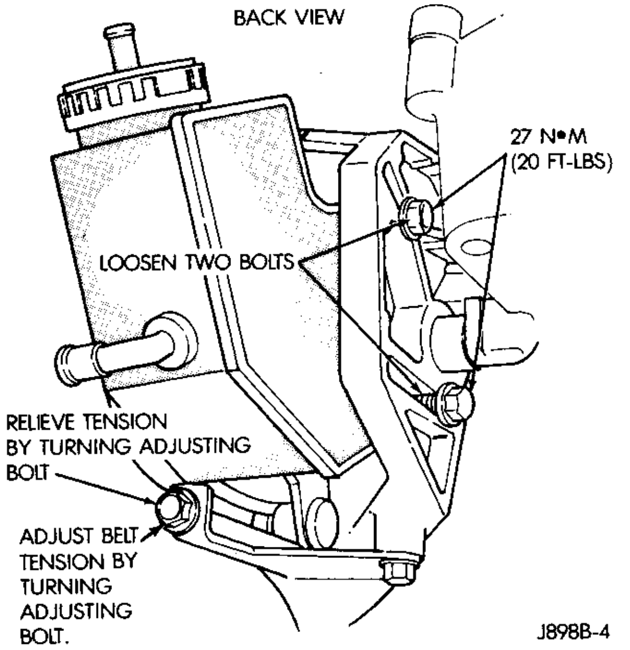


Fig. 18 Serpentine Drive Belt Adjustment 2.5L and 4.0L with P.S.—Rear View

(3) Loosen adjusting bolt to remove belt. Tighten to adjust belt tension.

(4) Tighten rear mounting bolts, pivot bolt, and lock nut to 27 N•m (20 ft-lbs) torque.

2.5L Engine with Serpentine Drive belt and without Power Steering

Belt tension is adjusted at idler pulley on left side of engine.

To adjust belt tension or to replace belt:

(1) Loosen idler pulley rear mounting bolts (Fig. 20).

(2) Loosen idler pulley pivot and lock bolts (Fig. 19).

(3) Loosen adjusting bolt to remove belt. Tighten to adjust belt tension.

(4) Tighten rear mounting bolts, pivot bolt, and lock bolt to 27 N•m (20 ft-lbs) torque.

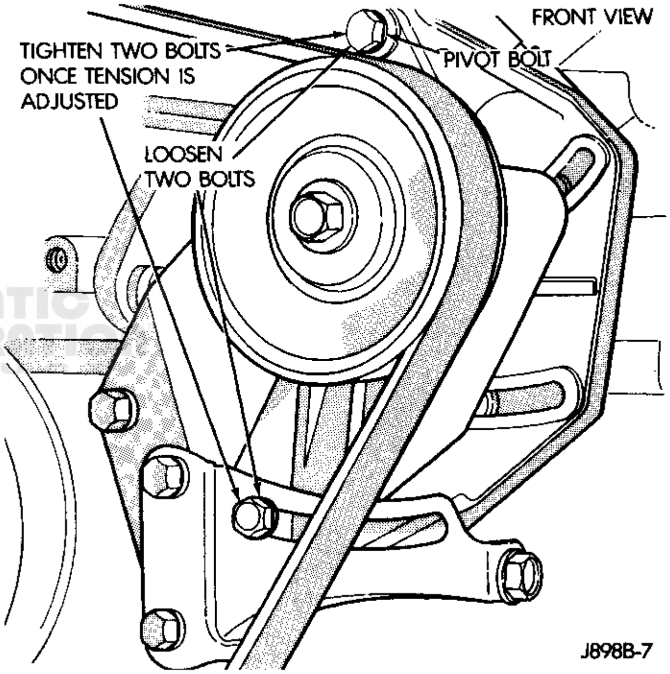


Fig. 19 Serpentine Drive Belt Adjustment 2.5L without P.S.—Front View

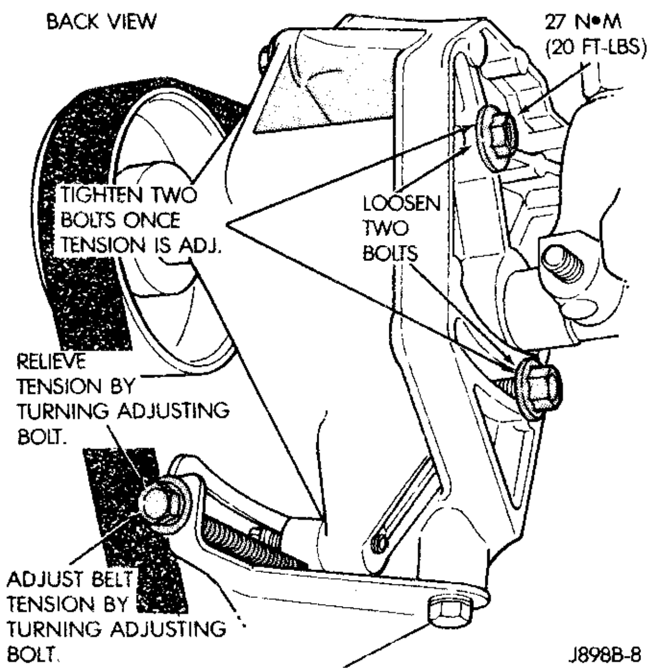


Fig. 20 Serpentine Drive Belt Adjustment 2.5L without P.S.—Rear View

4.2L Engine with Serpentine Drive Belt

Belt tension is adjusted at the alternator. To adjust belt tension or to replace belt:

(1) Disconnect battery negative cable.

(2) Loosen alternator front adjusting bolts and pivot bolt (Fig. 21).

(3) Loosen alternator rear adjusting bolt (Fig. 21).

(4) Install a 1/2 inch drive breaker bar or ratchet into adjusting hole in bracket and tighten belt.

(5) Tighten rear adjusting bolt to 27 N•m (20 ft-lbs) torque.

(6) Tighten front adjusting bolt, mounting bolt, and pivot bolt to 38 N•m (28 ft-lbs) torque.

(7) Connect battery negative cable.

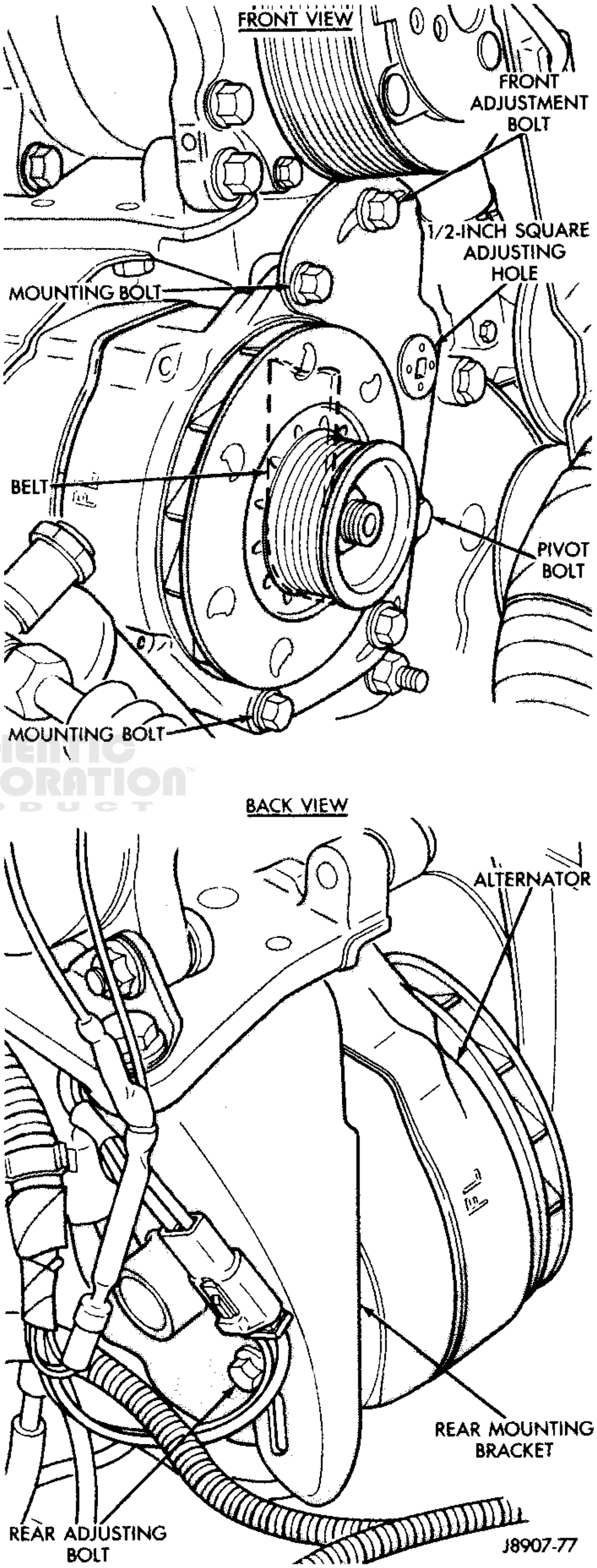


Fig. 21 Serpentine Drive Belt Adjustment—4.2L

5.9L Engine Alternator Belts Adjustment

(1) Disconnect battery negative cable.

(2) Loosen adjustment bolt (Fig. 22).

(3) Loosen pivot bolt (Fig. 22).

(4) Pry alternator away from engine block to tension belt.

(5) Tighten pivot bolt to 38 N•m (28 ft-lbs) torque.

(6) Tighten adjustment bolt to 27 N•m (20 ft-lbs) torque.

(7) Connect battery negative cable.

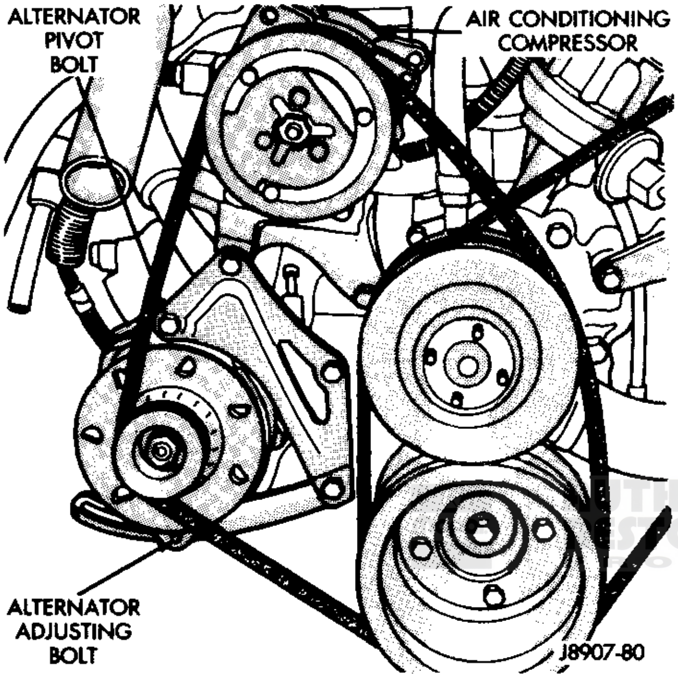


Fig. 22 Alternator Drive Belts Adjustment—5.9L

5.9L Engine Power Steering Pump Drive Belt Adjustment

CAUTION: Do not pry on the power steering pump reservoir to tighten the belt. Damage to the internal components may result.

(1) Loosen both power steering pump rear mounting bolts (Fig. 23).

(2) Insert a 1/2 inch breaker bar into square adjusting hole in bracket.

(3) Pull breaker bar to tension belt.

(4) Tighten pump rear mounting nuts to 38 N•m (28 ft-lbs) torque.

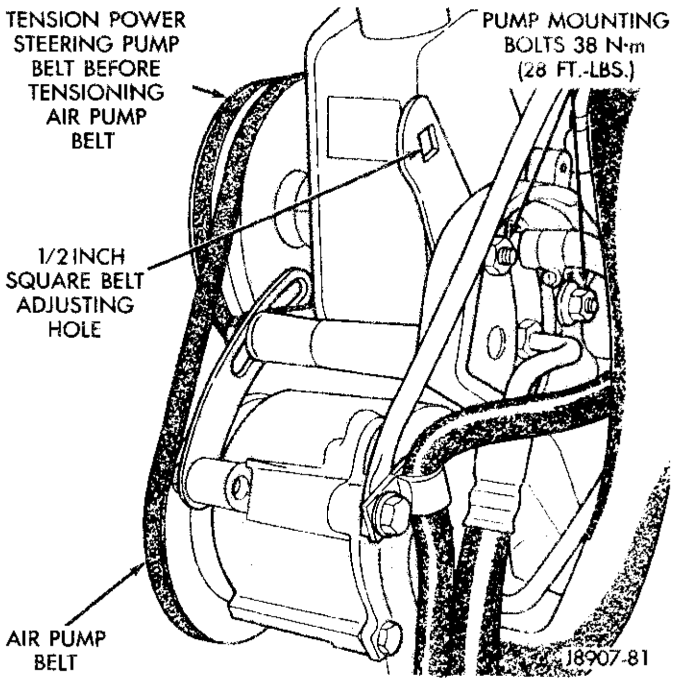


Fig. 23 Power Steering Pump Drive Belt Adjustment —5.9L

5.9L Engine Air Pump Drive Belt Adjustment

If the power steering pump belt is also to be tightened adjust it before adjusting the air pump.

(1) Loosen adjusting bolt (Fig. 24).

(2) Loosen pivot bolt (Fig. 24).

Do not pry against power steering pump reservoir to tension air pump belt.

(3) Pry air pump down to tension belt.

(4) Tighten pivot and adjusting bolts to 27 N•m (20 ft-lbs) torque.

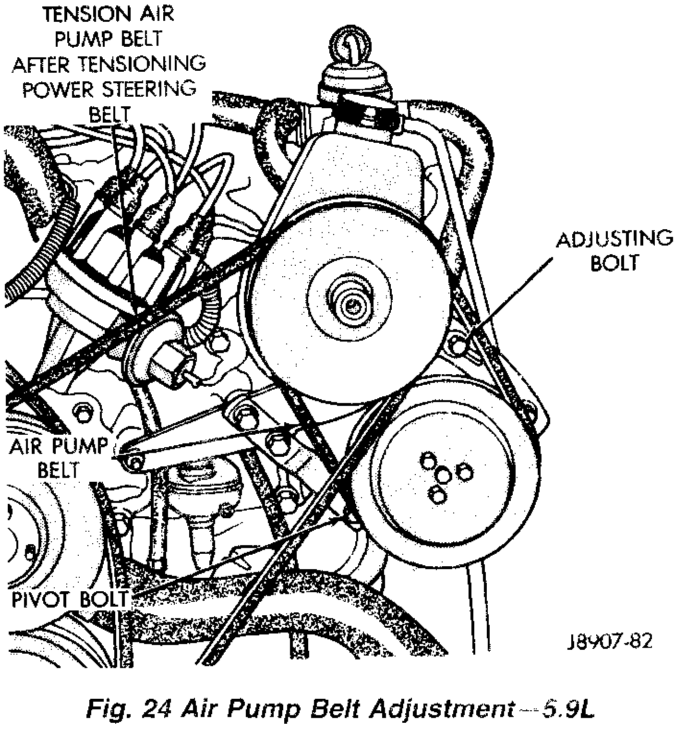


Fig. 24 Air Pump Belt Adjustment—5.9L

ENGINE BLOCK HEATER

INDEX

DESCRIPTION AND OPERATION

An optional engine block heater is available with for all models. The heater is equipped with a power cord. The cord is attached to an engine compartment component with tie-straps. The heater warms the engine providing easier engine starting and faster warm-up in low temperatures. The heater is mounted in a core hole of the engine cylinder block (in place of welsh plug) with the heating element immersed in engine coolant. Connect the power cord to a grounded 110-120 volt AC electrical outlet with a grounded, three wire extension cord.

WARNING: DO NOT OPERATE ENGINE UNLESS BLOCK HEATER CORD HAS BEEN DISCONNECTED FROM POWER SOURCE AND SECURED IN PLACE.

Block Heater Specifications

- 2.5L Engine: 115 Volts 400 Watts
- 4.0L Engine: 120 Volts 600 Watts
- 4.2L Engine: 120 Volts 600 Watts
- 5.9L Engine: 120 Volts 600 Watts

BLOCK HEATER SERVICE

Removal

Refer to correct illustration (Figures 78 - 83) when servicing block heater.

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

DO NOT WASTE reusable coolant. If solution is clean and is being drained only to service the engine or cooling system, drain coolant into a clean container for reuse.

(1) Drain coolant from radiator and engine cylinder block.

(2) Unplug power cord from heater.

(3) Loosen screw in center of heater.

(4) Remove heater from cylinder block.

Installation

(1) Thoroughly clean core hole and heater seat.

(2) Insert heater assembly into core hole with element loop pointing **Up**.

(3) Seat heater flush against block face. Tighten mounting screw to 3.6 N•m (32 in-lbs).

(4) Fill cooling system with coolant. Pressurize system and inspect for leaks.

(5) Plug power cord into heater. Route cord away from moving parts, linkages, and exhaust system components. Secure cord in place with tie-straps.

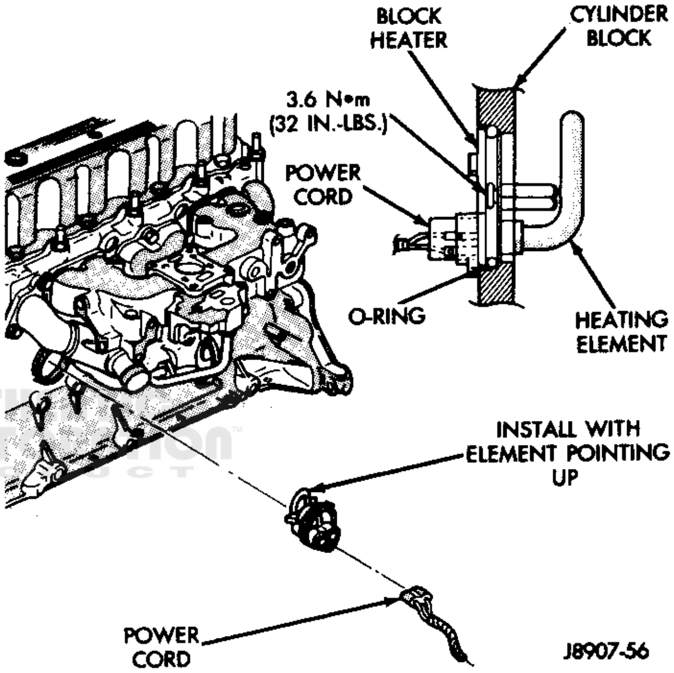


Fig. 25 Block Heater Location—2.5L

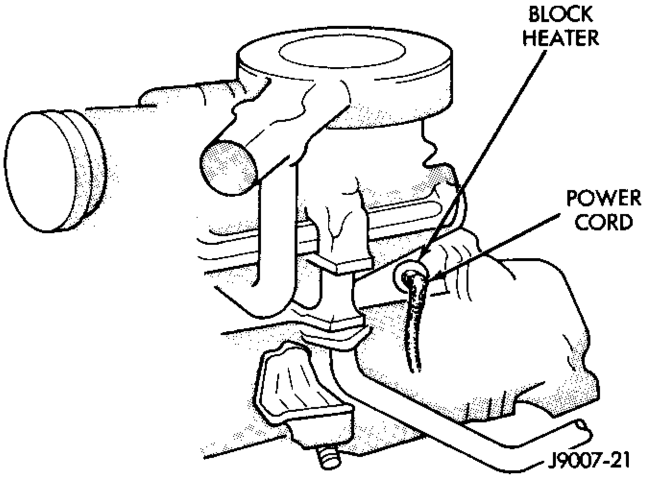


Fig. 26 Block Heater Location—4.0L and 4.2L

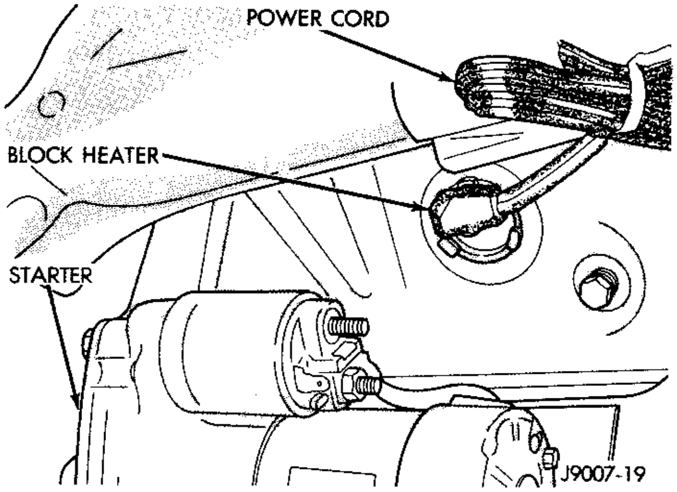


Fig. 27 Block Heater Location—SJ Vehicles

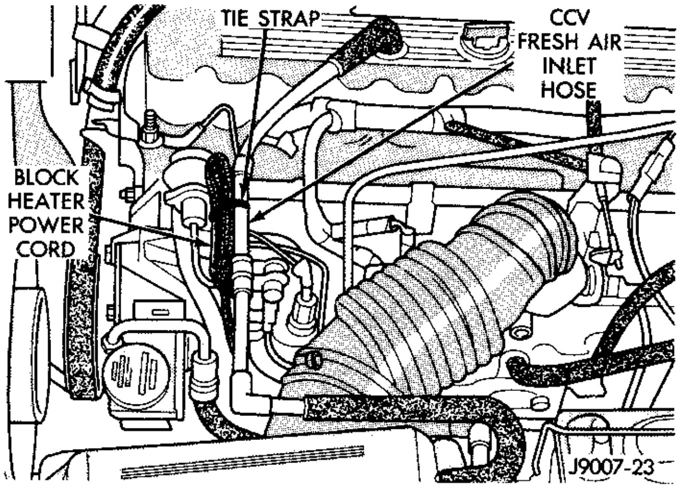


Fig. 29 Block Heater Power Cord Location—MJ and XJ Vehicles with 4.0L

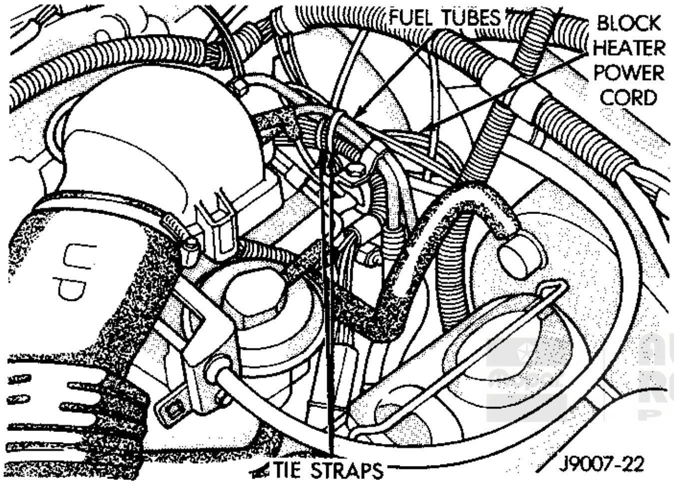


Fig. 28 Block Heater Power Cord Location—MJ and XJ Vehicles with 2.5L

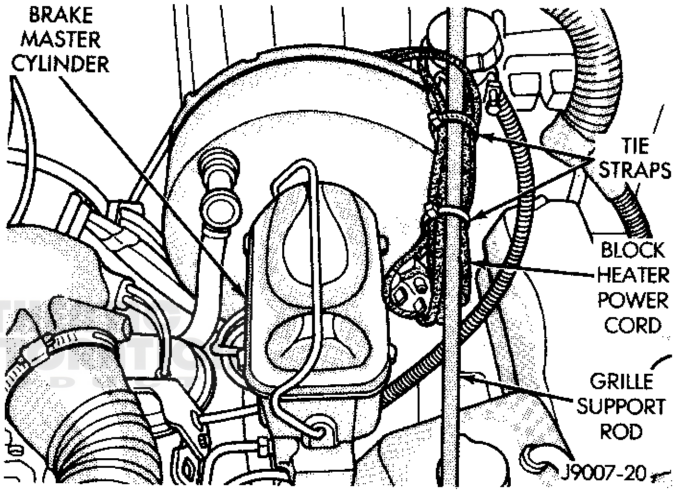


Fig. 30 Block Heater Power Cord Location—YJ Vehicles

COOLING SYSTEM SPECIFICATIONS

MODEL	ENGINE				COOLING* CAPACITY			COOLING PACKAGE		RADIATOR		A/C	ACCESSORY DRIVE BELT		MECHANICAL FAN (VISCOUS DRIVE)			AUXILIARY** ELECTRIC FAN			WATER PUMP ROTATION	
	2.5L	4.0L	4.2L	5.9L	QTS.	L	IMP. GAL.	STD.	HD.	ROWS OF TUBES	FINS PER INCH		V-BELT	SERP.	DIA. (INCH)	NO. OF BLADES	BLADE PITCH (INCH)	DIA. (INCH)	NO. OF BLADES	BLADE PITCH (INCH)	FOR-WARD ↷	RE-VERSE ↶
SJ				•	15.5	14.7	12.9		•	2	15	•	•		19.5	7	2.25				•	
				•	15.5	14.7	12.9		•	2	15		•		19.5	7	2.25				•	
MJ/XJ	•				10.0	9.5	8.3	•		1	15			•	16.0	5	2.5					•
	•				10.0	9.5	8.3		•	1	20	•		•	16.0	5	2.5					•
		•			12.0	11.4	10.0	•		1	19			•	15	7	2.0					•
		•			12.0	11.4	10.0	•		1	19	•		•	15	7	2.0	11.0	6	1.75		•
		•			12.0	11.4	10.0		•	2	19			•	15	7	2.0	11.0	6	1.75		•
		•			12.0	11.4	10.0		•	2	19	•		•	15	7	2.0	11.0	6	1.75		•
YJ	•				9.0	8.5	7.5	•		1	15		•		15	5	2.5				•	
			•		10.5	9.9	8.7	•		1	21		•		17.25	5	2.11				•	
***			•		10.5	9.9	8.7	•		1	21			•	17.25	5	2.11					•
			•		10.5	9.9	8.7		•	2	18		•		17.25	5	2.11				•	
***			•		10.5	9.9	8.7		•	2	18			•	17.25	5	2.11					•
			•		10.5	9.9	8.7	•		1	21	•		•	17.25	5	2.11					•
			•		10.5	9.9	8.7		•	2	18	•		•	17.25	5	2.11					•

*INCLUDES COOLANT RESERVE BOTTLE
**4.0L ENGINE ONLY. WITH HEAVY DUTY COOLING AND/OR AIR CONDITIONING
***WITH CALIFORNIA EMISSIONS

J9007-35

TIGHTENING REFERENCE

Component	N·m	Ft.-Lbs. (In.-Lbs.)
A/C COMPRESSOR MFG. BRKT. 5.9L	38N·m	28 Ft.-Lbs.
ALTERNATOR BRKT. MFG. BOLT 4.2L W/SERP. DRIVE BELT	38N·m	28 Ft.-Lbs.
ALTERNATOR FRONT ADJ. BOLT 4.2L W/SERP. DRIVE BELT	38N·m	28 Ft.-Lbs.
ALTERNATOR FRONT ADJ./MTG. BOLT 2.5L/ 4.2L V-BELT, 4.0L	27N·m	20 Ft.-Lbs.
ALTERNATOR PIVOT BOLT	38N·m	28 Ft.-Lbs.
ALTERNATOR REAR ADJ./MTG. BOLT	27N·m	20 Ft.-Lbs.
ALTERNATOR FRONT MTG. BRKT. 5.9L	38N·m	28 Ft.-Lbs.
AUTO. TRANS. AUXILIARY OIL COOLER MTG. SCREWS 4.0L	2N·m	18 In.-Lbs.
AIR PUMP MTG./ADJ. BOLTS 5.9L	27N·m	20 Ft.-Lbs.
AUXILIARY ELECTRIC COOLING FAN MTG. SCREWS 4.0L	4N·m	36 In.-Lbs.
CONDENSER TO RADIATOR SCREWS MJ/XJ VEHICLES W/2.5L ENGINE	6N·m	55 In.-Lbs.
FAN BLADE ASSY. TO VISCOUS DRIVE	24N·m	18 Ft.-Lbs.
FAN/DRIVE ASSY. TO WATER PUMP	24N·m	18 Ft.-Lbs.
FAN SHROUD MTG. BOLTS MJ/XJ W/2.5L	2N·m	20 In.-Lbs.
FAN SHROUD MTG. SCREWS YJ VEHICLE	16N·m	12 Ft.-Lbs.
FAN SHROUD MTG. SCREWS 4.0L	4N·m	36 In.-Lbs.
HEATER ENGINE CYL. BLOCK.	3.6N·m	32 In.-Lbs.
P.S. PUMP ADJ. BOLT 2.5L/4.2L V-BELT	38N·m	28 Ft.-Lbs.
P.S. PUMP MTG. NUTS 5.9L	38N·m	28 Ft.-Lbs.
P.S. PUMP ADJ. BOLTS 4.0L	27N·m	20 Ft.-Lbs.

J9007-36

Component	N·m	Ft.-Lbs. (In.-Lbs.)
P.S. PUMP MTG. BRKT. BOLTS AND STUD NUT 5.9L	38N·m	28 Ft.-Lbs.
P.S. PUMP PIVOT BOLTS 2.5L/4.2L V-BELT	38N·m	28 Ft.-Lbs.
RADIATOR MTG. BOLTS YJ VEHICLES	8N·m	6 Ft.-Lbs.
RADIATOR MOUNTING BOLTS MJ/XJ WITH 2.5L	6N·m	55 In.-Lbs.
THERMOSTAT HOUSING	18N·m	13 Ft.-Lbs.
WATER PUMP 2.5L/4.0L/4.2L	18N·m	13 Ft.-Lbs.
WATER PUMP TO TIMING CASE COVER - 5.9L	5.4N·m	48 In.-Lbs.

J9007-37

ENGINES

CONTENTS

GENERAL INFORMATION

INDEX

2.5L ENGINE

The 2.5 liter (150 CID) four-cylinder engine is an In-line, lightweight, overhead valve engine (Fig. 1).

This engine is designed for unleaded fuel.

The cylinder head has dual quench-type combustion chambers that create turbulence and fast burning of the air/fuel mixture, which results in good fuel economy.

The cylinders are numbered 1 through 4 from front to rear. The firing order is 1-3-4-2 (Fig. 2).

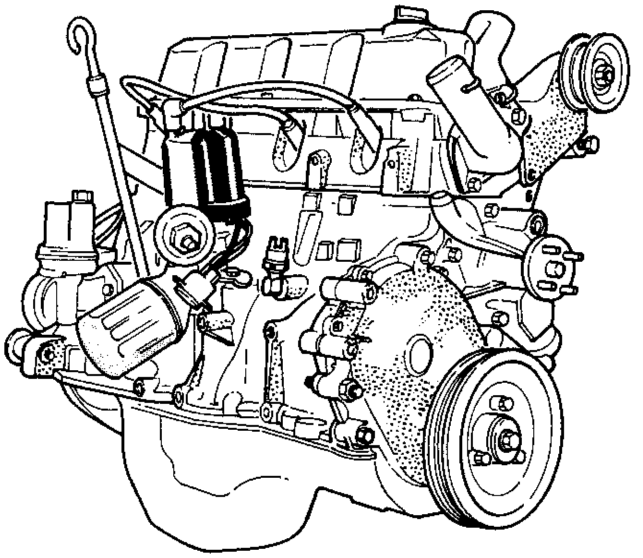


Fig. 1 Four-Cylinder Engine — 2.5 Liter

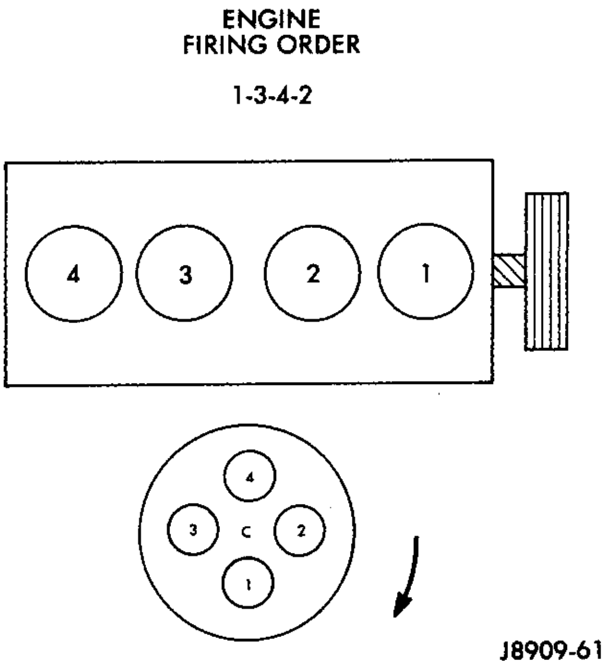


Fig. 2 Engine Firing Order — 2.5 Liter

Type	In-line 4 cylinder
Bore and Stroke	98.45 x 80.97 mm (3.876 x 3.188 in)
Displacement	2.5L (150 cu. inch)
Compression Ratio	9.2:1
Torque (MJ/XJ Vehicles)	192 N•m (141 ft-lbs) @ 3250 rpm
(YJ Vehicles)	188 N•m (138 ft-lbs) @ 3500 rpm
Firing Order	1-3-4-2
Lubrication	Pressure Feed-Full Flow Filtration
Engine Oil Capacity	3.8L (4 Quarts)
Cooling System	Liquid Cooled-Forced Circulation
Cooling System Capacity (MJ/XJ Vehicles)	9.5L (10 Quarts)
(YJ Vehicles)	8.5L (9 Quarts)
Cylinder Block	Cast Iron
Crankshaft	Cast Nodular Iron
Cylinder Head	Cast Nodular Iron
Camshaft	Cast Nodular Iron
Pistons	Aluminum Alloy (with Struts)
Pistons Combustion Cavity	Single Quench
Connecting Rods	Cast Nodular Iron

J9009-75

Fig. 3 Engine Description - 2.5 Liter

The crankshaft rotation is clockwise, when viewed from the front of the engine. The crankshaft rotates within five (5) main bearings and the camshaft rotates within four (4) bearings.

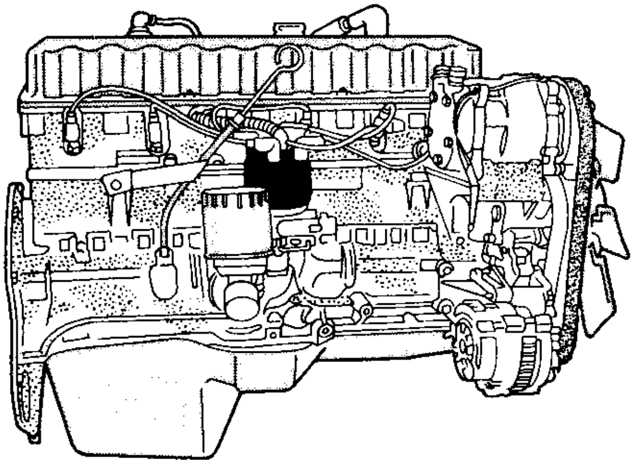
4.0L and 4.2L ENGINES

The 4.0 liter (243 CID) and the 4.2 liter (258 CID) six-cylinder engines are In-line, lightweight, overhead valve engines (Figs. 4 and 5).

These engines are designed for unleaded fuel.

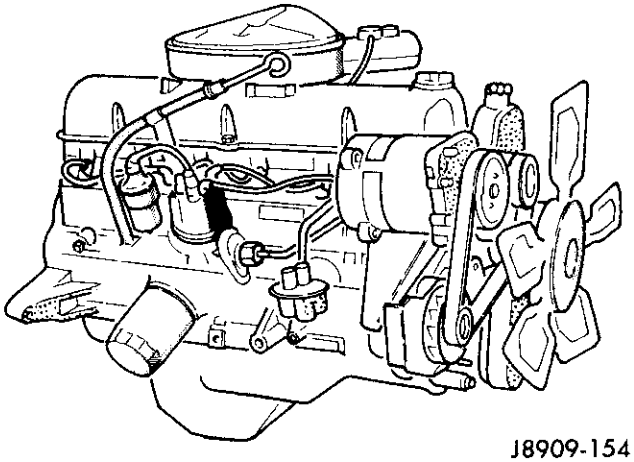
The cylinder head has a quench-type combustion chamber that create turbulence and fast burning of the air/fuel mixture, which results in good fuel economy.

The cylinders in the six-cylinder engine are numbered 1 through 6 from front to rear. The firing order is 1-5-3-6-2-4 (Fig. 6).



J8909-153

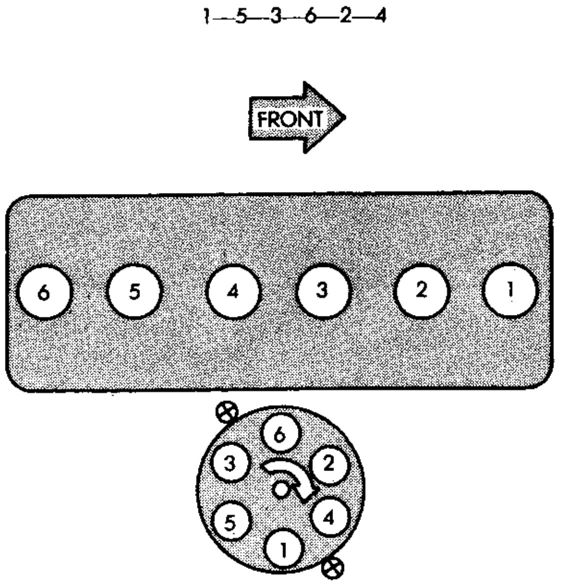
Fig. 4 Six-Cylinder Engine — 4.0 Liter



J8909-154

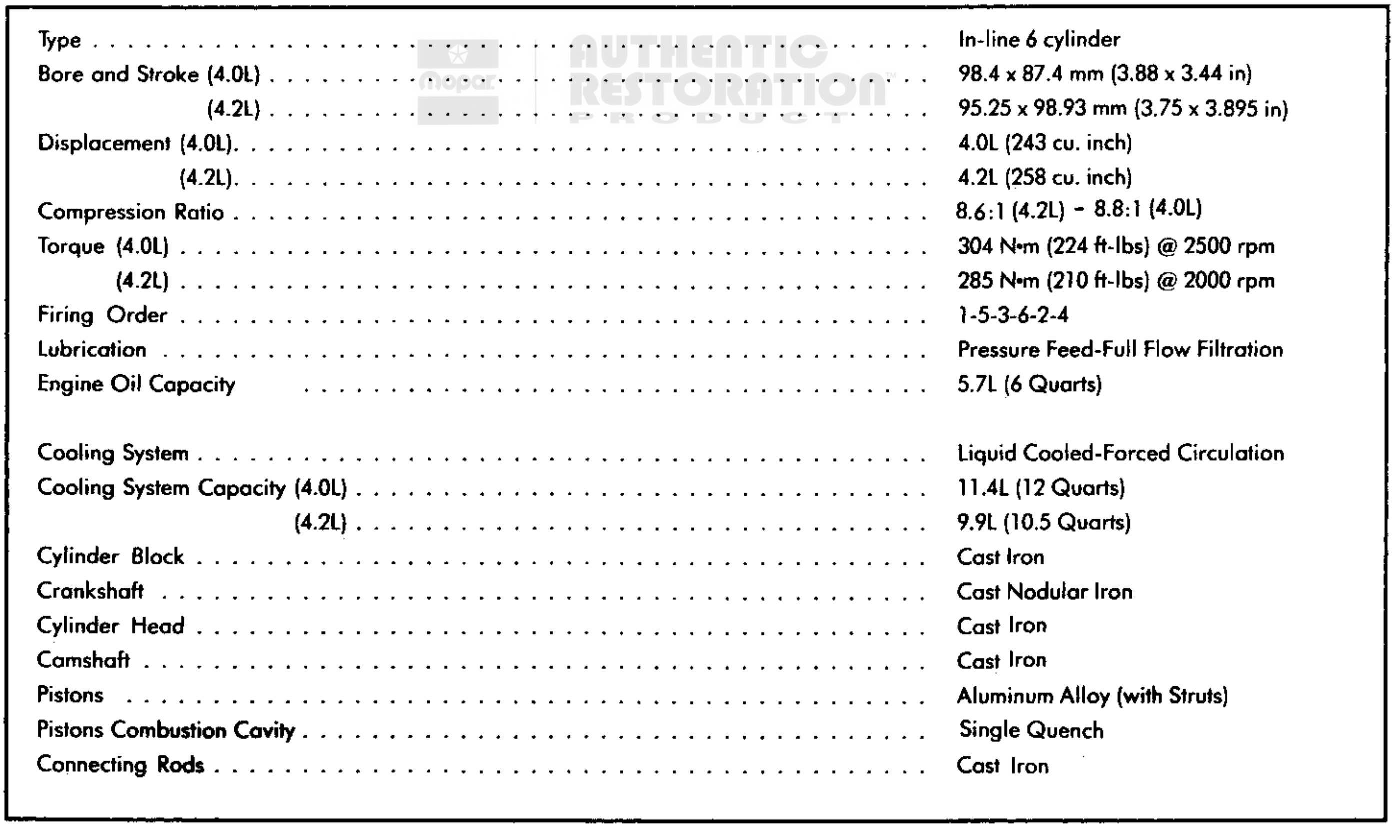
Fig. 5 Six-Cylinder Engine — 4.2 Liter

The crankshaft rotation is clockwise, when viewed from the front of the engine. The crankshaft rotates within seven (7) main bearings and the camshaft rotates within four (4) bearings.



J898D-10

Fig. 6 Engine Firing Order — 4.0 and 4.2 Liter



Type	In-line 6 cylinder
Bore and Stroke (4.0L)	98.4 x 87.4 mm (3.88 x 3.44 in)
(4.2L)	95.25 x 98.93 mm (3.75 x 3.895 in)
Displacement (4.0L)	4.0L (243 cu. inch)
(4.2L)	4.2L (258 cu. inch)
Compression Ratio	8.6:1 (4.2L) - 8.8:1 (4.0L)
Torque (4.0L)	304 N•m (224 ft-lbs) @ 2500 rpm
(4.2L)	285 N•m (210 ft-lbs) @ 2000 rpm
Firing Order	1-5-3-6-2-4
Lubrication	Pressure Feed-Full Flow Filtration
Engine Oil Capacity	5.7L (6 Quarts)
Cooling System	Liquid Cooled-Forced Circulation
Cooling System Capacity (4.0L)	11.4L (12 Quarts)
(4.2L)	9.9L (10.5 Quarts)
Cylinder Block	Cast Iron
Crankshaft	Cast Nodular Iron
Cylinder Head	Cast Iron
Camshaft	Cast Iron
Pistons	Aluminum Alloy (with Struts)
Pistons Combustion Cavity	Single Quench
Connecting Rods	Cast Iron

J9009-99

Fig. 7 Engine Description — 4.0 and 4.2 Liter

5.9L ENGINE

The 5.9 liter (360 CID) V-8 engine is a 90° "V" design incorporating overhead valves (Fig. 8).

This engine is designed for unleaded fuel.

The cylinders are numbered from front to rear. Cylinders 1, 3, 5 and 7 are on the left bank and cylinders 2, 4, 6 and 8 are on the right bank. The engine firing order is 1-8-4-3-6-5-7-2 (Fig. 9).

The cubic-inch displacement numbers are cast into both sides of the cylinder block. These numbers are located between the engine mounting bracket bosses.

BUILD DATE CODE

The engine Build Date Code is located:

- 2.5L Engine - On a machined surface on the right side of the cylinder block between the No. 3 and No. 4 cylinders.
- 4.0L and 4.2L Engines - On a machined surface on the right side of the cylinder block between the No. 2 and No. 3 cylinders.
- 5.9L Engine - On a plate attached to the right bank cylinder head cover.

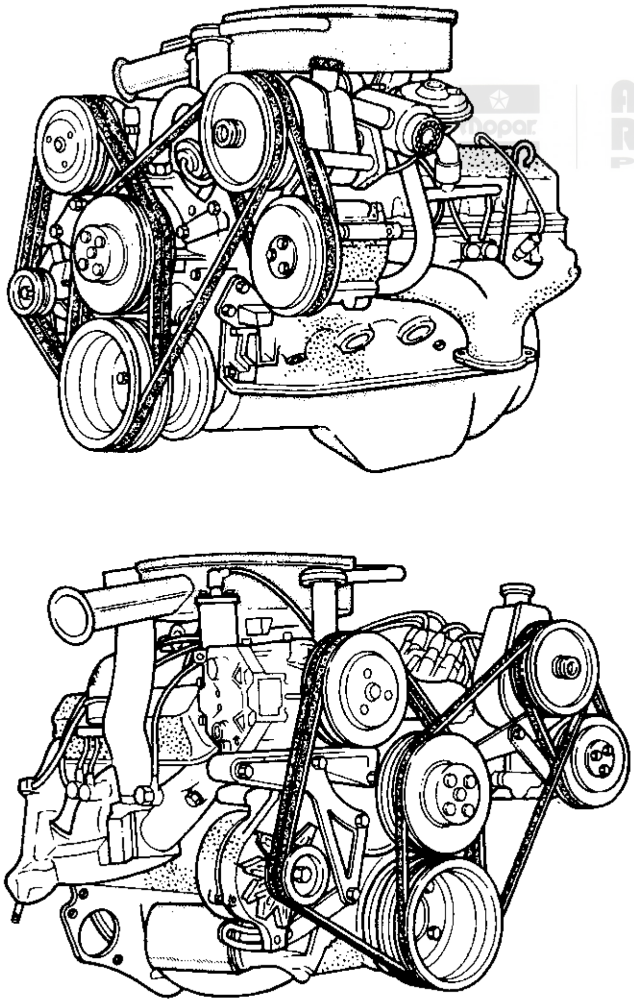


Fig. 8 Eight-Cylinder Engine — 5.9 Liter

The digits of the code identify the year (1st), month (2nd & 3rd), engine type/fuel system/compression ratio (4th & 5th), and day (6th & 7th) of engine build (Fig. 11).

For example: Code - 903MX03 - identifies a 4.0 liter (243 CID) engine with a multi-point fuel injection system, 8.8:1 compression ratio, and built on March 3, 1989.

OVERSIZE AND UNDERSIZE COMPONENT CODES

Some engines may be built with oversize or undersize components such as:

- Oversize cylinder bores.
- Oversize camshaft bearing bores.
- Undersize crankshaft main bearing journals.
- Undersize connecting rod journals.

These engines are identified by a letter code (Fig. 12) stamped on:

- 2.5L Engine - The oil filter boss near the distributor.
- 4.0L and 4.2L Engines - A boss between the ignition coil and the distributor.
- 5.9L Engine - The plate attached to the right bank cylinder head cover.

HONING CYLINDER BORES

Before honing, stuff plenty of clean shop towels under the bores and over the crankshaft to keep abrasive materials from entering the crankshaft area.

(1) Used carefully, the cylinder bore resizing hone C-823 equipped with 220 grit stones, is the best tool for this job. In addition to deglazing, it will reduce taper and out-of-round as well as removing light scuffing, scoring or scratches. Usually a few strokes will clean up a bore and maintain the required limits.

(2) Deglazing of the cylinder walls may be done using a cylinder surfacing hone, Tool C-3501, equipped with 280 grit stones (C-3501-3810) if the cylinder bore is straight and round. 20-60 strokes, depending on the bore condition, will be sufficiant to provide a satisfactory surface. Using honing oil C-3501-3880 or a light

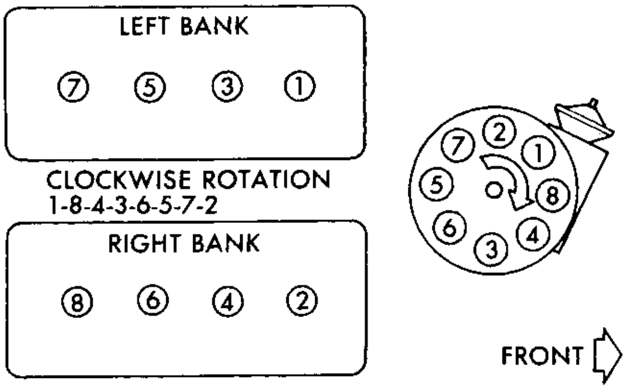


Fig. 9 Engine Firing Order — 5.9 Liter

Type	8 cylinder 90° V-Block
Bore and Stroke	103.63 x 87.38 mm (4.08 x 3.44 in)
Displacement	5.9L (360 cu. inch)
Compression Ratio	8.25:1
Torque	379 N•m (280 ft-lbs) @ 1500 rpm
Firing Order	1-8-4-3-6-5-7-2
Lubrication	Pressure Feed-Full Flow Filtration
Engine Oil Capacity	4.7L (5 Quarts)
Cooling System	Liquid Cooled-Forced Circulation
Cooling System Capacity	13.2L (14 Quarts)
Cylinder Block	Cast Iron
Crankshaft	Cast Nodular Iron
Cylinder Head	Cast Iron
Camshaft	Cast Iron
Pistons	Aluminum Alloy (with Struts)
Pistons Combustion Cavity	Open Chamber
Connecting Rods	Cast Iron

J8909-409

Fig. 10 Engine Description — 5.9 Liter

honing oil available from major oil distributors. **Do not use engine or transmission oil, mineral spirits or kerosene.**

(3) Honing should be done by moving the hone up and down fast enough to get a cross-hatch pattern. When hone marks **intersect** at 50° to 60°, the cross-hatch angle is most satisfactory for proper seating of rings (Fig. 13).

(4) A controlled hone motor speed between 200 and 300 rpm is necessary to obtain the proper cross-hatch angle. The number of up and down strokes per minute can be regulated to get the desired 50° to 60° angle. (Faster up and down strokes increase the cross-hatch angle).

EXAMPLE: 903MX03

1st Digit (Year)	2nd/3rd Digit (Month)	4th Digit (Type)	5th/6th Digit (Day)
7-1987 8-1988 9-1989	01-12	HX MX CX NX	01-31

Letter Code	CID Liter	Fuel System	Comp. Ratio
HX	150-2.5L	TBI	9.2:1
MX	243-4.0L	MPI	8.8:1
CX	258-4.2L	2V	9.2:1
NX	360-5.9L	2V	8.25:1

J8909-6

Fig. 11 Engine Identification and Build Date Code

CODE	COMPONENT	UNDERSIZE
P	One or more connecting rod bearing journals	0.254 mm (0.010 in)
M	All crankshaft main bearing journals	0.254 mm (0.010 in)
PM	All crankshaft main bearing journals and one or more connecting rod journals	0.254 mm (0.010 in)
CODE	**COMPONENT**	**OVERSIZE**
B	All cylinder bores	0.254 mm (0.010 in)
C	All camshaft bearing bores	0.254 mm (0.010 in)

J8909-54

Fig. 12 Oversize and Undersize Component Codes

(5) After honing, it is necessary that the block be cleaned again to remove all traces of abrasives.

CAUTION: Be sure all abrasives are removed from engine parts after honing. It is recommended that a solution of soap and water be used with a brush and the parts thoroughly dried. The bore can be considered clean when it can be wiped clean with a white cloth remains clean. Oil the bores after cleaning to prevent rusting.

MEASURING WITH PLASTIGAGE

Engine crankshaft bearing clearances can be determined by use of Plastigage or equivalent. The following is the recommended procedures for the use of Plastigage:

(1) Remove oil film from surface to be checked. Plastigage is soluble in oil.

(2) The total clearance of the main bearings can only be determined by removing the weight of the crankshaft. This can be accomplished by either of two methods:

PREFERRED METHOD - Shimming the bearings adjacent to the bearing to be checked in order to remove the clearance between upper bearing shell and the crankshaft. This can be accomplished by placing a minimum of 0.254 mm (0.010 inch) shim between the bearing shell and the bearing cap on the adjacent bearings and snugging bolts to 14-20 N•m (10-15 ft. lbs.) torque. When checking #1 main bearing, shim #2 main bearing. When checking #2 main bearing, shim #1 and #3 main bearing. Follow the same pattern for the rest of the main bearings. **Remove all shims before reassembling engine.**

ALTERNATIVE METHOD - The weight of the crankshaft is supported by a jack under the counterweight adjacent to the bearing being checked.

(3) Place a piece of Plastigage across the entire width of the bearing shell in the cap approximately 6.35 mm (1/4 inch) off center and away from the oil holes (Fig. 14). In addition, suspect areas can be checked by placing the Plastigage in the suspect area. Tighten the bearing cap bolts of the bearing being checked to the proper torque.

The checking of connecting rod clearances does not require shimming of the crankshaft. However, before assembling the rod cap with Plastigage in place, the crankshaft must be turned until the connecting rod to be checked starts moving toward the top of the engine. Only then should the cap be assembled and tightened to the proper torque. Do not rotate the crankshaft while assembling the cap or the Plastigage may be smeared, giving inaccurate results.

(4) Remove the bearing cap and compare the width of the flattened Plastigage with the metric scale provided on the package (Fig. 15). Locate the band closest to the same width. this band shows the amount of clearance in thousandths of a millimeter. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications in this section. **Plastigage generally is accompanied by two scales. One scale is in inches, the other is a metric scale.**

(5) Plastigage is available in a variety of clearance ranges. The 0.025-0.076 mm (0.001-0.003 inch) is usually the most appropriate for checking engine bearing proper specifications.

REPAIR OF DAMAGED OR WORN THREADS

Damaged or worn threads can be repaired. Essentially, this repair consists of drilling out worn or damaged threads, tapping the hole with a special Heli-Coil Tap,

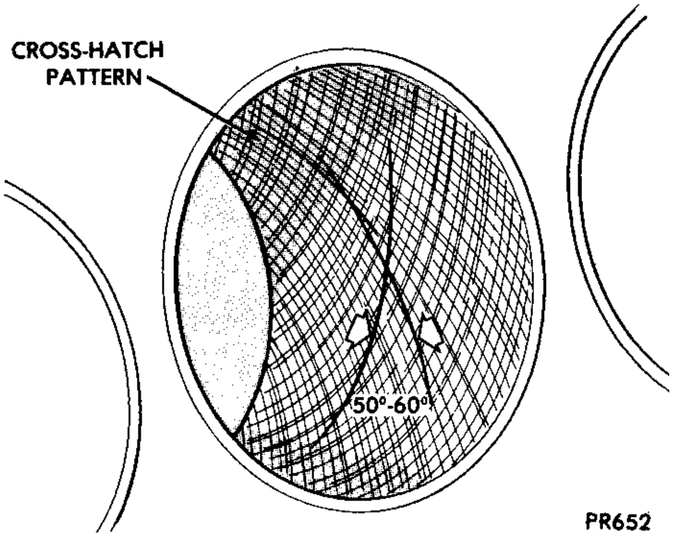


Fig. 13 Cylinder Bore Cross-Hatch Pattern

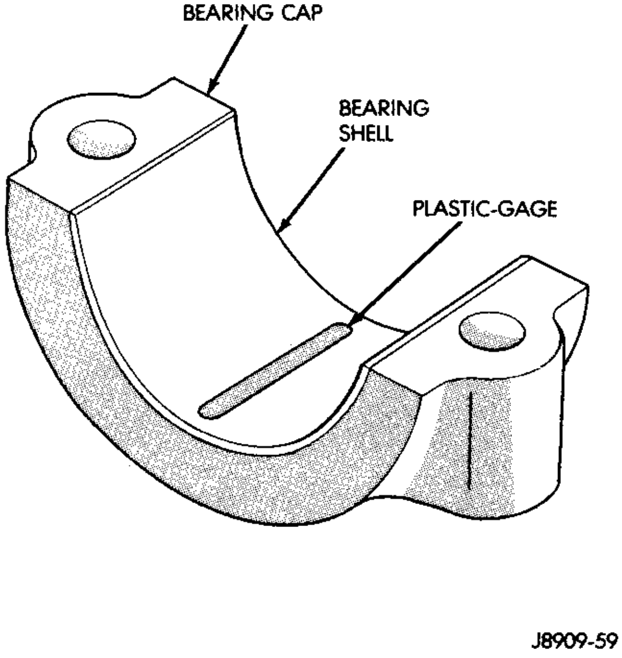


Fig. 14 Placement of Plastigage in Bearing Shell

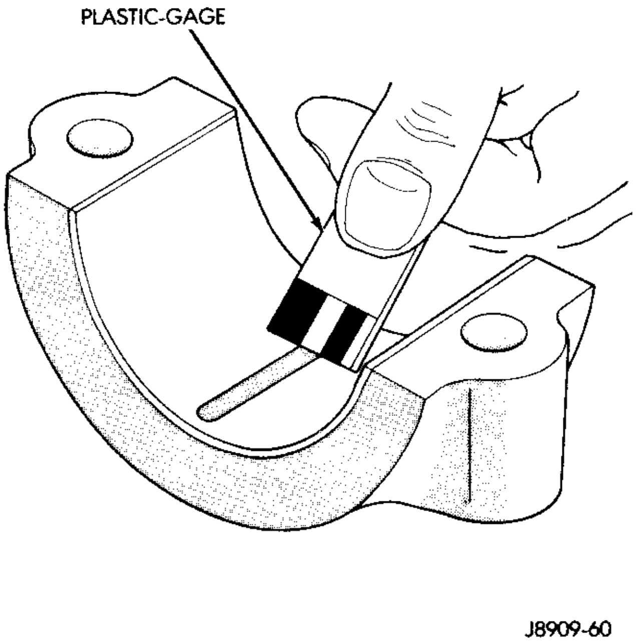


Fig. 15 Clearance Measurement

(or equivalent), and installing an insert into the tapped hole. This brings the hole back to its original thread size.

CAUTION: Be sure that the tapped holes maintain the original centerline.

Heli-Coil tools and inserts are readily available from automotive parts jobbers.

SERVICE ENGINE ASSEMBLY (SHORT BLOCK)

A service replacement engine assembly (short block) may be installed whenever the original cylinder block is defective or damaged beyond repair. It consists of the cylinder block, crankshaft piston and rod assemblies. The 5.9L engine short block also includes the camshaft, timing sprockets and chain. If needed, the camshaft must be procured separately (2.5L, 4.0L and 4.2L engines) and installed before the engine is installed in the vehicle.

A short block is identificated with the letter "S" stamped on the same machined surface where the build date code is stamped for complete engine assemblies.

Installation includes the transfer of components from the defective or damaged original engine. Follow the appropriate procedures for cleaning, inspection and torque tightening as outlined in the appropriate Engine Section.

ENGINE DIAGNOSIS

INDEX

GENERAL INFORMATION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine tune-ups.

These malfunctions may be classified as either mechanical (e.g., a strange noise), or performance (e.g., engine idles rough and stalls).

Refer to the Service Diagnosis—Mechanical chart and the Service Diagnosis—Performance chart for possible causes and corrections of malfunctions. Refer to Group 14, Fuel System for the fuel system diagnosis.

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that can not be isolated with the Service Diagnosis charts.

Information concerning additional tests and diagnosis is provided within the following diagnosis:

- Cylinder Compression Pressure Test.
- Cylinder Combustion Pressure Leakage Test.
- Cylinder Head Gasket Failure Diagnosis.
- Intake Manifold Leakage Diagnosis.

SERVICE DIAGNOSIS - MECHANICAL

CONDITION	POSSIBLE CAUSE	CORRECTION
LOW OIL PRESSURE	(1) Low oil level.	(1) Add oil to correct level.
	(2) Inaccurate gauge, warning lamp or sending unit.	(2) Refer to Oil Pressure Gauge or Warning Lamp.
	(3) Oil excessively thin because of dilution, poor quality, or improper grade.	(3) Drain and refill crankcase with recommended oil.
	(4) Excessive oil temperature.	(4) Correct cause of overheating engine.
	(5) Oil pressure relief spring weak or sticking.	(5) Remove and inspect oil pressure relief valve assembly.
	(6) Oil inlet tube and screen assembly has restriction or air leak.	(6) Remove and inspect oil inlet tube and screen assembly. (Fill inlet tube with lacquer thinner to locate leaks.)
	(7) Excessive oil pump clearance.	(7) Measure clearances; refer to Oil Pump.
	(8) Excessive main, rod, or camshaft bearing clearance.	(8) Measure bearing clearances, repair as necessary.
HIGH OIL PRESSURE	(1) Improper oil viscosity.	(1) Drain and refill crankcase with correct viscosity oil.
	(2) Oil pressure gauge or sending unit inaccurate.	(2) Refer to Oil Pressure Gauge.
	(3) Oil pressure relief valve sticking closed.	(3) Remove and inspect oil pressure relief valve assembly.

J9009-2

SERVICE DIAGNOSIS - MECHANICAL (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
NO OIL PRESSURE	(1) Low oil level.	(1) Add oil to correct level.
	(2) Oil pressure gauge, warning lamp or sending unit inaccurate.	(2) Refer to Oil Pressure Gauge or Warning Lamp.
	(3) Oil pump malfunction.	(3) Refer to Oil Pump.
	(4) Oil pressure relief valve sticking.	(4) Remove and inspect oil pressure relief valve assembly.
	(5) Oil passages on pressure side of pump obstructed.	(5) Inspect oil passages for obstructions.
	(6) Oil pickup screen or tube obstructed.	(6) Inspect oil pickup for obstructions.
	(7) Loose oil inlet tube.	(7) Tighten or seal inlet tube.
EXCESSIVE OIL CONSUMPTION	(1) Oil level too high.	(1) Drain oil to specified level.
	(2) Oil with wrong viscosity being used.	(2) Replace with specified oil.
	(3) PCV valve stuck closed.	(3) Replace PCV valve.
	(4) Valve stem oil deflectors (or seals) are damaged, missing, or incorrect type.	(4) Replace valve stem oil deflectors.
	(5) Valve stems or valve guides worn.	(5) Measure stem-to-guide clearance and repair as necessary.
	(6) Restrictor plugged.	(6) Clean restrictor. Replace if necessary.
	(7) Poorly fitted or missing valve cover baffles.	(7) Replace valve cover.
	(8) Piston rings broken or missing.	(8) Replace broken or missing rings.
	(9) Scuffed piston.	(9) Replace piston. Repair block as necessary.
	(10) Incorrect piston ring gap.	(10) Measure ring gap, repair as necessary.
	(11) Piston rings sticking or excessively loose in grooves.	(11) Measure ring side clearance, repair as necessary.
	(12) Compression rings installed upside down.	(12) Repair as necessary.
	(13) Cylinder walls worn, scored, or glazed.	(13) Repair as necessary.
	(14) Piston ring gaps not properly staggered.	(14) Repair as necessary.
	(15) Excessive main or connecting rod bearing clearance.	(15) Measure bearing clearance, repair as necessary.

J9009-3

SERVICE DIAGNOSIS - MECHANICAL (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
EXTERNAL OIL LEAKS	(1) Fuel pump gasket broken or improperly seated.	(1) Replace gasket.
	(2) Cylinder head cover RTV sealant broken or improperly seated.	(2) Replace sealant; inspect cylinder head cover sealant flange and cylinder head sealant surface for distortion and cracks.
	(3) Oil filler cap leaking or missing.	(3) Replace cap.
	(4) Oil filter gasket broken or improperly seated.	(4) Replace oil filter.
	(5) Oil pan side gasket broken, improperly seated or opening in RTV sealant.	(5) Replace gasket or repair opening in sealant; inspect oil pan gasket flange for distortion.
	(6) Oil pan front oil seal broken or improperly seated.	(6) Replace seal; inspect timing case cover and oil pan seal flange for distortion.
	(7) Oil pan rear oil seal broken or improperly seated.	(7) Replace seal; inspect oil pan rear oil seal flange; inspect rear main bearing cap for cracks, plugged oil return channels, or distortion in seal groove.
	(8) Timing case cover oil seal broken, improperly seated or porosity.	(8) Replace seal.
	(9) Excess oil pressure because of restricted PCV valve.	(9) Replace PCV valve.
	(10) Oil pan drain plug loose or has stripped threads.	(10) Repair as necessary and tighten.
	(11) Rear oil gallery plug loose.	(11) Use appropriate sealant on gallery plug and tighten.
	(12) Rear camshaft plug loose or improperly seated.	(12) Seat camshaft plug or replace and seal, as necessary.
	(13) Distributor base gasket damaged.	(13) Replace gasket.
MAIN BEARING NOISE	(1) Insufficient oil supply.	(1) Inspect for low oil level and low oil pressure.
	(2) Main bearing clearance excessive.	(2) Measure main bearing clearance, repair as necessary.
	(3) Bearing insert missing.	(3) Replace missing insert.
	(4) Crankshaft end play excessive.	(4) Measure end play, repair as necessary.
	(5) Improperly tightened main bearing cap bolts.	(5) Tighten bolts with specified torque.
	(6) Loose flywheel or drive plate.	(6) Tighten flywheel or drive plate attaching bolts.
	(7) Loose or damaged vibration damper.	(7) Repair as necessary.

J9009-4

SERVICE DIAGNOSIS - MECHANICAL (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
VALVE ACTUATING COMPONENT NOISE	(1) Insufficient oil supply.	(1) Check for: (a) Low oil level. (b) Low oil pressure. (c) Plugged push rods. (d) Wrong hydraulic tappets. (e) Restricted oil gallery. (f) Excessive tappet to bore clearance.
	(2) Push rods worn or bent.	(2) Replace worn or bent push rods.
	(3) Rocker arms or pivots worn.	(3) Replace worn rocker arms or pivots.
	(4) Foreign objects or chips in hydraulic tappets.	(4) Clean tappets.
	(5) Excessive tappet leak-down.	(5) Replace valve tappet.
	(6) Tappet face worn.	(6) Replace tappet; inspect corresponding cam lobe for wear.
	(7) Broken or cocked valve springs.	(7) Properly seat cocked springs; replace broken springs.
	(8) Stem-to-guide clearance excessive.	(8) Measure stem-to-guide clearance, repair as required.
	(9) Valve bent.	(9) Replace valve.
	(10) Loose rocker arms.	(10) Tighten bolts with specified torque.
	(11) Valve seat runout excessive.	(11) Regrind valve seat/valves.
	(12) Missing valve lock.	(12) Install valve lock.
	(13) Push rod rubbing or contacting cylinder head.	(13) Remove cylinder head and remove obstruction in head.
	(14) Excessive engine oil (four-cylinder engine).	(14) Correct oil level.
CONNECTING ROD BEARING NOISE	(1) Insufficient oil supply.	(1) Inspect for low oil level and low oil pressure.
	(2) Carbon build-up on piston.	(2) Remove carbon from piston crown.
	(3) Bearing clearance excessive or bearing missing.	(3) Measure clearance, repair as necessary.
	(4) Crankshaft connecting rod journal out-of-round.	(4) Measure journal dimensions, repair or replace as necessary.
	(5) Misaligned connecting rod or cap.	(5) Repair as necessary.
	(6) Connecting rod bolts tightened improperly.	(6) Tighten bolts with specified torque.

J9009-5

SERVICE DIAGNOSIS - MECHANICAL (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
PISTON NOISE	(1) Piston-to-cylinder wall clearance excessive (scuffed piston).	(1) Measure clearance and examine piston.
	(2) Cylinder walls excessively tapered or out-of-round.	(2) Measure cylinder wall dimensions, rebore cylinder.
	(3) Piston ring broken.	(3) Replace all rings on piston.
	(4) Loose or seized piston pin.	(4) Measure piston-to-pin clearance, repair as necessary.
	(5) Connecting rods misaligned.	(5) Measure rod alignment, straighten or replace.
	(6) Piston ring side clearance excessively loose or tight.	(6) Measure ring side clearance, repair as necessary.
	(7) Carbon build-up on piston is excessive.	(7) Remove carbon from piston.

J9009-6

SERVICE DIAGNOSIS - PERFORMANCE

CONDITION	POSSIBLE CAUSE	CORRECTION
ROUGH IDLE OR STALLING	(1) Incorrect curb or fast idle speed.	(1) Adjust curb or fast idle speed.
	(2) Incorrect ignition timing.	(2) Adjust timing to specification.
	(3) Improper feedback system operation.	(3) Refer to Feedback System Diagnosis.
	(4) Improper fast idle cam adjustment.	(4) Adjust fast idle cam.
	(5) Faulty EGR valve operation.	(5) Test EGR system and replace as necessary.
	(6) Faulty PCV valve air flow.	(6) Test PCV valve and replace as necessary.
	(7) Choke binding.	(7) Locate and eliminate binding condition.
	(8) Faulty TAC vacuum motor or valve.	(8) Repair as necessary.
	(9) Air leak into manifold vacuum.	(9) Inspect manifold vacuum connections and repair as necessary.
	(10) Improper fuel level.	(10) Adjust fuel level.
	(11) Faulty distributor rotor or cap.	(11) Replace rotor or cap.
	(12) Improperly seated valves.	(12) Test cylinder compression, repair as necessary.
	(13) Incorrect ignition wiring.	(13) Inspect wiring and correct as necessary.
	(14) Faulty ignition coil.	(14) Test coil and replace as necessary.
	(15) Restricted air vent or idle passages.	(15) Clean passages.
	(16) Restricted air cleaner.	(16) Clean or replace air cleaner filler element.
	(17) Faulty choke vacuum diaphragm.	(17) Repair as necessary.
FAULTY LOW-SPEED OPERATION	(1) Restricted idle transfer slots.	(1) Clean transfer slots.
	(2) Restricted idle air vents and passages.	(2) Clean air vents and passages.
	(3) Restricted air cleaner.	(3) Clean or replace air cleaner filter element.
	(4) Improper fuel level.	(4) Adjust fuel level.
	(5) Faulty spark plugs.	(5) Clean or replace spark plugs.
	(6) Dirty, corroded, or loose ignition secondary circuit wire connections.	(6) Clean or tighten secondary circuit wire connections.
	(7) Improper feedback system operation.	(7) Refer to Feedback System Diagnosis.
	(8) Faulty ignition coil high voltage wire.	(8) Replace ignition coil high voltage wire.
	(9) Faulty distributor cap.	(9) Replace cap.

J9009-7

SERVICE DIAGNOSIS - PERFORMANCE (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
FAULTY HIGH SPEED OPERATION	(1) Incorrect ignition timing.	(1) Adjust timing.
	(2) Faulty distributor centrifugal advance mechanism.	(2) Check centrifugal advance mechanism and repair as necessary.
	(3) Faulty distributor vacuum advance mechanism.	(3) Check vacuum advance mechanism and repair as necessary.
	(4) Low fuel pump volume.	(4) Replace fuel pump.
	(5) Wrong spark plug air gap or wrong plug.	(5) Adjust air gap or install correct plug.
	(6) Faulty choke operation.	(6) Adjust choke cover.
	(7) Partially restricted exhaust manifold, exhaust pipe, catalytic converter, muffler, or tailpipe.	(7) Eliminate restriction.
	(8) Restricted vacuum passages.	(8) Clean passages.
	(9) Improper size or restricted main jet.	(9) Clean or replace as necessary.
	(10) Restricted air cleaner.	(10) Clean or replace filter element as necessary.
	(11) Faulty distributor rotor or cap.	(11) Replace rotor or cap.
	(12) Faulty ignition coil.	(12) Test coil and replace as necessary.
	(13) Improper seated valve(s).	(13) Test cylinder compression, repair as necessary.
	(14) Faulty valve spring(s).	(14) Inspect and test valve spring tension, replace as necessary.
	(15) Incorrect valve timing.	(15) Check valve timing and repair as necessary.
	(16) Intake manifold restricted.	(16) Remove restriction or replace manifold.
	(17) Worn distributor shaft.	(17) Replace shaft.
	(18) Improper feedback system operation.	(18) Refer to Feedback System Diagnosis.
INTAKE BACKFIRE	(1) Improper ignition timing.	(1) Adjust timing.
	(2) Faulty accelerator pump discharge.	(2) Repair as necessary.
	(3) Defective EGR CTO valve.	(3) Replace EGR CTO valve.
	(4) Defective TAC vacuum motor or valve.	(4) Repair as necessary.
	(5) Lean air/fuel mixture.	(5) Check float level or manifold vacuum for air leak. Remove sediment from bowl.

J9009-8

SERVICE DIAGNOSIS - PERFORMANCE (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
EXHAUST BACKFIRE	(1) Air leak into manifold vacuum.	(1) Check manifold vacuum and repair as necessary.
	(2) Faulty air injection diverter valve.	(2) Test diverter valve and replace as necessary.
	(3) Exhaust leak.	(3) Locate and eliminate leak.
PING OR SPARK KNOCK	(1) Incorrect ignition timing.	(1) Adjust timing.
	(2) Distributor centrifugal or vacuum advance malfunction.	(2) Inspect advance mechanism and repair as necessary.
	(3) Excessive combustion chamber deposits.	(3) Remove with combustion chamber cleaner.
	(4) Air leak into manifold vacuum.	(4) Check manifold vacuum and repair as necessary.
	(5) Excessively high compression.	(5) Test compression and repair as necessary.
	(6) Fuel octane rating excessively low.	(6) Try alternate fuel source.
	(7) Sharp edges in combustion chamber.	(7) Grind smooth.
	(8) EGR Valve not functioning properly.	(8) Test EGR System and replace as necessary.
SURGING (AT CRUISING TO TOP SPEEDS)	(1) Low carburetor fuel level.	(1) Adjust fuel level.
	(2) Low fuel pump pressure or volume.	(2) Replace fuel pump.
	(3) Metering rod(s) not adjusted properly (BBD Model Carburetor).	(3) Adjust metering rod.
	(4) Improper PCV valve air flow.	(4) Test PCV valve and replace as necessary.
	(5) Air leak into manifold vacuum.	(5) Check manifold vacuum and repair as necessary.
	(6) Incorrect spark advance.	(6) Test and replace as necessary.
	(7) Restricted main jet(s).	(7) Clean main jet(s).
	(8) Undersize main jet(s).	(8) Replace main jet(s).
	(9) Restricted air vents.	(9) Clean air vents.
	(10) Restricted fuel filter.	(10) Replace fuel filter.
	(11) Restricted air cleaner.	(11) Clean or replace air cleaner filter element.
	(12) EGR valve not functioning properly.	(12) Test EGR System and replace as necessary.
	(13) Improper feedback system operation.	(13) Refer to Feedback System Diagnosis.

J9009-9

SERVICE DIAGNOSIS - PERFORMANCE (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
FAULTY ACCELERATION	(1) Improper accelerator pump stroke.	(1) Adjust accelerator pump stroke.
	(2) Incorrect ignition timing.	(2) Adjust timing.
	(3) Inoperative pump discharge check ball or needle.	(3) Clean or replace as necessary.
	(4) Worn or damaged pump diaphragm or piston.	(4) Replace diaphragm or piston.
	(5) Leaking carburetor main body cover gasket.	(5) Replace gasket.
	(6) Engine cold and choke set too lean.	(6) Adjust choke cover.
	(7) Improper metering rod adjustment (BBD Model carburetor).	(7) Adjust metering rod.
	(8) Faulty spark plug(s).	(8) Clean or replace spark plug(s).
	(9) Improperly seated valves.	(9) Test cylinder compression, repair as necessary.
	(10) Faulty ignition coil.	(10) Test coil and replace as necessary.
	(11) Improper feedback system operation.	(11) Refer to Feedback System Diagnosis.
POWER NOT UP TO NORMAL	(1) Incorrect ignition timing.	(1) Adjust timing.
	(2) Faulty distributor rotor.	(2) Replace rotor.
	(3) Trigger wheel loose on shaft.	(3) Reposition or replace trigger wheel.
	(4) Incorrect spark plug gap.	(4) Adjust gap.
	(5) Faulty fuel pump.	(5) Replace fuel pump.
	(6) Incorrect valve timing.	(6) Check valve timing and repair as necessary.
	(7) Faulty ignition coil.	(7) Test coil and replace as necessary.
	(8) Faulty ignition wires.	(8) Test wires and replace as necessary.
	(9) Improperly seated valves.	(9) Test cylinder compression and repair as necessary.
	(10) Blown cylinder head gasket.	(10) Replace gasket.
	(11) Leaking piston rings.	(11) Test compression and repair as necessary.
	(12) Worn distributor shaft.	(12) Replace shaft.
	(13) Improper feedback system operation.	(13) Refer to Feedback System Diagnosis.

J9009-10

SERVICE DIAGNOSIS - PERFORMANCE (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
MISFIRE AT ALL SPEEDS	(1) Faulty spark plug(s).	(1) Clean or replace spark plug(s).
	(2) Faulty spark plug wire(s).	(2) Replace as necessary.
	(3) Faulty distributor cap or rotor.	(3) Replace cap or rotor.
	(4) Faulty ignition coil.	(4) Test coil and replace as necessary.
	(5) Primary ignition circuit shorted or open intermittently.	(5) Troubleshoot primary circuit and repair as necessary.
	(6) Improperly seated valve(s).	(6) Test cylinder compression, repair as necessary.
	(7) Faulty hydraulic tappet(s).	(7) Clean or replace tappet(s).
	(8) Improper feedback system operation.	(8) Refer to Feedback System Diagnosis.
	(9) Faulty valve spring(s).	(9) Inspect and test valve spring tension, repair as necessary.
	(10) Worn camshaft lobes.	(10) Replace camshaft.
	(11) Air leak into manifold.	(11) Check manifold vacuum and repair as necessary.
	(12) Improper carburetor adjustment.	(12) Adjust carburetor.
	(13) Fuel pump volume or pressure low.	(13) Replace fuel pump.
	(14) Blown cylinder head gasket.	(14) Replace gasket.
	(15) Intake or exhaust manifold passage(s) restricted.	(15) Pass chain through passage(s) and repair as necessary.
	(16) Incorrect trigger wheel installed in distributor.	(16) Install correct trigger wheel.

J9009-11

SERVICE DIAGNOSIS - PERFORMANCE (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
HARD STARTING (ENGINE CRANKS NORMALLY)	(1) Binding linkage, choke valve or choke piston.	(1) Repair as necessary.
	(2) Restricted choke vacuum diaphragm.	(2) Clean passages.
	(3) Improper fuel level.	(3) Adjust float level.
	(4) Dirty, worn or faulty needle valve and seat.	(4) Repair as necessary.
	(5) Float sticking.	(5) Repair as necessary.
	(6) Faulty fuel pump.	(6) Replace fuel pump.
	(7) Incorrect choke cover adjustment.	(7) Adjust choke cover.
	(8) Inadequate choke unloader adjustment.	(8) Adjust choke unloader.
	(9) Faulty ignition coil.	(9) Test and replace as necessary.
	(10) Improper spark plug gap.	(10) Adjust gap.
	(11) Incorrect ignition timing.	(11) Adjust timing.
	(12) Incorrect valve timing.	(12) Check valve timing; repair as necessary.

J9009-12

CYLINDER COMPRESSION PRESSURE TEST

The results of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.

Ensure the battery is completely charged and the starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnosis purposes.

Clean the spark plug recesses with compressed air.

Remove the spark plugs.

Secure the throttle in the wide-open position.

Insert a compression pressure gauge and rotate the engine with the starter motor for three revolutions.

Record the compression pressure on the third revolution. Continue the test for the remaining cylinders.

Refer to the Specifications chart for the correct engine compression pressures.

CYLINDER HEAD GASKET FAILURE DIAGNOSIS

A leaking cylinder head gasket usually results in a loss of power, loss of coolant and engine misfire.

A cylinder head gasket leak can be located between adjacent cylinders or between a cylinder and the adjacent water jacket.

A cylinder head gasket leaking between two adjacent cylinders is indicated by a loss of power and/or engine misfire.

A cylinder head gasket leaking between a cylinder and an adjacent water jacket is indicated by coolant foaming or overheating and loss of coolant.

Cylinder-to-Cylinder Leakage Test

To determine if a cylinder head gasket is leaking between any two adjacent cylinders, follow the procedures outlined in Cylinder Compression Pressure Test. A cylinder head gasket leaking between two adjacent cylinders will result in approximately a 50-70% reduction in compression pressure (in comparison to the other cylinders) in the two affected cylinders.

Cylinder-to-Water Jacket Leakage Test

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

Remove the radiator cap.

Start the engine and allow it to warm up until the thermostat opens.

If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.

If bubbles are not visible, install a radiator pressure tester and pressurize the coolant system.

If a cylinder is leaking combustion pressure into the water jacket, the tester pointer will pulsate with every combustion stroke of the cylinder.

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

The combustion pressure leakage test provides an accurate means for determining engine condition.

Combustion pressure leakage testing will ascertain exhaust and intake valve leaks (improper seating), leaks between adjacent cylinders or into the water jacket, or any causes for combustion/compression pressure loss.

WARNING: DO NOT REMOVE THE RADIATOR CAP WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

Check the coolant level and fill as required. Do not install the radiator cap.

Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

Position the carburetor fast idle speed adjustment screw on the top step of the fast idle cam.

Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1 379 kPa (200 psi) maximum, and 552 kPa (80 psi) recommended.

Perform the test procedures on each cylinder according to the tester manufacturer's instructions. While testing, listen for pressurized air escaping through the carburetor, tailpipe and oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25 percent leakage. For example, at 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

Refer to the Cylinder Combustion Pressure Leakage Test Diagnosis (Fig. 1).

INTAKE MANIFOLD LEAKAGE DIAGNOSIS

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more cylinders may not be functioning.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

METHOD 1

(1) Start the engine.

(2) Open the acetylene valve of an oxyacetylene torch. Do not ignite.

(3) Pass the torch tip over the exposed gasket area (EDGE) between the manifold and the cylinder head.

(4) If the engine speed increases, the manifold has an air leak.

METHOD 2

(1) Start the engine.

(2) Apply engine oil to the exposed gasket area (EDGE) between the manifold and the cylinder head.

(3) If oil is forced into the manifold and if smoke is visible from the exhaust tailpipe, the manifold has an air leak.

CONDITION	POSSIBLE CAUSE	CORRECTION
AIR ESCAPES THROUGH CARBURETOR/THROTTLE BODY	Intake valve not seated properly.	Inspect valve. Reface or replace, if necessary.
AIR ESCAPES THROUGH TAILPIPE	Exhaust valve not seated properly.	Inspect valve.Reface or replace, if necessary.
AIR ESCAPES THROUGH RADIATOR	Head gasket leaks or crack in cylinder block.	Remove cylinder head and inspect. Replace, if necessary.
MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS	Head gasket leaks or crack in cylinder block or head between adjacent cylinders.	Remove cylinder head and inspect. Replace gasket or head, if necessary.
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	Stuck or broken piston ring(s); cracked piston; worn rings and/or cylinder wall.	Inspect for broken ring(s) or piston. Measure ring gap and cylinder diameter, taper, and out-of-round. Replace affected part, if necessary.

J8909-78

Fig. 1 Cylinder Combustion Pressure Leakage Test Diagnosis

2.5L ENGINE SERVICE PROCEDURES

INDEX

ENGINE FRONT MOUNTS — 2.5L

Resilient rubber cushions support the engine at each side on the centerline of the engine (Fig. 1).

Removal

(1) Disconnect the battery negative cable.

(2) Remove the nut from the through bolt. Do not remove the through bolt.

(3) Remove the retaining bolts from the engine mount cushions.

(4) Raise the vehicle.

(5) Support the engine.

(6) Remove the through bolt.

(7) Remove the engine mount cushions.

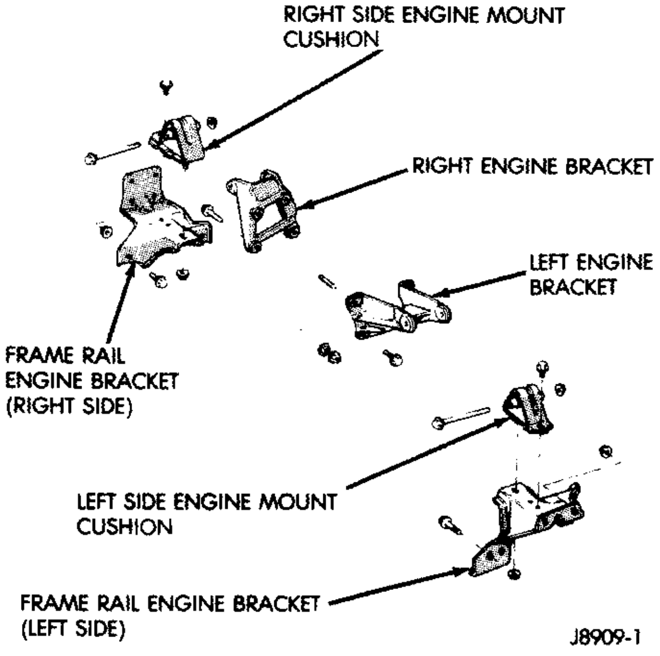


Fig. 1 Engine Front Mounts

Installation

(1) Place the engine mount cushion into position.

(2) Install the through bolt and the retaining nut.

(3) Remove the engine support.

(4) Lower the vehicle.

(5) Install the engine mount cushion retaining bolt and nut. Tighten the retaining bolt to 40 N•m (30 ft. lbs.) torque. Tighten the through bolt nut to 65 N•m (48 ft. lbs.) torque.

(6) Connect the battery negative cable.

ENGINE REAR MOUNT — 2.5L

A resilient rubber cushion supports the transmission at the rear between the transmission extension housing and the rear support crossmember (Fig. 2).

Removal

(1) Disconnect the battery negative cable.

(2) Raise the vehicle and support the transmission.

(3) Remove the rear engine mount cushion-to-crossmember nuts and bolts. Remove the crossmember-to-frame retaining nuts and bolts.

(4) Remove the crossmember.

(5) Remove the rear engine mount cushion-to-support bracket nuts.

(6) Remove the rear engine mount cushion.

Installation

(1) Attach the rear engine mount cushion-to-support bracket. Tighten the nuts to 43 N•m (32 ft. lbs.) torque.

(2) Install the crossmember. Tighten the nuts and bolts to 41 N•m (30 ft. lbs.) torque.

(3) Install the rear engine mount cushion-to-crossmember retaining nuts. Tighten the retaining nuts to 19 N•m (14 ft. lbs.) torque.

(4) Remove the transmission support.

(5) Lower the vehicle.

(6) Connect the battery negative cable.

ENGINE DAMPER — 2.5L

Removal

(1) Disconnect the battery negative cable.

(2) Remove the top and bottom damper nuts (Fig. 3).

(3) Remove the outer retainers and bushings (Fig. 3).

(4) Remove the top damper bracket nut and bolts (Fig. 3).

(5) Remove the bracket, inner retainers, bushings and the damper (Fig. 3).

Installation

(1) Install the damper on the lower bracket with the lower inner retainer and bushing in place.

(2) Install the upper inner retainer and bushing on the top of the damper.

(3) Position the upper damper bracket over the damper and install the stud nut and bolts.

(4) Tighten the stud nut to 23 N•m (17 ft. lbs.) torque and tighten the bracket bolts to 61 N•m (45 ft. lbs.) torque.

(5) Install the bushing, upper outer retainer and damper nut.

(6) Install the bushing, lower outer retainer and damper nut.

(7) Tighten the upper and lower damper nuts.

(8) Connect the battery negative cable.

ENGINE ASSEMBLY — 2.5L

Removal — MJ and XJ Vehicles

(1) Disconnect the battery cables.

(2) Mark the hinge locations on the hood panel for alignment reference during installation. Remove the engine compartment lamp. Remove the hood.

WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. USE CARE TO PREVENT SCALDING BY HOT COOLANT. CAREFULLY RELEASE THE PRESSURE BEFORE REMOVING THE RADIATOR DRAINCOCK AND CAP.

(3) Do not waste reuseable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

(4) Remove the lower radiator hose.

(5) Remove the upper radiator hose (Fig. 4) and coolant recovery hose.

(6) Remove the fan shroud (Fig. 4).

(7) Disconnect the transmission fluid cooler tubing (automatic transmission).

(8) Remove the radiator/condenser (if equipped with air conditioning).

(9) Remove the fan assembly and install a 5/16 x 1/2-inch SAE capscrew through the fan pulley into the water pump flange to maintain the pulley and water pump in alignment when the crankshaft is rotated.

(10) Disconnect the heater hoses.

(11) Disconnect the throttle linkages (Fig. 5), cruise control cable (if equipped) and throttle valve rod.

(12) Disconnect the wires from the starter motor solenoid.

(13) Disconnect all fuel injection harness connections.

(14) Disconnect the fuel supply and return lines at the throttle body (Fig. 5).

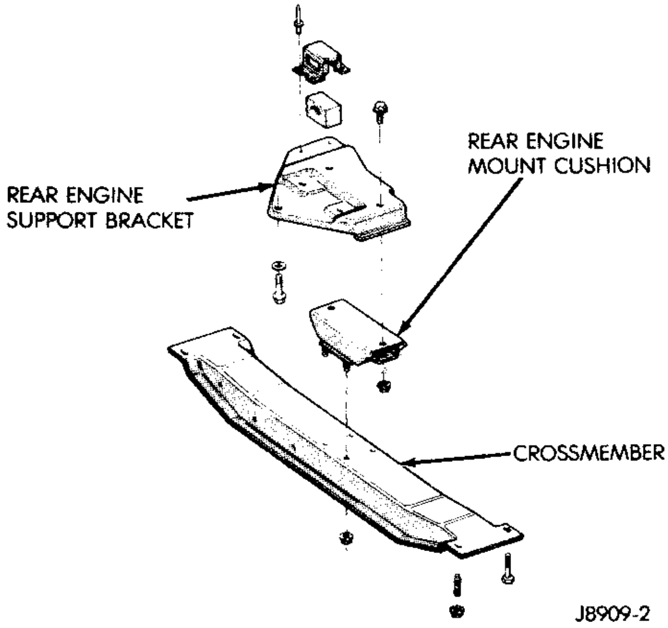


Fig. 2 Engine Rear Mount

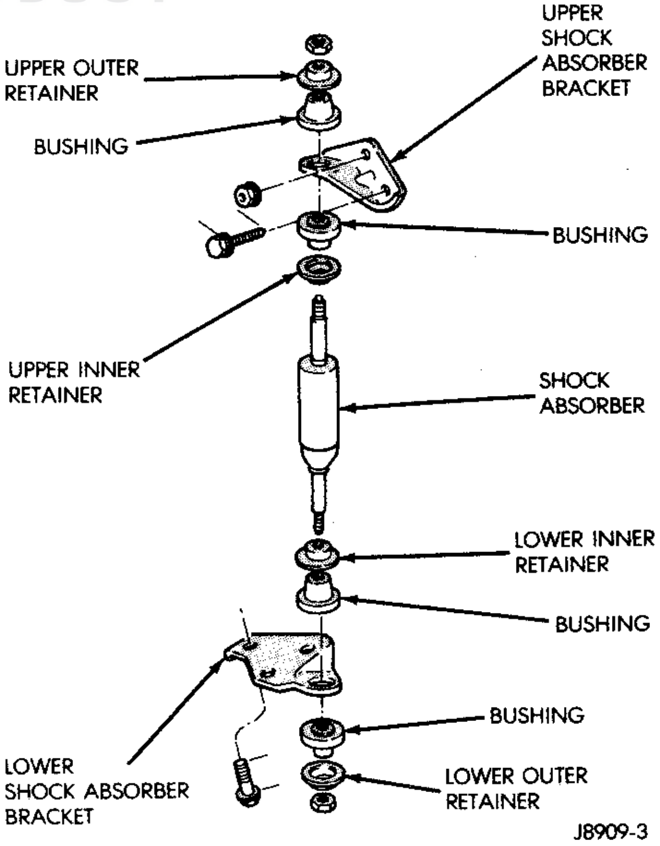


Fig. 3 Engine Damper

(15) If equipped with air conditioning, remove the service valves and cap the compressor ports.

(16) Remove the power brake vacuum check valve from the booster, if equipped.

(17) If equipped with power steering:

(a) Disconnect the power steering hoses from the fittings at the steering gear.

(b) Drain the pump reservoir.

(c) Cap the fittings on the hoses and steering gear to prevent foreign material from entering the system.

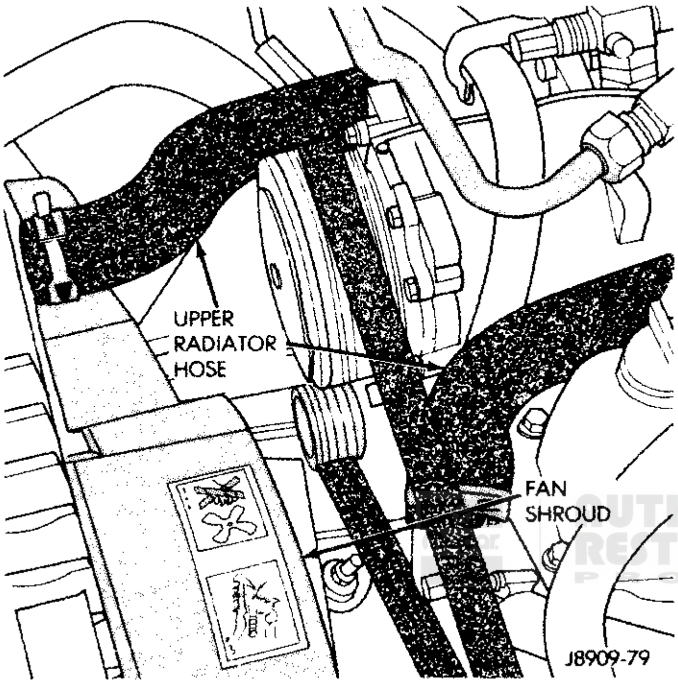


Fig. 4 Upper Radiator Hose and Fan Shroud

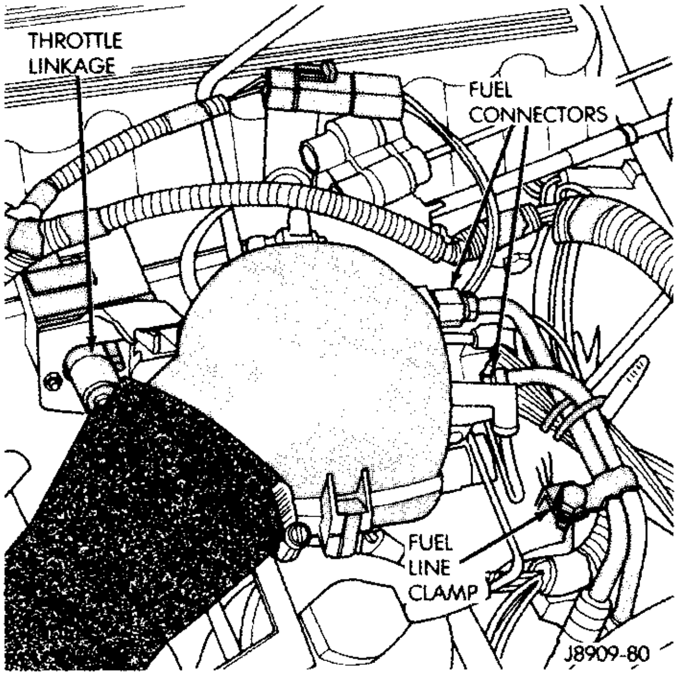


Fig. 5 Throttle Linkage and Fuel Connectors

(18) Identify, tag and disconnect all necessary wire connectors and vacuum hoses.

(19) Raise the vehicle.

(20) Remove the starter motor.

(21) Disconnect the exhaust downpipe from the exhaust manifold.

(22) Remove the flywheel/converter housing access cover.

(23) If equipped with an automatic transmission, mark the converter and drive plate location in reference to each other and remove the converter-to-drive plate bolts.

(24) Remove the upper flywheel/converter housing bolts and loosen the bottom bolts.

(25) Remove the engine mount cushion-to-engine compartment bracket bolts.

(26) Remove the engine shock damper bracket from the sill.

(27) Lower the vehicle.

(28) Attach a lifting device to the engine.

(29) Raise the engine slightly off the front supports.

(30) Place a support stand under the converter or flywheel housing.

(31) Remove the remaining bottom converter or flywheel housing bolts.

(32) Lift the engine out of the engine compartment.

Installation — MJ and XJ Vehicles

(1) Lower the engine into the engine compartment. **For easier installation, it may be useful to remove the engine mount cushions from the engine mount brackets as an aide for alignment of the engine-to-transmission.**

(2) If equipped with a manual transmission:

(a) Insert the transmission shaft into the clutch spline.

(b) Align the flywheel housing with the engine.

(c) Install and tighten the flywheel housing lower bolts finger tight.

(3) If equipped with an automatic transmission:

(a) Align the transmission torque converter housing with the engine.

(b) Loosely install the converter housing lower bolts and install the next higher bolt and nut on each side.

(c) Tighten all four bolts finger-tight.

(4) Install the engine mount cushions (if removed).

(5) Lower the engine and engine mount cushions onto the engine compartment brackets.

(6) Remove the engine lifting device.

(7) Raise the vehicle.

(8) If equipped with an automatic transmission:

(a) Install the converter-to-drive plate bolts. Ensure the installation reference marks are aligned. Tighten the bolts to 54 N•m (40 ft. lbs.) torque.

(b) Install the converter-housing access cover.

(c) Install the exhaust pipe support.

(9) Install the remaining converter or flywheel housing bolts.

(10) Install the starter motor and connect the cable. Tighten the bolts to 45 N•m (33 ft. lbs.) torque.

(11) Tighten the engine mount cushing-to-bracket through bolts to 65 N•m (48 ft. lbs.) torque.

(12) Install the remaining flywheel/converter housing bolts. Tighten the bolts to 38 N•m (28 ft. lbs.) torque.

(13) Connect the exhaust downpipe to the manifold.

(14) Lower the vehicle.

(15) Connect the coolant hoses and tighten the clamps.

(16) Connect the power steering pressure hoses to the steering gear. Tighten the nut to 52 N•m (38 ft. lbs.) torque.

(17) Remove the pulley-to-water pump flange alignment capscrew and install the fan and spacer or Tempatrol fan assembly.

(18) Install the fan shroud and radiator/condenser (if equipped with air conditioning).

(19) Connect the radiator hoses.

(20) Connect the automatic transmission fluid cooler pipes, if equipped.

(21) Connect the throttle valve rod and retainer. Connect the throttle cable and install the rod. Install the throttle valve rod spring.

(22) Connect the cruise control cable, if equipped.

(23) Connect the fuel supply and return lines to the throttle body.

(24) Connect all the vacuum hoses and wire connectors.

(25) Connect the CEC System wire harness connector at the solenoid.

(26) Connect the service valves to the A/C compressor ports, if equipped with air conditioning.

(27) Fill the power steering reservoir.

(28) Connect the battery cables.

(29) Install the hood.

(30) Install the air cleaner.

(31) Start the engine, inspect for leaks and correct the fluid levels, as necessary.

Removal — YJ Vehicles

(1) The engine is removed separate from the transmission.

WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. USE CARE TO PREVENT SCALDING BY HOT COOLANT. CAREFULLY RELEASE THE PRESSURE BEFORE REMOVING THE RADIATOR DRAINCOCK AND CAP.

(2) Remove the radiator draincock and radiator cap to drain the coolant. Do not waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

(3) Place a protective cloth over the windshield frame and raise the hood and rest it on the windshield frame (Fig. 6).

(4) Disconnect the battery cable clamps and remove the battery.

(5) Disconnect the wire connectors from the alternator.

(6) Disconnect the ignition coil and distributor wire connectors.

(7) Disconnect the oil pressure sender wire connector.

(8) Disconnect the wires at the starter motor solenoid and injection wire harness connector.

(9) Disconnect the fuel pipes at the fuel line quick connect coupling at left inner fender panel (Fig. 7).

(10) Disconnect the engine ground strap.

(11) Remove the air cleaner.

(12) Disconnect the vacuum purge hose at the fuel vapor canister tee.

(13) Disconnect the idle speed actuator wire connector.

(14) Disconnect the throttle cable (Fig. 8) and remove it from the bracket.

(15) Disconnect the throttle rod at the bellcrank.

(16) Disconnect the oxygen (O_2) sensor wire connector.

(17) Disconnect the upper (Fig. 8) and lower radiator hoses at the radiator.

(18) Disconnect the coolant hoses from the rear of the intake manifold and thermostat housing.

(19) Remove the fan shroud screws.

(20) Remove the radiator attaching bolts.

(21) Remove the radiator and fan shroud (Fig. 8).

(22) Remove the fan and spacer or Tempatrol fan assembly.

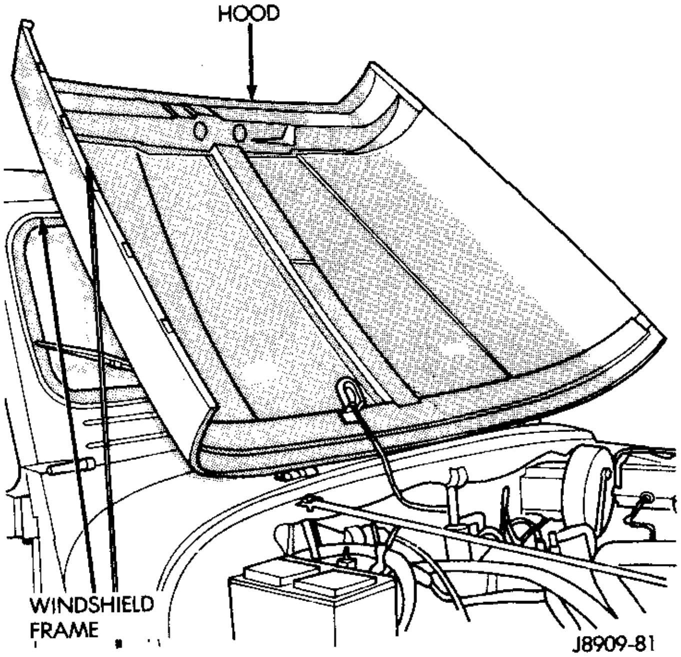


Fig. 6 Hood on Windshield Frame

(23) Install a 5/16 X 1/2-inch SAE capscrew through the fan pulley into the water pump flange to maintain the pulley and water pump in alignment when the crankshaft is rotated.

(24) Remove the power brake vacuum check valve from the booster, if equipped.

(25) If equipped with power steering:

(a) Disconnect the power steering hoses from the fittings at the steering gear.

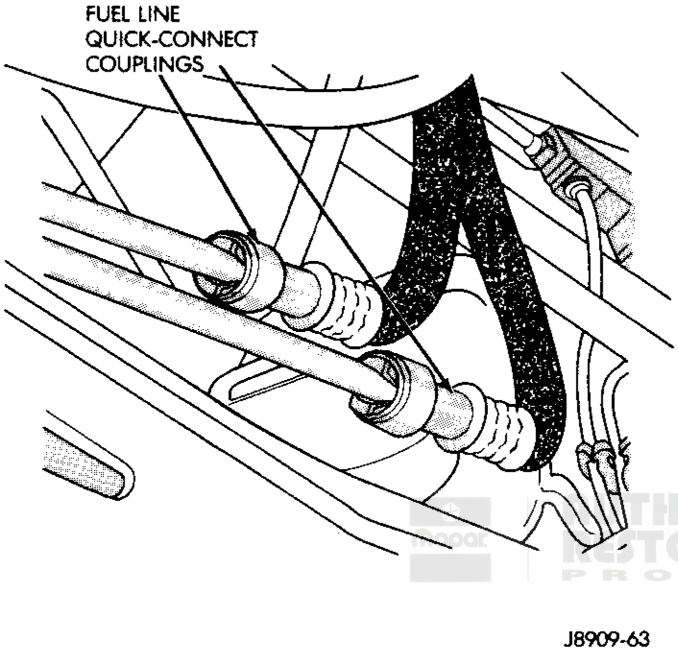


Fig. 7 Fuel Line Quick-Connect Couplings

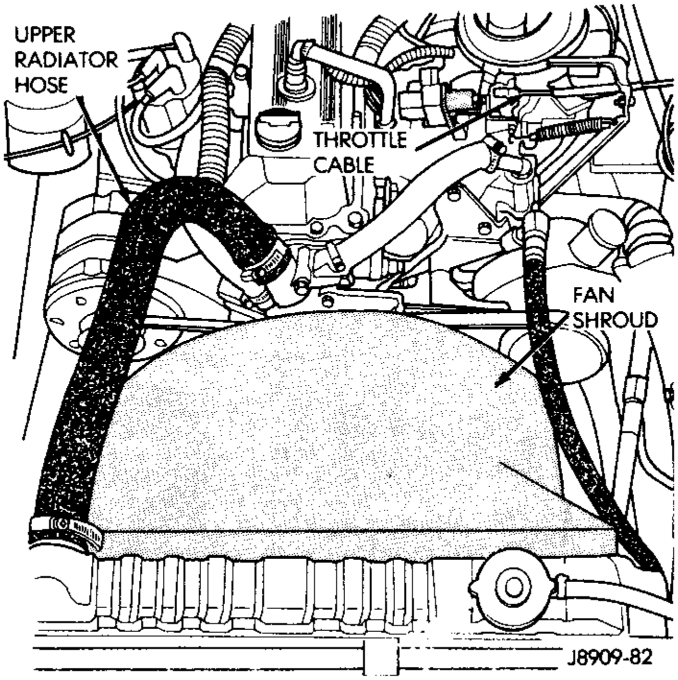


Fig. 8 Throttle Cable/Upper Radiator Hose/Fan Shroud

(b) Drain the power steering pump reservoir and cap the fittings on the hoses and steering gear to prevent foreign objects from entering the system.

(26) Lift the vehicle and support it with support stands.

(27) Remove the starter motor.

(28) Remove the flywheel housing access cover.

(29) Remove the engine mount cushion-to-bracket through bolts.

(30) Disconnect the exhaust downpipe from the manifold.

(31) Remove the upper flywheel housing bolts and loosen the bottom bolts.

(32) Lower the vehicle.

(33) Attach a lifting device to the engine.

(34) Raise the engine off the front supports.

(35) Place a support stand under the flywheel housing.

(36) Remove the remaining flywheel housing bolts.

(37) Lift the engine out of the engine compartment.

Installation — YJ Vehicles

(1) Lower the engine into the engine compartment. **For easier installation, it may be useful to remove the engine mount cushions from the engine mount brackets as an aide for alignment of the engine-to-transmission.**

(2) Insert the transmission shaft into the clutch spline.

(3) Align the flywheel housing with the engine.

(4) Install and finger tighten the flywheel housing lower bolts.

(5) Install the engine mount cushions (if removed).

(6) Remove the support stand fron beneath the flywheel housing.

(7) Lower the engine and engine mount cushions onto the engine compartment brackets. Ensure that the bolt holes are aligned. Install the bolts and tighten to 65 N•m (48 ft. lbs.) torque.

(8) Remove the engine lifting device.

(9) Raise the vehicle.

(10) Attach the exhaust downpipe to the manifold. Install and tighten the nuts to 31 N•m (23 ft. lbs.) torque.

(11) Install the flywheel housing access cover.

(12) Install the remaining flywheel housing bolts. Tighten the bolts to 38 N•m (28 ft. lbs.) torque.

(13) Install the starter motor and connect the cable. Tighten the bolts to 45 N•m (33 ft. lbs.) torque.

(14) Lower the vehicle.

(15) Connect the coolant hoses and tighten the clamps.

(16) Connect the power steering pressure hoses to the steering gear. Tighten the nut to 52 N•m (38 ft. lbs.) torque.

(17) Remove the pulley-to-water pump flange alignment capscrew and install the fan and spacer or Tempatrol fan assembly.

(18) Tighten the drive belts according to the specifications listed in Group 7, Cooling System.

(19) Install the fan shroud and radiator.

(20) Connect the radiator hoses.

(21) Connect the throttle valve rod and retainer.

(22) Connect the throttle cable and install the rod.

(23) Install the throttle valve rod spring.

(24) Connect the cruise control cable, if equipped.

(25) Connect the oxygen (O_2) sensor wire connector.

(26) Install the vacuum hose and check valve on the brake booster.

(27) Connect the coolant temperture sensor wire connector.

(28) Connect the idle speed actuator wire connector.

(25) Connect the fuel inlet and return hoses at the quick-connect fuel lines (Fig. 7). Verify that the quick-connect fitting assembly fits securely over the fuel lines by giving the fuel lines a firm tug.

(26) Connect all fuel injection wire connections.

(27) Install the engine ground strap.

(28) Connect the ignition coil wire connector.

(29) Remove the coolant temperature sending unit to permit air to escape from the block. Fill the cooling system with coolant. Install the coolant temperature sending unit when the system is filled.

(30) Fill the power steering pump reservoir with fluid.

(31) Install the battery and connect the battery cables.

(32) Install the air cleaner bonnet to the throttle body.

(33) Install the air cleaner.

(34) Start the engine and inspect for leaks. Stop the engine and check the all fluid levels. Add fluid, as required.

CYLINDER HEAD COVER — 2.5L

The following procedure can be performed with the engine in the vehicle or with the engine out of the vehicle.

Removal

(1) Disconnect the battery negative cable.

(2) Disconnect the Crankcase Ventilation (CCV) vacuum hose (MJ and XJ Vehicles - Fig. 1) or the Positive Crankcase Ventilation (PCV) vacuum hose (YJ Vehicles - Fig. 2) from cylinder head cover.

(3) Disconnect the CCV (Fig. 1) or the PCV (Fig. 2) fresh air inlet hose from the cylinder head cover.

(4) Remove the cylinder head cover mounting bolts.

(5) Remove the cylinder head cover.

Inspection

Inspect the cylinder head cover for cracks. Replace the cover, if cracked.

Installation

The cylinder head covers have a cured gasket attached to them.

(1) Thoroughly clean the sealing surface of the cylinder head and the seal on the cylinder head cover.

(2) Install cylinder head cover. Tighten the mounting bolts to 8 N•m (70 in.-lbs) torque.

(3) Connect the CCV hoses (Fig. 1) or the PCV hoses (Fig. 2).

(4) Connect the battery negative cable.

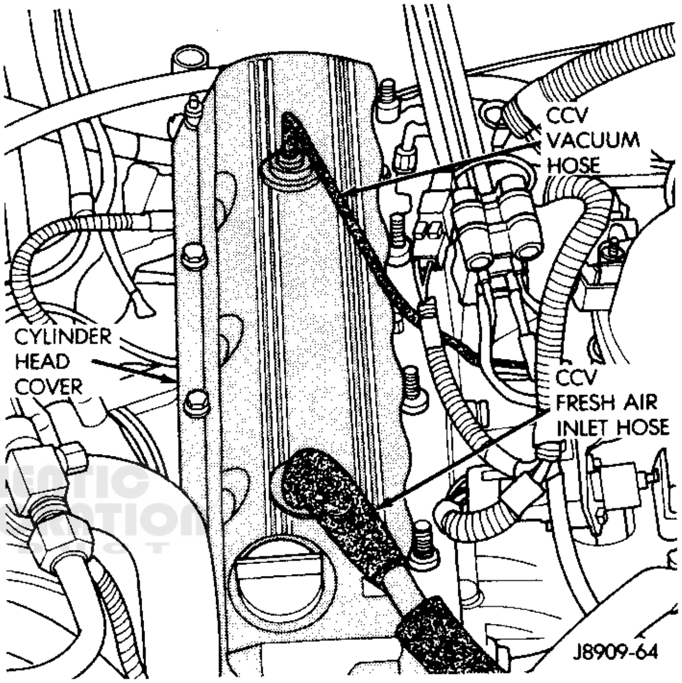


Fig. 1 Cylinder Head Cover — MJ and XJ Vehicles

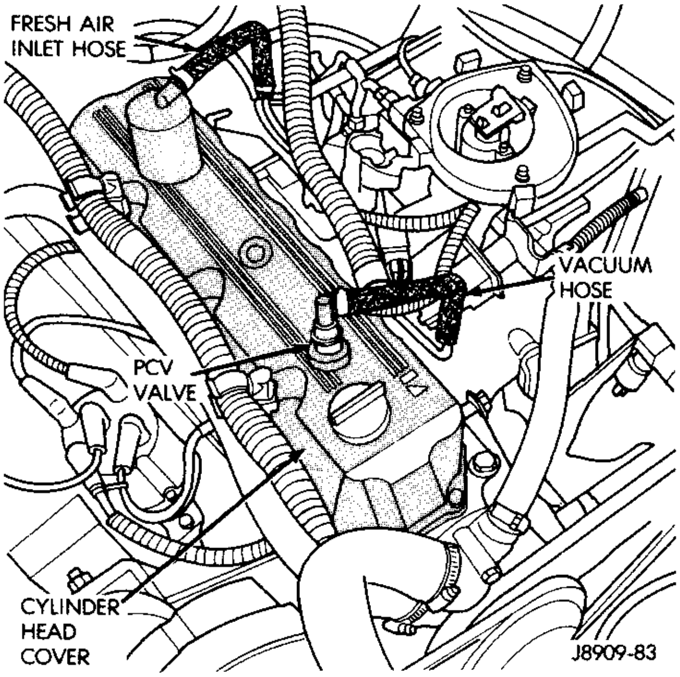


Fig. 2 Cylinder Head Cover — YJ Vehicles

ROCKER ARMS — 2.5L

The following procedure can be performed with the engine in the vehicle or with the engine out of the vehicle.

Removal

(1) Remove the cylinder head cover (see Cylinder Head Cover - Removal).

(2) Remove the two capscrews at each bridge and pivot assembly (Fig. 3). Alternately loosen the capscrews one turn at a time to avoid damaging the bridges.

(3) Check for rocker arm bridges which are causing misalignment of the rocker arm to valve tip area.

(4) Remove the bridges, pivots and corresponding pairs of rocker arms (Fig. 3) and place them on the bench in the same order as removed.

(5) Remove the pushrods and place them on the bench in the same order as removed.

Cleaning and Inspection

Clean all the components with cleaning solvent and use compressed air to blow out the oil passages in the rocker arms and push rods.

Inspect the pivot surface area of each rocker arm. Replace any that are scuffed, pitted, cracked or excessively worn.

Inspect the valve stem tip contact surface of each rocker arm and replace any rocker arm that is deeply pitted.

Inspect each push rod end for excessive wear and replace as required. If any push rod is excessively worn because of lack of oil, replace it and inspect the corresponding hydraulic tappet for excessive wear.

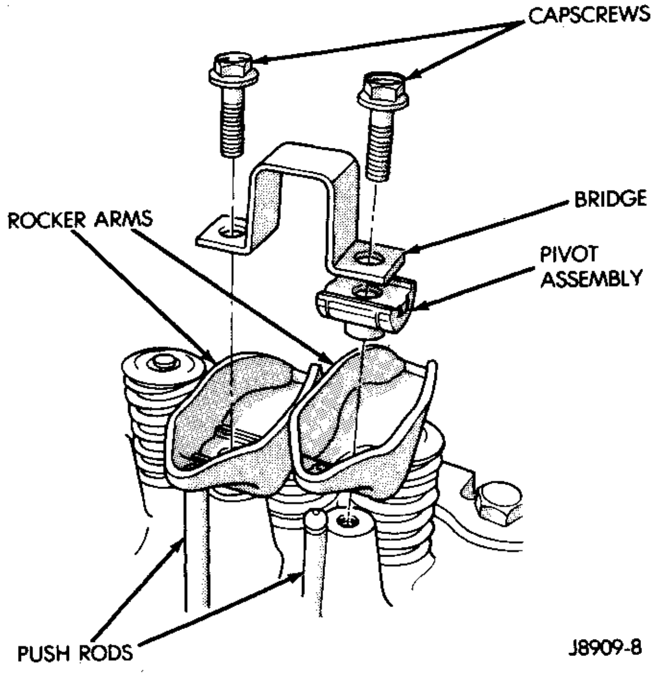


Fig. 3 Rocker Arm Components

Inspect the push rods for straightness by rolling them on a flat surface or by shining a light between the push rod and the flat surface.

A wear pattern along the length of the push rod is not normal. Inspect the cylinder head for obstruction if this condition exists.

Installation

(1) Lubricate the ball ends of the push rods with Jeep/Eagle Super Oil Conditioner or equivalent and install push rods in their original locations. Ensure that the bottom end of each push rod is centered in the tappet plunger cap seat.

(2) Lubricate the area of the rocker arm that the pivot contacts with Jeep/Eagle Super Oil Conditioner or equivalent and install rocker arms, pivots and bridge above each cylinder from where they were originally removed.

(3) Loosely install capscrews through each bridge.

(4) At each bridge, tighten the capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(5) Install the cylinder head cover (see Cylinder Head Cover - Installation).

CYLINDER HEAD — 2.5L

The following procedure can be performed with the engine in the vehicle or with the engine out of the vehicle.

Removal

(1) Disconnect the battery negative cable.

(2) Drain the cooling system. Refer to Group 7, Cooling System for the proper procedure.

(3) Loosen the accessory drive belt and remove the belt (see Group 7, Cooling System for the proper procedure).

(4) Without discharging the air conditioning system, remove the air conditioning compressor and stow to the side of the engine compartment.

(5) Remove the bolts that attach the air conditioning compressor mounting bracket to the cylinder head. Loosen the bolts that attach the bracket to the block.

(6) At the thermostat housing, disconnect the upper radiator hose and the heater hose.

(7) Remove the cylinder head cover (Fig. 4).

(8) Remove the rocker arms, bridges, pivots and push rods (Fig. 4).

(9) Remove the intake and exhaust manifolds (Fig. 4). Refer to Group 11, Exhaust System and Intake Manifold for the proper procedure.

(10) Remove the cylinder head bolts. If this was the first time the bolts were removed, put a paint dab on the top of the bolt. If the bolts have a paint dab on the top of the bolt or you don't know if they were used before, discard the bolts.

(11) Remove the cylinder head and gasket (Fig. 4).

Cleaning

Stuff clean lint free shop towels into the cylinder bores.

Thoroughly clean the cylinder head and cylinder block mating surfaces. Clean the intake and exhaust manifold and cylinder head mating surfaces. Remove all gasket material and carbon.

Check to ensure that no coolant or foreign material has fallen into the tappet bore area.

Remove the carbon deposits from the combustion chambers.

Inspection

Using a straight edge and feeler gauge, check the cylinder head flatness. The flatness is to be a maximum of .025 mm (.001 inch) per 25.4 mm (1.0 inch) section and no more than .051 mm (.002 inch) per 152.4 mm (6.0 inches) section.

Installation

The cylinder head gasket used on the 2.5L engine is a composition gasket. The gasket is to be installed DRY. Do not use gasket sealing compound on the gasket.

(1) Fabricate two cylinder head alignment dowels from two used head bolts (Fig. 5). Use the longest head bolt. Cut the head of the bolt off below the hex head. Then cut a slot in the top of the dowel to allow easier removal with a screwdriver.

(2) Install one dowel in bolt hole No. 10 and the other dowel in bolt hole No. 8 (Fig. 6).

(3) Place the cylinder head gasket (with the numbers facing up) over the dowels.

(4) Place the cylinder head over the dowels.

CAUTION: Cylinder head bolts should be reused only once. Replace the head bolts if they were used before or if they have a paint dab on the top of the bolt.

(5) Coat the threads of bolt No. 7, only, with Loctite PST sealant or equivalent.

(6) Install all head bolts, except No. 8 and 10.

(7) Remove the dowels.

(8) Install No. 8 and 10 head bolts.

(9) Tighten the cylinder head bolts in sequence (Fig. 7) according to the following procedure:

(a) Tighten all bolts in sequence (1 through 10) to 30 N•m (22 ft. lbs.) torque.

(b) Tighten all bolts in sequence (1 through 10) to 61 N•m (45 ft. lbs.) torque.

(c) Recheck all bolts to verify they are set to 61 N•m (45 ft. lbs.) torque.

(d) Tighten bolts (in sequence) 1 through 6 to 149 N•m (110 ft. lbs.), bolt 7 to 136 N•m (100 ft. lbs.) and bolts 8 through 10 to 149 N•m (110 ft. lbs.) torque. **During the final tightening sequence, bolt No. 7**

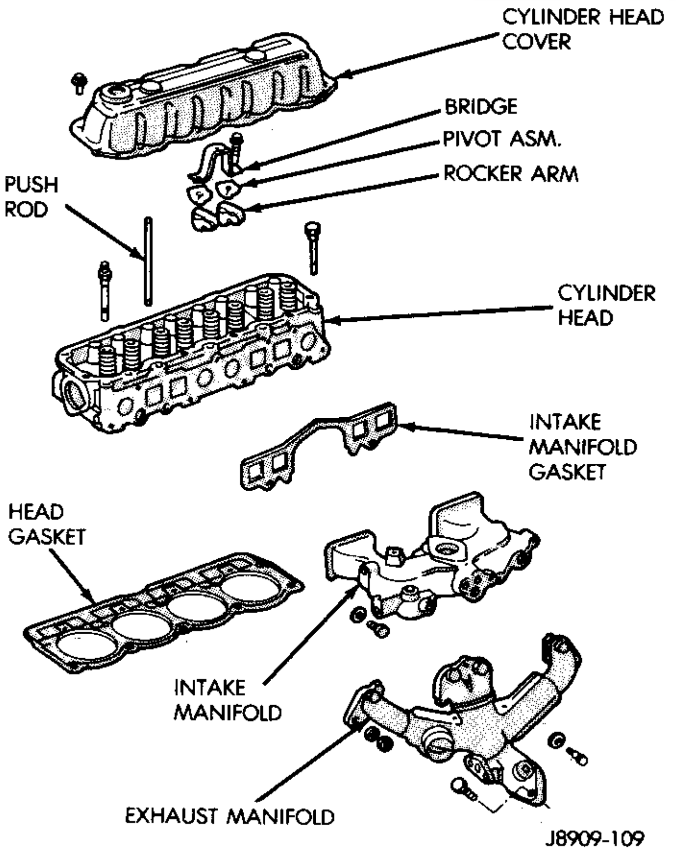


Fig. 4 Cylinder Head and Components

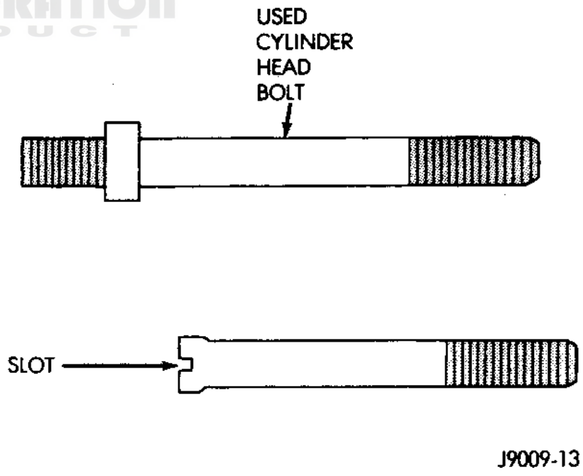


Fig. 5 Fabricate Alignment Dowels

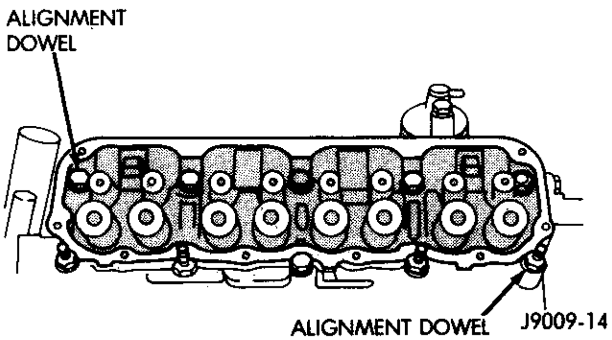


Fig. 6 Alignment Dowel Locations

will be tightened to a lower torque than the rest of the bolts. Do not overtighten bolt No. 7.

(e) Recheck all bolts in sequence to verify the correct torque.

(f) If not already done, clean and mark each bolt with a dab of paint after tightening. Should you encounter bolts which were painted in an earlier service operation, replace them.

(10) Install the push rods, rocker arms, pivots and bridges in the order they were removed.

(11) Install the cylinder head cover.

(12) Install the intake manifold, exhaust manifold and EGR tube assemblies. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedures.

(13) Connect the upper radiator hose and heater hose at the thermostat housing.

(14) Attach the air conditioning compressor mounting bracket to the cylinder head and block. Tighten the bolts to 40 N•m (30 ft. lbs.) torque.

(15) Attach the air conditioning compressor to the bracket. Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

CAUTION: The accessory drive belt must be routed correctly. Incorrect routing can cause the water pump to turn in the opposite direction causing the engine to overheat.

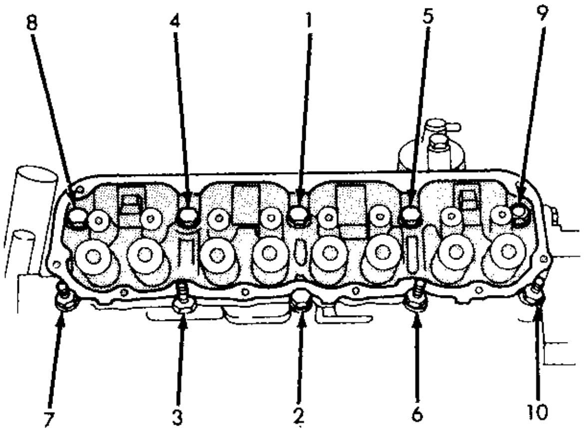
(16) Install the accessory drive belt and correctly tension the belt. Refer to Group 7, Cooling System for the proper procedure.

(17) Connect the battery negative cable.

(18) Fill the cooling system. Refer to Group 7, Cooling System for the proper procedure. Check for leaks.

VALVE SPRINGS AND OIL SEALS — 2.5L

This procedure is for the removal of valve springs and oil seals with the cylinder head installed on the cylinder block.



J9009-15

Fig. 7 Cylinder Head Bolt Tightening Sequence

Removal — Cylinder Head NOT Removed

Each valve spring is held in place around the valve stem by a retainer and a set of conical valve locks. The locks can be removed only by compressing the valve spring.

(1) Remove the cylinder head cover (see Cylinder Head Cover - Removal).

(2) Remove capscrews, bridge and pivot assemblies and rocker arms (Fig. 3) for access to each valve spring to be removed. Alternately loosen each capscrew one turn at a time to avoid damaging the bridge.

(3) Remove push rods (Fig. 3). Retain the push rods, bridges, pivots and rocker arms in the same order and position as removed.

(4) Inspect the springs and retainer for crackes and possible signs of weakening.

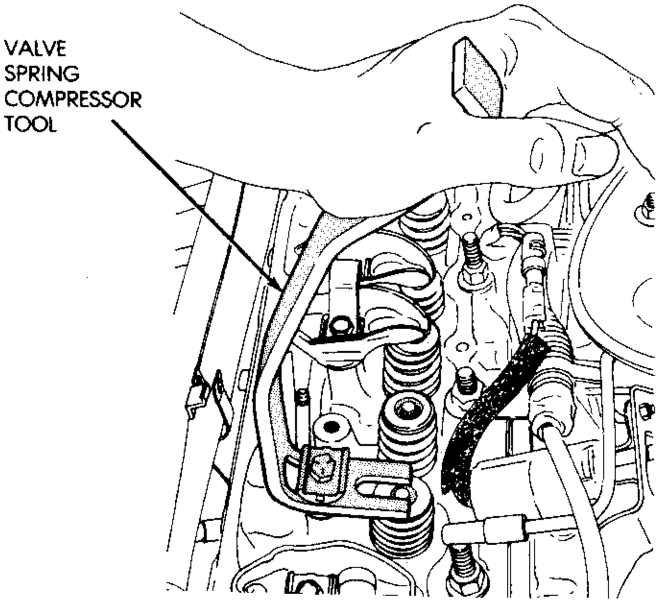
(5) Remove the spark plug(s) adjacent to the cylinder(s) below the valve springs to be removed.

(6) Install a 14 mm (1/2 inch) (thread size) air hose adaptor in the spark plug hole. An adaptor can be constructed by welding an air hose connection to the body of a spark plug with the porcelain removed.

(7) Connect an air hose to the adapter and apply air pressure slowly. Maintain at least 621 kPa (90 psi) of air pressure in the cylinder to hold the valves against their seats. For vehicles equipped with an air conditioner, use a flexible air adaptor when servicing the No. 1 cylinder.

(8) Tap the retainer or tip with a rawhide hammer to loosen the lock from the retainer. Use valve spring compressor tool (7631) to compress the spring and remove the locks (Fig. 8). Use an old rocker arm pivot and the supplied bolt to attach the tool.

(9) Remove valve spring and retainer (Fig. 8).



J8909-87

Fig. 8 Remove Valve Spring and Retainer

(10) Remove valve stem oil seals (Fig. 9). Note the valve seals are different for intake and exhaust valves. The top of each seal is marked either INT. or EXH. Do not mix the seals.

Inspection

Inspect the valve stems, especially the grooves. An Arkansas smoothstone should be used to remove nicks and high spots.

Installation — Cylinder Head NOT Removed

CAUTION: Install oil seals carefully to prevent damage from the sharp edges of the valve spring lock grove.

(1) Lightly push the valve seal over the valve stem and valve guide boss. Be sure the seal is completely seated on the valve guide boss.

(2) Install valve spring and retainer.

(3) Compress the valve spring with valve spring compressor tool (7631) and insert the valve locks. Release the spring tension and remove the tool. Tap the spring from side-to-side to ensure that the spring is seated properly on the cylinder head.

(4) Disconnect the air hose. Remove the adaptor from the spark plug hole and install the spark plug.

(5) Repeat the procedures for each remaining valve spring to be removed.

(6) Install the push rods. Ensure the bottom end of each rod is centered in the plunger cap seat of the hydraulic valve tappet.

(7) Install the rocker arms, pivots and bridge at their original location.

(8) Tighten the bridge capscrews alternately, one at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

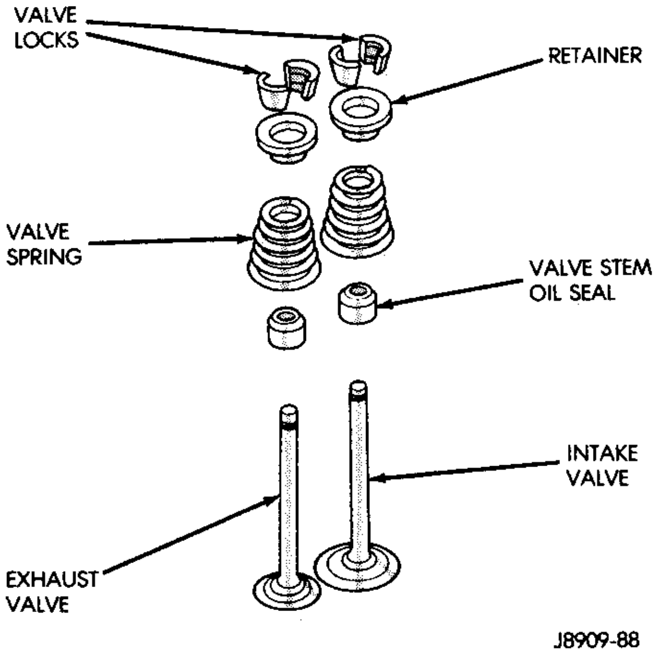


Fig. 9 Valve and Valve Components

(9) Install the cylinder head cover (see Cylinder Head Cover - Installation).

VALVE AND VALVE SPRINGS — 2.5L

This procedure is for the removal/installation of the valves and valve springs with the cylinder head removed from the cylinder block.

Removal — Cylinder Head Removed

(1) Remove the cylinder head from the cylinder block (see Cylinder Head - Removal).

(2) Use valve compressor tool (7631) or equivalent and compress each valve spring (Fig. 8).

(3) Remove the valve locks, retainers, springs and valve stem oil seals. Discard the oil seals.

(4) Use an Arkansas smooth stone or a jewelers file to remove any burrs on the top of the valve stem, especially around the groove for the locks.

(5) Remove the valves, and place them in a rack in the same order as removed.

Valve Cleaning

Clean all carbon deposits from the combustion chambers, valve ports, valve stems, valve stem guides and head.

Clean all grime and gasket material from the cylinder head machined gasket surface.

Inspection

Inspect for cracks in the combustion chambers and valve ports.

Inspect for cracks on the exhaust seat.

Inspect for cracks in the gasket surface at each coolant passage.

Inspect valves for burned, cracked or warped heads. Inspect for scuffed or bent valve stems. Replace valves displaying any damage.

Valve Refacing

(1) Use a valve refacing machine to reface the intake and exhaust valves to the specified angle. After refacing, at least a 0.787 mm (1/32 inch) margin must remain (Fig. 10). If not, replace the valve.

(2) The valve stem tip can be resurfaced and rechamfered when worn. Do not remove more than 0.25 mm (0.010 inch).

Valve Seat Refacing

(1) Install a pilot of the correct size in the valve guide bore and reface the valve seat to the specified angle with a good dressing stone (Fig. 11). Remove only enough metal to provide a smooth finish.

(2) Use tapered stones to obtain the specified seat widths when required.

(3) Control valve seat runout (Fig. 12) to a maximum of 0.0635 mm (0.0025 inch).

Valve Stem Seal Replacement

Valve stem seals are installed over each valve stem and valve guide boss preventing oil from entering the combustion chamber through the valve guides. There are separate seals for both the intake and exhaust valve stems. The seals marked INT are for intake valve stems. The seals marked EXH are for exhaust valve stems. Replace the valve stem seals when service is performed or if the seals have deteriorated.

Valve Guides

The valve guides are an integral part of the cylinder head and are not replaceable. When the valve stem guide clearance is excessive, the valve guide bores must be reamed oversize. Service valves with oversize stems are available in 0.076 mm (0.003 inch) and 0.381 mm (0.015 inch) increments. Corresponding oversize valve stem seals are also available and must be used with valves having 0.381 mm (0.015 inch) oversize stems. **If the valve guides are reamed oversize, the valve seats must be reground afterwards to ensure that the valve seat is concentric to the valve guide.**

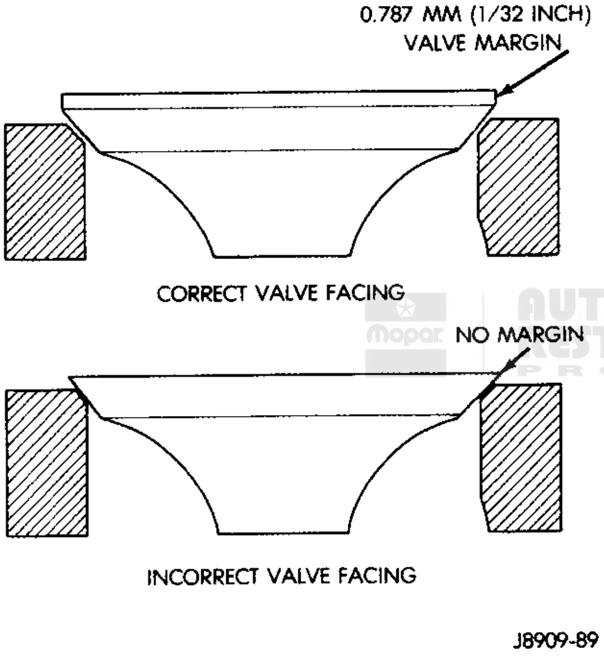


Fig. 10 Valve Facing Margin

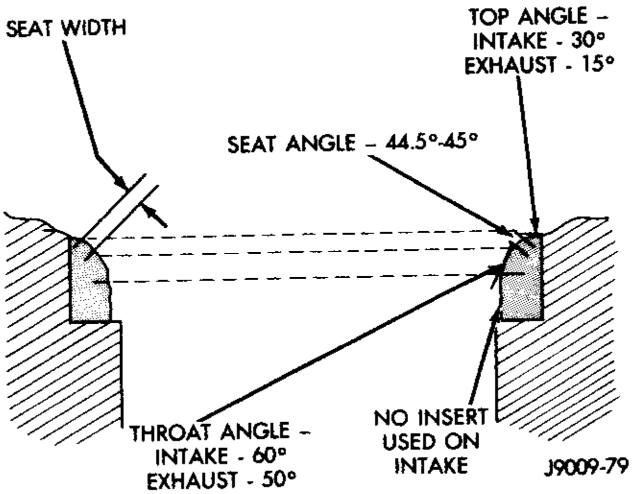


Fig. 11 Intake/Exhaust Seat Dimensions

Valve Stem-to-Guide Clearance Measurement

Valve stem-to-guide clearance may be measured by either of the following two methods.

Preferred Method:

(1) Remove the valve from the head.

(2) Clean the valve stem guide bore with solvent and bristle brush.

(3) Insert a telescoping gauge into the valve stem guide bore approximately 9.525 mm (3/8 inch) from the valve spring side of the head, with contacts crosswise to the cylinder head (Fig. 13). Remove and measure telescoping gauge with a micrometer.

(4) Repeat the measurement with contacts lengthwise to cylinder head.

(5) Compare the crosswise to lengthwise measurements to determine out-of-roundness. If the measurements differ by more than 0.0635 mm (0.0025 inch) ream the guide bore to accommodate an oversize valve stem.

(6) Compare the measured valve guide bore diameter with specifications (7.95-7.97 mm or 0.313-0.314 inch). If the measurement differs from specification by more than 0.076 mm (0.003 inch), ream the guide bore to accommodate an oversize valve stem.

Alternate Method:

(1) Use a dial indicator to measure the lateral movement of the valve stem (stem-to-guide clearance) with valve installed in its guide and just off the valve seat (Fig. 14).

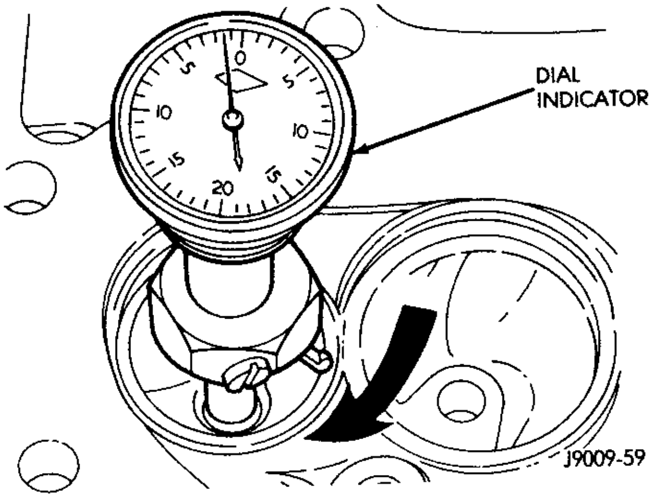


Fig. 12 Measurement of Valve Seat Runout

(2) Correct clearance is 0.025-0.0762 mm (0.001-0.003 inch). If indicated movement exceeds the specification ream the valve guide to accommodate an oversize valve stem. **Valve seats must be reground after reaming the valve guides to ensure that the valve seat is concentric to the valve guide.**

Valve Spring Tension Test

The 2.5L engines use a conical valve spring (Fig. 15).

Use the valve spring tester and a torque wrench to test each valve spring for the specified tension value (Fig. 16). Replace valve springs that are not within specification.

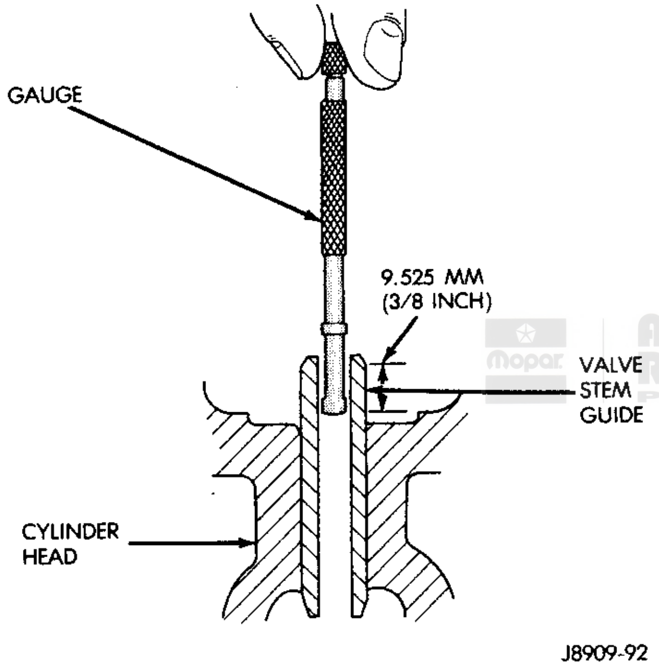


Fig. 13 Measurement of Valve Guide Bore Diameter

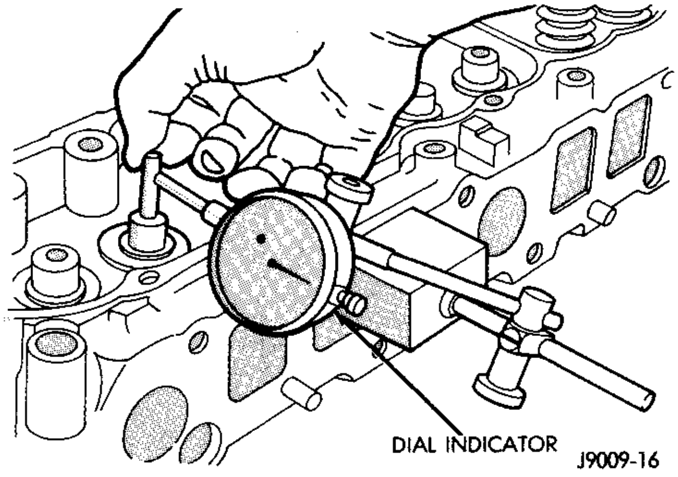


Fig. 14 Measurement of Lateral Movement Of Valve Stem

Installation — Cylinder Head Removed

(1) Thoroughly clean the valve stems and valve guide bores.

(2) Lightly lubricate the stem and install the valve in the original valve guide bore.

(3) Install replacement valve stem oil seals over the valve stems and onto the valve guide boss. **If valves with 0.381 mm (0.015 inch) oversize stems are used, oversize oil seals are required.**

(4) Position the valve spring and retainer on the cylinder head and compress the valve spring with valve spring compressor tool (7631). Install valve locks and release the tool.

(5) Lightly tap valve spring from side-to-side with rubber hammer to ensure the spring is properly seated at the cylinder head.

(6) Install the cylinder head to the cylinder block (see Cylinder Head - Installation).

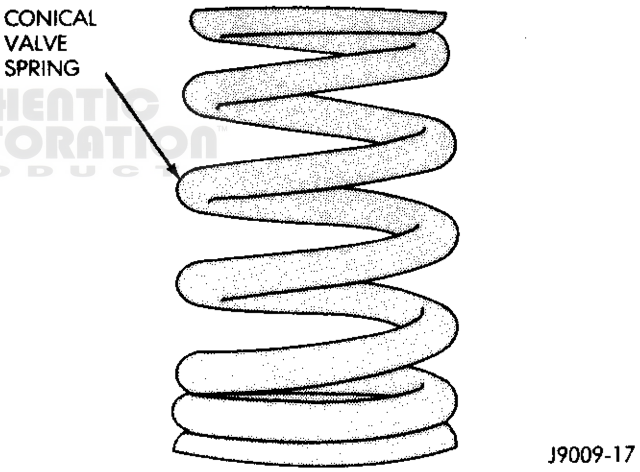


Fig. 15 Conical Valve Spring

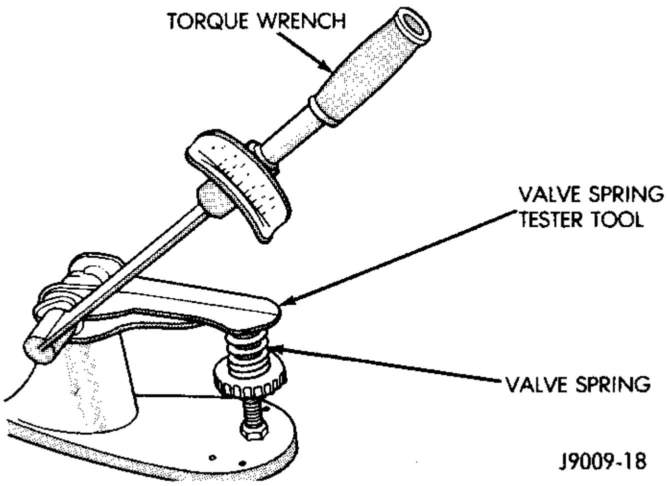


Fig. 16 Valve Spring Tester

HYDRAULIC TAPPETS — 2.5L

Removal — Cylinder Head Not Removed

(1) Remove the cylinder head cover (see Cylinder Head Cover - Removal).

(2) Remove the bridge and pivot assemblies and rocker arms by removing the two capscrews at each bridge. **Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridge.**

(3) Remove the push rods. Retain all the components in the same order as removed to facilitate installation in their original positions.

(4) Remove the tappets through the push rod openings in the cylinder head with a hydraulic valve tappet removal/installation tool - 7625 (Fig. 17).

(5) Inspect the tappets for wear. If worn, check the camshaft lobes for wear and replace if wear is found.

(6) Retain the tappets in the same order as removed to facilitate installation in their original locations.

Installation — Cylinder Head Not Removed

It is not necessary to charge the tappet assemblies with engine oil. They will charge themselves within a very short period of engine operation.

(1) Dip each tappet assembly in Jeep/Eagle Super Oil Conditioner, or equivalent.

(2) Use Hydraulic Valve Tappet Removal/Installation Tool (7625) to install each tappet in the same bore from where it was originally removed.

(3) Install the push rods in their original locations.

(4) Install the rocker arms and bridge and pivot assemblies at their original locations. Loosely install the capscrews at each bridge.

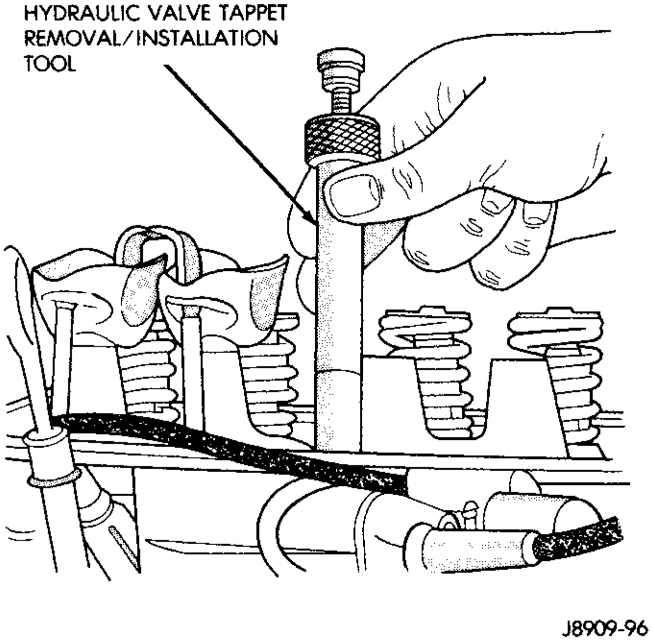


Fig. 17 Hydraulic Valve Tappet Removal/Installation Tool (7625)

(5) Tighten the capscrews alternately, one turn at a time, to avoid damaging the bridges. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(6) Pour the remaining Jeep/Eagle Super Oil Conditioner or equivalent over the entire valve actuating assembly. The Jeep/Eagle Super Oil Conditioner or equivalent must remain with the engine oil for at least 1 600 km (1,000 miles) but need not be drained until the next scheduled oil change.

(7) Install the cylinder head cover (see Cylinder Head Cover - Installation).

Disassembly, Cleaning and Inspection — Cylinder Head Removed

(1) Release snap ring and remove the plunger cap, metering valve, plunger, check valve assembly and plunger return spring from the tappet body (Fig. 18). Retain components of each tappet separately.

(2) Clean the components of each tappet assembly in cleaning solvent to remove all varnish, gum and sludge deposits.

(3) Inspect for indications of scuffing on the side and base of each tappet body.

(4) Inspect each tappet base for concave wear with straightedge positioned across base. If the base is concave, the corresponding lobe on camshaft is also worn. Replace the camshaft and defective tappets.

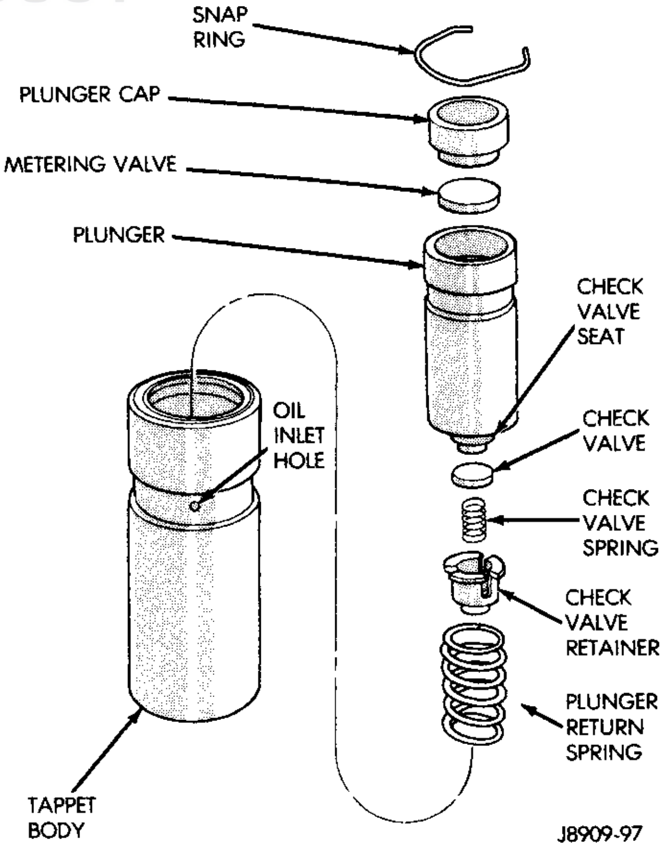


Fig. 18 Hydraulic Tappet

Assembly and Leak-down Test — Cylinder Head Removed

(1) Install the plunger return spring, check valve assembly, plunger, metering valve and the plunger cap in tappet body.

(2) Compress the plunger assembly by exerting force on the plunger cap with the push rod and install snap ring.

(3) After cleaning, inspection and assembly, test each tappet for specified leak-down rate tolerance to ensure zero-lash operation (Fig. 19).

(4) A timing device is required to test leak-down rate. Swing the weighted arm of a tester away from the ram of the tester.

(5) Place 7.925 to 7.950 mm (0.312 to 0.313 inch) diameter ball bearing on the plunger cap of the tappet.

(6) Lift the ram and position tappet (with ball bearing) inside the tester cup.

(7) Lower the ram, then adjust nose of ram until it contacts the ball bearing. Do not tighten the hex nut on the ram.

(8) Fill the tester cup with hydraulic valve tappet test oil until tappet is completely submerged.

(9) Swing the weighted arm onto the push rod and pump the tappet plunger up and down to remove air. When the air bubbles cease, swing the weighted arm away and allow the plunger to rise to normal position.

(10) Adjust the nose of the ram to align pointer with SET mark on scale of tester and tighten hex nut.

(11) Slowly swing weighted arm onto push rod.

(12) Rotate the cup by turning handle at base of the tester clockwise one revolution every two seconds.

(13) Observe the leak-down time interval from the instant the pointer aligns with the start mark on the scale until pointer aligns with 0.125 mark. Normally functioning tappet will require 20 to 110 seconds to leak-down. Discard tappets with leak-down time interval not within this specification.

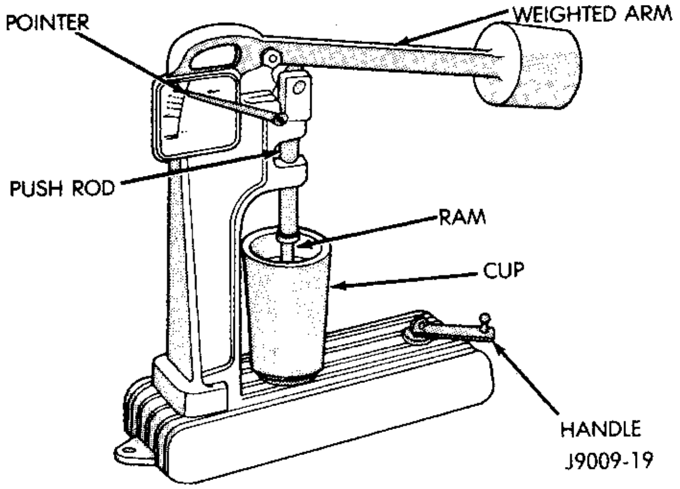


Fig. 19 Leak-Down Tester

VIBRATION DAMPER — 2.5L

Removal

(1) Disconnect the battery negative cable.

(2) Remove the drive belt(s) and fan shroud, if equipped.

(3) If equipped with a crankshaft pulley for the accessory drive belts, remove the retaining bolts and separate the crankshaft pulley from the vibration damper.

(4) Remove the vibration damper retaining bolt and washer.

(5) Use Vibration Damper Removal Tool (8068) to remove the damper from the crankshaft (Fig. 1).

Installation

(1) With the key in position, align the keyway on the vibration damper hub with the crankshaft key and tap the damper onto the crankshaft.

(2) Install the vibration damper retaining bolt and washer.

(3) Tighten the damper retaining bolt to 108 N•m (80 ft. lbs.) torque.

(4) If equipped, install the crankshaft pulley and retaining bolts.

(5) Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(6) Install the drive belt(s) and tighten to the specified tension.

(7) Connect the battery negative cable.

TIMING CASE COVER — 2.5L

Removal

(1) Disconnect the battery negative cable.

(2) Remove the vibration damper and pulley (Fig. 2).

(3) Remove the fan and hub assembly and remove the fan shroud.

(4) Remove the accessory drive brackets that are attached to the timing case cover.

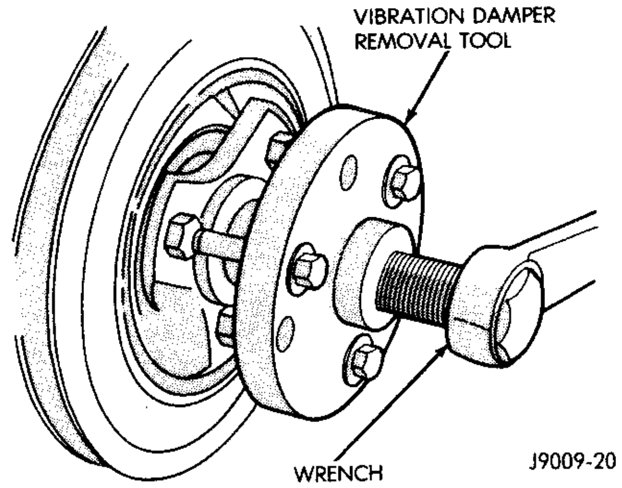


Fig. 1 Vibration Damper Removal Tool (8068)

(5) Remove the A/C compressor (if equipped) and alternator bracket assembly from the cylinder head and move to one side.

(6) Remove the oil pan-to-timing case cover bolts and cover-to-cylinder block bolts.

(7) Remove the timing case cover front seal and gasket from the engine.

(8) Cut off the oil pan side gasket end tabs and oil pan front seal tabs flush with the front face of the cylinder block and remove the gasket tabs (Fig. 3).

(9) Clean the timing case cover, oil pan and cylinder block gasket surfaces.

(10) Remove the crankshaft oil seal from the timing case cover (Fig. 2).

Installation

(1) Install a new seal in the timing case cover using a seal installation tool (6139).

(2) Apply sealing compound (Jeep/Eagle Gasket-in-a-Tube, or equivalent) to both sides of the replacement timing case cover gasket and position the gasket on the cylinder block.

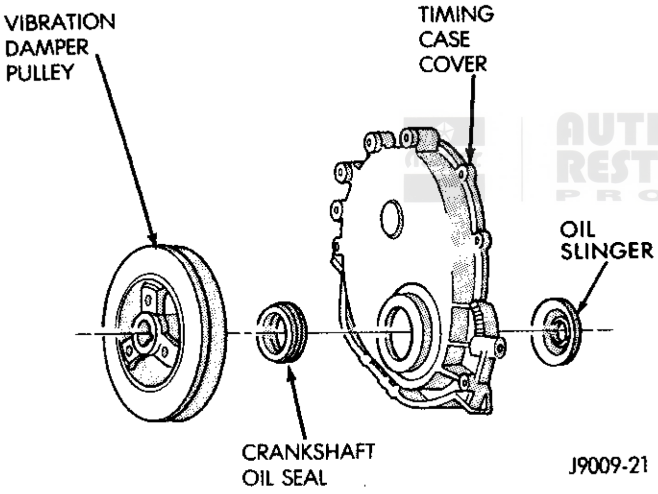


Fig. 2 Timing Case Cover and Related Components

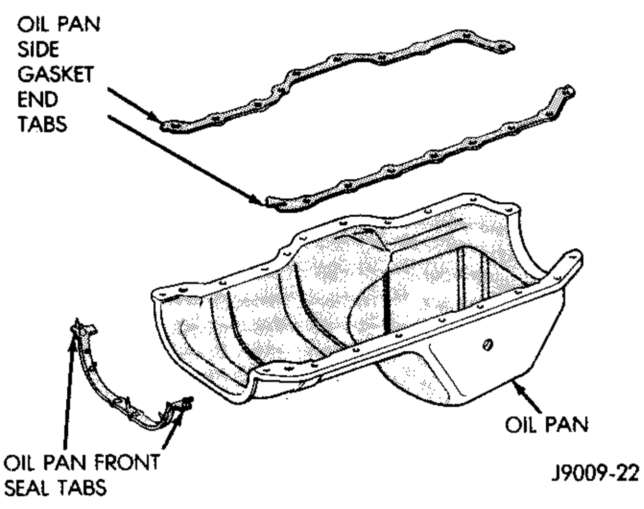


Fig. 3 Oil Pan Front Seal Tabs and Gasket End Tabs

(3) Cut the end tabs off the replacement oil pan side gaskets corresponding to those cut off the original gasket (Fig. 3). Attach the end tabs to the oil pan with cement.

(4) Coat the front cover seal end tab recesses generously with RTV sealant (Jeep/Eagle Gasket-In-A-Tube, or equivalent) and position the seal on the timing case cover.

(5) Apply engine oil to the seal-oil pan contact surface.

(6) Position the timing case cover on the cylinder block.

(7) Insert Timing Case Cover Alignment and Seal Installation Tool (6139) in the crankshaft opening in the cover (Fig. 4).

(8) Install the cover-to-cylinder block bolts and the oil pan-to-cover bolts.

(9) Tighten the cover-to-cylinder block bolts to 7 N•m (62 in.-lbs) torque and the oil pan-to-cover bolts to 13 N•m (11 ft. lbs.) torque.

(10) Remove the cover alignment tool and position a replacement oil seal on the tool with the seal lip facing outward. Apply a light film of Perfect Seal or equivalent on the outside diameter of the seal. Lightly coat the crankshaft with engine oil.

(11) Position the tool and seal over the end of the crankshaft and insert a draw screw tool into the a seal installation tool (Fig. 5).

(12) Tighten the nut against the tool until it contacts the cover.

(13) Remove the tools and apply a light film of engine oil on the vibration damper hub contact surface of the seal.

(14) With the key inserted in the keyway in the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N•m (80 ft. lbs.) torque.

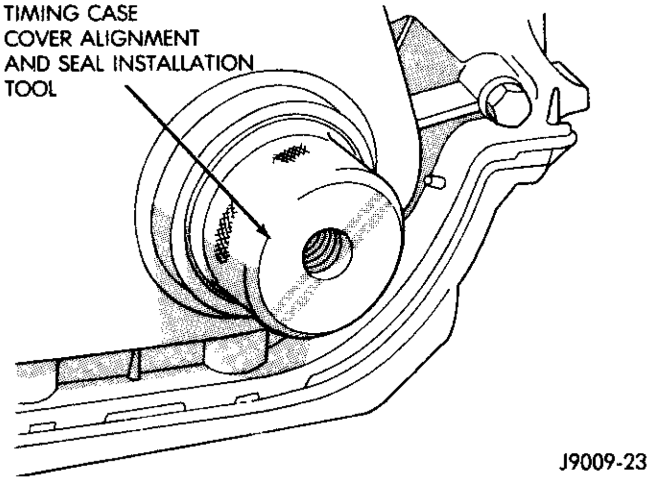


Fig. 4 Timing Case Cover Alignment and Seal Installation Tool (6139)

(15) Install the crankshaft pulley. If equipped with a serpentine drive, the pulley is integral with the damper and they are installed as a unit. Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(16) Install the A/C compressor (if equipped) and the alternator bracket assembly.

(17) Install the engine fan and hub assembly and shroud.

(18) Install the drive belt(s) and tighten to obtain the specified tension.

(19) Connect the battery negative cable.

TIMING CHAIN AND SPROCKETS — 2.5L

The timing chain tensioner reduces noise and prolongs timing chain life. In addition, it compensates for slack in a worn or stretched chain and maintains the correct valve timing.

Removal

(1) Disconnect the battery negative cable.

(2) Remove the fan and shroud.

(3) Remove the drive belt(s).

(4) Remove the crankshaft vibration damper and the pulley.

(5) Remove the timing case cover.

(6) Rotate the crankshaft until the zero timing mark on the crankshaft sprocket is closest to and on a center line with the timing mark on the camshaft sprocket (Fig. 6).

(7) Remove the oil slinger from the crankshaft.

(8) Remove the camshaft retaining bolt and remove the sprockets and chain as an assembly (Fig. 7).

Installation

To replace the timing chain tensioner, the oil pan must be removed. Refer to Oil Pan Removal for the procedure.

(1) Turn the tensioner lever to the unlock (down) position.

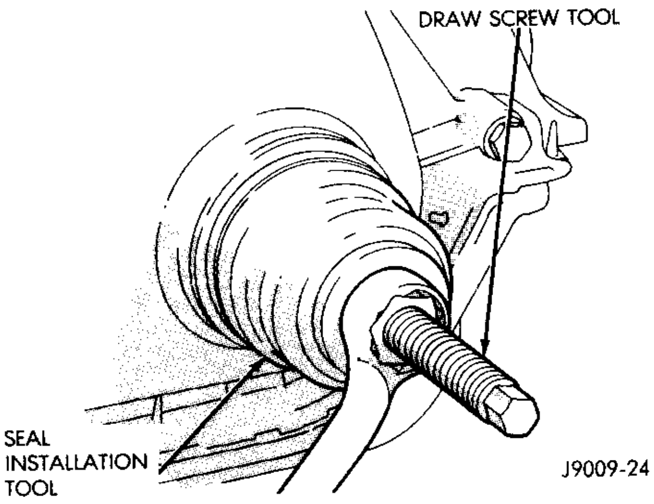


Fig. 5 Crankshaft Oil Seal Installation

(2) Pull the tensioner block toward the tensioner lever to compress the spring. Hold the block and turn the tensioner lever to the lock (up) position (Fig. 8).

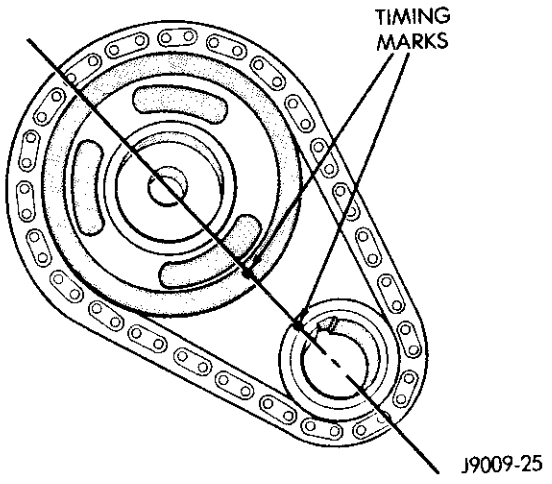


Fig. 6 Crankshaft/Camshaft Alignment

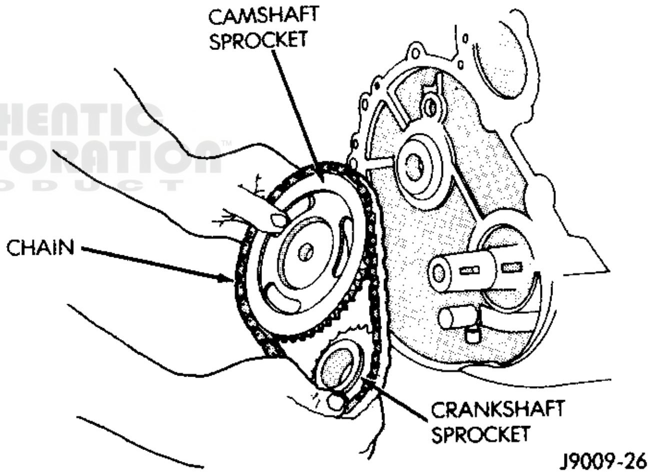


Fig. 7 Sprockets and Chain Removal

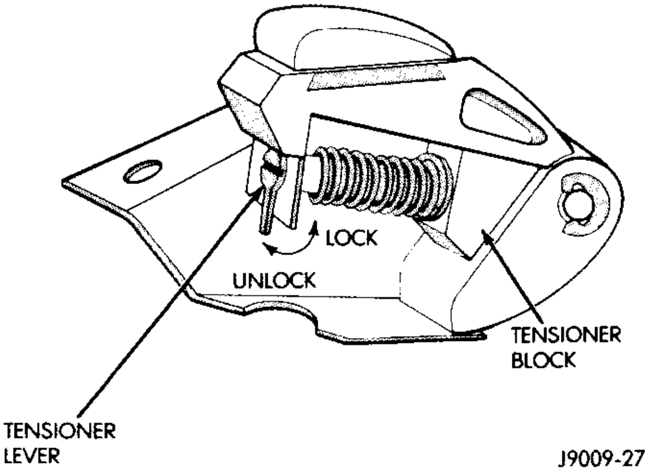


Fig. 8 Loading Timing Chain Tensioner

(3) Install the crankshaft/camshaft sprockets and timing chain. Ensure the timing marks on the sprockets are properly aligned (Fig. 6).

(4) Install the camshaft sprocket retaining bolt and washer and tighten the bolt to 108 N•m (80 ft. lbs.) torque.

To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark at approximately the one o'clock position (Fig. 9). This positions the crankshaft sprocket timing mark where the adjacent tooth meshes with the chain at the three o'clock position. Count the number of chain pins between the timing marks of both sprockets. There must be 20 pins.

(5) Install the oil slinger.

(6) Install the timing case cover and gasket as outlined in the installation procedure.

(7) Connect the battery negative cable.

TIMING CASE COVER OIL SEAL — 2.5L

Replacement — Timing Case Cover Removed

(1) Disconnect the battery negative cable.

(2) Pry the oil seal out of cover from the front with a large pry tool.

(3) Install the replacement seal so that the open end of the seal is toward the inside of the cover.

(4) Support the cover at the seal area while installing the seal and force it into position with Seal Installation Tool 6139.

(5) Connect the battery negative cable.

Replacement — Timing Case Cover Installed

(1) Disconnect the battery negative cable.

(2) Remove the drive belts.

(3) Remove the vibration damper.

(4) Remove the radiator shroud.

(5) Remove the oil seal (Fig. 10).

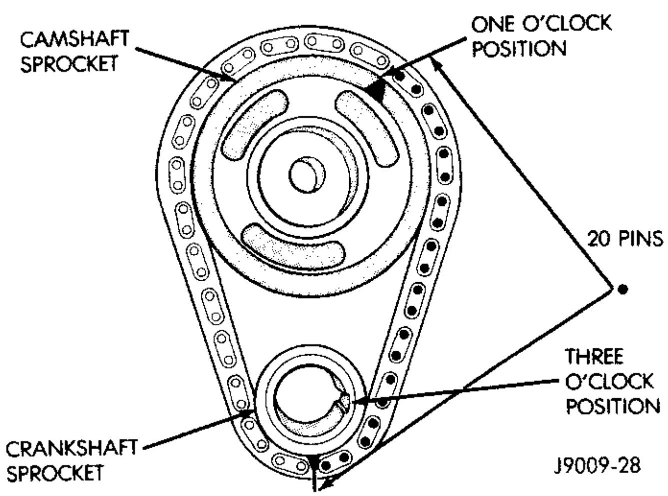


Fig. 9 Verify Crankshaft/Camshaft Installation

(6) Position the replacement oil seal on Timing Case Cover Alignment and Seal Installation Tool 6139 with seal lip facing outward. Apply a light film of Perfect Seal, or equivalent, on the outside diameter of the seal. Lightly coat the crankshaft with engine oil.

(7) Position the tool and seal over the end of the crankshaft and insert a draw screw tool into Seal Installation Tool 6139 (Fig. 11). Tighten the nut against the tool until it contacts the cover.

(8) Remove the tools. Apply a light film of engine oil on the vibration damper hub contact surface of the seal.

(9) With the key inserted in the keyway in the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N•m (80 ft. lbs.) torque.

(10) Install the crankshaft pulley. Tighten the bolt to 27 N•m (20 ft. lbs.) torque.

(11) Install the drive belt(s) and tighten to the specified tension. If equipped with a serpentine drive, the pulley is integral with the damper and they are installed as a unit.

(12) Install the A/C compressor/alternator bracket assembly.

(13) Connect the battery negative cable.

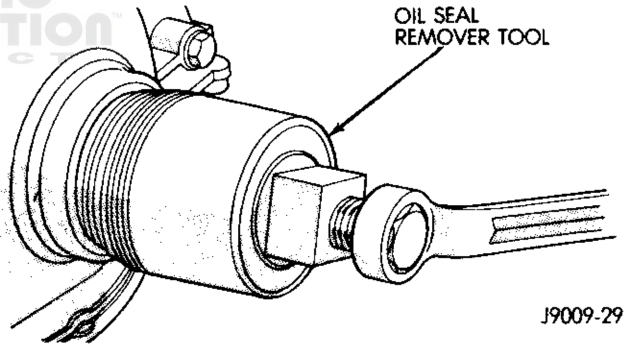


Fig. 10 Timing Case Cover Oil Seal Removal

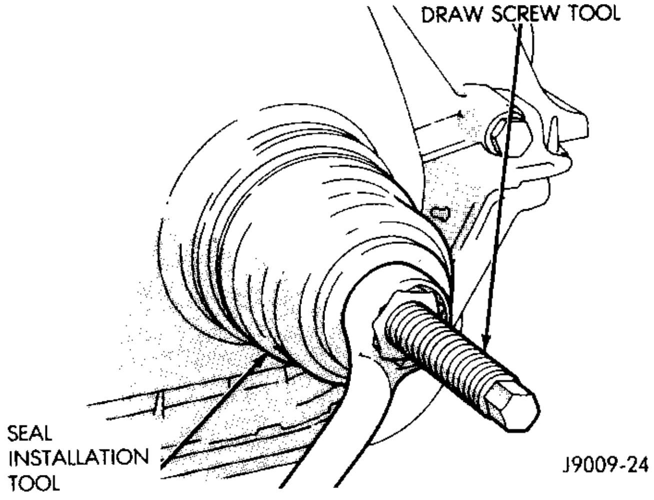


Fig. 11 Timing Case Cover Oil Seal Installation

CAMSHAFT — 2.5L

Removal

(1) Disconnect the battery negative cable.

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM IS PRESSURIZED.

(2) Drain the cooling system.

(3) Remove the radiator and condenser, if equipped with A/C.

(4) Scribe a mark on the distributor housing in line with the lip of the rotor.

(5) Scribe a mark on the distributor housing near the clamp and continue the scribe mark on the cylinder block in line with the distributor mark.

(6) Note the position of the rotor and distributor housing in relation to adjacent engine components as reference points for installing the distributor.

(7) Remove the distributor and ignition wires.

(8) Remove the cylinder head cover as outlined in the removal procedure.

(9) Remove the rocker arms, bridges and pivots as outlined in the removal procedure.

(10) Remove the push rods.

(11) Remove the hydraulic valve tappets from the cylinder head as outlined in the removal procedure.

(12) Remove the timing case cover (Fig. 1). If the camshaft appears to have been rubbing against the timing case cover, examine the oil pressure relief holes in the rear cam journal and ensure they are free of debris.

(13) Remove the timing chain and sprockets as outlined in the removal procedure.

(14) Remove the camshaft (Fig. 2).

Inspection

Inspect the cam lobes for wear.

Inspect the bearing journals for uneven wear pattern or finish.

Inspect the bearings for wear.

Inspect the distributor drive gear for wear.

Installation

(1) Lubricate the replacement camshaft with Jeep/ Eagle Super Oil Conditioner, or equivalent.

(2) Install the camshaft.

(3) Install the timing chain and sprockets as outlined in the installation procedure.

(4) Install the timing case cover as outlined in the installation procedure.

(5) Install the hydraulic valve tappets as outlined in the installation procedure.

(6) Install the push rods.

(7) Install the rocker arms, bridges and pivots as outlined in the installation procedure.

(8) Install the cylinder head cover as outlined in the installation procedure.

(9) Install the distributor and ignition wires.

(10) Properly position the distributor rotor as follows:

(a) Remove No. 1 spark plug. Hold your finger over the spark plug hole and rotate the crankshaft until compression pressure is felt. Slowly continue to rotate the crankshaft until the timing index on the vibration damper pulley aligns with the top dead center (TDC) mark (0°) on the timing degree scale. **Always rotate the crankshaft clockwise (the direction of normal rotation). Do not rotate the crankshaft backward to align the timing marks.**

(b) Using a flat blade screwdriver, rotate the oil pump gear so that the gear slot on the oil pump shaft is slightly past the three (3) o'clock position (Fig. 3).

(c) Turn the distributor shaft until the rotor tip points in the direction of No. 1 terminal in the distributor cap. Turn the rotor 1/8 turn counterclockwise past the position of No. 1 terminal.

(d) With the distributor cap removed, start the distributor into the cylinder block with the rotor located at the five (5) o'clock position (Fig. 4).

(e) Slide the distributor shaft down into the engine and position the distributor vacuum advance

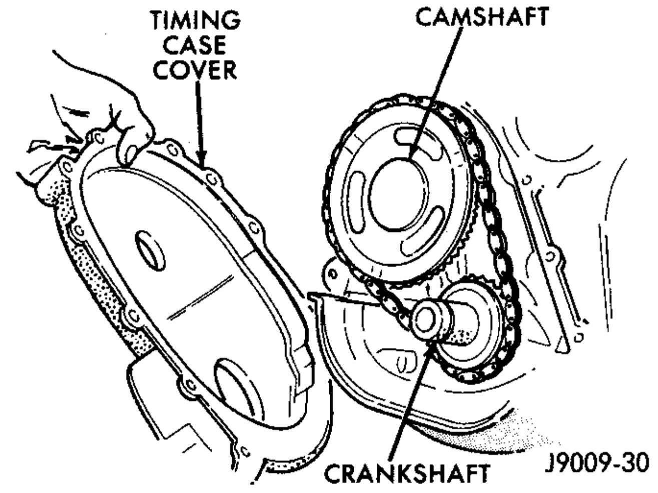


Fig. 1 Timing Case Cover Removal

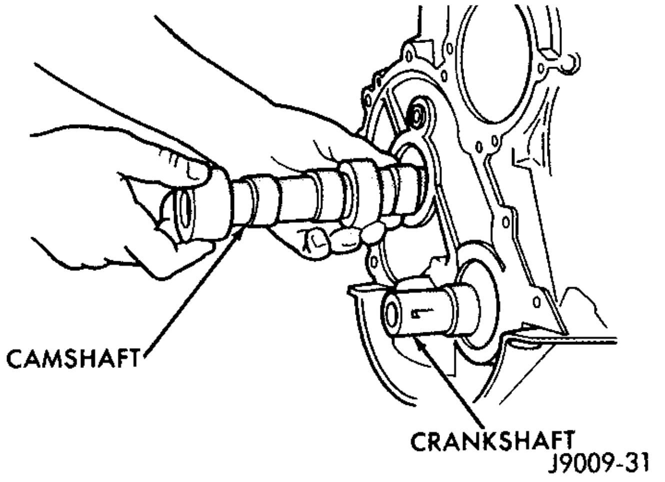


Fig. 2 Camshaft Removal

mechanism housing in approximately the same location (in relation to adjacent engine components) as when removed. Align the scribe mark on the distributor housing with the corresponding scribe mark on the cylinder block. It may be necessary to rotate the oil pump shaft with a long flat-blade screwdriver to engage the oil pump drive tang, but the rotor should align with the position of No. 1 terminal when the distributor shaft is down in place.

(f) Install the distributor holddown clamp and bolt, but do not tighten the bolt.

(g) When the distributor is fully engaged in its correct location, the rotor should be at the six (6) o'clock position (Fig. 5).

(h) If the distributor is not properly installed, or if it is removed later, then the complete installation procedures must be repeated.

(11) Install the radiator and condenser (if equipped with A/C).

(12) Fill the cooling system.

(13) Connect the battery negative cable.

CAMSHAFT PIN REPLACEMENT — 2.5L

Removal

(1) Disconnect the battery negative cable.

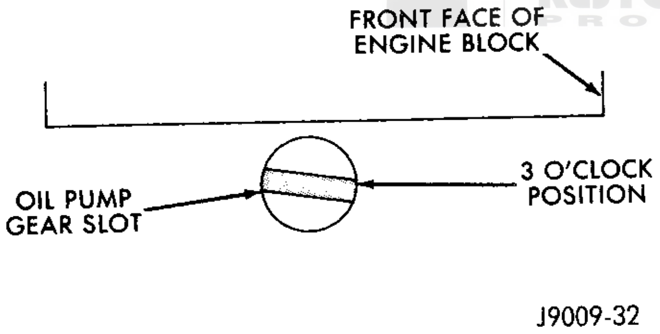


Fig. 3 Oil Pump Gear Slot Alignment

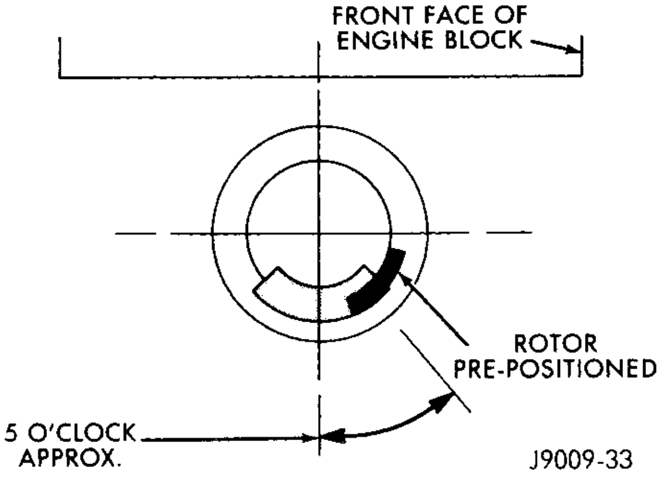


Fig. 4 Distributor Rotor Pre-Positioning

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

(2) Drain the radiator. Do not waste reusable coolant. Drain the coolant into a clean container.

(3) Remove the fan and shroud.

(4) Disconnect the radiator overflow tube, radiator hoses, automatic transmission fluid cooler pipes (if equipped).

(5) Remove the radiator.

(6) If equipped with air conditioning:

(a) Remove the A/C compressor drive belt idler pulley.

(b) Disconnect and remove the alternator.

CAUTION: Do not loosen or disconnect any air conditioner system fittings. Move the condenser and receiver/drier aside as a complete assembly.

(c) Remove the A/C condenser attaching bolts and move the condenser and receiver/drier assembly up and out of the way.

(7) Remove the drive belt(s).

(8) Remove the crankshaft vibration damper and pulley. Refer to the removal procedure.

(9) Remove the timing case cover. Refer to the removal procedure.

(10) Rotate the crankshaft until the zero degree (0°) timing mark on the crankshaft sprocket is closest to and on the center line with the timing mark on the camshaft sprocket (Fig. 6).

(11) Remove camshaft sprocket retaining bolt.

(12) Remove the crankshaft oil slinger.

(13) Remove the sprockets and chain as an assembly (Fig. 7).

CAUTION: The following procedural step must be accomplished to prevent the camshaft from damaging the rear camshaft plug during pin installation.

(14) Inspect the damaged camshaft pin.

(15) If the pin is a spring-type pin, remove the broken pin by inserting a self-tapping screw into the pin and

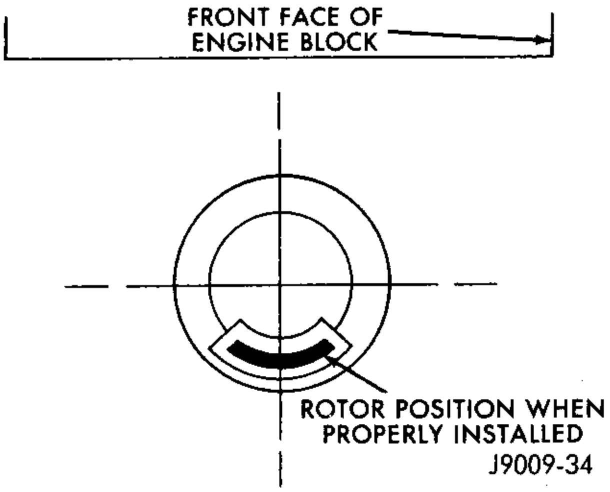


Fig. 5 Correct Rotor Position

carefully pulling the pin from the camshaft.

(16) If the pin is a dowel-type pin, center-punch it. Ensure the exact center is located when center-punching the pin.

CAUTION: Cover the opened oil pan area to prevent metal chips from entering the pan.

(17) Drill into the pin center with a 4 mm (5/32 inch) drill bit.

(18) Insert a self-tapping screw into the drilled pin and carefully pull the pin from the camshaft.

Installation

(1) Clean the camshaft pin hole.

(2) Compress the center of the replacement spring pin with vise grips.

(3) Carefully drive the pin into the camshaft pin hole until it is seated.

(4) Install the camshaft sprocket, crankshaft sprocket and timing chain with the timing marks aligned (Fig. 6).

(5) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark at approximately the one o'clock position. This positions the crankshaft sprocket timing mark where the adjacent tooth meshes with the chain at the three (3) o'clock position. Count the number of chain pins between the timing marks on both sprockets (Fig. 8). There must be 20 pins.

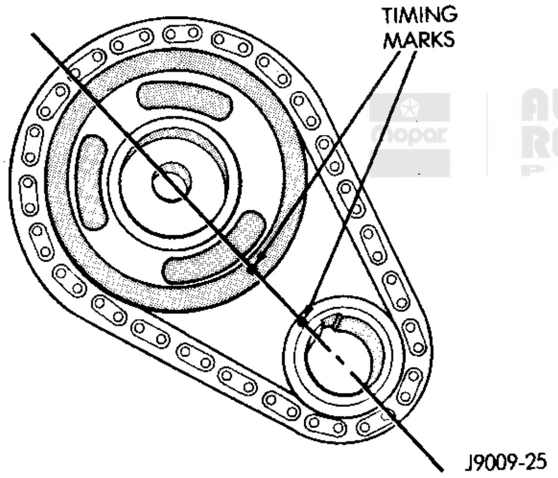


Fig. 6 Timing Chain Alignment

(6) Install the crankshaft oil slinger.

(7) Tighten the camshaft sprocket bolt with 108 N•m (80 ft. lbs.) torque.

(8) Check the valve timing. Refer to the timing procedure.

(9) Remove the timing case cover gaskets and seal and clean the cover.

(10) Position replacement oil pan tab gaskets on the oil pan and use RTV sealant to hold them in place.

(11) Coat both sides of the replacement timing case cover gasket with gasket sealer. Apply a 3 mm (1/8 inch) bead of RTV sealant to the joint formed at the oil pan and cylinder block.

(12) Loosen the front four oil pan bolts three turns to allow oil pan movement during the timing case cover installation.

(13) Position the timing case cover on the engine.

(14) Place Timing Case Cover Alignment and Seal Installation Tool 6139 in the crankshaft opening in the cover (Fig. 9).

(15) Install and tighten the oil pan and timing case cover bolts. Tighten the 1/4-20 oil pan bolts to 9 N•m (80 in-lbs) torque and the 5/16-18 oil pan bolts to 15 N•m (11 ft. lbs.) torque.

(16) Remove the cover alignment tool and place a replacement oil seal on the tool with the lip facing outward.

(17) Apply a light film of engine oil on the outside diameter of the seal.

(18) Position the tool and seal in the timing case cover crankshaft opening.

(19) Insert a screw tool into Seal Installation Tool 6139 (Fig. 10).

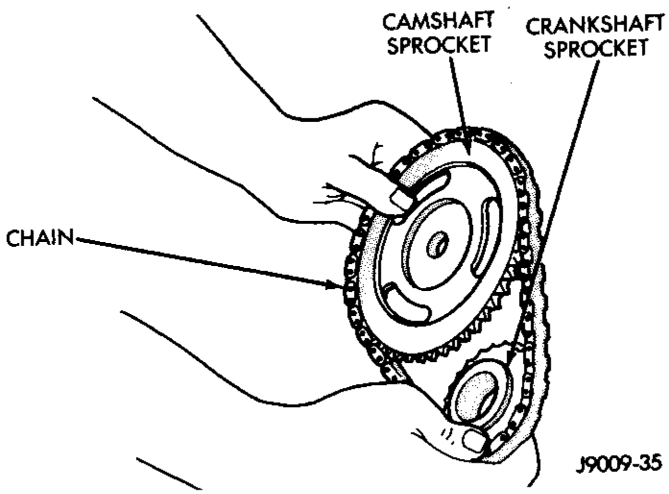


Fig. 7 Sprocket and Chain Removal

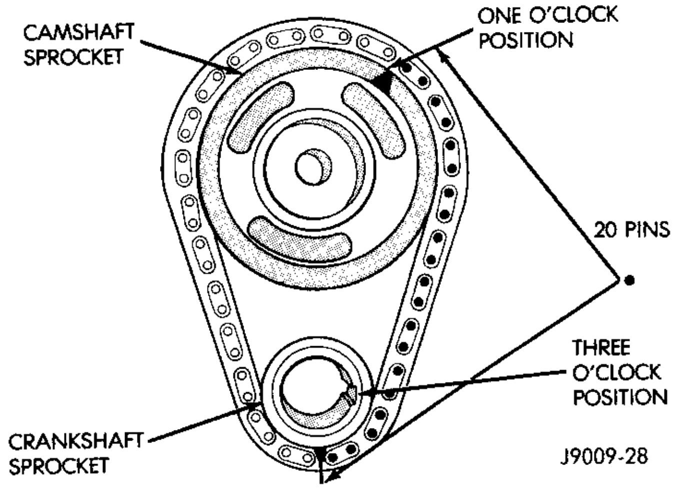


Fig. 8 Verify Crankshaft/Camshaft Installation

(20) Turn the nut until the tool contacts the cover.

(21) Remove the tool and install the vibration damper on the crankshaft.

(22) Lubricate and tighten the damper bolt to 108 N•m (80 ft. lbs.) torque. **If the crankshaft turns before the damper bolt torque value is attained, the crankshaft can be prevented from turning by placing two 5/16 X 1-1/2 inch bolts into the damper front pulley holes and wedging a bar between them. Rotate the bar until it contacts the frame member to prevent the crankshaft from turning.**

(23) Install the damper pulley, if applicable.

(24) If equipped with air conditioning:

(a) Install the A/C compressor drive belt idler pulley.

(b) Install the alternator.

(c) Install the A/C condenser and receiver/drier assembly.

(25) Install the drive belt(s) on the pulleys and tighten. Refer to Group 7, Cooling System for the specifications and procedures.

(26) Install the radiator. Connect the radiator hoses and automatic transmission fluid cooler pipes, if equipped. Fill the cooling system.

(27) Install the fan and shroud.

(28) Connect the battery negative cable.

CAMSHAFT BEARINGS — 2.5L

The camshaft rotates within four steel-shelled, babbitt-lined bearings that are pressed into the cylinder block and then line reamed. The four camshaft bearing bores and bearing diameters are not the same size. They are stepped down in 0.254 mm (0.010 inch) increments from the front bearing (largest) to the rear bearing (smallest). This permits easier removal and installation of the camshaft. The camshaft bearings are pressure lubricated.

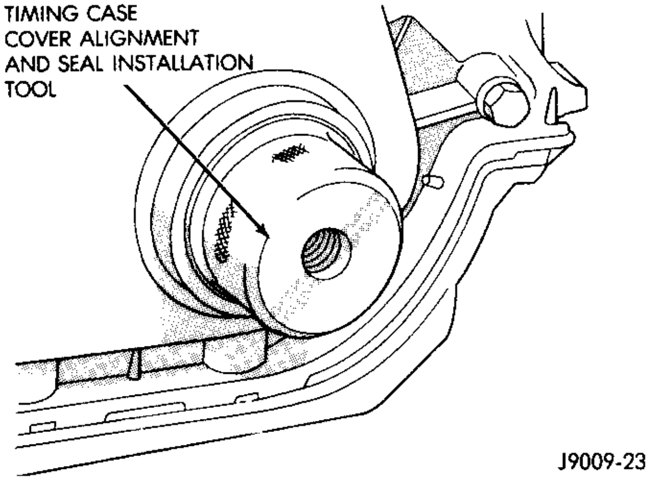


Fig. 9 Timing Case Cover Alignment and Seal Installation Tool (6139)

It is not advisable to attempt to replace camshaft bearings unless special removal and installation tools are available.

Camshaft end play is maintained by the load placed on the camshaft by the oil pump and distributor drive gear. The helical cut of the gear holds the camshaft sprocket thrust face against the cylinder block face. Camshaft end play is zero during engine operation.

OIL PAN — 2.5L

Removal

(1) Disconnect the battery negative cable.

(2) Raise the vehicle.

(3) Remove the oil pan drain plug and drain the engine oil.

(4) Disconnect the exhaust pipe at the exhaust manifold.

(5) Disconnect the exhaust hanger at the catalytic converter and lower the pipe.

(6) Remove the starter motor.

(7) Remove the converter/flywheel housing access cover.

(8) Position a jack stand directly under the engine vibration damper.

(9) Place a piece of wood (2 x 2) between the jack stand and the engine vibration damper.

(10) Remove the engine mount through bolts.

(11) Using the jack stand, raise the engine until adequate clearance is obtained to remove the oil pan.

(12) Remove the oil pan bolts and remove the oil pan.

Installation

(1) Clean the block and pan surfaces to remove gasket material and sealant.

(2) Install a replacement seal at the bottom of the timing case cover and at the rear bearing cap (Fig. 1).

(3) Install side gaskets at the cylinder block mating surfaces (Fig. 1).

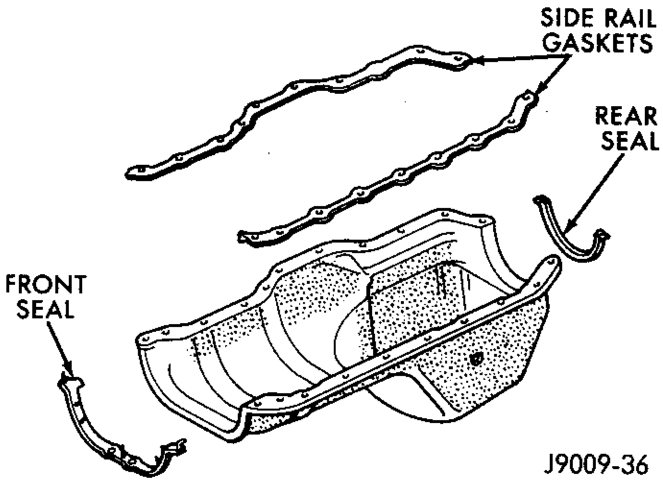


Fig. 1 Oil Pan Seals and Gaskets

(4) Install the oil pan and bolts. Tighten the 1/4 inch diameter bolts to 9 N•m (80 in. lbs.) torque and the 5/16 inch bolts (A) to 15 N•m (11 ft. lbs.) torque (Fig. 2).

(5) Lower the engine until it is properly located on the engine mounts.

(6) Install the through bolts and tighten the nuts to 65 N•m (48 ft. lbs.) torque.

(7) Lower the jack stand and remove the piece of wood.

(8) Install the converter/flywheel housing access cover.

(9) Install the starter motor.

(10) Connect the exhaust pipe to the hanger and to the exhaust manifold.

(11) Install the oil pan drain plug using a new gasket (Fig. 2). Tighten the plug to 34 N•m (25 ft. lbs.) torque.

(12) Lower the vehicle.

(13) Connect the battery negative cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(14) Fill the oil pan with engine oil to the specified level. Start the engine and inspect for leaks.

OIL PUMP — 2.5L

The positive-displacement gear-type oil pump is driven by the distributor shaft, which is driven by a gear on the camshaft. Oil is siphoned into the pump through an inlet tube and strainer assembly that is pressed into the pump body. The pump incorporates a nonadjustable pressure relief valve to limit maximum pressure to 75 psi (517 kPa). In the relief position, the valve permits oil to bypass through a passage in the pump body to the inlet side of the pump.

Oil pump removal or replacement will not affect distributor timing because the distributor drive gear remains in mesh with the camshaft gear.

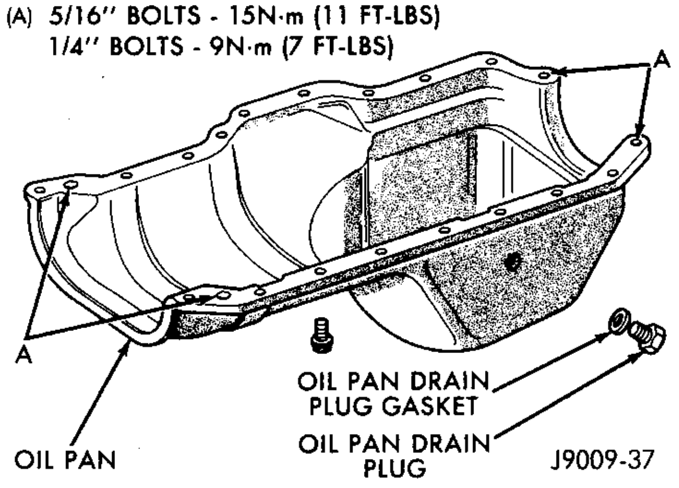


Fig. 2 Oil Pan Bolt Location

Removal

(1) Remove the oil pan as outlined in the removal procedure.

(2) Remove the pump-to-cylinder block attaching bolts and remove the pump assembly with gasket (Fig. 3).

CAUTION: If the oil pump is not to be serviced, do not disturb position of oil inlet tube and strainer assembly in pump body. If the tube is moved within the pump body, a replacement tube and strainer assembly must be installed to assure an airtight seal.

Gear End Clearance Measurement

Remove the cover retaining screws and cover from the pump body.

PREFERRED METHOD:

(1) Place a strip of Plastigage across the full width of each gear.

(2) Install the pump cover and tighten the bolts to 8 N•m (70 in. lbs.) torque.

(3) Remove the pump cover and determine the amount of clearance by measuring the width of compressed Plastigage with scale on the Plastigage envelope (Fig. 4).

(4) Correct clearance by this method is 0.051 to 0.152 mm with 0.051 mm preferred (0.002 to 0.006 inch with 0.002 inch preferred).

ALTERNATE METHOD:

(1) Place a straightedge across the ends of the gears and the pump body.

(2) Select a feeler gauge that fits snugly but freely between the straightedge and the pump body (Fig. 5).

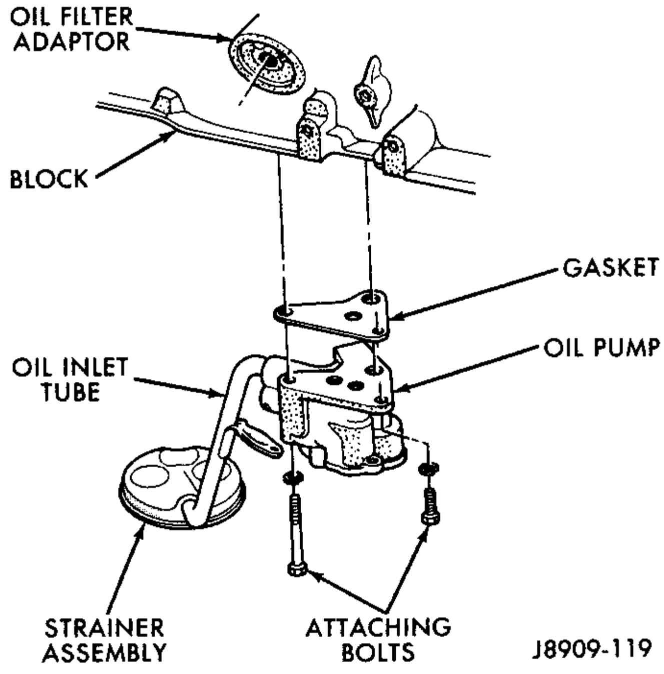


Fig. 3 Oil Pump and Components

(3) Correct clearance by this method is 0.051 to 0.152 mm with 0.051 mm preferred (0.002 to 0.006 inch with 0.002 inch preferred).

(4) If gear end clearance is excessive, replace the oil pump assembly.

Gear-to-Body Clearance Measurement

(1) With both gears in place, measure the gear-to-body clearance by inserting a feeler gauge between gear the tooth and the pump body inner wall directly opposite the point of gear mesh. Select a feeler gauge which fits snugly but freely. Rotate gears to measure each tooth-to-body clearance in this manner (Fig. 6).

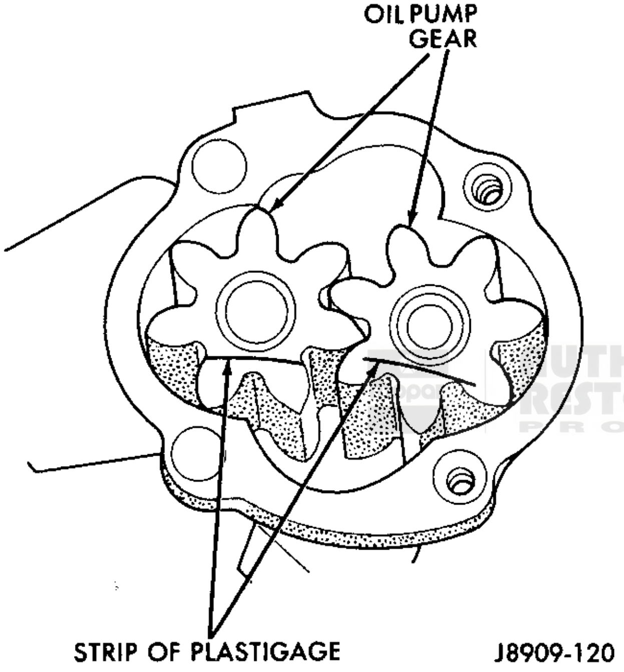


Fig. 4 Gear End Clearance Measurement — Preferred Method

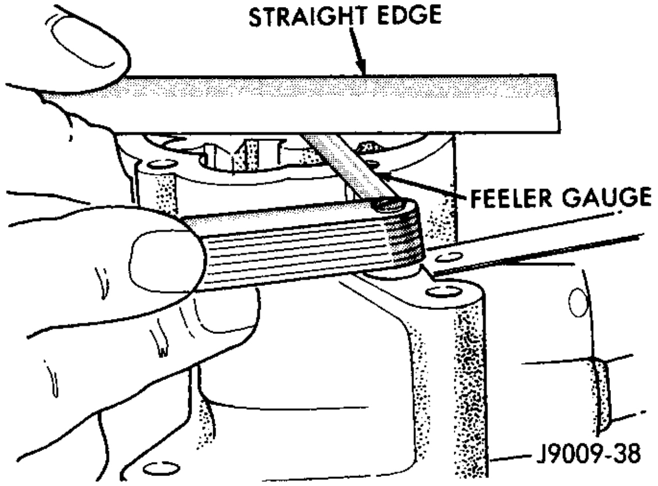


Fig. 5 Gear End Clearance Measurement — Alternate Method

(2) Correct clearance is 0.051 to 0.102 mm with 0.051 mm preferred (0.002 to 0.004 inch with 0.002 inch preferred).

(3) If the gear-to-body clearance is more than specified, replace oil pump.

(4) Remove the cotter pin and slide the spring retainer, spring and oil pressure relief valve plunger out of the pump body. Inspect for binding condition during disassembly. Clean or replace as necessary.

The oil inlet tube and strainer assembly must be moved to allow removal of the relief valve. Install a replacement inlet tube and strainer assembly.

Pump Assembly

Two relief valve plunger sizes (standard and oversize) are available. When replacing the valve, assure correct replacement valve, standard size or 0.254 mm (0.010 inch) oversize plunger diameter, is obtained and installed.

(1) Install the oil pressure relief valve plunger, spring, retainer and cotter pin.

(2) If the position of inlet tube in the pump body has been disturbed, install a replacement inlet tube and strainer assembly. Apply a light film of Permatex No. 2 sealant, or equivalent, around the end of tube. Use Oil Pump Inlet Tube Installation Tool 7624 to drive the inlet tube into body (Fig. 7). Assure support bracket is properly aligned.

(3) Install the idler gear and drive gear assembly.

(4) Spin the drive gear shaft to assure a binding condition does not exist before installing the oil pump.

(5) To assure self-priming of the oil pump, fill pump with petroleum jelly before installing the oil pump cover. Do not use grease.

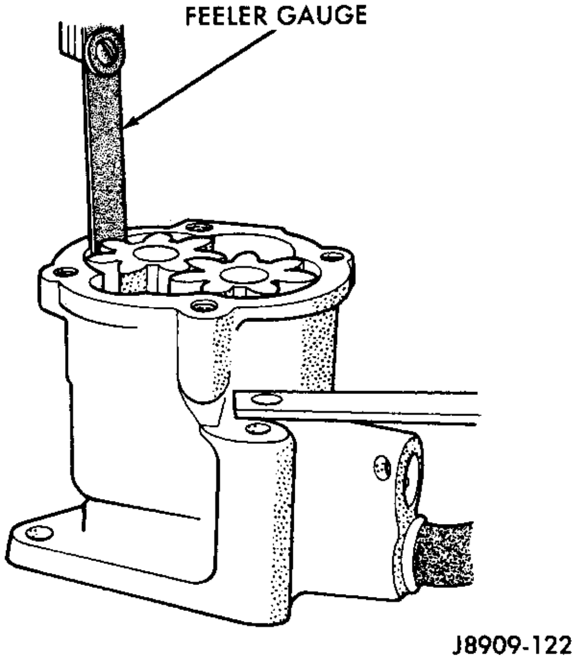


Fig. 6 Gear-to-Body Clearance Measurement

(6) Apply a thin bead of Loctite 515 (or equivalent) to the top of the pump housing and install the pump cover screws with 8 N•m (70 in.-lbs) torque.

Installation

(1) Install the oil pump on the cylinder block using a replacement gasket. Tighten the short bolt to 14 N•m (10 ft. lbs.) torque and the long bolt to 23 N•m (17 ft. lbs.) torque.

(2) Install the oil pan as outlined in the installation procedure.

(3) Fill the oil pan with oil to the specified level.

Oil Pump Pressure

The MINIMUM oil pump pressure is 89.6 kPa (13 psi) at 600 rpm. The MAXIMUM oil pump pressure is 255.1-517.1 kPa (37-75 psi) at 1600 rpm or more.

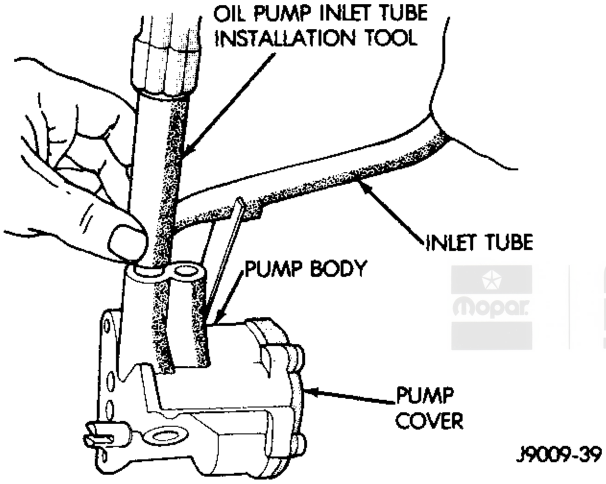


Fig. 7 Inlet Tube Installation (Tool 7624)

PISTONS AND CONNECTING RODS — 2.5L

Removal

(1) Remove the cylinder head cover as outlined in the removal procedure.

(2) Remove the rocker arms, bridges and pivots as outlined in the removal procedure.

(3) Remove the push rods.

(4) Remove the cylinder head as outlined in the removal procedure.

(5) Position the pistons one at a time near the bottom of the stroke and use a ridge reamer to remove the ridge from the top end of the cylinder walls. Use a protective cloth to collect the cuttings.

(6) Raise the vehicle.

(7) Drain the engine oil.

(8) Remove the oil pan, gaskets and seals. Refer to Oil Pan Removal for the procedure.

(9) Remove the connecting rod bearing caps and inserts and retain in the same order as removed to facilitate installation in the original locations. The connecting rods and caps are stamped with the corresponding cylinder number (Fig. 1).

(10) Lower the vehicle until it is about two (2) feet from the floor.

CAUTION: Ensure that the connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the rod bolts will prevent damage to the cylinder bores and crankshaft journals.

(11) Have an assistant push the piston/connecting rod assemblies up and through the top of the cylinder bores (Fig. 2).

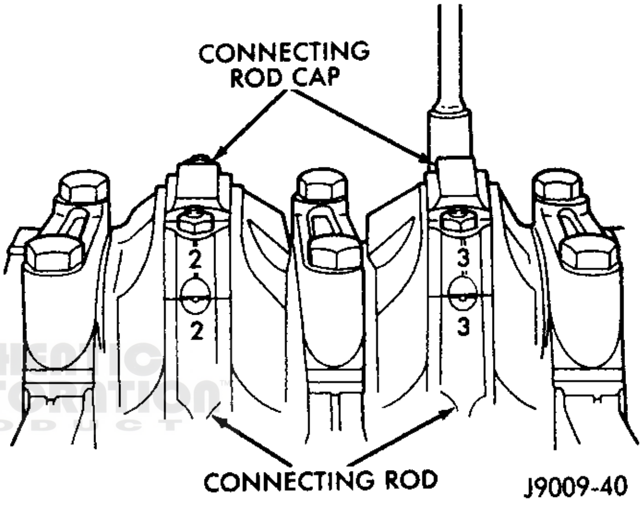


Fig. 1 Stamped Connecting Rods and Caps

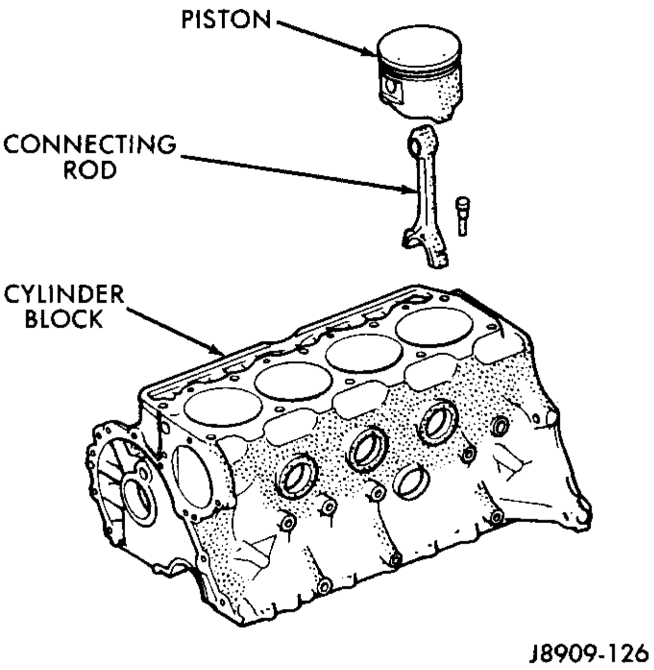


Fig. 2 Removal of Connecting Rod and Piston Assembly

Inspection — Connecting Rod

Connecting Rod Bearings

Inspect the connecting rod bearings for scoring and bent alignment tabs (Figs. 3 and 4). Check the bearings for normal wear patterns, scoring, grooving, fatigue and pitting (Fig. 5). Replace any bearing that shows abnormal wear.

Inspect the connecting rod journals for signs of scoring, nicks and burrs.

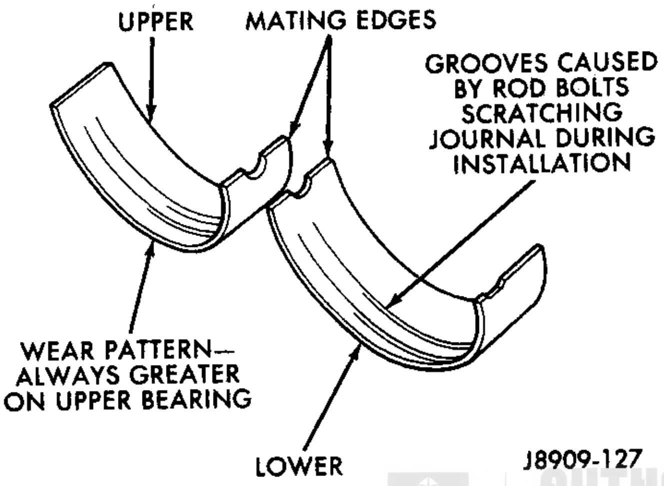


Fig. 3 Connecting Rod Bearing Inspection

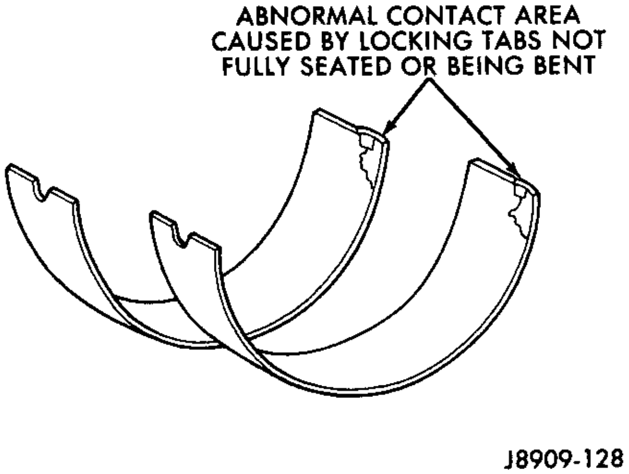


Fig. 4 Locking Tab Inspection

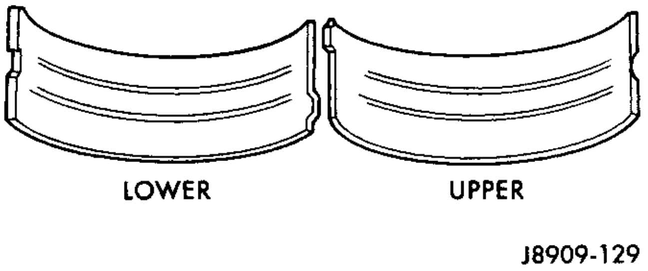


Fig. 5 Scoring Caused by Insufficient Lubrication or by Damaged Crankshaft Pin Journal

Connecting Rods

Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment. Replace misaligned, bent or twisted connecting rods.

Bearing-to-Journal Clearance

(1) Wipe the journal clean of oil.

(2) Use short rubber hose sections over rod bolts during installation.

(3) Lubricate the upper bearing insert and install in connecting rod.

(4) Use piston ring compressor to install the rod and piston assemblies with the oil squirt holes in the rods facing the camshaft and the arrow on the piston crown pointing to the front of the engine (Fig. 6). Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(5) Install the lower bearing insert in the bearing cap. The lower insert must be dry. Place strip of Plastigage across full width of the lower insert at the center of bearing cap. Plastigage must not crumble in use. If brittle, obtain fresh stock.

(6) Install bearing cap and connecting rod on the journal and tighten nuts to 45 N•m (33 ft. lbs.) torque. Do not rotate crankshaft. Plastigage will smear, resulting in inaccurate indication.

(7) Remove the bearing cap and determine amount of bearing-to-journal clearance by measuring the width of compressed Plastigage by using the scale on the Plastigage envelope (Fig. 7). The correct clearance is 0.0381 to 0.0635 mm (0.0015 to 0.0025 inch). **Plastigage should indicate the same clearance across the entire width of the insert. If the clearance varies, it may be caused by either a tapered journal, bent connecting rod, or foreign material trapped between the insert and cap or rod.**

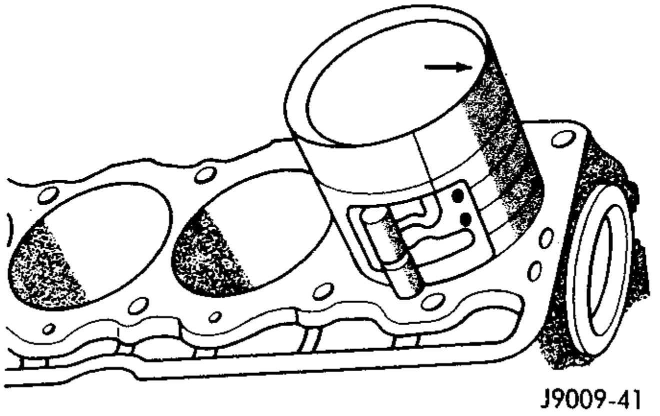


Fig. 6 Rod and Piston Assembly Installation

(8) If the correct clearance is indicated, replacement of the bearing inserts is not necessary. Remove the Plastigage from crankshaft journal and bearing insert. Proceed with installation.

(9) If bearing-to-journal clearance exceeds the specification, install a pair of 0.0254 mm (0.001 inch) undersize bearing inserts and measure the clearance as described in the previous steps.

(10) The clearance measured with a pair of 0.0254 mm (0.001 inch) undersize bearing inserts installed will determine if two 0.0254 mm (0.001 inch) undersize inserts or another combination is needed to provide the correct clearance (see the Connecting Rod Bearing Fitting Chart).

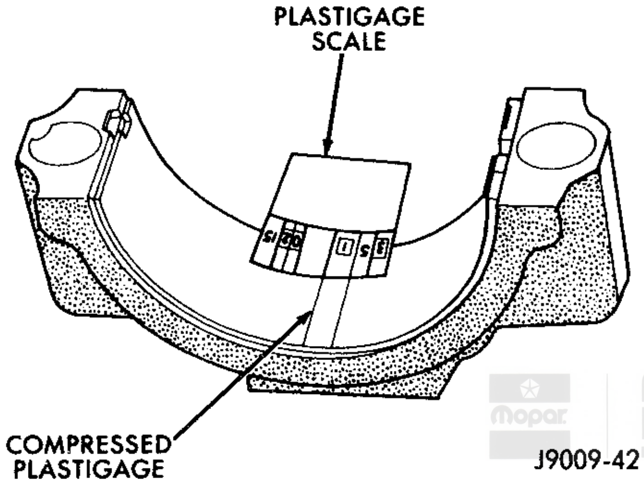


Fig. 7 Measuring Bearing Clearance with Plastigage

FOR EXAMPLE: - If the initial clearance was 0.0762 mm (0.003 inch), 0.0254 mm (0.001 inch) undersize inserts would reduce the clearance by 0.0254 mm (0.001 inch). The clearance would be 0.002 inch and within specification. A 0.0508 mm (0.002 inch) undersize insert would reduce the initial clearance an additional 0.0127 mm (0.0005 inch). The clearance would then be 0.0381 mm (0.0015 inch).

POINTS TO REMEMBER

- When replacing bearing inserts, all the odd size inserts must be on the bottom.
- The sizes of the service replacement bearing inserts are stamped on the backs of the inserts.
- Repeat the Plastigage measurement to verify your bearing selection prior to final assembly.
- Once you have selected the proper insert, install the insert and cap and tighten the bolts to 45 N•m (33 ft. lbs.) torque.

Side Clearance Measurement

Slide snug-fitting feeler gauge between the connecting rod and crankshaft journal flange. The correct clearance is 0.254 to .482 mm (0.010 to 0.019 inch). Replace the connecting rod if the side clearance is not within specification.

CONNECTING ROD BEARING FITTING CHART

Crankshaft Main Bearing Color Code and Diameter	Corresponding Connecting Rod Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow — 53.2257-53.2079 mm 2.0955-2.0948 inch Standard	Yellow — Standard	Yellow — Standard
Orange — 53.2079-53.1901 mm 2.0948-2.0941 inch Undersize (0.0178 mm or 0.0007 inch)	Yellow — Standard	Black — Undersize 0.025 mm 0.001 inch
Black — 53.1901-53.1723 mm 2.0941-2.0933 inch Undersize (0.0356 mm or 0.0014 inch)	Black — Undersize 0.025 mm 0.001 inch	Black — Undersize 0.025 mm 0.001 inch
Red — 53.9717-53.9539 mm 2.0855-2.0848 inch Undersize (0.254 mm or 0.010 inch)	Red — Undersize 0.254 mm 0.001 inch	Red — Undersize 0.254 mm 0.001 inch

J9009-43

Piston Fitting

Micrometer Method

(1) Measure the inside diameter of the cylinder bore at a point 58.725 mm (2-5/16 inches) below top of bore.

(2) Measure outside diameter of the piston. Because pistons are cam ground, measure at right angle to piston pin at centerline of pin (Fig. 8).

The difference between cylinder bore diameter and piston diameter is piston-to-bore clearance.

Feeler Gauge Method

(1) Remove the rings from the piston.

(2) Insert a long 0.025 mm (0.001 inch) feeler gauge into the cylinder bore.

(3) Insert the piston, top first, into cylinder bore alongside the feeler gauge. With entire piston inserted into cylinder bore, the piston should not bind against feeler gauge.

(4) Repeat steps with a long 0.051 mm (0.002 inch) feeler gauge. The piston should bind.

(5) If the piston binds on 0.025 mm (0.001 inch) feeler gauge, the piston is too large for thecylinder bore is too small. If the piston does not bind on 0.051 mm (0.002 inch) feeler gauge, the piston is too small for cylinder bore. Pistons up to 0.102 mm (0.004 inch) undersize may be enlarged by knurling or shot-peening. Replace pistons that are 0.102 mm (0.004 inch) or more undersize.

Piston Pin

Removal

Piston pins are press-fitted into the connecting rods and DO NOT require a locking device.

(1) Position the piston and connecting rod assembly on an arbor press.

(2) Apply force to a piloted driver and press the pin completely out of the connecting rod and piston assembly (Fig. 9). Note position of the pin through the gauge window of removal support tool.

Inspection

(1) Inspect the piston pin and pin bore in the connecting rod for nicks and burrs. Remove as necessary. Never reuse a piston pin after it has been installed in and removed from a connecting rod.

(2) With the pin removed from the piston and connecting rod, clean and dry piston pin bores and the replacement piston pin.

(3) Position the piston so that the pin bore is in vertical position. Insert the pin in bore. At room temperature, the replacement pin should slide completely through the pin bore in piston by force of gravity.

(4) Replace piston if pin jams in the pin bore.

Installation

(1) Insert the piston pin pilot through the piston and connecting rod pin bores. Ensure that the arrow on the piston crown is pointing up (Fig. 10).

(2) Position the pin pilot, piston and connecting rod on a support with the squirt hole of the connecting rod to the left-hand side (Fig. 10).

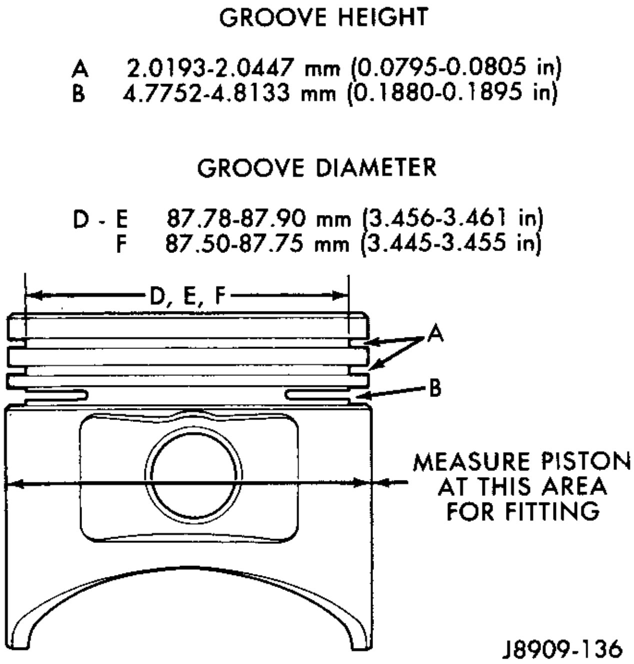


Fig. 8 Piston Dimensions

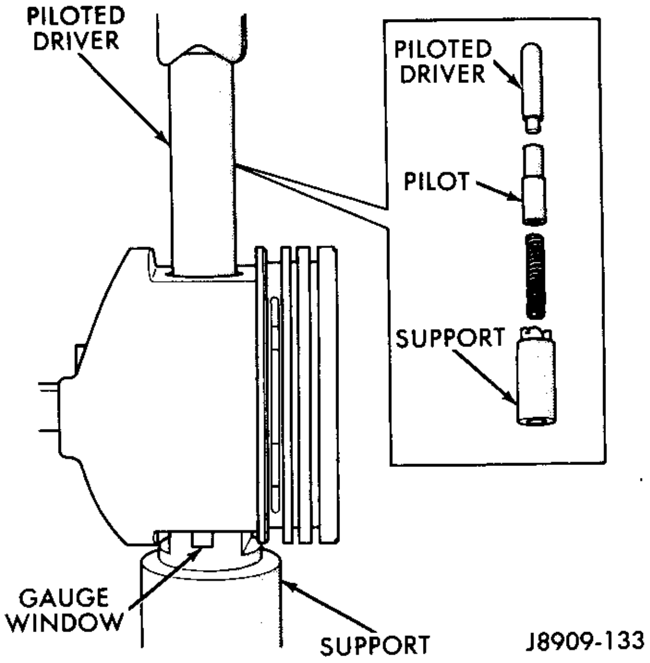


Fig. 9 Piston Pin Removal

(3) Insert piston pin through the upper piston pin bore and into the connecting rod pin bore (Fig. 9).

(4) Position the piloted driver inside the piston pin (Fig. 9).

(5) Using an arbor press, press the piston pin through the connecting rod and piston bores until pin pilot indexes with mark on the support. The piston pin requires a 8900 N (2,000 pounds) press-fit. If little effort is required to install piston pin in a connecting rod, or if the rod moves laterally on the pin, the connecting rod must be replaced.

(6) Remove the piston and connecting rod assembly from the press. The pin should be centered in the connecting rod (±0.792 mm or ±0.0312 inch) and float in the piston pin bore.

Piston Ring Fitting

(1) Carefully clean the carbon from all ring grooves. Oil drain openings in the oil ring groove and pin boss must be clear. Do not remove metal from the grooves or lands. This will change ring-to-groove clearances and will damage the ring-to-land seating.

(2) Measure the ring side clearance with a feeler gauge fitted snugly between the ring land and ring (Fig. 11). Rotate the ring in the groove. It must move freely around circumference of the groove.

(3) Place ring in the cylinder bore and push down with inverted piston to position near lower end of the ring travel. Measure ring gap with a feeler gauge fitting snugly between ring ends (Fig. 12). The correct compression ring end gap is 0.25-0.51 mm (0.010-0.020 inch). The correct oil control ring end gap is 0.381-1.397 mm (0.015-0.055 inch).

(4) Refer to Ring Gap Position for position of the ring gaps when installing piston rings.

(5) Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert expander ring first, then side rails

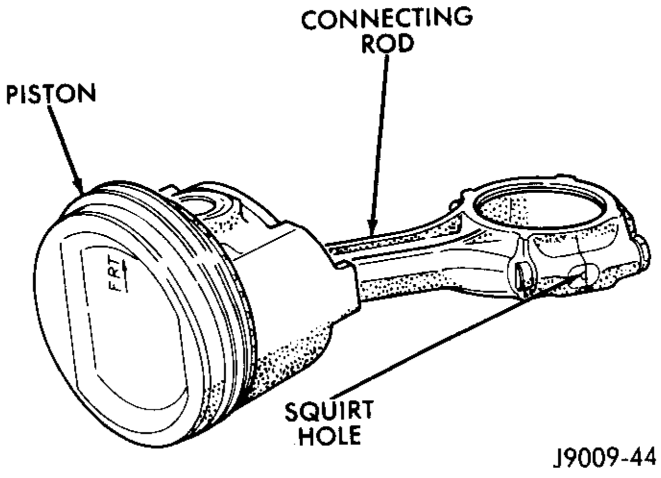


Fig. 10 Correct Alignment — Piston and Connecting Rod

(6) The two compression rings are different and cannot be interchanged (Fig. 13). The top ring is a molly ring (the scraping edge is gray in color). The second ring is a black cast iron ring (the scraping edge is black in color when new).

(7) The compression rings can be identified by a chamfer of either the top or bottom inside edge (Fig. 14). The rings may also be identified by one or two dots on the top surface of the ring.

(8) The second compression ring (black cast iron) has a chamfer on the BOTTOM of the inside edge (Fig. 14). This ring may also have two dots located on the top surface.

(9) Using a ring installer, install the ring with the chamfer facing down (Fig. 15). If the ring has dots, the dots will be facing up.

	Millimeters	Inches
No. 1 Compression	0.025-0.081 (0.043 Preferred)	0.001-0.0032 (0.0017 Preferred)
No. 2 Compression	0.025-0.081 (0.043 Preferred)	0.001-0.0032 (0.0017 Preferred)
Oil Control	0.025-0.241 (0.08 Preferred)	0.001-0.0095 (0.003 Preferred)

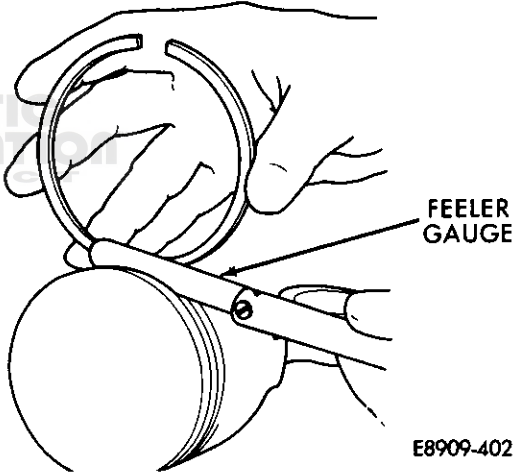


Fig. 11 Ring Side Clearance Measurement

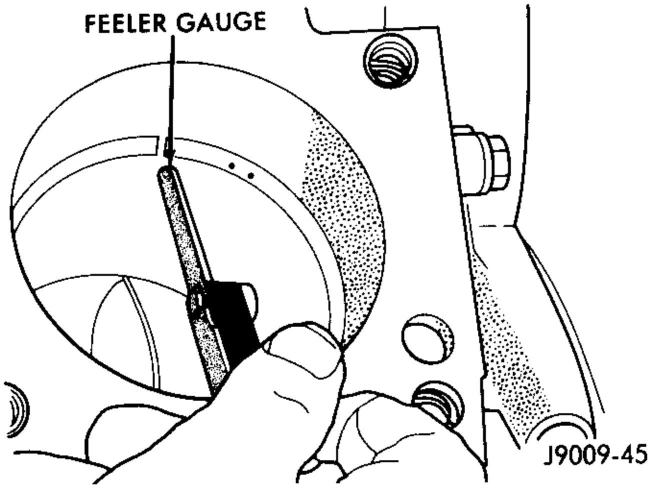


Fig. 12 Ring Gap Measurement

(10) The top compression ring (the scraping edge is gray in color) has a chamfer on the TOP of the inside edge (Fig. 16). This ring may also have one dot located on the top surface.

(11) Using a ring installer, install the top ring with the chamfer facing up. If the ring has a dot, the dot will be facing up.

(12) Position the ring end gaps on the piston as shown (Fig. 17).

Installation

Each bearing insert is selectively fitted to its respective journal to obtain the specified operating clearance between the bearing and the journal. In production, the select fit is obtained by using various-sized, color-coded bearing inserts as listed in the Connecting Rod Bearing Fitting Chart. The color code appears on the edge of the bearing insert. The size is not stamped on inserts used for production of engines.

The rod journal is identified during the engine production by a color-coded paint mark on the adjacent cheek or counterweight toward the flanged (rear) end of the crankshaft. The color codes used to indicate journal sizes are listed in the Connecting Rod Bearing Fitting Chart.

When required, upper and lower bearing inserts of different sizes may be used as a pair (see the Connecting Rod Bearing Fitting Chart). A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce clearance 0.013 mm (0.0005 inch).

CAUTION: Do not intermix bearing caps. Each connecting rod and its bearing cap are stamped with the associated cylinder number on a machined surface adjacent to the oil squirt hole that faces the camshaft side of the cylinder block.

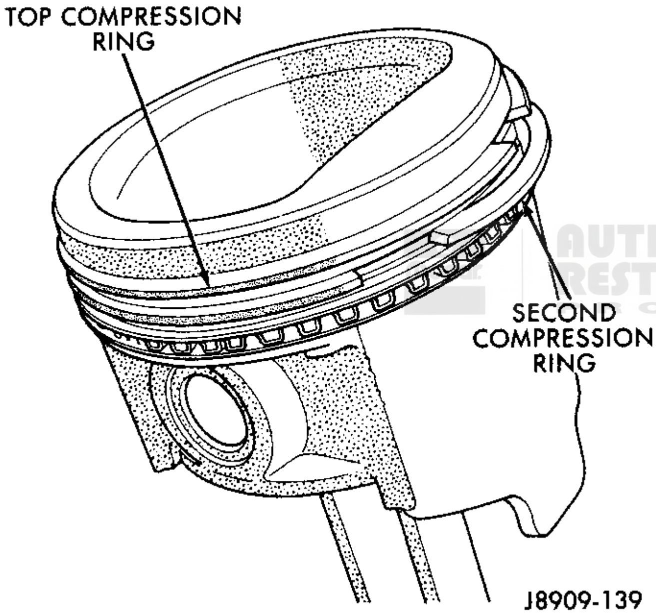


Fig. 13 Compression Ring Location

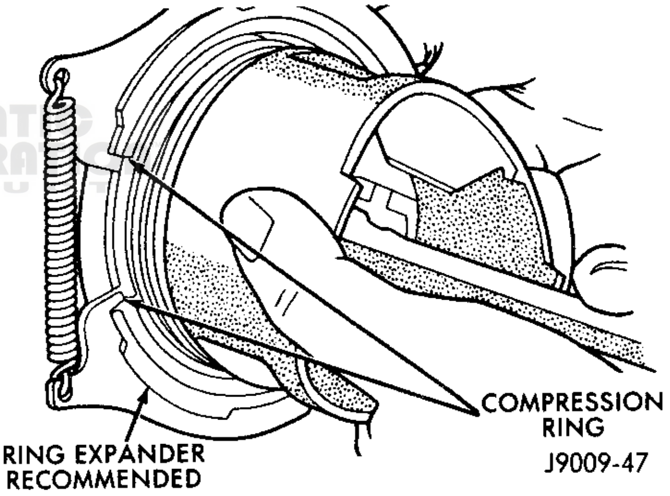


Fig. 15 Compression Ring Installation

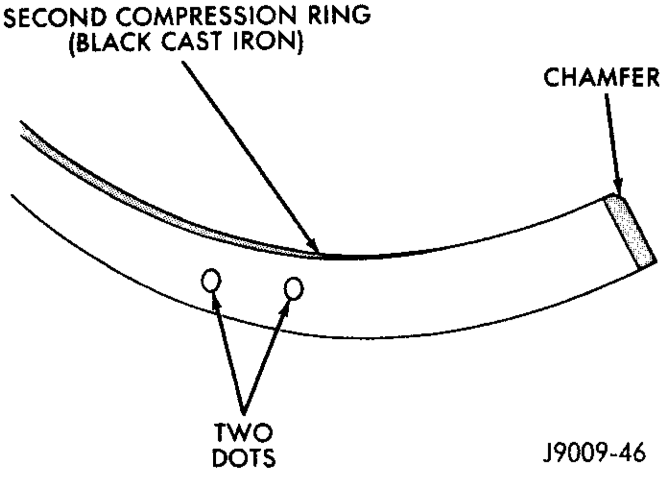


Fig. 14 Second Compression Ring Identification

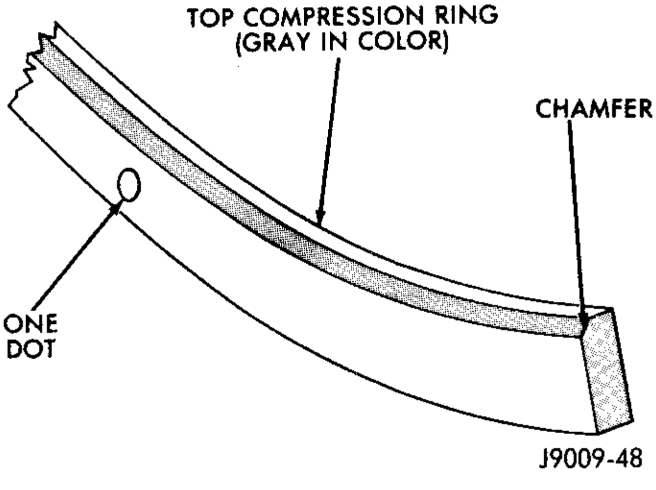


Fig. 16 Top Compression Ring Identification

(1) Clean the cylinder bores thoroughly. Apply a light film of clean engine oil to the bores with a clean lint-free cloth.

(2) Install the piston rings on the pistons if removed. Refer to Piston Ring Installation for the proper procedure.

(3) Lubricate the piston and rings with clean engine oil.

CAUTION: Ensure that connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during installation.

(4) Use a piston ring compressor to install the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 18).

(5) Ensure the arrow on the piston top points to the front of the engine (Fig. 18).

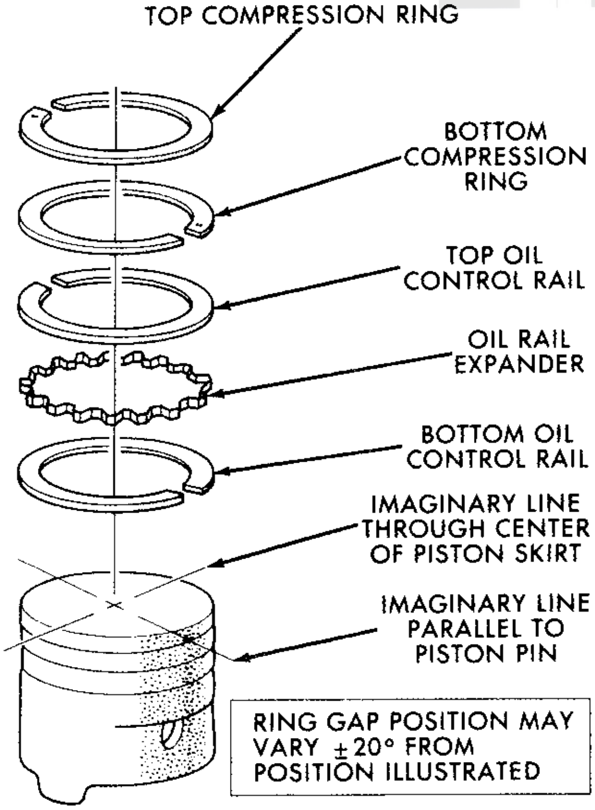
(6) Raise the vehicle.

(7) Install the connecting rod bearing caps and inserts in the same positions as removed.

CAUTION: Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(8) Install the oil pan and gaskets as outlined in the installation procedure.

(9) Lower the vehicle.

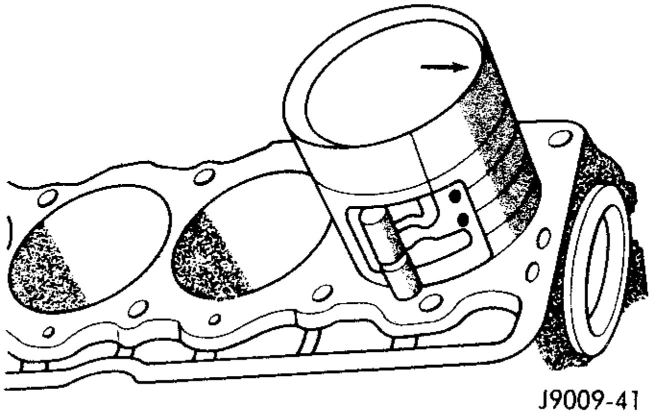


J8909-143

Fig. 17 Ring Gap Position

(10) Install the cylinder head, push rods, rocker arms, bridges, pivots and cylinder head cover as outlined in the installation procedures.

(11) Fill the crankcase with engine oil.



J9009-41

Fig. 18 Rod and Piston Assembly Installation

CRANKSHAFT MAIN BEARINGS — 2.5L

Removal

(1) Disconnect the battery negative cable.

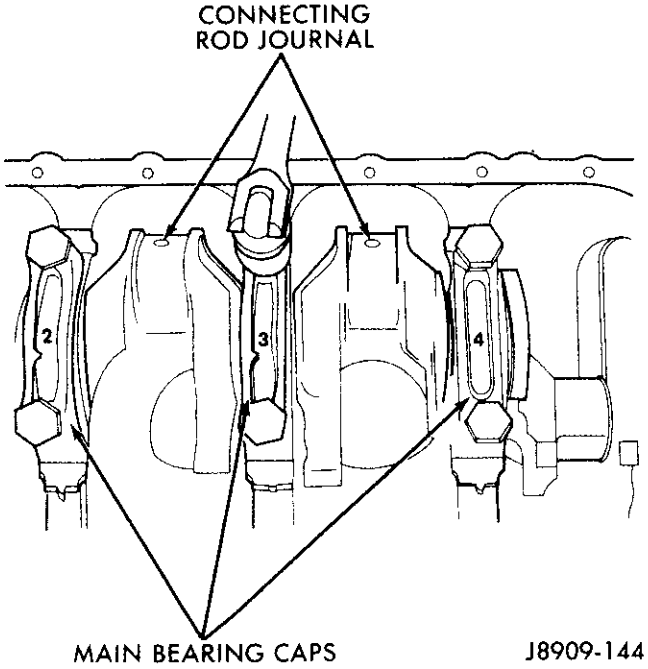
(2) Remove the spark plugs.

(3) Raise the vehicle.

(4) Remove the oil pan and oil pump as outlined in the removal procedures.

(5) Remove the main bearing caps and lower inserts (Fig. 1).

(6) Remove the lower insert from the bearing cap.



J8909-144

Fig. 1 Removing Main Bearing Caps and Lower Inserts

(7) Remove the upper insert by loosening all of the other bearing caps and inserting a small cotter pin tool in the crankshaft journal oil hole. Bend the cotter pin as illustrated to fabricate the tool (Fig. 2). With the cotter pin tool in place, rotate the crankshaft so that the upper bearing insert will rotate in the direction of its locking tab. **Because there is no hole in the number 3 main journal, use a tongue depressor or similar soft-faced tool to remove the bearing insert (Fig. 2). After moving the insert approximately 25 mm (1 inch), it can be removed by applying pressure under the tab.**

(8) Using the same procedure described above, remove the remaining bearing inserts one at a time for inspection.

Inspection

Wipe the inserts clean and inspect for abnormal wear patterns and for metal or other foreign material imbedded in the lining. Normal main bearing insert wear patterns are illustrated (Fig. 3).

If any of the crankshaft journals are scored, remove the engine for crankshaft repair.

Inspect the back of the inserts for fractures, scrapings or irregular wear patterns.

Inspect the upper insert locking tabs for damage.

Replace all damaged or worn bearing inserts.

Fitting

The main bearing caps, numbered (front to rear) from 1 through 5 have an arrow to indicate the forward position (Fig. 1). The upper main bearing inserts are grooved to provide oil channels while the lower inserts are smooth. Crankshaft end play is controlled by the thrust bearing which is flanged and installed at the number 2 main bearing position.

Each bearing insert pair is selectively fitted to its respective journal to obtain the specified operating clearance. In production, the select fit is obtained by using various-sized color-coded bearing insert pairs as listed in the Main Bearing Fitting Chart. The bearing color code appears on the edge of the insert. **The size is not stamped on bearing inserts used for engine production.**

The main bearing journal size (diameter) is identified in production by a color-coded paint mark on the adjacent cheek toward the flanged (rear) end of the crankshaft, except for the rear main journal, which is on the crankshaft rear flange.

When required, upper and lower bearing inserts of different sizes may be used as a pair. A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce the clearance by 0.013 mm (0.0005 inch). **Never use a pair of bearing inserts with greater than a 0.025 mm (0.001 inch) difference in size.**

FOR EXAMPLE:

When replacing inserts, the odd size inserts must be either all on the top (in cylinder block) or all on the bottom (in main bearing cap).

Bearing Insert Pairs

Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.025 mm (0.001 in.) Undersize	0.051 mm (0.002 in.) Undersize

J9009-62

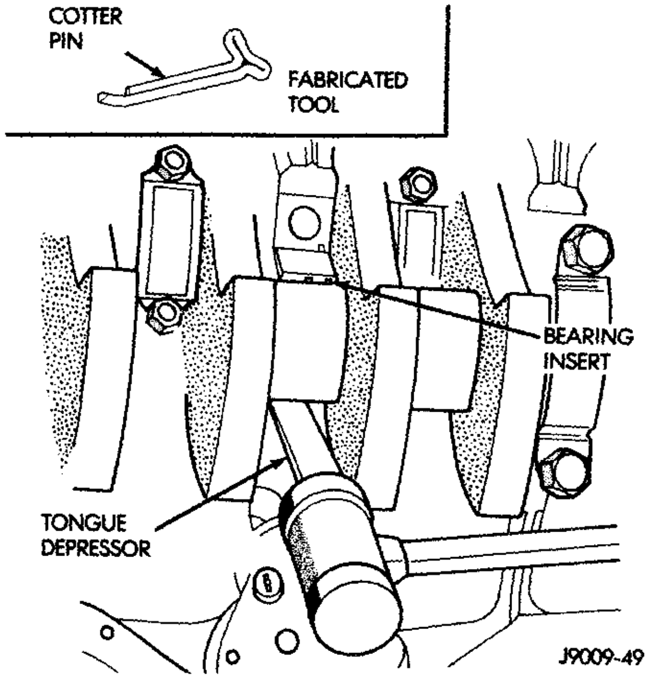


Fig. 2 Removing Upper Inserts

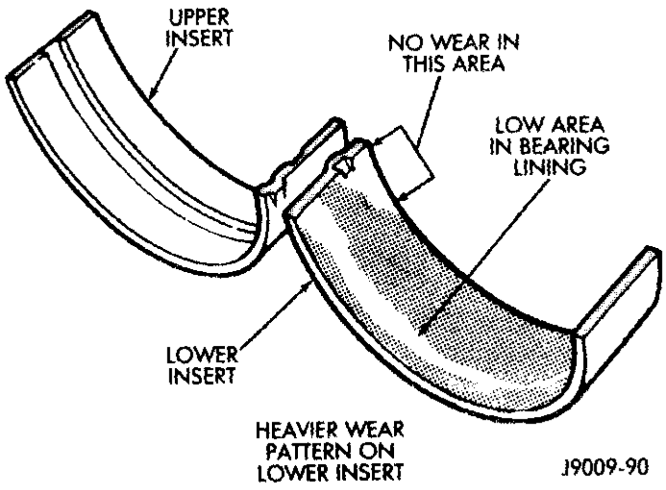


Fig. 3 Main Bearing Wear Patterns

Main Bearing-to-Journal Clearance — Crankshaft Installed

When using Plastigage, check only one bearing clearance at a time.

Install the grooved main bearings into the cylinder block and the non-grooved bearings into the bearing caps.

Install the crankshaft into the upper bearings dry.

Place a strip of Plastigage across full width of the crankshaft journal to be checked.

Install the bearing cap and tighten the bolts to 108 N•m (80 ft. lbs.) torque.

Do not rotate the crankshaft. This will cause the Plastigage to shift, resulting in an inaccurate reading. Plastigage must not be permitted to crumble. If brittle, obtain fresh stock.

Remove the bearing cap. Determine the amount of clearance by measuring the width of the compressed Plastigage with the scale on the Plastigage envelope (Fig. 4). The correct clearance is 0.0254 to 0.0635 mm (.0010 to .0025 inches) for all main bearing journals, with 0.051 mm (0.002 inch) preferred.

Plastigage should indicate the same clearance across the entire width of the insert. If clearance varies, it may indicate a tapered journal or foreign material trapped behind the insert.

If the specified clearance is indicated and there are no abnormal wear patterns, replacement of the bearing inserts is not necessary. Remove the Plastigage from the crankshaft journal and bearing insert. Proceed to Crankshaft Main Bearing - Installation.

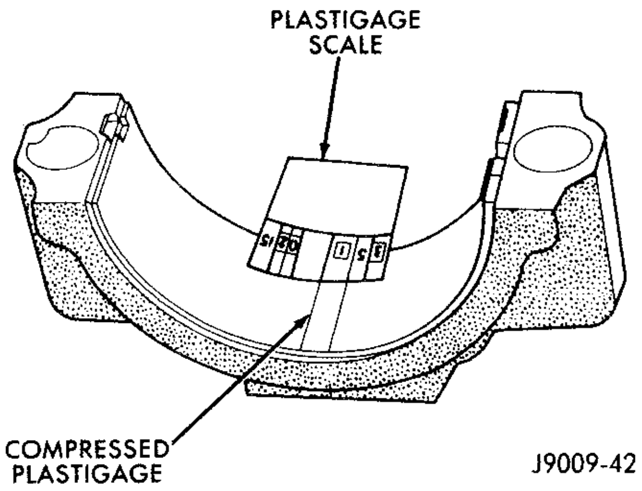


Fig. 4 Measuring Clearance with Plastigage

If the clearance exceeds specification, install a pair of 0.025 mm (0.001 inch) undersize bearing inserts and measure the clearance as described in the previous steps.

The clearance indicated with the 0.025 mm (0.001 inch) undersize insert pair installed will determine if this insert size or some other combination will provide the specified clearance.

FOR EXAMPLE:

If the clearance was 0.0762 mm (0.003 inch) originally, a pair of 0.0254 mm (0.001 inch) undersize inserts would reduce the clearance by 0.0254 mm (0.001 inch). The clearance would then be 0.0508 mm (0.002 inch) and within the specification. A 0.051 mm (0.002 inch) undersize bearing insert and a 0.0254 mm (0.001 inch) undersize insert would reduce the original clearance an additional 0.0127 mm (0.0005 inch) and the clearance would then be 0.0381 mm (0.0015 inch).

CAUTION: Never use a pair of inserts that differ more than one bearing size as a pair. For example, do not use a standard size upper insert and a 0.051 mm (0.002 inch) undersize lower insert.

If the clearance exceeds the specification using a pair of 0.051 mm (0.002 inch) undersize bearing inserts, measure the crankshaft journal diameter with a micrometer. If the journal diameter is correct, the crankshaft bore in the cylinder block may be misaligned, which requires cylinder block replacement or machining to true bore.

If the diameter for journals 1 through 5 is less than 63.4517 mm (2.4981 inches), replace the crankshaft or grind the crankshaft down to accept the appropriate undersize bearing inserts.

Once the proper clearances have been obtained remove the crankshaft and proceed to Crankshaft Main Bearing - Installation.

Main Bearing Journal Diameter — Crankshaft Removed

Clean the main bearing journal of oil.

Determine the maximum diameter of journal with a micrometer. Measure at two locations 90° apart at each end of the journal.

The maximum allowable taper and out of round is 0.013 mm (0.0005 inch). Compare measured diameter with the journal diameter specification listed in the Main Bearing Fitting Chart and select inserts required to obtain the specified bearing-to-journal clearance.

MAIN BEARING FITTING CHART

Crankshaft No. 1 Main Bearing Journal Color Codes and Diameter In Inches (mm)	Cylinder Block No. 1 Main Bearing Bore Color Code and Size In Inches (mm)	Bearing Insert Color Code	
		Upper Insert Size	Lower Insert Size
Yellow — 2.5001 to 2.4996 (Standard) (63.5025 to 63.4898)	Yellow — 2.6910 to 2.6915 (68.3514 to 68.3641)	Yellow — Standard	Yellow — Standard
	Black — 2.6915 to 2.6920 (68.3641 to 68.3768)	Yellow — Standard	Black — 0.001-Inch Undersize (0.025 mm)
Orange — 2.4996 to 2.4991 (0.0005 Undersize) (63.4898 to 63.4771)	Yellow — 2.6910 to 2.6915 (68.3514 to 68.3641)	Yellow — Standard	Black — 0.001-Inch Undersize — (0.001 mm)
	Black — 2.6915 to 2.6920 (68.3461 to 68.3768)	Black — 0.001-Inch Undersize (0.025 mm)	Black — 0.001-Inch Undersize (0.025 mm)
Black — 2.4991 to 2.4986 (0.001 Undersize) (63.4771 to 63.4644)	Yellow — 2.6910 to 2.6915 (68.3514 to 68.3641)	Black — 0.001-Inch Undersize — (0.025mm)	Black — 0.001-Inch Undersize — (0.025 mm)
	Black — 2.6915 to 2.6920 (68.3461 to 68.3768)	Black — 0.001-Inch Undersize (0.025 mm)	Green — 0.002-Inch Undersize (0.051 mm)
Green — 2.4986 to 2.4981 (0.0015 Undersize) (63.4644 to 63.4517)	Yellow — 2.6910 to 2.6915 (68.3514 to 68.3641)	Black — 0.001-Inch Undersize — (0.025 mm)	Green — 0.002-Inch Undersize — (0.051 mm)
Red — 2.4901 to 2.4896 (0.010 Undersize) (63.2485 to 63.2358)	Yellow — 2.6910 to 2.6915 (68.3514 to 68.3641)	Red — 0.010-Inch Undersize (0.254 mm)	Red — 0.010-Inch Undersize — (0.254 mm)

NOTE: With Green and Red Coded Crankshaft Journals, Use Yellow Coded Cylinder Block Bores Only.

Crankshaft Main Bearing Journal 2-3-4-5 Color Code and Diameter In Inches (Journal Size)	Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow — 2.5001 to 2.4996 (Standard) (63.5025 to 63.4898)	Yellow — Standard	Yellow — Standard
Orange — 2.4996 to 2.4991 (0.0005 Undersize) (63.4898 to 63.4771)	Yellow — Standard	Black — 0.001-Inch Undersize (0.025 mm)
Black — 2.4991 to 2.4986 (0.001 Undersize) (63.4771 to 63.4644)	Black — 0.001-Inch Undersize (0.025 mm)	Black — 0.001-Inch Undersize (0.025 mm)
Green — 2.4986 to 2.4981 (0.0015 Undersize) (63.4644 to 63.4517)	Black — 0.001-Inch Undersize (0.025 mm)	Green — 0.002-Inch Undersize (0.051 mm)
Red — 2.4901 to 2.4896 (0.010 Undersize) (63.2485 to 63.2358)	Red — 0.010 Inch Undersize (0.054 mm)	Red — 0.010-Inch Undersize (0.254 mm)

J9009-72

Installation

(1) Lubricate the bearing surface of each insert with engine oil.

(2) Loosen all the main bearing caps. Install the main bearing upper insert(s).

(3) Install the main bearing cap(s) and lower insert(s).

(4) Tighten the bolts of caps 1, 3, 4, and 5 to 54 N•m (40 ft. lbs.) torque, then tighten to 95 N•m (70 ft. lbs.) torque.

(5) Finally, tighten the bolts of main bearing caps 1, 3, 4, and 5 to 108 N•m (80 ft. lbs.) torque.

(6) Push the crankshaft forward and backward. Load the crankshaft front or rear and tighten cap bolt #2 to 54 N•m (40 ft. lbs.) torque. Then tighten to 95 N•m (70 ft. lbs.) torque and finally tighten to 108 N•m (80 ft. lbs.) torque.

(7) Rotate the crankshaft after tightening each main

the crankshaft rotates freely.

(8) Check crankshaft end play. Refer to Crankshaft End Play procedures.

(9) Install the oil pan with replacement gaskets and seals. Refer to the Oil Pan - Installation procedure.

(10) Tighten the drain plug to 34 N•m (25 ft. lbs.) torque.

(11) Lower the vehicle.

(12) Install the spark plugs. Tighten the plugs to 37 N•m (27 ft. lbs.) torque.

(13) Fill the oil pan with engine oil to the full mark on the dipstick level.

(14) Connect the battery negative cable.

Crankshaft End Play

(1) Attach a magnetic base dial indicator to the cylinder block at either the front or rear of the engine.

(2) Position the dial indicator rod so that it is parallel to the center line of the crankshaft.

(3) Pry the crankshaft forward, position the dial indicator to zero.

(4) Pry the crankshaft forward and backward. Note the dial indicator readings. End play is the difference between the high and low measurements (Fig. 5). Correct end play is 0.038 to 0.165 mm (0.0015 to 0.0065 inch). The desired specifications are 0.051 to 0.064 mm (0.002 to 0.0025 inch).

(5) If end play is not within specification, inspect crankshaft thrust faces for wear. If no wear is apparent, replace the thrust bearing and measure end play. If end play is still not within specification, replace the crankshaft.

REAR MAIN OIL SEALS — 2.5L

Removal

To replace the rear main oil seal, the transmission must be removed. Refer to Group 21, Transmission for the proper procedure.

(1) Remove the flywheel or converter drive plate. Discard the old bolts.

(2) Pry out the seal from around the crankshaft flange (Fig. 6).

Installation

(1) Coat the outer lip of the replacement rear main bearing seal with engine oil.

(2) Carefully position the seal into place. Use rear main Seal Installer Tool 6271 to install the seal flush with the cylinder block.

CAUTION: The felt lip must be located inside the flywheel mounting surface. If the lip is not positioned correctly the flywheel could tear the seal.

(3) Install the flywheel or converter drive plate. New bolts MUST be used when installing the flywheel or converter plate. Tighten the new bolts to 68 N•m (50 ft. lbs.) torque. Turn the bolts an additional 60°.

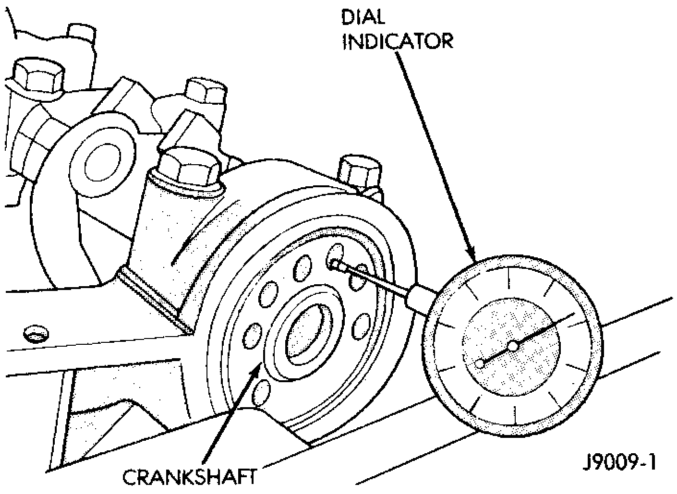


Fig. 5 Crankshaft End Play Measurement

(4) Install the transmission. Refer to Group 21, Transmission for the proper procedure.

CYLINDER BLOCK — 2.5L

Disassembly

(1) Remove the water pump and distributor from the cylinder block.

(2) Remove the vibration damper using Vibration Removal Tool 8068 (Fig. 7).

(3) Remove the timing case cover (Fig. 8) and lay upside down.

(4) Position a drift punch into the slot (Fig. 9) in the back of the cover and tap the old seal out.

(5) Remove the timing chain bumper (Fig. 9).

(6) Remove the oil slinger from crankshaft.

(7) Remove the camshaft retaining bolt and remove the sprockets and chain as an assembly (Fig. 10).

(8) Remove the camshaft (Fig. 11).

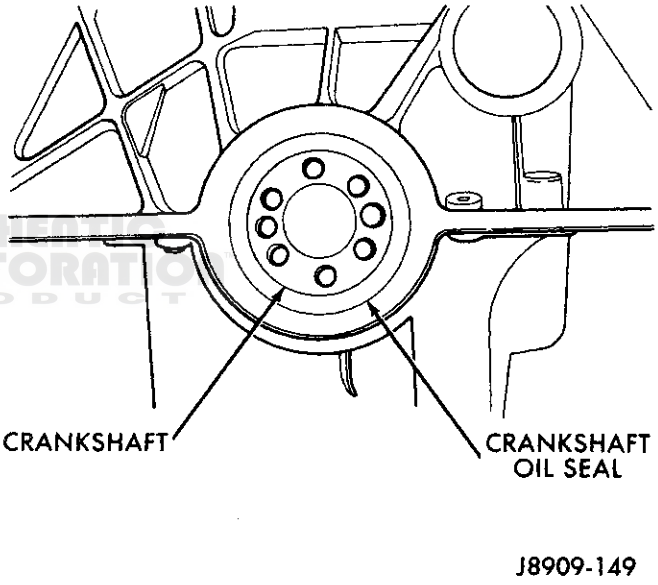


Fig. 6 Replacement of Rear Crankshaft Oil Seal

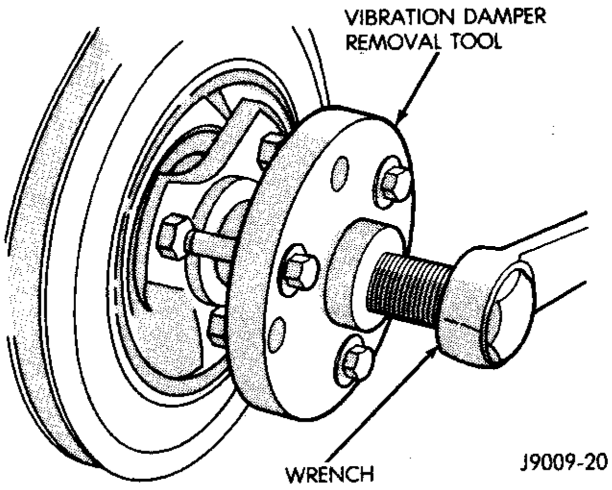


Fig. 7 Removing Vibration Damper

(9) Remove the oil pan, gaskets and seals.

(10) Thoroughly clean the pan and engine block gasket surfaces.

(11) Remove the timing chain tensioner (Fig. 12).

(12) Remove the front and rear oil galley plugs.

(13) Use compressed air to clean out:

- The galley at the oil filter adaptor hole, the filter bypass hole (Fig. 13).
- The front (Fig. 14) and rear oil galley holes (Fig. 15).
- The feed holes for the crankshaft main bearings.

Once the block has been completely cleaned, apply Loctite PST pipe sealant with Teflon 592 to the threads of the oil galley plugs and tighten them to 41 N•m (30 ft. lbs.) torque.

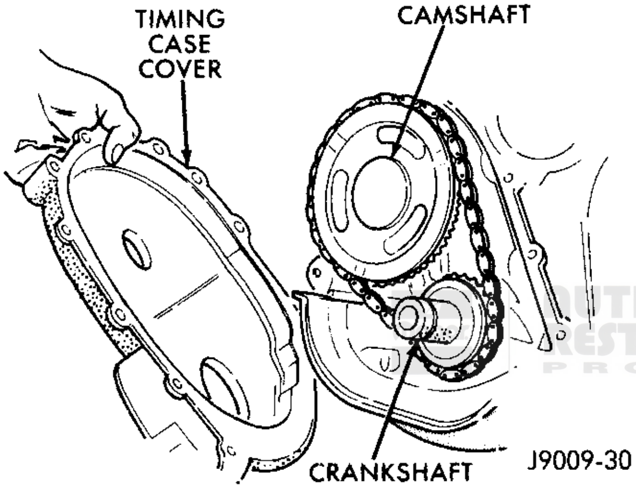


Fig. 8 Timing Case Cover Removal

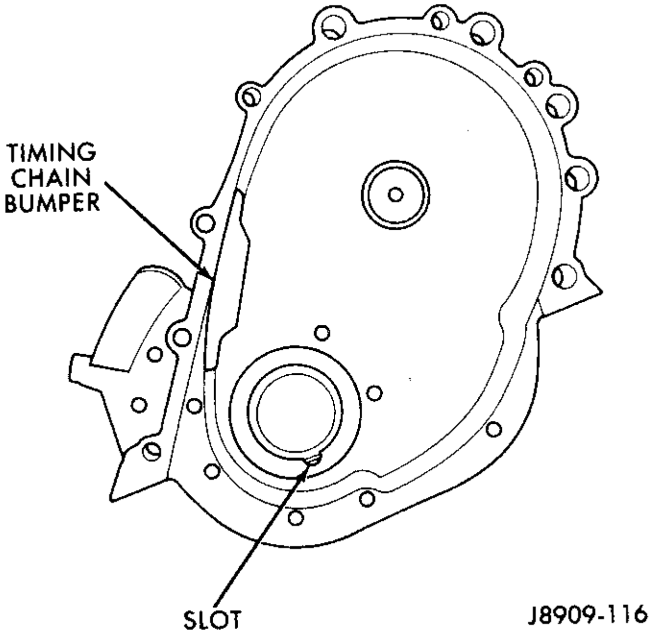


Fig. 9 Removing Timing Case Cover Oil Seal and Timing Chain Bumper

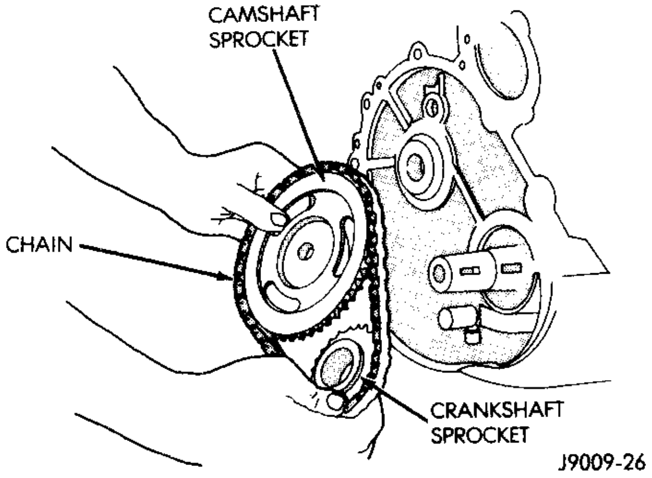


Fig. 10 Sprockets and Chain Removal

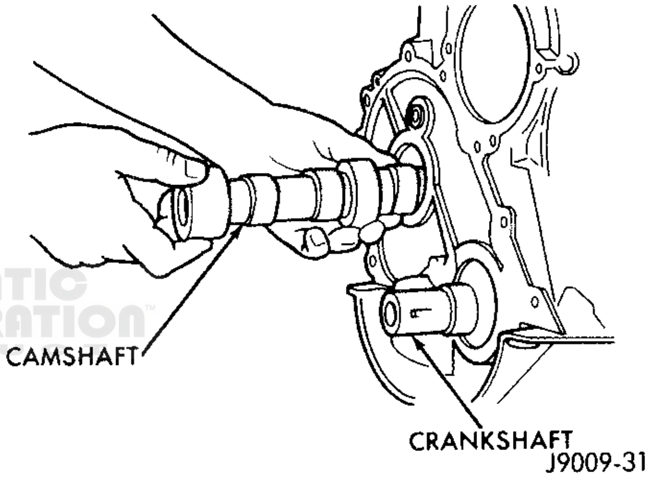


Fig. 11 Camshaft Removal

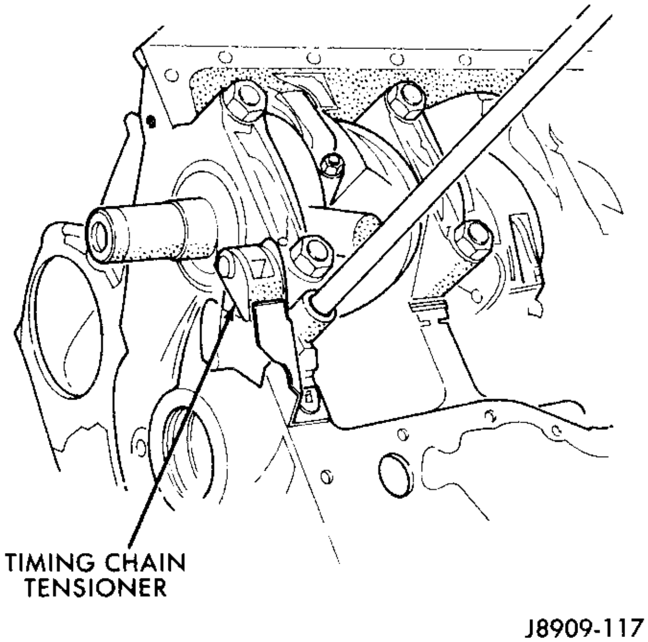


Fig. 12 Timing Chain Tensioner Removal

Inspection — Cylinder Bore

Bore Measurement

(1) Use a bore gauge (Fig. 16) to measure each cylinder bore diameter. If a bore gauge is not available, use an inside micrometer.

(2) Measure the cylinder bore diameter crosswise to the cylinder block near the top of bore. Repeat measurement at the bottom of the bore.

(3) Determine taper by subtracting the smaller diameter from the larger diameter.

(4) Rotate measuring device 120° and repeat steps above. Finally, rotate the device another 120° and repeat measurements.

(5) Determine out-of-roundness by comparing difference between each 120° measurement.

(6) If the cylinder bore taper does not exceed 0.025 mm (0.001 inch) and the out-of-roundness does not exceed 0.025 mm (0.001 inch), the cylinder bore can be honed. If the cylinder bore taper or out-of-round condition exceeds these maximum limits, the cylinder must be bored and then honed to accept an oversize piston. A slight amount of taper always exists in the cylinder bore after the engine has been in use for a period of time.

Cylinder Bore Reconditioning

CAUTION: Do not use rigid type hones to remove cylinder wall glaze.

(1) Use an expanding type hone on the cylinder bore and to remove glaze for faster piston ring seating. Move the hone down and up (stroke) at sufficient speed to produce uniform 60° angle crosshatch pattern on the cylinder walls. Do not use more than ten (10) strokes per cylinder (one stroke is one down-and-up movement). Refer to General Information section of this Group for the proper honing operation.

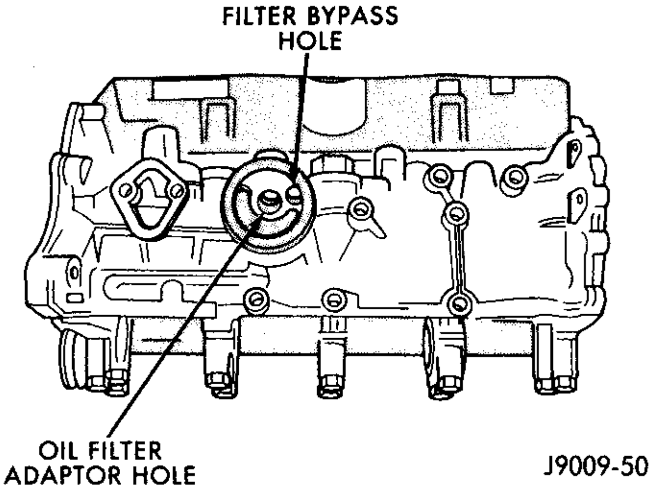


Fig. 13 Oil Filter Adaptor Hole

(2) Scrub the cylinder bores clean with a solution of hot water and detergent.

(3) Immediately apply light engine oil to the cylinder walls. Wipe with clean, lint-free cloth.

Assembly

(1) Install the water pump and gasket. Tighten the bolts to 18 N•m (13 ft. lbs.) torque.

(2) Lubricate the oil filter seal with clean engine oil.

(3) Install the oil filter to engine. Tighten oil filter 3/4 of a turn after oil filter seal contacts the mating surface of the engine.

(4) Align key slot on the vibration damper with the crankshaft key and tap damper onto the crankshaft.

(5) Install the vibration damper retaining bolt and washer. Tighten the bolt to 108 N•m (80 ft. lbs.) torque.

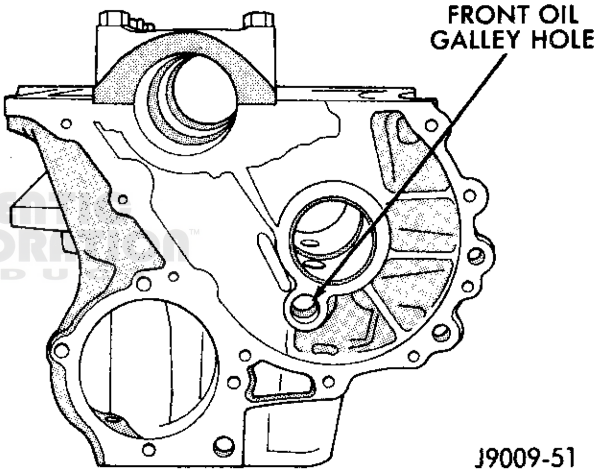


Fig. 14 Front Oil Galley Hole

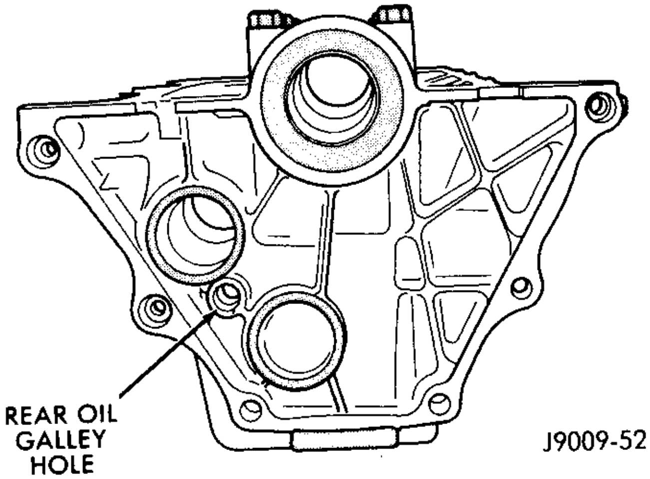


Fig. 15 Rear Oil Galley Hole

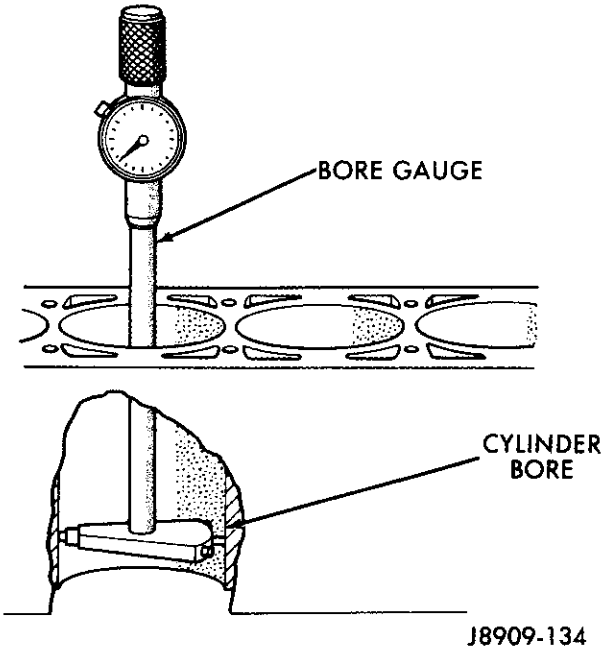


Fig. 16 Cylinder Bore Measurement

ENGINE SPECIFICATIONS — 2.5L

Camshaft

Tappet Clearance	Zero lash (hyd.) tappets	
End Play	Zero (engine operation)	
Bearing Clearance	0.025-0.076 mm	0.001-0.003 in.
Bearing Journal Diameter		
No. 1	51.54-51.56 mm	2.029-2.030 in.
No. 2	51.28-51.31 mm	2.019-2.020 in.
No. 3	51.03-51.05 mm	2.009-2.010 in.
No. 4	50.78-50.80 mm	1.999-2.000 in.
Base Circle Runout	0.03 mm max.	0.001 in. max.
Cam Lobe Lift		
Intake	6.731 mm	0.265 in.
Exhaust	6.731 mm	0.265 in.
Valve Lift		
Intake	10.770 mm	0.424 in.
Exhaust	10.770 mm	0.424 in.
Intake Valve Timing		
Opens	12° BTDC	
Closes	78° ABDC	
Exhaust Valve Timing		
Opens	56° BBDC	
Closes	34° ATDC	
Valve Overlap	46°	
Intake Duration	270°	
Exhaust Duration	270°	

Connecting Rods

Total Weight (Less Bearings)	657-665 grams	23.2-23.5 oz.
Total Length (Center-to-Center)	155.52-155.62 mm	6.123-6.127 in.
Piston Pin Bore Diameter	23.59-23.62 mm	0.9288-0.9298 in.
Connecting Rod Bore (Less Bearings)	56.08-56.09 mm	2.2080-2.2085 in.
Bearing Clearance	0.03-0.08 mm	0.001-0.0025 in.
Preferred	0.044-0.050 mm	0.0015-0.0020 in.
Side Clearance	0.25-0.48 mm	0.010-0.019 in.
Maximum Twist	0.001 mm per mm	0.001 in. per in.
Maximum Bend	0.001 mm per mm	0.001 in. per in.

Crankshafts

End Play	0.038-0.165 mm	0.0015-0.0065 in.
Main Bearing Journal Diameter	63.489-63.502 mm	2.4996-2.5001 in.
Main Bearing Journal Width		
No. 1	27.58-27.89 mm	1.086-1.098 in.
No. 2	32.28-32.33 mm	1.271-1.273 in.
No. 3-4-5	30.02-30.18 mm	1.182-1.188 in.
Main Bearing Clearance	0.03-0.06 mm	0.001-0.0025 in.
Preferred	0.051 mm	0.002 in.
Connecting Rod Journal Diameter	53.17-53.23 mm	2.0934-2.0955 in.
Connecting Rod Journal Width	27.18-27.33	1.070-1.076 in.
Maximum Out-of-Round (All Journals)	0.013 mm	0.0005 in.
Maximum Taper (All Journals)	0.013 mm	0.0005 in.

J8909-411

ENGINE SPECIFICATIONS — 2.5L (CONT.)

Cylinder Block		
Deck Height	236.73 mm	9.320 in.
Deck Clearance	0.000 mm	0.000 in.
Cylinder Bore Diameter (Standard)	98.42-98.48 mm	3.8751-3.8775 in.
Maximum Taper	0.025 mm	0.001 in.
Maximum Out-of-Round	0.025 mm	0.001 in.
Tappet Bore Diameter	23.000-23.025 mm	0.9055-0.9065 in.
Cylinder Block Flatness	0.03 per 25 mm	0.001 per 1 in.
	0.05 per 152 mm	0.002 per 6 in.
Main Bearing Bore Diameter	68.35-68.38 mm	2.691-2.692 in.
Cylinder Head		
Combustion Chamber Volume	49.9-52.9 cc	3.04-3.23 cu. in.
Valve Arrangement	E-I-I-E-E-I-I-E	
Valve Guide ID (Integral)	7.95-7.97 mm	0.313-0.314 in.
Valve Stem-to-Guide Clearance	0.02-0.07 mm	0.001-0.003 in.
Intake Valve Seat Angle	44°30′	
Exhaust Valve Seat Angle	44°30′	
Valve Seat Width	1.02-1.52 mm	0.040-0.060 in.
Valve Seat Runout	0.064 mm	0.0025 in.
Cylinder Head Flatness	0.03 per 25 mm	0.001 per 1 in.
	0.05 per 152 mm	0.002 per 6 in.
Oil Pressure		
At Idle Speed (800 rpm)	172-241 kPa	25-35 psi
At 1600+ rpm	255-517 kPa	37-75 psi
Oil Pressure Relief	517 kPa	75 psi
Oil Pump		
Gear-to-Body Clearance (Radial)	0.051-0.102 mm	0.002-0.004 in.
Preferred	0.051 mm	0.002 in.
Gear End Clearance — Plastigage	0.051-0.152 mm	0.002-0.006 in.
Preferred	0.051 mm	0.002 in.
Gear End Clearance — Feeler Gauge	0.1016-0.2032 mm	0.004-0.008 in.
Preferred	0.1778 mm	0.007 in.
Rocker Arms, Push Rods and Tappets		
Rocker Arm Ratio	1.6:1	
Push Rod Length	241.300-241.808 mm	9.500-9.520 in.
Push Rod Diameter	7.92-8.00 mm	0.312-0.315 in.
Hydraulic Tappet Diameter	22.962-22.974 mm	0.904-0.9045 in.
Tappet-to-Bore Clearance	0.03-0.05 mm	0.001-0.0025 in.

J8909-66

ENGINE SPECIFICATIONS — 2.5L (CONT.)

Pistons

Weight (Less Pin)	563-567 grams	19.86-20.00 oz.
Piston Pin Bore Centerline-to-Piston Top	40.67 mm	1.601 in.
Piston-to-Bore Clearance	0.033-0.053 mm	0.0013-0.0021 in.
Piston Ring Gap Clearance — Compression (Both)	0.25-0.51 mm	0.010-0.020 in.
Piston Ring Gap Clearance — Oil Control Steel Rails	0.381-1.397 mm	0.015-0.055 in.
Piston Ring Side Clearance		
No. 1 Compression	0.0254-0.0813 mm	0.001-0.0032 in.
No. 2 Compression	0.254-0.241 mm	0.001-0.0032 in.
Oil Control	0.254-0.2032 mm	0.001-0.0085 in.
Piston Ring Groove Height		
Compression (Both)	2.019-2.045 mm	0.0795-0.0805 in.
Oil Control	4.78-4.80 mm	0.188-0.1895 in.
Piston Ring Groove Diameter		
No. 1 and No. 2	87.78-87.90 mm	3.456-3.461 in.
Oil Control	87.50-87.75 mm	3.445-3.455 in.
Piston Pin Bore Diameter	23.624-23.655 mm	0.9308-0.9313 in.
Piston Pin Diameter	23.632-23.645 mm	0.9304-0.9309 in.
Piston-to-Pin Clearance	0.010-0.015 mm	0.0004-0.0006 in.
Preferred	Loose 0.015 mm	Loose 0.0006 in.
Piston Pin-to-Connecting Rod	8.9 kN Press-fit	2000 lbs.-f Press-fit

Valves

Valve Length (Tip-to-Gauge Dim. Line)		
Intake	124.435-125.070 mm	4.899-4.924 in.
Exhaust	125.120-125.755 mm	4.927-4.952 in.
Valve Stem Diameter	7.89-7.98 mm	0.311-0.312 in.
Stem-to-Guide Clearance	0.02-0.05 mm	0.001-0.003 in.
Intake Valve Head Diameter	48.38-48.6 mm	1.905-1.915 in.
Intake Valve Face Angle	45°	
Exhaust Valve Head Diameter	37.97-38.6 mm	1.495-1.505 in.
Exhaust Valve Face Angle	45°	
Maximum Allowable Removed for Tip Refinishing	0.25 mm	0.010 in.
Valve Springs Free Length	49.962 mm	1.967 in.
Valve Spring Tension Closed	355-400 N @ 41.656 mm	80-90 lbs @ 1.640 in.
Valve Spring Tension Open	890 N @ 30.886 mm	200 lbs @ 1.216 in.

E8909-405

TORQUE SPECIFICATIONS — 2.5L

Component	**Torque**	
A/C Bracket-to-Block/Head Bolts	40 N·m	30 ft-lbs
A/C Compressor-to-Bracket Bolts	27 N·m	20 ft-lbs
Alternator Adjusting Bolt	27 N·m	20 ft-lbs
Alternator Pivot Bolt/Nut	38 N·m	28 ft-lbs
Alternator Mounting Bracket-to-Engine Bolts	38 N·m	28 ft-lbs
Alternator Mounting-to-Head Bolts	45 N·m	33 ft-lbs
Block Heater Nut	1.8 N·m	16 in-lbs
Camshaft Sprocket Bolt	108 N·m	80 ft-lbs
Connecting Rod Bolt Nuts	45 N·m	33 ft-lbs
Converter Plate Bolts	68 N•m +60°	50 ft-lbs +60°
Crankshaft Main Bearing Bolts	108 N·m	80 ft-lbs
Crankshaft Pulley-to-Damper Nut	27 N·m	20 ft-lbs
Crossmember-to-Sill – Front Bolts	88 N·m	65 ft-lbs
– Rear Nuts	41 N·m	30 ft-lbs
Cylinder Block Oil Galley Plugs	41 N·m	30 ft-lbs
Cylinder Head Bolts (#1-7 & #9-10)	149 N·m	110 ft-lbs
(#8)	136 N·m	100 ft-lbs
Cylinder Head Cover Bolts	8 N·m	70 in-lbs
Drive Plate-to-Torque Converter Bolts	54 N·m	40 ft-lbs
Engine Shock Damper Stud Nut	23 N·m	17 ft-lbs
Exhaust Manifold-to-Downpipe Nuts	31 N·m	23 ft-lbs
Flywheel Bolts	68 N•m +60°	50 ft-lbs +60°
Front Support Bracket-to-Cylinder Block	61 N·m	45 ft-lbs
Front Support Cushion-to-Mount (Thru Bolt)	65 N·m	48 ft-lbs
Front Support Cushion-to-Sill Bracket	40 N·m	30 ft-lbs
Fuel Pump Bolts	22 N·m	16 ft-lbs
Oil Pan Bolts – 1/4-20	9 N·m	7 ft-lbs
– 5/16-18	15 N·m	11 ft-lbs
Oil Pan Drain Plug	34 N·m	25 ft-lbs
Oil Pan-to-Timing Case Cover Bolts	13 N·m	11 ft-lbs
Oil Pump Attaching Bolts (Short)	14 N·m	10 ft-lbs
Oil Pump Attaching Bolts (Long)	23 N·m	17 ft-lbs
Oil Pump Cover Bolts	8 N·m	70 in-lbs
Power Steering Pump Pressure Hose Nut	52 N·m	38 ft-lbs
Rear Support Cushion-to-Bracket Bolts	43 N·m	32 ft-lbs
Rocker Arm Assembly-to-Cylinder Head	26 N·m	19 ft-lbs
Spark Plugs	37 N•m	27 ft-lbs
Starting Motor-to-Cylinder Block Bolts	45 N·m	33 ft-lbs
Timing Case Cover-to-Block Bolts	7 N·m	62 in-lbs
Vibration Damper Bolt (Lubricated)	108 N·m	80 ft-lbs

J9009-53

4.0L ENGINE SERVICE PROCEDURES

INDEX

ENGINE MOUNTS — 4.0L

Resilient rubber cushions support the engine and transmission at three points: at each side on the centerline of the engine (Fig. 1) and at the rear between the transmission extension housing and the rear support crossmember.

Replacement of a cushion may be accomplished by supporting the weight of the engine or transmission at the area of the cushion.

ENGINE ASSEMBLY — 4.0L

Removal

(1) Disconnect the battery negative cable (Fig. 3).

(2) Remove the air cleaner assembly (Fig. 3).

(3) Disconnect the vacuum harness connector (Fig. 2).

(a) Lift the vacuum connector from the bracket on the intake manifold.

(b) Depress the lock tabs and pull the vacuum connector apart (Fig. 2).

(4) Remove the hood.

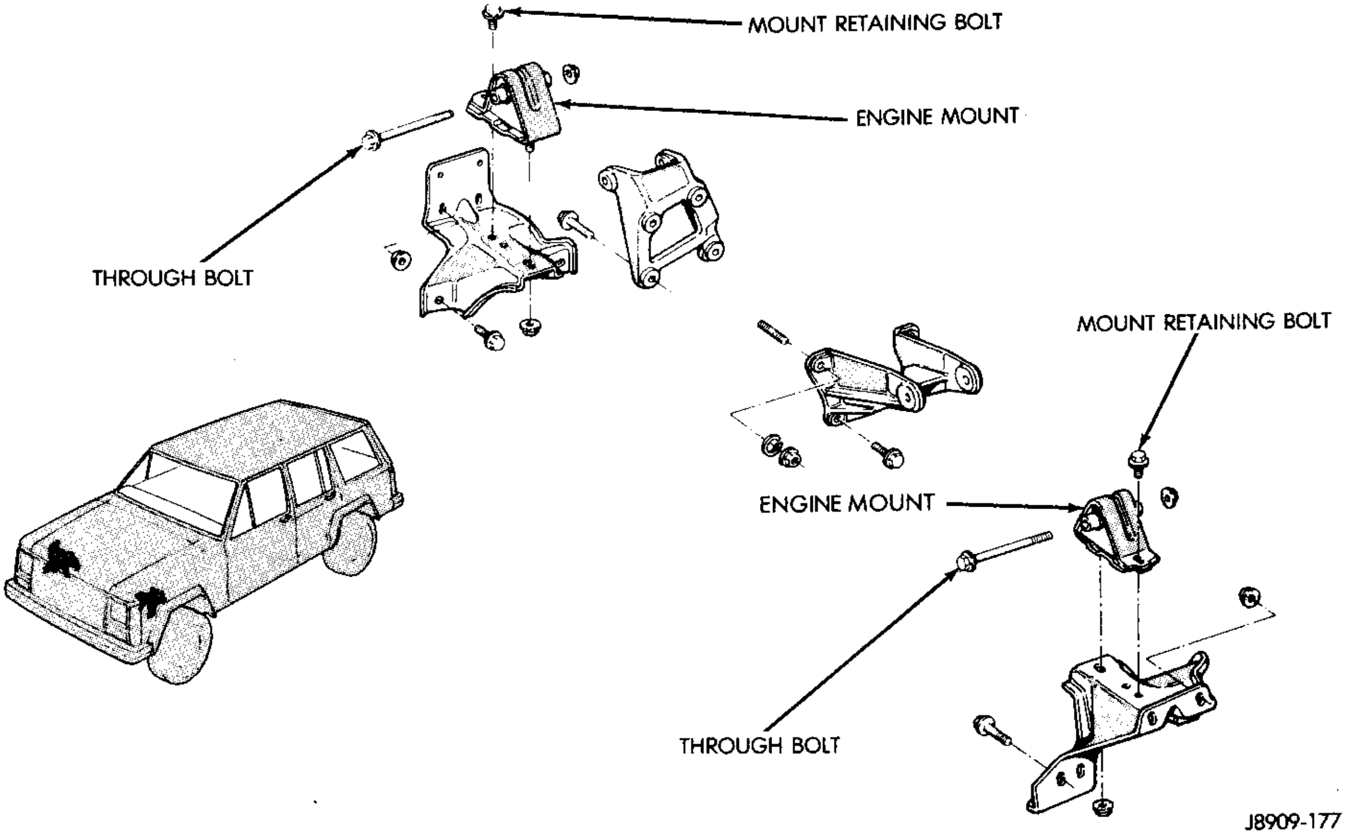


Fig. 1 Front Engine Mounts

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM IS PRESSURIZED.

(5) Drain the radiator. Save the coolant for reuse when installing the engine.

(6) Remove the lower radiator hose.

(7) Remove the upper radiator hose (Fig. 3).

(8) Remove upper radiator support retaining bolts and remove radiator support.

(9) Remove the fan shroud and electric cooling fan.

(10) Disconnect the transmission fluid cooler tubing (automatic transmission).

(11) Disconnect radiator fan switch wire connector.

(12) **Vehicles with Air Conditioning:**

(a) Discharge the A/C condenser.

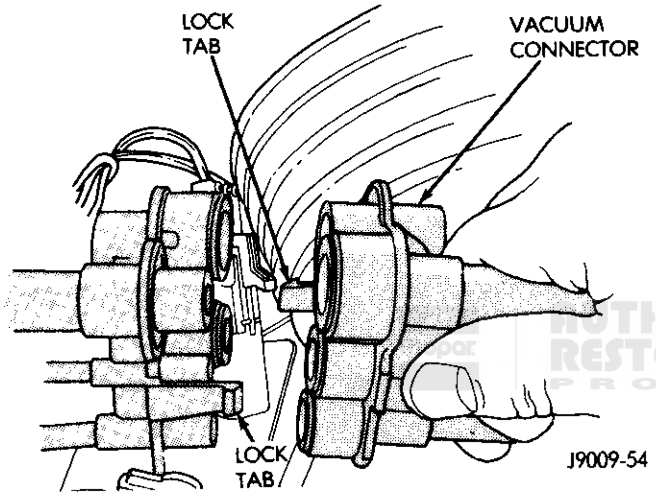


Fig. 2 Vacuum Harness Connector

(b) Remove the service valves and cap the compressor ports.

(13) Remove the radiator or radiator/condenser (if equipped with A/C).

(14) Remove the fan assembly from the idler pulley.

(15) Disconnect the heater hoses at the engine thermostat housing and water pump (Fig. 3).

(16) Disconnect the throttle linkages (Fig. 3).

(17) Disconnect the cruise control cable (if equipped) - (Fig. 3).

(18) Disconnect the line pressure cable (if equipped with automatic transmission).

(19) Disconnect injection system wire harness connector at the dash panel.

(20) Disconnect the distributor electrical connection and the oil pressure switch connector.

(21) Disconnect the quick-connect fuel lines at the fuel rail and return line by squeezing the 2 retaining tabs against the fuel tube. Pull the fuel tube and retainer from the quick-connect fitting.

(22) Remove the power brake vacuum check valve from the booster, if equipped (Fig. 3).

(23) **Vehicles with Power Steering - (Fig. 3):**

(a) Disconnect the power steering hoses from the fittings at the steering gear.

(b) Drain the pump reservoir.

(c) Cap the fittings on the hoses and steering gear to prevent foreign objects from entering the system.

(24) Identify, tag and disconnect all necessary wire connectors and vacuum hoses.

(25) Raise and support the vehicle.

(26) Disconnect the wires from the starter motor solenoid.

(27) Remove the starter motor.

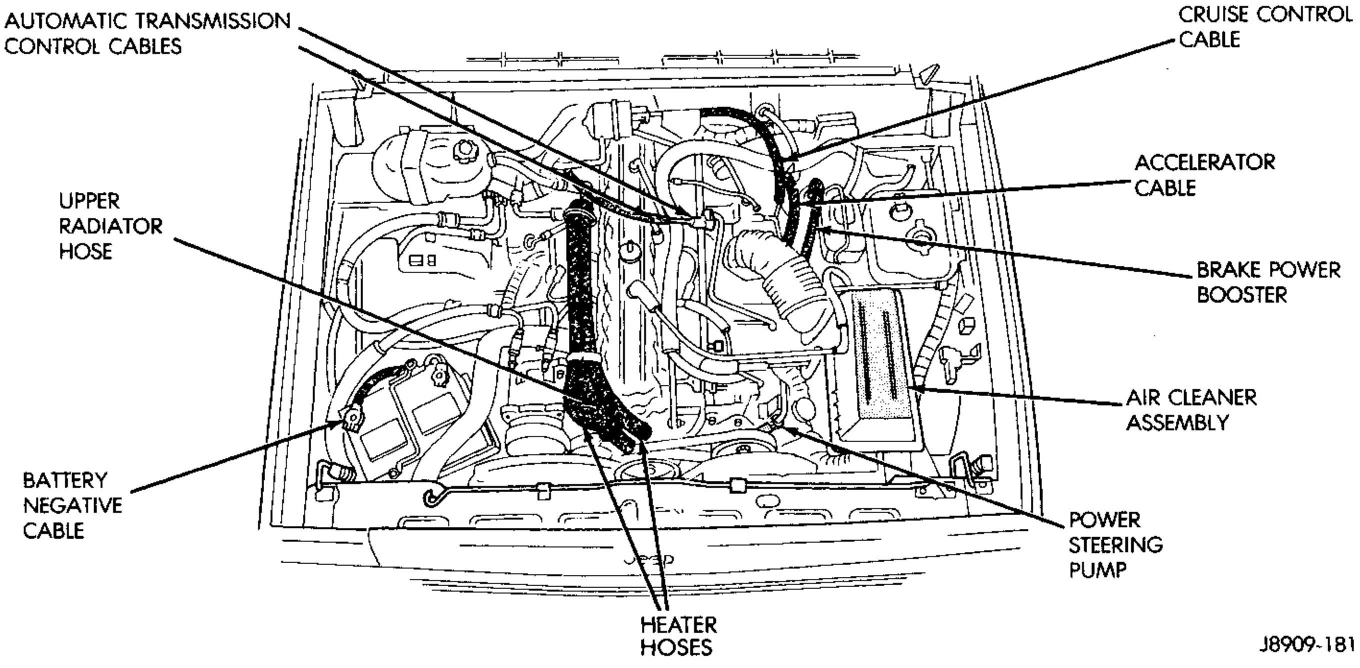


Fig. 3 Engine Compartment — Top View

(28) Disconnect the exhaust pipe from the manifold.

(29) Remove the two (2) screws and disconnect the engine speed sensor wire connection.

(30) Remove the exhaust pipe support.

(31) Remove the flywheel/converter housing access cover.

(32) **Vehicles with Automatic Transmission:**

(a) Mark the converter and drive plate location.

(b) Remove the converter-to-drive plate bolts.

(33) Remove the upper flywheel/converter housing bolts and loosen the bottom bolts.

(34) Remove the engine mount cushion-to-engine compartment bracket bolts.

(35) Lower the vehicle.

(36) Attach a lifting device to the engine.

(37) Raise the engine off the front supports.

(38) Place a support or floor jack under the converter (or flywheel) housing.

(39) Remove the remaining converter (or flywheel) housing bolts.

(40) Lift the engine out of the engine compartment.

Installation

CAUTION: When installing the engine into a vehicle equipped with an automatic transmission, be careful not to damage the trigger wheel on the flywheel.

(1) Attach a lifting device to the engine and lower the engine into the engine compartment. For easier installation, it may be necessary to remove the engine mount cushions from the engine mount bracket as an aide in alignment of the engine to the transmission.

(2) **Vehicles with Manual Transmission:**

(a) Insert the transmission shaft into the clutch spline.

(b) Align the flywheel housing with the engine.

(c) Install and tighten the flywheel housing lower bolts finger tight.

(3) **Vehicles with Automatic Transmission:**

(a) Align the transmission torque converter housing with the engine.

(b) Loosely install the converter housing lower bolts and install the next higher bolt and nut on each side.

(c) Tighten all four (4) bolts finger tight.

(4) Install the engine mount cushions (if removed).

(5) Lower the engine and engine mount cushions onto the engine compartment brackets. Install the bolts and finger tighten the nuts.

(6) Remove the engine lifting device.

(7) Raise and support the vehicle.

(8) Install the remaining flywheel/converter housing bolts and tighten all bolts to 38 N•m (28 ft. lbs.) torque.

(9) **Vehicles with Automatic Transmission:**

(a) Install the converter-to-drive plate bolts.

(b) Ensure the installation reference marks are aligned.

(10) Install the flywheel/converter housing access cover.

(11) Install the exhaust pipe support and tighten the screw.

(12) Tighten the engine mount-to-bracket bolts.

(13) Connect the engine speed sensor wire connections and tighten the two (2) screws.

(14) Connect the exhaust pipe to the manifold.

(15) Install the starter motor and connect the cable.

(16) Connect the wires to the starter motor solenoid.

(17) Lower the vehicle.

(18) Connect all the vacuum hoses and wire connectors identified during engine removal.

(19) **Vehicles with Power Steering:**

(a) Remove the caps from the fittings on the hoses and steering gear.

(b) Connect the power steering hoses to the steering gear.

(c) Fill the power steering pump reservoir.

(20) Remove the power brake vacuum check valve from the booster, if equipped.

(21) Connect the fuel inlet and return lines at the quick-connect connectors on the fuel rail. Refer to Group 14, Fuel System for the proper procedures.

(22) Connect the distributor electrical connector and oil pressure switch connector.

(23) Connect the injection system wire harness connector on the dash panel.

(24) Connect the line pressure cable (if equipped with automatic transmission).

(25) Connect the cruise control cable, if equipped.

(26) Connect the throttle cable linkages.

(27) Connect the heater hoses at the engine thermostat housing and water pump.

(28) Install the fan assembly to the idler pulley.

(29) Install the radiator or radiator/condenser (if equipped with A/C).

(30) Connect the service valves to the A/C compressor ports, if equipped with A/C.

(31) Charge the air conditioner system.

(32) Connect radiator fan switch wire.

(33) Connect the radiator hoses and automatic transmission fluid cooler pipes, if equipped.

(34) Install the fan shroud, electric cooling fan and radiator/condenser (if equipped with A/C).

(35) Remove upper radiator support retaining bolts and remove radiator support.

(36) Connect the upper radiator hose and tighten the clamp.

(37) Connect the lower radiator hose and tighten the clamp.

(38) Fill the cooling system with reuseable coolant and/or new coolant.

(39) Install the hood.

(40) Connect the vacuum harness connector.

(a) Firmly push the 2 connectors together ensuring that the retaining tabs are engaged.

(b) Insert the vacuum connector assembly into the retaining bracket on the intake manifold.

(41) Install the air cleaner assembly.

(42) Connect the battery negative cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(43) Start the engine, inspect for leaks and correct the fluid levels as necessary.

CYLINDER HEAD COVER — 4.0L

Removal

(1) Remove PCV molded hoses from the cover (Fig. 4).

(2) Remove the cruise control servo, if equipped (Fig. 4).

(3) Remove cylinder head cover retaining bolts.

(4) Lift and remove the cover. The cylinder head cover utilize a precured RTV sealer that is attached to the cover. Inspect the sealer for cracks and/or damage that may have occured during removal.

(5) Small cracks in the sealer are allowed and can be repaired by applying RTV sealer to the cracked area before cylinder head cover installation.

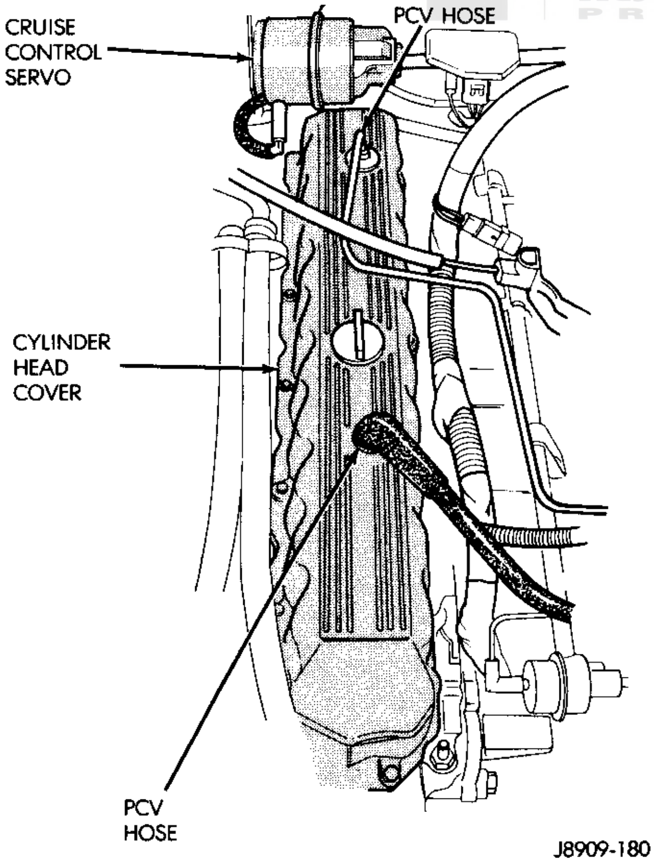


Fig. 4 Cylinder Head Cover

Inspection and Cleaning

Replace the cover if it is cracked or damaged in any way. If the pre-cured RTV seal is damaged, replace the cover.

If a replacement cover is installed, transfer the PCV valve grommet and oil filler cap from the original cover to the replacement cover.

Remove any original sealer from the cover sealing surface of the cylinder head and clean the surface using a fabric cleaner.

Remove all residue from the sealing surface using a clean, dry cloth.

Installation

(1) Clean the cover and cylinder head sealing surface using a clean dry cloth.

(2) Install the cover and retaining bolts. Tighten the retaining bolts to 6 N•m (55 in. lbs.) torque.

(3) Install the cruise control servo (if removed).

(4) Install the PCV molded hoses to the cylinder head cover.

ROCKER ARMS — 4.0L

Removal

(1) Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

(2) Remove the two capscrews at each bridge and pivot assembly (Fig. 5). Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridges.

(3) Remove the bridges, pivots and corresponding pairs of rocker arms (Fig. 4) and place them on a bench in the same order as removed.

(4) Remove the push rods (Fig. 5) and place them on a bench in the same order as removed.

Cleaning and Inspection

Clean all the components with cleaning solvent and use compressed air to blow out the oil passages in the rocker arms and push rods.

Inspect the pivot surface area of each rocker arm. Replace any that are scuffed, pitted or excessively worn.

Inspect the valve stem tip contact surface of each rocker arm and replace any rocker arm that is deeply pitted.

Inspect each push rod end for excessive wear and replace as required. If any push rod is excessively worn because of lack of oil, replace the push rod and inspect the corresponding hydraulic tappet.

A wear pattern along the length of the push rod is not normal. Inspect the cylinder head for obstruction if this condition exists.

Insatllation

(1) Install the push rods in their original locations. Ensure that the bottom end of each push rod is centered in the tappet plunger cap seat.

(2) Install the rocker arms, pivots and bridge above each cylinder from where they were originally removed.

(3) Loosely install the capscrews through each bridge.

(4) At each bridge, tighten the capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(5) Install the cylinder head cover. Refer to Cylinder Head Cover Installation for the procedure.

CYLINDER HEAD — 4.0L

Removal

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

(1) Drain the coolant and disconnect the hoses at the thermostat housing. Do not waste reusable coolant. If the solution is clean and is being drained only to service the engine or cooling system, drain the coolant into a clean container for reuse.

(2) Remove the air cleaner.

(3) Remove the fuel pipe and vacuum advance hose.

(4) Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

(5) Remove the capscrews, bridge and pivot assemblies and rocker arms (Fig. 5). Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridge.

(6) Remove the push rods (Fig. 5). **Retain the push rods, bridges, pivots and rocker arms in the same order as removed to facilitate installation in the original locations.**

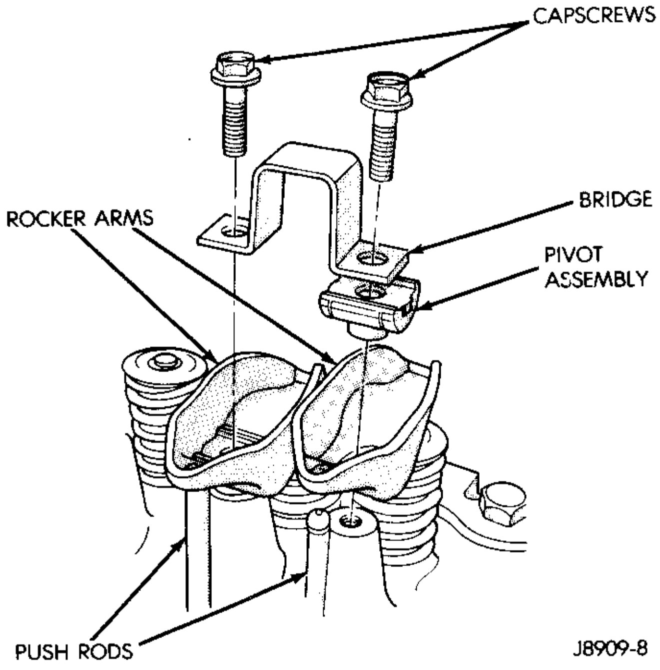


Fig. 5 Rocker Arm Assembly

(7) Loosen the alternator drive belt and remove the alternator bracket-to-cylinder head mounting bolt. **The serpentine drive belt tension is released by loosening the alternator.**

(8) Disconnect the power steering pump bracket. Set the pump and bracket aside. Do not disconnect the hoses.

(9) Remove the intake and exhaust manifolds from the cylinder head. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedures.

(10) If equipped with air conditioning, perform the following:

(a) Remove the air conditioner compressor bracket bolts from the cylinder head.

(b) Remove the bolts from the A/C compressor mounting bracket and set the compressor aside.

(c) Loosen the through bolt at the bottom of the bracket.

(11) Disconnect the ignition wires and remove the spark plugs.

(12) Disconnect the temperature sending unit wire connector and battery negative cable.

(13) Remove the ignition coil and bracket assembly.

(14) Remove the cylinder head bolts. Bolt No. 14 cannot be removed until the head is moved foreward (Fig. 6). Pull bolt No. 14 out as far as it will go and then suspend the bolt in this position (tape around the bolt).

(15) If this was the first time the bolts were removed, put a paint dab on the top of the bolt. If the bolts have a paint dab on the top of the bolt or you don't know if they were used before, discard the bolts.

(16) Remove the cylinder head and gasket (Fig. 6).

Cleaning and Inspection

Thoroughly clean the machined surfaces of the cylinder head and block. Remove all gasket material and cement.

Remove any carbon deposits from the combustion chambers and top of the pistons.

Use a straightedge and feeler gauge to check the flat-

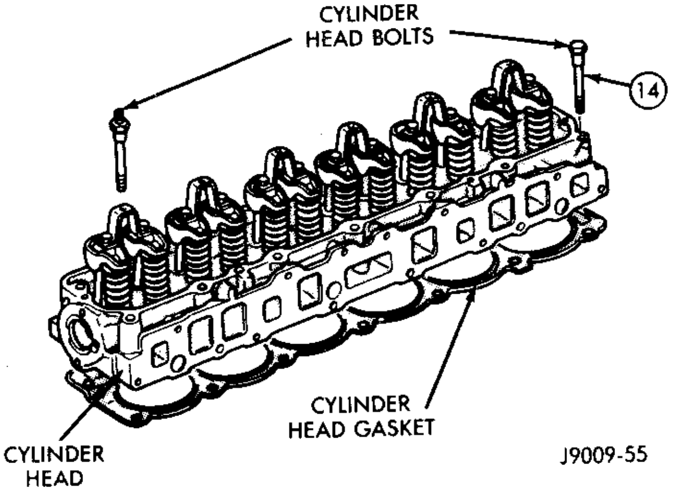


Fig. 6 Cylinder Head Assembly

ness of the cylinder head and block mating surfaces. Refer to the Specifications.

Installation

If the cylinder head is to be replaced and the original valves used, measure the valve stem diameter. Only standard size valves can be used with a service replacement cylinder head unless the replacement head valve stem guide bores are reamed to accommodate oversize valve stems. Remove all carbon buildup and reface the valves. Refer to Valve Refacing for the proper procedure.

(1) Install the valves in the cylinder head using replacement valve stem oil seals (Fig. 7). There are markings on the top of the seals indicating INT (Intake Valve) or EXH (Exhaust Valve). Refer to Valve Installation for the proper procedures.

(2) Transfer all attached components from the original cylinder head that are not included with the replacement head. Do not install the temperature sending unit until coolant is installed. This permits trapped air to escape from the cylinder block and head. Refer to Group 7, Cooling Systems for the proper procedure.

CAUTION: Do not apply sealing compound on the cylinder head and block gasket surfaces. Do not allow sealing compound to enter the cylinder bore.

(3) Coat the cylinder bores with clean engine oil.

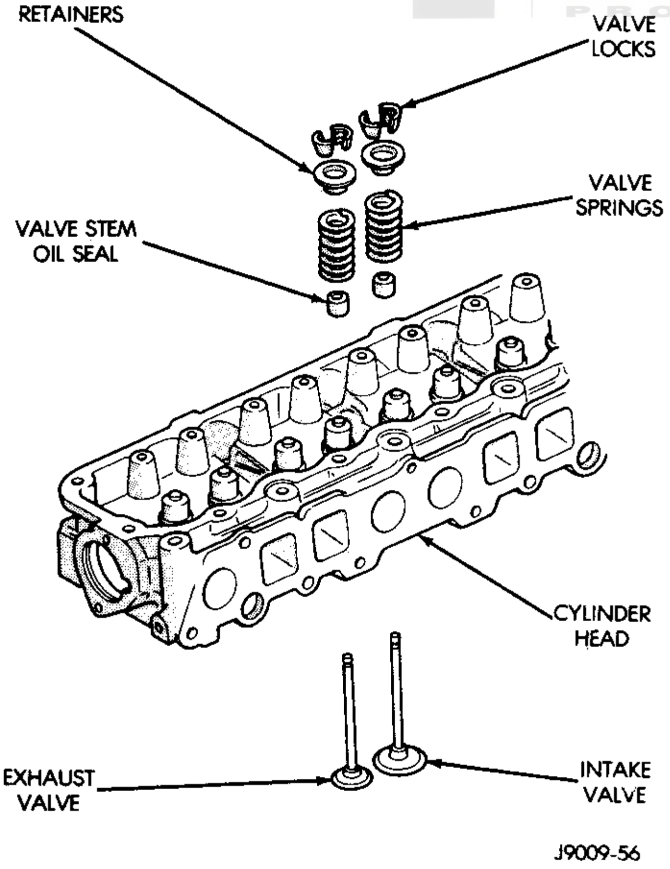


Fig. 7 Valve Components

(4) Install the cylinder head. Tighten the bolts in sequence (Fig. 8) as follows:

CAUTION: Cylinder head bolts should be reused only once. Replace the head bolts if they were used before or if they have a paint dab on the top of the bolt.

(a) Coat the threads of the stud bolt in the No. 11 position with Loctite 592 sealant, or equivalent, before installation.

(b) Tighten all cylinder head bolts to 29 N•m (22 ft. lbs.) torque using the tightening sequence.

(c) Tighten all cylinder head bolts to 61 N•m (45 ft. lbs.) torque using the tightening sequence.

(d) Recheck all cylinder head bolts at 61 N•m (45 ft. lbs.) torque using the tightening sequence.

(e) Tighten all cylinder head bolts (except No. 11) to 149 N•m (110 ft. lbs.) torque and tighten bolt No. 11 to 135 N•m (100 ft. lbs.) torque using the tightening sequence.

Clean and mark each bolt with a dab of paint after tightening. Should you encounter a set of bolts which were painted during an earlier servicing operation, replace them.

(5) Connect the battery negative cable.

(6) Install the ignition coil and bracket assembly.

(7) Install the spark plugs and connect the ignition wires. Tighten the spark plugs to 37 N•m (27 ft. lbs.) torque.

(8) Attach the air conditioner compressor mounting bracket to the cylinder head, if removed.

(9) Install the intake and exhaust manifolds. Use the correct tightening sequence. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedures.

(10) Install the alternator bracket bolt on the head. Install the alternator belt and adjust the tension.

(11) Install the power steering bracket and pump. Adjust the belt tension. Refer to Group 7, Cooling Systems for drive belt (including serpentine) adjustment procedures.

(12) Install the push rods in the order removed.

(13) Install the rocker arms and the bridge and pivot assemblies in the order removed. Loosely install the capscrews for each bridge and tighten alternately, one

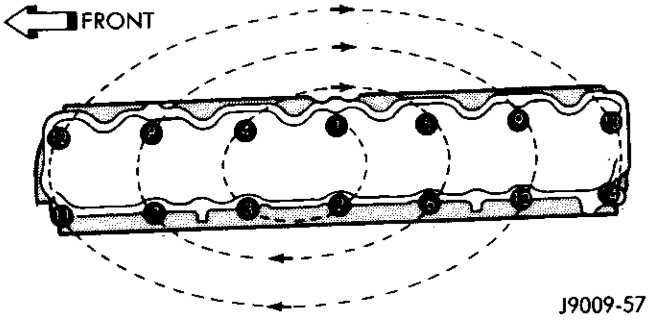


Fig. 8 Cylinder Head Tightening Sequence

turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(14) Install the cylinder head cover.

(15) Connect the hoses to the thermostat housing and fill the cooling system to the specified level. Refer to Group 7, Cooling Systems for the proper procedure.

(16) The automatic transmission throttle linkage and cable must be adjusted after completing the cylinder head installation. Refer to Group 21, Transmissions for the proper procedures.

(17) Install the temperature sending unit and connect the wire connector.

(18) Connect the fuel pipe and vacuum advance hose.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(19) Operate the engine with the radiator cap off. Inspect for leaks and continue operating the engine until the thermostat opens. Add coolant, if required.

(20) Install the air cleaner.

VALVES AND VALVE SPRINGS — 4.0L

Removal — Cylinder Head Removed

(1) Use the Valve Compressor Tool (8014) and compress each valve spring (Fig. 9).

(2) Remove the valve locks, the retainers, the valve springs, and the valve stem oil seals. Discard the seals.

(3) Remove the valves, and place them in a rack in the order in which they are removed.

Valve Cleaning and Inspection

Clean all carbon deposits from the combustion chambers, valve ports, valve stems, valve stem guides and head.

Clean all grime and gasket cement from the cylinder head machined gasket surface.

Inspect for cracks in the combustion chambers and valve ports.

Inspect for cracks on the exhaust seats.

Inspect for cracks in the gasket surface at each coolant passage.

Inspect the valves for burned, cracked or warped heads.

Inspect for scuffed or bent valve stems.

Replace valves displaying any damage.

Valve Refacing

(1) Use a valve refacing machine to reface the intake and exhaust valves to the specified angle.

(2) After refacing, a margin of at least 0.787 mm (0.031 inch) must remain (Fig. 10). If the margin is less than 0.787 mm (0.031 inch), the valve must be replaced.

Valve Seat Refacing

(1) Install a pilot of the correct size in the valve guide bore and reface the valve seat to the specified angle with a good dressing stone.

(2) Remove only enough metal to provide a smooth finish.

(3) Use tapered stones to obtain the specified seat width when required.

(4) Control seat runout to a maximum of 0.0635 mm (0.0025 in), using a dial indicator (Fig. 11).

Valve Stem Oil Seal Replacement

Valve stem oil seals are installed on each valve stem to prevent rocker arm lubricating oil from entering the combustion chamber through the valve guide bores. One seal is marked INT (intake valve) and the other one is marked EXH (exhaust valve).

Replace the oil seals whenever valve service is performed or if the seals have deteriorated.

Valve Guides

The valve guides are an integral part of the cylinder head and are not replaceable.

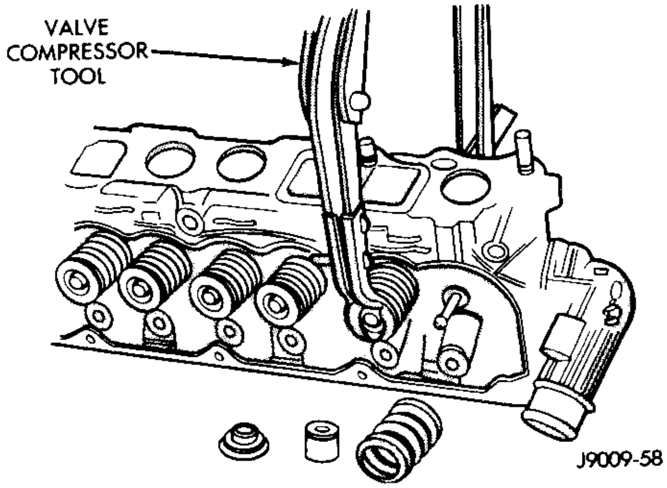


Fig. 9 Valve Compressor Tool (8014)

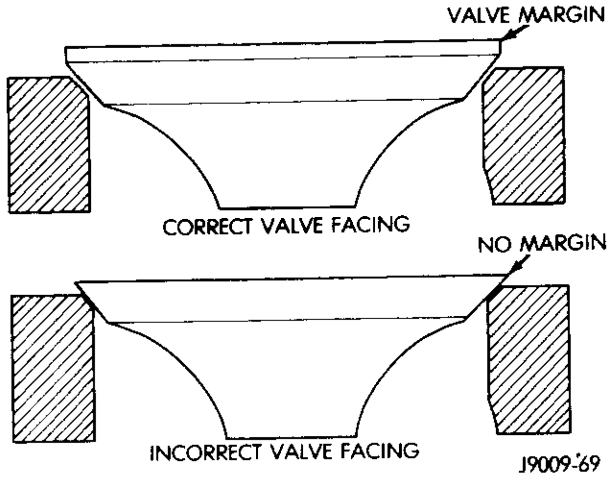


Fig. 10 Valve Facing Margin

When the stem-to-guide clearance is excessive, the valve guide bores must be reamed to accommodate the next larger oversize valve stem.

Oversize stem service valves are available in 0.0762 mm (0.003 inch), 0.381 mm (0.015 inch), and 0.762 mm (0.030 inch) stem sizes. Ream valve guide bores in steps, starting with the 0.0762 mm (0.003 inch) oversize reamer and progress to the size required.

Valve Stem-to-Guide Clearance Measurement

Valve stem-to-guide clearance may be measured by either of the following two methods.

Preferred Method:

(1) Remove the valve from the head. Refer to Valve Removal for the procedure.

(2) Clean the valve stem guide bore with solvent and a bristle brush.

(3) Insert the telescoping gauge into the bore of the valve stem guide approximately 9.525 mm (.375 inch) from the valve spring side of the head with contacts crosswise to the cylinder head (Fig. 12).

(4) Remove and measure the telescoping gauge with a micrometer.

(5) Repeat the measurement with contacts lengthwise to the cylinder head.

(6) Compare the crosswise to lengthwise measurements to determine out-of-roundness. If the measurements differ by more than 0.0635 mm (0.0025 inch), ream the guide bore to accommodate the oversize valve stem.

(7) Compare the measured valve guide bore diameter with the diameter listed in the Engine Specifications. If the measurement differs from the specification by more than 0.0762 mm (0.003 inch), ream the guide bore to accommodate the oversize valve stem.

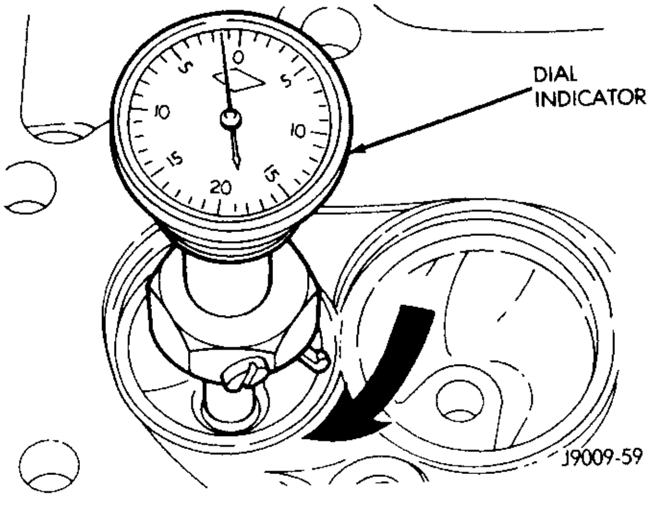


Fig. 11 Measurement of Valve Seat Runout

Alternate Method:

(1) Use a dial indicator to measure the lateral movement of the valve stem (stem-to-guide clearance) with the valve installed in its guide and just off the valve seat (Fig. 13). The correct clearance is 0.0025-0.0762 mm (0.001-0.003 inch).

(2) If the indicated movement exceeds the specification, ream the guide bore to accommodate an oversize valve stem.

Valve Spring Tension Test

Use valve spring tester (8011) and a torque wrench to test each valve spring for the specified tension value (Fig. 14).

Replace the valve springs that are not within specifications.

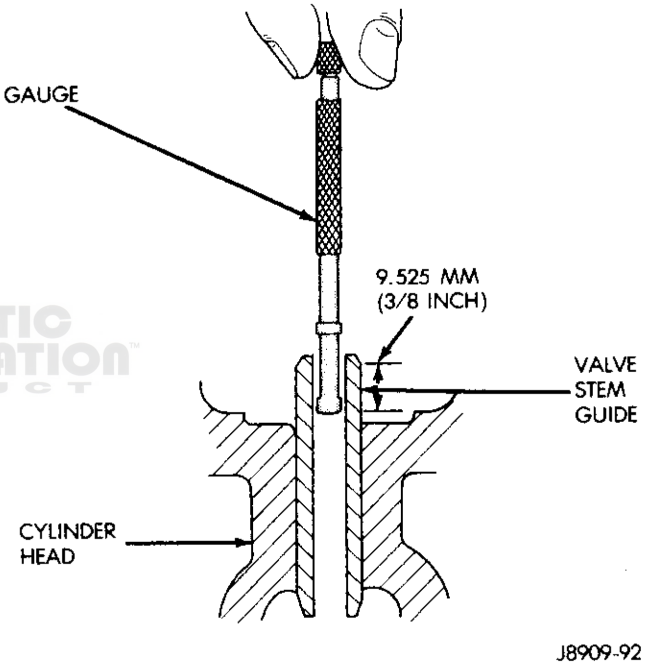


Fig. 12 Measurement of Valve Guide Bore Diameter

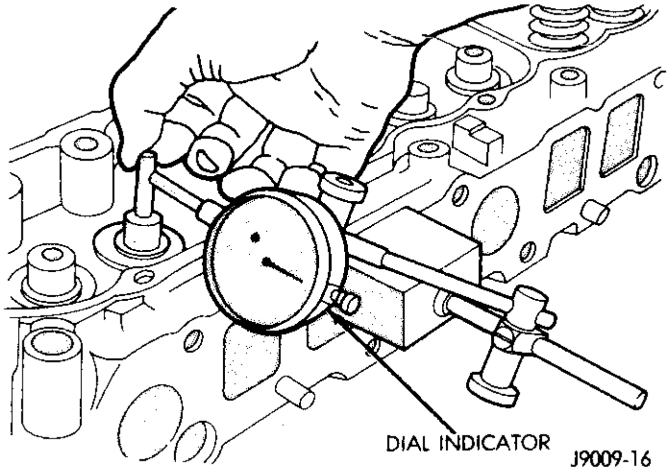


Fig. 13 Measurement of Lateral Movement of Valve Stem

Installation — Cylinder Head Removed

(1) Thoroughly clean the valve stems and the valve guide bores.

(2) Lubricate the stem lightly.

(3) Install the valve in the original valve guide bore from where it was removed (Fig. 7).

(4) Install the replacement valve stem oil seal on the valve stem (Fig. 7). If the 0.381 mm (0.015 inch) oversize valve stems are used, oversize oil seals are required.

(5) Position the valve spring and retainer on the cylinder head and compress the valve spring with Valve Spring Compressor (8014).

(6) Install the valve locks and release the tool.

(7) Tap the valve spring from side to side with a hammer to ensure that the spring is properly seated at the cylinder head. Also tap the top of the retainer to seat the valve locks.

HYDRAULIC TAPPETS — 4.0L

Removal

Retain all the components in the same order as removed to facilitate installation in their original positions.

(1) Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

(2) Remove the bridge and pivot assemblies and rocker arms by removing the two capscrews at each bridge. Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridges.

(3) Remove the push rods.

(4) Remove the intake and exhaust manifolds. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedure.

(5) Remove the cylinder head and gasket. Refer to Cylinder Head Removal for the procedure.

(6) Remove the tappets through the push rod openings in the cylinder block.

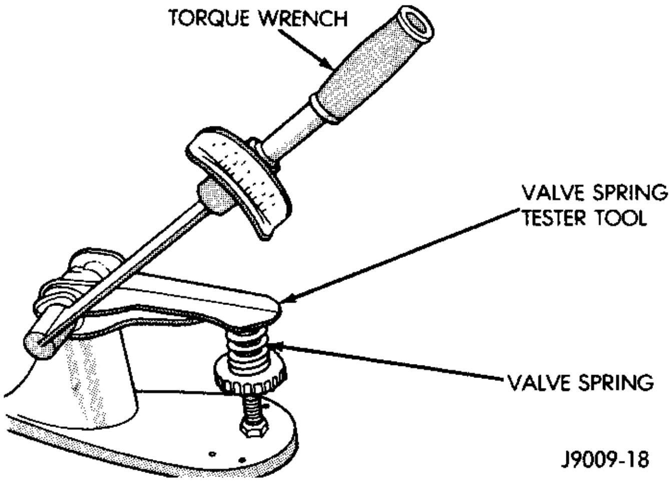


Fig. 14 Valve Spring Tester (8011)

Installation

It is not necessary to charge the tappets with engine oil. They will charge themselves within a very short period of engine operation.

(1) Dip each tappet in Jeep/Eagle Super Oil Conditioner, or equivalent.

(2) Install each tappet in the same bore from where it was originally removed.

(3) Install the exhaust and intake manifolds. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedure.

(4) Install the cylinder head and gasket. Refer to Cylinder Head Installation for the procedure.

(5) Install each push rod in the same location from where removed.

(6) Install the rocker arms and bridge and pivot assemblies at their original locations.

(7) Loosely install the capscrews through each bridge. Tighten the capscrews alternately, one turn at a time, to avoid damaging the bridges.

(8) Pour the remaining Jeep/Eagle Super Oil Conditioner over the entire valve actuating assembly. The Jeep/Eagle Super Oil Conditioner must remain with the engine oil for at least 1 609 km (1,000 mi) but need not be drained until the next scheduled oil change.

(9) Install the cylinder head cover. Refer to Cylinder Head Cover Installation for the procedure.

Disassemby, Cleaning and Inspection

Place the components of each tappet in a separate location. This will greatly assist in the installation operation.

(1) Release the snap ring.

(2) Remove the following from the tappet body (Fig. 15):

- (a) The plunger cap.
- (b) The metering valve.
- (c) The plunger.
- (d) The check valve assembly.
- (e) The plunger return spring.

(3) Clean the components of each tappet assembly in cleaning solvent to remove all varnish, gum and sludge deposits.

(4) Inspect for indications of scuffing on the side and base of each tappet body.

(5) Inspect each tappet base for concave wear with a straightedge positioned across the base.

(6) If the base is concave, the corresponding lobe on the camshaft is also worn. Replace the camshaft and tappets.

Assembly and Lead-Down Test

(1) Install the following in the tappet body:

- (a) The plunger return spring.
- (b) The check valve assembly.

(c) The plunger.

(d) The metering valve.

(e) The plunger cap.

(2) Compress the plunger assembly by exerting force on the plunger cap with the push rod and install the snap ring.

(3) After cleaning, inspection and assembly, test each tappet for the specified leak-down rate tolerance to ensure zero-lash operation (Fig. 16).

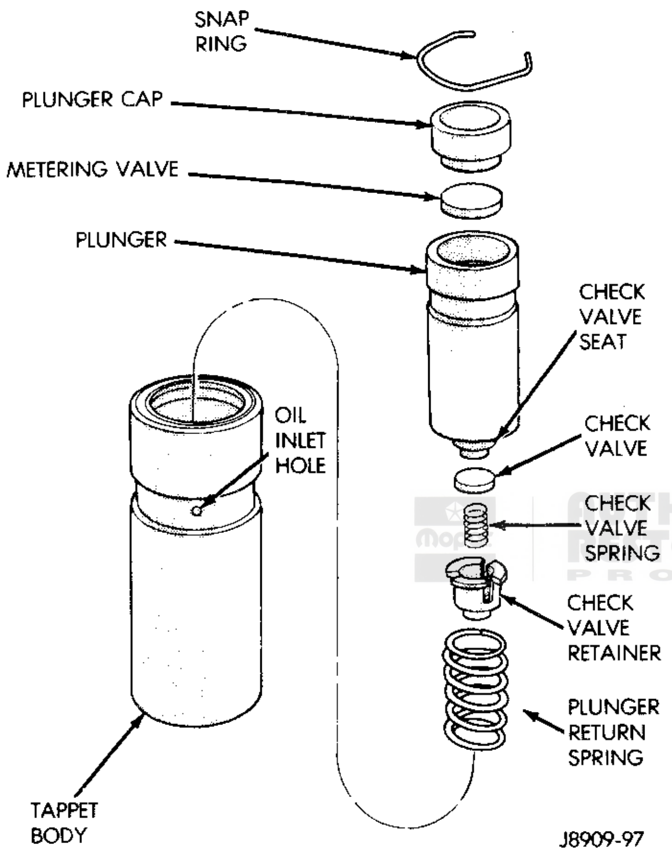


Fig. 15 Hydraulic Tappet

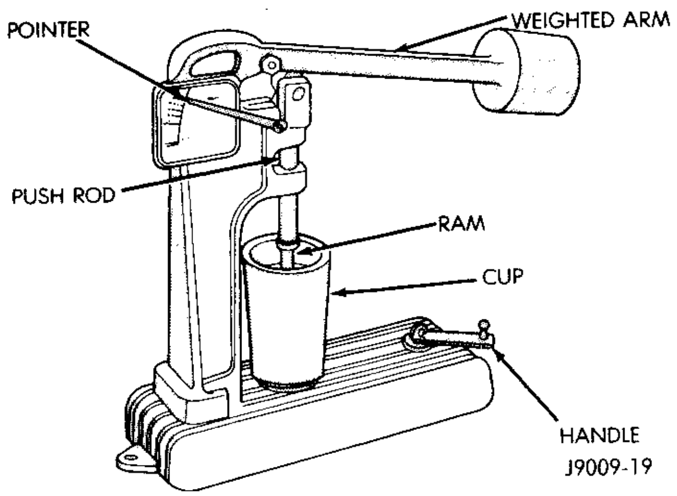


Fig. 16 Leak-Down Tester (7980)

(4) Swing the weighted arm of the hydraulic valve tappet tester away from the ram of the tester (7980).

(5) Place a 7.925-7.950 mm (0.312-0.313 inch) diameter ball bearing on the plunger cap of the tappet.

(6) Lift the ram and position the tappet (with the ball bearing) inside the tester cup.

(7) Lower the ram, then adjust the nose of the ram until it contacts the ball bearing. Do not tighten the hex nut on the ram.

(8) Fill the tester cup with hydraulic valve tappet test oil until the tappet is completely submerged.

(9) Swing the weighted arm onto the push rod and pump the tappet plunger up and down to remove air.

(10) When the air bubbles cease, swing the weighted arm away and allow the plunger to rise to the normal position.

(11) Adjust the nose of the ram to align the pointer with the SET mark on the scale of the tester and tighten the hex nut.

(12) Slowly swing the weighted arm onto the push rod.

(13) Rotate the cup by turning the handle at the base of the tester clockwise one revolution every two seconds.

(14) Observe the leak-down time interval from the instant the pointer aligns with the START mark on the scale until the pointer aligns with the 0.125 mark.

(15) A normally functioning tappet will require 20-110 seconds to leak-down. Discard the tappets with leak-down time intervals which are not within this specification.

VALVE TIMING — 4.0L

Disconnect the spark plug wires and remove the spark plugs.

Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

Remove the capscrews, bridge and pivot assembly, and rocker arms from above the No. 1 cylinder.

Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridge.

Rotate the crankshaft until the No. 6 piston is at top dead center (TDC) on the compression stroke.

Rotate the crankshaft counterclockwise (viewed from the front of the engine) 90°.

Install a dial indicator on the end of the No. 1 cylinder intake valve push rod. Use rubber tubing to secure the indicator stem on the push rod.

Set the dial indicator pointer at zero.

Rotate the crankshaft clockwise (viewed from the front of the engine) until the dial indicator pointer indicates 0.305 mm (0.012 inch) travel distance (lift).

The timing notch index on the vibration damper should be aligned with the TDC mark on the timing degree scale.

If the timing notch is more than 13 mm (1/2 inch) away from the TDC mark in either direction, the valve timing is incorrect.

If the valve timing is incorrect, the cause may be a broken camshaft pin. It is not necessary to replace the camshaft because of pin failure. A spring pin is available for service replacement.

VIBRATION DAMPER — 4.0L

Removal

(1) Remove the drive belt(s).

(2) Remove the retaining bolts and separate the vibration damper pulley (V-belt ONLY) from the vibration damper.

(3) Remove the vibration damper retaining bolt and washer.

(4) Use Vibration Damper Removal Tool (8068) to remove the damper from the crankshaft (Fig. 1).

Installation

(1) With the key in position, align the key slot of the vibration damper hub with the crankshaft key and tap the damper onto the crankshaft.

(2) Install the vibration damper retaining bolt and washer. Tighten the bolt to 108 N•m (80 ft. lbs.) torque. If the crankshaft turns before the damper bolt torque value is attained, the crankshaft can be prevented from turning by placing two 5/16 x 1 1/2 inch bolts into the damper front pulley holes and wedging a bar between them. Rotate the bar until it contacts the frame member to prevent the crankshaft from turning.

(3) Install the damper pulley (V-belt only) and retaining bolts. Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(4) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling Systems for the proper specifications and preocedures.

TIMING CASE COVER — 4.0L

Removal

(1) Remove the drive belt(s), engine fan and hub assembly, fan shroud, vibratation damper, pulley, and key. Refer to Vibration Damper Removal.

(2) Remove the A/C compressor and alternator bracket assembly, if equipped. Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

(3) Remove the oil pan-to-timing case cover screws and cover-to-cylinder block bolts.

(4) Remove the timing case cover, front seal and gasket from the engine (Fig. 2).

(5) Cut off the oil pan side gasket end tabs flush with the front face of the cylinder block. Remove the gasket tabs.

(6) Clean the timing case cover, oil pan, and cylinder block gasket surfaces.

(7) Remove the crankshaft oil seal from the timing case cover (Fig. 2).

(8) Remove the oil seal from the timing case cover.

Installation

(1) Apply sealing compound (Jeep/Eagle Gasket-In-A-Tube, or equivalent) to both sides of the replacement timing case cover gasket and position the gasket on the cylinder block.

(2) Cut the end tabs off of replacement oil pan side gaskets corresponding to those cut off the original gasket. Cement the end tabs on the oil pan.

(3) Coat the front cover end tab recesses (Fig. 3) generously with RTV sealant (Jeep/Eagle Gasket-In-A-Tube, or equivalent) and position the seal on the timing case cover. Apply engine oil to the seal-oil pan contact surface.

(4) Position the timing case cover on the cylinder block.

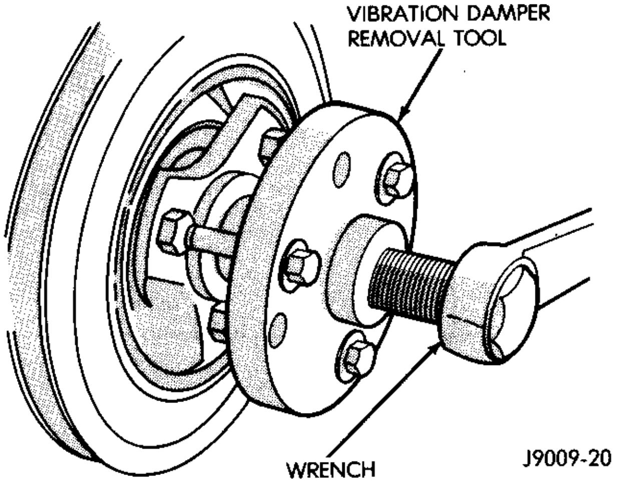


Fig. 1 Vibration Damper Removal Tool (8068)

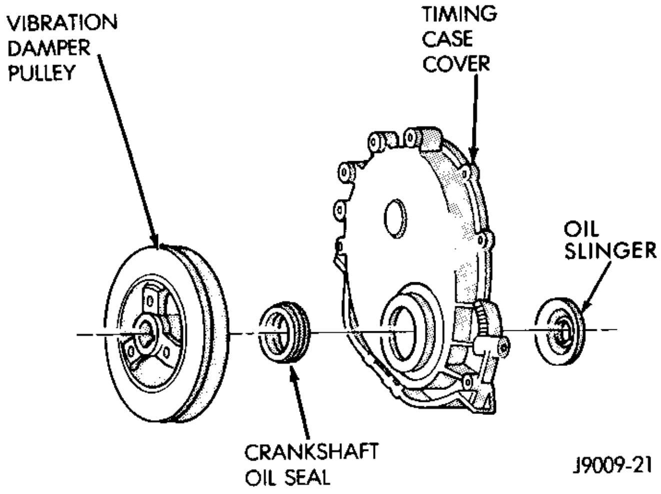


Fig. 2 Timing Case Cover and Related Components

(5) Place Timing Case Cover Alignment and Seal Installation Tool (6139) in the crankshaft opening of the cover (Fig. 4).

(6) Install the cover-to-cylinder block bolts and the oil pan-to-cover bolts.

(7) Tighten the cover-to-cylinder block bolts to 7 N•m (62 in. lbs.) torque and the oil pan-to-cover bolts to 13 N•m (11 ft. lbs.) torque.

(8) Remove the cover alignment tool and position the replacement oil seal on the tool with the seal lip facing outward.

(9) Apply a light film of Perfect Seal, or equivalent, on the outside diameter of the seal.

(10) Lightly coat the crankshaft with engine oil.

(11) Position the tool and seal over the end of the crankshaft and insert a screw tool into Seal Installation Tool (6139). Tighten the nut against the tool until the tool contacts the cover (Fig. 5).

(12) Remove the tools and apply a light film of engine oil on the vibration damper hub contact surface of the seal.

(13) With the key inserted in the keyway in the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N•m (80 ft. lbs.) torque.

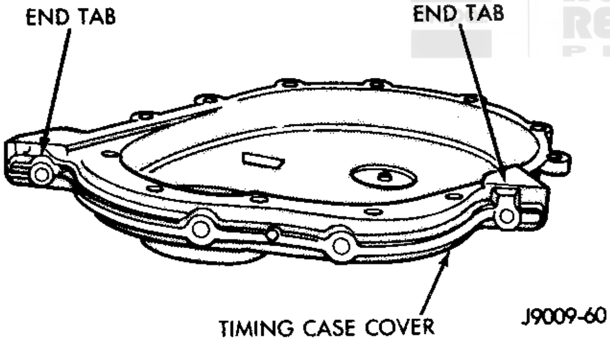


Fig. 3 Timing Case Cover End Tabs

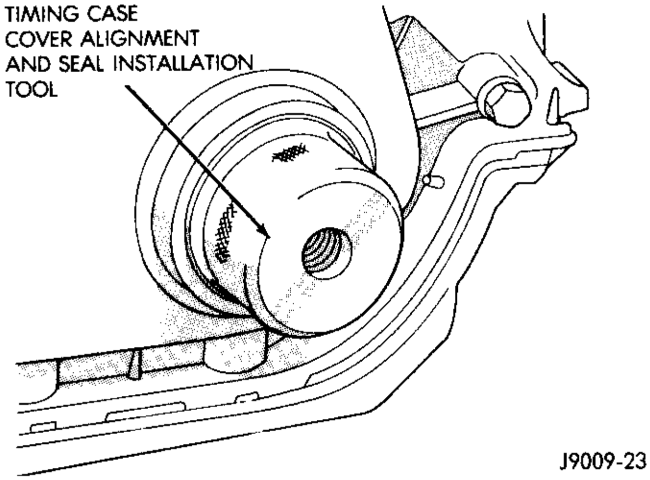


Fig. 4 Timing Case Cover Alignment and Seal Installation Tool (6139)

(14) Install the A/C compressor and alternator bracket assembly.

(15) Install the damper pulley, if removed. Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(16) Install the engine fan and hub assembly. Install the fan shroud.

(17) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling Systems for the proper procedures.

TIMING CHAIN AND SPROCKETS — 4.0L

Removal

Installation of the timing chain with the timing marks on the crankshaft and camshaft sprockets properly aligned ensures correct valve timing. A worn or stretched timing chain will adversely affect valve timing. If the timing chain deflects more than 12.7 mm (1/2 inch) replace it. The correct timing chain has 48 pins. A chain with more than 48 pins will cause excessive slack.

(1) Remove the drive belt(s).

(2) Remove the engine fan and hub (or Tempatrol fan) assembly.

(3) Remove the vibration damper pulley (V-belt drive only).

(4) Remove the vibration damper. Refer to the removal procedure.

(5) Remove the timing case cover. Refer to the Timing Case Cover Removal procedure.

(6) Remove the oil seal from the timing case cover.

(7) Remove the camshaft sprocket retaining bolt and washer.

(8) Rotate the crankshaft until the zero timing mark on the crankshaft sprocket in closest to and on the centerline with the timing mark on the camshaft sprocket (Fig. 6).

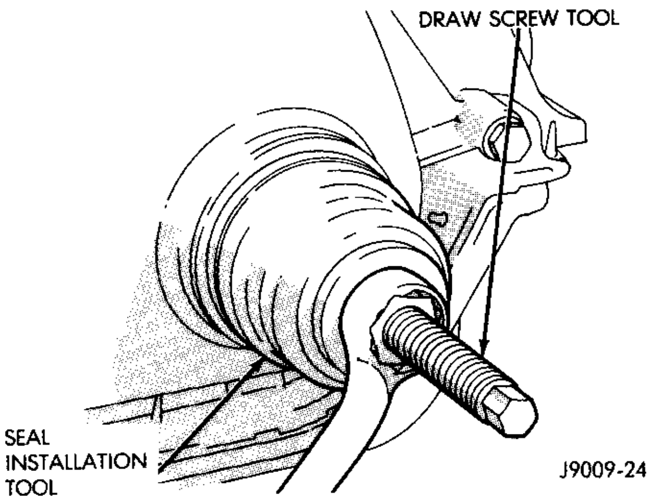


Fig. 5 Crankshaft Oil Seal Installation

(9) Remove the crankshaft sprocket, camshaft sprocket and timing chain as an assembly. Disassemble the chain and sprockets.

Installation

Assemble the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned.

(1) With the key in the keyway on the crankshaft, install the assembly on the crankshaft and camshaft.

(2) Install the camshaft sprocket retaining bolt and washer and tighten to 108 N•m (80 ft. lbs.) torque.

(3) To verify the correct installation of the timing chain, turn the crankshaft to locate the camshaft sprocket timing mark at approximately the one o'clock position. This positions the crankshaft sprocket timing mark where the adjacent tooth meshes with the chain at the three o'clock position. Count the number of chain pins between the timing marks on both sprockets (Fig. 7). There must be 15 pins.

(4) Install the crankshaft oil slinger (Fig. 2).

(5) Install the timing case cover and replacement oil seal (Fig. 2). Refer to Timing Case Cover Installation.

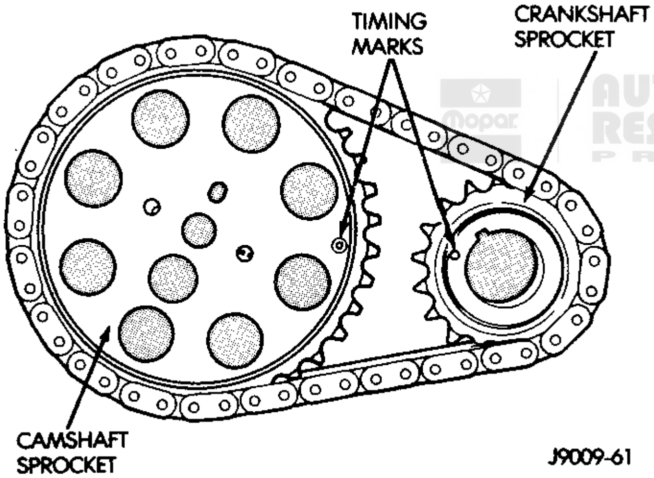


Fig. 6 Timing Marks on Sprockets

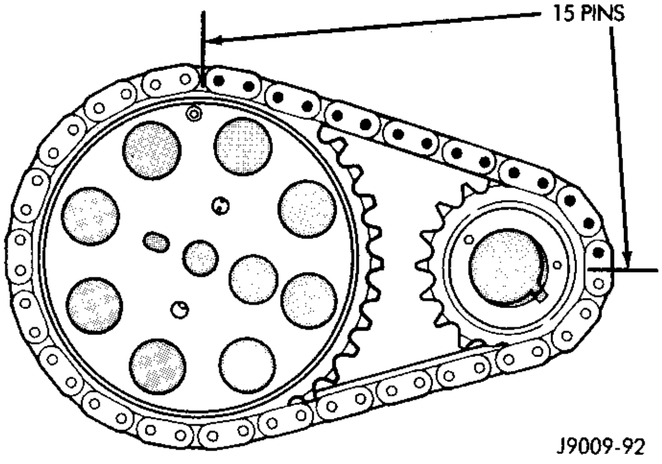


Fig. 7 Verify Crankshaft/Camshaft Installation

(6) With the key in the keyway on the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N•m (80 ft. lbs.) torque (Fig. 2).

(7) Install the damper pulley (if removed). Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(8) Install the engine fan and hub (or Tempatrol fan) assembly.

(9) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling System for the proper procedure.

CAMSHAFT — 4.0L

Removal

WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. RELEASE THE PRESSURE BEFORE REMOVING THE DRAINCOCK, CAP AND DRAIN PLUGS.

(1) Disconnect the battery negative cable.

(2) Drain the cooling system. Do not waste reusable coolant. If the solution is clean, drain it into a clean container for reuse.

(3) Remove the radiator. Refer to Group 7, Cooling System for the proper procedure.

(4) Remove the air conditioner condenser and receiver/drier assembly as a charged unit, if equipped. Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

(5) Remove the distributor cap and mark the position of the rotor.

(6) Remove the distributor and ignition wires.

(7) Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

(8) Remove the capscrews, bridge and pivot assemblies, and rocker arms (Fig. 8).

(9) Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridges.

(10) Remove the push rods (Fig. 8). Position all components on a work bench in the same order as removed to facilitate installation at the original locations.

(11) Remove the cylinder head and gasket. Refer to Cylinder Head Removal for the procedure.

(12) Remove the hydraulic valve tappets.

(13) Remove the vibration damper. Refer to the Vibration Damper removal procedure.

(14) Remove the timing case cover (Fig. 4). Refer to Timing Case Cover Removal.

(15) Remove the timing chain and sprockets. Refer to Timing Chain Removal.

(16) Remove the front bumper and/or grille as required.

(17) Remove the camshaft (Fig. 9).

Inspection

Inspect the cam lobes for wear.

Inspect the bearing journals for uneven wear pattern or finish.

Inspect the bearings for wear.

Inspect the distributor drive gear for wear.

If the camshaft appears to have been rubbing against the timing case cover, examine the oil pressure relief holes in the rear cam journal to ensure that they are free of debris.

Installation

(1) Lubricate the camshaft with Jeep/Eagle Super Oil Conditioner, or equivalent.

(2) Carefully install the camshaft to prevent damage to the camshaft bearings.

(3) Install the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned (Fig. 6). Refer to Timing Chain Installation for the procedure.

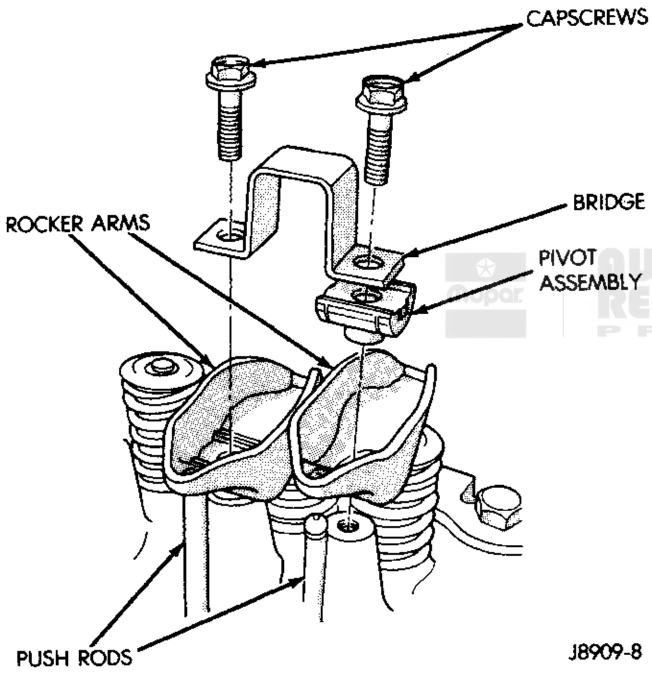


Fig. 8 Rocker Arm Components

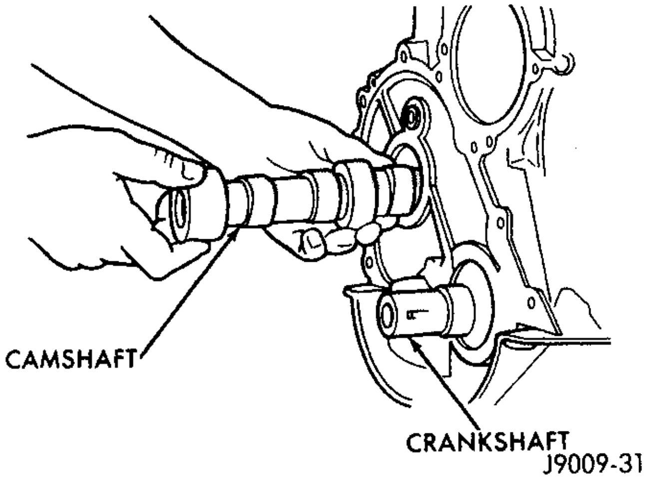


Fig. 9 Camshaft Removal

(4) Install the camshaft sprocket retaining bolt and tighten to 108 N•m (80 ft. lbs.) torque.

(5) Install the crankshaft oil slinger (Fig. 10).

(6) Install the timing case cover with a replacement oil seal (Fig. 10). Refer to Timing Case Cover Installation for the procedure.

(7) Install the vibration damper (Fig. 10).

(8) Install the damper pulley, if removed.

(9) Install the fan assembly and shroud.

(10) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling System for the proper procedure.

(11) Rotate the crankshaft until the No. 1 piston is at the TDC position on the compression stroke.

(12) Install the distributor, cap and ignition wires. Install the distributor so that the rotor is aligned with the mark made during removal. The rotor should be aligned with the No. 1 cylinder spark plug terminal on the cap when the distributor housing is fully seated on the cylinder block.

Lubricate the hydraulic valve tappets and all valve actuating components with Jeep/Eagle Super Oil Conditioner, or equivalent, during installation. The Jeep/Eagle Super Oil Conditioner must remain with the engine oil for at least 1 609 km (1,000 mi) but need not be drained until the next scheduled oil change.

(13) Install the hydraulic valve tappets.

(14) Install the cylinder head. Refer to Cylinder Head Installation for the procedure.

(15) Install the push rods (Fig. 8).

(16) Install the rocker arms and pivot and bridge assemblies (Fig. 8). Tighten each of the two capscrews for each bridge alternately, one turn at a time, to avoid damaging the bridge.

(17) Install the cylinder head cover. Refer to Cylinder Head Cover Installation for the procedure.

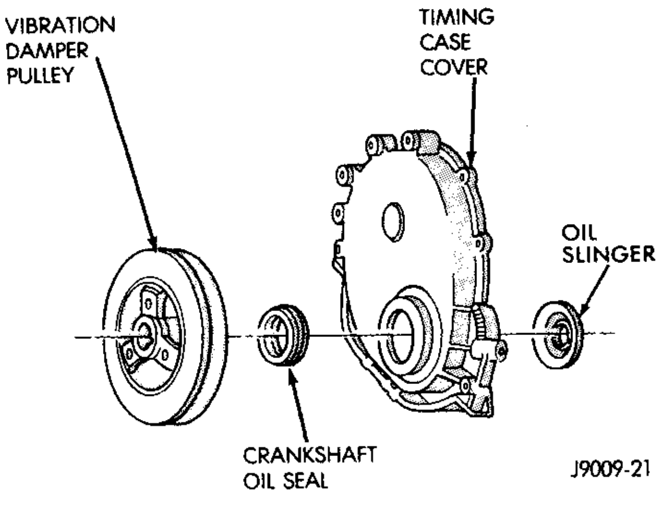


Fig. 10 Timing Case Cover Components

(18) Install the A/C condenser and receiver/drier assembly, if equipped. Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

CAUTION: Both service valves must be opened before the air conditioning system is operated.

(19) Install the radiator, connect the hoses and fill the cooling system to the specified level. Refer to Group 7, Cooling System for the proper procedure.

(20) Check the ignition timing and adjust as necessary.

(21) Install the grille and bumper, if removed.

(22) Connect the battery negative cable.

CAMSHAFT PIN REPLACEMENT — 4.0L

Removal

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

(1) Disconnect the battery negative cable.

(2) Drain the radiator. Do not waste reusable coolant. Drain the coolant into a clean container.

(3) Remove the fan and shroud.

(4) Disconnect the radiator overflow tube, radiator hoses, automatic transmission fluid cooler pipes (if equipped).

(5) Remove the radiator.

(6) If equipped with air conditioning:

CAUTION: Do not loosen or disconnect any air conditioner system fittings. Move the condenser and receiver/drier aside as a complete assembly.

(a) Remove the A/C compressor drive belt idler pulley.

(b) Disconnect and remove the alternator.

(c) Remove the A/C condenser attaching bolts and move the condenser and receiver/drier assembly up and out of the way.

(7) Remove the drive belt(s).

(8) Remove the crankshaft vibration damper and pulley. Refer to the removal procedure.

(9) Remove the timing case cover. Refer to the removal procedure.

(10) Rotate the crankshaft until the zero degree (0°) timing mark on the crankshaft sprocket is closest to and on the center line with the timing mark on the camshaft sprocket (Fig. 6).

(11) Remove camshaft sprocket retaining bolt.

(12) Remove the crankshaft oil slinger.

(13) Remove the sprockets and chain as an assembly.

CAUTION: The following procedural step must be accomplished to prevent the camshaft from damaging the rear camshaft plug during pin installation.

(14) Inspect the damaged camshaft pin.

(15) If the pin is a spring-type pin, remove the broken pin by inserting a self-tapping screw into the pin and carefully pulling the pin from the camshaft.

(16) If the pin is a dowel-type pin, center-punch it. Ensure the exact center is located when center-punching the pin.

CAUTION: Cover the opened oil pan area to prevent metal chips from entering the pan.

(17) Drill into the pin center with a 4 mm (5/32 inch) drill bit.

(18) Insert a self-tapping screw into the drilled pin and carefully pull the pin from the camshaft.

Installation

(1) Clean the camshaft pin hole.

(2) Compress the center of the replacement spring pin with vise grips.

(3) Carefully drive the pin into the camshaft pin hole until it is seated.

(4) Install the camshaft sprocket, crankshaft sprocket and timing chain with the timing marks aligned (Fig. 6).

(5) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark at approximately the one o'clock position. This positions the crankshaft sprocket timing mark where the adjacent tooth meshes with the chain at the three o'clock position. Count the number of chain pins between the timing marks on both sprockets (Fig. 7). There must be 15 pins.

(6) Install the crankshaft oil slinger.

(7) Tighten the camshaft sprocket bolt with 108 N•m (80 ft. lbs.) torque.

(8) Check the valve timing. Refer to the timing procedure.

(9) Remove the timing case cover gaskets and seal and clean the cover.

(10) Position replacement oil pan tab gaskets on the oil pan and use RTV sealant to hold them in place.

(11) Coat both sides of the replacement timing case cover gasket with gasket sealer. Apply a 3 mm (1/8 inch) bead of RTV sealant to the joint formed at the oil pan and cylinder block.

(12) Loosen the front four oil pan bolts three turns to allow oil pan movement during the timing case cover installation.

(13) Position the timing case cover on the engine.

(14) Place Timing Case Cover Alignment and Seal Installation Tool 6139 in the crankshaft opening in the cover (Fig. 4).

(15) Install and tighten the oil pan and timing case cover bolts. Tighten the 1/4-20 oil pan bolts to 9 N•m (80 in. lbs.) torque and the 5/16-18 oil pan bolts to 15 N•m (11 ft. lbs.) torque.

(16) Remove the cover alignment tool and place a replacement oil seal on the tool with the lip facing outward.

(17) Apply a light film of engine oil on the outside diameter of the seal.

(18) Position the tool and seal in the timing case cover crankshaft opening.

(19) Insert a screw tool into Seal Installation Tool 6139 (Fig. 4).

(20) Turn the nut until the tool contacts the cover.

(21) Remove the tool and install the vibration damper on the crankshaft.

(22) Lubricate and tighten the damper bolt to 108 N•m (80 ft. lbs.) torque. **If the crankshaft turns before the damper bolt torque value is attained, the crankshaft can be prevented from turning by placing two 5/16 X 1-1/2 inch bolts into the damper front pulley holes and wedging a bar between them. Rotate the bar until it contacts the frame member to prevent the crankshaft from turning.**

(23) Install the damper pulley, if applicable.

(24) If equipped with air conditioning:

(a) Install the A/C compressor drive belt idler pulley.

(b) Install the alternator.

(c) Install the A/C condenser and receiver/drier assembly.

(25) Install the drive belt(s) on the pulleys and tighten. Refer to Group 7, Cooling System for the specifications and procedures.

(26) Install the radiator. Connect the radiator hoses and automatic transmission fluid cooler pipes, if equipped. Fill the cooling system.

(27) Install the fan and shroud.

(28) Connect the battery negative cable.

OIL PAN — 4.0L

Removal

(1) Disconnect the battery negative cable.

(2) Raise and support the vehicle at the side sills.

(3) Remove the oil pan drain plug and drain the engine oil.

(4) Disconnect the exhaust pipe at the exhaust manifold.

(5) Disconnect the exhaust hanger at the catalytic converter and lower the pipe.

(6) Remove the starter motor.

(7) Remove the flywheel/torque converter housing access cover.

(8) Position a jack stand directly under the engine vibration damper.

(9) Place a piece of wood (2 x 2) between the jack stand and the engine vibration damper.

(10) Remove the engine mount through bolts.

(11) Using the jack stand, raise the engine until adequate clearance is obtained to remove the oil pan.

(12) Remove the oil pan bolts.

(13) Remove the oil pan by sliding it to the rear.

Cleaning

Clean the gasket and seal surfaces.

Remove all sludge and grime from the oil pan sump.

Installation

(1) Install a replacement oil pan front seal on the timing case cover and apply a generous amount of Jeep/Eagle Gasket-in-a-Tube, or equivalent to the recesses in the tab ends (Fig. 1).

(2) Cement the replacement oil pan side gaskets into position on the cylinder block (Fig. 1).

(3) Apply a generous amount of Jeep/Eagle Gasket-in-a-Tube, or equivalent sealant to the end tabs of the gaskets (Fig. 1).

(4) Coat the the inside curved surface of the replacement oil pan rear seal with soap (Fig. 1).

(5) Apply a generous amount of Jeep/Eagle Gasket-in-a-Tube, or equivalent sealant to the gasket contacting surface of the seal end tabs (Fig. 1).

(6) Install the seal in the recess of the rear main bearing cap. Ensure that it is fully seated. Either one of two sealing methods may be used.

(a) A sealant such as Jeep/Eagle Gasket-in-a-Tube, or equivalent, may be used instead of a gasket.

(b) If a gasket is used, coat both sides with a quick drying adhesive such as Jeep/Eagle Gasket Compound, or equivalent.

(7) Apply engine oil to the oil pan contacting surface of the front and rear oil pan seals.

(8) Install the oil pan. Tighten the 1/4-20 oil pan bolts to 9 N•m (80 in-lbs) torque and tighten the 5/16-18 oil pan bolts to 15 N•m (11 ft. lbs.) torque. Tighten the drain plug to 41 N•m (30 ft. lbs.) torque.

(9) Lower the engine until it is properly located on the engine mounts.

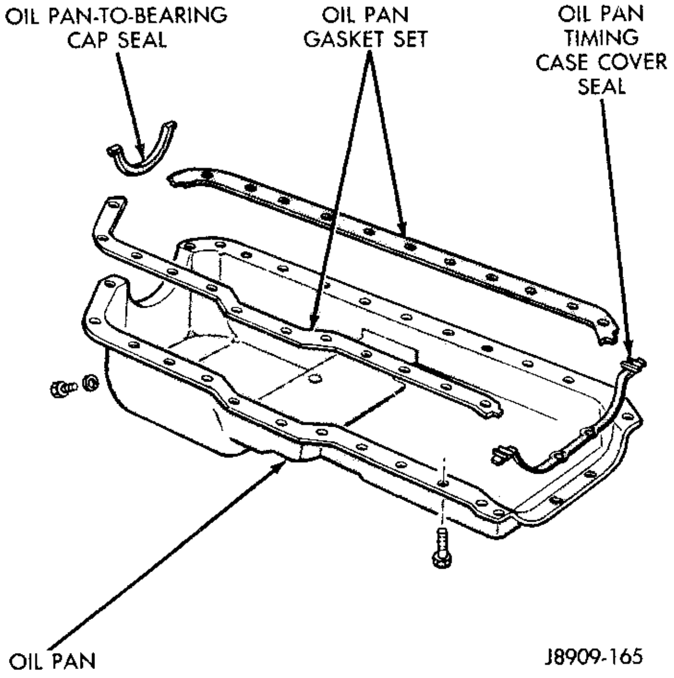


Fig. 1 Oil Pan, Gaskets and Seals

(10) Install the through bolts and tighten the nuts to 65 N•m (48 ft. lbs.) torque.

(11) Lower the jack stand and remove the piece of wood.

(12) Install the starter motor.

(13) Install the flywheel/torque converter housing access cover.

(14) Connect the exhaust pipe to the hanger and to the exhaust manifold.

(15) Lower the vehicle.

(16) Connect the battery negative cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(17) Fill the oil pan with engine oil to the specified level. Start the engine and inspect for leaks.

OIL PUMP — 4.0L

A gear-type oil pump is mounted at the underside of the cylinder block opposite the No. 4 main bearing.

Oil pump removal or replacement will not affect the distributor timing because the distributor drive gear remains in mesh with the camshaft gear.

Removal

(1) Drain the engine oil.

(2) Remove the oil pan. Refer to Oil Pan Removal for the procedure.

(3) Remove the oil pump retaining bolts, oil pump and gasket (Fig. 2).

CAUTION: Do not disturb the position of the oil inlet tube and strainer assembly in the pump body. If the tube is moved within the pump body, a replacement tube and strainer assembly must be installed to assure an airtight seal.

Gear End Clearance Measurement

Remove the cover retaining bolts and cover from the pump body.

Preferred Method:

(1) Place a strip of Plastigage across the full width of each gear (Fig. 3).

(2) Install the pump cover and tighten the bolts to 8 N•m (70 in. lbs.) torque.

(3) Remove the pump cover and determine the amount of clearance by measuring the width of compressed Plastigage with the scale on the Plastigage envelope.

(4) The correct clearance by this method is 0.051-0.152 mm (0.002-0.006 inch). The preferred measurement is 0.051 mm (0.002 inch).

Alternate Method:

(1) Place a straightedge across the ends of the gears and the pump body (Fig. 4).

(2) Select a feeler gauge that fits snugly but freely between the straightedge and the pump gears (Fig. 4).

(3) Using this method the correct clearance is 0.051-0.152 mm (0.002-0.006 inch), with the preferred measurement being 0.051 mm (0.002 inch).

(4) If the gear end clearance is excessive, replace the oil pump assembly.

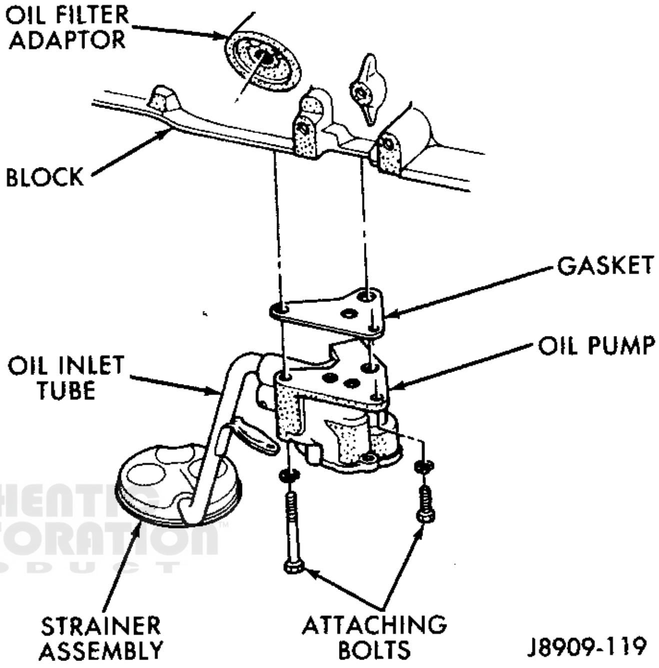


Fig. 2 Oil Pump Components

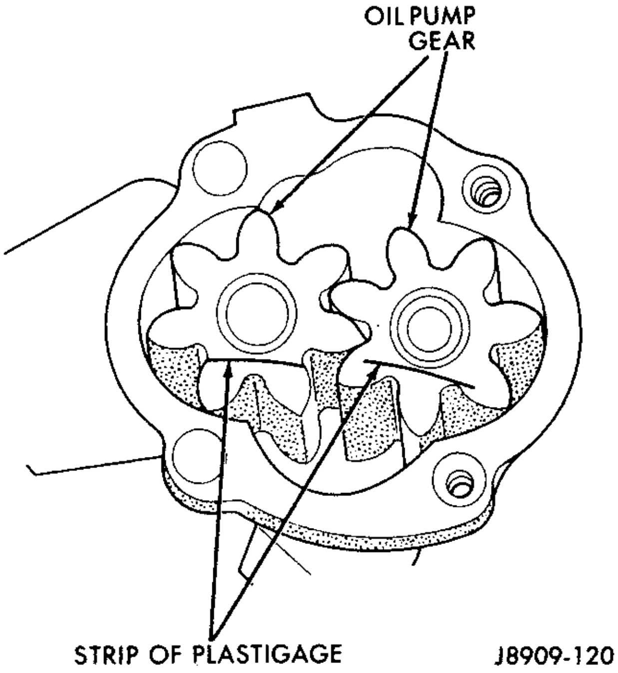


Fig. 3 Gear End Clearance Measurement — Preferred Method

Gear-to-Body Clearance Measurement

(1) Measure the gear-to-body clearance by inserting a feeler gauge between the gear tooth and the pump body inner wall directly opposite the point of the gear mesh (Fig. 5).

(2) Select a feeler gauge which fits snugly but freely.

(3) Rotate the gears to measure each tooth-to-body clearance in this manner.

(4) The correct clearance is 0.051-0.102 mm (0.002-0.004 inch). The preferred clearance is 0.051 mm (0.002 inch).

(5) If the gear-to-body clearance is more than specified, replace the idler gear, the idler shaft and the drive gear assembly.

(6) Remove the cotter pin and slide the spring retainer, spring and oil pressure relief valve plunger out of the pump body.

(7) Inspect for binding condition during disassembly.

(8) Clean or replace as necessary.

(9) The oil inlet tube and strainer assembly must be moved to allow removal of the relief valve. Install a replacement inlet tube and strainer assembly.

Oil Pump Assembly

Two relief valve plunger sizes (standard and oversize) are available. When replacing the valve, assure that the correct replacement valve, standard size or 0.254 mm (0.010 inch) oversize plunger diameter, is obtained and installed.

(1) Install the oil pressure relief valve plunger, the spring, the retainer, and the cotter pin.

(2) If the position of the inlet tube in the pump body has been disturbed, install a replacement inlet tube and strainer assembly. Apply a light film of Permatex No. 2 sealant, or equivalent, around the end of the tube.

(3) Use the Oil Pump Inlet Tube Installer Tool (7624), to drive the tube into the body (Fig. 6). Ensure that the support bracket is properly aligned.

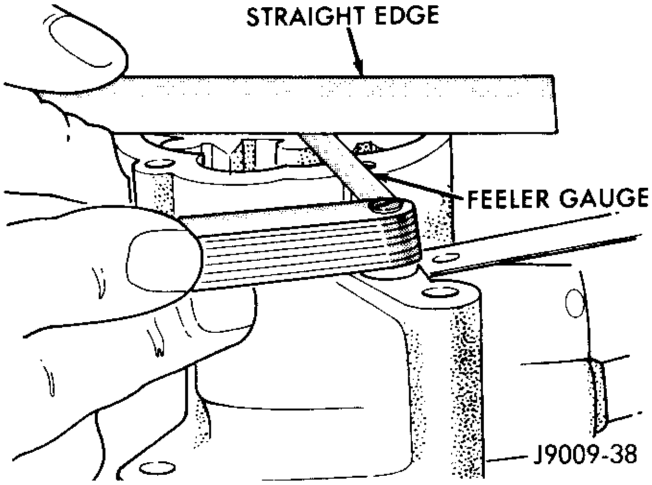


Fig. 4 Gear End Clearance Measurement — Alternate Method

(4) Install the idler gear and the drive gear assembly. Inspect the gears to ensure that a binding condition does not exist before installing the oil pump.

(5) To ensure self-priming of the oil pump, fill the pump with petroleum jelly before installing the oil pump cover. **Do not use grease.**

(6) Apply a bead of Loctite 515, or equivalent and install the pump cover.

(7) Tighten the cover bolts to 8 N•m (70 in. lbs.) torque.

Installation

(1) Install the oil pump with a replacement gasket. Tighten the short bolts to 14 N•m (10 ft. lbs.) torque and the long bolts to 23 N•m (17 ft. lbs.) torque.

(2) Install the oil pan with replacement gaskets and seals. Refer to Oil Pan Installation for the procedure.

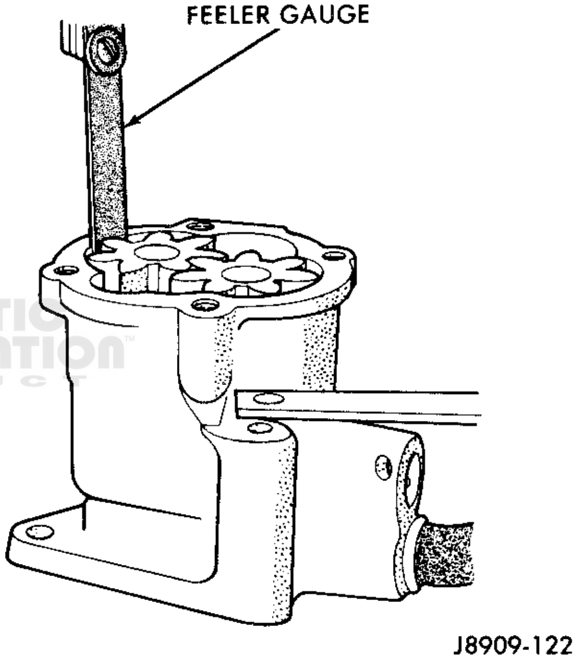


Fig. 5 Gear-to-Body Clearance Measurement

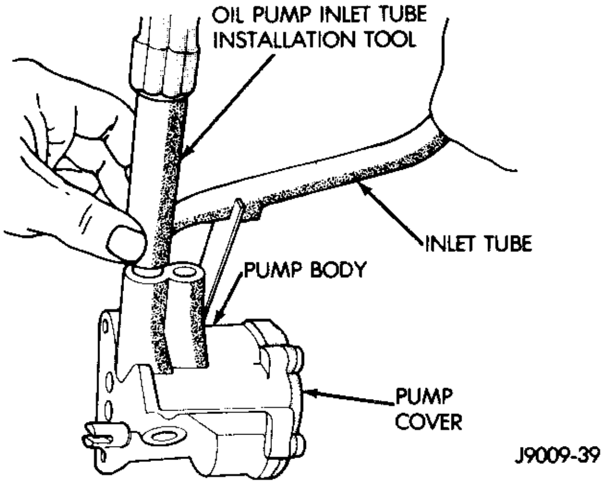


Fig. 6 Inlet Tube Installation

(3) Fill the oil pan with replacement engine oil to the specified level.

PISTONS AND CONNECTING RODS — 4.0L

Removal

(1) Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

(2) Remove the capscrews, bridge and pivot assemblies and rocker arms. Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridge (Fig. 1).

(3) Remove the push rods (Fig. 1).

(4) Remove the cylinder head and gasket. Refer to Cylinder Head Removal for the procedure.

(5) Position the pistons one at a time near the bottom of the stroke and use a ridge reamer to remove the ridge from the top end of the cylinder walls. Use a protective cloth to collect the cuttings.

(6) Drain the engine oil.

(7) Remove the oil pan, gasket and seals. Refer to Oil Pan Removal for the procedure.

(8) Remove the connecting rod bearing caps and inserts. Retain them in the same order as removed to facilitate installation in the original location (Fig. 2). The connecting rods and caps are stamped with the corresponding cylinder number.

CAUTION: Ensure that the connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose, slipped over the connecting rod bolts, will provide protection during removal.

(9) Remove the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 3).

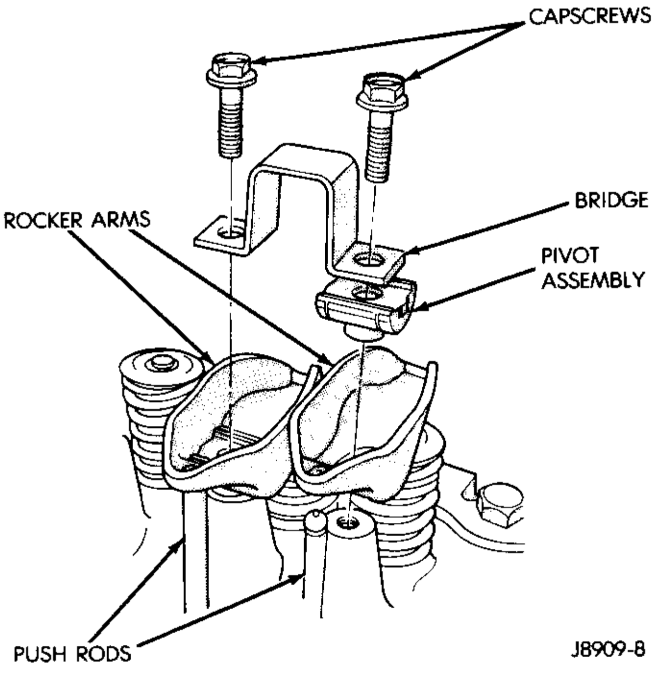


Fig. 1 Rocker Arm Components

Inspection - Connecting Rod

Connecting Rod Bearings

Inspect the connecting rod bearings for scoring and bent alignment tabs (Figs. 4 and 5). Check the bearings for normal wear patterns, scoring, grooving, fatigue and pitting (Fig. 6). Replace any bearing that shows abnormal wear.

Inspect the connecting rod journals for signs of scoring, nicks and burrs.

Connecting Rods

Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these

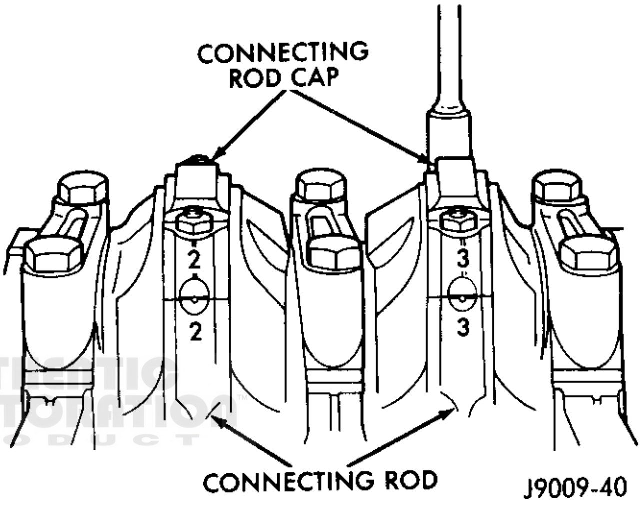


Fig. 2 Stamped Connecting Rods and Caps

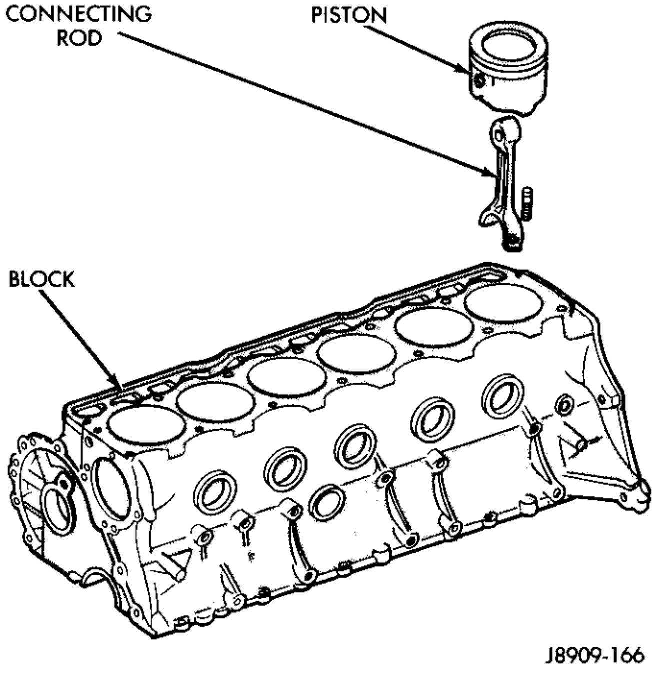


Fig. 3 Removal of Connecting Rod and Piston Assembly

components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment. Replace misaligned, bent or twisted connecting rods.

Bearing-to-Journal Clearance

(1) Wipe the journal clean of oil.

(2) Use short rubber hose sections over rod bolts during installation.

(3) Lubricate the upper bearing insert and install in connecting rod.

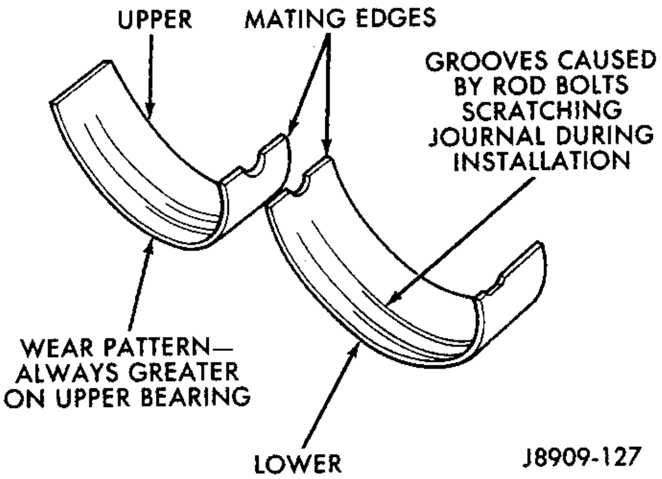


Fig. 4 Connecting Rod Bearing Inspection

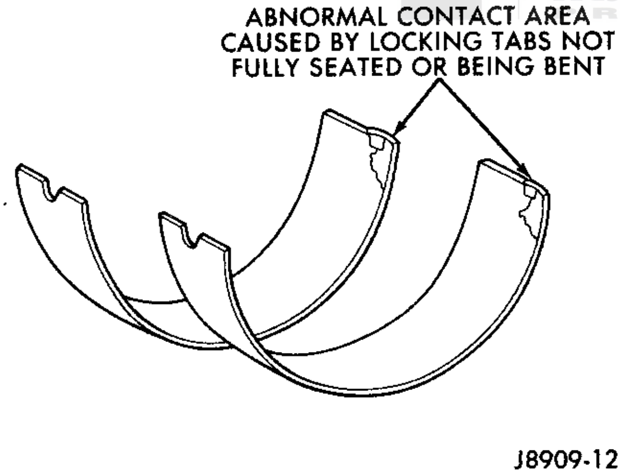


Fig. 5 Locking Tab Inspection

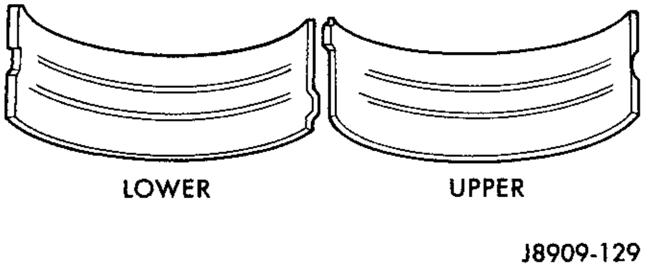


Fig. 6 Scoring Caused by Insufficient Lubrication or by Damaged Crankshaft Pin Journal

(4) Use piston ring compressor to install the rod and piston assemblies with the oil squirt holes in the rods facing the camshaft and the arrow on the piston crown pointing to the front of the engine (Fig. 7). Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(5) Install the lower bearing insert in the bearing cap. The lower insert must be dry. Place strip of Plastigage across full width of the lower insert at the center of bearing cap. Plastigage must not crumble in use. If brittle, obtain fresh stock.

(6) Install bearing cap and connecting rod on the journal and tighten nuts to 45 N•m (33 ft. lbs.) torque. Do not rotate crankshaft. Plastigage will smear, resulting in inaccurate indication.

(7) Remove the bearing cap and determine amount of bearing-to-journal clearance by measuring the width of compressed Plastigage by using the scale on the Plastigage envelope (Fig. 8). The correct clearance is 0.025 to 0.0762 mm (0.001 to 0.003 inch). **Plastigage should indicate the same clearance across the entire width of the insert. If the clearance varies, it may be caused by either a tapered journal, bent connecting rod, or foreign material trapped between the insert and cap or rod.**

(8) If the correct clearance is indicated, replacement of the bearing inserts is not necessary. Remove the Plastigage from crankshaft journal and bearing insert. Proceed with installation.

(9) If bearing-to-journal clearance exceeds the specification, install a pair of 0.0254 mm (0.001 inch) undersize bearing inserts. All the odd size inserts must be on the bottom. The sizes of the service replacement bearing inserts are stamped on the backs of the inserts. Measure the clearance as described in the previous steps.

(10) The clearance measured with a pair of 0.0254 mm (0.001 inch) undersize bearing inserts installed will determine if two 0.0254 mm (0.001 inch) undersize inserts

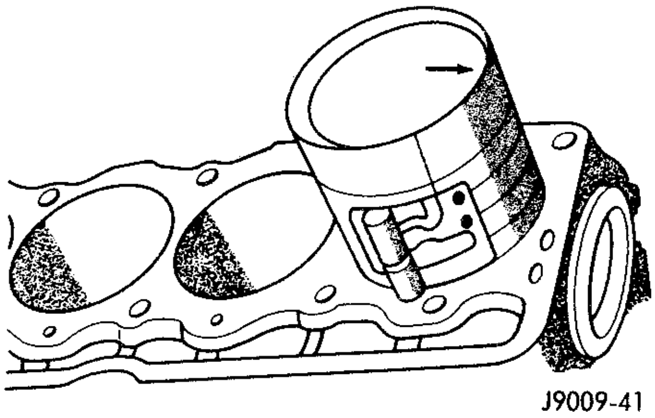


Fig. 7 Rod and Piston Assembly Installation

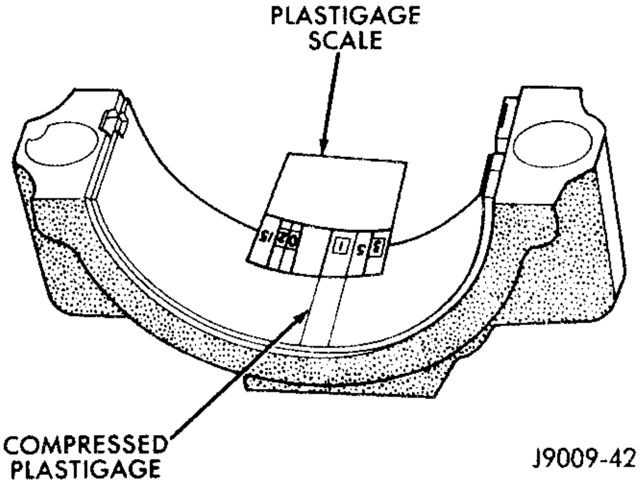


Fig. 8 Measuring Bearing Clearance with Plastigage

or another combination is needed to provide the correct clearance (see the Connecting Rod Bearing Fitting Chart).

FOR EXAMPLE:

If the initial clearance was 0.0762 mm (0.003 inch), 0.025 mm (0.001 inch) undersize inserts would reduce the clearance by 0.025 mm (0.001 inch). The clearance would be 0.002 inch and within specification. A 0.051 mm (0.002 inch) undersize insert would reduce the initial clearance an additional 0.013 mm (0.0005 inch). The clearance would then be 0.038 mm (0.0015 inch).

(11) Repeat the Plastigage measurement to verify your bearing selection prior to final assembly.

(12) Once you have selected the proper insert, install the insert and cap. Tighten the connecting rod bolts to 45 N•m (33 ft. lbs.) torque.

Side Clearance Measurement

Slide snug-fitting feeler gauge between the connecting rod and crankshaft journal flange. The correct clearance is 0.254 to .482 mm (0.010 to 0.019 inch). Replace the connecting rod if the side clearance is not within specification.

Piston Fitting

Micrometer Method

(1) Measure the inside diameter of the cylinder bore at a point 58.725 mm (2 5/16 inches) below the top of the bore.

(2) Measure outside diameter of the piston. Because pistons are cam ground, measure at right angle to piston pin at centerline of pin (Fig. 9).

The difference between cylinder bore diameter and piston diameter is piston-to-bore clearance.

Feeler Gauge Method

(1) Remove the rings from the piston.

(2) Insert a long 0.025 mm (0.001 inch) feeler gauge into the cylinder bore.

(3) Insert the piston, top first, into cylinder bore alongside the feeler gauge. With entire piston inserted into cylinder bore, the piston should not bind against feeler gauge.

(4) Repeat steps with a long 0.051 mm (0.002 inch) feeler gauge. The piston should bind.

(5) If the piston binds on 0.025 mm (0.001 inch) feeler gauge, the piston is too large or cylinder bore is too

CONNECTING ROD BEARING FITTING CHART

Crankshaft Main Bearing Journal Color Code and Diameter	Corresponding Connecting Rod Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow – 53.2257-53.2079 mm 2.0955-2.0948 in. Standard	Yellow – Standard	Yellow – Standard
Orange – 53.2079-53.1901 mm 2.0948-2.0941 in. Undersize (0.0178 mm or 0.0007 in.)	Yellow – Standard	Black – Undersize 0.025 mm 0.001 in.
Black – 53.1901-53.1723 mm 2.0941-2.0933 in. Undersize (0.0356 mm or 0.0014 in.)	Black – Undersize 0.025 mm 0.001 in.	Black – Undersize 0.025 mm 0.001 in.
Red – 52.9717-52.9539 mm 2.0855-2.0848 in. Undersize (0.254 mm or 0.010 in.)	Red – Undersize 0.254 mm 0.001 in.	Red – Undersize 0.254 mm 0.001 in.

J8909-22

small. If the piston does not bind on 0.051 mm (0.002 inch) feeler gauge, the piston is too small for cylinder bore. Pistons up to 0.102 mm (0.004 inch) undersize may be enlarged by knurling. Replace pistons that are 0.102 mm (0.004 inch) or more undersize.

Piston Pin

Removal

Piston pins are press-fitted into the connecting rods and require no locking device.

(1) Position the piston and connecting rod assembly on an arbor press.

(2) Apply force to a piloted driver and press the pin completely out of the connecting rod and piston assembly (Fig. 10). Note position of the pin through the gauge window of removal support tool.

Inspection

(1) Inspect the piston pin and pin bore in the connecting rod for nicks and burrs. Remove as necessary. Never reuse a piston pin after it has been installed in and removed from a connecting rod.

(2) With the pin removed from the piston and connecting rod, clean and dry piston pin bores and the replacement piston pin.

(3) Position the piston so that the pin bore is in vertical position. Insert the pin in bore. At room temperature, the replacement pin should slide completely through the pin bore in piston by force of gravity.

(4) Replace piston if pin jams in the pin bore.

Installation

(1) Insert the piston pin pilot through the piston and connecting rod pin bores. Ensure that the arrow on the piston crown is pointing up (Fig. 11).

(2) Position the pin pilot, piston and connecting rod on a support with the squirt hole of the connecting rod to the left-hand side.

(3) Insert piston pin through the upper piston pin bore and into the connecting rod pin bore (Fig. 10).

(4) Position the piloted driver inside the piston pin (Fig. 10).

(5) Using an arbor press, press the piston pin through the connecting rod and piston bores until pin pilot indexes with mark on the support. The piston pin requires a 8900 N (2,000 pounds) press-fit. If little effort is required to install piston pin in a connecting rod, or if the rod moves laterally on the pin, the connecting rod must be replaced.

(6) Remove the piston and connecting rod assembly from the press. The pin should be centered in the connecting rod (±0.792 mm or ±0.0312 inch).

Piston Ring Fitting

(1) Carefully clean the carbon from all ring grooves. Oil drain openings in the oil ring grooves and pin boss must be clear. Do not remove metal from the grooves or lands. This will change ring-to-groove clearances and will damage the ring-to-land seating.

(2) Measure the ring side clearance with a feeler gauge fitted snugly between the ring land and ring (Fig. 12). Rotate the ring in the groove. It must move freely around circumference of the groove.

(3) Place ring in the cylinder bore and push down with inverted piston to position near lower end of the ring

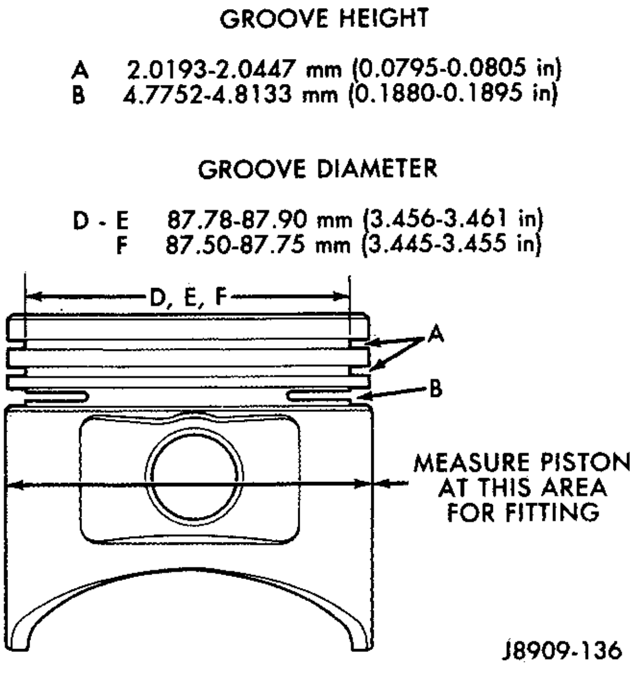


Fig. 9 Piston Dimensions

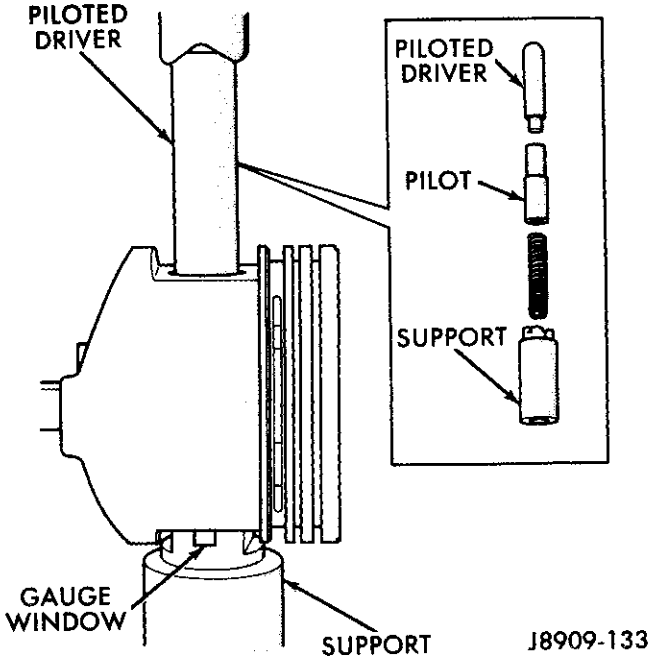


Fig. 10 Piston Pin Removal/Installation

travel. Measure ring gap with a feeler gauge fitting snugly between ring ends (Fig. 13). The correct compression ring end gap is 0.25-0.51 mm (0.010-0.020 inch). The correct oil control ring end gap is 0.381-1.397 mm (0.015-0.055 inch).

(4) Refer to Ring Gap Position for position of the ring gaps when installing piston rings.

(5) Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert expander ring first, then side rails

(6) The two compression rings are different and cannot be interchanged (Fig. 14). The top ring is a molly ring (the scraping edge is gray in color). The second ring is a black cast iron ring (the scraping edge is black in color when new).

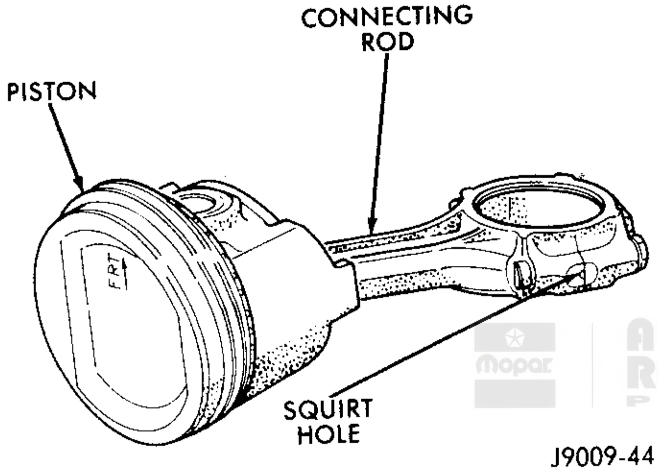


Fig. 11 Correct Alignment — Piston and Connecting Rod

	Millimeters	Inches
No. 1 Compression	0.025-0.081 (0.043 Preferred)	0.001-0.0032 (0.0017 Preferred)
No. 2 Compression	0.025-0.081 (0.043 Preferred)	0.001-0.0032 (0.0017 Preferred)
Oil Control	0.025-0.241 (0.08 Preferred)	0.001-0.0095 (0.003 Preferred)

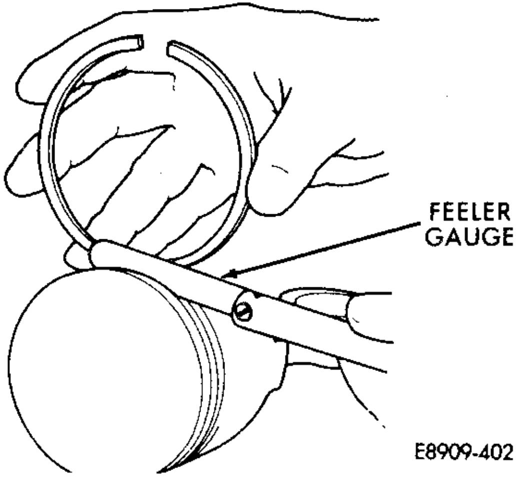


Fig. 12 Ring Side Clearance Measurement

(7) The compression rings can be identified by a chamfer of either the top or bottom inside edge (Fig. 15). The rings may also be identified by one or two dots on the top surface of the ring.

(8) The second compression ring (black cast iron) has a chamfer on the BOTTOM of the inside edge (Fig. 15). This ring may also have two dots located on the top surface.

(9) Using a ring installer, install the ring with the chamfer facing down (Fig. 16). If the ring has dots, the dots will be facing up.

(10) The top compression ring (the scraping edge is gray in color) has a chamfer on the TOP of the inside edge (Fig. 17). This ring may also have one dot located on the top surface.

(11) Using a ring installer, install the top ring with the chamfer facing up. If the ring has a dot, the dot will be facing up.

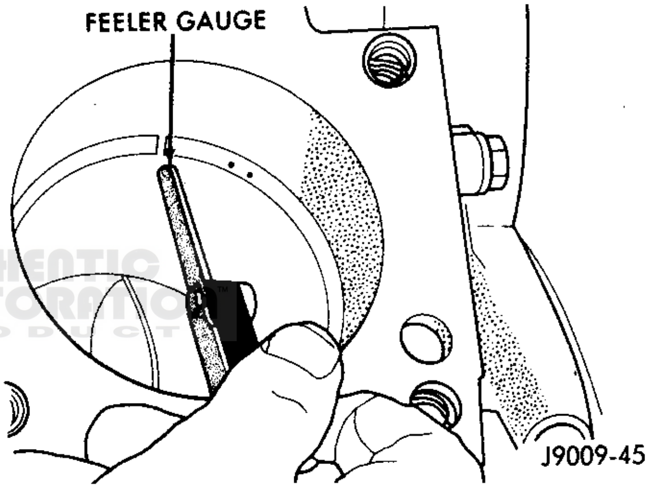


Fig. 13 Ring Gap Measurement

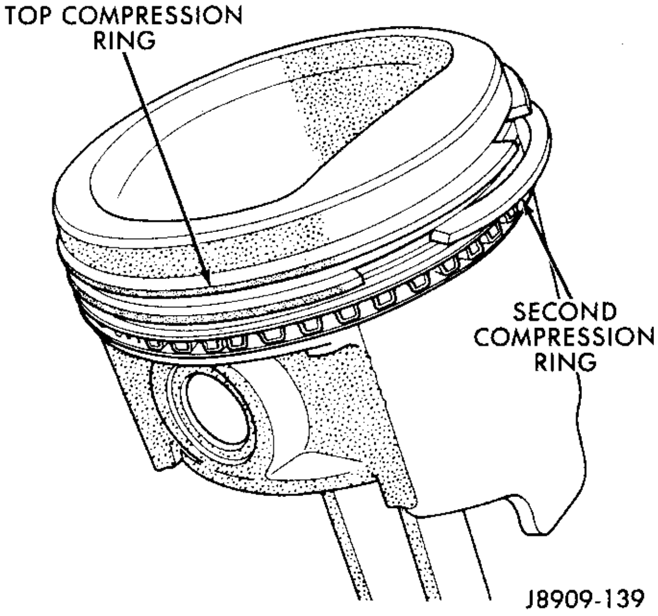


Fig. 14 Compression Ring Location

(12) Position the ring end gaps on the piston as shown (Fig. 18).

Installation

Each bearing insert is selectively fitted to its respective journal to obtain the specified operating clearance between the bearing and the journal. In production, the select fit is obtained by using various-sized, color-coded bearing inserts as listed in the Connecting Rod Bearing Fitting Chart. The color code appears on the edge of the bearing insert. The size is not stamped on inserts used for production of engines.

The rod journal is identified during the engine production by a color-coded paint mark on the adjacent cheek or counterweight toward the flanged (rear) end of the crankshaft. The color codes used to indicate journal sizes are listed in the Connecting Rod Bearing Fitting Chart.

When required, upper and lower bearing inserts of different sizes may be used as a pair (see the Connecting Rod Bearing Fitting Chart). A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce clearance 0.013 mm (0.0005 inch).

CAUTION: Do not intermix bearing caps. Each connecting rod and its bearing cap are stamped with the associated cylinder number on a machined surface adjacent to the oil squirt hole that faces the camshaft side of the cylinder block.

(1) Clean the cylinder bores thoroughly. Apply a light film of clean engine oil to the bores with a clean lint-free cloth.

(2) Install the piston rings on the pistons if removed. Refer to Piston Ring Installation for the proper procedure.

(3) Lubricate the piston and rings with clean engine oil.

CAUTION: Ensure that connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during installation.

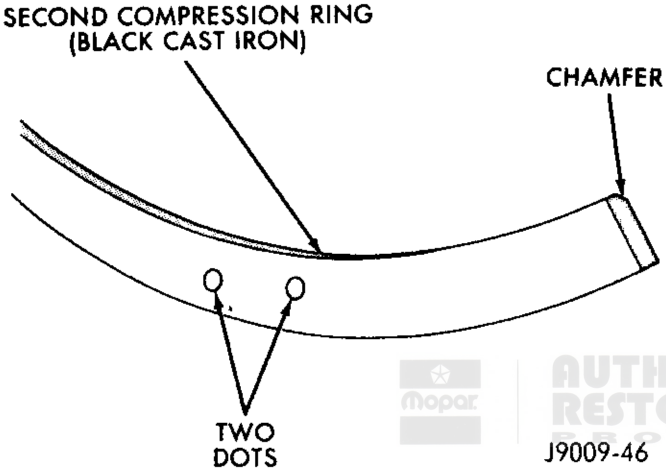


Fig. 15 Second Compression Ring Identification

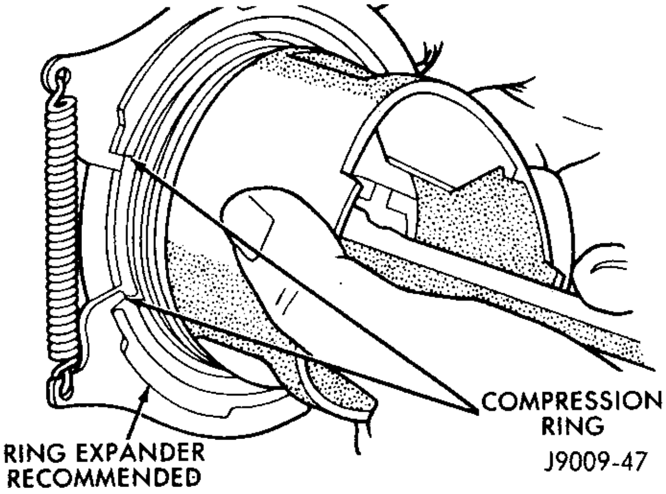


Fig. 16 Compression Ring Installation

Fig. 17 Top Compression Ring Identification

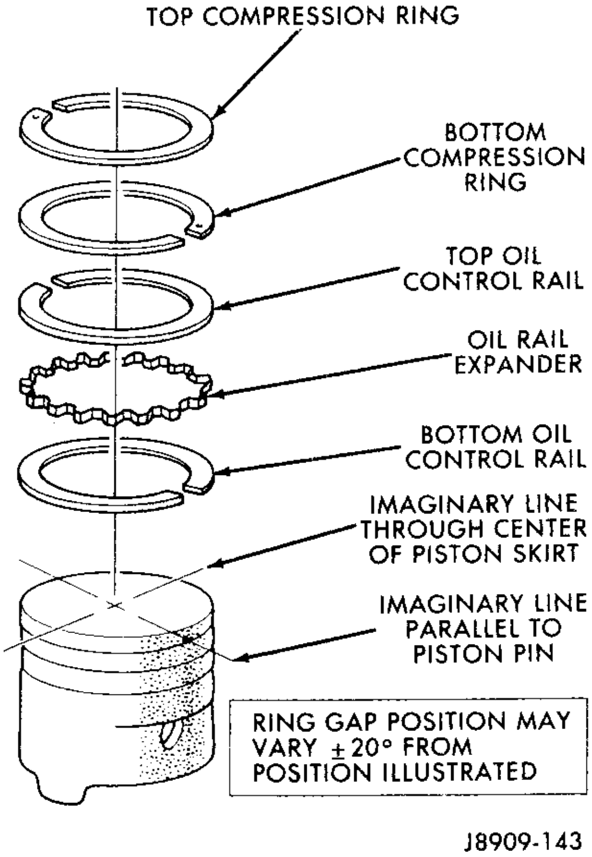


Fig. 18 Ring Gap Position

(4) Use a piston ring compressor to install the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 19).

(5) Ensure the arrow on the piston top points to the front of the engine (Fig. 19).

(6) Raise the vehicle.

(7) Install the connecting rod bearing caps and inserts in the same positions as removed.

CAUTION: Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(8) Install the oil pan and gaskets as outlined in the installation procedure.

(9) Lower the vehicle.

(10) Install the cylinder head, push rods, rocker arms, bridges, pivots and cylinder head cover as outlined in the installation procedures.

(11) Fill the crankcase with engine oil.

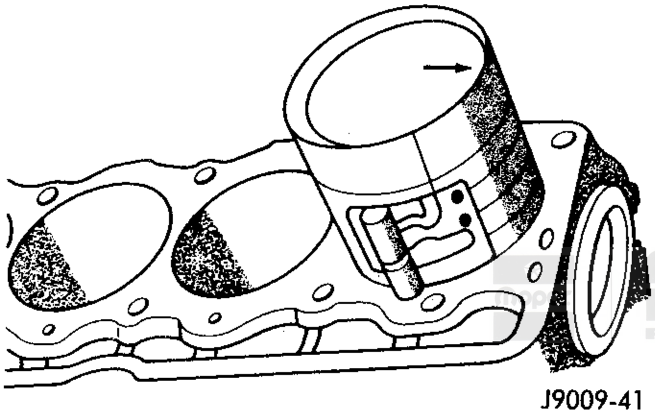


Fig. 19 Rod and Piston Assembly Installation

CRANKSHAFT MAIN BEARINGS — 4.0L

Removal

(1) Disconnect the battery negative cable.

(2) Remove the spark plugs.

(3) Raise the vehicle.

(4) Remove the oil pan and oil pump as outlined in the removal procedures.

(5) Remove the main bearing caps and lower inserts (Fig. 1).

(6) Remove the lower insert from the bearing cap.

(7) Remove the upper insert by loosening all of the other bearing caps and inserting a small cotter pin tool in the crankshaft journal oil hole. Bend the cotter pin as illustrated to fabricate the tool (Fig. 2). With the cotter pin tool in place, rotate the crankshaft so that the upper bearing insert will rotate in the direction of its locking tab. **Because there is no hole in the number 3 main journal, use a tongue depressor or similar soft-faced tool to remove the bearing insert (Fig. 2). After moving the insert approximately 25 mm (1 inch), it can be removed by applying pressure under the tab.**

(8) Using the same procedure described above, remove the remaining bearing inserts one at a time for inspection.

Inspection

Wipe the inserts clean and inspect for abnormal wear patterns and for metal or other foreign material imbedded in the lining. Normal main bearing insert wear patterns are illustrated (Fig. 3).

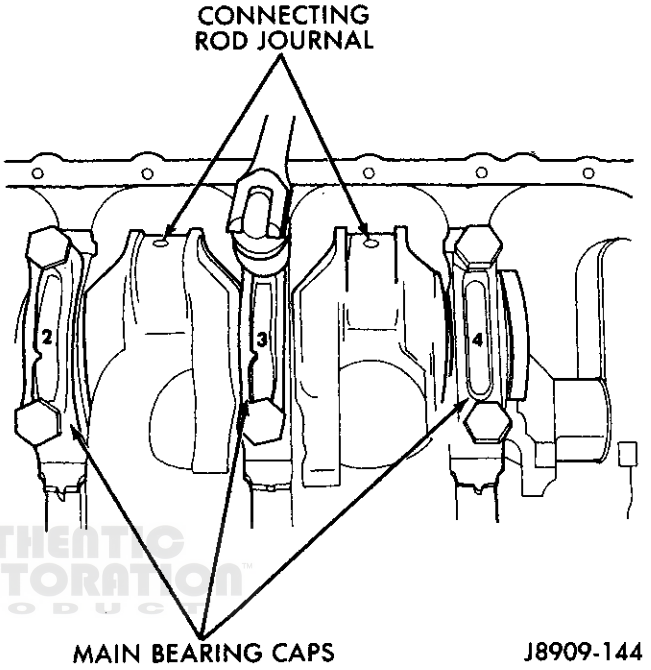


Fig. 1 Removing Main Bearing Caps and Lower Inserts

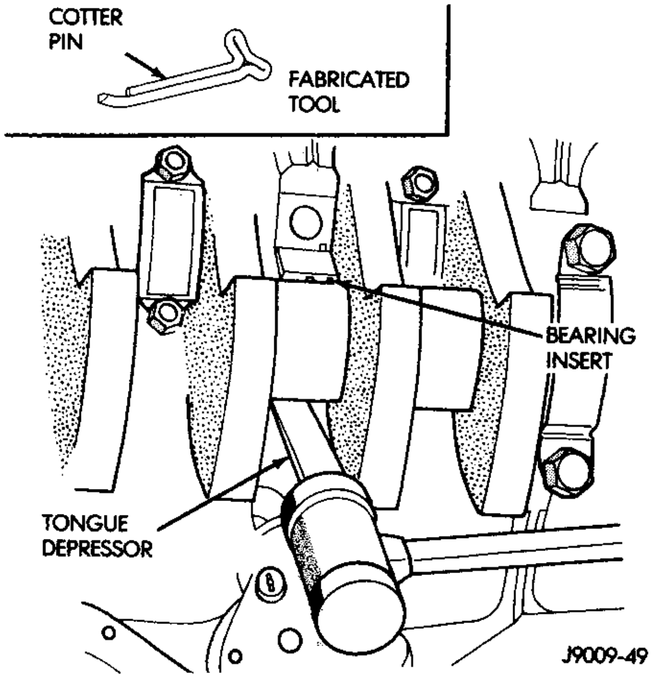


Fig. 2 Removing Upper Inserts

If any of the crankshaft journals are scored, remove the engine for crankshaft repair.

Inspect the back of the inserts for fractures, scrapings or irregular wear patterns.

Inspect the upper insert locking tabs for damage.

Replace all damaged or worn bearing inserts.

Fitting

The main bearing caps, numbered (front to rear) from 1 through 7 have an arrow to indicate the forward position. The upper main bearing inserts are grooved to provide oil channels while the lower inserts are smooth.

Each bearing insert pair is selectively fitted to its respective journal to obtain the specified operating clearance. In production, the select fit is obtained by using various-sized color-coded bearing insert pairs as listed in the Main Bearing Fitting Chart. The bearing color code appears on the edge of the insert. **The size is not stamped on bearing inserts used for engine production.**

The main bearing journal size (diameter) is identified in production by a color-coded paint mark on the adjacent cheek toward the flanged (rear) end of the crankshaft, except for the rear main journal, which is on the crankshaft rear flange

When required, upper and lower bearing inserts of different sizes may be used as a pair. A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce the clearance by 0.013 mm (0.0005 inch). **Never use a pair of bearing inserts with greater than a 0.025 mm (0.001 inch) difference in size.**

FOR EXAMPLE:

When replacing inserts, the odd size inserts must be either all on the top (in cylinder block) or all on the bottom (in main bearing cap).

Main Bearing-to-Journal Clearance (Crankshaft Installed)

When using Plastigage, check only one bearing clearance at a time.

Install the grooved main bearings into the cylinder block and the non-grooved bearings into the bearing caps.

Install the crankshaft into the upper bearings dry.

Place a strip of Plastigage across full width of the crankshaft journal to be checked.

Install the bearing cap and tighten the bolts to 108 N•m (80 ft. lbs.) torque.

Do not rotate the crankshaft. This will cause the Plastigage to shift, resulting in an inaccurate reading. Plastigage must not be permitted to crumble. If brittle, obtain fresh stock.

Remove the bearing cap. Determine the amount of clearance by measuring the width of the compressed Plastigage with the scale on the Plastigage envelope (Fig. 4). The correct clearance is 0.0254 to 0.0635 mm (.0010 to .0025 inches) for all main bearing journals, with 0.051 mm (0.002 inch) preferred.

Plastigage should indicate the same clearance across the entire width of the insert. If clearance varies, it may indicate a tapered journal or foreign material trapped behind the insert.

If the specified clearance is indicated and there are no abnormal wear patterns, replacement of the bearing inserts is not necessary. Remove the Plastigage from the crankshaft journal and bearing insert. Proceed to Crankshaft Main Bearing - Installation.

Bearing Insert Pairs

Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.025 mm (0.001 in.) Undersize	0.051 mm (0.002 in.) Undersize

J9009-62

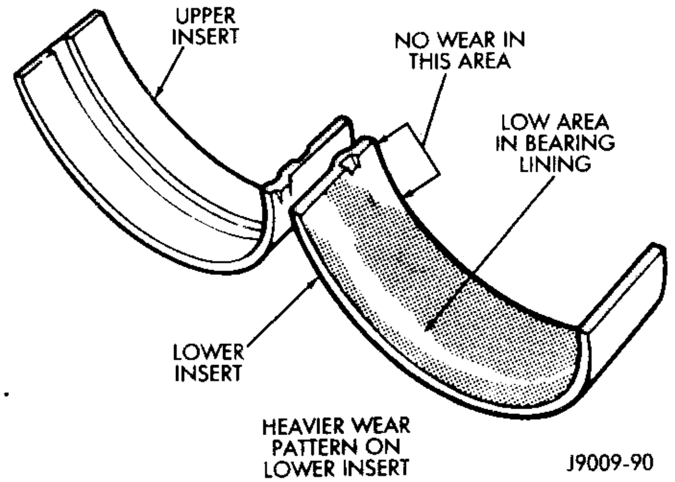


Fig. 3 Main Bearing Wear Patterns

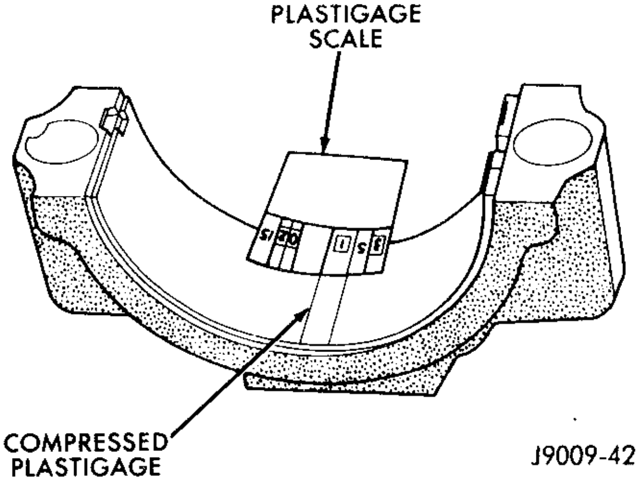


Fig. 4 Measuring Clearance with Plastigage

If the clearance exceeds specification, install a pair of 0.025 mm (0.001 inch) undersize bearing inserts and measure the clearance as described in the previous steps.

The clearance indicated with the 0.025 mm (0.001 inch) undersize insert pair installed will determine if this insert size or some other combination will provide the specified clearance.

FOR EXAMPLE:

If the clearance was 0.0762 mm (0.003 inch) originally, a pair of 0.0254 mm (0.001 inch) undersize inserts would reduce the clearance by 0.0254 mm (0.001 inch). The clearance would then be 0.0508 mm (0.002 inch) and within the specification. A 0.051 mm (0.002 inch) undersize bearing insert and a 0.0254 mm (0.001 inch) undersize insert would reduce the original clearance an additional 0.0127 mm (0.0005 inch) and the clearance would then be 0.0381 mm (0.0015 inch).

CAUTION: Never use a pair of inserts that differ more than one bearing size as a pair. For example, do not use a standard size upper insert and a 0.051 mm (0.002 inch) undersize lower insert.

If the clearance exceeds the specifications using a pair of 0.051 mm (0.002 inch) undersize bearing inserts, measure the crankshaft journal diameter with a micrometer. If the journal diameter is correct, the crankshaft bore in the cylinder block may be misaligned, which requires cylinder block replacement or machining to true bore.

If the diameter for journals 1 through 6 is less than 63.4517 mm (2.4981 inches) or journal 7 is less than 63.4365 mm (2.4975 inches), replace the crankshaft or grind down to accept the appropriate undersize bearing inserts.

Once the proper clearances have been obtained remove the crankshaft and proceed to Crankshaft Main Bearing - Installation.

Main Bearing Journal Diameter (Crankshaft Removed)

Clean the main bearing journal of oil.

Determine the maximum diameter of the journal with a micrometer. Measure at two locations 90° apart at each end of the journal.

Compare the measured diameter with the journal diameter specification listed in the Main Bearing Fitting Chart, and select inserts required to obtain the specified bearing-to-journal clearance.

Installation

(1) Lubricate the bearing surface of each insert with engine oil.

(2) Install the main bearing upper inserts to the cylinder block.

(3) Install the lower bearing inserts into the main bearing caps.

(4) Carefully lower the crankshaft into the cylinder block.

(5) Install the main bearing caps and lower inserts.

(6) Tighten all the bolts to 54 N•m (40 ft. lbs.) torque, then tighten to 95 N•m (70 ft. lbs.) torque.

(7) Finally, tighten the main bearing cap bolts to 108 N•m (80 ft. lbs.) torque.

(8) Rotate the crankshaft after tightening each main bearing cap to ensure the crankshaft rotates freely.

(9) Install the oil pan with replacement gaskets and seals. Refer to the Oil Pan - Installation procedure.

(10) Tighten the drain plug securely.

(11) Lower the vehicle.

(12) Install the spark plugs. Tighten the plugs to 37 N•m (27 ft. lbs.) torque.

(13) Fill the oil pan with engine oil to the full mark on the dipstick level.

(14) Connect the battery negative cable.

Crankshaft End Play

(1) Attach a magnetic base dial indicator to the cylinder block at either the front or rear of the engine.

(2) Position the dial indicator rod so that it is parallel to the center line of the crankshaft.

(3) Pry the crankshaft forward, position the dial indicator to zero.

(4) Pry the crankshaft forward and backward. Note the dial indicator readings. End play is the difference between the high and low measurements (Fig. 5). Correct end play is 0.038 to 0.165 mm (0.0015 to 0.0065 inch). The desired specifications are 0.051 to 0.064 mm (0.002 to 0.0025 inch).

(5) If end play is not within specification, inspect crankshaft thrust faces for wear. If no wear is apparent, replace the thrust bearing and measure end play. If end play is still not within specification, replace the crankshaft.

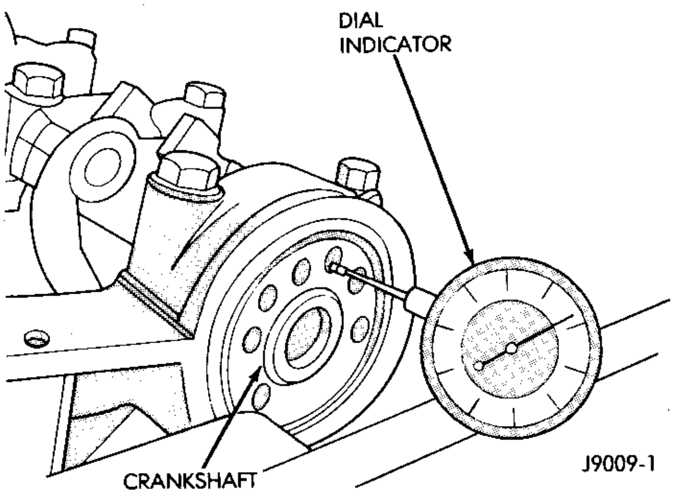


Fig. 5 Crankshaft End Play Measurement — Typical

MAIN BEARING FITTING CHART

Crankshaft No. 1 Main Bearing Journal Color Code and Diameter	Cylinder Block No. 1 Main Bearing Bore Color Code and Size	Bearing Insert Color Code	
		Upper Insert Size	Lower Insert Size
Yellow - 63.5025-63.4898 mm (2.5001-2.4996 in.) (Standard)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.) Black - 68.3641-68.3768 mm) (2.6915-2.6920 in.)	Yellow - Standard Yellow - Standard	Yellow - Standard Black - 0.025 mm Undersize (0.001 in.)
Orange - 63.4898-63.4771 mm (2.4996-2.4991 in.) (0.0005 Undersize)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.) Black - 68.3641-68.3768 mm (2.6915-2.6920 in.)	Yellow - Standard Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.) Black - 0.025 mm Undersize (0.001 in.)
Black - 63.4771-63.4644 mm (2.4991-2.4986 in.) (0.001 Undersize)	Yellow - 68.3514-68.36 41 mm (2.6910-2.6915 in.) Black - 68.3641-68.3768 mm (2.6915-2.6920 in.)	Black - 0.025 mm Undersize (0.001 in.) Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.) Green - 0.051 mm Undersize (0.002 in.)
Green - 63.4644-63.4517 mm (2.4986-2.4981 in.) (0.0015 Undersize)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.)	Black - 0.025 mm Undersize (0.001 in.)	Green - 0.051 mm Undersize (0.002 in.)
Red - 63.2485-63.2358 mm (2.4901-2.4986 in.) (0.010 Undersize)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.)	Red - 0.254 mm Undersize (0.010 in.)	Red - 0.254 mm Undersize (0.010 in.)

NOTE:With Green and Red Coded Crankshaft Journals, Use Yellow Coded Cylinder Block Bores Only.

Crankshaft Color Code and Diameter (Journal Size)	Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow - 63.5025-63.4898 mm (2.5001-2.4996 in.) (Standard)	Yellow - Standard	Yellow - Standard
Orange - 63.4898-63.4771 mm (2.4996-2.4991 in.) (0.0005 Undersize)	Yellow - Standard	Black - 0.025 mm Undersize (0.001 in.)
Black - 63.4771-63.4644 mm (2.4991-2.4986 in.) (0.001 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.)
Green - 63.4644-63.4517 mm (2.4986-2.4981 in.) (0.0015 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Green - 0.051 mm Undersize (0.002 in.)
Red - 63.2485-63.2358 mm (2.4901-2.4966 in.) (0.010 Undersize)	Red - 0.054 mm Undersize (0.010 in.)	Red - 0.254 mm Undersize (0.010 in.)

Crankshaft Main Bearing Journal 7 Color Code and Diameter (Journal Size)	Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow - 63.4873-63.4746 mm (2.499-2.4990 in.) (Standard)	Yellow - Standard	Yellow - Standard
Orange - 63.4746-63.4619 mm (2.4990-2.4985 in.) (0.0005 Undersize)	Yellow - Standard	Black - 0.025 mm Undersize (0.001 in.)
Black - 63.4619-63.4492 mm (2.4985-2.4980 in.) (0.001 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.)
Green - 63.4492-63.4365 mm (2.4980-2.4975 in.) (0.0015 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Green - 0.051 mm Undersize (0.002 in.)
Red - 63.2333-63.2206 mm (2.4895-2.4890 in.) (0.010 Undersize)	Red - 0.254 mm Undersize (0.010 in.)	Red - 0.254 mm Undersize (0.010 in.)

J8909-

REAR MAIN OIL SEALS — 4.0L

The crankshaft rear main bearing oil seal consists of two half pieces of neoprene with a single lip that effectively seals the rear of the crankshaft. Replace the upper and lower seal halves as a unit to ensure leak-free operation.

Removal

To replace the rear main oil seal, the transmission must be removed. Refer to Group 21, Transmission for the proper procedure.

(1) Remove the flywheel or converter drive plate.

(2) Remove the oil pan (see Oil Pan - Removal).

(3) Remove the rear main bearing cap (No. 7).

(4) Push the upper seal out of the groove. Ensure that the crankshaft is not damaged.

(5) Remove the lower half of the seal from the bearing cap.

Installation

(1) Wipe the seal surface area of the crankshaft until it is clean.

(2) Apply a thin coat of engine oil.

(3) Coat the lip of the seal with engine oil.

(4) Position the upper seal into the groove in the cylinder block. The lip of the seal faces toward the front of the engine.

(5) Place the lower half of the seal into the bearing cap (Fig. 6).

(6) Coat both sides of the lower seal end tabs with Jeep/Eagle Gasket-in-a-Tube, or equivalent). Do not apply sealant to the lip of the seal.

(7) Coat the outer curved surface of the lower seal with soap and the lip of the seal with engine oil (Fig. 6).

(8) Position the lower seal into the bearing cap recess and seat it firmly.

(9) Coat both chamfered edges of the rear main bearing cap with Jeep/Eagle Gasket-in-a-Tube, or equivalent (Fig. 6).

CAUTION: Do not apply sealant to the cylinder block mating surfaces of the rear main bearing cap because the bearing-to-journal clearance would be altered.

(10) Install the rear main bearing cap.

(11) Tighten all main bearing bolts to 108 N•m (80 ft. lbs.) torque.

CYLINDER BLOCK — 4.0L

Disassembly

(1) Remove the water pump from the cylinder block.

(2) Remove the vibration damper.

(3) Remove the timing case cover seal.

(4) Remove the timing case cover.

(5) Remove the oil slinger from the crankshaft.

(6) Remove the camshaft retaining bolt and remove the sprockets and chain as an assembly.

(7) Remove the camshaft.

(8) Remove the oil pan, the gaskets, and the seals (Fig. 7). Thoroughly clean the pan and engine block gasket surfaces.

(9) Remove the oil pump.

(10) Remove the connecting rods and the pistons. Remove the connecting rod and piston assemblies through the top of the cylinder bores.

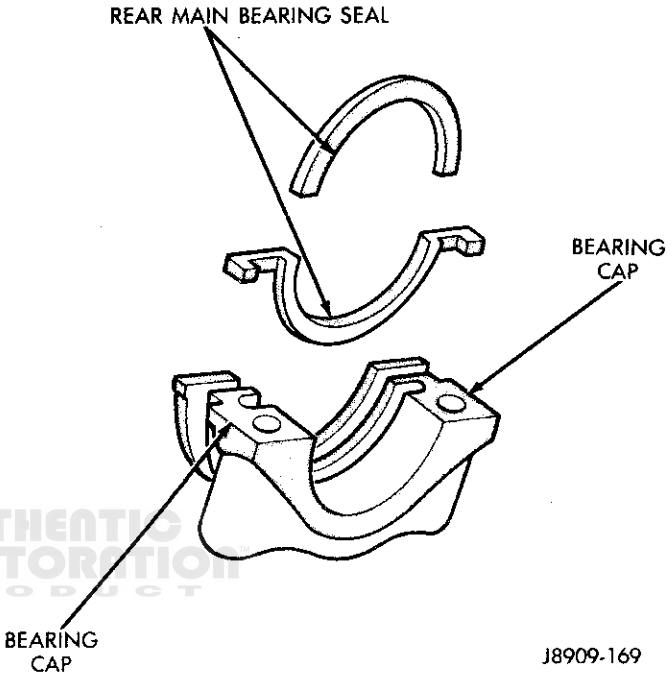


Fig. 6 Rear Main Bearing Oil Seal

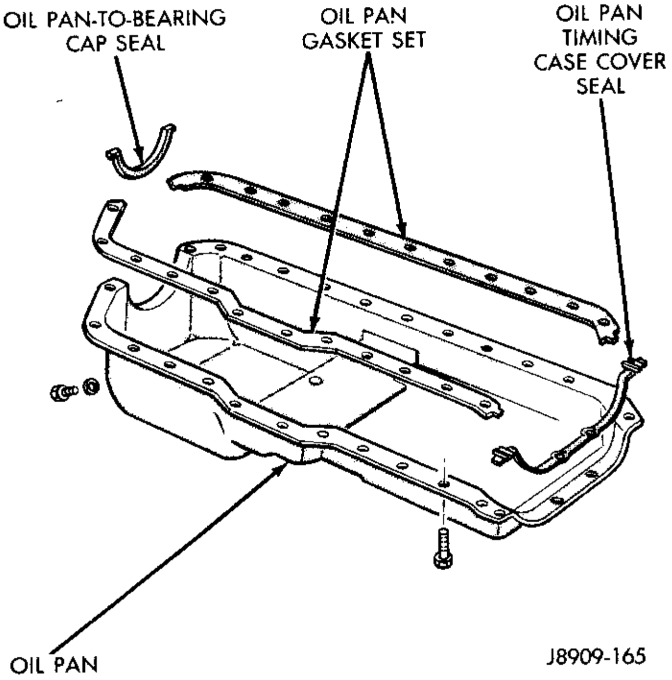


Fig. 7 Oil Pan, Gaskets and Seals

CAUTION: Be sure that the connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during removal.

(11) Remove the crankshaft.

Inspection — Cylinder Bore

Bore Measurement

(1) Use a bore gauge to measure each cylinder bore diameter. If a bore gauge is not available, use an inside micrometer (Fig. 8).

(2) Measure the cylinder bore diameter crosswise to the cylinder block near the top of the bore. Repeat the measurement at the bottom of the bore.

(3) Determine the taper by subtracting the smaller diameter from the larger diameter.

(4) Rotate the measuring device 120° and repeat steps above. Finally, rotate the device another 120° and repeat the measurements.

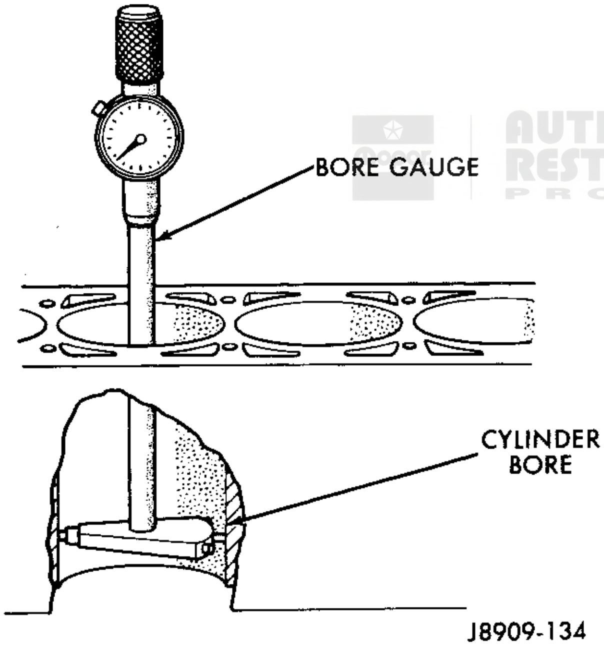


Fig. 8 Cylinder Bore Measurement

(5) Determine out-of-roundness by comparing the difference between each 120° measurement.

(6) If the cylinder bore taper does not exceed 0.025 mm (0.001 inch) and the out-of- roundness does not exceed 0.025 mm (0.001 inch) the cylinder bore can be trued by honing. If the cylinder bore taper or out-of-round condition exceeds these maximum limits, the cylinder must be bored and then honed to accept an oversize piston. A slight amount of taper always exists in the cylinder bore after the engine has been in use for a period of time.

Cylinder Bore Resurfacing

CAUTION: Do not use rigid type hones to remove cylinder wall glaze.

(1) Use an expanding type hone to true the cylinder bore and to remove the glaze for faster piston ring seating. Move the hone down and up (stroke) at sufficient speed to produce a uniform 60° angle crosshatch pattern on the cylinder walls. Do not use more than ten strokes per cylinder (one stroke is one down-and-up movement). Refer to General Information section of this Group for the proper honing operation.

(2) Scrub the cylinder bores clean with a solution of hot water and detergent.

(3) Immediately apply light engine oil to the cylinder walls. Wipe with a clean, lint-free cloth.

Assembly

(1) Install the crankshaft.

(2) Install the connecting rods and the pistons through the top of the cylinder bores.

CAUTION: Be sure that the connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during removal.

(3) Install the oil pump.

(4) Install the oil pan, the gaskets, and the seals.

(5) Install the camshaft.

(6) Install the camshaft retaining bolt and remove the sprockets and chain as an assembly.

(7) Install the oil slinger from the crankshaft.

(8) Install the timing case cover seal.

(9) Install the timing case cover.

(10) Install the vibration damper.

(11) Install the water pump to the cylinder block.

ENGINE SPECIFICATIONS — 4.0L

Camshaft

Tappet Clearance	Zero Lash (Hydraulic tappets)	
End Play	Zero (engine operating)	
Bearing Clearance	0.025-0.076 mm	0.001-0.003 in.
Bearing Journal Diameter		
No. 1	51.54-51.56 mm	2.029-2.030 in.
No. 2	51.28-51.31 mm	2.019-2.020 in.
No. 3	51.03-51.05 mm	2.009-2.010 in.
No. 4	50.78-50.80 mm	1.999-2.000 in.
Base Circle Runout	0.03 mm (max)	0.001 in. (max)
Cam Lobe Lift	6.43 mm	0.253 in.
Valve Lift	10.29 mm	0.405 in.
Intake Valve Timing		
Opens	15° BTDC	
Closes	75° ABDC	
Exhaust Valve Timing		
Opens	59° BBDC	
Closes	31° ATDC	
Valve Overlap	46°	
Intake Duration	270°	
Exhaust Duration	270°	

Crankshaft

End Play	0.038-0.165 mm	0.0015-0.0065 in.
Main Bearing Journal Diameter	63.489-63.502 mm	2.4996-2.5001 in.
Main Bearing Journal Width		
No. 1	27.58-27.89 mm	1.086-1.098 in.
No. 3	32.28-32.33 mm	1.271-1.273 in.
No. 2-4-5-6-7	30.02-30.18 mm	1.182-1.188 in.
Main Bearing Clearance	0.03-0.06 mm (0.051 mm preferred)	0.001-0.0025 in. (0.002 in. preferred)
Connecting Rod Journal Diameter	53.17-53.23 mm	2.0934-2.0955 in.
Connecting Rod Journal Width	27.18-27.33 mm	1.070-1.076 in.
Maximum Out-of-Round (All Journals)	0.013 mm	0.0005 in.
Maximum Taper (All Journals)	0.013 mm	0.0005 in.

J9009-65

ENGINE SPECIFICATIONS — 4.0L (CONT.)

Cylinder Block

Deck Height	239.49-239.64 mm	9.429-9.435 in.
Deck Clearance	0.546 mm (below block)	0.0215 in. (below block)
Cylinder Bore Diameter (standard)	98.42-98.48 mm	3.8751-3.8775 in.
Maximum Taper	0.025 mm	0.001 in.
Maximum Out-of-Round	0.025 mm	0.001 in.
Tappet Bore Diameter	23.000-23.025 mm	0.9055-0.9065 in.
Cylinder Block Flatness	0.03/25-0.05/152 mm (0.20 mm max)	0.001/1-0.002/6 in. (0.008 in. max)

Connecting Rods

Total Weight (less bearings)		657-665 grams
Total Length (center-to-center)	155.52-155.62 mm	6.123-6.127 in.
Piston Pin Bore Diameter	23.59-23.62 mm	0.9288-0.9298 in.
Connecting Rod Bore (less bearings)	56.09-56.08 mm	2.2085-2.2080 in.
Bearing Clearance	0.03-0.08 mm (0.044-.05 mm preferred)	0.001-0.003 in. (0.0015-0.002 in. preferred)
Side Clearance	0.25-0.48 mm	0.010-0.019 in.
Maximum Twist	0.001 mm per mm	0.001 in. per inch
Maximum Bend	0.0005 mm per mm	0.0005 in. per inch

Cylinder Head

Combustion Chamber Volume	64.45-67.45cc	
Valve Arrangement	EI-IE-IE-EI-EI-IE	
Valve Guide ID (Integral)	7.9 mm	3.12 in.
Valve Stem-to-Guide Clearance	0.03-0.08 mm	0.001-0.003 in.
Intake Valve Seat Angle	44.5°	
Exhaust Valve Seat Angle	44.5°	
Valve Seat Width	1.02-1.52 mm	0.040-0.060 in.
Valve Seat Runout	0.064 mm	0.0025 in.
Cylinder Head Flatness	0.03/25-0.05/152 mm (0.20 mm max)	0.001/1-0.002/6 in. (0.008 in. max)

Oil Pressure

At Idle Speed (600 rpm)	13 psi	89.6 kPa
At 1600+ rpm	37-75 psi	255.1-517.1 kPa
Oil Pressure Relief	75 psi	517.1 kPa

J9009-66

ENGINE SPECIFICATIONS — 4.0L (CONT.)

Oil Pump		
Gear-to Body Clearance (Radial)	0.051-0.102 (0.051 mm preferred)	0.002-0.004 in. (0.002 in. preferred)
Gear End Clearance, Plastigage	0.051-0.152 (0.051 mm preferred)	0.002-0.006 in. (0.002 in. preferred)
Gear End Clearance Feeler Gauge	0.1016-0.2032 mm (0.1778 preferred)	0.004-0.008 in. (0.007 in. preferred)
Pistons		
Weight (less pin)	563-567 grams	19.86-20.00 oz.
Piston Pin Bore Centerline-to-Piston Top	40.61-40.72 mm	1.599-1.603 in.
Piston-to-Bore Clearance	0.033-0.053 mm (0.033-0.038 mm preferred)	0.0013-0.0021 in. (0.0013-0.0015 in. preferred)
Piston Ring Gap Clearance — Compression (both)	0.25-0.51 mm	0.010-0.020 in.
Piston Ring Gap Clearance — Oil Control Steel Rails	0.25-0.64 mm	0.010-0.025 in.
Piston Ring Side Clearance —		
No. 1 Compression	0.025-0.081 mm (0.025 mm preferred)	0.001-0.0032 in. (0.001 in. preferred)
No. 2 Compression	0.025-0.081 mm (0.025 mm preferred)	0.001-0.0032 in. (0.001 in. preferred)
Oil Control	0.03-0.24 mm (0.08 mm preferred)	0.001-0.0095 in. (0.003 in. preferred)
Piston Ring Groove Height		
Compression (both)	2.019-2.045 mm	0.0795-0.0805 in.
Oil Control	4.78-4.80 mm	0.188-0.1895 in.
Piston Ring Groove Diameter		
No. 1 and No. 2	88.30-88.55 mm	3.476-3.486 in.
Oil Control	90.35-90.60 mm	3.557-3.566 in.
Piston Pin Bore Diameter	23.642-23.655 mm	0.9308-0.9313 in.
Piston Pin Diameter	23.632-23.645 mm	0.9304-0.9309 in.
Piston-to-Pin Clearance	0.010-0.015 mm loose (0.013 mm preferred)	0.0004-0.0006 in. loose (0.0005 in. preferred)
Piston-to-Pin Connecting Rod	8.9kN press-fit	2000 lbf press-fit

J9009-67

ENGINE SPECIFICATIONS — 4.0L (CONT.)

Rocker Arms, Push Rods and Tappets		
Rocker Arm Ratio	1.6:1	
Push Rod Length	244.856-245.364 mm	9.640-9.660 in.
Push Rod Diameter	7.92-8.00 mm	0.312-0.315 in.
Hydraulic Tappet Diameter	22.962-22.974 mm	0.904-0.9045 in.
Tappet-to-Bore Clearance	0.03-0.05 mm	0.001-0.0025 in.
Valves		
Valve Length (Tip-to-Gauge Dim. Line) (Intake)	122.4-122.8 mm	4.822-4.837 in.
(Exhaust)	122.8-123.2 mm	4.837-4.852 in.
Valve Stem Diameter	7.9 mm	3.12 in.
Stem-to-Guide Clearance	0.03-0.08 mm	0.001-0.003 in.
Intake Valve Head Diameter	48.5 mm	1.91 in.
Intake Valve Face Angle	45°	
Exhaust Valve Head Diameter	38 mm	1.50 in.
Exhaust Valve Face Angle	45°	
Maximum Allowable Removed for Tip Refinishing	0.25 mm	0.010 in.
Valve Springs		
Free Length	46.22 mm approx.	1.82 in. approx.
Spring Tension Valve Closed	293-329 N at 41.2	66-74 lbf at 1.625
Valve Open	911-978 N at 30.4	205-220 lbf at 1.200
Inside Diameter	24.08-24.59 mm	0.948-0.968 in.

J8909-187

TORQUE SPECIFICATIONS — 4.0L

Component	Torque	
A/C Compressor Bracket-to-Engine Bolts	34 N•m	(25 ft-lbs)
A/C Low Pressure Service Valve Nut	38 N•m	(28 ft-lbs)
Alternator Adjusting Bolt	24 N•m	(18 ft-lbs)
Alternator Pivot Bolt/Nut	38 N•m	(28 ft-lbs)
Camshaft Sprocket Bolt	108 N•m	(80 ft-lbs)
Connecting Rod Bolt Nuts	45 N•m	(33 ft-lbs)
Crankshaft Main Bearing Bolts	108 N•m	(80 ft-lbs)
Crankshaft Pulley-to-Damper Nut	27 N•m	(20 ft-lbs)
Cylinder Head Bolts (#1-10 & #12-14)	149 N•m	(110 ft-lbs)
(#11)	135 N•m	(100 ft-lbs)
Cylinder Head Cover Bolts	6 N•m	(55 in-lbs)
Exhaust Manifold-to-Downpipe Nuts	27 N•m	(20 ft-lbs)
Flywheel/Converter Housing Bolts	38 N•m	(28 ft-lbs)
Fuel Pump Bolts	22 N•m	(16 ft-lbs)
Oil Pan Bolts - 1/4-20	9 N•m	(7 ft-lbs)
- 5/16-18	15 N•m	(11 ft-lbs)
Oil Pan Drain Plug	41 N•m	(30 ft-lbs)
Oil Pump Attaching Bolts (Short)	14 N•m	(10 ft-lbs)
Oil Pump Attaching Bolts (Long)	23 N•m	(17 ft-lbs)
Oil Pan Cover Bolts	8 N•m	(70 in-lbs)
Power Steering Pump Pressure Hose Hut	52 N•m	(38 ft-lbs)
Rocker Arm Assembly-to-Cylinder Head	26 N•m	(19 ft-lbs)
Spark Plugs	37 N•m	(27 ft-lbs)
Starting Motor-to-Cylinder Block Bolts	45 N•m	(33 ft-lbs)
Timing Case Cover-to-Block Bolts	7 N•m	(62 in-lbs)
Vibration Damper Bolt (Lubricated)	108 N•m	(80 ft-lbs)

J9009-64

4.2L ENGINE SERVICE PROCEDURES

INDEX

ENGINE MOUNTS — 4.2L

Resilient rubber cushions support the engine and transmission at three points: at each side on the centerline of the engine (Fig. 1) and at the rear between the transmission extension housing and the rear support crossmember.

Replacement of a cushion may be accomplished by supporting the weight of the engine or transmission at the area of the cushion.

ENGINE ASSEMBLY — 4.2L

Removal

(1) Disconnect the battery cable clamps and remove the battery.

WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. RELEASE THE PRESSURE BEFORE REMOVING THE RADIATOR DRAINCOCK AND CAP.

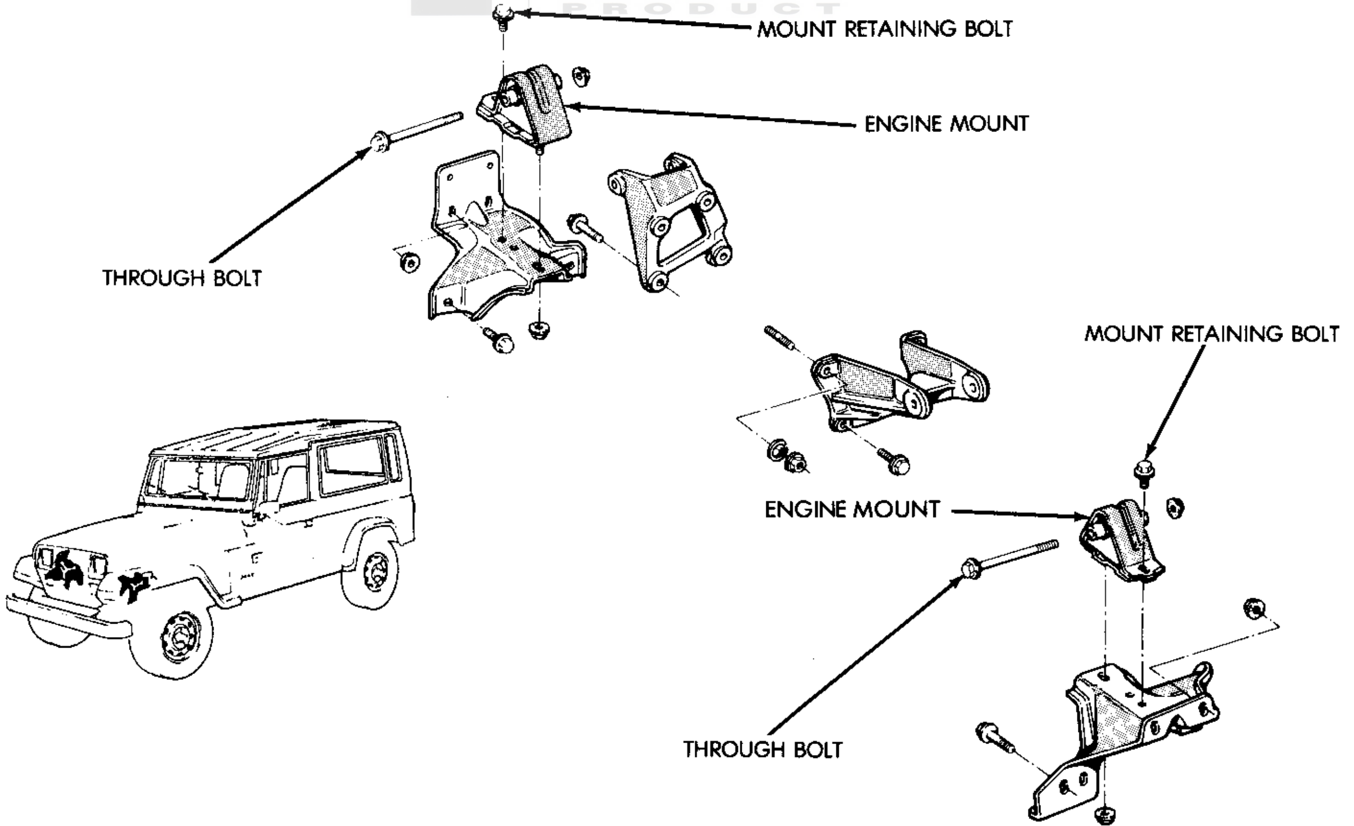


Fig. 1 Front Engine Mounts

(2) Remove the radiator draincock and radiator cap and drain the coolant. Do not waste reusable coolant. If the solution is clean, drain it into a clean container for reuse.

(3) Mark the hinge locations on the hood panel for alignment reference during installation.

(4) Remove the engine compartment lamp, if equipped, and remove the hood.

(5) Disconnect the wire connectors from the alternator.

(6) Disconnect the ignition coil and distributor wire connectors.

(7) Disconnect the oil pressure sender wire connector.

(8) Remove the vacuum switch assembly bracket from the cylinder head cover.

(9) Disconnect the front fuel pipe from the fuel pump and insert a plug to prevent entry of foreign objects.

(10) Disconnect the engine ground strap.

(11) Remove the right front engine support cushion-to-bracket nut from the thru-bolt.

(12) **Vehicles with Air Conditioning**

(a) Remove the service valve covers and front-seat the valves.

(b) Loosen the nut attaching the low pressure service valve to the compressor head.

(c) Discharge the compressor.

(d) Remove the service valve and cap the compressor port and service valve.

Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

(13) Remove the air cleaner.

(14) Disconnect the vacuum purge hose at the fuel vapor canister tee.

(15) Disconnect the TAC system vacuum hose at the intake manifold.

(16) Disconnect the idle speed control solenoid wire connector.

(17) Disconnect the fuel return hose from the fuel filter.

(18) Disconnect the carburetor bowl vent hose from the fuel vapor canister.

(19) Disconnect the throttle cable and remove it from the bracket.

(20) Disconnect the throttle valve rod, if equipped.

(21) Disconnect the throttle rod at the bellcrank.

(22) Disconnect the carburetor stepper motor wire connector.

(23) Disconnect the oxygen sensor wire connector.

(24) Disconnect the coolant temperature sender wire connector.

(25) Disconnect the upper and lower radiator hoses at the radiator.

(26) Disconnect the coolant hoses from the rear of the intake manifold and thermostat housing.

(27) Remove the fan shroud bolts.

(28) Disconnect the automatic transmission fluid cooler pipe fittings from the radiator, if equipped.

(29) Remove the radiator attaching bolts. Remove the radiator and fan shroud.

(30) Remove the fan and spacer or Tempatrol fan assembly.

(31) Install a 5/16 x 1/2-inch SAE capscrew through the fan pulley into the water pump flange to maintain the pulley and water pump in alignment when the crankshaft is rotated.

(32) Remove the power brake vacuum check valve from the booster, if equipped.

(33) **Vehicles with Power Steering**

(a) Disconnect the power steering hoses from the fittings at the steering gear.

(b) Drain the pump reservoir and cap the fittings on the hoses and steering gear to prevent foreign objects from entering the system.

(34) Remove the automatic transmission filler tube bracket bolt, if equipped.

(35) Lift the vehicle and support it with support stands.

(36) Remove the starter motor.

(37) **Vehicles with Automatic Transmission**

(a) Remove the converter housing access cover.

(b) Mark the converter and drive plate location for installation reference and remove the converter-to-drive plate bolts.

(c) Rotate the crankshaft for access to each bolt.

(d) Remove the exhaust pipe support brace from the converter housing (this brace also supports the inner end of the transmission linkage).

(38) If equipped with a manual transmission, remove the flywheel housing access cover bolts.

(39) Remove the left engine mount cushion-to-bracket nut from the thru-bolt.

(40) Disconnect the exhaust downpipe from the manifold.

(41) Remove the upper converter (or flywheel) housing bolts and loosen the bottom bolts.

(42) Lower the vehicle.

(43) Remove the A/C compressor idler pulley and mounting bracket, if equipped.

(44) Attach a lifting device to the engine.

(45) Raise the engine and remove motor mount thru-bolts.

(46) Place a support stand under the converter (or flywheel) housing.

(47) Remove the remaining converter (or flywheel) housing bolts.

(48) Lift the engine out of the engine compartment.

Installation

(1) Lower the engine into the engine compartment.

(2) **Vehicles with Manual Transmission**

(a) Insert the transmission shaft into the clutch spline.

(b) Align the flywheel housing with the engine.

(c) Install and tighten the flywheel housing lower bolts.

(3) **Vehicles with Automatic Transmission**

(a) Align the transmission torque converter housing with the engine.

(b) Loosely install the converter housing lower bolts.

(c) Install the next-higher bolt and nut on each side.

(d) Tighten all four (4) bolts.

(4) Remove the support stand from beneath the converter (or flywheel) housing.

(5) Lower the engine into the mount cushions. Ensure the bolt holes are aligned and insert the motor mount thru-bolts.

(6) Install the thru-bolt nuts and tighten with the specified torque.

(7) Lift the vehicle and position supports at the front frame rails.

(8) Install the seal and attach the exhaust downpipe to the manifold. Install and tighten the nuts to 27 N•m (20 ft. lbs.) torque.

(9) If equipped with a manual transmission, install the flywheel housing access cover.

(10) **Vehicles with Automatic Transmission**

(a) Install the converter-to-drive plate bolts (turn the crankshaft for access to each bolt hole).

(b) Ensure the installation reference marks are aligned.

(c) Install the converter housing access cover.

(d) Install the exhaust pipe support.

(11) Install the remaining converter or flywheel housing bolts.

(12) Install the starter motor and connect the cable.

(13) Lower the vehicle.

(14) Remove the engine lifting device.

(15) Install the A/C compressor idler pulley and mounting bracket, if removed.

(16) Connect the cooling system hoses and tighten the clamps.

(17) Connect the hoses to the power steering gear.

(18) Remove the pulley-to-water pump flange alignment capscrew and install the fan and spacer or Tempatrol fan assembly.

(19) Tighten the drive belts. Refer to Group 7, Cooling System for the proper procedure.

(20) Install the fan shroud and radiator (refer to Group 7, Cooling for the proper procedure.

(21) Connect the radiator hoses and automatic transmission fluid cooler pipes, if equipped.

(22) Connect the throttle valve rod and retainer. Connect the throttle cable and install the rod. Install the throttle valve rod spring.

(23) Connect the carburetor wire connectors.

(24) Connect the oxygen sensor wire connector.

(25) Install the vacuum hose and check valve on the brake booster.

(26) Connect the coolant temperature sender wire connector.

(27) Connect the idle speed control solenoid wire connector.

(28) Connect the carburetor bowl vent hose to the canister tee.

(29) Connect the fuel return hose to the fuel filter.

(30) Install the transmission filler tube bracket screw (automatic transmission only).

(31) Install the vacuum switch assembly bracket.

(32) Remove the plug and connect the fuel pipe to the fuel pump.

(33) Connect the alternator wire connectors.

(34) Install the engine ground strap.

(35) Connect the oil pressure sender wire connector.

(36) Connect the ignition system wire connectors.

(37) **Vehicles with Air Conditioning**

(a) Connect the compressor clutch wire.

(b) Connect the service valve to the port with replacement seals.

(c) Lubricate and tighten the low pressure service valve nut to 38 N•m (28 ft. lbs.) torque.

(d) Purge the compressor of air.

(e) Back-seat the service valves and install the covers.

Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

(38) Fill the cooling system with coolant. Remove the coolant temperature sending unit to permit air to escape from the cylinder block. Install the coolant temperature sending unit when the system is filled.

(39) Fill the power steering pump reservoir with fluid.

(40) Install the battery and connect the battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(41) Start the engine and inspect for leaks.

(42) Check the automatic transmission fluid level.

(43) Stop the engine and check the coolant and engine oil levels. Fill to the specified level, if necessary.

(44) Install the air cleaner and connect the vacuum hose.

(45) Connect the purge hose to the canister.

(46) Install and adjust the hood. Connect the underhood lamp, if equipped.

CYLINDER HEAD COVER — 4.2L

Removal

(1) Disconnect the battery negative cable.

(2) Remove the air cleaner and the PCV molded hose.

(3) Disconnect the distributor vacuum advance hose at the distributor.

(4) Disconnect the fuel pipe at the fuel pump. Rotate the pipe as necessary to provide clearance for the cylinder head cover removal/installation.

(5) Remove the PCV valve from the cylinder head cover grommet and disconnect the PCV shutoff valve vacuum hose (Fig. 2).

(6) Remove the vacuum switch and bracket assembly from the cylinder head cover.

(7) Remove all the necessary vacuum and air hoses to provide clearance for the cylinder head cover removal/ installation. Identify and tag the hoses for installation reference.

(8) Remove the cylinder head cover retaining bolts.

(9) Detach the cover from the cylinder head by breaking the silicone rubber seal with a putty knife or razor blade. Do not attempt to pry the cover up until the seal has been completely broken.

(10) Rotate the cylinder head cover toward the passenger side and remove the cover.

Inspection and Cleaning

Replace the cover if it is cracked or damaged in any way. If the pre-cured RTV seal is damaged, replace the cover.

If a replacement cover is installed, transfer the PCV valve grommet and oil filler cap from the original cover to the replacement cover.

Remove any original sealer from the cover sealing surface of the cylinder head and clean the surface using a fabric cleaner.

Remove all residue from the sealing surface using a clean, dry cloth.

Installation

(1) Install and tighten the cylinder head cover bolts to 8 N•m (70 in. lbs.) torque.

(2) Connect the fuel pipe and the distributor vacuum advance hose.

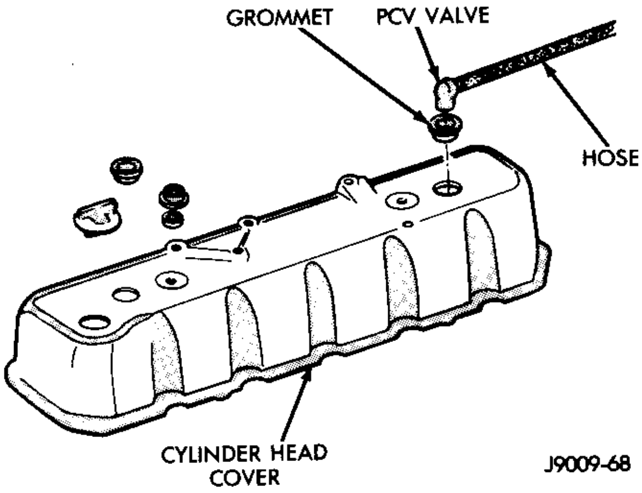


Fig. 2 Cylinder Head Cover

(3) Reposition and/or connect all the air and vacuum hoses that were moved for cover removal clearance.

(4) Connect the PCV valve and the PCV shutoff valve hose.

(5) Install the air cleaner and hoses.

(6) Connect the battery negative cable.

(7) Check the engine oil and add oil, if necessary.

ROCKER ARMS — 4.2L

Removal

(1) Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

(2) Remove the two capscrews at each bridge and pivot assembly (Fig. 3). Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridges.

(3) Remove the bridges, pivots and corresponding pairs of rocker arms (Fig. 3) and place them on a bench in the same order as removed.

(4) Remove the push rods (Fig. 3) and place them on a bench in the same order as removed.

Cleaning and Inspection

Clean all the components with cleaning solvent and use compressed air to blow out the oil passages in the rocker arms and push rods.

Inspect the pivot surface area of each rocker arm. Replace any that are scuffed, pitted or excessively worn.

Inspect the valve stem tip contact surface of each rocker arm and replace any rocker arm that is deeply pitted.

Inspect each push rod end for excessive wear and replace as required. If any push rod is excessively worn

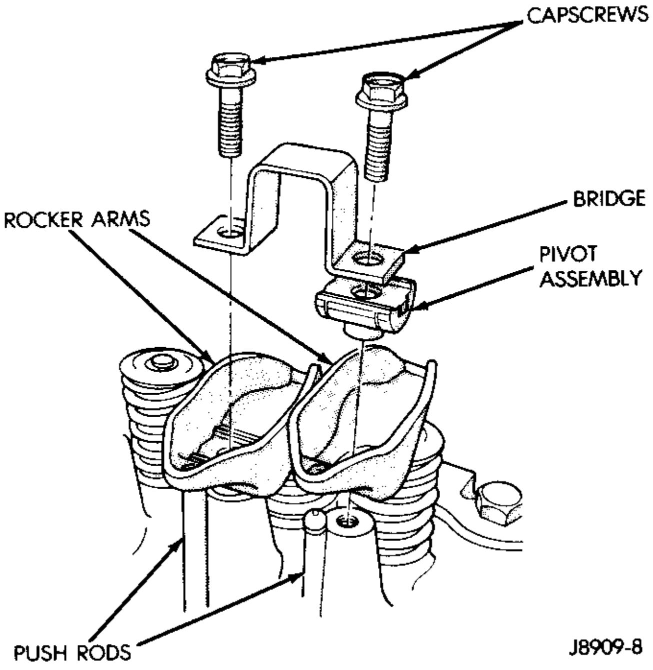


Fig. 3 Rocker Arm Assembly

because of lack of oil, replace the push rod and inspect the corresponding hydraulic tappet.

A wear pattern along the length of the push rod is not normal. Inspect the cylinder head for obstruction if this condition exists.

Insatllation

(1) Install the push rods in their original locations. Ensure that the bottom end of each push rod is centered in the tappet plunger cap seat.

(2) Install the rocker arms, pivots and bridge above each cylinder from where they were originally removed.

(3) Loosely install the capscrews through each bridge.

(4) At each bridge, tighten the capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(5) Install the cylinder head cover. Refer to Cylinder Head Cover - Installation for the procedure.

CYLINDER HEAD — 4.2L

Removal

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAIN-COCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

(1) Drain the coolant. Disconnect the hoses at the thermostat housing. Do not waste reusable coolant. If the solution is clean and is being drained only to service the engine or cooling system, drain the coolant into a clean container for reuse.

(2) Remove the air cleaner.

(3) Remove the fuel pipe and vacuum advance hose.

(4) Remove the cylinder head cover. Refer to Cylinder Head Cover - Removal for the procedure.

(5) Remove the capscrews, bridge and pivot assemblies and rocker arms (Fig. 3). Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridge.

(6) Remove the push rods (Fig. 3). **Retain the push rods, bridges, pivots and rocker arms in the same order as removed to facilitate installation in the original locations.**

(7) Disconnect the power steering pump bracket. Set the pump and bracket aside. Do not disconnect the hoses.

(8) Remove the intake and exhaust manifolds from the cylinder head. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedures.

(9) If equipped with air conditioning, perform the following:

(a) Remove the air conditioner compressor drive belt idler pulley bracket from the cylinder head.

(b) Loosen the alternator drive belt and remove the alternator bracket-to-cylinder head mounting bolt. **The serpentine drive belt tension is released by loosening the alternator.**

(c) Remove the bolts from the A/C compressor mounting bracket and set the compressor aside.

(10) Disconnect the ignition wires and remove the spark plugs.

(11) Disconnect the temperature sending unit wire connector and battery negative cable.

(12) Remove the ignition coil and bracket assembly.

(13) Remove the cylinder head bolts, cylinder head and gasket (Fig. 4).

Cleaning and Inspection

Thoroughly clean the machined surfaces of the cylinder head and block. Remove all gasket material and cement.

Remove any carbon deposits from the combustion chambers and top of the pistons.

Use a straightedge and feeler gauge to check the flatness of the cylinder head and block mating surfaces. Refer to Engine Specifications - 4.2L Engines.

Installation

If the cylinder head is to be replaced and the original valves used, measure the valve stem diameter. Only standard size valves can be used with a service replacement cylinder head unless the replacement head valve stem guide bores are reamed to accommodate oversize valve stems. Remove all carbon buildup and reface the valves. Refer to Valve Refacing for the proper procedure.

(1) Install the valves in the cylinder head using replacement valve stem oil deflectors (Fig. 5). Refer to Valve Installation for the proper procedures.

(2) Transfer all attached components from the original cylinder head that are not included with the replacement head. Do not install the temperature sending unit until coolant is installed. This permits trapped air to escape from the cylinder block and head. Refer to Group 7, Cooling Systems for the proper procedure.

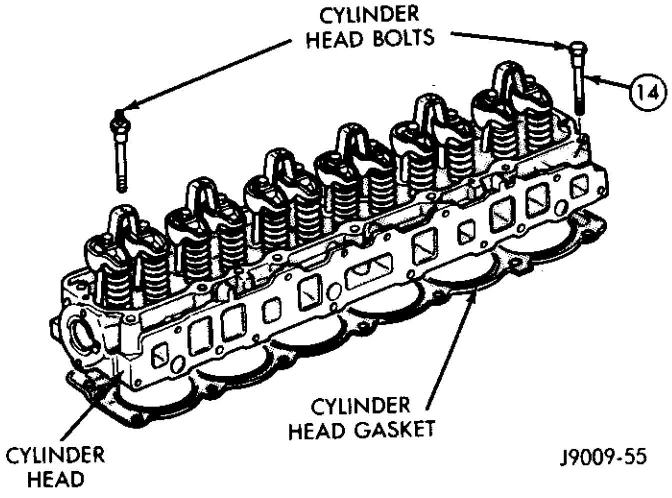


Fig. 4 Cylinder Head Assembly

CAUTION: Do not apply sealing compound on the cylinder head and block gasket surfaces. Do not allow sealing compound to enter the cylinder bore.

(3) Position the composition gasket on the cylinder block with the word TOP facing up.

(4) Install the cylinder head. Tighten the bolts in the sequence shown to 115 N•m (85 ft. lbs.) torque (Fig. 6). **The head gasket is made of aluminum-coated embossed steel and does not require the head bolts to be retightened.**

(5) Connect the battery negative cable.

(6) Install the ignition coil and bracket assembly.

(7) Install the spark plugs and connect the ignition wires. Tighten the spark plugs to 38 N•m (28 ft. lbs.) torque.

(8) Attach the air conditioner compressor mounting bracket to the cylinder head, if removed.

(9) Install the intake and exhaust manifolds. Use the correct tightening sequence. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedures.

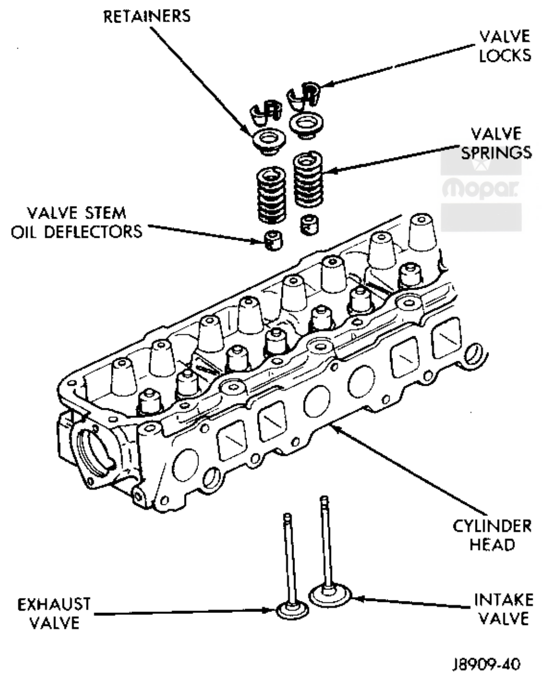


Fig. 5 Valve Components

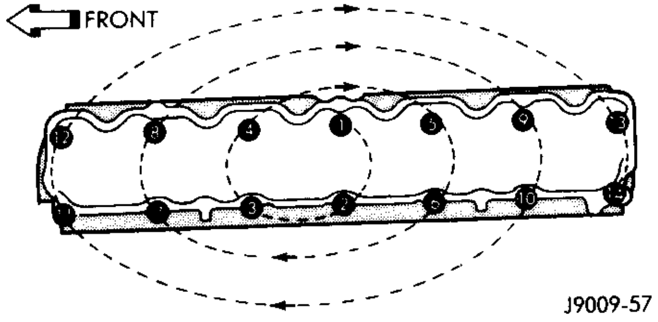


Fig. 6 Cylinder Head Tightening Sequence

(10) Install the alternator bracket bolt on the head. Install the alternator belt and adjust the tension.

(11) Install the power steering bracket and pump. Adjust the belt tension. Refer to Group 7, Cooling Systems for drive belt (including serpentine) adjustment procedures.

(12) Install the push rods in the same order they were removed.

(13) Install the rocker arms and the bridge and pivot assemblies in the order removed. Loosely install the capscrews for each bridge and tighten alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(14) Install the cylinder head cover.

(15) Connect the hoses to the thermostat housing and fill the cooling system to the specified level. Refer to Group 7, Cooling Systems for the proper procedure.

(16) The automatic transmission throttle linkage and cable must be adjusted after completing the cylinder head installation. Refer to Group 21, Transmission for the proper procedures.

(17) Install the temperature sending unit and connect the wire connector.

(18) Connect the fuel pipe and vacuum advance hose.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(19) Operate the engine with the radiator cap off. Inspect for leaks and continue operating the engine until the thermostat opens. Add coolant, if required.

(20) Install the air cleaner.

VALVES AND VALVE SPRINGS — 4.2L

Removal — Cylinder Head Removed

(1) Use the valve spring compressor tool (8014) to compress each valve spring (Fig. 7).

(2) Remove the valve locks, the retainers, the valve springs, and the valve stem oil deflectors. Discard the oil deflectors.

(3) Remove the valves, and place them in a rack in the order in which they are removed.

Valve Cleaning and Inspection

Clean all carbon deposits from the combustion chambers, valve ports, valve stems, valve stem guides and head.

Clean all grime and gasket cement from the cylinder head machined gasket surface.

Inspect for cracks in the combustion chambers and valve ports.

Inspect for cracks on the exhaust seats.

Inspect for cracks in the gasket surface at each coolant passage.

Inspect the valves for burned, cracked or warped heads.

Inspect for scuffed or bent valve stems.

Replace valves displaying any damage.

Valve Refacing

(1) Use a valve refacing machine to reface the intake and exhaust valves to the specified angle.

(2) After refacing, a margin of at least 0.787 mm (0.031 inch) must remain (Fig. 8). If the margin is less than 0.787 mm (0.031 inch), the valve must be replaced.

Valve Seat Refacing

(1) Install a pilot of the correct size in the valve guide bore and reface the valve seat to the specified angle with a good dressing stone.

(2) Remove only enough metal to provide a smooth finish.

(3) Use tapered stones to obtain the specified seat width when required.

(4) Control seat runout to a maximum of 0.0635 mm (0.0025 in), using a dial indicator (Fig. 9).

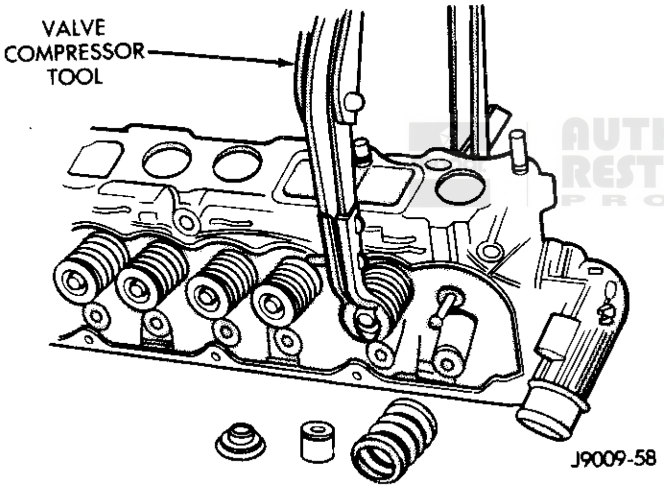


Fig. 7 Valve Spring Compressor Tool (8014)

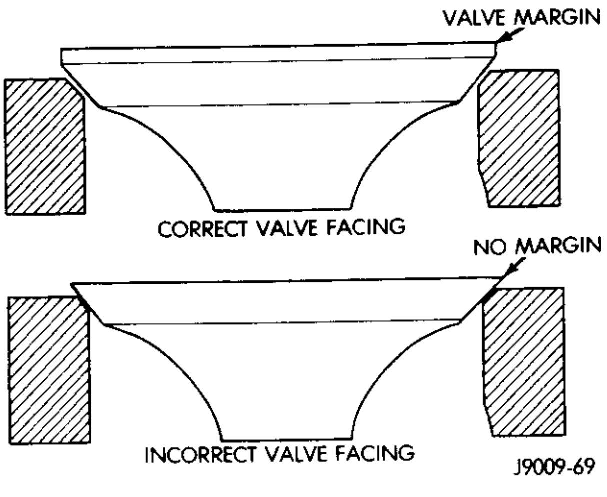


Fig. 8 Valve Facing Margin

Valve Stem Oil Deflector Replacement

Nylon valve stem oil deflectors are installed on each valve stem to prevent lubricating oil from entering the combustion chamber through the valve guide bores.

CAUTION: Ensure that the valve stem is free of burrs or sharp edges before replacing the oil deflectors.

Replace the oil deflectors whenever valve service is performed or if the oil deflectors have deteriorated.

Oil deflector replacement requires removal of the valve springs. Refer to Valve Springs for the removal procedure.

Valve Guides

The valve guides are an integral part of the cylinder head and are not replaceable.

When the stem-to-guide clearance is excessive, the valve guide bores must be reamed to accommodate the next larger oversize valve stem.

Oversize stem service valves are available in 0.076 mm (0.003 inch), 0.381 mm (0.015 inch), and 0.762 mm (0.030 inch) stem sizes. Ream valve guide bores in steps, starting with the 0.0762 mm (0.003 inch) oversize reamer and progress to the size required.

Valve Stem-to-Guide Clearance Measurement

Valve stem-to-guide clearance may be measured by either of the following two methods.

Preferred Method:

(1) Remove the valve from the head. Refer to Valve Removal for the procedure.

(2) Clean the valve stem guide bore with solvent and a bristle brush.

(3) Insert the telescoping gauge into the bore of the valve stem guide approximately 9.525 mm (.375 inch) from the valve spring side of the head with contacts crosswise to the cylinder head (Fig. 10).

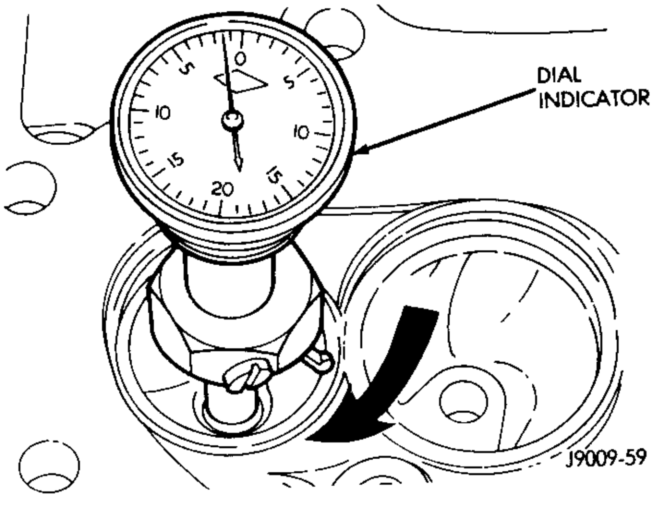


Fig. 9 Valve Seat Runout

(4) Remove and measure the telescoping gauge with a micrometer.

(5) Repeat the measurement with contacts lengthwise to the cylinder head.

(6) Compare the crosswise to lengthwise measurements to determine out-of-roundness. If the measurements differ by more than 0.0635 mm (0.0025 inch), ream the guide bore to accommodate the oversize valve stem.

(7) Compare the measured valve guide bore diameter with the diameter listed in the Engine Specifications. If the measurement differs from the specification by more than 0.0762 mm (0.003 inch), ream the guide bore to accommodate the oversize valve stem.

Alternate Method:

(1) Use a dial indicator to measure the lateral movement of the valve stem (stem-to-guide clearance) with the valve installed in its guide and just off the valve seat (Fig. 11). The correct clearance is 0.0025-0.0762 mm (0.001-0.003 inch).

(2) If the indicated movement exceeds the specification, ream the guide bore to accommodate an oversize valve stem.

Valve Spring Tension Test

Use valve spring tester (8011) and a torque wrench to test each valve spring for the specified tension value (Fig. 12).

Replace the valve springs that are not within specifications.

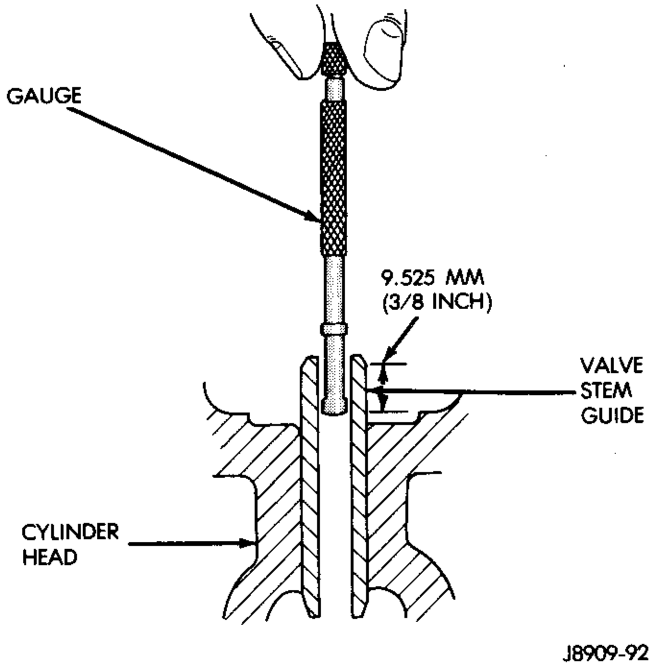


Fig. 10 Measurement of Valve Guide Bore Diameter

Installation — Cylinder Head Removed

(1) Thoroughly clean the valve stems and the valve guide bores.

(2) Lubricate the stem lightly.

(3) Install the valve in the original valve guide bore from where it was removed (Fig. 5).

(4) Install the replacement valve stem oil deflector on the valve stem (Fig. 5). If the oversize valve stems are used, oversize oil deflectors are required.

(5) Position the valve spring and retainer on the cylinder head and compress the valve spring with valve spring compressor (8014).

(6) Install the valve locks and release the tool.

(7) Tap the valve spring from side to side with a hammer to ensure that the spring is properly seated at the cylinder head.

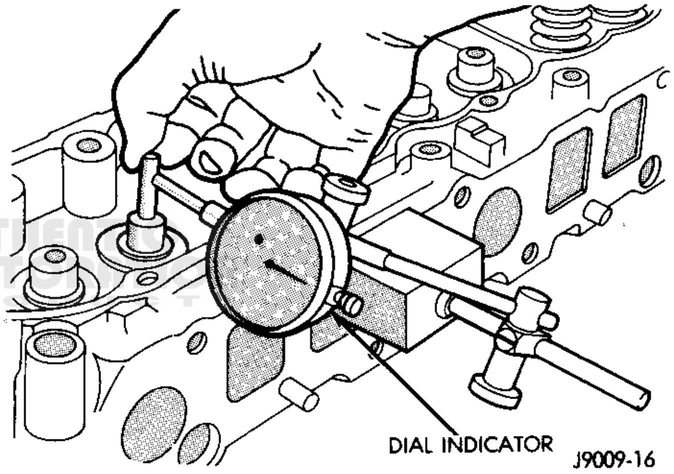


Fig. 11 Measurement of Lateral Movement of Valve Stem

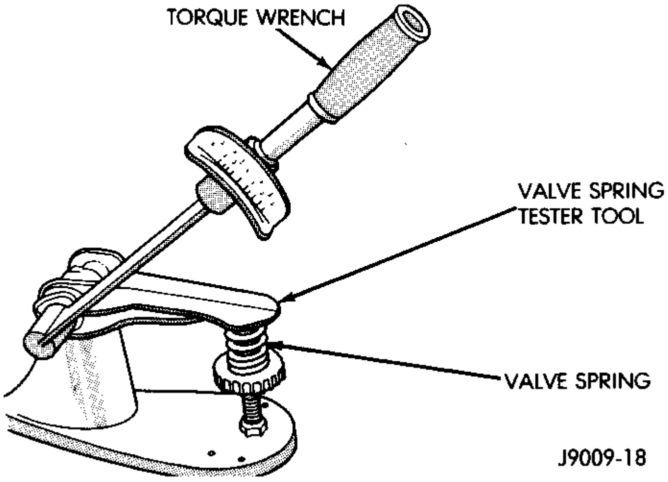


Fig. 12 Valve Spring Tester (8011)

HYDRAULIC TAPPETS — 4.2L

Removal

Retain all the components in the same order as removed to facilitate installation at the original positions.

(1) Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

(2) Remove the bridge and pivot assemblies and rocker arms by removing the two capscrews at each bridge. Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridges.

(3) Remove the push rods.

(4) Remove the intake and exhaust manifolds. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedure.

(5) Remove the cylinder head and gasket. Refer to Cylinder Head Removal for the procedure.

(6) Remove the tappets through the push rod openings in the cylinder block.

Installation

It is not necessary to charge the tappets with engine oil. They will charge themselves within a very short period of engine operation.

(1) Dip each tappet in Jeep/Eagle Super Oil Conditioner, or equivalent.

(2) Install each tappet in the same bore from where it was originally removed.

(3) Install the exhaust and intake manifolds. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedure.

(4) Install the cylinder head and gasket. Refer to Cylinder Head Installation for the procedure.

(5) Install each push rod in the same location from where removed.

(6) Install the rocker arms and bridge and pivot assemblies at their original locations.

(7) Loosely install the capscrews through each bridge. Tighten the capscrews alternately, one turn at a time, to avoid damaging the bridges.

(8) Pour the remaining Jeep/Eagle Super Oil Conditioner over the entire valve actuating assembly. The Jeep/Eagle Super Oil Conditioner must remain with the engine oil for at least 1 609 km (1,000 mi) but need not be drained until the next scheduled oil change.

(9) Install the cylinder head cover. Refer to Cylinder Head Cover Installation for the procedure.

Disassemby, Cleaning and Inspection

Place the components of each tappet in a separate location. This will greatly assist in the installation operation.

(1) Release the snap ring.

(2) Remove the following from the tappet body (Fig. 13):

- (a) The plunger cap.
- (b) The metering valve.
- (c) The plunger.
- (d) The check valve assembly.
- (e) The plunger return spring.

(3) Clean the components of each tappet assembly in cleaning solvent to remove all varnish, gum and sludge deposits.

(4) Inspect for indications of scuffing on the side and base of each tappet body.

(5) Inspect each tappet base for concave wear with a straightedge positioned across the base.

(6) If the base is concave, the corresponding lobe on the camshaft is also worn. Replace the camshaft and tappets.

Assembly and Lead-Down Test

(1) Install the following in the tappet body:

- (a) The plunger return spring.
- (b) The check valve assembly.
- (c) The plunger.
- (d) The metering valve.
- (e) The plunger cap.

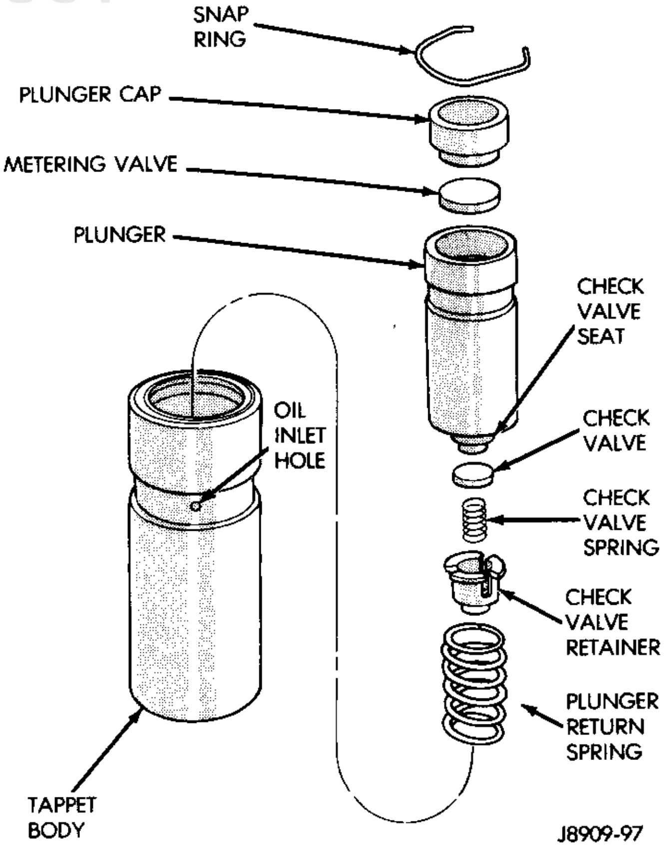


Fig. 13 Hydraulic Tappet

(2) Compress the plunger assembly by exerting force on the plunger cap with the push rod and install the snap ring.

(3) After cleaning, inspection and assembly, test each tappet for the specified leak-down rate tolerance to ensure zero-lash operation (Fig. 14).

(4) Swing the weighted arm of the hydraulic valve tappet tester away from the ram of the tester (7980).

(5) Place a 7.925-7.950 mm (0.312-0.313 inch) diameter ball bearing on the plunger cap of the tappet.

(6) Lift the ram and position the tappet (with the ball bearing) inside the tester cup.

(7) Lower the ram, then adjust the nose of the ram until it contacts the ball bearing. Do not tighten the hex nut on the ram.

(8) Fill the tester cup with hydraulic valve tappet test oil until the tappet is completely submerged.

(9) Swing the weighted arm onto the push rod and pump the tappet plunger up and down to remove air.

(10) When the air bubbles cease, swing the weighted arm away and allow the plunger to rise to the normal position.

(11) Adjust the nose of the ram to align the pointer with the SET mark on the scale of the tester and tighten the hex nut.

(12) Slowly swing the weighted arm onto the push rod.

(13) Rotate the cup by turning the handle at the base of the tester clockwise one revolution every two seconds.

(14) Observe the leak-down time interval from the instant the pointer aligns with the START mark on the scale until the pointer aligns with the 0.125 mark.

(15) A normally functioning tappet will require 20 - 110 seconds to leak-down. Discard the tappets with leak-down time intervals which are not within this specification.

VALVE TIMING — 4.2L

Disconnect the spark plug wires and remove the spark plugs.

Remove the cylinder head cover. Refer to Cylinder Head Cover Removal for the procedure.

Remove the capscrews, bridge and pivot assembly, and rocker arms from above the No. 1 cylinder.

Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridge.

Rotate the crankshaft until the No. 6 piston is at top dead center (TDC) on the compression stroke.

Rotate the crankshaft counterclockwise (viewed from the front of the engine) 90°.

Install a dial indicator on the end of the No. 1 cylinder intake valve push rod. Use rubber tubing to secure the indicator stem on the push rod.

Set the dial indicator pointer at zero.

Rotate the crankshaft clockwise (viewed from the front of the engine) until the dial indicator pointer indicates 0.305 mm (0.012 inch) travel distance (lift).

The timing notch index on the vibration damper should be aligned with the TDC mark on the timing degree scale.

If the timing notch is more than 13 mm (1/2 inch) away from the TDC mark in either direction, the valve timing is incorrect.

If the valve timing is incorrect, the cause may be a broken camshaft pin. It is not necessary to replace the camshaft because of pin failure. A spring pin is available for service replacement.

VIBRATION DAMPER — 4.2L

Removal

(1) Remove the drive belt(s).

(2) Remove the retaining bolts and separate the vibration damper pulley (V-belt ONLY) from the vibration damper.

(3) Remove the vibration damper retaining bolt and washer.

(4) Use a vibration damper removal tool (8068) to remove the damper from the crankshaft (Fig. 1).

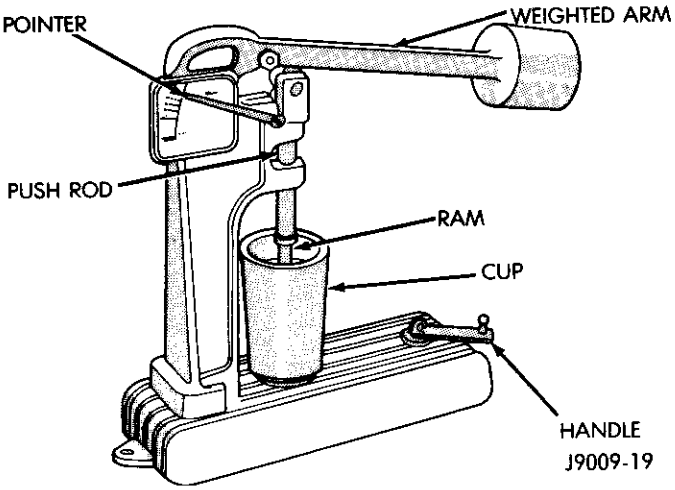


Fig. 14 Leak-Down Tester (7980)

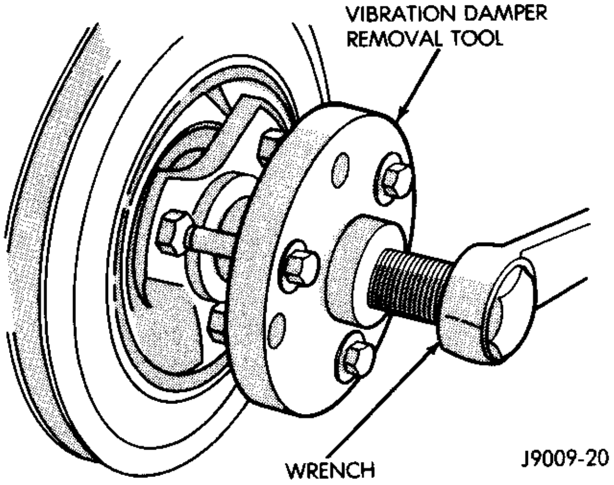


Fig. 1 Vibration Damper Removal Tool (8068)

Installation

(1) With the key in position, align the key slot of the vibration damper hub with the crankshaft key and tap the damper onto the crankshaft.

(2) Install the vibration damper retaining bolt and washer. Tighten the bolt to 108 N•m (80 ft. lbs.) torque. If the crankshaft turns before the damper bolt torque value is attained, the crankshaft can be prevented from turning by placing two 5/16 x 1 1/2-inch bolts into the damper front pulley holes and wedging a bar between them. Rotate the bar until it contacts the frame member to prevent the crankshaft from turning.

(3) Install the damper pulley (V-belt only) and retaining bolts. Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(4) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling Systems for the proper specifications and preocedures.

TIMING CASE COVER — 4.2L

Removal

(1) Remove the drive belt(s), engine fan and hub assembly, fan shroud, vibratation damper, pulley, and key. Refer to Vibration Damper Removal.

(2) Remove the A/C compressor and alternator bracket assembly, if equipped. Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

(3) Remove the oil pan-to-timing case cover bolts and cover-to-cylinder block bolts.

(4) Remove the timing case cover, front seal and gasket from the engine (Fig. 2).

(5) Cut off the oil pan side gasket end tabs flush with the front face of the cylinder block. Remove the gasket tabs.

(6) Clean the timing case cover, oil pan, and cylinder block gasket surfaces.

(7) Remove the crankshaft oil seal from the timing case cover (Fig. 2).

(8) Remove the oil seal from the timing case cover.

Installation

(1) Apply sealing compound (Jeep/Eagle Gasket-In-A-Tube, or equivalent) to both sides of the replacement timing case cover gasket and position the gasket on the cylinder block.

(2) Cut the end tabs off of replacement oil pan side gaskets corresponding to those cut off the original gasket. Cement the end tabs on the oil pan.

(3) Coat the front cover end tab recesses (Fig. 3) generously with RTV sealant (Jeep/Eagle Gasket-In-A-Tube, or equivalent) and position the seal on the timing case cover. Apply engine oil to the seal-oil pan contact surface.

(4) Position the timing case cover on the cylinder block.

(5) Place Timing Case Cover Alignment and Seal Installation Tool (6139) in the crankshaft opening of the cover (Fig. 4).

(6) Install the cover-to-cylinder block bolts and the oil pan-to-cover bolts.

(7) Tighten the cover-to-cylinder block bolts to 7 N•m (62 in. lbs.) torque and the oil pan-to-cover bolts to 13 N•m (11 ft. lbs.) torque.

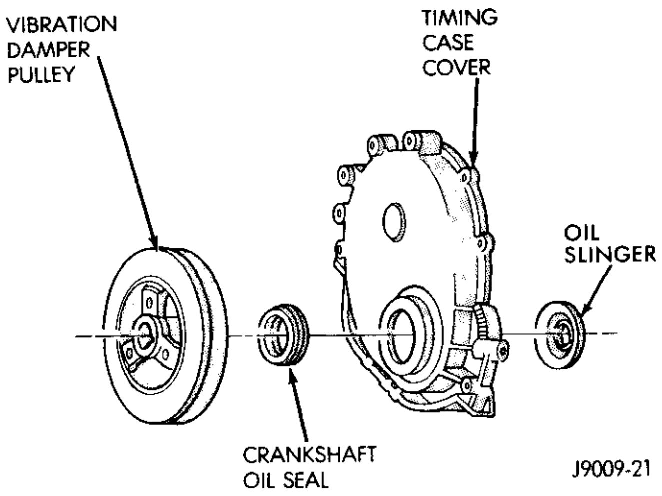


Fig. 2 Timing Case Cover and Related Components

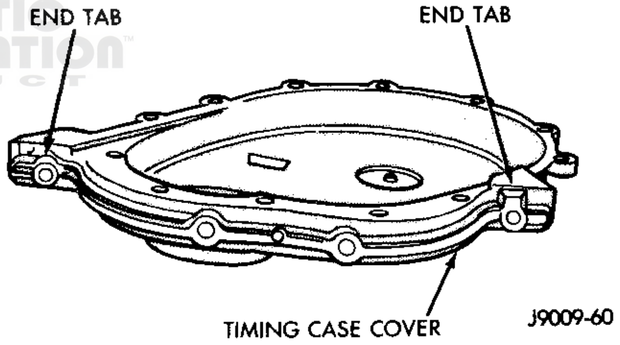


Fig. 3 Timing Case Cover End Tabs

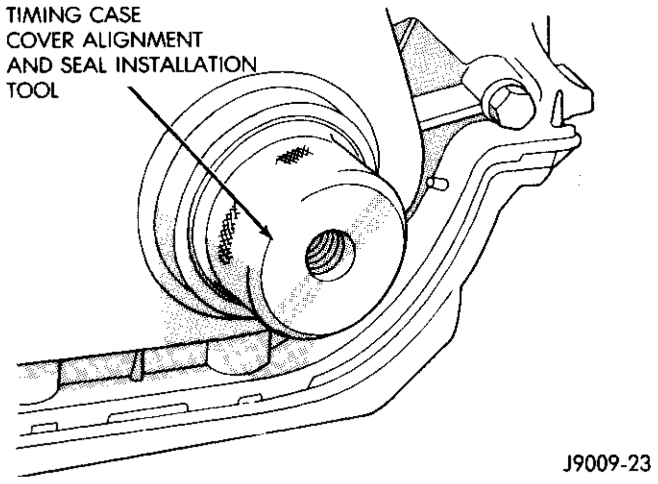


Fig. 4 Timing Case Cover Alignment and Seal Installation Tool (6139)

(8) Remove the cover alignment tool and position the replacement oil seal on the tool with the seal lip facing outward.

(9) Apply a light film of Perfect Seal, or equivalent, on the outside diameter of the seal.

(10) Lightly coat the crankshaft with engine oil.

(11) Position the tool and seal over the end of the crankshaft and insert a screw tool into Seal Installation Tool (6139). Tighten the nut against the tool until the tool contacts the cover (Fig. 5).

(12) Remove the tools and apply a light film of engine oil on the vibration damper hub contact surface of the seal.

(13) With the key inserted in the keyway in the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N•m (80 ft. lbs.) torque.

(14) Install the A/C compressor and alternator bracket assembly.

(15) Install the damper pulley, if removed. Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(16) Install the engine fan and hub assembly. Install the fan shroud.

(17) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling Systems for the proper procedures.

TIMING CHAIN AND SPROCKETS — 4.2L

Removal

Installation of the timing chain with the timing marks on the crankshaft and camshaft sprockets properly aligned ensures correct valve timing. A worn or stretched timing chain will adversely affect valve timing. If the timing chain deflects more than 12.7 mm (1/2 inch) replace it. The correct timing chain has 48 pins. A chain with more than 48 pins will cause excessive slack.

(1) Remove the drive belt(s).

(2) Remove the engine fan and hub (or Tempatrol fan) assembly.

(3) Remove the vibration damper pulley (V-belt drive only).

(4) Remove the vibration damper. Refer to the removal procedure.

(5) Remove the timing case cover. Refer to the Timing Case Cover - Removal procedure.

(6) Remove the oil seal from the timing case cover.

(7) Remove the camshaft sprocket retaining bolt and washer.

(8) Rotate the crankshaft until the zero timing mark on the crankshaft sprocket in closest to and on the centerline with the timing mark on the camshaft sprocket (Fig. 6).

(9) Remove the crankshaft sprocket, camshaft sprocket and timing chain as an assembly. Disassemble the chain and sprockets.

Installation

Assemble the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned.

(1) With the key in the keyway on the crankshaft, install the assembly on the crankshaft and camshaft.

(2) Install the camshaft sprocket retaining bolt and washer and tighten to 108 N•m (80 ft. lbs.) torque.

(3) To verify the correct installation of the timing chain, turn the crankshaft to locate the camshaft sprocket timing mark at approximately the one o'clock position. This positions the crankshaft sprocket timing mark where the adjacent tooth meshes with the chain at the three o'clock position. Count the number of chain pins between the timing marks on both sprockets (Fig. 7). There must be 15 pins.

(4) Install the crankshaft oil slinger (Fig. 2).

(5) Install the timing case cover and replacement oil seal (Fig. 2). Refer to Timing Case Cover - Installation.

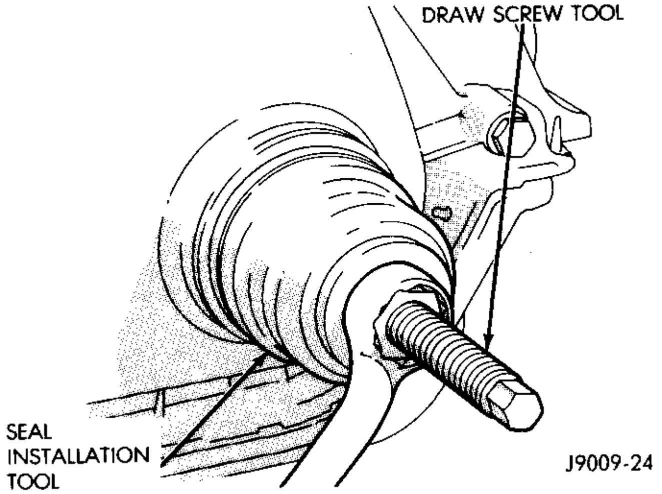


Fig. 5 Crankshaft Oil Seal Installation

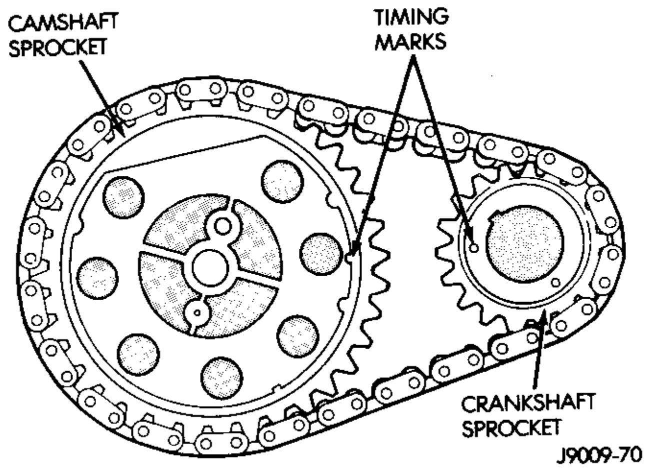


Fig. 6 Timing Marks on Sprockets

(6) With the key in the keyway on the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N•m (80 ft. lbs.) torque (Fig. 2).

(7) Install the damper pulley (if removed). Tighten the bolts to 27 N•m (20 ft. lbs.) torque.

(8) Install the engine fan and hub (or Tempatrol fan) assembly.

(9) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling System for the proper procedure.

CAMSHAFT — 4.2L

Removal

WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. RELEASE THE PRESSURE BEFORE REMOVING THE DRAINCOCK, CAP AND DRAIN PLUGS.

(1) Disconnect the battery negative cable.

(2) Drain the cooling system. Do not waste reusable coolant. If the solution is clean, drain it into a clean container for reuse.

(3) Remove the radiator. Refer to Group 7, Cooling System for the proper procedure.

(4) Remove the air conditioner condenser and receiver/drier assembly as a charged unit, if equipped. Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

(5) Remove the distributor and ignition wires.

(6) Remove the fuel pump (refer to Group 14, Fuel System, for the proper procedure.

(7) Remove the cylinder head cover. Refer to Cylinder Head Cover - Removal for the procedure.

(8) Remove the capscrews, bridge and pivot assemblies, and rocker arms (Fig. 8).

(9) Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridges.

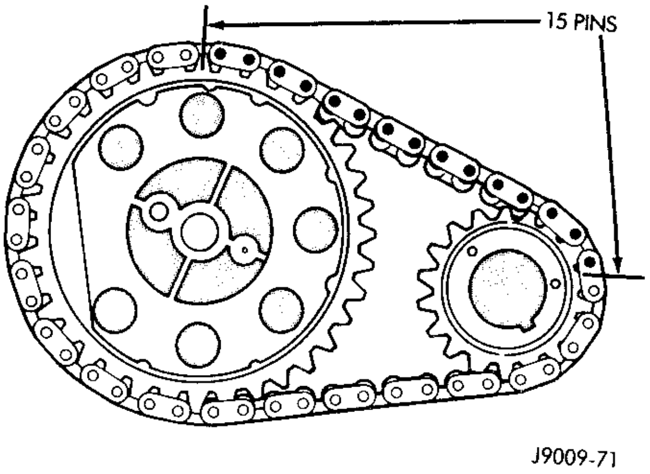


Fig. 7 Verify Crankshaft/Camshaft Installation

(10) Remove the push rods (Fig. 8). Position all components on a work bench in the same order as removed to facilitate installation at the original locations.

(11) Remove the cylinder head and gasket. Refer to Cylinder Head - Removal for the procedure.

(12) Remove the hydraulic valve tappets.

(13) Remove the vibration damper. Refer to the Vibration Damper - Removal procedure.

(14) Remove the timing case cover. Refer to Timing Case Cover - Removal procedure.

(15) Remove the timing chain and sprockets. Refer to Timing Chain - Removal procedure.

(16) Remove the grille (refer to Group 23, Body for the proper procedure).

(17) Remove the camshaft (Fig. 9).

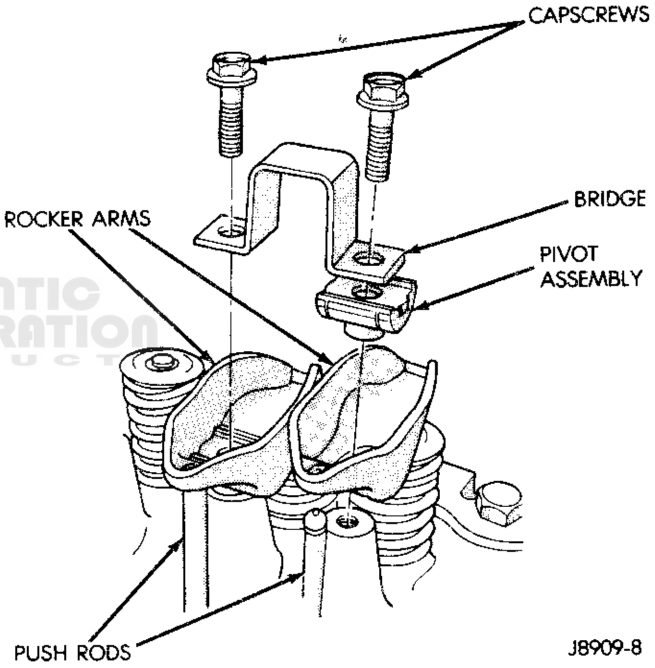


Fig. 8 Rocker Arm Components

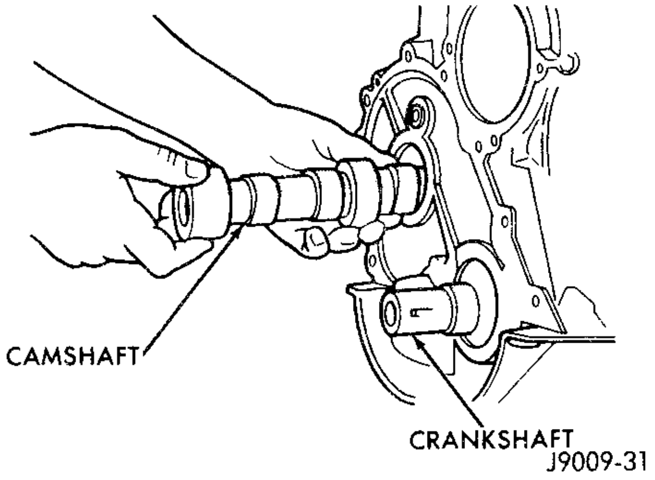


Fig. 9 Camshaft Removal

Inspection

Inspect the cam lobes for wear.

Inspect the bearing journals for uneven wear pattern or finish.

Inspect the bearings for wear.

Inspect the distributor drive gear for wear.

If the camshaft appears to have been rubbing against the timing case cover, examine the oil pressure relief holes in the rear cam journal to ensure that they are free of debris.

Installation

(1) Lubricate the camshaft with Jeep/Eagle Super Oil Conditioner, or equivalent.

(2) Carefully install the camshaft to prevent damage to the camshaft bearings.

(3) Install the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned (Fig. 6). Refer to Timing Chain - Installation for the procedure.

(4) Install the camshaft sprocket retaining bolt and tighten to 108 N•m (80 ft. lbs.) torque.

(5) Install the crankshaft oil slinger (Fig. 2).

(6) Install the timing case cover with a replacement oil seal (Fig. 2). Refer to Timing Case Cover Installation for the procedure.

(7) Install the vibration damper (Fig. 2).

(8) Install the damper pulley, if removed.

(9) Install the fan assembly and shroud.

(10) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling System for the proper procedure.

(11) Install the fuel pump.

(12) Rotate the crankshaft until the No. 1 piston is at the TDC position on the compression stroke.

(13) Install the distributor, cap and ignition wires. Install the distributor so that the rotor is aligned with the No. 1 cylinder spark plug terminal on the cap when the distributor housing is fully seated on the cylinder block.

Lubricate the hydraulic valve tappets and all valve actuating components with Jeep/Eagle Super Oil Conditioner, or equivalent, during installation. The Jeep/Eagle Super Oil Conditioner must remain with the engine oil for at least 1 609 km (1,000 mi) but need not be drained until the next scheduled oil change.

(14) Install the hydraulic valve tappets.

(15) Install the cylinder head. Refer to Cylinder Head Installation for the procedure.

(16) Install the push rods (Fig. 8).

(17) Install the rocker arms and pivot and bridge assemblies (Fig. 8). Tighten each of the two capscrews for each bridge alternately, one turn at a time, to avoid damaging the bridge.

(18) Install the cylinder head cover. Refer to Cylinder Head Cover Installation for the procedure.

(19) Install the fuel pump (refer to Group 14, Fuel System for the proper procedure).

(20) Install the A/C condenser and receiver/drier assembly, if equipped. Refer to Group 24, Heating and Air Conditioning for additional information pertaining to the A/C system.

CAUTION: Both service valves must be opened before the air conditioning system is operated.

(21) Install the radiator, connect the hoses and fill the cooling system to the specified level. Refer to Group 7, Cooling System for the proper procedure.

(22) Check the ignition timing and adjust as necessary.

(23) Install the grille (refer to Group 23, Body, for the proper procedure).

(24) Connect the battery negative cable.

CAMSHAFT PIN REPLACEMENT — 4.2L

Removal

(1) Disconnect the battery negative cable.

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

(2) Drain the radiator. Do not waste reusable coolant. Drain the coolant into a clean container.

(3) Remove the fan and shroud.

(4) Disconnect the radiator overflow tube, radiator hoses, automatic transmission fluid cooler pipes (if equipped).

(5) Remove the radiator.

(6) If equipped with air conditioning:

(a) Remove the A/C compressor drive belt idler pulley.

(b) Disconnect and remove the alternator.

CAUTION: Do not loosen or disconnect any air conditioner system fittings. Move the condenser and receiver/drier aside as a complete assembly.

(c) Remove the A/C condenser attaching bolts and move the condenser and receiver/drier assembly up and out of the way.

(7) Remove the drive belt(s).

(8) Remove the crankshaft vibration damper and pulley. Refer to the Vibration Damper - Removal procedure.

(9) Remove the timing case cover. Refer to the Timing Case Cover - Removal procedure.

(10) Rotate the crankshaft until the zero degree (0°) timing mark on the crankshaft sprocket is closest to and on the center line with the timing mark on the camshaft sprocket (Fig. 6).

(11) Remove camshaft sprocket retaining bolt.

(12) Remove the crankshaft oil slinger.

(13) Remove the sprockets and chain as an assembly.

CAUTION: The following procedural step must be accomplished to prevent the camshaft from damaging the rear camshaft plug during pin installation.

(14) Remove the fuel pump. Insert a suitable tool into the fuel pump opening and wedge the tool against the side of the opening and the camshaft to prevent camshaft movement.

(15) Inspect the damaged camshaft pin.

(16) If the pin is a spring-type pin, remove the broken pin by inserting a self-tapping screw into the pin and carefully pulling the pin from the camshaft.

(17) If the pin is a dowel-type pin, center-punch it. Ensure the exact center is located when center-punching the pin.

CAUTION: Cover the opened oil pan area to prevent metal chips from entering the pan.

(18) Drill into the pin center with a 4 mm (5/32 inch) drill bit.

(19) Insert a self-tapping screw into the drilled pin and carefully pull the pin from the camshaft.

Installation

(1) Clean the camshaft pin hole.

(2) Compress the center of the replacement spring pin with vise grips.

(3) Carefully drive the pin into the camshaft pin hole until it is seated.

(4) Install the camshaft sprocket, crankshaft sprocket and timing chain with the timing marks aligned (Fig. 6).

(5) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark at approximately the one o'clock position. This positions the crankshaft sprocket timing mark where the adjacent tooth meshes with the chain at the three o'clock position. Count the number of chain pins between the timing marks on both sprockets (Fig. 7). There must be 15 pins.

(6) Install the crankshaft oil slinger.

(7) Tighten the camshaft sprocket bolt to 108 N•m (80 ft. lbs.) torque.

(8) Remove the tool wedged in the fuel pump opening. Install the fuel pump. Tighten the pump bolts to 22 N•m (16 ft. lbs.) torque and connect the fuel pipes.

(9) Check the valve timing. Refer to the timing procedure.

(10) Remove the timing case cover gaskets and seal and clean the cover.

(11) Position replacement oil pan tab gaskets on the oil pan and use RTV sealant to hold them in place.

(12) Coat both sides of the replacement timing case cover gasket with gasket sealer. Apply a 3 mm (1/8 inch) bead of RTV sealant to the joint formed at the oil pan and cylinder block.

(13) Loosen the front four oil pan bolts three turns to allow oil pan movement during the timing case cover installation.

(14) Position the timing case cover on the engine.

(15) Place Timing Case Cover Alignment and Seal Installation Tool 6139 in the crankshaft opening in the cover (Fig. 4).

(16) Install and tighten the oil pan and timing case cover bolts. Tighten the 1/4-20 oil pan bolts to 9 N•m (80 in. lbs.) torque and the 5/16-18 oil pan bolts to 15 N•m (11 ft. lbs.) torque.

(17) Remove the cover alignment tool and place a replacement oil seal on the tool with the lip facing outward.

(18) Apply a light film of engine oil on the outside diameter of the seal.

(19) Position the tool and seal in the timing case cover crankshaft opening.

(20) Insert a screw tool into Seal Installation Tool 6139 (Fig. 4).

(21) Turn the nut until the tool contacts the cover.

(22) Remove the tool and install the vibration damper on the crankshaft.

(23) Lubricate and tighten the damper bolt to 108 N•m (80 ft. lbs.) torque. **If the crankshaft turns before the damper bolt torque value is attained, the crankshaft can be prevented from turning by placing two 5/16 X 1-1/2 inch bolts into the damper front pulley holes and wedging a bar between them. Rotate the bar until it contacts the frame member to prevent the crankshaft from turning.**

(24) Install the damper pulley, if applicable.

(25) If equipped with air conditioning:

(a) Install the A/C compressor drive belt idler pulley.

(b) Install the alternator.

(c) Install the A/C condenser and receiver/drier assembly.

(26) Install the drive belt(s) on the pulleys and tighten. Refer to Group 7, Cooling System for the specifications and procedures.

(27) Install the radiator. Connect the radiator hoses and automatic transmission fluid cooler pipes, if equipped. Fill the cooling system.

(28) Install the fan and shroud.

(29) Connect the battery negative cable.

OIL PAN — 4.2L

Removal

(1) Disconnect the battery negative cable.

(2) Raise and support the vehicle at the side sills.

(3) Drain the engine oil.

(4) Remove the starter motor.

(5) Remove the flywheel/torque converter housing access cover.

(6) It may be necessary to raise the engine in order to remove the oil pan.

(7) Remove the oil pan bolts.

(8) Remove the oil pan by sliding it to the rear.

Cleaning

Clean the gasket and seal surfaces.

Remove all sludge and residue from the oil pan sump.

Installation

(1) Install a replacement oil pan front seal on the timing case cover and apply a generous amount of Jeep/Eagle Gasket-in-a-Tube, or equivalent to the recesses in the tab ends (Fig. 1).

(2) Cement the replacement oil pan side gaskets into position on the cylinder block (Fig. 1).

(3) Apply a generous amount of Jeep/Eagle Gasket-in-a-Tube, or equivalent sealant to the end tabs of the gaskets (Fig. 1).

(4) Coat the the inside curved surface of the replacement oil pan rear seal with soap (Fig. 1).

(5) Apply a generous amount of Jeep/Eagle Gasket-in-a-Tube, or equivalent sealant to the gasket contacting surface of the seal end tabs (Fig. 1).

(6) Install the seal in the recess of the rear main bearing cap. Ensure that it is fully seated. Either one of two sealing methods may be used.

(a) A sealant such as Jeep/Eagle Gasket-in-a-Tube, or equivalent, may be used instead of a gasket.

(b) If a gasket is used, coat both sides with a quick drying adhesive such as Jeep/Eagle Gasket Compound, or equivalent.

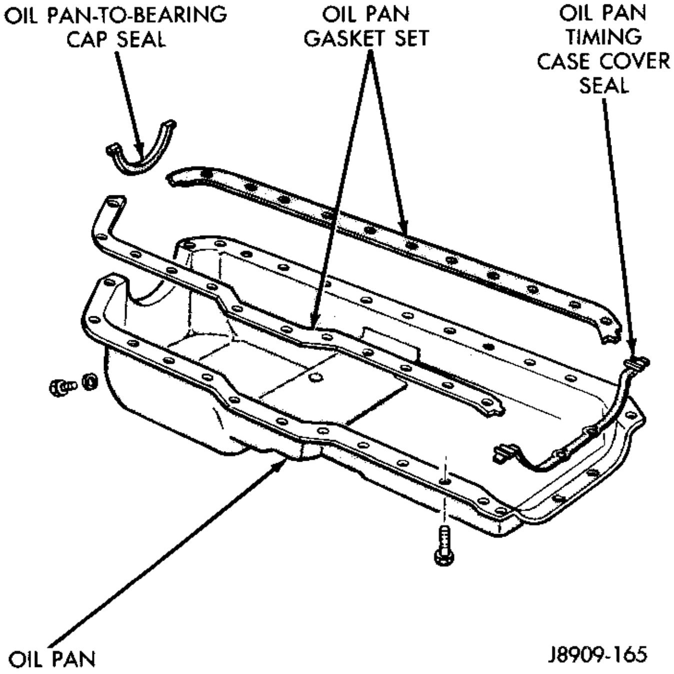


Fig. 1 Oil Pan, Gaskets and Seals

(7) Apply engine oil to the oil pan contacting surface of the front and rear oil pan seals.

(8) Install the oil pan. Tighten the 1/4-20 oil pan bolts to 9 N•m (80 in. lbs.) torque and tighten the 5/16-18 oil pan bolts to 15 N•m (11 ft. lbs.) torque. Tighten the drain plug securely.

(9) Lower and secure the engine if it was raised.

(10) Install the starter motor.

(11) Install the flywheel/torque converter housing access cover.

(12) Raise the vehicle and remove the sill supports and jack. Lower the vehicle.

(13) Connect the battery negative cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(14) Fill the oil pan with engine oil to the specified level. Start the engine and inspect for leaks.

OIL PUMP — 4.2L

A gear-type oil pump is mounted at the underside of the cylinder block opposite the No. 4 main bearing.

Oil pump removal or replacement will not affect the distributor timing because the distributor drive gear remains in mesh with the camshaft gear.

Removal

(1) Drain the engine oil.

(2) Remove the oil pan. Refer to Oil Pan - Removal for the procedure.

(3) Remove the oil pump retaining bolts, oil pump and gasket (Fig. 2).

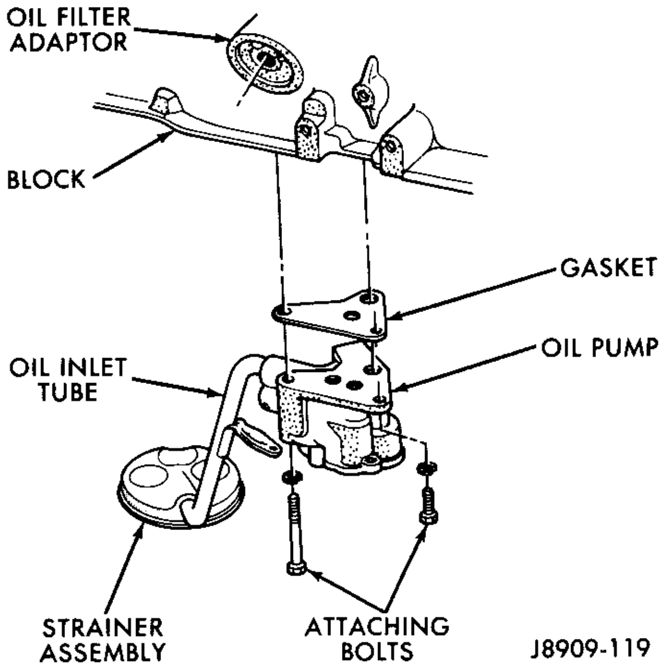


Fig. 2 Oil Pump Components

CAUTION: Do not disturb the position of the oil inlet tube and strainer assembly in the pump body. If the tube is moved within the pump body, a replacement tube and strainer assembly must be installed to assure an airtight seal.

Gear End Clearance Measurement

Remove the cover retaining bolts and cover from the pump body.

Preferred Method:

(1) Place a strip of Plastigage across the full width of each gear (Fig. 3).

(2) Install the pump cover and tighten the bolts to 8 N•m (70 in. lbs.) torque.

(3) Remove the pump cover and determine the amount of clearance by measuring the width of compressed Plastigage with the scale on the Plastigage envelope.

(4) The correct clearance by this method is 0.051-0.152 mm (0.002-0.006 inch). The preferred measurement is 0.051 mm (0.002 inch).

Alternate Method:

(1) Place a straightedge across the ends of the gears and the pump body (Fig. 4).

(2) Select a feeler gauge that fits snugly but freely between the straightedge and the pump gears (Fig. 4).

(3) Using this method the correct clearance is 0.051-0.152 mm (0.002-0.006 inch), with the preferred measurement being 0.051 mm (0.002 inch).

(4) If the gear end clearance is excessive, replace the oil pump assembly.

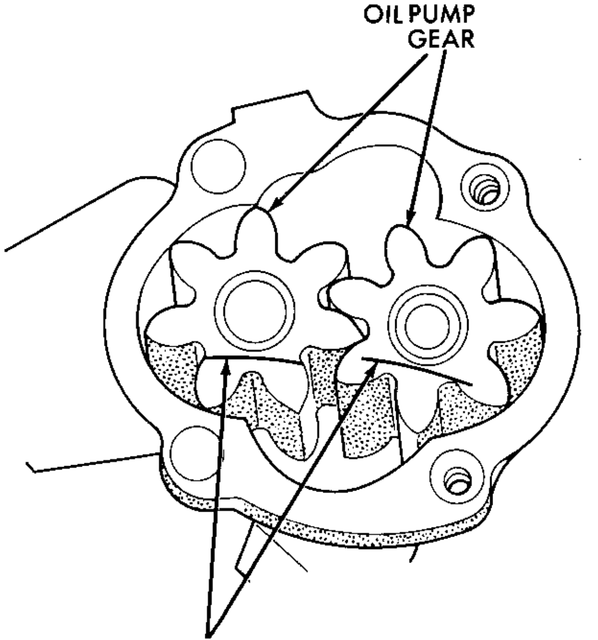


Fig. 3 Gear End Clearance Measurement — Preferred Method

Gear-to-Body Clearance Measurement

(1) Measure the gear-to-body clearance by inserting a feeler gauge between the gear tooth and the pump body inner wall directly opposite the point of the gear mesh (Fig. 5).

(2) Select a feeler gauge which fits snugly but freely.

(3) Rotate the gears to measure each tooth-to-body clearance in this manner.

(4) The correct clearance is 0.051-0.102 mm (0.002-0.004 inch). The preferred clearance is 0.051 mm (0.002 inch).

(5) If the gear-to-body clearance is more than specified, replace the idler gear, the idler shaft and the drive gear assembly.

(6) Remove the cotter pin and slide the spring retainer, spring and oil pressure relief valve plunger out of the pump body.

(7) Inspect for binding condition during disassembly.

(8) Clean or replace as necessary.

(9) The oil inlet tube and strainer assembly must be moved to allow removal of the relief valve. Install a replacement inlet tube and strainer assembly.

Oil Pump Assembly

Two relief valve plunger sizes (standard and oversize) are available. When replacing the valve, assure that the correct replacement valve, standard size or 0.254 mm (0.010 inch) oversize plunger diameter, is obtained and installed.

(1) Install the oil pressure relief valve plunger, the spring, the retainer, and the cotter pin.

(2) If the position of the inlet tube in the pump body has been disturbed, install a replacement inlet tube and

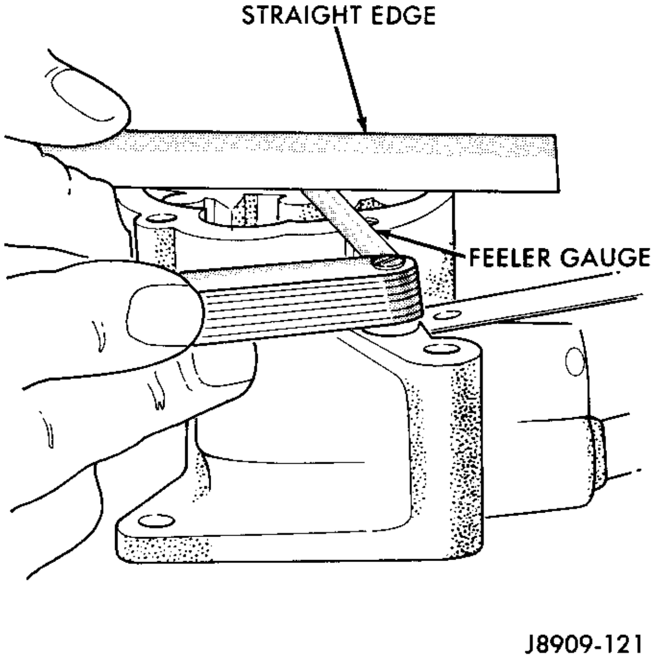


Fig. 4 Gear End Clearance Measurement — Alternate Method

strainer assembly. Apply a light film of Permatex No. 2 sealant, or equivalent, around the end of the tube.

(3) Use the Oil Pump Inlet Tube Installer Tool (7624), to drive the tube into the body (Fig. 6). Ensure that the support bracket is properly aligned.

(4) Install the idler gear and the drive gear assembly. Inspect the gears to ensure that a binding condition does not exist before installing the oil pump.

(5) To ensure self-priming of the oil pump, fill the pump with petroleum jelly before installing the oil pump cover. **Do not use grease.**

(6) Apply a bead of Loctite 515, or equivalent and install the pump cover.

(7) Tighten the cover bolts to 8 N•m (70 in. lbs.) torque.

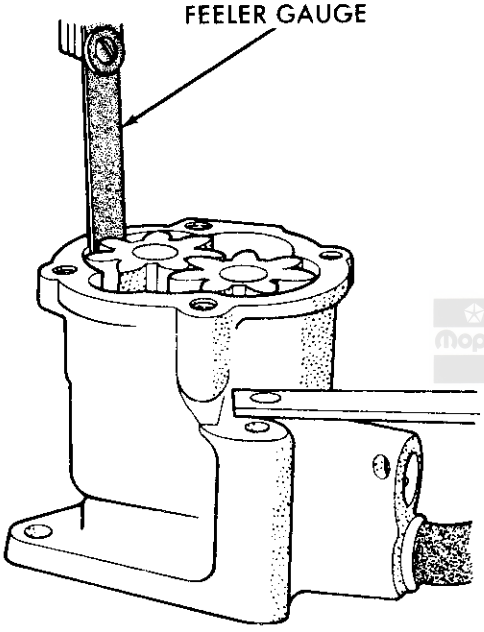


Fig. 5 Gear-to-Body Clearance Measurement

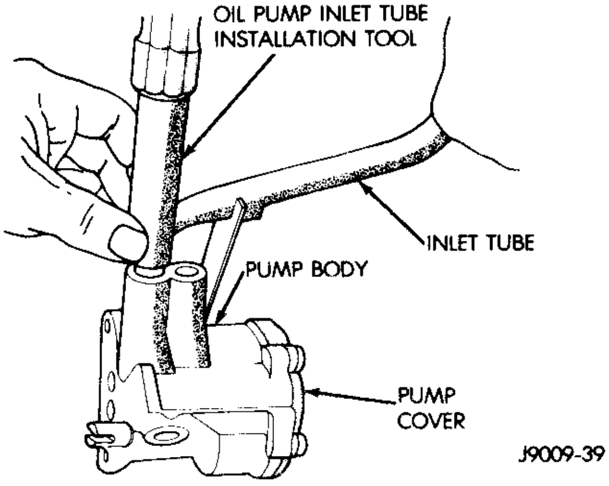


Fig. 6 Inlet Tube Installation

Installation

(1) Install the oil pump with a replacement gasket. Tighten the short bolts to 14 N•m (10 ft. lbs.) torque and the long bolts to 23 N•m (17 ft. lbs.) torque.

(2) Install the oil pan with replacement gaskets and seals. Refer to Oil Pan Installation for the procedure.

(3) Fill the oil pan with replacement engine oil to the specified level.

PISTONS AND CONNECTING RODS — 4.2L

Removal

(1) Remove the cylinder head cover. Refer to Cylinder Head Cover - Removal for the procedure.

(2) Remove the capscrews, bridge and pivot assemblies and rocker arms. Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridge (Fig. 1).

(3) Remove the push rods (Fig. 1).

(4) Remove the cylinder head and gasket. Refer to Cylinder Head Removal for the procedure.

(5) Position the pistons one at a time near the bottom of the stroke and use a ridge reamer to remove the ridge from the top end of the cylinder walls. Use a protective cloth to collect the cuttings.

(6) Drain the engine oil.

(7) Remove the oil pan, gasket and seals. Refer to Oil Pan Removal for the procedure.

(8) Remove the connecting rod bearing caps and inserts. Retain them in the same order as removed to facilitate installation in the original location (Fig. 2). The connecting rods and caps are stamped with the corresponding cylinder number.

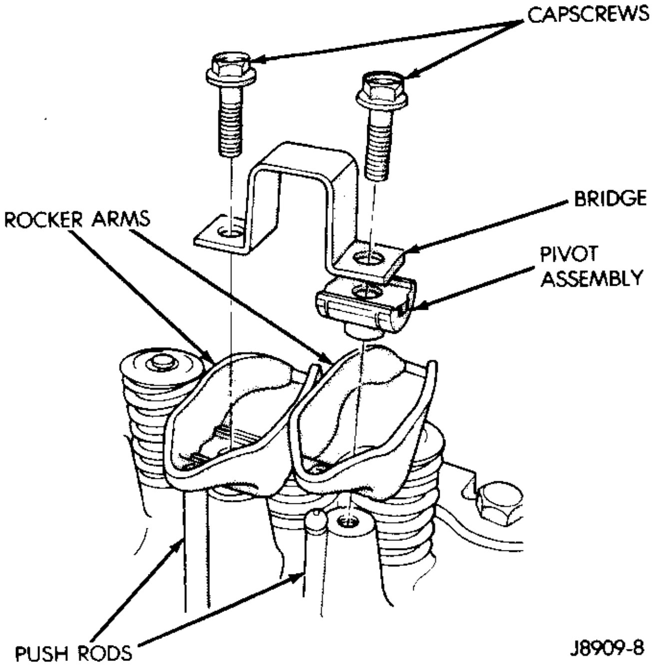


Fig. 1 Rocker Arm Components

CAUTION: Ensure that the connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose, slipped over the connecting rod bolts, will provide protection during removal.

(9) Remove the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 3).

Inspection — Connecting Rod

Connecting Rod Bearings

Inspect the connecting rod bearings for scoring and bent alignment tabs (Figs. 4 and 5). Check the bearings for normal wear patterns, scoring, grooving, fatigue and pitting (Fig. 6). Replace any bearing that shows abnormal wear.

Inspect the connecting rod journals for signs of scoring, nicks and burrs.

Connecting Rods

Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these

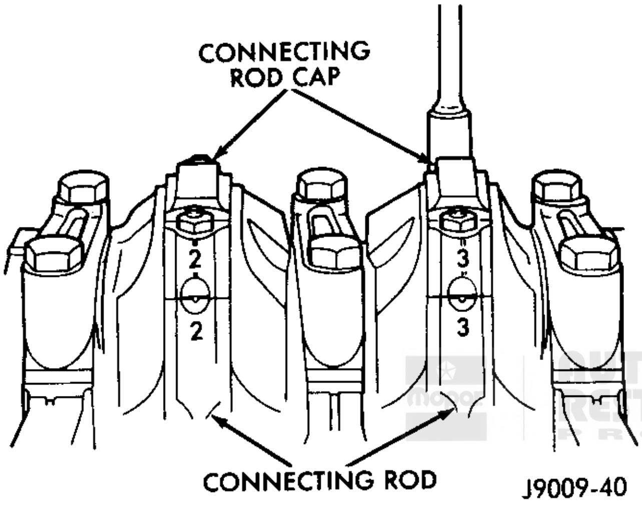


Fig. 2 Stamped Connecting Rods and Caps

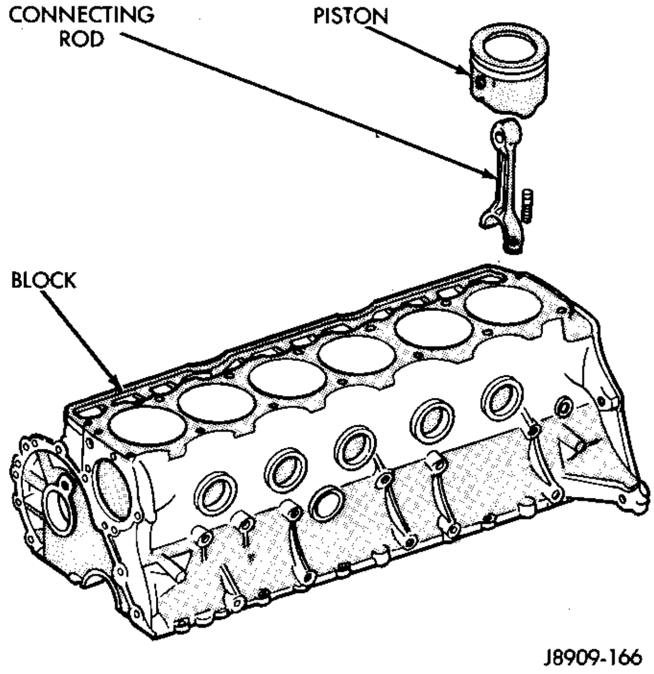


Fig. 3 Removal of Connecting Rod and Piston Assembly

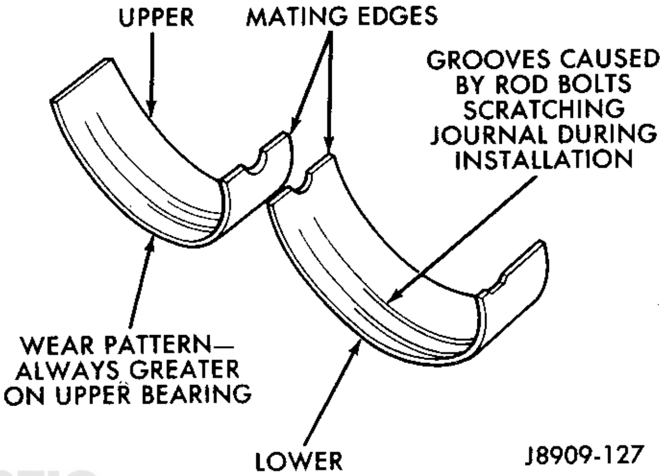


Fig. 4 Connecting Rod Bearing Inspection

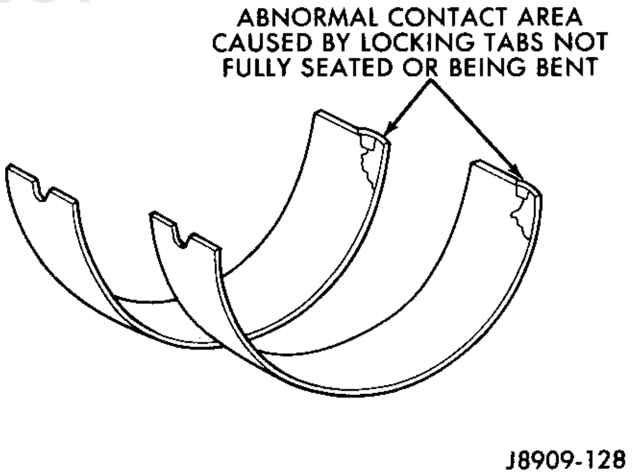


Fig. 5 Locking Tab Inspection

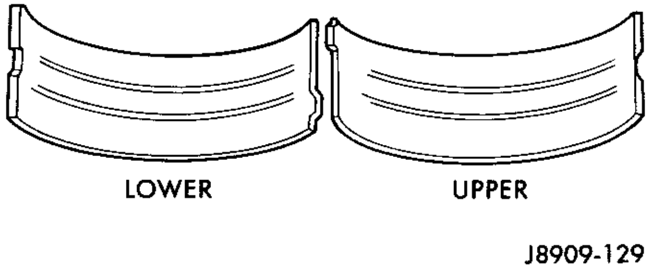


Fig. 6 Scoring Caused by Insufficient Lubrication

components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment. Replace misaligned, bent or twisted connecting rods.

Bearing-to-Journal Clearance

(1) Wipe the journal clean of oil.

(2) Use short rubber hose sections over rod bolts during installation.

(3) Lubricate the upper bearing insert and install in connecting rod.

(4) Use piston ring compressor to install the rod and piston assemblies with the oil squirt holes in the rods facing the camshaft and the arrow on the piston crown pointing to the front of the engine (Fig. 7). Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(5) Install the lower bearing insert in the bearing cap. The lower insert must be dry. Place strip of Plastigage across full width of the lower insert at the center of bearing cap. Plastigage must not crumble in use. If brittle, obtain fresh stock.

(6) Install bearing cap and connecting rod on the journal and tighten nuts to 45 N•m (33 ft. lbs.) torque. Do not rotate crankshaft. Plastigage will smear, resulting in inaccurate indication.

(7) Remove the bearing cap and determine amount of bearing-to-journal clearance by measuring the width of compressed Plastigage by using the scale on the Plastigage envelope (Fig. 8). The correct clearance is 0.025 to 0.076 mm (0.001 to 0.003 inch). **Plastigage should indicate the same clearance across the entire width of the insert. If the clearance varies, it may be caused by either a tapered journal, bent connecting rod, or foreign material trapped between the insert and cap or rod.**

(8) If the correct clearance is indicated, replacement of the bearing inserts is not necessary. Remove the Plastigage from crankshaft journal and bearing insert. Proceed with installation.

(9) If bearing-to-journal clearance exceeds the specification, install a pair of 0.0254 mm (0.001 inch) undersize bearing inserts. and Measure the clearance as described in the previous steps.

(10) The clearance measured with a pair of 0.0254 mm (0.001 inch) undersize bearing inserts installed will determine if two 0.0254 mm (0.001 inch) undersize inserts or another combination is needed to provide the correct clearance (see the Connecting Rod Bearing Fitting Chart).

FOR EXAMPLE:

If the initial clearance was 0.0762 mm (0.003 inch), 0.025 mm (0.001 inch) undersize inserts would reduce the clearance by 0.025 mm (0.001 inch). The clearance would be 0.002 inch and within specification. A 0.051 mm (0.002 inch) undersize insert would reduce the initial clearance an additional 0.013 mm (0.0005 inch). The clearance would then be 0.038 mm (0.0015 inch).

(11) Repeat the Plastigage measurement to verify your bearing selection prior to final assembly.

(12) Once you have selected the proper insert, install the insert and cap. Tighten the connecting rod bolts to 45 N•m (33 ft. lbs.) torque.

Side Clearance Measurement

Slide snug-fitting feeler gauge between the connecting rod and crankshaft journal flange. The correct clearance is 0.254 to .482 mm (0.010 to 0.019 inch). Replace the connecting rod if the side clearance is not within specification.

Piston Fitting

Micrometer Method

(1) Measure the inside diameter of the cylinder bore at a point 58.725 mm (2 5/16 inches) below the top of the bore.

(2) Measure outside diameter of the piston. Because pistons are cam ground, measure at right angle to piston pin at centerline of pin (Fig. 9).

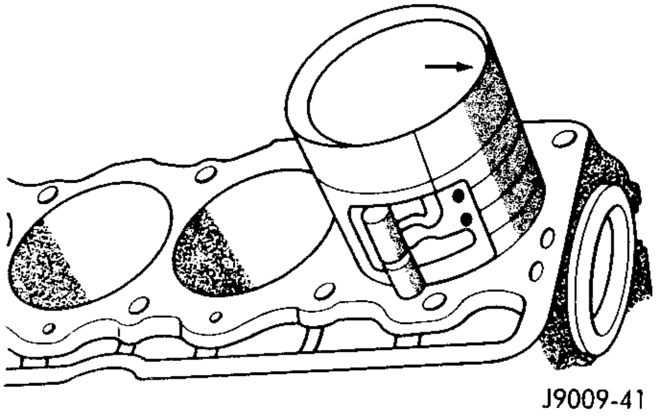


Fig. 7 Rod and Piston Assembly Installation

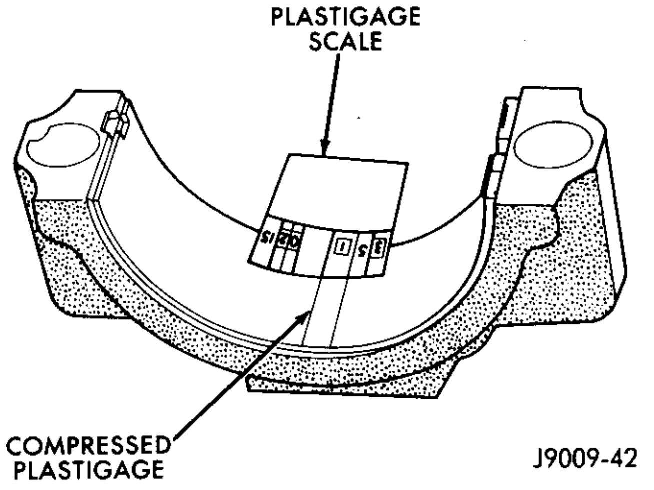


Fig. 8 Measuring Bearing Clearance with Plastigage

CONNECTING ROD BEARING FITTING CHART

Crankshaft Main Bearing Journal Color Code and Diameter	Corresponding Connecting Rod Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow – 53.2257-53.2079 mm 2.0955-2.0948 in. Standard	Yellow – Standard	Yellow – Standard
Orange – 53.2079-53.1901 mm 2.0948-2.0941 in. Undersize (0.0178 mm or 0.0007 in.)	Yellow – Standard	Black – Undersize 0.025 mm 0.001 in.
Black – 53.1901-53.1723 mm 2.0941-2.0933 in. Undersize (0.0356 mm or 0.0014 in.)	Black – Undersize 0.025 mm 0.001 in.	Black – Undersize 0.025 mm 0.001 in.
Red – 52.9717-52.9539 mm 2.0855-2.0848 in. Undersize (0.254 mm or 0.010 in.)	Red – Undersize 0.254 mm 0.001 in.	Red – Undersize 0.254 mm 0.001 in.

J8909-22

The difference between cylinder bore diameter and piston diameter is piston-to-bore clearance.

Feeler Gauge Method

(1) Remove the rings from the piston.

(2) Insert a long 0.025 mm (0.001 inch) feeler gauge into the cylinder bore.

(3) Insert the piston, top first, into cylinder bore alongside the feeler gauge. With entire piston inserted into cylinder bore, the piston should not bind against feeler gauge.

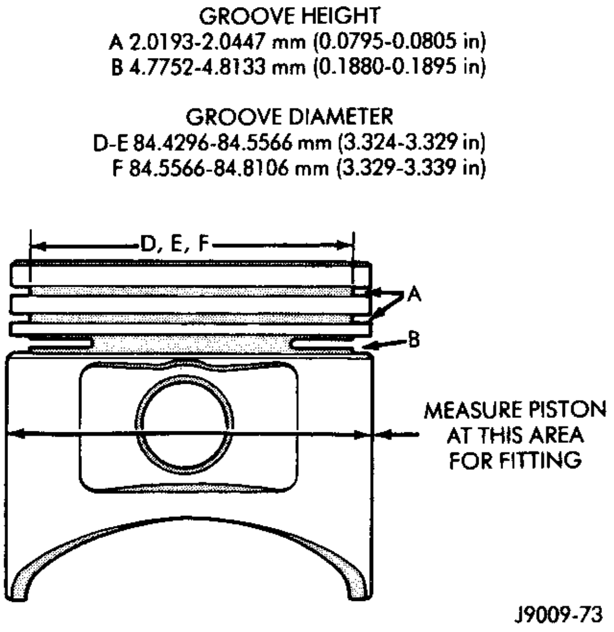


Fig. 9 Piston Dimensions

(4) Repeat steps with a long 0.051 mm (0.002 inch) feeler gauge. The piston should bind.

(5) If the piston binds on 0.025 mm (0.001 inch) feeler gauge, the piston is too large or cylinder bore is too small. If the piston does not bind on 0.051 mm (0.002 inch) feeler gauge, the piston is too small for cylinder bore. Pistons up to 0.102 mm (0.004 inch) undersize may be enlarged by knurling or shot-peening. Replace pistons that are 0.102 mm (0.004 inch) or more undersize.

Piston Pin

Removal

Piston pins are press-fitted into the connecting rods and require no locking device.

(1) Position the piston and connecting rod assembly on an arbor press.

(2) Apply force to a piloted driver and press the pin completely out of the connecting rod and piston assembly (Fig. 10). Note position of the pin through the gauge window of removal support tool.

Inspection

(1) Inspect the piston pin and pin bore in the connecting rod for nicks and burrs. Remove as necessary. Never reuse a piston pin after it has been installed in and removed from a connecting rod.

(2) With the pin removed from the piston and connecting rod, clean and dry piston pin bores and the replacement piston pin.

(3) Position the piston so that the pin bore is in vertical position. Insert the pin in bore. At room temperature, the replacement pin should slide completely through the pin bore in piston by force of gravity.

(4) Replace piston if pin jams in the pin bore.

Installation

(1) Insert the piston pin pilot through the piston and connecting rod pin bores. Ensure that the arrow on the piston crown is pointing up (Fig. 11).

(2) Position the pin pilot, piston and connecting rod on a support with the squirt hole of the connecting rod to the left-hand side.

(3) Insert piston pin through the upper piston pin bore and into the connecting rod pin bore (Fig. 10).

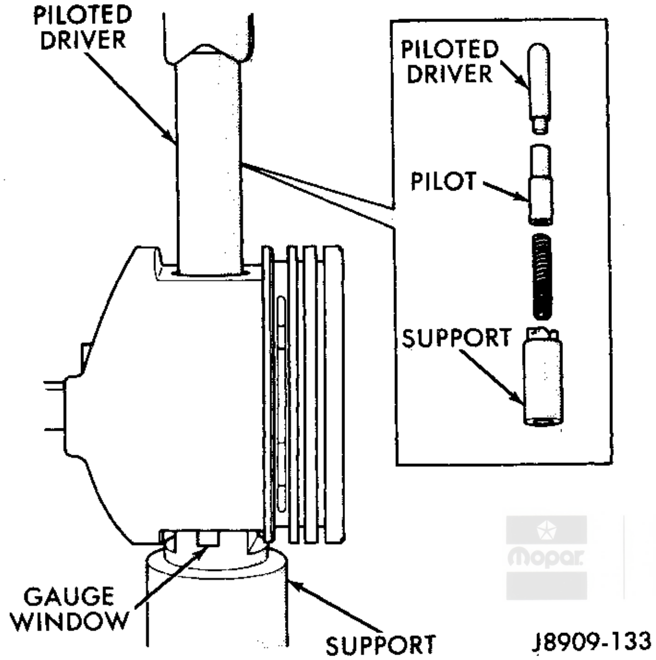


Fig. 10 Piston Pin Removal/Installation

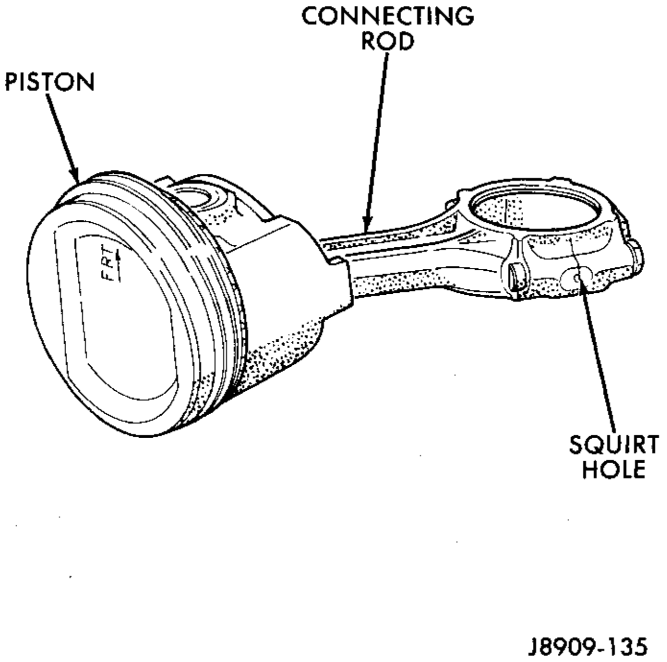


Fig. 11 Correct Alignment — Piston and Connecting Rod

(4) Position the piloted driver inside the piston pin (Fig. 10).

(5) Using an arbor press, press the piston pin through the connecting rod and piston bores until pin pilot indexes with mark on the support. The piston pin requires a 8900 N (2,000 pounds) press-fit. If little effort is required to install piston pin in a connecting rod, or if the rod moves laterally on the pin, the connecting rod must be replaced.

(6) Remove the piston and connecting rod assembly from the press. The pin should be centered in the connecting rod (±0.792 mm or ±0.0312 inch).

Piston Ring Fitting

(1) Carefully clean the carbon from all ring grooves. Oil drain openings in the oil ring grooves and pin boss must be clear. Do not remove metal from the grooves or lands. This will change ring-to-groove clearances and will damage the ring-to-land seating.

(2) Measure the ring side clearance with a feeler gauge fitted snugly between the ring land and ring (Fig. 12). Rotate the ring in the groove. It must move freely around circumference of the groove.

(3) Place ring in the cylinder bore and push down with inverted piston to position near lower end of the ring travel. Measure ring gap with a feeler gauge fitting snugly between ring ends (Fig. 13). The correct compression ring end gap is 0.25-0.51 mm (0.010-0.020 inch). The correct oil control ring end gap is 0.381-1.397 mm (0.015-0.055 inch).

(4) Refer to Ring Gap Position for position of the ring gaps when installing piston rings.

	Millimeters	**Inches**
No. 1 Compression	0.030-0.081 (0.043 Preferred)	0.0012-0.0032 (0.0017 Preferred)
No. 2 Compression	0.030-0.081 (0.043 Preferred)	0.0012-0.0032 (0.0017 Preferred)
Oil Control	0.025-0.203 (0.08 Preferred)	0.001-0.008 (0.003 Preferred)

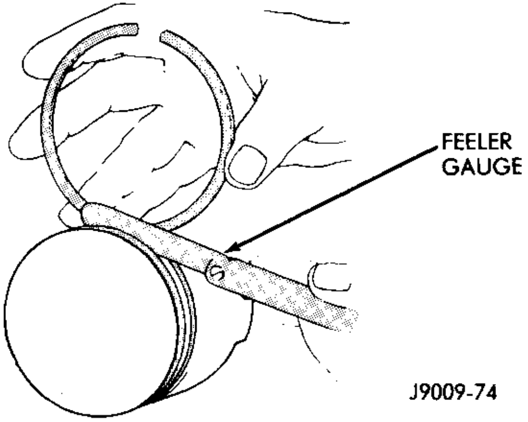


Fig. 12 Ring Side Clearance Measurement

(5) Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert expander ring first, then side rails

(6) The two compression rings are different and cannot be interchanged (Fig. 14). The top ring is a molly ring (the scraping edge is gray in color). The second ring is a black cast iron ring (the scraping edge is black in color when new).

(7) The compression rings can be identified by a chamfer of either the top or bottom inside edge (Fig. 15). The rings may also be identified by one or two dots on the top surface of the ring.

(8) The second compression ring (black cast iron) has a chamfer on the BOTTOM of the inside edge (Fig. 15). This ring may also have two dots located on the top surface.

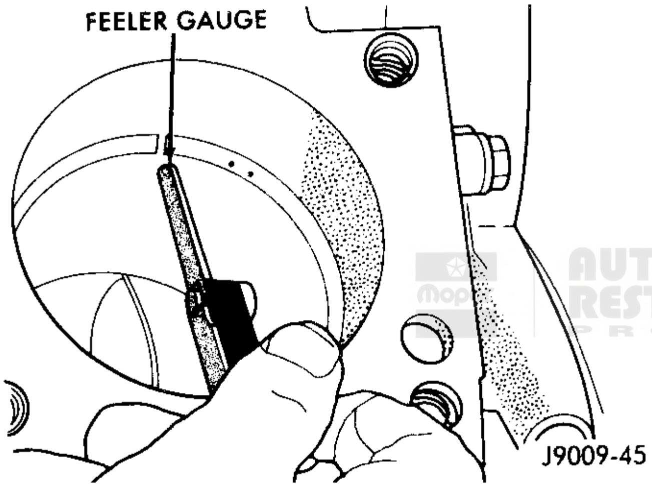


Fig. 13 Ring Gap Measurement

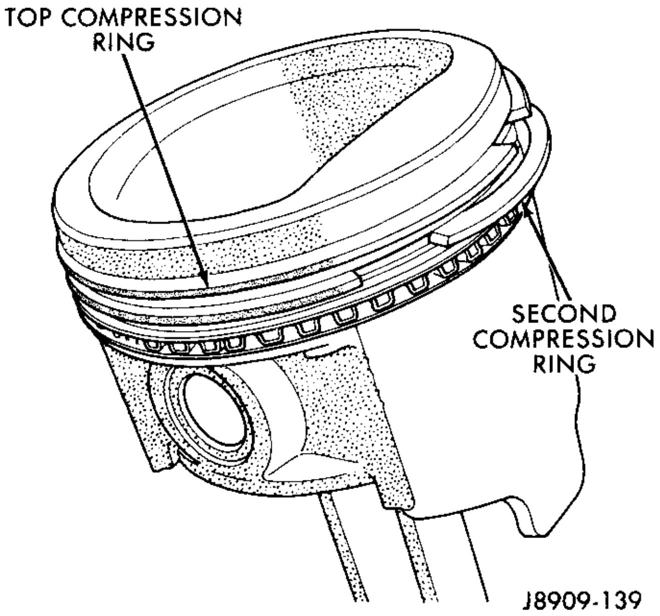


Fig. 14 Compression Ring Location

(9) Using a ring installer, install the ring with the chamfer facing down (Fig. 16). If the ring has dots, the dots will be facing up.

(10) The top compression ring (the scraping edge is gray in color) has a chamfer on the TOP of the inside edge (Fig. 17). This ring may also have one dot located on the top surface.

(11) Using a ring installer, install the top ring with the chamfer facing up. If the ring has a dot, the dot will be facing up.

(12) Position the ring end gaps on the piston as shown (Fig. 18).

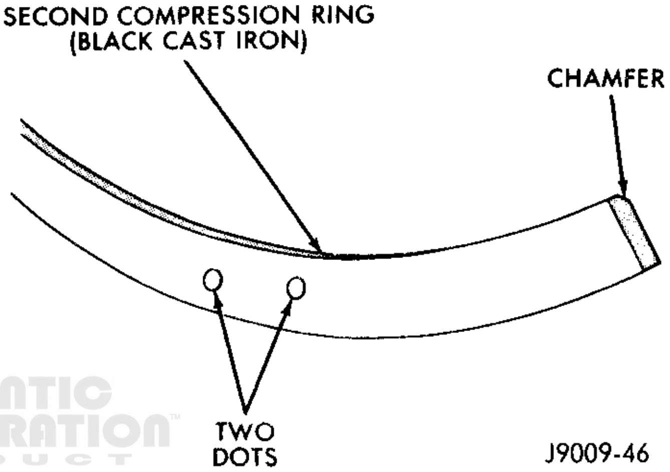


Fig. 15 Second Compression Ring Identification

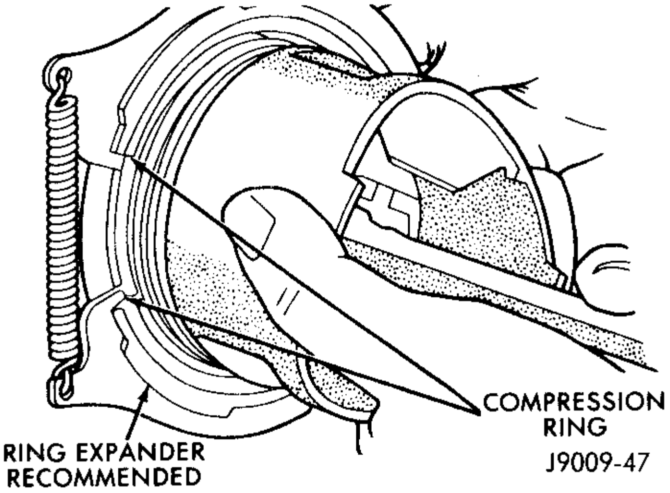


Fig. 16 Compression Ring Installation

Fig. 17 Top Compression Ring Identification

Installation

Each bearing insert is selectively fitted to its respective journal to obtain the specified operating clearance between the bearing and the journal. In production, the select fit is obtained by using various-sized, color-coded bearing inserts as listed in the Connecting Rod Bearing Fitting Chart. The color code appears on the edge of the bearing insert. The size is not stamped on inserts used for production of engines.

The rod journal is identified during the engine production by a color-coded paint mark on the adjacent cheek or counterweight toward the flanged (rear) end of the crankshaft. The color codes used to indicate journal sizes are listed in the Connecting Rod Bearing Fitting Chart.

When required, upper and lower bearing inserts of different sizes may be used as a pair (see the Connecting Rod Bearing Fitting Chart). A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce clearance 0.013 mm (0.0005 inch).

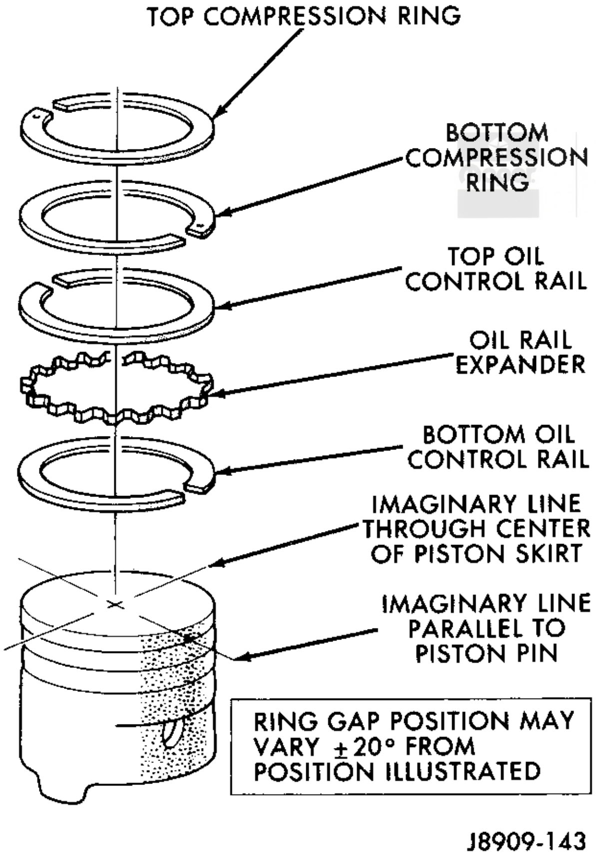


Fig. 18 Ring Gap Position

CAUTION: Do not intermix bearing caps. Each connecting rod and its bearing cap are stamped with the associated cylinder number on a machined surface adjacent to the oil squirt hole that faces the camshaft side of the cylinder block.

(1) Clean the cylinder bores thoroughly. Apply a light film of clean engine oil to the bores with a clean lint-free cloth.

(2) Install the piston rings on the pistons if removed. Refer to Piston Ring Installation for the proper procedure.

(3) Lubricate the piston and rings with clean engine oil.

CAUTION: Ensure that connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during installation.

(4) Use a piston ring compressor to install the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 19).

(5) Ensure the arrow on the piston top points to the front of the engine (Fig. 19).

(6) Raise the vehicle.

(7) Install the connecting rod bearing caps and inserts in the same positions as removed.

CAUTION: Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(8) Install the oil pan and gaskets as outlined in the installation procedure.

(9) Lower the vehicle.

(10) Install the cylinder head, push rods, rocker arms, bridges, pivots and cylinder head cover as outlined in the installation procedures.

(11) Fill the crankcase with engine oil.

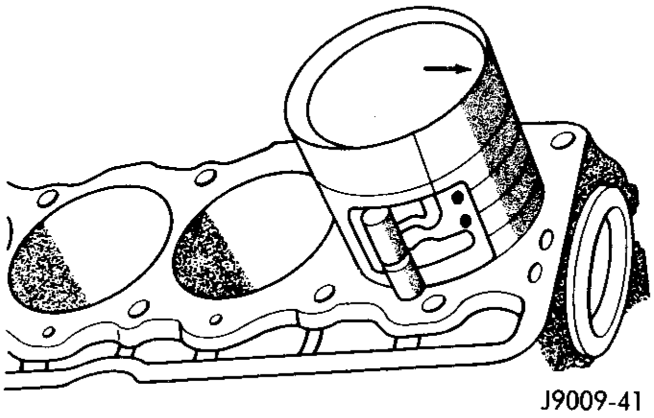


Fig. 19 Rod and Piston Assembly Installation

CRANKSHAFT MAIN BEARINGS — 4.2L

Removal

(1) Disconnect the battery negative cable.

(2) Remove the spark plugs.

(3) Raise the vehicle.

(4) Remove the oil pan and oil pump as outlined in the removal procedures.

(5) Remove the main bearing caps and lower inserts (Fig. 1).

(6) Remove the lower insert from the bearing cap.

(7) Remove the upper insert by loosening all of the other bearing caps and inserting a small cotter pin tool in the crankshaft journal oil hole. Bend the cotter pin as illustrated to fabricate the tool (Fig. 2). With the cotter pin tool in place, rotate the crankshaft so that the upper bearing insert will rotate in the direction of its locking tab. **Because there is no hole in the number 3 main journal, use a tongue depressor or similar soft-faced tool to remove the bearing insert (Fig. 2). After moving the insert approximately 25 mm (1 inch), it can be removed by applying pressure under the tab.**

(8) Using the same procedure described above, remove the remaining bearing inserts one at a time for inspection.

Inspection

Wipe the inserts clean and inspect for abnormal wear patterns and for metal or other foreign material imbedded in the lining. Normal main bearing insert wear patterns are illustrated (Fig. 3).

If any of the crankshaft journals are scored, remove the engine for crankshaft repair.

Inspect the back of the inserts for fractures, scrapings or irregular wear patterns.

Inspect the upper insert locking tabs for damage.

Replace all damaged or worn bearing inserts.

Fitting

The main bearing caps, numbered (front to rear) from 1 through 7 have an arrow to indicate the forward position. The upper main bearing inserts are grooved to provide oil channels while the lower inserts are smooth.

Each bearing insert pair is selectively fitted to its respective journal to obtain the specified operating clearance. In production, the select fit is obtained by using various-sized color-coded bearing insert pairs as listed in the Main Bearing Fitting Chart. The bearing

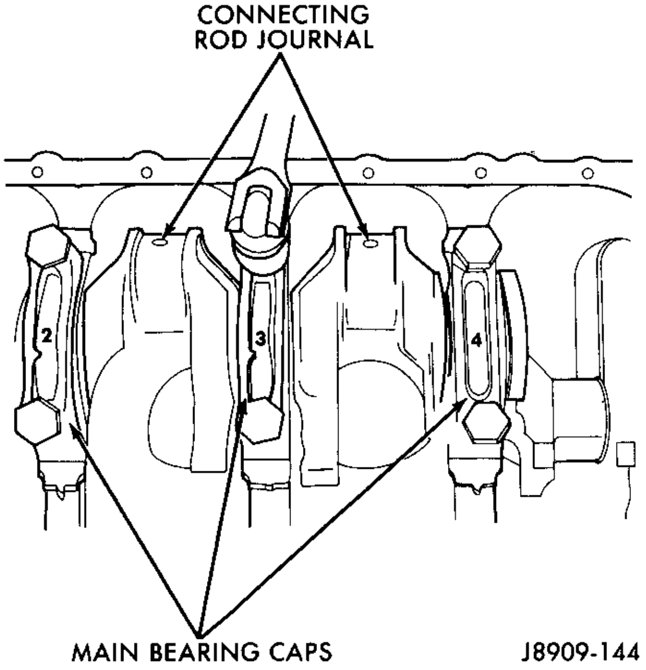


Fig. 1 Removing Main Bearing Caps and Lower Inserts

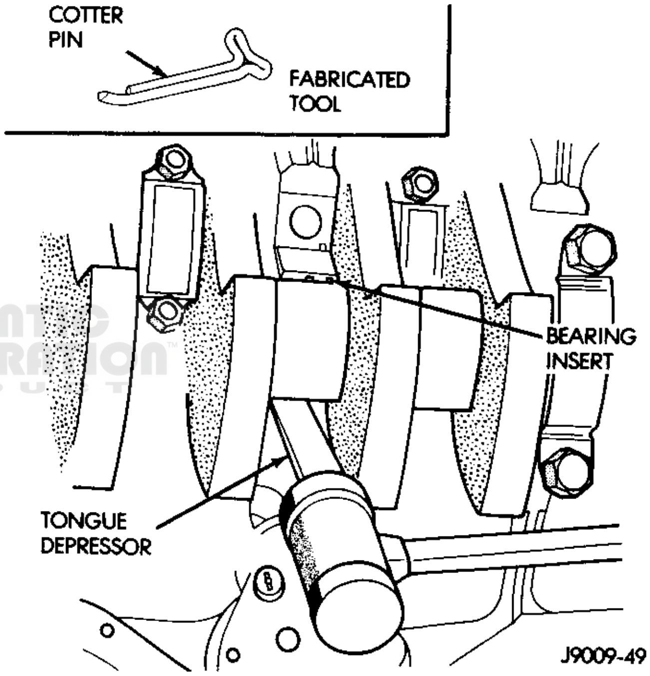


Fig. 2 Removing Upper Inserts

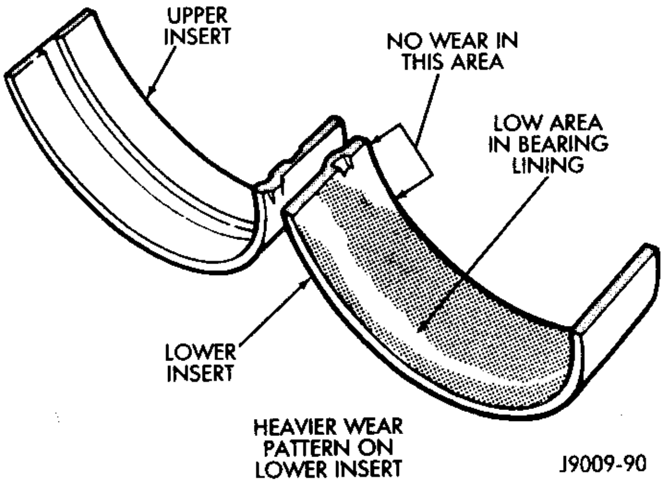


Fig. 3 Main Bearing Wear Patterns

color code appears on the edge of the insert. **The size is not stamped on bearing inserts used for engine production.**

The main bearing journal size (diameter) is identified in production by a color-coded paint mark on the adjacent cheek toward the flanged (rear) end of the crankshaft, except for the rear main journal, which is on the crankshaft rear flange.

When required, upper and lower bearing inserts of different sizes may be used as a pair. A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce the clearance by 0.013 mm (0.0005 inch). **Never use a pair of bearing inserts with greater than a 0.025 mm (0.001 inch) difference in size.**

FOR EXAMPLE:

When replacing inserts, the odd size inserts must be either all on the top (in cylinder block) or all on the bottom (in main bearing cap).

Main Bearing-to-Journal Clearance — Crankshaft Installed

When using Plastigage, check only one bearing clearance at a time.

Install the grooved main bearings into the cylinder block and the non-grooved bearings into the bearing caps.

Install the crankshaft into the upper bearings dry.

Place a strip of Plastigage across full width of the crankshaft journal to be checked.

Install the bearing cap and tighten the bolts to 108 N•m (80 ft. lbs.) torque.

Do not rotate the crankshaft. This will cause the Plastigage to shift, resulting in an inaccurate reading. Plastigage must not be permitted to crumble. If brittle, obtain fresh stock.

Remove the bearing cap. Determine the amount of clearance by measuring the width of the compressed Plastigage with the scale on the Plastigage envelope (Fig. 4). The correct clearance is 0.0254 to 0.0635 mm (.0010 to .0025 inches) for all main bearing journals, with 0.051 mm (0.002 inch) preferred.

Plastigage should indicate the same clearance across the entire width of the insert. If clearance varies, it may indicate a tapered journal or foreign material trapped behind the insert.

Bearing Insert Pairs

Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.025 mm (0.001 in.) Undersize	0.051 mm (0.002 in.) Undersize

J9009-62

If the specified clearance is indicated and there are no abnormal wear patterns, replacement of the bearing inserts is not necessary. Remove the Plastigage from the crankshaft journal and bearing insert. Proceed to Crankshaft Main Bearing - Installation.

If the clearance exceeds specification, install a pair of 0.025 mm (0.001 inch) undersize bearing inserts and measure the clearance as described in the previous steps.

The clearance indicated with the 0.025 mm (0.001 inch) undersize insert pair installed will determine if this insert size or some other combination will provide the specified clearance.

FOR EXAMPLE:

If the clearance was 0.0762 mm (0.003 inch) originally, a pair of 0.0254 mm (0.001 inch) undersize inserts would reduce the clearance by 0.0254 mm (0.001 inch). The clearance would then be 0.0508 mm (0.002 inch) and within the specification. A 0.051 mm (0.002 inch) undersize bearing insert and a 0.0254 mm (0.001 inch) undersize insert would reduce the original clearance an additional 0.0127 mm (0.0005 inch) and the clearance would then be 0.0381 mm (0.0015 inch).

CAUTION: Never use a pair of inserts that differ more than one bearing size as a pair. For example, do not use a standard size upper insert and a 0.051 mm (0.002 inch) undersize lower insert.

If the clearance exceeds the specifications using a pair of 0.051 mm (0.002 inch) undersize bearing inserts, measure the crankshaft journal diameter with a micrometer. If the journal diameter is correct, the crankshaft bore in the cylinder block may be misaligned, which requires cylinder block replacement or machining to true bore.

If the diameter for journals 1 through 6 is less than 63.4517 mm (2.4981 inches) or journal 7 is less than 63.4365 mm (2.4975 inches), replace the crankshaft or grind down to accept the appropriate undersize bearing inserts.

Once the proper clearances have been obtained re-

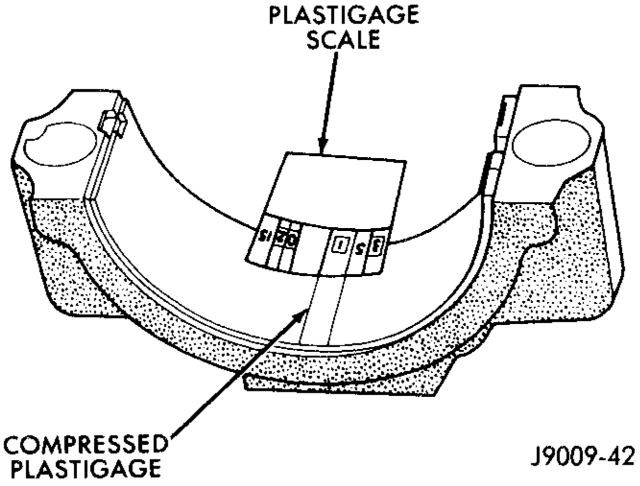


Fig. 4 Measuring Clearance with Plastigage

move the crankshaft and proceed to Crankshaft Main Bearing - Installation.

Main Bearing Journal Diameter — Crankshaft Removed

Clean the main bearing journal of oil.

Determine the maximum diameter of the journal with a micrometer. Measure at two locations 90° apart at each end of the journal.

Compare the measured diameter with the journal diameter specification listed in the Main Bearing Fitting Chart, and select inserts required to obtain the specified bearing-to-journal clearance.

Installation

(1) Lubricate the bearing surface of each insert with engine oil.

(2) Install the main bearing upper inserts to the cylinder block.

(3) Install the lower bearing inserts into the main bearing caps.

(4) Carefully lower the crankshaft into the cylinder block.

(5) Install the main bearing caps and lower inserts.

(6) Tighten all the bolts to 54 N•m (40 ft. lbs.) torque, then tighten to 95 N•m (70 ft. lbs.) torque.

(7) Finally, tighten the main bearing cap bolts to 108 N•m (80 ft. lbs.) torque.

(8) Rotate the crankshaft after tightening each main bearing cap to ensure the crankshaft rotates freely.

(9) Install the oil pan with replacement gaskets and seals. Refer to the Oil Pan - Installation procedure.

(10) Tighten the drain plug securely.

(11) Lower the vehicle.

(12) Install the spark plugs. Tighten the plugs to 37 N•m (27 ft. lbs.) torque.

(13) Fill the oil pan with engine oil to the full mark on the dipstick level.

(14) Connect the battery negative cable.

Crankshaft End Play

(1) Attach a magnetic base dial indicator to the cylinder block at either the front or rear of the engine.

(2) Position the dial indicator rod so that it is parallel to the center line of the crankshaft.

(3) Pry the crankshaft forward, position the dial indicator to zero.

(4) Pry the crankshaft forward and backward. Note the dial indicator readings. End play is the difference between the high and low measurements (Fig. 5). Correct end play is 0.038 to 0.165 mm (0.0015 to 0.0065 inch). The desired specifications are 0.051 to 0.064 mm (0.002 to 0.0025 inch).

(5) If end play is not within specification, inspect crankshaft thrust faces for wear. If no wear is apparent, replace the thrust bearing and measure end play. If end play is still not within specification, replace the crankshaft.

REAR MAIN OIL SEALS — 4.2L

The crankshaft rear main bearing oil seal consists of two half pieces of neoprene with a single lip that effectively seals the rear of the crankshaft. Replace the upper and lower seal halves as a unit to ensure leak-free operation.

Removal

To replace the rear main oil seal, the transmission must be removed. Refer to Group 21, Transmission for the proper procedure.

(1) Remove the flywheel or converter drive plate.

(2) Remove the oil pan (see Oil Pan - Removal).

(3) Remove the rear main bearing cap (No. 7).

(4) Push the upper seal out of the groove. Ensure that the crankshaft is not damaged.

(5) Remove the lower half of the seal from the bearing cap.

Installation

(1) Wipe the seal surface area of the crankshaft until it is clean.

(2) Apply a thin coat of engine oil.

(3) Coat the lip of the seal with engine oil.

(4) Position the upper seal into the groove in the cylinder block. The lip of the seal faces toward the front of the engine.

(5) Place the lower half of the seal into the bearing cap (Fig. 6).

(6) Coat both sides of the lower seal end tabs with Jeep/Eagle Gasket-in-a-Tube, or equivalent). Do not apply sealant to the lip of the seal.

(7) Coat the outer curved surface of the lower seal with soap and the lip of the seal with engine oil (Fig. 6).

(8) Position the lower seal into the bearing cap recess and seat it firmly.

(9) Coat both chamfered edges of the rear main bearing cap with Jeep/Eagle Gasket-in-a-Tube, or equivalent (Fig. 6).

CAUTION: Do not apply sealant to the cylinder block mating surfaces of the rear main bearing cap because the bearing-to-journal clearance would be altered.

(10) Install the rear main bearing cap.

(11) Tighten all main bearing bolts to 108 N•m (80 ft. lbs.) torque.

CYLINDER BLOCK — 4.2L

Disassembly

(1) Remove the water pump and fuel pump from the cylinder block.

(2) Remove the vibration damper.

(3) Remove the timing case cover seal.

MAIN BEARING FITTING CHART

Crankshaft No. 1 Main Bearing Journal Color Code and Diameter	Cylinder Block No. 1 Main Bearing Bore Color Code and Size	Bearing Insert Color Code	
		Upper Insert Size	**Lower Insert Size**
Yellow - 63.5025-63.4898 mm (2.5001-2.4996 in.) (Standard)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.) Black - 68.3641-68.3768 mm) (2.6915-2.6920 in.)	Yellow - Standard Yellow - Standard	Yellow - Standard Black - 0.025 mm Undersize (0.001 in.)
Orange - 63.4898-63.4771 mm (2.4996-2.4991 in.) (0.0005 Undersize)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.) Black - 68.3641-68.3768 mm (2.6915-2.6920 in.)	Yellow - Standard Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.) Black - 0.025 mm Undersize (0.001 in.)
Black - 63.4771-63.4644 mm (2.4991-2.4986 in.) (0.001 Undersize)	Yellow - 68.3514-68.36 41 mm (2.6910-2.6915 in.) Black - 68.3641-68.3768 mm (2.6915-2.6920 in.)	Black - 0.025 mm Undersize (0.001 in.) Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.) Green - 0.051 mm Undersize (0.002 in.)
Green - 63.4644-63.4517 mm (2.4986-2.4981 in.) (0.0015 Undersize)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.)	Black - 0.025 mm Undersize (0.001 in.)	Green - 0.051 mm Undersize (0.002 in.)
Red - 63.2485-63.2358 mm (2.4901-2.4986 in.) (0.010 Undersize)	Yellow - 68.3514-68.3641 mm (2.6910-2.6915 in.)	Red - 0.254 mm Undersize (0.010 in.)	Red - 0.254 mm Undersize (0.010 in.)

NOTE:With Green and Red Coded Crankshaft Journals, Use Yellow Coded Cylinder Block Bores Only.

Crankshaft Color Code and Diameter (Journal Size)	Bearing Insert Color Code	
	Upper Insert Size	**Lower Insert Size**
Yellow - 63.5025-63.4898 mm (2.5001-2.4996 in.) (Standard)	Yellow - Standard	Yellow - Standard
Orange - 63.4898-63.4771 mm (2.4996-2.4991 in.) (0.0005 Undersize)	Yellow - Standard	Black - 0.025 mm Undersize (0.001 in.)
Black - 63.4771-63.4644 mm (2.4991-2.4986 in.) (0.001 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.)
Green - 63.4644-63.4517 mm (2.4986-2.4981 in.) (0.0015 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Green - 0.051 mm Undersize (0.002 in.)
Red - 63.2485-63.2358 mm (2.4901-2.4966 in.) (0.010 Undersize)	Red - 0.054 mm Undersize (0.010 in.)	Red - 0.254 mm Undersize (0.010 in.)

Crankshaft Main Bearing Journal 7 Color Code and Diameter (Journal Size)	Bearing Insert Color Code	
	Upper Insert Size	**Lower Insert Size**
Yellow - 63.4873-63.4746 mm (2.499-2.4990 in.) (Standard)	Yellow - Standard	Yellow - Standard
Orange - 63.4746-63.4619 mm (2.4990-2.4985 in.) (0.0005 Undersize)	Yellow - Standard	Black - 0.025 mm Undersize (0.001 in.)
Black - 63.4619-63.4492 mm (2.4985-2.4980 in.) (0.001 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Black - 0.025 mm Undersize (0.001 in.)
Green - 63.4492-63.4365 mm (2.4980-2.4975 in.) (0.0015 Undersize)	Black - 0.025 mm Undersize (0.001 in.)	Green - 0.051 mm Undersize (0.002 in.)
Red - 63.2333-63.2206 mm (2.4895-2.4890 in.) (0.010 Undersize)	Red - 0.254 mm Undersize (0.010 in.)	Red - 0.254 mm Undersize (0.010 in.)

J8909-167

(4) Remove the timing case cover.

(5) Remove the oil slinger from the crankshaft.

(6) Remove the camshaft retaining bolt and remove the sprockets and chain as an assembly.

(7) Remove the camshaft.

(8) Remove the oil pan, the gaskets, and the seals (Fig. 7). Thoroughly clean the pan and engine block gasket surfaces.

(9) Remove the oil pump.

(10) Remove the connecting rods and the pistons. Remove the connecting rod and piston assemblies through the top of the cylinder bores.

CAUTION: Be sure that the connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during removal.

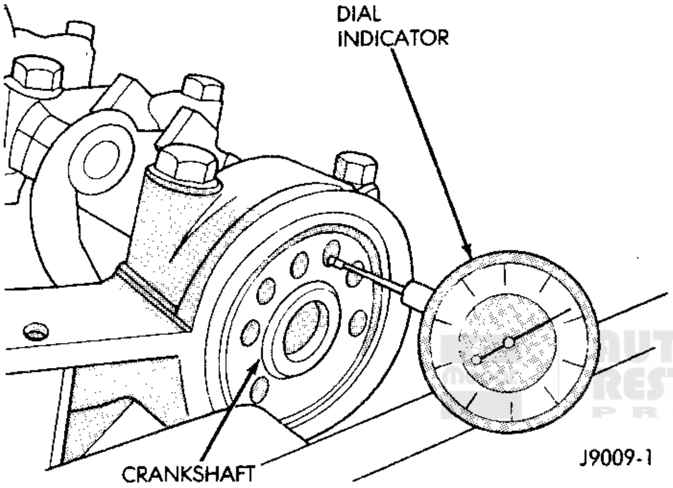


Fig. 5 Crankshaft End Play Measurement — Typical

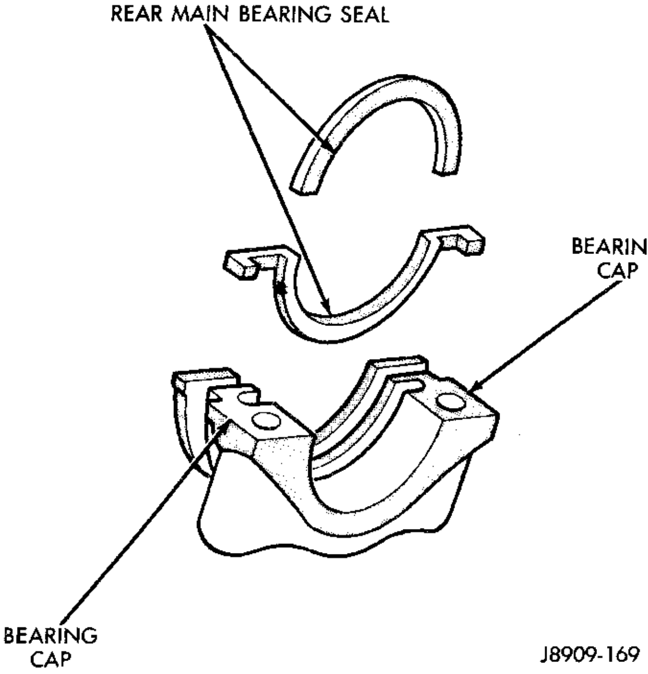


Fig. 6 Rear Main Bearing Oil Seal

(11) Remove the crankshaft.

Inspection — Cylinder Bore

Bore Measurement

(1) Use a bore gauge to measure each cylinder bore diameter. If a bore gauge is not available, use an inside micrometer (Fig. 8).

(2) Measure the cylinder bore diameter crosswise to the cylinder block near the top of the bore. Repeat the measurement at the bottom of the bore.

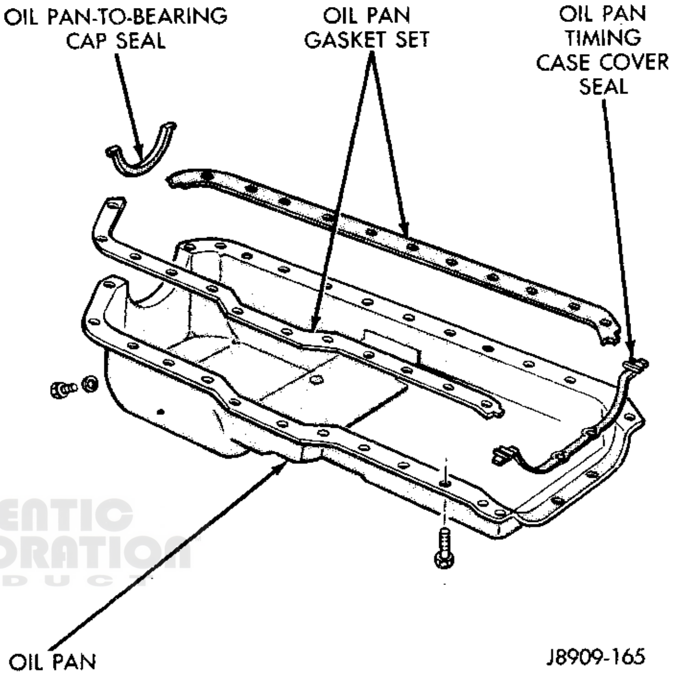


Fig. 7 Oil Pan, Gaskets and Seals

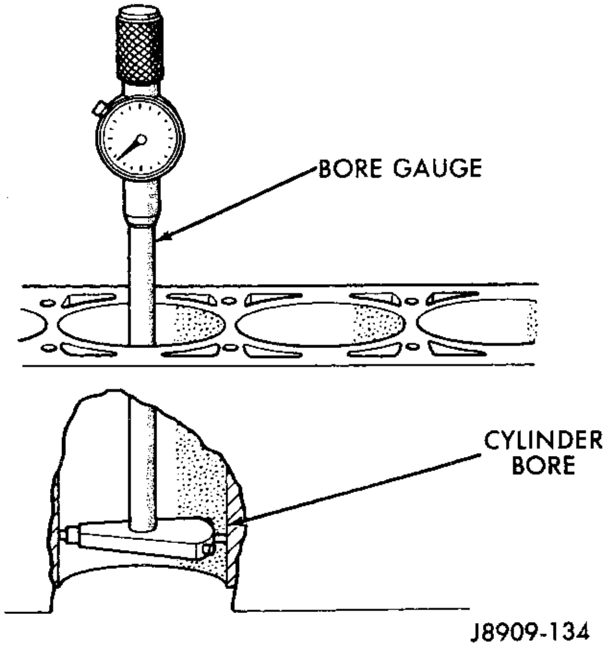


Fig. 8 Cylinder Bore Measurement

(3) Determine the taper by subtracting the smaller diameter from the larger diameter.

(4) Rotate the measuring device 120° and repeat steps above. Finally, rotate the device another 120° and repeat the measurements.

(5) Determine out-of-roundness by comparing the difference between each 120° measurement.

(6) If the cylinder bore taper does not exceed 0.025 mm (0.001 inch) and the out-of- roundness does not exceed 0.025 mm (0.001 inch) the cylinder bore can be trued by honing. If the cylinder bore taper or out-of-round condition exceeds these maximum limits, the cylinder must be bored and then honed to accept an oversize piston. A slight amount of taper always exists in the cylinder bore after the engine has been in use for a period of time.

Cylinder Bore Resurfacing

CAUTION: Do not use rigid type hones to remove cylinder wall glaze.

(1) Use an expanding type hone to true the cylinder bore and to remove the glaze for faster piston ring seating. Move the hone down and up (stroke) at sufficient speed to produce a uniform 60° angle crosshatch pattern on the cylinder walls. Do not use more than ten strokes per cylinder (one stroke is one down-and-up movement). Refer to General Information section of this Group for the proper honing operation.

(2) Scrub the cylinder bores clean with a solution of hot water and detergent.

(3) Immediately apply light engine oil to the cylinder walls. Wipe with a clean, lint-free cloth.

Assembly

(1) Install the crankshaft.

(2) Install the connecting rods and the pistons through the top of the cylinder bores.

CAUTION: Be sure that the connecting rod bolts do not scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during removal.

(3) Install the oil pump.

(4) Install the oil pan, the gaskets, and the seals.

(5) Install the camshaft.

(6) Install the camshaft retaining bolt and remove the sprockets and chain as an assembly.

(7) Install the oil slinger from the crankshaft.

(8) Install the timing case cover seal.

(9) Install the timing case cover.

(10) Install the vibration damper.

(11) Install the water pump and fuel pump to the cylinder block.

ENGINE SPECIFICATIONS — 4.2L

Camshaft		
Tappet Clearance	zero lash (hyd.) tappets	
End Play	zero (engine operation)	
Bearing Clearance	0.025-0.076 mm	0.001-0.003 in.
Bearing Journal Diameter		
No. 1	51.54-51.56 mm	2.029-2.030 in.
No. 2	51.28-51.31 mm	2.019-2.020 in.
No. 3	51.03-51.05 mm	2.009-2.010 in.
No. 4	50.78-50.80 mm	1.999-2.000 in.
Base Circle Runout	0.03 mm max.	0.001 in. max.
Cam Lobe Lift	6.43 mm	0.253 in.
Valve Life	10.29 mm	0.405 in.
Intake Valve Timing		
Opens	9° BTDC	
Closes	73° ABDC	
Exhaust Valve Timing		
Opens	57° BBDC	
Closes	25° ATDC	
Valve Overlap	34°	
Intake Duration	262°	
Exhaust Duration	262°	
Connecting Rods		
Total Weight (less bearings)	695-703 grams	24.5-24.9 oz.
Total Length (center-to-center)	149.17-149.28 mm	5.873-5.877 in.
Piston Pin Bore Diameter	23.59-23.62 mm	0.9288-0.9298 in.
Connecting Rod Bore (less bearings)	56.08-56.09 mm	2.2080-2.2085 in.
Bearing Clearance	0.03-0.08 mm	0.001-0.0025 in.
Preferred	0.044-.050 mm	0.0015-0.0020 in.
Side Clearance	0.25-0.48 mm	0.010-0.019 in.
Maximum Twist	0.025 per 25.4 mm	0.001 per in.
Maximum Bend	0.0127 per 25.4 mm	0.005 per in.
Crankshafts		
End Play	0.038-0.165 mm	0.0015-0.0065 in.
Main Bearing Journal Diameter	63.489-63.502 mm	2.4996-2.5001 in.
Main Bearing Journal Width		
No. 1	27.58-27.89 mm	1.086-1.098 in.
No. 2	32.28-32.33 mm	1.271-1.273 in.
No. 3-4-5-6-7	30.02-30.18 mm	1.182-1.188 in.
Main Bearing Clearance	0.03-0.06 mm	0.001-0.0025 in.
Preferred	0.051 mm	0.002 in.
Connecting Rod Journal Diameter	53.17-53.23 mm	2.0934-2.0955 in.
Connecting Rod Journal Width	27.18-27.33 mm	1.070-1.076 in.
Maximum Out-of-Round (All Journals)	0.013 mm	0.0005 in.
Maximum Taper (All Journals)	0.013 mm	0.0005 in.

J8909-172

ENGINE SPECIFICATIONS — 4.2L (CONT.)

Cylinder Block		
Deck Height	240.97-241.12 mm	9.487-9.493 in.
Deck Clearance (below deck)	0.376 mm	0.0148 in.
Cylinder Bore Diameter (standard)	95.253-95.334 mm	3.7501-3.7533 in.
Maximum Taper	0.025 mm	0.001 in.
Maximum Out-of-Round	0.025 mm	0.001 in.
Tappet Bore Diameter	23.000-23.025 mm	0.9055-0.9065 in.
Cylinder Block Flatness	.03 per 25 mm	.001 per 1 in.
	.05 per 152 mm	.002 per 6 in.
Main Bearing Bore Diameter	68.35-68.38 mm	2.691-2.692 in.
Cylinder Head		
Combustion Chamber Volume	64.45-67.45 cc	
Valve Arrangement	EI-IE-IE-EI-EI-IE	
Valve Guide ID (Integral)	9.487-9.512 mm	0.3735-0.3745 in.
Valve Stem-to-Guide Clearance	0.03-0.08 mm	.001-.003 in.
Intake Valve Seat Angle	30°	
Exhaust Valve Seat Angle	44°30′	
Valve Seat Width	1.02-1.52 mm	.040-.060 in.
Valve Seat Runout	0.064 mm	.0025 in.
Cylinder Head Flatness	.03 per 25 mm	.001 per 1 in.
	.05 per 152 mm	.002 per 6 in.
Oil Pressure		
At Idle Speed (600 rpm)	90 kPa	13 psi
At 1600 + rpm	255-517 kPa	37-75 psi
Oil Pressure Relief	517 kPa	75 psi
Oil Pump		
Gear-to-Body Clearance (radial)	0.051-0.102 mm	0.002-0.004 in.
Preferred	0.051 mm	0.002 in.
Gear End Clearance — Plastigauge	0.051-0.152 mm	0.002-0.006 in.
Preferred	0.051 mm	0.002 in.
Gear End Clearance — Feeler Gauge	0.1016-0.2032 mm	0.004-0.008 in.
Preferred	0.1778 mm	0.007 in.
Rocker Arms, Push Rods and Tappets		
Rocker Arm Ratio	1.6:1	
Push Rod Length	244.856-245.364 mm	9.640-9.660 in.
Push Rod Diameter	7.92-8.00 mm	0.312-0.315 in.
Hydraulic Tappet Diameter	22.962-22.974 mm	0.904-0.9045 in.
Tappet-to-Bore Clearance	0.03-0.05 mm	0.001-0.0025 in.

J8909-173

ENGINE SPECIFICATIONS — 4.2L (CONT.)

Pistons		
Weight (less pin)	510-514 grams	18-18.1 oz.
Piston Pin Bore		
Centerline-to-Piston Top	41.94-42.04 mm	1.651-1.655 in.
Piston-to-Bore Clearance	0.023-0.043 mm	0.0009-0.0017 in.
Preferred	0.030-0.033 mm	0.0012-0.0013 in.
Piston Ring Gap Clearance —		
Compression (both)	0.25-0.51 mm	0.010-0.020 in.
Piston Ring Gap Clearance —		
Oil Control Steel Rails	0.25-0.64 mm	0.010-0.025 in.
Piston Ring Side Clearance		
No. 1 and No. 2 Compression	0.030-0.081 mm	0.0012-0.0032 in.
Preferred	0.043 mm	0.0017 in.
Oil Control		
Preferred	0.03-0.20 mm	0.0080 in.
Piston Ring Groove Height	0.08 mm	0.003 in.
Copmression (both)	2.019-2.045 mm	0.0795-0.0805 in.
Oil Control	4.78-4.80 mm	0.188-0.1895 in.
Piston Ring Groove Diameter		
No. 1 and No. 2	84.43-84.56 mm	3.324-3.329 in.
Oil Control	84.56-84.81 mm	3.329-3.339 in.
Piston Pin Bore Diameter	23.624-23.655 mm	0.9308-0.9313 in.
Piston Pin Diameter	23.632-23.645 mm	0.9304-0.9309 in.
Piston-to-Pin Clearance	0.010-0.015 mm	0.0004-0.0006 in.
Preferred	Loose 0.015 mm	Loose 0.0006 in.
Piston Pin-to-Connecting Rod	8.9 kN Press-fit	2000 lbs.-f Press-fit
Valves		
Valve Length		
(Tip-to-Gauge Dim. Line) Intake	121.653-122.034 mm	4.7895-4.8045 in.
Valve Stem Diameter	9.436-9.462 mm	0.3715-0.3725 in.
Stem-to-Guide Clearance	0.03-0.08 mm	.001-.003 in.
Intake Valve Head Diameter	45.26-45.52 mm	1.782-1.792 in.
Intake Valve Face Angle	29°	
Exhaust Valve Head Diameter	35.59-35.84 mm	1.401-1.411 in.
Exhaust Valve Face Angle	44°	
Maximum Allowable Removed for		
Tip Refinishing	0.25 mm	0.010 in.
Valve Springs Free Length	50.55 mm	1.99 in.
Valve Spring Tension Closed	285-320 N @ 45.4 mm	64.72 lbs @ 1.786 in.
Valve Spring Tension Open	836-898 N @ 35.84 mm	188-202 lbs @ 1.411 in.

J9009-76

TORQUE SPECIFICATIONS — 4.2L

Component	Torque	
A/C Compressor Bracket-to-Engine Bolts	34 N•m	(25 ft-lbs)
A/C Low Pressure Service Valve Nut	38 N•m	(28 ft-lbs)
Alternator Adjusting Bolt	24 N•m	(18 ft-lbs)
Alternator Pivot Bolt/Nut	38 N•m	(28 ft-lbs)
Camshaft Sprocket Bolt	108 N•m	(80 ft-lbs)
Connecting Rod Bolt Nuts	45 N•m	(33 ft-lbs)
Crankshaft Main Bearing Bolts	108 N•m	(80 ft-lbs)
Cylinder Head Bolts	115 N•m	(85 ft-lbs)
Cylinder Head Cover Bolts	8 N•m	(70 in-lbs)
Cylinder Head Cover Retaining Bolts	6 N•m	(55 in-lbs)
Damper Pulley Retaining Bolts	27 N•m	(20 ft-lbs)
Exhaust Manifold-to-Downpipe Nuts	27 N•m	(20 ft-lbs)
Flywheel/Converter Housing Bolts	38 N•m	(28 ft-lbs)
Fuel Pump Bolts	22 N•m	(16 ft-lbs)
Oil Pan Bolts - 1/4-20	9 N•m	(7 ft-lbs)
- 5/16-18	15 N•m	(11 ft-lbs)
Oil Pan Drain Plug	41 N•m	(30 ft-lbs)
Oil Pan-to-Timing Case Cover Bolts	13 N•m	(11 ft-lbs)
Oil Pump Attaching Bolts (Short)	14 N•m	(10 ft-lbs)
Oil Pump Attaching Bolts (Long)	23 N•m	(17 ft-lbs)
Oil Pump Cover Bolts	8 N•m	(70 in-lbs)
Power Steering Pump Pressure Hose Hut	52 N•m	(38 ft-lbs)
Rocker Arm Assembly-to-Cylinder Head	26 N•m	(19 ft-lbs)
Spark Plugs	38 N•m	(28 ft-lbs)
Starting Motor-to-Cylinder Block Bolts	45 N•m	(33 ft-lbs)
Timing Case Cover-to-Block Bolts	7 N•m	(62 in-lbs)
Vibration Damper Bolt (Lubricated)	108 N•m	(80 ft-lbs)

J9009-77

5.9L ENGINE SERVICE PROCEDURES

INDEX

ENGINE MOUNTS — 5.9L

Resilient rubber mounting cushions support the engine and transmission at three points. A cushion is located at each side on the centerline of the engine (Fig. 1). The rear is supported by a cushion between the transmission extension housing and the rear support crossmember.

Removal or replacement of any cushion may be accomplished by supporting the weight of the engine or transmission in the area of the cushion.

ENGINE ASSEMBLY — 5.9L

The engine is removed with the transmission and drive plate housing detached.

Removal

(1) Mark the hood hinge locations at the hood panel for ease of alignment during installation. Remove the hood from the hinges.

(2) Remove the air cleaner assembly.

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM COULD STILL BE PRESSURIZED.

(3) Drain the cooling system and disconnect the upper (Fig. 2) and lower radiator hoses. If the coolant is reusable, drain into a clean container.

(4) Disconnect the heater hoses (Fig. 3).

(5) Disconnect the transaxle fluid cooler tubing from the radiator and the cylinder block.

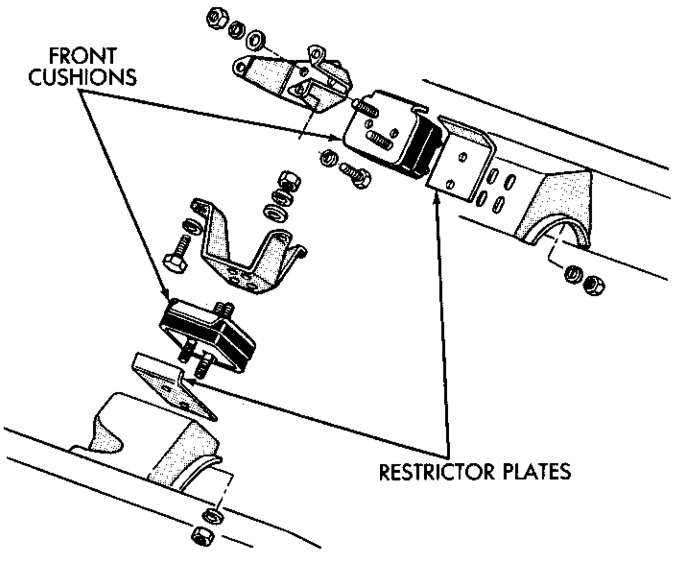


Fig. 1 Front Engine Cushions

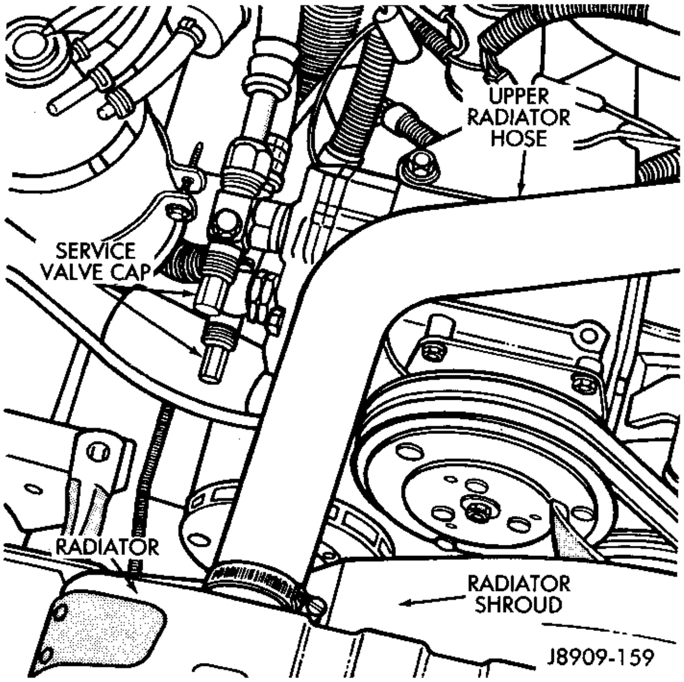


Fig. 2 Upper Radiator Hose/Radiator/Shroud

(6) If the vehicle is equipped with a radiator shroud, separate the shroud from the radiator to facilitate removal and installation of the radiator and fan assembly (Fig. 2).

(7) Remove the radiator.

(8) Remove the fan assembly. Remove the fluid from the power steering pump reservoir and disconnect the hoses (Fig. 4).

(9) Remove the protective caps from the service valves. Turn both A/C service valves clockwise to the front-seated position. Vent the compressor refrigerant charge by slowly loosening the service valve fittings (Fig. 4). Remove the service valves from the compressor.

(10) Remove the Cruise Command vacuum servo bellows and mounting bracket as an assembly.

(11) Remove the battery.

(12) Disconnect the wire harness from the engine and move it aside.

(13) Disconnect the following hoses:

(a) Fuel supply and return hoses at the chassis tubing.

(b) Vacuum hose at the power brake unit.

(c) Vacuum hose for the heater damper doors at the intake manifold.

(14) Disconnect the transmission filler tube bracket from the right cylinder head. Do not remove the filler tube from the transmission.

(15) Support the weight of the engine with a lifting device.

(16) Remove both engine front support cushion-to-frame retaining nuts.

(17) Remove the upper bolts securing the drive plate housing to the engine.

(18) Disconnect the exhaust pipe from the exhaust manifolds and support bracket. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedure.

(19) Remove the starter motor.

(20) Support the transmission with a floor jack.

(21) Remove the drive plate housing inspection cover. Scribe a mark to indicate the assembled position of the converter and drive plate and remove the converter-to-drive plate bolts.

(22) Remove the lower throttle valve and inner manual linkage support. Disconnect the throttle valve rod at the lower end of the bellcrank.

(23) Remove the remaining bolts securing the drive plate housing to the engine.

CAUTION: Avoid damaging the power brake unit while removing the engine.

(24) Remove the engine by lifting up and forward.

(25) Remove the remaining bolts securing the drive plate housing to the engine.

Installation

(1) Lower the engine slowly into the engine compartment and align it with the drive plate housing.

(2) Install the drive plate housing bolts. Tighten the bolts to 38 N•m (28 ft. lbs.) torque.

(3) Remove the floor jack used to support the transmission.

(4) Align the scribe marks previously made on the converter and drive plate. Install the converter-to-drive plate bolts and tighten to 30 N•m (22 ft. lbs.) torque. Install the throttle valve bellcrank and manual linkage support.

(5) Install the inspection cover.

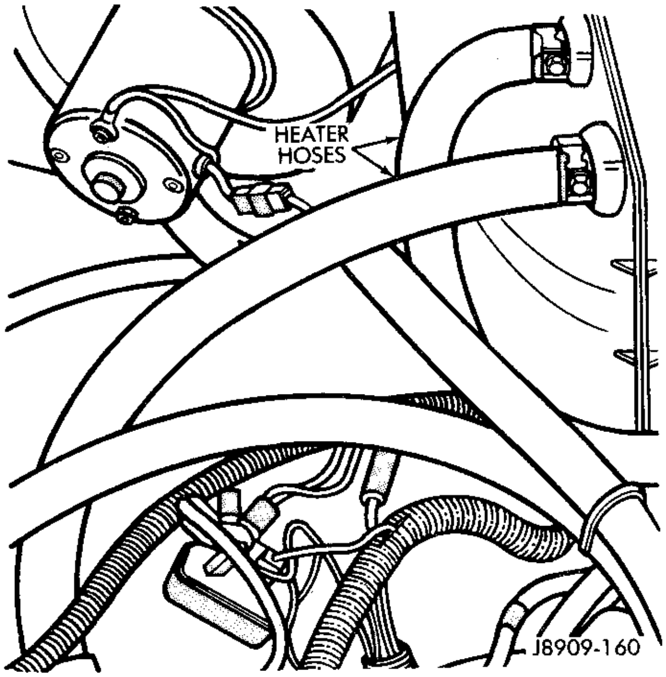


Fig. 3 Heater Hoses

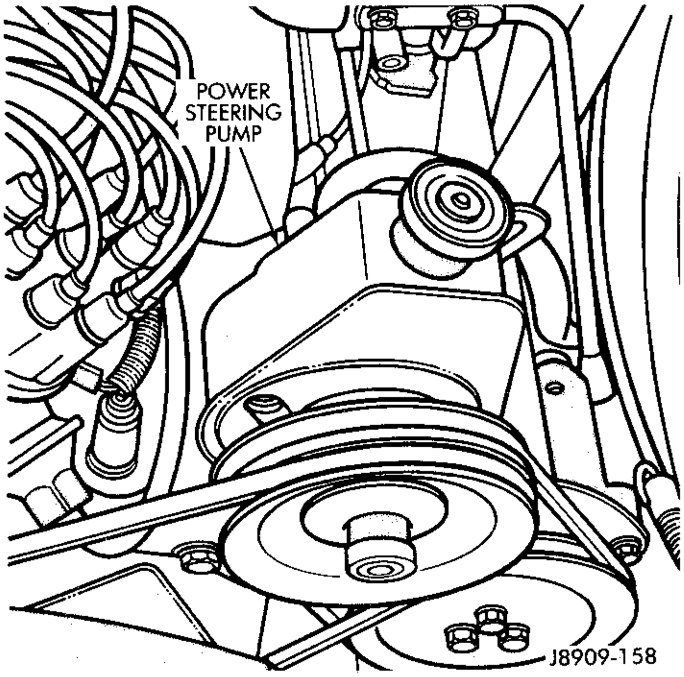


Fig. 4 Power Steering Pump

(6) Install the starter motor. Tighten the bolts to 24 N•m (18 ft. lbs.) torque.

(7) Lower the engine onto the supports. Remove the lifting device.

(8) Install the front support cushion retaining nuts. Tighten the nuts to 45 N•m (33 ft. lbs.) torque.

(9) Connect the exhaust pipe to the exhaust manifolds and support bracket.

(10) Connect the transmission filler tube bracket to the right cylinder head.

(11) Install the Cruise Command vacuum servo bellows and mounting bracket, if removed.

(12) Connect all wires, tubing, linkage and hoses to the engine.

(13) Connect the receiver outlet to the disconnect coupling. Connect the condenser and evaporator lines to the A/C compressor.

CAUTION: Both service valves must be open before the air conditioning system is operated.

(14) Purge the compressor of air.

(15) Connect the power steering hoses and fill the pump reservoir to the specified level.

(16) Install the radiator fan assembly and tighten the retaining bolts to 24 N•m (18 ft. lbs.) torque.

(17) Install the heater hoses.

(18) Install the radiator and connect the upper and lower hoses. Connect the fluid cooler tubing.

(19) Fill the cooling system to the specified level.

(20) Install the air cleaner assembly.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(21) Start the engine. Inspect all connections for leaks. Stop the engine.

(22) Install and align the hood assembly.

(23) Install the transmission access cover, floormat and transfer case shift lever boot.

CYLINDER HEAD COVER — 5.9L

The cylinder head covers are installed with a formed-in-place RTV (room temperature vulcanizing) silicone gasket.

Removal

(1) Remove the air cleaner assembly.

(2) Disconnect the air hose from the air injection manifold.

(3) On the left side, disconnect the power brake vacuum hose at the intake manifold.

(4) Disconnect the throttle stop solenoid wire on the left side.

(5) Remove the thermostatically controlled air cleaner (TAC) hot air hose on the right side.

(6) Disconnect the ignition wires and remove the plastic wire separator from the cylinder head cover bracket.

(7) Remove the retaining bolts and washers. Strike the cover with a rubber mallet to break it loose from the cylinder head. Remove the cover and gasket.

Inspection and Cleaning

Inspect the cover for bends or cracks and repair or replace as required.

Thoroughly clean the cylinder head cover and cylinder head gasket surface area.

Installation

(1) Apply a bead of Jeep/Eagle Gasket-In-A-Tube, or equivalent, to the cylinder head cover gasket surface area. Ensure the sealant is fresh (i.e., not stored for longer than one year and storage area temperature is less than 27°C (80°F).

(2) Position the cylinder head cover on the engine.

(3) Install the retaining bolts and tighten to 6 N•m (50 in. lbs.) torque.

(4) Connect the ignition wires and install the plastic wire separator on the cylinder head cover bracket.

(5) Install the TAC hot air hose.

(6) On the left side, connect the power brake vacuum hose at the intake manifold.

(7) Connect the throttle stop solenoid wire on the left side.

(8) Connect the air hose to the air injection manifold.

(9) Install the air cleaner assembly.

ROCKER ARMS — 5.9L

Removal

(1) Remove the cylinder head cover (see Cylinder Head Cover Removal).

(2) Remove the two capscrews at each bridge (Fig. 5). Alternately loosen the capscrews one turn at a time to avoid damaging the bridge.

(3) Remove the bridge and pivot assemblies and place them on the bench in the same order as removed (Fig. 5).

(4) Remove the rocker arms and place them on the bench in the same order as removed (Fig. 5).

(5) Remove the push rods and place them on the bench in the same order as removed (Fig. 5).

Cleaning and Inspection

Clean all the parts with cleaning solvent.Use compressed air to clean out the oil passages in the rocker arms and push rods.

Inspect the pivot contact surface of each rocker arm and push rod. Replace any parts that are scuffed, pitted or excessively worn. Inspect the valve stem contact surface of each rocker arm and replace if deeply pitted. Inspect each push rod end for scuffing or excessive wear. If any push rod is excessively worn from lack of oil, replace the push rod as well as the corresponding hydraulic valve tappet and rocker arm.

It is not normal for a wear pattern to exist along the length of the push rod. Inspect the cylinder head for obstruction if this condition exists.

Installation

(1) Install the push rods. Ensure the bottom end of each rod is centered in the plunger cap of the hydraulic valve tappet.

(2) Install the bridge and pivot assembly and pair of rocker arms adjacent to the cylinder from where they were originally removed.

(3) Loosely install two capscrews through each bridge. Tighten the rocker arm capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(4) Seal and install the cylinder head cover.

CYLINDER HEAD — 5.9L

Removal

(1) Disconnect the battery negative cable.

(2) Drain the cooling system and cylinder block. If the coolant is reusable, drain it into a clean container.

(3) Remove the ignition wires and spark plugs.

(4) Remove the cylinder head cover and gasket.

(5) Remove the capscrews, bridge and pivot assemblies and rocker arms (Fig. 5). Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridge.

(6) Remove the push rods. Retain the rocker arms, bridges, pivots and push rods in the same order as removed to facilitate installation in the original locations (Fig. 5).

(7) Remove the intake manifold.

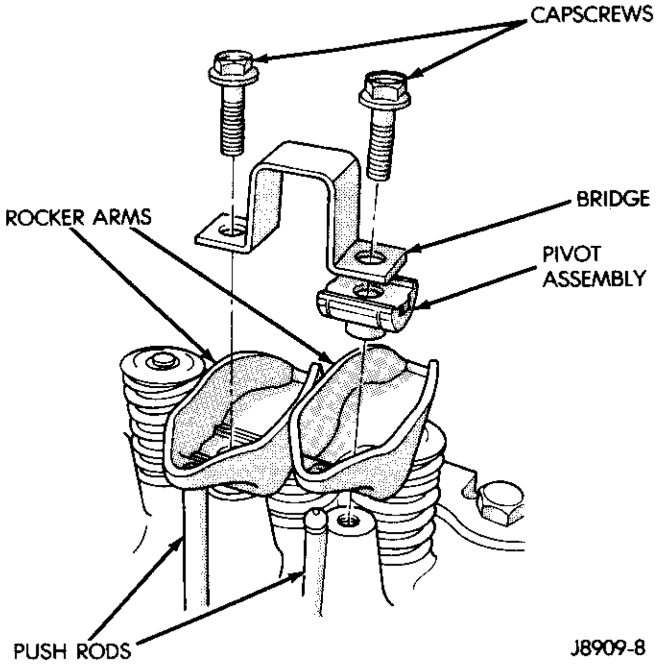


Fig. 5 Rocker Arm Assembly

(8) Disconnect the exhaust manifold from the head.It is not necessary to remove the exhaust downpipe from the manifold.

(9) Loosen all drive belts.

(10) On the right side, remove the A/C compressor mounting bracket and battery negative cable from the cylinder head.

(11) On the right side, disconnect the alternator support brace from the cylinder head.

(12) On the left side, disconnect the air pump and power steering mount bracket from the cylinder head.

(13) Remove the cylinder head retaining bolts.

(14) Remove the cylinder head and gasket.

Cleaning and Inspection

Thoroughly clean the gasket surfaces of the cylinder head and block to remove all foreign material and gasket cement. Remove carbon deposits from the combustion chambers and the top of each piston.

Use a straightedge and feeler gauge to determine the flatness of the cylinder head and block mating surfaces. Refer to Engine Specifications for the proper tolerances.

If the cylinder head is to be replaced and the original valves reused, remove the valves and measure the stem diameters.

Service replacement heads have standard-size valve guide bores. If valves with oversize stems from the original head are to be installed in a replacement head, ream the valve guide bores to the appropriate oversize diameter.

If the original valves are used, remove all carbon deposits and reface the valves. Install the valves in the cylinder head using replacement valve stem oil deflectors. If valves with oversize stems are used, oversize deflectors are also required. Transfer all the components from the original head that are not included with the replacement head.

Wire brush the threads of the cylinder head bolts prior to installation. Uncleaned threads will affect the tightening torque. Blow coolant from the bolt holes to prevent trapping coolant.

Installation

(1) Apply an even coat of nonhardening sealing compound to both sides of the replacement head gasket.

CAUTION: Do not apply sealing compound to the head and block surfaces. Do not allow sealer to enter the cylinder bores.

(2) Position the gasket flush on the block with the stamped word TOP facing up.

(3) Install the cylinder head over the gasket.

(4) Tighten the cylinder head bolts evenly with 108 N•m (80 ft. lbs.) torque following the tightening sequence (Fig. 6). Then repeat the sequence and tighten the bolts to 149 N•m (110 ft. lbs.) torque.

The 5.9 liter (360 CID) engine uses an aluminum coated laminated steel and asbestos gasket.

Retightening the head bolts after the engine has been operated is not necessary.

(5) On the left side, connect the air pump mounting bracket and power steering pump, if removed, to the cylinder head.

(6) On the right side, connect the alternator support bracket to the cylinder head.

(7) On the right side, install the air conditioner compressor mounting bracket and the battery negative cable on the cylinder head.

(8) Adjust all drive belts to the specified tension. Refer to Group 7, Cooling System for the proper tension and procedure.

(9) Install the exhaust manifold and tighten the two center retaining bolts to 34 N•m (25 ft. lbs.) torque. Tighten the four outer bolts to 20 N•m (15 ft. lbs.) torque. Install the other exhaust manifold.

(10) Install the intake manifold. Tighten the retaining bolts to 58 N•m (43 ft. lbs.) torque.

(11) Install all the disconnected pipes, hoses, linkage and wires.

(12) Install the push rods, rocker arms and bridge and pivot assemblies in the original position (Fig. 5). Loosely install the capscrews through the bridges. Tighten the capscrews alternately, one turn at a time, to avoid damaging the bridges. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(13) Install the cylinder head cover.

(14) Install the spark plugs and connect the ignition wires. Tighten the plugs to 38 N•m (28 ft. lbs.) torque.

(15) Fill the cooling system to the specified level.

(16) Connect the battery negative cable.

VALVE SPRING AND OIL DEFLECTOR — 5.9L

Removal

Valve springs and oil deflectors can be removed without removing the cylinder head.

Refer to Valves for the removal procedure with the cylinder head removed from the engine.

Each valve spring is held in place on the valve stem by a retainer and a set of valve locks. The locks can be removed only by compressing the valve spring.

(1) Remove the cylinder head cover.

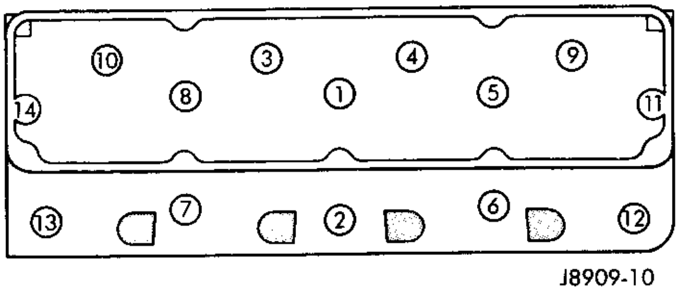


Fig. 6 Cylinder Head Bolt Tightening Sequence

(2) Remove the bridge and pivot assemblies and the rocker arms from the valves requiring valve spring or oil deflector removal.

(3) Remove the two capscrews at each bridge. Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridge.

(4) Remove the bridge, pivot and rocker arms.

(5) Remove the push rods. Retain the rocker arms, bridge and pivot assemblies and push rods in the same order as removed to facilitate installation at their original locations (Fig. 5).

(6) Remove the spark plug from the cylinder that requires valve spring or oil deflector removal.

(7) Install a 14 mm (thread size) air adaptor in the spark plug hole. An adaptor can be constructed by welding an air hose connection to the body of a spark plug that has the porcelain removed.

(8) Connect the air hose to the adapter and maintain at least 620 kPa (90 psi) pressure in the cylinder to hold the valves against their seats.

(9) Use a valve spring removal/installation tool (8014) to compress the valve spring.

(10) Remove the valve locks (Fig. 7).

(11) Remove the valve spring and retainer from the cylinder head (Fig. 7).

(12) Remove the oil deflector (Fig. 7).

Installation

(1) Use an 11 mm (7/16 inch) deep socket and a hammer to gently tap the oil deflector onto the valve stem.

(2) Install the valve spring and retainer. A close-coil valve spring is used with all valves. The close-coiled end must face the cylinder head when installed.

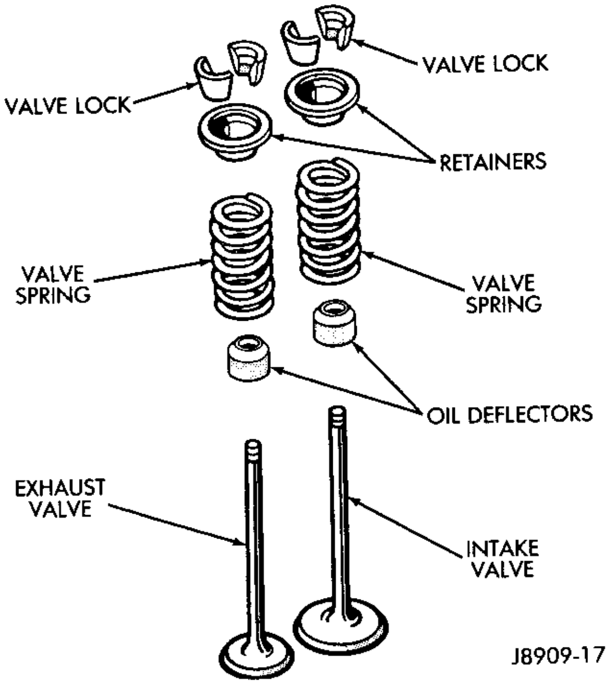


Fig. 7 Valve Components Location

(3) Compress the valve spring with a valve spring removal/installation tool.

(4) Insert the valve locks.

(5) Release the spring compression and remove the tool.

(6) Tap the valve spring from side to side with a light hammer to ensure the spring is seated properly on the cylinder head.

(7) Disconnect the air hose, remove the air adapter from the spark plug hole and install the spark plug. Tighten the spark plug to 38 N•m (28 ft. lbs.) torque.

(8) Install the push rods. Ensure that the bottom end of each rod is centered in the plunger cap of the hydraulic valve tappet.

(9) Install the rocker arms and bridge and pivot assembly.

(10) At each bridge, tighten the capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(11) Install the cylinder head cover.

VALVE AND VALVE SPRINGS — 5.9L

The following procedures apply only after the cylinder head has been removed from the engine and the bridge and pivot assemblies, rocker arms and push rods have been removed from the head. If the head has not been removed from the engine, refer to Cylinder Head for the removal procedure.

Removal

(1) Compress each valve spring with C-Clamp Type Spring Compressor Tool (8014) - (Fig. 8). Remove the valve locks and retainers. Release the compression tool.

(2) Remove the valve springs and retainers.

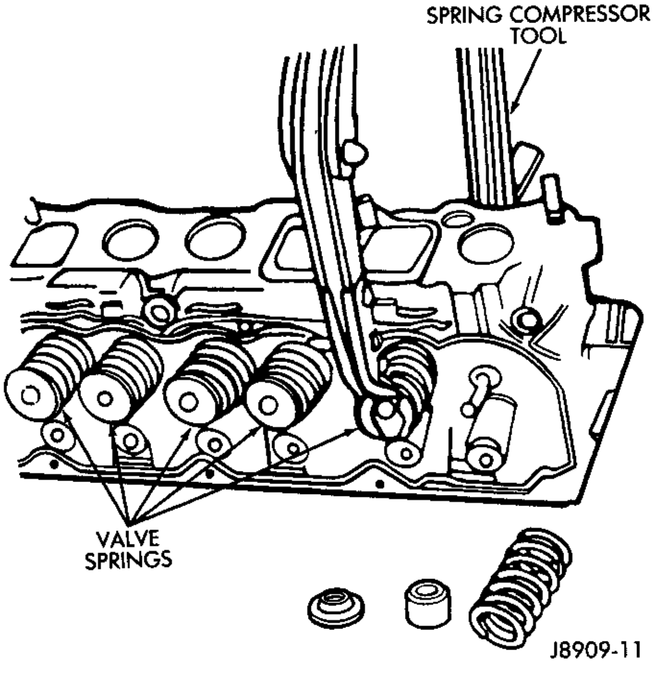


Fig. 8 Spring Compression Tool (8014)

(3) Remove the valve stem oil deflectors.

(4) Remove the valves individually and place them in a rack in the same order as installed in the cylinder head.

Valve Cleaning and Inspection

Remove all carbon deposits from the combustion chambers, valve ports, valve stems and heads.

Remove all foreign material and gasket cement from the cylinder head gasket mating surface.

Inspect for cracks in the combustion chambers and valve ports and in the gasket surface area at each coolant passage.

Inspect for cracks on the exhaust seats.

Inspect for burned or cracked valve heads and scuffed valve stems. Replace any valve that is bent, warped or scuffed.

Valve Refacing

Use a valve refacing machine to reface the intake and exhaust valves to the specified angle.

After refacing, a margin of at least 0.787 mm (0.031 inch) must remain. If the margin is less than 0.787 mm (0.031 inch), the valve must be replaced (Fig. 9).

Valve Seat Refacing

Install a pilot of the correct size in the valve guide and reface the valve seat to the specified angle with a dressing stone in good condition (Fig. 10).

Remove only enough metal to provide a smooth finish. This is especially important on exhaust valve seats. The seat hardness varies in depth.

Use tapered stones to obtain the specified seat widths when required. Measure the seat runout with a dial indicator (Fig. 11). Maximum seat runout is 0.064 mm (0.0025 inch).

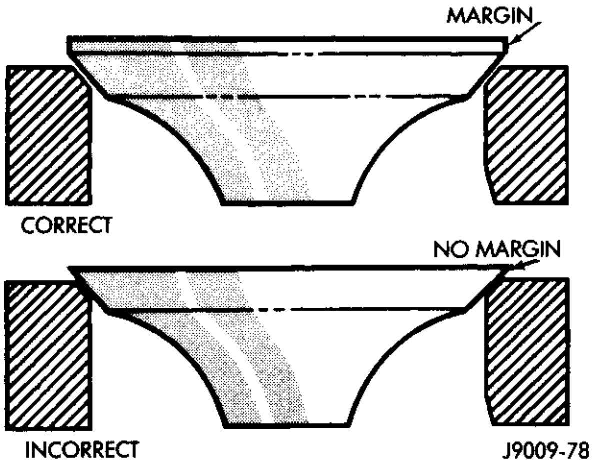


Fig. 9 Valve Margin

Valve Stem Oil Deflector Replacement

Nylon valve stem oil deflectors are installed on each valve stem to prevent lubricating oil from entering the combustion chamber through the valve guide bores.

CAUTION: Ensure that the valve stem is free of burrs or sharp edges before replacing the oil deflectors.

Replace the oil deflectors whenever valve service is performed or if the oil deflectors have deteriorated.

Oil deflector replacement requires removal of the valve springs. Refer to Valve Springs for the removal procedure.

Valve Guides

The valve guides are an integral part of the cylinder head and are not replaceable.

When the stem-to-guide clearance is excessive, ream the valve guide bores to the next higher valve stem size.

Service valves are available as follows:

- 0.076 mm (0.003 inch)
- 0.381 mm (0.015 inch)
- 0.762 mm (0.030 inch)

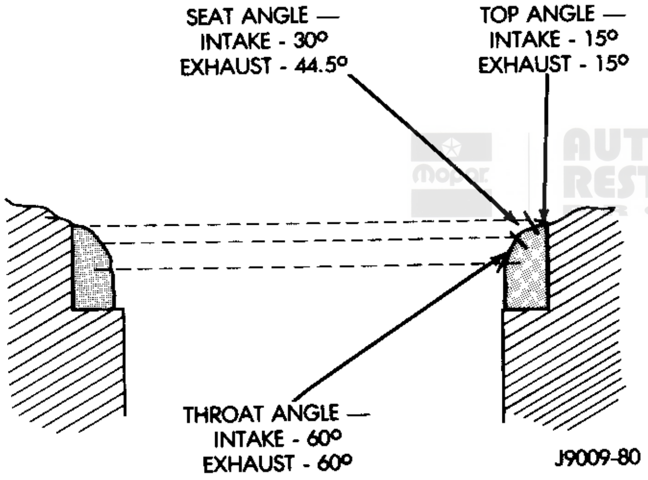


Fig. 10 Intake and Exhaust Valve Seat Dimensions

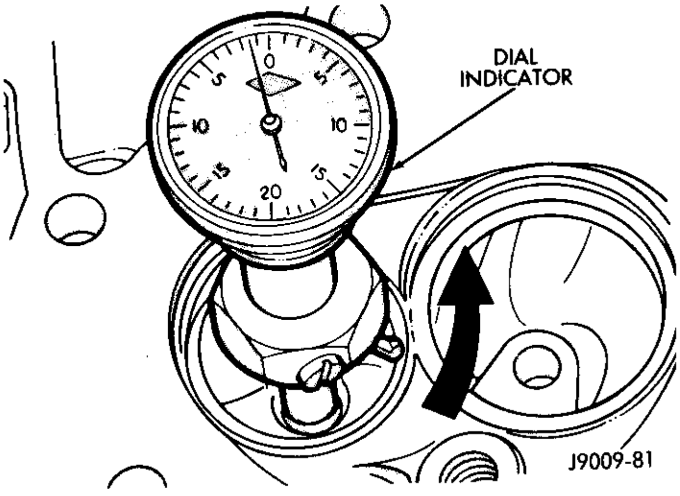


Fig. 11 Valve Seat Runout

Ream the valve guide bores in steps. Start with the 0.076 mm (0.003 inch) reamer and progress to the next size until the proper size is achieved.

Valve Stem-to-Guide Clearance Measurement

Valve stem-to-guide clearance can be measured by either one of two methods.

Preferred Method:

Remove the valve from the head and clean the valve guide bore with solvent and a bristle brush.

Insert a telescoping gauge into the valve stem guide bore approximately 9.525 mm (0.375 inch) from the valve spring side of the head with the contacts crosswise to the head (Fig. 12).

Use a micrometer to measure the telescoping gauge contact width.

Repeat the measurement with the contacts lengthwise to the cylinder head.

Compare the lengthwise and crosswise measurements to determine the out-of-round condition.

If the measurements differ by more than 0.0635 mm (0.0025 inch), ream the guide bore to accommodate an oversize valve stem.

Compare the valve guide bore diameter measurement with the diameter listed above.

If the measurement is larger by more than 0.076 mm (0.003 inch), ream the guide bore to accommodate an oversize valve stem.

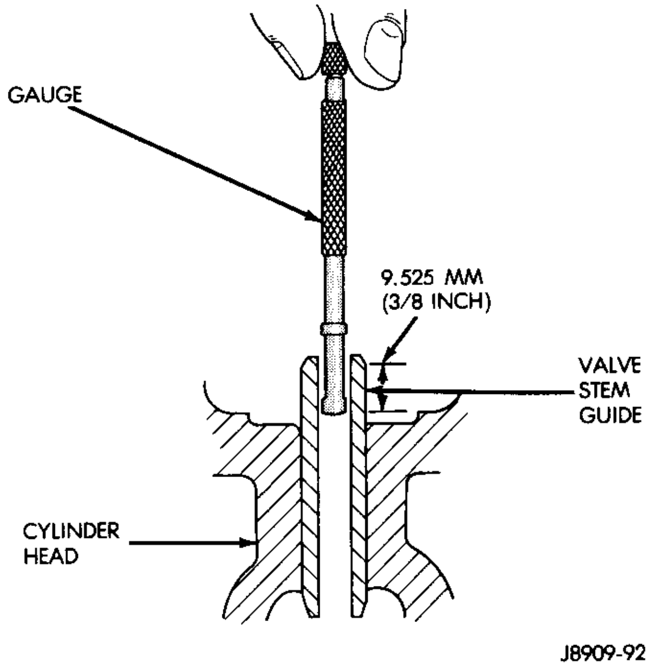


Fig. 12 Measurement — Valve Stem-to-Guide Clearance

Alternate Method:

Use a dial indicator to measure the lateral movement of the vlave stem sith the valve installed in its guide and barely off the valve seat (Fig. 13).

The correct clearance is 0.025-0.076 mm (0.001-0.003 inch).

Valve Spring Tension Test

Use a torque wrench with Valve Spring Tester (8011) to test each valve spring for the specified tension value (Fig. 14).

Replace springs that are not within the specificartions. Replace springs that bind because of warpage.

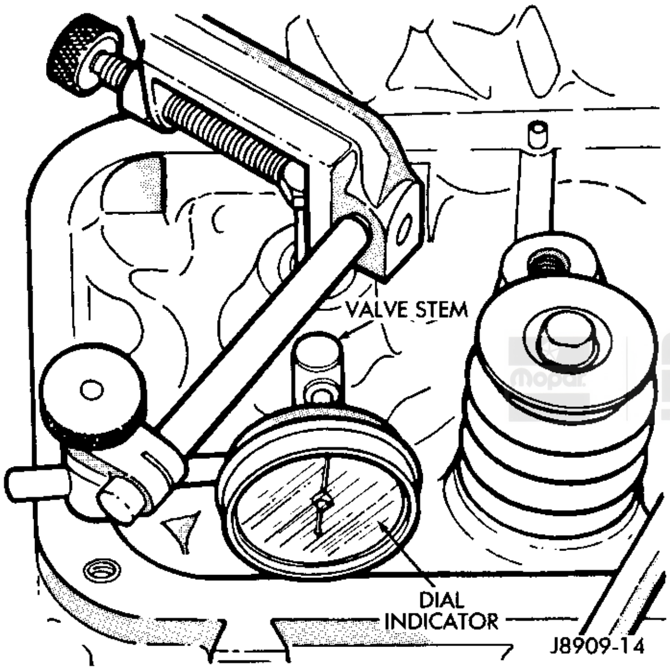


Fig. 13 Measurement — Valve Stem-to-Guide Clearance

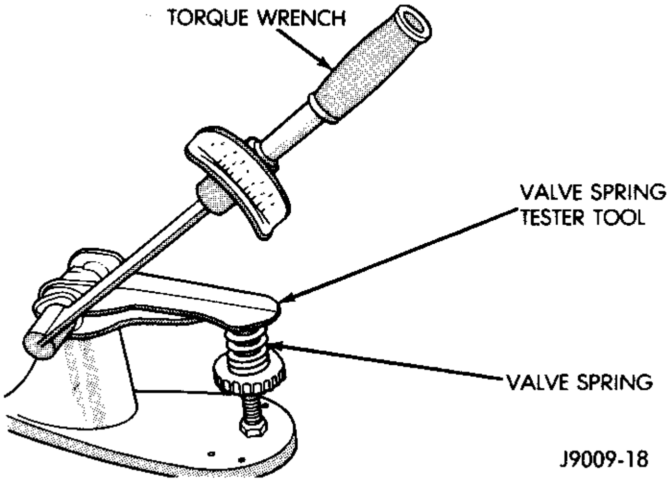


Fig. 14 Valve Spring Tester (8011)

Installation — Cylinder Head Removed

(1) Thoroughly clean the valve stems and valve guide bores.

(2) Lightly lubricate the stem and install the valve in the same valve guide bore from where it was originally removed.

(3) Install the replacement valve stem oil deflector on the valve stem.

(4) Position the valve spring and retainer on the cylinder head and compress the valve spring with the compressor tool (8014). Install the valve locks and release the tool.

(5) Tap the valve spring from side to side with a light hammer to seat the spring properly on the cylinder head.

HYDRAULIC TAPPETS — 5.9L

Removal — Cylinder Head Not Removed

(1) Remove the cylinder head cover.

(2) Remove the bridge and pivot assemblies and the rocker arms (Fig. 15). Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridge.

(3) Remove the push rods (Fig. 15). Retain the bridge and pivot assemblies, rocker arms and push rods in the same order as removed.

(4) Remove the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold for the proper procedure.

(5) Remove the tappet from the guide bore in the engine block.

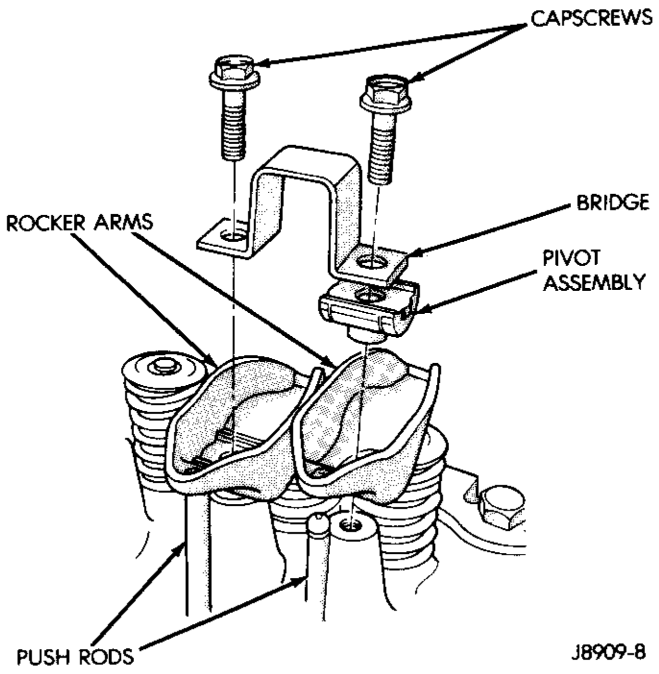


Fig. 15 Rocker Arm Assembly

Installation — Cylinder Head Not Removed

(1) Dip each tappet assembly in Jeep/Eagle Super Oil Conditioner, or equivalent.

(2) Install the tappet in the same bore from where it was originally removed.

(3) Install the push rods in the same position as removed.

(4) Install the rocker arm and bridge and pivot assemblies in the same position as removed. Tighten the capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(5) Pour the remaining Jeep/Eagle Super Oil Conditioner over the entire valve train mechanism. Do not drain the Jeep/Eagle Super Oil Conditioner from the engine for at least 1 609 km (1000 mi) or until the next scheduled oil change.

(6) Reseal and install the cylinder head cover.

(7) Install the intake manifold using a replacement gasket and end seals.

(8) Install all pipes, hoses, linkage and wires disconnected from the intake manifold.

Disassemby, Cleaning and Inspection — Cylinder Head Removed

(1) Release the lockring.

(2) Remove the plunger cap, metering disc, plunger assembly and plunger return spring from the tappet body (Fig. 16). Retain the tappets and all components in the same order as removed. Do not interchange components.

(3) Clean all tappet components in cleaning solvent to remove all varnish and gum deposits.

(4) Visually inspect each tappet assembly for evidence of scuffing on the side and face of the tappet body. Inspect the tappet face for wear using a straightedge across the face. If the tappet face is concave and the corresponding lobe on the camshaft is worn, replace the camshaft and tappets.

(5) Replace the entire assembly if any component is worn or damaged.

Assembly and Leak-Down Test — Cylinder Head Removed

(1) Install the plunger return spring, check valve assembly, plunger, metering valve and plunger cap in the tappet body.

(2) Use a push rod on the plunger cap to compress the plunger assembly and install the lockring.

(3) After cleaning, inspection and assembling, test the tappet leak-down rate to ensure zero-lash operating condition (Fig. 17).

(4) Swing the weighted arm of the tester away from the ram of the tester.

(5) Place a 7.92-7.95 mm (0.312-0.313 inch) diameter ball bearing on the plunger cap of the tappet.

(6) Lift the ram and place the tappet with the ball bearing inside the tester cup.

(7) Lower the ram, then adjust the nose of the ram until it contacts the ball bearing.

(8) Fill the tester cup with valve tappet test oil until the tappet is completely covered.

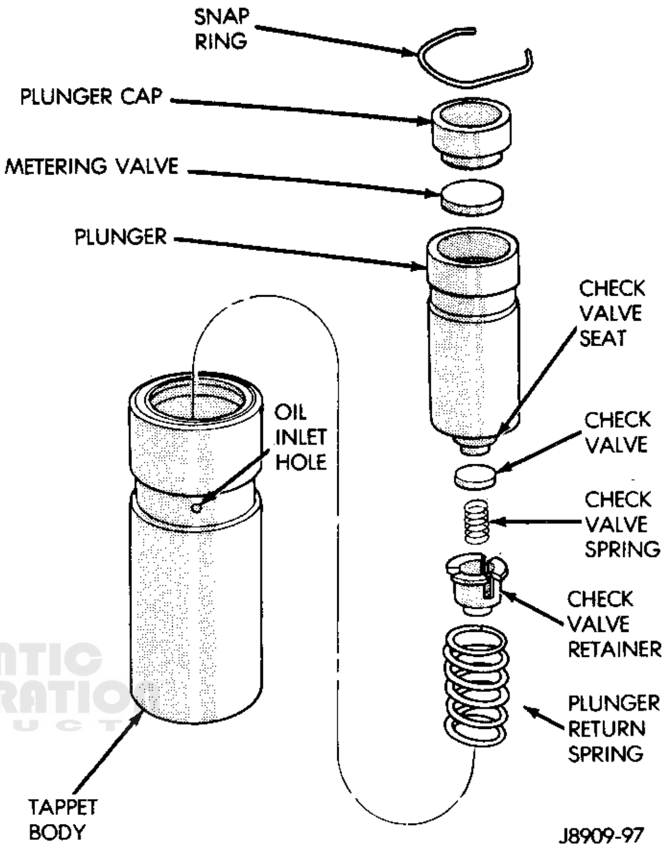


Fig. 16 Hydraulic Tappet Components

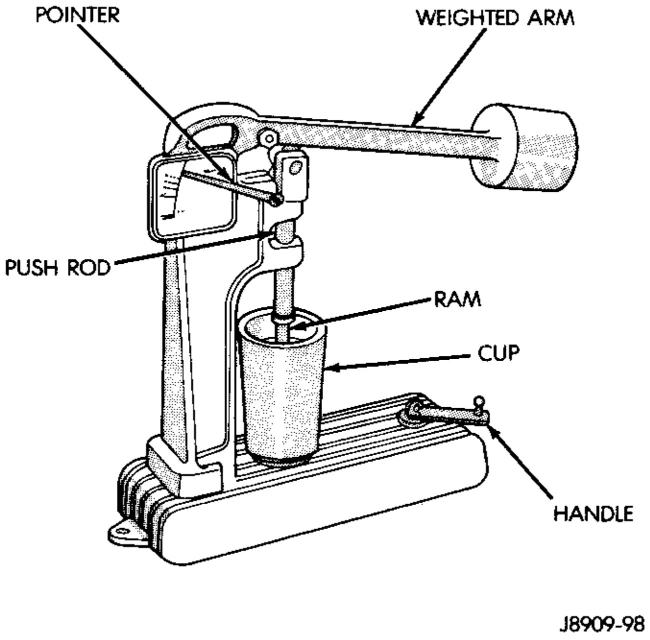


Fig. 17 Hydraulic Tappet Leak-Down Tester

(9) Swing the weighted arm onto the ram and pump up and down on the tappet to remove air. When air bubbles cease, swing the weighted arm away and allow the plunger to rise to the normal position.

(10) Adjust the nose of the ram to align the pointer with the SET mark on the scale of the tester and tighten the hex nut.

(11) Slowly swing the weighted arm onto the ram. Rotate the cup by turning the handle at the base of the tester clockwise one revolution every two seconds.

(12) Time the leak-down interval from the instant the pointer aligns with the START mark on the scale until the pointer aligns with the 0.125 mark.

(13) Acceptable tappets will require a 20 to 110 seconds interval to leak down. Replace tappets with a leak-down rate outside this range.

Do not charge the tappet assemblies with engine oil because they will charge themselves within three to eight minutes of engine operation.

VALVE TIMING — 5.9L

(1) Remove the spark plugs.

(2) Remove the cylinder head covers and gaskets.

(3) Remove the bridge and pivot assemblies and rocker arms from the No. 1 cylinder.

(4) Rotate the crankshaft until the No. 6 piston is at top dead center (TDC) on the compression stroke. This positions the No. 1 piston at TDC on the exhaust stroke in the valve overlap position.

(5) Rotate the crankshaft counterclockwise 90° as viewed from the front.

(6) Install a dial indicator on the No. 1 intake valve push rod end. Use rubber tubing to secure the stem on the push rod.

(7) Set the dial indicator at zero.

(8) Rotate the crankshaft slowly in the direction of normal rotation (clockwise, viewed from the front) until the dial indicator indicates 0.508 mm (0.020 inch).

(9) This should align the milled timing mark on the vibration damper with the TDC mark on the timing degree scale. If a variation of more than 13 mm (1/2 inch) exists in either direction from the TDC mark, remove the timing case cover and inspect the timing chain installation.

(10) Inspect for an incorrect camshaft sprocket location. The sprocket keyway should align with the centerline of the first lobe of the camshaft.

VIBRATION DAMPER — 5.9L

The vibration damper is balanced independently and then rebalanced as part of the complete crankshaft assembly.

Do not attempt to duplicate the original vibration damper balance holes when installing a service replacement damper.

The vibration damper is not repairable and is serviced only as a complete assembly.

Removal

(1) Loosen the damper retaining screw.

(2) Loosen the alternator drive belt.

(3) Loosen the air conditioner compressor drive belt and move it aside.

(4) Loosen the power steering pump drive belt and move it aside.

(5) Remove the damper pulley retaining bolts. Remove the damper pulley from the damper.

(6) Remove the damper retaining bolt and washer and loosely install the bolt to prevent damage to the bolt threads when the removal tool is used.

(7) Use Vibration Damper Removal Tool (8068) to remove the damper from the crankshaft (Fig. 1).

Installation

(1) Polish the damper hub with crocus cloth to prevent seal damage.

(2) Apply a light film of engine oil to the seal contact surface area of the damper.

(3) Align the key slot in the damper hub with the crankshaft keyway.

(4) Position the damper on the end of the crankshaft.

(5) Lubricate the bolt threads and washer with engine oil.

(6) Install the damper retaining bolt and washer and tighten to 122 N•m (90 ft. lbs.) torque. If the crankshaft turns before the specified torque is attained, proceed with the drive belt installation (refer to Group 7, Cooling System for the proper procedure). With the belts installed, tighten the damper retaining bolt to 122 N•m (90 ft. lbs.) torque.

(7) Install the damper pulley retaining bolts. Tighten the bolts to 41 N•m (30 ft. lbs.) torque.

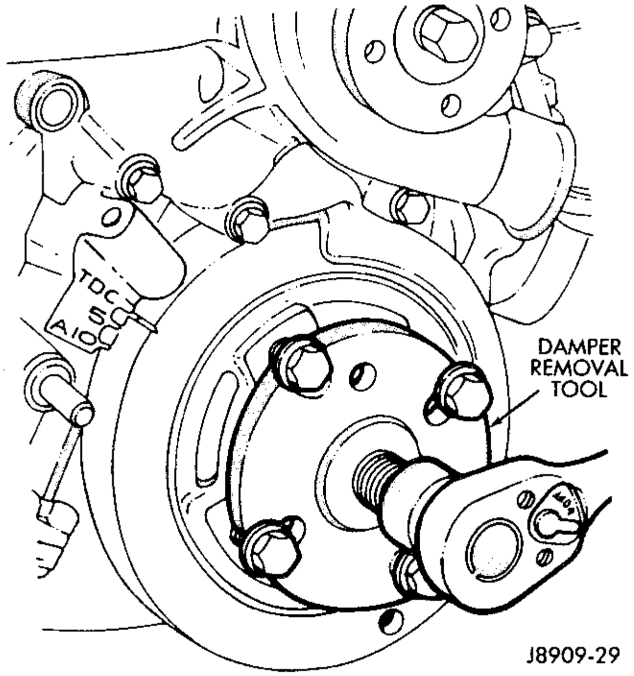


Fig. 1 Vibration Damper Removal Tool (8068)

(8) Install the drive belts and adjust to the specified tension. Refer to Group 7, Cooling System for the proper procedure.

TIMING CASE COVER — 5.9L

The timing case cover is die-cast aluminum (Fig. 2). A crankshaft oil seal is used to prevent oil leakage at the vibration damper hub. The oil seal may be installed from either side of the timing case cover. It is not necessary to remove the cover whenever oil seal replacement is required.

Removal

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM IS PRESSURIZED.

(1) Drain the radiator and cylinder block. If the coolant is reusable, drain it into a clean container.

(2) Disconnect the radiator hoses and bypass hose.

(3) Remove all drive belts.

(4) Remove the fan and hub assembly.

(5) Remove the A/C compressor and bracket assembly from the engine and move aside. Do not disconnect the air conditioner hoses.

(6) Remove the alternator, alternator mounting bracket and back idler pulley.

(7) Disconnect the heater hose at the water pump.

(8) Remove the power steering pump and bracket assembly. Remove the air pump and mounting bracket as an assembly. Do not disconnect the power steering pump hoses.

(9) Remove the distributor cap. **Note the rotor and housing position.**

(10) Remove the distributor.

(11) Remove the fuel pump.

(12) Remove the vibration damper pulley.

(13) Remove the vibration damper.

(14) Remove the two front oil pan bolts.

(15) Remove the bolts that secure the timing case cover to the engine block. **The cover retaining bolts are of various lengths and must be installed in the same location as removed.**

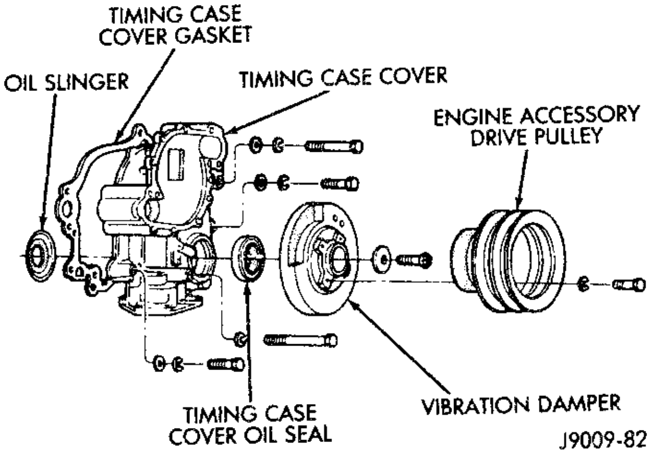


Fig. 2 Timing Case Cover Components

(16) Remove the cover by pulling it forward until it is clear of the locating dowel pins.

(17) Clean the gasket contact surface of the cover.

(18) Remove the oil seal. Always replace the oil seal whenever the timing case cover is removed. Refer to Oil Seal Replacement for the procedure.

Oil Seal Replacement

(1) Loosen all the drive belts.

(2) Remove the vibration damper pulley.

(3) Remove the vibration damper bolt and washer.

(4) Install the damper bolt in the crankshaft to prevent the damper puller from damaging the bolt threads in the crankshaft.

(5) Remove the vibration damper. Remove the damper bolt.

(6) Remove the oil seal (Fig. 3).

(7) Wipe the crankshaft sealing area clean.

(8) Apply Permatex No. 2, or equivalent, to the outer metal surface of the replacement seal.

(9) Install the seal using Installer Tool 7778 (Fig. 4).

(10) Apply a light coating of engine oil to the seal contact surface of the damper.

(11) Install the damper, flat washer and bolt. Tighten the damper bolt to 122 N•m (90 ft. lbs.) torque.

(12) Install the pulley and belts. Adjust the belts to the specifications. Refer to Group 7, Cooling System for the proper procedure.

Installation

(1) Remove the lower locating dowel pin from the engine block. The dowel pin is required for correct cover alignment. The dowel must be installed after the cover is in position.

(2) Use a sharp knife or razor blade to cut both sides of the oil pan gasket flush with the engine block.

(3) Apply Permatex No. 2, or equivalent, to both sides of the replacement timing case cover gasket. Install the

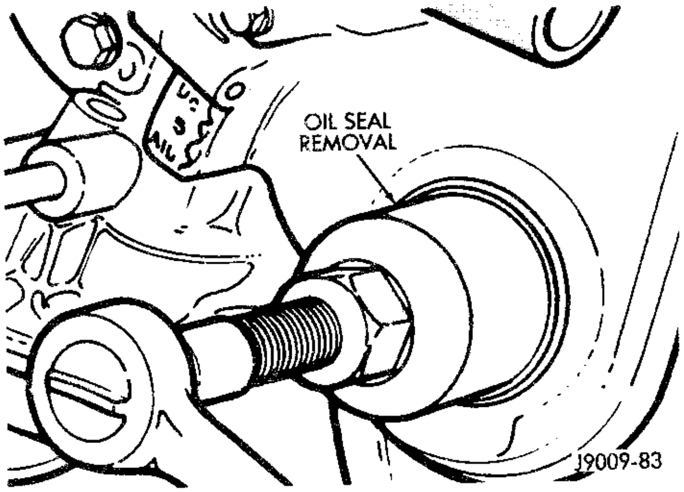


Fig. 3 Oil Seal Removal

gasket on the timing case cover.

(4) Install a replacement front oil pan seal to the bottom of the timing case cover. There are two methods of sealing the timing case cover to the oil pan where the oil pan gaskets were cut off. If replacement oil pan gaskets are used, perform step A. If room temperature vulcanizing (RTV) silicone is used, perform step B.

Step-A - Using Oil Pan Gaskets.

(a) Using original gasket pieces as a guide, trim the replacement gaskets to correspond to the amount cut off in the procedure above.

(b) Align the tongues of the replacement oil pan gasket pieces with the oil pan seal and cement them into place on the cover.

(c) Apply Permatex No. 2, or equivalent, to the cut off edges of the original oil pan gaskets.

(d) Place the timing case cover in position and install the front oil pan bolts.

(e) Tighten the bolts slowly and evenly until the cover aligns with the upper locating dowel.

(f) Insert the lower dowel through the cover and drive it into the corresponding hole in the engine block.

(g) Install the remaining cover retaining bolts in the same location as removed. Tighten all bolts to 34 N•m (25 ft. lbs.) torque.

Step-B - Using RTV.

(a) Apply a coating of RTV silicone 3.175 mm (1/8-inch) thick on the timing case cover flanges. Use Jeep/Eagle Gasket-In-A-Tube, or equivalent. The flanges must be clean and dry.

(b) Place the cover in position. Align it with the top dowel.

(c) Loosely install the front cover retaining bolts in the same location as removed.

(d) Insert the lower dowel through the cover and drive it into the corresponding hole in the engine block.

(e) Install the remaining cover retaining bolts and tighten all bolts to 34 N•m (25 ft. lbs.) torque.

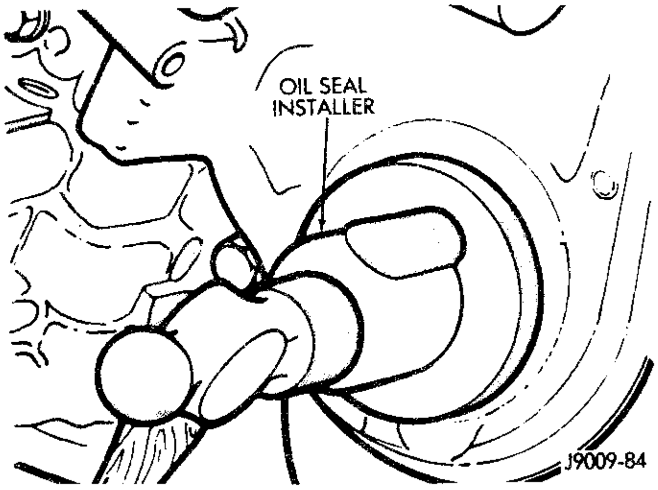


Fig. 4 Oil Seal Installation (Tool 7778)

(f) Apply a small bead of RTV to the joint between the pan and the cover and force it into place with a finger.

(g) Apply a drop of Loctite, or equivalent, to the oil pan bolts and tighten until snug. Do not over-tighten because the oil pan will distort.

(5) Once the timing case cover is sealed to the oil pan, install the vibration damper. Tighten the retaining bolt to 122 N•m (90 ft. lbs.) torque.

(6) Install the damper pulley. Tighten the retaining bolts to 41 N•m (30 ft. lbs.) torque.

(7) Install the fuel pump.

(8) Install the distributor with the rotor and housing in the same position.

(9) Install the distributor cap and connect the heater hose.

(10) Install the power steering pump, air pump and mounting bracket, if removed.

(11) Install the alternator, alternator mounting bracket, and back idler pulley assembly.

(12) Install the air conditioner compressor and bracket assembly, if removed.

(13) Install the fan and hub assembly.

(14) Install all drive belts and adjust to the specified tension.

(15) Connect the radiator hoses and bypass hose.

(16) Fill the cooling system to the specified level.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(17) Start the engine and inspect for oil and coolant leaks.

(18) Adjust the initial ignition timing to the specified degrees BTDC.

TIMING CHAIN AND SPROCKETS — 5.9L

Timing Chain Wear Measurement

(1) Remove the timing case cover.

(2) Rotate the camshaft or crankshaft sprocket until all slack is removed from the right side of the chain.

(3) Determine a reference point for the deflection measurement (Fig. 5). Measure up from the dowel on the right side of the engine 19 mm (3/4 inch) and mark the location.

(4) Position a straightedge across the timing chain from the point at the lowest tooth (X) on the camshaft sprocket to the point marked (Z) previously (Fig. 5).

(5) Grasp the chain where the straightedge dissects the chain and use it as a reference.

(6) Move the chain in toward the centerline of the engine and mark the engine block at the point of maximum inward chain deflection.

(7) Move the chain out from the centerline of the engine and mark the engine block at the point of maximum outward chain deflection (D - Fig. 5).

(8) Measure the distance between the two marks to determine the total deflection (E - Fig. 5).

(9) Replace the chain assembly if the deflection (wear) exceeds 22 mm (7/8 inch).

(10) Install the timing case cover.

Removal

(1) Remove the vibration damper pulley, damper, timing case cover and gasket.

(2) Remove the crankshaft oil slinger.

(3) Remove the camshaft sprocket retaining bolt and washer.

(4) Remove the distributor drive gear and fuel pump eccentric.

(5) Rotate the crankshaft until the zero timing mark on the crankshaft sprocket is closest to and on centerline with the zero timing mark on the camshaft sprocket (Fig. 6).

(6) Remove the crankshaft sprocket, camshaft sprocket and timing chain as an assembly.

Installation

Assemble the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks positioned on the same centerline.

(1) Install the chain and sprocket assembly on the crankshaft and camshaft.

(2) Install the fuel pump eccentric and the distributor drive gear. Install the fuel pump eccentric with the stamped word REAR facing the camshaft sprocket.

(3) Install the camshaft washer and retaining bolt. Tighten the bolt to 41 N•m (30 ft. lbs.) torque.

(4) To verify the correct installation of the timing chain:

(a) Rotate the crankshaft until the timing mark on the camshaft sprocket is on a horizontal line at the 3 o'clock position.

(b) Beginning with the pin directly adjacent to the camshaft sprocket timing mark, count the number of pins down to the timing mark on the crankshaft sprocket.

(c) There must be 20 pins between these two points; the crankshaft sprocket timing mark must be between pins 20 and 21 (Fig. 7).

(5) Install the crankshaft oil slinger.

(6) Remove the original oil seal from the timing case cover.

(7) Install a replacement oil seal in the timing case cover.

(8) Install the timing case cover using a replacement gasket. Tighten the retaining bolts to 34 N•m (25 ft. lbs.) torque.

(9) Install the vibration damper and pulley.

CAMSHAFT — 5.9L

Cam Lobe Lift Measurement

(1) Remove the cylinder head cover and gasket.

(2) Remove the bridge and pivot assemblies and rocker arms. Alternately loosen the capscrews one turn at a time to avoid damaging the bridge.

(3) Remove the spark plugs.

(4) Use a piece of rubber tubing to secure the dial indicator on the end of the push rod (Fig. 8).

(5) Rotate the crankshaft until the cam lobe base circle (push rod down) is under the valve tappet.

(6) Set the dial indicator to zero.

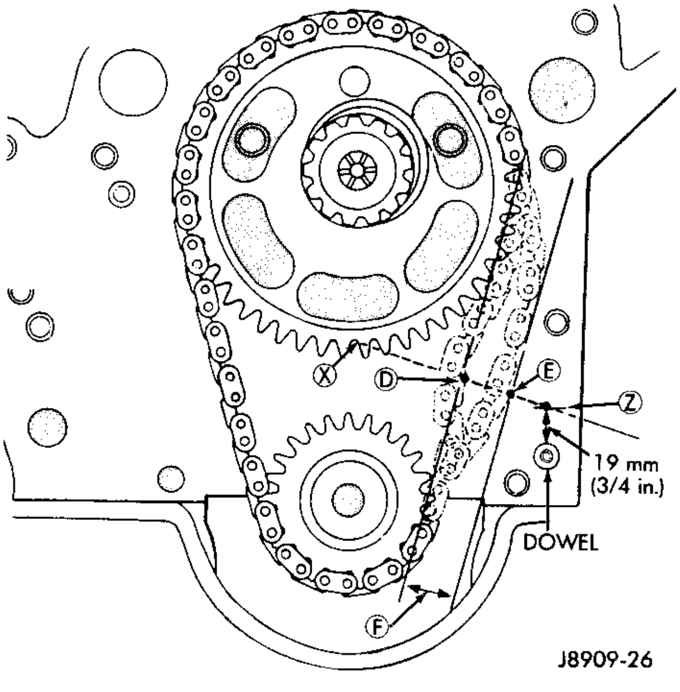


Fig. 5 Deflection Measurement — Reference Point

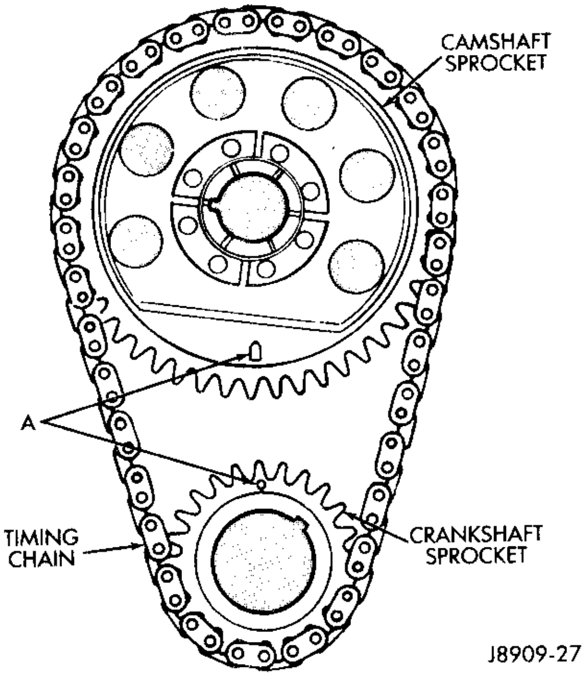


Fig. 6 Zero Timing Mark

(7) Rotate the crankshaft until the point of maximum push rod upward movement occurs.

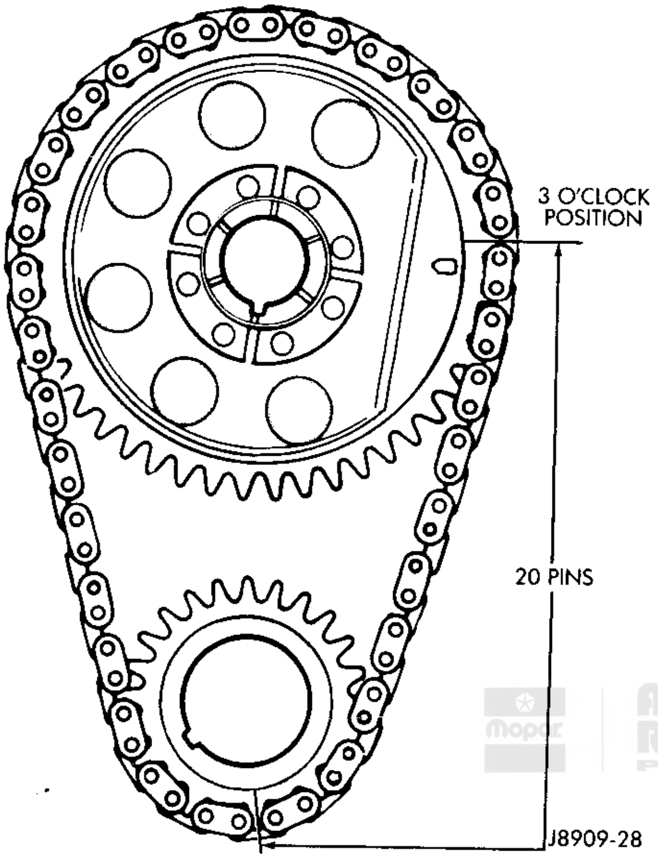


Fig. 7 Correct Timing Chain Installation Verification

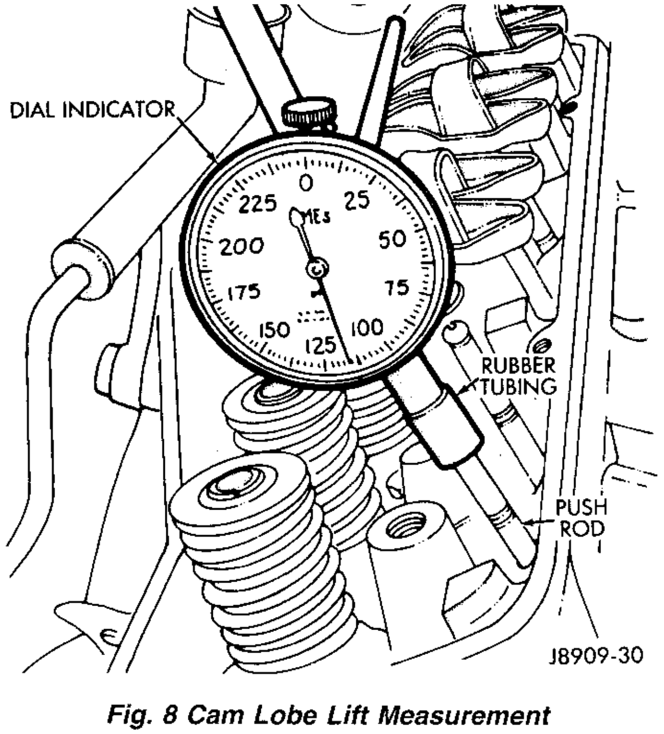


Fig. 8 Cam Lobe Lift Measurement

(8) Note the travel on the dial indicator. Correct lift is 6.604-6.858 mm (0.260-0.270 inch). The rocker arm ratio is 1.6:1. Multiply the cam lift by 1.6 to determine the valve lift.

Removal

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM IS PRESSURIZED.

(1) Drain the radiator and cylinder block. If the coolant is reusable, drain it into a clean container.

(2) Remove the radiator assembly.

(3) Remove the air conditioning condenser and receiver assembly as a charged unit.

(4) Remove the cylinder head covers and gaskets.

(5) Remove the bridge and pivot assemblies and rocker arms. Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridge.

(6) Remove the push rods. Retain the push rods, rocker arms, bridge and pivot assemblies and tappets in the same order as removed.

(7) Remove the intake manifold assembly.

(8) Remove the tappets.

(9) Remove the drive belts.

(10) Remove the fan and hub assembly.

(11) Remove the distributor.

(12) Remove the damper pulley and vibration damper.

(13) Remove the timing case cover.

(14) Install the vibration damper bolt with two or more flat washers to provide means of rotating the crankshaft.

(15) Rotate the crankshaft until the timing mark on the crankshaft sprocket is closest to and on the centerline with the timing mark on the camshaft sprocket.

(16) Remove the retaining bolt from the camshaft (Fig. 9). Remove the retaining bolt from the crankshaft.

(17) Remove the distributor drive gear and fuel pump eccentric from the camshaft (Fig. 9).

(18) Remove the crankshaft sprocket, camshaft sprocket and timing chain as an assembly (Fig. 4).

(19) Remove the hood latch support bracket, front bumper or grille as required and remove the camshaft.

Inspection

Inspect the camshaft bearing journals for an uneven wear pattern or rough finish. Replace the camshaft if either condition exists.

Inspect the distributor drive gear for damage or excessive wear.

Inspect the fuel pump eccentric for excessive wear.

Inspect each cam lobe and the associated hydraulic valve tappet for wear. If the face of the tappet(s) is worn concave and the corresponding camshaft lobe(s) is also worn, replace both the camshaft and tappet(s).

Installation

(1) Lubricate the entire camshaft generously with Jeep/Eagle Super Oil Conditioner, or equivalent.

(2) Carefully install the camshaft into the engine block.

(3) Assemble the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned. Refer to Timing Chain Installation for the procedure.

(4) Install the oil slinger on the crankshaft.

(5) Install the fuel pump eccentric and distributor drive gear on the camshaft. The fuel pump eccentric has the word REAR stamped on it to indicate the proper installed position. The camshaft washer fits into the recess in the distributor drive gear. Tighten the retaining bolt to 41 N•m (30 ft. lbs.) torque.

(6) Install a replacement timing case cover gasket.

(7) Install the timing case cover.

(8) Install a replacement oil seal. Apply a light film of engine oil to the lips of the seal.

(9) Install the vibration damper.

(10) Install the damper pulley with the retaining bolts. Tighten the bolts to 41 N•m (30 ft. lbs.) torque.

(11) Install the hydraulic valve tappets lubricated with Jeep/Eagle Super Oil Conditioner, or equivalent. Do not drain the Jeep/Eagle Super Oil Conditioner from the engine for at least 1 609 km (1000 mi) or until the next scheduled oil change.

(12) Install the intake manifold assembly with a replacement gasket.

(13) Install the push rods.

(14) Install the rocker arms and bridge and pivot assemblies. Tighten the capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(15) Reseal and install the cylinder head covers.

(16) Install the fuel pump.

(17) Rotate the crankshaft until the No. 1 piston is at the TDC position on the compression stroke. After the No. 1 intake valve has closed, TDC can be attained by rotating the crankshaft clockwise as viewed from the front until the timing mark on the vibration damper aligns with the TDC index on the timing degree scale.

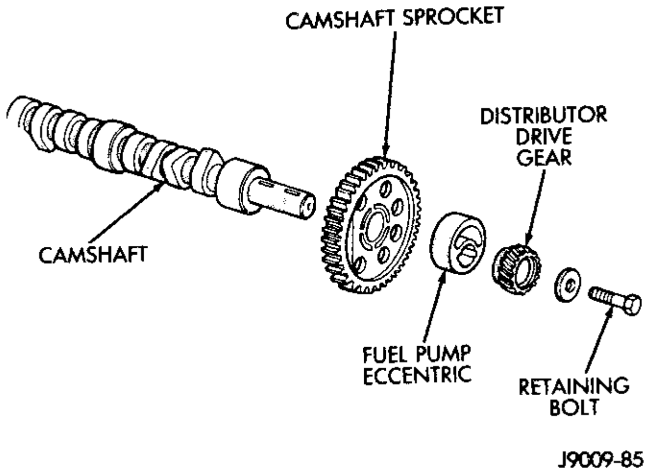


Fig. 9 Camshaft and Components

(18) Install the distributor so that the rotor is aligned with the No. 1 terminal of the cap when fully seated on the block.

(19) Install the distributor cap.

(20) Install the ignition wires.

(21) If removed, install the air conditioner condenser and receiver assembly.

CAUTION: Both service valves must be open before the air conditioning system is operated.

(22) Install the hood latch support bracket, and the front bumper or grille, if removed.

(23) Install the radiator.

(24) Install the fan and hub assembly.

(25) Fill the cooling system to the specified level.

(26) Install and adjust the drive belts to the proper tension.

CAMSHAFT BEARINGS — 5.9L

The camshaft is supported by five steel-shelled, babbitt-lined bearings that are pressed into the cylinder block and then line reamed. The stepped bored camshaft journals are larger at the front bearing than at the rear to permit easy removal and installation of the camshaft. The camshaft bearings are pressure lubricated.

It is not advisable to attempt to replace camshaft bearings unless special removal and installation tools are available.

Camshaft end play is maintained by the load placed on the camshaft by the oil pump and distributor drive gear. The helical cut of the gear holds the camshaft sprocket thrust face against the cylinder block face. Camshaft end play is zero during engine operation. The rear camshaft bearing journal has two holes drilled through it to relieve pressure that could develop between the journal and camshaft plug and force the camshaft forward.

OIL PAN — 5.9L

Removal

(1) Disconnect the battery negative cable.

(2) Raise and support the vehicle.

(3) Drain the engine oil.

(4) Remove the starter motor.

(5) It may be necessary to raise the engine in order to remove the oil pan.

(6) Remove the oil pan attaching bolts. Remove the oil pan.

(7) Remove the oil pan front and rear neoprene oil seals. Remove the oil pan bolts.

Cleaning

Thoroughly clean the gasket surfaces of the oil pan and engine block.

Remove all sludge and residue from the oil pan sump.

Installation

(1) Install a replacement oil pan front seal for the timing case cover. Apply a generous amount of Jeep/Eagle Gasket-In-A-Tube, or equivalent, to the end tabs.

(2) Coat the inside curved surface of the replacement oil pan rear seal with soap or Jeep/Eagle Gasket-In-A-Tube, or equivalent. Apply a generous amount of Jeep/Eagle Gasket-In-A-Tube, or equivalent, to the gasket contacting surface of the seal end tabs.

(3) Install the seal in the recess of the rear main bearing cap, ensuring it is fully seated.

(4) Apply Jeep/Eagle Gasket-In-A-Tube, or equivalent, to the oil pan contacting surface of the front and rear oil pan seals.

(5) Cement replacement oil pan side gaskets into position on the engine block. Apply a generous amount of Jeep/Eagle Gasket-In-A-Tube, or equivalent, to the gasket ends.

(6) Install the oil pan. Tighten the 1/4-20 oil pan bolts to 9 N•m (80 in. lbs.) torque and the 5/16-18 oil pan bolts to 15 N•m (11 ft. lbs.) torque.

(7) Lower and secure the engine if it was raised.

(8) Tighten the drain plug securely.

(9) Install the starter motor and connect the cable.

(10) Lower the vehicle.

(11) Connect the battery negative cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(12) Fill the oil pan with engine oil to the specified level. Start the engine and inspect for leaks.

OIL PUMP — 5.9L

The positive-displacement gear-type oil pump is driven by the distributor shaft, which is driven by a gear on the camshaft. The pump is integral with the timing case cover. A cavity in the cover forms the body of the pump. A pressure relief valve regulates the maximum oil pressure.

Oil pump removal or replacement will not affect the distributor timing because the distributor drive gear will remain in mesh with the camshaft drive gear.

Oil Pressure Relief Valve

The oil pressure relief valve is not adjustable. The spring tension is calibrated for 517 kPa (75 psi) maximum pressure.

In the relief position, the valve permits oil to bypass through a passage in the pump cover to the inlet side of the pump (Fig. 1).

Removal

(1) Remove the retaining bolts and separate the oil pump cover, gasket and oil filter as an assembly from the pump body (timing case cover) - (Fig. 2).

(2) Remove the drive gear assembly and idler gear by sliding them out of the body.

(3) Remove the oil pressure relief valve from the pump cover for cleaning by removing the retaining cap and spring.

Cleaning and Inspection

Clean the cover thoroughly. Test the operation of the relief valve by inserting the poppet valve and determining if it slides back and forth freely. If not, replace the pump cover and poppet valve.

Gear End Clearance Measurement

This measurement determines the distance between the end of the pump gear and the pump cover. The ideal clearance is as close as possible without binding the gears. The pump cover gasket is 0.229-0.279 mm (0.009-0.011 inch) thick. Symptoms of excessive pump clearance are fair to good pressure when the oil is cold and low or no pressure when the oil is hot.

Preferred Method:

Place a strip of Plastigage across the full width of each gear (Fig. 3).

Install the pump cover and gasket. Tighten the bolts to 6 N•m (55 in. lbs.) torque.

Remove the pump cover and determine the amount of clearance by measuring the width of the compressed

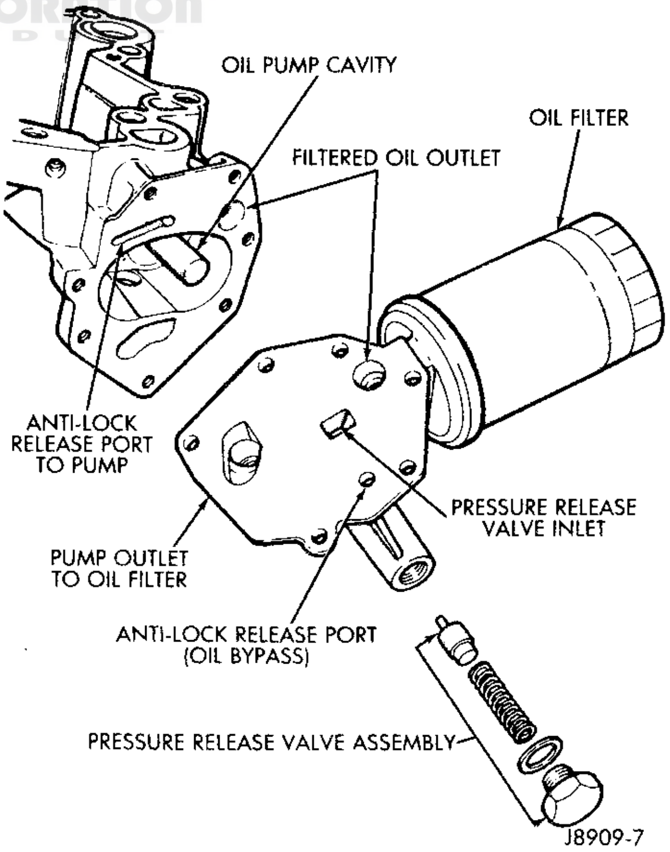


Fig. 1 Oil Pump Cover

Plastigage with a scale on the Plastigage envelope. The correct clearance by this method is 0.051-0.203 mm (0.002-0.008 inch) with 0.051 mm (0.002 inch) preferred.

Alternate Method:

Place a straightedge across the gears and pump body.

Select a feeler gauge that will fit snugly but freely between the straightedge and the top of the gear (Fig. 4). The correct clearance by this method is 0.102-0.203 mm (0.004-0.008 inch) with 0.203 mm (0.008 inch) preferred.

Ensure the gears are up into the body as far as possible before the measurement is made.

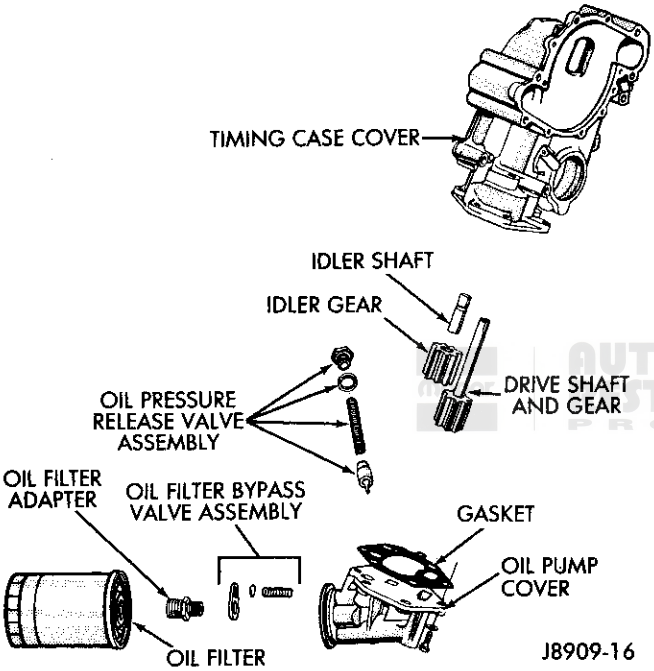


Fig. 2 Oil Pump and Filter Assembly

If the gear end clearance is excessive, install a thinner gasket. If the gear end clearance is still excessive, replace the gears and idler shaft.

Gear-to-Body Clearance

Insert a feeler gauge between the gear tooth and the pump body inner wall directly opposite the point of the gear mesh (Fig. 5). Select a feeler gauge that fits snugly but can be inserted freely.

Rotate the gears and measure the clearance of each tooth and body in this manner. The correct clearance is 0.013-0.064 mm (0.0005-0.0025 inch) with 0.013 mm (0.0005 inch) preferred.

If the gear-to-body clearance is more than specified, measure the gear diameter with a micrometer. If the gear diameter is correct and the gear end clearance is correct and the relief valve is functioning properly, replace the timing case cover. If the gear diameter is incorrect, replace the gears and idler shaft.

If the oil pump shaft or distributor drive shaft is broken, inspect for a loose oil pump gear-to-shaft fit or worn front cover. Oversize pump shafts are not available.

Installation

(1) Install the oil pressure relief valve in the pump cover with the spring and retaining cap.

(2) Install the idler shaft, idler gear and drive gear assembly.

To ensure self-priming of the oil pump, fill the pump with petroleum jelly prior to the installation of the oil pump cover. Do not use grease of any type.

(3) Install the pump cover and oil filter assembly with a replacement gasket. Tighten the retaining bolts to 6 N•m (55 in. lbs.) torque.

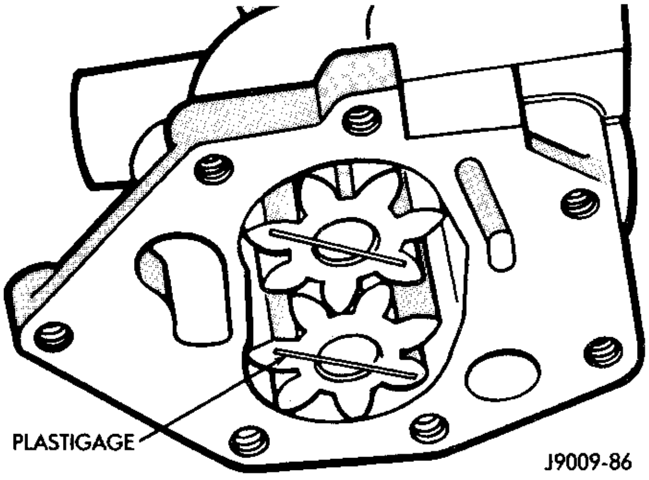


Fig. 3 Oil Pump Gear End Clearance Measurement — Plastigage Method

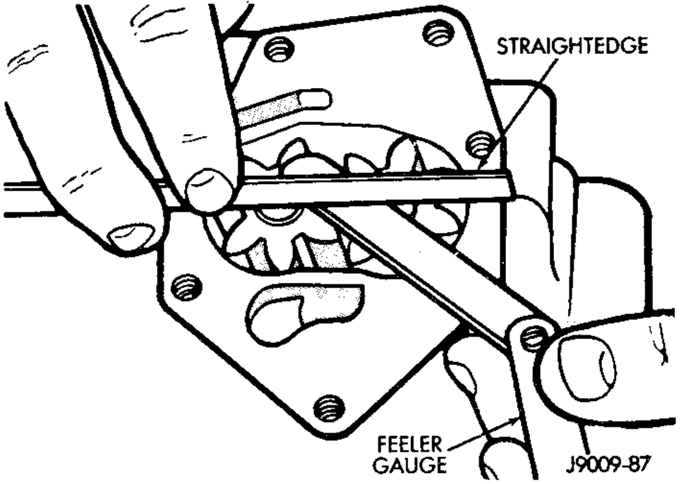


Fig. 4 Oil Pump Gear End Clearance Measurement — Feeler Gauge Method

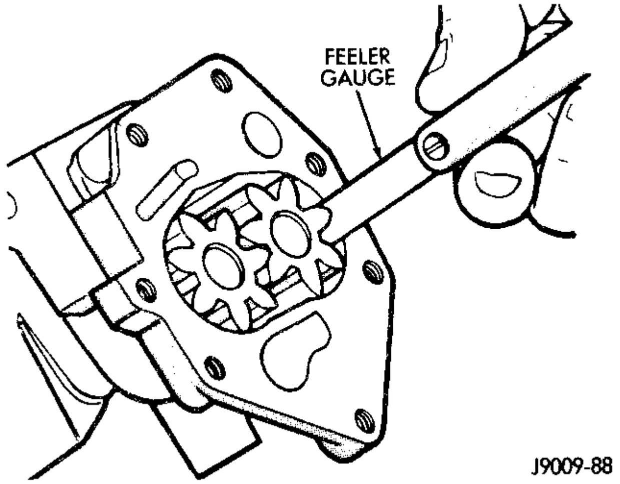


Fig. 5 Gear-to-Body Clearance Measurement

PISTONS AND CONNECTING RODS — 5.9L

Use the following procedures to service connecting rods and pistons with the engine installed in the vehicle.

Removal

(1) Remove the cylinder head cover(s).

(2) Alternately loosen the bridge and pivot assembly capscrews one turn at a time to avoid damaging the bridges. Remove the bridges, pivots and rocker arms.

(3) Remove the push rods. Retain the bridges, pivots, rocker arms and push rods in the same order as removed to facilitate installation in the original locations.

(4) Remove the intake manifold assembly.

(5) Remove the exhaust manifold(s). It is not necessary to disconnect the exhaust pipe from the manifold.

(6) Remove the cylinder head(s) and gasket(s).

(7) Position the pistons, one at a time, near the bottom of the stroke. Use a ridge reamer to remove any ridge from the top end of the cylinder walls.

(8) Drain the engine oil.

(9) Remove the oil pan.

(10) At any journal, loosen all four (4) connecting rod nuts at the same time. Remove the connecting rod bearing caps and inserts. Retain in the same order as removed to facilitate installation in their original locations. The number stamped onto the removable bearing cap and onto the adjacent machined surface of the rod corresponds to the associated cylinder.

(11) Remove the connecting rod and piston assemblies through the top of the cylinder bores. Ensure that the connecting rod bolts do not scratch the connecting rod journals or the cylinder walls. Short pieces of rubber hose slipped onto the rod bolts will provide protection during removal.

Inspection — Connecting Rod

Connecting Rod Bearings

Clean the inserts.

Inspect the linings and backs of the inserts for an irregular wear pattern. Note any scraping, stress cracks or distortion. If the bearing has spun in the rod, replace the bearing and connecting rod and inspect the crankshaft journal for scoring.

The wear pattern is always greater on the upper bearing insert. Grooves can be caused by the rod bolts scratching the journal during installation (Fig. 1).

Inspect for material imbedded in the linings that may indicate abnormal piston, timing gear, distributor gear or oil pump gear wear (Figs. 2 and 3).

Inspect the fit of the insert locking tab in the rod cap. If the inspection indicates that the insert tab may have been pinched between the rod and rod cap, replace the upper and lower bearing inserts.

Inspect the contact area of the locking tab. Abnormal wear indicates bent tabs or improper installation of the inserts (Fig. 4).

Replace the bearing inserts that are damaged or worn.

Connecting Rods

Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment. Replace misaligned, bent or twisted connecting rods.

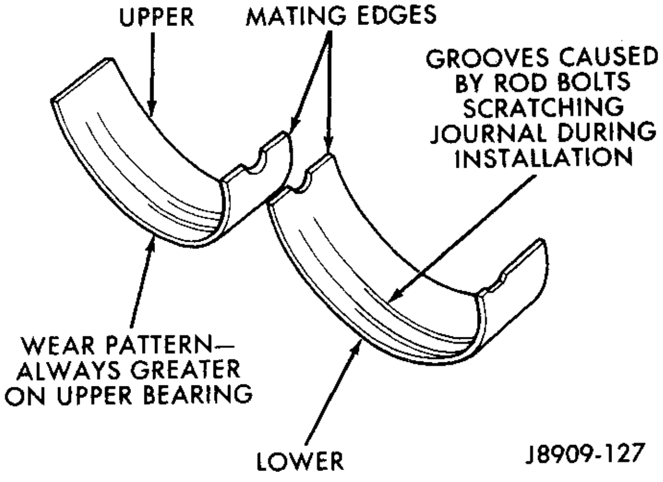


Fig. 1 Connecting Rod Bearing Inspection

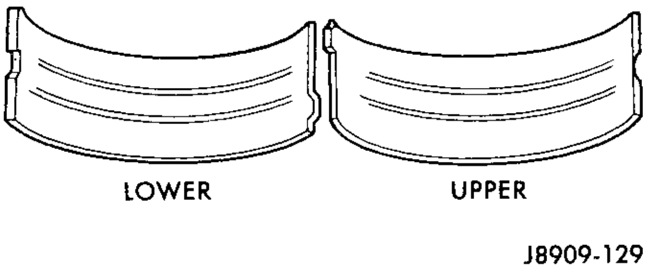


Fig. 2 Scoring Caused by Insufficient Lubrication

Plastigage with a scale on the Plastigage envelope. The correct clearance by this method is 0.051-0.203 mm (0.002-0.008 inch) with 0.051 mm (0.002 inch) preferred.

Alternate Method:

Place a straightedge across the gears and pump body.

Select a feeler gauge that will fit snugly but freely between the straightedge and the top of the gear (Fig. 4). The correct clearance by this method is 0.102-0.203 mm (0.004-0.008 inch) with 0.203 mm (0.008 inch) preferred.

Ensure the gears are up into the body as far as possible before the measurement is made.

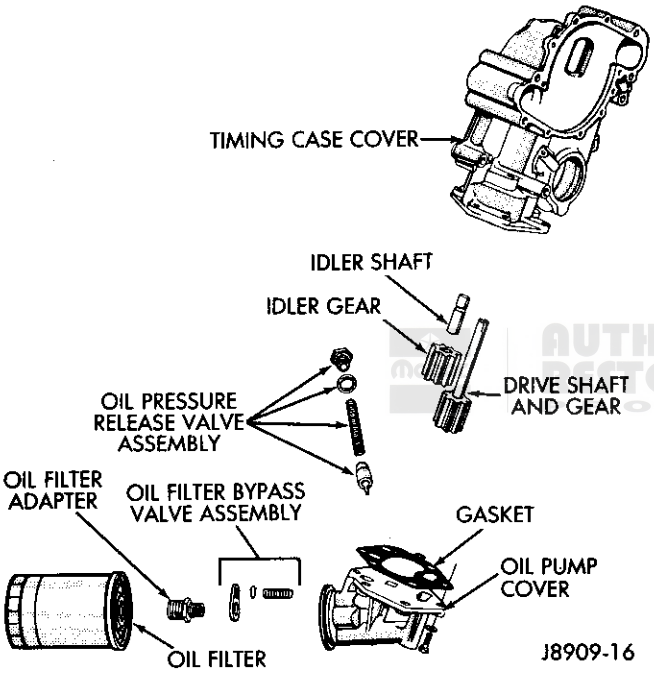


Fig. 2 Oil Pump and Filter Assembly

If the gear end clearance is excessive, install a thinner gasket. If the gear end clearance is still excessive, replace the gears and idler shaft.

Gear-to-Body Clearance

Insert a feeler gauge between the gear tooth and the pump body inner wall directly opposite the point of the gear mesh (Fig. 5). Select a feeler gauge that fits snugly but can be inserted freely.

Rotate the gears and measure the clearance of each tooth and body in this manner. The correct clearance is 0.013-0.064 mm (0.0005-0.0025 inch) with 0.013 mm (0.0005 inch) preferred.

If the gear-to-body clearance is more than specified, measure the gear diameter with a micrometer. If the gear diameter is correct and the gear end clearance is correct and the relief valve is functioning properly, replace the timing case cover. If the gear diameter is incorrect, replace the gears and idler shaft.

If the oil pump shaft or distributor drive shaft is broken, inspect for a loose oil pump gear-to-shaft fit or worn front cover. Oversize pump shafts are not available.

Installation

(1) Install the oil pressure relief valve in the pump cover with the spring and retaining cap.

(2) Install the idler shaft, idler gear and drive gear assembly.

To ensure self-priming of the oil pump, fill the pump with petroleum jelly prior to the installation of the oil pump cover. Do not use grease of any type.

(3) Install the pump cover and oil filter assembly with a replacement gasket. Tighten the retaining bolts to 6 N•m (55 in. lbs.) torque.

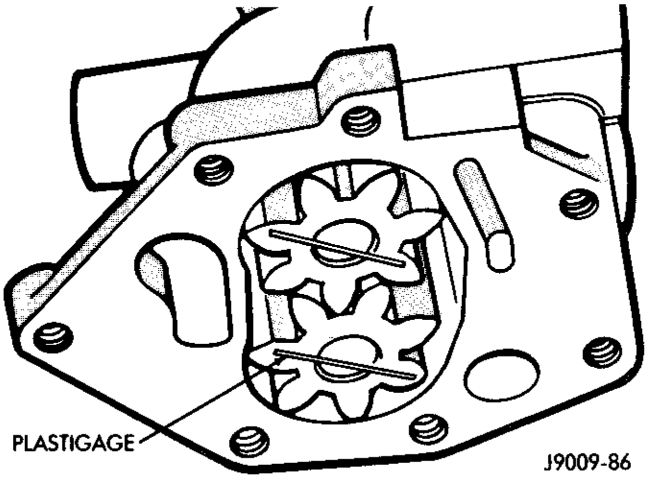


Fig. 3 Oil Pump Gear End Clearance Measurement — Plastigage Method

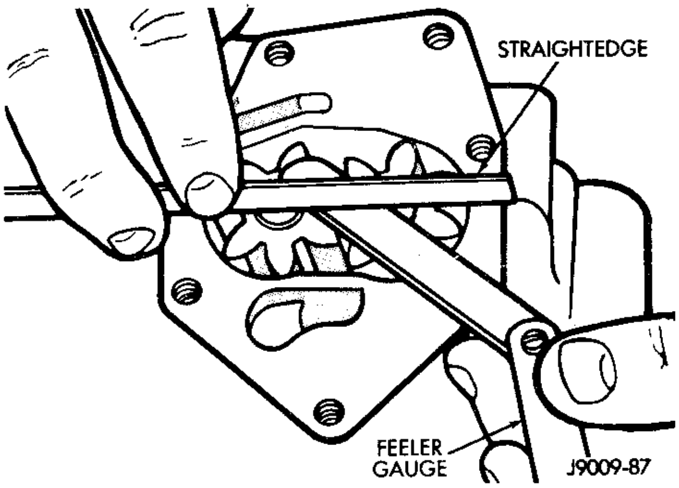


Fig. 4 Oil Pump Gear End Clearance Measurement — Feeler Gauge Method

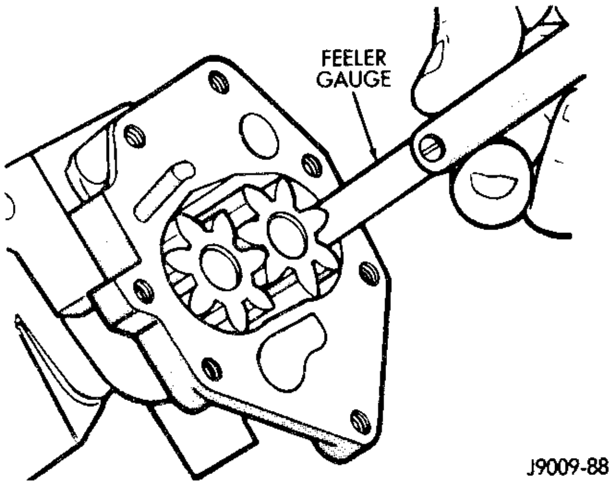


Fig. 5 Gear-to-Body Clearance Measurement

PISTONS AND CONNECTING RODS — 5.9L

Use the following procedures to service connecting rods and pistons with the engine installed in the vehicle.

Removal

(1) Remove the cylinder head cover(s).

(2) Alternately loosen the bridge and pivot assembly capscrews one turn at a time to avoid damaging the bridges. Remove the bridges, pivots and rocker arms.

(3) Remove the push rods. Retain the bridges, pivots, rocker arms and push rods in the same order as removed to facilitate installation in the original locations.

(4) Remove the intake manifold assembly.

(5) Remove the exhaust manifold(s). It is not necessary to disconnect the exhaust pipe from the manifold.

(6) Remove the cylinder head(s) and gasket(s).

(7) Position the pistons, one at a time, near the bottom of the stroke. Use a ridge reamer to remove any ridge from the top end of the cylinder walls.

(8) Drain the engine oil.

(9) Remove the oil pan.

(10) At any journal, loosen all four (4) connecting rod nuts at the same time. Remove the connecting rod bearing caps and inserts. Retain in the same order as removed to facilitate installation in their original locations. The number stamped onto the removable bearing cap and onto the adjacent machined surface of the rod corresponds to the associated cylinder.

(11) Remove the connecting rod and piston assemblies through the top of the cylinder bores. Ensure that the connecting rod bolts do not scratch the connecting rod journals or the cylinder walls. Short pieces of rubber hose slipped onto the rod bolts will provide protection during removal.

Inspection — Connecting Rod

Connecting Rod Bearings

Clean the inserts.

Inspect the linings and backs of the inserts for an irregular wear pattern. Note any scraping, stress cracks or distortion. If the bearing has spun in the rod, replace the bearing and connecting rod and inspect the crankshaft journal for scoring.

The wear pattern is always greater on the upper bearing insert. Grooves can be caused by the rod bolts scratching the journal during installation (Fig. 1).

Inspect for material imbedded in the linings that may indicate abnormal piston, timing gear, distributor gear or oil pump gear wear (Figs. 2 and 3).

Inspect the fit of the insert locking tab in the rod cap. If the inspection indicates that the insert tab may have been pinched between the rod and rod cap, replace the upper and lower bearing inserts.

Inspect the contact area of the locking tab. Abnormal wear indicates bent tabs or improper installation of the inserts (Fig. 4).

Replace the bearing inserts that are damaged or worn.

Connecting Rods

Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment. Replace misaligned, bent or twisted connecting rods.

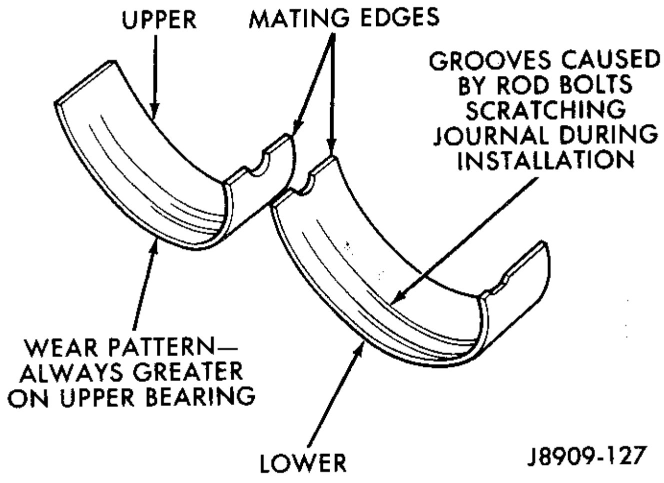


Fig. 1 Connecting Rod Bearing Inspection

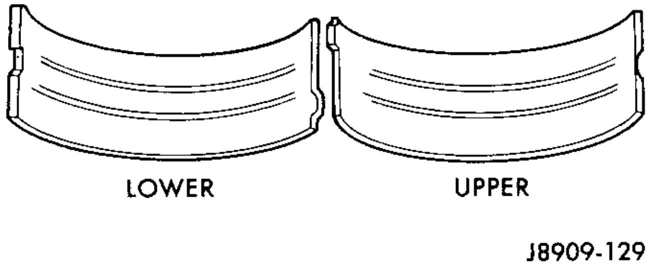


Fig. 2 Scoring Caused by Insufficient Lubrication

Bearing-to-Journal Clearance

Using Plastigage

Wipe the bearing inserts and rod journal clean.

Lubricate the upper insert and install it in the rod.

Place a strip of Plastigage across the full width of the lower insert at the center of the bearing cap. The lower insert must be dry.

Install the bearing cap on the connecting rod and tighten the retaining nuts to 45 N•m (33 ft. lbs.) torque. Do not rotate the crankshaft. The Plastigage will shift, resulting in an inaccurate indication. The Plastigage must not crumble. If brittle, obtain fresh stock.

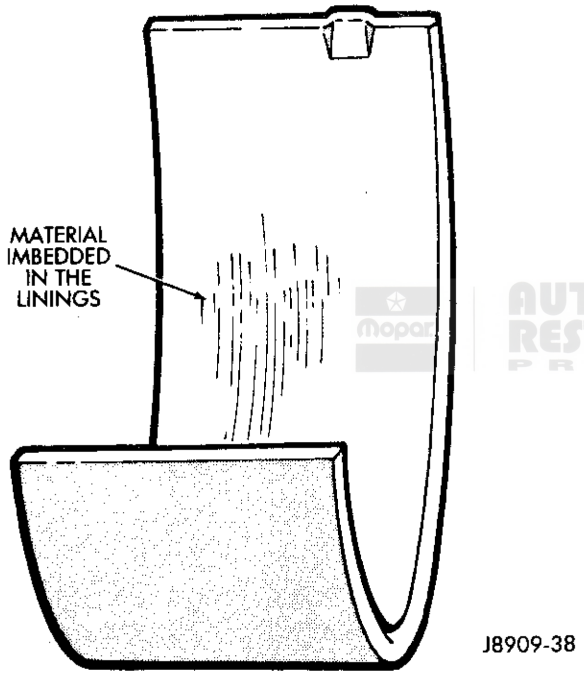


Fig. 3 Scoring Caused by Foreign Material

Remove the bearing cap and determine the amount of clearance by measuring the width of the compressed Plastigage with the scale on the Plastigage envelope (Fig. 5).

If the correct clearance is indicated, bearing fitting is not necessary. Remove the Plastigage from the crankshaft journal and bearing and proceed to Installation. Traces of Plastigage left on the bearing surfaces will dissolve in hot engine oil after the engine is operating.

If the oil clearance exceeds the specification, install 0.025 mm (0.001 inch) undersize bearing inserts and measure the clearance as described earlier.

The measured clearance with 0.025 mm (0.001 inch) undersize bearing inserts installed will determine if a pair of 0.025 mm (0.001 inch) undersize inserts or some other combination is needed to provide the correct clearance.

FOR EXAMPLE

If the initial clearance was 0.076 mm (0.003 inch), 0.025 mm (0.001 inch) undersize inserts will reduce the clearance by 0.025 mm (0.001 inch). The oil clearance will be 0.051 mm (0.002 inch) and within specification. A combination of a 0.051 mm (0.002 inch) undersize insert and a 0.025 mm (0.001 inch) undersize insert will reduce the clearance an additional 0.013 mm (0.0005 inch). The oil clearance will then be 0.038 mm (0.0015 inch).

CAUTION: Never use a combination of inserts that differ more than one bearing size as a pair. For example, do not use a standard upper and a 0.051 mm (0.002 in) undersize lower insert.

If the oil clearance exceeds the specification when 0.051 mm (0.002 in) undersize inserts are installed, measure the diameter of the connecting rod journal with a micrometer. If the journal diameter is correct, the inside diameter of the connecting rod is incorrect and the rod must be replaced.

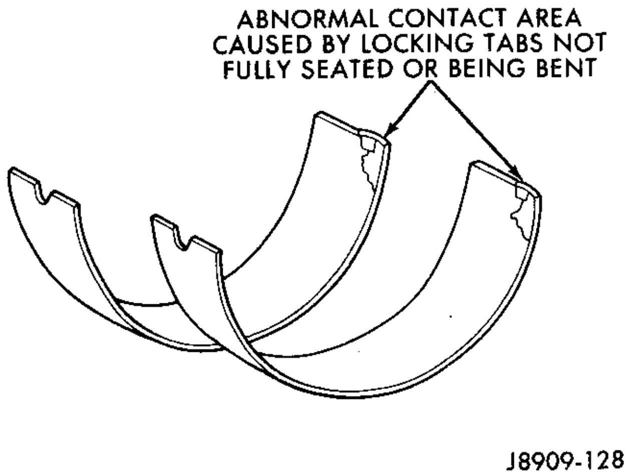


Fig. 4 Locking Tab Inspection

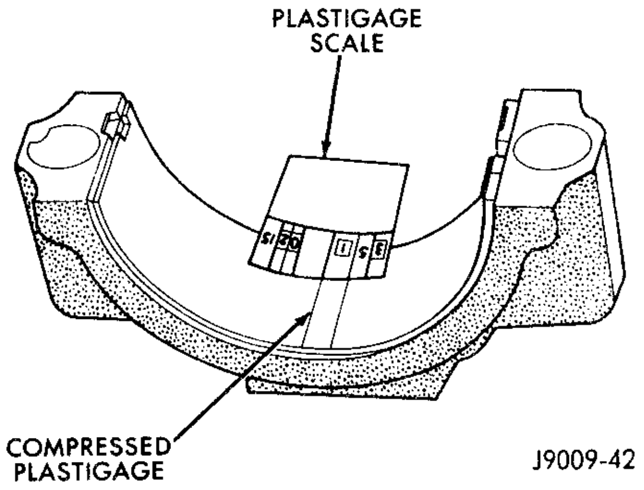


Fig. 5 Measuring Bearing Clearance with Plastigage

Using a Micrometer

If the journal diameter does not conform to the specification, it may have been ground 0.254 mm (0.010 inch) or more undersize.

If the journal diameter is incorrect, replace the crankshaft or grind the journal to accept the appropriate undersized bearing insert pair.

Wipe the connecting rod journal clean.

Use a micrometer to measure the journal diameter at two locations 90° apart at each end of the journal. Note the difference between the maximum and minimum diameters.

Refer to Engine Specifications for the maximum allowable taper and out-of-roundness. If any rod journal dimension is not within the specifications, replace the crankshaft or recondition the crankshaft journals and fit with the appropriate undersize bearing inserts.

Compare the largest diameter measurement with the journal diameters listed in the Connecting Rod Bearing Fitting Chart.

Select the bearing insert pair required to provide the specified bearing clearance (see the Bearing Insert Pairs Chart).

Always measure the clearance with Plastigage after installing the replacement bearing inserts. Also, measure the clearance of each journal after installing a crankshaft kit (crankshaft supplied with bearings).

Side Clearance Measurements

Rotate the crankshaft to the position where the connecting rod journal is at the bottom of the stroke.

Insert a snug fitting feeler gauge between the connecting rods (Fig. 6).

Compare the feeler gauge measurement to the specified clearance. Replace rods that are not within the specifications.

Piston Fitting

Micrometer Method

(1) Use an inside micrometer to measure the cylinder bore inside diameter at a location 59 mm (2 5/16 inch) below the top of the bore and crosswise to the block.

(2) Measure the outside diameter of the piston. Pistons are cam ground and must be measured at a right angle (90°) to the piston pin at the centerline of the pin (Fig. 7).

(3) The difference between the cylinder bore diameter and the piston diameter dimensions is the piston-to-bore clearance. Refer to Engine Specifications.

Feeler Gauge Method

(1) Remove the rings from the piston.

(2) Insert a long 0.013 mm (0.0005 inch) feeler gauge into the cylinder bore.

(3) Insert the piston (top first) into the cylinder bore along side the feeler gauge. With the entire piston inserted in the cylinder bore, the piston should not bind against the feeler gauge.

(4) Repeat the above procedure with a long 0.051 mm (0.002 inch) feeler gauge. The piston should bind.

(5) If the piston binds on the 0.013 mm (0.0005 inch) feeler gauge, either the piston is too large or the cylinder bore is too small. If the piston does not bind on the 0.051 mm (0.002 inch) feeler gauge, the piston may be enlarged by knurling or shot-peening. Replace any piston that is 0.102 mm (0.004 inch) or more undersize.

CONNECTING ROD BEARING FITTING CHART

Crankshaft Main Bearing Journal Color Code and Diameter	Corresponding Connecting Rod Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow – 53.2257-53.2079 mm 2.0955-2.0948 in. Standard	Yellow – Standard	Yellow – Standard
Orange – 53.2079-53.1901 mm 2.0948-2.0941 in. Undersize (0.0178 mm or 0.0007 in.)	Yellow – Standard	Black – Undersize 0.025 mm 0.001 in.
Black – 53.1901-53.1723 mm 2.0941-2.0933 in. Undersize (0.0356 mm or 0.0014 in.)	Black – Undersize 0.025 mm 0.001 in.	Black – Undersize 0.025 mm 0.001 in.
Red – 52.9717-52.9539 mm 2.0855-2.0848 in. Undersize (0.254 mm or 0.010 in.)	Red – Undersize 0.254 mm 0.001 in.	Red – Undersize 0.254 mm 0.001 in.

J8909-22

Piston Pin

Removal

Piston pins are press-fitted into the connecting rods and DO NOT require a locking device.

(1) Position the piston and connecting rod assembly on an arbor press.

(2) Apply force to a piloted driver and press the pin completely out of the connecting rod and piston assembly (Fig. 8). Note position of the pin through the gauge window of removal support tool.

Inspection

Inspect the piston and connecting rod bores for nicks and burrs. Replace the rod and piston, if necessary.

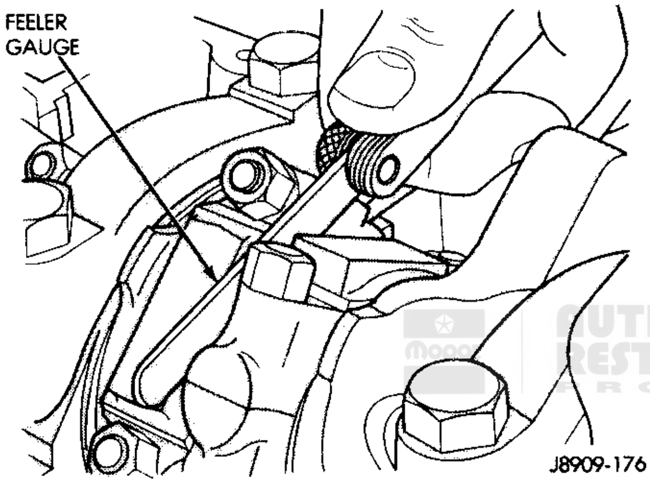


Fig. 6 Side Clearance Measurement

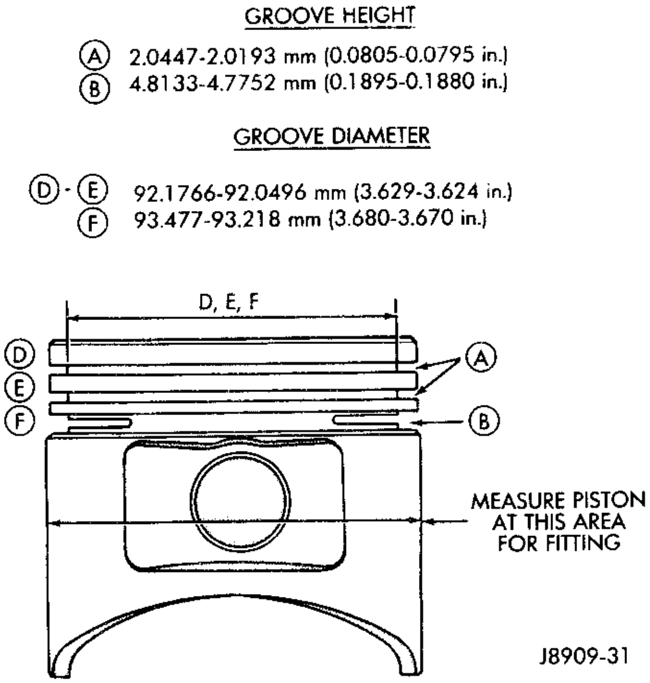


Fig. 7 Piston Dimensions

CAUTION: Never reuse a piston pin after it has been pressed in and out of a connecting rod.

With the pin removed from the piston and connecting rod, clean and dry the piston pin bores.

Position the piston so that the pin bore is in a vertical position. Insert a replacement pin in the bore. At room temperature, the replacement pin should slide completely through the piston bore without forcing.

Replace the piston if the pin jams in the bore.

Installation

(1) Position the piston and connecting rod so that the piston notches will face forward and the rod squirt hole will face in when the assembly is installed in the engine.

(2) Place a pilot tool through the piston and connecting rod pin bores.

(3) Place the pin pilot, piston and connecting rod on a support tool.

(4) Insert the piston pin into the piston pin bore and into the connecting rod pin bore.

(5) Insert a driver tool into the piston pin.

(6) Use an arbor press to press the piston pin through the connecting rod and piston bores until the pin pilot indexes with the mark on the support. The piston pin requires 8 900 N (2,000 lbs) force for installation. If insufficient force is required to press the piston pin into the connecting rod, or if the rod slides along the pin, replace the connecting rod.

(7) Remove the piston and connecting rod assembly from the press. The pin should be centered in the rod ±0.787 mm (1/32 inch).

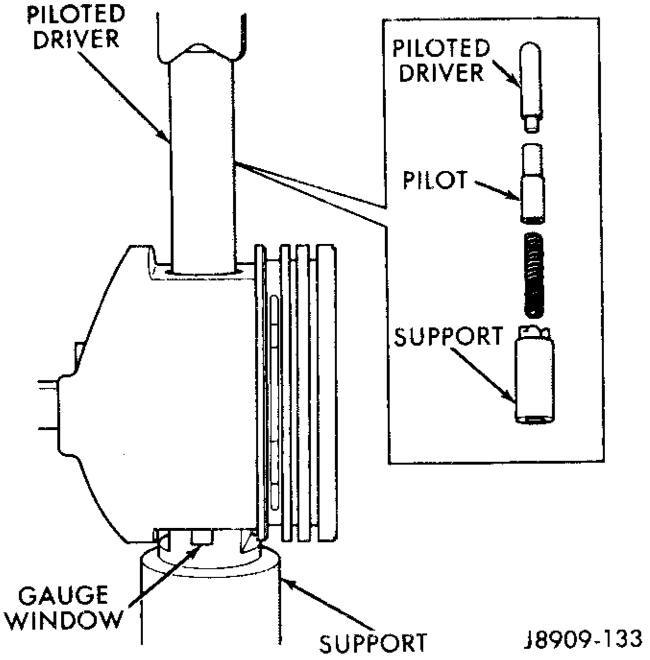


Fig. 8 Piston Pin Removal

Connecting Rod Bearing Fitting

The connecting rod bearing inserts are selectively fitted to their respective journals to obtain the desired operating clearance. In production, the select fit is obtained by using various sized color coded bearing inserts as listed in the Connecting Rod Bearing Fitting Chart. The bearing color code appears on the edge of the insert. **Bearing size is not stamped on production inserts.**

The rod journal size is identified in production by a color coded paint mark on the adjacent cheek or counterweight toward the flanged (rear) end of the crankshaft. Refer to the color codes listed in the Bearing Fitting Chart to identify the journal size and select the correct bearing inserts to obtain the correct clearances.

CAUTION: Never use a pair of bearing inserts that are greater than 0.025 mm (0.001 inch) difference in size.

When required, different sized upper and lower bearing inserts may be used as a pair. A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce clearance by 0.013 mm (0.0005 inch).

FOR EXAMPLE: - (see the Bearing Insert Pairs Chart)

Service replacement bearing inserts are available in pairs in the following sizes:

- Standard
- 0.025 mm (0.001 inch) undersize
- 0.051 mm (0.002 inch) undersize
- 0.254 mm (0.010 inch) undersize
- 0.305 mm (0.012 inch) undersize

The size is stamped on the back of the service replacement inserts. The 0.051 mm (0.002 inch) and 0.305 mm (0.012 inch) undersize inserts are not used for production engine assembly.

Piston Ring Fitting

CAUTION: Do not remove metal from the grooves or lands. This will change the ring groove clearances and will destroy the ring-to-land seating.

(1) Carefully clean carbon deposits from all the ring grooves. Ensure the oil drain openings in the oil ring grooves and pin boss are open.

(2) Measure the ring side clearance with the correct size feeler gauge that fits snugly between the ring land and ring (Fig. 9). Slide the ring around the groove. It must slide freely around the circumference of the groove. Refer to Engine Specifications for the the correct ring side clearance.

Bearing Insert Pairs

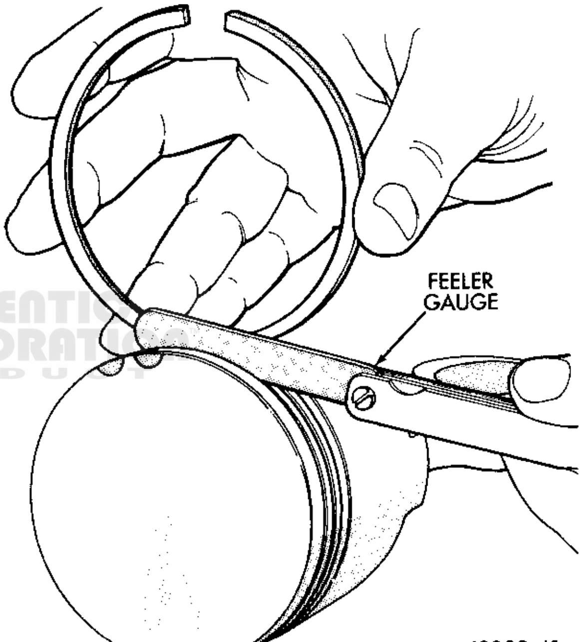
Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.025 mm (0.001 in.) Undersize	0.051 mm (0.002 in.) Undersize

J9009-62

(3) Place the ring in the cylinder bore. Use an inverted piston to push the ring down near the lower end of the ring travel area. Measure the ring gap (clearance) with a feeler gauge fitted snugly in the ring opening (Fig. 10). Refer to Engine Specifications for the the correct ring gap (clearance).

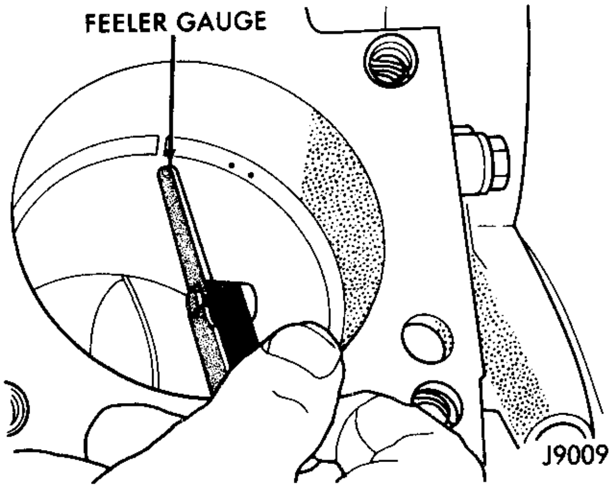
(4) Install the oil control rings according to the instructions in the package. Roll the upper and lower rails into place without the use of a tool (Fig. 11).

(5) Install the bottom compression ring using the ring installer to expand the ring around the piston (Fig. 12). Install the top compression ring using the ring installer to expand the ring around the piston.



J8909-41

Fig. 9 Ring Side Clearance Measurement



J9009-45

Fig. 10 Ring Gap (Clearance) Measurement

(6) Ensure the top and bottom compression rings are installed properly. Ideally, the ring gaps should be spaced 180° from each other (Fig. 13).

(7) Ensure the top and bottom compression rings are installed with the top side up (Fig. 14).

Installation

(1) Thoroughly clean the cylinder bores. Apply a light film of clean engine oil to the bores with a clean, lint-free cloth.

(2) Arrange the spacing of the piston ring gaps. Refer to Piston Ring Fitting for the procedure.

(3) Lubricate the piston and ring surfaces with clean engine oil.

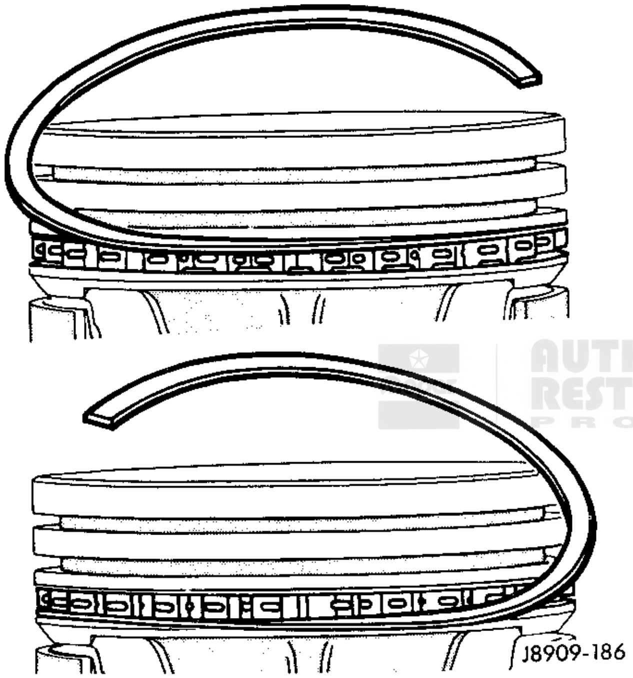


Fig. 11 Installing Oil Control Ring Upper and Lower Rails

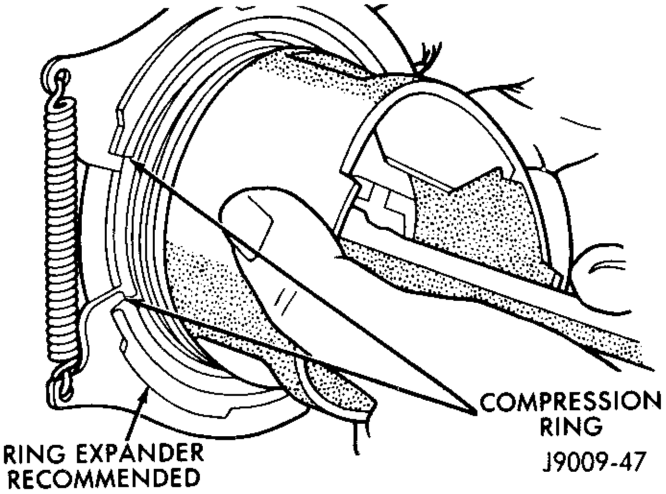


Fig. 12 Compression Ring Installation

CAUTION: Ensure that the connecting rod bolts do not scratch the connecting rod journals or cylinder walls. Short lengths of rubber hose slipped over the connecting rod bolts will provide protection during installation.

(4) Use a piston ring compressor tool to install the connecting rod and piston assemblies through the top of the cylinder bores. To ensure correct installation of the pistons in the bore, two notches are cast in the top perimeter of the pistons. **The notches must face forward when installed (Fig. 15). The squirt holes in the connecting rods must face inward. The rod and cylinder numbers face outward.**

(5) Install the connecting rod bearing caps and inserts in the original positions. Tighten the retaining nuts to 45 N•m (33 ft. lbs.) torque.

(6) Install the engine oil pan using replacement gaskets and seals.

(7) Install the cylinder head(s) and replacement gasket(s).

(8) Install the push rods.

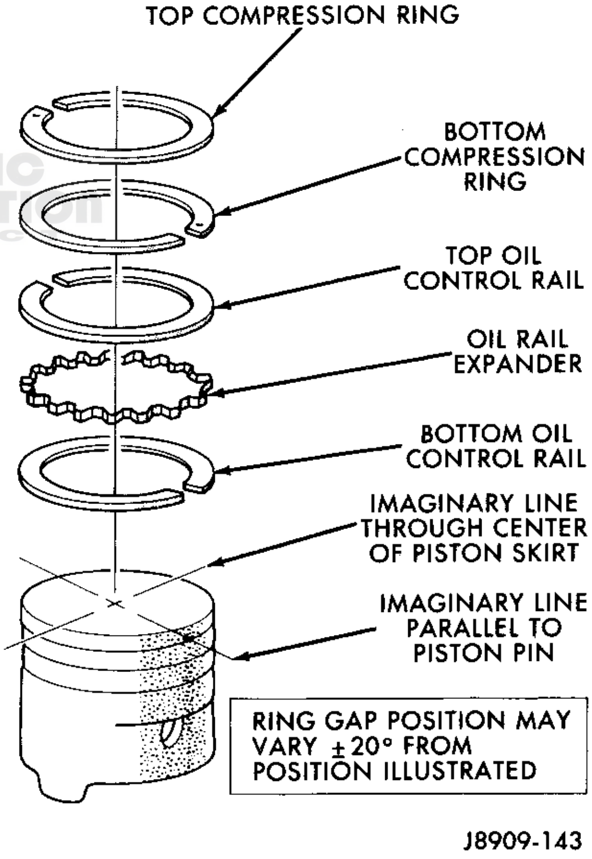


Fig. 13 Ring Gap Spacing

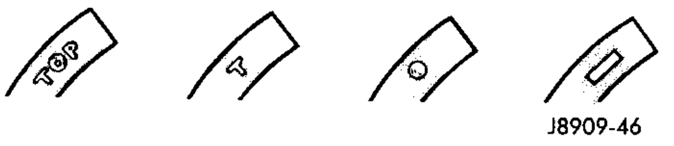


Fig. 14 Typical Compression Ring Marks — Top Side

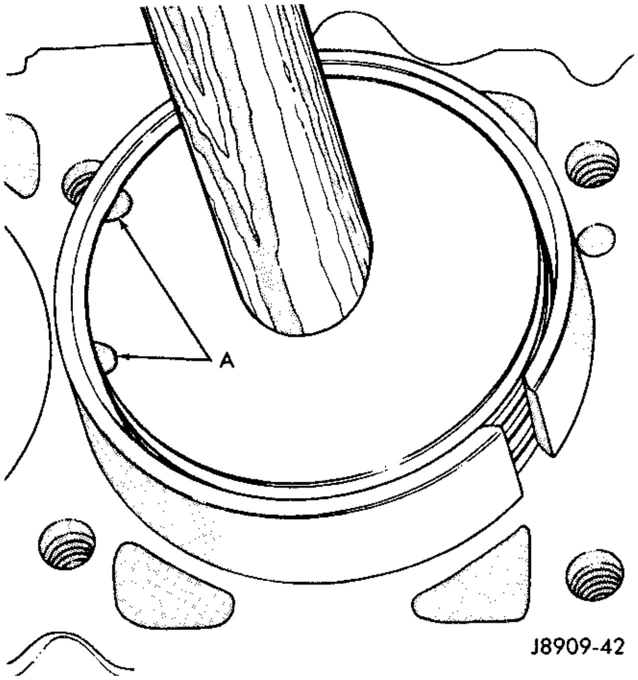


Fig. 15 Installing Piston Assembly into Cylinder Bore

(9) Install the rocker arms and bridge and pivot assemblies. Loosely install the capscrews through each bridge and alternately tighten, one turn at a time, to avoid damaging the bridge.

(10) Install the intake manifold gasket and manifold assembly.

(11) Install the exhaust manifold(s).

(12) Reseal and install the cylinder head cover(s).

(13) Fill the crankcase with clean oil to the specified level.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(14) Start the engine and inspect for leaks.

CRANKSHAFT MAIN BEARINGS — 5.9L

Replace crankshafts that are damaged or worn beyond feasible reconditioning. Use the procedures outlined within Cylinder Block to remove and install a crankshaft.

Removal

The following procedure can be used when the engine is installed in the vehicle.

(1) Drain the engine oil and remove the oil pan.

(2) Remove the main bearing cap and lower insert.

(3) Remove the lower insert from the bearing cap.

(4) Remove the upper insert by loosening all the other bearing caps and inserting a tool fabricated from a cotter pin approximately 14 mm (1/2 in) into the crankshaft oil hole.Fabricate a cotter pin (Fig. 1).

(5) With the cotter pin in place, rotate the crankshaft so that the upper bearing insert is rotated in the direction of its locking tab.

(6) Remove the remaining bearings in the same manner.

Inspection

Wipe the inserts clean and inspect for abnormal wear patterns and for metal or other foreign material imbedded in the lining. Normal main bearing insert wear patterns are illustrated (Fig. 2).

If any of the crankshaft journals are scored, remove the engine for crankshaft repair.

Inspect the back of the inserts for fractures, scrapings or irregular wear patterns.

Inspect the upper insert locking tabs for damage.

Replace all damaged or worn bearing inserts.

Fitting

The main bearing caps are numbered 1 through 5, front to rear, with an arrow to indicate the forward position. The upper main bearing insert surfaces are grooved. The lower insert surfaces are smooth.

Each bearing insert pair is selectively fitted to its respective journal to obtain the desired operating oil clearance.In production, the select fit is obtained by

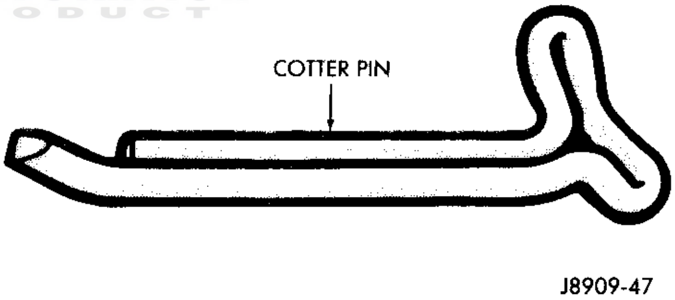


Fig. 1 Fabricated Cotter Pin

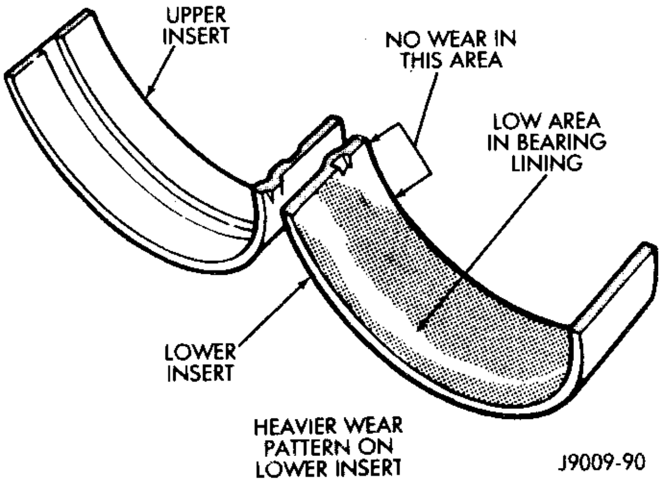


Fig. 2 Main Bearing Wear Patterns

using various-sized color-coded main bearing inserts as listed in the Main Bearing Fitting Chart. The bearing color code appears on the edge of the insert. The bearing size is not stamped on production inserts.

The main bearing journal diameter is identified in production by a color-coded paint mark on the adjacent cheek toward the flanged (rear) end of the crankshaft, except for the rear main journal. The paint mark that identifies the rear main journal diameter is on the crankshaft rear flange.

Refer to the Main Bearing Fitting Chart to select the proper bearing inserts to obtain the specified bearing clearance. Refer to Engine Specifications for the correct main bearing clearances.

When required, use different size upper and lower bearing inserts as a pair. Use a standard size upper insert in combination with a 0.025 mm (0.001 inch) undersize lower insert to reduce the clearance by 0.013 mm (0.0005 inch). Never use bearing inserts in combination with greater than 0.025 mm (0.001 inch) difference in size.

FOR EXAMPLE:

When installing upper and lower inserts having different sizes, install the undersize inserts either all on the top (upper) or all on the bottom (lower).

Service replacement main bearing inserts are available as pairs in the following sizes:

- Standard
- 0.025 mm (0.001 inch) undersize.
- 0.051 mm (0.002 inch) undersize
- 0.254 mm (0.010 inch) undersize
- 0.305 mm (0.012 inch) undersize

The bearing size is stamped on the back of the service replacement inserts.

The 0.305 mm (0.012 inch) undersize insert is not used for production engine assembly.

Main Bearing-to-Journal Clearance — Crankshaft Installed

Support the weight of the crankshaft with a jack placed under the counterweight adjacent to the journal being measured. **Measure the clearance of one bearing at a time. ALL other bearing caps must remain tightened.**

Remove the main bearing cap and lower insert.

Wipe the insert and the exposed portion of the crankshaft journal clean.

Place a strip of Plastigage across the full width of the bearing insert. The Plastigage must not crumble. If brittle, obtain fresh stock.

Install the bearing cap and tighten the retaining bolts to 136 N•m (100 ft. lbs.) torque.

CAUTION: Do not rotate the crankshaft. The Plastigage will shift, resulting in an inaccurate indication.

MAIN BEARING FITTING CHART

Crankshaft Main Bearing Journal Color Code and Diameter	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow – 69.8220-69.8093 mm (2.7489-2.7484 in.) (Standard)	Yellow – Standard	Yellow – Standard
Orange – 69.8093-69.7966 mm (2.7484-2.7479 in.) (0.0005 Undersize)	Yellow – Standard	Black – 0.025 mm Undersize (0.001 in.)
Black – 69.7966-69.7839 mm (2.7479-2.7474 in.) (0.001 Undersize)	Black – 0.025 mm Undersize (0.001 in.)	Black – 0.025 mm Undersize (0.001 in.)
Green – 69.7839-69.7712 mm (2.7474-2.7469 in.) (0.0015 Undersize)	Black – 0.025 mm Undersize (0.001 in.)	Green – 0.051 mm Undersize (0.002 in.)
Red – 69.5680-69.5553 mm (2.7389-2.7384 in.) (0.010 Undersize)	Red – 0.254 mm Undersize (0.010 in.)	Red – 0.254 mm Undersize (0.010 in.)

J8909-34

Remove the bearing cap and determine the amount of clearance by measuring the width of the compressed Plastigage with the scale on the Plastigage envelope (Fig. 3). Refer to Engine Specifications for the correct clearance.

The compressed Plastigage should maintain the same size across the entire width of the insert. If the size varies, this may indicate either a tapered journal or foreign material trapped behind the insert.

If the correct clearance is indicated, bearing replacement is not necessary. Remove the Plastigage from the crankshaft and insert. Proceed to Installation. Small pieces of Plastigage may remain on the insert or journal surfaces. If so, they will dissolve in hot engine oil when the engine is operated.

If the oil clearance exceeds the specification, install a pair of 0.025 mm (0.001 inch) undersize bearing inserts and measure the clearance as described earlier.

The clearance measured with 0.025 mm (0.001 inch) undersize inserts installed will determine if a pair of 0.025 mm (0.001 inch) undersize inserts or some other size combination will provide the correct clearance.

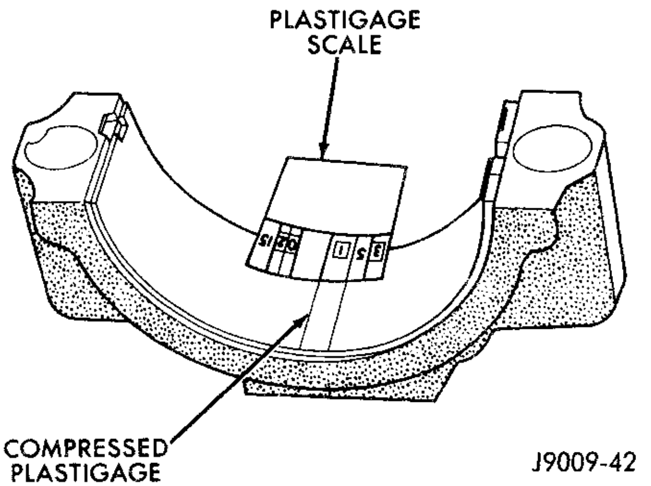
FOR EXAMPLE

If the clearance was 0.089 mm (0.0035 inch) originally, a pair of 0.025 mm (0.001 inch) undersize inserts will reduce the clearance by 0.025 mm (0.001 inch). The oil clearance will be 0.064 mm (0.0025 inch) and within the specification. The combination of a 0.051 mm (0.002 inch) undersize insert and 0.025 mm (0.001 inch) undersize insert will reduce this clearance by an additional 0.013 mm (0.0005 inch) and the oil clearance will be 0.051 mm (0.002 inch).

Bearing Insert Pairs

Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.025 mm (0.001 in.) Undersize	0.051 mm (0.002 in.) Undersize

J9009-62



J9009-42

Fig. 3 Measuring Clearance with Plastigage

CAUTION: Never use a combination of inserts that have a difference of more than one bearing size. For example, do not use a standard upper and 0.051 mm (0.002 inch) undersize lower insert.

If the oil clearance exceeds the specification with a pair of 0.051 mm (0.002 inch) undersize inserts, measure the crankshaft journal diameter with a micrometer. If the journal diameter is correct, the crankshaft bore in the cylinder block may be misaligned, which requires cylinder block replacement. If the journal diameter is incorrect, replace or grind the crankshaft to the standard undersize.

Main Bearing Journal Diameter — Crankshaft Removed

Wipe the main bearing journals clean.

Measure each journal diameter with a micrometer. Note the difference between the maximum and minimum diameters of each journal.

Refer to Engine Specifications for the maximum allowable taper and out-of-roundness.

Compare the measured largest diameter dimension with the journal diameter dimension listed in the Main Bearing Fitting Chart.

Select the insert pairs that will provide the specified bearing clearance. Refer to Engine Specifications for the correct clearance.

Installation

(1) Lubricate the journal contact surface of each insert with clean engine oil.

(2) Loosen all main bearing caps.

(3) Install the main bearing upper insert(s).

(4) Install the main bearing cap(s) and lower insert(s). Tighten the retaining bolts evenly to 136 N•m (100 ft. lbs.) torque in steps of 41, 81, 122 and 136 N•m (30, 60, 90 and 100 ft. lbs.) torque. Rotate the crankshaft after each tightening step to determine if it rotates freely. If it does not rotate freely, examine the inserts for proper installation and size.

(5) Install the oil pan using replacement gaskets and seals. Tighten the drain plug securely.

(6) Fill the crankcase to the specified level with clean lube oil.

Crankshaft End Play

Crankshaft end play is controlled by the No. 3 main bearing, which is flanged for this purpose.

(1) Attach a dial indicator to the crankcase adjacent to the No. 3 main bearing.

(2) Set the dial indicator stem on the face of the adjacent counterweight (Fig. 4).

(3) Pry the crankshaft fore and aft (Fig. 4).

(4) Note the dial indicator readings. End play is the difference between the high and low measurements. The proper crankshaft end play is 0.08-0.20 mm (0.003-0.008 inch).

(5) If the end play is not within the specification, inspect the crankshaft thrust faces for wear. If no wear is apparent, replace the No. 3 (thrust) main bearing inserts and measure the end play. If the end play is not within specification, replace the crankshaft.

When installing the No. 3 (thrust) main bearing inserts, pry the crankshaft fore and aft to align the thrust faces of the bearing inserts before final tightening.

REAR MAIN OIL SEALS — 5.9L

The rear main bearing oil seal consists of a two-piece neoprene single lip seal. Correct installation of the seal is required for leak-free engine operation.

Removal

(1) Drain the engine oil.

(2) Remove the starter motor.

(3) Remove the oil pan.

(4) Remove the oil pan front and rear neoprene oil seals.

(5) Remove the oil pan side gaskets.

(6) Thoroughly clean the gasket mating surfaces of the oil pan and engine block. Remove all sludge and residue from the oil pan sump.

(7) Remove the rear main bearing cap.

(8) Remove and discard the lower seal.

To ensure leak-free operation, always replace the upper and lower seal halves as a pair.

(9) Clean the main bearing cap thoroughly to remove all sealer.

(10) Loosen all remaining main bearing capscrews.

(11) Use a brass drift and hammer to tap the upper seal half until a sufficient portion of the seal is protruding to permit pulling the seal out completely.

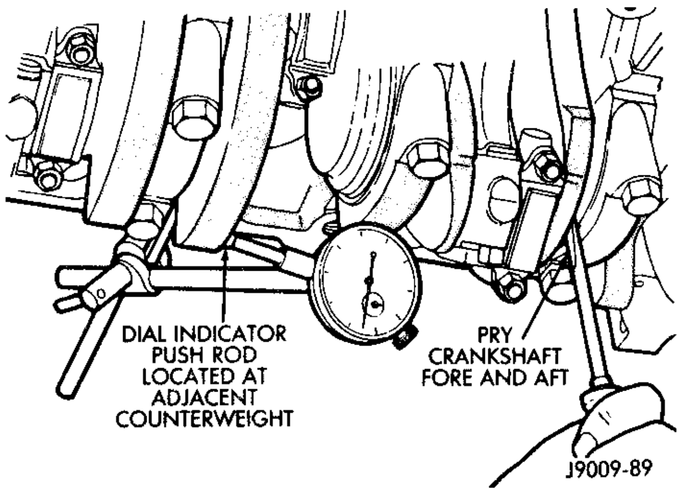


Fig. 4 Crankshaft End Play Measurement

Installation

(1) Wipe the crankshaft seal surface area clean and apply a light film of oil.

(2) Coat the block contact surface area of the replacement upper seal half with soap and the lip of the seal with clean engine oil.

(3) Insert the upper seal half into the engine block. **The lip of the seal must face the front of the engine.**

(4) Coat both sides of the replacement lower seal half end tabs with Jeep/Eagle Gasket-In-A-Tube, or equivalent. Do not apply sealer to the lip of the seal.

(5) Coat the outer curved surface of the lower seal half with soap and the lip of the seal with clean engine oil.

(6) Insert the seal into the cap recess and seat firmly (Fig. 5).

(7) Apply Jeep/Eagle Gasket-In-A-Tube, or equivalent, to both chamfered edges of the rear main bearing cap.

CAUTION: Do not apply sealer to the cylinder block mating surface of the rear main cap because bearing clearance could be affected.

(8) Tighten all main bearing bolts to 136 N•m (100 ft. lbs.) torque.

(9) Install the oil pan using replacement gaskets and seals. Tighten the drain plug securely.

(10) Install the starter motor.

(11) Fill the crankcase to the specified level with clean engine lubrication oil.

CYLINDER BLOCK — 5.9L

Disassembly

(1) Drain the engine oil.

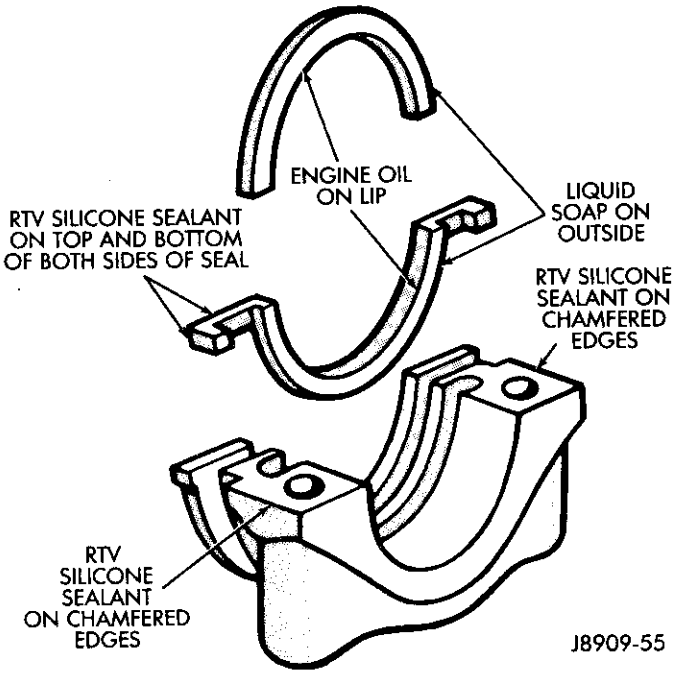


Fig. 5 Rear Main Oil Seal Installation

(2) Remove the engine assembly from the vehicle as outlined in Engine Removal.

(3) Use an engine stand to support the engine assembly.

(4) Remove the distributor.

(5) Remove the cylinder head covers and gaskets.

(6) Remove the bridge and pivot assemblies and rocker arms. Alternately loosen the capscrews, one turn at a time, to avoid damaging the bridge.

(7) Remove the push rods. Retain the bridges, pivots, rocker arms, push rods and tappets in the cylinder sets to facilitate installation in the original locations.

(8) Remove the intake manifold assembly.

(9) Remove the valve tappets.

(10) Remove the cylinder heads and gaskets.

(11) Position the pistons, one at a time, near the bottom of the stroke. Use a ridge reamer to remove the ridge, if any, from the top end of the cylinder walls.

(12) Loosen all drive belts. Remove the power steering pump, air pump and air conditioner compressor, if equipped.

(13) Scribe a mark on the torque converter and drive plate prior to crankshaft removal. Install in the same position during assembly.

Remove the damper pulley and vibration damper.

(14) Remove the timing case cover.

(15) Remove the oil pan.

(16) Remove the camshaft.

(17) Remove the connecting rod bearing caps and inserts. Retain in the same order as removed. The connecting rods and caps are stamped with the number of the associated cylinder.

(18) Remove the connecting rod and piston assemblies through the top of the cylinder bores. Ensure that the connecting rod bolts do not scratch the connecting rod journals or cylinder walls. Short pieces of rubber hose slipped over the rod bolts will provide protection during removal.

(19) Remove the oil pickup tube and screen assembly.

(20) Scribe a mark on the torque converter and drive plate prior to crankshaft removal. Install in the same position during assembly.

(21) Remove the main bearing caps and inserts.

(22) Remove the crankshaft.

Cylinder Bore Measurement

Use a bore gauge to measure the cylinder bores (Fig. 6). If a bore gauge is not available, use an inside micrometer.

Measure the cylinder bore crosswise to the block near the top of the bore. Repeat the measurement at the bottom of the bore.

Determine the taper by subtracting the smaller dimension from the larger dimension.

Turn the measuring device 120° and repeat the procedure. Then turn another 120° and repeat the measurements.

Determine out-of-roundness by comparing the difference between the measurements taken 120° apart.

If the cylinder taper does not exceed 0.127 mm (0.005 inch) and the out-of-roundness does not exceed 0.076 mm (0.003 inch), true the cylinder bore by honing. If the cylinder taper or out-of-round condition exceeds these limits, bore and then hone the cylinder for an oversize piston.

Cylinder Bore Reconditioning

CAUTION: Do not use rigid type hones to remove cylinder glaze. A slight amount of taper always exists in cylinder walls after the engine has been in service for a period of time.

Use an expanding hone to true the cylinder bore and to remove glaze for faster ring seating. Move the hone up and down at sufficient speed to produce a uniform 60° angle crosshatch pattern on the cylinder walls. Do not use more than ten (10) strokes per cylinder. A stroke is one down-and-up motion.

CAUTION: Protect the engine bearings and lubrication system from abrasives.

Scrub the cylinder bores clean with a solution of hot water and detergent.

Wipe with a clean, lint-free cloth.

If the crankshaft is not removed from the block, cover the connecting rod journals with a clean cloth during the cleaning operation.

Assembly

(1) Install and lubricate the upper main bearing inserts and rear main upper seal half. Lubricate the seal lip.

(2) Install the crankshaft.

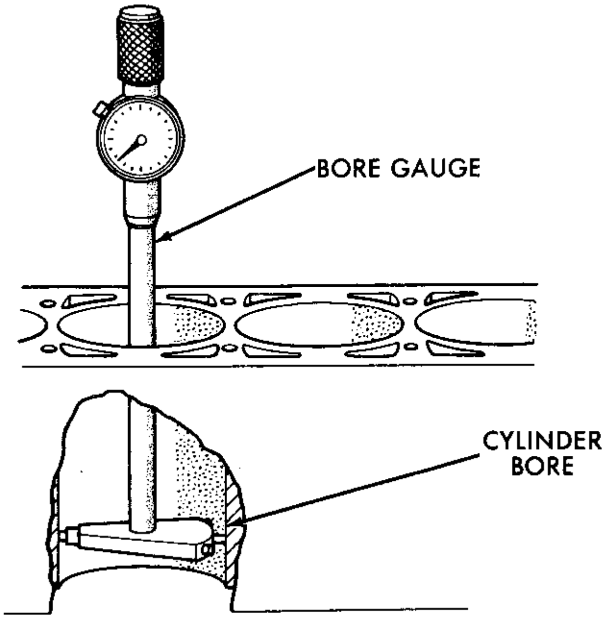


Fig. 6 Measuring Cylinder Bore with a Bore Gauge

(3) Install the main bearing caps and inserts. If replacement bearings are installed, measure each bearing clearance with Plastigage.

(4) Install a replacement oil pickup tube and screen assembly. Do not attempt to install the original pickup tube. Ensure the plastic button is inserted in the bottom of the replacement screen.

(5) Install the camshaft.

(6) Position the piston rings on the pistons. Refer to Piston Rings for the procedure.

(7) Lubricate the piston and ring surfaces with clean engine oil.

(8) Use a piston ring compressor tool to install the connecting rod and piston assemblies through the top of the cylinder bores. Ensure that the connecting rod bolts do not scratch the connecting rod journals or cylinder walls. Short lengths of rubber hose slipped over the connecting rod bolts will provide protection during installation.

(9) Install the connecting rod bearing caps and inserts in the same location as removed. Tighten the nuts to 45 N•m (33 ft. lbs.) torque.

(10) Install the camshaft and crankshaft sprockets and timing chain as an assembly.

(11) Install the timing case cover and gaskets. Refer to Timing Case Cover - Installation for the procedure.

(12) Install the engine oil pan using replacement gaskets and seals. Tighten the drain plug securely.

(13) Install the vibration damper and pulley.

(14) Install the cylinder heads with replacement gaskets.

(15) Install the valve tappets.

(16) Install the intake manifold with a replacement gasket.

(17) Install the push rods.

(18) Install the rocker arms and bridge and pivot assemblies. Loosely install the capscrews through each bridge and then alternately tighten the capscrews, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 26 N•m (19 ft. lbs.) torque.

(19) Turn the crankshaft to position the No. 1 piston at TDC on the compression stroke.

(20) Reseal and install the cylinder head covers.

(21) Install the power steering pump, air pump and air conditioner compressor.

(22) Install the distributor.

(23) Point the rotor at the No. 1 spark plug firing position.

(24) Turn the oil pump drive shaft with a long screwdriver to engage it with the distributor shaft.

(25) With the rotor pointing at the No. 1 spark plug firing position, rotate the distributor housing counterclockwise until the leading edge of the trigger wheel segment is aligned with the center of the sensor. Tighten the distributor holddown clamp. When the engine is installed and operating, check the ignition timing.

(26) Remove the engine from the stand.

(27) Install the engine assembly as outlined in Engine Installation.

ENGINE SPECIFICATIONS — 5.9L

Type	90° V-Block	
No. of Cylinders	8	
Bore	103.63 mm	4.08 in.
Stroke	87.38 mm	3.44 in.
Displacement	5.9 liter	360 cu. in.
Compression Ratio	8.25:1	
Compression Pressure (Minimum)	827-1 034 kPa	120-140 psi
Maximum Variation Between Cylinders	206 kPa	30 psi
Camshaft		
Fuel Pump Eccentric Diameter	55.423-55.677 mm	2.182-2.192 in.
Tappet Clearance	Zero lash (hydraulic tappets)	
End Play	Zero (engine operating)	
Bearing Clearance	0.0254-0.0762 mm	0.001-0.003 in.
Preferred	0.0432-0.0508 mm	0.0017-0.002 in.
Crankshaft Bearing Journal Diameter		
No. 1	53.835-53.861 mm	2.1195-2.1205 in.
No. 2	53.073-53.099 mm	2.0895-2.0905 in.
No. 3	52.311-52.337 mm	2.0595-2.0605 in.
No. 4	51.549-51.575 mm	2.0295-2.0305 in.
No. 5	50.787-50.813 mm	1.9995-2.0005 in.
Maximum Base Circle Runout	0.0254 mm	0.001 in.
Cam Lobe Lift	6.7564 mm	0.266 in.
Intake Valve Timing		
Opens	14.75° BTDC	
Closes	68.75° BTDC	
Exhaust Valve Timing		
Opens	56.75° BBDC	
Closes	26.75° ATDC	
Valve Overlap	41.5°	
Intake Duration	263.5°	
Exhaust Duration	263.5°	
Connecting Rods		
Total Weight (Less Bearings)	681-689 grams	24.0-24.3 oz.
Total Length (Center-to-Center)	149.17-149.28 mm	5.873-5.877 in.
Bearing Clearance	0.03-0.08 mm	0.001-0.003 in.
Preferred	0.051-0.064 mm	0.002-0.0025 in.
Side Clearance	0.15-0.46 mm	0.006-0.018 in.
Maximum Twist (per in.)	0.013 mm	0.0005 in.
Maximum Bend (per in.)	0.03 mm	0.001 in.

J8909-48

ENGINE SPECIFICATIONS — 5.9L (CONT.)

Crankshaft		
End Play	0.08-0.20 mm	0.003-0.008 in.
Main Bearing Journal Diameter		
Nos. 1, 2, 3, and 4	69.784-69.822 mm	2.7474-2.7489 in.
Rear Main	69.759-69.797 mm	2.7464-2.7479 in.
Main Bearing Journal Width		
No. 1	32.093-32.250 mm	1.2635-1.2695 in.
No. 2	31.650-31.700 mm	1.2460-1.2480 in.
No. 3	32.330-32.390 mm	1.2730-1.2750 in.
No. 4	31.650-31.700 mm	1.2460-1.2480 in.
No. 5	30.860-30.910 mm	1.2150-1.2170 in.
Main Bearing Clearance		
Nos. 1, 2, 3, and 4	0.03-0.08 mm	0.001-0.003 in.
Preferred	0.04-0.05 mm	0.0017-0.002 in.
No. 5 (Rear Main)	0.05-0.10 mm	0.002-0.004 in.
Preferred	0.06-0.08 mm	0.0025-0.003 in.
Connecting Rod Journal		
Diameter	53.172-53.266 mm	2.0934-2.0955 in.
Width	50.750-50.900 mm	1.998-2.004 in.
Connecting Rod Bearing		
Clearance	0.03-0.08 mm	0.001-0.003 in.
Preferred	0.051-0.064 mm	0.002-0.0025 in.
Maximum Taper (All Journals)	0.013 mm	0.0005 in.
Maximum Out-of-Round (All Journals)	0.013 mm	0.0005 in.
Cylinder Block		
Deck Height	233.81-233.96 mm	9.205-9.211 in.
Deck Clearance (Below Block)	0.368 mm	0.0145 in.
Maximum Cylinder Taper	0.13 mm	0.005 in.
Maximum Cylinder Out-of-Round	0.08 mm	0.003 in.
Taper Bore Diameter	22.999-23.025 mm	0.9055-0.9065 in.
Flatness (per 25 mm/in.)	0.03 mm	0.001 in.
(per 152 mm/6 in.)	0.05 mm	0.002 in.
(Maximum)	0.20 mm	0.008 in.
Cylinder Head		
Combustion Chamber Volume	58.62-61.62 cc	3.58-3.76 cu. in.
Valve Arrangement	EI-IE-EI-IE	
Valve Guide ID (Integral)	9.487-9.512 mm	0.3735-0.3745 in.
Valve Stem-to-Guide Clearance	0.03-0.08 mm	0.001-0.003 in.
Intake Valve Seat Angle	30°	
Exhaust Valve Seat Angle	44.5°	
Valve Seat Width	1.02-1.52 mm	0.040-0.060 in.
Valve Seat Runout (Maximum)	0.064 mm	0.0025 in.
Flatness (per 25 mm/in.)	0.030 mm	0.0010 in.
(per 152 mm/6 in.)	0.050 mm	0.0020 in.
(Maximum)	0.200 mm	0.0080 in.

J8909-49

ENGINE SPECIFICATIONS — 5.9L (CONT.)

Lubrication System		
Oil Capacity (with Oil Filter)	4.7 liters	5.0 quarts
Normal Operating Pressure		
@ 600 rpm	90 kPa	13 psi
@ 1600 + rpm	255-517 kPa	37-75 psi
Oil Pressure Relief	517 kPa	75 psi
Gear-to-Body Clearance	0.013-0.064 mm	0.0005-0.0025 in.
Preferred	0.013 mm	0.0005 in.
Oil Pump Gear End Clearance		
Feeler Gauge Method	0.102-0.203 mm	0.004-0.008 in.
Preferred	0.203 mm	0.008 in.
Plastigage Method	0.051-0.203 mm	0.002-0.008 in.
Preferred	0.051 mm	0.002 in.
Pistons (Weight)	601-605 grams	21.20-21.34 oz.
Piston Pin Bore CL-to-Piston Top	40.62-40.72 mm	1.599-1.603 in.
Piston-to-Bore Clearance	0.030-0.051 mm	0.0012-0.002 in.
Preferred	0.041 mm	0.0016 in.
Piston Ring Gap Clearance		
Nos. 1 and 2	0.25-0.51 mm	0.010-0.020 in.
Preferred	0.25-0.305 mm	0.010-0.012 in.
Oil Control Steel Rail	0.38-1.14 mm	0.015-0.045 in.
Preferred	0.25-0.51 mm	0.010-0.020 in.
Piston Ring Side Clearance		
No. 1	0.038-0.076 mm	0.0015-0.0035 in.
Preferred	0.038 mm	0.0015 in.
No. 2	0.038-0.089 mm	0.0015-0.0035 in.
Preferred	0.038 mm	0.0015 in.
Oil Control	0.000-0.180 mm	0.0000-0.0070 in.
Piston Ring Groove		
Height		
Nos. 1 and 2	2.019-2.045 mm	0.0795-0.0805 in.
Oil Control	4.775-4.813 mm	0.1880-0.1895 in.
Diameter		
Nos. 1 and 2	92.05-92.18 mm	3.624-3.629 in.
Oil Control	92.05-92.33 mm	3.624-3.635 in.
Piston Pin Diameter	23.649-23.655 mm	0.9308-0.9313 in.
Piston Pin Bore		
Diameter	23.592-23.617 mm	0.9288-0.9298 in.
Clearance	0.008-0.013 mm	0.0003-0.0005 in.
Preferred (Loose)	0.013 mm	0.0005 in.
Piston Pin-to-Connecting Rod Fit (Press Fit)	8900 N	2000 lbf

J8909-50

ENGINE SPECIFICATIONS — 5.9L (CONT.)

Rocker Arms, Push Rods and Tappets		
Rocker Arm Ratio	1.6:1	
Push Rod Length	197.87-198.37 mm	7.790-7.810 in.
Push Rod Diameter	7.93-8.00 mm	0.312-0.315 in.
Hydraulic Tappet Diameter	22.962-22.974 mm	0.9040-0.9045 in.
Tappet-to-Bore Clearance	0.025-0.064 mm	0.001-0.0025 in.
Valves		
Length (Tip-to-Gauge Dim. Line)	121.653-122.034 mm	4.7895-4.8045 in.
Stem Diameter	9.436-9.462 mm	0.3715-0.3725 in.
Stem-to-Guide Clearance	0.03-0.08 mm	0.001-0.003 in.
Intake Valve		
Head Diameter	51.31-51.56 mm	2.020-2.030 in.
Face Angle	29°	
Exhaust Valve		
Head Diameter	42.55-42.80 mm	1.675-1.685 in.
Face Angle	44°	
Valve Springs		
Free Length	50.55 mm	1.99 in.
Spring Tension – Valve Closed (@45.36 mm/1.786 in.)	282-317 N	64-72 lbf
Spring Tension – Valve Open (@34.44 mm/1.356 in.)	889-968 N	202-220 lbf
Inside Diameter (All Springs)	24.08-24.59 mm	0.948-0.968 in.

J8909-51

TORQUE SPECIFICATIONS — 5.9L

Component	Torque	
A/C Compressor Bracket-to-Engine Bolts	34 N•m	(25 ft-lbs)
Alternator Adjusting Bolt	24 N•m	(18 ft-lbs)
Alternator Pivot Bolt/Nut	38 N•m	(28 ft-lbs)
Camshaft Gear Retaining Bolt	41 N•m	(30 ft-lbs)
Connecting Rod Bolt Nuts	45 N•m	(33 ft-lbs)
Crankshaft Main Bearing Bolts	136 N•m	(100 ft-lbs)
Cylinder Head Bolts	149 N•m	(110 ft-lbs)
Cylinder Head Cover Retaining Bolts	6 N•m	(55 in-lbs)
Drive Plate-to-Converter Bolts	30 N•m	(22 ft-lbs)
Exhaust Manifold Bolts - Center (2)	34 N•m	(25 ft-lbs)
Exhaust Manifold Bolts - Outer (4)	20 N•m	(15 ft-lbs)
Exhaust Manifold-to-Downpipe Nuts	27 N•m	(20 ft-lbs)
Fan and Hub Assembly Bolts	24 N•m	(18 ft-lbs)
Front Support Cushion Retaining Nuts	45 N•m	(33 ft-lbs)
Fuel Pump Bolts	22 N•m	(16 ft-lbs)
Intake Manifold Bolts	58 N•m	(43 ft-lbs)
Oil Pan Bolts - 1/4-20	9 N•m	(7 ft-lbs)
- 5/16-18	15 N•m	(11 ft-lbs)
Oil Pump Cover Bolts	6 N•m	(55 in-lbs)
Rocker Arm Assembly-to-Cylinder Head	26 N•m	(19 ft-lbs)
Spark Plugs	37 N•m	(27 ft-lbs)
Starting Motor-to-Converter Housing	24 N•m	(18 ft-lbs)
Timing Case Cover-to-Block Bolts	34 N•m	(25 ft-lbs)
Vibration Damper Bolt (Lubricated)	122 N•m	(90 ft-lbs)
Vibration Damper Retaining Bolts	41 N•m	(30 ft-lbs)

J9009-91

EXHAUST SYSTEM AND INTAKE MANIFOLD

CONTENTS

EXHAUST SYSTEM

INDEX

GENERAL INFORMATION

The basic exhaust system on all vehicles consists of an exhaust manifold(s), front exhaust pipe, catalytic converter, heat shield(s), muffler, and tailpipe (Fig. 1).

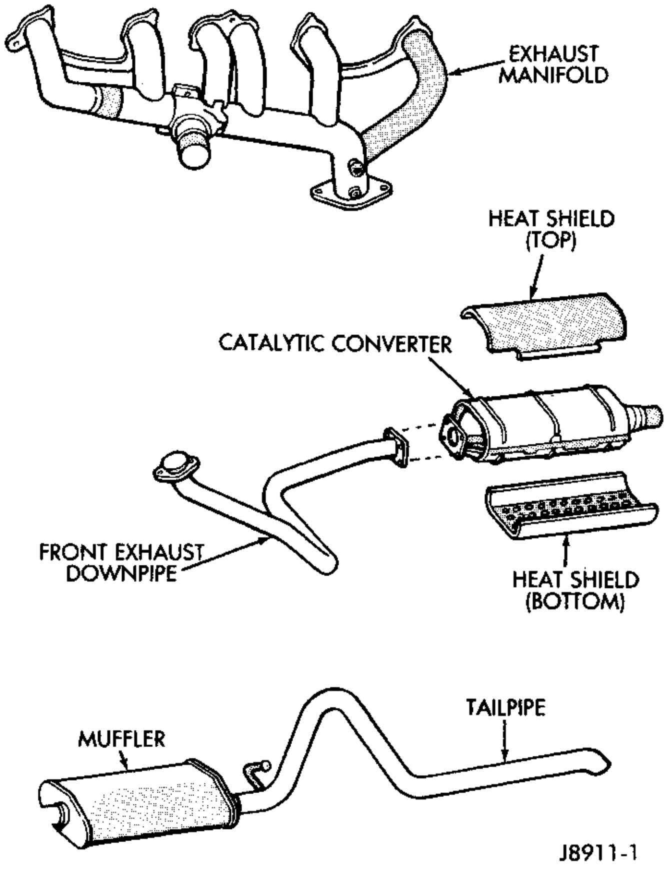


Fig. 1 Typical Exhaust System

Vehicles with the 2.5L and 4.0L engines use a single muffler exhaust system with a single monolithic-type catalytic converter.

Vehicles with the 4.2L engine use a dual bed (COC and TWC) monolithic-type converter with downstream pulsair injection.

Vehicles with the 5.9L engine use a conventional oxidizing catalytic (COC) type converter with downstream air injection.

The exhaust system must be properly aligned to prevent stress, leakage, and body contact. If the system contacts any body panel, it may amplify objectionable noises originating from the engine or body.

When inspecting an exhaust system, critically inspect for cracked or loose joints, stripped screw or bolt threads, corrosion damage, and worn, cracked or broken hangers. Replace all components that are badly corroded or damaged. Do not attempt to repair.

CATALYTIC CONVERTERS

The stainless steel catalytic converter body is designed to last the life of the vehicle. Excessive heat can result in bulging or other distortion, but excessive heat will not be the fault of the converter. A fuel system, air injection system or ignition system malfunction that permits unburned fuel to enter the converter will usually cause overheating. If a converter is heat-damaged, correct the cause of the damage at the same time the converter is replaced. Also, inspect all other components of the exhaust system for heat damage.

Unleaded gasoline must be used to avoid contaminating the catalyst core.

HEAT SHIELDS

Heat shields are needed to protect both the car and the environment from the high temperatures developed in the vicinity of the catalytic converter. The combustion reaction facilitated by the catalyst releases additional heat in the exhaust system. Under severe operating conditions, the temperature increases in the area of the reactor. Such conditions can exist when the engine misfires or otherwise does not operate at peak efficiency. **DO NOT** remove spark plug wires from plugs or by any other means short out cylinders. Failure of the catalytic converter can occur due to a temperature increase caused by unburned fuel passing through the converter.

Do not allow the engine to operate at fast idle for extended periods (over five minutes). This condition may result in excessive temperatures in the exhaust system and on the floor pan.

EXHAUST GAS RECIRCULATION (EGR)

To assist in the control of oxides of nitrogen (NOx) in engine exhaust, all engines are equipped with a gas recirculation system (Fig. 2). The use of gas to dilute incoming air/fuel mixtures lowers peak flame temperature during combustion, thus limiting the formation of NOx.

Exhaust gases are taken from openings in the exhaust gas crossover passage in the intake manifold. Refer to Section 25, Emission Control Systems for a complete description, diagnosis and proper service procedures.

EXHAUST MANIFOLD HEAT VALVE - 5.9L ENGINES

A thermostatically controlled heat valve is located between the right exhaust manifold and the exhaust pipe.

The valve directs heated air to the intake manifold for rapid fuel vaporization during engine warmup.

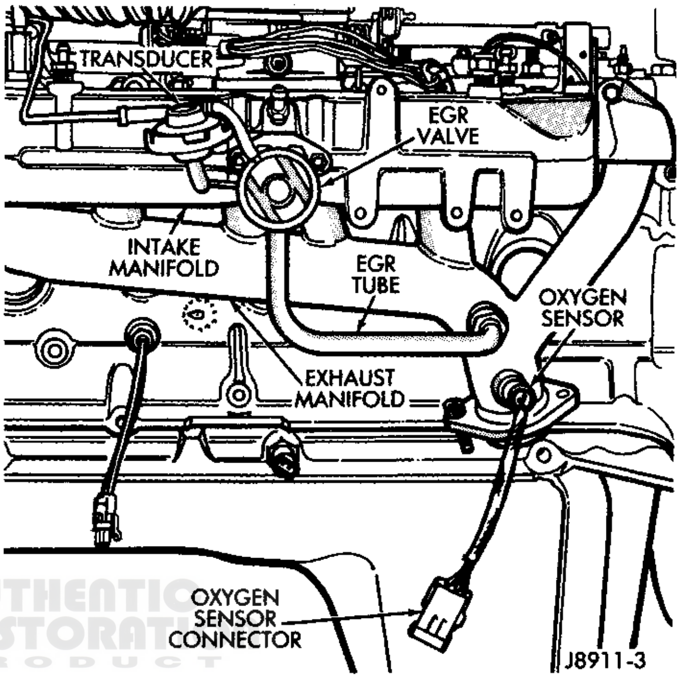


Fig. 2 Typical EGR System

SERVICE DIAGNOSIS

EXHAUST SYSTEM DIAGNOSIS CHART

Condition	Possible Cause	Correction
EXCESSIVE EXHAUST NOISE	(a) Leaks at pipe joints.	(a) Tighten clamps at leaking joints.
	(b) Burned or blown-out muffler.	(b) Replace muffler assembly.
	(c) Burned or rusted-out exhaust pipe.	(c) Replace exhaust pipe.
	(d) Exhaust pipe leaking at manifold flange.	(d) Tighten connection attaching nuts.
	(e) Exhaust manifold cracked or broken.	(e) Replace manifold.
	(f) Leak between manifold and cylinder head.	(f) Tighten manifold to cylinder head stud nuts or bolts.
	(g) Restriction in muffler or tailpipe.	(g) Remove restriction, if possible, or replace, as necessary.
LEAKING EXHAUST GASES	(a) Leaks at pipe joints.	(a) Tighten U-bolt nuts at leaking joints.
	(b) Damaged or improperly installed gaskets.	(b) Replace gaskets as necessary.
ENGINE HARD TO WARM UP OR WILL NOT RETURN TO NORMAL IDLE	(a) Heat control valve frozen in the open position.	(a) Free-up manifold heat control valve using a suitable solvent.
	(b) Blocked crossover passage in intake manifold.	(b) Remove restriction or replace intake manifold.
HEAT CONTROL VALVE NOISY	(a) Thermostat broken.	(a) Replace thermostat.
	(b) Broken, weak or missing anti-rattle spring.	(b) Replace spring.

J8911-2

RESTRICTED EXHAUST SYSTEM DIAGNOSIS

A partially restricted or blocked exhaust system usually results in loss of power or backfire up through the carburetor (4.2L and 5.9L engines). Verify that the condition is not caused by ignition or fuel system problems, then perform a visual inspection of the exhaust system. If the restriction cannot be located by visual inspection, perform the following procedure.

(1) Attach a vacuum gauge to the intake manifold.

(2) Connect a tachometer to the ignition coil negative (TACH) terminal.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(3) Start the engine and observe the vacuum gauge. The gauge should indicate a vacuum of 53.88-70.73 kPa (16-21 in. Hg).

(4) Increase the engine speed to 2000 rpm and observe the vacuum gauge. The vacuum will decrease when the speed is increased rapidly, but should stabilize at 53.88-70.73 kPa (16-21 in. Hg) and remain constant. If the vacuum remains below 53.88 kPa (16 in. Hg), the exhaust system is restricted or blocked. Stop the engine and proceed to the next step.

(5) Disconnect the exhaust pipe at the manifold.

(6) Start the engine and increase the speed to 2000 rpm. Observe the vacuum gauge.

(7) If the vacuum stabilizes at 53.88-70.73 kPa (16-21 in. Hg), restriction or blockage is either in the exhaust pipe, catalytic converter, muffler or tail pipe.

(8) If the vacuum stabilizes below the 53.88 kPa (16 in. Hg) with the exhaust pipe disconnected, the exhaust manifold is restricted.

(9) Stop the engine, connect the exhaust pipe and remove the muffler. Start the engine and increase the engine speed to 2000 rpm. Observe the vacuum gauge.

(10) If the vacuum stabilizes below 53.88 kPa (16 in. Hg), the restriction or blockage is in the catalytic converter. **In the event of a catalytic converter failure, always inspect the muffler and ensure converter debris has not entered the muffler.**

(11) If the vacuum is normal, the muffler or tail pipe is restricted.

(12) Stop the engine.

(13) Disconnect the tachometer and vacuum gauge.

(14) Remove the exhaust manifold. Refer to Exhaust Manifold Removal in this section for the proper procedures.

(15) Inspect the ports of the exhaust manifold for casting flash by inserting a chain into each port. **Do not**

use a wire or a light to inspect the ports.The restricted opening may be large enough for wire or light to pass through but small enough to cause excessive back pressure at high engine rpm.

(16) Remove the casting flash. Run the chain back and forth to remove any restriction in the exhaust manifold. If the flash is at the lower end of the port, it can usually be chipped out. If the flash cannot be removed, replace the manifold.

(17) Install the exhaust manifold. Refer to Exhaust Manifold Installation in this section for the proper procedures.

SERVICE PROCEDURES — MJ AND XJ VEHICLES

INDEX

EXHAUST DOWNPIPES

Removal

(1) Raise and support the vehicle.

(2) Saturate the bolts and nuts with heat valve lubricant (Fig. 1). Allow five (5) minutes for penetration.

(3) Disconnect the exhaust downpipe from the exhaust manifold. Discard the seal (4.0L engine, only).

(4) Support the transmission and remove the rear crossmember. Refer to Group 9, Engines for the proper procedure.

(5) Remove the exhaust downpipe-to-clutch housing bracket (Fig. 2).

(6) Disconnect the exhaust pipe from the catalytic converter flange and support (Fig. 3). Discard the gasket. Remove the exhaust downpipe.

Installation

(1) Use a replacement gasket and connect the exhaust downpipe to the catalytic converter flange and support (Fig. 3).

(2) Connect the exhaust downpipe to the exhaust manifold. Install a new seal between the exhaust manifold and the downpipe (4.0L engine, only). Tighten the nuts to 31 N•m (23 ft. lbs.) torque (Fig. 1).

(3) Install the exhaust downpipe-to-clutch housing bracket (Fig. 2).

(4) Install the rear crossmember and remove the support from the transmission. Refer to Group 9, Engines for the proper procedures.

(5) Lower the vehicle.

CATALYTIC CONVERTER

Removal

(1) Raise and support the vehicle.

(2) Remove the clamp from the catalytic converter and muffler connection (Fig. 4).

(3) Heat the catalytic converter and muffler connection with an oxyacetylene torch until the metal becomes cherry red.

(4) While the metal is still cherry red, twist the muffler assembly back and forth to separate it from the catalytic converter.

(5) Disconnect the exhaust downpipe from the catalytic converter flange and support (Fig. 3).

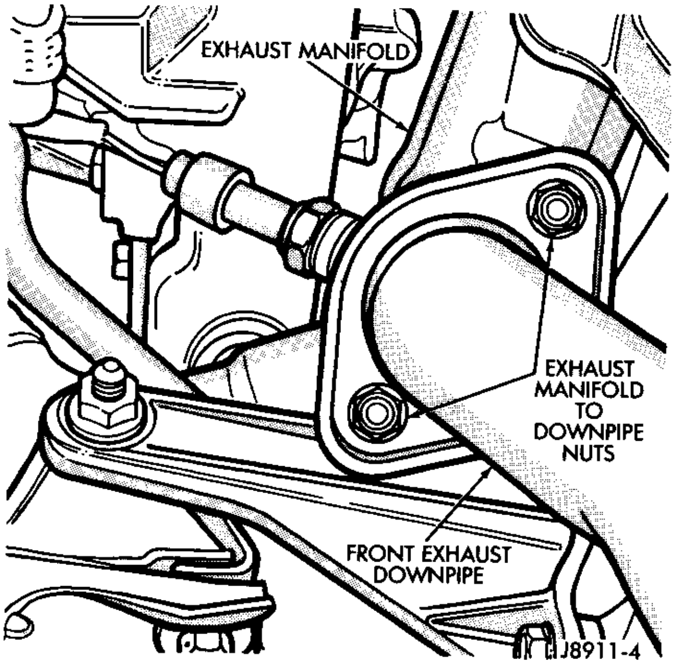


Fig. 1 Exhaust Downpipe-to-Exhaust Manifold Nuts

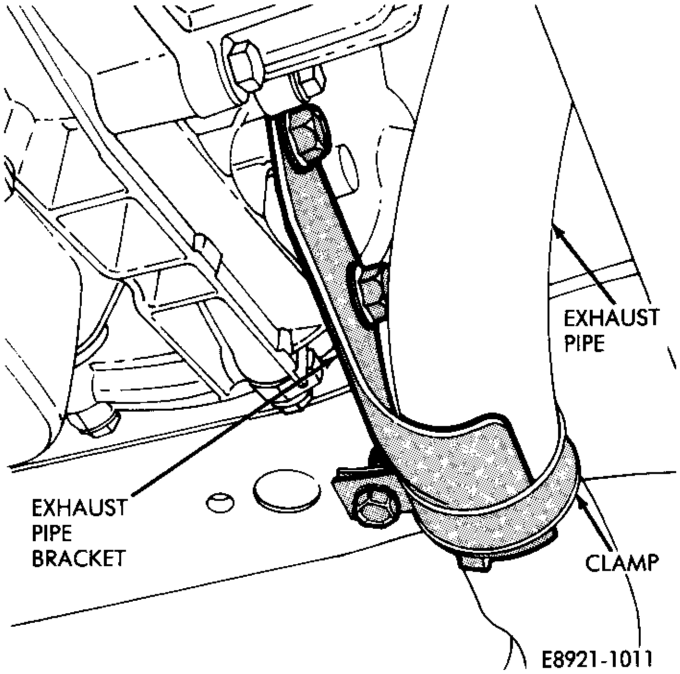


Fig. 2 Exhaust Downpipe-to-Clutch Housing Bracket

Installation

(1) Use a replacement gasket and connect the catalytic converter flange to the exhaust downpipe flange (Fig. 3).

(2) Install the muffler onto the catalytic converter until the alignment tab is inserted into the alignment slot.

(3) Use a replacement gasket and connect the catalytic converter flange to the exhaust downpipe flange (Fig. 3).

(4) Install a clamp at the muffler and catalytic converter connection (Fig. 4). Tighten the clamp nuts to 61 N•m (45 ft. lbs.) torque.

(5) Lower the vehicle.

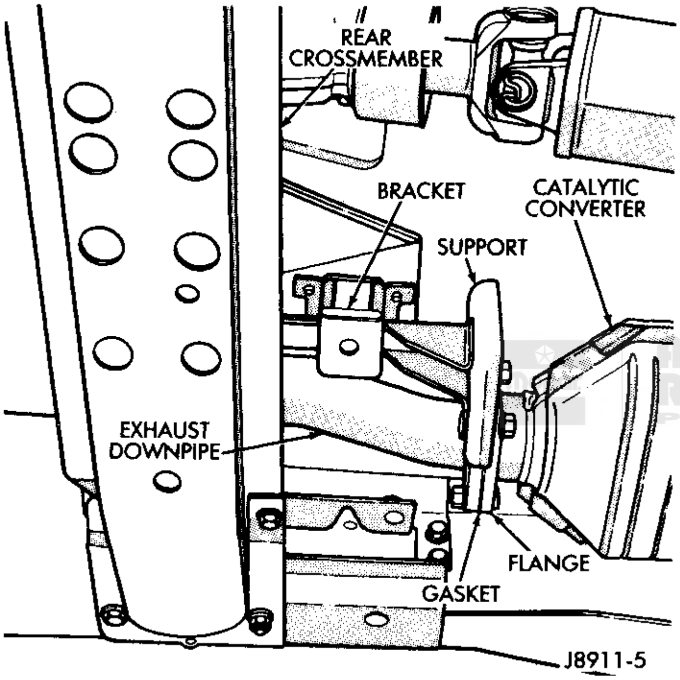


Fig. 3 Exhaust Downpipe-to-Catalytic Converter Connection

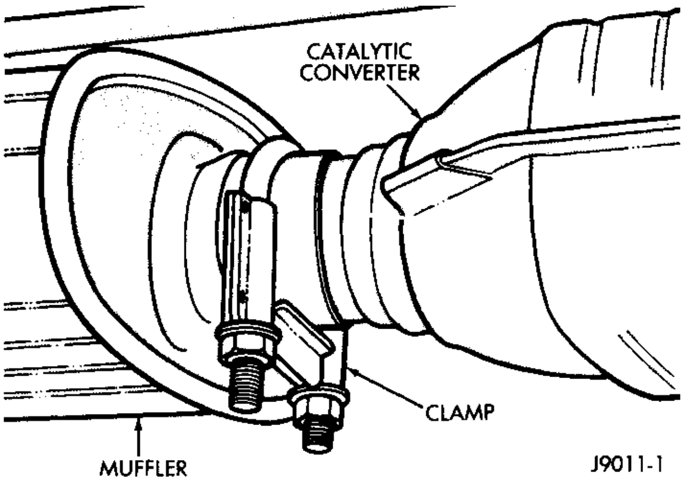


Fig. 4 Catalytic Converter-to-Muffler Connection

MUFFLER AND TAILPIPE

All original equipment exhaust systems are manufactured with the tailpipe welded to a stamped muffler. Service replacement mufflers and tailpipes are either clamped together or welded together.

Removal

(1) Raise and support the vehicle.

(2) Remove the front muffler clamp from the catalytic converter and muffler connection (Fig. 4).

(3) Remove the rear tailpipe hanger clamp (Fig. 5) and remove the tailpipe from the front tailpipe hanger (Fig. 6).

(4) Heat the catalytic converter-to-muffler connection with an oxyacetylene torch until the metal becomes cherry red.

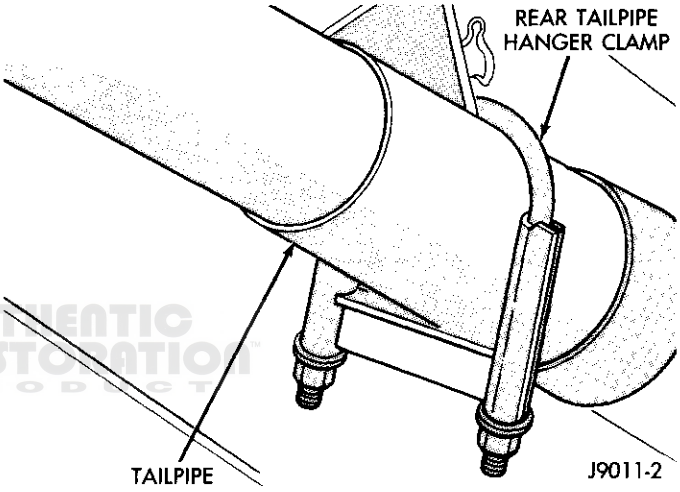


Fig. 5 Rear Tailpipe Hanger Clamp

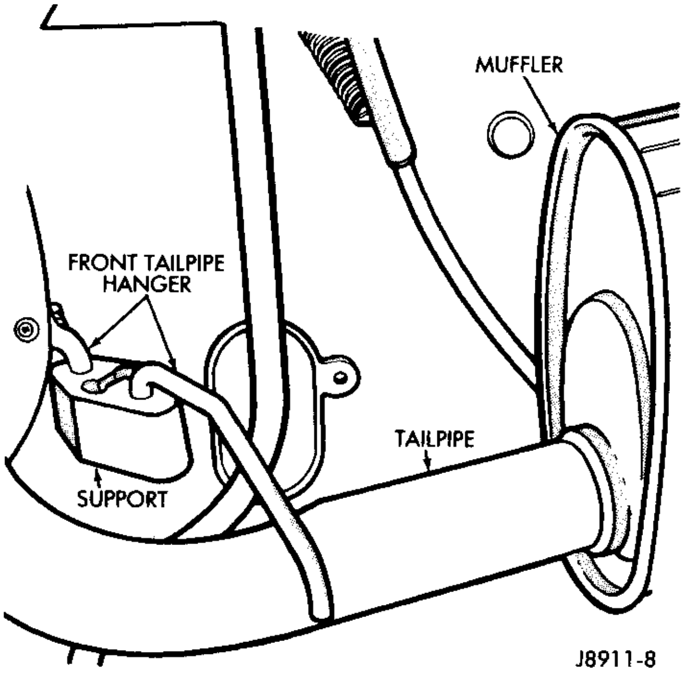


Fig. 6 Front Tailpipe Hanger

(5) While the metal is still cherry red, remove the tailpipe/muffler assembly from the catalytic converter.

(6) Remove the tailpipe from the muffler:

- To remove an original equipment tailpipe/muffler combination, cut the tailpipe close to the muffler. Collapse the part remaining in the muffler and remove.
- To remove a service tailpipe/muffler combination, apply heat until the metal becomes cherry red and then remove the tailpipe/muffler clamp and twist the tailpipe out of the muffler.

Installation

(1) Install the muffler onto the catalytic converter. Install the clamp and tighten the nuts finger tight.

(2) Install the tailpipe into the rear of the muffler.

(3) Install the tailpipe/muffler assembly on the rear tailpipe hanger and ensure that the tailpipe has sufficient clearance from the floor pan.

(4) Install the remaining clamps and the front tailpipe hanger.

(5) Tighten the nuts on the muffler-to-catalytic converter clamp to 61 N•m (45 ft. lbs.) torque (Fig. 4). Tighten the nuts on the rear tailpipe clamp to 14 N•m (10 ft. lbs.) torque (Fig. 5).

(6) Lower the vehicle.

(7) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

EXHAUST MANIFOLD - 2.5L ENGINE

Removal

(1) Disconnect the battery negative cable.

(2) Loosen the exhaust gas recirculation (EGR) tube nut at the intake manifold and the EGR tube bolts at the exhaust manifold (Fig. 7).

(3) Remove all components attached to the intake manifold. Refer to Intake Manifold Removal in this section for the proper procedures.

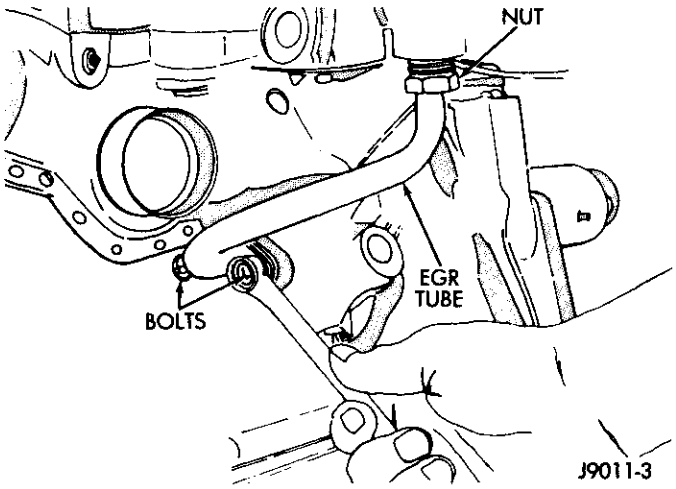


Fig. 7 EGR Tube — 2.5L Engine

(4) Raise the vehicle on a side mounted swing arm hoist.

(5) Disconnect the exhaust downpipe from the exhaust manifold.

(6) Disconnect the oxygen (O_2) sensor wire connector (Fig. 8).

(7) Remove the oxygen (O_2) sensor from the exhaust manifold if a replacement manifold is to be installed or the sensor is defective.

(8) Lower the vehicle.

(9) Remove the intake manifold/exhaust manifold/EGR tube assembly.

(10) Remove the EGR tube and separate the exhaust and intake manifolds.

Cleaning and Inspection

Clean the intake and exhaust manifolds and cylinder head mating surfaces. **Do not allow foreign material to enter either the intake manifold or the ports in the cylinder head.**

Clean the EGR tube to exhaust manifold mating surfaces.

Installation

(1) Using new gaskets, loosely attach the EGR tube to the intake and exhaust manifolds. Do not tighten the fasteners at this time.

(2) Install a new intake manifold gasket over the alignment dowels on the cylinder head.

(3) Install the intake manifold/exhaust manifold/EGR tube assembly. **Exhaust manifold must be centrally located over the end studs and spacer (Fig. 9).**

(4) Tighten bolt #1 to 41 N•m (30 ft. lbs.) torque.

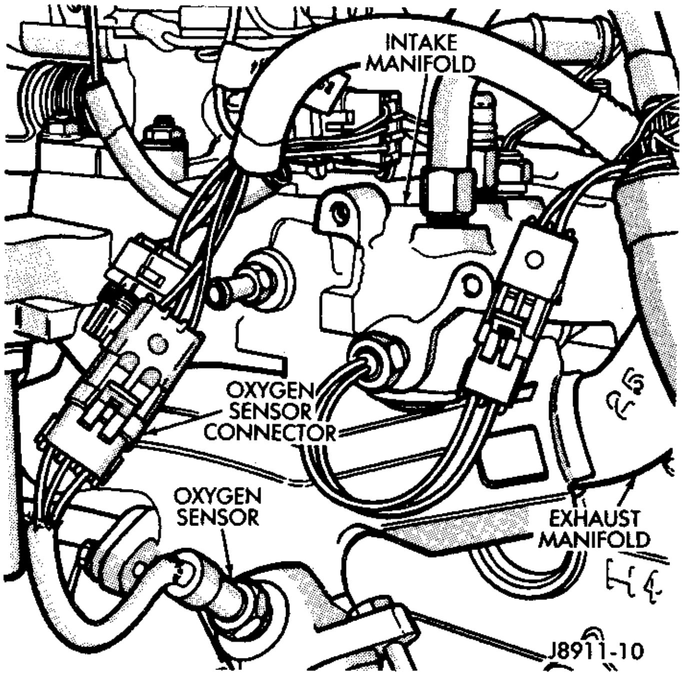


Fig. 8 Oxygen (O_2) Sensor and Connector

(5) Tighten bolts #2 through #5 to 31 N•m (23 ft. lbs.) torque.

(6) Install new exhaust manifold spacers over the exhaust manifold mounting studs in the cylinder head (Fig. 10).

(7) Tighten nuts #6 and #7 to 41 N•m (30 ft. lbs.) torque.

(8) Tighten nut #8 (EGR tube) to 41 N•m (30 ft. lbs.) torque.

(9) Tighten bolts #9 and #10 (EGR tube) to 19 N•m (14 ft. lbs.) torque.

(10) Install all components to the intake manifold. Refer to Intake Manifold Installation in this section for the proper procedures.

(11) Raise the vehicle on a side mounted hoist.

(12) Connect the exhaust downpipe. Tighten the bolts to 31 N•m (23 ft. lbs.) torque.

(13) Install the oxygen (O_2) sensor, if removed. Tighten the sensor to 48 N•m (35 ft. lbs.) torque.

(14) Connect the oxygen (O_2) sensor connector.

(15) Lower the vehicle.

(16) Connect the battery negative cable.

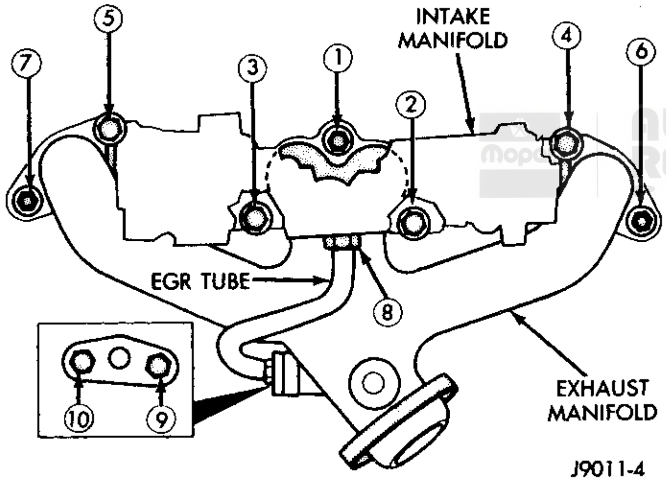


Fig. 9 Intake and Exhaust Manifold Installation

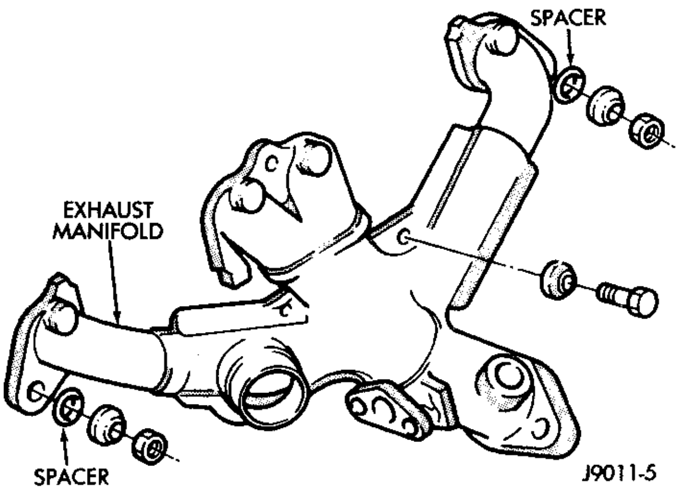


Fig. 10 Exhaust Manifold Spacers

(17) Start the engine and check for leaks.

EXHAUST MANIFOLD - 4.0L ENGINES

The intake and exhaust manifolds on the 4.0L engines must be removed and installed together because the manifolds use a common gasket at the cylinder head.

Refer to Intake Manifold - 4.0L Engine in this section for the proper removal and installation procedures.

INTAKE MANIFOLD - 2.5L ENGINES

Removal

(1) Disconnect the battery negative cable.

(2) Remove the throttle body bonnet/air inlet hose from the throttle body and air cleaner.

(3) Loosen the accessory drive belt tension and remove the belt from the power steering pump.

(4) Remove the power steering pump and brackets from the water pump and intake manifold. Support power steering pump and bracket with mechanics wire attached to the radiator upper crossmember.

(5) Remove the fuel tank filler cap to relieve the fuel tank pressure.

(6) Install the fuel tank filler cap.

(7) Disconnect black fuel supply tube and grey fuel return tube from the throttle body by squeezing the retaining tabs and pulling the tabs out (Fig. 11). The retainers will remain on the fuel tubes.

(8) Disconnect the accelerator cable from the throttle body and the holddown bracket.

CAUTION: When disconnecting the cruise control connector at the throttle body, do not pry the connector off with pliers or screwdriver. Use finger pressure only. Prying the connector off could break it.

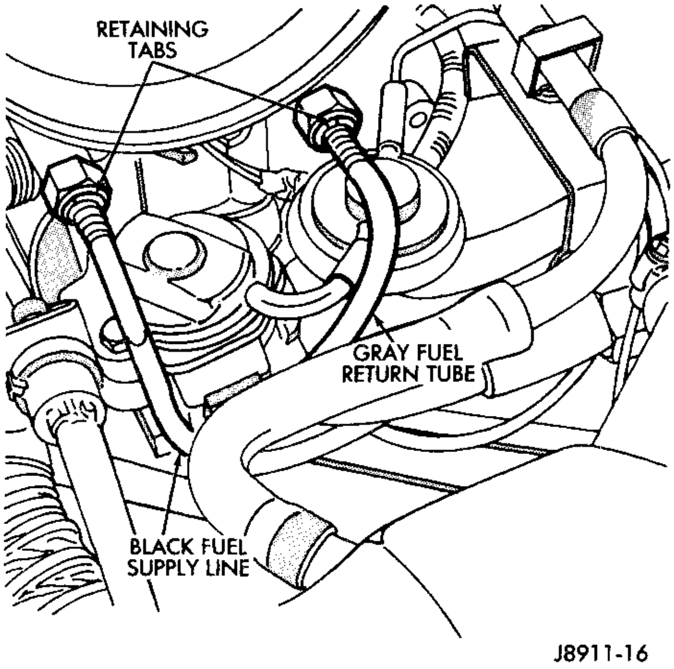


Fig. 11 Fuel Line Removal

(9) Disconnect the electrical connectors for the throttle position sensor, the idle speed control motor, the coolant temperature sensor at the thermostat, the coolant temperature sensor at the intake manifold, the fuel injector, the air temperature sensor and the oxygen (O_2) sensor. Pull the harnesses away from the manifold.

(10) Disconnect the crankcase ventilation vacuum (CCV) hose and manifold absolute pressure (MAP) sensor vacuum hose connector at the throttle body.

(11) Disconnect vacuum hose from vacuum port on the intake manifold (Fig. 12).

(12) Disconnect vacuum hose at EGR transducer (Fig. 13).

(13) Disconnect vacuum hoses and at EGR solenoid on the drivers side of the engine compartment (Fig. 14).

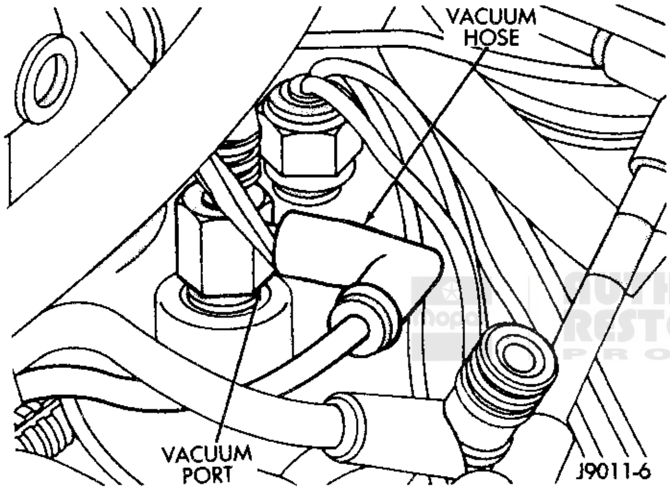


Fig. 12 Vacuum Hose and Port

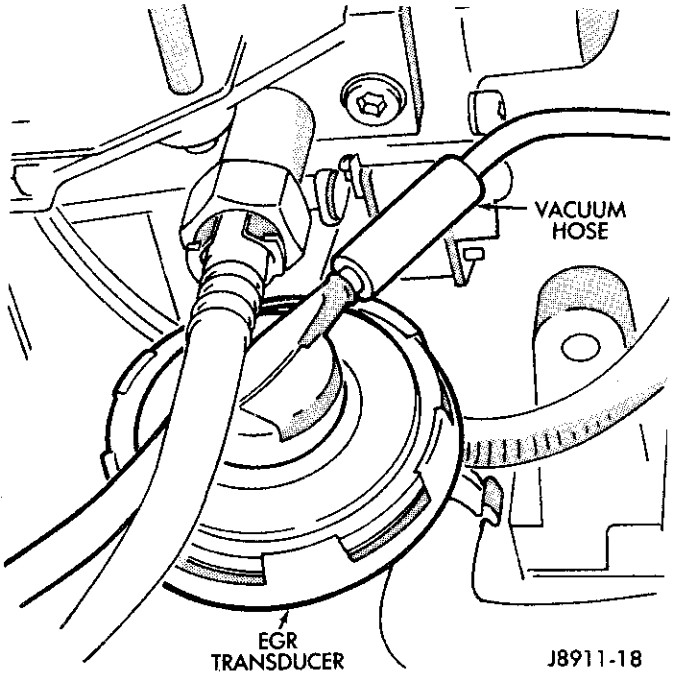


Fig. 13 EGR Transducer and Vacuum Hose

(14) Disconnect CCV hose at the cylinder head cover (Fig. 15).

(15) Remove the molded vacuum harness.

(16) Disconnect the vacuum brake booster hose at the intake manifold.

(17) Loosen the EGR tube nut at the intake manifold.

(18) Remove the bolts securing the EGR tube to the exhaust manifold.

(19) Drain the cooling system. Refer to Group 7, Cooling System for the proper procedure.

(20) Remove bolts 2, 3, 4 and 5 securing the intake manifold to the cylinder head (Fig. 9). Slightly loosen bolt 1 and nuts 6 and 7.

(21) Remove the intake manifold and gaskets. Drain the coolant from the manifold.

Cleaning and Inspection

Clean the intake manifold and cylinder head mating surfaces. Do not allow foreign material to enter either the intake manifold or the ports in the cylinder head.

Clean the EGR tube to exhaust manifold mating surfaces.

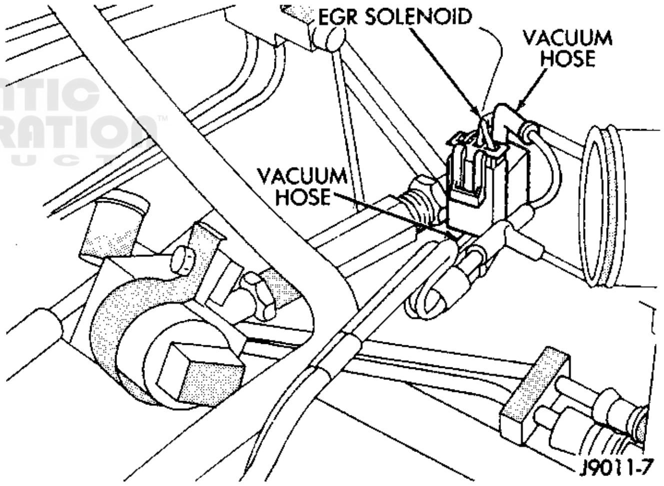


Fig. 14 EGR Solenoid and Vacuum Hoses

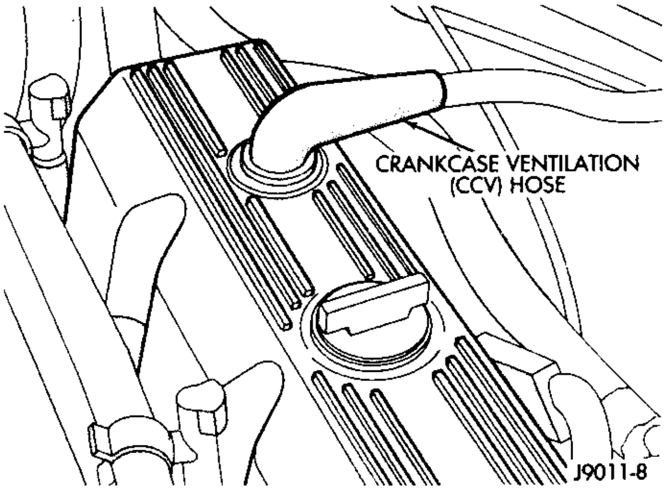


Fig. 15 Crankcase Ventilation (CCV) Hose

Installation

(1) Install the new intake manifold gasket over the locating dowels.

(2) Position the manifold in place and finger tighten the mounting bolts.

(3) Use a new EGR tube gasket and attach the EGR tube to the exhaust manifold. Finger tighten bolts 9 and 10. Leave the EGR tube nut at the intake manifold, finger tight.

(4) Tighten the fasteners in sequence and to the specified torque (Fig. 9).

- Fasteners 1, 6, 7, and 8 - 41 N•m (30 ft. lbs.).
- Fasteners 2, 3, 4, and 5 - 31 N•m (23 ft. lbs.).
- Fasteners 9 and 10 - 19 N•m (14 ft. lbs.).

(5) Connect the grey fuel return tube to the connector next to the pressure regulator. Connect the black fuel supply tube to the connector next to the throttle linkage. Push them into the fitting until a click is heard. Verify that the connections are complete by first ensuring only the retainer tabs protrude from the connectors and second by pulling out on the fuel tubes to ensure they are locked in place.

(6) Attach the heater hoses to the intake manifold.

(7) Connect the molded vacuum hoses to the vacuum port on the intake manifold, the EGR transducer, the EGR solenoid and the cylinder head cover.

(8) Connect the electrical connectors to the throttle position sensor, the idle speed control motor, the coolant temperature sensor at the thermostat housing, the coolant temperature sensor at the intake manifold, the fuel injector, the air temperature sensor and the oxygen (O_2) sensor.

(9) Connect the CCV vacuum hose and MAP sensor vacuum hose connectors to the throttle body.

(10) Install the power steering pump and bracket assembly to the water pump and intake manifold.

(11) Connect the accelerator cable and cruise control cable to the hold down bracket and the throttle arm.

CAUTION: Ensure that the accessory drive belt is routed correctly. Failure to do so can cause the water pump to turn in the opposite direction resulting in engine overheating. Refer to Group 7, Cooling System for the proper procedure.

(12) Tension the accessory drive belt. Refer to Group 7, Cooling System for the proper procedure.

(13) Connect the throttle body bonnet/air inlet hose to the throttle body and the air cleaner.

(14) Fill the cooling system. Refer to Group Cooling System for the proper filling procedures.

(15) Connect the battery negative cable.

(16) Start the engine and check for leaks.

EXHAUST AND INTAKE MANIFOLDS - 4.0L ENGINE

The intake and exhaust manifolds on the 4.0L engines must be removed and installed together because the two manifolds use a common gasket at the cylinder head.

Removal

(1) Disconnect the battery negative cable.

(2) Drain the cooling system. Refer to Group 7, Cooling System for the procedure.

(3) Remove air cleaner inlet hose from throttle plate assembly.

(4) Remove the air cleaner assembly.

(5) Remove the throttle cable, cruise control cable (if equipped) and the transmission line pressure cable.

(6) Disconnect the vacuum connector on the intake manifold (Fig. 16).

- Lift vacuum connector from the bracket on the intake manifold.
- Depress lock tabs and pull the vacuum connector apart.

(7) Disconnect all electrical connectors on the intake manifold.

(8) Disconnect and remove the fuel supply and return lines from the fuel rail assembly.

(9) Loosen the serpentine drive belt tensioner.

(10) Remove the power steering pump and bracket from the intake manifold and set aside.

(11) Remove the fuel rail and injectors.

(12) Remove the intake manifold heat shield.

(13) Raise the vehicle on a side mounted swing arm hoist.

(14) Disconnect the exhaust downpipe from the exhaust manifold (Fig. 17). Discard the seal.

(15) Disconnect the oxygen (O_2) sensor wire connector (Fig. 18).

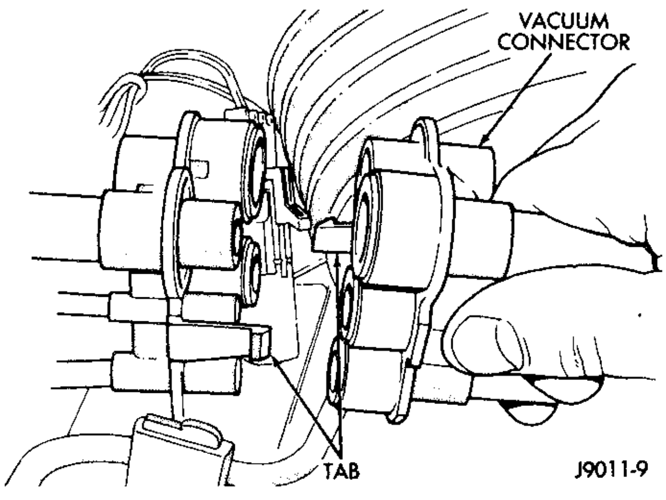


Fig. 16 Vacuum Connector Removal

(16) Remove the oxygen (O_2) sensor from the exhaust manifold if a replacement manifold is to be installed or the sensor is defective.

(17) Lower the vehicle.

(18) Remove the intake manifold/exhaust manifold/ EGR tube assembly.

(19) Remove the EGR tube and separate the exhaust and intake manifolds.

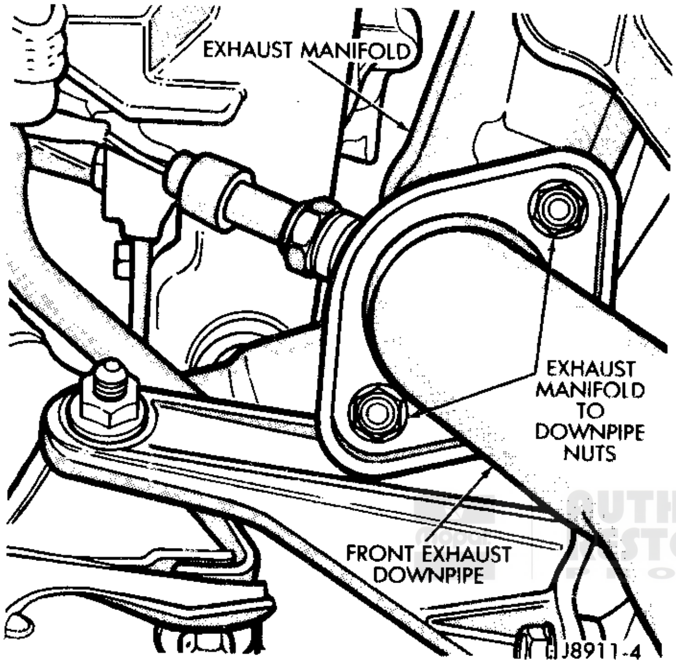


Fig. 17 Exhaust Downpipe-to-Exhaust Manifold Nuts

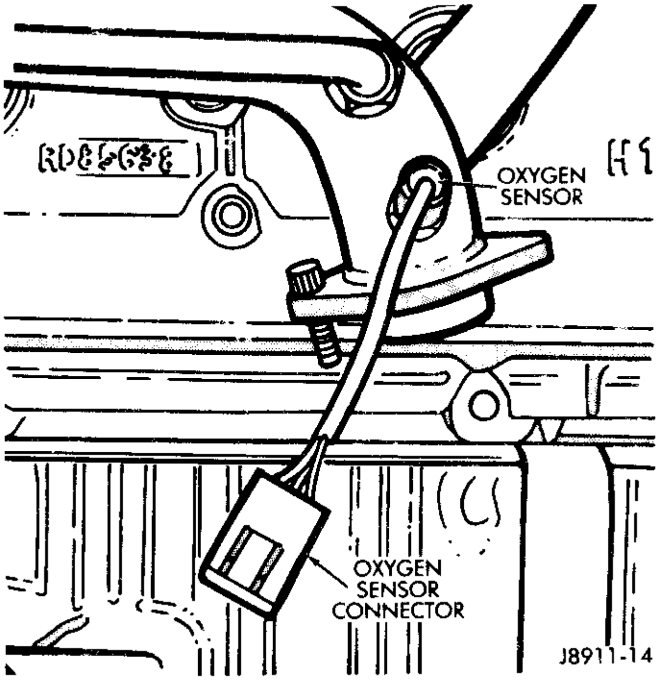


Fig. 18 Oxygen (O_2) Sensor and Connector

Cleaning and Inspection

Clean the mating surfaces of the cylinder head and the manifold if the original manifold is to be installed.

If the manifold is being replaced, ensure all the fitting, etc. are transferred to the replacement manifold.

Installation

(1) Loosely attach the EGR tube to the intake and exhaust manifolds. Do not tighten the fasteners at this time.

(2) Install a new exhaust/intake manifold gasket over the alignment dowels on the cylinder head.

(3) Install the intake manifold/exhaust manifold/EGR tube assembly (Fig. 19).

(4) Tighten bolt #1 to 41 N•m (30 ft. lbs.) torque.

(5) Tighten bolts #2 through #9 to 31 N•m (23 ft. lbs.) torque.

(6) Tighten bolts #10 and #11 to 23 N•m (17 ft. lbs.) torque.

(7) Tighten nuts #12 and #13 (EGR tube) to 41 N•m (30 ft. lbs.) torque.

(8) Install the intake manifold heat shield.

(9) Install the fuel rail and injectors.

(10) Install the power steering pump and bracket to the intake manifold. Tighten the belt to specification. Refer to Group 7, Cooling System for the proper procedures.

(11) Install the fuel supply and return lines to the fuel rail assembly. **Before connecting the fuel lines to the fuel rail replace the O-rings in the quick-connect fuel line couplings.** Refer to Group 14, Fuel System for the proper procedure.

(12) Connect all electrical connections on the intake manifold.

(13) Connect the vacuum connector on the intake manifold and install it in the bracket.

(14) Install throttle cable, cruise control cable (if equipped).

(15) Install the transmission line pressure cable (if equipped).

(16) Install air cleaner assembly.

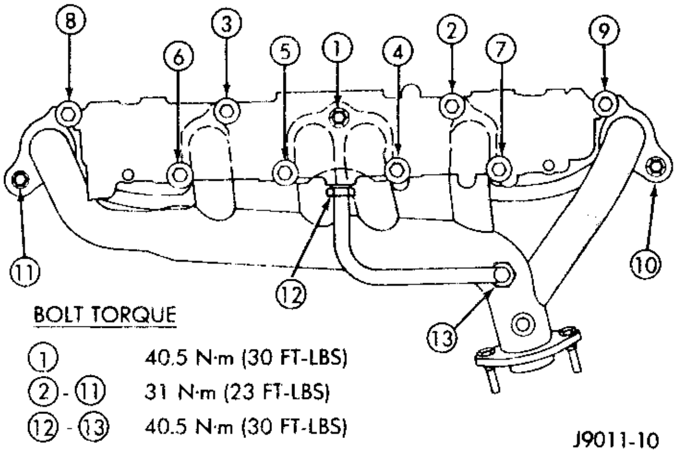


Fig. 19 Intake/Exhaust Manifold Installation

(17) Connect air inlet hose to the throttle plate assembly.

(18) Raise the vehicle on a side mounted hoist.

(19) Using a new seal, connect the exhaust downpipe to the exhaust manifold. Tighten the bolts to 31 N•m (23 ft. lbs.) torque.

(20) Install the oxygen (O_2) sensor, if removed. Tighten the sensor to 48 N•m (35 ft. lbs.) torque.

(21) Connect the oxygen (O_2) sensor connector.

(22) Lower the vehicle.

(23) Fill the cooling system. Refer to Group 7, Cooling System for the proper procedure.

(24) Connect the battery negative cable.

(25) Start the engine and check for leaks.

SERVICE PROCEDURES — YJ VEHICLES

INDEX

EXHAUST DOWNPIPE

Removal

(1) Raise and support the vehicle.

(2) Disconnect the upstream air injection tube from the exhaust dowmpipe port (4.2L engines only - Fig. 1).

(3) Saturate the bolts and nuts with heat valve lubricant (Fig. 2). Allow five (5) minutes for penetration.

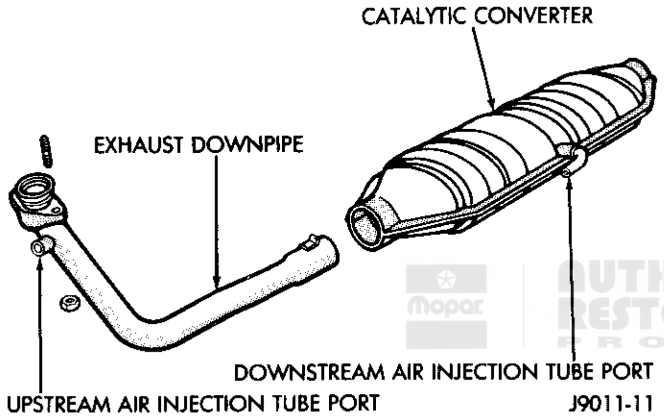


Fig. 1 Upstream and Downstream Air Injection

(4) Disconnect the front exhaust downpipe from the exhaust manifold.

(5) Disconnect the rear end of the downpipe flange from the catalytic converter flange at the support (Fig. 3). Note the bolt locations. Discard the gasket. Remove the exhaust downpipe.

Installation

(1) Using a new gasket, connect the rear of the exhaust downpipe flange to the catalytic converter flange at the support (Fig. 3). Install the bolts and nuts in the same location as removed. Do not tighten the nuts.

(2) Clean the mating surface of the exhaust manifold flange.

(3) Using replacement nuts, connect the exhaust downpipe to the exhaust manifold. Do not tighten the replacement nuts.

(4) Align the exhaust downpipe.

(5) Tighten the nuts at the catalytic converter, exhaust downpipe and support area.

(6) Tighten the exhaust manifold/downpipe nuts to 27 N•m (20 ft. lbs.) torque.

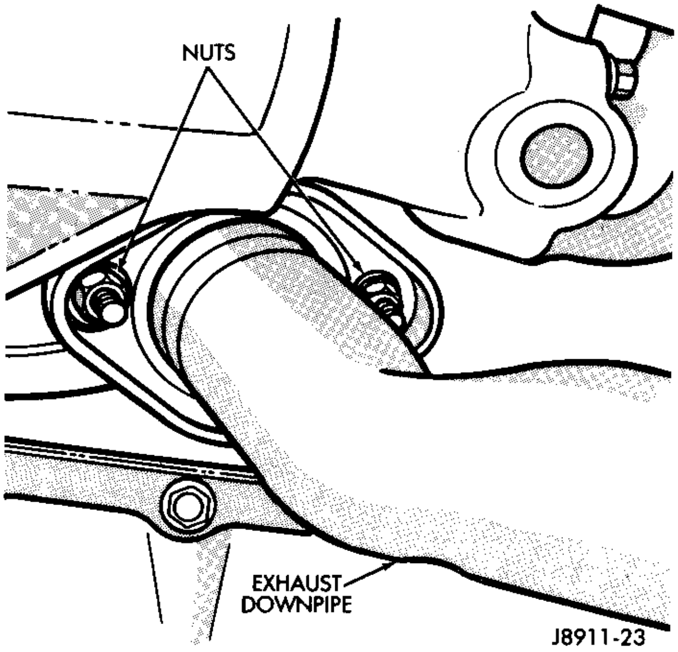


Fig. 2 Exhaust Downpipe-to-Exhaust Manifold Bolts and Nuts

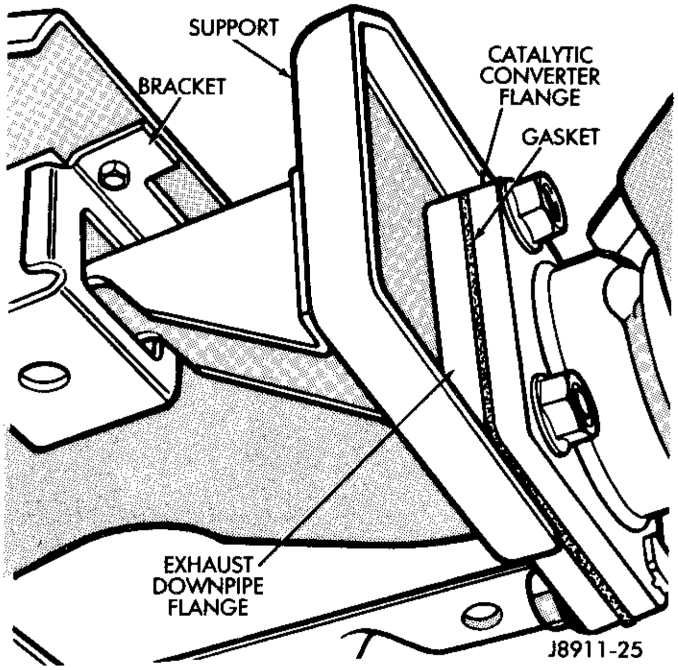


Fig. 3 Exhaust Downpipe-to-Catalytic Converter Connection

(7) Install the upstream air injection tube to the exhaust downpipe port (4.2L engine only).

(8) Lower the vehicle.

CATALYTIC CONVERTER

Removal

(1) Raise and support the vehicle.

(2) Disconnect the downstream air injection tube from the catalytic converter port (4.2L engine only - Fig. 1).

(3) Remove the catalytic converter-to-exhaust downpipe flange bolts at the support area. Note the bolt locations. Discard the gasket.

(4) Remove the clamp from the catalytic converter and muffler connection (Fig. 4).

(5) Heat the catalytic converter and muffler connection with an oxyacetylene torch until the metal becomes cherry red.

(6) While the metal is still cherry red, twist the catalytic converter back and forth to separate it from the muffler.

Installation

(1) Install the new catalytic converter.

(2) Using a new gasket, install the bolts in the exhaust downpipe-to-catalytic converter flanges. Tighten the bolts at the flanges to 34 N•m (25 ft. lbs.) torque.

(3) Install the clamp on the catalytic converter-to-muffler connection. Tighten the nuts to 61 N•m (45 ft. lbs.) torque.

(4) Install the downstream air injection tube to the catalytic converter port (4.2L engines only). Tighten the clamps to 5 N•m (44 in. lbs.) torque.

(5) Lower the vehicle.

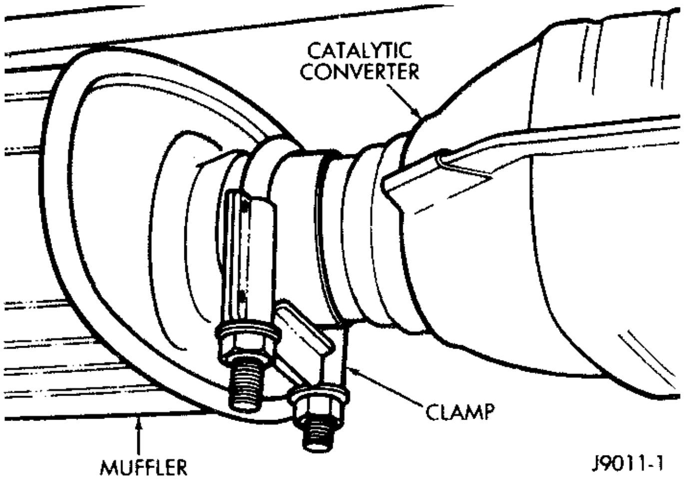


Fig. 4 Catalytic Converter-to-Muffler Connection

MUFFLER AND TAILPIPE

All original equipment exhaust systems are manufactured with the tailpipe welded to the muffler. Service replacement mufflers and tailpipes are clamped together.

Removal

(1) Raise the vehicle and support the rear of the vehicle by the side rails and allow the axle to hang free.

(2) Remove the front muffler clamp from the catalytic converter and muffler connection (Fig. 4).

(3) Remove the tailpipe hanger/bracket (Fig. 5).

(4) Remove the tailpipe from the front tailpipe hanger (Fig. 6).

(5) Heat the converter-to-muffler connection with an oxyacetylene torch until the metal becomes cherry red.

(6) While the metal is still cherry red, place a block of wood against the front of the muffler and drive the muffler rearward to disengage.

(7) Remove the tailpipe/muffler assembly.

(8) Remove the tailpipe from the muffler:

- To remove an original equipment tailpipe/muffler combination, cut the tailpipe close to the muffler. Collapse the part remaining in the muffler and remove.
- To remove a service tailpipe/muffler combination, remove the tailpipe/muffler clamp. Heat the tailpipe-to-muffler connection with an oxyacetylene torch until the metal becomes cherry red. While the metal is still cherry red, twist the tailpipe out of the muffler.

Installation

(1) Install the muffler onto the catalytic converter outlet. Ensure that the locator on the converter aligns with the notch on the muffler, if so equipped. Install the

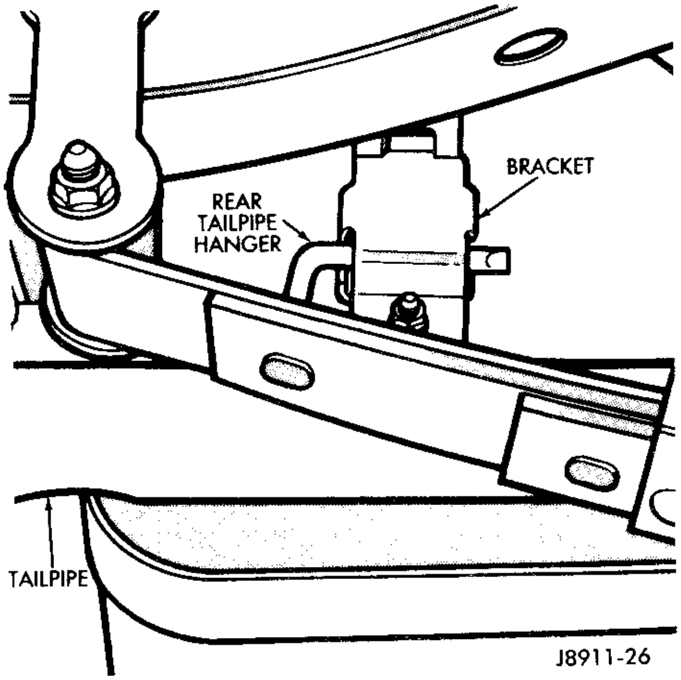


Fig. 5 Rear Tailpipe Hanger/Bracket

clamp and tighten the nuts finger tight.

(2) Install the tailpipe into the muffler outlet. Ensure that the locator on the tailpipe alignes with the notch on the muffler, if so equipped. Install the clamp and tighten the nuts finger tight.

(3) Install the front tailpipe supports and the rear tailpipe hanger. Ensure that the tailpipe has sufficient clearance from the floor pan and shields.

(4) Tighten the nuts on the muffler-to-catalytic converter and the muffler-to-tailpipe clamps to 61 N•m (45 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Start the engine and inspect for exhaust leaks and contact with the body panels and shields.

EXHAUST MANIFOLD - 2.5L ENGINE

Refer to Service Procedures - MJ and XJ Vehicle (Exhaust Manifold) in this section for the proper procedures.

EXHAUST MANIFOLD - 4.2L ENGINE

Removal

(1) Remove the intake manifold. Refer to Intake Manifold Removal in this section for the proper procedure.

(2) Disconnect the exhaust downpipe from the exhaust manifold.

(3) Disconnect the oxygen (O_2) sensor wire connector (Fig. 7). Remove the sensor from the exhaust manifold.

(4) Remove the nuts from the end studs and remove the exhaust manifold.

Cleaning and Inspection

Clean the mating surfaces of the cylinder head and the manifold if the original manifold is to be installed.

Installation

(1) Position the exhaust manifold over the end studs on the cylinder head.

(2) Install the nuts finger-tight on the end studs.

(3) Clean the threads in the bore for the oxygen (O_2) sensor.

(4) Apply an anti-sieze compound to the oxygen (O_2) sensor threads.

(5) Install the oxygen (O_2) sensor. Tighten the sensor to 48 N•m (35 ft. lbs.) torque.

(6) Connect the oxygen (O_2) sensor wire connector.

(7) Connect the exhaust downpipe to the exhaust manifold. Tighten the nuts to 27 N•m (20 ft. lbs.) torque.

(8) Install the EGR valve tube to the exhaust and intake manifolds and tighten the nuts finger tight.

(9) Install the intake manifold. Refer to Intake Manifold Installation in this section for the proper procedure.

(10) Tighten the exhaust manifold nuts 1 and 2 to 41 N•m (30 ft. lbs.) torque and nuts 11 and 12 to 31 N•m (23 ft. lbs.) torque (Fig. 8).

(11) Tighten the EGR valve tube nuts to 41 N•m (30 ft. lbs.) torque.

INTAKE MANIFOLD - 2.5L ENGINE

Refer to Service Procedures - MJ and XJ Vehicle (Intake Manifold) in this section for the proper procedures.

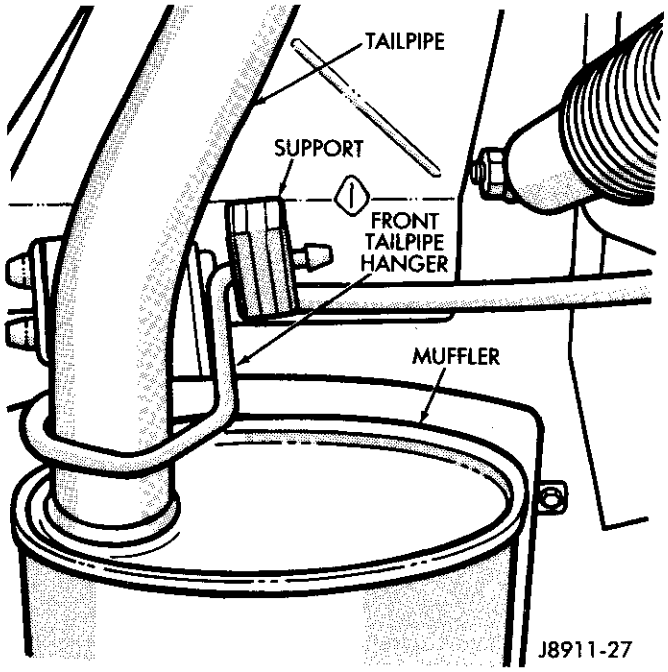


Fig. 6 Front Tailpipe Hanger

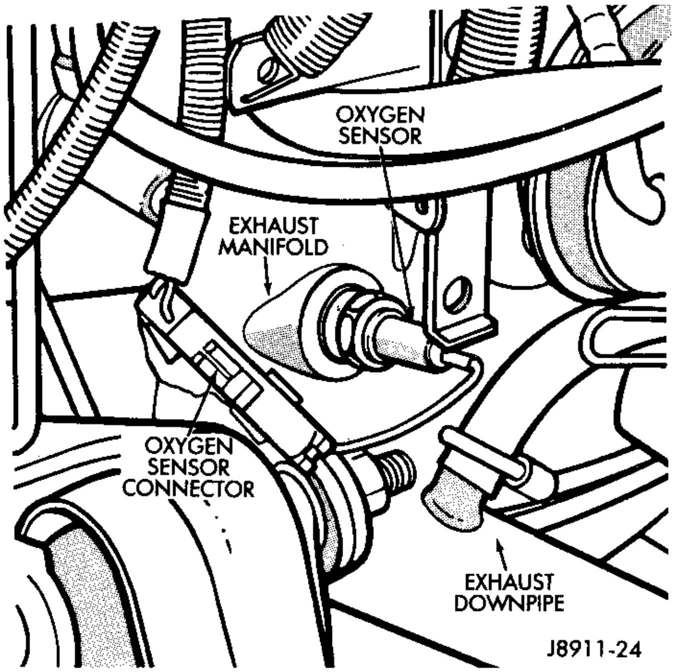


Fig. 7 Oxygen (O_2) Sensor

INTAKE MANIFOLD - 4.2L ENGINE

Removal

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM IS PRESSURIZED.

(1) Remove the radiator cap and draincock to drain the coolant. **Do not waste reusable coolant. If the coolant is acceptable for reuse, drain it into a clean container.**

(2) Remove the air cleaner. Disconnect the fuel pipe, carburetor air horn vent hose, idle speed control vacuum hose and wire connector.

(3) Disconnect the coolant hoses from the intake manifold.

(4) Disconnect the throttle cable from the bellcrank.

(5) Disconnect the positive crankcase ventilation (PCV) valve vacuum hose from the intake manifold.

(6) Remove the vacuum advance coolant temperature operated (CTO) valve vacuum hoses.

(7) Disconnect the computerized emission control (CEC) system coolant temperature sender wire connector (located on the intake manifold).

(8) Disconnect the vacuum hose from the exhaust gas recirculation (EGR) system valve.

(9) Disconnect the intake manifold electric heater wire connector.

(10) Remove the carburetor from the intake manifold. After removing the carburetor from the intake manifold, set it to one side with the vacuum hoses still attached.

(11) Remove the power steering mounting bracket, if equipped.

(12) Detach the power steering pump and set aside, if equipped. Do not remove the hoses.

(13) Remove the A/C compressor drive belt idler pulley assembly from the cylinder head, if equipped.

(14) Disconnect the throttle valve linkage, if equipped with an automatic transmission.

(15) Disconnect the EGR valve tube from the intake manifold (Fig. 9).

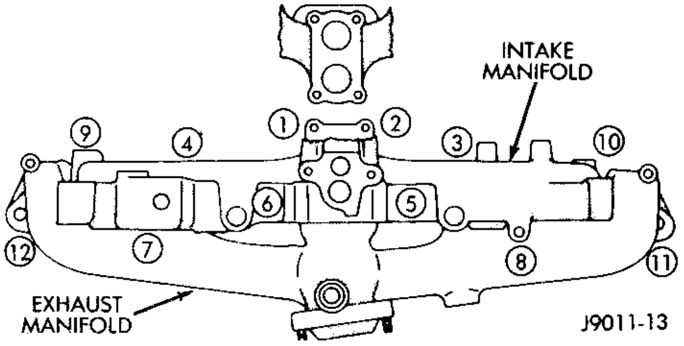


Fig. 8 Exhaust/Intake Manifold Bolt/Nut Tightening Sequence

(16) Remove the intake manifold attaching bolts, nuts and clamps. Remove the intake manifold. Discard the gasket.

If the manifold is being replaced, ensure all the fittings etc., are transferred to the replacement manifold.

Cleaning and Inspection

Clean the mating surfaces on the manifold and cylinder head.

Installation

(1) Position a replacement intake manifold gasket on the cylinder head and install the intake manifold (Fig. 9).

(2) Install the remaining attaching hardware.

(3) Tighten bolts and nuts in sequence (3-10) to 31 N•m (23 ft. lbs.) torque (Fig. 8).

(4) Install the vacuum hoses.

(5) Install the carburetor studs, replacement gaskets and spacer.

(6) Install the carburetor and connect the linkage and hoses.

(7) Tighten the carburetor mounting nuts to 19 N•m (14 ft. lbs.) torque.

(8) Connect the fuel pipe and air horn vent hose to the carburetor.

(9) Connect the idle speed control vacuum hose and wire connector.

(10) Connect the choke heater wire connector.

(11) Install the A/C compressor drive belt idler pulley assembly, if removed.

(12) Install the power steering pump mounting bracket, if removed.

(13) Install the drive belt(s) and tighten to the specified tension. Refer to Group 7, Cooling System for the proper procedures.

(14) Install the vacuum advance CTO valve vacuum hoses.

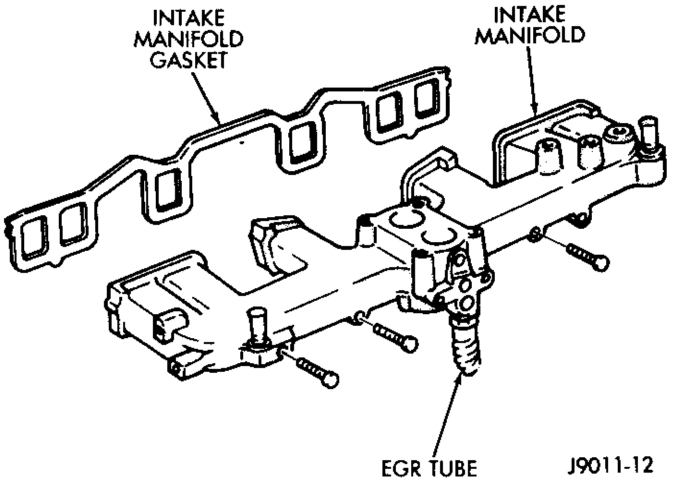


Fig. 9 Intake Manifold and Gasket

(15) Connect the CEC (feedback) system coolant temperature sender wire connector.

(16) Connect the electric intake manifold heater wire connector.

(17) Connect the EGR valve tube to the intake manifold (Fig. 9).

(18) Connect the coolant hoses to the intake manifold.

(19) Connect the vacuum hose to the EGR valve.

(20) Connect the throttle cable and the PCV valve hose. Connect the throttle valve rod retainer and spring.

(21) Install the air cleaner.

(22) Refill the cooling system with coolant.

(23) If replacement coolant is being used, ensure that the mixture of antifreeze and low mineral content water is acceptable for the climate.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(24) Start the engine and inspect for leaks. Repair as necessary.

PULSE AIR SYSTEM

General Information

The Pulse Air System (air injection) utilizes the alternating positive and negative exhaust pressure pulsations instead of an air pump to inject air into the exhaust system and produce exhaust gas oxidation (Fig. 10).

The air is routed from the filtered side of the air cleaner through a hose to the air control valve.

When opened by the air switch solenoid, the air control valve allows the air to continue to and through the air injection check valve.

The air enters the exhaust system (upstream or downstream) from the check valve. Air is injected either into the front exhaust pipe (upstream) or into the catalytic converter (downstream) depending upon engine operating conditions.

The CEC system micro computer unit (MCU) controls the switching operation.

Refer to Group 14 Fuel System for the diagnosis of the system.

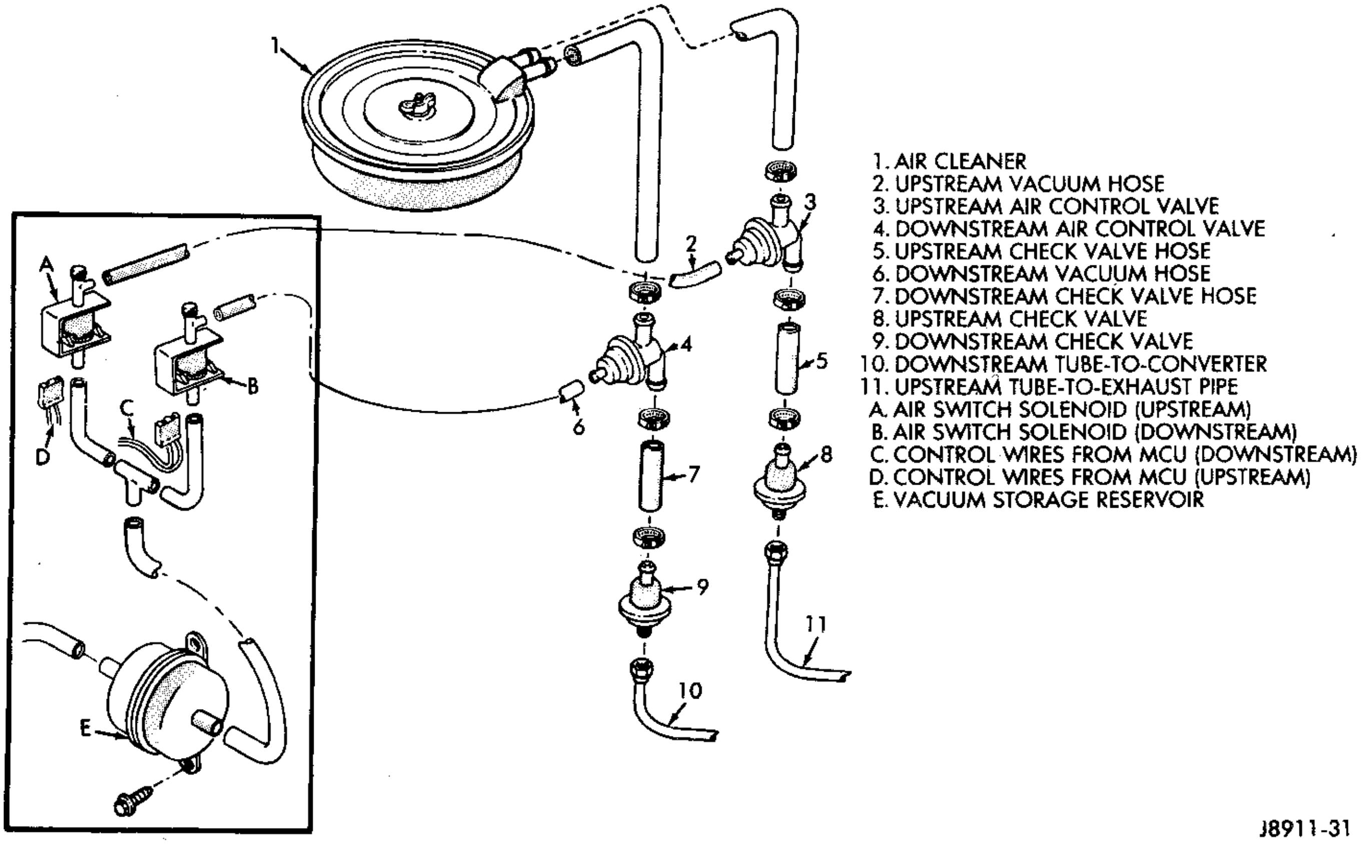


Fig. 10 Pulse Air System

Air Injection Check Valve

The air injection check valve is a reed valve that is opened and closed by the negative and positive exhaust pressure pulsations.

During the negative exhaust pulse (low pressure) atmospheric pressure opens the check valve and forces air into the exhaust system.

Air Control Valve

The air control valve controls the supply of filtered air routed to the air injection check valve. The valve is opened and closed by the air switch solenoid.

Air Switch Solenoid

The air switch solenoid controls the air control valve by switching vacuum on and off. The solenoid is controlled by the micro computer unit (MCU).

Vacuum Storage Tank

Vacuum is stored in the tank until released by the air switch solenoid.

Micro Computer Unit (MCU)

The MCU switches air either UPSTREAM or DOWNSTREAM, depending upon the engine operating conditions by energizing and de-energizing the air switch solenoids.

SERVICE PROCEDURES — SJ VEHICLES

INDEX

EXHAUST DOWNPIPE

Removal

(1) Raise and support the vehicle.

(2) Disconnect the exhaust downpipe from the exhaust manifolds. Discard the seal.

(3) Disconnect the rear end of the downpipe from the catalytic converter (Fig. 1).

(4) Disconnect the downpipe from the support bracket.

Cleaning

Clean the mating surface of the exhaust manifold flange.

Installation

(1) Install the exhaust downpipe to the support bracket and finger tighten the nut to the bolt.

(2) Connect the rear of the downpipe to the catalytic converter. Do not tighten the nuts.

(3) Connect the exhaust downpipe to the manifold, but do not tighten. Use replacement nuts.

(4) Align the pipe. Tighten the clamp at the catalytic converter.

(5) Secure the downpipe flange to the manifold flange. Tighten the nuts to 27 N•m (20 ft. lbs.) torque.

(6) Tighten the nut at the support bracket.

(7) Lower the vehicle.

CATALYTIC CONVERTER

Removal

(1) Raise and support the vehicle.

(2) Remove the catalytic converter-to-exhaust downpipe flange clamp.

(3) Remove the clamp from the catalytic converter and muffler connection (Fig. 2).

(4) Heat the catalytic converter and muffler connection with an oxyacetylene torch until the metal becomes cherry red.

(5) While the metal is still cherry red, twist the catalytic converter back and forth to separate it from the muffler.

Installation

(1) Install a new catalytic converter.

(2) Install the clamp on the exhaust downpipe-to-catalytic converter connection. Tighten the nuts to 61 N•m (45 ft. lbs.) torque.

(3) Install the clamp on the catalytic converter-to-muffler connection. Tighten the nuts to 61 N•m (45 ft. lbs.) torque.

(4) Lower the vehicle.

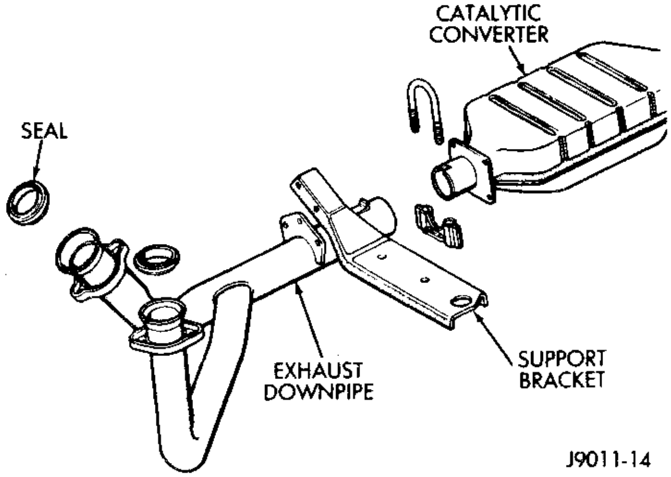


Fig. 1 Exhaust Downpipe

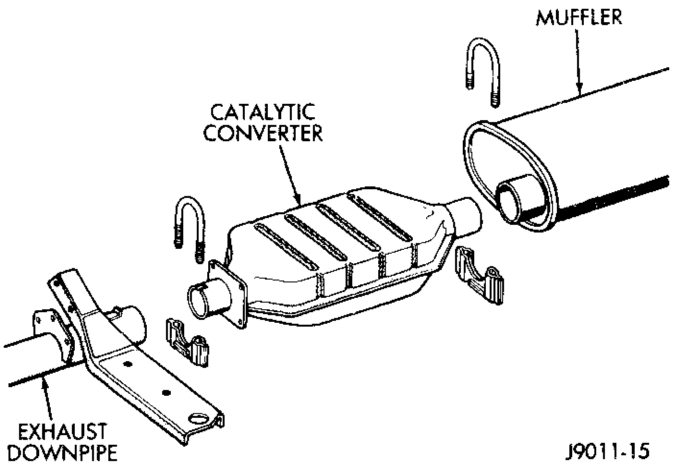


Fig. 2 Catalytic Converter-to-Muffler Connection

MUFFLER AND TAILPIPE

All original equipment exhaust systems are manufactured with the tailpipe clamped to the muffler. Service replacement mufflers and tailpipes are also clamped together.

Removal

(1) Raise the vehicle and support the rear of the vehicle by the side rails and allow the axle to hang free.

(2) Remove the rear muffler clamp from the muffler and tailpipe connection (Fig. 3).

(3) Remove the tailpipe hanger/bracket (Fig. 3) from both front and rear.

(4) Heat the muffler-to-tailpipe connection with an oxyacetylene torch until the metal becomes cherry red.

(5) While the metal is still cherry red, twist the tailpipe out of the muffler.

(6) Remove the front muffler clamp from the catalytic converter and muffler connection (Fig. 2).

(7) Heat the catalytic converter-to-muffler connection with an oxyacetylene torch until the metal becomes cherry red.

(8) While the metal is still cherry red, twist the muffler off the catalytic converter.

Installation

(1) Install the muffler onto the catalytic converter outlet. Ensure that the locator on the converter aligns with the notch on the muffler, if so equipped. Install the clamp and tighten the nuts finger tight (Fig. 4).

(2) Install the tailpipe into the muffler outlet. Ensure that the locator on the tailpipe aligns with the notch on the muffler, if so equipped. Install the clamp and tighten the nuts finger tight (Fig. 4).

(3) Install the front tailpipe wupports and rear tailpipe hanger. Ensure that the tailpipe has sufficient clearance from the floor pan and shields.

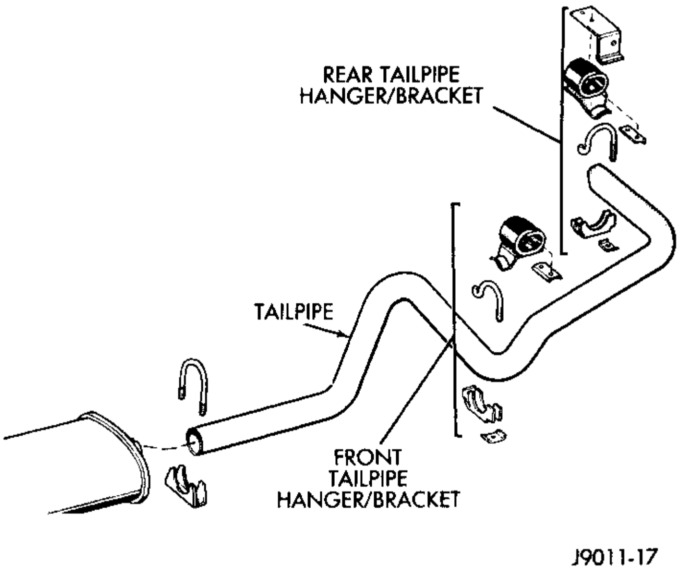


Fig. 3 Rear Tailpipe Hanger/Bracket

(4) Tighten the nuts on the muffler-to-catalytic converter and the muffler-to-tailpipe clamps to 61 N•m (45 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Start the engine and inspect for exhaust leaks and contact with the body panels and shields.

EXHAUST MANIFOLDS

Removal

(1) Disconnect the ignition wires.

(2) Disconnect the air hose at the injection manifold.

(3) Raise and support the vehicle.

(4) Disconnect the exhaust pipe at the exhaust manifold.

(5) Remove the exhaust manifold retaining bolts.

(6) Separate the exhaust manifold from the cylinder head.

(7) Remove the air injection manifold, fittings and washers.

Cleaning and Inspection

Clean the mating surfaces of the exhaust manifold and cylinder head. Do not nick or scratch the surfaces.

Installation

(1) Install the air injection manifold on the exhaust manifold.

CAUTION: The correct bolts and washers must be used to allow the manifold to expand and prevent cracking.

(2) Install the exhaust manifold and retaining bolts. Tighten the two center bolts to 34 N•m (25 ft. lbs.) torque. Tighten the four outer bolts to 20 N•m (15 ft. lbs.) torque.

(3) Connect the exhaust downpipe using a replacement seal, if required.

Tighten the nuts to 27 N•m (20 ft. lbs.) torque.

(4) Lower the vehicle.

(5) Connect the air hose to the air injection manifold.

(6) Connect the ignition wires.

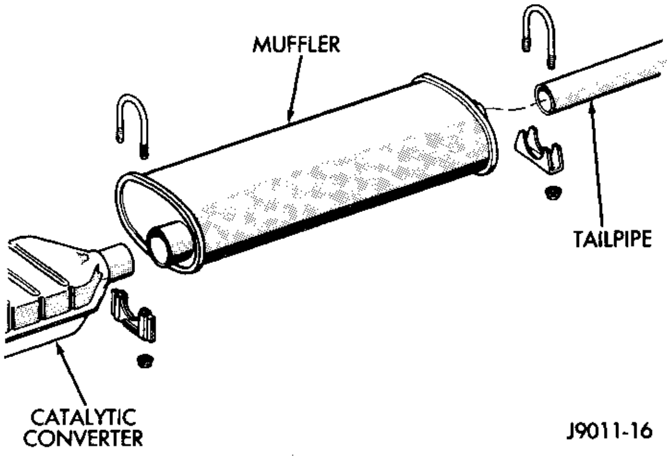


Fig. 4 Muffler Installation

EXHAUST MANIFOLD HEAT VALVE

Removal

(1) Raise and support the vehicle.

(2) Disconnect and lower the exhaust downpipe.

(3) Remove the heat valve and gasket.

Installation

(1) Install a new heat valve and gasket.

(2) Install new exhaust downpipe seals.

(3) Position the exhaust downpipe and connect it to the exhaust manifold.

(4) Tighten the exhaust downpipe to manifold nuts to 27 N•m (20 ft. lbs.) torque.

(5) Lower the vehicle.

INTAKE MANIFOLDS

Removal

WARNING: IF THE ENGINE HAS BEEN RECENTLY OPERATED, USE CARE TO PREVENT SCALDING BY HOT COOLANT. THE SYSTEM IS PRESSURIZED.

(1) Drain the coolant from the radiator and cylinder block. If the coolant is reusable, drain it into a clean container. Refer to Group 7, Cooling System for the proper procedures.

(2) Remove the air cleaner assembly.

(3) Disconnect the ignition wires.

(4) Remove the ignition wire plastic separators from the cylinder head cover brackets.

(5) Disconnect the radiator upper hose and bypass hose from the intake manifold.

(6) Disconnect and move aside the wire from the coolant temperature gauge sending unit.

(7) Disconnect the ignition coil bracket and move the coil and bracket assembly aside.

(8) Disconnect the heater hose from the rear of the manifold.

(9) Identify and disconnect all hoses, pipes and wire connectors from the carburetor assembly.

(10) Disconnect the throttle and throttle valve linkage from the carburetor and intake manifold.

(11) Disconnect the air hoses from the air injection manifolds.

(12) Disconnect the diverter valve from the air pump output hose and move the valve and air hoses aside.

(13) Remove the carburetor.

(14) Remove the intake manifold, metal gasket and end seals.

Cleaning and Inspection

Clean the gasket mating surfaces of the engine block, cylinder head and intake manifold.

Installation

When installing a replacement intake manifold, transfer all the components (i.e., EGR valve and back-pressure sensor, EGR CTO valve, thermostat housing and coolant temperature gauge sending unit) from the original manifold. Clean and tighten the components as required.

(1) Apply a nonhardening sealer or RTV silicone sealant such as Gasket-In-A-Tube, or equivalent, to both sides of the replacement manifold gasket.

(2) Position the gasket by aligning the locators at the rear of the cylinder head. While holding the rear of the gasket in place, align the front locators.

(3) Install the two end seals. Apply Permatex No. 2, Gasket-In-A-Tube, or equivalent, to the seal ends.

(4) Install the intake manifold and retaining bolts. Ensure all bolts are properly started before tightening. Tighten all intake manifold bolts to 58 N•m (43 ft. lbs.) torque.

(5) Install the diverter valve and connect the air pump output hose.

(6) Connect the air hoses to the air injection manifolds.

(7) Identify and connect all the disconnected hoses, pipes, linkages and wires to the intake manifold and carburetor.

(8) Install the ignition coil and bracket assembly.

(9) Connect the radiator upper hose and bypass hose.

(10) Install the ignition wire plastic separators on the cylinder head cover brackets.

(11) Connect the ignition wires.

(12) Install the air cleaner assembly.

(13) Add coolant as necessary.

AIR INJECTION SYSTEM

General

The air injection system (Fig. 5) consists of:

- A belt driven air pump.
- A vacuum controlled diverter (bypass) valve.
- Two air injection manifolds with check valves.
- Connecting hoses.

Air Pump

The major components of the air pump (Fig. 6) are enclosed in a die-cast aluminum housing.

A filter-fan assembly, rotor shaft and drive hub are visible on the exterior of the pump (Fig. 6).

The pump is designed for long life and is serviceable only by replacement.

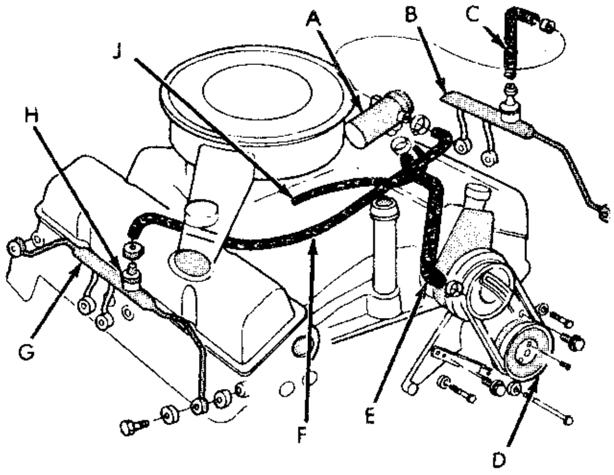
Do not remove the rear cover from the housing for any reason. The internal components are not serviceable.

Service Precautions

The following list of service precautions are for preventing damage to the air pump.

- Do not attempt to prevent the pulley from rotating by inserting tools into the filter-fan.

- Do not operate an engine with the pump belt removed or disconnected, except for noise diagnosis.
- Do not attempt to lubricate any part of the pump.
- Do not clean the filter.



A. DIVERTER (BYPASS) VALVE
B. AIR INJECTION MANIFOLD (LEFT)
C. AIR HOSE — DIVERTER VALVE-TO-AIR INJECTION MANIFOLD (LEFT)
D. AIR PUMP
E. AIR HOSE — AIR PUMP-TO-DIVERTER VALVE
F. AIR HOSE — DIVERTER VALVE-TO-AIR INJECTION MANIFOLD (RIGHT)
G. AIR INJECTION MANIFOLD (RIGHT)
H. CHECK VALVE
J. VACUUM HOSE FROM INTAKE MANIFOLD

Fig. 5 Air Injection System

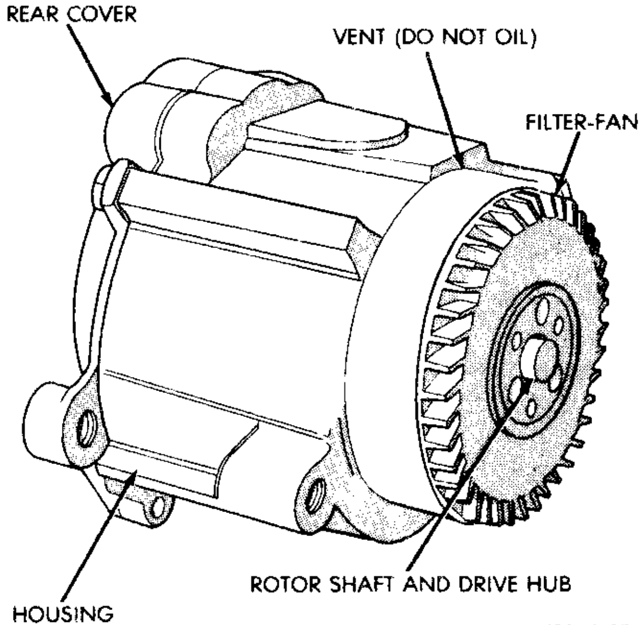


Fig. 6 Air Pump Components

- Do not disassemble the pump of remove the rear cover.
- Do not exceed 27 N•m (20 ft. lbs.) torque when tightening the mounting bolts.
- Do not pry on the aluminum housing to adjust the belt tension.
- Do not clamp the pump in a vise.
- Do not permit liquids to enter the pump when steam or water pressure cleaning the engine.

Replacement

The air pump is not serviceable and must be replaced, if defective.

(1) Disconnect the output hose from the pump.

(2) Loosen the mount bracket-to-pump attaching bolts.

(3) Remove the drive belt.

(4) Remove the pivot bolt and brace bolts.

(5) Remove the pump.

(6) Position the replacement pump at the mounting location and install the pivot and brace attaching bolts. Do not tighten the bolts.

CAUTION: Adjust the belt tension by hand only.

(7) Install the drive belt and adjust to the specified tension. Refer to Group 7, Cooling System for the proper procedures.

(8) Tighten the mounting bolts and adjustment strap bolt to 27 N•m (20 ft. lbs.) torque.

Diverter (Bypass) Valve

The diverter (bypass) valve has two outlets; one for each air injection manifold (Fig. 7).

The valve momentarily diverts air pump outlet from the manifolds and vents it to the atmosphere during rapid engine deceleration.

The valve also functions as a pressure release valve for excessive air pump output.

Functional Test

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

Start the engine and operate it at idle speed.

Examine the diverter valve vent.

Little or no air should flow from the vent.

Accelerate the engine to a speed of 2000-3000 rpm and rapidly close the throttle.

A strong flow of air should pass from the diverter valve vent for approximately three (3) seconds.

If air does not flow or if the engine backfires, ensure that the vacuum hose has vacuum and that there is no air leakage.

The diverter valve diverts and vents air pump output when a manifold vacuum of 68 kPa (20 in. Hg) or more is applied to the diaphragm. The valve also vents when the air pump output exceeds 35 kPa (5 psi).

Slowly accelerate the engine.

Between 2500 and 3500 rpm, air should begin to flow from the diverter valve vent.

If vacuum is present at the valve and it does not function as described above, replace it.

Replacement

The diverter valve is not serviceable and must be replaced, if defective.

(1) The valve is attached to a bracket. Disconnect the air hoses, vacuum hose and bracket clamp.

(2) To install, connect the air hoses, vacuum hose and bracket clamp.

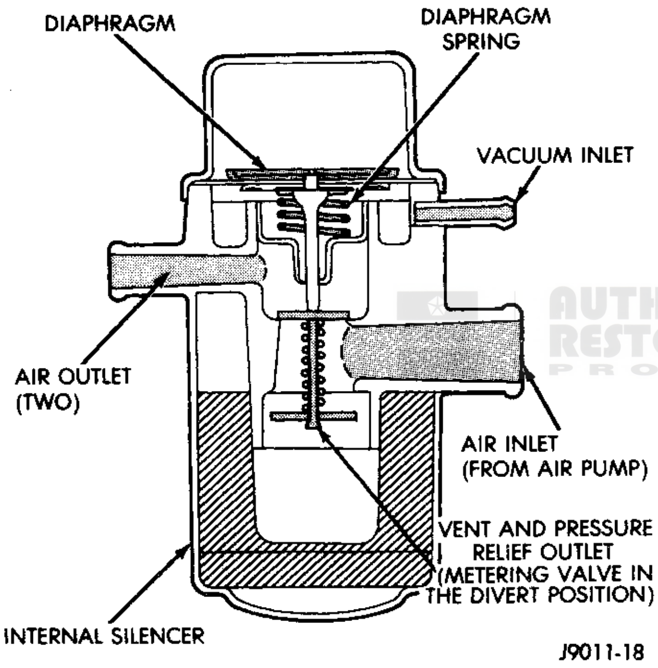


Fig. 7 Diverter (Bypass) Valve Components

Air Injection Manifolds

The air injection manifolds distribute air via the diverter valve to each of the exhaust manifold inlet ports.

A check valve, incorporating a stainless steel spring plunger and an asbestos seat, is integral with each air injection manifold.

The function of the check valve is to prevent the reverse flow of exhaust gas to the air pump during pump or drive belt failure, or diverter valve bypass (vent) operation.

The air injection manifold distribution tubes are connected directly to the exhaust manifold and route the airflow into the inlet ports.

Check Valve Functional Test

To test the check valves for proper operation, disconnect the air hoses at the air injection manifolds.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

With the engine operating above idle speed, listen and feel for exhaust gas leakage from the check valves. A slight leak is normal.

Replacement

(1) Disconnect the air hoses at the check valve.

(2) Remove the distribution tube fittings from the exhaust manifold inlet ports. Some resistance to turning may be encountered because of carbon build-up on the threads.

(3) Remove the air injection manifold.

(4) Duplicate the procedure for the other manifold.

(5) Install the replacement manifolds with a replacement gasket positioned on either side of each inlet port.

(6) Install the manifold distribution fittings on the exhaust manifold.

(7) Tighten the fittings to 52 N•m (38 ft. lbs.) torque.

(8) Connect the air hoses to the check valves.

TORQUE SPECIFICATIONS

COMPONENTS	ENGINES	TORQUES
Air Injection Manifold Fittings	5.9L	52 N•m 38 ft-lbs
Air Pump Adjustment Strap	5.9L	27 N•m 20 ft-lbs
Air Pump Mounting Bolts	5.9L	27 N•m 20 ft-lbs
Carburetor Mounting Nuts	5.9L	19 N•m 14 ft-lbs
Catalytic Converter-to-Muffler Clamp Nuts	4.2L & 5.9L	61 N•m 45 ft-lbs
Downpipe-to-Catalytic Converter Nuts	4.2L	34 N•m 25 ft-lbs
Downpipe-to-Catalytic Converter Clamp Nuts	5.9L	61 N•m 45 ft-lbs
Downpipe-to-Exhaust Manifold Nuts	2.5L & 4.0L	31 N•m 23 ft-lbs
Downpipe-to-Exhaust Manifold Nuts	4.2L & 5.9L	27 N•m 20 ft-lbs
Downstream Tube-to-Catalytic Converter Clamp	4.2L	5 N•m (44 in-lbs)
Exhaust Manifold Bolts/Nuts	2.5L	41 N•m 30 ft-lbs
Exhaust Manifold Middle Nuts	4.0L & 4.2L	41 N•m 30 ft-lbs
Exhaust Manifold Outside Nuts	4.0L & 4.2L	31 N•m 23 ft-lbs
Exhaust Manifold Center Two Bolts	5.9L	34 N•m 25 ft-lbs
Exhaust Manifold Outer Four Bolts	5.9L	20 N•m 15 ft-lbs
EGR Tube Nuts	2.5L, 4.0L & 4.2L	41 N•m 30 ft-lbs
EGR Tube Bolts	2.5L	19 N•m 14 ft-lbs
Intake Manifold Bolts	2.5L, 4.0L & 4.2L	31 N•m 23 ft-lbs
Intake Manifold Bolts	5.9L	58 N•m 43 ft-lbs
Oxygen Sensor	2.6L, 4.0L & 4.2L	48 N•m 35 ft-lbs

J8911-39

BODY AND FRAME CONSTRUCTION

CONTENTS

UNIBODY CONSTRUCTION

GENERAL INFORMATION

Jeep MJ and XJ series vehicles are unibody construction, they do not have a conventional frame to which the body is bolted.

Special high-strength steels and coated metals were developed to save weight and to have the necessary strength to handle the forces required of structural parts. These parts give the unibody its strength.

A vehicle with unibody construction reacts differently than a vehicle with a frame.

While damage at the point of impact can easily be seen, the rest of the damage must be systematically examined.

There are five (5) logical areas in analyzing damage to a vehicle with unibody construction.

(1) Where vehicle was hit (primary area).
(2) Other body damage (secondary damage).
(3) Mechanical components.
(4) Interior trim and accessories.
(5) Exterior trim and components.

Usually in making a repair, you do things in reverse order of the collision. You must use a logical approach.

When you have collision damage on a unibody vehicle, the critical control points must be brought back to manufacturers specifications. This means:

(1) Accurate measuring.
(2) Measure often.
(3) Recheck your measurements.

You can do the job right the first time if you do the basic structural details of unibody construction and the basic steps that must be performed to repair collision damage (Figs. 1,2,3,4, and 5).

FRAME CONSTRUCTION

INDEX

GENERAL INFORMATION

The frame is the foundation and structural center of the vehicle. In addition to carrying the load, it mounts and supports the power unit while maintaining correct relationship and alignment of the power train. This relationship assures normal functioning of the units and freedom from excessive wear, stress, and strain. The frame is constructed of heavy channel steel siderails and crossmembers. The crossmembers maintain the proper positions of the siderails in direct relationship to each other, providing maximum resistance to torsional twist and strains.

In the event of collision damage, it is important that the frame alignment be checked and realigned to frame dimensions shown on the individual dimension charts (Figs. 6 through 8). Wheel geometry and axle alignment should be checked.

INSPECTION

Improper frame alignment is usually a result of an accident or vehicle being operated with excessive loads or with loads not positioned in a reasonably distributed manner.

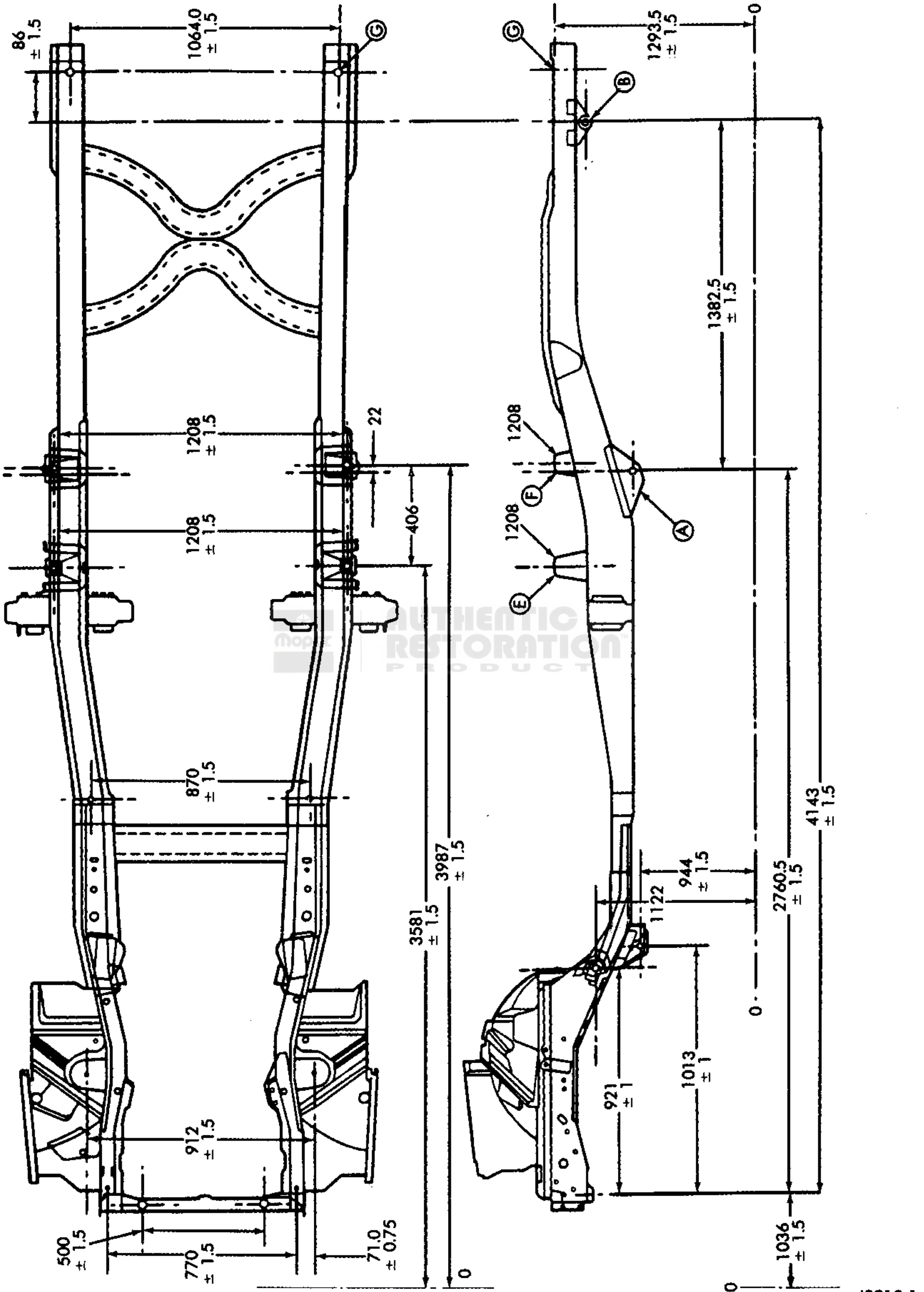
A distorted frame will affect front axle or rear axle alignment and cause excessive wear, mechanical failures in power train, window glass cracks, and door opening problems. Vehicle performance, handling, and ride quality can be impaired.

Before proceeding with frame alignment checks, inspect all frame parts for visible damage such as cracks, twists, bends. or other excessive deformations. Also, riveted, bolted, or welded connections, looseness, or missing parts.

All damaged areas must be repaired or parts replaced as necessary.

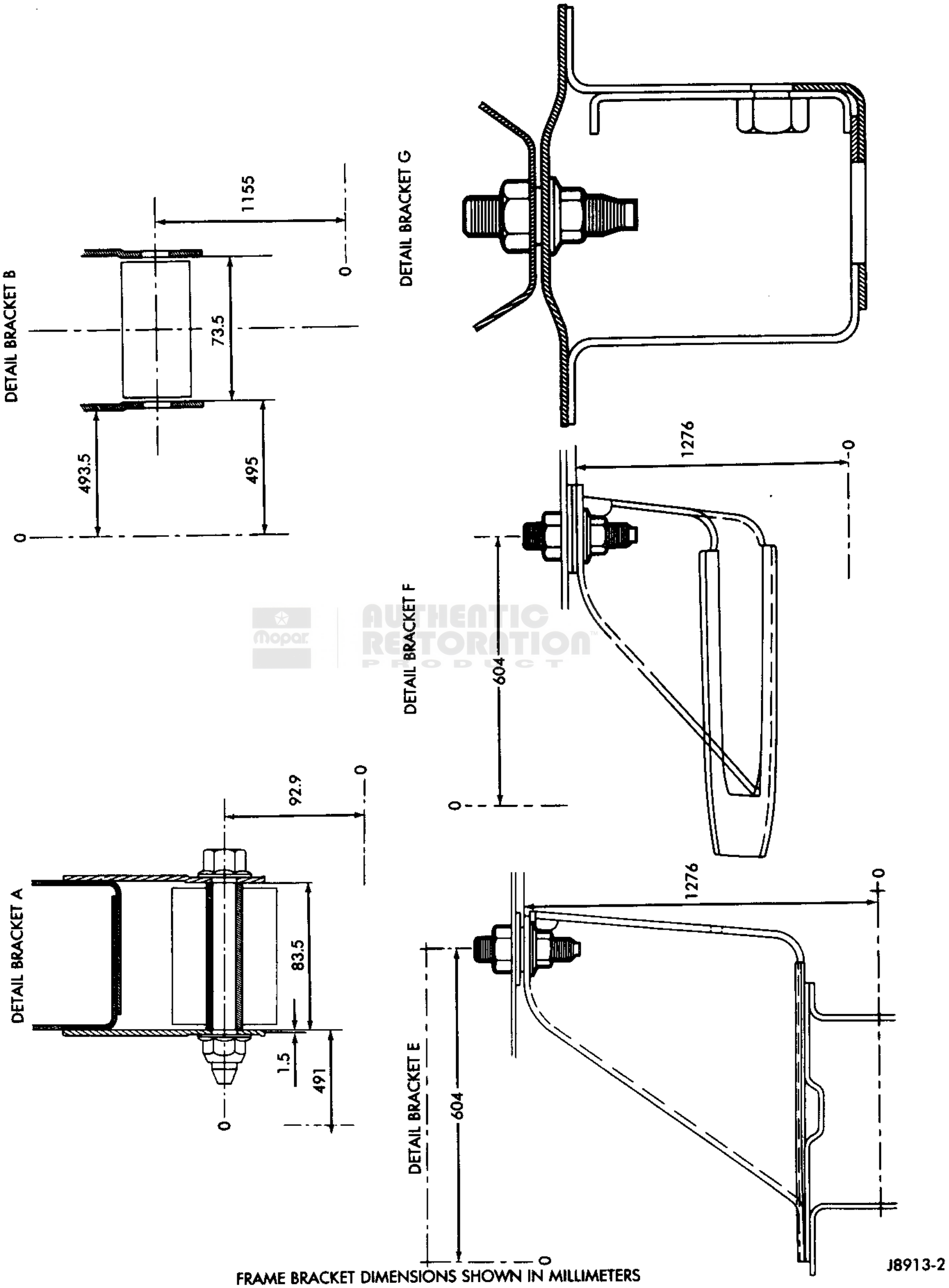
Horizontal or Diagonal

Determine frame deviation from being square by the following procedure:



FRAME DIMENSIONS SHOWN IN MILLIMETERS

Fig. 1 Frame Alignment Dimensions — MJ Models (Short Bed)



FRAME BRACKET DIMENSIONS SHOWN IN MILLIMETERS

Fig. 2 Frame Bracket Dimensions — MJ Models (Short Bed)

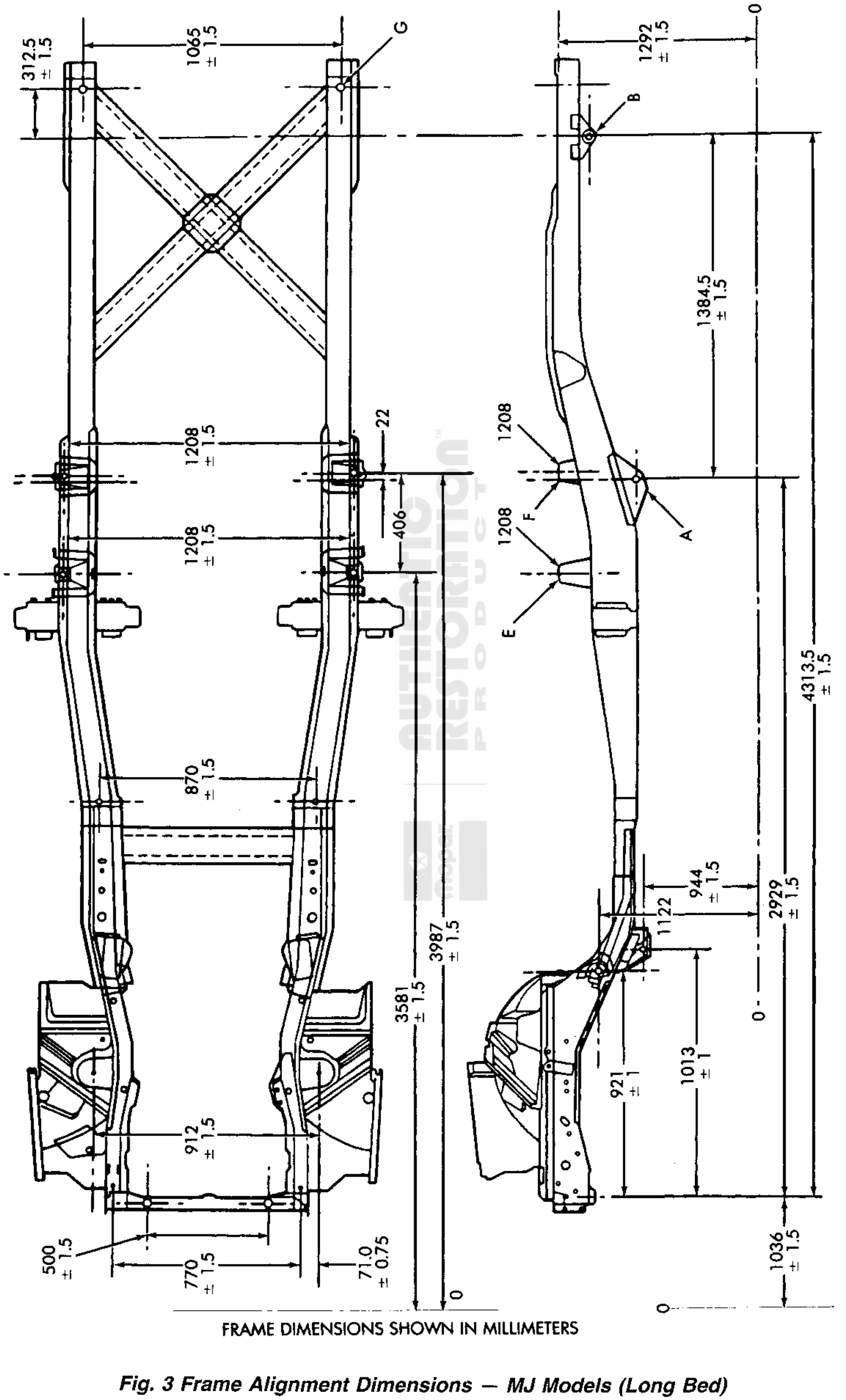


Fig. 3 Frame Alignment Dimensions — MJ Models (Long Bed)

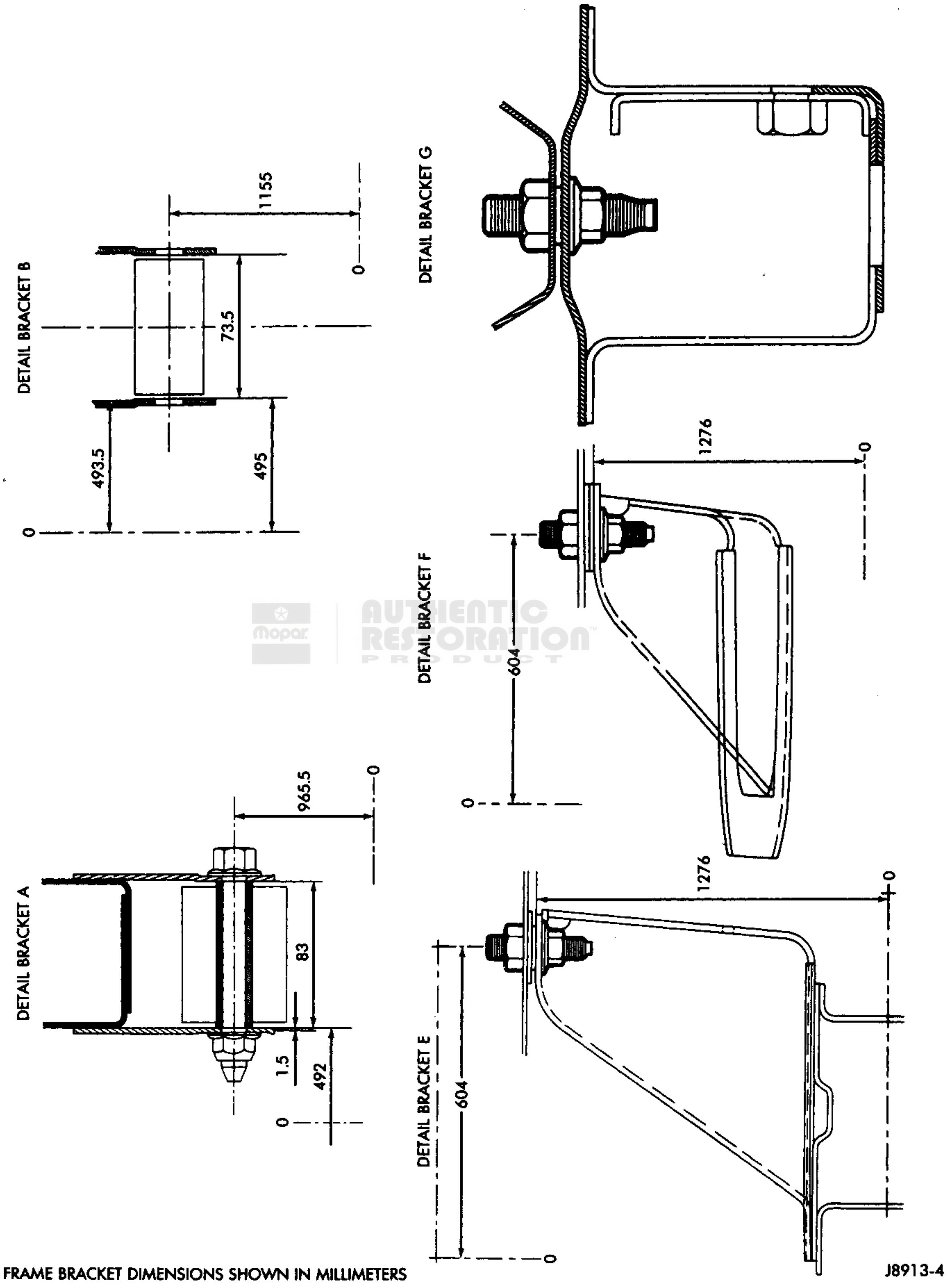


Fig. 4 Frame Bracket Dimensions — MJ Models (Long Bed)

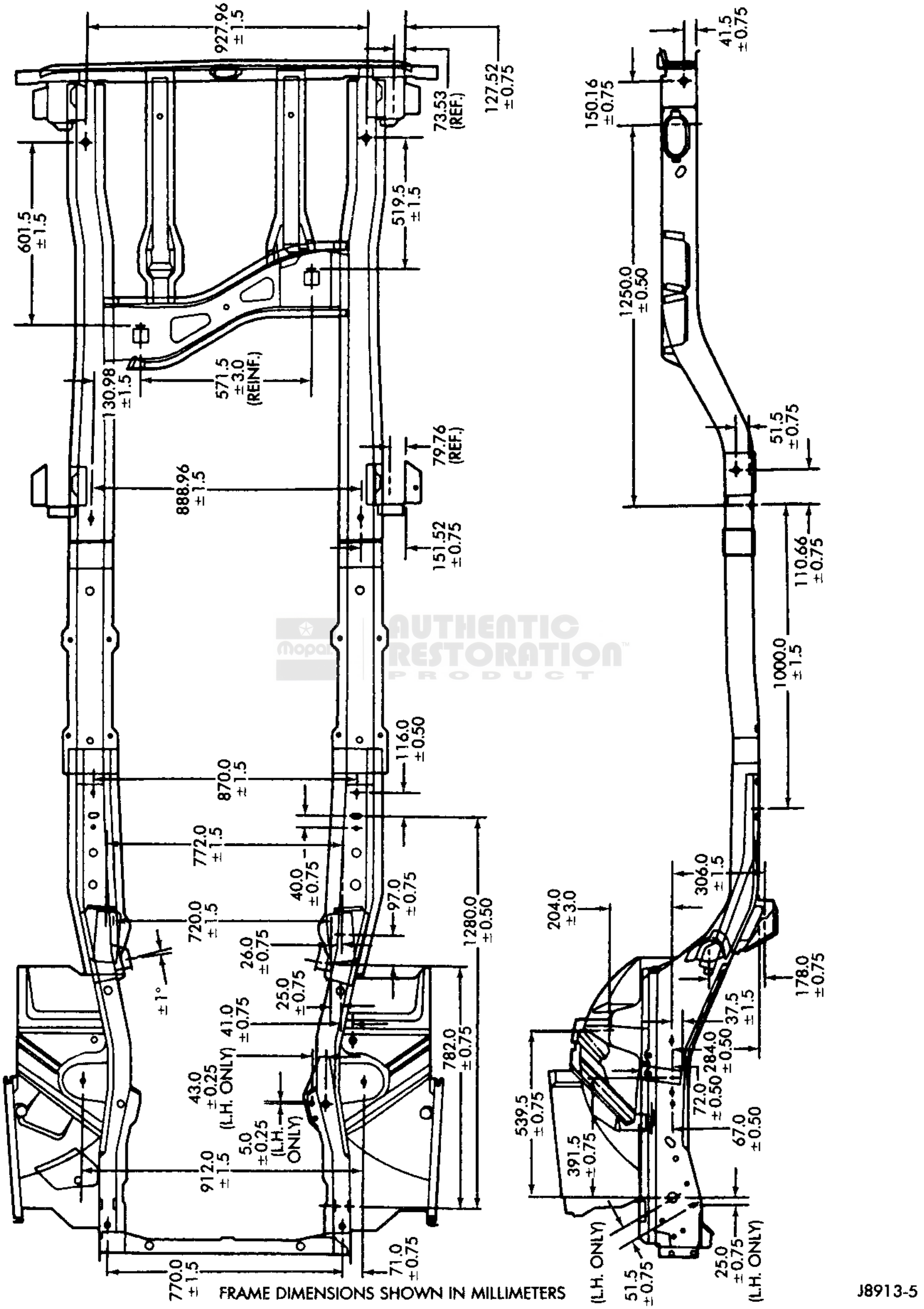
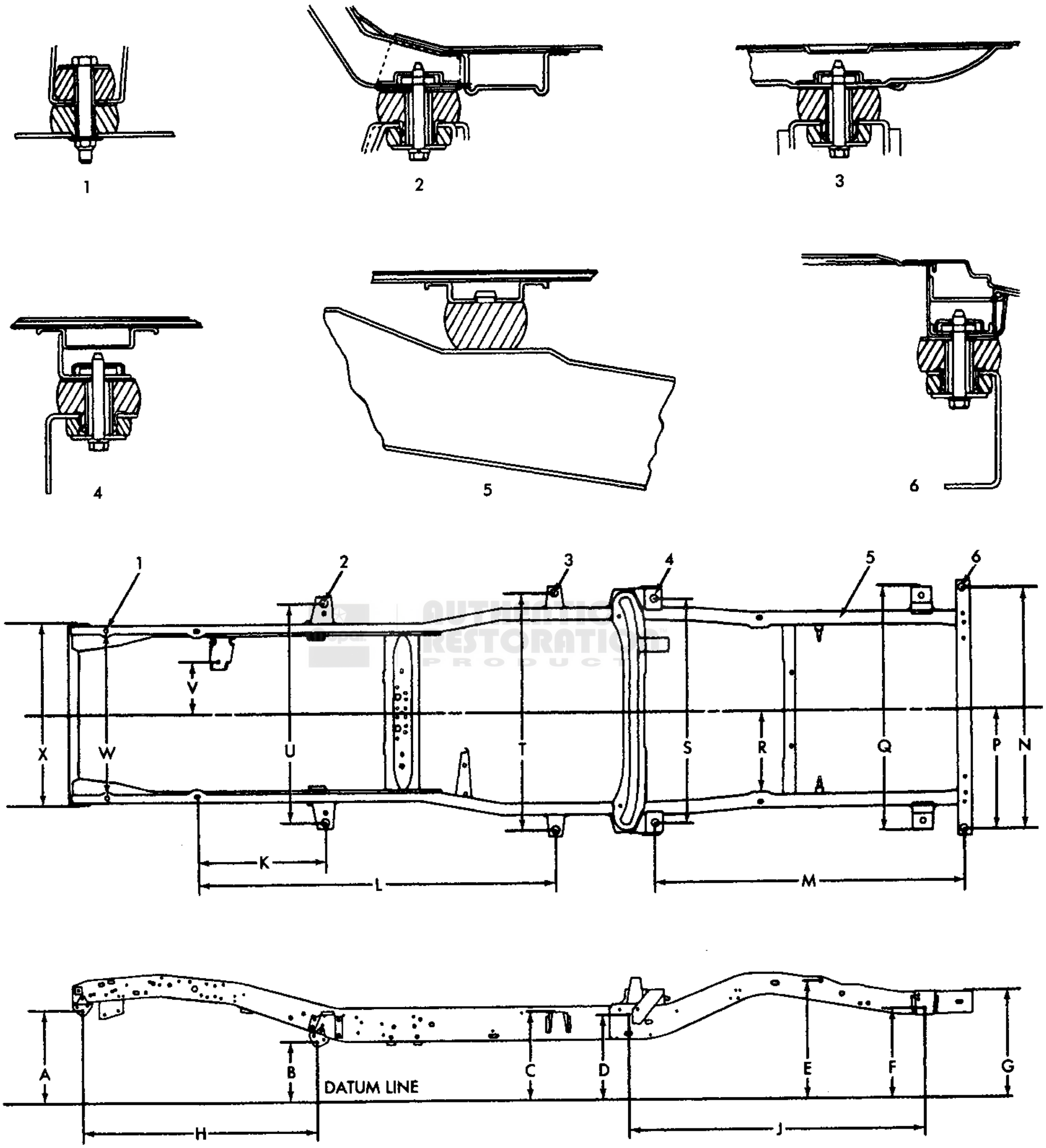


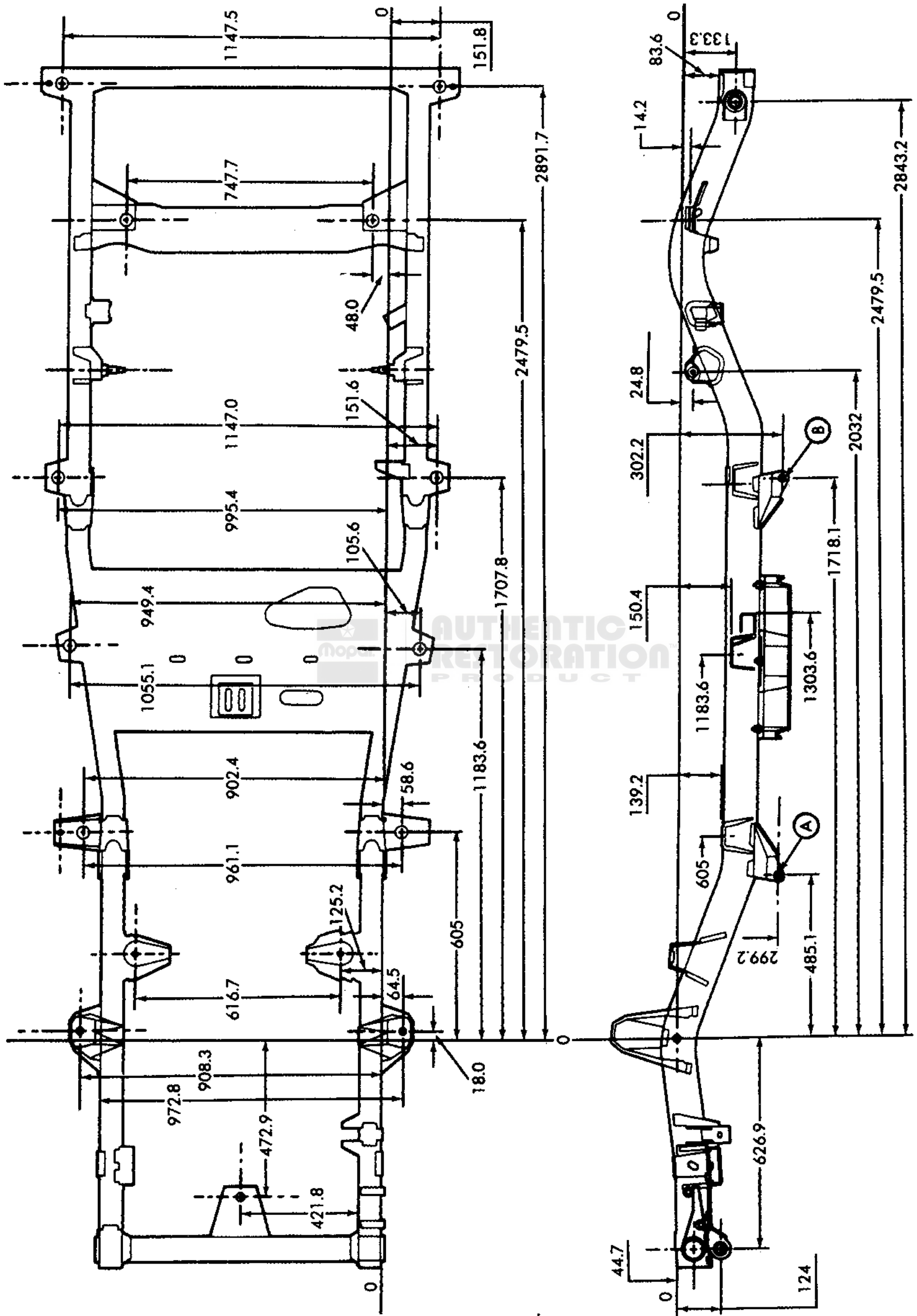
Fig. 5 Frame Alignment Dimensions — XJ Models



	mm	Inches		mm	Inches		mm	Inches
A –	306.07	(12.05)	J –	1454.15	(57.25)	R –	454.152	(17.88)
B –	138.68	(5.46)	K –	626.87	(24.68)	S –	1105.92	(43.54)
C –	269.24	(10.60)	L –	1752.60	(69.00)	T –	1165.35	(45.88)
D –	252.48	(9.94)	M –	1514.60	(59.63)	U –	1079.5	(42.50)
E –	410.72	(16.17)	N –	1187.70	(46.76)	V –	292.6	(11.52)
F –	274.83	(10.82)	P –	593.85	(23.38)	W –	822.96	(32.40)
G –	356.36	(14.03)	Q –	1194.31	(47.02)	X –	869.19	(34.22)
H –	1149.60	(45.26)						

J8913-6

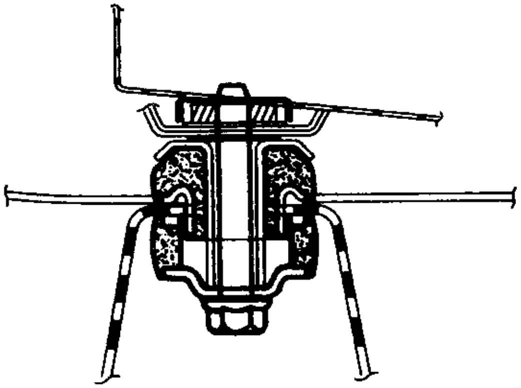
Fig. 6 Frame Alignment Dimensions — SJ Model



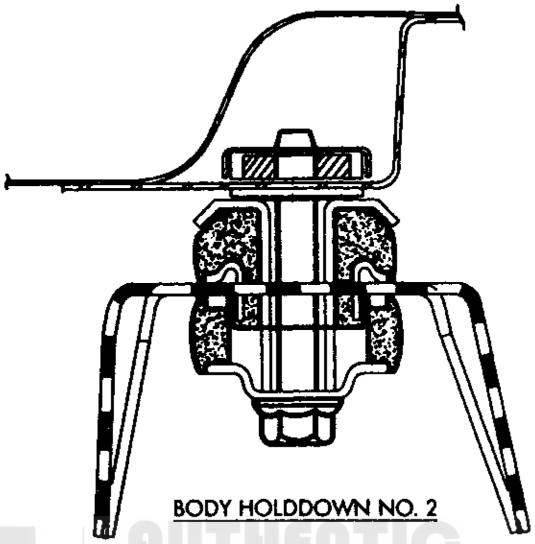
FRAME DIMENSIONS SHOWN IN MILLIMETERS

J8913-7

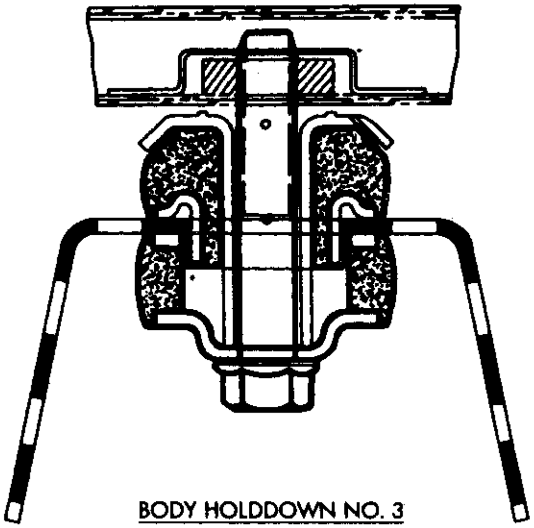
Fig. 7 Frame Alignment Dimensions — YJ Model



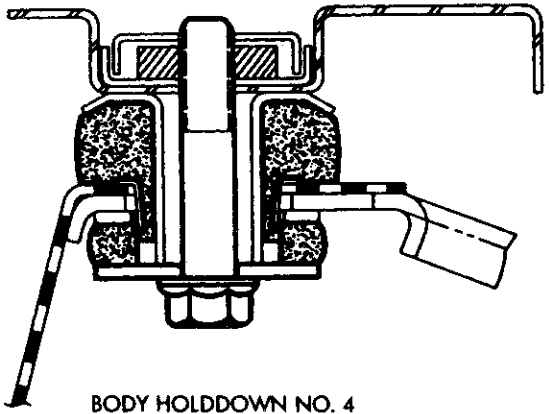
BODY HOLDDOWN NO. 1



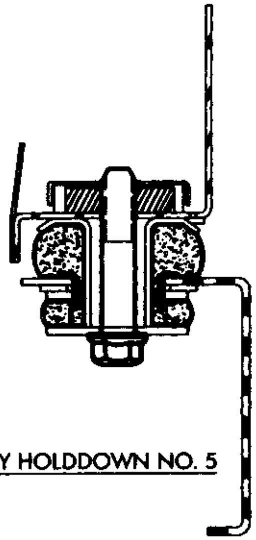
BODY HOLDDOWN NO. 2



BODY HOLDDOWN NO. 3



BODY HOLDDOWN NO. 4



BODY HOLDDOWN NO. 5

J8913-8

Fig. 8 Body Hold Downs — YJ Model

(1) Select several points along one siderail; preferably at crossmember locations.

(2) Transfer these with a plumb bob to floor; paper sheets can be fastened to floor at these points for better accuracy.

(3) Locate corresponding points on other siderail and transfer them in the same manner to the floor.

(4) Move vehicle away and measure between all points diagonally and parallel to siderails; corresponding measurements should not differ by more than 1/4 inch.

(5) Take measurement across at front and rear marks; and by dividing distances in half, indicate the two points on floor.

(6) Stretch a chalk-line between points 1 and 2 in Fig. 9 and snap string.

(7) Check to see how close center line is to diagonal intersection points A, B, C, D, E, and F in Fig. 9.

(8) Markings on floor will now give an indication of frame distortion in plan view.

(9) Any point on one siderail should be within 1/8 inch ahead or behind corresponding point on opposite side.

(10) Frame bow sideways should not exceed 1/8 inch per 100 inch length of frame.

(11) Overall width of frame should not vary more than 1/8 inch.

(12) Repeat steps (1) through (11) after straightening frame.

Vertical or Sideview

Determine twist of frame and degree of siderails not being parallel to one another as follows:

Vertical dimensions are measured from a level floor to corresponding points on left and right siderails. Dimensions should then be plotted to scale vertical and horizontal on a sheet of paper and points connected for each sidemember separately. Graph will show the relative position of the sidemembers.

Points on siderail or for horizontal check are selected at rear frame crossmembers, and any one of these points on one sidemember should be maximum 1/8 inch above or below corresponding point on other siderail.

MEASUREMENTS

Obtain measurements for frame alignment check with the body on vehicle. Figures 6 and 7, as identified, indicate dimensions in chosen areas to determine frame alignment. The procedures are recommended as follows:

(1) Place vehicle on level floor.

(2) If vehicle is loaded, make sure payload does not exceed specified limit, and the load is distributed as evenly as possible. For better accuracy of measurements, all payload should be removed.

(3) Check tires for recommended air pressure and adjust as necessary.

SERVICE PROCEDURES

Frames which are bent or twisted can be straightened, if necessary, by heat application. The temperature is to be kept under 1050°F, (a dull red glow) as excessive heat will impair the strength of the material, resulting in a weakened frame.

Damaged frame rails, crossmembers, and brackets can be repaired by straightening or replacing.

Welded connections between rails and crossmembers are not recommended.

Straightening

Straigntening should be limited to parts not severely damaged. New bolts or rivets for attaching the parts should be of same specifications as original bolts or rivets.

Replacement

Replacement is recommended as the original shape of the part may not be easily recognizable. Also, improperly straightened frame components will have harmful effects on alignment.

Repairing

Drilling

No holes should be drilled in siderail flanges, as this

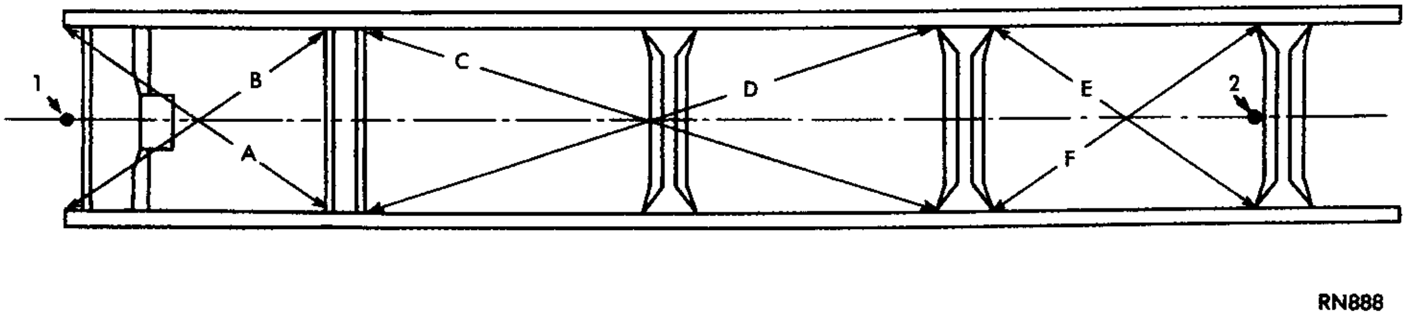


Fig. 9 Alignment Markings (Typical)

will reduce frame strength. Holes drilled in siderail vertical web must be 1-1/2 inches minimum from top and bottom flanges.

New holes should be located a distance away from existing holes, as not to reduce cross section of siderails in any one vertical section by more than 30%.

Welding

Welding of siderails and crossmembers should be done, preferably, with electric welding equipment, as it retains heat in a small area limiting the change of hardness of metal.

A damaged frame member is to be closely inspected from cracks. It is possible that cracks will apear as a result of straightening of a member. In either case, crack or cracks are to be repaired as follows:

(1) Stop drill at the end point of the crack with 1/8 inch drill.

(2) V-groove crack to allow good weld penetration.

(3) Weld up the crack

(4) Grind surface smooth if reinforcement is to be used.

Use of Fasteners

Bolts or rivets can be used in repairing frames or adding reinforcement. When it is more practical to substitute a bolt for a rivet, use next larger size bolt to prevent bolt from working loose. Ream holes if necessary.

Coned washers are preferred to split lock type. Generally Grade 5 bolts will suffice in repair work. Grade 3 bolts should be avoided. Proper torque is mandatory to provide adequate locking and preclude loosening of fasteners.

Reinforcing

Reinforcement can be made from channel, angle, or flat stock of common carbon steel and approximately equal in thickness to the part to be repaired. It is not possible to recommend proper reinforcement for all repairs. A reinforcement should provide an adequate section in cracked area and have sufficient overlap with the original part, and be properly attached.

Reinforcing channel should have flanges shorter than sidemember flanges to preclude welding along edge of rail flange. Otherwise, longitudinal welds are quite acceptable. Complete transverse welds are to be avoided.

FUEL SYSTEM

CONTENTS

GENERAL INFORMATION

Throughout this group, references are made to particular vehicle models by alphabetical designation or by the particular vehicle nameplate. A chart showing a breakdown of the alphabetical designations is included in the Introduction section of this manual.

The Fuel System of vehicles equipped with fuel injected engines consists of the fuel tank, electric fuel pump, fuel filter, fuel tubes, fuel hoses, vacuum hoses, throttle body, and fuel injector(s).

The Fuel System of vehicles equipped with carbureted engines consists of the fuel tank, fuel tubes, mechanical fuel pump, fuel filter, fuel hoses, vacuum hoses, and carburetor.

The **Fuel Delivery System** consists of the fuel pump, fuel filter, fuel tubes, and fuel hoses.

A Fuel Return System is used on all vehicles. The system consists of the fuel tubes and hoses that route back to the fuel tank.

The **Fuel Tank Assembly** consists of the fuel tank, filler tube, a fuel gauge sending unit (carbureted vehicles) or a fuel gauge sending unit/fuel pump assembly (fuel injected vehicles), and a pressure vacuum filler cap.

Also to be considered part of the fuel system is the **Evaporation Control System**, which is designed to reduce the emission of fuel vapors into the atmosphere.

The description and function of the Evaporative Control System is found in Group 25 of this manual.

Fuel Usage Statement

All Jeep vehicles have been designed and developed for optimum operating performance and efficiency using gasoline. In order to retain the optimum performance qualities and to enjoy trouble free operation of your vehicle, it is recommended that only gasolines from reputable dealers be used. Use unleaded gasolines with a minimum octane rating of 87, (R+M)/2.

Unsatisfactory fuels, particularly those having excess volatility, can cause problems such as: hard starting, stalling or driveability deterioration. If problems are experienced, it is recommended that another brand of gasoline be used prior to considering service for the vehicle.

In addition to choosing the proper octane rating, use of gasolines containing a high level of detergent additives is also recommended. The use of these high detergent gasolines will reduce the intake system deposit build-up and maintain the excellent driveability of your vehicle.

THE FOLLOWING IS APPLICABLE TO ALL JEEP VEHICLES: Use unleaded gasolines only in all Jeep vehicles. All Jeep vehicles are equipped with a catalyst emission control system requiring the use of unleaded fuels. All vehicles have labels located on the instrument panel and adjacent to the fuel filler cap or door that state **UNLEADED FUEL ONLY**.

The fuel filler neck is designed to only accept the smaller diameter nozzles used with unleaded gasoline pumps of retail dealers.

The exhaust emission system of Jeep vehicles is designed to meet all emission regulations while at the same time providing excellent fuel economy. The catalyst system require that only unleaded fuel be used. Use of leaded fuels will destroy the effectiveness of the catalytic converter used to reduce exhaust emissions, and will render parts of the fuel control system inoperative and lead to excessive fuel consumption. Use of the wrong fuel may void the vehicle warranty.

GASOLINE CONTAINING ALCOHOL

Jeep vehicles are designed for optimum operating performance, durability and fuel economy using unleaded gasoline fuels. Gasoline/Alcohol blends are also sold as motor vehicle fuel. The type and amount of alcohol used in the blend are important. Many states require gasoline stations to display the type and amount of alcohol contained in the gasoline/alcohol blend on the pump. If your state does not have this requirement, it is recommended that you ask the station operator if their fuel contains alcohol and if so, what type and amount it contains.

The following two types of alcohol are generally used in gasoline/alcohol blends:

ETHANOL: is used as a mixture of 90 percent unleaded gasoline and 10 percent ethanol (ethyl or grain alcohol). These fuel blends are available in some states and are usually identified at the pump as “Ethanol Enhanced”, “Contains Alcohol”, or “Gasohol”. Gasoline blended with ethanol may be used in your vehicle. Note that these blends may adversely affect the starting, driveability, and fuel efficiency of your vehicle due to their generally higher volatility. If problems are experienced with the use of ethanol/gasoline blends, it is recommended that the vehicle be operated on unleaded gasoline.

CAUTION: EXCLUSIVE USE OF THESE FUEL BLENDS IS NOT RECOMMENDED. Vehicle test results have shown that significant fuel system corrosion can result when they are used exclusively.

METHANOL: (Methyl or Wood Alcohol) is used in a variety of concentrations blended with unleaded gasoline. You may encounter fuels containing 3 percent or more methanol along with other alcohols, called cosolvents. **DO NOT USE GASOLINES CONTAINING METHANOL.**

Use of methanol/gasoline blends may result in starting and driveability deterioration and damage to fuel system components.

Fuel system damage and vehicle performance problems resulting from the use of gasolines containing methanol are not the responsibility of Chrysler Motors and may not be covered by the New Vehicle Warranty.

GASOLINES CONTAINING MTBE

Fuels that are a mixture of unleaded gasoline and up to 15 percent MTBE (Methyl Tertiary Butyl Ether) may be used in Jeep vehicles.

Materials Added To Fuel

Indiscriminate use of fuel system cleaning agents should be avoided. Many of these solutions intended to remove gum and varnish may contain highly active solvents or similar ingredients that can be harmful to gasket and diaphragm materials used in fuel system components.

The use of fuel additives which are sold as octane enhancers or boosters is not recommended. Most of these products contain high concentrations of methanol. Fuel system damage or vehicle performance problems resulting from the use of such fuel additives is not the responsibility of Chrysler Motors and may not be covered under the New Vehicle Warranty.

FUEL DELIVERY SYSTEM

INDEX

GENERAL INFORMATION

The fuel pumps of carbureted and fuel injected vehicles are different. Carbureted vehicles have a mechanical fuel pump driven by a eccentric lobe of the engine camshaft. Fuel injected engines have a gear/rotor type pump driven by a permanent magnet electric motor. The mechanical pump is mounted to the engine block while electric fuel pumps are suspended in the fuel tank and immersed in fuel. The electric fuel pumps used with Throttle Body Injection and Multi-Point Injection systems are different and cannot be interchanged.

Fuel Return System—Carbureted Vehicles

Carbureted Jeep vehicles employ a fuel return system to reduce the possibility of high temperature fuel vapors. The fuel return system consists of a fuel filter equipped with a return nipple and a return tube to the fuel tank. The fuel return tube is routed to the fuel tank where it connects to a nipple on the fuel sending unit. During normal operation a small amount of liquid fuel is returned to the tank. During periods of high under hood temperatures, vaporized fuel is also returned to the tank instead of being passed to the carburetor. The fuel filter must be installed with the return nipple positioned upward to ensure fuel system operation.

FUEL PUMPS

Mechanical Fuel Pumps

All SJ and YJ vehicles with 4.2L engines have a single action, mechanical fuel pump. The fuel pump is comprised of an actuating lever, a diaphragm and spring, an inlet valve and an outlet valve (Fig. 1). An eccentric on the engine camshaft operates the fuel pump lever, which is linked to the pump diaphragm. The lever pulls the diaphragm to its extended position to pump fuel into the inlet valve. When the carburetor float needle valve closes, fuel pump output is limited to the amount that returns back to the fuel tank through the fuel return tube. The fuel accumulated in fuel pump chamber prevents the diaphragm from relaxing. The actuating lever continues to move up and down, but is prevented from operating the diaphragm, which is held in its extended position by fuel pressure. Fuel flow from the pump remains halted until excess pressure is released through the fuel return tube or until the carburetor float needle moves off its seat. This process continues as long as the engine is running.

Mechanical fuel pumps cannot be overhauled. Replace any mechanical fuel pump that fails either a Pressure Test, Capacity (volume), or Vacuum Test.

Mechanical Fuel Pump Tests

Prior to performing the fuel pump tests, inspect for kinked or bent fuel tubes or hoses that could cause restrictions. Also inspect for fuel leaks in the supply tubes and hoses.

Pressure Test

(1) Remove air cleaner assembly.

(2) Disconnect fuel inlet fitting at carburetor.

(3) Disconnect fuel return hose at fuel filter and plug nipple on filter.

Remove any spilled fuel from engine.

(4) Connect pressure gauge, restrictor and flexible hose between fuel filter and carburetor (Fig. 2).

(5) Position flexible hose and restrictor so fuel can be discharged into suitable graduated container.

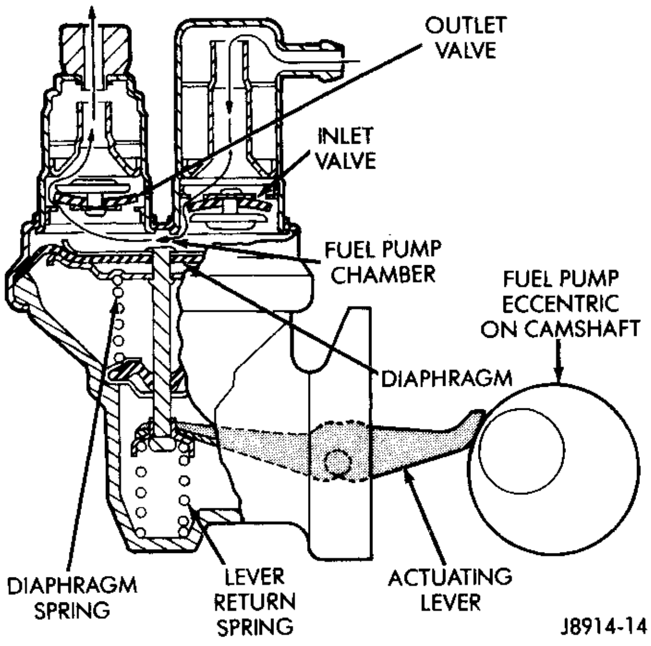


Fig. 1 Mechanical Fuel Pump—Typical

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(6) Operate engine at curb idle RPM and discharge fuel into graduated container by momentarily opening hose restrictor.

(7) Close hose restrictor, allow pressure to stabilize, and note pressure reading on gauge. Gauge should indicate 28-34 kPa (4 to 5 psi) for six-cylinder engines and 34-45 kPa (5 to 6.5 psi) for eight cylinder engines.

If pump pressure is not within specifications and the fuel tubes and filter are in satisfactory condition, the pump is defective and should be replaced. If pump pressure is within specification, perform capacity test.

Capacity (Volume) Test

Test the capacity (volume) as follows:

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(1) Operate engine at curb idle.

(2) Open hose restrictor and allow fuel to discharge into graduated container for 30 seconds, then close restrictor.

At least 470 ml (16 oz.) of fuel should have been discharged. If pump volume is less than 470 ml (16 oz.), repeat the test using an auxiliary fuel supply and replacement fuel filter. If pump volume conforms to the specifications while using the auxiliary fuel supply, inspect for a restriction in the fuel supply tube from the tank and for proper fuel tank venting.

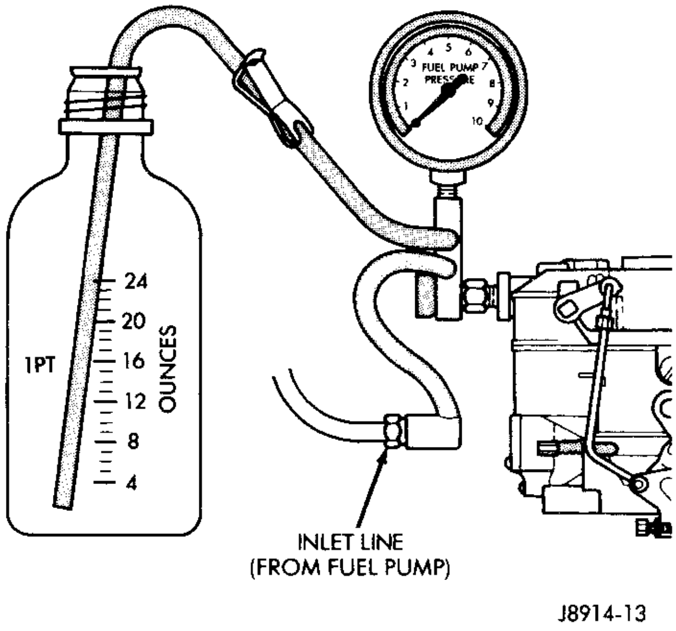


Fig. 2 Mechanical Fuel Pump Pressure and Capacity Tests

Vacuum Tests

Two separate vacuum tests, the Direct Connection Test and the Indirect Connection Test, can be performed on mechanical fuel pumps. In the Direct Connection Test, the vacuum test gauge is connected directly to the fuel pump inlet. This tests the pump's ability to create a vacuum. In the Indirect connection test, a vacuum gauge is connected by a T-fitting into the pump inlet tube. This test will indicate if an obstruction exists in the fuel tube or the in-tank fuel filter.

Direct Connection Test

(1) Disconnect fuel inlet pipe at fuel pump

(2) Connect vacuum gauge to fuel pump inlet.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

The vacuum gauge will not indicate a vacuum until fuel in the carburetor float bowl has been consumed and the fuel pump begins to operate at full capacity.

(3) Operate engine at curb idle RPM and note vacuum gauge reading. Gauge should indicate a vacuum of approximately 34 kPa (10 in Hg). If pump vacuum is not within specification, the pump is defective and should be replaced.

Indirect Connection Test

(1) Disconnect fuel inlet pipe at fuel pump.

(2) Install T-fitting between disconnected fitting and fuel pump inlet. Connect vacuum gauge to T-fitting.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

The vacuum gauge will not indicate a vacuum until fuel in the carburetor float bowl has been consumed and the fuel pump begins to operate at full capacity.

(3) Operate engine at 1500 RPM for 30 seconds. Vacuum should not exceed 10 kPa (3 in. Hg).

(4) If vacuum exceeds 10 kPa (3 in. Hg) check fuel tube for restriction. A partially clogged in-tank fuel filter can also cause excess vacuum.

Mechanical Fuel Pump Removal

(1) Disconnect battery negative cable.

(2) Remove fuel tank filler cap.

CAUTION: Wrap shop towels around fuel pump inlet hose and outlet tube fitting to absorb any fuel spillage during fuel pump removal.

(3) Disconnect fuel inlet hose and outlet tube fitting from fuel pump.

(4) Remove Fuel Pump Mounting bolts. Remove Fuel Pump.

(5) Remove old gasket material from fuel pump boss of engine block.

Mechanical Fuel Pump Installation

(1) Install fuel pump and new gasket. Tighten mounting bolts to 18 N•m (13 ft-lbs) torque.

(2) Connect fuel inlet hose and fuel outlet tube to fuel pump. Secure hose with clamp. Tighten outlet tube fitting to 24.5 N•m (18 ft-lbs) torque.

(3) Connect battery negative cable.

(4) Install fuel tank filler cap.

(5) Start vehicle and check for leaks.

MPI and TBI Fuel Pumps

Although MPI (4.0L engines) and TBI (2.5L engines) fuel pumps are similar in operation and construction, they are not the same and CANNOT be interchanged (Fig. 3).

Refer to FUEL PUMP/GAUGE SENDER UNIT REPLACEMENT—FUEL INJECTED ENGINES for fuel pump removal and installation.

The fuel pumps used with MPI and TBI Fuel Injection systems are gear/rotor type pumps driven by permanent magnet, 12 volt electric motors that are immersed in the fuel tank. Both pumps are integral with the fuel sender unit. The pump/sender assembly is installed inside the fuel tank.

MPI and TBI fuel pumps have a check valve at the outlet end that consists of a steel ball held against a seat by force applied from a spring. When the pump is operating fuel pressure overcomes spring pressure and forces the ball off its seat, allowing fuel to flow. When the pump is not operating, spring pressure forces the ball back against the seat preventing fuel backflow through the pump.

MPI system fuel pressure is maintained at 214 kPa (31 psi) when the pump is operating and vacuum is supplied to the fuel pressure regulator. If vacuum is not supplied to the pressure regulator, because of a broken or clogged vacuum line, fuel pressure will be 55-69 kPa (8-10 psi) higher. When the fuel pump is not operating system fuel pressure of 131-269 kPa (19-39 psi) is maintained by fuel pump outlet check valve and the vacuum assisted fuel pressure regulator.

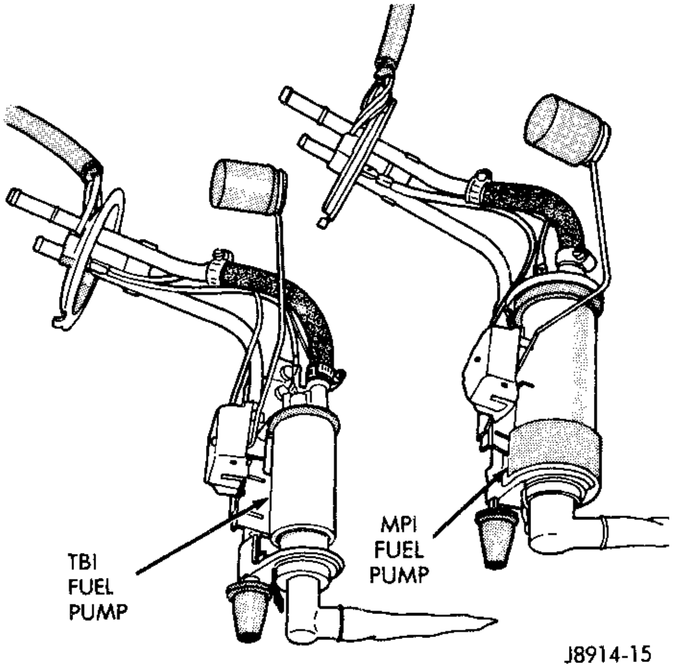


Fig. 3 Electric Fuel Pumps

TBI system fuel pressure is maintained at 97-103 kPa (14-15 psi) while the pump is operating and is zero (0) when the pump is not operating.

MPI Fuel Pump Controls—4.0L Engines

The fuel pump circuit of MPI systems are equipped with a ballast resistor to reduce fuel pump noise. Voltage to operate the fuel pump is supplied through the Fuel Pump Relay except during engine starting (cranking) and wide open throttle conditions. Ground for the fuel pump relay is controlled by the engine Electronic Control Unit (ECU). During engine starting the fuel pump relay and ballast resistor are by-passed and voltage is supplied to the fuel pump through the starter relay. During wide open throttle conditions the fuel pump relay and ballast resistor are again by-passed and voltage is supplied to the fuel pump through the oxygen sensor relay.

TBI Fuel Pump Controls—2.5L Engines

Voltage to operate the TBI fuel pump is supplied through the Fuel Pump Relay when the relay is grounded by the engine Electronic Control Unit (ECU).

MPI Fuel Pressure Release Procedure

(1) Disconnect battery negative cable.

(2) Remove fuel tank filler cap to relieve fuel tank pressure.

(3) Remove cap from pressure test port on fuel rail.

WARNING: DO NOT ALLOW FUEL TO SPILL ONTO THE ENGINE INTAKE OR EXHAUST MANIFOLDS. PLACE SHOP TOWELS UNDER THE PRESSURE PORT TO ABSORB FUEL WHEN THE PRESSURE IS RELEASED FROM THE FUEL RAIL.

(4) Place shop towels under the fuel pressure test port.

(5) Using a small screw driver or pin punch push the test port valve in to relieve fuel pressure (Fig. 4). Absorb spilled fuel with shop towels.

(6) Remove shop towels and dispose of properly.

(7) Install cap over pressure test port.

TBI FUEL SYSTEM PRESSURE TEST

The fuel system of vehicles equipped with Throttle Body Injection (TBI) is only under pressure when the fuel pump is operating. As long as the fuel pump is not operating, TBI fuel system components can be removed without the need to release system pressure.

(1) Remove pressure test port plug from throttle body (Fig. 5). Install a pressure test fitting in place of the test port plug. Pressure test fittings are available from the parts department.

(3) Connect an accurate 0-207 kPa (0-30 psi) fuel pressure gauge to pressure test fitting.

(4) Start engine and let idle. The pressure gauge should read 97-103 kPa (14-15 psi). If pressure is correct, the fuel pump is operating normally and no further testing is required. If pressure is not correct adjust the pressure regulator to obtain the correct fuel pressure. Turn the screw at the bottom of the regulator inward to increase pressure or outward to decrease pressure (Fig. 6).

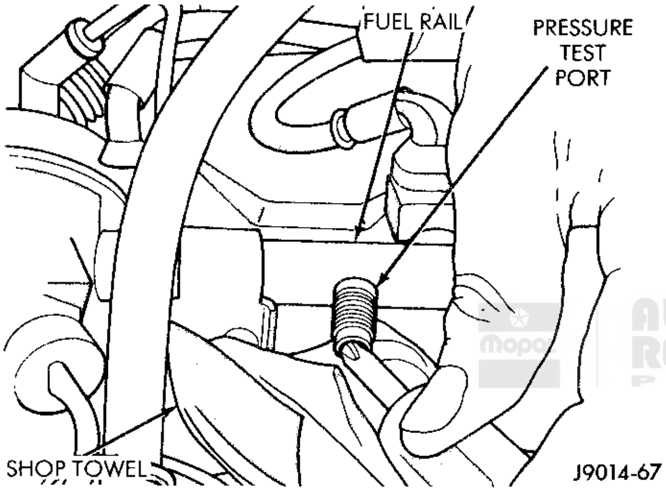


Fig. 4 Releasing MPI Fuel Pressure

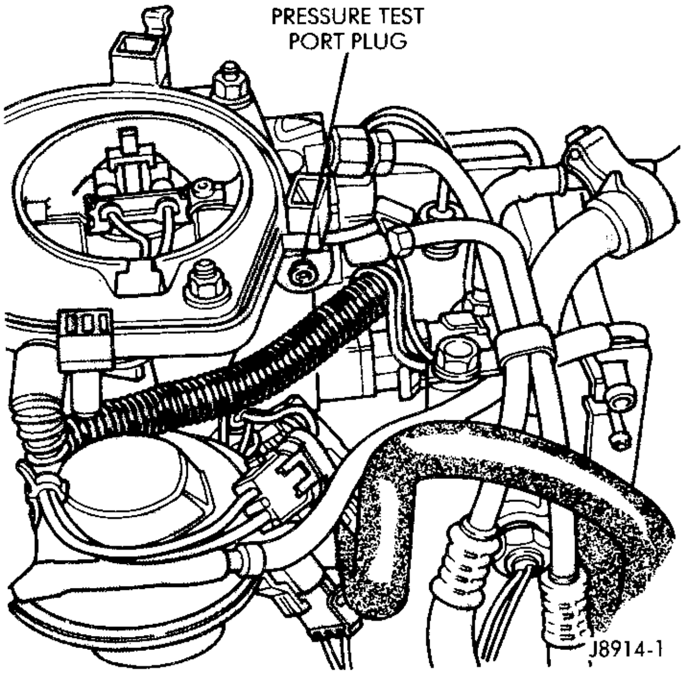


Fig. 5 Pressure Test Port Plug—TBI

(5) If the fuel pressure is considerably above specification and adjusting the regulator fails to lower it to specification, inspect the fuel return line for blockage.

CAUTION: Fuel pressure will rise to as much as 655 kPa (95 psi) when the fuel return line is pinched shut, shut engine down immediately after pinching off fuel return line.

(6) If the fuel pressure is considerably below specification and adjusting the regulator fails to raise it to specification, momentarily pinch off the fuel return line and recheck pressure. If the fuel pressure has risen replace the pressure regulator. If pressure has not risen check fuel filter and fuel supply line for blockage.

MPI FUEL SYSTEM PRESSURE TESTS

MPI Fuel System Pressure Test

The MPI fuel system used in vehicles equipped with a 4.0L engine employs a vacuum balanced pressure regulator. Fuel pressure should be approximately 55-69 kPa (8-10 psi) lower with the vacuum line attached to the regulator than with the vacuum line disconnected. System fuel should be 214 kPa (31 psi) with the vacuum line connected to the regulator and 269 kPa (39 psi) with the vacuum line disconnected.

CAUTION: Some fuel may be discharged when connecting fuel gauge to fuel rail.

(1) Connect a 0-414 kPa (0-60 psi) fuel pressure gauge to test port pressure fitting on fuel rail (Fig. 7).

(2) Remove vacuum line from pressure regulator.

(3) Start the vehicle.

(4) Note gauge reading. With vacuum line disconnected, fuel pressure should be approximately 269 kPa (39 psi).

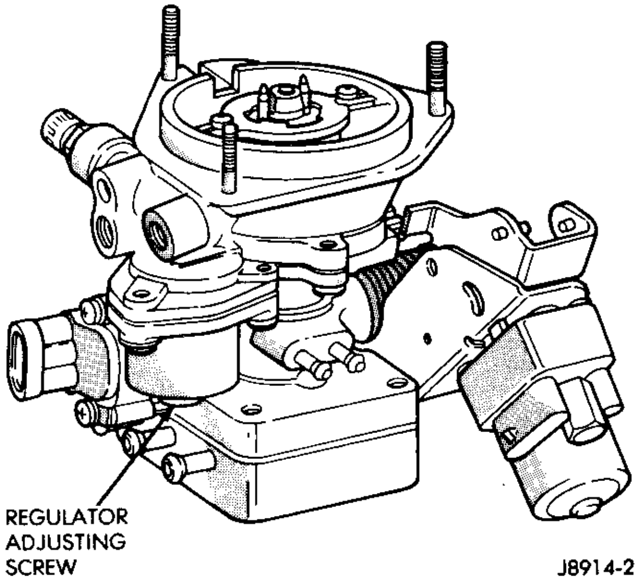


Fig. 6 Adjusting TBI Fuel Pressure

(5) Connect vacuum line to pressure regulator. Note gauge reading. Fuel pressure should be approximately 214 kPa (31 psi).

(6) If fuel pressure is not approximately 55-69 kPa (8-10 psi) higher with vacuum line removed from regulator, inspect pressure regulator vacuum line for leaks, kinks or blockage.

CAUTION: Fuel pressure will rise to as much as 655 kPa (95 psi) when the fuel return line is pinched shut, shut engine down immediately after pinching off fuel return line.

(7) If fuel pressure is low, momentarily pinch shut the **hose section** of the fuel return line. If fuel pressure remains low, inspect the fuel supply line, fuel filter, and fuel rail inlet for blockage. If fuel pressure rises replace fuel pressure regulator.

(8) If fuel pressure is above specifications, inspect the fuel return line for kinks and blockage.

Capacity Test

(1) Remove the cap from the pressure test port in the fuel rail.

(2) Connect a 0-414 kPa (0-60 psi) fuel pressure gauge to the pressure fitting on the fuel rail (Fig. 7).

(3) Start the vehicle. Pressure should be approximately 214 kPa (31 psi) with the vacuum hose connected to the pressure regulator and 269 kPa (39 psi) with the vacuum hose removed from the pressure regulator.

(4) If the pressure is not to specification, check the following before replacing the fuel pressure regulator:

- Inspect the fuel supply and return lines/hoses for kinks or restricting bends

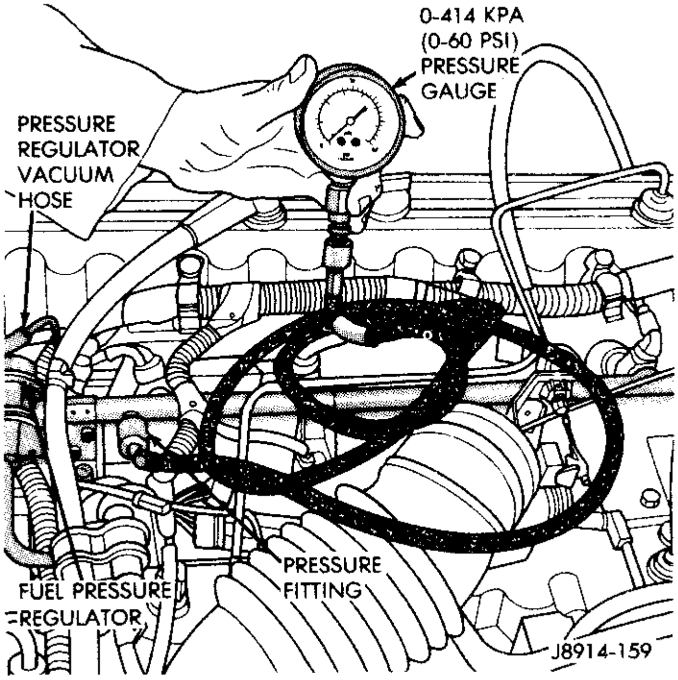


Fig. 7 Fuel Pressure Test

- Check the fuel pump flow rate. A good fuel pump will deliver at least 1 liter of fuel per minute with the fuel return line pinched off. If the fuel pump does not pump adequately, then inspect the fuel system for a plugged fuel filter or fuel pump inlet filter (sock).

Fuel pump flow rate can be done by connecting one end of an old A/C gauge hose to the fuel test port on the fuel rail and inserting the other end of the hose into a container of at least 1 liter capacity. Run the fuel pump by installing a jumper wire into diagnostic connector terminals D1-5 and D1-6. Be sure to pinch off the fuel return line or most of the fuel will be returned to the fuel tank.

The fuel pressure regulator is not adjustable.

MPI Fuel Pressure Leak Down Test with Engine Off

If abnormally long periods of cranking are required to restart a hot engine after the vehicle has been shut down for a short period of time, fuel pressure may be bleeding past the fuel pressure regulator or the check valve in the outlet end of the fuel pump.

(1) With the engine off, connect an accurate 0-689 kPa (0-100 psi) fuel gauge to the pressure test port fitting on the fuel rail.

(2) Start the vehicle and let engine idle. Check fuel pressure reading on gauge. Fuel pressure should be within specifications. Refer to MPI System Fuel Pressure Test.

(3) Shut engine off. Note fuel pressure reading on gauge. Leave fuel pressure gauge connected. Allow engine to set for 30 minutes and then compare fuel pressure reading on gauge to reading taken when engine was shut down. A pressure drop up to 138 kPa (20 psi) to a range of 131-269 kPa (19-39 psi) is within specifications.

(4) If fuel pressure drop is within specifications, the fuel pump outlet check valve and the fuel pressure regulator are both operating normally.

(5) If fuel pressure drop is greater than 138 kPa (20 psi), restart the vehicle and let engine idle.

CAUTION: Fuel pressure will rise to as much as 95 psi when the fuel return line is pinched shut, shut engine down immediately after pinching off fuel return line.

(6) Momentarily pinch shut the **hose section** of the fuel return line and shut engine off. Note pressure reading on gauge. Allow engine to set for 30 minutes. Compare fuel pressure reading to reading taken when engine was shut down. If fuel pressure drops approximately 138 kPa (20 psi), replace the fuel pressure regulator. If fuel pressure has dropped considerably more than 138 kPa (20 psi) fuel pressure is bleeding off past the outlet check valve in pump and the fuel pump must be replaced.

FUEL FILTER

Vehicles Equipped with Carbureted Engines

The carburetor is protected from dirt and other foreign matter by a replaceable, pleated paper filter. The fuel filter is located in the fuel supply tube between the fuel pump and carburetor and is secured in place with hoses and clamps. The filter has an extra nipple for the fuel return tube. The filter must be installed with the return nipple pointing upward to ensure correct operation of the Fuel Return System. Replace the fuel filter at the intervals outlined in the Maintenance Schedule.

Removal

(1) Disconnect battery negative cable.

WARNING: USE A SHOP TOWEL TO REMOVE ANY SPILLED FUEL WHEN REMOVING THE FUEL FILTER.

(2) Disconnect fuel supply tube at carburetor.

(3) Remove and discard fuel filter, hoses and clamps (Fig. 8).

Installation

(1) Install fuel filter with arrows on casing toward carburetor and with fuel return nipple upward.

(2) Secure hoses and filter with new clamps.

(3) Connect fuel supply tube to carburetor.

(4) Connect battery negative cable.

Vehicles Equipped with Fuel Injected Engines

The filter protects the injectors from dirt, water and other foreign matter. The filter is located under the vehicle along the drivers side frame rail. Replace filter at intervals specified in the Maintenance Schedule.

Removal

(1) Disconnect battery negative cable. Remove fuel filler cap.

WARNING: FUEL PRESSURE MUST BE RELEASED ON VEHICLES EQUIPPED WITH MULTI-POINT INJECTED 4.0L ENGINES BEFORE DISCONNECTING ANY FUEL SYSTEM COMPONENT.

(2) On vehicles equipped with MPI 4.0L engines, release fuel system pressure. Refer to Fuel Pressure Release Procedure.

(3) Raise and support vehicle.

(4) On YJ Vehicles remove the fuel filter shield (Fig. 9).

(5) Remove and hoses and clamps from inlet and outlet sides of filter.

(6) Remove retaining strap bolt.

(7) Remove filter (Fig. 10).

Installation

CAUTION: The ends of the fuel filter are marked for correct installation. Install filter with the end marked "IN" towards fuel tank and the end marked "OUT" towards engine.

(1) Place fuel filter in retaining strap with the marked ends in the correct position.

(2) Install retaining strap bolt and tighten to 12 N•m (106 in-lbs) torque.

(3) Install inlet and outlet hoses, and hose clamps. Tighten clamps securely.

(4) On YJ Vehicles, install fuel filter shield (Fig. 9).

(5) Lower Vehicle.

(6) Connect battery negative cable.

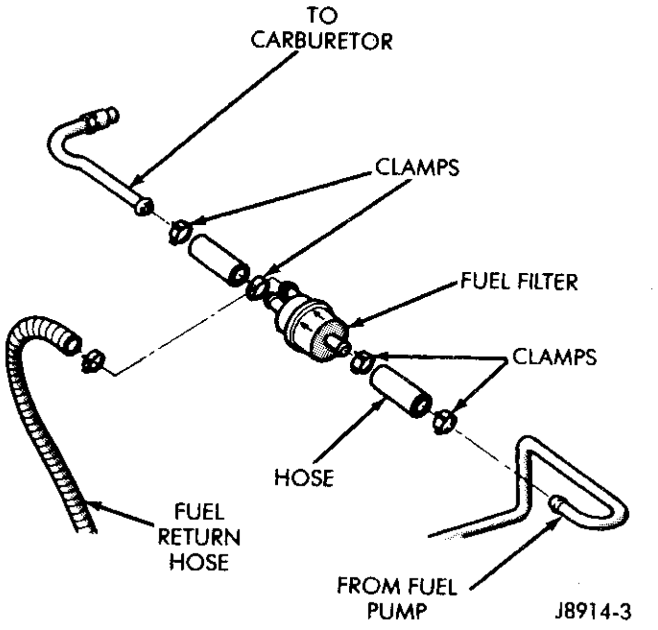


Fig. 8 Fuel Filter Remove/Install—YJ Vehicles with 4.2L Engine

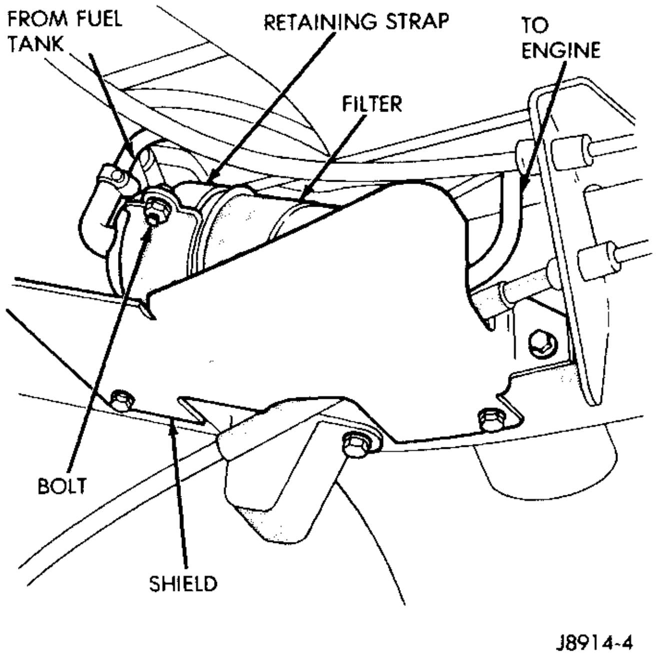


Fig. 9 Fuel Filter and Shield—YJ Vehicles

FUEL HOSES AND CLAMPS

Quick Connect Fuel Tube Fittings

Fuel Injected engines utilize quick-connect fuel tube fittings at the ends of the nylon reinforced hoses that connect the fuel rail and pressure regulator (MPI) or throttle body (TBI) to the fuel supply and return tubes. The fittings consist of two O-rings, a spacer (installed between O-rings), and an O-ring retainer (Fig. 11).

CAUTION: The O-ring and spacer assembly must be replaced when ever the quick connect fittings are disassembled.

On vehicles equipped with TBI the fittings are located under the vehicle along the left frame rail (Fig. 12). On vehicles equipped with MPI the fittings are used at the inlet side of the fuel rail, the pressure regulator end of the fuel rail, and at the end of the tube/hose assembly that connects the pressure regulator to the return tube (located below the EGR valve transducer) (Fig. 13).

Tube/Fitting Disassembly

WARNING: FUEL PRESSURE MUST BE RELEASED ON VEHICLES EQUIPPED WITH MULTI-POINT INJECTED 4.0L ENGINES BEFORE DISCONNECTING ANY FUEL SYSTEM COMPONENT.

The retainer has two tabs. To disconnect the quick-connect fitting, squeeze the tabs against the fuel tube and then pull the fitting off of the quick connect fitting/hose assembly. The retainer will stay on the fuel tube when the tube is disconnected. The O-rings and spacer will remain in the connector.

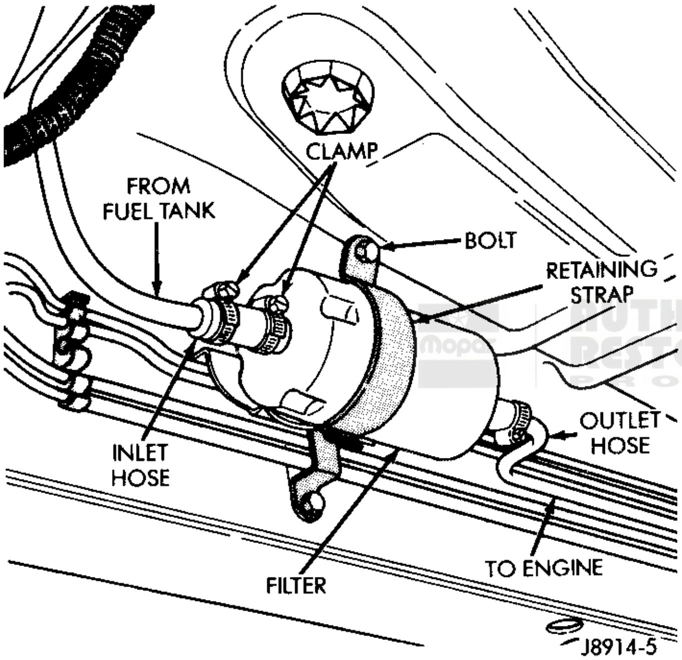


Fig. 10 Fuel Filter — MJ and XJ Vehicles

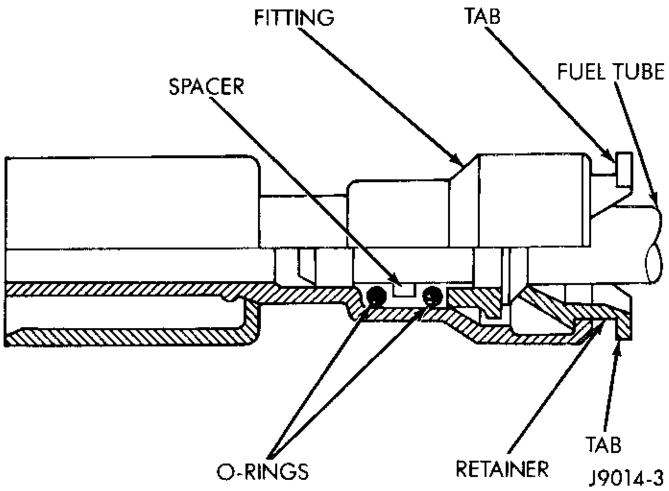


Fig. 11 Quick-Connect Fitting

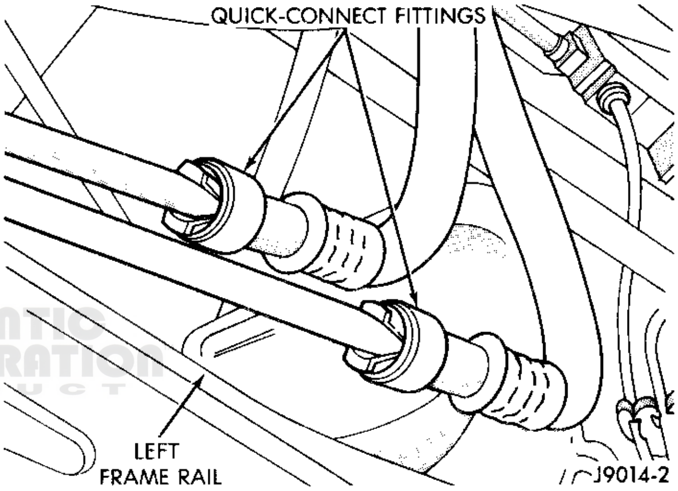


Fig. 12 Quick Connect Fitting Location—TBI Models

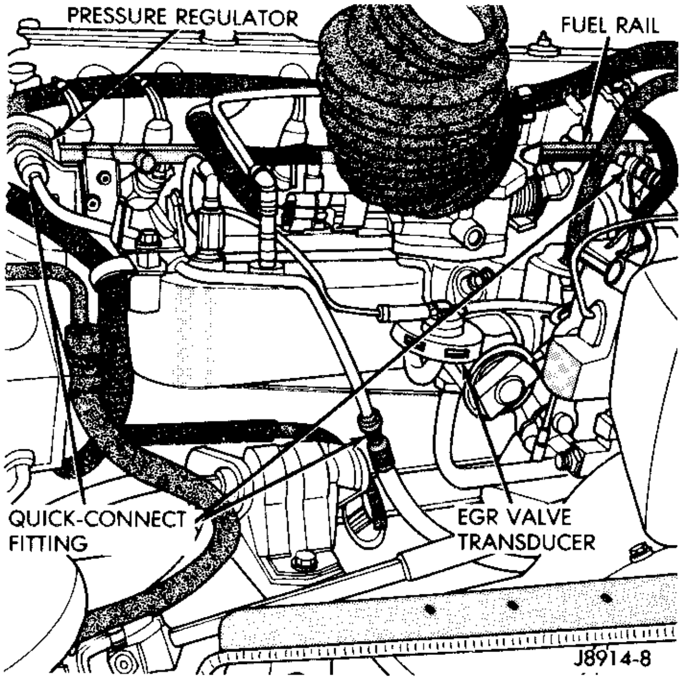


Fig. 13 Quick-Connect Fitting Location—MPI Models

CAUTION: When ever a fuel tube quick connect fitting is disconnected the O-rings, spacer, and retainer MUST be replaced.

The O-rings and spacer can be removed with the bent end of an “L” shaped paper clip.

O-ring Replacement

A repair kit consisting of replacement O-rings, spacer, and retainer is available through the parts department. The replacement parts are installed on a disposable plastic plug. Install the replacement kit as follows:

(1) Push kit/disposable plug assembly into quick connect fitting until an “click” sound is heard (Fig. 14).

(2) Grasp end of disposable plug and pull outward to remove it from fitting.

Tube/Fitting Assembly

(1) Push fuel tube into quick-connect fitting until a “click” is heard (Fig. 15).

(2) Verify that connection is secure by firmly pulling back on fuel tube (Fig. 15). The tube should be locked in place.

Hoses and Clamps

Inspect all hose/clamp connections for completeness and ensure that no leaks are present. Hoses that are cracked, scuffed, swelled, have rubbed against other vehicle components or show any other sign of wear that could lead to failure must be replaced.

When installing hoses, ensure that they are routed away from contact with other vehicle components that could rub against them and cause failure.

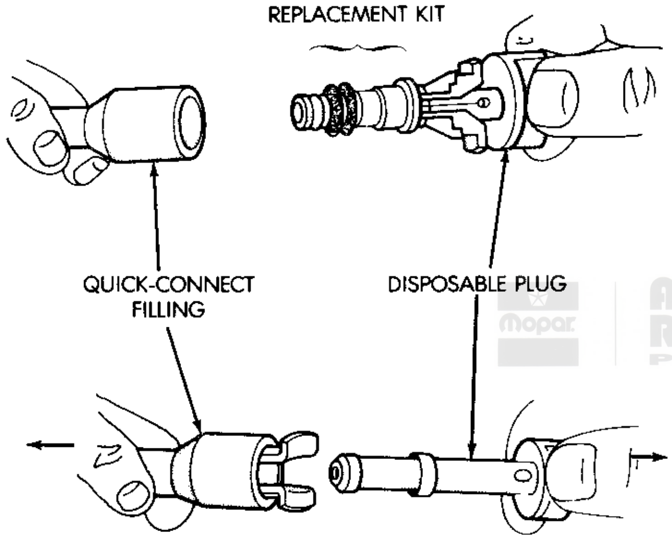


Fig. 14 Repair Kit Installation

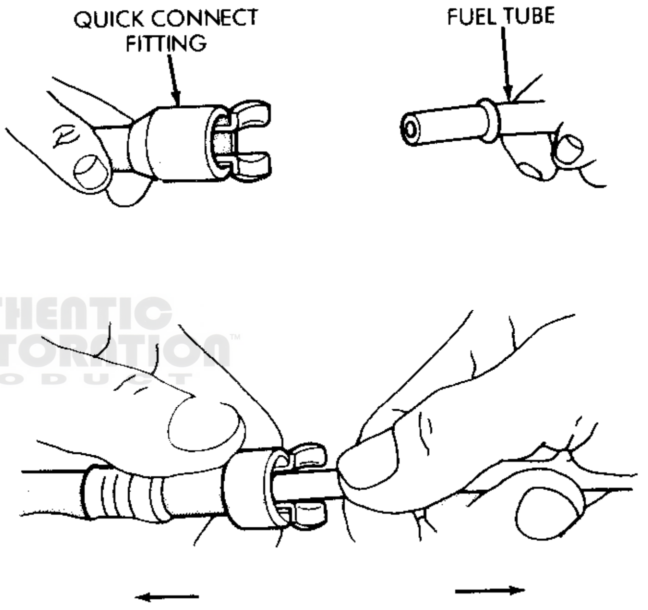


Fig. 15 Fuel Tube to Fitting Connection

FUEL TANKS

INDEX

GENERAL INFORMATION

The fuel tanks of all Jeep vehicles are equipped with fuel and vapor controls that allow the vehicles to pass a 360 rollover without fuel leakage.

An evaporative control system prevents raw fuel vapor from escaping into the atmosphere. Fuel vapors from the fuel tank and carburetor bowl (carbureted engines only) are collected in a canister. When the engine is operating the vapors are drawn into the intake manifold to be used in combustion.

Inspect all hose/clamp connections for completeness and ensure that no leaks are present. Hoses that are cracked, scuffed, swelled, have rubbed against other vehicle components or show any other sign of wear that could lead to failure.

When installing hoses, ensure that they are routed away from contact with other vehicle components that could rub against them and cause failure.

No-Lead Fuel Tank Filler Tube

Jeep vehicles are designed to operate using Unleaded fuels. The diameter of the opening in the fuel tank filler neck is sized to only accept unleaded fuel nozzles. Gasoline station pumps for unleaded and leaded fuels have different size nozzles. Leaded fuel nozzles are larger in diameter than unleaded nozzles. The fuel tank filler neck opening is also equipped with a deflector which the smaller unleaded nozzle pushes back upon entering the filler neck. The deflector will prevent the larger diameter leaded fuel nozzles from entering the filler neck and will deflect fuel away from the filler neck if filling of the tank with leaded fuel is attempted.

PRESSURE-VACUUM FILLER CAPS

The fuel filler cap incorporates a two-way relief valve that is closed to atmosphere during normal operating conditions. The relief valve used in the filler caps of SJ and YJ vehicles are calibrated to open only when a pressure of 7.7 kPa (1.1 psi) or a vacuum of 5 kPa (1.5 in. Hg) occurs within the fuel tank. The relief valve used in fuel filler caps of all other Jeep vehicles is calibrated at a pressure of 10 kPa (1.5 psi) or a vacuum of 6 kPa (1.8 in. Hg). When the pressure or vacuum is relieved the valve returns to the normally closed position.

CAUTION: The fuel filler cap must be removed prior to disconnecting any fuel system component.

FUEL TANK CAPACITIES

Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerances, ambient temperature and refill procedure.

FUEL TANK	GALLONS	LITERS
SJ	20.3	76.8
MJ SHORT BED	18.5	70.0
MJ LONG BED	23.5	89.6
XJ	20.2	76.4
YJ	20.0	75.7

J9014-106

FUEL TANK

Draining Fuel Tank

(1) Remove fuel filler cap. On vehicles equipped with Multi-Point Injection (MPI), perform MPI Fuel Pressure Release Procedure.

(2) Disconnect battery negative cable.

(3) Using a portable gasoline siphon/storage tank drain the fuel tank until dry.

MPI Fuel Pressure Release Procedure

The MPI fuel system is under constant fuel pressure of 131-269 kPa (19-39 psi). Vehicles equipped with multi-point injected 4.0L engine must have the fuel pressure released before servicing any fuel supply or return system component.

(1) Disconnect battery negative cable.

(2) Remove fuel tank filler neck cap to release fuel tank pressure.

(3) Remove cap from pressure test port on the fuel rail.

WARNING: DO NOT ALLOW FUEL TO SPILL ONTO THE ENGINE INTAKE OR EXHAUST MANIFOLDS. PLACE SHOP TOWELS UNDER THE PRESSURE PORT TO ABSORB FUEL WHEN THE PRESSURE IS RELEASED FROM THE FUEL RAIL.

(4) Place shop towels under the fuel pressure test port.

(5) Using a small screw driver or pin punch push the test port valve in to relieve fuel pressure (Fig. 1). Absorb spilled fuel with shop towels.

(6) Remove shop towels and dispose of properly.

(7) Install cap over pressure test port.

Fuel Tank Removal MJ/XJ Vehicles

If vehicle is equipped with a 4.0L engine perform MPI Fuel System Pressure Release Procedure.

(1) Disconnect battery negative cable.

(2) Remove the fuel filler cap. Using a portable gasoline siphon/storage tank drain fuel tank.

(3) Raise and support vehicle.

(4) Disconnect fuel fill hose and fill vent hose from filler neck (Fig. 2).

(5) Disconnect fuel pump/gauge sender unit wire connector. Remove tie straps securing connector harness to fuel supply and return tubes.

WARNING: WRAP SHOP TOWELS AROUND FUEL HOSES TO ABSORB ANY FUEL SPILLAGE DURING FUEL TANK REMOVAL.

(6) Disconnect fuel tank vent hose from vent tube.

(7) Disconnect fuel supply and return hoses from tubes (Fig. 3).

(8) If equipped, remove skid plate (Fig. 4, Fig. 5).

(9) Remove fuel tank shield (Fig. 6, Fig. 7, Fig. 8 or Fig. 9).

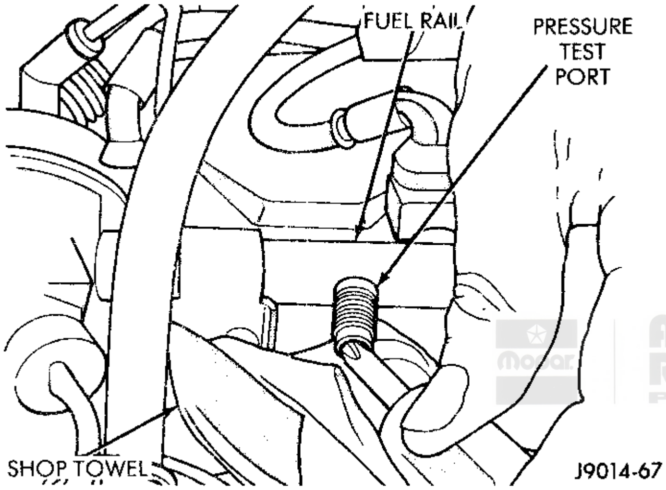


Fig. 1 Releasing MPI Fuel Pressure

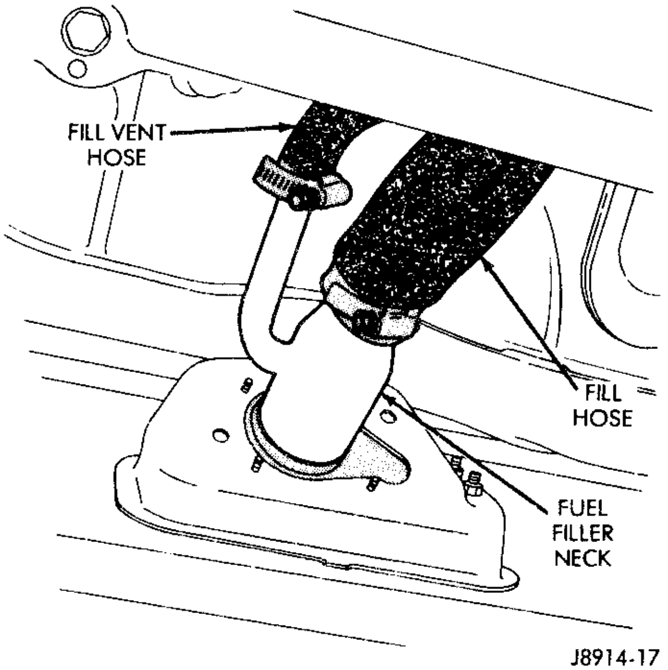


Fig. 2 Filler Neck Hoses—MJ/XJ Vehicles

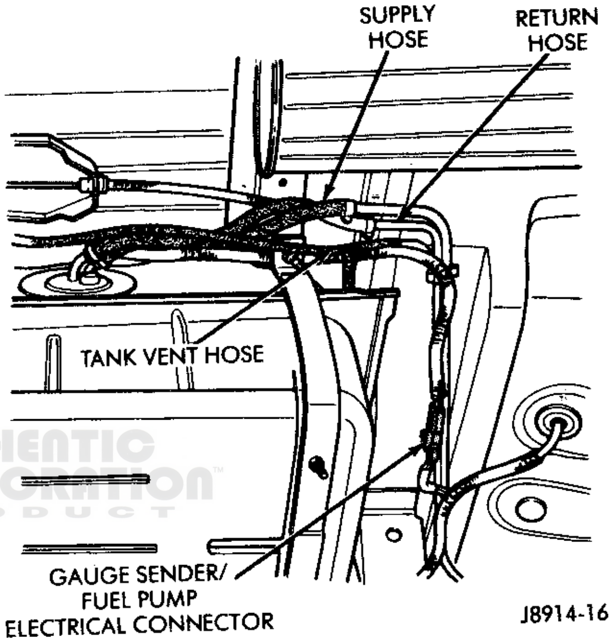


Fig. 3 Fuel Tank Hoses—MJ/XJ Vehicles

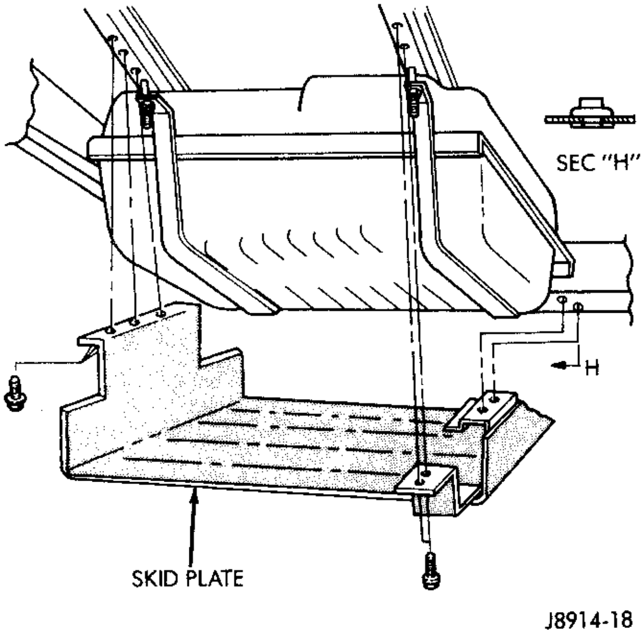


Fig. 4 Skid Plate—MJ Vehicles

(10) Center a transmission jack under the fuel tank.

(11) Remove support strap nuts. Move straps away from tank (Figs. 6, 7, 8, 9)

(12) Lower tank on transmission jack.

Fuel Tank Installation—MJ/XJ Vehicles

(1) Raise tank into position. Connect fuel fill hose and vent hose to filler neck and tighten clamps.

(2) Wrap straps around tank and over studs. On XJ vehicles, tighten strap nuts to 11.3 N•m (100 in-lbs). On MJ vehicles, if two straps are used to support tank tighten them to 7.3 N•m (65 in-lbs), if three straps are used tighten the two end straps to 7.3 N•m (65 in-lbs) and the center strap to 4.5 N•m (43 in-lbs).

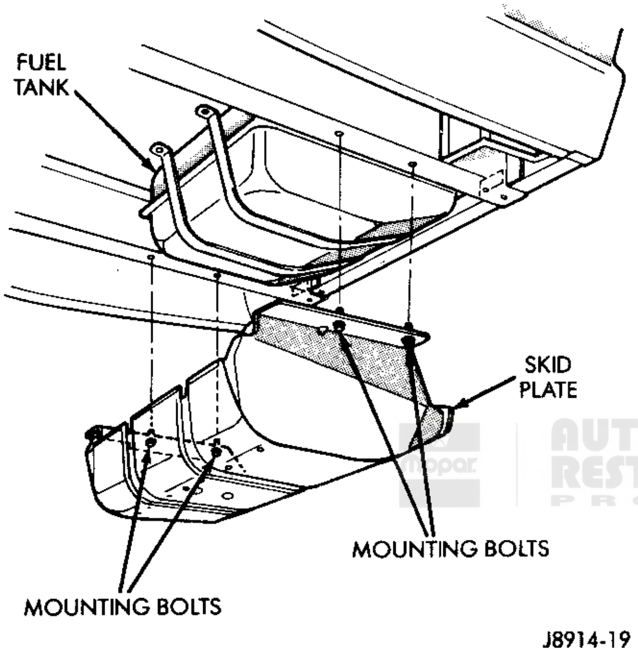


Fig. 5 Skid Plate—XJ Vehicles

(3) Remove transmission jack.

(4) Install tank shield.

(5) If equipped, install tank skid plate.

(6) Connect vent hose to vent tube.

(7) Connect fuel supply hose to supply tube and fuel return hose to return tube. Tighten hose clamps.

(8) Connect fuel pump/gauge sender unit wire connector to harness connector. Secure fuel pump/gauge sender unit wire harness to fuel tubes with tie straps.

(9) Lower vehicle.

(10) Fill fuel tank. Install filler cap.

(11) Connect battery negative cable to battery negative terminal.

(12) Start vehicle and inspect for leaks.

Fuel Tank Removal—YJ Vehicles

(1) Disconnect battery negative cable.

(2) Remove the fuel filler cap. Using a portable gasoline siphon/storage tank drain fuel tank.

(3) Raise and support vehicle.

(4) Using a small straight blade screwdriver, pull back the stem of the push clips that secure the fuel filler neck shroud (located at bottom of left rear wheel well) in place (Fig. 10). This unlocks the push clip allowing them to be removed by pulling assembly out of shroud. Remove shroud.

(5) Disconnect fuel fill hose and fill vent hose from filler neck (Fig. 11).

WARNING: WRAP SHOP TOWELS AROUND FUEL HOSES TO ABSORB ANY FUEL SPILLAGE DURING FUEL TANK REMOVAL.

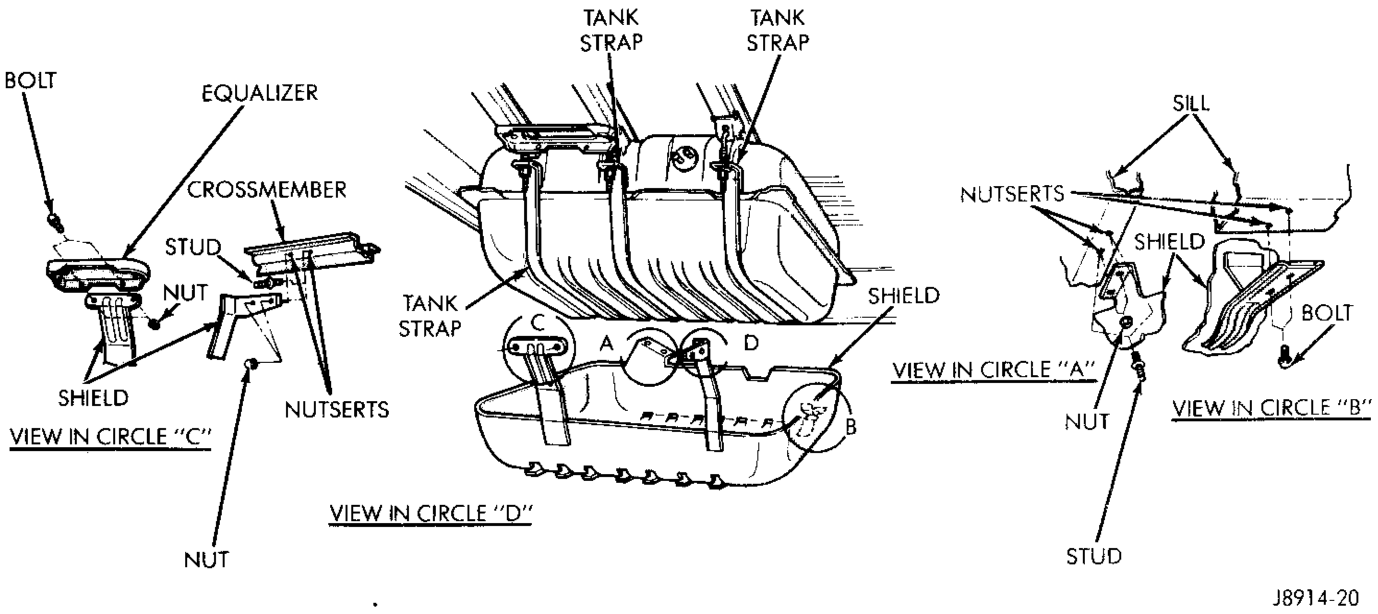


Fig. 6 Fuel Tank and Shield—4WD Long Bed Comanche with Skid Plate

(6) Disconnect fuel tank vent hose from vent tube. Disconnect fuel supply and return hoses from tubes (Fig. 12).

The fuel tank and skid plate are removed as an assembly.

(7) Centrally position a transmission jack under skid plate/fuel tank assembly.

(8) Remove skid plate/fuel tank assembly mounting nuts (Fig. 13). **Do not loosen tank strap nuts.**

(9) Lower the skid plate/fuel tank assembly slightly and disconnect the gauge sender wire connector.

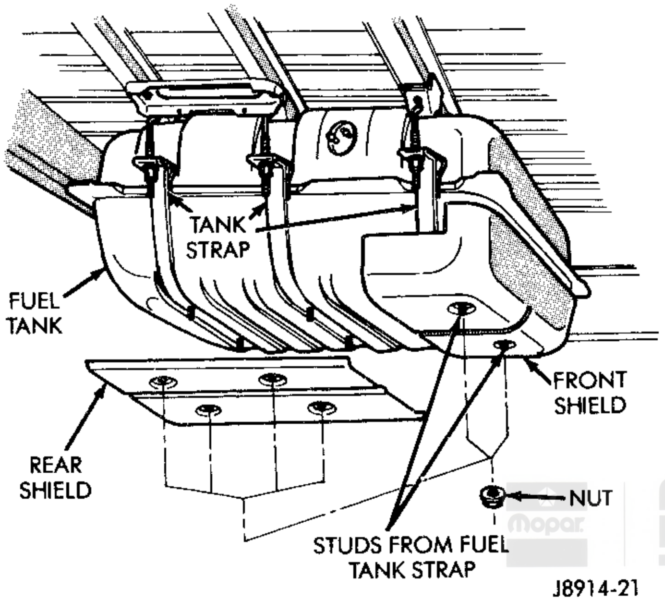


Fig. 7 Fuel Tank and Shield—Long Bed Comanche without Skid Plate

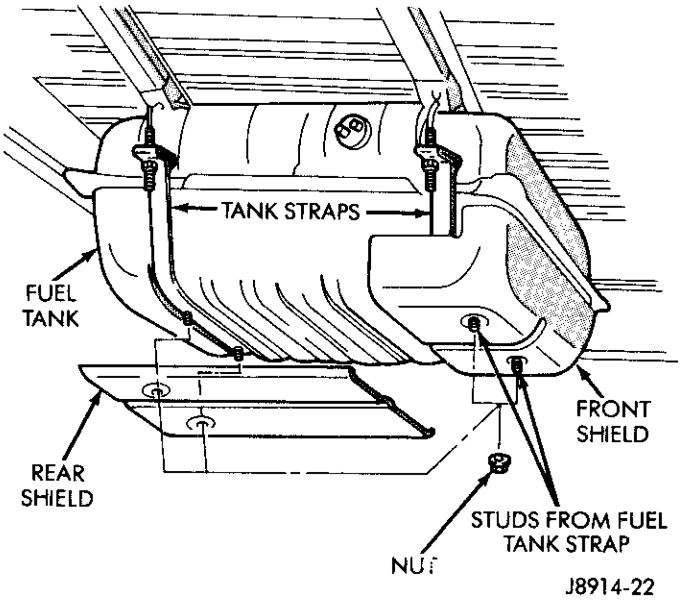


Fig. 8 Fuel Tank and Shield—Short Bed Comanche without Skid Plate

(10) Lower tank on transmission jack.

(11) Remove tank strap nuts to remove tank from skid plate.

Fuel Tank Installation—YJ Vehicles

(1) Place tank into skid plate. Wrap straps around tank with strap bolts inserted through holes in skid plate. Tighten strap nuts to 7.3 N•m (65 in-lbs) torque.

(2) Raise skid plate/fuel tank until gauge sender wire connector can be connected to harness connector.

(3) Finish raising skid plate/fuel tank assembly into position. Tighten mounting nuts to 16 N•m (12 ft-lbs) torque. Remove transmission jack.

(4) Connect fuel fill hose and fill vent hose to filler neck. Tighten hose clamps.

(5) Connect vent hose to vent tube.

(6) Connect fuel supply hose to supply tube and fuel return hose to return tube. Tighten hose clamps.

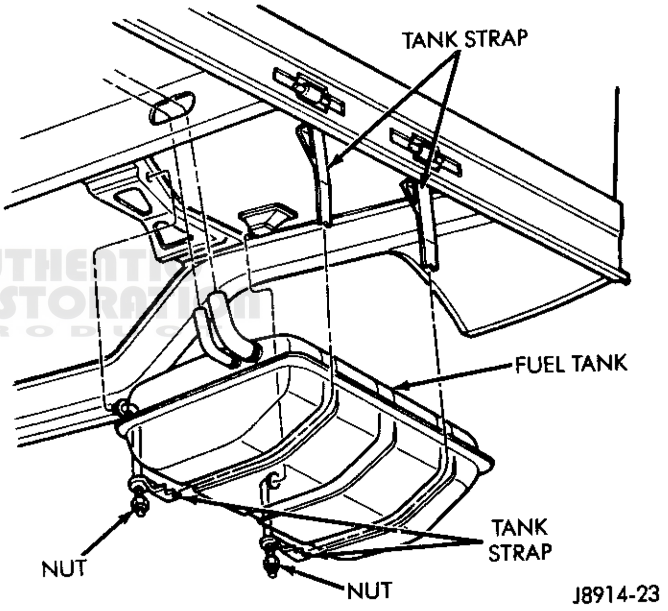


Fig. 9 Fuel Tank Remove/Install—XJ Vehicles

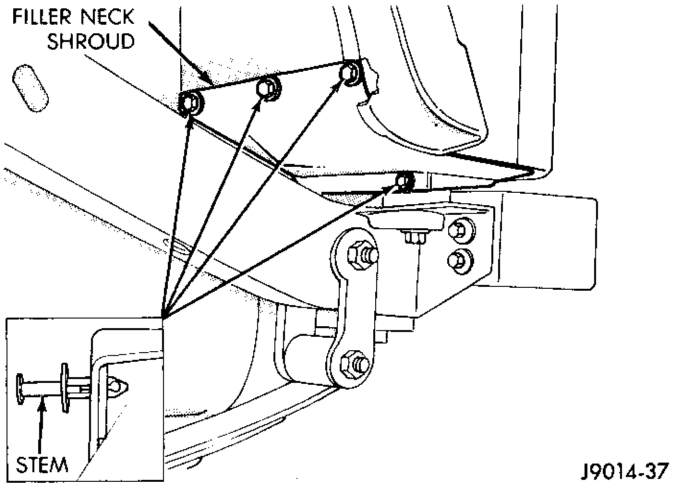


Fig. 10 Fuel Filler Neck Shroud—YJ Vehicles

(7) Install fuel filler neck shroud with push clips.

(8) Lower vehicle.

(9) Fill fuel tank. Install filler cap.

(10) Connect battery negative cable to battery negative terminal.

(11) Start vehicle and inspect for leaks.

Fuel Tank Removal—SJ Vehicles

(1) Disconnect battery negative cable.

(2) Remove fuel filler cap. Using a portable gasoline siphon/storage tank, drain fuel tank.

(3) Raise and support vehicle.

(4) Disconnect fuel fill hose and fill vent hose from filler neck.

(5) Remove clips holding fuel fill and fill vent hoses to shock absorber mount and under body.

The fuel tank and skid plate are removed as an assembly.

(6) Centrally position a transmission jack under the skid plate/fuel tank assembly.

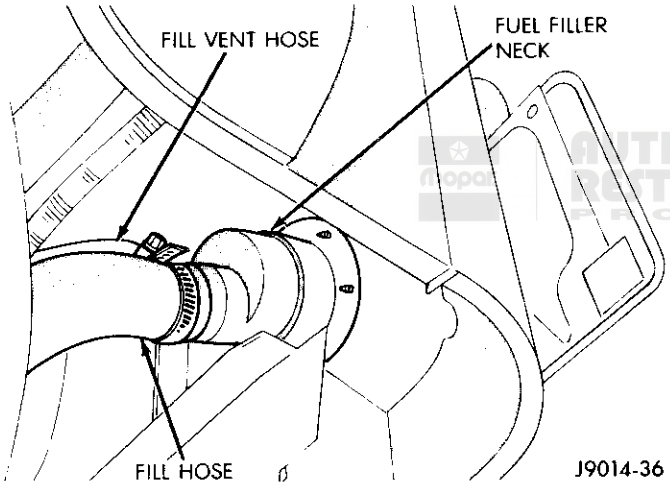


Fig. 11 Filler Neck Hoses—YJ Vehicles

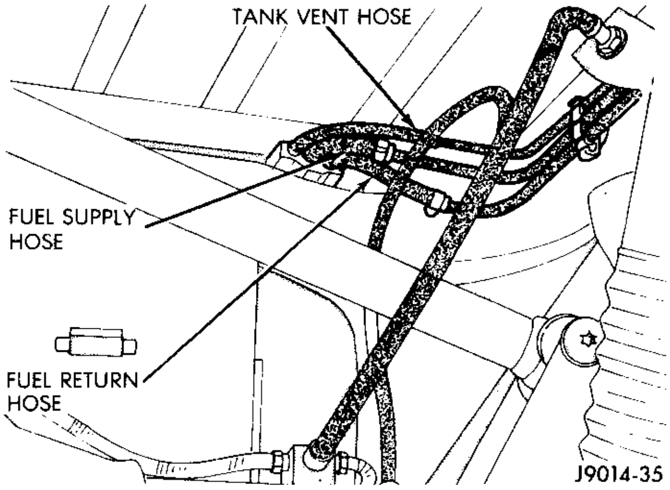


Fig. 12 Fuel Tank Hoses—YJ Vehicles

(7) Remove bolts attaching skid plate/fuel tank assembly to bracket mounted on frame rail. Remove bolts attaching skid plate/fuel tank assembly to frame rail.

(8) Remove tank support strap nuts mounted to under body.

WARNING: WRAP SHOP TOWELS AROUND FUEL HOSES TO ABSORB ANY FUEL SPILLAGE DURING FUEL TANK REMOVAL.

(9) Lower assembly far enough to disconnect fuel tank vent hose from vent tube, fuel supply and return hoses from tubes, and gauge sender electrical harness connector from main harness.

(10) Lower fuel tank on transmission jack.

(11) Remove tank straps to remove tank from skid plate.

Fuel Tank Installation—SJ Vehicles

(1) Place tank into skid plate. Wrap straps around tank.

(2) Raise skid plate/fuel tank until assembly is in position to connect gauge sender electrical harness connector to main harness connector. Connect fuel vent, supply, and return hoses to appropriate fuel tube.

(3) Finish raising skid plate/fuel tank assembly into position. Tighten mounting bolts. Remove transmission jack.

(4) Connect fuel fill hose and fill vent hose to filler neck. Tighten hose clamps. Secure hoses to shock absorber mount and under body with clips.

(6) Lower vehicle.

(7) Fill fuel tank. Install filler cap.

(8) Connect battery negative cable to battery negative terminal.

(9) Start vehicle and inspect for leaks.

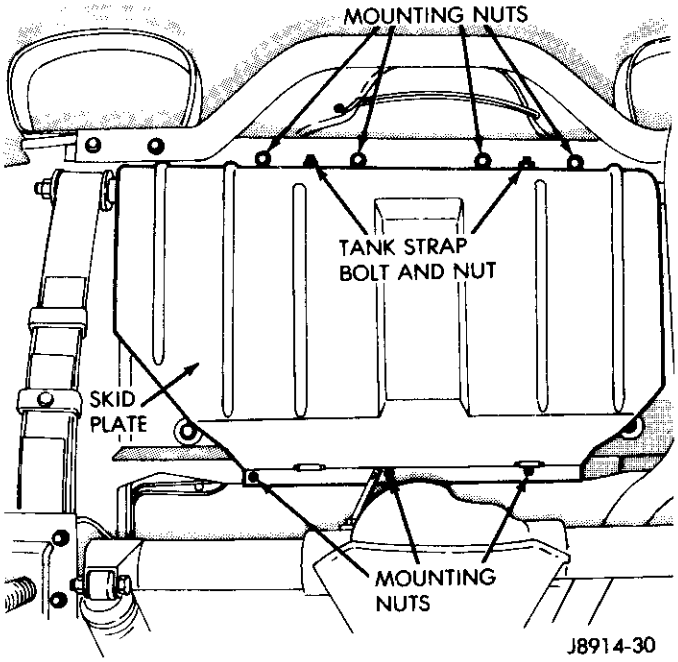


Fig. 13 Fuel Tank Remove/Install—YJ Vehicles

FUEL PUMP/GAUGE SENDER UNIT REPLACEMENT—FUEL INJECTED ENGINES

Fuel Pump/Gauge Sender Unit Removal—MJ/ XJ Vehicles

The fuel pump/gauge sender unit assembly can be removed with the fuel tank installed in the vehicle.

(1) Remove fuel filler cap. On vehicles equipped with the 4.0L engine, perform MPI Fuel Pressure Release Procedure.

(2) Disconnect battery negative cable.

(3) Using a portable gasoline siphon/storage tank drain fuel tank until fuel level is below one quarter full.

(4) Raise and support vehicle.

WARNING: WRAP SHOP TOWELS AROUND FUEL HOSES TO ABSORB ANY FUEL SPILLAGE DURING FUEL TANK REMOVAL.

(5) Disconnect fuel vent supply and return hoses from nipples on fuel pump/gauge sender unit.

(6) Disconnect fuel pump/gauge sender unit electrical harness connector from main harness.

(7) Using a brass punch and hammer, remove fuel pump/gauge sender lock ring by carefully tapping it counter clockwise (Fig. 14).

(8) Remove fuel pump/gauge sender unit and O-ring seal. Discard old O-ring and fuel pump inlet filter.

Fuel Pump/Gauge Sender Unit Disassemble—MJ/XJ Vehicles

Although MPI and TBI fuel pumps are similar in operation and construction, they are not the same and cannot be interchanged.

(1) Remove and discard fuel pump inlet filter.

The wire terminals to the fuel pump motor are different in size and cannot be connected to the wrong terminal.

(2) Disconnect fuel pump terminal wires.

(3) Remove fuel pump outlet hose and clamp. Replace the hose if shows signs of fatigue or failure.

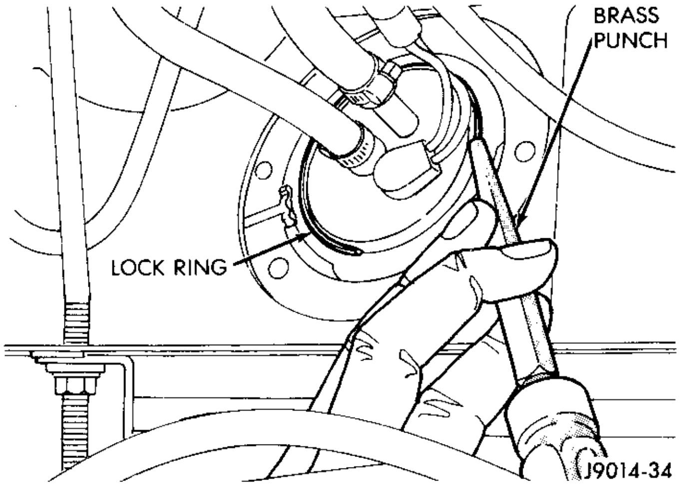


Fig. 14 Removing Lock Ring—Typical

(4) Remove fuel pump top mounting bracket nut. Remove fuel pump (Fig. 15, Fig. 16).

Fuel Pump/Gauge Sender Unit Assemble—MJ/ XJ Vehicles

Whenever the fuel pump is replaced, the fuel pump inlet filter must also be replaced.

(1) Place fuel pump top mounting bracket over top of pump.

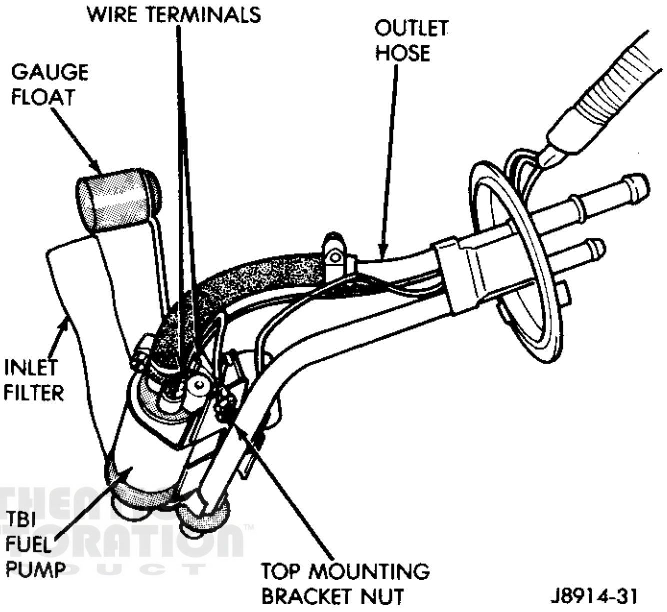


Fig. 15 TBI Fuel Pump/Gauge Sender Unit Disassemble/Assemble

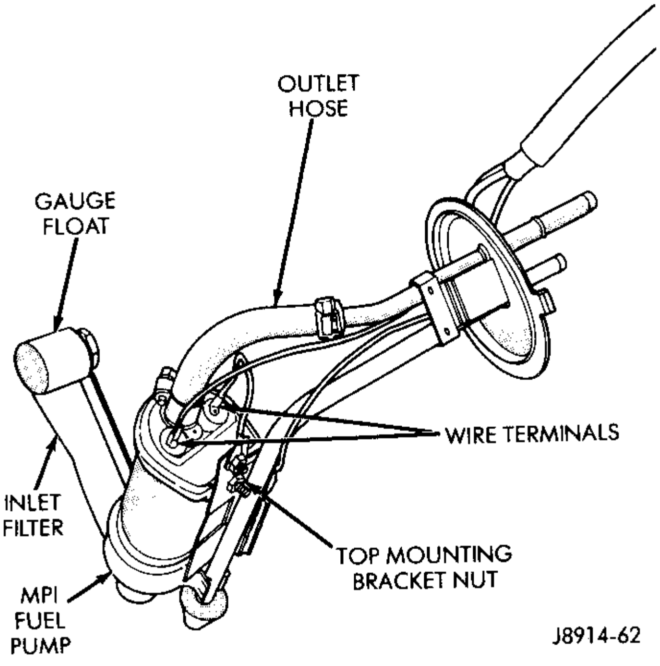


Fig. 16 MPI Fuel Pump/Gauge Sender Unit Disassemble/Assemble

(2) Position fuel pump into lower bracket. Slide stud of top bracket through hole in fuel pump side bracket. Tighten fuel pump top mounting nut.

(3) Install new fuel pump outlet hose. Secure with new clamps.

(4) Connect wire terminals to motor.

(5) Install new fuel pump inlet filter.

Fuel Pump/Gauge Sender Unit Installation—MJ/XJ Vehicles

Whenever the fuel pump is replaced, the fuel pump inlet filter must also be replaced.

(1) Install new fuel pump inlet filter onto fuel pump.

(2) Install fuel pump/gauge sender unit assembly and new O-ring seal. The rubber stopper on the end of the fuel return tube of the assembly must be inserted into the cup in the fuel tank reservoir (Fig. 17).

(3) Using a brass punch and a hammer, install lock ring. Carefully tap lock ring clockwise until it seats against stop on fuel tank.

(4) Connect fuel supply and return hoses to nipples on fuel pump/gauge sender unit. Tighten hose clamps.

(5) Connect fuel pump/gauge sender unit electrical harness connector to main harness connector.

(6) Lower vehicle.

(7) Fill fuel tank. Install fuel tank cap.

(8) Connect battery negative cable.

(9) Start vehicle and inspect for leaks.

Fuel Pump/Gauge Sender Unit Removal—YJ Vehicles

The fuel tank must be removed to remove the fuel pump/gauge sender unit.

(1) Remove battery negative cable.

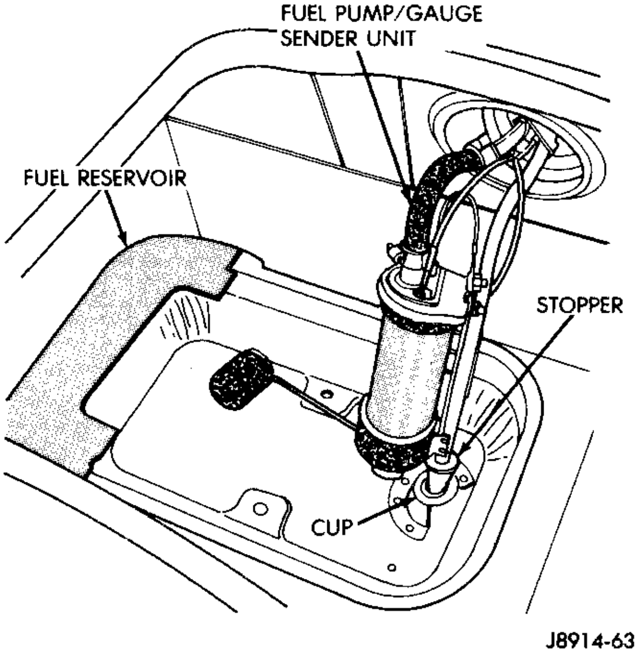


Fig. 17 Fuel Pump/Gauge Sender Unit Installation

(2) Drain the fuel tank. Refer to Draining Fuel Tank.

(3) Remove fuel tank. Refer to Fuel Tank Removal —YJ Vehicles.

(4) Remove fuel pump/gauge sender unit assembly.

- On 20 gallon tanks: Remove mounting bolts. Lift assembly and gasket out of fuel tank. Discard gasket (Fig. 18).
- On 15 gallon tanks: Using a brass punch and hammer, carefully remove lock ring by tapping it counter clockwise. Lift assembly and O-ring seal out of tank. Discard O-ring (Fig. 14).

(5) Remove and discard fuel pump inlet filter.

Fuel Pump/Gauge Sender Unit Disassemble—YJ Vehicles

(1) Remove and discard fuel pump inlet filter.

The wire terminals to the fuel pump motor are different in size and cannot be connected to the wrong terminal.

(2) Disconnect fuel pump terminal wires (Fig. 15).

(3) Remove fuel pump outlet hose and clamp (Fig. 15). Replace the hose if it shows signs of fatigue or failure.

(4) Remove fuel pump top mounting bracket nut (Fig. 15). Remove fuel pump.

Fuel Pump/Gauge Sender Unit Assemble—YJ Vehicles

Whenever the fuel pump is replaced, the fuel pump inlet filter must also be replaced.

(1) Place fuel pump top mounting bracket over top of pump.

(2) Position fuel pump into lower bracket. Slide stud of top bracket through hole in fuel pump side bracket. Tighten fuel pump top mounting nut.

(3) Install new fuel pump outlet hose. Secure with new clamps.

(4) Connect wire terminals to motor.

(5) Install new fuel pump inlet filter.

Installation—YJ Vehicles

(1) Install a new fuel pump inlet filter.

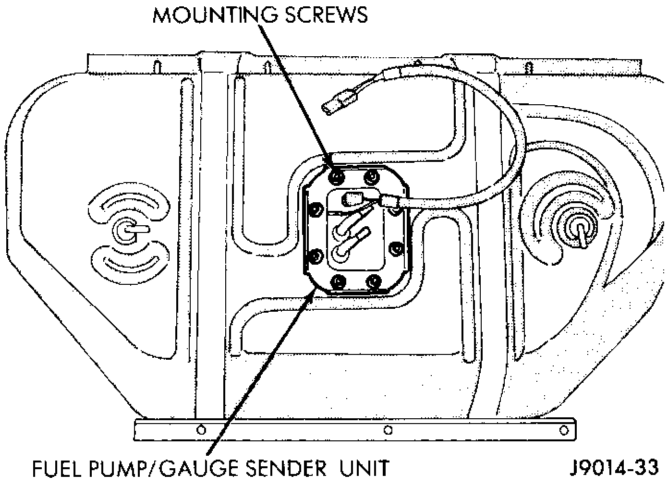


Fig. 18 Fuel Pump/Gauge Sender Unit Remove/ Install—YJ Vehicles with 20 Gallon Fuel Tank

(2) Install fuel pump/gauge sender unit assembly:

- On 20 gallon tanks: With a new gasket between the assembly and tank, tighten mounting screws to 2 N•m (18 in-lbs) torque.
- On 15 gallon tanks: With a new O-ring seal between the assembly and tank, carefully tap the lock ring clockwise with a hammer and brass punch until the ring locks against the stops on the tank.

(3) Install fuel tank. Refer to Fuel Tank Installation—YJ Vehicles.

(4) Fill fuel tank. Install fuel tank cap.

(5) Install battery negative cable.

(6) Start vehicle and check for leaks.

FUEL GAUGE SENDING UNIT—CARBURETED ENGINES

Removal

The fuel tank must be removed to remove the fuel gauge sending unit.

(1) Remove battery negative cable.

(2) Drain the fuel tank. Refer Draining Fuel Tank.

(3) Remove fuel tank. Refer to Fuel Tank Removal —YJ Vehicles.

(4) Remove fuel gauge sending unit assembly.

(a) SJ 15 vehicles:

- Remove gauge sender unit nut. Remove gauge sender unit and O-ring. Discard O-ring

(b) YJ Vehicles with 20 gallon fuel tanks:

- Remove mounting bolts. Lift assembly and gasket out of fuel tank. Discard gasket (Fig. 18).

(c) YJ Vehicles with 15 gallon tanks:

- Using a hammer and brass punch, carefully remove lock ring by tapping it counter clockwise. Lift assembly and O-ring seal out of tank. Discard O-ring (Fig. 14).

(5) Remove and discard fuel inlet filter.

Installation

(1) Install a new fuel inlet filter.

(2) Install fuel gauge sending unit assembly:

(a) SJ vehicles:

- Install fuel gauge sender with a new O-ring seal. Install nut.

(b) YJ vehicles with 20 gallon fuel tanks:

- With a new gasket installed between the assembly and tank, tighten mounting screws to 2 N•m (18 in-lbs) torque.

(c) YJ vehicles with 15 gallon tanks:

- With a new O-ring seal installed between the assembly and tank, carefully tap the lock ring clockwise with a hammer and brass punch until the ring locks against the stops on the tank.

(3) Install fuel tank. Refer to Fuel Tank Installation—YJ Vehicles.

(4) Fill fuel tank. Install fuel tank cap.

(5) Install battery negative cable.

(6) Start vehicle and check for leaks.

FUEL RESERVOIR

The fuel tanks of all Jeep vehicles are equipped with a fuel reservoir (Fig. 19) that provides fuel to the fuel pump inlet (fuel injected vehicles) or the inlet tube of the fuel sender (carbureted vehicles) during all driving conditions, especially when the fuel tank has a low level of fuel. The reservoir is a small tray with raised sides that the fuel pump inlet or fuel sender sets in. The fuel return tube empties into the reservoir. The fuel reservoir assures that the fuel pump inlet is always submerged in fuel.

FUEL TANK PRESSURE RELIEF AND ROLLOVER VALVE

The fuel tanks of all Jeep vehicles are equipped with one or two pressure relief/rollover valves depending upon vehicle. The dual function valves relieve fuel tank pressure and prevent fuel flow through the fuel tank vent hoses in the event of vehicle rollover.

The valve consists of a plunger, spring, and orifice and guide plate (Fig. 20). The valve is normally open allowing fuel vapor to vent to the canister where it is stored until it can be consumed by the engine under controlled conditions. If the bottom of the plunger is contacted by fuel sloshing in the tank when the vehicle is cornering, the plunger seats in the guide plate at the orifice preventing liquid fuel from reaching the canister.

In vehicle rollover the valve is inverted. In this position the plunger is forced against the guide plate and raw fuel is prevented from flowing through the valve orifice into the fuel tank vent tube.

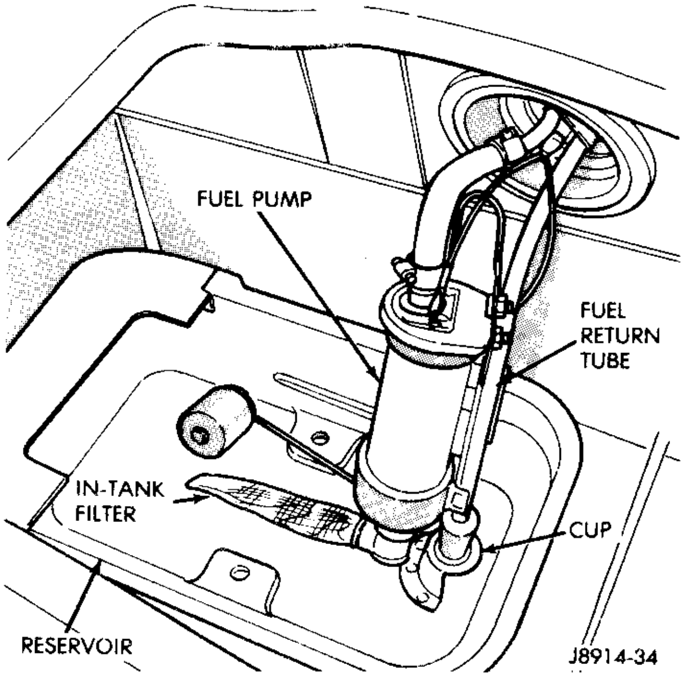


Fig. 19 Fuel Tank Reservoir—Typical

Removal

(1) Disconnect battery negative cable.

(2) Remove the fuel filler cap and drain fuel tank. Refer to Draining Fuel Tank.

(3) Remove fuel tank. Refer to Fuel Tank Removal.

(4) The rollover valve is seated in a grommet. Remove by prying one side upward and then roll the grommet out of tank (Fig. 21).

Installation

(1) Start one side of grommet into opening in fuel tank. Using finger pressure only, press valve/grommet into place.

(2) Install fuel tank. Refer to Fuel Tank Installation.

(3) Fill fuel tank. Install fuel tank filler cap.

(4) Connect battery negative cable.

(5) Start vehicle and check for leaks.

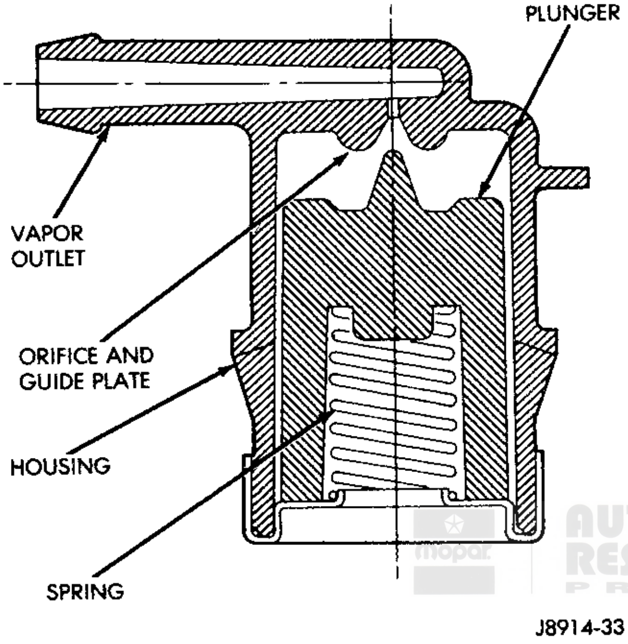


Fig. 20 Pressure Relief/RollOver Valve Operation

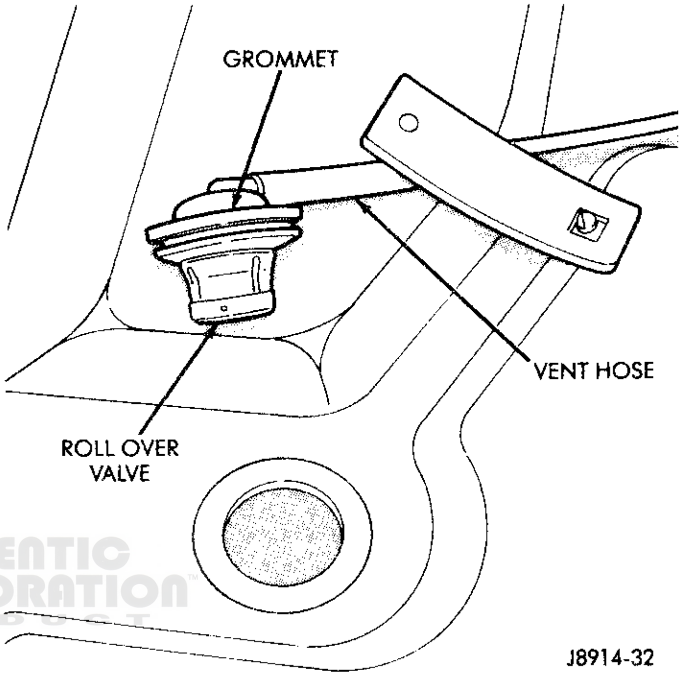


Fig. 21 Pressure Relief/RollOver Valve

ACCELERATOR PEDAL AND THROTTLE CABLE

INDEX

GENERAL INFORMATION

The accelerator pedal of all Jeep vehicles is connected to the throttle lever by the throttle cable. The cable is protected by a plastic sheathing. The cable is connected to the throttle lever by a clasp and to the accelerator pedal by a clip that snaps into the top of the pedal arm. Retainer tabs built into the cable sheathing fasten the cable to the dash panel and throttle bracket.

Depending upon vehicle, one or two throttle return springs are used to close the throttle.

SERVICE PROCEDURES

Accelerator Pedal

Removal

(1) The clip connecting the accelerator cable and pedal has tabs on the backside. Compress the tabs and pull clip forward. Slide accelerator cable out of opening in top of pedal arm.

(2) Remove accelerator pedal mounting nuts. Remove accelerator pedal (Fig. 1).

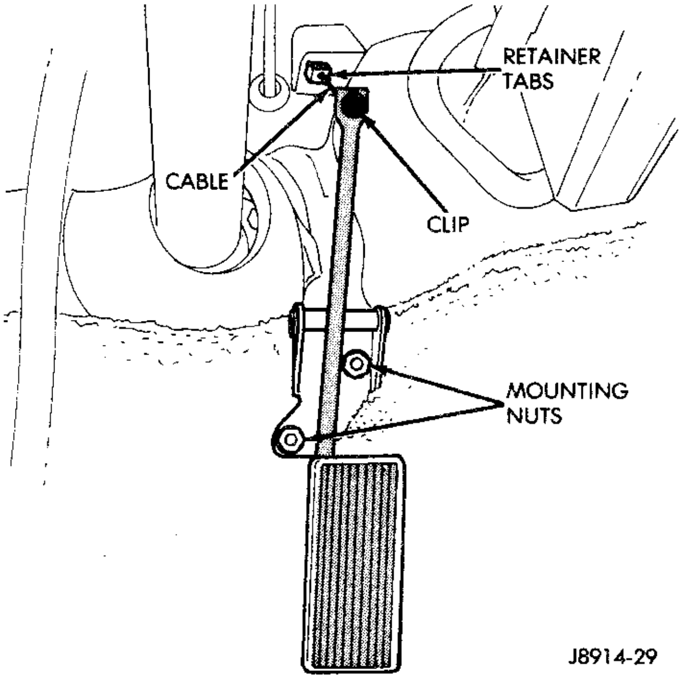


Fig. 1 Accelerator Pedal—Typical

Installation

(1) Place accelerator pedal over studs protruding from floorpan. Tighten mounting nuts to 4.3 N•m (36 in-lbs) torque.

(2) Slide accelerator cable into opening in top of pedal arm. Push cable clip into pedal arm opening until it snaps in place.

ACCELERATOR CABLE

Removal

(1) The clip connecting the accelerator cable and pedal has tabs on the backside. Compress the tabs and pull clip forward. Slide accelerator cable out of opening in top of pedal arm.

(2) The accelerator cable is anchored to dash panel by retainer tabs built into the cable sheathing. The tabs are located behind the accelerator pedal arm. From inside the drivers compartment, compress the retainer tabs and push cable through dash panel (Fig. 1).

(3) At the throttle body, use a straight blade screwdriver to disconnect the accelerator cable clasp from throttle lever.

(4) Remove accelerator cable from throttle bracket by compressing retainer tabs and pushing cable through hole in bracket. Remove accelerator cable (Fig. 2, 3, 4, or 5).

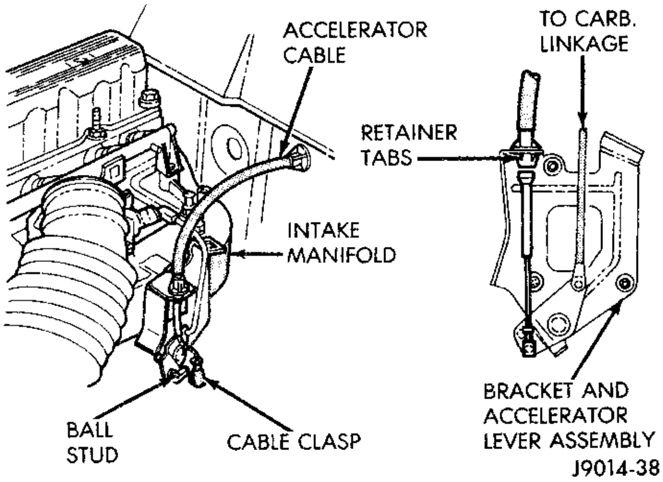


Fig. 2 Accelerator cable Remove/Install—MJ/XJ Vehicles with 4.0L Engine

Installation

(1) Slide clasp end of accelerator cable through hole in throttle bracket until retainer tabs lock into bracket.

(2) Connect cable clasp to ball stud on throttle lever.

(3) Push other end of cable through opening in dash panel until retaining tabs lock into panel.

(4) From inside drivers compartment, Slide accelerator cable into opening in top of pedal arm. Push cable clip into pedal arm opening until it snaps in place.

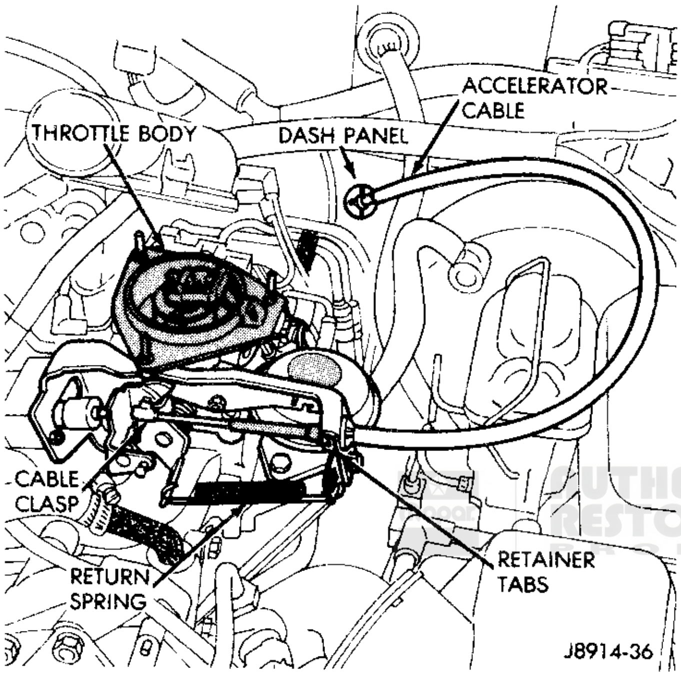


Fig. 3 Accelerator cable Remove/Install—2.5L Engine

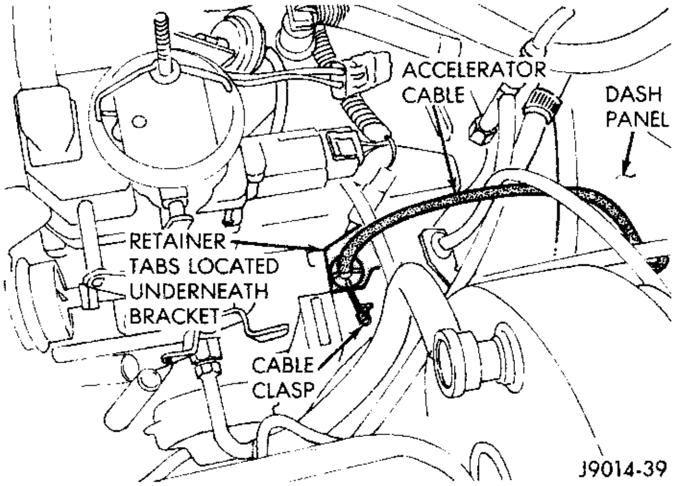


Fig. 4 Accelerator cable Remove/Install—YJ with 4.2L Engine

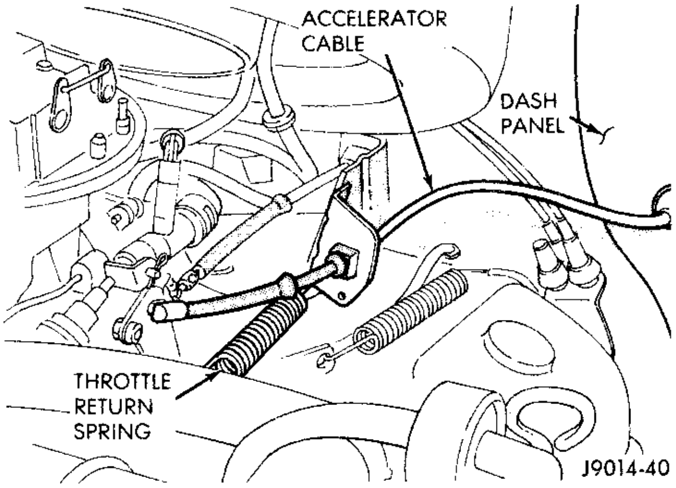


Fig. 5 Accelerator cable Remove/Install—SJ Vehicles

THROTTLE BODY (SINGLE POINT) FUEL INJECTION

INDEX

GENERAL INFORMATION

MJ, XJ and YJ vehicles equipped with the 2.5L engine use a Throttle Body Fuel Injection (TBI) System. TBI is a single point, pulse time system that injects fuel through an electrically operated fuel injector into the throttle body above the throttle plate.

The fuel injection pulse width (period of time that the injector is energized causing fuel to be released into the throttle body) is controlled by the engine Electronic Control Unit (ECU). The ECU accomplishes this by opening and closing the ground path to the injector. By controlling fuel injector pulse width the ECU is able to meter the amount of fuel to the engine and constantly adjust the air-fuel ratio.

The ECU receives inputs from sensors that react to exhaust gas oxygen content, coolant temperature, manifold absolute pressure, engine speed (crankshaft position), throttle position, battery voltage, and air-fuel temperature. These inputs represent the engines instantaneous operating conditions. Based on these inputs the ECU adjusts air-fuel ratio and ignition timing for the current operating conditions. The sensors and switches that provide input to the ECU, the ECU, and the ECU outputs (engine control devices that the ECU constantly adjusts), comprise the Engine Control System.

The Engine Control System consists of:

- Coolant Temperature Sensor (CTS)
- Manifold Air Temperature (MAT) Sensor
- Manifold Absolute Pressure (MAP) Sensor
- Engine Speed Sensor (Crankshaft Position Sensor—CPS)
- Throttle Position Switch (TPS)
- Exhaust Oxygen (O_2) Sensor
- Battery Voltage (B+)
- A/C Select Signal
- A/C Request Signal
- Wide Open Throttle (WOT) Switch—YJ Vehicles Only
- Closed Throttle Switch
- Neutral Safety Switch
- Power Steering High Pressure Switch
- Starter Motor Relay
- Electronic Control Unit (ECU)
- Fuel Pump Relay
- B+ Latch Relay
- Idle Speed Actuator (ISA)
- Ignition Control Module
- Fuel Injector
- EGR/Evaporative Canister Purge Solenoid—YJ Vehicles Only
- EGR Valve Vacuum Solenoid—MJ/XJ Vehicles
- A/C Compressor Clutch Relay—MJ/XJ Vehicles Only

Air-Fuel mixture calibrations for various driving and atmospheric conditions are pre-programmed into the ECU. The ECU monitors and analyzes its various inputs, computes engine fuel and ignition timing requirements based on these inputs, and controls fuel delivery and ignition timing accordingly. As operating conditions change, the ECU adjusts injector pulse width and ignition timing for optimum performance and fuel economy. Refer to Operation Modes for system operation.

System Diagnosis

For diagnosing TBI electronic control system malfunctions refer to the Service Diagnostic Tester and accompanying manual. The Service Diagnostic Tester plugs into two diagnostic connectors inside the engine compartment. After performing the required diagnostic test the tester will display a fault code if a malfunction is detected. Diagnostic charts for all fault codes are listed in the tester manual.

ENGINE ELECTRONIC CONTROL UNIT (ECU)

The ECU controls the fuel injector pulse width and ignition timing based on inputs received from sensors that react to exhaust gas oxygen content, air-fuel temperature, coolant temperature, manifold absolute pressure, battery voltage, crankshaft position (engine speed), throttle position, and inputs from switches that are triggered by power steering pump output pressure, wide open throttle conditions (YJ vehicles only), and transmission gear selection (automatic transmissions only). Battery voltage is also monitored to determine injector pulse width. These sensors and switches are considered ECU inputs.

ECU Inputs

The ECU is powered by the vehicle's battery. When the ignition is turned to the ON or START position, the following inputs are supplied to the ECU:

- Start Signal
- Engine coolant temperature
- Intake manifold air-fuel temperature
- Intake manifold absolute pressure
- Engine speed (crankshaft position)
- Throttle position
- Exhaust gas oxygen content
- Battery voltage
- A/C select and request
- Wide Open Throttle switch (YJ vehicles only)
- Closed Throttle switch
- Neutral Safety Switch
- Power Steering Pressure Switch

ECU Outputs

The following are controlled by the ECU:

- Electric Fuel Pump relay
- B+ Latch relay
- A/C compressor clutch relay
- Idle Speed Actuator (ISA) Motor
- Ignition Power Module (MPA)
- Fuel Injector
- EGR/Evaporative Canister Purge Solenoid—YJ Vehicles Only
- EGR Valve Vacuum Solenoid—MJ/XJ Vehicles Only
- Shift indicator lamp (manual transmissions only)

STARTER RELAY (START SIGNAL)—ECU INPUT

The starter motor relay (Fig. 1) provides an input (start signal) to the ECU indicating that the starter motor is being engaged. The ECU then begins monitoring ECU inputs to determine current operating conditions.

COOLANT TEMPERATURE SENSOR (CTS)—ECU INPUT

The Coolant Temperature Sensor is installed in the intake manifold coolant jacket and provides an input voltage to the ECU (Fig. 2). As coolant temperature varies the Coolant Temperature Sensors resistance changes resulting in a different input voltage to the ECU. Based on this input the ECU will:

- Adjust the injector pulse width. Colder coolant temperatures will result in longer injector pulse width and richer air-fuel mixtures.
- Compensate for fuel condensation in the intake manifold.
- Control engine warm-up idle speed.
- Increase the ignition advance when the coolant is cold.
- Energize the EGR valve solenoid thus preventing the flow of vacuum to the EGR valve.

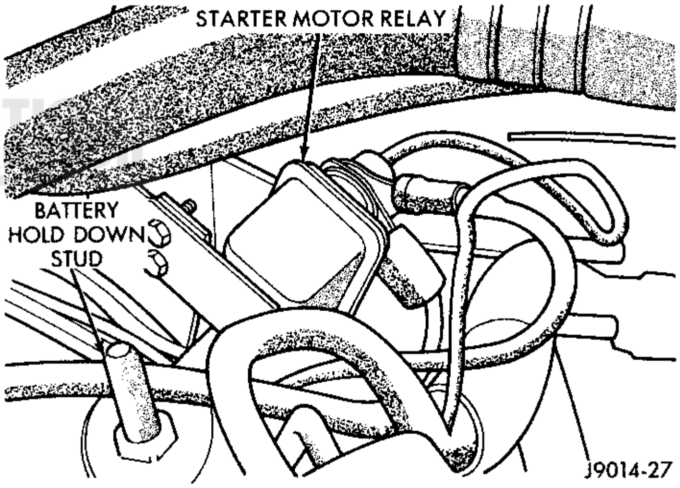


Fig. 1 Starter Motor Relay

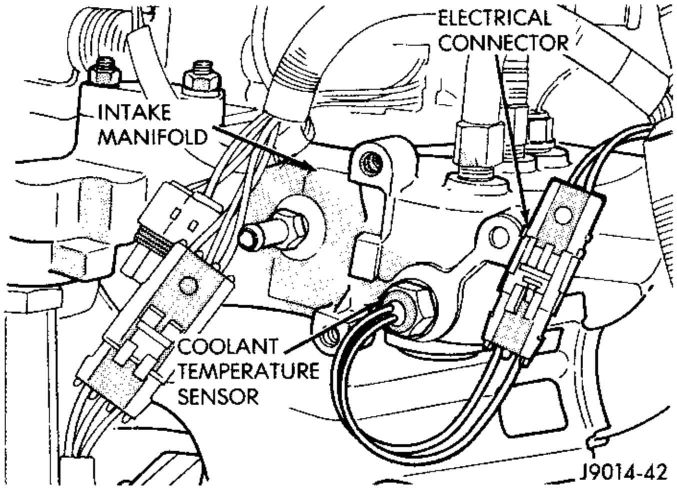


Fig. 2 Coolant Temperature Sensor

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

The Manifold Air Temperature (MAT) sensor is installed in the intake manifold with sensor element extending into the air-fuel stream (Fig. 3). The MAT sensor provides an input voltage to the ECU. As the temperature of the air-fuel stream in the manifold varies, the MAT sensors resistance changes resulting a different input voltage to the ECU.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—ECU INPUT

The MAP sensor reacts to absolute pressure in the intake manifold and provides an input voltage to the ECU. As engine load changes manifold pressure varies, causing the MAP sensors resistance to change. The change in MAP sensor resistance results in a different input voltage to the ECU. The input voltage level supplies the ECU with information relating to ambient barometric pressure during engine start-up (cranking) and to engine load while the engine is running. The ECU computes this information and adjusts air-fuel mixture accordingly.

The MAP sensor (Fig. 4) is mounted underhood on the dash panel and is connected to the throttle body with a vacuum hose.

ENGINE SPEED SENSOR (CRANKSHAFT POSITION SENSOR—CPS)—ECU INPUT

The speed sensor is attached to the flywheel/drive plate housing (Fig. 5). The sensor detects the flywheel/drive plate teeth as they pass during engine operation and provides engine speed and crankshaft angle (position) information to the ECU.

The flywheel/drive plate has a large trigger tooth and notch located 90 degrees before each top dead center (TDC) position. There are 12 small teeth between the notch and TDC (Fig. 6).

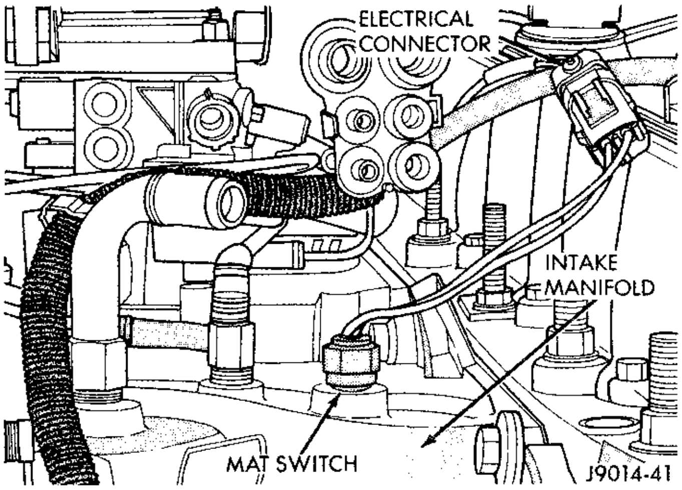


Fig. 3 Manifold Air Temperature Sensor

When a small tooth and notch pass under the magnet core in the sensor, the concentration and then collapse of the magnetic flux induces a small voltage (spike) into the sensor pick-up coil winding. These small voltage spikes enable the ECU to count the teeth as they pass the sensor.

When a large trigger tooth and notch pass under the magnet core in the sensor, the increased concentration and then collapse of the magnetic flux induces a higher voltage (spike) into the sensor pick-up coil winding (Fig. 7).

The higher voltage (spike) indicates to the ECU that a piston will be at the TDC position 12 teeth later. The ignition timing for the cylinder is either advanced or retarded as necessary by the ECU according to the sensor inputs.

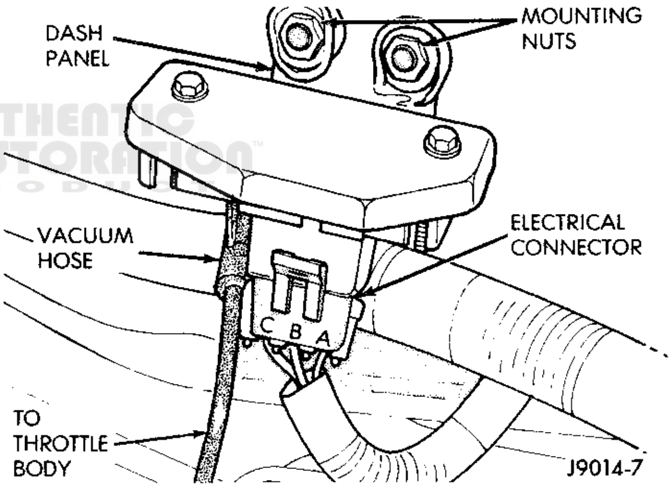


Fig. 4 MAP Sensor

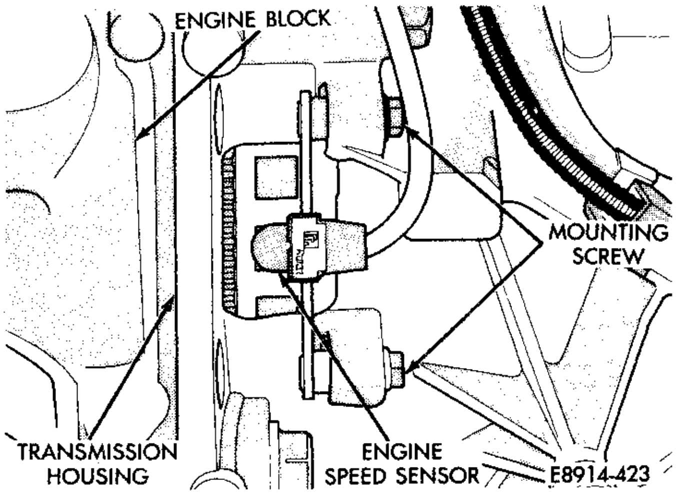


Fig. 5 Engine Speed Sensor

THROTTLE POSITION SENSOR (TPS)—ECU INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle valve shaft. The sensor is a variable resistor that provides the ECU with an input voltage that represents throttle valve position. Input voltage to the ECU from the TPS varies in an approximate range of from 1 volt at minimum throttle opening (idle) to 5 volts at wide open throttle. The ECU uses TPS input voltage to determine current engine operating conditions.

There are two different Throttle Position Sensors, one used with manual transmissions (Fig. 8) and one used with automatic transmissions (Fig. 9). The TPS used with automatic transmissions has two integral wire harness connectors (one four pin connector and one three pin connector) that plug into the engine wire harness. The four pin connector supplies input to the ECU while the three pin connector supplies input to the Transmission Control Unit. The TPS used with manual transmissions does not have an integral wire harness connector. The engine wire harness connects directly to the TPS used with manual transmissions.

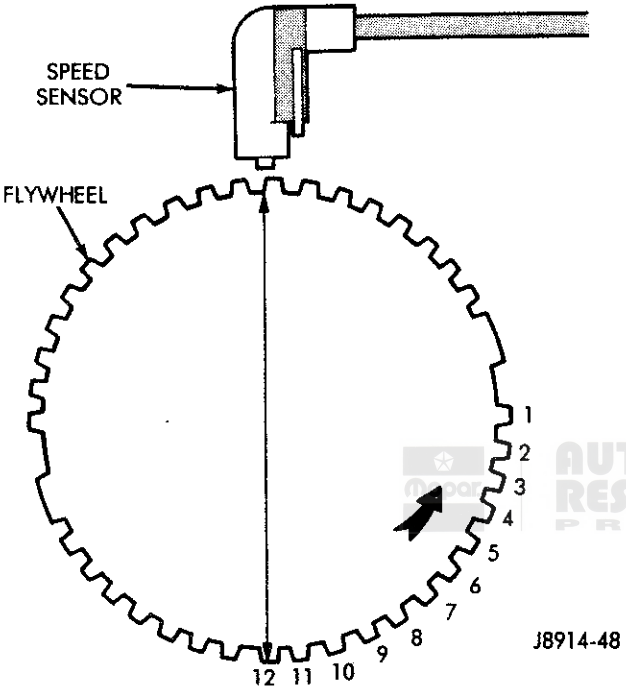


Fig. 6 Engine Speed Sensor and Flywheel

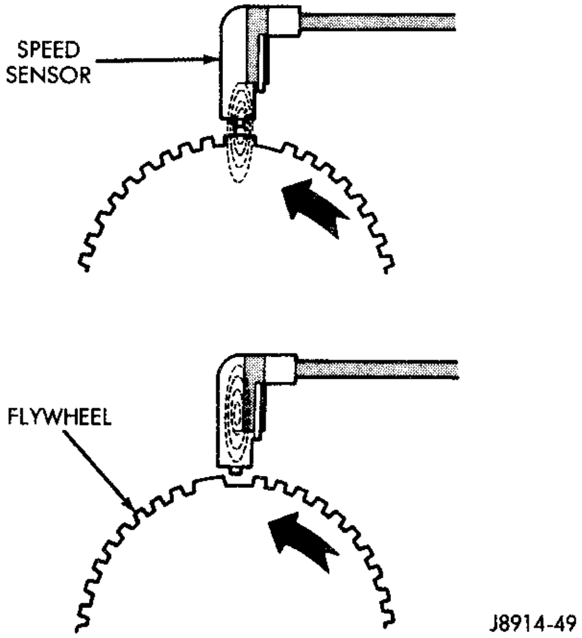


Fig. 7 Engine Speed Sensor Operation

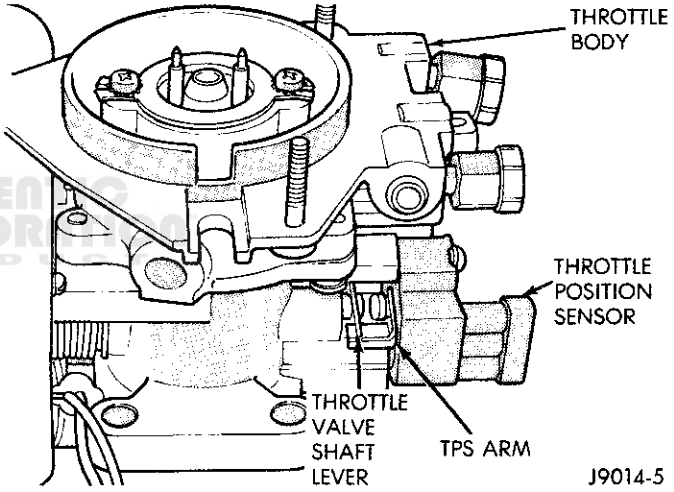


Fig. 8 Throttle Position Sensor—with Manual Transmission

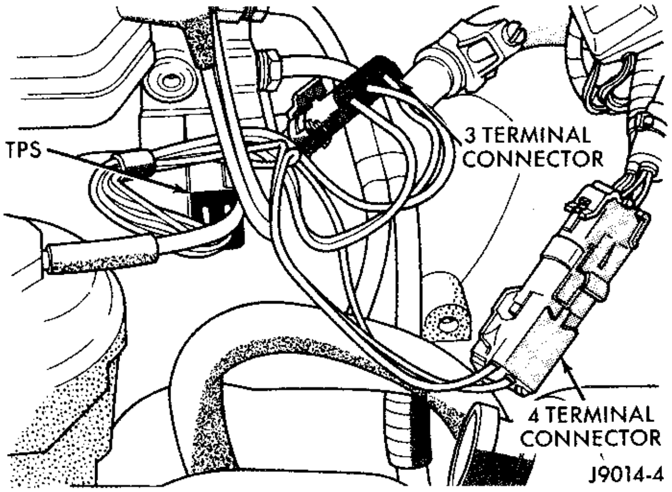


Fig. 9 Throttle Position Sensor—with Automatic Transmission

HEATED OXYGEN SENSOR (O_2 SENSOR)—ECU INPUT

The oxygen sensor is located in the exhaust manifold and provides an input voltage to the ECU relating the oxygen content of the exhaust gas (Fig. 10). The ECU uses this information to vary the air-fuel ratio.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner and to remain in closed loop operation during periods of extended idle.

Voltage is supplied to the Oxygen sensor through the ignition switch.

BATTERY VOLTAGE—ECU INPUT

The battery voltage input to the ECU is used to ensure that proper voltage is applied to the fuel injector. The ECU varies the voltage applied to the injector to compensate for battery voltage fluctuations.

A/C CONTROLS—MJ/XJ VEHICLES ONLY—ECU INPUT

The A/C inputs indicate to the ECU that the A/C switch is in the ON position and when the compressor clutch must be engaged. The ECU changes the engine idle speed to compensate for increased engine load during A/C compressor operation through the A/C select and request controls. The Idle Speed Actuator is extended through the A/C select and request circuit.

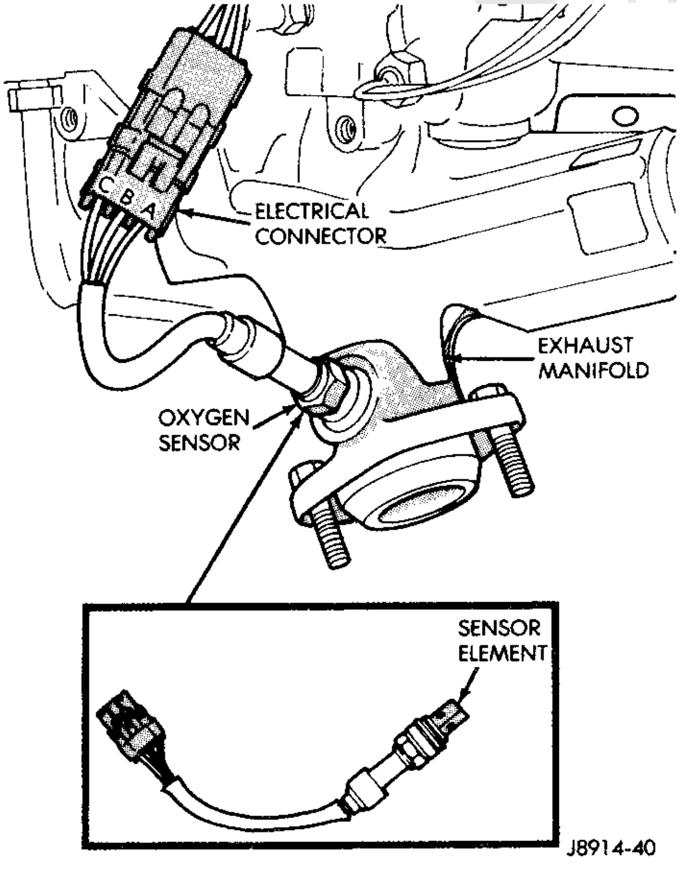


Fig. 10 Oxygen Sensor — 2.5L

WIDE OPEN THROTTLE (WOT) SWITCH—YJ VEHICLES ONLY—ECU INPUT

The WOT switch is only used on YJ vehicles with 2.5L engines. The WOT switch is attached to the throttle bracket on the front side of the throttle body (Fig. 11). The switch provides an input to the ECU that indicates a wide-open-throttle condition exists. The ECU enriches the air-fuel ratio by increasing the fuel injector pulse width to correspond with the increased air flow through the throttle body during wide-open-throttle conditions.

In the TBI system used on MJ/XJ vehicles the Throttle Position Sensor (TPS) performs the function of the wide open throttle switch. Although a WOT switch is not used on these vehicles, an input indicating a wide open throttle condition is sent to the ECU by the TPS.

CLOSED THROTTLE SWITCH—ECU INPUT

The Closed Throttle Switch is integral with the idle speed actuator (ISA) motor and provides an input signal to the ECU (Fig. 12). This input enables the ECU to increase or decrease the throttle stop angle (by extending or retracting the ISA) in response to engine operating conditions.

NEUTRAL SAFETY SWITCH—ECU INPUT

The neutral safety switch provides an input to the ECU that indicates the automatic transaxle is in a driving mode and not in Park or Neutral. Refer to group 21 Transmissions, for testing, replacement, and adjustment information.

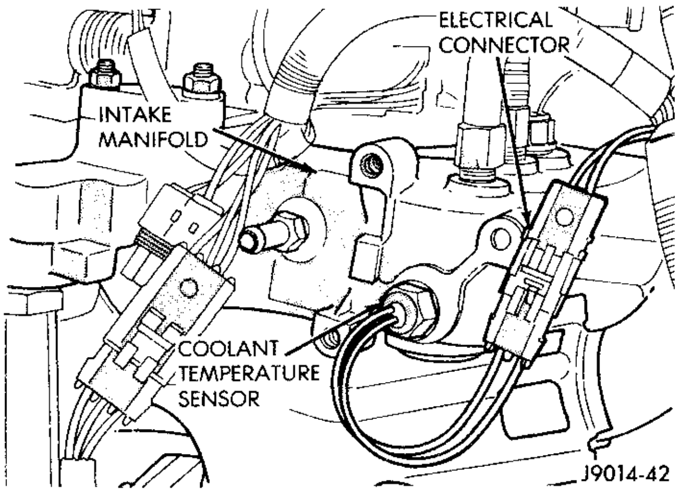


Fig. 11 Wide Open Throttle Switch—YJ Vehicles Only

POWER STEERING HIGH PRESSURE SWITCH—ECU INPUT

YJ Vehicles

A pressure sensing switch is included in the power steering system used on YJ vehicles equipped with 2.5L engine and power steering. The switch (Fig. 13) provides an input to the ECU during periods of high pump load and low engine RPM; such as during parking maneuvers. The ECU will then extend the Idle Speed Actuator to increases the idle speed to prevent the engine from stalling under the increased load.

Input signals from the power steering pressure switch are routed to the ECU through the A/C request and select input circuits. When power steering pump pressure exceeds 1896 kPa ± 172 kPa (275 ± 25 psi) the ECU will increase the engine idle speed to prevent the engine from stalling.

MJ/XJ Vehicles

A pressure sensing switch is included in the power steering system used on MJ/XJ vehicles equipped with 2.5L engine and power steering. The switch (Fig. 14) provides an input to the ECU during periods of high pump load and low engine RPM; such as during parking maneuvers.

When power steering pump pressure exceeds 1896 kPa ± 172 kPa (275 ± 25 psi) with the air-conditioning clutch not engaged, the ECU will increase the engine idle speed to prevent the engine from stalling.

If the A/C compressor clutch is engaged when power steering pump pressure exceeds 1896 kPa ± 172 kPa (275 ± 25 psi) the ECU will disengage the A/C clutch to compensate for the increased engine load (the ECU previously raised the engine idle speed based on input from the A/C select and request circuitry to compensate for the increased engine load from the compressor clutch when the A/C was selected—refer to A/C Controls under ECU outputs).

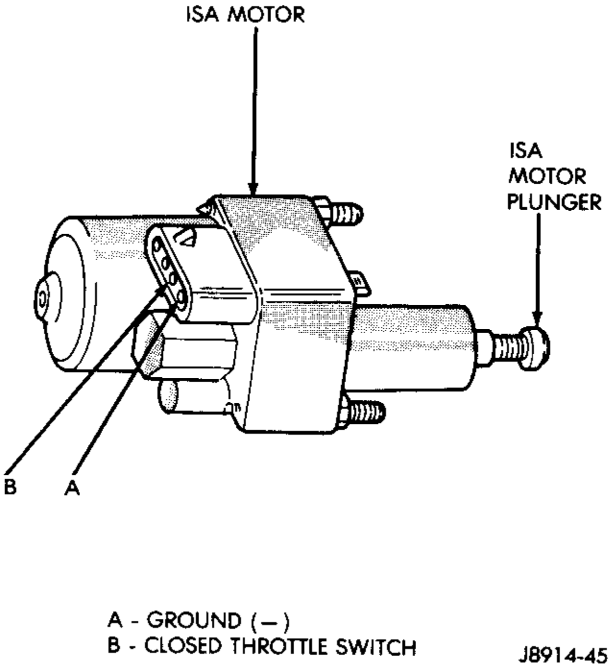


Fig. 12 Closed Throttle Switch—Integral with ISA Motor

FUEL PUMP CONTROL RELAY—ECU OUTPUT

The fuel pump control relay (Fig. 15) is located on the front of the right strut tower. Battery voltage is applied to the relay via the ignition switch. The relay is energized when a ground is provided by the ECU. When the relay is energized, voltage is applied to the fuel pump.

B+ LATCH RELAY—ECU OUTPUT

The Power Latch relay (Fig. 15) is located on the right inner fender panel. This relay is initially energized during engine start-up and remains energized until 3 to

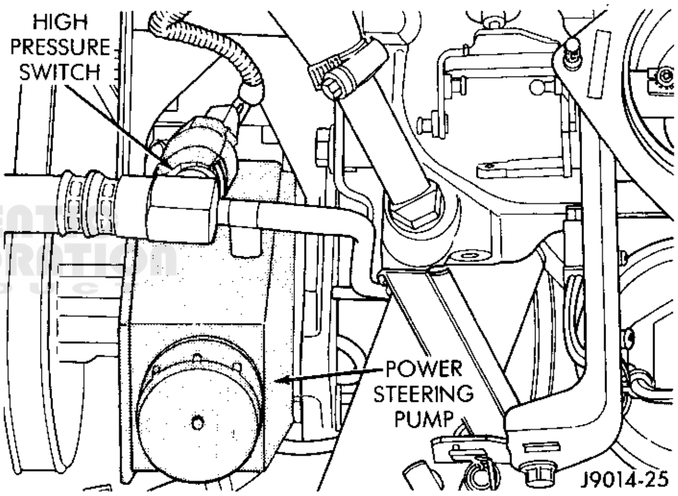


Fig. 13 Power Steering Pump High Pressure Switch—YJ Vehicles

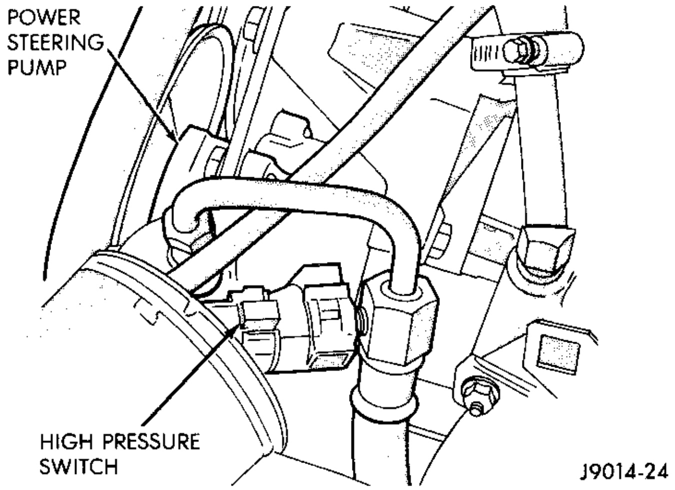


Fig. 14 Power Steering Pump High Pressure Switch—MJ/XJ Vehicles

5 seconds after the engine is stopped. The relay supplies current to the ISA motor enabling the ECU to extend the idle speed actuator (ISA) for the next start-up.

A/C COMPRESSOR CLUTCH RELAY (MJ and XJ ONLY)—ECU OUTPUT

The ECU controls the A/C compressor clutch via the A/C compressor clutch relay (Fig. 15).

IDLE SPEED ACTUATOR (ISA) MOTOR—ECU OUTPUT

The Idle Speed Actuator (ISA) motor is mounted to the throttle body and controlled by the ECU (Fig. 16). The throttle lever rests against the initial adjustment screw of the actuator (plunger). **The idle speed is not adjustable. The initial adjustment screw is only used to establish the initial positioning of the actuator when the ISA motor has been replaced.**

The actuator (plunger) extends or retracts to control engine idle speed and to set throttle stop angle during deceleration. Based on inputs from the various engine control system sensors and switches the ECU supplies current to the ISA motor to adjust the actuator (plunger) position for the particular operating conditions.

Once the engine has been shut off, current is momentarily supplied to ISA motor through the B+ Latch relay causing the actuator to extend to a set position for the next start-up. When the engine is next started it operates at a fast idle until sensor inputs tell the ECU that the engine has reached normal operating temperature. The ECU then retracts the actuator until the idle is set to a programmed RPM for the current operating conditions. Idle speed varies slightly due to different operating conditions.

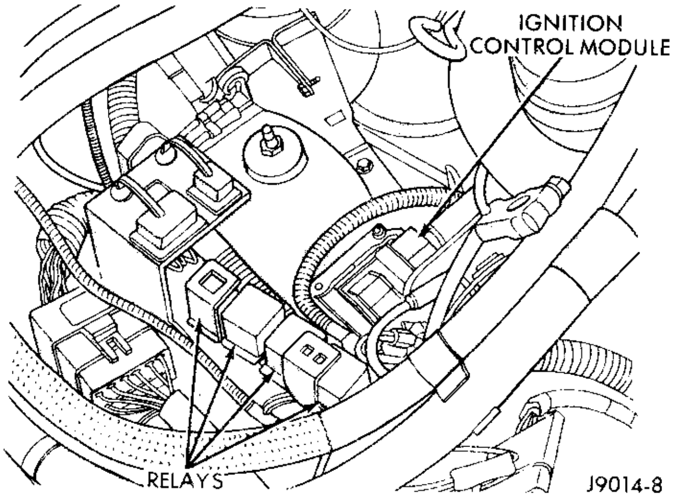


Fig. 15 Fuel Pump Relay, B+ Latch Relay, A/C Compressor Clutch Relay

IGNITION CONTROL MODULE—ECU OUTPUT

The ignition control module is mounted to the ignition coil (Fig. 17). Based on control system inputs, the ECU triggers the ignition coil via the ignition control module. The ECU is able to advance or retard ignition timing by controlling the ignition coil through the ignition control module.

FUEL INJECTOR—ECU OUTPUT

The fuel injector is located within the throttle body (Fig. 18). The injector is electronically and exclusively controlled by the ECU. The injection pulse width is based on engine operating conditions, which are provided to the ECU by the input sensors.

EGR/EVAPORATIVE CANISTER PURGE SOLENOID—YJ VEHICLES ONLY—ECU OUTPUT

Vacuum for the EGR valve and Evaporative Canister is controlled by the EGR Valve/Evaporative Canister

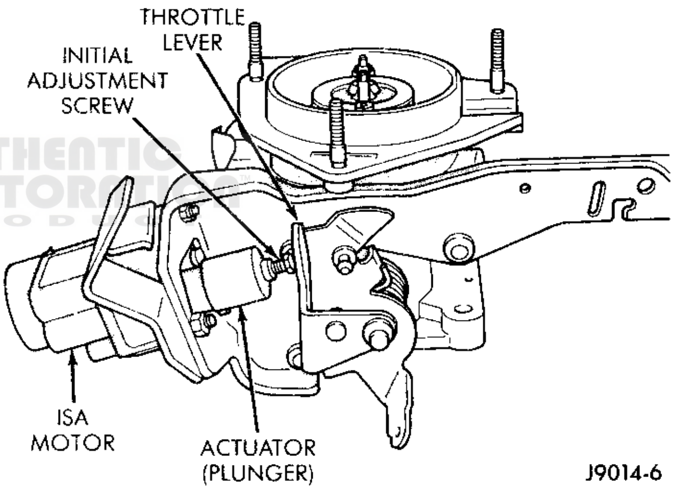


Fig. 16 ISA Motor

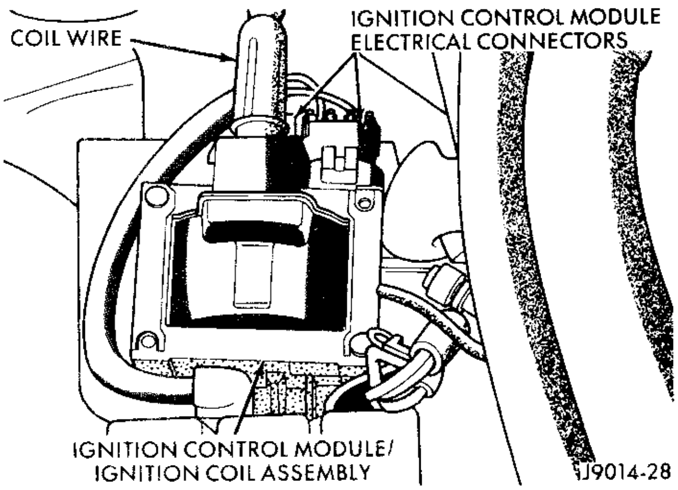


Fig. 17 Ignition Control Module

Purge Solenoid (Fig. 19). The solenoid is controlled by the ECU. When energized, the solenoid prevents vacuum from reaching the EGR valve and Evaporative Canister. When not energized the solenoid allows vacuum to flow through to the EGR valve and Canister.

The solenoid is energized during engine warm-up, closed throttle (idle), wide open throttle and rapid acceleration/deceleration. **If the solenoid wire connector is disconnected, the EGR valve and evaporative canister purge function will be operational at all times.**

EGR VALVE VACUUM SOLENOID—MJ/XJ VEHICLES ONLY—OUTPUT

Vacuum for the EGR valve is controlled by the EGR Valve/Canister Purge Solenoid (Fig. 20). The solenoid is controlled by the ECU. When energized, the solenoid prevents vacuum from reaching the EGR valve. When not energized the solenoid allows vacuum to flow through to the EGR valve.

The solenoid is energized during engine warm-up, closed throttle (idle), wide open throttle and rapid acceleration/deceleration. **If the solenoid wire connector is disconnected, the EGR valve will be operational at all times.**

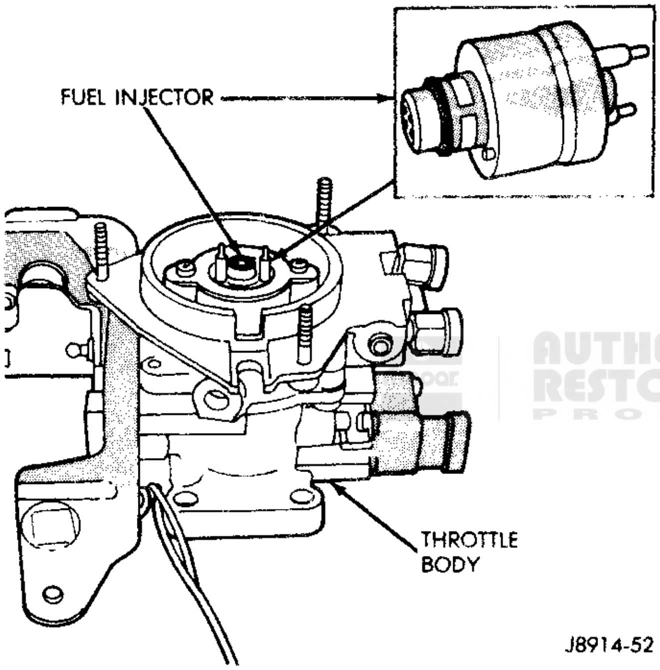


Fig. 18 TBI Fuel Injector

UP-SHIFT INDICATOR LAMP (MANUAL TRANSMISSIONS ONLY)— ECU OUTPUT

Vehicles equipped with manual transmissions have an optional Up-Shift indicator lamp. The lamp is controlled by the ECU. The lamp illuminates to indicate when the driver should shift to the next highest gear for best fuel economy. The lamp is located on the left side of the instrument cluster (Fig. 21). The ECU will turn the lamp OFF after 3 to 5 seconds if the shift of gears is not performed.

The indicator lamp is normally illuminated when the ignition switch is turned ON and it is turned OFF when the engine is started up.

The lamp will be illuminated during engine operation according to engine speed and load.

A switch located on the transmission prevents the lamp from being illuminated when the transmission is shifted to the highest gear.

MODES OF OPERATION

As input signals to the ECU change, the ECU adjusts its response to the output devices. For example, the ECU must calculate a different injector pulse width and ignition timing for idle than it does for wide open throt-

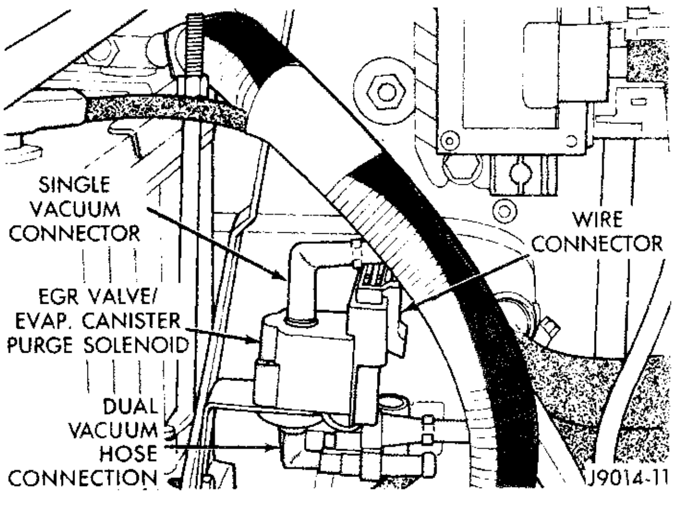


Fig. 19 EGR/Evaporative Canister Purge Solenoid—YJ Vehicles Only

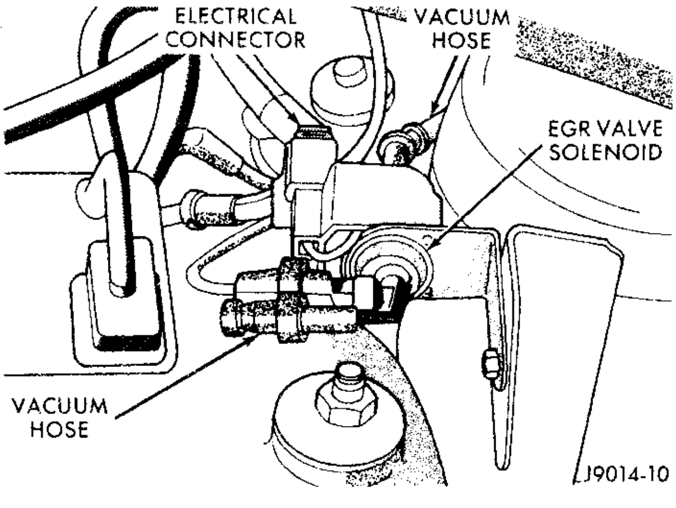


Fig. 20 EGR Valve Vacuum Solenoid—MJ/XJ Vehicles Only

tle (WOT). There are seven different modes of operation that determine how the ECU responds to the various input signals.

Modes of operation are of two different types. OPEN LOOP and CLOSED LOOP.

During OPEN LOOP modes the ECU receives input signals and responds only according to preset ECU programming. Input from the oxygen (O_2) sensor is not monitored during OPEN LOOP modes.

During CLOSED LOOP modes the ECU does monitor the oxygen (O_2) sensor input. This input indicates to the ECU whether or not the calculated injector pulse width results in the ideal air-fuel ratio of 14.7 parts air to 1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the ECU can "fine tune" the injector pulse width to achieve optimum fuel economy combined with low emission engine performance.

The TBI system has the following modes of operation:

- Ignition switch ON
- Engine start-up
- Engine warm-up
- Cruise
- Deceleration
- Throttle
- Ignition switch OFF

The ignition switch on, engine start-up (crank), engine warm-up, deceleration, and throttle modes are OPEN LOOP modes. The deceleration and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes.

Ignition Switch ON Mode

This is an OPEN LOOP mode. When the TBI System is activated by the ignition switch, the following actions occur:

- The system power relay is energized.
- The fuel pump is activated by the ECU via the relay.

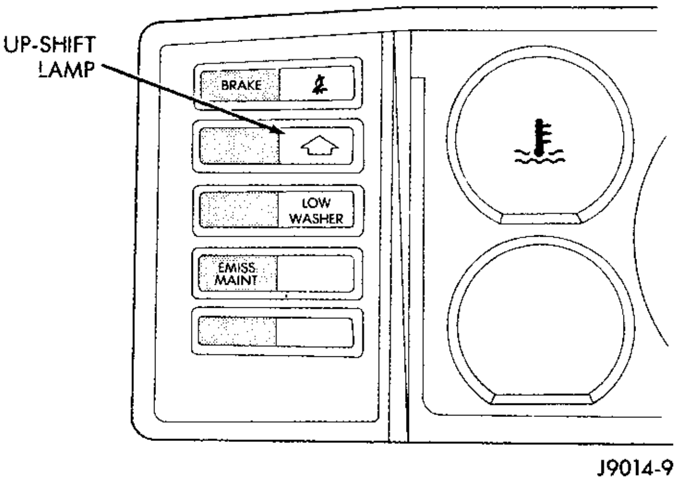


Fig. 21 Up-Shift Indicator Lamp

The fuel pump will operate for approximately one second unless the engine is operating or the starter motor is engaged.

The following engine sensors are activated and begin providing input to the ECU:

- Coolant temperature sensor (CTS)
- Manifold air/fuel temperature sensor
- Manifold absolute pressure (MAP) sensor

The up-shift indicator lamp is illuminated.

Engine Start-Up Mode

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

The following inputs are received by the ECU:

- Coolant temperature sensor (CTS)
- Starter motor relay
- Speed sensor
- WOT switch

The fuel pump is activated by the ECU. Voltage is applied to the fuel injector and the ECU controls the injector pulse width. The ECU determines the proper ignition timing according to the input from the speed sensor. If a wide open throttle condition exists, the ECU will deactivate the injector because a possible flooding condition could occur.

Engine Warm-Up Mode

This is a OPEN LOOP mode. The following inputs are received by the ECU:

- coolant temperature
- manifold air/fuel temperature
- manifold absolute pressure
- engine speed
- throttle position
- gear position (automatic transmission)
- A/C control positions

The ECU provides a ground path for the injector enabling it to precisely control injector pulse width. The ECU controls engine idle speed, throttle stop angle, and ignition timing.

For vehicles equipped with a manual transmission, the up-shift indicator lamp is controlled by the ECU according to engine speed and load.

Cruise Mode

When the engine is at operating temperature this is a CLOSED LOOP mode. During cruising speed the following inputs are received by the ECU:

- coolant temperature
- manifold air/fuel temperature
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content
- gear position (automatic transmission)
- A/C control positions

The ECU provides a ground path for the injector enabling it to precisely control injector pulse width. The ECU controls engine idle speed, throttle stop angle, and ignition timing. The ECU controls the air/fuel mixture ratio according to the oxygen content in the exhaust gas.

For vehicles equipped with a manual transmission, the up-shift indicator lamp is controlled by the ECU according to engine speed and load.

Deceleration Mode

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the ECU:

- coolant temperature
- manifold air/fuel temperature
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content
- gear position (automatic transmission)
- A/C control positions

When the ECU receives input from the closed throttle switch informing it that the engine is decelerating, it will provide a ground for the EGR valve/canister purge solenoid (YJ vehicles) or EGR valve vacuum solenoid (MJ/XJ vehicles) depending upon vehicle application. When grounded, the solenoid interrupts the flow of vacuum to the EGR valve and evaporative canister (YJ vehicles only), causing the EGR valve to close and stopping the canister purge function. The ECU provides a ground for the injector to precisely control the injector pulse width. During rapid deceleration the ECU may stop all fuel injection for a short period of time. The ECU controls engine idle speed and throttle stop angle.

Throttle Mode

This is an OPEN LOOP mode. During wide-open-throttle operation, the following inputs are received by the ECU:

- coolant temperature
- manifold air/fuel temperature
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content

When the ECU receives wide open throttle input from the wide-open-throttle (WOT) switch on YJ vehicles or the ISA motor on MJ/XJ vehicles, it will provide a ground for the EGR valve/canister purge solenoid (YJ vehicles) or EGR valve vacuum solenoid (MJ/XJ vehicles) depending upon vehicle application. When grounded, the solenoid interrupts the flow of vacuum to the EGR valve and evaporative canister (YJ vehicles only) causing the EGR valve to close and stopping the canister purge function.

The exhaust gas oxygen content input is not accepted by the ECU and it will ground the injector to precisely control a predetermined amount of additional fuel.

Ignition Switch OFF Mode

This is an OPEN LOOP mode. When the ignition switch is turned to the OFF position, the ECU ceases to provide a ground for the injector and all fuel injection stops.

Current is supplied to the ISA motor through the B+ latch relay enabling the ECU to extend the ISA for the next start-up. The ECU then deactivates.

THROTTLE BODY

The throttle body is mounted on top of the intake manifold and contains the fuel injector, fuel pressure regulator and throttle valve (Fig. 22). The fuel inlet and return tubes are connected to the throttle body by pressure fittings. The ISA motor and throttle position sensor (TPS) are also mounted to the throttle body.

Fuel Injector

The fuel injector is located within the throttle body. The injector contains an electrically operated solenoid, plunger (or core piece), spring loaded ball valve, ball seat and fuel atomizer/discharge nozzle. The injector is sealed in the bore of the throttle body by an upper and lower O-ring (Fig. 23).

When the injector is energized by the ECU, the solenoid armature pulls the plunger upward allowing the spring loaded ball valve to move off of its seat. Fuel then flows through the atomizer/spray nozzle.

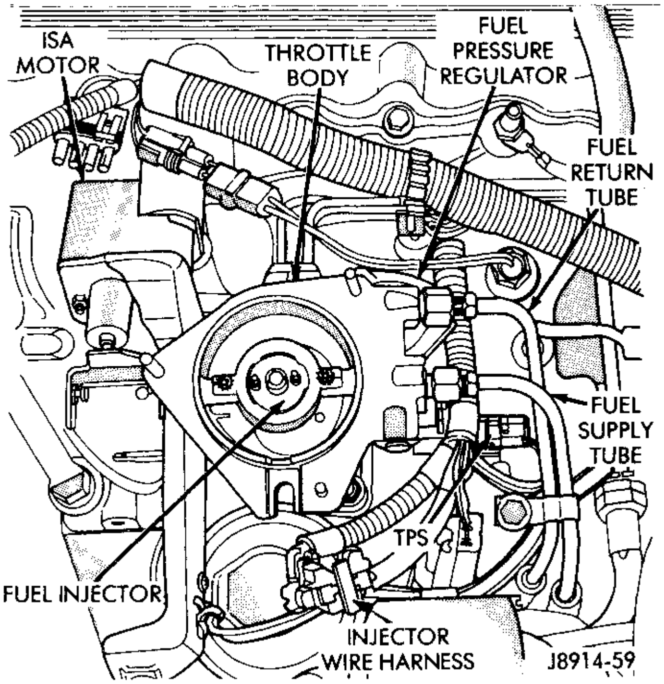


Fig. 22 Throttle Body Assembly

The injector is exclusively controlled by the ECU. The injection pulse width is based on the engine operating conditions, which are provided to the ECU by the input sensors.

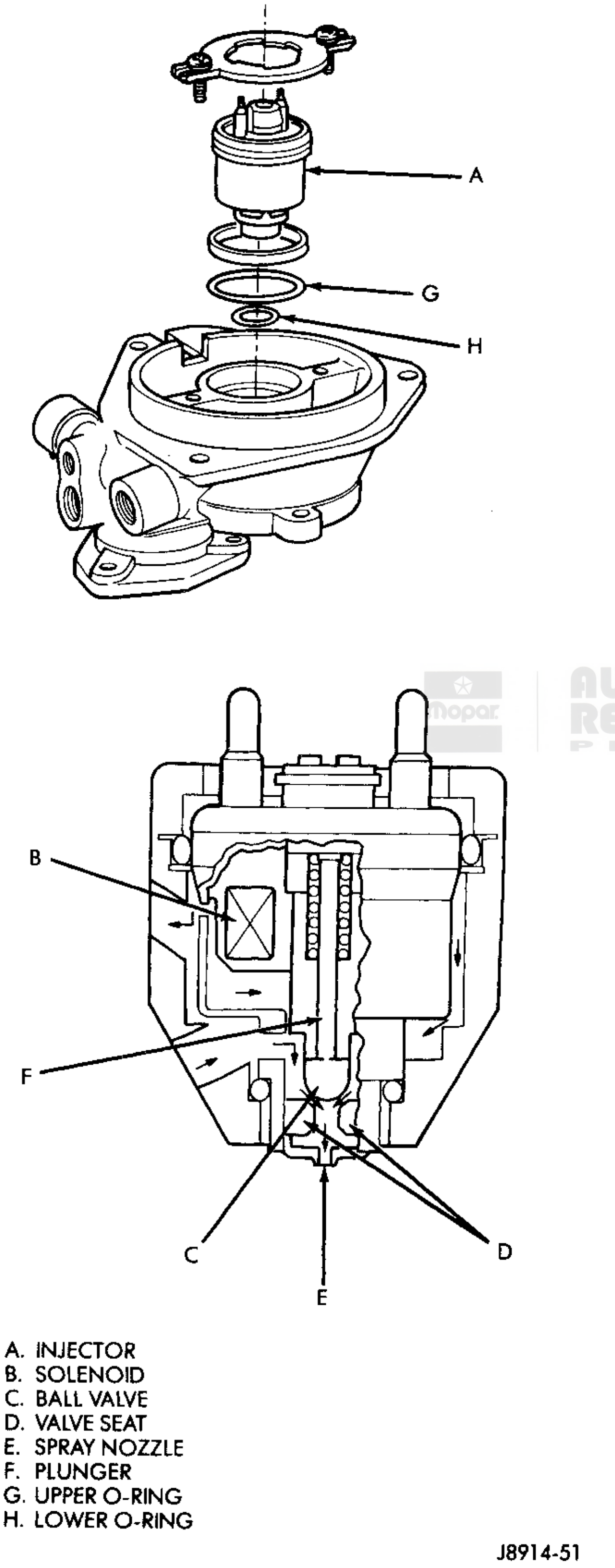


Fig. 23 TBI Fuel Injector Operation

Fuel Pressure Regulator

The fuel pressure regulator used with the TBI system is an over flow type and is attached to the throttle body. The regulator is adjustable and controls the amount of pressure under which the fuel system operates.

The fuel pump delivers fuel in excess of the maximum required by the engine and the excess fuel flows back to the fuel tank from the pressure regulator via the fuel return hose.

The regulator consists of a spring chamber, calibrated spring, spring seats, diaphragm, pivot and pressure adjusting screw (Fig. 24). A lead plug seals the adjusting screw hole.

As fuel from the fuel pump enters the top of the regulator, the relief valve and regulator spring are forced down opening a passage to the fuel return tube (Fig. 24), allowing a certain amount of fuel to return to the fuel tank. A pivot atop of the diaphragm keeps the diaphragm from tipping to one side. The amount of pressure required to force the regulator spring down determines fuel system pressure. Fuel system pressure is controlled by the adjusting screw at the bottom of the regulator housing. Turning the screw inward increases fuel pressure, turning the screw outward decreases fuel pressure.

A small passage through the throttle body, regulator diaphragm, and the regulator casing vents the spring chamber to the atmospheric pressure. The tip of the fuel injector is also vented to atmospheric pressure. Because the injector nozzle and spring chamber are vented to the same pressure, the volume of fuel injected is dependent only on the length of time the injector is energized (injector pulse width).

Once the fuel pump stops operating, fuel pressure will bleed down to zero almost immediately. The fuel pressure regulator is not controlled by the ECU.

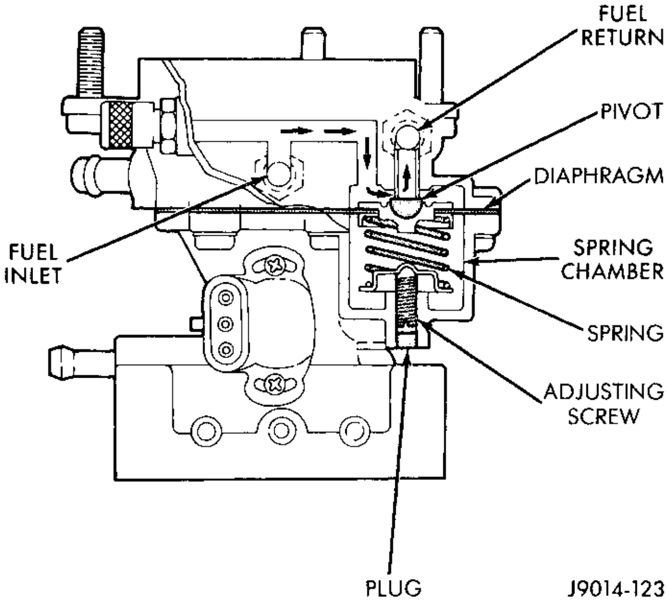


Fig. 24 Fuel Pressure Regulator

GENERAL DIAGNOSIS

Visual Inspection

A visual inspection for loose, disconnected, or improperly routed wires and hoses should be made before attempting to diagnose the fuel injection system. A visual check will help spot these faults and save unnecessary test and diagnostic time. A thorough visual inspection includes the following checks:

(1) Inspect battery cable connections (Fig. 25). They should be tight. The top of the battery and the cable connections should be free of corrosion and grime. Check the electrolyte level in the battery cells. Refer to group 8A.

(2) Inspect fuel pump relay, B+ latch relay, and A/C compressor clutch relay connections (Fig. 26). Inspect starter motor relay connections (Fig. 27). Inspect relays for sings of physical damage and corrosion.

(3) Inspect Ignition Control Module connections (Fig. 28). Verify that coil wire is connected to coil.

(4) Depending upon vehicle application, verify that vacuum hose(s) and wire connector are connected to either the EGR valve solenoid (MJ/XJ vehicles—Fig. 29) or EGR valve/Evaporative canister purge solenoid (YJ vehicles—Fig. 30).

(5) Verify that distributor cap is attached to distributor, that spark plug wires are connected to distributor cap and spark plugs in correct firing order, and that coil wire is connected to distributor cap and coil (Fig. 31).

(6) Inspect ECU system ground connections at engine dipstick tube mounting stud (Fig. 32).

(7) Verify that alternator output wire and two terminal connector are connected to alternator (Fig. 33).

(8) Verify that wire connector is connected to power steering high pressure switch (Fig. 34, Fig. 35).

(9) Verify that main vacuum harness connector (located on intake manifold behind throttle body) is connected and not leaking (Fig. 36).

(10) Verify that vacuum tubes are connected to rear of throttle body and that tubes are not pinched or broken (Fig. 37).

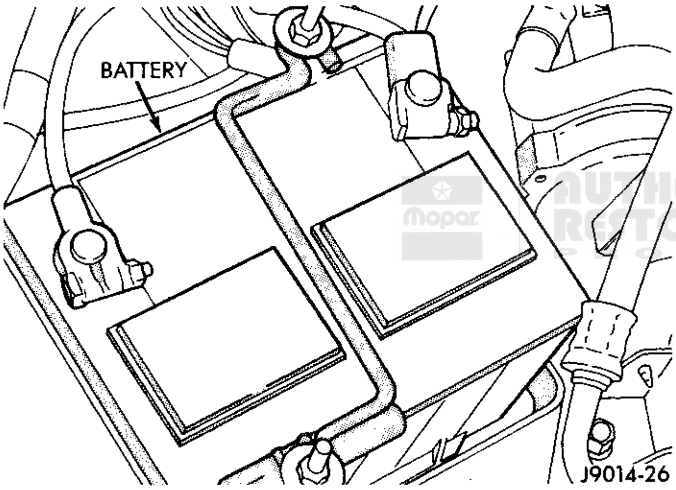


Fig. 25 Battery Cable Connections—Typical

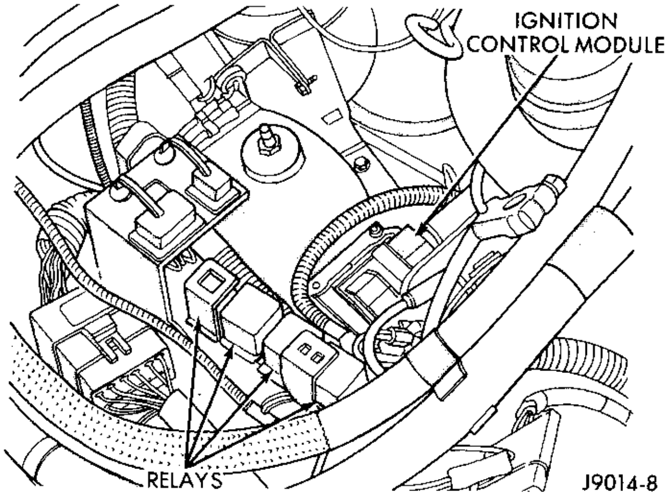


Fig. 26 Fuel Pump Relay, B+ Latch Relay, A/C Compressor Clutch Relay

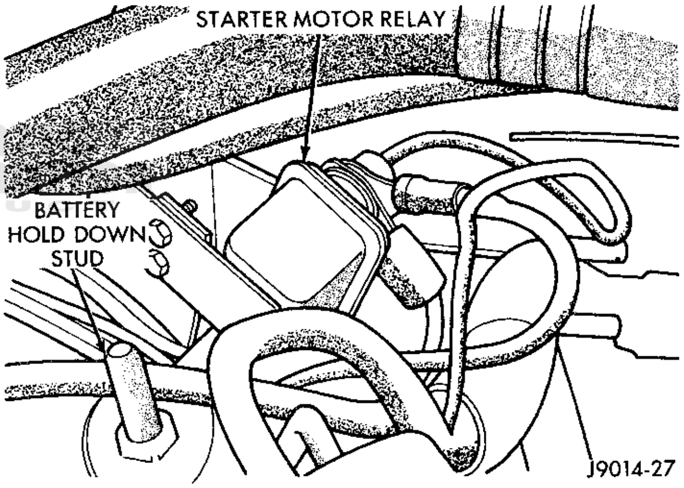


Fig. 27 Starter Motor Relay

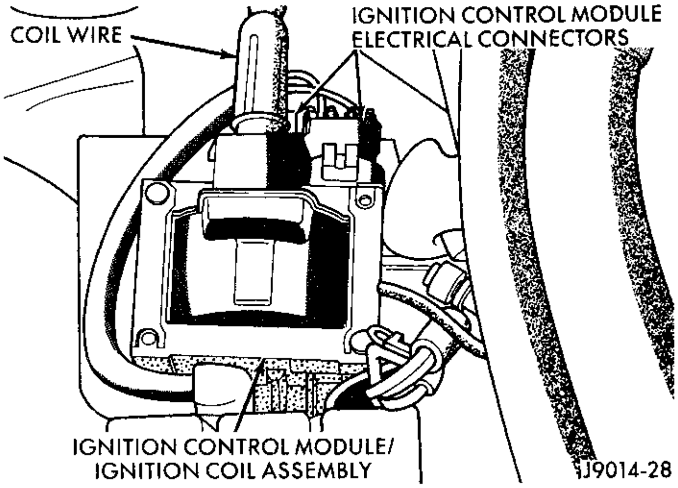


Fig. 28 Ignition Control Module Connections

(11) Verify that wire connector is connected to ISA motor (Fig. 38).

(12) Verify that when engine is turned off (if engine will start and run) the ISA motor operates momentarily to extend and position the actuator for the next start.

(13) Verify that vacuum hose/tube connections at EGR valve and throttle body bonnet air temperature sensor are tight and that the hoses/tubes are not pinched or broken (Fig. 39).

(14) If vehicle is equipped with a vacuum brake booster, verify that the vacuum hose is connected to the booster and to fitting on intake manifold (Fig. 40).

(15) Verify that TPS wire connector is connected to sensor (manual transmission equipped—Fig. 41) or that both TPS wire harness connectors are connected to the engine harness (automatic transmission—Fig. 42).

(16) Verify that throttle body mounting nuts are tight (Fig. 43). Tighten as necessary.

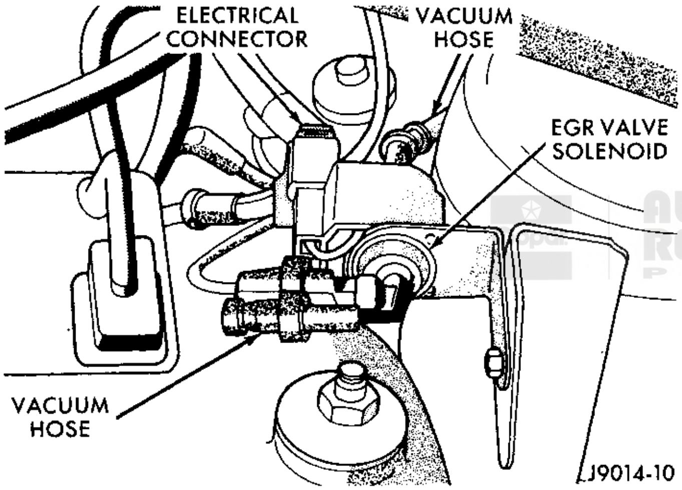


Fig. 29 EGR Valve Vacuum Solenoid—MJ/XJ Vehicles Only

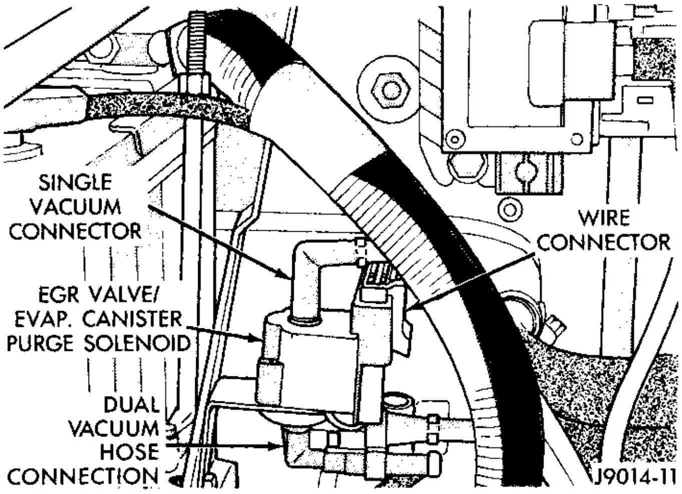


Fig. 30 EGR Valve/Evaporative Canister Purge Solenoid—YJ Vehicles Only

(17) Verify that MAT sensor wire connector is connected to engine harness (Fig. 44).

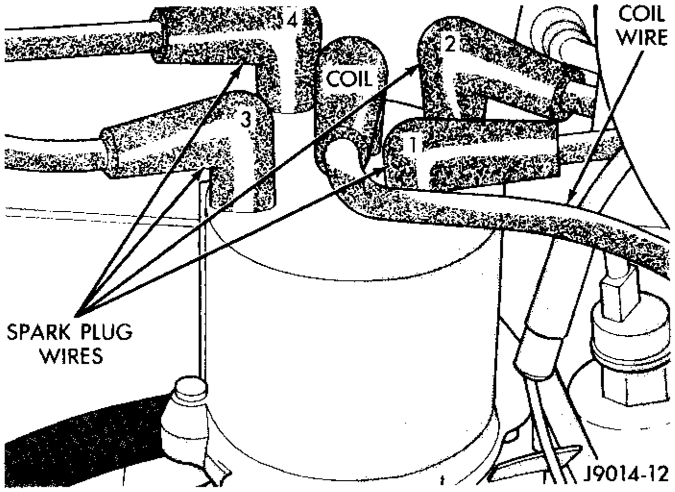


Fig. 31 Distributor Cap, Spark Plug Wires

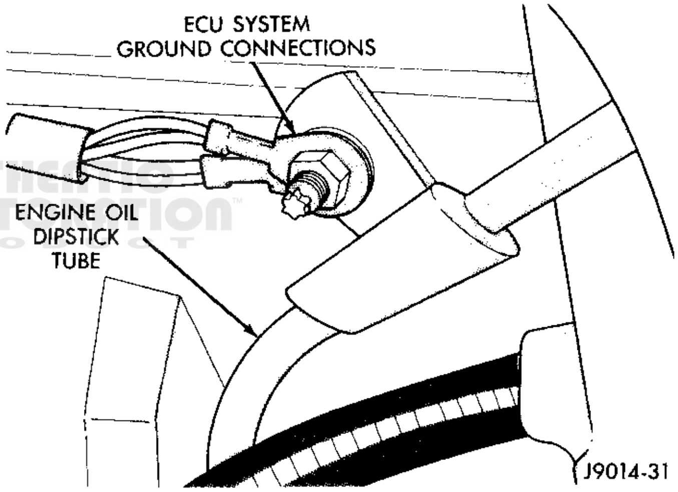


Fig. 32 ECU System Ground Connections

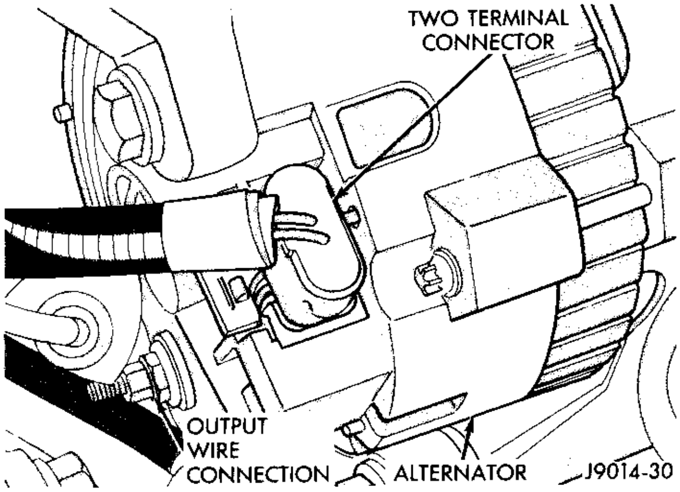


Fig. 33 Alternator Two Terminal Connector and Output Wire Connections—Typical

(18) Verify that MAP sensor wire connector and vacuum hose are connected (Fig. 45). Inspect vacuum hose for pinches or breaks.

(19) Remove air inlet bonnet from top of throttle body. Verify that fuel injector wire connector is connected to injector (Fig. 46).

(20) YJ vehicles only, verify that the WOT switch electrical connector is connected (Fig. 47).

(21) Verify that Oxygen Sensor wire connector is connected. Inspect sensor for damage (Fig. 48).

(22) Verify that Engine Ground Strap is attached to dash panel and engine (Fig. 49).

(23) Verify that the Thermostatic Air Cleaner (TAC) vacuum hoses are connected (Fig. 50). Inspect the hoses for pinches or breaks. Check for a possible clogged air filter element.

(24) Verify that the preheated air hose is connected to the air cleaner inlet door and heat stove on the exhaust manifold. Inspect the hose for tears (Fig. 50).

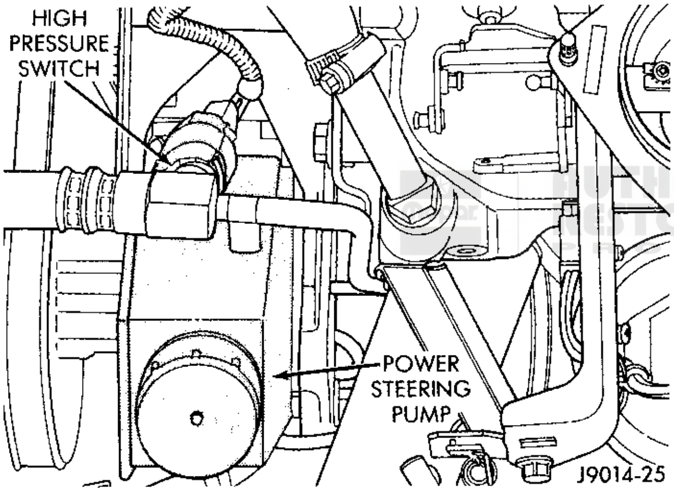


Fig. 34 Power Steering High Pressure Switch—YJ Vehicles

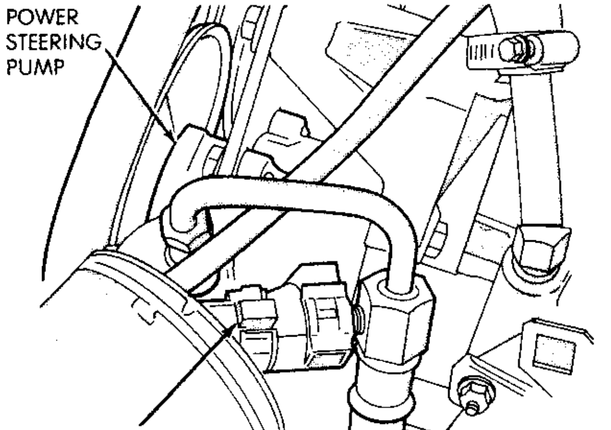


Fig. 35 Power Steering High Pressure Switch—MJ/XJ Vehicles

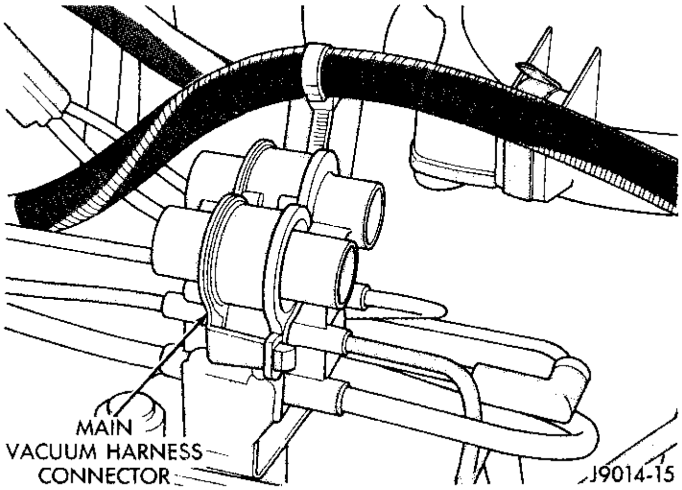


Fig. 36 Main Vacuum Harness Connector

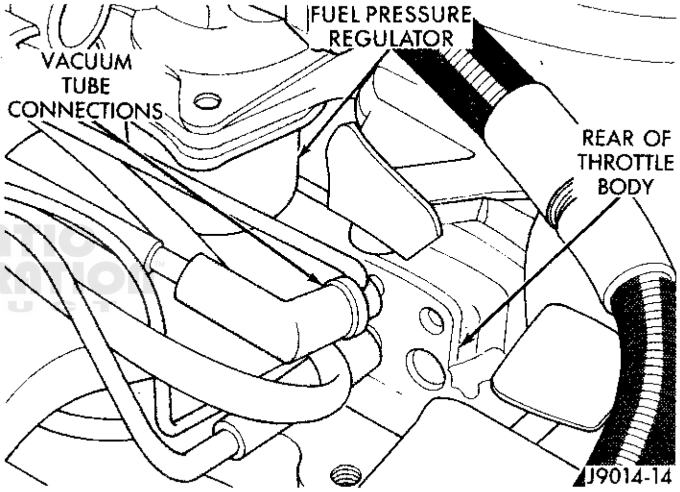


Fig. 37 Throttle Body Vacuum Tubes

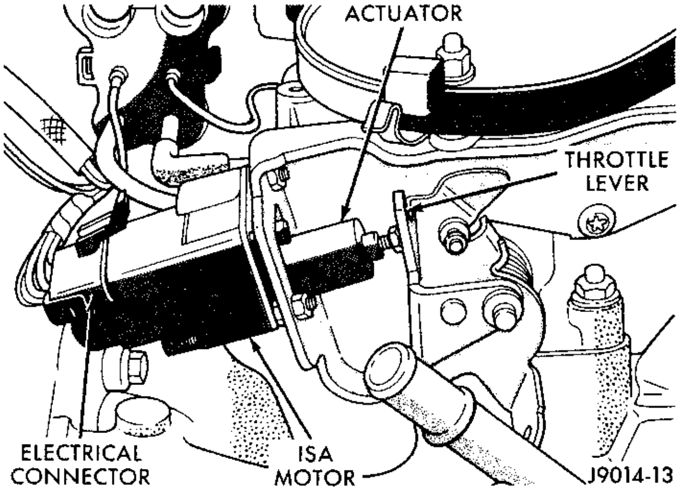


Fig. 38 ISA Motor

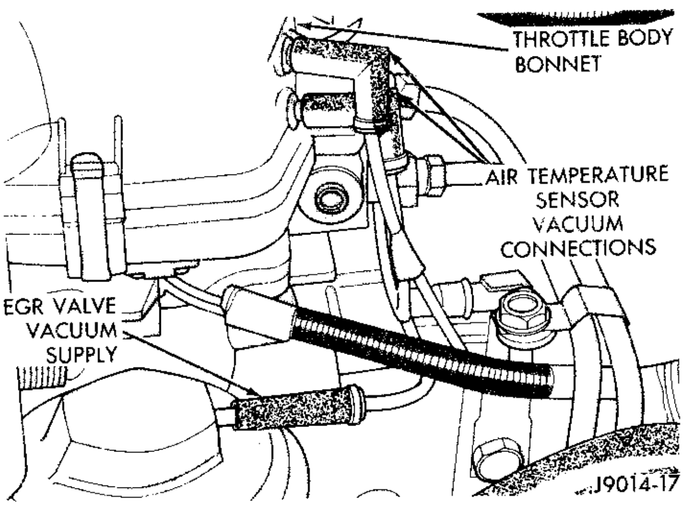


Fig. 39 Vacuum Hose/Tube Connections

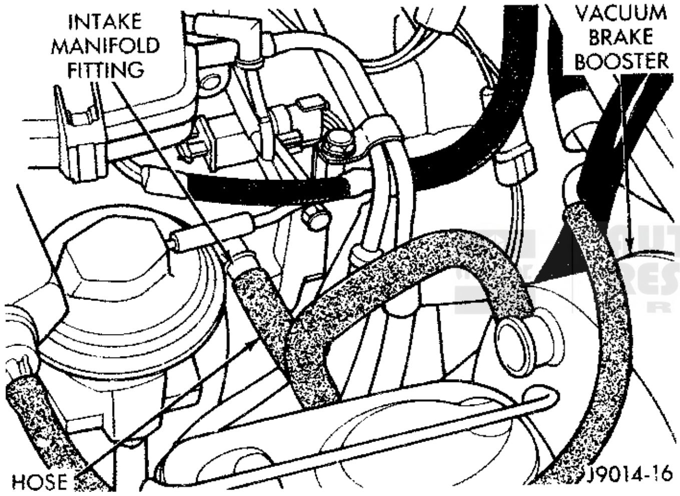


Fig. 40 Vacuum Brake Booster Hose

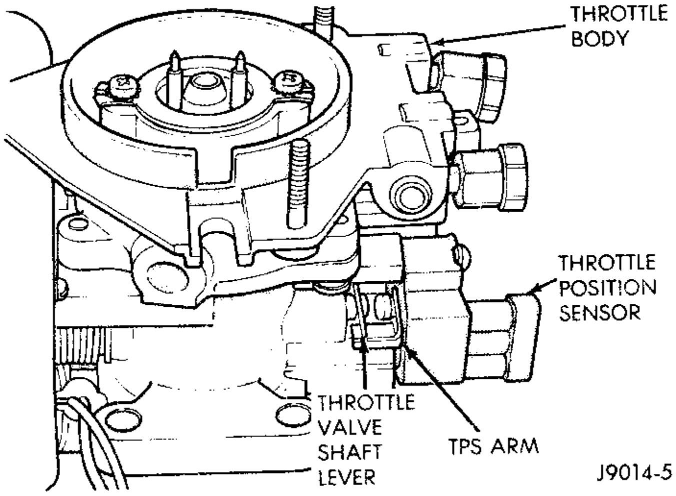


Fig. 41 TPS Wire Connector—Manual Transmission

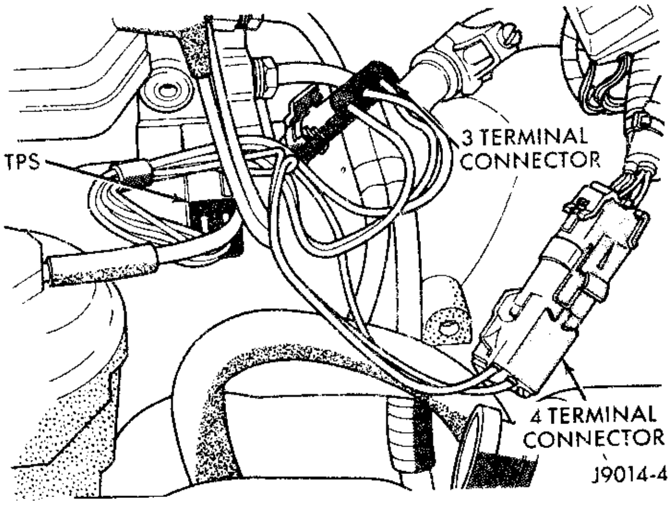


Fig. 42 TPS Wire Connectors—Automatic Transmission

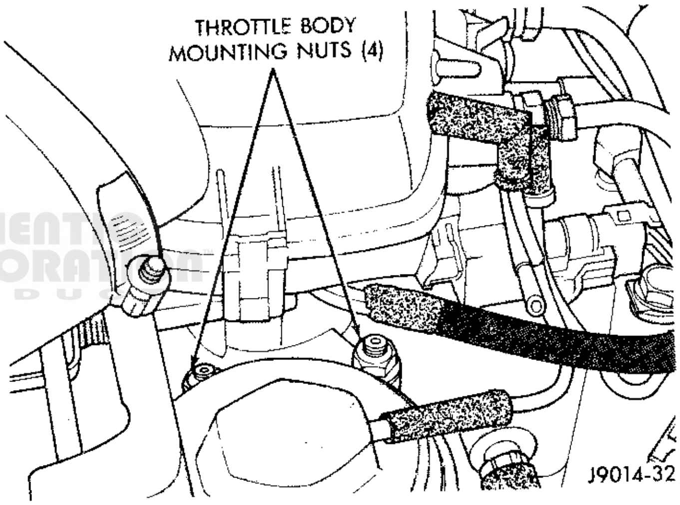


Fig. 43 Throttle Body Mounting Nuts

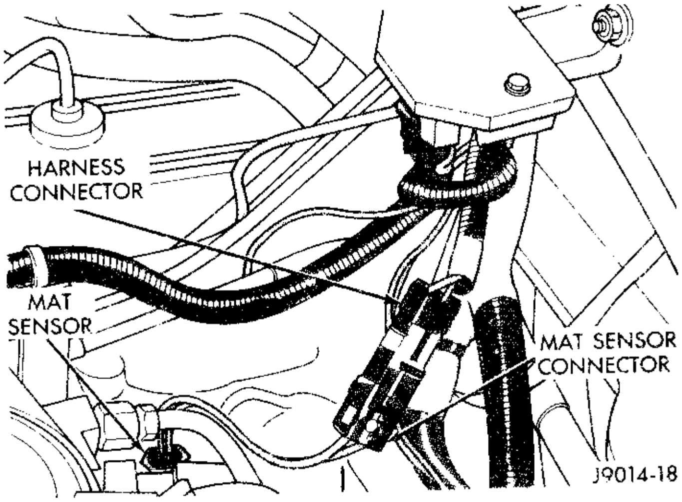


Fig. 44 MAT Sensor Wire Connector

(25) Inspect radiator grille area for a possible clogged bug screen restricting air flow to the air cleaner. Inspect the air cleaner inlet door (behind left front headlight) for blockage.

(26) Verify that fuel tube connections at throttle body are tight and do not leak (Fig. 51).

(27) Verify that vacuum hoses or caps are attached to all ports of the vacuum fitting on the intake manifold (Fig. 51).

(28) Raise and support the vehicle.

(29) Inspect fuel line quick connect fittings (along the left frame rail at the back of the engine compartment) for leaks (Fig. 52).

(30) Inspect for pinched or leaking fuel tubes. Inspect for pinched cracked or leaking fuel hoses.

(31) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic convertor.

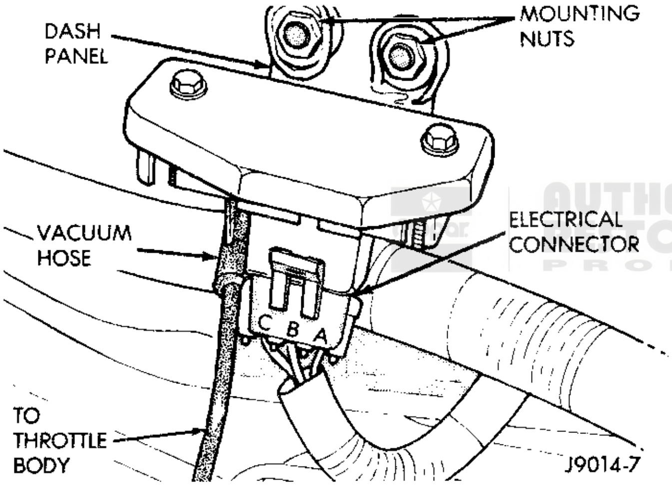


Fig. 45 MAP Sensor Electrical and Vacuum Connections

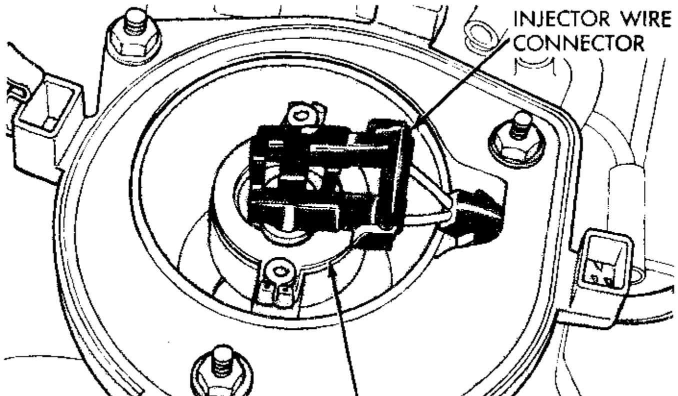


Fig. 46 Fuel Injector Wire Connector

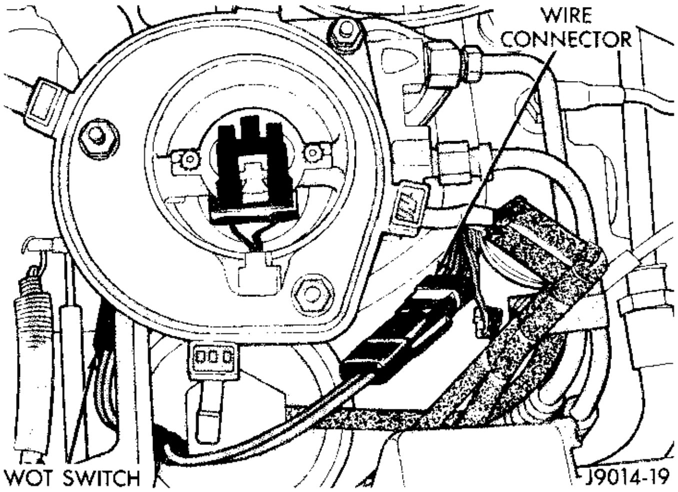


Fig. 47 WOT Switch Wire Connector—YJ Vehicles Only

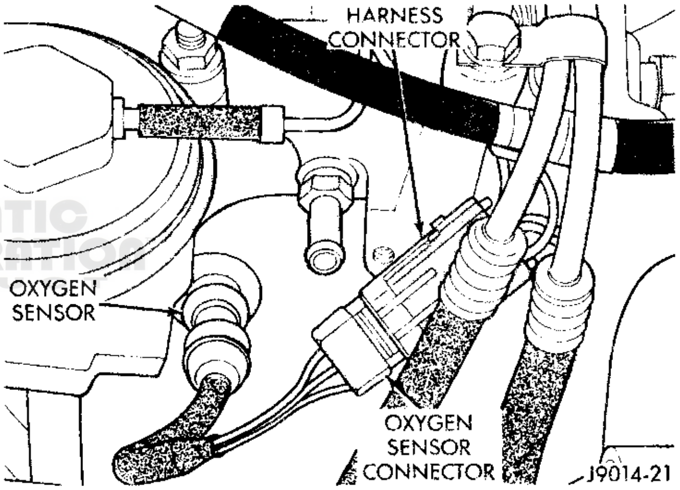


Fig. 48 Oxygen Sensor Wire Connector

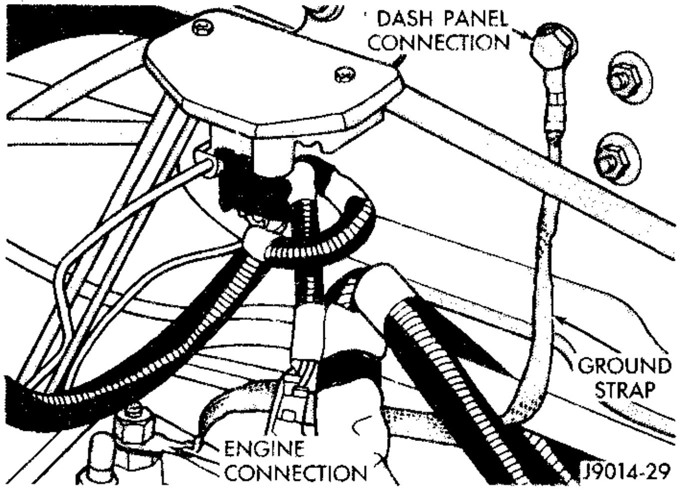


Fig. 49 Engine Ground Strap

(32) If equipped with automatic transmission, verify that electrical harness is connected to neutral safety switch. Refer to automatic transmission section of group 21.

(33) Verify that fuel pump/gauge sender unit wire connector is connected to harness connector.

(34) Inspect fuel hoses at fuel pump/gauge sender unit for cracks or leaks (Fig. 53).

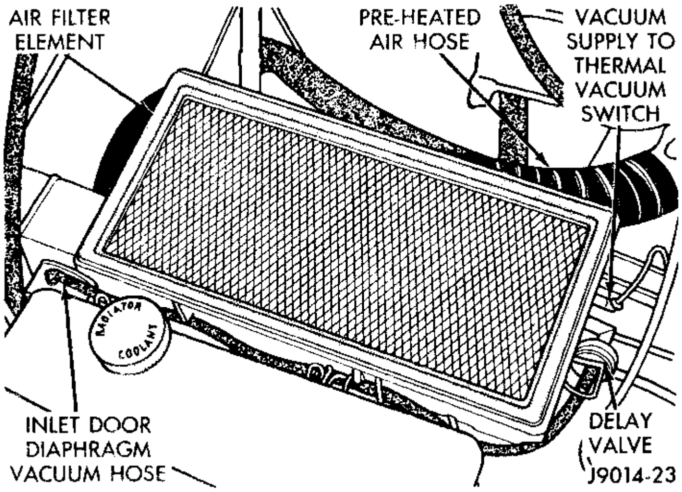


Fig. 50 TAC Vacuum Hoses and Pre-Heated Air Hose

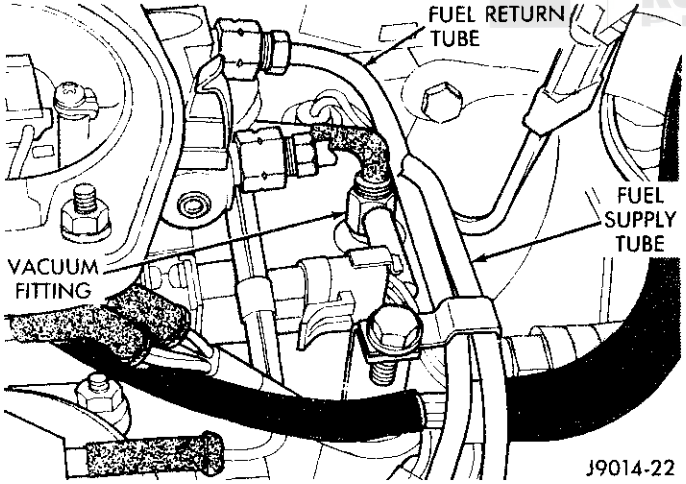


Fig. 51 Fuel Tube and Vacuum Fitting Connections

(35) Inspect transmission convertor housing (automatic transmission) or clutch housing (manual transmission) for damage that might have damaged the timing ring on the drive plate/flywheel.

(36) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean (Fig. 54). Inspect for chaffed wires or wires rubbing up against other components.

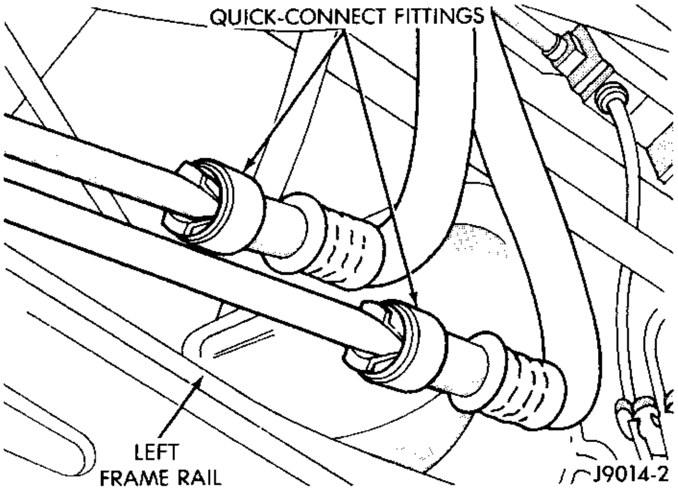


Fig. 52 Quick Connect Fittings

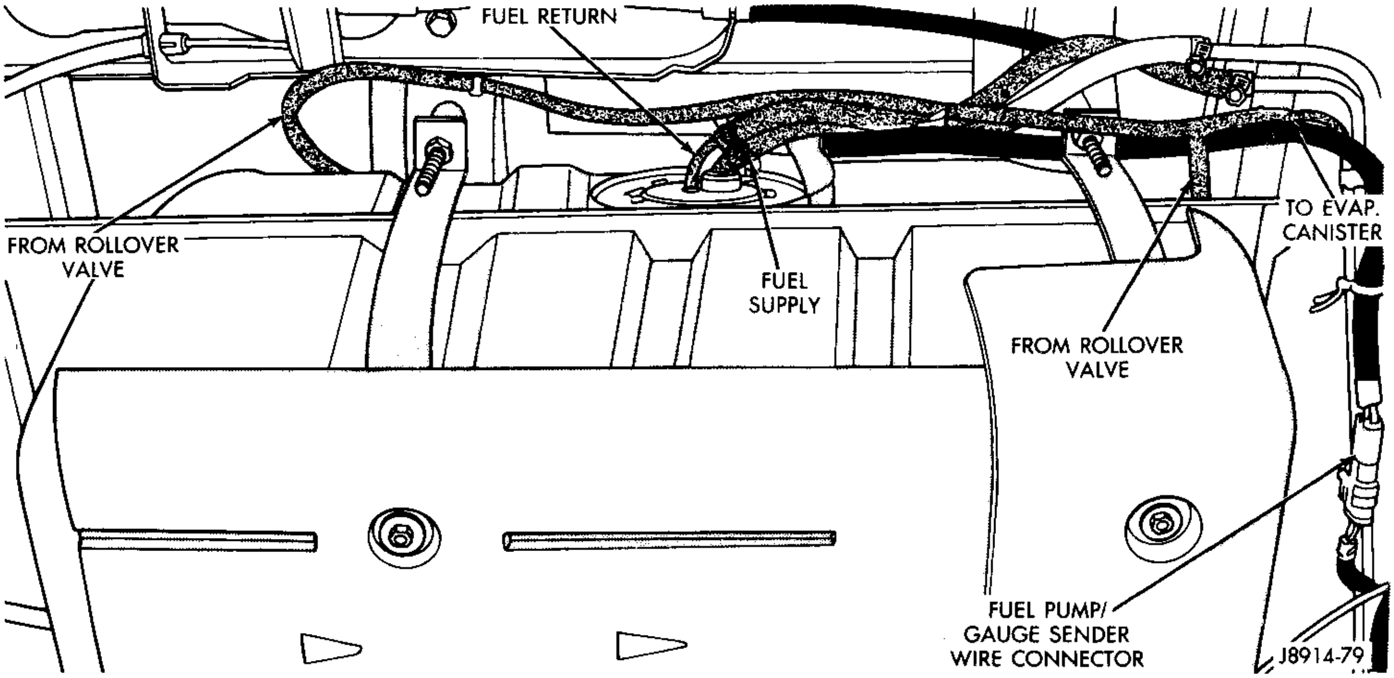


Fig. 53 Fuel Pump and/or Gauge Sender Unit Connector and Fuel Tank Hoses—Typical

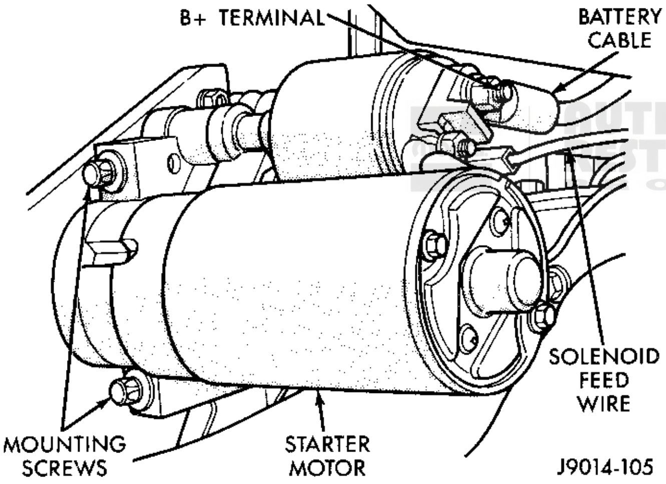
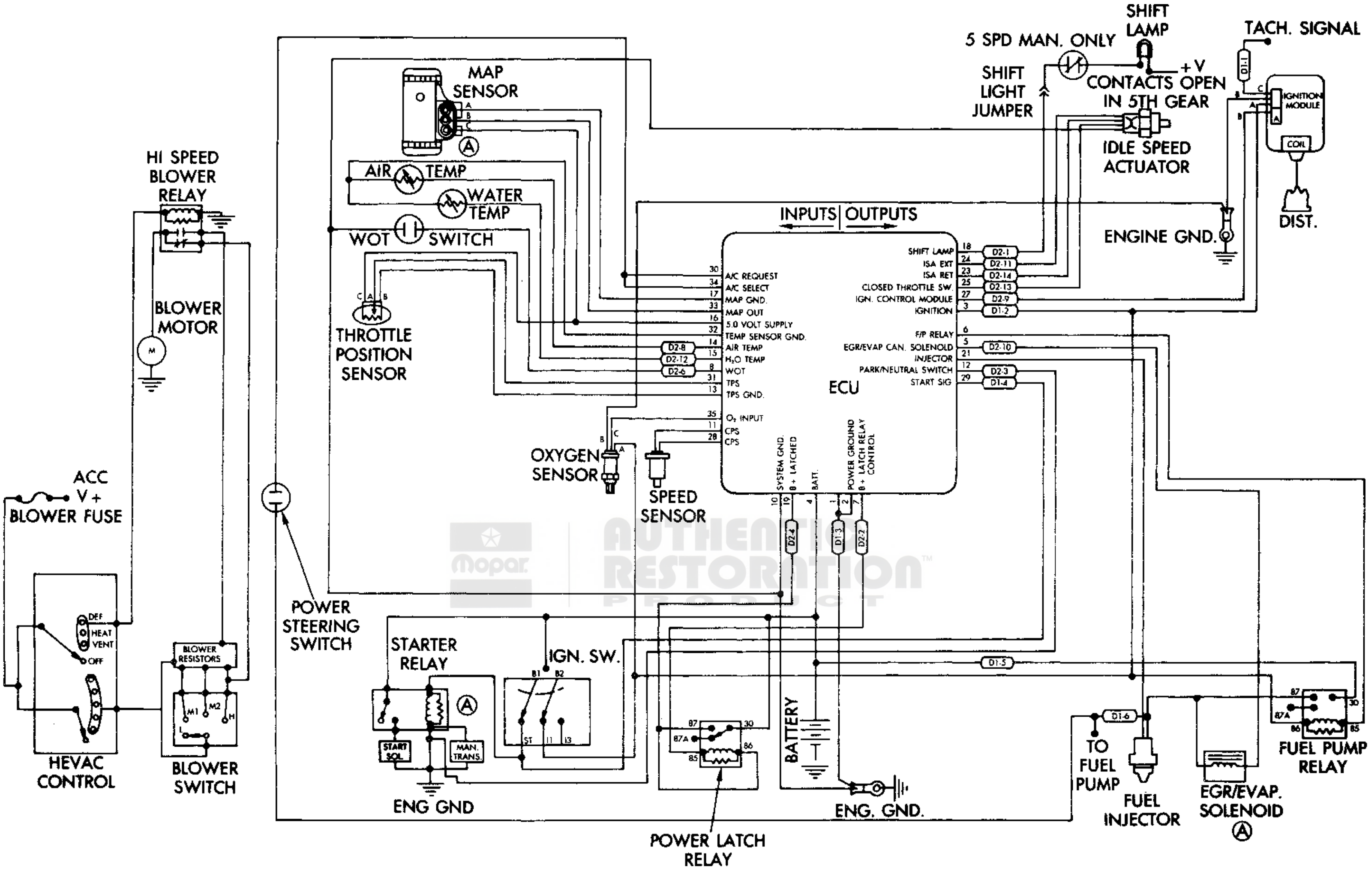


Fig. 54 Starter Solenoid Connections

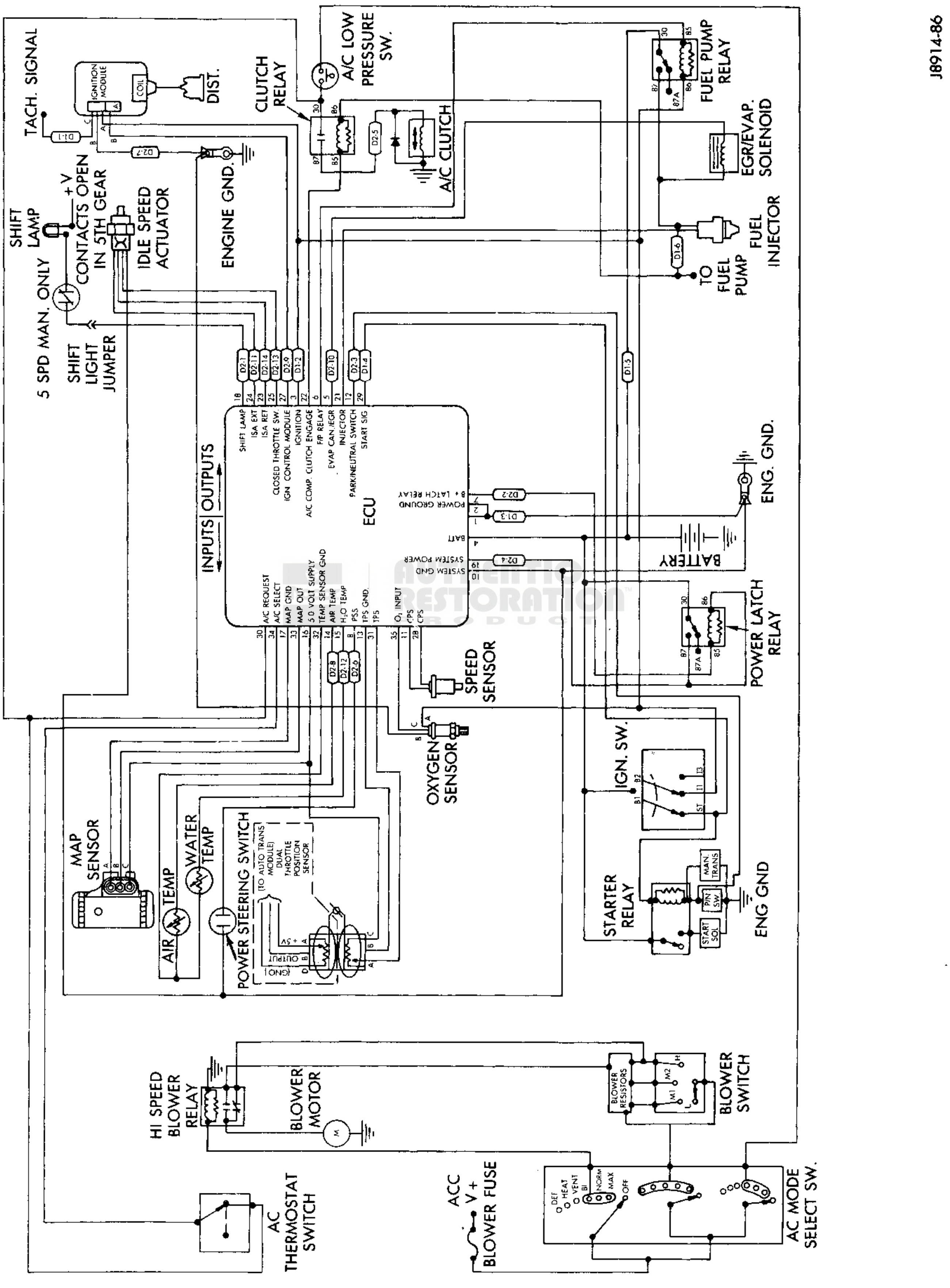
COMPONENT DIAGNOSTIC PROCEDURES

This section contains information for determining individual TBI system component performance. Diagnosis of ECU/Engine Control System is performed using the Service Diagnostic Tester. Refer to the tester manual for the appropriate system test procedure.



TBI Engine Control System Schematic—YJ Vehicles Only

TBI Engine Control System Schematic—MJ/XJ Vehicles Only

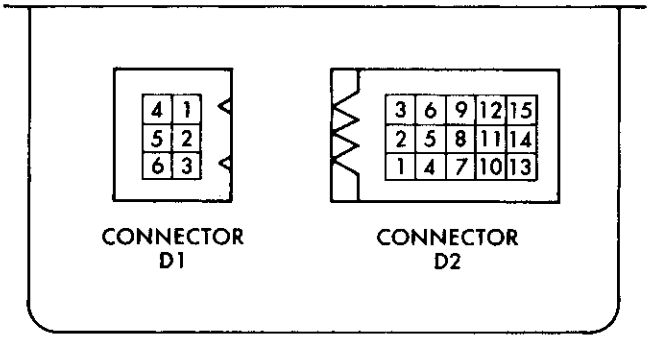


Diagnostic Connectors

The diagnostic connectors provide are located in the engine compartment. The connectors are protected by rubber covers. Cavity identification and specific engine function is listed in the following illustrations. For MJ/XJ vehicles, the information is listed in Fig. 55. For YJ vehicles, the information is listed in Fig. 56.

ECU Connector

The ECU connector used for TBI systems is similar to the connector used in previous systems. Terminal identification and specific engine application is detailed in the following illustrations. For YJ vehicles, the information is listed in Fig. 57. For MJ/XJ vehicles, the information is listed in Fig. 58.



Connector D1

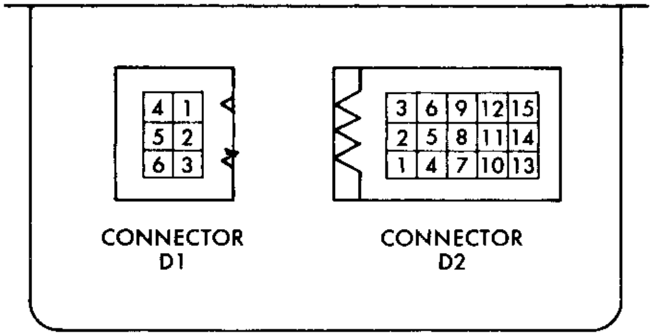
1. Tach Input
2. Ignition
3. Ground
4. Start Solenoid
5. Battery
6. Fuel Pump Relay

Connector D2

1. Shift Lamp
2. Power Latch Relay
3. Park/Neutral Switch
4. B + Latch Relay
5. Air Conditioning Clutch Relay
6. Power Steering Switch
7. Ground
8. Manifold Air Temperature Sensor
9. Ignition Control Module
10. EGR Valve Solenoid
11. ISA Motor Extend (Forward)
12. Coolant Temperature Sensor
13. Closed Throttle Switch
14. ISA Motor Retract (Reverse)
15. Not Used

J8914-83

Fig. 55 Diagnostic Connectors—MJ/XJ Vehicles with TBI



Connector D1

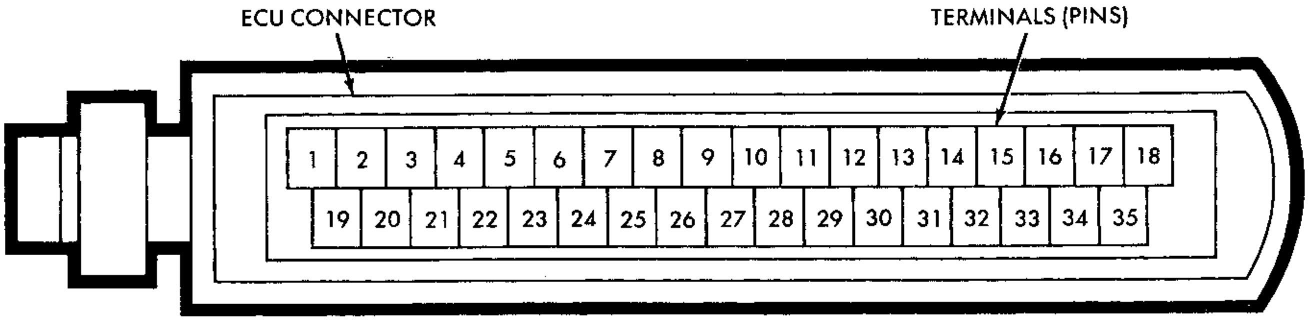
1. Tach Input
2. Ignition
3. Ground
4. Start Solenoid
5. Battery
6. Fuel Pump Relay

Connector D2

1. Shift Lamp
2. Power Latch Relay
3. Park/Neutral
4. Power Latch Relay (B +)
5. Not Used
6. WOT Switch
7. Not Used
8. Manifold Air Temperature Sensor
9. Ignition Control Module
10. EGR Valve Solenoid
11. ISA Motor Extend (Forward)
12. Coolant Temperature Sensor
13. Closed Throttle Switch
14. ISA Motor Retract (Reverse)
15. Not Used

J8914-84

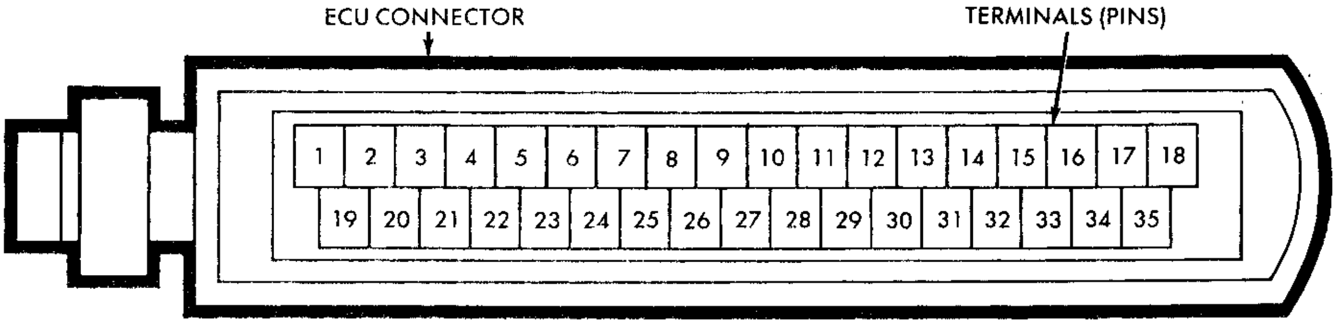
Fig. 56 Diagnostic Connectors—YJ Vehicles with TBI



1. Ground
2. Ground
3. Ignition Switch
4. Battery
5. EGR Valve/Canister Purge Solenoid
6. Fuel Pump Relay
7. B+ Latch Relay
8. WOT Switch
9. Not Used
10. System Ground
11. Speed Sensor (Crankshaft Position Sensor)
12. Park/Neutral Switch (auto. trans. only)
13. Throttle Position Sensor Ground
14. Manifold Air/Fuel Temperature Sensor
15. Coolant Temperature Sensor
16. 5.0 Volt Supply to Map Sensor and TPS Sensor
17. Manifold Absolute Pressure—Ground
18. Shift Lamp (manual trans. only)
19. System Power (B+)
20. Not Used
21. Injector
22. Not Used
23. ISA Motor Retract (reverse)
24. ISA Motor Extend (forward)
25. Closed Throttle (idle) Switch
26. Not Used
27. Ignition Control Module
28. Speed Sensor (Crankshaft Position Sensor)
29. Start Signal
30. A/C Request
31. Throttle Position Sensor
32. Temperature Sensor Ground
33. MAP Sensor Output
34. A/C Select
35. O_2 Sensor Input

J8914-88

Fig. 57 TBI ECU Connector Diagram—YJ Vehicles



1. Ground
2. Ground
3. Ignition Switch
4. Battery
5. EGR Valve Vacuum Solenoid
6. Fuel Pump Relay
7. B+ Latch Relay
8. Power Steering High Pressure Switch
9. Not Used
10. System Ground
11. Speed Sensor (Crankshaft Position Sensor)
12. Park/Neutral Switch (auto. trans. only)
13. Throttle Position Sensor Ground
14. Manifold Air/Fuel Temperature Sensor
15. Coolant Temperature Sensor
16. 5.0 Volt Supply to Map Sensor and TPS Sensor
17. Map Sensor Ground
18. Shift Lamp (manual trans. only)
19. System Power (B+)
20. Nut Used
21. Injector
22. A/C Compressor Clutch
23. ISA Motor Retract (reverse)
24. ISA Motor Extend (forward)
25. Closed Throttle (idle) Switch
26. Not Used
27. Ignition Control Module
28. Speed Sensor (Crankshaft Position Sensor)
29. Start Signal
30. A/C Select
31. Throttle Position Sensor
32. Temperature Sensor Ground
33. MAP Sensor Output
34. A/C Request
35. O_2 Sensor Input

Fig. 58 TBI ECU Connector Diagram—MJ/XJ Vehicles

J8914-87

Coolant Temperature Sensor Test

Disconnect the wire harness connector from the coolant temperature sensor (Fig. 59).

Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance should be less than 1000 with the engine warm. Refer to the resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

Test the resistance of the wire harness between ECU wire harness connector terminal 15 and the sensor connector terminal, and terminal 32 to the sensor connector terminal. Repair the wire harness if an open circuit is indicated.

Manifold Air/Fuel Temperature (MAT) Sensor Test

Disconnect the wire harness connector from the MAT sensor (Fig. 60).

Test the resistance of the sensor with a input impedance (digital) volt-ohmmeter. The resistance should be less than 1000 ohms with the engine warm. Refer to the resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

Test the resistance of the wire harness between the ECU wire harness connector terminal 32 and the sensor connector terminal, and terminal 14 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

Manifold Absolute Pressure (MAP) Sensor Test

Inspect the MAP sensor vacuum hose connections at the throttle body and sensor. Repair as necessary.

Test the MAP sensor output voltage at the MAP sensor connector terminal B (as marked on the sensor body) with the ignition switch ON and the engine OFF (Fig.

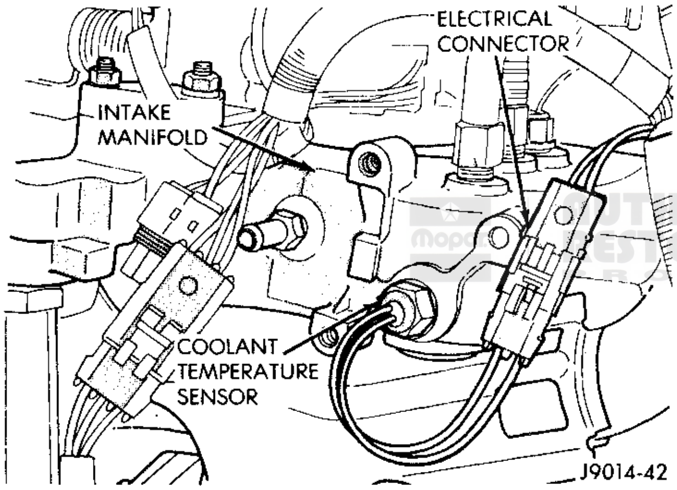


Fig. 59 Coolant Temperature Sensor

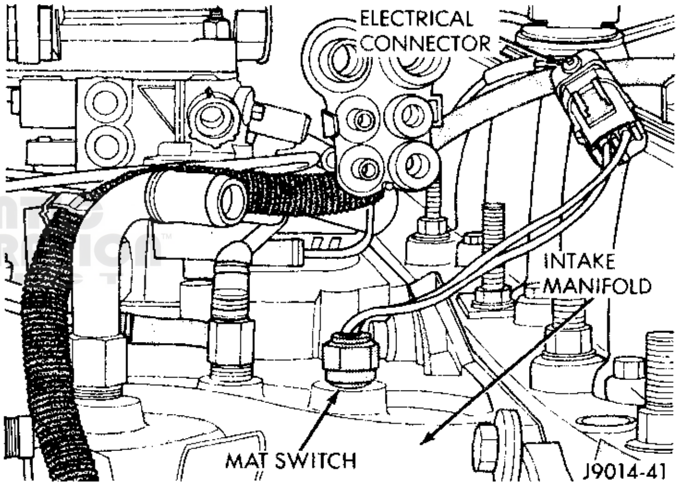


Fig. 60 Manifold Air Temperature Sensor

Coolant Temperature Sensor Temperature-to-Resistance Values (Approximate)		
°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

J8914-89

Manifold Air/Fuel Temperature Sensor Temperature-to-Resistance Values (Approximate)		
°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

J8914-90

61). Output voltage should be 4 - 5 volts. **The voltage should drop to 1.5 - 2.1 volts with a hot, neutral idle speed condition.**

Test ECU terminal 33 for the same voltage described above to verify the wire harness condition. Repair as necessary.

Test the MAP sensor supply voltage at the sensor connector terminal C with the ignition ON. The voltage should be 5 volts (±0.5V). Five volts (±0.5V) should also be at terminal 16 of the ECU wire harness connector. Repair or replace the wire harness as necessary.

Test the MAP sensor ground circuit at sensor connector terminal A and ECU connector terminal 17. Repair the wire harness if necessary.

Test the MAP sensor ground circuit at the ECU connector between terminal 17 and terminal 2 with an ohmmeter. If the ohmmeter indicates an open circuit, inspect for a defective sensor ground connection on the flywheel/drive plate housing near the starter motor. If the ground connection is good, replace the ECU. If terminal 17 has a short circuit to 12 volts, correct this condition before replacing the ECU.

Speed Sensor (Crankshaft Position Sensor-CPS) Test

Disconnect the speed sensor connector from the harness (Fig. 62).

Place an ohmmeter across terminals A and B (marked on connector). The meter reading should be 200±75 ohms (hot engine). Replace sensor if readings are not to specifications.

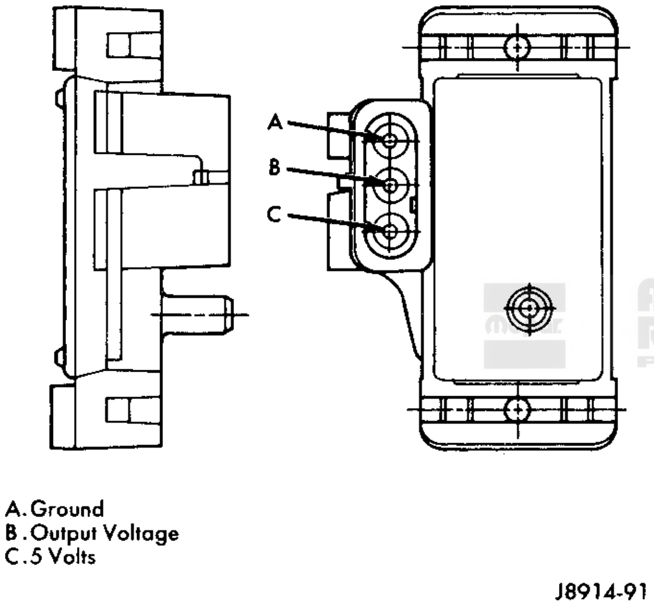


Fig. 61 MAP Sensor Connector Terminals

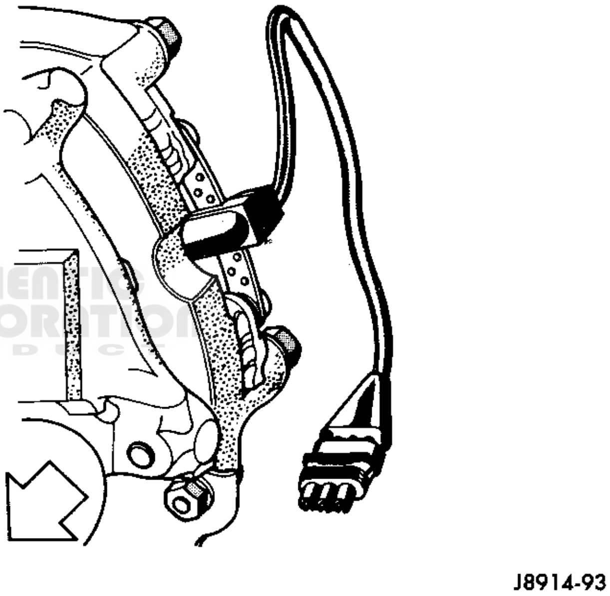
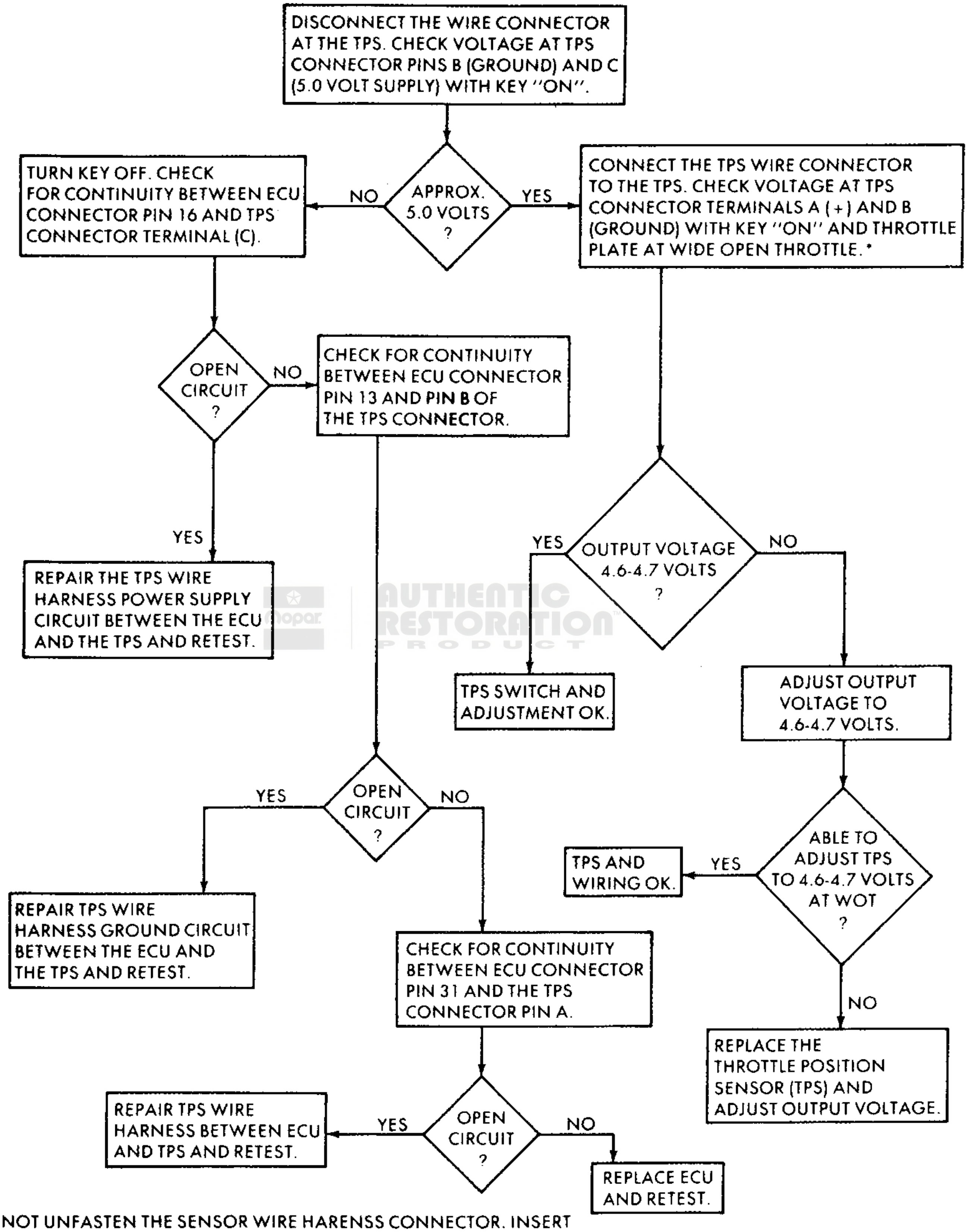


Fig. 62 Engine Speed Sensor

Throttle Position Sensor (TPS) Test



*DO NOT UNFASTEN THE SENSOR WIRE HARENSS CONNECTOR. INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS. ON SOME MODELS, IT MAY ALSO BE NECESSARY TO REMOVE THE THROTTLE BODY FROM THE INTAKE MANIFOLD, TO GAIN ACCESS TO THE SENSOR WIRE.

J8914-95

2.46L Oxygen Sensor Heating Element Test

MJ/XJ Vehicles

The oxygen sensor heating element can be tested with an ohmmeter as follows:

Disconnect the O_2 sensor connector. Connect the ohmmeter test loads to connector terminals A and C of the sensor connector (Fig. 63). Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity reading.

YJ Vehicles

The oxygen sensor heating element can be tested with an ohmmeter as follows:

Disconnect the O_2 sensor connector. Connect the ohmmeter test loads to connector terminals A and B of the sensor connector. Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity reading.

Wide-Open-Throttle (WOT) Switch Test—YJ Vehicles Only

Disconnect the wire harness connector from the WOT switch (Fig. 64).

Test the on-off operation of the WOT switch with a high input impedance (digital) volt-ohmmeter. Test the switch operation several times. Operate the switch by manually opening and closing the throttle valve. The resistance should be infinite when the throttle valve is closed. A low resistance should be indicated at the WOT position.

Replace the WOT switch if it is defective.

Connect the wire harness connector. With the ignition switch ON and the engine not running, connect a voltmeter across diagnostic connectors D2-6 and D2-7 (ground). There should be no voltage reading when the throttle valve is at the WOT position. Voltage should be greater than 2 volts when not at the WOT position.

If no voltage is present in either position, test for a short circuit to ground in the wire harness or switch. Check for an open circuit between ECU connector terminal 8 and the switch connector. Repair or replace the wire harness as necessary.

If the voltage is always greater than 2 volts, test for an open circuit in the wire or connector between the switch and ground. Repair as necessary.

Closed Throttle (Idle) Switch Test

It is important that all testing be done with the idle speed actuator (ISA) motor plunger in the fully extended position, as it would be after a normal engine shut down. Shut the engine off and note if the ISA motor plunger extends. If it is necessary to extend the ISA motor plunger to test the switch, an ISA motor failure can be suspected. Refer to the ISA Motor Adjustment if necessary.

With the ignition switch ON, test the switch voltage at diagnostic connectors D2-13 and D2-7/ground. The voltage should be close to zero at closed throttle and greater than 2 volts when off the closed throttle position.

If no voltage is present in either position, test for a short circuit to ground in the wire harness or switch. Test for an open circuit between ECU connector terminal 25 and the switch.

If the voltage is always more than 2 volts, test for an open circuit in the wire harness between the ECU and the switch connector, and between the switch connector and ground (Fig. 65). Repair or replace the wire harness as necessary.

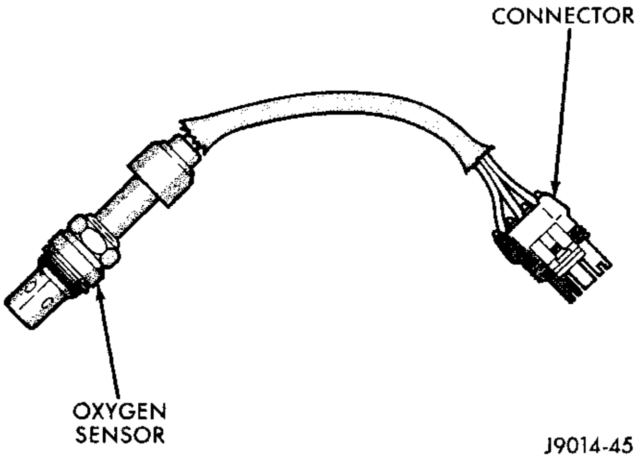


Fig. 63 Oxygen Sensor Connector Terminals

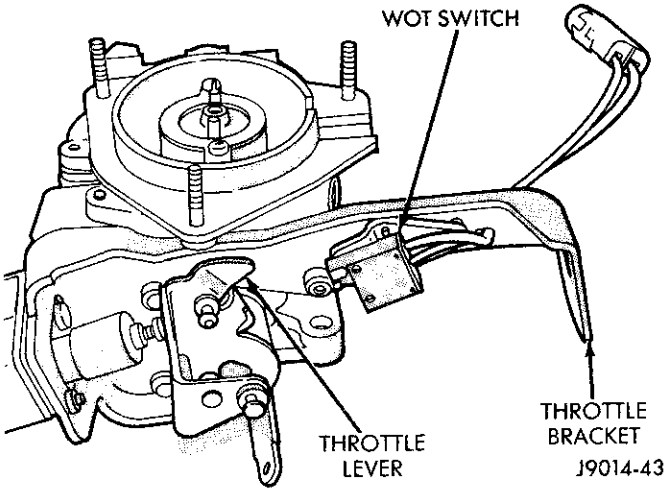


Fig. 64 Wide Open Throttle Switch

ISA Motor Diagnostic Test

WARNING: AFTER TESTING THE OPERATION OF THE ISA MOTOR, OR IF THE ISA MOTOR HAS BEEN REPLACED, ALWAYS EXTEND THE ISA MOTOR BEFORE STARTING THE ENGINE TO PREVENT THE ISA MOTOR FROM JAMMING.

The following test must be performed using ISA Exerciser tool 7088.

If the ISA motor is to be tested off the vehicle, the ISA motor shaft must be lightly preloaded to avoid having the ISA motor jam during the test. Use light finger pressure to preload the ISA motor shaft and simulate throttle return pressure.

Check to ensure that the rubber boot is correctly positioned in its groove on the ISA motor shaft.

- If not, correct its position and recheck vehicle for proper idle speed operation.

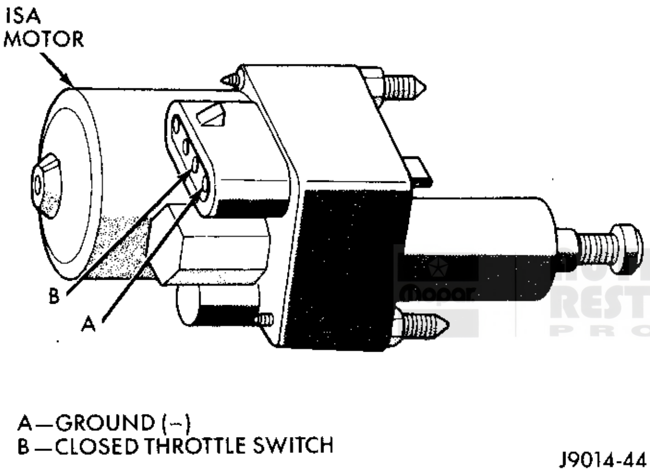


Fig. 65 Closed Throttle Switch

- If correctly positioned, continue diagnosis procedure.

Open the throttle and attempt to extend and retract the ISA motor by pulling and pushing axially (in and out) on the ISA shaft.

CAUTION: If the shaft axial movement is more than 9.525 mm (3/8 in.), do not continue. Replace the ISA motor.

Be sure the ignition switch is in the OFF position.

Connect ISA exerciser tool 7088 power leads to the vehicle battery (red to positive/black to negative—Fig. 66). Disconnect the ISA motor connector. Connect the ISA motor exerciser 4-pin connector to the ISA motor (it may be necessary to slot the casing of one of the exerciser pins to connect the exerciser to the ISA motor). Proceed to ISA Motor Diagnostic Testing charts.

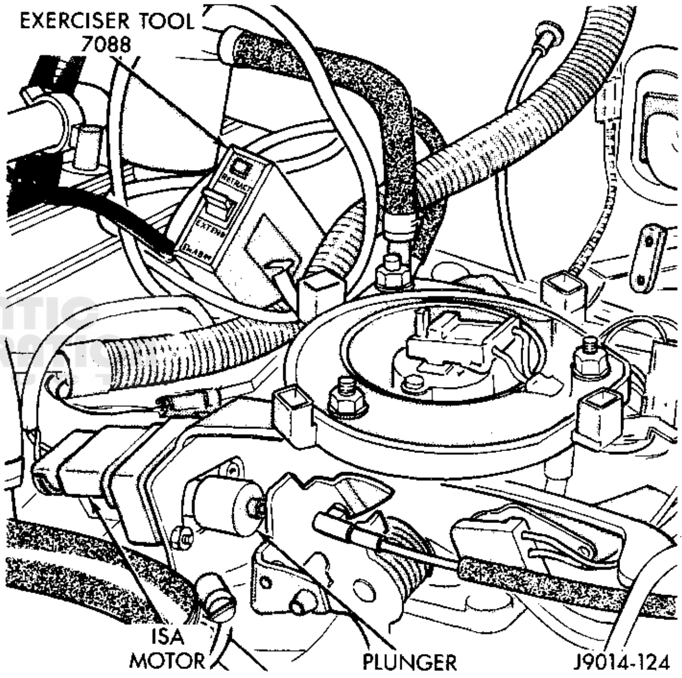


Fig. 66 ISA Testing with Exerciser Tool 7088

ISA MOTOR DIAGNOSTIC TESTING

TEST SEQUENCE	DESIRED RESULTS	POSSIBLE ACTUAL RESULTS	DIAGNOSIS CORRECTIVE ACTION
1. Examine the ISA motor shaft tip position.	The ISA motor tip should be in contact with the throttle lever. Throttle should be partially open.	IF, the ISA motor tip is not in contact with throttle lever and throttle lever is closed.	THEN,ISA motor is fully retracted and jammed. Go to sequence No. 2 to unjam ISA motor.
		IF, desired results were obtained.	THEN, skip test sequence No. 2 and perform test sequence No.3.
2. Apply parking brake, and start engine. With the engine running, open throttle to approx. 1500 rpm and move exerciser switch in the EXTEND direction several times to unjam the ISA. Turn ignition switch to OFF position.	ISA motor tip should be in contact with the throttle lever. Throttle should be partially open.	IF, The ISA motor shaft tip is *not* in contact with the throttle lever and throttle is still closed.	THEN, ISA motor is permanently jammed. Stop procedure and replace ISA motor.
		IF, desired results were obtained.	THEN, ISA motor is unjammed Go to test sequence No. 3.
3. Move the exerciser switch in the EXTEND direction for 5 seconds. Watch ISA motor action.	ISA motor should ratched (click) several times when it has reached fully extended position.	IF, it does not ratchet (click).	THEN, ISA motor is defective. Stop procedure. Replace ISA motor.
		IF, desired results were obtained	THEN, ISA motor is OK. Perform test sequence No. 4.
4. Move the exerciser switch in the RETRACT direction for 5 seconds. Watch the ISA motor action.	ISA motor should close throttle and stop automatically in 3 seconds. The closed throttle switch light on the exerciser will go out when ISA motor reaches closed throttle position. The tip of the ISA should be in contact with, or no more than 0.50 mm (0.20-in) away from, throttle lever (A) when ISA motor has stopped movement (see next illustration). The throttle lever should also be in contact with the throttle stop screw on the main body of the TBI when ISA motor movement has stopped.	IF, ISA motor did not move.	THEN, ISA motor is defective. Stop the procedure. Replace ISA motor.
		IF, ISA motor closed the throttle, but retracted away from throttle lever and was no longer in contact with throttle lever.	THEN, ISA motor is defective. Stop the procedure. Replace the ISA motor.
		IF, ISA motor moved the throttle, but throttle was not in contact with the closed throttle stop screw on the TBI main body when ISA motor movement stopped.	THEN, perform test sequence No. 5
		IF, desired results were obtained.	THEN, skip test sequence No.5 and perform test sequence No. 6.
5. Push throttle in CLOSED direction while pressing exerciser switch in RETRACT direction for 5 seconds	ISA motor should continue to retract until throttle lever contacts with closed throttle stop screw on TBI main body.	IF, desired results were obtained.	THEN, ISA motor is OK. Check throttle control system for freedom and smoothness of movement. Inspect throttle return springs. Repair as necessary. After repair, perform test sequence No. 6.
		IF, ISA motor did not move.	THEN, ISA motor is defective. Stop the procedure. Replace the ISA motor.
6. Move the ISA motor in the EXTEND and RETRACT direction 2 or 3 times. *ALWAYS* leave ISA motor *EXTENDED*.	ISA motor should operate smoothly and ratchet (click) at end of EXTEND travel. It should stop automatically at end of RETRACT level.	IF, the movement is intermittant, slow, or "gritty sounding".	THEN, replace ISA motor.
		IF, desired results were obtained.	THEN, ISA motor is OK. Do not replace ISA motor.
		IF, an idle problem still exsists.	THEN, further diagnosis is necessary.

J8914-113

Disconnect the ISA motor exerciser connector from the ISA motor and from the battery. Connect the original harness connector to the ISA motor.

Neutral Safety Switch

Refer to Automatic Transmission section of group 21 for Park/Neutral switch diagnosis.

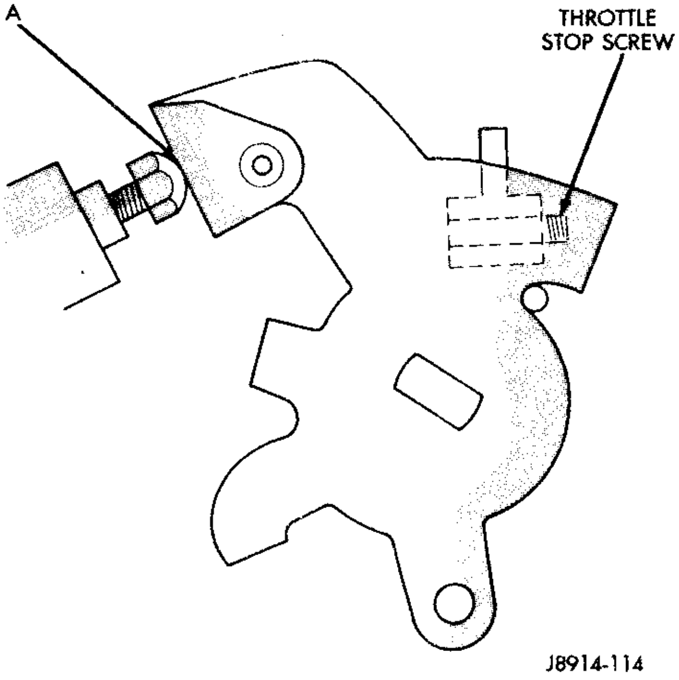


Fig. 67 ISA Motor Testing—See Step 4 Diagnostic Chart

TBI SERVICE PROCEDURES

INDEX

FUEL TUBES AND HOSES

TBI fuel system pressure is bled off when the fuel pump is not operating. Fuel hoses and tubes can be removed once the vehicle is turned off. When removing fuel system hoses and tubes use care to avoid damaging the hoses or tube ends.

Quick Connect Fittings

Fuel Injected engines utilize quick-connect fuel tube fittings at the ends of the nylon reinforced hoses that connect the throttle body to the fuel supply and return tubes. The fittings consist of two O-rings, a spacer (installed between O-rings), and an O-ring retainer.

CAUTION: Whenever a fuel tube quick connect fitting is disconnected the O-rings, spacer, and retainer MUST be replaced. A repair kit consisting of the these parts is available through the parts department (Fig. 1).

Quick connect fittings are located under the vehicle along the frame rail (Fig. 2).

The retainer has two tabs. To disconnect the quick-connect fitting, squeeze the tabs against the fuel tube and then pull the fitting off of the quick connect fitting/hose assembly. The retainer will stay on the fuel tube when the tube is disconnected. The O-rings and spacer will remain in the connector.

The O-rings and spacer can be removed with the bent end of an "L" shaped paper clip.

O-ring Replacement

A repair kit consisting of replacement O-rings, spacer, and retainer is available through the parts department. The replacement parts are installed on a disposable plastic plug (Fig. 3). Install the replacement kit as follows:

(1) Push kit/disposable plug assembly into quick connect fitting until an "click" sound is heard (Fig. 3).

(2) Grasp end of disposable plug and pull outward to remove it from fitting.

Tube/Fitting Assembly

(1) Push fuel tube into quick-connect fitting until a "click" is heard (Fig. 4).

(2) Verify that connection is secure by firmly pulling back on fuel tube. The tube should be locked in place.

THROTTLE BODY

Removal

(1) Disconnect the battery negative cable.

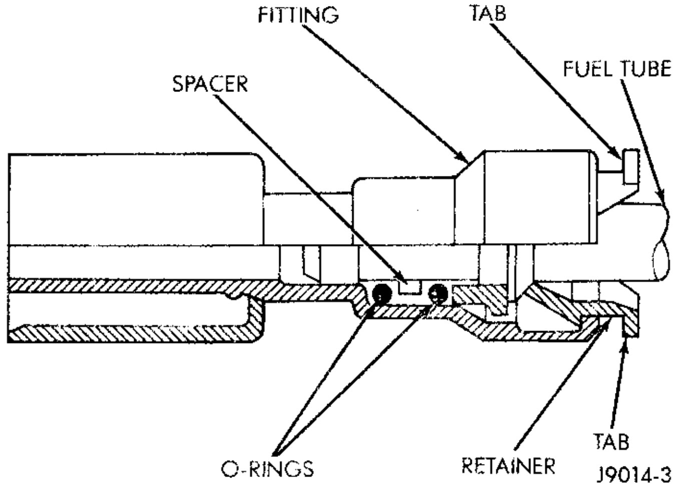


Fig. 1 Quick-Connect Fitting

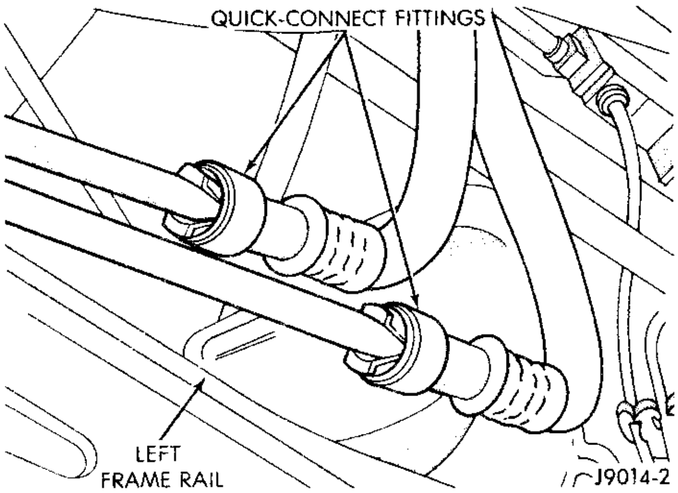


Fig. 2 Quick Connect Fitting Location

(2) Disconnect vacuum hoses from throttle body upper bonnet. Release bonnet retaining clips and remove upper bonnet (Fig. 5).

(3) Remove lower bonnet retaining bolts and lower bonnet (Fig. 6).

(4) Disconnect ISA motor connector (Fig. 6).

(5) Disconnect fuel supply and return tubes from throttle body (Fig. 6).

(6) Remove the throttle cable and return spring (Fig. 7).

(7) Disconnect the wire harness connector from the injector by compressing lock tabs and lifting upward (Fig. 7).

(8) Identify and tag vacuum hoses at back of throttle body for installation reference. Disconnect vacuum tubes from throttle body (Fig. 8).

(9) Disconnect TPS (if equipped with an automatic transmission, disconnect both TPS connectors) and Wot switch (YJ vehicles only) connectors (Fig. 8).

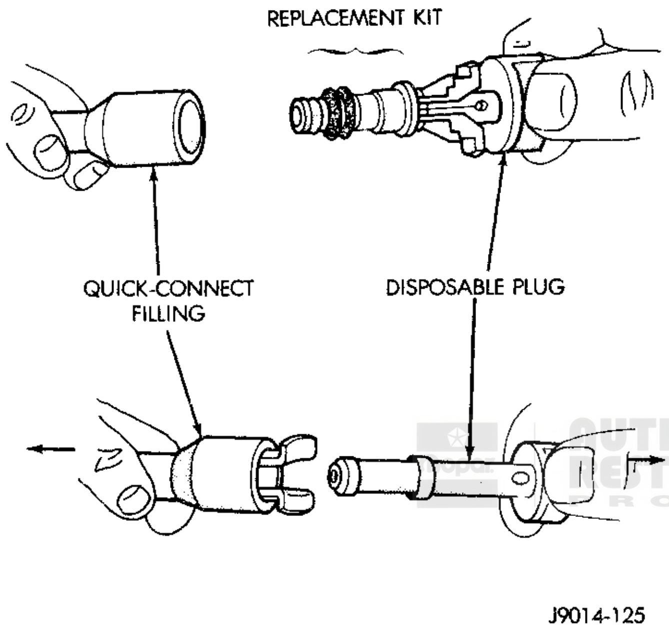


Fig. 3 Repair Kit Installation

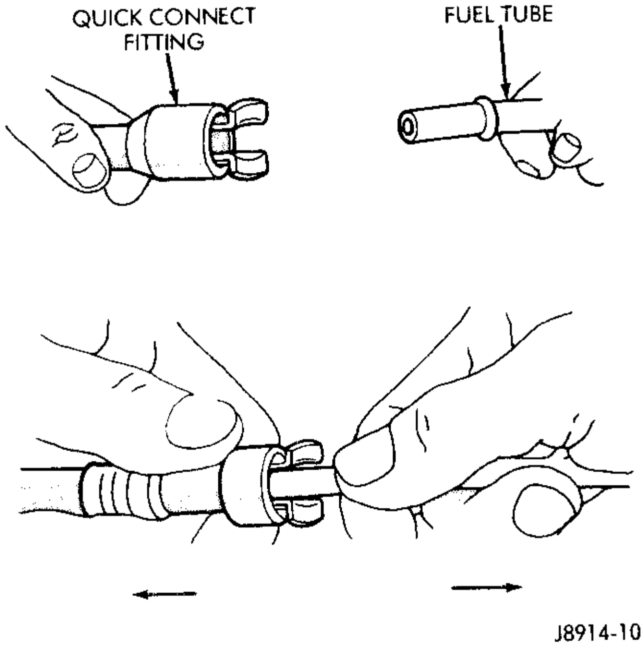


Fig. 4 Fuel Tube to Fitting Connection

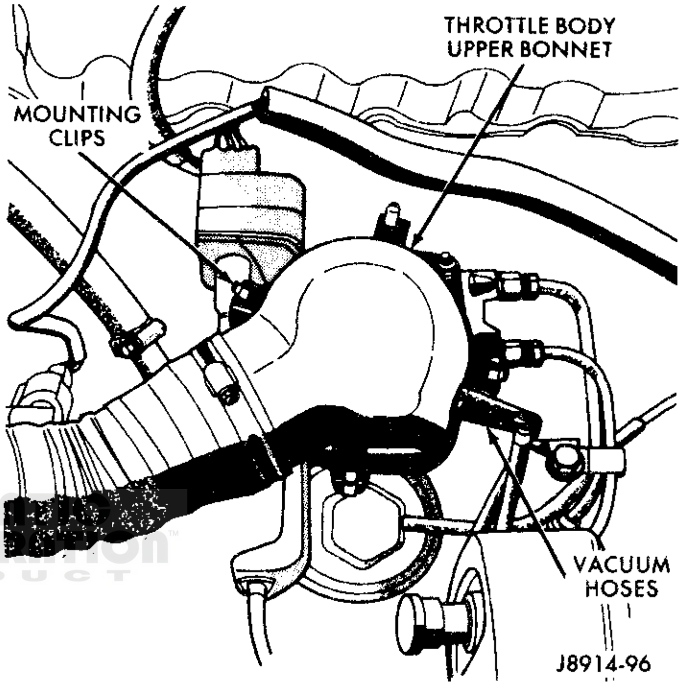


Fig. 5 Throttle Body Upper Bonnet

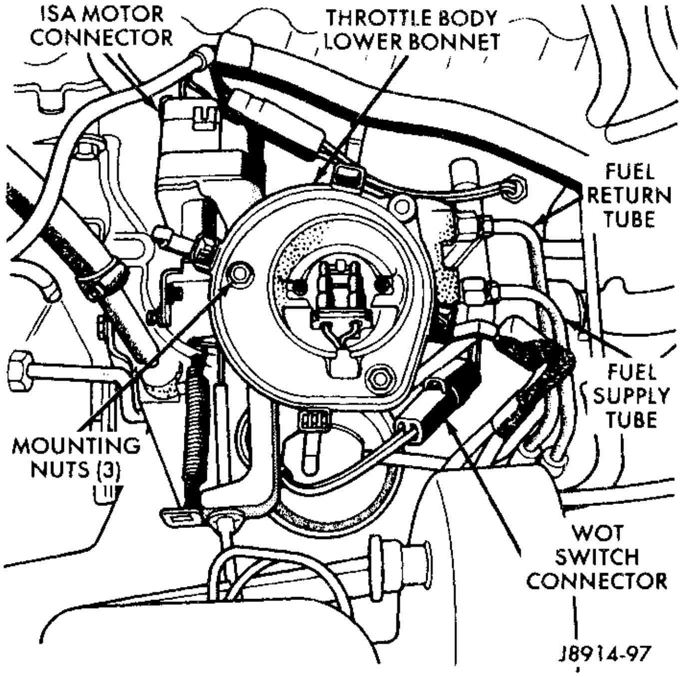


Fig. 6 Throttle Body Lower Bonnet

(10) Remove throttle body mounting nuts (Fig. 8). Remove throttle body.

(11) Clean intake manifold and throttle body mating surfaces of old gasket material and grime.

If the throttle body assembly is being replaced and the WOT switch, ISA motor and throttle position sensor (TPS) are transferred to the replacement throttle body, they must be adjusted after installation. Refer to WOT switch adjustment, ISA motor adjustment, and TPS Adjustment.

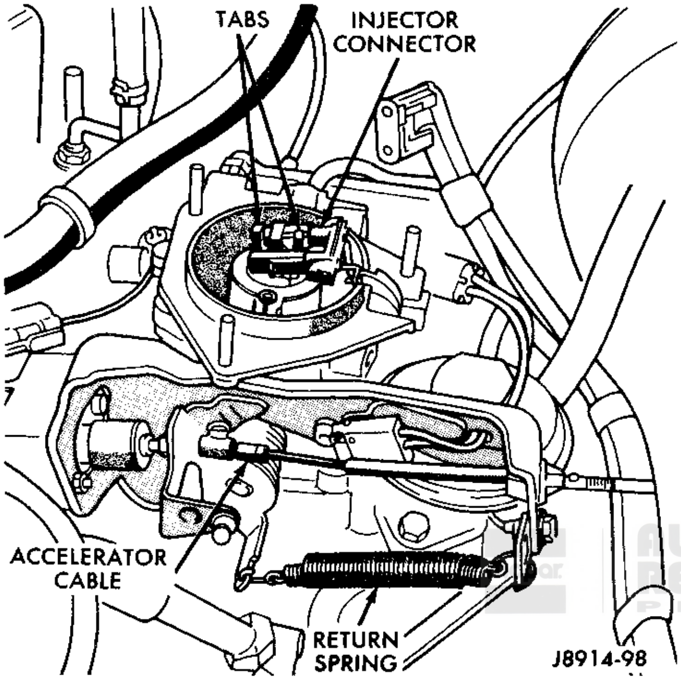


Fig. 7 Accelerator Cable, Return Spring, Injector Connector.

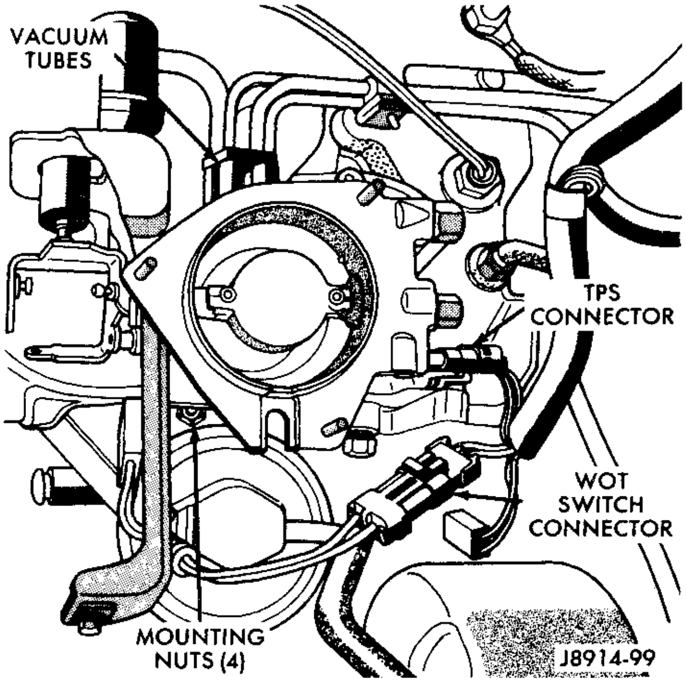


Fig. 8 Throttle Body Removal

Installation

(1) With a new gasket, install the replacement throttle body assembly on the intake manifold. Tighten mounting nuts to 22 N•m (16 ft-lbs) torque.

(2) Connect vacuum hoses to back of throttle body.

(3) Connect the fuel supply and return tubes to throttle body.

(4) Connect WOT switch wire harness connector.

(5) Connect wire harness connector to the ISA motor.

(6) Connect TPS wire connector(s).

(7) Connect wire connector to injector.

(8) Install accelerator cable and return spring.

(9) Install the lower bonnet assembly and retaining nuts.

(10) Install the upper bonnet assembly.

(11) Connect battery negative cable to battery terminal. Tighten terminal nut to 8.5 N•m (75 in-lbs) torque.

Fuel Body

Removal

(1) Remove fuel filler cap to relieve fuel tank pressure.

(2) Remove throttle body assembly as described in this section.

(3) Remove the 3 Torx head screws that mount fuel body to throttle body (Fig. 9).

(4) Remove the original gasket and discard (Fig. 9).

Installation

(1) Install fuel body on throttle body using a new gasket.

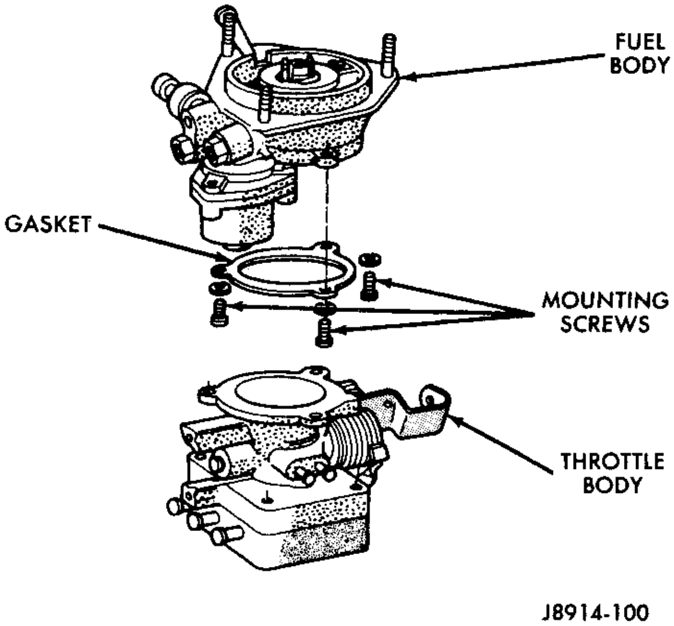


Fig. 9 Fuel Body

Tighten the 3 fuel body-to-throttle retaining screws securely.

(2) Install throttle body assembly as described in this section.

(3) Install fuel filler cap.

Fuel Injector

Removal

(1) Remove fuel filler cap to relieve fuel tank pressure.

(2) Disconnect battery negative cable.

(3) Remove throttle body upper bonnet (Fig. 5).

(4) Remove throttle body lower bonnet (Fig. 6).

(5) Remove injector connector by compressing lock tabs and lifting upward.

(6) Remove injector retainer screws. Remove retainer.

CAUTION: The injector has a small locating tab that fits into a slot in the bottom of the injector bore of the throttle body. DO NOT TWIST the injector during removal.

(7) Using a small pair of pliers, gently grasp center collar of injector and carefully remove injector by rocking it back and forth while lifting upward (Fig. 10).

(8) Remove and discard centering ring, upper O-ring, and lower O-ring (Fig. 11).

CAUTION: DO NOT reuse centering or upper and lower O-rings as fuel leakage and poor driveability can result.

Installation

To prevent damage to the lower O-ring seal during installation, throttle body injector installation tool 6172 must be used (Fig. 12).

(1) Lubricate replacement lower O-ring with silicone dielectric grease. Install replacement lower O-ring into bottom of housing bore.

(2) Lubricate replacement upper O-ring with silicone dielectric grease. Install replacement upper O-ring into housing bore.

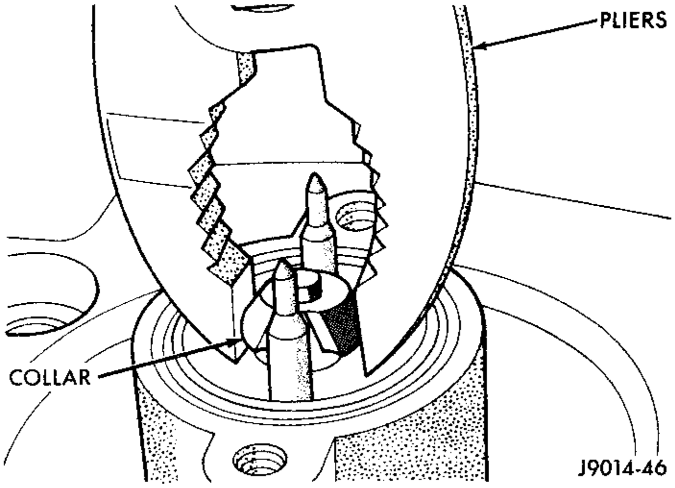


Fig. 10 Fuel Injector Removal

(3) Install centering ring on top of upper O-ring.

WARNING: WHEN INSTALLING INJECTOR WITH INSTALLATION TOOL 6172, THE THROTTLE VALVE OF THE THROTTLE BODY MUST BE CLOSED.

(5) Ensure that the throttle valve is closed. Position bottom of installation tool 6172 on top of lower O-ring seal (Fig. 13).

(6) Align locating tab on bottom of injector with slot in bottom of throttle body injector housing. Lower injector until discharge nozzle pilots into installation tool 6172.

(7) Push injector down until installation tool 6172 drops onto throttle valve and injector seats in throttle body.

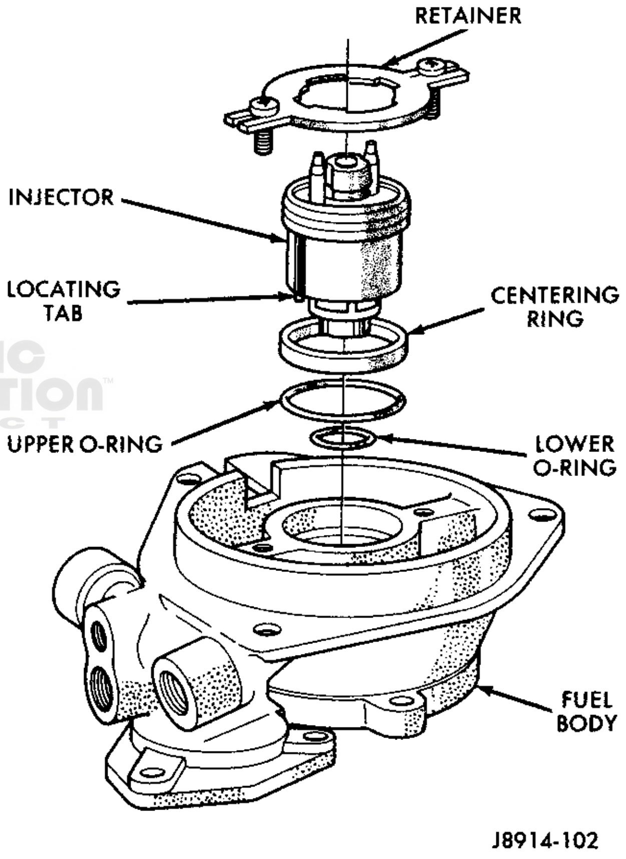


Fig. 11 Fuel Injector Components

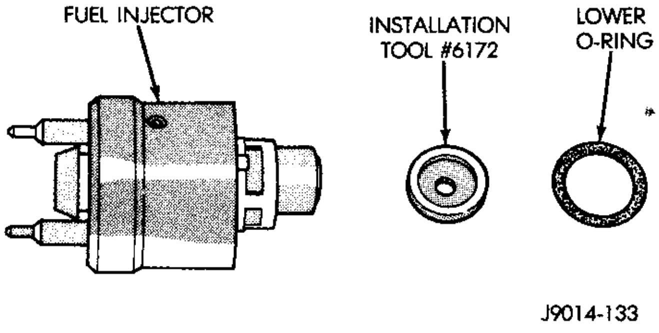


Fig. 12 Injector Installation Tool 6172

(8) Use a magnet to remove installation tool 6172 from throttle body.

(9) Install retainer and tighten screws.

(10) Connect the injector wire connector.

(11) Install lower and upper bonnet.

(12) Install fuel filler cap.

(13) Connect battery negative cable to battery negative terminal. Tighten terminal bolt to 8.5 N•m (75 in-lbs) torque.

Fuel Pressure Regulator

Removal

(1) Remove throttle body from engine as described in this section.

CAUTION: To prevent release of spring pressure, keep regulator housing forced against throttle body while removing regulator mounting screws.

(2) Remove pressure regulator mounting screws (Fig. 14).

(3) Remove housing, spring and seats, diaphragm, and pivot (Fig. 14).

(4) Clean housing of any foreign material.

Installation

CAUTION: The pressure regulator diaphragm MUST be installed with the vent hole aligned with the vent holes in the throttle body and regulator housing.

(1) Install pressure regulator assembly in correct order. Tighten mounting screws.

(2) Install throttle body on engine as described in this section.

(3) Start engine and check for leaks.

(4) Adjust fuel pressure. Refer to Fuel Pressure Adjustment.

Throttle Position Sensor

Removal

(1) Remove upper and lower air inlet bonnet.

(2) If necessary, remove throttle body assembly as described in this section.

(3) Remove mounting screws.

(4) Remove throttle position sensor from throttle shaft lever (Fig. 15).

Installation

(1) Install throttle position sensor. **Ensure that sensor arm is underneath arm of throttle valve shaft.**

(2) Tighten mounting screws.

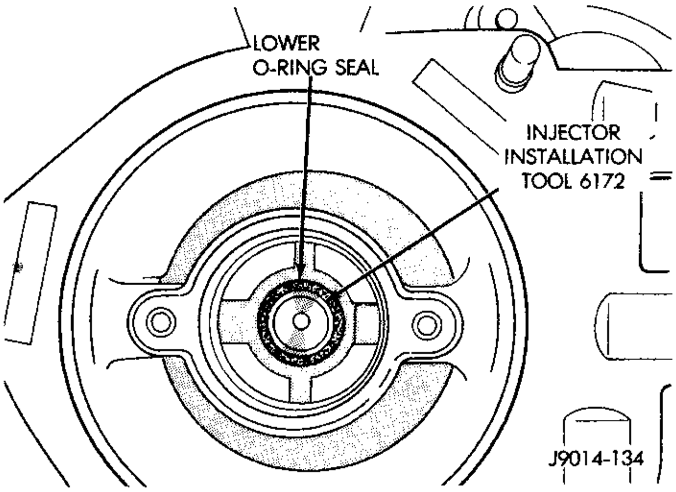


Fig. 13 Fuel Injector Installation

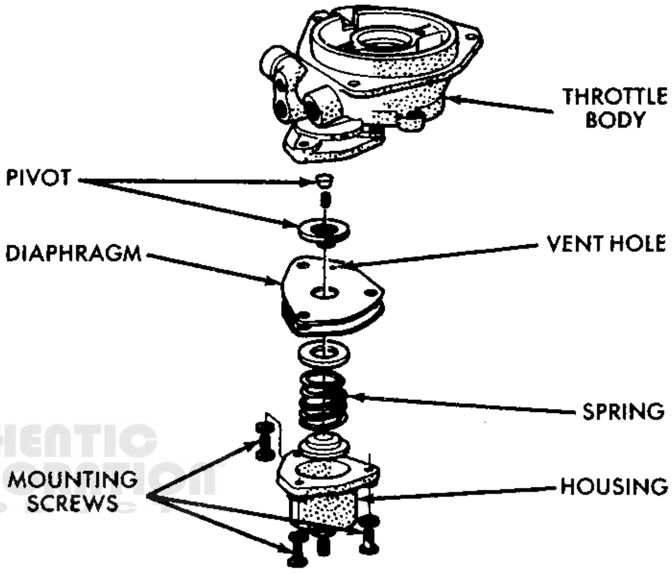


Fig. 14 Fuel Pressure Regulator Remove/Install

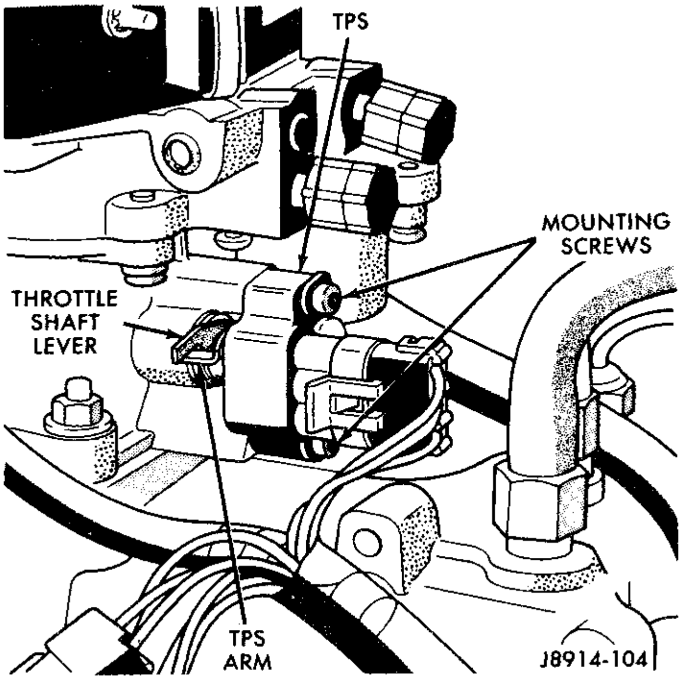


Fig. 15 TPS Remove/Install

(3) Adjust throttle position sensor. Refer to Throttle Position Sensor Adjustment switch as described in this manual.

(4) If removed, install throttle body assembly as described in this section.

(5) Install upper and lower air inlet bonnet.

Idle Speed Actuator (ISA) Motor

Removal

The closed throttle (idle) switch is integral with the motor.

(1) Disconnect throttle return springs from throttle lever.

(2) Disconnect wire harness connector from ISA motor (Fig. 16).

CAUTION: Do not attempt to remove the ISA motor-to-bracket nuts without using a backup wrench on the stud nuts. ISA motor internal components may be damaged if the studs disengage.

(3) Remove motor-to-bracket retaining nuts. Use a backup wrench to prevent the studs which hold the ISA motor together from turning.

(4) Remove ISA motor from bracket (Fig. 16).

Installation

(1) Install ISA motor on bracket. Tighten mounting nuts.

(2) Connect wire harness connector to ISA motor.

(3) Connect throttle return springs to throttle lever.

(4) Adjust ISA motor. Refer to ISA Motor Adjustment.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Removal

(1) Disconnect wire harness connector from MAP sensor (Fig. 17).

(2) Disconnect vacuum hose from MAP sensor (Fig. 17).

(3) Remove MAP sensor mounting nuts. Remove sensor (Fig. 17).

Installation

(1) Install MAP sensor over studs. Tighten mounting nuts to 4 N•m (35 in-lbs) torque.

(2) Connect vacuum hose to MAP sensor.

(3) Connect wire harness connector to MAP sensor.

EGR VALVE VACUUM SOLENOID—MJ/XJ VEHICLES ONLY

Removal

The EGR valve solenoid is mounted on the evaporative purge canister bracket.

(1) Disconnect wire harness connector (Fig. 18).

(2) Disconnect vacuum hoses and mark for reference (Fig. 18).

(3) Remove mounting screw and solenoid (Fig. 18).

Installation

(1) Mount solenoid to evaporative canister bracket. Tighten mounting screw.

(2) Connect vacuum hoses to solenoid.

(3) Connect wire harness to solenoid.

EGR VALVE/EVAPORATIVE CANISTER PURGE SOLENOID—YJ VEHICLES ONLY

Removal

(1) Disconnect wire harness connector (Fig. 19).

(2) Disconnect vacuum hoses and mark for reference (Fig. 19).

(3) Remove mounting screw and solenoid (Fig. 19).

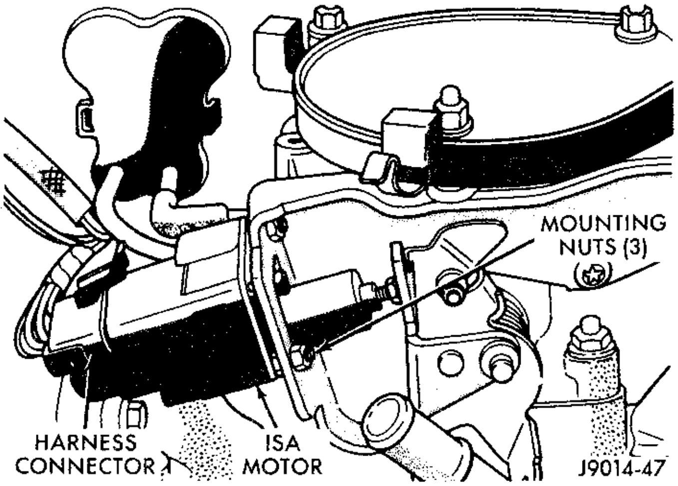


Fig. 16 ISA Motor Remove/Install

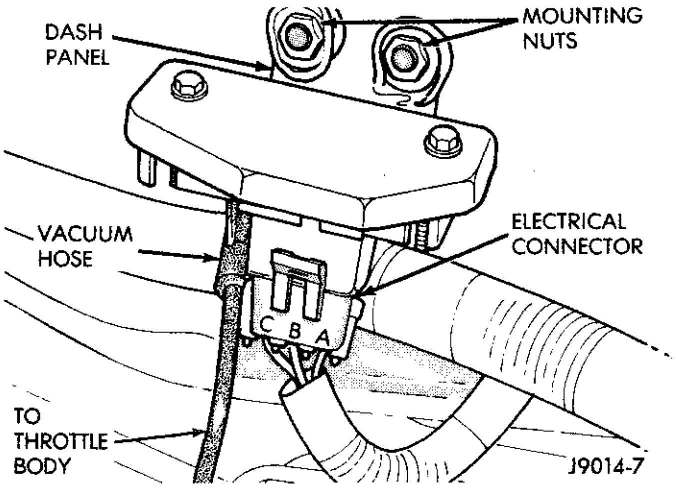


Fig. 17 MAP Sensor

Installation

(1) Mount solenoid to evaporative canister bracket. Tighten mounting screw.

(2) Connect vacuum hoses to solenoid.

(3) Connect wire harness to solenoid.

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

Removal

(1) Disconnect wire harness connector (Fig. 20).

(2) Remove MAT sensor from intake manifold.

Installation

(1) Install MAT sensor in intake manifold. Tighten sensor to 28 N•m (21 ft-lbs) torque.

(2) Connect wire harness to sensor connector.

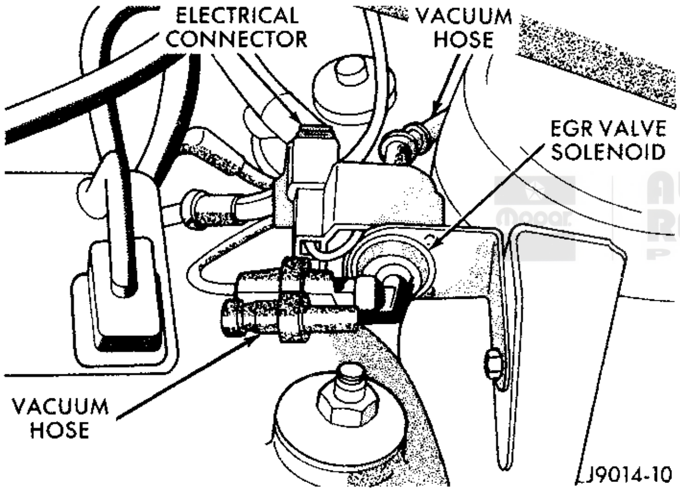


Fig. 18 MJ/XJ EGR Valve Vacuum Solenoid Remove/ Install

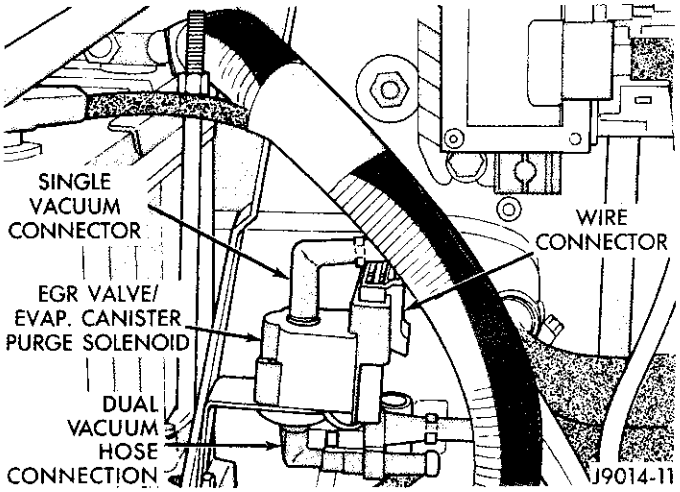


Fig. 19 YJ EGR Valve/Evaporative Canister Purge Solenoid Remove/Install

COOLANT TEMPERATURE SENSOR (CTS)

Removal

(1) Disconnect wire harness connector (Fig. 21).

(2) Remove coolant temperature sensor from intake manifold from intake manifold and immediately plug hole to prevent coolant loss.

Installation

(1) Install coolant temperature sensor in intake manifold. Tighten sensor to 28 N•m (21 ft-lbs) torque.

(2) Connect wire harness to sensor connector.

EXHAUST OXYGEN CONTENT (O_2) SENSOR

Removal

WARNING: EXHAUST MANIFOLD BECOMES VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENOR.

(1) Disconnect wire harness connector (Fig. 22).

(2) Remove oxygen sensor from intake manifold.

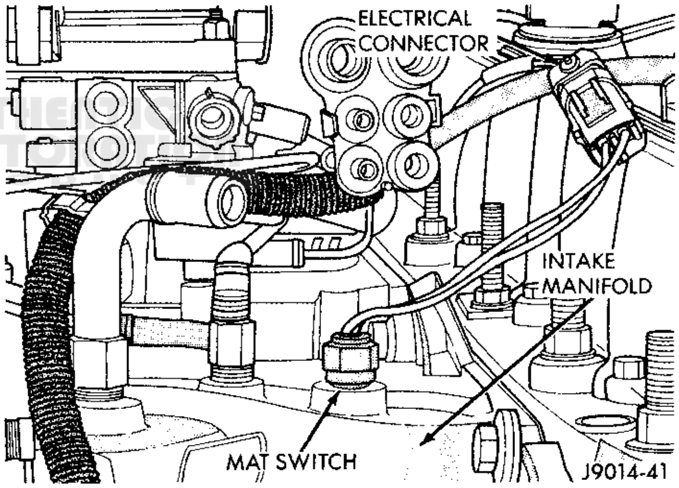


Fig. 20 MAT Sensor Remove/Install

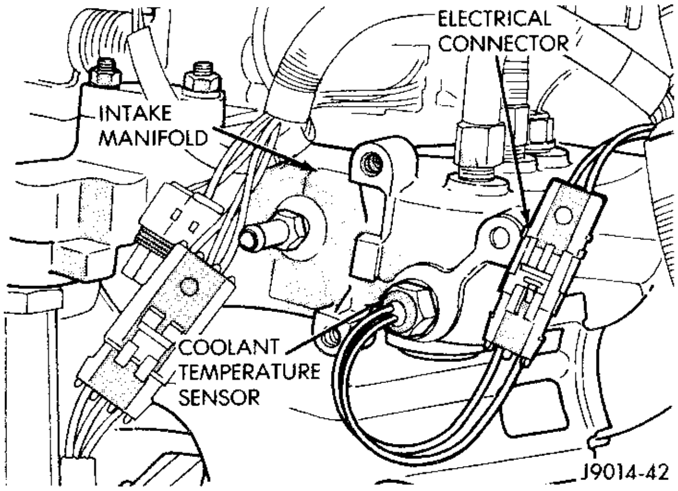


Fig. 21 Coolant Temperature Sensor Remove/Install

Installation

Threads of new oxygen sensors are coated with anti-seize compound to aid in removal.

(1) Install oxygen sensor in exhaust manifold. Tighten sensor to 30 N•m (22 ft-lbs) torque.

(2) Connect wire harness to oxygen sensor connector.

SPEED SENSOR (CRANKSHAFT POSITION SENSOR-CPS)

Removal

The engine speed sensor is mounted to the flywheel/ driveplate housing at the rear of the engine cylinder block.

(1) Disconnect speed sensor connector below MAP sensor in engine compartment.

(2) Raise and support vehicle.

(3) Remove speed sensor mounting bolts (Fig. 23). Remove sensor.

Installation

(1) Install speed sensor. Tighten mounting bolts to 8 N•m (71 in-lbs) torque.

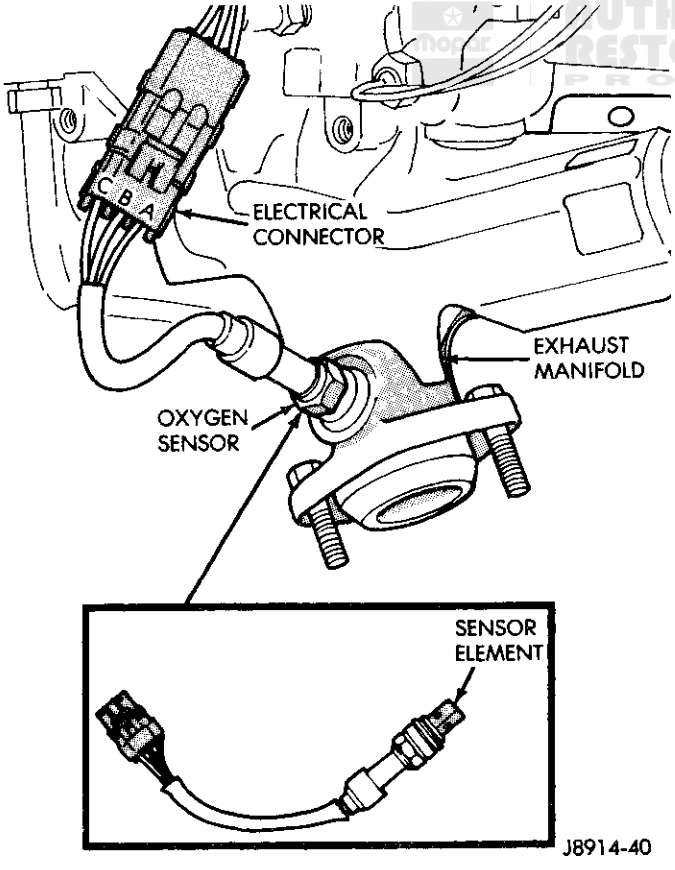


Fig. 22 Oxygen Sensor Remove/Install

ELECTRONIC CONTROL UNIT (ECU)

Removal

The ECU is located underneath the instrument panel between the steering column and heater A/C housing. The ECU is mounted to a bracket by three screws (Fig. 24).

(1) Disconnect battery negative cable.

(2) Remove three ECU mounting screws (Fig. 25). Lower ECU.

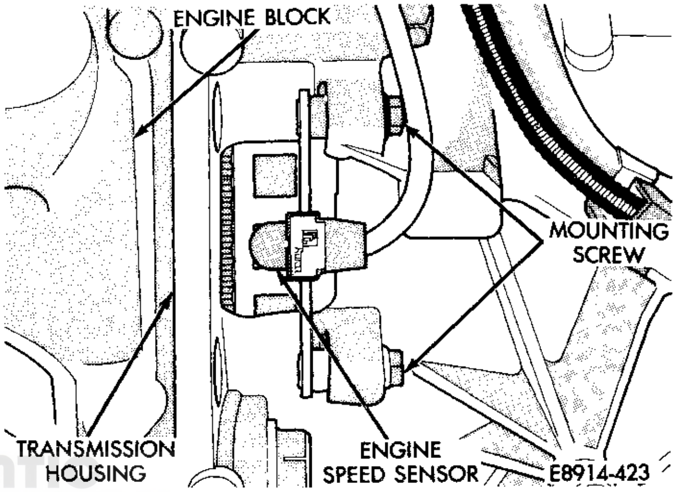


Fig. 23 Speed Sensor Remove/Install

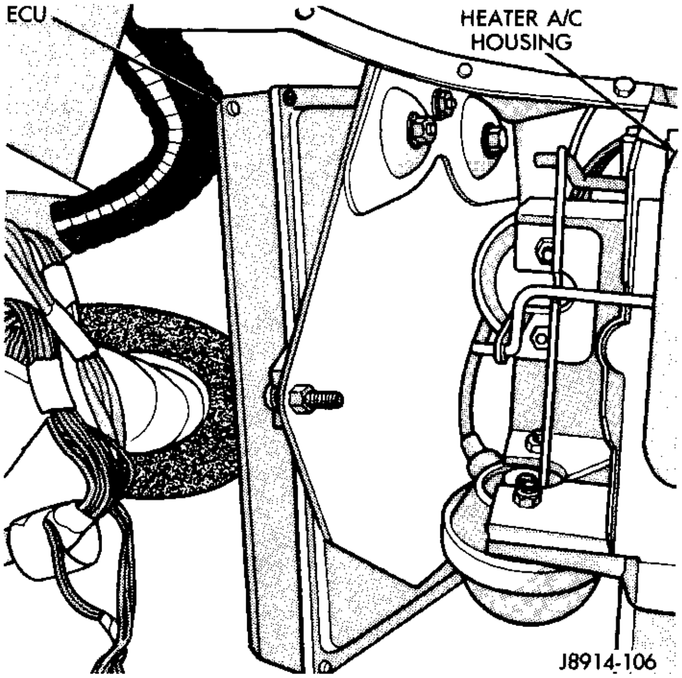


Fig. 24 ECU Location

(3) Disconnect ECU wiring harness. Remove ECU.

Installation

(1) Connect ECU wire harness to ECU.

(2) Position ECU under instrument panel and install retaining screws.

(3) Connect battery negative cable to battery negative terminal.

WIDE OPEN THROTTLE SWITCH—YJ VEHICLES ONLY

(1) Remove air inlet bonnet.

(2) Disconnect throttle return spring from throttle lever.

(3) Disconnect accelerator cable from throttle lever.

(4) Disconnect wire harness from WOT switch connector.

(5) Remove WOT switch mounting screws (Fig. 26). Remove WOT switch.

Installation

(1) Install replacement WOT switch on throttle bracket, do not fully tighten screws at this time.

(2) Connect wire harness to WOT switch connector.

(3) Connect throttle return spring to throttle lever.

(4) Connect accelerator cable to throttle lever.

(5) Adjust WOT switch. Refer to WOT Switch Adjustment.

(6) Once WOT switch has been adjusted, fully tighten mounting screws and install air bonnet.

NEUTRAL SAFETY SWITCH

Refer to Automatic Transmissions in group 21 for neutral safety switch removal and installation.

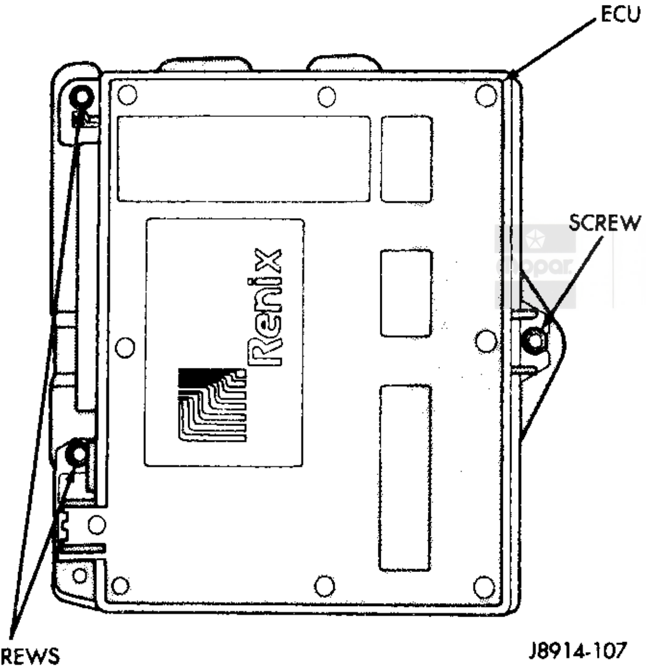


Fig. 25 ECU Remove/Install

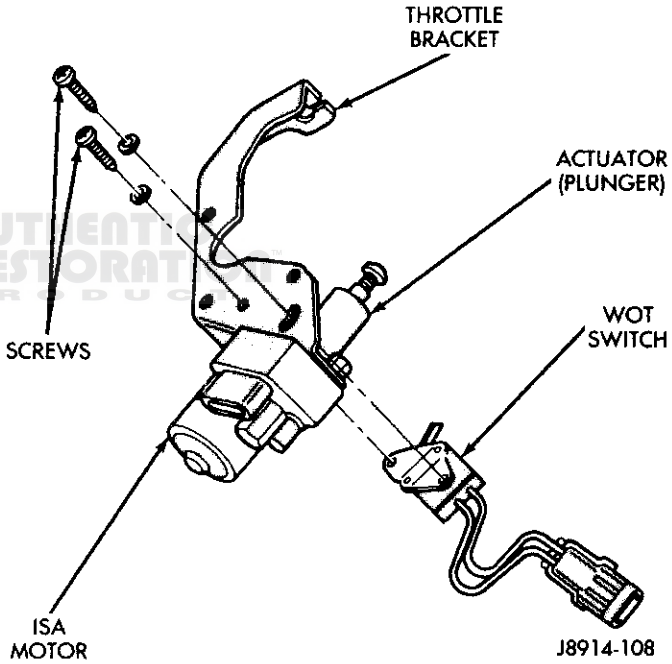


Fig. 26 WOT Switch Remove/Install

TBI SERVICE ADJUSTMENTS

INDEX

IDLE SPEED ACTUATOR (ISA) MOTOR ADJUSTMENT

Adjustment of the ISA motor plunger is necessary only to establish the initial position of the actuator (plunger) after the motor has been replaced.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(1) Remove air inlet bonnet.

(2) Start engine and allow it to reach normal operating temperature (upper radiator hose hot).

(3) Turn A/C to OFF position (if equipped).

(4) Connect a digital tachometer to diagnostic terminals D1-1 and D1-3 (Fig. 1).

(5) Disconnect the ISA motor wire connector.

(6) Connect Exerciser Tool 7088 to the ISA motor (Fig. 2). Connect exerciser power leads to vehicle battery terminals (red to positive, black to negative).

(7) Fully extend ISA motor plunger.

(8) Turn Adjustment screw (plunger screw) until engine speed is 3500 RPM (Fig. 3).

(9) Remove exerciser tool 7088 and connect ISA motor wire connector. Idle speed should automatically return to normal within a few seconds.

(10) Install air inlet bonnet.

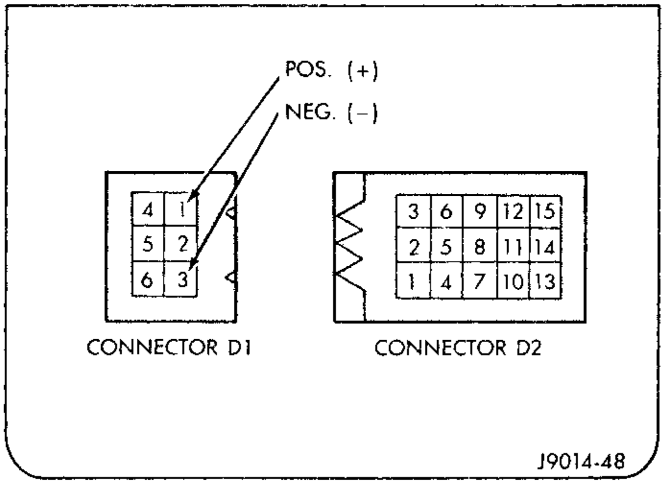


Fig. 1 Diagnostic Connectors

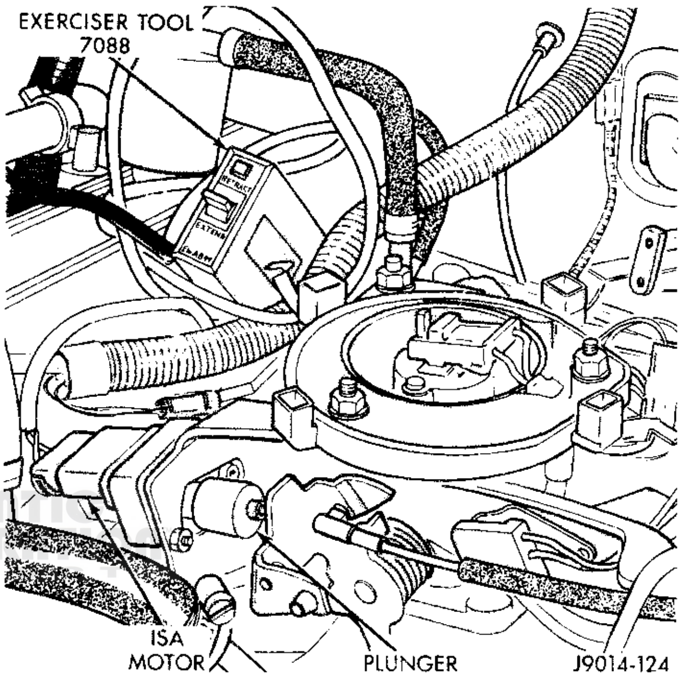


Fig. 2 ISA Motor Exerciser Tool 7088

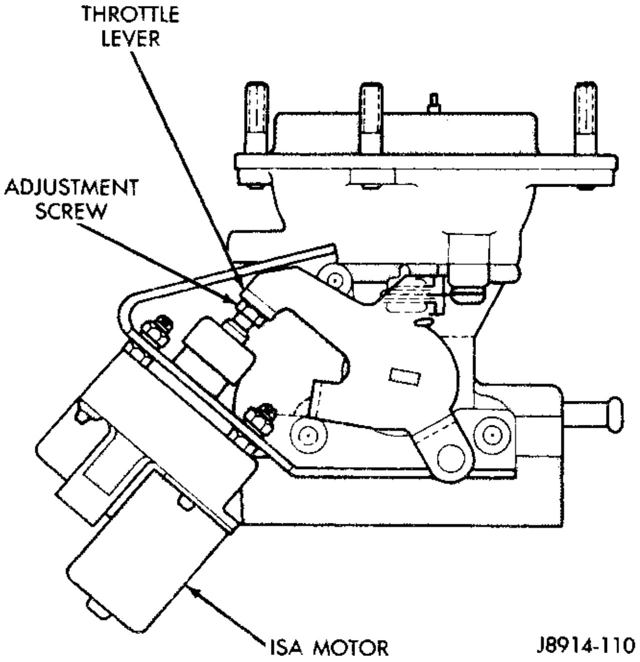


Fig. 3 ISA Motor Adjustment

THROTTLE POSITION SENSOR (TPS) ADJUSTMENT

This throttle position sensor adjustment uses a digital volt meter and ISA exerciser 7088. The TPS adjustment can also be preformed using the DRB-II Service Diagnostic Tester and is the preferred method. Refer to the tester manual for adjustment procedure.

(1) Disconnect ISA motor wire harness connector.

(2) Connect ISA exerciser tool 7088 to ISA motor (Fig. 2).

(3) Retract ISA plunger until the throttle lever contacts the idle stop screw and the plunger does not contact the throttle lever.

The TPS used on vehicles equipped with an automatic transmission has two wire harness connectors, a four terminal connector and a three terminal connector. The 4 terminal TPS connector is used to adjust the TPS. On vehicles equipped with manual transmissions, only one wire harness connector is used and it connects directly to the TPS.

(4) Turn the ignition key to the on position.

(5) Continue to either Manual or Automatic Transmission.

Manual Transmission

The TPS terminals are marked A,B, and C on the connector (Fig. 4).

(6) Check TPS input voltage as follows. Locate terminal B and insert negative lead of voltmeter into the back of it. Insert positive lead of voltmeter into the back of terminal C. Note sensor input voltage (across terminals B and C).

(7) Check the TPS output voltage as follows. Disconnect voltmeter positive lead from sensor terminal C and insert it into the back of terminal A. Note sensor output voltage.

(8) Divide the output voltage reading by the input voltage reading. The desired ratio should be .925 to .935 (.930 desired). EXAMPLE: if the input voltage is 5 volts and the output voltage is 4.65 volts; divide 4.65 by 5 (4.65/5 = .93 or 93).

(9) If necessary, adjust the TPS sensor until the correct ratio is obtained. To adjust input and output voltages, loosen the sensor top mounting screw and pivot the sensor for a large adjustment. Loosen the bottom sensor mounting screw and pivot the sensor for a fine adjustment.

Automatic Transmission

Use the four terminal connector (Fig. 5) to adjust the TPS. The terminals are marked A, B, C and D on the connector.

(6) Check TPS input voltage as follows. Locate terminal D and insert negative lead of voltmeter into the back of it. Insert positive lead of voltmeter into the back of terminal A. Note sensor input voltage (across terminals D and A).

(7) Check the TPS output voltage as follows. Disconnect voltmeter positive lead from sensor terminal A and insert it into the back of terminal B. Note sensor output voltage (across terminals B and D).

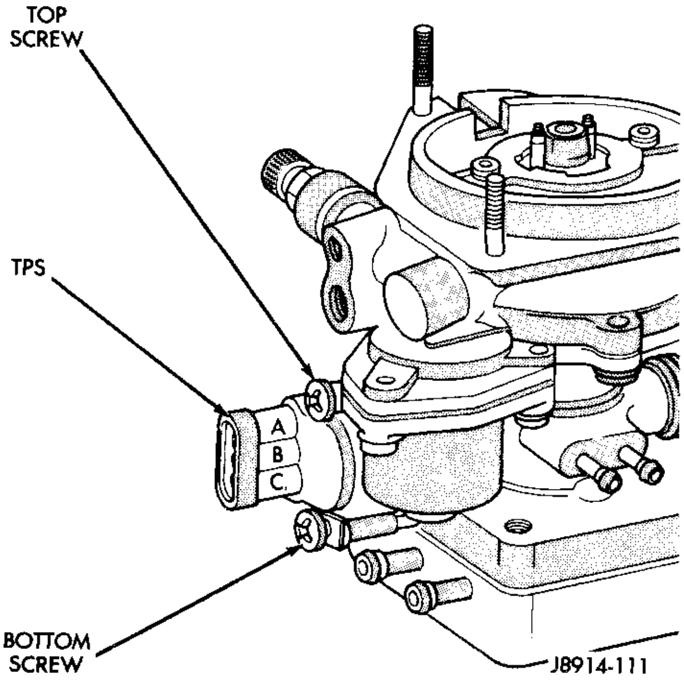


Fig. 4 TPS Adjustment—with Manual Transmission

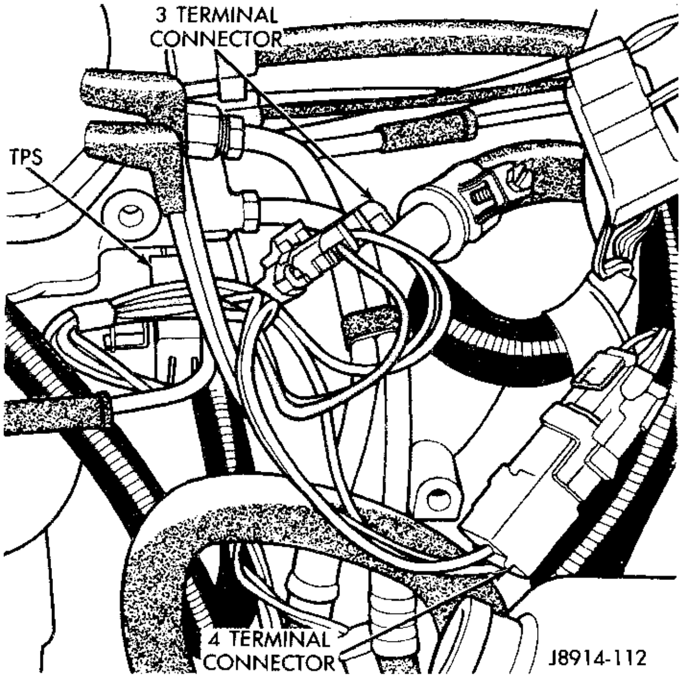


Fig. 5 TPS Adjustment—with Automatic Transmission

(8) Divide the output voltage reading by the input voltage reading. The desired ratio should be .925 to .935 (.930 desired). EXAMPLE: if the input voltage is 5 volts and the output voltage is 4.65 volts; divide 4.65 by 5 (4.65/5 = .93 or 93).

(9) If necessary, adjust the TPS sensor until the correct ratio is obtained. To adjust input and output voltages, loosen the sensor top mounting screw and pivot the sensor for a large adjustment. Loosen the bottom sensor mounting screw and pivot the sensor for a fine adjustment.

WIDE OPEN THROTTLE (WOT) SWITCH ADJUSTMENT—YJ VEHICLES ONLY

Adjustment of the WOT switch is necessary only to establish the initial position of the switch after it has been replaced.

(1) Block or tie throttle linkage in wide open throttle position.

(2) Attach Choke Angle Measuring Gauge 7785 or an equivalent to the flat surface of the throttle lever (Fig. 6).

(3) Center the gauge bubble between the alignment marks using the bubble adjusting screw.

(4) Rotate the degree scale of gauge until the 15 degree mark is aligned with the gauge pointer.

(5) Rotate the gauge degree scale until the zero degree mark is aligned with the gauge pointer.

(6) Close the throttle until the gauge bubble is again centered between the alignment marks. This positions the throttle plate at 15 degrees before wide open throttle.

(7) Rotate the WOT switch until the switch lever contacts the throttle cam. Stop rotating the switch when the lever starts closing the switch plunger (plunger will make a click sound at this point). Then tighten the switch screws 90 N•m (8.8 in.lbs) torque.

(8) Verify WOT throttle switch position adjustment. Switch plunger should "click" when the throttle plate is 15 degrees ± 3 degrees (12 to 18 degrees) before wide open throttle position.

(9) Remove gauge.

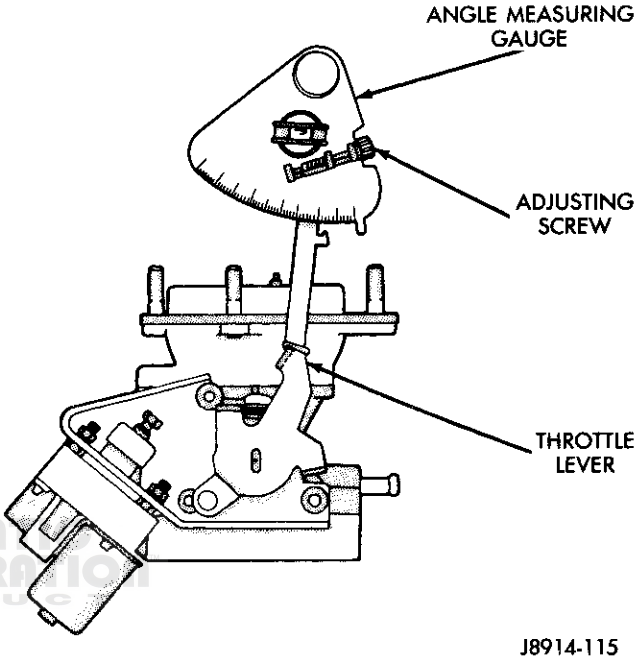


Fig. 6 WOT Switch Adjustment

MULTI-POINT FUEL INJECTION (MPI)

INDEX

GENERAL INFORMATION

MJ and XJ vehicles equipped with the 4.0L engine use a sequential Multi-Point Fuel Injection (MPI) System. Fuel is injected into the intake manifold before the intake valve in precise metered amounts through electrically operated injectors. The injectors are fired in a specific sequence by the engine Electronic Control Unit (ECU). The ECU constantly adjusts the amount of fuel injected to meet changing operating conditions by controlling injector pulse width (the length of time the injector is energized). The ECU also adjusts ignition timing by controlling the ignition coil operation through the ignition control module. The ECU determines air-fuel mixture and ignition timing based on inputs it receives from various sensors that monitor engine operating conditions.

The ECU receives inputs from sensors that react to exhaust gas oxygen content, coolant temperature, manifold absolute pressure, engine speed (crankshaft position), throttle position, battery voltage, intake manifold air temperature, engine knock, and transmission gear selection. These inputs represent the engines instantaneous operating conditions. Air-Fuel mixture and ignition timing calibrations for various driving and atmospheric conditions are pre-programmed into the ECU. The ECU monitors and analyzes its various inputs, computes engine fuel and ignition timing requirements based on these inputs, and controls fuel delivery and ignition timing accordingly.

The ECU, the various sensors and switches that provide input to the ECU, and the ECU outputs (engine control devices controlled by the ECU) comprise the engine control system.

The engine control system consists of:

- Battery voltage
- Manifold absolute pressure (MAP) sensor
- Coolant temperature sensor
- Manifold air temperature (MAT) sensor
- Exhaust Oxygen (O_2) sensor
- Speed (crankshaft position) sensor
- Throttle position sensor
- Injector sync signal
- Air conditioning select signal
- Air conditioning request signal
- Neutral safety switch (gear selection—auto. trans.)
- Knock sensor
- Fuel pump relay
- Fuel injectors
- Idle speed stepper motor
- B+ latch relay
- Oxygen sensor heater relay
- EGR valve solenoid
- Ignition control module
- Shift indicator light (manual trans. only)
- Air conditioning clutch relay

System Diagnosis

For diagnosing MPI electronic control system malfunctions refer to the DRBII Service Diagnostic Tester and accompanying manual. The Service Diagnostic Tester plugs into two diagnostic connectors inside the engine compartment. After performing the required diagnostic test the tester will display a fault code if a malfunction is detected. Diagnostic charts for all fault codes are listed in the tester manual.

ELECTRONIC CONTROL UNIT (ECU)

The Electronic Control Unit (ECU) is a digital microprocessor. Air-Fuel mixture calibrations for various driving and atmospheric conditions are pre-programmed into the ECU. The ECU monitors and analyzes its various inputs, computes engine fuel and ignition timing requirements based on these inputs, and controls fuel delivery and ignition timing accordingly. As operating conditions change, the ECU adjusts injector pulse width and ignition timing for optimum performance and fuel economy.

ECU Inputs

The ECU is powered by the vehicle's battery. When the ignition is turned to the ON or START position, the following inputs are supplied to the ECU:

- Battery voltage
- Manifold absolute pressure (MAP) sensor
- Coolant temperature sensor
- Manifold air temperature (MAT) sensor
- Exhaust Oxygen (O_2) sensor
- Speed (crankshaft position) sensor
- Throttle position sensor
- Injector sync signal
- Air conditioning select signal
- Air conditioning request signal
- Neutral safety switch (gear selection—auto. trans.)
- Knock sensor
- Start signal

ECU Outputs

Based upon input signals from the various input sensors and switches, the ECU adjusts the following components (ECU outputs):

- Fuel pump relay
- B+ latch relay
- Oxygen sensor heater relay
- Air conditioning clutch relay
- Fuel injectors
- Idle speed stepper motor
- EGR valve solenoid
- Ignition control module
- Shift indicator light (manual trans. only)

BATTERY VOLTAGE—ECU INPUT

The battery voltage input to the ECU is used to ensure that proper voltage is applied to the fuel injector. The ECU varies the injector pulse width to compensate for battery voltage fluctuations and their effects on injector opening time.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—ECU INPUT

The MAP sensor reacts to absolute pressure in the intake manifold and provides an input voltage to the ECU. As engine load changes manifold pressure varies, causing the MAP sensors resistance to change. The change in MAP sensor resistance results in a different input voltage to the ECU. The input voltage level supplies the ECU with information relating to ambient barometric pressure during engine start-up (cranking) and to engine load while the engine is running. The ECU uses this information to adjust the air-fuel mixture accordingly.

The MAP sensor is mounted underhood on the dash panel and is connected to the throttle body with a vacuum hose (Fig. 1).

COOLANT TEMPERATURE SENSOR—ECU INPUT

The coolant temperature sensor is installed in the engine water jacket on the left side of the engine (Fig. 2). It provides an input voltage to the ECU. As coolant temperature varies the Coolant Temperature Sensors resistance changes resulting in a different input voltage to the ECU. Based on this input the ECU will:

- Adjust fuel injector pulse width. Colder coolant temperatures will result in longer injector pulse width and richer air-fuel mixtures.
- Compensate for fuel condensation in the intake manifold.
- Control engine warm-up idle speed.
- Increase ignition advance when the coolant is cold.
- Energize the EGR valve solenoid thus preventing the flow of vacuum to the EGR valve.

MANIFOLD AIR TEMPERATURE (MAT) SENSOR—ECU INPUT

The Manifold Air Temperature (MAT) sensor is installed in the intake manifold with sensor element extending into the air stream (Fig. 3). The MAT sensor provides an input voltage to the ECU. As the temperature of the air stream in the manifold varies, the MAT sensors resistance changes resulting in a different input voltage to the ECU.

HEATED OXYGEN SENSOR (O_2 SENSOR)

The oxygen sensor is located in the exhaust manifold and provides an input voltage to the ECU relating the

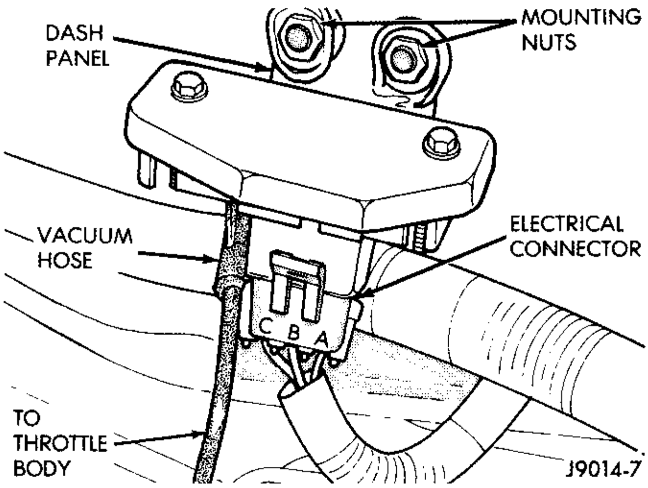


Fig. 1 MAP Sensor

oxygen content of the exhaust gas (Fig. 4). The ECU uses this information to vary the air-fuel ratio.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner and to remain in closed loop operation during periods of extended idle. Refer to Modes of Operation for an explanation of OPEN and CLOSED LOOP operation.

Voltage is supplied to the Oxygen sensor heater through the oxygen sensor heater relay.

SPEED SENSOR (CRANKSHAFT POSITION SENSOR—CPS)—ECU INPUT

The engine speed sensor, attached to the flywheel/drive plate housing, provides an input signal to the ECU relating to crankshaft angle (position) (Fig. 5). The ECU converts the rate of change of crankshaft angle into engine RPM and the crankshaft angle to piston position. The speed sensor senses TDC, BDC and engine speed by detecting the flywheel teeth as they pass during engine operation. The speed sensor is non-adjustable.

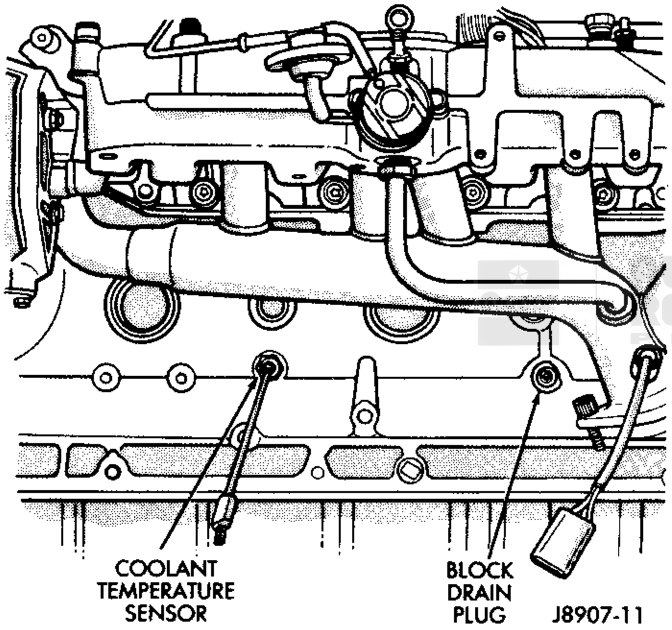


Fig. 2 Coolant Temperature Sensor

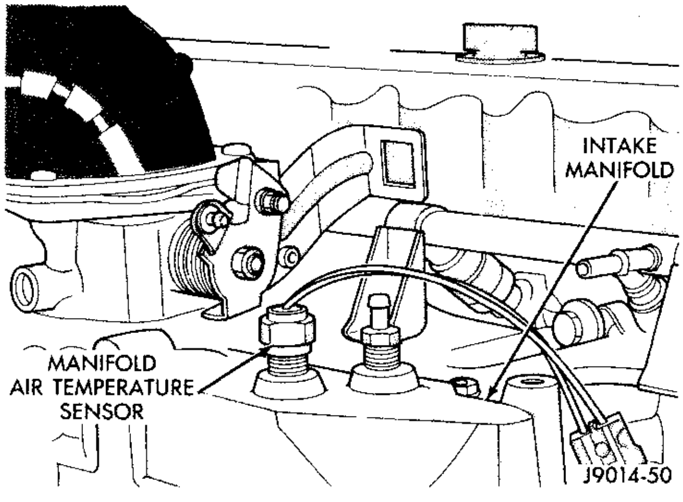


Fig. 3 Manifold Air Temperature Sensor

The flywheel has three trigger notches, 120° apart. There are 20 small teeth between each trigger notch. Each large trigger notch is located 12 small teeth before each Top Dead Center (TDC) position of the corresponding pistons (Fig. 6).

When a tooth and notch pass the magnet core of the speed sensor, a voltage spike is induced in the sensor pick-up coil winding (Fig. 7). These voltage spikes allow the ECU to count the teeth as they pass the sensor.

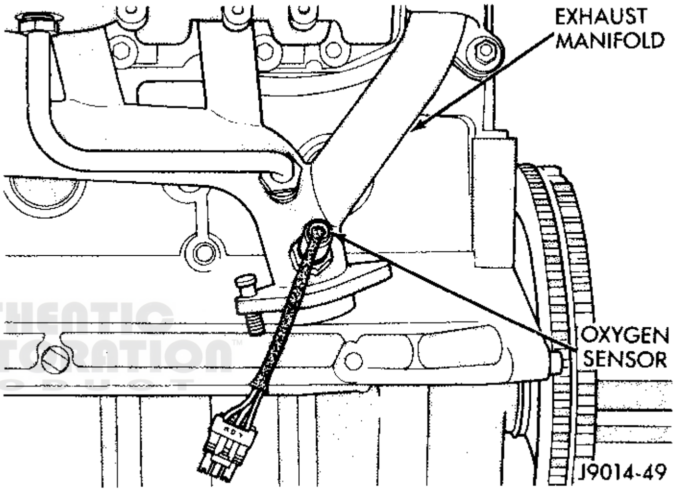


Fig. 4 Heated Oxygen Sensor

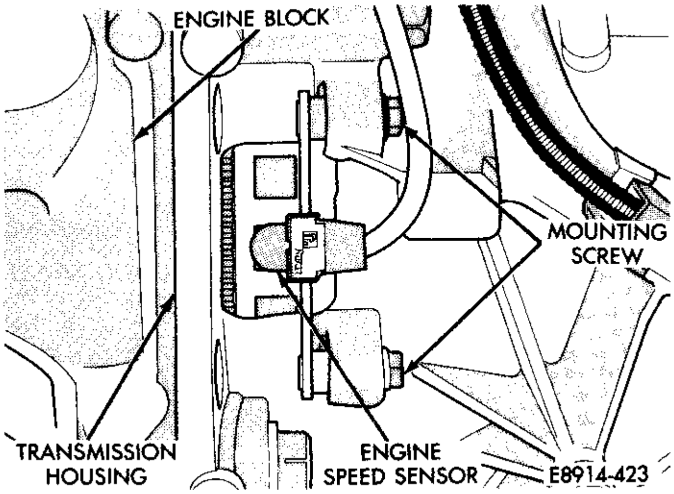


Fig. 5 Engine Speed Sensor

When a trigger notch passes the speed sensor there is a longer than usual delay between voltage spikes. This longer delay tells the ECU that a piston will be at the TDC position 12 voltage spikes later. The ECU uses information from the speed sensor to control spark timing and fuel injection timing for each cylinder.

The longer voltage spike indicates to the ECU that a piston will soon be at the TDC position, 12 teeth later. The ignition timing for the particular cylinder is either advanced or retarded as necessary by the ECU according to sensor inputs. The ECU also starts calculating fuel requirements and begins fuel injection.

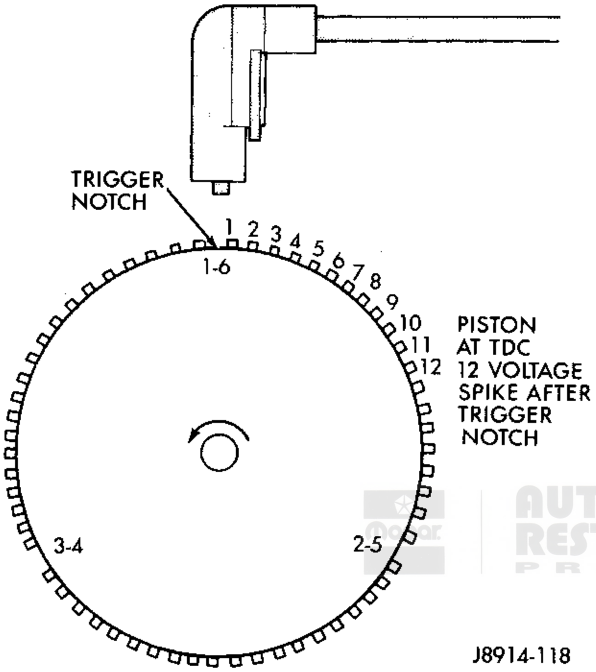


Fig. 6 Engine Speed Sensor, Trigger Notches and TDC Position

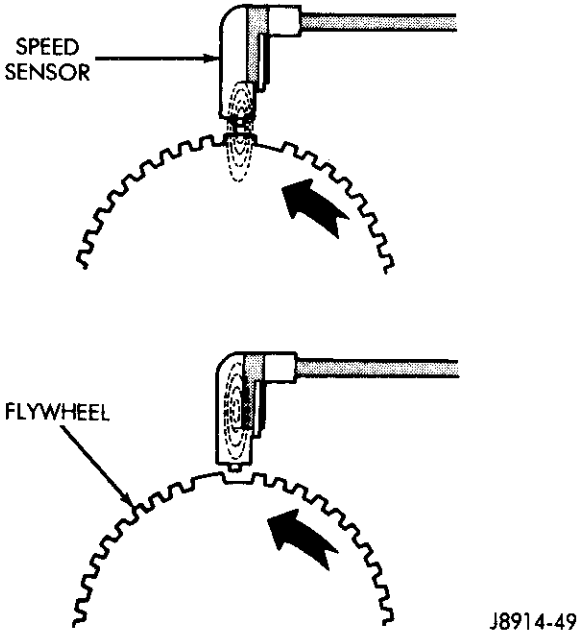


Fig. 7 Engine Speed Sensor Operation

THROTTLE POSITION SENSOR (TPS)—ECU INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle valve shaft. The sensor is a variable resistor that provides the ECU with an input voltage that represents throttle valve position. Input voltage to the ECU from the TPS varies in an approximate range of from 1 volt at minimum throttle opening (idle) to 5 volts at wide open throttle. The ECU uses TPS input voltage to determine current engine operating conditions.

There are two different Throttle Position Sensors, one used with automatic transmissions (Fig. 8) and one used with manual transmissions (Fig. 9). The TPS used with automatic transmissions has two integral wire harness connectors (one four pin connector and one three pin connector) that plug into the engine wire harness. The four pin connector supplies input to the ECU while the three pin connector supplies input to the Transmission Control Unit. The TPS used with manual transmissions has an integral connector. The engine wire harness connects directly to the TPS.

SYNC SIGNAL—ECU INPUT

The sync signal generator is located in the distributor and references the position of pistons one and six. The sync signal works in conjunction with the engine speed sensor to provide the ECU with inputs to establish and maintain correct injector firing order.

The sync signal generator consists of a pulse ring mounted to the distributor shaft and a sync signal generator (Fig. 10). The sync signal generator is a Hall Effect switch. The pulse ring rotates 180° through the sync signal generator. When the leading edge of the pulse ring enters the sync signal generator, the change

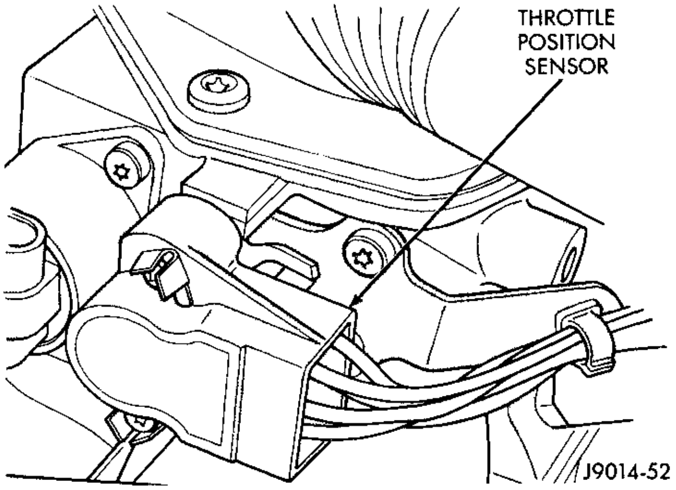


Fig. 8 Throttle Position Sensor—with Automatic Transmission

of magnetic field induces a voltage rise resulting in a sync signal of 5 volts. This indicates to the ECU that the piston number one will be the next piston at TDC. When the trailing edge of the pulse ring leaves the sync signal generator, the change of the magnetic field causes the sync signal voltage to drop to 0 volts. This indicates to the ECU that piston number six will be the next piston at TDC.

The pulse ring rotates through the sync signal generator for 180°. When the leading edge of the pulse ring enters the sync signal generator, the magnetic field becomes stronger. This indicates the position of piston number one to the ECU. When the trailing edge of the pulse ring leaves the sync signal generator the magnetic field becomes weaker. This indicates to the ECU the position of piston number six (Fig. 11).

The sync signal input and speed sensor input allow the ECU to establish the necessary reference point to synchronize injection.

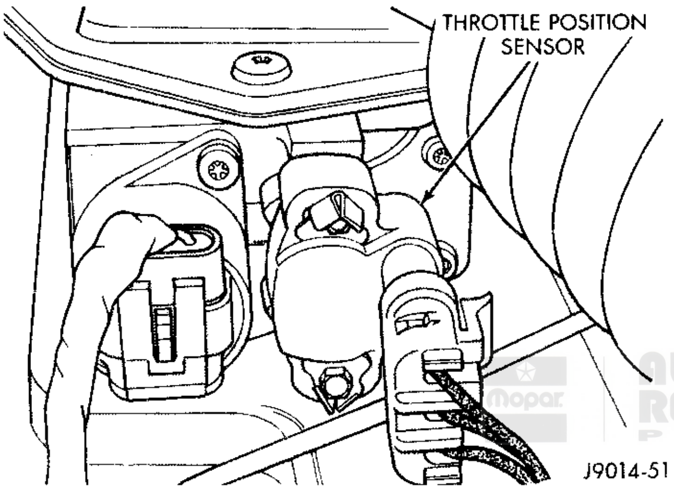


Fig. 9 Throttle Position Sensor—with Manual Transmission

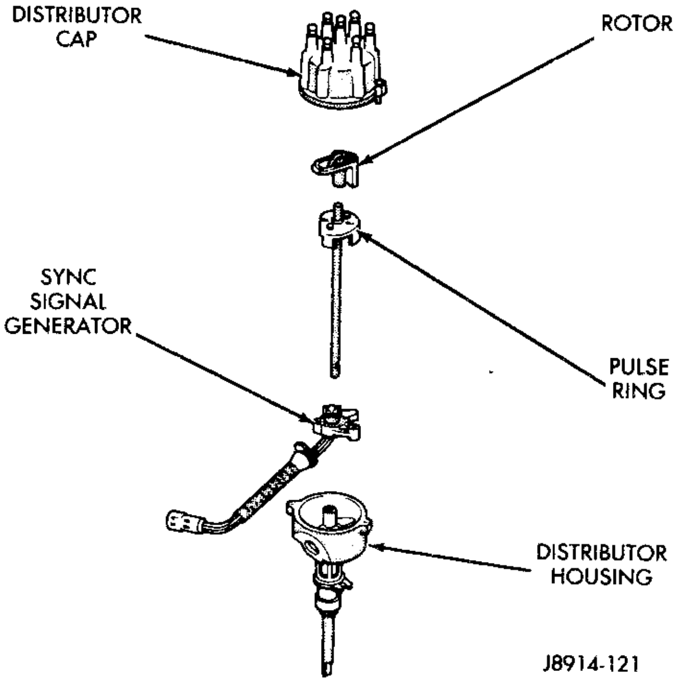


Fig. 10 Sync Signal Generator and Pulse Ring

AIR CONDITIONING CONTROLS—ECU INPUT

Air Conditioning Select Signal

When the air conditioning switch is placed in the on position an input signal is sent to the ECU informing it that the A/C has been selected. The ECU uses this information to determine correct engine idle speed.

Air Conditioning Request Signal

Once air conditioning has been selected, the A/C request signal provides information to the ECU from the evaporator switch indicating that the evaporator temperature is in the proper range for air conditioning application. The ECU uses this input to cycle the air conditioning compressor clutch and to determine correct idle speed stepper motor position.

NEUTRAL SAFETY SWITCH—ECU INPUT

On vehicles equipped with automatic transmissions, a gear selection indicator signal is sent to the ECU from the neutral safety switch (Fig. 12). When the transmission is in a drive range the ECU will adjust engine idle speed to compensate for increased engine load.

KNOCK SENSOR—ECU INPUT

The knock sensor is located on the lower left side of the engine cylinder block just above the oil pan (Fig. 13).

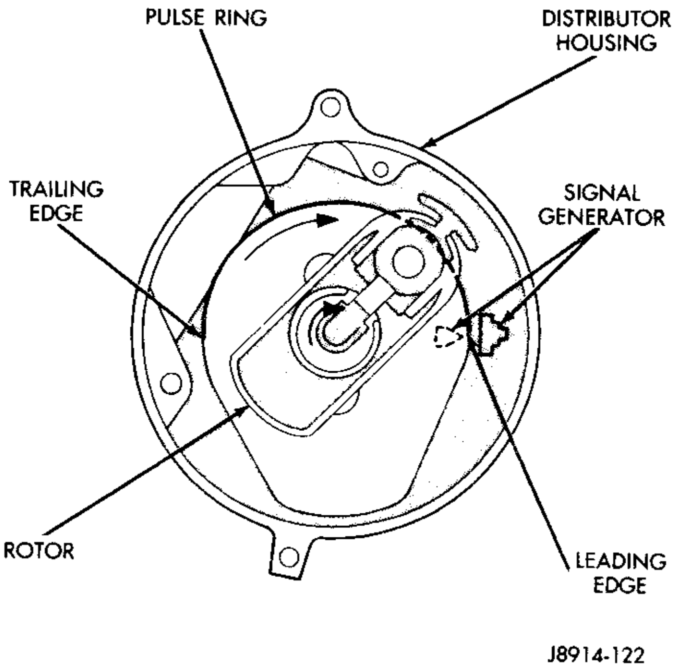


Fig. 11 Sync Signal Generator Operation

The knock sensor provides an input to the ECU that indicates detonation (knock) during engine operation. When detonation (knock) occurs, the ECU retards the ignition advance to eliminate the detonation (knock) at the applicable cylinder(s).

FUEL PUMP RELAY—ECU OUTPUT

The fuel pump relay is an electro-mechanical switch. The relay is located on the right inner fender panel. Battery voltage is applied to the relay from the ignition switch and is energized when a ground is provided by the ECU. When the relay is energized, voltage is applied to the fuel pump through the fuel pump ballast resistor. **During engine start up (key in start position) and wide open throttle conditions the fuel pump relay and fuel pump ballast resistor are bypassed. During start up battery voltage is supplied to the fuel pump through the starter relay, during wide open throttle conditions battery voltage is supplied to the fuel pump through the oxygen sensor heater relay.**

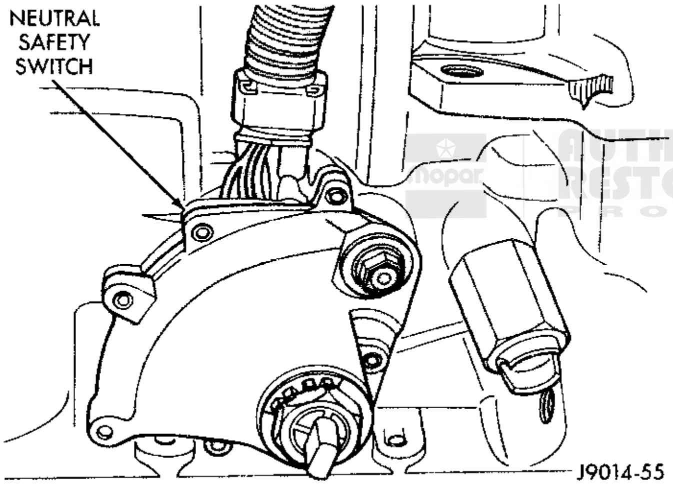


Fig. 12 Neutral Safety Switch

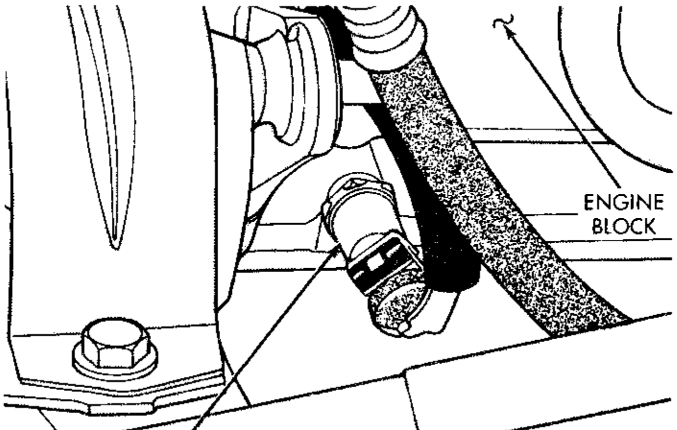


Fig. 13 Knock Sensor

B+ LATCH RELAY—ECU OUTPUT

The B+ latch relay is located on the right inner fender panel (Fig. 14). The relay is energized by the ECU for 3 to 5 seconds after the key has been turned off. The time delay allows the ECU to reposition the idle speed stepper motor to a programmed position for the next start up.

OXYGEN (O_2) SENSOR HEATER RELAY—ECU OUTPUT

The O_2 heater relay is normally closed, which then supplies voltage to the O_2 sensor heater under warm-up and idle conditions. The oxygen sensor relay is located on the right inner fender panel (Fig. 14).

The O_2 heater relay is controlled by the ECU. When the speed sensor and the MAP sensor reach a predetermined input, telling the ECU that under this condition the O_2 sensor will stay heated by the exhaust heat, the ECU can open the O_2 sensor heater relay which will stop the voltage to the heater. The ECU controls the O_2 sensor heater relay by opening and closing the relays' ground path.

When the O_2 sensor heater is shutoff, the relay contacts bypass the fuel pump ballast resistor. This is occurs normally in the high load, wide open throttle positions.

AIR CONDITIONING CLUTCH RELAY—ECU OUTPUT

The ECU controls the air conditioning compressor clutch through the A/C clutch relay. When the ECU receives a request for air conditioning from the A/C evaporator switch it will adjust idle speed stepper motor position to increase idle speed and then activate the A/C clutch through the A/C clutch relay. The ECU adjusts idle speed stepper motor position to compensate for in-

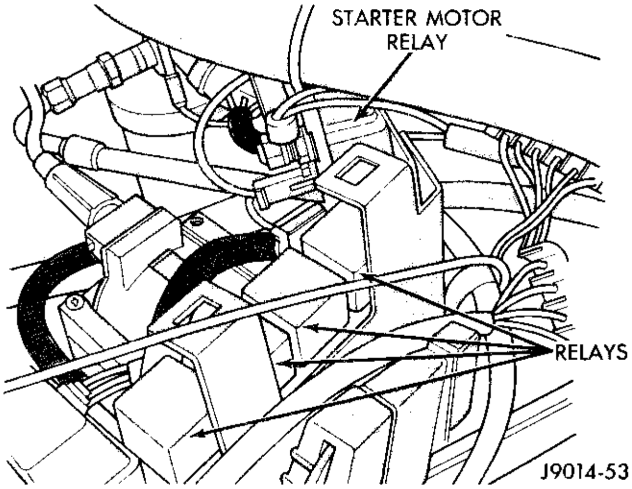


Fig. 14 Fuel Pump Relay, Oxygen Sensor Heater Relay, B+ Latch Relay, A/C Clutch Relay

creased engine load from the A/C compressor. The A/C clutch relay is located on the right inner fender panel (Fig. 14).

FUEL INJECTORS—ECU OUTPUT

There is one injector per cylinder. The injectors are attached to the fuel rail and the nozzle ends are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head (Fig. 15). The injectors are electrically operated and exclusively controlled by the ECU. Each injector is connected to a permanent ground. Battery voltage is supplied to the injectors through the ECU. The ECU controls injector pulse width. The ECU determines injector pulse width based on various inputs.

IDLE SPEED STEPPER MOTOR—ECU OUTPUT

The idle speed stepper motor is mounted on the throttle body and is controlled by the ECU (Fig. 16).

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle plate is closed). The idle speed stepper motor pintle protrudes into the air bypass passage and regulates air flow through it (Fig. 17). Based on various sensor inputs, the ECU adjusts engine idle speed by moving the stepper motor pintle in and out of the bypass passage.

EGR VALVE SOLENOID—ECU OUTPUT

Vacuum for the EGR valve function is controlled by the EGR valve solenoid. The solenoid is mounted to the left inner fender panel behind the fuel pump ballast resistor (Fig. 18).

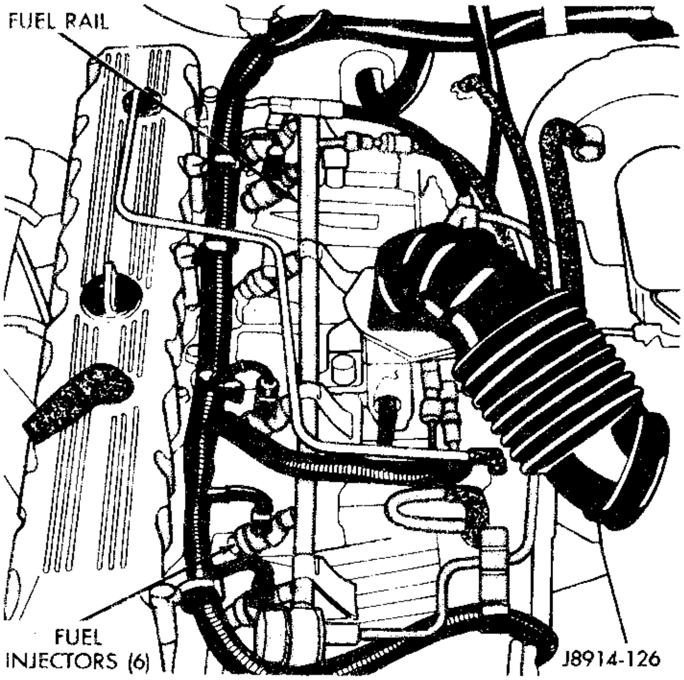


Fig. 15 Fuel Injectors

When the solenoid is energized by the ECU, it prevents vacuum from reaching the EGR valve transducer and EGR valve. The solenoid is energized during engine warm-up, closed throttle (idle), wide open throttle and rapid acceleration/deceleration. **If the solenoid wire connector is disconnected, the EGR valve function will be operational at all times.**

IGNITION CONTROL MODULE—ECU OUTPUT

The ignition control module is mounted to the ignition coil (Fig. 19). Based on control system inputs, the ECU triggers the ignition coil via the ignition control module. The ECU is able to advance or retard ignition timing by controlling the ignition coil through the ignition control module.

SHIFT INDICATOR LIGHT—ECU OUTPUT

Vehicles equipped with manual transmissions have an optional Up-Shift indicator lamp. The lamp is controlled by the ECU. The lamp illuminates to indicate when the driver should shift to the next highest gear for

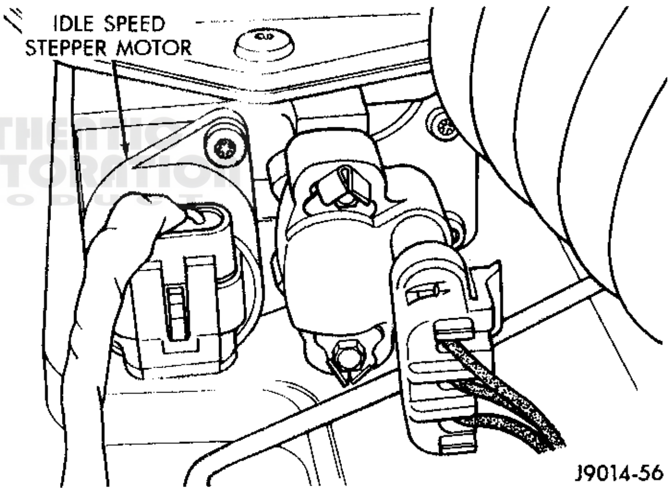


Fig. 16 Idle Speed Stepper Motor

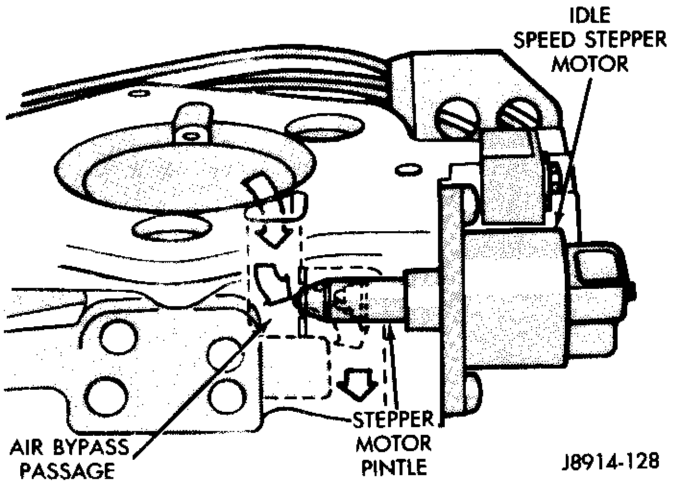


Fig. 17 Throttle Body Air Bypass Passage

best fuel economy. The lamp is located on the left side of the instrument cluster (Fig. 20). The ECU will turn the lamp OFF after 3 to 5 seconds if the shift of gears is not performed. The shift light will remain off until the vehicle stops accelerating and is brought back to the range of shift light operation.

The indicator lamp is normally illuminated when the ignition switch is turned ON and it is turned OFF when the engine is started up.

The lamp will be illuminated during engine operation according to engine speed and load.

THROTTLE BODY

Filtered air from the air cleaner enters the intake manifold through the throttle body. Fuel does not enter the intake manifold through the throttle body, fuel is sprayed into the manifold by the fuel injectors. The throttle body, which is mounted on the intake manifold, contains an air bypass passage that is used to supply air for idle conditions, and a throttle valve for above idle conditions (Fig. 21).

The throttle position sensor and idle speed stepper motor are attached to the throttle body. The accelerator cable is connected to the throttle valve through a bell-crank and linkage mounted to the intake manifold.

There are different throttle bodies for automatic transmission and manual transmission equipped vehicles. The throttle valve is not controlled by the ECU.

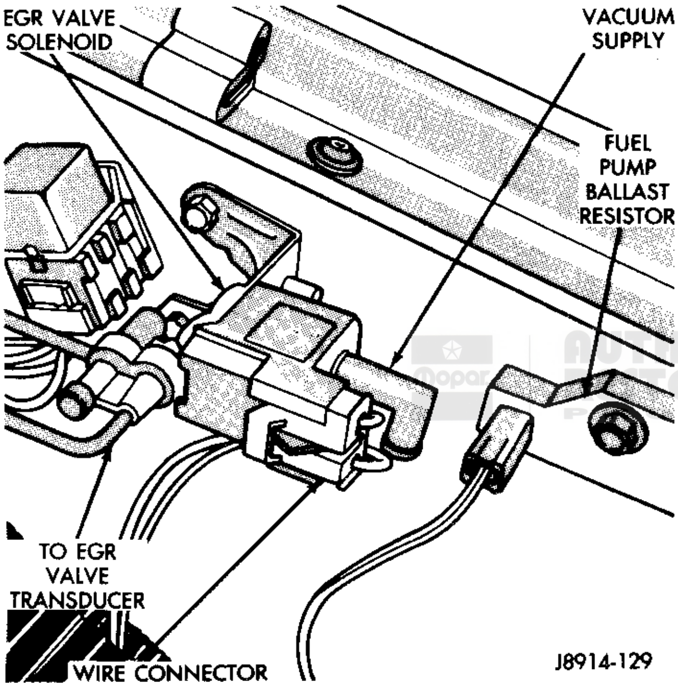


Fig. 18 EGR Valve Solenoid—ECU OUTPUT

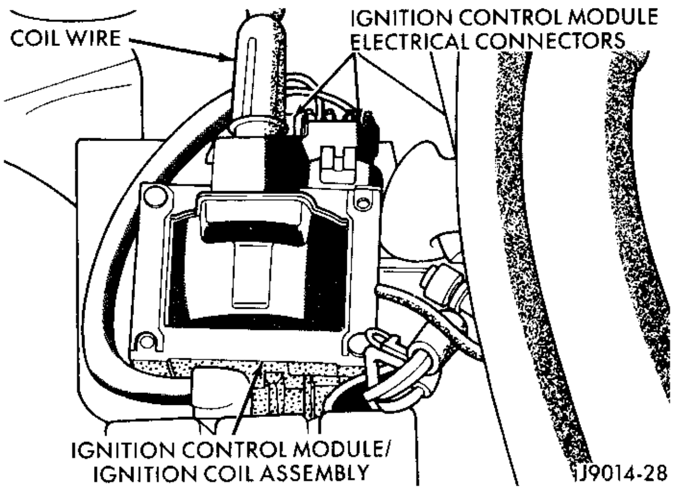


Fig. 19 Ignition Control Module

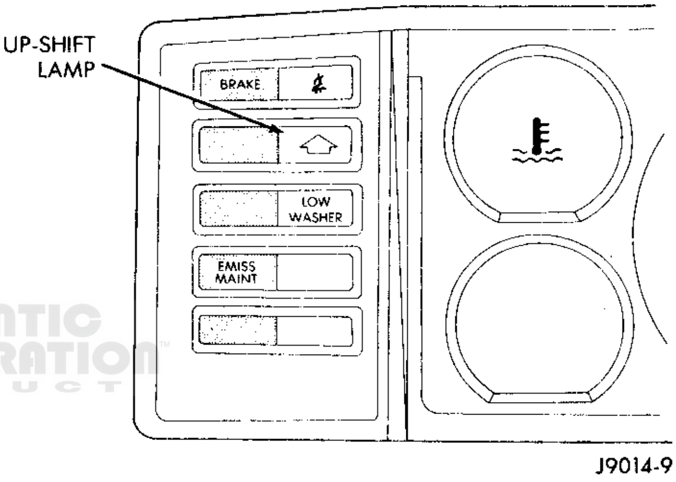


Fig. 20 Up-Shift Indicator Lamp

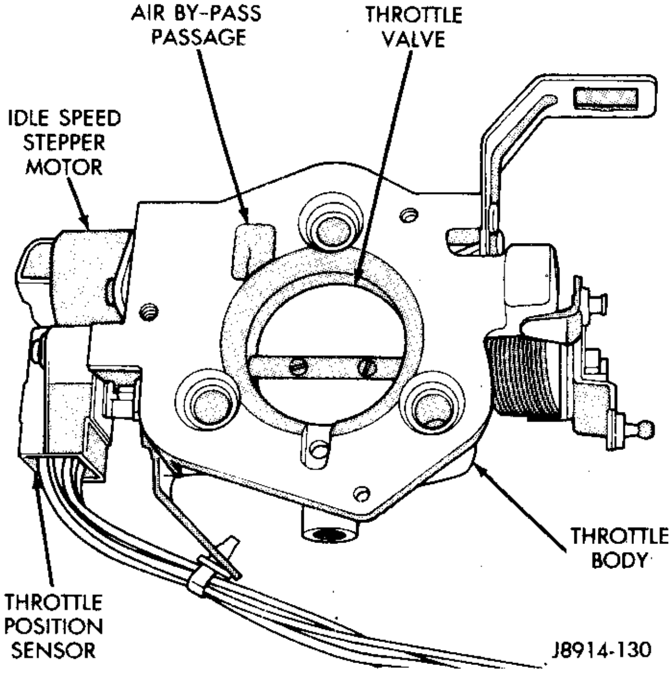


Fig. 21 MPI Throttle Body—Typical

FUEL RAIL

The fuel rail supplies fuel to the injectors and is mounted to the intake manifold (Fig. 22). The fuel pressure regulator is attached to the rail and the fuel pressure test port is integral with the rail. The fuel rail is not repairable.

FUEL PRESSURE REGULATOR

The fuel pressure regulator used with the MPI fuel system is a vacuum balanced, nonadjustable type. The regulator is mounted on the output end of the fuel rail and is connected to intake manifold vacuum (Fig. 23).

The regulator is calibrated to maintain fuel system pressure at approximately 214 kPa (31 psi) with vacuum applied while the engine is at idle. Fuel pressure will be 55-69 kPa (8-10 psi) higher if vacuum is not applied to the regulator.

The pressure regulator contains a diaphragm, calibrated spring and a fuel return valve (Fig. 24). Fuel pressure operates on one side of the regulator while spring pressure and intake manifold vacuum operate on the other side. Spring pressure on the top side of the diaphragm tries to force the return valve closed. Fuel pressure on the bottom side of the diaphragm, with assistance from manifold vacuum on the spring side of the diaphragm, act against the spring pressure to open the return valve. System fuel pressure is the amount of fuel pressure required to force against spring pressure and unseat the return valve.

Without vacuum applied to the spring side of the regulator, the spring is calibrated to open the fuel return outlet when the pressure differential between the fuel injectors and the intake manifold reaches approximately 269 kPa (39 psi). Since manifold vacuum varies with engine operating conditions, the amount of vacuum applied to the spring side of the diaphragm varies. For this reason fuel pressure varies depending upon intake manifold vacuum. With low vacuum, such as during wide open throttle conditions, minimal vacuum assistance is available and full spring pressure is exerted to seal the fuel outlet causing system pressure to increase. With high vacuum, such as during idle, fuel pressure on the bottom of the diaphragm is balanced by intake manifold pressure on the spring side of the diaphragm, resulting in lower system fuel pressure. The fuel pressure regulator is not controlled by the ECU.

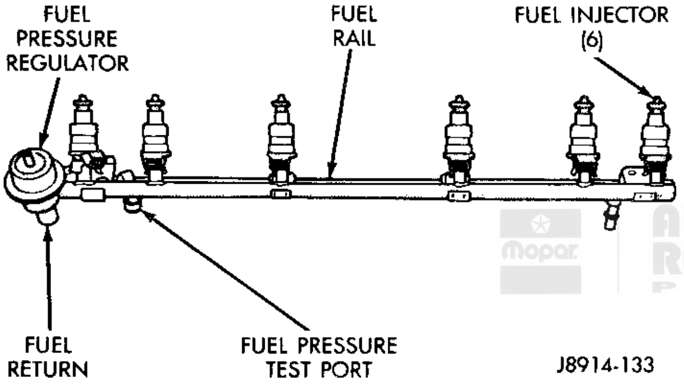


Fig. 22 Fuel Rail

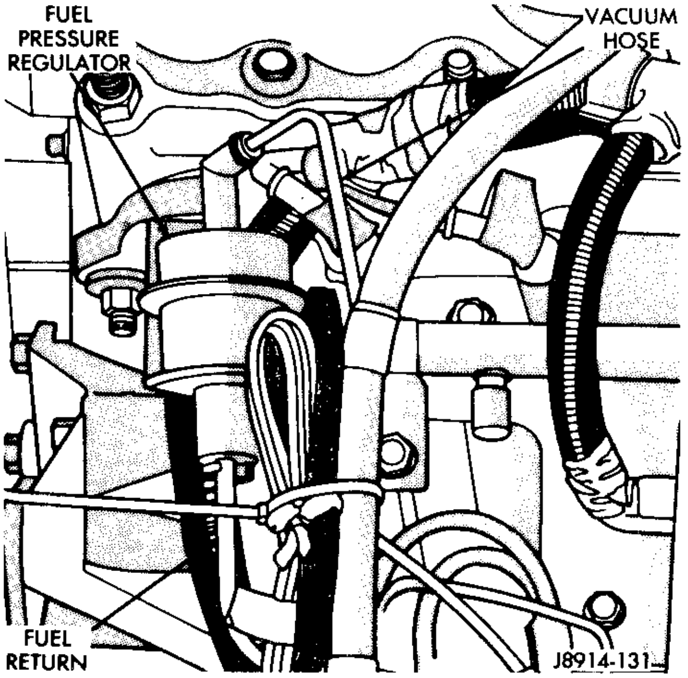


Fig. 23 MPI Fuel Pressure Regulator

MODES OF OPERATION

As input signals to the ECU change, the ECU adjusts its response to the output devices. For example, the ECU must calculate a different injector pulse width and ignition timing for idle than it does for wide open throt-

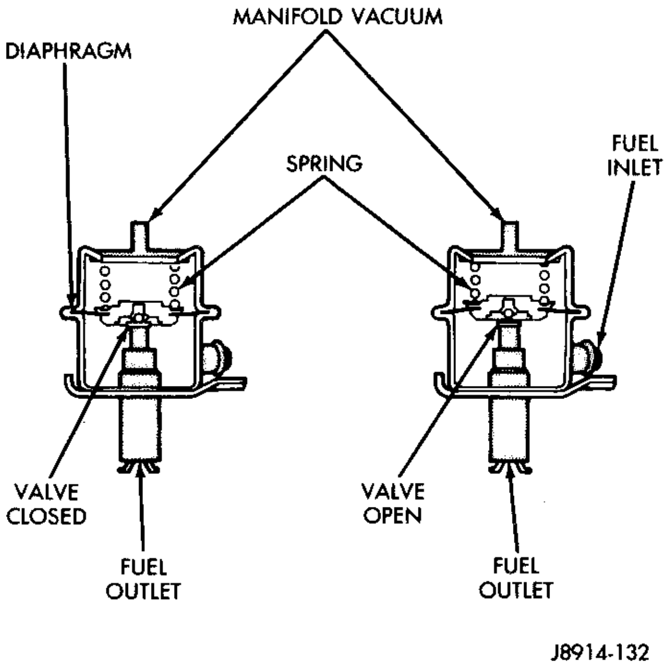


Fig. 24 Fuel Pressure Regulator Operation

tle (WOT). There are eight different modes of operation that determine how the ECU responds to the various input signals.

Modes of operation are of two different types. OPEN LOOP and CLOSED LOOP.

During OPEN LOOP modes the ECU receives input signals and responds only according to preset ECU programming. Input from the oxygen (O_2) sensor is not monitored during OPEN LOOP modes.

During CLOSED LOOP modes the ECU does monitor the oxygen (O_2) sensor input. This input indicates to the ECU whether or not the calculated injector pulse width results in the ideal air-fuel ratio of 14.7 parts air to 1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the ECU can "fine tune" the injector pulse width to achieve optimum fuel economy combined with low emission engine performance.

The MPI system has the following modes of operation:

- Ignition switch ON
- Engine start-up (crank)
- Engine warm-up
- Idle
- Cruise
- Deceleration
- Wide open throttle (WOT)
- Ignition switch OFF

The ignition switch on, engine start-up (crank), engine warm-up, deceleration, and wide open throttle modes are OPEN LOOP modes. The idle and cruise, modes, **with the engine at operating temperature** are CLOSED LOOP modes.

Ignition Switch On Mode

This is an OPEN LOOP mode. When the MPI system is activated by the ignition switch, the following actions occur:

- The system power relay is energized.
- The fuel pump is activated by the ECU.

The fuel pump will operate for approximately one second unless the engine is operating or the starter motor is engaged.

- The B+ latch relay is energized for 1 to 3 seconds
- The O_2 sensor heater element is activated (though the O_2 input is not used by the ECU to calibrate air-fuel ratio during this mode of operation).
- The EGR valve solenoid is energized by the ECU preventing EGR valve operation.
- The upshift light is illuminated (manual transmission only).

The following engine sensors are activated and begin providing input to the ECU:

- Coolant temperature
- Air temperature (MAT) sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)

Engine Start-up Mode

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

The ECU receives inputs from:

- Coolant temperature sensor
- Manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor
- Starter motor relay
- Speed sensor
- Sync signal
- Battery voltage

The fuel pump is activated by the ECU. Voltage is applied to the fuel injectors with the ECU controlling the injection sequence and injector pulse width. The ECU determines the proper ignition timing according to input received from the speed sensor. The EGR valve solenoid is energized by the ECU preventing EGR operation. If the ECU detects a wide open throttle condition it assumes that a flooding condition exists. The ECU will then discontinue injector operation until engine speed reaches approximately 400 rpm.

Engine Warm-up Mode

This is an OPEN LOOP mode. During engine warm-up the ECU receives inputs from:

- Coolant temperature sensor
- Manifold air temperature (MAT) sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Speed sensor
- Sync signal
- Battery voltage
- Neutral Safety Switch (Gear indicator signal—auto. trans. only)
- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Knock sensor

Based on these inputs the following occurs: voltage is applied to the fuel injectors with the ECU controlling the injection sequence and injector pulse width. The ECU adjusts engine idle speed through the idle speed stepper motor and ignition timing through the ignition control module. The ECU energizes the EGR valve solenoid to restrict EGR operation, and operates the A/C compressor clutch through the clutch relay if A/C has been selected by the vehicle operator and requested by the A/C thermostat. If the vehicle has a manual transmission, the upshift light is operated by the ECU.

When the engine has reached operating temperature the ECU will begin monitoring the O_2 sensor input, the system will leave the warm-up mode and go into closed loop operation.

Idle Mode

This is a CLOSED LOOP mode. At idle speed **with the engine at operating temperature,** the ECU receives inputs from:

- Coolant temperature sensor
- Manifold air temperature (MAT) sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Speed sensor
- Sync signal
- Battery voltage
- Neutral Safety Switch (Gear indicator signal auto. trans. only)
- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Knock sensor
- Oxygen sensor

Based on these inputs the following occurs: voltage is applied to the fuel injectors with the ECU controlling the injection sequence and injector pulse width (the length of injection time). The ECU monitors the O_2 sensor input and adjusts air-fuel ratio by varying injector pulse width, adjusts engine idle speed through the idle speed stepper motor, and controls ignition timing through the ignition control module. The ECU energizes the EGR valve solenoid to restrict EGR operation, operates the A/C compressor clutch through the clutch relay if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

Cruise Mode

This is a CLOSED LOOP mode. At cruising speed **with the engine at operating temperature,** the ECU receives inputs from:

- Coolant temperature sensor
- Manifold air temperature (MAT) sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Speed sensor
- Sync signal
- Battery voltage
- Gear indicator signal (auto. trans. only)
- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Knock sensor
- Oxygen sensor

Based on these inputs the following occurs: voltage is applied to the fuel injectors with the ECU controlling the injection sequence and injector pulse width. The ECU monitors the O_2 sensor input and adjusts air-fuel ratio, adjusts engine idle speed through the idle speed stepper motor, and controls ignition timing through the ignition control module. The ECU operates the A/C compressor clutch through the clutch relay if A/C has been selected by the vehicle operator and requested by the A/C thermostat, and the ECU breaks the ground path for the EGR valve solenoid allowing vacuum to reach the EGR valve transducer in anticipation of EGR operation.

Deceleration Mode

This is an OPEN LOOP mode. During hard deceleration, **when the engine is at operating temperature,** the ECU receives the following inputs.

- Coolant temperature sensor
- Manifold air temperature (MAT) sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Speed sensor
- Sync signal
- Battery voltage
- Gear indicator signal (auto. trans. only)
- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)

If the vehicle is under hard deceleration with the proper RPM and closed throttle conditions, the ECU will ignore the oxygen sensor input signal and enter a fuel cut-off strategy in which it will not supply battery voltage to the injectors. If a hard deceleration does not exist, the ECU will determine the proper injector pulse width and continue injection.

Based on the above inputs the ECU will adjust engine idle speed through the idle speed stepper motor, ignition timing through the ignition control module, and energize the EGR valve solenoid to prevent EGR operation.

Wide Open Throttle Mode

This is an OPEN LOOP mode. During wide open throttle operation the ECU receives the following inputs.

- Coolant temperature sensor
- Manifold air temperature (MAT) sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Speed sensor
- Sync signal
- Battery voltage
- Knock sensor

During wide open throttle conditions the following occurs: The ballast resistor is bypassed and battery voltage is applied to the fuel pump through the oxygen sensor heater relay. Voltage is applied to the fuel injectors with the ECU controlling the injection sequence and injector pulse width. The ECU ignores the oxygen sensor input signal and provides a predetermined amount of additional fuel by adjusting injector pulse width. The oxygen sensor heater relay is energized by the ECU causing the relay switch to open and stop power to the oxygen sensor heating element. The ECU adjusts ignition timing through the ignition control module, energizes the EGR valve solenoid to restrict EGR operation, and disengages the A/C compressor clutch through the clutch relay for approximately 15 seconds. If the vehicle has a manual transmission, the upshift light is operated by the ECU.

Ignition Switch Off Mode

When the ignition switch is turned to the OFF position, the ECU stops supplying power to the injectors, ignition system power is shut off, the fuel pump relay ground path is broken by the ECU and fuel pump operation stops, the ECU positions the idle speed stepper motor in anticipation of the next start-up and de-energizes the B+ latch relay.

GENERAL DIAGNOSIS

Visual Inspection

A visual inspection for loose, disconnected, or improperly routed wires and hoses should be made before attempting to diagnose the fuel injection system. A visual check will help spot these faults and save unnecessary test and diagnostic time. A thorough visual inspection includes the following checks:

(1) Inspect battery cable connections (Fig. 25). They should be tight. The top of the battery and the cable connections should be free of corrosion and grime. Check the electrolyte level in the battery cells. Refer to group 8A.

(2) Inspect fuel pump relay, B+ latch relay, A/C compressor clutch relay, and oxygen sensor heater relay connections (Fig. 26). Inspect starter motor relay connections. Inspect relays for sings of physical damage and corrosion.

(3) Inspect Ignition Control Module connections. Verify that coil wire is connected to coil (Fig. 27).

(4) Verify that distributor cap is attached to distributor, that spark plug wires are connected to distributor cap and spark plugs in correct firing order, that coil wire is connected to distributor cap and coil, and that sync signal generator wire connector is connected to harness connector (Fig. 28).

(5) Verify that alternator output wire and two terminal connector are connected (Fig. 29).

(6) Verify that CCV fresh air hose is connected to cylinder head cover and air cleaner cover (Fig. 30).

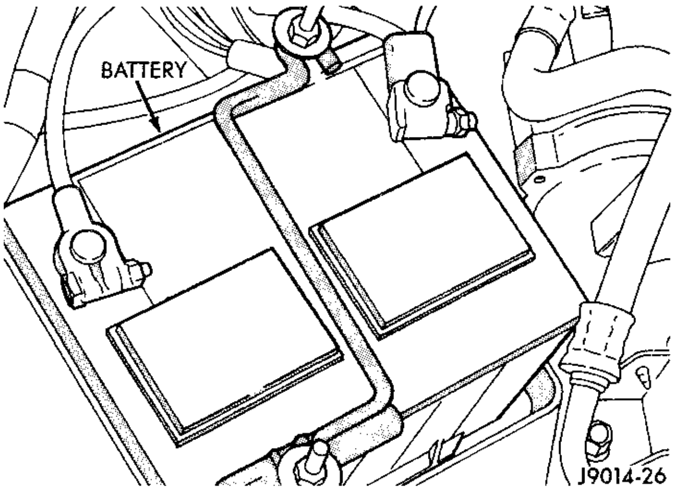


Fig. 25 Battery Cable Connections—Typical

(7) Verify that vacuum hose is connected to fuel pressure regulator, and that harness connectors are connected to fuel pump ballast resistor (Fig. 30).

(8) Verify that vacuum hoses and wire connector are connected to the EGR valve solenoid (Fig. 31).

(9) Verify that main vacuum harness connector on intake manifold is completely closed and vacuum is not leaking (Fig. 32).

(10) Verify that hose connections to all ports of vacuum fittings on intake manifold are tight and not leaking (Fig. 32).

(11) If equipped with a vacuum brake booster, verify that brake vacuum booster hose is connected to fitting on intake manifold and to brake vacuum booster (Fig. 32).

(12) Verify that auxiliary cooling fan wire connector is connected to harness connector (Fig. 33).

(13) Verify that preheated air hose is connected to air cleaner inlet door and to exhaust manifold heat stove (Fig. 33).

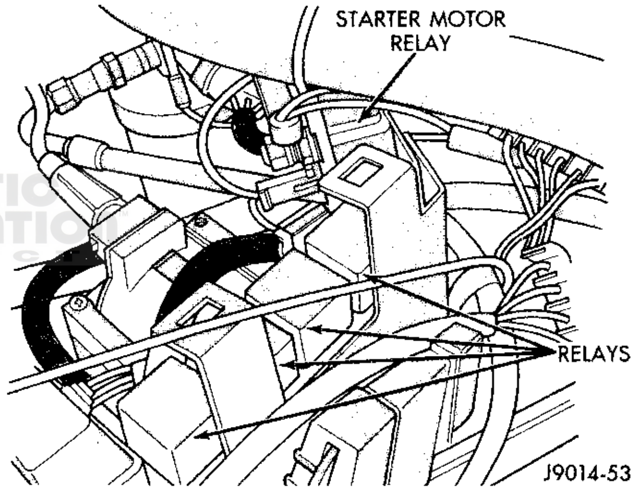


Fig. 26 Fuel Pump Relay, Oxygen Sensor Heater Relay, B+ Latch Relay, A/C Compressor Clutch Relay

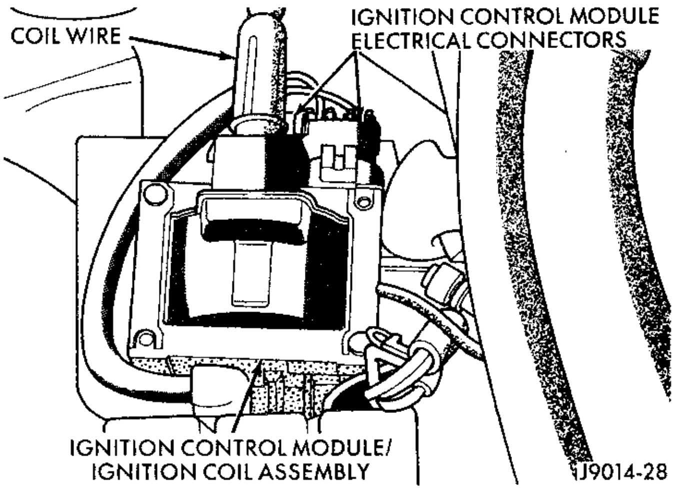


Fig. 27 Ignition Control Module Connections

(14) Verify that thermal air cleaner (TAC) vacuum hoses are connected to vacuum switch in air cleaner cover and to diaphragm in inlet door (Fig. 33).

(15) Inspect radiator grille area for a possible clogged bug screen restricting air flow to the air cleaner. Inspect the air cleaner inlet door (behind left front headlight) for blockage.

(16) Verify that MAT sensor wire connector is connected to harness connector (Fig. 34).

(17) Verify that EGR Valve transducer inlet vacuum hose, transducer to EGR valve vacuum hose, and transducer back pressure hose are connected and not leaking. Ensure hoses are not pinched, chaffed or deteriorated (Fig. 35).

(18) Verify complete connection of fuel return tube to return hose quick connect fitting (Fig. 36).

(19) Verify Engine ground strap connections at dash panel and rear cylinder head bolt (Fig. 36).

(20) Verify complete connection of fuel supply tube to fuel rail quick connect fitting (Fig. 36).

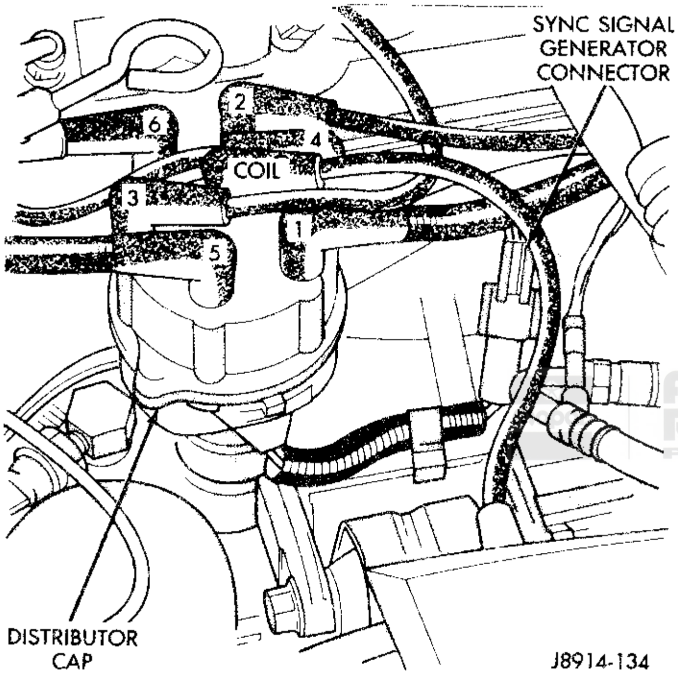


Fig. 28 Distributor Cap, Spark Plug Wires, and Sync Signal Generator Connector

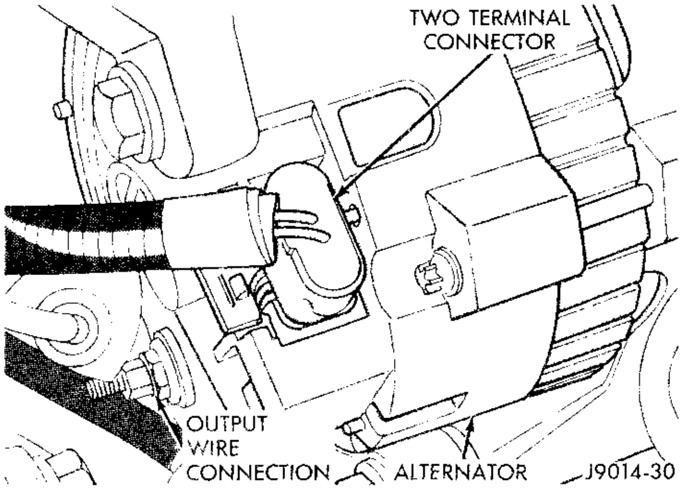


Fig. 29 Alternator Two Terminal Connector and Output Wire Connections—Typical

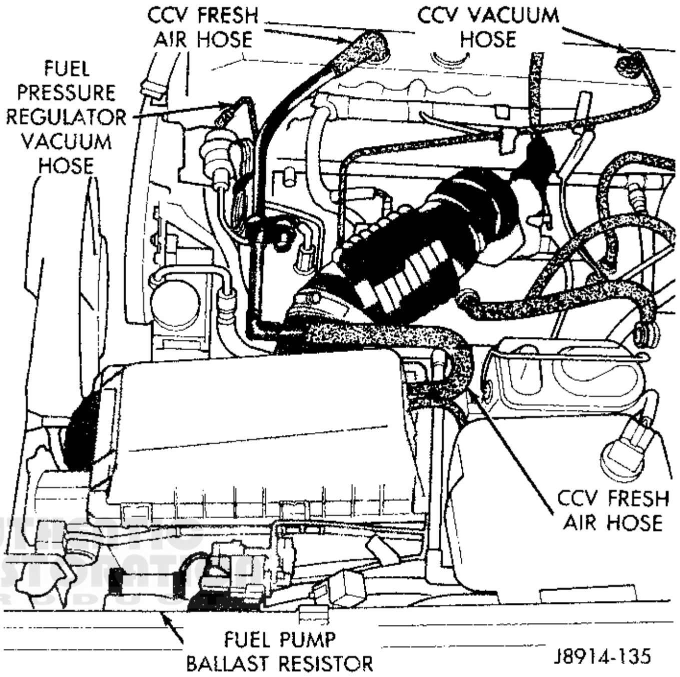


Fig. 30 Pressure Regulator Vacuum Hose, CCV Hoses, Ballast Resistor

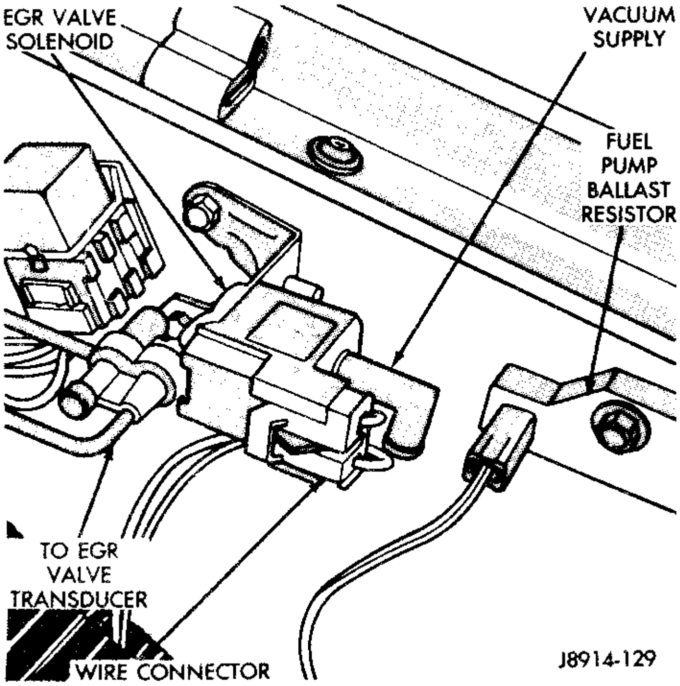


Fig. 31 EGR Valve Solenoid

(21) Verify that MAP sensor electrical connector is connected to MAP sensor (Fig. 37). Verify that vacuum hose is connected to sensor and to back of throttle body (Fig. 38).

(22) Verify that injector wire harness connectors are connected to the fuel injectors in the correct order (each harness connector is tagged with the number of its corresponding injector at the factory—Fig. 39).

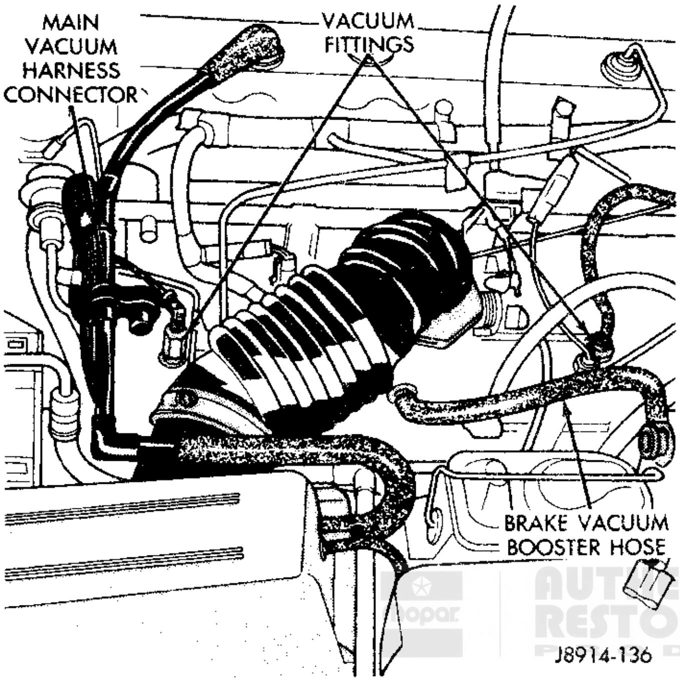


Fig. 32 Main Vacuum Harness, Intake Manifold Vacuum Fittings, Brake Vacuum Booster Hose

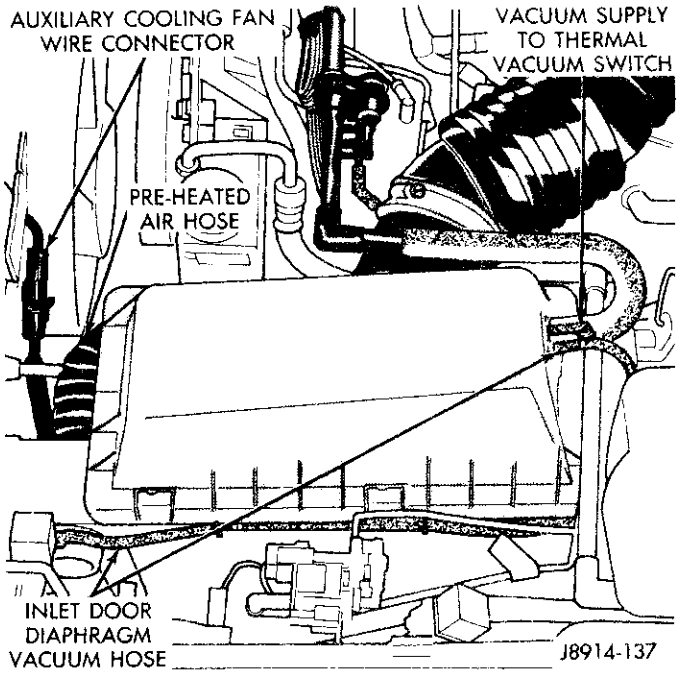


Fig. 33 Auxiliary Cooling Fan Wire Connector, TAC Hoses, Preheated Air Hose

(23) Verify that wire harness connectors are connected at idle speed stepper motor and throttle position sensor (Fig. 40, Fig. 41).

(24) Verify that wire harness connectors are connected to coolant temperature sensor and knock sensor (Fig. 42).

(25) Verify that Oxygen Sensor wire connector is connected to the sensor. Inspect sensor and connector for damage (Fig. 43).

(26) Raise and support the vehicle.

(27) Inspect for pinched or leaking fuel tubes. Inspect for pinched cracked or leaking fuel hoses.

(28) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic convertor.

(29) If equipped with automatic transmission, verify

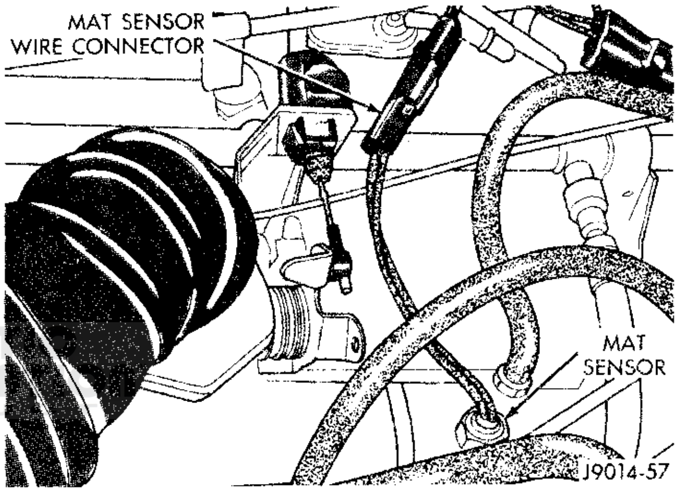


Fig. 34 MAT Sensor Wire Connector

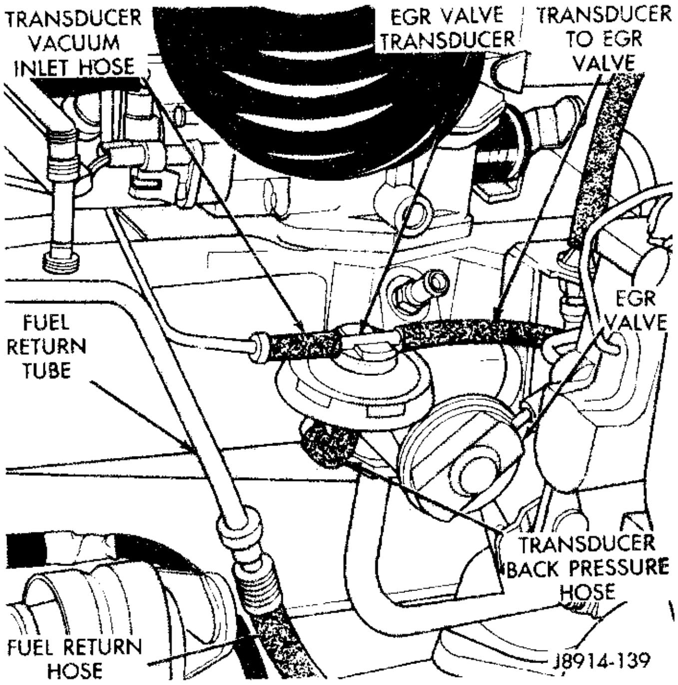


Fig. 35 EGR hoses and Fuel Return Tube

that electrical harness is connected to neutral safety switch. Refer to automatic transmission section of group 21.

(30) Verify that fuel pump/gauge sender unit wire connector is connected to harness connector.

(31) Inspect fuel hoses at fuel pump/gauge sender unit for cracks or leaks (Fig. 44).

(32) Inspect transmission convertor housing (automatic transmission) or clutch housing (manual transmission) for damage that might have damaged the timing ring on the drive plate/flywheel.

(33) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean. Inspect for chaffed wires or wires rubbing up against other components (Fig. 45).

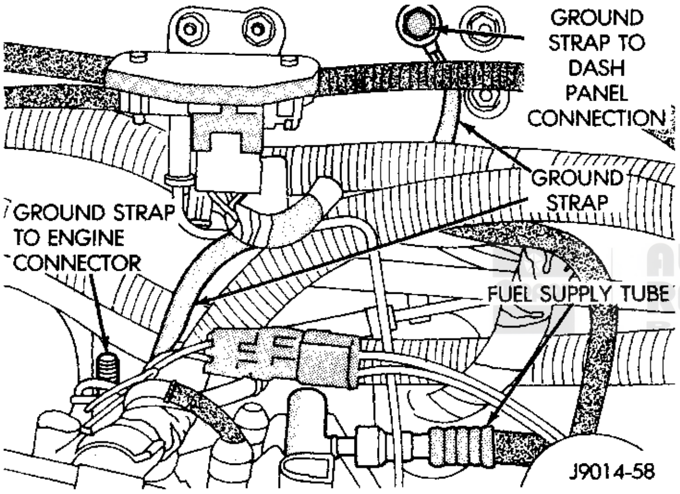


Fig. 36 Engine Ground Strap and Fuel Supply Tube

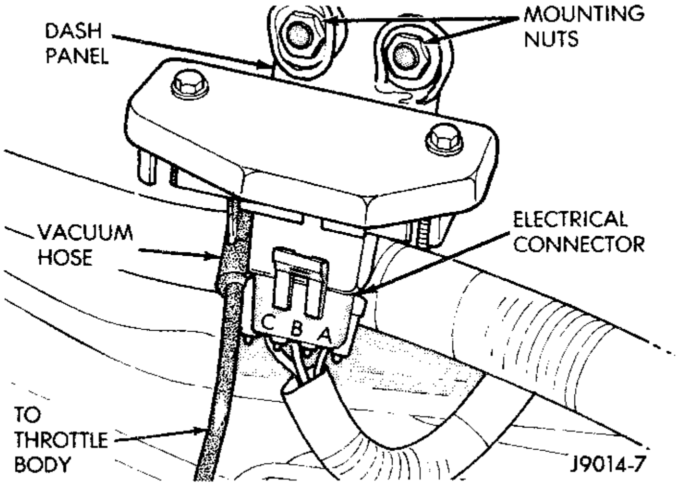


Fig. 37 MAP Sensor

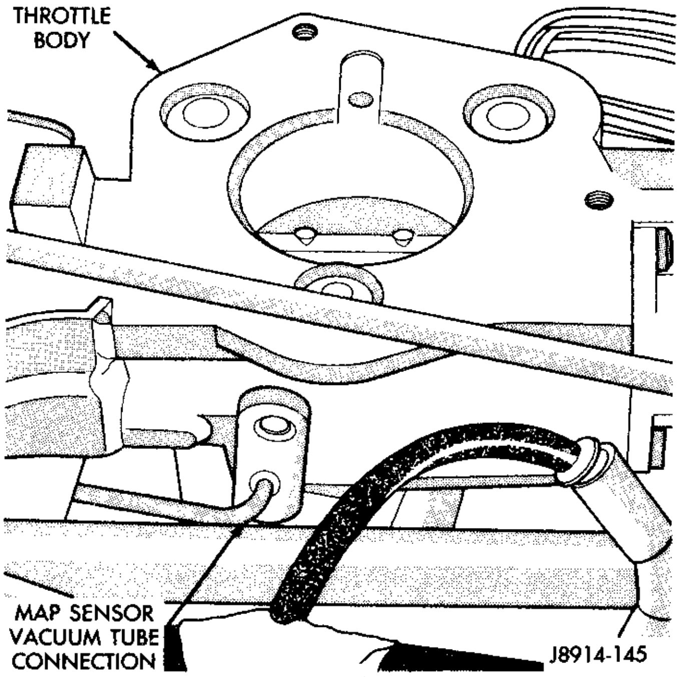


Fig. 38 MAP Sensor Vacuum Tube

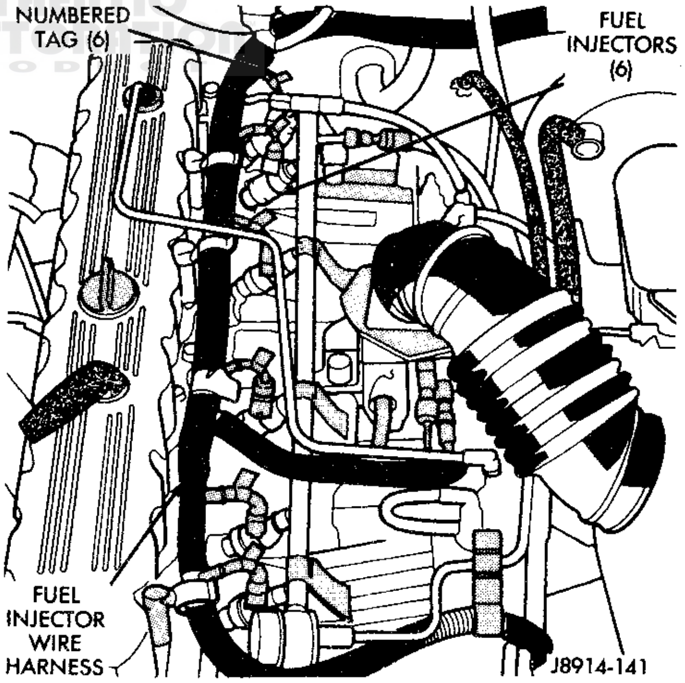


Fig. 39 Fuel Injector Wire Harness

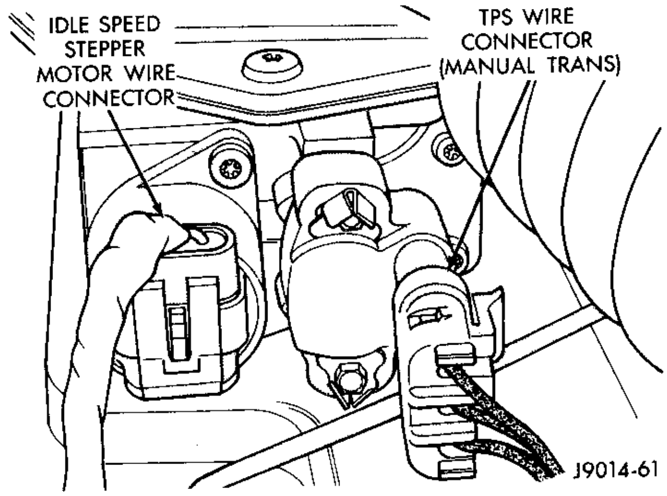


Fig. 40 Idle Speed Stepper Motor and TPS (with manual transmission)

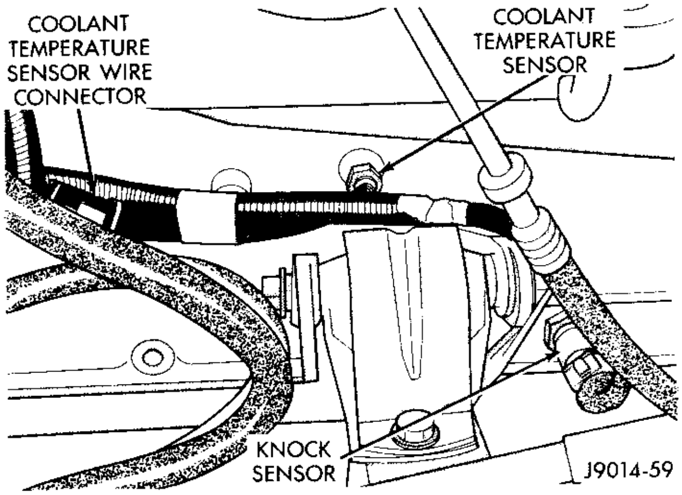


Fig. 42 Coolant Temperature Sensor and Knock Sensor

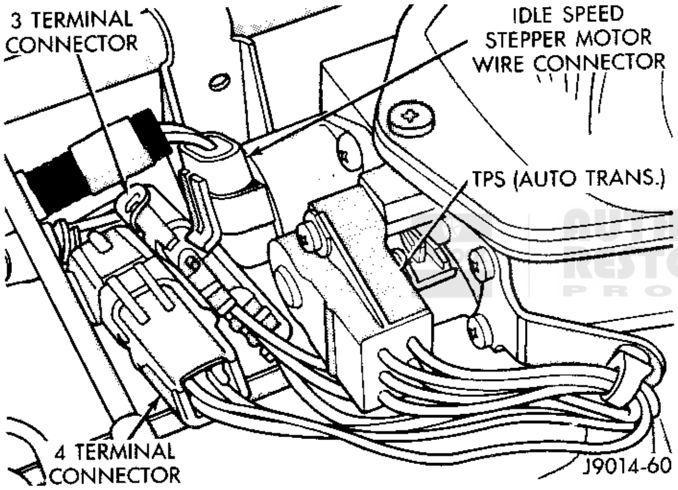


Fig. 41 Idle Speed Stepper Motor and TPS (with automatic transmission)

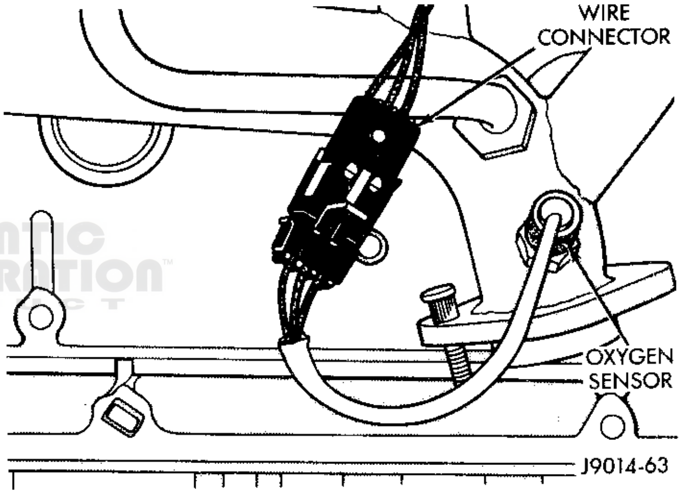


Fig. 43 Oxygen Sensor Wire Connector

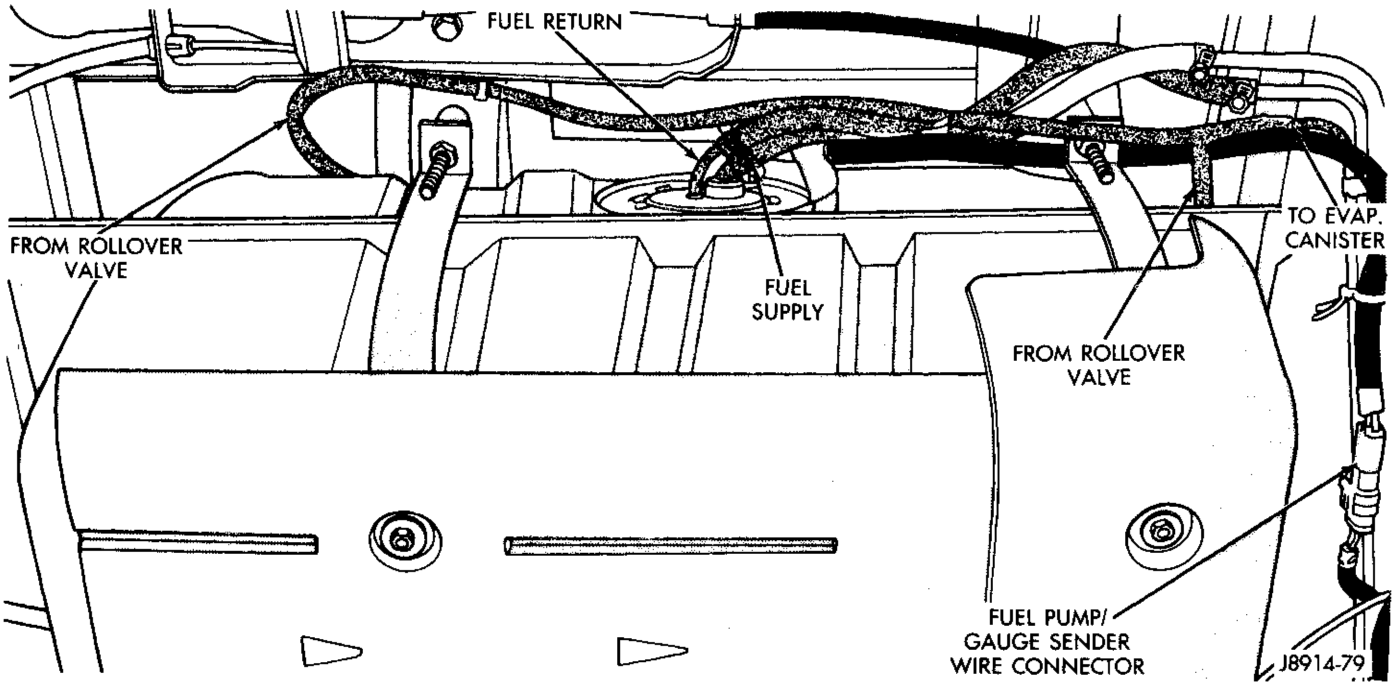


Fig. 44 Fuel Pump and/or Gauge Sender Unit Connector and Fuel Hoses—Typical

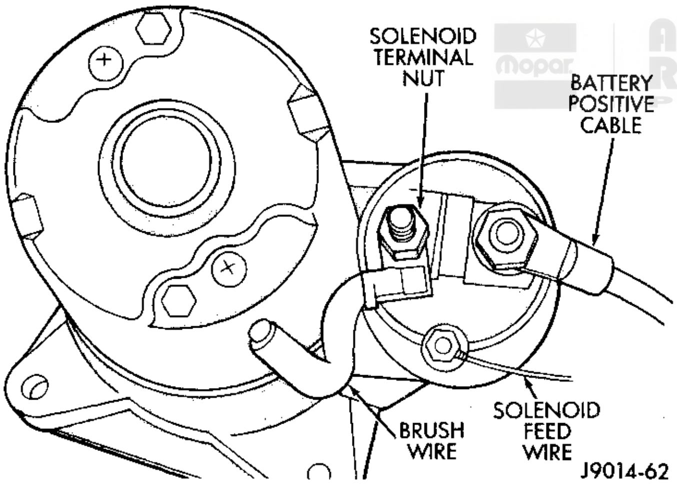
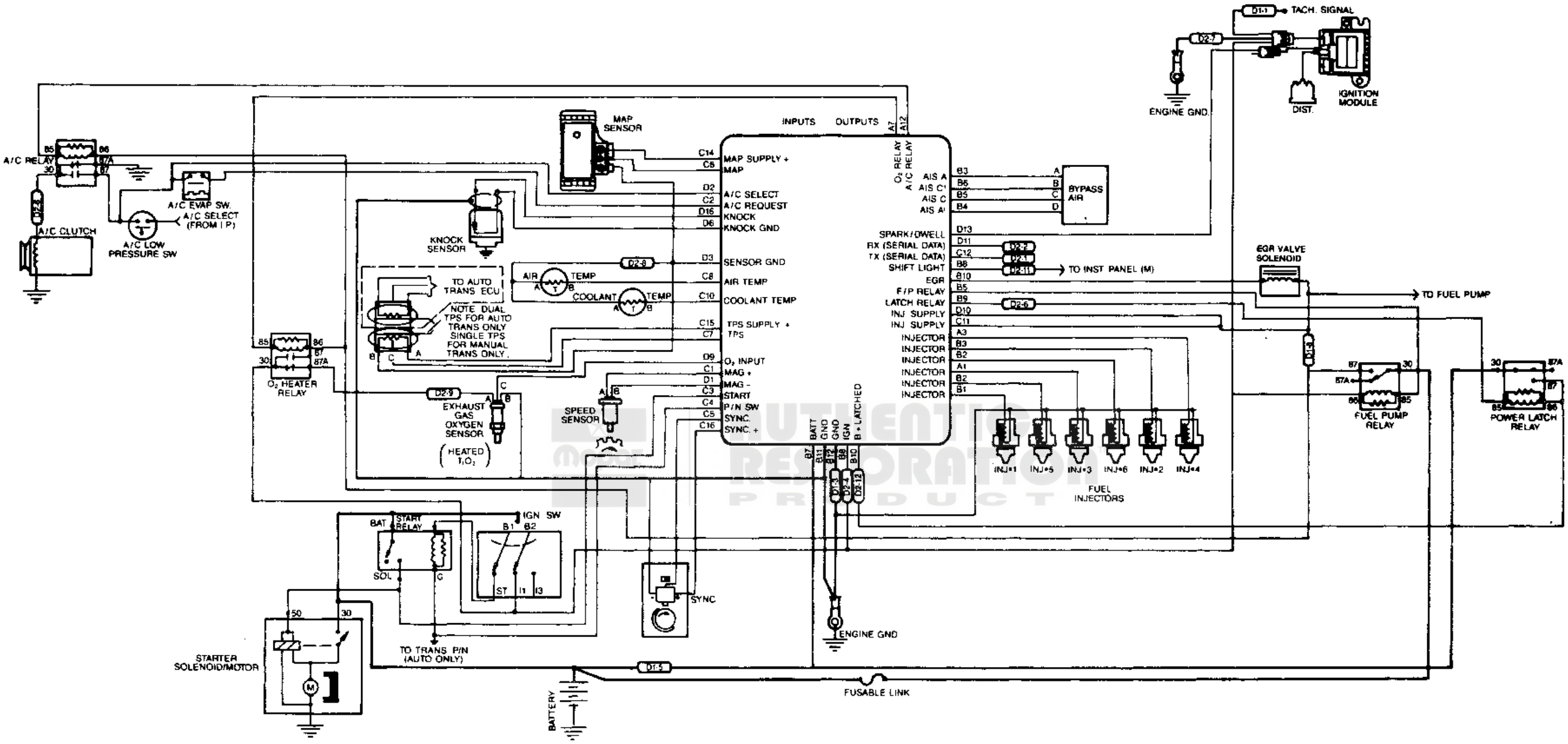


Fig. 45 Starter Solenoid Connections

MPI COMPONENT DIAGNOSTIC PROCEDURES

This section contains information for determining individual MPI system component performance. Diagnosis of ECU/Engine Control System is performed using the DRBII Service Diagnostic Tester. Refer to the tester manual for the appropriate system test procedure.

Engine Control System Schematic 4.0L MPI

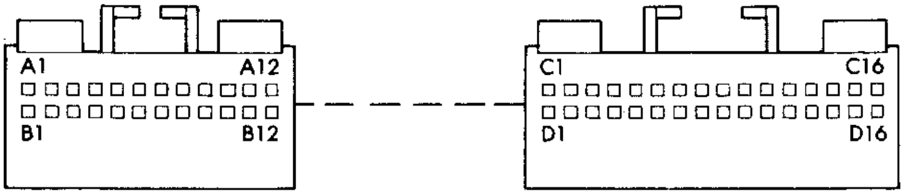


J8914-148

ECU Connector

The ECU connector used for the 4.0L MPI system is similar to the connector used in previous systems. Terminal identification and specific engine application is detailed in the ECU connector chart.

ECU CONNECTORS



A

1. INJECTOR #3
2. INJECTOR #6
3. INJECTOR #2
4. INJECTOR #4
5. FUEL PUMP RELAY
6. NOT USED
7. OXYGEN SENSOR RELAY
8. SHIFT LAMP
9. LATCH RELAY
10. EGR/EVAP. SOLENOID
11. NOT USED
12. A/C RELAY

B

1. INJECTOR #1
2. INJECTOR #5
3. AIS A
4. AIS A'
5. AIS C
6. AIS C'
7. BATTERY (+)
8. IGNITION
9. NOT USED
10. LATCHED B+
11. GROUND
12. GROUND

C

1. SPEED SENSOR (+)
2. A/C REQUEST
3. START
4. P/N SWITCH
5. SYNC.
6. MAP SENSOR
7. TPS SENSOR
8. AIR TEMPERATURE SENSOR
9. NOT USED
10. COOLANT TEMPERATURE SENSOR
11. INJECTION SUPPLY
12. TX (SERIAL DATA)
13. NOT USED
14. MAP SENSOR SUPPLY (+)
15. TPS SUPPLY (+)
16. SYNC. (+)

D

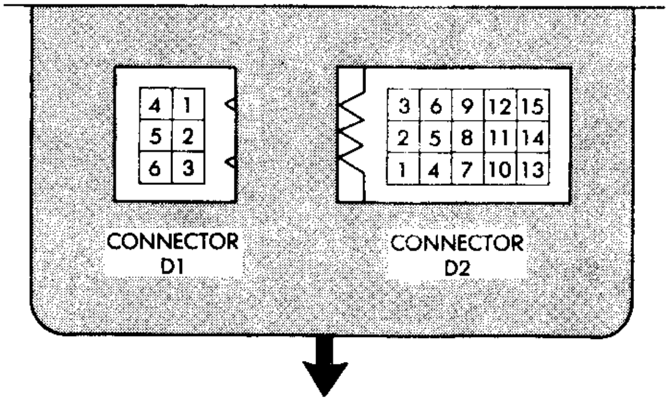
1. SPEED SENSOR (−)
2. A/C SELECT
3. SENSOR GROUND
4. NOT USED
5. NOT USED
6. NOT USED
7. NOT USED
8. KNOCK SENSOR GROUND
9. OXYGEN SENSOR INPUT
10. INJECTION SUPPLY
11. RX (SERIAL DATA)
12. NOT USED
13. SPARK/DWELL
14. NOT USED
15. NOT USED
16. KNOCK SENSOR

J8914-149

Diagnostic Connectors

The diagnostic connectors are located in the engine compartment. The connectors are protected by rubber covers. Cavity identification and specific engine function is listed in the following charts.

MPI DIAGNOSTIC CONNECTORS



CONNECTOR D1

1. TACH SIGNAL
2. NOT USED
3. ECU GROUND
4. ANTI-LOCK BRAKES
5. BATTERY (+)
6. FUEL PUMP (+)

CONNECTOR D2

1. ECU OUTPUT (TX)
2. RX DATA (ECU)
3. LATCH RELAY
4. IGNITION
5. ANTI-LOCK BRAKES
6. A/C CLUTCH
7. IGNITION GROUND
8. SENSOR GROUND
9. OXYGEN SENSOR HEATER
10. NOT USED
11. SHIFT LAMP
12. B+ LATCH
13. NOT USED
14. CHECK ANTI-LOCK BRAKES
15. AUTOMATIC TRANSMISSION DIAGNOSIS

J8914-150

Coolant Temperature Sensor Test

Disconnect wire harness connector from coolant temperature sensor (Fig. 46).

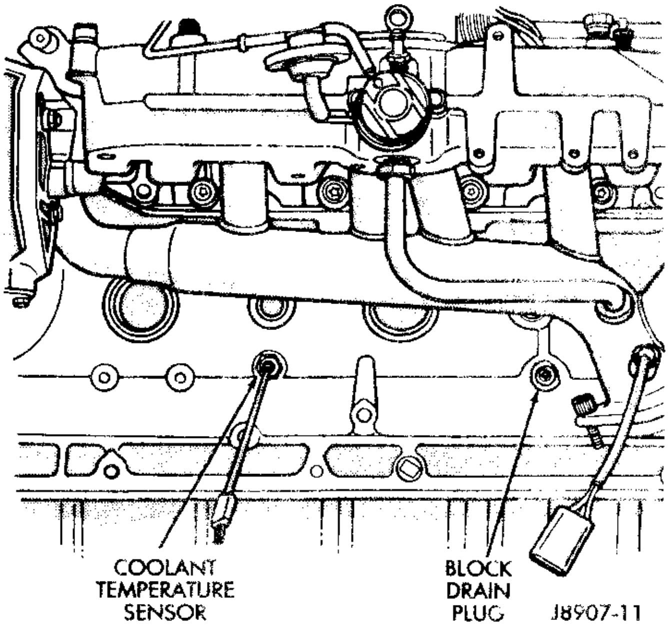


Fig. 46 Coolant Temperature Sensor

Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance should be less than 1000 with the engine warm. Refer to the resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

Test the resistance of the wire harness between ECU wire harness connector terminal D-3 and the sensor connector terminal, and wire harness terminal C-10 to the sensor connector terminal. Repair the wire harness if an open circuit is indicated.

Coolant Temperature Sensor Temperature-to-Resistance Values (Approximate)

°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

J8914-89

Manifold Air/Fuel Temperature (MAT) Sensor Test

Disconnect the wire harness connector from the MAT sensor (Fig. 47).

Test the resistance of the sensor with a input impedance (digital) volt-ohmmeter. The resistance should be less than 1000 ohms with the engine warm. Refer to the resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

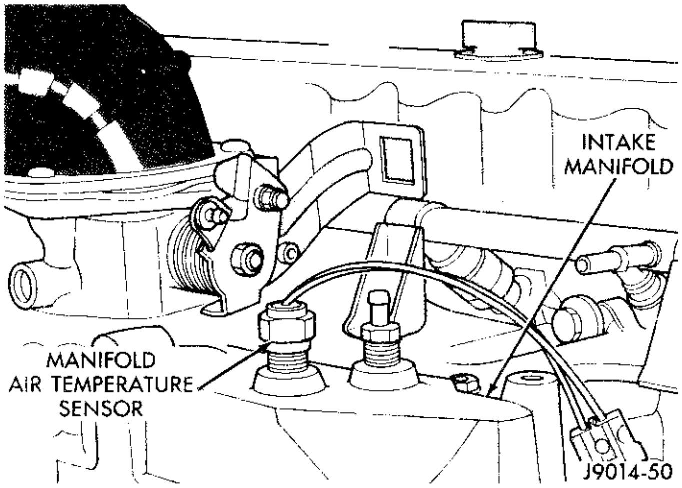


Fig. 47 Manifold Air Temperature Sensor

Test the resistance of the wire harness between the ECU wire harness connector terminal D-3 and the sensor connector terminal, and terminal C-8 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

Manifold Air/Fuel Temperature Sensor Temperature-to-Resistance Values (Approximate)

°F	°C	Ohms
212	100	185
160	70	450
100	38	1,600
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

J8914-90

Manifold Absolute Pressure (MAP) Sensor Test

Inspect the MAP sensor vacuum hose connections at the throttle body and sensor. Repair as necessary.

CAUTION: When testing the MAP sensor, ensure that the harness wires are not damaged by the test meter probes.

Test the MAP sensor output voltage at the MAP sensor connector terminal B (as marked on the sensor body) with the ignition switch ON and the engine OFF (Fig. 48). Output voltage should be 4 - 5 volts. **The voltage should drop to 1.5 - 2.1 volts with a hot, neutral idle speed condition.**

Test ECU terminal C-6 for the same voltage described above to verify the wire harness condition. Repair as necessary.

Test MAP sensor supply voltage at sensor connector terminal C with the ignition ON. The voltage should be 5 volts (±0.5V). Five volts (±0.5V) should also be at terminal C-14 of the ECU wire harness connector. Repair or replace the wire harness as necessary.

Test the MAP sensor ground circuit at sensor connector terminal A and ECU connector terminal D-3. Repair the wire harness if necessary.

Test the MAP sensor ground circuit at the ECU connector between terminal D-3 and terminal B-11 with an ohmmeter. If the ohmmeter indicates an open circuit, inspect for a defective sensor ground connection located on the right side of the cylinder block at the oil dipstick tube mounting stud. If the ground connection is good, replace the ECU. If terminal D-3 has a short circuit to 12 volts, correct this condition before replacing the ECU.

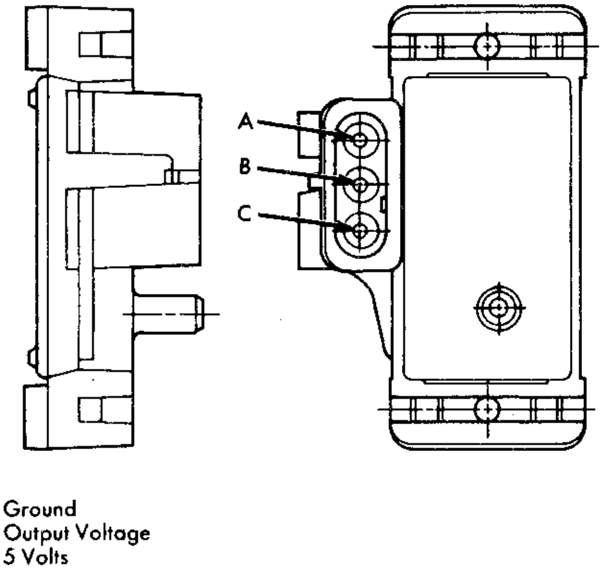


Fig. 48 MAP Sensor Connector Terminals

Speed Sensor (Crankshaft Position Sensor-CPS) Test

Disconnect the speed sensor connector from the harness (Fig. 49).

Place an ohmmeter across terminals A and B (marked on connector). The meter reading should be 200±75 ohms (hot engine). Replace sensor if readings are not to specifications.

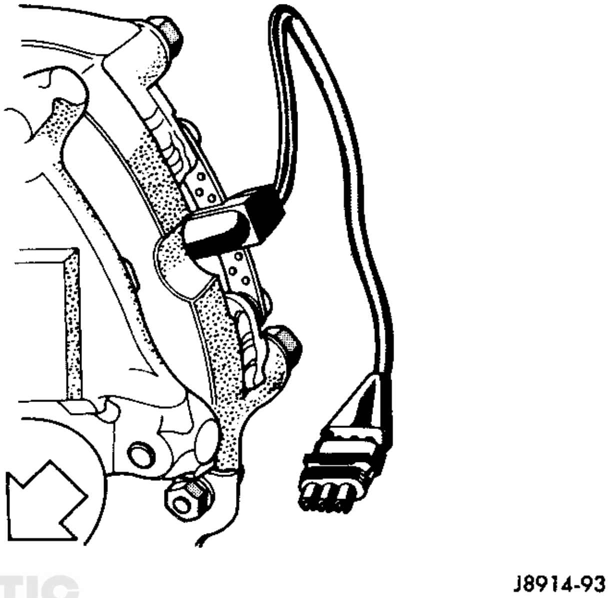
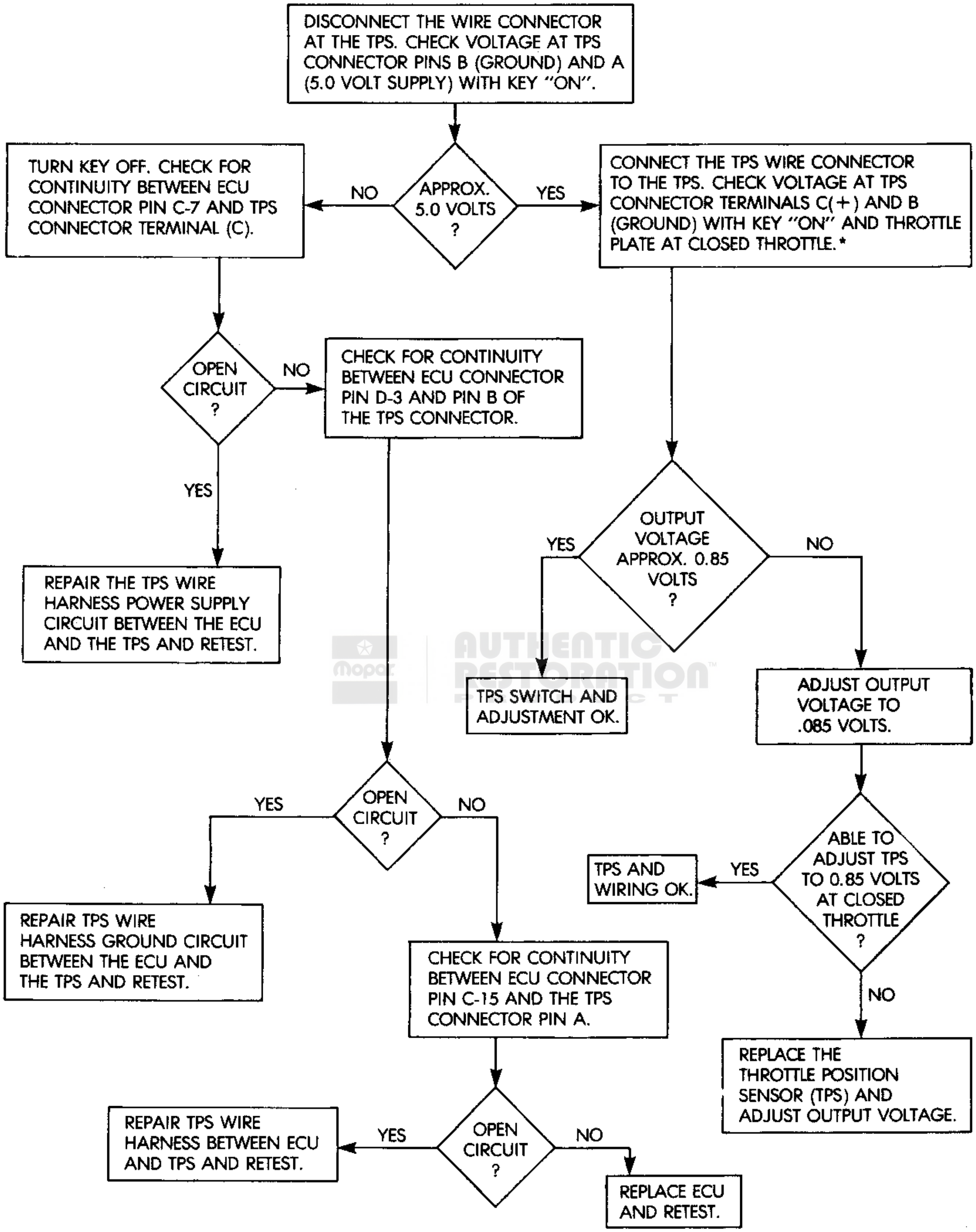


Fig. 49 Engine Speed Sensor

Throttle Position Sensor (TPS) Test—Manual Transmission

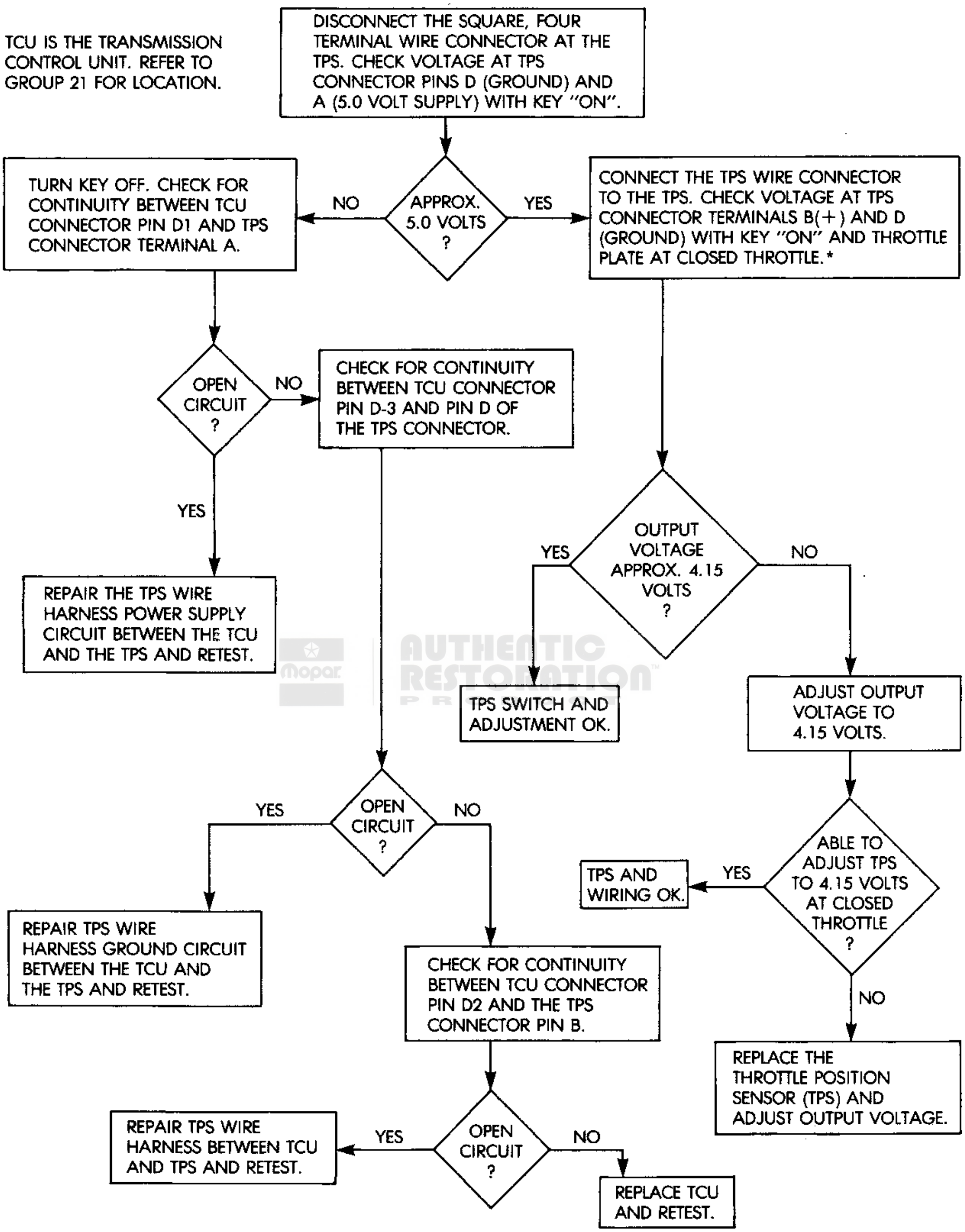


*DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR. INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS.

J9014-131

Throttle Position Sensor (TPS) Test—Automatic Transmission

TCU IS THE TRANSMISSION CONTROL UNIT. REFER TO GROUP 21 FOR LOCATION.



*DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR. INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS.

J9014-130

Oxygen Sensor (O_2) Heating Element Test

The oxygen sensor heating element can be tested with an ohmmeter as follows:

Disconnect the O_2 sensor connector (Fig. 50). Connect the ohmmeter test leads to connector terminals A and B of the sensor connector. Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity reading.

Idle Speed Stepper Motor Test

Idle speed stepper motor operation can be tested using exerciser tool 7558 (Fig. 51).

CAUTION: Proper safety precautions must be taken when testing the idle speed stepper motor.

- Set the parking brake and block the drive wheels
- Route all tester cables away from the cooling fans, drive belt, pulleys, and exhaust components.
- Provide proper ventilation while operating the engine.
- Always return the engine idle speed to normal before disconnecting the exerciser tool

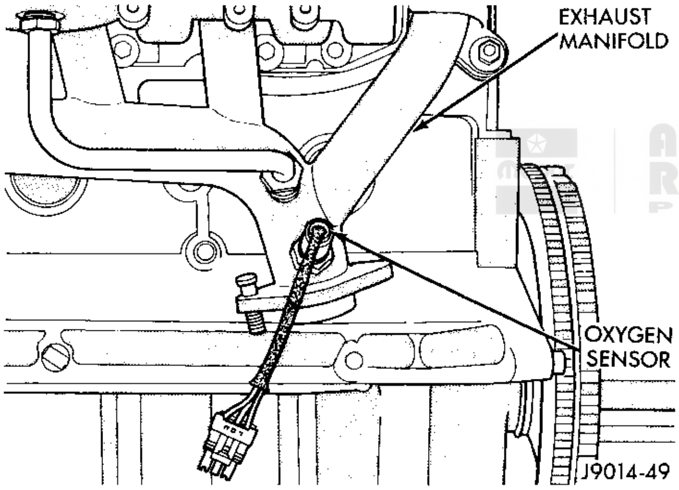


Fig. 50 Heated Oxygen Sensor

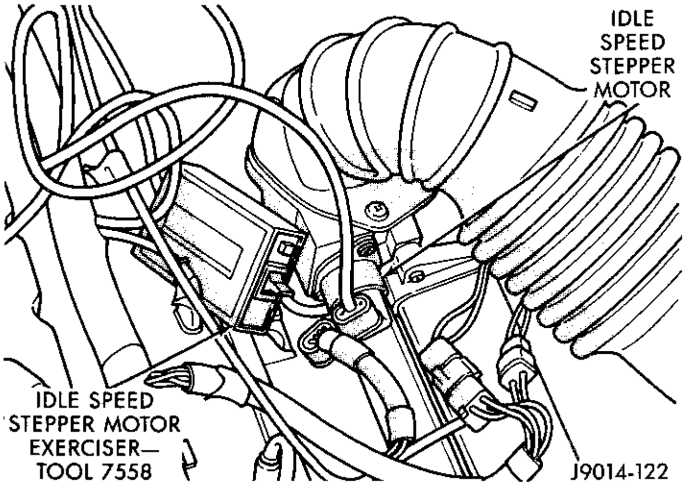


Fig. 51 Idle Speed Stepper Motor Testing

(1) With the ignition "OFF", disconnect the idle speed stepper motor wire connector at throttle body (Fig. 52).

(2) Plug the exerciser tool 7558 harness connector into the idle speed stepper motor.

(3) Connect red clip of exerciser tool 7558 to battery positive terminal. Connect black clip to battery negative terminal. The red light on the exerciser will flash when the exerciser is properly connected.

(4) Start engine.

When the switch is in the "HIGH" or "LOW" position; the light on the exerciser will flash indicating that voltage pulses are being sent to the stepper motor.

(5) Move the switch to the "HIGH" position; the engine speed should increase. Move the switch to the "LOW" position; the engine speed should decrease.

(a) If the engine speed changes while using the exerciser tool, the idle speed stepper motor is functioning properly. Disconnect the exerciser tool and connect the stepper motor wire connector to the stepper motor.

(b) If the engine speed does not change, turn the ignition "OFF" and proceed to step (6). Do not disconnect exerciser from stepper motor.

(6) Remove the idle speed motor from the throttle body.

CAUTION: When checking the idle speed stepper motor operation with the stepper motor removed from the throttle body, DO NOT EXTEND the pintle (Fig. 53) more than 6.35 mm (.250 in). IF the pintle is extended more than this amount it may separate from the stepper motor. The idle speed stepper motor must be replaced if the pintle separates from the motor.

(7) With the ignition "OFF", cycle the exerciser tool switch between the "HIGH" and "LOW" positions and observe the pintle. The pintle should move in and out of the motor.

(a) If the pintle does not move, replace the idle speed stepper motor. Start the engine and test the replacement motor operation as described in step (5).

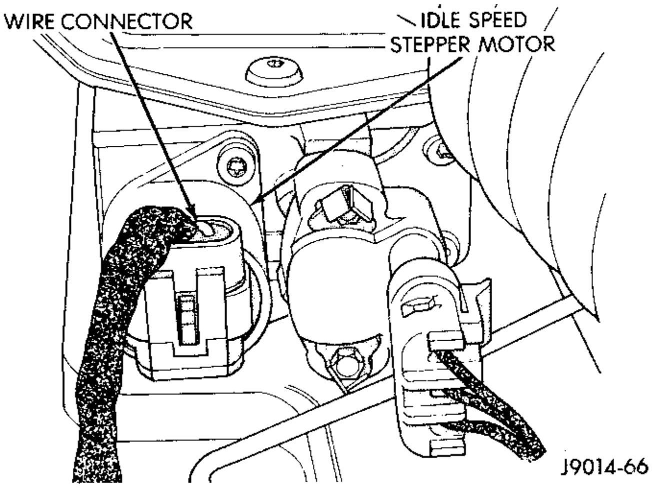


Fig. 52 Idle Speed Stepper Motor

(b) If the pintle operates properly, check the stepper motor bore in the throttle body bore for blockage and clean as necessary. Reinstall the stepper motor and retest. If no blockage is found, refer to the Service Diagnostic Tester and tester manual.

Relay Operation/Testing

Operation

- Terminal No. 30 is usually connected to battery voltage and can be switched or B+ at all times (Fig. 54).
- Terminal No. 87A is connected to terminal 30 in the de-energized position (Fig. 54).
- Terminal No. 87 is connected to terminal 30 in the energized position which supplies battery voltage to the operated device (Fig. 54).
- Terminal No. 86 is connected to the electromagnet and usually connected to a switched power source (Fig. 54).
- Terminal No. 85 is connected to the electromagnet and is usually grounded by a switch or ECU (Fig. 54).

Testing

- A relay in the de-energized position should have continuity between terminal 87A and terminal 30.
- Resistance value between terminals 85 and 86 (electromagnet) is 75 ±5 ohms for resistor relays and 86 ±5 ohms for diode relays.

Not all relays have battery voltage connected to terminal No. 30. Some may have battery voltage connected to terminals 87 or 87A.

Starter Motor Relay Test

(1) Disconnect wire connectors from the ignition terminal and ground terminal (Fig. 55).

(2) Measure the resistance between the terminals with an ohmmeter. Correct resistance is approximately 22 ohms.

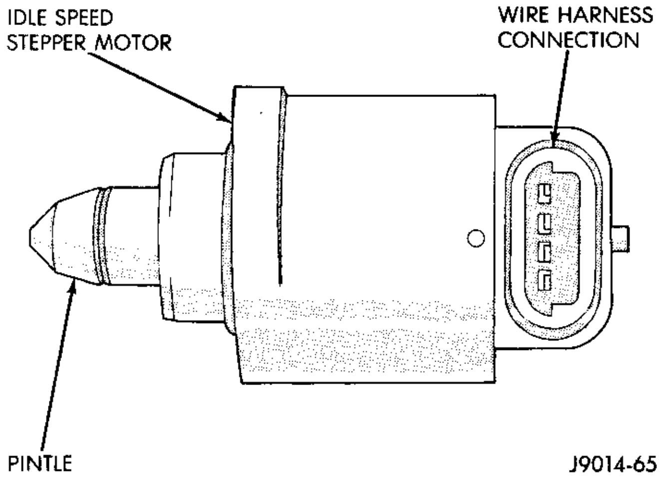


Fig. 53 Idle Speed Stepper Motor Pintle

(3) Measure the resistance between either terminal and the battery negative post. Resistance should be infinite. If defective, replace the relay. If acceptable, connect wire connectors.

(4) Remove the starter solenoid terminal wire connector and connect a voltmeter between the terminal and the battery negative post.

(5) With the ignition switch in the start position, the voltmeter should indicate battery voltage (12 volts). If battery voltage is not present, check the related wiring, bulkhead connector and ignition switch adjustment.

(6) Disconnect the fuel pump ballast resistor terminal connector.

(7) Connect a voltmeter between the ballast resistor terminal and the battery negative post. With the ignition switch in the start position, the voltmeter should indicate battery voltage (12 volts). If battery voltage is not present replace the relay.

WARNING: CHECK TO ENSURE THAT THE TRANSMISSION IS IN PARK (AUTOMATIC TRANSMISSION) OR NEUTRAL (MANUAL TRANSMISSION) WITH THE PARKING BRAKE APPLIED BEFORE THE GROUND TERMINAL IS JUMPED.

(8) If battery voltage is present during steps (5) and (7) and the starter relay isn't working, connect the ignition terminal connector and connect a jumper wire between the ground terminal and the battery negative post.

- If the starter relay doesn't click, replace the relay.
- If the starter relay does click, repair the ground circuit. Refer to the Wiring Diagram Manual for ground circuit information.

Sync Pulse (Stator) Test

For this test, an analog voltmeter is needed. Do not remove the distributor connector from the distributor. Insert the voltmeter leads into the backside of the distributor connector to make contact with the terminals. Ensure that the connector is not damaged when inserting the tester probes.

(1) Insert the positive (+) voltmeter lead into the Blue wire at the distributor connector.

(2) Install the negative (-) voltmeter lead into the Gray W/tracer wire at the distributor connector.

(3) Set the voltmeter on a 15 Volt A/C scale. Turn key on. The voltmeter should show approximately 5.0 volts.

(a) If there is no voltage, check the voltmeter leads for a good connection.

(4) If there is still no voltage:

(a) Remove ECU and check for voltage at pin C-16 and ground with harness connected.

(5) If there is still no voltage:

(a) Perform vehicle test using the DRBII Service Diagnostic Tester.

(6) If voltage is present:

(a) Check continuity between the Blue wire at the distributor connector and C-16 at the ECU. If there is no continuity, repair the harness as necessary.

(b) Check for continuity between the Gray W/ tracer wire at the distributor connector and pin C-5 at the ECU. If there is no continuity, repair the harness as necessary.

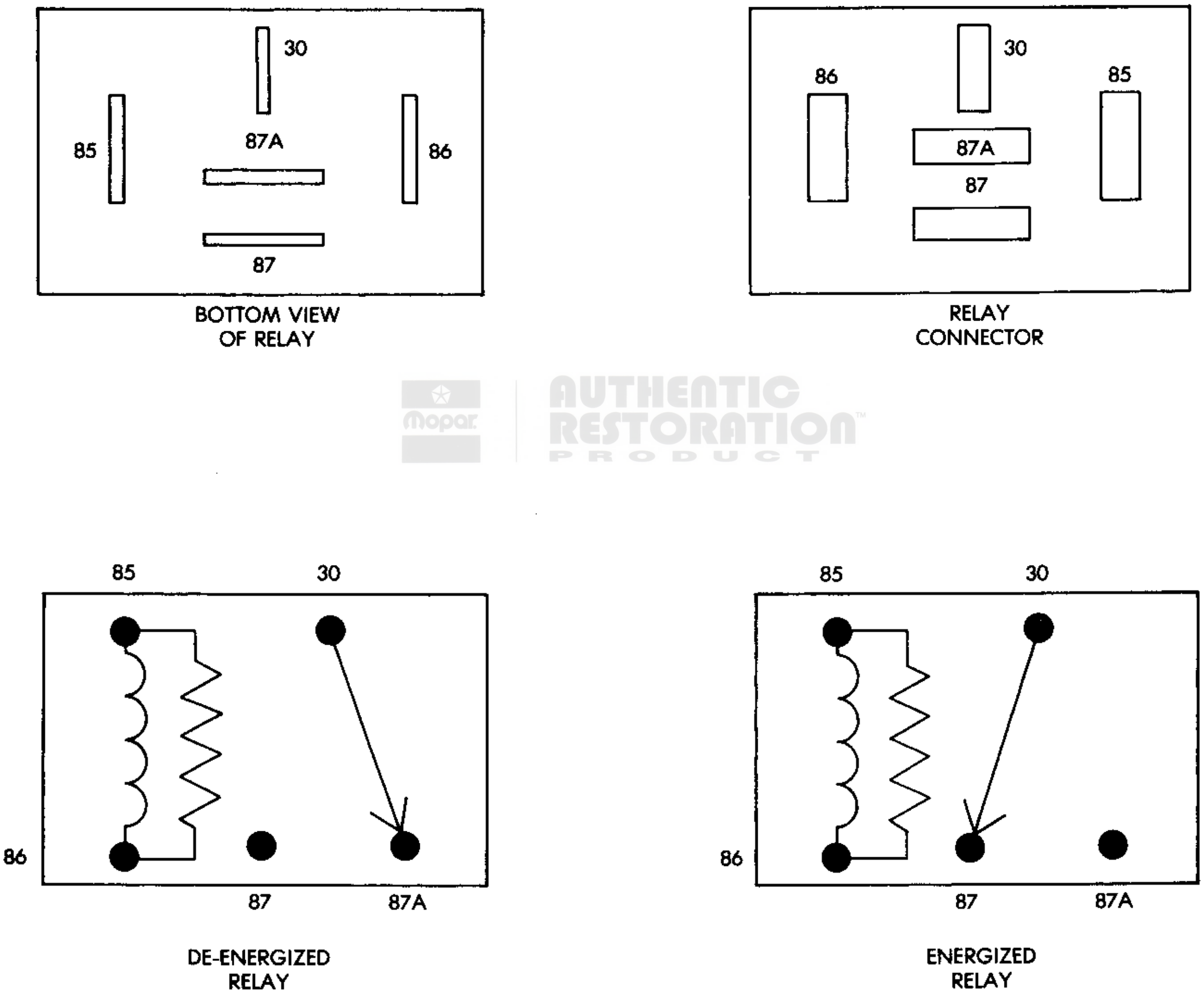
(c) Check for continuity between the Black wire at the distributor connector and ground. If there is no continuity, repair the harness as necessary.

(7) While observing the voltmeter, crank the engine; the voltmeter needle should fluctuate back and forth while the engine is cranking. This verifies that the stator in the distributor is operating properly and a sync pulse (signal) is being generated.

(a) If there is no sync pulse, replacement of the stator is necessary.

EGR Solenoid Test

(1) Prior to this test, verify that vacuum is present at the vacuum source connector.



J8914-155

Fig. 54 Relay Terminals

(2) Remove the output side, two port vacuum connector (to EGR valve transducer—Fig. 56).

(3) Connect a vacuum gauge at (B) (Fig. 57).

(4) Start and idle the engine. There should be no vacuum at (B).

(5) Disconnect wire connector from the solenoid. There should now be manifold vacuum at (B).

(6) Connect wire connector to the solenoid.

(7) Remove vacuum gauge and connect two port connector (A and B—Fig. 56).

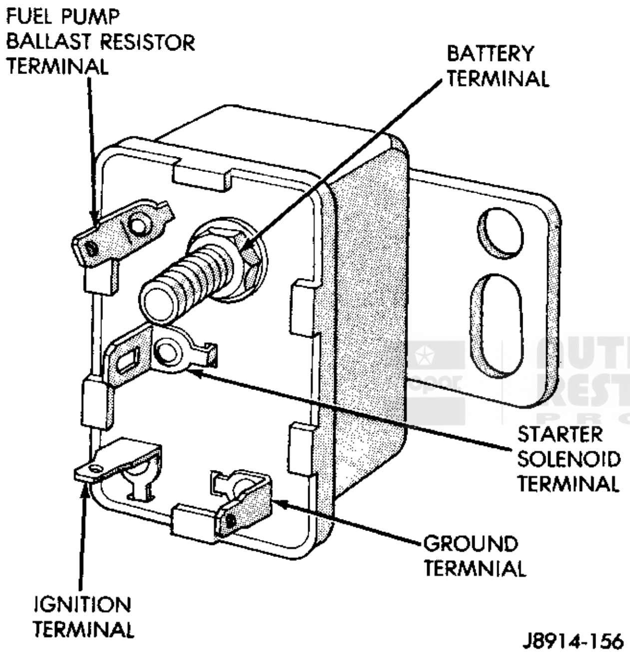


Fig. 55 Starter Motor Relay Terminals

Injector Test

Disconnect the injector wire connector from the injector. Place an ohmmeter on the injector terminals. Resistance reading should be approximately 16 ohms ±12 at 20°C (68°F). Proceed to following diagnosis chart.

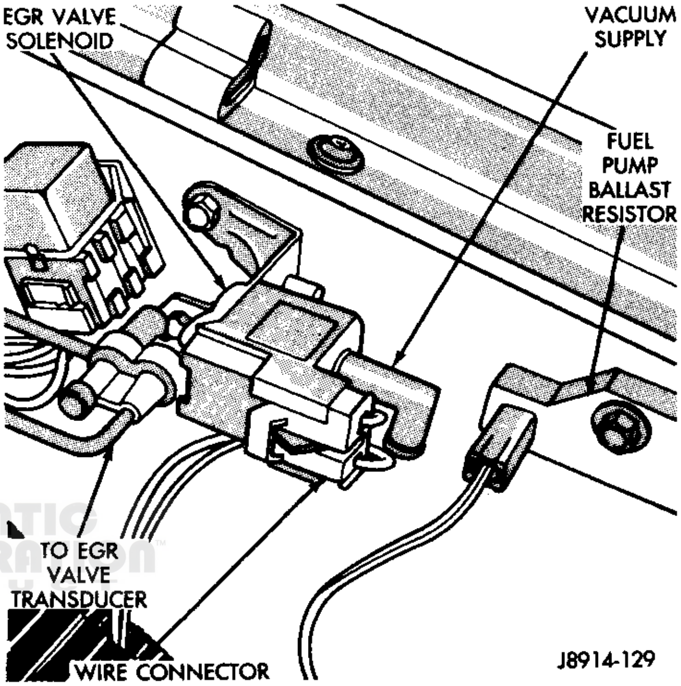


Fig. 56 EGR Valve Solenoid

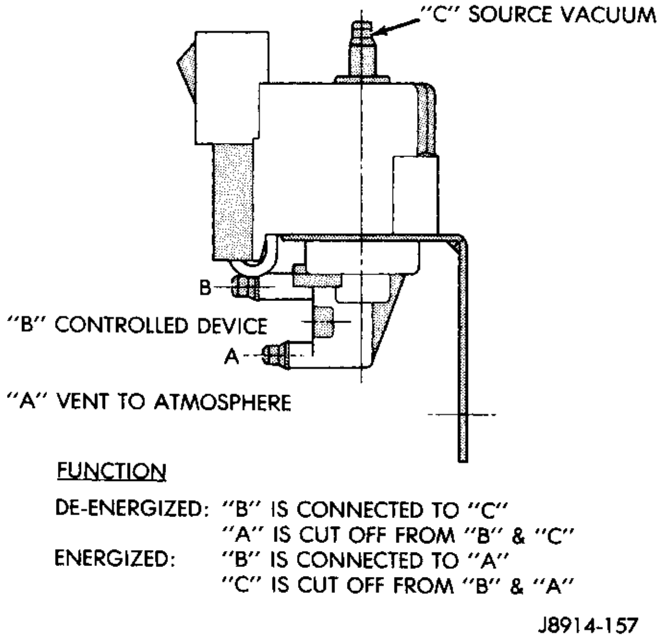
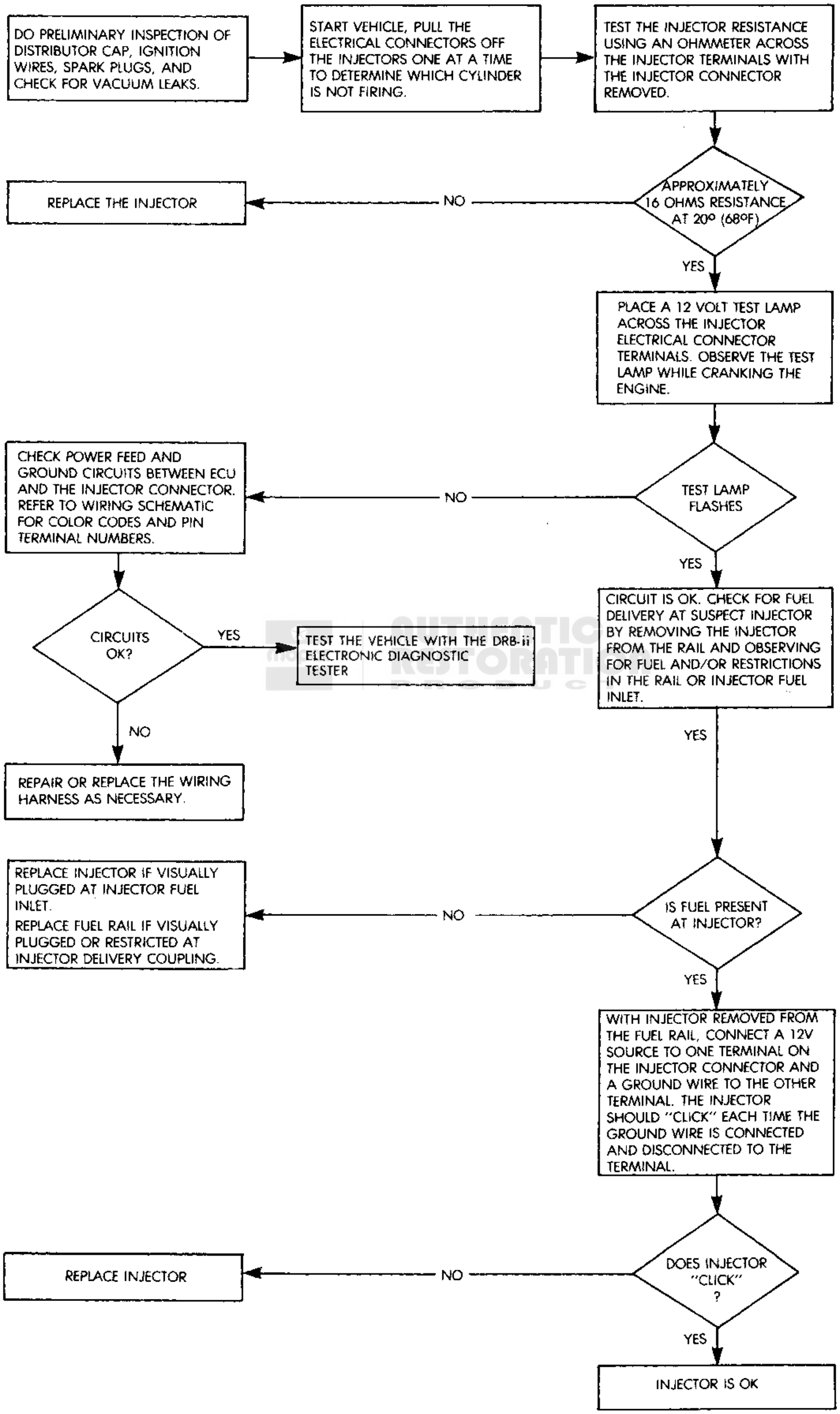


Fig. 57 EGR Valve Solenoid Operation

INJECTOR DIAGNOSIS— Vehicle runs rough and/or has a miss



DO PRELIMINARY INSPECTION OF DISTRIBUTOR CAP, IGNITION WIRES, SPARK PLUGS, AND CHECK FOR VACUUM LEAKS.

START VEHICLE, PULL THE ELECTRICAL CONNECTORS OFF THE INJECTORS ONE AT A TIME TO DETERMINE WHICH CYLINDER IS NOT FIRING.

TEST THE INJECTOR RESISTANCE USING AN OHMMETER ACROSS THE INJECTOR TERMINALS WITH THE INJECTOR CONNECTOR REMOVED.

APPROXIMATELY 16 OHMS RESISTANCE AT 20° (68°F)

REPLACE THE INJECTOR

PLACE A 12 VOLT TEST LAMP ACROSS THE INJECTOR ELECTRICAL CONNECTOR TERMINALS. OBSERVE THE TEST LAMP WHILE CRANKING THE ENGINE.

TEST LAMP FLASHES

CHECK POWER FEED AND GROUND CIRCUITS BETWEEN ECU AND THE INJECTOR CONNECTOR. REFER TO WIRING SCHEMATIC FOR COLOR CODES AND PIN TERMINAL NUMBERS.

CIRCUITS OK?

TEST THE VEHICLE WITH THE DRB-II ELECTRONIC DIAGNOSTIC TESTER

REPAIR OR REPLACE THE WIRING HARNESS AS NECESSARY.

CIRCUIT IS OK. CHECK FOR FUEL DELIVERY AT SUSPECT INJECTOR BY REMOVING THE INJECTOR FROM THE RAIL AND OBSERVING FOR FUEL AND/OR RESTRICTIONS IN THE RAIL OR INJECTOR FUEL INLET.

IS FUEL PRESENT AT INJECTOR?

REPLACE INJECTOR IF VISUALLY PLUGGED AT INJECTOR FUEL INLET.

REPLACE FUEL RAIL IF VISUALLY PLUGGED OR RESTRICTED AT INJECTOR DELIVERY COUPLING.

WITH INJECTOR REMOVED FROM THE FUEL RAIL, CONNECT A 12V SOURCE TO ONE TERMINAL ON THE INJECTOR CONNECTOR AND A GROUND WIRE TO THE OTHER TERMINAL. THE INJECTOR SHOULD "CLICK" EACH TIME THE GROUND WIRE IS CONNECTED AND DISCONNECTED TO THE TERMINAL.

DOES INJECTOR "CLICK" ?

REPLACE INJECTOR

INJECTOR IS OK

J8914-158

MPI Fuel System Pressure Tests

MPI Fuel System Pressure Test

The MPI fuel system used in vehicles equipped with a 4.0L engine employs a vacuum assisted pressure regulator. Fuel pressure should be approximately 55-69 kPa (8-10 psi) lower with the vacuum line attached to the regulator than with the vacuum line disconnected. System fuel should be 214 kPa (31 psi) with the vacuum line connected to the regulator and 269 kPa (39 psi) with the vacuum line disconnected.

(1) Connect a 0-414 kPa (0-60 psi) fuel pressure gauge to test port pressure fitting on fuel rail (Fig. 58).

(2) Remove vacuum line from pressure regulator.

(3) Start the vehicle.

(4) Note gauge reading. With vacuum line disconnected, fuel pressure should be approximately 269 kPa (39 psi).

(5) Connect vacuum line to pressure regulator. Note gauge reading. Fuel pressure should be approximately 214 kPa (31 psi).

(6) If fuel pressure is not approximately 55-69 kPa (8-10 psi) higher with vacuum line removed from regulator, inspect pressure regulator vacuum line for leaks, kinks or blockage.

CAUTION: Fuel pressure will rise to as much as 95 psi when the fuel return line is pinched shut, shut engine down immediately after pinching off fuel return line.

(7) If fuel pressure is low, momentarily pinch shut the **hose section** of the fuel return line. If fuel pressure remains low, inspect the fuel supply line, fuel filter, and fuel rail inlet for blockage. If fuel pressure rises replace fuel pressure regulator.

(8) If fuel pressure is above specifications, inspect the fuel return line for kinks and blockage.

- Check the fuel pump flow rate. A good fuel pump will deliver at least 1 liter of fuel per minute with the fuel return line pinched off. If the fuel pump does not pump adequately inspect the fuel system for a plugged fuel filter or filter sock.

Fuel pump flow rate can be done by connecting one end of an old A/C gauge hose to the fuel test port on the fuel rail and inserting the other end of the hose into a container of at least 1 liter capacity. Run the fuel pump by installing a jumper wire into diagnostic connector terminals D1-5 and D1-6. Be sure to pinch off the fuel return line or most of the fuel will be returned to the fuel tank.

The fuel pressure regulator is not adjustable.

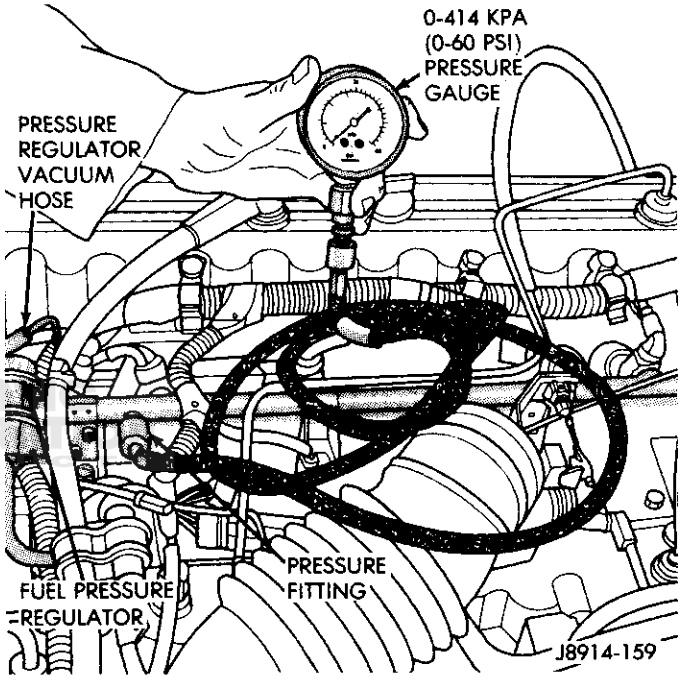


Fig. 58 Fuel Pressure Test

MPI SERVICE PROCEDURES

INDEX

MPI FUEL SYSTEM PRESSURE RELEASE PROCEDURE

The MPI fuel system is under constant fuel pressure of 131-269 kPa (19-39 psi). Vehicles equipped with multi-point injected 4.0L engine must have the fuel pressure released before servicing any fuel supply or return system component.

(1) Disconnect battery negative cable.

(2) Remove fuel tank filler neck cap to release fuel tank pressure.

(3) Remove cap from pressure test port on the fuel rail.

WARNING: DO NOT ALLOW FUEL TO SPILL ONTO THE ENGINE INTAKE OR EXHAUST MANIFOLDS. PLACE SHOP TOWELS UNDER THE PRESSURE PORT TO ABSORB FUEL WHEN THE PRESSURE IS RELEASED FROM THE FUEL RAIL.

(4) Place shop towels under the fuel pressure test port.

(5) Using a small screw driver or pin punch push the test port valve in to relieve fuel pressure (Fig. 1). Absorb spilled fuel with shop towels.

(6) Remove shop towels and dispose of properly.

(7) Install cap over pressure test port.

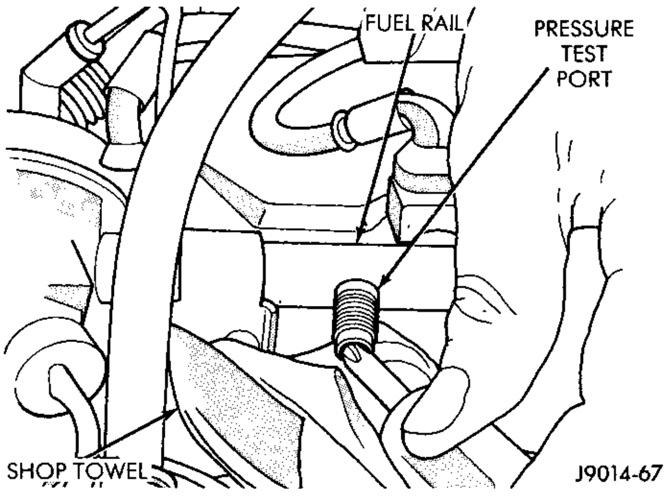


Fig. 1 Releasing MPI Fuel Pressure

THROTTLE BODY

Removal

(1) Disconnect battery negative cable.

(2) Disconnect air cleaner snorkel from throttle body.

(3) Disconnect idle speed stepper motor and throttle position sensor wire connectors.

(4) Disconnect MAP sensor vacuum tube from back of throttle body.

(5) Disconnect throttle linkage at throttle arm.

(6) If equipped, disconnect automatic transmission line pressure cable at throttle arm (Fig. 2).

(7) Remove throttle body mounting bolts, throttle body, and gasket. Discard old gasket.

Installation

(1) Install throttle body and new gasket. Tighten throttle body mounting bolts to 30 N•m (23 ft-lbs) torque.

(2) Connect MAP sensor vacuum tube to throttle body.

(3) Connect idle speed stepper motor and throttle position sensor wire connectors.

(4) Connect throttle linkage to throttle arm.

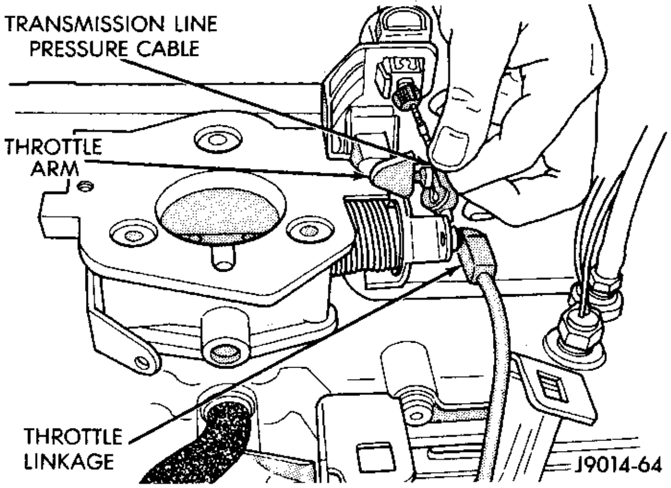


Fig. 2 Throttle Linkage and Transmission Line Pressure Cable

CAUTION: When the automatic transmission line pressure cable is reconnected it MUST be adjusted.

(5) Connect and adjust the transmission line pressure cable. Refer to group 21 for adjustment procedure.

(6) Install air cleaner snorkel onto throttle body.

(7) Connect battery negative cable to battery negative terminal.

IDLE SPEED STEPPER MOTOR

Removal

(1) Disconnect the electrical connector from the idle speed stepper motor (Fig. 3).

(2) Remove the stepper motor retaining screws and remove the idle speed stepper motor (Fig. 3).

Installation

(1) Install the idle speed stepper motor and retaining screws.

(2) Connect the idle speed stepper motor electrical connector.

THROTTLE POSITION SENSOR

Removal

(1) Disconnect the TPS electrical connector(s).

(2) Bend the lock tabs back and remove the retaining screws (Fig. 4).

(3) Remove the TPS from the throttle plate assembly (Fig. 4).

Installation

(1) Position TPS onto the throttle plate assembly.

(2) Install and tighten retaining screws.

(3) Adjust the TPS. Refer to TPS adjustment procedure in this group.

(4) Bend the lock tabs over the mounting screws.

(5) Connect the TPS electrical connector(s).

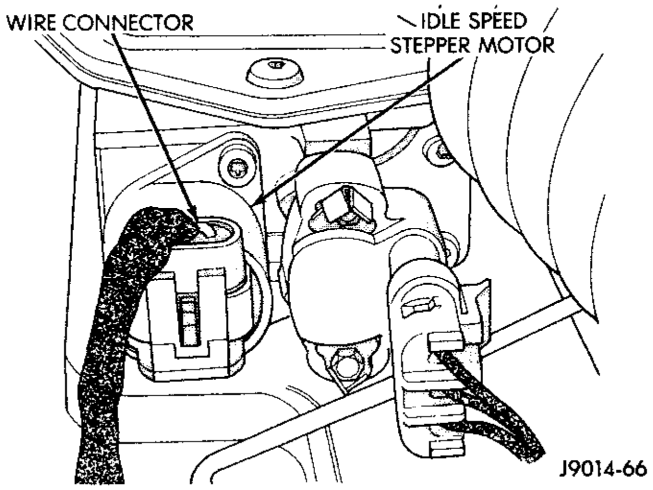


Fig. 3 Idle Speed Stepper Motor

COOLANT TEMPERATURE SENSOR

Removal

(1) Drain cooling system.

(2) Remove air cleaner assembly.

(3) Disconnect the coolant temperature sensor wire connector.

(4) Remove the sensor from the engine block and immediately plug the block to prevent coolant loss (Fig. 5).

Installation

(1) Install coolant temperature sensor into the cylinder block and tighten to 28 N•m (21 ft-lbs) torque.

(2) Connect the wire connector.

(3) Install the air cleaner assembly.

(4) Fill the cooling system.

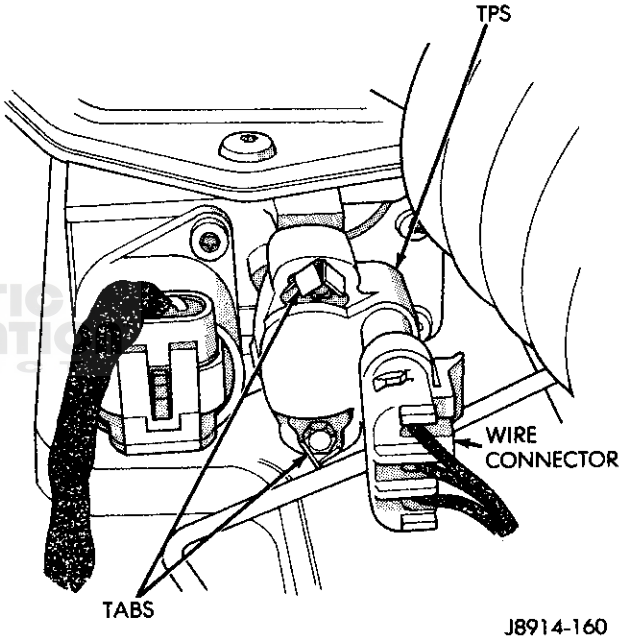


Fig. 4 Throttle Position Sensor Remove/Install—Typical

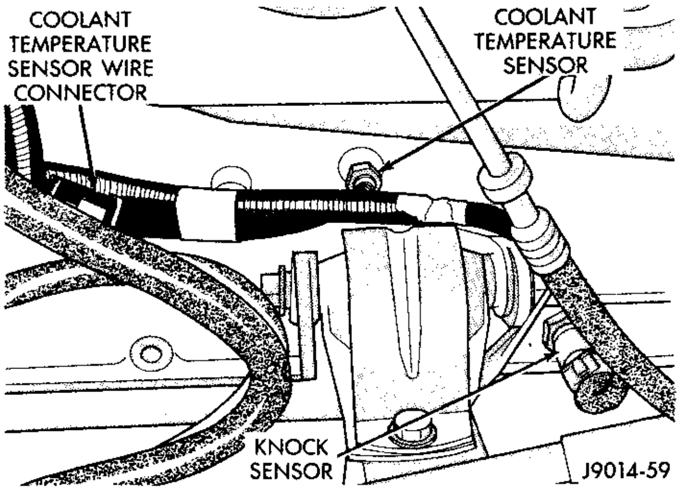


Fig. 5 Coolant Temperature Sensor Remove/Install

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

Removal

(1) Disconnect the MAT sensor electrical connector.

(2) Remove MAT sensor from the intake manifold (Fig. 6).

Installation

(1) Install the MAT sensor into the intake manifold. Tighten to 28 N•m (21 ft-lbs) torque.

(2) Connect the MAT sensor electrical connector.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Removal

(1) Disconnect the MAP sensor electrical connector (Fig. 7).

(2) Disconnect the MAP sensor vacuum supply hose (Fig. 7).

(3) Remove the MAP sensor mounting nuts and remove MAP sensor (Fig. 7).

Installation

(1) Install MAP sensor to dash panel and secure with mounting nuts.

(2) Install the MAP sensor vacuum supply hose.

(3) Connect the MAP sensor electrical connector.

OXYGEN (O_2) SENSOR

Removal

WARNING: EXHAUST MANIFOLD BECOMES VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

(1) Raise and support the vehicle.

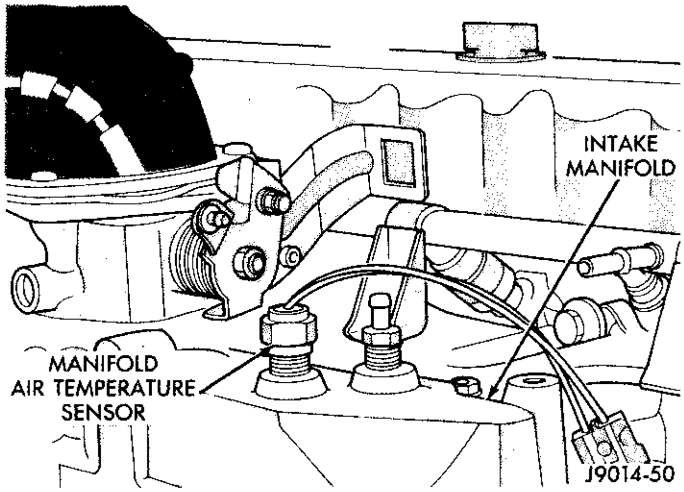


Fig. 6 MAT Sensor Remove/Install

(2) Disconnect the wire connector from the O_2 sensor (Fig. 8).

(3) Remove the O_2 sensor from the exhaust manifold (Fig. 8).

Installation

Threads of new oxygen sensors are coated with anti-seize compound to aid in removal.

(1) Install the O_2 sensor into the exhaust manifold and tighten to 30 N•m (22ft.-lbs.).

(2) Connect the O_2 sensor wire connector.

(3) Lower the vehicle.

KNOCK SENSOR

Removal

(1) Raise and support the vehicle.

(2) Disconnect the knock sensor wire connector (Fig. 9).

(3) Remove the knock sensor.

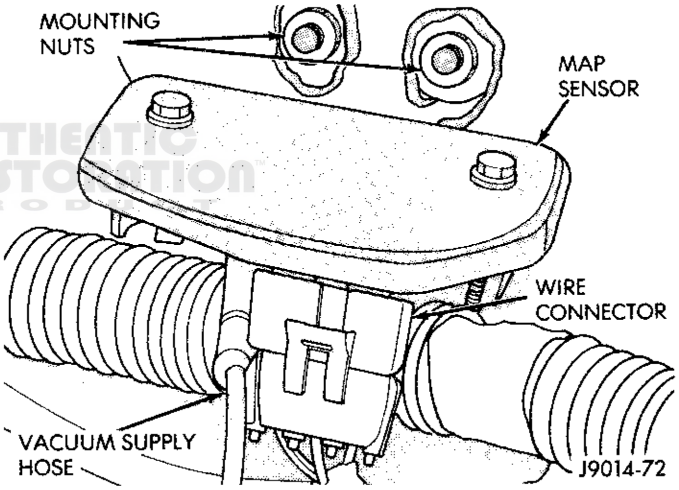


Fig. 7 MAP Sensor Remove/Install

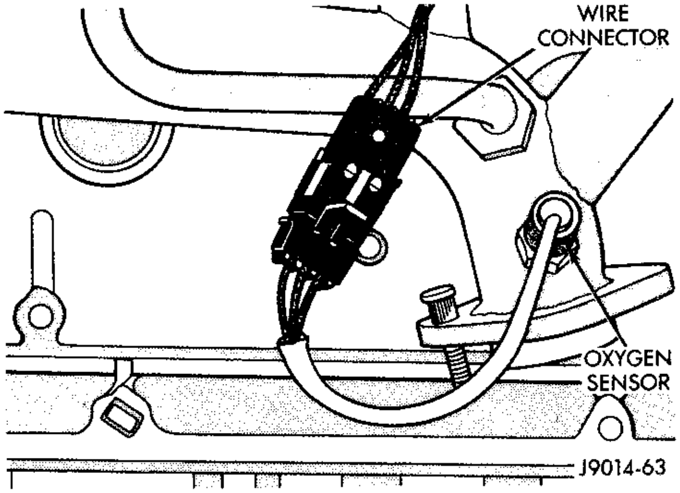


Fig. 8 Oxygen Sensor Remove/Install

Installation

CAUTION: The knock sensor MUST be tightened to the appropriate torque. Tightening torque is critical to knock sensor operation.

(1) Install the knock sensor into the cylinder block. Tighten to 10 N•m (89 in-lbs) torque.

(2) Connect the wire connector to the knock sensor.

(3) Lower the vehicle.

ENGINE SPEED SENSOR (CRANKSHAFT POSITION SENSOR—CPS)

Removal

(1) Disconnect the wire connector.

(2) Remove 2 bolts attaching speed sensor to the transmission housing (Fig. 10).

Installation

(1) Install the speed sensor. Tighten bolts to 8 N•m (71 in-lbs) torque.

(2) Connect the wire connector.

STARTER MOTOR RELAY

Removal

(1) Disconnect battery negative cable from battery.

(2) Identify, tag and disconnect wires attached to the relay.

(3) Remove the relay attaching screws and the relay from the inner fender panel (Fig. 11).

Installation

(1) Install the replacement relay on the inner fender panel.

(2) Connect wires to the relay.

(3) Connect the battery negative cable.

(4) Test relay operation.

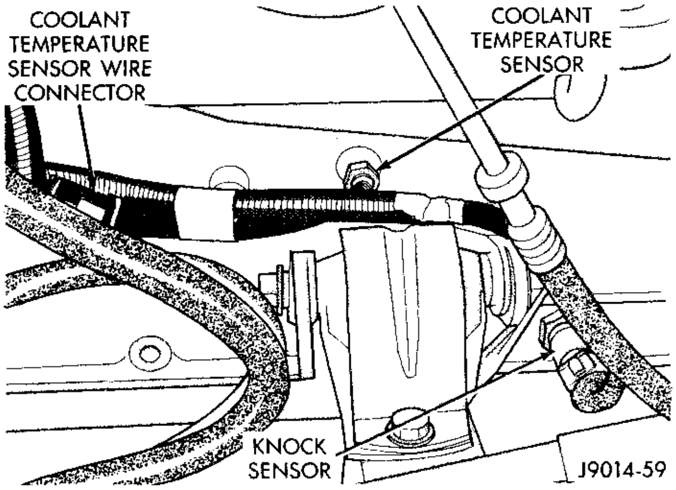


Fig. 9 Knock Sensor Remove/Install

EGR VALVE SOLENOID

Removal

The EGR valve solenoid is located on the left inner fender panel behind the fuel pump ballast resistor.

(1) Disconnect the solenoid vacuum hoses.

(2) Disconnect the solenoid wire connector (Fig. 12).

(3) Remove the solenoid retaining screw and remove solenoid (Fig. 12).

Installation

(1) Position solenoid on left inner fender and install retaining screw.

(2) Connect wire connector to solenoid.

(3) Connect vacuum hoses to solenoid.

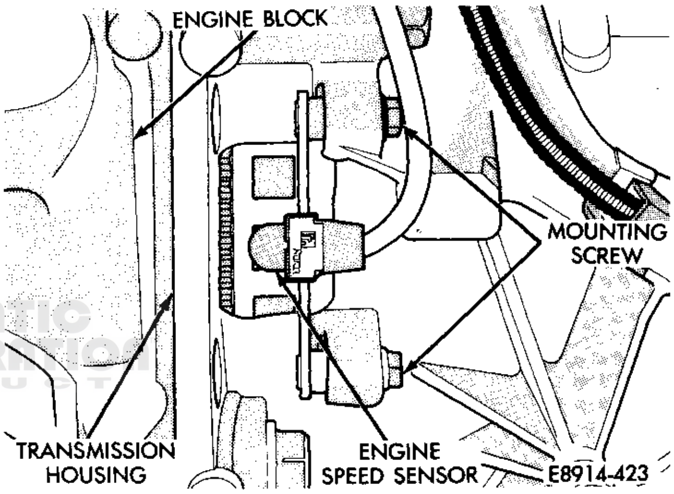


Fig. 10 Engine Speed Sensor

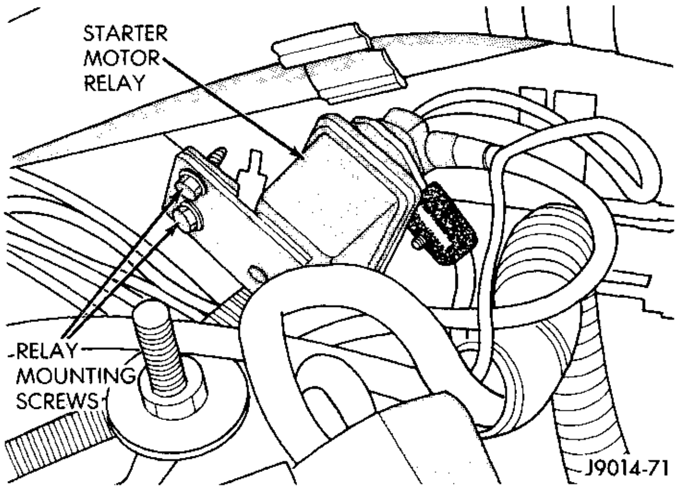


Fig. 11 Starter Motor Relay Remove/Install

FUEL PUMP BALLAST RESISTOR

Removal

The fuel pump ballast resistor is located on the left inner fender panel in front of the EGR solenoid.

(1) Disconnect wire connectors from ballast resistor (Fig. 13).

(2) Remove mounting screw and resistor (Fig. 13).

Installation

(1) Install resistor. Tighten mounting screw securely.

(2) Connect wire connectors to resistor.

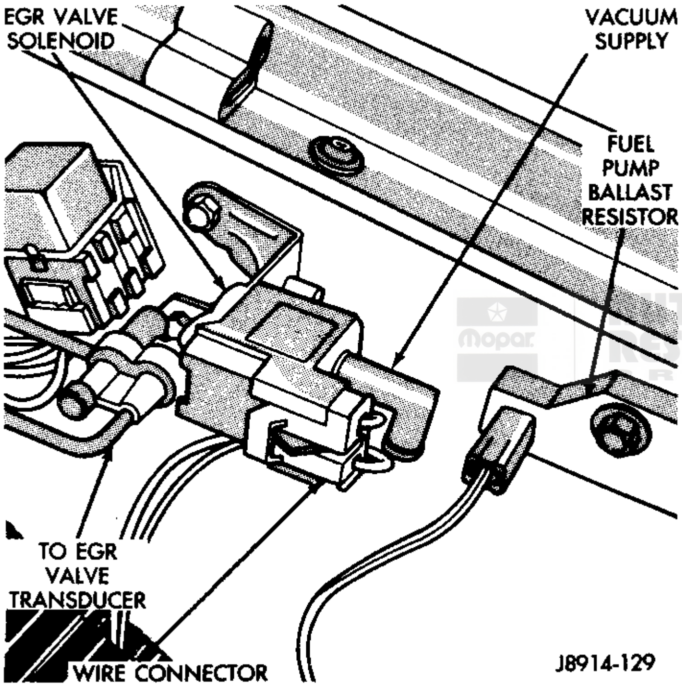


Fig. 12 EGR Valve Solenoid Remove/Install

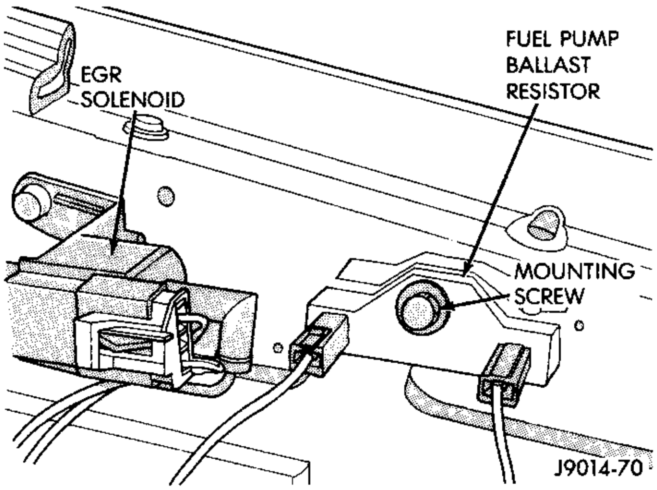


Fig. 13 Fuel Pump Ballast Resistor Remove/Install

ELECTRONIC CONTROL UNIT (ECU)

Removal

The ECU is located underneath the instrument panel between the steering column and heater A/C housing (Fig. 14). The ECU is mounted to a bracket by three screws.

(1) Disconnect battery negative cable.

(2) Remove three ECU mounting screws (Fig. 15). Lower ECU.

(3) Disconnect ECU wiring harness. Remove ECU.

Installation

(1) Connect ECU wire harness to ECU.

(2) Position ECU under instrument panel and install retaining screws.

(3) Connect battery negative cable to battery negative terminal.

FUEL TUBES AND HOSES

MPI fuel system pressure is held between approximately 131-269 kPa (19 and 39 psi) when the fuel pump is not operating. Fuel hoses and tubes cannot be removed once the vehicle is turned off. The MPI Fuel System Pressure Release, as described in this group, must be performed before removing any fuel supply or return system component. When removing fuel system hoses and tubes use care to avoid damaging the hoses or tube ends.

Quick Connect Fittings

Multi-Point Fuel Injected engines utilize quick-connect fuel tube fittings where the fuel supply hose connects to the fuel rail inlet port, and where the fuel return tube from the pressure regulator connects to the

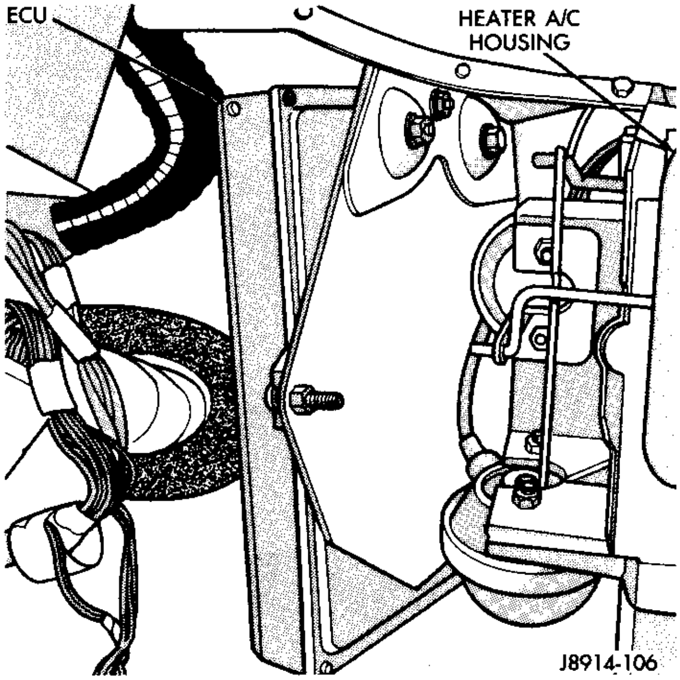


Fig. 14 ECU Location

regulator and to the fuel return hose. The fittings consist of two O-rings, a spacer (installed between O-rings), and an O-ring retainer (Fig. 16).

CAUTION: Whenever a fuel tube quick connect fitting is disconnected the O-rings, spacer, and retainer MUST be replaced. A repair kit consisting of the these parts is available through the parts department.

Quick connect fittings are located under the vehicle along the frame rail (Fig. 17).

The retainer has two tabs. To disconnect the quick-connect fitting, squeeze the tabs against the fuel tube and then pull the fitting off of the quick connect fitting/hose assembly. The retainer will stay on the fuel tube when the tube is disconnected. The O-rings and spacer will remain in the connector.

The O-rings and spacer can be removed with the bent end of an "L" shaped paper clip.

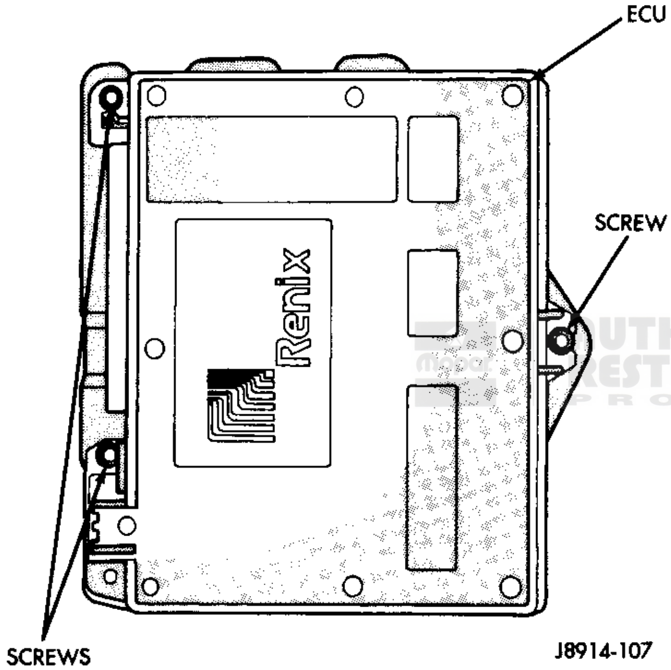


Fig. 15 ECU Remove/Install

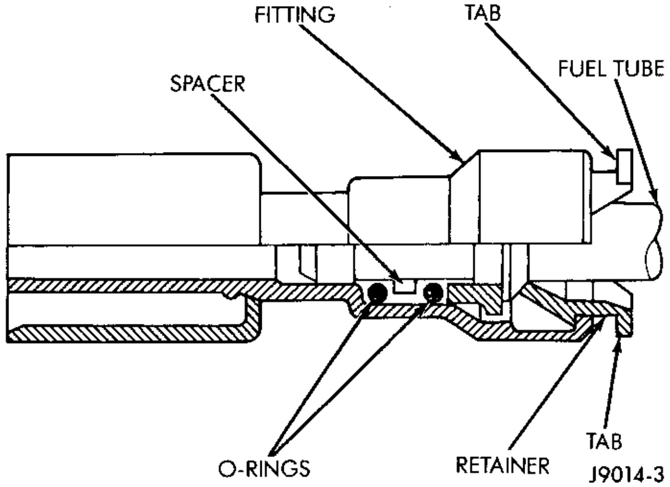


Fig. 16 Quick-Connect Fitting

O-ring Replacement

A repair kit consisting of replacement O-rings, spacer, and retainer is available through the parts department. The replacement parts are installed on a disposable plastic plug. Install the replacement kit as follows:

(1) Push kit/disposable plug assembly into quick connect fitting until an "click" sound is heard (Fig. 18).

(2) Grasp end of disposable plug and pull outward to remove it from fitting.

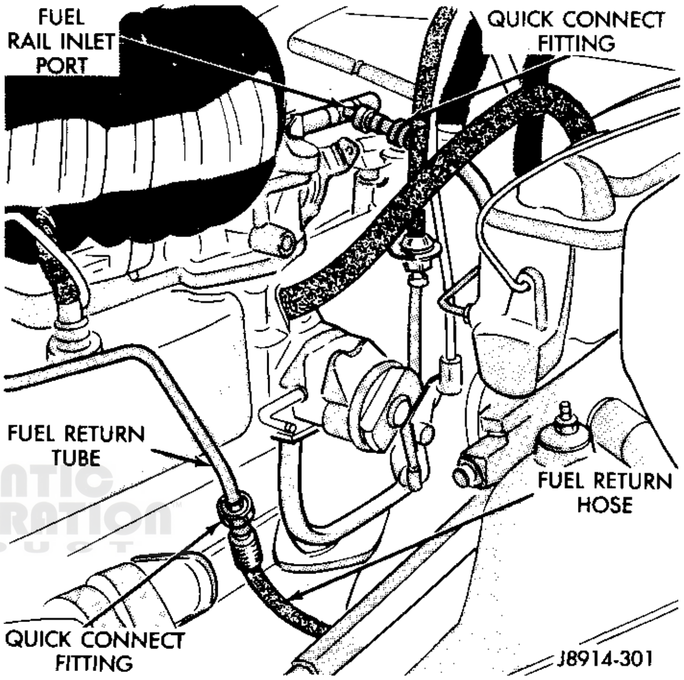


Fig. 17 Quick Connect Fitting Location

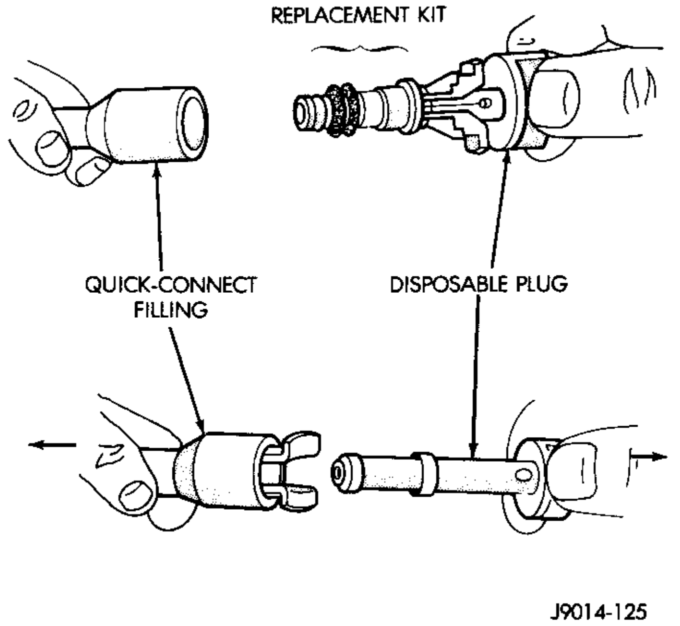


Fig. 18 Repair Kit Installation

Tube/Fitting Assembly

(1) Push fuel tube into quick-connect fitting until a "click" is heard (Fig. 19).

(2) Verify that connection is secure by firmly pulling back on fuel tube. The tube should be locked in place.

FUEL INJECTOR RAIL ASSEMBLY

Removal

(1) Remove fuel tank cap.

(2) Perform MPI Fuel System Pressure Release Procedure as described in this group.

(3) Disconnect battery negative cable from battery.

(4) Remove and numerically tag, the injector harness connectors from each injector (Fig. 20).

(5) Disconnect vacuum tube from fuel pressure regulator (Fig. 21).

(6) Disconnect fuel supply hose from fuel rail and fuel return tube from fuel pressure regulator (Fig. 21). Refer to Fuel Tubes and Hoses for Quick Connect Fitting Disassembly.

(7) Remove fuel rail mounting bolts (Fig. 21).

On models with automatic transmissions, it may be necessary to remove the automatic transmission throttle line pressure cable and bracket to remove the fuel rail assembly.

(8) Remove fuel rail by gently rocking until all injectors are out of the intake manifold.

Installation

(1) Position tips of all injectors into the corresponding injector bore in the intake manifold. Seat injectors into manifold.

(2) Tighten fuel rail mounting bolts to 27 N•m (20 ft-lbs) torque.

(3) Connect injector harness connectors to appropriate injector.

(4) Connect fuel return tube to pressure regulator and fuel supply hose to fuel rail **USING NEW A O-RING, SPACER, RETAINER REPAIR KIT**.

Refer to Fuel Tubes and Hoses for Quick Connect Fitting Assembly.

(5) Connect vacuum supply tube to pressure regulator.

(6) Install cap over pressure test port fitting.

(7) Install fuel tank cap.

(8) Connect battery negative cable to battery negative post.

FUEL INJECTOR

Removal

(1) Remove fuel tank cap.

(2) Perform MPI Fuel System Pressure Release Procedure.

(3) Disconnect battery negative cable from battery.

(4) Remove the fuel rail. Refer to Fuel Rail Removal in this section.

(5) Remove the clip(s) that retain the injector(s) to the fuel rail (Fig. 22).

An O-ring kit is available through the Parts department. The kit consists of 6 brown seals and 7 black seals. The brown seals fit on the injector tip area and seal the injector to the intake manifold when installed. The black seals fit on the rail end of the injector to seal the injector when it is installed into the fuel rail. The last black seal is for the fuel pressure regulator to seal the pressure regulator to the fuel rail. Due to the different O-ring material and usage, the brown and black O-rings cannot be interchanged.

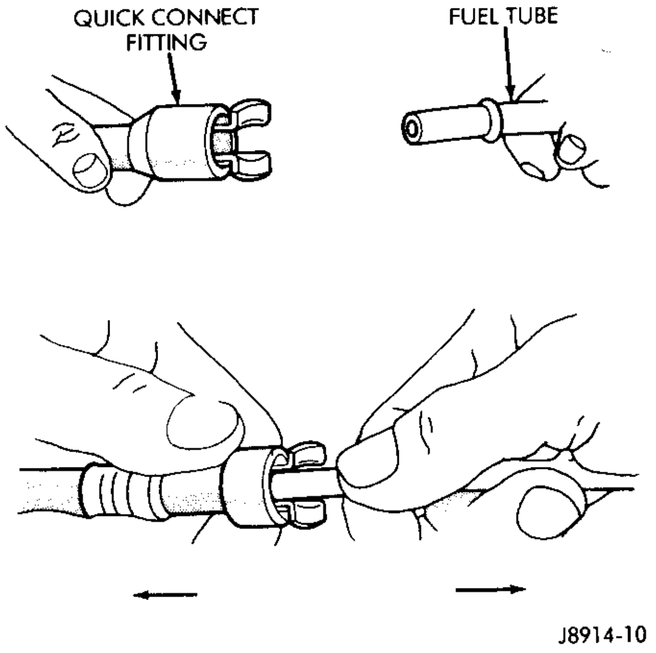


Fig. 19 Fuel Tube to Fitting Connection

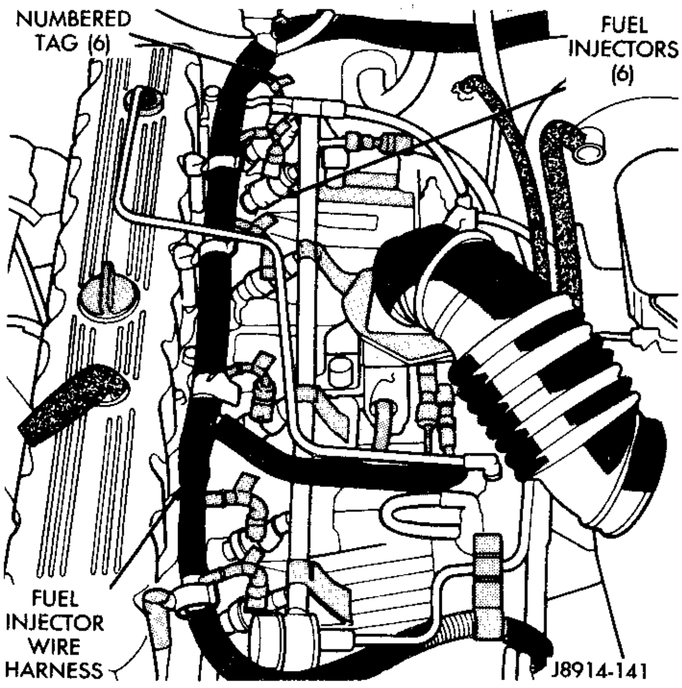


Fig. 20 Fuel Injector Harness

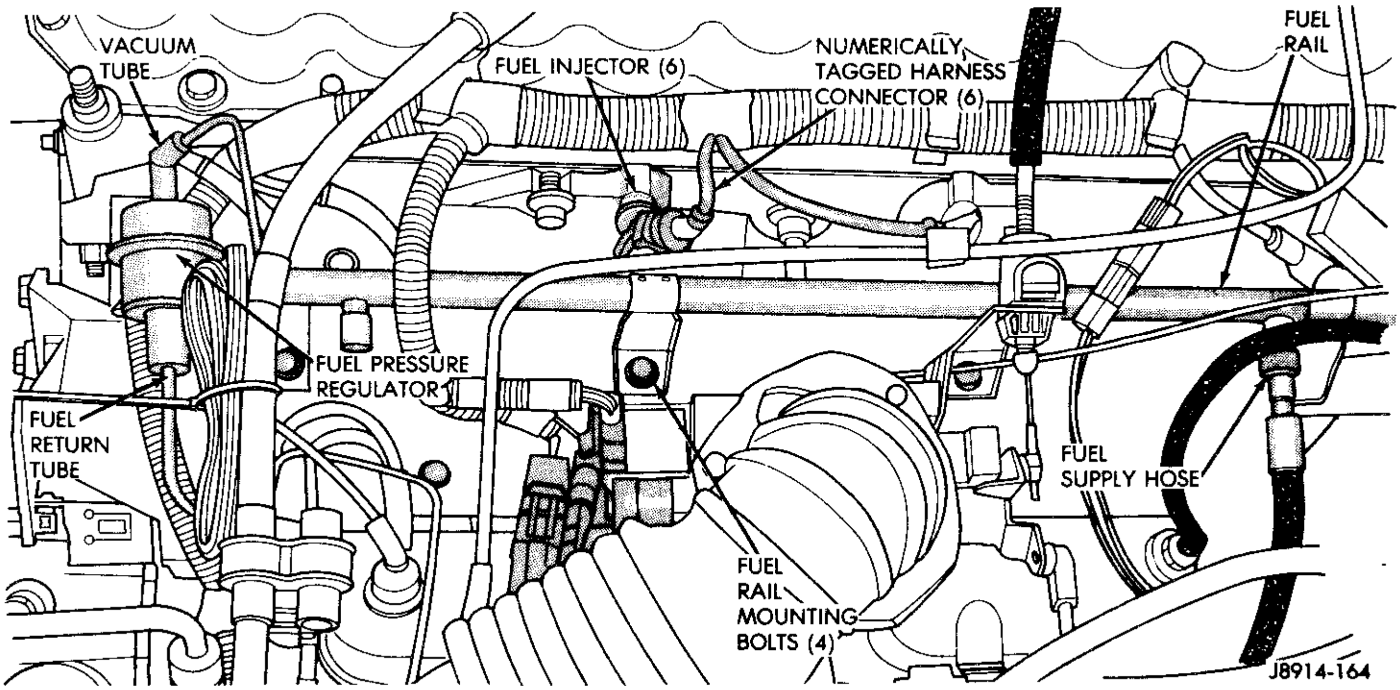


Fig. 21 Fuel Rail Assembly Remove/Install

Installation

(1) Install the fuel injector(s) into the fuel rail assembly and install retaining clip(s).

(2) Install fuel rail. Refer to Fuel Rail Installation in this section.

(3) Install fuel tank cap.

(4) Connect battery negative cable to battery negative post.

FUEL PRESSURE REGULATOR

Removal

(1) Remove fuel tank cap.

(2) Perform MPI Fuel System Pressure Release Procedure.

(3) Disconnect battery negative cable from battery.

(4) Remove the fuel rail. Refer to Fuel Rail Removal in this section.

(5) Remove the fuel pressure regulator retaining screws and remove the regulator from the fuel rail (Fig. 23).

Installation

An O-ring kit for the fuel pressure regulator is available through the Parts department. One of the black O-ring seals contained in the kit is to be installed on the fuel pressure regulator before installation.

(1) Install pressure regulator into the fuel rail. Tighten mounting screws securely.

(2) Install fuel rail. Refer to Fuel Rail Installation in this section.

(3) Install fuel tank cap.

(4) Connect battery negative cable to battery negative post.

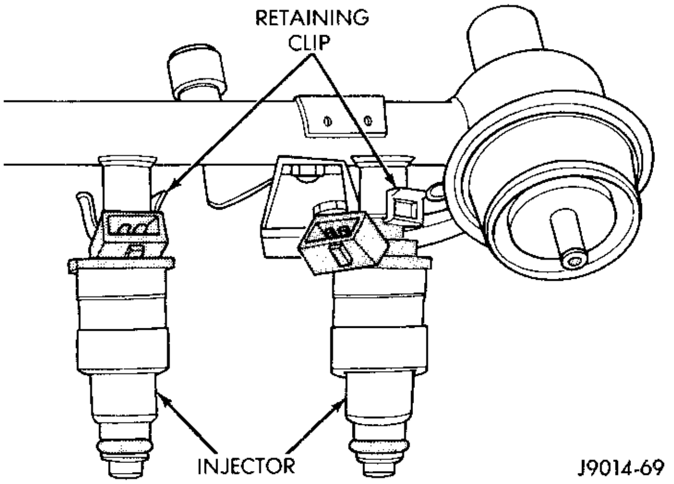


Fig. 22 Injector Retaining Clips

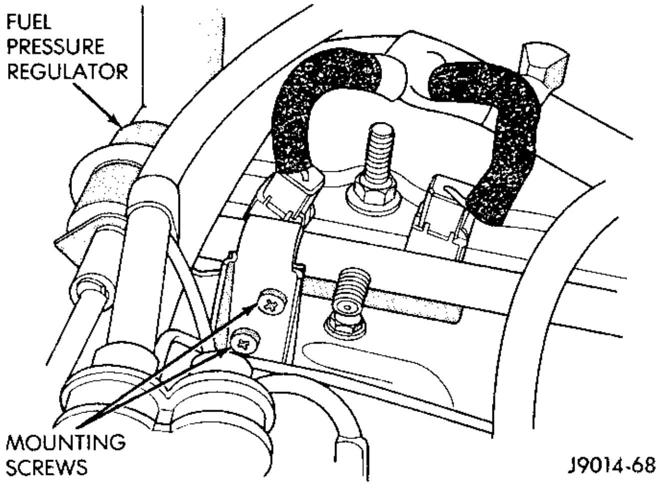


Fig. 23 Fuel Pressure Regulator Remove/Install

MPI SERVICE ADJUSTMENTS

INDEX

THROTTLE POSITION SENSOR (TPS) ADJUSTMENT

This throttle position sensor adjustment uses a digital volt meter. The TPS adjustment can also be preformed using the DRBII Service Diagnostic Tester and is the preferred method. Refer to the tester manual for adjustment procedure.

The TPS used on vehicles equipped with an automatic transmission has two wire harness connectors. The 4 terminal TPS connector is used to adjust the TPS. On vehicles equipped with manual transmissions, only one wire harness connector is used and it connects directly to the TPS.

Manual Transmission

The TPS terminals are marked A,B, and C on the back of the harness connector.

(1) Turn the ignition key to the ON position.

Do not unfasten the sensor wire harness connector (Fig. 1). Without damaging the sensor wires, insert the voltmeter test leads through the back of the wire harness connector to make contact with sensor terminals.

(2) Check the sensor input voltage. Insert the negative lead of the voltmeter into the back of terminal (B) and the positive lead of the voltmeter into the back of terminal (A). Ensure that the throttle plate (valve) is completely closed against the idle stop. Note the sensor input voltage (across terminals A and B).

(3) Check sensor output voltage. Disconnect the voltmeter positive lead from sensor terminal (A) and connect it to terminal (C). Ensure that the throttle plate is in the closed position. Note the sensor output voltage reading on the voltmeter (across terminals B and C).

(4) Divide the output voltage reading by the input voltage reading. The desired ratio is .170. EXAMPLE: if the input voltage is 5 volts and the output voltage is .85 volts; divide 0.85 by 5 (0.85/5 = .17 or 17 percent).

(5) If necessary, adjust the TPS sensor until the correct ratio is obtained. To adjust input and output voltages, loosen the sensor bottom mounting screw and pivot the sensor for a large adjustment. Loosen the top sensor mounting screw and pivot the sensor for a fine adjustment. Adjust TPS until the correct ratio is obtained.

(6) Remove the voltmeter. Tighten sensor mounting screws securely.

Automatic Transmission

Use the four terminal connector to adjust the TPS (Fig. 2). The terminals are marked A, B, C and D on the connector.

(1) Turn the ignition key to the ON position.

Do not unfasten the sensor wire harness connector. Without damaging the sensor wires, insert the voltmeter test leads through the back of the wire harness connector to make contact with sensor terminals.

(2) Check TPS input voltage as follows. Locate terminal (D) and insert negative lead of voltmeter into the

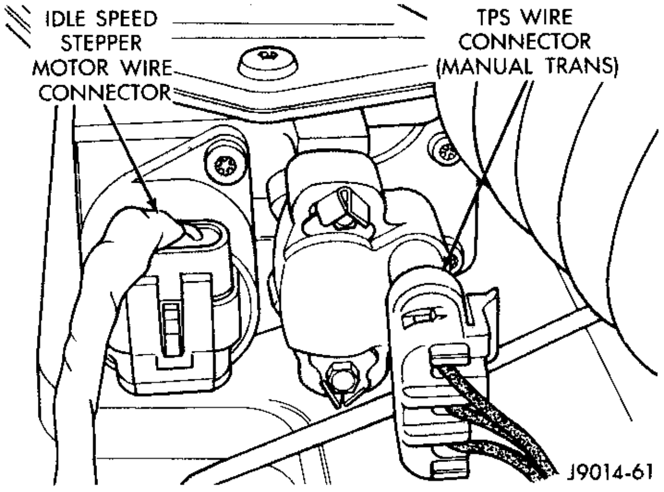


Fig. 1 TPS Adjustment—Manual Transmission

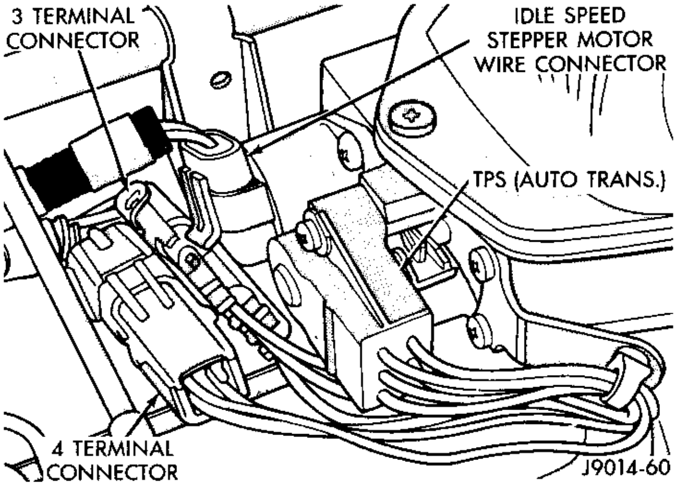


Fig. 2 TPS Adjustment—Automatic Transmission

back of it. Insert positive lead of voltmeter into the back of terminal (A). Note sensor input voltage (across terminals D and A).

(3) Check the TPS output voltage as follows. Disconnect voltmeter positive lead from sensor terminal A and insert it into the back of terminal B. Note sensor output voltage (across terminals B and D).

(4) Divide the output voltage reading by the input voltage reading. The desired ratio is .825 to .835 (.830 desired). EXAMPLE: if the input voltage is 5 volts and the output voltage is 4.15 volts; divide 4.15 by 5 (4.15/5 = .83 or 83 percent).

(5) If necessary, adjust the TPS sensor until the correct ratio is obtained. To adjust input and output voltages, loosen the sensor bottom mounting screw and pivot the sensor for a large adjustment. Loosen the top sensor mounting screw and pivot the sensor for a fine adjustment. Adjust TPS until the correct ratio is obtained.

(6) Remove the voltmeter. Tighten sensor mounting screws to 5.65 N•m (50 in-lbs).

BBD CARBURETOR

INDEX

GENERAL INFORMATION

YJ vehicles with the 4.2 liter (258 CID) six-cylinder engine are equipped with a model BBD two-venturi, feedback type carburetor.

The microprocessor controlled stepper motor included with this carburetor has two tapered metering pins. Each metering pin is moved in and out of the carburetor air cavity to achieve the proper air/fuel ratio.

CARBURETOR CIRCUITS

Five conventional circuits are used: Float (fuel inlet) Circuit, Idle (Low Speed) Circuit, Main (High Speed) Circuit, Pump Circuit, and Choke Circuit.

Float (Fuel Inlet) Circuit

The float circuit maintains the specified fuel level in the bowl to provide sufficient fuel to metering circuits for all engine operating conditions (Fig. 1).

Fuel flows into the bowl through a needle and seat assembly controlled directly by dual floats hinged to the float fulcrum pin. When the fuel in the bowl fills to the proper level, the float lever pushes the needle toward its seat and restricts incoming fuel, admitting only enough to replace that being used.

Idle (Low Speed) Circuit

Fuel for idle and early part-throttle operation is metered through the idle circuit. Fuel flows through main metering jets into the main wells and continues through the idle fuel pickup tube where fuel mixes with air entering through the idle air bleeds located in the venturi cluster screws (Fig. 2).

At curb idle, this air-fuel mixture flows down the idle channel and is further mixed with air entering the idle channel through the transfer slot which is above the position of the throttle valve at curb idle. The mixture discharged then passes the idle mixture adjustment screw which controls the volume of mixture discharged below the throttle valve.

During low speed operation, the throttle valve moves to expose the transfer slot as well as the idle port. This increased airflow creates a low pressure in the venturi and the main metering system begins to discharge fuel.

Main (High Speed) Metering Circuit

At part throttle and cruising speed, increased airflow through the venturi creates a low pressure area in the venturi. Since air above the fuel level in the bowl is at normal pressure, fuel flows to the lower pressure area created by the venturi and magnified by the booster venturi.

The fuel flow moves through the main jets to the main well. Air enters through the main well air bleeds. The

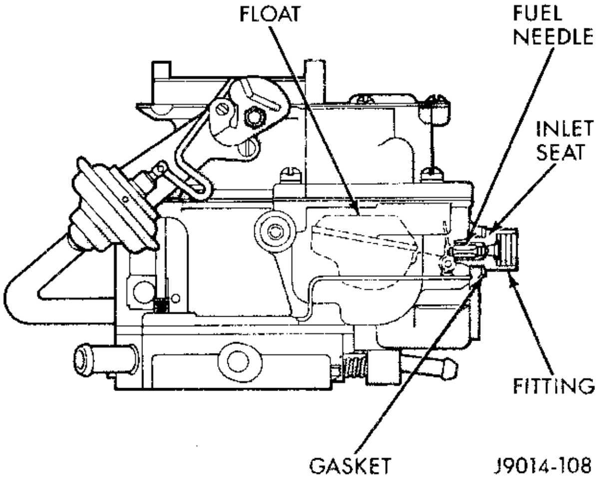


Fig. 1 Float Circuit

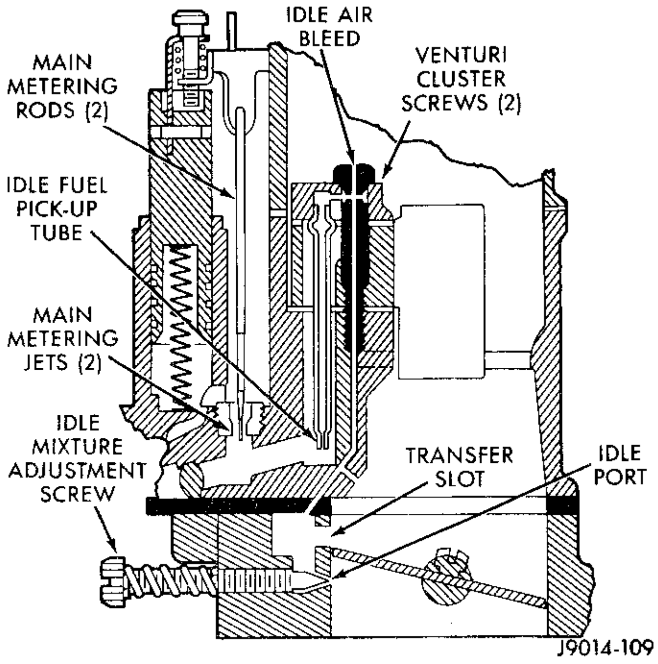


Fig. 2 Idle Circuit

resulting mixture of fuel and air is lighter than raw fuel, responds more quickly to changes in venturi vacuum, and is more readily vaporized when discharged into the venturi (Fig. 3).

Main Metering Circuit Enrichment

During heavy or high speed operation, the air-fuel ratio must be enriched to provide increased engine power.

Fuel enrichment is accomplished by means of two calibrated metering rods connected to a single manifold vacuum actuated piston (Fig. 3). The metering rod piston rides on a calibrated spring that functions to maintain the piston at the top of its cylinder. This allows only the smallest diameter of the tapered metering rods to extend into the main metering jets and permits maximum fuel flow through the jets to the main well cavities.

At idle, partial throttle or cruise conditions when manifold vacuum is high, the piston is drawn sown into the vacuum cylinder against calibrated spring tension and the larger diameters of the metering rods extend into the main metering jets, restricting the fuel flow to the main well cavities. An additional control is provided by the rod lifter on the accelerator pump rod. This provides a direct relationship between metering rod position and throttle valve opening.

Pump (Acceleration) Circuit

When the throttle is opened suddenly, airflow response through the carburetor is almost immediate. There is a brief time lag before fuel inertia can be overcome. This lag causes the desired air-fuel ratio to be leaned out.

A piston-type accelerating pump system mechanically supplies the fuel necessary to compensate for this deficiency (Fig. 4).

Fuel is forced into the pump cylinder from the fuel bowl past the pump piston on the upward movement of the accelerator pump shaft. When the engine is turned off, fuel vapors in the pump cylinder vent through the area between the pump rod and pump piston.

As the throttle lever is moved, the pump link, operating through a system of levers and assisted by the pump drive spring, pushes the pump piston down. Fuel is forced through a passage, past the pump discharge check valve ball, and our the pump discharge jets in the venturi cluster.

Choke Circuit

The choke valve, located in the air horn assembly, provides a high vacuum both above and below the throttle valve when closed. During engine start, vacuum above the throttle valve causes fuel to flow from the main metering and idle circuits and provides the richer air-fuel mixture ratio needed for cold engine starting (Fig. 5).

The choke shaft is connected by linkage to a bimetallic coil located within the choke cover, which winds up (contracts) when cold and unwinds (expands) when heated. When the engine is cold, the tension of the coil holds the choke valve closed. When the engine starts, manifold vacuum is applied to the diaphragm assembly to open the choke valve slightly. This is referred to as the initial choke valve clearance.

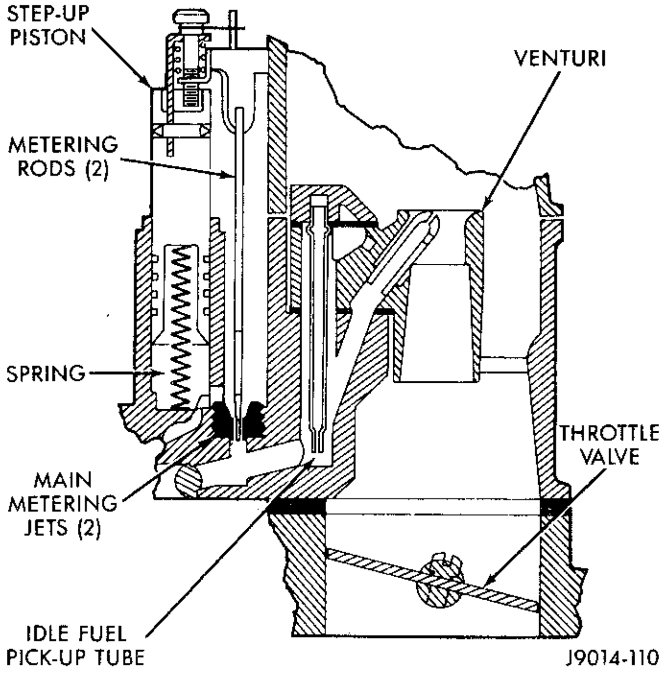


Fig. 3 Main Metering Circuit

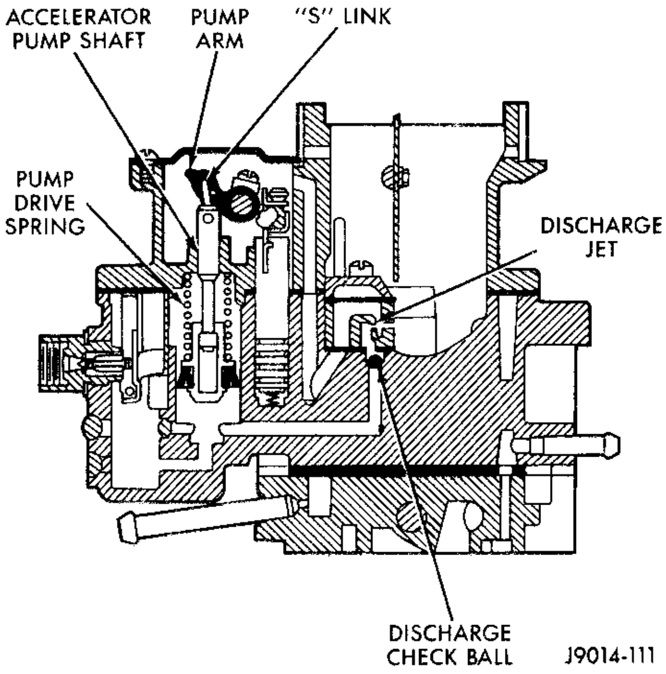


Fig. 4 Pump Circuit

As the coil is warmed by the electric heater (Fig. 6), it expands and exerts pressure to further open the choke valve, keeping it fully open normal engine operating temperature.

If the engine is accelerated during the warm-up period, the corresponding drop in the manifold vacuum allows the coil to momentarily close the choke valve to provide a richer air-fuel mixture.

A faster idle speed is provided to prevent stalling during warm-up. The fast idle cam, actuated by the choke shaft through the connecting linkage, rotates into position against the fast idle screw. The cam is progressively stepped to provide the correct idle speed in proportion to the choke valve opening. When the choke valve reaches its fully open position, the cam rotates free of the fast idle screw and allows the throttle lever to return to the curb isle speed position when released.

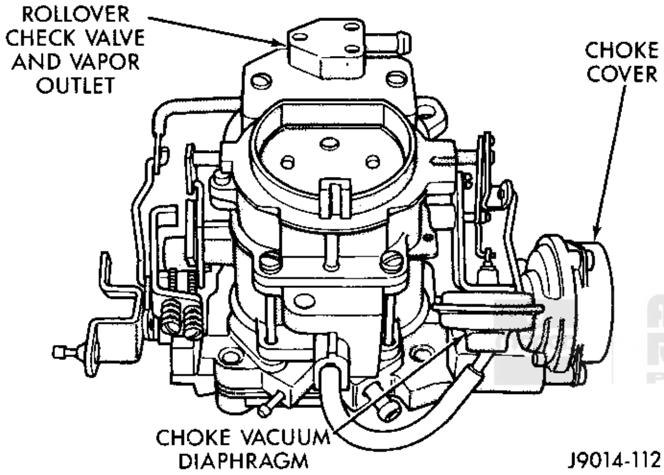


Fig. 5 Choke Circuit Components

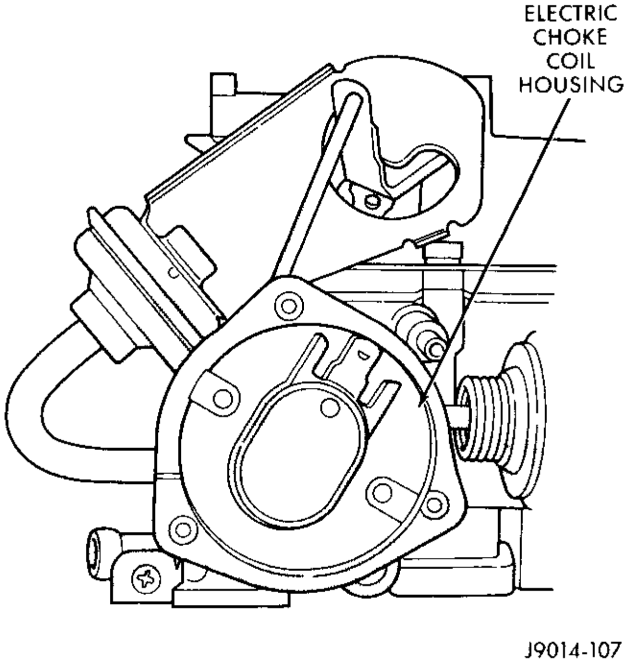


Fig. 6 Electric Choke Coil

If the engine is flooded during starting, the choke valve may be opened to vent excess fuel by depressing the accelerator pedal to the floor and cranking the engine via the starter motor. With the accelerator linkage in this position, a tang on the throttle lever contacts the fast idle cam and causes the choke rod to move upward to open the choke valve a predetermined distance.

The electric choke is controlled by the oil pressure switch. When oil pressure is below 27.6 kPa (4 psi), the switch is open preventing current from reaching the coil. When oil pressure is above 27.6 kPa (4 psi) the switch closes and current is applied to the coil. Refer to group 8W—Wiring Diagrams for circuit schematic.

Idle Speed Control

The idle speed control Sole-Vac throttle (Fig. 7) positioner is part of the BBD carburetor assembly. It is activated in two ways, by an electric holding solenoid and by pneumatic vacuum actuator. The holding solenoid is capable of maintaining a preset throttle position, but does not have the capability of moving the throttle out to a new position. However, the vacuum actuator portion of the Sole-Vac throttle positioner is capable of moving the throttle to a new position when manifold vacuum is applied to it. Once the throttle is positioned by the vacuum actuator, the holding solenoid maintains the position.

The Sole-Vac throttle positioner has three positioner has three positions: Off or deactivated position (curb idle); holding solenoid position; and vacuum actuator position. Manifold vacuum stored in a reservoir is applied to the vacuum actuator through an electric vac-

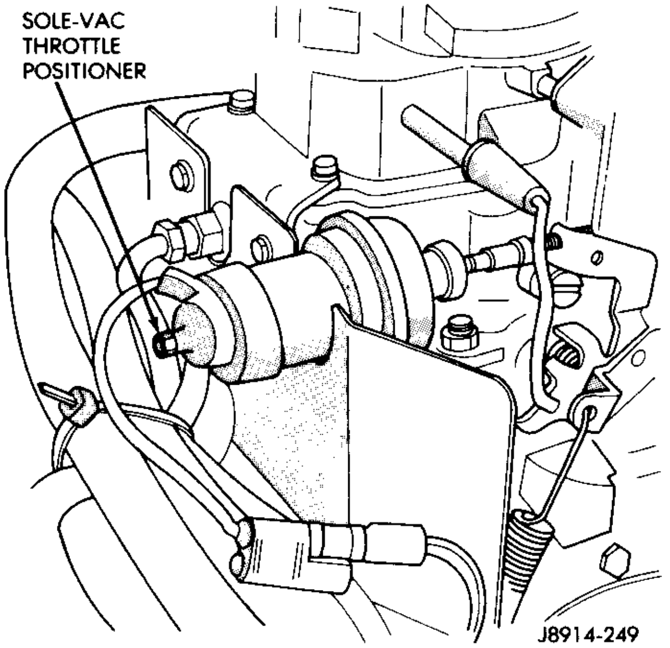


Fig. 7 Sole-Vac Throttle Positioner

uum switching solenoid. The solenoid is controlled by the CEC system microprocessor.

The holding solenoid is energized if either the intake manifold (EFE) heater, air conditioner or rear window defogger are in use; the vacuum actuator is engaged if the air cleaner air temperature is below approximately 16°C (60°F). When the temperature of the air in the air cleaner is above 16°C (60°F), the vacuum actuator is disengaged and when engine idle speed drops below the calibrated minimum speed (Auto trans: 435 ± 10 RPM, Manual trans: 563 ± 10 RPM). The vacuum actuator changes the throttle position through the idle solenoid. Two (2) seconds after the idle solenoid is energized by the idle speed relay, the holding solenoid is energized. The holding solenoid remains energized until the four (4) inch vacuum solenoid is tripped for 2.5 seconds. The engine then returns to curb idle speed. If the four (4) inch vacuum switch is not tripped, the idle speed will remain controlled by the holding solenoid. **Refer to FUEL FEEDBACK SYSTEMS—4.2L ENGINE in this group for additional information regarding the Fuel Feedback System, Four (4) inch vacuum solenoid, idle speed relay, and idle solenoid.**

BBD CARBURETOR

Removal

(1) Disconnect battery negative cable from negative post.

(2) Remove fuel tank cap.

(3) Remove air cleaner.

(4) Identify and tag all hoses attached to carburetor for reference to aid during installation.

(5) Remove throttle cable from throttle lever and disconnect vacuum hoses, return spring, PCV valve hose, fuel pipe, choke heater wire connector, stepper motor wire connector, bowl cooler deflector (if equipped) and Sole-Vac solenoid wire connector (Fig. 8).

(6) Remove carburetor mounting nuts.

(7) Remove carburetor.

(8) Remove carburetor gasket from spacer.

Installation

(1) Clean gasket mating surfaces. Install a replacement gaskets and spacer.

(2) Position carburetor on spacer and gasket. **To prevent leakage, distortion or damage to carburetor body flange, alternately tighten mounting nuts in a crisscross pattern in increments of 9 N•m (7 ft-lbs) torque once the carburetor is installed.**

Install carburetor and tighten mounting nuts to 22 N•m (16 ft-lbs) torque.

(3) Connect fuel supply tube, throttle cable, choke heater wire connector, PCV valve hose, return spring, stepper motor wire connector, all the vacuum hoses and Sole-Vac solenoid wire connector to carburetor.

(4) Install air cleaner.

(5) Adjust the engine idle speed, idle mixture (if necessary) and idle speed control (Sole-Vac) solenoid. Refer to Idle Speed and Mixture Adjustment procedures.

CHOKE MECHANISM

Disassembly

The choke mechanism on model BBD carburetors cannot be serviced with the carburetor installed on the engine. The carburetor must be removed to properly service the choke components.

Throughout the BBD carburetor choke mechanism procedures each component is referred to by name and the number associated with it in Fig. 11 and the Parts Identification List.

(1) Note and record the color and position of the choke housing index key (Fig. 9) for assembly reference. The key color indicates the basic choke setting.

(2) Grind off heads of choke cover rivets and remove retainer (26), choke cover and coil (25), gasket (24), and baffle (23). Remove the remaining portion of the rivets after removing the cover (Fig. 10).

(3) Remove the choke lever screw and the choke lever (27).

(4) Disconnect choke rod (48) and remove choke shaft (48) from choke housing (22).

(5) Clean and polish the choke shaft (48) and the shaft bore in the housing with crocus cloth.

(6) Inspect the choke cover and coil (22). Replace both components as an assembly if either part is damaged. Replace the cover gasket (24) if damaged and replace the choke lever (27) or baffle (23) if they are damaged.

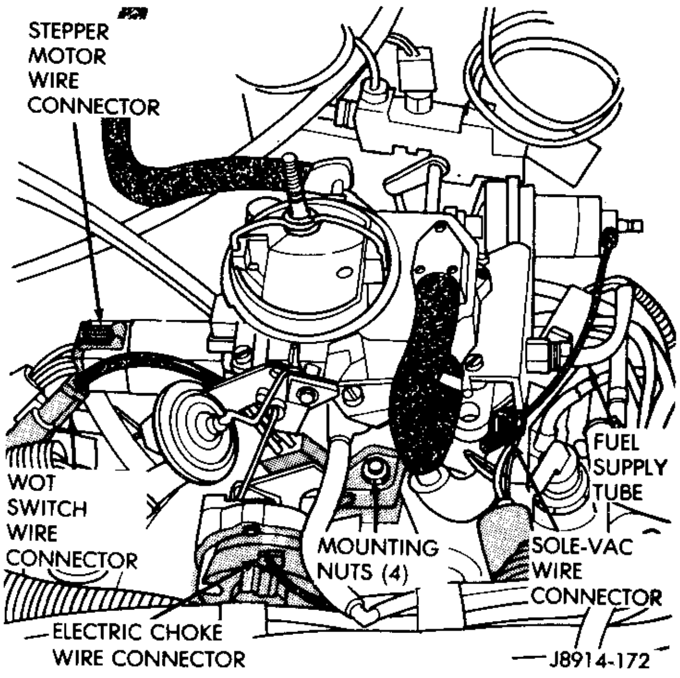


Fig. 8 BBD Carburetor Remove/Install

Assembly

(1) Install the choke shaft (48) in the housing and connect the choke rod (48) to the shaft.

(2) Install the choke lever (27) and lever attaching screw.

(3) Install the choke baffle (23), gasket (24), cover and coil (22), and index key. Ensure that the key notch in the cover is aligned with the index key tang.

(4) Install the choke cover retainer (26). Secure the retainer and cover with screws. Do not tighten the screws completely at this time.

(5) Position the choke cover (25) at the following basic setting as indicated by index key color:

- GOLD INDEX KEY — set the choke index at 0
- RED INDEX KEY — set the choke index at one-notch rich
- GREEN INDEX KEY — set the choke index at two-notches rich

(6) Tighten the choke cover screws.

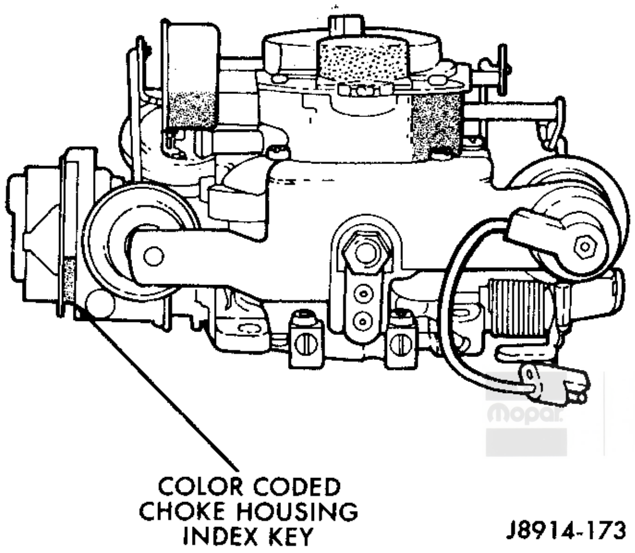


Fig. 9 Choke Housing Index Key—BBD Carburetor

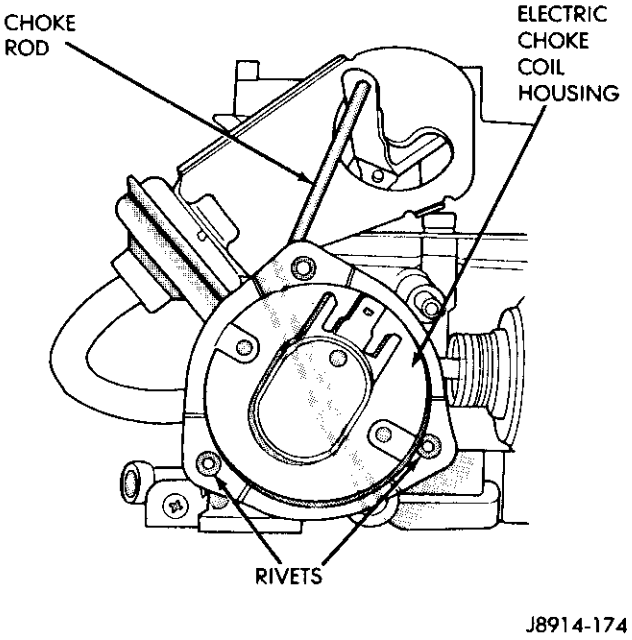


Fig. 10 Choke Cover Rivets—BBD Carburetor

COMPLETE CARBURETOR OVERHAUL

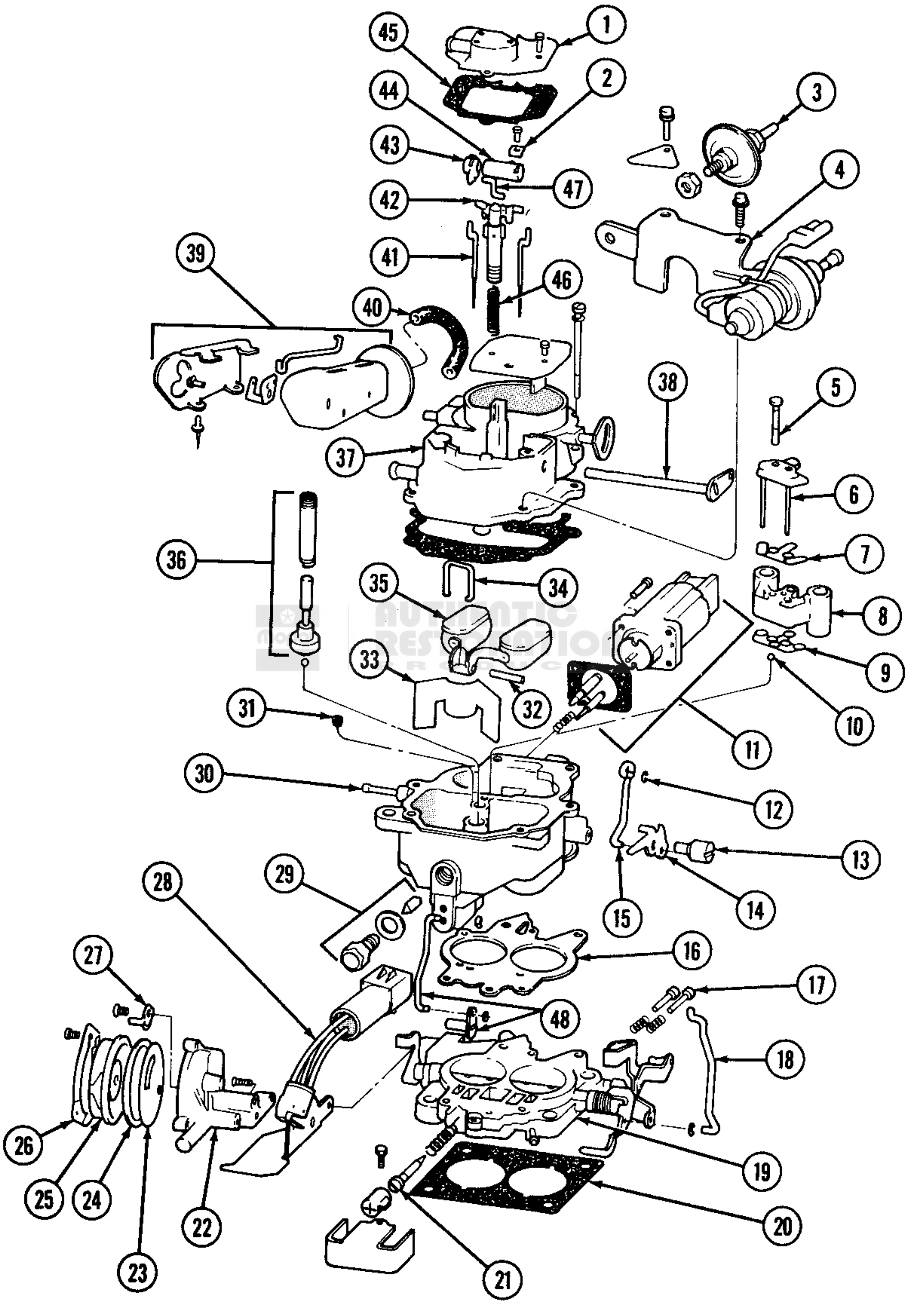
Overhaul information

Throughout the BBD carburetor overhaul procedures each component is referred to by name and the number associated with it in Fig. 11 and the Parts Identification List.

Parts Identification List

1. ROLLOVER CHECK VALVE AND BOWL VENT
2. LOCK
3. DASHPOT
4. SOLENOID AND BRACKET
5. CLUSTER SCREW
6. IDLE FUEL PICKUP TUBE
7. GASKET
8. VENTURI CLUSTER
9. GASKET
10. CHECK BALL (SMALL)
11. STEPPER MOTOR (ACTUATOR)
12. CLIP
13. SCREW
14. FAST IDLE CAM
15. CHOKE LINK
16. GASKET
17. SCREW
18. PUMP LINK
19. THROTTLE BODY
20. FLANGE GASKET
21. IDLE MIXTURE SCREW
22. CHOKE HOUSING
23. BAFFLE
24. GASKET
25. CHOKE COIL
26. RETAINER
27. LEVER
28. WIDE OPEN THROTTLE SWITCH AND BRACKET
29. NEEDLE AND SEAT ASSEMBLY
30. MAIN BODY
31. MAIN METERING JET
32. PIN
33. BAFFLE
34. FULCRUM RETAINER
35. FLOAT
36. SPRING AND ACCELERATOR PUMP PLUNGER
37. AIR HORN
38. ACCELERATOR PUMP LEVER
39. CHOKE VACUUM DIAPHRAGM AND HOUSING
40. HOSE
41. METERING ROD
42. VACUUM PISTON
43. PUMP ARM
44. ROD LIFTER
45. GASKET
46. SPRING
47. S-LINK
48. CHOKE ROD AND SHAFT

J8914-176



J8914-175

Fig. 11 Model BBD Carburetor

SPECIFICATIONS

Model BBD Carburetor Idle Speed Specifications

Displacement and Carburetion	Trans.	Curb Idle Speed—RPM (Auto in Drive, Manual in Neutral)		Sole-Vac Adjustment		
				Vacuum Actuator Energized	Holding Solenoid Energized	
		Set To	OK Range	Set To		OK Range
258 CID 2V	M	680	±50	1100	900	±50
	A	600	±50	900	800	±50

J8914-168

Model BBD Carburetor Mixture Adjustment Specifications

Displacement and Carburetion	Transmission	Application	Idle Drop
258 CID 2V	Manual	All	50 rpm
	Automatic	All	50 rpm

J8914-169

Model BBD Carburetor Specifications

List Number	258 (2V) Application		Float Level		Vacuum Piston Gap		Initial Choke Valve Clearance		Fast Idle Cam Setting		Automatic Choke Cover Setting (Notches Rich)		Accelerator Pump Dimension		Choke Unloader	Fast Idle Speed (RPM)		Bowl Vent Starts To Open	Choke Bi-Metal ID	Choke
	Model	Trans.	Set To	OK Range	Set To	OK Range	Set To	OK Range	Set To	OK Range	Set To	OK Range	Set To	OK Range	(Min)	Set To	OK Range			
8383	81	Auto.	6.35 mm (0.25 in)	5.56-7.14 mm (0.218-0.282) in)	0.9 mm (0.035-in)	0.5-1.3 mm (0.020-0.050) in)	3.5 mm (0.140 in)	3.18-3.97 mm (0.125-0.155 in)	2.4 mm (0.095 in)	2.0-2.8 mm (0.080-0.110 in)	NON-ADJUSTABLE	1/2 1-1/2	13.1 mm (0.520 in)	12.7-13.6 mm (0.500-0.540 in)	7.1 mm (0.280 in)	1850	1950-1750	2nd Step	ET	TR
8384	81	Man	6.5 mm (0.25 in)	5.56-7.14 mm (0.218-0.282) in)	0.9 mm (0.035-in)	0.5-1.3 mm (0.020-0.050) in)	3.5 mm (0.140 in)	3.18-3.97 mm (0.125-0.155 in)	2.4 mm (0.095 in)	2.0-2.8 mm (0.080-0.110 in)		1/2 1-1/2	13.1 mm (0.520 in)	12.7-13.6 mm (0.500-0.540 in)	7.1 mm (0.280 in)	1700	1800-1600	2nd Step	ET	TR

J9014-126

Model BBD Carburetor Calibrations

List Number	8383	8384
Throttle Bore Size	36.5mm (1.44 in)	36.5mm (1.44 in)
Main Venturi Valve	27mm (1.0625 in)	27mm (1.0625 in)
Fuel Inlet Diameter	2.6mm (0.101 in)	2.6mm (0.101 in)
Low Speed Jet (Tube)	0.75mm (0.0295 in)	0.75mm (0.0295 in)
Economizer	1.5mm (0.059 in)	1.5mm (0.059 in)
Idle Air Bleed	1.7mm (0.067 in)	1.7mm (0.067 in)
Mainjet Size	2.35mm (0.092 in)	2.35mm (0.092 in)
Accelerator Pump Jet	0.85mm (0.033 in)	0.85mm (0.033 in)
Main Metering Jet Number	120-392	120-392
Metering Rod Number	75-2384	75-2384

J8914-171

Code Number/Build Date Identification

The carburetor is identified by a code number and a build date stamped on the identification tag (Fig. 12). Each carburetor build month is coded alphabetically beginning with the letter A in January and ending with the letter M in December (the letter I is not used). The tag is attached to the carburetor air horn and must remain there to assure proper carburetor identification.

The following procedures apply to a complete overhaul with the carburetor removed from the engine. Throughout the BBD carburetor overhaul procedures each component is referred to by the name and number associated with it in Fig. 11 and the Parts Identification List.

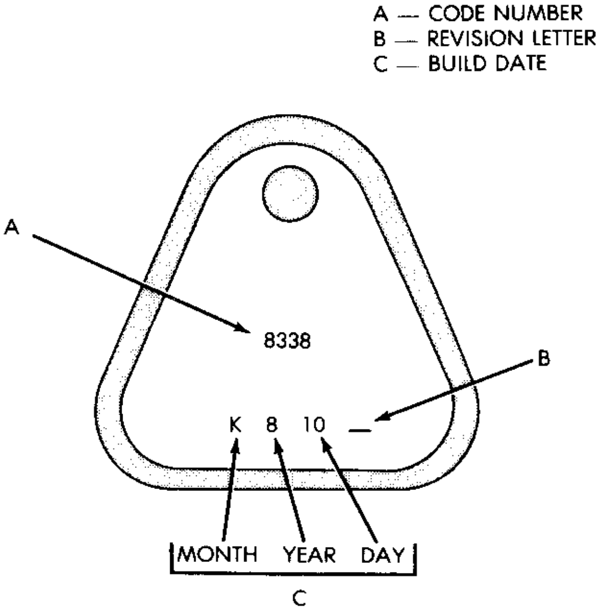


Fig. 12 Build Date Tag—Model BBD Carburetor

A complete disassembly is not necessary for adjustments. In most instances, service adjustments of the individual circuits may be completed without removing the carburetor from the engine.

A complete carburetor overhaul includes:

- Disassembly,
- Thorough cleaning and inspection,
- Replacement of all gaskets, and worn or damaged components, and,
- Assembly.

It also includes idle speed adjustment, idle mixture adjustment (if necessary) and fast idle speed adjustment after the carburetor is installed.

When using an overhaul kit, use all parts included in the kit.

CAUTION: Flooding, hesitation on acceleration, and other performance problems are in many instances caused by the presence of dirt, water or other foreign matter in the carburetor. To aid in diagnosing a problem, carefully remove the carburetor from the engine without removing the fuel from the bowl. Examine the bowl contents for contamination as the carburetor is disassembled.

Carburetor Disassembly

(1) Place the carburetor on a repair stand to protect the throttle valves from damage and to provide a stable work surface.

(2) Remove the stepper motor (11).

(3) Remove the retaining clip from the accelerator pump arm link (18) and remove the link (Fig. 13).

(4) Remove the cover containing the rollover check valve and bowl vent (1), and gasket (45) from the top of the air horn (37).

(5) Remove the screws and locks from the accelerator pump arm (43) and vacuum piston rod lifter (44).

(6) Slide the accelerator pump lever (38) out of the air horn. Remove the pump arm (43) and rod lifter (44) and "S" link (47).

(7) Remove the vacuum piston (42) and metering rods (41) by lifting them straight up and out of the air horn as an assembly (Fig. 14).

(8) Remove the vacuum piston spring (46) from bore in main body (30).

(9) If the air horn (37) is to be immersed in cleaning solution, rotate the bowl vent assembly up and out of the bowl as far as possible to gain access to the rubber valve seal (Fig. 15). Carefully remove the valve seal from the lever.

(10) Disconnect the clips and remove the link from the choke housing lever (27) and choke lever arm (Fig. 16).

(11) Remove the screw and lever from the choke shaft.

(12) Remove the vacuum hose (40) between the carburetor main body and the choke vacuum diaphragm.

(13) Remove the choke vacuum diaphragm, linkage and bracket assembly (39). Place the diaphragm aside to be cleaned separately.

(14) Remove the fast idle cam retaining screw (13). Remove the fast idle cam (14), choke linkage (15), and clip (12).

(15) Grind the heads off the choke cover rivets. Remove the choke housing cover (25), retainers (26) and the remaining portion of the rivets. Remove the gasket (24), and baffle (23).

(16) Remove the choke housing (22) from the throttle body (19).

(17) Remove the air horn retaining screws and lift the air horn (37) straight up and away from the main body (30) (Fig. 17).

(18) Remove the Sole-Vac solenoid (4). Discard the air horn to main body gasket.

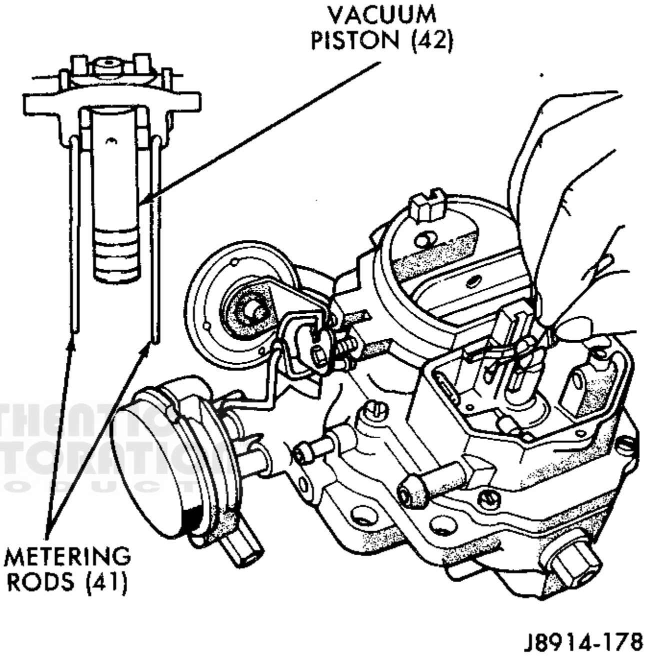


Fig. 14 Vacuum Piston and Metering Rods Removal

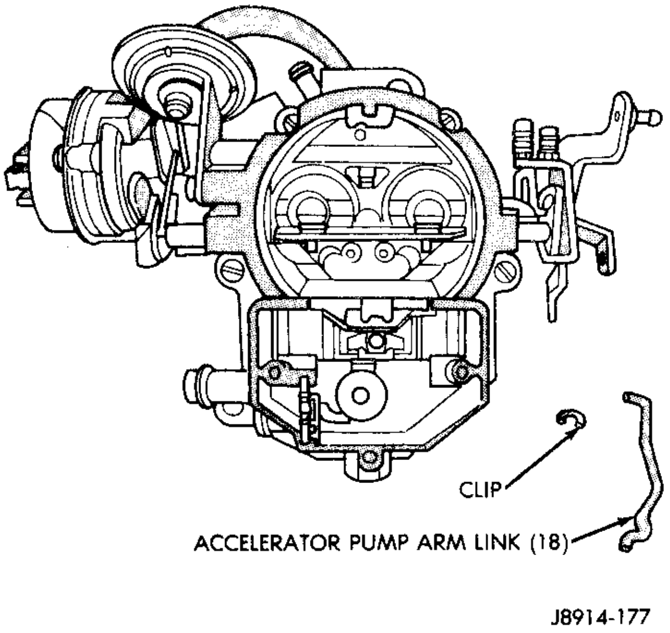


Fig. 13 Accelerator Pump Link Removal

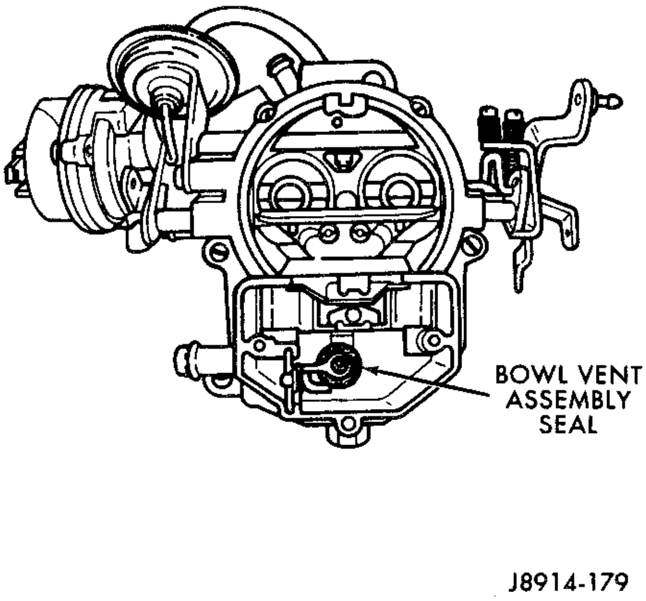


Fig. 15 Bowl Vent Assembly Seal Removal

(19) Remove the accelerator pump, spring and ball (36) from the main body.

(20) Remove the fuel inlet needle valve, seat, and gasket assembly (29) from the main body.

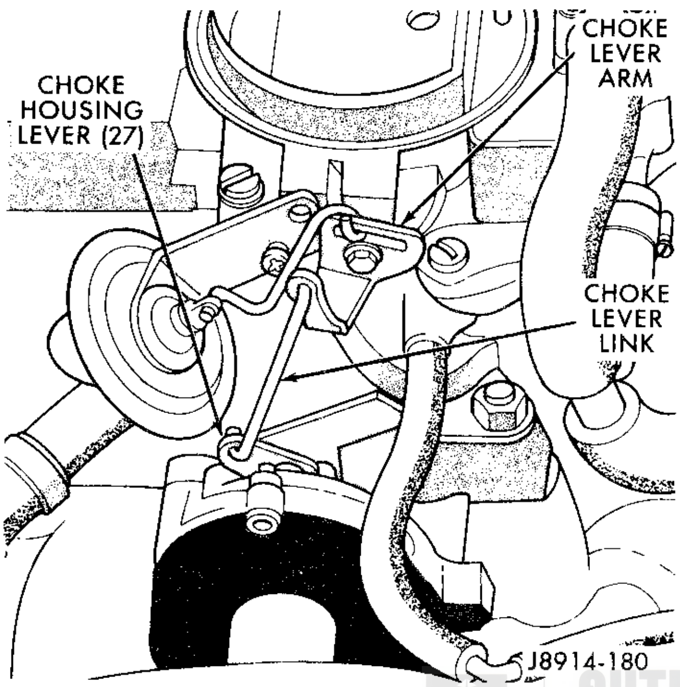


Fig. 16 Choke Lever Link Removal

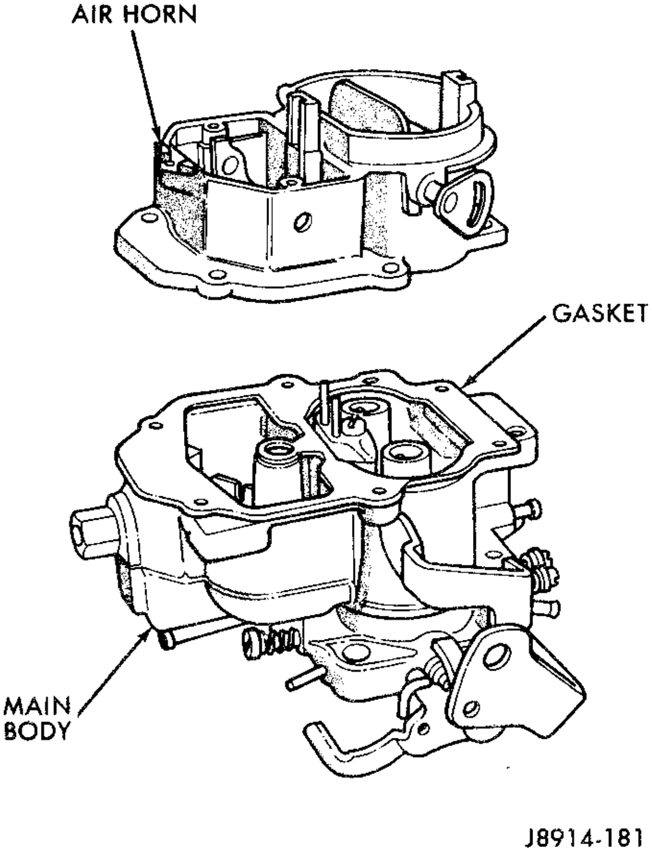


Fig. 17 Air Horn Removal

(21) Lift out the float fulcrum pin retainer (34) and baffle (33). Lift out the floats (35) and fulcrum pin (32) (Fig. 18).

(22) Remove main metering jets (31) (Fig. 19).

(23) Remove the venturi cluster screws. Lift the venturi cluster (8) and gaskets (7), (9) away from the main body. Discard the gaskets.

Do not remove the idle orifice tubes or main vent tubes from the cluster.

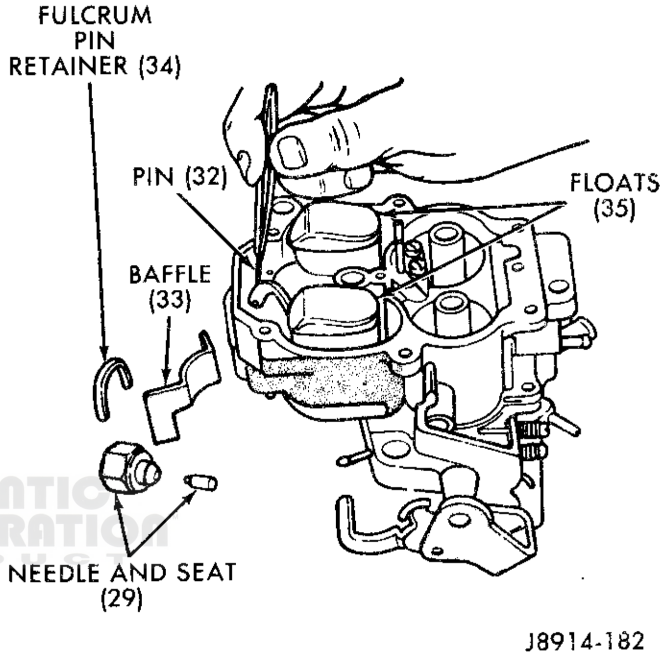


Fig. 18 Float Removal

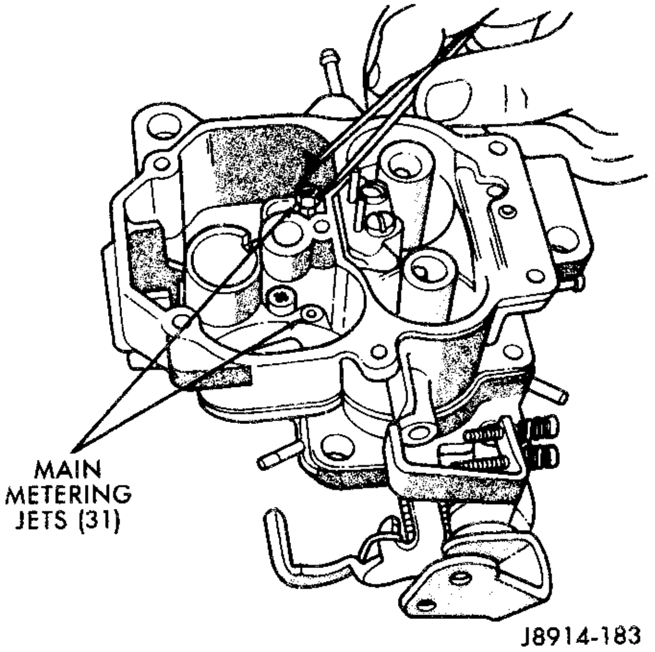


Fig. 19 Main Metering Jets and Venturi Cluster Removal

(24) Clean the tubes with cleaning solvent and dry with compressed air.

(25) Invert the carburetor main body and drop out the accelerator pump discharge check valve ball (10) (Fig. 20).

(26) Remove the screws attaching the throttle body (19) to the main body (30) and separate the bodies. Discard the gasket (16).

If it is necessary to remove the idle mixture adjustment screws because of inability to clean the passages with air pressure or by soaking, remove the dowel pins with a drill and punch.

Count the number of turns required to lightly seat each mixture screw (21) and record this for use during assembly. Remove the screws and springs from the throttle body.

Carburetor Cleaning and Inspection

Dirt, gum, water and carbon contamination in the carburetor or on exterior moving parts is often responsible for unsatisfactory engine performance. Efficient carburetion depends upon careful cleaning and inspection.

The cleaning and inspection procedures listed below do not involve those parts included in the carburetor overhaul/repair kit. Install all gaskets and parts included in the repair kit when the carburetor is assembled. Discard the original gaskets and parts.

CAUTION: Do not use a wire brush to clean any component. Do not use a drill bit or wire to clean out openings or passages. This may enlarge the passages and change the calibration of the carburetor.

(1) Wash all the components with the exception of the vacuum break diaphragm (39), Sole-Vac solenoid (4), bowl vent seal and stepper motor 11 in clean, commercial carburetor cleaning solvent. If a commercial solvent is not available, use mineral spirits, lacquer thinner or denatured alcohol. If a commercial solvent is used, rinse the components in hot water to remove all traces of the cleaning solvent, then blow dry with compressed air.

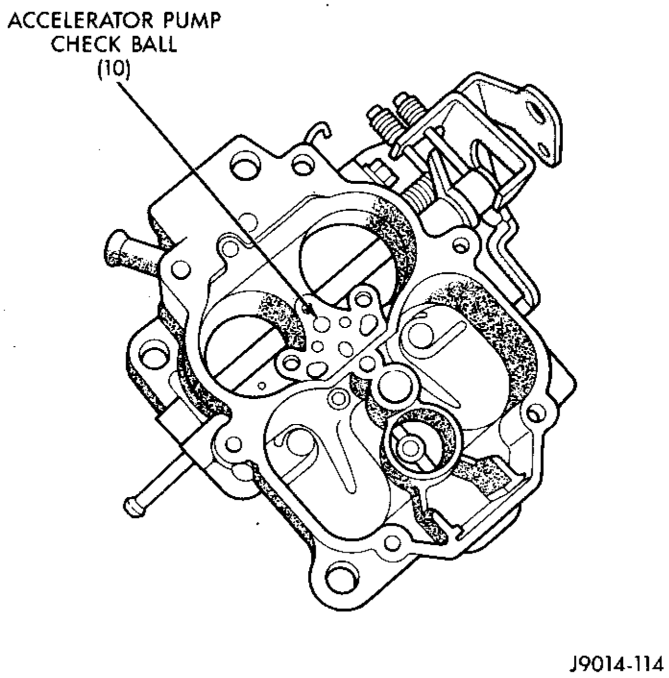


Fig. 20 Accelerator Pump Check Ball Removal

(2) Wipe the components that cannot be immersed in solvent with a clean, soft, dry cloth. Ensure that all dirt, gum, carbon and other foreign matter are removed from the components.

(3) Force compressed air through all carburetor passages.

(4) Inspect the choke shaft for excessive looseness or binding.

(5) Inspect the choke valve for nicked edges and for ease of operation.

(6) Inspect the throttle shaft for excessive looseness or binding in its bore.

(7) Inspect throttle valve for burrs or nicks that might prevent proper closing.

(8) Inspect the main body, throttle body, air horn, venturi assemblies, choke housing and choke cover for cracks.

(9) Replace the float if the arm needle contact surface is grooved.

(10) If the float is serviceable, polish the needle contact surface of the arm with crocus cloth or steel wool.

(11) Replace the float shaft if worn.

(12) Replace all damaged screws and nuts and all distorted or broken springs.

(13) Inspect all gasket mating surfaces for nicks or burrs.

(14) Replace any components that have damaged gasket surfaces.

Carburetor Assembly

(1) Ensure that all holes in the replacement gaskets have been properly punched and that no foreign material has adhered to the gaskets.

(2) If removed, install the idle mixture screws (21) and springs in the throttle body (19).

(3) Turn the idle mixture screws lightly against the seats. Then turn the idle mixture screws out the same number of turns counted and recorded during disassembly.

(4) Invert the main body (30). Place the throttle body (19) on the main body and align. Install the screws and tighten securely.

(5) Install accelerator pump ball, accelerator pump and spring assembly (36).

(6) Install the accelerator pump discharge check valve ball (10) in the discharge passage (Fig. 20).

(7) Test the accelerator pump circuit (Fig. 21).

- Pour clean no-lead fuel into the carburetor bowl 13mm (1/2-in) deep

- Insert the pump piston (36) into the pump cylinder and work the piston up and down gently to expel air from the pump passage
- With a suitable, clean brass rod, hold the discharge check valve firmly against its seat
- Raise the piston and press down.
- No fuel should be emitted from either the intake or discharge passages.

(8) Clean the passage and accelerator discharge check valve (ball) seat if leakage is evident. If leakage persists, replace the main body.

(9) Install replacement gaskets (7), (9), on the venturi cluster (8). Install the cluster screws and tighten securely.

(10) Install the main metering jets (31).

(11) Install the floats with the fulcrum pin (32) and fulcrum retainer (34) in the main body (Fig. 18).

(12) Install the inlet needle, seat, and gasket assembly (29). Tighten securely.

(13) Adjust the float level. Refer to Service Adjustment Procedures.

(14) Install the baffle plate (33).

(15) If not previously done when checking the testing the accelerator pump circuit, install the accelerator pump ball (36) into main body well.

(16) Place accelerator pump drive spring (36) on pump plunger shaft (36) and insert shaft into the air horn. Compress the spring and insert the S-link (47).

(17) Position a replacement gasket on the main body and install the air horn (37) and Sole-Vac solenoid (4). Tighten the retaining screws alternately to compress the gasket evenly.

(18) Place the vacuum piston spring (46) in the vacuum piston bore.

(19) Adjust the vacuum piston gap. Refer to Service Adjustment Procedures.

(20) Carefully install the vacuum piston and metering rod assembly (41), (42) into its bore in the air horn.

(21) Using light finger pressure, push down on the top of the vacuum piston screw to ensure that the metering rods (41) are inserted in the main metering jets and that the vacuum piston spring is installed in vacuum piston (42). The vacuum piston and metering rods assembly will slide up and down freely when installed correctly.

(22) Ensure that the metering rod spring is installed between the metering rods and metering rod bracket (Fig. 22).

(23) Rotate the bowl vent assembly up and out of the bowl and install the vent seal, if removed (Fig. 15).

(24) While preventing allow "S" (47) link from sliding out of accelerator pump shaft (36), install pump arm (43) onto "S" link.

(25) Place two of the plastic rod lifter tangs (44) under the vacuum piston yoke.

(26) Slide the accelerator pump lever shaft (38) through the rod lifter and pump arm.

(27) Install the accelerator pump shaft locks and adjusting screws (2), but do not tighten.

(28) Install the fast idle cam (14), choke linkage (15) and clip (12). Tighten the retaining screw (13) securely.

(29) Connect the accelerator pump linkage (18) to the accelerator pump lever (38) and throttle lever. Install retaining clip at throttle lever end of linkage.

(30) Adjust the vacuum piston and accelerator pump. Refer to Service Adjustment Procedures.

(31) Adjust the bowl vent. Refer to Service Adjustment Procedures.

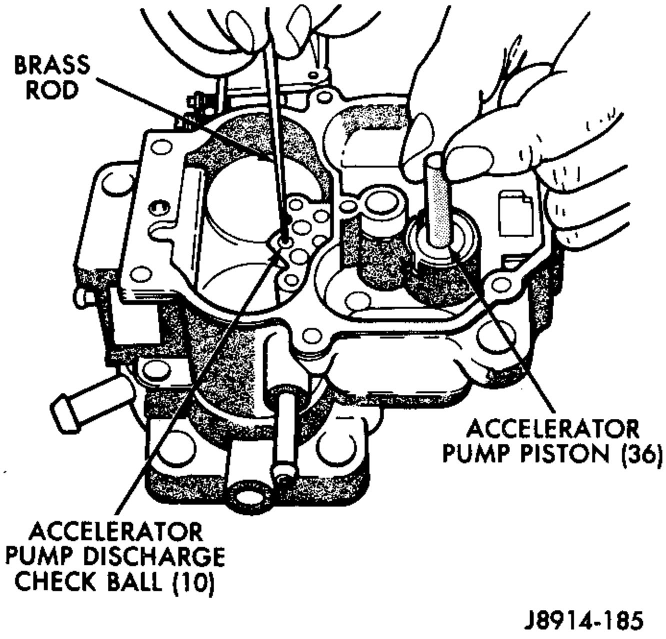


Fig. 21 Testing Accelerator Pump Circuit

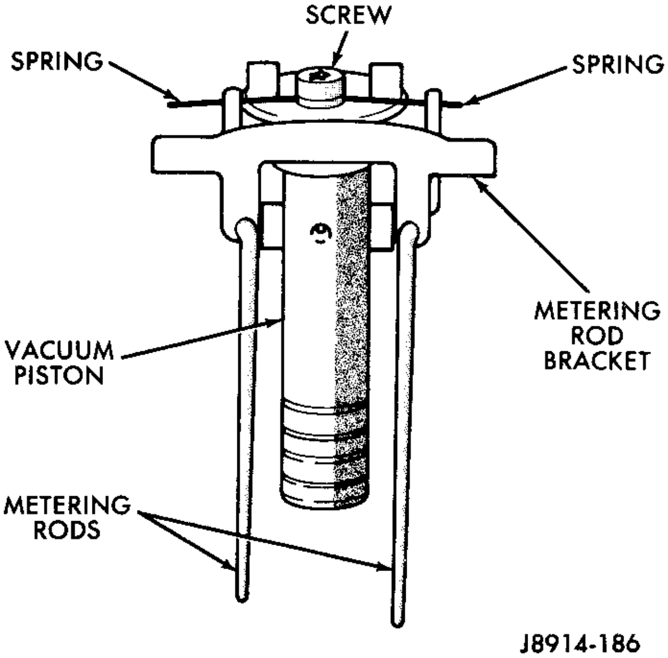


Fig. 22 Metering Rod Spring Installation

(32) Using a replacement gasket, install the rollover check valve and bowl vent (1).

(33) Install the diaphragm assembly (39) and secure with the attaching screws.

(34) Do not connect the vacuum hose (40) to the vacuum break diaphragm fitting until the initial choke valve clearance has been adjusted. Refer to Service Adjustment Procedures.

(3) Engage the diaphragm link with the slot in the choke lever (39).

(35) Install the choke lever (48) and screw on the choke shaft.

(36) Install the choke housing (22) on the throttle body.

(37) Install the baffle (23), gasket (24) and cover (25) on the choke housing. Turn the cover 1/4 turn rich (clockwise) and tighten one straight slot-type screw for preliminary adjustment purposes.

(38) Install the choke rod (48) and clips between the choke lever and the choke housing lever.

(39) Adjust the initial choke valve clearance. Refer to Service Adjustment Procedures.

(40) Adjust the fast idle cam clearance. Refer to Service Adjustment Procedures.

(41) Adjust the choke unloader clearance. Refer to Service Adjustment Procedures.

(42) Remove the choke cover screw and rotate the cover index to the following basic setting as indicated by index key color:

- GOLD INDEX KEY — set the choke index at 0
- RED INDEX KEY — set the choke index at one-notch rich
- GREEN INDEX KEY — set the choke index at two-notches rich

(43) Install and tighten the choke cover replacement screws.

(44) Install the stepper motor with a replacement gasket.

(45) Install the carburetor. Refer to the installation procedure.

CARBURETOR SERVICE ADJUSTMENTS

Float Level Adjustment

(1) Remove the air horn (37).

(2) Hold the float gently against the inlet needle to raise the float.

(3) Place a straightedge across the float bowl to measure the float level. Refer to the Specifications chart.

CAUTION: Never bend the float lever while it is resting against the inlet needle. Pressure may damage the synthetic tip and cause an incorrect adjustment.

(4) If adjustment is necessary, release the floats and bend the float lever (Fig. 23).

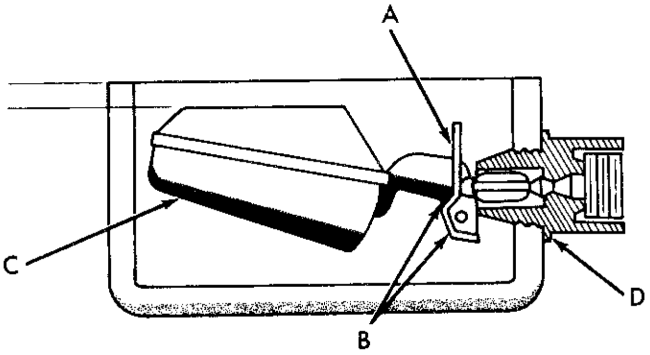
(5) Install the air horn.

Vacuum Piston Gap Adjustment

(1) The correct vacuum piston gap is a critical adjustment.

- Turning the adjusting screw (2) clockwise enriches the air/fuel mixture
- turning the adjusting screw counterclockwise leans the air/fuel mixture

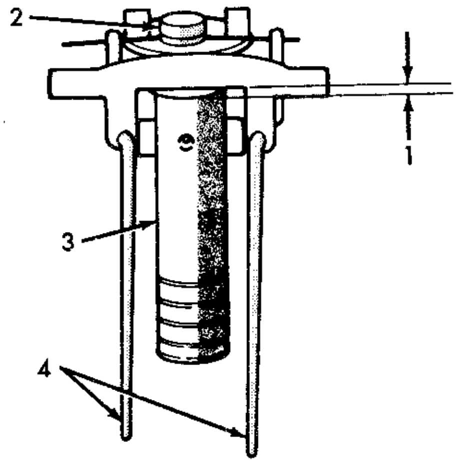
(2) Turn the adjusting screw to adjust the gap (Fig. 24). Refer to the Specifications chart.



A - Apply Slight Pressure
B - Bend to Adjust
C - Float
D - Gasket

J8914-187

Fig. 23 Float Adjustment



1 - Gap
2 - Adjustment Screw
3 - Vacuum Piston
4 - Metering Rods

J8914-188

Fig. 24 Vacuum Piston Gap Adjustment

Vacuum Piston Adjustment

Adjust the vacuum piston gap to the specified dimension. When adjusting the vacuum piston it is necessary to change the curb idle speed adjustment screw setting. Count and record the number of turns so the screw can be returned to the original position.

(1) Turn the curb idle speed adjustment screw counterclockwise until the throttle valves are completely closed.

(2) Fully depress the vacuum piston while holding moderate finger pressure on the rod lifter tab (Fig. 25). While in this position, tighten the rod lifter lock screw.

(1) Release the piston and rod lifter.

(2) Adjust the accelerator pump. Refer to Accelerator Pump Adjustment.

(3) Return the curb idle speed adjustment screw to its original position.

Accelerator Pump Adjustment

When performing the accelerator pump adjustment it is necessary to change the curb idle speed adjustment screw setting. Count and record the number of turns so the screw can be returned to the original position.

(1) Turn the curb idle speed adjustment screw counterclockwise until the throttle valves are completely closed.

(2) Open the choke valve so that the fast idle cam allows the throttle valves to seat in the bores.

(3) Turn the curb idle speed adjustment screw clockwise until it just barely contacts the stop, then continue two complete turns further.

(4) Measure the distance between the surface of the air horn and the top of the accelerator pump shaft with a T-scale (Fig. 26). Refer to the Specifications chart for the correct dimension.

(5) Loosen the pump arm adjusting lock screw and rotate the sleeve to adjust the pump travel to the correct dimension. Tighten the lock screw.

(6) Return the curb idle speed adjustment screw to its original position.

Initial Choke Valve Clearance Adjustment

(1) Grind off the choke housing cover rivets. Remove the remaining portion of the cover rivets.

(2) Turn the cover to 1/4 turn rich position. Install and tighten one retaining screw. Use a straight-slot type screw for service.

(3) Open the throttle valve slightly and place the fast idle speed adjustment screw on the high step of the cam.

(4) Use a hand held vacuum pump that provides vacuum of at least 64 kPa (19 in. Hg) and apply vacuum to force the diaphragm against the stop.

(5) Measure the clearance between the choke valve and the air horn wall with a plug gauge (Fig. 27). Refer to the Specifications chart for the correct dimension.

(6) Adjust the clearance by bending the vacuum diaphragm connector link (Fig. 27).

(7) Loosen the choke housing cover retaining straight slot screw and adjust the choke cover index to the specified position.

(8) Install and tighten all the cover retaining screws.

Fast Idle Cam Position Adjustment

(1) Grind off the choke housing cover retaining rivets. Remove the remaining portion of the rivets.

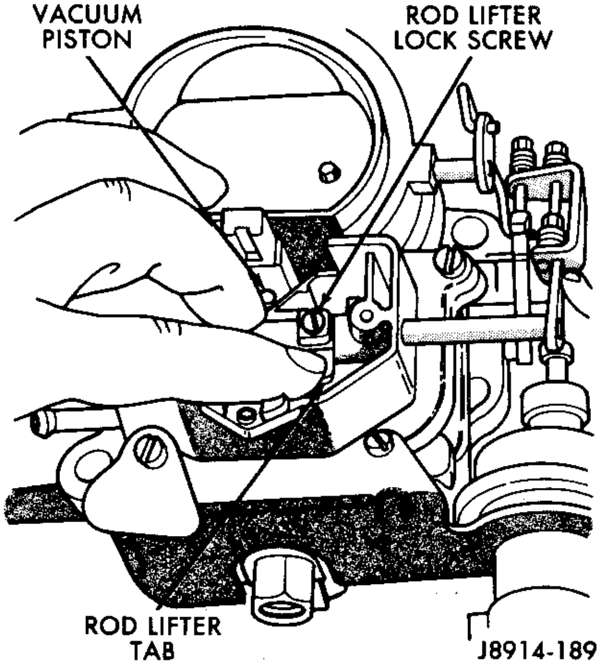


Fig. 25 Vacuum Piston Adjustment

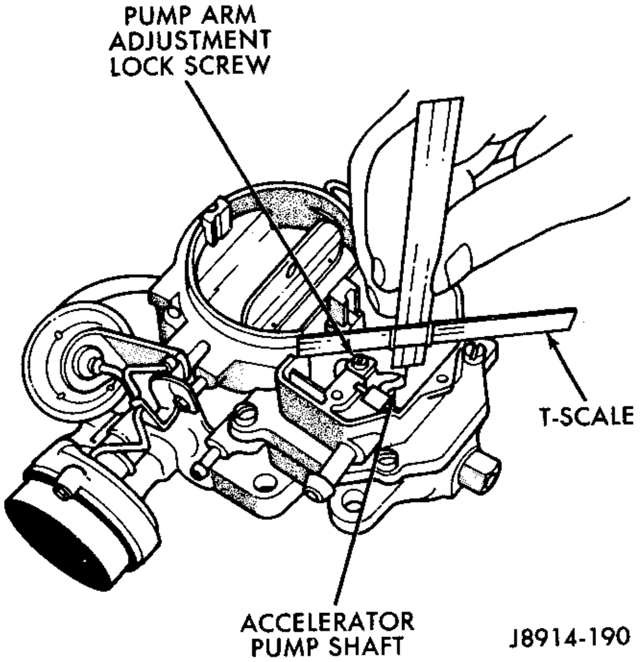


Fig. 26 Accelerator Pump Adjustment

(2) Turn the cover to the 1/4 turn rich position. Install and tighten one retaining straight-slot type screw.

(3) Open the throttle slightly and place the fast idle speed adjustment screw on the second step of the fast idle cam.

(4) Measure the distance between the choke valve and the air horn wall with a plug gauge (Fig. 28). Refer to the Specifications chart for the correct dimension.

(5) Adjust by bending the fast choke link down to increase the distance or up to decrease the distance (Fig. 28).

(6) Remove the choke housing cover retaining straight slot screw.

(7) Adjust the choke cover index to the specified position.

(8) Install and tighten the choke cover retaining screws.

Choke Unloader Adjustment

(1) Hold the throttle lever in the wide open position.

(2) Insert a plug gauge and apply light pressure to close the choke valve (Fig. 29).

(3) Using plug gauges, measure the distance between the choke valve and the air horn wall (Fig. 29). Refer to the Specifications chart for the correct dimension.

(4) Adjust by bending choke unloader tang (Fig. 29). Do not bend the tang so that it binds or interferes with any other component.

Fuel Bowl Vent Adjustment

THIS IS NOT A PRECISE ADJUSTMENT.

The fuel bowl vent adjustment is only necessary to ensure that the mechanical fuel bowl vent is open at idle speed and closed at greater throttle openings. The adjustment can be accomplished with the carburetor either on or off the engine.

(1) Remove the rollover check valve from the air horn to gain access to the metering rod area.

(2) Open the throttle and position the fast idle speed adjustment screw on the high step of the cam.

(3) Observe the fuel bowl vent. It should be closed.

(4) Manually move the fast idle cam until the fast idle speed screw drops into the second step of the cam. The bowl vent should just begin to open. If the valve is not

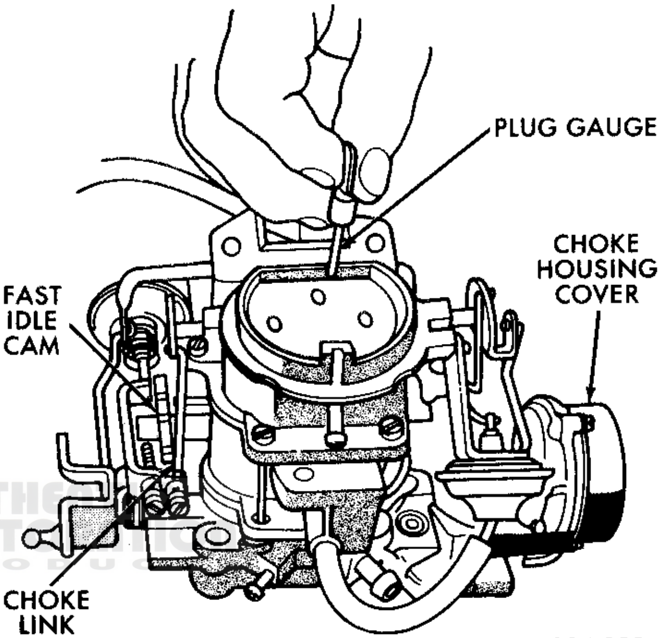


Fig. 28 Fast Idle Cam Position Adjustment

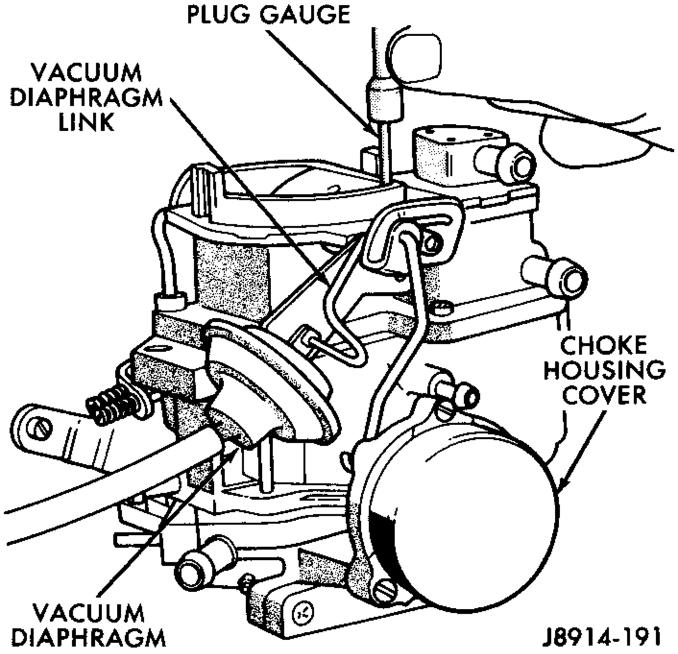


Fig. 27 Initial Choke Valve Adjustment

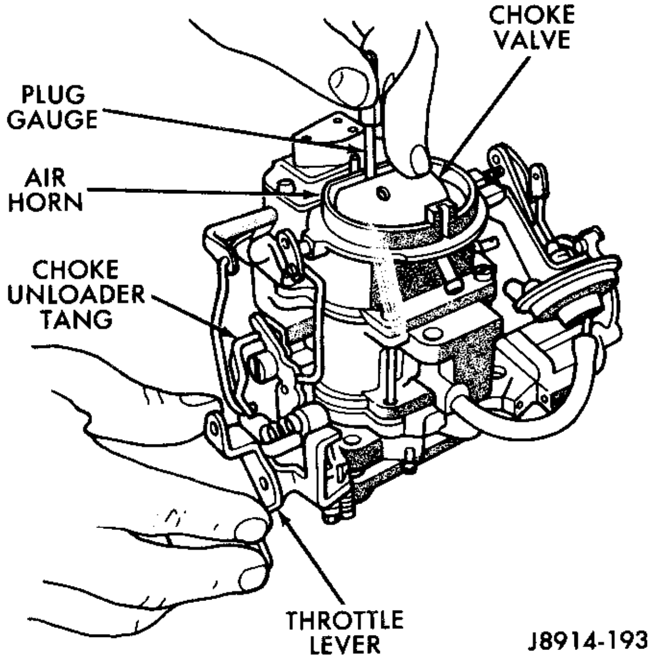


Fig. 29 Choke Unloader Adjustment

closed on high, fourth or third steps of the cam, bend the valve tab (Fig. 30) until it is closed. If the valve does not just begin to open with the fast idle speed adjustment screw on the second step of the cam, bend the tab until it is just off its seat.

Choke Adjustment (On- or Off-Engine)

The choke adjustment is preset during factory assembly and should not normally require readjustment. The choke should be serviced only if absolutely necessary or during major carburetor overhaul. Break-away torque-head cover retaining screws are used to discourage indiscriminate choke adjustment.

The automatic choke adjustment is accomplished by removing the housing cover retainers and rotating the cover in the desired direction as indicated by the arrow on the face of the cover.

(1) Position the choke cover at the following basic setting as indicated by index key color:

- GOLD INDEX KEY—set the choke index at 0
- RED INDEX KEY —set the choke index at one-notch rich
- GREEN INDEX KEY—set the choke index at two-notches rich

The richer the choke setting, the greater length of time that spring tension is exerted against the linkage to hold the choke valve in a closed position. As the electric heater relaxes the spring tension, the fast idle cam weight opens the choke valve.

Fast Idle Speed Adjustment

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

Adjust the fast idle speed with the engine at normal operating temperature and the EGR valve vacuum hose disconnected and plugged.

(1) Connect a tachometer to the ignition coil negative (TACH) terminal and observe it for the adjustment.

(2) Position the fast idle speed adjustment screw in contact with and against the shoulder of the second step of the fast idle cam (Fig. 31).

(3) Refer to the Specifications chart and adjust the engine speed for the correct RPM. Adjust by turning the fast idle speed adjustment screw.

(4) Disconnect the tachometer.

Idle Speed Adjustment

(1) Install the carburetor, fuel pipe, vacuum hoses etc., if removed. Refer to the installation procedure.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(2) Connect a tachometer to the ignition coil negative (TACH) terminal.

(3) Start and allow the engine to attain the normal operating temperature.

(4) The carburetor choke and intake manifold heater must be off. This occurs when the engine coolant heats to approximately 71°C (160°F).

(5) Disconnect the vacuum hose from the Sole-Vac vacuum actuator and plug it (Fig. 32).

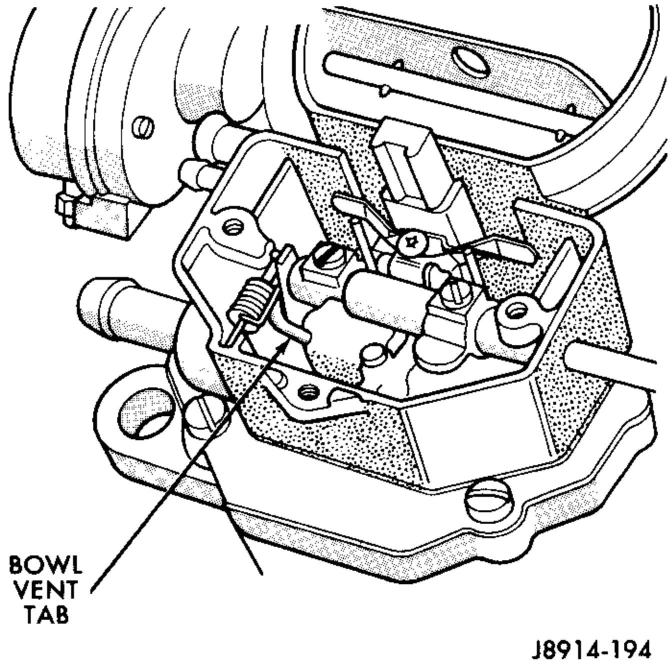


Fig. 30 Fuel Bowl Vent Adjustment

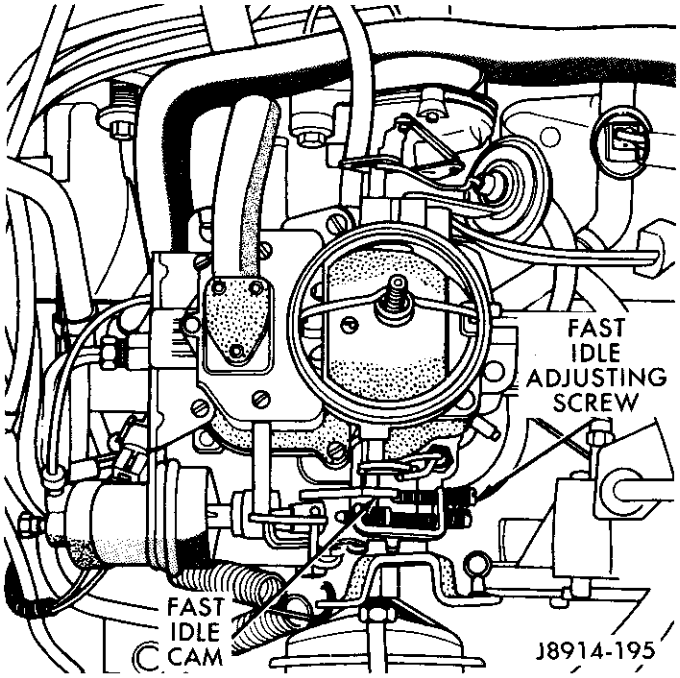


Fig. 31 Fast Idle Cam Adjustment

(6) Disconnect the Sole-Vac holding solenoid wire connector (Fig. 33).

(7) Start the engine.

(8) **Set the parking brake firmly.**

Place manual transmission in NEUTRAL, automatic transmission in DRIVE.

(8) Increase the engine speed to above 1200 RPM for 3 to 5 seconds and allow the engine to return to curb idle speed.

(9) Adjust the carburetor curb (slow) idle speed adjustment screw (Fig. 34) to obtain the specified curb (slow) idle engine RPM, if not at the specified speed. Refer to the Emission Control Label for idle speed information.

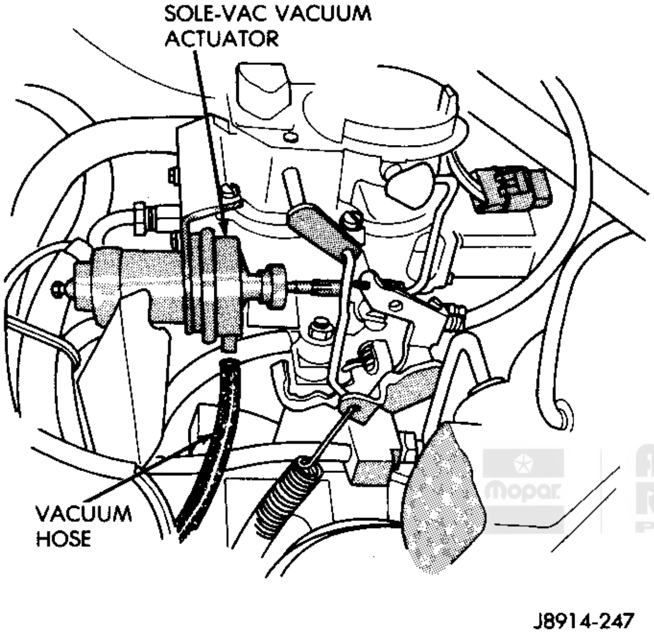


Fig. 32 Sole-Vac Vacuum Actuator Hose

(10) Using a hand held vacuum pump, apply a direct source of 34-51 kPa (10-15 in. Hg.) vacuum to the vacuum actuator.

(11) Increase the engine speed to above 1200 RPM for 3 to 5 seconds and allow the engine to return to curb idle speed.

(12) Refer to the vehicle Emission Control Label for the specified curb idle speed. With the Sole-Vac throttle positioner fully extended, turn the vacuum actuator adjustment screw on the throttle lever until the specified engine RPM is obtained (Fig. 35).

(13) Disconnect the vacuum source from the vacuum actuator.

(14) With a jumper wire, apply battery voltage (12V) to energize the holding solenoid.

(15) Hold the throttle open manually to allow the throttle positioner to fully extend.

Without vacuum applied to the vacuum actuator, the throttle must be opened manually to allow the Sole-Vac throttle positioner to be fully extended.

(16) If the holding solenoid idle speed is not within specification, adjust the Sole-Vac throttle positioner (hex-head adjustment screw—Fig. 36) to the engine RPM specified on the vehicle Emission Control Label.

(17) Verify that the adjustments made to curb idle speed and the Sole-Vac (vacuum actuator and electric holding solenoid) have not changed.

(18) Turn the ignition switch to the OFF position.

(19) Remove the jumper wire from the Sole-Vac holding solenoid wire connector. Connect the Sole-Vac holding solenoid wire connector.

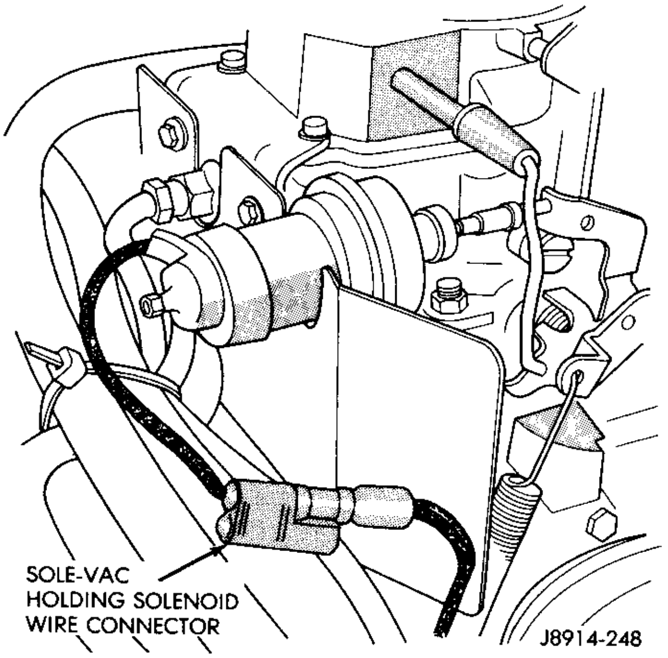


Fig. 33 Sole-Vac Holding Solenoid Wire Connector

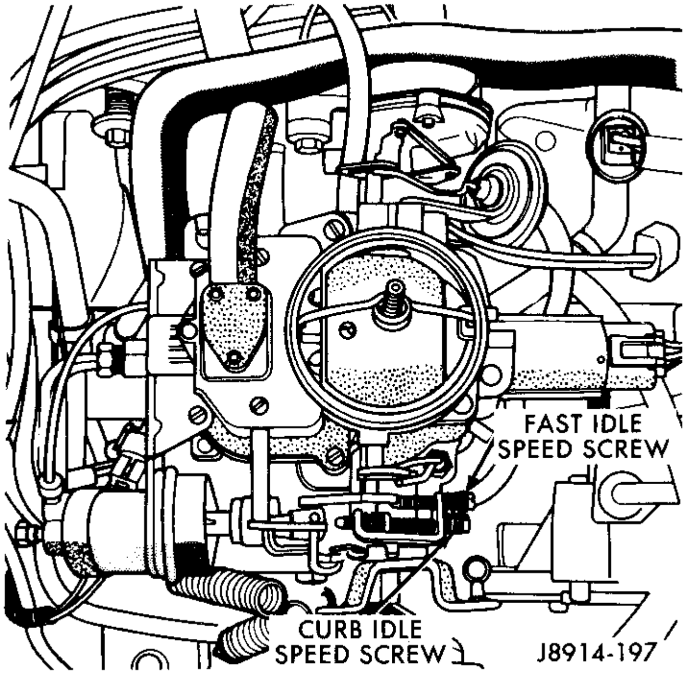


Fig. 34 Curb Idle Screw

(20) Remove the plug and reconnect the vacuum hose to the vacuum actuator.

(21) Remove the tachometer.

Idle Mixture Adjustment

It is necessary to remove the carburetor to gain access for removing the dowel pins. Refer to Carburetor Removal for the procedure.

CAUTION: The idle mixture adjustment should only be performed if the adjustment screws were removed during carburetor overhaul for cleaning purposes.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(1) Install the carburetor, fuel pipe, vacuum hoses, etc. Refer to the installation procedure.

(2) Connect a tachometer. Start the engine and warm it to the normal operating temperature.

Use a tachometer with an expanded scale of 400-800 or 0-1000 RPM. Inspect periodically to ensure the accuracy is within two percent.

(3) Position the gear selector in NEUTRAL for manual transmissions and DRIVE for automatic transmissions. Set the parking brake firmly.

(4) Adjust the idle speed as described in the adjustment procedure. Use the Set-To engine RPM.

(5) Adjust the mixture screw(s) leaner (clockwise) until a perceptible loss of RPM is noted.

(6) Turn the mixture screw(s) richer (counterclockwise) until the highest RPM indication is obtained. Do not turn the screw(s) any further than the point at which the highest RPM is first obtained. This is referred to as LEAN BEST IDLE. The engine speed will increase above the curb idle speed by an amount that corresponds to approximately the IDLE DROP specification to be obtained in the next step.

(7) As a final adjustment, turn the mixture screws clockwise (leaner) to obtain the specified drop in engine idle RPM. Turn both the idle mixture screws in small, equal amounts until the specified IDLE DROP is achieved. Refer to the Mixture Adjustment chart.

If the final engine RPM differs more than ± 30 RPM from the original curb idle RPM, adjust the curb idle speed to the specified RPM and repeat the last two steps listed above.

It is necessary to remove the carburetor to gain access for installing the dowel pins. Refer to Carburetor Removal for the procedure.

Install the dowel pins after completing the idle mixture adjustment. Use care to prevent disturbing the mixture adjustment screw positions.

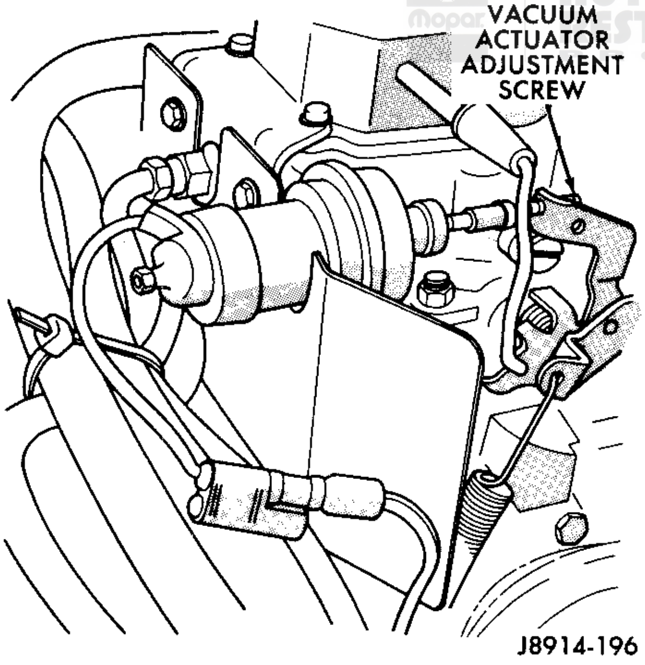


Fig. 35 Sole-Vac Vacuum Actuator Screw

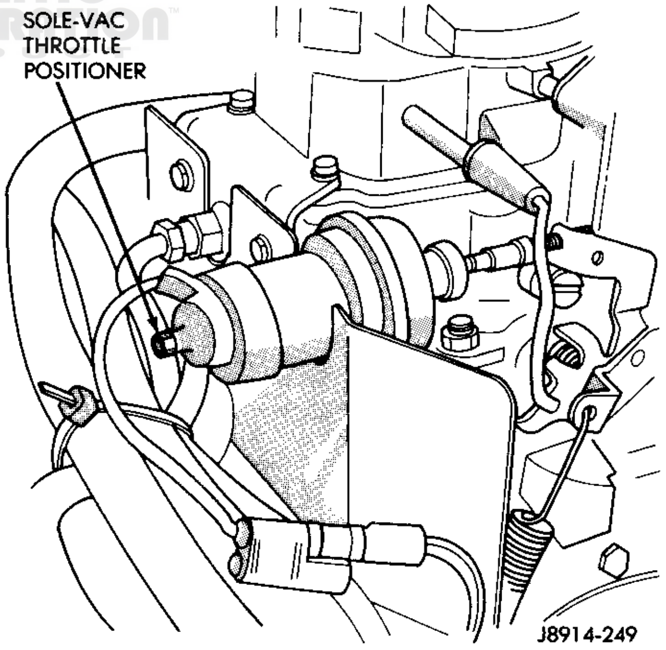


Fig. 36 Sole-Vac Throttle Positioner

FUEL FEEDBACK SYSTEMS—4.2L ENGINE

INDEX

GENERAL INFORMATION

Computerized Emission Control (CEC) Fuel Feedback Systems

The CEC Feedback System on 4.2L six-cylinder engines in YJ vehicles, controls undesirable emission to the atmosphere and maintains an ideal air/fuel ratio to provide an optimum balance between emission control and engine performance. This is accomplished by the use of a micro computer unit (MCU), several MCU input components and several MCU output components.

The MCU monitors various engine operating conditions. Based on these conditions, the MCU may, depending on the mode of operation, generate output signals to provide the proper air/fuel mixture, proper ignition timing and engine idle speed. Each system operates in two modes of operation: CLOSED LOOP and OPEN LOOP.

Closed loop operation occurs when the air/fuel ratio is varied according to the oxygen content in the exhaust gas.

During open loop operation, the air/fuel ratio is predetermined by the MCU for several engine operating conditions, such as:

- start-up
- cold engine operation
- wide open throttle (WOT) engine operation

When the engine is started, the MCU determines which mode of operation (closed loop or open loop) is correct. It can determine this by monitoring the input signals from the various input components (Fig. 1). Air and coolant temperature information, engine RPM information and vacuum levels are all provided to the MCU for this determination.

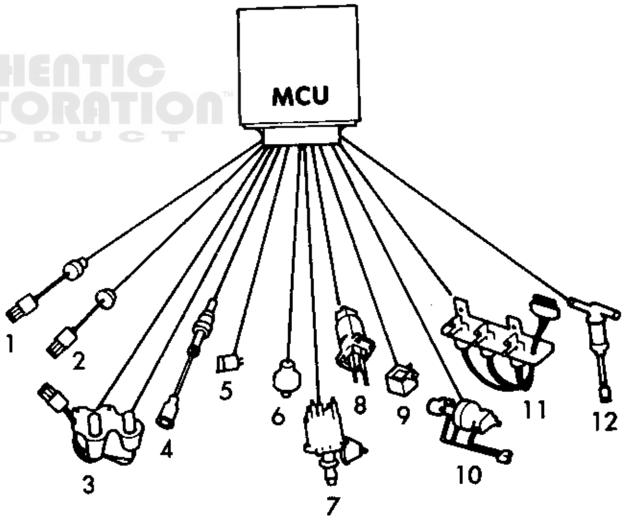
The MCU operates the system in the open loop mode based on a priority rating for the various predetermined engine operating conditions. It continues to operate the system and the output components (Fig. 1) in the open loop mode until such time when the engine operating conditions indicate that the closed loop mode of operation is appropriate. At this time, the MCU shifts the operation to closed loop. Based upon the oxygen content in the exhaust gas and other inputs, it continues to operate the system in the closed loop mode and constantly varies the air/fuel ratio to maintain an optimum 14.7:1 ratio.

As the engine operating conditions are constantly monitored by the MCU, any change in condition such as the engine being placed in wide open throttle (WOT) operation, is quickly detected by the MCU. The MCU then places the system back in the appropriate open loop mode of operation.

Micro Computer Unit (MCU)

The MCU is a permanently sealed, microprocessor that monitors various engine operating conditions (Fig. 2). Based upon these conditions, the MCU generates output control signals to provide the correct air/fuel mixture, proper ignition timing and engine idle speed. The MCU is located in the passenger compartment.

MCU Inputs



Inputs
1. Coolant Temperature Switch
2. Thermal Electric Switch
3. Four- and Ten-Inch Hg Vacuum Switches
4. Oxygen Sensor
5. Wide Open Throttle (WOT) Switch
6. Knock Sensor
7. Distributor

Outputs
8. Stepper Motor
9. Idle Relay
10. Sole-Vac Throttle Positioner
11. Upstream and Downstream Solenoids
12. PCV Solenoid

J8914-198

Fig. 1 Fuel Feedback System—4.2L Engine

The MCU monitors engine operating conditions by receiving input signals from several components (Fig. 3).

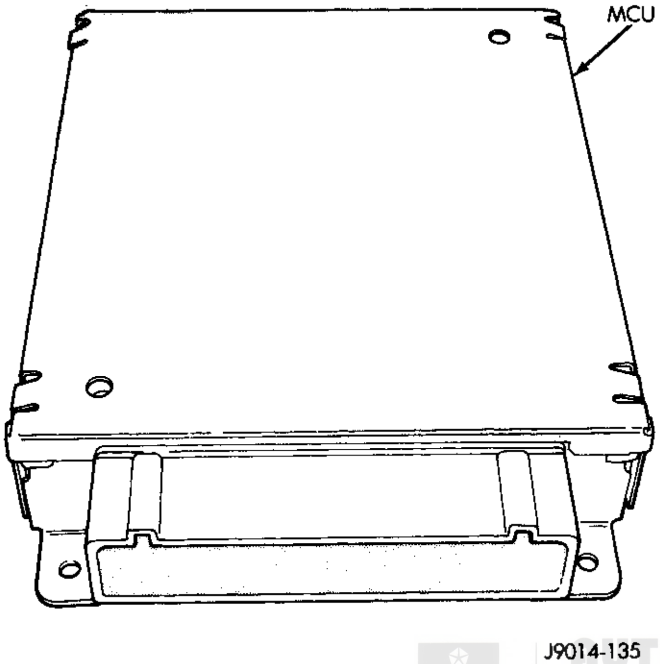


Fig. 2 MCU

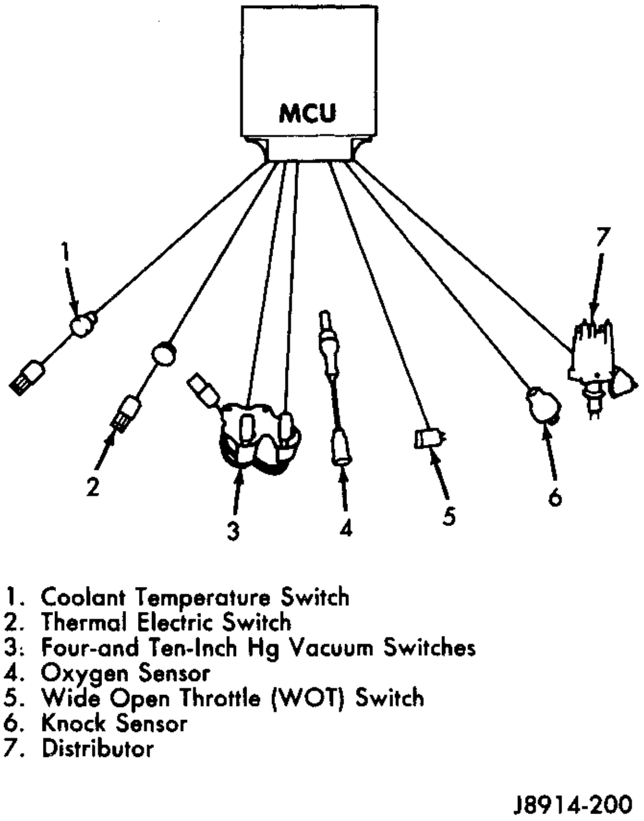


Fig. 3 MCU Inputs

Coolant Temperature Switch

The coolant temperature switch is located at the rear of the cylinder head (Fig. 4). It provides the MCU with the temperature of the engine coolant. At a temperature less than 57° C (135° F), the switch is open, indicating a cold engine condition. When the engine coolant is sufficiently warmed, 57° C (135° F) and above, the switch closes. The switching temperatures are nominal values.

Thermal Electric Switch

The thermal electric switch (2) is located inside the air cleaner (Fig. 5). It detects the incoming air temperature and indicates to the MCU a cold weather engine start-up condition when the air temperature is below 10° C (50° F). Above 18° C (65° F), it provides an open circuit to indicate a warm engine start-up condition to the MCU.

Four-and Ten-Inch Hg Vacuum Switches

The 4-inch Hg (ported vacuum) and 10-inch Hg (adaptive vacuum) switches are located together in a bracket attached to the dash panel (center) in the engine compartment (Fig. 6). The 4-inch Hg vacuum switch can be identified by its natural color. The 10-inch Hg vacuum switch is green in color.

The 4-inch Hg vacuum switch is controlled by ported vacuum. Its electrical contact is normally in the open position when the vacuum level is less than 4-inch Hg. When the vacuum level is 4-inch Hg or greater, the switch closes. The 4-inch Hg vacuum switch indicates to the MCU when either a closed or deep throttle condition exists.

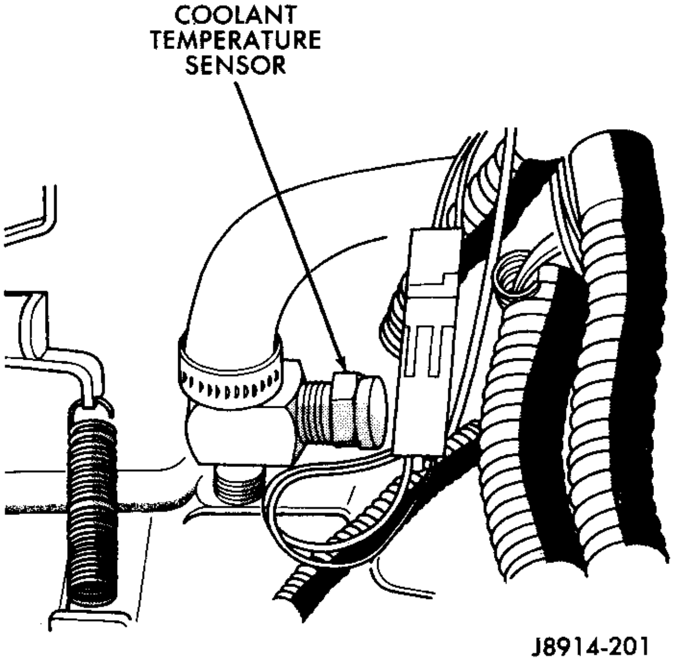


Fig. 4 Coolant Temperature Sensor

The 10-inch Hg vacuum switch is controlled by manifold vacuum. Its electrical contact is normally closed when the vacuum level is less than 10-inch Hg. When the vacuum level is 10-inch Hg or greater, the switch opens. This indicates to the MCU that either a partial throttle or a medium throttle condition exists. The switching values are nominal.

Oxygen (O_2) Sensor

The oxygen sensor is located in the exhaust manifold (Fig. 7). It reacts to the oxygen content in the exhaust gas and provides a variable voltage to the MCU. The MCU then adjusts the air/fuel mixture based on the voltage received from the oxygen sensor and other inputs. A lean air/fuel mixture causes a greater oxygen content in the exhaust gas and a rich air/fuel mixture causes less oxygen content.

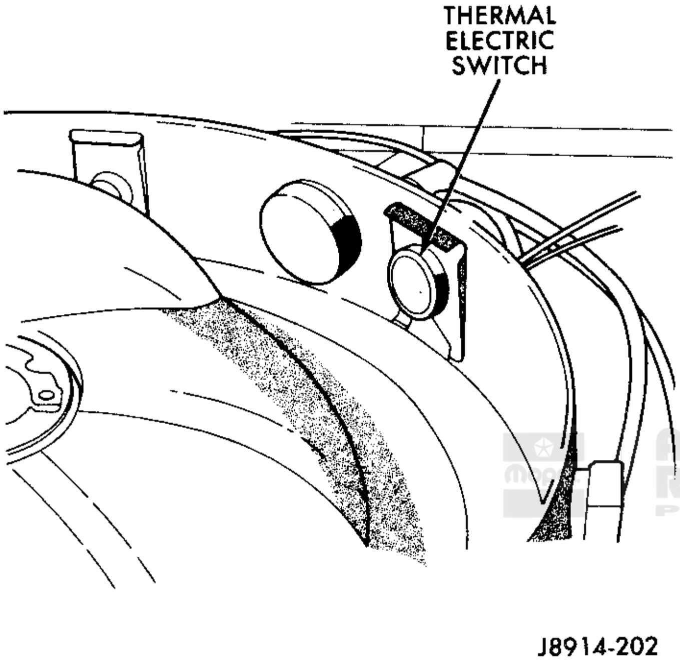


Fig. 5 Thermal Electric Switch

Wide-Open Throttle (WOT) Switch

The wide-open throttle (WOT) switch is attached to the base of the carburetor by a mounting bracket (Fig. 8). The switch is a mechanically operated electrical switch. It is controlled by the position of the throttle. When the throttle is placed in the wide-open position, a cam on the throttle shaft actuates the switch at 15° from wide-open throttle position to indicate a wide-open throttle condition to the MCU.

Knock Sensor

The knock sensor is a tuned piezoelectric crystal transducer that is located in the intake manifold (Fig. 9). The knock sensor provides the MCU with an input voltage that represents an engine knock (or ping) condition. The input is produced by oscillations that correspond to the knock sensors center frequency (5 KHz).

Vibrations from engine knock (ping) cause the crystal inside the sensor to oscillate and produce the electrical voltage (Fig. 10). Based on the input, the MCU can retard the ignition timing to eliminate the knock (ping) condition.

Distributor

The MCU also changes the ignition timing according to the engine speed (tach) voltage input provided by the distributor. With other ignition systems, the distributor information is routed directly to the ignition system

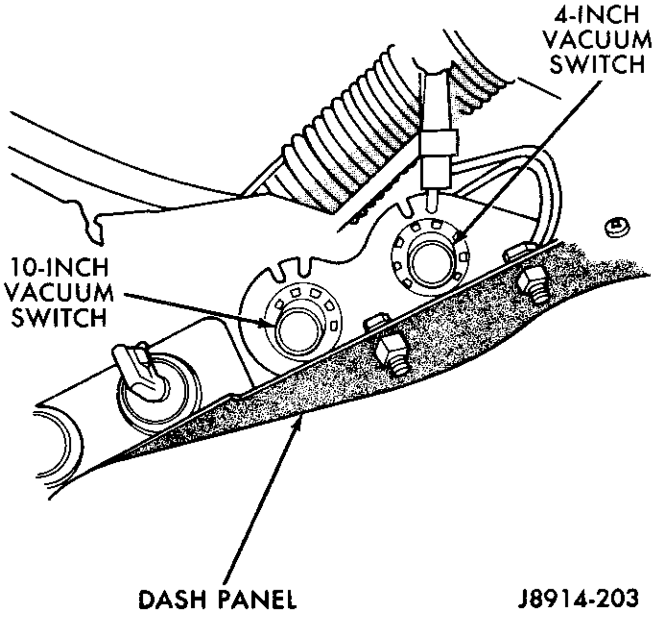


Fig. 6 Four-and Ten-Inch Hg Vacuum Switches

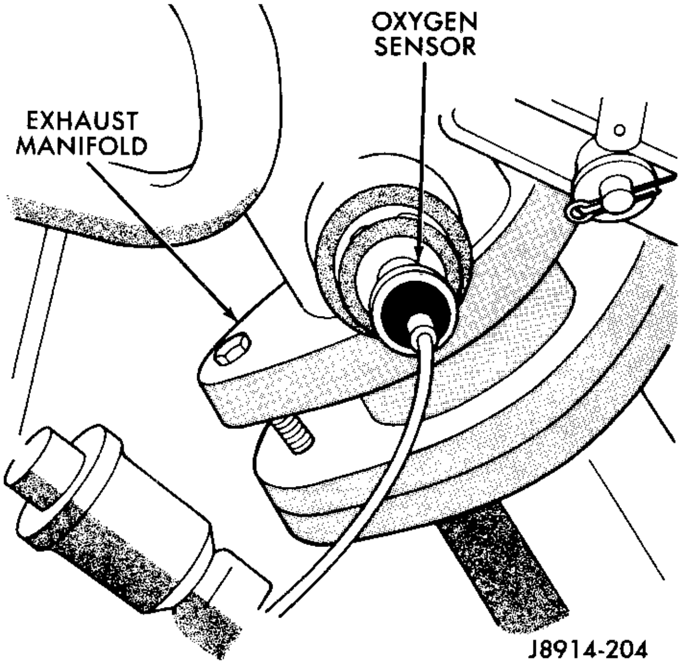


Fig. 7 Oxygen (O_2) Sensor

electronic control unit (ECU). With the CEC Fuel Feedback System, the distributor information must first pass through the MCU (Fig. 11). The MCU then advances or retards the ignition timing as necessary for the engine operating condition that is occurring.

Altitude Jumper Wire

The two terminal connector for the altitude jumper wire is located behind the dash panel in back of the radio. The connector is taped to the CEC system wire harness next to the MCU (Fig. 12). When the jumper wire is installed; it provides the MCU with an indication that the vehicle is being operated above 122 meters (4,000-foot) altitude.

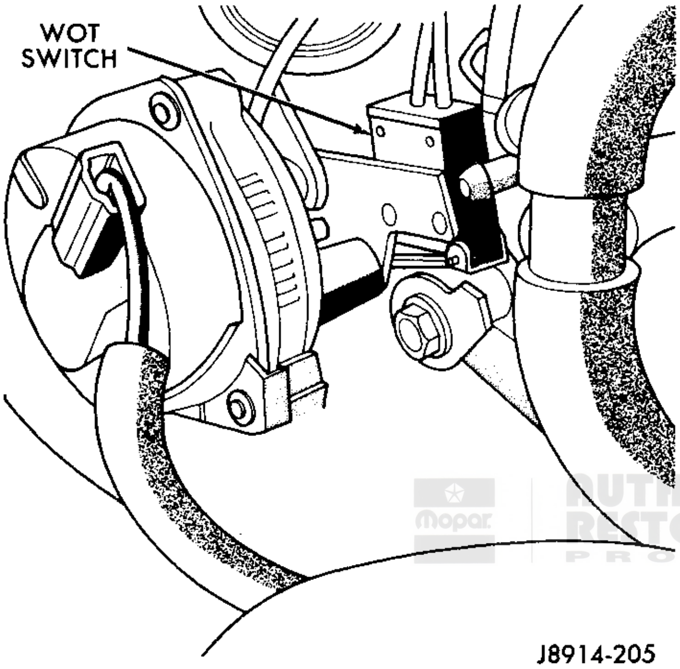


Fig. 8 WOT Switch

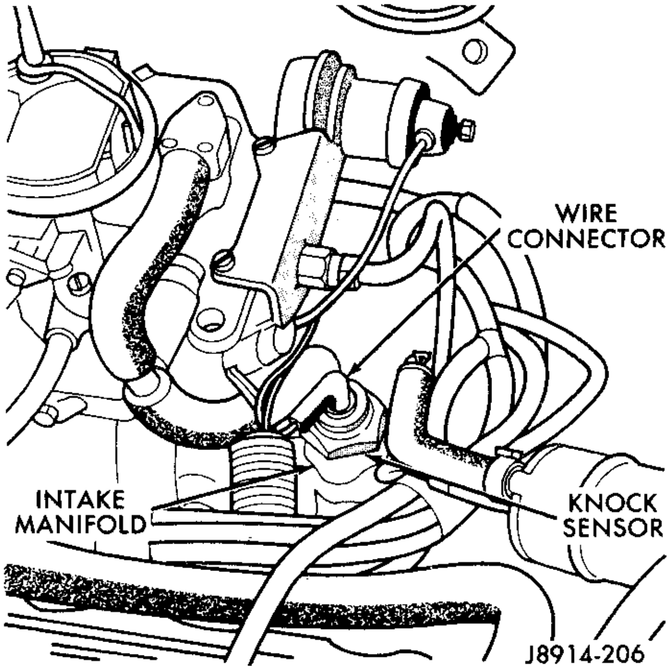


Fig. 9 Knock Sensor

The jumper wire is not connected to connector when the vehicle is being operated below 122 meters (4,000 feet) altitude. For vehicles operated above 122 meters (4,000 feet), the jumper wire must be connected to the connector.

CAUTION: Altitude adjustments require carburetion, ignition timing, and vacuum harness routing changes in addition to the altitude jumper wire. A Vehicle Emission Control Information Update Packet is available to Jeep owners who operate their vehicles primarily at altitudes higher or lower than those for which their vehicles were originally certified.

The packet consists of a supplementary Vehicle Emission Control Information Label and specific instructions for making adjustments to improve emission control performance either above or below 122 meters (4,000 feet) altitude. The Packet may be obtained from your dealer.

MCU Outputs

Based on the information received from the various MCU inputs, the MCU generates a number of outputs that provide the correct air/fuel mixture, ignition timing and engine idle speed (Fig. 13).

Stepper Motor

The stepper motor is an integral part of the Model BBD carburetor (Fig. 14). The MCU operates the stepper motor air metering pins (visible from the top of the carburetor air horn—Fig. 14) in increments (small steps) in reaction to the input from the oxygen sensor and other MCU inputs.

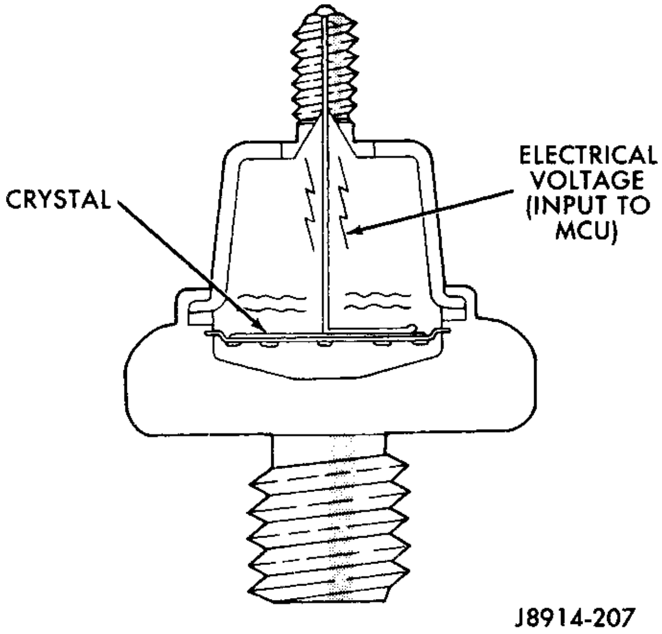


Fig. 10 Knock Sensor Operation

Varying engine operating conditions prohibit the MCU from computing a stationary position for the metering pin that would provide the optimum air/fuel mixture at all times. Therefore, closed loop operation is characterized by constant movement of the metering pins because the MCU is forced to make small corrections in an attempt to maintain an optimum air/fuel mixture.

Idle Relay

The idle relay (Fig. 15) is energized by the MCU. The MCU controls the vacuum actuator portion of the Sole-Vac throttle positioner by providing a ground for the idle relay. The relay energizes the idle solenoid, which allows vacuum to operate the Sole-Vac vacuum actuator. This, in turn, opens the throttle and increases engine RPM.

Sole-Vac Throttle Positioner

The Sole-Vac throttle positioner is attached to the carburetor and consists of a holding solenoid and a vacuum actuator (Fig. 16).

The holding solenoid maintains throttle position. The vacuum actuator provides additional engine idle speed when the air conditioner is in use. The vacuum actuator is also activated at start-up and during deceleration.

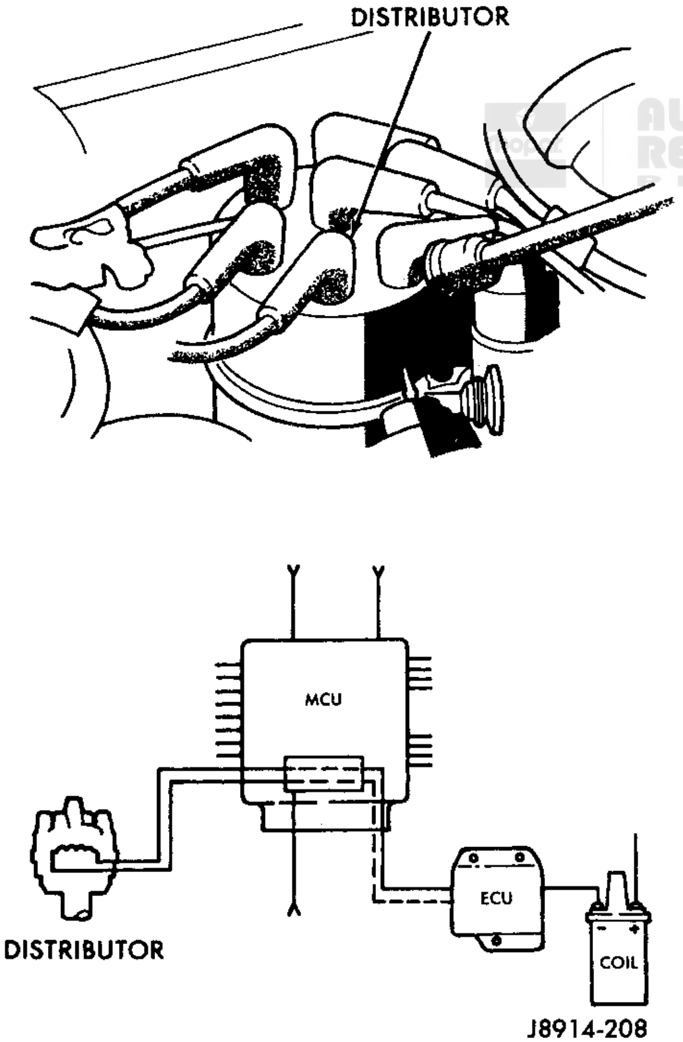


Fig. 11 Distributor and Ignition Timing Control

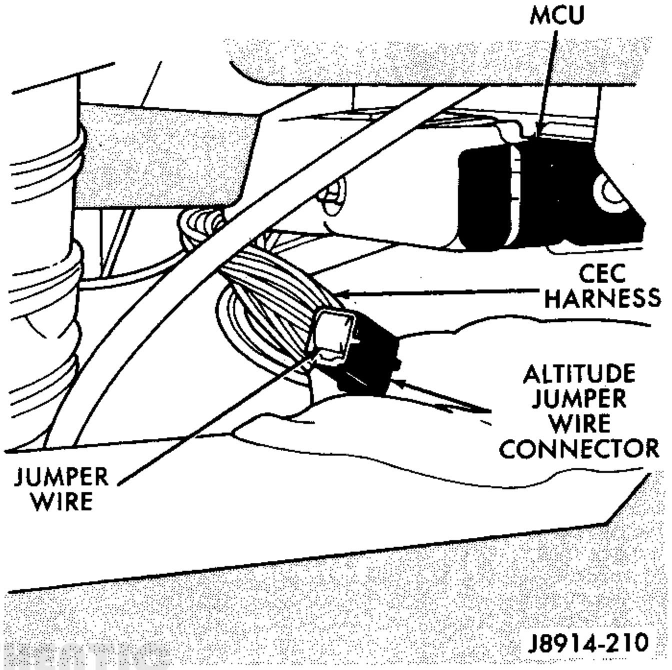
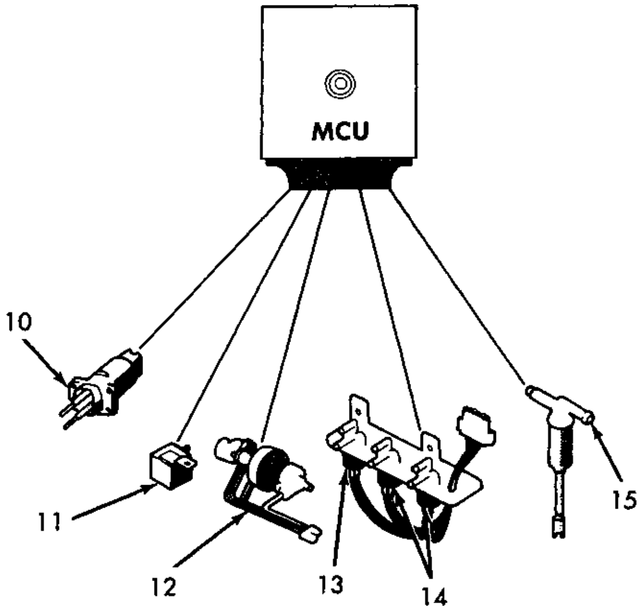


Fig. 12 Altitude Jumper Wire



10. Mixture Control Solenoid/Stepper Motor
11. Idle Relay
12. Sole-Vac Throttle Positioner
13. Idle Solenoid
14. Upstream and Downstream Solenoids
15. P.C.V. Solenoid

J8914-209

Fig. 13 MCU Outputs

Idle Solenoid

The idle solenoid is located on a bracket mounted to the rear of the cylinder head cover (Fig. 17). The upstream and downstream solenoids for the Pulse Air System are also located on the bracket and look physically the same. The idle solenoid is identified by the red connecting wires.

The idle solenoid is energized electrically by the MCU via the idle relay and allows vacuum to operate the Sole-Vac vacuum actuator to increase idle speed.

Upstream and Downstream Solenoids

The upstream and downstream solenoids of the Pulse Air System distribute air to the exhaust pipe and catalytic converter. The upstream and downstream solenoids are located on the same bracket as the idle solenoid on the cylinder head cover (Fig. 17).

The upstream and downstream solenoids are energized by the MCU. The MCU energizes the upstream solenoid to route air into the exhaust pipe at a location after the oxygen sensor. When energized by the MCU, the downstream solenoid routes air into the second bed of the dual-bed catalytic converter.

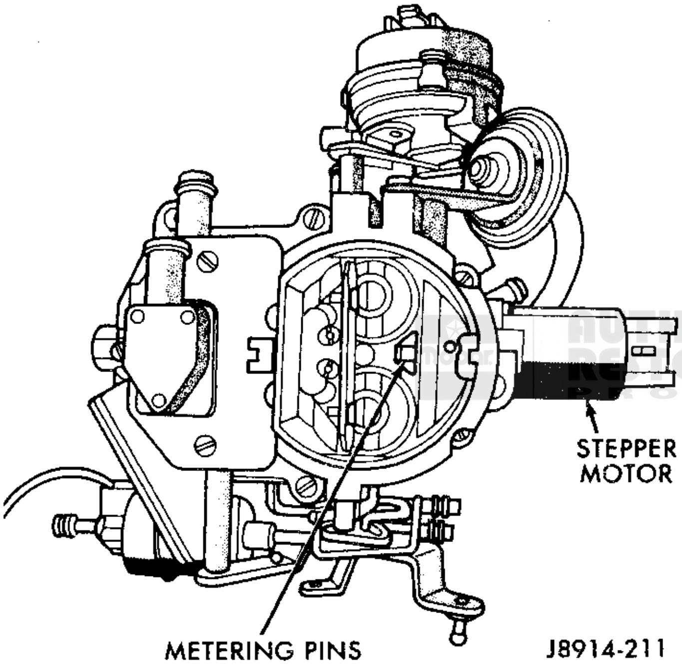


Fig. 14 Stepper Motor and Metering Pins

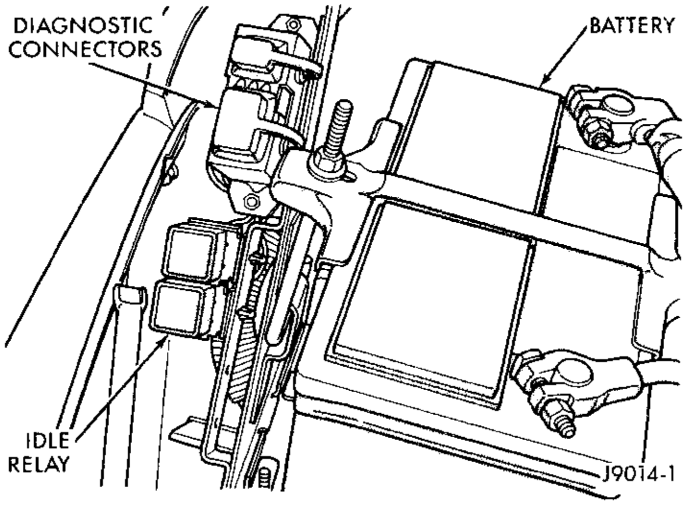


Fig. 15 Idle Relay

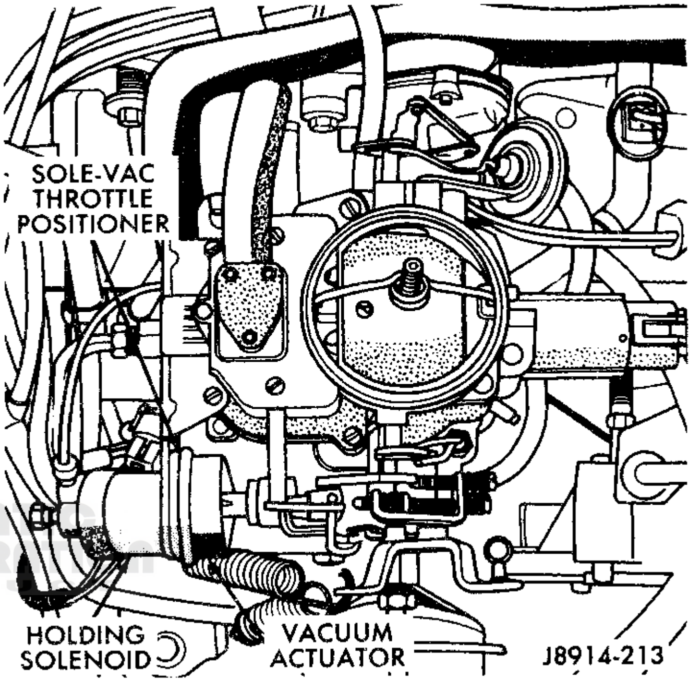


Fig. 16 Sole-Vac Throttle Positioner

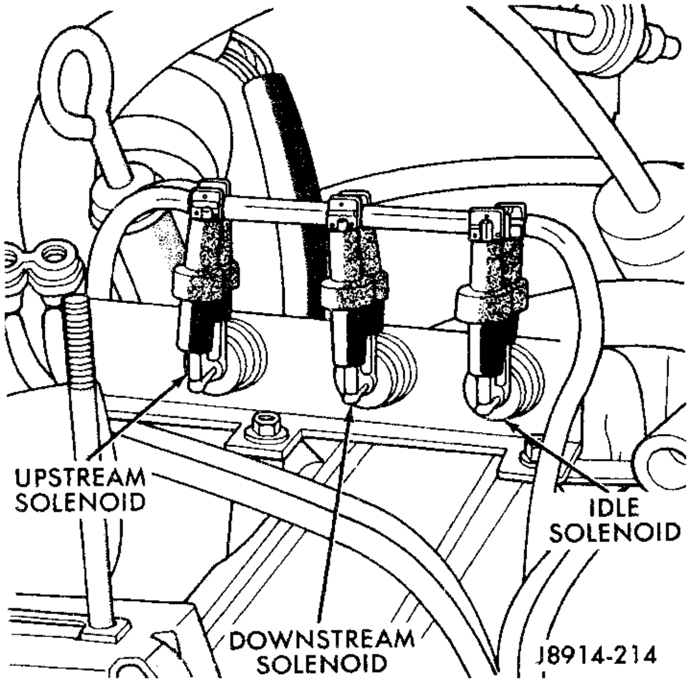


Fig. 17 Idle, Upstream, and Downstream Solenoids

The additional air routed into the system by the solenoids reacts with the exhaust gases to reduce undesirable emissions.

Positive Crankcase Ventilation (PCV) Valve Shut-Off Solenoid

The PCV valve solenoid is installed in-line with the PCV valve hose (Fig. 18). It is energized by the MCU and turns off the crankcase ventilation when the engine is at idle speed. The system momentarily energizes the PCV valve solenoid when the ignition key is turned off to prevent air entering below the throttle plate. This prevents engine dieseling.

Intake Manifold Heater Switch

The intake manifold heater switch is located in the intake manifold water jacket (Fig. 19). It is controlled by the temperature of the engine coolant and indicates a cold engine condition. At temperatures below 71°C (160°F), the manifold heater switch actuates the intake manifold heater, which in turn heats the intake manifold to improve fuel vaporization. The intake manifold heater is located at the bottom of the intake manifold directly below the carburetor. The heater switch is not controlled by the MCU and does not provide input information to it.

CEC Fuel Feedback System Modes Of Operation

The CEC Fuel Feedback System has four modes of operation.

- Key-on
- Start-up
- Warm-up
- Cruise

Key-on Mode

In the key-on mode, the system operates as follows:

- Ignition switch ON
- MCU is energized
- Sole-Vac holding solenoid is energized
- Idle relay activated; (voltage supplied; no ground)
- PCV valve shut-off solenoid energized by the MCU via the anti-diesel.

START-UP MODE

In the start-up mode, the system operates as follows:

- Key to the START position
- Starter motor solenoid is energized
- Choke relay and intake manifold heater relay (if the intake manifold heater switch is closed) are energized by the oil pressure switch
- Intake manifold heater is activated (if the coolant is cold)
- Start signal provided to the MCU
- Engine RPM (tach) voltage from the distributor provided to the MCU
- MCU controls the ignition timing

Warm-Up Mode

In the warm-up mode, the system operates as follows:

- System is in open loop operation
- MCU receives certain inputs
- 4-inch Hg vacuum switch is open because the vacuum is less than 4-inch Hg.
- 10-inch Hg vacuum switch closed below 10-inch Hg and open at 10-inch Hg vacuum level and above
- Coolant temperature switch closed at 57° C (135° F)

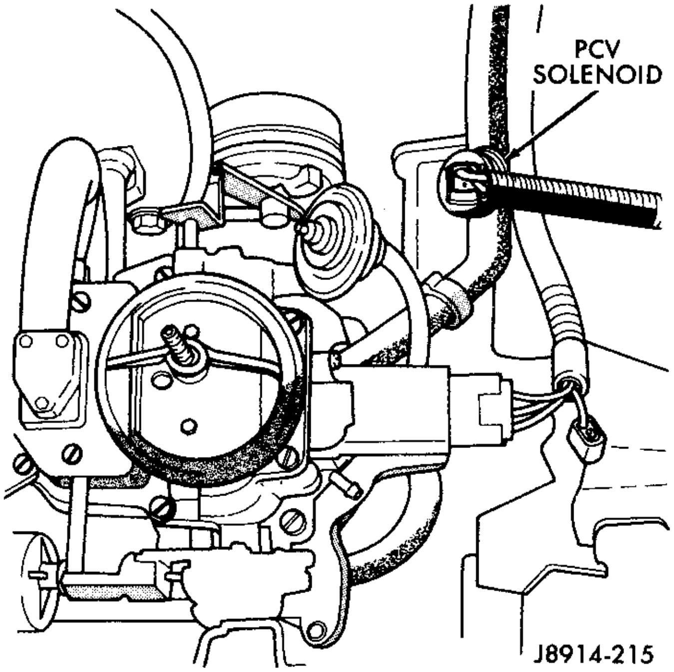


Fig. 18 PCV Solenoid

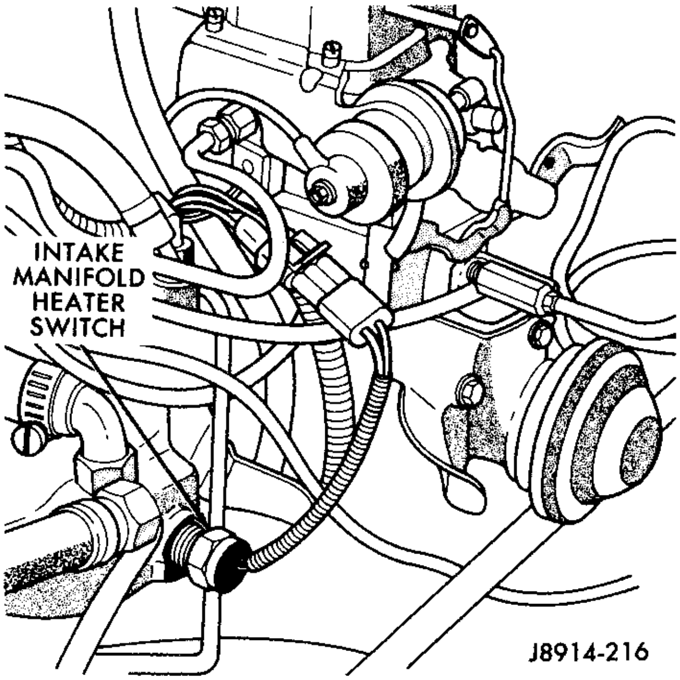


Fig. 19 Intake Manifold Heater Switch

- Wide-open throttle switch open
- Thermal electric switch opens at 18° C(65° F)
- Manifold heater switch opens at 71° C (160° F) (the manifold heater is off)
- Mixture control (MC) solenoid or stepper motor controlled by the MCU to provide a pre-programmed amount of air for the air/fuel mixture
- Upstream and downstream solenoids controlled by the MCU to distribute air to either the exhaust or the catalytic converter
- Sole-Vac holding solenoid is activated if the air conditioner is in operation (six-cylinder engine only); also activated during deceleration.

Cruise Mode

In the cruise mode, the system operates as follows:

- System is in closed loop operation
- MCU produces outputs
- Components are controlled as in the warm-up mode
- Oxygen (O2) sensor input accepted by the MCU
- MCU controls the mixture control (MC) solenoid or stepper motor according to the inputs
- MCU may receive input from the knock sensor to advance or retard the ignition timing
- Upstream and downstream solenoids route air to the exhaust pipe or catalytic converter
- Wide-open throttle switch indicates the throttle position

CEC Diagnostic Tests

Each CEC Fuel Feedback System incorporates a diagnostic connector to provide a means for a systematic evaluation of each component that could cause an operational malfunction.

An electronic Fuel Feedback Tester (ET-501) is available to aid in the system diagnosis. When a tester is not available, there are several diagnostic tests for each system that are detailed in this section.

To perform a complete system diagnosis, test No. 1 should be performed first and the succeeding tests thereafter. This series of tests will provide a thorough system diagnosis.

The steps in each test will provide a systematic evaluation of each component that could cause an operational malfunction. After completing a repair, repeat the test to ensure that the malfunction has been eliminated. The equipment required to perform the tests is a tachometer, a hand vacuum pump, a digital volt-ohmmeter with a minimum ohms-per-volt input impedance of 10 meg-ohms, and jumper wires.

WARNING: WHEN PERFORMING SYSTEM DIAGNOSTIC TESTS, THE FOLLOWING SAFETY PRECAUTIONS MUST BE FOLLOWED.

- SHAPE A SHEET OF CLEAR ACRYLIC PLASTIC AT LEAST 0.250-INCH THICK AND 15 INCHES X 15 INCHES. SECURE THE ACRYLIC SHEET ON TOP OF THE AIR CLEANER WITH THE WING NUT AFTER THE AIR CLEANER COVER HAS BEEN REMOVED.
- WEAR EYE PROTECTION WHENEVER PERFORMING THE TESTS.
- WHEN THE ENGINE IS OPERATING, KEEP YOUR HANDS AND ARMS CLEAR OF THE FAN, DRIVE PULLEYS AND BELTS. DO NOT WEAR LOOSE CLOTHING. DO NOT STAND IN A DIRECT LINE WITH THE FAN BLADES.

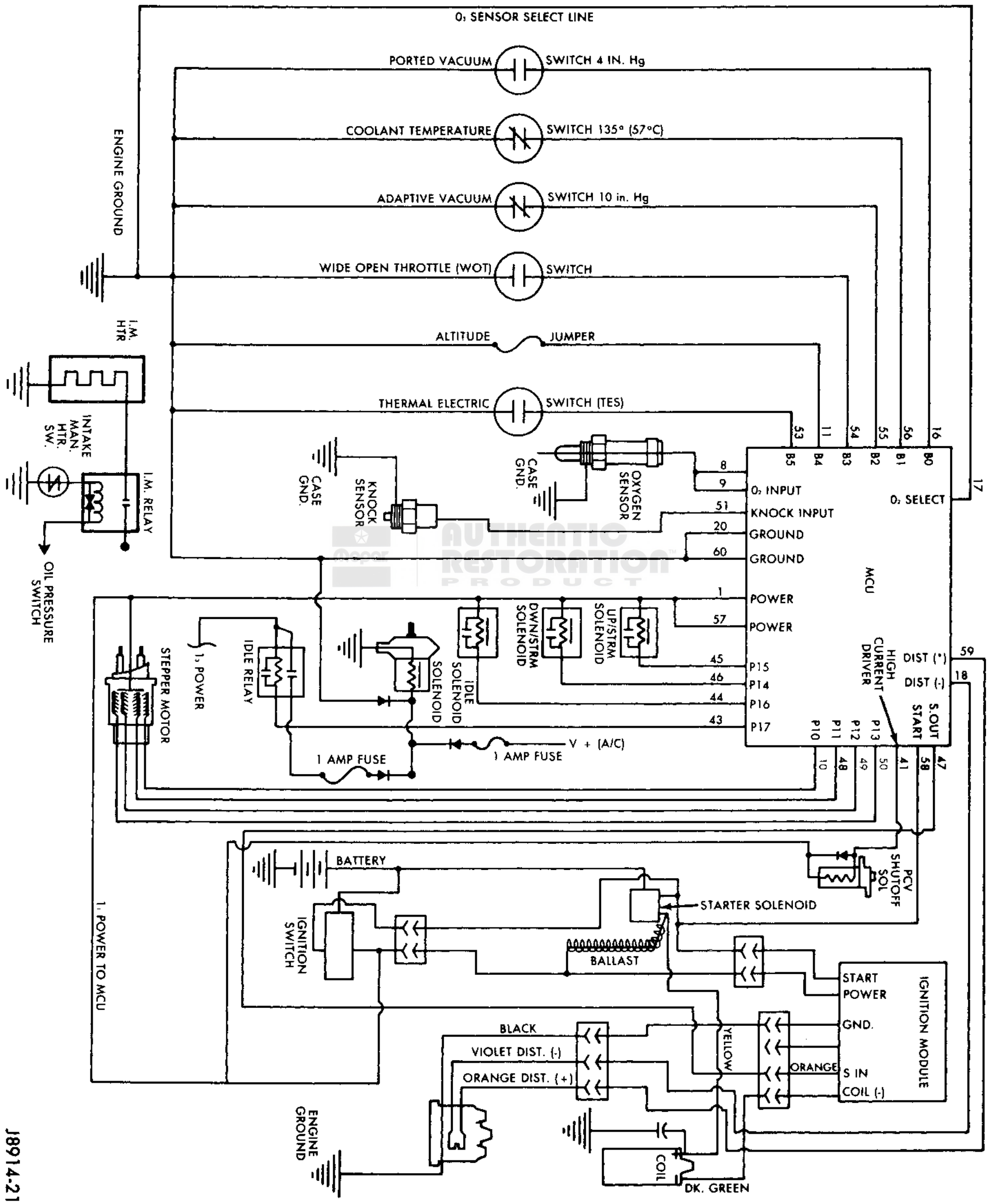
Preliminary Tests

The CEC System should be considered as a possible source of trouble for engine performance, fuel economy and exhaust emission complaints only after normal tests that would apply to a vehicle not equipped with the system have been performed.

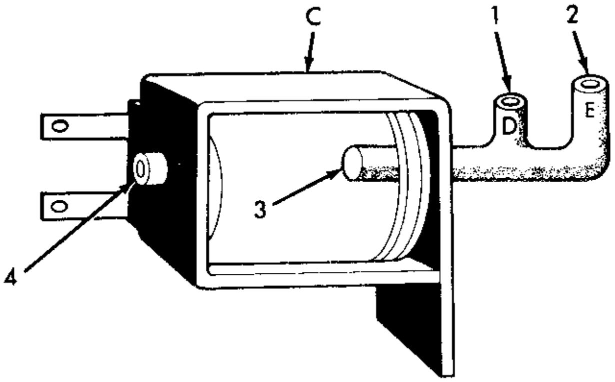
Before performing any diagnostic test, other engine associated components and systems that can affect the air/fuel mixture, combustion efficiency or exhaust gas composition should be tested for malfunctions. These include:

- Basic carburetor adjustments
- Mechanical engine operation (i.e., spark plugs, valves and rings)
- Ignition system
- Gaskets (intake manifold, carburetor or base plate)
- Loose vacuum hoses or fittings

4.2L ENGINE CEC SYSTEM WIRING DIAGRAM



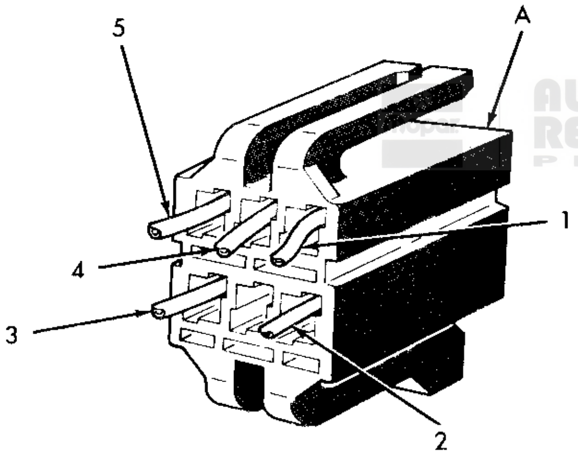
J8914-217A



C - Vacuum Switch Solenoid
1 - Common (D)
2 - Normally Closed - NC (E)
3 - Springloaded Pin
4 - Normally Open - NO (Vent)

J8914-218

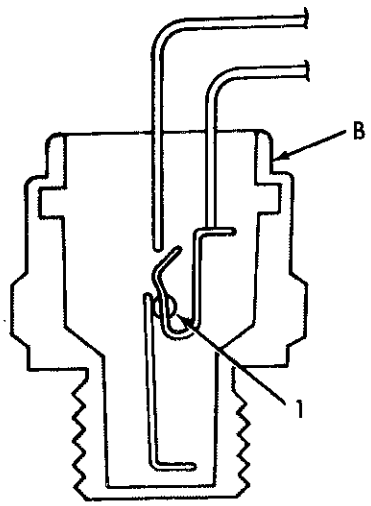
Fig. 20 Vacuum Switch Solenoid



A - Stepper Motor Connector
1 - Brown
2 - Red
3 - Pink
4 - Yellow
5 - Pink

J8914-219A

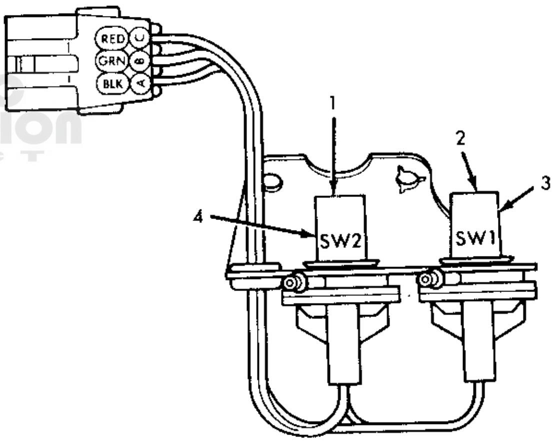
Fig. 21 Stepper Motor Connector



B - Coolant Temperature Switch
1 - Insulator

J8914-220

Fig. 22 Coolant Temperature Switch

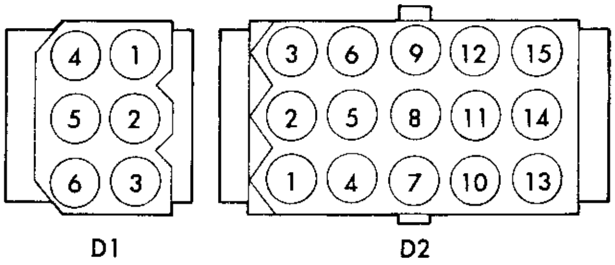


1 - 4-in Hg Vacuum Switch
2 - 10-in Hg Vacuum Switch
3 - Green Color
4 - Natural Color

J8914-221

Fig. 23 4-and 10-Inch Vacuum Switches

DIAGNOSTIC CONNECTORS



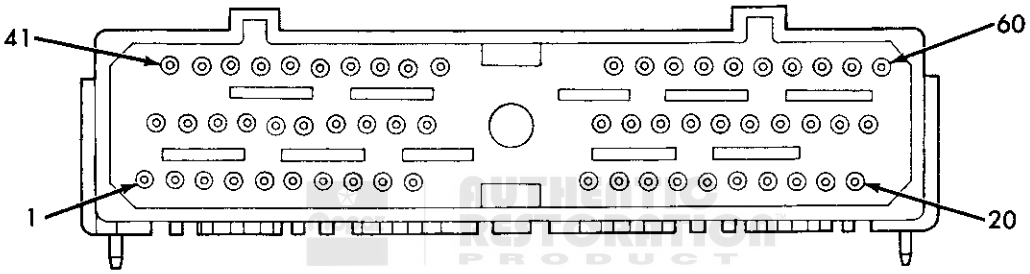
D1

1. TACH
2. ELECTRIC CHOKE
3. GROUND
4. START
5. SOLE-VAC (AFTER RELAY)
6. NOT USED

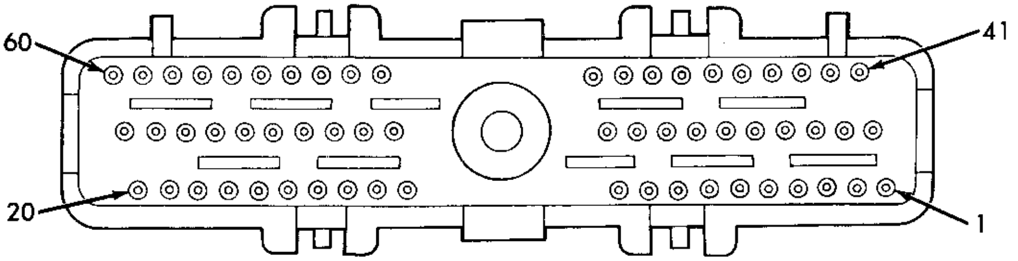
D2

1. PCV SHUTOFF SOLENOID
2. IDLE (SOLE-VAC) SOLENOID
3. ALTITUDE JUMPER WIRE
4. B + (12V) I1
5. DOWNSTREAM SOLENOID
6. WOT SWITCH
7. GROUND
8. UPSTREAM SOLENOID
9. 10 IN. HG VACUUM SWITCH
10. THERMAL ELECTRIC SWITCH (TES)
11. STEPPER MOTOR B0
12. COOLANT TEMP. SWITCH
13. IDLE SPEED RELAY
14. STEPPER MOTOR A0
15. 4 IN. HG VACUUM SWITCH

MCU CONNECTOR



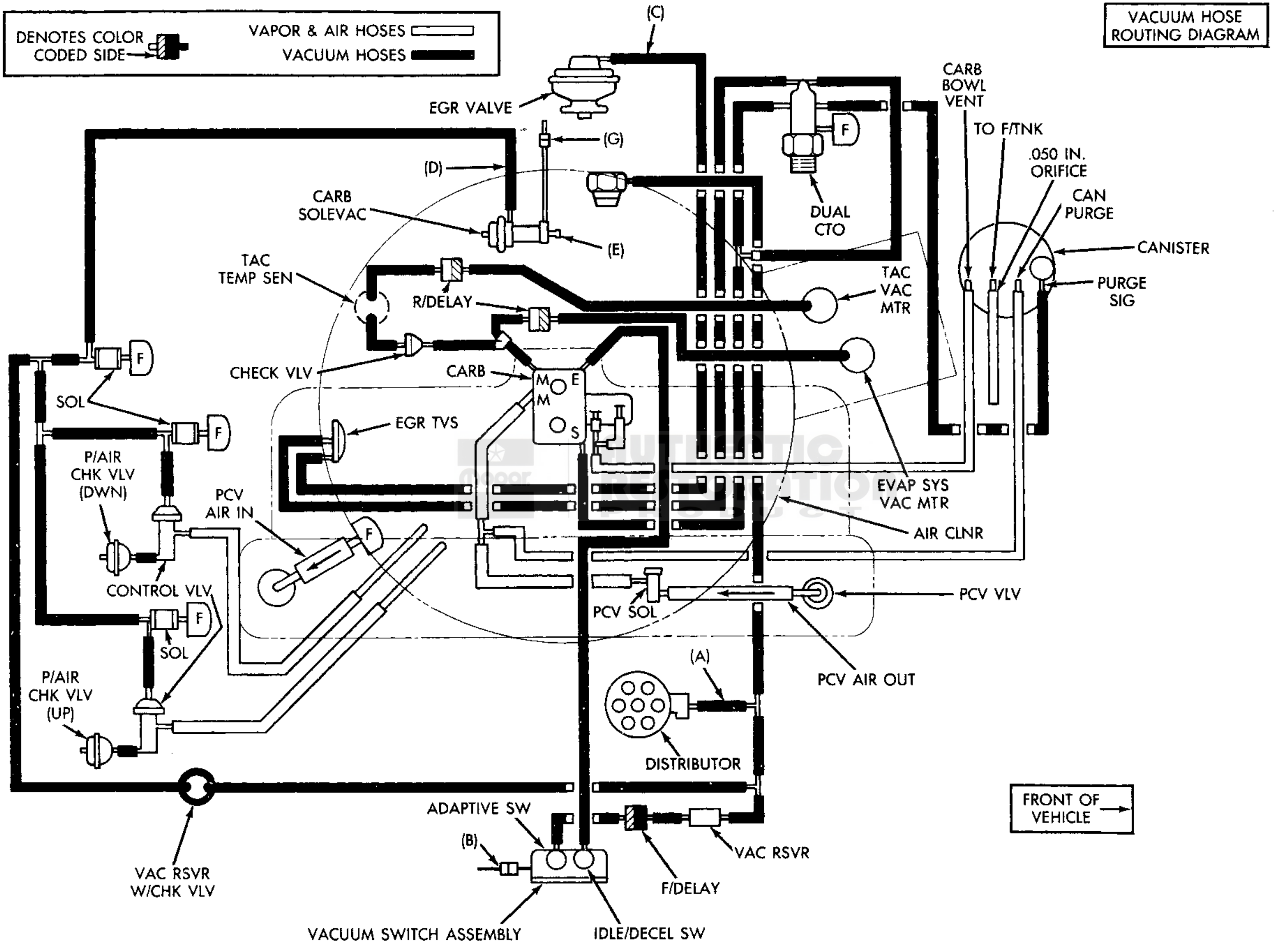
WIRE HARNESS CONNECTOR



PIN	FUNCTION	PIN	FUNCTION
1	BATTERY	41	HIGH CURRENT
2		42	
3		43	P17
4		44	P16
5		45	P15
6		46	P14
7		47	S. OUT
8	O_2 INPUT	48	P11
9	O_2 INPUT	49	P10
10	P13	50	P12
11	B4	51	KNOCK INPUT
12		52	
13		53	B5
14		54	B3
15		55	B2
16	BO	56	B1
17	O_2 SELECT	57	BATTERY
18	DIST (−)	58	START
19		59	DIST (+)
20	GROUND	60	GROUND

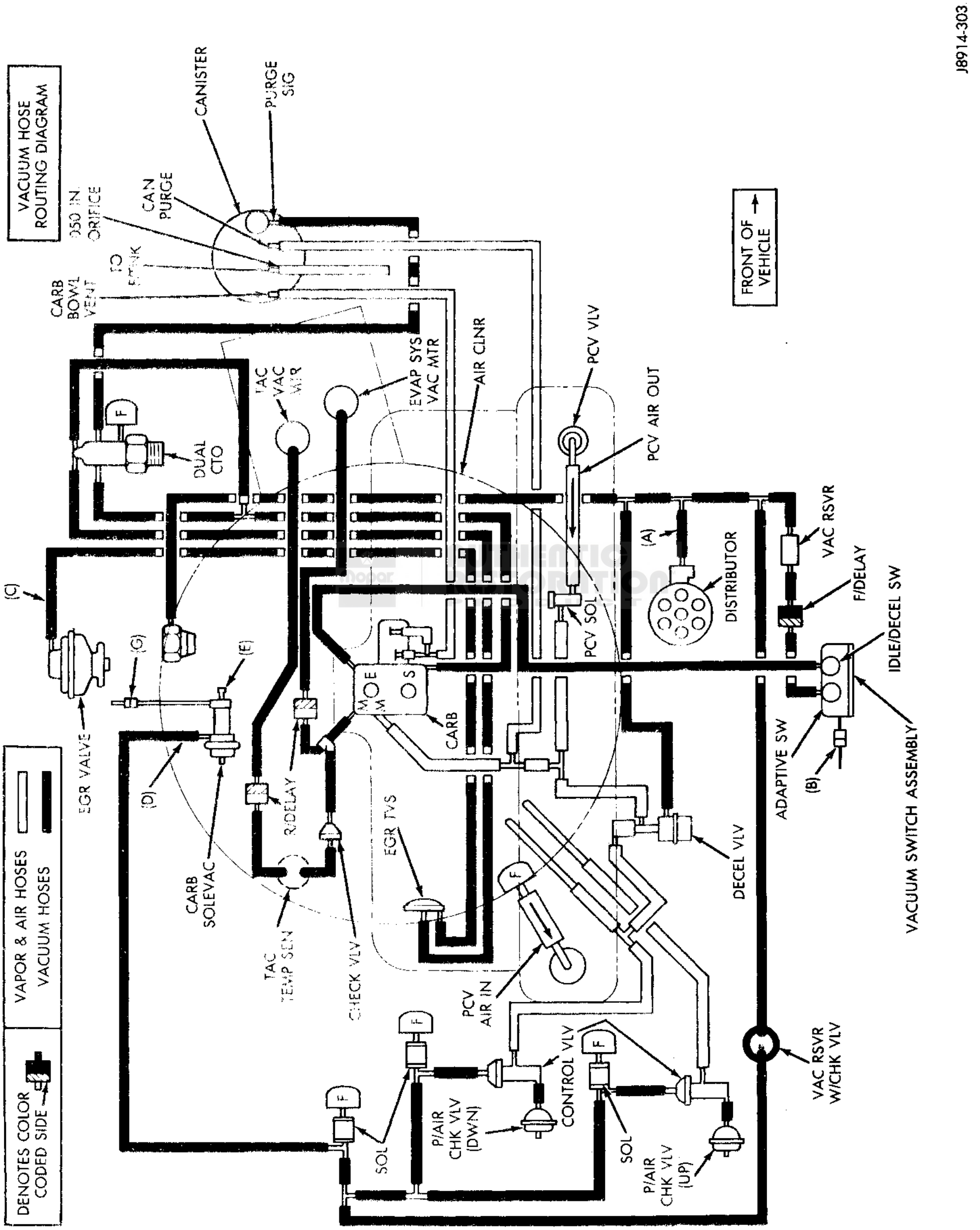
J8914-222

SIX-CYLINDER ENGINE VACUUM DIAGRAM
YJ Vehicles with Automatic Transmission



J8914-302

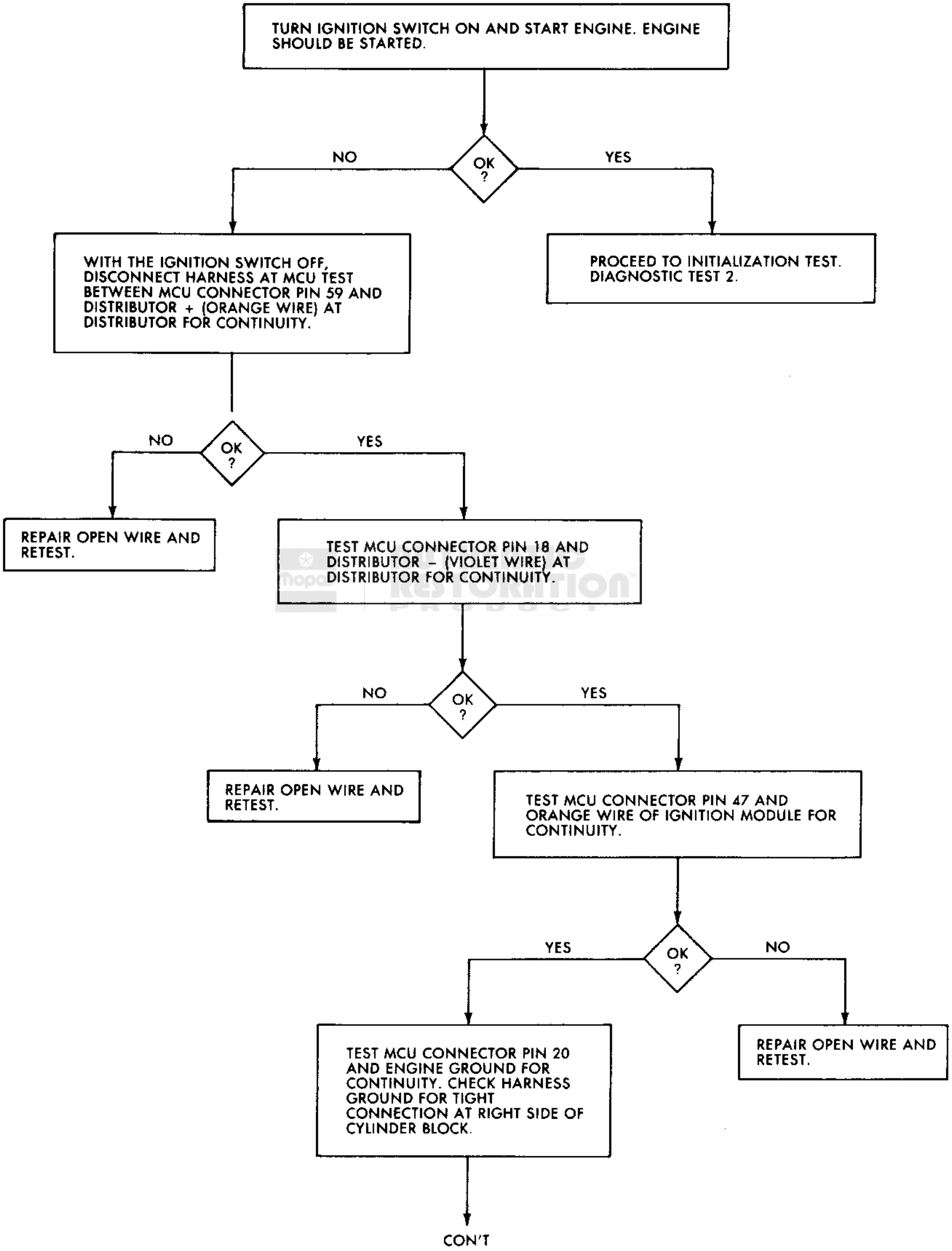
YJ Vehicles with Manual Transmission



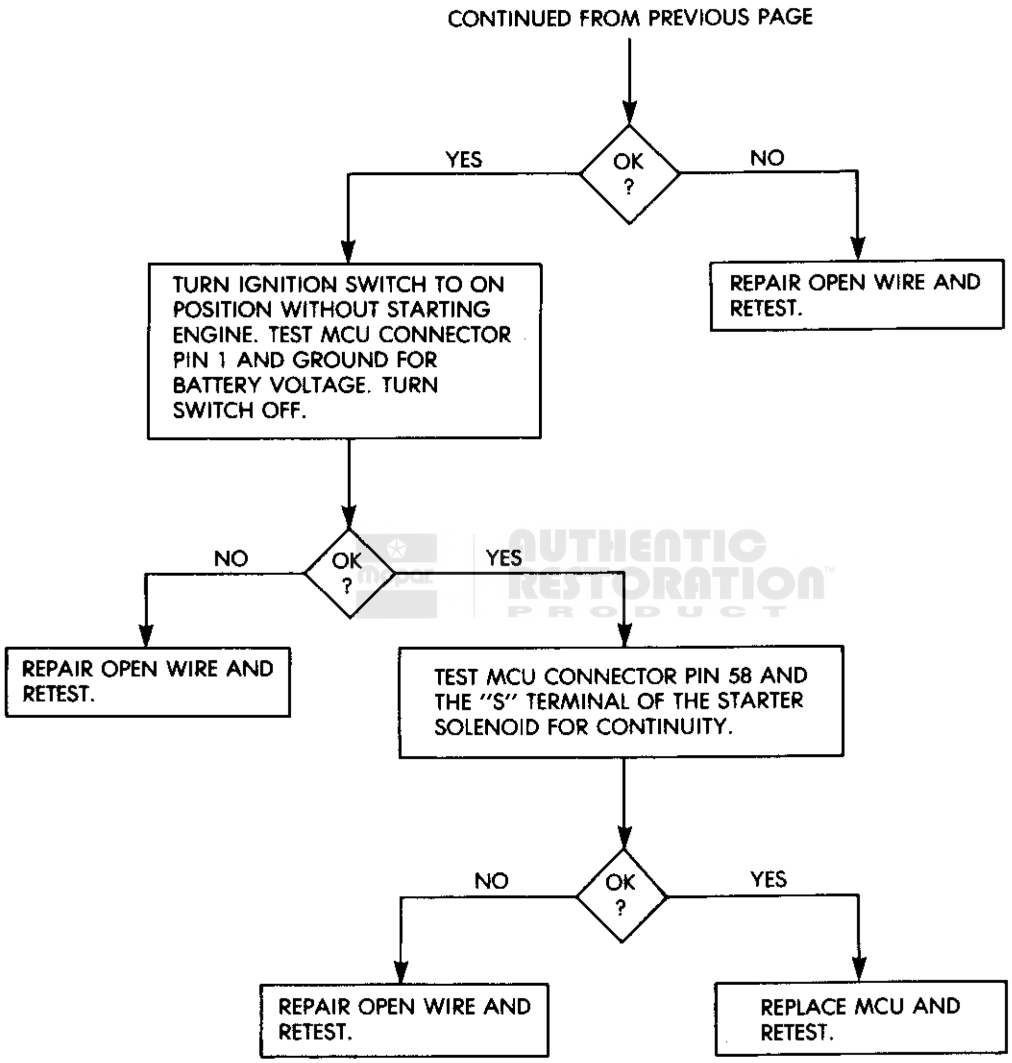
SIX-CYLINDER ENGINE CEC SYSTEM DIAGNOSTIC TESTS

DIAGNOSTIC TEST 1

OPERATIONAL TEST



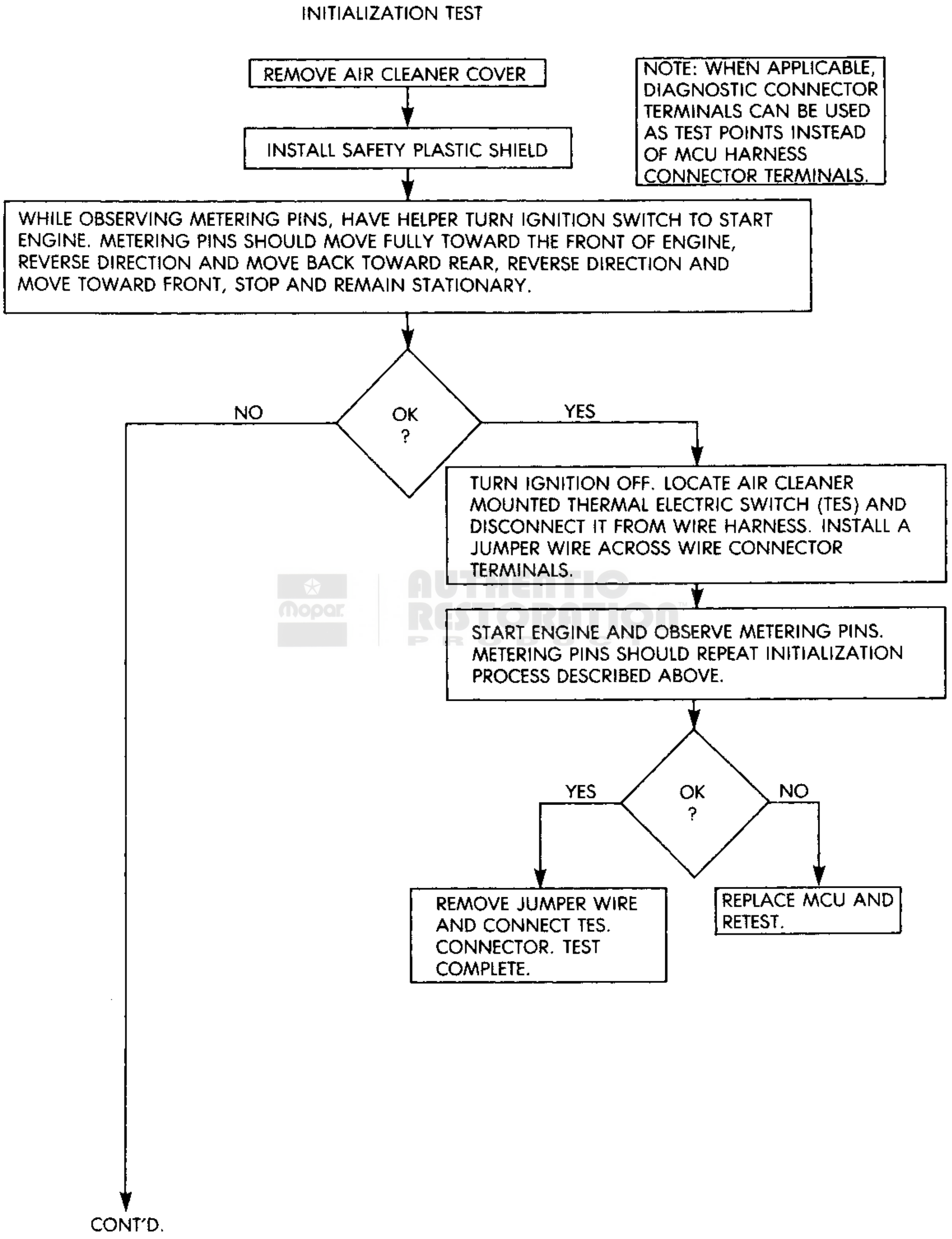
J8914-223



*NOTE: BEFORE REPLACING MCU, IF ENGINE FAILS TO START, CHECK FOR FAILURE OF IGNITION MODULE, COIL, DISTRIBUTOR, ETC. REFER TO IGNITION SYSTEMS - CHAPTER C.

J8914-224

DIAGNOSTIC TEST 2



INITIALIZATION TEST

REMOVE AIR CLEANER COVER

INSTALL SAFETY PLASTIC SHIELD

NOTE: WHEN APPLICABLE, DIAGNOSTIC CONNECTOR TERMINALS CAN BE USED AS TEST POINTS INSTEAD OF MCU HARNESS CONNECTOR TERMINALS.

WHILE OBSERVING METERING PINS, HAVE HELPER TURN IGNITION SWITCH TO START ENGINE. METERING PINS SHOULD MOVE FULLY TOWARD THE FRONT OF ENGINE, REVERSE DIRECTION AND MOVE BACK TOWARD REAR, REVERSE DIRECTION AND MOVE TOWARD FRONT, STOP AND REMAIN STATIONARY.

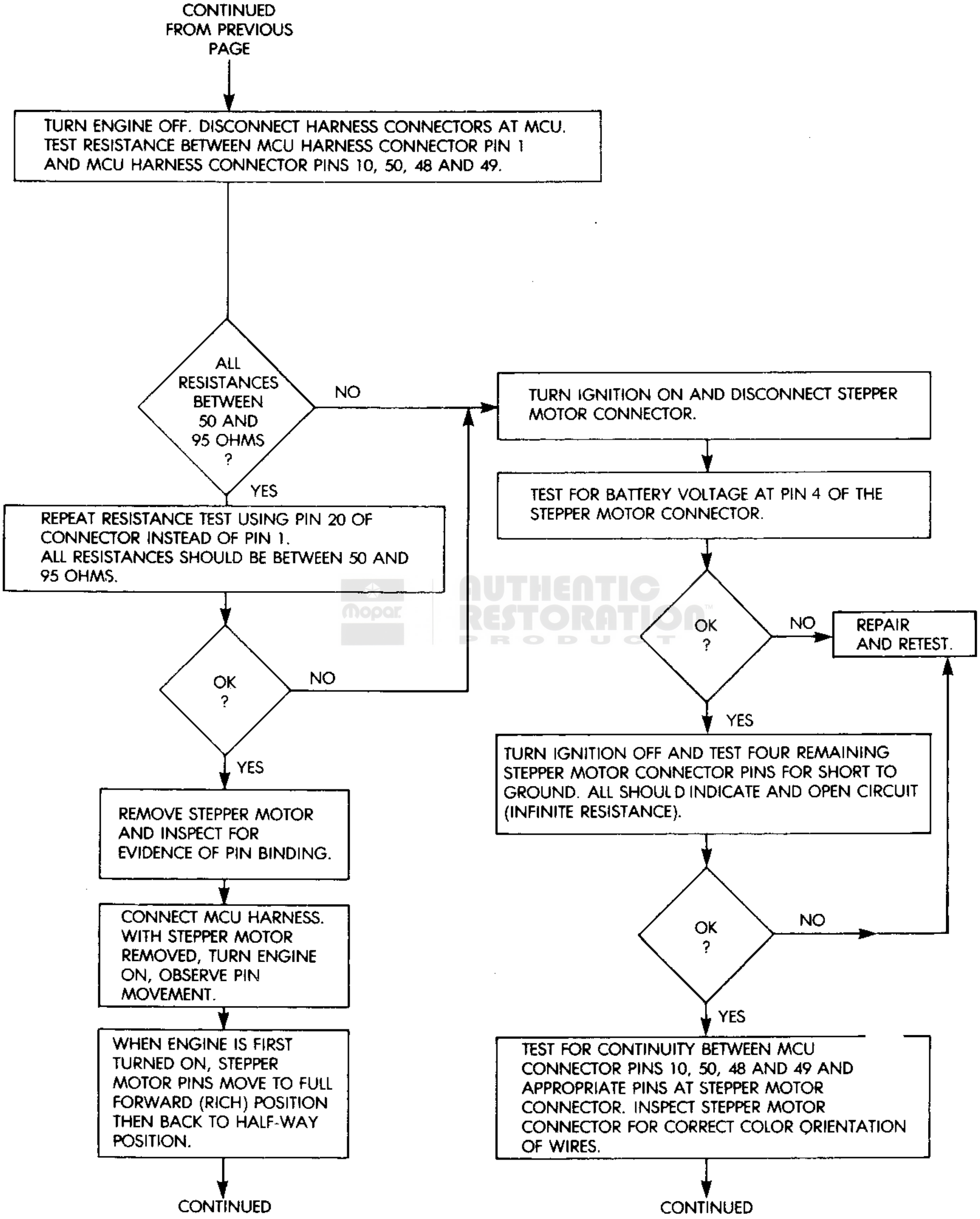
TURN IGNITION OFF. LOCATE AIR CLEANER MOUNTED THERMAL ELECTRIC SWITCH (TES) AND DISCONNECT IT FROM WIRE HARNESS. INSTALL A JUMPER WIRE ACROSS WIRE CONNECTOR TERMINALS.

START ENGINE AND OBSERVE METERING PINS. METERING PINS SHOULD REPEAT INITIALIZATION PROCESS DESCRIBED ABOVE.

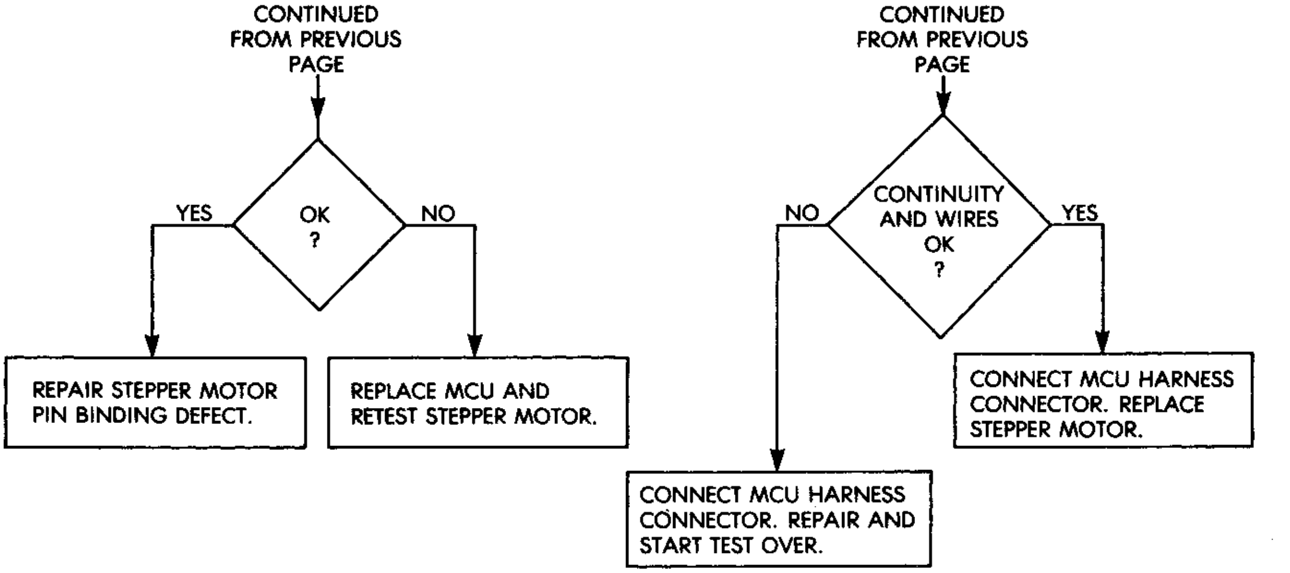
REMOVE JUMPER WIRE AND CONNECT TES. CONNECTOR. TEST COMPLETE.

REPLACE MCU AND RETEST.

J8914-225


CONTINUED FROM PREVIOUS PAGE
TURN ENGINE OFF. DISCONNECT HARNESS CONNECTORS AT MCU. TEST RESISTANCE BETWEEN MCU HARNESS CONNECTOR PIN 1 AND MCU HARNESS CONNECTOR PINS 10, 50, 48 AND 49.
ALL RESISTANCES BETWEEN 50 AND 95 OHMS ?
NO
YES
REPEAT RESISTANCE TEST USING PIN 20 OF CONNECTOR INSTEAD OF PIN 1. ALL RESISTANCES SHOULD BE BETWEEN 50 AND 95 OHMS.
OK ?
NO
YES
REMOVE STEPPER MOTOR AND INSPECT FOR EVIDENCE OF PIN BINDING.
CONNECT MCU HARNESS. WITH STEPPER MOTOR REMOVED, TURN ENGINE ON, OBSERVE PIN MOVEMENT.
WHEN ENGINE IS FIRST TURNED ON, STEPPER MOTOR PINS MOVE TO FULL FORWARD (RICH) POSITION THEN BACK TO HALF-WAY POSITION.
CONTINUED
TURN IGNITION ON AND DISCONNECT STEPPER MOTOR CONNECTOR.
TEST FOR BATTERY VOLTAGE AT PIN 4 OF THE STEPPER MOTOR CONNECTOR.
OK ?
NO
REPAIR AND RETEST.
YES
TURN IGNITION OFF AND TEST FOUR REMAINING STEPPER MOTOR CONNECTOR PINS FOR SHORT TO GROUND. ALL SHOULD INDICATE AND OPEN CIRCUIT (INFINITE RESISTANCE).
OK ?
NO
YES
TEST FOR CONTINUITY BETWEEN MCU CONNECTOR PINS 10, 50, 48 AND 49 AND APPROPRIATE PINS AT STEPPER MOTOR CONNECTOR. INSPECT STEPPER MOTOR CONNECTOR FOR CORRECT COLOR ORIENTATION OF WIRES.
CONTINUED

J8914-226 A


CONTINUED FROM PREVIOUS PAGE
OK ?
YES
NO
REPAIR STEPPER MOTOR PIN BINDING DEFECT.
REPLACE MCU AND RETEST STEPPER MOTOR.
CONTINUED FROM PREVIOUS PAGE
CONTINUITY AND WIRES OK ?
NO
YES
CONNECT MCU HARNESS CONNECTOR. REPLACE STEPPER MOTOR.
CONNECT MCU HARNESS CONNECTOR. REPAIR AND START TEST OVER.

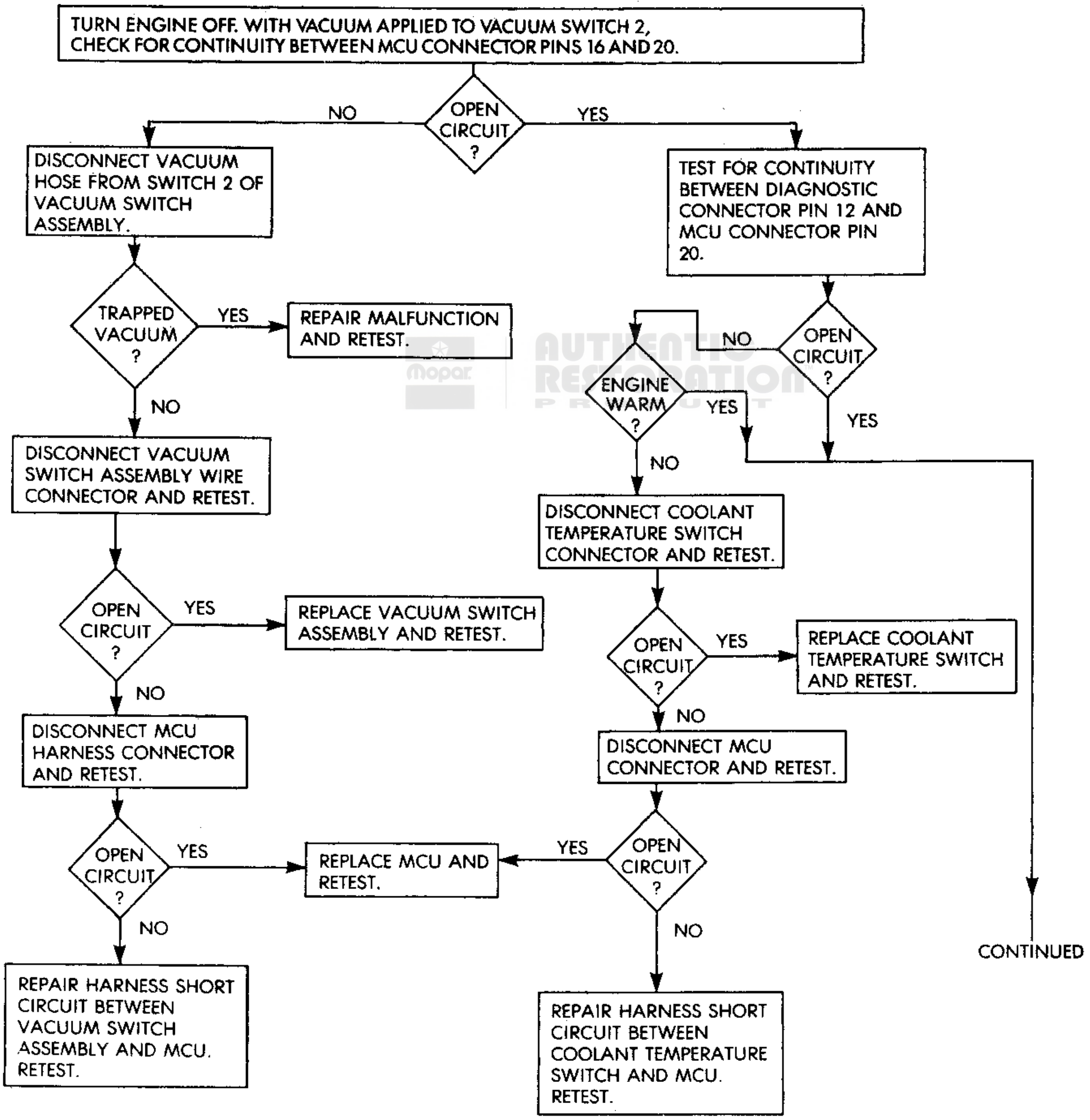
J8914-227

DIAGNOSTIC TEST 3

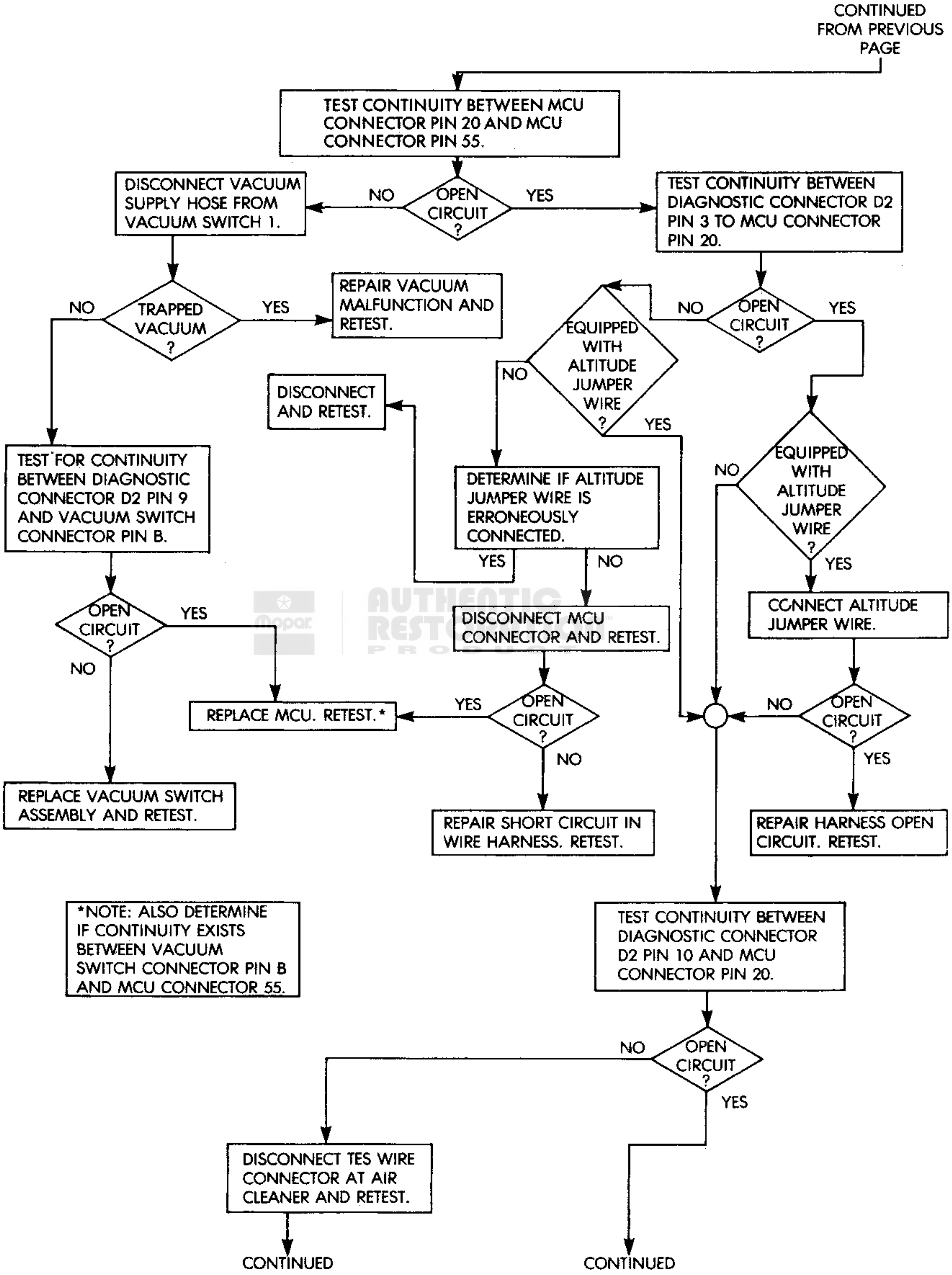
OPEN LOOP SWITCH TEST

NOTE: ENGINE SHOULD BE AT NORMAL OPERATING TEMPERATURE. ALL CONTINUITY TESTING SHOULD BE DONE WITH MCU DISCONNECTED.

NOTE: CONTINUITY TESTING WITH MCU CONNECTED TO THE SYSTEM SHOULD INDICATE 2 OHMS. WHEN THE MCU IS DISCONNECTED FROM THE SYSTEM, ALL CONTINUITY SHOULD INDICATE LESS THAN 1 OHM. WHEN APPLICABLE, DIAGNOSTIC CONNECTOR TERMINALS CAN BE USED AS TEST POINTS INSTEAD OF MCU HARNESS CONNECTOR TERMINALS.

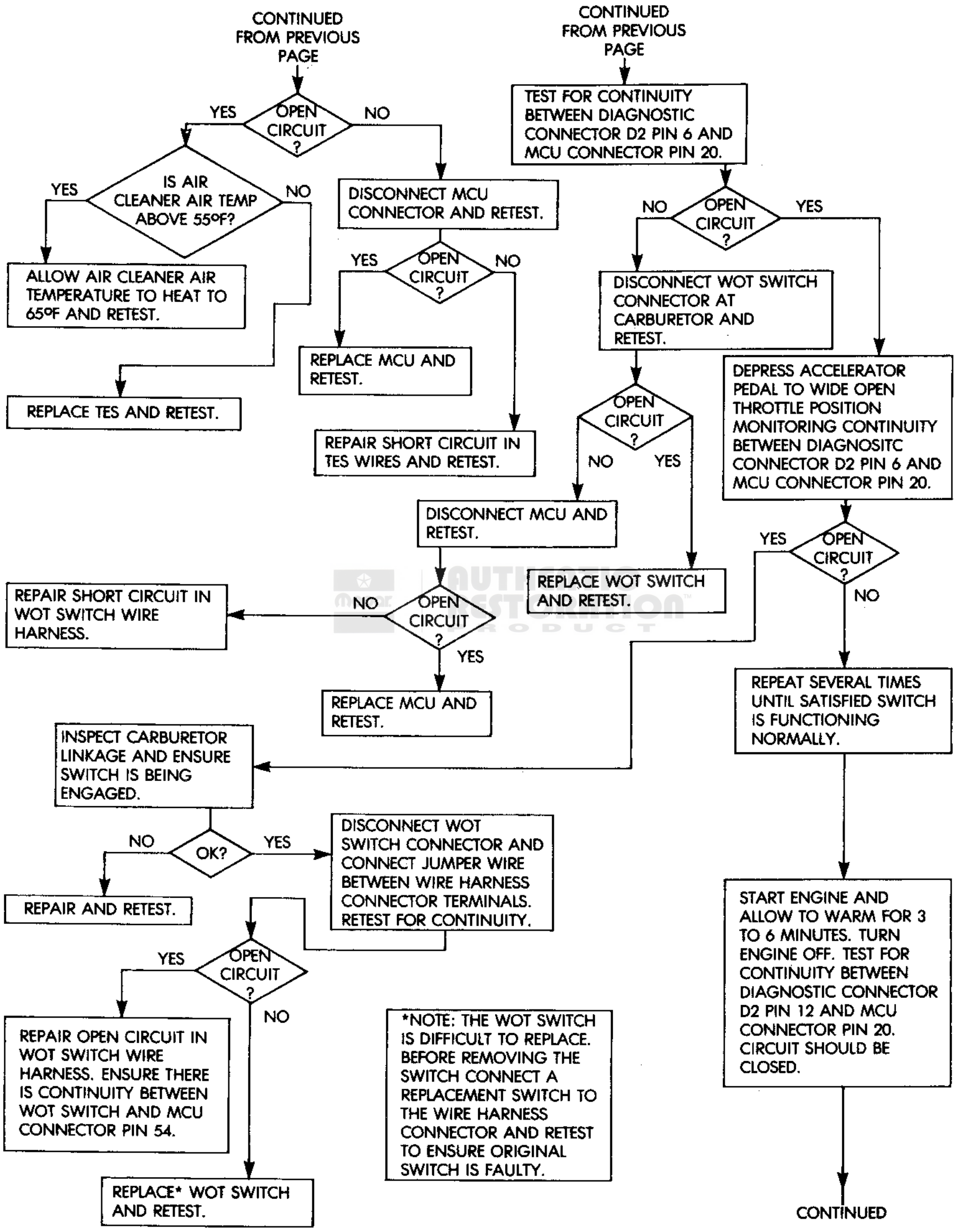


J9014-147

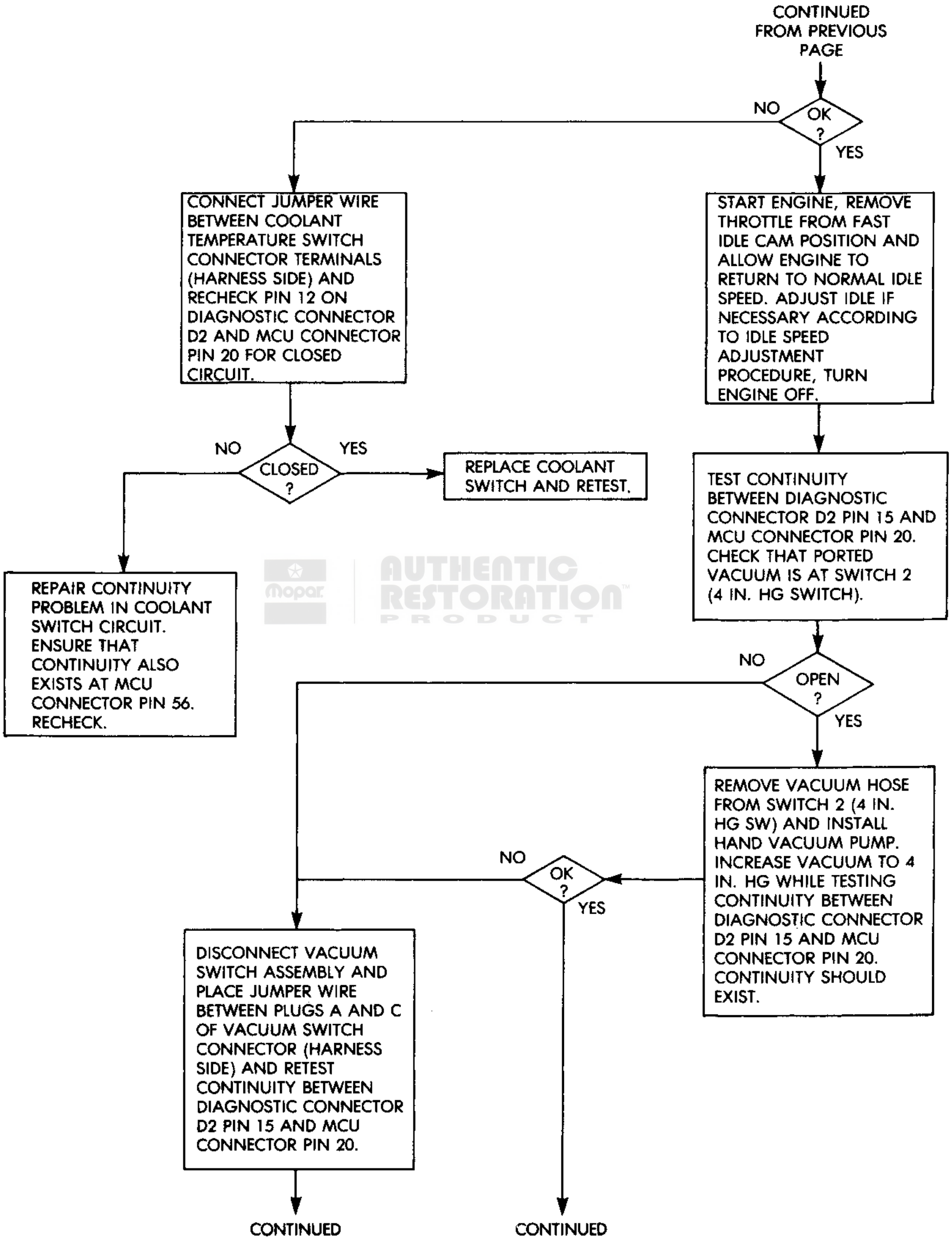


*NOTE: ALSO DETERMINE IF CONTINUITY EXISTS BETWEEN VACUUM SWITCH CONNECTOR PIN B AND MCU CONNECTOR 55.

J9014-148


CONTINUED FROM PREVIOUS PAGE
OPEN CIRCUIT ?
YES
NO
IS AIR CLEANER AIR TEMP ABOVE 55ºF?
YES
NO
ALLOW AIR CLEANER AIR TEMPERATURE TO HEAT TO 65ºF AND RETEST.
REPLACE TES AND RETEST.
DISCONNECT MCU CONNECTOR AND RETEST.
OPEN CIRCUIT ?
YES
NO
REPLACE MCU AND RETEST.
REPAIR SHORT CIRCUIT IN TES WIRES AND RETEST.
CONTINUED FROM PREVIOUS PAGE
TEST FOR CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR D2 PIN 6 AND MCU CONNECTOR PIN 20.
OPEN CIRCUIT ?
NO
YES
DISCONNECT WOT SWITCH CONNECTOR AT CARBURETOR AND RETEST.
OPEN CIRCUIT ?
NO
YES
DISCONNECT MCU AND RETEST.
REPLACE WOT SWITCH AND RETEST.
OPEN CIRCUIT ?
NO
YES
REPAIR SHORT CIRCUIT IN WOT SWITCH WIRE HARNESS.
REPLACE MCU AND RETEST.
DEPRESS ACCELERATOR PEDAL TO WIDE OPEN THROTTLE POSITION MONITORING CONTINUITY BETWEEN DIAGNOSITC CONNECTOR D2 PIN 6 AND MCU CONNECTOR PIN 20.
OPEN CIRCUIT ?
YES
NO
REPEAT SEVERAL TIMES UNTIL SATISFIED SWITCH IS FUNCTIONING NORMALLY.
INSPECT CARBURETOR LINKAGE AND ENSURE SWITCH IS BEING ENGAGED.
OK?
NO
YES
REPAIR AND RETEST.
DISCONNECT WOT SWITCH CONNECTOR AND CONNECT JUMPER WIRE BETWEEN WIRE HARNESS CONNECTOR TERMINALS. RETEST FOR CONTINUITY.
OPEN CIRCUIT ?
YES
NO
REPAIR OPEN CIRCUIT IN WOT SWITCH WIRE HARNESS. ENSURE THERE IS CONTINUITY BETWEEN WOT SWITCH AND MCU CONNECTOR PIN 54.
REPLACE* WOT SWITCH AND RETEST.
*NOTE: THE WOT SWITCH IS DIFFICULT TO REPLACE. BEFORE REMOVING THE SWITCH CONNECT A REPLACEMENT SWITCH TO THE WIRE HARNESS CONNECTOR AND RETEST TO ENSURE ORIGINAL SWITCH IS FAULTY.
START ENGINE AND ALLOW TO WARM FOR 3 TO 6 MINUTES. TURN ENGINE OFF. TEST FOR CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR D2 PIN 12 AND MCU CONNECTOR PIN 20. CIRCUIT SHOULD BE CLOSED.
CONTINUED

J8914-230



CONNECT JUMPER WIRE BETWEEN COOLANT TEMPERATURE SWITCH CONNECTOR TERMINALS (HARNESS SIDE) AND RECHECK PIN 12 ON DIAGNOSTIC CONNECTOR D2 AND MCU CONNECTOR PIN 20 FOR CLOSED CIRCUIT.

START ENGINE, REMOVE THROTTLE FROM FAST IDLE CAM POSITION AND ALLOW ENGINE TO RETURN TO NORMAL IDLE SPEED. ADJUST IDLE IF NECESSARY ACCORDING TO IDLE SPEED ADJUSTMENT PROCEDURE, TURN ENGINE OFF.

REPLACE COOLANT SWITCH AND RETEST.

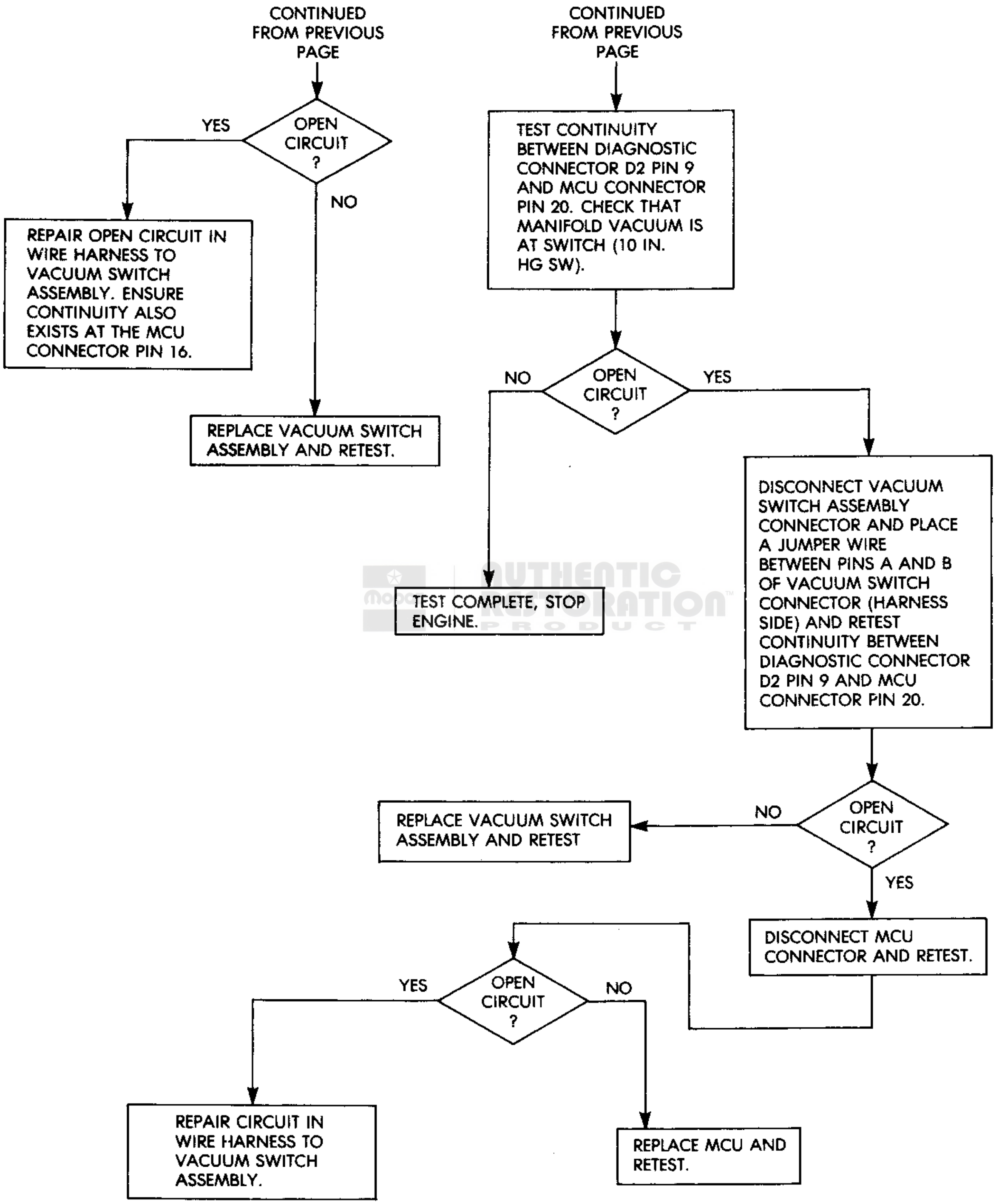
TEST CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR D2 PIN 15 AND MCU CONNECTOR PIN 20. CHECK THAT PORTED VACUUM IS AT SWITCH 2 (4 IN. HG SWITCH).

REPAIR CONTINUITY PROBLEM IN COOLANT SWITCH CIRCUIT. ENSURE THAT CONTINUITY ALSO EXISTS AT MCU CONNECTOR PIN 56. RECHECK.

REMOVE VACUUM HOSE FROM SWITCH 2 (4 IN. HG SW) AND INSTALL HAND VACUUM PUMP. INCREASE VACUUM TO 4 IN. HG WHILE TESTING CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR D2 PIN 15 AND MCU CONNECTOR PIN 20. CONTINUITY SHOULD EXIST.

DISCONNECT VACUUM SWITCH ASSEMBLY AND PLACE JUMPER WIRE BETWEEN PLUGS A AND C OF VACUUM SWITCH CONNECTOR (HARNESS SIDE) AND RETEST CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR D2 PIN 15 AND MCU CONNECTOR PIN 20.

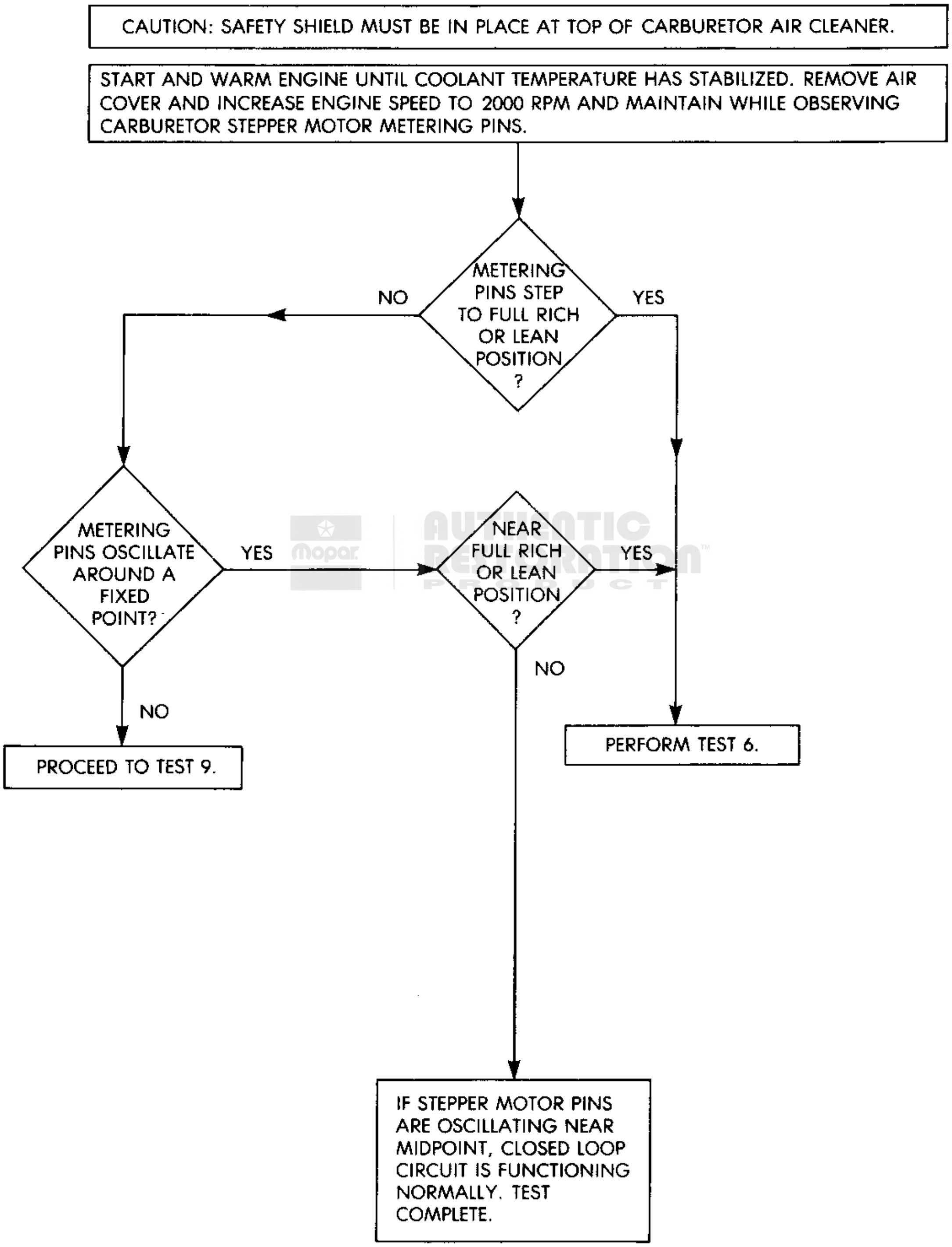
J8914-231


CONTINUED FROM PREVIOUS PAGE
OPEN CIRCUIT ?
YES
NO
REPAIR OPEN CIRCUIT IN WIRE HARNESS TO VACUUM SWITCH ASSEMBLY. ENSURE CONTINUITY ALSO EXISTS AT THE MCU CONNECTOR PIN 16.
REPLACE VACUUM SWITCH ASSEMBLY AND RETEST.
CONTINUED FROM PREVIOUS PAGE
TEST CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR D2 PIN 9 AND MCU CONNECTOR PIN 20. CHECK THAT MANIFOLD VACUUM IS AT SWITCH (10 IN. HG SW).
OPEN CIRCUIT ?
NO
YES
TEST COMPLETE, STOP ENGINE.
DISCONNECT VACUUM SWITCH ASSEMBLY CONNECTOR AND PLACE A JUMPER WIRE BETWEEN PINS A AND B OF VACUUM SWITCH CONNECTOR (HARNESS SIDE) AND RETEST CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR D2 PIN 9 AND MCU CONNECTOR PIN 20.
OPEN CIRCUIT ?
NO
YES
REPLACE VACUUM SWITCH ASSEMBLY AND RETEST
DISCONNECT MCU CONNECTOR AND RETEST.
OPEN CIRCUIT ?
YES
NO
REPAIR CIRCUIT IN WIRE HARNESS TO VACUUM SWITCH ASSEMBLY.
REPLACE MCU AND RETEST.

J8914-232

DIAGNOSTIC TEST 4

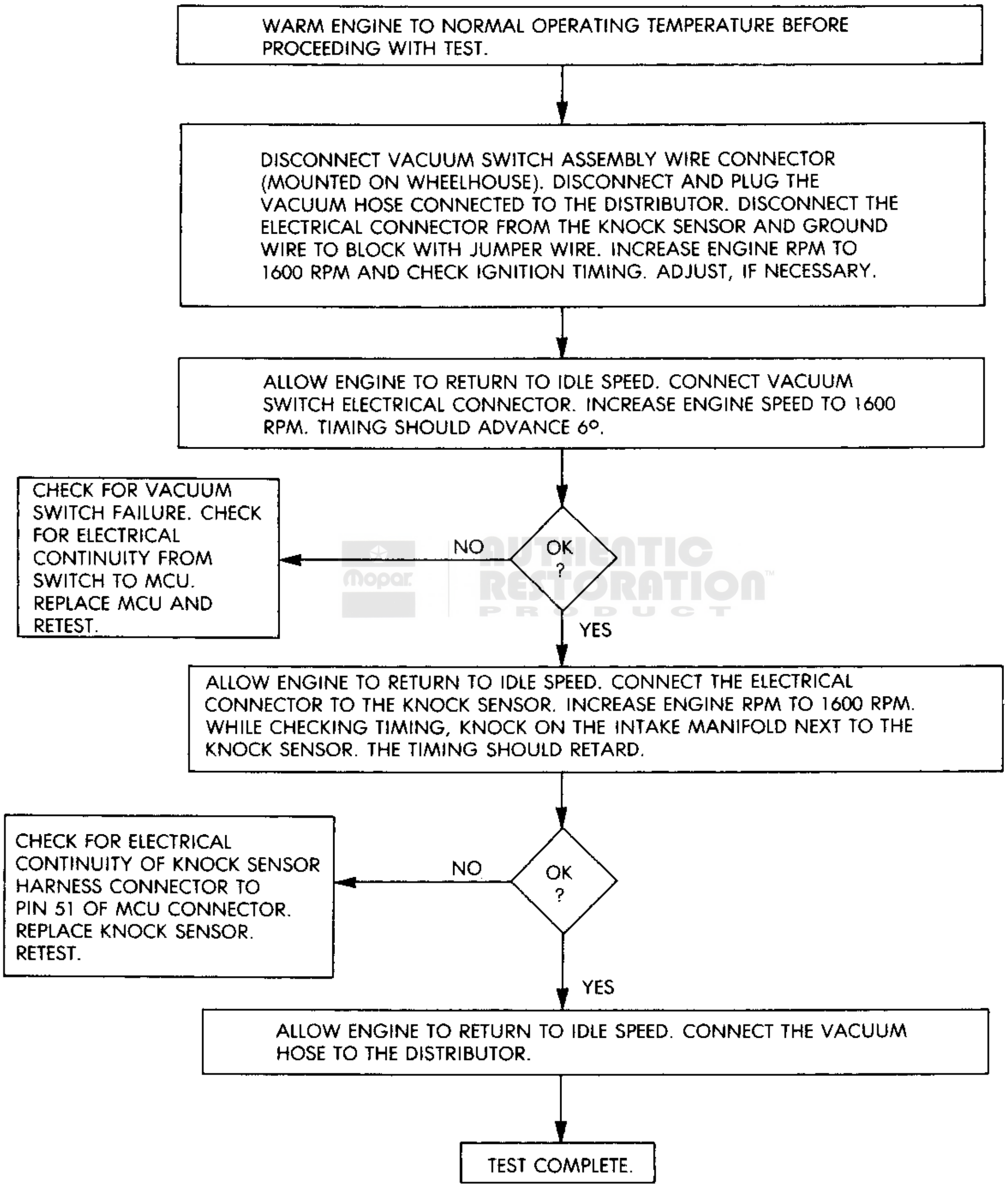
CLOSED LOOP OPERATIONAL TEST



J8914-233

DIAGNOSTIC TEST 5

ELECTRONIC IGNITION RETARD TEST



WARM ENGINE TO NORMAL OPERATING TEMPERATURE BEFORE PROCEEDING WITH TEST.

DISCONNECT VACUUM SWITCH ASSEMBLY WIRE CONNECTOR (MOUNTED ON WHEELHOUSE). DISCONNECT AND PLUG THE VACUUM HOSE CONNECTED TO THE DISTRIBUTOR. DISCONNECT THE ELECTRICAL CONNECTOR FROM THE KNOCK SENSOR AND GROUND WIRE TO BLOCK WITH JUMPER WIRE. INCREASE ENGINE RPM TO 1600 RPM AND CHECK IGNITION TIMING. ADJUST, IF NECESSARY.

ALLOW ENGINE TO RETURN TO IDLE SPEED. CONNECT VACUUM SWITCH ELECTRICAL CONNECTOR. INCREASE ENGINE SPEED TO 1600 RPM. TIMING SHOULD ADVANCE 6°.

CHECK FOR VACUUM SWITCH FAILURE. CHECK FOR ELECTRICAL CONTINUITY FROM SWITCH TO MCU. REPLACE MCU AND RETEST.

ALLOW ENGINE TO RETURN TO IDLE SPEED. CONNECT THE ELECTRICAL CONNECTOR TO THE KNOCK SENSOR. INCREASE ENGINE RPM TO 1600 RPM. WHILE CHECKING TIMING, KNOCK ON THE INTAKE MANIFOLD NEXT TO THE KNOCK SENSOR. THE TIMING SHOULD RETARD.

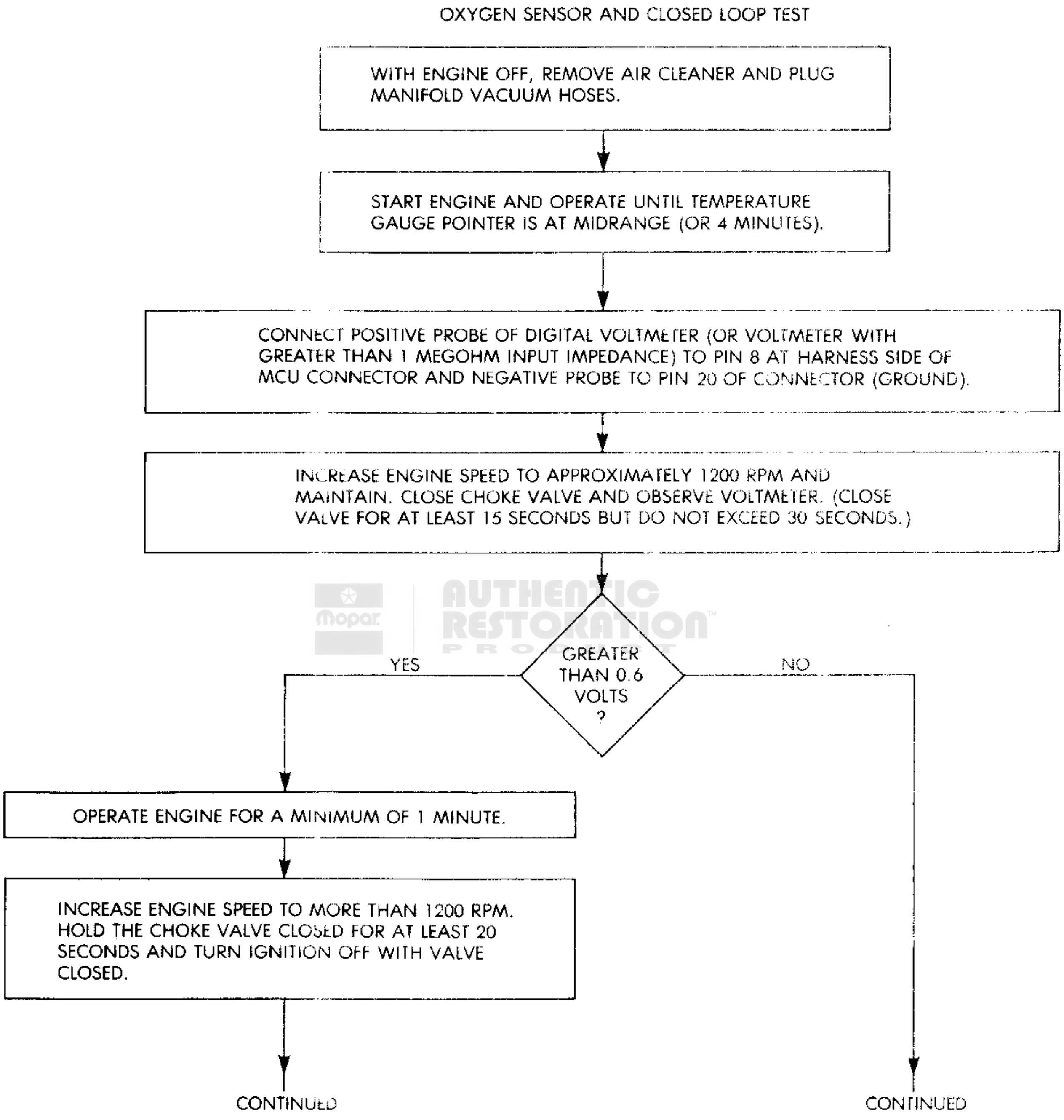
CHECK FOR ELECTRICAL CONTINUITY OF KNOCK SENSOR HARNESS CONNECTOR TO PIN 51 OF MCU CONNECTOR. REPLACE KNOCK SENSOR. RETEST.

ALLOW ENGINE TO RETURN TO IDLE SPEED. CONNECT THE VACUUM HOSE TO THE DISTRIBUTOR.

TEST COMPLETE.

J8914-234

DIAGNOSTIC TEST 6



OXYGEN SENSOR AND CLOSED LOOP TEST

WITH ENGINE OFF, REMOVE AIR CLEANER AND PLUG MANIFOLD VACUUM HOSES.

START ENGINE AND OPERATE UNTIL TEMPERATURE GAUGE POINTER IS AT MIDRANGE (OR 4 MINUTES).

CONNECT POSITIVE PROBE OF DIGITAL VOLTMETER (OR VOLTMETER WITH GREATER THAN 1 MEGOHM INPUT IMPEDANCE) TO PIN 8 AT HARNESS SIDE OF MCU CONNECTOR AND NEGATIVE PROBE TO PIN 20 OF CONNECTOR (GROUND).

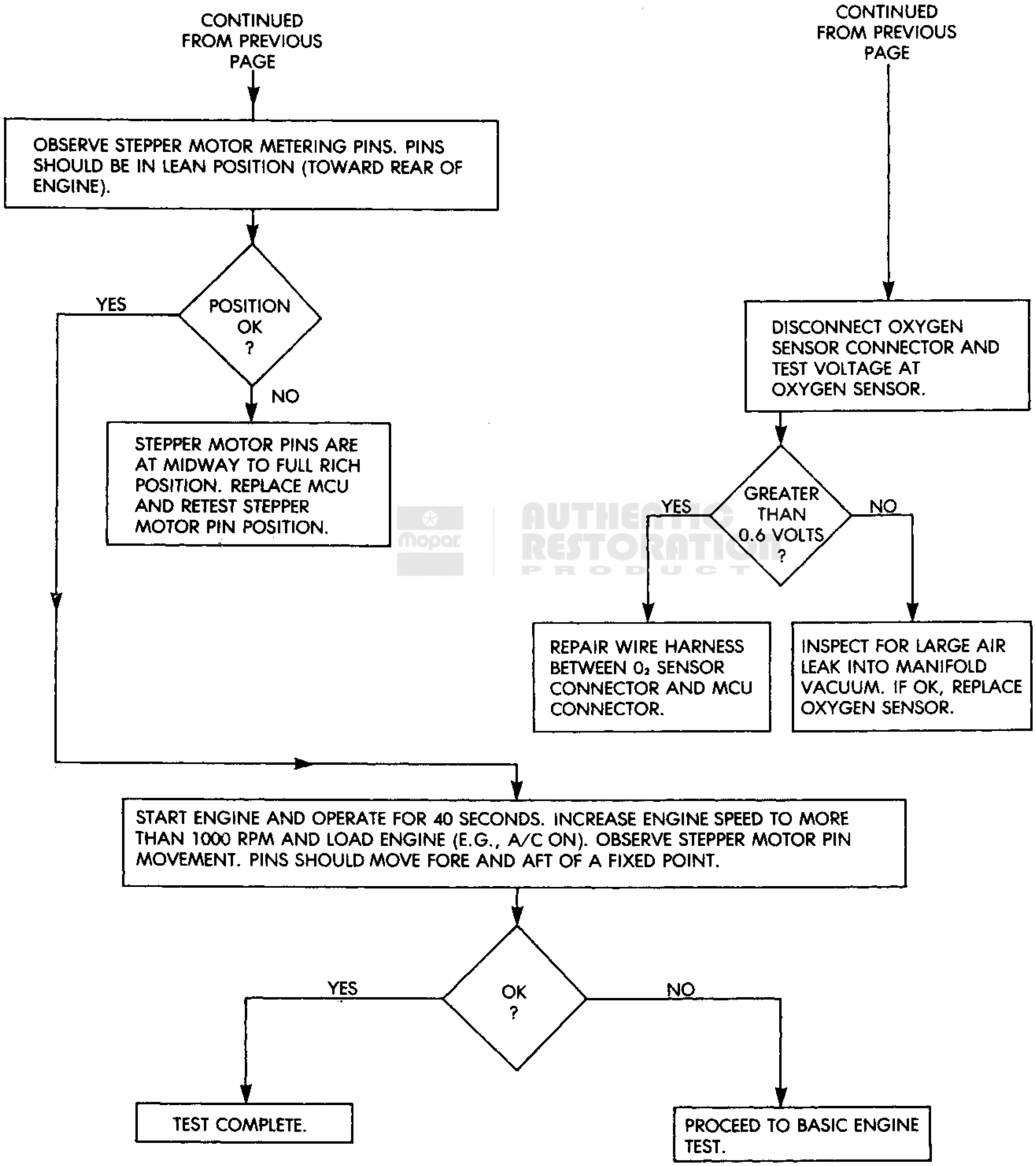
INCREASE ENGINE SPEED TO APPROXIMATELY 1200 RPM AND MAINTAIN. CLOSE CHOKE VALVE AND OBSERVE VOLTMETER. (CLOSE VALVE FOR AT LEAST 15 SECONDS BUT DO NOT EXCEED 30 SECONDS.)

GREATER THAN 0.6 VOLTS ?

OPERATE ENGINE FOR A MINIMUM OF 1 MINUTE.

INCREASE ENGINE SPEED TO MORE THAN 1200 RPM. HOLD THE CHOKE VALVE CLOSED FOR AT LEAST 20 SECONDS AND TURN IGNITION OFF WITH VALVE CLOSED.

J8914-235

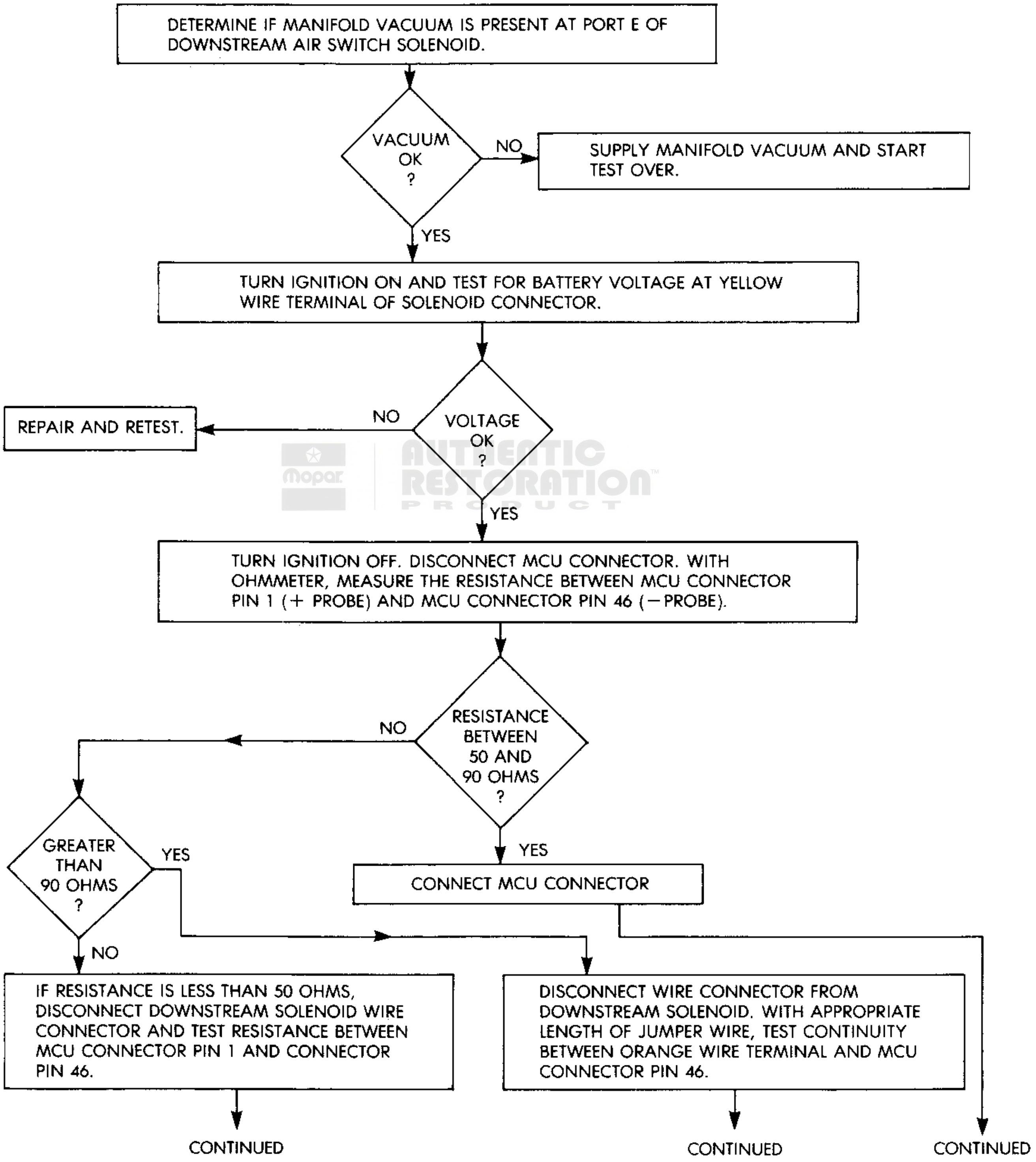

CONTINUED FROM PREVIOUS PAGE
OBSERVE STEPPER MOTOR METERING PINS. PINS SHOULD BE IN LEAN POSITION (TOWARD REAR OF ENGINE).
POSITION OK ?
YES
NO
STEPPER MOTOR PINS ARE AT MIDWAY TO FULL RICH POSITION. REPLACE MCU AND RETEST STEPPER MOTOR PIN POSITION.
CONTINUED FROM PREVIOUS PAGE
DISCONNECT OXYGEN SENSOR CONNECTOR AND TEST VOLTAGE AT OXYGEN SENSOR.
GREATER THAN 0.6 VOLTS ?
YES
NO
REPAIR WIRE HARNESS BETWEEN O₂ SENSOR CONNECTOR AND MCU CONNECTOR.
INSPECT FOR LARGE AIR LEAK INTO MANIFOLD VACUUM. IF OK, REPLACE OXYGEN SENSOR.
START ENGINE AND OPERATE FOR 40 SECONDS. INCREASE ENGINE SPEED TO MORE THAN 1000 RPM AND LOAD ENGINE (E.G., A/C ON). OBSERVE STEPPER MOTOR PIN MOVEMENT. PINS SHOULD MOVE FORE AND AFT OF A FIXED POINT.
OK ?
YES
NO
TEST COMPLETE.
PROCEED TO BASIC ENGINE TEST.

J8914-236

DIAGNOSTIC TEST 7

DOWNSTREAM SOLENOID TEST

NOTE: WHEN APPLICABLE, DIAGNOSTIC CONNECTOR TERMINALS CAN BE USED AS TEST POINTS INSTEAD OF MCU CONNECTOR TERMINALS.



DETERMINE IF MANIFOLD VACUUM IS PRESENT AT PORT E OF DOWNSTREAM AIR SWITCH SOLENOID.

SUPPLY MANIFOLD VACUUM AND START TEST OVER.

TURN IGNITION ON AND TEST FOR BATTERY VOLTAGE AT YELLOW WIRE TERMINAL OF SOLENOID CONNECTOR.

REPAIR AND RETEST.

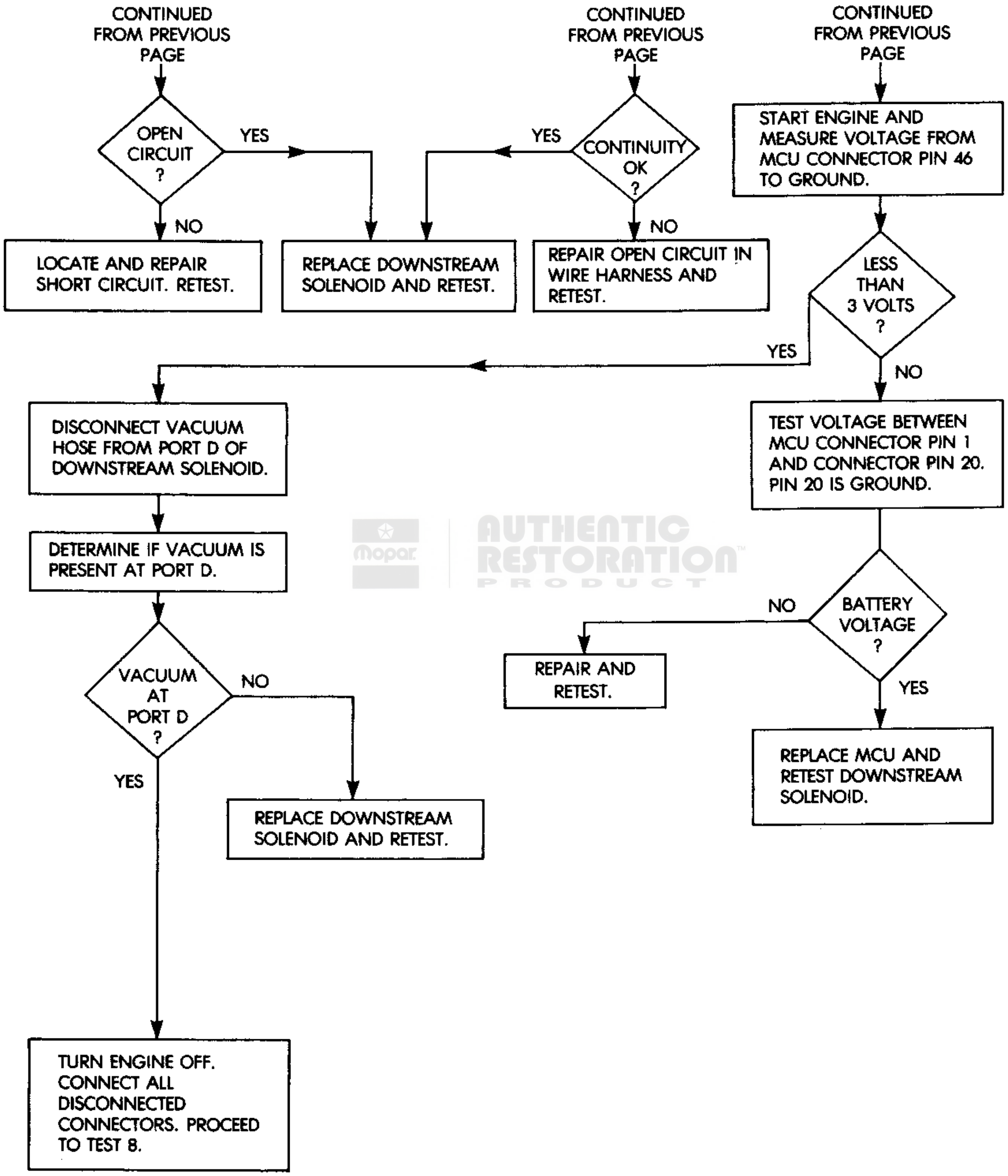
TURN IGNITION OFF. DISCONNECT MCU CONNECTOR. WITH OHMMETER, MEASURE THE RESISTANCE BETWEEN MCU CONNECTOR PIN 1 (+ PROBE) AND MCU CONNECTOR PIN 46 (− PROBE).

CONNECT MCU CONNECTOR

IF RESISTANCE IS LESS THAN 50 OHMS, DISCONNECT DOWNSTREAM SOLENOID WIRE CONNECTOR AND TEST RESISTANCE BETWEEN MCU CONNECTOR PIN 1 AND CONNECTOR PIN 46.

DISCONNECT WIRE CONNECTOR FROM DOWNSTREAM SOLENOID. WITH APPROPRIATE LENGTH OF JUMPER WIRE, TEST CONTINUITY BETWEEN ORANGE WIRE TERMINAL AND MCU CONNECTOR PIN 46.

J8914-237

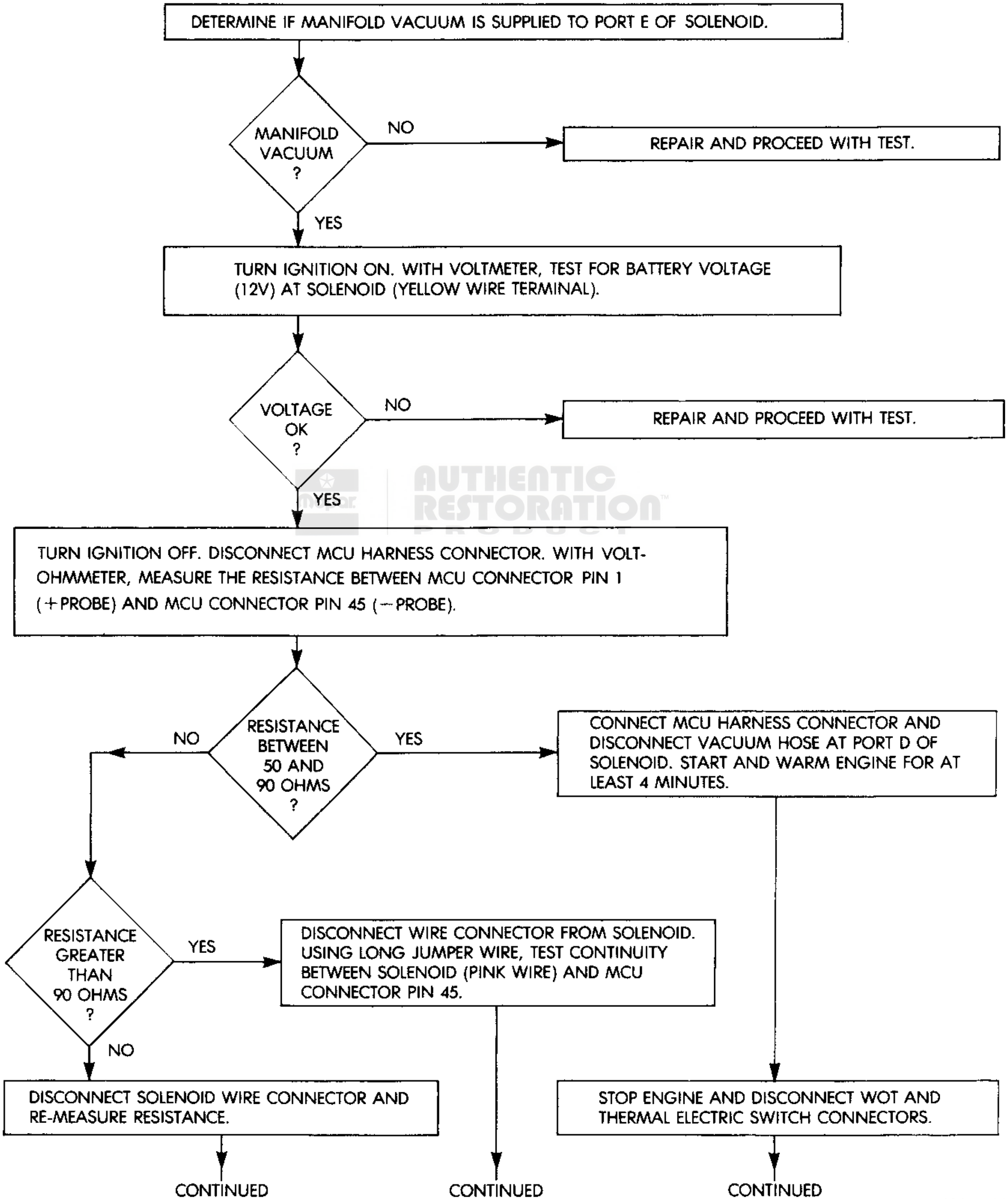

CONTINUED FROM PREVIOUS PAGE
OPEN CIRCUIT ?
YES
NO
LOCATE AND REPAIR SHORT CIRCUIT. RETEST.
REPLACE DOWNSTREAM SOLENOID AND RETEST.
CONTINUED FROM PREVIOUS PAGE
CONTINUITY OK ?
YES
NO
REPAIR OPEN CIRCUIT IN WIRE HARNESS AND RETEST.
CONTINUED FROM PREVIOUS PAGE
START ENGINE AND MEASURE VOLTAGE FROM MCU CONNECTOR PIN 46 TO GROUND.
LESS THAN 3 VOLTS ?
YES
NO
DISCONNECT VACUUM HOSE FROM PORT D OF DOWNSTREAM SOLENOID.
DETERMINE IF VACUUM IS PRESENT AT PORT D.
VACUUM AT PORT D ?
NO
YES
REPLACE DOWNSTREAM SOLENOID AND RETEST.
TURN ENGINE OFF. CONNECT ALL DISCONNECTED CONNECTORS. PROCEED TO TEST 8.
TEST VOLTAGE BETWEEN MCU CONNECTOR PIN 1 AND CONNECTOR PIN 20. PIN 20 IS GROUND.
BATTERY VOLTAGE ?
NO
YES
REPAIR AND RETEST.
REPLACE MCU AND RETEST DOWNSTREAM SOLENOID.

J8914-238

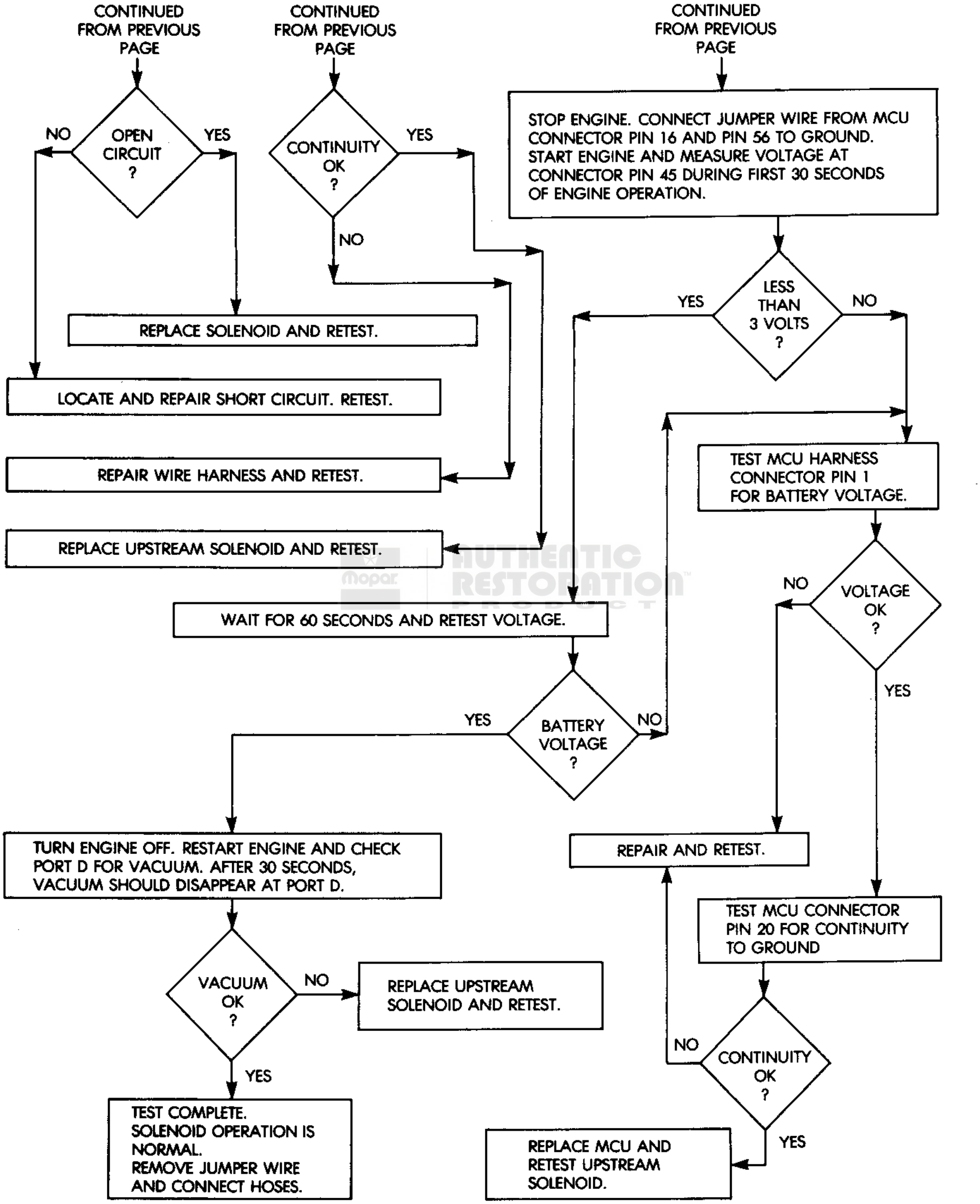
DIAGNOSTIC TEST 8

UPSTREAM SOLENOID TEST

NOTE: WHEN APPLICABLE, DIAGNOSTIC CONNECTOR TERMINALS CAN BE USED AS TEST POINTS INSTEAD OF MCU CONNECTOR TERMINALS.



J8914-239

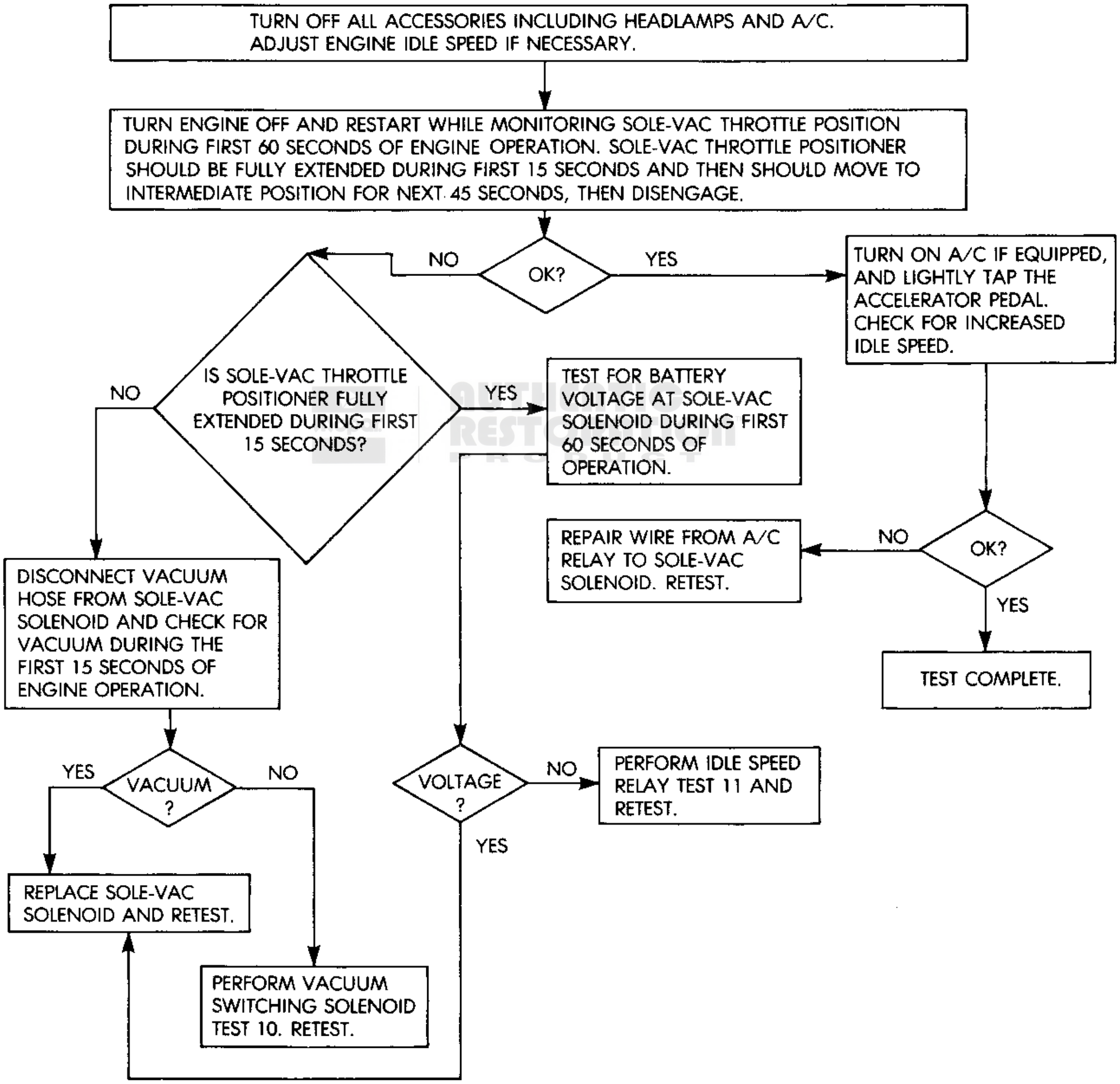

CONTINUED FROM PREVIOUS PAGE
OPEN CIRCUIT ?
NO
YES
CONTINUED FROM PREVIOUS PAGE
CONTINUITY OK ?
YES
NO
CONTINUED FROM PREVIOUS PAGE
STOP ENGINE. CONNECT JUMPER WIRE FROM MCU CONNECTOR PIN 16 AND PIN 56 TO GROUND. START ENGINE AND MEASURE VOLTAGE AT CONNECTOR PIN 45 DURING FIRST 30 SECONDS OF ENGINE OPERATION.
LESS THAN 3 VOLTS ?
YES
NO
REPLACE SOLENOID AND RETEST.
LOCATE AND REPAIR SHORT CIRCUIT. RETEST.
REPAIR WIRE HARNESS AND RETEST.
TEST MCU HARNESS CONNECTOR PIN 1 FOR BATTERY VOLTAGE.
REPLACE UPSTREAM SOLENOID AND RETEST.
VOLTAGE OK ?
NO
YES
WAIT FOR 60 SECONDS AND RETEST VOLTAGE.
BATTERY VOLTAGE ?
YES
NO
TURN ENGINE OFF. RESTART ENGINE AND CHECK PORT D FOR VACUUM. AFTER 30 SECONDS, VACUUM SHOULD DISAPPEAR AT PORT D.
REPAIR AND RETEST.
TEST MCU CONNECTOR PIN 20 FOR CONTINUITY TO GROUND
VACUUM OK ?
NO
REPLACE UPSTREAM SOLENOID AND RETEST.
YES
TEST COMPLETE. SOLENOID OPERATION IS NORMAL. REMOVE JUMPER WIRE AND CONNECT HOSES.
CONTINUITY OK ?
NO
YES
REPLACE MCU AND RETEST UPSTREAM SOLENOID.

J8914-240

DIAGNOSTIC TEST 9

IDLE SPEED CONTROL SYSTEM TEST

NOTE: TEST MUST BE PERFORMED WITH ENGINE AT NORMAL OPERATING TEMPERATURE AND AFTER PRECEDING CEC SYSTEM DIAGNOSTIC TESTS ARE COMPLETED.



TURN OFF ALL ACCESSORIES INCLUDING HEADLAMPS AND A/C. ADJUST ENGINE IDLE SPEED IF NECESSARY.

TURN ENGINE OFF AND RESTART WHILE MONITORING SOLE-VAC THROTTLE POSITION DURING FIRST 60 SECONDS OF ENGINE OPERATION. SOLE-VAC THROTTLE POSITIONER SHOULD BE FULLY EXTENDED DURING FIRST 15 SECONDS AND THEN SHOULD MOVE TO INTERMEDIATE POSITION FOR NEXT 45 SECONDS, THEN DISENGAGE.

TURN ON A/C IF EQUIPPED, AND LIGHTLY TAP THE ACCELERATOR PEDAL. CHECK FOR INCREASED IDLE SPEED.

IS SOLE-VAC THROTTLE POSITIONER FULLY EXTENDED DURING FIRST 15 SECONDS?

TEST FOR BATTERY VOLTAGE AT SOLE-VAC SOLENOID DURING FIRST 60 SECONDS OF OPERATION.

REPAIR WIRE FROM A/C RELAY TO SOLE-VAC SOLENOID. RETEST.

DISCONNECT VACUUM HOSE FROM SOLE-VAC SOLENOID AND CHECK FOR VACUUM DURING THE FIRST 15 SECONDS OF ENGINE OPERATION.

TEST COMPLETE.

PERFORM IDLE SPEED RELAY TEST 11 AND RETEST.

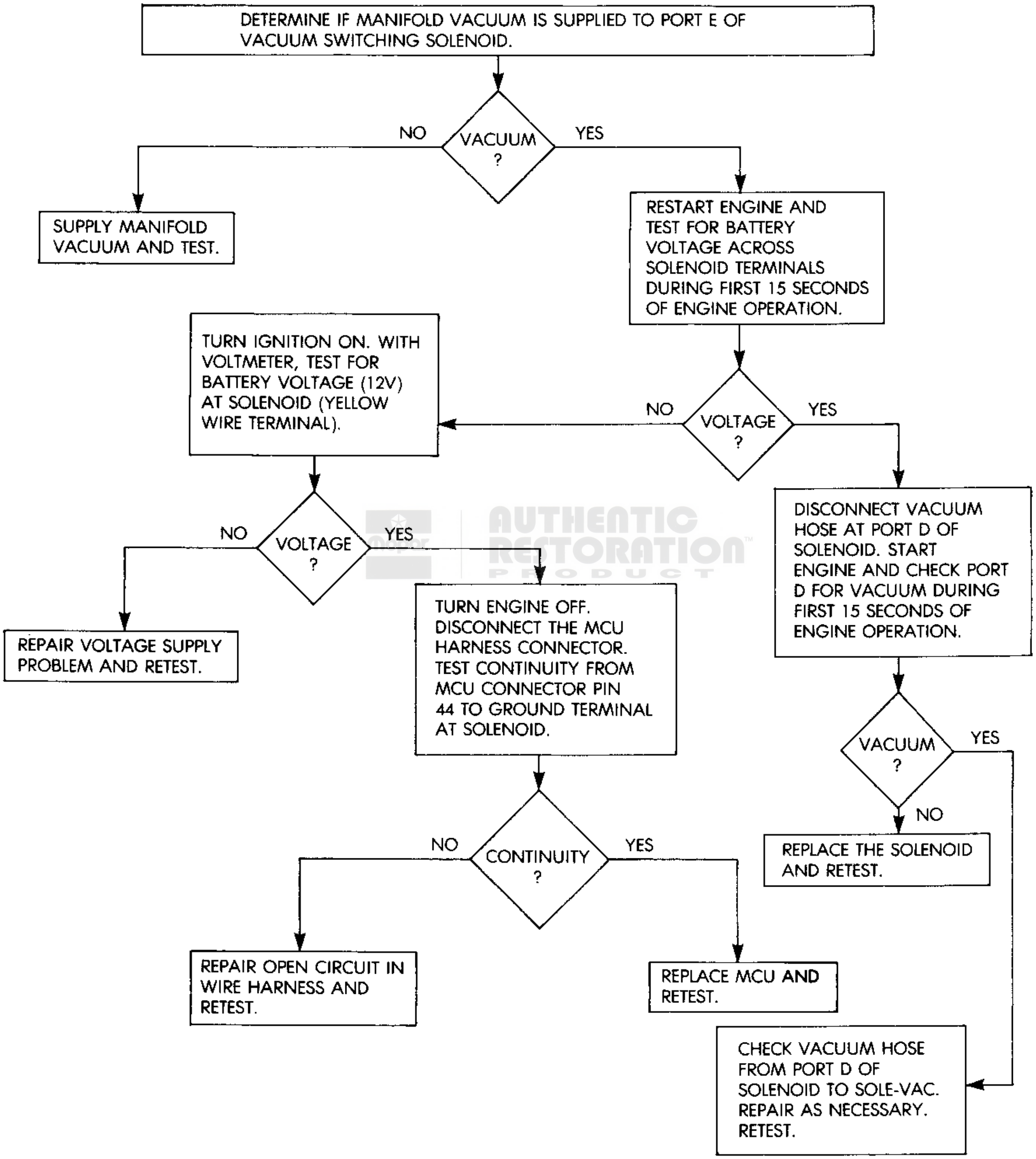
REPLACE SOLE-VAC SOLENOID AND RETEST.

PERFORM VACUUM SWITCHING SOLENOID TEST 10. RETEST.

J8914-241

DIAGNOSTIC TEST 10

SOLE-VAC VACUUM SWITCHING SOLENOID TEST



DETERMINE IF MANIFOLD VACUUM IS SUPPLIED TO PORT E OF VACUUM SWITCHING SOLENOID.

SUPPLY MANIFOLD VACUUM AND TEST.

RESTART ENGINE AND TEST FOR BATTERY VOLTAGE ACROSS SOLENOID TERMINALS DURING FIRST 15 SECONDS OF ENGINE OPERATION.

TURN IGNITION ON. WITH VOLTMETER, TEST FOR BATTERY VOLTAGE (12V) AT SOLENOID (YELLOW WIRE TERMINAL).

DISCONNECT VACUUM HOSE AT PORT D OF SOLENOID. START ENGINE AND CHECK PORT D FOR VACUUM DURING FIRST 15 SECONDS OF ENGINE OPERATION.

REPAIR VOLTAGE SUPPLY PROBLEM AND RETEST.

TURN ENGINE OFF. DISCONNECT THE MCU HARNESS CONNECTOR. TEST CONTINUITY FROM MCU CONNECTOR PIN 44 TO GROUND TERMINAL AT SOLENOID.

REPLACE THE SOLENOID AND RETEST.

REPAIR OPEN CIRCUIT IN WIRE HARNESS AND RETEST.

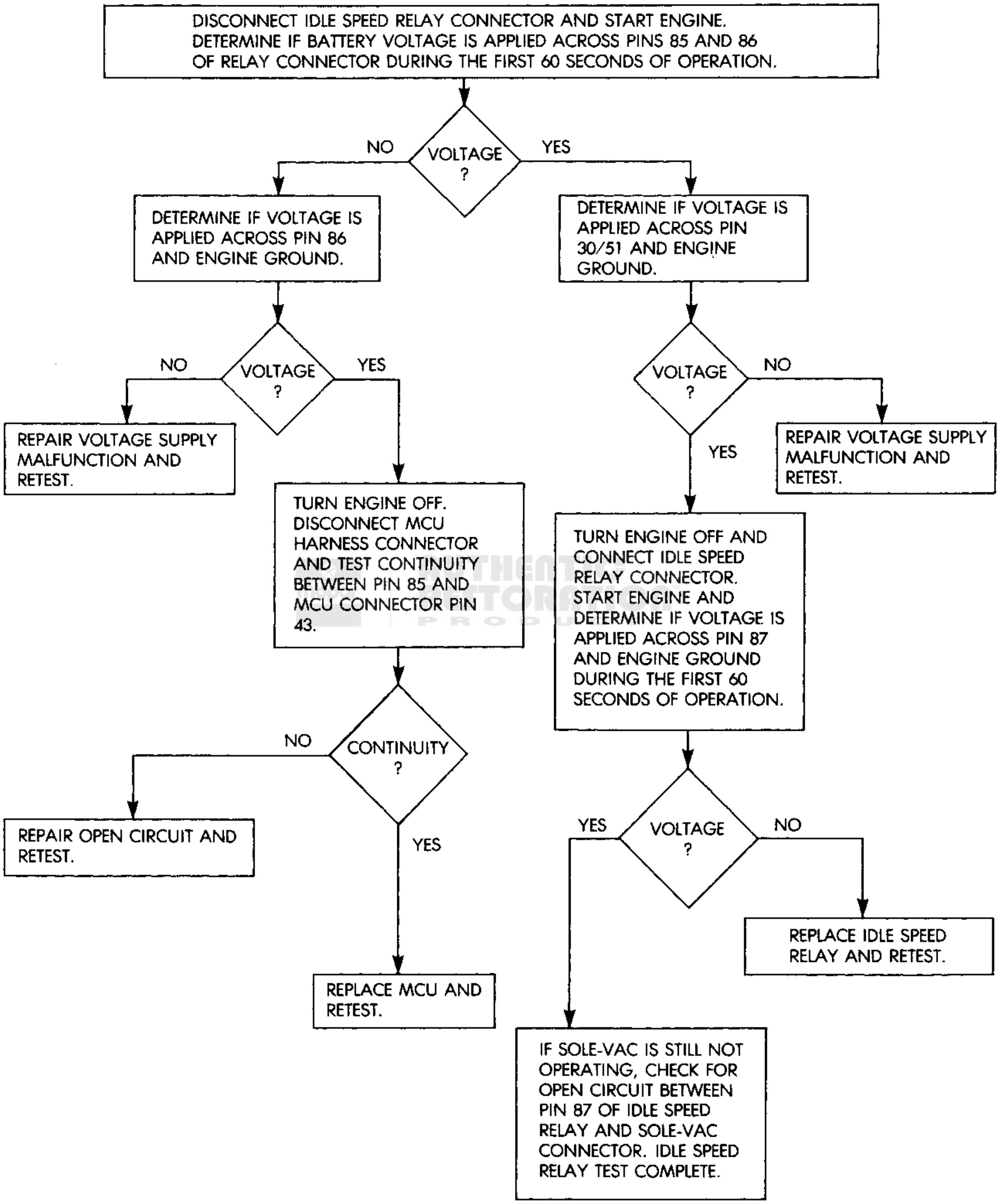
REPLACE MCU AND RETEST.

CHECK VACUUM HOSE FROM PORT D OF SOLENOID TO SOLE-VAC. REPAIR AS NECESSARY. RETEST.

J8914-242

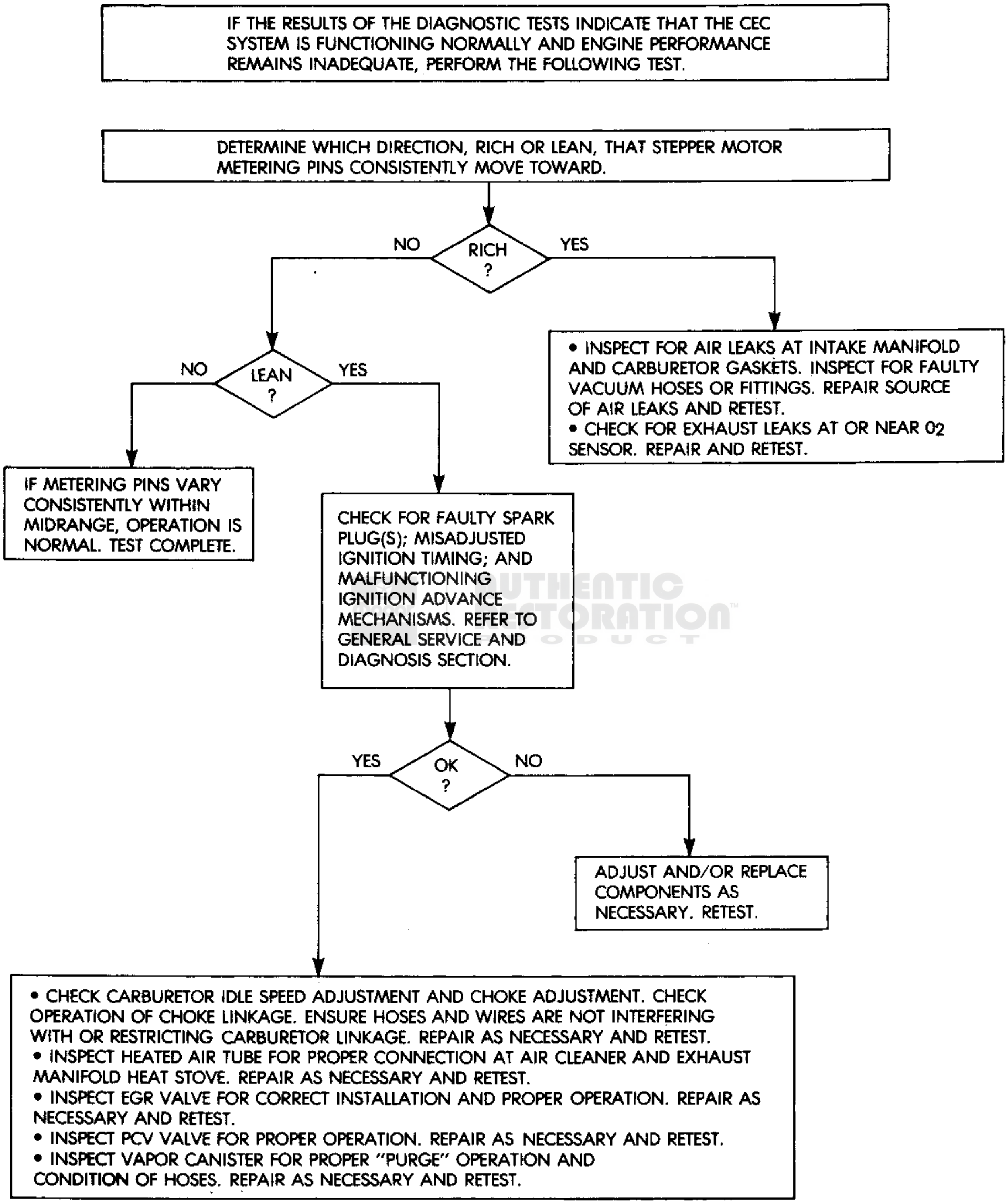
DIAGNOSTIC TEST 11

SOLE-VAC IDLE SPEED RELAY TEST



J8914-243

BASIC ENGINE TEST



IF THE RESULTS OF THE DIAGNOSTIC TESTS INDICATE THAT THE CEC SYSTEM IS FUNCTIONING NORMALLY AND ENGINE PERFORMANCE REMAINS INADEQUATE, PERFORM THE FOLLOWING TEST.

DETERMINE WHICH DIRECTION, RICH OR LEAN, THAT STEPPER MOTOR METERING PINS CONSISTENTLY MOVE TOWARD.

- INSPECT FOR AIR LEAKS AT INTAKE MANIFOLD AND CARBURETOR GASKETS. INSPECT FOR FAULTY VACUUM HOSES OR FITTINGS. REPAIR SOURCE OF AIR LEAKS AND RETEST.
- CHECK FOR EXHAUST LEAKS AT OR NEAR O_2 SENSOR. REPAIR AND RETEST.

IF METERING PINS VARY CONSISTENTLY WITHIN MIDRANGE, OPERATION IS NORMAL. TEST COMPLETE.

CHECK FOR FAULTY SPARK PLUG(S); MISADJUSTED IGNITION TIMING; AND MALFUNCTIONING IGNITION ADVANCE MECHANISMS. REFER TO GENERAL SERVICE AND DIAGNOSIS SECTION.

ADJUST AND/OR REPLACE COMPONENTS AS NECESSARY. RETEST.

- CHECK CARBURETOR IDLE SPEED ADJUSTMENT AND CHOKE ADJUSTMENT. CHECK OPERATION OF CHOKE LINKAGE. ENSURE HOSES AND WIRES ARE NOT INTERFERING WITH OR RESTRICTING CARBURETOR LINKAGE. REPAIR AS NECESSARY AND RETEST.
- INSPECT HEATED AIR TUBE FOR PROPER CONNECTION AT AIR CLEANER AND EXHAUST MANIFOLD HEAT STOVE. REPAIR AS NECESSARY AND RETEST.
- INSPECT EGR VALVE FOR CORRECT INSTALLATION AND PROPER OPERATION. REPAIR AS NECESSARY AND RETEST.
- INSPECT PCV VALVE FOR PROPER OPERATION. REPAIR AS NECESSARY AND RETEST.
- INSPECT VAPOR CANISTER FOR PROPER "PURGE" OPERATION AND CONDITION OF HOSES. REPAIR AS NECESSARY AND RETEST.

J8914-244

2150 CARBURETOR

INDEX

GENERAL INFORMATION

The 5.9 liter (360 CID) V-8 engine used in SJ vehicles is equipped with a Model 2150 two venturi carburetor (Fig. 1).

Identification

The carburetor is identified by a code number and build date code stamped on the identification tag (Fig. 2). Each carburetor build month is coded alphabetically beginning with the letter A for January and ending with the letter M for December (the letter I is not used). The tag is attached to the carburetor and must remain with it to assure proper identification.

CARBURETOR CIRCUITS

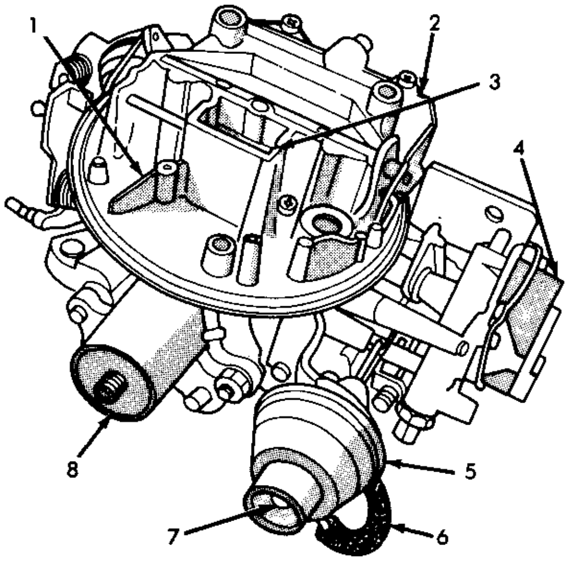
Float (Fuel Inlet) Circuit

Pressurized fuel enters the fuel bowl through the fuel inlet fitting in the main body. The Viton tipped fuel inlet needle is controlled by the float and lever assembly, which is hinged on the float shaft. A wire retainer is hooked over grooves on opposite ends of the float shaft and into a groove behind the fuel inlet needle seat. The retainer holds the float shaft firmly in the fuel bowl guides and also centers the float assembly in the fuel bowl. An integral retaining clip is hooked over the end of the float lever and attached to the fuel inlet needle. This assures reaction of the fuel inlet needle during downward movement of float (Fig. 3).

The float circuit maintains the correct fuel level in the bowl. This enables the fuel metering circuits to deliver the proper air-fuel mixture to the combustion chambers. The amount of fuel entering the bowl is regulated by the distance the fuel inlet needle is raised off its seat. The float drops as the fuel level drops and allows the fuel inlet needle to move off its seat. This permits additional fuel to enter the bowl. When the fuel reaches the preset level, the fuel inlet needle is lowered and admits only enough fuel to replace that being used.

Bowl Vent

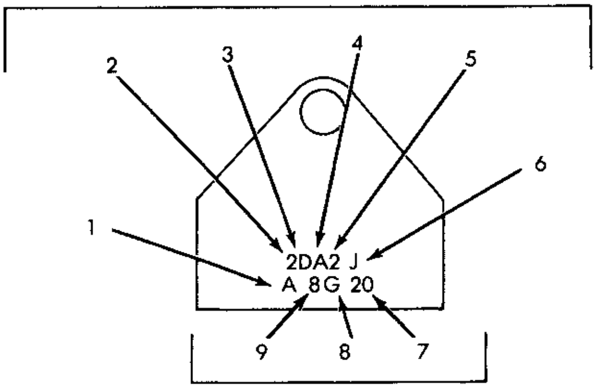
Two bowl vents are required. The internal vent is used to balance air pressure in the fuel when the engine



1. AIR HORN
2. MAIN BODY
3. ALTITUDE COMPENSATION CHOKE CIRCUIT
4. CHOKE COVER
5. CHOKE VACUUM DIAPHRAGM
6. VACUUM SOURCE HOSE
7. ADJUSTMENT SCREW
8. ALTITUDE COMPENSATION ANEROID

J8914-245

Fig. 1 Model 2150 Carburetor



CODE
1. VENDOR CHECK LETTER
2. MODEL YEAR
3. ENGINE
4. TRANSMISSION
5. VENTURI
6. REVISION LETTER

BUILD DATE
7. DAY
8. MONTH
9. YEAR

J8914-246

Fig. 2 Model 2150 Carburetor Identification is operating. The external vent provides a method of controlling fuel vapor in the bowl when the engine is not operating.

The external fuel bowl vent permits vapor to move from the carburetor to the fuel vapor storage canister (Fig. 4).

Idle Metering (Low Speed) Circuit

Fuel for idle and low speed operation flows from the fuel bowl through the main jets into the main wells. From the main wells, the is metered as it passes through calibrated restrictions at the lower end of the idle tubes. After flowing through the idle tubes, the fuel is metered again as it flows downward through restrictions at the lower end of the diagonal passages and then enters the idle passages in the main body (Fig. 5).

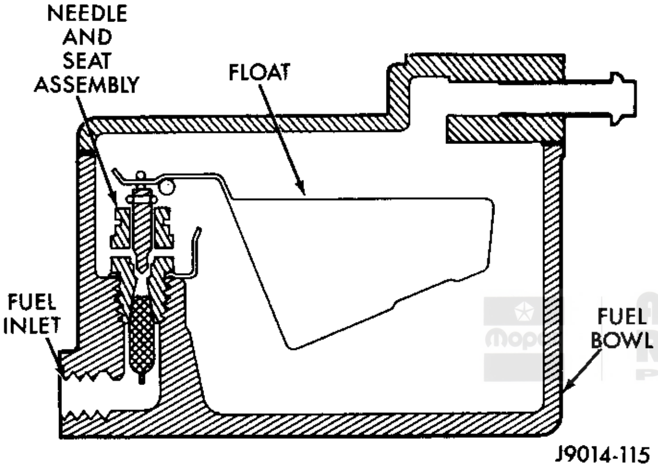


Fig. 3 Float Circuit

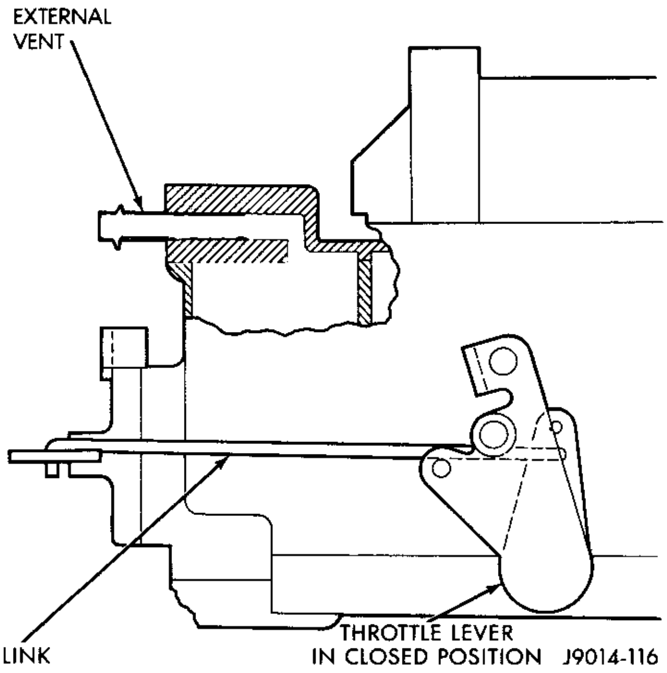


Fig. 4 Bowl Vent

Air enters the idle circuit through air inlets that are located in the main body directly below the booster venturi. The air inlets serve as anti-siphon vents during off-idle, high speed operation and when the engine is stopped.

The air-fuel mixture moves down the idle passages past the idle transfer slots, which serve as additional air inlets during curb idle operation. The air-fuel mixture then moves past the idle mixture adjustment screw tips, which control the amount of discharge. From the adjustment screw ports the air-fuel mixture moves through short horizontal passages and is discharged below the throttle valves.

At speeds slightly above idle, the idle transfer slots begin discharging the air-fuel mixture as the throttle valves expose them to manifold vacuum. As the throttle valves continue opening and engine speed increases, the airflow through the carburetor increases proportionately. This increased airflow creates a vacuum in the venturi and the main metering circuit begins discharging the air-fuel mixture. The discharge from the idle circuit tapers off as the main metering circuit begins discharging.

Main Metering (High Speed) Circuit

As engine speed increases, the air velocity through the booster venturi creates a low pressure area. Fuel flow through the main metering circuit is caused by atmospheric pressure in the fuel bowl and a lower pressure at the main discharge ports. Fuel flows from the fuel bowl, through the main jets and into the main wells. The fuel then moves up the main well tubes where it is mixed with air. The air, supplied through the main air inlets, mixes with the fuel through small holes

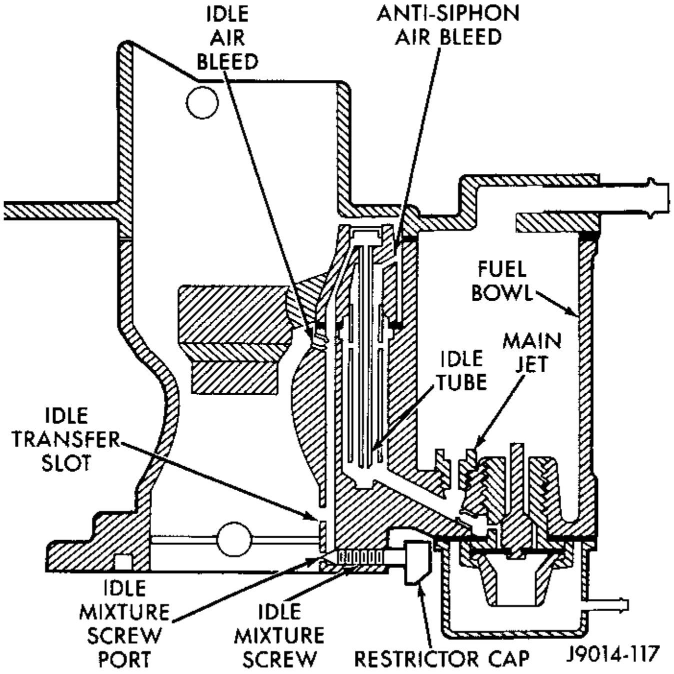


Fig. 5 Idle Metering Circuit

in the sides of the main well tubes. The main air inlets meter an increasing amount of air, whenever venturi vacuum increases, to maintain the proper air-fuel mixture ratio. The mixture of fuel and air, being lighter than raw fuel, responds quickly to changes in venturi vacuum. It also atomizes more readily than raw fuel.

The air-fuel mixture moves from the main well tubes to the discharge ports and is discharged into the booster venturi (Fig. 6).

Anti-siphon air vents, located near the top of the main well tubes, prevent siphoning of fuel from the main well when decelerating.

Power Enrichment

During heavy load conditions or high speed operation, the air-fuel mixture ratio must be increased to provide higher engine power output. The power enrichment valve supplies extra fuel during this period. It is controlled by intake manifold vacuum (Fig. 7).

Manifold vacuum is applied to the power valve diaphragm from an external source. During engine idle and cruise speed conditions, manifold vacuum is high enough to overcome the power valve spring tension and holds the valve closed. When higher engine power output id required, the increased load on the engine results in decreased manifold vacuum. The power valve spring opens the first stage of the power valve when manifold vacuum drops below a predetermined value and a small amount of fuel flows through the valve. When manifold vacuum drops to a lower value, the power valve spring opens the second stage of the power valve and allows a greater amount of fuel through the valve. The fuel that flows through the power valve is added to the fuel in the main metering circuit to enrich the mixture. As engine load requirements decrease, manifold vacuum increases and overcomes the tension of the power valve spring, closing the power valve.

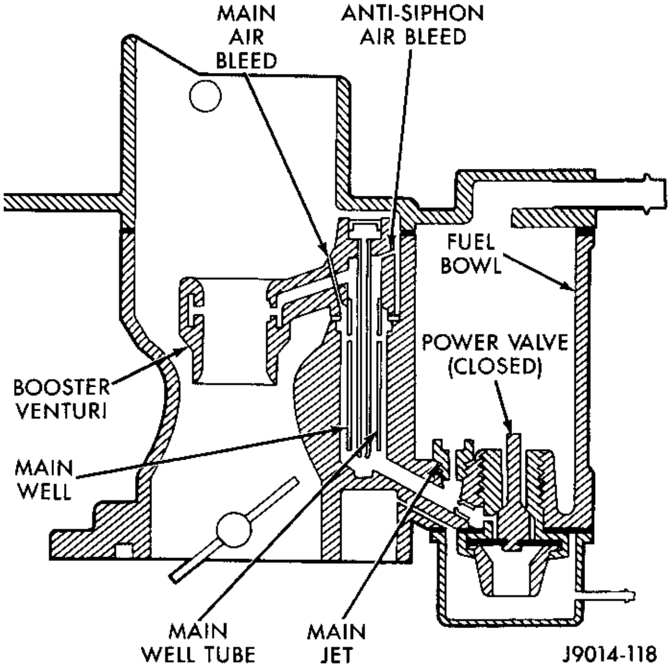


Fig. 6 Main Metering Circuit

Pump Circuit

When the throttle valves are opened quickly, the airflow through the carburetor responds almost immediately. Because fuel is heavier than air, there is a brief lag in time before the fuel flow can gain sufficient velocity to maintain the proper air-fuel ratio. During this lag, the pump circuit supplies the required fuel until the proper air-fuel mixture can be maintained by the other metering circuits (Fig. 8).

The pump is charged when the throttle valves are closed. The diaphragm return spring exerts force against the diaphragm and pushes it against the cover.

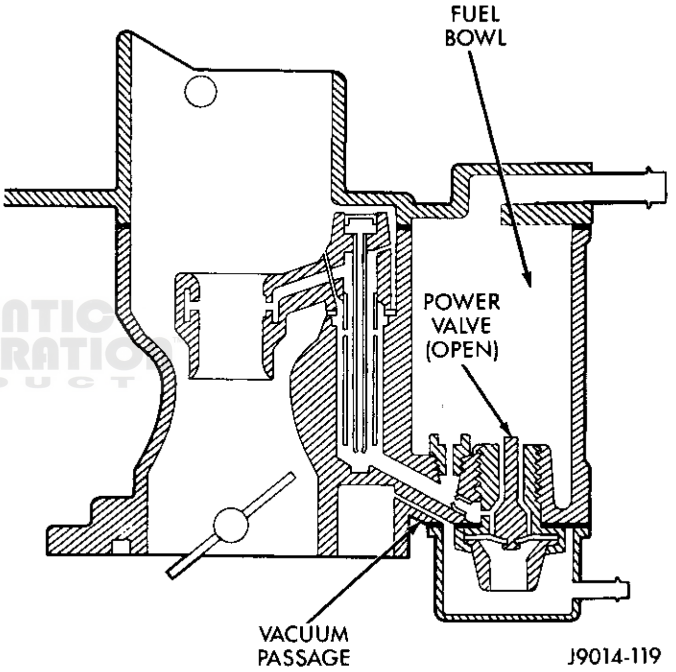


Fig. 7 Power Enrichment Valve

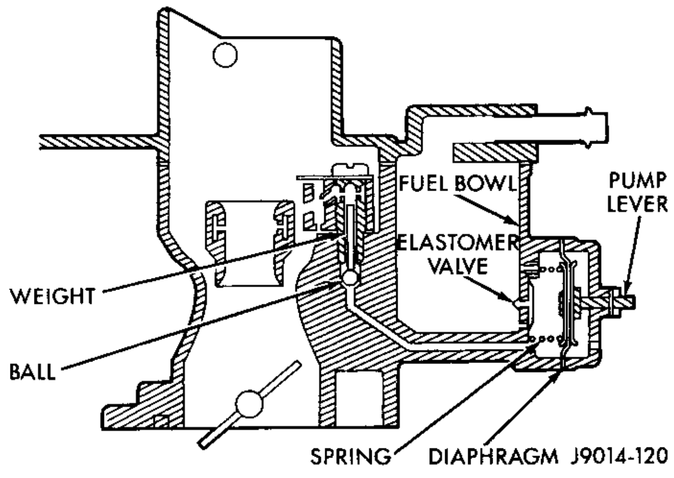


Fig. 8 Pump Circuit

Fuel is drawn through the inlet, past the elastomer valve, and into the pump chamber.

When the throttle valves are opened, the diaphragm rod is pushed inward forcing fuel from the pump chamber into the discharge passages. The elastomer valve seals the inlet hole during pump discharge preventing fuel from returning to the fuel bowl. Fuel under pressure unseats the discharge check ball and weight and is forced through the pump discharge screw. The fuel is then sprayed into the main venturi through discharge ports.

A vent is provided in the pump chamber to prevent vapor accumulation and pressure buildup.

Choke Circuit

The choke valve, located in the air horn assembly, provides a high vacuum above as well as below the throttle valves when closed. During cranking, vacuum above the throttle valves causes fuel to flow from the main and idle metering circuits. This provides the richer air-fuel mixture required for cold engine starting.

The choke shaft is connected by linkage to a bimetallic coil that winds up (contracts) when cold and unwinds (expands) when warm.

The position of the choke valve is controlled by the action of a vacuum modulator that exerts force against the tension of the bimetallic coil.

The altitude compensation circuit has a separate nonadjustable choke valve that is linked directly with the primary choke valve.

When the engine is cold, tension of the bimetallic coil holds the choke valve closed. When the engine is started, manifold vacuum is channeled through an opening at the base of the carburetor through a passage on the bottom side of the modulator diaphragm assembly, to move the diaphragm downward against the setscrew. At the same time, the modulator arm contacts a tang on the choke shaft. The downward movement of the diaphragm assembly compresses the piston spring and exerts a pulling force on the modulator arm, causing the choke valve to open slightly. This opening is referred to as initial choke valve clearance.

The bimetallic coil is warmed by an electric heater element and, as the engine begins to warm up, heated air routed from the exhaust crossover through a heat tube to the choke housing. A thermostatically controlled bypass valve, which is an integral part of the choke heat tube, helps prevent premature choke valve opening during the early part of the engine warmup period. The valve regulates the temperature of the hot airflow to the choke housing by allowing outside unheated air to enter the heat tube. A thermostatic disc is incorporated in the valve. It is calibrated to close the valve at 24°C (75°F) and to open it at 13°C (55°F).

The electric heater element and heated air entering the choke housing cause the bimetallic coil to begin unwinding and decrease the closing tension exerted against the choke valve. The coil gradually loses its tension and allows the choke valve open.

When the engine reaches normal operating temperature, the bimetallic coil continues unwinding and exerts pressure against the choke linkage, forcing the choke valve fully open. A continual flow of heated air passes through the choke housing and is exhausted into the intake manifold. The bimetallic coil remains fully open until the engine is stopped and is allowed to cool.

Air flowing through the choke housing must be filtered to minimize contamination of the choke coil and associated parts. The filtered air is supplied through a tube that originates inside the air cleaner.

A fast idle is required to prevent engine stalling during the warmup period. The fast idle cam, actuated by the choke rod, contacts the fast idle speed adjustment screw and increases engine speed in proportion to the choke valve opening. When the choke valve reaches the fully open position, the fast idle cam rotates free of the fast idle speed adjustment screw and allows the throttle lever to return the curb idle speed position.

If the engine is accelerated during the warmup period, the resulting drop in manifold vacuum allows the bimetallic coil to momentarily close the choke valve. This provides a richer air-fuel mixture to prevent engine stalling.

If the engine is "flooded" during the starting operation, the choke valve may be opened manually to purge excess fuel from the intake manifold. This is accomplished by depressing the accelerator pedal to the floor and cranking the engine with the starter motor. With the throttle linkage in this position, a tang on the fast idle lever contacts the fast idle cam and causes the choke valve to open a predetermined amount. This is referred to as the choke unloader clearance.

Altitude Compensation Circuit

The altitude compensator supplies the extra air necessary to lean out the air-fuel mixture at high altitudes. The compensation circuit parallels the main carburetor intake circuit (Fig. 9). At the top, a small choke valve controls the airflow when the main choke is closed. Air flows down through a passage in the main body into a plenum chamber located adjacent to the two main venturi bores. A spring-loaded valve regulates the amount of air passed from the plenum into the compensator body. Air flows from the compensator body through two air passages bored into the main venturi tubes.

The opening and closing of the valve in the compensator body is controlled by an aneroid that reacts to the atmospheric pressure. At the lower atmospheric pressure of higher altitudes, the aneroid pushes on the end of the compensator valve stem, opening the valve. At lower altitudes, the aneroid relaxes, automatically closing the valve.

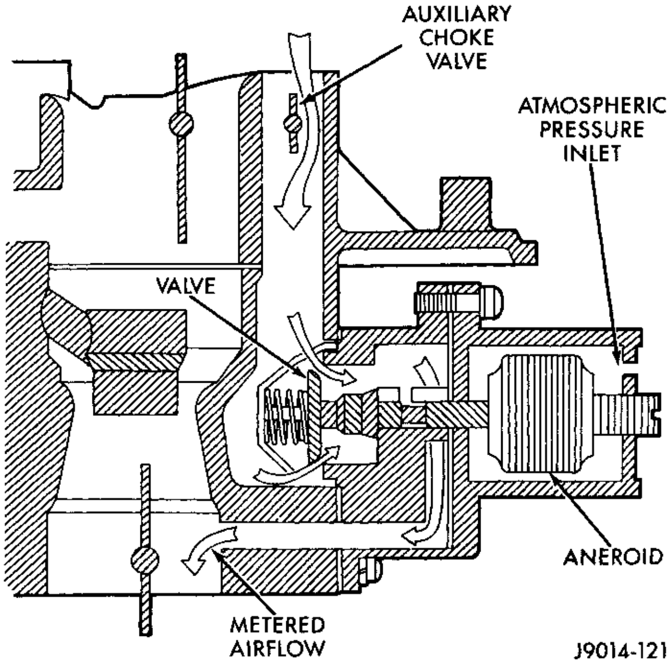


Fig. 9 Altitude Compensator Circuit

The aneroid is calibrated during factory assembly and is not adjustable. Do not tamper with the hex-head plug on the aneroid.

SPECIFICATIONS

Model 2150 Carburetor Specifications

List Number	Engine Trans. Application	Float Level (Wet) (Inches)		Float Level (Dry)		Initial Choke Valve Clearance (Inches)		Fast Idle Cam Setting (Inches)		Automatic Choke Cover Setting (Notches Rich)	Choke Unloader (Inches)	Curb Idle Speed[1]		Fast Idle Speed		Bowl Vent Clearance
		Set To	OK Range	Set To	OK Range	Set To	OK Range	Set To	OK Range	Set To		Set To	OK Range	Set To	OK Range	
5RHA2	360 Automatic 50-State	0.93	0.868 to 0.992	0.328	0.296 to 0.375	0.098 ± 0.020	0.098 to 0.140	0.076	0.061 to 0.091	V (NOTCH)	0.420 min.	600	550 to 650	1600	1500 to 1700	N/A

[1] Adjust with transmission in Drive (all brakes applied). Idle Speed is 500 rpm with solenoid de-energized.

J9014-127

Model 2150 Calibrations (Inches)

Throttle Bore Size	1.562
Main Venturi Size	1.21
Fuel Inlet Diameter	0.101
Low Speed Jet (Tube)	0.036
Economizer	0.055
Idle Air Bleed	0.086
Main Jet Number	55
High Speed Bleed	0.055
Power Valve Timing (inches of Hg)	
—First Stage	9.0
—Second Stage	5.0
Accelerator Pump Jet	0.024
Vacuum Spark Port	
—Height	0.050
—Width	0.085
Choke Heat Bypass	0.076
Choke Heat Inlet Restriction	0.089
Choke Vacuum Restriction	0.089

J9014-128

CARBURETOR REPLACEMENT

Removal

(1) Remove the air cleaner.

(2) Remove the throttle cable from the throttle lever.

(3) Disconnect the vacuum hoses, return spring, choke filtered air tube, choke heater element wire connector, solenoid wire connector, PCV valve hose, in-line fuel filter and choke heated air tube at the carburetor.

(4) Remove the carburetor retaining nuts. Remove the carburetor and gasket from the intake manifold.

Installation

(1) Clean the gasket mounting surfaces of the spacer and carburetor.

(2) Position carburetor on spacer and gasket. **To prevent leakage, distortion or damage to carburetor body flange, alternately tighten mounting nuts in a crisscross pattern in increments of 9 N•m (7 ft-lbs) torque once the carburetor is installed.**

Install carburetor and tighten mounting nuts to 22 N•m (16 ft-lbs) torque.

(3) Connect the in-line fuel filter, throttle cable, choke heated air tube, PCV valve hose, return spring, choke heater element wire connector, solenoid wire connector, choke filtered air tube and vacuum hoses.

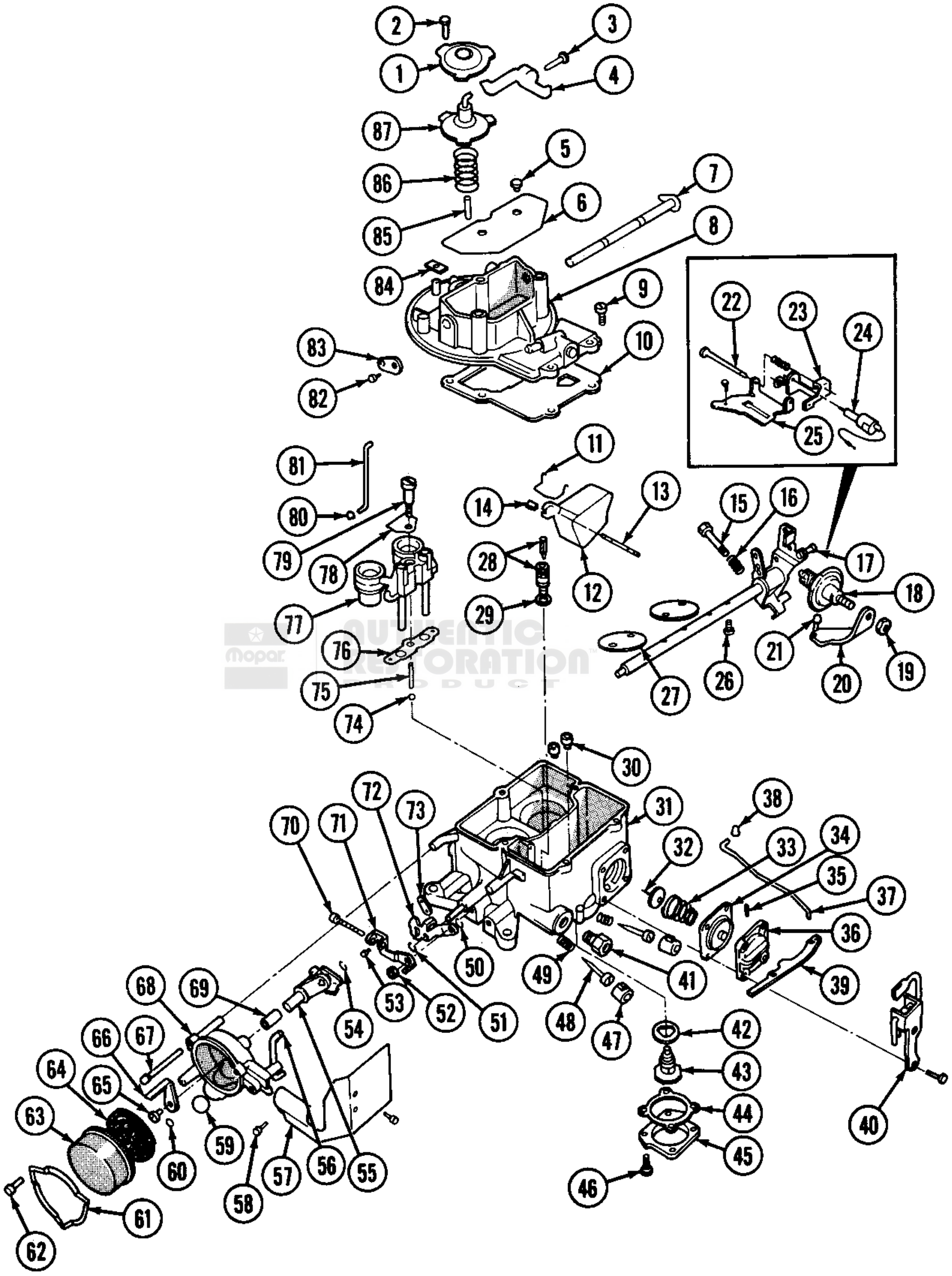
(4) Adjust the engine idle speed. Refer to General Service and Diagnosis for the procedures.

CARBURETOR OVERHAUL

Overhaul Information

Throughout the Model 2150 carburetor overhaul procedures each component is referred to by name and the number associated with it in Fig. 10 and the Parts Identification List.

Model 2150 Carburetor



J8914-252

Fig. 10 Model 2150 Carburetor

Parts Identification List

1. MODULATOR COVER (IF EQUIPPED)
2. MODULATOR RETAINING SCREW (3) (IF EQUIPPED)
3. PIVOT PIN
4. MODULATOR ARM
5. CHOKE VALVE RETAINING SCREW (2)
6. CHOKE VALVE
7. CHOKE SHAFT
8. AIR HORN
9. AIR HORN RETAINING SCREW (4)
10. AIR HORN GASKET
11. FLOAT AND LEVER ASSEMBLY
12. FLOAT SHAFT RETAINER
13. FLOAT SHAFT
14. NEEDLE RETAINING CLIP
15. CURB IDLE ADJUSTING SCREW
16. CURB IDLE ADJUSTING SCREW SPRING
17. THROTTLE SHAFT AND LEVER ASSEMBLY
18. DASHPOT
19. DASHPOT LOCKNUT
20. DASHPOT BRACKET
21. DASHPOT BRACKET RETAINING SCREW
22. ADJUSTING SCREW
23. CARRIAGE
24. ELECTRIC SOLENOID
25. MOUNTING BRACKET
26. THROTTLE VALVE RETAINING SCREW (4)
27. THROTTLE VALVE (2)
28. NEEDLE AND SEAT ASSEMBLY
29. NEEDLE SEAT GASKET
30. MAIN JET (2)
31. MAIN BODY
32. ELASTOMER VALVE
33. PUMP RETURN SPRING
34. PUMP DIAPHRAGM
35. PUMP LEVER PIN
36. PUMP COVER
37. PUMP ROD
38. PUMP ROD RETAINER
39. PUMP LEVER
40. BOWL VENT BELLCRANK
41. FUEL INLET FITTING
42. POWER VALVE GASKET
43. POWER VALVE
44. POWER VALVE COVER GASKET
45. POWER VALVE COVER
46. POWER VALVE COVER RETAINING SCREW (4)
47. IDLE LIMITER CAP (2)
48. IDLE MIXTURE SCREW (2)
49. IDLE MIXTURE SCREW SPRING (2)
50. RETAINER
51. FAST IDLE CAM RETAINING CLIP
52. FAST IDLE LEVER RETAINING NUT
53. FAST IDLE LEVER PIN
54. RETAINER
55. LEVER AND SHAFT
56. FAST IDLE CAM ROD
57. CHOKE SHIELD
58. CHOKE SHIELD RETAINING SCREW (2)
59. PISTON PASSAGE PLUG
60. HEAT PASSAGE PLUG
61. CHOKE COVER RETAINING CLAMP
62. CHOKE COVER RETAINING SCREW (3)
63. CHOKE COVER AND COIL
64. CHOKE COVER GASKET
65. COIL LEVER RETAINING SCREW
66. COIL LEVER
67. CHOKE HOUSING RETAINING SCREW (3)
68. CHOKE HOUSING
69. CHOKE SHAFT BUSHING
70. FAST IDLE SPEED ADJUSTING SCREW
71. FAST IDLE LEVER
72. FAST IDLE CAM
73. CHOKE HOUSING GASKET
74. PUMP DISCHARGE CHECK BALL
75. PUMP DISCHARGE WEIGHT
76. BOOSTER VENTURI GASKET
77. BOOSTER VENTURI ASSEMBLY
78. AIR DISTRIBUTION PLATE
79. PUMP DISCHARGE SCREW
80. RETAINER
81. CHOKE ROD
82. CHOKE LEVER RETAINING SCREW
83. CHOKE VALVE LEVER
84. CHOKE ROD SEAL
85. STOP SCREW
86. MODULATOR RETURN SPRING (IF EQUIPPED)
87. MODULATOR DIAPHRAGM ASSEMBLY (IF EQUIPPED)

J8914-267

The following procedure applies to a complete overhaul with the carburetor removed from the engine.

A complete disassembly is not necessary when performing routine service adjustments. In most instances, service adjustments of individual circuits may be accomplished without removing the carburetor from the engine. Refer to Service Diagnosis Procedures.

A complete carburetor overhaul includes disassembly, thorough cleaning, inspection and replacement of all gaskets and worn or damaged parts. When using an overhaul kit, use all parts included in the kit.

Flooding, hesitation on acceleration, and other performance problems are in many instances caused by the presence of debris, water, or other foreign matter in the carburetor. To aid in diagnosing the cause of a problem, carefully remove the carburetor from the engine without removing the fuel from the bowl. Examine the contents of the bowl for contamination as the carburetor is disassembled.

Disassembly

(1) Remove the air cleaner anchor screw.

(2) Note which position the choke rod (81) is indexed to in the choke valve lever (83) for assembly reference (Fig. 11). Remove the choke valve lever retaining screw (82). Slide the choke rod out of the choke lever (55).

(3) Remove the air horn retaining screws (9), and carburetor identification tag. Remove the air horn (8) and air horn gasket (10) (Fig. 12).

(4) Remove the choke rod plastic dust seal (84) from the air horn.

(5) Remove the fast idle cam retaining clip (51) (Fig. 13).

(6) Remove the choke shield (57).

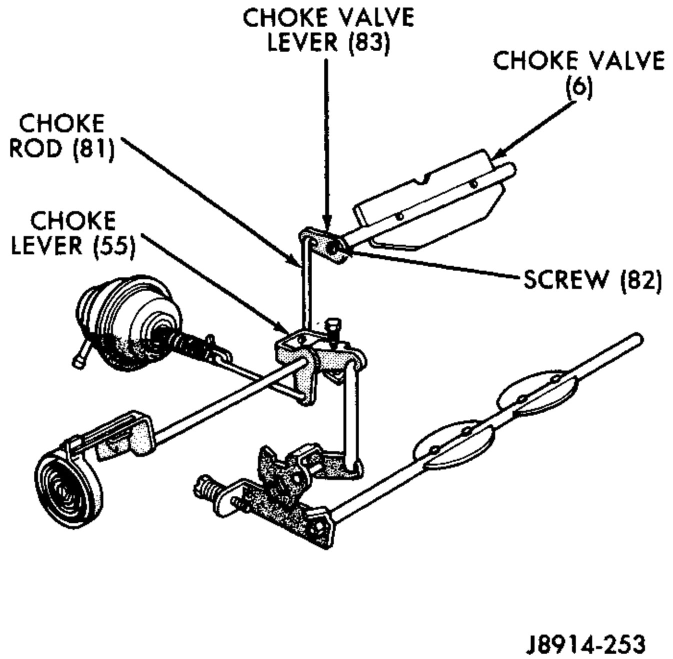


Fig. 11 Choke Rod Removal/Install

(7) Grind off the heads of the choke housing cover retaining rivets (Fig. 14).

(8) Remove the retainer (61), cover and coil (63) and gasket (64) (Fig. 15).

(9) Remove the remaining portion of the rivets.

(10) Remove the fast idle cam rod (56) from the fast idle cam lever (71) (Fig. 16).

(11) Remove the choke housing assembly retaining screws (67), housing assembly (68) and gasket (73) (Fig. 17).

(12) Remove the fast idle cam (72) (Fig. 18).

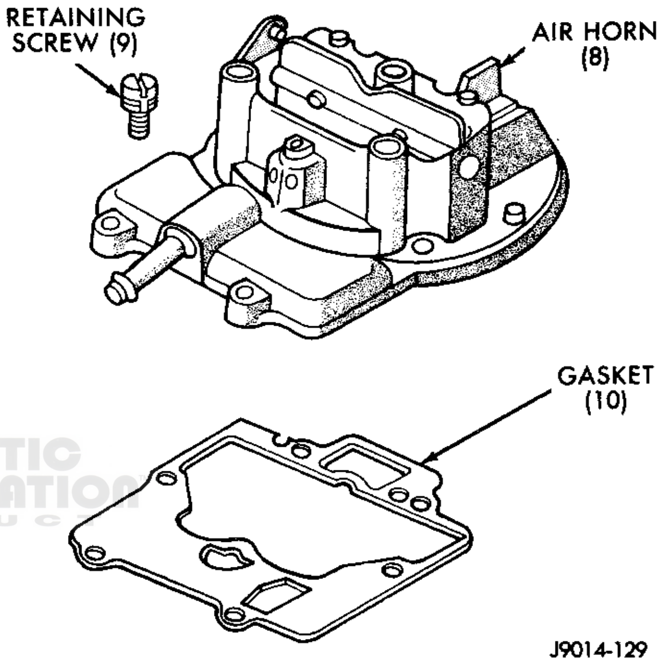


Fig. 12 Air Horn Remove/Install

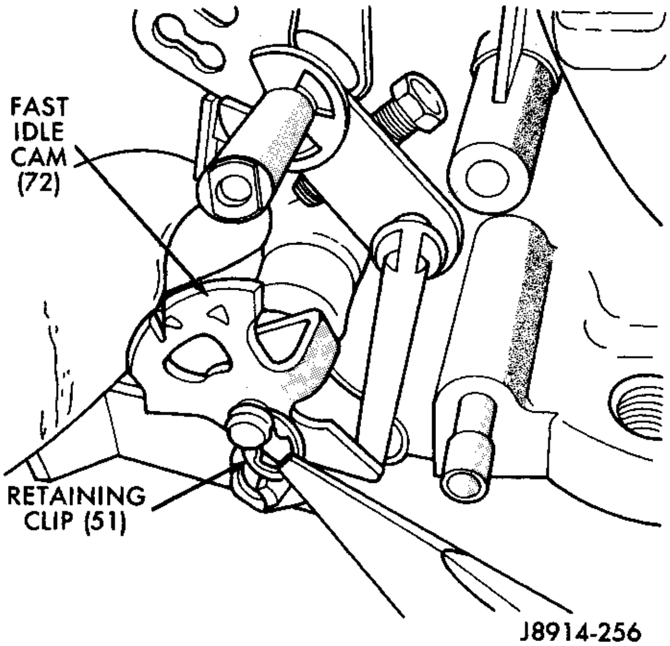


Fig. 13 Fast Idle Cam Retaining Clip

(13) Remove the retaining screw (65), coil lever (66) and washer, choke lever and shaft (55) and fast idle cam lever from the choke housing (Fig. 19).

(14) Pry the float shaft retainer (12) from the fuel inlet seat.

(15) Remove the float (11), float shaft retainer (12) and fuel inlet needle as an assembly (Fig. 20).

(16) Remove the retainer (12) and float shaft (13) from the float lever (11) (Fig. 21).

(17) Remove the fuel inlet needle seat and gasket (28). Remove the main jets (30) (Fig. 22).

(18) Remove the accelerator pump discharge screw (79) (Fig. 24), air distribution plate (78), booster venturi (77) (Fig. 23) and gasket (76). Do not attempt to remove the tubes from the venturi assembly.

(19) Invert the main body (31) and catch the accelerator pump discharge weight (75) and ball (74) (Fig. 24).

(20) Remove the accelerator pump cover (36), pump rod (37) and pump lever, diaphragm (34) and spring (33) (Fig. 25). Disconnect the accelerator pump rod (37) from the overtravel lever (Fig. 26). Remove the rod and retainer.

(21) Remove the elastomer valve (12) by grasping it firmly and pulling out. If the elastomer valve tip breaks off during removal, ensure the tip is removed from the fuel bowl. The elastomer valve must be replaced whenever it has been removed from the carburetor.

(22) Invert the main body (31) and remove the power valve cover screws (56), power valve cover (45), and gasket (44).

(23) Remove the power valve (43) with an eight point socket (Fig. 27). Remove and discard power valve gasket (42).

(24) Remove the altitude compensator mounting screws, altitude compensator assembly, and gasket from the main body (31) (Fig. 28).

(25) Remove the aneroid-to-chamber screws. Remove the gasket and aneroid from the chamber.

(26) If it is necessary to remove the idle mixture screws because air pressure and soaking did not completely clean the air passages, remove the caps concealing the screws (Fig. 29). Count and record the number of turns necessary to lightly seat the mixture screws for assembly reference. Remove the idle mixture screws.

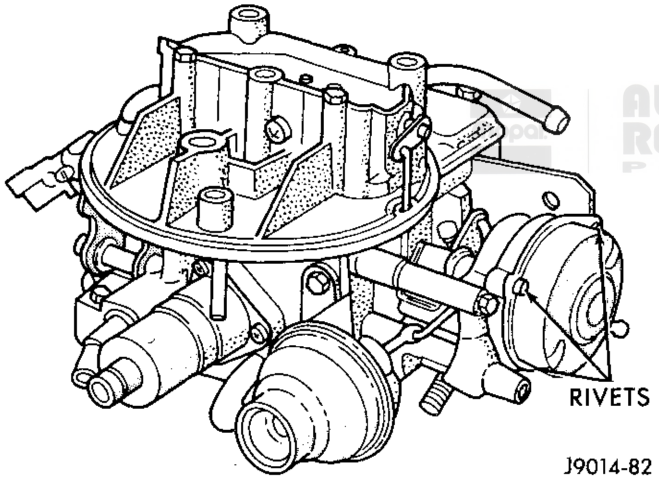


Fig. 14 Choke Housing Cover Rivets

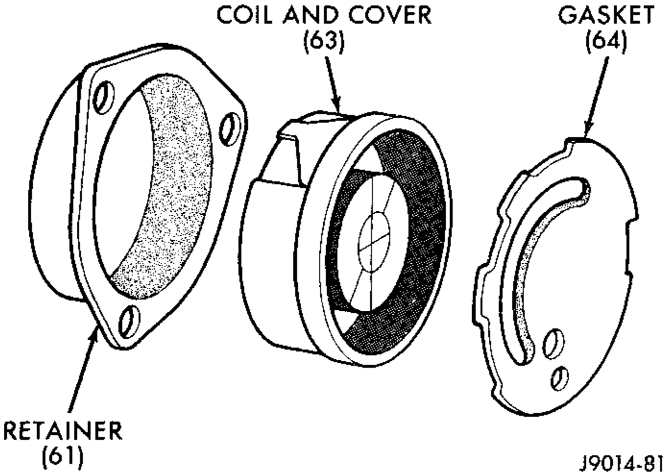


Fig. 15 Choke Coil Remove/Install

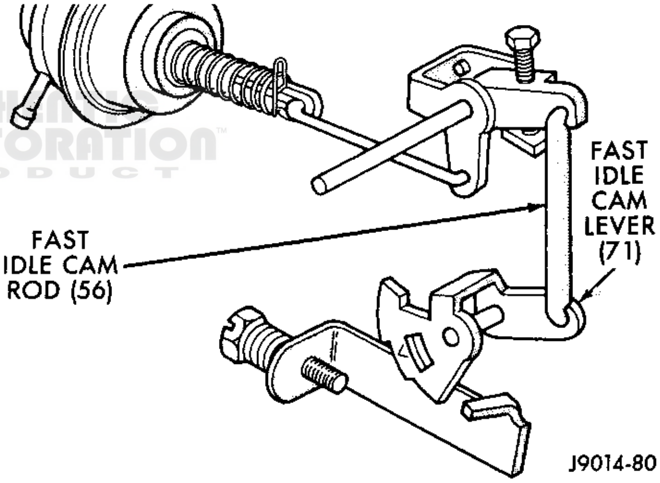


Fig. 16 Fast Idle Cam Rod Remove/Install

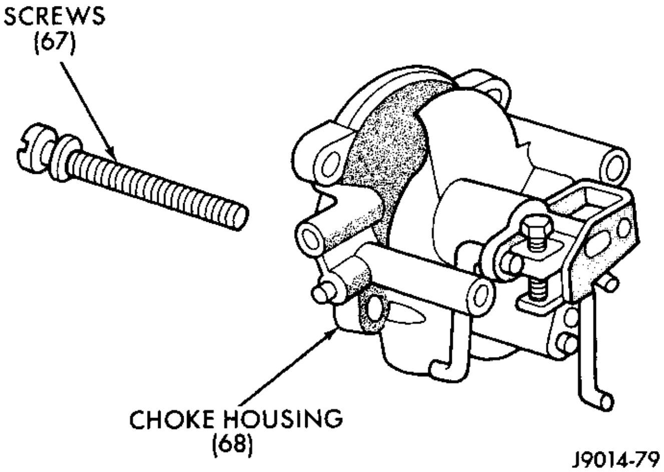


Fig. 17 Choke Housing Remove/Install

(27) Remove the fast idle lever (71) assembly from the throttle shaft (Fig. 30).

(28) Remove the throttle solenoid (Fig. 31).

(29) Remove the choke diaphragm (18) (Fig. 32).

Cleaning and Inspection

Debris, gum, water and carbon contamination in the carburetor or on the exterior moving parts of the carburetor are often responsible for unsatisfactory engine performance.Efficient carburetion depends upon careful cleaning and inspection.

The cleaning and inspection procedure listed below does not involve the replacement parts included in the carburetor overhaul/repair kit. Install all gaskets and parts included in the repair kit when the carburetor is assembled. Discard the original gaskets and replaced parts.

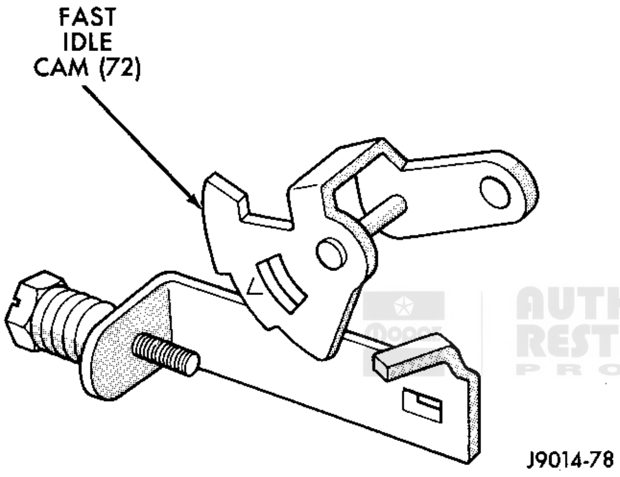


Fig. 18 Fast Idle Cam

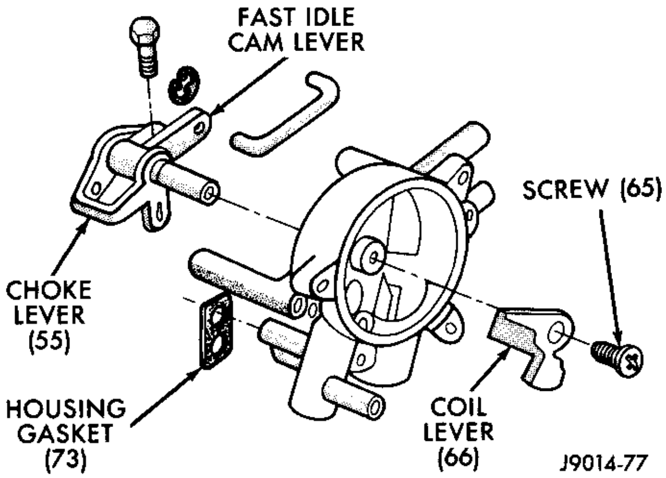


Fig. 19 Choke Housing Disassembly

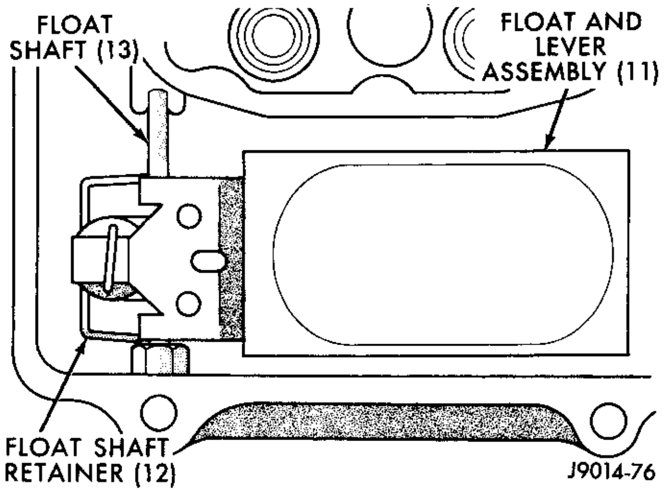


Fig. 20 Float Removal

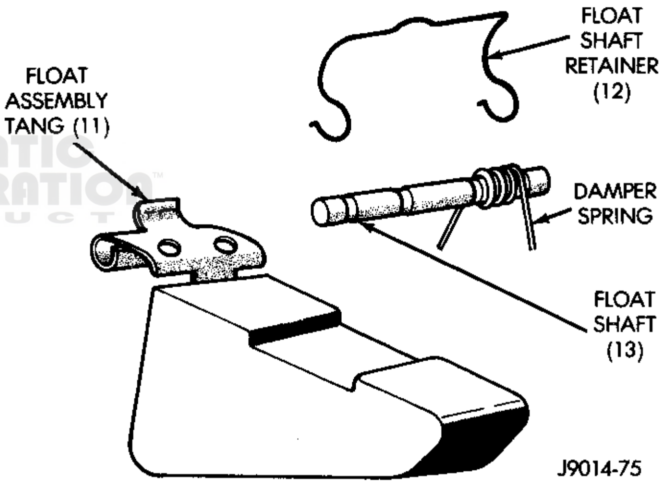


Fig. 21 Float Assembly

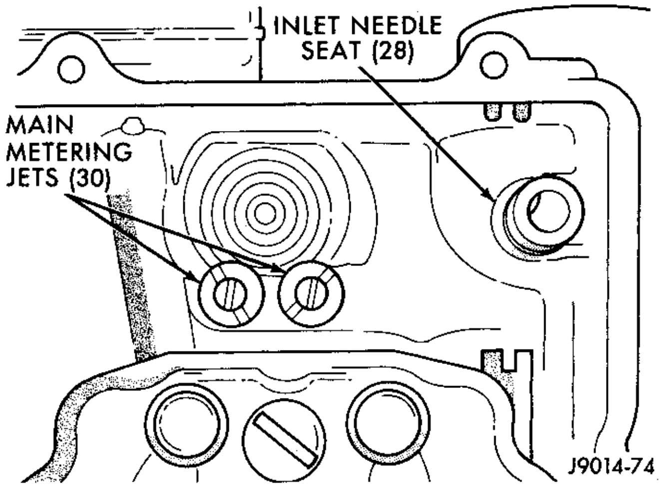


Fig. 22 Main Metering Jets and Needle Seat

CAUTION: Do not use a wire brush to clean any parts. Do not use a drill or wire to clean any openings or passages in the carburetor. A drill or wire may enlarge the hole or passage and change the calibration of the carburetor.

CAUTION: Do not immerse any part of the altitude compensation assembly in cleaning solvent. Wipe all parts with clean, lint-free shop towels.

Wash all carburetor parts except the accelerator pump diaphragm, power valve, vacuum modulator diaphragm dashpot assembly and altitude compensation assembly in clean commercial carburetor cleaning solvent. If a commercial solvent is not available, use lacquer thinner or denatured alcohol. If a commercial cleaner is used, rinse the parts in hot water to remove all traces of the cleaning solvent, then dry them with compressed air. Wipe all parts that cannot be immersed in solvent with a clean, soft, lint free, dry shop towel. Ensure all sediment, gum, carbon and other foreign matter is removed from all parts. Force compressed air through all passages of the carburetor.

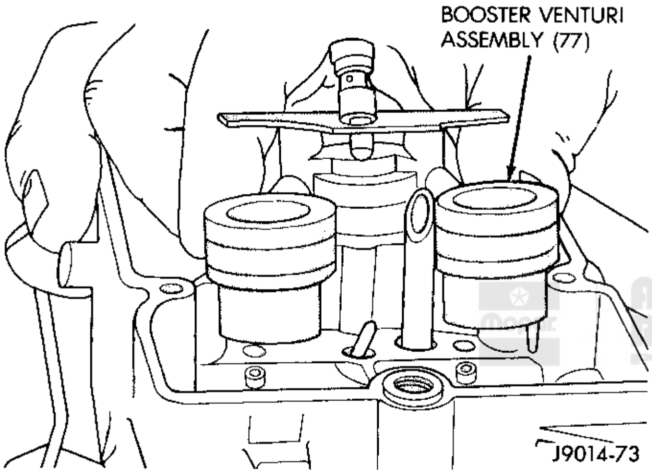


Fig. 23 Venturi Assembly Remove/Install

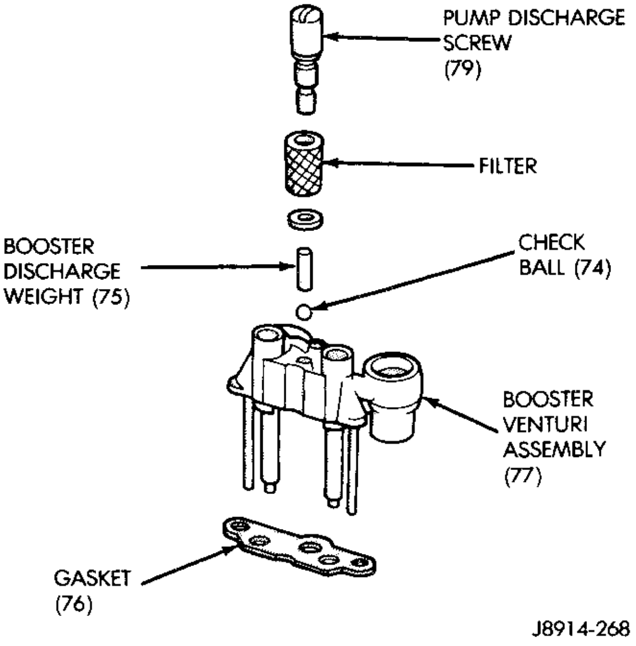


Fig. 24 Accelerator Pump Discharge Weight and Ball

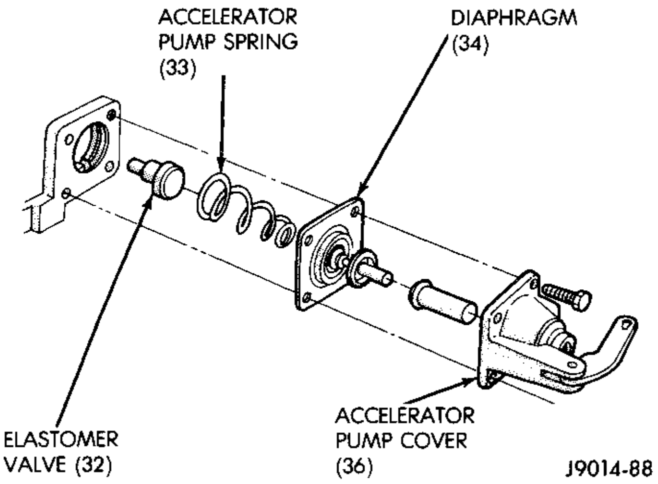


Fig. 25 Accelerator Pump Remove/Install

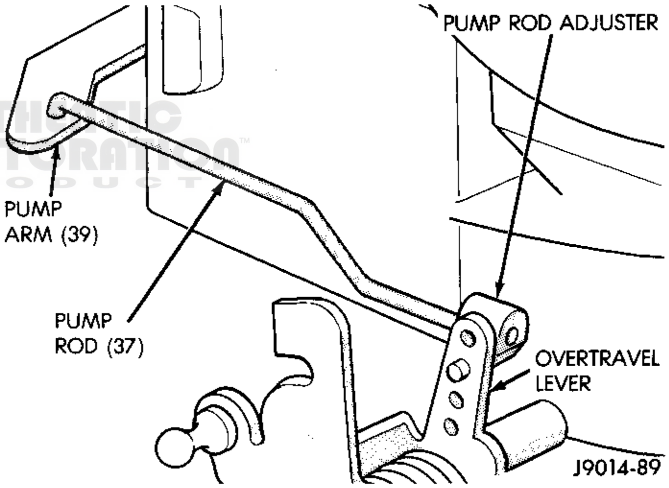


Fig. 26 Accelerator Pump Rod and Overtravel Lever

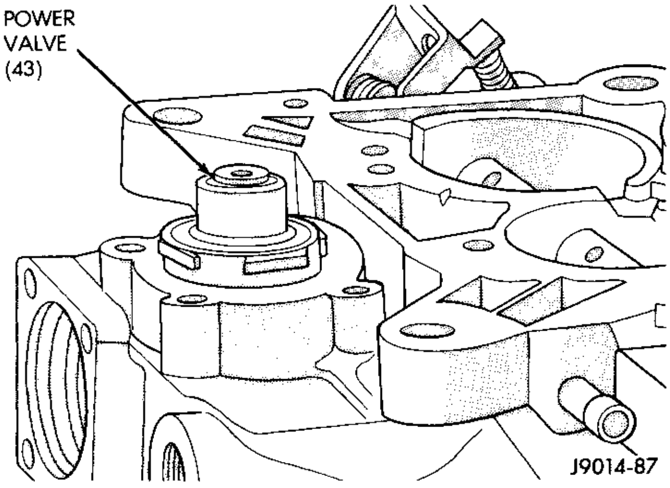


Fig. 27 Power valve

Examine the choke shaft for wear and excessive looseness or a binding condition. Inspect the choke shaft and polish with fine crocus cloth or equivalent material.

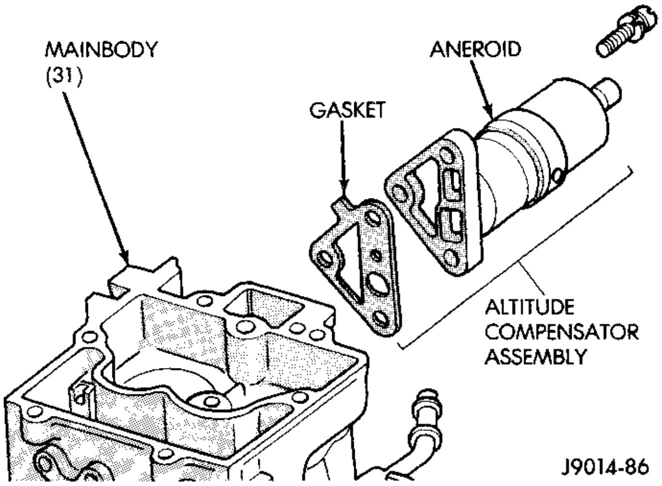


Fig. 28 Altitude Compensator Remove/Install

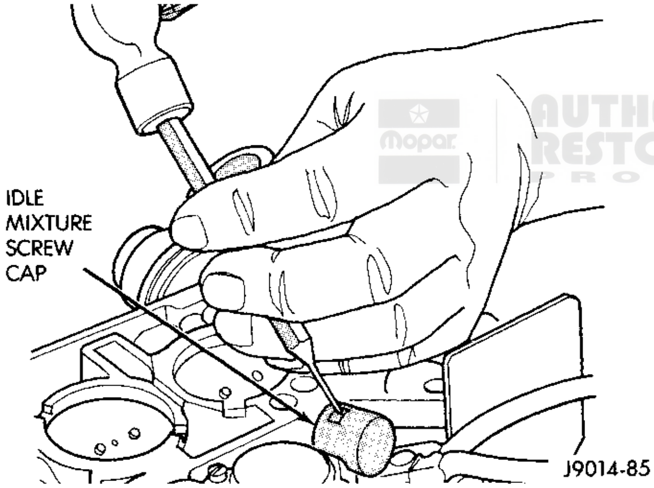


Fig. 29 Idle Mixture Screw Cap Removal

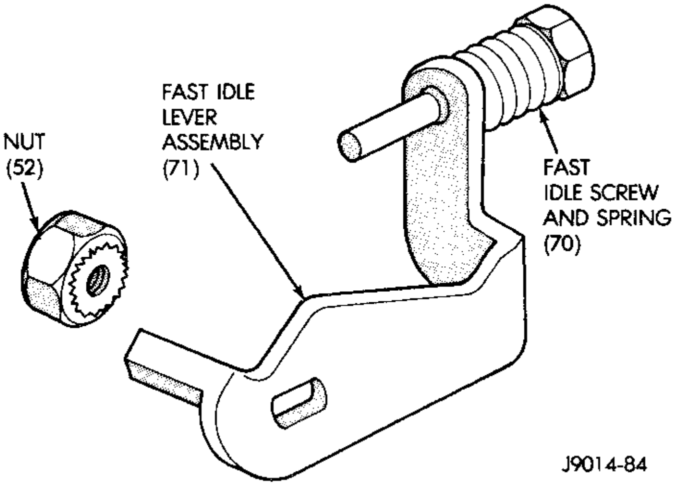


Fig. 30 Fast Idle Lever

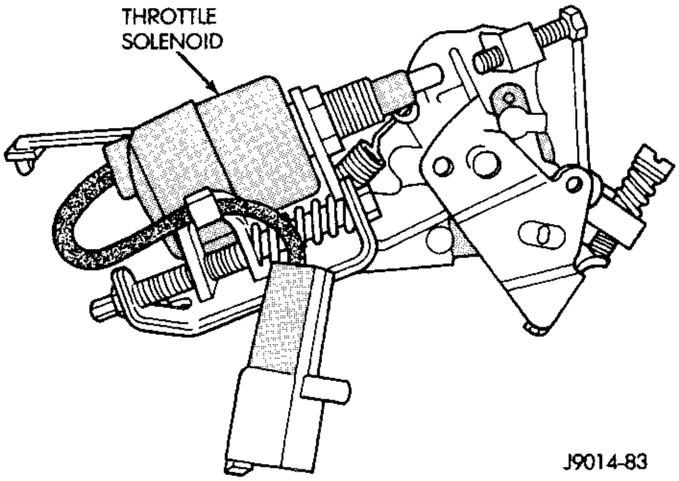


Fig. 31 Throttle Solenoid

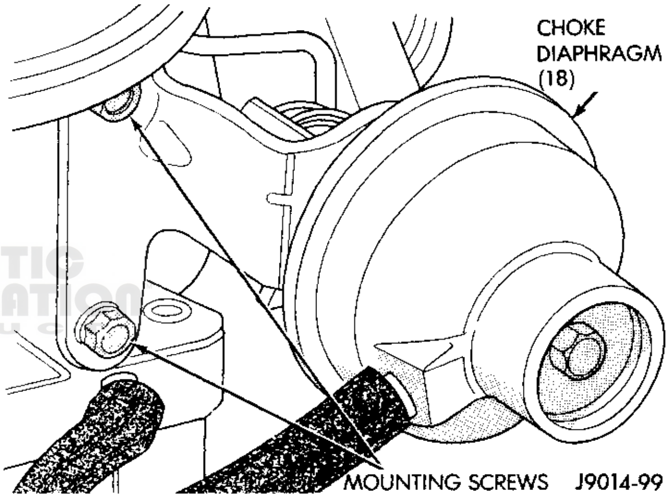


Fig. 32 Choke Diaphragm Remove/Install

Inspect the choke valve for nicked edges and for ease of operation and repair if necessary. Ensure all carbon and foreign residue has been removed from the automatic choke housing. Examine the throttle shaft for excessive looseness or a binding condition.

With the altitude compensator aneroid removed from the chamber, spring tension should fully close the air valve (Fig. 33). Examine the position of the spring in the retainer and ensure it is properly seated. Inspect the rubber seal on the valve stem. Examine the aneroid assembly and ensure that the atmospheric pressure inlet hole is free of debris.

Examine the throttle valves for burrs that could prevent closing. Inspect the main body, air horn, booster venturi assemblies, choke housing and choke cover, power valve cover and accelerator pump cover for cracks. Replace the float if the arm needle contact surface is grooved.

If the float is serviceable, polish the needle contact surface of the arm with crocus cloth or equivalent material. Replace the float shaft if worn. Examine the float shaft retainer. Replace if bent, distorted, fatigued, or broken (Fig. 34).

Replace all screws and nuts that have stripped threads. Replace all distorted or broken springs. Inspect all gasket mating surfaces for nicks or burrs. Repair or replace any parts that have a damaged gasket surface.

Assembly

Ensure all holes in the replacement gaskets have been properly punched and that no foreign material has adhered to the gaskets. Inspect the vacuum diaphragms for tears or cuts.

(1) Install the fast idle speed adjustment screw and spring on the fast idle lever (Fig. 30).

(2) Install the solenoid (Fig. 31).

(3) Place the fast idle lever assembly (71) on the throttle shaft (17) and install the retaining washer and nut (52) (Fig. 30).

(4) Lubricate the tip of the replacement elastomer valve (32) and insert the tip into the accelerator pump cavity center hole. Using needle-nose pliers, grasp the valve tip from inside the fuel bowl. Pull the valve in until it seats in the pump cavity wall. Cut off the tip forward of the retaining shoulder. Remove the tip from the bowl (Fig. 26).

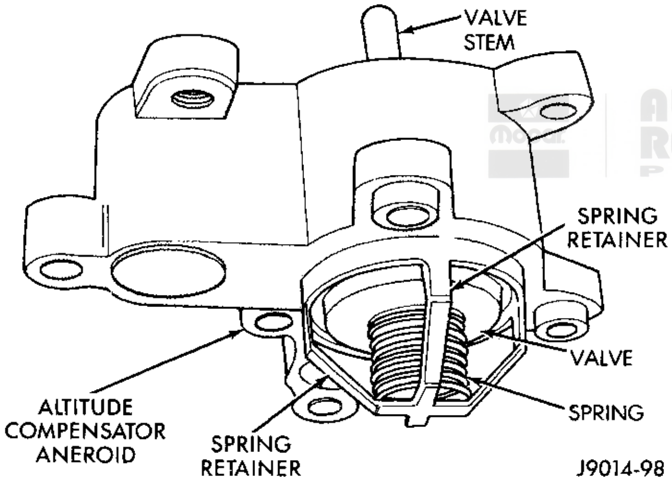


Fig. 33 Altitude Compensator Aneroid Inspection

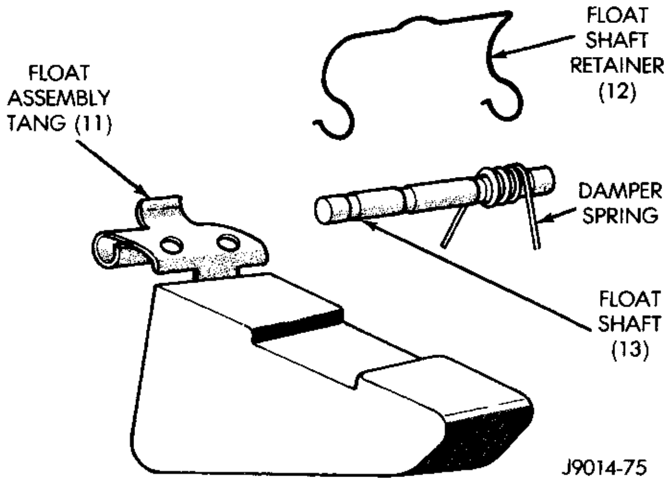


Fig. 34 Float Inspection

(5) Insert the accelerator pump operating rod (37) into the hole of the accelerator pump actuating lever (39). Position the accelerator pump operating rod retainer into hole three in the overtravel lever. Adjust the pump rod length to 4.7mm (.185 in) (Fig. 25). Refer to Accelerator Pump Rod Stroke Adjustment in the Service Adjustments section.

(6) Install the accelerator pump diaphragm return spring (33) in the chamber depression. Insert the diaphragm assembly (34) in the cover (36). Place the cover and diaphragm assembly into position on the main body (31) and install the cover screws (Fig. 26).

(7) Invert the main body and install the power valve (43) and replacement gasket (42). Tighten the valve securely (Fig. 27).

(8) Install the power valve cover (44) with the extensions adjacent to the main body to provide entry for the slots on the idle mixture adjustment screw caps. Install the power valve cover (45) and replacement gasket (44).

(9) If removed, install the cap recepticals, idle mixture adjustment screws and springs (Fig. 35).

(10) Turn the idle mixture screws in gently by hand until they lightly seat, then back off the number of turns recorded during removal for the preliminary idle mixture adjustment. **Do not install the idle mixture screw caps at this time.**

(11) Install the main jets (30) (Fig. 36).

(12) Install the fuel inlet seat (28) and replacement gasket (29).

(13) Install the fuel inlet needle assembly in the fuel inlet seat (Fig. 37). The fuel inlet needles and seats are matched assemblies and cannot be interchanged. Ensure that the correct needle and seat are assembled together.

(14) Slide the float shaft (13) into the float lever. Position the float shaft retainer (12) on the float shaft.

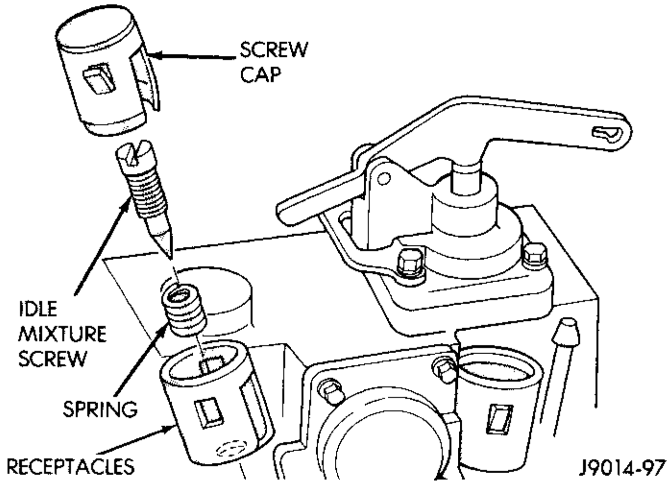


Fig. 35 Idle Mixture Screw Installation

(15) Install the float damper spring with the short end wire under the float lever.

(16) Insert the float assembly into the fuel bowl and with the float lever tab under the fuel inlet needle assembly hook (Fig. 38). Insert the float shaft (13) into its guides at the sides of the fuel bowl and the long straight wire end of the float damper spring against the wall of the main body (Fig. 39).

(17) Press the float shaft retainer (12) into the groove on the fuel inlet needle seat (28) and adjust the float level.

- Raise the float by pressing down on the float tab until the fuel inlet needle is lightly seated
- Use a T-scale to measure the distance from the fuel bowl machined surface to the flat surface on either corner of the float at the free end (Fig. 40):
- Refer to the Specifications chart for the correct dimension
- Bend the float tab to adjust the float level
- Hold the fuel inlet needle off its seat while adjusting to prevent damaging the synthetic tip.

(18) Drop the accelerator pump discharge ball (74) into the passage in the main body.

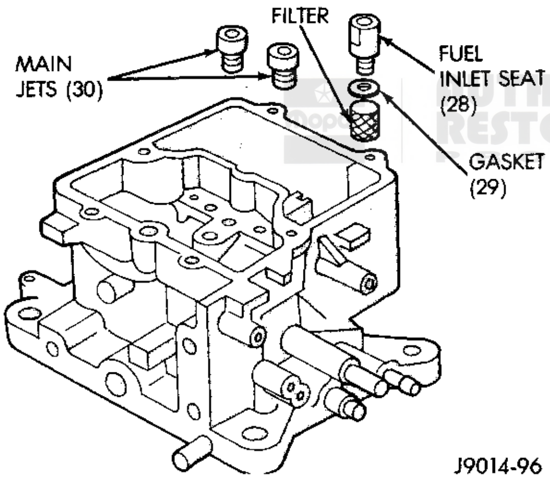


Fig. 36 Main Jets Installation

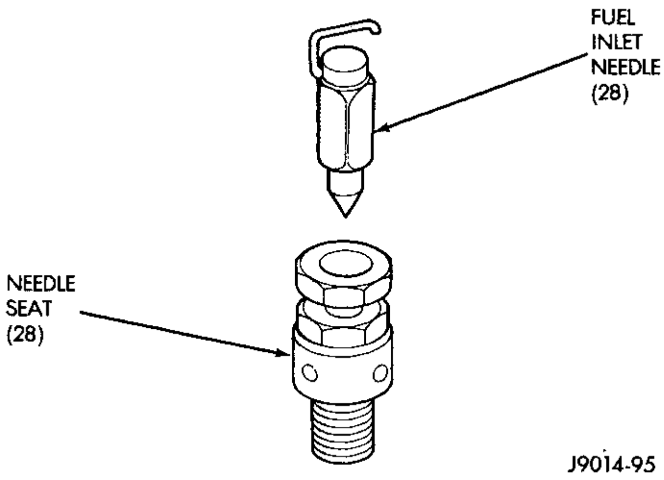


Fig. 37 Fuel Inlet Needle Installation

(19) Position the replacement booster venturi gasket (76) and booster venturi (77) in the main body.

(20) Drop the accelerator pump discharge weight (75) into the booster venturi on top of the discharge ball (Fig. 24).

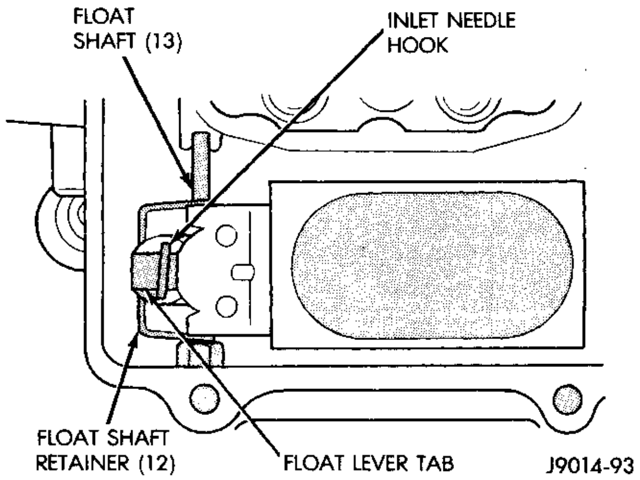


Fig. 38 Float Assembly Installation

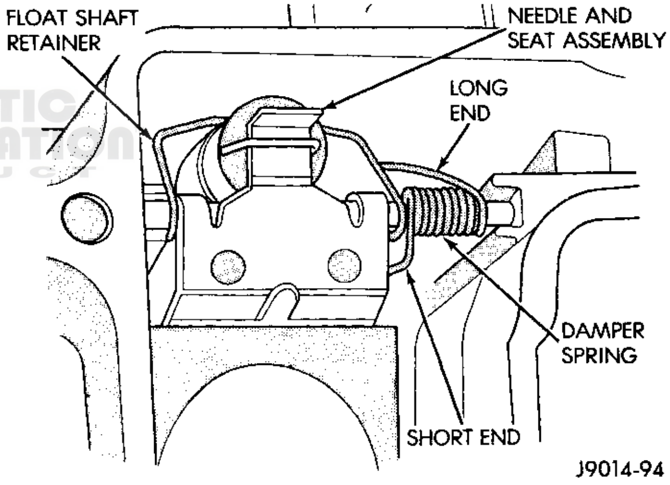


Fig. 39 Float Damper Spring Installation

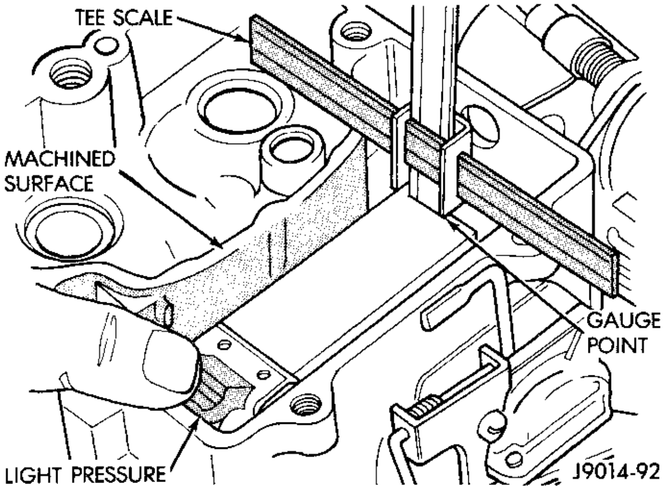


Fig. 40 Float Level Adjustment—Dry

(21) Install the air distribution plate (78) and accelerator pump discharge screw (79). Tighten the screw (Fig. 23).

(22) Install the choke vacuum diaphragm. Tighten the mounting screws (Fig. 32).

(23) Position the fast idle cam lever (71) on the choke shaft (55). Install the retainer (54). The bottom of the fast idle cam lever adjustment screw must rest against the tang on the choke shaft (Fig. 19).

(24) Insert the choke shaft (55) into the rear of the choke housing (68). Position the choke shaft so that the hole in the shaft is on the left side of the choke housing.

(25) Install the fast idle cam rod (37) on the fast idle cam lever (71).

(26) Install the fast idle cam (72) and retainer (80) to the hub on the main body (Fig. 13).

(27) Place the choke housing vacuum pickup port-to-main body gasket (73) on the choke housing flange.

(28) Wipe the choke shaft bushing (69) clean (small piece of plastic material), and install it in the choke shaft bore in the choke housing (68).

(29) Position the choke housing (68) on the main body and install the choke housing attaching screws (67).

(30) Install the retainer (54) on the fast idle cam rod (56) at the fast idle cam (72).

(31) Install the coil lever (66) (Fig. 19).

(32) Install the choke housing gasket (64) cover and coil (63), retainer (61) and screws. Turn the choke cover 1/4 turn rich and tighten one retaining screw.

(33) Install the choke shield (57), if equipped.

(34) Insert the choke rod (81) into the choke valve lever (83) in the position noted during disassembly (Fig. 11). The lower end of the rod must protrude through the air horn (8).

(35) Install the choke valve lever (83) on the choke shaft (7) and tighten the screw (82).

(36) Install the plastic dust shield (84) on the choke rod (81).

(37) Position the main body gasket (10) on the main body (31).

(38) Position the air horn on the main body and gasket so that the choke valve rod fits through the opening in the main body and that the plastic shield is free to slide.

(39) Insert the lower end of the choke valve rod (81) into the choke valve lever (71).

(40) Install the air horn attaching screws (9) and carburetor identification tag. Tighten the attaching screws.

(41) Install the air cleaner anchor screw.

(42) Adjust the initial choke valve clearance and adjust the fast idle cam linkage. Refer to Service Adjustment Procedures,

(43) Adjust the choke unloader clearance. Refer to Service Adjustments Procedure.

(44) Loosen the choke housing cover screw and align the cover index with the specified notch. Refer to Specifications.

(45) Tighten all choke cover screws.

(46) Position the altitude compensator aneroid on the chamber with a replacement gasket. Tighten the mounting screws.

(47) Position the altitude compensator assembly on the carburetor body with a replacement gasket. Tighten the mounting screws.

There are no adjustments for the altitude compensator assembly. Do not attempt to turn the fitting on the aneroid. It is adjusted and sealed during factory assembly.

SERVICE ADJUSTMENT PROCEDURES

Float Level Adjustment—Dry

(1) Remove the air horn assembly and gasket.

(2) Raise the float by pressing down on the float tab until the fuel inlet needle is lightly seated.

(3) Use a T-scale to measure the distance from the fuel bowl machined top surface to the flat surface on either corner of the float at the free end (Fig. 1). Refer to Specifications for the correct dimension.

(4) Hold the fuel inlet needle off its seat while adjusting to prevent damage to the synthetic tip of the needle. Bend the float tab to adjust float level.

Float Level Adjustment—Wet

WARNING: EXERCISE EXTREME CAUTION WHEN PERFORMING THIS PROCEDURE. FUEL VAPOR IS PRESENT WHEN THE CARBURETOR AIR HORN IS REMOVED. EXTINGUISH CIGARETTES AND OTHER SMOKING MATERIALS.

(1) Position the vehicle on a flat, level surface and warm the engine to normal operating temperature. Turn the engine off.

(2) Remove the carburetor air cleaner assembly and anchor screw.

(3) Remove the air horn attaching screws and the carburetor identification tag.

(4) Temporarily place the air horn and gasket in po-

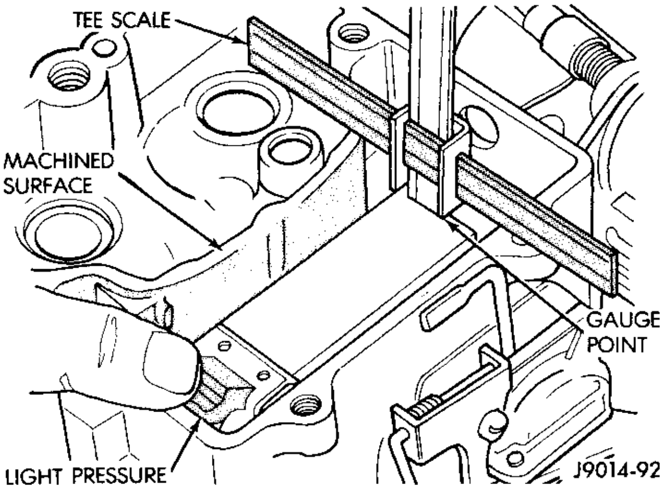


Fig. 1 Float Level Adjustment—Dry

sition on the carburetor main body and start the engine. Let the engine idle one minute, then turn the engine off and move the air horn aside.

(5) Remove the air horn gasket to provide access to the float assembly.

(6) Use a T-scale to measure the vertical distance from the top machined surface of the carburetor main body to the level of the fuel in the fuel bowl (Fig. 2). Measure at least 6.35 mm (1/4 in) away from the vertical surface to assure an accurate indication because the top surface of the fuel is concave (higher at edges than in center). Measure the fuel level at the exact point of contact between the scale and fuel. Refer to Specifications for the correct fuel level (wet) dimension.

(7) To adjust the fuel level, bend the float tab (contacting the fuel inlet valve) up in relation to the original position to raise the fuel level, and down to lower it. Each time an adjustment is made to the float tab to alter the fuel level, place the gasket and air horn on the carburetor, start the engine and permit it to idle one minute to stabilize the fuel level. Turn the engine off and measure the fuel level after each adjustment until the specified level is obtained.

(8) Install a replacement air horn gasket, air horn assembly, carburetor identification tag and attaching screws. Ensure the plastic dust seal on the choke operating rod is positioned correctly and does not cause the rod to bind. Tighten the screws.

(9) Install the air cleaner anchor screw and tighten.

(10) Adjust the idle speed.Refer to Idle Speed Adjustment.

(11) Install the air cleaner.

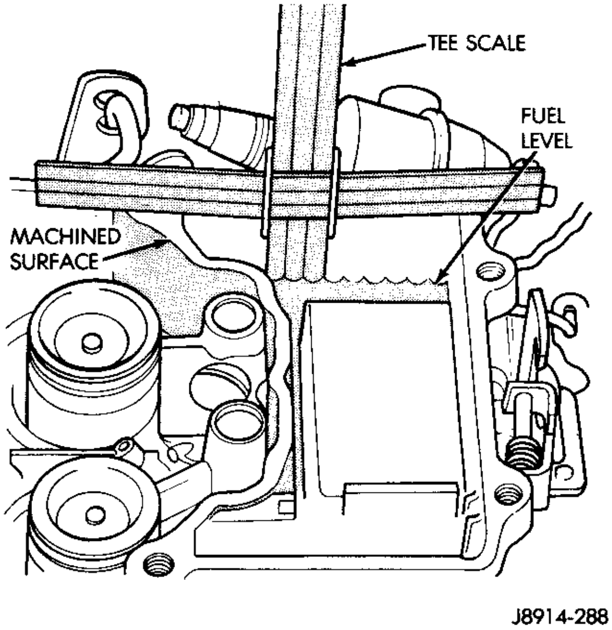


Fig. 2 Float Adjustment—Wet

Initial Choke Valve Clearance and Fast Idle Cam Linkage Adjustments

(1) Open the throttle to allow choke mechanism to set and fast idle screw to set on top step of cam.

(2) Using a hand held vacuum pump, apply vacuum to hold the choke diaphragm against the setscrew while using finger pressure to load the choke diaphragm stem in the direction opposite the diaphragm (Fig. 3).

If vacuum is applied to the choke diaphragm with a hand pump, an air leak may be noticed. This is normal.

Do not press on the linkage rods.

(3) Measure the clearance between the top of the choke valve and the air horn. Refer to the Specifications Chart at the beginning of this section for the Initial Choke Setting dimension.

(4) Adjust the clearance by turning the screw at the rear of the choke vacuum diaphragm (Fig. 4).

(5) Push down on the fast idle cam lever until the fast idle speed adjustment screw is in contact with the second step of the fast idle cam and against the shoulder of the high step (Fig. 5) .

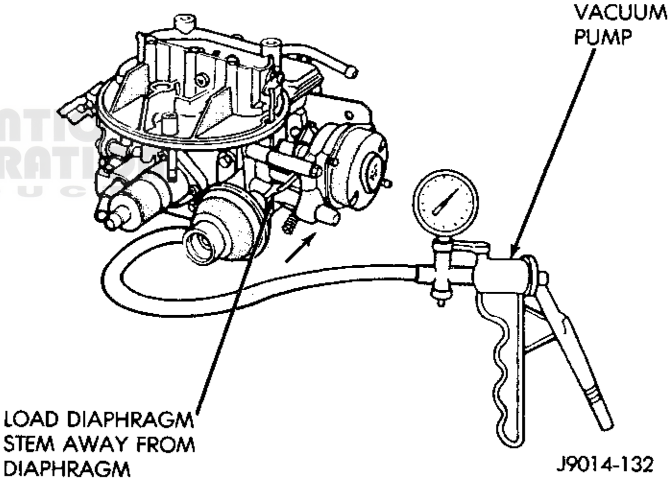


Fig. 3 Retracting Choke Diaphragm

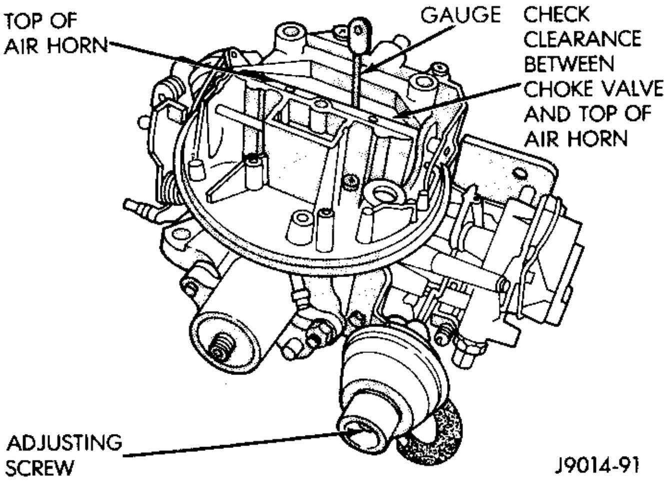


Fig. 4 Initial Choke Valve Clearance Adjustment

(6) Measure clearance between upper edge of choke valve and air horn wall. Refer to fast idle cam setting in the Specifications chart for the correct dimension.

(7) Adjust the clearance by turning the fast idle cam lever screw (Fig. 5).

Choke Unloader Adjustment.

(1) Hold the throttle fully open and apply pressure on the choke valve toward the closed position.

(2) Measure the clearance between the lower edge of the choke valve and the air horn wall. Refer to choke unloader in the Specifications chart for the correct dimension.

CAUTION: Do not bend the unloader tang downward from a horizontal plane.

(3) Adjust by bending the unloader tang (which contacts the fast idle cam—Fig. 6). Bend the tang toward the cam to increase the clearance and away from the cam to decrease clearance.

(4) After completing the adjustment, open the throttle until the unloader tang is directly below the fast idle cam pivot.

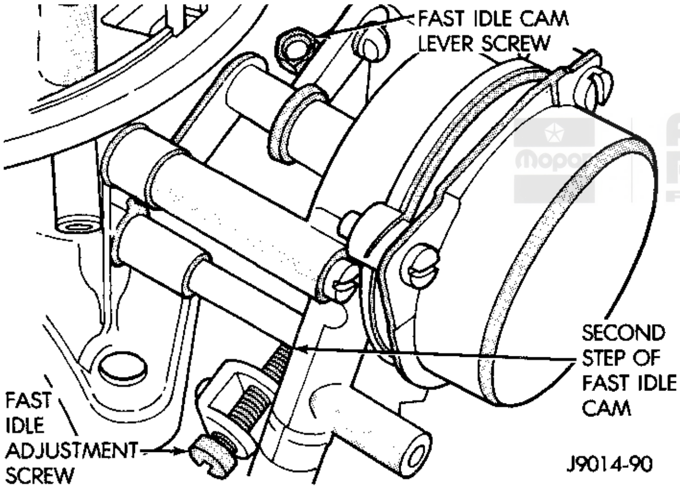


Fig. 5 Fast Idle Cam Linkage Adjustment

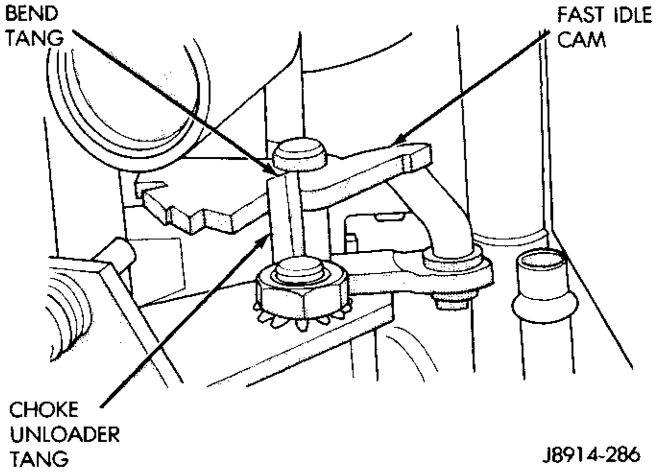


Fig. 6 Choke Unloader Adjustment

(5) There must be exactly 1.8 mm (0.070 in) clearance between the unloader tang and the edge of the fast idle cam (Fig. 7).

(6) Operate the throttle and inspect the unloader tang to ensure it does not bind, contact or stick on any part of the carburetor casting or linkage.

(7) Inspect for full throttle opening when the throttle is operated from inside the vehicle (After carburetor installation if procedure is being performed during carburetor overhaul).

(8) If a full throttle opening is not obtainable, it may be necessary to remove excess padding under the floormat or reposition the throttle cable bracket located on the engine

Automatic Choke Adjustment

The automatic choke adjustment is preset during factory assembly and should not normally require adjustment. The preset position will be satisfactory for most driving conditions. The Choke Mechanism should be serviced only during major carburetor overhaul.

Choke Disassembly

The choke mechanism on Model 2150 carburetors cannot be serviced with the carburetor on the engine. The carburetor must be removed to properly service the choke components.

(1) If equipped, remove the choke shield.

(2) Grind the heads off the choke cover rivets (Fig. 8).

(3) Remove the retaining clamp, choke cover and coil and cover gasket (Fig. 9). Remove the remaining portion of the rivets after removing the cover.

(4) Remove the clips that retain the choke rod, fast idle cam rod and the vacuum diaphragm rod to the choke lever and shaft (Fig. 10).

(5) Remove the choke housing retaining screws and remove the housing and gasket (Fig. 11).

(6) Remove the coil lever screw and remove the lever (Fig. 12). Remove the choke lever and shaft.

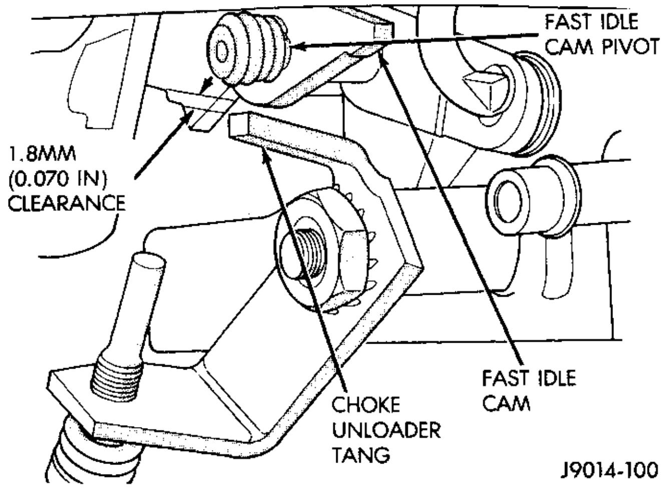


Fig. 7 Unloader—Fast Idle Cam Clearance

(7) Clean and polish the choke lever and shaft with crocus cloth. Inspect the shaft bushing in the housing. Replace the bushing if worn or damaged. Clean and inspect each of the choke mechanism components. Replace any parts that are worn or damaged.

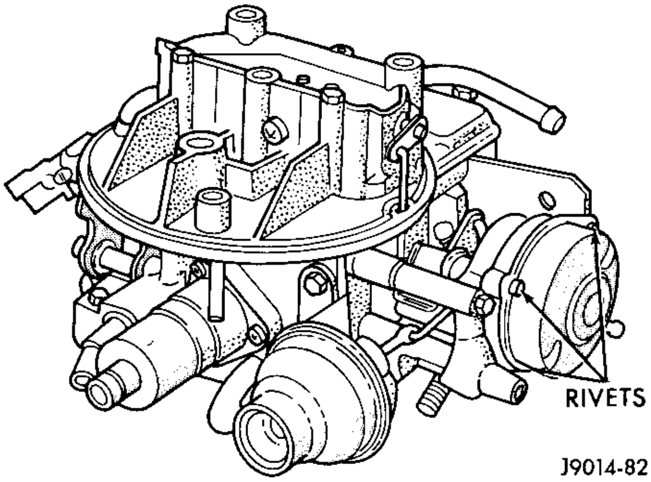


Fig. 8 Choke Cover Rivets

Choke Assembly

(1) Install the choke lever and shaft and the shaft bushing in the choke housing.

(2) Install the coil lever and lever attaching screw (Fig. 12).

(3) Install the choke housing and gasket on the carburetor (Fig. 11).

(4) Connect the choke rod, fast idle cam rod and vacuum diaphragm rod to the choke lever and shaft (Fig. 10).

(5) Install the choke cover and coil, cover retainer and gasket (Fig. 9). Secure the cover with replacement screws but do not tighten the screws completely at this time.

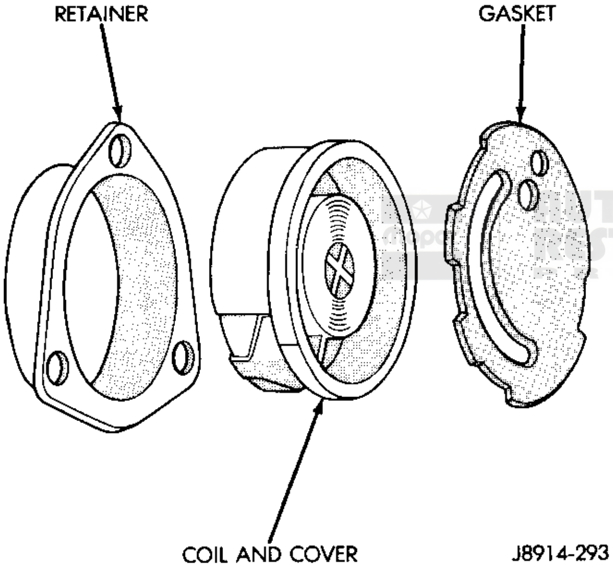


Fig. 9 Choke Coil and Cover, Retainer, and Gasket

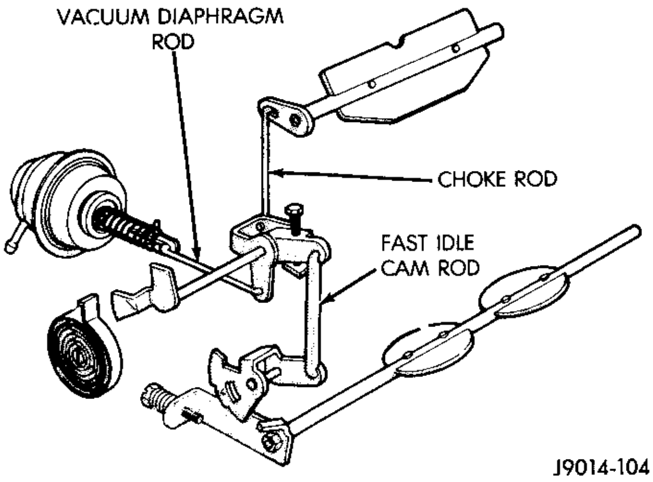


Fig. 10 Choke Disassembly/Assembly

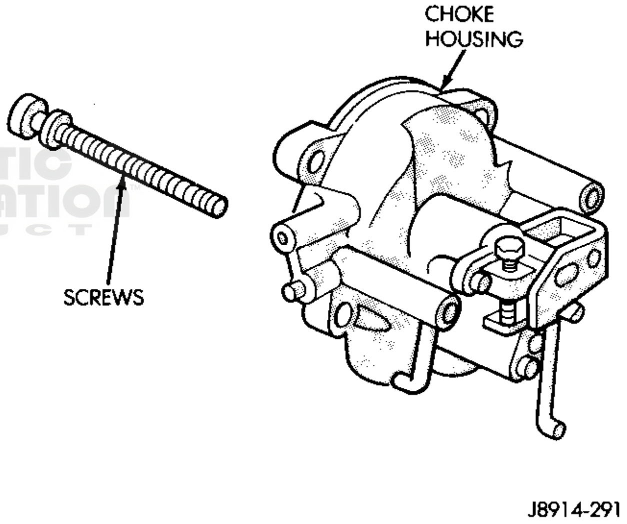


Fig. 11 Choke Housing Remove/Install

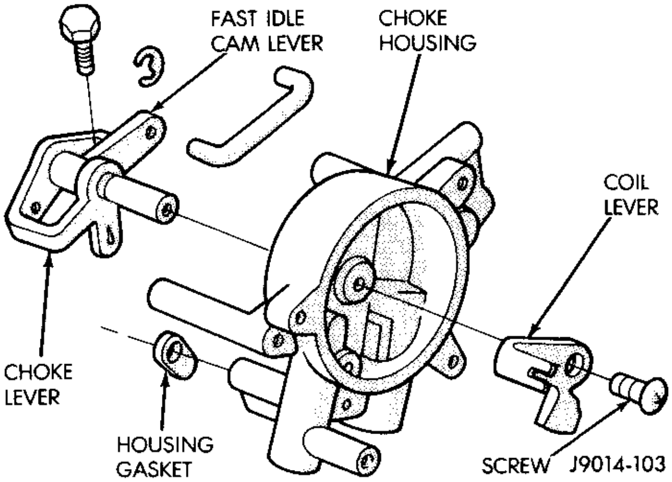


Fig. 12 Choke Coil Lever Remove/Install

(6) Align the index marks on the choke cover and housing and tighten the cover retaining screws securely. Refer to the Specifications chart for the correct setting.

Accelerator Pump Stroke Adjustment

The specified accelerator pump rod position and resulting stroke have been selected to help maintain the exhaust emission level of the engine within regulations. The additional adjustment holes in the throttle shaft overtravel lever permit adjusting the stroke for a specific engine application and ambient location. The end of the pump rod is threaded into a plastic adjuster that is used to adjust pump rod stroke. A small spanner wrench is required to adjust the pump rod stroke. The overtravel lever has three holes (numbered 2, 3, 4) and the accelerator pump lever one hole (Fig. 13). For all applications set the pump rod in the middle hole (number three).

(1) Remove the accelerator pump cover to remove the accelerator pump rod adjuster from the overtravel lever.

(2) Position the adjuster into the specified hole in the overtravel lever.

(3) Energize solenoid with a 12 volt supply.

(4) Accelerator pump rod stroke is measured from the top of the accelerator pump shaft to the tip of the pump cover. Using a small spanner wrench or spanner socket, turn the pump rod adjuster until the accelerator pump shaft protrudes 4.7 mm ± .50 mm (.185 in ± .020 in) out of the pump cover when the solenoid is energized.

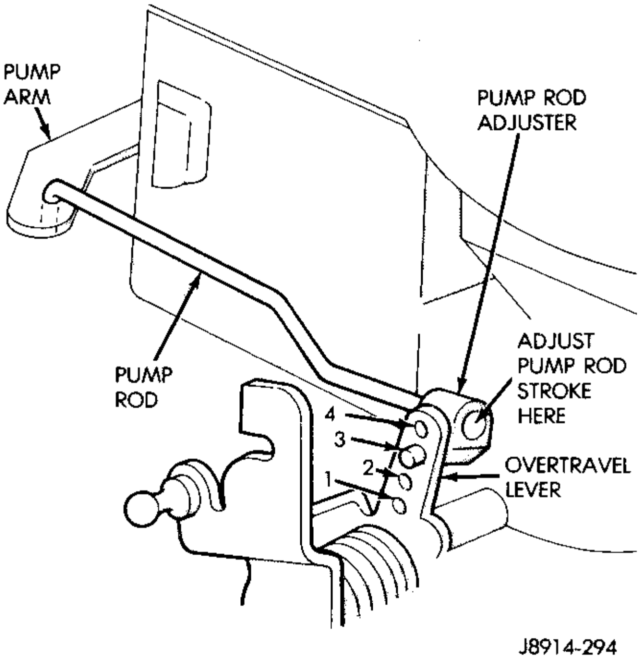


Fig. 13 Accelerator Pump Rod

Idle Speed Adjustment

When adjusting the idle speed, put the transmission in Neutral.

WARNING: SET THE PARKING BRAKE FIRMLY. DO NOT ACCELERATE THE ENGINE.

(1) Connect a tachometer to the engine coil negative (TACH) terminal.

Use a tachometer with an expanded scale of 400-800 or 0-1000 RPM. Inspect the tachometer periodically to ensure that the accuracy is within two percent.

(2) Start the engine and let it idle until normal operating temperature is reached. The choke must be OFF.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(3) Turn the hex-head adjusting screw (Fig. 14) on the solenoid carriage to obtain an engine operating speed of 600 rpm.

(4) Disconnect the solenoid wire connector and adjust the curb idle screw to obtain 500 rpm curb idle speed (Fig. 14).

(5) Connect the solenoid wire connector.

(6) If equipped with a dashpot:

- With the throttle at the curb idle position, fully depress the dashpot stem and measure the clearance between the stem and the throttle lever (Fig. 15). The clearance should be 0.813 mm (0.032 in).
- Adjust by loosening the locknut and turning the dashpot (Fig. 15).

Idle Mixture Adjustment

The idle mixture screws are concealed by tamper resistant caps (Fig. 16). The idle mixture should be adjusted only if the mixture adjustment screws were removed or altered during major carburetor overhaul.

(1) Connect a tachometer to the ignition coil negative (TACH) terminal. Use a tachometer with an expanded

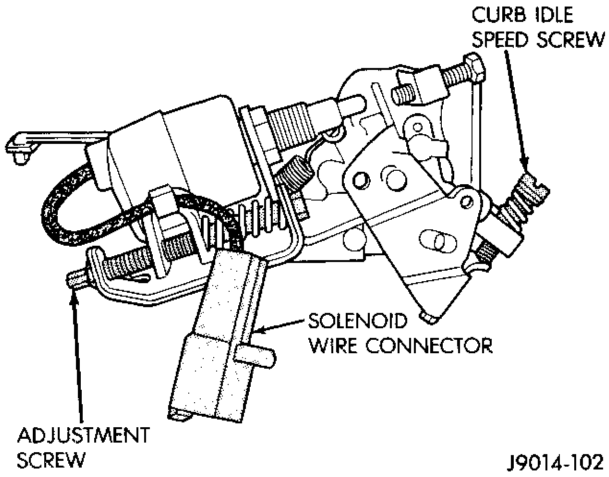


Fig. 14 Idle Speed Adjustment

scale of 400-800 or 0-1000 rpm. Inspect the tachometer periodically to ensure the accuracy is within two percent.

(2) Start the engine and let it idle until normal operating temperature is reached. The choke must be OFF.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(3) Position the transmission in Neutral.

(4) Adjust the idle speed to the specified rpm. Refer to Idle Speed Adjustment in this section.

(5) Turn the idle mixture adjustment screws clockwise (resulting in a leaner air-fuel ratio) until a perceptible loss of rpm is noted on the tachometer.

(6) Turn the mixture screws counterclockwise (resulting in a richer air-fuel ratio) until the highest RPM is obtained. Do not turn screws any further than the position where the highest rpm is first obtained. This is referred to as LEAN BEST IDLE.

Engine speed will increase above the curb idle speed an amount that corresponds approximately to the lean drop specification.

Model 2150 Carburetor Idle Speed Drop

(7) For the final adjustment, turn both idle mixture screws clockwise in small, equal amounts until the specified drop is achieved.

If the final rpm differs more than ± 30 rpm from the originally adjusted curb idle speed, adjust the curb idle to specification and repeat the Idle Mixture Procedure.

(8) Install the idle mixture screw tamper resistant caps (Fig. 17). Use care to prevent disturbing the mixture adjustment screw positions while installing the caps.

Fast Idle Speed Adjustment

Adjust the fast idle speed with the engine at normal operating temperature and with the EGR valve vacuum hose disconnected and plugged.

(1) Connect a tachometer to the ignition coil negative (TACH) terminal. Use a tachometer with an expanded

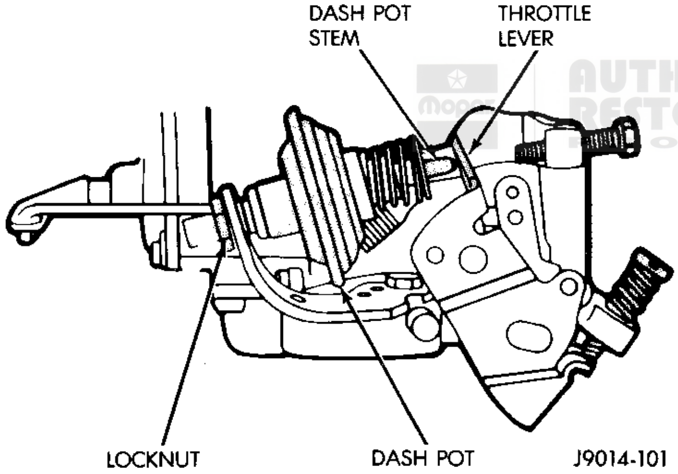


Fig. 15 Dashpot Adjustment

Engine	Transmission	Idle Speed Drop RPM
360 2V	Automatic	20

J8914-298

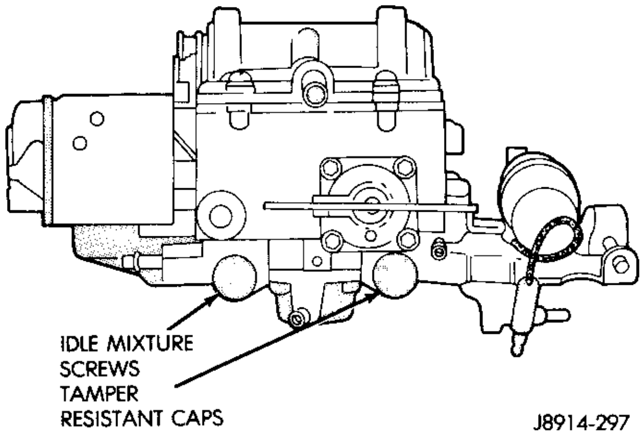


Fig. 16 Idle Mixture Screws Tamper Resistant Caps

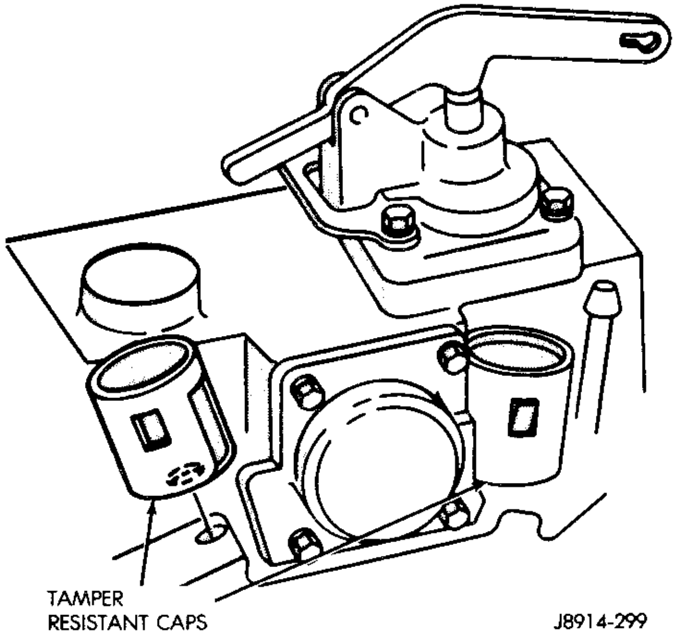


Fig. 17 Tamper Resistant Cap Installation

scale of 400-800 or 0-1000 rpm. Inspect the tachometer periodically to ensure the accuracy is within two percent.

(2) Start the engine and allow it to warm up to operating temperature. The choke must be OFF.

(3) Place the transmission in NEUTRAL.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

(4) Position the fast idle adjustment screw in contact with the second step of the fast idle cam. Refer to Specifications for the correct engine rpm. Adjust the fast idle speed by turning the fast idle adjustment screw (Fig. 18).

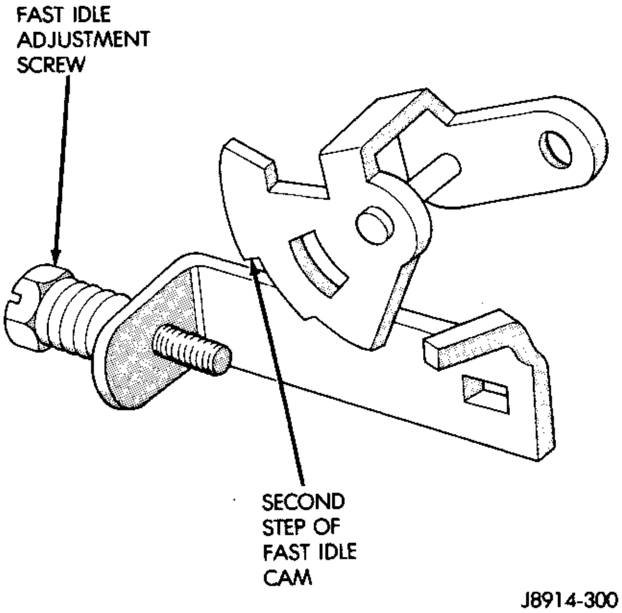


Fig. 18 Fast Idle Speed Adjustment

DRIVE SHAFTS

CONTENTS

GENERAL INFORMATION

DESCRIPTION

Jeep vehicles use tubular steel drive shafts to transfer engine torque from the transmission to the rear axle (2WD vehicles) and to transfer engine torque from the transfer case to the front and rear axles (4WD vehicles). Universal joints are used to connect each drive shaft to the transmission or transfer case output shaft yoke and to the drive pinion gear shaft (axle) yoke. A splined slip yoke is located at one end of most of the drive shafts to compensate for variations in the shaft length caused by suspension spring movement.

Because of the various driveline combinations that are available for Jeep vehicles, several different types of drive shafts and universal joints are necessary.

Universal Joints

Two different types of universal joints are used for the various driveline combinations:

- single cardan U-joint (Fig. 1) and
- double cardan U-joint (Fig. 2).

The single cardan universal joint (Fig. 1) is used for most driveline applications and is comprised of a single spider, four sets of needle bearings, four bearing seals, four bearing caps and four cap retaining clips. Clamp straps are used to attach the universal joint to the drive pinion gear shaft (axle) yoke and to the transmission or transfer case output shaft yoke.

The double cardan universal joint (Fig. 2), also referred to as a constant velocity (CV) universal joint, is comprised of two spiders; one socket ball and retainer; one link yoke; one socket spring; one socket yoke; one socket yoke needle bearing; two thrust washers; eight sets of spider needle bearings; sixteen bearing seals; eight bearing caps and retaining clips; and one drive shaft yoke.

SJ Vehicles

The front drive shaft (Fig. 3) is connected to the drive pinion gear shaft (axle) yoke with a slip yoke and a single cardan universal joint and to the transfer case output shaft yoke with a double cardan (CV) universal joint.

The rear drive shaft (Fig. 4) is connected to both the drive pinion gear shaft (axle) yoke and the transfer case yoke with a single cardan universal joint. The slip yoke is located at the transfer case end of the shaft.

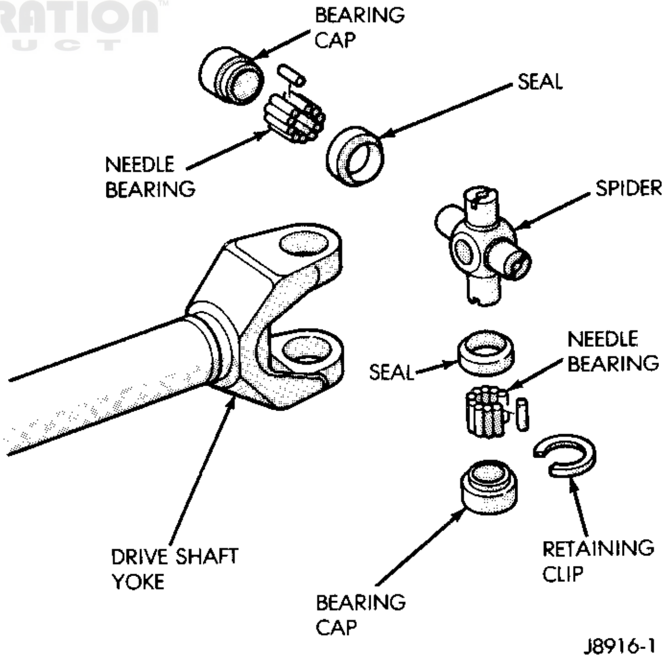
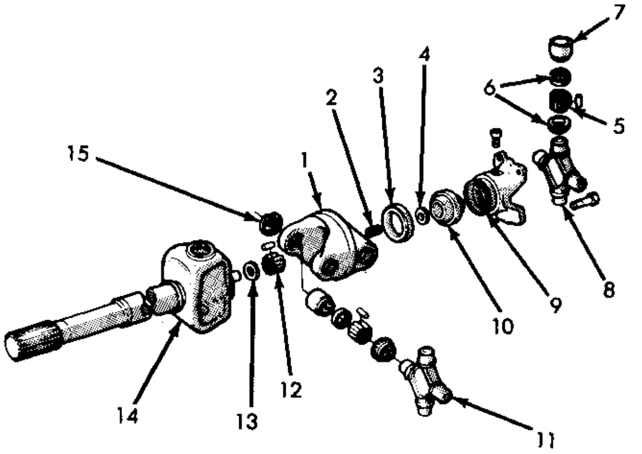


Fig. 1 Single Cardan Universal Joint

MJ/XJ Vehicles

The front drive shaft (Fig. 5) has a double cardan (CV) universal joint that attaches to the transfer case output shaft yoke and a single cardan universal joint with a slip yoke that attaches to the drive pinion gear shaft (axle) yoke.

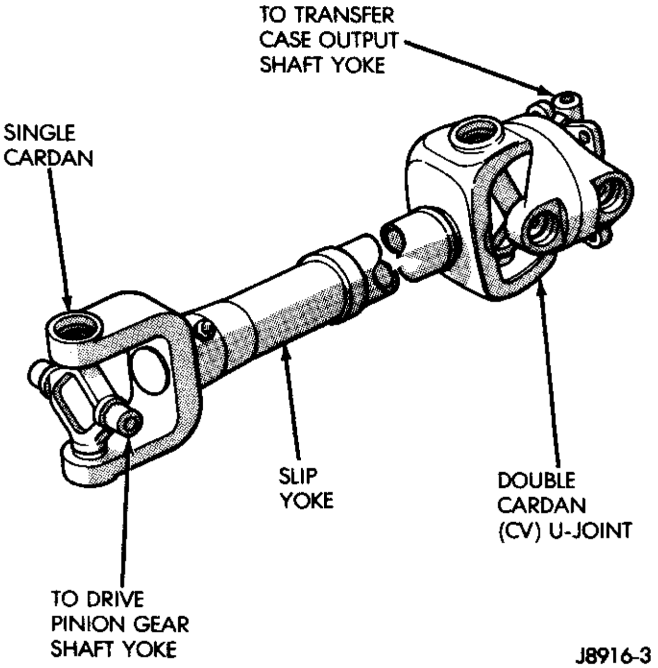
The rear drive shafts (Fig. 6) are one-piece shafts with single cardan universal joint yokes welded at each end. A slip yoke attaches to the transmission/transfer case output shaft.



1. LINK YOKE
2. SOCKET SPRING
3. SOCKET BALL RETAINER
4. THRUST WASHER
5. NEEDLE BEARINGS
6. SEAL
7. BEARING CAP
8. REAR SPIDER
9. SOCKET YOKE
10. SOCKET BALL
11. FRONT SPIDER
12. SOCKET NEEDLE BEARINGS
13. THRUST WASHER
14. DRIVE SHAFT YOKE
15. RETAINING CLIP

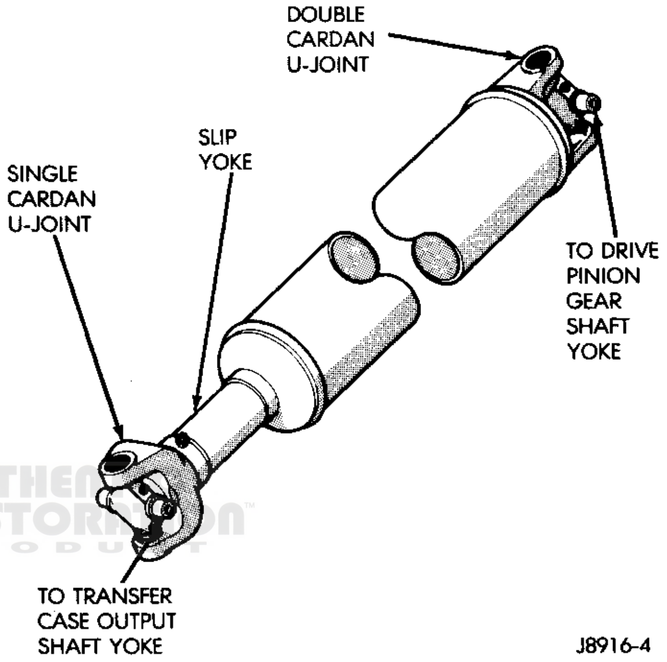
J8916-2

Fig. 2 Double Cardan (CV) Universal Joint



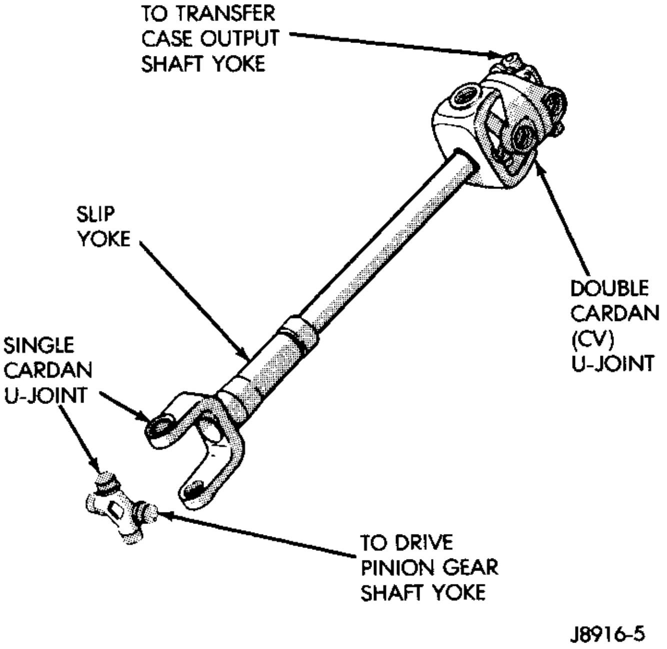
J8916-3

Fig. 3 Front Drive Shaft—SJ Vehicles



J8916-4

Fig. 4 Rear Drive Shaft—SJ Vehicles



J8916-5

Fig. 5 Front Drive Shaft—MJ/XJ Vehicles

YJ Vehicles

The front drive shaft (Fig. 7) has a single cardan universal joint at each end. A slip yoke is used to attach the shaft to the drive pinion gear shaft (axle) yoke.

The rear drive shaft (Fig. 8) has a single cardan universal joint at each end. A slip yoke is used to attach the drive shaft to the transfer case output shaft yoke.

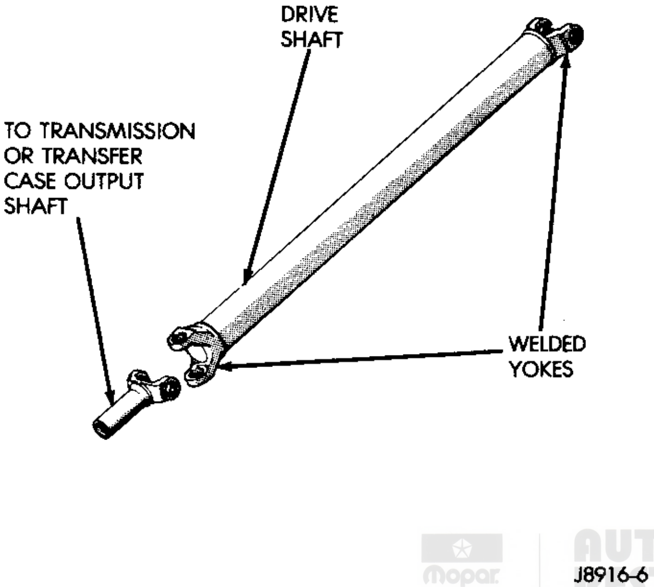


Fig. 6 Rear Drive Shafts—MJ/XJ Vehicles

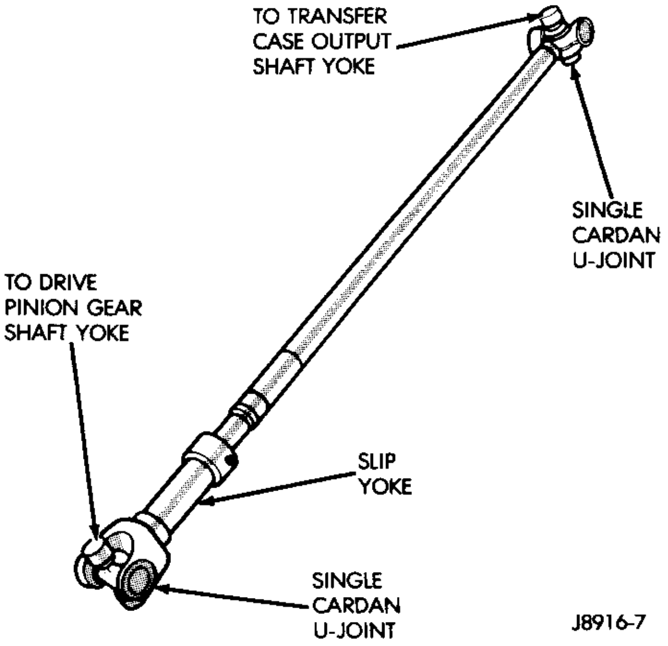


Fig. 7 Front Drive Shaft—YJ Vehicles

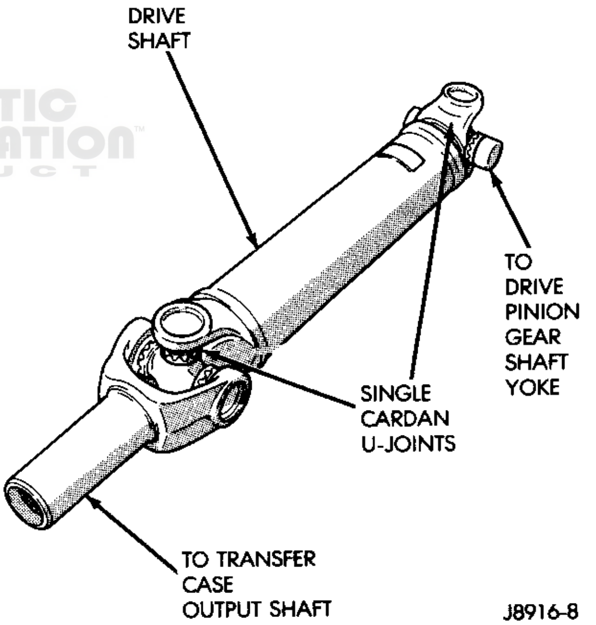


Fig. 8 Rear Drive Shaft—YJ Vehicles

DRIVE SHAFT SERVICE

INDEX

LUBRICATION

The drive shaft single cardan universal joints (U-joints) and the slip yokes are equipped with "Zerk" type lubrication fittings. The double cardan (CV) universal joints (U-joints) are permanently lubricated when assembled during manufacture and do not require additional lubrication during their service life. The slip yokes and U-joints should be lubricated at the specified periodic intervals with an extreme pressure (EP), lithium-base lubricant.

DRIVELINE VIBRATION

Causes

Driveline vibration can be caused by the drive shaft, drive pinion gear shaft (axle) yokes, universal joints, or an incorrect universal joint angle.

Vibration caused by the drive shaft(s) can be the result of:

- undercoating material on the drive shaft tube,
- missing drive shaft balance weight,
- excessive drive shaft runout,
- worn or damaged drive shaft yokes or U-joints,
- cracked seam welds at either end of the drive shaft, or
- dents or bends in the drive shaft tube.

Vibration from the drive pinion gear shaft yoke can be the result of:

- excessive yoke runout,
- loose clamp or strap bolts/screws or yoke retaining nut, or
- damaged yoke.

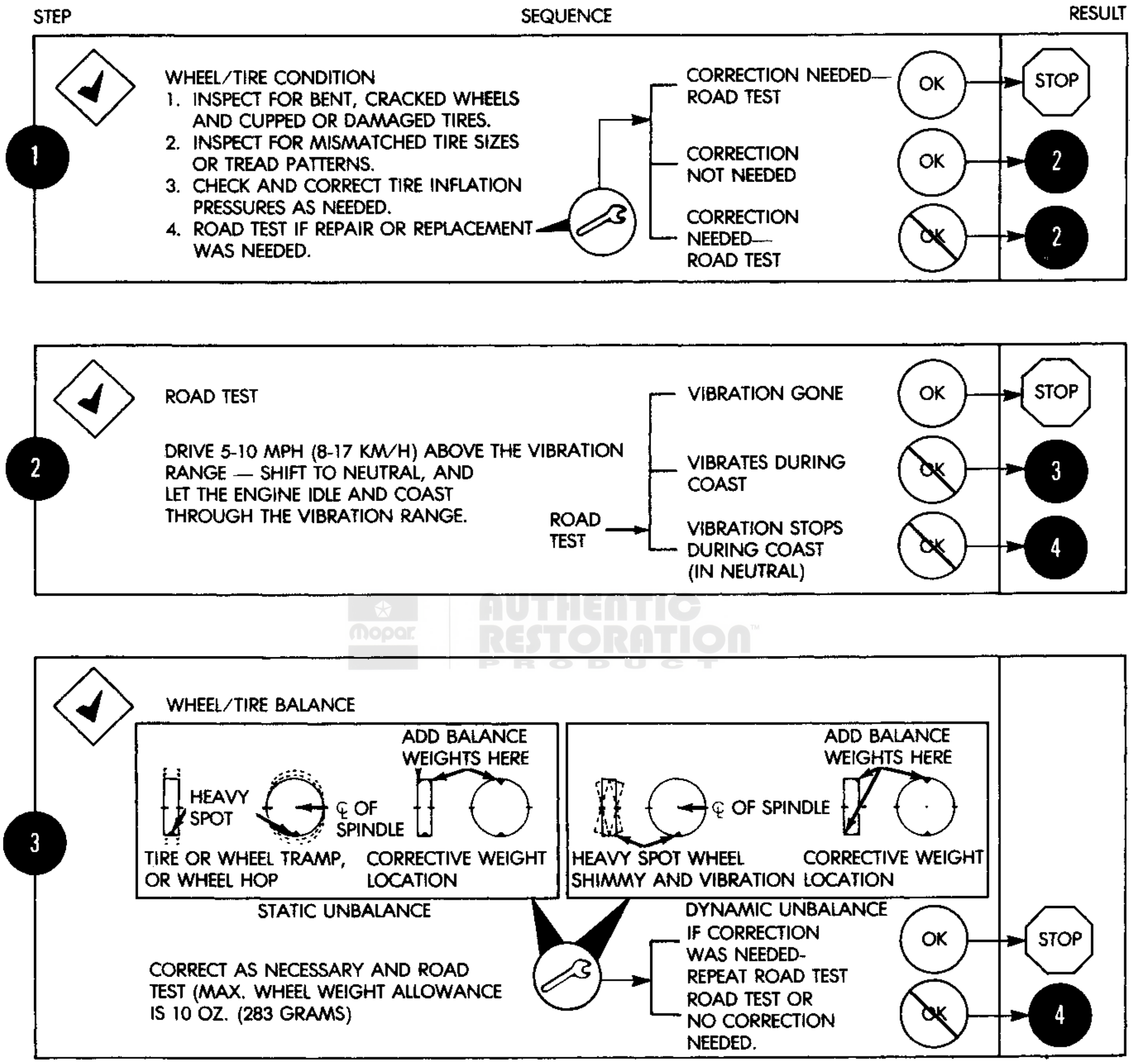
An incorrect U-joint angle can produce an out-of-phase condition in the U-joint that results in vibration at low or high vehicle speeds.

Driveline vibration can also result from loose or damaged engine mounts, or engine operated accessories. Also, loose or damaged crossmembers, support cushions and driveline retaining bolts/nuts can produce vibration. Refer to Group 22—Tires And Wheels for additional information involving vibration diagnosis.

Diagnosis

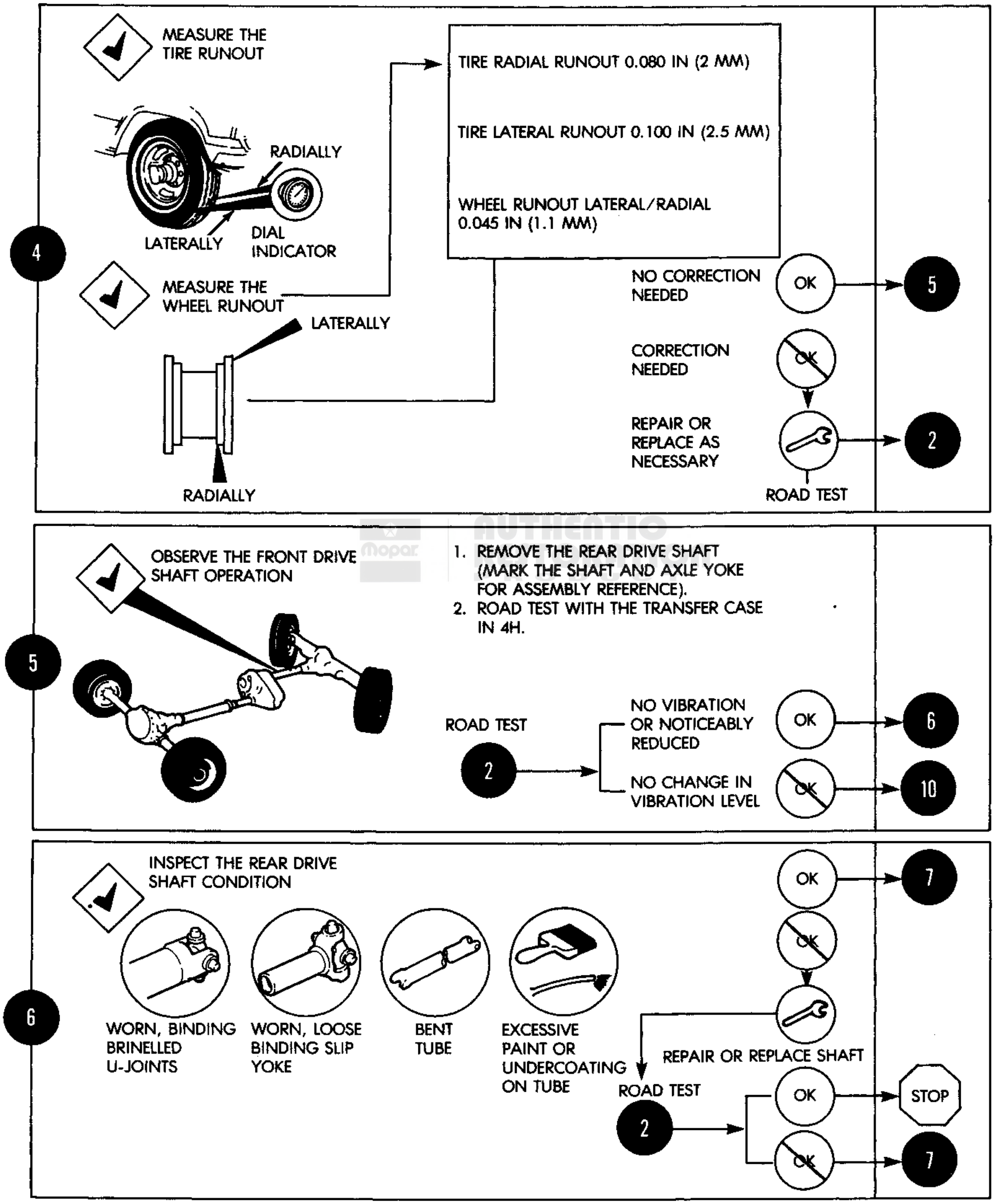
When a driveline vibration condition exists, do not initiate corrective action until the actual source of the vibration has been identified. This is very important if unnecessary or ineffective repairs are to be avoided. The following diagnosis charts will help to identify the most common causes of driveline vibration.

Driveline Vibration Diagnosis



J8916-11

Driveline Vibration Diagnosis (Cont'd)



TIRE RADIAL RUNOUT 0.080 IN (2 MM)

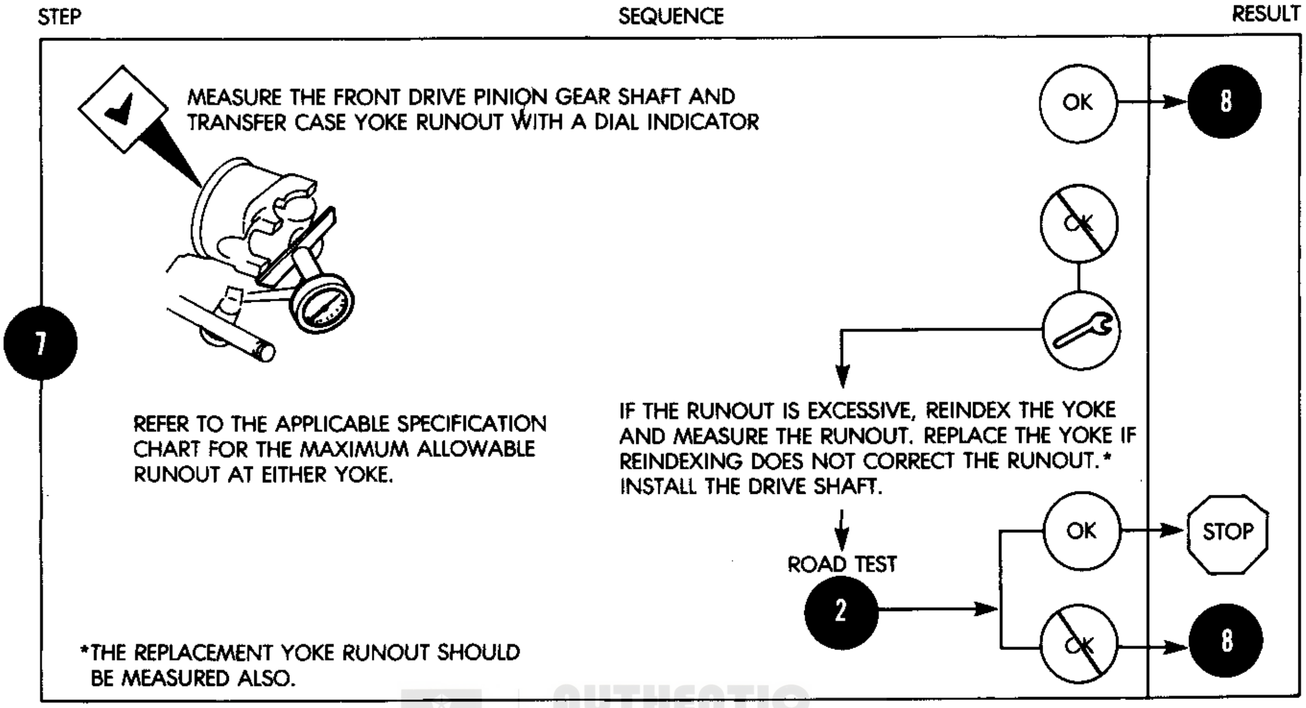
TIRE LATERAL RUNOUT 0.100 IN (2.5 MM)

WHEEL RUNOUT LATERAL/RADIAL 0.045 IN (1.1 MM)

1. REMOVE THE REAR DRIVE SHAFT (MARK THE SHAFT AND AXLE YOKE FOR ASSEMBLY REFERENCE).
2. ROAD TEST WITH THE TRANSFER CASE IN 4H.

J8916-12

Driveline Vibration Diagnosis (Cont'd)

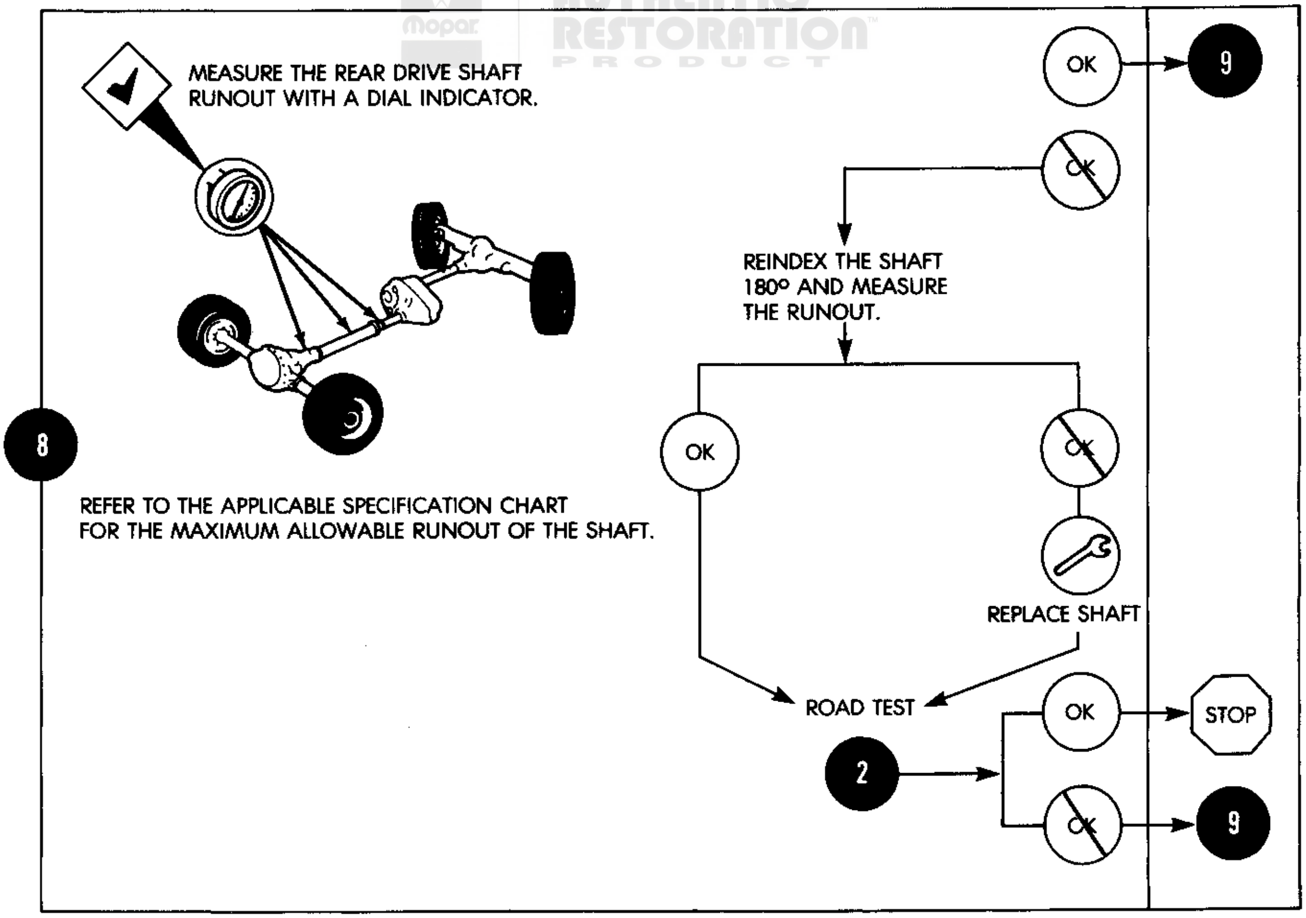


MEASURE THE FRONT DRIVE PINION GEAR SHAFT AND TRANSFER CASE YOKE RUNOUT WITH A DIAL INDICATOR

REFER TO THE APPLICABLE SPECIFICATION CHART FOR THE MAXIMUM ALLOWABLE RUNOUT AT EITHER YOKE.

IF THE RUNOUT IS EXCESSIVE, REINDEX THE YOKE AND MEASURE THE RUNOUT. REPLACE THE YOKE IF REINDEXING DOES NOT CORRECT THE RUNOUT.* INSTALL THE DRIVE SHAFT.

*THE REPLACEMENT YOKE RUNOUT SHOULD BE MEASURED ALSO.



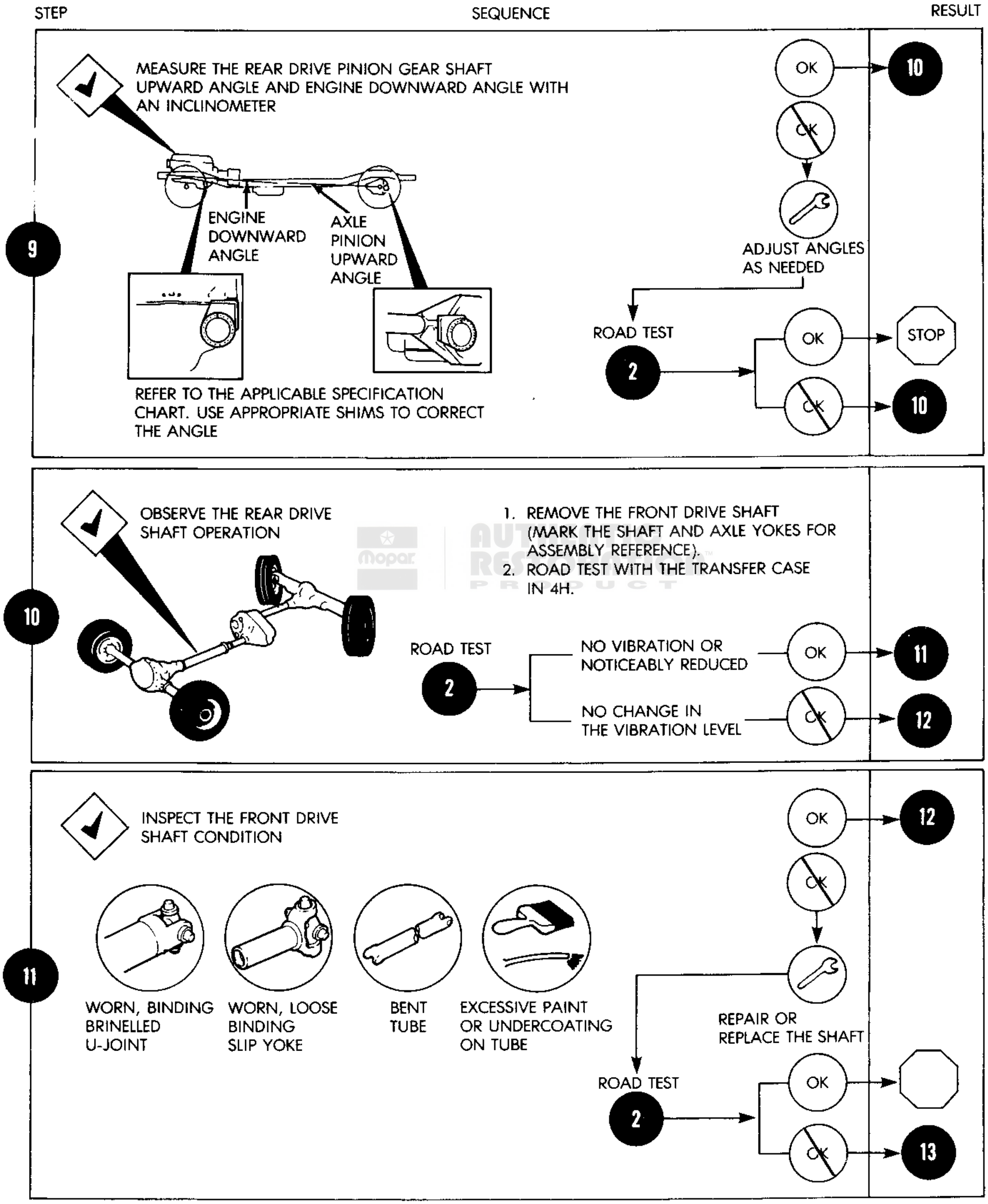
MEASURE THE REAR DRIVE SHAFT RUNOUT WITH A DIAL INDICATOR.

REFER TO THE APPLICABLE SPECIFICATION CHART FOR THE MAXIMUM ALLOWABLE RUNOUT OF THE SHAFT.

REINDEX THE SHAFT 180° AND MEASURE THE RUNOUT.

J8916-13

Driveline Vibration Diagnosis (Cont'd)



MEASURE THE REAR DRIVE PINION GEAR SHAFT UPWARD ANGLE AND ENGINE DOWNWARD ANGLE WITH AN INCLINOMETER

REFER TO THE APPLICABLE SPECIFICATION CHART. USE APPROPRIATE SHIMS TO CORRECT THE ANGLE

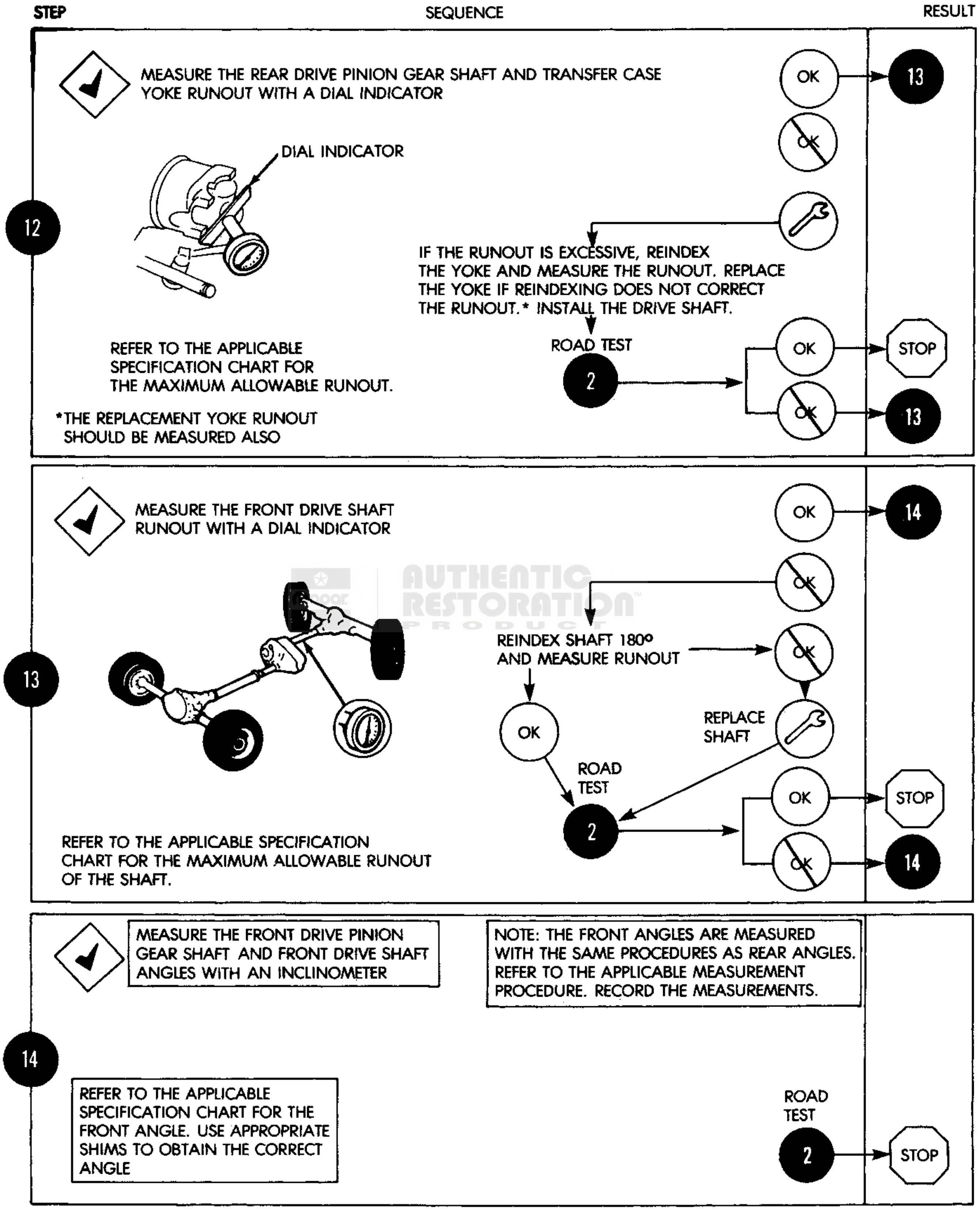
OBSERVE THE REAR DRIVE SHAFT OPERATION

1. REMOVE THE FRONT DRIVE SHAFT (MARK THE SHAFT AND AXLE YOKES FOR ASSEMBLY REFERENCE).
2. ROAD TEST WITH THE TRANSFER CASE IN 4H.

INSPECT THE FRONT DRIVE SHAFT CONDITION

J8916-14

Driveline Vibration Diagnosis (Cont'd)



MEASURE THE REAR DRIVE PINION GEAR SHAFT AND TRANSFER CASE YOKE RUNOUT WITH A DIAL INDICATOR

IF THE RUNOUT IS EXCESSIVE, REINDEX THE YOKE AND MEASURE THE RUNOUT. REPLACE THE YOKE IF REINDEXING DOES NOT CORRECT THE RUNOUT.* INSTALL THE DRIVE SHAFT.

REFER TO THE APPLICABLE SPECIFICATION CHART FOR THE MAXIMUM ALLOWABLE RUNOUT.

*THE REPLACEMENT YOKE RUNOUT SHOULD BE MEASURED ALSO

MEASURE THE FRONT DRIVE SHAFT RUNOUT WITH A DIAL INDICATOR

REINDEX SHAFT 180° AND MEASURE RUNOUT

REFER TO THE APPLICABLE SPECIFICATION CHART FOR THE MAXIMUM ALLOWABLE RUNOUT OF THE SHAFT.

MEASURE THE FRONT DRIVE PINION GEAR SHAFT AND FRONT DRIVE SHAFT ANGLES WITH AN INCLINOMETER

NOTE: THE FRONT ANGLES ARE MEASURED WITH THE SAME PROCEDURES AS REAR ANGLES. REFER TO THE APPLICABLE MEASUREMENT PROCEDURE. RECORD THE MEASUREMENTS.

REFER TO THE APPLICABLE SPECIFICATION CHART FOR THE FRONT ANGLE. USE APPROPRIATE SHIMS TO OBTAIN THE CORRECT ANGLE

J8916-15

Drive Shaft Runout Measurement

(1) Remove all dirt, rust, paint, and undercoating from the drive shaft surface areas where the dial indicator stylus will contact the surface of the shaft.

(2) The dial indicator must be installed perpendicular to the shaft surface and must be firmly attached to a fixed surface to prevent inaccurate measurements.

(3) Measure the drive shaft runout at the center and at both ends of the shaft with the dial indicator.

(4) Refer to the applicable Drive Shaft Runout Specifications chart.

(5) Replace the drive shaft if the runout exceeds the specified limit at either the front, center or rear of the shaft.

Drive Shaft Runout Specifications

SJ Vehicles

Front of shaft	0.015 in. (0.38 mm)
Center of shaft	0.015 in. (0.38 mm)
Rear of shaft	0.015 in. (0.38 mm)

NOTE: Measure front/rear runout approximately 3 inches (76 mm) from the weld seam at each end of the shaft tube.

J8916-16

Drive Shaft Runout Specifications

YJ Vehicles

Front of shaft	0.009 in. (0.25 mm)
Center of shaft	0.015 in. (0.38 mm)
Rear of shaft	0.009 in. (0.25 mm)

NOTE: Measure front/rear runout approximately 1/2 inch (1.3 cm) from the weld seam at each end of the shaft tube.

J8916-33

Drive Shaft Runout Specifications

MJ/XJ Vehicles

Front	(with welded yoke)	0.010 in. (0.25 mm)
	(with slip yoke)	0.020 in. (0.50 mm)
Center	(with welded yoke)	0.015 in. (0.38 mm)
	(with slip yoke)	0.020 in. (0.50 mm)
Rear	(with welded yoke)	0.010 in. (0.25 mm)
	(with slip yoke)	0.020 in. (0.50 mm)

NOTE: Front and rear measurements are taken 3 inches (76 mm) toward the middle from the weld circles.

J8916-17

U-Joint Angle Measurement and Adjustment

General Information

When engine torque is transferred via single cardan U-joints that are not in-line (i.e., operate at an angle), the angular velocities of the driving yoke and the driven yoke will be different. For a given engine speed, the driving yoke will rotate at a constant velocity while the velocity of the driven yoke will increase and decrease twice every revolution.

The variation in the velocity of the driven yoke is directly proportional to the operating angle of the U-joint (i.e., the larger the U-joint operating angle, the greater the variation in the velocity of the driven yoke).

If the variation in the angular velocity of the driven yoke is excessive, driveline vibration will occur. As a result, the U-joint operating angle(s) must be adjusted to minimize the vibration.

With certain Jeep vehicles equipped with Selec-Trac, an incorrect rear drive shaft U-joint angle will produce an audible-type vibration. The vibration produces a constant "booming" or "drone-like" sound that is most noticeable within the 40—50 mph (64—97 km/h) speed range.

When this vibration condition exists, the rear drive shaft U-joint and engine angles must be measured. If the angles are not within the specified limits, shims must be installed to correct the operating angle and minimize the vibration.

Front Measurement—SJ Vehicles

(1) Place the vehicle on a level surface.

(2) Position an inclinometer on the front drive shaft tube.

(3) Measure and record the front drive shaft downward incline angle.

(4) Remove the inclinometer.

(5) Position the inclinometer on the front differential housing.

(6) Measure and record the drive pinion gear shaft upward incline angle.

(7) Remove the inclinometer.

(8) If the drive pinion gear shaft upward incline angle is one degree more than the drive shaft downward incline angle, the drive pinion gear shaft angle is acceptable.

(9) If the drive pinion gear shaft upward incline angle is less than the drive shaft downward incline angle by more than one degree, an adjustment is necessary.

EXAMPLE—If the drive shaft angle is 7 degrees downward and the drive pinion gear shaft is 5 degrees upward, the drive pinion gear shaft angle must be adjusted upward 3 degrees. This will change the drive pinion gear shaft upward angle to 8 degrees, which provides the required 1 degree more than the drive shaft downward angle.

U-Joint Angles—SJ Vehicles

	Front		Rear	
	OK Range	Set-To	OK Range	Set-To
SJ Vehicles	+1° to −1° of Drive Shaft Angle	+1° of Drive Shaft Angle	−1° to +1° of Engine Angle	−1° of Engine Angle

J8916-18

Rear Measurement—SJ Vehicles

(1) Place the vehicle on a level surface.

(2) Measure the engine downward incline angle according to the following instructions:

- position the inclinometer in the fore and aft direction on the left side of the cylinder block adjacent to the transmission mating surface,
- use a mirror to view the inclinometer if necessary,
- measure and record the engine downward incline angle, and
- remove the inclinometer.

(3) Position the inclinometer at the left side of the rear differential housing on the flat, machined surface adjacent to the welded plug. **Ensure that the surface is free of weld flash.**

(4) Measure and record the drive pinion gear shaft upward incline angle.

(5) Remove the inclinometer.

(6) If the drive pinion gear shaft upward incline angle is one degree less than the engine downward incline angle, the drive pinion gear shaft angle is acceptable.

(7) If the drive pinion gear shaft upward incline angle is greater than the engine downward incline angle by more than one degree, an adjustment is necessary.

EXAMPLE—If the engine angle is 5 degrees downward and the drive pinion gear shaft is 7 degrees upward, the drive pinion gear shaft angle must be adjusted downward 3 degrees. This will change the drive pinion gear shaft upward angle to 4 degrees, which provides the required 1 degree less than the engine downward angle.

Angle Adjustment—SJ Vehicles

Adjust the front or rear drive pinion gear shaft angle at the front or rear springs with tapered shims. Tapered shims are commercially available from automotive parts supply sources.

(1) Raise the front or rear of the vehicle, as applicable, and place support stands under the frame.

(2) Position a hydraulic jack under the differential housing and raise the jack just enough to support the weight of the axle.

(3) Remove the front or rear wheels, as applicable.

(4) Loosen the spring U-bolt nuts.

(5) Install tapered shims (with the required degrees) between the springs and the axle spring brackets according to the following instructions:

- front spring (spring is mounted below the axle)—if the angle must be adjusted upward (i.e., increased), install the shims so that the thick end of each shim is facing the front of the vehicle;
- front spring (spring is mounted below the axle)—if the angle must be adjusted downward (i.e., decreased), install the shims so that the thick end of each shim is facing the rear of the vehicle;
- rear spring (spring is mounted above the axle)—if the angle must be adjusted upward (i.e., increased), install the shims so that the thick end of each shim is facing the front of the vehicle; and
- rear spring (spring is mounted above the axle)—if the angle must be adjusted downward (i.e., decreased), in-

stall the shims so that the thick end of each shim is facing the rear of the vehicle.

(6) Tighten the spring U-bolt nuts with 136 N•m (100 ft-lbs) torque.

(7) Remove the hydraulic jack, install the wheels, remove the support stands and lower the vehicle.

Front Angle Measurement—MJ/XJ Vehicles

(1) Before a measurement is initiated, the vehicle height should be measured and adjusted, if necessary.

(2) Measure from the top of the axle tubes to the frame rail located directly above the axles.

(3) The acceptable heights are:

- front axle—6.2 to 7.0 inches (157.5 to 177.8 mm) and
- rear axle—5.7 to 6.5 inches (144.5 to 165 mm).

Add 0.354 inch (9 mm) to all height measurements if the vehicle is equipped with P205/75RI5 tires, and add 0.787 inch (20 mm) to all height measurements if the vehicle is equipped with P215/75R15 tires.

(4) Measure the front drive shaft front U-joint angle according to the following instructions:

- shift the transmission and transfer case to their neutral positions;
- raise the vehicle on a twin post or a similar type hoist that will support the vehicle at the axles and allow the wheels to be turned;

If a drive-on type hoist is used, place support stands under each axle shaft tube and lower the hoist until the wheels turn freely.

- use Inclinometer Tool 7663 (J23498A) (Fig. 9) for the measurements;
- attach the inclinometer magnet (7663/J23498A) on the drive pinion gear shaft (axle) yoke bearing cap and note the angle; and

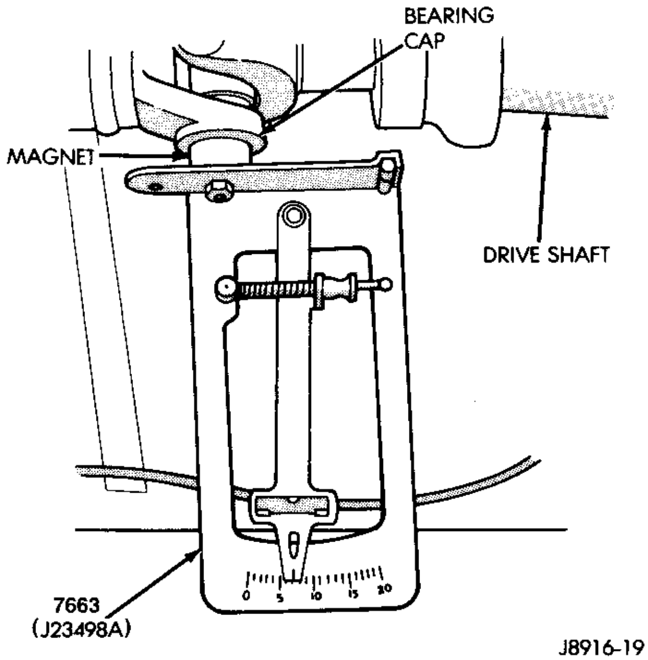


Fig. 9 Front U-Joint Angle Measurement

- rotate the drive shaft 90°, attach the inclinometer magnet (7663/J23498A) to the drive shaft yoke bearing cap and note the angle.

The inclinometer frame must face the same direction for both measurements.

(5) The difference between angle measurements taken at the front drive shaft front yoke and the drive pinion gear shaft (axle) yoke is the front universal joint angle **B** (Fig. 10).

(6) Refer to the specification chart; front U-joint angle **B** should be within the specified range.

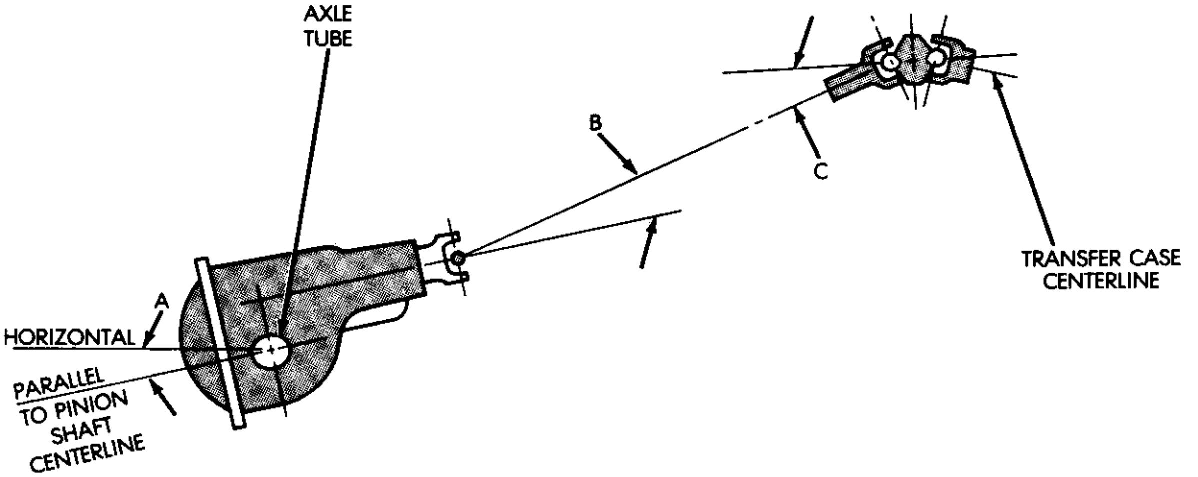


Fig. 10 Front Drive Shaft Angles

(7) If angle **B** is not within the specified range, adjust the front axle (i.e., drive pinion gear shaft angle **A**) at the lower suspension arms with shims to obtain the correct angle.

If front U-joint angle **B** and the vehicle height are correct, the drive pinion gear shaft angle **A** and the rear U-joint angle **C** should also be correct (Fig. 10).

Front Angle Adjustment—MJ/XJ Vehicles

Adjust the drive pinion gear shaft angle **A** at the lower suspension arms with shims (Fig. 11). Adding shims will decrease the pinion gear shaft angle **A** but will increase the caster angle. The pinion gear shaft angle **A** has priority over the caster angle if both cannot be adjusted to be within the specification ranges.

When pinion gear shaft angle **A**, U-joint angle **B** and the vehicle height are correct, the rear U-joint angle **C** will also be correct (Fig. 10).

Rear Angle Measurement—MJ/XJ Vehicles

(1) Before a measurement is initiated, the vehicle height should be measured and adjusted, if necessary.

(2) Measure from the top of the axle tubes to the frame rail located directly above the axles.

(3) The acceptable heights are:

- front axle—6.2 to 7.0 inches (157.5 to 177.8 mm) and
- rear axle—5.7 to 6.5 inches (144.5 to 165 mm).

Add 0.354 inch (9 mm) to all height measurements if the vehicle is equipped with P205/75RI5 tires, and add 0.787 inch (20 mm) to all height measurements if the vehicle is equipped with P215/75R15 tires.

(4) Measure the rear drive shaft rear U-joint angle according to the following instructions:

- shift the transmission to the neutral position;
- raise the vehicle on a twin post or a similar type hoist that will support the vehicle at the axles and allow the wheels to be turned;

If a drive-on type hoist is used, place support stands under each axle tube and lower the hoist until the wheels turn freely.

- use Inclinometer Tool 7663 (J23498A) (Fig. 12) for the measurements;
- attach the inclinometer magnet (7663/J23498A) to the drive pinion gear shaft (axle) yoke bearing cap and note the angle; and
- rotate the drive shaft 90°, attach the inclinometer magnet (7663/J23498A) to the rear drive shaft rear yoke bearing cap and note the angle.

The inclinometer frame must face the same direction for both measurements.

(5) The difference between angle measurements taken at the rear drive shaft rear yoke and the drive pinion gear shaft (axle) yoke is the rear universal joint angle **B** (Fig. 13).

(6) Refer to the specification chart. The rear U-joint angle **B** should be within the specified range.

(7) If the angle is not within the specified range, adjust the rear axle (i.e., the drive pinion gear shaft angle **C**) with tapered shims between the rear springs and the spring brackets to obtain the correct angle. Refer to the adjustment procedure.

If U-joint angle **B** and the vehicle height are correct, the drive pinion gear shaft angle **C** and the front U-joint angle **A** should also be correct (Fig. 13).

Rear Angle Adjustment—MJ/XJ Vehicles

Adjust the rear drive pinion gear shaft angle **C** at the rear springs with tapered shims. Tapered shims are commercially available from automotive parts supply sources.

(1) Raise the rear of the vehicle and place support stands under the frame.

(2) Position a hydraulic jack under the differential housing and raise the jack just enough to support the weight of the axle.

(3) Remove the rear wheels.

(4) Loosen the spring U-bolt nuts.

(5) Install tapered shims (with the required degrees) between the springs and the axle spring brackets according to the following instructions:

- MJ vehicles (spring is mounted below the axle)—if angle **B** (Fig. 13) must be adjusted upward (i.e., increased), install the shims so that the thick end of each shim is facing the front of the vehicle;
- MJ vehicles (spring is mounted below the axle)—if angle **B** (Fig. 13) must be adjusted downward (i.e., decreased), install the shims so that the thick end of each shim is facing the rear of the vehicle;
- XJ vehicles (spring is mounted above the axle)—if angle **B** (Fig. 13) must be adjusted upward (i.e., increased), install the shims so that the thick end of each shim is facing the front of the vehicle; and
- XJ vehicles (spring is mounted above the axle)—if angle **B** (Fig. 13) must be adjusted downward (i.e., decreased), install the shims so that the thick end of each shim is facing the rear of the vehicle.

(6) Tighten the spring U-bolt nuts with 70 N•m (52 ft-lbs) torque.

(7) Remove the hydraulic jack, install the wheels, remove the support stands and lower the vehicle.

When pinion gear shaft angle **C**, U-joint angle **B** and the vehicle height are correct, the front U-joint angle **A** will also be correct (Fig. 13).

Front Angle Measurement—YJ Vehicles

(1) Shift the transmission and transfer case into their Neutral positions.

Front Drive Shaft Angles—MJ/XJ Vehicles

VEHICLE SERIES — ROAD PACKAGE	ENGINE/TRANSMISSION/ TRANSFER CASE	ANGLE A	ANGLE B	ANGLE C
63 — Off Road	I6/Auto/231	2.0° to 2.5°	0° to 1.0°	−3.5° to −4.5°
65 — Off Road	I6/Auto/231	2.0° to 2.5°	0° to 1.0°	−3.5° to −4.5°
63 — Off Road	I6/Man/231	2.0° to 2.5°	0° to 1.0°	−3.5° to −4.5°
65 — Off Road	I6/Man/231	2.0° to 2.5°	0° to 1.0°	−3.5° to −4.5°
65 — Metric Ton	I6/Man or Auto/231	2.0° to 2.5°	0° to 1.0°	−3.5° to −4.5°
63 — Off Road	I4/Auto/231	2.0° to 2.5°	0.5° to 1.5°	−4.0° to −5.0°
65 — Off Road	I4/Auto/231	2.0° to 2.5°	0.5° to 1.5°	−4.0° to −5.0°
63 — On Road	I4/Man/231	1.5° to 2.0°	1.5° to 2.5°	−4.5° to −5.5°
63 — Off Road	I4/Man/231	2.0° to 2.5°	1.5° to 2.5°	−4.5° to −5.5°
65 — On Road	I4/Man/231	1.5° to 2.0°	1.5° to 2.5°	−4.5° to −5.5°
65 — Off Road	I4/Man/231	2.0° to 2.5°	1.5° to 2.5°	−4.5° to −5.5°
65 — Metric Ton	I4/Man/231	2.0° to 2.5°	1.5° to 2.5°	−4.5° to −5.5°
63 — On Road	I6/Auto/242	1.5° to 2.0°	0.5° to 1.5°	−0.5° to −3.5°
63 — On Road	I6/Man or Auto/231	1.5° to 2.0°	0.5° to 1.5°	−0.5° to −3.5°
65 — On Road	I6/Auto/242	1.5° to 2.0°	0.5° to 1.5°	−0.5° to −3.5°
65 — On Road	I6/Man or Auto/231	1.5° to 2.0°	0.5° to 1.5°	−0.5° to −3.5°
70 — On Road	I6/Man or Auto/231 or 242	1.0° to 2.0°	0.5° to 1.0°	−7.5° to −8.5°
70 — On Road	I4/Man or Auto/231 or 242	1.0° to 2.0°	0.5° to 1.0°	−7.5° to −8.5°
70 — Off Road	I6/Man/231	1.0° to 2.0°	0.5° to 1.5°	−8.0° to −9.0°
70 — Off Road	I4/Man/231	1.0° to 2.0°	0.5° to 1.5°	−8.0° to −9.0°
70 — Off Road	I6/Auto/231 or 242	1.0° to 2.0°	0.5° to 1.5°	−3.5° to −4.5°
70 — Off Road	I4/Auto/231 or 242	1.0° to 2.0°	0.5° to 1.5°	−3.5° to −4.5°

J8916-20

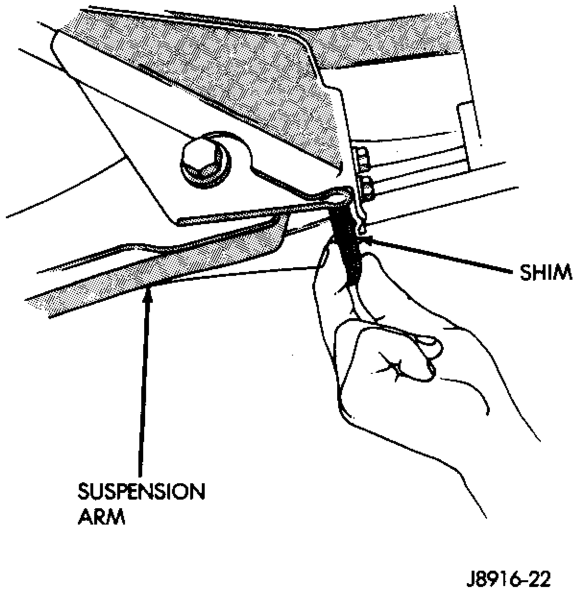


Fig. 11 Drive Pinion Gear Shaft Angle Adjustment

(2) Raise the vehicle on a twin post or a similar type hoist that will support the vehicle at the axles and allow the wheels to be rotated.

If a drive-on type hoist is used, place support stands under each axle tube and lower the hoist until the wheels rotate freely.

(3) Rotate the front drive shaft until one of the drive pinion gear shaft (axle) yoke bearing caps is facing downward.

(4) Attach the magnet of Inclinometer Tool 7663 (J23498A) on the bearing cap and note the angle (Fig. 14).

(5) Rotate the front drive shaft until one of the drive shaft slip yoke bearing caps is facing downward.

(6) Attach the inclinometer magnet to the bearing cap and note the angle.

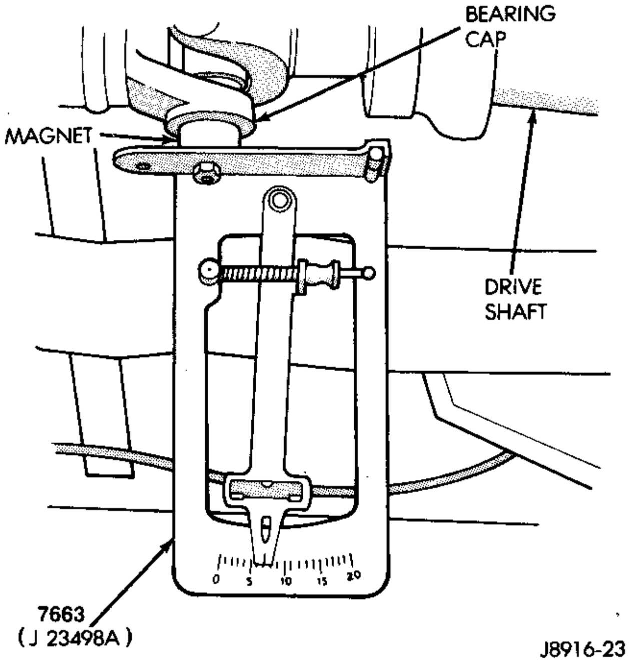


Fig. 12 Rear U-Joint Angle Measurement

The inclinometer frame must face the same direction for both measurements.

(7) The difference between the two angles is the U-joint front angle.

(8) Rotate the front drive shaft until one of the transfer case output shaft yoke bearing caps is facing downward.

(9) Attach the inclinometer magnet to the bearing cap and note the angle (Fig. 15).

(10) Rotate the front drive shaft until one of the drive shaft rear yoke bearing caps is facing downward.

(11) Attach the inclinometer magnet to the bearing cap and note the angle.

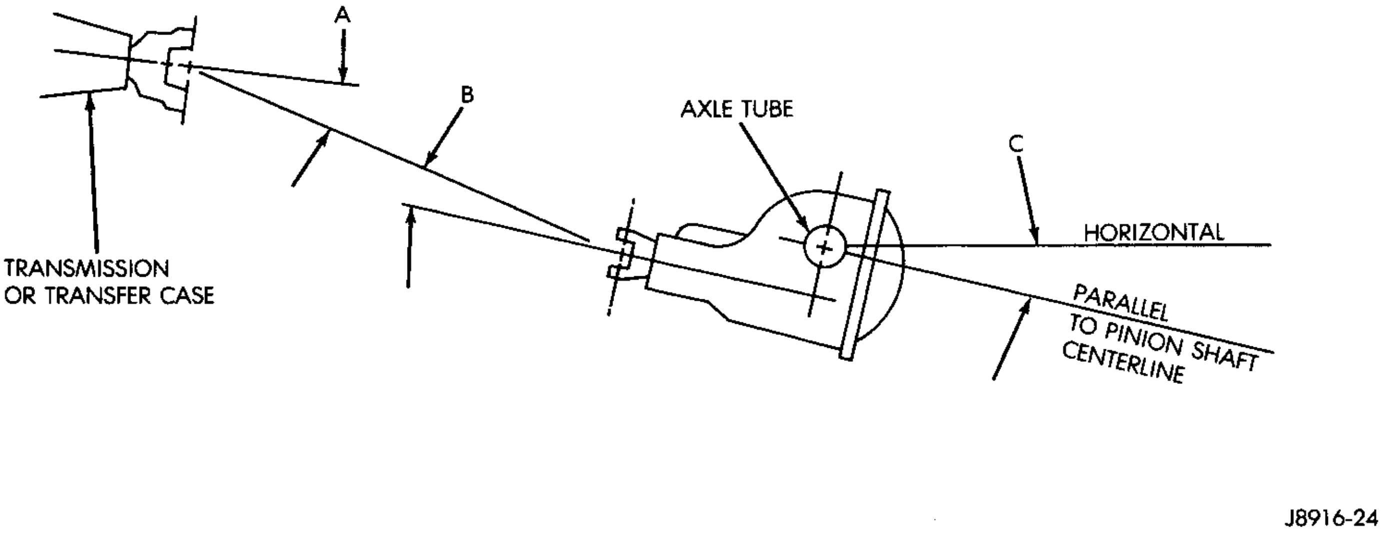


Fig. 13 Rear Drive Shaft Angles

Rear Drive Shaft Angles—MJ/XJ Vehicles

VEHICLE SERIES — ROAD PACKAGE	ENGINE/TRANSMISSION/ TRANSFER CASE OR 2WD	ANGLE A	ANGLE B	ANGLE C
64 — On Road-Std.	I4/Auto or Man/2WD	−1.0° to −2.0°	2.0° to 3.0°	4.5° to 5.5°
64 — On Road-Std.	I6/Auto or Man/2WD	−1.5° to −2.5°	2.5° to 3.5°	
63 — On Road-Std.	I4/Auto or Man/231	−2.5° to −3.5°	3.5° to 4.5°	
63 — Off Road-Std.	I4/Auto or Man/231	−2.5° to −3.5°	3.5° to 4.5°	
63 — On Road-Std.	I6/Auto/242 or Man/231	−3.5° to −4.5°	4.0° to 5.0°	
63 — Off Road-Std.	I6/Auto or Man/231	−3.5° to −4.5°	4.0° to 5.0°	
64 —On Road-H.D.	I6/Auto or Man/2WD	−1.5° to −2.5°	2.5° to 3.5°	
63 — On Road-H.D.	I6/Auto or Man/231	−3.0° to −4.0°	3.5° to 4.5°	
63 — Off Road-H.D.	I6/Auto/231	−3.0° to −4.0°	3.5° to 4.5°	
63 — Off Road-H.D.	I6/Man/231	−3.5° to −4.5°	4.0° to 5.0°	
66 — On Road-Std.	I4/Auto or Man/2WD	0° to −1.0°	0.5° to −0.5°	6.5° to 7.5°
66 — On Road-H.D.	I4/Man/2WD	−1.0° to −2.0°	0.5° to −0.5°	
66 — On Road-Std.	I6/Auto or Man/2WD	−1.0° to −2.0°	0.5° to −0.5°	
66 — On Road-H.D.	I6/Auto or Man/2WD	−1.5° to −2.5°	0.5° to −0.5°	
65 — On Road-Std.	I4/Auto or Man/231	−1.5° to −2.5°	0° to 1.0°	
65 — Off Road-Std.	I4/Auto or Man/231	−1.5° to −2.5°	0° to 1.0°	
65 — On Road-H.D.	I4/Man/231	−1.5° to −2.5°	0° to 1.0°	
65 — On Road-Std.	I6/Auto/242 or Man/231	−2.0° to −3.0°	0.5° to 1.5°	
65 — Off Road-Std.	I6/Auto or Man/231	−2.0° to −3.0°	0.5° to 1.5°	
65 — On Road-H.D.	I6/Auto or Man/231	−2.0° to −3.0°	0.5° to 1.5°	
70 — On Road-Std.	I6/Auto or Man/2WD	−2.0° to −3.0°	1.5° to 2.5°	5.5° to 6.5°
70 — On Road-Std.	I4/Auto or Man/2WD	−2.0° to −3.0°	1.5° to 2.5°	
70 — On Road-Std.	I6/Auto or Man/242 or 231	−2.5° to −3.5°	2.0° to 3.0°	
70 — On Road-Std.	I4/Auto or Man/231	−2.5° to −3.5°	2.0° to 3.0°	
70 — Off Road-H.D.	I6/Auto or Man/231	−4.0° to −5.0°	3.0° to 4.0°	
70 — Off Road-H.D.	I4/Auto or Man/231	−4.0° to −5.0°	3.0° to 4.0°	

J8916-25

(12) The difference between the two angles is the U-joint rear angle.

(13) Compare the U-joint front and rear angles. The difference between the two angles is the front drive shaft universal joint angle.

(14) The front drive shaft U-Joint angle should be:

- automatic transmission—0.5° to 2.5°,
- 2.5L engine/manual transmission—0.5° to 1.5°, and
- 4.2L engine/manual transmission—0° to 1°.

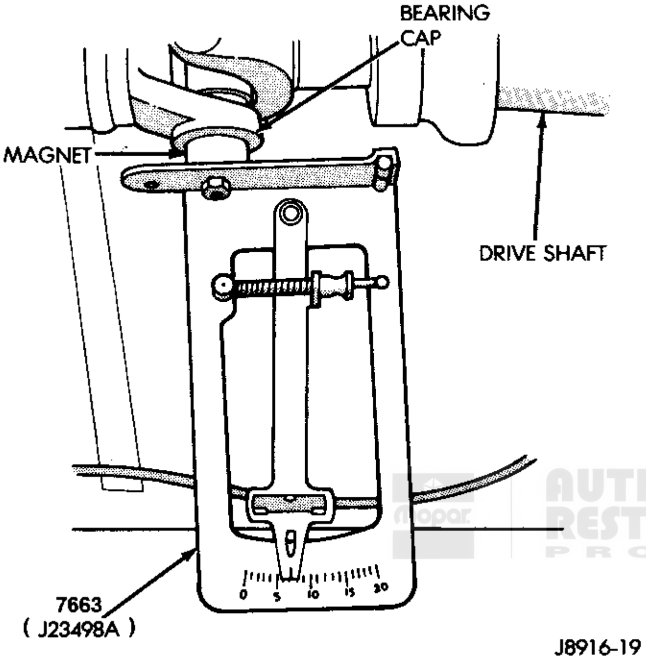


Fig. 14 U-Joint Front Angle Measurement

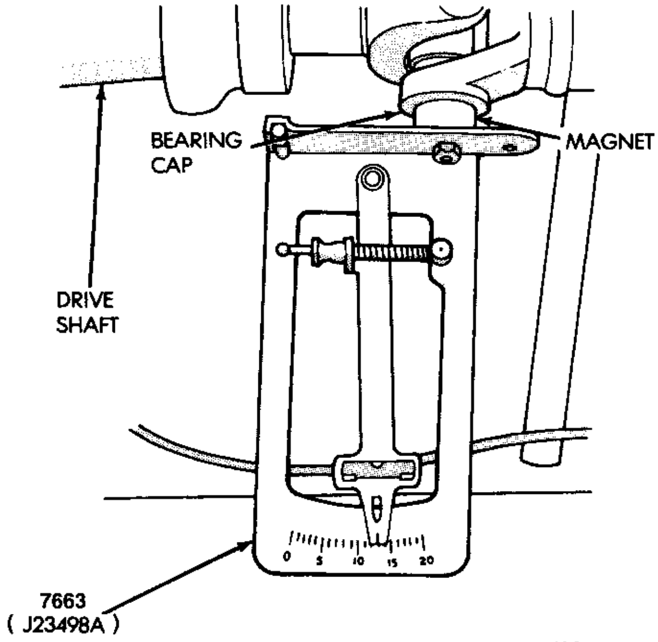


Fig. 15 U-Joint Rear Angle Measurement

If the angle is not within the specification range, the drive pinion gear shaft angle must be adjusted with tapered shims. Refer to the adjustment procedure.

(15) If the front drive shaft U-joint angle is correct, the drive pinion gear shaft angle should also be correct.

Rear Angle Measurement—YJ Vehicles

(1) Shift the transmission and transfer case into their Neutral positions.

(2) Raise the vehicle on a twin post or a similar type hoist that will support the vehicle at the axles and allow the wheels to be rotated.

If a drive-on type hoist is used, place support stands under each axle tube and lower the hoist until the wheels rotate freely.

(3) Rotate the rear drive shaft until one of the drive pinion gear shaft (axle) yoke bearing caps is facing downward.

(4) Attach the magnet of Inclinometer Tool 7663 (J23498A) on the bearing cap and note the angle (Fig. 16).

(5) Rotate the rear drive shaft until one of the drive shaft rear yoke bearing caps is facing downward.

(6) Attach the inclinometer magnet to the bearing cap and note the angle.

The inclinometer frame must face the same direction for both measurements.

(7) The difference between the two angles is the U-joint rear angle (Fig. 18).

(8) Rotate the rear drive shaft until one of the transfer case output shaft yoke bearing caps is facing downward.

(9) Attach the inclinometer magnet to the bearing cap and note the angle (Fig. 17).

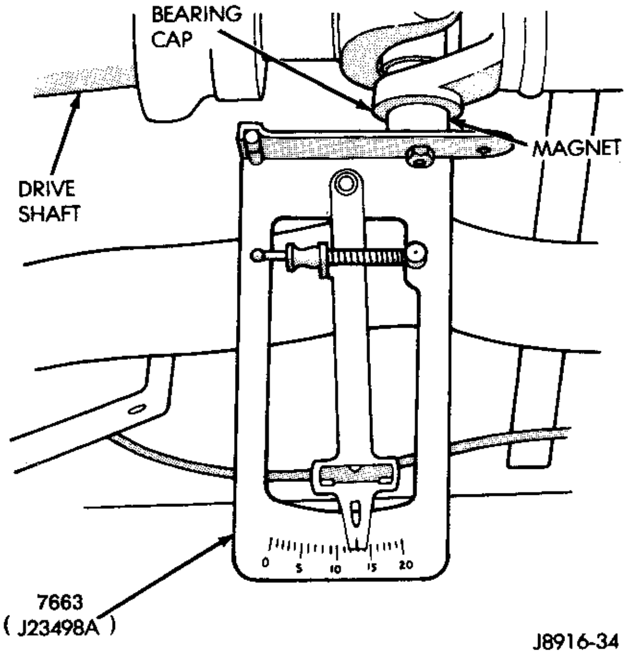


Fig. 16 U-Joint Rear Angle Measurement

(10) Rotate the rear drive shaft until one of the drive shaft front yoke bearing caps is facing downward.

(11) Attach the inclinometer magnet to the bearing cap and note the angle.

(12) The difference between the two angles is the U-joint front angle (Fig. 18).

(13) Compare the U-joint rear and front angles (Fig. 18). The difference between the two angles is the rear drive shaft U-joint angle.

(14) The rear drive shaft U-Joint angle should be:

- automatic transmission—0.5° to 1.5°,
- 2.5L engine/manual transmission—0° to 1°, and
- 4.2L engine/manual transmission—0.5° to 1.5°.

If the angle is not within the specification range, the drive pinion gear shaft angle must be adjusted with tapered shims. Refer to the adjustment procedure.

(15) If the front drive shaft U-joint angle is correct, the drive pinion gear shaft angle should also be correct.

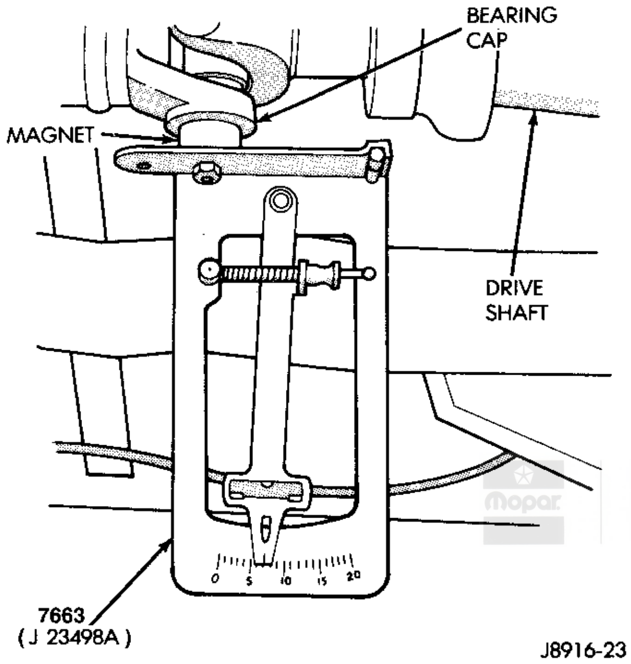


Fig. 17 U-Joint Front Angle Measurement

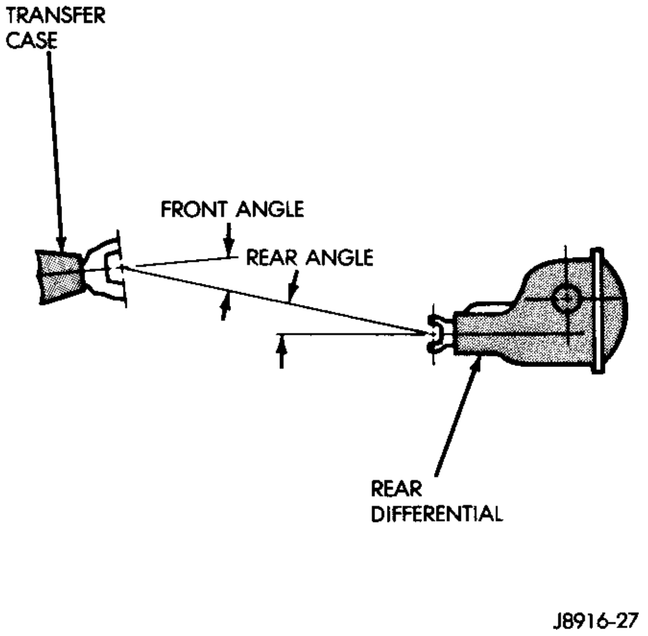


Fig. 18 U-Joint Angles

Angle Adjustment—YJ Vehicles

Adjust the front or rear drive pinion gear shaft angle at the front or rear springs with tapered shims. Tapered shims are commercially available from automotive parts supply sources.

(1) Raise the front or rear of the vehicle, as applicable, and place support stands under the frame.

(2) Position a hydraulic jack under the differential housing and raise the jack just enough to support the weight of the axle.

(3) Remove the front or rear wheels, as applicable.

(4) Loosen the spring U-bolt nuts.

(5) Install tapered shims (with the required degrees) between the springs and the axle spring brackets according to the following instructions:

- front spring (spring is mounted below the axle)—if the pinion gear shaft angle must be adjusted upward (i.e., increased), install the shims so that the thick end of each shim is facing the front of the vehicle;
- front spring (spring is mounted below the axle)—if the pinion gear shaft angle must be adjusted downward (i.e., decreased), install the shims so that the thick end of each shim is facing the rear of the vehicle;
- rear spring (spring is mounted below the axle)—if the pinion gear shaft angle must be adjusted upward (i.e., increased), install the shims so that the thick end of each shim is facing the front of the vehicle; and
- rear spring (spring is mounted below the axle)—if the pinion gear shaft angle must be adjusted downward (i.e., decreased), install the shims so that the thick end of each shim is facing the rear of the vehicle.

(6) Tighten the spring U-bolt nuts with 136 N•m (100 ft-lbs) torque.

(7) Remove the hydraulic jack, install the wheels, remove the support stands and lower the vehicle.

DRIVE SHAFT REMOVAL/INSTALLATION

Front Or Rear—SJ Vehicles

Removal

(1) Raise the vehicle.

(2) Scribe alignment marks on the yokes at the transfer case, at the drive pinion gear shaft and at each end of the drive shaft for installation reference.

(3) Disconnect the drive shaft at the transfer case and at the drive pinion gear shaft yokes (Fig. 19, Fig. 20). Remove the drive shaft.

Installation

(1) Position the drive shaft with the yoke installation reference marks aligned at the transfer case and at the drive pinion gear shaft (Fig. 19, Fig. 20). Install the drive shaft.

(2) Tighten the clamp strap screws with 22 N•m (16 ft-lbs) torque at drive pinion gear shaft and with 27 N•m (20 ft-lbs) torque at the transfer case.

(3) Lower the vehicle.

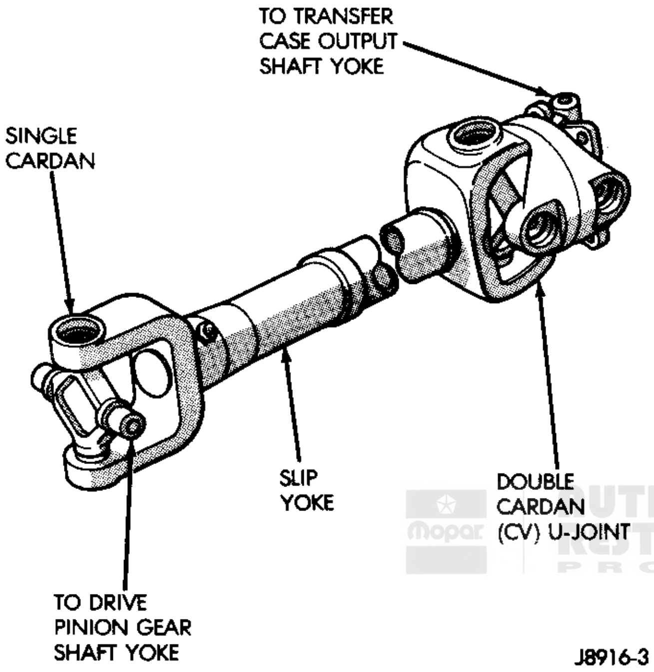


Fig. 19 Front Drive Shaft Removal/Installation

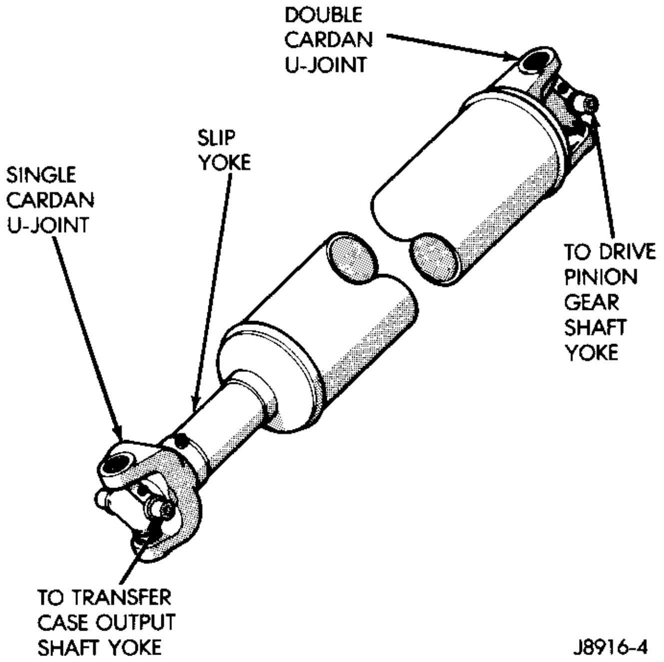


Fig. 20 Rear Drive Shaft Removal/Installation

Front—MJ/XJ Vehicles

Removal

(1) Raise the vehicle.

(2) Scribe alignment marks on the yokes at the transfer case, at the drive pinion gear shaft and at each end of the drive shaft for installation reference (Fig. 21).

(3) Remove the U-joint strap bolts at the drive pinion gear shaft (axle) yoke.

(4) Disconnect the drive shaft at the transfer case and remove the drive shaft.

Installation

(1) Position the drive shaft with the yoke installation reference marks aligned at the transfer case and the drive pinion gear shaft yokes (Fig. 21). Install the drive shaft.

Replacement U-joint straps and bolts must be installed.

(2) Tighten the U-joint strap bolts at the drive pinion gear shaft with 19 N•m (14 ft-lbs) torque and at the transfer case with 27 N•m (22 ft-lbs) torque.

(3) Lower the vehicle.

Rear—MJ/XJ Vehicles

Removal

(1) Shift the transmission and transfer case (if applicable) to their Neutral positions. Raise the vehicle.

(2) Scribe alignment marks on the yokes at the drive pinion gear shaft and on the drive shaft for installation reference (Fig. 22).

(3) Remove the U-joint strap bolts at the drive pinion gear shaft (axle) yoke.

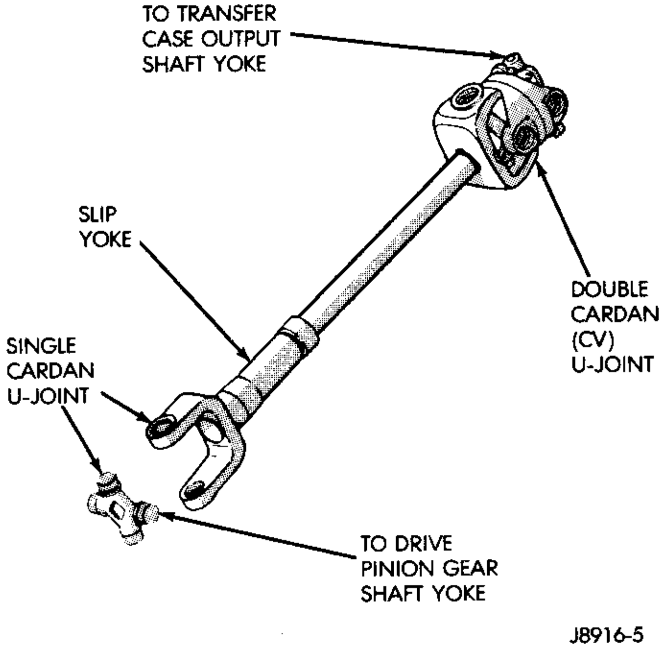


Fig. 21 Front Drive Shaft Removal/Installation

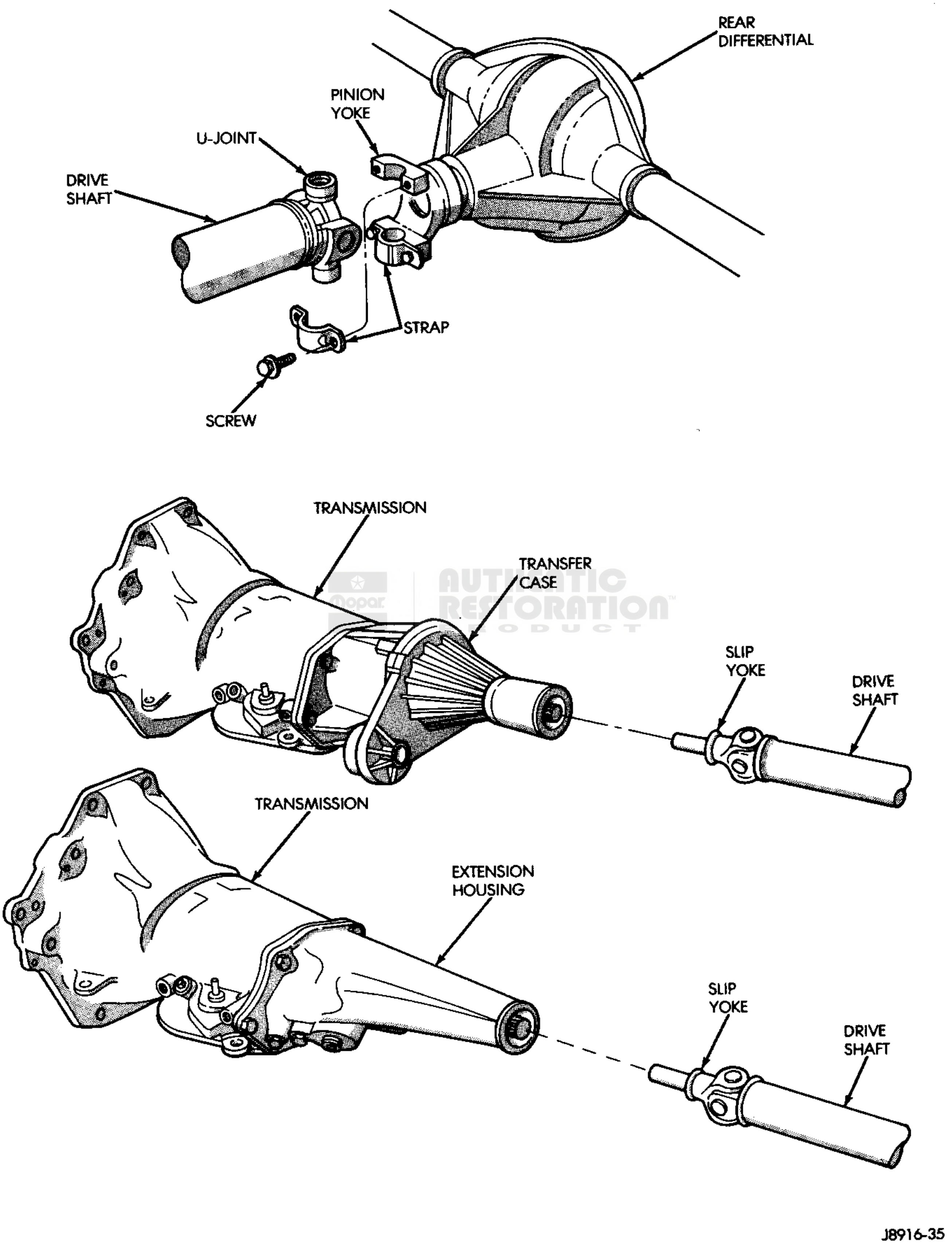


Fig. 22 Rear Drive Shaft Removal/Installation

(4) Slide the slip yoke off of the transmission/transfer case output shaft and remove the drive shaft (Fig. 22).

Installation

(1) Slide the slip yoke on the transmission/transfer case output shaft, align the installation reference marks at the drive pinion gear shaft yoke and install the drive shaft (Fig. 22).

Replacement U-joint straps and bolts must be installed.

(2) Tighten the U-joint strap bolts with 19 N•m (14 ft-lbs) torque.

(3) Lower the vehicle.

Front—YJ Vehicles

Removal

(1) Raise the vehicle.

(2) Scribe alignment marks on the yokes at the transfer case, at the drive pinion gear shaft and at each end of the drive shaft for installation reference (Fig. 23).

(3) Remove the U-joint strap bolts at the drive pinion gear shaft (axle) yoke.

(4) Disconnect the drive shaft at the transfer case and remove the drive shaft (Fig. 23).

Installation

(1) Position the drive shaft with the yoke installation reference marks aligned at the transfer case and the drive pinion gear shaft yokes (Fig. 23). Install the drive shaft.

Replacement U-joint straps and bolts must be installed.

(2) Tighten the U-joint strap bolts with 19 N•m (14 ft-lbs) torque.

(3) Lower the vehicle.

Rear—YJ Vehicles

Removal

(1) Shift the transmission and transfer case to their Neutral positions. Raise the vehicle.

(2) Scribe alignment marks on the yokes at the drive pinion gear shaft and at the rear of the drive shaft for installation reference (Fig. 24).

(3) Remove the U-joint strap bolts at the drive pinion gear shaft (axle) yoke.

(4) Slide the slip yoke off of the transfer case output shaft and remove the drive shaft (Fig. 24).

Installation

(1) Slide the slip yoke on the transfer case output shaft, align the installation reference marks at the drive pinion gear shaft yoke and install the drive shaft (Fig. 24).

Replacement U-joint straps and bolts must be installed.

(2) Tighten the U-joint strap bolts with 19 N•m (14 ft-lbs) torque.

(3) Lower the vehicle.

UNIVERSAL JOINT REPLACEMENT

Single Cardan U-Joint—Removal/Disassembly

Single cardan U-joints are not serviceable and, if defective, must be replaced as a unit. If the bearings, seals, spider or bearing caps are damaged or excessively worn, replace the complete U-joint.

(1) If not removed from the vehicle, remove the drive

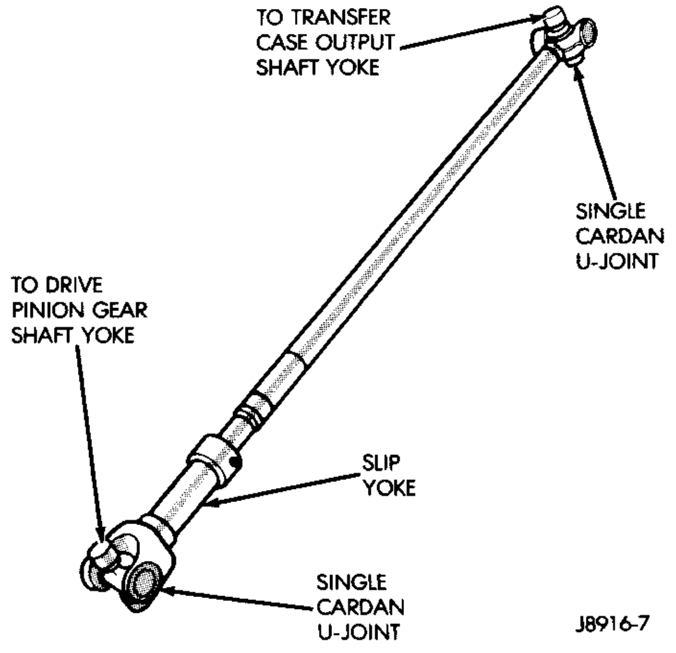


Fig. 23 Front Drive Shaft Removal/Installation

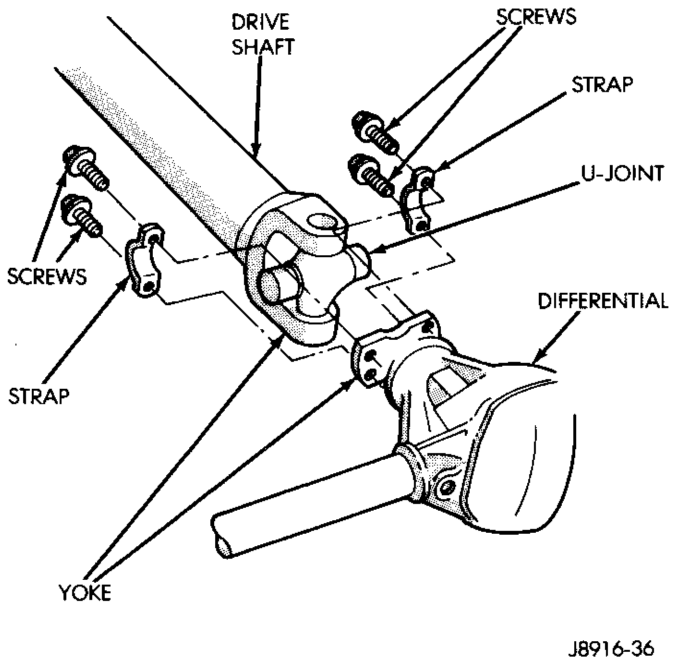


Fig. 24 Rear Drive Shaft Removal/Installation

shaft. Refer to the removal procedure.

(2) If a slip yoke U-joint is to be serviced, paint or score alignment marks on the slip yoke and drive shaft for installation reference. Remove the slip yoke from the drive shaft.

CAUTION: Do not clamp the slip yoke tube or drive shaft tube in a vise. Clamp only the forged portion of the slip yoke or drive shaft yoke in the vise. Also, to avoid distorting the yoke, do not over tighten the vise jaws.

(3) Position the drive shaft yoke in a vise and remove the bearing cap retaining clips (Fig. 25). Remove the drive shaft from the vise.

It can be helpful to saturate the bearing caps with penetrating oil prior to removal.

(4) Place a suitable size socket wrench (larger in diameter than the bearing cap) against the yoke and around the perimeter of the first bearing cap to be removed. This will be the bearing cap receiver. Place a socket wrench (slightly smaller in diameter than the yoke bore) against the opposite bearing cap. This will be the bearing cap driver. Position the yoke with the socket wrenches in a vise (Fig. 26).

(5) Compress the vise jaws until the smaller socket wrench (driver) forces the opposite bearing cap out of the yoke and into the larger socket wrench (receiver).

(6) Release the vise jaws, remove the socket wrenches and remove the bearing cap that was partially forced out of the yoke.

(7) Place the larger diameter socket wrench (receiver) against the yoke and around the perimeter of the remaining bearing cap. Place the smaller socket wrench (driver) against the spider and position the yoke with the socket wrenches in a vise (Fig. 26).

(8) Compress the vise jaws until the remaining bearing cap is forced out of the yoke.

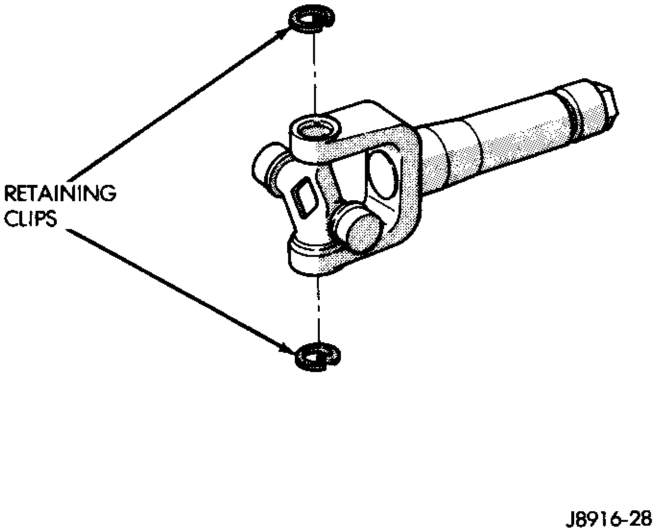


Fig. 25 Bearing Cap Retaining Clips

(9) Remove the yoke and socket wrenches from the vise.

(10) Remove the remaining bearing cap, bearings, seals and spider from the drive shaft yoke (Fig. 27).

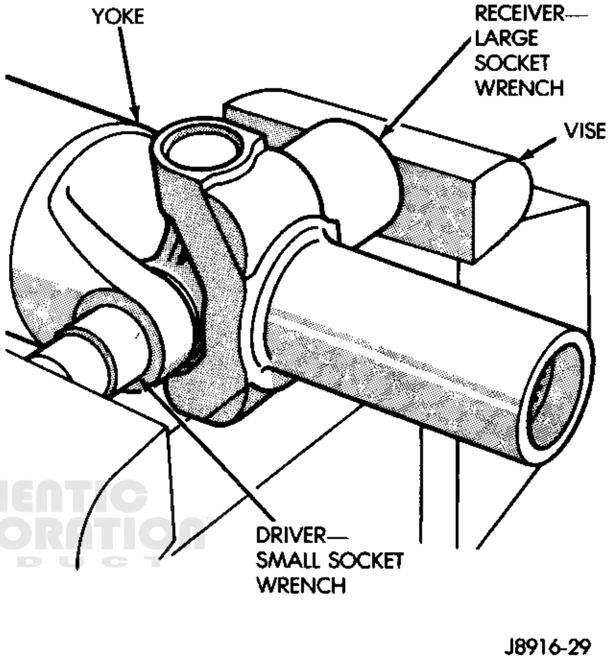


Fig. 26 Bearing Cap Removal

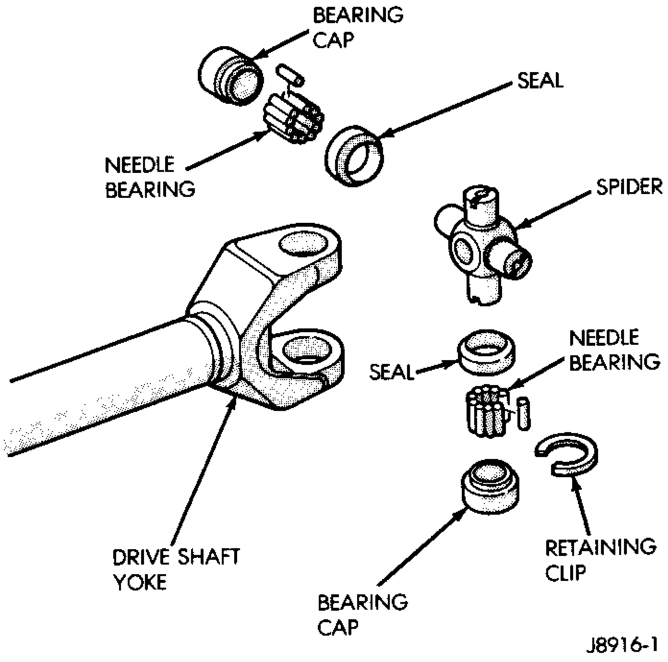


Fig. 27 Single Cardan U-Joint Disassembled

Single Cardan U-Joint—Cleaning And Inspection

Cleaning

(1) Clean the U-joint yoke bores with cleaning solvent and a wire brush. Ensure that all the rust and foreign matter are removed from the bores.

(2) Clean the bearing caps, bearings, seals and spider (Fig. 27) in cleaning solvent and wipe them dry with a shop cloth.

Inspection

(1) Inspect the bearing caps, bearings, and the bearing contact surfaces on the spider (Fig. 27) for evidence of "Brineling" (i.e., concave, spherical areas), excessive wear, flat spots, scoring and cracks.

(2) Replace the complete U-joint if any of the components are defective.

Single Cardan U-Joint—Assembly/Installation

(1) Apply extreme pressure (EP), lithium-base lubricant to the yoke bores, the bearing caps, the bearings, the seals and the bearing contact surfaces on the spider.

(2) Position the spider in the yoke, insert the seals and bearings, and tap the bearing caps into the yoke bores far enough to hold the spider in position (Fig. 27).

CAUTION: Do not clamp the drive shaft tube in a vise. Clamp only the forged portion of each yoke in the vise. Also, to avoid distorting a yoke, do not over tighten the vise jaws.

(3) For a driver, place a socket wrench (slightly smaller in diameter than the yoke bore) against one bearing cap and position the yoke with the socket wrench in a vise (Fig. 28).

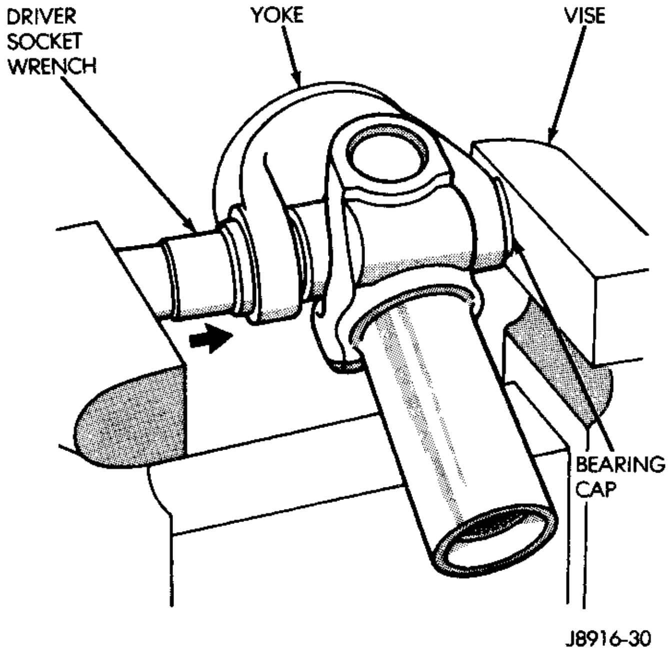


Fig. 28 Bearing Cap Installation

(4) Compress the vise (Fig. 28) and force the bearing caps into the yoke with the socket wrench (driver). Ensure that the caps are forced into the yoke bores far enough to expose the bearing cap retaining clip grooves.

(5) Install the bearing cap retaining clips (Fig. 25) after the bearing caps are completely seated.

(6) If applicable, install the slip yoke on the drive shaft with the reference marks aligned. Position the drive shaft with the yoke reference marks aligned and install it with replacement U-joint straps and screws/bolts.

(7) Tighten the strap screws/bolts:

- SJ vehicles with 22 N•m (16 ft-lbs) torque,
- MJ/XJ vehicles with 19 N•m (170 in-lbs) torque, and
- YJ vehicles with 19 N•m (170 in-lbs) torque.

(8) Lower the vehicle.

Double Cardan (CV) U-Joint—Removal/Disassembly

Double cardan (CV) U-joints are not serviceable and, if defective, must be replaced as a unit. If the socket yoke, ball, spring, bearings, seals, thrust washers, spiders or bearing caps are damaged or excessively worn, do not disassemble; replace the complete U-joint.

(1) If not removed from the vehicle, remove the drive shaft. Refer to the removal procedure.

(2) Score alignment marks or identify, as applicable, the yokes, spiders and bearing caps for installation reference.

CAUTION: Do not clamp the drive shaft tube in a vise. Clamp only the forged portion of each yoke in the vise. Also, to avoid distorting a yoke, do not over tighten the vise jaws.

(3) Remove all the bearing cap retaining clips.

(4) Remove the bearing caps that retain the **front** spider in the drive shaft link yoke (Fig. 30):

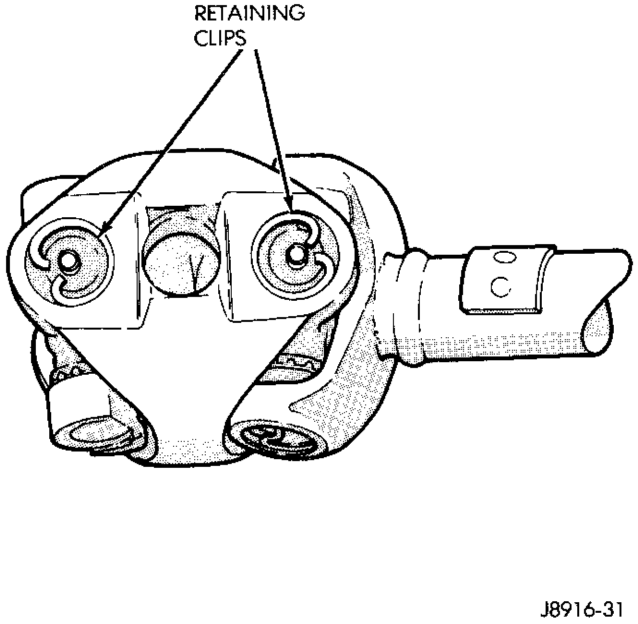


Fig. 29 Bearing Cap Retaining Clips

It can be helpful to saturate the bearing caps with penetrating oil prior to removal.

- place a suitable size socket wrench (larger in diameter than the bearing cap) against the link yoke and around the perimeter of the first bearing cap to be removed;
- this will be the bearing cap receiver;
- place a socket wrench (slightly smaller in diameter than the link yoke bore) against the opposite bearing cap;
- this will be the bearing cap driver;
- position the link yoke with the socket wrenches in a vise;
- compress the vise jaws until the smaller socket wrench (driver) forces the opposite bearing cap out of the link yoke and into the larger socket wrench (receiver);
- release the vise jaws, remove the socket wrenches and remove the bearing cap that was partially forced out of the yoke;
- place the larger diameter socket wrench (receiver) against the link yoke and around the perimeter of the remaining bearing cap;
- place the smaller socket wrench (driver) against the spider and position the link yoke with the socket wrenches in a vise;
- compress the vise jaws until the remaining bearing cap is forced out of the link yoke; and
- remove the link yoke and socket wrenches from the vise.

(5) Detach the link yoke from the drive shaft yoke (Fig. 30).

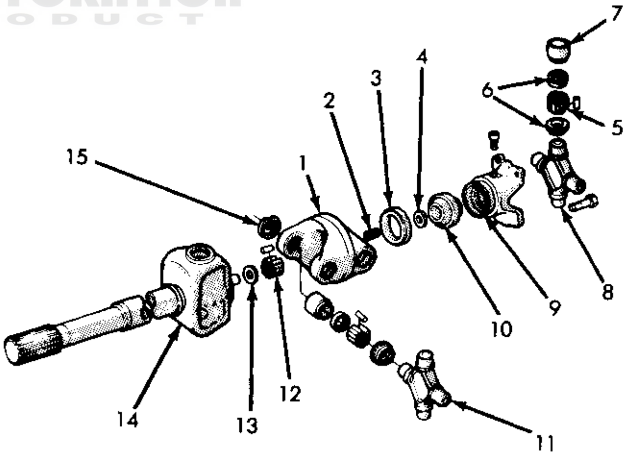
(6) Remove the bearing caps that retain the **rear** spider in the link yoke (Fig. 30):

- place a suitable size socket wrench (larger in diameter than the bearing cap) against the link yoke and around the perimeter of the first bearing cap to be removed;
- place a socket wrench (slightly smaller in diameter than the link yoke bore) against the opposite bearing cap;
- position the link yoke with the socket wrenches in a vise;
- compress the vise jaws until the smaller socket wrench (driver) forces the opposite bearing cap out of the link yoke and into the larger socket wrench (receiver);
- release the vise jaws, remove the socket wrenches and remove the bearing cap that was partially forced out of the yoke;
- place the larger diameter socket wrench (receiver) against the link yoke and around the perimeter of the remaining bearing cap;
- place the smaller socket wrench (driver) against the spider and position the link yoke with the socket wrenches in a vise;
- compress the vise jaws until the remaining bearing cap is forced out of the link yoke; and
- remove the link yoke and socket wrenches from the vise.

(7) Remove the rear spider and socket yoke from the link yoke (Fig. 30).

(8) Remove the bearing caps that retain the **front** spider in the drive shaft yoke (Fig. 30):

- place a suitable size socket wrench (larger in diameter than the bearing cap) against the yoke and around the perimeter of the first bearing cap to be removed;
- place a socket wrench (slightly smaller in diameter than the yoke bore) against the opposite bearing cap;
- position the yoke with the socket wrenches in a vise;
- compress the vise jaws until the smaller socket wrench (driver) forces the opposite bearing cap out of the yoke and into the larger socket wrench (receiver);
- release the vise jaws, remove the socket wrenches and remove the bearing cap that was partially forced out of the yoke;
- place the larger diameter socket wrench (receiver) against the yoke and around the perimeter of the remaining bearing cap;
- place the smaller socket wrench (driver) against the spider and position the yoke with the socket wrenches in a vise;
- compress the vise jaws until the remaining bearing cap is forced out of the yoke; and



1. LINK YOKE
2. SOCKET SPRING
3. SOCKET BALL RETAINER
4. THRUST WASHER
5. NEEDLE BEARINGS
6. SEAL
7. BEARING CAP
8. REAR SPIDER
9. SOCKET YOKE
10. SOCKET BALL
11. FRONT SPIDER
12. SOCKET NEEDLE BEARINGS
13. THRUST WASHER
14. DRIVE SHAFT YOKE
15. RETAINING CLIP

J8916-2

Fig. 30 Double Cardan (CV) U-Joint Disassembled

- remove the yoke and socket wrenches from the vise.

(9) Remove the front spider from the drive shaft yoke (Fig. 30).

Double Cardan (CV) U-Joint—Cleaning And Inspection

Cleaning

(1) Clean all the U-joint yoke bores with cleaning solvent and a wire brush. Ensure that all the rust and foreign matter are removed from the bores.

(2) Clean the bearing caps and spiders (Fig. 30) in cleaning solvent and wipe them dry with a shop cloth.

Inspection

(1) Inspect the bearing caps, bearings, and the bearing contact surfaces on the spiders (Fig. 30) for evidence of "Brinelling" (i.e., brittleness), excessive wear, flat spots, scoring and cracks.

(2) Inspect the yokes for distortion, cracks and worn bearing cap bores.

(3) Replace the complete U-joint if any of the components are defective.

Double Cardan (CV) U-Joint—Assembly/ Installation

When installing the U-joint components, ensure that the spiders and yokes are aligned according to the reference marks.

(1) Apply extreme pressure (EP), lithium-base lubricant to the yoke bores, the bearing caps, the bearings, the seals and the bearing contact surfaces on the spider.

(2) Position the bearing caps on the ends of the **rear** spider that mate with the transfer case yoke. Retain the caps on the spider with tape.

(3) Assemble the socket yoke and rear spider (Fig. 30).

(4) Position the rear spider in the link yoke and insert the bearing caps in the yoke bores. Tap the bearing caps into the yoke bores far enough to hold the rear spider in position.

CAUTION: Do not clamp the drive shaft tube in a vise. Clamp only the forged portion of each yoke in the vise. Also, to avoid distorting a yoke, do not over tighten the vise jaws.

(5) For a driver, place a socket wrench (slightly smaller in diameter than the link yoke bore) against one bearing cap and position the link yoke with the socket wrench in a vise.

Ensure that the caps are forced far enough into the link yoke bores to expose the bearing cap retaining clip grooves.

(6) Compress the vise and force the bearing caps into the link yoke bores with the socket wrench (driver).

(7) Install the bearing cap retaining clips after the bearing caps are completely seated in the bores.

(8) Position the **front** spider in the drive shaft yoke and insert the bearing caps in the yoke bores. Tap the bearing caps into the yoke bores far enough to hold the front spider in position.

(9) For a driver, place a socket wrench (slightly smaller in diameter than the drive shaft yoke bore) against one bearing cap and position the drive shaft yoke with the socket wrench in a vise.

Ensure that the caps are forced far enough into the drive shaft yoke bores to expose the bearing cap retaining clip grooves.

(10) Compress the vise and force the bearing caps into the drive shaft yoke bores with the socket wrench (driver).

(11) Install the bearing cap retaining clips after the bearing caps are completely seated in the bores.

(12) Install the thrust washer on the ball socket bearing boss (located on the drive shaft yoke), if removed.

(13) Align the ball socket bearing boss with the ball socket bearing bore (in the drive shaft yoke) and insert the boss in the bore (Fig. 30).

(14) Position the **front** spider in the link yoke bores and insert the bearing caps in the link yoke bores. Tap the bearing caps into the yoke bores far enough to hold the front spider in position.

(15) For a driver, place a socket wrench (slightly smaller in diameter than the link yoke bore) against one bearing cap and position the link yoke with the socket wrench in a vise.

Ensure that the caps are forced far enough into the link yoke bores to expose the bearing cap retaining clip grooves.

(16) Compress the vise and force the bearing caps into the link yoke bores with the socket wrench (driver).

(17) Install the bearing cap retaining clips (Fig. 29) after the bearing caps are completely seated in the bores.

(18) Position the drive shaft with the yoke reference marks aligned and install it with replacement U-joint straps and screws/bolts.

(19) Tighten the strap screws/bolts:

- SJ vehicles with 22 N•m (16 ft-lbs) torque at the drive pinion gear shaft and 27 N•m (20 ft-lbs) torque at the transfer case,
- MJ/XJ vehicles with 19 N•m (14 ft-lbs) torque at both ends, and
- YJ vehicles with 19 N•m (14 ft-lbs) torque at both ends.

(20) Lower the vehicle.

SPECIFICATIONS

Torque Specifications

Component	Service Set-To Torque	Service Recheck Torque
Drive Shaft Yoke Strap Bolt-to-Axle Yoke MJ/XJ and YJ Vehicles)	19 N•m (14 ft-lbs)	16-22 N•m (12-16 ft-lbs)
Slip Yoke Nut	74 N•m (55 ft-lbs)	68-81 N•m (50-60 ft-lbs)
Spring U-Bolt Nut (SJ Vehicles)		
9/16-18	136 N•m (100 ft-lbs)	115-142 N•m (85-105 ft-lbs)
1/2-20	122 N•m (90 ft-lbs)	108-136 N•m (80-100 ft-lbs)
Leaf Spring U-Bolt Nut (XJ Vehicles)	70 N•m (52 ft-lbs)	60-80 N•m (44-59 ft-lbs)
Leaf Spring U-Bolt Nut (MJ Vehicles)	88 N•m (65 ft-lbs)	82-95 N•m (60-70 ft-lbs)
Spring U-Bolt Nut (YJ Vehicles)	136 N•m (100 ft-lbs)	115-142 N•m (85-105 ft-lbs)
Drive Shaft Strap Screw (SJ Vehicles)		
At Drive Pinion Gear Shaft	22 N•m (16 ft-lbs)	22-26 N•m (16-19 ft-lbs)
At Transfer Case	27 N.m (20 ft-lbs)	23-31 N.m (17-23 ft-lbs)

J9016-1

SPRINGS/SHOCK ABSORBERS

CONTENTS

GENERAL INFORMATION

INDEX

SUSPENSION SYSTEM DESCRIPTIONS

SJ Vehicles

SJ vehicles are equipped with semi-elliptic, tapered, multi-leaf springs and dual-action, hydraulic shock absorbers at both the front and rear of the vehicle (Fig.1 and 2). A front axle stabilizer bar (refer to Group 2—Front Suspension for service information) and a front and rear axle track bar are also utilized.

The front and rear springs are both located parallel to the frame side rails. The forward end of the front springs and the rear end of the rear springs are attached to the frame by pivoting shackles. The opposite spring ends are attached to the frame by fixed pivot bolts. All the spring ends have silent-block type rubber bushings that do not require lubrication.

The front springs (Fig. 1) are mounted below the front axle and the rear springs (Fig. 2) are mounted above the rear axle.

The shock absorbers are designed to dampen vehicle body movement. The shock absorber upper ends are attached to brackets located on the frame rails. The lower ends are attached to the axle shaft tube brackets. Rubber bushings are inserted in the shock absorber eyes to dampen out road shock and noise.

SJ vehicles are also equipped with frame-mounted jounce bumpers located at the front and rear of the vehicle. The bumpers are attached to the underside of the frame and are positioned above and in-line with the axle tubes.

MJ/XJ Vehicles

Two coil springs and dual-action, hydraulic shock absorbers are used with the front suspension system for MJ/XJ vehicles (Fig. 3). In addition, a track bar and stabilizer bar are utilized with the front suspension system (refer to Group 2—Front Suspension for service information).

Two tapered, multi-leaf springs and dual-action, hydraulic shock absorbers are used with the rear suspension system (Fig. 4 and 5). A stabilizer bar is also utilized with the rear suspension system for XJ vehicles.

The hydraulic shock absorbers are designed to dampen vehicle body movement. At the top, the front shock absorbers are insulated with rubber grommets (Fig. 3) and are attached to the shock tower. At the bottom, they are attached to the axle shaft tube bracket.

The top of the rear shock absorbers is attached to either the crossmember (XJ vehicles) or to the frame (MJ vehicles). The bottom of the rear shock absorbers is attached either to the axle shaft tube bracket (XJ vehicles) or to the spring bracket (MJ vehicles). Rubber bushings are inserted in the attaching eyes to dampen road shock and noise (Fig. 4 and 5).

All MJ/XJ vehicles are equipped with frame-mounted jounce bumpers located at the rear of the vehicle. The bumpers are attached to the underside of the frame rail/frame and are positioned above and in-line with the axle tubes.

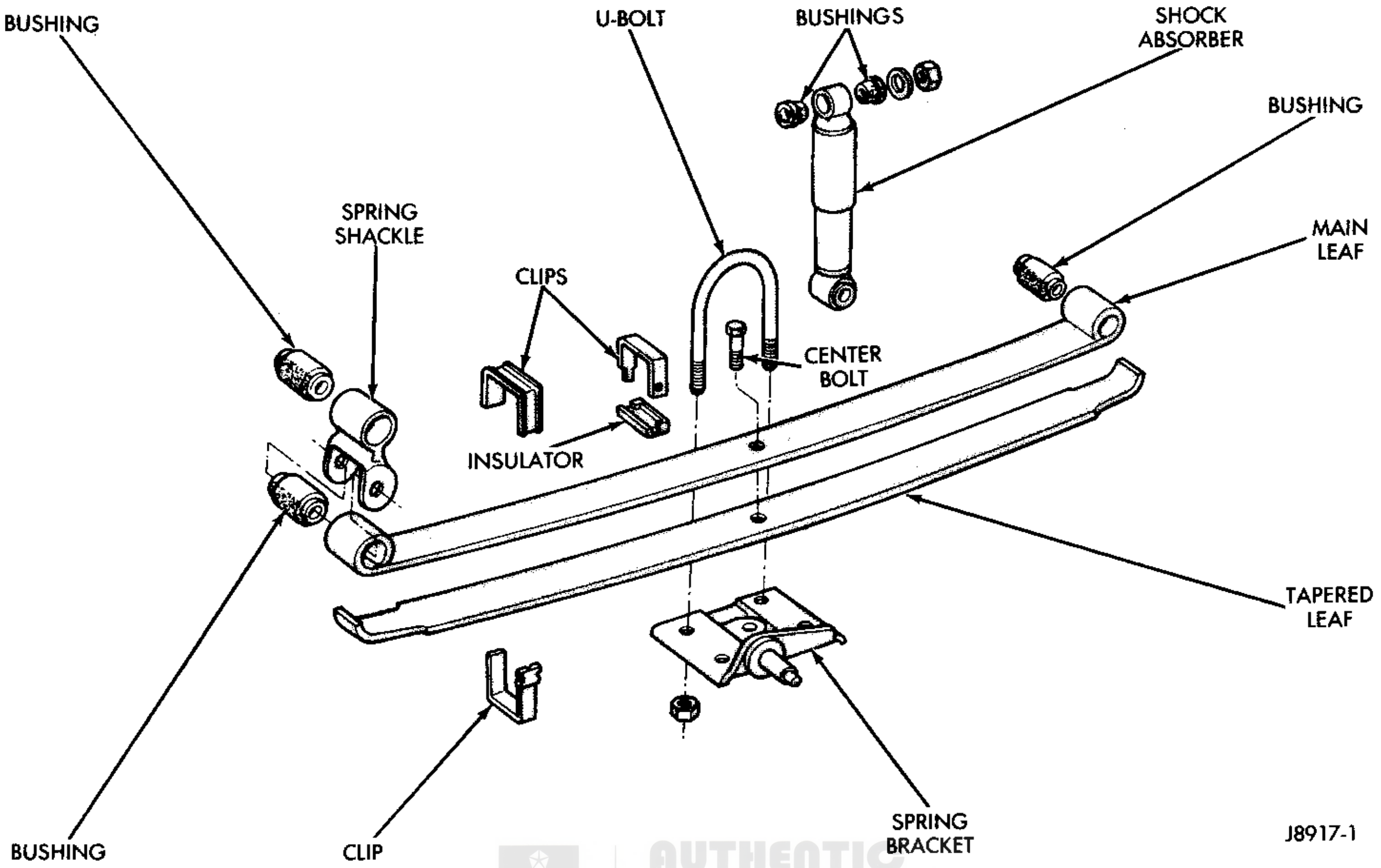


Fig. 1 Front Spring & Shock Absorber—SJ Vehicles

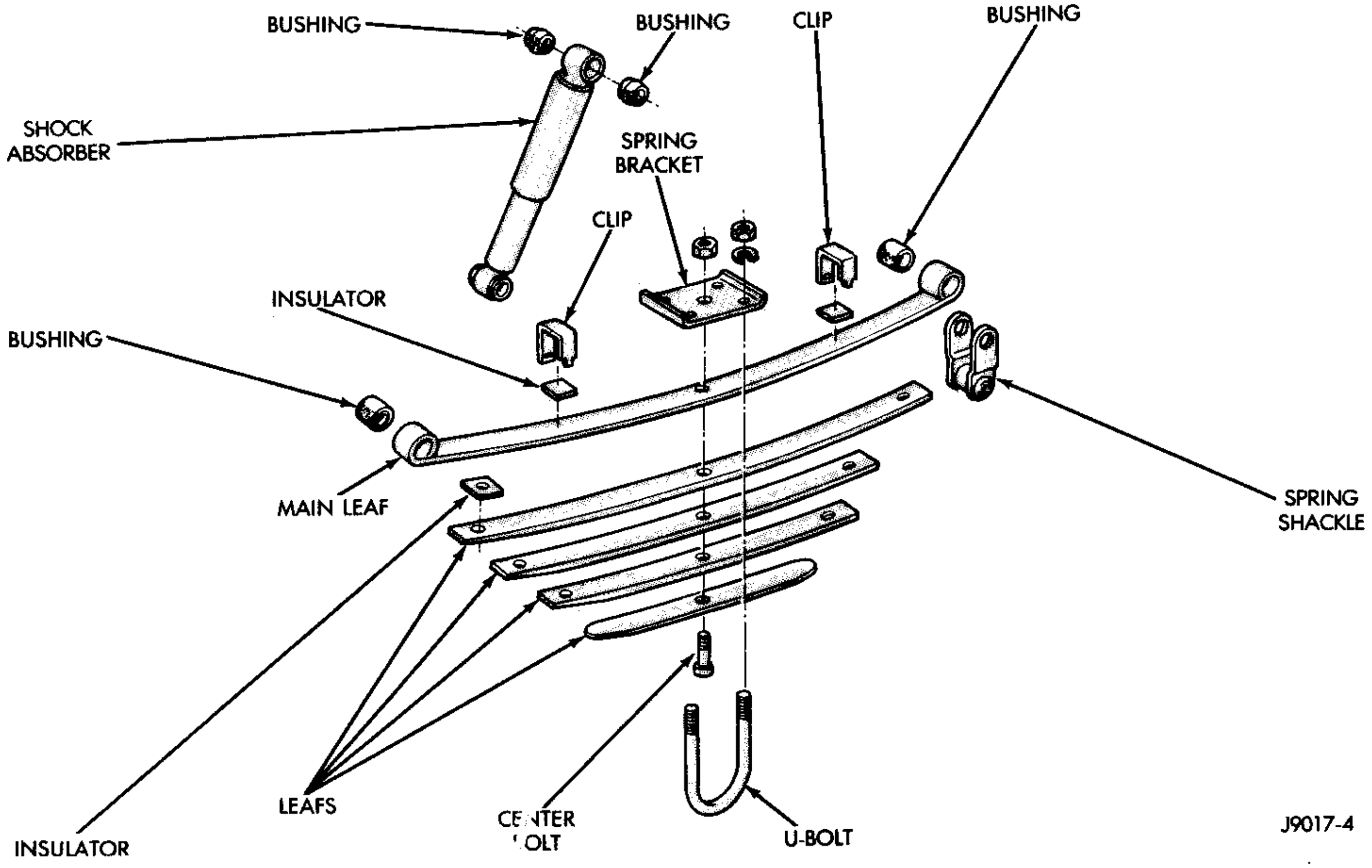


Fig. 2 Rear Spring & Shock Absorber—SJ Vehicles

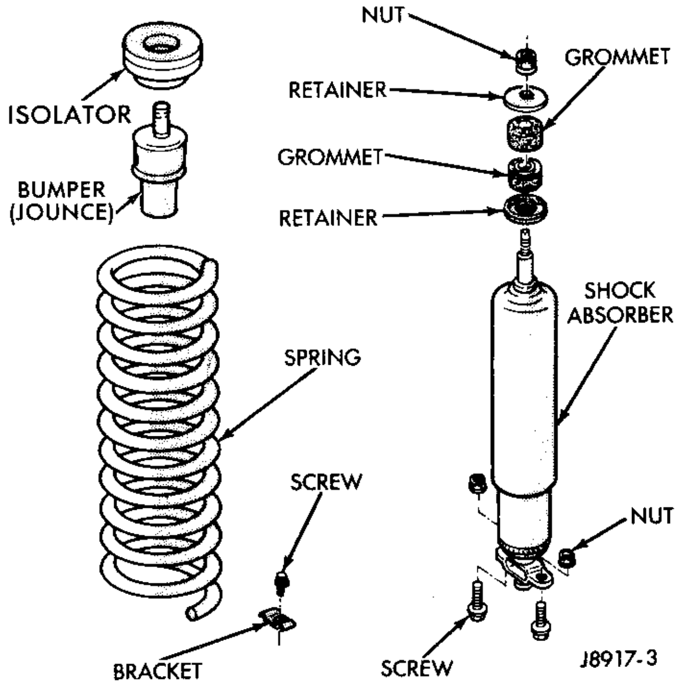


Fig. 3 Front Spring & Shock Absorber—MJ/XJ Vehicles

YJ Vehicles

Multi-leaf springs and dual-action, hydraulic shock absorbers are used with both the front and rear suspension systems of YJ vehicles (Fig. 6 and 7). In addition, a track bar and a stabilizer bar are utilized with the front suspension system (refer to Group 2—Front Suspension for service information). The rear suspension system also utilizes a track bar.

The hydraulic shock absorbers are designed to dampen vehicle body movement. At the top, the front shock absorbers are insulated with rubber grommets (Fig. 6) and are attached to the shock tower. At the bottom, they are attached to the axle shaft tube bracket.

The rear shock absorbers are attached to the frame at the top and to the axle shaft tube bracket at the bottom. Rubber bushings are inserted in the attaching eyes to dampen road shock and noise (Fig. 7).

YJ vehicles are also equipped with frame-mounted jounce bumpers located at the front and rear of the vehicle. The bumpers are attached to the underside of the frame rail and are positioned above and in-line with the axle shaft tubes.

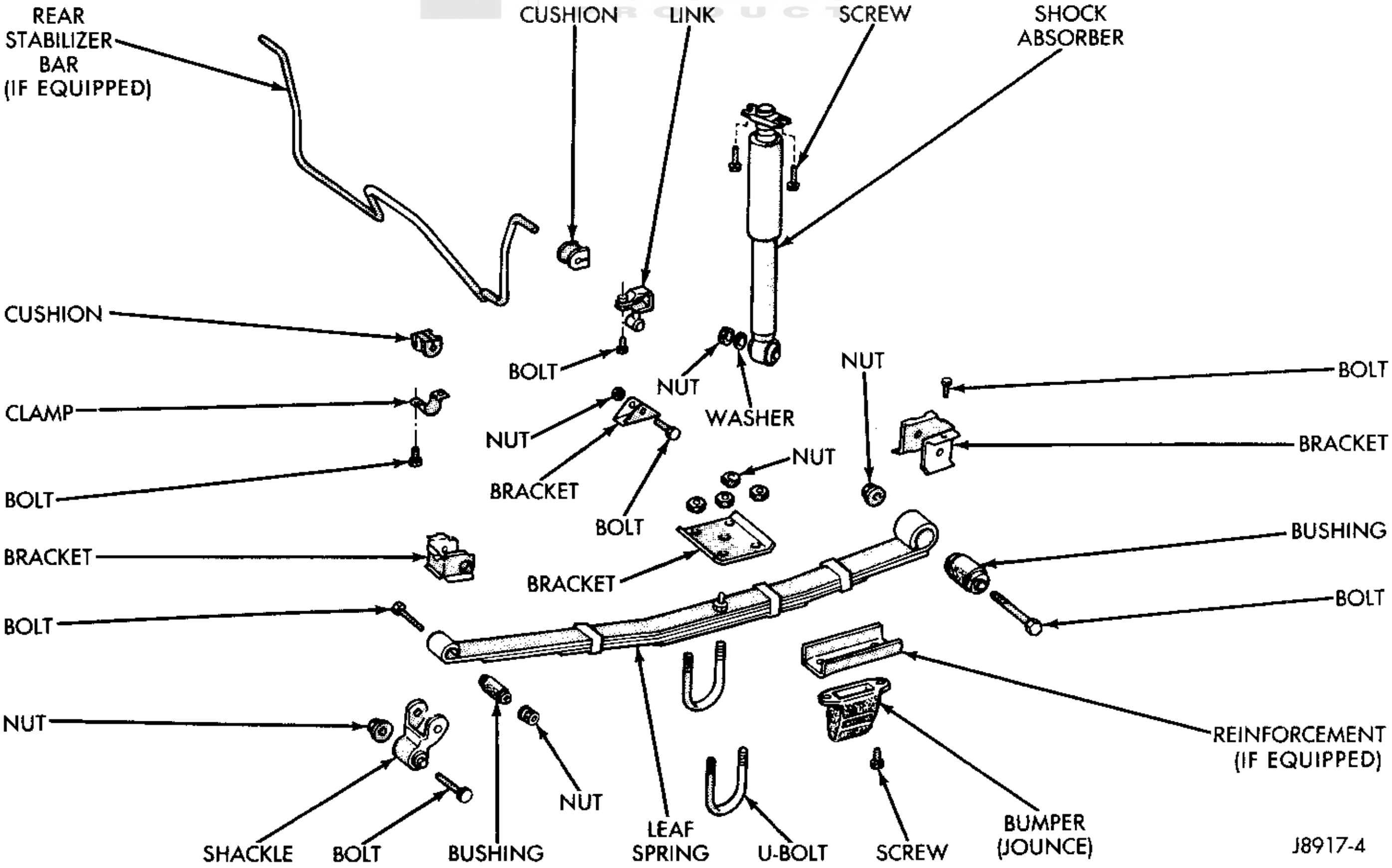


Fig. 4 Rear Spring & Shock Absorber—XJ Vehicles

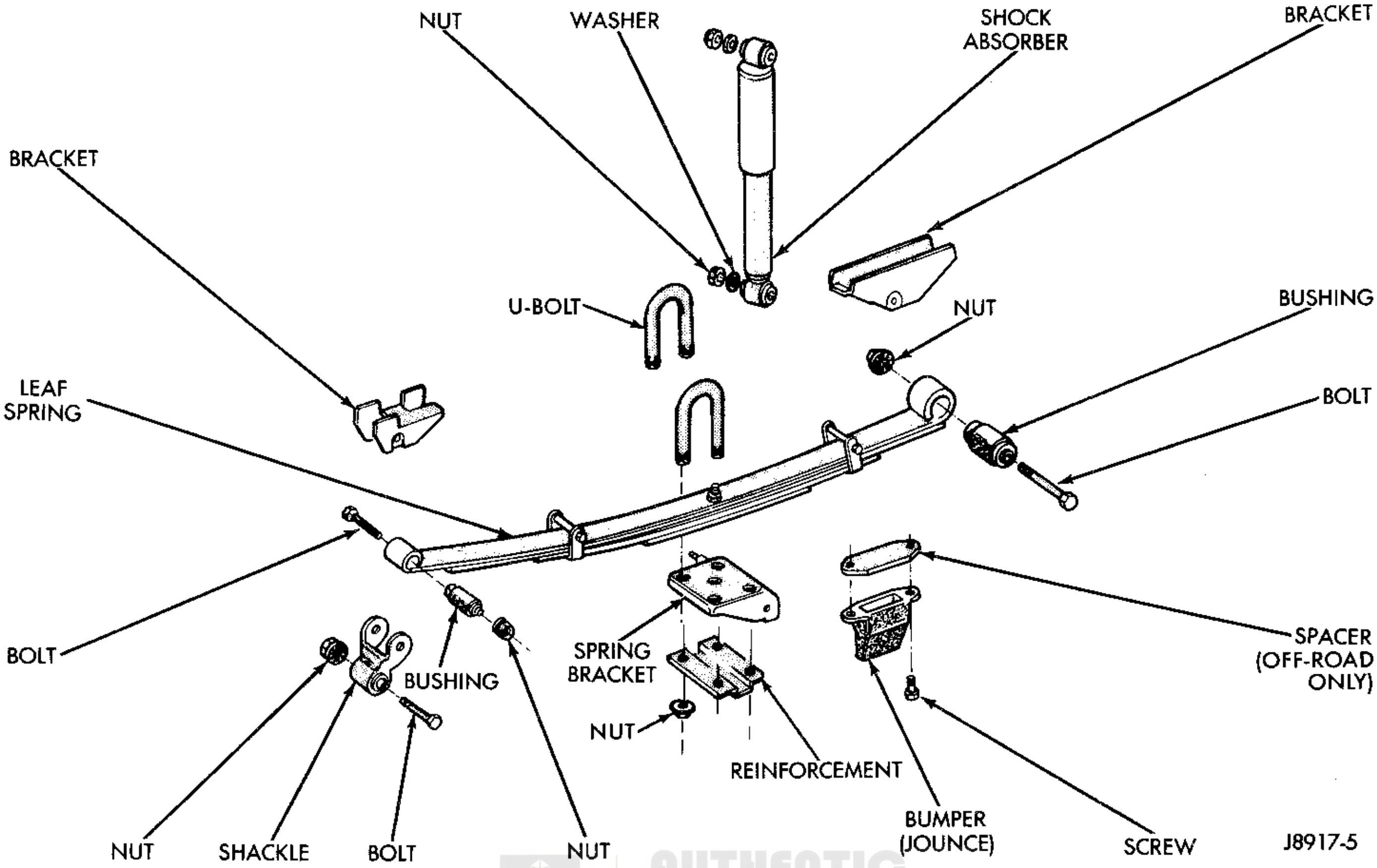


Fig. 5 Rear Spring & Shock Absorber—MJ Vehicles

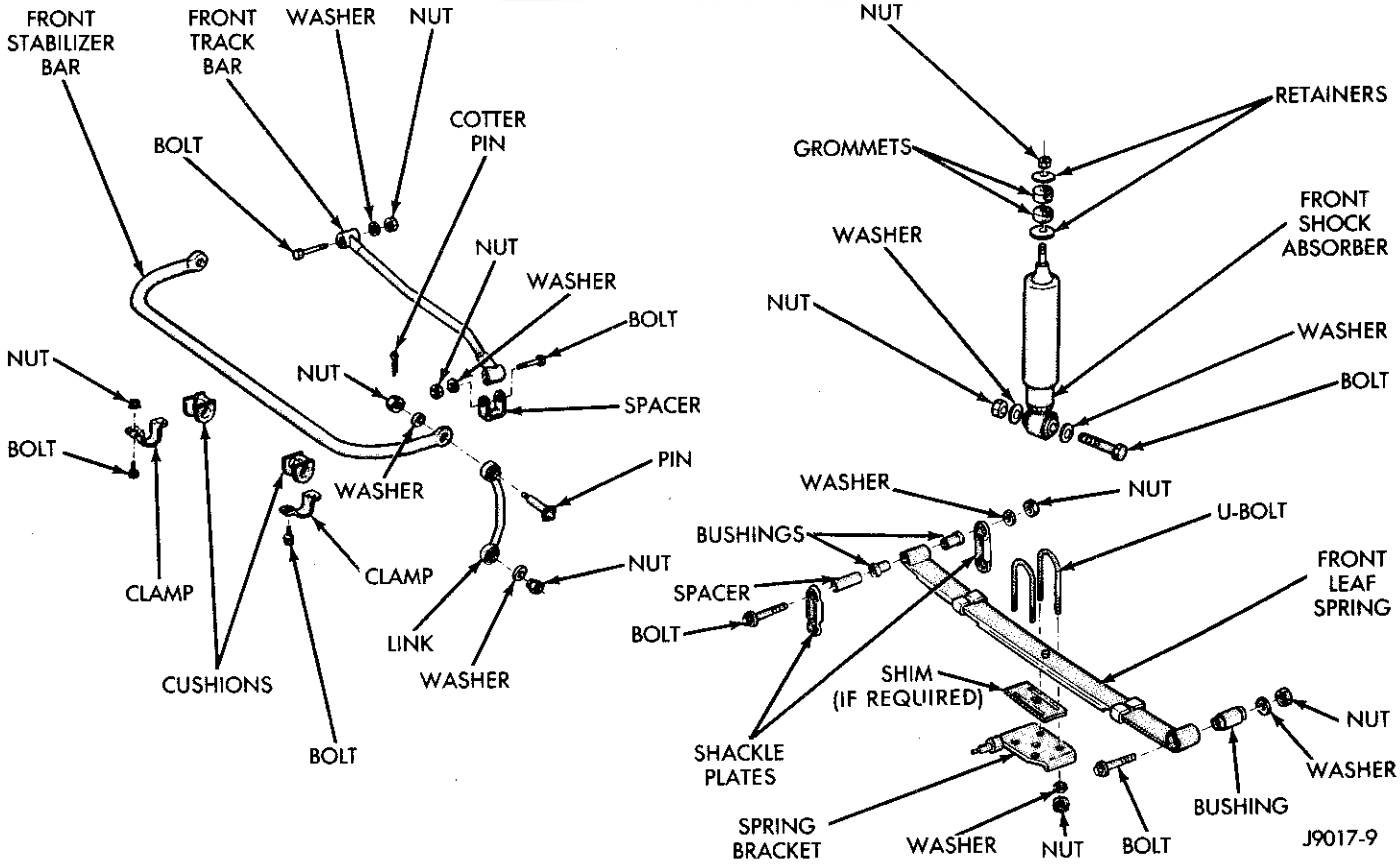


Fig. 6 Front Spring & Shock Absorber—YJ Vehicles

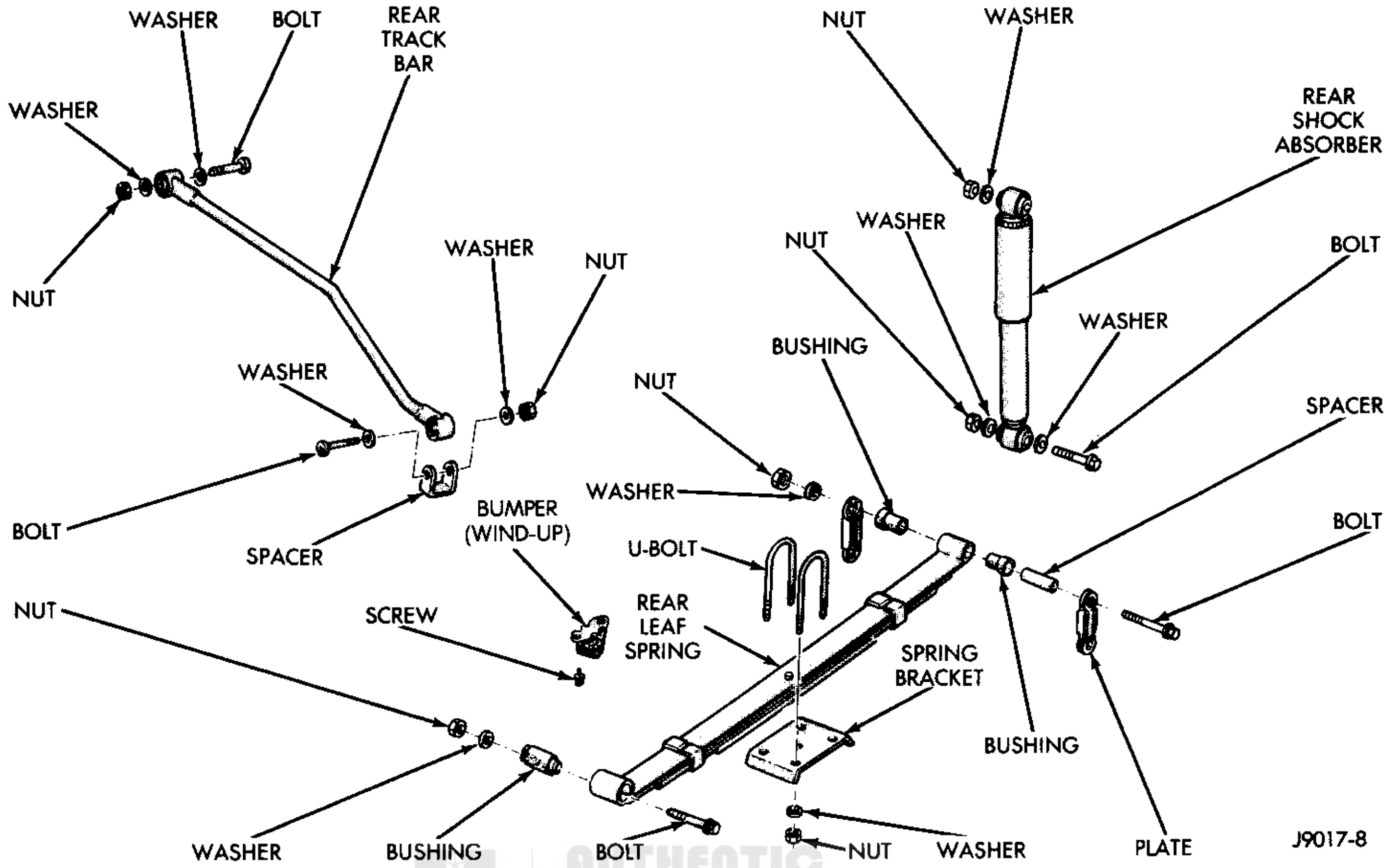


Fig. 7 Rear Spring & Shock Absorber—YJ Vehicles

SERVICE INSPECTION AND DIAGNOSIS

Leaf Springs

The multi-leaf springs used with all Jeep vehicles are attached to the axle by U-bolts and brackets. They are retained in place on the axle by spring saddles welded to the axle shaft tubes. Spring center bolts and spring clips are used to align and retain the spring leafs (plates) in place. If the vehicle is used for severe, off-road operation, the springs should be examined periodically for broken and shifted leafs, loose and missing clips, and broken center bolts.

A Squeak noise can be produced when movement between the spring rubber bushings and the metal occurs. This noise can usually be eliminated by tightening the spring attaching bolts with the specified torque. However, if a squeak noise persists after the bolt tightening, inspect for a loose bushing in a spring eye, a misaligned bushing (not centered in the spring eye), or spring misalignment caused by damaged suspension components. Repair as necessary if any of these conditions exist.

The spring eye bushings do not require any type of lubrication. Do not attempt to eliminate spring bushing noise by lubricating them. Grease and mineral oil-base lubricants will cause deterioration of the bushing rubber.

Shock Absorbers

A squeak noise from the shock absorber bushings can be produced if movement between the rubber bushings and the metal occurs. This noise can usually be eliminated by tightening the shock absorber attaching nuts. However, if the squeak noise persists, inspect for damaged and worn bushings, and damaged shock absorber attaching components. Repair as necessary if any of these conditions exist.

The shock absorber bushings do not require any type of lubrication. Do not lubricate the bushings in an attempt to reduce bushing noise. Grease or mineral oil-base lubricants will cause deterioration of the bushing rubber.

The shock absorbers are not refillable or adjustable. If a malfunction occurs, the shock absorber must be replaced. To test a shock absorber, hold it in an upright position and force the piston into and out of the cylinder four or five times. The action throughout each stroke should be smooth and produce a greater amount of resistance to piston movement inward than piston movement outward.

SERVICE PROCEDURES

INDEX

SHOCK ABSORBER REPLACEMENT

Front Or Rear—SJ Vehicles

(1) Raise the vehicle.

(2) Position a hydraulic jack under the axle and raise the axle to relieve the springs of axle weight.

(3) Remove the locknut and washer that attach the shock absorber to the stud at the frame rail bracket (Fig. 8).

(4) Remove the locknut and bolt that attach the shock absorber to the axle shaft tube bracket (Fig. 8).

(5) Remove the shock absorber and the washer from the stud at the frame rail bracket.

(6) Install replacement bushings in the replacement shock absorber upper eye (Fig. 8). Do not lubricate the bushings, install them dry.

(7) Position a washer and the upper eye of the replacement shock absorber on the stud at the frame rail bracket, and the lower eye in the axle shaft tube bracket.

(8) Install the shock absorber washer and locknut on the stud at the frame rail bracket (Fig. 8).

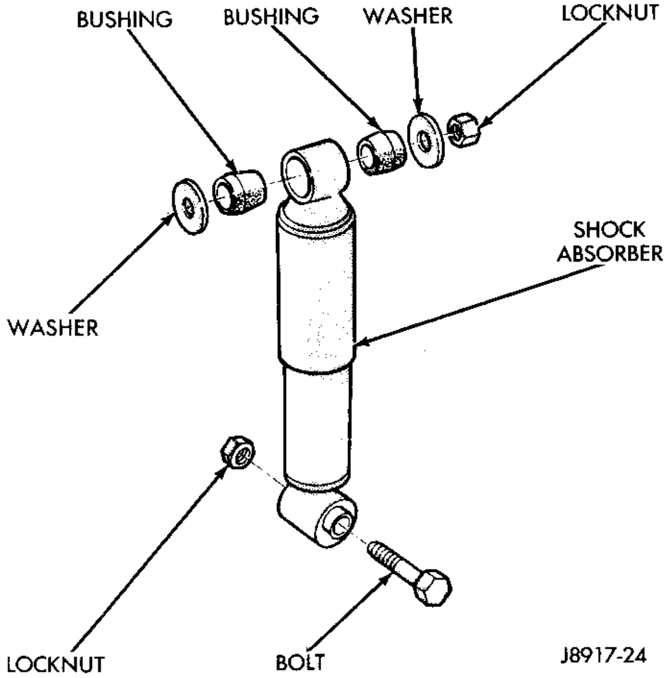


Fig. 8 Shock Absorber—SJ Vehicles

(9) Install the bolt and locknut and attach the shock absorber to the axle shaft tube bracket (Fig. 8).

(10) Tighten the upper and lower locknuts with 61 N•m (45 ft-lbs) torque.

(11) Remove the hydraulic jack and lower the vehicle.

Front Removal—MJ/XJ Vehicles

(1) Remove the bayonet attaching nut, retainer and grommet from the shock absorber upper stud in the engine compartment (Fig. 9).

(2) Raise the vehicle, remove the lower attaching nuts and bolts and remove the front shock absorber (Fig. 9).

Front Installation—MJ/XJ Vehicles

(1) Position the lower retainer and grommet on the upper stud and insert the replacement front shock ab-

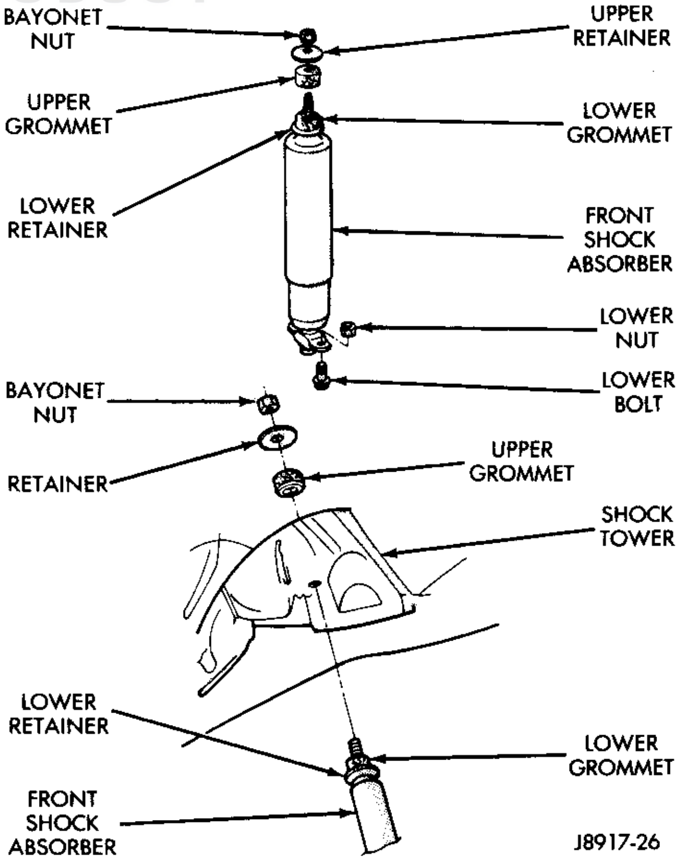


Fig. 9 Front Shock Absorber—MJ/XJ Vehicles

sorber through the shock tower hole. Install the lower attaching bolts and nuts (Fig.9).

(2) Tighten the lower attaching nuts with 19 N•m (14 ft-lbs) torque.

(3) Lower the vehicle and install the upper grommet and retainer on the stud in the engine compartment (Fig. 9). Install the bayonet nut and tighten it with 11 N•m (8 ft-lbs) torque.

Rear Removal—MJ/XJ Vehicles

(1) Raise the vehicle, position a hydraulic jack under the axle and raise the axle to relieve the springs of axle weight.

(2) Remove the upper shock absorber attaching screws from the crossmember — XJ vehicles. Remove the shock absorber upper attaching nut and washer from the frame bracket stud — MJ vehicles (Fig. 10).

(3) Remove the lower attaching nut and washer (Fig. 10) from the bracket stud and remove the rear shock absorber.

Rear Installation—MJ/XJ Vehicles

(1) For XJ vehicles, position the replacement rear shock absorber on the axle shaft tube bracket stud and install the shock absorber upper attaching screws in the crossmember (Fig. 10).

(2) For MJ vehicles, position the replacement rear shock absorber on the spring bracket stud and install the shock absorber upper attaching washer and nut on the frame bracket stud (Fig. 10).

(3) Install the washer and the attaching nut on the applicable bracket stud (Fig. 10).

(4) Tighten the nuts with 60 N•m (44 ft-lbs) torque.

(5) Tighten the screws with 20 N•m (15 ft-lbs) torque.

(6) Remove the hydraulic jack and lower the vehicle.

Front Removal—YJ Vehicles

(1) Remove the attaching nut, retainer and grommet from the shock absorber stud at the frame bracket in the engine compartment (Fig. 11).

(2) Raise and support the vehicle.

(3) Remove the nut, washers and bolt that attach the shock absorber lower eye (Fig. 11) to the axle shaft tube bracket stud.

(4) Remove the shock absorber (Fig. 11).

(5) Remove the remaining grommet and retainer from the shock absorber stud (Fig. 11).

Front Installation—YJ Vehicles

(1) Install the lower retainer and grommet on the replacement shock absorber stud (Fig. 11). Ensure that the alignment shoulder on the grommet faces upward.

(2) Position the replacement shock absorber eye on the axle shaft tube bracket stud and install the lower attaching bolt, washers and nut (Fig. 11) "finger tight".

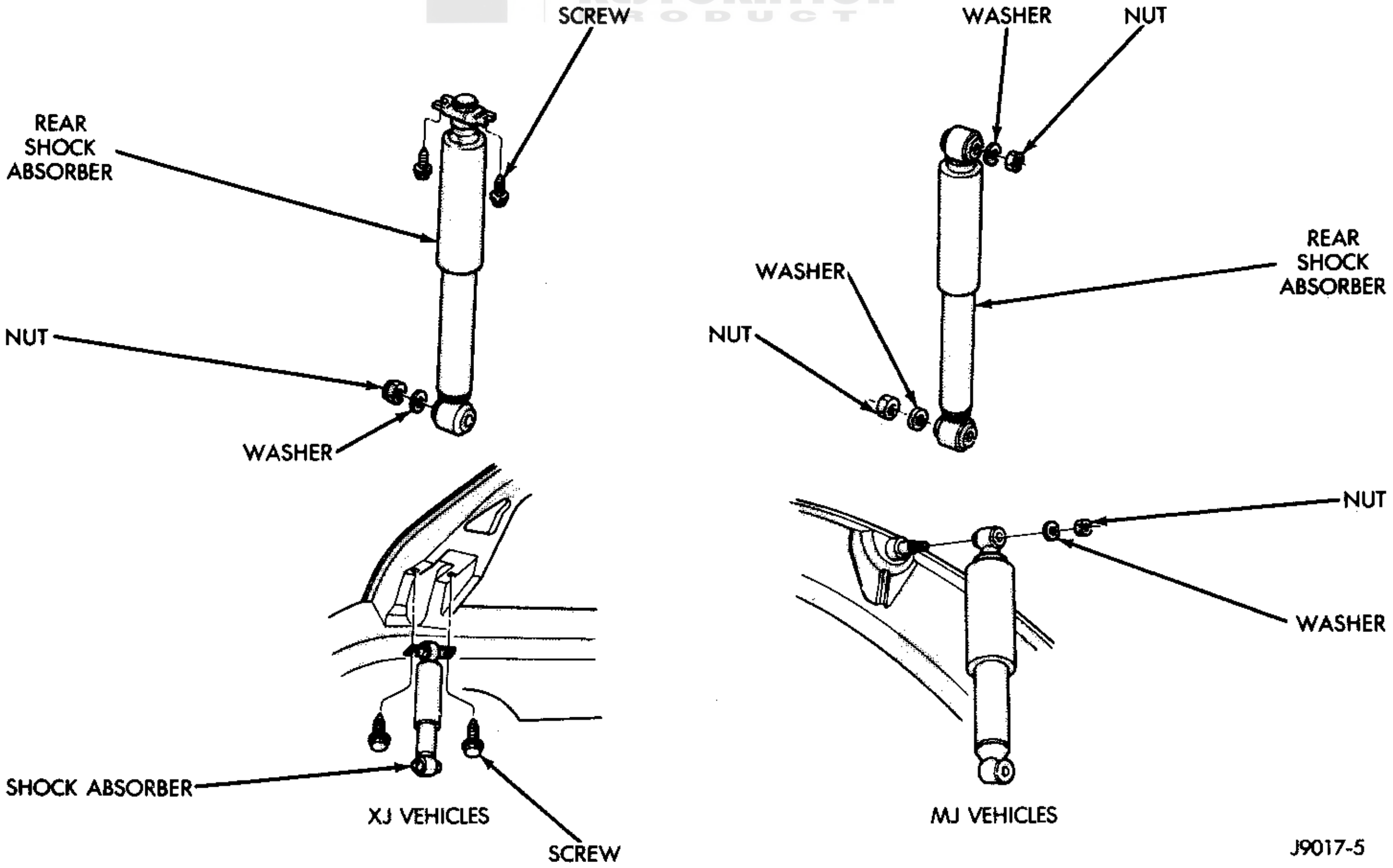


Fig. 10 Rear Shock Absorber—MJ/XJ Vehicles

(3) Insert the shock absorber stud into the hole in the frame bracket.

(4) Tighten the lower attaching bolt and nut with 61 N•m (45 ft-lbs) torque.

(5) Remove the supports and lower the vehicle.

(6) Install the upper grommet on the shock absorber stud (Fig. 11). Ensure that the alignment shoulder on the upper grommet faces downward (toward the shock absorber body).

(7) Align both grommet shoulders in the stud hole in the frame bracket.

(8) Install the retainer and nut on the shock absorber stud (Fig. 11). Tighten the nut with 13 N•m (9 ft-lbs) torque.

Rear Removal—YJ Vehicles

(1) Raise and support the vehicle.

(2) Position a jack under the rear axle and raise it enough to relieve the axle weight from the rear springs.

(3) Remove the shock absorber upper attaching nut and washer from the frame bracket stud (Fig. 12).

(4) Remove the lower attaching nut, washers and bolt from the axle shaft tube bracket, and remove the shock absorber (Fig. 12).

Rear Installation—YJ Vehicles

(1) Position the replacement shock absorber upper eye on the frame bracket stud and install the washer and nut (Fig. 12).

(2) Position the shock absorber lower eye in the axle shaft tube bracket and install the lower attaching bolt, washers and nut (Fig. 12).

(3) Tighten the upper attaching nut and lower attaching bolt and nut with 60 N•m (44 ft-lbs) torque.

(4) Remove the supports and the jack supporting the rear axle, and lower the vehicle.

COIL SPRING REPLACEMENT

Removal—MJ/XJ Vehicles

(1) Raise and support the vehicle. Position a hydraulic jack under the axle to support it.

(2) Remove the wheel/tire.

(3) If equipped, score alignment marks for installation alignment reference and disconnect the front drive shaft from the front axle yoke. If necessary, refer to the removal procedure within Group 2—Front Suspension.

(4) Disconnect the lower suspension arm from the axle shaft tube bracket (Fig. 13).

(5) Disconnect the stabilizer bar link (Fig. 14) and the shock absorber (Fig. 13) from the axle shaft tube brackets.

(6) Disconnect the track bar stud from the frame rail bracket (Fig. 15). If necessary, use a puller tool.

(7) Disconnect the drag link from the pitman arm. If necessary, use a puller tool.

(8) Lower the hydraulic jack and the axle, loosen the coil spring retainer bracket screw (Fig. 13) and remove the spring from the axle pad.

Installation—MJ/XJ Vehicles

(1) Position the replacement coil spring on the axle pad. Install the spring retainer and tighten the screw securely (Fig. 13).

(2) Raise the axle into position for installation with the hydraulic jack.

(3) Connect the lower suspension arm to the axle shaft tube bracket (Fig.13).

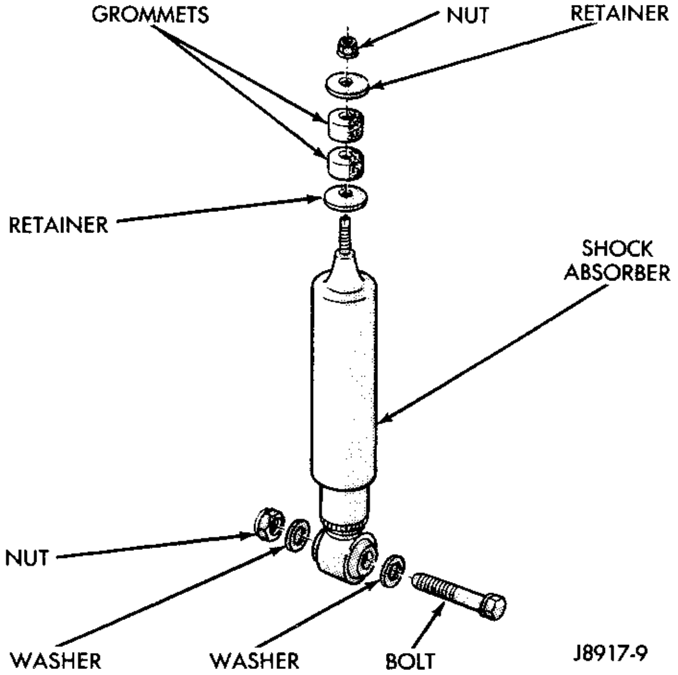


Fig. 11 Front Shock Absorber—YJ Vehicles

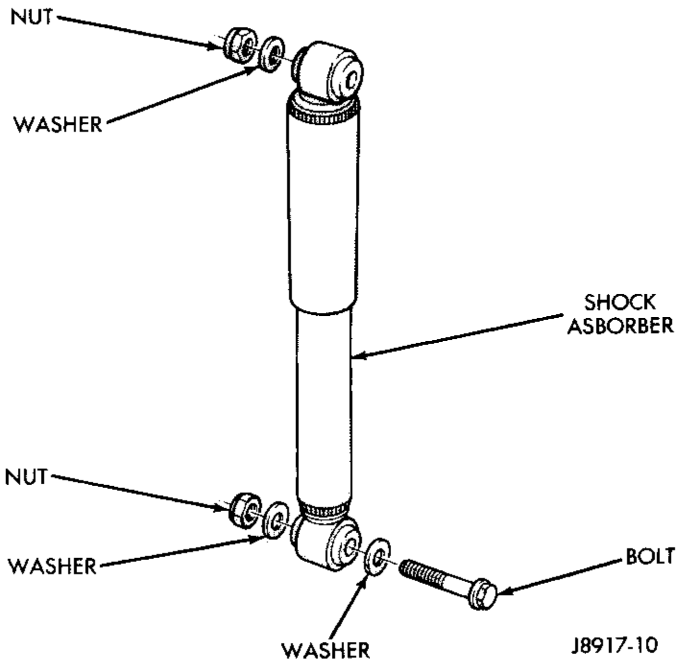


Fig. 12 Rear Shock Absorber—YJ Vehicles

Remove the hydraulic jack. It is important that the front springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the track bar is connected to the frame rail bracket, otherwise it will be difficult to align the stud with the bracket hole. In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(4) Connect the drag link to the pitman arm, the stabilizer bar link to the axle shaft tube bracket (Fig. 14), the shock absorber (Fig. 13) to the axle shaft tube bracket and the track bar to the frame rail bracket (Fig. 15). Refer to the applicable tightening torque specifications below:

- pitman arm nut — 83 N•m (62 ft-lbs);
- stabilizer bar link nut — 95 N•m (70 ft-lbs);
- shock absorber nut — 19 N•m (14 ft-lbs); and
- track bar nut — 48 N•m (35 ft-lbs).

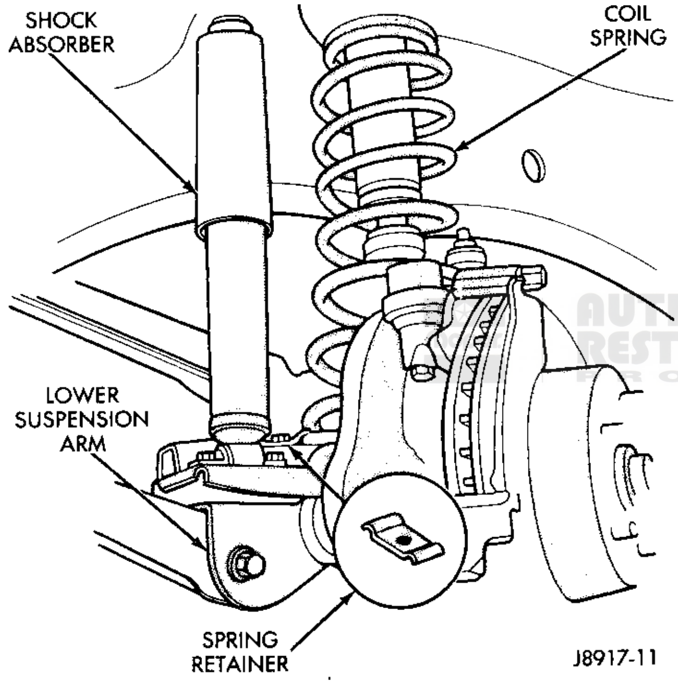


Fig. 13 Coil Spring Replacement

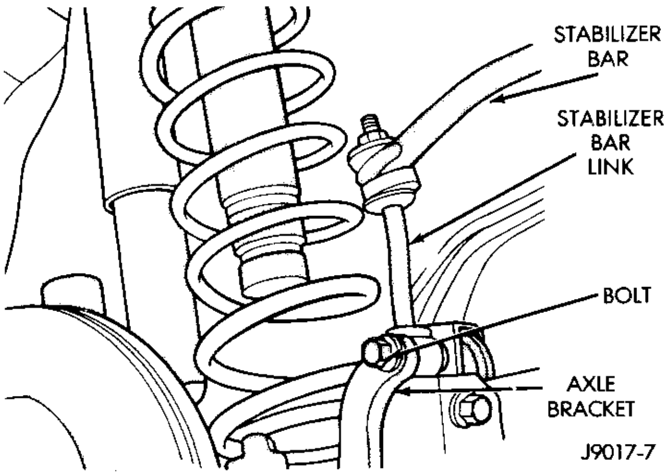


Fig. 14 Stabilizer Bar Link

(5) If equipped, connect the front drive shaft to the drive pinion gear shaft (axle) yoke with the installation reference marks aligned. Tighten the strap bolts with 19 N•m (14 ft-lbs or 170 in-lbs) torque.

(6) Install the wheel/tire. Tighten the lug nuts with 102 N•m (75 ft-lbs) torque.

(7) Remove the supports and lower the vehicle.

FRONT LEAF SPRING REPLACEMENT

Removal—SJ Vehicles

(1) Raise the vehicle.

(2) Support the vehicle with jack stands placed under the frame.

(3) Position a hydraulic jack under the axle and raise it to relieve the axle weight from the springs.

(4) Disconnect the stabilizer bar connecting link from the spring bracket stud (Fig. 16).

(5) Remove the nuts, the U-bolts and the spring bracket from the axle shaft tube (Fig. 17).

(6) Remove the nut and bolt that attaches the spring front eye to the shackle (Fig. 17).

(7) Remove the nut and bolt that attaches the spring rear eye to the spring hanger bracket (Fig. 17).

(8) Remove the spring from the vehicle (Fig. 17). **The spring can be disassembled by removing the spring clips and the center bolt. If the spring bushings require replacement, refer to the bushing removal and installation procedures.**

Installation—SJ Vehicles

(1) Position the replacement spring front eye in the shackle and loosely install the attaching bolt and nut (Fig. 17). Do not tighten the bolt at this time.

(2) Position the replacement spring rear eye in the hanger bracket and loosely install the attaching bolt and nut (Fig. 17). Do not tighten the bolt at this time.

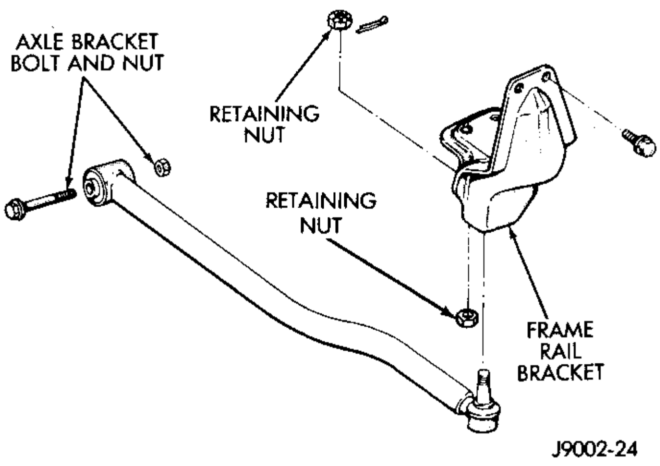


Fig. 15 Track Bar

(3) Position and align the replacement spring with the axle shaft tube. Install the spring bracket, the U-bolts and the nuts (Fig. 17). Tighten the U-bolt nuts with 136 N•m (100 ft-lbs) torque.

(4) Connect the stabilizer bar connecting link to the spring bracket (Fig. 16) and tighten the attaching nut with 75 N•m (55 ft-lbs) torque.

(5) Remove the hydraulic jack used to support the axle weight.

(6) Remove the support stands and lower the vehicle.

(7) Tighten the spring front and rear eye attaching bolts and nuts with 136 N•m (100 ft-lbs) torque.

Removal—YJ Vehicles

(1) Raise and support the vehicle.

(2) Remove one or both of the front wheels/tires, as necessary.

(3) Use a hydraulic jack to raise the front axle enough to relieve the axle weight from the springs.

(4) Loosen, but do not remove the stabilizer bar link attaching nut (Fig. 18).

(5) Remove the U-bolt nuts and the U-bolts from the spring bracket (Fig. 18).

(6) Move the spring bracket aside (Fig. 18).

(7) Remove the spring front eye-to-shackle plate attaching nut and bolt (Fig. 18).

(8) Remove the spring rear eye-to-frame bracket attaching nut and bolt.

(9) Remove the spring.

Installation—YJ Vehicles

(1) Position the replacement spring eyes in the frame bracket and shackle plate.

(2) Install, but do not tighten the bolts and nuts that attach the spring eyes to the frame bracket and shackle plate (Fig. 18).

(3) Align the replacement front spring center bolt with the locating hole in the axle shaft tube spring pad.

(4) Lower the front axle until it is fully supported by the spring.

Ensure that the spring center bolt is seated in the axle tube spring pad locating hole. Realign the center bolt in the locating hole, if necessary.

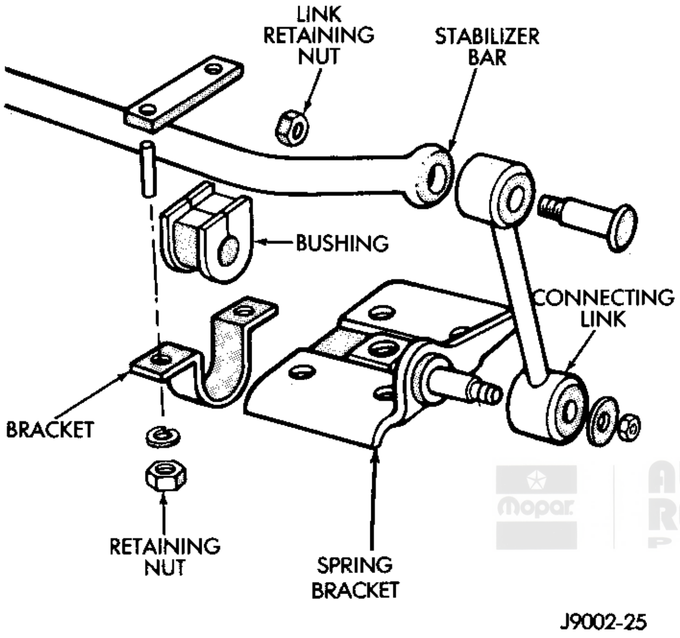


Fig. 16 Stabilizer Bar

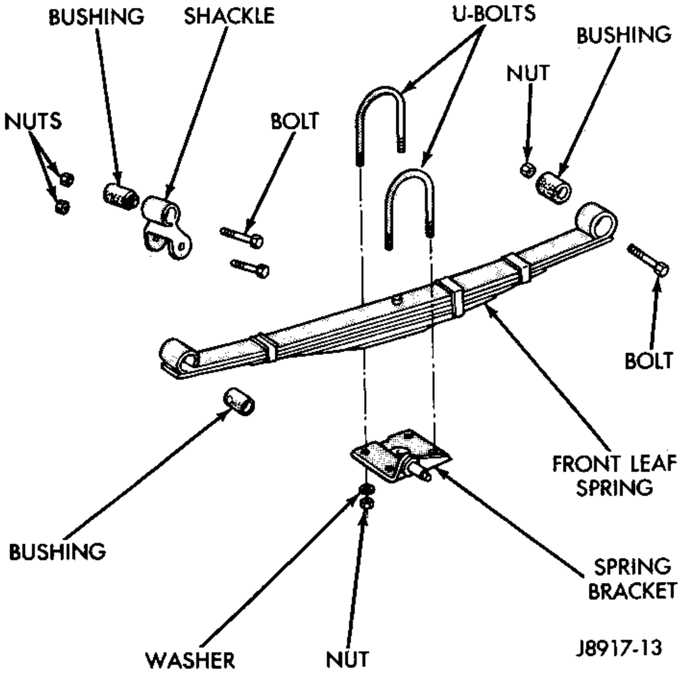


Fig. 17 Leaf Spring Removal/Installation

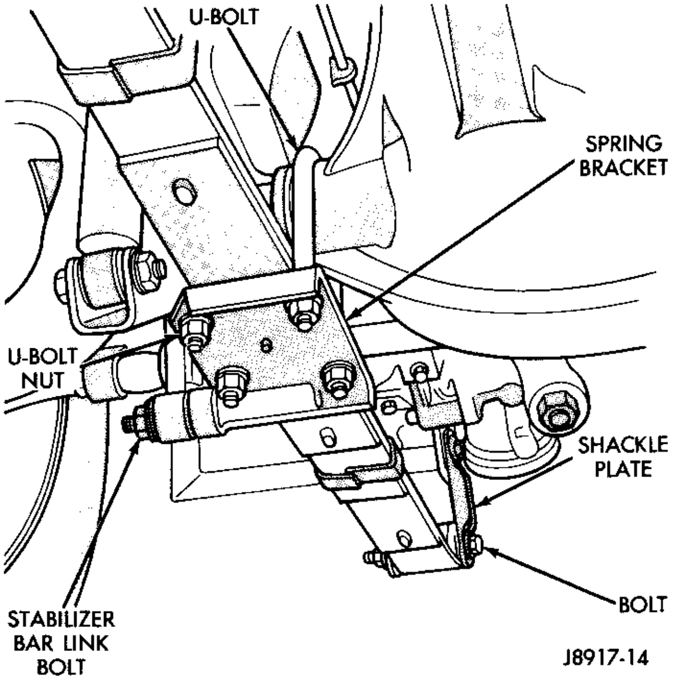


Fig. 18 Front Spring Removal/Installation

(5) Position the spring bracket under the spring, and install the U-bolts and the U-bolt nuts (Fig. 18).

(6) Tighten the U-bolt nuts with 122 N•m (90 ft-lbs) torque.

(7) Install the stabilizer bar link on the spring bracket stud (Fig. 18) and tighten the nut with 61 N•m (45 ft-lbs) torque.

(8) Install the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(9) Remove all the supports and lower the vehicle.

(10) Tighten the spring front eye-to-shackle plate nut (Fig. 18) with 129 N•m (95 ft-lbs) torque.

(11) Tighten the spring rear eye-to-frame bracket nut with 142 N•m (105 ft-lbs) torque.

REAR SPRING REPLACEMENT

Removal—SJ Vehicles

(1) Raise the vehicle.

(2) Support the vehicle with jack stands placed under the frame.

(3) If the left-side spring is to be replaced, remove the fuel tank skid plate.

(4) Position a hydraulic jack under the axle and raise it to relieve the axle weight from the spring.

(5) Disconnect the rear shock absorber from the axle shaft tube bracket.

(6) Remove the wheel/tire.

(7) Remove the nuts, the U-bolts and the spring bracket from the axle shaft tube (Fig. 19).

(8) Remove the spring rear eye-to-spring shackle attaching nut and bolt (Fig. 19).

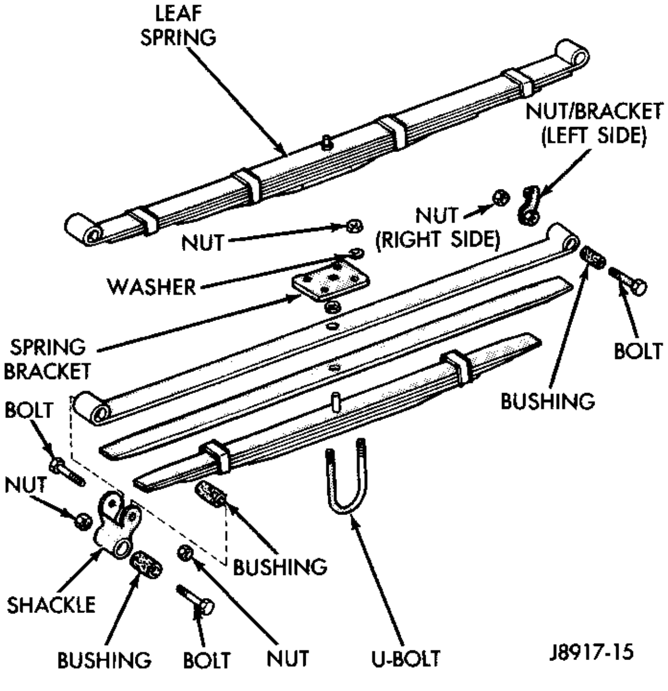


Fig. 19 Rear Spring Removal/Installation

(9) Remove the spring front eye-to-spring hanger bracket attaching nut and bolt (Fig. 19).

(10) Remove the spring from the vehicle (Fig.19).

The spring can be disassembled by removing the spring clips and the center bolt. If the spring eye bushings require replacement, refer to Leaf Spring Eye Bushing Replacement.

Installation—SJ Vehicles

(1) Position the replacement spring front eye in the hanger bracket and loosely install the attaching bolt and nut (Fig. 19). Do not tighten the bolt at this time.

(2) Position the replacement spring rear eye in the shackle and loosely install the attaching bolt and nut (Fig. 19). Do not tighten the nut at this time.

(3) Position and align the axle on the replacement spring and install the spring bracket, the U-bolts and the attaching nuts (Fig. 19). Tighten the U-bolt nuts with 136 N•m (100 ft-lbs) torque.

(4) Connect the shock absorber to the axle shaft tube bracket.

(5) Install the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(6) Install the fuel tank skid plate, if removed.

(7) Remove the hydraulic jack supporting the axle.

(8) Remove the support stands and lower the vehicle.

(9) Tighten the spring eye attaching nuts with 136 N•m (100 ft-lbs) torque.

Removal—MJ/XJ Vehicles

(1) Raise the vehicle and support it at the frame or frame rails (as applicable).

(2) Use a hydraulic jack to raise the axle and relieve the axle weight from the rear springs.

(3) As applicable, disconnect the shock absorber from the axle shaft tube bracket or the spring bracket (Fig. 20 and 21).

(4) Remove the wheel/tire.

(5) For XJ vehicles, disconnect the stabilizer bar link from the spring bracket stud (Fig. 21).

(6) Remove the spring bracket U-bolt nuts, the U-bolts and the spring bracket from the axle shaft tube (Fig. 22 and 23).

(7) Remove the spring rear eye-to-shackle attaching nut and bolt and the spring front eye-to-bracket nut and bolt (Fig. 22 and 23).

(8) Lower the axle for clearance and remove the spring from the vehicle.

Installation—MJ/XJ Vehicles

(1) Position the replacement spring front eye in the bracket and the rear eye in the shackle (Fig. 22 and 23). Install the attaching bolts and nuts, but do not tighten completely.

(2) Position and align the axle with the replacement spring and raise the axle with the hydraulic jack.

(3) Install the U-bolts, the spring bracket and the attaching nuts (Fig. 22 and 23). For XJ vehicles, tighten the nuts with 70 N•m (52 ft-lbs) torque. For MJ vehicles, tighten the nuts with 88 N•m (65 ft-lbs) torque.

(4) For XJ vehicles, connect the stabilizer bar link (Fig. 21) to the spring bracket and tighten the attaching nut with 95 N•m (70 ft-lbs) torque.

(5) As applicable, connect the shock absorber to the axle shaft tube bracket or the spring bracket (Fig. 20 and 21) and tighten the bolt/nut with 60 N•m (44 ft-lbs) torque.

(6) Install the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(7) Tighten the spring front and rear eye attaching bolts with 88 N•m (65 ft-lbs) torque.

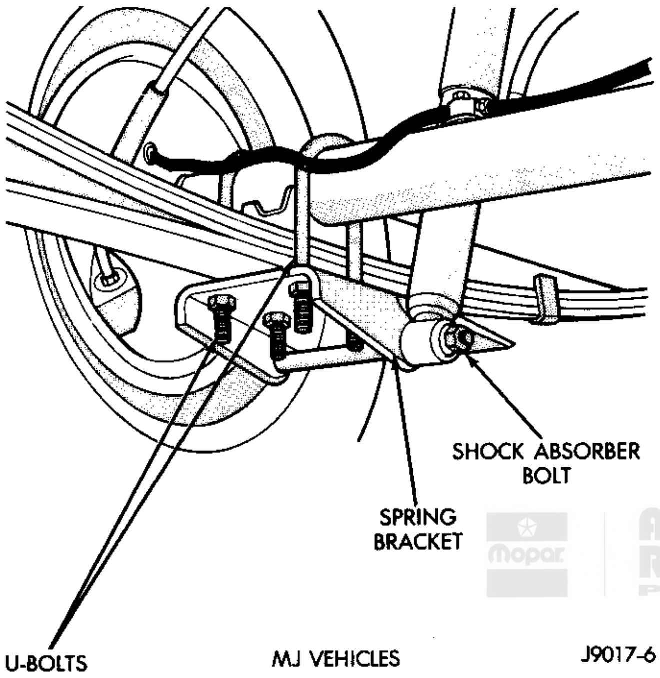


Fig. 20 Rear Spring & Shock Absorber—MJ Vehicles

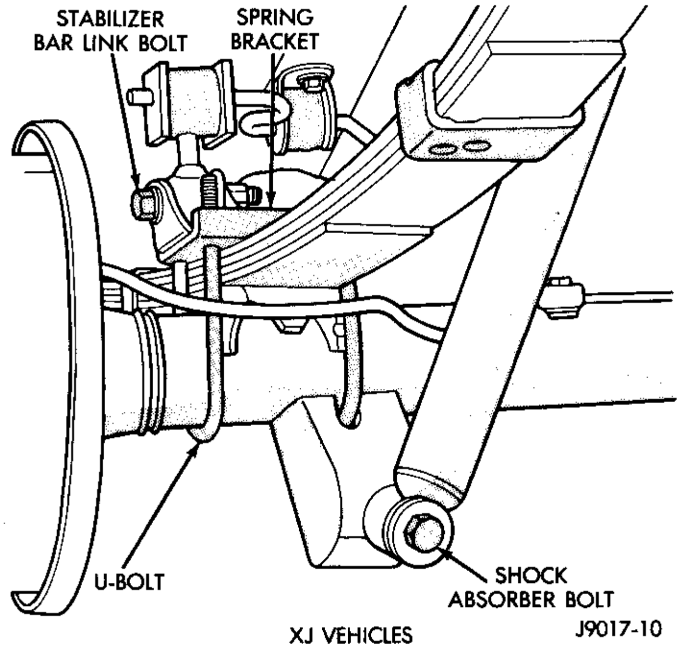


Fig. 21 Rear Spring & Shock Absorber—XJ Vehicles

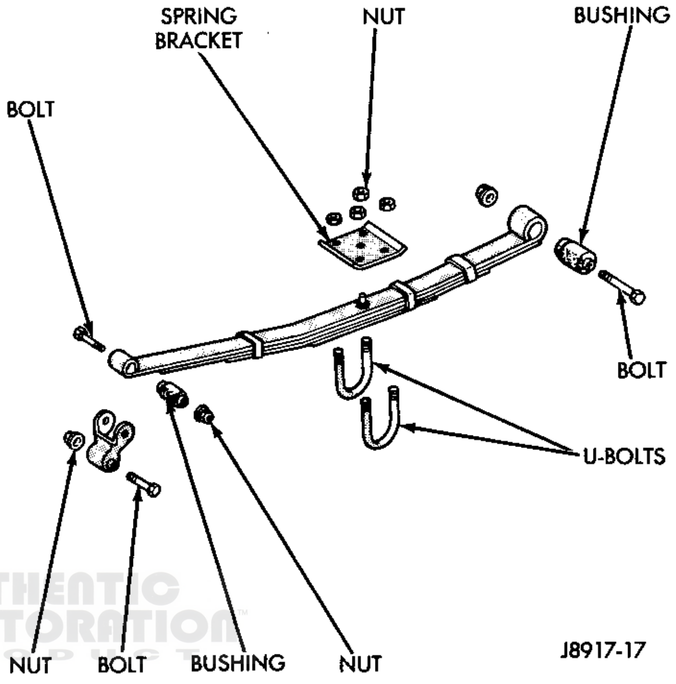


Fig. 22 Rear Spring Removal/Installation—XJ Vehicles

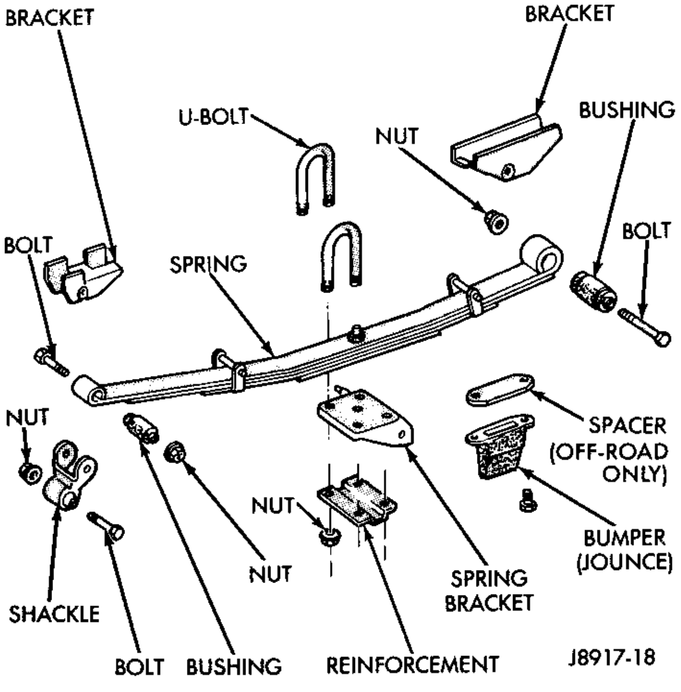


Fig. 23 Rear Spring Removal/Installation—MJ Vehicles

(8) Remove the support stands and the jack, and lower the vehicle.

Removal—YJ Vehicles

(1) Raise and support the vehicle.

(2) Remove one or both of the rear wheels/tires, as necessary.

(3) Use a hydraulic jack to raise the rear axle enough to relieve the axle weight from the rear springs.

(4) Disconnect the rear shock absorber from the axle shaft tube bracket.

(5) Remove the U-bolt nuts, the U-bolts and the spring bracket from the axle shaft tube (Fig. 24).

(6) Remove the bolts attaching the spring eyes to the rear shackle plate and to the front frame bracket.

(7) Remove the spring from the vehicle.

Installation—YJ Vehicles

(1) Position the replacement spring eyes at the rear shackle plate and the front frame bracket.

(2) Install the spring eye attaching bolts and nuts but do not tighten them at this time.

(3) Align the rear spring center bolt with the locating hole in the rear axle spring pad.

(4) Lower the rear axle until it is completely supported by the spring.

Ensure that the spring center bolt is seated in the axle spring pad locating hole. Realign the center bolt with the locating hole, if necessary.

(5) Install the spring bracket, the U-bolts and the U-bolt nuts (Fig. 24).

(6) Tighten the U-bolt nuts with 122 N•m (90 ft-lbs) torque.

(7) Connect the shock absorber to the axle shaft tube bracket. Tighten the attaching nut with 60 N•m (44 ft-lbs) torque.

(8) Install the wheels/tires. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(9) Remove the supports and lower the vehicle.

(10) Tighten the spring front eye-to-shackle plate bolt with 129 N•m (95 ft-lbs) torque.

(11) Tighten the spring rear eye-to-frame bracket bolt with 142 N•m (105 ft-lbs) torque.

LEAF SPRING EYE BUSHING REPLACEMENT

All Vehicles

(1) With the spring removed from the vehicle, insert an appropriate length of threaded rod halfway through the spring eye bushing (Fig. 25).

(2) Place a suitable size socket wrench over one end of the threaded rod with the open end of the socket facing toward the bushing. The socket wrench will be the bushing driver tool (Fig. 25).

The socket wrench must be large enough in diameter to mate with the metal outer sleeve on the bushing but must also be small enough in diameter to pass through the spring eye (Fig. 25).

(3) Install a flat washer and a hex nut on the threaded rod and against the socket wrench (Fig. 25).

(4) Place an appropriate length of pipe (with an inside diameter that will accept the bushing) over the opposite end of the threaded rod (Fig. 25). The pipe will be the bushing receiver tool.

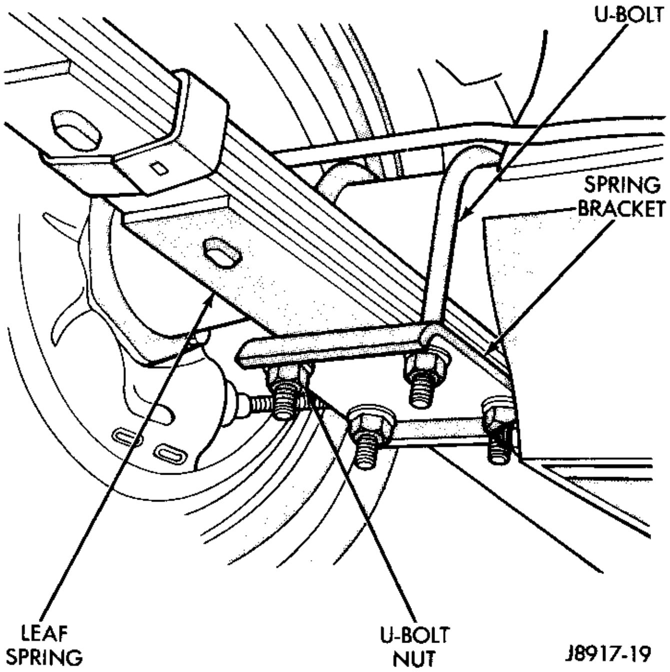


Fig. 24 Rear Spring Removal/Installation

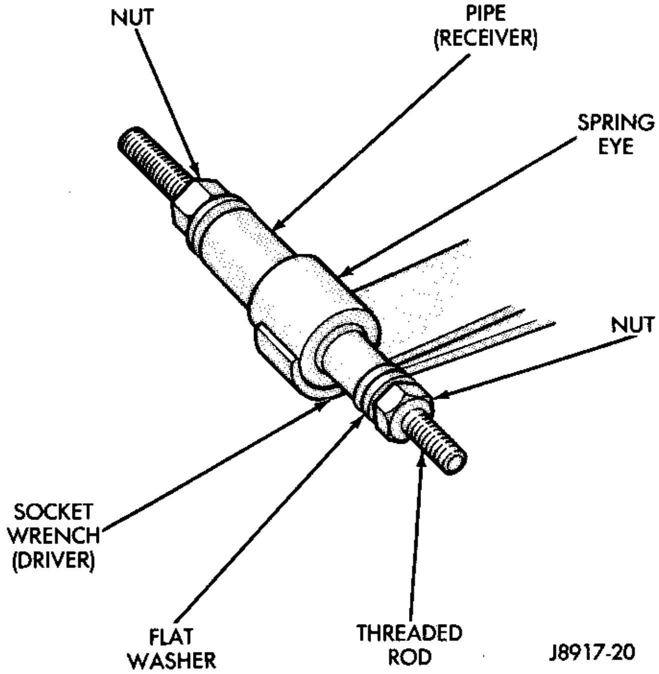


Fig. 25 Spring Eye Bushing Removal

The inside diameter of the pipe must be large enough to accept the bushing but the end of the pipe must completely mate with the spring eye end surface (Fig. 25).

(5) Install a flat washer and a hex nut on the threaded rod to secure the pipe against the spring eye (Fig. 25). Ensure that the flat washer is large enough in diameter to support and maintain the alignment of the pipe with the spring eye.

(6) Tighten both of the hex nuts "finger-tight" and align all the removal tool components.

(7) Ensure that the socket wrench is centered in the spring eye and is correctly aligned with the bushing.

The pipe must completely mate with the spring eye end surface so that the bushing will enter it when the socket wrench (the driver) forces the bushing out of the spring eye.

(8) Tighten the nut located at the socket wrench end of the threaded rod until the bushing is forced out of the spring eye and into the pipe.

(9) Remove the bushing removal tools and the bushing.

(10) Place a replacement bushing over the threaded rod.

(11) Assemble and align the bushing installation tools as described for the bushing removal above (Fig. 25).

(12) Align the bushing with the spring eye and tighten the nut located at the socket wrench end of the threaded rod until the bushing is forced into the spring eye.

(13) Loosen the bushing installation tools and examine the bushing position in the spring eye. The bushing must be centered in the spring eye. The ends of the bushing must be flush or slightly recessed within the end surfaces of the spring eye.

(14) If the bushing is not centered, use the bushing installation tools to correct the bushing position as necessary.

REAR STABILIZER BAR REPLACEMENT

Removal—XJ Vehicles

(1) Raise and support the vehicle.

(2) Disconnect the rear stabilizer bar links from the spring brackets (Fig. 26).

(3) Disconnect the rear stabilizer bar brackets from the frame rails (Fig. 26) and remove the stabilizer bar and links.

Installation—XJ Vehicles

(1) Position the rear stabilizer bar links at the spring brackets and install the attaching bolts and nuts (Fig. 26).

(2) Tighten the attaching nuts with 95 N•m (70 ft-lbs) torque.

(3) Attach the rear stabilizer bar to the frame rail brackets with the bolts (Fig. 26).

(4) Tighten the attaching nuts with 75 N•m (55 ft-lbs) torque.

(5) Remove the supports and lower the vehicle.

REAR TRACK BAR REPLACEMENT

Removal—SJ And YJ Vehicles

(1) Raise and support (if applicable) the vehicle.

Lift the vehicle either with the arms of a hoist positioned under the axle tubes or with a platform-type lifting device under the wheels/tires. It is important that the rear springs are supporting the weight of the vehicle (i.e., the springs at their usual position) when the replacement track bar is installed, otherwise it will be difficult to align the bolt hole with the bracket bolt holes. In addition, if the springs are not at their usual position when the track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(2) Remove the nut and the bolt that attach the track bar to the frame bracket (Fig. 27 and 28).

(3) Remove the nut, the washer and the bolt that attach the track bar to the axle shaft tube bracket (Fig. 27, Fig. 28).

(4) Remove the track bar from the vehicle.

Installation—SJ And YJ Vehicles

(1) Position the ends of the replacement track bar in the frame and axle shaft tube brackets and insert the attaching bolts through the bracket and track bar holes (Fig. 27 and 28).

If the rear springs are not at their usual position (i.e., supporting the weight of the vehicle) when the

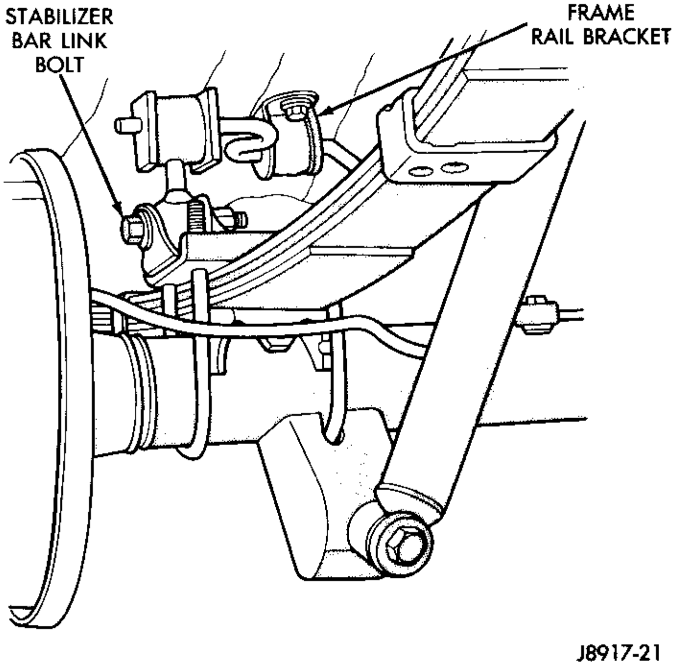


Fig. 26 Rear Stabilizer Bar Removal/Installation

replacement track bar attaching nuts are tightened, the vehicle "ride comfort" could be adversely affected.

(2) Install and tighten the track bar attaching nuts with 168 N•m (125 ft-lbs) torque.

(3) Remove the supports (if applicable) and lower the vehicle.

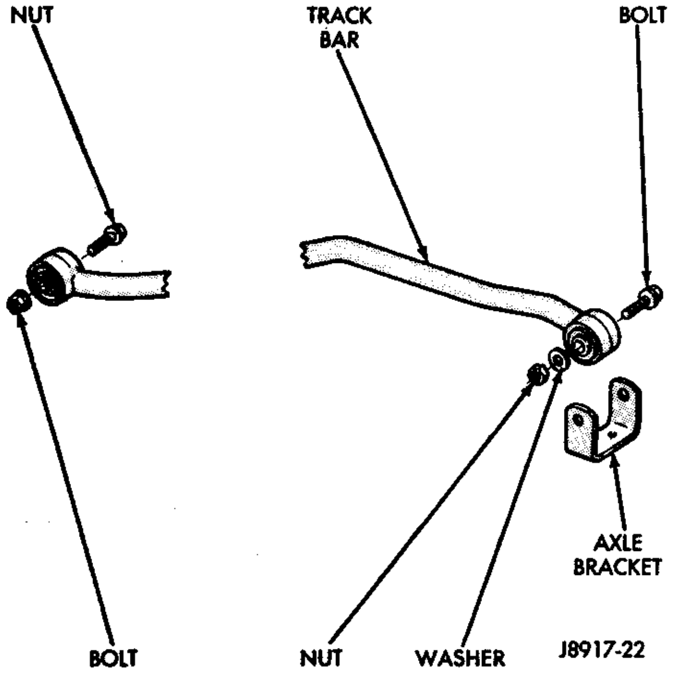


Fig. 27 Rear Track Bar—SJ Vehicles

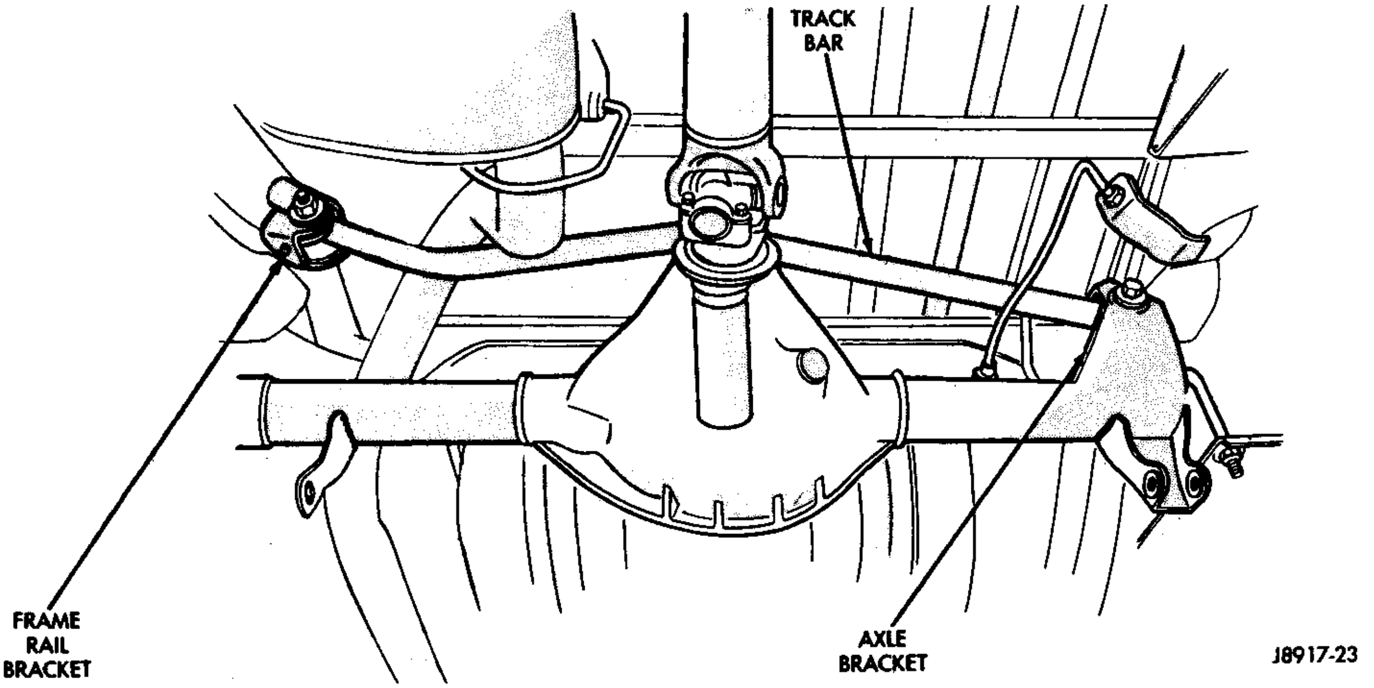


Fig. 28 Rear Track Bar—YJ Vehicles

SPECIFICATIONS

Torque Specifications—SJ Vehicles

COMPONENT	SERVICE SET-TO TORQUE	SERVICE RECHECK TORQUE
Shock Absorber Upper Locknut (1/2-20)	61 N·m (45 ft-lbs)	47-68 N·m (35-50 ft-lbs)
Shock Absorber Lower Locknut (1/2-20)	61 N·m (45 ft-lbs)	47-68 N·m (35-50 ft-lbs)
Spring Bracket U-Bolt Nut (9/16-18)	136 N·m (100 ft-lbs)	115-142 N·m (85-105 ft-lbs)
Spring Bracket U-Bolt Nut (1/2-20)	122 N·m (90 ft-lbs)	61-88 N·m (45-65 ft-lbs)
Spring Shackle and Eye Bolt/Nut	136 N·m (100 ft-lbs)	108-136 N·m (80-100 ft-lbs)
Stabilizer Bar Mounting Bracket Bolt (All)	47 N·m (35 ft-lbs)	37-61 N·m (27-45 ft-lbs)
Wheel Lug Nut	102 N·m (75 ft-lbs)	88-122 N·m (65-90 ft-lbs)
Spring Center Bolt	47 N·m (35 ft-lbs)	34-54 N·m (25-40 ft-lbs)
Stabilizer Bar Link Nut	75 N·m (55 ft-lbs)	65-84 N·m (48-62 ft-lbs)
Rear Track Bar-to-Axle or Frame Nut	168 N·m (125 ft-lbs)	122-214 N·m (90-156 ft-lbs)

J9017-1

Torque Specifications—MJ/XJ vehicles

COMPONENT	SERVICE SET-TO TORQUE	SERVICE RECHECK TORQUE
Front Shock Absorber Upper Bayonet Nut	11 N•m (8 ft-lbs)	7-19 N•m (5-14 ft-lbs)
Front Shock Absorber Lower Attaching Bolt Nut	19 N•m (14 ft-lbs)	16-22 N•m (12-16 ft-lbs)
Rear Shock Absorber-to-Axle or Spring Nut	60 N•m (44 ft-lbs)	50-70 N•m (37-51 ft-lbs)
Rear Shock Absorber-to-Body Nut (MJ Vehicles)	60 N•m (44 ft-lbs)	50-70 N•m (37-51 ft-lbs)
Rear Shock Absorber-to-Body Screws (XJ Vehicles)	20 N•m (15 ft-lbs)	17-23 N•m (13-17 ft-lbs)
Lower Suspension Arm-to-Axle Nut	115 N•m (85 ft-lbs)	98-133 N•m (72-98 ft-lbs)
Stabilizer Bar-to-Frame Rail Bracket Bolt/Nut	75 N•m (50 ft-lbs)	
Stabilizer Bar Link-to-Axle Bracket Nut	95 N•m (70 ft-lbs)	80-110 N•m (59-81 ft-lbs)
Drive Shaft Yoke Strap (at Front Axle) Bolt	19 N•m (170 in-lbs)	16-23 N•m (140-200 in-lbs)
Drag Link-to-Pitman Arm Nut	83 N•m (62 ft-lbs)	67-100 N•m (50-75 ft-lbs)
Track Bar-to-Frame Rail Bracket Nut	48 N•m (35 ft-lbs)	41-54 N•m (30-40 ft-lbs)
Rear Spring Front Eye Bolt Nut	88 N•m (65 ft-lbs)	82-95 N•m (60-70 ft-lbs)
Rear Spring Shackle-to-Body-Nut	88 N•m (65 ft-lbs)	82-95 N•m (60-70 ft-lbs)
Rear Spring U-Bolt Nut (MJ Vehicles)	88 N•m (65 ft-lbs)	82-95 N•m (60-70 ft-lbs)
Rear Spring U-Bolt Nut (XJ Vehicles)	70 N•m (52 ft-lbs)	60-80 N•m (44-59 ft-lbs)
Rear Spring-to-Shackle Nut	88 N•m (65 ft-lbs)	82-95 N•m (60-70 ft-lbs)

J9017-2

Torque Specifications—YJ Vehicles

COMPONENT	SERVICE SET-TO TORQUE	SERVICE RECHECK TORQUE
Front Shock Upper Stud Nut	13 N·m (9 ft-lbs)	7-19 N·m (5-14 ft-lbs)
Front Shock Lower Eye Bolt	61 N·m (45 ft-lbs)	47-75 N·m (35-55 ft-lbs)
Rear Shock Upper Nut and Lower Bolt	60 N·m (44 ft-lbs)	50-70 N·m (37-51 ft-lbs)
Front Track Bar-to-Frame Nut	168 N·m (125 ft-lbs)	122-214 N·m (90-156 ft-lbs)
Front Track Bar-to-Axle Bolt and Nut	100 N·m (74 ft-lbs)	90-110 N·m (67-81 ft-lbs)
Rear Track Bar-to-Frame and Axle Bolt	168 N·m (125 ft-lbs)	122-214 N·m (90-156 ft-lbs)
Stabilizer Bar-to-Link Bolt	61 N·m (45 ft-lbs)	48-75 N·m (35-55 ft-lbs)
Stabilizer Bar Bracket Bolt	41 N·m (30 ft-lbs)	34-48 N·m (25-35 ft-lbs)
Stabilizer Bar Link-to-Spring Bracket Nut	61 N·m (45 ft-lbs)	48-75 N·m (35-55 ft-lbs)
Spring Bracket U-Bolt Nuts	122 N·m (90 ft-lbs)	108-136 N·m (80-100 ft-lbs)
Front/Rear Spring Eye-to-Shackle Bolt	129 N·m (95 ft-lbs)	115-142 N·m (85-105 ft-lbs)
Front/Rear Spring Eye-to-Frame Bracket Bolt	142 N·m (105 ft-lbs)	129-156 N·m (95-115 ft-lbs)
Jounce Bumper Screw	18 N·m (13 ft-lbs)	15-20 N·m (11-15 ft-lbs)
Front/Rear Wheel Lug Nut	102 N·m (75 ft-lbs)	81-122 N·m (60-90 ft-lbs)

J9017-3

STEERING

CONTENTS

GENERAL INFORMATION

DESCRIPTION

Jeep vehicles can be equipped with either manual steering or a power steering system (Fig. 1). A recirculating-ball type steering gear is used for both systems.

A Jeep vehicle power steering system consists of a steering gear, the interconnecting hoses and fittings, and a belt-driven power steering pump with either an integral or a remote fluid reservoir (Fig. 2):

- integral—SJ and YJ vehicles, and
- remote—MJ/XJ vehicles.

The power steering pumps are constant displacement, vane-type pumps. With the integral (vane-submerged) reservoir type pump, the pump housing and internal components are combined with the reservoir to form a one-piece mechanism. With the remote reservoir (vane-nonsubmerged) type pump, fluid hoses are used to connect the remote reservoir to the pump. The pump shafts have a “pressed-on” pulley that is belt driven by the crankshaft pulley.

Two general types of steering columns are installed on Jeep vehicles: a fixed, non-tiltable column and a tiltable column (Fig. 3).

A multi-position, tiltable column is available as an option with either manual or automatic transmissions. Vehicles equipped with an automatic transmission can have either a tiltable or fixed (non-tilt) column with a column-mounted gear shift/selector mechanism. Vehicles equipped with a manual transmission can have either a tiltable or fixed (non-tilt) column with an ignition key release lever.

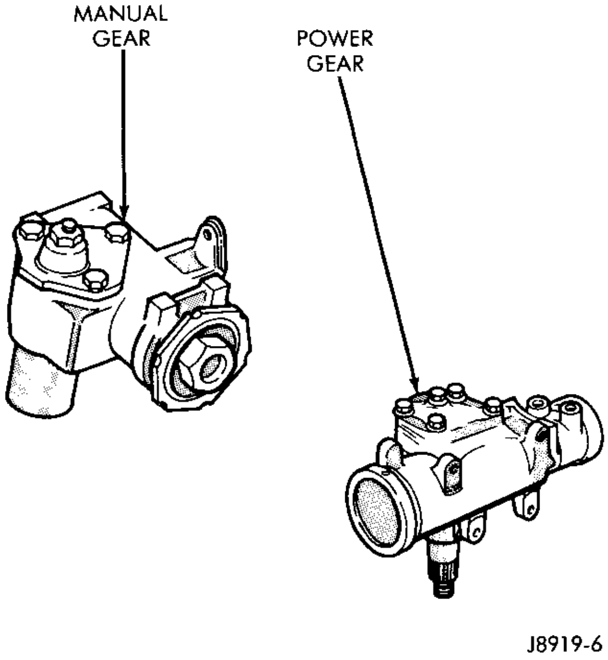


Fig. 1 Steering Gears

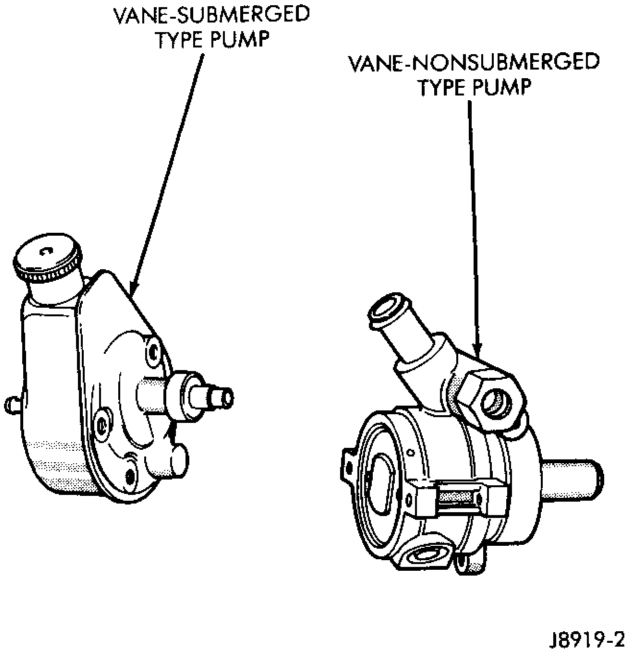


Fig. 2 Power Steering Pumps

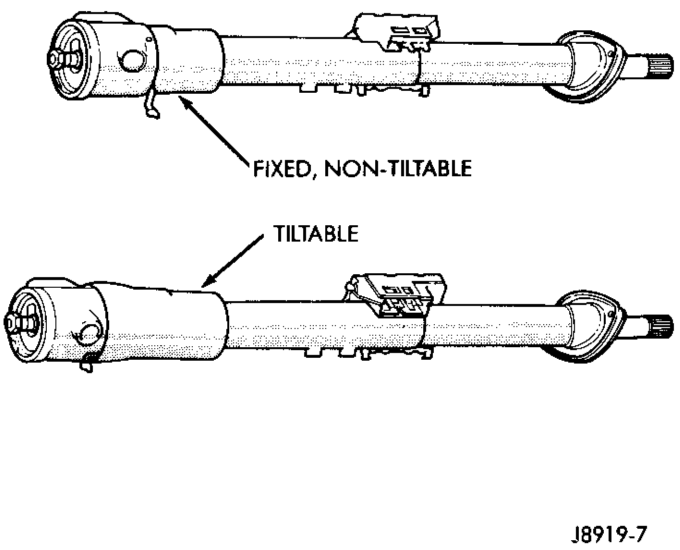


Fig. 3 Steering Columns

The ignition key/lock cylinder and the ignition switch are located in the steering column. When the key/lock cylinder is turned to the LOCK position, the ignition switch and the steering shaft cannot be operated. For vehicles with an automatic transmission, the lock mechanism also prevents operation of the column-mounted gear shift/selector mechanism.

The center, slip-type (telescoping) intermediate shaft is attached to the steering gear with a flexible coupling and to the steering column shaft with a universal joint.

Both types of steering columns have anti-theft provisions, plus they are energy-absorbing (i.e., compress from impact in the event of a front-end collision).

The tiltable steering column has a "spring-loaded", movable upper housing that provides multi-steering wheel positions in a vertical plane.

MANUAL STEERING GEAR

SERVICE PROCEDURES AND DIAGNOSIS

Pitman Shaft Seal—Replacement

(1) Raise and support the vehicle. Place the front wheels in the straight-ahead position.

(2) If necessary, remove the front stabilizer bar.

(3) Disconnect the drag link from the pitman arm.

(4) Mark the pitman arm and the pitman shaft positions for installation reference and remove the pitman arm from the pitman shaft with a puller tool (Fig. 1).

(5) Remove the pitman shaft seal with a pointed tool or a screw driver with a small blade.

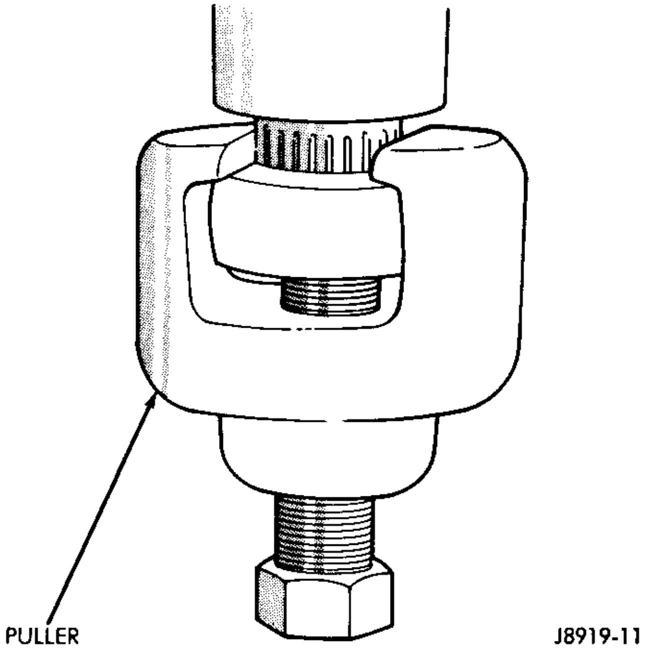


Fig. 1 Pitman Arm Removal

(6) Inspect the condition of the steering gear lubricant. If it is contaminated (e.g., contains metal particles), remove and recondition the steering gear.

CAUTION: A protective wrap must be used to enclose the shaft threads/splines during the shaft seal installation. If the shaft seal is installed over exposed shaft threads or splines, the seal lip could be cut or distorted and result in leakage after installation.

(7) Wrap the pitman shaft threads/splines with 0.1-mm (0.005-in) thick shimstock (or a single layer of the thinnest plastic tape available) to protect the replacement seal during installation.

(8) Lubricate the lip of the replacement seal with chassis lubricant. Slide the seal over the shimstock/tape and shaft and into the steering gear housing recess. Remove the shimstock/tape from the shaft. Complete the seal installation by tapping the seal with a small plastic mallet to "seat" it in the housing recess.

(9) With the arm and the shaft installation reference marks aligned, position the pitman arm on the pitman shaft.

(10) Install the washers and the retaining nut on the pitman shaft and tighten the nut with 251 N•m (185 ft-lbs) torque (all vehicles).

WARNING: The pitman arm retaining nut must be securely "staked" against the pitman shaft threads for safe retention.

(11) "Stake" the pitman arm retaining nut against the pitman shaft threads.

(12) Connect the drag link to the pitman arm. Tighten the retaining nut with 81 N•m (60 ft-lbs) torque (all vehicles). Install a replacement cotter pin.

(13) If removed, install the front stabilizer bar.

(14) Remove the supports and lower the vehicle.

Service Diagnosis

CONDITION	POSSIBLE CAUSE	CORRECTION
HARD OR ERRATIC STEERING	(1) Incorrect tire pressure.	(1) Inflate tires to recommended pressures.
	(2) Insufficient or incorrect lubrication.	(2) Lubricate as required (refer to Maintenance Section.
	(3) Suspension, or steering linkage parts damaged or misaligned.	(3) Repair or replace parts as necessary.
	(4) Improper front wheel alignment.	(4) Adjust incorrect wheel alignment angles.
	(5) Incorrect steering gear adjustment.	(5) Adjust steering gear.
	(6) Sagging springs.	(6) Replace springs.
PLAY OR LOOSENESS IN STEERING	(1) Steering wheel loose.	(1) Inspect shaft splines and repair as necessary. Tighten attaching nut and stake in place.
	(2) Steering linkage or attaching parts loose or worn.	(2) Tighten, adjust, or replace faulty components.
	(3) Pitman arm loose.	(3) Inspect shaft splines and repair as necessary. Tighten attaching nut and stake in place.
	(4) Steering gear attaching bolts loose.	(4) Tighten bolts.
	(5) Loose or worn wheel bearings.	(5) Adjust or replace bearings.
	(6) Steering gear adjustment incorrect or parts badly worn.	(6) Adjust gear or replace defective parts.
WHEEL SHIMMY OR TRAMP	(1) Improper tire pressure.	(1) Inflate tires to recommended pressures.
	(2) Wheels, tires, or brake rotors out-of-balance or out-of-round.	(2) Inspect and replace or balance parts.
	(3) Inoperative, worn, or loose shock absorbers or mounting parts.	(3) Repair or replace shocks or mountings.
	(4) Loose or worn steering or suspension parts.	(4) Tighten or replace as necessary.
	(5) Loose or worn wheel bearings.	(5) Adjust or replace bearings.
	(6) Incorrect steering gear adjustments.	(6) Adjust steering gear.
	(7) Incorrect front wheel alignment.	(7) Correct front wheel alignment.
TIRE WEAR	(1) Improper tire pressure.	(1) Inflate tires to recommended pressures.
	(2) Failure to rotate tires.	(2) Rotate tires.
	(3) Brakes grabbing.	(3) Adjust or repair brakes.

J8919-8

Service Diagnosis (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTION
TIRE WEAR (Continued)	(4) Incorrect front wheel alignment.	(4) Align incorrect angles.
	(5) Broken or damgaed steering and suspension parts.	(5) Repair or replace defective parts.
	(6) Wheel runout.	(6) Replace faulty wheel.
	(7) Excessive speed on turns.	(7) Make driver aware of condition.
VEHICLE LEADS TO ONE SIDE	(1) Improper tire pressures.	(1) Inflate tires to recommended pressures.
	(2) Front tires with uneven tread depth, wear pattern, or different cord design (i.e., one bias ply and one belted or radial tire on front wheels).	(2) Install tires of same cord construction and reasonably even tread depth, design, and wear pattern.
	(3) Incorrect front wheel alignment.	(3) Align incorrect angles.
	(4) Brakes dragging.	(4) Adjust or repair brakes.
	(5) Pulling due to uneven tire construction.	(5) Replace faulty tire.

J8919-9

Manual Steering Gear Specifications

Wormshaft Bearing Preload Torque	0.6-0.9 N•m (5 to 8 in-lbs)
Pitman Shaft Overcenter Drag Torque	0.5-1 N•m (4 to 10 in-lbs) (in addition to above)
Maximum Steering Gear Torque	2 N•m (18 in-lbs) total (maximum)
Steering Gear Lubricant	Multi-purpose chassis grease
Steering Gear Ratio	24:1
Steering Gear Type	Recirculating Ball

J9019-2

Steering Gear—Adjustments On Vehicle

CAUTION: Adjust the steering gear in the following order only. Always adjust the wormshaft bearing "preload" torque first, and then adjust the pitman shaft overcenter drag torque last. Failure to do so could result in damage to the gear or improper steering response.

(1) Raise and support the vehicle. Check and correct the steering gear retaining bolt torque, if necessary.

(2) If necessary, remove the front stabilizer bar.

(3) Mark the pitman arm and pitman shaft positions for installation reference.

(4) Remove the pitman arm retaining nuts (and washers) and remove the pitman arm with a puller tool (Fig. 1).

(5) Loosen the pitman shaft adjustment screw locknut and loosen the adjustment screw 2 - 3 turns.

CAUTION: Do not turn the steering wheel hard against the stop when the linkage is disconnected. This could result in damage to the steering gear recirculating ball guides.

(6) Remove the horn button or cover from the steering wheel. Slowly turn the steering wheel in one direction until stopped by the steering gear; then turn the wheel back 1/2 of-a-turn.

(7) Place a low calibration (e.g., inch-pounds) torque bar with a socket wrench on the steering wheel nut. Measure the wormshaft bearing "preload" torque by rotating the steering wheel through a 90° arc (1/4 of-a-turn). The "preload" should be 0.6 to 1 N•m (5 to 8 in-lbs) torque.

(8) Steering column/shaft misalignment or damage will increase the amount of torque required to rotate the steering wheel. If the rotating torque is exceptionally high, inspect the steering column/shaft alignment. If the alignment is correct, remove the steering gear, determine the cause of the high "preload" torque, and repair as necessary.

(9) If a "preload" torque adjustment is necessary, loosen the wormshaft bearing adjustment cap locknut and (as applicable) turn the adjustment cap clockwise to increase the "preload" torque or counterclockwise to decrease the "preload" torque. After the specified "preload" torque is obtained, tighten the adjustment cap locknut with 68 N•m (50 ft-lbs) torque and measure the "preload" torque. If necessary, adjust the "preload" torque again.

CAUTION: Do not attempt to adjust the pitman shaft overcenter drag torque before the wormshaft bearing "preload" torque has been adjusted.

(10) Adjust the pitman shaft overcenter drag torque:

- rotate the steering wheel slowly from stop-to-stop, count the total number of steering wheel rotations, and rotate the steering wheel in the reverse direction 1/2 of the total number of rotations to center the steering gear;
- rotate the steering wheel 1/2 of-a-turn from the center position;
- place a low calibration (e.g., inch-pounds) torque bar with a socket wrench on the steering wheel nut and measure the torque required to rotate the steering gear through the center of travel (this is the overcenter drag torque);
- the overcenter drag torque should be equal to the wormshaft bearing "preload" torque plus 0.5 to 1 N•m (4 to 10 in-lbs) torque but must not exceed a total of 2 N•m (18 in-lbs) torque;
- example-
- the wormshaft bearing "preload" torque is 0.7 N•m (6 in-lbs) torque,
- the overcenter drag torque is 1.5 N•m (13 in-lbs) torque,
- the 0.8 N•m (7 in-lbs) torque in addition to the wormshaft bearing "preload" torque is acceptable,
- the total of 1.5 N•m (13 in-lbs) overcenter drag torque is also acceptable;
- if an adjustment is required, loosen or tighten the adjustment screw to obtain an acceptable overcenter drag torque;
- hold the pitman shaft adjustment screw and tighten the locknut with 34 N•m (25 ft-lbs) torque; and
- after tightening the locknut, measure the overcenter drag torque again and readjust the torque, if necessary.

(11) With the arm and the shaft installation reference marks aligned, position the pitman arm on the pitman shaft.

(12) Install the washers and the retaining nut on the pitman shaft and tighten the nut with 251 N•m (185 ft-lbs) torque.

WARNING: The pitman arm retaining nut must be securely "staked" against the pitman shaft threads for safe retention.

(13) "Stake" the pitman arm retaining nut against the pitman shaft threads.

(14) Connect the drag link to the pitman arm. Tighten the retaining nut with 81 N•m (60 ft-lbs) torque (all vehicles). Install a replacement cotter pin.

(15) If removed, install the front stabilizer bar.

(16) Remove the supports and lower the vehicle.

(17) Install the horn button or cover.

Steering Gear—Removal

(1) Disconnect the steering intermediate shaft from the steering gear.

(2) Raise and support the vehicle.

(3) Disconnect the drag link from the pitman arm.

(4) If necessary, remove the front stabilizer bar.

(5) Remove the pitman arm retaining nut and washers, mark the pitman arm and the pitman shaft positions for installation reference and remove the pitman arm from the pitman shaft with a puller tool (Fig. 2).

(6) Remove the steering gear retaining bolts and the steering gear from the vehicle.

Steering Gear—Disassembly

(1) Remove the flexible coupling.

(2) Position the steering gear in a vise and clamp it in-place at the mounting bosses only.

(3) Rotate the wormshaft from stop-to-stop and count the total number of rotations. Rotate the wormshaft in the reverse direction 1/2 of the total number of rotations to center it and the ball nut.

(4) Remove the pitman shaft adjustment screw locknut. Remove the cover retaining bolts, cover, and gasket (Fig. 3).

(5) Slide the adjustment screw head (Fig. 3) out of the pitman shaft T-slot and remove it and the shim(s).

(6) Retain the shim(s) for "end-play" measurement during assembly.

(7) Remove the pitman shaft, the wormshaft bearing

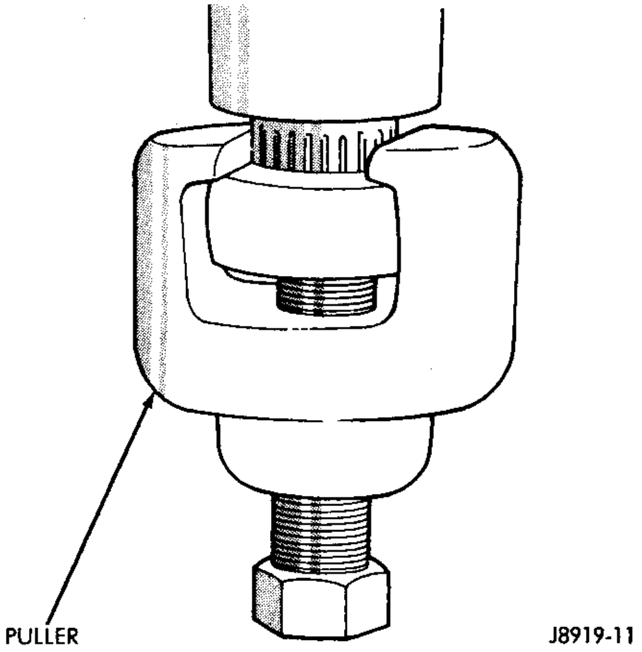


Fig. 2 Pitman Arm Removal

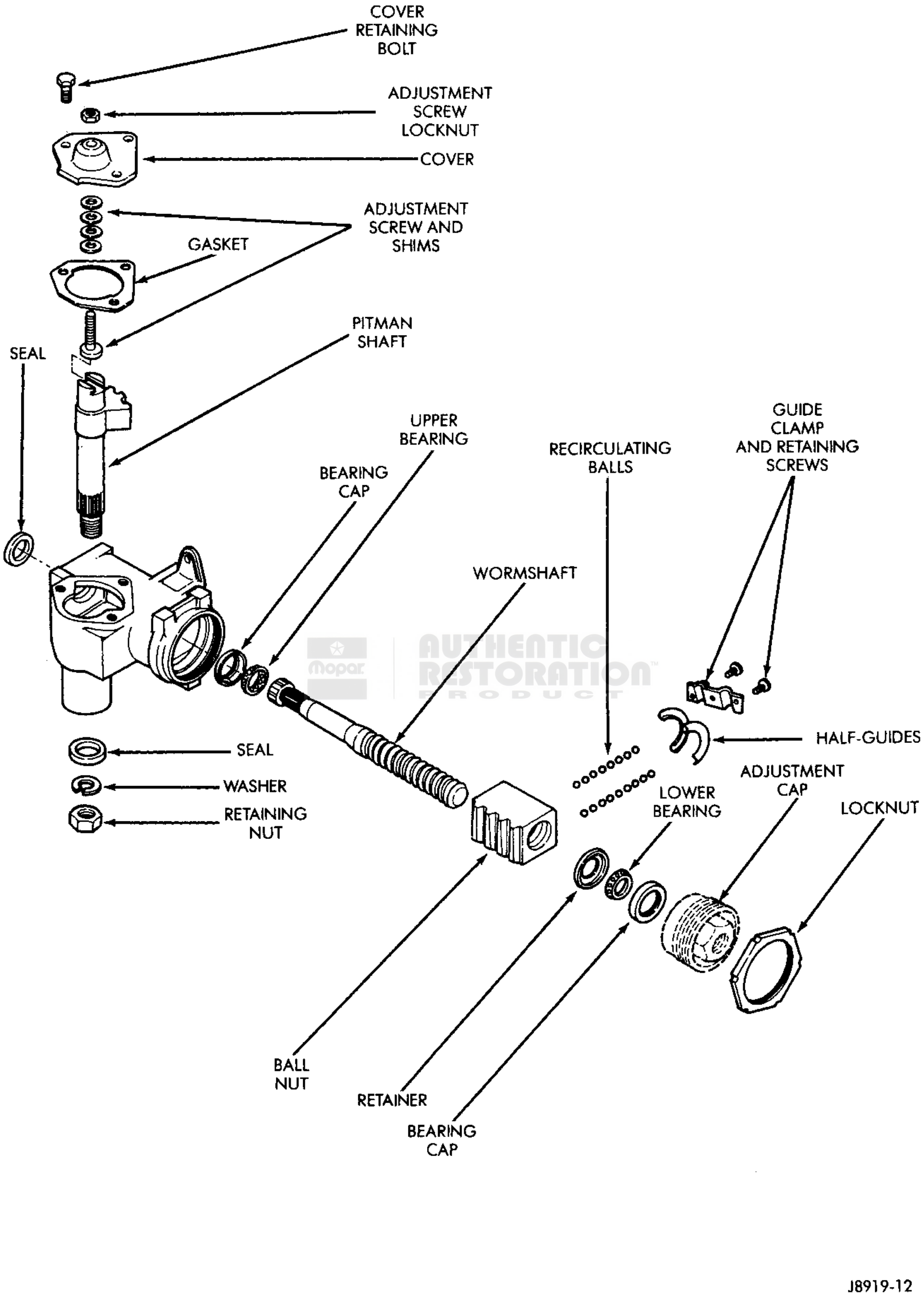


Fig. 3 Manual Steering Gear — Exploded View

"preload" torque adjustment cap locknut, and the adjustment cap (Fig. 3).

(8) Remove the wormshaft and the ball nut (Fig. 3).

(9) Remove (pry) the pitman shaft and the wormshaft seals from the steering gear housing (Fig. 4).

Wormshaft And Ball Nut—Disassembly

(1) Remove the upper bearing from the wormshaft (Fig. 3).

CAUTION: Do not allow the ball nut to rotate freely and travel to either extreme end of the wormshaft. This could damage the tangs at the ends of the recirculating ball guides (Fig. 3).

(2) Remove the recirculating ball guide clamp retaining screws, the clamp and the guides (Fig. 3). Separate the half-guides and place the recirculating balls aside in a container.

(3) Hold the ball nut over a cloth and remove the remaining recirculating balls from the ball nut circuits by rotating the wormshaft back and forth until the balls drop out on the cloth.

There are a total of 50 recirculating balls within the ball nut and the guides (25 in each circuit).

(4) Remove the wormshaft from the ball nut (Fig. 3).

Wormshaft And Ball Nut—Cleaning And Inspection

(1) Clean all the components in a cleaning solvent and dry them with a clean cloth and/or compressed air.

(2) Inspect each component for wear, scoring, cracks, nicks and surface pitting. Replace as necessary.

Wormshaft And Ball Nut—Assembly

CAUTION: The ball nut teeth are wider and deeper on one side than on the other. When assembling the wormshaft and ball nut, position the ball nut so that the wider/deeper side of the teeth is closer to the housing cover opening after installation.

(1) Position the ball nut with the recirculating ball guide holes facing upward and the ball nut teeth facing downward. Install the wormshaft in the ball nut. Rotate the shaft and thread it into the nut until an equal number of shaft threads are visible at each end of the nut (Fig. 5).

(2) Install one recirculating ball in each ball guide hole. Move the wormshaft up/down and side-to-side until the balls roll into the ball nut threads at the bottom of wormshaft and support the wormshaft.

(3) Assemble and install the ball guides in the ball nut (Fig. 6).

(4) Divide the remaining 48 recirculating balls into two groups and install 24 balls in each ball nut circuit. Insert the balls in the ball nut circuits through the holes in the ball guides (Fig. 6).

To aid the recirculating ball installation, rotate wormshaft back and forth slightly while inserting the balls.

(5) Place the ball guide clamp on the ball nut and install the clamp retaining screws (Fig. 3). Tighten the screws with 14 N•m (10 ft-lbs) torque.

CAUTION: To avoid damaging the tangs on the ball guide ends, do not allow the wormshaft to travel to the end of the thread in either direction.

(6) Lubricate the wormshaft threads with chassis lubricant and rotate the shaft to move it in-and-out of the ball nut and distribute the lubricant.

(7) Lubricate the wormshaft upper bearing with chassis lubricant and install it on the wormshaft.

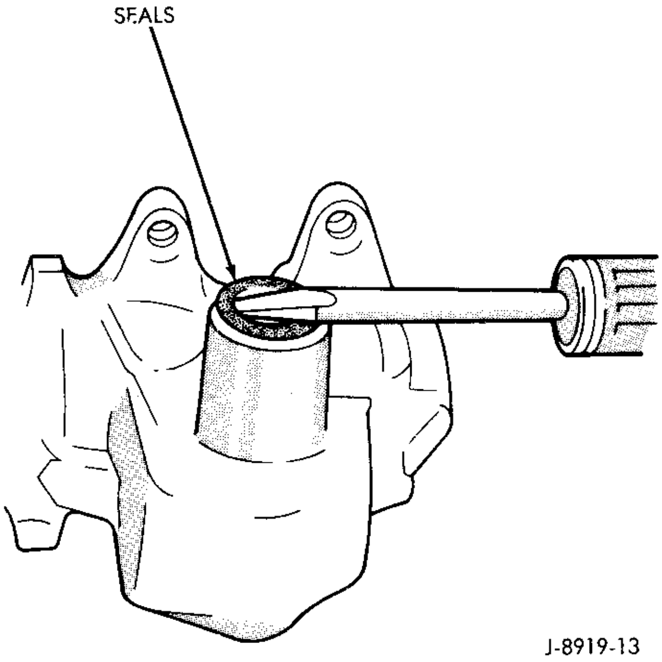


Fig. 4 Shaft Seal Removal

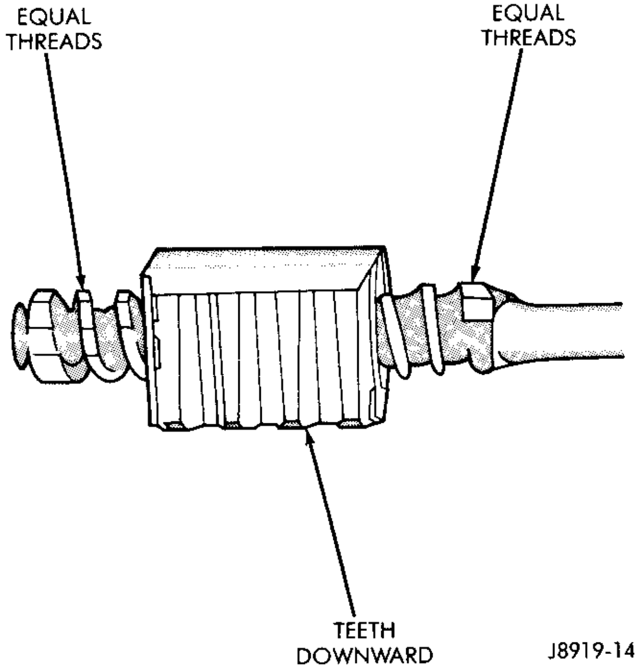


Fig. 5 Wormshaft & Ball Nut

Wormshaft Bearing Adjustment Cap—Disassembly

(1) Pry out and remove the wormshaft lower bearing retainer from the adjustment cap (Fig. 7).

(2) Remove the wormshaft lower bearing from the adjustment cap.

Wormshaft Bearing Adjustment Cap—Cleaning/Inspection

(1) Clean all the components in cleaning solvent and dry with a clean cloth only.

(2) Inspect each component for wear and damage. Replace as necessary.

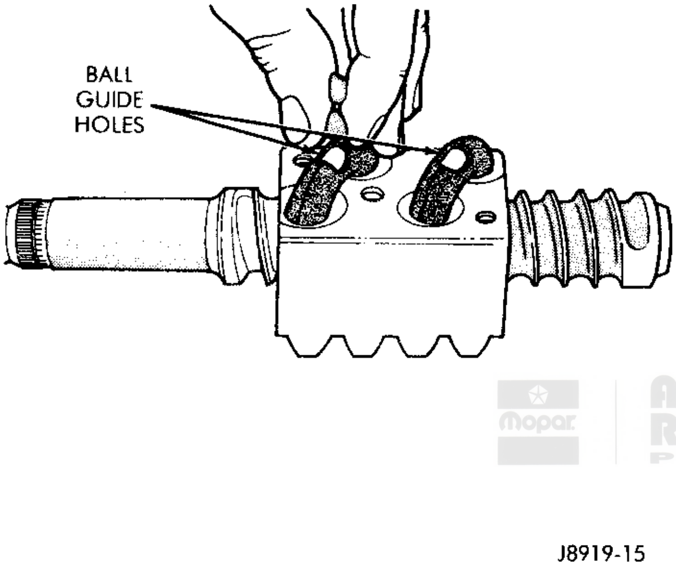


Fig. 6 Recirculating Ball Installation

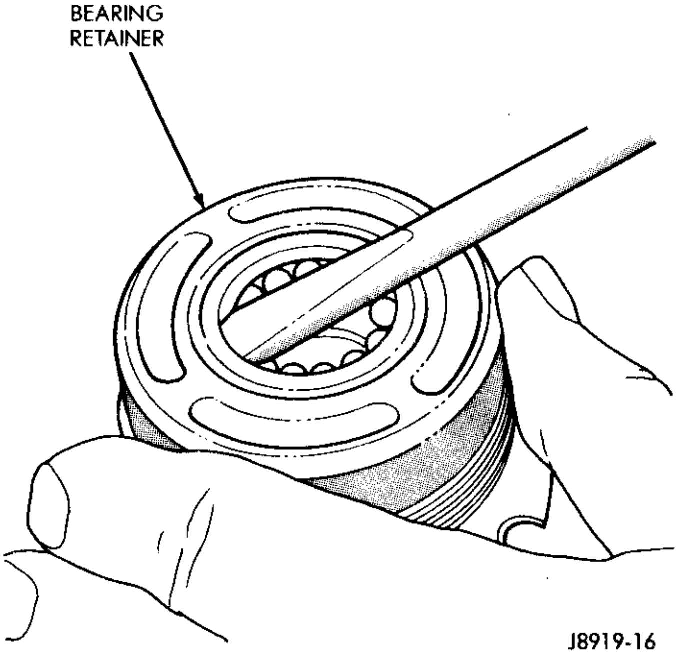


Fig. 7 Wormshaft Lower Bearing Retainer Removal

Wormshaft Bearing Adjustment Cap—Assembly

(1) If the lower bearing cup must be replaced, remove the original cup (Fig. 8) and install a replacement cup (Fig. 9) according to the following instructions:

- install a spare locknut on the adjustment cap (Fig. 8) and clamp the cap in a vise **(clamp the vise jaws on the locknut only)**;
- assemble a puller tool and a slide hammer;
- position the puller tool legs between the bearing cup and the inside of the adjustment cap (Fig. 8);
- tighten the puller tool screw (Fig. 8) to expand and hold the legs in position;
- move the slide hammer weight outward to remove the bearing cup from the adjustment cap (Fig. 8);
- remove the adjustment cap from the vise and remove the spare locknut; and
- install a replacement bearing cup in the adjustment cap with an appropriate installation tool (Fig. 9).

(2) Lubricate the wormshaft lower bearing and place it in the bearing cup.

(3) Install the lower bearing retainer on the adjustment cap. If necessary, tap the retainer lightly with a plastic mallet to “seat” it.

Steering Gear—Cleaning And Inspection

(1) Clean the housing and the pitman shaft with cleaning solvent and dry them with a clean cloth and/or compressed air.

(2) Inspect the housing for cracks, porosity, damaged threads and scoring/distortion of the gasket surface area. Repair or replace as necessary.

(3) Inspect the pitman shaft contact surface and the sector teeth for wear, pitting, and other damage. Replace as necessary.

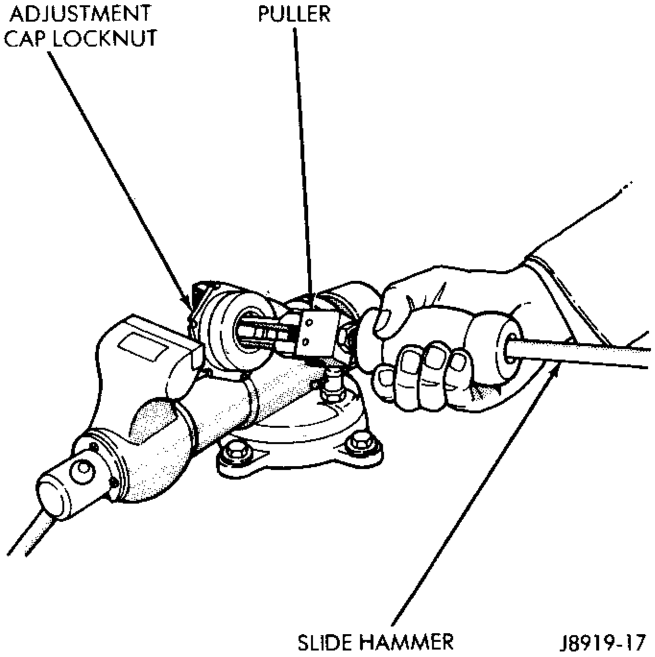


Fig. 8 Bearing Cup Removal

(4) Insert the pitman shaft in the steering gear housing shaft bore and inspect for excessive shaft or housing shaft bore wear. The shaft should have a smooth, "bind-free" fit with no visible side play when installed in the shaft bore.

(5) If the shaft fit is loose but it is not visibly worn, trail fit a replacement pitman shaft in the housing shaft bore. If the replacement shaft also has a loose fit, replace the housing. However, if the replacement pitman fits properly, replace the original pitman shaft.

(6) Measure the pitman shaft adjustment screw fit and "end-play" in the T-slot (Fig. 10). When installed, the adjustment screw must rotate freely and not bind in any position. Measure the "end-play" by inserting a feeler gauge between the screw head and the T-slot surface. **The "end-play" must not exceed 0.05 mm (0.002 in). If the "end-play" exceeds the specified limit, select and install a replacement shim that reduces the "end-play" to below the specified limit.**

(7) Inspect the wormshaft shaft upper bearing and bearing cup for wear, looseness, flat spots, pitting, cracks, and other damage. If either the bearing or the bearing cup is damaged, both components must be replaced.

(8) If the cup fits loosely in the housing, trial fit a replacement cup. If the replacement cup also fits loosely, replace the housing. If the replacement cup fits properly, replace only the original bearing cup.

Steering Gear—Assembly

(1) If the original wormshaft upper bearing cup must be replaced because of damage, remove it with a hammer and a brass punch (Fig. 11).

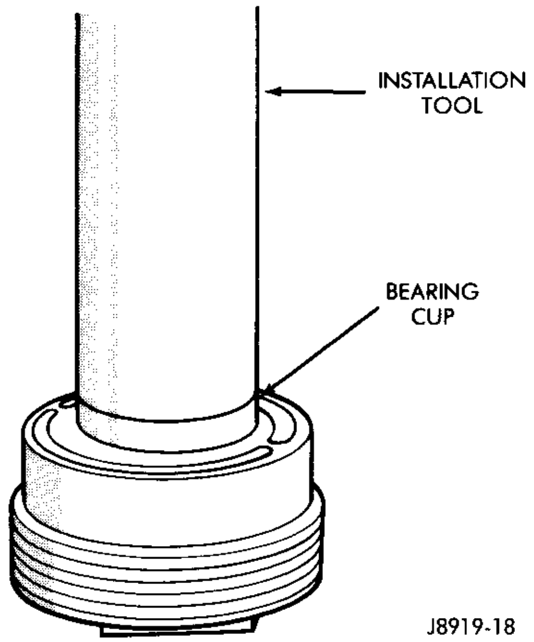


Fig. 9 Bearing Cup Installation

(2) Install a replacement bearing cup with an appropriate installation tool (Fig. 12).

Do not install the wormshaft or the pitman shaft seals at this time.

(3) Lubricate all the components with chassis lubricant.

(4) Place the steering gear housing in a vise. Clamp the vise jaws on the housing mounting bosses only.

(5) Install the wormshaft and ball nut in the steering gear housing.

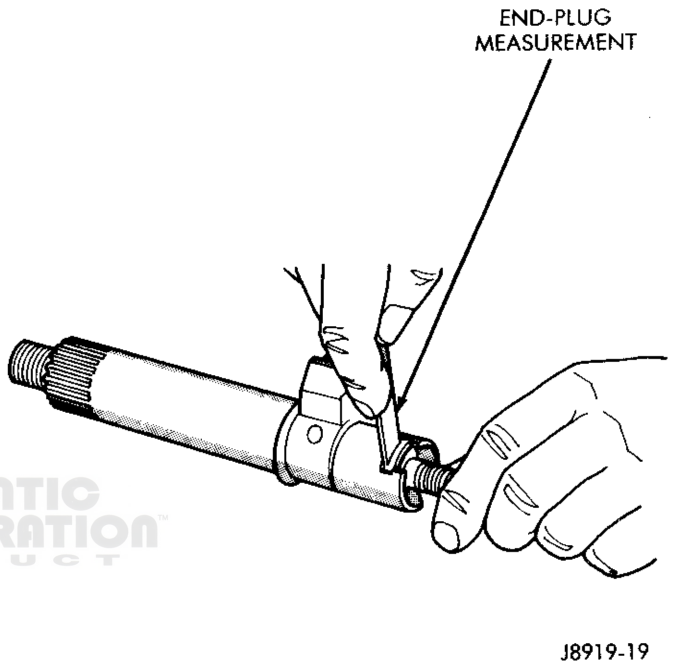


Fig. 10 Adjustment Screw End-Play Measurement

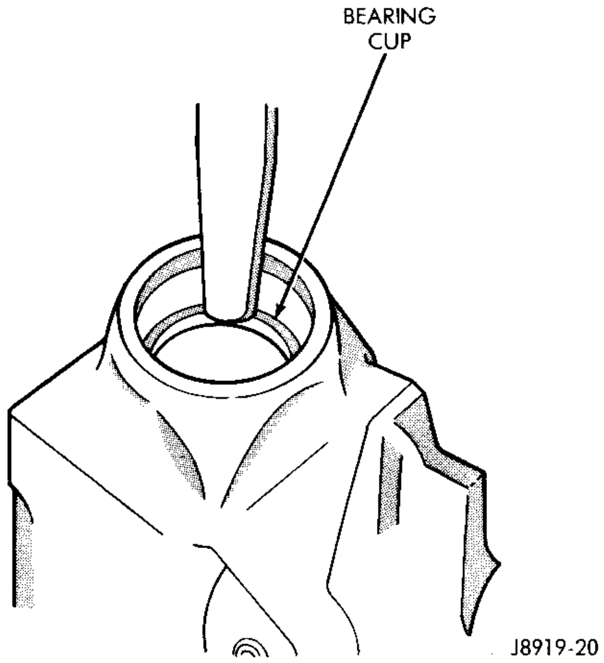


Fig. 11 Wormshaft Upper Bearing Cup Removal

CAUTION: Ensure that the ball nut is installed with the wide/deep side of the ball nut teeth facing toward the cover opening.

(6) Install the wormshaft bearing adjustment cap in the housing and tighten it only enough to remove the wormshaft "end-play".

(7) Install the locknut on the wormshaft bearing adjustment cap but do not tighten it at this time.

(8) Pack the steering gear housing with as much chassis lubricant as possible.

To be able to pack the maximum amount of lubricant into the housing, the ball nut must be moved back and forth for better access to the housing interior. Rotate the wormshaft in one direction until the ball nut ceases. Pack the unobstructed end of the housing full of lubricant, rotate the shaft in the opposite direction and repeat the packing procedure.

(9) Place the ball nut (Fig. 13) in the centered position (i.e., rotate the wormshaft from stop-to-stop and count the total number rotations, and then rotate wormshaft in the reverse direction 1/2 of the total number of rotations to center the ball nut).

(10) Lubricate the pitman shaft with chassis lubricant and insert it in the steering gear housing. Engage the center tooth on the shaft with the center groove on the ball nut.

(11) Apply chassis lubricant to the replacement housing cover gasket and position it so that it surrounds the housing cover opening.

(12) Place the shim(s) on the adjustment screw and thread the screw into the cover to a depth of 2 to 3 threads.

(13) Slide the head of the adjustment screw into the pitman shaft T-slot and, with the cover in place, rotate the screw counterclockwise to thread it into the cover. Rotate the screw until the cover almost comes in contact with the gasket.

(14) Install the cover retaining bolts and "finger tighten" them only. Continue tightening the adjustment screw counterclockwise until the cover is tight against the gasket and then loosen the screw 1/2 rotation.

(15) Tighten the cover bolts with 61 N•m (45 ft-lbs) torque.

CAUTION: A protective wrap must be used to enclose the shaft threads/splines during the shaft seal installation. If the shaft seals are installed over exposed shaft splines or threads, the seal lips could be cut or distorted and result in leakage after assembly.

(16) Install the pitman shaft and wormshaft seals according to the following procedure:

- wrap the pitman shaft threads/splines with 0.1-mm (0.005-in) thick shimstock (or a single layer of the thinnest plastic tape available) to protect the replacement seals during installation;
- lubricate the lips of the replacement seals with chassis lubricant;
- slide the seals over the shimstock/tape and shaft and into the steering gear housing recess;
- remove the shimstock/tape from the shaft;
- complete the seal installation by tapping the seals into the recesses with a small plastic mallet; and
- ensure that each seal is fully "seated" in the housing recess.

(17) Rotate the wormshaft and observe the steering gear operation. With the adjustment screw and the cap loose, the wormshaft should rotate freely and not "bind"

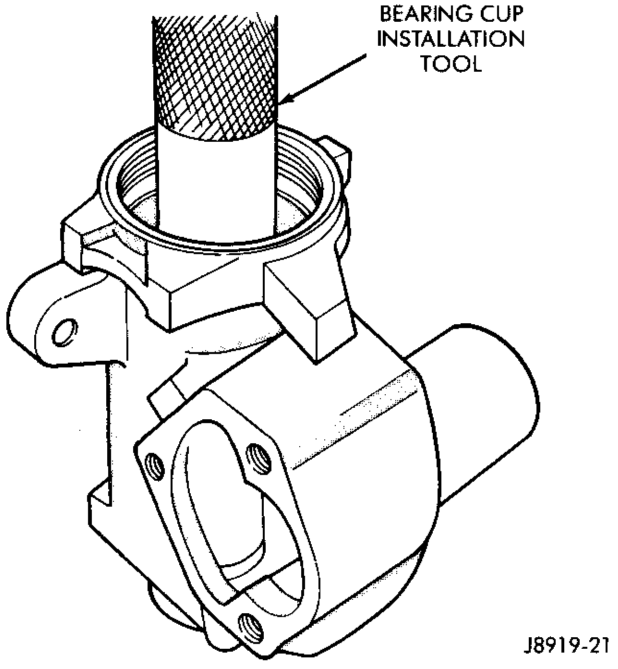


Fig. 12 Wormshaft Upper Bearing Cup Installation

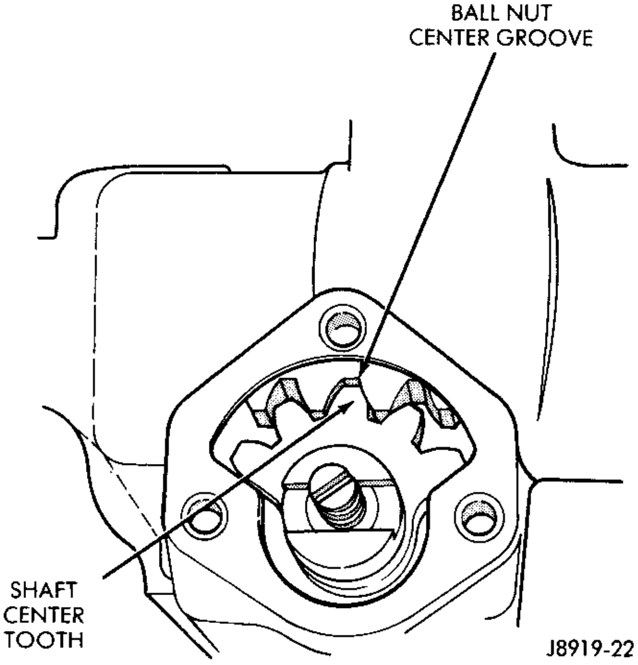


Fig. 13 Pitman Shaft & Ball Nut Engagement

in either direction of rotation. If the steering gear "binds", repair as necessary.

(18) Inspect for lubricant leakage from the shaft seals. If there is a leak at either seal, replace the defective seal(s).

Steering Gear—Adjustments On Bench

A recirculating-ball type steering gear requires two adjustments after assembly:

- wormshaft bearing "preload" torque, and
- pitman shaft overcenter drag torque.

CAUTION: Adjust the steering gear in the following order only. Always adjust the wormshaft bearing "preload" torque first, and then adjust the pitman shaft overcenter drag torque last. Failure to do so could result in damage to the gear or improper steering response.

(1) Tighten the wormshaft bearing adjustment cap until it is "snug" tight against the bearing, then loosen the adjustment cap 1/4 of-a-turn.

(2) Install a low calibration (e.g., inch-pounds) torque bar with a socket wrench on the splined end of the wormshaft.

The "preload" torque adjustment must be accomplished with the wormshaft rotated away a maximum of 1/2 of-a-turn from either the full-right or the full-left turn stop positions.

(3) Rotate the wormshaft clockwise or counterclockwise to the stop position and then away 1/2 of-a-turn from the stop position.

(4) Tighten the wormshaft bearing adjustment cap (Fig. 14) until the torque required to rotate the wormshaft is 0.6 to 1.0 N•m (5 to 8 in-lbs) torque.

(5) Tighten the adjustment cap locknut with 68 N•m (50 ft-lbs) torque and measure the "preload" torque. If necessary, adjust the "preload" torque again. Record the "preload" torque for later reference.

CAUTION: Do not attempt to adjust the pitman shaft overcenter drag torque before the wormshaft bearing "preload" torque has been adjusted.

(6) Adjust the pitman shaft overcenter drag torque:

- rotate the wormshaft from stop-to-stop, count the total number of rotations, and rotate the wormshaft in the reverse direction 1/2 of the total number of rotations to center the ball nut/pitman shaft;
- place a low calibration (e.g., inch-pounds) torque bar with a socket wrench on the wormshaft splines and, while rotating the wormshaft back and forth overcenter, tighten the pitman shaft adjustment screw until the torque required to rotate the wormshaft overcenter is the same as the wormshaft bearing "preload" torque (Fig. 15);
- the overcenter drag torque should be equal to the wormshaft bearing "preload" torque plus 0.5 to 1 N•m (4 to 10 in-lbs) torque but must not exceed a total of 2 N•m (18 in-lbs) torque;
- while rotating the wormshaft overcenter, continue to tighten the pitman shaft adjustment screw until the drag torque is increased by an additional 0.5 to 1.0 N•m (4 to 10 in-lbs) torque but do not exceed 2 N•m (18 in-lbs) torque;
- hold the pitman shaft adjustment screw and tighten the locknut with 34 N•m (25 ft-lbs) torque; and
- after tightening the locknut, measure the overcenter drag torque again and readjust the torque, if necessary.

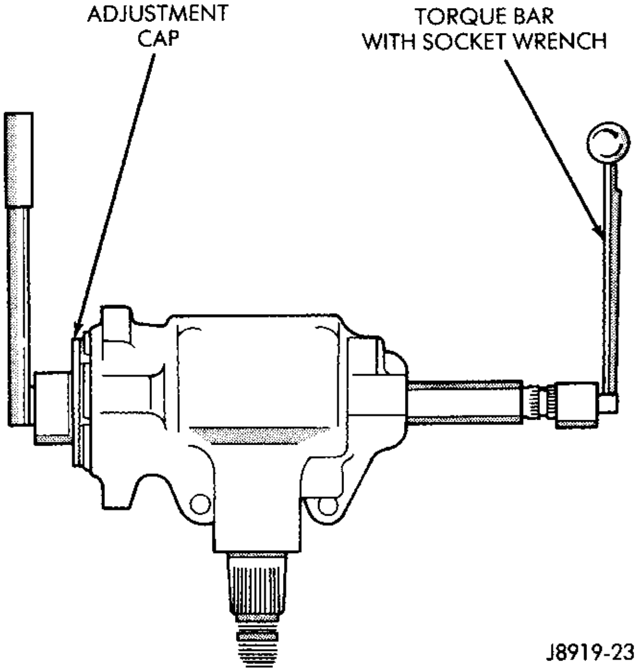


Fig. 14 Bearing "Preload" Torque Adjustment

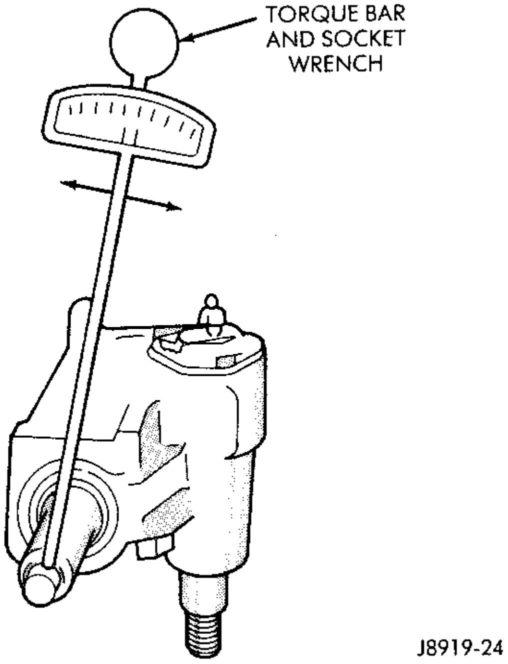


Fig. 15 Overcenter Drag Torque Adjustment

If the adjustment screw is allowed to rotate while tightening the locknut, the complete overcenter drag torque adjustment procedure must be repeated.

Steering Gear—Installation

(1) Position the steering gear and install the retaining bolts. Tighten the retaining bolts with 88 N•m (65 ft-lbs) torque.

(2) Connect the steering intermediate shaft to the steering gear.

(3) With the pitman arm and the shaft installation reference marks aligned, position the pitman arm on the pitman shaft.

(4) Install the washers and the retaining nut on the pitman shaft and tighten the nut with 251 N•m (185 ft-lbs) torque (all vehicles).

WARNING: The pitman arm retaining nut must be securely "staked" against the pitman shaft threads for safe retention.

(5) "Stake" the pitman arm retaining nut against the pitman shaft threads.

(6) Connect the drag link to the pitman arm. Tighten the retaining nut with 81 N•m (60 ft-lbs) torque (all vehicles). Install a replacement cotter pin.

(7) If removed, install the front stabilizer bar.

(8) Remove the supports and lower the vehicle.

POWER STEERING

SERVICE PROCEDURES AND DIAGNOSIS

Fluid Leakage—Detection

In addition to the following procedure, a "black light" detection device can be used to locate power steering fluid leakage. The dye is factory installed and, unless the original fluid in the system has been drained/flushed/replaced, no additional dye is necessary.

CAUTION: If the fluid reservoir cap is not properly tightened after a fluid level check, the result can be fluid leakage and possible loss of the cap. Ensure that the cap is securely tightened when installing it.

(1) Power steering fluid leakage is possible from the following steering gear areas:

- hoses and fittings;
- "preload" torque adjustment cap seal;
- stub shaft seals;
- housing ball plug;
- pitman shaft cover, gasket, adjustment screw and locknut;
- pitman shaft seals;
- housing end-plug seal; and
- cracked or porous housing.

(2) Raise and support the front of the vehicle. Clean the exterior surfaces of the steering gear, the pump, the reservoir, the hoses and the fittings thoroughly.

(3) Check and correct the fluid level in the reservoir. If the reservoir is overfilled, drain the excess fluid down to the correct level before proceeding.

(4) Inspect for aerated (milky color) fluid, which can cause an overflow from the reservoir and be mistaken for an actual fluid leak.

(5) Inspect and tighten all the hose connections at the steering gear and at the pump.

(6) Start the engine. Have a helper turn the steering wheel to the left and to the right several times while you search for the source of the fluid leak. Contact the stops momentarily in each direction. Stop the engine when the source of the fluid leak is located.

System Service Diagnosis

CONDITION	POSSIBLE CAUSE	CORRECTION
HISSING NOISE IN STEERING GEAR	(1) There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. There is no relationship between this noise and performance of the steering. Hiss may be expected when steering wheel is at end of travel or when slowly turning at standstill.	(1) Slight hiss is normal and in no way affects steering. Do not replace valve unless hiss is extremely objectionable. A replacement valve will also exhibit slight noise and is not always a cure. Investigate clearance around flexible coupling rivets. Be sure steering shaft and gear are aligned so flexible coupling rotates in a flat plane and is not distorted as shaft rotates. Any metal-to-metal contacts through flexible coupling will transmit valve hiss into passenger compartment through the steering column.
RATTLE OR CHUCKLE NOISE IN STEERING GEAR	(1) Gear loose on frame.	(1) Check gear-to-frame mounting screws. Tighten screws to 88 N·m (65 foot pounds) torque.
	(2) Steering linkage looseness.	(2) Check linkage pivot points for wear. Replace if necessary.
	(3) Pressure hose touching other parts of car.	(3) Adjust hose position. Do not bend tubing by hand.
	(4) Loose pitman shaft over center adjustment.	(4) Adjust to specifications.
	NOTE: A slight rattle may occur on turns because of increased clearance off the "high point." This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	
	(5) Loose pitman arm.	(5) Tighten pitman arm nut to specifications.
SQUAWK NOISE IN STEERING GEAR WHEN TURNING OR RECOVERING FROM A TURN	(1) Damper O-ring on valve spool cut.	(1) Replace damper O-ring.
POOR RETURN OF STEERING WHEEL TO CENTER	(1) Tires not properly inflated.	(1) Inflate tires to specified pressure.
	(2) Lack of lubrication in linkage and ball joints.	(2) Lube linkage and ball joints.
	(3) Lower coupling flange rubbing against steering gear adjuster plug.	(3) Loosen pinch bolt and assemble properly.
	(4) Steering gear to column misalignment.	(4) Align steering column.
	(5) Pump flow control valve sticking.	(5) Inspect for varnish or damage, replace if necessary.

J8919-28

System Service Diagnosis (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTION
POOR RETURN OF STEERING WHEEL TO CENTER (Continued)	(5) Improper front wheel alignment.	(5) Check and adjust as necessary. With front wheels still on alignment pads of front-end machine, disconnect pitman arm of linkage from pitman shaft of gear. Turn front wheels by hand. If wheels will not turn or turn with considerable effort, determine if linkage or ball joints are binding.
	(6) Steering linkage binding.	(6) Replace pivots.
	(7) Ball joints binding.	(7) Replace ball joints.
	(8) Steering wheel rubbing against housing.	(8) Align housing.
	(9) Tight or frozen steering shaft bearings.	(9) Replace bearings.
	(10) Sticking or plugged valve spool.	(10) Remove and clean or replace valve.
	(11) Steering gear adjustments over specifications.	(11) Check adjustment with gear out of car. Adjust as required.
	(12) Kink in return hose.	(12) Replace hose.
CAR LEADS TO ONE SIDE OR THE OTHER (KEEP IN MIND ROAD CONDITION AND WIND. TEST CAR IN BOTH DIRECTIONS ON FLAT ROAD)	(1) Front end misaligned.	(1) Adjust to specifications.
	(2) Unbalanced steering gear valve. **NOTE:** If this is cause, steering effort will be very light in direction of lead and normal or heavier in opposite direction.	(2) Replace valve.
MOMENTARY INCREASE IN EFFORT WHEN TURNING WHEEL FAST TO RIGHT OR LEFT	(1) Low oil level.	(1) Add power steering fluid as required.
	(2) Pump belt slipping.	(2) Tighten or replace belt.
	(3) High internal leakage.	(3) Check pump pressure. (See pressure test)
STEERING WHEEL SURGES OR JERKS WHEN TURNING WITH ENGINE RUNNING ESPECIALLY DURING PARKING	(1) Low oil level.	(1) Fill as required.
	(2) Loose pump belt.	(2) Adjust tension to specification.
	(3) Steering linkage hitting engine oil pan at full turn.	(3) Correct clearance.
	(4) Insufficient pump pressure.	(4) Check pump pressure. (See pressure test.) Replace relief valve if defective.

J8919-27

System Service Diagnosis (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTION
EXCESSIVE WHEEL KICKBACK OR LOOSE STEERING	(1) Air in system.	(1) Add oil to pump reservoir and bleed by operating steering. Check hose connectors for proper torque and adjust as required.
	(2) Steering gear loose on frame.	(2) Tighten attaching screws to specified torque.
	(3) Steering linkage joints worn enough to be loose.	(3) Replace loose pivots.
	(4) Worn poppet valve.	(4) Replace poppet valve.
	(5) Loose thrust bearing preload adjustment.	(5) Adjust to specification with gear out of vehicle.
	(6) Excessive overcenter lash.	(6) Adjust to specification with gear out of car.
HARD STEERING OR LACK OF ASSIST	(1) Loose pump belt.	(1) Adjust belt tension to specification.
	(2) Low oil level. **NOTE:** Low oil level will also result in excessive pump noise.	(2) Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors.
	(3) Steering gear to column misalignment.	(3) Align steering column.
NOTE: IF CHECKS (1) THROUGH (5) DO NOT REVEAL CAUSE OF HARD STEERING, REFER TO PRESSURE TEST		
	(4) Lower coupling flange rubbing against steering gear adjuster plug.	(4) Loosen pinch bolt and assemble properly.
	(5) Tires not properly inflated.	(5) Inflate to recommended pressure.
	Further possible causes could be:	
	(6) Sticky flow control valve.	In order to diagnose conditions such as listed in (6), (7), (8), (9) a test of the entire power steering system is required.
	(7) Insufficient pump pressure output.	
	(8) Excessive internal pump leakage.	
	(9) Excessive internal gear leakage.	

J8919-26

System Service Diagnosis (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTION
FOAMING MILKY POWER STEERING FLUID, LOW FLUID LEVEL AND POSSIBLE LOW PRESSURE	(1) Air in the fluid, and loss of fluid due to internal pump leakage causing overflow.	(1) Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeration should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.
LOW PRESSURE DUE TO STEERING PUMP	(1) Flow control valve stuck or inoperative.	(1) Remove burrs or dirt or replace. Flush system.
	(2) Pressure plate not flat against cam ring.	(2) Correct.
LOW PRESSURE DUE TO STEERING GEAR	(1) Pressure loss in cylinder due to worn piston ring or badly worn housing bore.	(1) Remove gear from car for disassembly and inspection of ring and housing bore.
	(2) Leakage at valve rings, valve body-to-worm seal.	(2) Remove gear from car for disassembly and replace seals.

J8919-25

Power Steering Gear Specifications

Steering Gear Type	Recirculating ball with hydraulic assist.
Steering Gear Ratio	
60/70 Series & Model 81 Vehicles	14:1
Model 15 Vehicles	13-16:1
Steering Gear Hydraulic Fluid	Use Mopar Power Steering Fluid, Dexron II, or equivalent.
Steering Gear Lubricants	Lubricate pitman shaft seals, bearings races, and rack piston recirculating balls with petroleum jelly. Lubricate all other parts with power steering fluid.
Steering Gear Adjustments:	
Wormshaft Bearing Preload Torque	0.45-1.13 N•m (4 to 10 in-lbs)
Pitman Shaft Overcenter drag torque	
New Gear (less than 400 miles/640 km)	0.45-0.90 N•m (4 to 8 in-lbs) in addition to wormshaft bearing preload but not to exceed combined total of 2 N•m (18 in-lbs)
Used Gear (over 400 miles/640 km)	0.5-0.6 N•m (4 to 5 in-lbs) in addition to wormshaft bearing preload but not to exceed combined total of 2 N•m (18 in-lbs)

Caution: Gears must be adjusted exactly as outlined in Steering Gear Adjustments-On Bench. Failure to adhere to the recommended procedures may result in gear damage or improper steering response.

J8919-29

Pitman Shaft Seal—Replacement

(1) Raise and support the vehicle. Place the front wheels in a straight-ahead position.

(2) If necessary, remove the front stabilizer bar.

(3) Disconnect the drag link from the pitman arm.

(4) Mark the pitman arm and the pitman shaft positions for installation reference and remove the pitman arm from the pitman shaft with a puller tool (Fig. 1).

(5) Place a drain pan under the steering gear.

(6) Remove the pitman shaft seal retaining ring with "snap" ring pliers and remove the outer backup washer from the shaft bore.

CAUTION: To prevent excessive fluid loss and pump wear, do not hold the steering wheel in an extreme left-turn position for more than one or two seconds at a time.

(7) Start the engine and momentarily hold the steering wheel in an extreme left-turn position to actuate the spool valve. This should develop enough pressure on the upper side of the rack piston and in the pitman shaft chamber to force the pitman shaft seals and the remaining backup washer out of the shaft bore (Fig. 2).

(8) Stop the engine and remove the seals and backup washer from the pitman shaft. Discard the seals.

(9) Inspect the outer circumference surface area of the seals for damage to the rubber covers. If the outer circumference surface area is scored, inspect the shaft bore in the housing for burrs. If present, remove the burrs from the bore before installing the replacement seals.

(10) Inspect the seal contact surface area on the pitman shaft for pitting and roughness. If pitted, replace the shaft.

(11) Remove all rust, foreign material and rough areas from the seal contact surface area on the pitman shaft with a crocus cloth.

(12) Lubricate the replacement seals and the backup washers with power steering fluid.

CAUTION: A protective wrap must be used to enclose the shaft threads/splines during seal installation. If the shaft seals are installed over exposed shaft threads or splines, the seal lips could be cut or distorted and result in leakage after installation.

(13) Wrap the pitman shaft threads/splines with 0.1-mm (0.005-in) thick shimstock (or a single layer of the thinnest plastic tape available) to protect the replacement seals during installation.

(14) Install the single-lip seal first, and then the inner backup washer (Fig. 2) with a seal installation tool. Position the seal and the washer only far enough in the shaft bore to provide sufficient clearance for the second seal, the outer backup washer and the retaining ring. **Do not force the seal against the inner bore surface.**

CAUTION: For proper sealing, ensure that the seals are spaced so that they are separately "seated" in the shaft bore.

(15) Install the "double-lip" seal and the outer backup washer (Fig. 2) with a seal installation tool. Position the seal and the backup washer only far enough in the shaft bore to provide sufficient clearance for the retaining ring.

(16) Remove the shimstock/tape from the shaft. Install the retaining ring (Fig. 2). Ensure that the ring is "seated" correctly in the housing bore groove.

(17) With the pitman arm and shaft installation reference marks aligned, position the pitman arm on the pitman shaft.

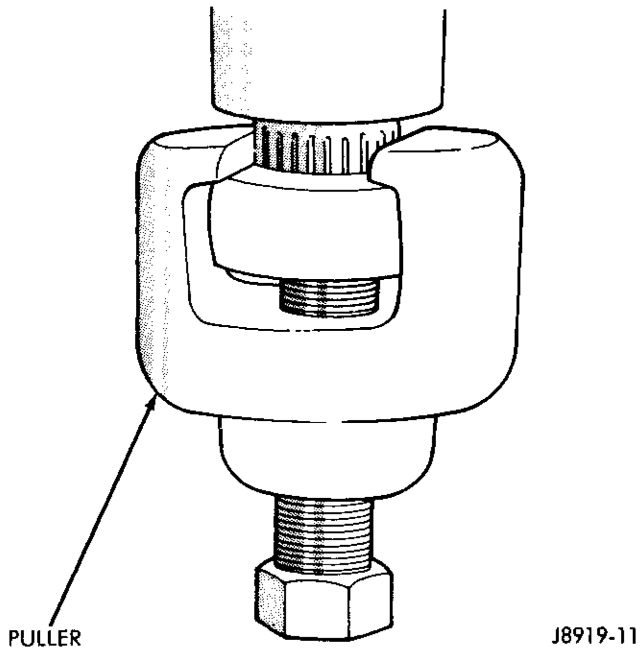


Fig. 1 Pitman Arm Removal

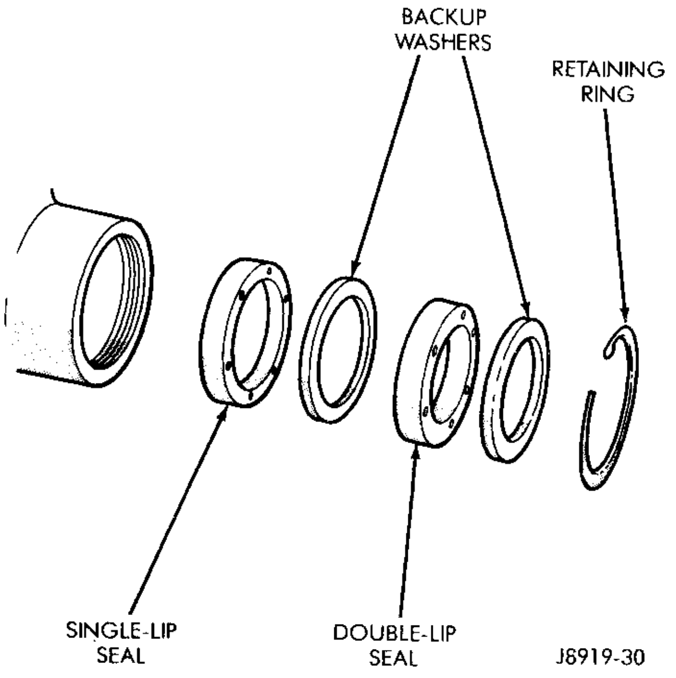


Fig. 2 Seals, Backup Washers & Retaining Ring

(18) Install the washer and the retaining nut on the pitman shaft and tighten the nut with 251 N•m (185 ft-lbs) torque (all vehicles).

WARNING: The pitman arm retaining nut must be securely "staked" against the pitman shaft threads for safe retention.

(19) "Stake" the pitman arm retaining nut against the pitman shaft threads.

(20) Connect the drag link to the pitman arm. Tighten the retaining nut with 81 N•m (60 ft-lbs) torque (all vehicles). Install a replacement cotter pin.

(21) If removed, install the front stabilizer bar.

(22) Remove the supports and lower the vehicle.

(23) Fill the reservoir with power steering fluid.

(24) Start the engine and allow it to operate at idle speed for at least three minutes. **Do not turn the steering wheel during this time.**

(25) Turn the steering wheel to the left and to the right and inspect for fluid leakage. Add power steering fluid as required.

(26) Remove the drain pan.

End-Plug Seal—Replacement

(1) Raise and support the vehicle. Place the front wheels in a straight-ahead position.

(2) Place a drain pan under the steering gear.

(3) Rotate the end-plug retaining ring until one end of the ring is positioned under the adjacent hole located in the side of the gear housing. "Unseat" and force the ring from the groove by inserting a punch through the hole in the housing (Fig. 3).

CAUTION: Do not turn the wheel any farther than necessary because, otherwise, the recirculating balls will drop out of the rack piston circuit and fall inside the rack piston chamber.

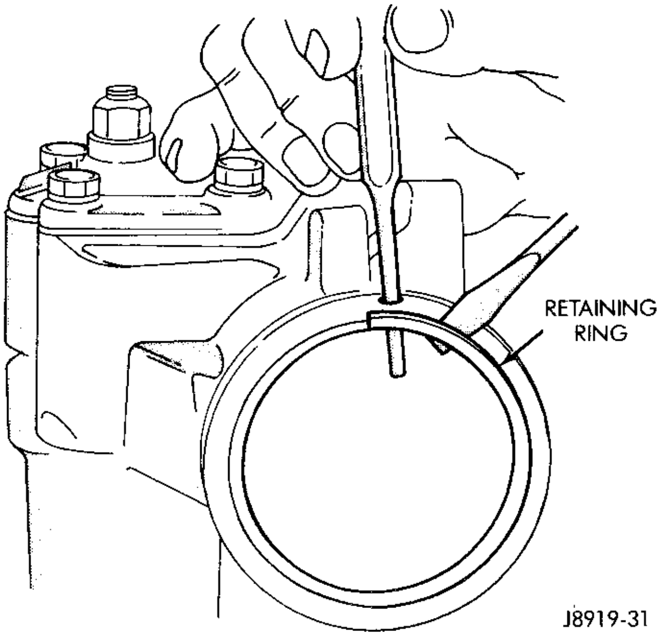


Fig. 3 End-Plug Retaining Ring Removal

(4) Turn the steering wheel slowly to the left until the rack piston forces the end-plug out of the housing and then turn the steering wheel back to the center position.

(5) Remove and discard the end-plug O-ring seal.

(6) Lubricate the replacement O-ring seal with power steering fluid and install it on the end plug.

(7) Install the end plug and the retaining ring.

(8) Lower the vehicle.

(9) Fill the fluid reservoir with power steering fluid.

(10) Start the engine and allow it to operate at idle speed for at least three minutes. **Do not turn the steering wheel during this time.**

(11) Turn the steering wheel to the left and to the right and inspect for fluid leakage. Add power steering fluid as required.

(12) Remove the drain pan.

Power Steering Gear—Removal

(1) Place the front wheels in a straight-ahead position.

(2) Place a drain pan under the steering gear.

(3) Disconnect the fluid hoses from the steering gear. Raise and secure the hoses above the reservoir fluid level to prevent excessive fluid loss. Cap the ends of the hoses to prevent any entry of foreign material.

(4) Disconnect the intermediate shaft from the stub shaft.

(5) Raise and support the vehicle.

(6) Disconnect the drag link from the pitman arm.

(7) If necessary, remove the front stabilizer bar.

(8) Remove the pitman arm retaining nut and washer, mark the pitman arm and the pitman shaft positions for installation reference and remove the pitman arm from the pitman shaft with a puller tool.

(9) Remove the steering gear retaining bolts and the steering gear from the vehicle.

Power Steering Gear—Disassembly

CAUTION: Cleanliness is extremely important when repairing a power steering gear. Maintain the bench, the tools and the components clean at all times. Thoroughly clean the exterior of the gear with cleaning solvent before disassembly and drain as much of the fluid as possible. Use protective vise jaws at all times when clamping components in a vise. During assembly, lubricate all the components with power steering fluid except when instructed otherwise.

(1) Drain the fluid, position the steering gear in a vise and clamp it in-place with the pitman shaft downward. Use the un-machined bosses for clamping pads (Fig. 4).

(2) Rotate the housing end-plug retaining ring until one end of the ring is positioned under the adjacent hole located in the side of the gear housing. “Unseat” and force the ring from the groove by inserting a punch through the hole in the housing (Fig. 5).

CAUTION: Do not rotate the stub shaft any farther than necessary because, otherwise, the recirculating balls will drop out of the circuits and cause the pitman shaft and rack piston teeth to disengage. If the teeth become disengaged, remove the cover and the pitman shaft and engage the teeth.

(3) Rotate the stub shaft counterclockwise (with a 12-point deep wrench and a ratchet handle) until the rack piston forces the end plug out of the housing.

(4) Remove and discard the end-plug O-ring seal.

(5) Rotate the stub shaft clockwise 180 degrees to remove the rack piston end plug (Fig. 6).

CAUTION: The rack piston end plug could break during removal if it is not initially “unseated” by striking it with a plastic-tipped hammer.

(6) Strike the rack piston end plug sharply with a plastic-tipped hammer and use a 13-mm (1/2-in) square drive ratchet to remove the end plug. **Do not use a ratchet with a worn drive lug or with a drive lug that is rounded on the bottom corners.**

(7) Hold the pitman shaft adjustment screw with an Allen wrench to prevent the screw from turning and remove the locknut (Fig. 6). Discard the locknut.

(8) Remove the pitman shaft cover attaching bolts and lockwashers from the housing (Fig. 6).

(9) Thread the pitman shaft adjustment screw into the cover with and Allen wrench until the cover can be removed from the screw. Remove the cover from the housing and discard the gasket (Fig. 6).

(10) Rotate the stub shaft until the pitman shaft teeth are centered in the housing. Tap the end of the pitman shaft with a plastic-tipped hammer and remove it from the housing (Fig. 6). **Do not disassemble the pitman shaft, it is serviced and replaced as a unit only.**

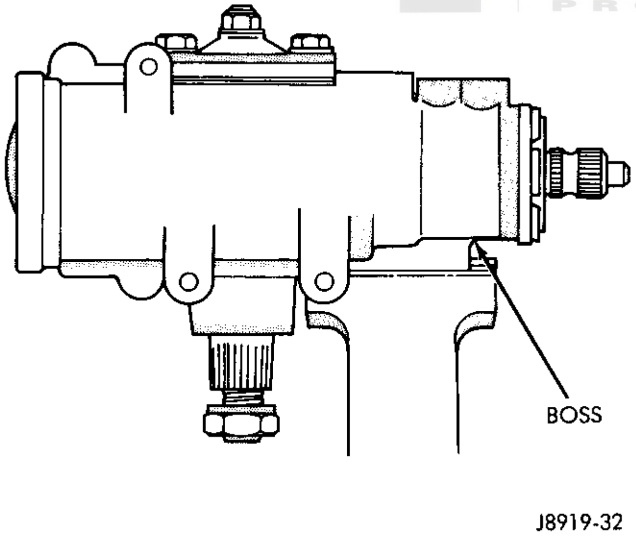


Fig. 4 Steering Gear Clamped In A Vise

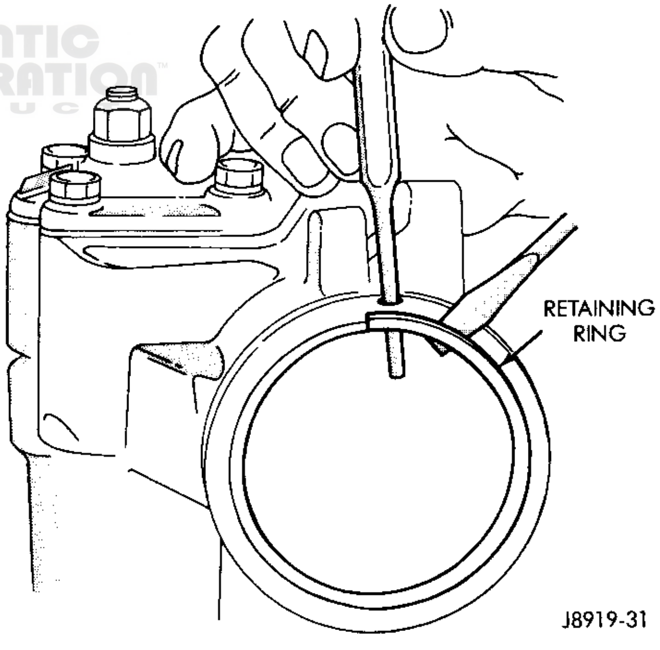
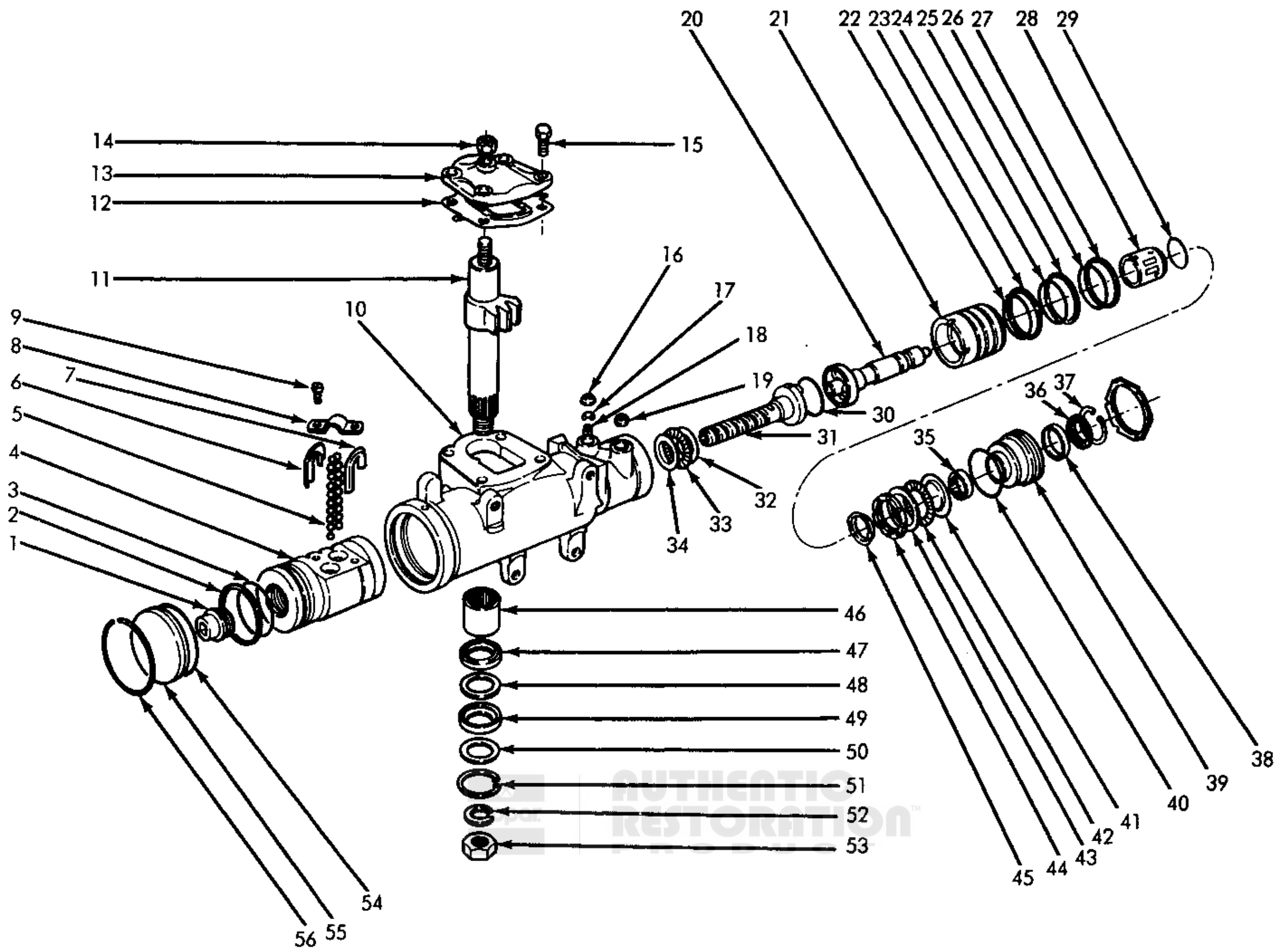


Fig. 5 End-Plug Retaining Ring Removal



1. PISTON END-PLUG
2. TEFLON RING
3. O-RING SEAL
4. RACK PISTON
5. BLACK & SILVER BALLS
6. BALL HALF-GUIDE
7. BALL HALF-GUIDE
8. CLAMP
9. CLAMP BOLT
10. GEAR HOUSING
11. PITMAN SHAFT
12. COVER GASKET
13. COVER
14. LOCKNUT
15. BOLT
16. HOSE CONNECTOR SEAT
17. CHECK VALVE
18. CHECK VALVE SPRING
19. HOSE CONNECTOR SEAT
20. STUB SHAFT
21. VALVE BODY
22. O-RING SEAL
23. TEFLON RING
24. O-RING SEAL
25. TEFLON RING
26. O-RING SEAL
27. TEFLON RING
28. SPOOL VALVE
29. O-RING SEAL
30. O-RING SEAL
31. WORMSHAFT
32. BEARING RACE
33. THRUST BEARING
34. BEARING RACE
35. NEEDLE BEARING
36. DUST SEAL
37. RETAINING SNAP RING
38. SEAL
39. ADJUSTMENT CAP
40. O-RING SEAL
41. LARGE THRUST WASHER
42. THRUST BEARING
43. SMALL THRUST WASHER
44. SPACER
45. RETAINING RING
46. NEEDLE BEARING
47. SINGLE-LIP SEAL
48. BACK-UP WASHER
49. DOUBLE-LIP SEAL
50. BACK-UP WASHER
51. RETAINING SNAP RING
52. SPRING WASHER
53. RETAINING NUT
54. O-RING SEAL
55. HOUSING END-PLUG
56. RETAINING RING

J8919-33

Fig. 6 Power Steering Gear — Exploded View

(11) Insert an arbor tool in the rack piston until it stops at the end of the wormshaft (Fig. 7).

(12) Grip the tool firmly and turn the stub shaft counterclockwise to force the rack piston on the arbor tool (Fig. 7). Remove the tool and the rack piston as a unit from the steering gear housing.

(13) Loosen the wormshaft bearing "preload" torque adjustment cap locknut with a brass drift and remove it from the cap. Remove the adjustment cap from the housing with a spanner wrench (Fig. 8).

(14) Remove the complete valve body from the housing by pulling outward on the splined end of the stub shaft.

(15) Remove the wormshaft lower thrust bearing and the conical bearing races from the wormshaft. Note the relative position of each race for assembly reference (Fig. 9).

Steering Gear Housing—Disassembly

(1) Remove the pitman shaft seal retaining ring from the shaft bore groove with "snap" ring pliers. Remove the outer backup washer from the shaft bore (Fig. 10).

If the upper seal is difficult to remove, force it out of the shaft bore from the top of the housing. In extreme situations, it may be necessary to force out both the needle bearing and the upper seal simultaneously. Discard the seal and the needle bearing if they are removed by this method.

(2) Remove the pitman shaft needle bearing from the housing inner bore with the appropriate removal tools (Fig. 11).

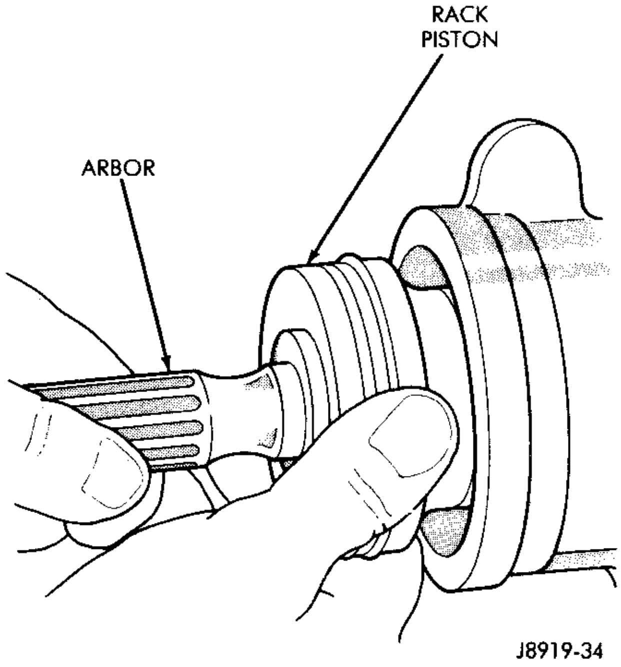


Fig. 7 Rack Piston Removal

Steering Gear Housing—Inspection

(1) Clean the steering gear housing thoroughly with cleaning solvent.

(2) Inspect the pitman shaft bore. If it is badly scored or worn, replace the housing. However, slight scratches in the bore are usually acceptable.

(3) Inspect the hose connector "seats" and the poppet check valve. If they are deeply scored, cracked or worn, they must be replaced.

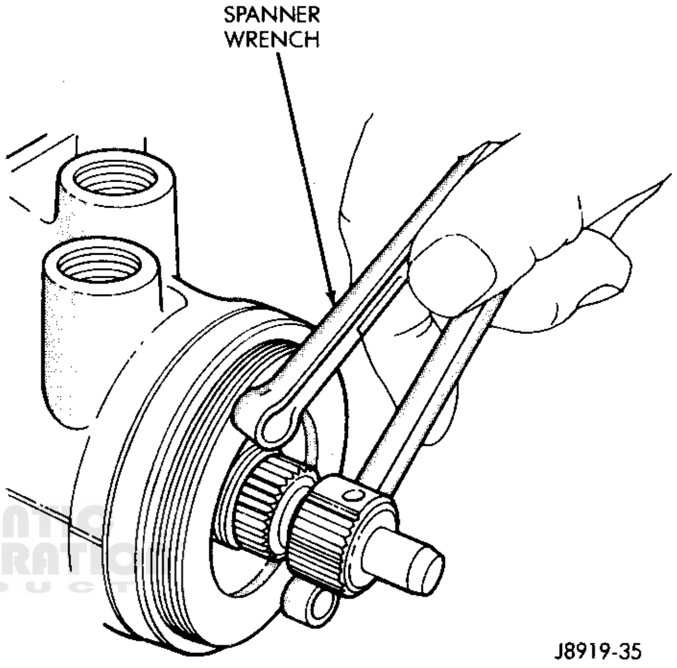


Fig. 8 "Preload" Adjustment Cap Removal

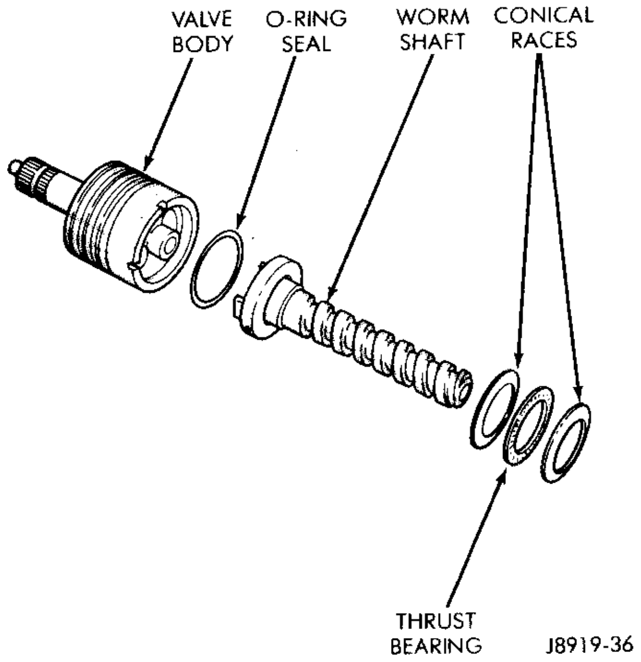


Fig. 9 Valve Body & Wormshaft

(4) Inspect the ball plug in the housing (Fig. 12). If fluid leakage past the ball plug occurred before disassembly or if it is raised above the housing surface, the housing must be replaced.

(5) Inspect all the retaining ring grooves and O-ring seal mating surfaces. If any are chipped, scored, cracked or otherwise worn, replace the housing.

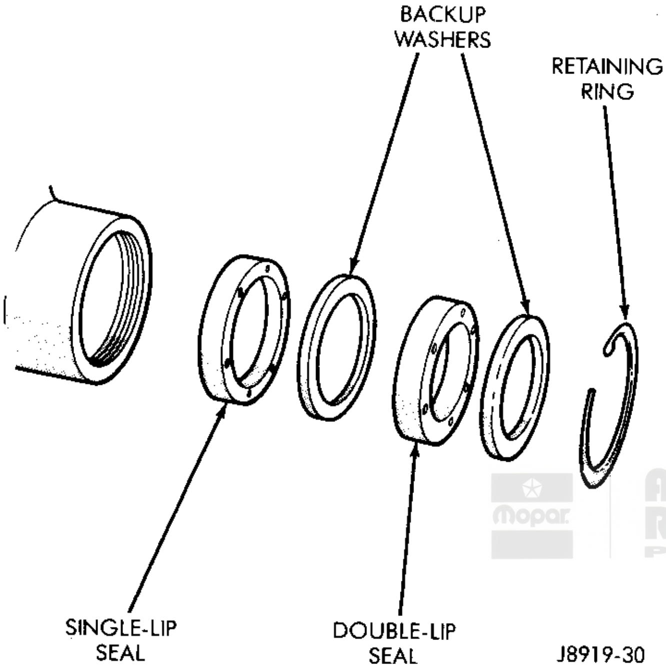


Fig. 10 Seals, Backup Washers & Retaining Ring

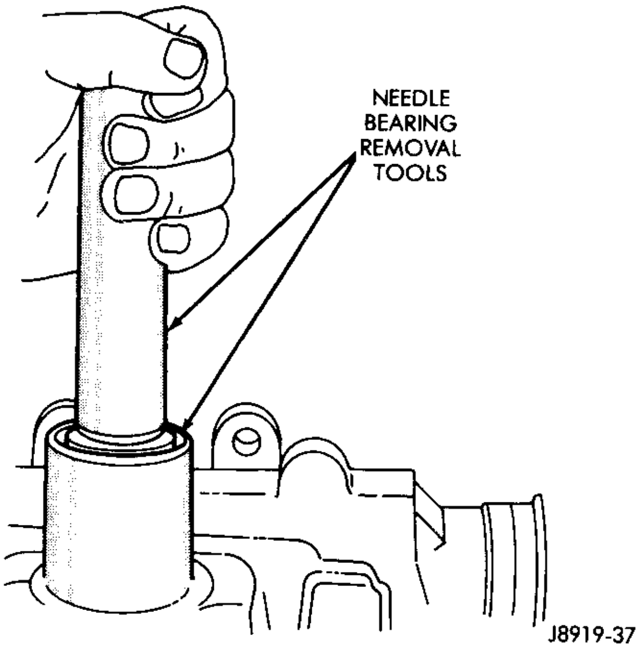


Fig. 11 Pitman Shaft Needle Bearing Removal

Steering Gear Housing—Assembly

(1) Lubricate the pitman shaft bore in the housing, the replacement needle bearing, the lip seals and the backup washers with power steering fluid (Fig. 13).

(2) Install the replacement needle bearing with the appropriate installation tools (Fig. 14).

(3) Insert the bearing in the pitman shaft inner bore until it is approximately 0.76 mm (0.03 in) below the shoulder of the inner bore.

(4) Install the single-lip seal first, and then the inner backup washer with a seal installation tool. Position the

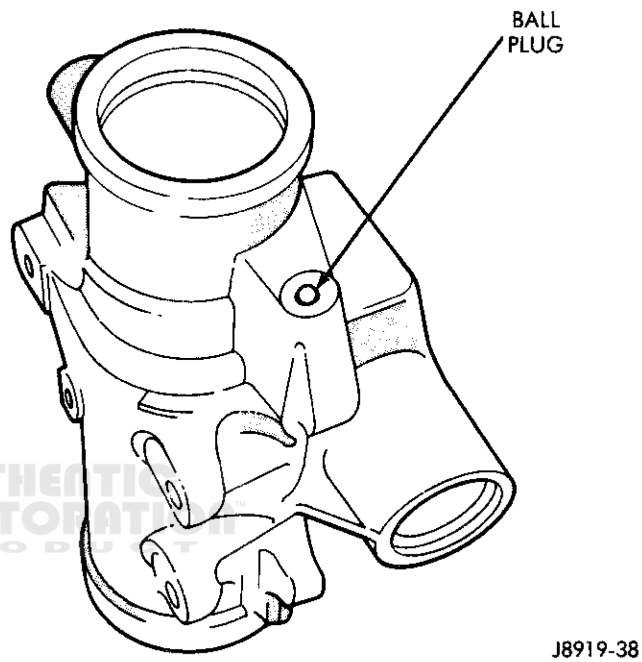


Fig. 12 Steering Gear Housing & Ball Plug

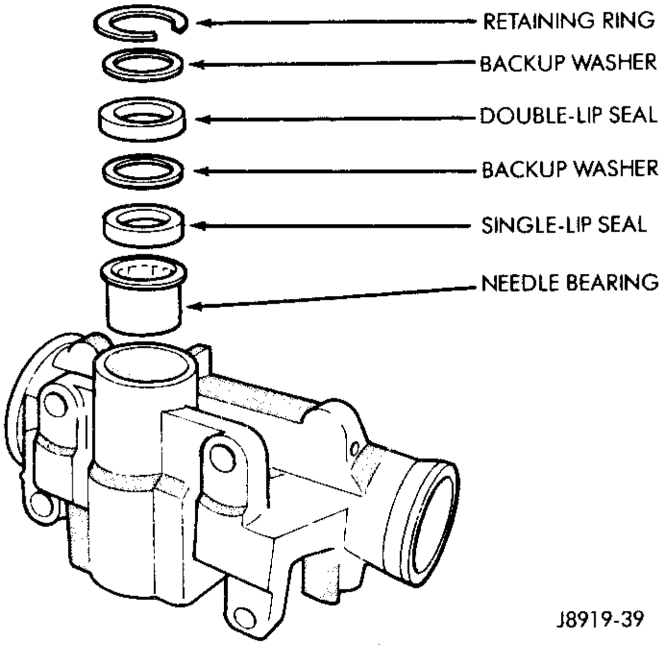


Fig. 13 Pitman Shaft Bearing, Seals & Washers

seal and washer only far enough in the shaft bore to provide sufficient clearance for the second seal, the outer backup washer and the retaining ring (Fig. 13). **Do not force the seal against the inner bore surface.**

CAUTION: For proper sealing, ensure that the seals are spaced so that they are separately "seated" in the shaft bore.

(5) Install the double-lip seal and the outer backup washer (Fig. 15) with a seal installation tool. Position the seal and the backup washer only far enough in the shaft bore to provide sufficient clearance for the retaining ring.

(6) Install the retaining ring (Fig. 13). Ensure that the ring is "seated" correctly in the bore groove.

Preload Torque Adjustment Cap—Disassembly

(1) Remove the thrust bearing retaining ring from the adjustment cap with a small pry bar (Fig. 16). Discard the retaining ring. **Use care to prevent damaging the needle bearing bore.**

(2) Remove the thrust bearing spacer, the thrust bearing washers, the thrust bearing and the O-ring seal from the adjustment cap (Fig. 17). Discard the seal.

(3) Remove the stub shaft seal retaining "snap" ring from the adjustment cap with "snap" ring pliers (Fig. 17).

(4) Remove (and discard) the stub shaft dust seal and the oil seal from the adjustment cap (Fig. 17).

(5) Remove the stub shaft needle bearing from the adjustment cap with an appropriate removal tool (Fig. 18).

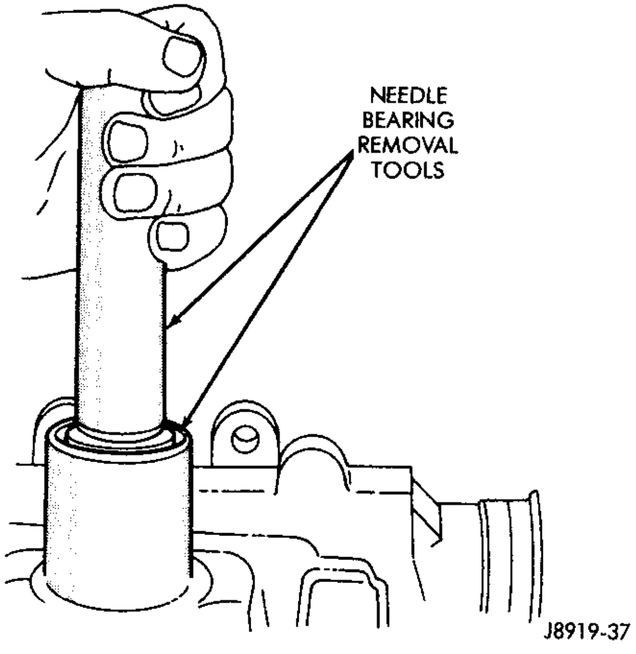


Fig. 14 Pitman Shaft Bearing Installation

Preload Torque Adjustment Cap—Inspection

(1) Clean the adjustment cap and its components thoroughly with cleaning solvent.

(2) Inspect the adjustment cap and all the components for wear, scoring, nicks, cuts and distortion.

(3) Replace all defective components.

Preload Torque Adjustment Cap—Assembly

(1) Lubricate the adjustment cap and the components with power steering fluid.

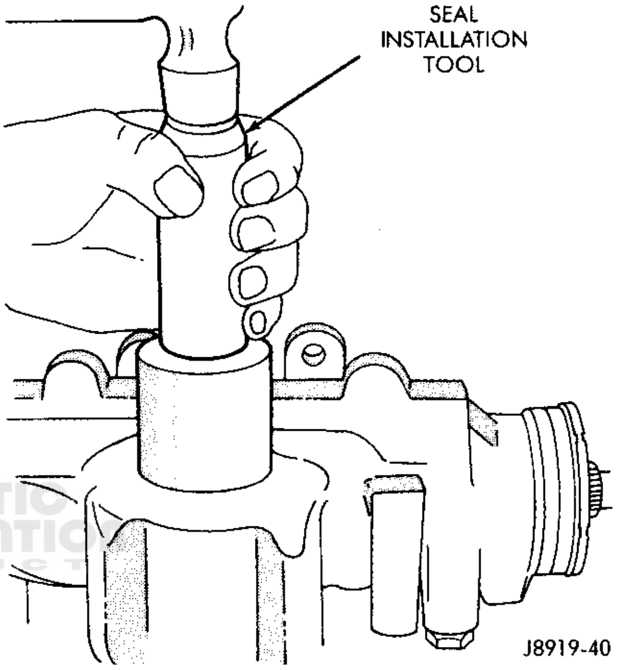


Fig. 15 Pitman Shaft Seal Installation

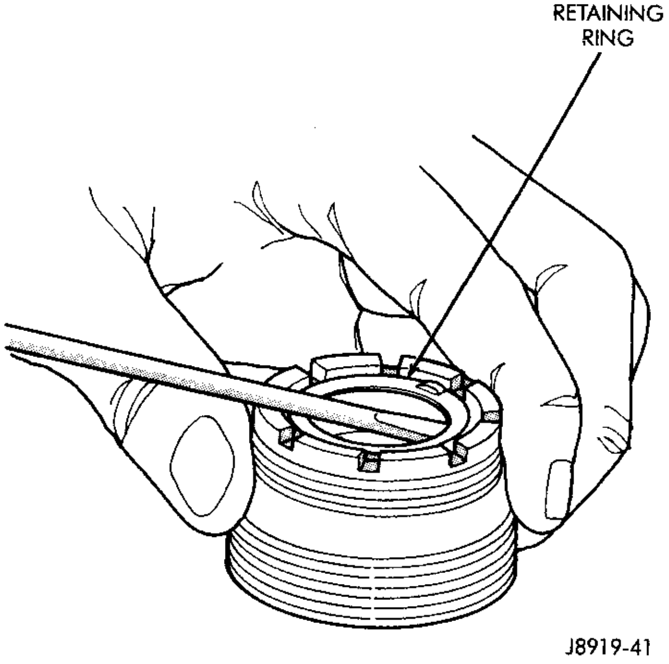


Fig. 16 Thrust Bearing Retaining Ring Removal

(2) Place the stub shaft needle bearing on the installation tool with the bearing manufacturer's identification number facing toward the tool.

(3) Position the bearing and the tool over the inner bore and press the bearing into the bore until it is flush with the bottom surface of the outer bore.

(4) Insert the stub shaft oil seal far enough into the seal bore to provide sufficient clearance for the dust seal and the retaining ring (Fig. 17).

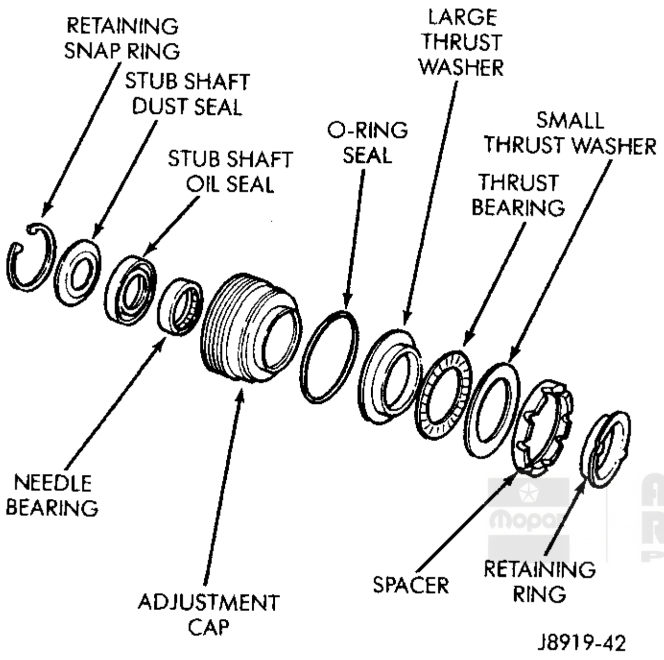


Fig. 17 "Preload" Torque Adjustment Cap

(5) Lubricate the dust seal with petroleum jelly and install it in the seal bore with the rubber side facing outward (Fig. 17).

(6) Install the retaining "snap" ring. Ensure that the ring is properly "seated" in the cap groove.

(7) Lubricate the O-ring seal with petroleum jelly and install it in the cap seal groove (Fig. 17).

(8) Position the large thrust washer, the thrust bearing, the small thrust washer and the spacer on the adjustment cap (Fig. 17).

The radial locations of the spacer notches are not important. However, do not damage the notches during installation.

(9) Press the replacement retaining ring into the stub shaft needle bearing bore with a brass or wooden drift.

Valve Body And Stub Shaft—Disassembly

CAUTION: The valve body is a precisely manufactured unit with components selectively fitted to conform to tolerances as close as 0.00082 mm (0.0004 in). The unit is hydraulically and mechanically balanced during manufacture. If replacement is necessary, the complete valve body must be replaced. To avoid possible damage, the valve body should not be disassembled unless absolutely necessary. If the valve spool damper O-ring seal requires replacement, remove the valve spool only as instructed in the following procedure.

(1) Hold the valve body in both hands with the stub shaft downward and tap the end of the stub shaft lightly against the workbench until the stub shaft cap disengages from the valve body (Fig. 19).

(2) Remove and discard the stub shaft cap-to-wormshaft O-ring seal.

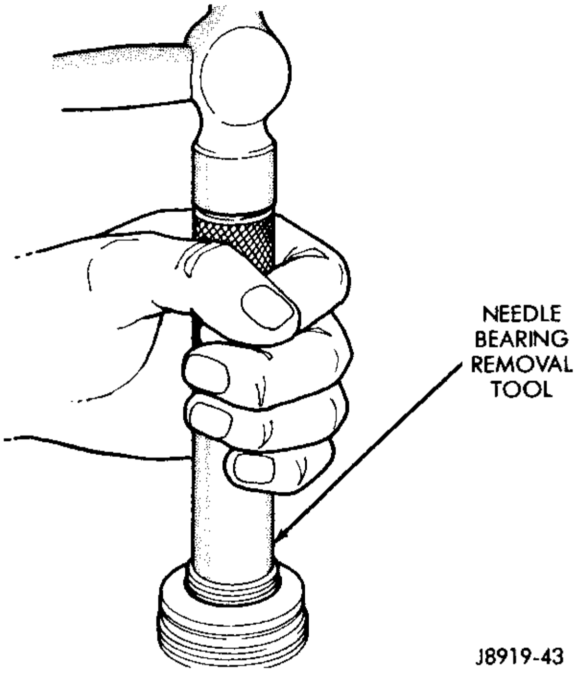


Fig. 18 Stub Shaft Needle Bearing Removal

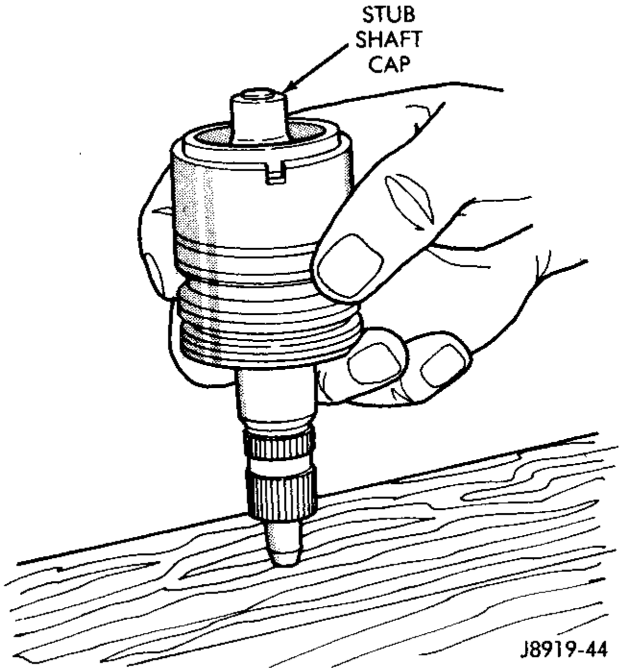


Fig. 19 Stub Shaft Cap Disengagement

CAUTION: Do not pull the stub shaft out too far beyond the specified distance because the spool valve could become cocked in the valve body.

(3) Pull outward on the cap end of the stub shaft until it clears the valve body by approximately 6.35 mm (1/4 in).

(4) Carefully disengage the stub shaft locating pin from the hole in the spool valve and remove the stub shaft from the valve body (Fig. 20).

(5) Rotate the spool valve and remove it from the valve body (Fig. 21). If the spool valve becomes cocked, carefully realign it and then remove it.

(6) Remove the damper O-ring seal from the spool valve (Fig. 21). Discard the O-ring seal.

(7) Cut the teflon rings and the inner O-ring seals (located between the teflon rings and the valve body) and remove them from the valve body. Carefully cut the rings with either a knife or diagonal pliers.

Valve Body And Stub Shaft—Inspection

(1) Clean all the components in cleaning solvent and open all of the fluid passages by blowing with compressed air. If the stub shaft locating pin or the spool valve locating hole is either cracked, excessively worn or broken, replace the complete valve body. **Small flat spots on either side of the stub shaft locating pin head are normal and acceptable.**

(2) If the stub shaft ground surfaces has scores, nicks or burrs that cannot be removed with crocus cloth, replace the complete valve body. Inspect the outside surface area of the spool valve and the inside surface area of the valve body for nicks, burrs and wear. Slight wear is normal on the valve mating surfaces. **If any serious defects cannot be removed with crocus cloth, replace the complete valve body.**

(3) If the small notch in the skirt of the valve body is excessively worn, replace the complete valve body (Fig. 22).

(4) Lubricate the spool valve with power steering fluid and check the fit of the spool valve in the valve body without the spool valve dampener O-ring seal installed. If the spool valve does not rotate freely within the valve body, replace the complete valve body.

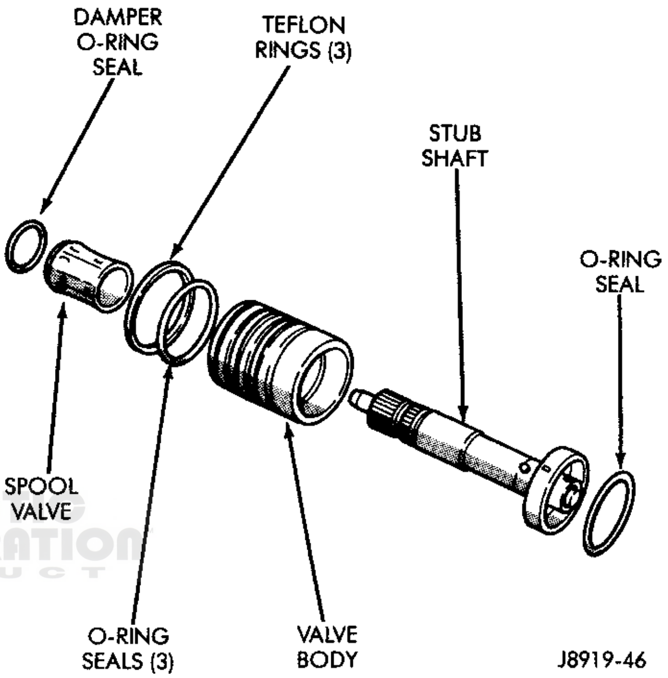


Fig. 21 Valve Body & Stub Shaft Disassembly

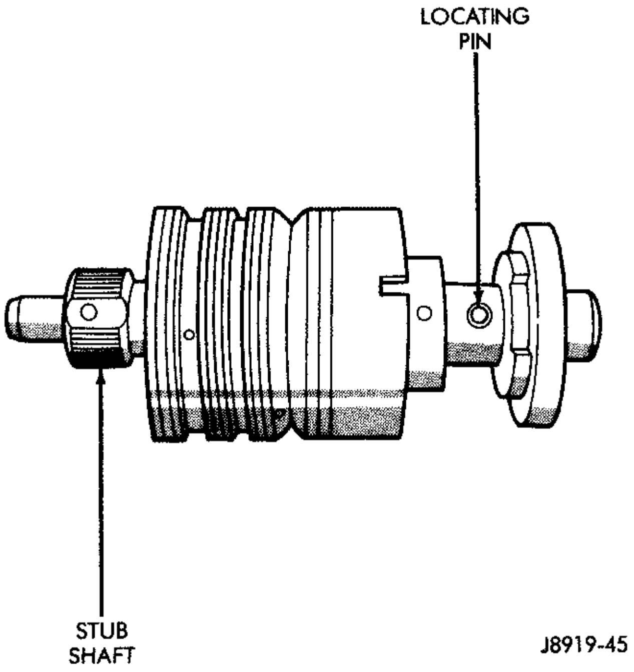


Fig. 20 Stub Shaft Removal

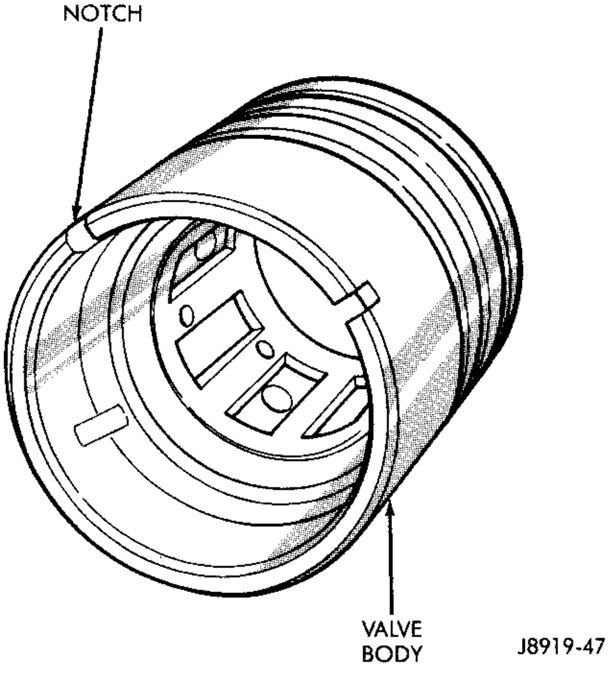


Fig. 22 Valve Body Inspection

Valve Body And Stub Shaft—Assembly

(1) Lubricate the replacement inner O-ring seals and the teflon rings (Fig. 24) with power steering fluid.

(2) Install the inner O-ring seals in the valve body ring grooves (Fig. 23) and install the teflon rings on top of the O-ring seals. **Use care to avoid damaging the teflon rings during installation.**

The teflon rings can appear slightly distorted when first installed; however, during operation, hot power steering fluid will cause them to straighten out.

(3) Lubricate the spool valve dampener O-ring seal with petroleum jelly and install it in the spool valve groove (Fig. 24).

(4) Lubricate the spool valve and valve body with power steering fluid and carefully insert the spool valve in the valve body (Fig. 24).

(5) Move the spool valve through the valve body until the stub shaft locating pin hole in the spool valve is visible and the spool valve is flush with the notched end of the valve body.

(6) Carefully insert the stub shaft into the spool valve until the stub shaft locating pin is aligned with the locating pin hole in the spool valve (Fig. 25).

CAUTION: Ensure that the stub shaft cap notch is aligned with the valve body pin before installing the valve body in the steering gear housing.

(7) Align the notch in the stub shaft cap with the locating pin in the valve body and press the spool valve and the stub shaft in the valve body (Fig. 25).

(8) Lubricate the stub shaft cap-to-wormshaft O-ring seal with power steering fluid and position it in the cap groove.

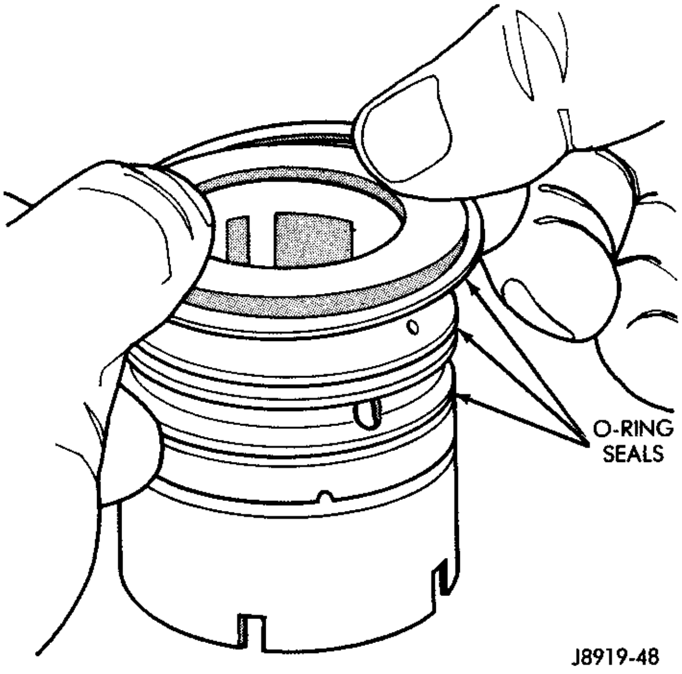


Fig. 23 O-Ring Seal Installation

Pitman Shaft And Cover—Inspection

(1) Inspect the cover-to-housing contact surface.

(2) Inspect the pitman shaft sector teeth, upper contact surface and bearing/seal contact surface (Fig. 26).

(3) Replace the cover and the shaft if they are severely worn, scored or pitted. If the pitman shaft adjustment screw head fits loose in the T-slot, replace the pitman shaft.

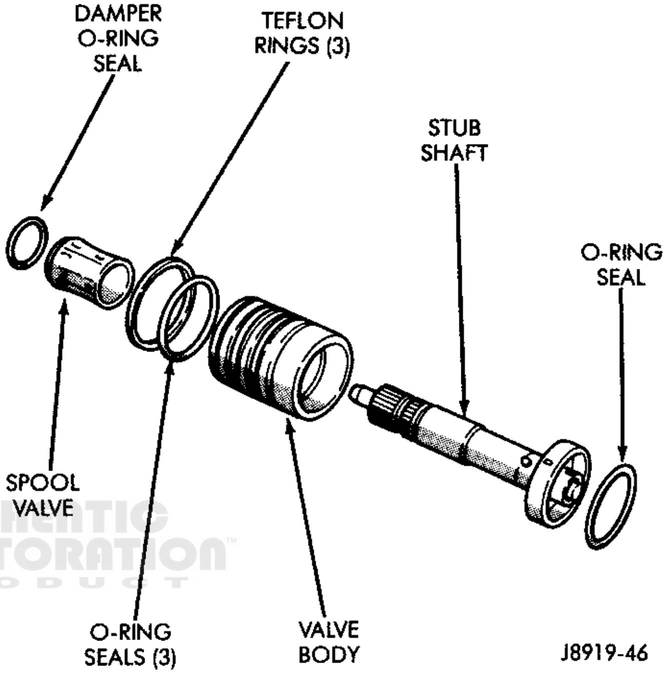


Fig. 24 Valve Body & Stub Shaft Assembly

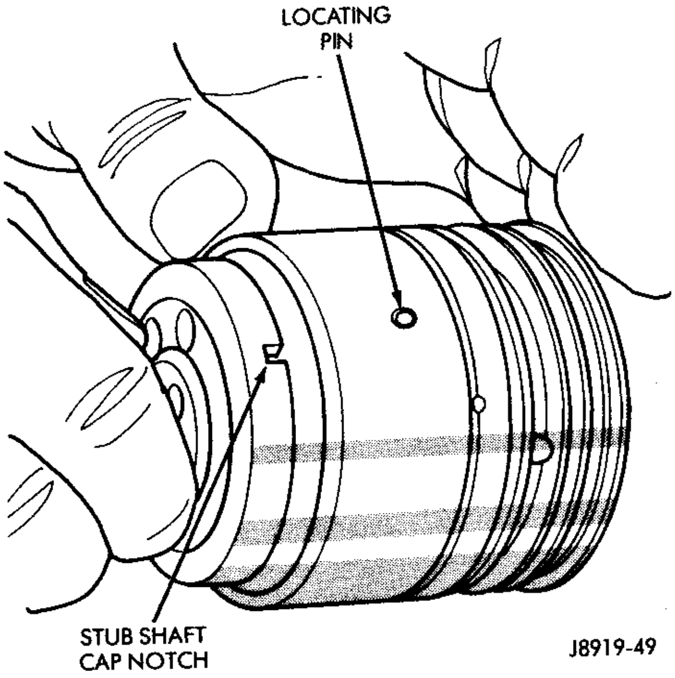


Fig. 25 Stub Shaft Installation

Rack Piston/Wormshaft—Disassembly

(1) Remove the ball return guide clamp.

(2) Place the complete assembly on clean paper and remove the ball return guides, the wormshaft with an arbor tool, and the recirculating balls. **Ensure that all 24 balls are removed and retained.**

(3) Remove the arbor tool from the wormshaft.

(4) Remove the teflon piston ring and the O-ring seal from the rack piston (Fig. 27).

Rack Piston/Wormshaft—Assembly

(1) Lubricate all of the components with power steering fluid.

(2) Install the O-ring seal in the rack piston groove (Fig. 27). **Do not allow the O-ring seal to become twisted during installation.**

(3) Install the teflon piston ring over the O-ring seal.

(4) Insert the wormshaft completely into the rack piston.

(5) Install the recirculating balls in the rack piston by alternately installing one black ball followed by one silver ball until a total of 18 balls have been installed in the inner return guide hole (Fig. 28). After installing each ball, press it downward to provide space for the next ball.

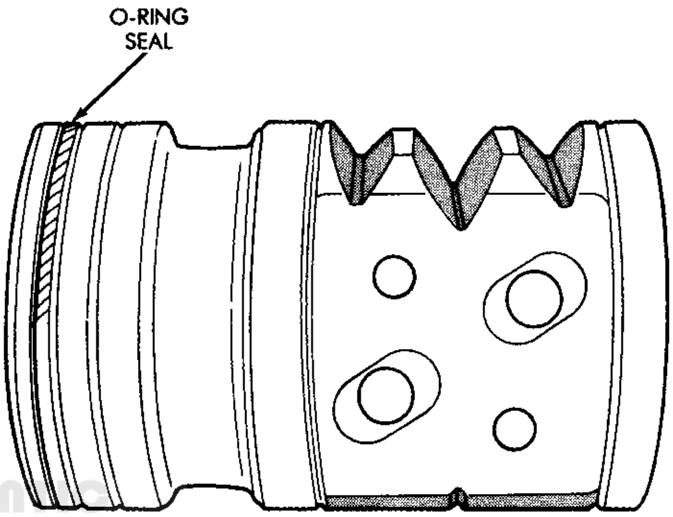
(6) Rotate the wormshaft counterclockwise (viewed from the steering shaft end) to route the balls into the circuit. **The wormshaft will spiral out of the rack piston as it is rotated and the balls are circulated.**

(7) Fill one ball return half-guide with petroleum jelly and install the six remaining balls in the ball return half-guide (Fig. 29). Ensure that the balls in the half-guide are installed alternately by color (i.e., a black ball followed by a silver ball) and are in alternating color sequence with the balls previously installed in the rack piston.

(8) Mate the two half-guides and insert the assembled ball return guide into the guide holes in the rack piston.

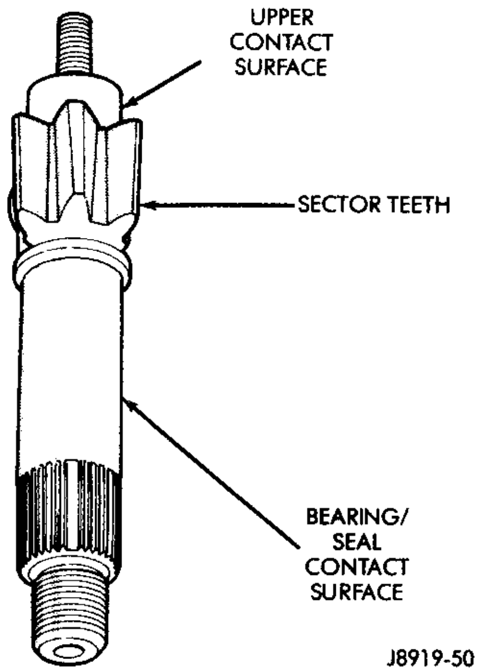
(9) Install the ball return guide clamp, the lockwashers and the retaining screws. Tighten the screws with 14 N•m (10 ft-lbs) torque.

(10) Insert an arbor tool (Fig. 30) into the wormshaft and position the end of the assembled rack piston (with



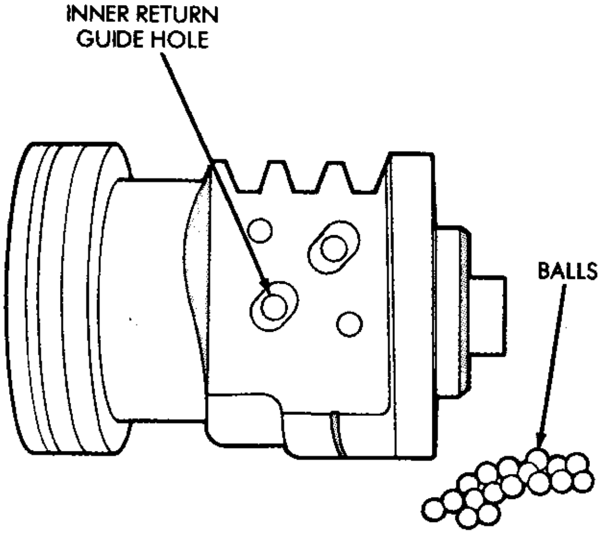
J8919-51

Fig. 27 Rack Piston



J8919-50

Fig. 26 Pitman Shaft Inspection



J8919-52

Fig. 28 Recirculating Ball Installation tool) on wooden blocks. Ensure that the rack piston is supported with wooden blocks after it is inverted (Fig. 30).

(11) Do not permit the tool to separate from the wormshaft until the rack piston is completely installed on the wormshaft.

Power Steering Gear—Assembly

All components must be clean and lubricated with power steering fluid (except as stated otherwise) before assembly.

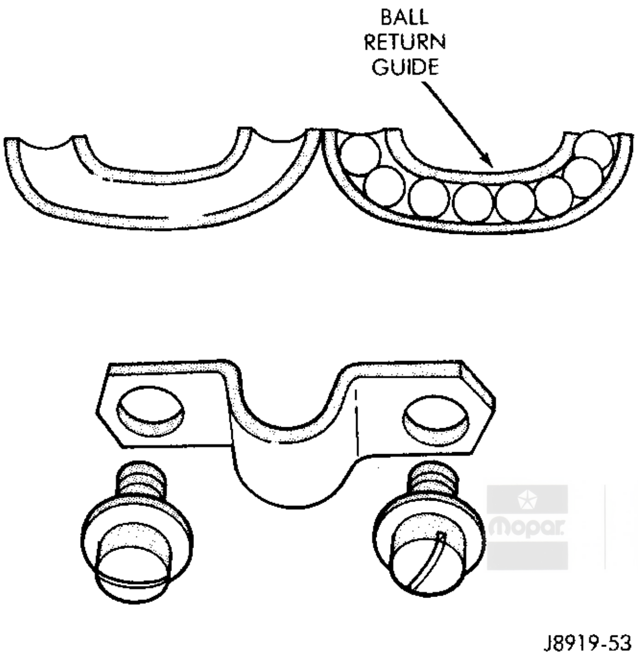


Fig. 29 Ball Return Guide

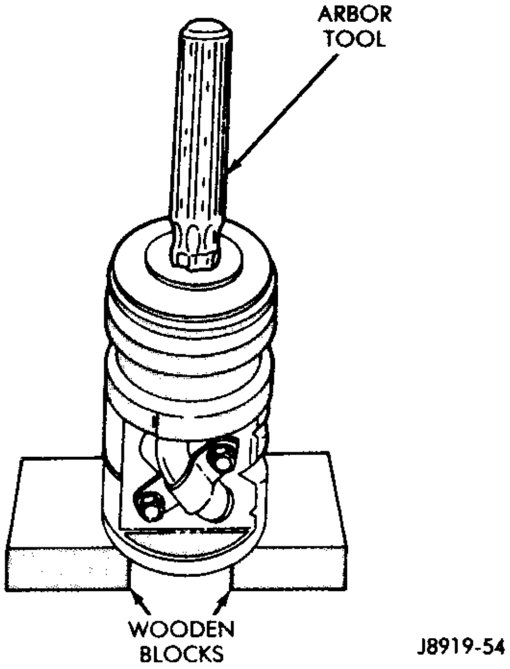


Fig. 30 Rack Piston Assembled

(1) Clamp the steering gear housing in a vise with the pitman shaft bore facing downward. Use the un-machined housing bosses for the clamping pads (Fig. 31).

(2) Install the wormshaft conical bearing races and the lower thrust bearing. Install the first conical bearing race followed by the thrust bearing, and then the second conical bearing race (Fig. 32). **Both of the conical bearing races must be installed so that the top of each cone faces the bottom of the gear housing.**

(3) Install the stub shaft cap-to-valve body O-ring seal in the valve body so that it is "seated" against the inner edge of the stub shaft cap (Fig. 32).

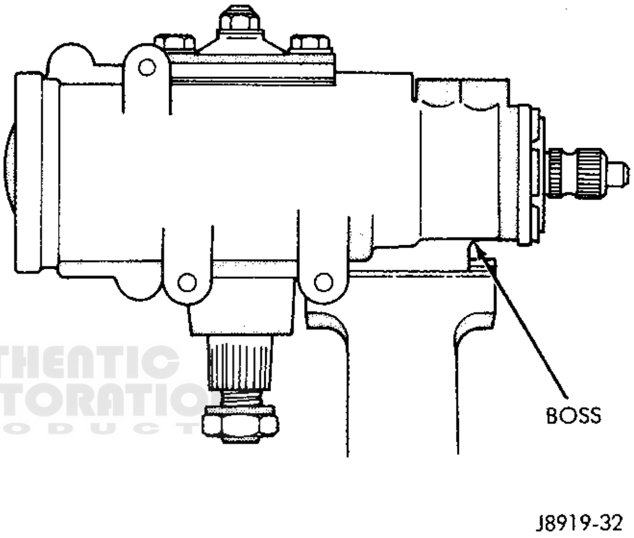


Fig. 31 Steering Gear Housing

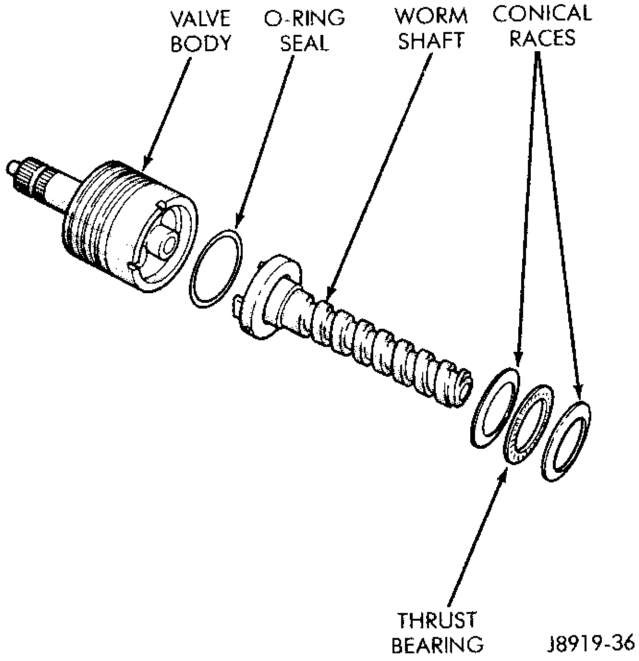


Fig. 32 Lower Thrust Bearing & Race Installation

CAUTION: Do not press against the stub shaft to "seat" the valve body. This could cause the stub shaft and cap to separate from the valve body and allow the spool valve dampener O-ring seal to slip into the valve body fluid grooves. "seat" the valve body only by pushing on the outer diameter surface of the valve body with your fingertips (Fig. 33). Ensure that the teflon rings do not bind inside the housing. The valve body is correctly "seated" when all or most of the fluid return hole in the steering gear housing is visible.

(4) Align the narrow slot in the valve body with the locating pin in the wormshaft (Fig. 33) and insert the valve body into the steering gear housing. "seat" the valve body in the housing (Fig. 33).

(5) Install a seal protector tool over the end of the stub shaft (Fig. 34).

(6) Install the adjustment cap over the end of the stub shaft (Fig. 34).

(7) Tighten the adjustment cap with a spanner wrench until it "seats" against the valve body. Approximately 27 N•m (20 ft-lbs) torque is required to "seat" the cap.

(8) Remove the seal protector tool after installing the adjustment cap.

(9) Insert the rack piston into the steering gear housing until the wormshaft engages with the valve body and the stub shaft.

Use care to prevent damage to the piston ring during installation.

(10) Rotate the stub shaft clockwise to force the rack piston into the steering gear housing. Do not remove the arbor tool until the valve body piston ring has entered the housing bore.

(11) Rotate the stub shaft until the rack piston center groove is aligned with the center of the pitman shaft bearing bore.

(12) Lubricate the pitman shaft adjustment screw cover gasket with petroleum jelly and place it on the cover. Ensure that the rubber seal in the gasket is properly "seated" in the cover groove.

(13) Position the cover over the pitman shaft and thread the cover onto the adjustment screw until it contacts the pitman shaft.

(14) Install the pitman shaft with the long, center sector tooth meshing with the rack piston center groove.

(15) Ensure that the adjustment screw cover gasket is correctly in place before attaching the cover to the steering gear housing. Install the cover lockwashers and bolts. Tighten the bolts with 61 N•m (45 ft-lbs) torque.

(16) Thread the adjustment screw locknut half-way on the adjustment screw. If necessary, insert an Allen wrench into the adjustment screw head to prevent it from turning while threading the nut on it.

(17) Install the end plug in the rack piston. Tighten the plug with 68 N•m (50 ft-lbs) torque.

(18) Lubricate the steering gear housing end-plug O-ring seal with power steering fluid and position it on the end plug.

(19) Install and "seat" the end plug in the steering gear housing. If necessary, tap the end plug lightly with a plastic mallet to "seat" it properly.

(20) Install the end-plug retaining ring with the ring end gap **not aligned** with the hole inside the steering gear housing. Tap lightly on the plug to ensure that the ring is "seated" properly.

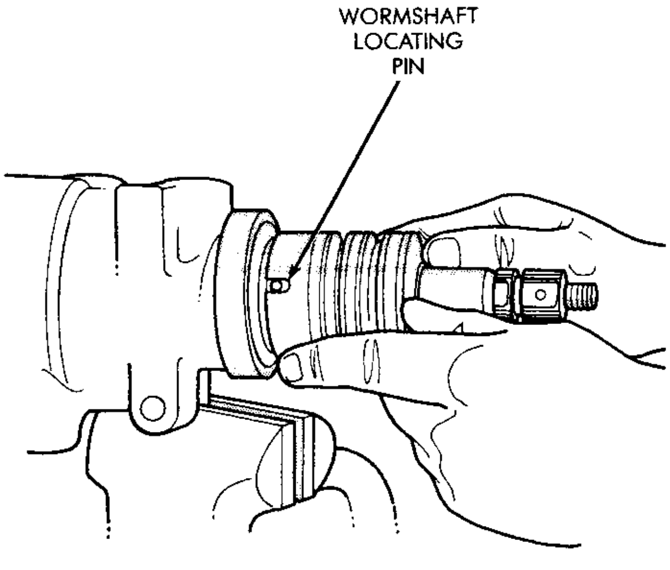


Fig. 33 Valve Body Installation

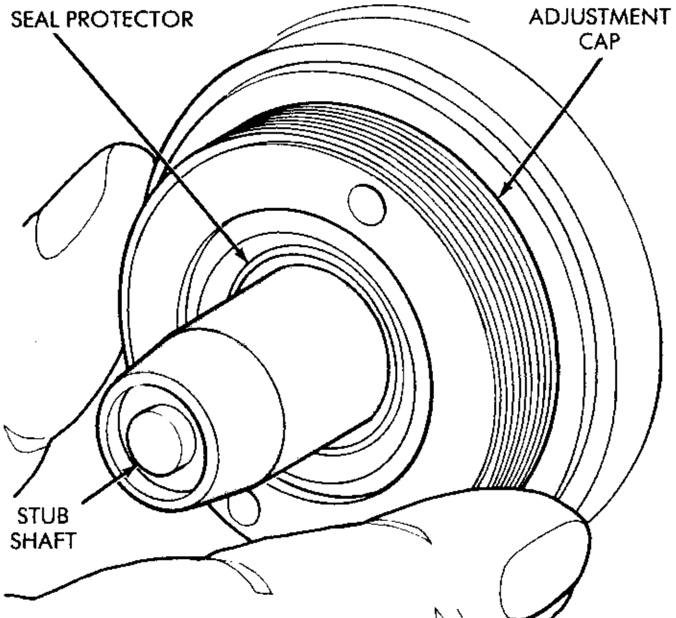


Fig. 34 Adjustment Cap Installation

(21) Adjust the wormshaft bearing “preload” torque and the pitman shaft overcenter drag torque according to the procedures listed within **Steering Gear—Adjustments On Bench.**

Steering Gear—Adjustments On Bench

After assembly, the steering gear requires two adjustments:

- wormshaft bearing “preload” torque, and
- pitman shaft overcenter drag torque.

CAUTION: Adjust the steering gear in the following order only. Always adjust the wormshaft bearing “preload” torque first, and then adjust the pitman shaft overcenter drag torque last. Failure to do so could result in damage to the gear or improper steering response.

Wormshaft Bearing Preload Torque—Adjustment

(1) Tighten the wormshaft bearing adjustment cap with a spanner wrench until it is “seated” in the steering gear housing. Approximately 27 N•m (20 ft-lbs) torque is required to “seat” the cap in the housing.

(2) Score an index mark on the steering gear housing adjacent to one of the spanner wrench tightening holes in the adjustment cap (Fig. 35).

(3) Measure counterclockwise 4.7 to 6.3 mm (3/16 to 1/4 in) from the index mark and score an adjustment reference mark on the housing (Fig. 36).

(4) Rotate the adjustment cap counterclockwise until the spanner wrench tightening hole in the cap (adjacent to the index mark) is aligned with the adjustment reference mark on the housing.

(5) Install the adjustment cap locknut and tighten it with 115 N•m (85 ft-lbs) torque. Ensure that the adjustment cap does not rotate while tightening the locknut.

(6) Rotate the stub shaft clockwise to the stop, then rotate it counterclockwise 1/4 of-a-turn.

(7) Use a low calibration (e.g., inch-pounds) torque bar with a maximum capacity of 6 N•m/50 in-lbs torque and a 12-point deep socket wrench to measure the “preload” torque required to rotate the stub shaft (and wormshaft). Rotate the stub shaft at a constant speed (rpm) and measure the wormshaft “preload” torque with the beam of the torque bar at or near the vertical position (Fig. 37).

(8) Record the wormshaft bearing “preload” torque measurement. The “preload” torque required to rotate the stub shaft (and wormshaft) should be 0.45 to 1.13 N•m (4 to 10 in-lbs). If the torque measurement is not within the specified torque range:

- the adjustment cap may not have been tightened correctly or it may have rotated while the locknut was being tightened;
- the steering gear may be assembled incorrectly; or
- the thrust bearings and the races could be defective.

(9) If necessary, correct the cause for the incorrect “preload” torque and readjust the adjustment cap.

Pitman Shaft Overcenter Drag Torque—Adjustment

CAUTION: Do not attempt to adjust the pitman shaft overcenter drag torque before the wormshaft bearing “preload” torque has been adjusted.

(1) Rotate the pitman shaft adjustment screw counterclockwise until it is fully extended, then rotate it 180 degrees clockwise.

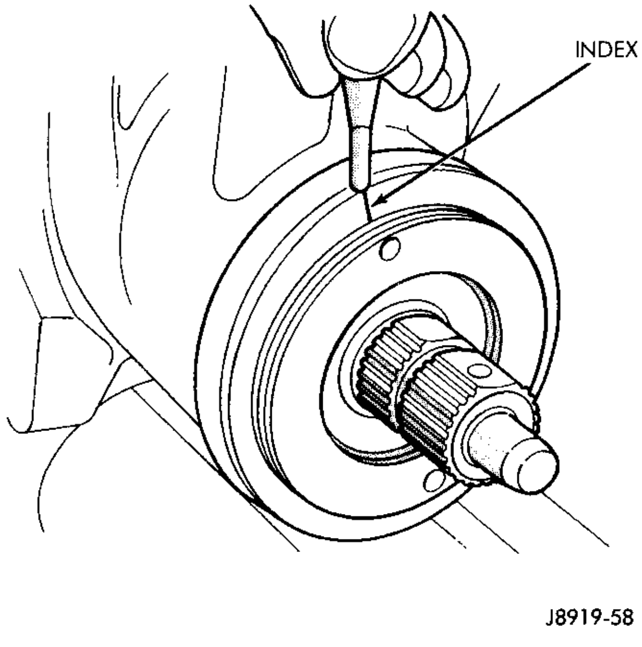


Fig. 35 Adjustment Cap Index Mark

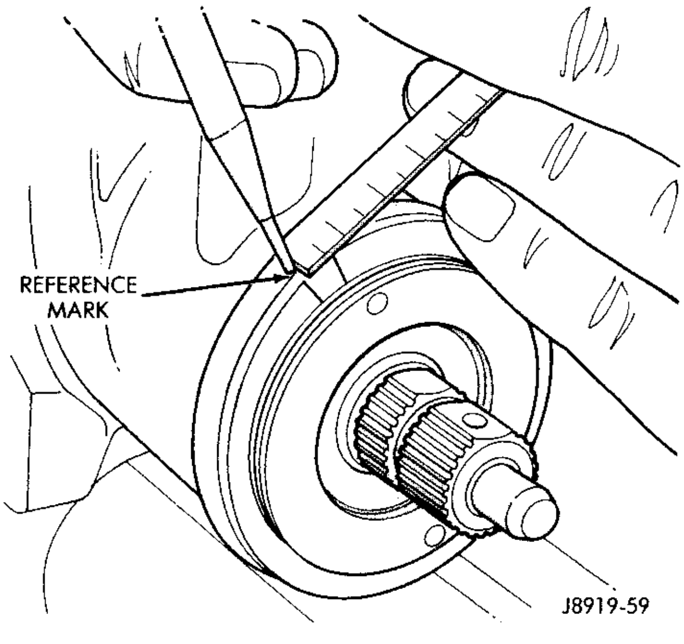


Fig. 36 Adjustment Reference Mark

(2) Rotate the stub shaft from stop-to-stop, count the total number of rotations, and rotate the stub shaft in the reverse direction 1/2 of the total number of rotations to center the steering gear.

When the steering gear is centered, the flat area on the stub shaft should face upward and be parallel with the adjustment screw cover (Fig. 38) and the pitman shaft master spline should be aligned with the adjustment screw as illustrated in Fig. 39.

(3) Place a low calibration (e.g., inch-pounds) torque bar with a maximum capacity of 6 N•m/50 in-lbs torque and a 12-point deep socket wrench on the stub shaft. Place the torque bar in a vertical position for the measurement. Rotate the torque bar 45 degrees each side of vertical position)center) and record the highest overcenter drag torque measured at or near the steering gear center position (Fig. 40).

(4) The overcenter drag torque must conform (as applicable) to the following specifications:

- for new steering gears (less than 400 miles/640 km)—the overcenter drag torque should be equal to the previously measured wormshaft bearing "preload" torque plus an additional 0.45 to 0.90 N•m (4 to 8 in-lbs) torque but must not exceed a maximum of 2 N•m (18 in-lbs) torque; and
- for used steering gears (400 miles/640 km or more) —the overcenter drag torque should be equal to the previously measured wormshaft bearing torque plus an additional 0.5 to 0.6 N•m (4 to 5 in-lbs) torque but do not exceed a maximum of 2 N•m (18 in-lbs) torque.

(5) if necessary, adjust the overcenter drag torque by rotating the pitman shaft adjustment screw clockwise until the specified overcenter drag torque is obtained. Hold the pitman shaft adjustment screw and tighten the locknut with 27 N•m (20 ft-lbs) torque after the adjustment is completed (Fig. 41).

If the adjustment screw is allowed to rotate while tightening the locknut, the complete overcenter drag torque adjustment procedure must be repeated.

(6) Install the steering gear according to the procedure listed below.

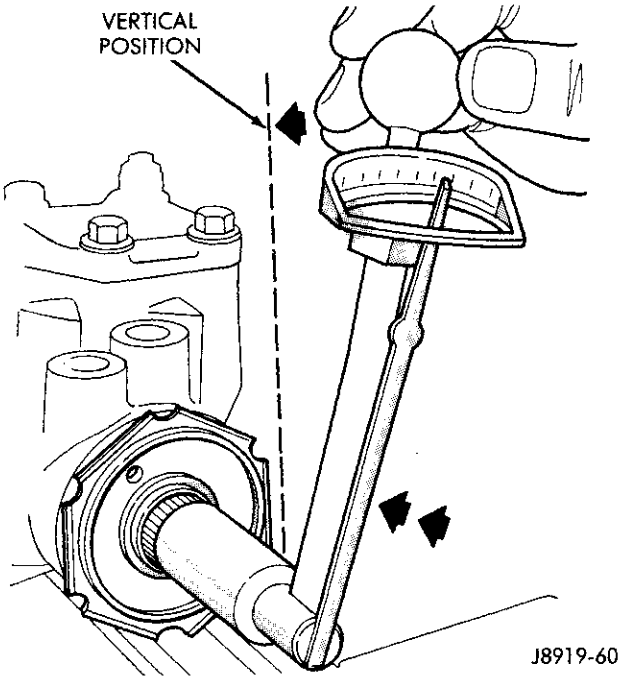


Fig. 37 Wormshaft Bearing "Preload" Torque Measurement

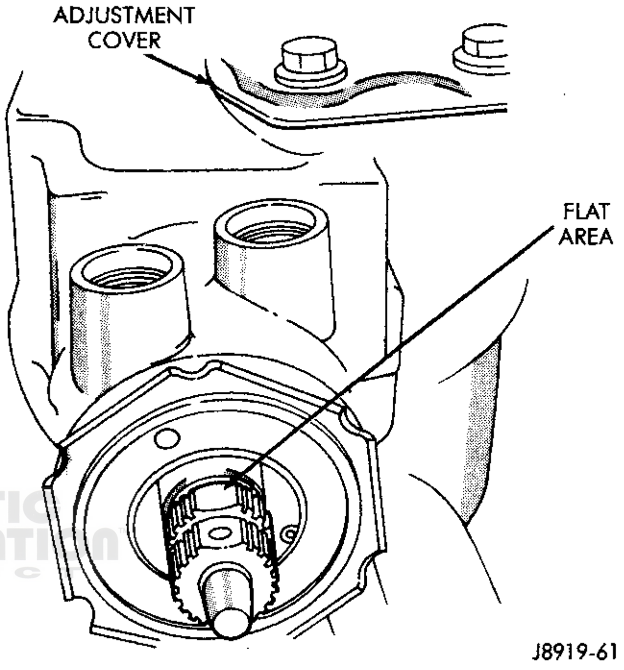


Fig. 38 Steering Gear Centered (Reference)

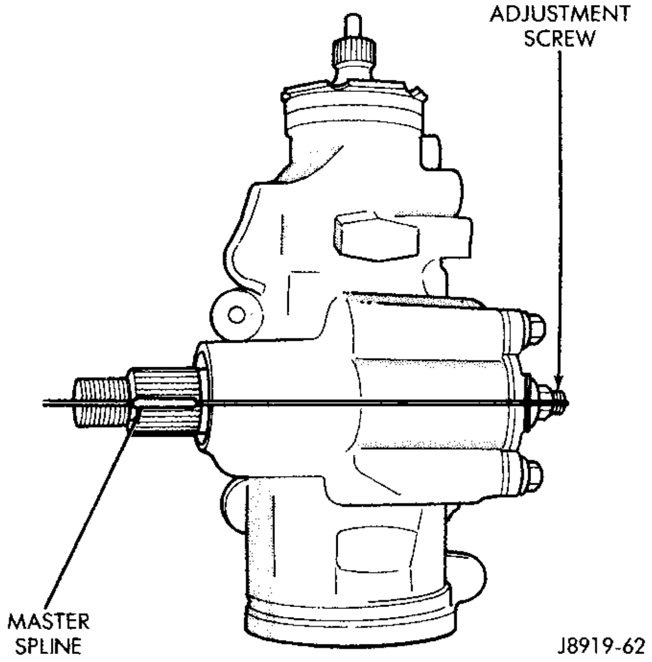


Fig. 39 Steering Gear Centered (Reference)

(7) Fill the pump reservoir with power steering fluid and purge the system according to the procedure listed within **Steering Gear—Initial Operation.**

Power Steering Gear—Installation

(1) Center the steering gear, align the intermediate shaft and the stub shaft, and position the steering gear at the frame sill. Install the retaining bolts. Tighten the retaining bolts with 88 N•m (65 ft-lbs) torque.

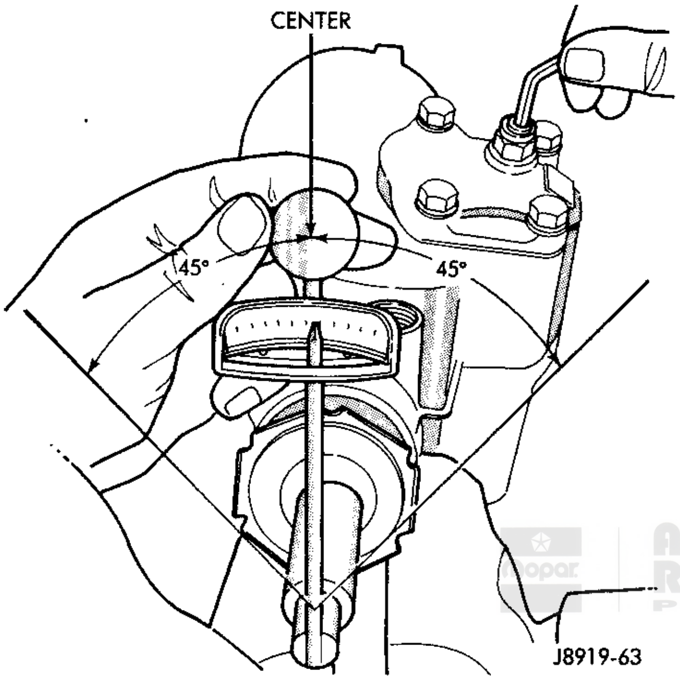


Fig. 40 Overcenter Drag Torque Measurement

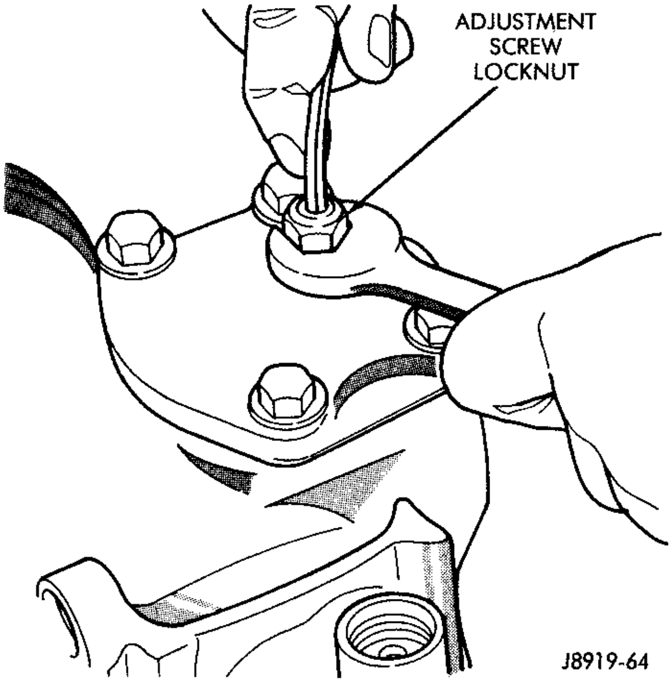


Fig. 41 Tightening Adjustment Screw Locknut

(2) Connect the intermediate shaft to the steering gear stub shaft. Tighten the bolts with 45 N•m (33 ft-lbs) torque.

(3) With the pitman arm and the shaft installation reference marks aligned, position the pitman arm on the pitman shaft.

(4) Install the washers and the retaining nut on the pitman shaft and tighten the nut with 251 N•m (185 ft-lbs) torque (all vehicles).

WARNING: The pitman arm retaining nut must be securely "staked" against the pitman shaft threads for safe retention.

(5) "Stake" the pitman arm retaining nut against the pitman shaft threads.

(6) Connect the drag link to the pitman arm. Tighten the retaining nut with 81 N•m (60 ft-lbs) torque (all vehicles). Install a replacement cotter pin.

(7) If removed, install the front stabilizer bar.

(8) Remove the supports and lower the vehicle.

Steering Gear—Initial Operation

(1) Fill the pump reservoir and operate the engine until the power steering fluid reaches the normal operating temperature of approximately 77°C (170°F), then stop the engine.

(2) Turn the wheels to a full-left-turn position and add power steering fluid until the reservoir is full.

(3) Start the engine. Operate it at high idle speed and then observe the fluid level on the dipstick. Add fluid, if necessary.

(4) Purge the system of air by turning the wheels from side-to-side without contacting the stops. Fluid with air in it will have a milky-red color. Maintain the reservoir full of fluid.

Because air is compressible, it must be eliminated from the fluid before normal steering action can be obtained.

(5) Return the wheels to the straight-ahead position and operate the engine for an additional 2 to 3 minutes, then stop the engine.

(6) Road test the vehicle to ensure that the steering system functions normally and is free of noise.

(7) Observe the fluid level. Add fluid as necessary to fill the reservoir with the system stabilized at the normal operating temperature.

CAUTION: If the fluid reservoir cap is not properly tightened after a fluid level check, the result can be fluid leakage and possible loss of the cap. Ensure that the cap is securely tightened when installing it.

Power Steering Pump—Service

Fluid Pressure—Test

(1) Check and adjust the power steering pump belt tension as necessary. Refer to the procedure listed within **Drive Belt Adjustments.**

(2) Place a drip pan under the engine and disconnect the power steering pump high pressure hose either at the pump or at the steering gear (whichever is the most convenient). Maintain the hose end raised above the reservoir to prevent fluid loss.

(3) Connect a pressure test gauge to the pump pressure hose and to an adapter hose (use an additional adapter hose if necessary). Connect the test gauge between the power steering pump and the steering gear (Fig. 42).

CAUTION: Ensure that the test gauge is connected in the fluid pressure circuit between the pump and the steering gear.

(4) Open the test valve completely. Rotate the valve counterclockwise to open it (Fig. 42).

(5) Fill the fluid reservoir with power steering fluid as necessary.

(6) Operate the engine until the power steering fluid reaches the normal operating temperature of approximately 77°C (170°F).

(7) The pressure should be less than 1 030 kPa (150 psi). If the pressure is 1 030 kPa (150 psi) or more, inspect the hoses for restrictions and repair as necessary.

CAUTION: The following test procedure involves testing the maximum pump pressure output and the flow control valve operation. Do not close the test gauge valve for more than five seconds at a time because this could damage the pump.

(8) Close the test gauge valve fully, then immediately open it (Fig. 42). Repeat this procedure three times and record the highest pressure indicated on the test gauge each time the test gauge valve is closed.

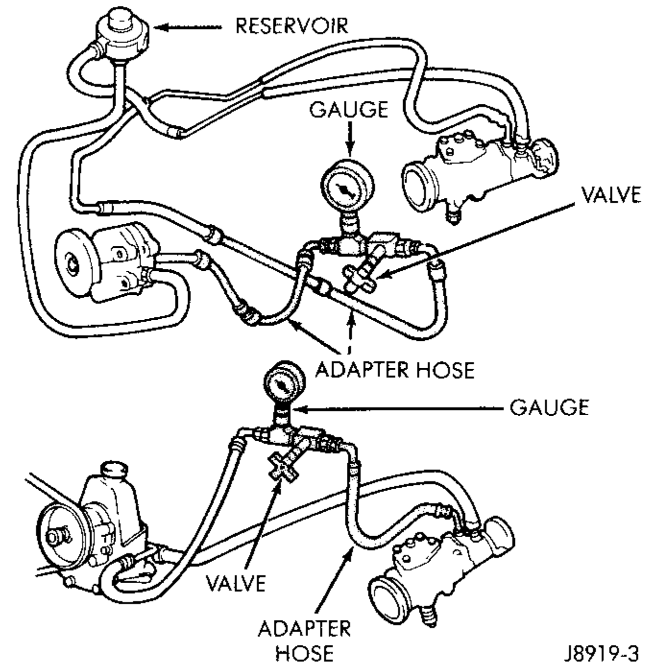


Fig. 42 Pressure Testing

(9) Compare the highest indicated pressures. If the pressure indications are within the range specified in the **Pump Operating Specifications** chart and the variance of the three pressure indications is within the 345 kPa (50 psi) allowable variance, the pump is functioning normally.

Pump Operating Specifications

For example: if the highest indicated pressures for a vehicle equipped with a 4.0L engine are 9 530 kPa, 9 700 kPa and 9 820 kPa (1,377 psi, 1,407 psi and 1,424 psi), they are acceptable and, because the pressure variance is within the 345 kPa (50 psi) allowable variance, the pump operation is normal.

(10) If the highest indicated pressures are more than the acceptable limit for the vehicle or the pressures are not within the 345 kPa (50 psi) allowable variance, the flow control valve is not functioning correctly. Remove and clean the valve (Fig. 43). Remove burrs with a crocus cloth or a fine grit hone. If the system is contaminated, flush it.

CAUTION: The power steering system is a closed system. Contaminated fluid in either the pump or in the steering gear is circulated to the other unit. If the system is exceptionally contaminated, the pump and the steering gear must be disassembled and cleaned, and all the hoses removed and flushed.

CAUTION: Do not force the pump to operate against the stops for more than 2 to 4 seconds at a time because, otherwise, pump damage will result.

(11) If the pump operation is acceptable (i.e., the highest indicated pressures are within the specified range and variance), continue with the test. With the gauge valve open, turn the steering wheel to the extreme left and right positions to force the pump to operate against the stops (Fig. 44). Record the highest indicated pressure at each steering wheel position.

(12) Compare the extreme left and the right turn pressures with the previously noted pump highest output pressures. If the pump highest output pressures are not duplicated when the pump is forced to operate

Pump Operating Specifications

Pressure Relief			
2.5L YJ Vehicles kPa (psi)	**4.2L YJ Vehicles kPa (psi)**	**2.5L & 4.0L XJ/MJ Vehicles kPa (psi)**	**5.9L SJ Vehicles kPa (psi)**
6,900-7,600 (1,000-1,100)	6,900-7,600 (1,000-1,100)	9,300-10,000 (1,350-1,450)	9,300-10,000 (1,350-1,450)

J9019-6

against either stop, the steering gear is leaking internally and must be disassembled and repaired.

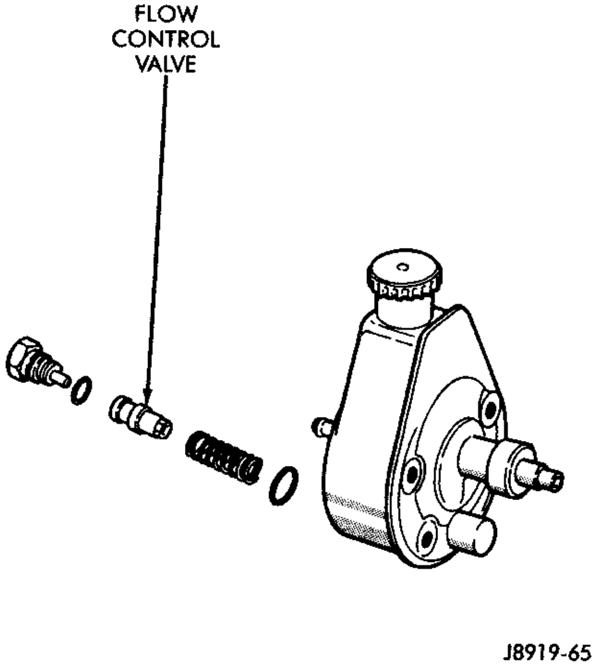


Fig. 43 Flow Control Valve

(13) Stop the engine and remove the test equipment. Connect the pressure hose to the pump (or steering gear).

(14) Repair the system as necessary and correct the fluid level. Remove the drip pan.

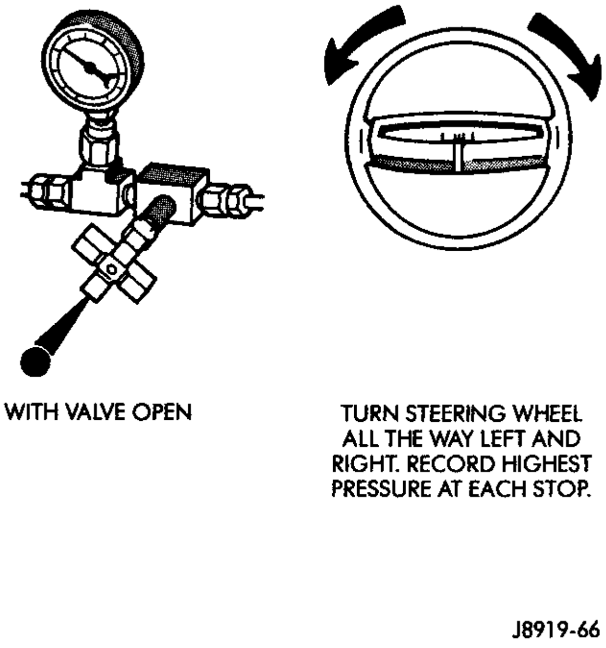


Fig. 44 Pressure Test

Pump Service Diagnosis

CONDITION	POSSIBLE CAUSE	CORRECTION
CHIRP NOISE IN STEERING PUMP	(1) Loose belt.	(1) Adjust belt tension to specification.
BELT SQUEAL (PARTICULARLY NOTICEABLE AT FULL WHEEL TRAVEL AND STAND STILL PARKING)	(1) Loose belt.	(1) Adjust belt tension to specification.
GROWL NOISE IN STEERING PUMP	(1) Excessive back pressure in hoses or steering gear caused by restriction.	(1) Locate restriction and correct. Replace part if necessary.
GROWL NOISE IN STEERING PUMP (PARTICULARLY NOTICEABLE AT STAND STILL PARKING	(1) Scored pressure plates, thrust plate or rotor.	(1) Replace parts and flush system.
	(2) Extreme wear of cam ring.	(2) Replace parts.
GROAN NOISE IN STEERING PUMP	(1) Low oil level.	(1) Fill reservoir to proper level.
	(2) Air in the oil. Poor pressure hose connection.	(2) Tighten connector to specified torque. Bleed system by operating steering from right to left - full turn.
RATTLE NOISE IN STEERING PUMP	(1) Vanes not installed properly.	(1) Install properly.
	(2) Vanes sticking in rotor slots.	(2) Free up by removing burrs, varnish, or dirt.
SWISH NOISE IN STEERING PUMP	(1) Defective flow control valve.	(1) Replace part.
WHINE NOISE IN STEERING PUMP	(1) Pump shaft bearing scored.	(1) Replace housing and shaft. Flush system.
HARD STEERING OR LACK OF ASSIST	(1) Loose pump belt.	(1) Adjust belt tension to specification.
	(2) Low oil in reservoir. **NOTE:** Low oil level will also result in excessive pump noise.	(2) Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors.
	(3) Steering gear to column misalignment.	(3) Align steering column.
	(4) Lower coupling flange rubbing against steering gear adjuster.	(4) Loosen pinch bolt and assemble properly.
	(5) Tires not properly inflated.	(5) Inflate to recommended pressure.

J8919-68

Pump Service Diagnosis (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTION
	Further possible causes could be:	
	(6) Sticking flow control valve.	In order to diagnose conditions such as listed in (6), (7), (8), (9) a pressure test of the entire power steering system is required.
	(7) Insufficient pump pressure output.	
	(8) Excessive internal pump leakage.	
	(9) Excessive internal gear leakage.	
FOAMING MILKY POWER STEERING FLUID, LOW FLUID LEVEL AND POSSIBLE LOW PRESSURE	(1) Air in the fluid, and loss of fluid due to internal pump leakage causing overflow.	(1) Check for leaks and correct. Bleed system. Extremely cold temperatures will cause system aeriation should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from body. Check welsh plug and body for cracks. If plug is loose or body is cracked, replace body.
LOW PUMP PRESSURE	(1) Flow control valve stuck or inoperative.	(1) Remove burrs or dirt or replace. Flush system.
	(2) Pressure plate not flat against cam ring.	(2) Correct.
MOMENTARY INCREASE IN EFFORT WHEN TURNING WHEEL FAST TO RIGHT OR LEFT	(1) Low oil level in pump.	(1) Add power steering fluid as required.
	(2) Pump belt slipping.	(2) Tighten or replace belt.
	(3) High internal leakage.	(3) Check pump pressure. (See pressure test.)
STEERING WHEEL SURGES OR JERKS WHEN TURNING WITH ENGINE RUNNING ESPECIALLY DURING PARKING	(1) Low oil level.	(1) Fill as required.
	(2) Loose pump belt.	(2) Adjust tension to specification.
	(3) Steering linkage hitting engine oil pan at full turn.	(3) Correct clearance.
	(4) Insufficient pump pressure.	(4) Check pump pressure. (See pressure test.) Replace flow control valve if defective.
	(5) Sticking flow control valve.	(5) Inspect for varnish or damage, replace if necessary.
EXCESSIVE WHEEL KICKBACK OR LOOSE STEERING	(1) Air in system.	(1) Add oil to pump reservoir and bleed by operating steering. Check hose connectors for proper torque and adjust as required.

J8919-69

Pump Service Diagnosis (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTION
LOW PUMP PRESSURE	(1) Extreme wear of cam ring.	(1) Replace parts. Flush system.
	(2) Scored pressure plate, thrust plate, or rotor.	(2) Replace parts. Flush system.
	(3) Vanes not installed properly.	(3) Install properly.
	(4) Vanes sticking in rotor slots.	(4) Freeup by removing burrs, varnish, or dirt.
	(5) Cracked or broken thrust or pressure plate.	(5) Replace part.

J8919-70

Drive Belt—Adjustments

4.2L Engine Serpentine Drive Belt

(1) Position the belt tension gauge on the longest span of the drive belt and test the tension.

(2) If an adjustment is necessary, loosen the alternator front and rear adjustment slot lock-bolts and the pivot bolt (Fig. 45).

Because of the higher tension required for serpentine drive belts, a helper may be necessary for the belt adjustment.

(3) Insert the drive lug of a 1/2-inch drive ratchet in the alternator front bracket adjustment hole (Fig. 45) and pivot the brackets and alternator until the correct belt tension is obtained. The correct tension is:

- new belt—800 to 900 N (180 to 200 lbs-f), and
- used belt—623 to 712 N (140 to 160 lbs-f).

(4) Tighten the adjustment slot lock-bolts with 27 N•m (20 ft-lbs) and the pivot bolt with 38 N•m (28 ft-lbs) torque. Re-test the belt tension.

2.5L/4.0L Engine Serpentine Drive Belt

(1) Position the belt tension gauge between the idler pulley and the power steering pump pulley and test the tension.

(2) If an adjustment is necessary, loosen the power steering pump adjustment slot locknut and the pivot bolt (Fig. 46). Loosen and then "finger tighten" the rear bracket-to-pump bolts (Fig. 47).

(3) Tighten the adjustment bolt (Fig. 46) until the correct belt tension is obtained. The correct tension is:

- new belt—800 to 900 N (180 to 200 lbs-f), and
- used belt—623 to 712 N (140 to 160 lbs-f).

(4) Tighten the adjustment slot locknut, the pivot bolt and the rear bracket-to-pump bolts with 27 N•m (20 ft-lbs) torque. Re-test the belt tension.

2.5L/4.2L Engine V-Belt

(1) Position the belt tension gauge on the longest span of the drive belt and test the tension.

(2) If an adjustment is necessary, loosen the power steering pump front and rear pivot bolts and the adjustment slot lock-bolt (Fig. 48).

CAUTION: DO NOT pry on the pump reservoir to tighten the drive belt because this can cause damage to the pump internal components. Use the rear bracket adjustment hole.

(3) Insert the drive lug of a 1/2-inch drive ratchet in the pump rear bracket adjustment hole (Fig. 48) and pivot the bracket and pump until the correct belt tension is obtained. The correct tension is:

- new belt—534 to 712 N (120 to 160 lbs-f), and
- used belt—400 to 512 N (90 to 115 lbs-f).

(4) Tighten the power steering pump adjustment slot lock-bolt and the pivot bolts with 38 N•m (28 ft-lbs) torque. Re-test the belt tension.

5.9L Engine V-Belt

(1) Position the belt tension gauge on the longest span of the drive belt and test the tension.

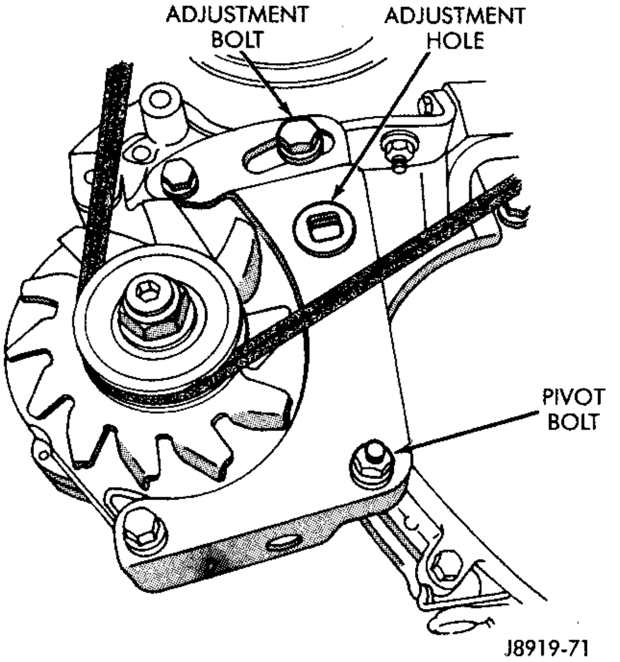


Fig. 45 Serpentine Drive Belt Adjustment — 4.2L

(2) If an adjustment is necessary, loosen the power steering pump rear bracket adjustment slot locknuts (Fig. 49).

CAUTION: DO NOT pry on the pump reservoir to tighten the drive belt because this can cause damage to the pump internal components. Use the rear bracket adjustment hole.

(3) Insert the drive lug of a 1/2-inch drive ratchet in the rear bracket adjustment hole (Fig. 49) and pivot the bracket and pump until the correct belt tension is obtained. The correct tension is:

- new belt—534 to 712 N (120 to 160 lbs-f), and
- used belt—400 to 512 N (90 to 115 lbs-f).

(4) Tighten the power steering pump adjustment slot locknuts with 38 N•m (28 ft-lbs) torque. Re-test the belt tension.

If the air pump drive belt also must be tightened, refer to Group 7—Cooling System for detailed instructions.

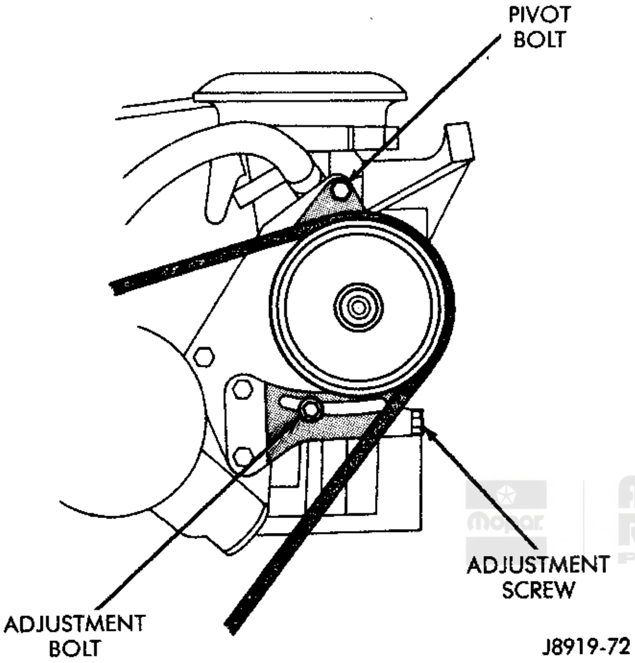


Fig. 46 Serpentine Drive Belt Adjustment — 2.5L/4.0L

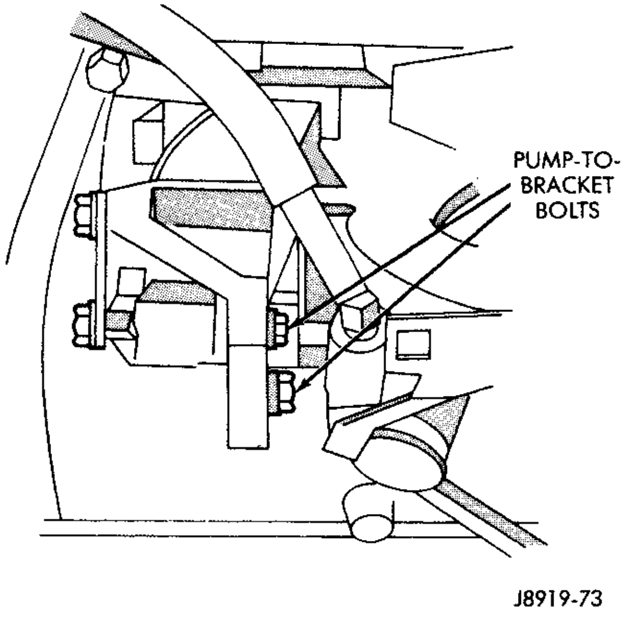


Fig. 47 Rear Bracket-To-Pump Bolts

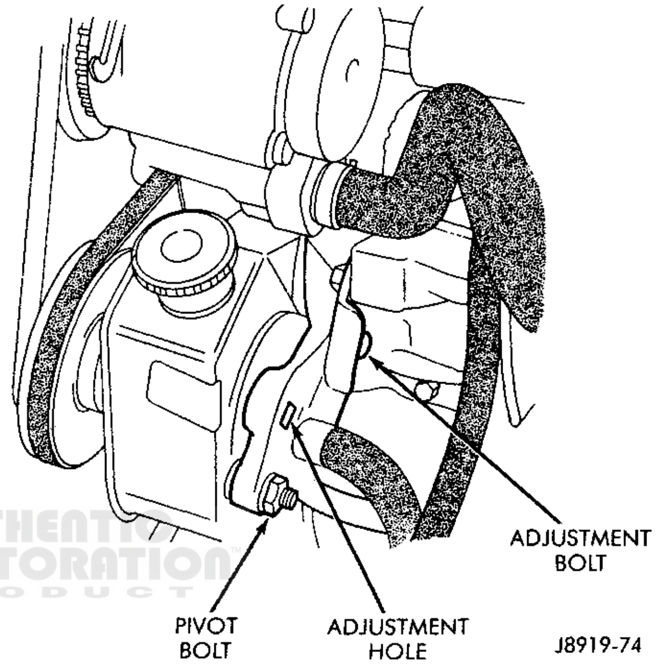


Fig. 48 V-Belt Adjustment — 2.5L/4.2L

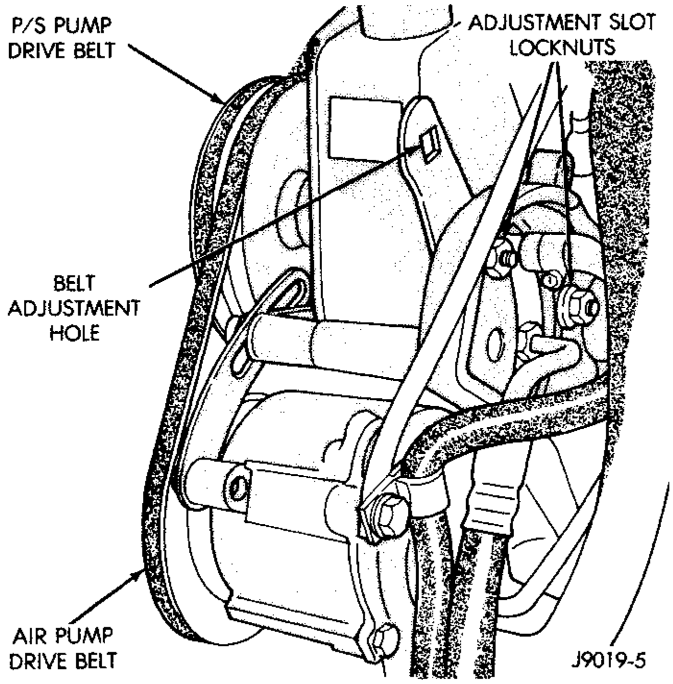


Fig. 49 V-Belt Adjustment — 5.9L

Drive Belt Tension

Engine	Drive Belt	Tension N (lbs-f)	
		Initial (New Belt)	Reset (Used Belt)
4-Cylinder 6-Cylinder	Serpentine	800-900 (180-200)	623-712 (140-160)
All	V-Belt	534-712 (120-160)	400-512 (90-115)

J8919-75

Power Steering Pump—Removal

SJ And YJ Vehicles

CAUTION: The drive belt must be loosened before removing the pump. Do not attempt to remove the pump without loosening the belt because, if not loosened, the pulley will be damaged.

(1) Loosen the pump drive belt as instructed in the applicable drive belt adjustment procedure. Remove the belt from the pump pulley.

(2) Remove the air cleaner, if necessary, and place a drain pan under the power steering pump.

(3) Clamp the fluid return hose, if necessary, and disconnect the hoses from the power steering pump. Cap the fittings.

(4) Remove the front bracket attaching bolts.

(5) Remove the pump-to-rear bracket bolts/nuts and remove the pump. With the pump removed, remove the front bracket from the pump, if necessary.

MJ/XJ Vehicles

CAUTION: The serpentine drive belt tension must be released before removing the pump. Do not attempt to remove the pump without loosening the belt and releasing the tension because, otherwise, the pump pulley could be damaged.

(1) Loosen the serpentine drive belt:
- loosen the power steering pump adjustment slot locknut and the pivot bolt (Fig. 50);
- loosen the rear bracket-to-pump bolts (Fig. 51); and
- turn the adjustment bolt (Fig. 50) counterclockwise until sufficient slack in drive belt tension is obtained to separate the pump pulley from the belt.

(2) Place a drain pan under the power steering pump.

(3) Install a clamp on the pump fluid return hose (Fig. 52) to prevent excessive fluid spillage. Disconnect the return hose from the pump.

(4) Disconnect the high pressure tubing fitting from the pump (Fig. 52).

(5) Remove the rear bracket-to-pump bolts (Fig. 52).

(6) Remove the adjustment bracket-to-rear bracket bolts and the pivot bolt (Fig. 53).

(7) Remove the P/S pump, the front bracket and the adjustment bracket as a unit from the rear bracket and the engine.

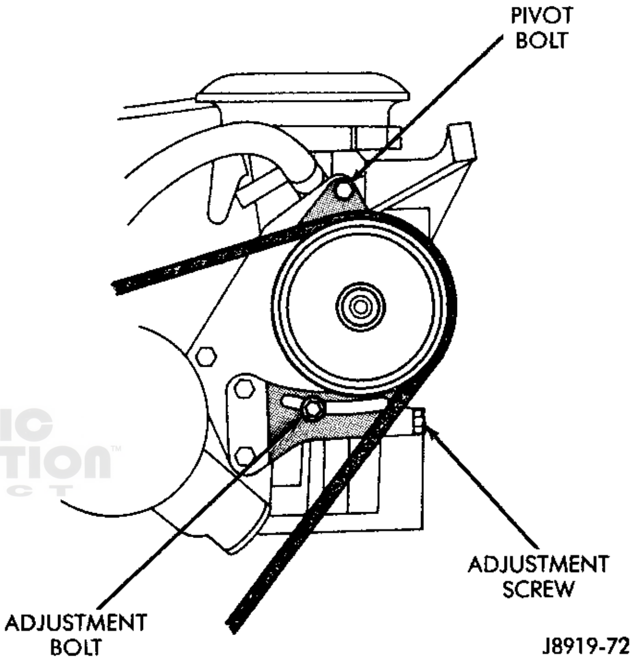


Fig. 50 Drive Belt Tension Release

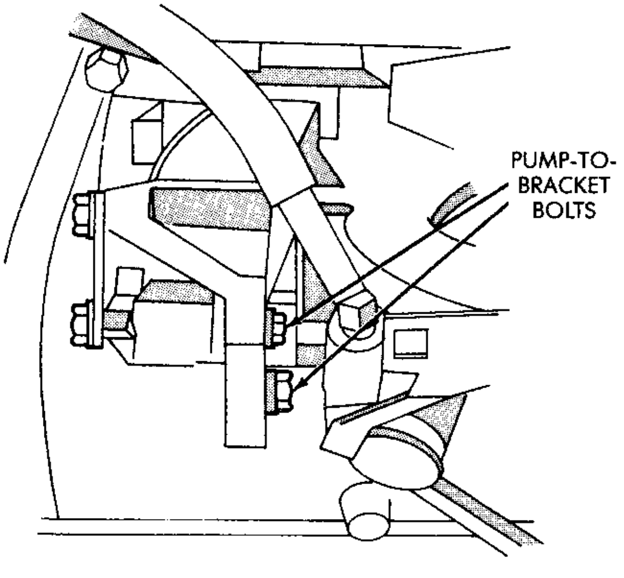


Fig. 51 Rear Bracket-To-Pump Bolts

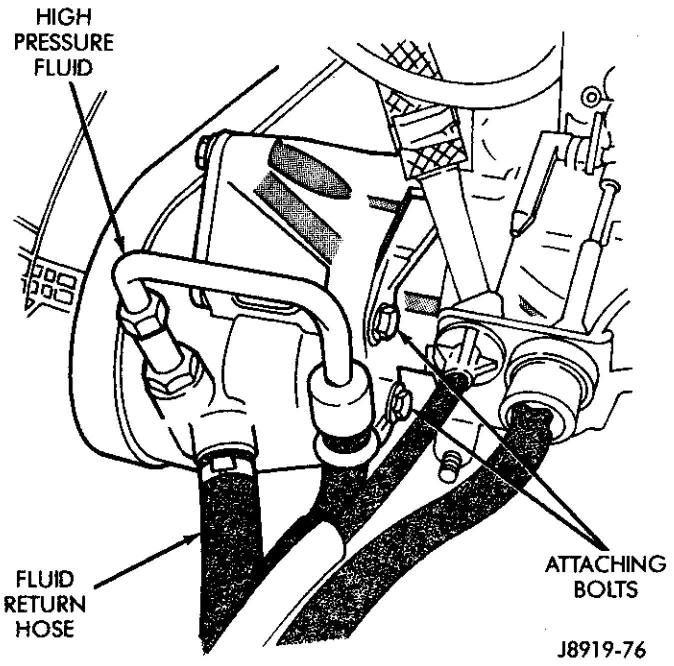


Fig. 52 P/S Pump Removal/Installation—MJ & XJ

(8) If the pump is being replaced, remove the pulley, the adjustment bracket, and the front bracket from the pump (Fig. 54). Refer to the pulley removal and installation procedures (located within this Group) for detailed instructions.

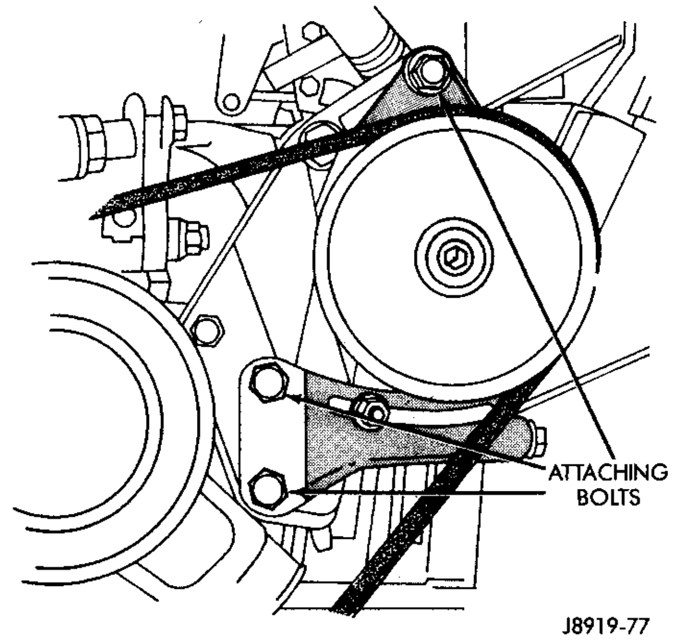


Fig. 53 Adjustment Bracket & Pivot Bolts

Power Steering Pump Pulley—MJ/XJ Vehicles

Plastic Pulley—Removal

(1) Remove the pump according to the removal procedure.

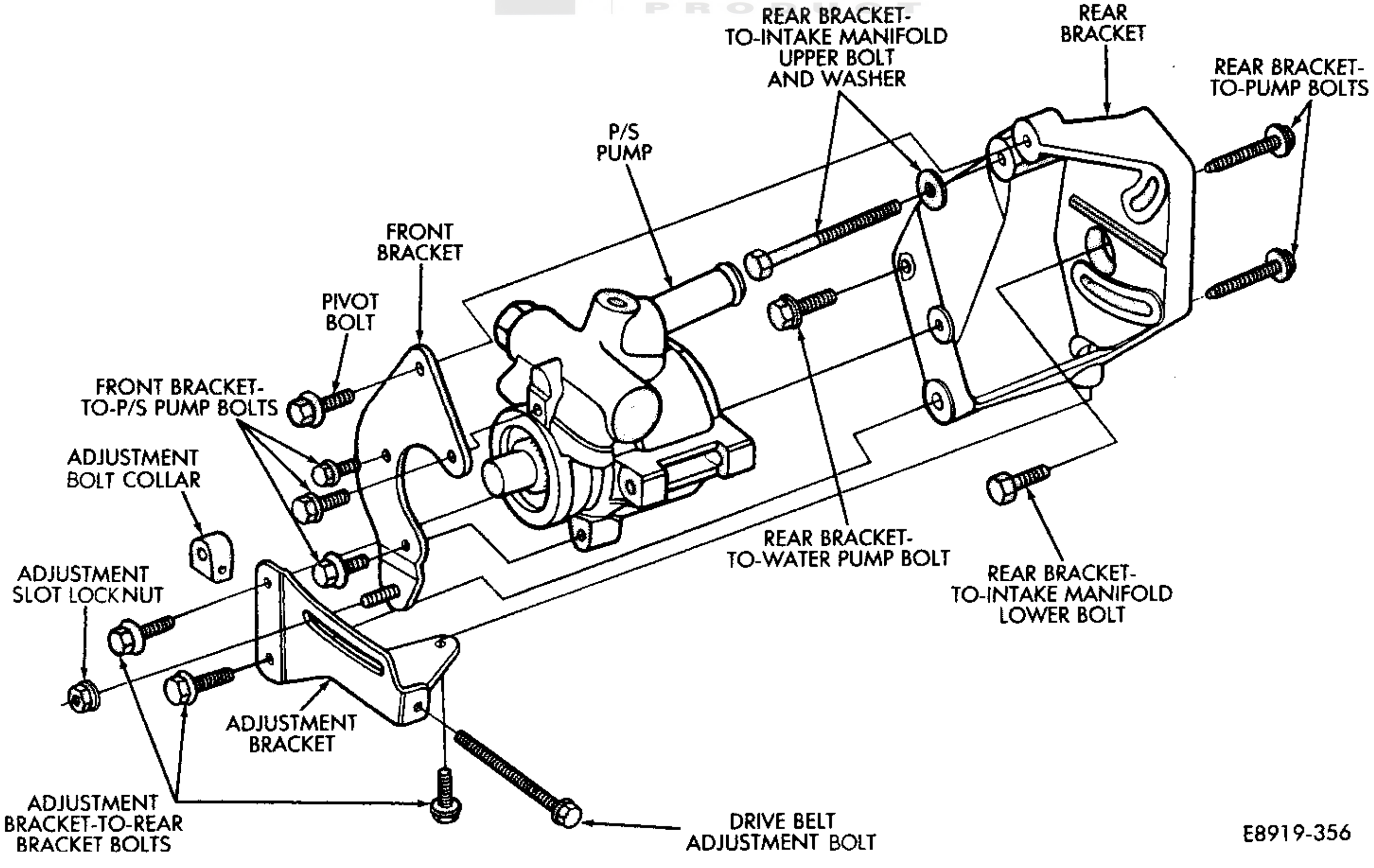


Fig. 54 P/S Pump & Brackets

(2) Remove the pulley from the pump shaft with an appropriate removal tool (Fig. 55):

- thread the tool screw into the pump shaft bore and position the tool nut against the pulley hub;
- position the removal tool puller rings around and into the pulley hub groove and the nut groove;
- position the tapered collar around the puller rings; and
- tighten the tool nut to remove the pulley from the shaft.

Metal Pulley—Removal

(1) Remove the pump according to the removal procedure.

(2) If the end of the shaft and the hub **are not flush**, measure the distance that the pump shaft protrudes outward from the pulley hub (Fig. 56). Record this distance for installation reference.

If not originally flush with the pump shaft, the hub of a replacement metal pulley (or the original metal pulley to be installed on a replacement pump) must be installed the same distance back from the end of the pump shaft (i.e., the shaft protrusion must be the same distance from the hub).

(3) Remove the pulley from the pump shaft with an appropriate removal tool (Fig. 55):

- if the pump shaft protrudes outward beyond the pulley hub, place a spacer or a flat washer over the shaft and on the hub;
- insert the tool screw through the spacer/washer (if used), thread it into the pump shaft bore and position the tool nut against the spacer/washer;
- position the removal tool puller rings around and into the pulley hub groove and the nut groove;
- position the tapered collar around the puller rings; and
- tighten the tool nut to remove the pulley from the shaft.

Plastic Pulley—Installation

A replacement plastic pulley (or the original plastic pulley to be installed on a replacement pump) must be installed so that the front of the pulley hub is located a distance of 7 ± 0.25 mm (0.275 ± 0.010 in) forward of the end of the pump shaft (Fig. 57).

(1) Install the pulley on the pump shaft with an appropriate installation tool (Fig. 58):

- position the pulley on the end of the pump shaft;
- place the tool spacers or flat washers on the pulley hub;
- thread the tool screw into the pump shaft bore; and
- tighten the tool nut to force the pulley the required distance on the shaft.

(2) Measure the distance that the front of the pulley hub is located forward of the end of the pump shaft (Fig. 57). **Ensure that the front of the hub is 7 ± 0.25 mm (0.275 ± 0.010 in) forward of the end of the pump shaft**

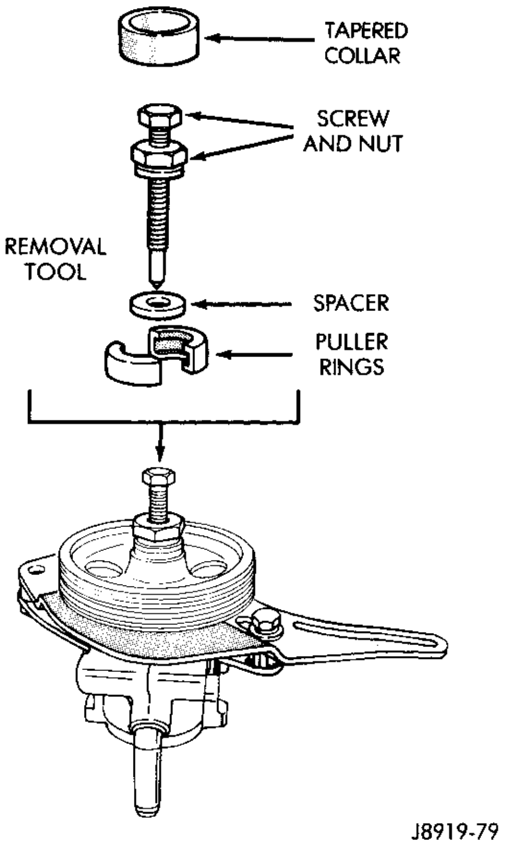


Fig. 55 Pump Pulley Removal

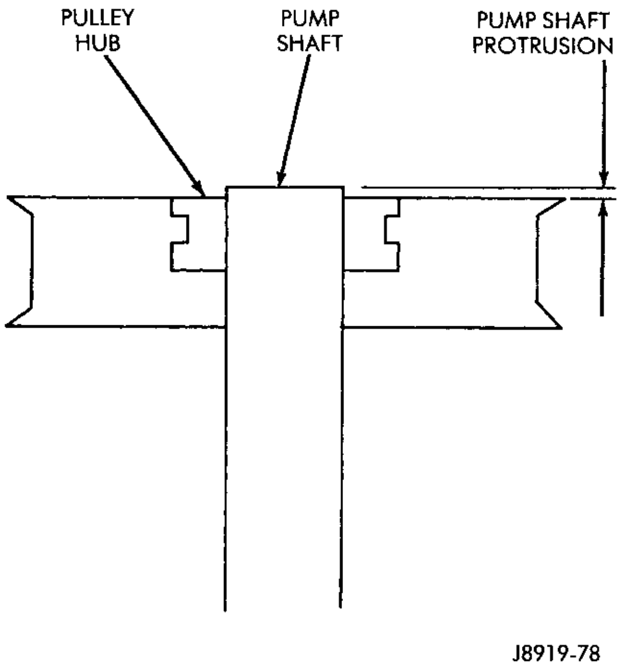


Fig. 56 Pump Shaft Protrusion — Metal Pulley

(3) Install the pump according to the installation procedure.

Metal Pulley—Installation

(1) Install the pulley on the pump shaft with an appropriate installation tool (Fig. 58):

- position the pulley on the end of the pump shaft;
- place the tool spacers or flat washers on the pulley hub;
- thread the tool screw into the pump shaft bore; and
- tighten the tool nut to force the pulley the required distance on the shaft.

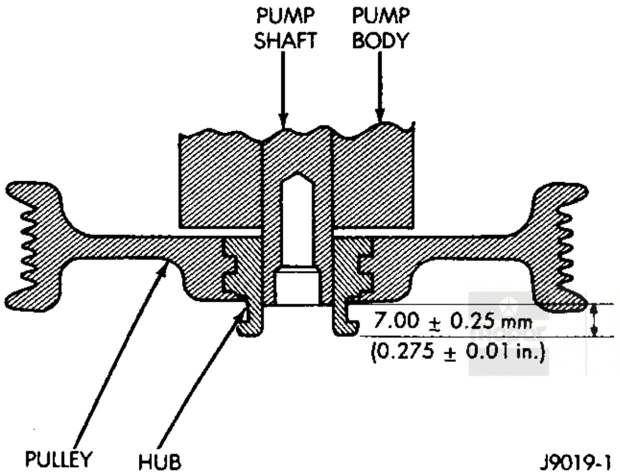


Fig. 57 Pump Shaft Location — Plastic Pulley

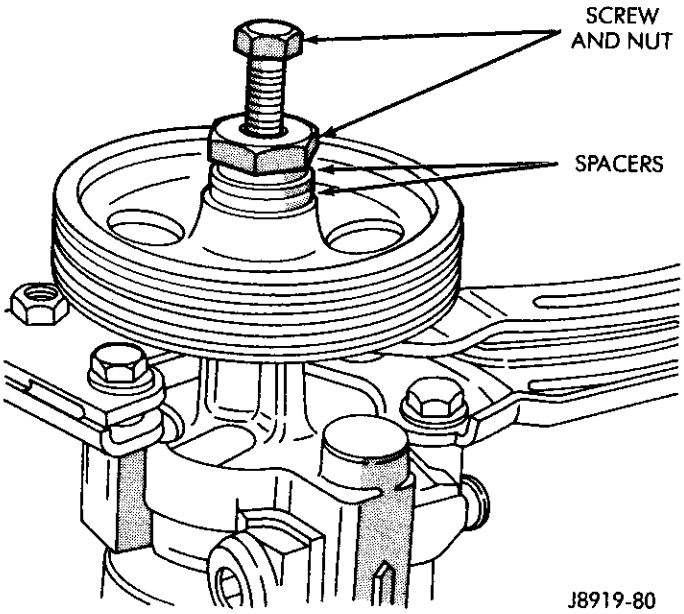


Fig. 58 Pump Pulley Installation

(2) Measure the distance that the pump shaft protrudes out from the pulley hub (Fig. 56). **Ensure that it is the same distance as the original shaft protrusion.**

When replacing a plastic pulley with a metal pulley, install the metal pulley hub so that it is flush with the end of the pump shaft. After pump installation on the engine, compare the pump pulley alignment with the two adjacent serpentine drive pulleys. If not correct, reposition the pulley hub on the pump shaft as necessary to align it with the adjacent pulleys.

(3) Install the pump according to the installation procedure.

Power Steering Pump—Disassembly

The power steering pumps installed in Jeep vehicles are either the vane-submerged type pump (Fig. 59) or the vane-nonsubmerged type pump (Fig. 60). The vane-nonsubmerged type pump (MJ/XJ vehicles) functions the same as the vane-submerged type except the fluid reservoir is separated (non-integral) from the housing and the internal pump components. The service procedures are similar for both pump types.

The non-integral fluid reservoir for vane-nonsubmerged type pumps installed in MJ/XJ vehicles equipped with a 2.5L engine is remotely located (front-left side of the engine compartment) from the pump. The non-integral fluid reservoir for vane-nonsubmerged type pumps installed in MJ/XJ vehicles equipped with a 4.0L engine is attached to the pump.

(1) Remove the pump mounting brackets, as necessary.

(2) If applicable, remove the fluid reservoir filler cap and drain the fluid. Install the reservoir filler cap.

(3) Clean the pump exterior with cleaning solvent.

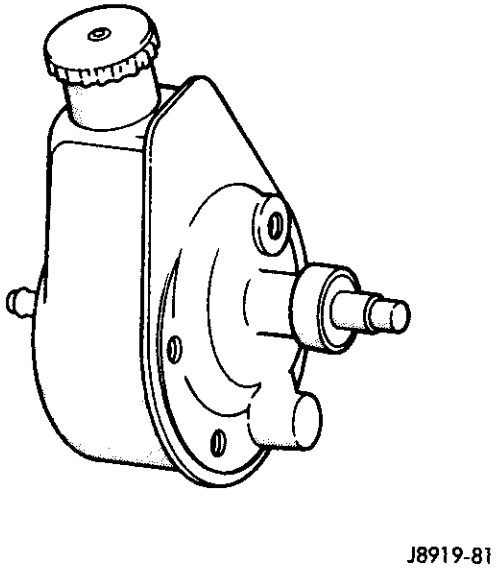
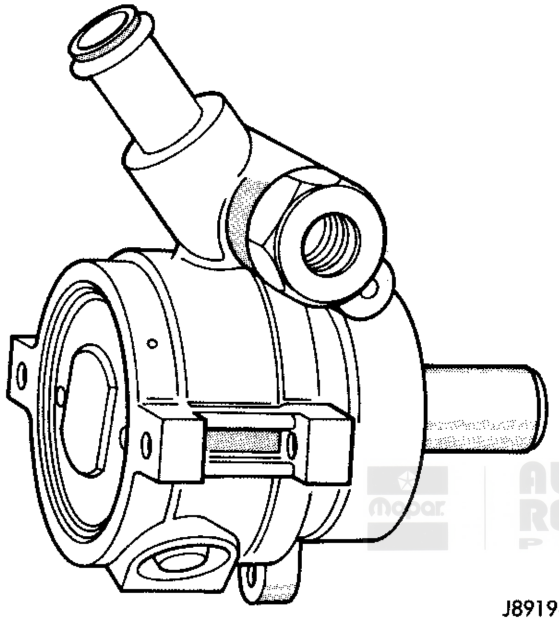


Fig. 59 Vane-Submerged Type Pump

(4) Remove the pump pulley:

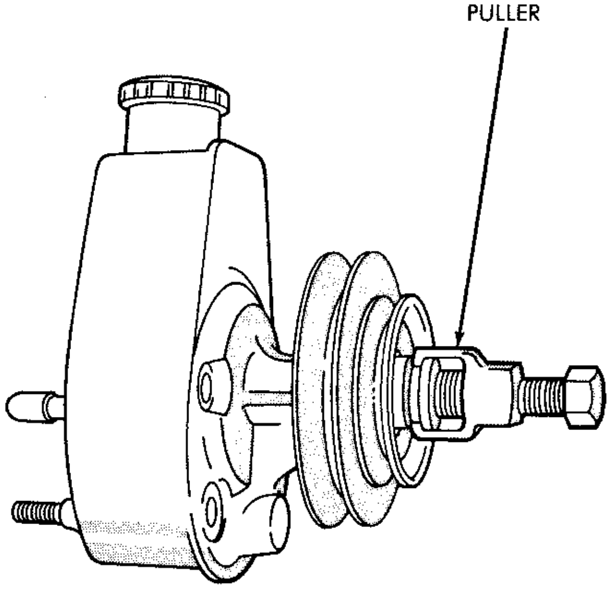
- use an appropriate puller tool for a vane-submerged type pump (Fig. 61); and,
- for a vane-nonsubmerged type pump, refer to the removal procedures for MJ/XJ vehicles.

(5) Continue with the disassembly procedure for the applicable type pump.



J8919-82

Fig. 60 Vane-Nonsubmerged Type Pump



J8919-83

Fig. 61 Vane-Submerged Type Pump Pulley Removal

Vane-Submerged Type Pump—SJ And YJ Vehicles

(1) Clamp the pump housing front hub in a vise with the pump shaft pointing downward. **Do not overtighten the vise jaws because this will distort the bearing.**

(2) Remove the pump pressure hose fitting and the mounting studs. Discard the stud seals and the hose fitting O-ring seal (Fig. 62).

(3) Remove the reservoir by tilting it slightly back and forth to "unseat" the O-ring seal. Remove and discard the reservoir O-ring seal (Fig. 62).

(4) Remove the mounting stud and the hose fitting seals from the counterbored spaces in the pump housing (Fig. 62). Discard the seals.

(5) Remove the end plate retaining ring (Fig. 63):

- insert a small punch in the 3.1-mm (1/8-in) diameter hole in the pump housing opposite the flow control valve orifice;
- force the retaining ring upward with a punch; and
- remove the retaining ring from the pump housing by inserting a pry tool under the ring and turning it.

(6) Remove the end plate and the spring from the pump housing (Fig. 62). If the end plate is not loose, tilt it slightly or tap it with a plastic hammer to loosen it.

(7) Remove the pump housing from the vise.

(8) Remove the flow control valve and the valve spring from the pump housing (Fig. 62). Invert the pump housing to allow the valve and spring to slide out of the orifice.

CAUTION: Ensure that the outer (exposed) end of the pump shaft is free of corrosion before removing it from the pump housing. If corrosion exists, use crocus cloth to remove it. Failure to remove corrosion from the shaft can result in a damaged (non-reusable) shaft seal and bushing.

(9) Tap the outer end of the pump shaft with a plastic hammer until the pressure plate, the pump ring and rotor, the thrust plate, and the shaft can be removed as a unit from the pump housing (Fig. 64).

(10) Remove the retaining ring from the pump shaft (Fig. 62). Discard the retaining ring.

(11) Remove the pump ring and rotor, and the thrust plate from the shaft (Fig. 62). **Use care to prevent dropping the rotor vanes.**

(12) Remove the end plate O-ring seal and the shaft seal (Fig. 62). **Use care to prevent damaging the pump housing bore.**

(13) Continue with **Power Steering Pump —Cleaning And Inspection.**

Vane-Nonsubmerged Type Pump—MJ/XJ Vehicles

(1) If equipped, remove the fluid reservoir from the pump (4.0L engine only).

(2) Remove the flow control valve fitting from the pump body (Fig. 65). Discard the O-ring seal.

(3) Remove the flow control valve and the valve spring from the pump body (Fig. 65).

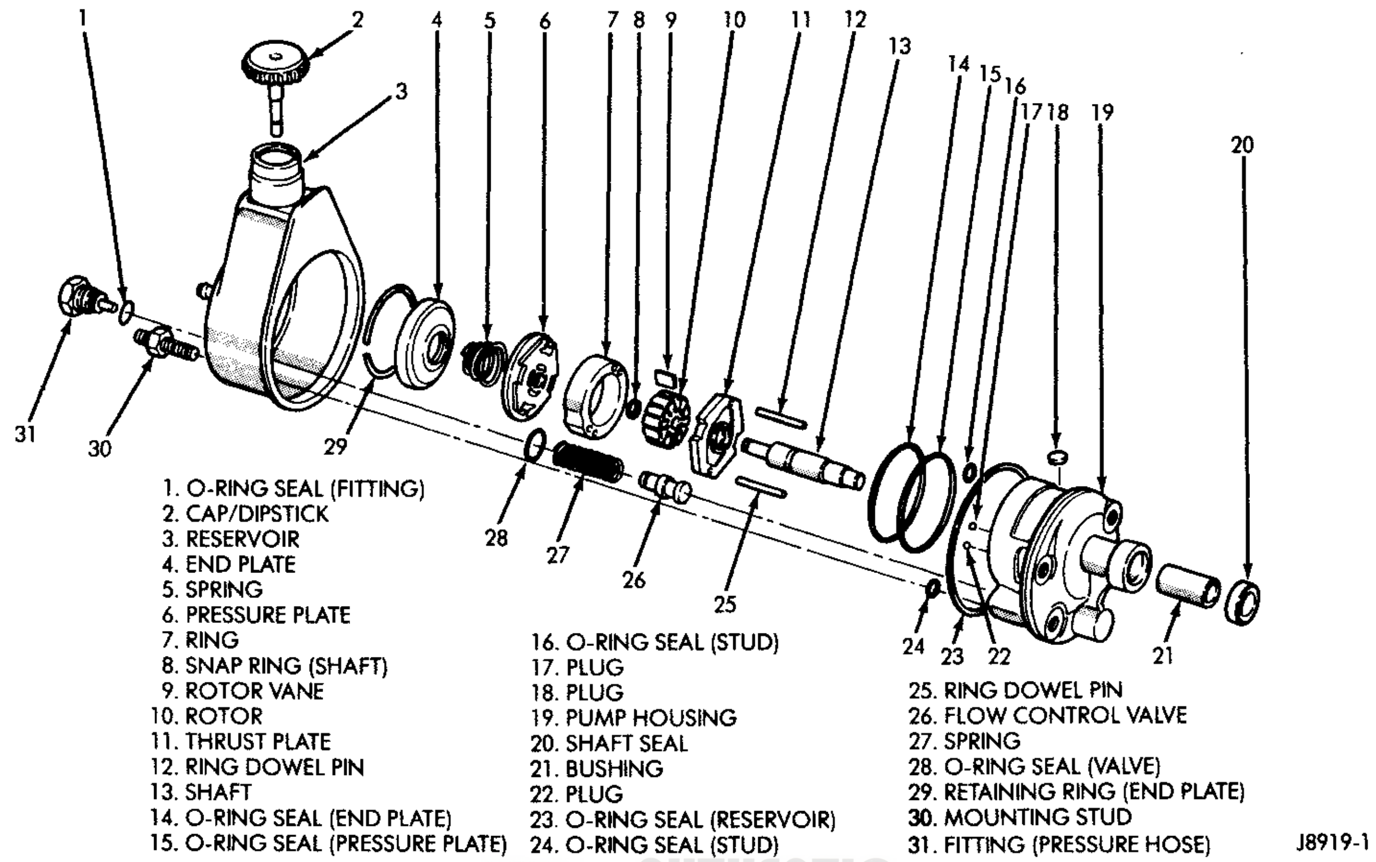


Fig. 62 Vane-Submerged Type Pump — Exploded View

(4) Remove and discard the pump shaft retaining ring (Fig. 66).

(5) Remove the pump shaft and bearing (Fig. 66).

(6) Support the pump shaft bearing on its inner race and force the pump shaft from the bearing (Fig. 67).

(7) Pry the pump shaft seal from the pump body with a small pry bar (Fig. 68).

(8) Remove the thrust plate retaining ring (Fig. 69):

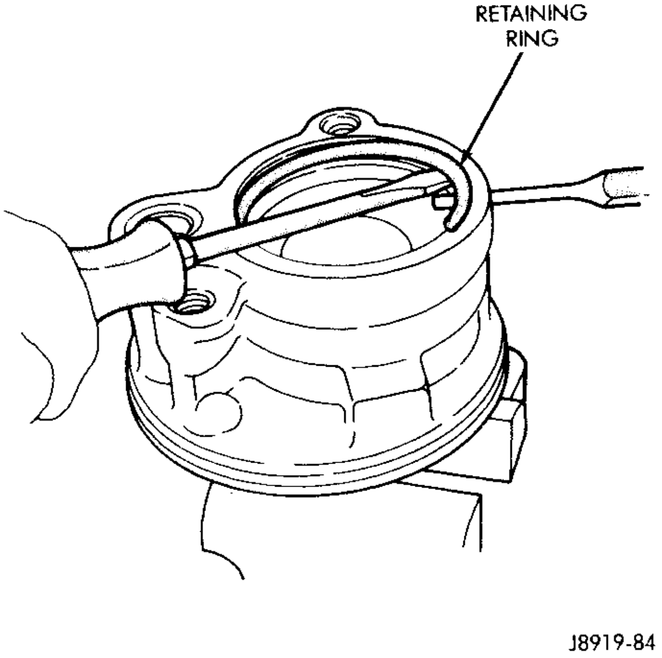


Fig. 63 End Plate Retaining Ring Removal

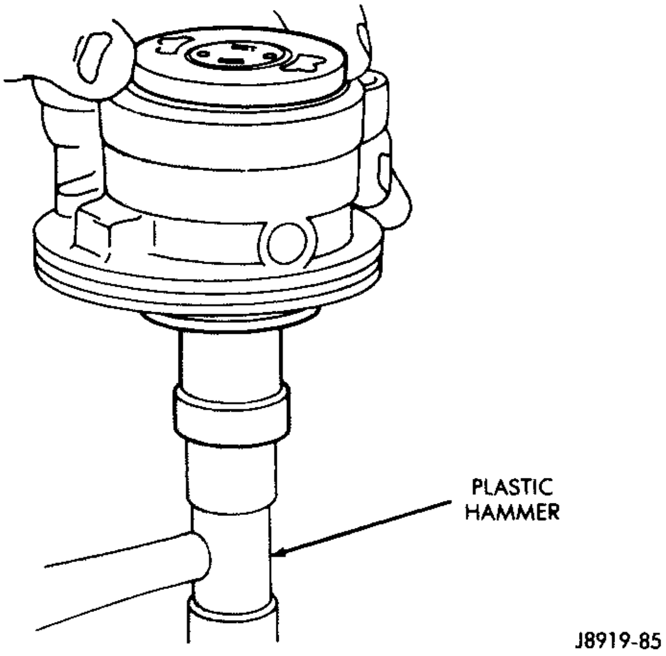


Fig. 64 Pressure/Thrust Plates & Ring/Rotor Removal

- insert a small punch in the access hole in the pump body;
- force the retaining ring upward with a punch; and
- remove the retaining ring from the pump body by inserting a pry tool under the ring and prying upward.

(9) Force the thrust plate from the pump body with a 15-mm (5/8-in) diameter brass drift (Fig. 70).

(10) Remove and discard the thrust plate O-ring seal (Fig. 70).

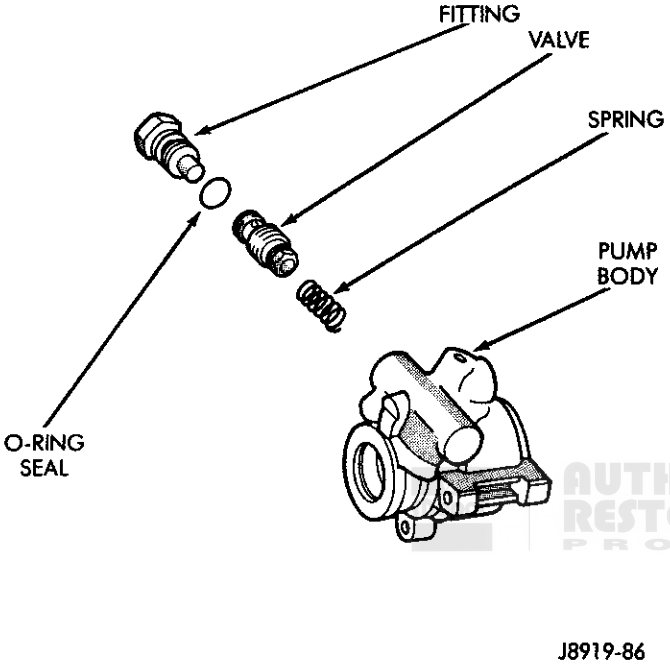


Fig. 65 Flow Control Valve Removal

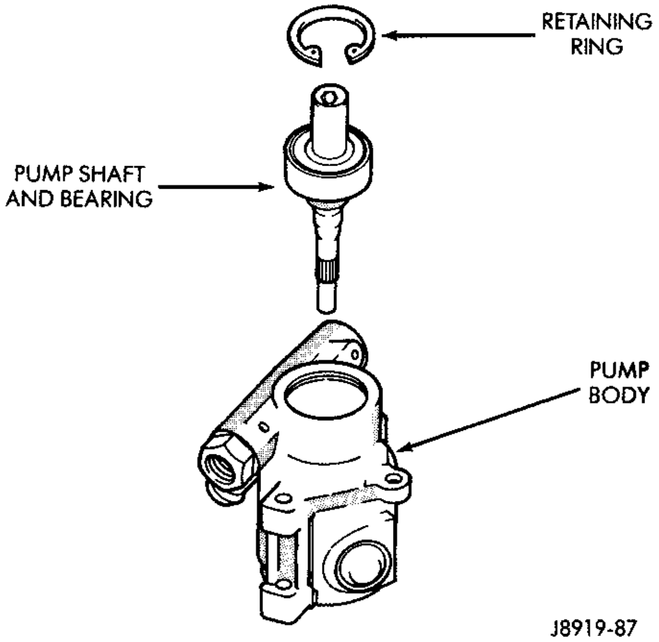


Fig. 66 Pump Shaft & Bearing Removal

(11) Remove the pump ring, the rotor, the vanes, the dowel pins and the pressure plate (Fig. 71). If necessary, use a press to remove the pressure plate.

(12) Remove and discard the pressure plate O-ring seal (Fig. 71).

(13) Remove the pressure plate spring, the dowel pin and the pump shaft sleeve O-ring seal (Fig. 71).

(14) Insert a punch in the front (pump shaft side) of the pump body bore and use a hammer to remove the pump shaft sleeve (Fig. 72).

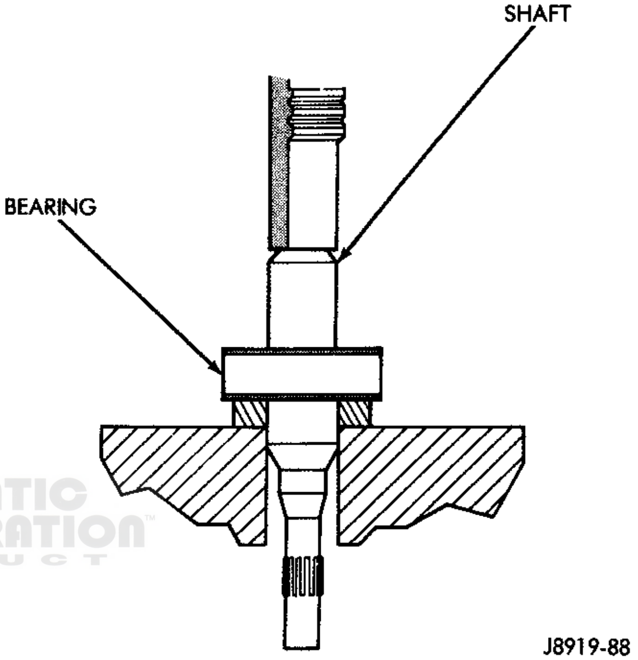


Fig. 67 Shaft & Bearing Separation

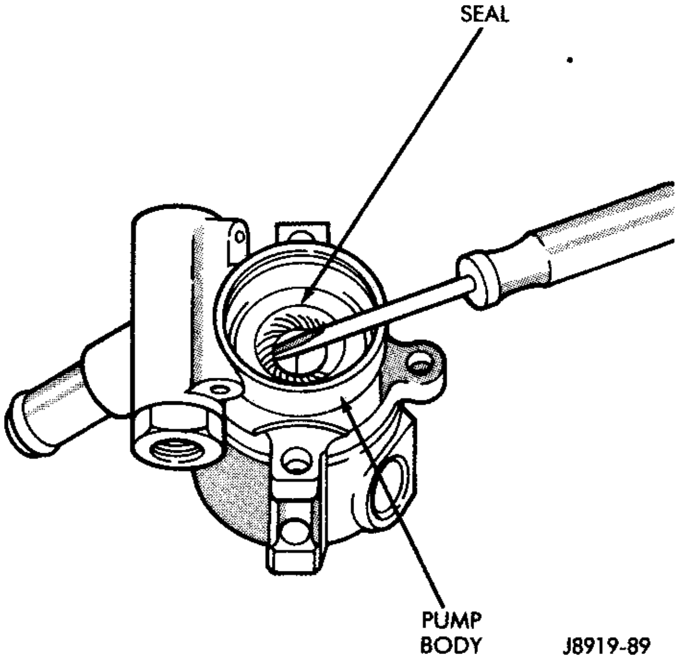


Fig. 68 Pump Shaft Seal Removal

(15) Continue with **Power Steering Pump—Cleaning And Inspection.**

Power Steering Pump—Cleaning And Inspection

(1) Clean all the metal components with mineral spirits (Fig. 62, Fig. 73). Either dry the components with compressed air or wipe them dry with a clean, lint-free cloth.

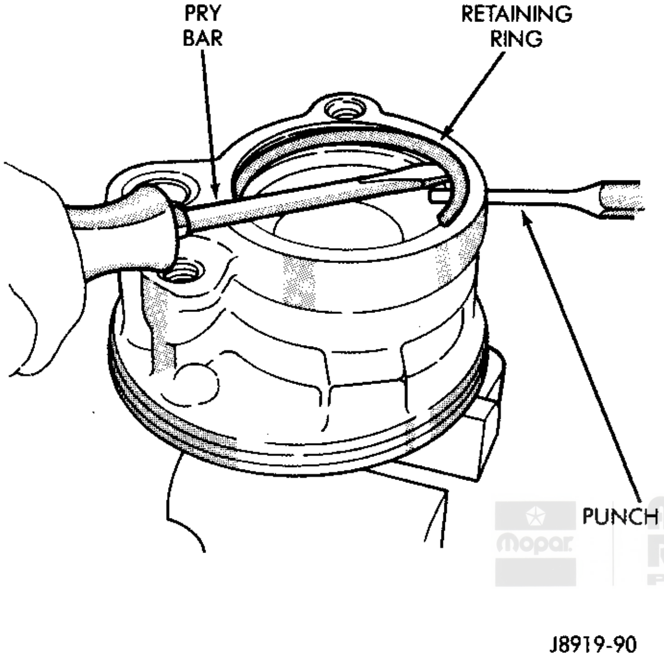


Fig. 69 Thrust Plate Retaining Ring Removal

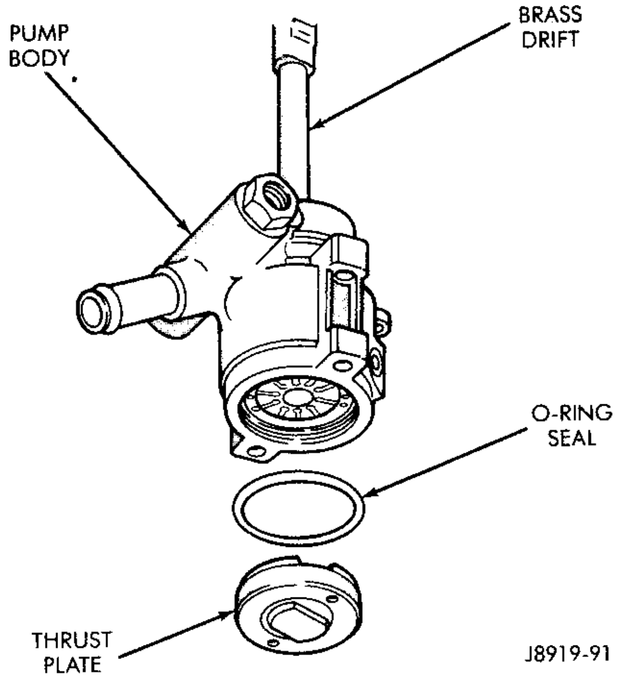


Fig. 70 Thrust Plate Removal

(2) Inspect the flow control valve and ensure that it slides freely in the pump housing/body bore (Fig. 62, Fig. 73). If it binds, inspect both the valve and the pump housing/body bore for foreign objects, scratches and burrs. Burrs can be removed with crocus cloth. Replace the valve or pump housing/body if either are damaged and not repairable.

The flow control valve is serviced as a unit only and it must not be disassembled.

(3) If the pump is the vane-submerged type, inspect the capscrew in the end of the flow control valve for

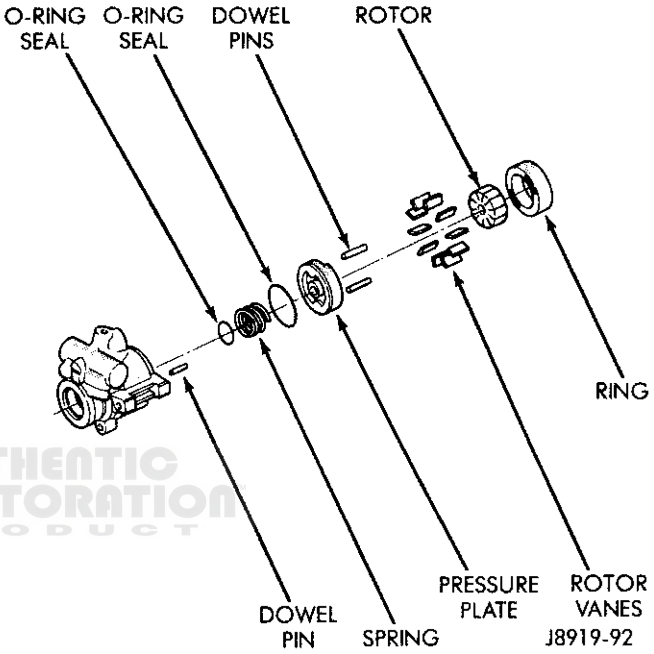


Fig. 71 Pump Disassembled

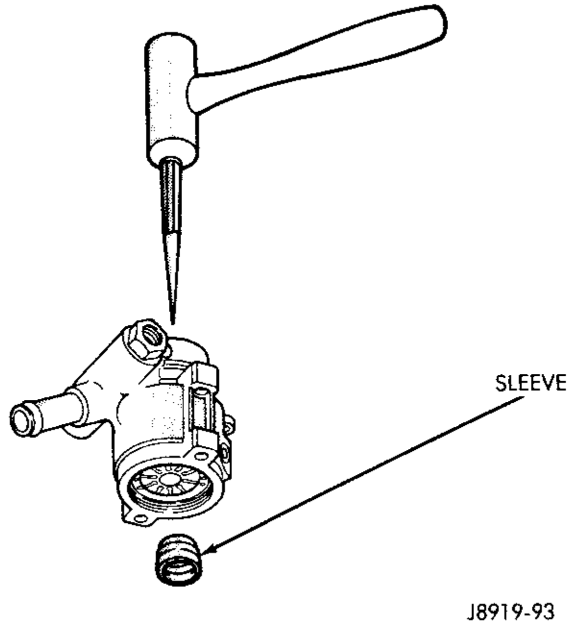


Fig. 72 Pump Shaft Sleeve Removal

tightness. If loose, tighten it with care to avoid damaging the machined surfaces.

(4) Inspect the pressure plate and the thrust plate surfaces for flatness and, when installed, ensure that they will be parallel with the pump ring. Inspect all the components for cracks and scoring (Fig. 62, Fig. 73). Replace any component that is defective or damaged.

A highly polished surface always exists on the pressure plate, the thrust plate and the pump ring as a result of normal friction. Do not confuse this condition with scoring.

(5) Inspect all the rotor vanes for free movement in the rotor slots. Inspect the pump shaft for worn splines, cracks, and other defects (Fig. 62, Fig. 73). Replace all excessively worn or damaged components. Replace the discarded pump shaft retaining ring (it should not be reused).

(6) Inspect the pump housing/body for wear, cracks, porosity and damage (Fig. 62, Fig. 73). Replace the pump housing/body if any of the conditions listed exist.

(7) Inspect the pressure hose/flow control valve fitting (Fig. 62, Fig. 73). If damaged, replace it.

(8) Inspect the end plate and retaining ring (Fig. 62, Fig. 73). If either one is damaged, replace it. Do not reuse the retaining ring if it is bent or distorted. If the condition is uncertain, replace the retaining ring.

(9) Inspect the pump shaft sleeve (vane-nonsubmerged type pump), the bushing/bearing and the seal (Fig. 62, Fig. 73). Replace, if damaged.

(10) Assemble the pump according to the assembly procedure for the applicable type of pump.

Power Steering Pump—Assembly

Vane-Submerged Type Pump—SJ And YJ Vehicles

CAUTION: Do not allow any foreign objects to enter the pump during assembly. All components must be clean and lubricated with power steering fluid. Install replacement seals, retaining rings and O-ring seals during assembly. Used, damaged and worn seals will cause leakage, noise and rapid wear after assembly.

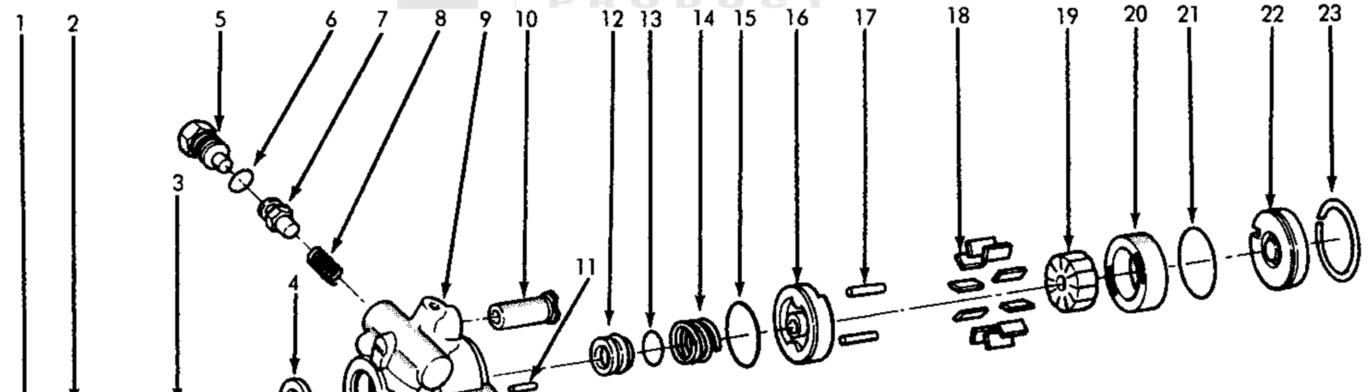
(1) Install the pump shaft seal with an appropriate installation tool (Fig. 74).

(2) Lubricate with petroleum jelly and install the replacement seal in the third groove in the pump housing bore (Fig. 75).

(3) Clamp the pump housing in a vise with the large bore side facing downward. **Do not over-tighten the vise jaws because this will damage the bearing.**

(4) Insert both dowel pins in the thrust plate.

(5) Insert the splined end of the pump shaft through the thrust plate and the rotor, and install the retaining ring on the end of the shaft. **Open the retaining ring**



1. RETAINING RING
2. PUMP SHAFT BEARING
3. PUMP SHAFT
4. PUMP SHAFT SEAL
5. FLOW CONTROL VALVE FITTING
6. O-RING SEAL
7. FLOW CONTROL VALVE
8. FLOW CONTROL VALVE SPRING
9. PUMP HOUSING
10. RETURN TUBE
11. DOWEL PIN
12. SLEEVE
13. O-RING SEAL
14. PRESSURE PLATE SPRING
15. O-RING SEAL
16. PRESSURE PLATE
17. PUMP RING DOWEL PINS
18. VANES (10)
19. PUMP ROTOR
20. PUMP RING
21. O-RING SEAL
22. THRUST PLATE
23. THRUST PLATE RETAINING RING

J8919-94

Fig. 73 Vane-Nonsubmerged Type Pump — Exploded View

only wide enough to slide it over the end of the shaft. The rotor must slide freely on the splines.

(6) Insert the pump shaft in the pump housing. Ensure that the dowel pins are properly engaged in the thrust plate.

(7) Install the pump ring (Fig. 76) on the dowel pins with the pump rotation arrow (Fig. 77) facing upward.

(8) Install all 10 rotor vanes in the rotor slots (Fig. 78) with the rounded edges of the vanes facing outward.

(9) Lubricate the outside diameter surface and the chamfered edge of the pressure plate with petroleum jelly.

(10) Install the pressure plate on the dowel pins (Fig. 62) with the plate spring groove facing upward.

(11) Place a large socket wrench on top of the pressure plate and force the plate downward approximately 1.5 mm (1/16 in) to "seat" it.

(12) Lubricate the end plate seal (Fig. 62) with petroleum jelly and install it in the second groove in the pump housing bore.

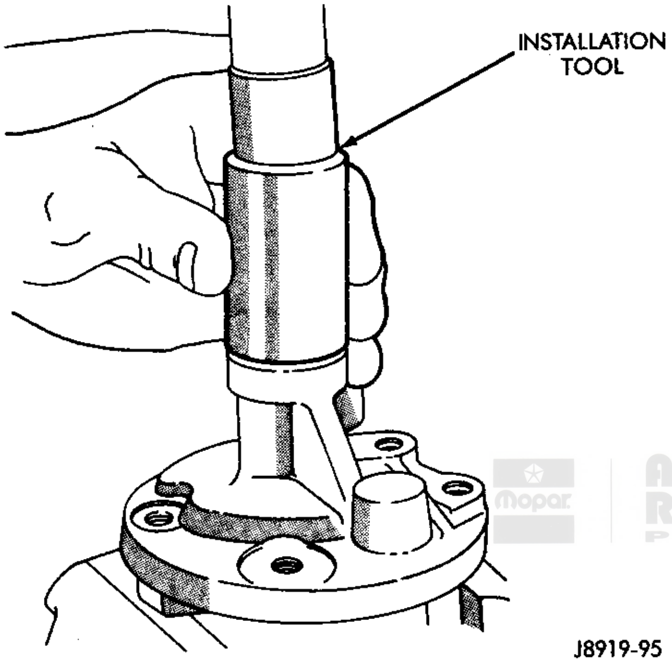


Fig. 74 Pump Shaft Seal Installation

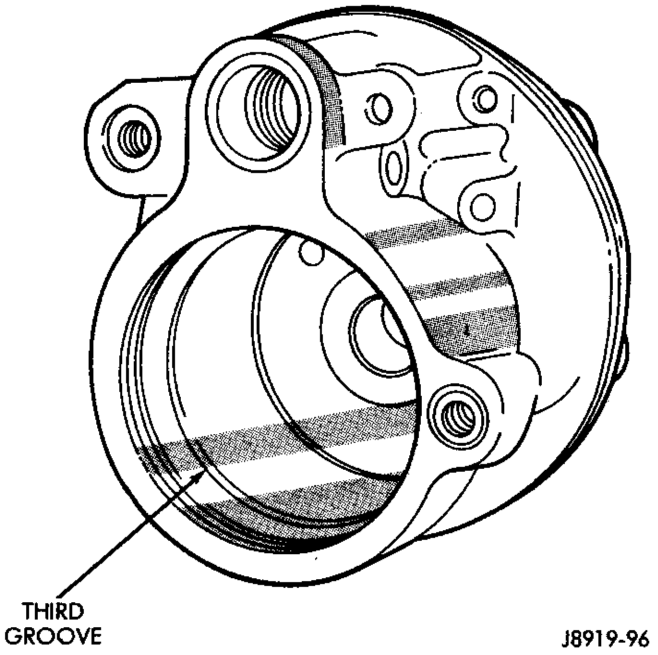


Fig. 75 Pump Housing Bore

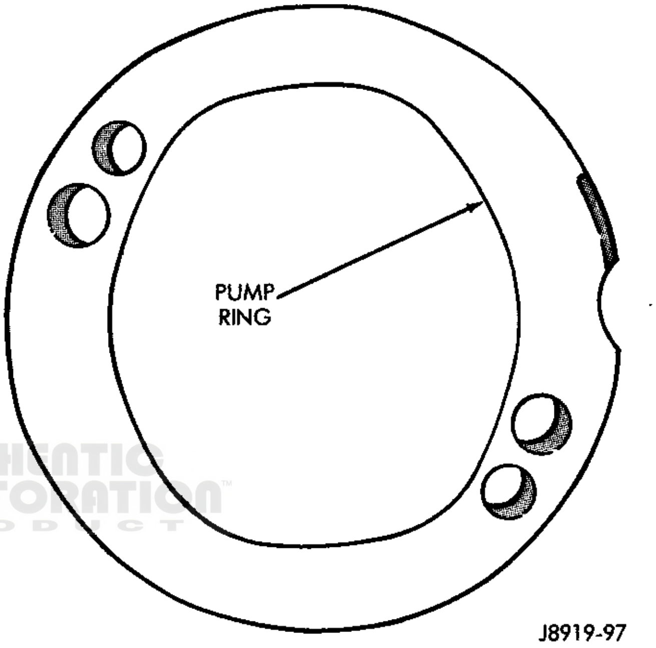


Fig. 76 Pump Ring

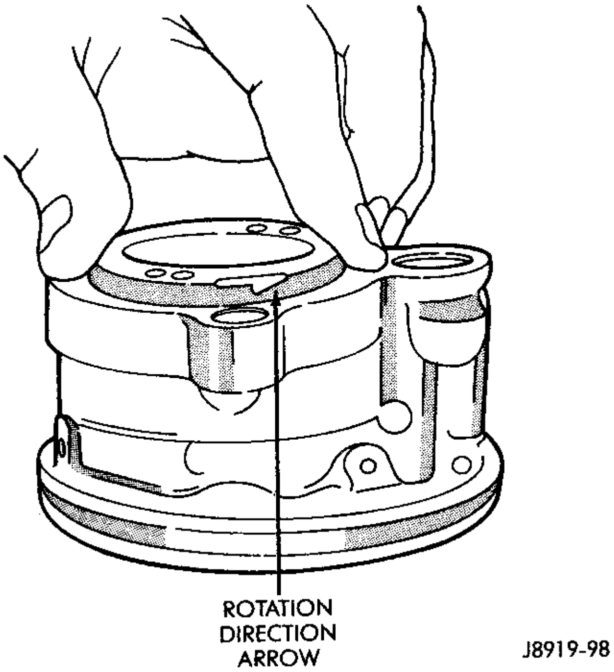


Fig. 77 Pump Rotation Direction Arrow

(13) Install the spring in the center groove in the pressure plate (Fig. 62).

(14) Lubricate the end plate outside diameter surface with petroleum jelly and install the plate in the pump housing (Fig. 79).

(15) Press the end plate downward and install the end plate retaining ring (Fig. 79).

(16) Install the spring over the hex-nut end of the flow control valve (Fig. 62).

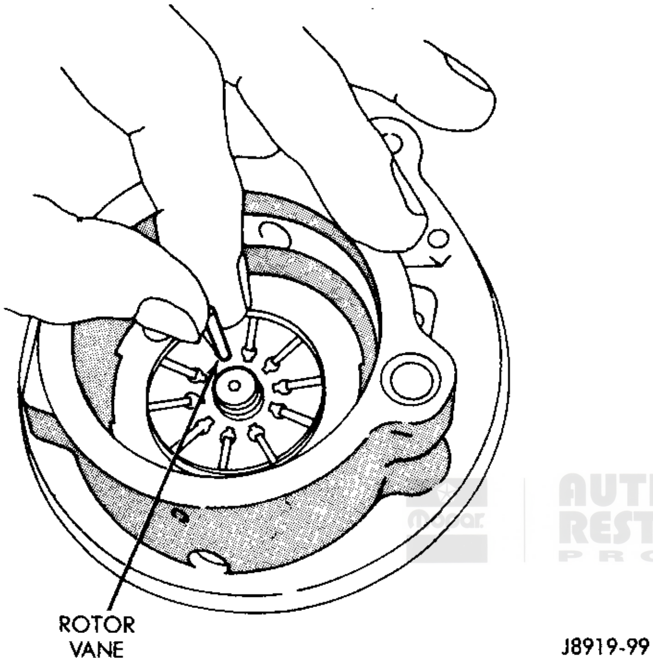


Fig. 78 Rotor Vane Installation

(17) Install the flow control valve and spring in the pump housing bore with the hex-nut end of the valve facing the interior of the housing bore (Fig. 80).

(18) Install the mounting stud O-ring seals and the flow control valve O-ring seal in the counterbored holes in the pump housing (Fig. 62).

(19) Position the fluid reservoir O-ring seal on the pump housing (Fig. 62).

CAUTION: When installing the fluid reservoir, use care to prevent damaging the O-ring seal. While applying pressure on the reservoir to "seat" it , guide the seal into the seal grooves with a wooden or plastic tool.

(20) Lubricate the inner edge of the fluid reservoir with petroleum jelly and position the reservoir on the pump housing. Force the reservoir downward to "seat" it on the pump housing.

(21) Inspect the alignment of the mounting stud O-ring seals after installing the fluid reservoir. Re-align the seals, if necessary.

(22) Install the mounting studs (Fig. 62) and tighten them with 47 N•m (35 ft-lbs) torque.

(23) Install the O-ring seal on the pressure hose/flow control valve fitting (Fig. 62) and install the fitting in the flow control valve bore. Tighten the fitting with 75 N•m (55 ft-lbs) torque.

(24) Install the pump shaft pulley with an appropriate installation tool.

(25) Install the pump on the engine. Refer to the installation procedure.

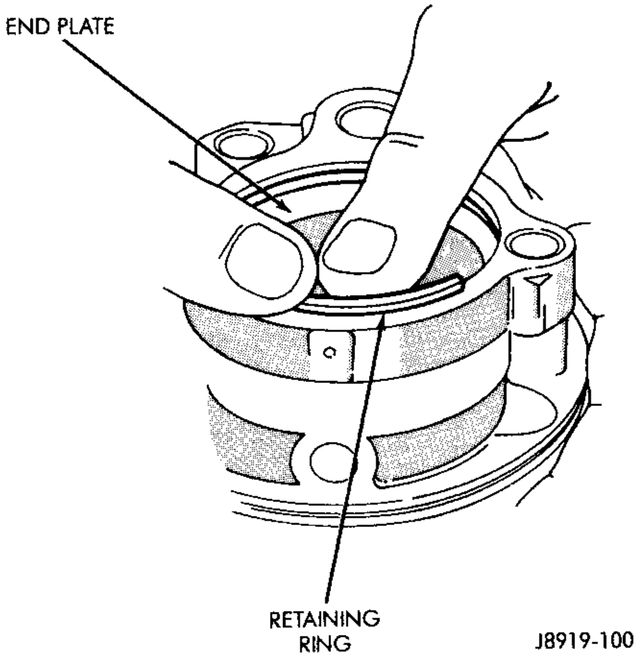


Fig. 79 End Plate Installation

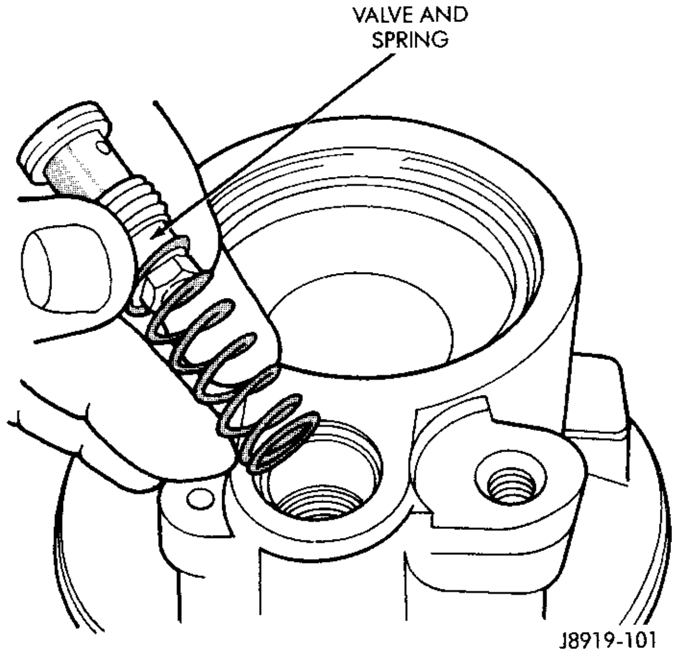


Fig. 80 Flow Control Valve/Spring Installation

Vane-Nonsubmerged Type Pump—MJ/XJ Vehicles

CAUTION: Do not allow any foreign objects to enter the pump during assembly. All components must be clean and lubricated with power steering fluid. Install replacement seals, retaining rings and O-ring seals during assembly. Used, damaged and worn seals will cause leakage, noise and rapid wear after assembly.

CAUTION: Do not exert excessive force on the pump shaft sleeve when forcing it into the pump body bore because the O-ring seal "seat" in the sleeve can be damaged.

(1) Force the pump shaft sleeve into the pump body bore with the appropriate size socket wrench (Fig. 81). Ensure that the sleeve is completely "seated" in the bore.

(2) Install a replacement O-ring seal in the sleeve "seat" (Fig. 73).

(3) Install the short dowel pin in the pump body (Fig. 73).

(4) Install the pressure plate spring over the pump shaft sleeve (Fig. 73).

(5) Position a replacement O-ring seal on the pressure plate (Fig. 73).

(6) Score a reference mark on top of the pressure plate (Fig. 73) and directly over the short dowel pin hole. **The mark will aid aligning the short dowel pin and the hole during pressure plate installation.**

(7) Install the pressure plate in the pump body (Fig. 73). Ensure that the short dowel pin is completely inserted in the pressure plate hole.

(8) Insert the two pump ring dowel pins in the pressure plate (Fig. 73).

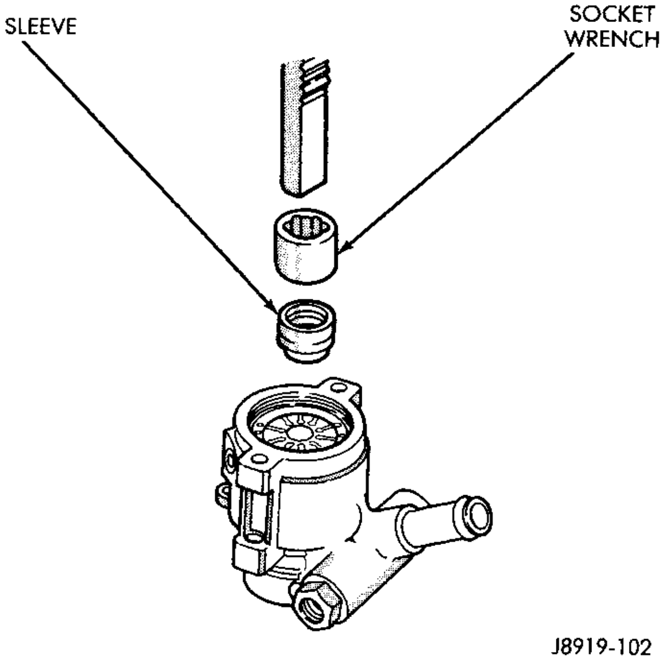


Fig. 81 Pump Shaft Sleeve Installation

(9) Install the pump ring on the dowel pins. Ensure that the pump ring identification marks are located adjacent to one of the dowel pin holes (Fig. 82).

(10) Install the pump rotor with its counterbored end facing toward the pump shaft side of the pump body (Fig. 83).

(11) Install the vanes in the pump rotor (Fig. 73). The rounded edges on the vanes must face outward.

(12) Place a replacement thrust plate O-ring seal in the pump body (Fig. 84).

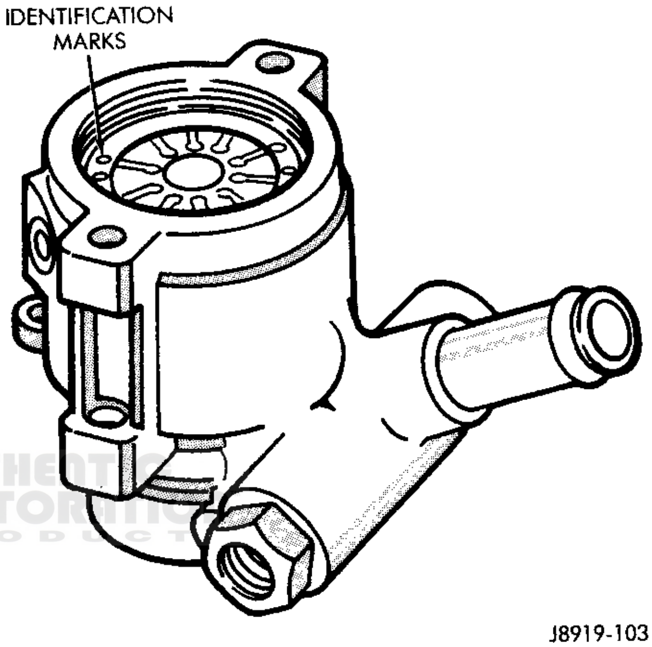


Fig. 82 Pump Ring Identification Marks

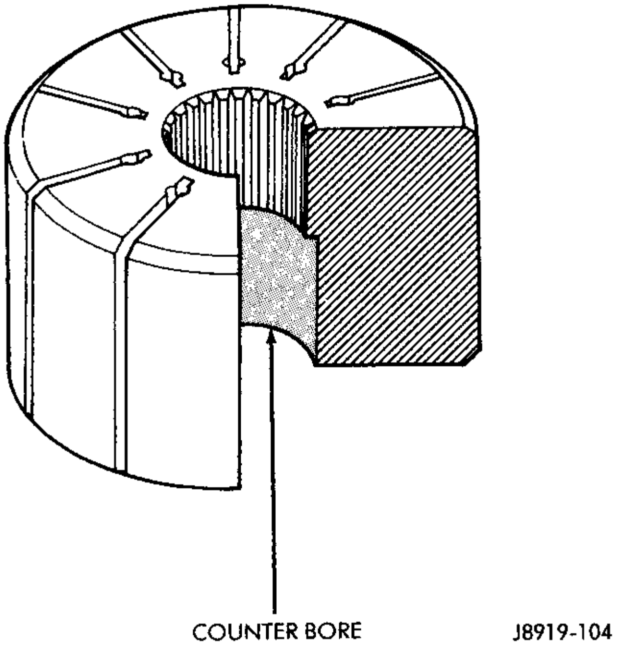


Fig. 83 Pump Rotor

(13) Position the thrust plate in the pump body (Fig. 84). **Align the reference indentations on the plate with the mounting bolt holes in the pump body. Ensure that the thrust plate engages with the two pump ring dowel pins.**

(14) Force the thrust plate into the pump body and install the retaining ring (Fig. 73).

(15) Force a replacement shaft seal into the shaft bore with an appropriate size socket wrench until it contacts the end of the counterbore (Fig. 85).

(16) Press the bearing on the pump shaft. Support the bearing on its inner race when pressing it on the shaft (Fig. 86).

(17) Insert the pump shaft and bearing into the shaft bore in the pump body and rotate it until the splines mesh with the rotor. Ensure that the shaft bearing is completely "seated" against the end of the bore in the pump body.

(18) Install the replacement pump shaft retaining ring with the large lug positioned to the right of the small lug (Fig. 87).

(19) If applicable, attach the fluid reservoir to the pump (4.0L engine only).

(20) Install the pump shaft pulley. Refer to the applicable installation procedure (located within this Section of Group 19).

(21) Install the pump on the engine. Refer to the installation procedure (below).

Power Steering Pump—Installation

SJ And YJ Vehicles

(1) If removed, attach the front mounting bracket to the pump.

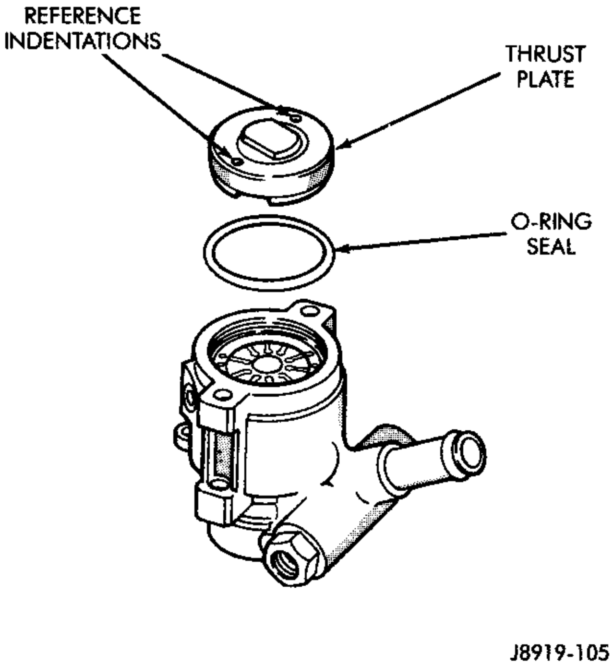


Fig. 84 Thrust Plate Installation

(2) Position the pump in the rear mounting bracket, install the retaining bolts/nuts and tighten with 27 N•m (20 ft-lbs) torque.

(3) Install the front bracket-to-engine bolts and tighten with 27 N•m (20 ft-lbs) torque.

(4) Connect the fluid hoses to the pump.

(5) Install the drive belt and adjust the tension according to the applicable adjustment procedure.

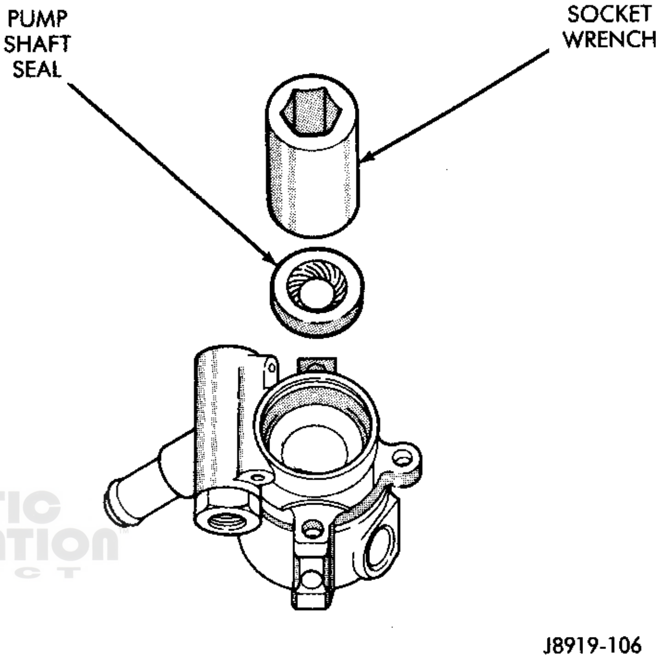


Fig. 85 Pump Shaft Seal Installation

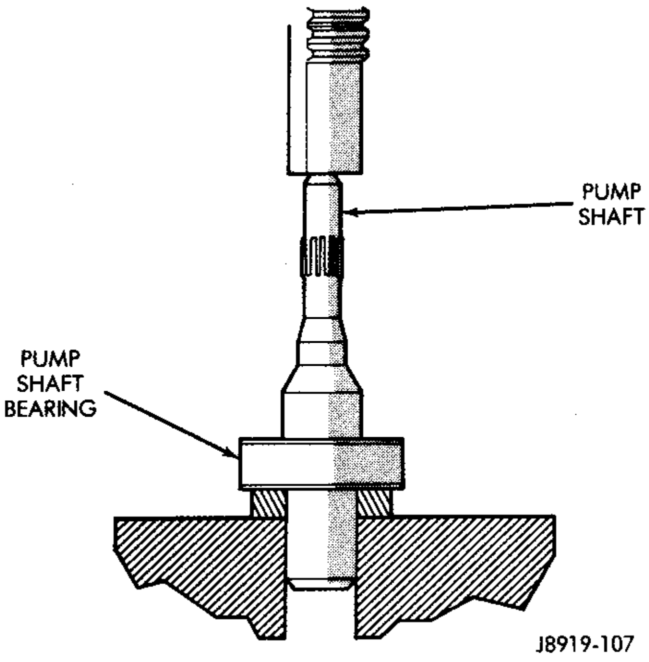


Fig. 86 Pump Shaft Bearing Installation

(6) Fill the reservoir with power steering fluid. If necessary, refer to **Power Steering Pump—Initial Operation** (below) for detailed instructions.

(7) If removed, install the air cleaner.

MJ/XJ Vehicles

(1) If not installed, install the front bracket, the adjustment bracket, and the pulley on the pump. If necessary, refer to the applicable pulley installation procedure (located within this Section of Group 19) for detailed instructions.

(2) Place the pump (with the front bracket, the adjustment bracket, and the pulley installed) adjacent to the rear bracket.

(3) Install the adjustment bracket-to-rear bracket bolts, the pivot bolt (Fig. 88) and the rear bracket-to-pump bolts (Fig. 89).

(4) Tighten the adjustment bracket-to-rear bracket bolts with 40 N•m (30 ft-lbs) torque and the pivot bolt “finger-tight” (Fig. 88).

(5) Tighten the rear bracket-to-pump bolts “finger-tight” (Fig. 89).

(6) Position the serpentine drive belt on the pump pulley and adjust the tension (Fig. 90). If necessary, refer to the drive belt adjustment procedure (located within this Section of Group 19) for detailed instructions.

(7) Tighten the adjustment slot locknut (Fig. 90), the pivot bolt (Fig. 90) and the rear bracket-to-pump bolts (Fig. 89) with 27 N•m (20 ft-lbs) torque.

The O-ring seal inserted in the end of the high pressure tubing fitting (Fig. 89) must be replaced before the fitting is connected to the P/S pump.

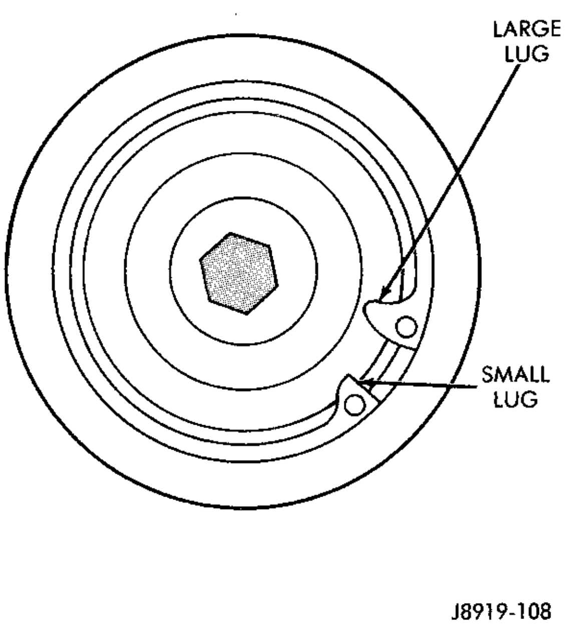


Fig. 87 Pump Shaft Retaining Ring Installation

(8) Replace the O-ring seal and connect the high pressure tubing fitting to the pump (Fig. 89).

(9) Connect the fluid return hose (Fig. 89) to the pump or the reservoir, as applicable, and remove the clamp from the hose.

(10) Fill the pump reservoir with power steering fluid. If necessary, refer to **Power Steering Pump—Initial Operation** (below) for detailed instructions.

Power Steering Pump—Initial Operation

(1) Operate the engine until the power steering fluid reaches the normal operating temperature of approxi-

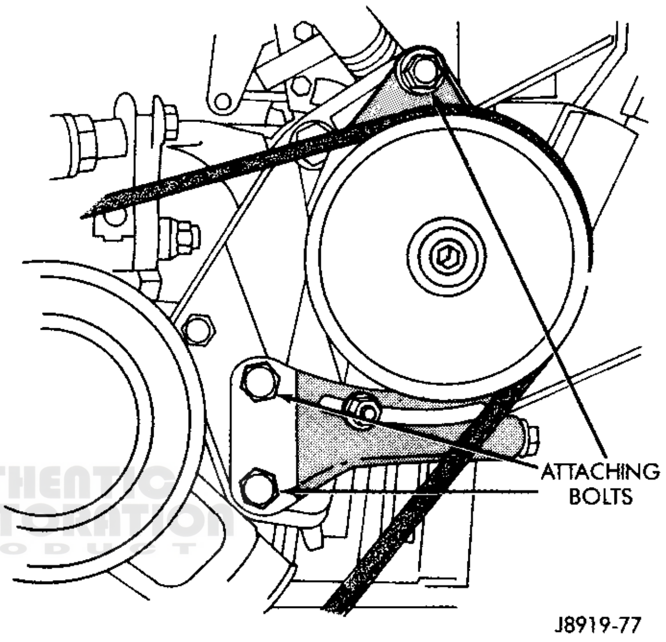


Fig. 88 Adjustment Bracket & Pivot Bolts

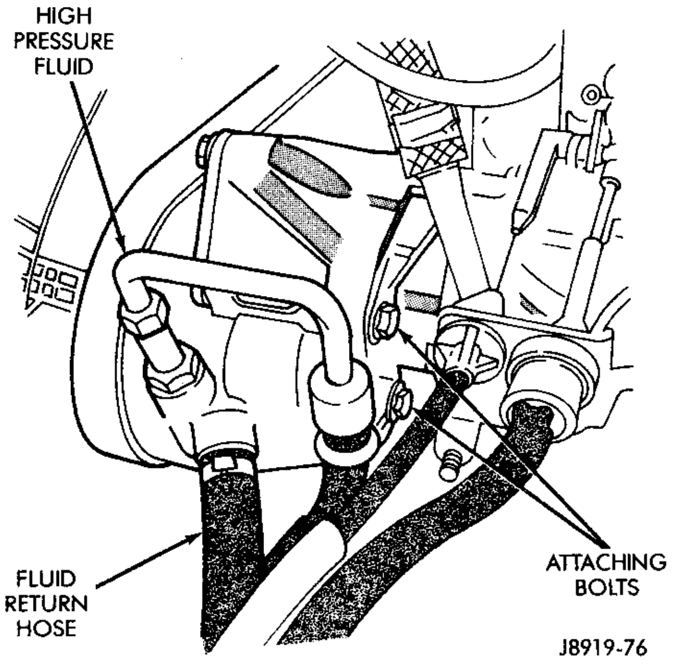


Fig. 89 P/S Pump Installation

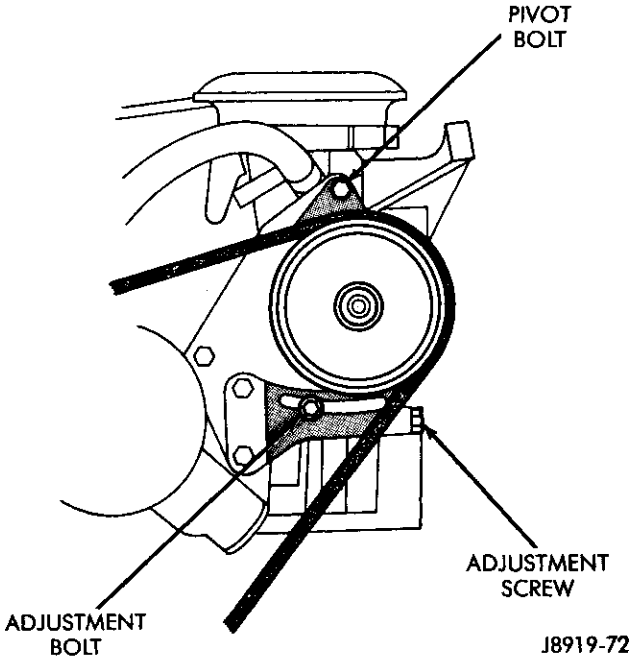


Fig. 90 Drive Belt Adjustment

mately 77°C (170°F), then stop the engine. Add power steering fluid as necessary to fill the reservoir.

(2) Turn the wheels to a full-left-turn position and then to a full-right-turn position to circulate the fluid. Add power steering fluid until the reservoir is full.

(3) Start the engine. Operate it at high idle speed and then observe the fluid level on the dipstick. Add fluid, if necessary.

(4) Purge the system of air by turning the wheels from side-to-side without contacting the stops. Fluid with air in it will have a milky-red color. Maintain the reservoir full of fluid.

Because air is compressible, it must be eliminated from the fluid before normal steering action can be obtained.

(5) Return the wheels to the straight-ahead position and operate the engine for an additional 2 to 3 minutes, then stop the engine.

(6) Road test the vehicle to ensure that the steering system functions normally and is free of noise.

(7) Observe the fluid level. Add fluid as necessary to fill the reservoir with the system stabilized at the normal operating temperature.

CAUTION: If the fluid reservoir cap is not properly tightened after a fluid level check, the result can be fluid leakage and possible loss of the cap. Ensure that the cap is securely tightened when installing it.

STEERING COLUMNS

INDEX

COMMON SERVICE INFORMATION

Some steering column service procedures are common for both the tiltable and the fixed (non-tilt) types of steering column. These common procedures are described below. Service procedures that are not common to both types of steering column are described separately within the applicable **tilt-column or fixed (non-tilt) column service categories.**

Steering Wheel—Removal

(1) Disconnect the battery negative cable.

(2) If equipped with a standard steering wheel, remove the trim cover attaching screws from the underside of the wheel and remove the cover (Fig. 1). If equipped with a sport steering wheel, remove the horn button by pulling it outward (Fig. 2).

(3) If equipped with a standard steering wheel, disconnect the horn wire connectors from the contact switch (Fig. 3).

(4) If equipped with a sport steering wheel, remove the horn contact mechanism and the flex-plate from the steering wheel (Fig. 4).

(5) Remove the steering wheel retaining nut and the vibration dampener, if equipped. Inspect for alignment marks on the steering shaft and the steering wheel. Paint alignment marks on the steering shaft and the wheel (if none exist) for installation reference.

(6) Remove the steering wheel with an appropriate puller tool (Fig. 5).

Steering Wheel—Installation

(1) Position the steering wheel on the steering shaft hub with the installation alignment marks aligned.

(2) If equipped, position the vibration dampener on the hub (Fig. 6). Install and tighten the steering wheel retaining nut with 34 N•m (25 ft-lbs) torque.

(3) Install the internal components, the horn flex-plate and the trim cover/horn button (Fig. 7).

(4) Connect the battery negative cable.

(5) Test the horn and reset the clock, If equipped.

Park-Lock Cable—AW-4 Console Shift

A park-lock cable is used only with MJ/XJ vehicles equipped with a console shift AW-4 transmission.

Removal

(1) Disconnect the battery negative cable.

(2) Remove the lower portion of the instrument panel.

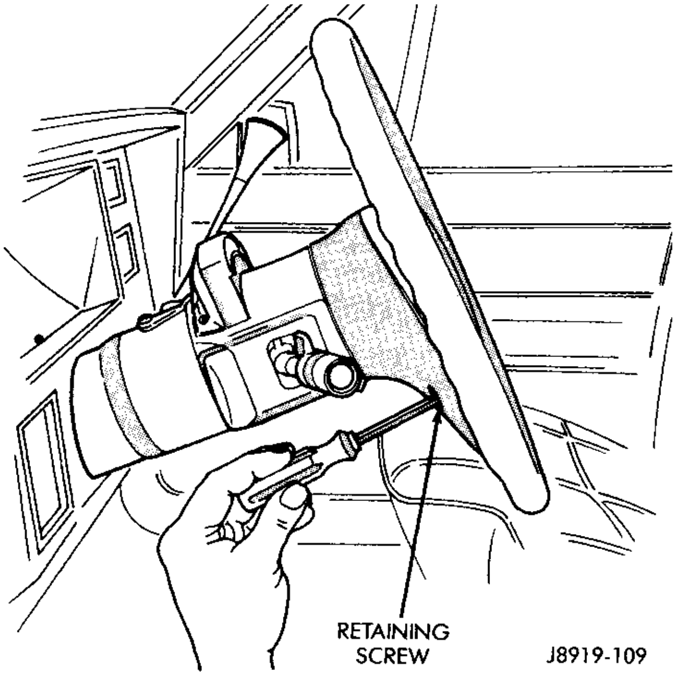


Fig. 1 Trim Cover Removal

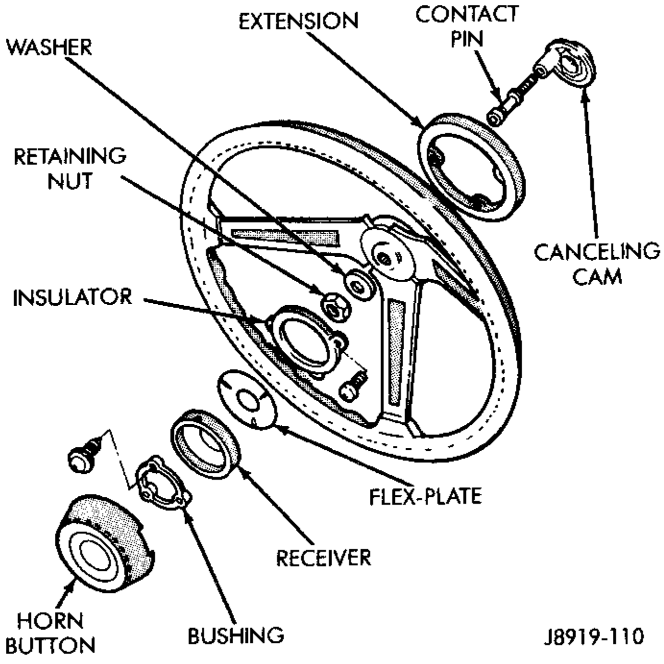


Fig. 2 Sport Wheel Removal/Installation

(3) Remove the steering column mounting bracket-to-instrument panel nuts and lower the steering column.

(4) Disconnect the park-lock cable from the steering column and remove the cable from the bracket.

(5) Remove the center console.

(6) Remove the mouldings, the panels, the accelerator pedal bracket, and the carpet screws. Pull the carpet backward to expose the cable at the gear selector lever bellcrank (Fig. 8).

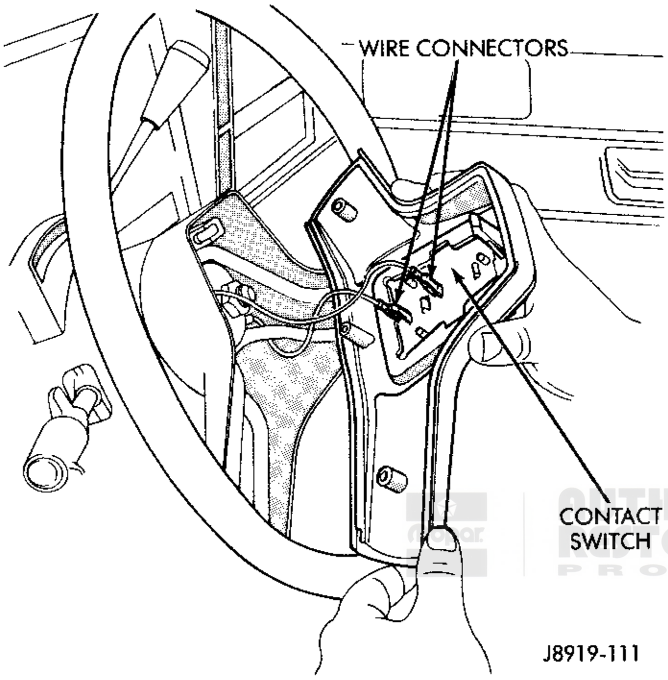


Fig. 3 Horn Wire Connectors

(7) Disconnect the cable eyelet from the gear selector lever bellcrank (Fig. 8).

(8) Remove the cable from the mounting bracket (Fig. 8) and from the vehicle.

Installation

(1) Route the cable under the instrument panel, connect it at the steering column and bracket, and position the cable eyelet (Fig. 8) near the gear selector lever mounting bracket.

(2) Adjust the park lock cable. Refer to the adjustment procedure.

(3) Position the carpet and install the retaining screws, the accelerator pedal bracket, the panels and the mouldings.

(4) Install the center console.

(5) Raise the steering column and attach the bracket to the instrument panel with the attaching nuts. Tighten the nuts with 30 N•m (22 ft-lbs) torque.

(6) Install the lower part of the instrument panel.

(7) Connect the battery negative cable.

Adjustment

(1) Pry upward and release the park-lock cable adjuster lock clamp (Fig. 8).

(2) Connect the park-lock cable eyelet to the bellcrank pin (Fig. 8).

(3) Push the spring-loaded cable adjuster forward and lower it into the mounting bracket until the tabs are fully engaged in the adjuster (fig. 8).

(4) Push the cable adjuster lock clamp downward to lock it (Fig. 8).

(5) Test the park-lock cable operation:

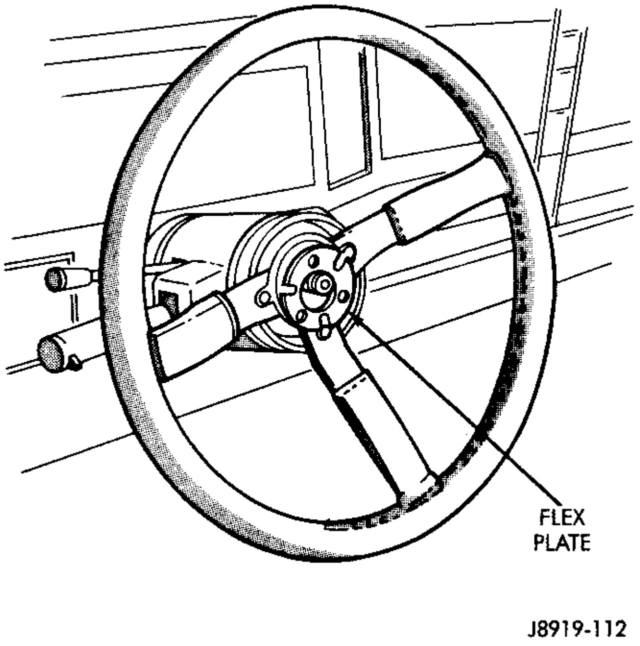


Fig. 4 Sport Wheel Horn Flex-Plate

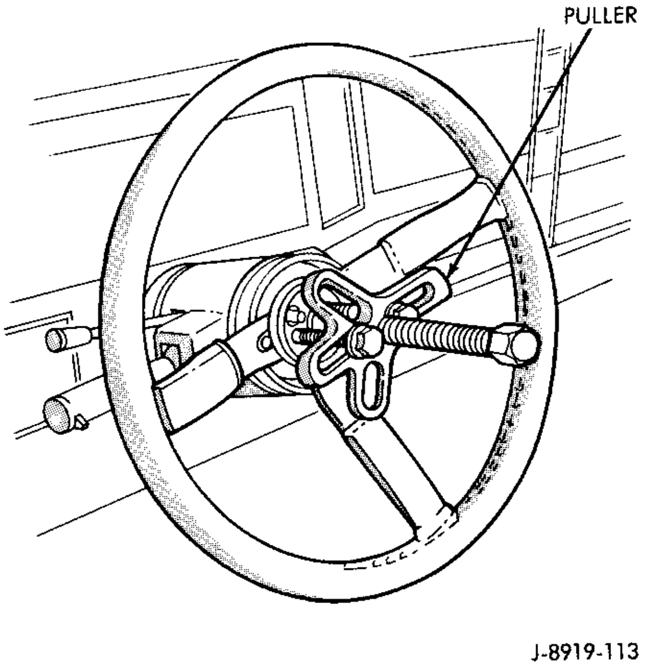


Fig. 5 Steering Wheel Removal

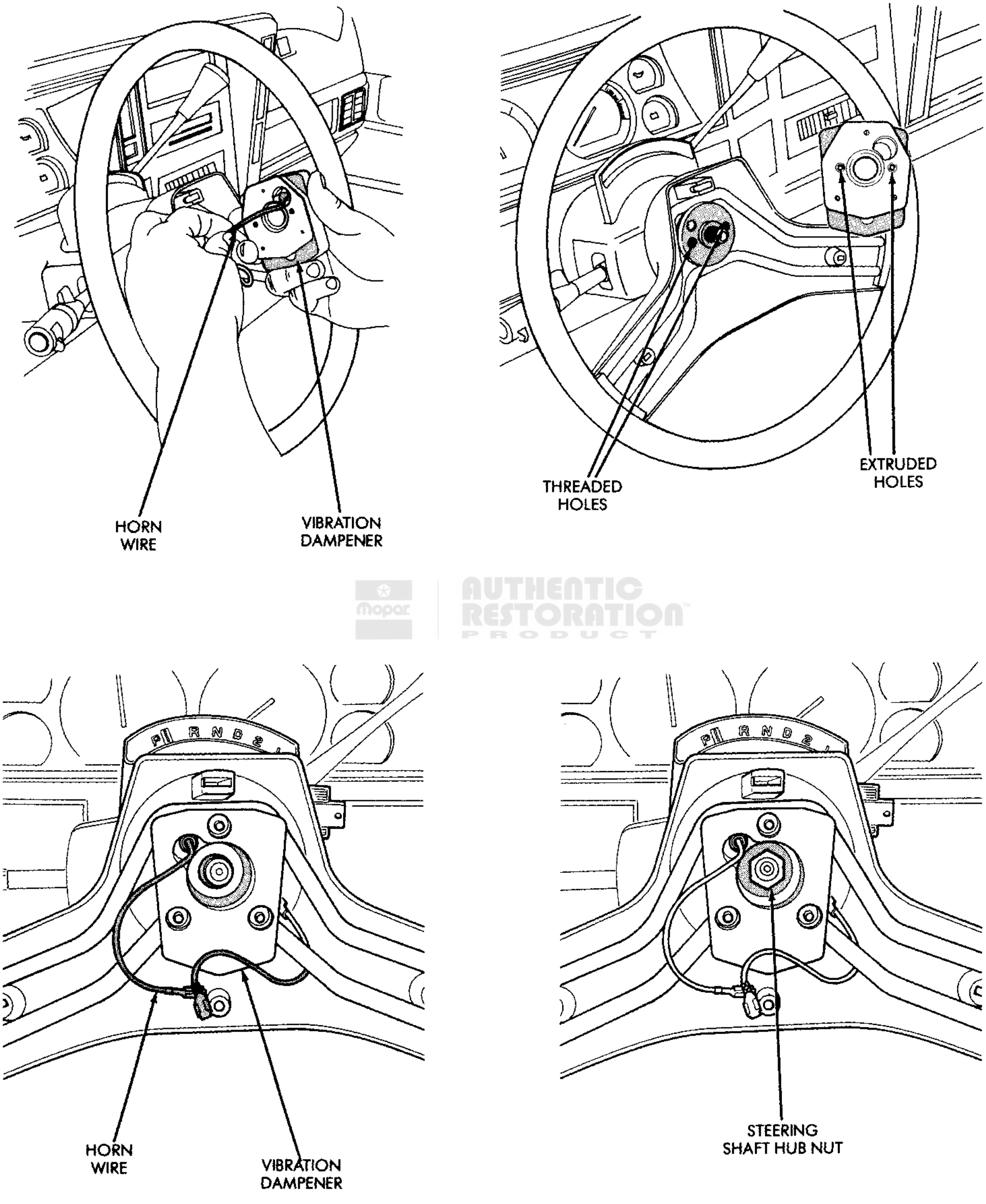


Fig. 6 Vibration Dampener Installation

- turn the ignition switch key to the LOCK position and press inward on the gear selector handle release button;
- the release button should not move when pressed;
- turn the ignition switch key to the ON position, press inward on the gear selector handle release button and move the gear selector handle to the DRIVE or NEUTRAL position;
- attempt to turn the ignition switch key to the LOCK position;

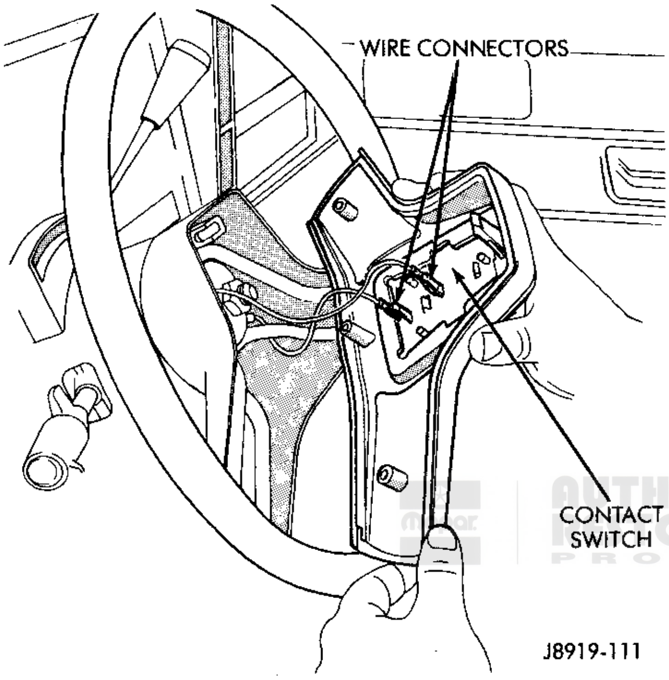


Fig. 7 Horn Wire Connectors

- if the park-lock cable is correctly adjusted, the key will not turn to the LOCK position;
- press inward on the gear selector handle release button, move the gear selector handle to the PARK position and turn the ignition switch key to the LOCK position; and,
- if the park-lock cable is correctly adjusted, the key will turn to the LOCK position.

(6) If additional cable adjustment is required, release (pry upward) the cable adjuster lock clamp and slide the spring-loaded cable adjuster forward or rearward (as necessary) to obtain the correct position (Fig. 8).

Gear Shift Control Cable Adjustment—AW-4 Column Shift

A gear shift control cable is used only with MJ/XJ vehicles equipped with a column shift AW-4 transmission.

(1) Place the gear selector lever in the PARK position. Raise and support the vehicle.

(2) Release the gear shift control cable (at the transmission) from the cable bracket by prying upward on the T-shaped adjuster lock clamp (Fig. 9).

The cable adjuster lock clamp is located at the top of the cable mounting bracket (Fig. 9).

(3) Move the transmission shift lever as far as possible rearward into the PARK detent position (Fig. 9). Ensure that the lever is completely "seated" in the detent.

(4) Test for a positive "lock" in the PARK detent position by attempting to rotate the rear drive shaft. The drive shaft should not rotate when the transmission shift lever is "locked" in the PARK detent position.

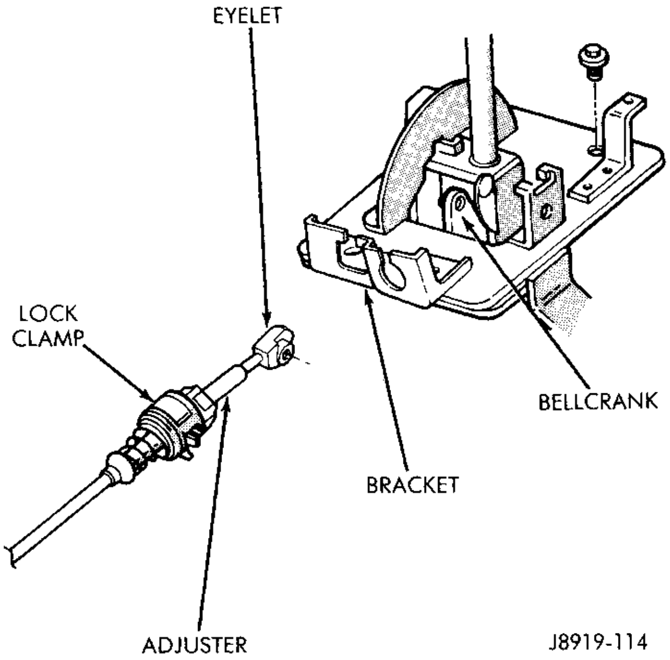


Fig. 8 Park-Lock Cable

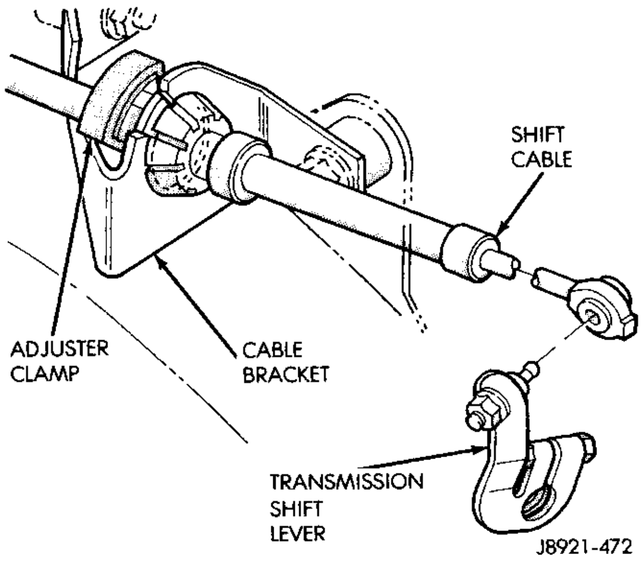


Fig. 9 Shift Control Cable Adjustment

(5) After assuring that a positive "lock" exists in the PARK detent position, press the T-shaped cable adjuster lock clamp downward until it is completely "seated" on the cable.

(6) Test the gear shift cable operation:

- lower the vehicle;
- move the gear selector lever to the PARK and the NEUTRAL positions and turn the ignition switch key to the START position;
- the starter motor should **engage** and rotate the engine with the gear selector in PARK or the NEUTRAL position;
- move the gear selector lever to all the DRIVE positions and the REVERSE position and turn the ignition switch key to the START position;
- the starter motor should **not engage** with the gear selector in any DRIVE or the REVERSE position; and
- the engine **must not start** in any gear position except the PARK and NEUTRAL positions.

Dimmer Switch—Removal

(1) Disconnect the negative cable from the battery.

(2) If necessary, remove the lower part of the instrument panel.

(3) Lower the steering column as necessary.

(4) Use tape to attach the actuator rod to the steering column, then remove the retaining screws and pull the dimmer switch from the rod.

Dimmer Switch—Installation

(1) Push the dimmer switch onto the actuator rod and install the retaining screws. Install the retaining screws but do not tighten them.

(2) Remove the tape that is attaching the actuator rod to the steering column.

(3) Depress the switch slightly and insert a 3/32-inch drill bit into the adjustment hole (Fig. 10) to temporarily prevent horizontal movement of the switch.

(4) Move the dimmer switch toward the steering wheel to remove any lash from the actuator rod. Tighten the dimmer switch retaining screws with 4 N•m (35 in-lbs) torque.

(5) Remove the drill bit and test the dimmer switch operation by moving dimmer switch stalk. If a tiltable steering column is involved, also test the dimmer switch operation in the full-up, down and center steering wheel positions.

(6) Raise the steering column as necessary.

(7) If removed, install the lower part of the instrument panel.

(8) Connect the negative cable to the battery. If equipped, reset the clock.

Dimmer Switch—Adjustment

(1) If necessary, refer to the dimmer switch removal procedure for access to the dimmer switch.

(2) Depress the dimmer switch slightly and insert a 3/32-inch drill bit into the adjustment hole (Fig. 10) to temporarily prevent horizontal movement of the switch.

(3) Loosen the retaining screws and move the dimmer switch toward the steering wheel to remove any lash from the actuator rod. Tighten the dimmer switch retaining screws with 4 N•m (35 in-lbs) torque.

(4) Remove the drill bit and test the dimmer switch operation by moving the dimmer switch stalk. If a tiltable steering column is involved, also test the dimmer switch operation in the full-up, down and center steering wheel positions.

(5) Raise the steering column as necessary.

(6) If removed, install the lower part of the instrument panel.

(7) Connect the negative cable to the battery. If equipped, reset the clock.

Cruise/Turn Switches And Key Buzzer

The procedures for removal/installation of the cruise control and turn signal switches, and the key buzzer are located in the applicable steering column disassembly/assembly procedure.

Ignition Switch Key/Lock Cylinder

The key/lock cylinder is serviced by replacement only. Refer to the applicable steering column disassembly/assembly procedure for key/lock cylinder replacement.

Steering Column—Removal

Steering column removal from the vehicle is not necessary for lockplate cover, lockplate, steering shaft re-

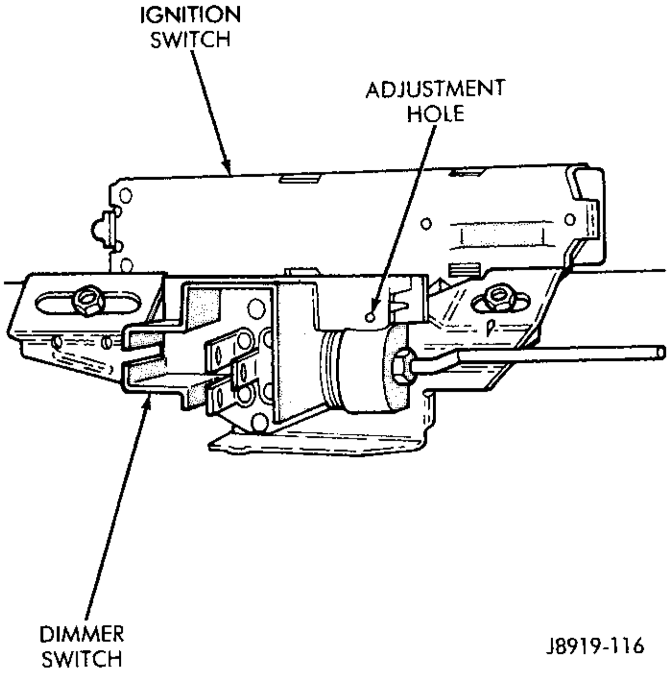


Fig. 10 Dimmer Switch

taining ring, canceling cam, turn signal switch, upper bearing "preload" spring, or ignition key/lock cylinder service. **The steering column must be removed from the vehicle to service any other component.**

CAUTION: When removed from the vehicle, a steering column must be handled very carefully. Otherwise, the plastic fasteners that maintain the rigidity of the energy-absorbing components could be sheared or loosened.

(1) Disconnect the battery negative cable.

(2) Paint alignment marks on the intermediate shaft and the steering shaft for assembly reference.

(3) Disconnect the steering shaft from the intermediate shaft (Fig. 11).

(4) If necessary, remove the lower part of the instrument panel.

(5) Disconnect the bracket (Fig. 12) from the instrument panel and lower the steering column.

(6) Disconnect the following items from the steering column connectors:

- ignition switch wire harness;
- dimmer switch wire harness;
- turn signal switch wire harness;
- windshield wiper wire harness;
- cruise control wire harness (if equipped); and
- park-lock cable (if equipped).

(7) Disconnect the steering column toe plate from the instrument panel and remove the steering column from the vehicle.

Steering Column—Installation

CAUTION: When removed from the vehicle, a steering column must be handled very carefully. Otherwise, the plastic fasteners that maintain the rigidity of the energy-absorbing components could be sheared or loosened.

(1) Position the steering column in the vehicle, align the reference marks and connect the steering shaft to intermediate shaft (Fig. 11).

(2) As applicable, connect the following items to the steering column connectors:

- ignition switch wire harness;
- dimmer switch wire harness;
- turn signal switch wire harness;
- windshield wiper wire harness;
- cruise control wire harness (if equipped); and
- park-lock cable (if equipped).

(3) Raise the steering column and connect the bracket (Fig. 12) to the instrument panel.

(4) Connect the steering column toe plate to the instrument panel.

(5) Tighten all the nuts and bolts with the specified torque.

(6) If removed, install the lower part of the instrument panel.

(7) Connect the battery negative cable.

(8) If equipped, reset the clock and test the operation of all the applicable equipment.

FIXED (NON-TILTABLE) STEERING COLUMN

Disassembly

Steering column removal from the vehicle is not necessary for lockplate cover, lockplate, steering shaft retaining ring, canceling cam, turn signal switch, upper bearing "preload" spring, or ignition key/lock cylinder service. **The steering column must be removed from**

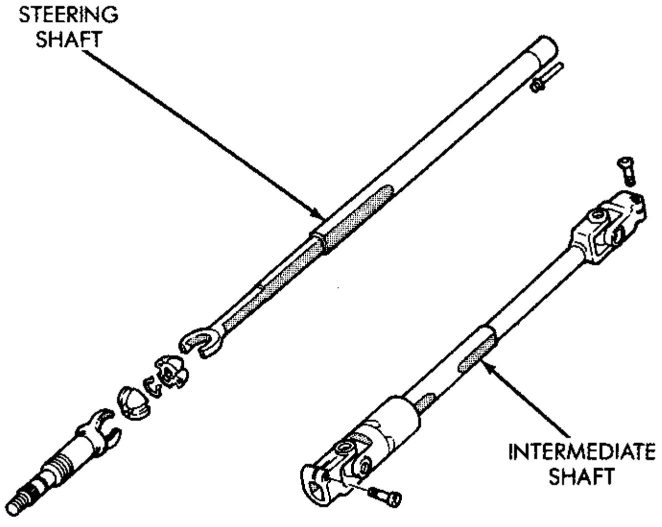


Fig. 11 Steering Shaft/Intermediate Shaft

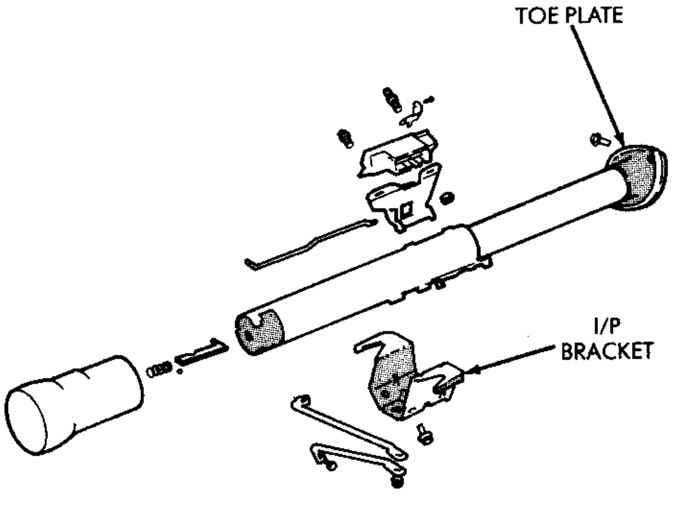


Fig. 12 Steering Column

the vehicle to service any other component.

(1) If the steering column is removed from the vehicle, attach a steering column support fixture (Fig. 13) to the steering column and clamp the fixture in a vise. If the steering column is not removed from the vehicle, disconnect the battery negative cable.

(2) Remove the steering wheel. Refer to the removal procedure.

(3) Remove the lockplate cover.

WARNING: The lockplate retains a very strong, spring force. Do not attempt to remove the steering shaft retaining "snap" ring without using an appropriate lockplate compressor tool.

(4) Compress the lockplate with a compressor tool and release the steering shaft retaining "snap" ring (Fig. 14).

(5) Remove the lockplate compressor tool and the retaining "snap" ring. Discard the "snap" ring.

CAUTION: When the steering shaft retaining "snap" ring is removed, the steering shaft is no longer retained within the column. During bench disassembly, remove the shaft by pulling it out from the lower end of the column. If the retaining "snap" ring is removed while the steering column is installed in the vehicle, do not allow the shaft to slip out if/when the column is removed from the vehicle.

(6) Remove the lockplate, canceling cam, upper bearing "preload" spring, and the thrust washer from the steering column/shaft (Fig. 15).

(7) Remove the hazard warning switch knob. Press the knob inward and remove it from the column by turning it counterclockwise.

(8) Remove the turn signal/wiper/cruise control stalk by pulling it out straight from the column.

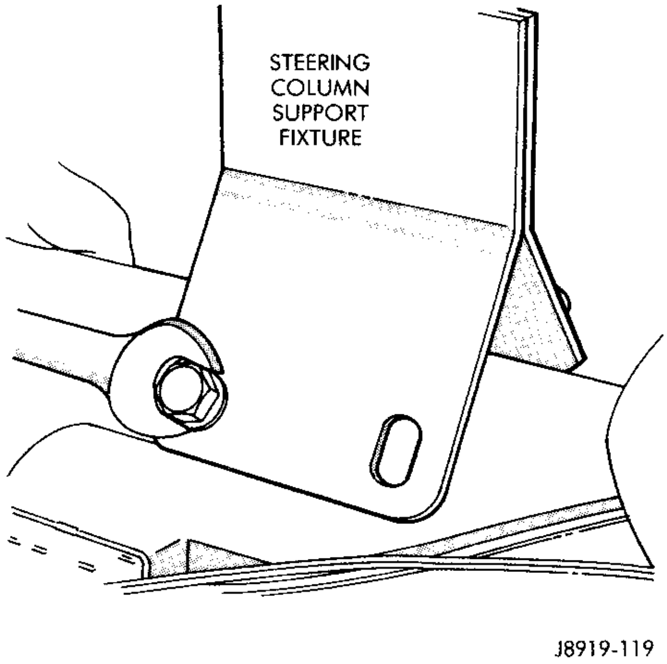


Fig. 13 Steering Column Support Fixture

(9) Disconnect the turn signal wire harness connector from the bracket located at the lower end of the steering column.

CAUTION: Wrap tape around the turn signal switch wire harness connector (Fig. 16) to prevent it from becoming entangled during removal.

(10) Remove the turn signal switch retaining screws (Fig. 17) and the dimmer switch actuator arm, and then remove the switch. Guide the switch straight up and out of the steering column.

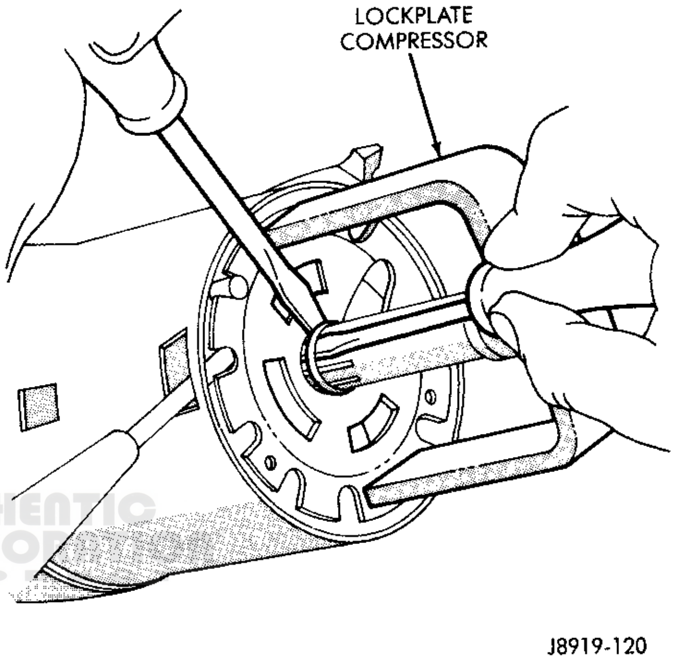


Fig. 14 Retaining Snap Ring Removal

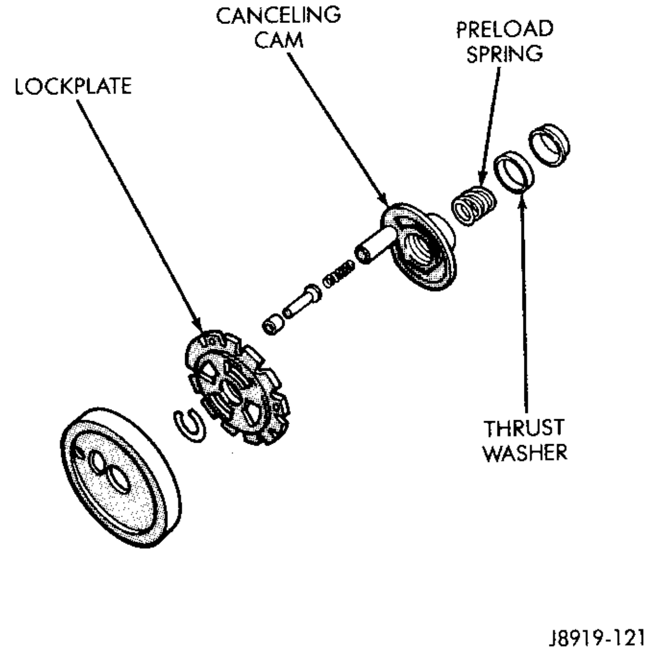


Fig. 15 Steering Column Disassembly

(11) Remove the wiper switch wire harness and all the other wire harnesses located within the steering column.

(12) Insert the ignition switch key into the key/lock cylinder and turn the key to the ON position.

CAUTION: Do not attempt to remove the key warning buzzer switch and the contacts separately because, if separated, the contacts can detach and drop into the steering column.

(13) Remove the key warning buzzer switch and the contacts as a unit (Fig. 18) with needlenose pliers or a paper clip bent at a right angle (i.e., 90 degrees).

(14) With the ignition key/lock cylinder in the ON position, remove the retaining screw and pull the cylinder out of the steering column (Fig. 19).

(15) Remove the ignition switch and the dimmer switch (Fig. 20) from the lower end of the steering column.

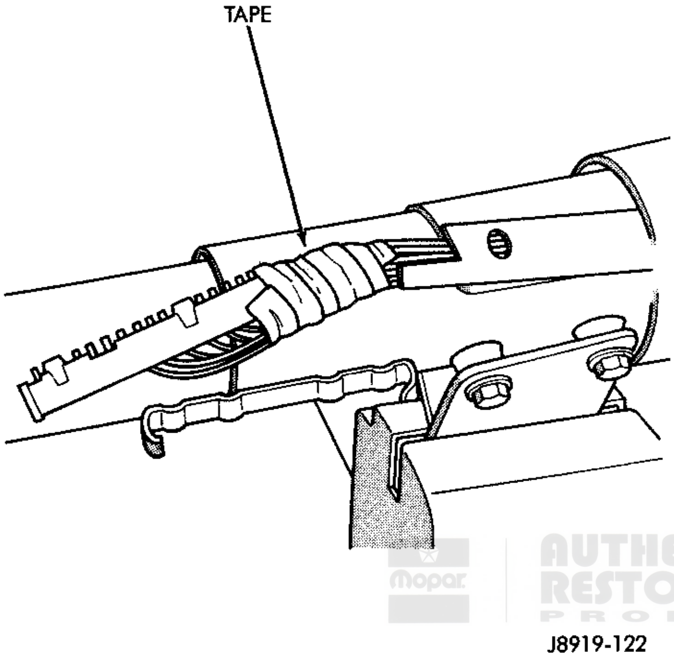


Fig. 16 Taped Turn Signal Switch Wire Harness Connector

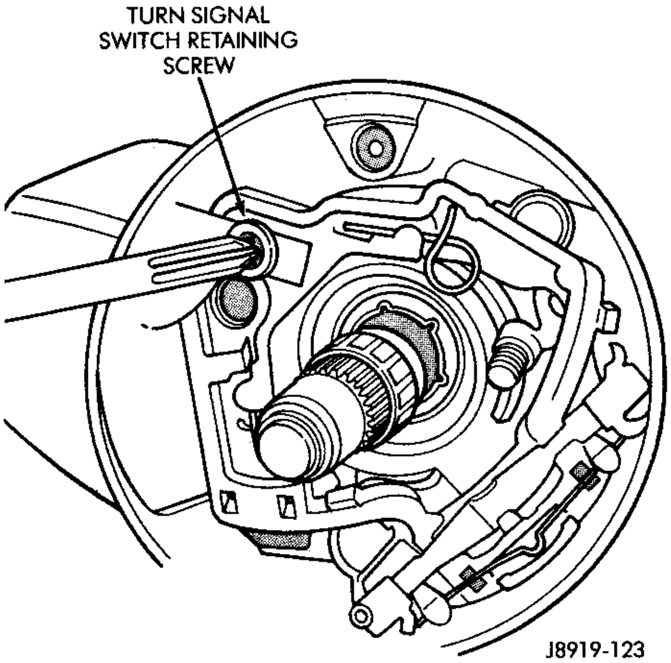


Fig. 17 Turn Signal Switch Retaining Screw

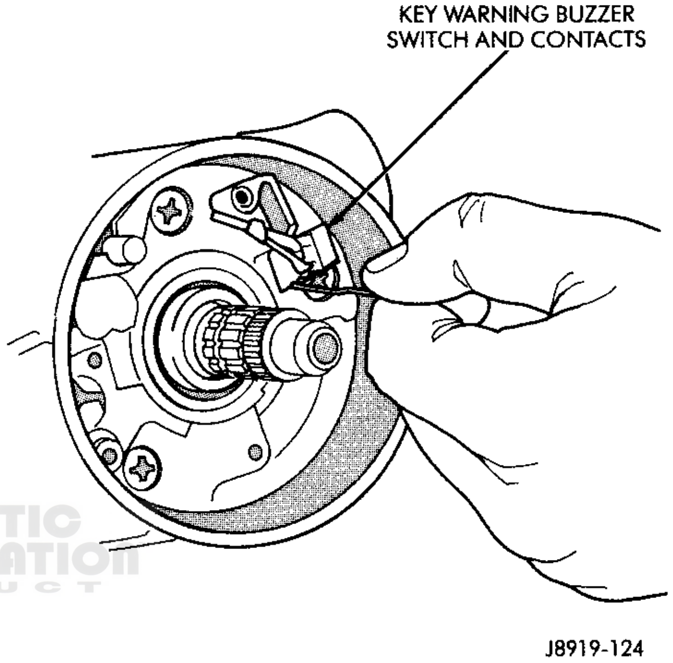


Fig. 18 Key Warning Buzzer/Contacts Removal

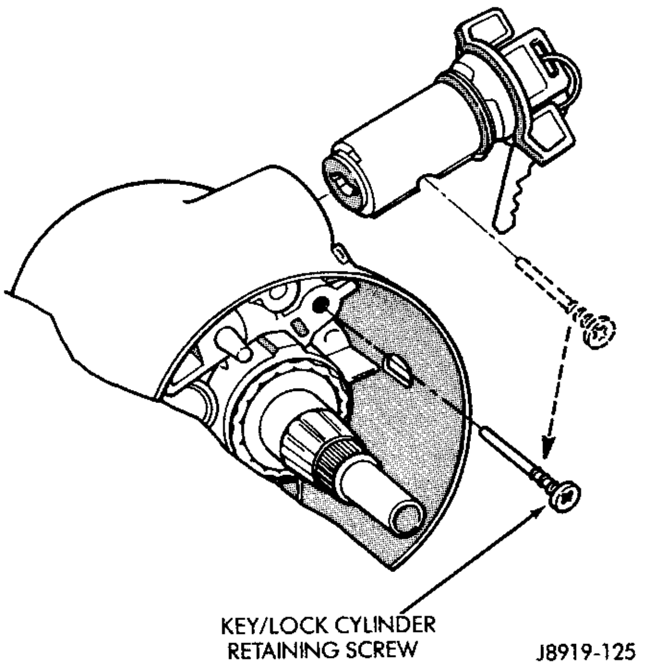


Fig. 19 Key/lock Cylinder Removal

Column Shift Only

(16) Remove the gear selector lever upper pivot pin and the selector lever.

(17) Remove the upper bearing thrust washer.

(18) Remove the four screws that attach the key/lock cylinder housing to the steering column jacket, and remove the housing (Fig. 21).

(19) Remove the thrust cap from the key/lock cylinder housing (Fig. 22).

(20) Remove the ignition switch actuating rod and rack from the key/lock cylinder housing (Fig. 22).

(21) Remove the rack "preload" spring and the shaft lock bolt and spring from the key/lock cylinder housing. Remove the shift lever detent plate from the housing (Fig. 22).

(22) Use a blunt punch to exert force on the block tooth to disengage and remove the lock sector (Fig. 23).

(23) Remove the gear selector lever housing and the shroud from the steering column jacket.

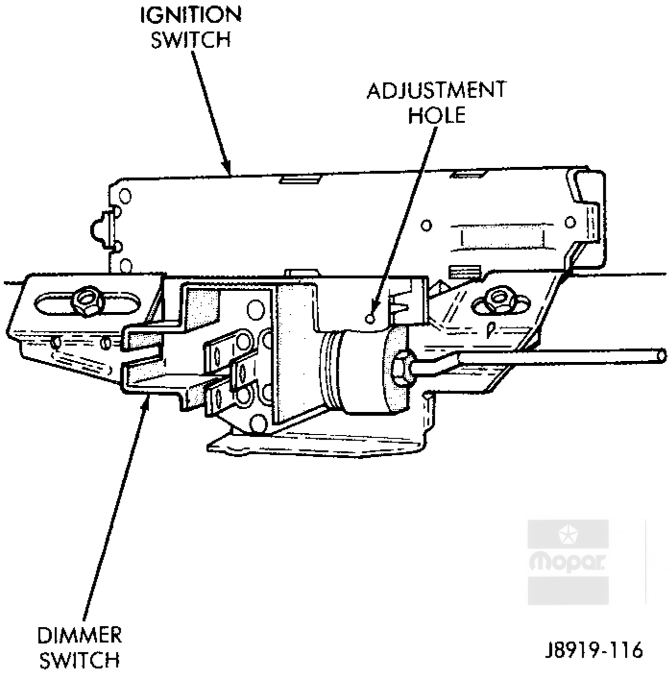


Fig. 20 Ignition Switch & Dimmer Switch

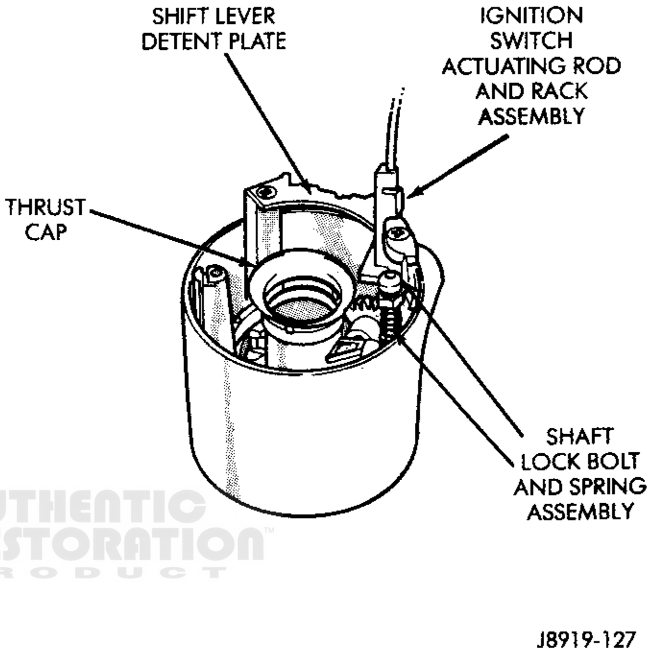


Fig. 22 Key/Lock Cylinder Housing Components

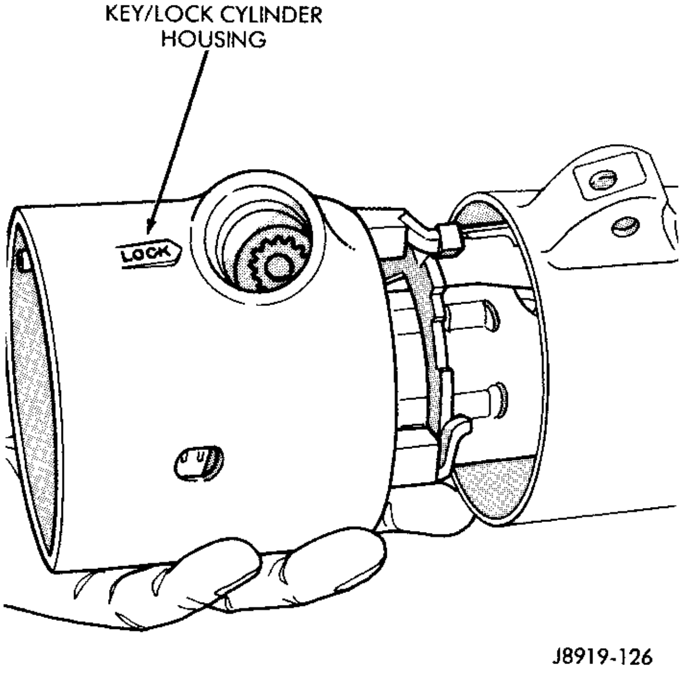


Fig. 21 Key/Lock Cylinder Housing

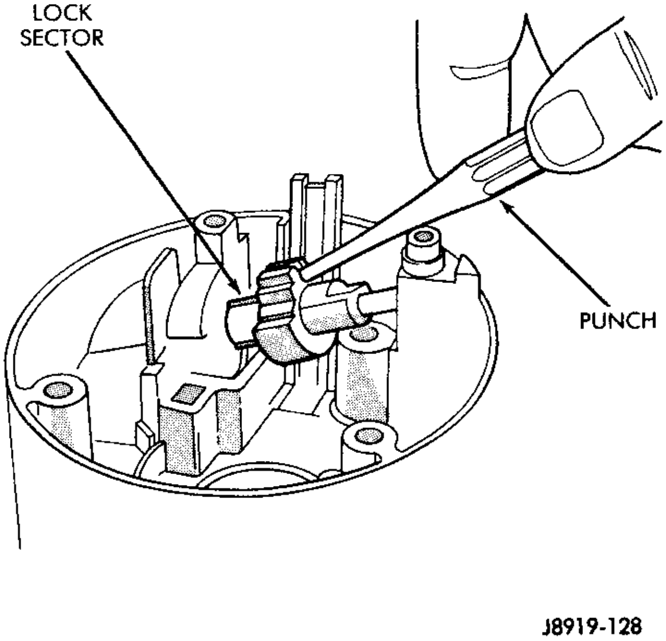


Fig. 23 Lock Sector Removal

(24) Remove the gear selector lever spring from the lever housing.

The steering column must be removed from the vehicle to disassemble the remaining steering column components.

(25) Remove the steering shaft (if not previously removed).

(26) Remove the spring clip from the steering column lower bearing retainer. Remove the retainer, the lower bearing and the adapter (Fig. 24).

(27) Slide out and remove the shift tube.

Console Shift Only

(16) Remove the screws that attach the key/lock cylinder housing and the shroud to the steering column jacket (Fig. 25).

(17) Remove the dimmer switch actuator arm.

(18) Disengage the remote rod from the lock rack.

(19) Remove the key/lock cylinder housing-to-shroud attaching screws (Fig. 26) and separate the housing and the shroud.

(20) Remove the wave washer from the key release lever pivot. Remove the key release lever and the pivot.

(21) Remove the lock rack and the lock bolt (Fig. 27).

(22) Remove the lock rack "preload" spring.

(23) Use a blunt punch to exert force on the block tooth to disengage and remove the lock sector (Fig. 28).

The steering column must be removed from the vehicle to disassemble the remaining steering column components.

(24) Remove the steering shaft (if not previously removed).

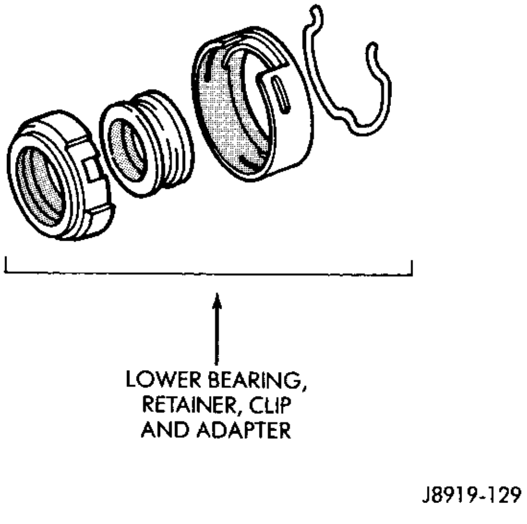


Fig. 24 Lower Bearing, Adapter, Retainer & Clip

(25) Remove the spring clip from the lower bearing retainer. Remove the retainer, the bearing and the adapter (Fig. 29).

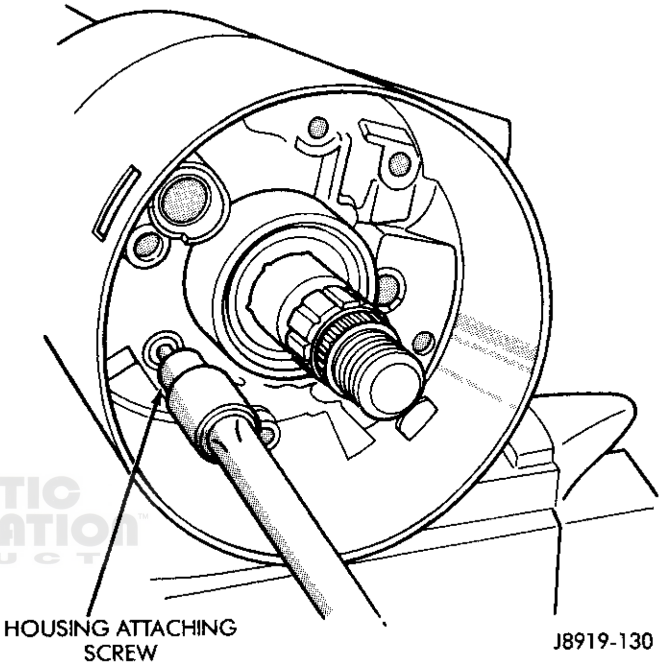


Fig. 25 Key/Lock Cylinder Housing Removal

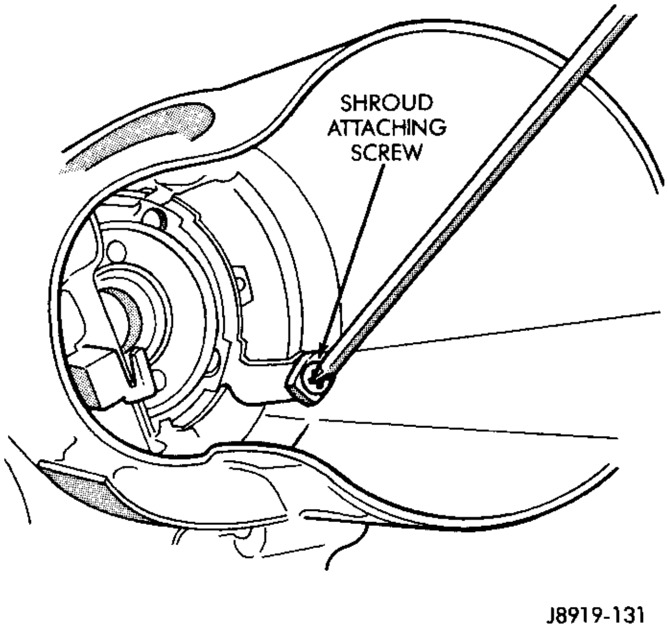


Fig. 26 Housing/Shroud Attaching Screw

Assembly

WARNING: Use only the original or exact replacement screws, bolts and nuts to assemble the steering column. Incorrect screw or bolt length could prevent the column from compressing with impact (i.e., front-end collision). All the fasteners that are used for assembly must be tightened with the correct torque to ensure that the energy-absorbing (compression) action of the column is maintained. The bolts and nuts that are used to attach the column and bracket to the instrument panel must also be tightened with the correct torque to ensure that the bracket will breakaway with impact.

CAUTION: Apply chassis lubricant to all the bearing, thrust and friction producing mating surfaces before assembly.

Column Shift Only

(1) Insert the lock sector through the key/lock cylinder hole in the key/lock cylinder housing and install the lock sector on the lock sector shaft (Fig. 30). Ensure that the lock sector turns freely after installation.

(2) Install the lock rack "preload" spring. The bowed side of the spring must contact the lock rack when the rack is installed.

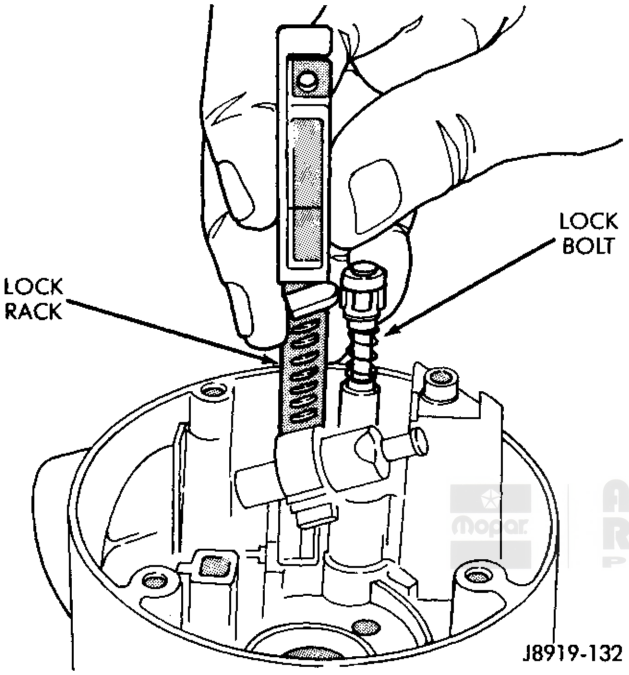


Fig. 27 Lock Rack & Lock Bolt

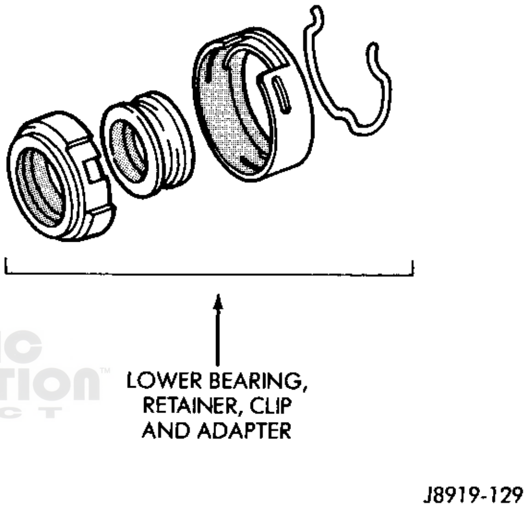


Fig. 29 Lower Bearing Components

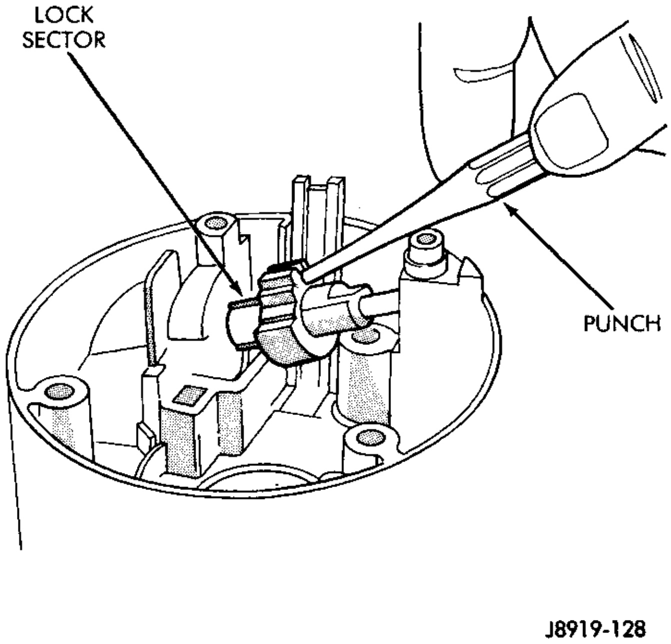


Fig. 28 Lock Sector Removal

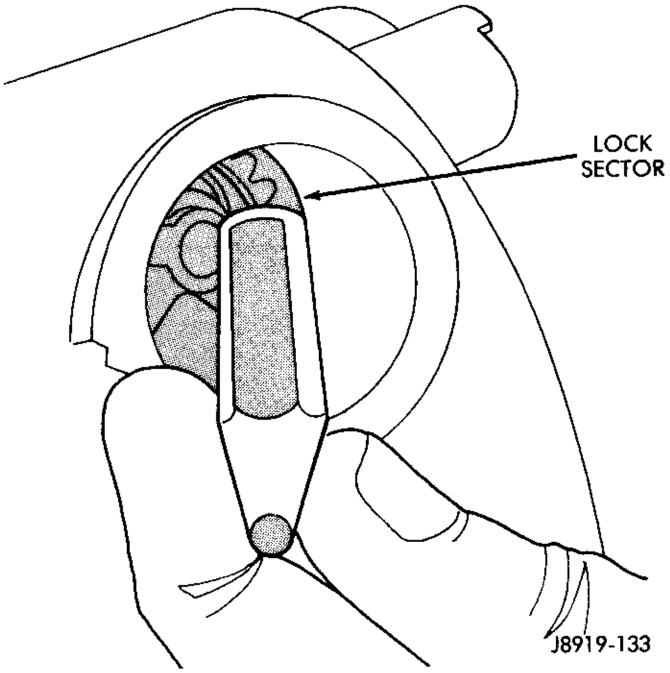


Fig. 30 Lock Sector Installation

(3) Assemble the lock bolt and the lock rack (Fig. 31).

(4) Install the assembled lock bolt and lock rack in the key/lock cylinder housing (Fig. 32). Mate the lock rack block tooth with the lock sector block tooth.

(5) Install the shift lever detent plate on the key/lock cylinder housing (Fig. 33).

(6) Install the thrust cap on the key/lock cylinder housing (Fig. 33).

(7) Install the ignition switch actuating rod and rack on the key/lock cylinder housing.

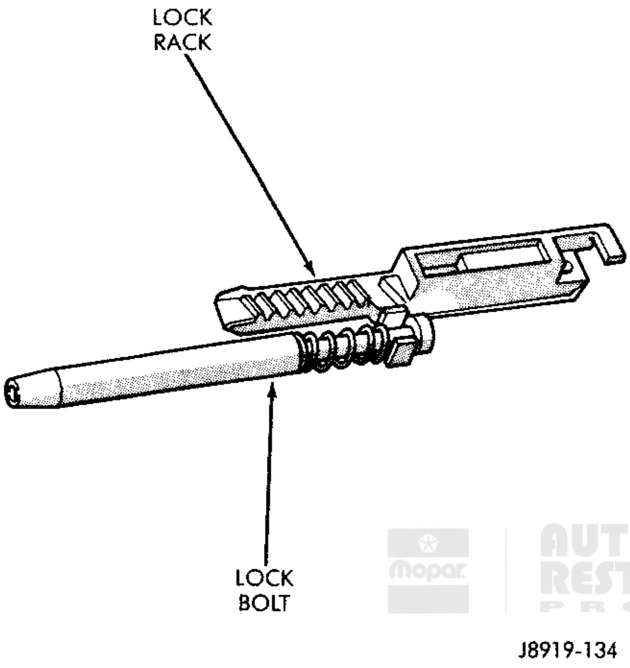


Fig. 31 Lock Bolt & Lock Rack

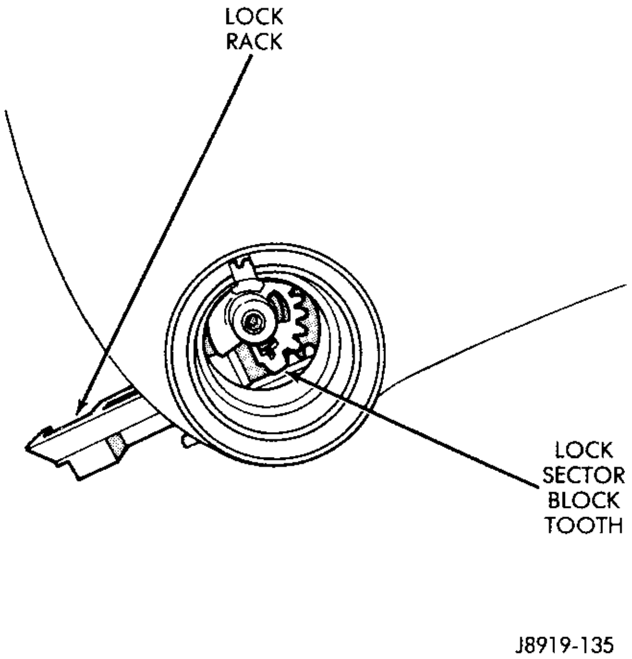


Fig. 32 Lock Bolt/Lock Rack Installation

(8) Insert and install the gear selector lever housing lower bearing the housing. Align the indentations in the bearing shell with the projections on the housing jacket.

(9) Install the gear selector lever spring in the lever housing.

(10) Install the gear selector lever housing and shroud on the upper end of the steering column jacket. Rotate the housing and ensure that the bearing is properly "seated".

(11) With the gear selector lever housing in the PARK position, and the lock rack pulled downward, position and correctly "seat" the key/lock cylinder housing on the steering column jacket. Install and tighten the four attaching screws.

(12) Insert the shift tube in the lower end of the steering column jacket and rotate it until the shift tube upper key slides into the gear selector housing keyway.

Console Shift Only

(1) Insert the lock sector through the key/lock cylinder hole in the key/lock cylinder housing and install the lock sector on the lock sector shaft (Fig. 34). Ensure that the lock sector turns freely after installation.

(2) Install the lock rack "preload" spring. The bowed side of the spring must contact the lock rack when the rack is installed.

(3) Assemble the lock bolt and the lock rack (Fig. 35).

(4) Install the assembled lock bolt and lock rack in the key/lock cylinder housing (Fig. 36). Mate the lock rack block tooth with the lock sector block tooth.

(5) Install the key-release lever return spring over the threaded pivot post on the key/lock cylinder housing (Fig. 37).

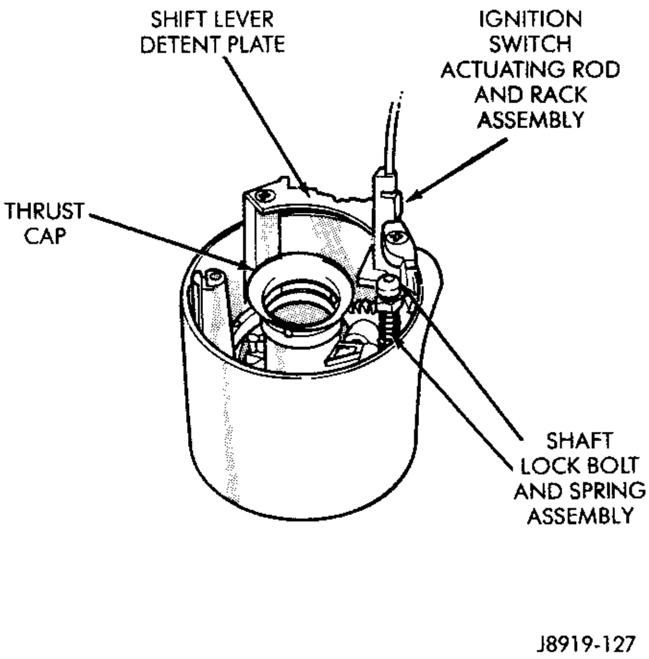


Fig. 33 Key/Lock Cylinder Housing

(6) Insert the key-release lever finger into the lock rack slot and position the hole in the lever over the threaded pivot post on key/lock cylinder housing (Fig. 38). Ensure that the inner end of the spring contacts the release lever.

(7) Raise the key-release lever slightly and install the end of the lever spring between the lever and the boss on the housing (Fig. 39).

(8) Apply chassis lubricant to the wave washer (Fig. 39) and position it on the threaded pivot post and resting on the release lever.

(9) Position the shroud on the key/lock cylinder housing and install the attaching screws. Tighten the screws with 2 N•m (18 in-lbs) torque. **Ensure that the wave washer (Fig. 39) is not displaced while attaching the shroud to the key/lock cylinder housing.**

(10) Insert the short, hooked end of the remote rod in the lock rack.

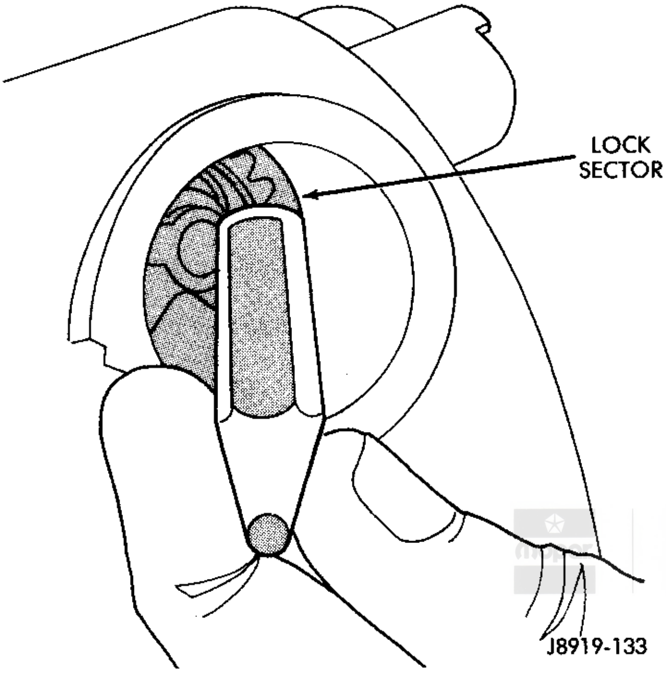


Fig. 34 Lock Sector Installation

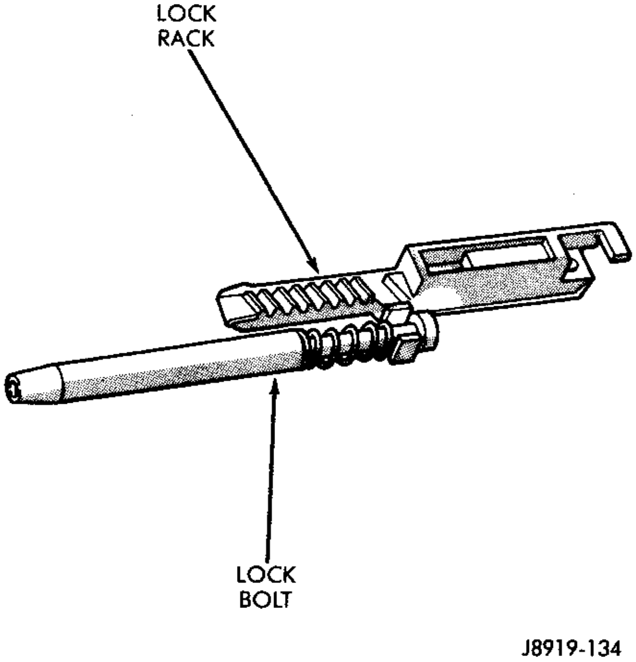


Fig. 35 Lock Bolt & Lock Rack

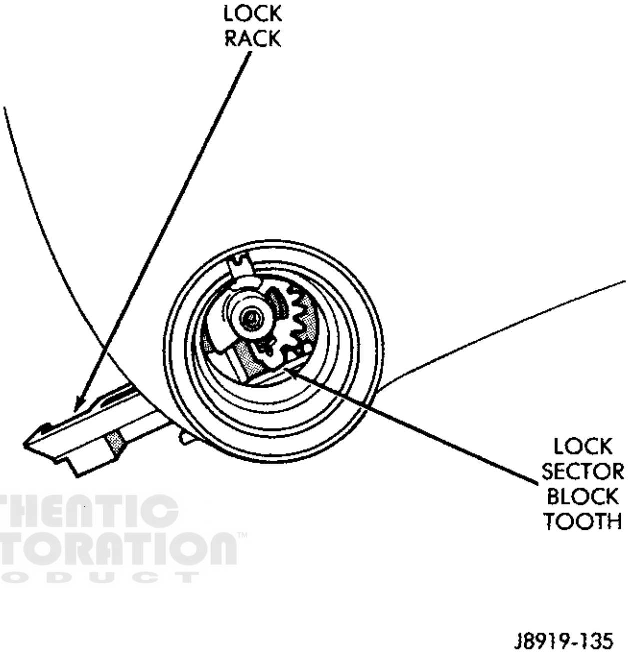


Fig. 36 Lock Bolt/Lock Rack Installation

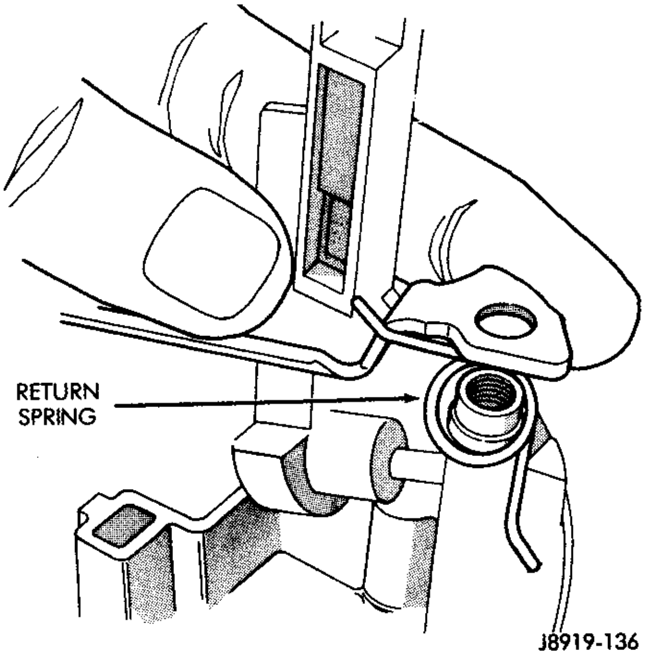


Fig. 37 Key-Release Lever Return Spring

(11) Install the assembled key/lock cylinder housing and shroud on the steering column jacket and install the attaching screws (Fig. 40). Tighten the screws with 7 N•m (60 in-lbs) torque.

Column Shift And Console Shift (Cont'd)

(1) Install the key/lock cylinder in the housing. Insert the key into the cylinder and rotate the cylinder until the key is aligned with the keyway in the housing. Push the key/lock cylinder inward and install the retaining screw (Fig. 41). Tighten the retaining screw with 4.5 N•m (40 in-lbs) torque.

(2) Turn the key/lock cylinder to the ON position and install the key warning buzzer switch.

(3) Install the ignition switch according to the following instructions:

- move the ignition switch slider to the ACCESSORY position, and then back two “clicks” to the OFF (un-

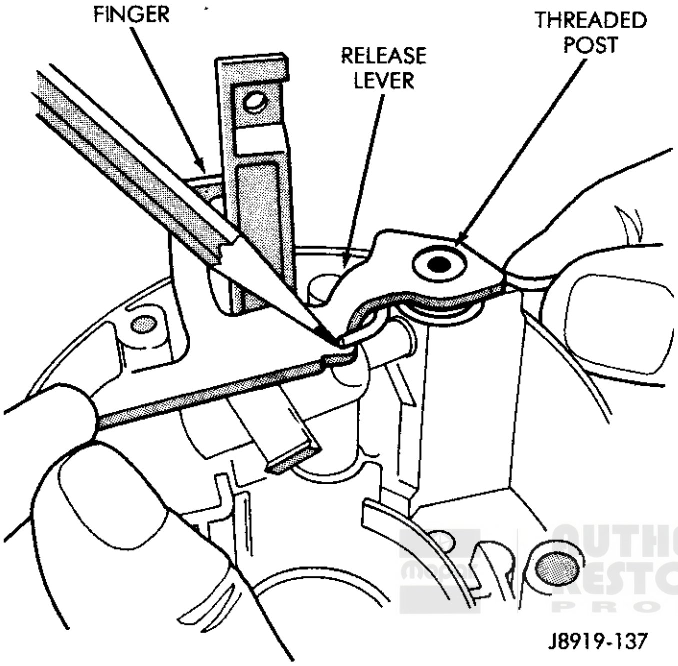


Fig. 38 Key-Release Lever Installation

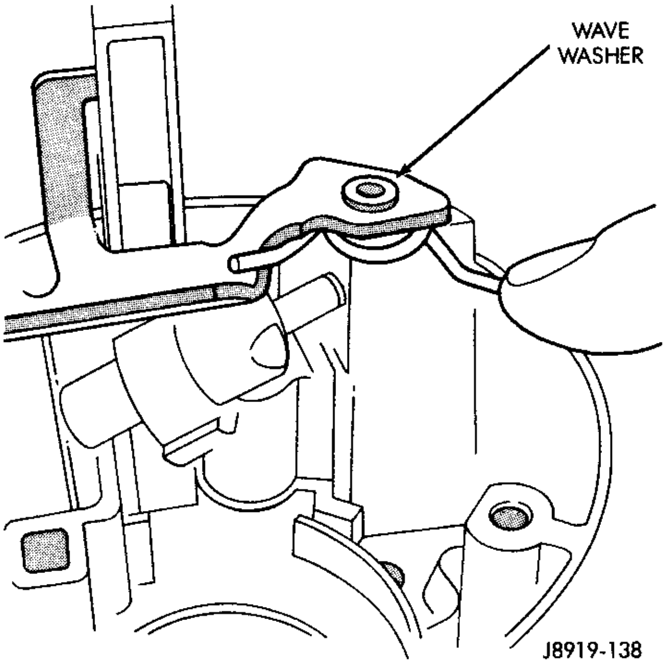


Fig. 39 Spring Positioning & Wave Washer Installation

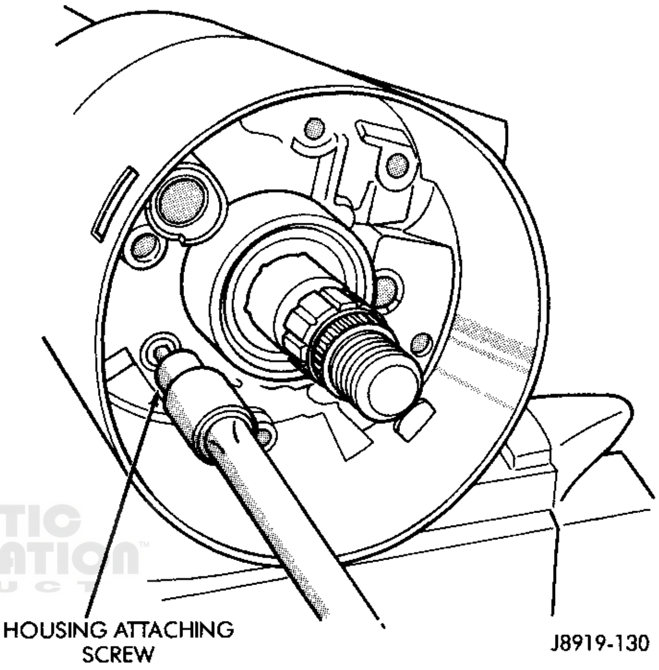


Fig. 40 Key/Lock Cylinder Housing Installation

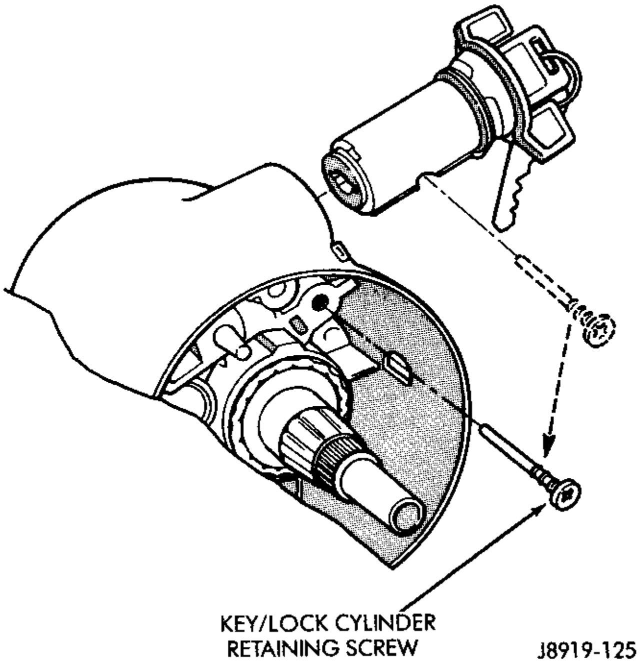


Fig. 41 Key/Lock Cylinder Installation

locked) position (the remote rod hole in the ignition switch slider should now be centered); and

- insert the remote rod in the ignition switch slider hole and install the ignition switch on the steering column jacket (Fig. 42).

(4) Install the lower bearing, the adapter, the retainer and spring clip at the lower end of the steering column.

(5) Install the steering shaft through the lower end of the steering column and insert it into the upper bearing.

(6) Position the turn signal switch and wire harness in the key/lock cylinder housing. Fold the wires against the connector and route the connector down through the steering column jacket.

(7) Install the windshield wiper wire harness and switch. Route the wire harness down through steering column jacket.

(8) Align the turn signal switch in the housing and secure the switch with the attaching screws. Tighten the screws with 4 N•m (35 in-lbs) torque.

(9) Install the dimmer switch actuator arm. Tighten the attaching screws with 4 N•m (35 in-lbs) torque.

(10) If equipped, route the cruise control wire harness into and through the steering column jacket. Install the turn signal/wiper/dimmer switch/cruise control (if equipped) stalk by pushing it straight into the column.

(11) Position the thrust washer, the upper bearing "preload" spring and the canceling cam on the steering shaft (Fig. 43).

(12) Place the turn signal switch in the neutral (OFF) position and install the hazard warning switch knob.

(13) Position the lockplate on the steering shaft and install a replacement lockplate retaining "snap" ring on the sleeve of the compressor tool. Install the tool on the steering shaft (Fig. 44).

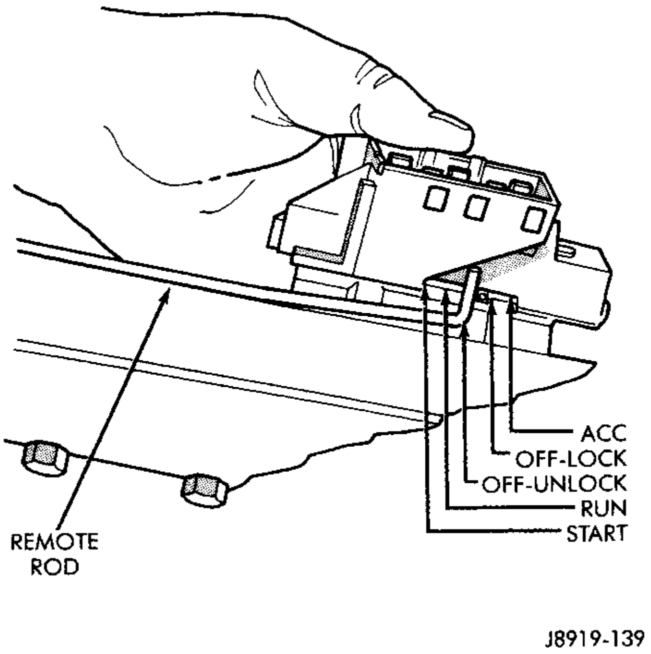


Fig. 42 Ignition Switch Slider Positions

(14) Compress the lockplate with the compressor tool and position the retaining "snap" ring in the steering shaft groove.

(15) **Ensure that the retaining "snap" ring is completely "seated" in the groove before removing the tool.** Remove the tool and install the lockplate cover.

(16) Install the steering wheel. Refer to the installation procedure. Tighten the steering wheel retaining nut with 34 N•m (25 ft-lbs) torque.

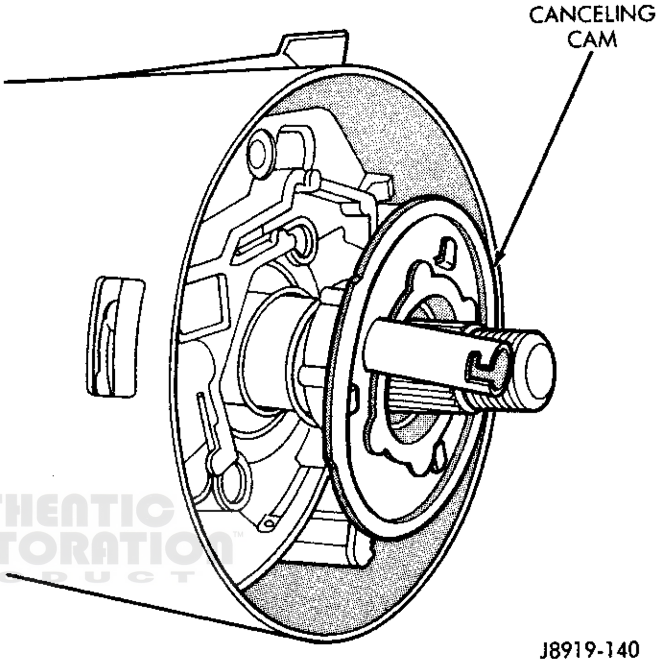


Fig. 43 Canceling Cam Position

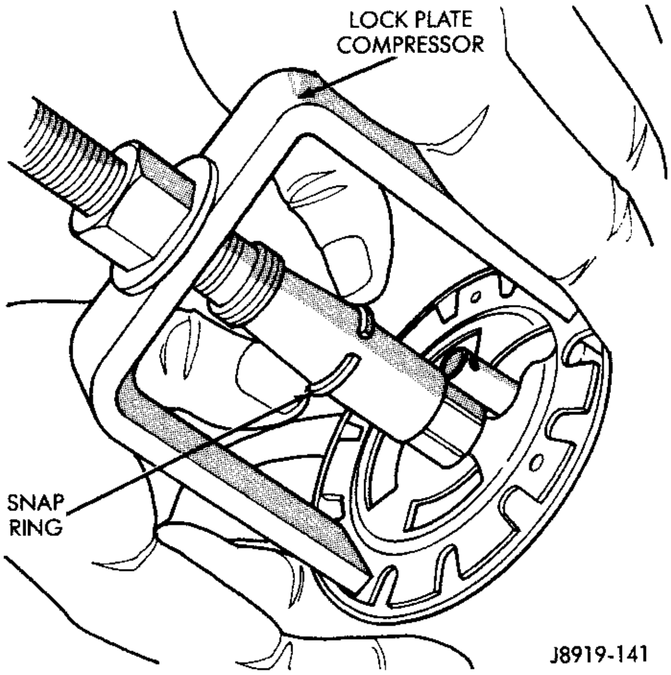


Fig. 44 Lockplate Snap Ring Installation

(17) If removed, install the steering column in the vehicle. Refer to the installation procedure.

(18) If disconnected, connect the battery negative cable and, if equipped, reset the clock

TILTABLE STEERING COLUMN

Disassembly

Although a tiltable steering column can be disassembled down to the jacket when it is installed in a vehicle, it must be removed from the vehicle if further disassembly is required. If the column is removed for service, use a column support fixture to clamp it in a vise.

(1) Remove the steering column from the vehicle, if necessary. Refer to the removal procedure.

(2) If the steering column is removed from the vehicle, attach a steering column support fixture (Fig. 45) to the steering column and clamp the fixture in a vise.

(3) If the steering column has not been removed from the vehicle, place the front wheels in the straight-ahead position. Disconnect the battery negative cable.

(4) Protect the painted areas on the steering column.

(5) Remove the steering wheel. Refer to the removal procedure.

(6) If the steering column is the column shift type, remove the gear selector lever retaining pin and the lever from the housing.

(7) Remove the lockplate cover. Use two small pry bars to pry the cover off the lockplate.

WARNING: The lockplate retains a very strong, spring force. Do not attempt to remove the steering shaft retaining "snap" ring without using an appropriate lockplate compressor tool.

(8) Compress the lockplate with a compressor tool and release the steering shaft retaining "snap" ring (Fig. 46).

(9) Remove the lockplate compressor tool and the retaining "snap" ring. Discard the "snap" ring.

(10) Remove the lockplate, canceling cam, upper bearing "preload" spring, and the thrust washer from the steering column/shaft.

(11) Remove the hazard warning switch knob. Press the knob inward and remove it from the steering column by turning it counterclockwise.

(12) If the steering column is the column shift type, remove the two retaining screws and the gear selector indicator cover.

(13) If the steering column is the column shift type, remove the gear selector indicator lamp bracket retaining screw. Do not remove the lamp and bracket at this time.

(14) Remove the tilt-release lever.

(15) Disconnect the turn signal wire harness connector from the bracket located at the lower end of the steering column (Fig. 47).

CAUTION: Wrap tape around the turn signal switch wire harness connector to prevent it from becoming entangled during removal.

(16) Remove the plastic protector from the wire harness.

(17) Remove the turn signal switch retaining screws (Fig. 48) and the dimmer switch actuator arm, and then remove the switch. Guide the switch straight up and out of the steering column.

(18) Remove the windshield wiper switch wire harness and all the other wire harnesses located within the steering column.

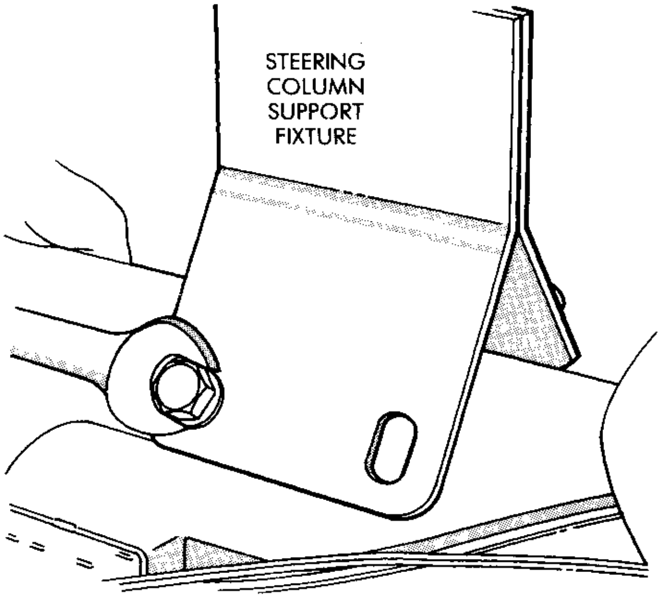


Fig. 45 Steering Column Support Fixture

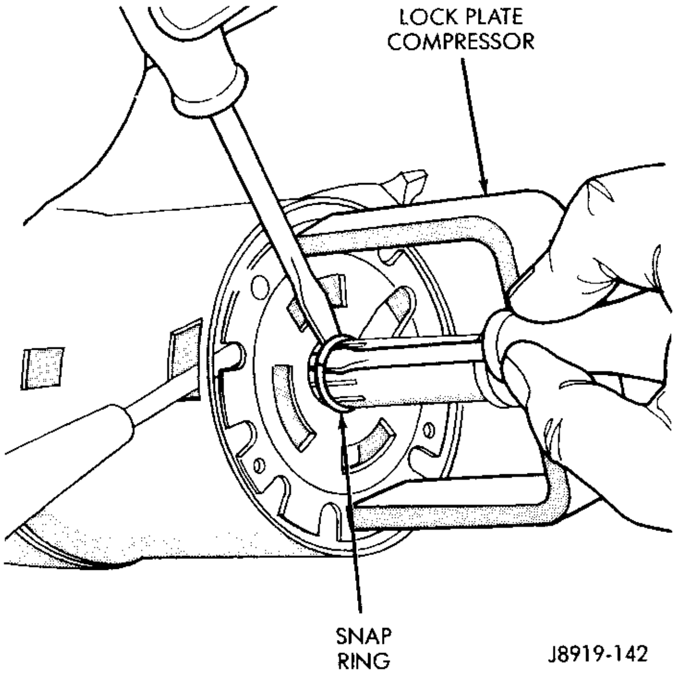


Fig. 46 Lockplate Snap Ring Removal

(19) Insert the ignition switch key into the key/lock cylinder and turn the key to the ON position.

CAUTION: Do not attempt to remove the key warning buzzer switch and the contacts separately because, if separated, the contacts can detach and drop into the steering column.

(20) Remove the key warning buzzer switch and the contacts as a unit (Fig. 49) with needlenose pliers or a paper clip bent at a right angle (i.e., 90 degrees).

(21) With the ignition key/lock cylinder in the ON position, remove the retaining screw and pull the cylinder out of the housing (Fig. 50).

(22) Remove the ignition switch and the dimmer switch (Fig. 51) from the lower end of the steering column.

(23) Remove the screws that attach the key/lock cylinder housing cover to the steering column jacket, and remove the cover.

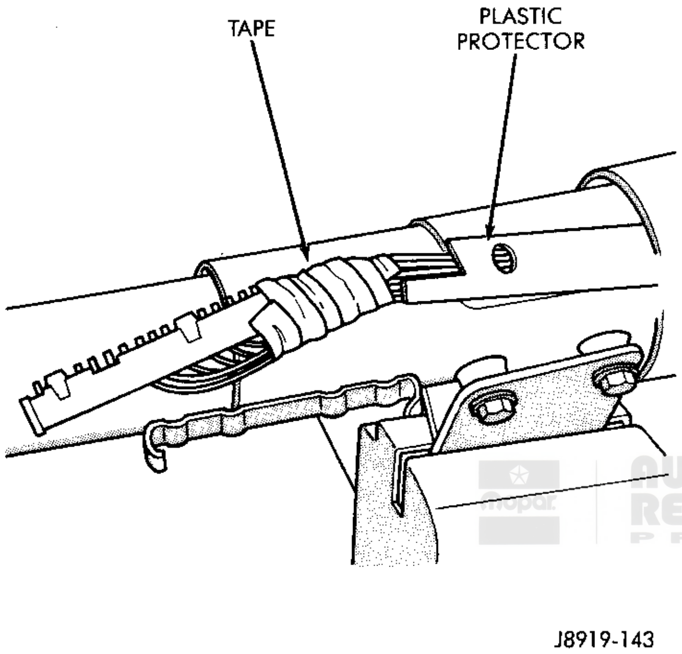


Fig. 47 Turn Signal Switch Wire Harness Connector

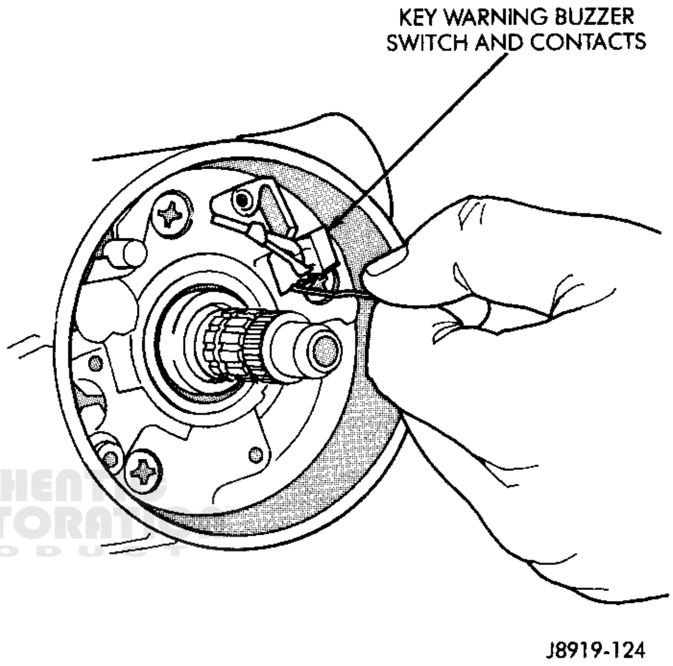


Fig. 49 Key Warning Buzzer/Contacts Removal

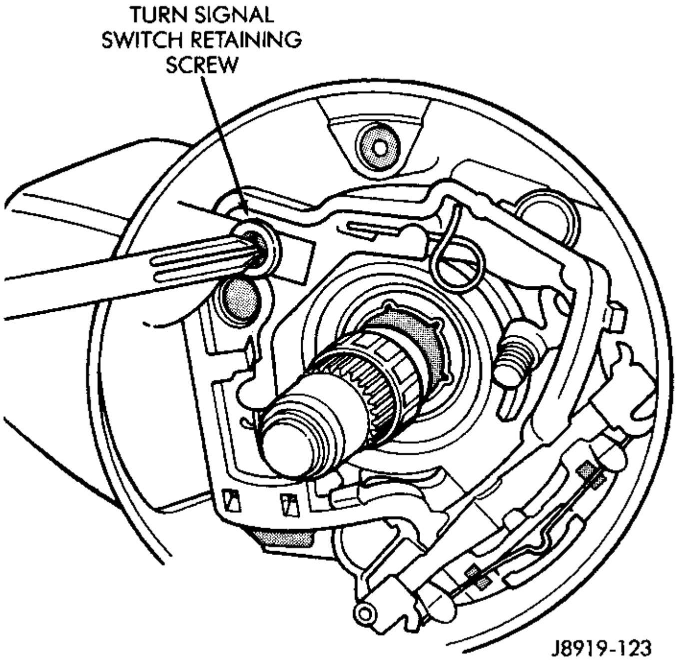


Fig. 48 Turn Signal Switch Removal

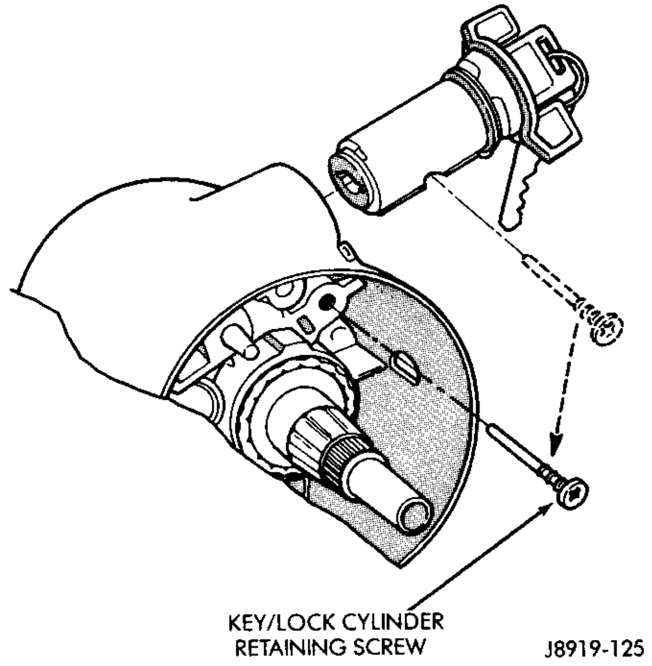


Fig. 50 Key/lock Cylinder Removal

(24) Remove the upper bearing race and the bearing "seat" from the steering shaft (Fig. 52).

(25) Install the tilt-release lever and place the steering column in the full upward tilt position.

WARNING: The tilt spring guide retainer retains strong spring force.

(26) Press the tilt spring guide retainer inward and turn it counterclockwise until the retainer tabs disengage from the key/lock cylinder housing lugs. Ensure that the screwdriver blade properly fits the retainer slot. Remove the tilt spring guide retainer, the guide and the spring from the housing (Fig. 53).

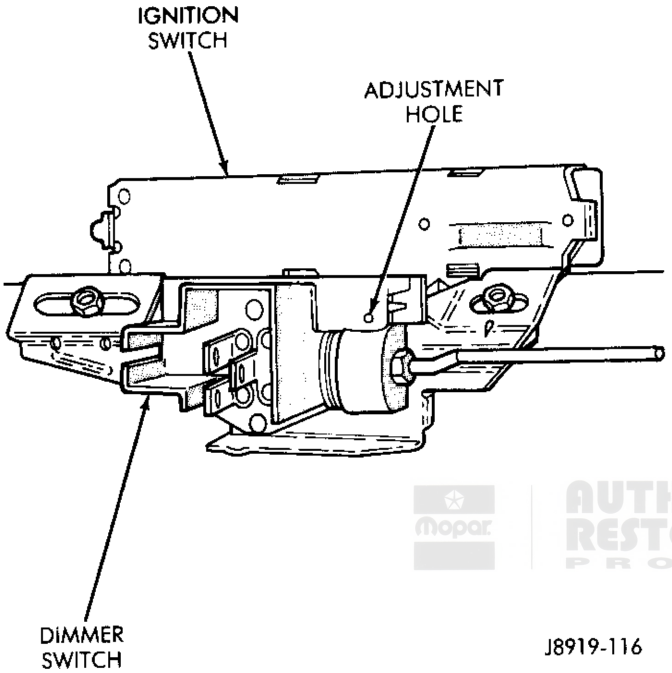


Fig. 51 Ignition Switch & Dimmer Switch

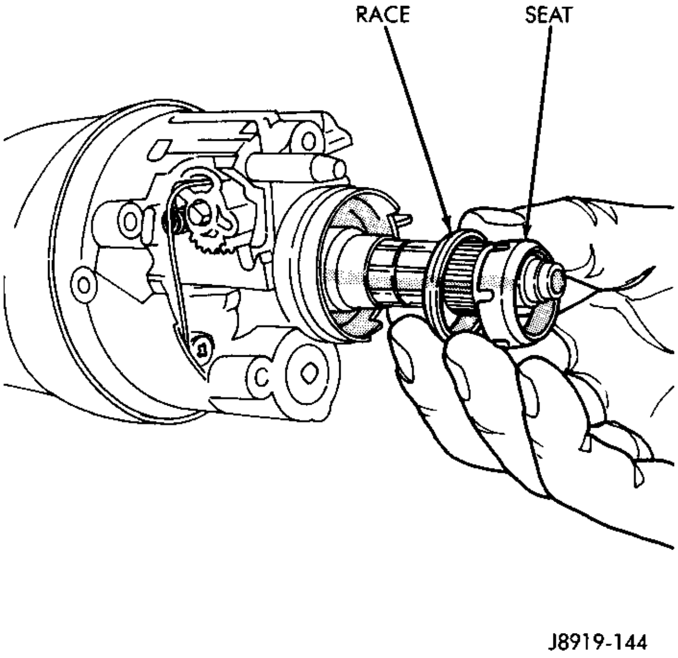


Fig. 52 Steering Shaft Bearing Race & "Seat"

(27) Position the steering column in the center, non-tilt position.

(28) Remove the key/lock cylinder housing-to-steering column support pivot pins with Pivot Pin Removal Tool 7101 (J21854-01) (Fig. 54).

(29) Lift the tilt-release lever to release the lock shoes. Pull the key/lock cylinder housing upward to disengage the shoes and turn the housing clockwise to separate the lock rack from the remote rod. Remove the key/lock cylinder housing from the support (Fig. 55).

(30) Remove the tilt-release lever from the key/lock cylinder housing.

(31) Remove the lock sector spring retaining screw and then remove the spring (Fig. 56). Rotate the spring in a clockwise direction to remove it from the lock bolt.

(32) Remove the lock bolt, the lock rack, the rack "preload" spring and the remote rod from the key/lock cylinder housing.

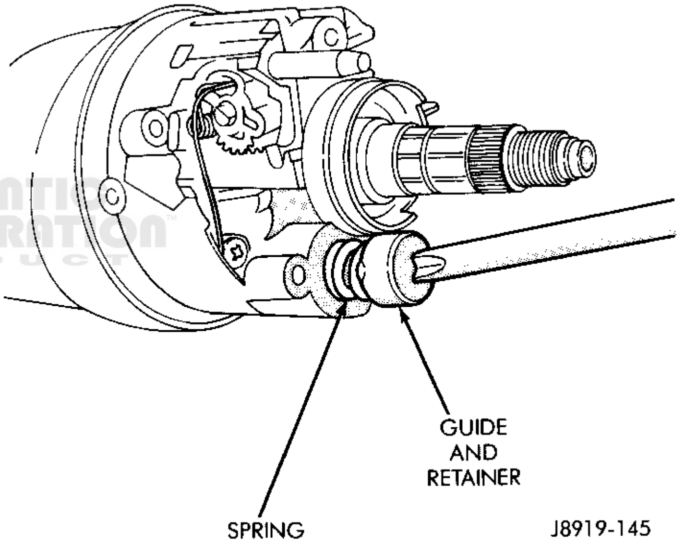


Fig. 53 Retainer/Guide/Spring Removal

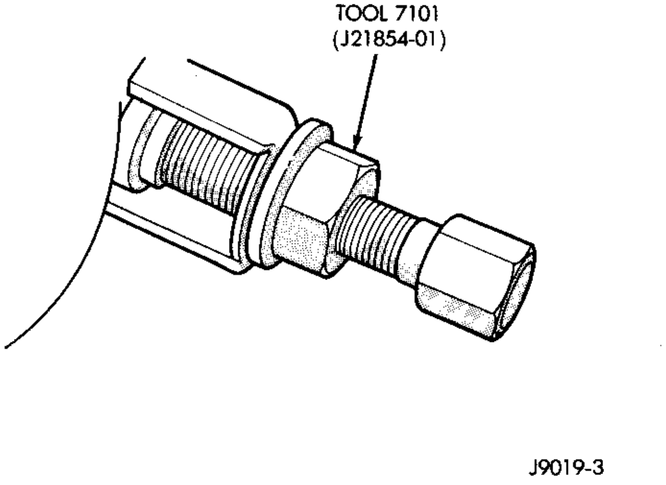


Fig. 54 Pivot Pin Removal Tool 7101 (J21854-01)

(33) Insert a wedge between the lock shoes and the key/lock cylinder housing (Fig. 57) to relieve the spring tension on the tilt-release lever pin and the lock shoe pin.

(34) Remove the tilt-release lever pin from the key/lock cylinder housing with a standard pin punch (Fig. 58).

(35) Remove the lock shoe pin from the key/lock cylinder housing with a standard pin punch (Fig. 59). Remove the lock shoes, the springs and the wedge.

(36) Remove the upper and the lower bearings and the races from the key/lock cylinder only if they are damaged or worn. If the bearings and the races must be replaced, remove them with a hammer and punch. Discard the bearings and races after removal. They are not reusable.

(37) Remove the steering shaft from the upper end of the steering column.

(38) Separate the steering shaft by folding it 90 degrees at the flexible joint and detaching the upper and the lower shaft halves (Fig. 60).

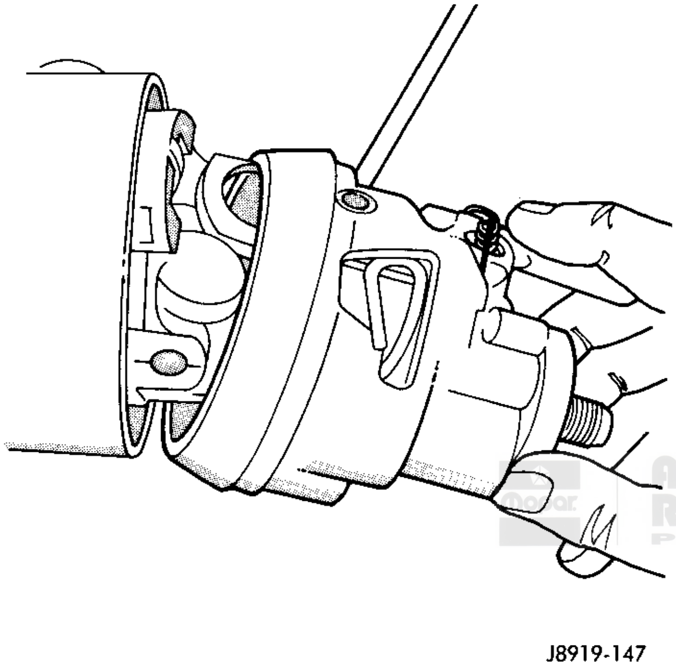


Fig. 55 Key/Lock Cylinder Housing Removal

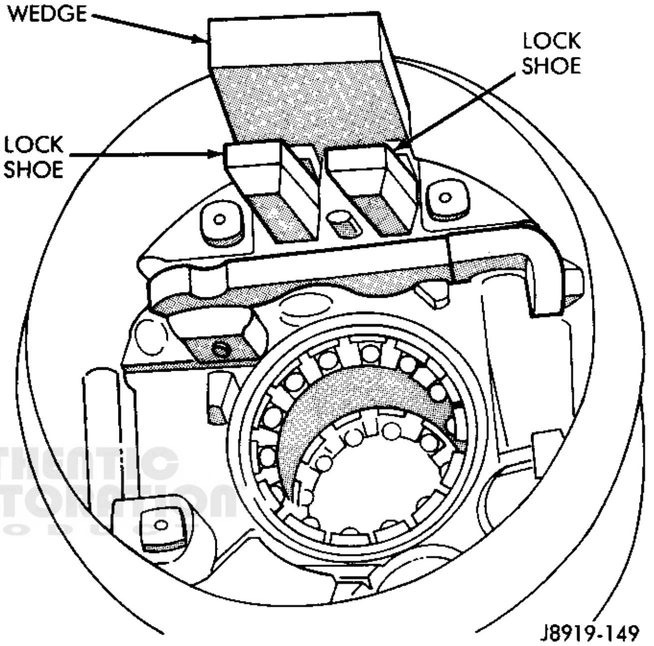


Fig. 57 Wedge Between Lock Shoes & Housing

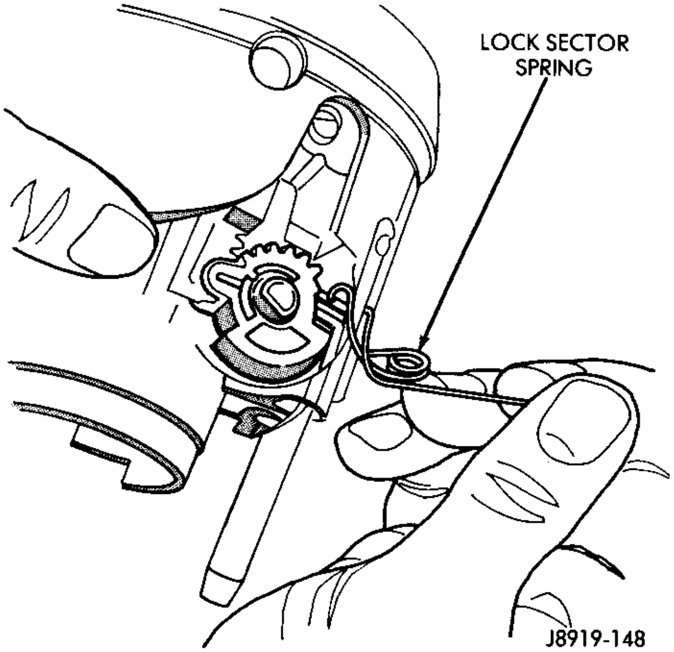


Fig. 56 Lock Sector Spring Removal

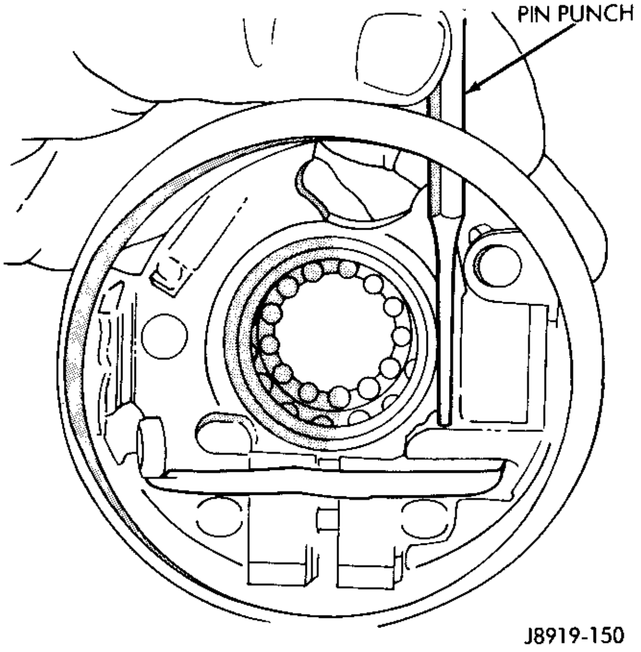


Fig. 58 Tilt-release Lever Pin Removal

(39) Remove the attaching bolts and the steering column support (Fig. 61).

(40) Remove the retaining screws and the shift gate from the steering column support.

(41) Remove the retainer and the bearing from the lower end of the steering column.

(42) Remove the shift tube retaining ring and the thrust washer.

(43) Remove the shift tube from the steering column jacket with an appropriate puller tool (Fig. 62).

(44) Tilt the upper end of the retainer plate toward the lower end of the column, turn the plate counterclockwise and remove it (Fig. 63).

(45) If equipped with a column shift:

- remove the wave washer and the shift tube spring, and
- remove the shift bowl from the steering column jacket.

(46) If equipped with a console shift, remove the key-release lever and the lever spring from the shroud. Tilt the lever forward and lift upward to remove it (Fig. 64).

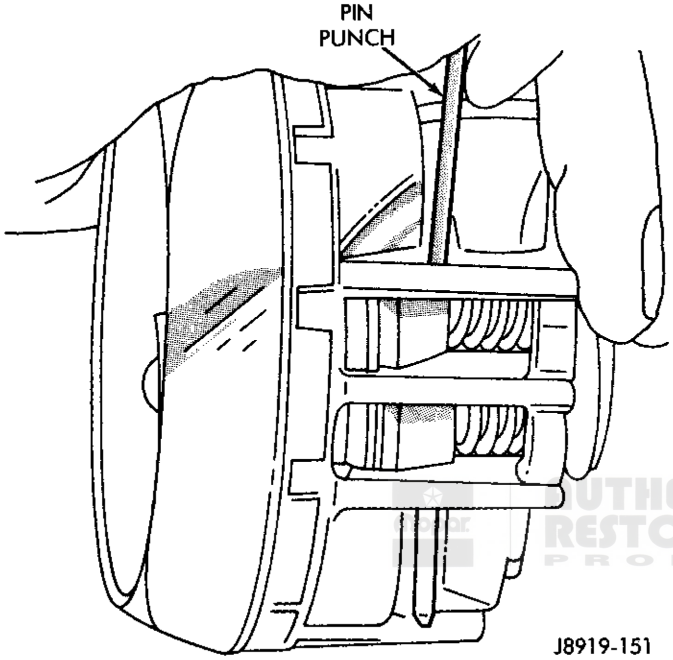


Fig. 59 Lock Shoe Pin Removal

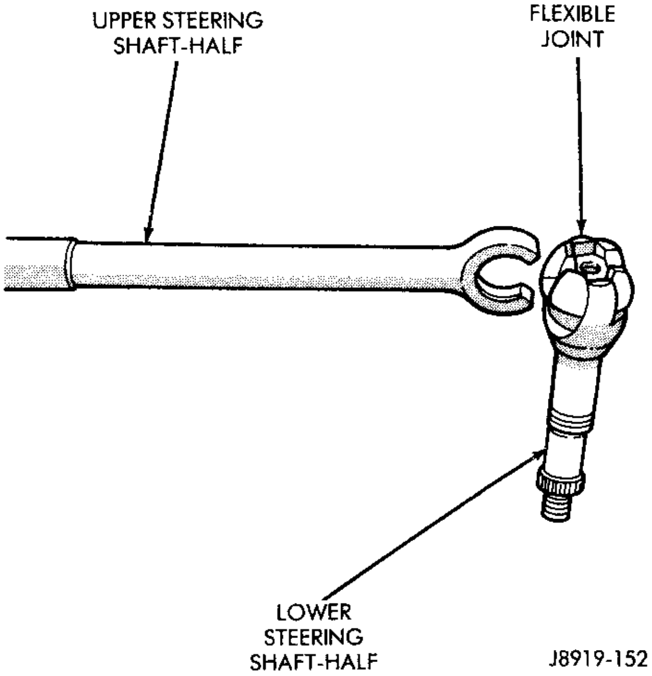


Fig. 60 Steering Shaft Separation

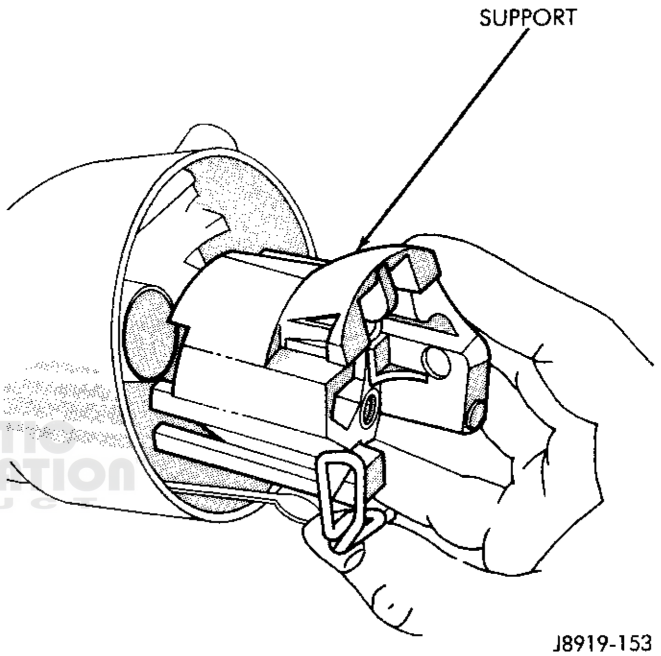


Fig. 61 Steering Column Support Removal

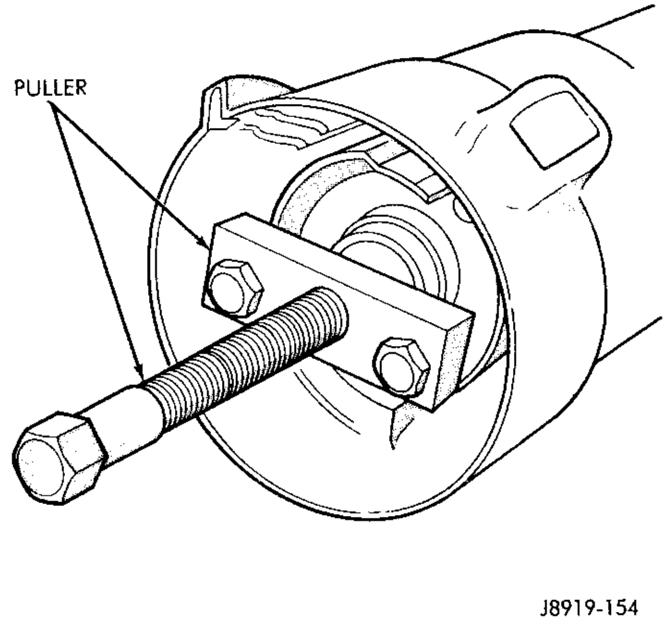


Fig. 62 Shift Tube Removal

Assembly

WARNING: Use only the original or exact replacement screws, bolts and nuts to assemble the steering column. Incorrect screw or bolt length could prevent the column from compressing from impact (i.e., front-end collision). All the fasteners that are used for assembly must be tightened with the correct torque to ensure that the energy-absorbing (compression) action of the column is maintained. The bolts and nuts that are used to attach the column and bracket to the instrument panel must also be tightened with the correct torque to ensure that the bracket will breakaway from impact.

CAUTION: Apply chassis lubricant to all the bearing, thrust and friction producing mating surfaces before assembly.

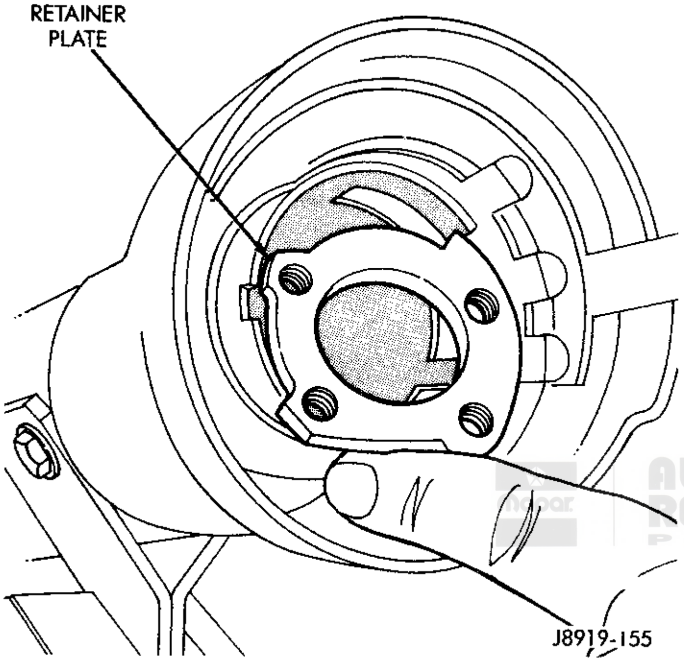


Fig. 63 Retainer Plate Removal

Column Shift Only

(1) Install the shift bowl on the steering column jacket.

(2) Install the shift tube spring, the wave washer and the retainer plate in the shift bowl.

(3) Insert the shift tube through the lower end of the steering column jacket and align the tube key/spline with the shift bowl keyway.

(4) Insert the appropriate installation tools in the shift tube. The "spring-loaded" lower foot of the tool must engage the shift tube inner shoulder and the tool guide must be "seated" in the shift tube (Fig. 65).

(5) Tighten the nut on the stud (Fig. 65) only enough to obtain a "snug fit" against the spring tension.

(6) Remove the nut and place the receiver installation tool over the stud (Fig. 66).

(7) Install the nut and tighten it to force the shift tube into the shift bowl (Fig. 66).

(8) Remove the shift tube installation tools.

(9) Install the shift tube thrust washer and the retainer plate "snap" ring.

(10) Install the lower bearing in the steering column.

(11) Position the shift gate in the steering column support and install the attaching screws.

(12) Position the steering column support in the steering column.

(13) Install all the steering column support attaching screws "finger-tight". Next, tighten the screws alternately and evenly with 7 N•m (60 in-lbs) torque.

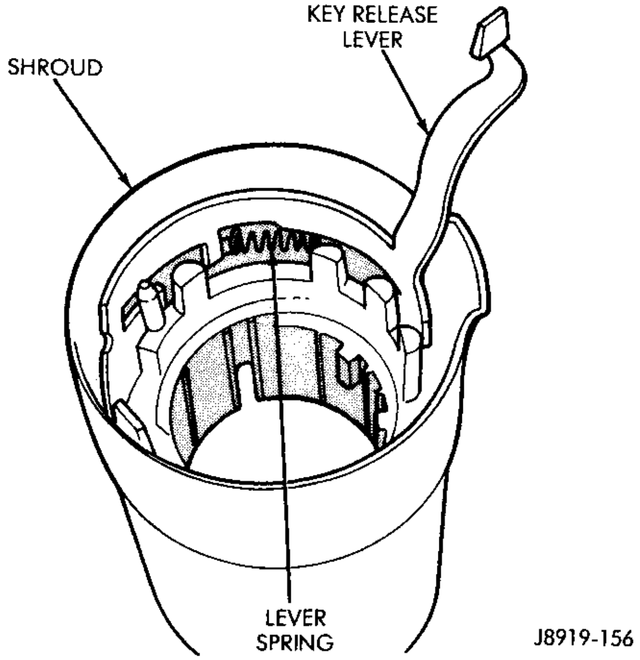


Fig. 64 Key-Release Lever & Spring Removal

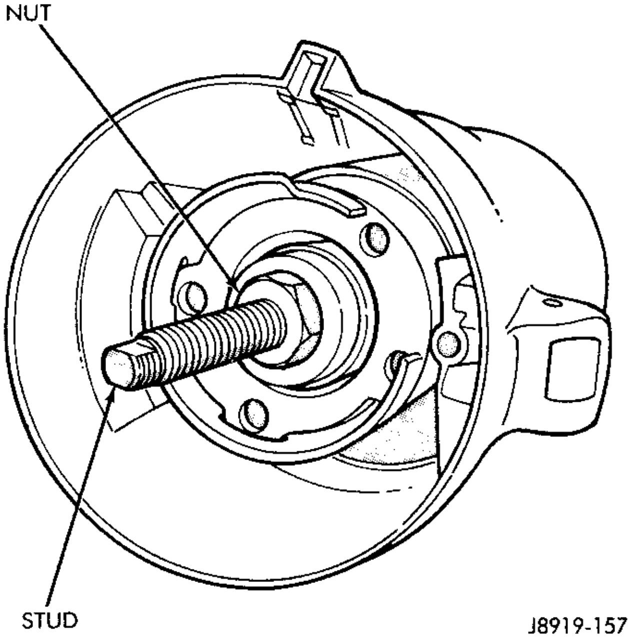


Fig. 65 Shift Tube Installation Tools

(14) Install the remote rod in the steering column support. Route the rod through the upper end of the shroud and insert it into the rod slot located in the support.

(15) Install the dimmer switch and the ignition switch.

(16) Install the steering shaft in the steering column.

(17) Install replacement races and bearings in the key/lock cylinder, if removed. **Ensure that the bearings are lubricated with chassis lubricant before installation.**

(18) Install the lock shoes, the lock shoe springs and the lock shoe pin the key/lock cylinder housing. Use a 4.5-mm (0.18-in) diameter rod to align the shoes and the pin during installation.

(19) Install the tilt-release lever, the lever spring and the lever pin in the key/lock cylinder housing. Insert a wedge between the housing and the lever to relieve the spring tension and to allow easier release lever pin installation.

(20) Install the lock bolt in the key/lock cylinder housing and engage it in the lock sector cam surface.

(21) Install the lock rack, the rack "preload" spring and a replacement shim in the key/lock cylinder housing. The square block tooth on the lock rack must mate with the square block tooth on the lock sector.

(22) Install the lock spring and the spring retaining screw. Tighten the screw with 4 N•m (35 in-lbs) torque.

(23) Align and install the assembled key/lock cylinder housing on the steering column support. Retain the lock shoes in the disengaged position for easier housing installation.

(24) Align the pivot pin holes in the key/lock cylinder housing with those in the steering column support and insert the pivot pins. **Press the housing firmly downward when inserting the pivot pins to prevent damaging the holes in the support.** When the pivot pins are within both the housing and the support holes, "seat" them fully with a punch and a hammer.

(25) Insert the tilt-release lever in the key/lock cylinder housing and place the housing in the full-upward tilt position.

(26) Lubricate the tilt spring guide and the tilt spring liberally with chassis lubricant and position the spring on the guide.

(27) Insert the tilt spring guide and the spring into the key/lock cylinder housing and install the guide retainer over the spring. Engage the retainer lock tabs with the housing lugs by pressing the retainer downward and turning clockwise with a screwdriver.

(28) Place the cover on the key/lock cylinder housing. Align and install the cover retaining screws. Tighten the screws with 7 N•m (60 in-lbs) torque.

(29) Install the gear selector indicator lamp mounting bracket screw.

(30) Install the gear selector indicator cover and retaining screws.

(31) Route the dimmer switch wire harness and the gear selector indicator wires down through the steering column.

(32) Install the key/lock cylinder in the housing. Rotate the cylinder until the cylinder key is aligned with the keyway in the housing. Press the cylinder inward and install the retaining screw. Tighten the retaining screw with 4.5 N•m (40 in-lbs) torque (Fig. 67).

(33) Insert the ignition key in the cylinder and turn it to the ON position. Install the key warning buzzer switch.

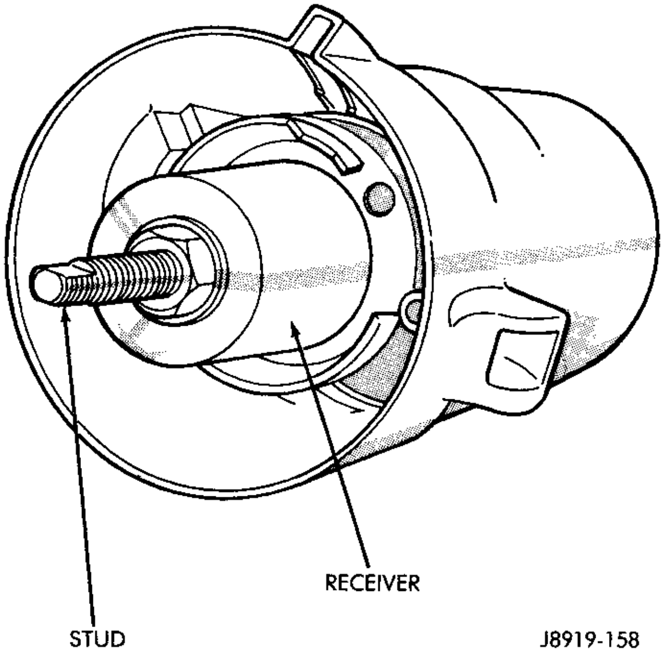


Fig. 66 Shift Tube Installation

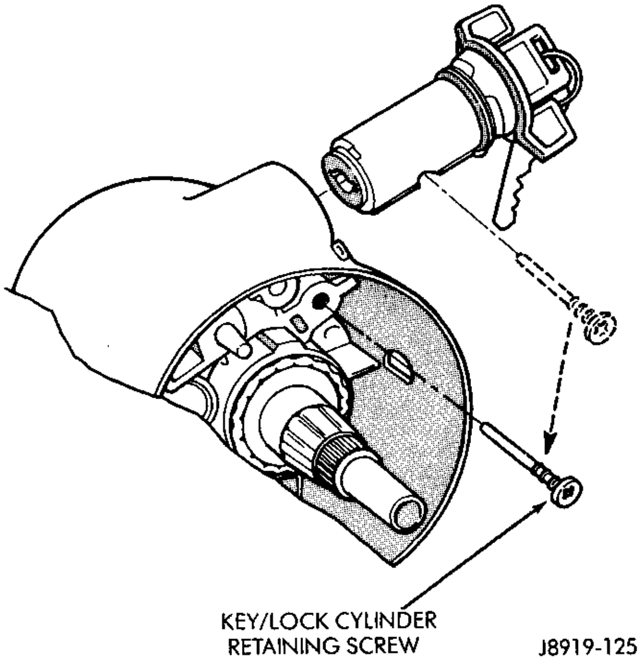


Fig. 67 Key/Lock Cylinder Retaining Screw

(34) Install the turn signal switch. Fold the wires against the connector and route the wire harness and connector down through the steering column and position the switch in the key/lock cylinder housing. **Do not** install the switch retaining screws at this time.

(35) Install the windshield wiper wire harness and switch. Route the wire harness down through steering column jacket.

(36) If equipped, route the cruise control wire harness into and through the steering column jacket. Install the turn signal/wiper/dimmer switch/cruise control (if equipped) stalk by pushing it straight into the column.

(37) Insert the hazard warning knob in the hazard warning switch and press it inward. Align and install the turn signal switch retaining screws. Ensure that the turn signal switch is properly "seated" before tightening the screws. Tighten the screws with 4 N•m (33 in-lbs) torque. Thread the hazard warning switch knob into the switch and pull the knob outward.

(38) Install and "seat" the upper bearing race in the key/lock cylinder housing.

(39) Install the upper bearing "preload" spring, the canceling cam and the lockplate.

(40) Install a replacement lockplate retaining "snap" ring on the sleeve of a compressor tool and install the tool on the steering shaft (Fig. 68).

(41) Compress the lockplate with the compressor tool and position the retaining "snap" ring in the steering shaft groove.

(42) Remove the compressor tool. Ensure that the retaining ring is completely "seated" in the groove before removing the tool.

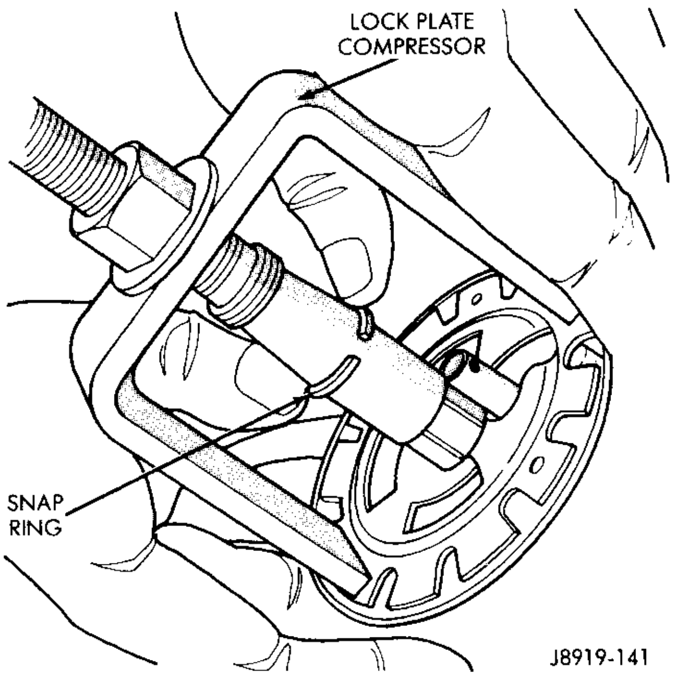


Fig. 68 Lockplate Retaining Ring Installation

(43) Position the wire harness protectors, if equipped, over the wire harnesses and "snap" them in place on the steering column.

(44) Install the lockplate cover.

(45) Install the gear selector lever and the retaining pin.

(46) Install the steering wheel. Refer to the installation procedure.

(47) Insert the ignition key in the key/lock cylinder; turn the cylinder to the OFF-UNLOCK position ; move the ignition switch downward to eliminate any switch-to-remote rod lash; and tighten the ignition switch attaching screws with 4 N•m (35 in-lbs) torque.

(48) Depress the dimmer switch slightly and insert a 3/32-inch drill bit into the adjustment hole to temporarily prevent horizontal movement of the switch.

(49) Loosen the retaining screws and move the dimmer switch toward the steering wheel to remove any lash from the actuator rod. Tighten the dimmer switch retaining screws with 4 N•m (35 in-lbs) torque.

(50) Remove the drill bit and test the dimmer switch operation by moving the dimmer switch stalk. Test the dimmer switch operation in the full-up, down and center steering wheel positions.

(51) Install the steering column, if applicable. Refer to the installation procedure.

Console Shift Only

(1) Position the key-release lever spring on the lever and install the lever with the spring in the shroud.

(2) Align and install the shroud on the steering column jacket.

(3) Install the retainer plate. Tilt the plate toward the 12 o'clock position, slide it under the steering column jacket opening, and "seat" it in the jacket notches.

(4) Align the steering column jacket V-notch with the corresponding **V** on the support and install the support in the steering column. To completely "seat" the support, press the key-release lever downward while pressing the support into place (Fig. 69).

(5) Install all the support retaining screws "finger-tight". Next, tighten the screws alternately and evenly with 7 N•m (60 in-lbs) torque.

(6) Install the remote rod in the steering column support. Route the rod through the upper end of the shroud and insert it into the rod slot located in the support.

(7) Install the dimmer switch and the ignition switch.

(8) Install the steering shaft in the steering column.

(9) Install replacement races and bearings in the key/lock cylinder, if removed. **Ensure that the bearings are lubricated with chassis lubricant before installation.**

(10) Install the lock shoes, the lock shoe springs and the lock shoe pin the key/lock cylinder housing. Use a 4.5-mm (0.18-in) diameter rod to align the shoes and the pin during installation.

(11) Install the tilt-release lever, the lever spring and the lever pin in the key/lock cylinder housing. Insert a wedge between the housing and the lever to relieve the spring tension and to allow easier release lever pin installation.

(12) Install the lock bolt in the key/lock cylinder housing and engage it in the lock sector cam surface.

(13) Install the lock rack, the rack "preload" spring and a replacement shim in the key/lock cylinder housing. The square block tooth on the lock rack must mate with the square block tooth on the lock sector.

(14) Install the lock spring and the spring retaining screw. Tighten the screw with 4 N•m (35 in-lbs) torque.

(15) Align and install the assembled key/lock cylinder housing on the steering column support. Retain the lock shoes in the disengaged position for easier housing installation.

(16) Align the pivot pin holes in the key/lock cylinder housing with those in the steering column support and insert the pivot pins. **Press the housing firmly downward when inserting the pivot pins to prevent damaging the holes in the support.** When the pivot pins are within both the housing and the support holes, "seat" them fully with a punch and a hammer.

(17) Insert the tilt-release lever in the key/lock cylinder housing and place the housing in the full-upward tilt position.

(18) Lubricate the tilt spring guide and the tilt spring liberally with chassis lubricant and position the spring on the guide.

(19) Insert the tilt spring guide and the spring into the key/lock cylinder housing and install the guide retainer over the spring. Engage the retainer lock tabs with the housing lugs by pressing the retainer downward and turning clockwise with a screwdriver.

(20) Place the cover on the key/lock cylinder housing. Align and install the cover retaining screws. Tighten the screws with 7 N•m (60 in-lbs) torque.

(21) Route the dimmer switch wire harness down through the steering column.

(22) Install the key/lock cylinder in the housing. Rotate the cylinder until the cylinder key is aligned with the keyway in the housing. Press the cylinder inward and install the retaining screw. Tighten the retaining screw with 4.5 N•m (40 in-lbs) torque (Fig. 70).

(23) Insert the ignition key in the cylinder and turn it to the ON position. Install the key warning buzzer switch.

(24) Install the turn signal switch. Fold the wires against the connector and route the wire harness and connector down through the steering column and position the switch in the key/lock cylinder housing. **Do not** install the switch retaining screws at this time.

(25) Install the windshield wiper wire harness and switch. Route the wire harness down through steering column jacket.

(26) If equipped, route the cruise control wire harness into and through the steering column jacket, and install the turn signal/wiper/cruise control stalk by pushing it straight into the column.

(27) Insert the hazard warning knob in the hazard warning switch and press it inward. Align and install the turn signal switch retaining screws. Ensure that the turn signal switch is properly "seated" before tightening the screws. Tighten the screws with 4 N•m (33 in-lbs) torque. Thread the hazard warning switch knob into the switch and pull the knob outward.

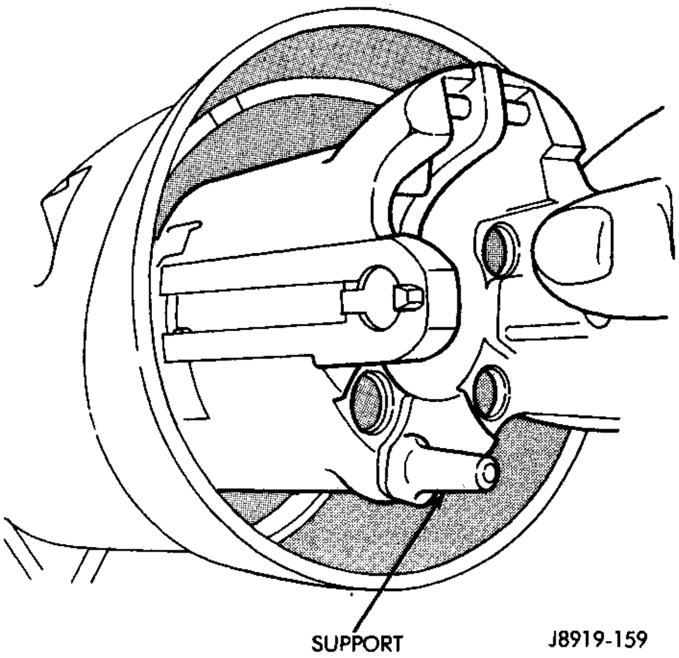


Fig. 69 Steering Column Support Installation

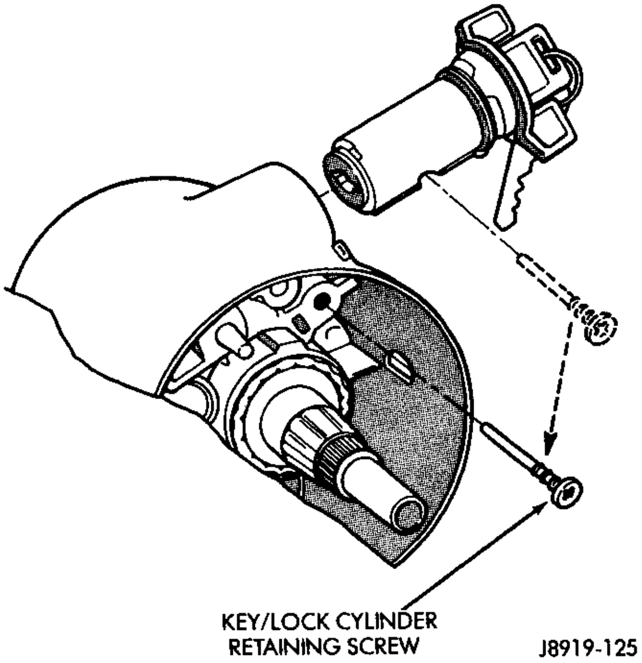


Fig. 70 Key/Lock Cylinder Retaining Screw

(28) Install and "seat" the upper bearing race in the key/lock cylinder housing.

(29) Install the upper bearing "preload" spring, the canceling cam and the lockplate.

(30) Install a replacement lockplate retaining "snap" ring on the sleeve of a compressor tool and install the tool on the steering shaft (Fig. 71).

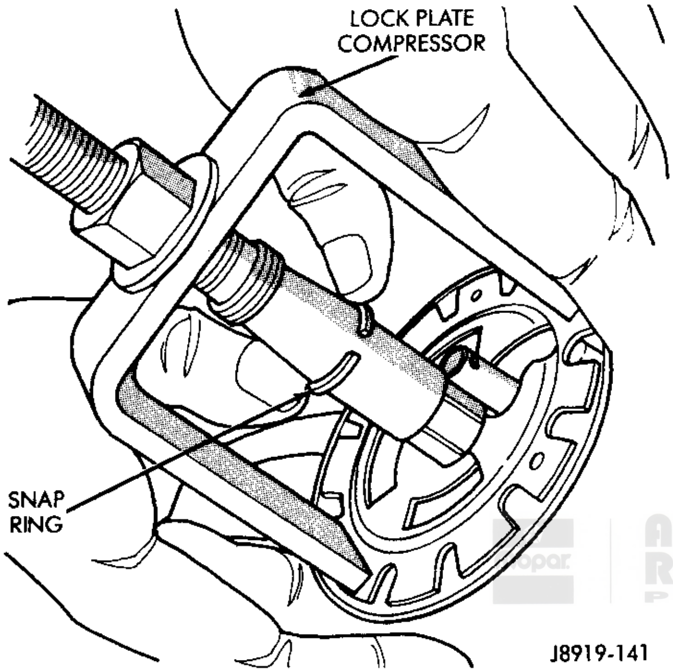


Fig. 71 Lockplate Retaining Ring Installation

(31) Compress the lockplate with the compressor tool and position the retaining "snap" ring in the steering shaft groove.

(32) Remove the compressor tool. Ensure that the retaining ring is completely "seated" in the groove before removing the tool.

(33) Position the wire harness protectors, if equipped, over the wire harnesses and "snap" them in place on the steering column.

(34) Install the lockplate cover.

(35) Install the steering wheel. Refer to the installation procedure.

(36) Insert the ignition key in the key/lock cylinder; turn the cylinder to the OFF-UNLOCK position ; move the ignition switch downward to eliminate any switch-to-remote rod lash; and tighten the ignition switch attaching screws with 4 N•m (35 in-lbs) torque.

(37) Depress the dimmer switch slightly and insert a 3/32-inch drill bit into the adjustment hole to temporarily prevent horizontal movement of the switch.

(38) Loosen the retaining screws and move the dimmer switch toward the steering wheel to remove any lash from the actuator rod. Tighten the dimmer switch retaining screws with 4 N•m (35 in-lbs) torque.

(39) Remove the drill bit and test the dimmer switch operation by moving the dimmer switch stalk. Test the dimmer switch operation in the full-up, down and center steering wheel positions.

(40) Install the steering column, if applicable. Refer to the installation procedure. Tighten the steering wheel retaining nut with 34 N•m (25 ft-lbs) torque.

(41) If disconnected, connect the battery negative cable and, if equipped, reset the clock.

TORQUE SPECIFICATIONS

Component	Set-To-Torque	Recheck Torque
Steering Gear-to-Frame Sill	88 N•m (65 ft-lbs)	75-102 N•m (55-75 ft-lbs)
Pitman Arm-to-Steering Gear	251 N•m (185 ft-lbs)	217-284 N•m (160-210 ft-lbs)
Front Stabilizer Bar-to-Frame Sill	75 N•m (55 ft-lbs)	65-85 N•m (48-62 ft-lbs)
Front Stabilizer Bar-to-Link	36 N•m (27 ft-lbs)	31-42 N•m (23-31 ft-lbs)
Drag Link-to-Pitman Arm	47 N•m (35 ft-lbs)	34-61 N•m (25-45 ft-lbs)
Adjustment Cap Locknut	108 N•m (80 ft-lbs)	102-129 N•m (75-95 ft-lbs)
Return Hose Fitting	28 N•m (21 ft-lbs)	20-36 N•m (15-26 ft-lbs)
Pressure Hose Fitting	28 N•m (21 ft-lbs)	20-36 N•m (15-26 ft-lbs)
Pitman Shaft Cover Bolts	61 N•m (45 ft-lbs)	54-68 N•m (40-50 ft-lbs)
Gear Rack Piston End-Plug	68 N•m (50 ft-lbs)	61-75 N•m (45-55 ft-lbs)
Intermediate Shaft Pinch Bolts	45 N•m (33 ft-lbs)	35-55 N•m (26-40 ft-lbs)
Pressure Hose-to-Pump	28 N•m (21 ft-lbs)	20-36 N•m (15-26 ft-lbs)
Pump-to-Bracket Bolts	38 N•m (28 ft-lbs)	34-37 N•m (25-35 ft-lbs)
Pump Bracket-to-Engine Bolts	45 N•m (33 ft-lbs)	38-52 N•m (28-38 ft-lbs)
Pump Mounting Studs-to-Pump	47 N•m (35 ft-lbs)	68-81 N•m (50-60 ft-lbs)
Pump Union-to-Pump	75 N•m (55 ft-lbs)	72-77 N•m (53-57 ft-lbs)
Alternator Adjustment Bolt	27 N•m (20 ft-lbs)	24-44 N•m (18-33 ft-lbs)
Alternator Pivot Bolt	38 N•m (28 ft-lbs)	25-35 N•m (18-26 ft-lbs)
Pump Pivot Stud Nut	28 N•m (21 ft-lbs)	20-36 N•m (15-26 ft-lbs)
Pump Adjustment Bolt	28 N•m (21 ft-lbs)	20-36 N•m (15-26 ft-lbs)
Pump Adjustment Bracket and Rear Mounting Bracket-to-Water Pump Bolts	40 N•m (30 ft-lbs)	33-47 N•m (24-35 ft-lbs)
Pump Adjustment Bracket-to-Rear Mounting Bracket Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Pump Front Mounting Bracket-to-Pump Bolt	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Pump Front Mounting Bracket (Pivot)-to-Rear Mounting Bracket Bolt and Washer	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Pump Rear Mounting Bracket (Adjustment)-to-Pump Bolt and Washer	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Adjustment Bracket-to-Stud Lock Nut	27 N•m (20 ft-lbs)	20-34 N•m (15-25 ft-lbs)
Ignition Switch-to-Column Screws	4 N•m (35 in-lbs)	
Column Mounting Bracket-to-Instrument Panel Bolts	30 N•m (22 ft-lbs)	25-35 N•m (18-26 ft-lbs)
Toe Plate-to-Dash Panel Nuts	8 N•m (6 ft-lbs)	6-10 N•m (4-7 ft-lbs)
Intermediate Shaft-to-Steering Shaft Retaining Bolts	45 N•m (33 ft-lbs)	35-55 N•m (25-40 ft-lbs)
Steering Shaft Hub Nut	**60 N•m (45 ft-lbs)**	**47-73 N•m (35-55 ft-lbs)**
Column Bracket-to-Column Bolts	28 N•m (21 ft-lbs)	20-40 N•m (15-30 ft-lbs)
Key/Lock Cylinder Retaining Screw	4.5 N•m (40 in-lbs)	

J9019-4

TRANSMISSION-TRANSFER CASE

CONTENTS

AX 4/5 MANUAL TRANSMISSION

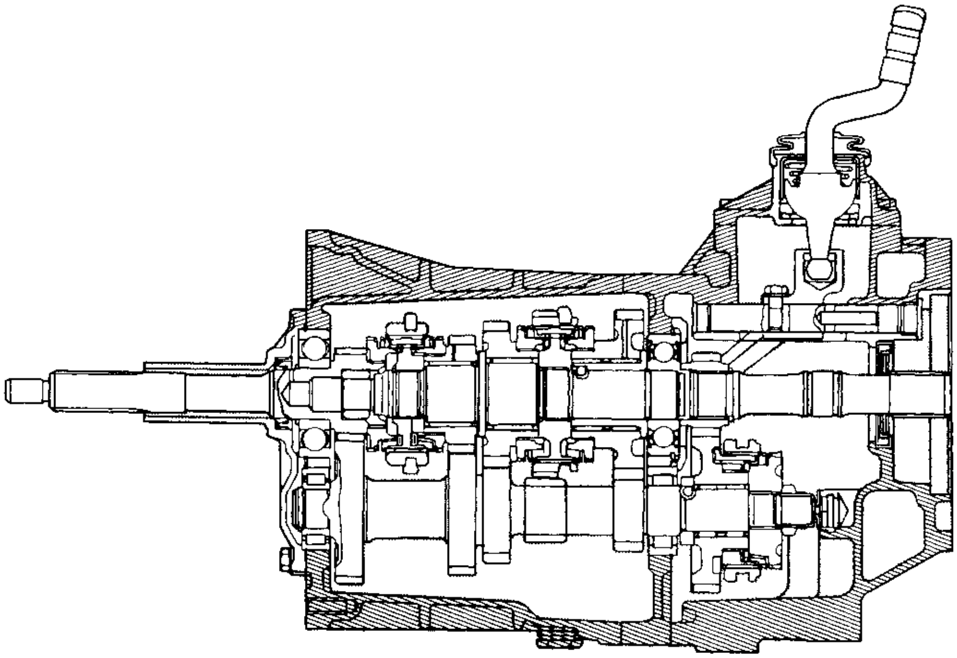
INDEX

GENERAL INFORMATION

The AX 4 is a four speed, synchromesh manual transmission. The AX 5 is a five speed, synchromesh transmission. Fifth gear is an overdrive range with a ratio of .85:1. The shift mechanism in both transmissions is integral and mounted in the shift tower portion of the adapter housing (Fig. 1). The AX 4/5 is used for I-4, 2.5L engine applications.

TRANSMISSION IDENTIFICATION

The AX 4/5 identification code is on the bottom surface of the transmission case near the fill plug (Fig. 2). The first number is year of manufacture (e.g. 9 = 1989). The second and third numbers indicate month of manufacture (e.g. 01 = January, 02 = February, etc.). The next series of numbers is the transmission serial number.



J8921-1

Fig. 1 AX 4/5 Manual Transmission

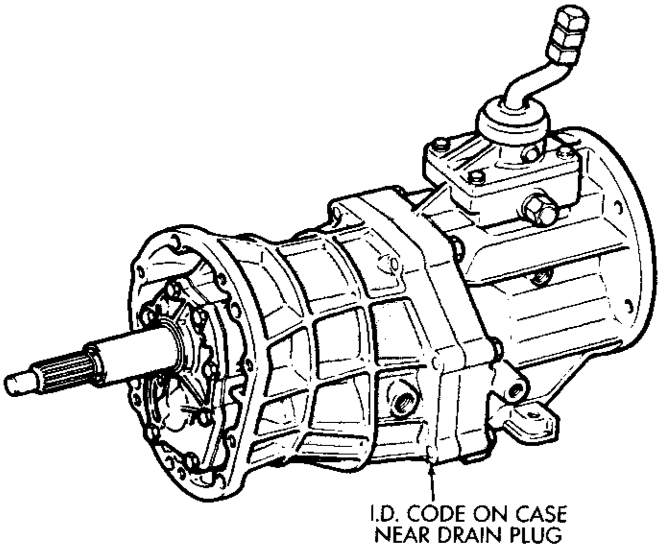


Fig. 2 Transmission Identification

TRANSMISSION SHIFT PATTERN

The AX 4/5 first through fourth gear shift pattern is in a conventional H configuration. Fifth gear is up and to the right and reverse gear is down and to the right (Fig. 3).

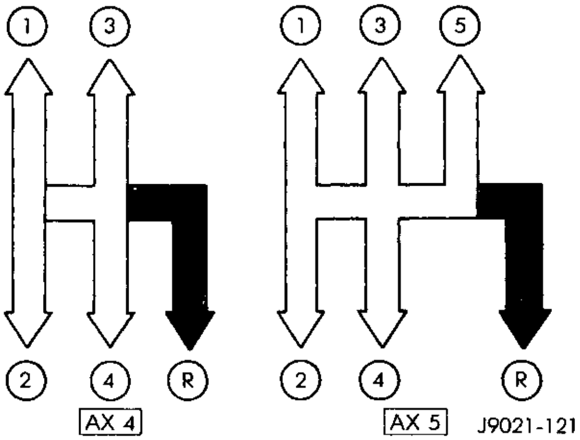


Fig. 3 AX 5 Shift Pattern

TRANSMISSION LUBRICANT

Recommended lubricant for AX 4/5 transmissions is SAE 75W-90, API Grade GL-5 gear lubricant.

Correct lubricant refill or top-off level is to the bottom edge of the fill plug hole.

The fill plug is at the passenger side of the adaptor housing Fig. 4). The drain plug is located at the bottom of the case.

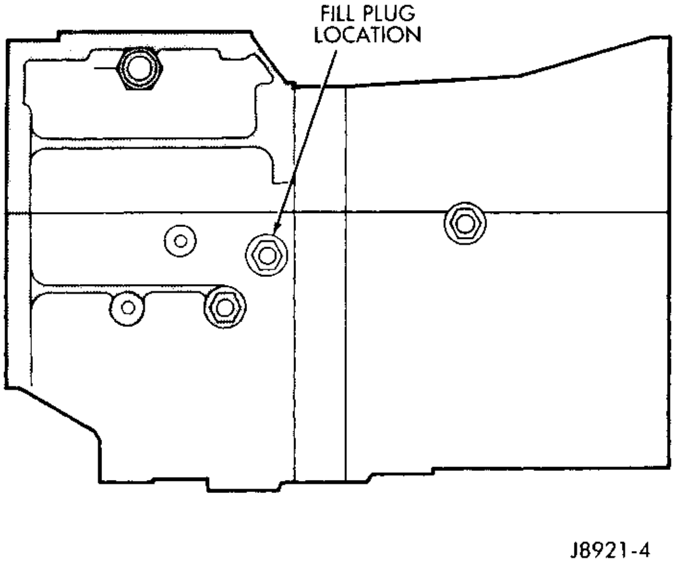


Fig. 4 Fill Plug Location

TRANSMISSION REMOVAL/INSTALLATION—AX 4/5

Removal

(1) Shift transmission into first or third gear. Then raise vehicle on hoist.

(2) Support engine with adjustable jack stand. Be sure to position wood block between jack and oil pan.

(3) Remove rear crossmember.

(4) Disconnect transmission shift linkage, speedometer cable, transfer case vacuum lines and clutch hydraulic lines.

(5) Lower transmission-transfer case assembly no more than 3 inches for access to shift lever.

(6) Reach up and around transmission case and unseat shift lever dust boot from transmission shift tower (Fig. 5). Move boot upward on shift lever for access to retainer that secures lever in shift tower.

(7) Disengage shift lever from transmission. Reach up and around transmission case and press shift lever retainer downward with your fingers. Turn retainer counterclockwise to release it. Then lift lever and retainer out of shift tower (Fig. 5). **Do not remove the shift lever from the floorpan boots. Leave the lever in place for later transmission installation.**

(8) Mark front and rear propeller shafts for installation alignment. Then remove shafts.

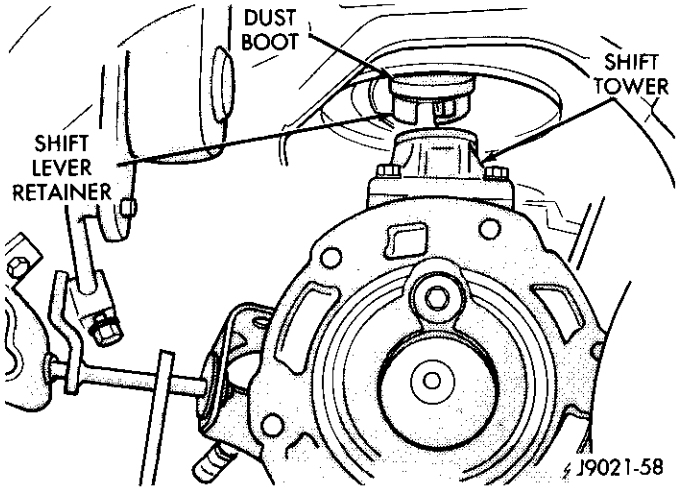


Fig. 5 Removing/Installing Shift Lever

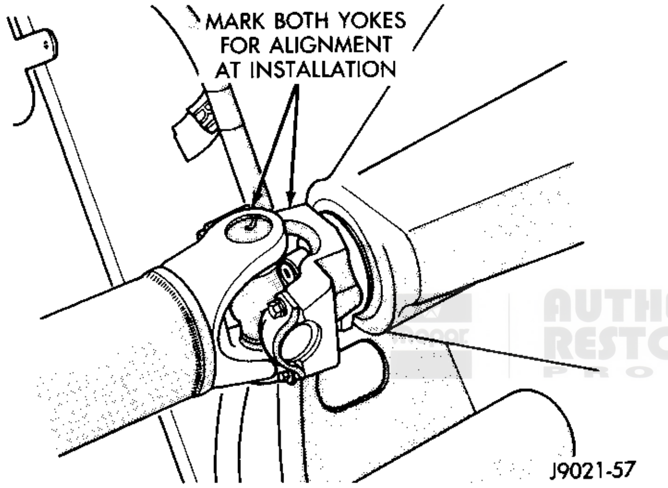


Fig. 6 Mark Propeller Shaft And Axle Yoke For Assembly Alignment

(9) Disconnect engine speed timing sensor (Fig. 7).

(10) Disconnect transmission and transfer case vent hoses.

(11) Disconnect clutch master cylinder hydraulic line from concentric bearing inlet line (Fig. 7).

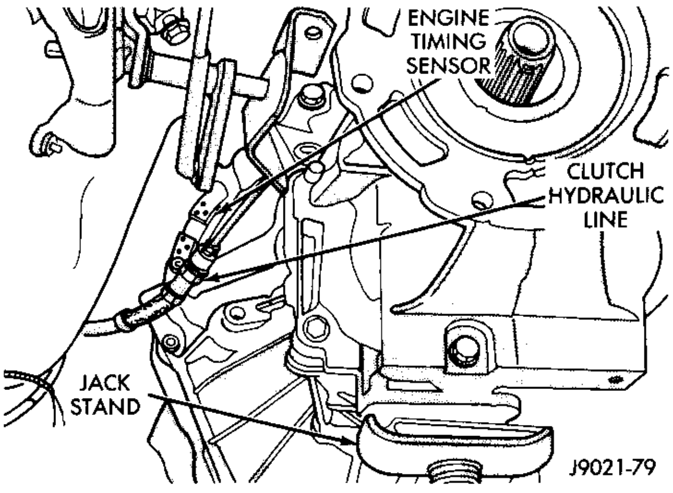


Fig. 7 Hydraulic Line And Timing Sensor Location

(12) Support transmission-transfer case assembly with a transmission jack. Secure assembly to jack with safety chains.

(13) Remove clutch housing brace rod on 4-cylinder models.

(14) Remove clutch housing-to-engine bolts and remove transmission-transfer case assembly.

(15) Remove bolts attaching transmission to transfer case and separate components.

(16) Remove concentric bearing and clutch housing from transmission.

Installation

(1) Shift transmission into first or third gear.

(2) Install clutch housing on transmission. Tighten housing bolts to 27 ft-lbs (37 N•m) torque.

(3) Install concentric bearing. Secure bearing to mounting pin with new retainer clip.

(4) Mount transmission on transmission jack.

(5) Lightly lubricate pilot bearing and transmission input shaft splines with Mopar high temperature grease.

(6) Align transmission input shaft and clutch disc splines and install transmission.

(7) Install and tighten clutch housing-to-engine bolts to 28 ft-lbs (38 N•m) torque. **Be sure the housing is properly seated on engine block before tightening bolts.**

(8) Lower transmission no more than 3 inches for access to shift tower. Be sure transmission is in first or third gear.

(9) Reach up and around transmission and insert shift lever in shift tower. Press lever retainer downward and turn it clockwise to lock it in place. Then install lever dust boot on shift tower.

(10) Connect concentric bearing hydraulic line and connect engine timing sensor wires.

(11) Remove jack from under transmission and mount transfer case on jack.

(12) Align transfer case and transmission shafts and install transfer case. Tighten transfer case-to-transmission nuts/bolts to 26 ft-lbs (35 N•m) torque.

(13) Remove jack stand from under engine and reposition jack under transmission. Then remove transmission jack.

(14) Connect transfer case vacuum hoses and linkage.

(15) Connect transmission and transfer case vent hoses.

(16) Connect backup light switch switch wires.

(17) Connect speedometer cable.

(18) Install rear crossmember. Tighten crossmember-to-frame bolts to 30 ft-lbs (41 N•m) torque. Tighten transmission-to-rearsupport bolts/nuts to 33 ft-lbs (45 N•m) torque.

(19) Align and install front/rear propeller shafts. Tighten shaft U-joint clamp bolts to 170 in-lbs (19N•m)torque.

(20) Top off transmission and transfer lubricant levels and lower vehicle.

TRANSMISSION OVERHAUL—AX 4/5

INDEX

TRANSMISSION DISASSEMBLY

Adapter Housing—Front Bearing Retainer Removal

(1) Drain transmission lubricant.

(2) Remove concentric bearing.

(3) Remove clutch housing bolts and remove housing.

(4) On 2WD models, remove extension housing seal (Fig. 8).

(5) Remove detent spring and ball. Remove detent plug (Fig. 9) and remove detent spring and ball with pencil magnet.

(6) Remove adapter housing bolts (Fig. 10).

(7) Remove shift arm set bolt (Fig. 11) and remove bolt and lockplate.

(8) Remove shift lever shaft plug (Fig. 12). Then pull shaft out with large magnet.

(9) Remove adapter housing by tapping it with a plastic mallet.

(10) Remove front bearing snap rings (Fig. 13).

(11) Remove front bearing retainer and intermediate plate by tapping them withplastic mallet (Fig. 14).

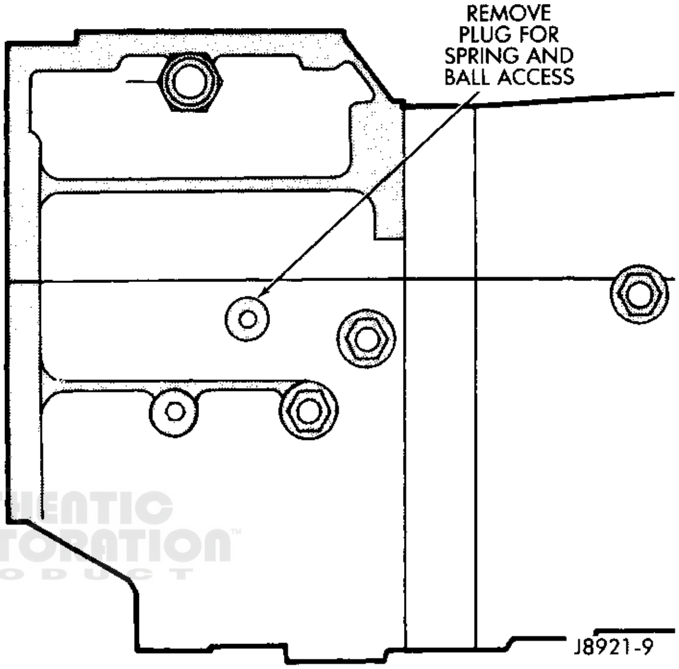


Fig. 9 Detent Ball Plug Location

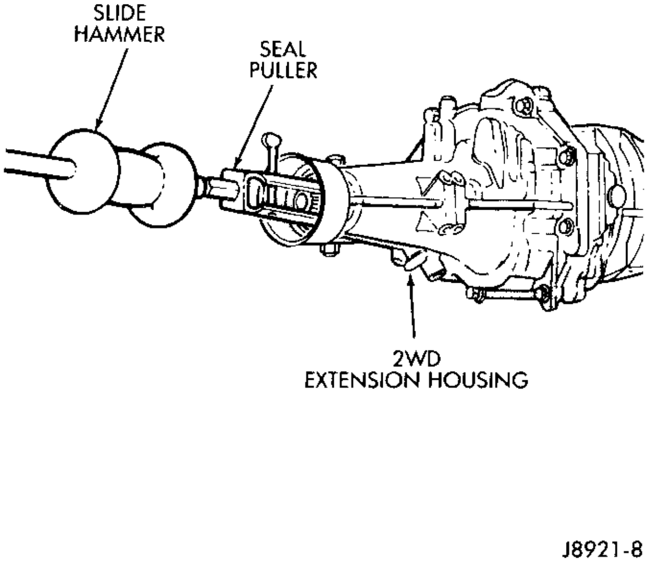


Fig. 8 Removing 2WD Extension Housing Seal

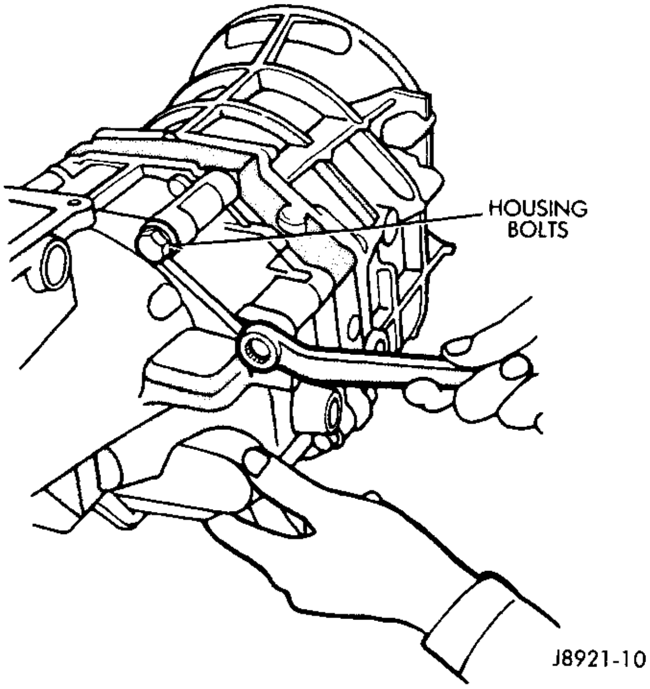


Fig. 10 Removing Adapter Housing

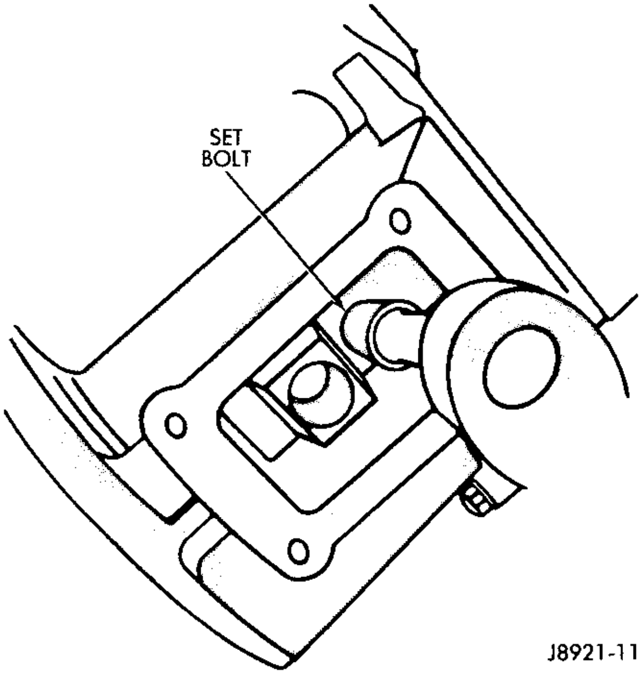


Fig. 11 Set Bolt Removal

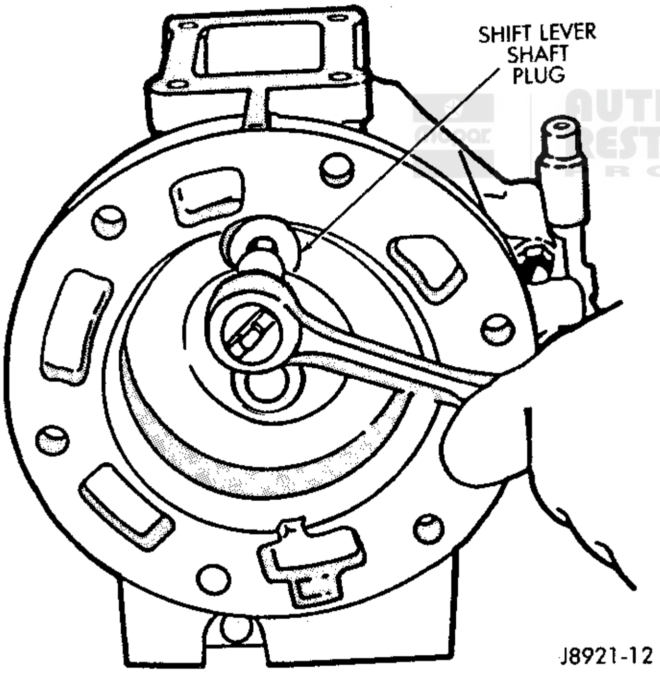


Fig. 12 Removing Shift Lever Shaft Plug

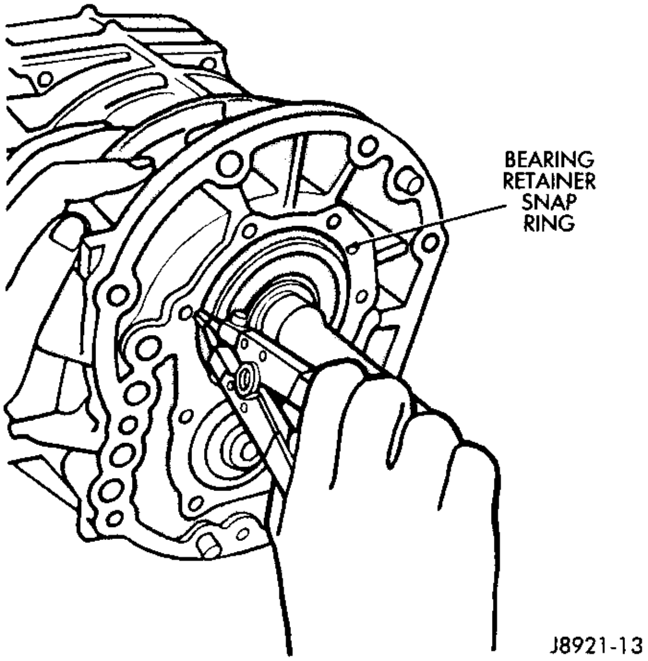


Fig. 13 Removing Bearing Retainer Snap Ring

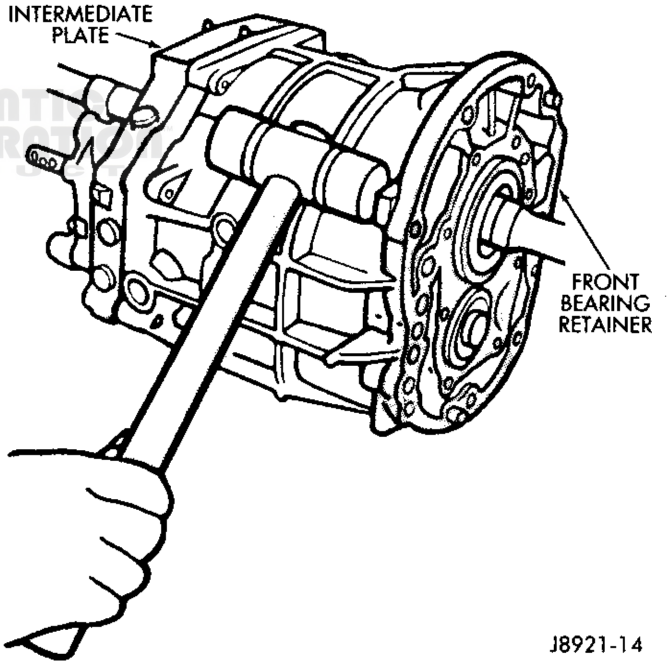


Fig. 14 Removing Bearing Retainer And Intermediate Plate

Shift Mechanism Disassembly

(1) Install two clutch housing bolts and spare washers in intermediate plate (Fig. 15). Then clamp plate and gear assembly in vise. **Use enough washers to prevent bolts from touching. Also be sure vise jaws are clamped on bolt heads (Fig. 15).**

(2) Remove threaded plugs from intermediate plate. Then remove lock ball and spring from plug holes with a pencil magnet (Fig. 16).

(3) Remove shift fork pins with punch and hammer (Fig. 17).

(4) Remove shift rail C-rings (Fig. 18).

(5) Pull No. 4 shift rail outward and remove lock balls and pin (Fig. 19).

(6) Remove No. 4 shift rail, fifth gear and No. 3 shift fork (Fig. 20).

(7) Pull No. 5 shift rail and shift head out of plate (Fig. 21).

(8) Remove shift rail No.3. **Catch interlock pins as rail is removed (Fig. 22).**

(9) Remove No. 1 shift rail and interlock pin (Fig. 23).

(10) Remove shift rail No. 2 and shift forks 1 and 2 (Fig. 24).

(11) Remove reverse idler gear and shaft (Fig. 25).

(12) Remove reverse shift arm and fork (Fig. 26).

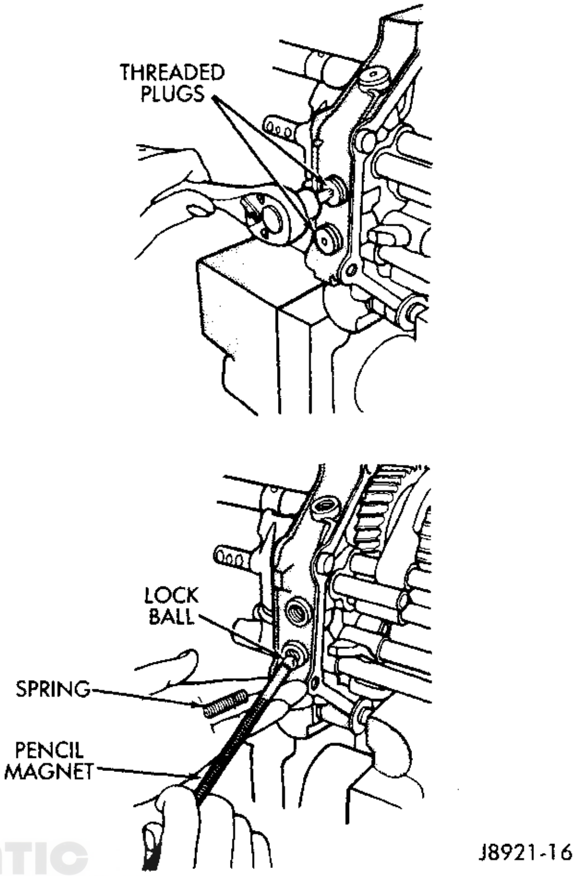


Fig. 16 Removing Lock Ball And Spring

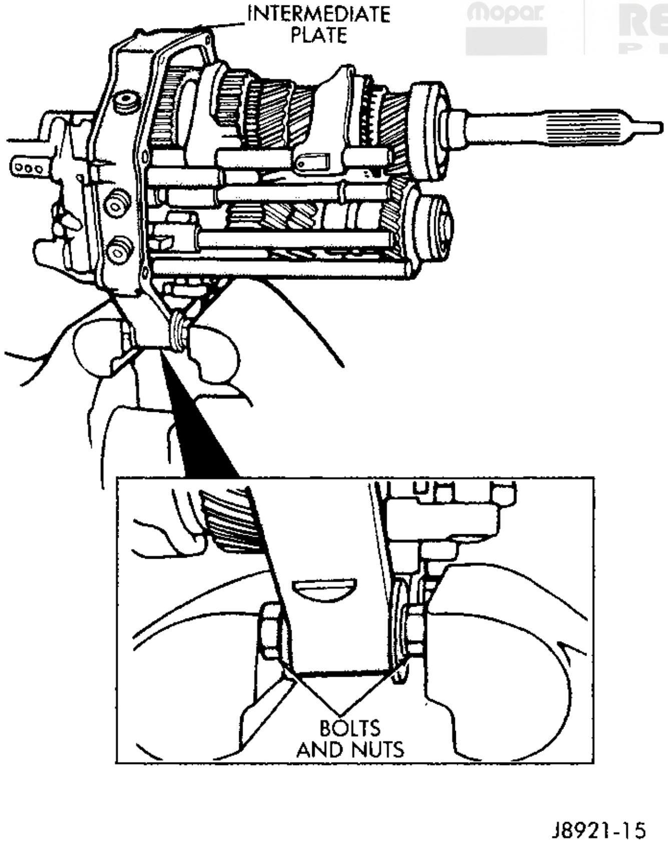


Fig. 15 Positioning Intermediate Plate In Vise

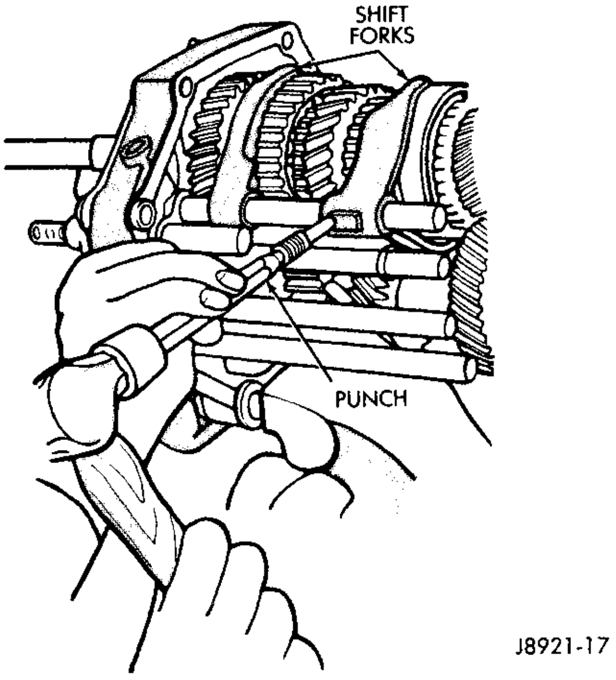


Fig. 17 Removing Shift Fork Pin

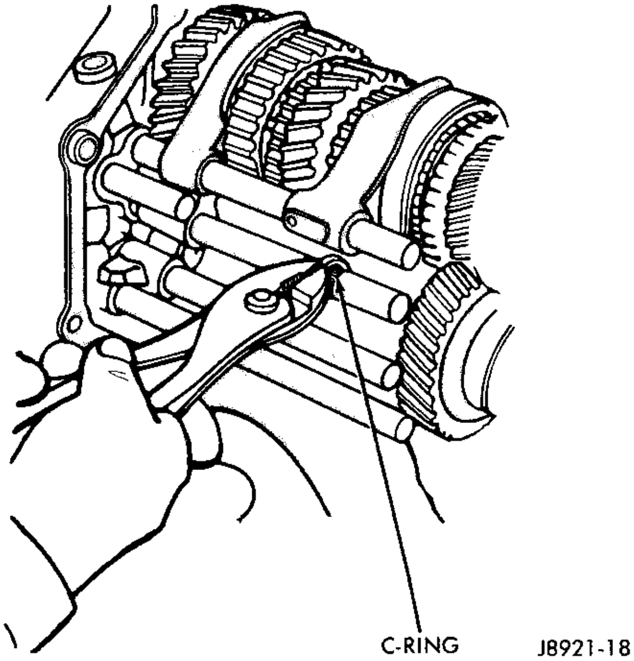


Fig. 18 Shift Rail C-Ring Removal

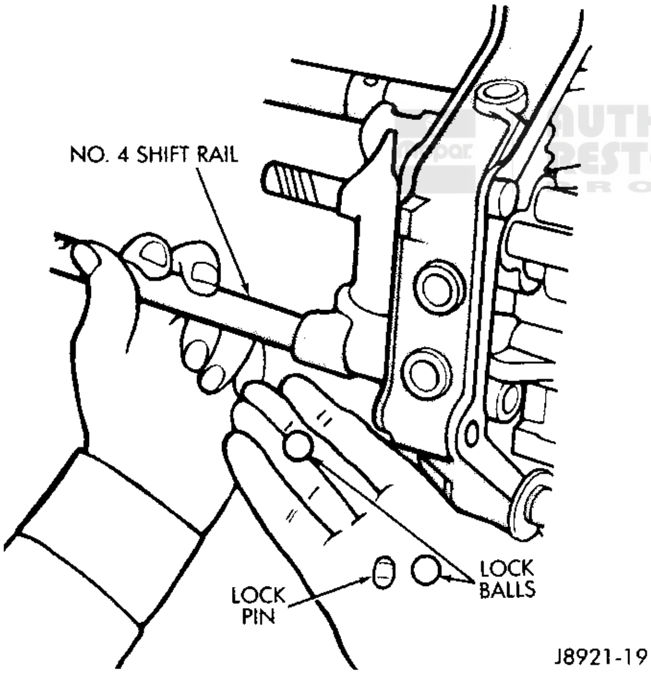


Fig. 19 Removing No. 4 Shift Rail, Lock Balls And Pin

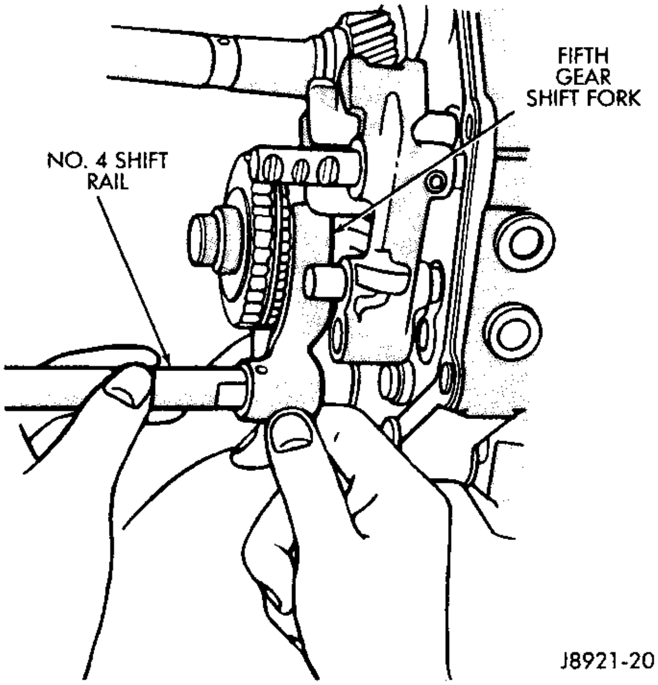


Fig. 20 Removing No. 4 Shift Rail And Fifth Gear Shift Fork

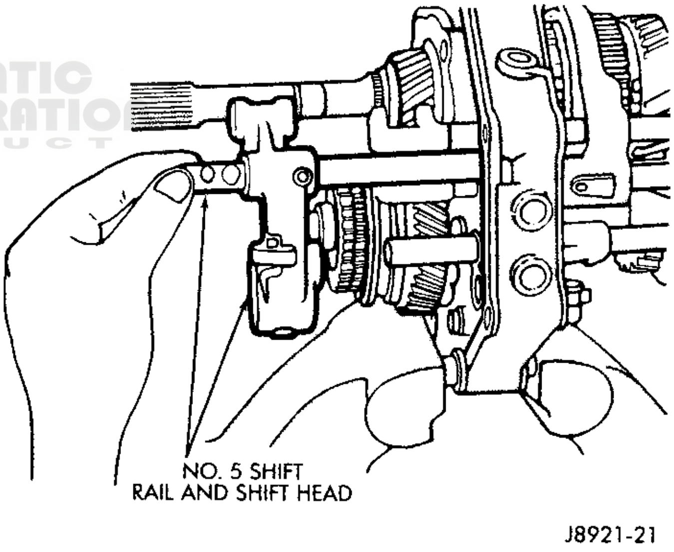


Fig. 21 Removing No. 5 Shift Rail And Shift Head

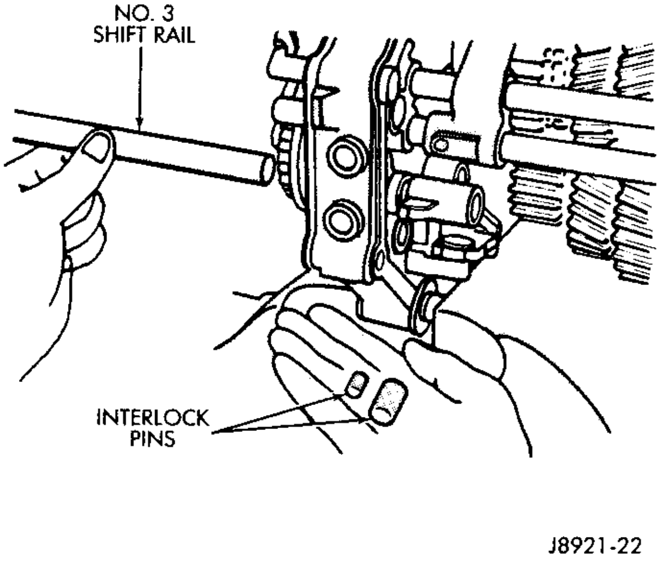
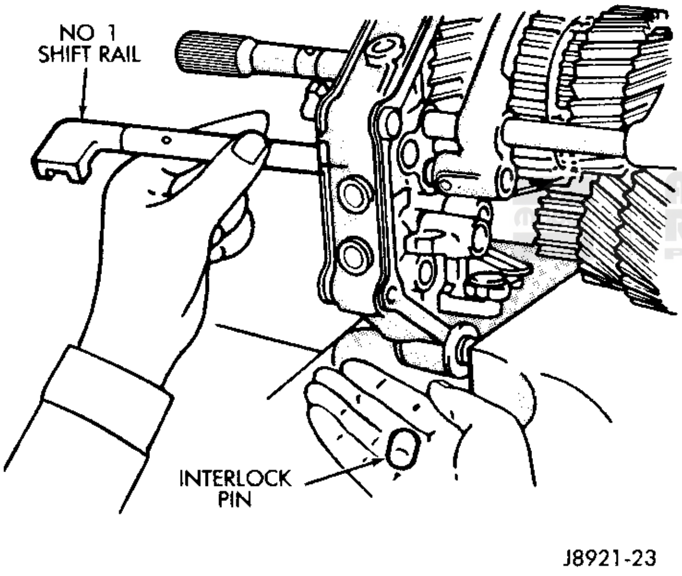


Fig. 22 Removing No. 3 Shift Rail And Interlock Pin



Fig, 23 Removing No. 1 Shift Rail And Interlock Pin

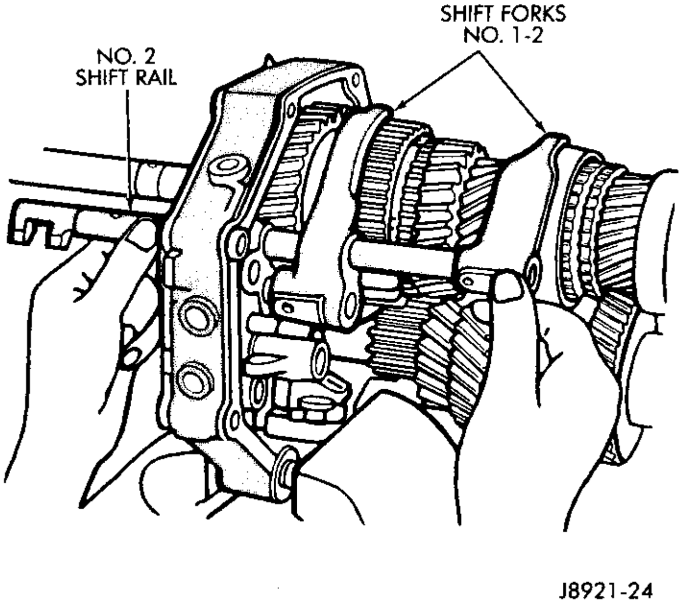


Fig. 24 Removing Shift Forks And No. 2 Shift Rail

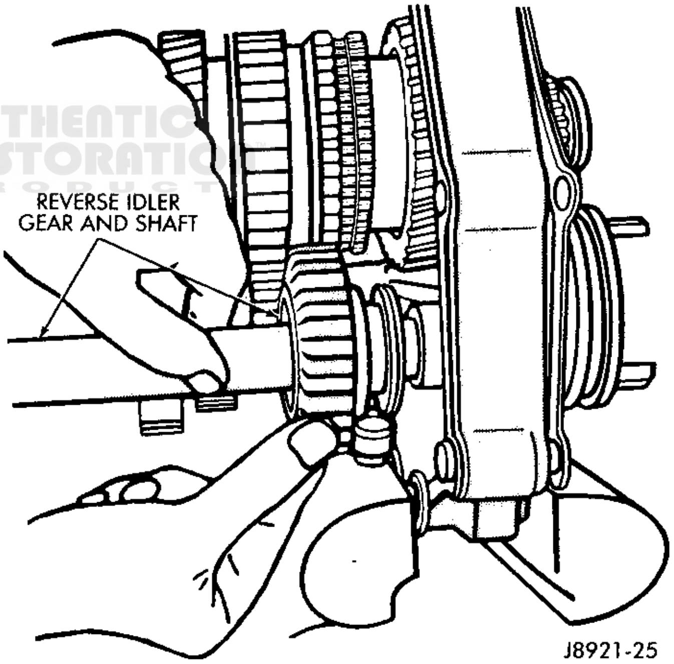


Fig. 25 Removing Reverse Idler Gear And Shaft

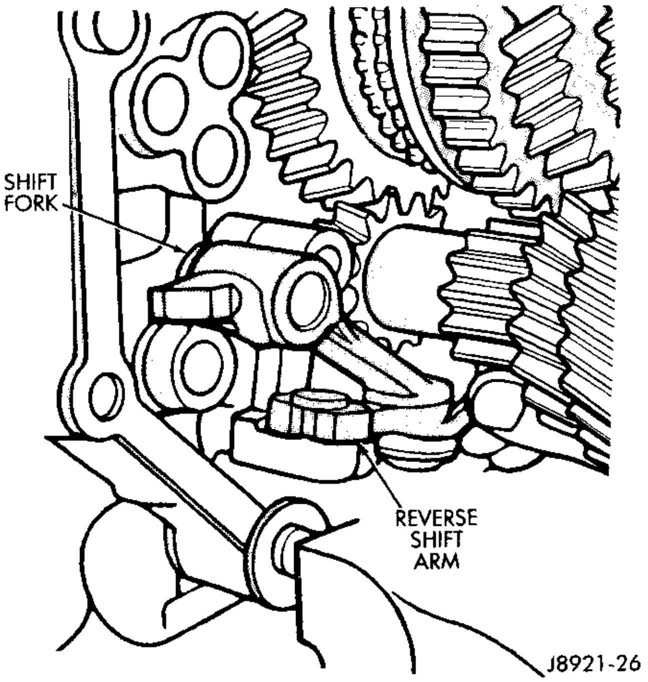


Fig. 26 Reverse Shift Arm Removal

Mainshaft Disassembly

(1) On AX 5, measure fifth counter gear thrust clearance on (Fig. 27). Clearance should be .004 to .012 inch (.10 to.30 mm).

(2) Engage two synchro sleeves to lock mainshaft gears (Fig. 28).

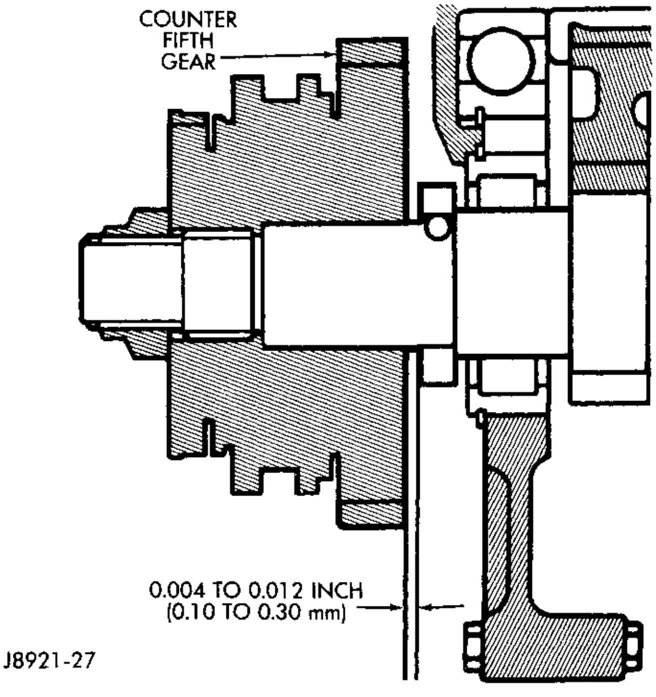


Fig. 27 Measuring AX 5 Counter Fifth Gear Thrust Clearance

(3) On AX 4, remove counter gear nut and slinger. On AX 5, loosen staked part of fifth gear nut with hammer and chisel. Then remove nut with socket (Fig. 29).

(4) Remove fifth spline gear, synchronizer and counter fifth gear with two-jaw puller (Fig. 30).

(5) Remove spacer and remove lock ball with pencil magnet (Fig. 31).

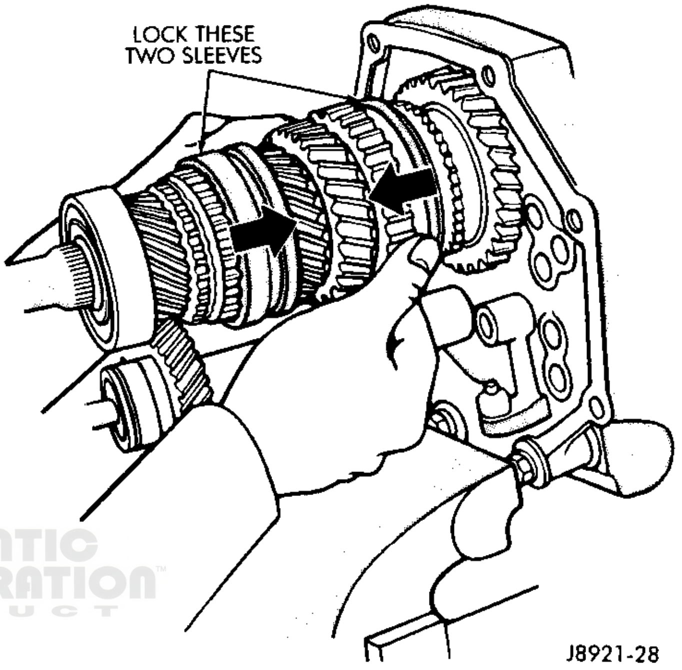


Fig. 28 Locking Mainshaft Gears

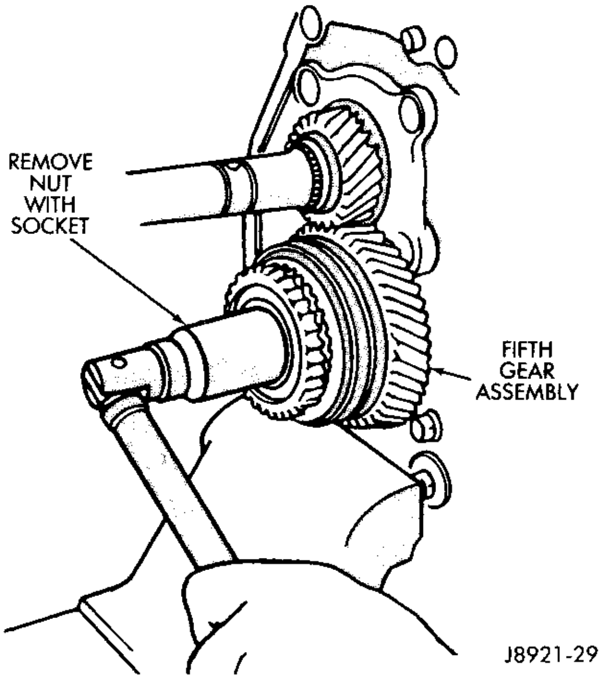


Fig. 29 Removing AX 5 Fifth Gear Nut

(6) Remove reverse shift arm bracket (Fig. 32).

(7) Remove rear bearing retainer bolts with torx bit (Fig. 33) and remove retainer.

(8) Remove rear bearing snap ring (Fig. 34).

(9) Tap the intermediate plate with a plastic mallet and pull the output shaft-counter gear assemblies out of the plate (Fig. 35).

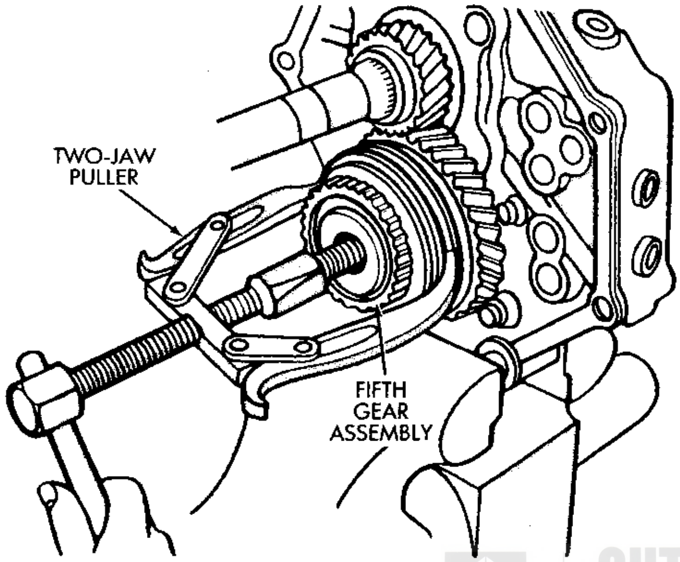


Fig. 30 Removing AX 5 Fifth Gear Assembly

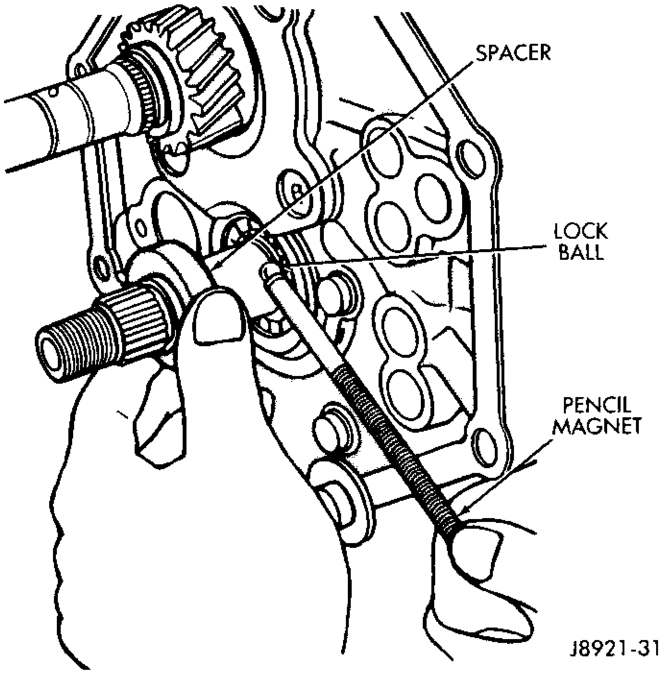


Fig. 31 Spacer And Lock Ball Removal

(10) Remove rear bearing from intermediate plate.

(11) Remove input shaft and shaft roller bearings from output shaft.

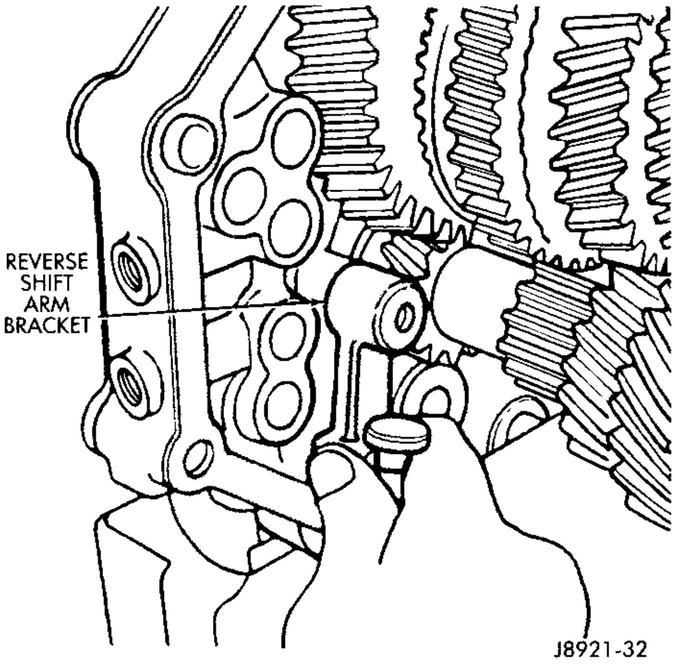


Fig. 32 Removing Reverse Shift Arm Bracket

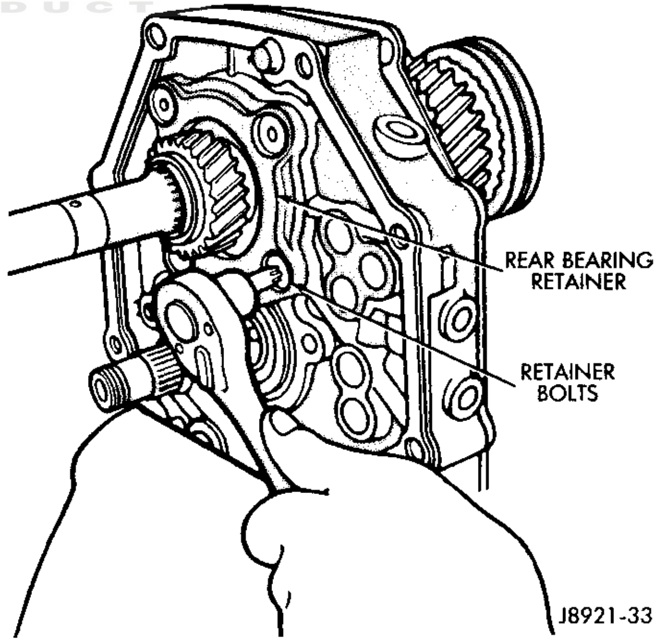


Fig. 33 Removing Rear Bearing Retainer

(12) Measure thrust clearance of output shaft gears (Fig. 36). Clearance should be .10 to .25 mm (.004 to .010 inch) . (13) Remove output shaft fifth gear snap ring with two screwdrivers (Fig. 37).

(14) Press fifth gear, rear bearing, first gear and inner race off output shaft (Fig. 38).

(15) Remove needle roller bearing.

(16) Remove synchronizer ring.

(17) Remove synchronizer lock ball with pencil magnet (Fig. 39). (18) Press 1-2 synchronizer and second gear off output shaft (Fig. 40).

(19) Remove needle roller bearing from the shaft or second gear.

(20) Remove 3-4 synchronizer snap ring (Fig. 41).

(21) Press 3-4 synchronizer and third gear off shaft (Fig. 42).

(22) Remove needle roller bearing from shaft or gear.

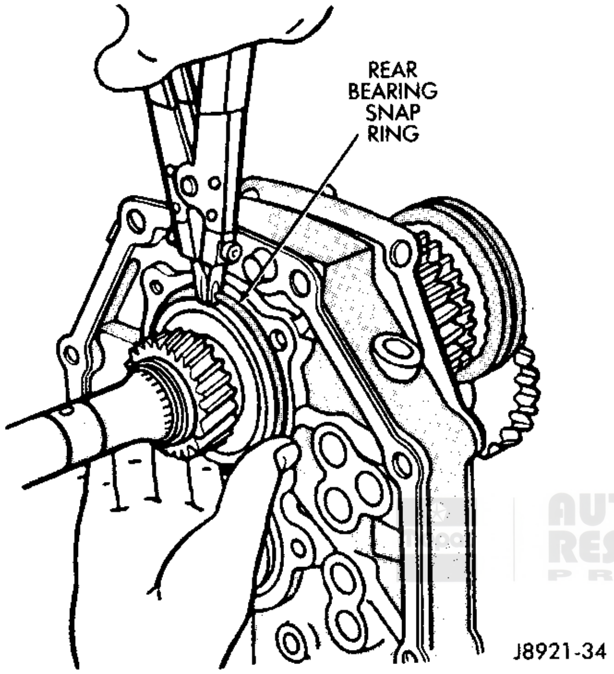


Fig. 34 Removing Rear Bearing Snap Ring

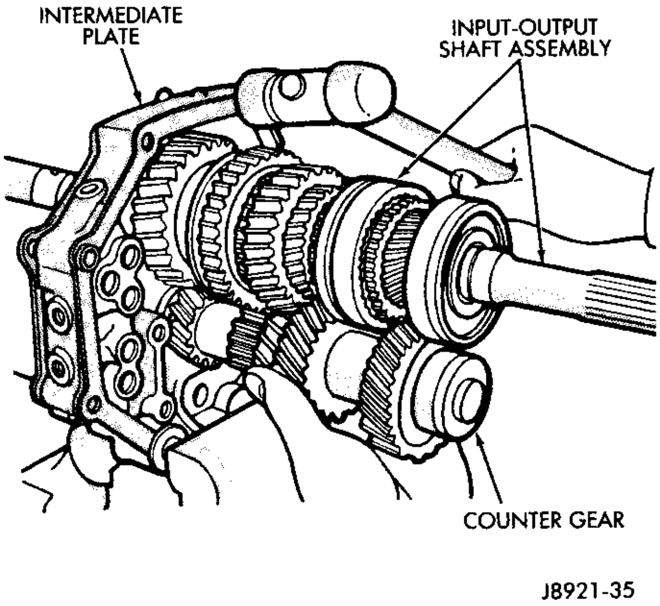


Fig. 35 Removing Counter Gear And Output Shaft

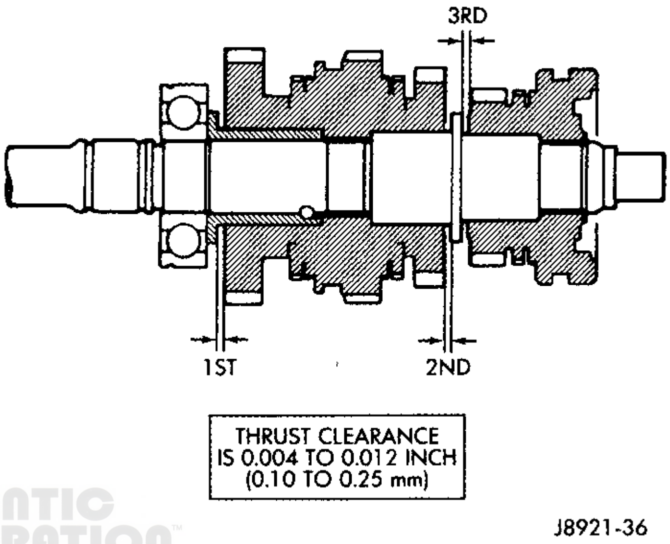


Fig. 36 Checking AX 5 Output Shaft Gear Thrust Clearance

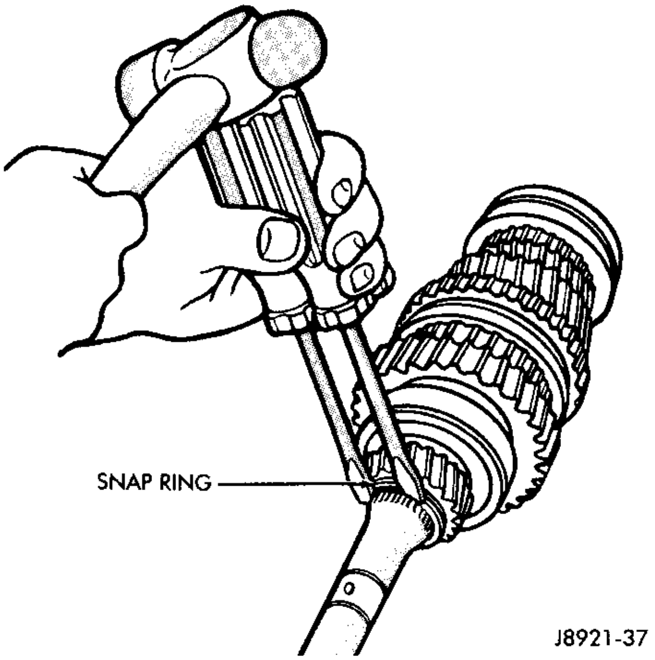


Fig. 37 Removing AX 5 Fifth Gear Snap Ring

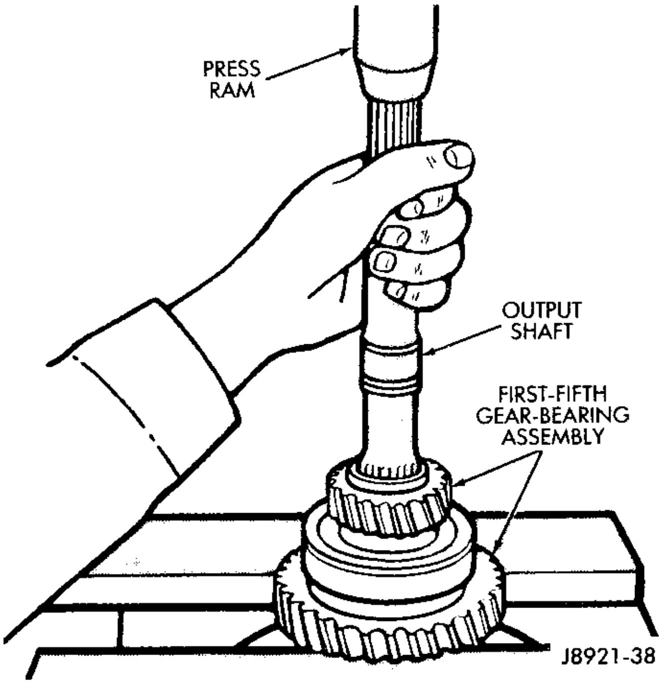


Fig. 38 Removing Fifth Gear And First Gear Bearing And Race

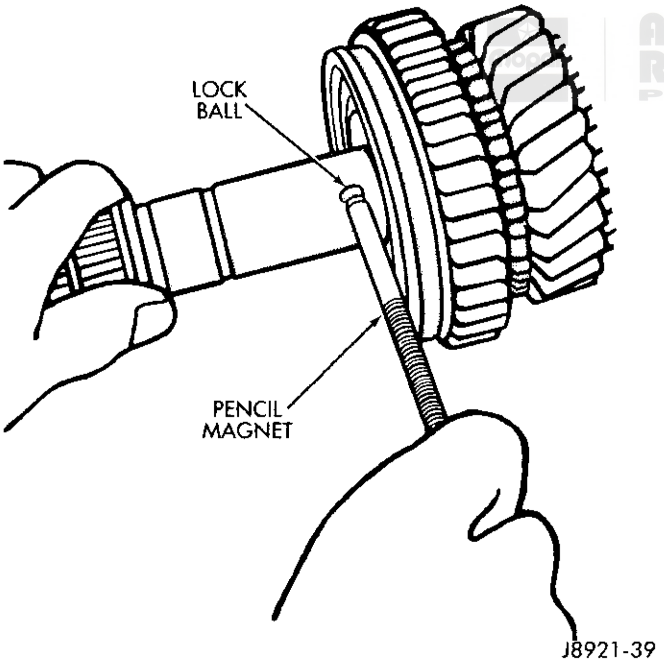


Fig. 39 Synchronizer Lock Ball Removal

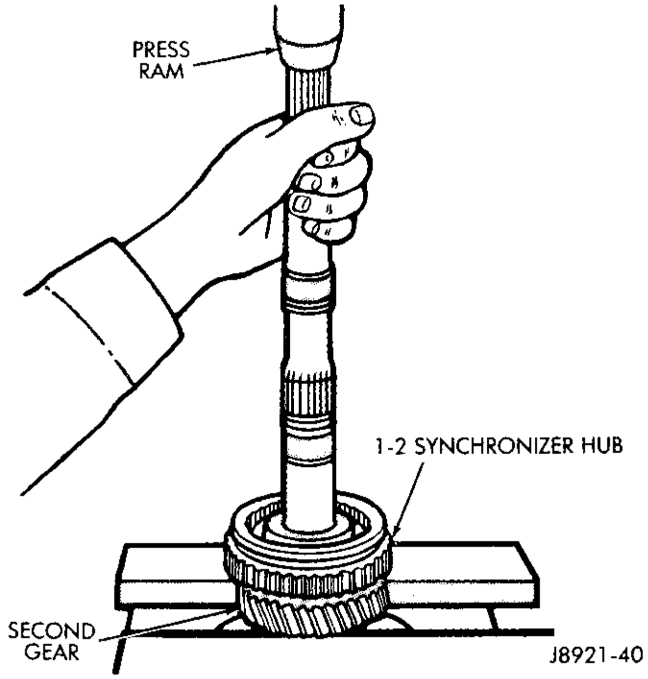


Fig. 40 1-2 Synchronizer And Second Gear Removal

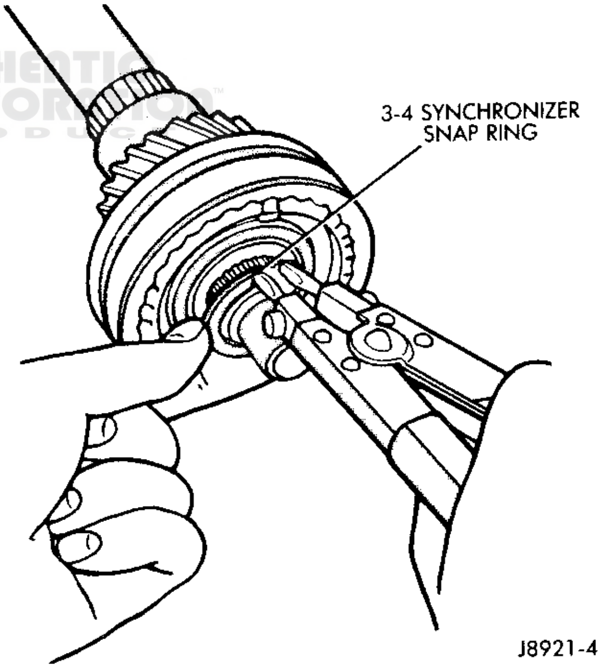


Fig. 41 Removing 3-4 Synchronizer Snap Ring

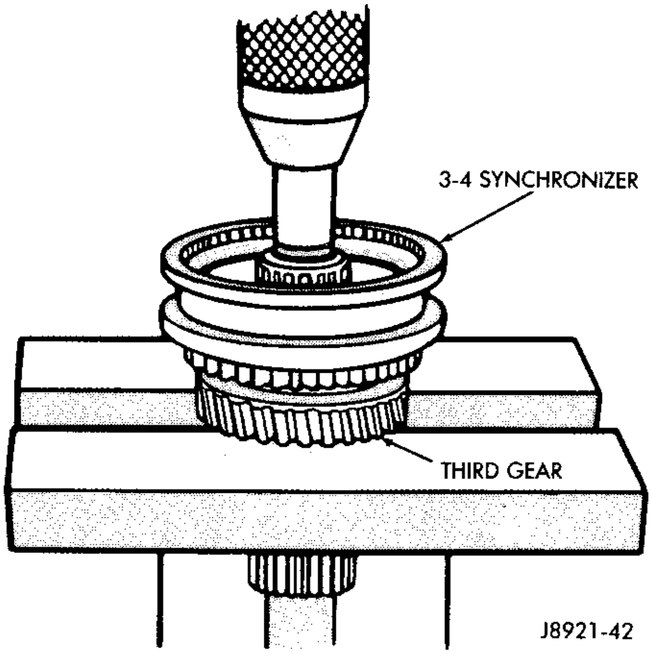


Fig. 42 Removing 3-4 Synchronizer And Third Gear

CLEANING AND INSPECTION

Clean the transmission components in solvent. Dry the cases, gears, shift mechanism and shafts with compressed air. **Dry the bearings with clean, dry shop towels only. Never use compressed air on the bearings. This could cause severe damage to the bearing roller and race surfaces.**

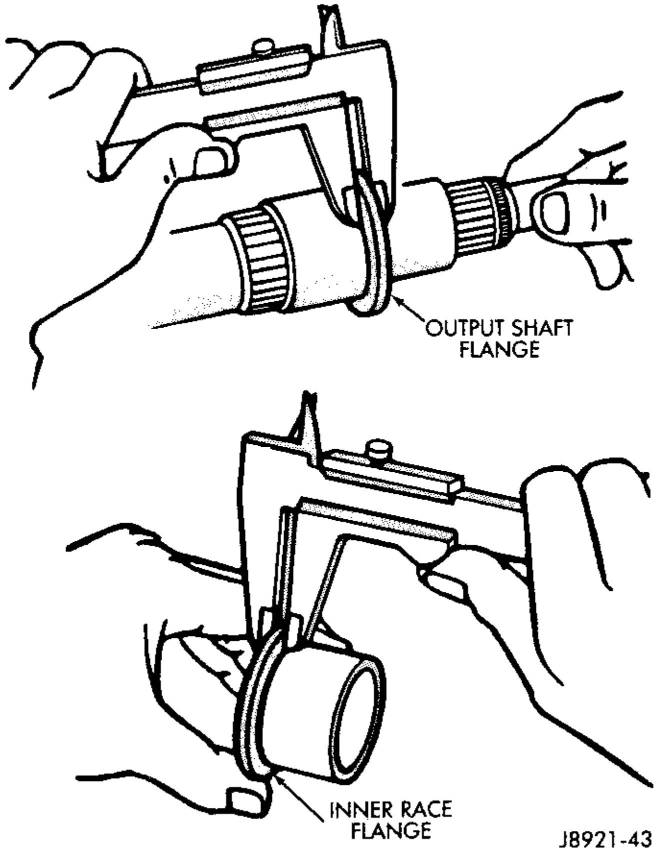


Fig. 43 Checking Flange Thickness

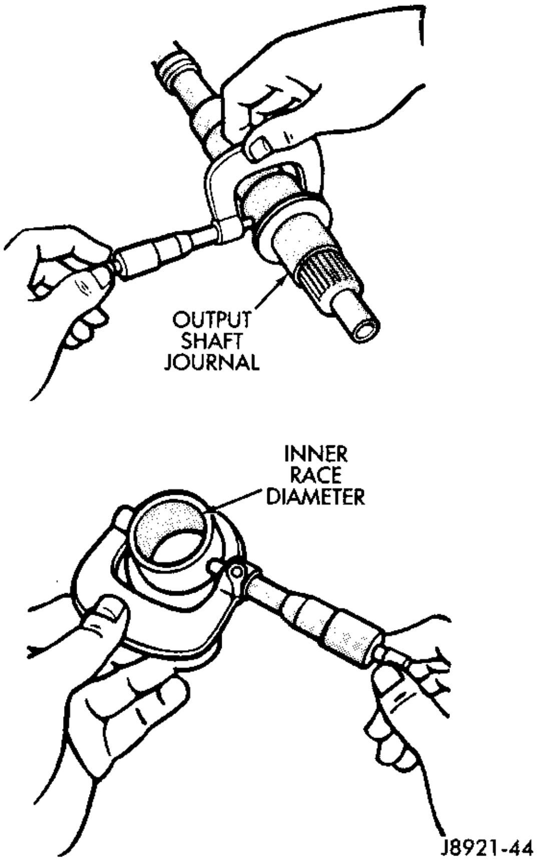


Fig. 44 Checking Shaft And Race Diameters

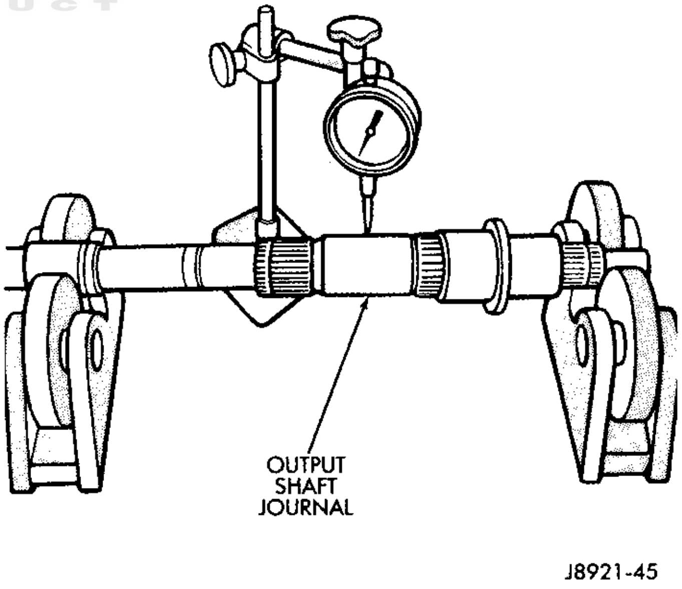


Fig. 45 Checking Output Shaft Runout

Replace any components that are worn, cracked, chipped or damaged in any way.

Inspect the transmission case. Replace the case if cracked or porous or if any of the bearing and gear bores are damaged.

Check thickness of output shaft and inner bearing race flanges with micrometer or vernier calipers (Fig. 43). Minimum thickness for shaft flange is 4.8 mm (.189

in) and 3.99 mm (.157 in) for race flange.

Check diameter of output shaft journal surfaces with micrometer (Fig. 44). Second gear surface minimum diameter is 37.96 mm (1.495 in). Third gear surface minimum diameter is 34.98 mm (1.377 in).

Check output shaft runout with dial indicator (Fig. 45). Replace shaft if runout exceeds .05 mm (.002 in).

Install the needle bearing and inner race in the first gear. Then check oil clearance between the gear and inner race (Fig. 46). Clearance should be .009 to .032 mm (.0004 to .0013 in).

Install the needle bearings and the second, third and counter fifth gears on the output shaft. Check oil clearance between the gears and shaft with a dial indicator (Fig. 47).

Oil clearance for all three gears is .009 to .0013 mm (.0004 to .0013 in).

Check synchronizer ring wear (Fig. 48). Insert each ring in matching gear. Measure clearance between ring and gear with feeler gauge. Replace ring if clearance exceeds 2.0 mm (.078 in).

Measure shift fork-to-synchronizer hub clearance with a feeler gauge (Fig. 49). Replace the fork if clearance exceeds 1.0 mm (.039 in).

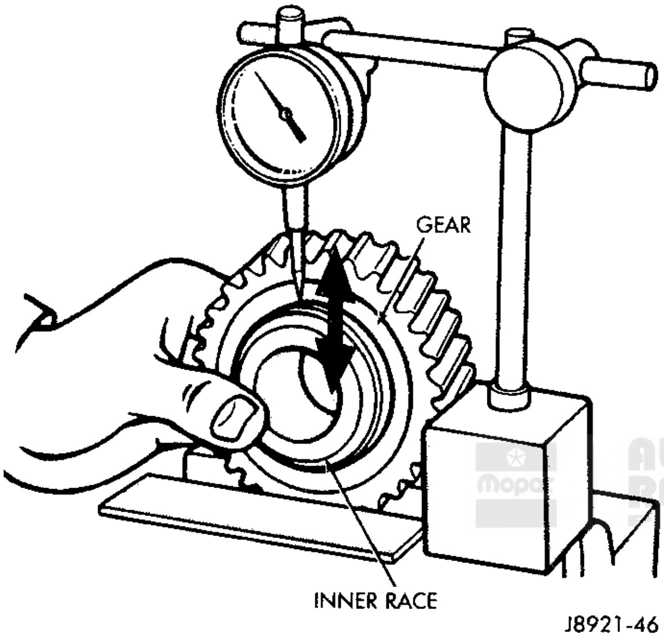


Fig. 46 Checking Gear-To-Race Clearance

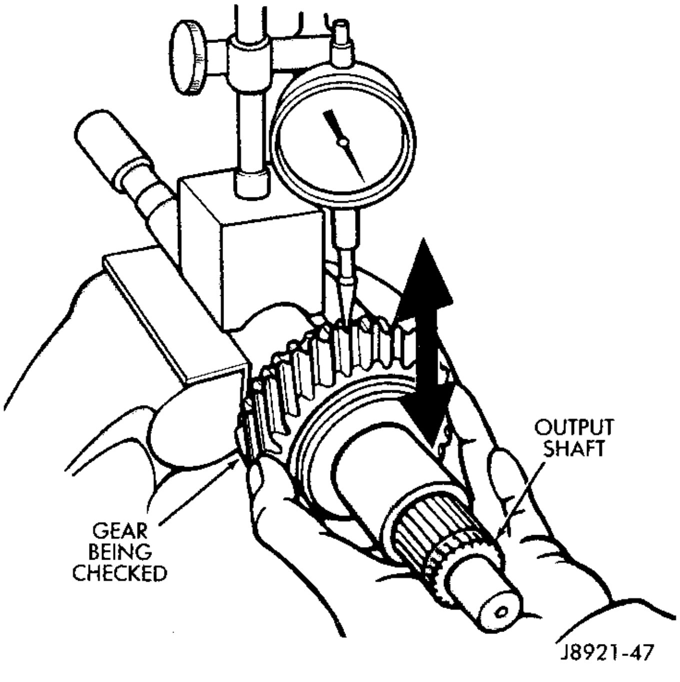


Fig. 47 Checking Gear-To-Shaft Clearance

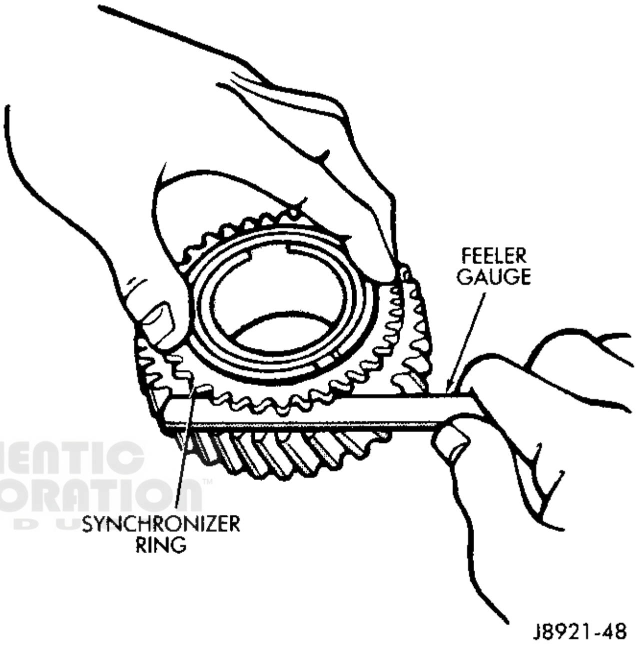


Fig. 48 Checking Synchronizer Ring Wear

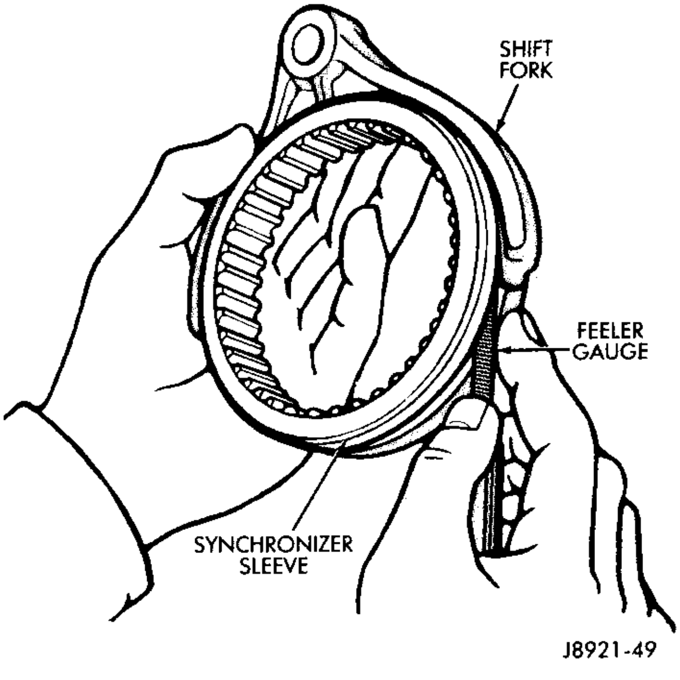


Fig. 49 Checking Fork-To-Hub Clearance

TRANSMISSION ASSEMBLY

Lubricate the transmission components with SAE 75W-90, GL 5 grade gear lubricant during assembly. Use petroleum jelly to lubricate seal lips and/or hold parts in place during installation. Refer to the counter gear comparison chart (Fig. 104) during assembly for AX 4/5 differences.

Output-Input Shaft And Counter Gear Assembly

(1) Press front bearing on shaft (Fig. 50).

(2) Secure front bearing with thickest snap ring that will fit in groove (Fig. 50).

(3) Press front bearing on counter gear. Secure bearing with thickest snap ring that will fit in ring groove (Fig. 51).

(4) Install new oil seals in the front bearing retainer and adapter (Fig. 52). Bearing retainer seal depth is 11.2 to 12.1 mm (.441 to .480 in).

(5) Install reverse shaft and shaft retaining pin in adapter. Then install access hole plug with torx bit (Fig. 53).

(6) Lubricate transmission components with specified gear lubricant.

(7) Assemble the 1-2 and 3-4 synchronizer hubs, sleeves, springs and key inserts (Fig. 54).

(8) Assemble and install third gear, needle bearing, synchronizer ring, 3-4 synchronizer and snap ring on output shaft (Fig. 55). Use thickest snap ring that fits in shaft groove.

(9) Verify third gear thrust clearance with feeler gauge (Fig. 56). Clearance should be .10 to .25 mm (.004 to .010 in).

(10) Assemble second gear, gear needle bearing, synchronizer ring and 1-2 synchronizer. Then press assembly on output shaft (Fig. 57).

(11) Install first gear lock ball in output shaft (Fig. 58).

(12) Assemble first gear, synchronizer ring, gear needle bearing and inner race (Fig. 59). Then install assembly on output shaft. **Rotate inner race until aligned with locking ball.** (13) Press rear bearing on shaft (Fig. 60). Snap ring groove in bearing goes toward rear. Use screwdriver to hold inner race in position when installing bearing (Fig. 60).

(14) Install snap ring on rear bearing.

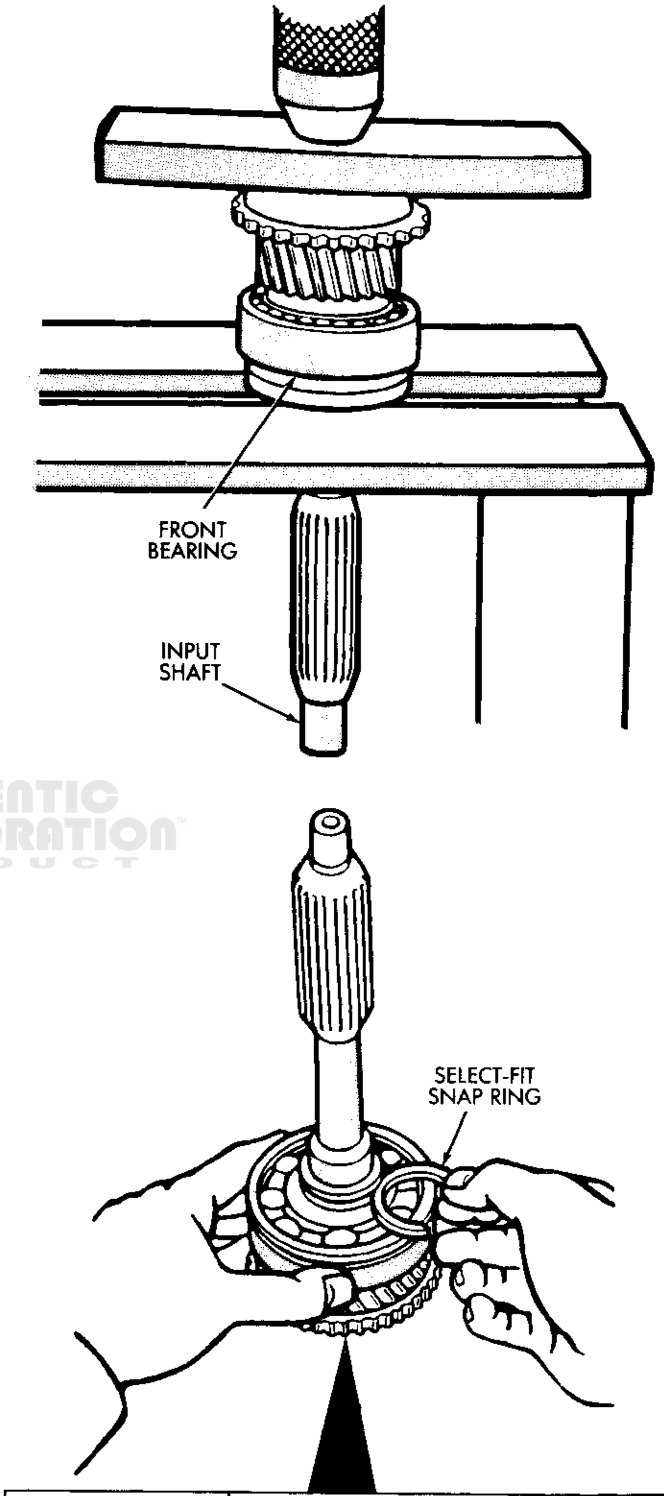
(15) Check first-second gear thrust clearance (Fig. 61). Standard clearance is .10 to .25 mm (.004 to .010 in).

(16) Press fifth gear on output shaft (Fig. 62).

(17) Install fifth gear snap ring (Fig. 63). Use thickest snap ring hat will fit in shaft groove.

(18) Lubricate input shaft roller bearings with petroleum jelly and install rollers in shaft (Fig. 64).

(19) Install output shaft assembly in intermediate plate (Fig. 65). Tap plate with mallet and pull on shaft to seat assembly.



I.D. Mark	Snap Ring Thickness mm (in.)
0	2.05-2.10 (0.0807-0.0827)
1	2.10-2.15 (0.0827-0.0846)
2	2.15-2.20 (0.0846-0.0866)
3	2.20-2.25 (0.0866-0.0886)
4	2.25-2.30 (0.0886-0.0906)
5	2.30-2.35 (0.0906-0.0925)

J8921-50

Fig. 50 Installing Front Bearing And Snap Ring

(20) Install input shaft on output shaft.

(21) Install counter gear in intermediate plate (Fig. 66).

(22) Install rear bearing snap ring and install bearing retainer (Fig. 67). Tighten retainer screws to 18 N•m (13 ft-lbs) torque.

(23) Install reverse shift arm (Fig. 68). Tighten attaching bolt to 18 N•m (13 ft-lbs) torque.

(24) Install lock ball, spacer and needle bearing (Fig. 69) on counter gear.

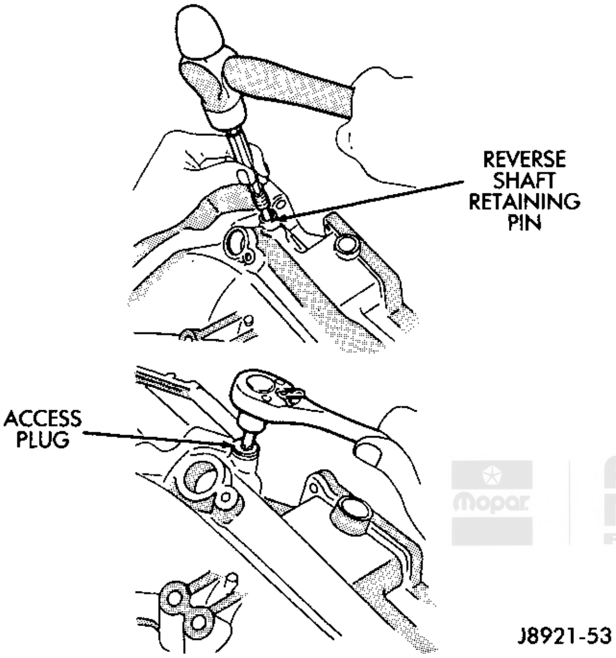


Fig. 53 Installing Reverse Shaft Pin

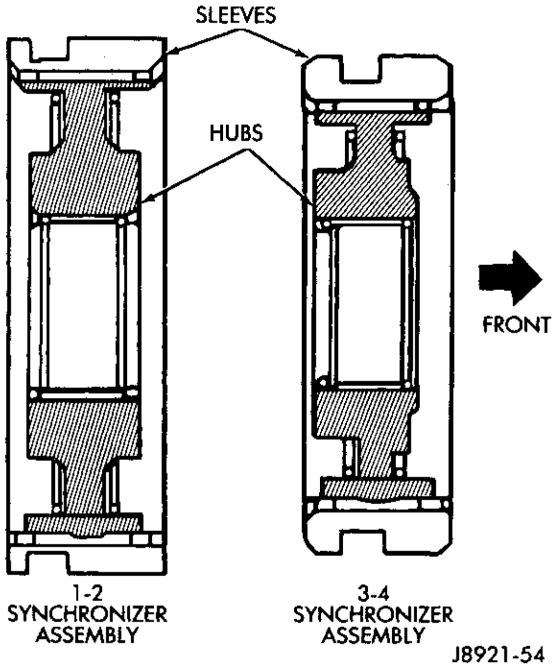
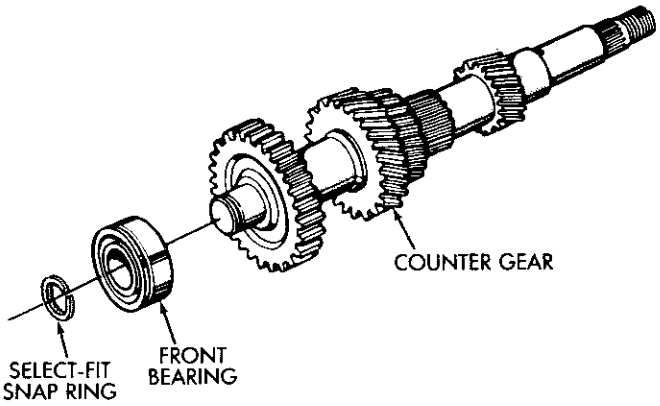


Fig. 54 Synchronizer Identification

(25) On AX 5, assemble and install counter fifth gear components on counter gear (Fig. 69).

(26) On AX 5, install assembled gear and synchronizer on counter gear shaft (Fig. 70).



I.D. Mark	Snap Ring Thickness mm (in.)
1	2.05-2.10 (0.0807-0.0827)
2	2.10-2.15 (0.0827-0.0846)
3	2.15-2.20 (0.0846-0.0866)
4	2.20-2.25 (0.0866-0.0886)
5	2.25-2.30 (0.0886-0.0906)
6	2.30-2.35 (0.0906-0.0925)

J8921-51

Fig. 51 Installing Counter Gear Front Bearing And Snap Ring

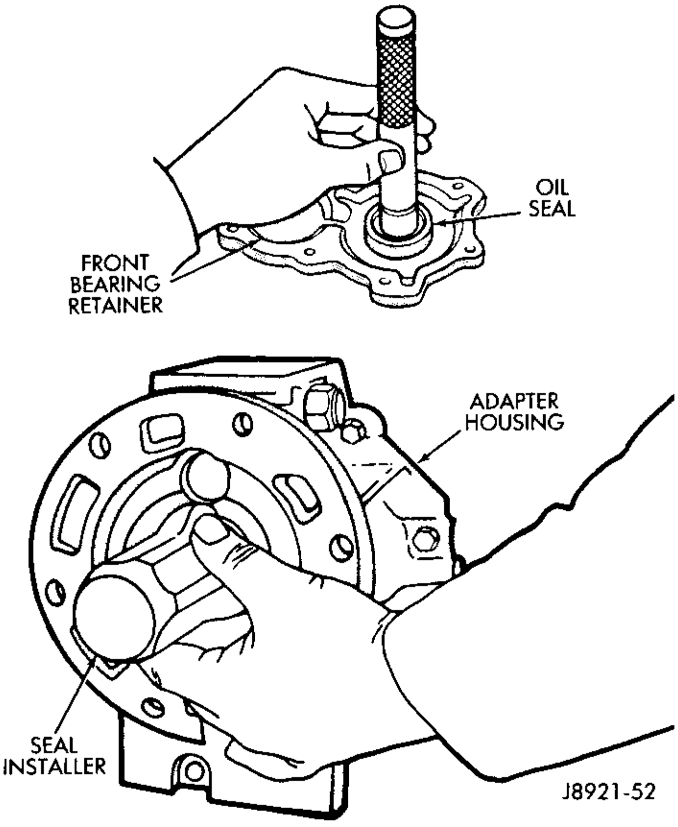


Fig. 52 Oil Seal Installation

(27) Install remaining synchronizer in fifth gear and install gear (Fig. 71). Use length of pipe and hammer to install gear.

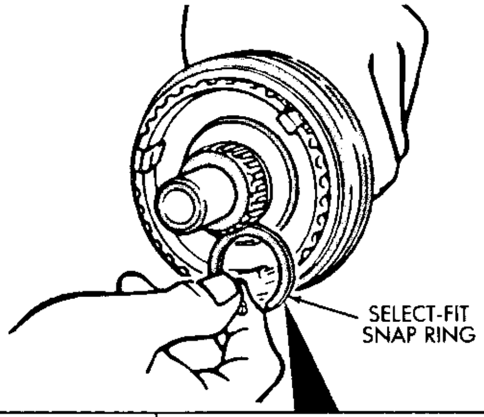
(28) Shift 1-2 and 3-4 synchronizer sleeves into gear to lock output shaft and counter gear (Fig. 28).

(29) On AX 4, install slinger and lock nut on counter gear. On AX 5, install fifth gear nut on counter gear (Fig. 72). Tighten nut to 90 ft-lbs (122 N•m) torque.

(30) Stake lock nut securely in two places after tightening.

(31) Disengage 1-2 and 3-4 synchronizer sleeves.

(32) Check counter fifth gear thrust clearance (Fig. 72). Standard clearance is .10 to .30 mm (.004 to .010 in).



I.D. Mark	Snap Ring Thickness mm (in.)
C-1	1.75-1.80 (0.0689-0.0709)
D	1.80-1.85 (0.0709-0.0728)
D-1	1.85-1.90 (0.0728-0.0748)
E	1.90-1.95 (0.0748-0.0768)
E-1	1.95-2.00 (0.0768-0.0787)
F	2.00-2.05 (0.0788-0.0807)
F-1	2.05-2.10 (0.0807-0.0827)

Fig. 55 Installing Third Gear And 3-4 Synchronizer

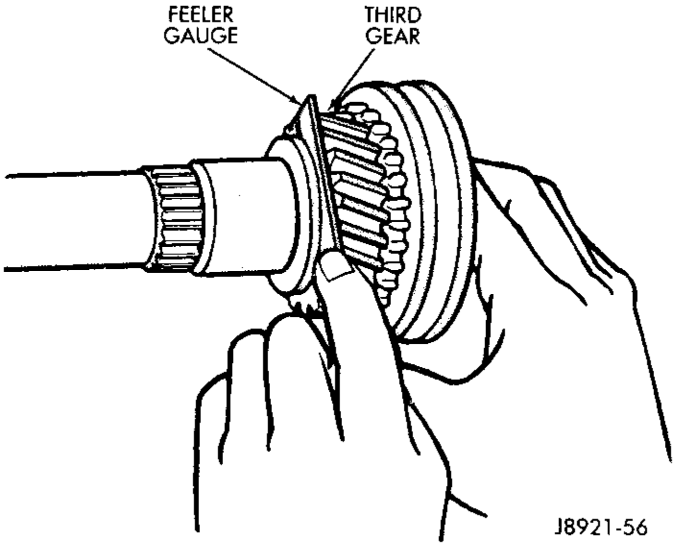


Fig. 56 Checking Third Gear Clearance

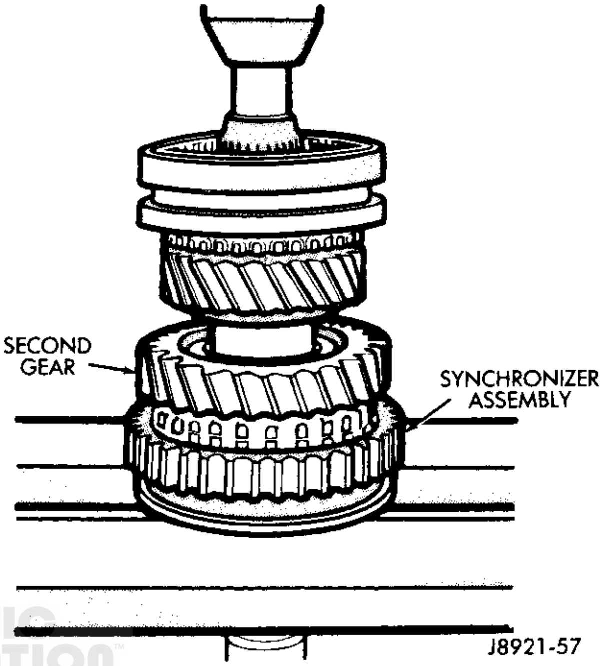


Fig. 57 Installing Second Gear And Synchronizer

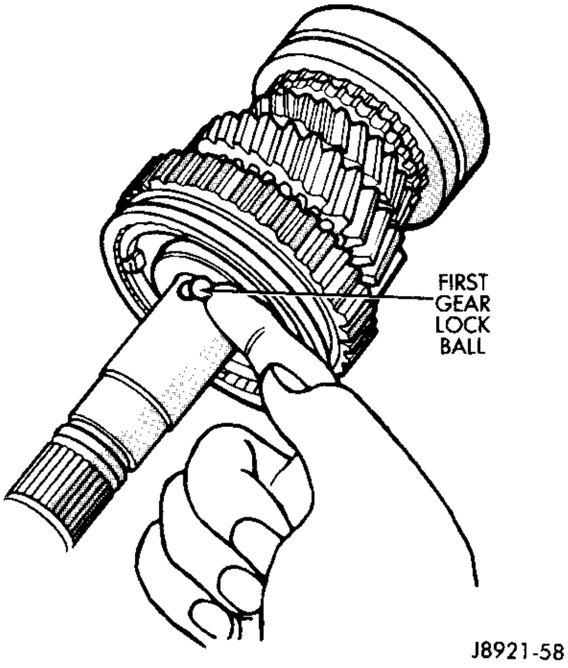
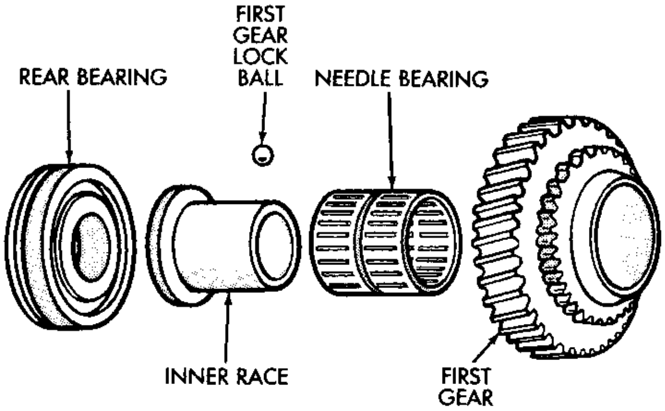
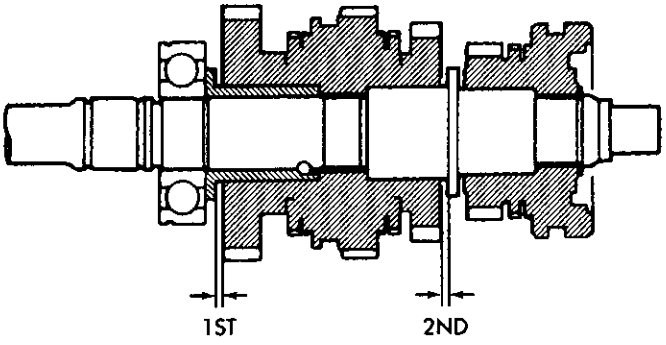


Fig. 58 Installing First Gear And Lock Ball



J8921-59

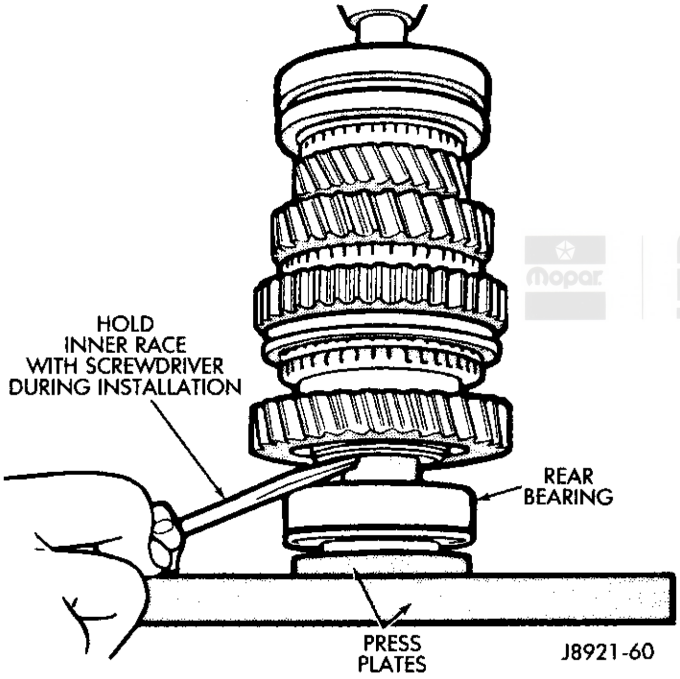
Fig. 59 First Gear Gearing Inner Race Installation



STANDARD CLEARANCE
0.004-0.010 INCH
(0.10-0.25 mm)

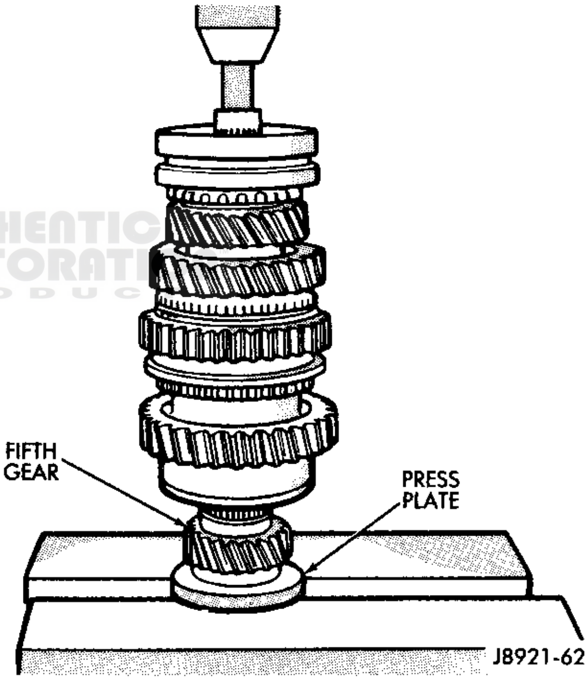
J8921-61

Fig. 61 Checking First-Second Gear Clearance



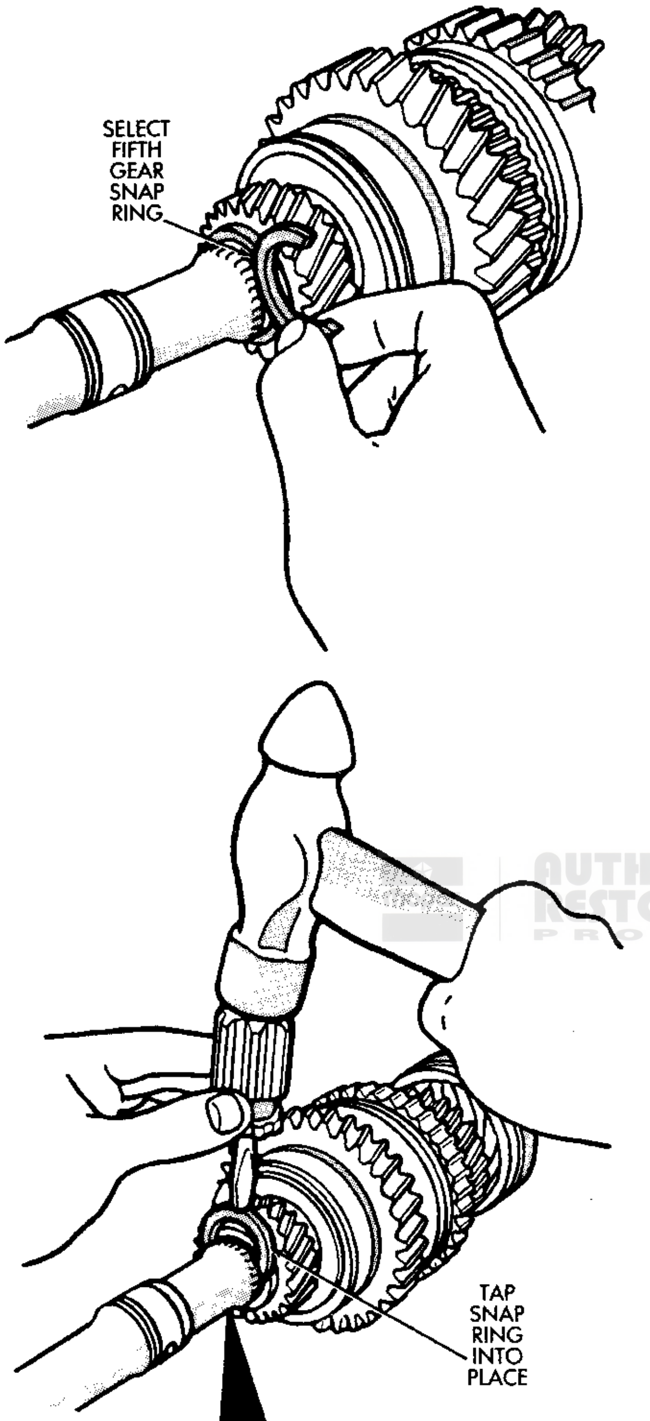
J8921-60

Fig. 60 Installing Output Shaft Rear Bearing



J8921-62

Fig. 62 Installing Output Shaft Fifth Gear



I.D. Mark	Snap Ring Thickness mm (in.)
A	2.67-2.72 (0.1051-0.1071)
B	2.73-2.78 (0.1075-0.1094)
C	2.79-2.84 (0.1098-0.1118)
D	2.85-2.90 (0.1122-0.1142)
E	2.91-2.96 (0.1146-0.1165)
F	2.97-3.02 (0.1169-0.1189)
G	3.03-3.08 (0.1193-0.1213)
H	3.09-3.14 (0.1217-0.1236)
J	3.15-3.20 (0.1240-0.1260)
K	3.21-3.26 (0.1264-0.1283)
L	3.27-3.32 (0.1287-0.1307)

J8921-63

Fig. 63 Selecting/Installing Fifth Gear Snap Ring

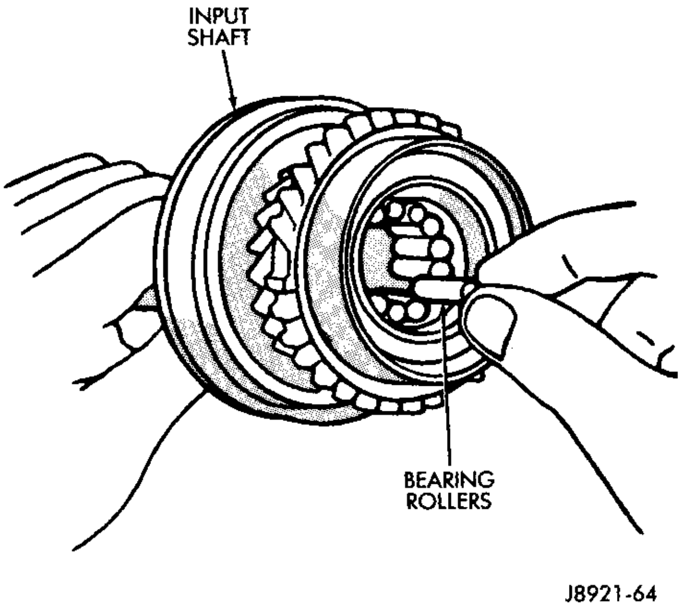


Fig. 64 Installing Input Shaft Bearing Rollers

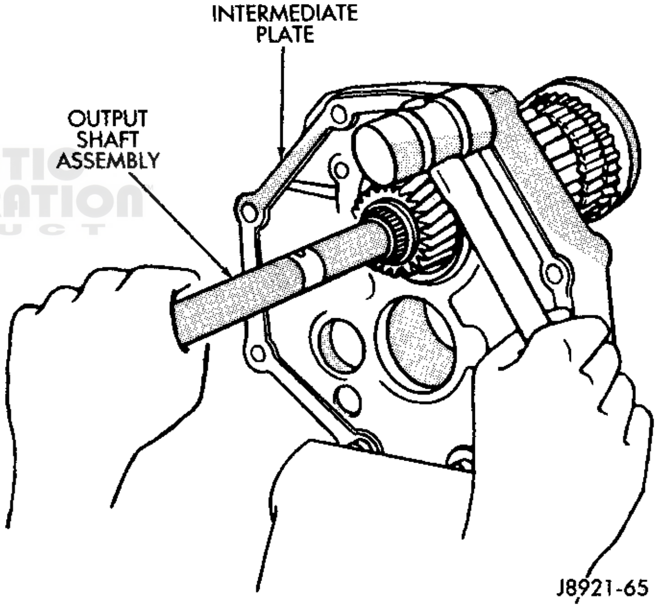


Fig. 65 Installing Output Shaft In Intermediate Plate

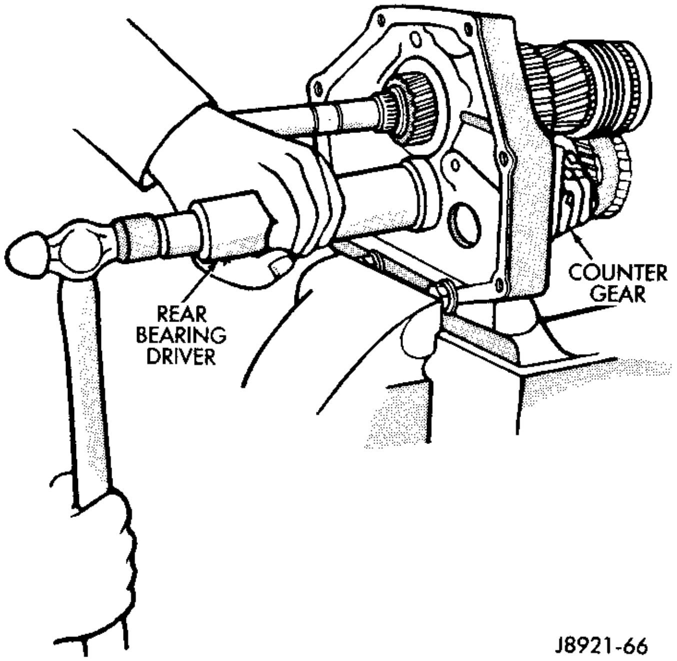


Fig. 66 Installing Counter Gear

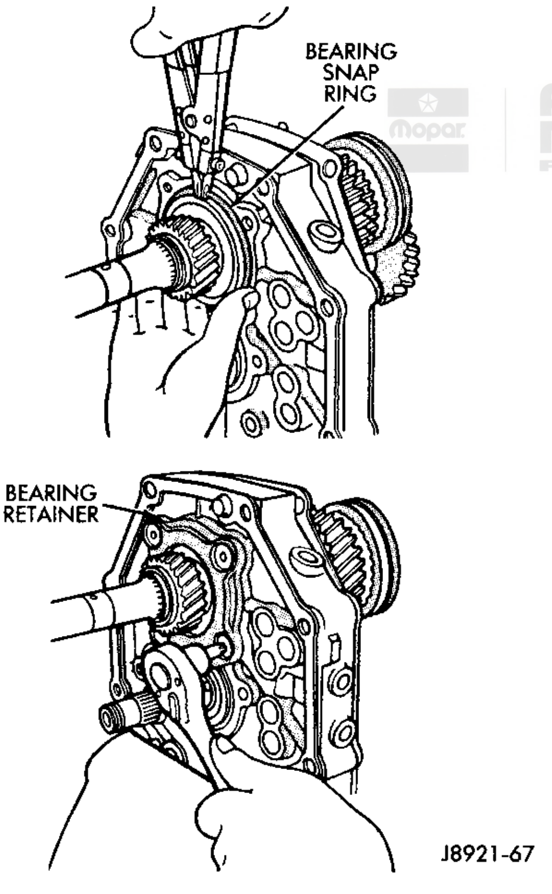


Fig. 67 Installing Bearing Retainer And Snap Ring

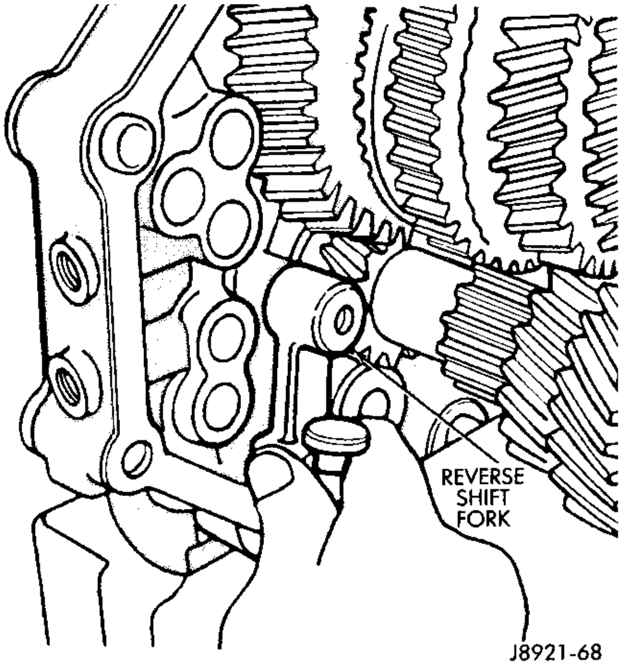


Fig. 68 Installing Reverse Shift Fork

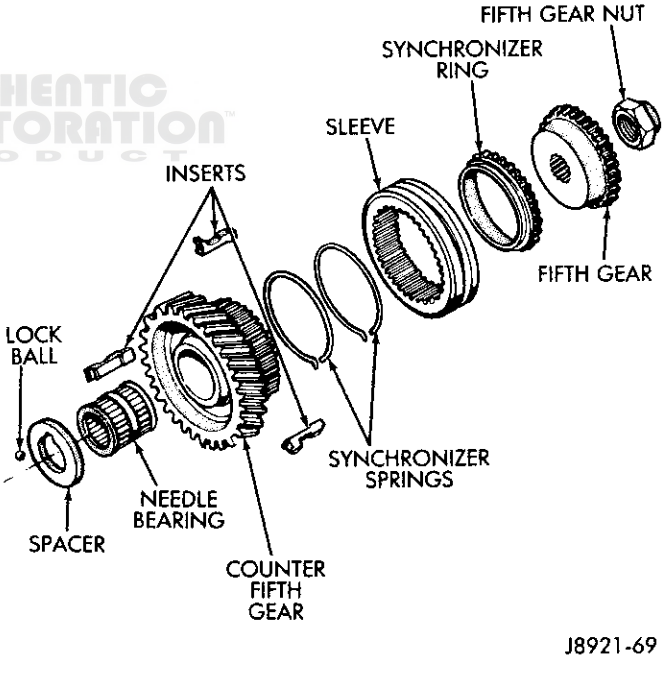


Fig. 69 Counter Fifth Gear And Synchronizer Assembly — AX 5

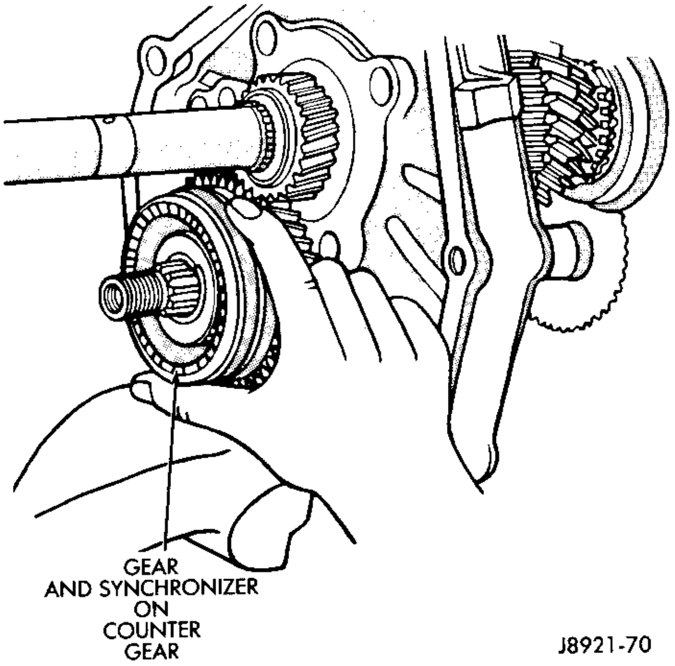


Fig. 70 Installing Counter Fifth Gear And Synchronizer — AX 5

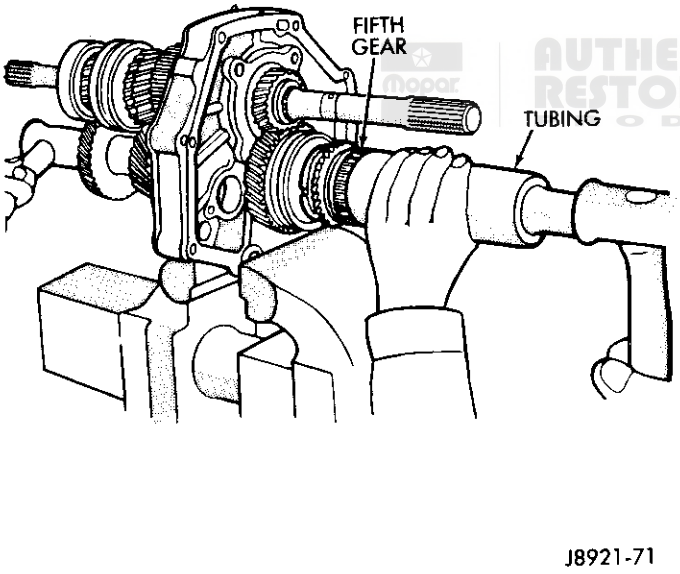


Fig. 71 Installing Fifth Gear — AX 5

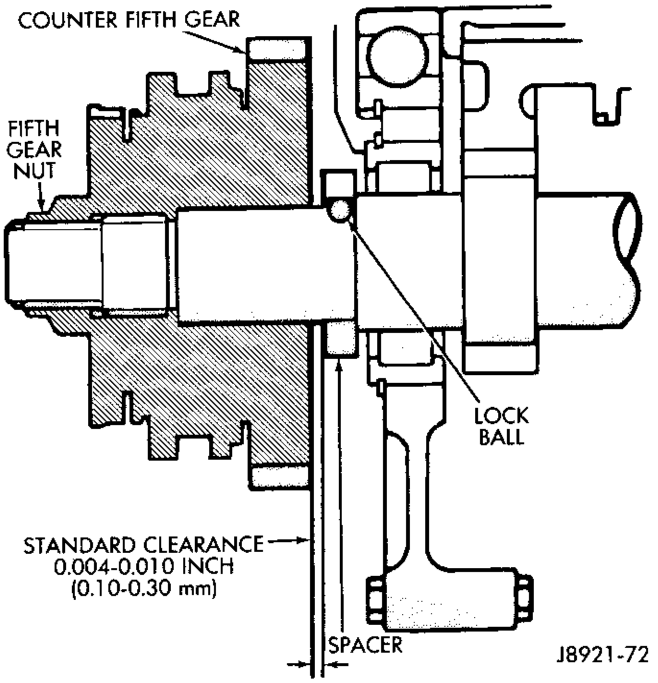


Fig. 72 Checking Fifth Gear Thrust Clearance — AX5

Shift Component Assembly

When assembling the shift mechanism, refer to Figure 73 for component details and location.

(1) Install reverse shift arm. Then seat shift fork in bracket (Fig. 74).

(2) Install reverse idler gear on shaft. Then install shaft and gearin intermediate plate (Fig. 75). Install shaft lock plate and tighten attaching bolt to 18 N•m (13 ft-lbs) torque.

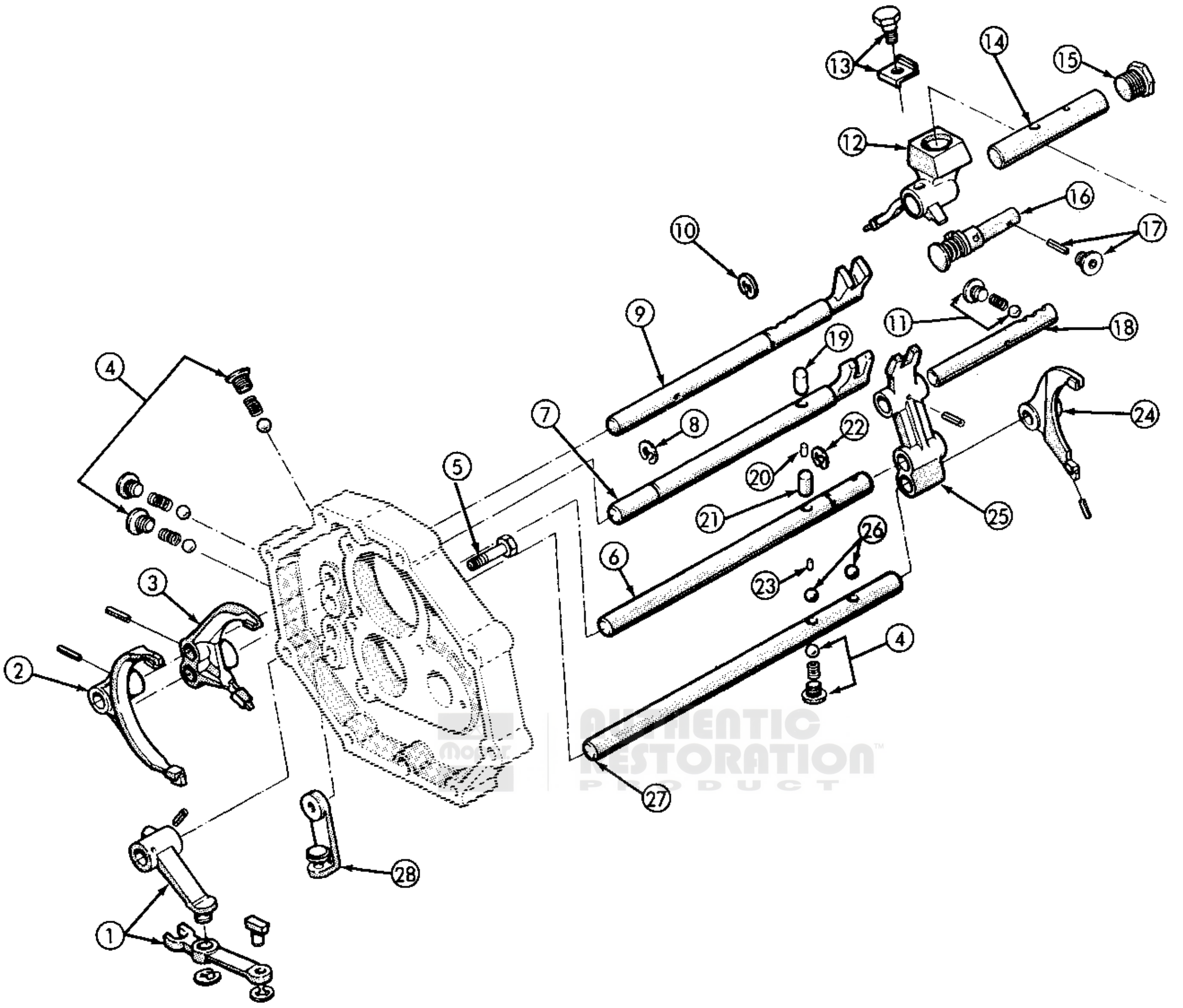
(3) Install 1-2 and 3-4 shift forks in synchronizer sleeves. Then slide No. 2 shift rail through intermediate plate and into forks (Fig. 76).

(4) Coat shift rail interlock pins and balls with liberal quantity petroleum jelly to hold them in place.

(5) Refer to Figure 77 for interlock ball and pin positions.

(6) Insert first interlock pin in intermediate plate (Fig. 78). Use pencil magnet and screwdriver to install pin.

(7) Install smaller diameter interlock pin in No. 1 rail (Fig. 79).



① REVERSE FORK AND SHIFT ARM
② 1-2 SHIFT FORK
③ 3-4 SHIFT FORK
④ LOCK BALL, SPRING AND PLUG (AX 5)
⑤ BRACKET BOLT
⑥ NO. 3 SHIFT RAIL
⑦ NO. 1 SHIFT RAIL
⑧ C-RING
⑨ NO. 2 SHIFT RAIL
⑩ C-RING
⑪ LOCK BALL, SPRING AND PLUG
⑫ SHIFT ARM
⑬ SET BOLT AND LOCK PLATE
⑭ SHIFT LEVER SHAFT
⑮ SHAFT PLUG
⑯ REVERSE PIN
⑰ RETAINING PIN AND PLUG
⑱ NO. 5 SHIFT RAIL
⑲ INTERLOCK PIN
⑳ INTERLOCK PIN
㉑ INTERLOCK PIN
㉒ C-RING
㉓ INTERLOCK PIN
㉔ FIFTH-REVERSE FORK (AX 5)
㉕ REVERSE SHIFT HEAD
㉖ LOCK BALLS (AX 5)
㉗ NO. 4 SHIFT RAIL (AX 5)
㉘ REVERSE ARM BRACKET

J9021-122

Fig. 73 Shift Components

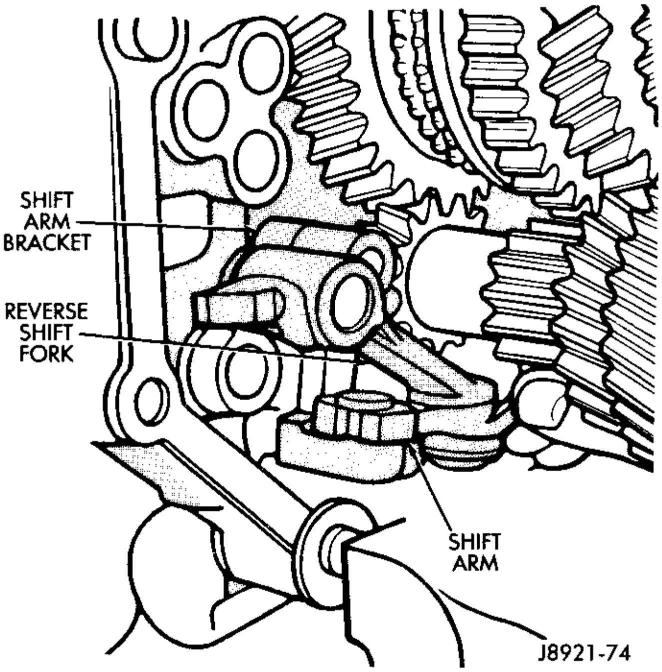


Fig. 74 Installing Reverse Shift Arm

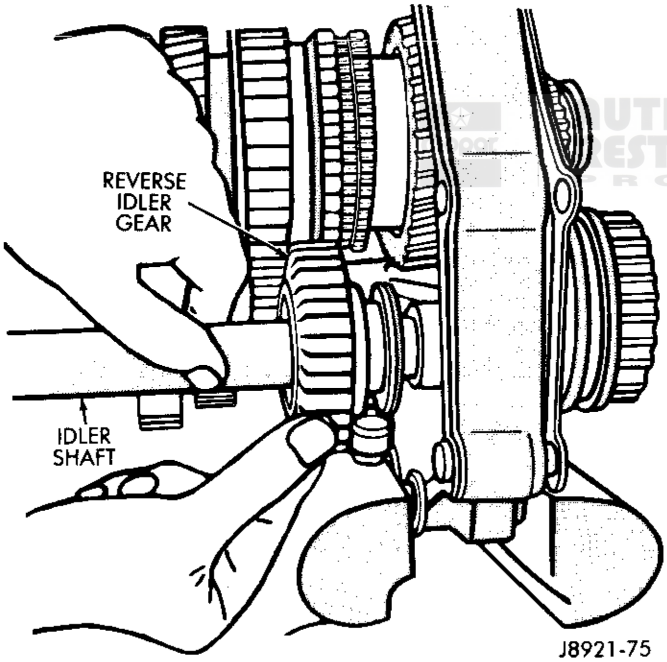


Fig. 75 Installing Reverse Idler Gear And Shaft

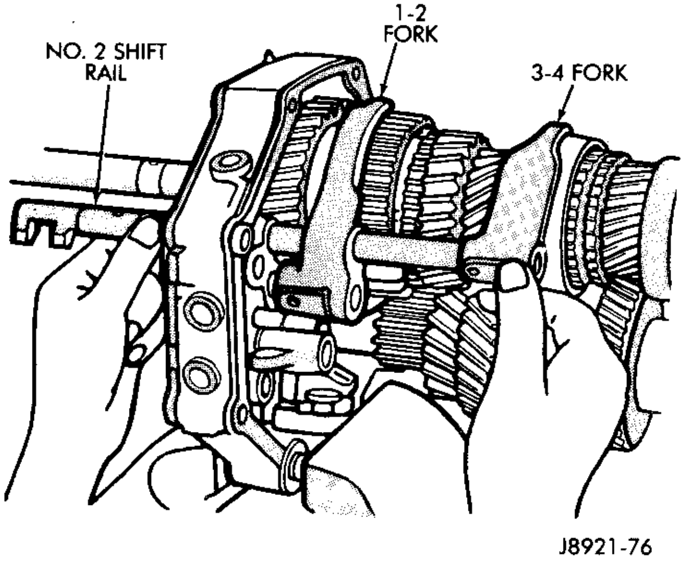


Fig. 76 Installing No. 2 Shift Rail and Shift Forks

(8) Slide No. 1 rail through 1-2 shift fork (Fig. 80).

(9) Install largest interlock pin between Nos. 1 and 3 shift rails (Fig. 81).

(10) Install interlock pin in No. 3 shift rail (Fig. 82).

(11) Slide No. 3 rail into reverse shift head (Fig. 83).

(12) Assemble reverse shift head and No. 5 shift rail.

(13) Install no.5 shift rail in intermediate plate and engage shift head on No. 3 shift rail (Fig. 84).

(14) Install reverse shift head lock ball with screwdriver and pencilmagnet (Fig. 85).

(15) Shift fifth gear synchronizer sleeve rearward to lock it (Fig. 86).

(16) Install fifth-reverse shift fork in synchronizer sleeve. Then slide No. 4 shift rail into fork (Fig. 87).

(17) Install shift rail lock ball with pencil magnet and screwdriver (Fig. 88).

(18) Check interlock operation as follows: Move No. 1 shift rail rearward to first gear position. Interlock operation is OK if remaining shift rails did not move.

(19) Install new shift fork pins (Fig. 89).

(20) Install new shift rail C-rings (Fig. 90).

(21) Apply sealer to threads of lock ball plugs.

(22) Install lock balls and springs in intermediate plate. **Short spring goes in top hole of intermediate plate.**

(23) Install lock ball and spring plugs (Fig. 91). Tighten plugs to 19 N•m (14 ft-lbs) torque.

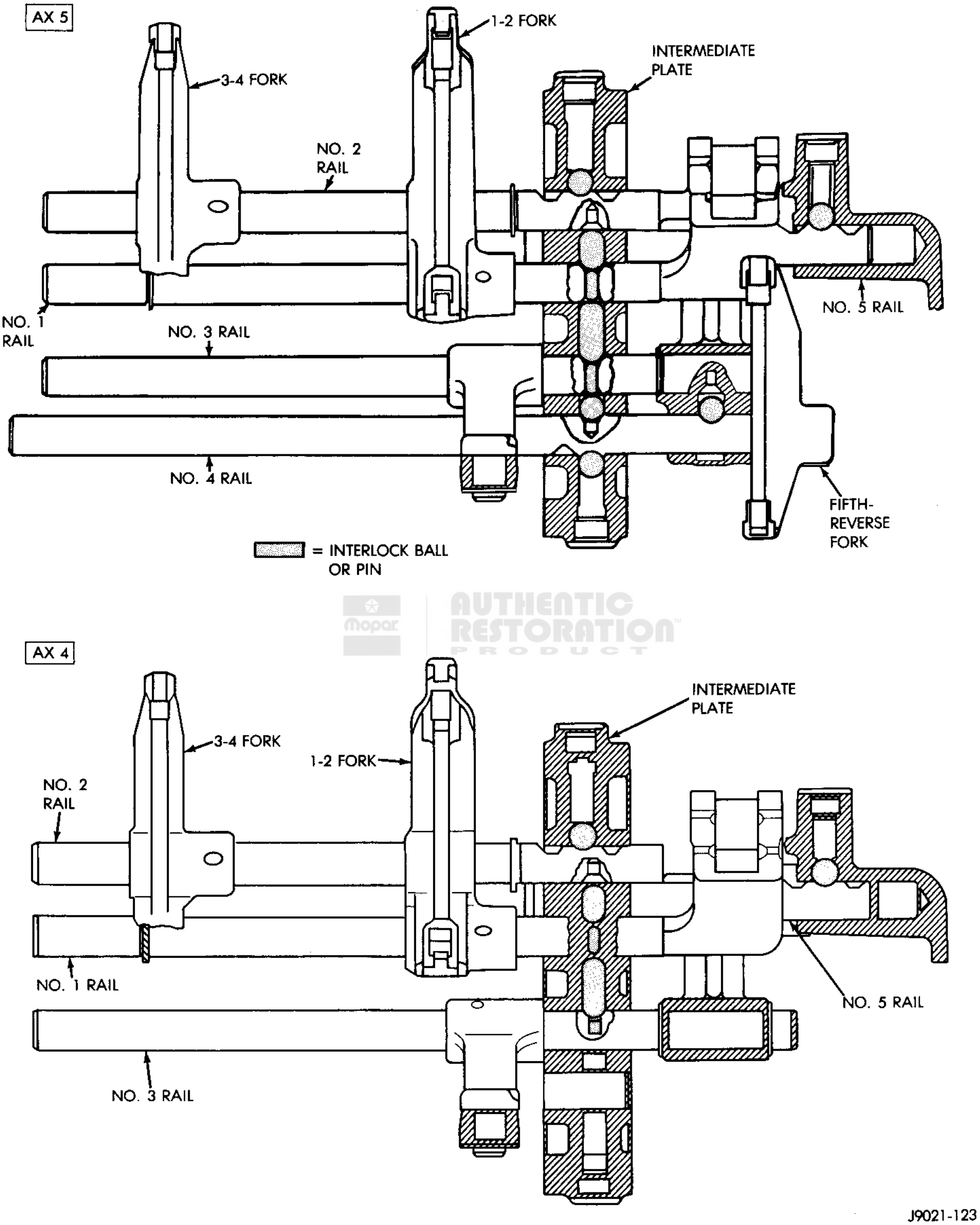


Fig. 77 Interlock Ball And Pin Position — AX 4/5

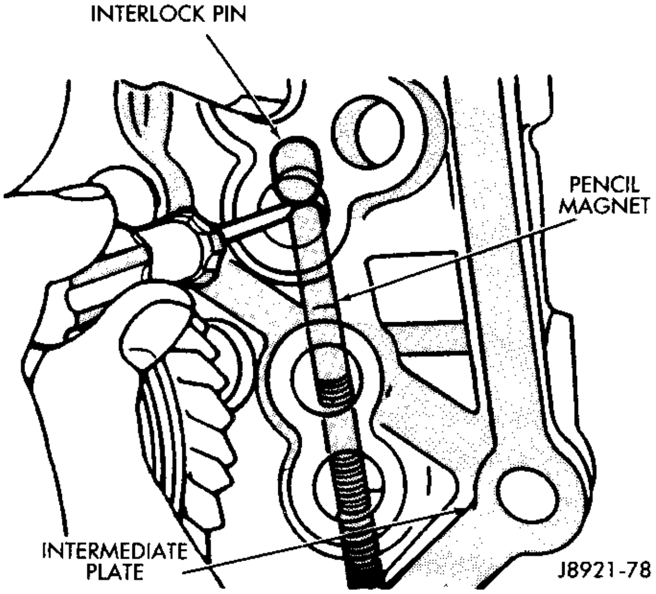


Fig. 78 Installing First Interlock Pin

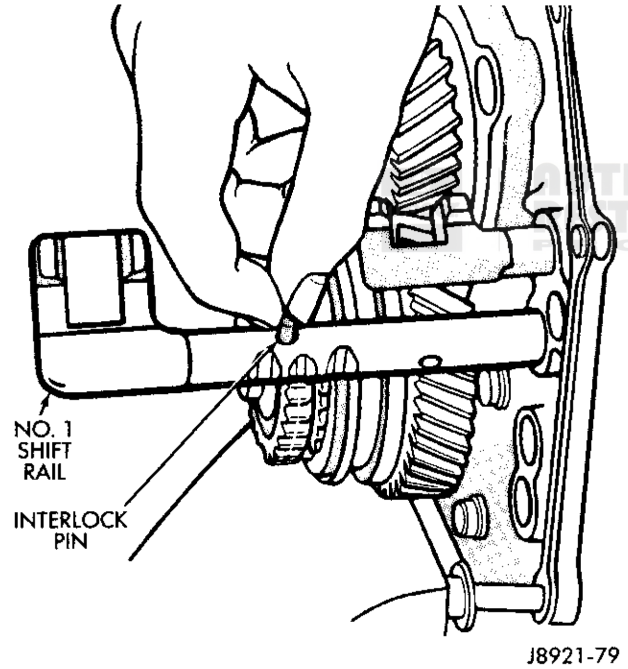


Fig. 79 Installing Interlock Pin In No. 1 Shift Rail

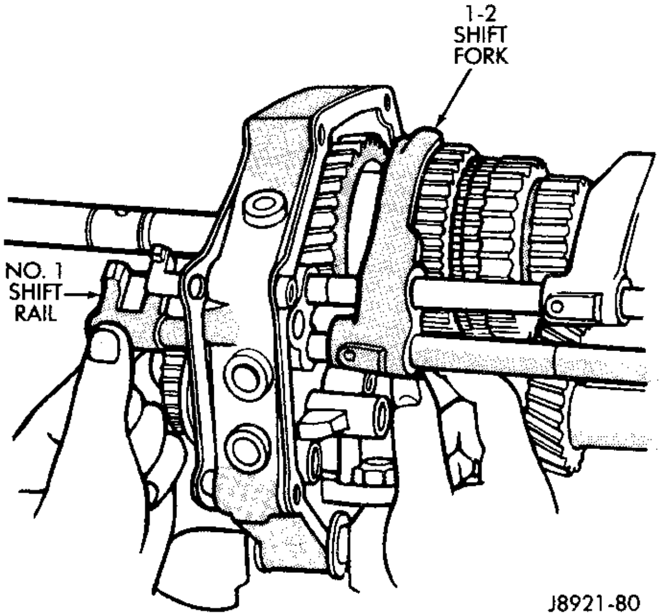


Fig. 80 Installing No. 1 Shift Rail

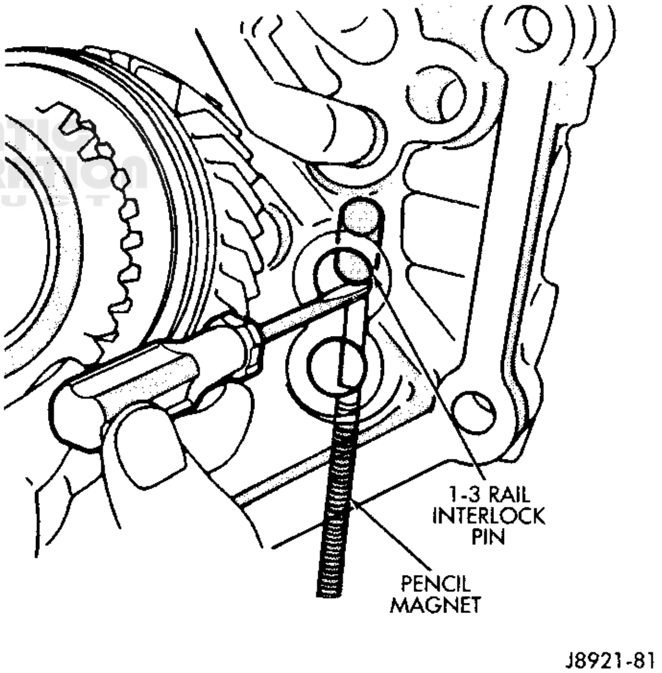


Fig. 81 Installing 1-3 Shift Rail Interlock Pin

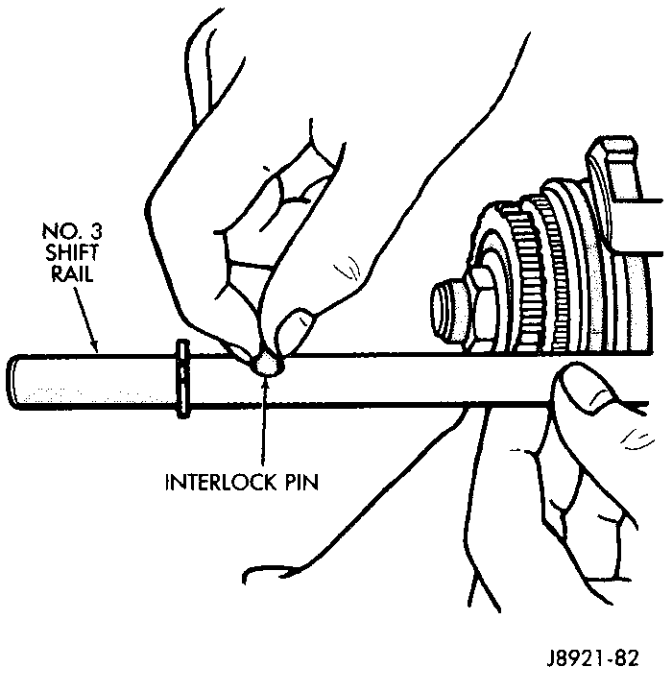


Fig. 82 Installing Interlock Pin In No. 3 Shift Rail

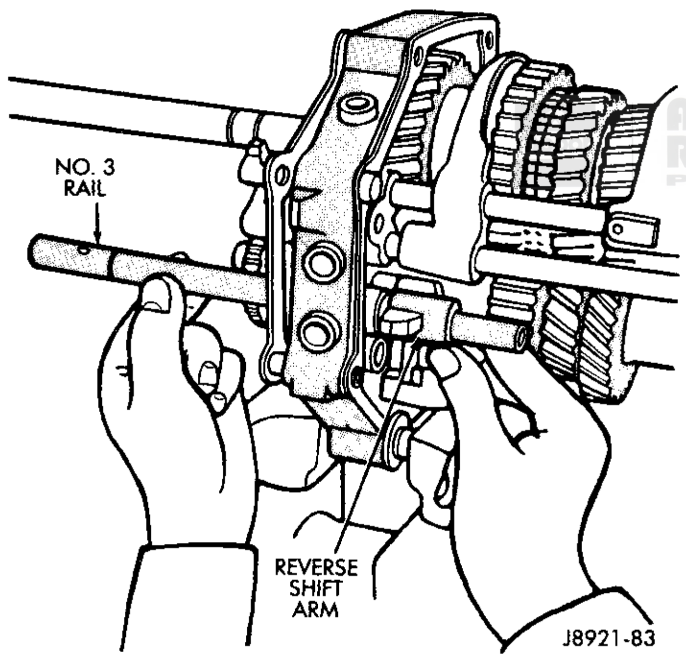


Fig. 83 Installing No. 3 Shift Rail

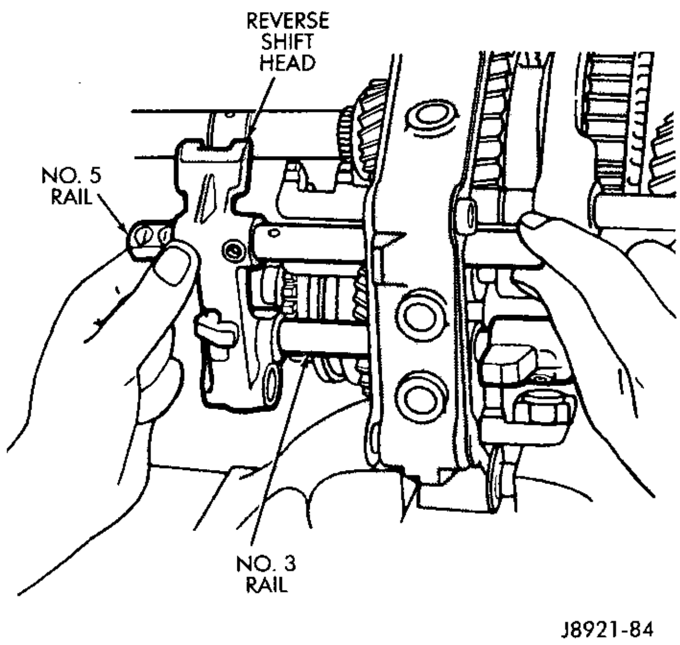


Fig. 84 Installing Reverse Shift Head

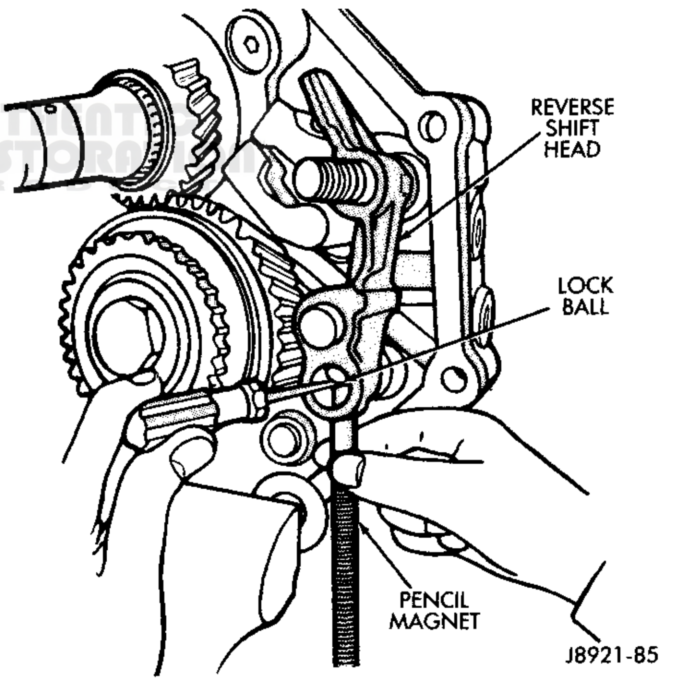


Fig. 85 Installing Reverse Shift Head Lock Ball

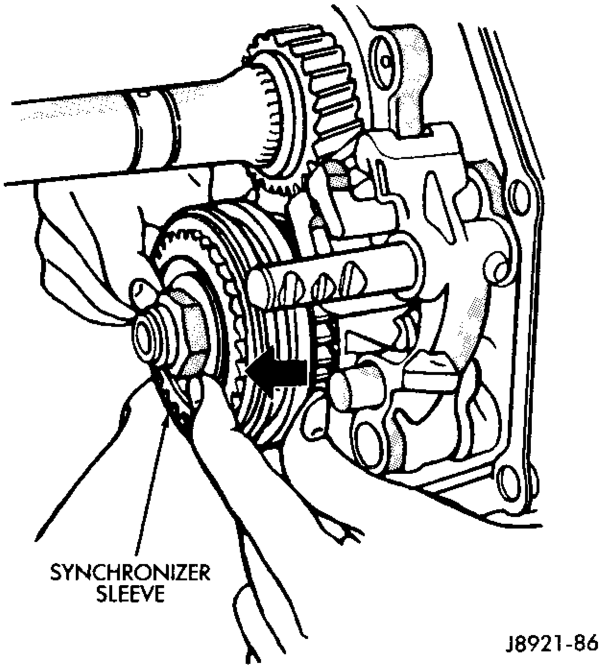


Fig. 86 Locking Fifth Synchronizer — AX 5

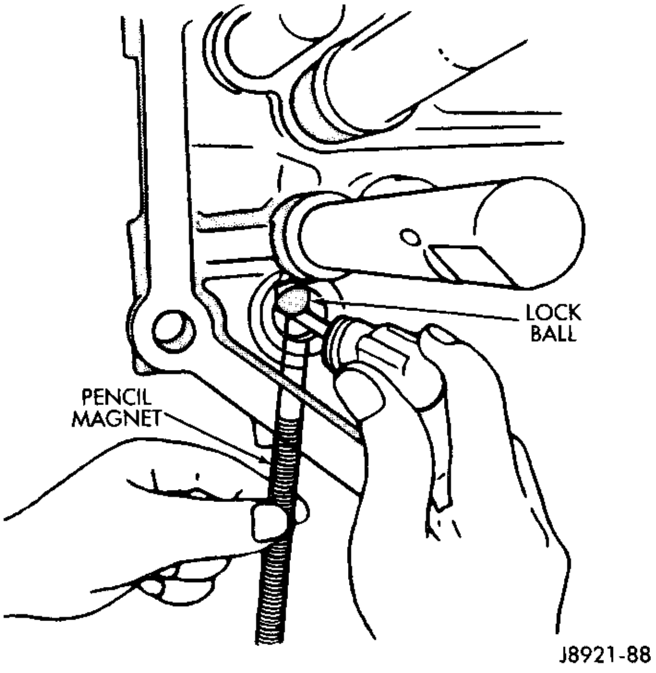


Fig. 88 Lock Ball Installation

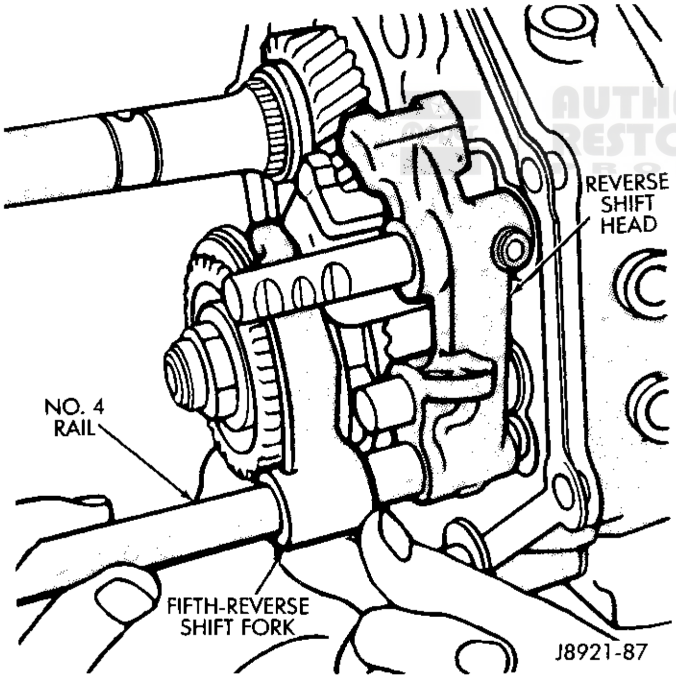


Fig. 87 Fifth-Reverse Shift Fork Installation — AX 5

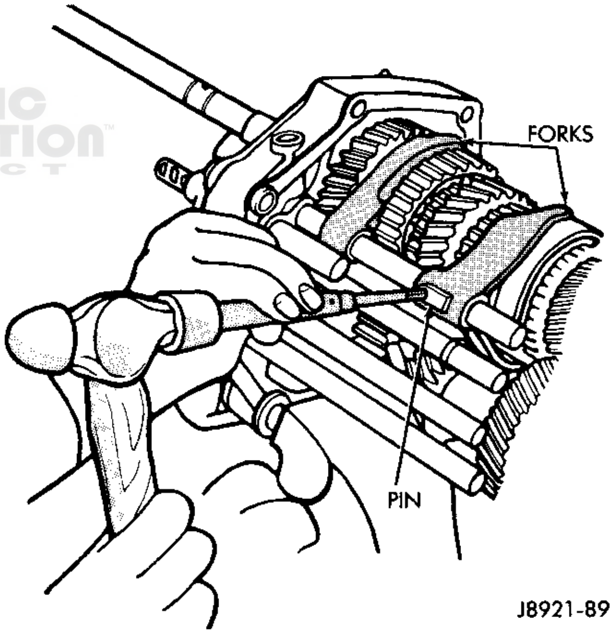


Fig. 89 Installing Shift Fork Pins

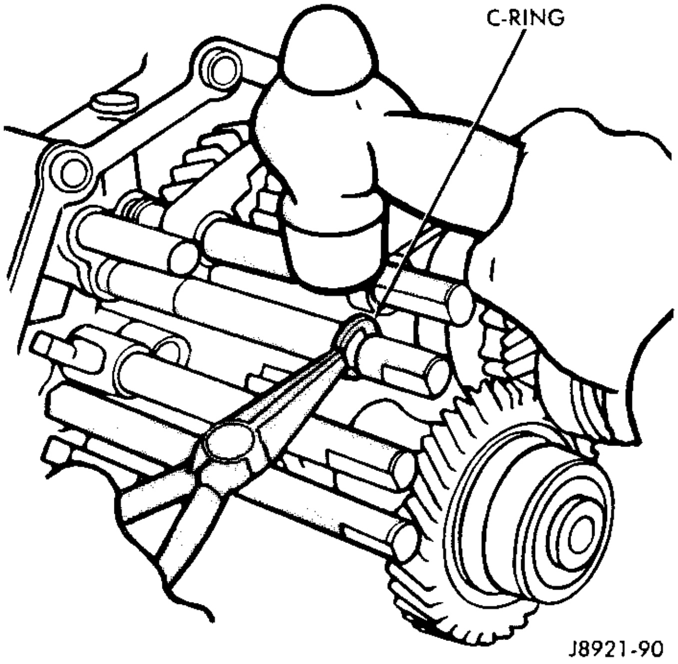


Fig. 90 Installing Shift Rail C-Rings

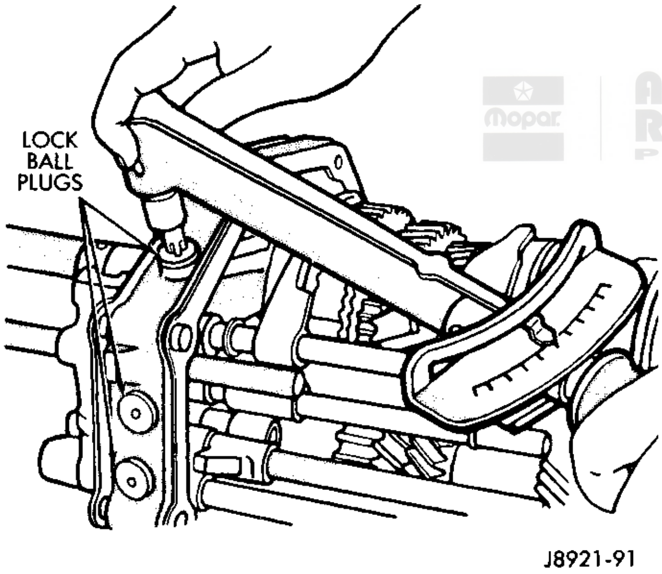


Fig. 91 Installing Lock Ball Plugs

Transmission Case Assembly

(1) Remove intermediate plate from vise.

(2) Install new gaskets on intermediate plate.

(3) Install transmission case on intermediate plate (Fig. 92).

(4) Install new front bearing snap ring (Fig. 93).

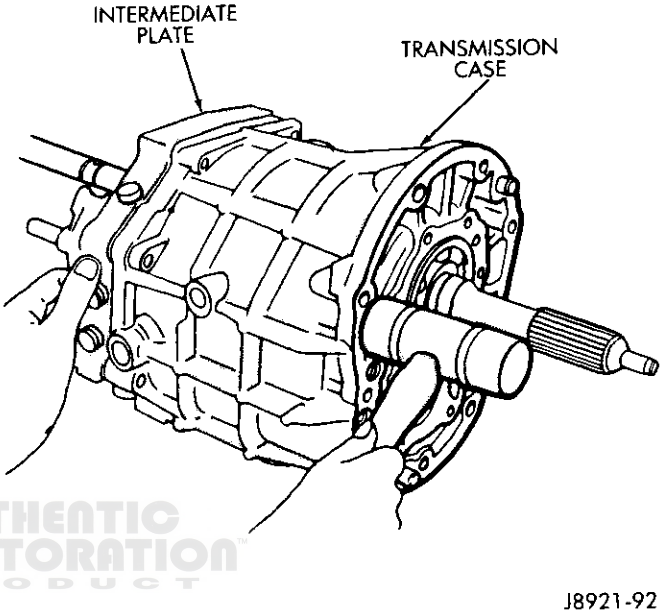


Fig. 92 Installing Transmission Case

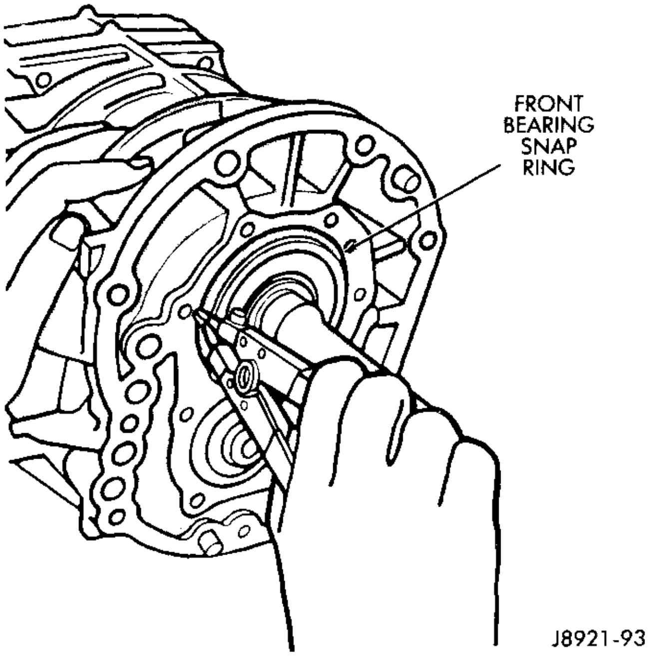


Fig. 93 Installing Front Bearing Snap Ring

(5) Install new gasket on front bearing retainer and install retainer on case (Fig. 94).

(6) Install adapter or extension housing on intermediate plate (Fig. 95). Tighten housing bolts to 37 N•m (27 ft-lbs) torque.

(7) Install shift arm (Fig. 95).

(8) Install shift arm lock plate with pliers (Fig. 96). Then install and tighten lock plate set bolt to 38 N•m (28 ft-lbs) torque.

(9) Install and tighten shaft plug to 18 N•m (13 ft-lbs) torque (Fig. 97).

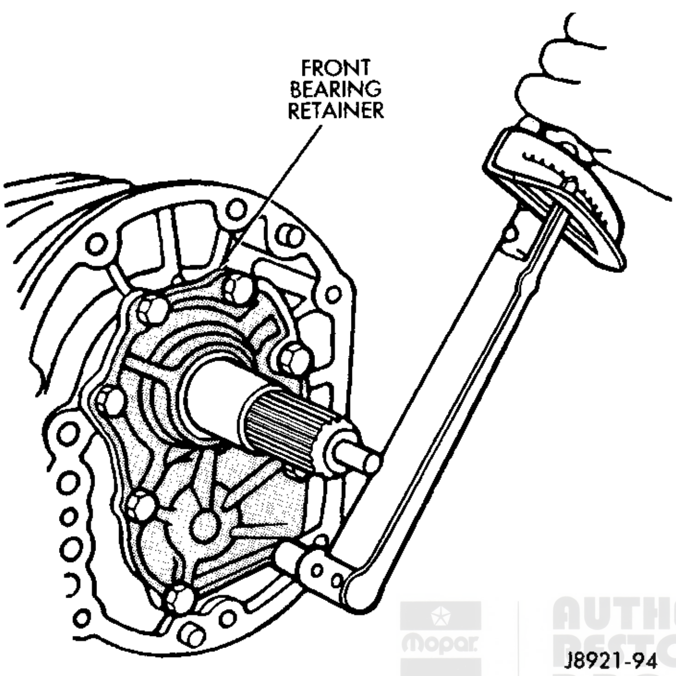


Fig. 94 Installing Front Bearing Retainer

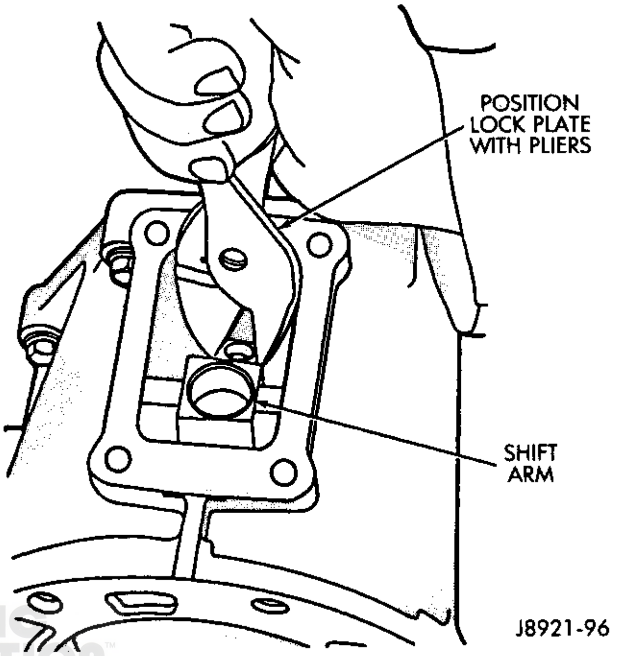


Fig. 96 Shift Arm Lock Plate Installation

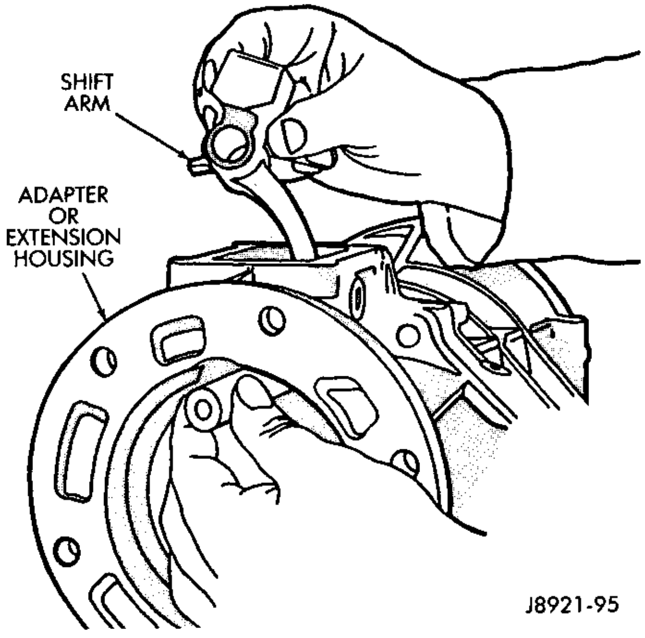


Fig. 95 Installing Adapter Housing And Shift Arm

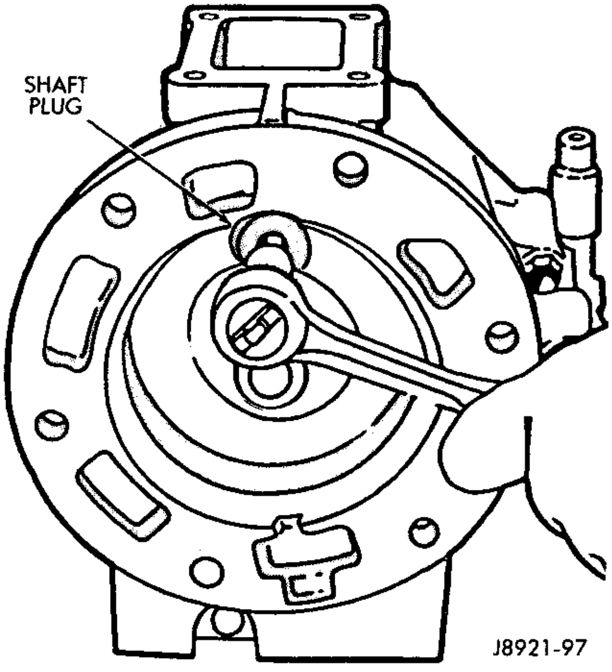


Fig. 97 Shaft Plug Installation

(10) Install lock ball and spring in housing. Then apply sealer to ball plug and install plug (Fig. 98). Tighten plug to 19 N•m (14 ft-lbs) torque.

(11) Install reverse pins in housing (Fig. 99). Tighten pins to 27 N•m (20 ft-lbs) torque.

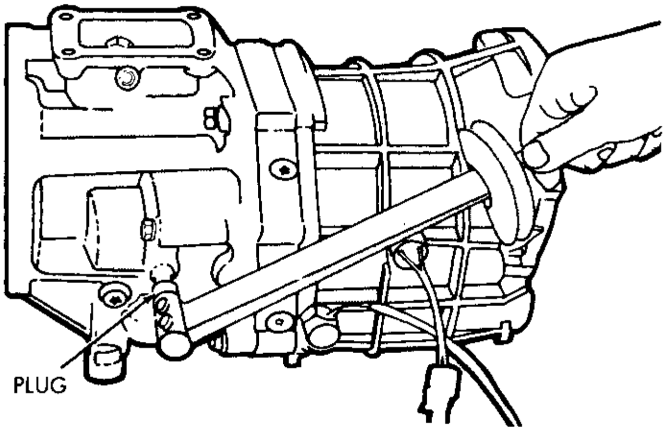


Fig. 98 Installing Ball Plug

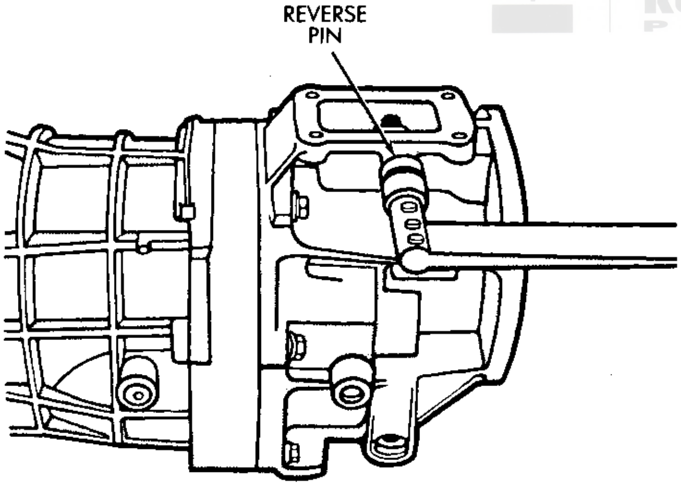


Fig. 99 Install Reverse Pins

(12) Install shift tower and new gasket on housing (Fig. 100). Tighten tower bolts to 18 N•m (13 ft-lbs) torque.

(13) Install backup lamp switch (Fig. 100). Tighten switch to 37 N•m (27 ft-lbs) torque.

(14) On 2WD models, install retainer and new seal in extension housing (Fig. 101).

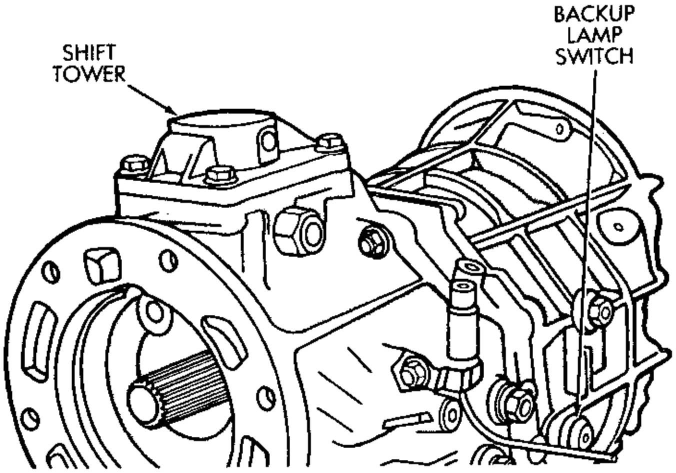


Fig. 100 Installing Shift Tower And Backup Lamp Switch

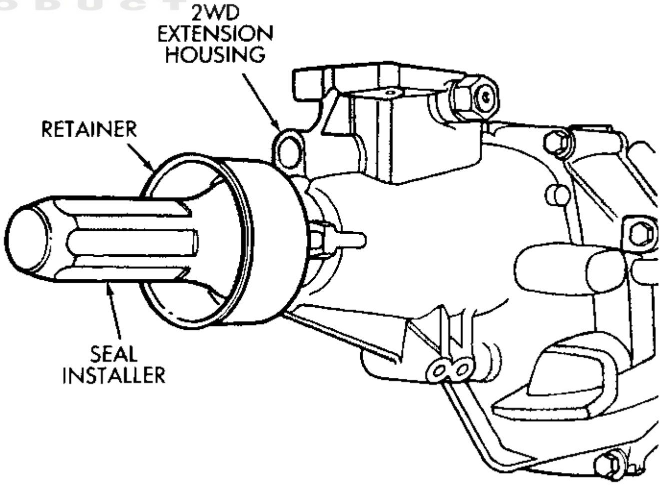


Fig. 101 Installing Rear Seal — 2WD Models

(15) On 2WD models, install speedometer assembly as follows:

(a) Assemble and install speedometer components (Fig. 102).

(b) Count number of teeth on pinion gear.

(c) Locate number sets on adapter face that correspond to number of teeth on pinion gear (Fig. 103).

(d) Rotate adapter until desired number set aligns with index mark on extension housing (Fig. 103).

(e) Install and tighten adapter retainer bolt to 11 N•m (100 in-lbs) torque.

(16) Install clutch housing and concentric bearing.

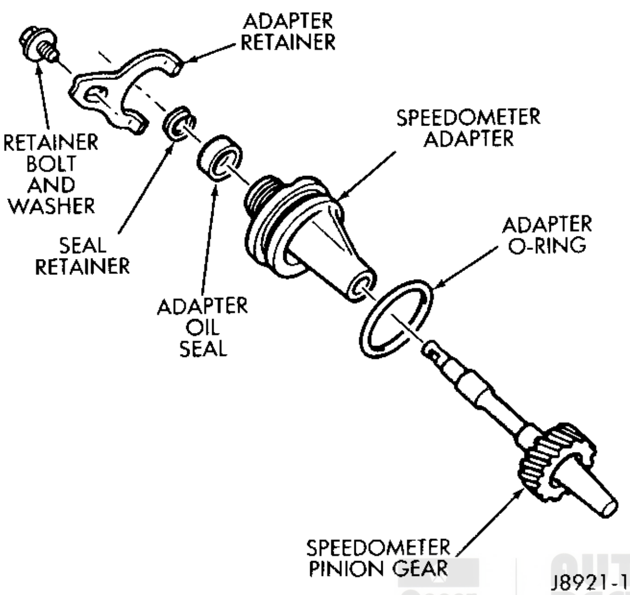


Fig. 102 Speedometer Assembly

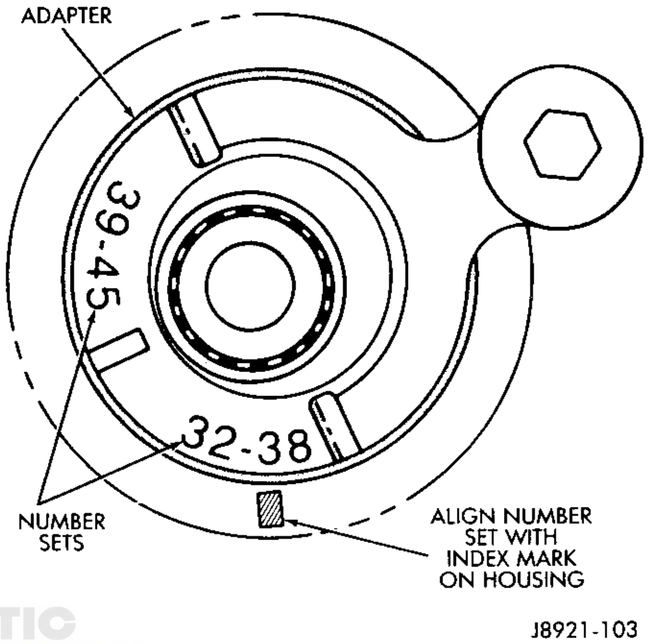


Fig. 103 Indexing Speedometer

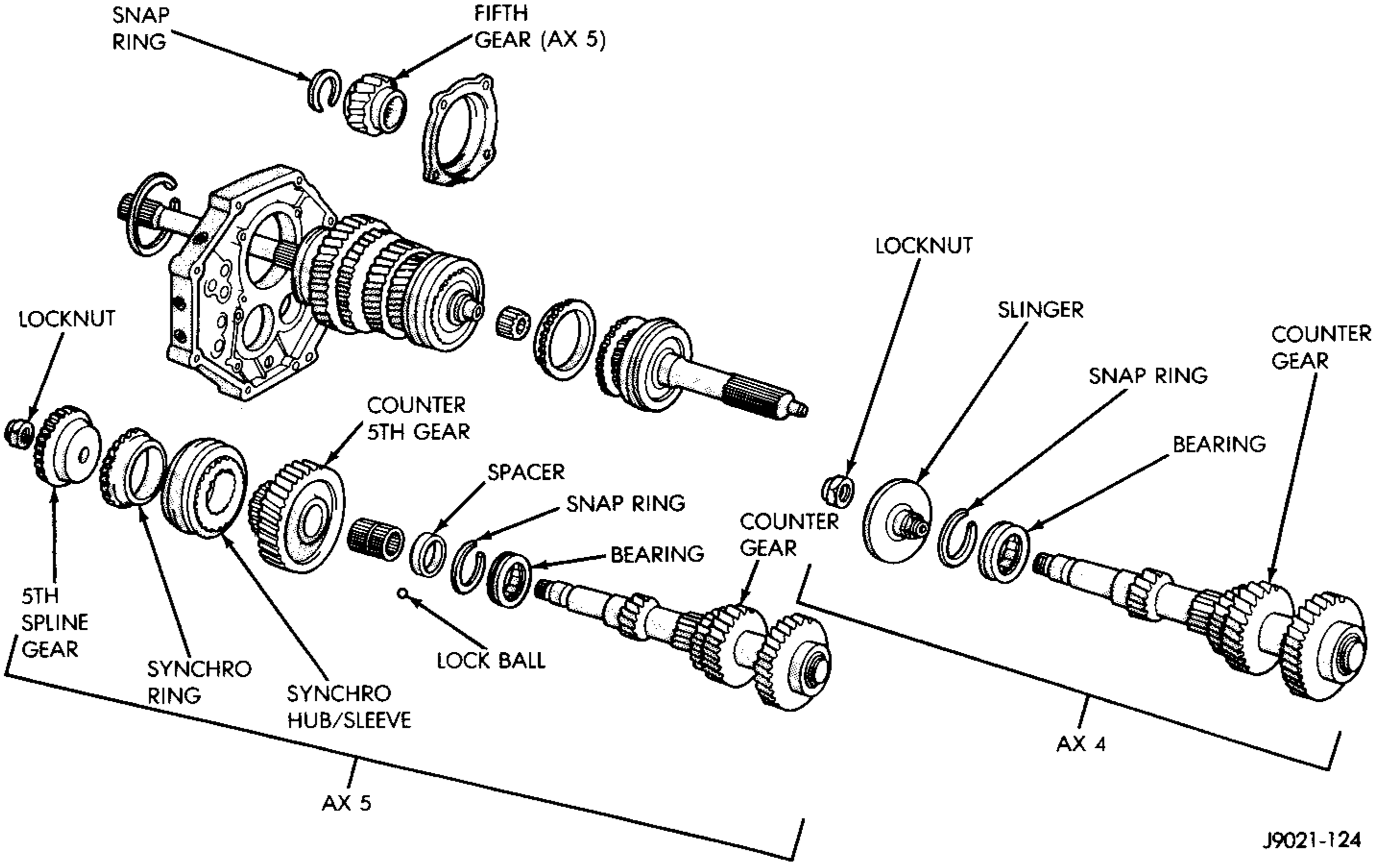


Fig. 104 Counter Gear Component Chart

SERVICE SPECIFICATIONS

Transmission Lubricant . . . . SAE 75W-90 Gear Lube, API Grade GL-5

Lubricant Capacity . . . . 3.3 liters (3.5 qts.)

Gear Ratios . . . . First – 3.93:1, Second – 2.33:1, Third – 1.45:1, Fourth – 1.00:1, Fifth – 0.85:1, Reverse – 4.74:1

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Clutch Housing-to-Transmission Case	37 N·m (27 ft-lbs)	26-47 N·m (19-35 ft-lbs)
Front Bearing Retainer-to-Transmission Case	18 N·m (13 ft-lbs)	12-23 N·m (9-17 ft-lbs)
Adapter Housing-to-Transmission Case	37 N·m (27 ft-lbs)	26-47 N·m (19-35 ft-lbs)
Rear Bearing Retainer-to-Intermediate Plate	18 N·m (13 ft-lbs)	12-23 N·m (9-17 ft-lbs)
Plug-Shift Lever Shaft-to-Adapter Housing	18 N·m (13 ft-lbs)	12-23 N·m (9-17 ft-lbs)
Shift Lever Housing-to-Shift Lever Shaft	37 N·m (27 ft-lbs)	26-47 N·m (19-35 ft-lbs)
Shift Lever Retainer-to-Adapter Housing	18 N·m (13 ft-lbs)	12-23 N·m (9-17 ft-lbs)
Reverse Shift Arm Bracket-to-Intermediate Plate	18 N·m (13 ft-lbs)	10-23 N·m (7-17 ft-lbs)
Reverse Idle Gear Shaft-to-Intermediate Plate	18 N·m (13 ft-lbs)	10-23 N·m (7-17 ft-lbs)
Reverse Restrict Pin-to-Adapter Housing	37 N·m (27 ft-lbs)	26-47 N·m (19-35 ft-lbs)
Plug-Lock Ball Spring	19 N·m (14 ft-lbs)	12-23 N·m (9-17 ft-lbs)
Counter Gear Locknut	122 N·m (90 ft-lbs)	98-146 N·m (72-108 ft-lbs)
Filler/Drain Plug – Transmission Case	37 N·m (27 ft-lbs)	26-47 N·m (19-35 ft-lbs)
Back-Up Lamp Switch	37 N·m (27 ft-lbs)	26-47 N·m (19-35 ft-lbs)
Top Gear Switch	37 N·m (27 ft-lbs)	26-47 N·m (19-35 ft-lbs)
Plug – Oil Lever Sensor	18 N·m (13 ft-lbs)	12-23 N·m (9-17 ft-lbs)

J8921-734

AX 15 MANUAL TRANSMISSION

INDEX

GENERAL SERVICE INFORMATION

The AX 15 is a high capacity, five speed, synchromesh, manual transmission. Fifth gear is an overdrive range with a ratio of .789:1. The shift mechanism is integral and mounted in the shift tower portion of the adapter housing (Fig. 1).

An adaptor housing is used to attach the transmission to the transfer case on 4-wheel drive models. A standard extension housing is used on 2-wheel drive models.

The AX 15 is used in XJ and MJ models with the 4.0L, I-6 engine and in YJ models with the 4.2L, I-6 engine. The AX 15 is designed for use with either a two-wheel drive or four-wheel drive powertrain.

TRANSMISSION IDENTIFICATION

The AX-15 identification code numbers are on the bottom surface of the transmission gear case (Fig. 2).

The first number is year of manufacture (e.g. 9 = 1989). The second and third numbers indicate month of manufacture (e.g. 01 = January, 10 = October, etc.). The next series of numbers is the transmission serial number.

TRANSMISSION SHIFT PATTERN

The AX 15 shift pattern is shown in Figure 3. First and second and third and fourth gear ranges are in line for improved shifting. Fifth and reverse gear ranges are also in line at the extreme right of the pattern (Fig. 3).

The AX 15 is equipped with a reverse lockout mechanism. The shift lever must be moved through the Neutral detent before making a shift to reverse.

TRANSMISSION LUBRICANT

Recommended lubricant for AX-15 transmissions is SAE 75W-90, API Grade GL-5 gear lubricant.

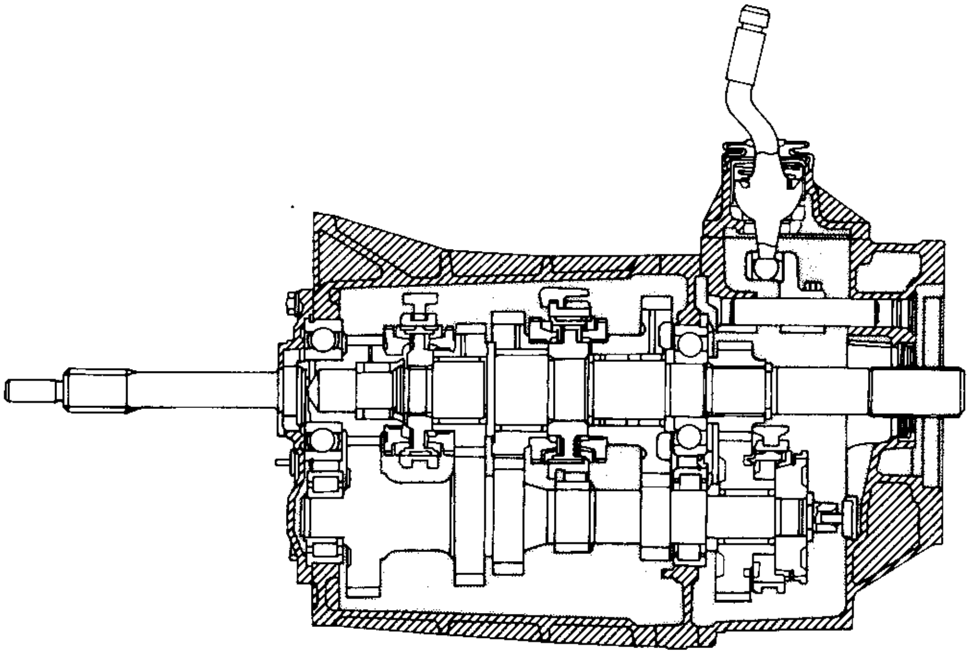
Correct lubricant refill or top-off level is to the bottom edge of the fill plug hole.

Lubricant capacity is as follows:

- 3.10 liters (3.27 U.S. quarts) in 4-wheel drive models.
- 3.15 liters (3.32 U.S. quarts) in 2-wheel drive models.

TRANSMISSION SWITCH AND PLUG LOCATIONS

The fill plug is at the driver side of the gear case (Fig. 4).



J8921-1023

Fig. 1 AX 15 Manual Transmission

The drain plug and backup light switch are on the passenger side of the gear case (Fig. 5).

TRANSMISSION GEAR RATIOS

The transmission gear ratios are as follows:
First gear - 3.83:1
Second gear - 2.33:1
Third gear - 1.43:1
Fourth gear - 1.00:1
Fifth gear - .789:1
Reverse - 4.22:1

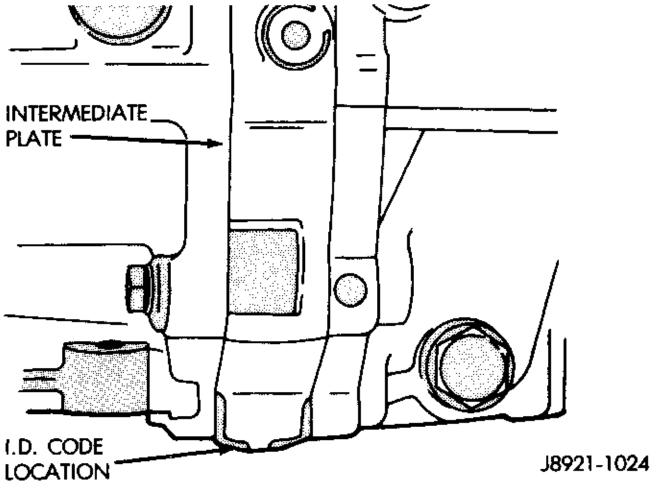


Fig. 2 Identification Code Number Location

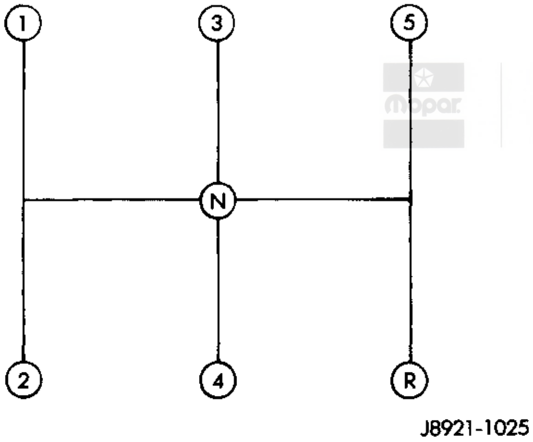


Fig. 3 AX 5 Shift Pattern

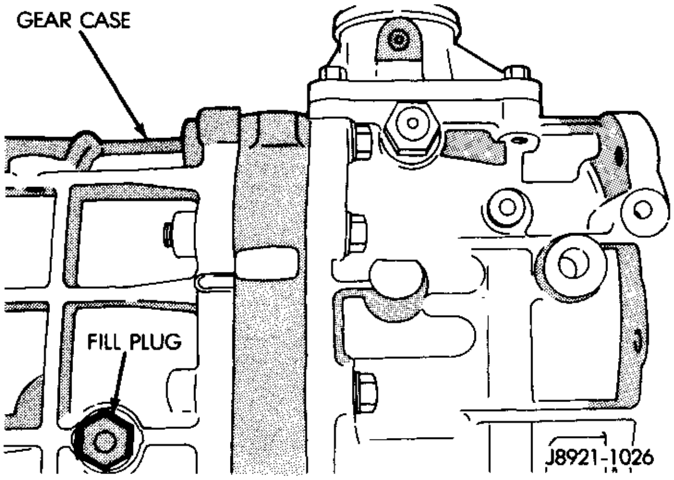


Fig. 4 Fill Plug Location

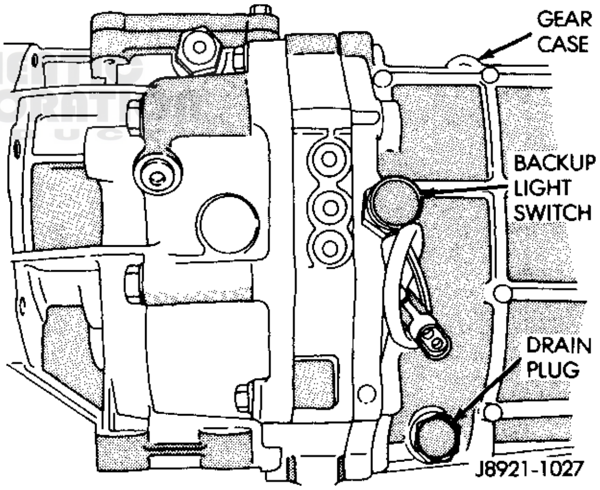


Fig. 5 Drain Plug And Backup Light Switch Location

SERVICE DIAGNOSIS

INDEX

LOW LUBRICANT LEVEL

A low transmission lubricant level is generally the result of a leak, inadequate lubricant fill, or an incorrect lubricant level check.

Leaks can occur at the mating surfaces of the gear case, intermediate plate and adaptor or extension housing, or from the front/rear seals. A suspected leak could also be the result of an overfill condition.

Leaks at the rear of the extension or adapter housing will be from the housing oil seals. Leaks at component mating surfaces will probably be the result of inadequate sealer, gaps in the sealer, incorrect bolt tightening, or use of a non-recommended sealer.

A leak at the front of the transmission will be from either the front bearing retainer or retainer seal. Lubricant may be seen dripping from the clutch housing after extended operation. If the leak is severe, it may also contaminate the clutch disc causing slip, grab and chatter.

Transmissions filled from air or electrically powered lubricant containers can be underfilled. This generally happens when the container delivery mechanism is improperly calibrated. Always check the lubricant level after filling to avoid an under fill condition.

A correct lubricant level check can only be made when the vehicle is level; use a drive-on hoist to ensure this. Also allow the lubricant to settle for a minute or so before checking. These recommendations will ensure an accurate check and avoid an under-or-overfill condition.

HARD SHIFTING

Hard shifting is usually caused by a low lubricant level, inproper or contaminated lubricants, component damage, incorrect clutch adjustment, or by a damaged clutch pressure plate or disc.

Substantial lubricant leaks can result in gear, shift rail, synchro and bearing damage. If a leak goes undetected for an extended period, the first indications of a problem are usually hard shifting and noise.

Incorrect or contaminated lubricants can also contribute to hard shifting. The consequence of using non-recommended lubricants is noise, excessive wear, internal bind and hard shifting.

Improper clutch release is a frequent cause of hard shifting. Incorrect adjustment or a worn, damaged pressure plate or disc can cause incorrect release. If the clutch problem is advanced, gear clash during shifts can result.

Worn or damaged synchro rings can cause gear clash when shifting into any forward gear. In some new or rebuilt transmissions, new synchro rings may tend to stick slightly causing hard or noisy shifts. In most cases, this condition will decline as the rings wear-in.

TRANSMISSION NOISE

Most manual transmissions make some noise during normal operation. Rotating gears can generate a mild whine that may only be audible at extreme speeds.

Severe, obviously audible transmission noise is generally the result of a lubricant problem. Insufficient, improper, or contaminated lubricant can promote rapid wear of gears, synchros, shift rails, forks and bearings. The overheating caused by a lubricant problem, can also lead to gear breakage.

TRANSMISSION REMOVAL/INSTALLATION

Transmission Removal

(1) Shift the transmission into first or third gear.

(2) Raise the vehicle on a hoist.

(3) Support the transmission with an adjustable jack stand and remove the rear crossmember.

(4) Disconnect the transmission shift linkage, speedometer cable, transfer case vacuum lines and the clutch hydraulic lines.

(5) Lower the transmission-transfer case assembly no more than 3 inches for access to the shift lever.

(6) Reach up and around the transmission case and unseat the shift lever dust boot from the transmission shift tower (Fig. 1). Move the boot upward on the shift

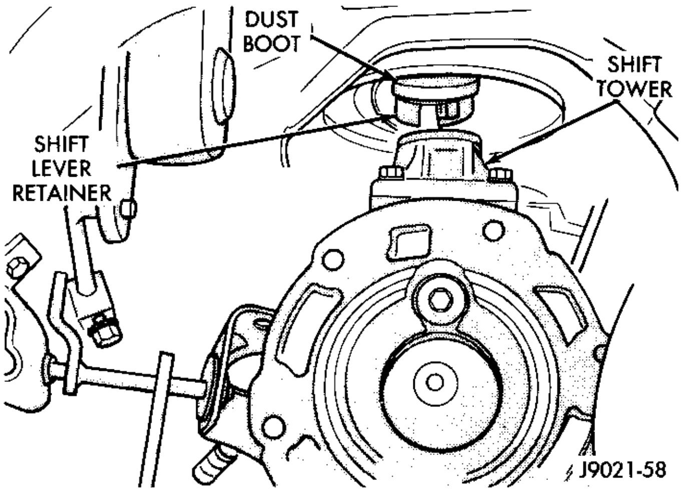


Fig. 1 Removing/Installing Shift Lever

lever for access to the retainer that secures the lever in the tower.

(7) Disengage the shift lever from the transmission as follows: Reach up and around the transmission case and press the shift lever retainer downward with your fingers. Turn the retainer counterclockwise to release it. Then lift the lever and retainer out of the shift tower (Fig. 1). **It is not necessary to remove the shift lever from the floorpan boot. Simply leave the lever in place for later installation.**

(8) Mark the front and rear propeller shafts for installation alignment (Fig. 2). Then remove the propeller shafts.

(9) Disconnect the engine timing sensor (Fig. 3).

(10) Disconnect the transmission and transfer case vent hoses.

(11) Disconnect the clutch master cylinder hydraulic line from the concentric bearing inlet line (Fig. 3).

(12) Support the transmission-transfer case assembly with a transmission jack. Secure the assembly to the jack with safety chains.

(13) Reposition the adjustable jack stand under the engine. Be sure to place a wood block between the jack and oil pan.

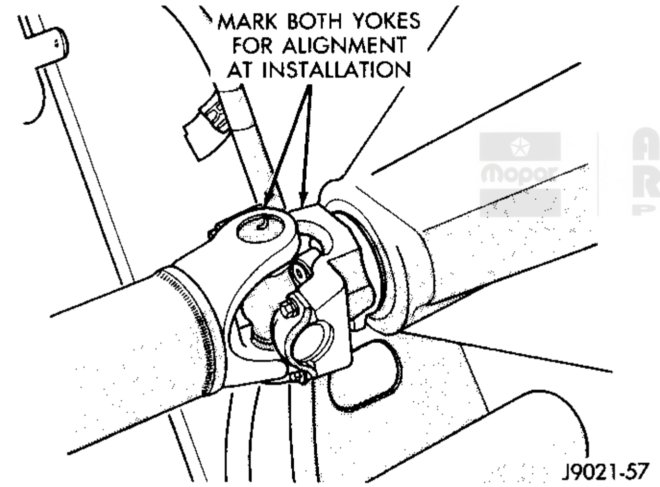


Fig. 2 Mark Propeller Shaft And Axle Yoke For Assembly Reference

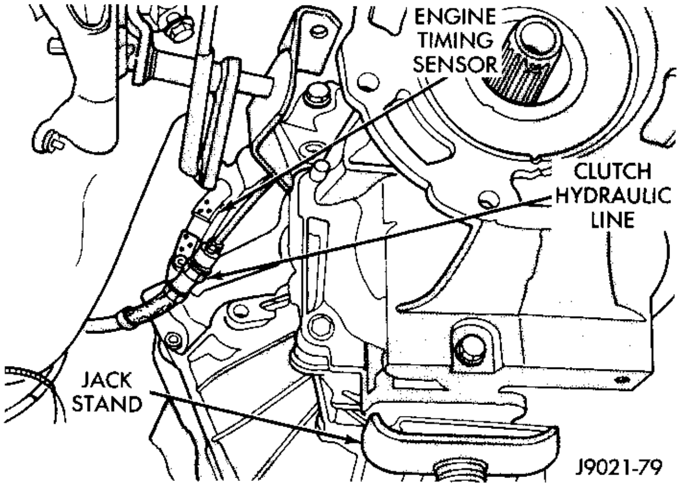


Fig. 3 Timing Sensor And Clutch Hydraulic Line Location

(14) Remove the clutch housing brace rod.

(15) Remove the clutch housing-to-engine bolts and remove the transmission-transfer case assembly.

(16) Remove the bolts attaching the transmission to the transfer case and separate the components.

(17) Remove the concentric bearing and clutch housing from the transmission. Resecure the bearing nylon straps to hold the bearing piston in place.

Transmission Installation

(1) Install the clutch housing on the transmission. Tighten the housing bolts to 37 N•m (27 ft-lbs) torque.

(2) Install the concentric bearing. Secure the bearing to the mounting pin with a new retainer clip.

(3) Mount the transmission on a transmission jack. Secure the transmission with safety chains.

(4) Lightly lubricate the pilot bearing and transmission input shaft splines with Mopar high temperature grease.

(5) Align the transmission input shaft and clutch disc splines and install the transmission.

(6) Install and tighten the clutch housing-to-engine bolts to 38 N•m (28 ft-lbs) torque. **Be sure the housing is properly seated on the engine block before tightening the bolt.**

(7) Lower the transmission no more than 3 inches for access to the shift tower.

(8) Reach up and around the transmission and insert the shift lever in the shift tower. Press the lever retainer downward and turn it clockwise to lock it in place. Then install the lever dust boot on the shift tower.

(9) Connect the concentric bearing hydraulic line and the engine timing sensor.

(10) Remove the jack from under the transmission and mount the transfer case on the jack.

(11) Align the transfer case and transmission shafts and install the transfer case. Tighten the transfer case-to-transmission nuts/bolts to 35 N•m (26 ft-lbs) torque.

(12) Move the jack stand from under the engine and reposition it under the transmission. Then remove the transmission jack.

(13) Connect the transfer case vacuum hoses and linkage.

(14) Connect the transmission and transfer case vent hoses.

(15) Connect the backup light switch switch wires.

(16) Connect the speedometer cable.

(17) Install the rear crossmember. Tighten the crossmember-to-frame bolts to 41 N•m (30 ft-lbs) torque. Tighten the transmission-to-rear support bolts/nuts to 45 N•m (33 ft-lbs) torque.

(18) Align and install the front/rear propeller shafts. Tighten the shaft U-joint clamp bolts to 19 N•m (170 in-lbs) torque.

(19) Top off the transmission and transfer lubricant levels and lower the vehicle.

TRANSMISSION OVERHAUL — AX 15

INDEX

TRANSMISSION DISASSEMBLY

Adapter/Extension Housing Removal

(1) Remove the hydraulic throwout bearing, clutch housing and shift lever if not previously removed.

(2) On 2-wheel drive models, remove the extension housing seal (Fig. 1).

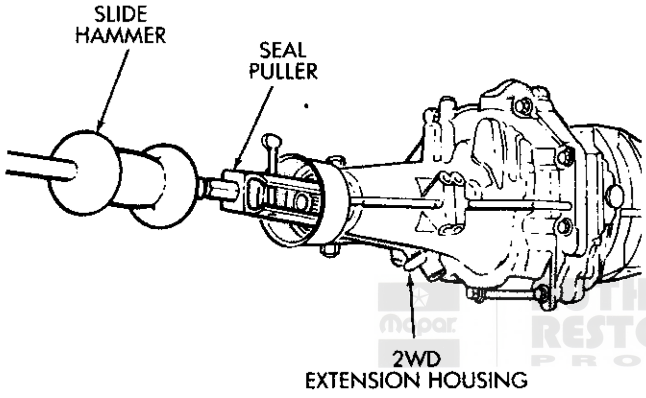


Fig. 1 Removing 2-Wheel Drive Extension Housing Seal

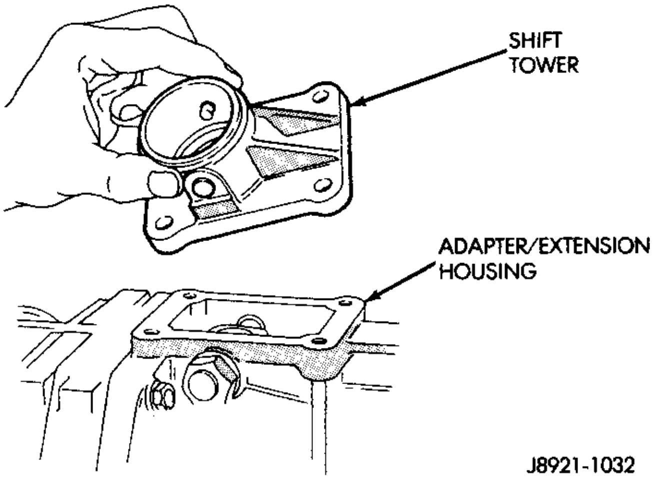


Fig. 2 Shift Tower Removal/Installation

(3) Remove the shift tower bolts and remove the tower from the adapter or extension housing (Fig. 2).

(4) Remove the gasket from the shift tower (Fig. 3).

(5) Remove the shift arm retainer bolt (Fig. 4).

(6) Loosen and remove the restrictor pins (Fig. 5).

(7) Remove the shift arm shaft plug (Fig. 6).

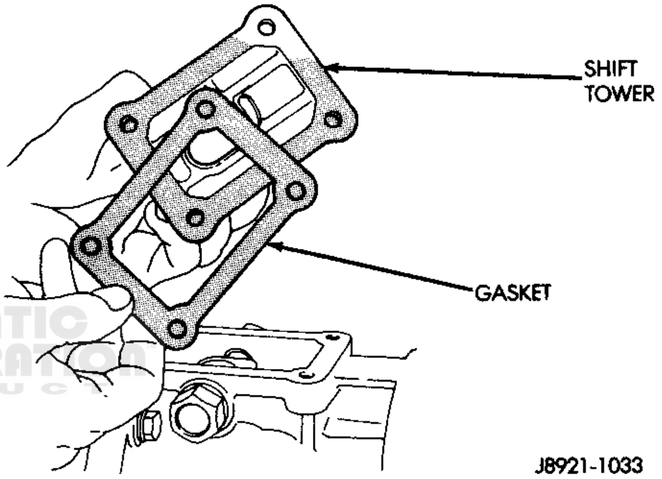


Fig. 3 Shift Tower Gasket Removal/Installation

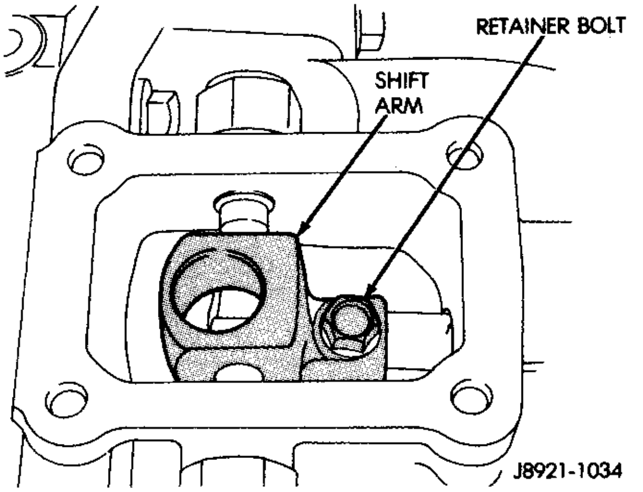


Fig. 4 Shift Arm Retainer Bolt Removal/Installation

(8) Remove the shift arm shaft with a large magnet (Fig. 7).

(9) Remove the shift arm (Fig. 8).

(10) Remove the plug for the reverse shift head lock ball. The plug is at the right side of the adapter housing near the backup light switch (Fig. 9).

(11) Remove the lock ball spring with a pencil magnet (Fig. 10).

(12) Remove the shift head lock ball with a pencil magnet (Fig. 11).

(13) Remove the backup light switch from the adapter/extension housing.

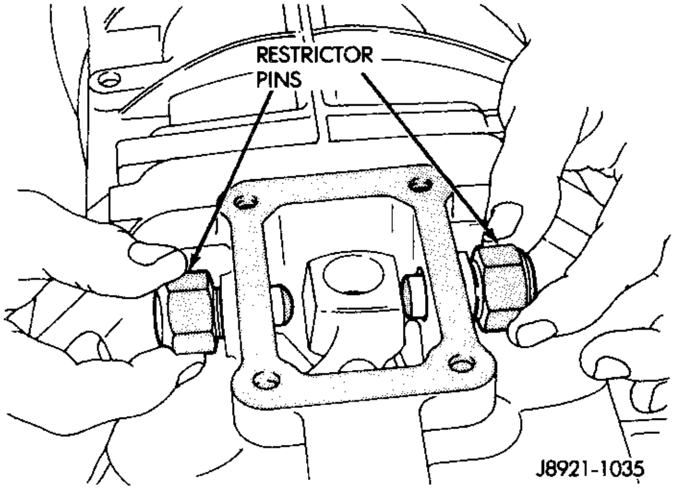


Fig. 5 Removing/Installing Restrictor Pins

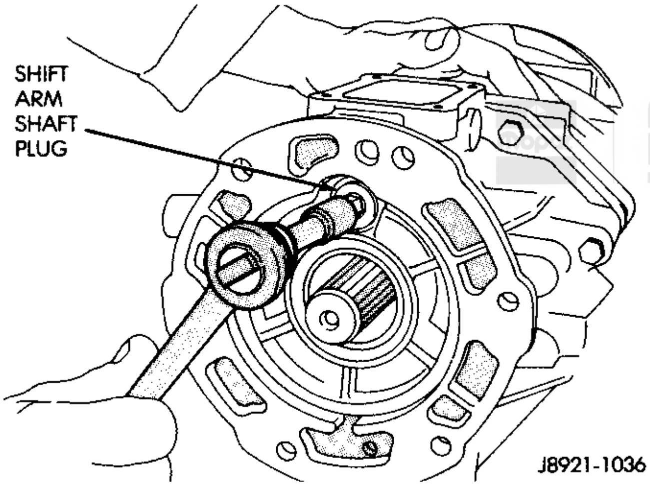


Fig. 6 Removing/Installing Shift Lever Shaft Plug

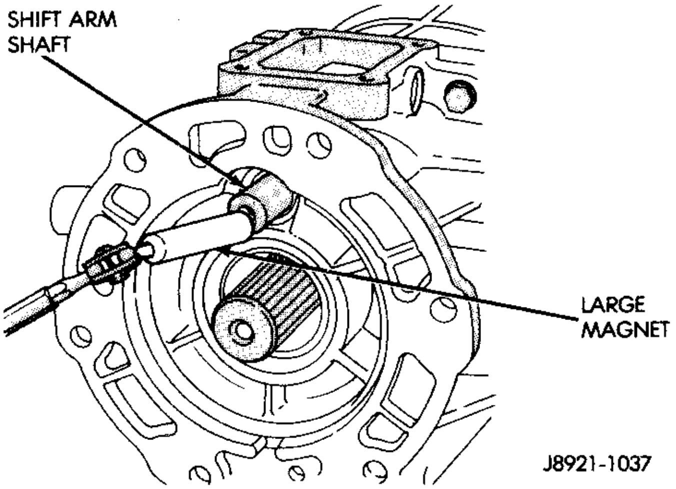


Fig. 7 Removing/Installing Shift Lever Shaft

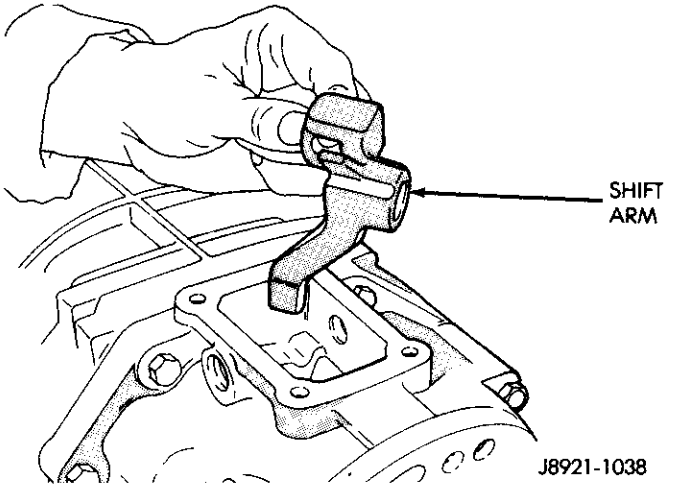


Fig. 8 Shift Arm Removal/Installation

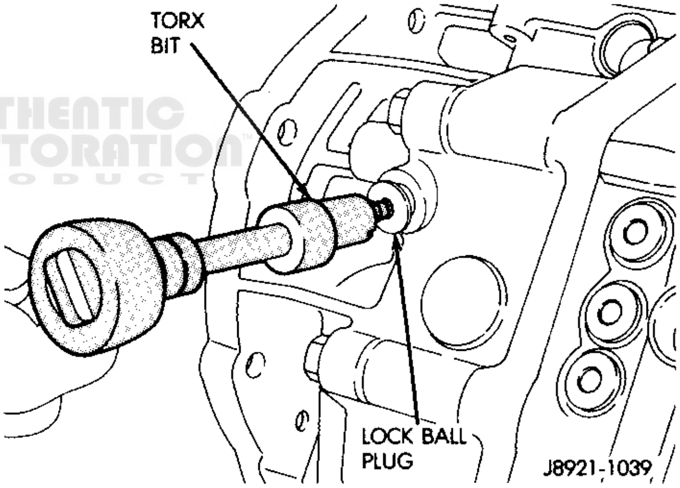


Fig. 9 Removing/Installing Lock Ball Plug

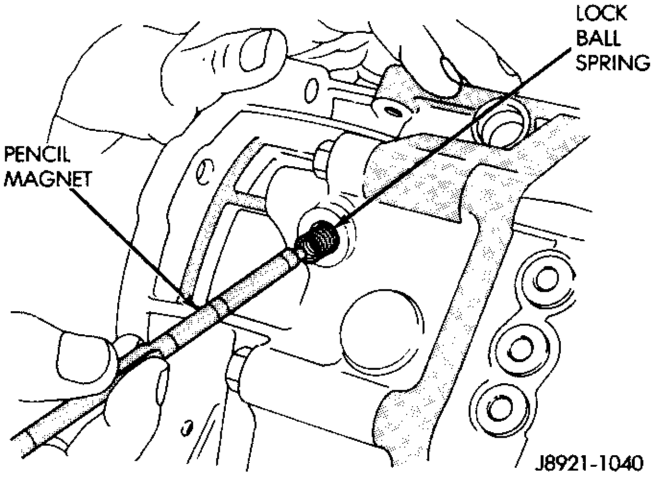


Fig. 10 Removing/Installing Lock Ball Spring

(14) On 2-wheel drive models, remove the speedometer driven gear assembly if not removed previously.

(15) Remove the adapter/extension housing bolts (Fig. 12).

(16) Loosen the adapter/extension housing by tapping the housing with a rubber face mallet (Fig. 13).

(17) Remove the adapter housing after loosening it (Fig. 14)

(18) Remove the adapter housing oil seal with a pry tool (Fig. 15).

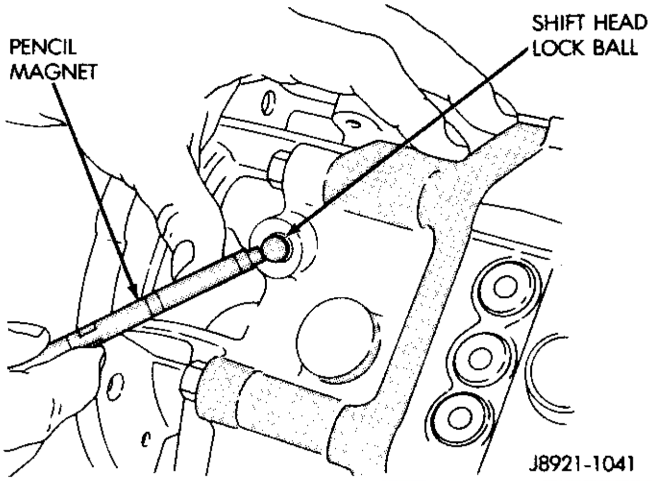


Fig. 11 Removing/Installing Shift Head Lock Ball

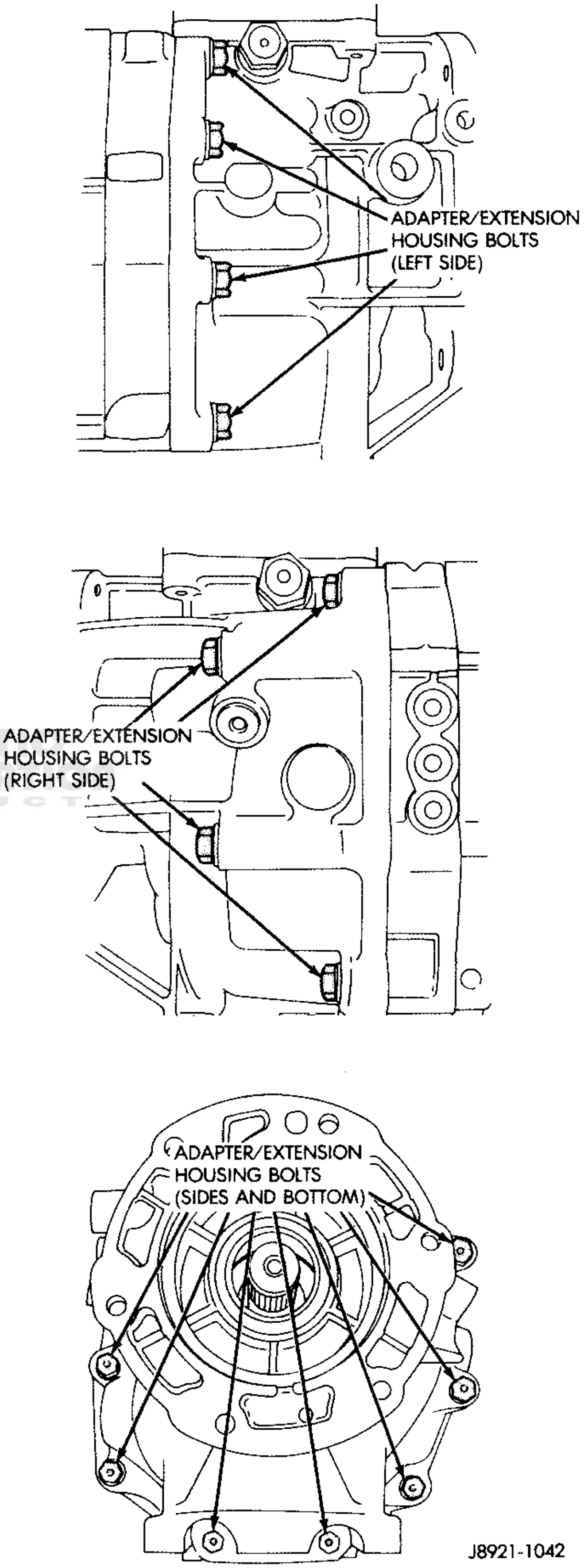


Fig. 12 Adapter Housing Bolt Locations

Gear Case Removal

(1) Remove the bearing retainer bolts and remove the retainer (Fig. 16).

(2) Remove the retainer oil seal with a pry tool (Fig. 17).

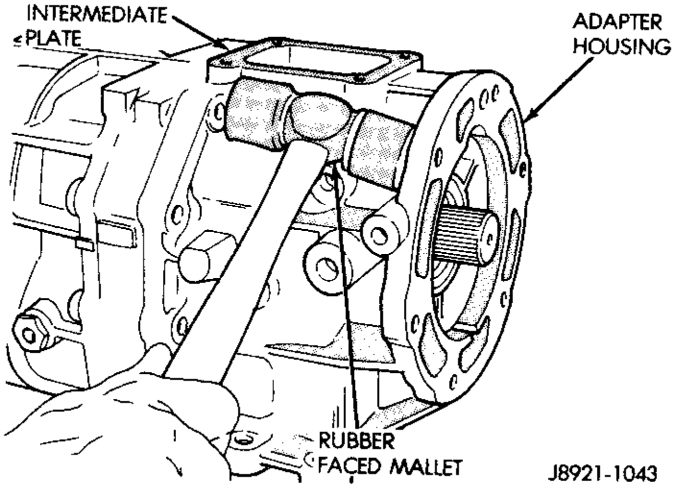


Fig. 13 Loosening Adapter Housing

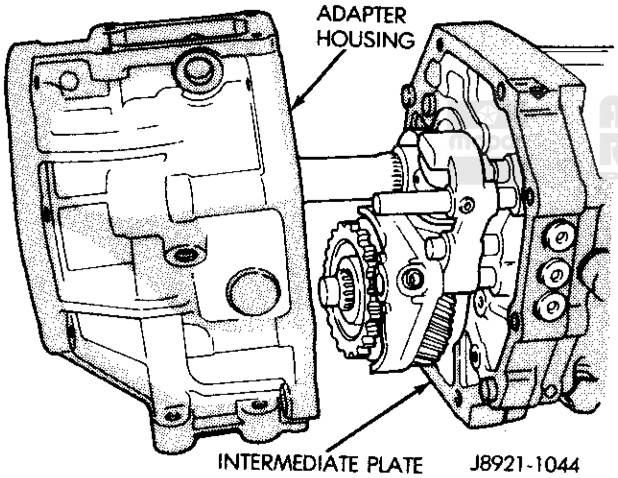


Fig. 14 Adapter Housing Removal

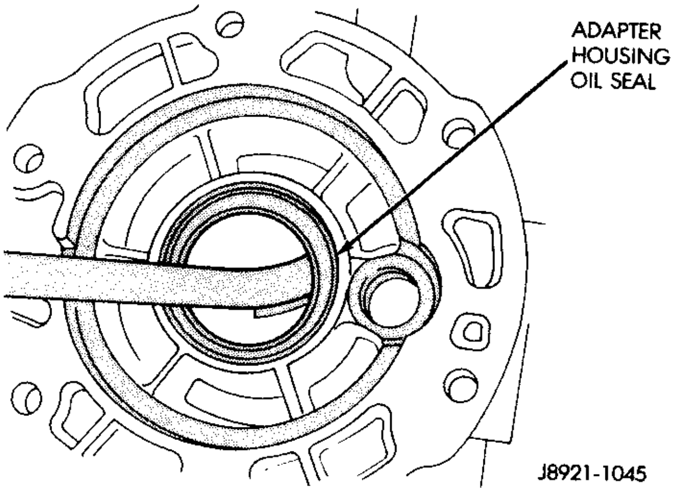


Fig. 15 Removing Adapter Housing Seal

(3) Remove the input shaft bearing snap ring (Fig. 18).

(4) Remove the cluster gear front bearing snap ring (Fig. 19).

(5) Loosen the gear case by tapping it away from the intermediate plate with a rubber mallet (Fig. 20).

(6) Remove the gear case from the geartrain and intermediate plate (Fig. 21).

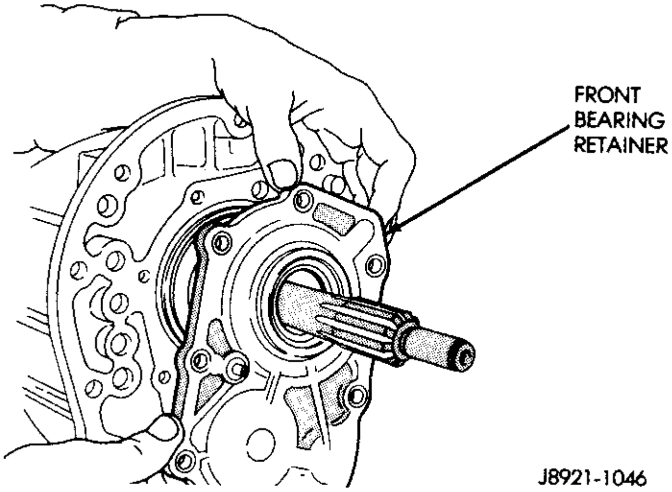


Fig. 16 Front Bearing Retainer Removal

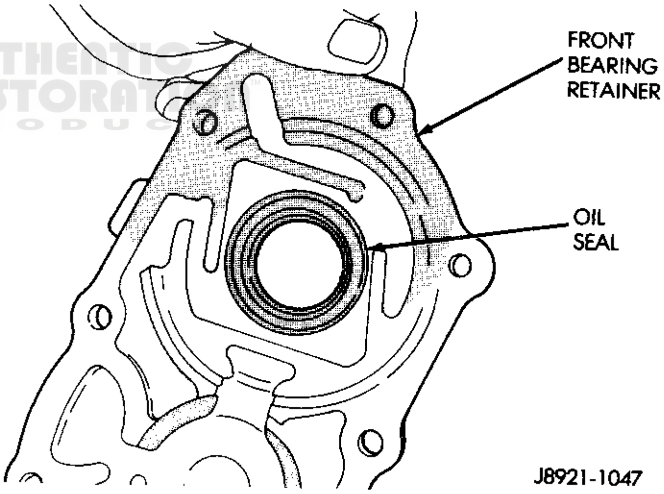


Fig. 17 Front Bearing Retainer Seal Location

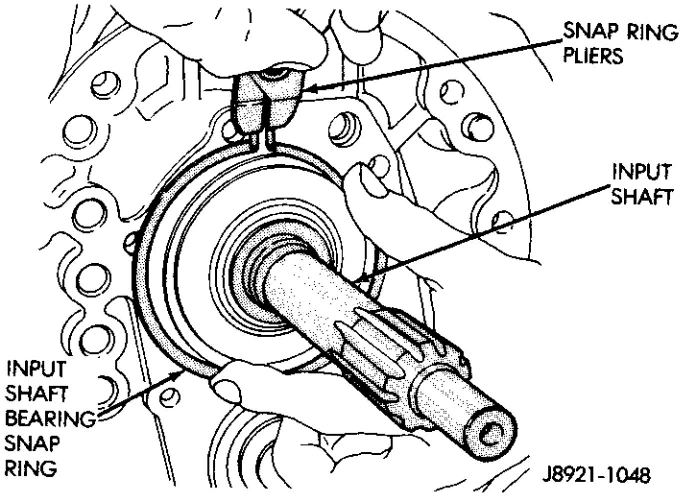


Fig. 18 Removing Input Shaft Bearing Snap Ring

(7) On 2WD models, remove the speedometer gear snap ring and remove the speedometer gear and spacer from the output shaft.

Fifth Gear And Synchro Assembly Removal

(1) Remove the three lock ball plugs from the intermediate plate (Fig. 22).

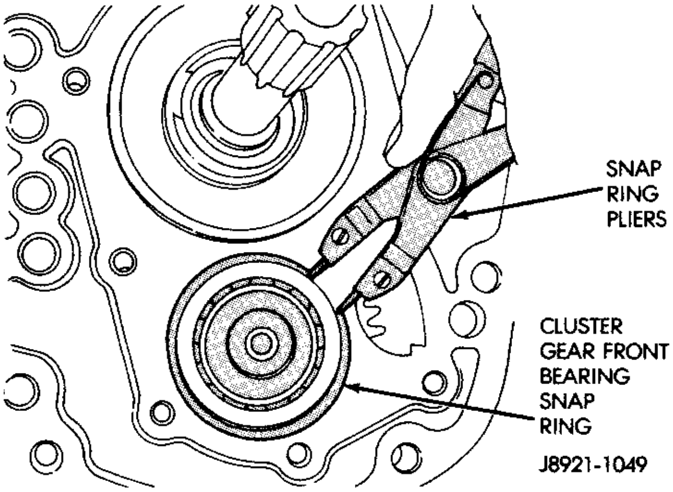


Fig. 19 Removing Cluster Gear Front Bearing Snap Ring

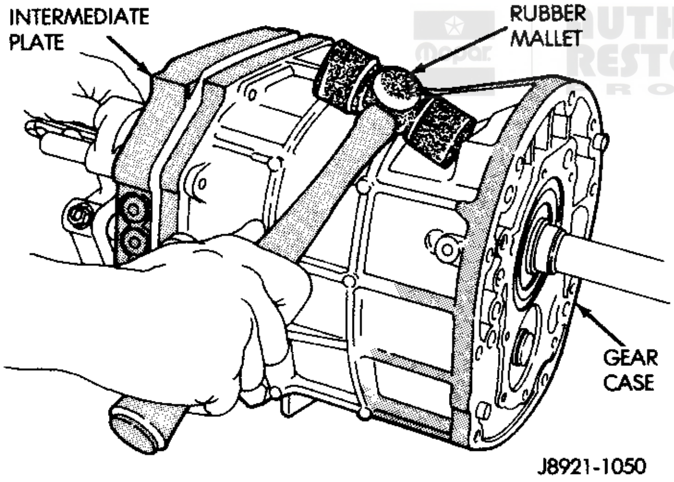
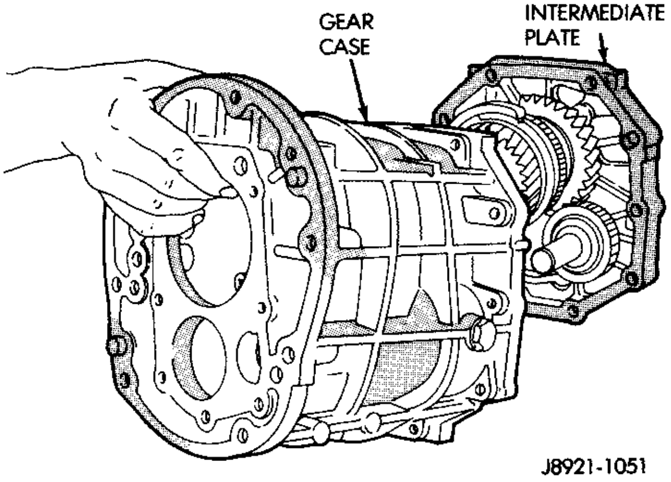


Fig. 20 Loosening Gear Case



(2) Remove the three lock ball springs and lock balls from the intermediate plate with a pencil magnet (Fig. 23).

(3) Mount the intermediate plate and geartrain assembly in a vise as follows:

(a) Insert two spare bolts in one of the bottom bolt holes in the intermediate plate. Insert the bolts from the opposite sides of the plates (Fig. 24).

(b) Install enough flat washers under each bolt head to prevent the two bolts from touching (Fig. 24).

(c) Tape the bolts and washers in place and mount the intermediate plate in the vise (Fig. 24).

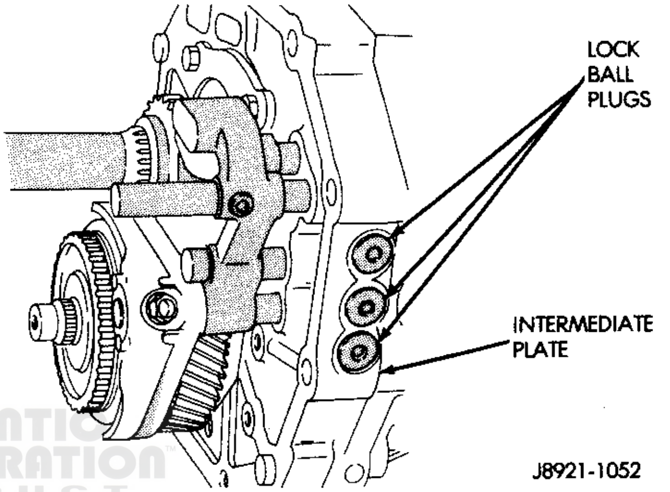


Fig. 22 Lock Ball Plug Locations

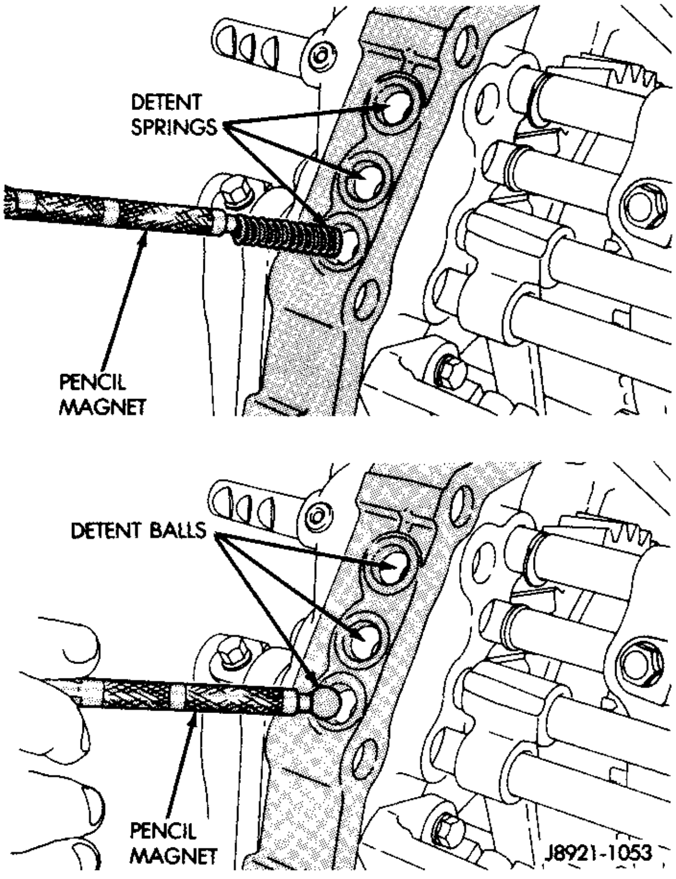


Fig. 23 Removing/Installing Lock Ball And Spring

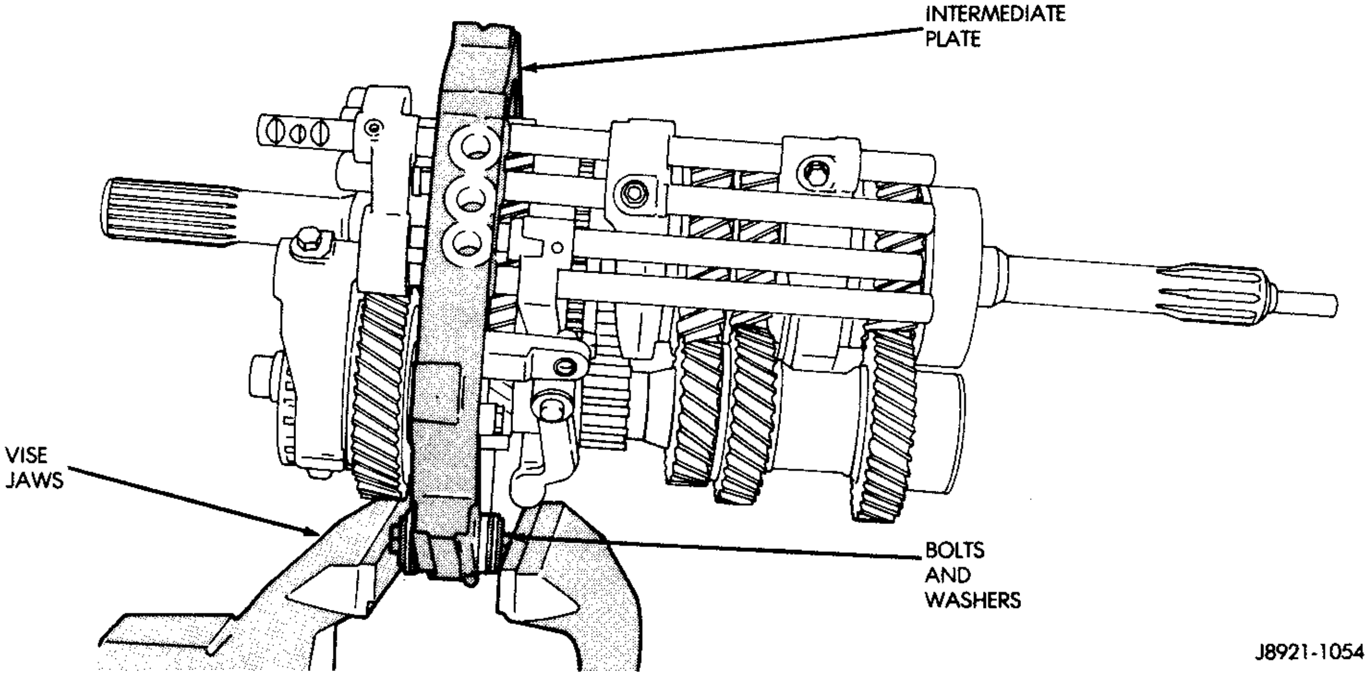


Fig. 24 Mounting Intermediate Plate And Geartrain In Vise

(d) Clamp the vise jaws securely against the bolt heads (Fig. 24). **Do not clamp the vise jaws on the intermediate plate. Clamp only on the bolt heads.**

(4) Remove the fifth gear snap ring (Fig. 25). Retain the snap ring for assembly reference. It is a select fit component.

(5) Remove the E-ring that secures the reverse shift arm to the fork (Fig. 26).

(6) Remove the bolts attaching the reverse shift arm bracket to the intermediate plate. Then remove the bracket (Fig. 27).

(7) Remove the reverse shift arm and shoe (Fig. 28).

(8) Remove the fifth gear shift fork set screw (Fig. 29).

(9) Move the fifth gear shift rail forward until it clears the shift fork.

(10) Remove the fifth gear shift fork from the synchro sleeve (Fig. 30).

(11) Remove the reverse shift rail and the reverse shift head as an assembly (Fig. 31).

(12) Measure thrust clearance between the counter fifth gear and the thrust ring with a feeler gauge. Clearance should be .10 to .40 mm (.003 to .019 in). If clearance exceeds limits, the gear and/or ring will have to be replaced.

(13) Loosen the fifth spline gear with a standard two-jaw puller (Fig. 32). Position the puller jaws behind the fifth **counter** gear as shown.

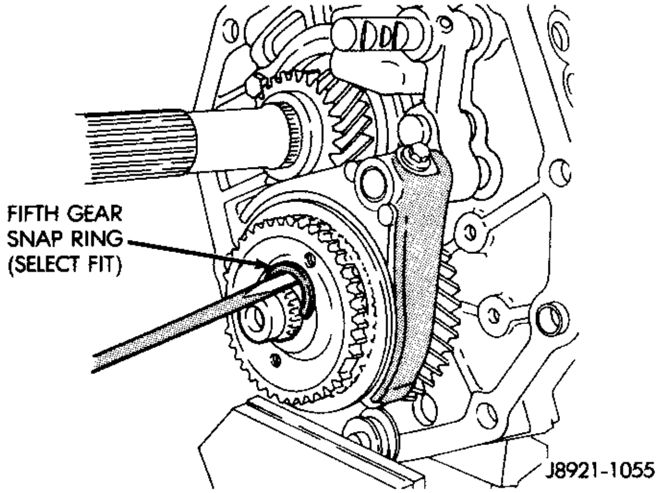


Fig. 25 Fifth Gear Snap Ring Removal

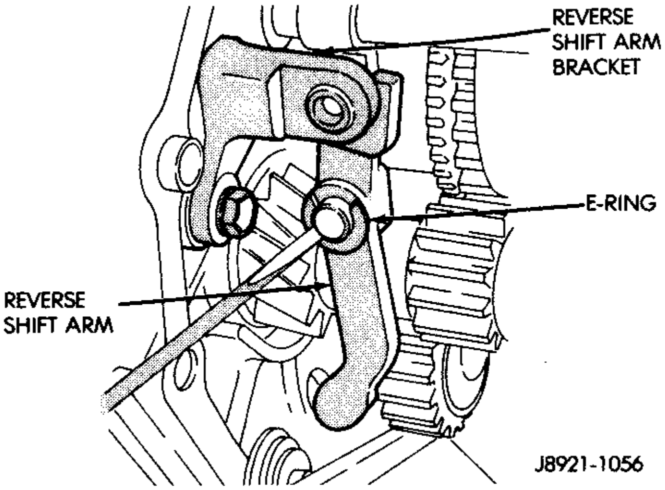


Fig. 26 Removing Reverse Shift Arm E-Ring

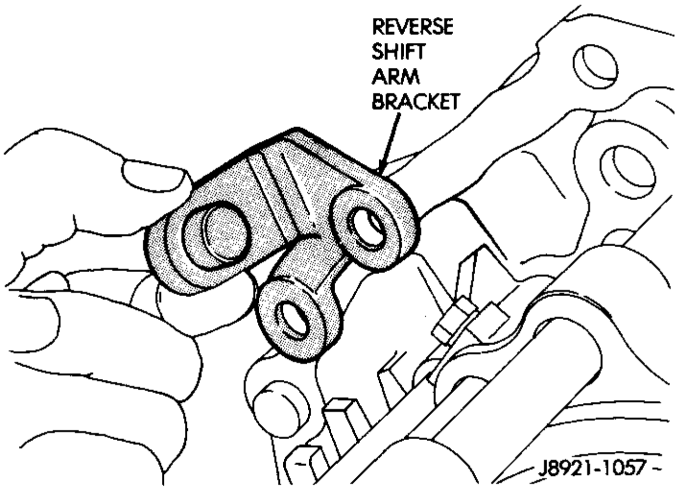


Fig. 27 Removing Reverse Shift Arm Bracket

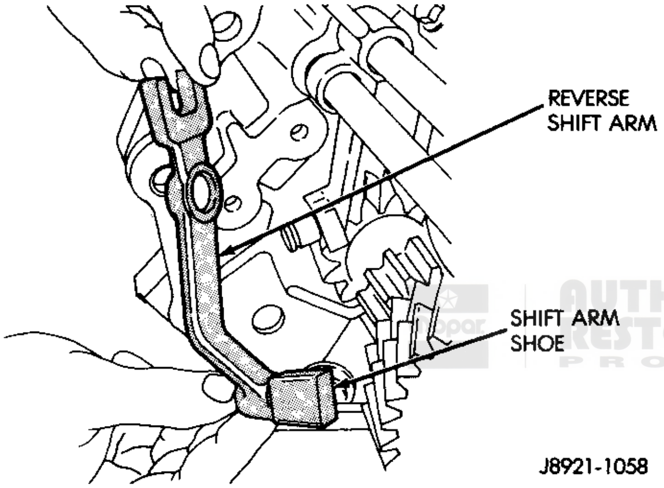


Fig. 28 Removing Reverse Shift Arm And Shoe

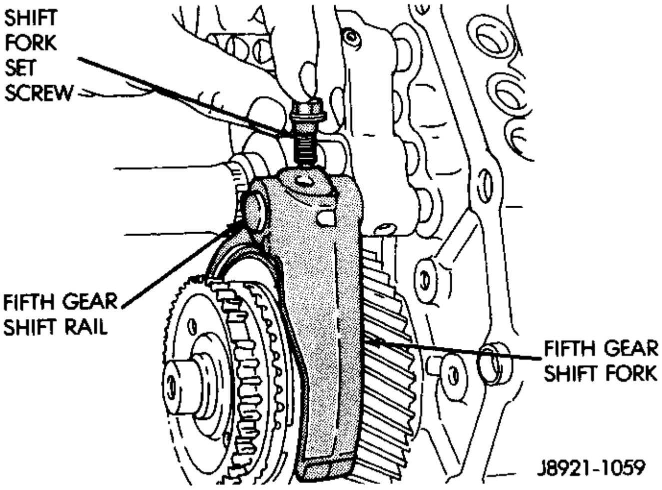


Fig. 29 Removing Fifth Gear Fork Set Screw

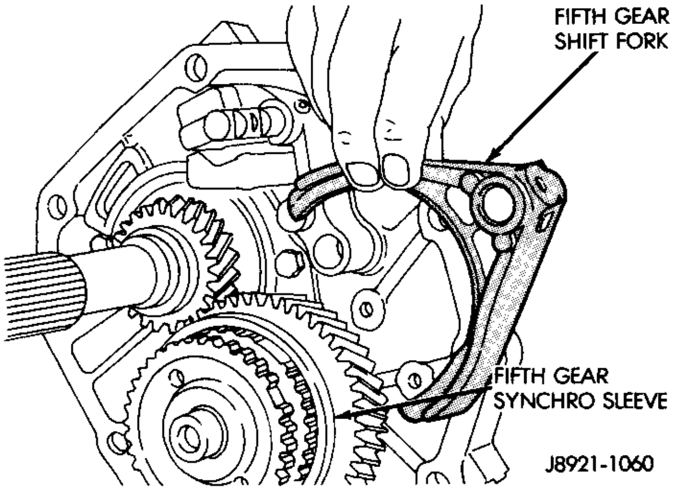


Fig. 30 Removing Fifth Gear Shift Fork

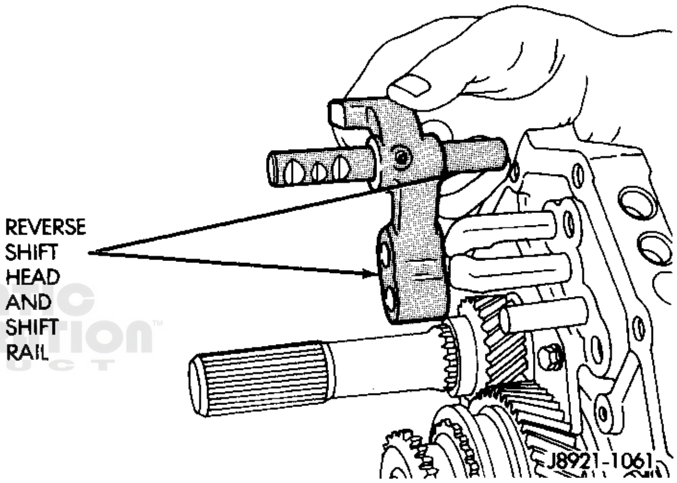


Fig. 31 Removing Reverse Shift Head And Rail

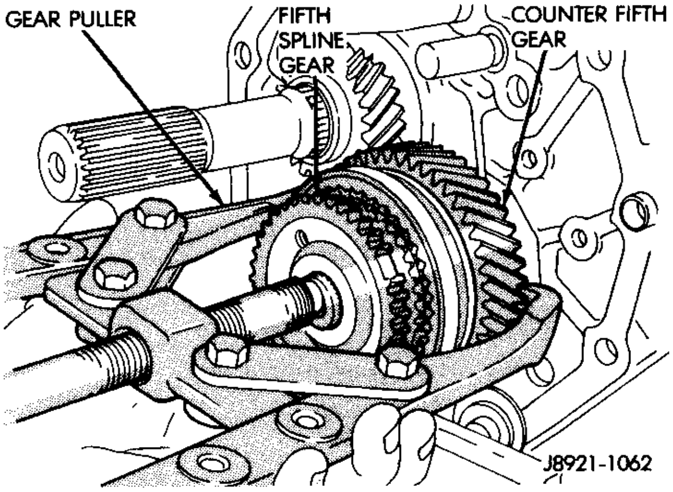


Fig. 32 Loosening Fifth Spline Gear

(14) Remove the fifth spline gear (Fig. 33).

(15) Remove the fifth gear synchro ring (Fig. 34).

(16) Remove the fifth gear synchro and sleeve assembly (Fig. 35).

(17) Remove the counter fifth gear thrust ring (Fig. 36).

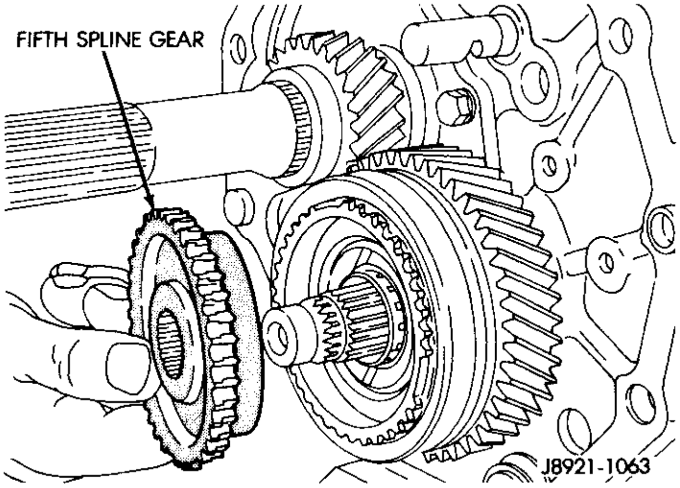


Fig. 33 Removing Fifth Spline Gear

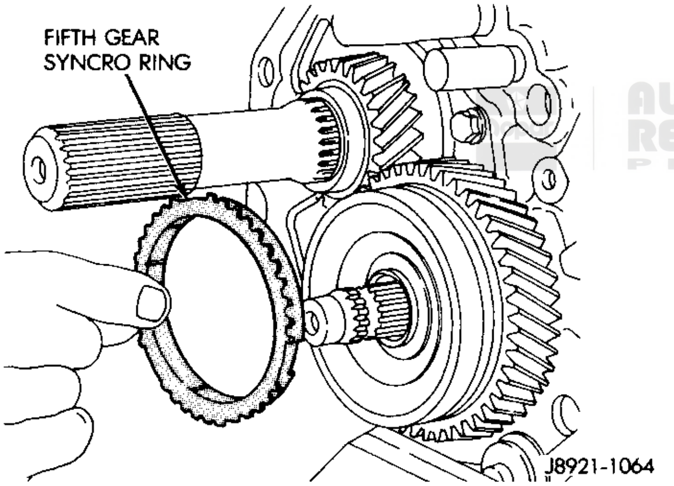


Fig. 34 Removing Fifth Gear Synchro Ring

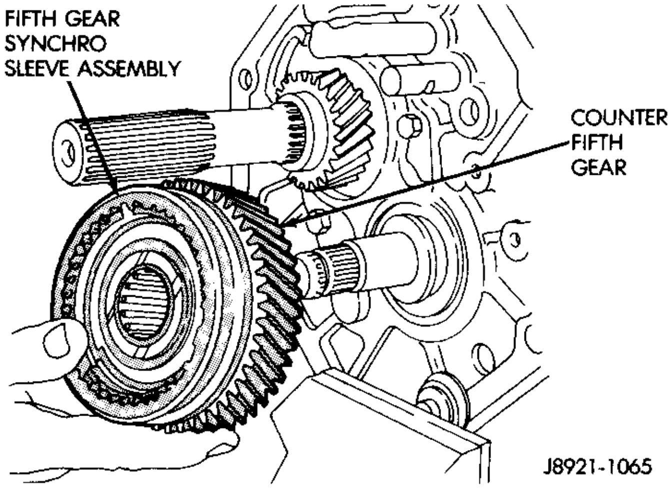


Fig. 35 Removing Counter Fifth Gear And Synchro Assembly

(18) Remove the thrust ring lock ball with a pencil magnet (Fig. 37).

(19) Remove the bolts attaching the output shaft rear bearing retainer to the intermediate plate (Fig. 38).

(20) Remove the rear bearing retainer (Fig. 39).

(21) Remove the reverse gear and shaft (Fig. 40).

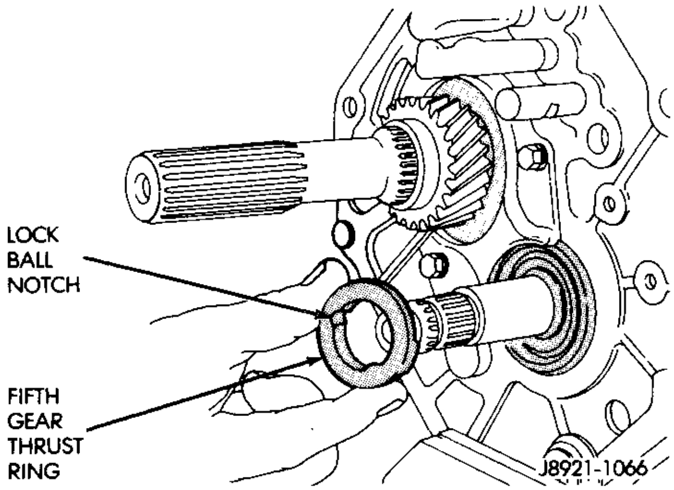


Fig. 36 Removing Fifth Gear Thrust Ring

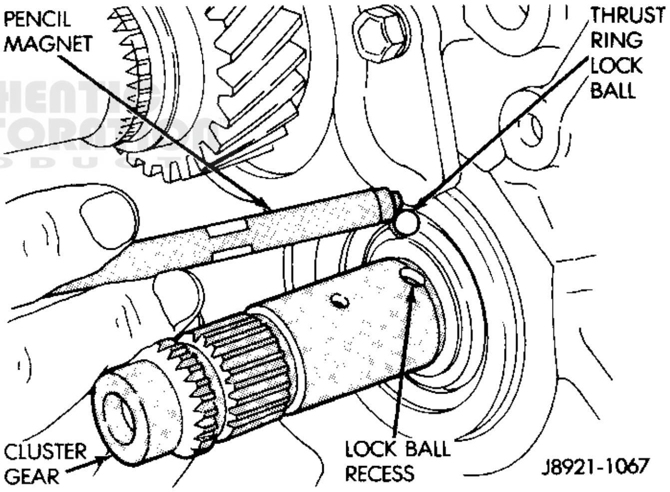


Fig. 37 Removing Thrust Ring Lock Ball

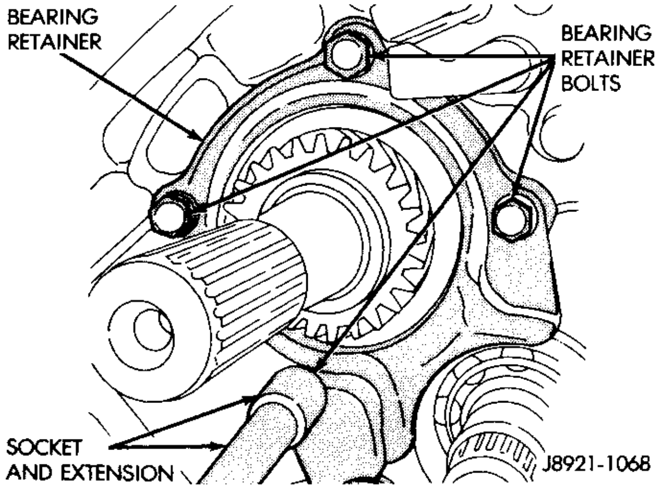


Fig. 38 Removing Output Shaft Rear Bearing Retainer Bolts

Shift Rail And Fork Removal

There are a total of five shift rails in the AX 15 transmission. The 1-2, 3-4, fifth gear and front reverse shift rails are shown in Figure 41. Two shift rails are used for reverse gear range. The front reverse rail is at the forward side of the intermediate plate (Fig. 41). The short rear reverse rail and reverse shift head are at the rear side of the intermediate plate.

It is not necessary to remove the shift rails if they do not require service during overhaul. Only the shift forks need be removed for access to the shafts and gears.

(1) Remove the fifth gear shift rail (Fig. 41). Catch the lock ball in your hand as the rail comes out of the intermediate plate.

(2) Remove the 1-2 and 3-4 shift rail C-rings with two screwdrivers of equal size and length (Fig. 42).

(3) Remove the shift fork set screws (Fig. 43).

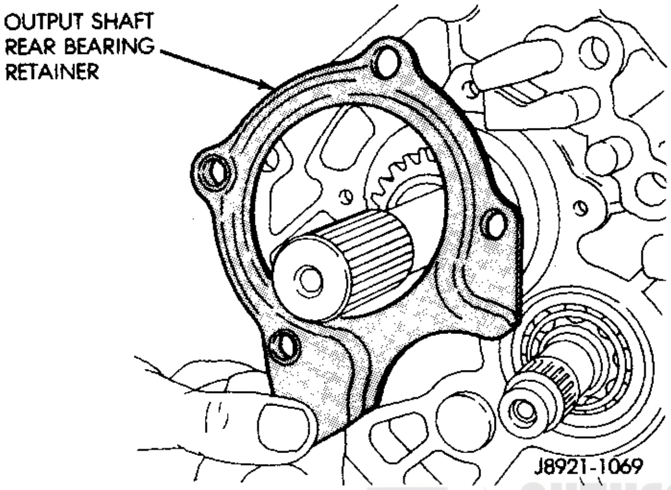


Fig. 39 Removing Output Shaft Rear Bearing Retainer

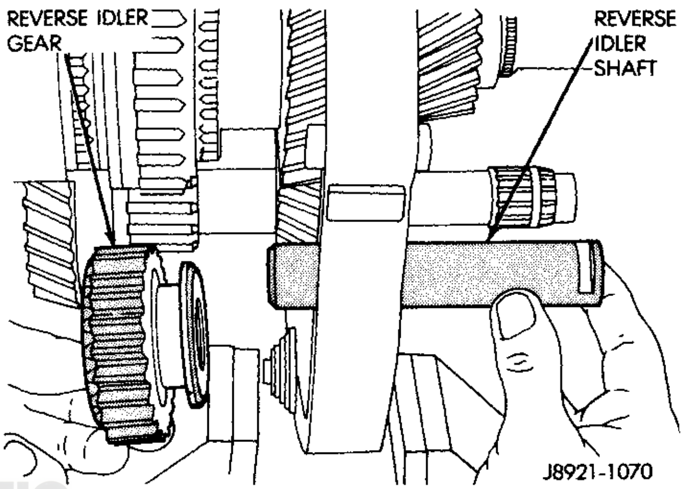


Fig. 40 Removing Reverse Idler Gear And Shaft

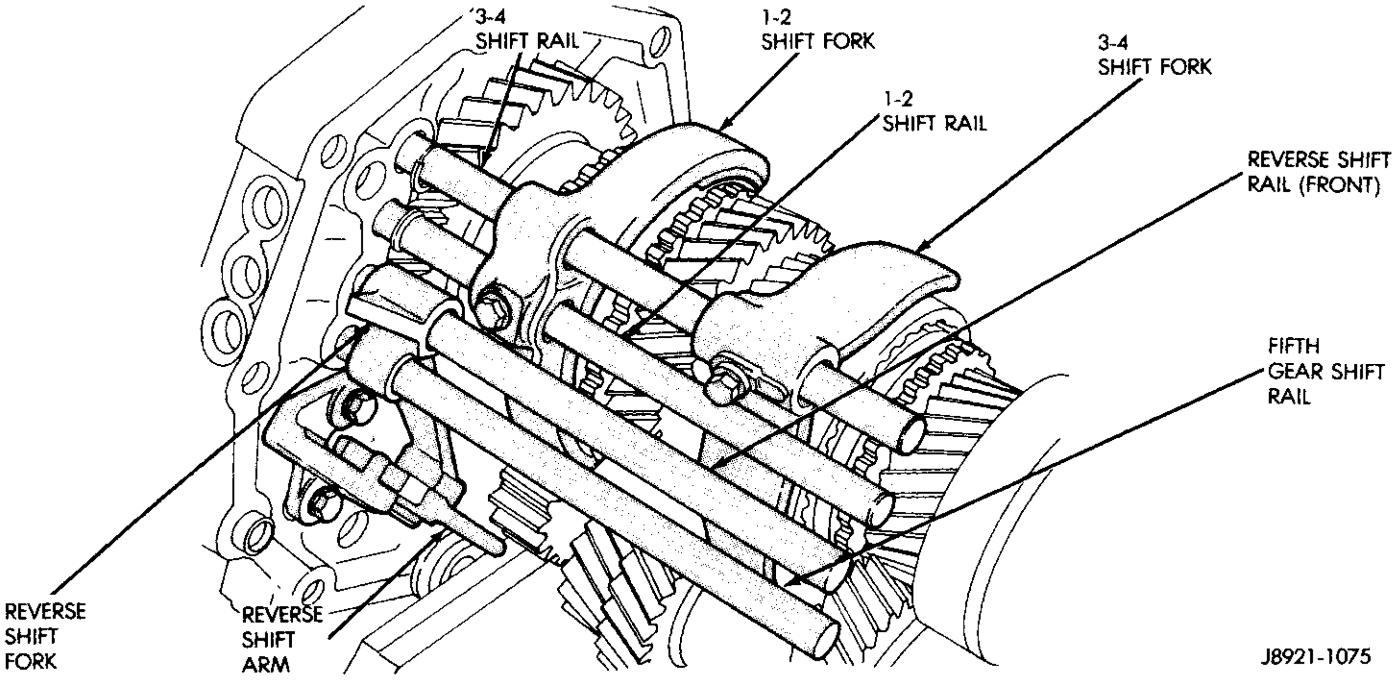


Fig. 41 Shift Rail Identification

(4) Remove the 3-4 shift rail from the shift fork and intermediate plate (Fig. 44).

(5) Remove the 3-4 shift rail interlock plug from the intermediate plate with a magnet (Fig. 45).

(6) Remove the 1-2 shift rail from the shift fork and intermediate plate (Fig. 46).

(7) Remove the 1-2 shift rail interlock pin from the shift rail (Fig. 47).

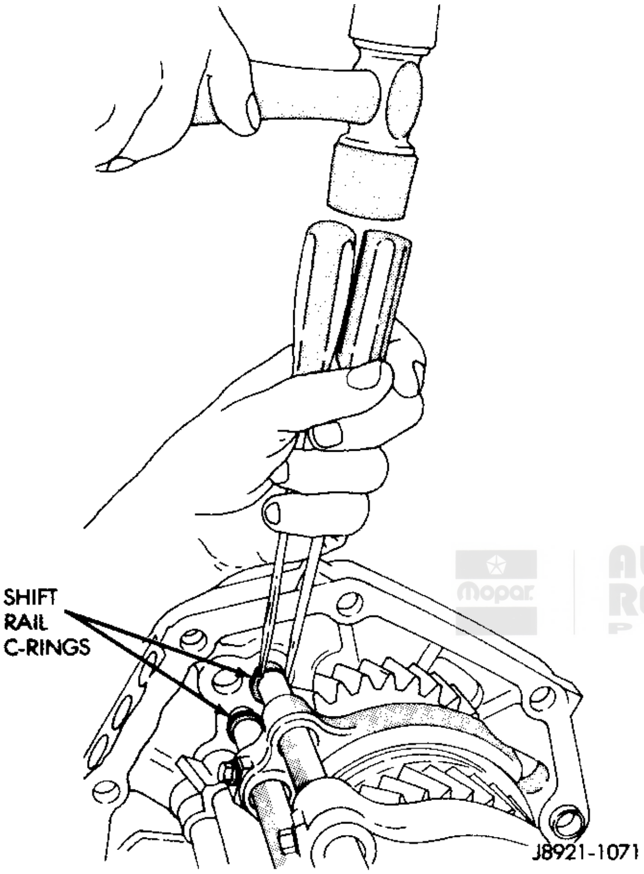


Fig. 42 Removing Shift Rail C-Rings

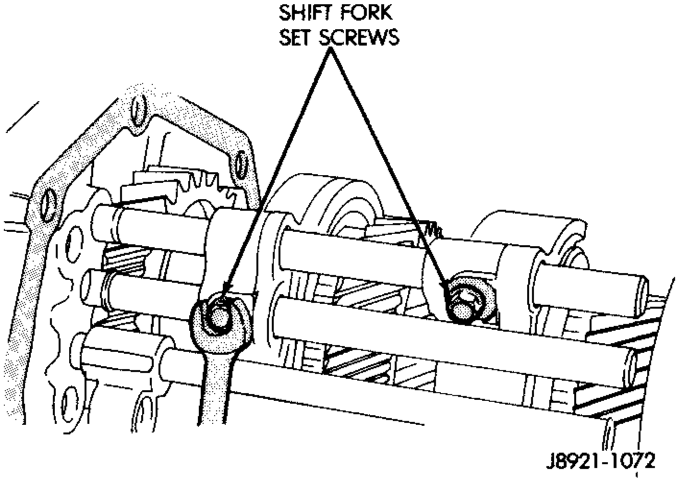


Fig. 43 Removing Shift Fork Set Screws

(8) Remove the 1-2 shift rail interlock plug from the intermediate plate (Fig. 48).

(9) Lift the reverse shift fork upward and remove the fifth gear shift rail lock ball (Fig. 49).

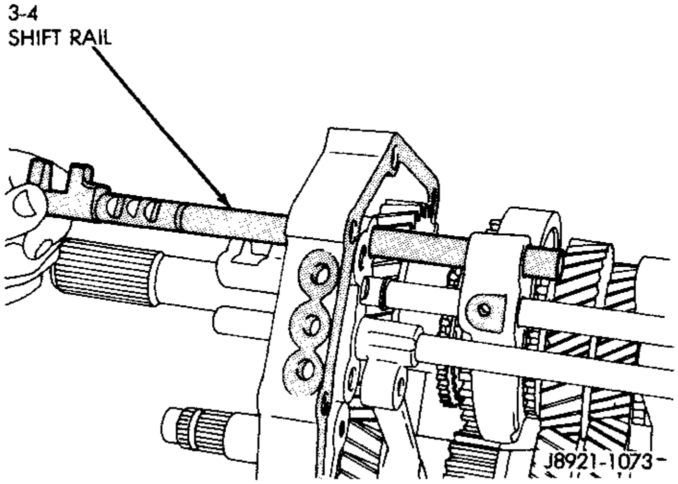


Fig. 44 Removing 3-4 Shift Rail

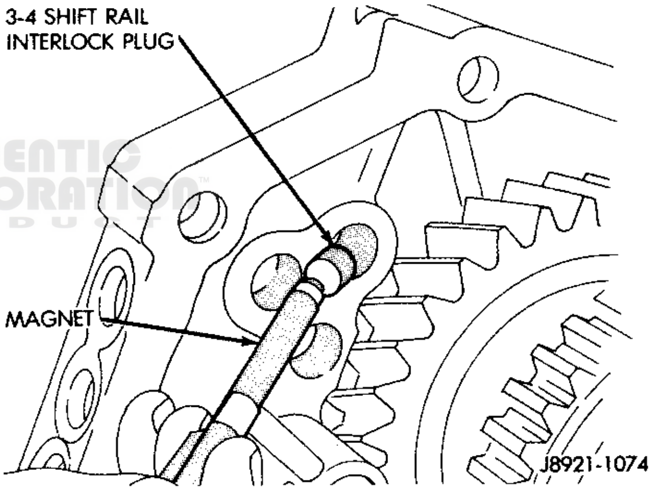


Fig. 45 Removing 3-4 Shift Rail Interlock Plug

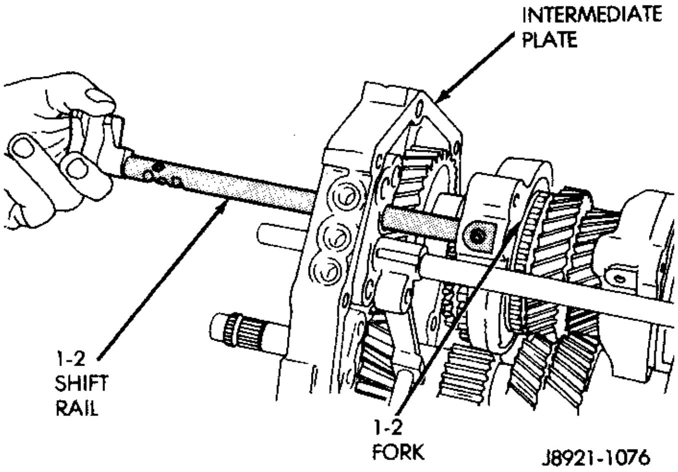


Fig. 46 Removing 1-2 Shift Rail

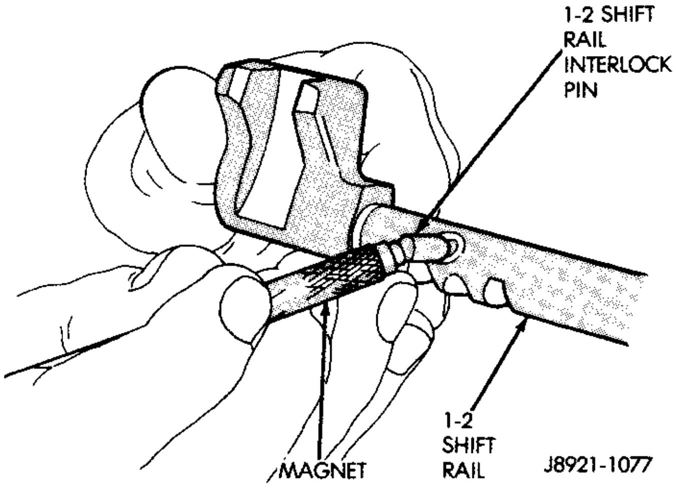


Fig. 47 Removing 1-2 Shift Rail Interlock Pin

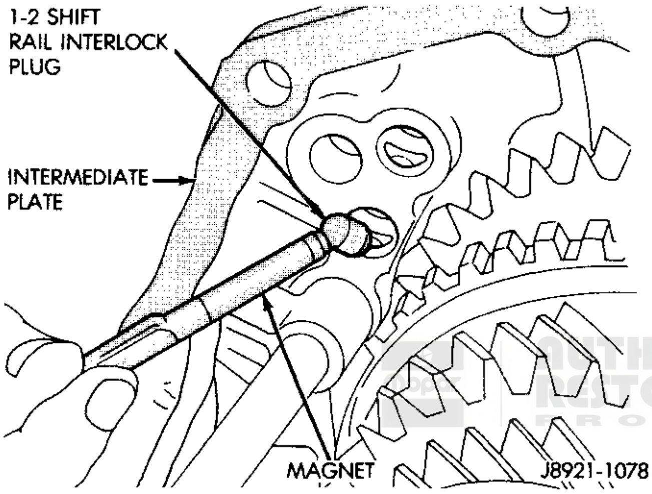


Fig. 48 Removing 1-2 Shift Rail Interlock Plug

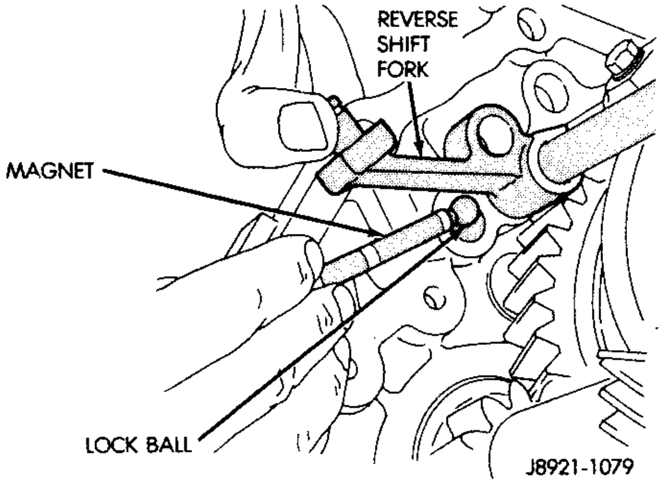


Fig. 49 Removing Fifth Gear Shift Rail Lock Ball

(10) Remove the 3-4 shift fork (Fig. 50).

(11) Remove the 1-2 shift fork (Fig. 50).

(12) Remove the reverse shift rail C-ring with two equal length and size screwdrivers (Fig. 51).

(13) Remove the reverse shift rail and fork (Fig. 52).

(14) Remove the interlock pin from the reverse shift rail (Fig. 53).

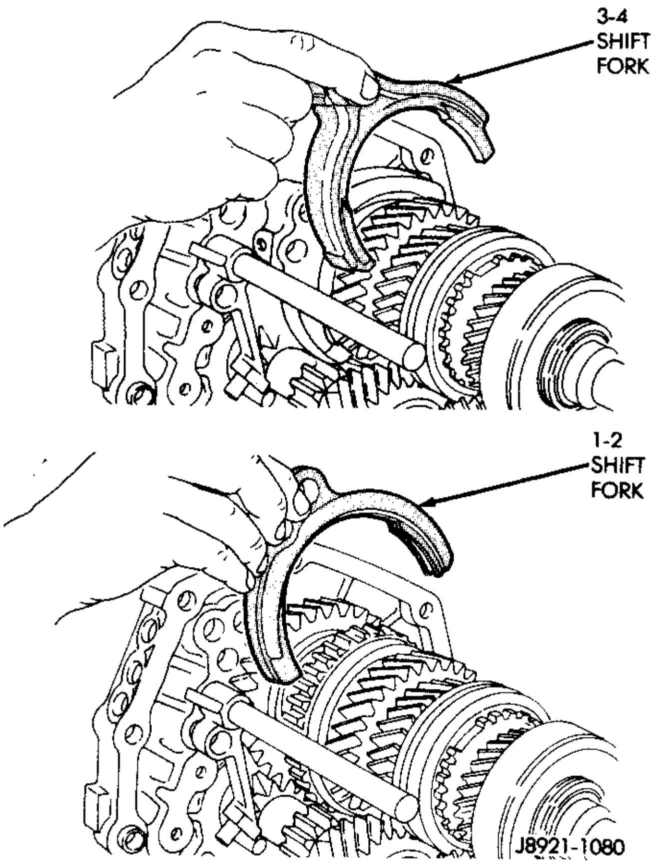
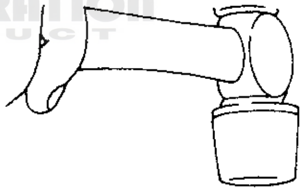


Fig. 50 Shift Fork Removal



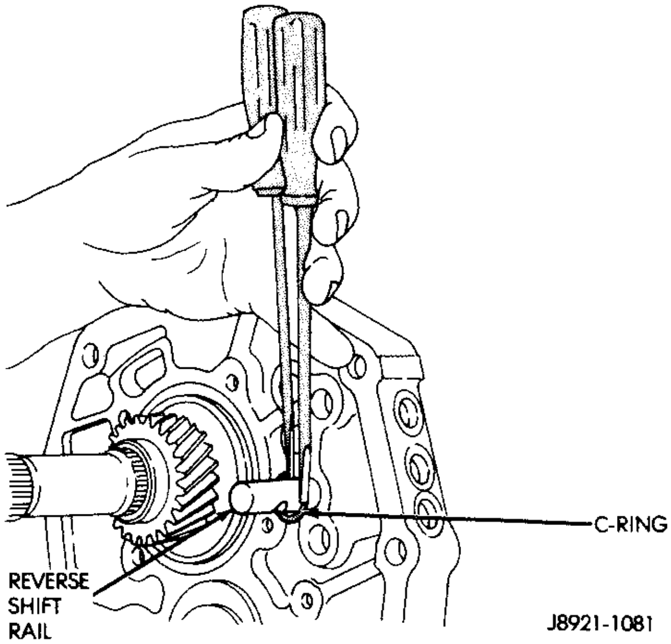


Fig. 51 Removing Reverse Shift Rail C-Ring

(15) Position the shift rails, shift forks, lock balls, interlock plugs and interlock pins on the workbench in order of removal. This will help in identifying the components during inspection and assembly.

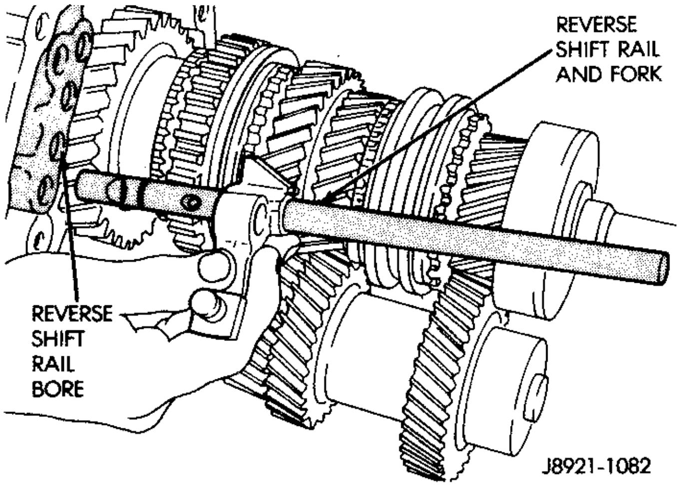


Fig. 52 Removing Reverse Shift Rail And Fork

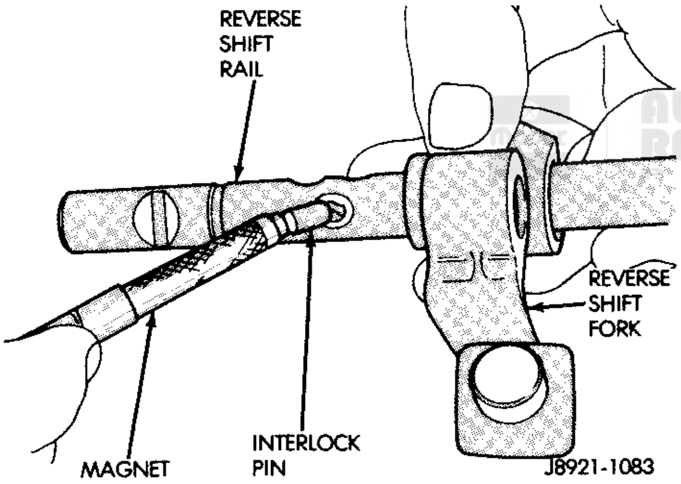


Fig. 53 Removing Reverse Shift Rail Interlock Pin

Shaft And Gear Removal

(1) Remove the output shaft rear bearing snap ring (Fig. 54).

(2) Remove the cluster gear rear bearing snap ring (Fig. 54).

(3) Tap the end of the output shaft with a mallet to unseat and start the rear bearing out of the intermediate plate (Fig. 55).

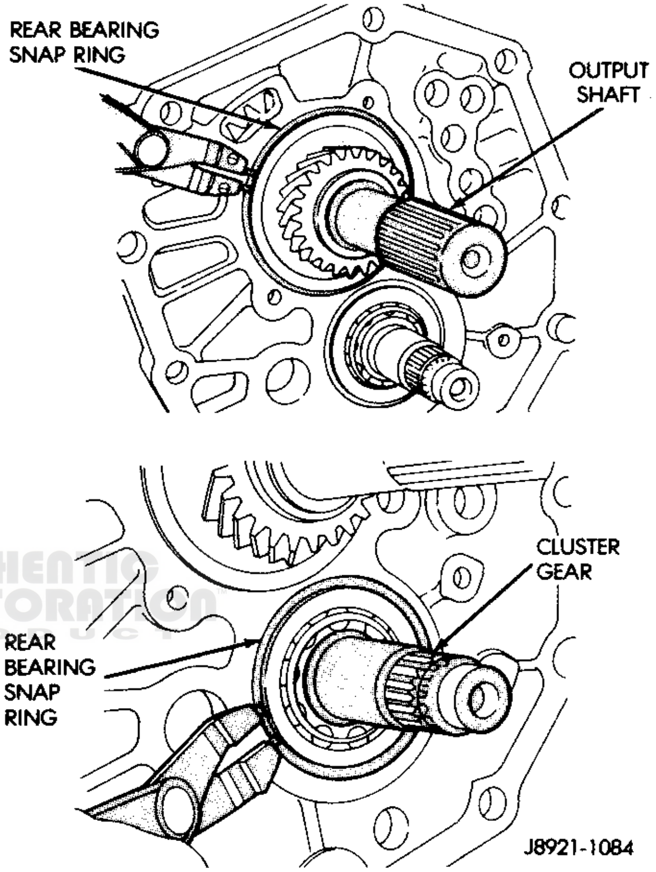


Fig. 54 Removing Bearing Snap Rings

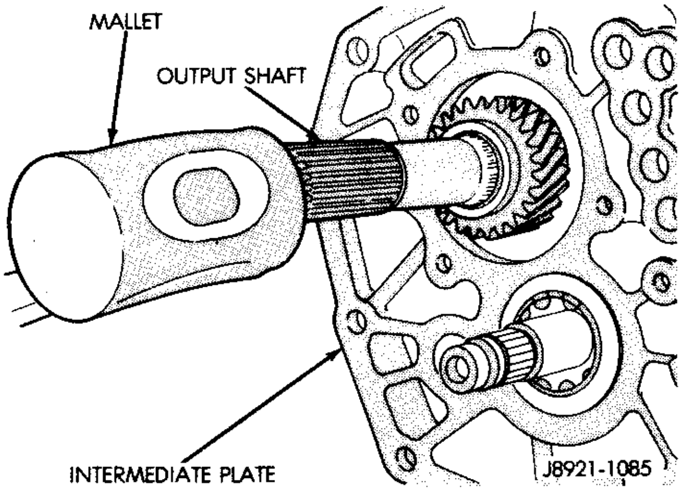


Fig. 55 Unseating Output Shaft Rear Bearing

(4) Remove the output shaft by rocking it lightly until the rear bearing comes out of the intermediate plate (Fig. 56).

(5) Remove the cluster gear by pulling it out of the rear bearing (Fig. 57).

(6) Remove the cluster gear rear bearing from the intermediate plate (Fig. 58).

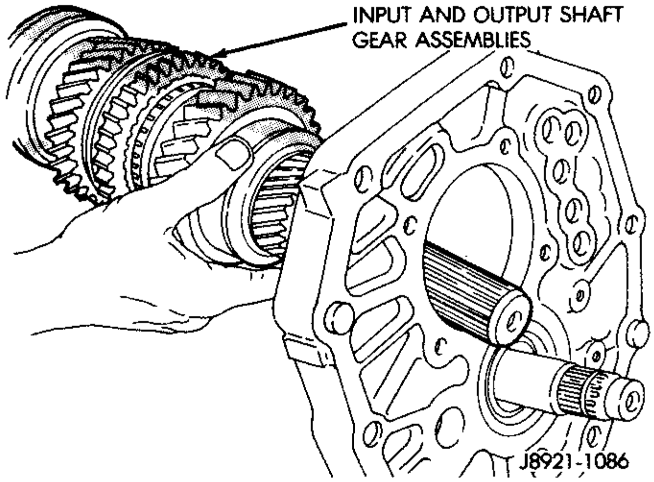


Fig. 56 Input/Output Shaft Assembly Removal

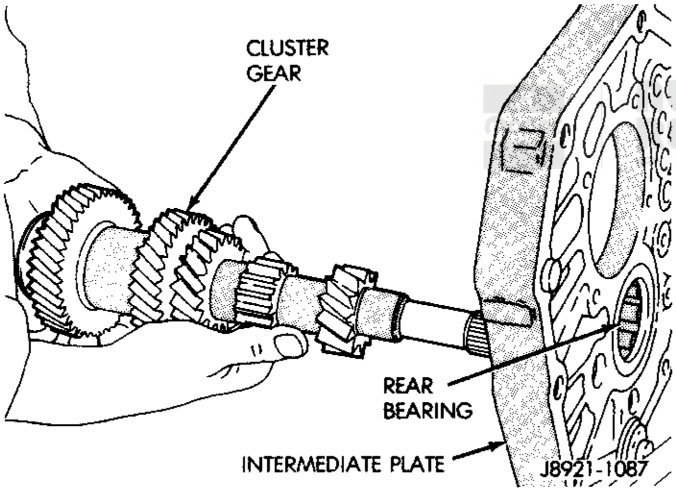


Fig. 57 Cluster Gear Removal

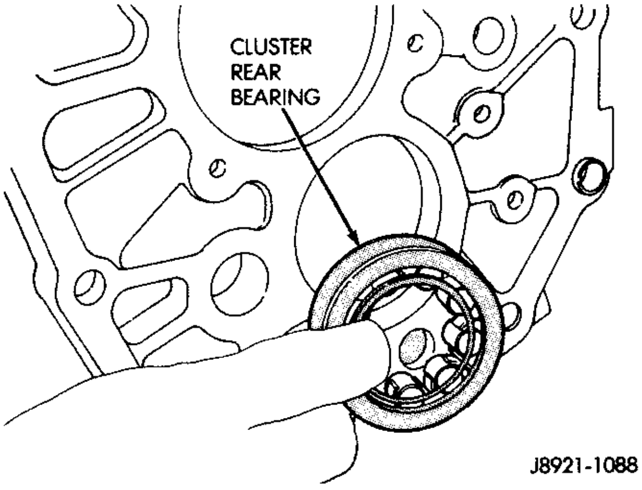


Fig. 58 Removing Cluster Gear Rear Bearing

(7) Remove the input shaft from the output shaft (Fig. 59).

(8) Remove the output shaft pilot bearing from the input shaft (Fig. 60).

(9) Remove the synchro ring from the input shaft (Fig. 61).

(10) Remove the bearing snap ring and press the bearing off the input shaft (Fig. 61).

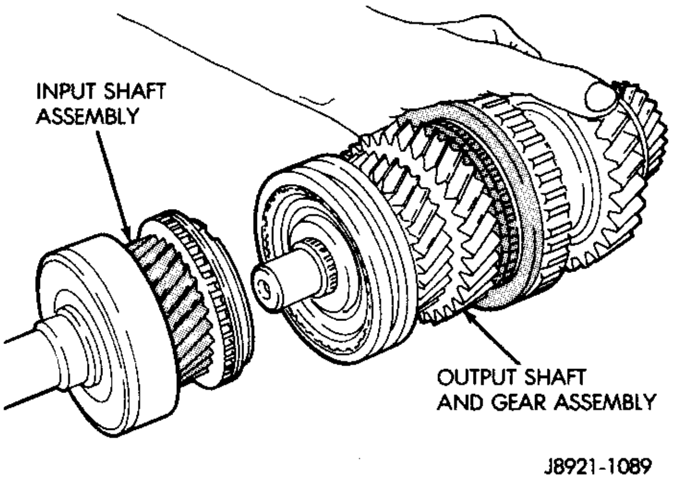


Fig. 59 Input Shaft Removal

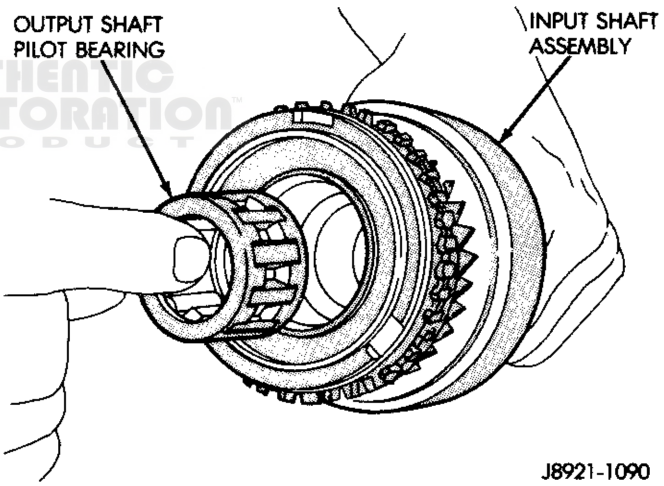


Fig. 60 Removing Input Shaft Pilot Bearing

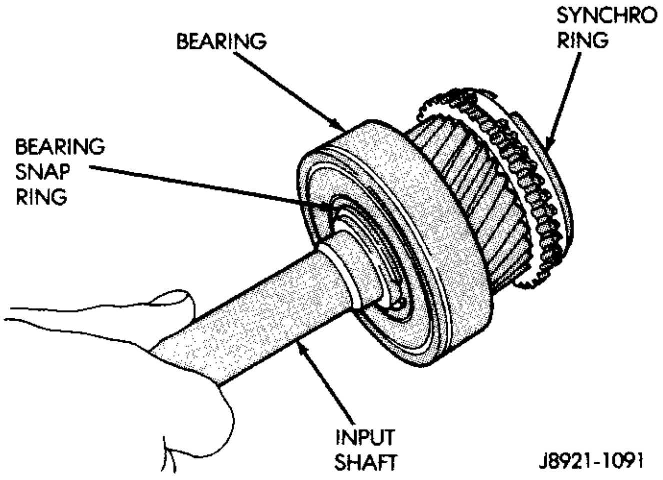


Fig. 61 Input Shaft Components

Output Shaft Disassembly

(1) Measure thrust clearance of the output shaft first, second and third gears with a feeler gauge (Fig. 62). First gear clearance should be .10 to .40 mm (.003 to .0197 in). Second and third gear clearance should be .10 to .30 mm (.003 to .0118 in).

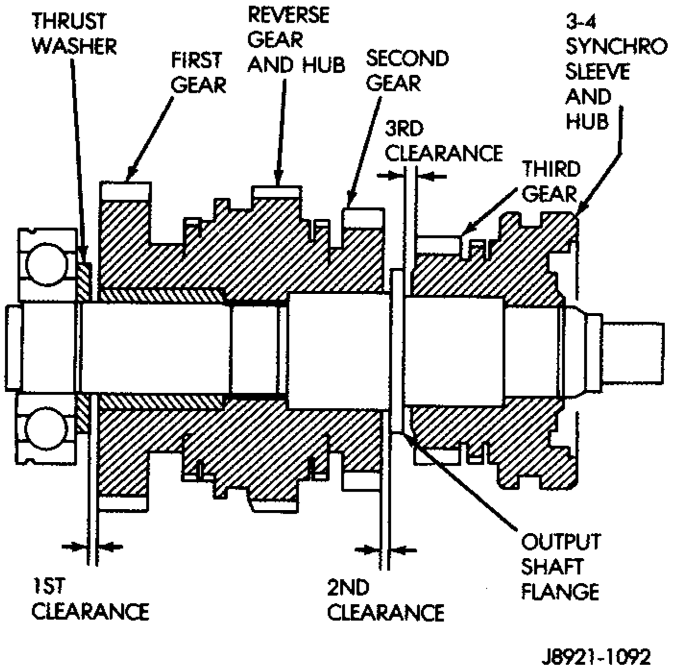


Fig. 62 Checking Output Shaft Gear Thrust Clearance

(2) If first gear thrust clearance is incorrect, replace the gear and thrust washer. **If either the second or third gear clearance is incorrect, either the gear and bearing are worn or the output shaft flange is worn. Refer to output shaft inspection in the Cleaning and Inspection section.**

(3) Press the fifth gear and rear bearing off the rear of the output shaft.

(4) Remove the thrust washer, pin, and first gear and bearing (Fig. 62).

(5) Remove the first/reverse hub snap ring (Fig. 63).

(6) Remove the synchro ring.

(7) Press the reverse gear and first/reverse hub off the shaft as an assembly.

(8) Remove the remaining synchro ring and the second gear and bearing (Fig. 63).

(9) Remove the snap ring at the front of the output shaft (Fig. 63).

(10) Press the 3-4 hub and sleeve off the output shaft as an assembly (Fig. 63).

(11) Remove the synchro ring.

(12) Remove the third gear and needle bearing (Fig. 63).

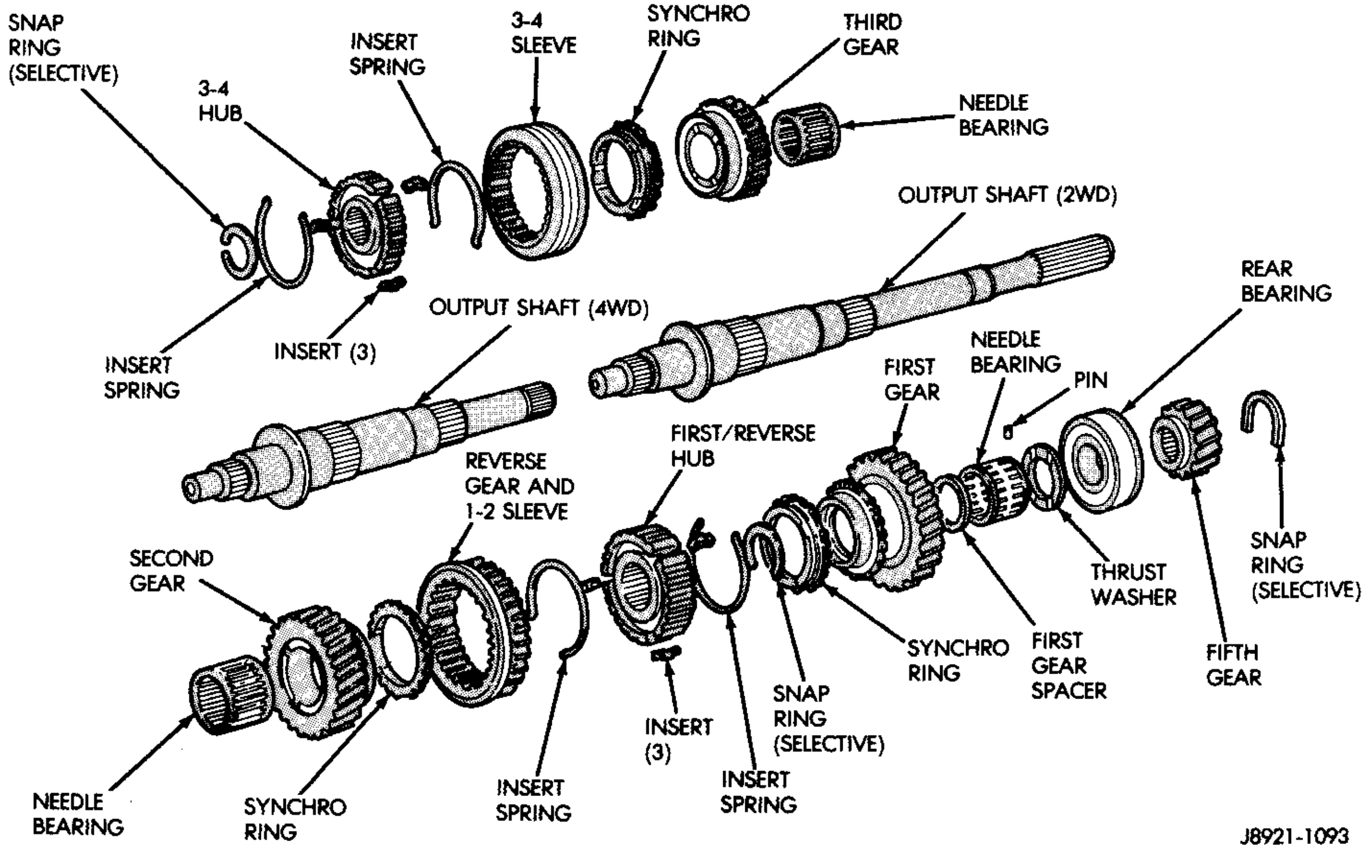


Fig. 63 Output Shaft And Gears

CLEANING AND INSPECTION

Clean the transmission components in solvent. Dry the cases, gears, shift mechanism and shafts with compressed air. **Dry the bearings with clean, dry shop towels only. Never use compressed air on the bearings. This could damage the bearing rollers.**

Replace components that are obviously worn, cracked, chipped or damaged in any way.

Inspect the transmission case. Replace the case if cracked or porous or if any of the bearing and gear bores are damaged.

Output Shaft Inspection

Check thickness of the output shaft flange with a micrometer (Fig. 64). Minimum allowable flange thickness is 4.70 mm (.185 in).

If shaft flange thickness is OK but previously measured second/third gear thrust clearance was incorrect (Fig. 62), replace the necessary gear and needle bearing as an assembly.

Check diameter of the first, second and third gear bearing surfaces of the output shaft (Fig. 64). Minimum allowable diameters are:

- 38.86 mm (1.529 in) for first gear surface
- 46.86 mm (1.844 in) for second gear surface
- 37.86 mm (1.490 in) for third gear surface

Check output shaft runout with V-blocks and dial indicator (Fig. 64). Maximum allowable runout is .06 mm (.0024 in).

Replace the output shaft if any surface measured fails to meet stated tolerance.

Cluster Gear Inspection

Inspect the cluster gear teeth. Replace the gear if any teeth are worn or damaged or if the bearing surfaces are damaged.

Check diameter of the cluster gear journal with a micrometer (Fig. 65). Minimum allowable diameter is 27.860 mm (1.096 in).

Check condition of the cluster gear front bearing. Replace the bearing if worn, noisy, or damaged.

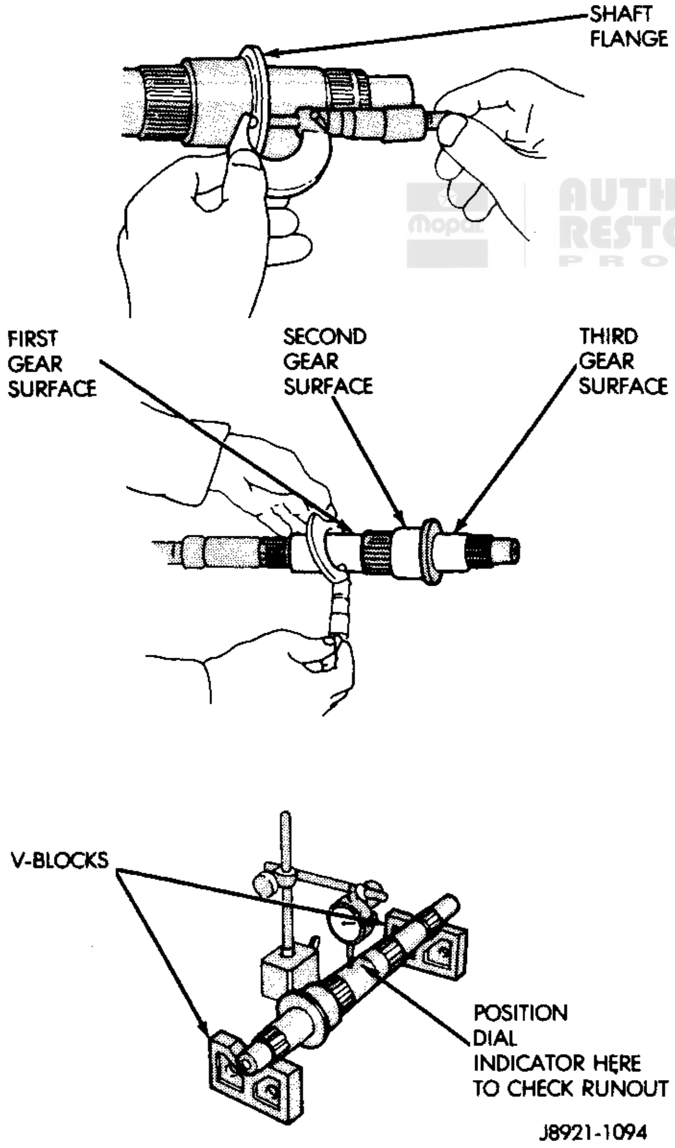


Fig. 64 Checking Output Shaft Tolerances

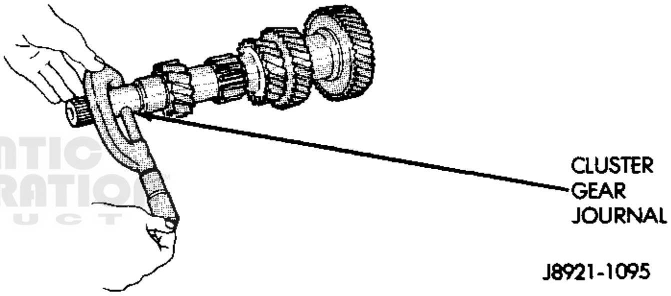


Fig. 65 Checking Cluster Gear Journal Diameter

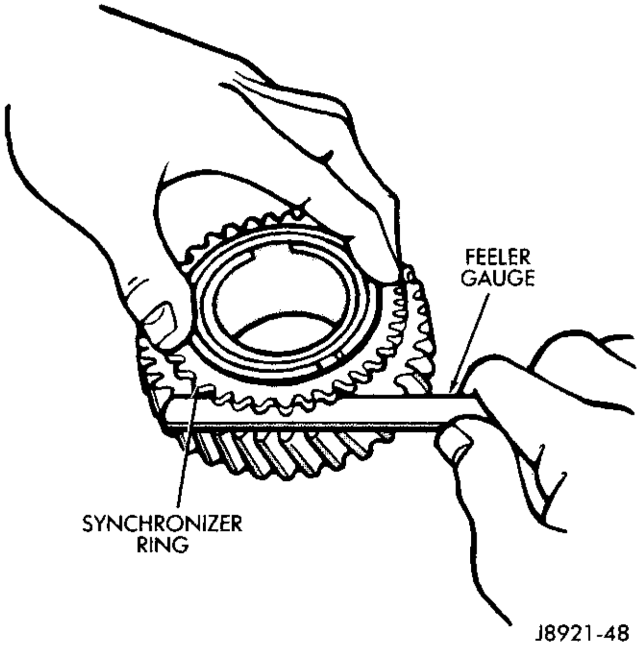


Fig. 66 Checking Synchro Ring End Clearance

Gear And Synchro Inspection

Install the synchro rings on their respective gears. Rotate each ring on the gear and note synchro action. Replace any synchro ring that exhibits a lack of braking action or binds on the gear. Also replace any ring that is worn or has chipped or broken teeth.

Measure end clearance between the synchro ring and the gear with a feeler gauge (Fig. 66). Clearance should be .06 mm to 1.6 mm (.024 to .063 in).

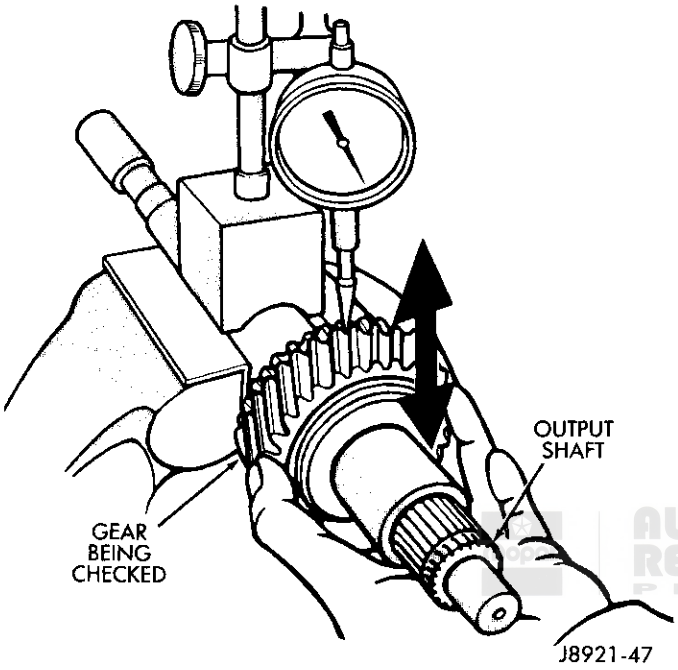


Fig. 67 Checking Gear-To-Shaft Clearance

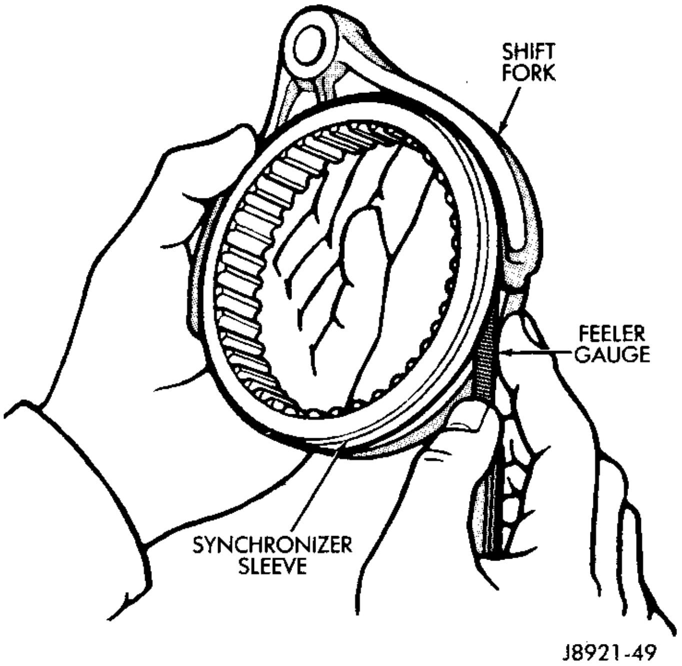


Fig. 68 Checking Shift Fork-To-Sleeve Clearance

Install the needle bearings in the first, second and third gears. Then install the gears on the output shaft and check shaft-to-gear clearance with a dial indicator (Fig. 67).

Maximum allowable clearance is .16 mm (.0063 in). If any gear exhibits excessive clearance, replace the gear and needle bearing.

Check clearance between the shift forks and synchro sleeves with a feeler gauge (Fig. 68). Clearance should not exceed 1.0 mm (.039 in). Replace the synchro sleeve (and matching hub) if clearance exceeds the stated limit.

Check condition of the reverse idler gear bushing (Fig. 69). Replace the gear if the bushing is damaged or worn.

Gear Case-Housing-Intermediate Plate

Clean the case, housing and plate with solvent and dry with compressed air. Replace any component that is cracked, warped or damaged in any way.

Inspect the threads in the case, housing and plate. Minor thread damage can be repaired with steel thread inserts if necessary. However, do not attempt to repair if the cracks are evident around any threaded hole.

Inspect the reverse pin in the adaptor/extension housing. Replace the pin if worn or damaged. Refer to the replacement procedure in the Transmission Assembly section.

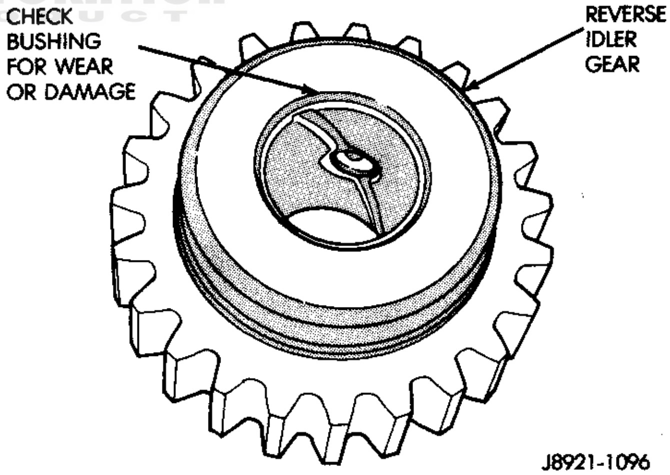


Fig. 69 Reverse Idler Gear Bushing

TRANSMISSION ASSEMBLY

Lubricate the transmission components with 75W-90 gear lubricant during assembly. Use petroleum jelly to lubricate seal lips and/or hold parts in place during installation.

Bearing-Seal-Pin Installation

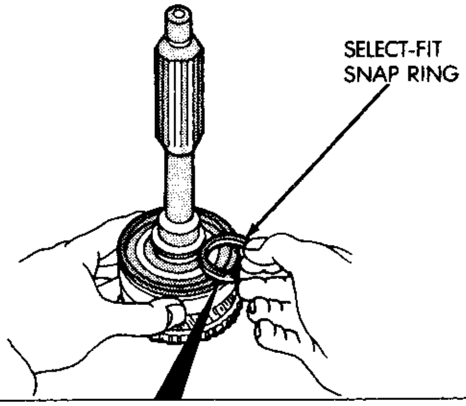
(1) Press the front bearing on the input shaft. Then secure the bearing with the thickest snap ring that will fit in the shaft groove (Fig. 70).

(2) Press the front bearing on the cluster gear. Then secure the bearing with the thickest snap ring that will fit in the ring groove on the gear (Fig. 71).

(3) Install new oil seals in the front bearing retainer and adapter housing (Fig. 72). Installation depth for the bearing retainer seal is 10.5 to 11.5 mm (.414 to .453 in).

(4) Install the reverse shaft and shaft retaining pin in the adapter housing. Then install the access hole plug with a torx bit (Fig. 73).

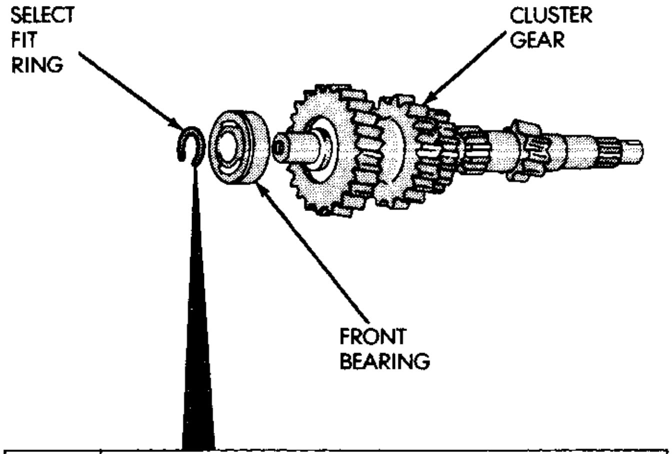
(5) Lubricate the reverse shaft and gear components with 75W-90 gear lubricant.



I.D. MARK	SNAP RING THICKNESS	MM (IN.)
A	2.10 - 2.15	(0.0827 - 0.0846)
B	2.15 - 2.20	(0.0846 - 0.0866)
C	2.20 - 2.25	(0.0866 - 0.0886)
D	2.25 - 2.30	(0.0886 - 0.0906)
E	2.30 - 2.35	(0.0906 - 0.0925)
F	2.35 - 2.40	(0.0925 - 0.0945)
G	2.40 - 2.45	(0.0945 - 0.0965)

J8921-1097

Fig. 70 Selecting Input Shaft Front Bearing Snap Ring



I.D. MARK	SNAP RING THICKNESS	MM (IN.)
A	2.00 - 2.05	(0.0787 - 0.0807)
B	2.05 - 2.10	(0.0807 - 0.0827)
C	2.10 - 2.15	(0.0827 - 0.0846)
D	2.15 - 2.20	(0.0846 - 0.0866)
E	2.20 - 2.25	(0.0866 - 0.0886)

J8921-1098

Fig. 71 Selecting Cluster Gear Front Bearing Snap Ring

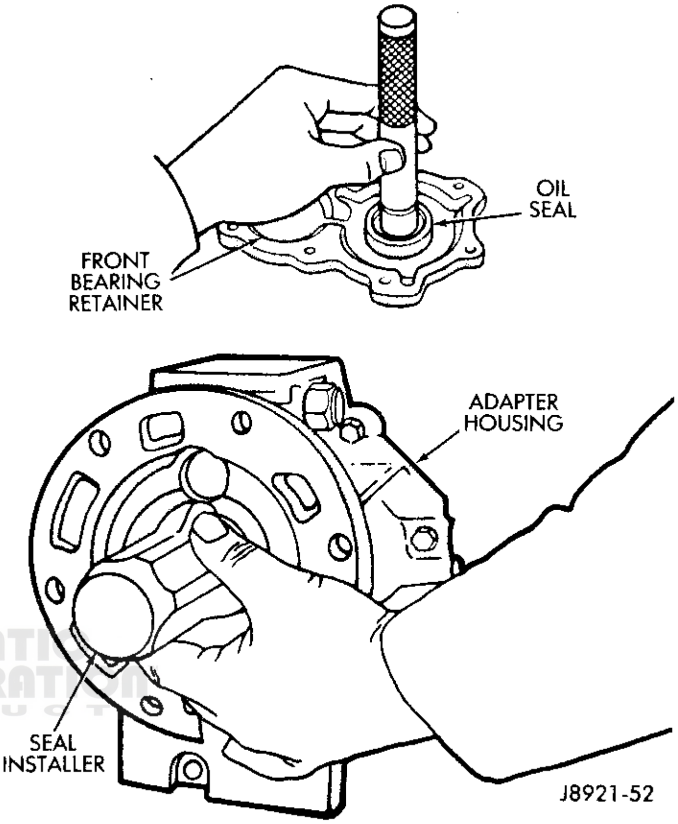


Fig. 72 Oil Seal Installation

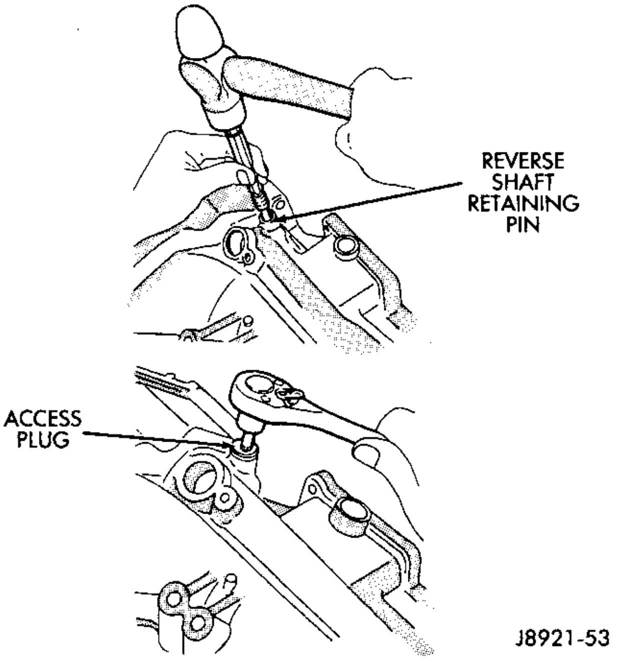


Fig. 73 Installing Reverse Shaft Pin

Output Shaft Assembly

(1) Lubricate the output shaft journals, gears and needle bearings with 75W-90 gear lubricant.

(2) Install the third gear and needle bearing on the shaft (Fig. 63)

(3) Install the synchro ring on the third gear (Fig. 63).

(4) Assemble the 1-2 and 3-4 synchro hubs and sleeves (Fig.74).

(5) Install the inserts and springs in the synchro sleeves. Position the open ends of the springs 180 degrees apart as shown (Fig. 75).

(6) Install the 3-4 synchro hub and sleeve onto the output shaft. Press the hub onto the shaft if necessary.

(7) Install the 3-4 synchro hub snap ring (Fig. 76). Use the thickest snap ring that will fit in the shaft groove.

(8) Verify third gear thrust clearance with a feeler gauge (Fig. 56). Clearance should be .10 to .25 mm (.004 to .010 inch).

(9) Lubricate the remaining output shaft gears and bearings with gear lubricant.

(10) Install the second gear and needle bearing on the shaft (Fig. 78).

(11) Install the synchro ring on the second gear (Fig. 78).

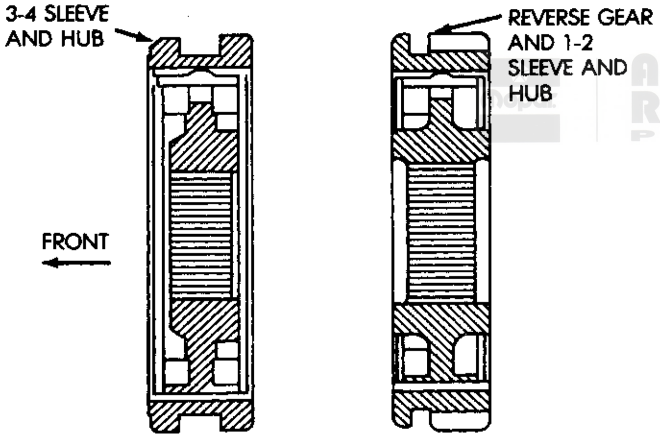


Fig. 74 Synchro Sleeve And Hub Identification

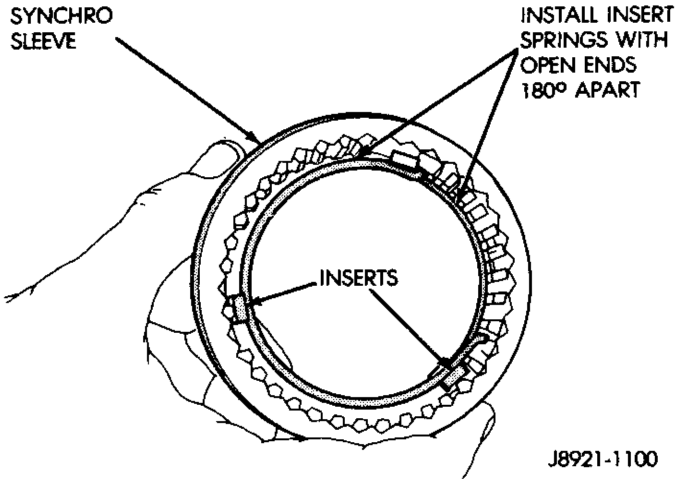
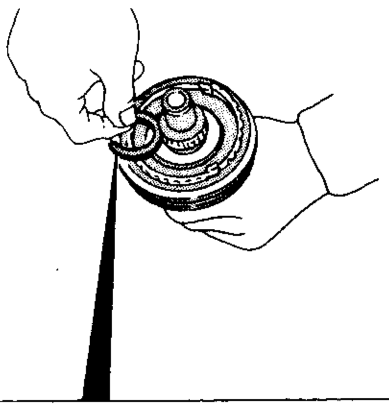


Fig. 75 Insert Spring Position

(12) Assemble the first/reverse hub, insert springs, inserts and the reverse gear and 1-2 sleeve (Fig. 78). **Be sure the spring ends are 180 degrees apart. Also note that the splines in the hub bore are chamfered on one side. Install the hub so the chamfered side faces the front of the output shaft.**

(13) Press the assembled hub and sleeve on the output shaft.

(14) Install the selective snap ring (Fig. 78). Use the thickest snap ring that will fit in the output shaft groove.



I.D. MARK	SNAP RING THICKNESS	MM (IN.)
A	1.80 - 1.85	(0.0709 - 0.0728)
B	1.85 - 1.90	(0.0728 - 0.0748)
C	1.90 - 1.95	(0.0748 - 0.0768)
D	1.95 - 2.00	(0.0768 - 0.0787)
E	2.00 - 2.05	(0.0787 - 0.0807)
F	2.05 - 2.10	(0.0807 - 0.0827)
G	2.10 - 2.15	(0.0827 - 0.0846)

Fig. 76 Installing 3-4 Synchro Hub Snap Ring

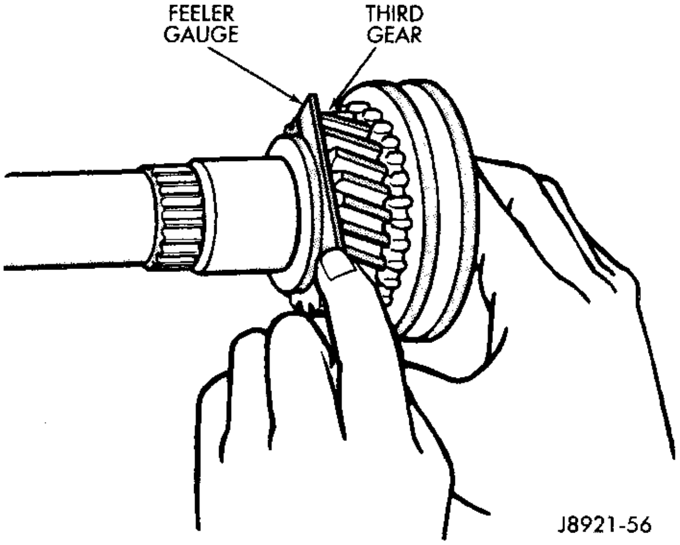


Fig. 77 Checking Third Gear Clearance

(15) Install the synchro ring on the first gear (Fig. 79).

(16) Install the first gear spacer on the shaft and against the selective fit snap ring (Fig. 79).

(17) install the first gear and needle bearing (Fig. 79) on the output shaft.

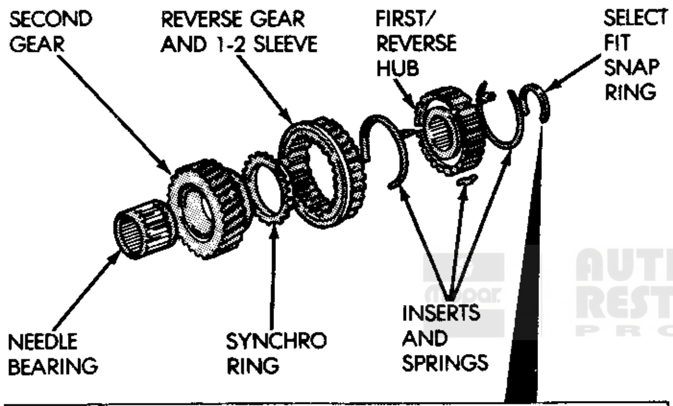
(18) Install the locating pin and thrust washer on the shaft (Fig. 79).

(19) Press the rear bearing on the shaft. Position the bearing snap ring groove so it is closest to the end of the output shaft.

(20) Check first and second gear thrust clearance with a feeler gauge (Fig. 62). First gear clearance should be .10 to .40 mm (.003 to .0197 in). Second gear clearance should be .10 to .30 mm (.003 to .0118 in).

(21) Press the fifth gear onto the output shaft. Then install the select fit snap ring (Fig. 80). Use the thickest snap ring that will fit in the shaft groove.

(22) Lubricate the input shaft pilot bearing with petroleum jelly and install the bearing in the shaft (Fig. 60).



I.D. MARK	SNAP RING THICKNESS	MM (IN.)
B	2.35 - 2.40	(0.0925 - 0.0945)
C	2.40 - 2.45	(0.0945 - 0.0965)
D	2.45 - 2.50	(0.0965 - 0.0984)
E	2.50 - 2.55	(0.0984 - 0.1004)
F	2.55 - 2.60	(0.1004 - 0.1024)
G	2.60 - 2.65	(0.1024 - 0.1043)

J8921-1102

Fig. 78 Second Gear And Synchro Assembly

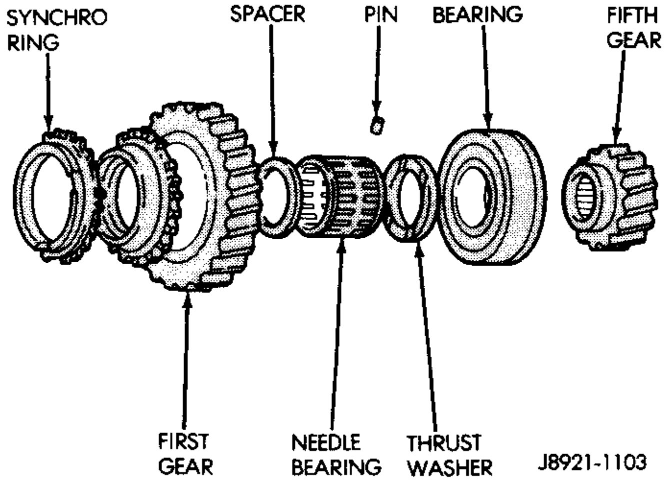


Fig. 79 First And Fifth Gear Components

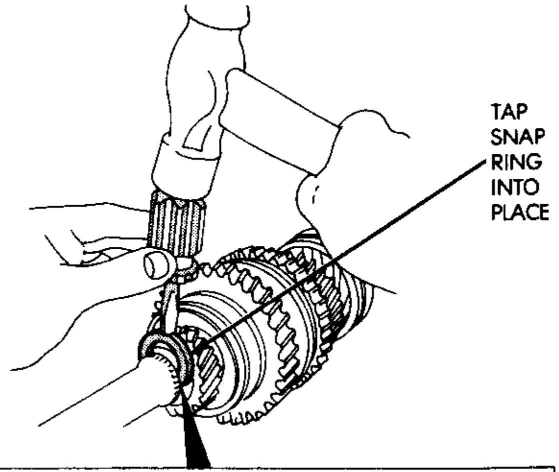
(23) Install the input shaft on the output shaft (Fig. 59). Be sure the output shaft hub is fully seated in the pilot bearing.

Output Shaft And Cluster Gear Installation

(1) Mount the intermediate plate in a vise (Fig. 24).

(2) Lubricate the cluster gear journal and rear bearing with petroleum jelly or gear lubricant.

(3) Install the cluster gear rear bearing in the intermediate plate (Fig. 81). be sure the snap ring groove in the bearing is rearward as shown.



I.D. MARK	SNAP RING THICKNESS	MM (IN.)
A	2.75 - 2.80	(0.1083 - 0.1102)
B	2.80 - 2.85	(0.1002 - 0.1122)
C	2.85 - 2.90	(0.1122 - 0.1142)
D	2.90 - 2.95	(0.1142 - 0.1161)
E	2.95 - 3.00	(0.1161 - 0.1181)
F	3.00 - 3.05	(0.1181 - 0.1201)
G	3.05 - 3.10	(0.1201 - 0.1220)
H	3.10 - 3.15	(0.1220 - 0.1240)
J	3.15 - 3.20	(0.1240 - 0.1260)
K	3.20 - 3.25	(0.1260 - 0.1280)
L	3.25 - 3.30	(0.1280 - 0.1299)
M	3.30 - 3.35	(0.1299 - 0.1319)

J8921-1104

Fig. 80 Selecting Fifth Gear Snap Ring

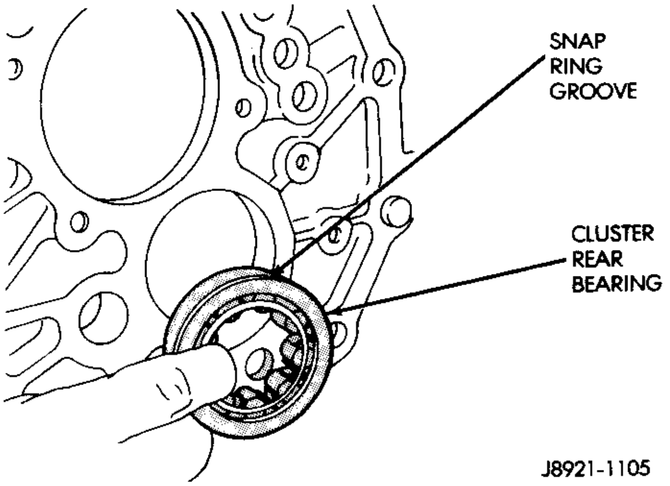


Fig. 81 Installing Cluster Gear Rear Bearing

(4) Start the cluster gear into the bearing (Fig. 57). Then hold the bearing and push the gear into place. Use a plastic mallet to seat the bearing if necessary.

(5) Start the output shaft rear bearing in the intermediate plate. Then push the shaft rearward and tap the intermediate plate with a plastic mallet to seat the shaft bearing.

(6) Install the snap rings on the cluster and output shaft **rear** bearings only (Fig. 82). Do not install the front bearing snap rings at this time.

(7) Install the reverse idler gear and shaft (Fig. 83).

(8) Position the rear bearing retainer over the output shaft and rear bearing. **Be sure the bearing retainer tab is engaged in the reverse idler shaft notch (Fig. 84).**

(9) Install and tighten the rear bearing retainer bolts to 18 N•m (13 ft-lbs).

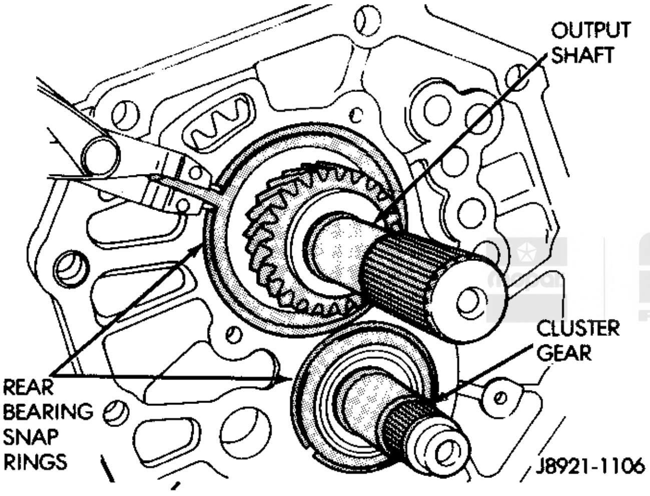


Fig. 82 Installing Rear Bearing Snap Rings

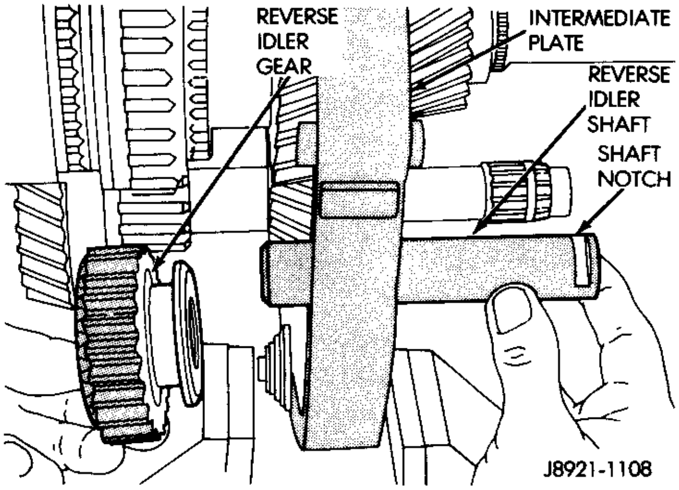


Fig. 83 Installing Reverse Idler Gear And Shaft

Shift Rail And Fork Installation

The shift rail interlock pins, balls and plugs must be installed in the correct sequence for proper shifting. Refer to the installation diagram (Fig. 85) during assembly.

Coat the intermediate plate shift rail bores and the interlock balls, pins and plugs with a thick covering of petroleum jelly before assembly. The jelly will hold the interlock components in place making installation easier. Use a pencil magnet to hold and insert the interlocks. Then use a small screwdriver to push the interlock components into place.

(1) Coat the reverse rail interlock pin with petroleum jelly and install the pin in the rail (Fig. 86).

(2) Install the reverse shift rail in the intermediate plate (Fig. 87).

(3) Install the reverse shift rail C-ring (Fig. 51).

(4) Position the 1-2 and 3-4 shift forks in the synchro sleeves (Fig. 88).

(5) Coat the reverse rail lock ball with petroleum jelly. Then tilt the reverse shift fork upward and insert the ball in the intermediate plate (Fig. 89).

(6) Coat the 1-2 shift rail interlock plug with petroleum jelly and install it in the intermediate plate bore (Fig. 90).

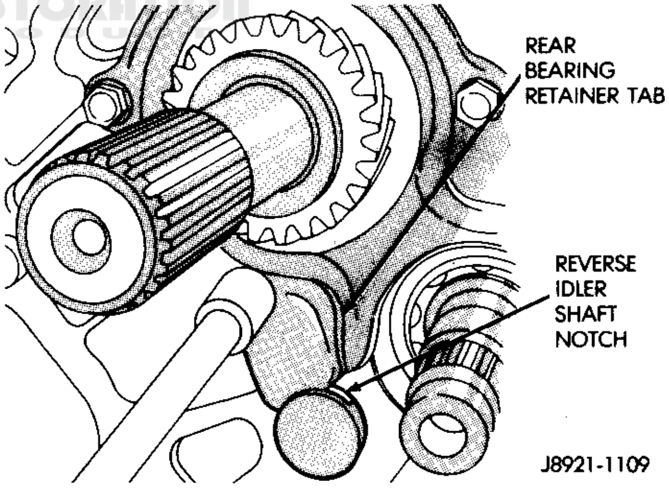


Fig. 84 Installing Rear Bearing Retainer

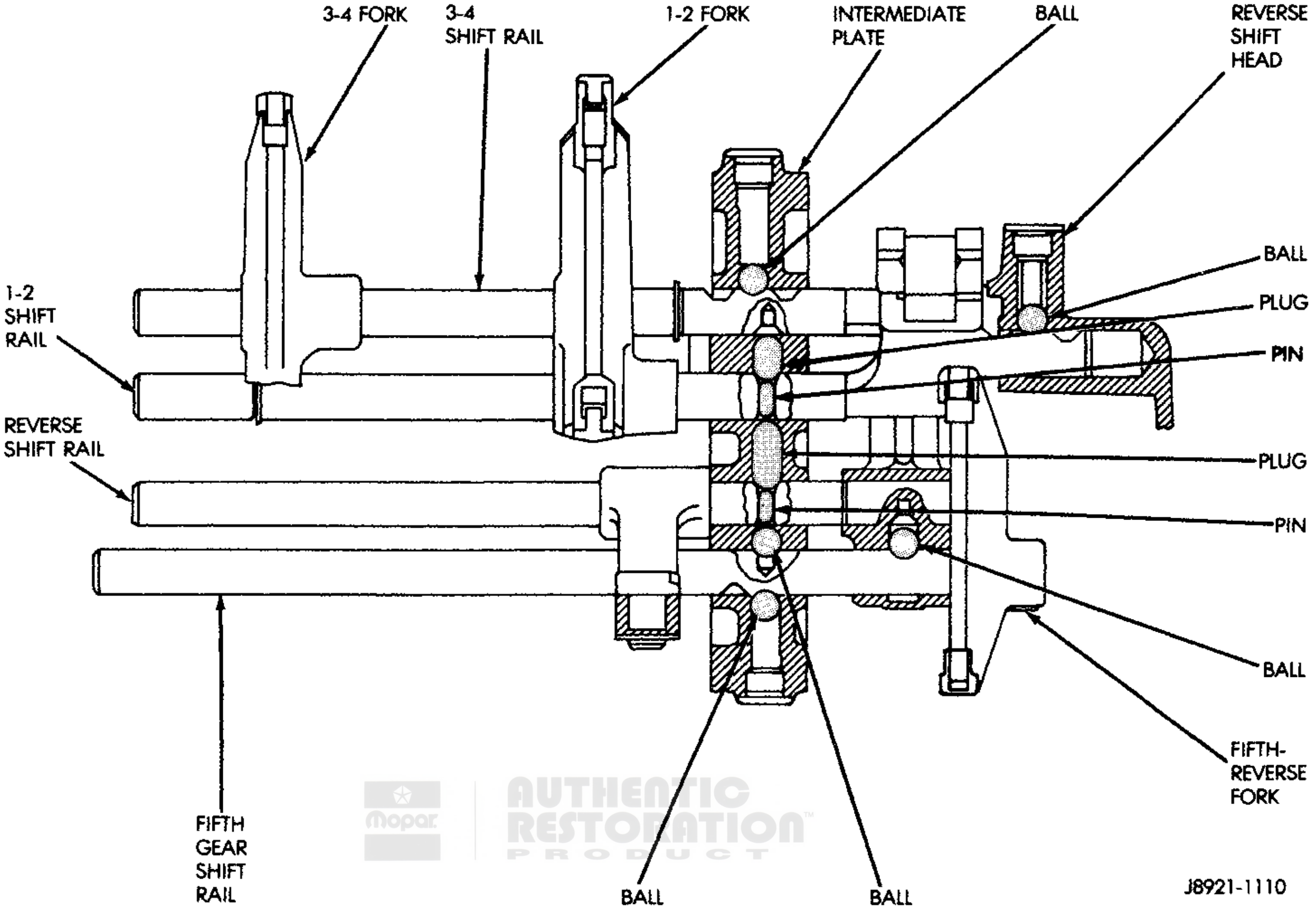


Fig. 85 Shift Rail Ball-Plug-Pin Position

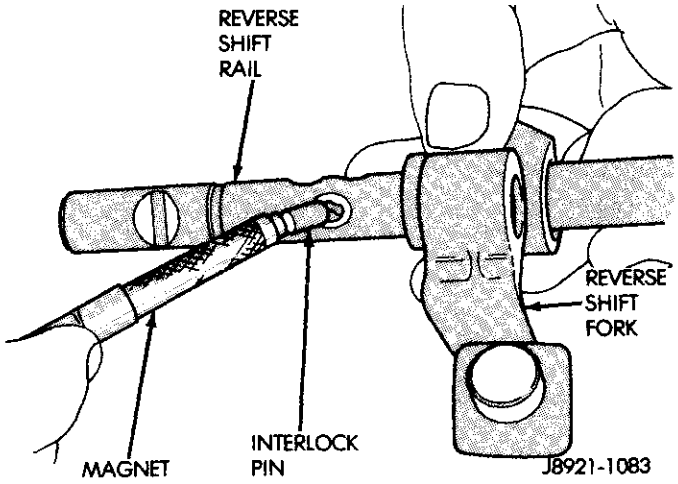


Fig. 86 Installing Reverse Shift Rail Interlock Pin

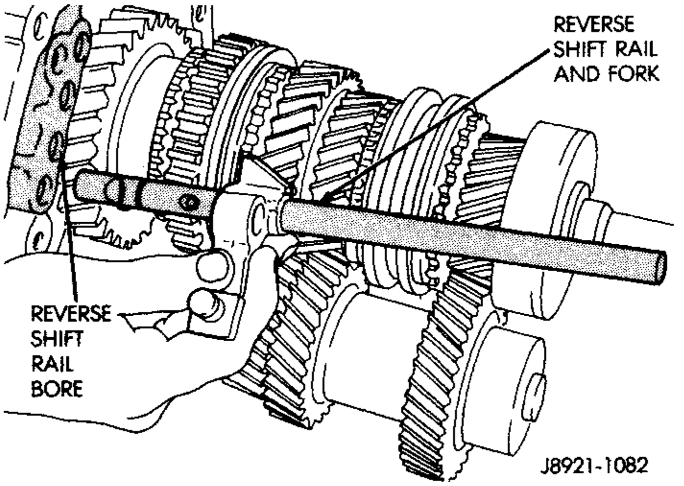


Fig. 87 Installing Reverse Shift Rail And Fork

(7) Coat the 1-2 shift rail interlock pin with petroleum jelly and insert it in the shift rail (Fig. 91).

(8) Install the 1-2 shift rail in the intermediate plate and 1-2 fork (Fig. 92).

(9) Coat the 3-4 shift rail interlock plug with petroleum jelly and install the plug in the intermediate plate (Fig. 93).

(10) Install the 3-4 shift rail in the intermediate plate and in both shift forks (Fig. 94).

(11) Verify that none of the interlock balls, plugs, or pins were displaced during shift rail installation.

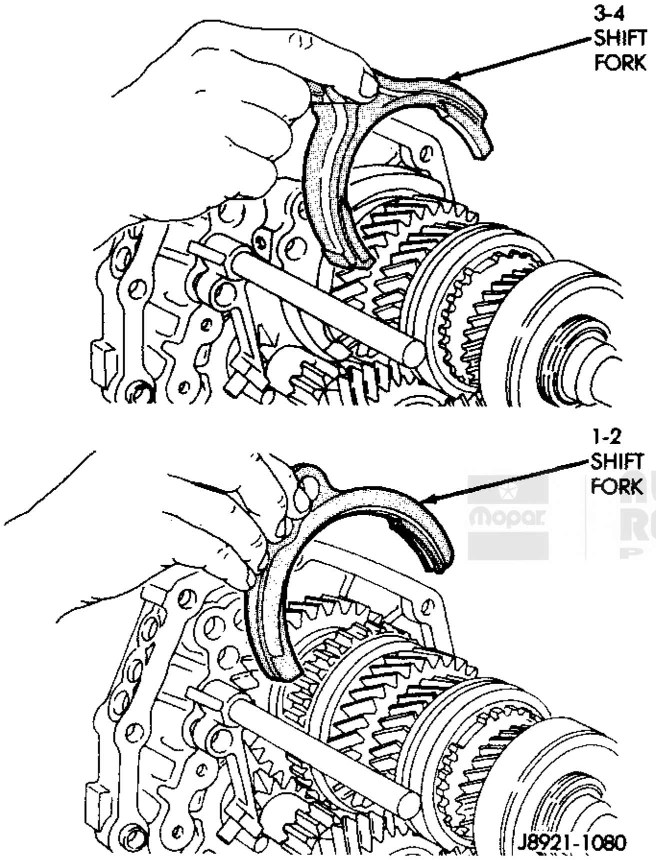


Fig. 88 Shift Fork Installation

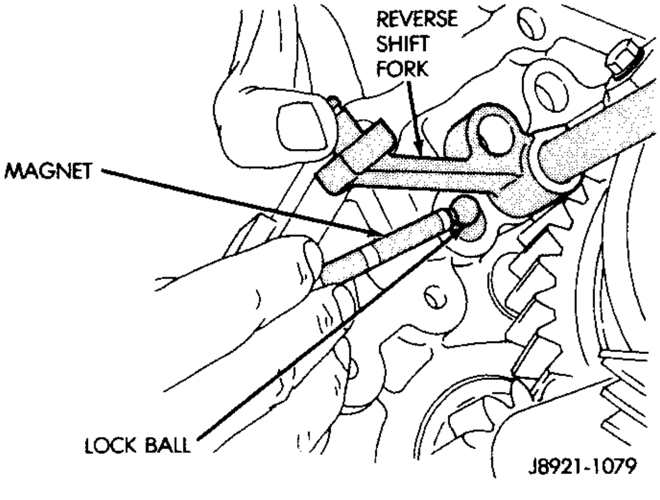


Fig. 89 Installing Reverse Shift Rail Lock Ball

(12) Install and tighten the shift fork setscrews to 20 N•m (14 ft-lbs) torque (Fig. 95).

(13) Install the 1-2 and 3-4 shift rail C-rings (Fig. 96).

(14) Insert the fifth gear shift rail through the reverse shift fork. **Then slide the rail into the intermediate plate just far enough to secure the interlock ball. Do not fully install the shift rail at this time.**

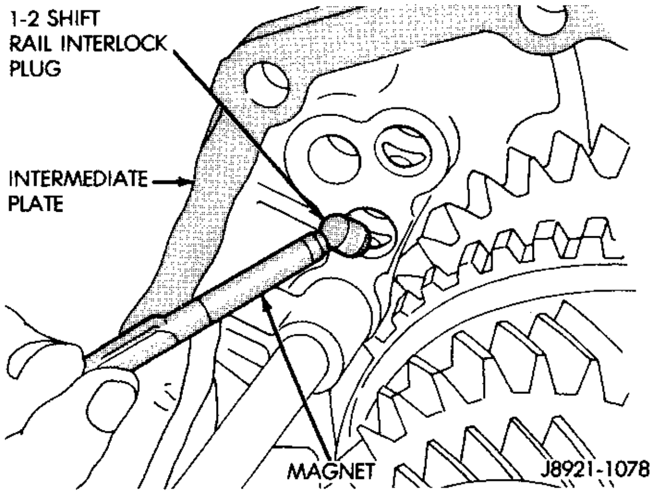


Fig. 90 Installing 1-2 Shift Rail Interlock Plug

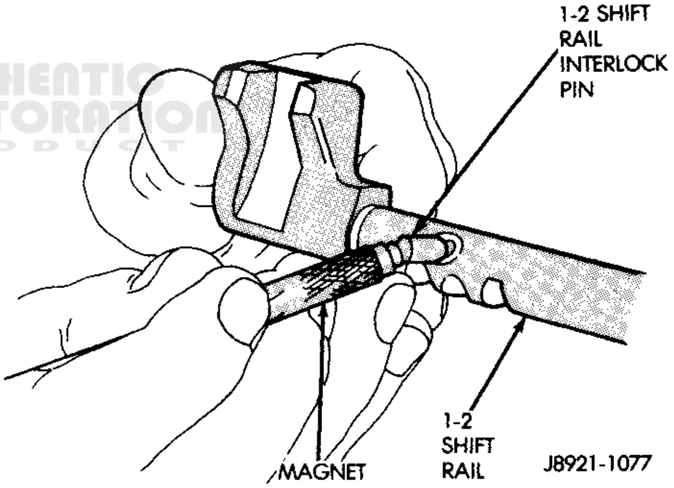


Fig. 91 Installing 1-2 Shift Rail Interlock Pin

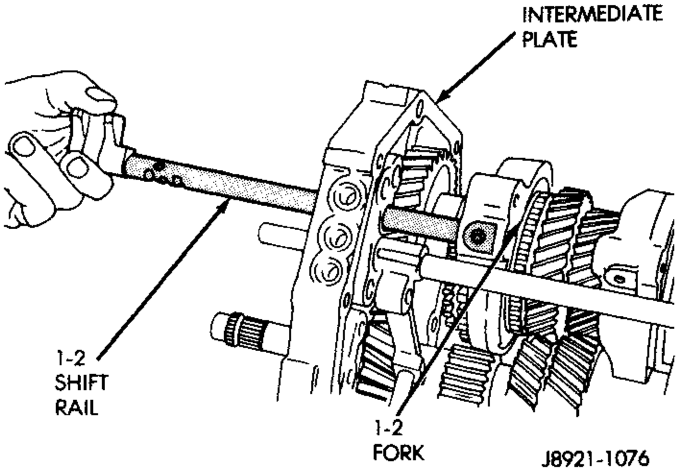


Fig. 92 Installing 1-2 Shift Rail

Fifth/Reverse Gear And Shift Component Installation

(1) Install the thrust ring lock ball in the cluster gear journal (Fig. 97). Use petroleum jelly to hold the ball in place.

(2) Install the fifth gear thrust ring (Fig. 98). Be sure the thrust ring notch fits over the lock ball.

(3) Assemble the counter fifth gear, synchro sleeve, inserts and insert springs (Fig. 99).

(4) Lubricate the two-piece bearing with petroleum jelly and install it in the counter fifth gear (Fig. 100).

(5) Install the counter fifth gear and synchro assembly on the cluster gear journal (Fig. 101).

(6) Install the synchro ring in the synchro sleeve (Fig. 102).

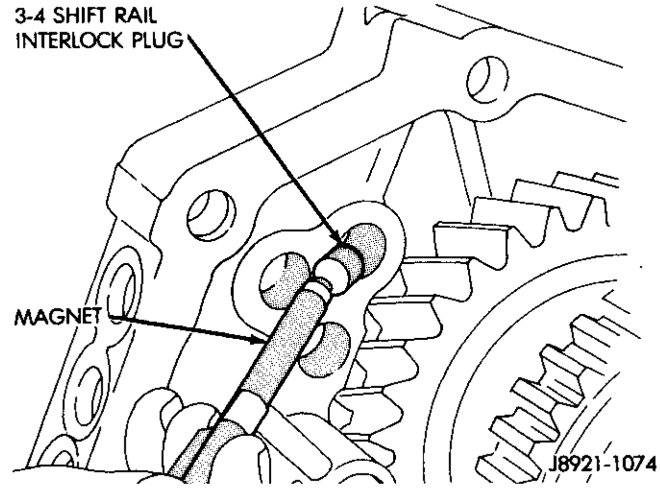


Fig. 93 Installing 3-4 Shift Rail Interlock Plug

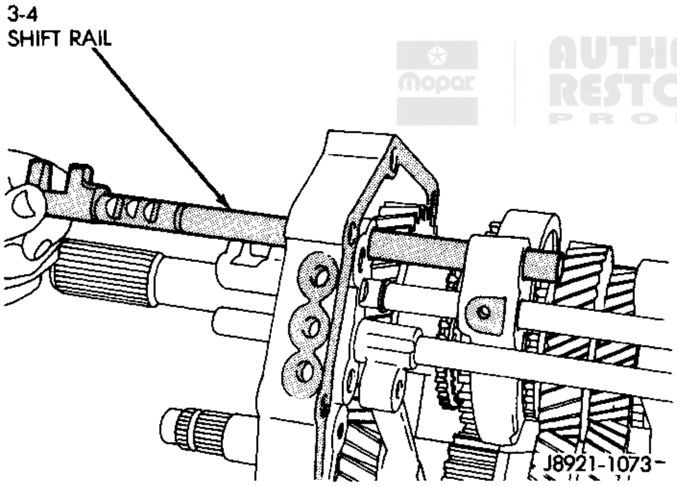


Fig. 94 Installing 3-4 Shift Rail

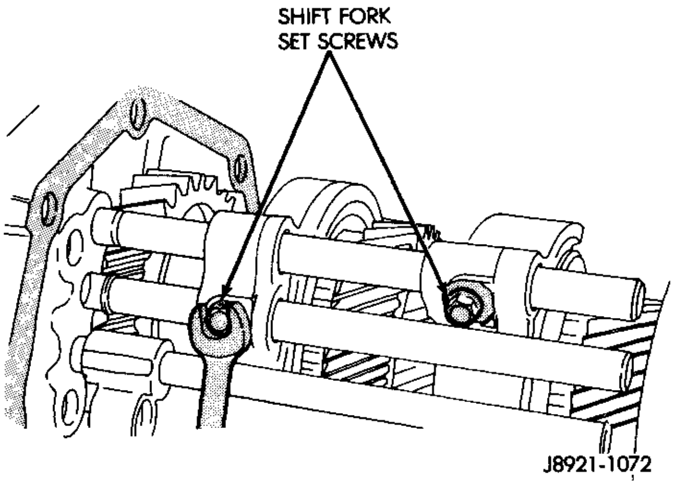


Fig. 95 Installing Shift Fork Set Screws

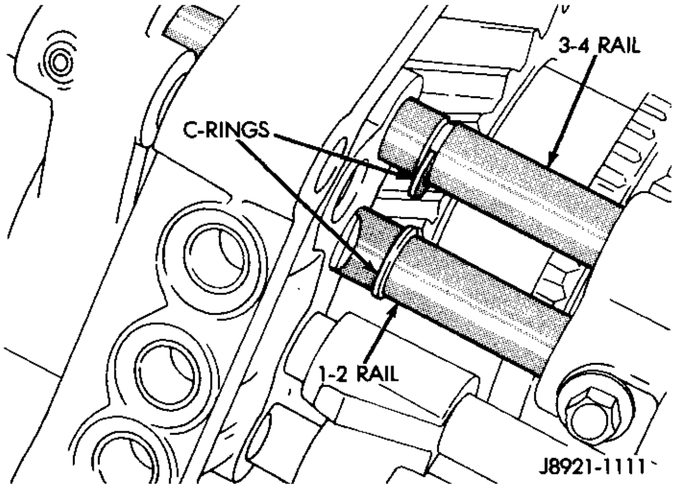


Fig. 96 Installing Shift Rail C-Rings

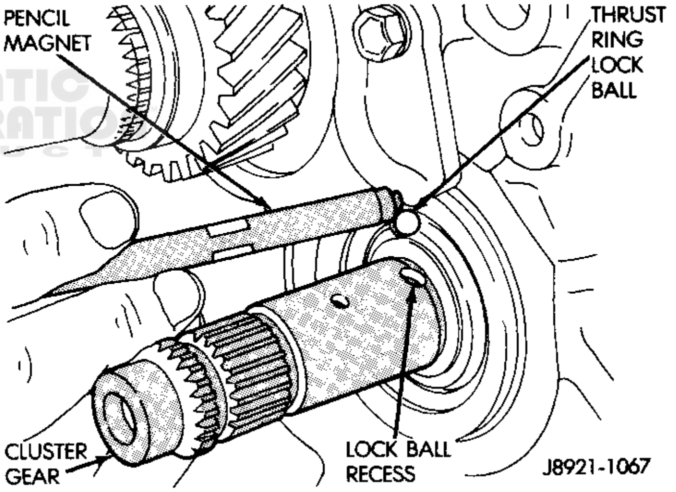


Fig. 97 Installing Thrust Ring Lock Ball

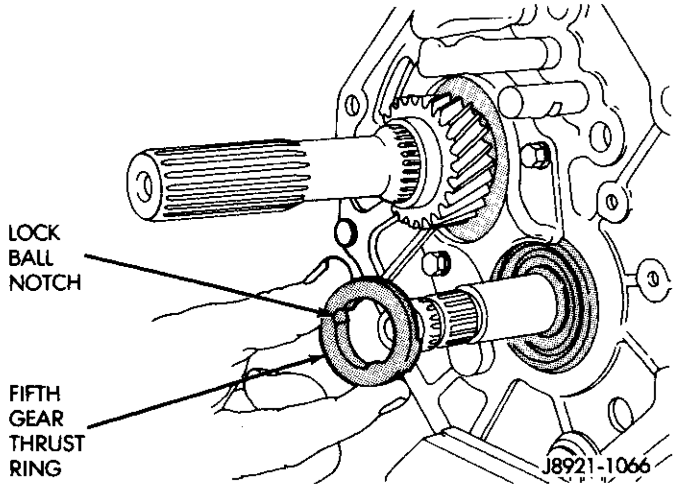


Fig. 98 Installing Fifth Gear Thrust Ring

(7) Install the fifth spline gear on the cluster journal (Fig. 103). Tap the spline gear into place with a plastic mallet if necessary.

(8) Install the fifth gear selective snap ring (Fig. 104). Use the thickest snap ring that will fit in the shaft groove.

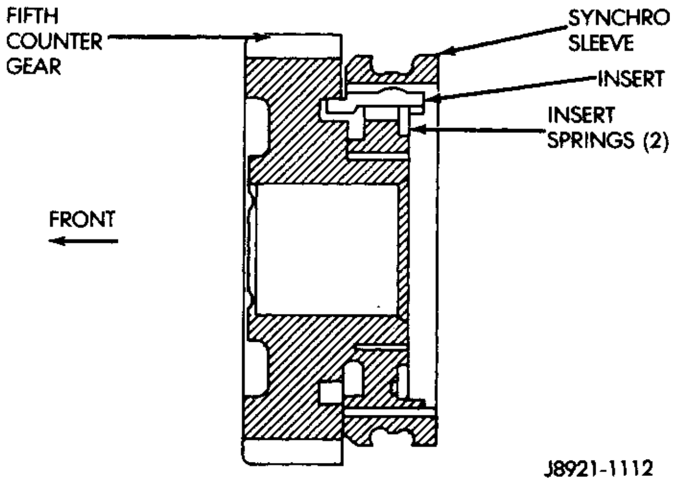


Fig. 99 Assembling Fifth Gear And Synchro Assembly

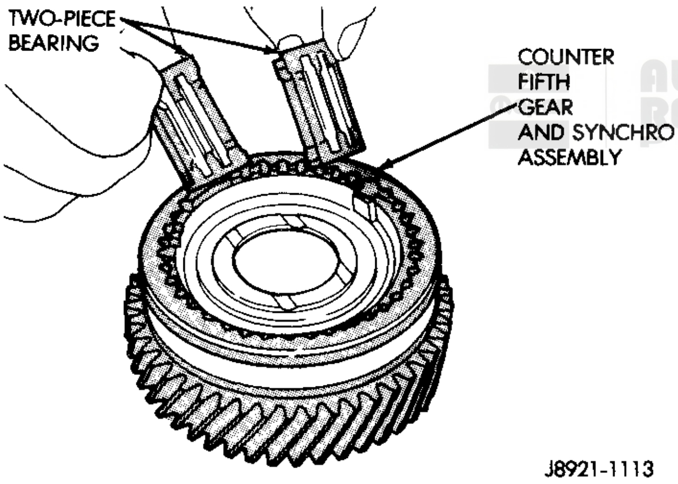


Fig. 100 Installing Counter Fifth Gear Bearing

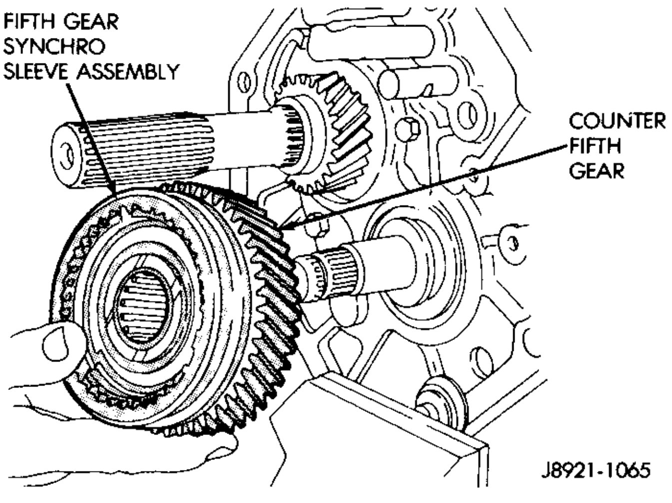


Fig. 101 Installing Counter Fifth Gear And Sleeve

(9) Install the reverse shift head and rail (Fig. 105). Then install the lock ball in the shift head.

(10) Position the fifth gear shift fork in the synchro sleeve (Fig. 106).

(11) Install the fifth gear shift rail (Fig. 107). Slide the rail through the fork, shift head, intermediate plate and reverse shift fork. Be sure the interlock ball is not displaced during installation.

(12) Align the screw holes in the shift fork and rail and install the set screw (Fig. 108). Tighten the screw to 20 N•m (15 ft-lbs) torque.

(13) Install the lock balls and springs in the intermediate plate (Fig. 109). Then install and tighten the lock ball plugs to 19 N•m (14 ft-lbs) torque.

(14) Install the reverse shift arm bracket (Fig. 110). Tighten the bracket bolts to 18 N•m (13 ft-lbs) torque.

(15) Install the reverse shift arm (Fig. 110). Position the arm on the reverse fork pin and engage it with the pin on the shift arm bracket.

(16) Verify that the shift arm shoe is engaged in the reverse idler gear. Then secure the shift arm to the pin on the reverse fork with a new E-clip.

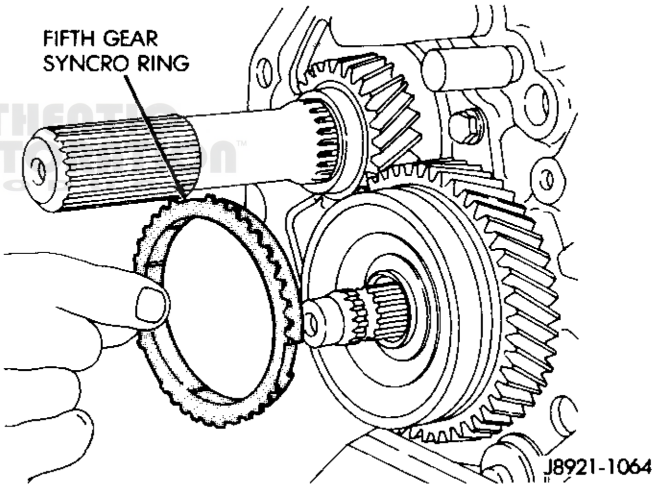


Fig. 102 Installing Fifth Gear Synchro Ring

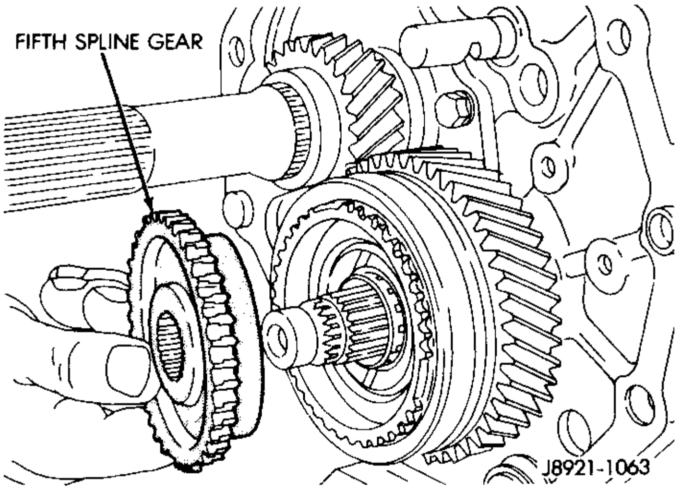
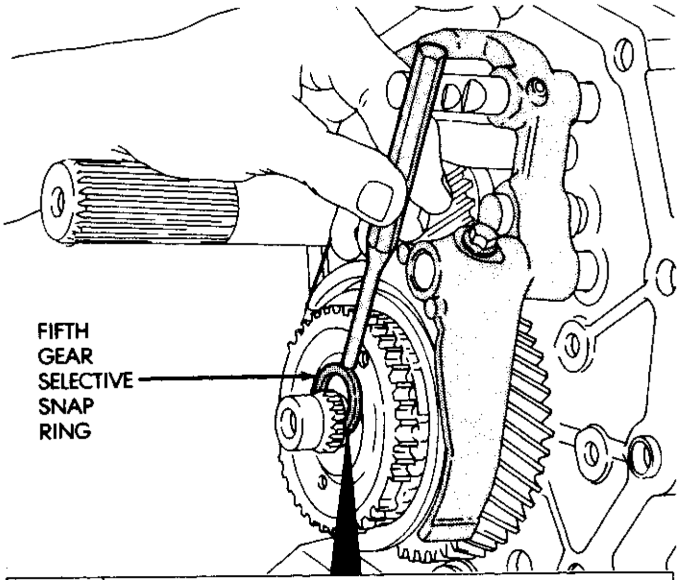


Fig. 103 Installing Fifth Spline Gear



I.D. MARK	SNAP RING THICKNESS	MM (IN.)
A	2.85 - 2.90	(0.1122 - 0.1142)
B	2.90 - 2.95	(0.1142 - 0.1161)
C	2.95 - 3.00	(0.1161 - 0.1181)
D	3.00 - 3.05	(0.1181 - 0.1201)
E	3.05 - 3.10	(0.1201 - 0.1220)
F	3.10 - 3.15	(0.1220 - 0.1240)
G	3.15 - 3.20	(0.1240 - 0.1260)
H	3.20 - 3.25	(0.1260 - 0.1280)

J8921-1114

Fig. 104 Installing Fifth Gear Snap Ring

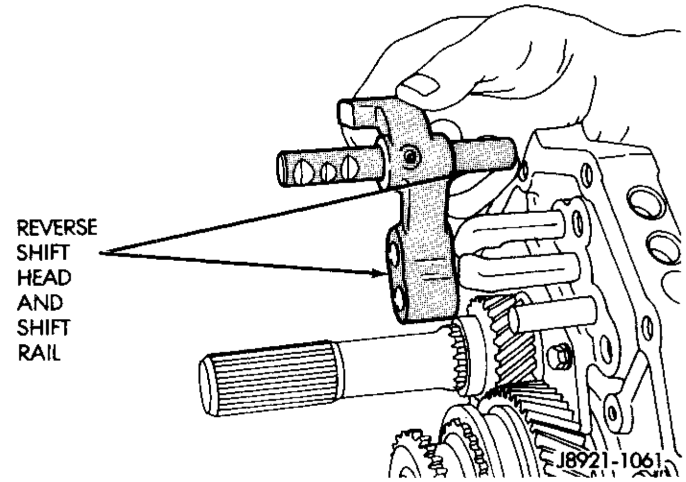


Fig. 105 Installing Reverse Shift Head And Rail

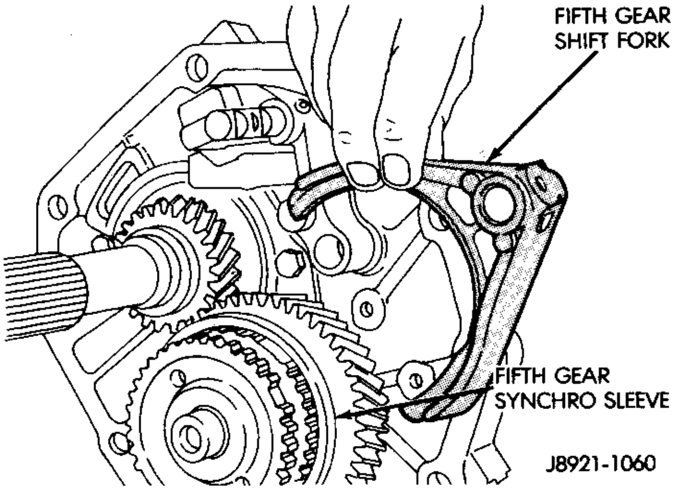


Fig. 106 Installing Fifth Gear Shift Fork

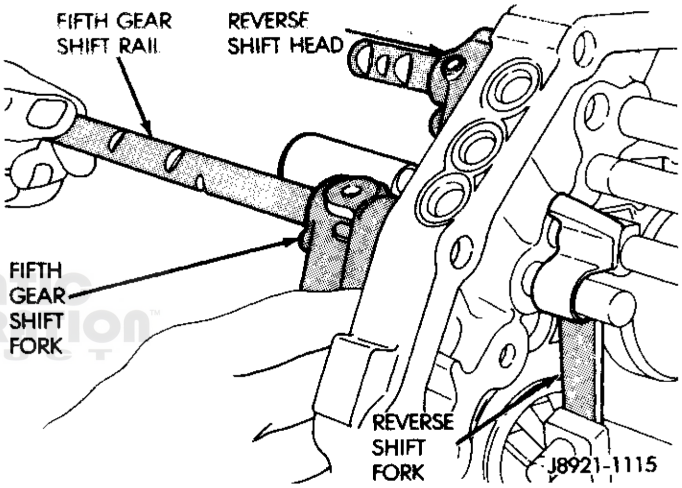


Fig. 107 Installing Fifth Gear Shift Rail

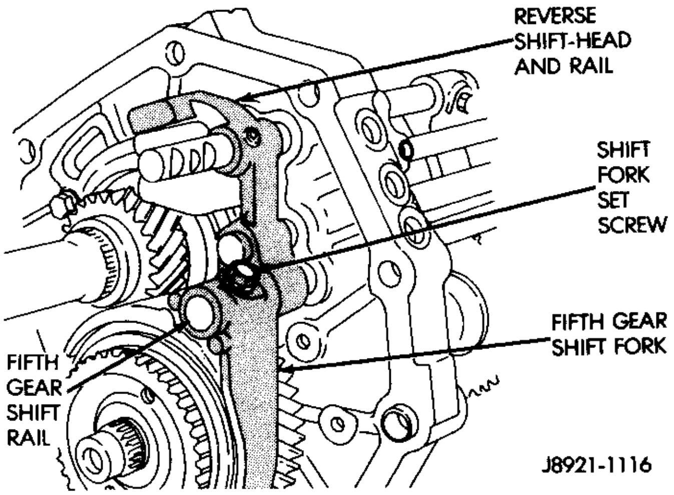


Fig. 108 Shift Fork Set Screw Installation

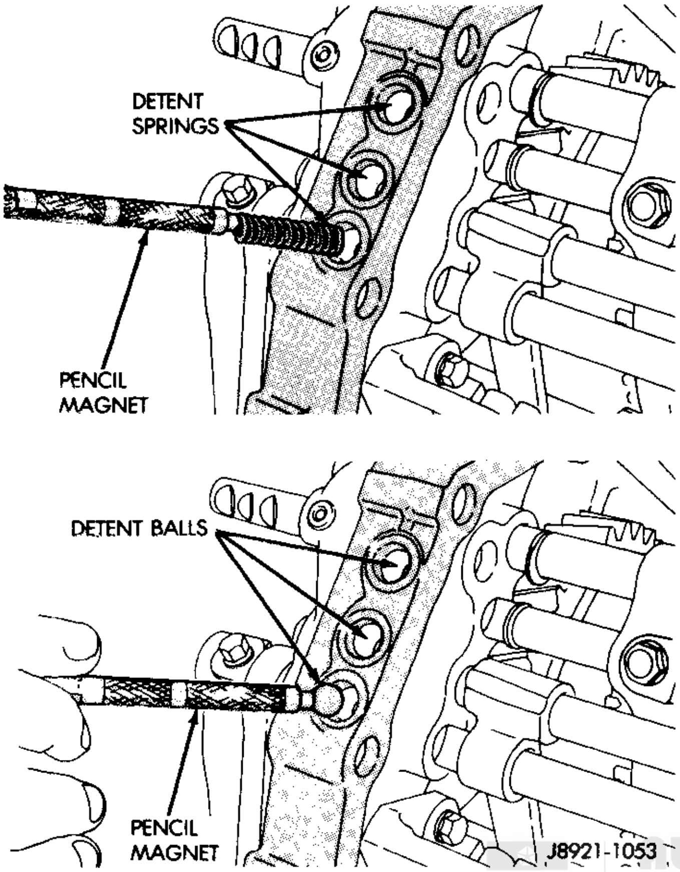


Fig. 109 Detent Ball And Spring Installation

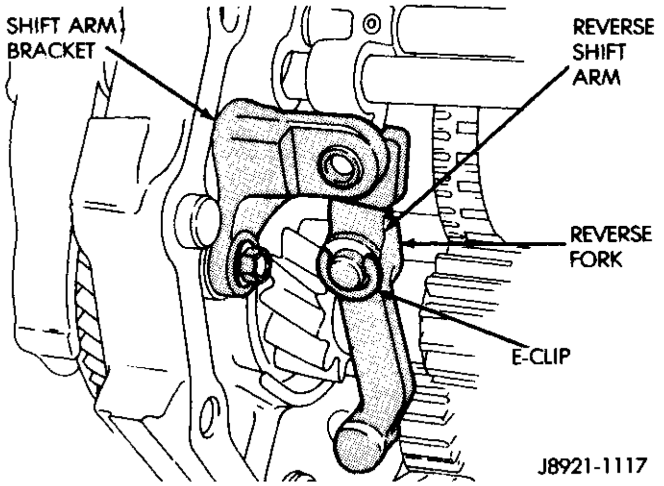


Fig. 110 Reverse Shift Arm And Bracket Installation

Gear Case And Adapter Installation

(1) Dismount the intermediate and gear assemblies from the vise.

(2) Clean the mating surfaces of the intermediate plate and transmission gear case with a wax and grease remover. Then wipe them dry with a clean cloth.

(3) Apply a 1/8 to 3/16 inch wide bead of Mopar Gasket Maker to the mating/sealing surface of the gear case. Keep the sealer bead inside the bolt holes as shown (Fig. 111).

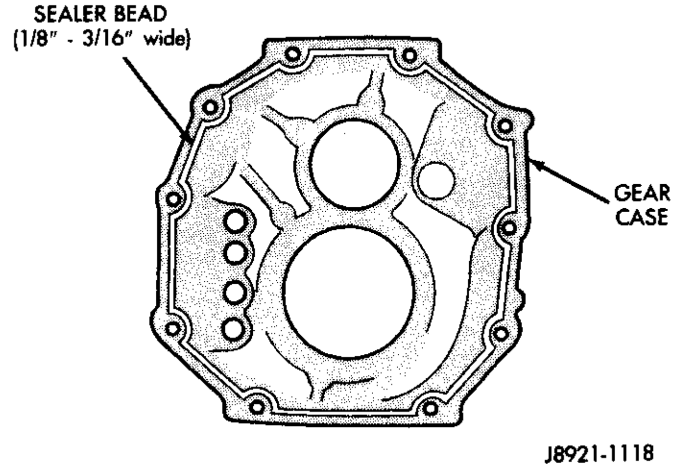


Fig. 111 Applying Sealer To Gear Case

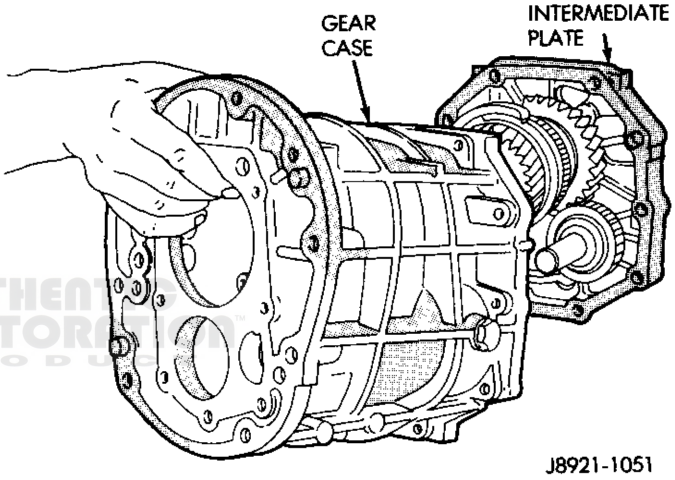


Fig. 112 Installing Gear Case

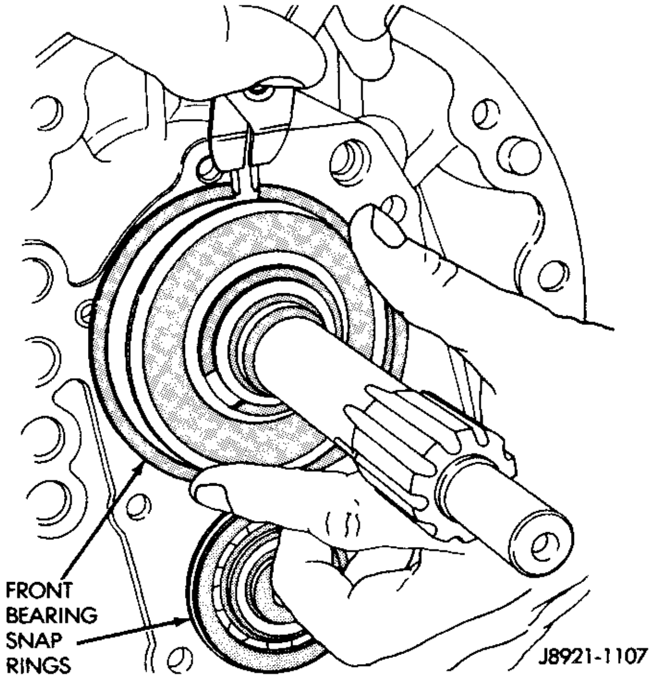


Fig. 113 Installing Front Bearing Snap Rings

(4) Install the gear case (Fig. 112). Align the shift rails and bearings in the case and tap the case into position.

(5) Verify that the gear case is seated on the intermediate plate dowel pins.

(6) Install the front bearing snap rings (Fig. 113).

(7) Clean the gear case and front bearing retainer sealing surfaces with a wax and grease remover. Then wipe dry with a clean cloth.

(8) Install a new seal in the front bearing retainer. Then lubricate the seal lip with petroleum jelly. **Installation depth for the seal is 10.5 to 11.5 mm (.413 to .453 in).**

(9) Apply a 1/8 inch wide bead of Mopar Gasket Maker to the front bearing retainer sealing surface.

(10) Align and install the front bearing retainer (Fig. 114). Be sure the retainer is properly seated on the case and bearings.

(11) Install and tighten the front bearing retainer bolts to 17 N•m (12 ft-lbs) torque.

(12) On two-wheel drive models, install the speedometer gear, lock ball and retaining rings (Fig. 115). Be sure the lock ball is engaged in the gear.

(13) Inspect condition of the reverse pin in the adapter/extension housing (Fig. 116). If the pin is worn or damaged, replace it as follows:

(a) Remove the roll pin access plug (Fig. 117).

(b) Tap the roll pin out of the housing with a pin punch (Fig. 118). Then remove the old reverse pin.

(c) Install the new reverse pin and secure it with the roll pin. Then install and tighten the access plug to 19 N•m (14 ft-lbs) torque.

(14) Clean the sealing surfaces of the adapter or extension housing and intermediate plate with a wax and grease remover. Then wipe dry with a clean cloth.

(15) Apply a 1/8 to 3/16 inch wide bead of Mopar Gasket Maker to the sealing surface of the adapter or extension housing. Keep the sealer bead inside the bolt holes as shown in Figure 111.

(16) Align and install the adapter or extension housing on the intermediate plate (Fig. 119). Be sure the housing is seated on the intermediate plate dowel pins.

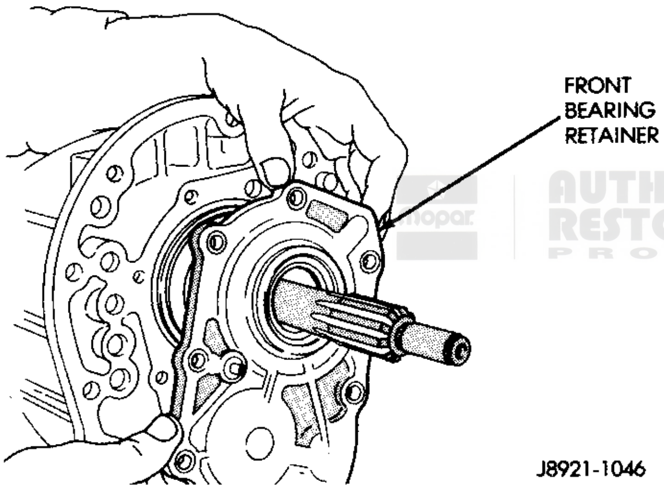


Fig. 114 Installing Front Bearing Retainer

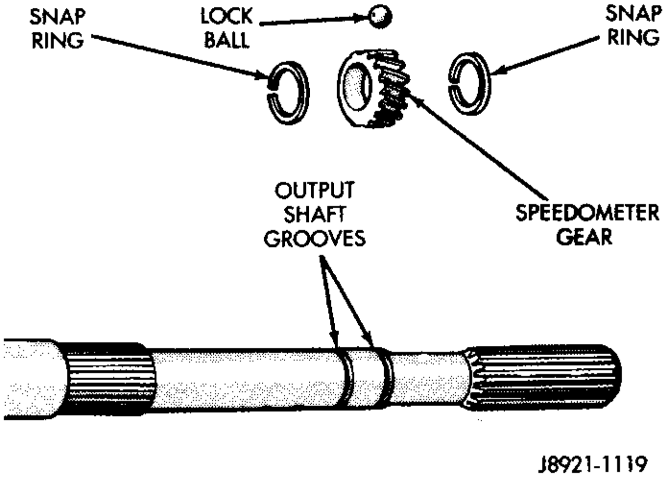


Fig. 115 Speedometer Gear Installation (2WD Models)

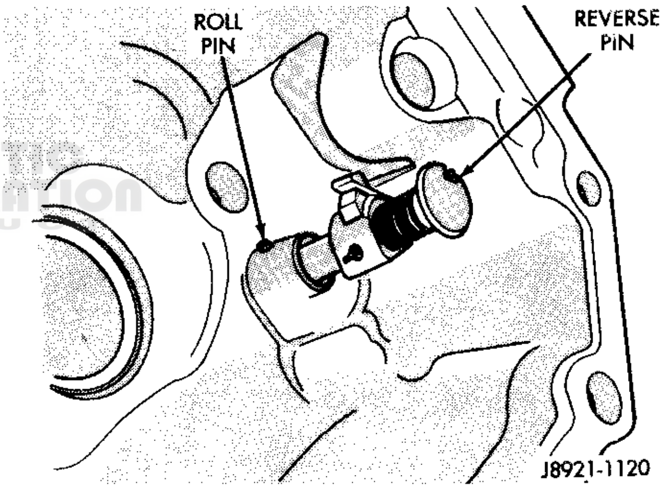


Fig. 116 Reverse Pin Position

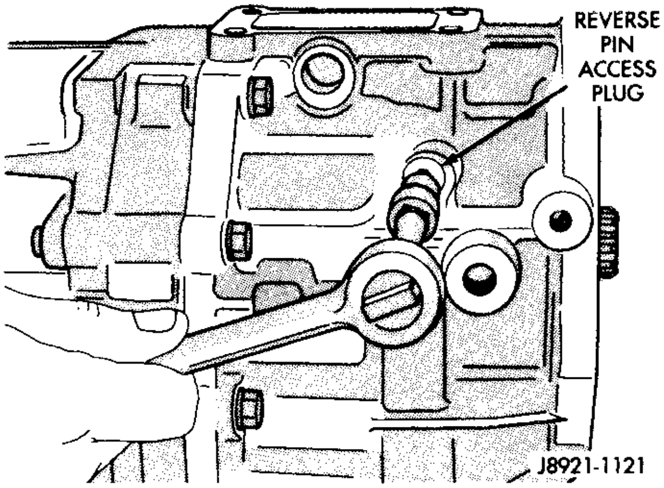


Fig. 117 Access Plug Removal/Installation

(17) Coat the threads of the housing attaching bolts with silicone sealer. Then install and tighten the bolts to 37 N•m (27 ft-lbs) torque.

(18) Install the detent ball (Fig. 120).

(19) Install the detent spring (Fig. 121).

(20) Install the detent access plug (Fig. 122). Tighten the plug to 19 N•m (14 ft-lbs) torque.

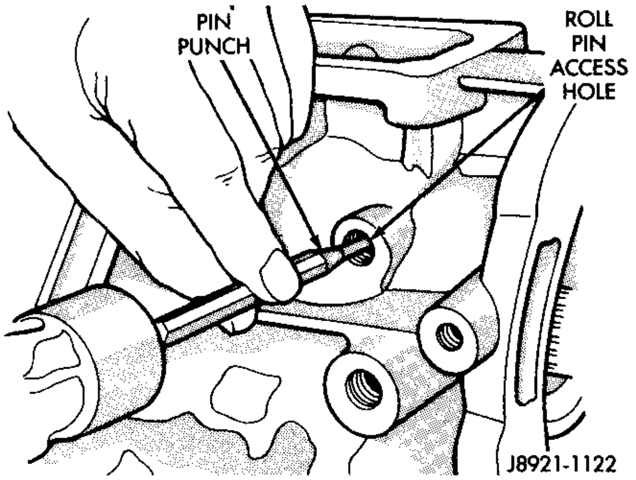


Fig. 118 Roll Pin Removal/Installation

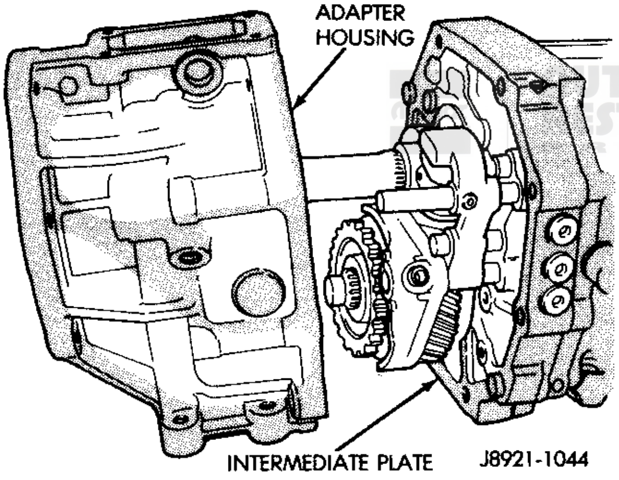


Fig. 119 Adapter/Extension Housing Installation

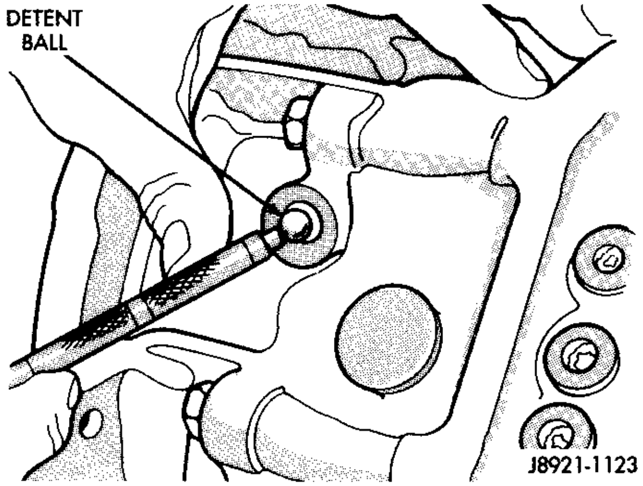


Fig. 120 Installing Detent Ball

(21) Lubricate the shift arm shaft and install it in the adapter housing (Fig. 123).

(22) Position the shift arm in the adapter housing (Fig. 124). Be sure the arm is engaged in the shift rails.

(23) Align the shift arm with the shaft and push the shaft into the arm.

(24) Rotate the shift arm shaft until the set screw holes in the shaft and arm are aligned.

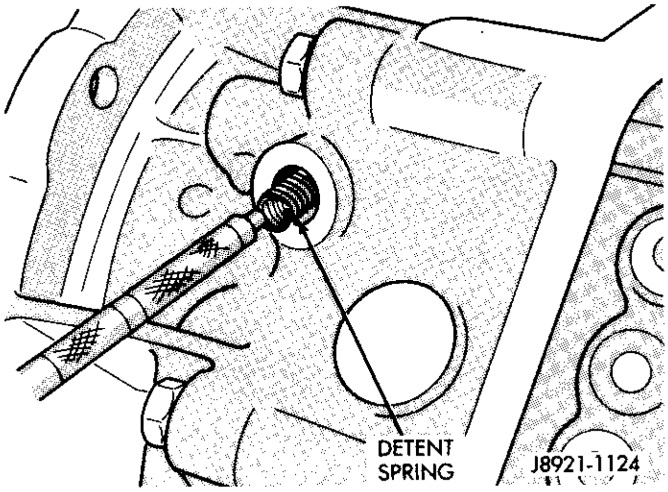


Fig. 121 Installing Detent Spring

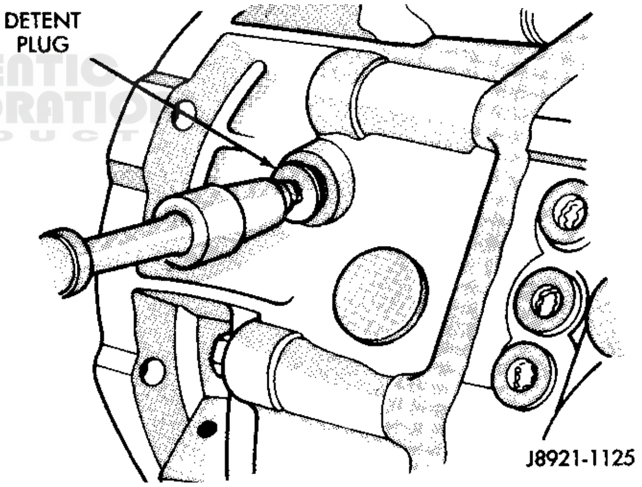


Fig. 122 Installing Detent Access Plug

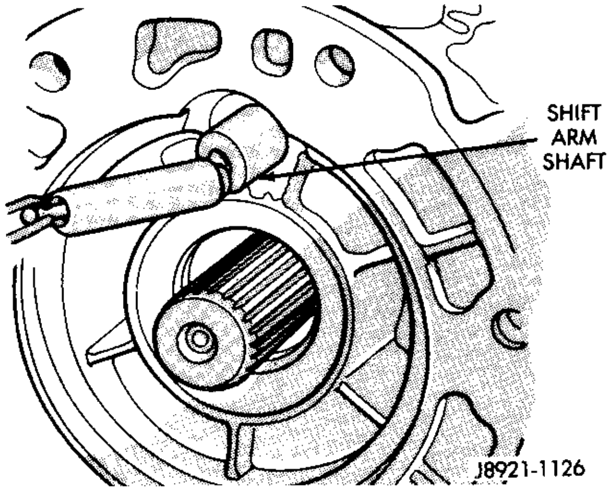


Fig. 123 Installing Shift Arm Shaft

(25) Install and tighten the shift arm set screw to 38 N•m (28 ft-lbs) torque (Fig. 125).

(26) Install and tighten the restrictor pins to 19 N•m (14 ft-lbs) torque (Fig. 125).

(27) Install and tighten the shift arm shaft access plug to 19 N•m (14 ft-lbs) torque (Fig. 126).

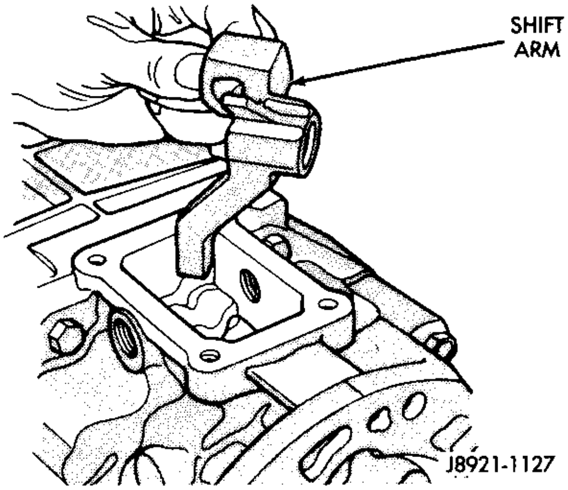


Fig. 124 Shift Arm Installation

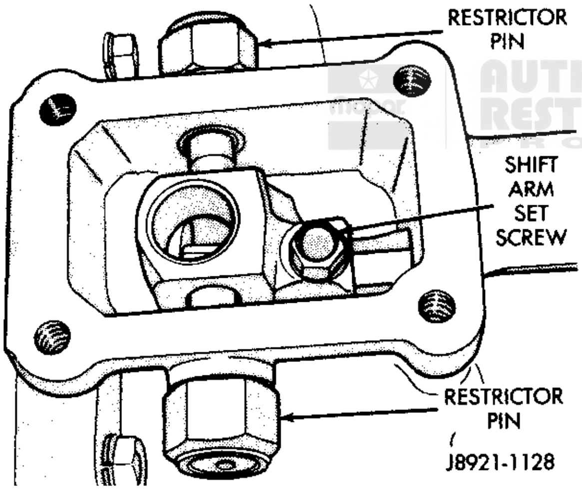


Fig. 125 Set Screw And Restrictor Pin Installation

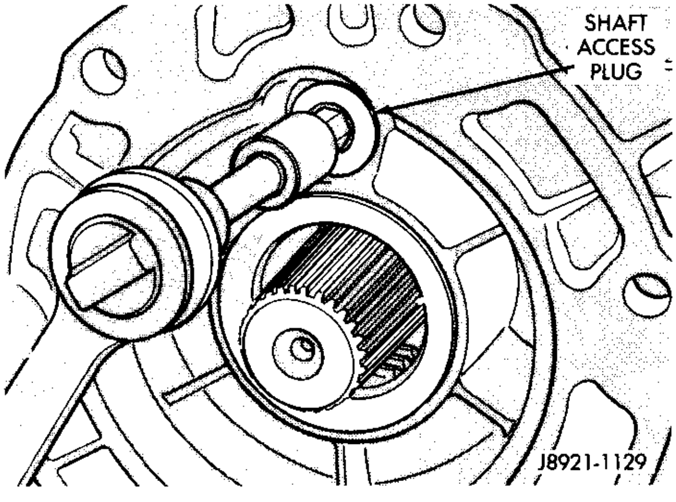


Fig. 126 Access Plug Installation

(28) Position a new shift tower gasket on the adapter housing (Fig 127).

(29) Install the shift tower (Fig. 128). Tighten the tower attaching bolts to 18 N•m (13 ft-lbs) torque.

(30) Install a new gasket on the backup light switch and install the switch. Tighten the switch to 37 N•m (27 ft-lbs) torque.

(31) Install a new washer on the drain plug. Then install and tighten the plug to 37 N•m (27 ft-lbs) torque.

(32) If the transmission will be filled with gear lubricant before installation, place the transmission in a level position.

(33) Fill the transmission with 75W-90, grade GL-5 gear lubricant. Correct level is to the bottom edge of the fill plug hole.

(34) Install a new washer on the fill plug. Then install and tighten the plug to 37 N•m (27 ft-lbs) torque.

(35) Install the clutch housing and hydraulic throwout bearing.

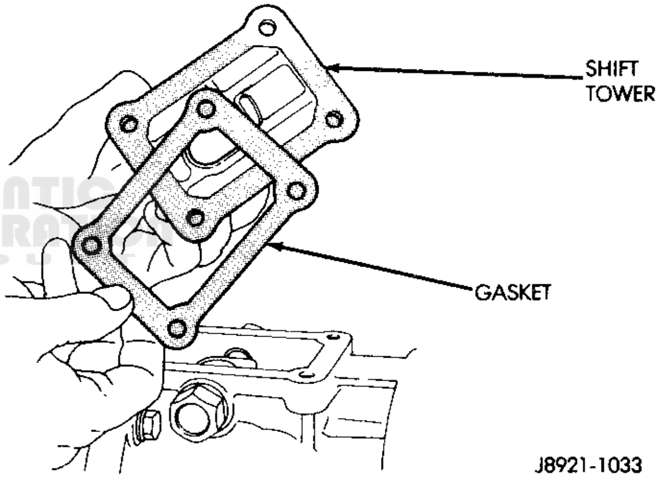


Fig. 127 Shift Tower Gasket Installation

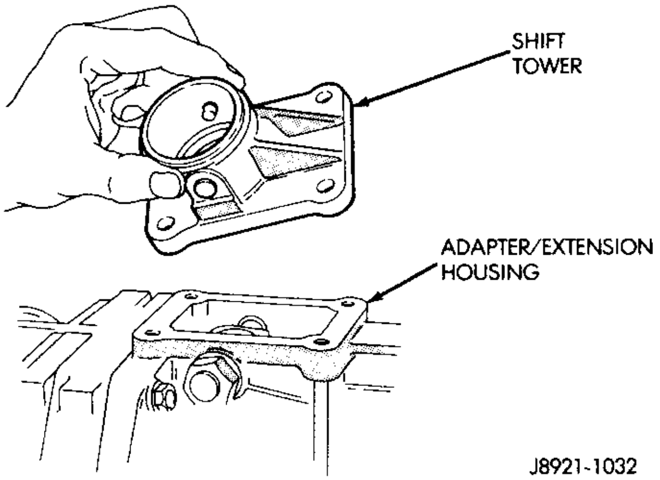


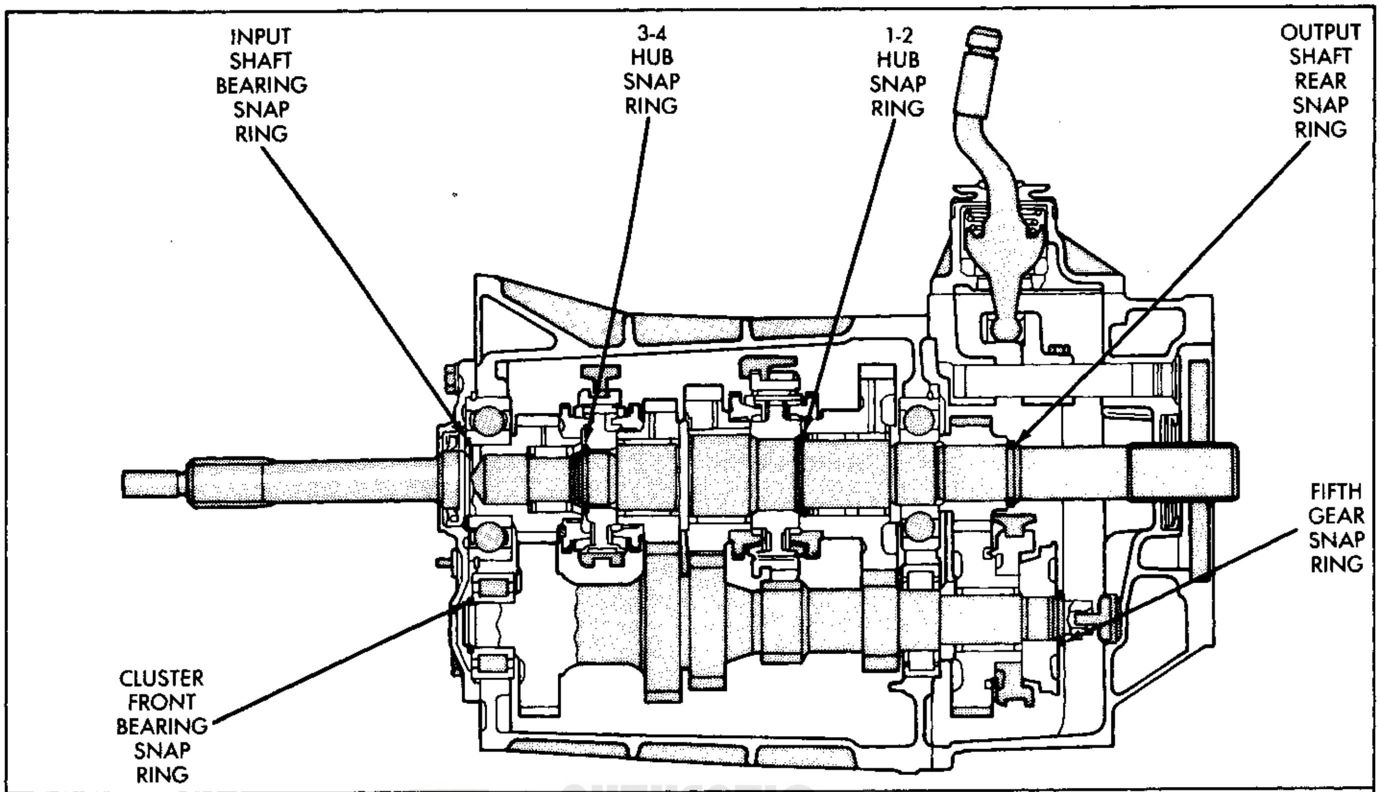
Fig. 128 Shift Tower Installation

TORQUE SPECIFICATIONS

COMPONENT	SET-TO TORQUE
SHIFT TOWER BOLTS	18 N·m (13 ft-lbs)
ACCESS PLUGS	19 N·m (14 ft-lbs)
INTERLOCK/DETENT BALL PLUGS	19 N·m (14 ft-lbs)
DRAIN/FILL PLUGS	37 N·m (27 ft-lbs)
GEAR CASE-TO-ADAPTER HOUSING BOLTS	37 N·m (27 ft-lbs)
BACKUP LIGHT SWITCH	37 N·m (27 ft-lbs)
FRONT BEARING RETAINER BOLTS	17 N·m (12 ft-lbs)
REAR BEARING RETAINER BOLTS	18 N·m (13 ft-lbs)
SHIFT FORK SET SCREWS	20 N·m (15 ft-lbs)
REVERSE SHIFT ARM BRACKET BOLTS	18 N·m (13 ft-lbs)
SHIFT ARM SET SCREW	38 N·m (28 ft-lbs)
RESTRICTOR PINS	19 N·m (14 ft-lbs)

J8921-1130

SELECTIVE SNAP RING CHART



INPUT SHAFT BEARING SNAP RING

I.D. MARK	THICKNESS
A	2.10-2.15 mm
B	2.15-2.20 mm
C	2.20-2.25 mm
D	2.25-2.30 mm
E	2.30-2.35 mm
F	2.35-2.40 mm
G	2.40-2.45 mm

1-2 HUB SNAP RING

I.D. MARK	THICKNESS
B	2.35-2.40 mm
C	2.40-2.45 mm
D	2.45-2.50 mm
E	2.50-2.55 mm
F	2.55-2.60 mm
G	2.60-2.65 mm

CLUSTER FRONT BEARING SNAP RING

I.D. MARK	THICKNESS
A	2.00-2.05 mm
B	2.05-2.10 mm
C	2.10-2.15 mm
D	2.15-2.20 mm
E	2.20-2.25 mm

OUTPUT SHAFT REAR SNAP RING

I.D. MARK	THICKNESS
A	2.75-2.80 mm
B	2.80-2.85 mm
C	2.85-2.90 mm
D	2.90-2.95 mm
E	2.95-3.00 mm
F	3.00-3.05 mm
G	3.05-3.10 mm
H	3.10-3.15 mm
I	3.15-3.20 mm
J	3.20-3.25 mm
K	3.25-3.30 mm
L	3.30-3.35 mm

3-4 HUB SNAP RING

I.D. MARK	THICKNESS
A	1.80-1.85 mm
B	1.85-1.90 mm
C	1.90-1.95 mm
D	1.95-2.00 mm
E	2.00-2.05 mm
F	2.05-2.10 mm
G	2.10-2.15 mm

FIFTH GEAR SNAP RING

I.D. MARK	THICKNESS
A	2.80-2.85 mm
B	2.85-2.90 mm
C	2.90-2.95 mm
D	2.95-3.00 mm
E	3.00-3.05 mm
F	3.05-3.10 mm
G	3.10-3.15 mm
H	3.15-3.20 mm

J8921-1131

CHRYSLER 999/727 AUTOMATIC TRANSMISSION

CONTENTS

GENERAL INFORMATION

INDEX

TRANSMISSION APPLICATION

Chrysler automatic transmission Models 999 and 727 are used in Jeep vehicles. Both are three speed, fully automatic units with a compound planetary gear system (Fig. 1). The 999 is used in YJ models. The 727 is used in SJ models

COMPONENT CHANGES

The input and output shafts in 1990 model 999/727 transmissions have been redesigned and are not interchangeable with previous models. The No. 3 thrust washer and thrust plate are also a new design and not interchangeable with prior models.

The new thrust plate is .060-.063 inch thick and is installed on the output shaft. The same thrust plate is used for 999/727 applications.

The new thrust washer is installed in the bore at the rearward end of the input shaft. A .068 - .070 inch thrust washer is used in all 999 models. A selective thrust washer with thickness ranges of .052 to .085 inch, is used in 727 models.

TORQUE CONVERTER

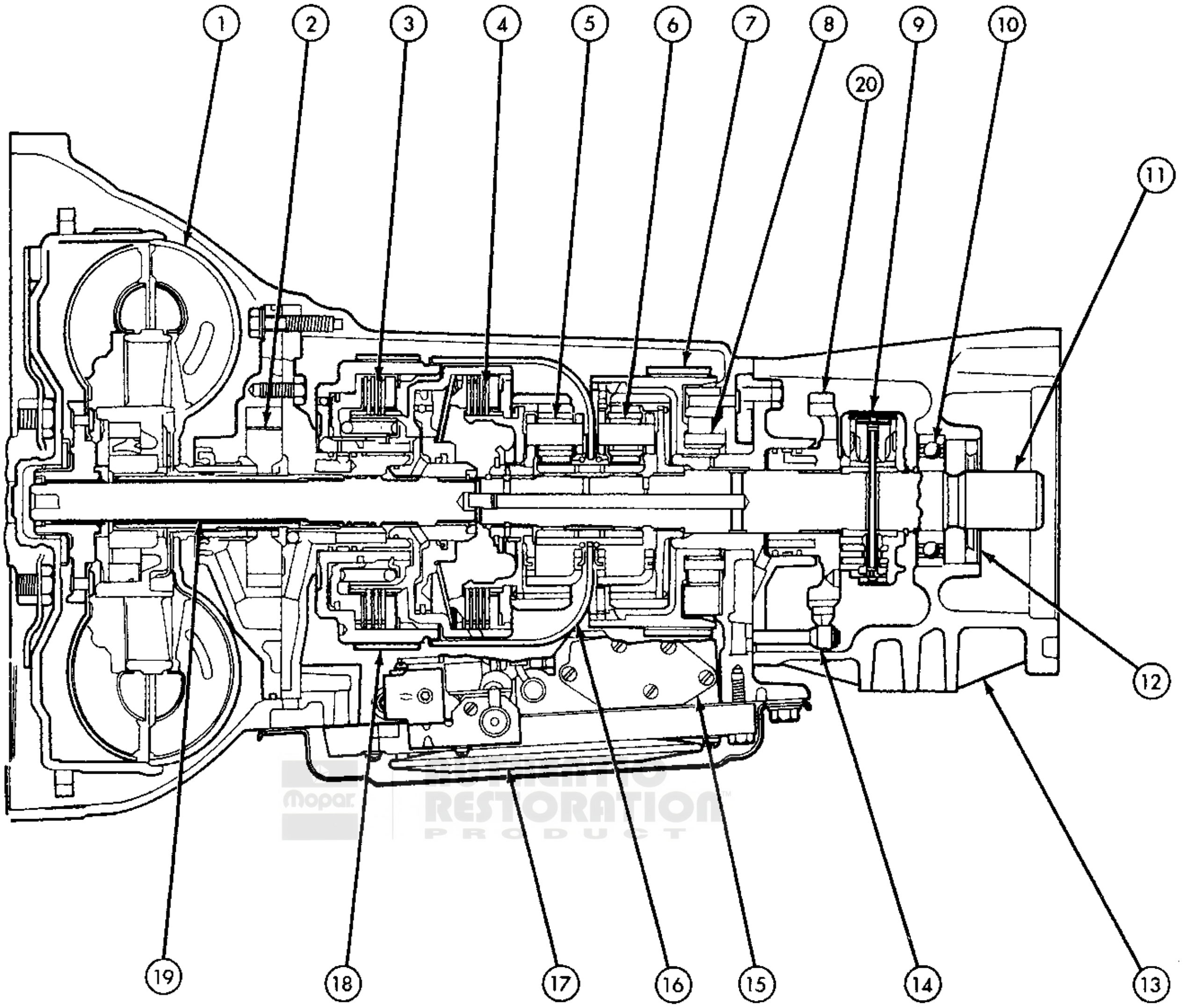
A conventional, three element torque converter is used for all applications. The converter consists of the front cover, impeller, stator, turbine, hub and overrunning clutch.

The impeller is connected to the engine crankshaft through the front cover which is welded to the impeller. The turbine is splined to the transmission input shaft and the stator is splined to the transmission reaction shaft.

The torque converter is a welded assembly and is not a repairable component. The converter is serviced as an assembly only.

WIDE RATIO PLANETARY GEARS—MODEL 999

A wide ratio planetary gear set is used in Model 999 transmissions (Fig. 2). The wide ratio gears provide a 1.74:1 first gear and a 1.54:1 second gear. Third gear is direct with ratio of 1.00:1.



① CONVERTER
② OIL PUMP
③ FRONT CLUTCH
④ REAR CLUTCH
⑤ FRONT PLANETARY GEAR SET
⑥ REAR PLANETARY GEAR SET
⑦ LOW AND REVERSE (REAR) BAND
⑧ OVERRUNNING CLUTCH
⑨ GOVERNOR
⑩ BEARING
⑪ OUTPUT SHAFT
⑫ SEAL
⑬ ADAPTER HOUSING
⑭ PARK LOCK ROD
⑮ VALVE BODY
⑯ SUN GEAR DRIVING SHELL
⑰ OIL FILTER
⑱ KICK DOWN (FRONT) BAND
⑲ INPUT SHAFT
⑳ PARK GEAR

J9021-30

Fig. 1 999/727 Automatic Transmission

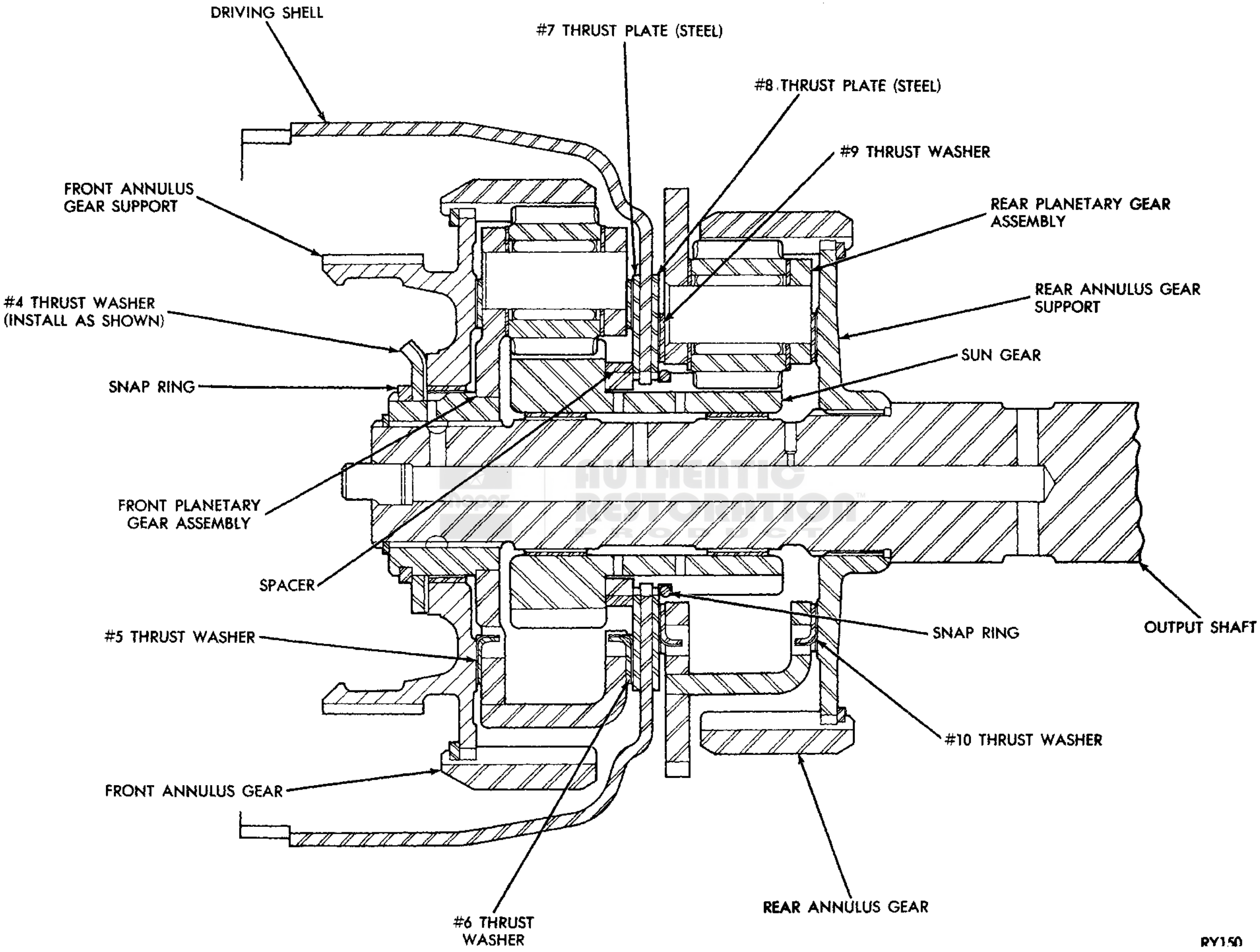


Fig. 2 Wide Ratio Gear Set—Model 999

RECOMMENDED FLUID

Recommended fluid for Model 999 and 727 transmissions is Mopar ATF PLUS, Type 7176. Mopar Dexron II™ can be used if ATF PLUS is not available.

Mopar Dexron/Mercon should only be used to top off fluid level during periodic checks. It is **not** recommended for refilling the transmission after filter/fluid changes, or after overhaul.

Fluid capacity for Model 999 and 727 transmissions is 17 pints (7.9 liters). This is the total capacity and reflects the combined amount required to fill the transmission and torque converter.

AUXILIARY COOLER—SJ

A transmission auxiliary cooler is used on SJ models. The cooler is in addition to the standard cooler in the radiator lower tank. The auxiliary cooler is located behind the grille. It is mounted on the grille panel in front of the A/C condenser and radiator (Fig. 3).

During an overhaul to correct a malfunction that generated sludge or heavy accumulations of metal particles or friction material, the auxiliary cooler and cooler hoses must be flushed thoroughly along with the radiator cooler.

TRANSMISSION IDENTIFICATION

The transmission identification numbers are stamped on the left side of the case just above the oil pan gasket surface (Fig. 3). The first set of numbers is the transmission part number. The next set of code numbers set is the date of build. The final set of code numbers represents the transmission serial number.

TRANSMISSION CONTROLS AND COMPONENTS

The transmission hydraulic control system provides fully automatic operation. The system performs five basic functions, which are:

- pressure supply
- pressure regulation
- flow control
- clutch/band apply and release
- lubrication

Pressure Regulation

The oil pump develops fluid pressure for operation and lubrication. The pump is driven by the torque converter which is attached to the engine crankshaft.

The pressure regulator valve maintains transmission line pressure. The amount of pressure developed is controlled by governor pressure which is dependent on the degree of throttle opening. The regulator valve is located in the valve body. The governor valve is operated by the transmission output shaft.

The governor valve determines line pressure and shift speed. Governor pressure increases in almost direct proportion to vehicle speed.

The throttle valve also controls upshift and downshift speeds by regulating pressure in conjunction with throttle position.

Shift Valves

The manual valve is operated by the gearshift linkage and provides the operating range selected by the driver.

The 1-2 shift valve provides automatic 1-2 or 2-1 shifts and the 2-3 shift valve provides automatic 2-3 or 3-2 shifts. The kickdown valve provides forced 3-2 or 3-1 downshifts depending on vehicle speed. Downshifts occur when the throttle is opened beyond downshift detent position which is just before wide open throttle.

The 2-3 valve throttle pressure plug provides 3-2 downshifts with varying throttle openings and depending on vehicle speed. The 1-2 shift control valve transmits 1-2 shift pressure to the accumulator piston to control kickdown band capacity on 1-2 upshifts and 3-2 downshifts.

The shuttle valve has two functions. First is fast front band release and smooth engagement during lift-foot 2-3 upshifts. The second is to regulate front servo and band application during 3-2 downshifts.

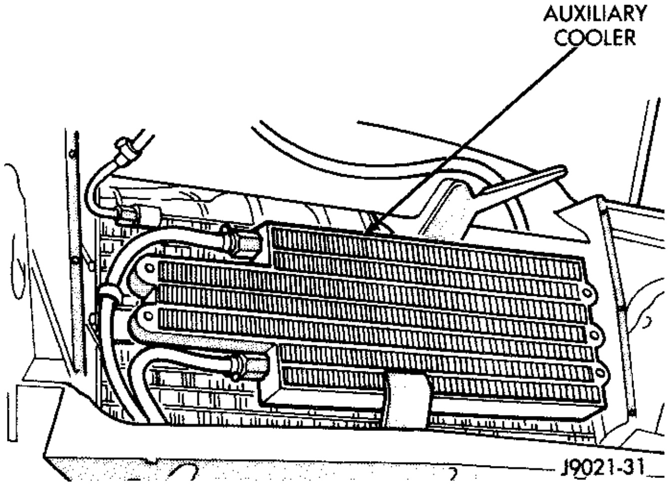


Fig. 3 Auxiliary Cooler—SJ

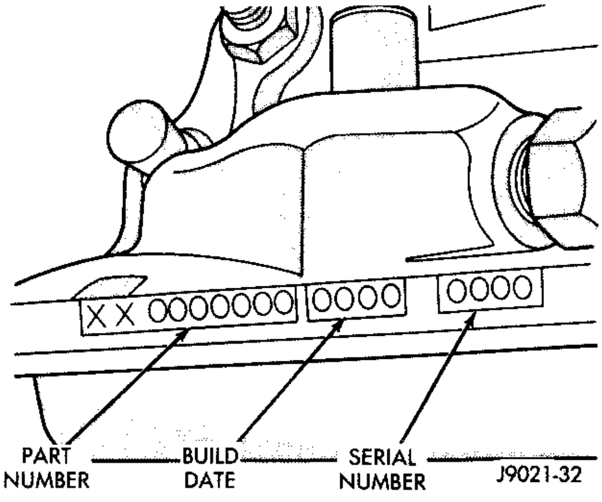


Fig. 4 Transmission Identification

Clutches-Bands-Servos-Accumulator

The front/rear clutch pistons and servo pistons are actuated by line pressure. When line pressure is removed, the pistons are released by spring tension.

On 2-3 upshifts, the front servo piston is released by spring tension and hydraulic pressure. The accumulator controls hydraulic pressure on the apply side of the front servo during 1-2 upshifts. The accumulator also cushions front band application at all throttle openings.

Gearshift And Parking Lock Controls

The gearshift lever provides six operating positions: Park (P), Reverse (R), Neutral (N), and the D, 2 and 1 forward drive ranges.

1 position provides overrun braking when the throttle is released. However, upshifts are not provided in 1 position. 1-2 up shifts will occur in 2 position but no 2-3 upshift will take place. D position provides 1-2, 2-3 upshifts and 3-2 and 3-1 downshifts.

A neutral switch controls engine starting. The switch is designed to allow engine starts only in Park or Neutral positions.

The transmission parking lock mechanism is engaged when the shift lever is moved into the Park detent. The mechanism consists of a pawl that engages a gear on the output shaft.

DIAGNOSIS AND TEST PROCEDURES

INDEX

General Information

Automatic transmission problems can be a result of poor engine performance, incorrect fluid level, incorrect linkage adjustment, band or hydraulic control pressure adjustments, hydraulic system malfunctions or mechanical component malfunctions.

Begin diagnosis by checking the easily accessible items such as fluid level and condition and linkage adjustments. A road test will determine if further diagnosis is necessary.

Procedures outlined in this section should be performed in the following sequence to realize the most accurate results:

- Preliminary diagnosis
- Fluid Level and condition
- Linkage Adjustment
- Road test
- Stall test
- Hydraulic pressure test
- Air pressure tests
- Leak Tests
- Analyze test results and consult diagnosis charts

PRELIMINARY DIAGNOSIS

Two basic procedures are required. One procedure for vehicles that are driveable and an alternate procedure for disabled vehicles (will not back up or move forward).

Vehicle Is Driveable

(1) Check fluid level and condition.

(2) Adjust throttle and gearshift linkage if complaint was based on delayed, erratic, or harsh shifts.

(3) Road test and note transmission operating characteristics.

(4) Perform stall test if complaint is based on sluggish, low- speed acceleration or abnormal throttle opening needed to maintain normal speeds with properly tuned engine.

(5) Perform hydraulic pressure tests.

(6) Perform air pressure test to check clutch-band operation.

Vehicle Is Disabled

(1) Check fluid level and condition.

(2) Check for broken, disconnected throttle linkage.

(3) Check for cracked, leaking cooler lines, or loose, missing pressure port plugs.

(4) Raise vehicle, start engine, shift transmission into gear and note following:

(a) If propeller shafts turn but wheels do not, problem is with differential or axle shafts.

(b) If propeller shafts do not turn and transmission is noisy, stop engine. Remove oil pan, and check for debris. If pan is clear, remove transmission and check for damaged drive plate, converter, oil pump or input shaft.

(c) If propeller shafts do not turn and transmission is not noisy, perform hydraulic pressure test to determine if problem is a hydraulic or mechanical.

CHECKING FLUID LEVEL AND CONDITION

(1) To avoid false readings, which could produce under or over fill condition, do not check level until fluid is at normal operating temperature.

(2) Shift transmission into Neutral.

(3) Apply parking brakes.

(4) Operate engine at curb idle speed.

WARNING: WHEN PERFORMING UNDERHOOD OPERATIONS WITH THE ENGINE RUNNING, KEEP YOUR HANDS WELL AWAY FROM HOT OR ROTATING ENGINE COMPONENTS. DO NOT WEAR LOOSE ARTICLES OF CLOTHING WHICH COULD BECOME ENTANGLED IN ENGINE COMPONENTS OR ACCESSORIES.

(5) Clean dipstick filler cap and tube before removing dipstick.

(6) Remove dipstick and inspect fluid level. Correct level is to FILL mark. Acceptable level is between ADD and FULL marks.

(7) Check fluid condition. Fluid should be dark to light red in color and free of dirt or debris.

(8) If fluid is discolored or smells burned but transmission operation was OK, flush cooler and lines and change fluid and filter. Then road test again to confirm proper operation.

(9) If fluid is black or dark brown, burned/turned to sludge, contains metal or friction material particles,

transmission will probably need overhaul; Especially if problems were evident during road test and preliminary diagnosis.

Effects Of Incorrect Fluid Level

A low fluid level allows the pump to take in air along with the fluid. Air in the fluid will cause fluid pressures to be low and develop slower than normal.

If the transmission is overfilled, the gears churn the fluid into foam, aerating the fluid and causing the same conditions that occur with a low level.

In either case, air bubbles cause fluid overheating, oxidation and varnish buildup which interferes with valve, clutch and servo operation. Foaming also causes fluid expansion which can result in fluid overflow from the transmission vent or fill tube. Fluid overflow can easily be mistaken for a leak if inspection is not careful.

THROTTLE VALVE LINKAGE

Throttle valve linkage adjustment is important to proper operation. This adjustment positions the throttle valve which controls shift speed, quality and part throttle downshift sensitivity. If linkage setting is too short, early shifts and slippage between shifts may occur. If the setting is too long, shifts may be delayed and part throttle downshifts may be very sensitive. Refer to the In-Vehicle Service section for adjustment procedure.

GEARSHIFT LINKAGE

Gearshift linkage adjustment is important because it positions the valve body manual valve. Incorrect adjustment will cause creeping in Neutral, premature clutch wear, delayed engagement in any gear, or a no-start in Park or Neutral position.

Proper operation of the neutral start switch will provide a quick check of linkage adjustment. Refer to the In-Vehicle Service section for adjustment procedure.

ROAD TEST

Before road testing, be sure the fluid level and all linkage adjustments have been checked and adjusted if necessary.

Observe engine performance during the road test. A poorly tuned engine will not allow an accurate analysis of transmission operation.

Operate the transmission in all gear ranges. Check for slippage and shift variations. Note whether the shifts are harsh, spongy, delayed, early, or if part throttle downshifts are sensitive.

Watch closely for slippage or engine flare which usually indicates clutch, band or overrunning clutch problems. If the condition is advanced, an overhaul may be necessary to restore normal operation.

A slipping clutch or band can often be determined by comparing which internal units are applied in the various gear ranges. The Clutch and Band Application chart (Fig. 5) provides a basis for analyzing road test results.

ANALYZING THE ROAD TEST

Refer to the Clutch and Band Application chart (Fig. 5) and note which elements are in use in the various gear ranges.

The rear clutch is applied in all forward ranges (D, 2, 1). The overrunning clutch is applied in first gear (D and 2 range only).

The front band is applied in 1 and R range only.

For example: If slippage occurs in first gear in D and 2 range but not in 1 range, the overrunning clutch is slipping. Similarly, if slippage occurs in any two forward gears, the rear clutch is slipping.

Applying the same method of analysis, note that both clutches are applied in D range third gear only. If the transmission slips in third gear, either the front clutch or the rear clutch is slipping. By selecting another gear which does not use one of these units, the slipping clutch can be determined. For example, if the transmission also slips in Reverse, the front clutch is slipping. If the transmission does not slip in Reverse, the rear clutch is slipping.

This process of elimination can be used to determine the slipping unit and check operation. Proper use of the Clutch and Band Application Chart is the key.

Although road test analysis will help determine the slipping unit, the actual cause of a malfunction usually cannot be determined until hydraulic and air pressure tests are performed. Practically any condition can be caused by leaking hydraulic circuits or sticking valves.

Unless the condition is obvious, such as no drive in D range, first gear only, do not disassemble the transmis-

	Gearshift Lever Position								
DRIVE ELEMENTS	P	R	N	D			2		1
				1	2	3	1	2	
FRONT CLUTCH		●				●			
FRONT BAND (KICKDOWN)					●			●	
REAR CLUTCH				●	●	●	●	●	●
REAR BAND (LOW-REV.)		●							●
OVER-RUNNING CLUTCH				●			●		●

J9021-33

Fig. 5 Clutch And Band Application Chart sion until hydraulic and air pressure tests have been performed.

HYDRAULIC PRESSURE TEST

Hydraulic test pressures range from a low of one psi (6.895 kPa) governor pressure, to 300 psi (2068.5 kPa) at the rear servo pressure port in reverse.

Use 100 psi test gauge C-3292 to check pressure at the accumulator, front servo, governor and fluid cooler line. Use 300 psi gauge C-3293 to check pressure at the rear servo.

Pressure Test Port Locations

There are pressure test ports at the accumulator, front servo, rear servo, governor and fluid cooler return line (for lubrication pressure).

Line pressure is checked at the accumulator port on the right side of the case (Fig. 6). The front servo release pressure port is at the right side of the case just behind the filler tube opening (Fig. 6).

The rear servo pressure port is at the right rear of the transmission case (Fig. 7). The governor pressure port is at the left side of case at the transmission rear (Fig. 7).

Lubrication pressure is measured by installing a T-fitting in the fluid cooler return line.

Pressure Test Procedure

Connect a tachometer to the engine. Position the tachometer so it can be observed from under the vehicle. Raise the vehicle on hoist that will allow the wheels to rotate freely.

Test One-Transmission In 1 Range

This test checks pump output, pressure regulation, and condition of the rear clutch and rear servo circuits.

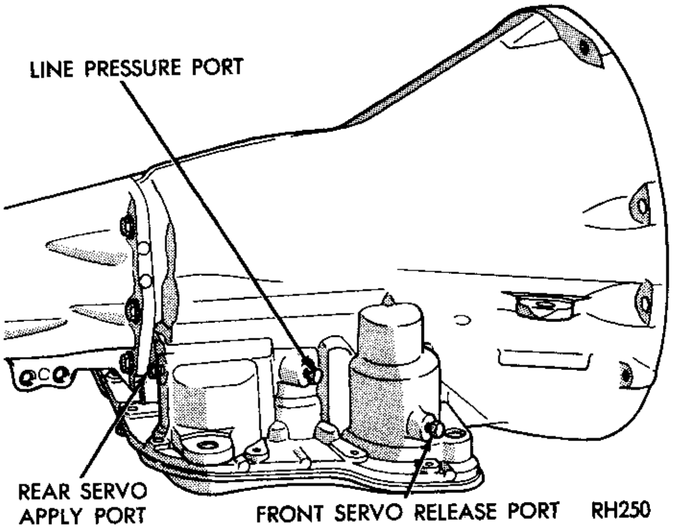


Fig. 6 Pressure Test Ports At Side Of Transmission

(1) Connect test gauges to the line pressure and rear servo ports (Figs. 6-7). **Be sure the 300 psi (2068.5 kPa) gauge is connected to the rear servo port.**

(2) Disconnect the throttle and gearshift rods at the transmission.

(3) Start and run the engine at 1000 rpm.

(4) Move the valve body selector lever all the way forward into 1 range.

(5) Read pressures on both gauges as the transmission throttle lever is is moved from full forward to full rearward position.

(6) Line pressure should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase to 90-96 psi (620-662 kPa) as lever is moved rearward.

(7) Rear servo pressure should be the same as line pressure within 3 psi.

Test Two-Transmission In 2 Range

This test checks pump output, pressure regulation and condition of the lubrication circuit.

(1) Connect a test gauge to the line pressure port (Fig. 6).

(2) Connect another gauge to the cooler return line to read lubrication pressure. Use a T-fitting to connect the gauge to the fitting or line.

(3) Start and run the engine at 1000 rpm.

(4) Move the valve body selector lever one detent rearward from full forward position. This is 2 range.

(5) Move the transmission throttle lever from full forward to full rearward position and read pressure at both gauges.

(6) Line pressure should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase to 90-96 psi (620-662 kPa) as the lever is moved rearward.

(7) Lubrication pressure should be 5-15 psi (34-103 kPa) with lever forward and increase to 10-30 psi (68-204 kPa) as lever is moved rearward.

Test Three-Transmission In D Range

This test checks pressure regulation and condition of the front and rear clutch circuits.

(1) Connect test gauges to the line pressure and front servo ports (Fig. 6).

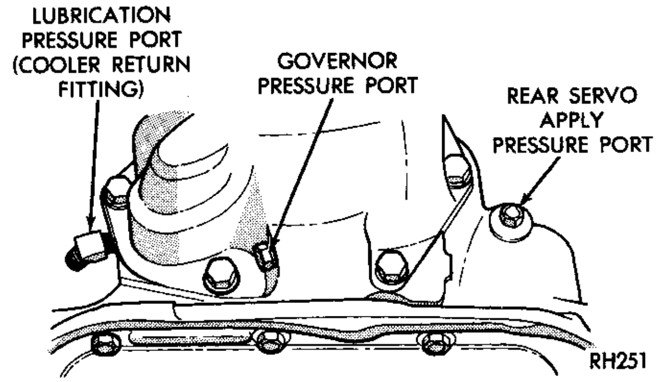


Fig. 7 Pressure Test Ports At Rear Of Transmission

(2) Start and run the engine at 1600 rpm for this test.

(3) Move the selector lever two detents rearward from full forward position. This is D range.

(4) Read pressures on both gauges as transmission throttle lever is moved from full forward to full rearward position.

(5) Line pressure should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase as lever is moved rearward.

(6) Front servo is pressurized only in D range and should be the same as line pressure within 3 psi (21 kPa) up to downshift point.

Test Four-Transmission In Reverse

This test checks pump output, pressure regulation and the front clutch and rear servo circuits.

(1) Connect the 300 psi gauge to the rear servo port (Fig. 7).

(2) Start and run the engine at 1600 rpm for test.

(3) Move the valve body selector lever four detents rearward from the full forward position. This is Reverse range.

(4) Move the throttle lever all the way forward then all the way rearward and note the gauge readings.

(5) Pressure should be 145 - 175 psi (1000-1207 kPa) with lever forward and increase to 230 - 280 psi (1586-1931 kPa) as lever is moved rearward.

Test Five-Governor Pressure

(1) This test checks governor operation by measuring governor pressure response to changes in engine speed. It is usually not necessary to check governor operation unless shift speeds are incorrect or if the transmission will not downshift.

(2) Connect a test gauge to the governor pressure port (Fig. 7).

(3) Move the selector lever to D range.

(4) Start and run the engine at curb idle speed and note pressure. At idle, pressure should be zero to 1-1/2 psi maximum. If pressure exceeds this figure, the governor valve or weights are sticking open.

(5) Slowly increase engine speed and observe speedometer and pressure test gauge. Governor pressure should increase in proportion to vehicle speed. Or approximately 1 psi for every 1 mph .

(6) Pressure rise should be smooth and drop back to 0 to 1-1/2 psi when the throttle is closed.

(7) Compare results of the pressure tests with the analysis chart (Fig. 8).

CONVERTER STALL TEST

Stall testing involves determining maximum engine rpm obtainable at full throttle with the rear wheels locked and the transmission in D range. This test checks the holding ability of the the converter overrunning clutch and both of the transmission clutches. When stall testing is completed, refer to the Stall Speed Specifications chart and Stall Speed Diagnosis guides.

WARNING: NEVER ALLOW ANYONE TO STAND IN FRONT OF THE VEHICLE DURING A STALL TEST. ALWAYS BLOCK THE FRONT WHEELS AND APPLY THE SERVICE AND PARKING BRAKES DURING THE TEST.

Stall Test Procedure

(1) Connect a tachometer to the engine.

(2) Check and adjust transmission fluid level.

(3) Start and run the engine until transmission fluid reaches normal operating temperature.

(4) Block the front wheels.

(5) Fully apply the service and parking brakes.

(6) Open the throttle completely for no more than five seconds and record maximum engine rpm registered on the tachometer.

CAUTION: Stall testing causes a rapid increase in transmission fluid temperature. Do not hold the throttle open any longer than five seconds. If more than one stall test is required, run the engine at 1000 rpm with the transmission in Neutral for at least 20 seconds to cool the fluid.

(7) If engine speed exceeds maximum shown in the stall speed chart, release the accelerator immediately. This indicates that transmission clutch slippage is occurring.

TEST CONDITION	INDICATION
Line pressure OK during any one test	Pump and regulator valve OK
Line Pressure OK in R but low in D, 2, 1	Leakage in rear clutch area (servo, clutch seals, governor support seal rings)
Pressure OK in 1, 2 but low in D3 and R	Leakage in front clutch area (servo, clutch seals, retainer bore, pump seal rings)
Pressure OK in 2 but low in R and 1	Leakage in rear servo
Front servo pressure in 2	Leakage in servo; broken servo ring or cracked servo piston
Pressure low in all positions	Clogged filter, stuck pressure regulator valve, worn or defective pump
Governor pressure too high at idle speed:	Governor valve sticking open
Governor pressure low at all mph figures	Governor valve sticking closed
Lubrication pressure low at all throttle positions	Clogged oil cooler or lines, seal rings leaking, output shaft plugged with debris, worn bushings in pump or clutch retainer

J9021-34

Fig. 8 Pressure Test Analysis Chart

(8) Shift the transmission into Neutral. Operate the engine for 20 seconds. Stop the engine, shift the transmission into Park and release the brakes.

(9) Stall speeds should be in 1700-2000 rpm range for 999 and 727 transmissions.

(10) Refer to Stall Test Diagnosis.

Stall Test Diagnosis

Stall Speed Too High

If the stall speed exceeds specifications by more than 200 rpm, transmission clutch slippage is indicated.

Stall Speed Too Low

Low stall speeds with a properly tuned engine indicate a torque converter overrunning clutch problem. The condition should be confirmed by road testing prior to converter replacement.

The converter overrunning clutch is slipping when: Stall speeds are 250 to 350 rpm below specified minimum and the vehicle operates properly at highway speeds but has poor low speed acceleration.

Stall Speed Normal

If stall speeds are normal but abnormal throttle opening is required to maintain highway speeds, the converter overrunning clutch is seized and the torque converter must be replaced.

Converter Noise During Test

A whining noise caused by fluid flow is normal during a stall test. However, loud metallic noises indicate a damaged converter. To confirm that noise is originating from the converter, operate the vehicle at light throttle in Drive and Neutral on a hoist and listen for noise coming from the converter housing.

AIR PRESSURE TEST

Air pressure testing can be used to check clutch and band operation with the transmission either in the vehicle, or on the work bench as a final check after overhaul.

Air pressure testing requires that the oil pan and valve body be removed from the transmission.

The servo and clutch apply passages are shown in Figure 9.

Front Clutch Test

Place one or two fingers on the clutch housing and apply air pressure through front clutch apply passage (Fig. 11). Piston movement can be felt and a soft thud heard as the clutch applies.

Rear Clutch Test

Place one or two fingers on the clutch housing and apply air pressure through rear clutch apply passage (Fig. 11). Piston movement can be felt and a soft thud heard as the clutch applies.

Front Servo Test

Apply air pressure to the front servo apply passage. The servo rod should extend and cause the band to tighten around the drum. Spring tension should release the servo when air pressure is removed.

Rear Servo Test

Apply air pressure to the rear servo apply passage. The servo rod should extend and cause the band to tighten around the drum. Spring tension should release the servo when air pressure is removed.

CONVERTER HOUSING FLUID LEAK DIAGNOSIS

When diagnosing converter housing fluid leaks, two items must be established before repair. First, it must be verified that a leak condition actually exists. And second, the true source of the leak must be determined.

Some suspected converter housing fluid leaks may not be leaks at all. They may only be the result of residual fluid in the converter housing, or excess fluid spilled during factory fill or refill after repair.

Converter housing leaks have several potential sources. Through careful observation, a leak source can be identified before removing the transmission for repair.

Pump seal leaks tend to move along the drive hub and onto the rear of the converter. Pump O-ring or pump body leaks follow the same path as a seal leak (Fig. 10).

Pump vent or pump attaching bolt leaks are generally deposited on the inside of the converter housing and not on the converter itself (Fig. 10).

Pump seal or gasket leaks usually travel down the

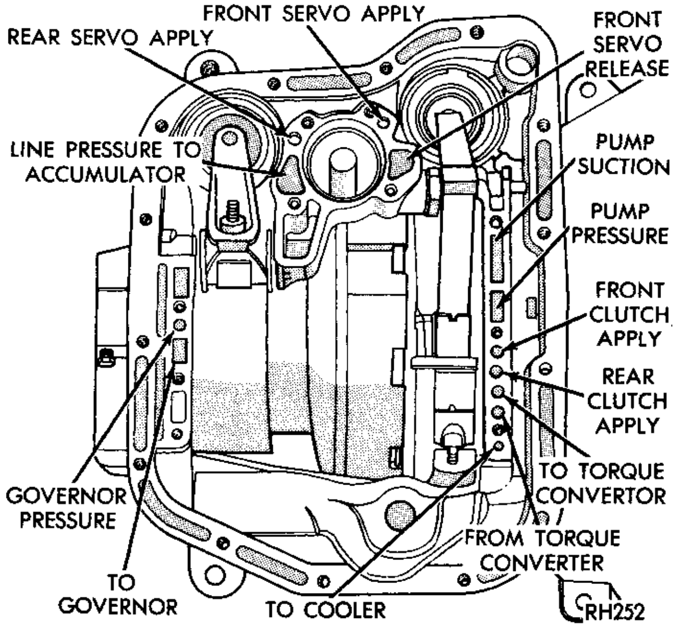


Fig. 9 Air Pressure Test Passages

inside of the converter housing.

Front band lever pin plug leaks are generally deposited on the housing and not on the converter.

Leak Diagnosis Procedure

(1) Raise the rear of the vehicle and allow accumulated fluid to drain out of the converter housing.

(2) Check and adjust the transmission fluid level.

(3) Raise the vehicle. Remove the converter housing dust cover and wipe as much fluid as possible from the converter housing.

(4) Fabricate a test probe (Fig. 11). Then attach the probe to the converter housing with one of the dust shield bolts (Fig. 11).

(5) Have a helper run the engine at 2500 rpm (with the transmission in Neutral) for two minutes; then stop the engine.

(6) Inspect the test probe and converter housing. If a leak is evident, note the color of the fluid. Transmission fluid is red. Engine oil ranges in color from brown to green, or to black when the oil is dirty.

(7) If the probe upper surface is dry, the converter and seal are not at fault. A path of fluid across the probe upper surface indicates a converter or seal leak. Fluid leaking **under** the probe is coming from the pump housing area (Fig. 12).

(8) Fluid leaking under the probe could be from the: pump seal and/or bushing, pump vent, kickdown lever shaft access plug, pump bolts, or porous spots in the pump body or transmission case (Fig. 12).

(9) If porous spots in the transmission case or pump body are the suspected leak source, pressurize the transmission as described in Leak Testing With Air Pressure.

Leak Testing With Air Pressure

This test involves closing off the transmission openings and pressurizing the transmission to 8 psi with air pump tool C-4080.

A soapy water solution is applied to suspected leak points before and during the pressure test. Leaks will be indicated by the presence of air bubbles coming through the solution.

Some transmission openings such as the fill tube and front cooler line fitting can be closed off with a rubber plug or similar device. Plugs can secured with wire or duct tape.

The transmission rear output shaft opening is closed off simply by leaving the transfer case bolted in place. However, if the transfer case has been removed, a shipping plug can used to close off this opening.

The torque converter hub opening in the pump and the pump vent require special tools to close them off. The converter hub seal cap is made from thin wall tube and a 1/8 inch thick disc (Fig. 13). A retaining strap is needed to secure the seal cup for testing. The strap can be made from 1-1/4 inch wide stock (Fig. 14). The strap attaching hole positions are approximate only. Measure hole position on the converter housing before drilling.

The pump vent tool is made from 1/4 inch rod and 3/16 plate (Fig. 15). The fabricated tools can all be made from mild steel or aluminum stock.

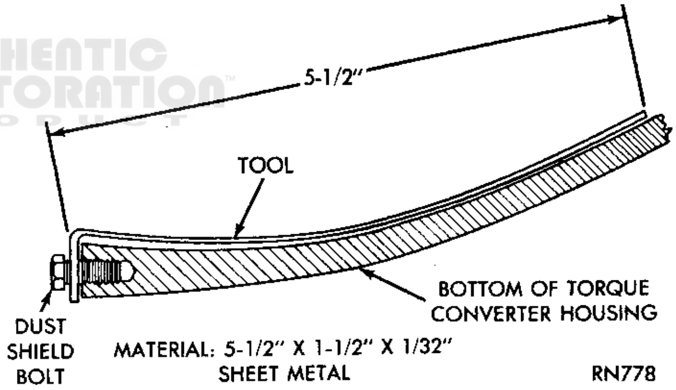


Fig. 11 Leak Test Probe

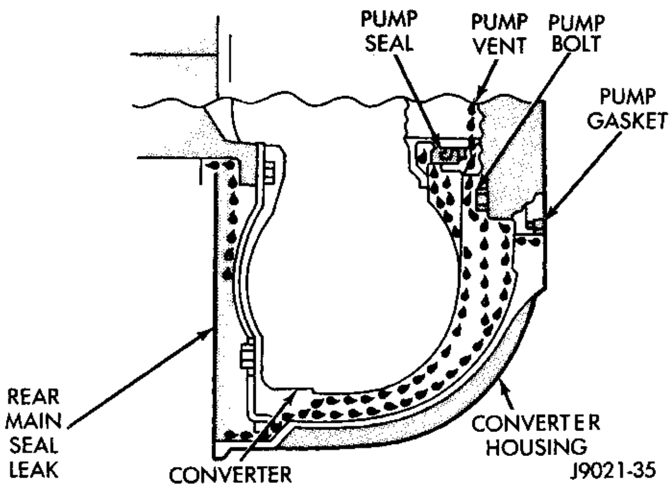


Fig. 10 Converter Housing Leak Paths

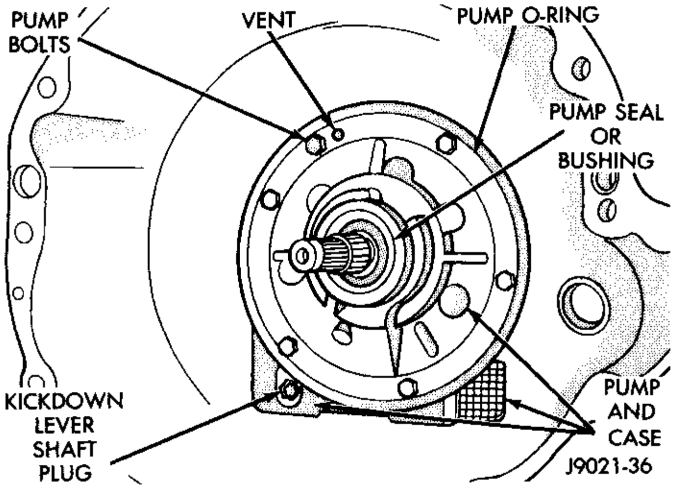


Fig. 12 Pump Area Inspection Points

Air Pressure Leak Test Procedure

(1) Install the vent plug, converter hub seal cup and cup retaining strap (Fig. 16).

(2) Close off the remaining transmission openings with rubber plugs, or stoppers. **Do not close off the rear cooler line fitting. The air pump will be attached to this fitting.**

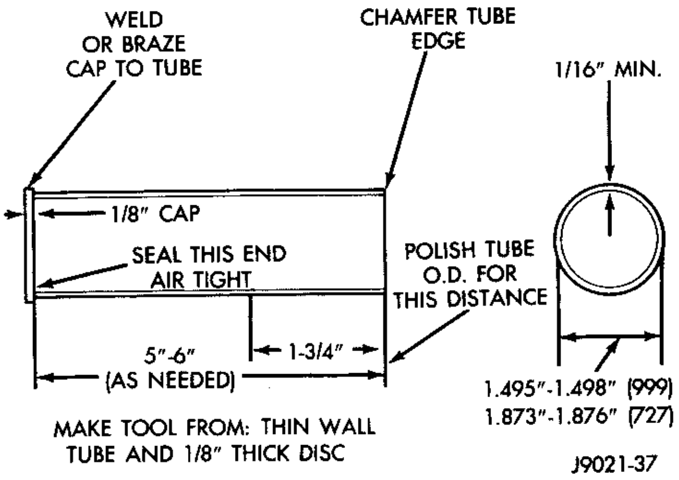


Fig. 13 Converter Hub Seal Cup

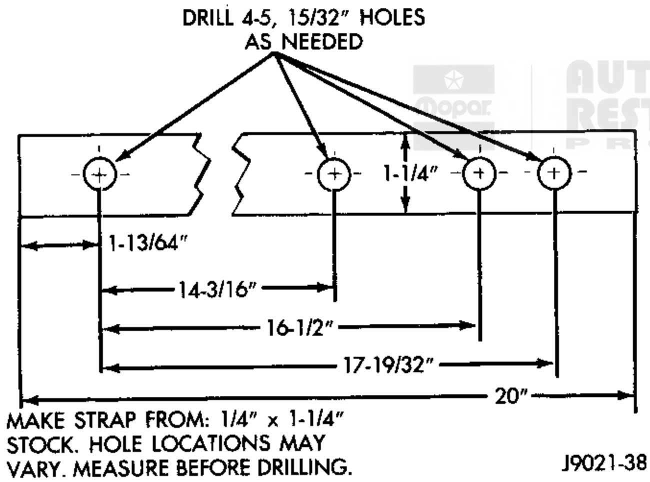


Fig. 14 Seal Cup Retaining Strap

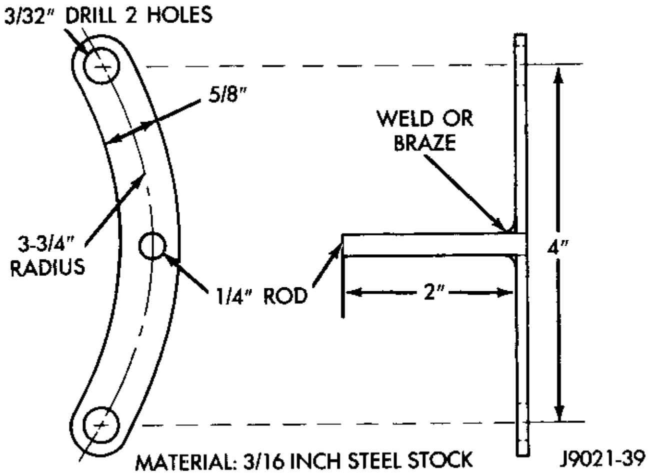


Fig. 15 Pump Vent Plug

(3) Attach air pump C-4080 to the rear cooler line fitting. Connect a length of copper tube to the fitting. Then attach the air pump hose to the tube with a hose clamp (Fig. 17).

(4) Apply a thick soapy water solution to the suspected leak areas.

CAUTION: The recommended test pressure is 8 psi. The maximum allowable test pressure is 10 psi. Do not exceed specified pressure.

(5) Pressurize the transmission to 8 psi with the air pump.

(6) Observe the suspected leak areas. Air bubbles appearing in the soapy water solution indicate leak points.

(7) Remove the test tools and plugs after test completion and make necessary repairs as described in the Leak Correction procedure.

Converter Housing Area Leak Correction

(1) Remove the converter.

(2) Tighten the front band adjusting screw until the band is tight around the front clutch retainer. This prevents the front clutch from coming out when the oil pump is removed.

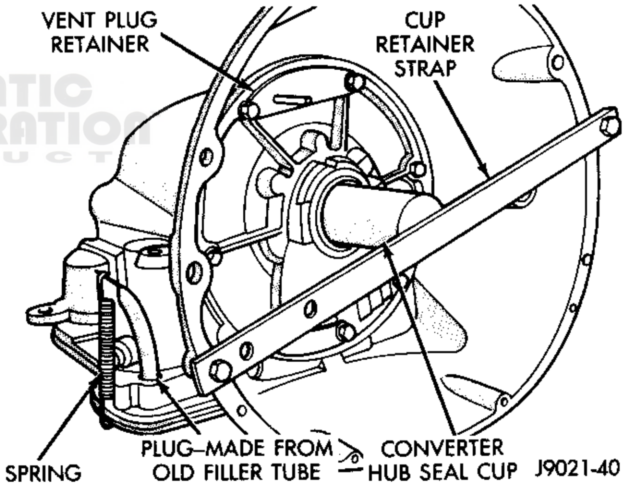


Fig. 16 Vent Plug And Hub Seal Cup Installation

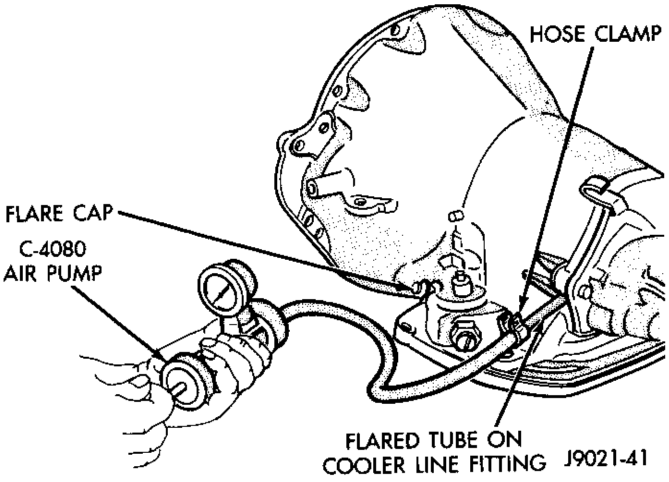


Fig. 17 Pressurizing Transmission

(3) Remove the oil pump and seal. Inspect the pump housing drainback and vent holes for obstructions. Clear the holes with solvent and wire.

(4) Inspect the pump bushing and converter hub. If the bushing is scored, replace it. If the converter hub is scored, either polish it with crocus cloth or replace the converter if scoring is severe.

(5) Install a new pump seal, O-ring, gasket, bushing. Replace the oil pump if cracked, porous or damaged in any way.

(6) Loosen the kickdown lever pin plug two turns. Apply Permatex No. 2 or equivalent to the plug threads and tighten the plug to 17 N•m (150 in-lbs) torque.

(7) Adjust the front (kickdown) band.

(8) Lubricate the pump seal and converter hub with transmission fluid or petroleum jelly and install the converter.

(9) Install the transmission and converter housing dust shield

(10) Lower the vehicle.

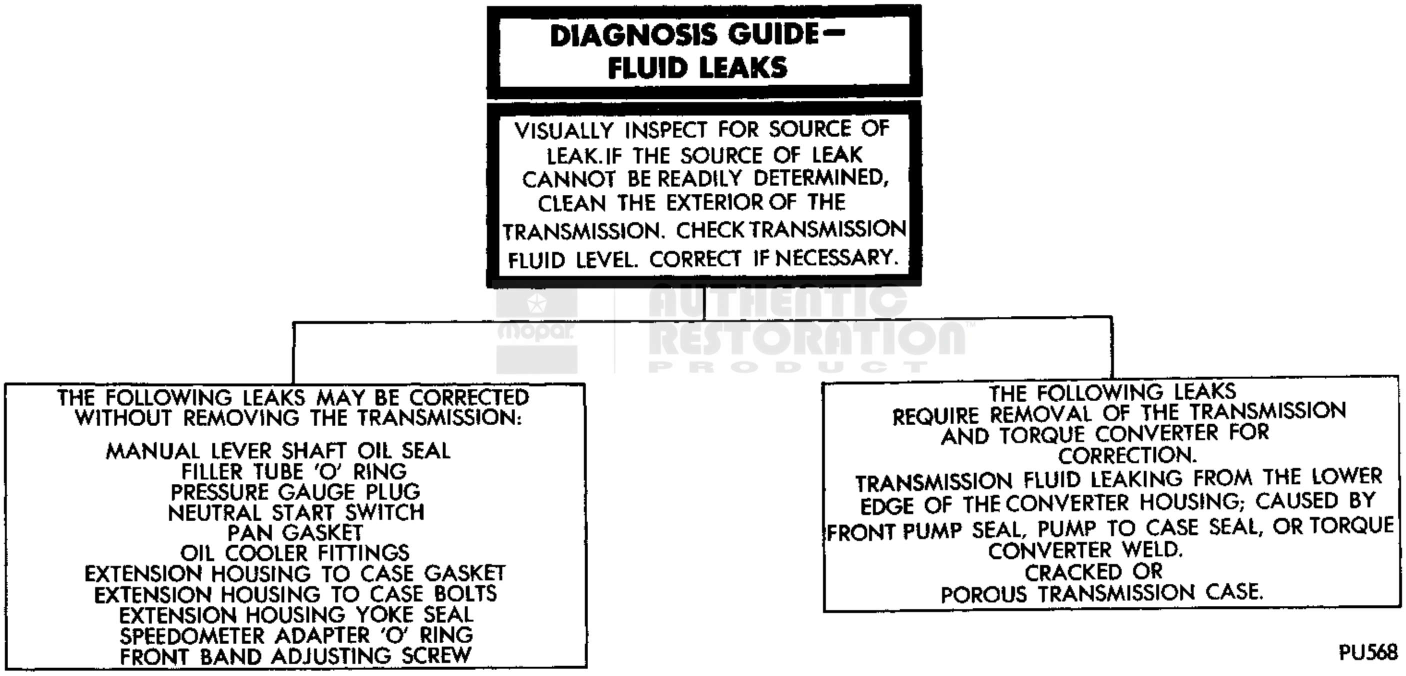
DIAGNOSIS GUIDES AND CHARTS

The diagnosis guides and charts provide additional reference for transmission diagnosis.

The guides provide basic procedures for conditions involving, abnormal noise, fluid leaks, or if the vehicle will not move forward or in reverse.

The diagnosis chart provides general information on a variety of transmission fault conditions.

The hydraulic flow charts outline fluid flow and hydraulic circuitry. Circuit operation is provided for all gear ranges. Normal working pressures are also supplied for each of the various gear ranges.



DIAGNOSIS GUIDE— FLUID LEAKS

VISUALLY INSPECT FOR SOURCE OF LEAK. IF THE SOURCE OF LEAK CANNOT BE READILY DETERMINED, CLEAN THE EXTERIOR OF THE TRANSMISSION. CHECK TRANSMISSION FLUID LEVEL. CORRECT IF NECESSARY.

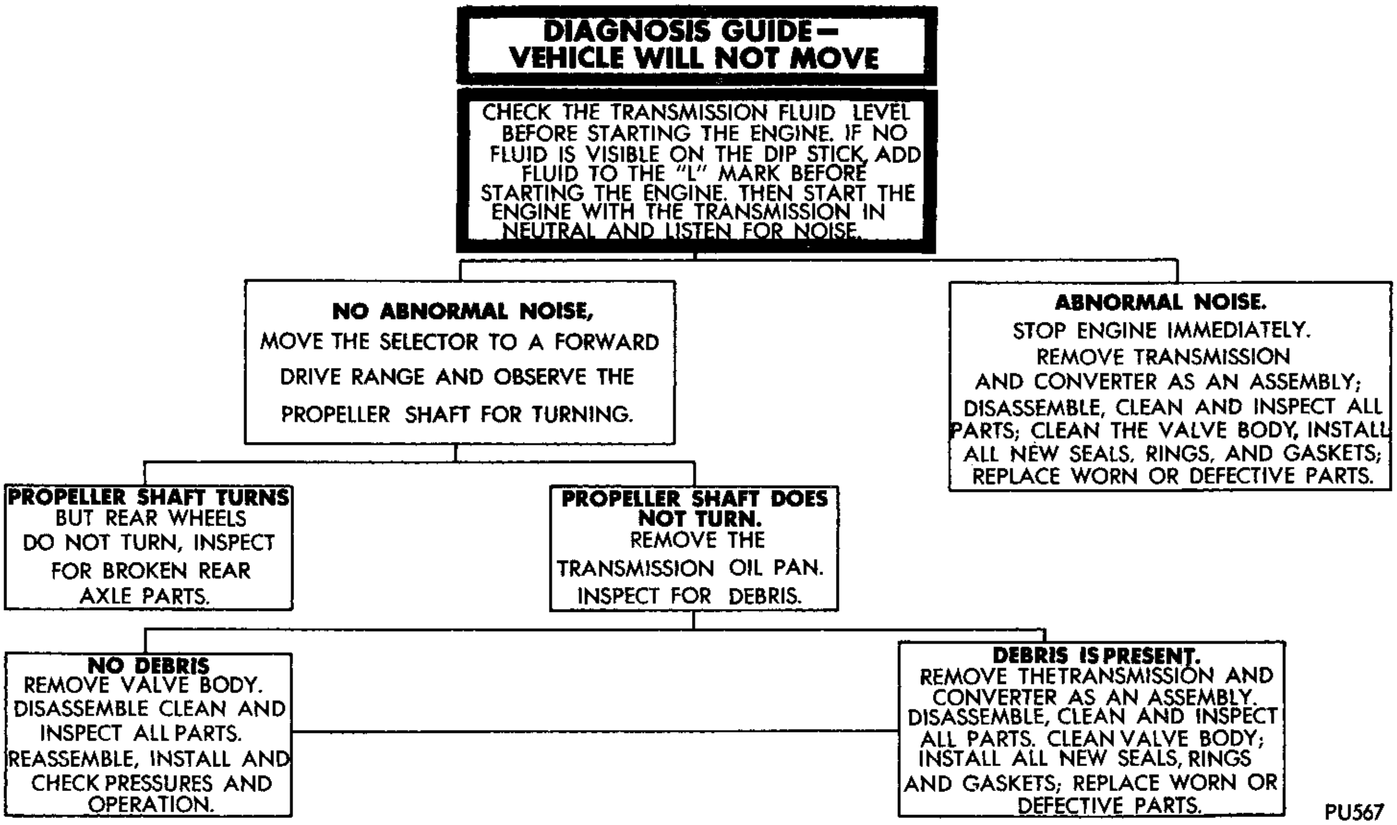
THE FOLLOWING LEAKS MAY BE CORRECTED WITHOUT REMOVING THE TRANSMISSION:

MANUAL LEVER SHAFT OIL SEAL
FILLER TUBE 'O' RING
PRESSURE GAUGE PLUG
NEUTRAL START SWITCH
PAN GASKET
OIL COOLER FITTINGS
EXTENSION HOUSING TO CASE GASKET
EXTENSION HOUSING TO CASE BOLTS
EXTENSION HOUSING YOKE SEAL
SPEEDOMETER ADAPTER 'O' RING
FRONT BAND ADJUSTING SCREW

THE FOLLOWING LEAKS REQUIRE REMOVAL OF THE TRANSMISSION AND TORQUE CONVERTER FOR CORRECTION.

TRANSMISSION FLUID LEAKING FROM THE LOWER EDGE OF THE CONVERTER HOUSING; CAUSED BY FRONT PUMP SEAL, PUMP TO CASE SEAL, OR TORQUE CONVERTER WELD.
CRACKED OR POROUS TRANSMISSION CASE.

PU568



DIAGNOSIS GUIDE — VEHICLE WILL NOT MOVE

CHECK THE TRANSMISSION FLUID LEVEL BEFORE STARTING THE ENGINE. IF NO FLUID IS VISIBLE ON THE DIP STICK, ADD FLUID TO THE "L" MARK BEFORE STARTING THE ENGINE. THEN START THE ENGINE WITH THE TRANSMISSION IN NEUTRAL AND LISTEN FOR NOISE.

NO ABNORMAL NOISE, MOVE THE SELECTOR TO A FORWARD DRIVE RANGE AND OBSERVE THE PROPELLER SHAFT FOR TURNING.

ABNORMAL NOISE. STOP ENGINE IMMEDIATELY. REMOVE TRANSMISSION AND CONVERTER AS AN ASSEMBLY; DISASSEMBLE, CLEAN AND INSPECT ALL PARTS; CLEAN THE VALVE BODY, INSTALL ALL NEW SEALS, RINGS, AND GASKETS; REPLACE WORN OR DEFECTIVE PARTS.

PROPELLER SHAFT TURNS BUT REAR WHEELS DO NOT TURN, INSPECT FOR BROKEN REAR AXLE PARTS.

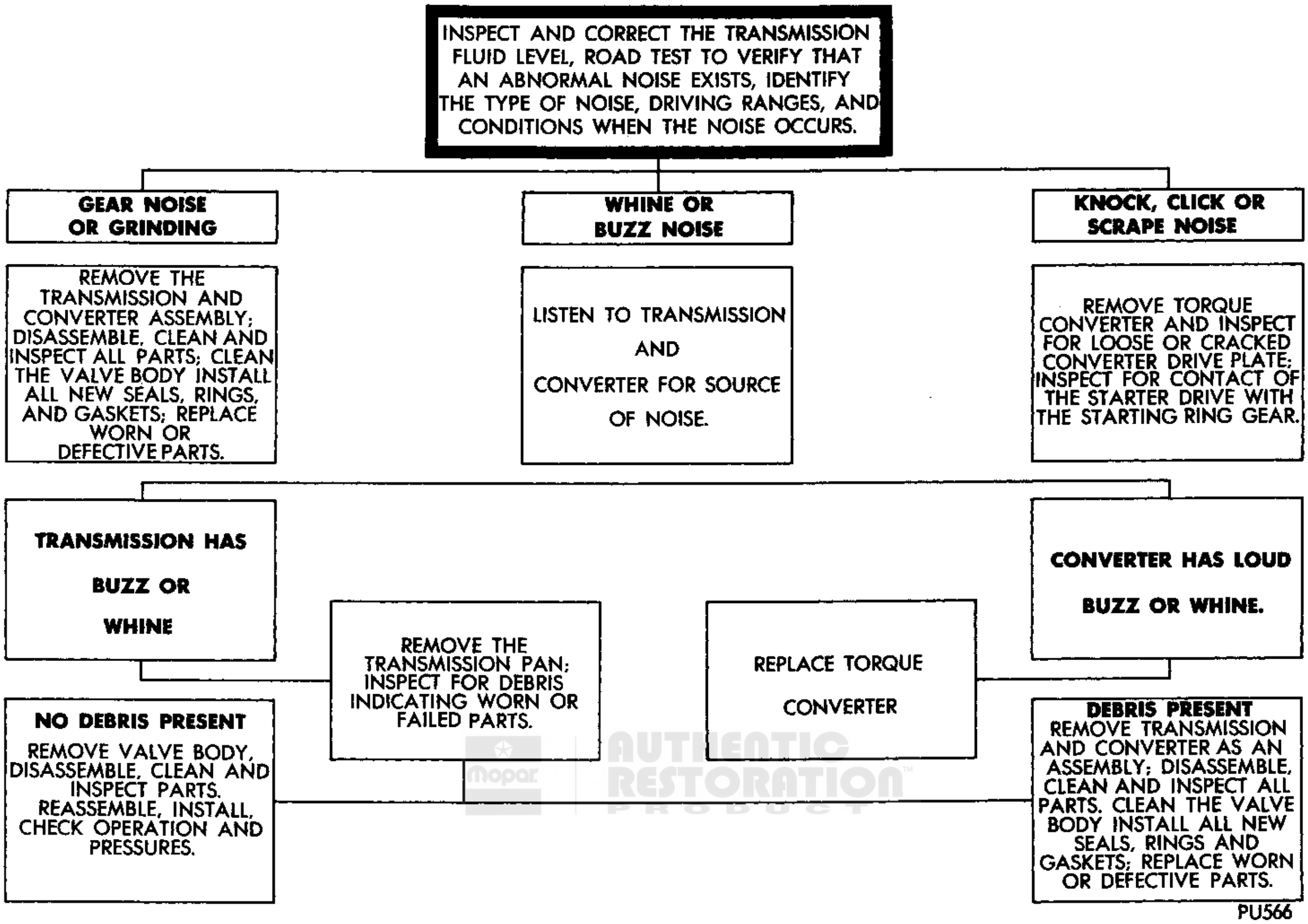
PROPELLER SHAFT DOES NOT TURN. REMOVE THE TRANSMISSION OIL PAN. INSPECT FOR DEBRIS.

NO DEBRIS REMOVE VALVE BODY. DISASSEMBLE CLEAN AND INSPECT ALL PARTS. REASSEMBLE, INSTALL AND CHECK PRESSURES AND OPERATION.

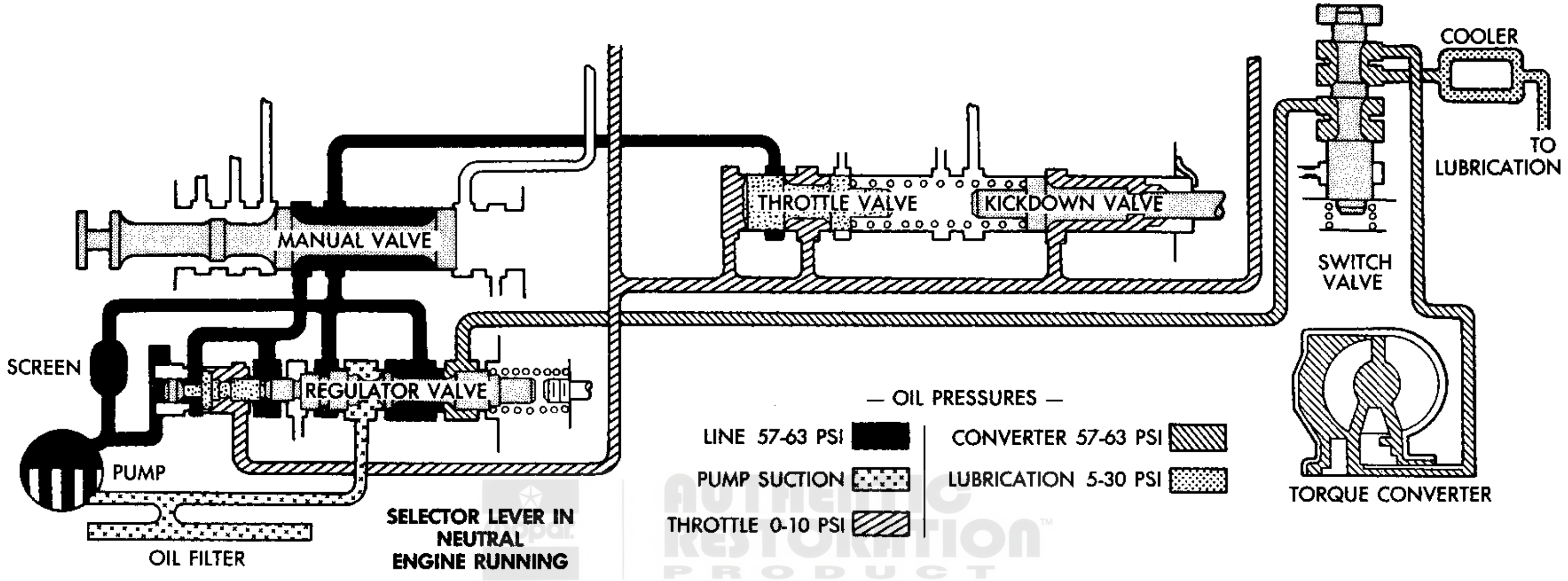
DEBRIS IS PRESENT. REMOVE THETRANSMISSION AND CONVERTER AS AN ASSEMBLY. DISASSEMBLE, CLEAN AND INSPECT ALL PARTS. CLEAN VALVE BODY; INSTALL ALL NEW SEALS, RINGS AND GASKETS; REPLACE WORN OR DEFECTIVE PARTS.

PU567

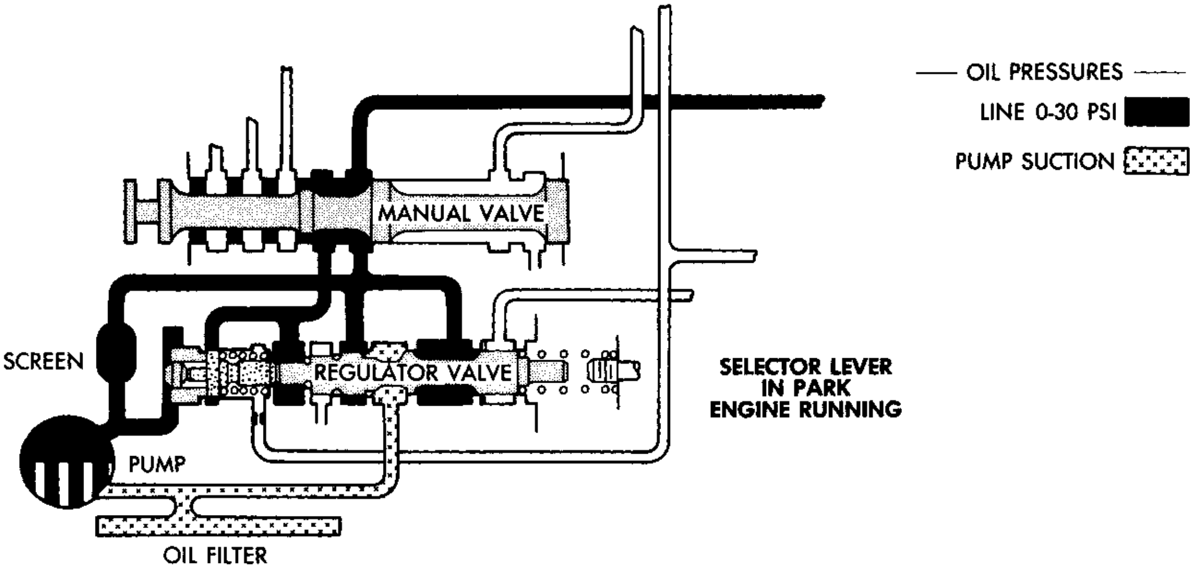
DIAGNOSIS GUIDE—ABNORMAL NOISE



PU566

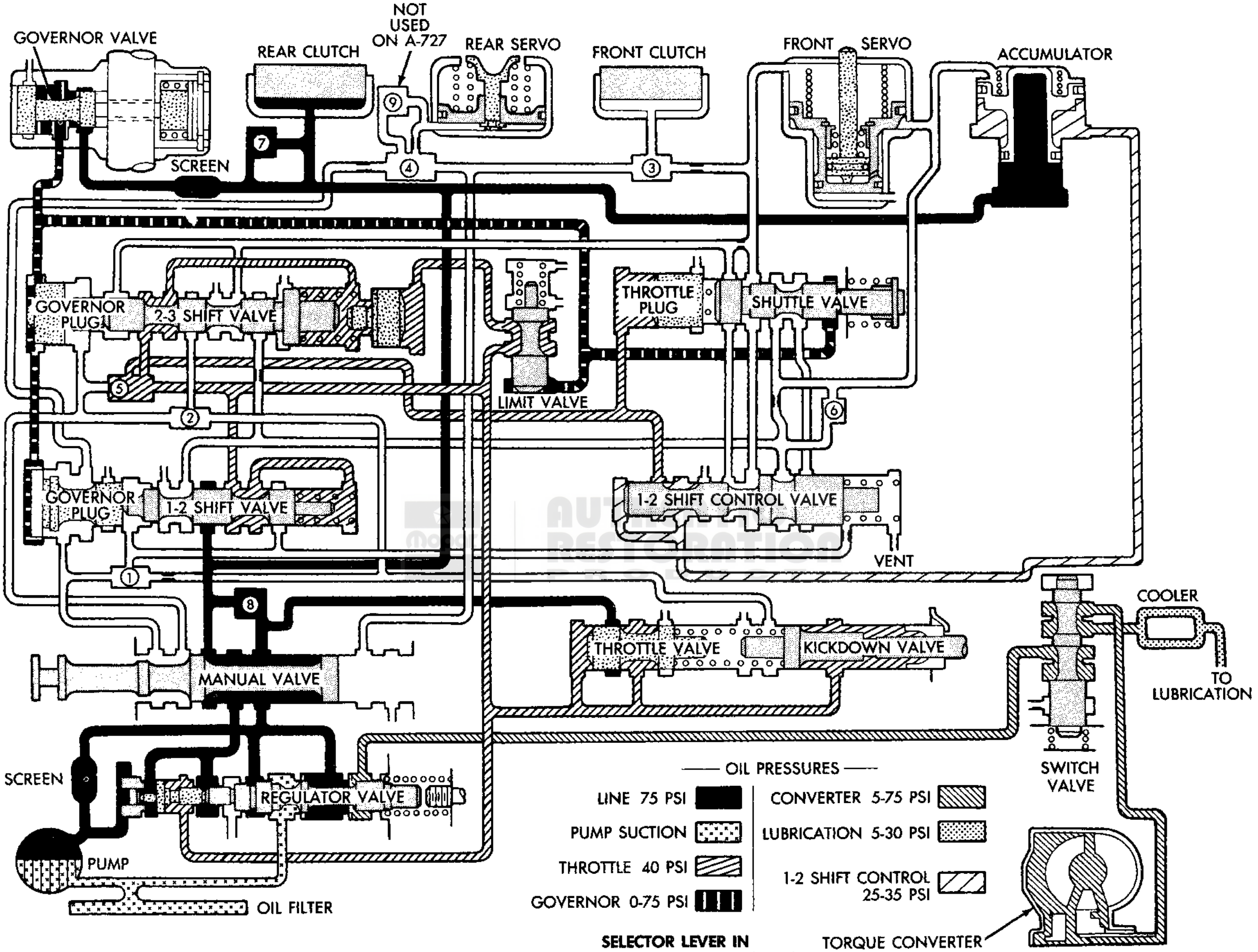


SELECTOR LEVER IN NEUTRAL ENGINE RUNNING



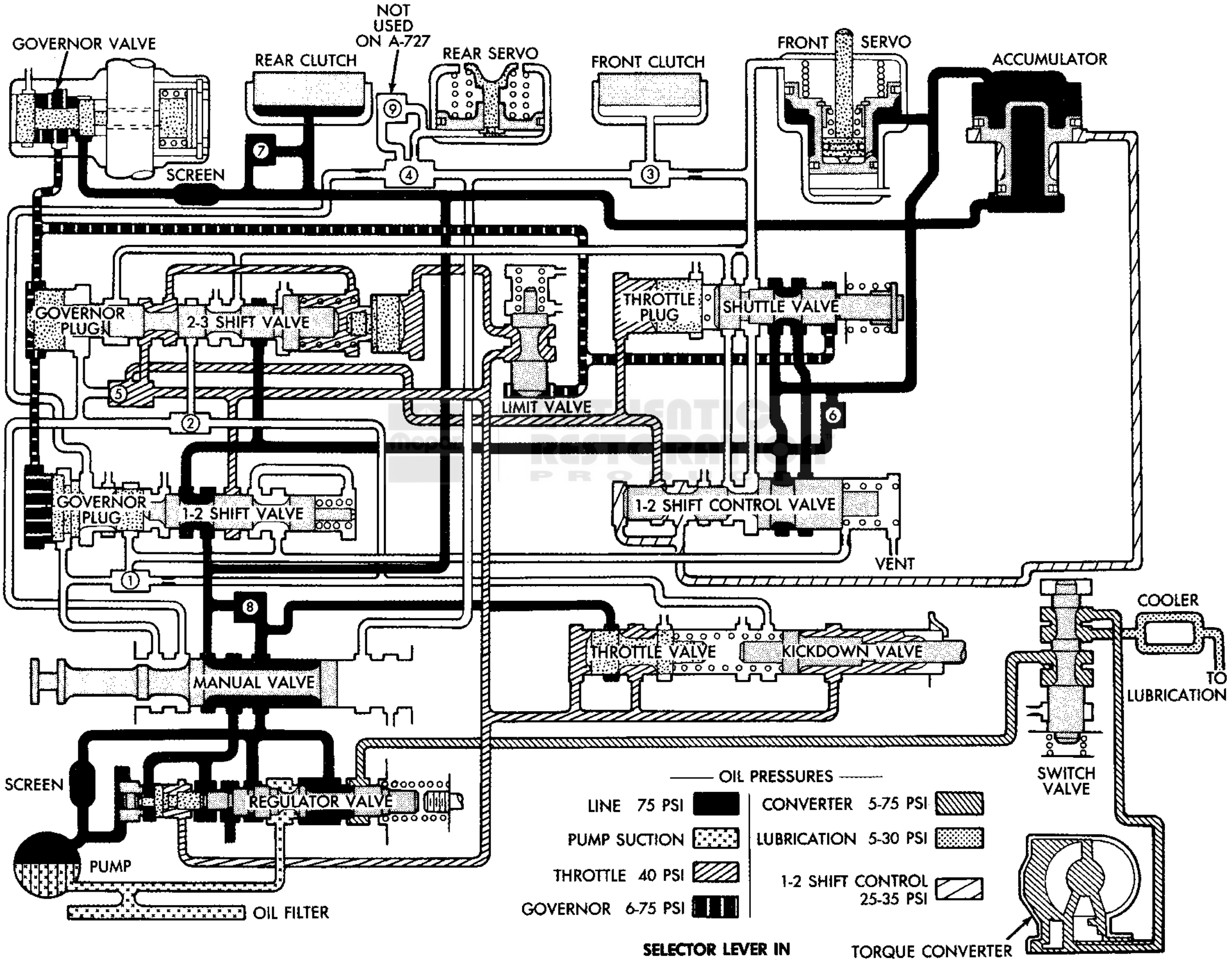
SELECTOR LEVER IN PARK ENGINE RUNNING

J9021-63



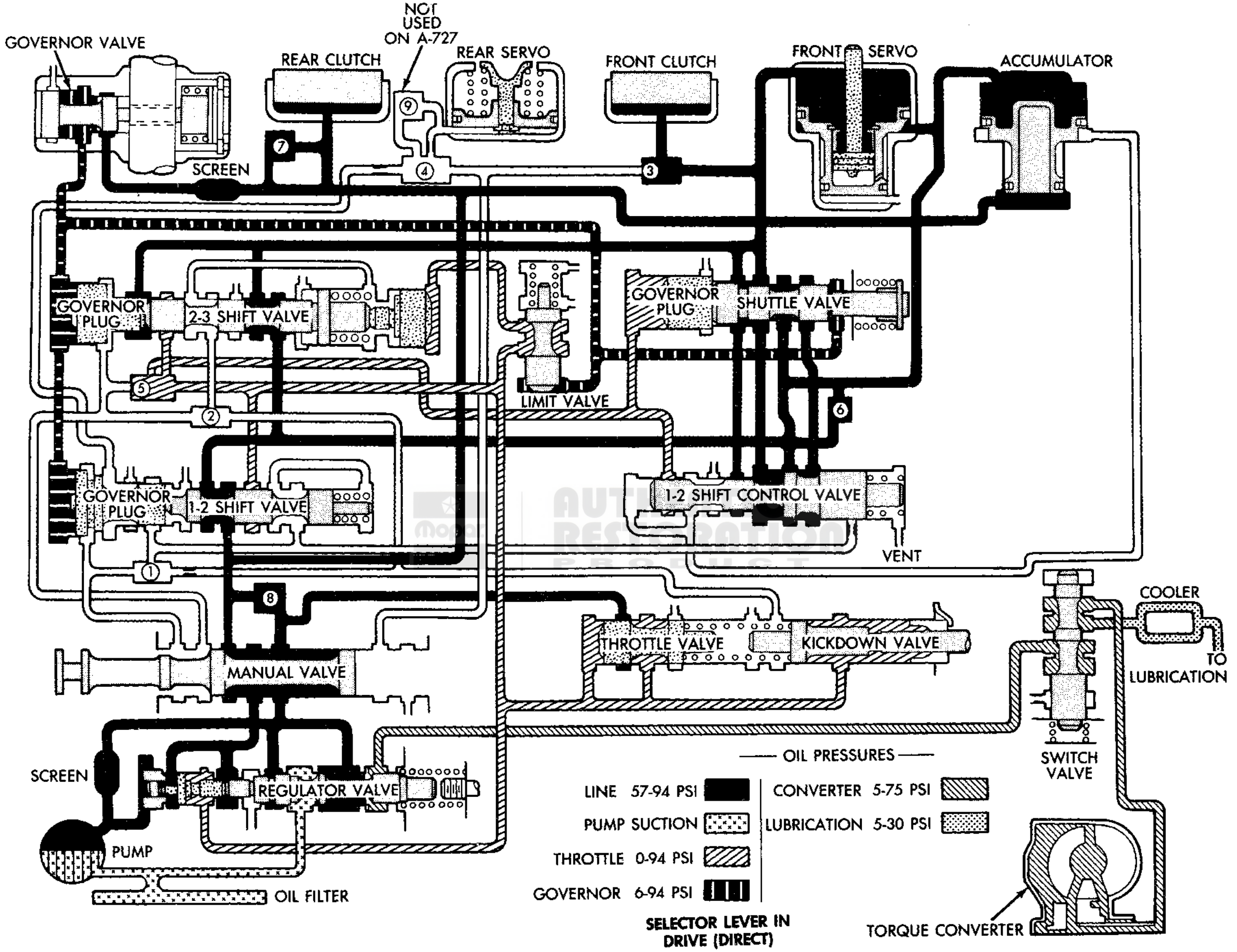
SELECTOR LEVER IN DRIVE (BREAKAWAY–1ST GEAR) HALF THROTTLE

J9021-64



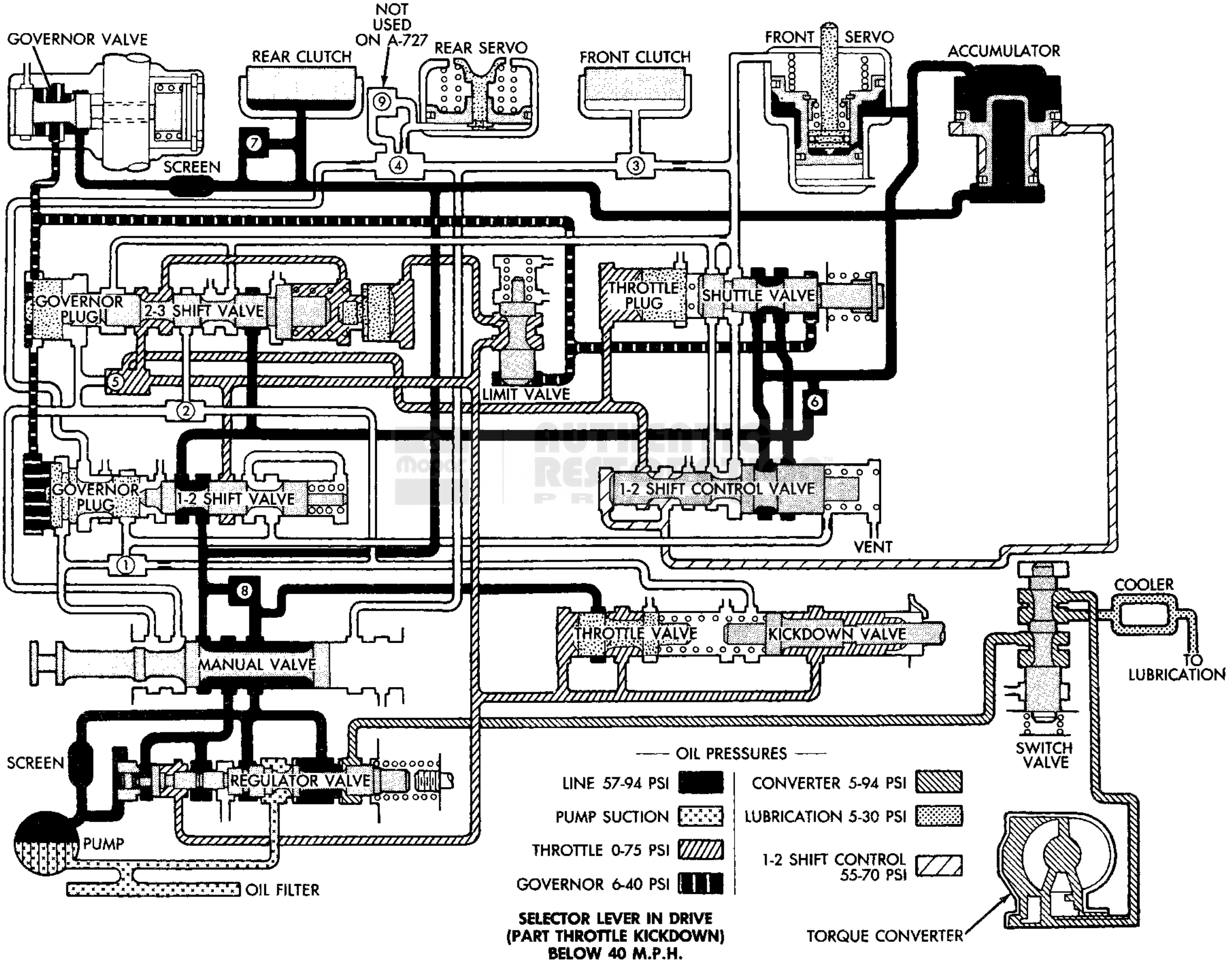
SELECTOR LEVER IN DRIVE (SECOND) HALF THROTTLE

J9021-65



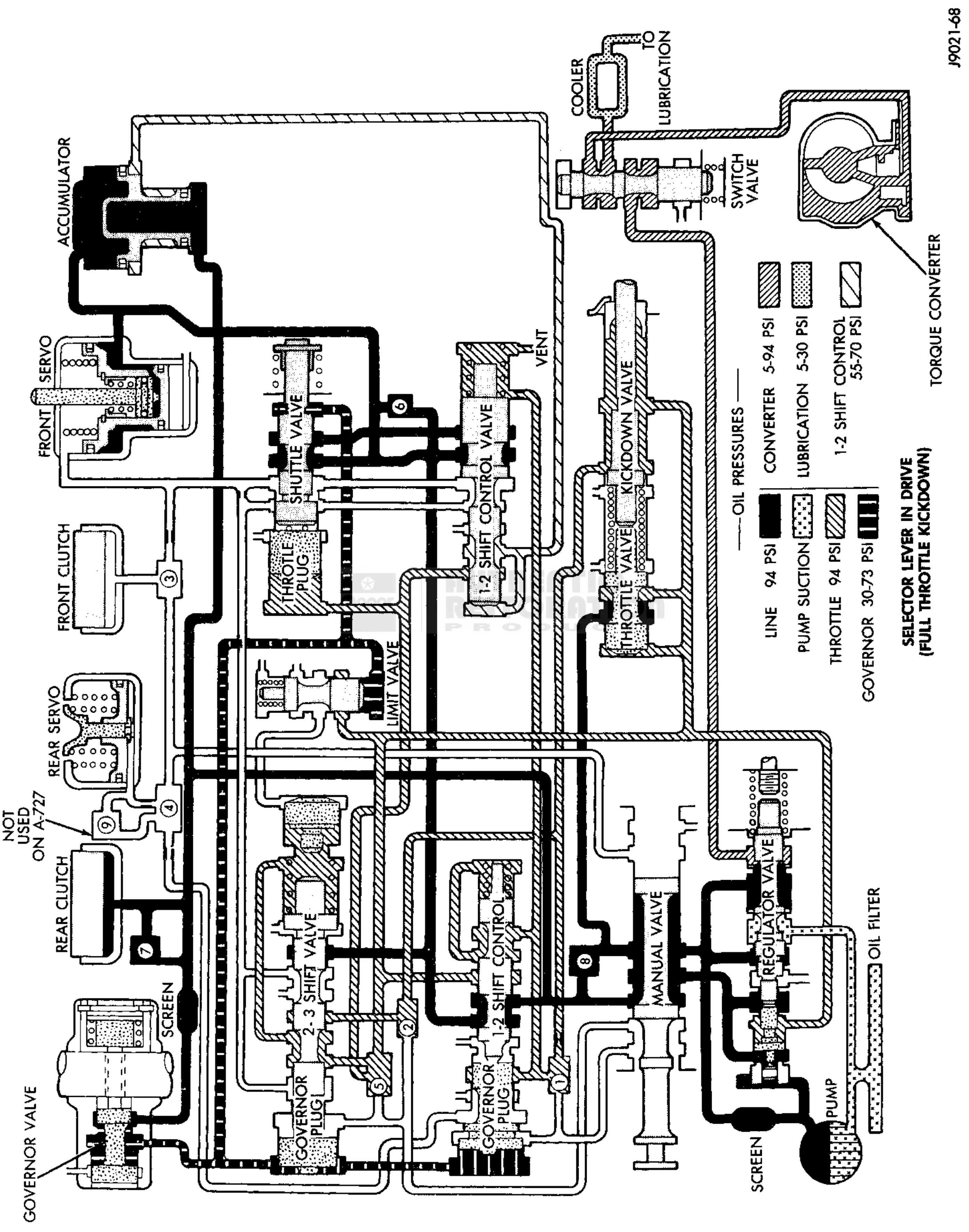
SELECTOR LEVER IN DRIVE (DIRECT)

J9021-66

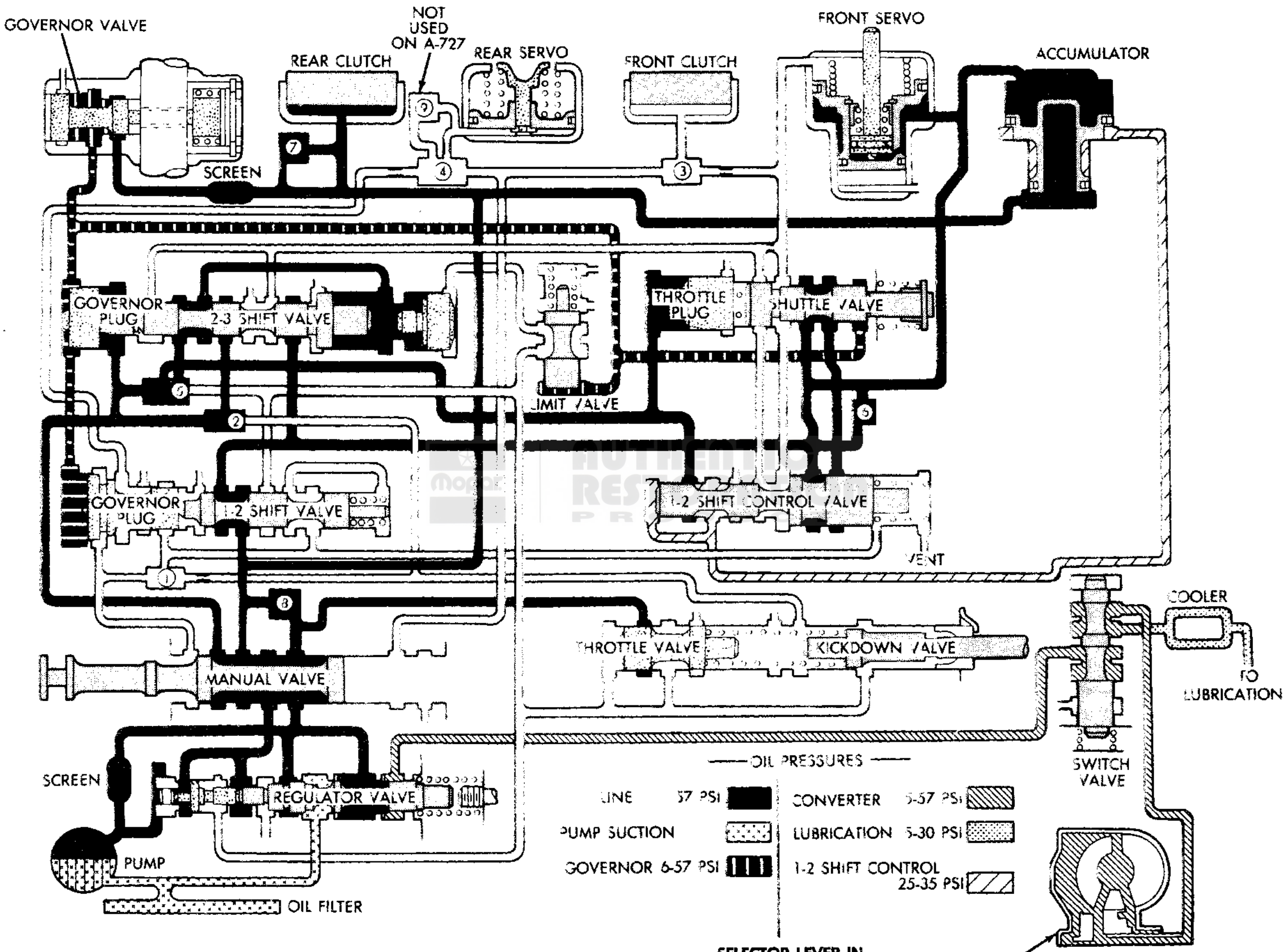


SELECTOR LEVER IN DRIVE (PART THROTTLE KICKDOWN) BELOW 40 M.P.H.

J9021-67

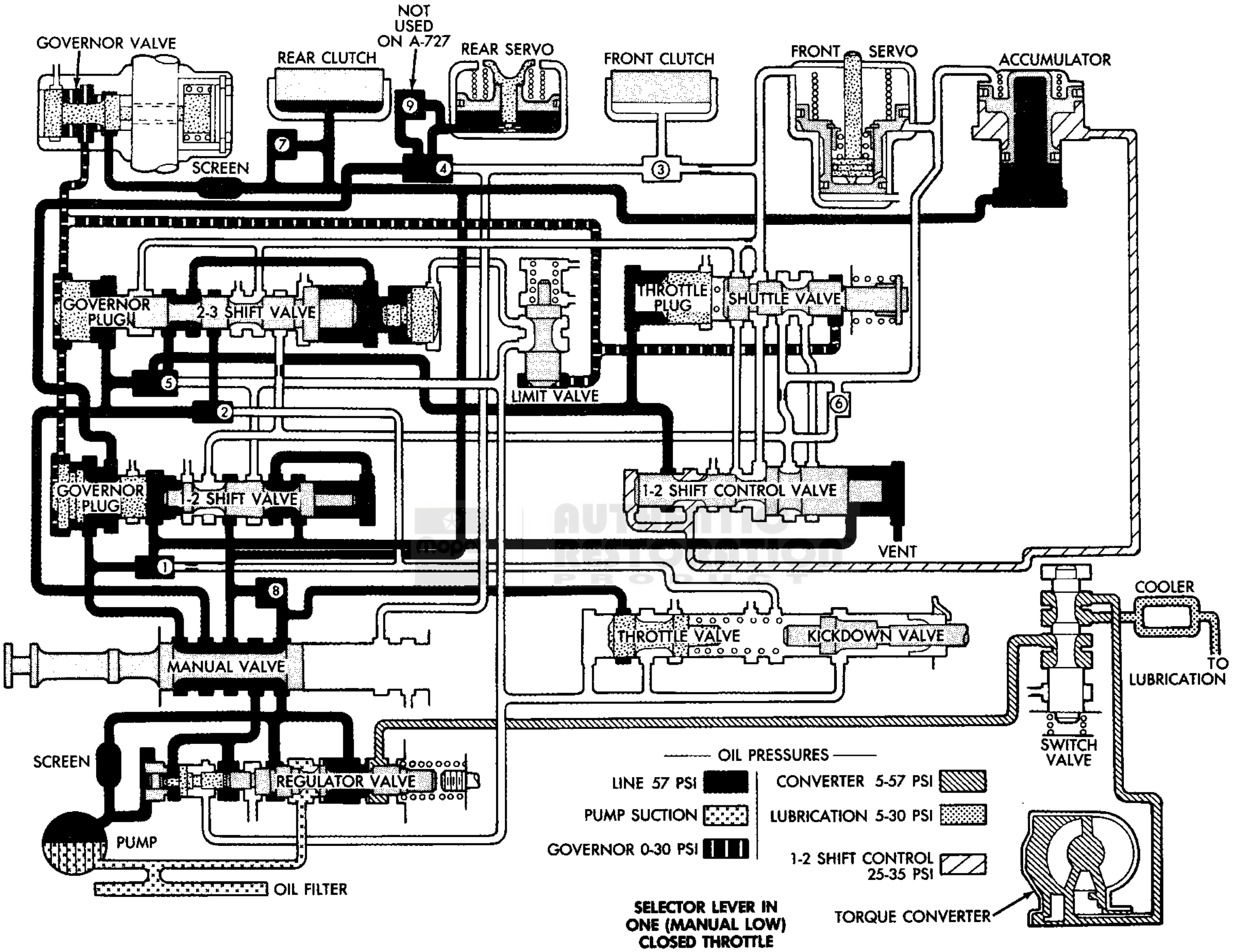


SELECTOR LEVER IN DRIVE (FULL THROTTLE KICKDOWN)



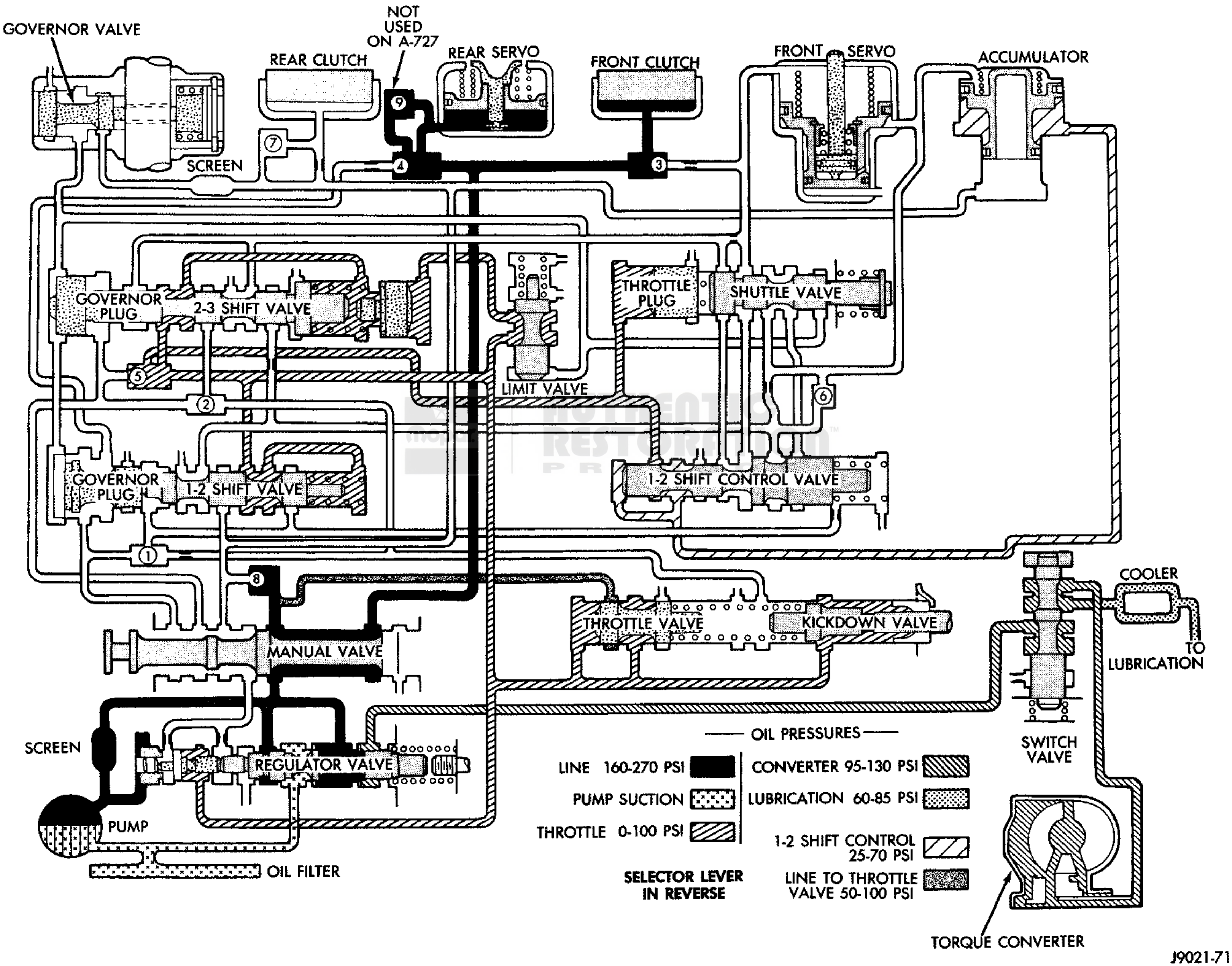
SELECTOR LEVER IN TWO (MANUAL SECOND) CLOSED THROTTLE

J9021-69



SELECTOR LEVER IN ONE (MANUAL LOW) CLOSED THROTTLE

J9021-70



SELECTOR LEVER IN REVERSE

J9021-71

SERVICE DIAGNOSIS

POSSIBLE CAUSE		HARSH ENGAGEMENT FROM NEUTRAL TO D OR R	DELAYED ENGAGEMENT FROM NEUTRAL TO D OR R	RUNAWAY UPSHIFT	NO UPSHIFT	3-2 KICKDOWN RUNAWAY	NO KICKDOWN OR NORMAL DOWNSHIFT	SHIFTS ERRATIC	SLIPS IN FORWARD DRIVE POSITIONS	SLIPS IN REVERSE ONLY	SLIPS IN ALL POSITIONS	NO DRIVE IN ANY POSITION	NO DRIVE IN FORWARD DRIVE POSITIONS	NO DRIVE IN REVERSE	DRIVES IN NEUTRAL	DRAGS OR LOCKS	GRATING, SCRAPING GROWLING NOISE	BUZZING NOISE	HARD TO FILL, OIL BLOWS OUT FILLER TUBE	TRANSMISSION OVERHEATS	HARSH UPSHIFT	DELAYED UPSHIFT	SLIPS IN REVERSE OR MANUAL LOW
Overrunning clutch inner race damaged.	32																	X					
Overrunning clutch worn, broken or seized.	31								X				X			X	X						
Planetary gear set broken or seized	30											X	X	X		X	X						
Rear clutch dragging.	29														X								
Worn of faulty rear clutch.	28	X	X						X				X	X	X								
Insufficient clutch plate clearance.	27														X					X			
Faulty cooling system.	26	X																		X			
Kickdown band adjustment too tight.	25															X				X			
Hydraulic pressure too high.	24	X																			X		
Breather clogged.	23																		X				
High fluid level.	22																		X				
Worn or faulty front clutch.	21		X	X	X	X		X		X				X								X	
Kickdown servo band or linkage malfuntion.	20			X	X	X	X	X														X	
Governor malfunction.	19				X		X	X														X	
Worn or broken reaction shaft support seal rings.	18		X	X	X	X		X		X				X								X	
Governor support seal rings broken or worn.	17				X			X														X	
Output shaft bearing and/or bushing damaged.	16																X						
Overrunning clutch not holding.	15								X				X										
Kickdown band out of adjustment.	14					X											X				X	X	
Incorrect throttle linkage adjustment	13			X	X	X	X	X	X												X	X	
Engine idle speed too low.	12		X																				
Aerated fluid.	11		X	X		X		X	X	X	X							X	X				
Worn or broken input shaft seal rings.	10		X						X		X		X										
Faulty oil pump.	9		X					X	X	X	X	X				X		X		X			X
Oil filter clogged.	8		X	X				X	X		X	X							X				
Incorrect gearshift control linkage adjustment.	7		X		X			X	X	X				X	X					X			
Low fluid level.	6		X	X	X	X		X	X	X	X	X	X					X		X			
Low-reverse servo, band or linkage malfuntion.	5		X							X				X									
Valve body malfuntion or leakage.	4	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X					
Low-reverse band out of adjustment.	3									X				X		X	X						X
Hydraulic pressures too low.	2		X	X	X	X		X	X	X	X	X	X	X						X	X		
Engine idle speed too high.	1	X																		X			

CONDITION

J8921-368

MAINTENANCE AND ADJUSTMENTS

INDEX

GEARSHIFT LINKAGE ADJUSTMENT

Checking Adjustment

(1) Check linkage adjustment by starting the engine in Park and Neutral.

(2) Adjustment is OK if the engine starts only in park and Neutral.Adjustment is incorrect if the engine starts in one but not both positions.

(3) If the engine starts in any position other than Park or Neutral, or if the engine will not start at all, the neutral switch may be faulty.

Gearshift Linkage Adjustment

(1) Shift transmission into Park.

(2) Raise vehicle.

(3) Check condition of shift rods, bellcrank, bellcrank brackets and linkage bushings (Figs. 1 and 2). Tighten, repair, replace any worn or damaged parts. Do not attempt adjustment if any linkage components are worn or damaged.

(4) Loosen shift rod trunnion lock bolt or nut. Be sure upper shift rod slides freely in trunnion (Fig. 1). Also be sure shift rods and bellcrank rotate freely and do not bind at any point.

(5) Verify that manual valve lever is in Park detent (Figs. 1 and 2). Move lever all the way rearward to be sure it is in Park.

(6) Check for positive engagement of park lock by attempting to rotate propeller shaft. Shaft will not turn when park pawl is engaged.

(7) Adjust shift rod trunnion to a obtain free pin fit in bellcrank arm and tighten trunnion lock bolt or nut. Prevent shift rod from turning while tightening bolt or nut.Gearshift linkage lash must be eliminated to obtain proper adjustment. Eliminate lash by pulling downward on shift rod and pressing upward on bellcrank.

(8) Check adjustment by starting engine in Park and Neutral. Engine should start in these positions only. **If engine starts in any position other than Park or Neutral, adjustment is incorrect or neutral switch is faulty.**

(9) Lower vehicle and verify that steering lock operates correctly.

THROTTLE VALVE LINKAGE ADJUSTMENT

A correct throttle valve linkage adjustment is important to proper operation. Linkage (Fig. 3 and 4), positions throttle valve which controls shift speed, shift quality and part throttle downshift sensitivity. If setting is incorrect, shift quality and shift speeds will be unsatisfactory.

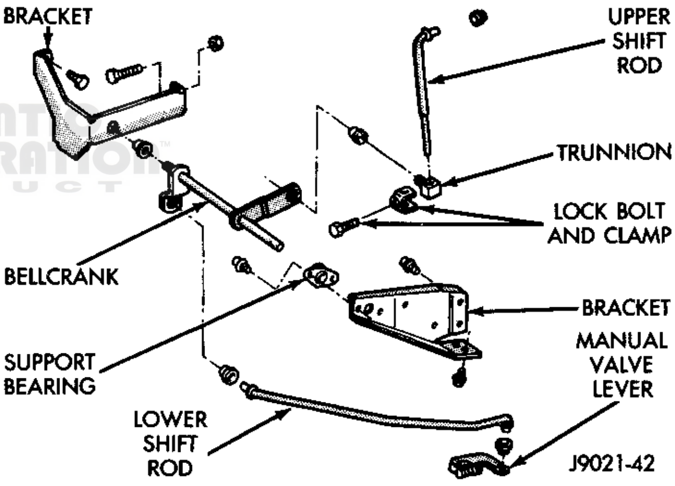


Fig. 1 Gearshift Linkage — YJ

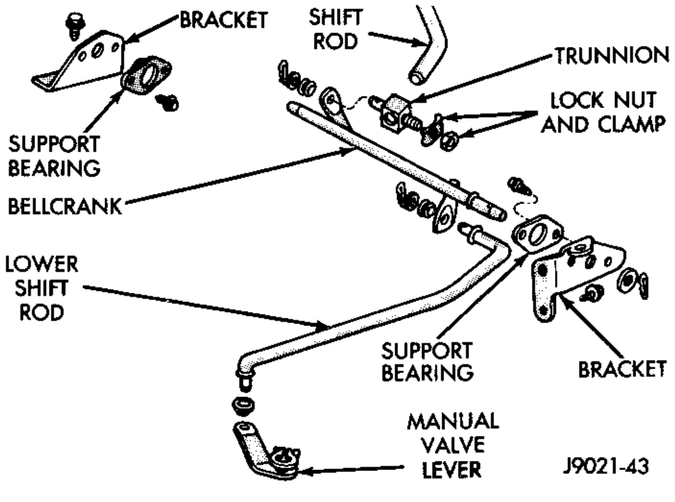


Fig. 2 Gearshift Linkage — SJ

Linkage Adjustment — 6 Cylinder Engine

(1) Disconnect throttle rod spring (Fig. 3).

(2) Use throttle rod spring to hold link forward against nylon stop (Fig. 5).

(3) On carburetors without a solenoid valve, block choke open and set throttle off fast idle cam.

(4) On carburetors with throttle operated solenoid valve, turn ignition switch on to energize solenoid. Then open throttle halfway to allow solenoid to lock and return carburetor to idle position.

(5) Raise vehicle.

(6) Loosen two throttle rod retainer bolts (Fig. 5).

(7) Hold throttle valve lever forward with spare spring (Fig. 6).

(8) Pull on end of link to eliminate all lash (Fig. 5).

(9) Slide clamp rearward until bolt retaining throttle rod to clamp bottoms against rear of slot in throttle rod (Fig. 5).

(10) Tighten throttle rod retainer bolts securely.

(11) Remove holding spring from throttle valve lever (Fig. 6).

(12) Remove throttle valve spring from link.

(13) Lower vehicle.

(14) Connect throttle rod spring to rod and bracket.

Linkage Adjustment—Eight Cylinder Engine

(1) Disconnect throttle rod spring from bellcrank (Fig. 7).

(2) Block choke open and set carburetor throttle off fast idle cam.

(3) If carburetor has throttle operated solenoid valve, turn ignition switch On to energize solenoid. Then open throttle halfway to allow solenoid to lock and return carburetor to idle position.

(4) Loosen throttle rod retainer bolt (Fig. 7).

(5) Remove spring clip from the nylon stop. Remove stop from the lug and move stop to rear of link (Fig. 7).

(6) Hold bellcrank in place. Then push end of link to eliminate lash and tighten link retaining bolt (Fig. 7).

(7) Install nylon stop and spring clip and connect throttle rod spring (Fig. 8).

FRONT (KICKDOWN) BAND ADJUSTMENT

The front (kickdown) band adjusting screw is located on the left side of the transmission case above the manual valve and throttle valve levers.

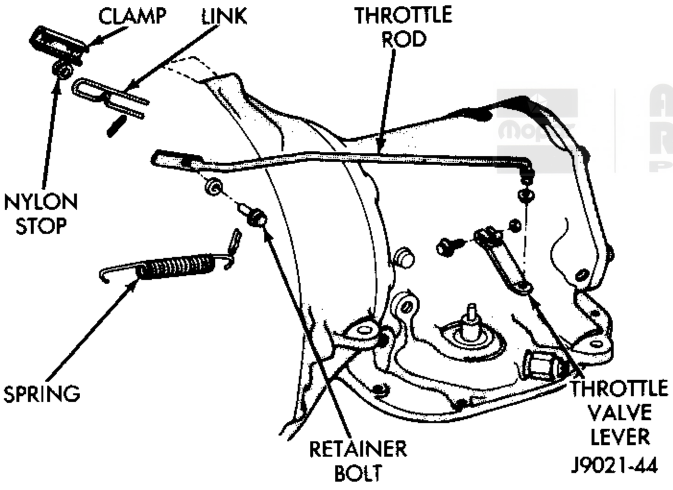


Fig. 3 Throttle Valve Linkage — 6 Cylinder Engine

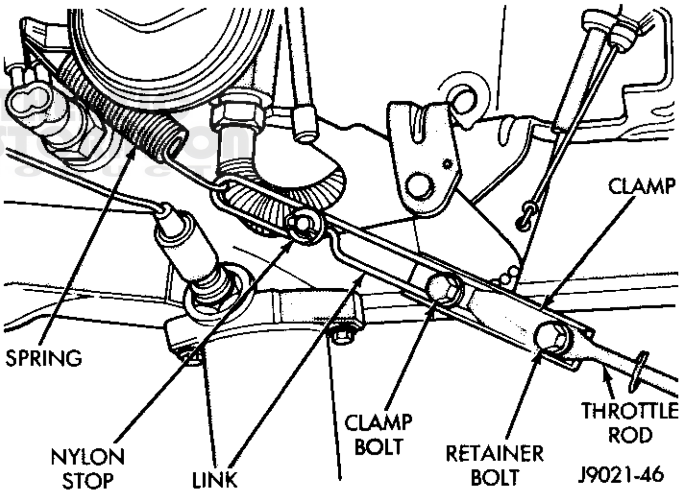


Fig. 5 Linkage Adjustment — 6 Cylinder Engine

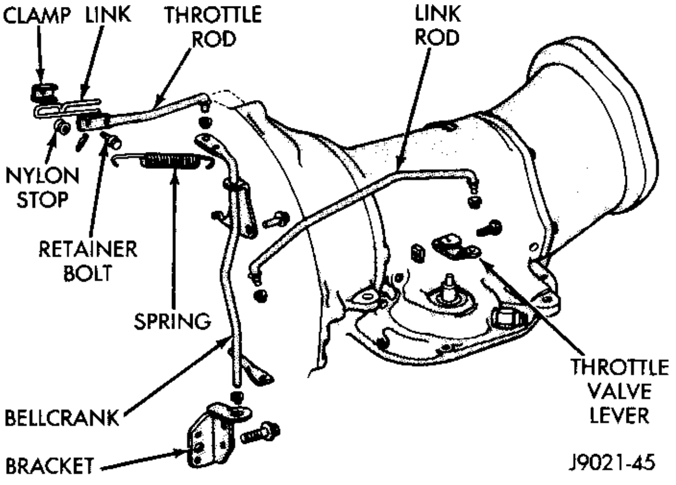


Fig. 4 Throttle Valve Linkage — 8 Cylinder Engine

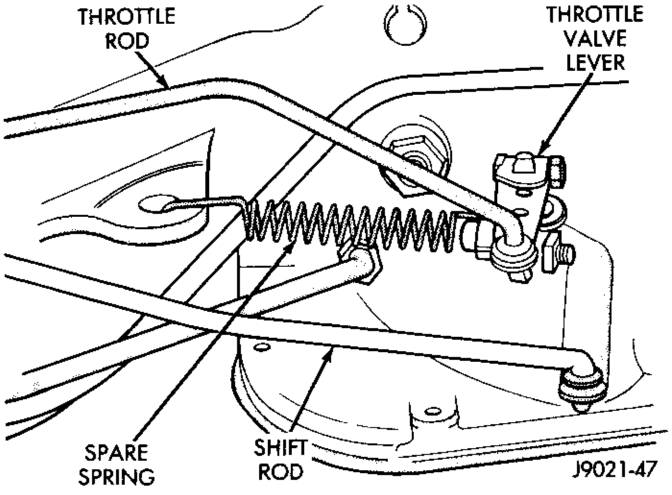


Fig. 6 Securing Throttle Valve Lever

Adjustment Procedure

(1) Raise vehicle.

(2) Loosen band adjusting screw locknut. Then back locknut off 4-5 turns. Be sure adjusting screw turns freely in case.

(3) Tighten band adjusting screw to 8 N•m (72 in-lbs) torque. However, if adapter extension C-3705 is used on torque wrench, tighten screw to only 5.3-5.6 N•m (47-50 in-lbs) torque (Fig. 9).

(4) Back off band adjusting screw 2-1/2 turns.

(5) Hold adjuster screw in position and tighten locknut to 41 N•m (30 ft-lbs) torque.

(6) Lower vehicle.

REAR (LOW-REVERSE) BAND ADJUSTMENT

The transmission oil pan must be removed for access to the rear band adjusting screw.

(1) Raise vehicle.

(2) Remove transmission oil pan and drain the fluid.

(3) Loosen band adjusting screw locknut 5-6 turns. Be sure adjusting screw turns freely in lever.

(4) Tighten adjusting screw to 8 N•m (72 in-lbs) torque (Fig. 10).

(5) On 999 transmissions, back off adjusting screw four turns. On 727 transmissions, back off adjusting screw 2 turns.

(6) Hold adjusting screw in place and tighten locknut to 34 N•m (25 ft-lbs) torque.

(7) Position new gasket on oil pan and install pan on transmission. Tighten pan bolts to 17 N•m (150 in-lbs) torque.

(8) Lower vehicle and refill transmission with Mopar ATF PLUS, Type 7176 or Dexron II™.

OIL FILTER REPLACEMENT

(1) Raise vehicle.

(2) Remove oil pan and drain the fluid.

(3) Remove the three oil filter screws and remove filter (Fig. 11).

(4) Position new filter on valve body and install filter screws finger tight.

(5) Tighten filter screws to 4 N•m (35 in-lbs) with inch pound torque wrench.

(6) Position new gasket on oil pan and install pan on transmission. Tighten pan bolts to 17 N•m (150 in-lbs) torque.

(7) Lower vehicle.

(8) Refill transmission with Mopar ATF PLUS, Type 7176.

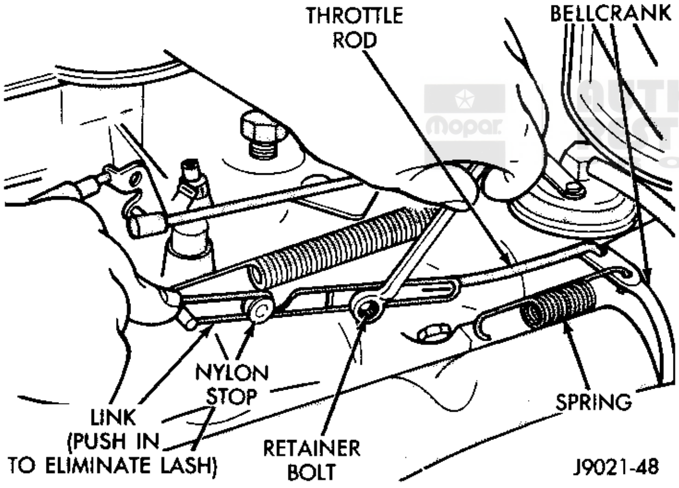


Fig. 7 Linkage Adjustment — 8 Cylinder Engine

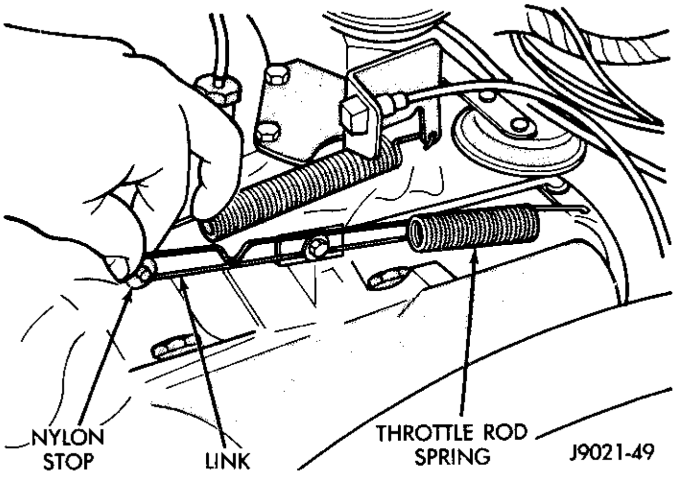


Fig. 8 Linkage Components — 8 Cylinder Engine

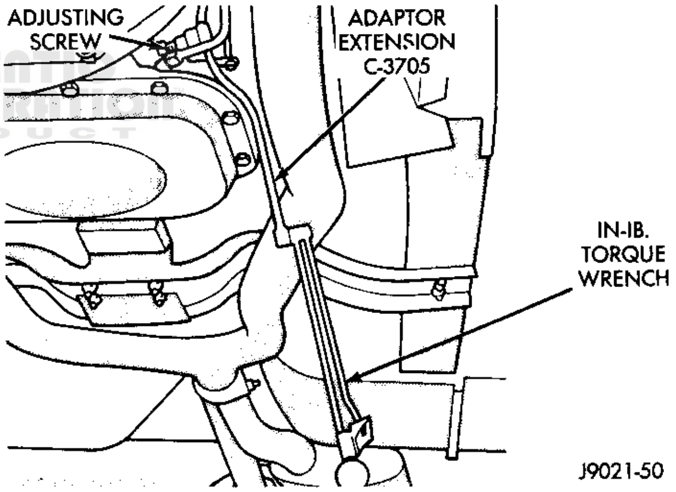


Fig. 9 Front Band Adjustment

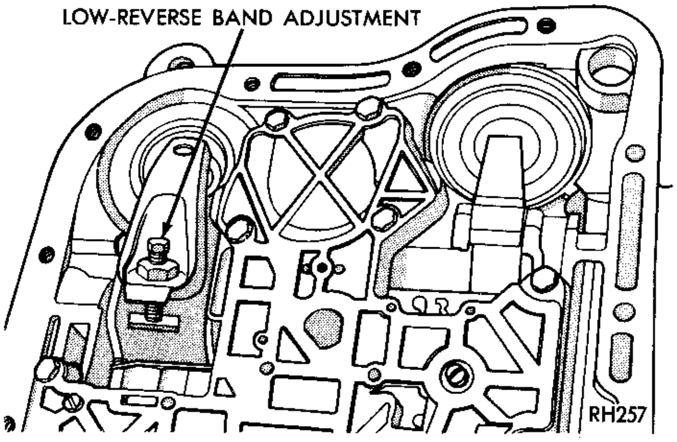


Fig. 10 Rear Band Adjustment

VALVE BODY REMOVAL

(1) Raise vehicle.

(2) Remove oil pan and drain fluid.

(3) Loosen clamp bolts and remove throttle and manual valve levers from manual valve shaft.

(4) Remove neutral switch.

(5) Remove valve body oil filter.

(6) Remove valve body attaching screws.

(7) Lower valve body, pull valve body forward to disengage park lock rod and remove valve body. If necessary, rotate propeller shaft so park lock rod will clear sprag.

(8) Mount valve body on repair stand (Fig. 12).

(9) Remove accumulator piston and spring (Fig. 13).

Front/Rear Servo

The front and rear servos are accessible and can be serviced after valve body removal. Refer to the servo overhaul procedures in the Transmission Overhaul section

VALVE BODY DISASSEMBLY

CAUTION: Tag all valve body springs for reference as they are removed. Do not clamp any part of the valve body in a vise. This practice will distort the valve body and transfer plate and result in valve bind. When removing the valves and plugs, slide them out carefully. Do not use force at any time. Both the valve and valve body will be damaged if force is used.

(1) Remove park lock rod E-clip and remove rod.

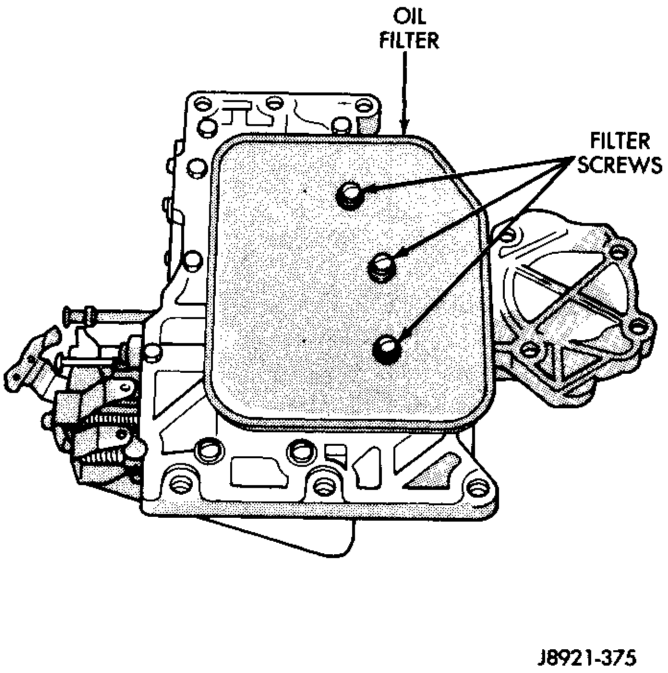


Fig. 11 Oil Filter Removal/Installation

(2) Remove top and bottom screws attaching the spring retainer and adjusting screw bracket (Fig. 12).Hold spring retainer firmly against spring force while removing last screw.

(3) Remove spring retainer and bracket and line pressure adjusting screw assembly (Fig. 14). **Do not disturb adjusting screw settings.**

(4) Remove switch and regulator valves and springs (Fig. 14).

(5) Remove manual lever E-clip, washer and seal (Fig. 14).

(6) Secure detent ball and spring (Fig. 14) with clip tool or shim stock and slide manual lever off throttle lever (Fig. 14).

(7) Remove and retain detent ball and spring (Fig. 14).

(8) Remove throttle lever assembly (Fig. 14).

(9) Remove manual valve, kickdown valve and detent, and throttle valve components (Fig. 14).

(10) Remove transfer plate screws and remove transfer plate and separator plate (Fig. 15).

(11) Remove screws attaching the two plates and remove separator plate from transfer plate (Fig. 15).

(12) On 999 models, remove and retain rear (low-reverse) servo check ball (Fig. 15).

(13) Remove and inspect filter screen in separator plate (Fig. 15). Replace screen if damaged.

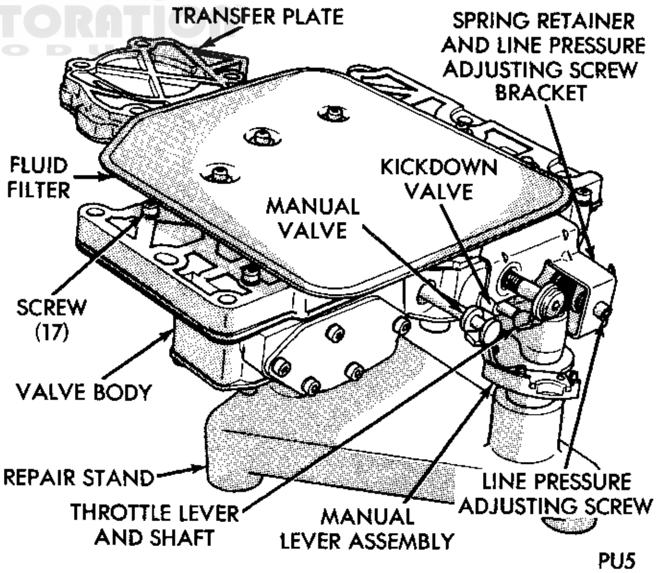


Fig. 12 Valve Body Assembly

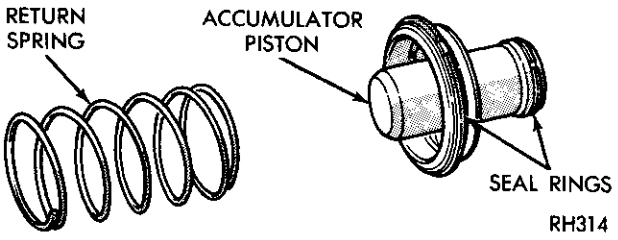


Fig. 13 Accumulator Piston And Spring

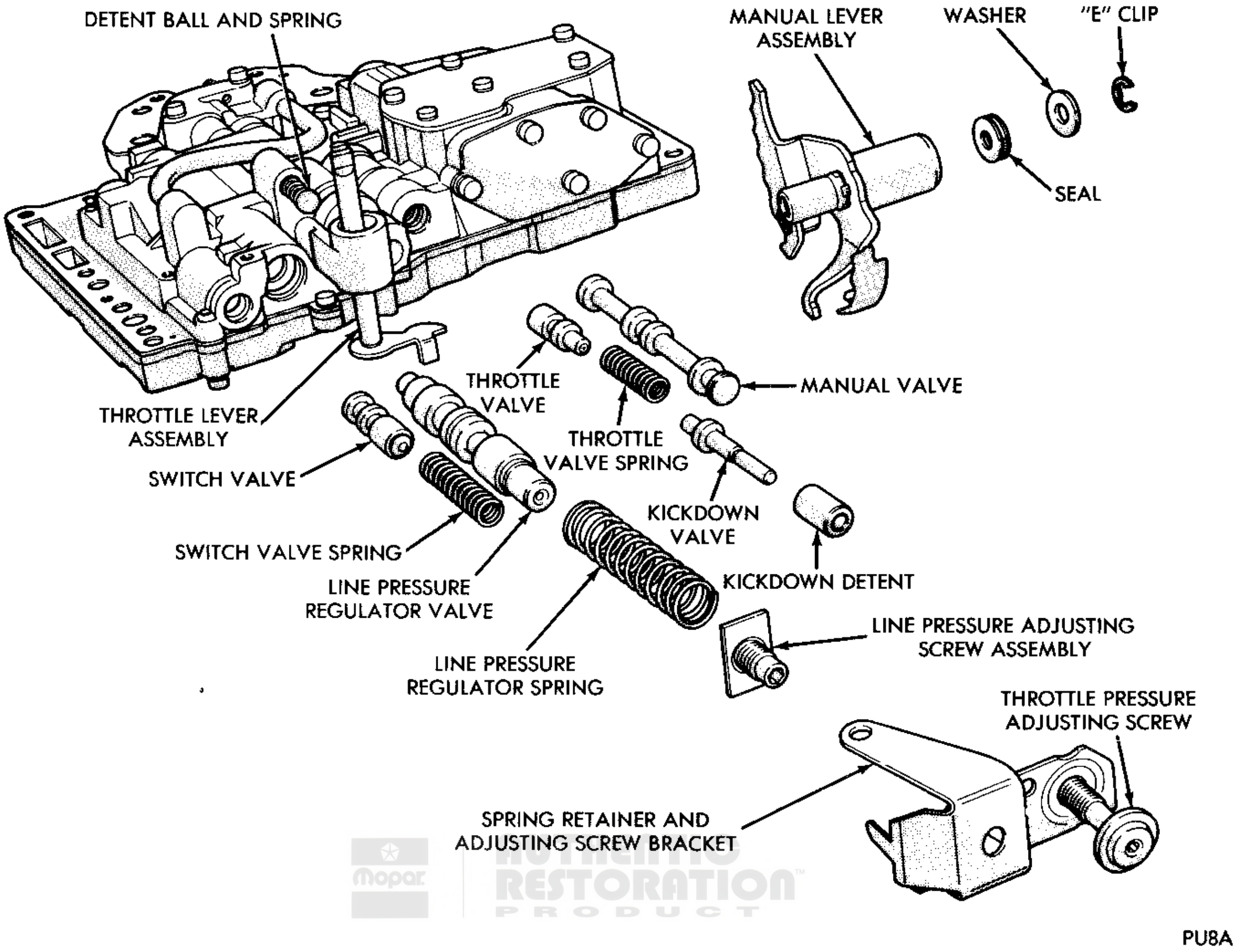


Fig. 14 Pressure Regulators And Manual Controls

(14) Remove valve body check balls (Fig. 16). Note check ball sizes and location for assembly reference.

(15) Turn valve body over.

(16) Remove shuttle valve end plate (Fig. 17).

(17) Remove governor plug end plate (Fig. 18).

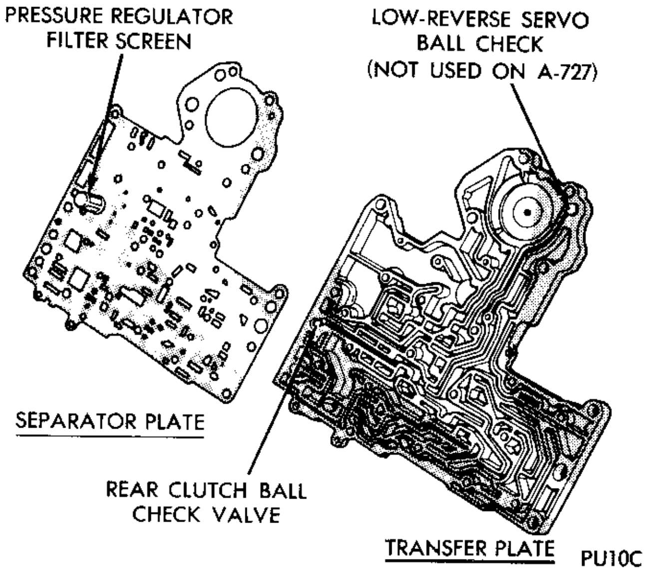


Fig. 15 Transfer And Separator Plates

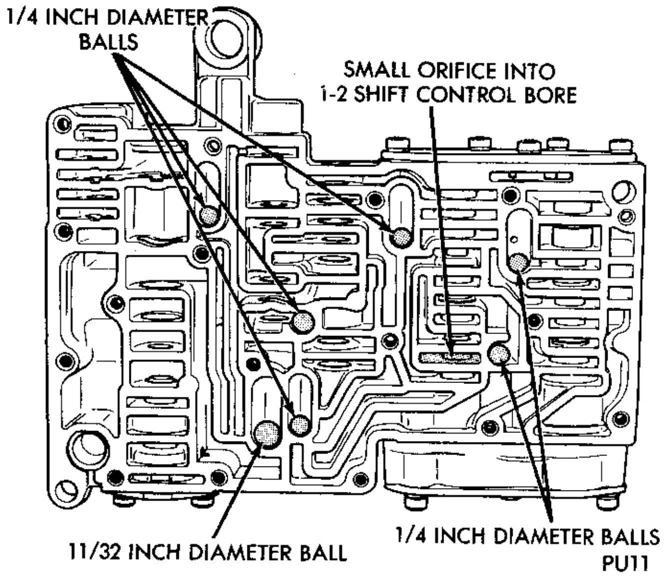


Fig. 16 Valve Body Check Balls

(18) Remove shuttle valve, plug, spring and governor plugs (Fig. 18).

(19) Remove E-clip and remove shuttle valve secondary spring and guides (Fig. 18).

(20) Remove shift valve end plates (Fig. 19).

(21) Remove 1-2 and 2-3 shift valves, plugs and springs (Fig. 19). Tag springs for assembly reference.

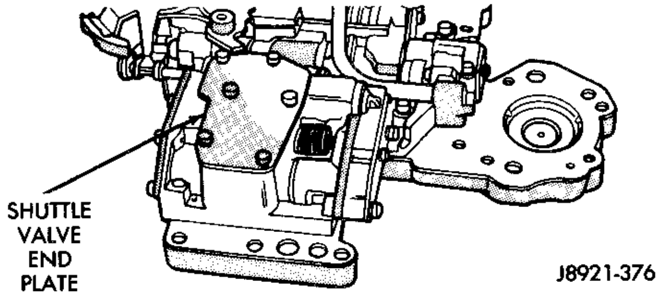


Fig. 17 Shuttle Valve End Plate Location

Valve Body Cleaning And Inspection

Clean the valve body components in clean solvent. Dry the parts with compressed air. Make sure all passages are clean and free from obstructions.

Inspect the throttle and manual valve levers and shafts. **Do not attempt to straighten a bent shaft or correct a loose lever. Replace these components if worn, bent, loose or damaged in any way.**

Inspect all of the valve body mating surfaces for scratches, nicks, burrs, or distortion. Use a straightedge to check surface flatness. Minor scratches may be removed with crocus cloth using only very light pressure. Minor distortion of a mating surface may be corrected by smoothing the surface with a sheet of crocus cloth placed on a surface plate (or equally flat surface). If distortion is severe or any surfaces are heavily scored, the valve body will have to be replaced.

Verify that the 1-2 shift orifice is clear. Check the orifice by inserting a 1/32 inch drill through the orifice and into the 1-2 shift bore.

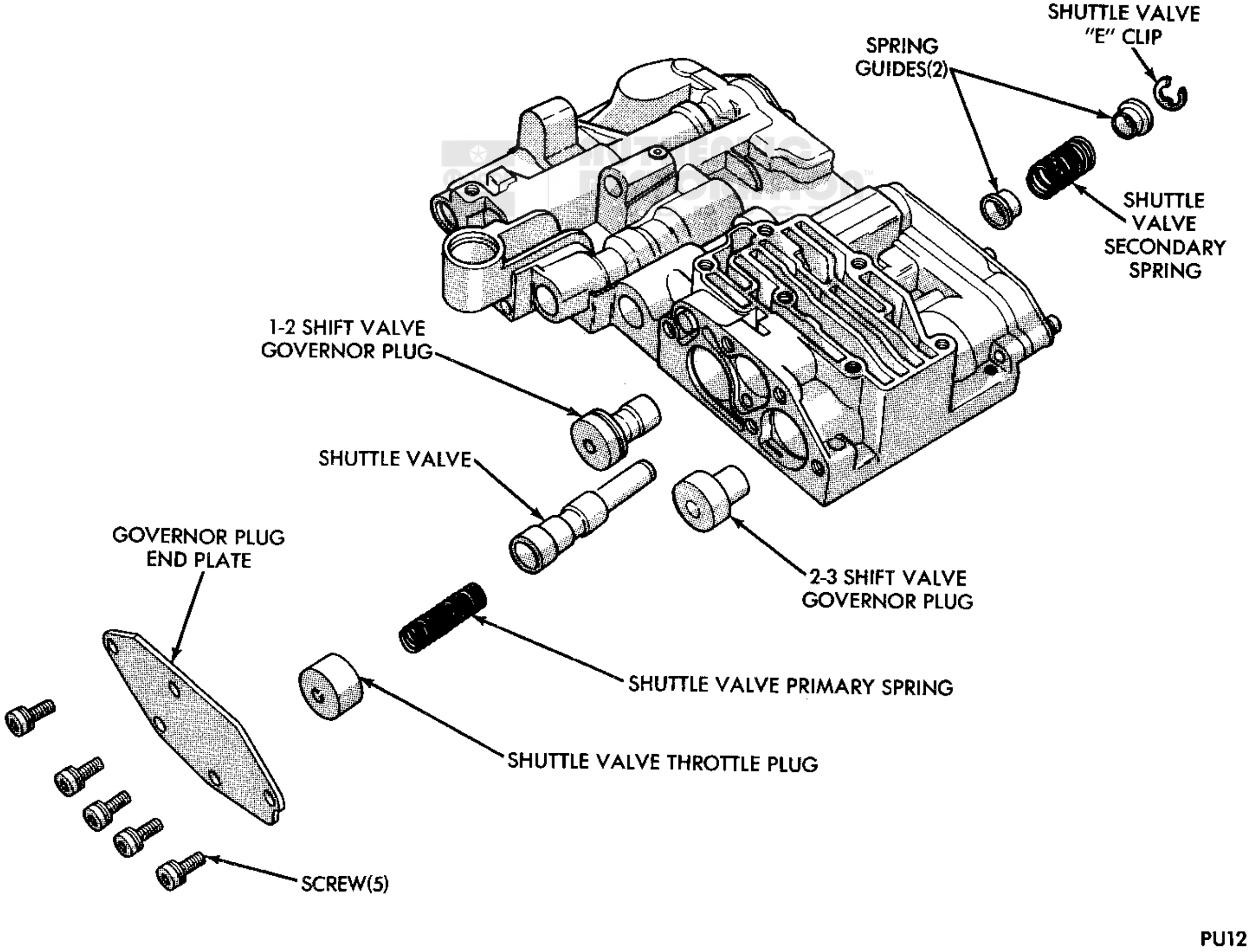


Fig. 18 Shuttle Valve And Governor Plugs

Inspect the valves and plugs for scratches, burrs, nicks, or scores. Minor surface scratches can be removed with crocus cloth but **do not round off the edges of the valve or plug lands.** Maintaining the sharpness of these edges is vitally important. These edges prevent foreign matter from lodging between the valves and plugs and the bore.

Inspect all the valve and plug bores in the valve body. Use a penlight to view the bore interiors. Replace the valve body if any bores are distorted or scored. Inspect all of the valve body springs. The springs must be free of distortion, warpage or broken coils.

Trial fit each valve and plug in its bore to check freedom of operation. When clean and dry, the valves and plugs should slide freely in the bores. Valve body bores do not change dimensionally with use. If the valve body functioned correctly when new, it will continue to operate properly after repair. It should not be necessary to replace a valve body assembly unless it is damaged in handling.

VALVE BODY ASSEMBLY

CAUTION: Do not force any valves or plugs into place during reassembly. If the valves, plugs and bores are free of distortion or burrs, they should slide into place easily. In addition, do not overtighten the valve body screws during reassembly. Overtightening will distort the valve body resulting in valve sticking, cross leakage and unsatisfactory operation. Tighten the screws alternately and evenly to 4 N•m (35 in-lbs) torque only.

(1) Install 1-2 and 2-3 shift valves and throttle and pressure regulating plugs and springs (Fig. 19).

(2) Install two shift valve end plates and tighten plate screws to 4 N•m (35 in-lbs) torque.

(3) Install throttle valve, manual valve, kickdown valve and detent (Fig. 14).

(4) Install regulator and switch valves and valve springs (Fig. 14).

(5) Install detent ball and spring (Fig. 14). Secure ball and spring with a clip tool or similar device.

(6) Install throttle lever (Fig. 14).

(7) Install manual lever on the throttle lever. Position manual lever so it engages manual lever and detent ball.

(8) Install manual lever washer, seal and E-clip (Fig. 14).

(9) Remove tool used to retain detent ball and spring.

(10) Install shuttle valve secondary spring, spring guids and E-clip (Fig. 18).

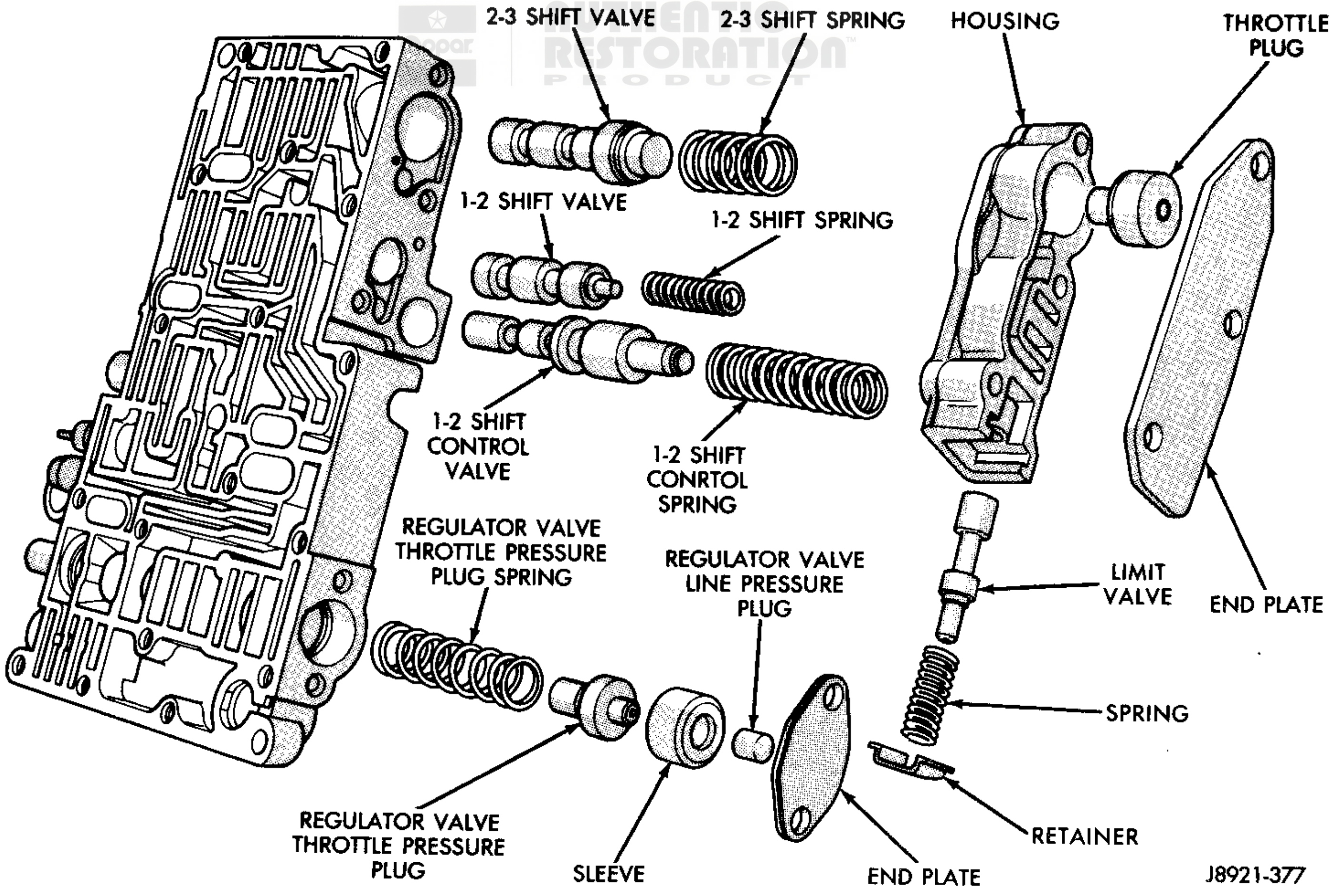


Fig. 19 Shift And Pressure Regulator Valves/Plugs

(11) Install governor plugs, shuttle valve and spring and throttle plug (Fig. 18).

(12) Install governor plug end plate and tighten plate screws to 4 N•m (35 in-lbs) torque.

(13) Install shuttle valve end plate and screws (Fig. 17). Tighten screws to 4 N•m (35 in-lbs) torque

(14) Install valve body check balls. Be sure 11/32 inch diameter ball is installed where shown (Fig. 16)

(15) Install filter screen in separator plate and check ball in transfer plate (Fig. 15)

(16) Assemble separator and transfer plates. Then position stiffener plate on separator plate. Install and tighten plate attaching screws to 4 N•m (35 in-lbs) torque.

(17) Install assembled transfer and separator plates. Be sure filter screen is properly aligned

(18) Tighten valve body screws to 4 N•m (35 in-lbs) torque. Start at center and work outward when tightening screws.

(19) Install line pressure adjusting screw assembly on spring retainer and bracket (Fig. 14)

(20) Align and position assembled adjusting screws and bracket on valve body. Start both attaching screws before final tightening them to 4 N•m (35 in-lbs) torque.

(21) Install E-clip and park rod on manual lever

(22) Proceed to control pressure adjustment procedure **only** if line and throttle pressures were unsatisfactory before disassembly.

VALVE BODY CONTROL PRESSURE ADJUSTMENTS

There are two control pressure adjustments on the valve body which are: Line pressure and throttle pressure.

Because line and throttle pressures are interdependent (each affects the shift quality and timing), both adjustments must be performed properly and in the correct sequence, the line pressure adjustment first, the throttle pressure adjustment last

Line Pressure Adjustment

Measure distance from the valve body to the inner edge of the adjusting screw with an accurate steel scale (Fig. 20).

Distance should be 33.4 mm (1-5/16 inch).

If adjustment is required, turn the adjusting screw in, or out, to obtain required distance setting.

The 33.4 mm (1-5/16 inch) setting is an approximate setting. Because of manufacturing tolerances, it may be necessary to vary from this dimension to obtain desired pressure. One complete turn of the adjusting screw changes line pressure approximately 1-2/3 psi (9 kPa). Turning the adjusting screw counterclockwise increases pressure while turning the screw clockwise decreases pressure.

Throttle Pressure Adjustment

Insert gauge tool C-3763 between the throttle lever cam and kickdown valve (Fig. 21).

Push the gauge tool inward to compress the kickdown valve against the spring and bottom the throttle valve.

Maintain pressure against kickdown valve spring. Turn throttle lever stop screw until the screw head touches throttle lever tang and the throttle lever cam touches gauge tool.

The kickdown valve spring must be fully compressed and the kickdown valve completely bottomed to obtain correct adjustment.

Manual Lever Shaft Seal

If the shaft seal must be replaced, tap it out of the case with a punch. Then install the new seal with a 15/16 socket (Fig. 22).

VALVE BODY INSTALLATION

(1) Install new seals on accumulator piston and install piston in case.

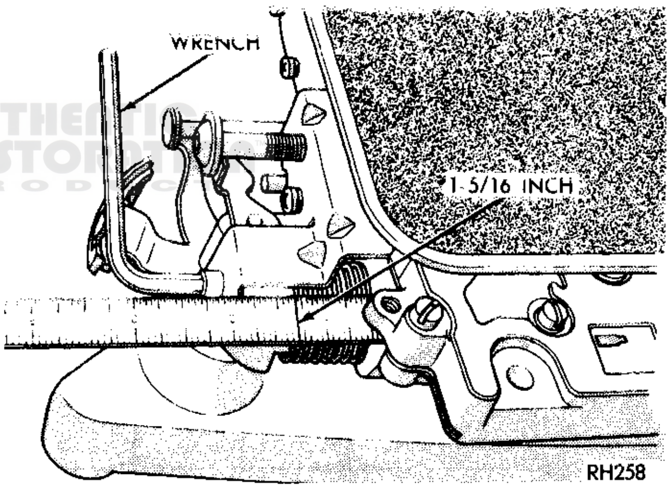


Fig. 20 Line Pressure Adjustment

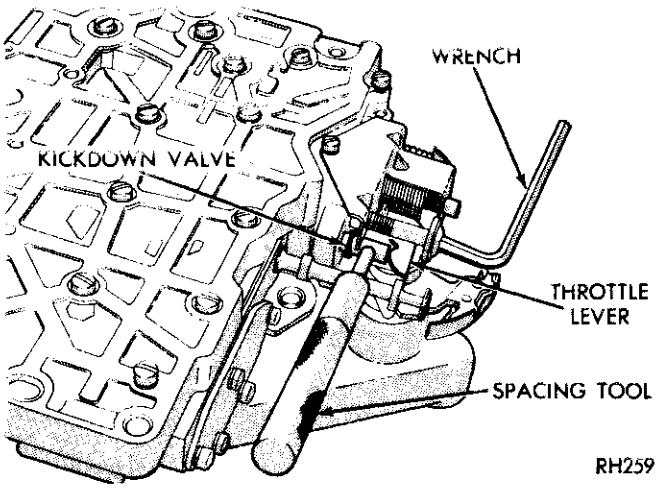


Fig. 21 Throttle Pressure Adjustment

(2) Place valve body manual lever in low (1 position) so park lock rod can be installed in sprag.

(3) Position park sprag with screwdriver to ease lock rod engagement.

(4) Position accumulator spring between piston and valve body.

(5) Position valve body on transmission and work knob on park lock rod past sprag.

(6) Hold valve body in position and install valve body attaching screws finger tight only.

(7) Install neutral safety switch in case.

(8) Move manual valve lever to Neutral position.

(9) Move valve body as needed to align neutral finger of manual lever with neutral switch plunger.

(10) Tighten valve body attaching screws alternately and evenly to 11 N•m (100 in-lbs) torque.

(11) Install new oil filter. Tighten filter screws to 4 N•m (35 in-lbs) torque.

(12) Install manual and throttle levers on throttle lever shaft. Tighten lever clamp screws and check for free operation. Shaft and levers must operate freely without any bind.

(13) Install oil pan and new gasket. Tighten pan bolts to 17 N•m (150 in-lbs) torque.

(14) Connect neutral switch wires.

(15) Lower vehicle.

(16) Fill transmission with Mopar ATF PLUS, Type 7176 fluid.

(17) Adjust gearshift and throttle linkage.

GOVERNOR-PARKING GEAR SERVICE

Governor Removal

(1) Raise the vehicle.

(2) Mark both propeller shaft yokes for assembly reference.

(3) Disconnect front and rear propeller shafts at transfer case.

(4) Disconnect speedometer cable.

(5) Position support stand under transmission converter housing.

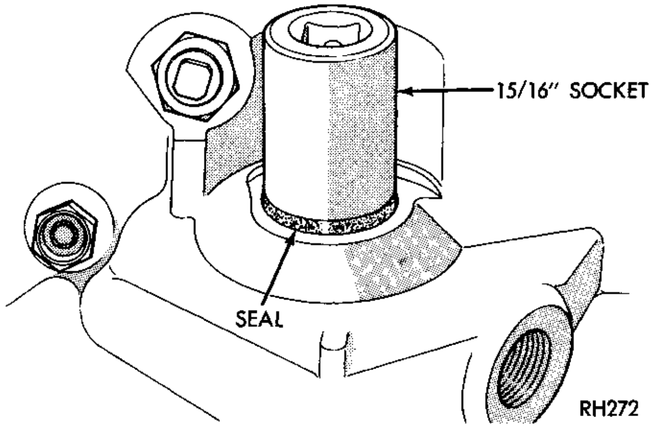


Fig. 22 Installing Manual Lever Shaft Seal

(6) Remove rear crossmember.

(7) Disconnect parking brake cable at equalizer and disconnect exhaust pipe support brackets, if necessary.

(8) Support transfer case with jack.

(9) Remove bolts attaching transfer case to transmission adapter housing and remove transfer case.

(10) Remove bolts attaching adapter housing to transmission and remove adapter housing.

(11) Rotate transmission output shaft until governor snap rings face downward (Fig. 23).

(12) Remove small snap ring from governor valve shaft (Fig. 23).

(13) Remove governor valve and shaft from governor body.

(14) Remove snap ring that retains governor body-park gear assembly on output shaft (Fig. 23).

(15) Remove governor body-park gear assembly from output shaft.

Governor Disassembly

(1) Remove remaining snap rings from end of governor body (Fig. 24).

(2) Remove governor weights and spring (Fig. 24).

(3) Separate inner weight and outer weights and spring (Fig 24).

(4) Remove governor lock bolts and separate park gear and governor body. If bolts have lock tabs, straighten the tabs before bolt removal (Fig. 24).

(5) Remove park gear from governor body.

(6) Remove filter from governor body (Fig. 24).

Cleaning and Inspection

Thoroughly clean all the governor parts in a suitable cleaning solution but do not use any type of caustic cleaning agents. The weights and valves should fall freely in their bores when clean and dry. Minor surface scratches and burrs can be removed with crocus cloth. Inspect the governor weight spring for distortion. Re-

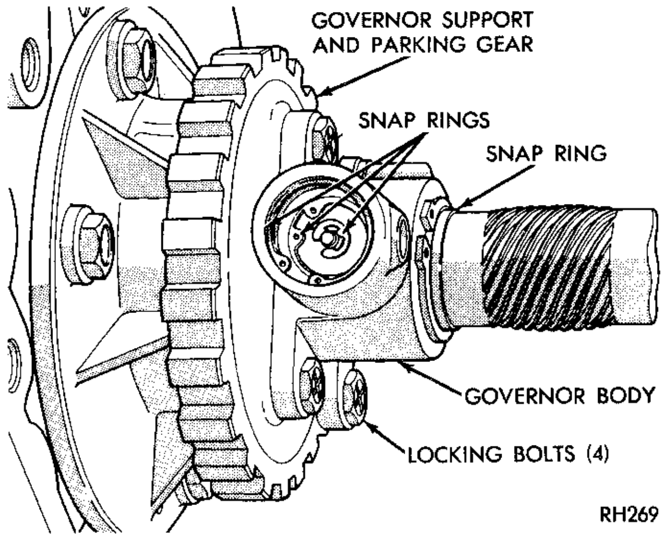


Fig. 23 Governor Snap Rings And Lock Bolts

place the spring, if damaged. Clean the filter in solvent and dry it with compressed air. Replace the filter, if damaged. Inspect the park gear for chipped or worn gear teeth or damaged ring grooves. Replace the gear, if damaged.

Governor Assembly

(1) Install the filter in the governor body.

(2) Assemble governor body and park gear. Be sure oil passages in body and gear are aligned.

(3) Install the lock bolts finger tight only at this time.

(4) Assemble and install governor weights and spring and install snap ring.

Governor Installation

(1) Install parking gear-governor assembly on output shaft.

(2) Align shaft bore in governor body with bore in output shaft.

(3) Install governor valve shaft in body and through output shaft.

(4) Install first snap ring on valve shaft to secure it.

(5) Install governor valve on shaft and in governor body. Then install second shaft retaining snap ring.

(6) Install remaining governor snap ring (Fig. 24).

(7) Install snap ring that retains governor on output shaft (Fig. 24).

(8) Tighten governor lock bolts to 11 N•m (95 in-lbs) torque.

(9) If lock bolts have lock tabs, bend tabs against bolt heads to secure them.

(10) Position the adapter on the transmission and tighten the adapter bolts to 32 N•m (24 ft-lbs) torque.

(11) Install the transfer case and rear crossmember.

(12) Connect speedometer cable, exhaust pipe brackets and brake cable, if removed.

(13) Align and connect propeller shafts. Tighten clamp bolts to 19 N•m (14 ft-lbs) torque.

(14) Remove supports and lower vehicle.

(15) Check and adjust transmission fluid level.

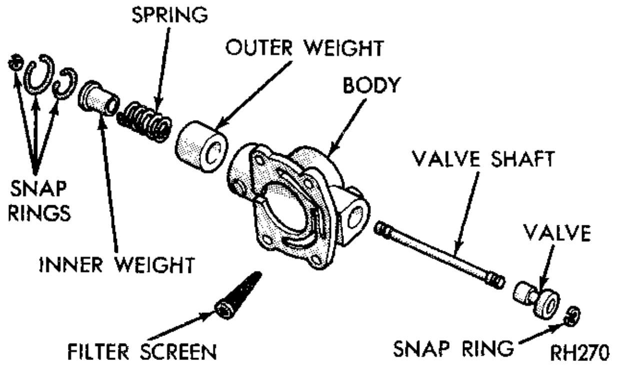


Fig. 24 Governor Components

PARKING LOCK COMPONENT REPLACEMENT

Component Removal

(1) Raise vehicle and remove transfer case and adapter housing from transmission.

(2) Slide sprag shaft out of housing and remove park sprag and spring (Fig. 25).

(3) Remove snap ring and slide plug and pin assembly out of housing (Fig. 25).

(4) If park lock rod is to be serviced, remove valve body and remove rod.

Inspection

Check sprag shaft for scores and for free movement in housing and sprag. Check the sprag and control rod springs for loss of tension or distortion. Check the square lug on the sprag for broken edges. Check the lugs on the governor support (park gear) for broken edges. Check the knob on the end of the control rod for nicks, burrs and free turning. Replace any components that are worn or damaged.

CAUTION: Different length park lock rods are used in 999/727 transmissions. The rods are not interchangeable. The 727 rod is longer than the 999 rod (Fig. 25). If rod replacement is necessary, be sure to install the correct part.

Component Installation

(1) Install park lock rod on valve body.

(2) Install reaction plug and pin assembly in the housing and install the snap ring.

(3) Position sprag and spring in housing and install sprag shaft. Be sure square lug on sprag is facing park gear and that spring is positioned so it moves sprag away from park gear.

(4) Install valve body.

(5) Install adapter housing and transfer case.

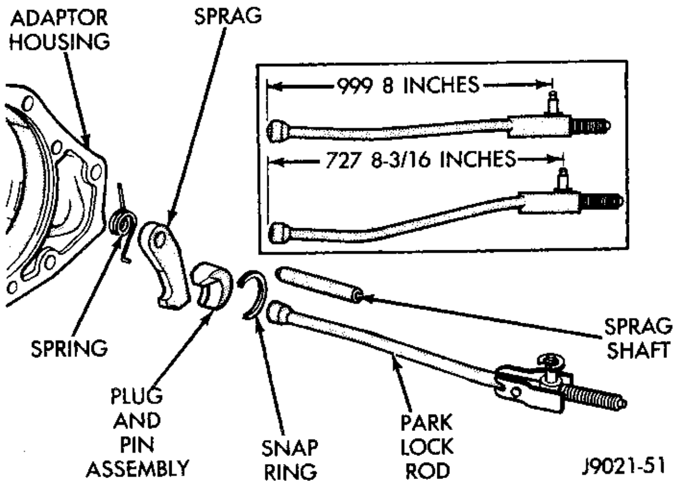


Fig. 25 Parking Lock Components

NEUTRAL SWITCH SERVICE

The starter feed circuit of the neutral switch is through the switch center terminal (Fig. 26). It provides a ground for the starter solenoid circuit through the gearshift lever in Park and Neutral only.

The two outer terminals of the neutral switch are for the backup lamp switch circuit.

Switch Test Procedure

(1) Remove wiring connector from switch.

(2) Test continuity between switch center terminal and transmission case. Continuity should exist only when transmission is in Park or Neutral. Replace switch if continuity occurs in any gear other than Park or Neutral.

(3) Shift into reverse and test continuity between two outside terminals on switch. Continuity should exist only when transmission is in reverse.

(4) Leave transmission in reverse and test continuity between each switch outer terminal and transmission case. Continuity should not exist between either pin and case in reverse.

(5) If switch tests OK, check gearshift linkage adjustment or backup light circuit. Replace switch if it fails continuity tests.

Switch Replacement

(1) Position drain pan under neutral switch.

(2) Disconnect switch wires.

(3) Remove switch from transmission.

(4) Move shift lever to Park and Neutral positions. Inspect manual lever fingers ands lever and shaft for proper alignment with switch opening in case. Replace lever if worn or bent. Do not attempt to straighten the lever.

(5) Install new switch and seal in case. Tighten switch to 33 N•m (24 ft-lbs) torque.

(6) Adjust transmission fluid level as required.

(7) Verify switch operation.

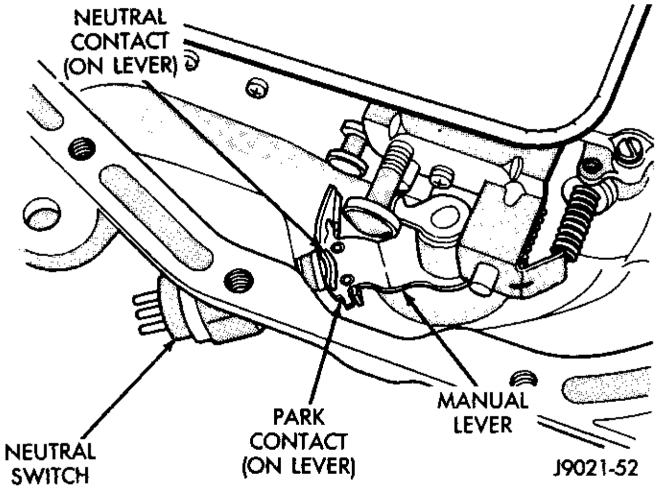


Fig. 26 Neutral Switch And Manual Lever

TRANSMISSION COOLER SERVICE

Flushing Coolers And Lines

If a transmission fault contaminates the fluid, the oil coolers and lines must be flushed thoroughly. This is necessary to prevent sludge and particles from flowing back into the transmission after repair. The flushing procedure applies to the standard in-radiator cooler and the auxiliary cooler on SJ models.

Flushing Procedure

(1) Disconnect cooler lines at transmission, cooler and radiator.

(2) Dislodge any foreign material at inlet side of cooler with small screwdriver.

(3) Flush cooler and lines with mineral spirits. Use short pulses of compressed air to force mineral spirits through cooler and lines.

(4) Flush coolers and lines a second time but with fresh transmission fluid. Continue flushing until only clean fluid emerges from lines and cooler.

(5) Check cooler flow by measuring amount of fluid pumped through cooler by transmission oil pump.

(a) Disconnect cooler return line from radiator and place it in one quart (0.9 liter) container.

(b) Add extra quart of fluid to transmission.

(c) Use stopwatch to check test time.

(d) Shift into Neutral. Then start and operate engine at curb idle speed. Approximately one quart (0.9 liter) of fluid should flow through cooler in 20 seconds.

(e) If flow is **considerably less** than one quart in 20 seconds, cooler is plugged or damaged and should be replaced.

Main Cooler Replacement—All Models

The main transmission cooler is located in the radiator lower tank. The cooler is not a serviceable component. If the cooler is damaged in any way, the radiator will have to be replaced.

Auxiliary Cooler Replacement—SJ

(1) Remove screws and washers attaching grille panel to grille face panel assembly.

(2) Remove grille panel.

(3) Tag cooler hoses for installation reference.

(4) Position drain pan under cooler.

(5) Loosen cooler hose clamps and remove cooler hoses from cooler fittings (Fig. 27). Cover hose ends to prevent dirt entry.

(6) Remove cooler screws and remove cooler (Fig. 27).

(7) Position cooler on grille face panel and install cooler attaching screws.

(8) Remove protective covering from cooler hose ends and connect hoses to cooler.

(9) Tighten cooler hose clamps securely.

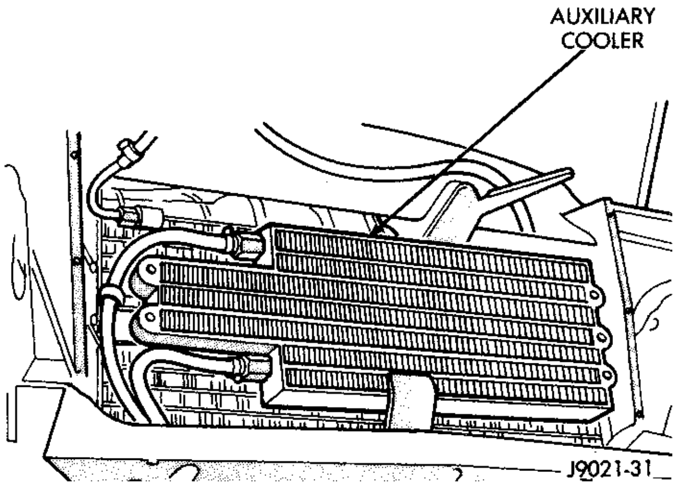


Fig. 27 Auxiliary Cooler — SJ

(10) Position grille panel on grille face panel and install the grille panel attaching screws.

(11) Check and adjust transmission fluid level.

TRANSMISSION AND CONVERTER REMOVAL/INSTALLATION

INDEX

TRANSMISSION AND CONVERTER REMOVAL

(1) Remove fan shroud attaching bolts.

(2) Disconnect transmission fill tube at upper bracket.

(3) Raise vehicle.

(4) Remove inspection cover from converter housing.

(5) Remove transmission fill tube.

(6) Remove starter motor.

(7) Mark propeller shafts and axle yokes for alignment reference.

(8) Disconnect propeller shafts at transfer case yokes. Secure shafts to frame rails with wire.

(9) On eight-cylinder models, disconnect exhaust pipes at exhaust manifolds.

(10) Drain transfer case lubricant.

(11) Disconnect speedometer cable at transfer case.

(12) Disconnect transfer case shift linkage.

(13) Disconnect gearshift and throttle linkage at transmission.

(14) Disconnect neutral switch wires.

(15) Mark drive plate and converter for alignment reference.

(16) Remove bolts attaching converter to drive plate.

(17) Support engine with support stand.

(18) Support transmission-transfer case assembly with transmission jack. Secure transmission to jack with safety chain.

(19) Remove bolts attaching transmission to rear crossmember.

(20) Remove rear crossmember.

(21) Lower transmission slightly and disconnect cooler lines at transmission.

(22) Remove bolts attaching transmission to engine.

(23) Move transmission and converter rearward until clear of crankshaft.

(24) Hold converter in position and lower transmission until converter housing clears engine.

(25) Remove converter from transmission.

(26) Remove transfer case from transmission.

(27) If necessary, following components can now be serviced:

- torque converter
- torque converter drive plate
- oil pump seal
- engine rear core hole plugs
- engine rear oil galley plugs

CAUTION: If the transmission was removed to correct a malfunction that generated sludge or heavy accumulations of metal particles or friction material, the oil cooler and cooler lines must be flushed thoroughly and the torque converter replaced. Do not attempt to flush the converter if contaminated.

CONVERTER-PUMP SEAL-DRIVE PLATE SERVICE

After the transmission has been removed, the drive plate and torque converter can be replaced or removed for service access (Fig. 28).

The torque converter is not a serviceable part. If the converter is contaminated or damaged in any way, it must be replaced as an assembly. **Do not attempt to flush a converter contaminated by metal or clutch facing particles. Flushing will not remove these contaminants.**

The oil pump seal is accessible and can be replaced after the transmission and torque converter are removed. Use an extenally threaded-type tool to remove the seal (Fig. 29). To install the seal, use a standard seal driver of the correct size (Fig. 30). Be sure to lubricate the pump seal and converter hub with transmission fluid or petroleum jelly before installation.

TRANSMISSION AND CONVERTER INSTALLATION

(1) If the torque converter was removed, insert an aligning tool in the pump rotor to align the rotor drive lugs. Be sure the lugs are engaged in the tool slots.

(2) Rotate converter until drive slots in converter hub are aligned with rotor lugs and carefully insert converter hub into pump. Be sure converter is fully seated in pump rotor.

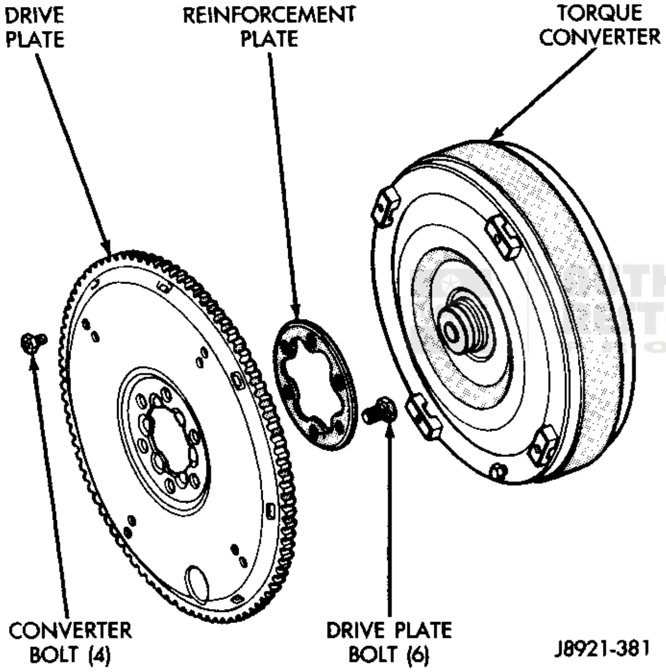


Fig. 28 Converter And Drive Plate — Typical

(3) If necessary, temporarily secure converter with metal strap attached across converter housing.

(4) Position transmission on jack and secure it with chains.

(5) Raise transmission and align converter with drive plate.

(6) Move transmission forward. Then raise, lower or tilt transmission to align converter housing with engine block dowels.

(7) Install two converter housing lower attaching bolts and tighten bolts to draw housing to engine.

(8) Install drive plate-to-converter attaching bolts.

(9) Install and tighten remaining converter housing-to-engine bolts. Tighten bolts to 38 N•m (28 ft-lbs) torque.

(10) Connect cooler lines to transmission.

(11) Position support under transmission and remove transmission jack.

(12) Install transfer case on transmission.

(13) Install rear crossmember and attach transmission rear support cushion to crossmember.

(14) Install speedometer cable.

(15) Install inspection cover on converter housing.

(16) Install exhaust pipes and support brackets, if removed.

(17) Install starter motor.

(18) Connect wires to neutral switch.

(19) Connect gearshift and throttle linkage.

(20) Connect transfer case shift linkage.

(21) Connect propeller shafts to transfer case yokes.

(22) Connect front exhaust pipes and catalytic converter support bracket bolts, if removed.

(23) Fill transfer case to bottom edge of fill plug hole with Mopar ATF PLUS Type 7176, or Dexron II™ transmission fluid.

(24) Lower vehicle and fill transmission to correct level.

(25) Check and adjust gearshift and throttle linkage if necessary.

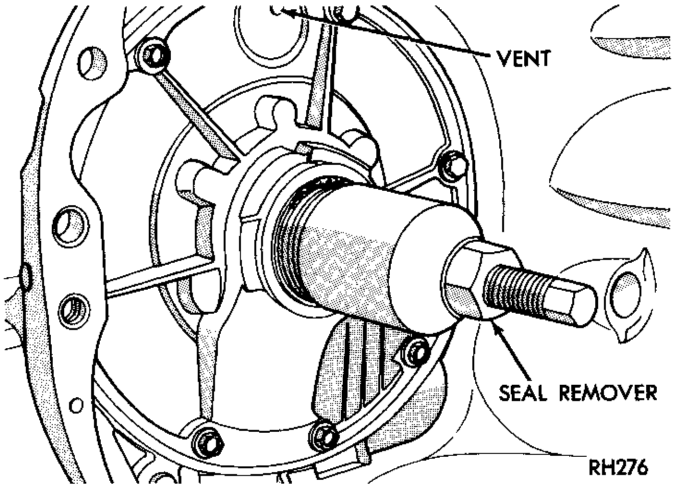


Fig. 29 Oil Pump Seal Removal

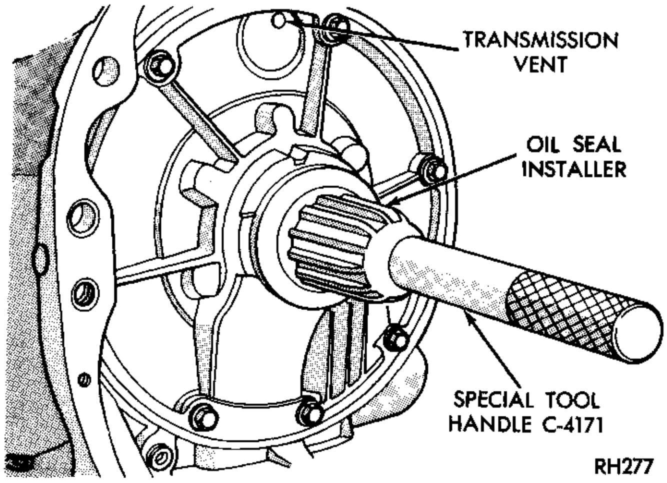


Fig. 30 Oil Pump Seal Installation

TRANSMISSION OVERHAUL

INDEX

TRANSMISSION DISASSEMBLY

(1) Clean transmission exterior with a steam cleaner or with solvent. Cleanliness during overhaul is extremely important. Clean all parts with solvent and dry with compressed air only. **Do not use shop towels to dry transmission parts. Shop towels will leave lint particles on transmission parts which can plug fluid passages or interfere with valve operation.**

(2) Place transmission in a repair stand (Fig. 1).

(3) Measure input shaft end play **before disassembly** to determine if a thrust washer change is needed (Fig. 2).

(a) In 999 transmission, washer is located between input and output shafts. In 727 transmission, washer is between reaction shaft support and front clutch retainer.

(b) Attach dial indicator to converter housing (Fig. 2). Position indicator plunger against input shaft and zero indicator.

(c) Move input shaft in and out and record reading. End play should be .022 - .091 inch (.56 - 2.31 mm) on 999. On 727, end play should be .034 - .084 inch (.86 - 2.13 mm).

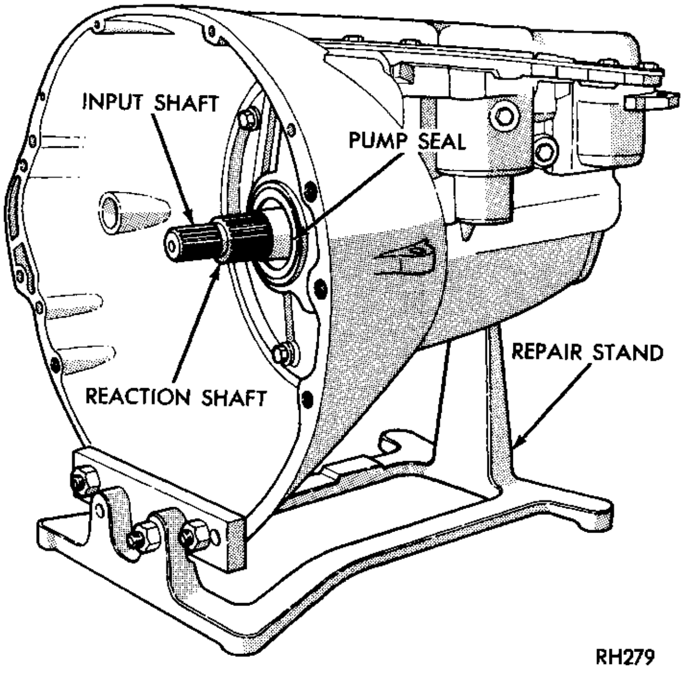


Fig. 1 Transmission Mounted On Repair Stand

Oil Pan And Valve Body

(1) Remove oil pan bolts and remove pan and gasket.

(2) Loosen clamp bolts and remove throttle and manual valve levers from manual shaft.

(3) Remove neutral switch.

(4) Remove valve body bolts and park lock rod E-clip. Lift valve up and off transmission and remove rod from park pawl.

(5) Remove accumulator spring and piston.

Governor And Park Gear

(1) Remove adapter housing from transmission.

(2) Remove snap ring that retains governor and park gear on output shaft.

(3) Remove governor valve shaft snap rings and remove governor valve and shaft from governor body.

(4) Slide governor body and park gear off output shaft.

Oil Pump And Reaction Shaft Support

(1) Tighten front band adjusting screw until band is tight on front clutch retainer. This prevents retainer from coming out with pump and causing unecessary damage to clutch components.

(2) Remove oil pump bolts.

(3) Remove oil pump and reaction shaft support assembly with two slide hammer tools C-3752 (Fig. 3). Thread slide hammers into threaded holes in pump body flange.

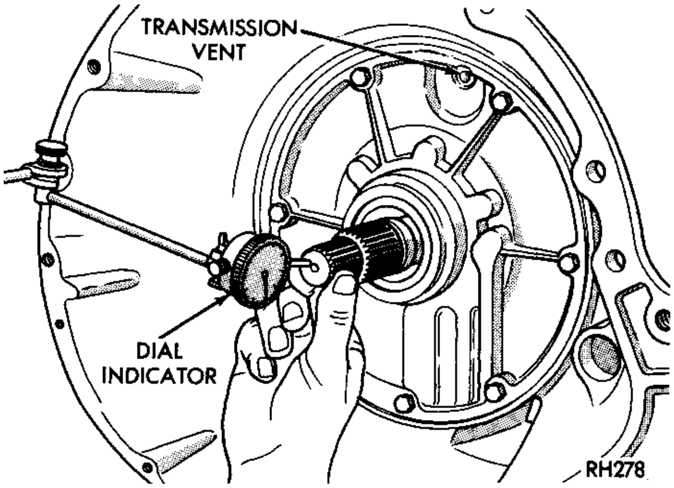


Fig. 2 Measuring Input Shaft End Play

Front Clutch

(1) Loosen band adjusting screw.

(2) Remove band strut and and remove strut anchor on 727 models.

(3) Slide front clutch out of case.

Input Shaft And Rear Clutch

(1) Pull input shaft and rear clutch assembly out of case.

(2) On 999 models, remove and retain thrust washer located between input and output shafts.

Planetary Gears-Sun Gear-Driving Shell

(1) Lift and support output shaft and driving shell.

(2) Carefully slide assembly forward and out of case. Be careful with the machined surfaces of the output shaft. Do not allow these surfaces to become nicked or damaged during removal.

(3) Remove and retain No. 3 thrust plate and washer from shaft.

Rear Band-Low Reverse Drum

(1) Remove low-reverse drum.

(2) Loosen rear band adjusting screw.

(3) On 727 models, remove band strut and link then remove rear band.

(4) On 999 models, loosen band adjuster screw. Then remove band and low-reverse drum as assembly.

Overrunning Clutch

(1) Note position of clutch rollers and springs for assembly reference.

(2) Carefully remove clutch hub and remove rollers and springs.

Kickdown (Front) Servo

(1) Remove plug from front servo test port.

(2) Compress servo piston and spring with tool C-3422A (Fig. 4).

(3) Remove servo piston snap ring and remove the compressor tool.

(4) Remove servo piston.

Rear Servo

(1) Compress servo piston and remove snap ring (Fig. 5).

(2) Remove servo retainer, springs, piston plug and spring and piston.

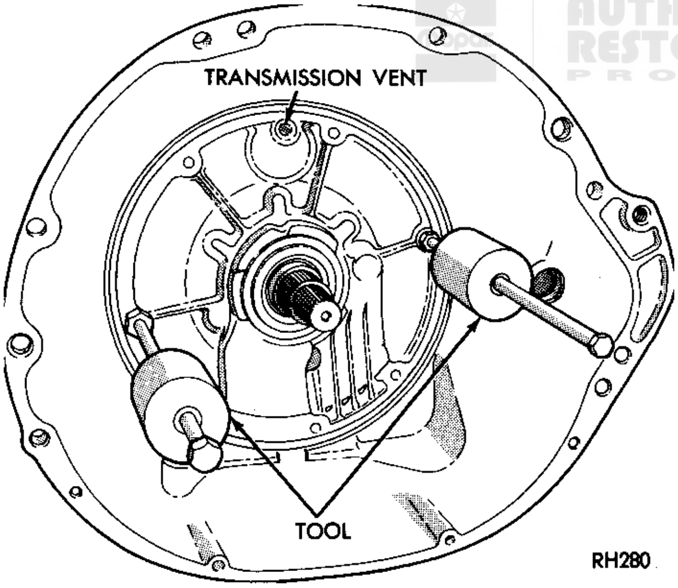


Fig. 3 Removing Oil Pump

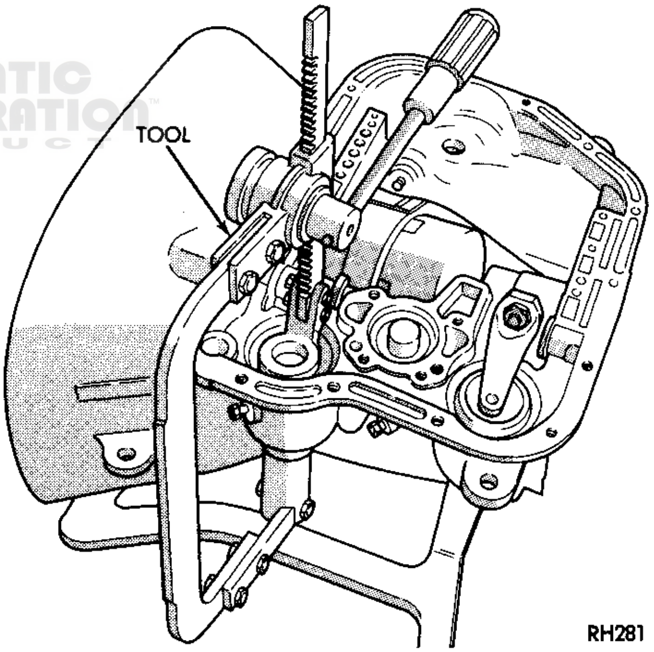


Fig. 4 Removing Front Servo Components

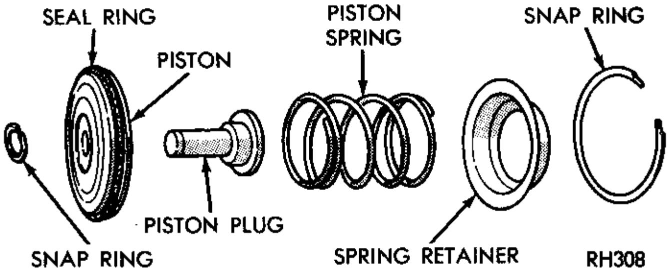


Fig. 5 Rear Servo Components

SUBASSEMBLY OVERHAUL

INDEX

GENERAL SERVICE INFORMATION

The procedures in this section cover disassembly, inspection, overhaul and reassembly of the various transmission subassembly components.

Inspect all the transmission bushings during overhaul. Bushing condition is important as worn, scored bushings contribute to low pressures, improper clutch apply and accelerated wear of other components. Replace worn, or scored bushings. Also replace any bushing if doubt exists about its condition. The bushings in a high milage transmission should all be replaced during overhaul.

Use recommended tools to replace bushings. The tools are sized and designed to install and seat bushings correctly. Bushing replacement tools with SP numbers are part of Tool Kit C-3887B.

Presized service bushings are available for replacement purposes. Only the sun gear bushings are not serviced. Low cost of the sun gear assembly makes it easier to simply replace the gear and bushings as an assembly.

Heli-Coil inserts are recommended for repairing damaged, stripped or worn threads in aluminum parts. These inserts are available from most automotive jobbers.

The use of crocus cloth is permissible where necessary, providing it is used carefully. When used on valves, use extreme care to avoid rounding off sharp edges. Sharp edges are vital as they prevent foreign matter from getting between the valve and valve bore.

Do not reuse oil seals, gaskets, seal rings, O-rings, or snap rings during overhaul. Replace these parts to as a matter of course.

Coat the transmission parts with MOPAR ATF PLUS, Type 7176 transmission fluid during assembly. Use Door Ease or petroleum jelly to prelubricate seals, O-rings, and thrust washers.

OIL PUMP AND REACTION SHAFT SUPPORT—999

Pump And Support Disassembly

(1) Remove support bolts and separate support and pump body (Fig. 6).

(2) Remove O-ring seal from pump body.

(3) Remove pump seal with a punch.

(4) Mark pump gears for assembly reference and remove gears.

(5) Remove seal rings from reaction shaft support (Fig. 6).

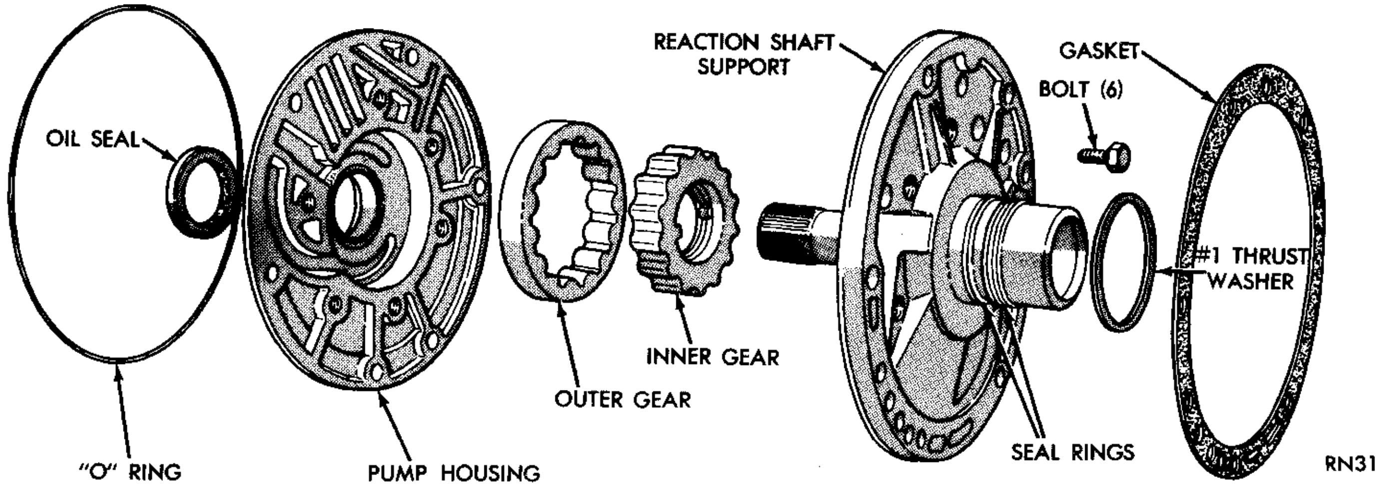


Fig. 6 Oil Pump/Reaction Shaft Components—999

(6) Clean pump and support components with solvent and dry them with compressed air.

Pump And Support Inspection

Inspect the pump and support components. Replace the pump or support if the seal ring grooves or machined surfaces are worn, scored, pitted, or damaged.

Replace the pump gears if pitted, worn chipped, or damaged. Inspect the No. 1 and 2 thrust washers for wear or damage. Replace the washers if worn.

Replace the pump bushing and the reaction shaft support bushing during overhaul. Do not reuse the original bushings even if they look OK.

Install the gears in the pump body and measure end clearance with a feeler gauge and straightedge (Fig. 7). Clearance should be .010 - .06 mm (.0004 - .0025 in).

Measure gear tooth clearance with a feeler gauge. Align one tooth of the outer gear with one tooth of the inner gear and measure clearance (Fig. 8). Clearance should be .08 - .19 mm (.0035 - .0075 in).

Measure clearance between the outer gear and the pump body (Fig. 8). Clearance should be .08 -.19 mm (.0035 - .0075 in).

Replacing Oil Pump Bushing—999

(1) Remove pump bushing with tool handle C-4171 and remover tool SP 3551 (Fig. 9).

(2) Install new pump bushing with tool handle C-4171 and installer tool SP 5117 (Fig. 9). Bushing should be flush with pump body bore.

(3) Stake new pump bushing in two places with blunt punch (Fig. 10). Remove burrs from stake points with knife blade (Fig. 10).

Replacing Reaction Shaft Support Bushing—999

(1) Assemble bushing remover tools SP 1191, 3633 and 5324 (Fig. 11). **Do not clamp any part of reaction shaft or support in vise.**

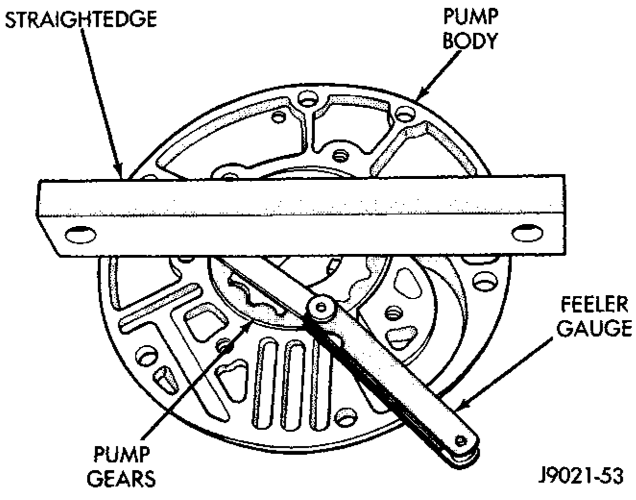


Fig. 7 Measuring Pump Gear End Clearance—999/727

(2) Hold cup tool SP-3633 firmly against reaction shaft and thread remover SP-5324 into bushing as far as possible by hand. Then thread remover tool 3-4 additional turns into bushing with a wrench.

(3) Turn tool hex nut down against the cup to pull bushing from reaction shaft. Clean all chips from shaft after bushing removal.

(4) Lightly grip old bushing in vise or with pliers and back remover tool out of bushing.

(5) Assemble bushing installer tools C-4171 and SP-5325 (Fig. 11).

(6) Slide new bushing onto installer tool SP-5325.

(7) Position reaction shaft support upright on a clean smooth surface.

(8) Align bushing in bore. Then tap bushing into place until installer tool SP-5325 bottoms.

(9) Clean reaction shaft support thoroughly after installing bushing.

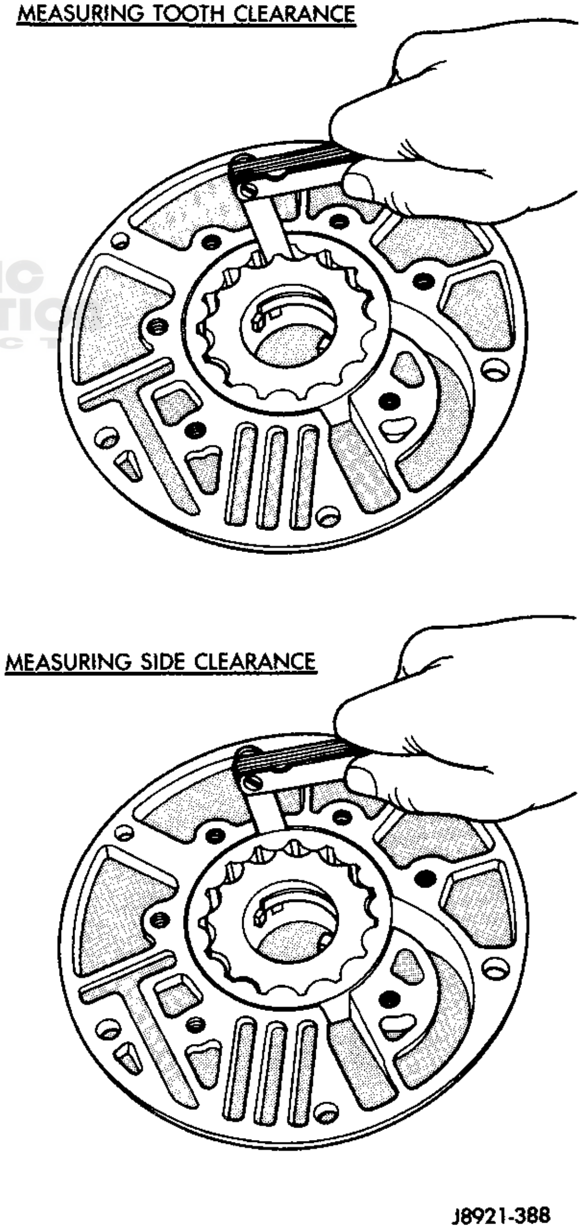


Fig. 8 Measuring Pump Gear Clearances—999/727

Assembling Oil Pump And Reaction Shaft Support—999

(1) Lubricate pump gears with transmission fluid and install them in pump body. Install new gears with either face up. Install original gears in same position as removed.

(2) Install new thrust washer and seal rings on reaction shaft support. Lubricate washer and seal rings with transmission fluid.

(3) Place reaction shaft support in assembly tool C-3759. Shaft hub and assembly tool should be positioned on clean smooth work surface.

(4) Thread two pilot stud tools C-3283-A into threaded holes of reaction shaft support flange (Fig. 12).

(5) Align and lower pump body onto pilot studs (Fig. 12).

(6) Insert aligning tool C-3756 through pump body and engage pump inner gear.

(7) Rotate pump gears with tool to center them in pump.

(8) Tighten clamping tool securely when gears are centered and pump body is firmly seated against shaft support.

(9) Turn assembly over and install and tighten support-to-pump bolts to 175 in-lbs (20 N•m) torque.

(10) Remove assembly tool from pump and support.

(11) Install new pump seal with tool C-4193 and handle C-4171. Be sure seal lip faces inward.

(12) Install new O-ring on pump body (Fig. 6).

(13) Lubricate O-ring and lip of pump seal with transmission fluid or petroleum jelly.

(14) Set pump and support aside for final assembly.

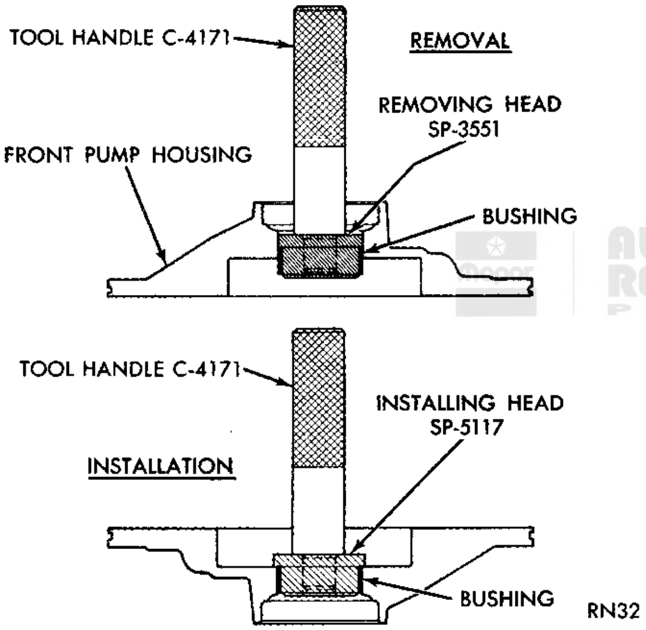


Fig. 9 Replacing Oil Pump Bushing—999

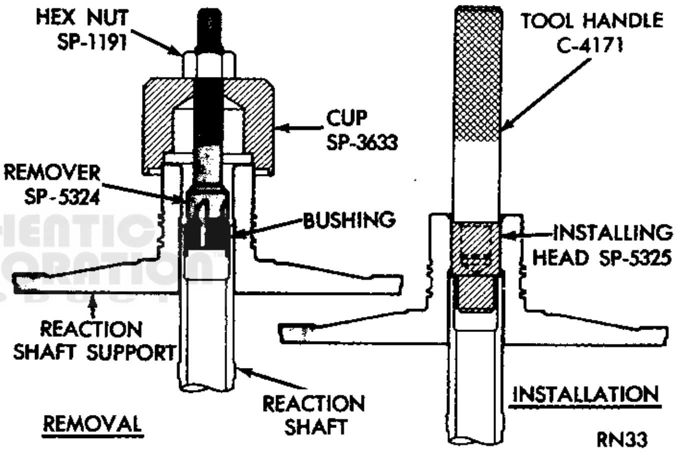


Fig. 11 Replacing Reaction Shaft Support Bushing—999

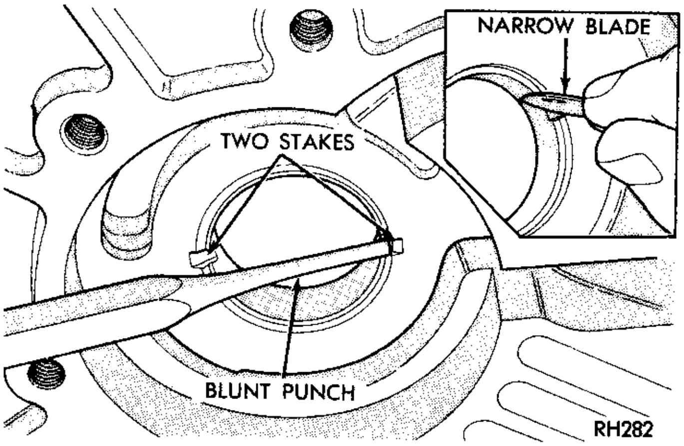


Fig. 10 Staking Oil Pump Bushing—999

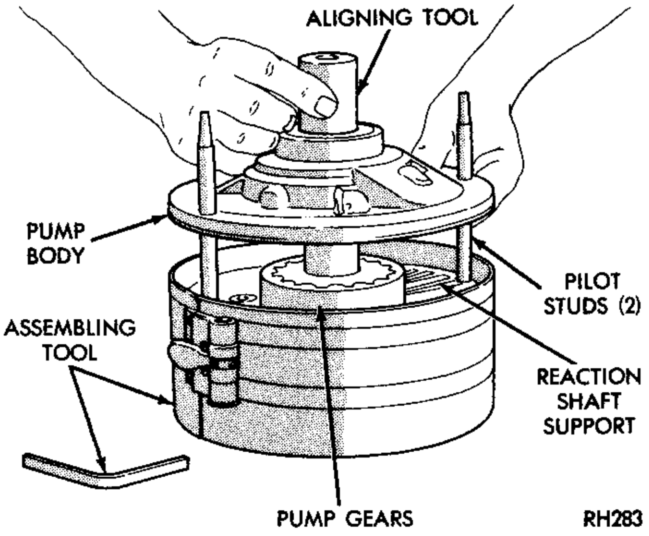


Fig. 12 Assembling Oil Pump And Reaction Shaft—999

OIL PUMP AND REACTION SHAFT SUPPORT—727

Pump And Support Disassembly

(1) Remove support bolts and separate support and pump body (Fig. 13).

(2) Remove O-ring seal from pump body.

(3) Remove pump seal with blunt punch.

(4) Mark pump gears for assembly reference and remove gears.

(5) Remove seal rings and thrust washer from reaction shaft support (Fig. 13).

(6) Clean pump and support components with solvent and dry them with compressed air.

Inspecting Pump And Support

Inspect the pump and support components. Replace the pump or support if the seal ring grooves or machined surfaces are worn, scored, pitted, or damaged.

Replace the pump gears if pitted, worn chipped, or damaged. Inspect the No. 1 thrust washer. Replace the washer if worn or damaged.

Replace the pump bushing and the reaction shaft support bushing during overhaul. Do not reuse the original bushings even if they look OK.

Install the gears in the pump body and measure end clearance with a feeler gauge and straightedge (Fig. 7). Clearance should be .025 to .076 mm (.001 to .003 in).

Clearance between the pump outer gear and the pump body should be .89 to 1.90 mm (.0035 to .0075 in).

Oil Pump Bushing Replacement—727

(1) Position pump housing on clean, smooth surface with gear cavity facing down.

(2) Remove bushing with handle C-4171 and remover tool SP-3550 (Fig. 14).

(3) Assemble handle C-4171 and bushing installer tool SP-3550 (Fig. 14).

(4) Place bushing on installer tool and start bushing into shaft (Fig. 14).

(5) Tap bushing into place until tool SP-3550 bottoms in pump cavity (Fig. 14). Keep tool and bushing square with bore. Do not allow bushing to become cocked during installation.

(6) Stake pump bushing in two places with blunt punch. Remove burrs from stake points with knife blade (Fig. 15).

Replacing 727 Reaction Shaft Support Bushing

(1) Assemble cup tool SP-3633, nut SP-1191 and remover SP-5301 (Fig. 16).

(2) Hold cup tool firmly against reaction shaft. Thread remover tool into bushing as far as possible by hand.

(3) Using wrench, thread remover tool an additional 3-4 turns into bushing to firmly engage tool.

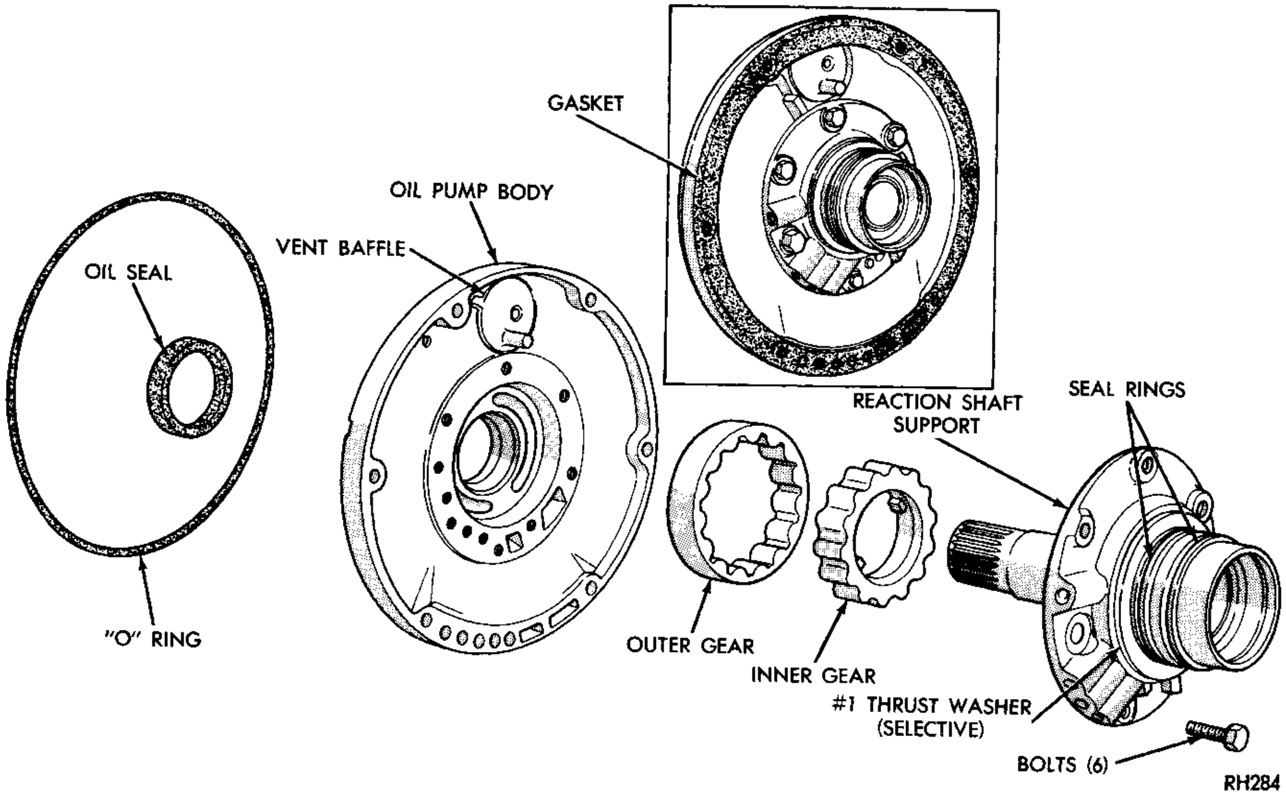


Fig. 13 Oil Pump/Reaction Shaft Components—727

(4) Tighten tool hex nut against cup tool to pull bushing from shaft. Clean all chips from shaft and support after bushing removal.

(5) Place reaction shaft support upright on a clean, smooth surface.

(6) Assemble bushing installer tools C-4171 and SP-5302 (Fig. 16). Then slide new bushing onto installer tool.

(7) Start bushing in shaft. Tap bushing into shaft until installer tool bottoms against support flange (Fig. 16).

(8) Clean reaction shaft support thoroughly after bushing replacement.

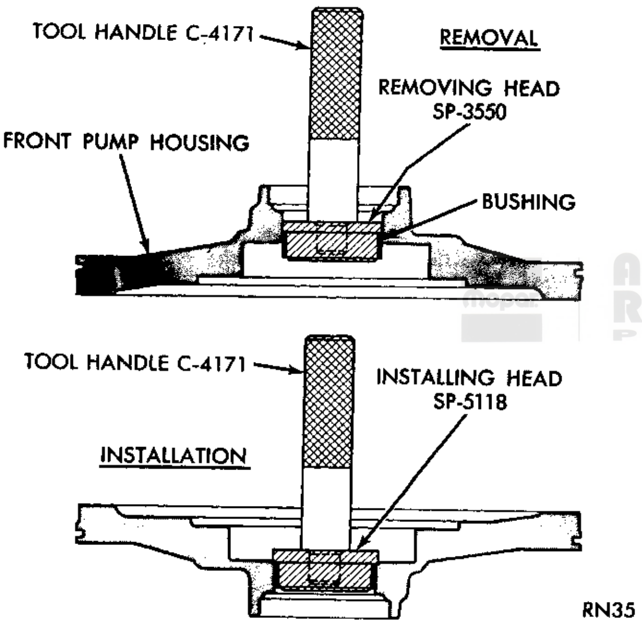


Fig. 14 Replacing Oil Pump Bushing—727

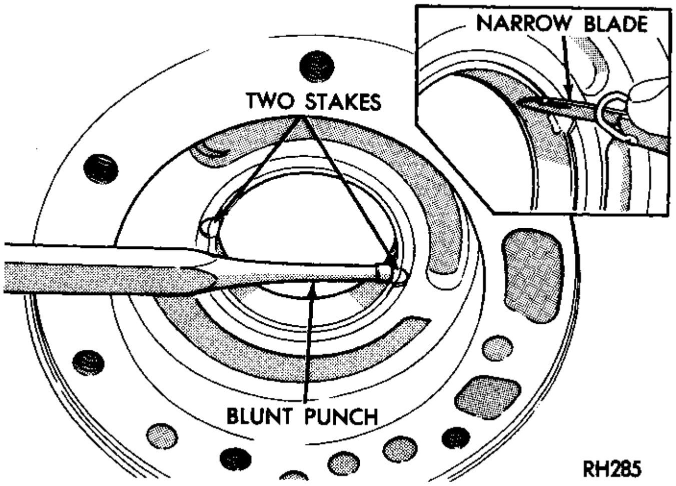


Fig. 15 Staking Pump Bushing—727

Assembling 727 Oil Pump And Reaction Shaft Support

(1) Lubricate pump gears with transmission fluid and install them in pump body. Install new gears with either face up. Install original rotors in same position as removed.

(2) Install new thrust washer and seal rings on reaction shaft support. Lubricate seal rings with transmission fluid.

(3) Align and install reaction shaft support on pump body.

(4) Install bolts attaching reaction shaft support to pump. Tighten bolts to 20 N•m (175 in-lbs) torque.

(5) Install new pump seal with installer C-3860-A and driver handle C-4171.

(6) Install new O-ring on pump body. Lubricate oil seal and O-ring with transmission fluid or petroleum jelly.

(7) Set pump and support aside for assembly installation.

FRONT CLUTCH—999

Front Clutch Disassembly

(1) Remove waved snap ring and remove pressure plate, clutch plates and driving discs (Fig. 17).

(2) Compress return spring and spring retainer with compressor tool C-3575-A (Fig. 18).

(3) Remove piston snap ring and spring retainer and remove compressor tool.

(4) Remove clutch piston and piston retainer (Fig. 17).

(5) Remove and discard piston inner and outer seals. Also discard retainer snap ring.

Clutch Inspection

Clean and inspect the front clutch components. Replace the clutch discs if warped, worn, scored, burned or charred, the lugs are damaged, or if the facing is flaking

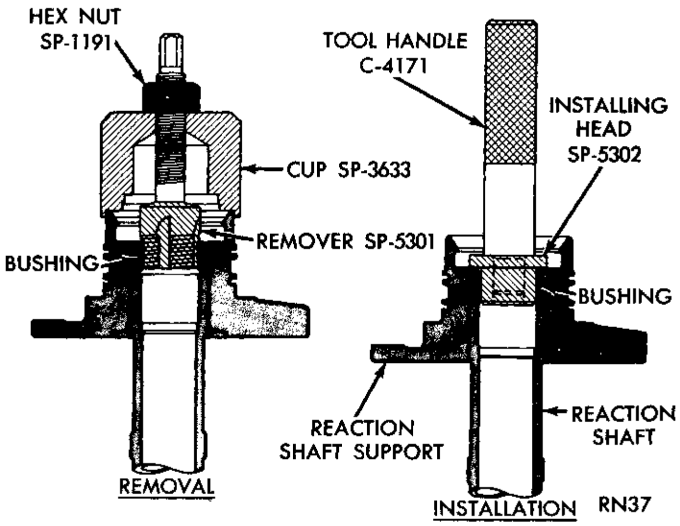


Fig. 16 Replacing Reaction Shaft Bushing—727

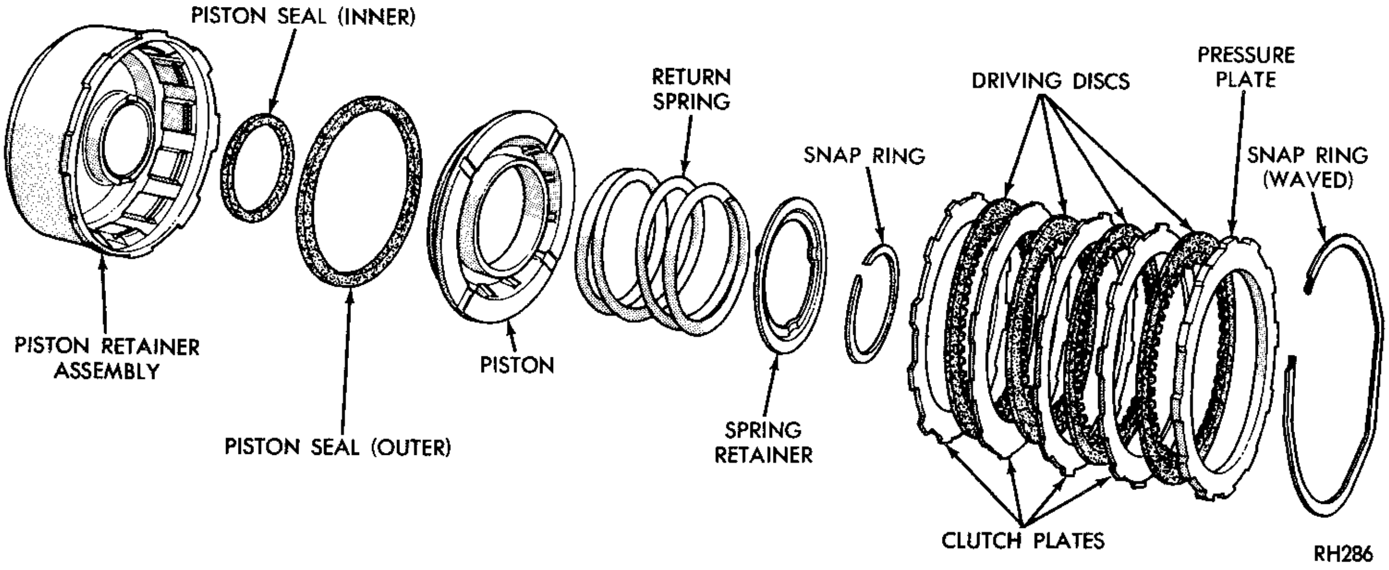


Fig. 17 Front Clutch Components—999

off. Replace the steel plates if heavily scored, warped, or broken. Be sure the driving lugs on the discs and plate are also in good condition. The lugs must not be bent, cracked or damaged in any way.

Replace the return spring and spring retainer if either is distorted, warped or broken.

Check the lug grooves in the clutch piston retainer. The steel plates should slide freely in the slots. Replace the piston retainer if the grooves are worn or damaged. Also check action of the check ball in the piston retainer. The ball must move freely and not stick.

Replace the retainer bushing if worn, scored, or there is any doubt about bushing condition.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously scored.

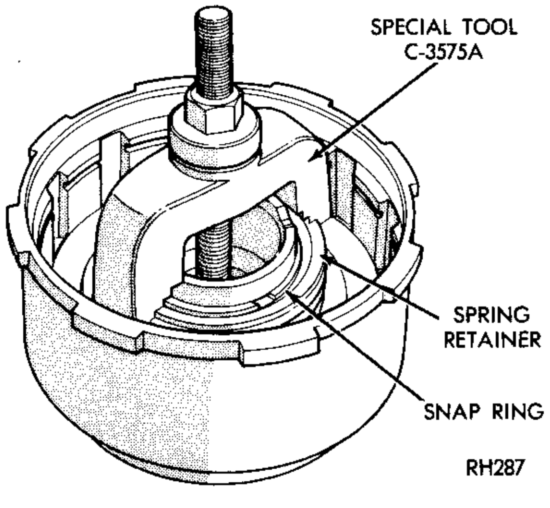


Fig. 18 Removing Front Clutch Spring Retainer Snap Ring—999

Replacing 999 Front Clutch Retainer Bushing

(1) Assemble driver handle C-4171 and bushing remover SP-3627 (Fig. 19).

(2) Insert remover tool in bushing and drive old bushing out of retainer (Fig. 19).

(3) Mount bushing installer tool SP-3626 on driver handle. Then slide new bushing onto installer tool.

(4) Align and install new bushing. Tap bushing into retainer until installer tool bottoms against retainer (Fig. 19).

(5) Remove installer tools and clean retainer thoroughly.

Assembling 999 Front Clutch

(1) Lubricate clutch plates and soak clutch discs with transmission fluid.

(2) Lubricate new inner and outer piston seals with Door Ease, or petroleum jelly.

(3) Install new seals on clutch piston. Be sure seal lips face inside of retainer.

(3) Install clutch piston in retainer. Use twisting motion to seat piston at retainer bottom. **Do not attempt**

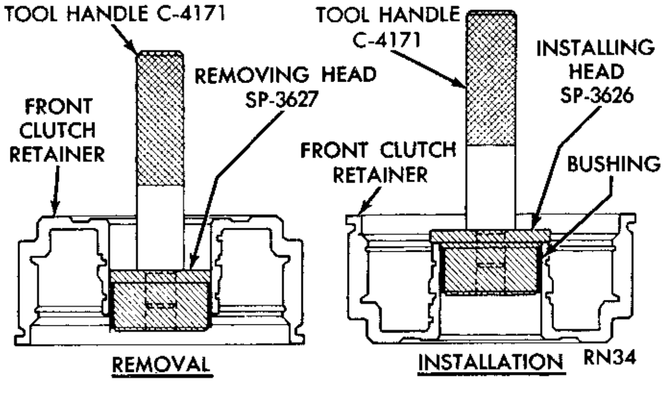


Fig. 19 Clutch Retainer Bushing Replacement—999

to force piston straight in. This will fold seals over causing leakage and clutch slip.

(4) Install return spring and spring retainer.

(5) Compress return spring and spring retainer with compressor tool C-3575-A. Then install new snap ring to secure spring retainer (Fig. 18).

(6) Install clutch plates and discs (Fig. 17). Install steel plate then disc until all plates and discs are installed.

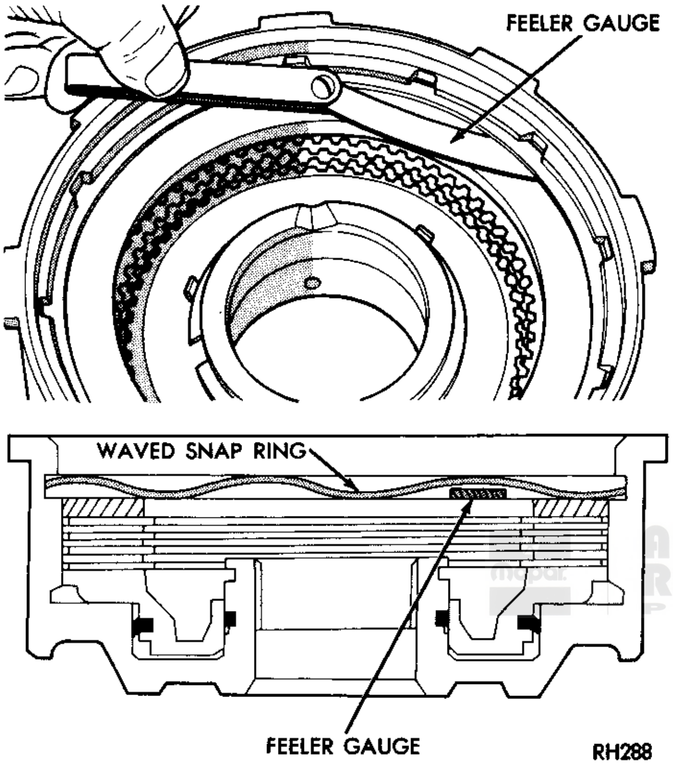


Fig. 20 Measuring Front Clutch Pack Clearance

(7) Install pressure plate and waved snap ring (Fig. 17).

(8) Check clutch plate clearance (Fig. 20). Clearance should be 1.70 to 3.40 mm (.067 to .134 in) with 4-disc clutch and 1.90 to 3.86 mm (.075 to .152 in) with 5-disc clutch. If clearance is incorrect, clutch plates, discs and/or pressure plate will have to be changed.

FRONT CLUTCH—727

Clutch Disassembly

(1) Remove waved snap ring and remove pressure plate, clutch plates and driving discs (Fig. 21).

(1) Compress clutch piston retainer and springs with compressor tool C-3863-A (Fig. 22).

(2) Remove piston snap ring and spring retainer (Fig. 21).

(3) Remove piston springs. **Note number and position of piston springs for assembly reference.**

(4) Remove compressor tool and remove clutch piston.

(5) Remove and discard clutch piston seals. Also discard spring retainer snap ring.

Clutch Inspection

Clean and inspect the front clutch components. Replace the clutch discs if warped, worn, scored, burned or charred, the lugs are damaged, or if the facing is flaking off. Replace the steel plates if heavily scored, warped, or broken. Be sure the driving lugs on the discs and plate are also in good condition. The lugs must not be bent, cracked or damaged in any way.

Replace the piston springs and spring retainer if either are distorted, warped or broken.

Check the lug grooves in the clutch piston retainer. The steel plates should slide freely in the slots. Replace

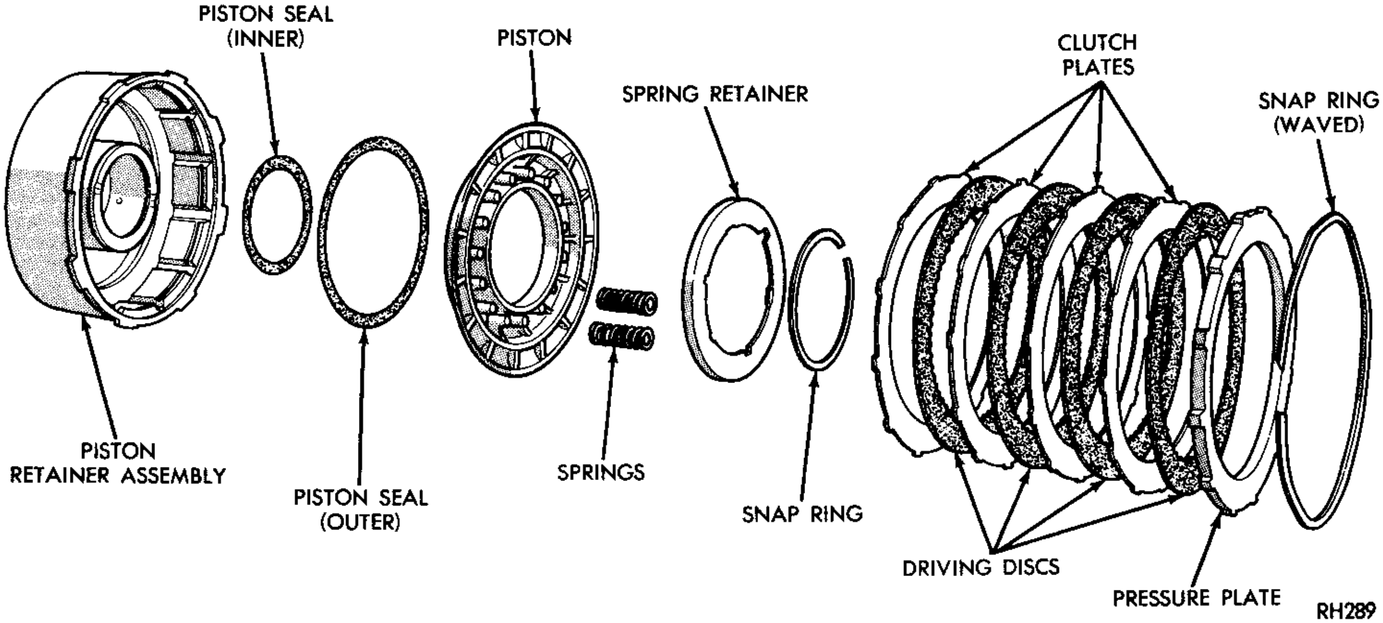


Fig. 21 Front Clutch Components—727

the piston retainer if the grooves are worn or damaged. Also check action of the check ball in the piston retainer. The ball must move freely and not stick.

Replace the retainer bushing if worn, scored, or there is any doubt about bushing condition.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously scored.

Replacing 727 Front Clutch Retainer Bushing

(1) Assemble driver handle C-4171 and bushing remover head SP-3629 (Fig. 23).

(2) Insert remover head in bushing and drive bushing straight out of piston retainer.

(3) Mount bushing installer head SP-5511 on driver handle (Fig. 23).

(4) Slide new bushing onto installer head and start bushing in retainer.

(5) Install new bushing until installer head bottoms against retainer (Fig. 23).

(6) Remove installer tools and clean retainer thoroughly.

Assembling 727 Front Clutch

(1) Lubricate clutch plates and soak clutch discs with transmission fluid.

(2) Lubricate new inner and outer piston seals with Door Ease, or petroleum jelly.

(3) Install new seals on clutch piston. Be sure seal lips face inside of retainer.

(3) Install clutch piston in retainer. Use twisting motion to seat piston in retainer. **Do not attempt to force the piston straight in. This will fold the seals over causing leakage and clutch slip.**

(4) Install clutch piston springs.

(a) On 9 spring clutch, position springs as shown (Fig. 24).

(b) On 11 or 13 spring clutch, position springs as shown (Fig. 25).

(5) Install retainer on piston springs.

(6) Compress spring retainer and piston springs with tool C-3863-A (Fig. 22).

(7) Install new spring retainer snap ring (Fig. 22) and remove compressor tool.

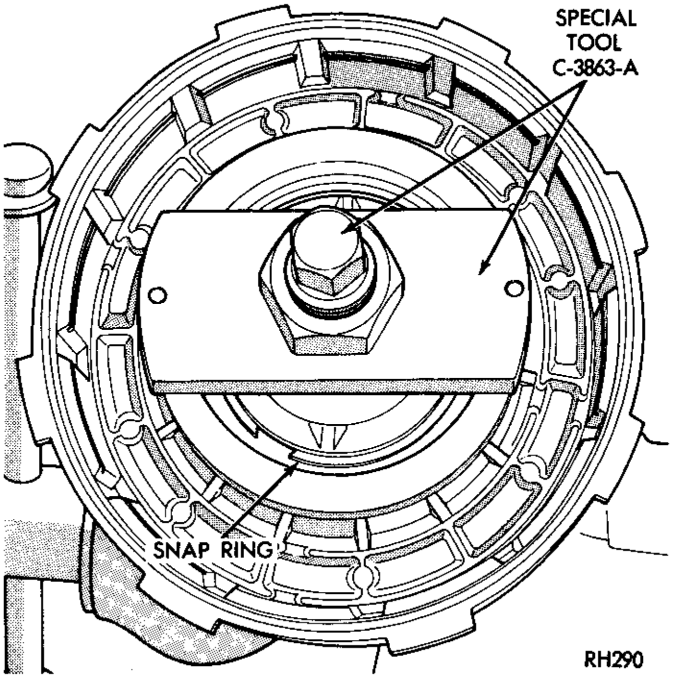


Fig. 22 Removing Front Clutch Spring Retainer Snap Ring—727

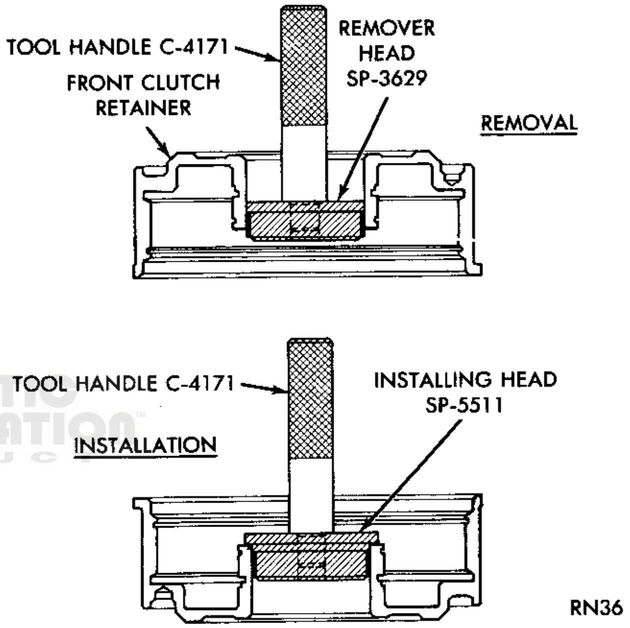


Fig. 23 Replacing Front Clutch Retainer Bushing—727

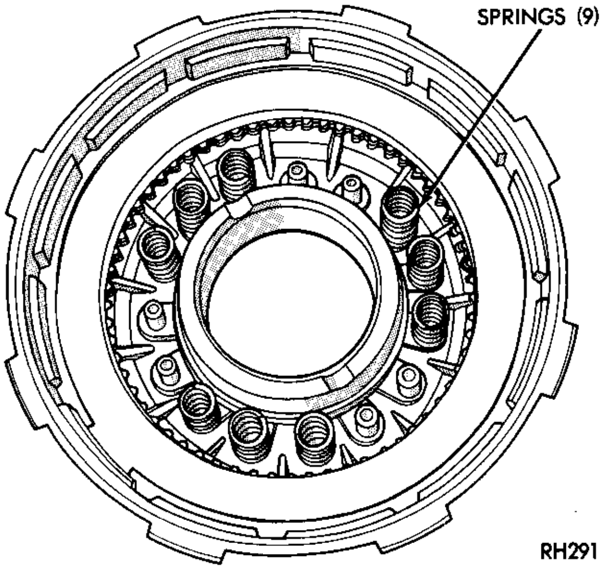


Fig. 24 Front Clutch Spring Location (9 Spring)

(8) Install clutch plates and discs (Fig. 21). Install steel plate then a disc until four plates and discs are installed.

(9) Install pressure plate and waved snap ring (Fig. 21).

(10) Check front clutch pack clearance (Fig. 20). Clearance between waved spring and pressure plate should be 2.08 to 3.83 mm (.082 to .151 in). If clearance is incorrect, clutch plates, discs and/or pressure plate will have to be changed.

(11) Set front clutch aside for assembly installation.

REAR CLUTCH-999

Clutch Disassembly

(1) Remove selective snap ring (Fig. 26).

(2) Remove pressure plate and clutch discs and steel plates (Fig. 26).

(3) Remove wave spring and piston spring (Fig. 26).

(4) Remove No. 2 thrust washer (Fig. 26).

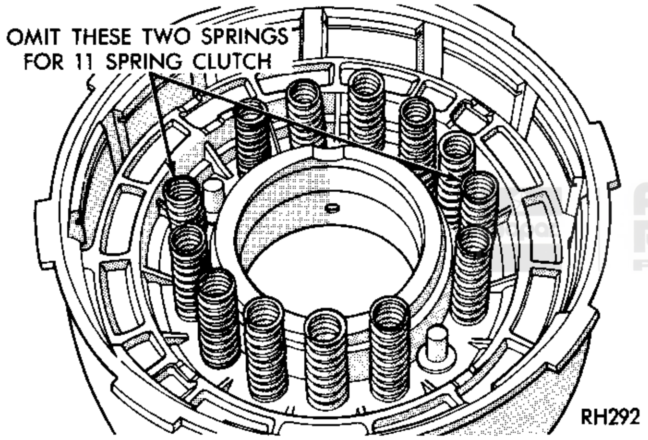


Fig. 25 Front Clutch Spring Location (11 or 13 Spring)

(5) Turn clutch retainer over and tap it on wood block to dislodge clutch piston.

(6) Remove and discard piston seals.

(7) Remove input shaft snap ring and press input shaft out of the retainer. Discard the shaft snap ring. Use a new ring at assembly.

(8) Remove seal ring from clutch retainer but leave input shaft seal rings in place for inspection.

Clutch Inspection

Clean the clutch components with solvent.

Replace the clutch discs if warped, worn, scored, burned/charred, the lugs are damaged, or if the facing is flaking off. Replace the steel plates and the pressure plate if heavily scored, warped, or broken. Be sure the driving lugs on the discs and plates are also in good condition. The lugs must not be bent, cracked or damaged in any way.

Replace the piston spring and wave spring if part is distorted, warped or broken.

Check the lug grooves in the clutch piston retainer. The steel plates should slide freely in the slots. Replace the piston retainer if the grooves are worn or damaged. Also check action of the check ball in the piston retainer. The ball must move freely and not stick.

Replace the retainer bushing if worn, scored, or there is any doubt about bushing condition.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously scored.

Check condition of the #2 thrust washer. Replace the washer if worn or damaged. Refer to Specifications section for washer thickness.

Check condition of the teflon or cast iron seal rings on the input shaft. Replace these seal rings only if they are obviously damaged. If new rings are required, service replacement rings will be cast iron hooked-joint type.

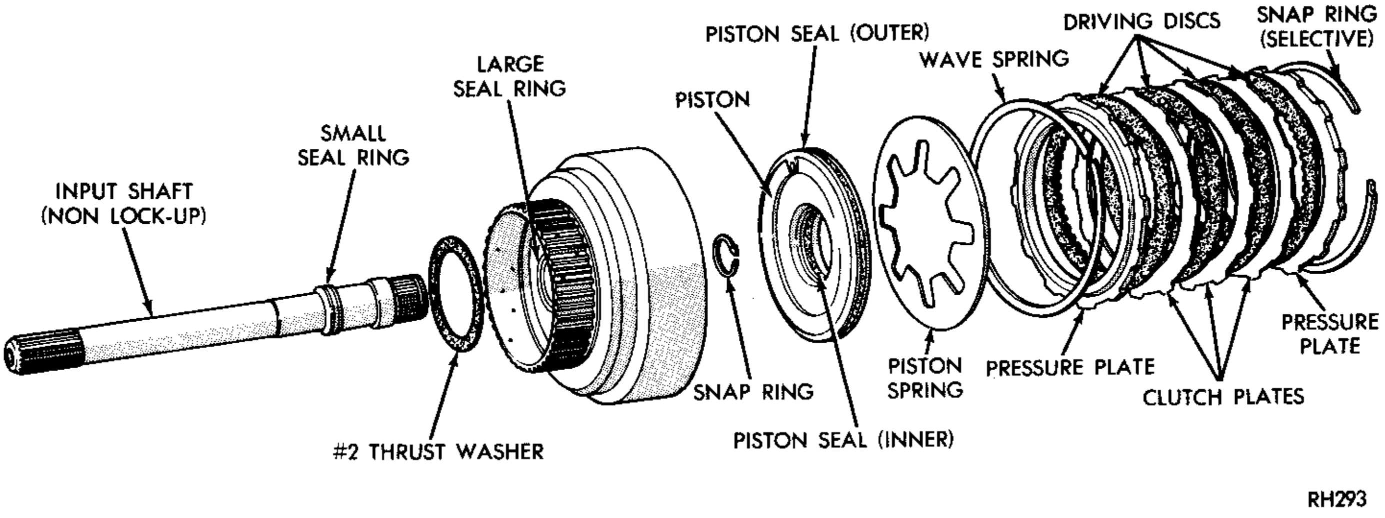


Fig. 26 Rear Clutch Components—999

Check the input shaft for wear, or damage. Replace the shaft if worn, scored or damaged in any way.

Assembling 999 Rear Clutch

(1) Soak steel plates and drive discs in transmission fluid.

(2) Install new seal rings in clutch retainer and on input shaft if necessary.

(3) Press input shaft into clutch retainer and secure shaft with new snap ring.

(4) Install new seals on clutch piston. Lubricate seals with Door Ease or petroleum jelly to ease piston installation.

(5) Install clutch piston in retainer. Use twisting motion to seat piston in retainer. **Do not attempt to force piston straight in. This could distort seals causing leakage and slip.**

(6) Install piston spring and wave spring (Fig. 27). **Do not install a spacer ring in 999 rear clutch. Spacer ring is only used in a 727 rear clutch (Fig. 27).**

(7) Install first pressure plate in retainer. Then install clutch disc followed by steel plate until all discs and plates are installed (Fig. 26).

(8) Install remaining pressure plate and selective snap ring (Fig. 26).

(9) Measure clutch pack clearance (Fig. 28). Clearance should be .81 to 1.39 mm (.032 to .055 in). **If clearance is incorrect, change selective snap ring (see specifications section). A low limit clearance is most desirable. However, if a thicker or thinner snap ring does not provide proper clearance, steel plates, discs and pressure plates may have to be changed.**

(10) Coat No. 2 and No.3 thrust washers with petroleum jelly and install it over input shaft and into piston retainer. Use enough petroleum jelly to hold washers in place.

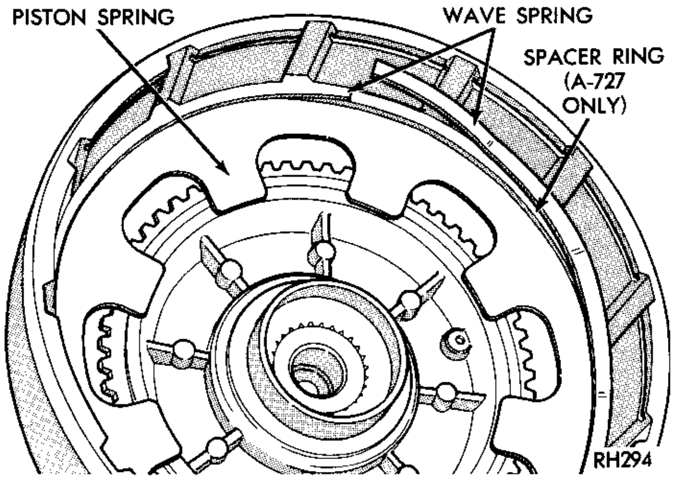


Fig. 27 Piston Spring And Wave Spring Position—999/727

REAR CLUTCH—727

Clutch Disassembly

(1) Remove selective snap ring (Fig. 29).

(2) Remove outer pressure plate and steel plates and discs (Fig. 29).

(3) Remove inner pressure plate, wave spring, spacer ring and piston spring (Fig. 29).

(4) Remove clutch piston and piston retainer from clutch retainer. Bump clutch retainer on a wood block to dislodge piston and retainer.

(5) Remove No. 2 and 3 thrust washers from input shaft. **No. 3 thrust washer and output shaft thrust plate are thicker and not interchangeable with prior models.**

(6) Remove input shaft snap ring and press shaft out of clutch retainer.

(7) Remove and discard clutch piston seals (Fig. 29).

(8) Do not remove shaft seal rings unless they are obviously damaged (broken, cracked).

Clutch Inspection

Clean the clutch components with solvent.

Replace the clutch discs if warped, worn, scored, burned/charred, the lugs are damaged, or if the facing is flaking off. Replace the steel plates and the pressure plate if heavily scored, warped, or broken. Be sure the driving lugs on the discs and plates are also in good condition. The lugs must not be bent, cracked or damaged in any way.

Replace the piston spring and wave spring if part is distorted, warped or broken.

Check the lug grooves in the clutch piston retainer. The steel plates should slide freely in the slots. Replace

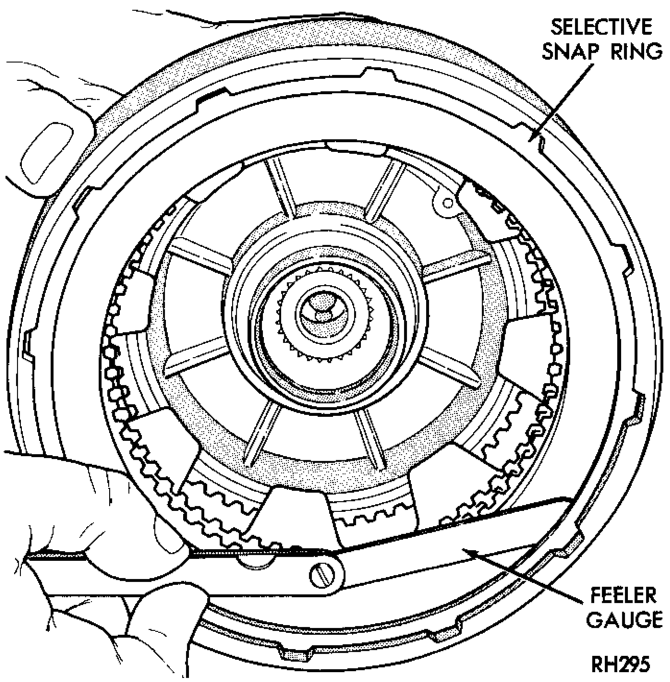


Fig. 28 Measuring Rear Clutch Pack Clearance—All

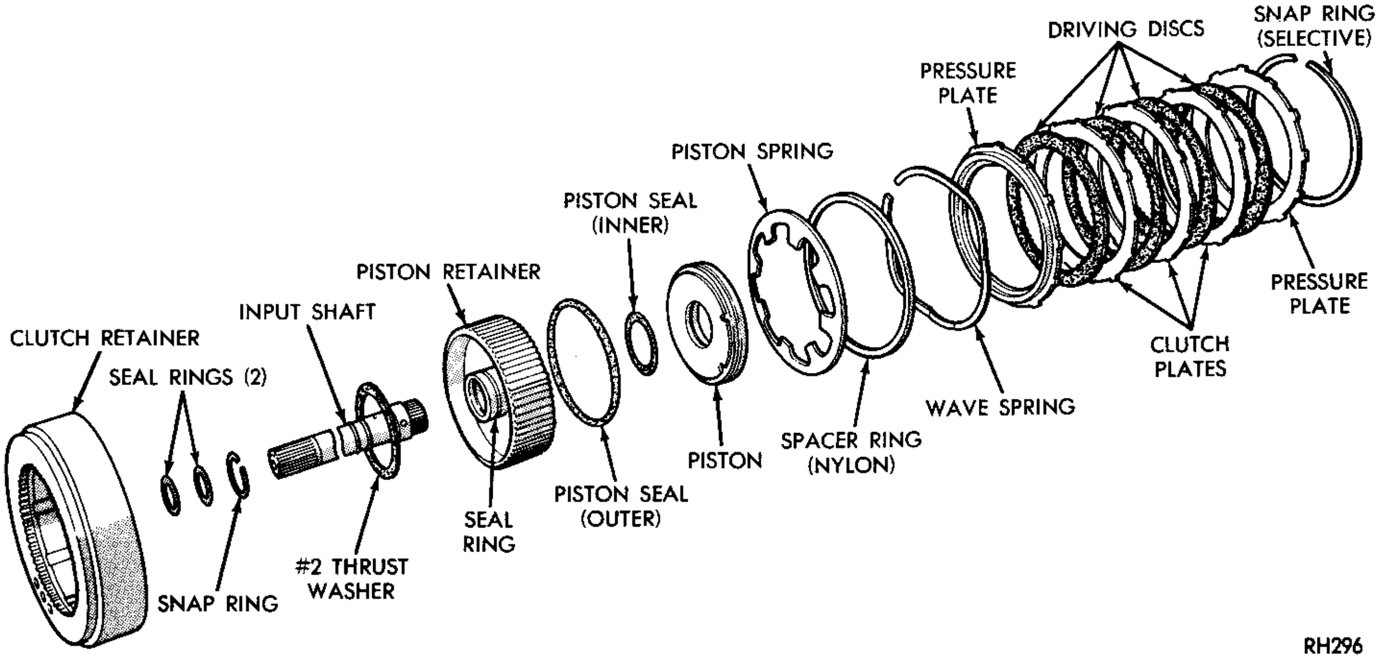


Fig. 29 Rear Clutch Components—727

the piston retainer if the grooves are worn or damaged. Also check action of the check ball in the piston retainer. The ball must move freely and not stick.

Replace the input shaft bushing (in the retainer) if worn, scored, or there is any doubt about bushing condition.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously scored.

Check condition of the #2 thrust washer. Replace the washer if worn or damaged. Washer thickness should be .061 to .063 inch.

Check condition of the seal rings on the input shaft and piston retainer. Replace these seal rings if worn or damaged.

Check the input shaft for wear, or damage. Replace the shaft if worn, scored or damaged in any way.

Replacing 727 Input Shaft Bushing

(1) Clamp input shaft in vise with protective jaws. Do not clamp seal ring lands or bearing journals.

(2) Assemble remover tool SP-3630, cup tool SP-3633 and hex nut SP-1191 (Fig. 30).

(3) Hold cup tool firmly against clutch piston retainer. Then thread remover tool into bushing as far as possible by hand.

(4) Thread bushing remover an additional 3-4 turns with a wrench to firmly engage tool in bushing.

(5) Tighten hex nut with wrench to pull bushing out of input shaft (Fig. 30).

(6) Clean input shaft thoroughly to remove chips. Be sure small lubrication hole next to shaft ball is not plugged. Also be sure ball itself is not restricet by any chips.

(7) Assemble tool handle C-4171 and bushing installer head SP-3636 (Fig. 30). Then slide new bushing on installer head.

(8) Align bushing in shaft. Tap bushing into place until installer head bottoms.

(9) Remove bushing installer tools and clean clutch retainer and shaft again.

Assembling 727 Rear Clutch

(1) Soak clutch plates and discs in transmission fluid.

(2) Install new seal rings on input shaft and piston retainer (Fig. 29).

(3) Press input shaft into retainer. Secure shaft with new snap ring.

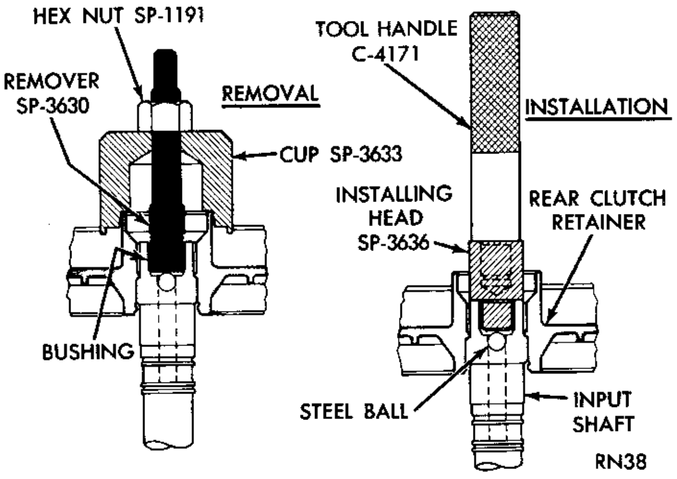


Fig. 30 Replacing Input Shaft Bushing—727

(3) Install new seals on clutch piston. Lubricate piston seals with Door Ease or petroleum jelly to ease installation. Be sure seal lips face input shaft.

(4) Install clutch piston in retainer. Use twisting motion to seat piston in retainer. **Do not attempt to push the piston straight in. This could distort seals causing leakage and clutch slip.**

(5) Install No. 2 thrust washer on the retainer (Fig. 29). Use petroleum jelly to hold thrust washer in place.

(6) Install assembled piston retainer in clutch retainer (Fig. 29).

(7) Install piston spring, spacer spring and wave spring in clutch retainer (Fig. 27). Be sure wave spring is fully seated. Tap spring into place if necessary.

(8) Install inner pressure plate. Then install first disc followed by a steel plate until discs and plates are installed.

(9) Install outer pressure plate and selective snap ring.

(10) Check clutch pack clearance with feeler gauge (Fig. 28). Clearance should be .63 to 1.14 mm (.025 to .045 in). A low limit clearance is most desirable.

(11) If clutch pack clearance is incorrect, change selective snap ring as needed. See specifications section for available snap ring thicknesses.

(12) Set clutch assembly aside for final installation.

PLANETARY GEAR TRAIN—999

Geartrain End Play Measurement

(1) Measure planetary gear train end play before disassembly (Fig. 31).

(2) Stand assembly upright with forward end of output shaft on wood block. This is necessary for accurate measurement as it causes planetary components to move forward against snap ring at front of shaft (Fig. 31).

(3) Measure end play with feeler gauge. Insert gauge between shoulder on output shaft and rear annulus gear support hub (Fig. 31).

(4) End play should be .12 to 1.22 mm (.005 to .048 in). If end play is incorrect, snap ring or thrust washer may have to be replaced.

Disassembling 999 Planetery Geartrain

(1) Remove selective snap ring and #3 thrust washer from front end of output shaft (Fig. 32).

(3) Remove planetary gear components from output shaft (Fig. 32).

(4) Remove snap ring and #4 thrust washer (Fig. 32).

(5) Remove annulus support, annulus gear, #5 thrust washer, front planetary, #6 thrust washer, sun gear, spacer and #7 thrust plate (Fig. 32).

(6) Remove driving shell, #8 thrust plate, snap ring rear planetary and #10 thrust washer (Fig. 32).

(7) Remove and dissassemble rear annulus gear, support, low-reverse drum and output shaft (Fig. 32).

Geartrain Inspection

Clean the planetary components in solvent and dry them with compressed air.

Check sun gear and driving shell condition. Replace the gear if damaged or if the bushings are scored or worn (bushings are not serviceable). Replace the driving shell if worn, cracked or damaged.

Replace planetary gear sets if gears, pinion pins, or carrier are damaged in any way. Replace the annulus gear and support if either component is worn or damaged. Inspect machined surfaces of output shaft.

Replace the output shaft if scored, pitted, or damaged in any way. Replace the thrust washers and plates if worn or damaged.

Assembling Planetary Geartrain—Model 999

(1) Lubricate planetary components with transmission fluid during assembly. Petroleum jelly can be used to lubricate and hold thrust washers and plates in position.

(2) Assemble low-reverse drum, annulus gear and support and output shaft.

(3) Install #10 thrust washer on rear planetary gear and install gear in rear annulus.

(4) Install #9 thrust washer and snap ring on output shaft and seat washer against rear planetary.

(5) Assemble #8 and #7 thrust plates, spacer, sun gear and driving shell (Fig. 32). Install assembled components on output shaft.

(6) Assemble #6 thrust washer, front planetary gear and annulus gear and support (Fig. 32). Install assembled components on output shaft.

(7) Verify that all planetary components are properly seated and properly meshed.

(8) Install final snap ring and check end play again. If end play is not correct, it can be adjusted with a different thickness snap ring. Refer to Specifications for snap ring thicknesses.

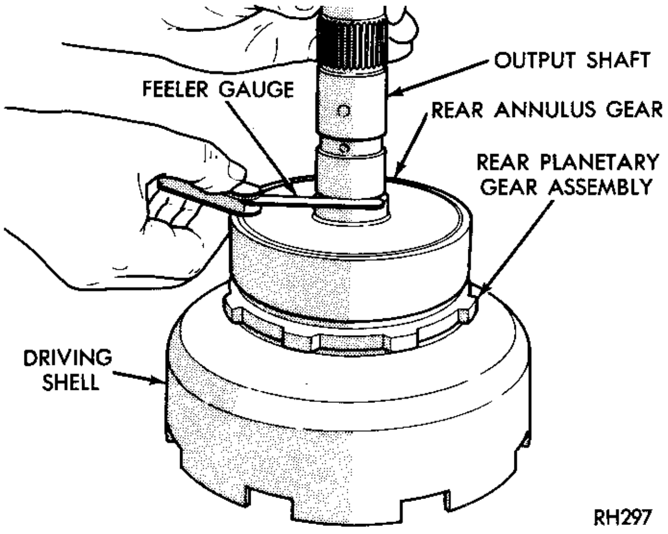


Fig. 31 Measuring Planetary End Play—999/727

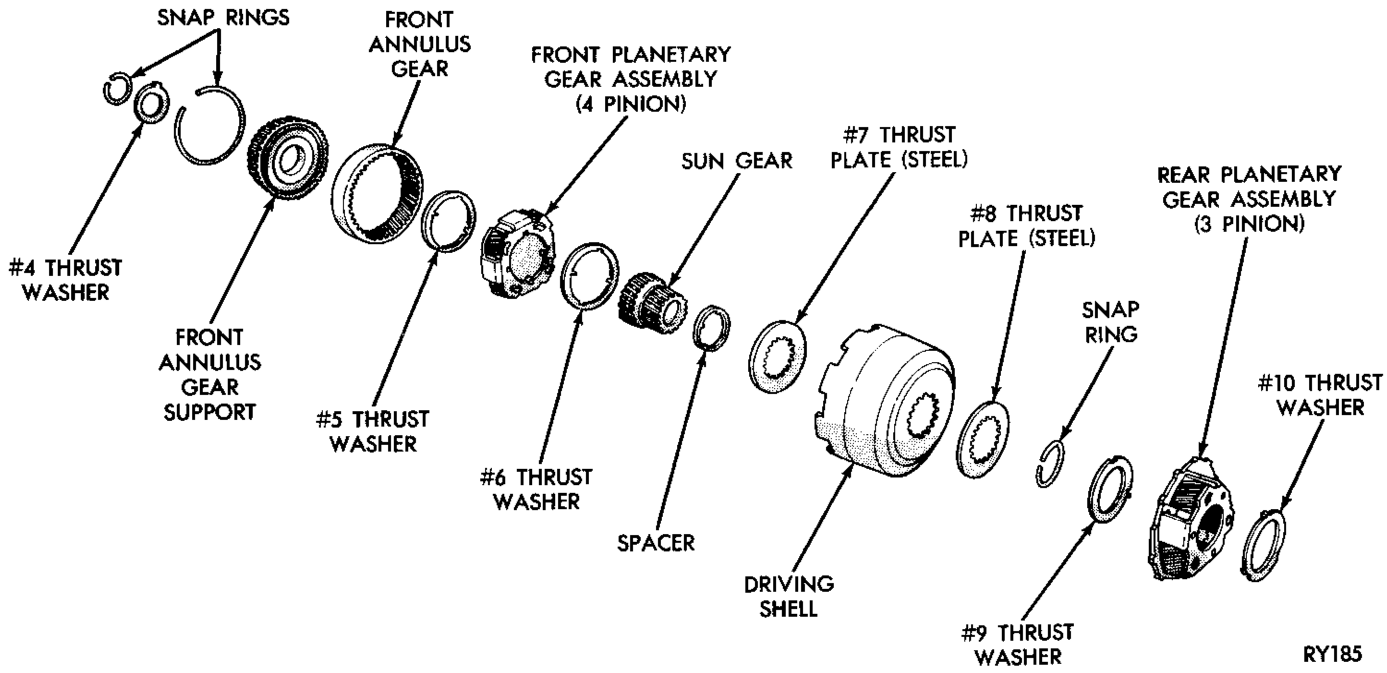


Fig. 32 Planetary Gear Train—999

PLANETARY GEAR TRAIN—727

Geartrain End Play Measurement

(1) Measure gear train end play before disassembly (Fig. 31).

(2) Stand assembly upright with forward end of output shaft on wood block so all parts will move forward against snap ring at front of shaft (Fig. 31). This is necessary for an accurate measurement.

(3) Insert feeler gauge between shoulder on output shaft and rear annulus gear support hub (Fig. 31). End play should be .15 to 1.22 mm (.006 to .048 in).

(4) If end play is incorrect, the selective snap ring or thrust washer may need replacement.

Disassembling 727 Planetary Geartrain

(2) Remove select fit snap ring (Fig. 33).

(3) Remove front planetary gear, #4 thrust washer, front annulus gear and #5 thrust washer (Fig. 33).

(4) Remove snap ring and remove sun gear, driving shell and #6 thrust plate (Fig. 33).

(5) Remove snap ring and remove #7 thrust washer, rear planetary gear, #8 thrust plate, rear annulus and low-reverse drum (Fig. 33).

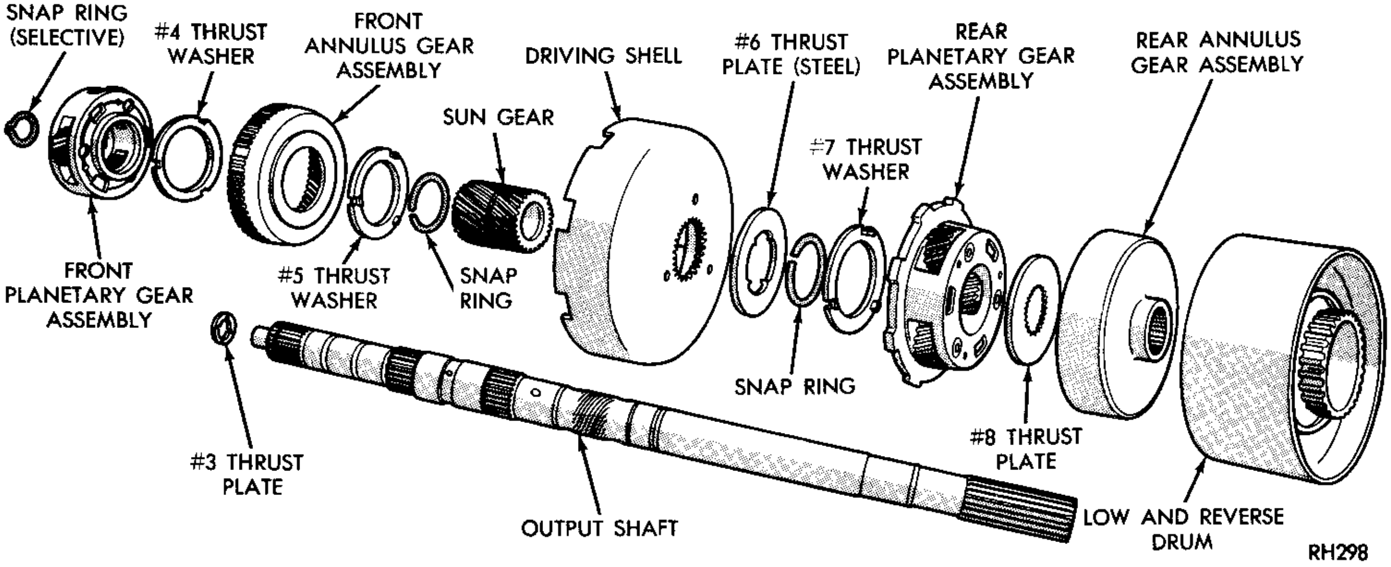


Fig. 33 Planetary Gear Train—727

Geartrain Inspection

Clean the geartrain components in solvent and dry them with compressed air.

Check sun gear and driving shell condition. Replace the sun gear as an assembly if the gear or bushings are scored or worn (the sun gear bushings are not serviceable). Replace the driving sheel if damaged in any way.

Replace thrust washers and plates if cracked, scored or worn.

Inspect the planetary gear sets. Replace the gear sets if the gears, pinion pins, or carrier are damaged in any way.

Check condition of the annulus gear and support. Replace the annulus gear and support if either component is worn or damaged.

Inspect the machined surfaces of the output shaft. Replace the shaft if scored, pitted, or damaged in any way.

Inspect the low-reverse drum and annulus gears. Replace the annulus gears and the low reverse drum if worn, cracked or damaged in any fashion.

Assembling 727 Planetary Geartrain

(1) Lubricate planetary components with transmission fluid during assembly. Petroleum jelly can be used to lubricate and hold thrust washers and plates in position.

(2) Assemble low-reverse drum, rear annulus gear, #8 thrust plate and rear planetary gear (Fig. 33). Install the assembled components on the output shaft.

(3) Install #7 thrust washer on rear planetary gear and install snap ring on output shaft (Fig. 33).

(4) Assemble sun gear, #6 thrust plate, and driving shell. Install assembled components on output shaft and install retaining snap ring.

(5) Install #5 thrust washer front annulus gear, #4 thrust washer and front planetary gear (Fig. 33).

(6) Install select fit snap ring on output shaft and check end play again. If end play is not correct,it can be adjusted with a different thickness snap ring. Refer to Specifications for snap ring thicknesses.

(7) Set gear train aside for final assembly.

TRANSMISSION CASE

Clean the case thoroughly with solvent and dry with compressed air. Apply air through all case channels and passages to be sure they are clear and to remove cleaning residue.

Inspect the case for cracks, stripped threads, or other damage. Stripped threads in case bolt holes can be repaired with steel thread inserts. However, do not attempt to repair cracks or porous spots in the case.

Inspect the band levers, pins, links and adjusting levers. Replace any component exhibiting wear or damage.

OVERRUNNING CLUTCH—MODEL 999

Inspect the overrunning clutch cam, rollers and spring retainer (Fig. 34). Replace the cam as an assembly if the rollers are worn, chipped, flat spotted, or any of the roller or cam surfaces are brinneled or damaged. If cam replacement is necessary, install a new cam as described in the following steps.

Factory installed cams are attached to the case with rivets. Service replacement cams use bolts to attach the cam to the case. If an original cam must be replaced, remove the old cam and install the new one as follows:

Replacing 999 Overrunning Clutch Cam

(1) Remove bolts attaching output shaft support to transmission case.

(2) Center punch rivet heads exactly in center of each rivet (Fig. 35).

(3) Drill through rivet heads with 3/8 diameter drill bit. Be careful not to drill into transmission case.

(4) Cut rivet heads off with chisel and drive rivets out of case with appropriate size pin punch.

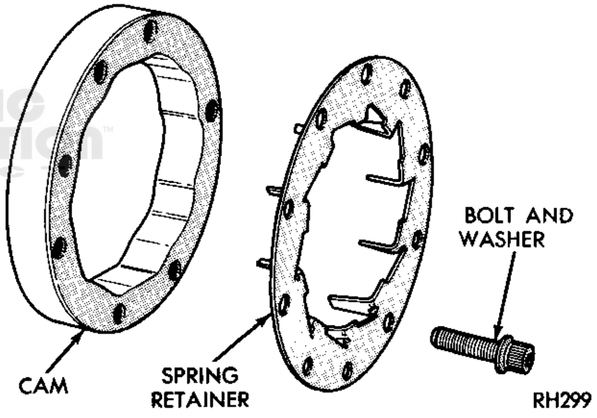


Fig. 34 Replacement Overrunning Clutch Cam—999

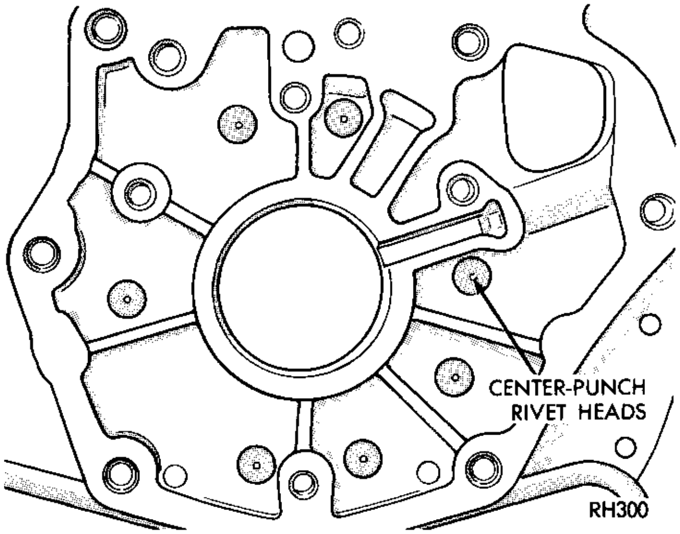


Fig. 35 Center Punch Clutch Cam Rivet Heads—999

(5) Enlarge rivet holes in case with 17/64 inch diameter drill.

(6) Clean all chips from case.

(7) Position new cam and spring retainer in case and align cam and retainer bolt holes with holes in case.

(8) Thread replacement cam bolts through retainer and into cam a few turns. Be sure coned washers on cam bolts are installed so small diameter faces bolt head.

(9) Tap cam firmly into case. Then tighten new cam bolts alternately and evenly to 11 N•m (100 in-lbs) torque (Fig. 36).

(10) Thread two pilot stud tools C-3288-B, into rear of case (Fig. 37). Position shaft support on studs and tap support into case with rawhide mallet.

(11) Install and tighten support bolts to 17 N•m (150 in-lbs) torque. Then install springs and rollers in cam.

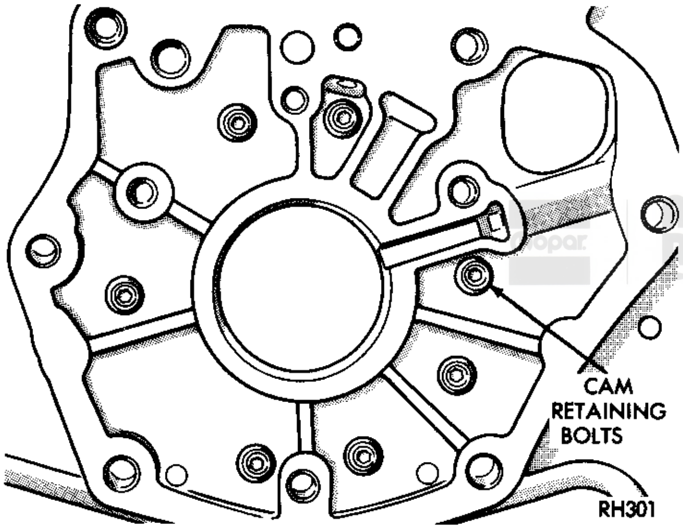


Fig. 36 Cam Retaining Bolts Installed—999

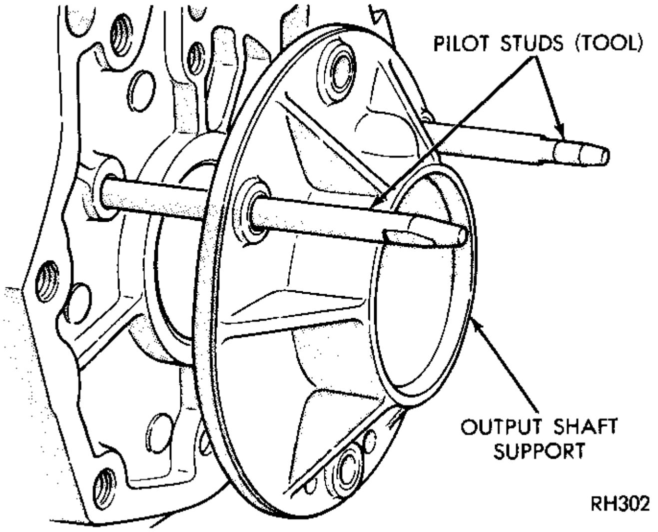


Fig. 37 Installing Output Shaft Support—999

OVERRUNNING CLUTCH—727

Inspect the overrunning clutch cam, rollers and spring retainer. Replace the cam as an assembly if the rollers are worn, chipped, flat spotted, or any of the roller or cam surfaces are brinneled or damaged. If cam replacement is necessary, install a new cam as described in the following steps.

Replacing 727 Overrunning Clutch Cam

(1) Remove set screw securing cam in case.

(2) Remove bolts attaching output shaft support to rear of case.

(3) Tap clutch cam out of case with punch. Insert punch through bolt holes in shaft support to contact cam (Fig. 38). Alternate punch from one bolt hole to another so cam is driven from case evenly.

(4) Tap shaft support from case with rawhide mallet.

(5) Clean case thoroughly to remove any burrs or chips produced by cam removal.

(6) Install two C-3288-B pilot studs in rear of case (Fig. 39).

(7) Position support on pilot studs and tap it into case with rawhide mallet (Fig. 39). Remove stud tools after support is seated.

(8) Align serrations on cam with those in case and start cam in case. Tap cam evenly into case as far as possible with a rawhide mallet.

(9) Seat cam fully in case with cam installer tool C-3863-A and adapter SP-5124 (Fig. 40). Be sure cam is bottomed in case before removing installer tools.

(10) Install and tighten cam set screw (Fig. 40).

(11) Stake case in at least 12 places around new clutch cam to secure it (Fig. 41). Use a blunt punch or chisel for staking purposes.

(12) Install and tighten shaft support bolts to 17 N•m (150 in-lbs) torque. Then install clutch springs and rollers in cam.

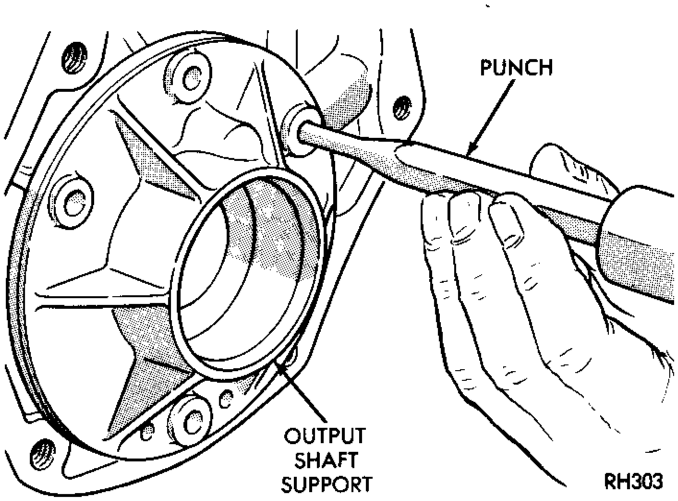


Fig. 38 Overrunning Clutch Cam Removal—727

FRONT (KICKDOWN) SERVO AND BAND—999/727

Front Servo Disassembly

(1) Remove the small snap ring from the servo piston.

(2) Remove the piston, rod, springs and guide (Fig. 42).

(3) Remove and discard the servo piston rings and O-ring.

Front Band And Servo Inspection

Clean the servo components with solvent and dry them with compressed air.

Inspect the servo components. Replace the springs if collapsed, distorted or broken. Replace the guide, rod and piston if cracked, bent, or worn. Discard the servo snap ring if distorted or warped.

Replace the front band if distorted, the lining is burned or flaking off, or worn (grooves no longer visible at any point on band).

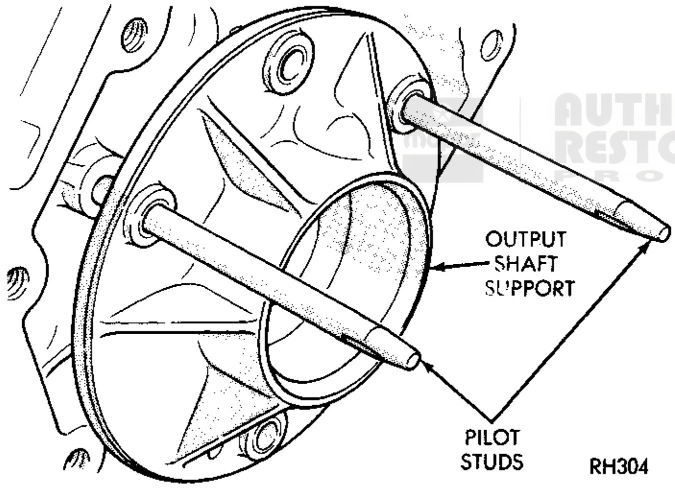


Fig. 39 Installing Output Shaft Support—727

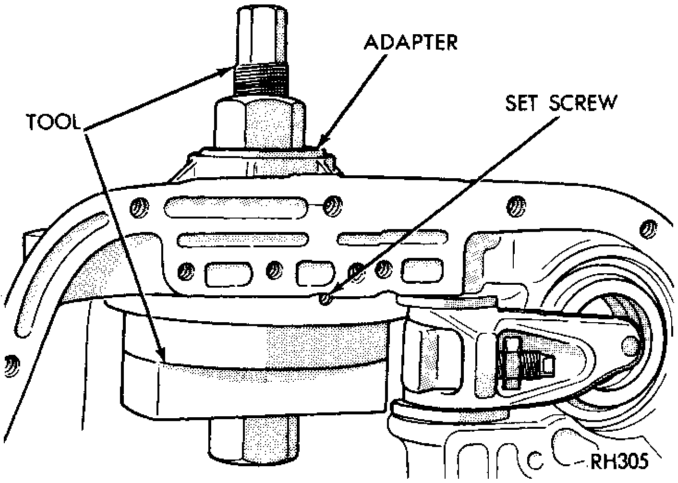


Fig. 40 Seating Overrunning Clutch Cam—727

Check the servo piston bore for wear. Replace the piston and rod as an assembly if either part is worn or damaged.

Replace any servo component if doubt exists about its condition. Do not reuse suspect parts.

Assembling Front Servo

(1) Lubricate seal rings and O-rings with petroleum jelly. Lubricate other servo parts with transmission fluid.

(2) Install new O-ring on servo piston rod.

(3) Install new seal on piston rod guide and install new seal rings on piston.

(4) Assemble rod, piston, servo springs, washer (727 only) and snap ring (Fig. 42).

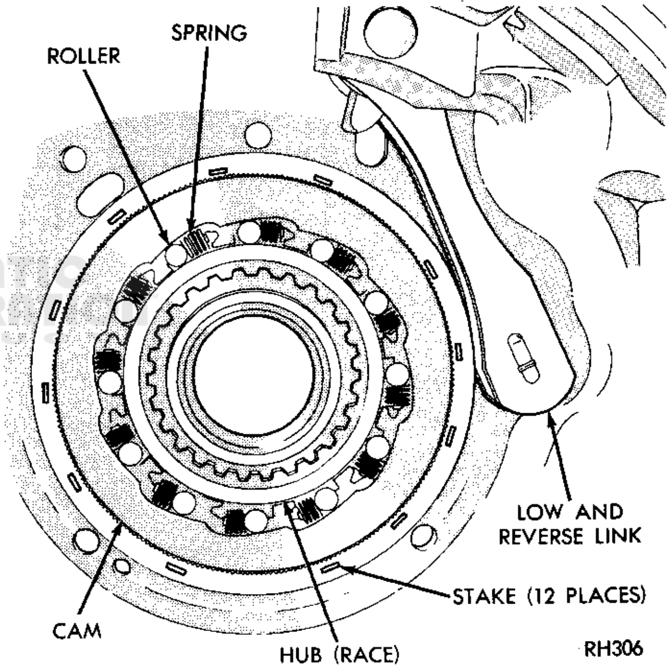


Fig. 41 Overrunning Clutch And Low-Reverse Band Link

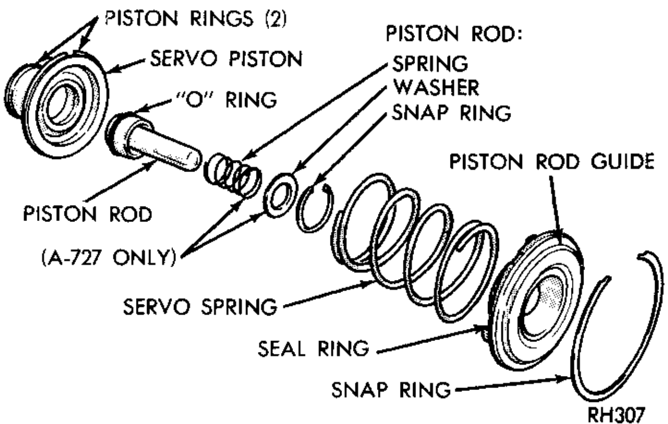


Fig. 42 Front (Kickdown) Servo Components—999/727

REAR (LOW-REVERSE) SERVO AND BAND—999/727

(1) Dissassemble servo piston, plug, spring and retainer (Fig. 43).

(2) Remove and discard the servo piston seal ring.

Rear Servo And Band Inspection

Clean the servo components with solvent and dry them with compressed air.

Inspect the servo components. Replace the spring if collapsed, distorted or broken. Replace the plug and piston if cracked, bent, or worn. Discard the servo snap ring if distorted or warped.

Check rear band condition. Replace the band if distorted, the lining is burned or flaking off, or the lining is worn (grooves no longer visible at any point on band).

If doubt exists about the condition of any servo component, replace it. Do not reuse suspect parts.

Assembling Rear (Low-Reverse) Servo

(1) Lubricate piston and guide seals with petroleum jelly. Lubricate other servo parts with transmission fluid.

(2) Install new seal ring on servo piston (Fig. 43).

(3) Assemble piston, plug and snap ring (Fig. 43).

TRANSMISSION ASSEMBLY

Installing Front/Rear Servos

(1) Lubricate front servo bore in transmission case with transmission fluid. Then install front servo assembly in bore with a twisting motion. Compress servo with tool C-3422-A. Secure servo with new snap ring and remove compressor tool.

(2) Lubricate rear servo bore in transmission case with transmission fluid. Then install rear servo assembly in case bore with twisting motion. Compress servo with tool C-3422-A and install new snap ring.

Installing Overrunning Clutch

(1) Place transmission case in upright position.

(2) Install overrunning clutch hub, rollers and springs as shown (Fig. 41). Lubricate hub, rollers and springs with transmission fluid.

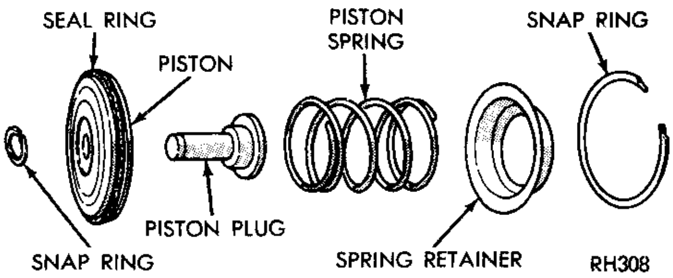


Fig. 43 Rear Servo Components—999/727

Installing 727 Rear Band And Linkage

(1) Assemble lever, pin and link and anchor (Fig. 44).

(2) Install new O-ring on rear band pin (Fig. 44).

(3) Position rear band in case.

(4) Install short strut. Then connect link and anchor to band. Be sure link and anchor are installed as shown in Figure 44.

(5) Tighten band adjuster screw just enough to hold strut in place.

(6) Install low-reverse drum. Verify that link does not touch drum (if it does, link and anchor are improperly installed).

Installing 999 Double Wrap Rear Band

(1) Install a new O-ring on the band reaction pin and lubricate pin with transmission fluid (Fig. 45).

(2) Push reaction pin into case until flush with gasket surface.

(3) Position double wrap band in case so band lugs are resting against reaction pin.

(4) Install low-reverse drum into band and overrunning clutch.

(5) Lubricate adjuster lever pivot pin with transmission fluid.

(6) Install adjuster lever (Fig. 46).

(7) Position adjuster lever so lever pivot pin is flush with case and adjusting screw is touching center lug of band.

Installing Planetary Gears, Sun Gear And Driving Shell

(1) Lubricate output shaft and geartrain with transmission fluid.

(2) Insert output shaft through the rear support.

(3) Carefully work shaft and geartrain assembly rearward. Continue rearward movement until rear plane-

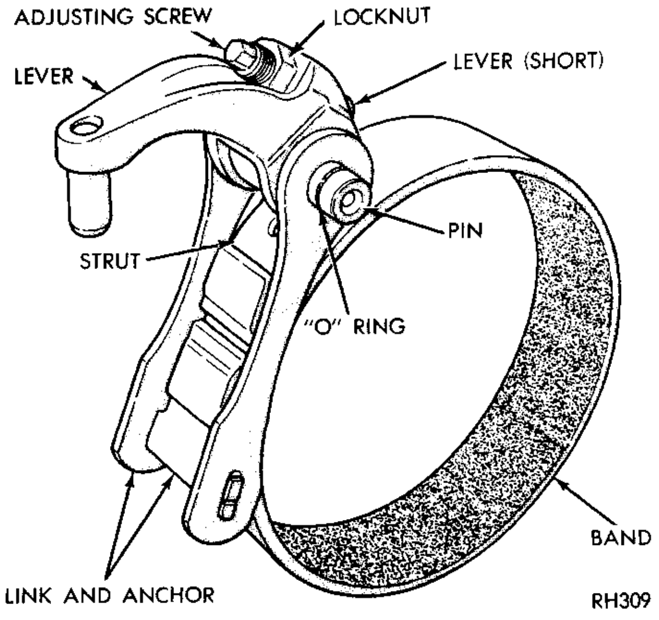


Fig. 44 Low-Reverse (Rear) Band And Linkage—727

tary gears are fully engaged in low-reverse drum slots.

Positioning Transmission Case For Final Assembly

The remaining transmission components (clutches, front band, oil pump/reaction shaft support), are much easier to install if the transmission case is in an upright position.

Two methods can be used to hold the transmission case upright. The first method involves using a C-clamp style transmission holding tool. The second (and simpler) method only requires modifying a shop workbench.

Workbench modification involves drilling or cutting a 3-1/2 inch diameter mounting hole in the bench; then cutting notches at the hole sides large enough to clear the output shaft support flanges. **Be sure the mounting hole will be located at a convenient location on the bench before cutting/drilling.**

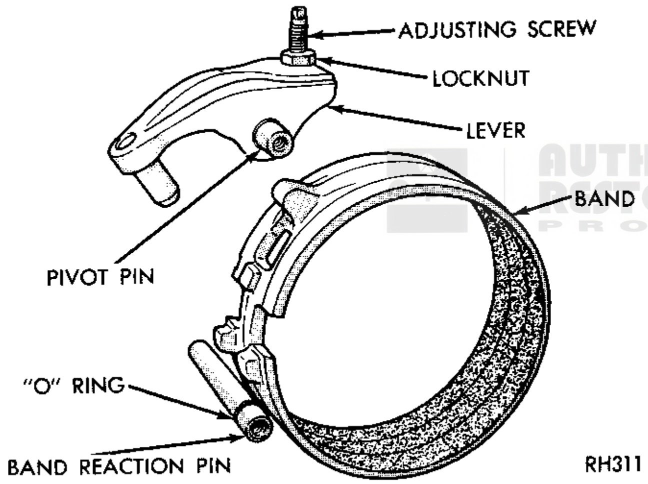


Fig. 45 Low-Reverse (Rear) Band Components—999

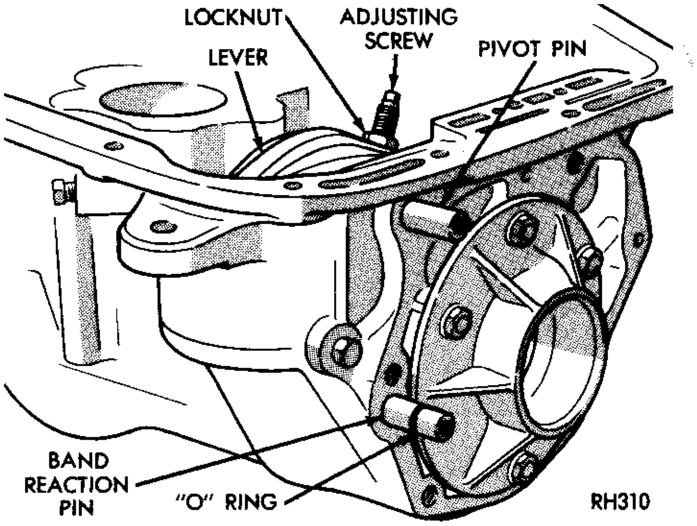


Fig. 46 Low-Reverse (Rear) Band Installation—999

After preparing the workbench mounting hole, carefully lower the transmission output shaft through the hole until the shaft support and case are resting on the bench surface.

Assembling/Installing Front And Rear Clutches

(1) Coat No. 3 thrust washer with petroleum jelly and insert washer in end of input shaft (Fig. 47). Use enough petroleum jelly to hold it in place. **If a new thrust washer is being installed, use the washer indicated for 1990 models only. The 1990 thrust washer (and output shaft thrust plate) are different and not interchangeable with prior models.**

(2) Coat output shaft thrust plate with petroleum jelly and install plate on forward end of output shaft (Fig. 47). **If a new thrust plate is being installed, use the plate indicated for 1990 models only. The 1990 thrust thrust plate is different and not interchangeable with prior models.**

(3) Align front clutch plate inner splines. Then install front clutch on rear clutch. **Be sure front clutch plate splines are fully engaged in rear clutch hub.**

(4) Lower front/rear clutch assembly into case.

(5) Carefully work assembled clutches in a circular motion to engage rear clutch splines over splines of front annulus gear. Be sure the front clutch drive lugs are fully engaged in slots of driving shell.

Front (Kickdown) Band Installation

(1) Slide front band over front clutch.

(2) Install band lever and shaft (Fig. 48).

(3) Install band strut (Fig. 48).

(4) Install band adjusting screw. On 727 models, also install adjusting screw anchor (Fig. 48).

(5) Coat lever shaft plug with a non-hardening sealer such as Permatex No. 2 and install the plug in the case.

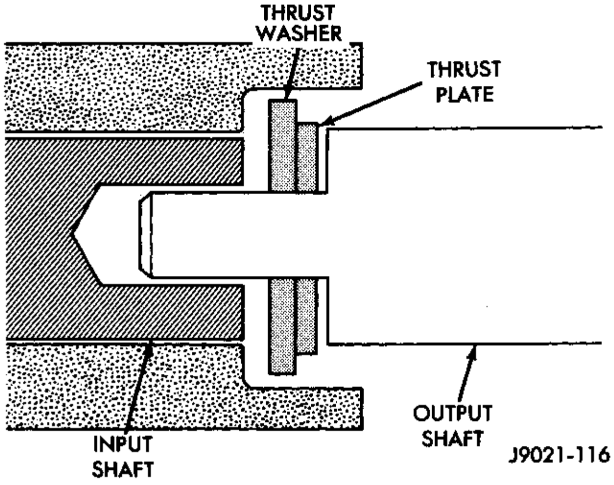


Fig. 47 No. 3 Thrust Washer And Output Shaft Thrust Plate Position

Installing Oil Pump And Reaction Shaft Support

(1) If oil pump was an extremely tight fit and difficult to remove at start of overhaul, warm pump mounting area of case with heat lamp. A few minutes of heat application should expand case enough to ease pump installation. Leave heat lamp on until pump is ready for installation.

(2) On 999 models, install #1 thrust washer on reaction shaft support hub (Fig. 6). Use petroleum jelly to hold washer in place.

(3) On 727 models, if input shaft end play measured during disassembly was incorrect, install a new thrust washer that will provide correct end play. Select fit washers are available for this purpose. Refer to the specifications section for select fit washer thicknesses.

(4) Install two pilot stud tools C-3288-B in pump mounting holes (Fig. 49).

(5) Install new pump gasket over studs and seat gasket in case.

(6) Coat pump O-ring with Door Ease or petroleum jelly to aid installation. Apply either of same lubricants to lip of pump oil seal.

(7) Remove heat lamp (if used).

(8) Position pump and reaction shaft support assembly on pilot studs. Then slide pump and shaft assembly into case (Fig. 49). Gently tap pump body with rubber mallet to fully seat it.

(9) Remove pilot stud tools and install pump bolts. Tighten bolts snugly but not to final torque at this time.

(10) Check for correct component installation as follows:

(a) Rotate input and output shafts and observe shaft operation.

(b) If both shafts rotate freely, proceed to next assembly step.

(c) If either shaft binds, clutches, planetary gears or thrust washers are misassembled. Remove and reassemble transmission components as necessary to eliminate bind condition.

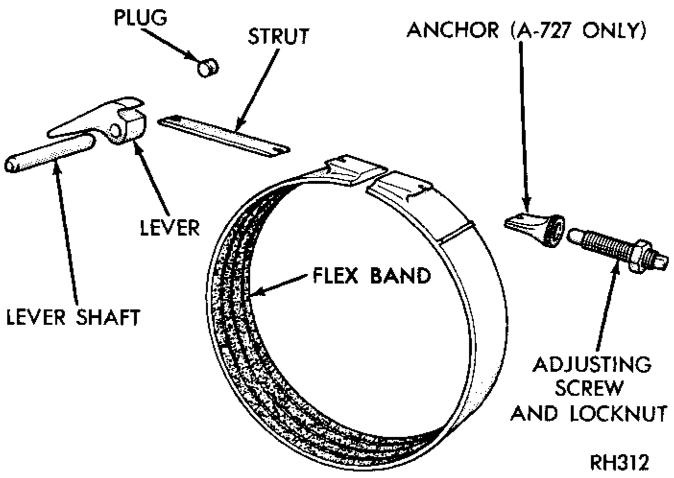


Fig. 48 Front (Kickdown) Band And Linkage

(11) Final-tighten pump bolts to 175 in-lbs (20 N•m) torque.

(12) Check input and output shaft rotation one more time.

Installing Governor And Support

(1) Lubricate governor valve, weights, body and shaft with transmission fluid.

(2) Install filter screen in governor body.

(3) Position governor body on park gear and install body attaching bolts finger tight.

(4) Install assembled park gear and governor body on output shaft (Fig. 50).

(5) Align governor valve shaft holes in governor body and output shaft.

(6) Install governor retaining snap ring on output shaft (Fig. 50).

(7) Tighten bolts attaching governor body to park gear to 95 in-lbs (11 N•m) torque.

(8) Assemble governor weights and spring. Use new snap ring to secure inner weight and spring in outer weight.

(9) Install weights in governor body and install retaining snap ring (Fig. 50).

(10) Assemble governor valve, valve shaft and snap ring. Then insert shaft into governor body and through output shaft and governor weights. Secure shaft to weights with new snap ring.

(11) Verify that governor valve and weights move freely in governor body.

Installing Rear Bearing And Adapter Housing

(1) Position new adapter housing gasket on transmission case.

(2) Install new oil seal in adapter housing.

(3) Install rear bearing on output shaft.

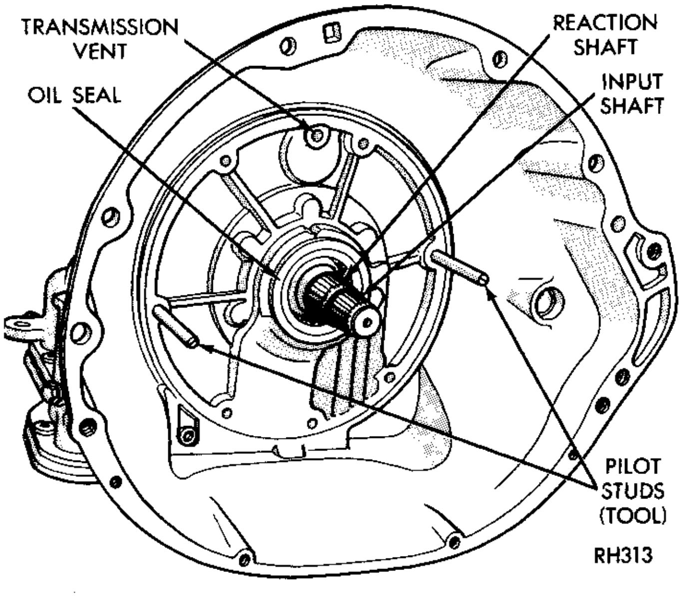


Fig. 49 Installing Oil Pump And Reaction Shaft Support

(4) Install adapter housing on transmission case. Tighten the housing bolts/nuts to 33 N•m (24 ft-lbs) torque.

Installing Valve Body, Accumulator And Oil Pan

(1) Make sure **neutral switch has not been installed in case. Switch will interfere with valve body installation if installed.**

(2) Install new seal rings on accumulator piston (Fig. 51).

(3) Lubricate accumulator piston, seals and accumulator bore (in the case) with transmission fluid.

(4) Install accumulator piston and spring (Fig. 51) in case.

(5) Place valve body manual lever in low to move park lock rod rearward.

(6) Position valve body on case. Work park lock rod past sprag and install valve body bolts finger-tight.

(7) Install neutral switch in the case and move park lock rod to Neutral position.

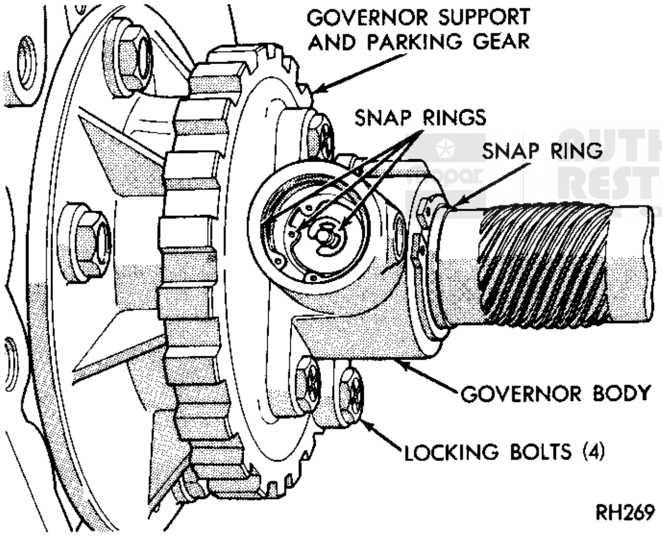


Fig. 50 Governor And Park Gear Installation

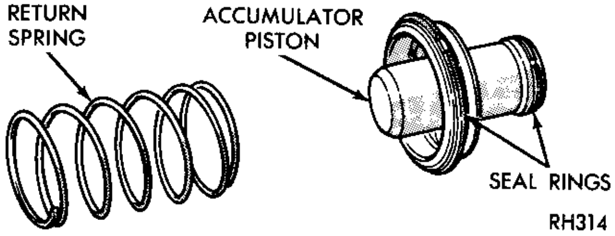


Fig. 51 Accumulator Piston And Spring

(8) Align valve body on transmission case and install valve body screws. Tighten screws alternately and evenly to 4 N•m (35 in-lbs) torque.

(9) Install new oil filter on valve body. Tighten filter screws evenly to 4 N•m (35 in-lbs) torque.

(10) Install new manual lever shaft seal in case. Then install throttle valve and manual valve levers on shaft.

(11) Position new oil pan gasket on case.

(12) Install oil pan and tighten pan bolts to 17 N•m (150 ft-lbs) torque.

Torque Converter Installation

CAUTION: The transmission and torque converter must be installed in the vehicle as an assembly. To do otherwise will result in damage to the converter hub, pump gears, pump seal and pump bushing. In addition, never mount the converter on the driveplate and then attempt to install the transmission. This procedure can result in damaging the driveplate along with the pump and converter.

(1) Align oil pump rotor lugs with an alignment tool (Fig. 52). Use tool C-3756 for Model 999. Use tool C-3881 for Model 727.

(2) Lubricate converter hub with transmission fluid and carefully install converter. Be sure converter hub slots are fully seated in inner gear lugs.

(3) Use metal strapping or small C-clamp to hold converter in place during installation. Attach strapping or clamp to converter housing.

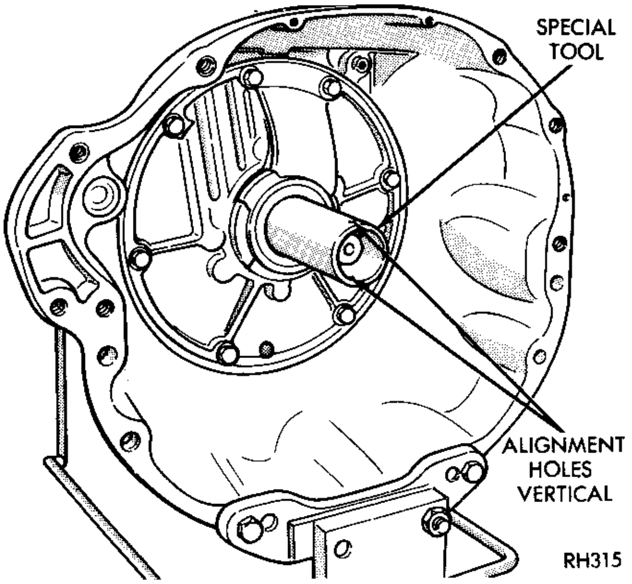


Fig. 52 Aligning Oil Pump Inner Gear Lugs—Typical

GENERAL SPECIFICATIONS

Transmission Models	A-999		A-727	
TYPE	Automatic Three-Speed with Torque Converter			
TORQUE CONVERTER DIAMETER	10-3/4 inches		10-3/4 inches	
FLUID CAPACITY–TRANSMISSION AND TORQUE CONVERTER	U.S. 17.1 Pts.	Metric 8.1 Liters	U.S. 17.1 Pts.	Metric 8.1 Liters
RECOMMENDED FLUID	Mopar ATF Plus (7176) or Mopar Dexron II®			
COOLING METHOD	Water Heat Exchanger in Radiator		Water Heat Exchanger in Radiator plus Auxiliary Cooler (oil-to-air)	
LUBRICATION	Pump (Gear Type)			
GEAR RATIOS:	First:	Second:	Third:	Reverse:
A-727	2.45	1.45	1 to 1	2.21
A-999	2.74	1.54	1 to 1	2.21
PUMP CLEARANCES:				
Outer Gear to Case Bore	.0035 to .0075 inch			
End Clearance–Gears	.0004 to .0025 inch		.001 to .003 inch	
GEAR TRAIN END PLAY	.005 to .048 inch		.006 to .048 inch	
INPUT SHAFT END PLAY	.022 to .091 inch		.034 to .084 inch	
SNAP RINGS:				
Rear Clutch Snap Ring (selective)	.060 to .062 inch .068 to .070 inch .076 to .078 inch .098 to .100 inch		.060 to .062 inch .074 to .076 inch .088 to .090 inch .106 to .108 inch	
Output Shaft (Forward End)	.040 to .044 inch .062 to .066 inch .082 to .086 inch		.048 to .052 inch .055 to .059 inch .062 to .066 inch	
CLUTCH PLATE CLEARANCE:				
Front Clutch	5 Disc. .075 to .152 inch		4 Disc. .082 to .151 inch	
Rear Clutch	4 Disc. .032 to .055 inch		4 Disc. .025 to .045 inch	
CLUTCH DISCS:				
Number of Front Clutch Discs	5		4	
Number of Rear Clutch Discs	4		4	
BAND ADJUSTMENTS:				
Kickdown (Front) Turns*	2-1/2		2-1/2	
Low-Reverse (Internal) Turns*	4		2	

*Backed off from 72 inch-pounds (5 N·m)

J9021-55

THRUST WASHER AND TORQUE SPECIFICATIONS

THRUST WASHERS

	904/999	727
Reaction Shaft Support Thrust Washer	# 1 .061 to .063 inch	# 1 Selective .016 to .063 inch (Natural) .084 to .086 inch (Red) .102 to .104 inch (Yellow)
Rear Clutch Retainer Thrust Washer	# 2 .061 to .063 inch	# 2 .061 to .063 inch (Natural)
Output Shaft Thrust Washer	# 3 Selective .068 to .070 inch	# 3 Selective .052 to .054 inch (Tin) .068 to .070 inch (Red) .083 to .085 inch (Green)
Output/Input Shaft Thrust Plate	.060 to .063 inch (All)	
Front Annulus Thrust Washer	# 4 .121 to .125 inch	
Front Carrier (To Annulus) Thrust	# 5 .048 to .050 inch	# 4 .059 to .062 inch
Drive Shell (To Front Annulus) Thrust Washer	–	# 5 .059 to .062 inch
Front Carrier (To Drive Shell) Thrust Washer	# 6 .048 to .050 inch	
Sun Gear Drive Shell Thrust Plate	# 7 .050 to .052 inch	
	# 8 .050 to .052 inch	# 6 .034 to .036 inch
Rear Carrier (To Drive Shell) Thrust Washer	# 9 .048 to .050 inch	# 7 .059 to .062 inch
Rear Carrier (To Annulus) Thrust Plate	–	# 8 .034 to .036 inch
Rear Carrier (To Annulus) Thrust Washer	#10 .048 to .050 inch	

TIGHTENING REFERENCE

	Ft. Lbs.	N·m
Cooler Line Fitting	155*	18
Cooler Line Nut	85*	10
Converter Drive Plate To Cranksaft Bolt	55	75
Converter Drive Plate to Torque Converter Bolt	270*	31
Extension Housing to Transmission Case Bolt	32	43
Extension Housing to Insulator Mounting Bolt	50	68
Governor Body to Support Bolt	95*	11
Kickdown Band Adjusting Screw Lock Nut	30	41
Kickdown Lever Shaft Plug	150*	17
Lockup Solenoid Wiring Connector	150*	17

*Inch Pounds

	Ft. Lbs.	N·m
Neutral Starter Switch	25	34
Oil Pan Bolt	150*	17
Oil Pump Housing to Transmission Case Bolt	175*	20
Output Shaft Support Bolt	150*	17
Overrunning Clutch Cam Set Screw	40*	5
Pressure Test Take-Off Plug	120*	14
Reaction Shaft Support to Oil Pump Bolt	175*	20
Reverse Band Adjusting Screw Lock Nut	25	34
Speedometer Drive Clamp Screw	100*	11
Transmission to Engine Bolt	30	41
Valve Body Screw	35*	4
Valve Body to Transmission Case Bolt	105*	12

*Inch Pounds

J9021-115

PRESSURE TEST SPECIFICATIONS

Lube Pressure	Closed Throttle Full Throttle	34-207 kPa (5-30 psi) 34-207 kPa (5-30 psi)
Line Pressure	Closed Throttle 1000 rpm	372-414 kPa (54-60 psi) 648 kPa (94 psi)
Front Servo Release	Third Gear Only	No more than 21 kPa (3 psi) lower than line pressure.
Rear Servo Apply	1 Range R Range	No more than 21 kPa (3 psi) lower than line pressure. 1103 kPa (160 psi) at idle, builds to 1862 kPa (270 psi) at 1600 rpm.
Governor	D Range Closed Throttle	Pressure should respond smoothly to changes in mph and return to 0-7 kPa (0-1½ psi) when stopped with transmission in D, 1, 2. **Pressure above 7 kPa (1½ psi) at standstill will prevent transmission from downshifting.**

J8921-752

AW-4 AUTOMATIC TRANSMISSION

CONTENTS

GENERAL INFORMATION

INDEX

DESCRIPTION

The AW-4 is a four-speed, electronically controlled automatic transmission (Fig. 1). Running gear consists of a lockup torque converter; oil pump; three planetary gear sets; clutch and brake units; hydraulic accumulators; a valve body with electrical solenoids and a transmission computer unit (TCU). Cables are used for shifting and throttle pressure control. A neutral safety switch permits engine starting in Park and Neutral range only.

The valve body solenoids are controlled by signals from the TCU. Signal sequence is determined by vehicle speed and throttle position.

Fourth gear is an .70:1 ratio overdrive range. First, second, third and reverse gear are conventional ranges. Third gear ratio is 1:1. A separate planetery gear set provides overdrive operation in fourth gear.

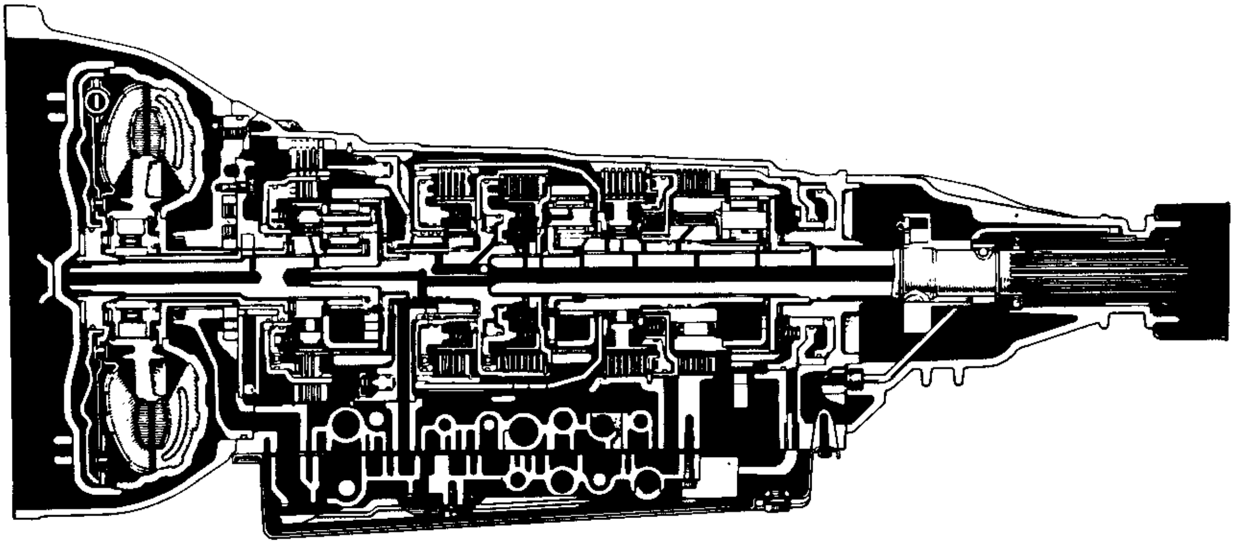


Fig. 1 AW-4 Automatic Transmission

GEAR SHIFT POSITIONS

The AW-4 transmission has six gear shift lever positions. Park, Reverse and Neutral positions are conventional and mechanically operated. The 1-2, 3 and D ranges provide electronically controlled shifting.

The 1-2 position provides first and second gear only. The 3 position provides first, second and third gear. The D range provides first through fourth gear. Overdrive fourth gear range is available only when the shift lever is in D position (Fig. 2).

TRANSMISSION IDENTIFICATION

The transmission I.D. plate is attached to the case (Fig. 3). The plate contains the transmission serial and model numbers. Refer to the information on this plate when ordering service parts.

COMPONENTS AND OPERATION

Electronic Controls

The AW-4 is electronically controlled in the forward gear ranges. The controls consist of the TCU, valve body solenoids and sensors that monitor vehicle speed, throttle opening, shift lever position and brake pedal application.

TCU

The TCU determines shift and converter lockup timing based on signals from the sensors. The valve body solenoids are activated/deactivated accordingly.

The TCU has a self diagnostic program. Component and circuitry malfunctions can be diagnosed with the DRB II tester. Once a malfunction is noted and stored in TCU memory, it is retained even after the problem has been corrected. To cancel a stored malfunction, simply disconnect and reconnect the "Trans." fuse in the TCU harness.

Shift Modes

Two separate shift modes are programmed into the TCU. The Comfort mode provides normal shift speeds and points. The Power mode provides higher engine speeds and shift points when extra acceleration and torque are needed. The shift modes are activated by a switch in the instrument panel.

Valve Body Solenoids

The solenoids are mounted on the valve body and operated by the TCU. The solenoids control operation of the converter lockup and shift valves in response to input signals from the TCU.

Sensors

The sensors include the throttle position sensor (TPS), the speed sensor, the neutral safety switch and the brake pedal application switch.

The throttle position sensor is mounted on the throttle body. It electronically determines throttle position and relays this information to the TCU to control shift points and converter lockup.

The speed sensor consists of a rotor and magnet on the transmission output shaft and a switch in the extension housing or adapter. The sensor switch is activated each time the rotor and magnet complete one revolution. Sensor signals are transmitted to the TCU.

The neutral safety switch is mounted on the valve body manual shaft. The switch signals shift linkage and manual valve position to the TCU through an interconnecting harness. The switch prevents engine starting in all gears other than Park or Neutral.

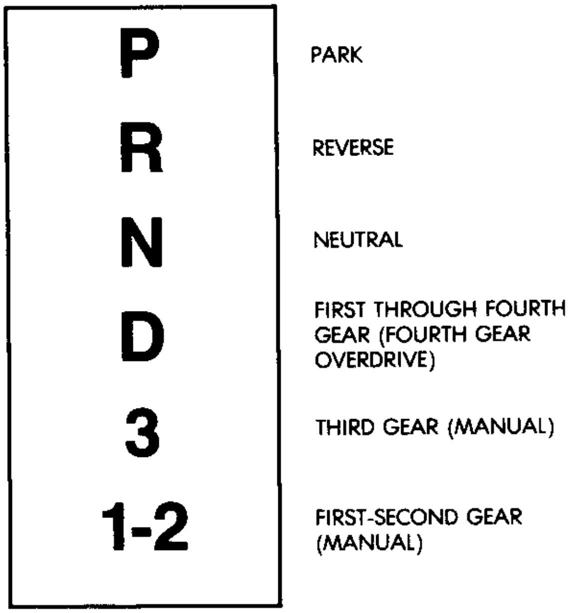


Fig. 2 Gear Shift Positions

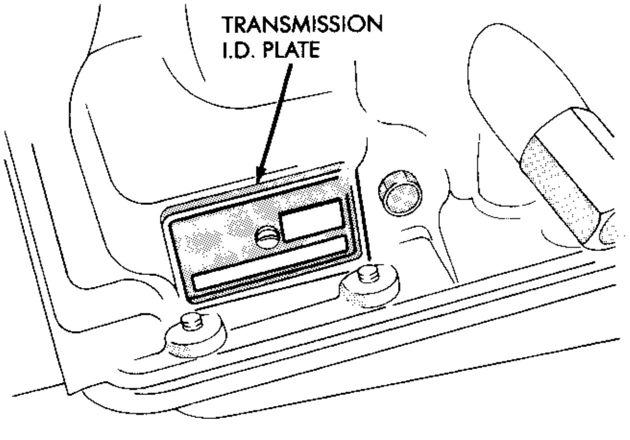


Fig. 3 Transmission Identification

The brake application switch releases the lock-up clutch in the torque converter whenever the brakes are applied. The switch is mounted on the brake pedal bracket and signals the TCU when the pedal is pressed or released.

TORQUE CONVERTER

A lockup torque converter is used for all applications. The lockup mechanism consists of a sliding clutch piston, clutch springs and the clutch disc material (Fig. 4).

The disc is attached to the converter front cover. The clutch piston and clutch springs are attached to the turbine hub. The springs dampen engine firing impulses and loads during the initial phase of converter lockup.

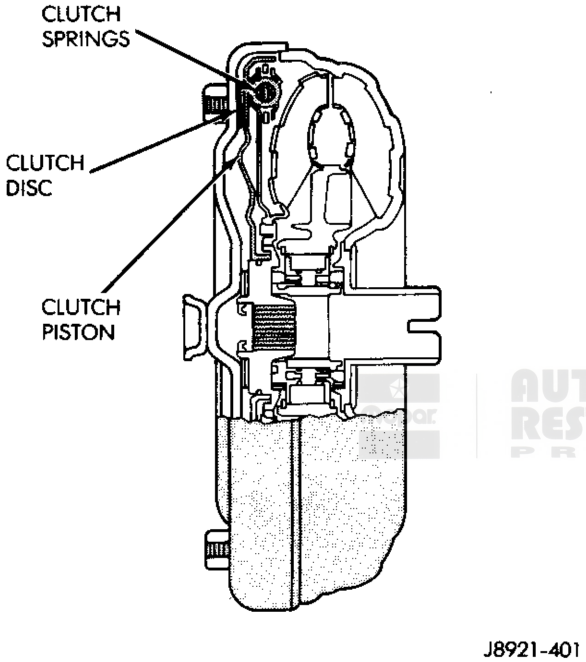


Fig. 4 Lockup Torque Converter

Lockup is controlled by valve body solenoid number three and by the lockup relay valve. At lockup speed, the solenoid channels line pressure to the lockup clutch through the relay valve.

Torque converter lockup occurs in second gear in 1-2 position; third gear in 3 position and third and fourth gear in D position.

FOURTH GEAR OVERDRIVE COMPONENTS

The overdrive system consists of the input shaft, one-way clutch, planetary sun gear, ring gear, planetary carrier, direct clutch and overdrive brake (Fig. 5). The overdrive elements are controlled and applied through valve body solenoid number two.

In overdrive fourth gear, the brake prevents the overdrive sun gear from turning. During operation, the overdrive elements operate as follows:

The overdrive input shaft and planetary carrier rotate as a unit. The sun gear and overdrive direct clutch drum are in mesh and operate as a single unit. The direct clutch splines function as the hub for the overdrive brake. The one-way clutch outer race is in mesh with the planetary carrier. The inner race is fixed to the sun gear shaft.

FIRST-THIRD-REVERSE GEAR COMPONENTS

First-third and reverse gear components are outlined in Figure 6.

The input shaft is meshed with the direct clutch hub and the forward clutch drum. These elements rotate as a unit. The forward clutch hub rotates as a unit with the front planetary ring gear. The direct clutch drum is meshed with the forward end of the planetary sun gear.

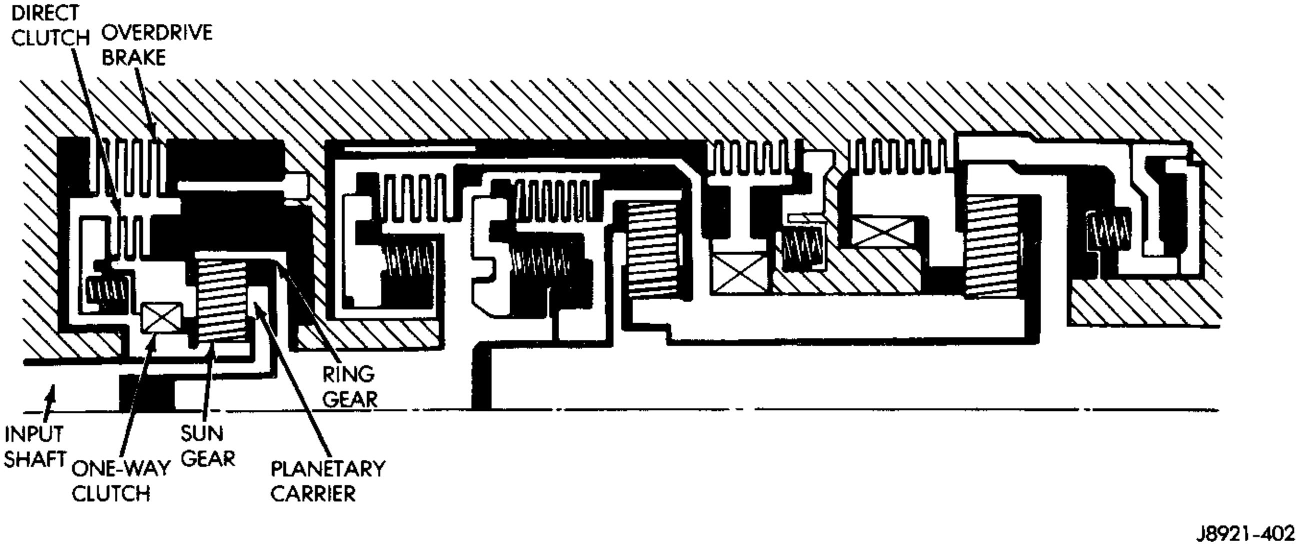


Fig. 5 Fourth Gear Overdrive Components

The second brake hub serves as the outer race of one-way clutch No. 1. The clutch inner race is locked with the front/rear sun gear. The inner race of one-way clutch No. 2 is splined to the transmission case and is locked. The outer race rotates as a unit with the rear planetary carrier.

The rear planetary ring gear is splined to the output shaft. The front planetary carrier and rear carrier ring gear are meshed and rotate as a unit with the output shaft.

GEARTRAIN OPERATION AND APPLICATION CHARTS

Operation and application of the first through fourth and reverse gear elements are outlined in the function and application charts.

The Component Function Chart (Fig. 7) describes basic function of various geartrain elements. The Component Application Chart (Fig. 8) indicates which elements (including valve body solenoids), are applied in the various gear ranges.

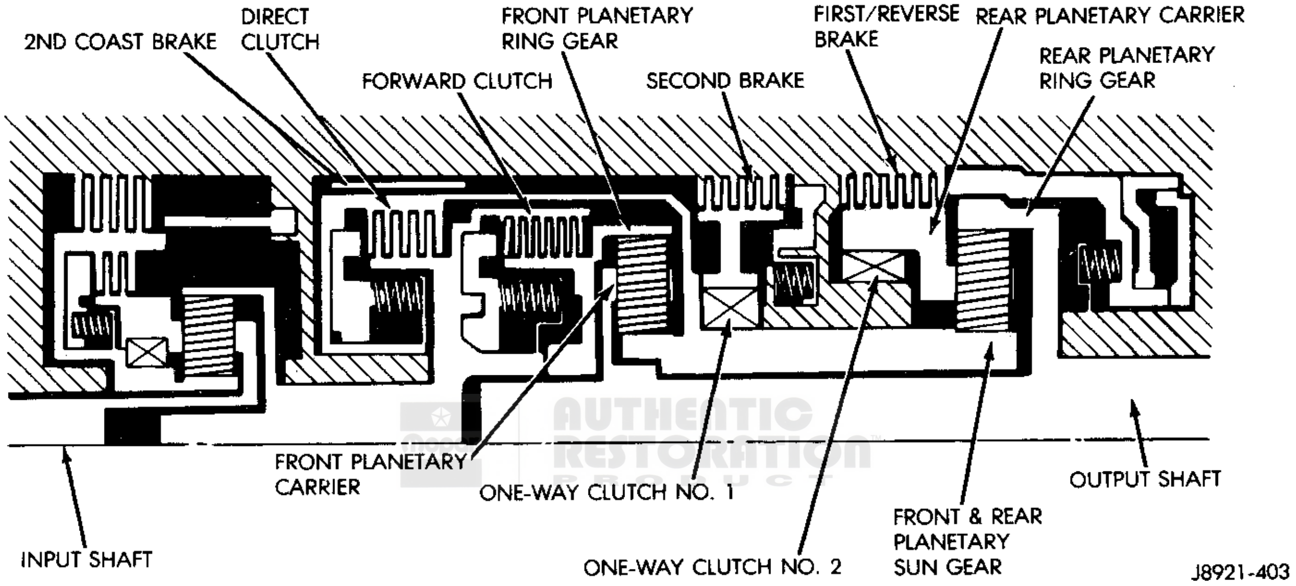


Fig. 6 First-Third And Reverse Gear Components

NOMENCLATURE	FUNCTION
Overdrive Direct Clutch	Connects overdrive sun gear and overdrive carrier
Overdrive Brake	Prevents overdrive sun gear from turning either clockwise or counterclockwise
Overdrive One-Way Clutch	When transmission is driven by engine, connects overdrive sun gear and overdrive carrier
Forward Clutch	Connects input shaft and front ring gear
Direct Clutch	Connects input shaft and front and rear sun gear
Second Coast Brake	Prevents front and rear sun gear from turning either clockwise or counterclockwise
Second Brake	Prevents outer race of No. 1 one-way clutch from turning either clockwise or counterclockwise, thus preventing front and rear sun gear from turning counterclockwise
First/Reverse Brake	Prevents rear planetary carrier from turning either clockwise or counterclockwise
One-Way Clutch No. 1	When second brake is operating, prevents front and rear sun gear from turning counterclockwise
One-Way Clutch No. 2	Prevents rear planetary carrier from turning counterclockwise

J8921-404

Fig. 7 Component Function Chart

Shift Lever Position	Gear	Valve Body Solenoid No. 1	Valve Body Solenoid No. 2	OVERDRIVE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	OVERDRIVE BRAKE	SECOND COAST BRAKE	SECOND BRAKE	FIRST/ REVERSE BRAKE	OVERDRIVE ONE-WAY CLUTCH	NO.1 ONE-WAY CLUTCH	NO.2 ONE-WAY CLUTCH
P	Park	ON	OFF	●									
R	Reverse	ON	OFF	●		●				●	●		
N	Neutral	ON	OFF	●									
D	First	ON	OFF	●	●						●		●
	Second	ON	ON	●	●				●		●	●	
	Third	OFF	ON	●	●	●			●		●		
	OD	OFF	OFF		●	●	●		●				
3	First	ON	OFF	●	●						●		●
	Second	ON	ON	●	●			●	●		●	●	
	Third	OFF	ON	●	●	●			●		●		
1-2	First	ON	OFF	●	●					●	●		●
	Second	ON	ON	●	●			●	●		●	●	

● = Applied

J8921-405

Fig. 8 Component Application Chart

HYDRAULIC SYSTEM

The basic hydraulic system consists of the oil pump, valve body and solenoids and four hydraulic accumulators. The oil pump provides the necessary system lubrication and operating pressure.

The valve body controls application of the clutches, brakes, second coast band and the torque converter lockup clutch. The valve body solenoids control sequencing of the 1-2, 2-3 and 3-4 shift valves within the valve body. The solenoids are activated by signals from the TCU.

The accumulators are used in the clutch and brake feed circuits to control initial apply pressure. Spring loaded accumulator pistons modulate the initial surge of apply pressure for smooth engagement.

Oil Pump

A gear-type oil pump is used in all AW-4 transmissions. The pump gears are mounted in the oil pump body. The drive gear is operated by the torque converter hub. Drive tangs on the hub engage in drive slots in the drive gear.

Valve Body Components

Transmission operating pressure is supplied to the clutch and brake apply circuits through the valve body. The valve body consists of an upper body, lower body, separator plate and upper and lower gaskets (Fig. 9). The various spool valves, sleeves, plugs and springs are located within the two body sections.

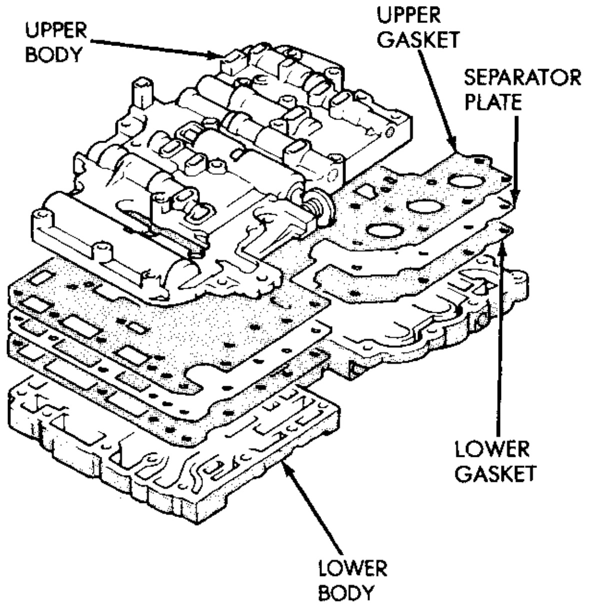
The manual valve, 1-2 shift valve, primary regulator valve, accumulator control valve, check balls, solenoids and oil strainers are located in the lower body section (Fig. 10). The remaining control and shift valves plus check balls and one additional oil strainer are located in the upper body section (Fig. 11).

Manual Valve

The manual valve is operated by the gearshift linkage. The valve diverts fluid to the apply circuits according to shift lever position.

Primary Regulator Valve

The primary regulator valve (Fig. 13) modulates line pressure to the clutches and brakes according to engine load. The valve is actuated by throttle valve pressure.



J8921-406

Fig. 9 Two-Section Valve Body

During high load operation, the valve increases line pressure to maintain positive clutch and brake engagement. At light load, the valve decreases line pressure just enough to maintain smooth engagement.

Throttle Valve and Downshift Plug

The throttle valve and downshift plug (Fig. 14) control throttle pressure to the primary regulator valve.

The downshift plug and throttle valve are operated by the throttle valve cam and line pressure cable in response to engine throttle position. Throttle valve pressure is also modulated by the cut-back valve in second, third and fourth gear ranges.

Cut-Back Valve

The cut-back valve (Fig. 15) helps prevent excessive pump pressure buildup in second, third and fourth gear. The valve is actuated by throttle pressure and by line pressure from the second brake. The valve also helps regulate line pressure by controlling the amount of cut-back pressure to the throttle valve.

Secondary Regulator Valve

The secondary regulator valve (Fig. 16) regulates converter lockup clutch and transmission lubrication pressure. When primary regulator valve pressure exceeds requirements for lockup clutch engagement or trans-

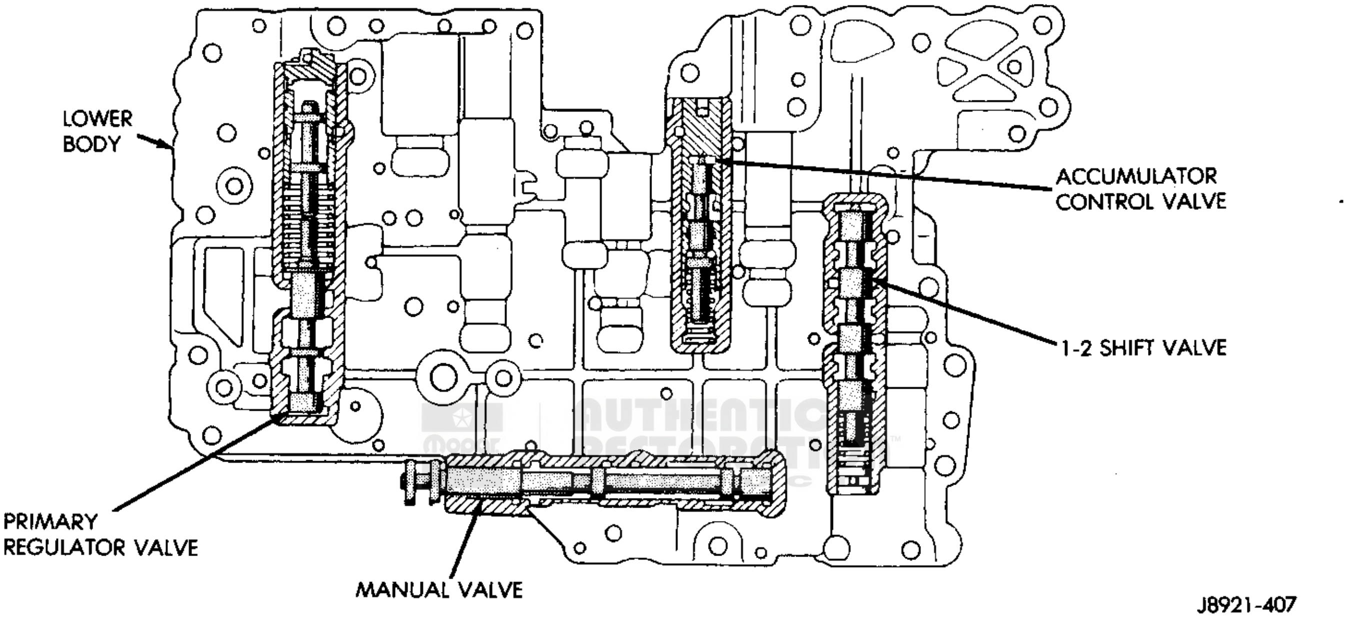


Fig. 10 Upper Body Components

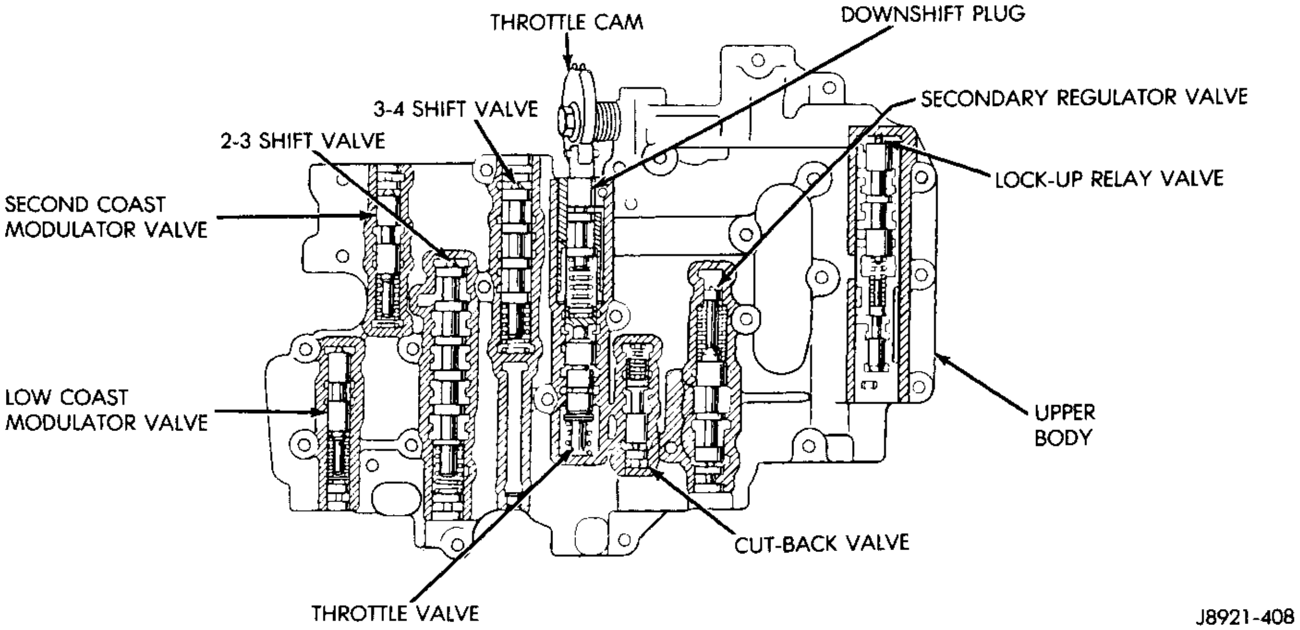


Fig. 11 Lower Body Components

mission lubrication, the secondary regulator valve is moved upward exposing the drain port. Excess pressure then bleeds off as needed. As pressure drops, spring tension moves the valve downward closing the drain port.

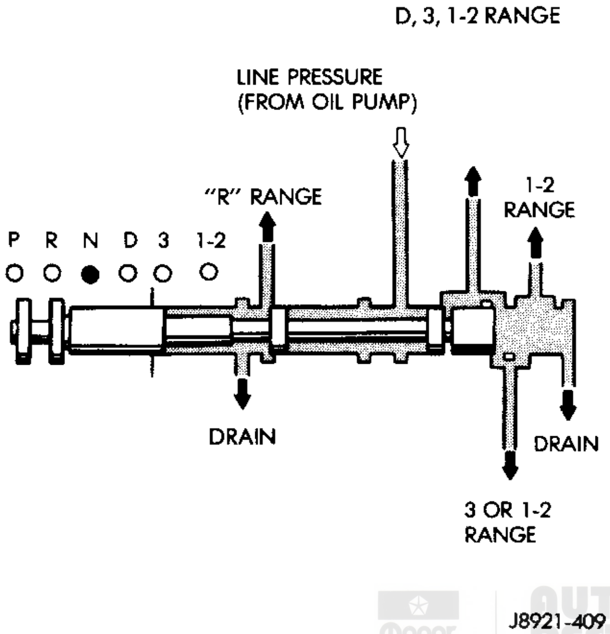


Fig. 12 Manual Valve

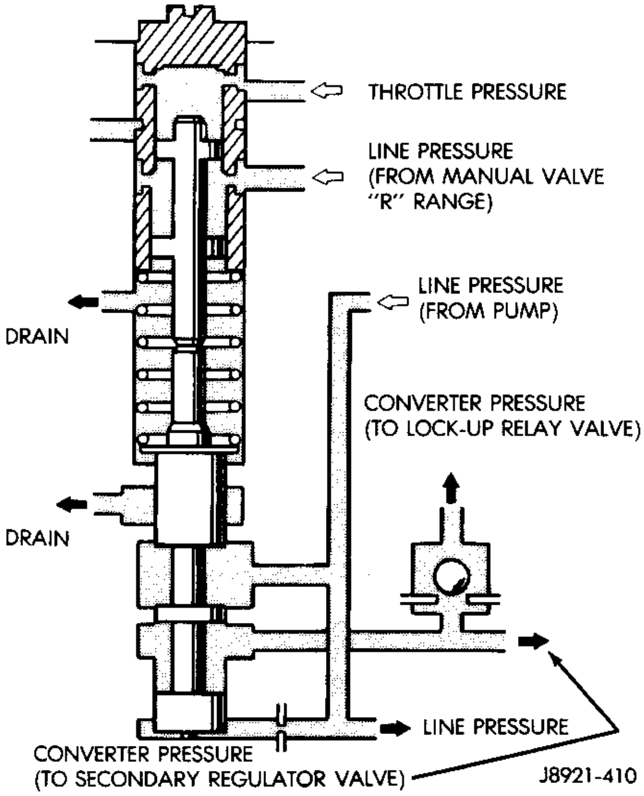


Fig. 13 Primary Regulator Valve

Lockup Relay Valve

The lockup relay valve (Fig. 17) controls fluid flow to the converter lockup clutch. The valve is operated by line pressure from the 1-2 shift valve and is controlled by solenoid valve number three.

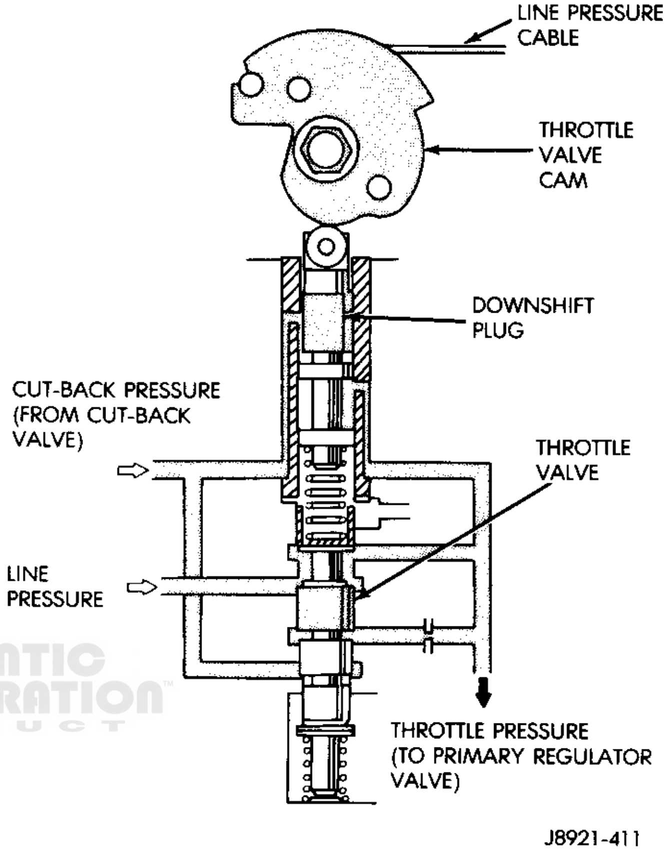


Fig. 14 Throttle Valve And Downshift Plug

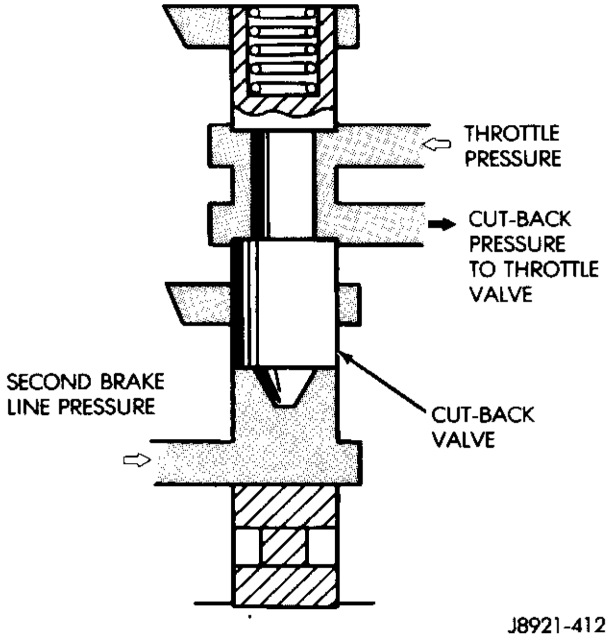


Fig. 15 Cut-Back Valve

1-2 Shift Valve

The 1-2 shift valve (Fig. 18) controls 1-2 upshifts and downshifts. The valve is operated by the No. 2 valve body solenoid and line pressure from the manual valve, second coast modulator valve and the 2-3 shift valve.

When the TCU deactivates the solenoid, line pressure at the top of the valve moves the valve down closing the second brake accumulator feed port. As the solenoid is activated and the drain port opens, spring force moves the valve up exposing the second brake feed port for the shift to second gear.

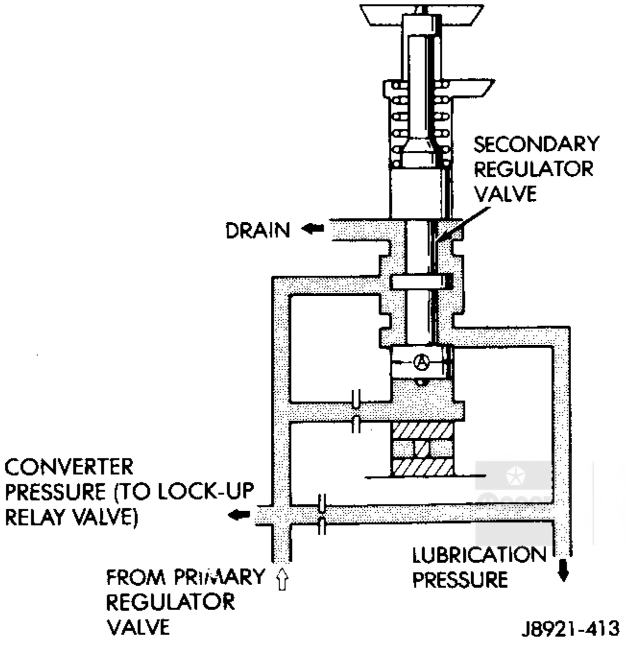


Fig. 16 Secondary Regulator Valve

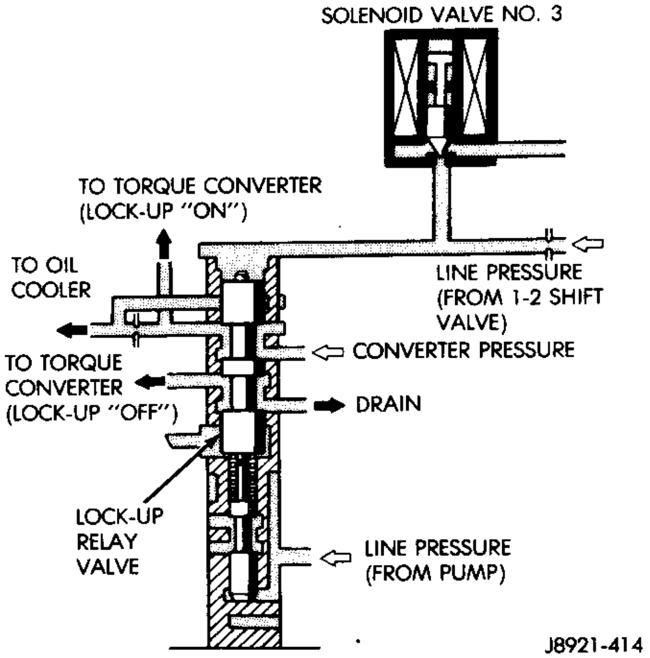


Fig. 17 Lockup Relay Valve

2-3 Shift Valve

The 2-3 shift valve (Fig. 19) controls 2-3 upshifts and downshifts. The valve is actuated by the No. 1 valve body solenoid and by line pressure from the manual valve and primary regulator valve.

When the TCU activates solenoid No. 1, line pressure at the top of the 2-3 valve is released through the solenoid drain port. Spring tension moves the valve up to hold the valve in second gear position. As the solenoid is deactivated, line pressure then moves the valve down exposing the direct clutch feed port for the shift to third gear.

3-4 Shift Valve

The 3-4 shift valve (Fig. 20) is operated by the No. 2 solenoid and by line pressure from the maual valve, 2-3 valve and primary regulator valve.

As the TCU activates solenoid No. 2, line pressure at the top of the 3-4 valve is released through the solenoid valve drain port. Spring tension moves the valve up exposing the overdrive clutch accumulator feed port to apply the clutch.

When the solenoid is deactivated and the drain port closes, line pressure moves the valve down exposing the overdrive brake accumulator feed port for the shift to fourth gear.

In the 1-2 or 3 gearshift lever positions, line pressure from the 2-3 shift valve is applied to the lower end of the 3-4 valve. This holds the valve upward, closing off the overdrive brake feed port preventing a shift into fourth gear.

Second Coast Modulator Valve

The second coast modulator valve (Fig. 21) momentarily reduces line pressure from the 1-2 shift valve to cushion application of the second coast brake. The valve is operative when the shift lever and manual valve are in the 3 position.

Low Coast Modulator Valve

The low coast modulator valve (Fig. 22) momentarily reduces line pressure from the 2-3 shift valve to cushion application of the first/reverse brake. The valve operates when the shift lever and manual valve are in the 1-2 position.

Accumulator Control Valve

The accumulator control valve (Fig. 23) cushions clutch and brake application by reducing back pressure to the accumulators when throttle opening is small. The valve is operated by oil pump (line) pressure and by throttle pressure.

Accumulators

Four accumulators are used to cushion application of the clutches and brakes (Fig. 24). The accumulators consist of spring loaded pistons which dampen the initial surge of apply pressure to provide smooth engagement during shifts.

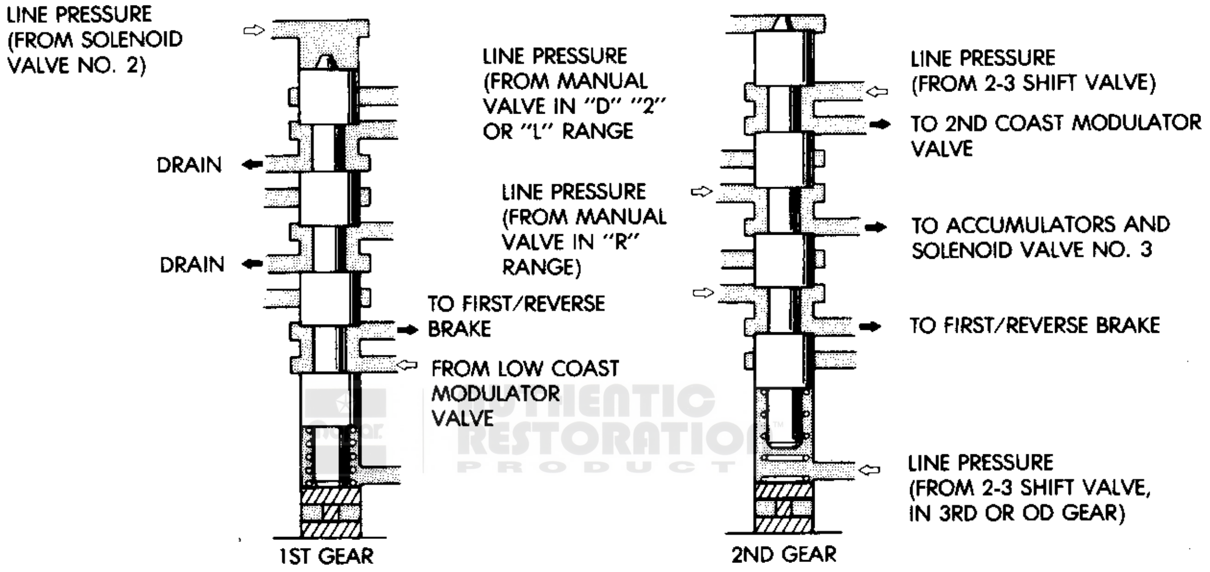
Control pressure from the accumulator control valve is continously applied to the back pressure side of the accumulator pistons. This pressure plus spring tension holds the pistons down. As line pressure from the shift valves enters the opposite end of the piston bore, control pressure and spring tension momentarily delay application of full line pressure to cushion engagement. The accumulators are all located in the transmission case (Fig. 24).

Valve Body Solenoids

Three solenoids are used (Fig. 25). The No. 1 and 2 solenoids control shift valve operation by applying or releasing line pressure as indicated by TCU signal. The No. 3 solenoid controls operation of the converter lockup clutch in response to signals from the TCU.

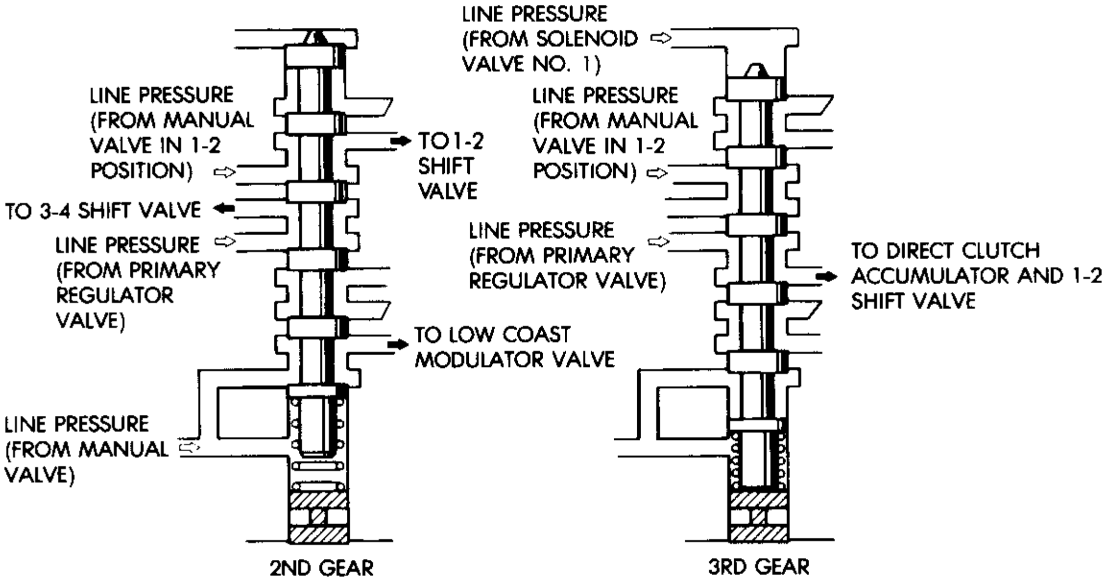
When the No. 1 and 2 solenoids are activated, the solenoid plunger is moved off its seat opening the drain port to release line pressure. When either solenoid is deactivated, the plunger closes the drain port.

The No. 3 solenoid operates in reverse. When the solenoid is deactivated, the solenoid plunger is moved off its seat opening the drain port to release line pressure. When the solenoid is activated, the plunger closes the drain port.



J8921-415

Fig. 18 1-2 Shift Valve



J8921-416

Fig. 19 2-3 Shift Valve

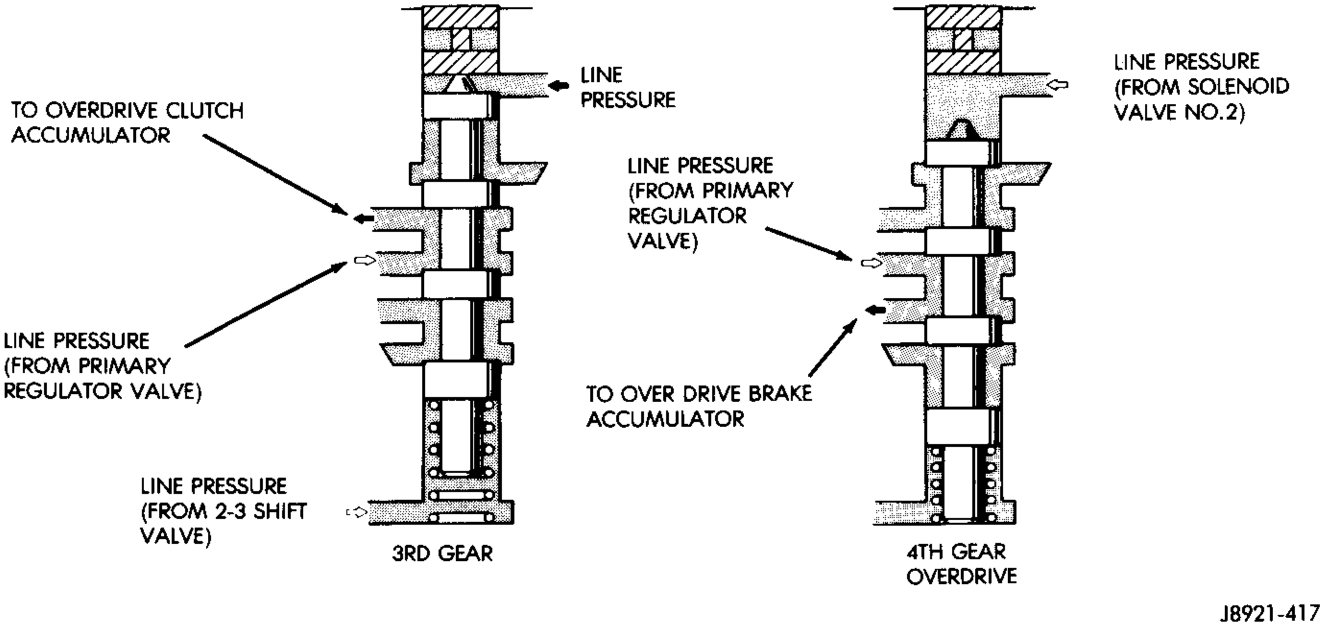


Fig. 20 3-4 Shift Valve

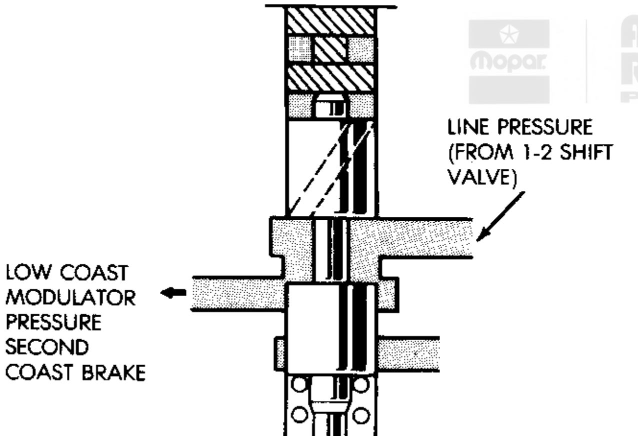


Fig. 21 Second Coast Modulator Valve

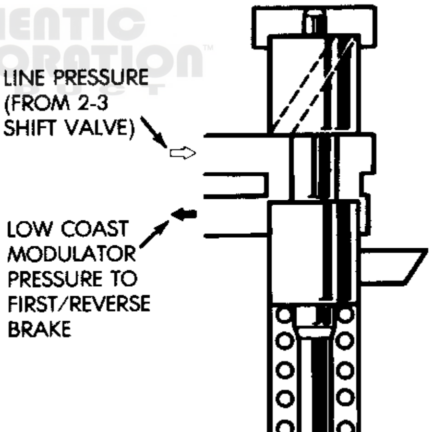


Fig. 22 Low Coast Modulator Valve

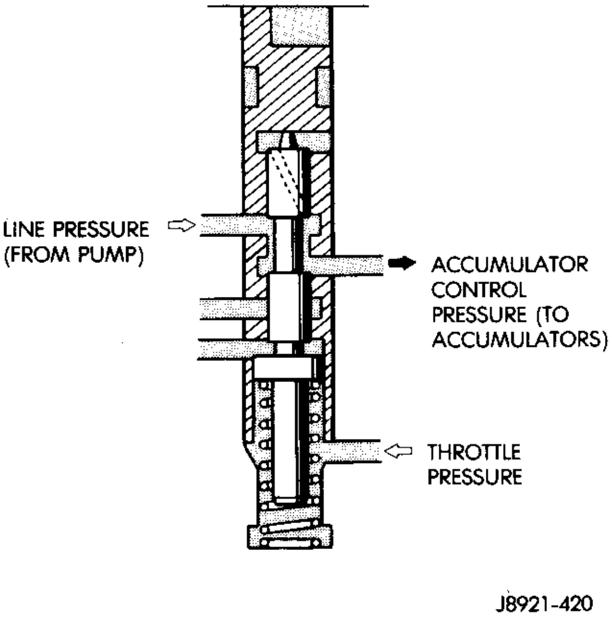


Fig. 23 Accumulator Control Valve

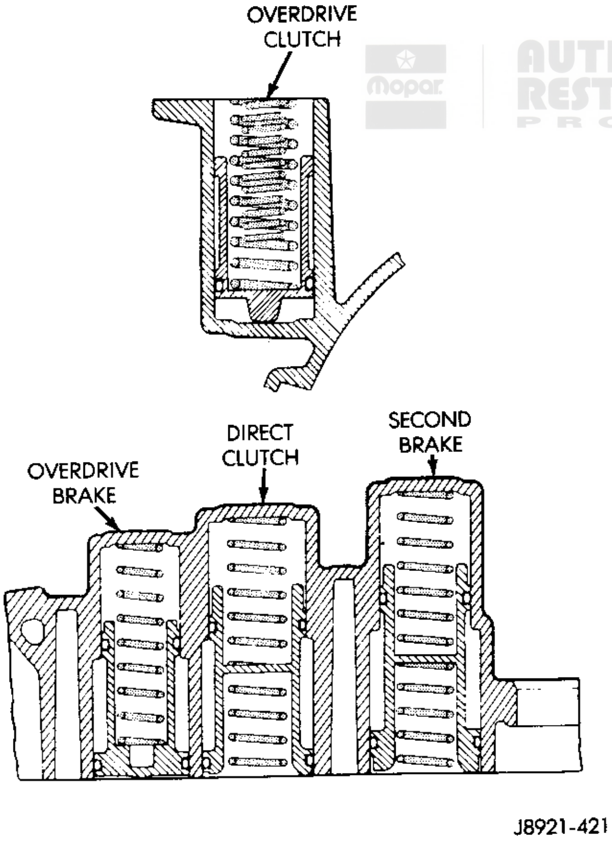


Fig. 24 Accumulators

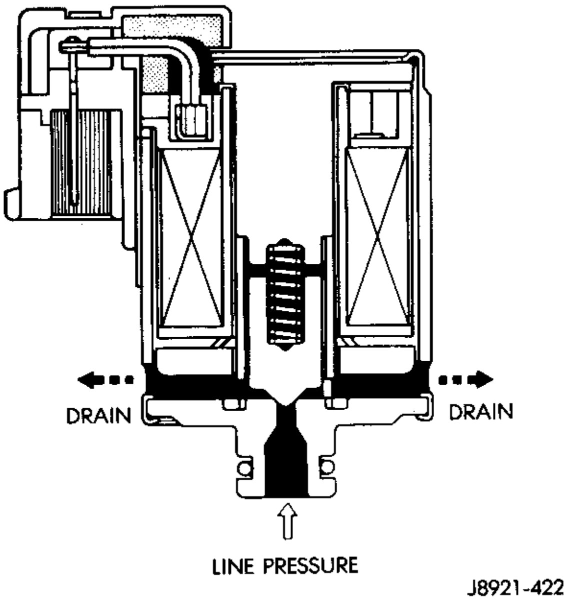


Fig. 25 Valve Body Solenoids

SERVICE DIAGNOSIS

INDEX

GENERAL DIAGNOSIS INFORMATION

The TCU used with the AW-4 transmission has a self-diagnostic program. The program is compatible with the DRB II tester.

The AW-4 is an electronically controlled transmission. Shift points and sequence in the forward gear ranges are controlled by the TCU. Before attempting repair, it will be necessary to determine if a malfunction is electrical or mechanical.

The DRB II tester will identify faults in the electrical control system. The road test, pressure test, stall test and time lag test plus the general diagnosis charts will help locate faults in the mechanical running gear.

All AW-4 diagnosis should begin with the Preliminary Check Procedure. The procedure is designed to help identify the type of problem (mechanical/electrical) that has occurred. The first step of the procedure is Initial Inspection and Adjustment which is detailed in this section.

INITIAL INSPECTION AND ADJUSTMENT

(1) Check and adjust shift linkage.

(2) Verify line pressure cable operation. Repair or replace cable if it binds or is damaged.

(3) Check engine throttle operation. Have helper press accelerator to floor and observe injector throttle plate movement. Adjust linkage if throttle plate does not reach wide open position.

(4) Check and adjust line pressure cable if necessary.

(5) Check transmission fluid level when fluid is at normal operating temperature. Start engine. Shift transmission through all gear ranges then back to Neutral. Correct level is to Full or Add mark on dipstick with engine at curb idle speed.

(6) Check and adjust neutral switch if necessary.

(7) Check TPS adjustment and operation. Adjust the sensor if necessary.

MANUAL SHIFTING TEST

(1) This test determines if the problem is related to a mechanical or electrical component.

(2) Stop engine and disconnect TCU or TCU fuse.

(3) Road test vehicle. Shift transmission into each gear range. Transmission should operate as follows:

- lock in Park
- back up in Reverse
- not move in Neutral
- provide first gear only with shift lever in 1-2 position
- operate in third gear only with shift lever in 3 position
- operate in overdrive fourth gear in D position

(4) If transmission operates as described, proceed to next step. However, if forward gear ranges were difficult to distinguish (all feel the same), or vehicle would not back up, refer to diagnosis charts. Do not perform stall or time lag tests.

CAUTION: Do not overspeed the engine during the next test step. Ease off the throttle and allow the vehicle to slow before downshifting.

(5) Continue road test. Manually downshift transmission from D to 3, and from 3 to 1-2 position. Then manually upshift transmission through forward ranges again.

(6) If transmission operation is OK, perform stall, time lag and pressure tests. If transmission shifting problem is encountered, refer to diagnosis charts.

(7) If a problem still exists, continue testing with DRB II tester.

HYDRAULIC PRESSURE TEST

Pressure Test Procedure

(1) Connect pressure test gauge to test port on passenger side of transmission. Use adapter 7554 to connect gauge. Be sure test gauge capacity is a minimum of 300 psi (2100 kPa).

(2) Bring transmission fluid to normal operating temperature.

(3) Apply parking brakes and block wheels.

WARNING: DO NOT ALLOW ANYONE TO STAND AT THE FRONT OR REAR OF THE VEHICLE WHILE PERFORMING THE FOLLOWING STEPS IN THE PRESSURE TEST.

(4) Check and adjust engine curb idle speed.

(5) Apply service brakes.

(6) Shift transmission into D range and note line pressure with engine at curb idle speed. Pressure should be 53-to-61 psi (363-to-422 kPa).

(7) Press accelerator to wide open throttle position and note line pressure. Pressure should be 161-to-196 psi (1108-to-1353 kPa).

CAUTION: Do not maintain wide open throttle for more than three or four seconds at a time.

(8) Shift transmission into Reverse and note line pressure with engine at curb idle speed. Pressure should be 73-to-87 psi (500-to-598 kPa).

(9) Press accelerator to wide open throttle position and note line pressure in Reverse. Pressure should be 223-to-273 psi (1540-to-1883 kPa).

CAUTION: Do not maintain wide open throttle for more than three or four seconds at a time.

(10) If line pressure is not within specifications, adjust line pressure cable and repeat pressure test.

Pressure Test Analysis

If pressures in D and Reverse are higher than specified, check for the following:

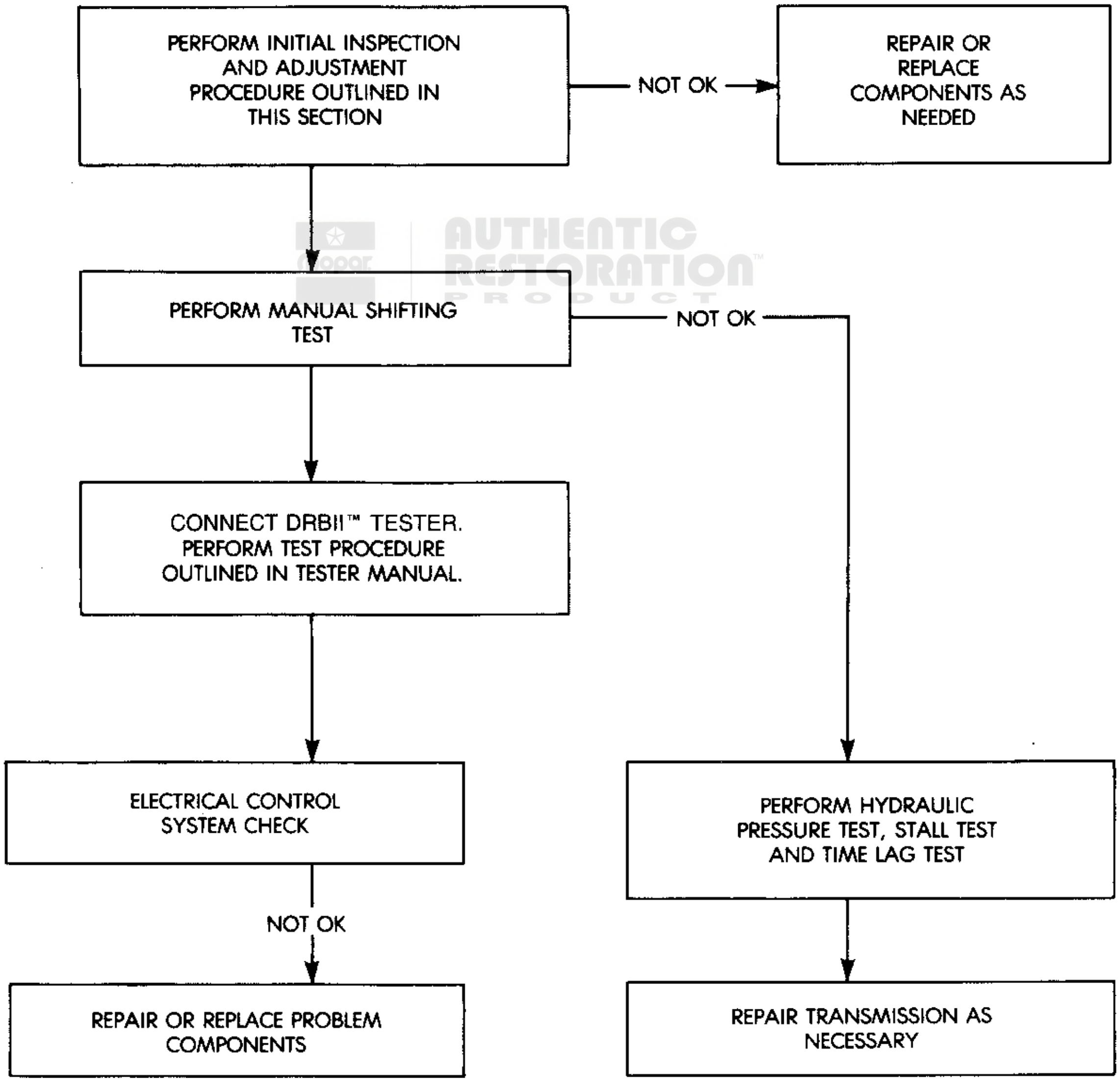
- line pressure cable loose, worn, binding or out of adjustment
- throttle valve, downshift plug, throttle cam sticking, worn or damaged
- primary regulator valve sticking, worn, or damaged

If pressures in D and Reverse are lower than specified, check for the following:

- line pressure cable loose, worn, binding or out of adjustment
- throttle valve, downshift plug, throttle cam sticking, worn or damaged
- primary regulator valve sticking, worn, or damaged
- oil pump gears or housing worn or damaged
- overdrive clutch worn or damaged

If pressures are low in D range only, check for the following:

- forward clutch worn or damaged
- fluid leakage in D range circuit (component seal and O-rings)



J8921-423

Fig. 26 Preliminary Check Procedure

If pressures are low in Reverse only, check for the following:

- shift linkage (and manual valve) out of adjustment
- fluid leakage in Reverse circuit (component seal and O-rings)
- direct clutch worn or damaged
- first/reverse brake worn or damaged

STALL TEST

(1) The stall test checks holding ability of the transmission clutches and brakes and the torque converter stator clutch.

(2) Bring transmission fluid to normal (hot) operating temperature.

(3) Connect tachometer to engine. Position tachometer so itcan be viewed from drivers seat.

(4) Apply parking brakes and block wheels.

(5) Apply and hold service brakes.

(6) On 4WD models, shift transfer case into two-wheel high position.

(7) Start engine.

WARNING: DO NOT ALLOW ANYONE TO STAND AT THE FRONT OR REAR OF THE VEHICLE DURING THE TEST.

(8) Shift transmission into D range.

(9) Press accelerator to wide open throttle position and note maximum engine rpm. Stall speed should be 2100-to-2400 rpm in D range.

CAUTION: Do not maintain wide open throttle for more than four or five seconds at a time.

(10) Release throttle and shift transmission into Neutral. Allow transmission fluid to cool for 15-20 seconds.

(11) Shift transmission into Reverse.

(12) Press accelerator down to wide open throttle position and note maximum engine rpm. Stall speed should be 2100-to-2400 rpm in Reverse.

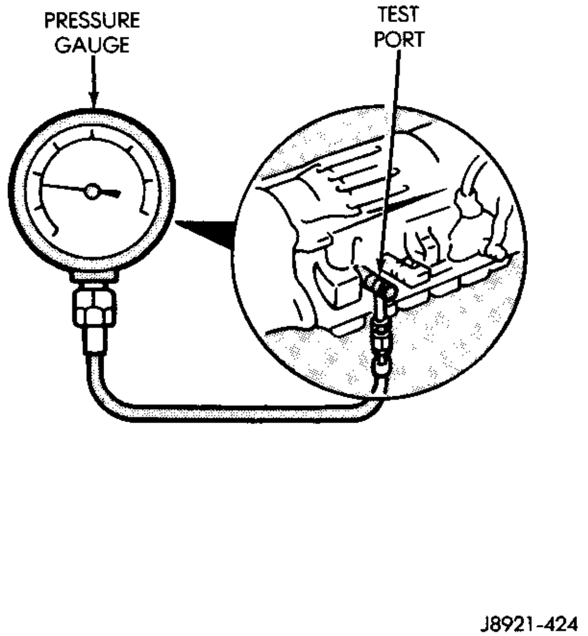


Fig. 27 Pressure Test Gauge Hookup

Stall Speed Test Analysis

If engine rpm is lower than specified in D and Reverse, check for the following:

- engine output/performance insufficient
- stator clutch in torque converter not holding if engine speed was 1500 rpm or less.

If stall speed in D range is higher than specified, check for the following:

- line pressure low
- forward clutch slipping
- No. 2 one-way clutch not holding
- overdrive one-way clutch not holding

If stall speed in Reverse was higher than specified, check for the following:

- line pressure low
- direct clutch slipping
- first/ reverse brake slipping
- overdrive one-way clutch not holding

If stall speeds were higher than specified in both D and Reverse, check for the following:

- low fluid level
- line pressure low
- overdrive one-way clutch not holding

TIME LAG TEST

This test checks general condition of the overdrive clutch, forward clutch, rear clutch and first/reverse brake. Condition is indicated by the amount of time required for clutch/brake engagement with the engine at curb idle speed. Engagement time is measured for D and Reverse positions. A stop watch is recommended for test accuracy.

Test Procedure

(1) Check and adjust transmission fluid level if necessary.

(2) Bring transmission to normal (hot) operating tempertue.

(3) Apply parking brakes.

(4) Turn off air conditioning unit.

(5) On 4WD models, shift transfer case into two-wheel high.

(6) Start engine and check curb idle speed. Adjust speed if necessary. Curb idle must be correct to ensure accurate test results.

(7) Shift transmission into Neutral and set stop watch.

(8) During following test steps, start stop watch as soon as shift lever reaches D and Reverse detents.

(9) Shift transmission into D range and record time it takes for engagement. Repeat test two more times.

(10) Reset stop watch and shift transmission back to Neutral.

(11) Shift transmission into Reverse and record time it takes for engagement. Repeat test two more times.

(12) Engagement time in D range should be a maximum of 1.2 seconds. Engagement time for Reverse should be a maximum of 1.5 seconds.

Time Lag Test Analysis

If engagement time is longer than specified for D range, check for the following:

- shift linkage misadjusted
- line pressure low
- forward clutch worn
- overdrive clutch worn or damaged

If engagement time is longer than specified for Reverse, check for the following:

- shift linkage misadjusted
- line pressure low
- direct clutch worn
- first/reverse brake worn
- overdrive clutch worn or damaged

SERVICE DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTION
FLUID DISCOLORED OR SMELLS BURNT	Fluid contaminated Torque converter faulty Transmission faulty	Replace fluid Replace torque converter Disassemble and repair transmission
VEHICLE DOES NOT MOVE IN ANY FORWARD RANGE OR REVERSE	Shift linkage out of adjustment Valve body or primary regulator faulty Park lock pawl faulty Torque converter faulty Converter drive plate broken Oil pump intake screen blocked Transmission faulty	Adjust linkage Inspect/repair valve body Repair park pawl Replace torque converter Replace drive plate Clean screen Disassemble and repair transmission
SHIFT LEVER POSITION INCORRECT	Shift linkage out of adjustment Manual valve and lever faulty	Adjust linkage Repair valve body
HARSH ENGAGEMENT (ALL RANGES)	Throttle cable out of adjustment Valve body or primary regulator faulty Accumulator pistons faulty Transmission faulty	Adjust throttle cable Repair valve body Repair pistons Disassemble and repair transmission
DELAYED 1-2, 2-3 OR 3-OD UP-SHIFT, OR DOWN-SHIFTS FROM 4-3 OR 3-2 AND SHIFTS BACK TO 4 OR 3	Electronic control problem Valve body faulty Solenoid faulty	Find faulty part with DRBII™ Tester Repair valve body Repair solenoid
SLIPS ON 1-2, 2-3 OR 3-OD UP-SHIFT, OR SLIPS OR SHUDDERS ON TAKE-OFF	Shift linkage out of adjustment LP cable out of adjustment Valve body faulty Solenoid faulty Transmission faulty	Adjust linkage Adjust cable Repair valve body Replace solenoid Disassemble and repair transmission
DRAG OR BIND ON 1-2, 2-3 OR 3-OD UP-SHIFT	Shift linkage out of adjustment Valve body faulty Transmission faulty	Adjust linkage Repair valve body Disassemble and repair transmission
NO LOCK-UP IN 2ND, 3RD OR OD	Electronic control problem Valve body faulty Solenoid faulty Transmission faulty	Repair with DRBII™ Tester Repair valve body Replace solenoid Disassemble and repair transmission
HARSH DOWN-SHIFT	Throttle cable out of adjustment Throttle cable and cam faulty Accumulator pistons faulty Valve body faulty Transmission faulty	Adjust cable Replace cable and cam Repair pistons Repair valve body Disassemble and repair transmission
NO DOWN-SHIFT WHEN COASTING	Valve body faulty Solenoid faulty Electronic control problem	Repair valve body Replace solenoid Locate problem with DRBII™ Tester

J8921-425

SERVICE DIAGNOSIS (CONT.)

CONDITION	POSSIBLE CAUSE	CORRECTION
DOWN-SHIFT LATE OR EARLY DURING COAST	Throttle cable faulty	Replace cable
	Valve body faulty	Repair valve body
	Transmission faulty	Disassemble and repair transmission
	Solenoid faulty	Replace solenoid
	Electronic control problem	Locate problem with DRBII™ Tester
NO OD-3, 3-2 OR 2-1 KICKDOWN	Solenoid faulty	Replace solenoid
	Electronic control problem	Locate problem with DRBII™ Tester
	Valve body faulty	Repair valve body
NO ENGINE BRAKING IN 1-2 POSITION	Solenoid faulty	Replace solenoid
	Electronic control problem	Locate problem with DRBII™ Tester
	Valve body faulty	Repair valve body
	Transmission faulty	Disassemble and repair transmission
VEHICLE DOES NOT HOLD IN PARK	Shift linkage out of adjustment	Adjust linkage
	Parking lock pawl cam and spring faulty	Replace cam and spring

J8921-426

IN-VEHICLE SERVICE-TESTING-ADJUSTMENT

INDEX

CHECKING TRANSMISSION FLUID LEVEL AND CONDITION

Recommended Fluid

Recommended fluid for AW 4 transmissions is Jeep or Mopar Mercon™ automatic transmission fluid. Mopar Dexron II™ may also be used if Mercon fluid is not available.

Checking Fluid Level

(1) Be sure transmission fluid is at normal operating temperature. Normal operating temperature is reached after approximately 15 miles (25 km) of operation.

(2) Position the vehicle on a level surface. This is important for an accurate fluid level check.

(3) Shift the transmission through all gear ranges and back to Neutral.

(4) Apply the parking brakes.

(5) Verify that the transmission is in Neutral.

(6) Wipe off the dipstick handle to prevent dirt from entering the fill tube. Then remove the dipstick and check fluid level and condition.

(7) Correct fluid level is **to the FULL mark on the dipstick when the fluid is at normal operating temperature** (Fig. 1).

(8) If fluid level is low, top off the level with Jeep Mercon™, transmission fluid. Mopar Dexron II™ may also be used if Mercon is not available. **Do not overfill the transmission. Add only enough fluid to bring the level to the FULL mark.**

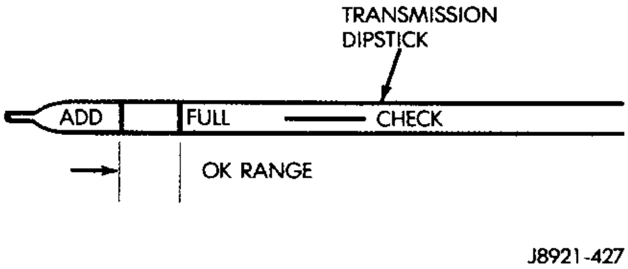


Fig. 1 Transmission Fluid Level

Checking Fluid Condition

Inspect the appearance of the fluid during the fluid level check. The fluid should be clear and free of foreign material or particles. If the fluid is dark brown or black in color and smells burnt, the fluid has been overheated and should be replaced.

Transmission operation should also be checked if the fluid is severely discolored and contains quantities of foreign material, metal particles, or clutch disc friction material.

A small quantity of friction material or metal particles in the oil pan is normal. The particles are usually generated during the break-in period and indicate normal seating of the various transmission components.

TCU SERVICE

Use the DRB II tester to diagnose TCU function whenever a fault is suspected. Replace the TCU only when the tester indicates a TCU fault.

TCU Replacement

The TCU is located under the instrument panel on the passenger side of the vehicle (Fig. 2). Turn the ignition off. Remove the TCU by unsnapping the wire harness connector and removing the TCU from under the instrument panel. To install the replacement part, snap the wire harness connector into the new TCU and position it under the panel.

NEUTRAL SWITCH

Switch Testing

Test switch continuity with an ohmmeter. Disconnect the switch and check continuity at the connector terminal positions and in the gear ranges indicated in Figure 3. Switch continuity should be as follows:

- Continuity should exist between terminals B and C with the transmission in Park and Neutral only (Fig. 3).
- Continuity should exist between terminals A and E with the transmission in Reverse (Fig. 3).

- Continuity should exist between terminals A and G with the the transmission in third gear (Fig. 3).
- Continuity should exist between terminals A and H with the transmission in first and/or second gear (Fig. 3).
- Continuity should not exist in D position.

Neutral Switch Removal

(1) Raise vehicle.

(2) Disconnect switch wire harness connector.

(3) Pry washer lock tabs upward and remove switch attaching nut and tabbed washer (Fig. 4).

(4) Remove switch adjusting bolt (Fig. 4).

(5) Slide switch off manual valve shaft.

Neutral Switch Installation And Adjustment

(1) Disconnect shift linkage rod from shift lever on left side of transmission.

(2) Rotate manual shift lever all the way rearward. Then rotate lever forward two detent positions to Neutral.

(3) Install switch on manual valve shaft and install switch adjusting bolt finger tight. Do not tighten bolt at this time.

(4) Install tabbed washer on manual valve shaft and install switch attaching nut. Tighten nut to 6.9 N•m (61 in-lbs) torque but do not bend washer lock tabs over nut at this time.

(5) Verify that transmission is in Neutral.

(6) Rotate switch to align neutral standard line with vertical groove on manual valve shaft (Fig. 5).

(7) Align switch standard line with groove or flat on manual valve shaft.

(8) Tighten switch adjusting bolt to 13 N•m (9 ft-lbs) torque.

(9) Bend at least two washer lock tabs over switch attaching nut to secure it.

(10) Connect shift linkage rod to shift lever on left side of case.

(11) Connect switch wires to harness and lower vehicle.

(12) Check switch operation. Engine should start in Park and Neutral only.

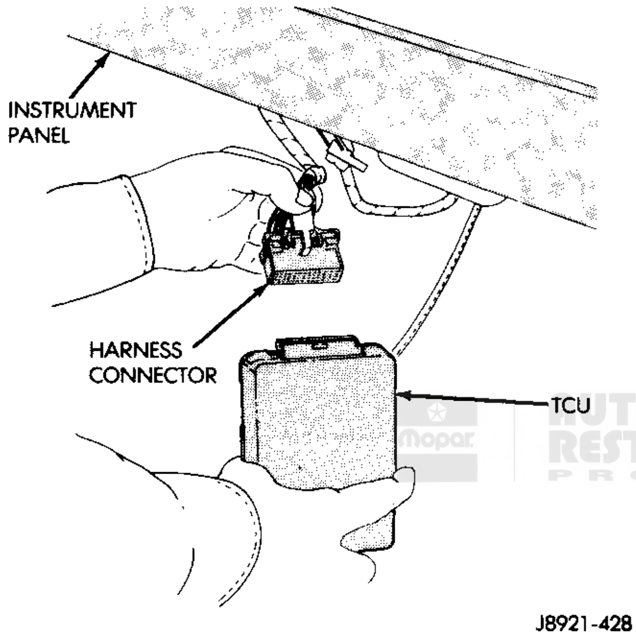
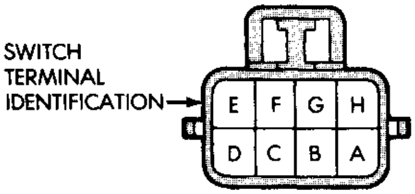


Fig. 2 TCU Removal/Installation



	B	C	A	E	G	H
P	○—	—○				
R			○—	—○		
N	○—	—○				
D						
3			○—	——	—○	
1-2			○—	——	——	—○

J8921-429

Fig. 3 Neutral Switch Terminals And Testing

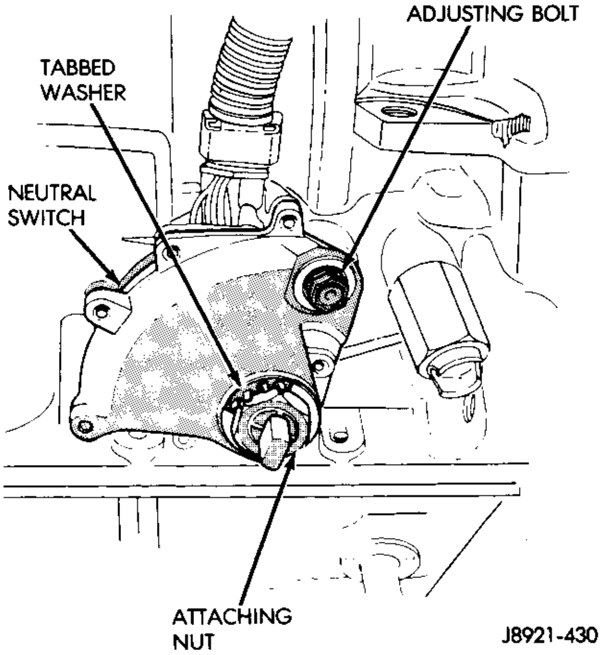


Fig. 4 Neutral Switch Removal/Installation

VALVE BODY SOLENOIDS

Solenoid Removal And Testing

(1) Remove transmission oil pan drain plug and drain fluid.

(2) Remove pan bolts and remove oil pan.

(3) Remove oil screen bolts and remove screen (Fig. 6) and gasket. Discard the gasket.

(4) Disconnect solenoid wire connector (Fig. 7).

(5) If all solenoids are being removed, mark or tag wires for assembly reference before disconnecting them.

(6) Remove bolt attaching solenoids to valve body and remove solenoids (Fig. 8). Do not allow any valve body components to fall out when solenoids are removed.

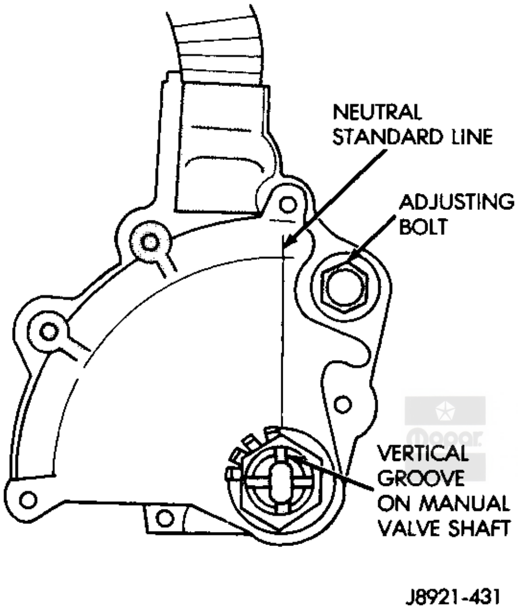


Fig. 5 Neutral Switch Adjustment

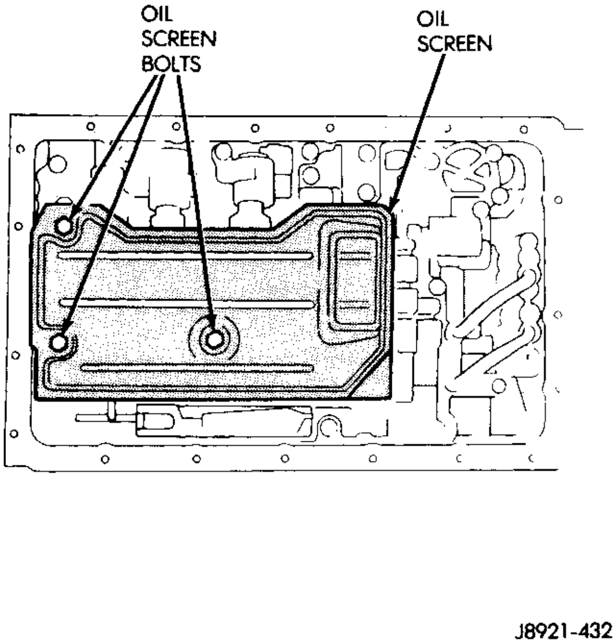


Fig. 6 Oil Screen Removal/Installation

(7) Clean oil filter and pan with solvent and dry with compressed air.

(8) Remove old sealer material from oil pan and transmission case.

Solenoid Testing

Test solenoid resistance with an ohmmeter.

Connect the ohmmeter leads to the solenoid mounting bracket and to the solenoid wire terminal (Fig. 9).

Solenoid resistance should be 11-15 ohms.

Replace the solenoid if resistance is above or below the specified range.

Solenoid Installation

(1) Position solenoids on valve body and install solenoid bolts. Tighten bolts to 10 N•m (7 ft-lbs) torque.

(2) Connect feed wires to solenoids.

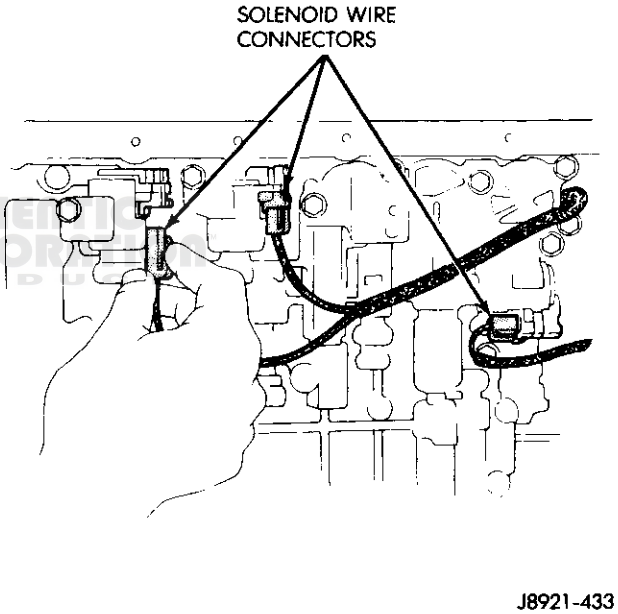


Fig. 7 Solenoid Wire Connectors

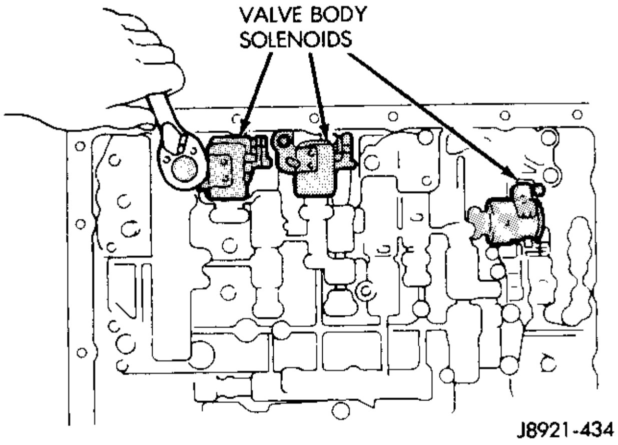


Fig. 8 Valve Body Solenoids

(3) Install new gaskets on oil screen and install screen. Tighten screen bolts to 10 N•m (7 ft-lbs) torque.

(4) Apply bead of Three-Bond TB 1281 or equivalent sealer to oil pan sealing surface. Sealer bead should be at least 1.0 mm (.040 in) wide.

(5) Install oil pan on transmission. Tighten pan bolts to 7.4 N•m (65 in-lbs) torque.

(6) Install and tighten oil pan drain plug to 20 N•m (15 ft-lbs) torque.

(7) Fill transmission with Mopar Mercon™ or Dexron II™ transmission fluid.

Solenoid Harness Adapter Seal Replacement

(1) Remove oil pan and oil screen. Refer to Solenoid Removal procedure.

(2) Disconnect solenoid wire connectors (Fig. 7).

(3) Remove bracket securing solenoid harness adaptor (Fig. 10) to case.

(4) Pull harness adapter and wires out of case.

(5) Remove and discard adapter O-ring.

(6) Lubricate new O-ring and install it on adapter.

(7) Install solenoid wire harness and adapter in case.

(8) Install adapter bracket and bracket bolt.

(9) Connect wires to solenoids.

(10) Install oil screen and oil pan.

VALVE BODY

Removal and installation are the only valve body service procedures covered in this section. Refer to the transmission overhaul section for valve body disassembly, cleaning, inspection and reassembly.

Valve Body Removal

(1) Remove oil pan plug and drain transmission fluid.

(2) Remove oil pan and oil screen. Clean pan and screen in solvent and dry them with compressed air.

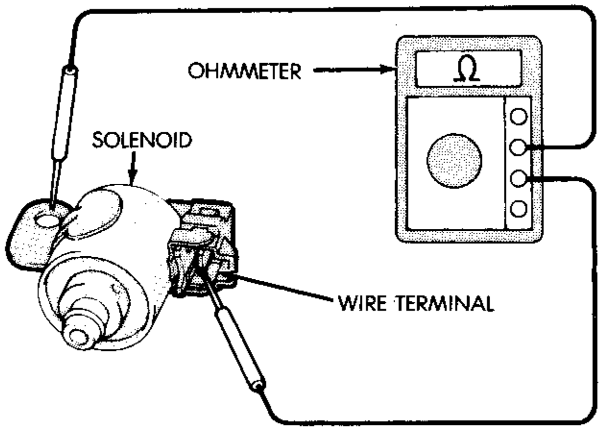


Fig. 9 Testing Valve Body Solenoid

(3) Disconnect solenoid wire connectors (Fig. 7). Mark wires for assembly reference.

(4) Remove valve body oil tubes (Fig. 13). Carefully pry tubes out of valve body with screwdriver.

(5) Disconnect throttle cable from throttle cam (Fig. 13).

(6) Remove valve body bolts. Locations for seventeen bolts are outlined in Figure 14.

(7) Lower valve body and remove overdrive clutch accumulator springs; direct clutch accumulator spring and spacer; second brake accumulator spring and spacer (Fig. 15)

(8) Remove valve body and check ball and spring (Fig. 16).

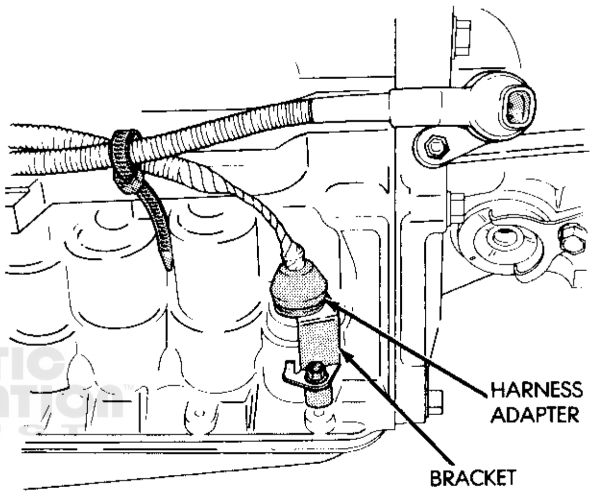


Fig. 10 Harness Adapter Removal/Installation

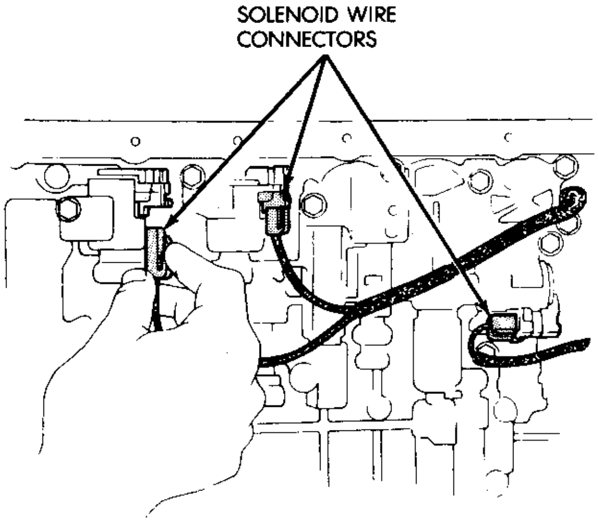


Fig. 11 Disconnect Solenoid Wires

Valve Body Installation

(1) Connect cable to throttle cam (Fig. 13).

(2) Install check ball and spring (Fig. 16).

(3) Position accumulator springs and spacers on valve body.

(4) Align valve body manual valve with shift sector (Fig. 17) and carefully position valve body on case.

(5) Install valve body bolts (Fig. 14). Tighten bolts evenly to 10 N•m (7 ft-lbs) torque.

(6) Install valve body oil tubes. Be sure tube ends (L) and (M) are installed as shown in Figure 18.

(7) Remove old sealer material from oil pan and transmission case.

(8) Clean oil screen and oil pan with solvent (if not done previously). Dry both components with compressed air only. Do not use shop towels.

(9) Install new gaskets on oil screen and install screen on case. Tighten screen attaching bolts to 10 N•m (7 ft-lbs) torque.

(10) Apply bead of Three Bond TB 1281 sealer to sealing surface of oil pan. Sealer bead should be at least 1.0 mm (.040 in) wide. Then install oil pan and tighten pan bolts to 7.4 N•m (65 in-lbs) torque.

(11) Install new gasket on oil pan drain plug and install plug in pan. Tighten plug to 20 N•m (15 ft-lbs) torque.

(12) Fill transmission with Mopar Mercon™ fluid.

MANUAL VALVE SHAFT SEAL REPLACEMENT

(1) Remove neutral safety switch and disconnect transmission shift lever.

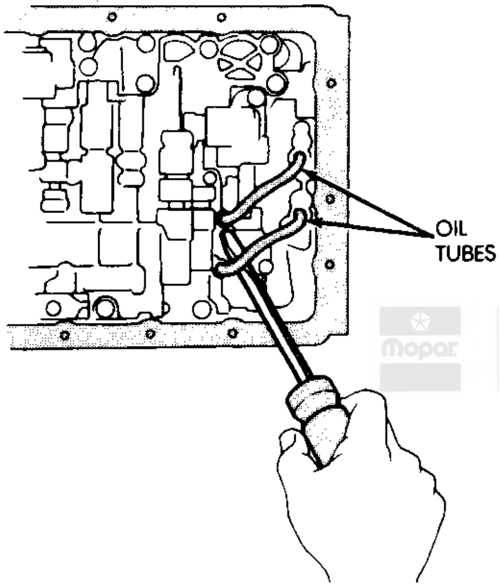


Fig. 12 Removing Valve Body Oil Tubes

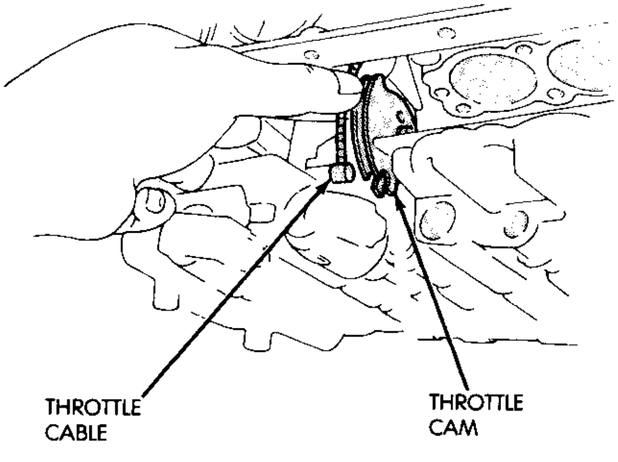


Fig. 13 Removing/Installing Throttle Cable

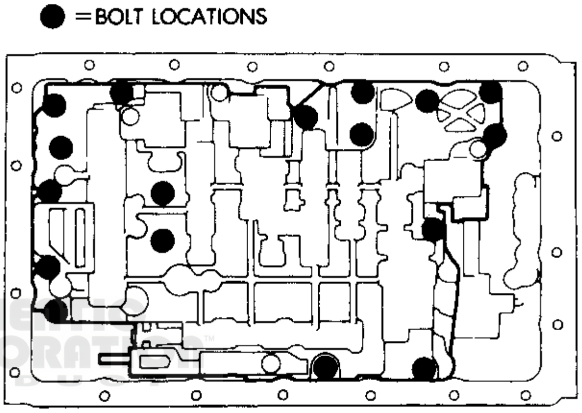


Fig. 14 Valve Body Bolt Locations

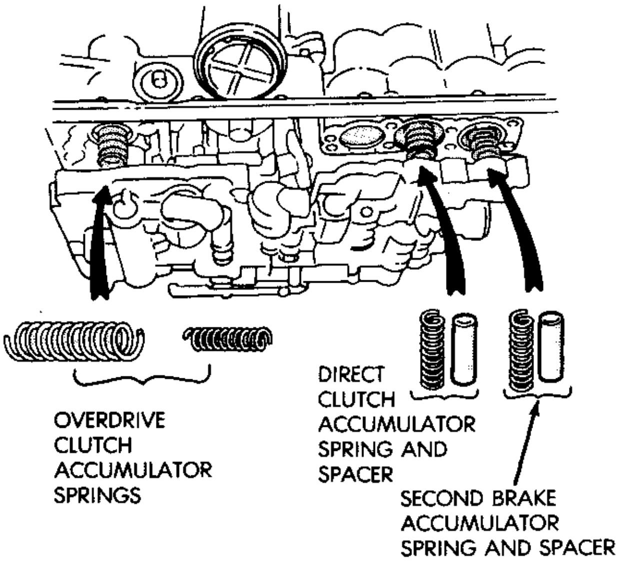


Fig. 15 Accumulator Springs

(2) Remove oil pan and valve body.

(3) Remove bolts attaching park rod bracket to case (Fig. 20).

(4) Remove park rod from shift sector (Fig. 21).

(5) Cut spacer sleeve with chisel and remove it from manual valve shaft (Fig. 22).

(6) Remove pin from shaft and sector with pin punch.

(7) Remove shaft and sector from case.

(8) Pry shaft seals out of case (Fig. 23).

(9) Inspect the manual valve shaft and sector. Replace either component if worn or damaged.

(10) Coat replacement shaft seals with petroleum jelly and seat them in the case (Fig. 24).

(11) Install new spacer sleeve on sector (Fig. 25).

(12) Lubricate manual valve shaft and install it in case.

(13) Lubricate sector and sleeve and install them on shaft.

(14) Align hole in spacer sleeve with notch in sector. Then install shift sector roll pin. Tap pin into sector and shaft and stake sleeve to sector and shaft securely.

(15) Connect park rod to sector (Fig. 21).

(16) Install park rod bracket (Fig. 26). Tighten bracket bolts to 10 N•m (7 ft-lbs) torque.

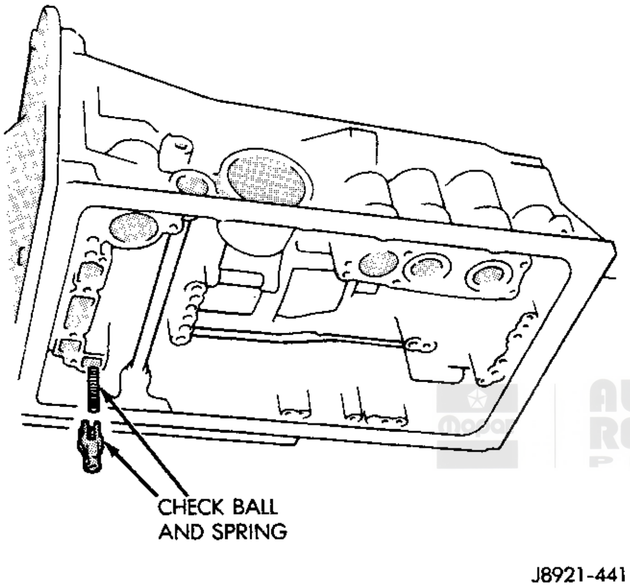


Fig. 16 Removing/Installing Valve Body Check Ball And Spring

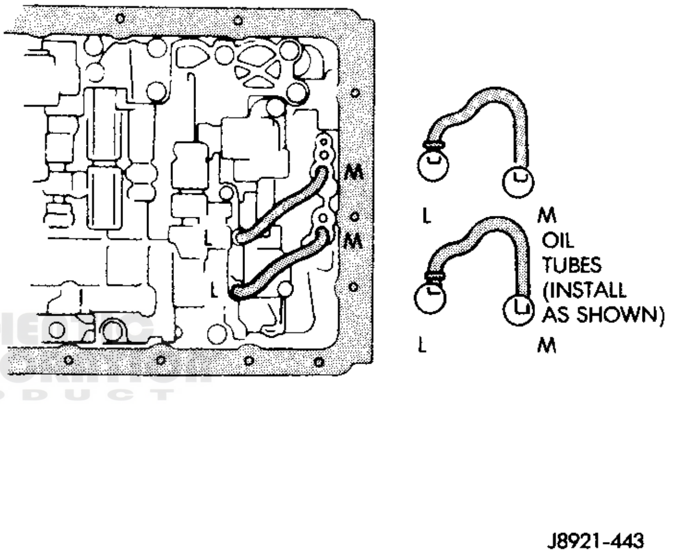


Fig. 18 Installing Valve Body Oil Tubes

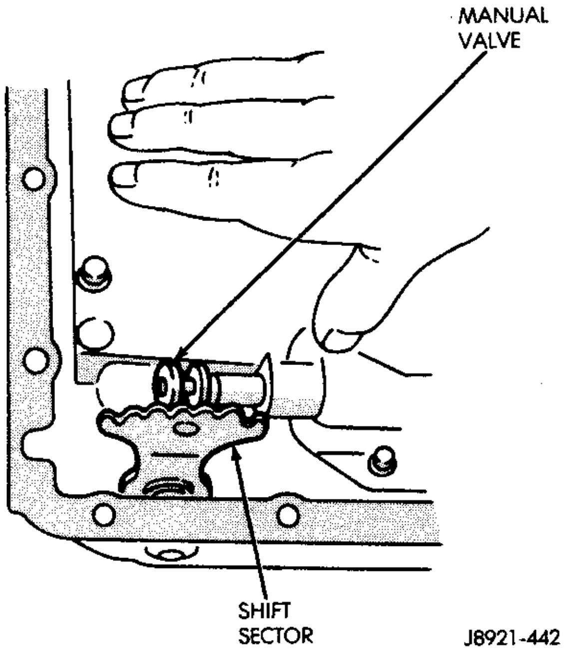


Fig. 17 Align Shift Sector And Manual Valve

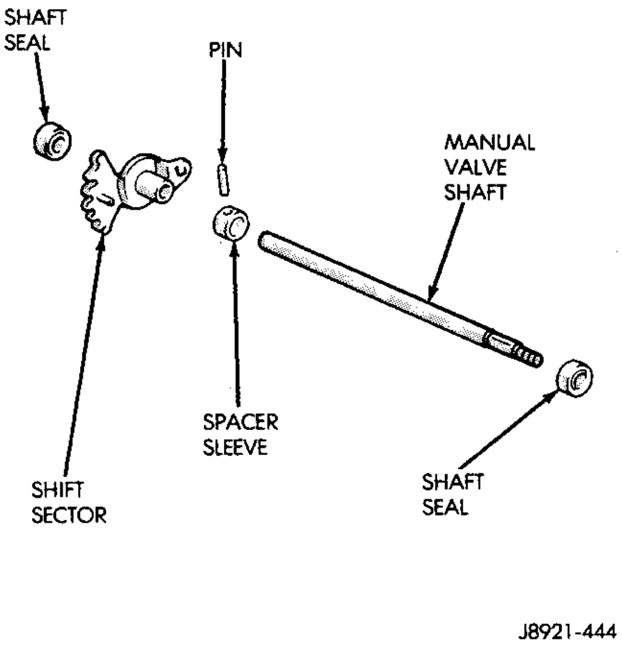


Fig. 19 Manual Valve Shaft And Seals

(17) Install valve body, oil screen, oil pan and neutral switch.

THROTTLE CABLE REPLACEMENT-ADJUSTMENT

Throttle Cable Removal

(1) In engine compartment, disconnect cable from throttle linkage. Then compress cable mounting ears and remove cable from linkage bracket.

(2) Raise vehicle.

(3) Remove transmission oil pan.

(4) Disengage cable from throttle valve cam (Fig. 27).

(5) Remove cable bracket bolt and remove cable and bracket from case (Fig. 28).

(6) Remove and discard cable seal.

Throttle Cable Installation

(1) Lubricate and install new seal on cable.

(2) Insert cable in transmission case.

(3) Attach cable to throttle cam (Fig. 27).

(4) Install cable bracket on case and tighten attaching bolt to 10 N•m (7 ft-lbs) torque (Fig. 28).

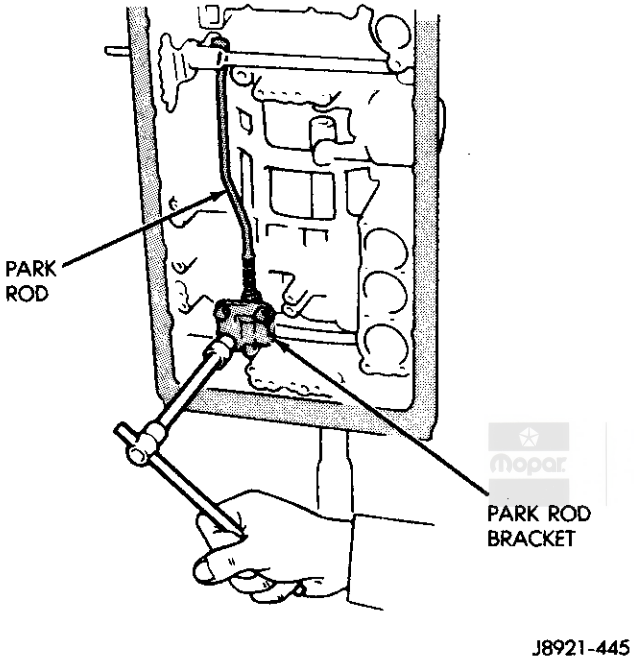


Fig. 20 Removing/Installing Park Rod Bracket

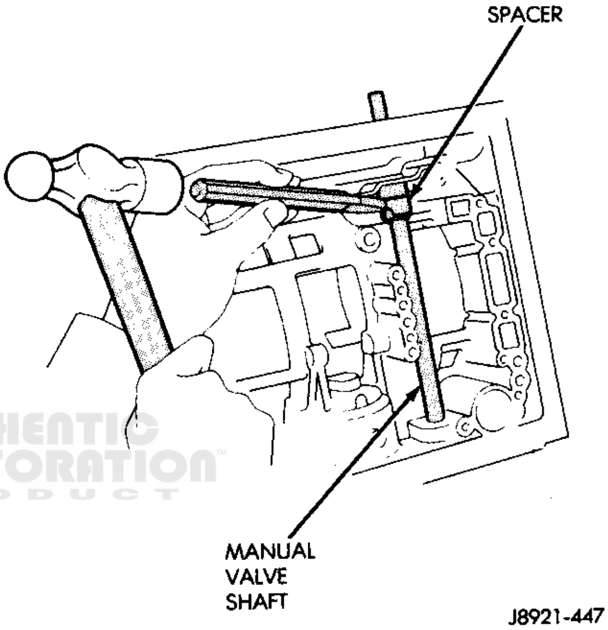


Fig. 22 Cutting Spacer Sleeve

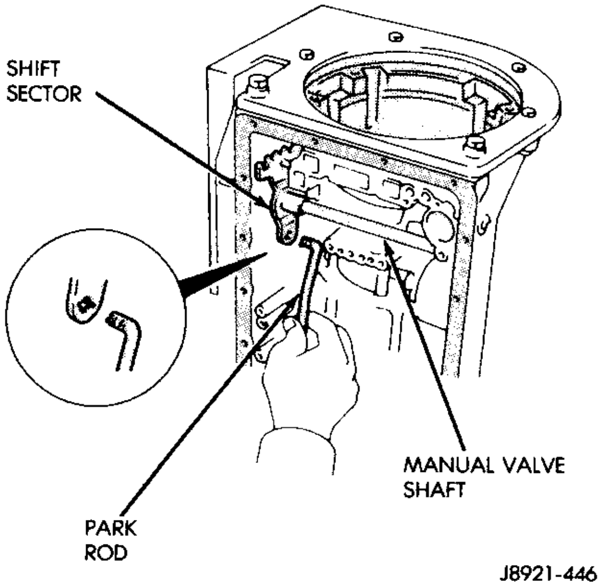


Fig. 21 Removing/Installing Park Rod

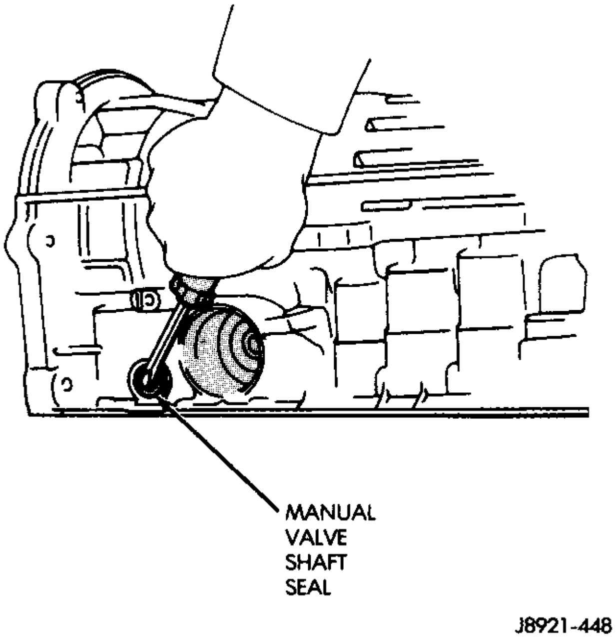


Fig. 23 Removing Manual Valve Shaft Seals

(5) Remove old sealer material from oil pan and transmission case. Clean oil pan with solvent and dry it with compressed air.

(6) Apply bead of Three Bond TB 1281 sealer to oil pan sealing surface. Sealer bead should be at least 1.0 mm (.040 in) wide. Then install pan and tighten pan bolts to 7.4 N•m (65 in-lbs) torque.

(7) Install new gasket on oil pan drain plug. Install and tighten plug to 20 N•m (15 ft-lbs) torque.

(8) Connect cable to engine bracket and throttle linkage.

(9) Fill transmission with Mopar Mercon™.

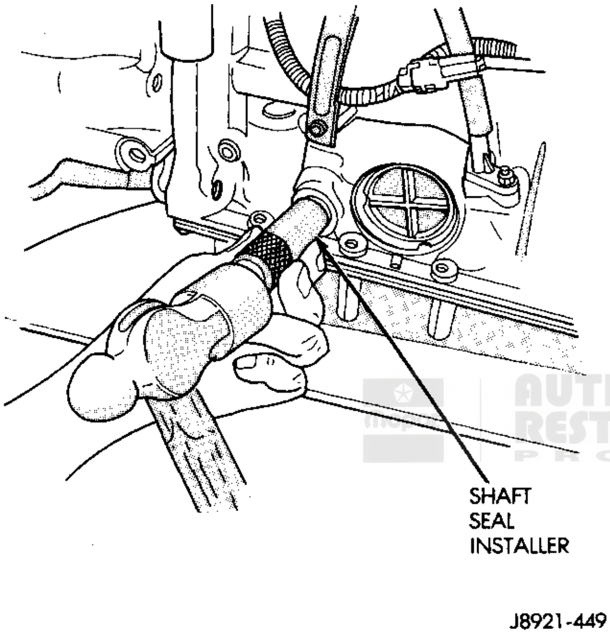


Fig. 24 Installing Manual Valve Shaft Seals

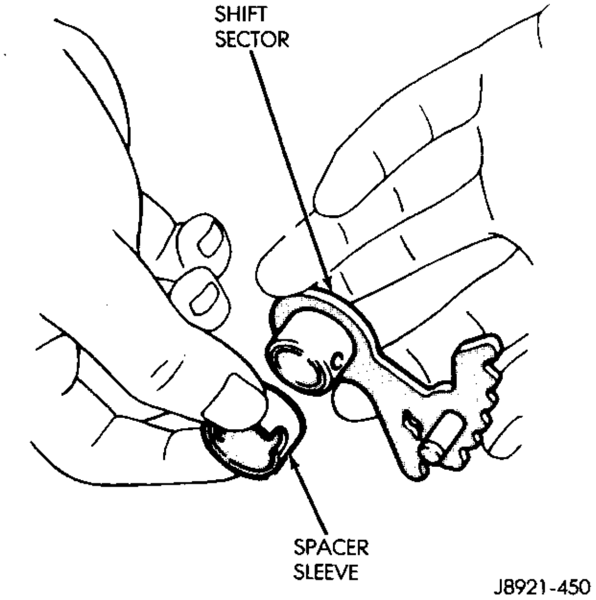


Fig. 25 Installing Spacer Sleeve On Sector

(10) Adjust the cable as outlined in the Line Pressure Cable Adjustment procedure.

Throttle Cable Adjustment

(1) Turn ignition switch to Off position.

(2) Fully retract cable plunger. Press cable button all the way down. Then push cable plunger inward (Fig. 29).

(3) Rotate primary throttle lever to wide open throttle position (Fig. 30).

(4) Hold primary throttle lever in wide open position and let cable plunger extend. Release lever when plunger is fully extended. Cable is now adjusted.

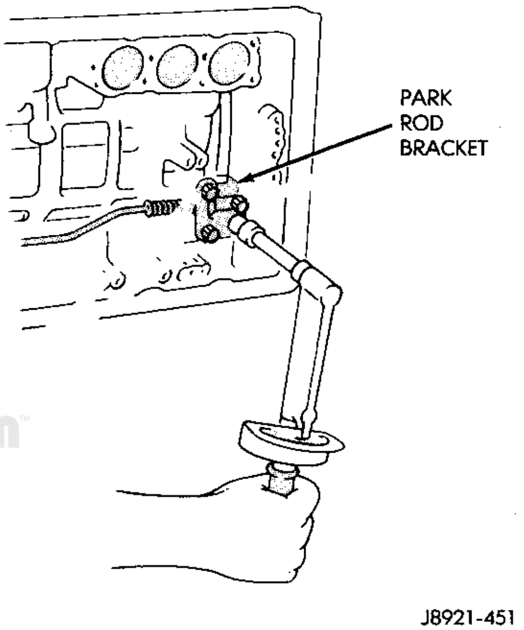


Fig. 26 Installing Park Rod Bracket

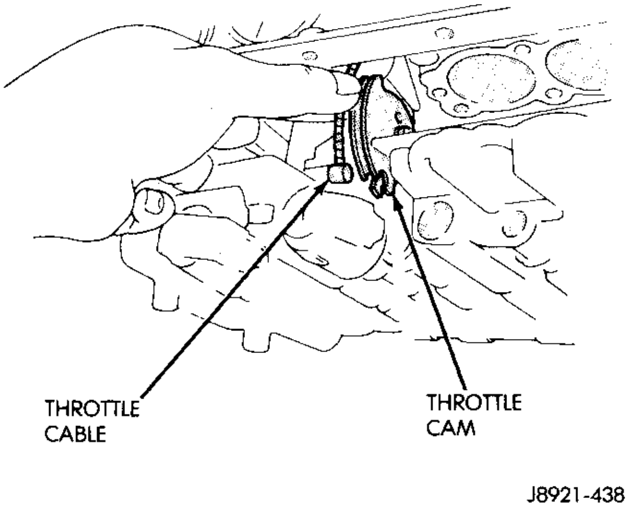


Fig. 27 Removing/Installing Throttle Cable

ACCUMULATOR PISTONS AND SPRINGS

Accumulator Piston and Spring Removal

(1) Remove valve body.Refer to procedure in this section.

(2) Remove accumulator pistons with compressed air (Fig. 31). Apply air through small feed hole next to each piston bore. Catch each piston in a shop towel as it exits the bore.

CAUTION: Use only enough air pressure to ease each piston out of the bore. In addition, remove the pistons one at a time and tag the pistons and springs for assembly reference. Do not intermix them.

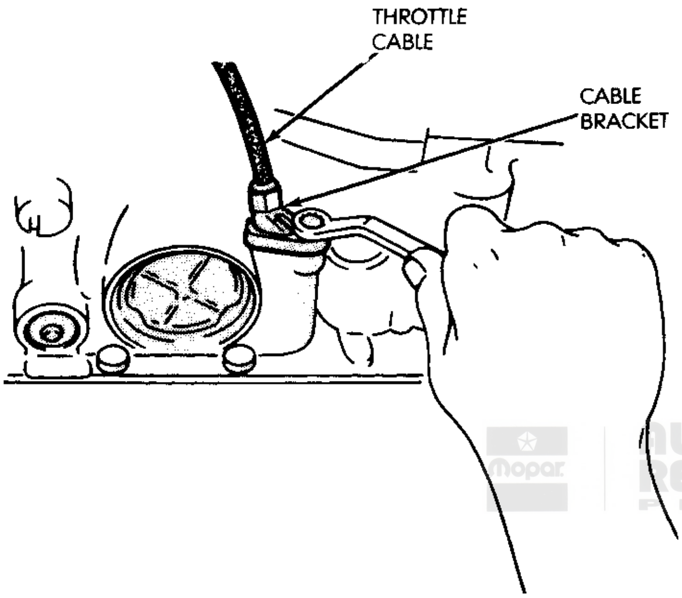


Fig. 28 Removing/Installing Cable And Bracket

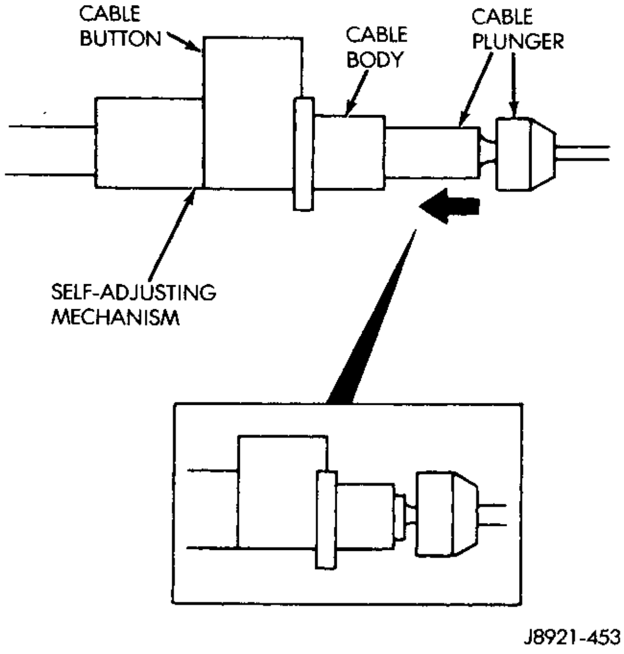


Fig. 29 Retract Throttle Cable Plunger

(3) Remove and discard piston O-ring seals. Then clean the pistons and springs with solvent.

(4) Inspect the pistons and springs and the piston bores in the case. Replace worn damaged pistons. Replace broken, collapsed or distorted springs. Replace the case if the piston bores are damaged.

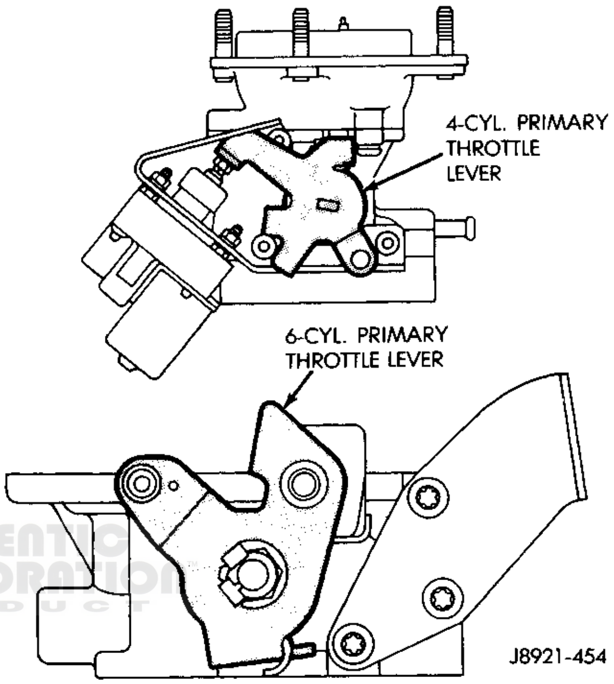


Fig. 30 Rotate Primary Throttle Lever To Wide Open Position

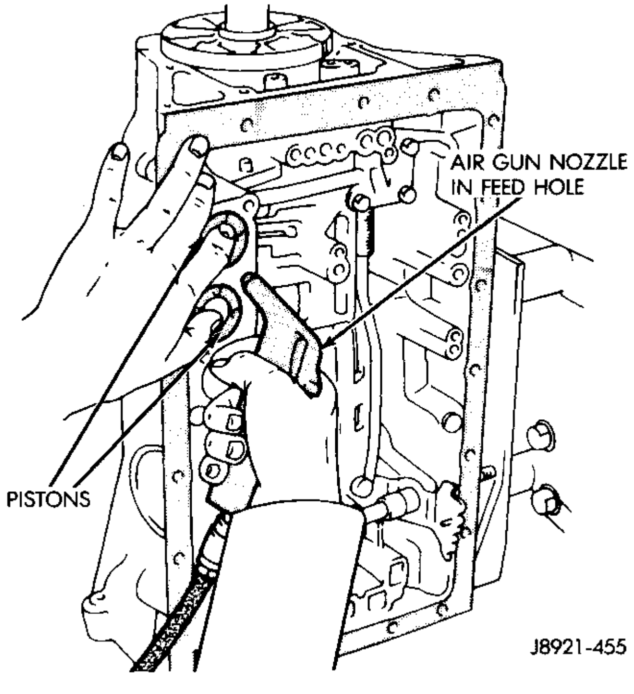


Fig. 31 Removing Accumulator Pistons

(5) Install new O-ring seals on pistons. Lubricate seals and pistons and piston bores with transmission fluid.

(6) Install pistons and springs (Fig. 32).

(7) Install valve body, oil screen and oil pan.

SECOND COAST BRAKE SERVO

Servo Overhaul

(1) Remove valve body as outlined in this section.

(2) Remove servo piston cover snap ring with snap ring pliers (Fig. 33).

(3) Remove servo piston and cover with compressed air. Apply compressed air through oil hole in servo boss to ease piston out of bore (Fig. 34).

(4) Remove and discard seal and O-rings from cover and piston (Fig. 35). Inspect E-ring, piston, spring and retainer, piston rod and piston spring. Replace worn or damaged parts.

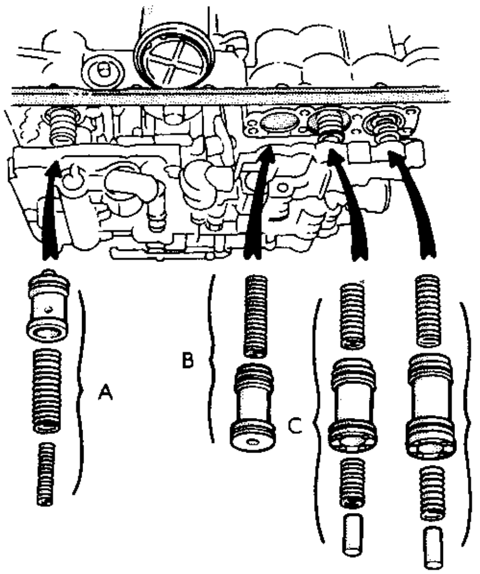
(5) Install new seals on cover and piston.

(6) Lubricate servo components with transmission fluid.

(7) Assemble and install servo components in case. Be sure servo piston rod is properly engaged in the second coast brake band.

(8) Compress cover and piston and install cover snap ring.

(9) Install valve body, oil screen and oil pan.



A. OVERDRIVE CLUTCH ACCUMULATOR PISTON AND SPRINGS
B. OVERDRIVE BRAKE ACCUMULATOR PISTON AND SPRINGS
C. SECOND CLUTCH ACCUMULATOR PISTON, SPRINGS AND SPACER
D. SECOND CLUTCH ACCUMULATOR PISTON, SPRINGS AND SPACER

NOTE: PISTON HEIGHT AND DIAMETER ARE OUTLINED IN THE SPECIFICATIONS SECTION.

J8921-456

Fig. 32 Accumulator Piston-Springs-Spacers

PARK ROD AND PAWL

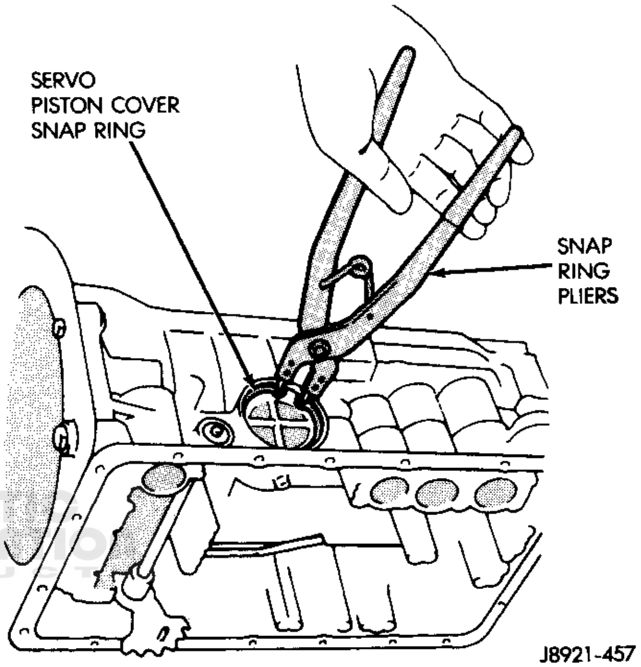
Park Rod and Pawl Removal

(1) Remove valve body as outlined in this section.

(2) Remove bolts attaching park rod bracket to case (Fig. 36).

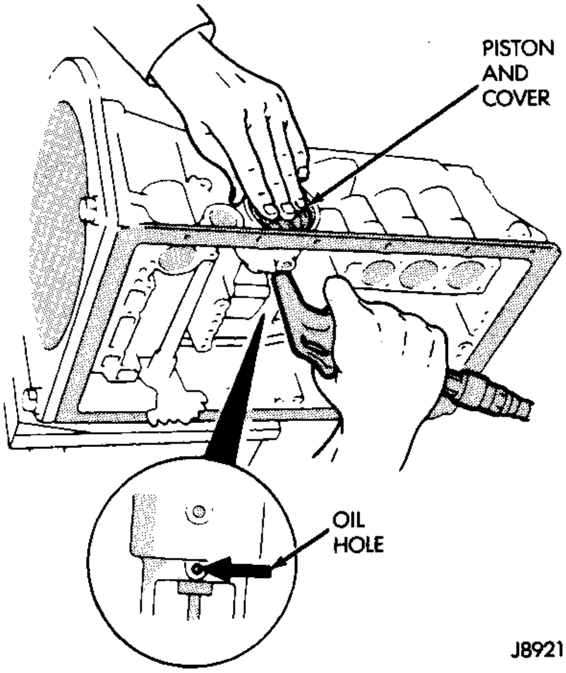
(3) Remove park rod from manual valve shaft sector (Fig. 37).

(4) Remove park rod.



J8921-457

Fig. 33 Removing/Installing Servo Piston Cover Snap Ring



J8921-458

Fig. 34 Removing Servo Cover And Piston

(5) Remove park pawl, pin and spring (Fig. 38).

(6) Examine park rod, pawl, pin and spring. Replace any component that is worn or damaged.

(7) Install pawl in case. Insert pin and install spring. Be sure spring is positioned as shown in Figure 38.

(8) Install park rod and bracket (Fig. 36). Tighten bracket bolts to 10 N•m (7 ft-lbs) torque.

(9) Install valve body, oil screen and oil pan as outlined in this section.

EXTENSION/ADAPTOR HOUSING SEAL REPLACEMENT

(1) Raise vehicle.

(2) On 2WD or 4WD models, disconnect or remove components necessary to gain access to the seal (e.g. propeller shaft, crossmember, shift linkage, transfer case, exhaust components, hoses, wires).

(3) On 2WD models, remove seal from adaptor housing (Fig. 39).

(4) On 4WD model, remove dust shield and remove seal from extension housing (Fig. 39).

(5) Install new seal with appropriate size seal installer. On 4WD models, also install dust shield.

(6) Reinstall components removed to gain access to seal.

(7) Top off transmission fluid if necessary.

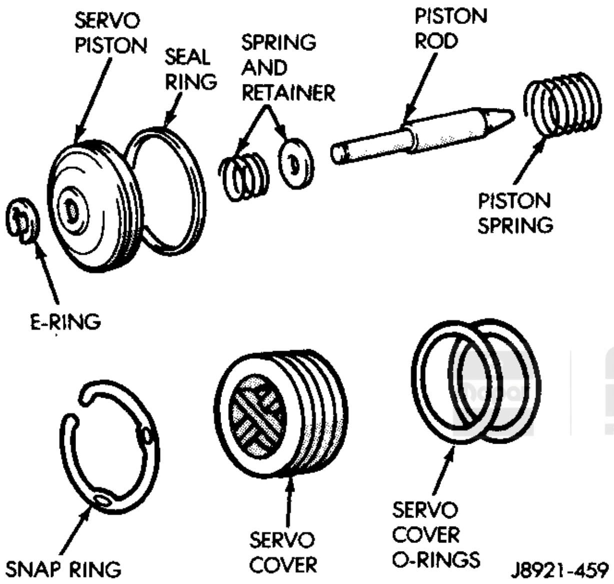


Fig. 35 Second Coast Brake Servo Components

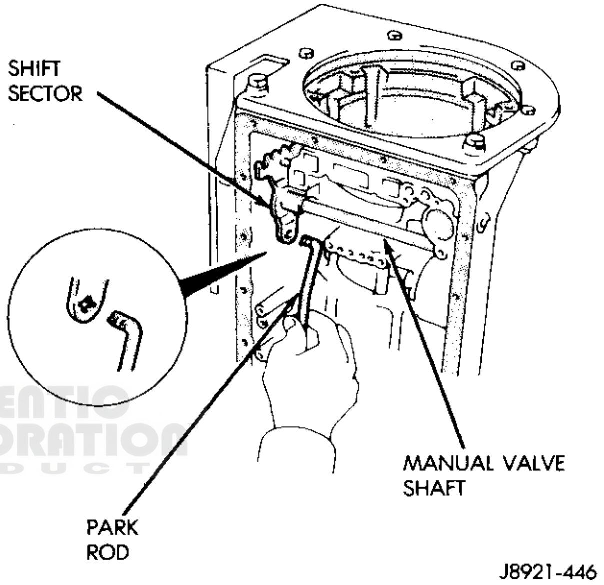


Fig. 37 Removing/Installing Park Rod

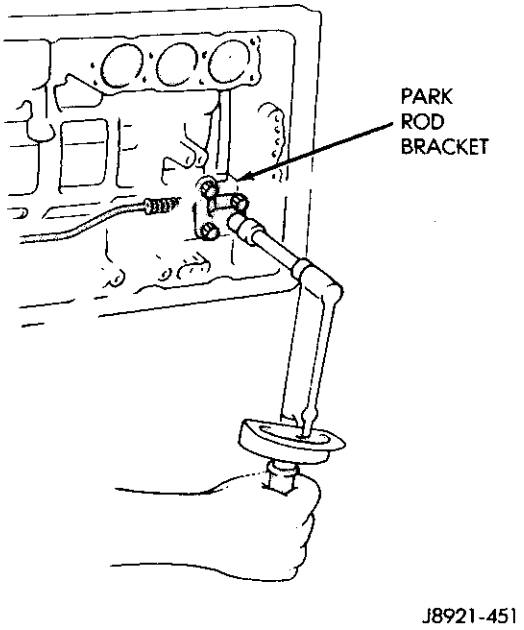


Fig. 36 Removing/Installing Park Rod Bracket

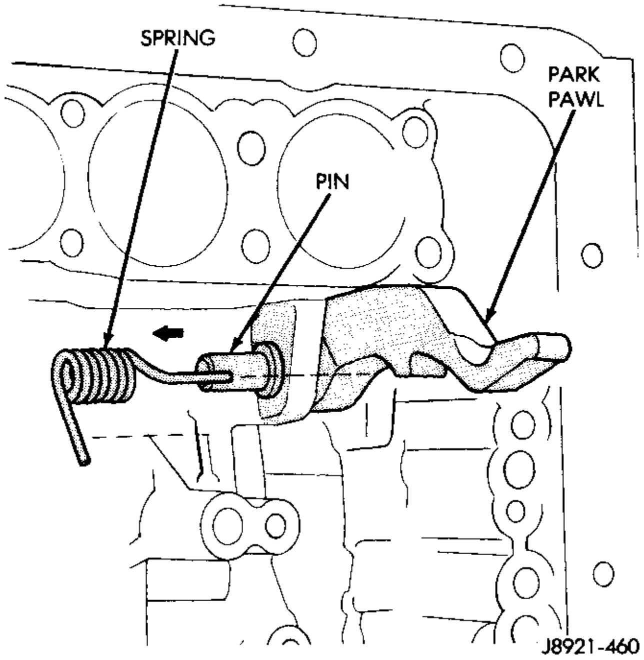


Fig. 38 Removing/Installing Park Pawl-Pin-Spring

SPEED SENSOR

Speed Sensor Testing

Test the speed sensor with an ohmmeter. Place the ohmmeter leads on the terminals in the sensor connector (Fig. 40).

Rotate the transmission output shaft and observe the ohmmeter needle. The needle should deflect indicating the switch is opening/closing as the rotor moves past the sensor (Fig. 40). Replace the sensor if the ohmmeter does not display any kind of reading.

If a digital ohmmeter is being used, the sensor should generate an ohmmeter readout each time the switch opens and closes.

Speed Sensor Replacement

(1) Disconnect sensor wire harness connector.

(2) Remove sensor retainer bolt and remove sensor (Fig. 41).

(3) Remove and discard speed sensor O-ring.

(4) Install new O-ring on speed sensor and install sensor in transmission case.

(5) Install sensor bracket and retainer bolt. Tighten bolt to 7.4 N•m (65 in-lbs) torque.

(6) Connect sensor wire harness connector.

SPEED SENSOR ROTOR-SPEEDOMETER DRIVE GEAR

Rotor-Drive Gear Removal

(1) Raise vehicle.

(2) Remove components necessary to gain access to rotor and drive gear (e.g. propeller shaft, transfer case, crossmember, shift linkage).

(3) Disconnect speedometer cable and/or speed sensor.

(4) Remove extension or adaptor housing.

(5) Remove speedometer drive gear snap ring (Fig. 42).

(6) Remove the speedometer drive gear and spacer (if equipped).

(7) Remove rotor by carefully prying it off output shaft with wood dowel or hammer handle (Fig. 43).

(8) Clean sealing surfaces of transmission case and extension/adaptor housing.

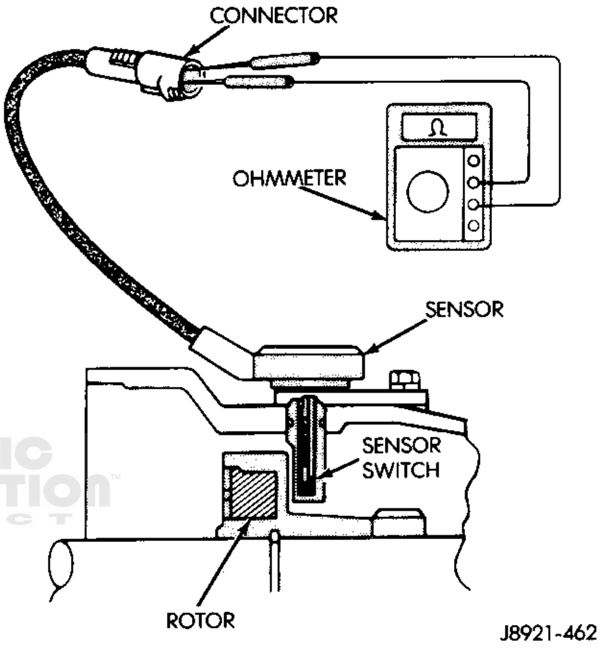


Fig. 40 Speed Sensor Testing

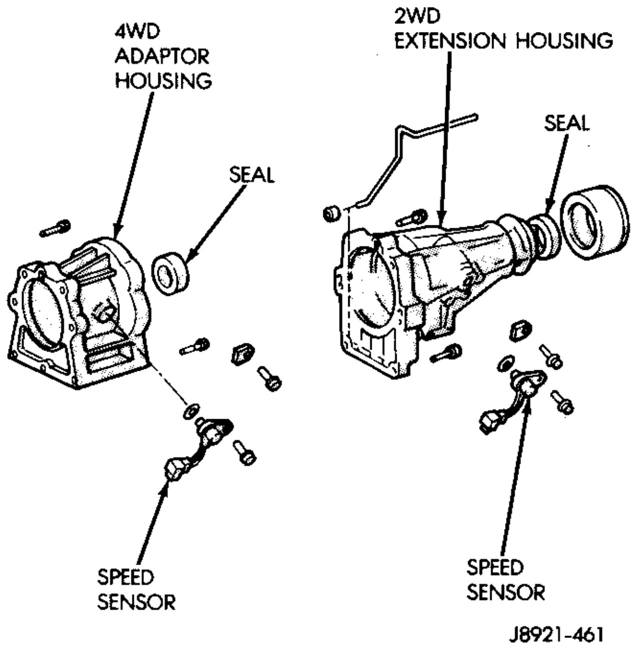


Fig. 39 Adaptor/Extension Housing Seals

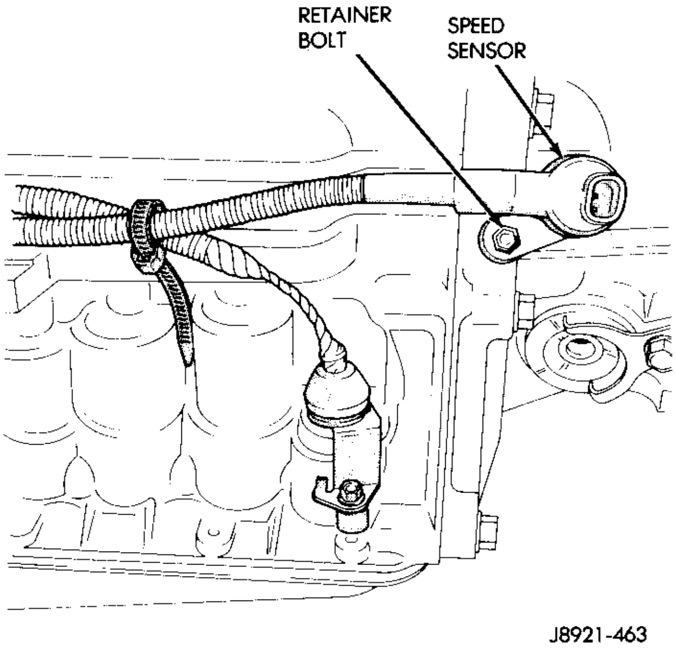


Fig. 41 Speed Sensor Removal/Installation

Rotor-Drive Gear Installation

(1) Install rotor, spacer (if equipped) and drive gear on output shaft. Then install drive gear snap ring (Fig. 42).

(2) Apply bead of RTV sealer, to transmission case sealing surface and install extension/adaptor housing on case.

(3) Tighten extension/adaptor housing bolts to 34 N•m (25 ft-lbs) torque.

(4) Install components removed to gain access to rotor and drive gear.

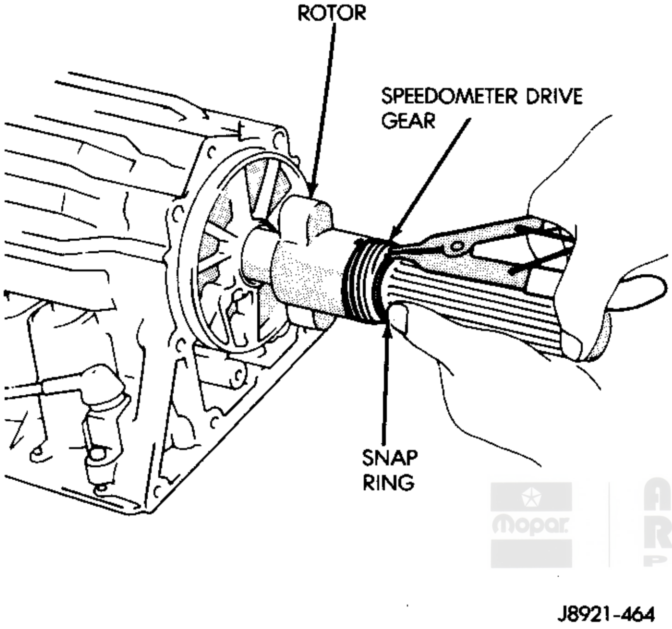


Fig. 42 Removing/Installation Speedometer Drive Gear

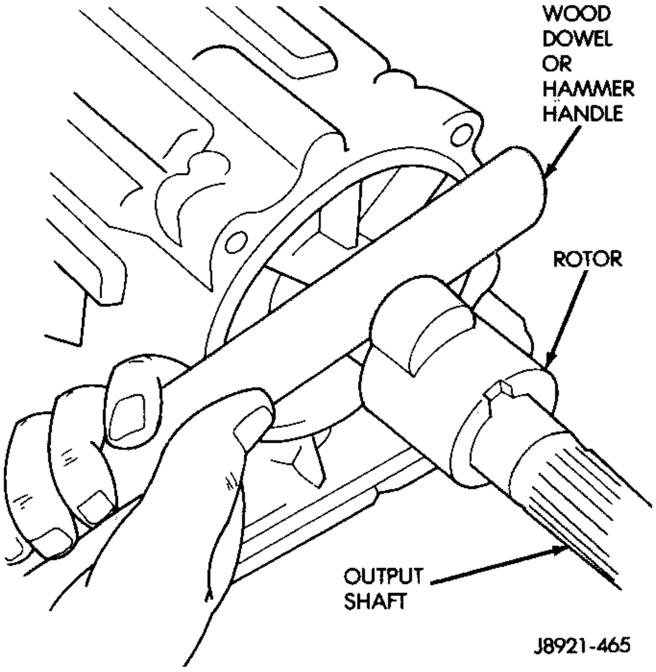


Fig. 43 Removing Speed Sensor Rotor

TPS SERVICE

A separate throttle position sensor is used for automatic transmission applications. The sensor is attached to the base of the throttle body. Refer to Group 14 for TPS service and adjustment.

SHIFT CABLE ADJUSTMENT

(1) Shift transmission into Park.

(2) Raise vehicle.

(3) Release cable adjuster clamp to unlock cable (Fig. 47).

(4) Unsnap cable from cable bracket (Fig. 47).

(5) Move transmission shift lever all the way rearward into Park detent. Lever is on manual valve shaft at left side of case.

(6) Verify positive engagement of park lock by attempting to rotate propeller shaft. Shaft will not rotate when park lock is engaged.

(7) Snap cable into cable bracket.

(8) Lock shaft cable by pressing cable adjuster clamp down until it snaps into place.

(9) Check engine starting. Engine should start only in Park and Neutral.

(10) Lower automobile.

PARK LOCK CABLE ADJUSTMENT

(1) Shift transmission into Park.

(2) Turn ignition switch to Lock position.

(3) Remove shift lever bezel and console screws. Raise bezel and console for access to cable.

(4) Pull cable lock button up to release cable (Fig. 48).

(5) Pull cable forward. Then release cable and press cable lock button down until it snaps in place.

(6) Check adjustment as follows:

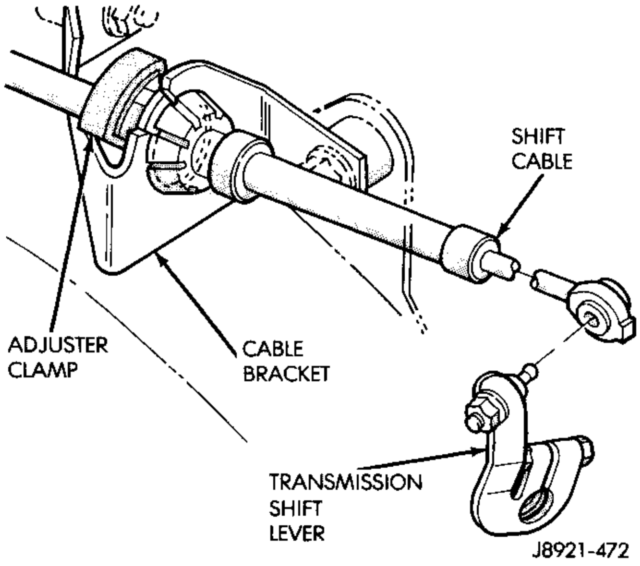


Fig. 47 Shift Cable Adjustment

(a) Check movement of release shift handle button (floor shift) or release lever (column shift). You should not be able to press button inward or move column lever.

(b) Turn ignition switch to On position.

(c) Press floor shift lever release button or move column lever. Then shift into Neutral. If cable adjustment is correct, ignition switch can not be turned to Lock position. Perform same check with transmission in D range.

(7) Move shift lever back to Park and check ignition switch operation. You should be able to turn switch to Lock position and shift lever release button/lever should not move.

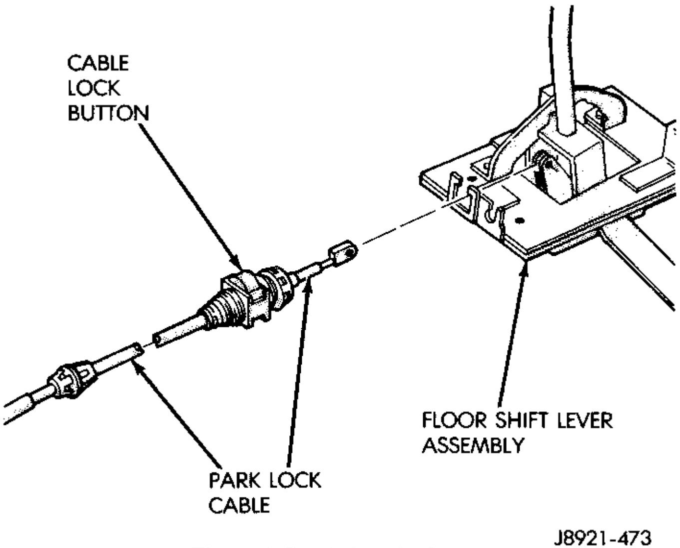


Fig. 48 Park Lock Cable

TRANSMISSION AND TORQUE CONVERTER REMOVAL/INSTALLATION

INDEX

TRANSMISSION AND TORQUE CONVERTER REMOVAL

(1) Raise vehicle.

(2) Drain transmission fluid and reinstall oil pan drain plug.

(3) Remove upper half of transmission fill tube (Fig. 49).

(4) Disconnect cooler lines at transmission. Cooler lines have quick-disconnect fittings. Press fitting release tabs and pull cooler line and fitting out of case.

(5) Support engine with safety stand and support transmission with jack.

(6) Disconnect or remove following: transmission/transfer case shift linkage; necessary exhaust components; speedometer cable; front/rear propeller shaft; transmission wire harnesses; transfer case vacuum and wire harnesses.

(7) Remove rear crossmember.

(8) Disconnect transmission throttle cable at engine.

(9) Disconnect necessary vacuum and fluid hoses.

(10) Remove starter motor.

(11) Remove converter-to-drive plate bolts.

(12) Remove converter housing-to-engine bolts.

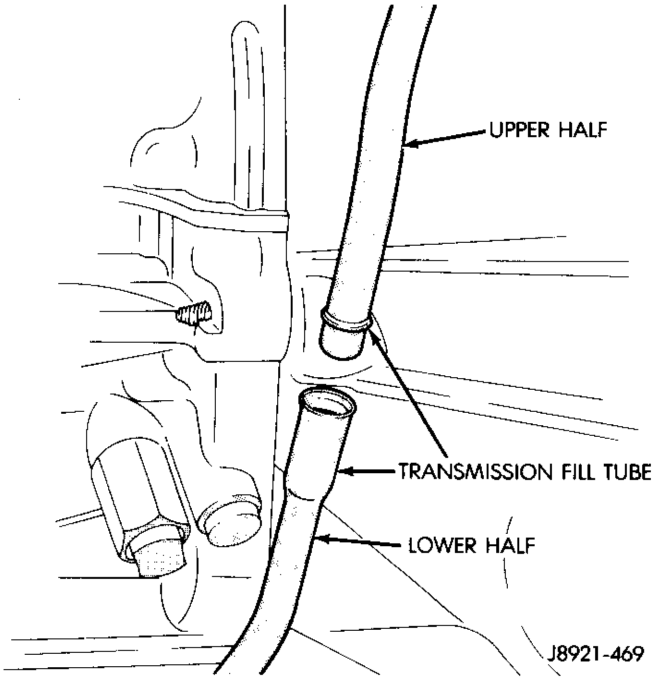


Fig. 49 Two-Piece Transmission Fill Tube

(13) Secure transmission (and transfer case assembly on 4WD models) to transmission jack with safety chains. Then remove transmission.

(14) Remove torque converter if converter or oil pump seal are to be serviced.

(15) Remove transfer case if transmission is to be overhauled.

TORQUE CONVERTER STATOR CLUTCH INSPECTION

(1) Insert rotating tool B.Vi. FM. 36 into converter hub and seat tool in one-way clutch (Fig. 50).

(2) Insert stopper tool B.Vi. FM. 37 in one converter hub notch and into outer race of rotating tool.

(3) Turn rotating tool clockwise. Converter clutch should rotate freely and smoothly. Less than 2.5 N•m (22 in-lbs) of torque should be required to rotate clutch in clockwise direction.

(4) Turn rotating tool in counterclockwise direction. Converter clutch should lock.

(5) Replace converter if clutch binds or will not lock.

OIL PUMP SEAL REPLACEMENT

(1) Remove converter.

(2) Remove old seal. Use blunt punch to collapse seal and pry seal out of pump housing. Do not scratch or damage seal bore.

(3) Lubricate lip of new seal with petroleum jelly and install seal in pump (Fig. 51).

(4) Align and install torque converter.

TRANSMISSION AND TORQUE CONVERTER INSTALLATION

(1) Mount transmission on transmission jack.

(2) Install torque converter on transmission.

(3) On 4WD models, install transfer case on transmission.

(4) Secure transmission (and transfer case assembly on 4WD models) to jack with safety chains.

(5) Align and position transmission and converter on engine.

(6) Install converter housing-to-engine bolts.

(7) Install converter-to-drive plate bolts.

(8) Install and connect starter motor.

(9) On 4WD models, connect transfer case shift linkage and vacuum hoses.

(10) Connect exhaust components.

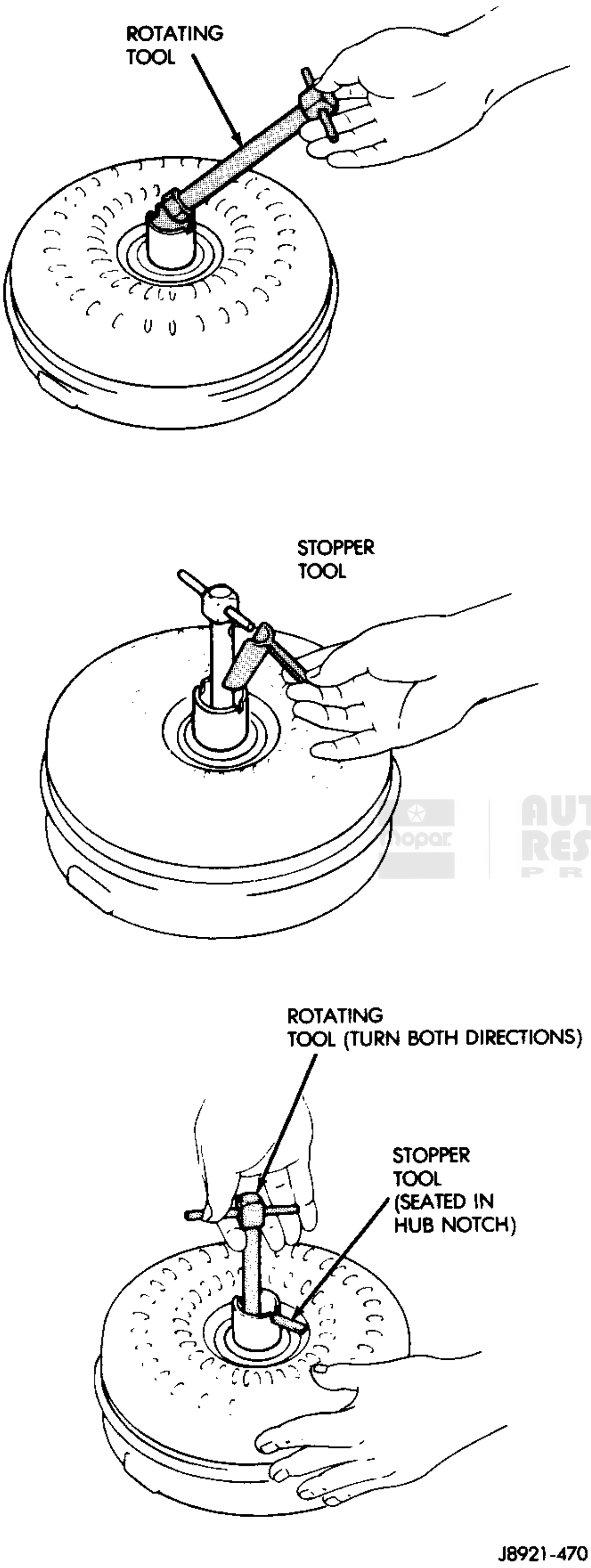


Fig. 50 Checking Converter Clutch Operation

(11) Install rear crossmember.

(12) Connect speedometer cable and neutral switch wires.

(13) Align and connect front and rear propeller shafts.

(14) Connect transmission wire harnesses and transfer case vacuum and wire harnesses.

(15) Connect transmission cooler lines.

(16) Connect transmission throttle valve cable at engine.

(17) Install new O-ring seal on upper half of transmission fill tube. Then connect upper and lower tube halves.

(18) Lower vehicle.

(19) Fill transmission with Mopar Mercon™ automatic transmission fluid.

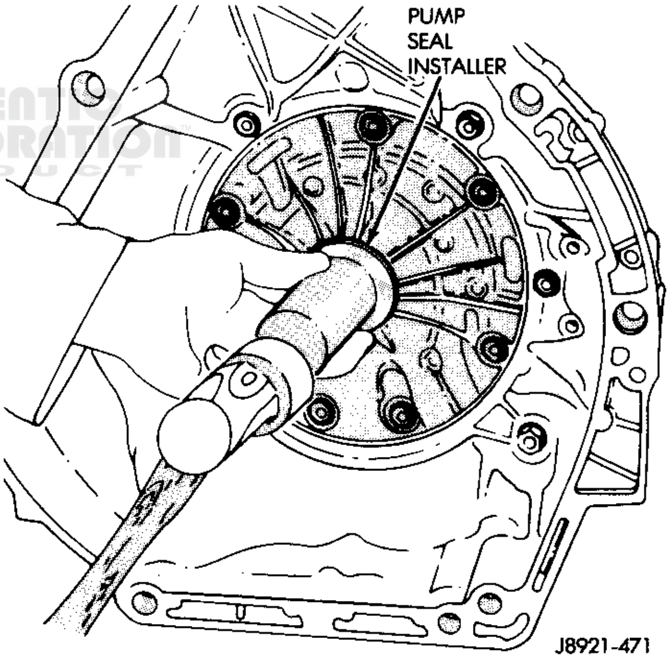


Fig. 51 Installing Oil Pump Seal

TRANSMISSION OVERHAUL

INDEX

OVERHAUL SERVICE TOOLS

The special tools needed to overhaul the AW 4 transmission are provided in tool kit 6294 (B.Vi.FM. 23). However, pressure test port adapter 7554 is not included in this kit and will have to be ordered separately. The overhaul tool kit and test port adapter are available through the parts division and dealer special tool program.

TRANSMISSION DISASSEMBLY

(1) Remove torque converter.
(2) Remove dipstick and both halves of oil filler tube.
(3) Remove clamp attaching wire harness and throttle pressure cable (Fig. 1) to transmission.
(4) Remove shift lever from manual valve shaft at left side of transmission.
(5) Remove neutral switch.
(6) Remove speedometer driven gear (if equipped) and remove speed sensor (Fig. 2).
(7) Remove converter housing bolts and remove housing (Fig. 3) from case.
(8) Remove extension housing or adapter housing.
(9) On 2WD models, measure inside diameter of extension housing bushing with cylinder bore gauge or inside micrometer. Diameter should be 38.09 mm

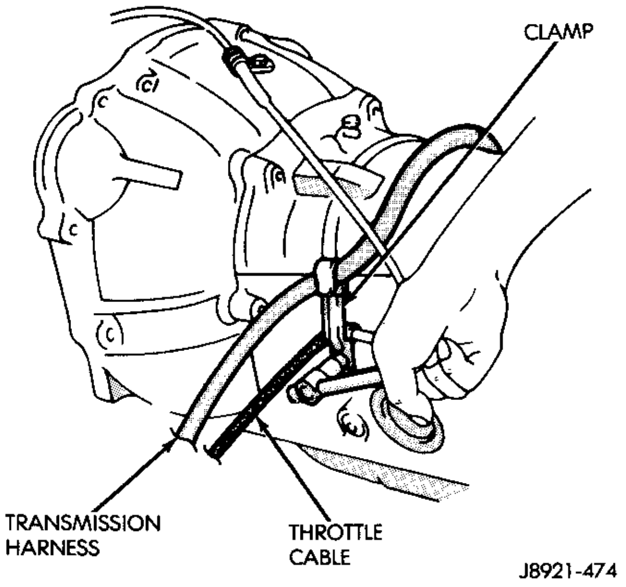


Fig. 1 Remove Harness And Cable Clamp

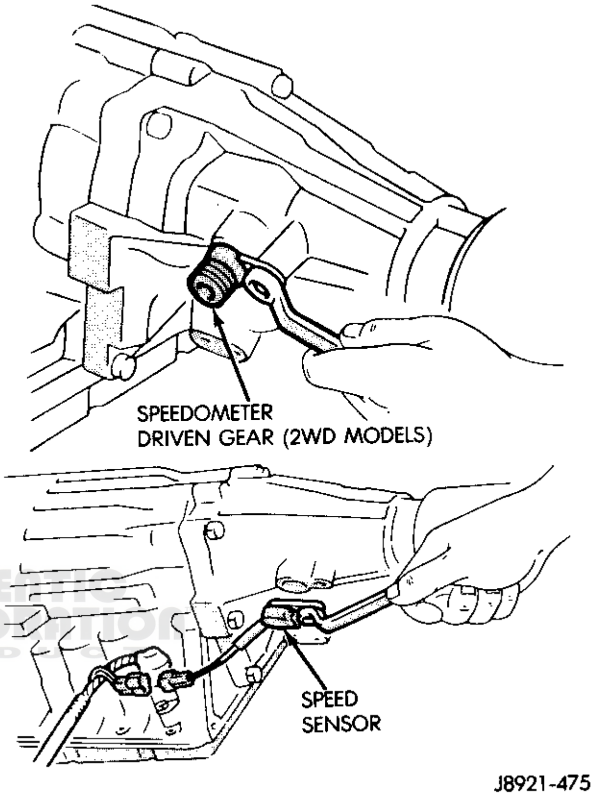


Fig. 2 Removing/Installing Speedometer Driven Gear And Speed Sensor

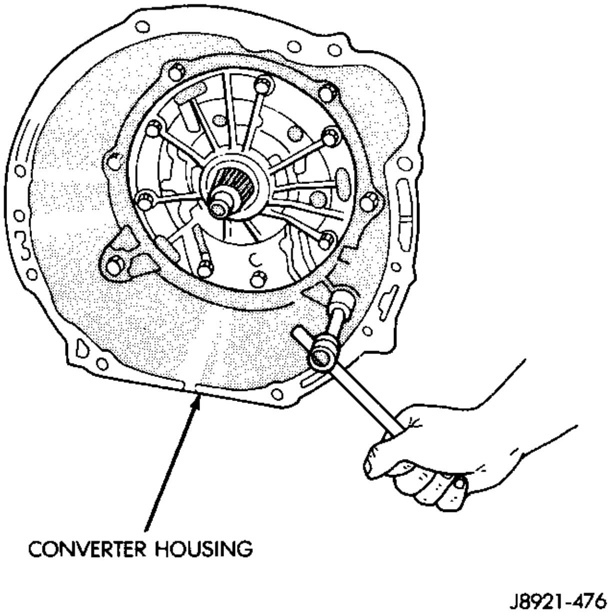


Fig. 3 Removing/Installing Converter Housing

(1.4996 in) or less. Replace housing as assembly if inside diameter exceeds specified limit.

(10) Remove the speedometer drive gear snap ring and remove the gear and gear spacer if equipped (Fig. 5).

(11) Remove speed sensor rotor and key. Use wood dowel or hammer handle to loosen and remove rotor (Fig. 6).

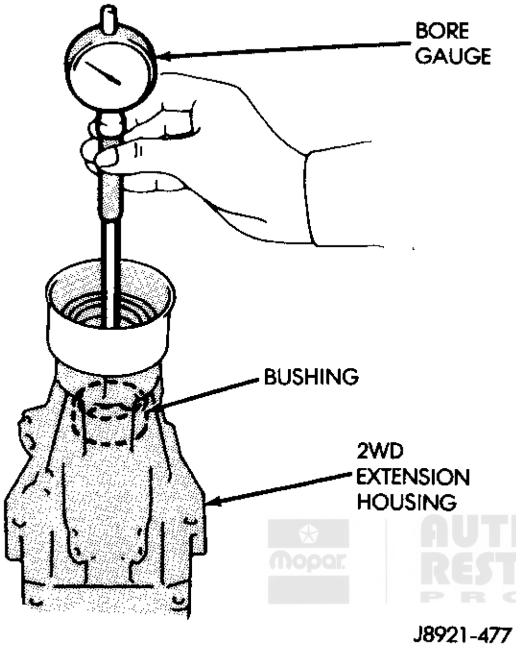


Fig. 4 Checking Bushing Diameter—2WD Extension Housing

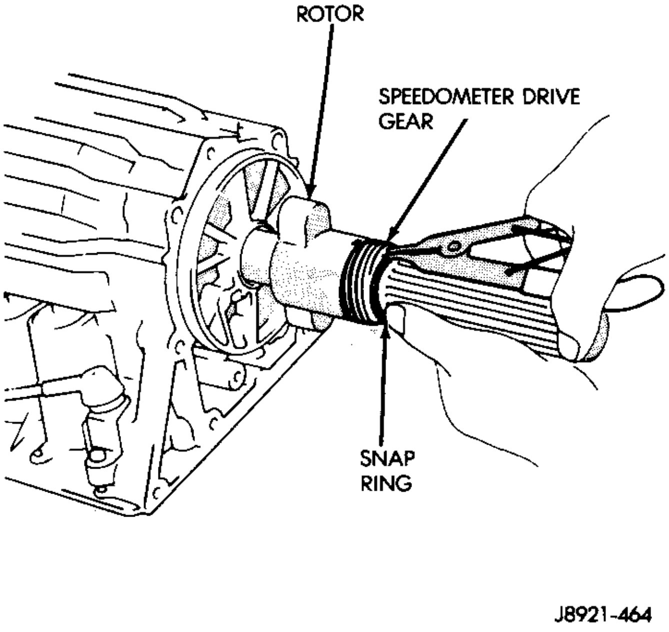


Fig. 5 Removing Speed Sensor And Speedometer Drive Gear

(12) Remove transmission oil pan, oil screen and screen gaskets (Fig. 7). Then mount transmission in holding fixture.

(13) Remove valve body oil feed tubes (Fig. 8).

(14) Disconnect solenoid wires (Fig. 9).

(15) Remove harness bracket bolt and remove harness and bracket Fig. 10).

(16) Remove valve body bolts (Fig. 11).

(17) Disconnect throttle cable from throttle cam (Fig. 12).

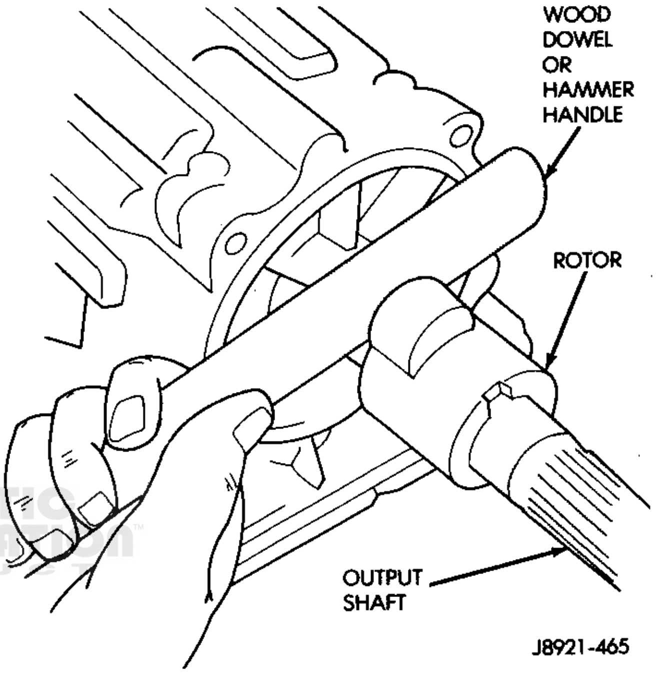


Fig. 6 Removing Speed Sensor Rotor

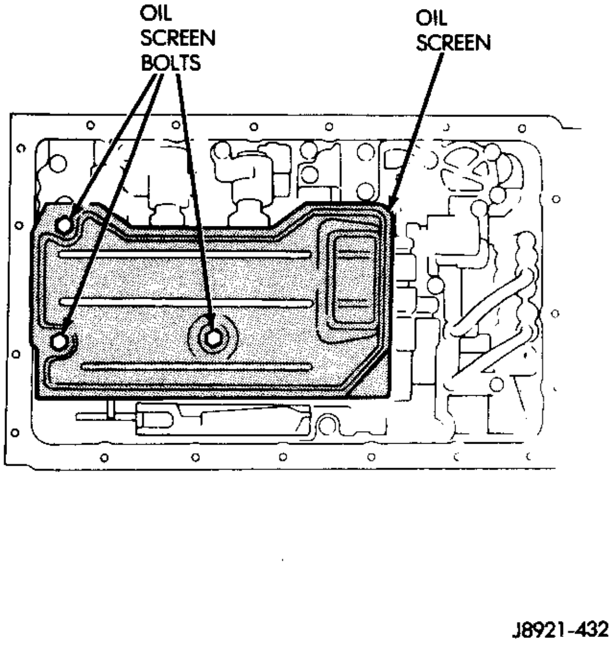


Fig. 7 Removing Oil Screen

(18) Remove valve body from case. Then remove accumulator springs, spacers and check ball and spring (Fig. 13).

(19) Remove second brake and clutch accumulator pistons with compressed air (Fig. 14). Apply air pressure through feed port and ease the pistons out of the bore.

(20) Remove overdrive brake accumulator piston with compressed air (Fig. 14).

(21) Remove overdrive clutch accumulator piston with compressed air (Fig. 14).

(22) Remove throttle cable.

(23) Remove oil pump bolts and remove pump with bridge-type puller B.Vi. FM. 25 (Fig. 15).

(24) Remove race from oil pump (Fig. 16).

(25) Remove fourth gear overdrive planetary gear and overdrive direct clutch assembly (Fig. 17).

(26) Remove race from fourth gear overdrive planetary (Fig. 18).

(27) Remove thrust bearing, race and overdrive planetary ring gear (Fig. 19).

(28) Measure stroke length of overdrive brake piston as follows:

(a) Mount dial indicator on case (Fig. 20).

(b) Mount gauge tool B.Vi. FM. 35 so it contacts piston (Fig. 20).

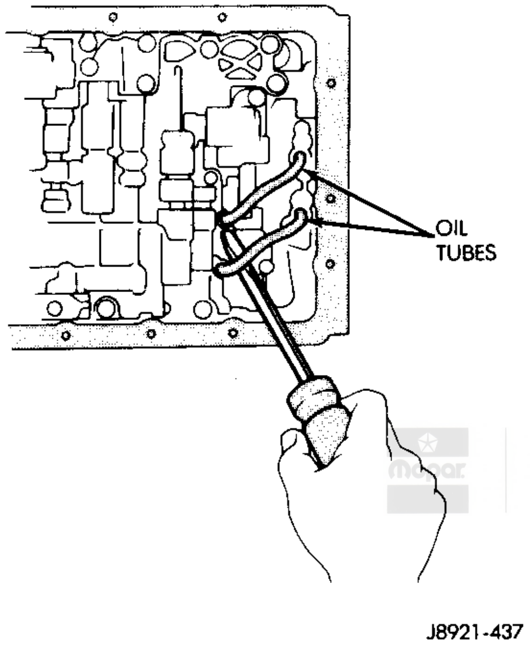


Fig. 8 Removing Valve Body Oil Tubes

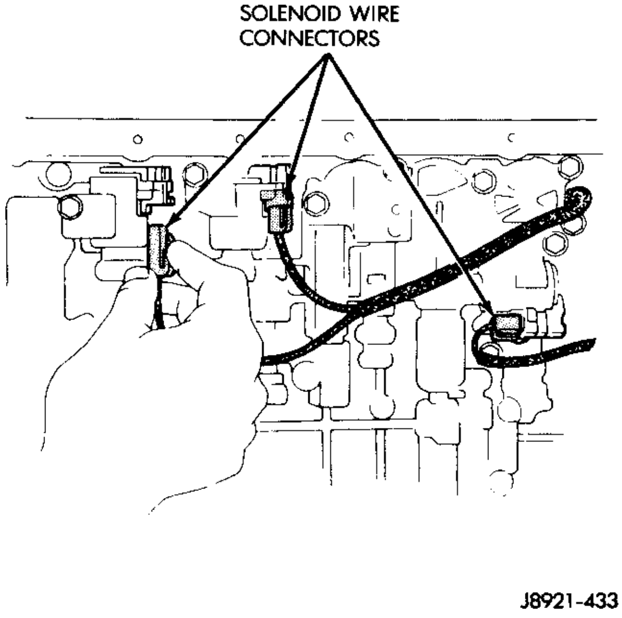


Fig. 9 Solenoid Wires

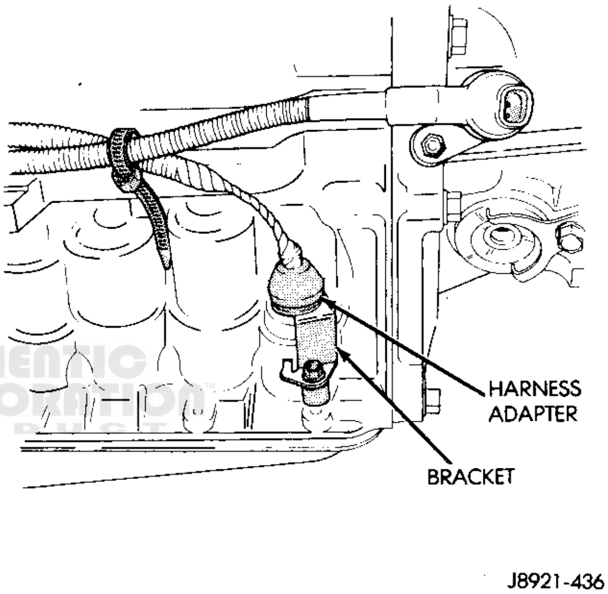


Fig. 10 Removing Bracket And Harness

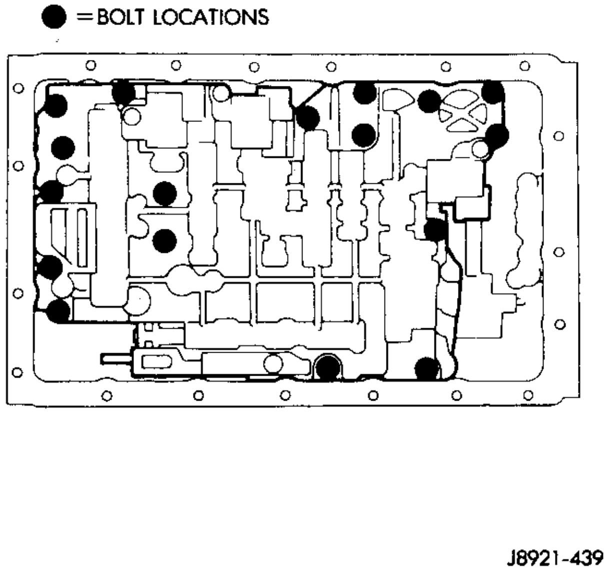


Fig. 11 Valve Body Bolt Locations

(c) Apply 57-114 psi air pressure through piston apply port and note piston stroke on dial indicator. Stroke length should be: 1.40 - 1.70 mm (.055 to .0699 in) on 6-cylinder models and 1.32 - 1.62 mm (.0520 to .0638 in) on 4-cylinder models.

(d) If stroke is not within limits, replace brake pack retainer. Select required retainer from Overdrive Brake Retainer Selection chart in Specifications section.

(29) Remove overdrive brake snap ring (Fig. 21).

(30) Remove overdrive brake discs and plates (Fig. 22). Then measure disc thickness with a micrometer. Minimum disc thickness is 1.84 mm (.0724 in). Replace discs if thickness is less than specified.

(31) Remove overdrive support lower race (43) and upper bearing and race assembly (Fig. 23).

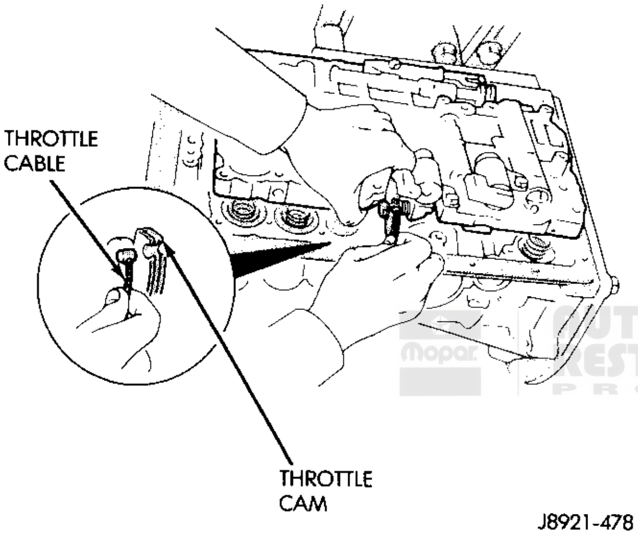


Fig. 12 Removing Throttle Cable

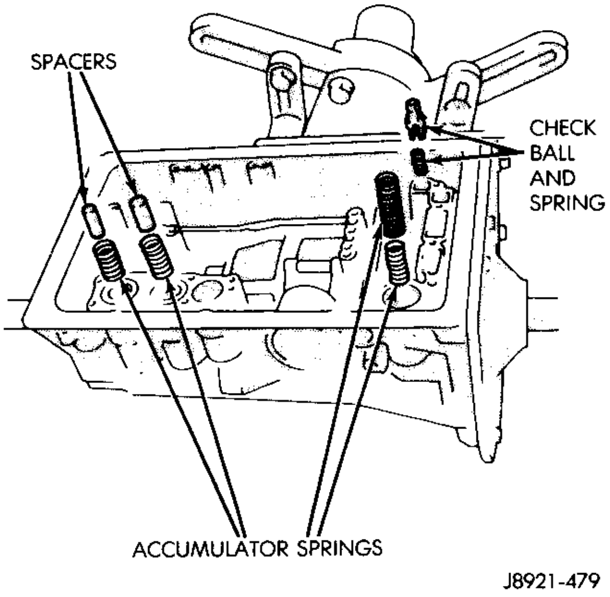


Fig. 13 Removing Accumulator Springs-Spacers-Check Ball

(32) Remove overdrive support bolts (Fig. 24).

(33) Remove overdrive support snap ring with tool B.Vi. FM. 29 (Fig. 25).

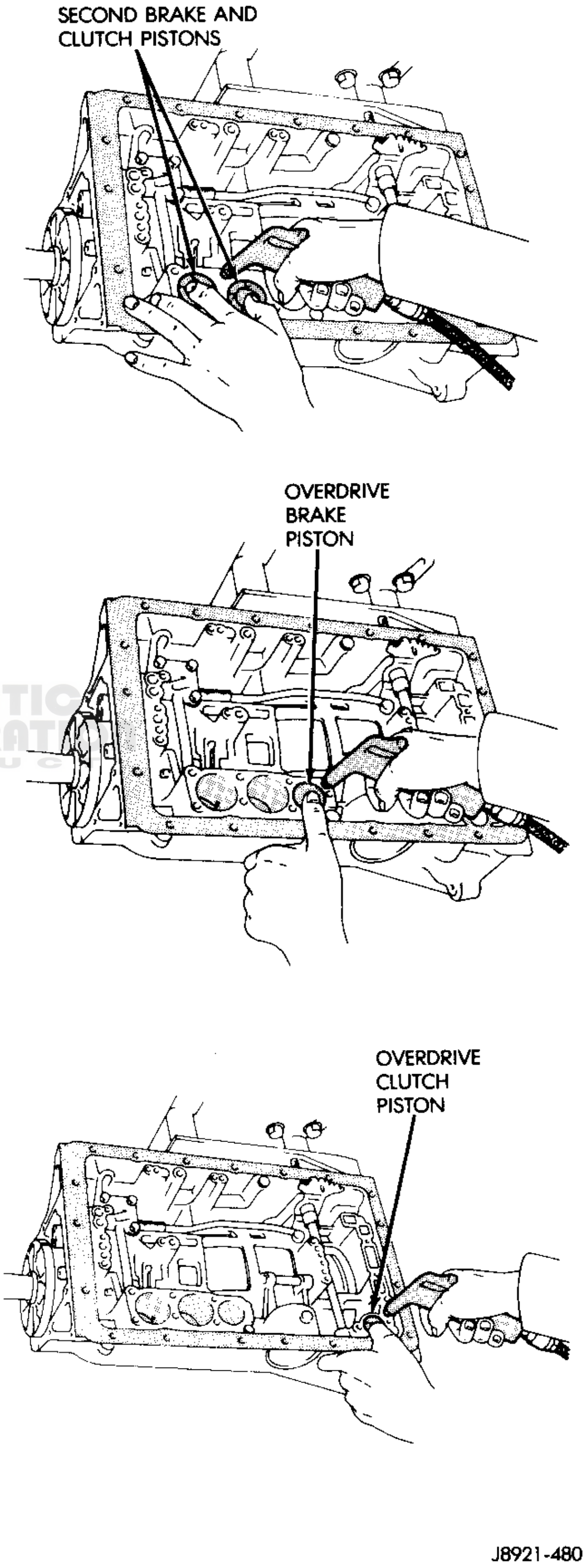


Fig. 14 Removing Accumulator Pistons

(34) Remove overdrive support (Fig. 26) with bridge-type puller tool B.Vi. FM. 25.

(35) Remove race from hub of overdrive support (Fig. 27).

(36) Measure stroke length of second coast brake piston rod as follows:

(a) Make reference mark on piston rod (Fig. 28) as shown.

(b) Apply 57-114 psi air pressure through piston feed hole and check stroke length with gauge B.Vi. FM. 40/41 (Fig. 28).

(c) Stroke length should be 1.5-to-3.0 mm (.059 to .118 in).

(d) If stroke length is incorrect, install new piston rod and recheck stroke. If stroke is still incorrect, replace second coast brake band.

(e) Replacement piston rods are available in two different lengths which are: 71.4 mm (2.811 in) and 72.9 mm (2.870 in).

(37) Remove second coast brake piston snap ring with tool B.Vi. FM. 29. Then remove piston cover and piston assembly with compressed air applied through piston feed hole (Fig. 29).

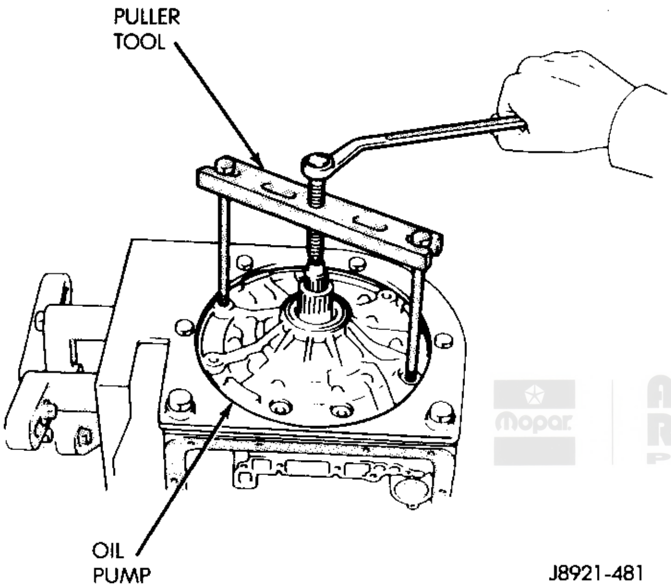


Fig. 15 Removing Oil Pump

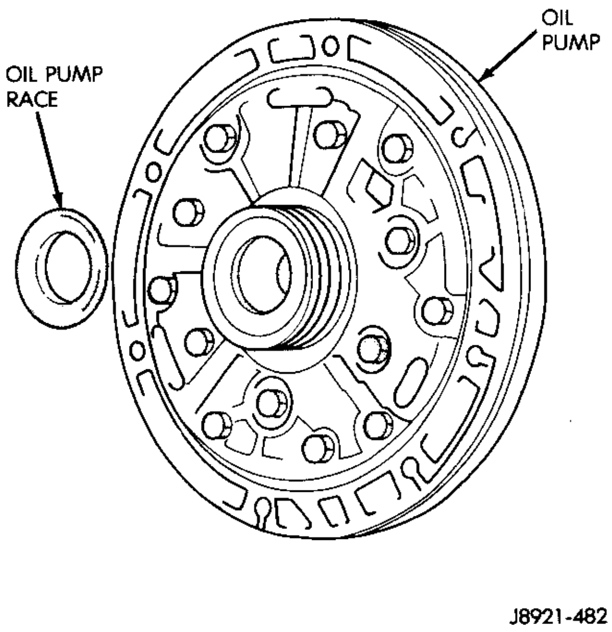


Fig. 16 Removing Oil Pump Race

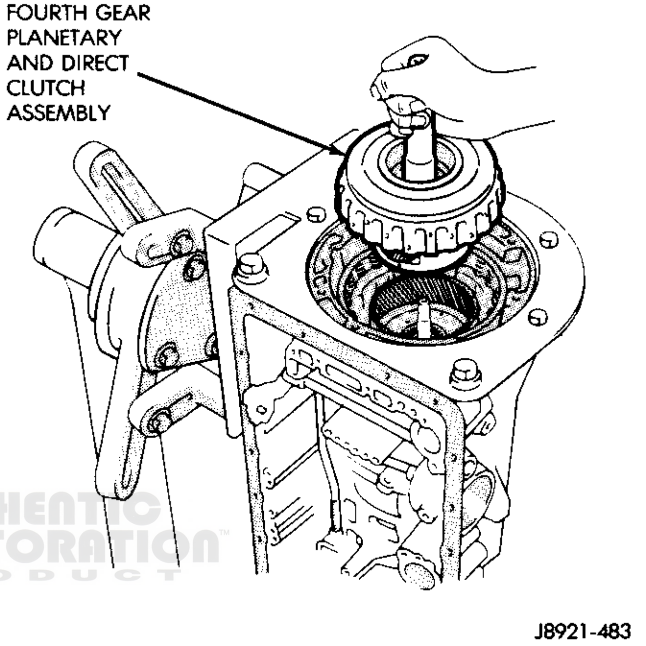


Fig. 17 Removing Fourth Gear Planetary And Direct Clutch Assembly

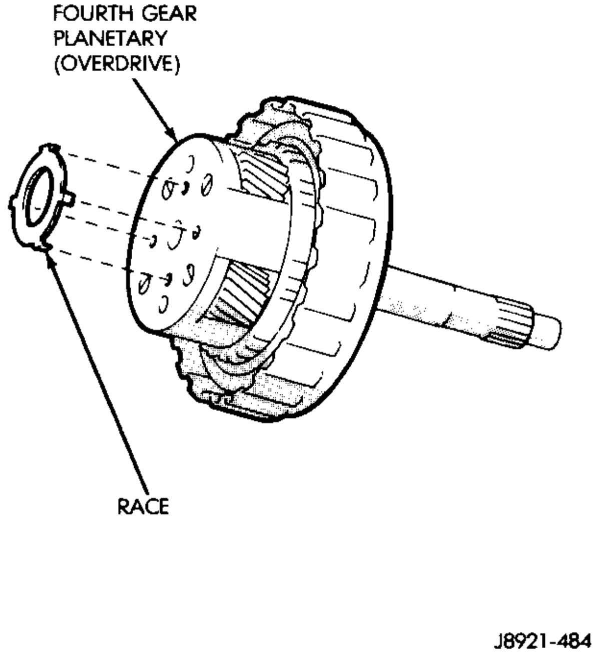


Fig. 18 Remove Fourth Gear Planetary Race

(38) Disassemble second coast brake piston (Fig. 30).

(39) Remove direct and forward clutch assembly (Fig. 31).

(40) Remove thrust bearing and race from clutch hub (Fig. 32).

(41) Remove the second coast brake band E-ring from band pin and remove brake band (Fig. 33).

(42) Remove front planetary ring gear front bearing race and remove front planetary ring gear (Fig. 34).

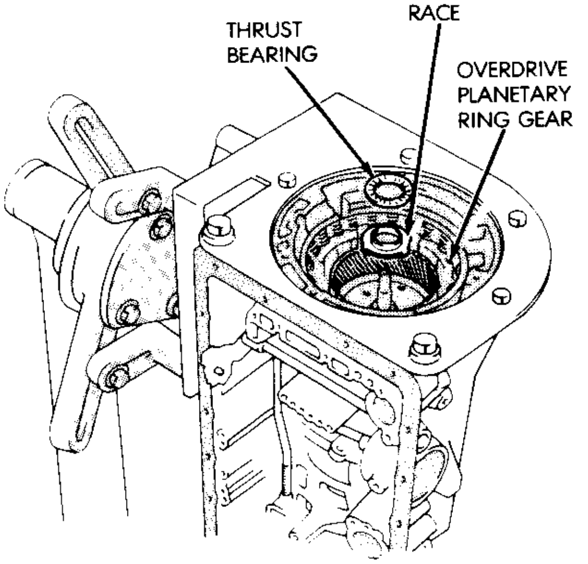


Fig. 19 Remove Bearing, Race And Planetary Ring Gear

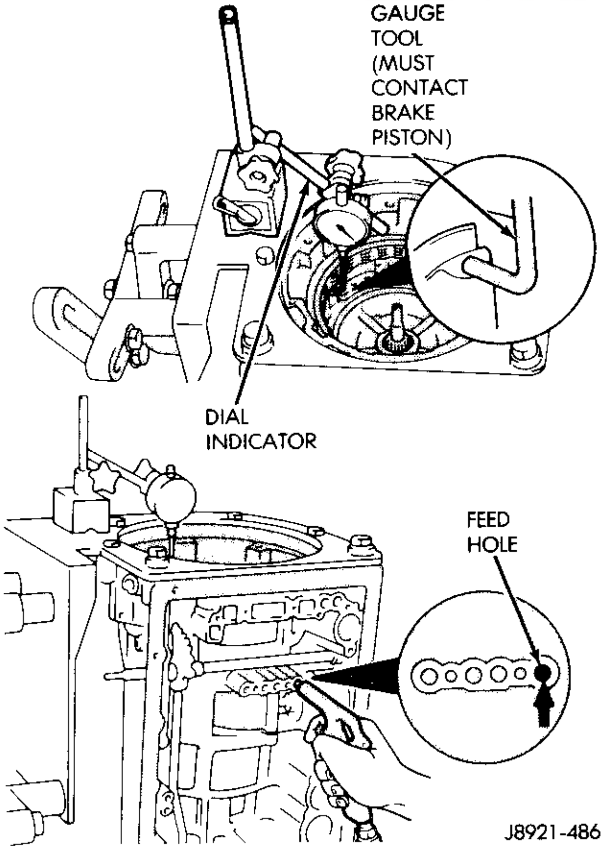


Fig. 20 Measuring Overdrive Brake Piston Stroke

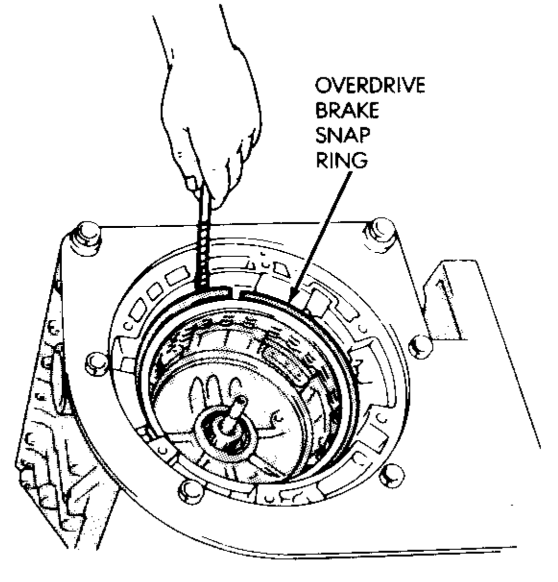


Fig. 21 Remove Overdrive Brake Snap Ring

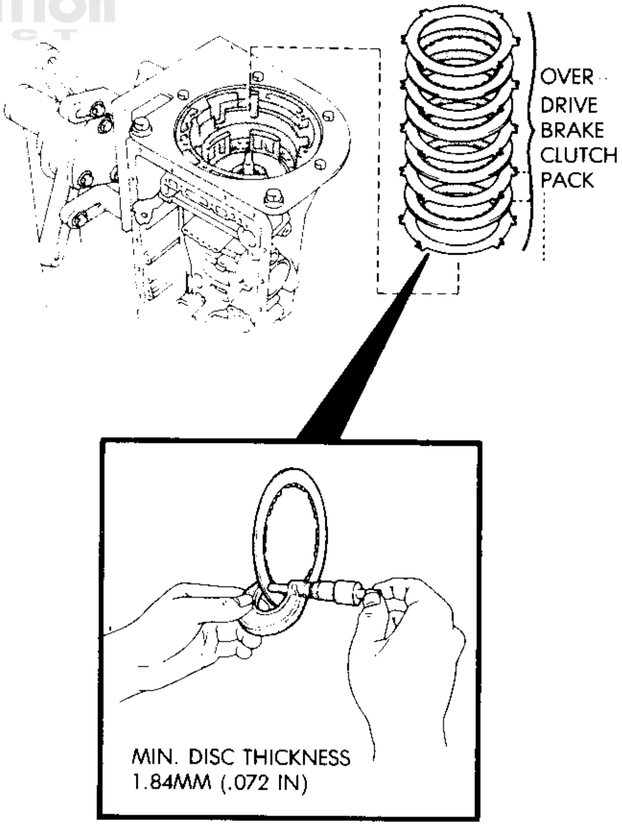


Fig. 22 Remove/Measure Overdrive Brake Disc Thickness

(43) Remove thrust bearing and rear race from ring gear (Fig. 35).

(44) Remove planetary thrust race (Fig. 36).

(45) Relieve load on planetary snap ring as follows: Loosen transmission holding fixture. Turn transmission over and allow output shaft to support transmission weight. Place wood blocks under shaft to protect splines (Fig. 36).

(46) Remove planetary snap ring and remove planetary gear (Fig. 37).

(47) Remove sun gear, input drum and one-way clutch as assembly (Fig. 38).

(48) Measure second brake clutch pack clearance (Fig. 39). Clearance should be: .62 to 1.98 mm (.0244 to .0780 in) on six-cyl. transmissions and .89 to 2.15 mm (.0350 to .0846 in) on four-cyl. transmissions. Replace discs if clearance is not within specifications.

(49) Remove second brake clutch pack snap ring (Fig. 40).

(50) Remove second brake clutch pack (Fig. 41). Measure disc thickness with micrometer. Minimum thickness should be 1.84 mm (.0724 in). Replace discs if not within specfications.

(51) Remove bolts attaching park rod bracket to case. Then disconnect park rod from manual shaft lever and remove rod and bracket (Fig. 42).

(52) Remove park pawl spring, pin and pawl (Fig. 43).

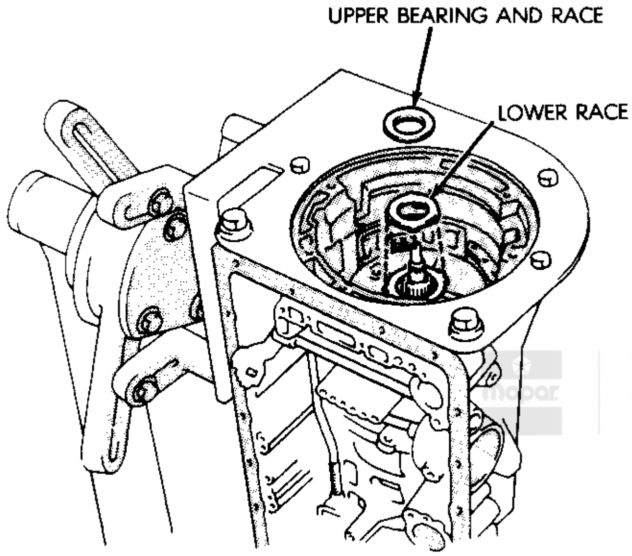


Fig. 23 Remove Overdrive Support Bearing/Races

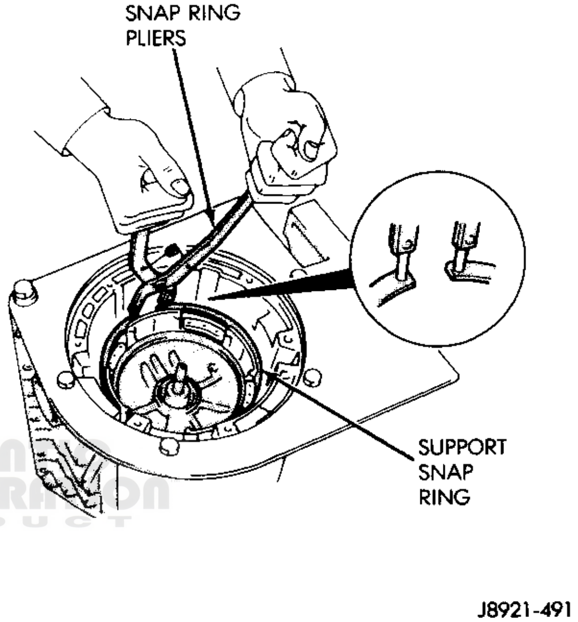


Fig. 25 Removing/Installing Overdrive Support Snap Ring

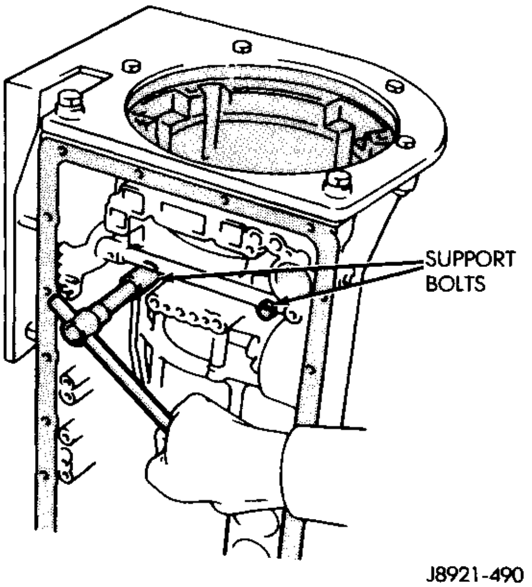


Fig. 24 Remove Overdrive Support Bolts

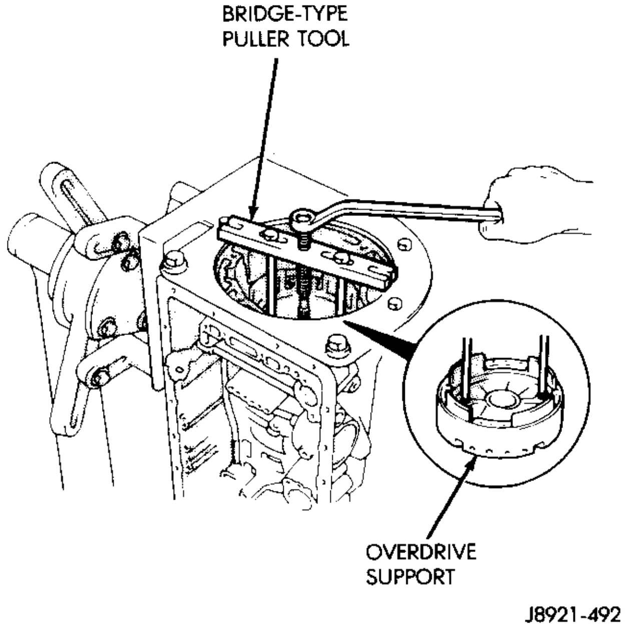


Fig. 26 Removing Overdrive Support

(53) Measure clearance of first-reverse brake clutch pack (Fig. 44). Clearance should be: .70 to 2.00 mm (.0276 to .0787 in) on 6-cyl. transmissions and .60 to 1.74 mm (.0236 to .0685 in) on 4-cyl. transmissions. Replace discs if clearance is not as specified.

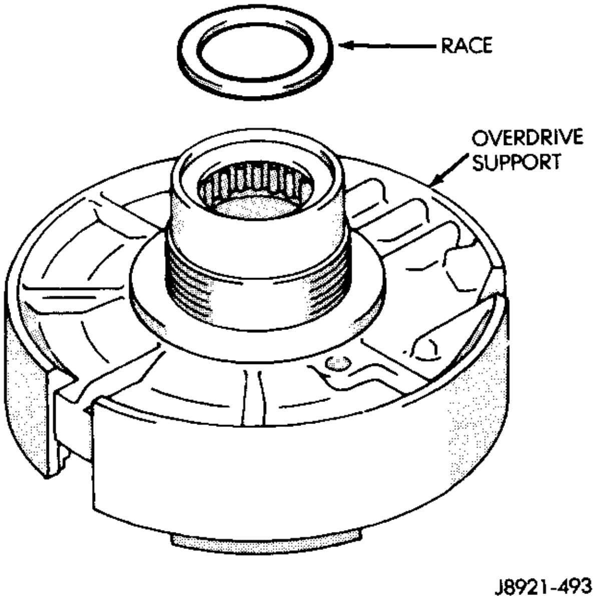


Fig. 27 Remove Overdrive Support Race

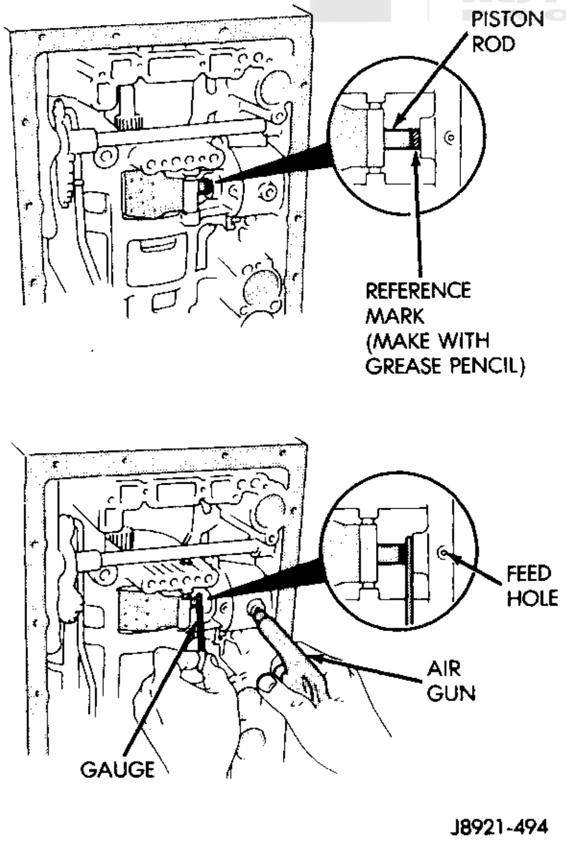


Fig. 28 Measuring Second Coast Brake Piston Rod Stroke

(54) Remove second brake piston sleeve (Fig. 45). Cover remover tool with tape to avoid damaging case.

(55) Remove rear planetary gear, second brake drum and output shaft as an assembly (Fig. 46).

(56) Remove planetary and brake drum thrust bearing and race assembly (Fig. 47).

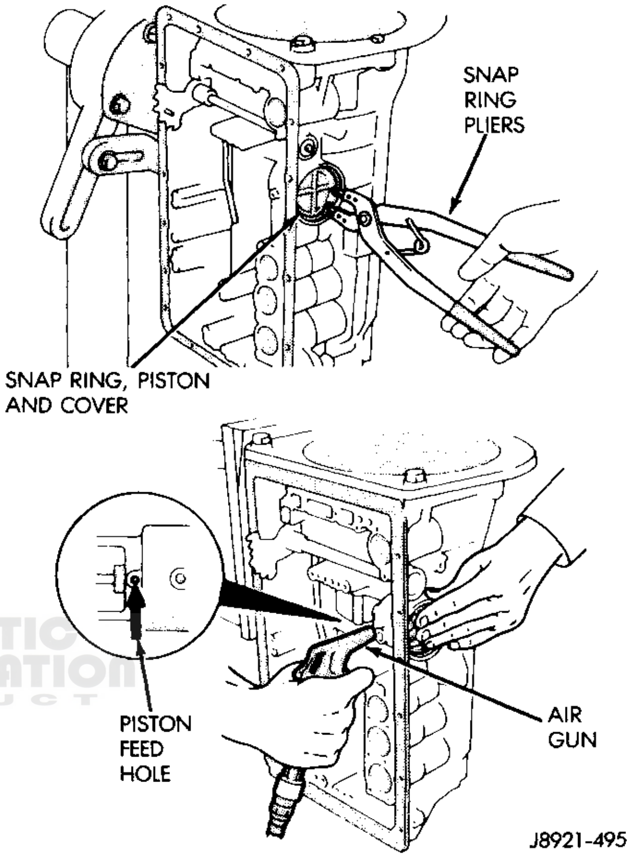


Fig. 29 Removing Second Coast Brake Cover And Piston

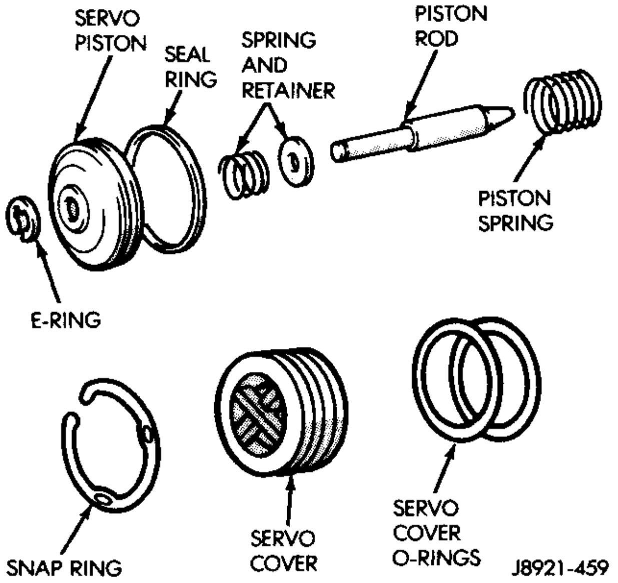


Fig. 30 Second Coast Brake Piston Components

(57) Remove second brake drum gasket from case with gasket scraper or screwdriver (Fig. 48).

(58) Measure inside diameter of transmission case rear bushing with bore gauge or inside micrometer (Fig. 49). Maximum allowable diameter is 38.18 mm (1.5031 in). **Replace transmission case if bushing I.D. is greater than specified. Bushing is not serviceable.**

CLEANING-INSPECTION

Clean the transmission components with solvent and dry them with compressed air only. Do not use shop towels or rags.

Blow compressed air through all oil feed passages and channels to be sure they are clear. Inspect the transmission components for wear and damage. Replace components that are damaged or worn beyond the limits specified in the individual overhaul procedures.

Replace all O-rings, gaskets and seals. These components are not reusable. Also replace any snap ring that is distorted or damaged.

During overhaul assembly operations, lubricate the transmission components with Jeep or Mopar Mercon™ automatic transmission fluid or petroleum jelly as indicated. Petroleum jelly should be used to prelubricate thrust bearings, washers and races. It can also be used to hold parts in position during assembly.

Soak replacement clutch and brake pack components in transmission fluid for at least 30 minutes before installation.

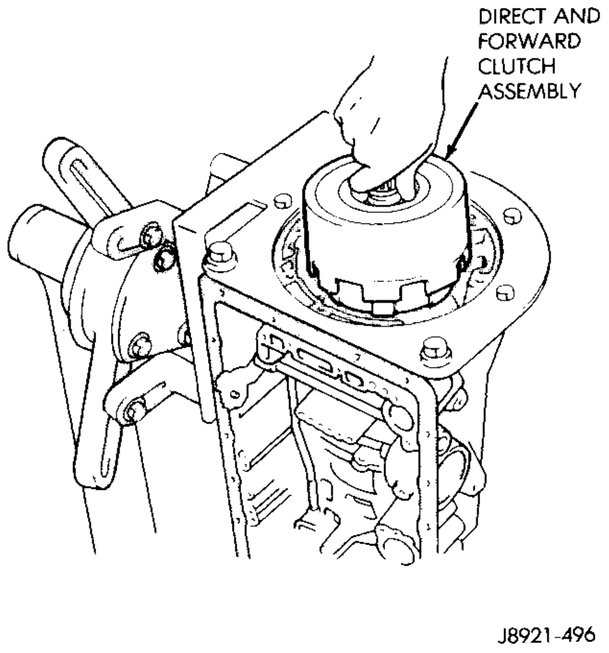


Fig. 31 Removing Direct And Forward Clutch Assembly

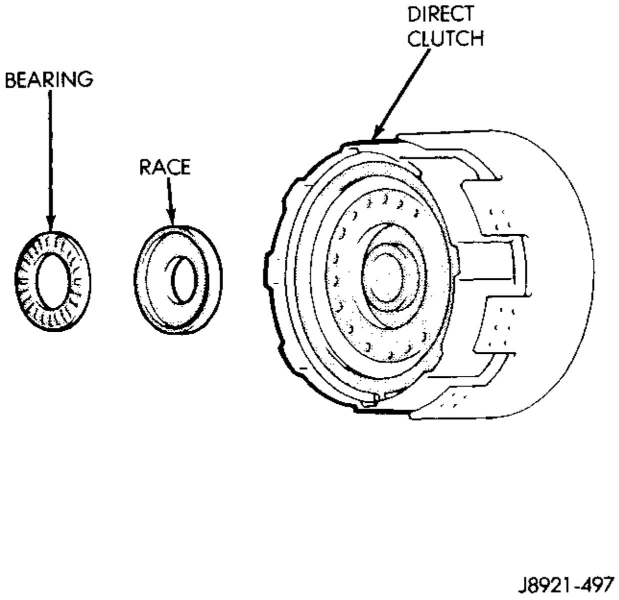


Fig. 32 Remove Bearing And Race From Clutch Hub

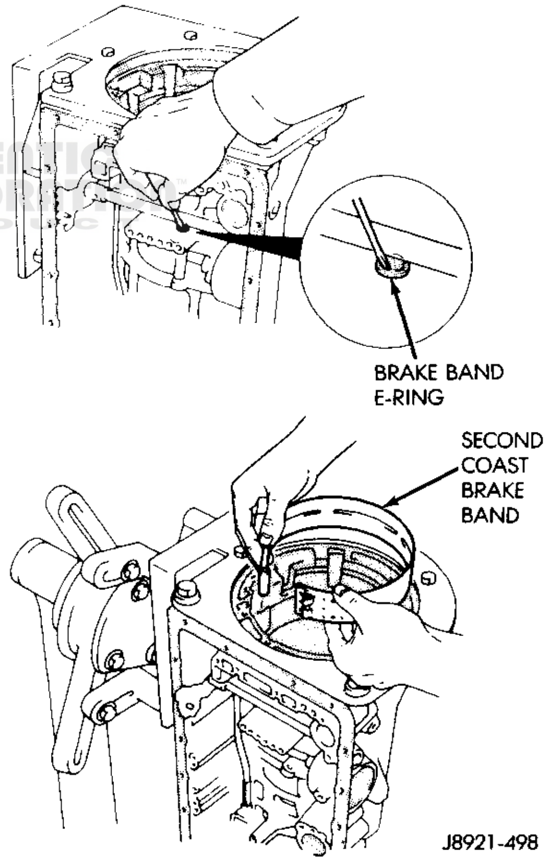


Fig. 33 Removing Second Coast Brake Band

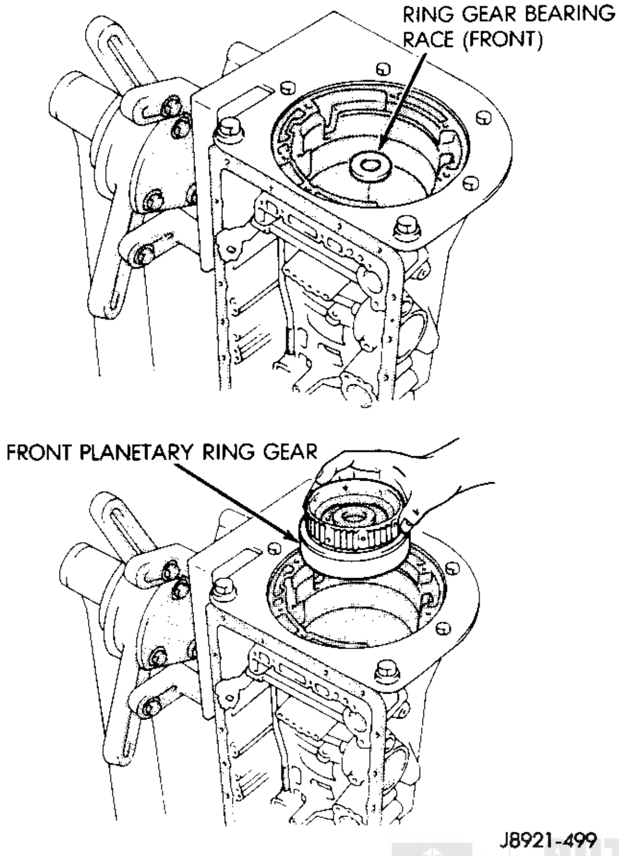


Fig. 34 Removing Front Planetary Ring Gear

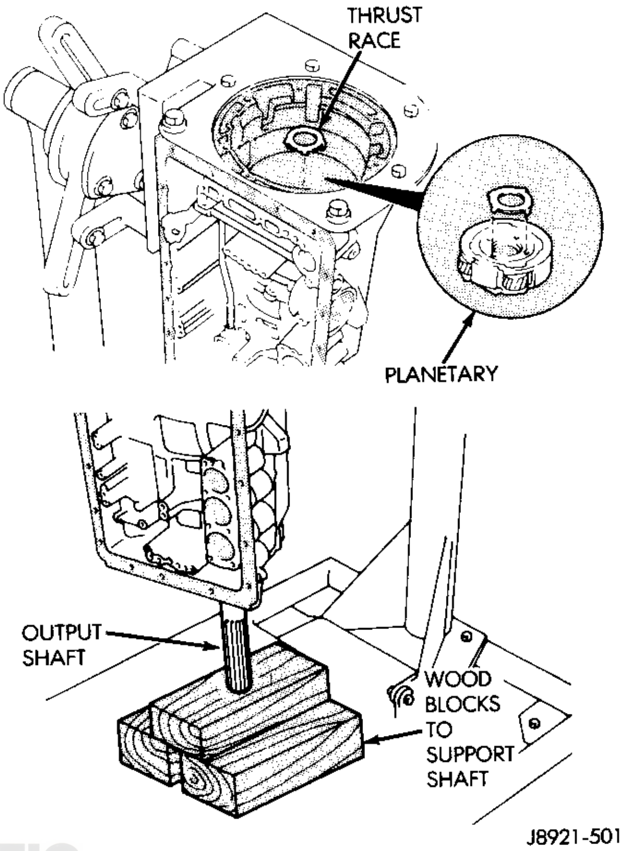


Fig. 36 Relieving Load On Planetary Snap Ring

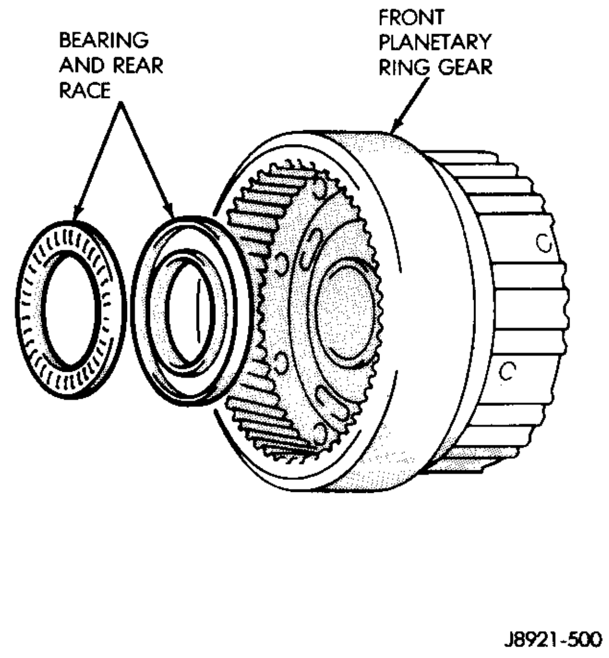


Fig. 35 Removing Ring Gear Bearing And Rear Race

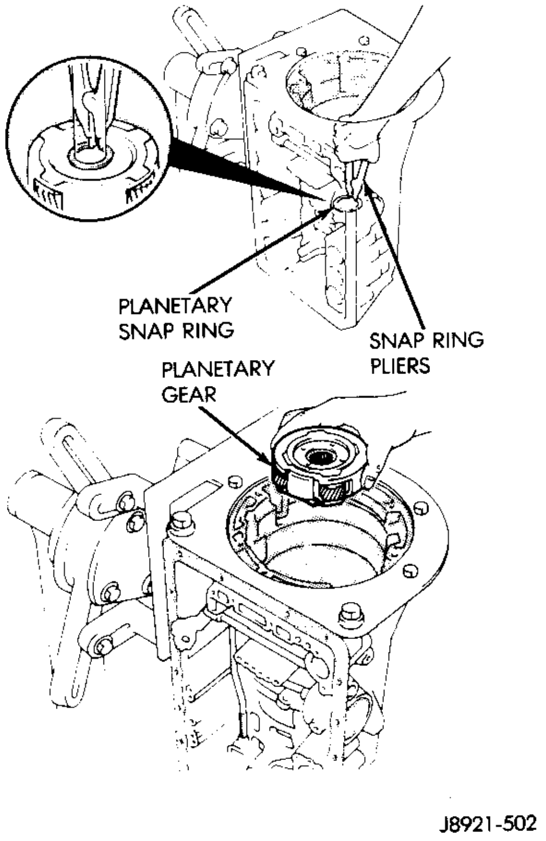


Fig. 37 Removing Planetary Snap Ring And Gear

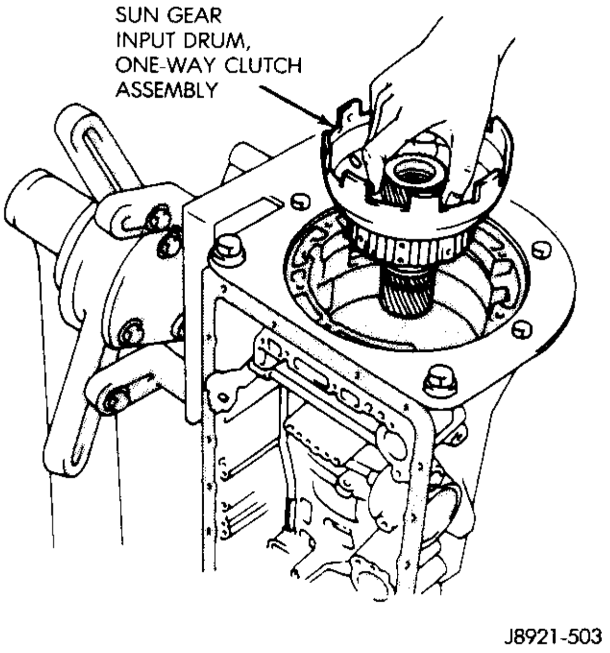


Fig. 38 Removing Sun Gear, Input Drum And One-Way Clutch

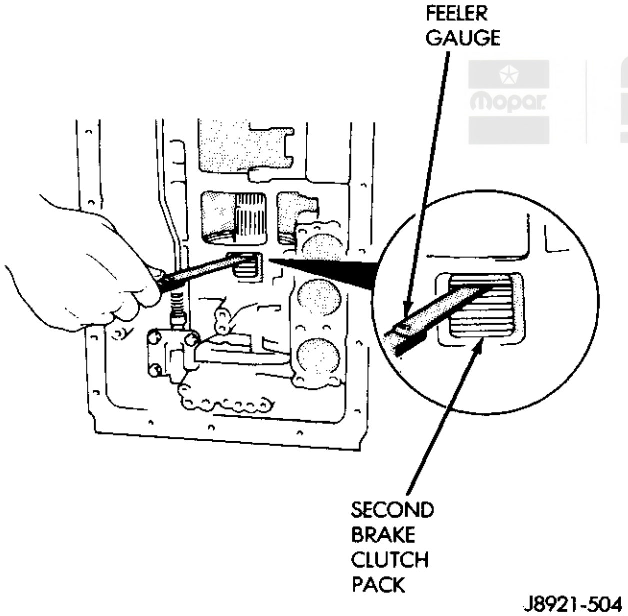


Fig. 39 Checking Second Brake Clutch Pack Clearance

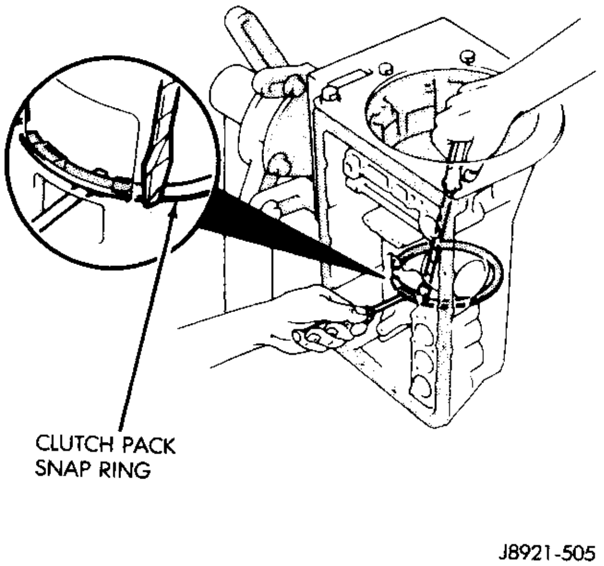


Fig. 40 Removing Second Brake Clutch Pack Snap Ring

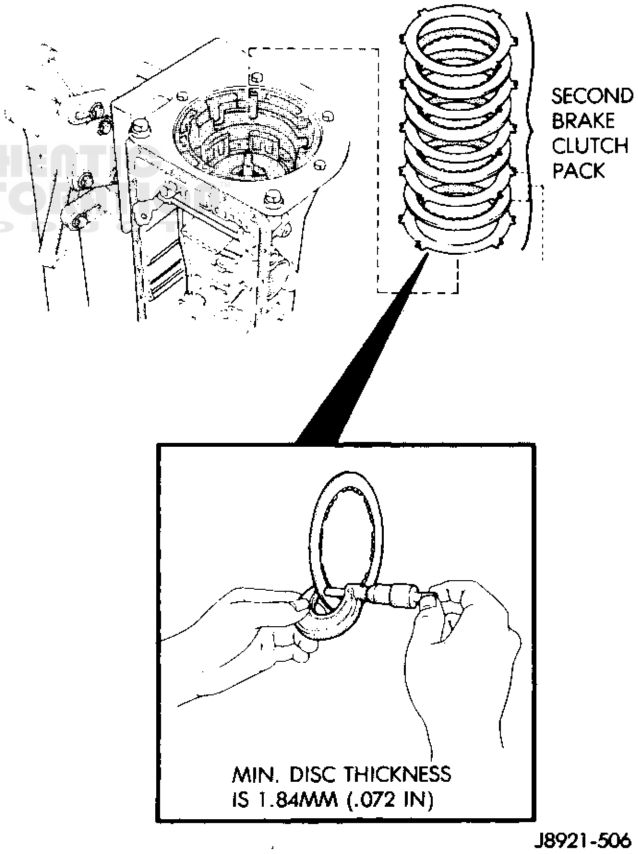


Fig. 41 Remove/Measure Second Brake Clutch Disc Thickness

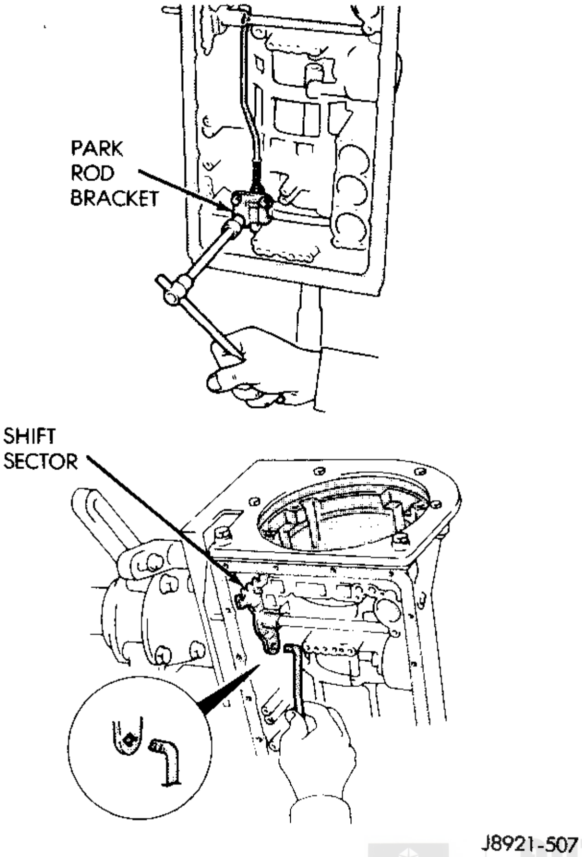


Fig. 42 Removing Park Rod And Bracket

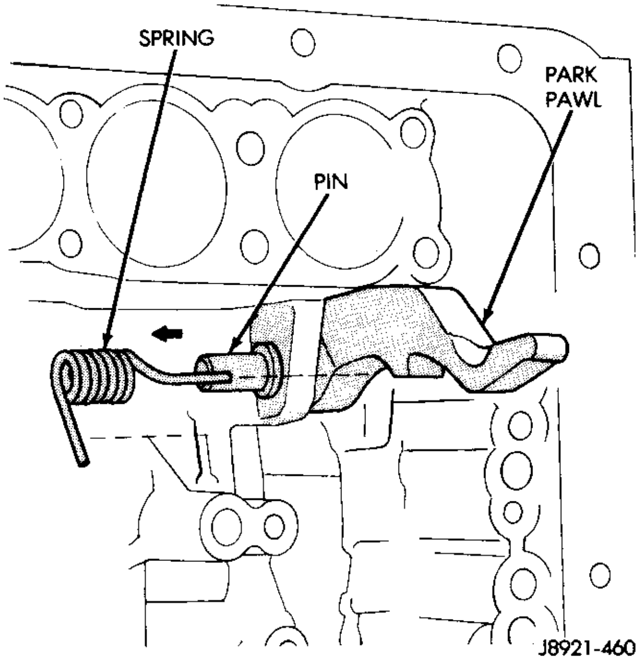


Fig. 43 Removing Park Pawl, Pin And Spring

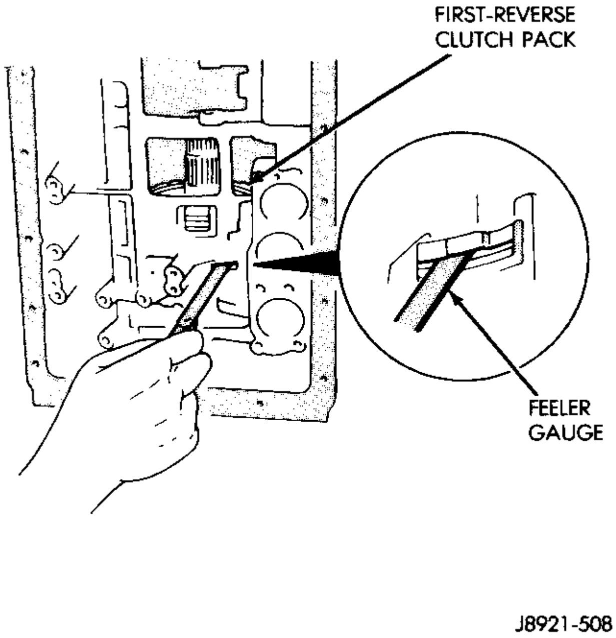


Fig. 44 Checking First-Reverse Brake Clutch Pack Clearance

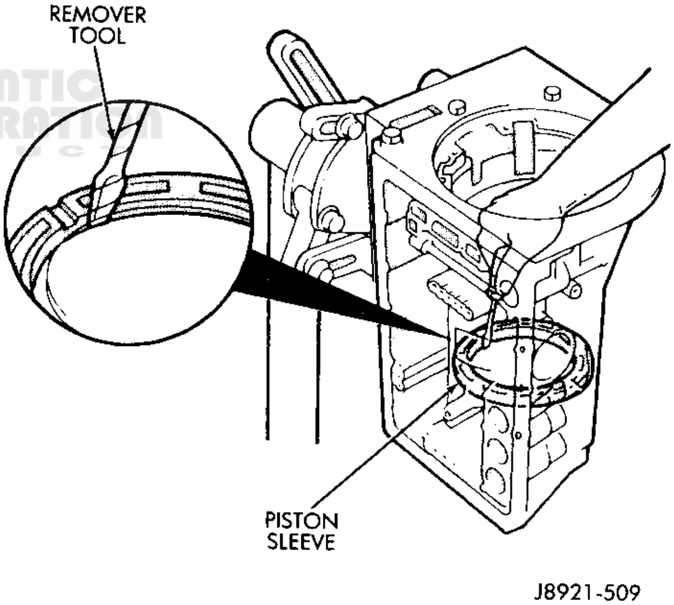


Fig. 45 Removing Second Brake Piston Sleeve

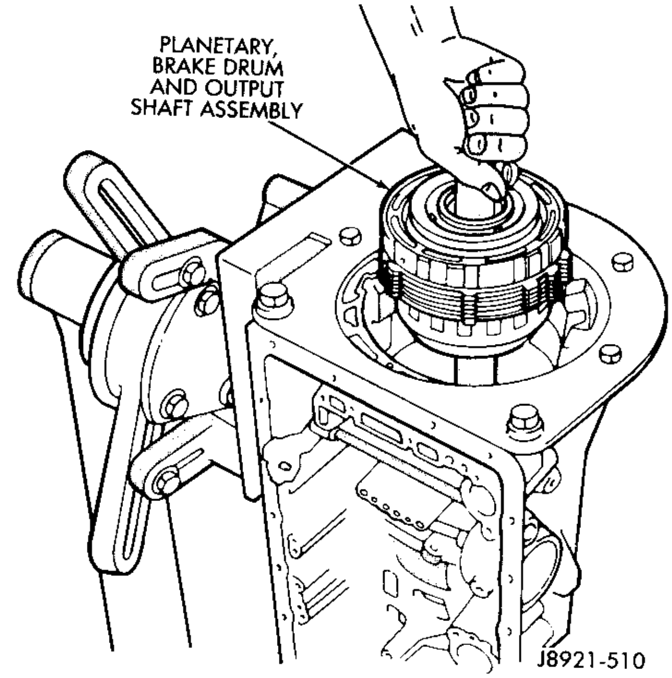


Fig. 46 Removing Rear Planetary, Second Brake Drum And Output Shaft

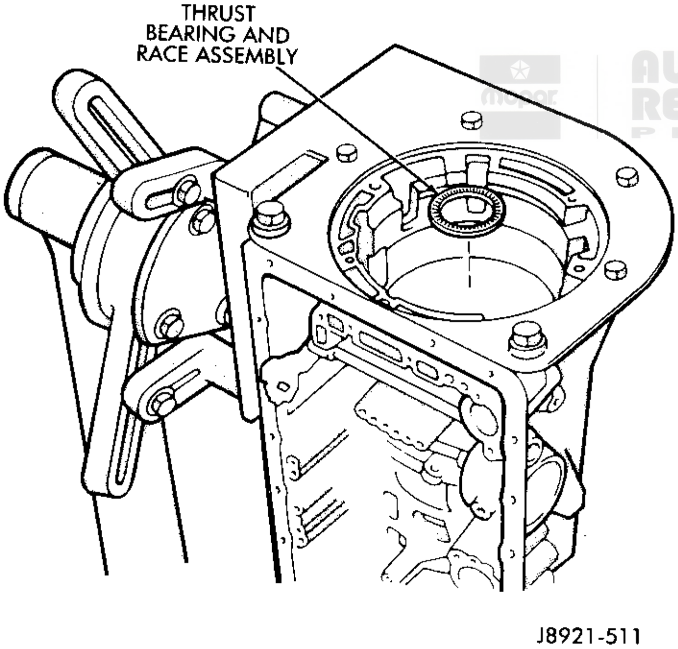


Fig. 47 Removing Planetary And Brake Drum Thrust Bearing And Race Assembly

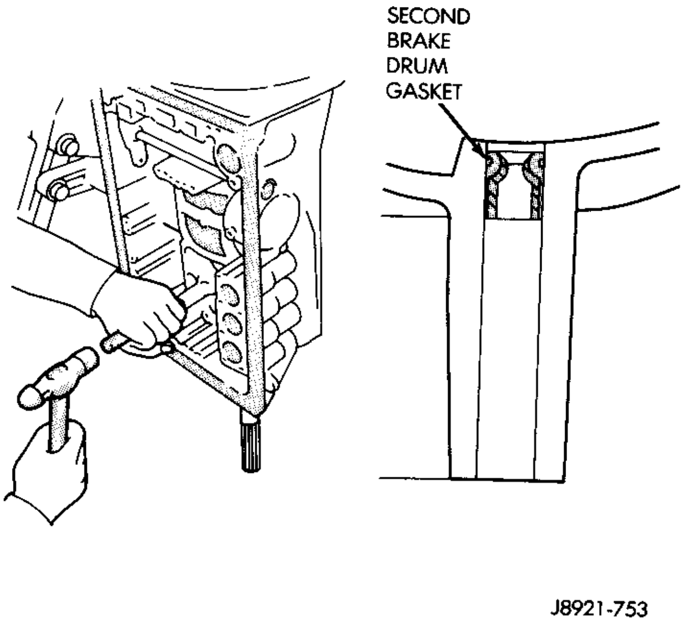


Fig. 48 Removing Brake Drum Gasket

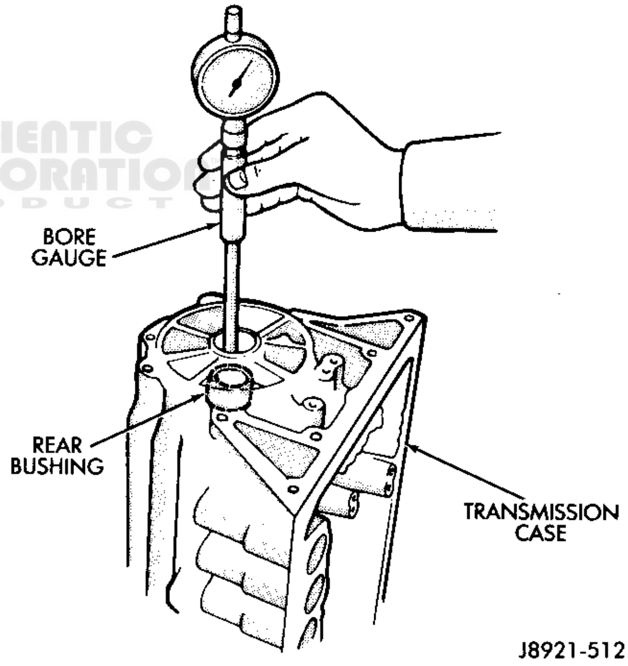


Fig. 49 Checking Rear Bushing Inside Diameter

SUBASSEMBLY OVERHAUL AND TRANSMISSION ASSEMBLY

INDEX

MANUAL VALVE SHAFT OVERHAUL

(1) Remove shaft spacer sleeve in half with chisel and remove it from lever and shaft (Fig. 2).

(2) Remove shift sector retaining pin with pin punch (Fig. 3).

(3) Pull shaft out of case and remove manual lever.

(4) Carefully pry shaft seals from case.

(5) Lubricate new seals with petroleum jelly and install them in case (Fig. 4).

(6) Install new spacer sleeve on shift sector (Fig. 5).

(7) Install sector and sleeve on shaft and install shaft in case.

(8) Align sector and sleeve and install new retaining pin.

(9) Align notch in sleeve with depression in sector and stake sleeve in two places. Be sure lever and shaft rotate smoothly.

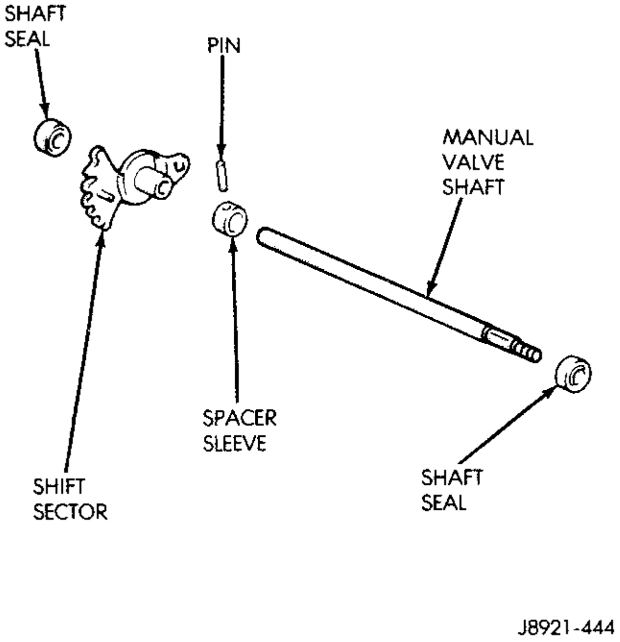


Fig. 1 Manual Valve Shaft Components

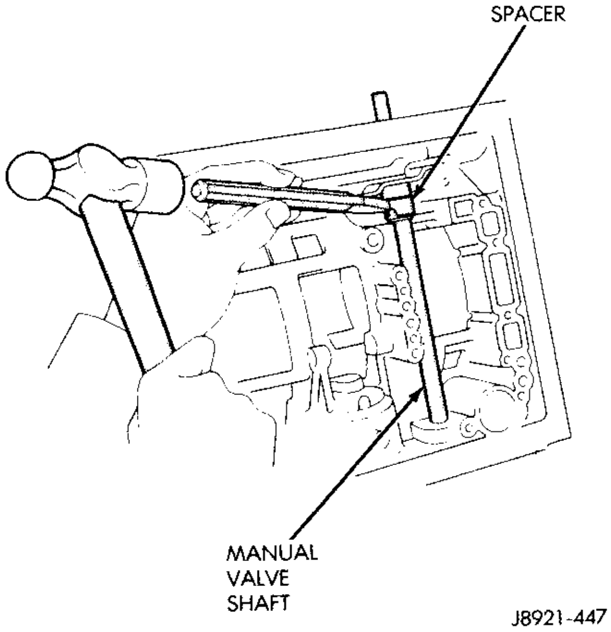


Fig. 2 Cutting Shaft Spacer Sleeve

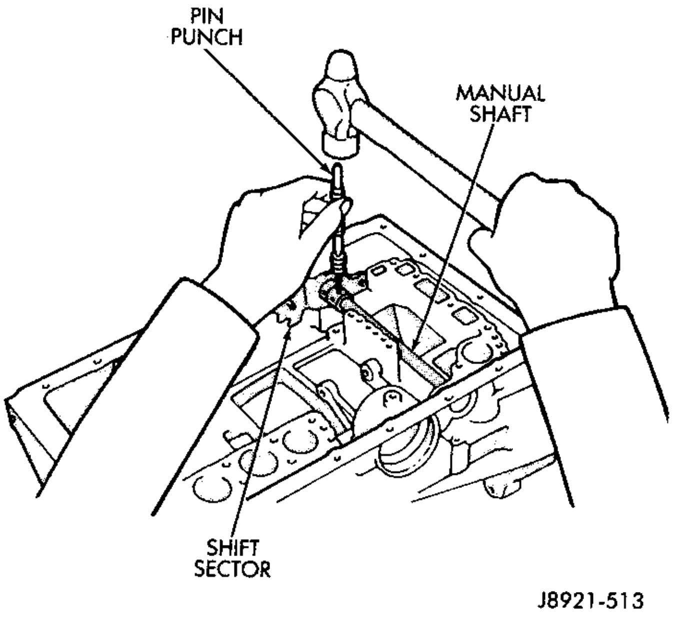


Fig. 3 Removing/Installing Sector Retaining Pin

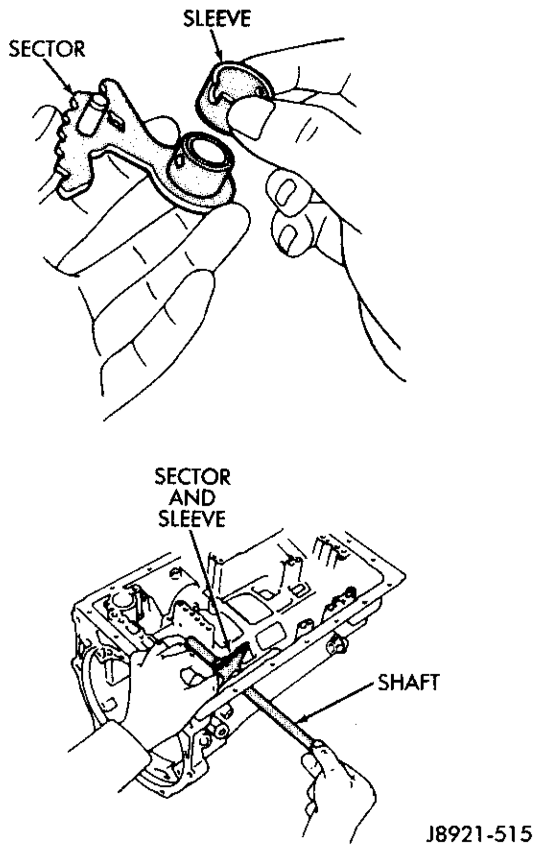


Fig. 5 Installing Manual Shaft And Sector

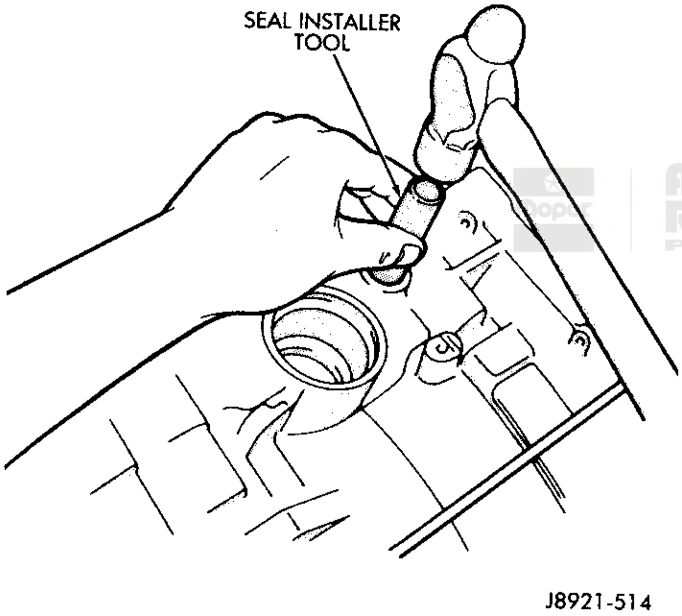


Fig. 4 Installing Manual Shaft Seals

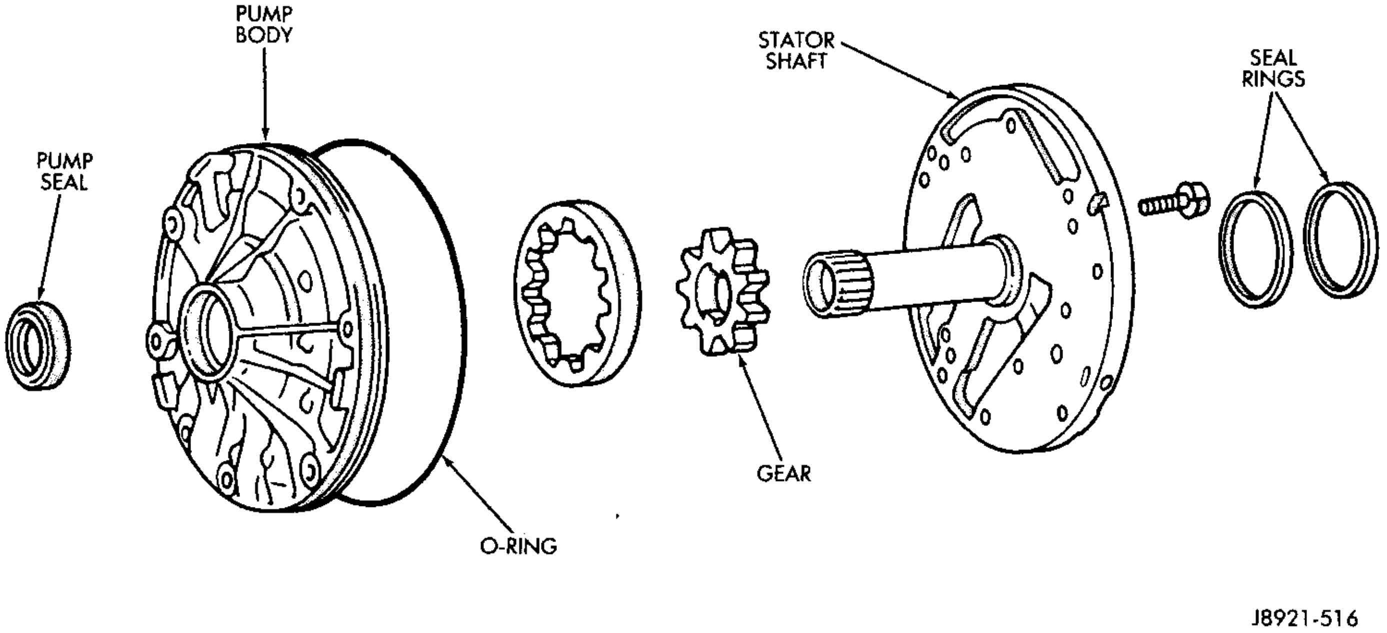


Fig. 1 Oil Pump Components

OIL PUMP OVERHAUL

(1) Remove pump body O-ring (Fig. 1).

(2) Remove pump seal rings (Fig. 1).

(3) Remove bolts attaching stator shaft to pump body and separate components.

(4) Remove drive gear and driven gear from pump body (Fig. 1).

(5) Measure inside diameter of pump body bushing with bore gauge (Fig. 2). Diameter should be maximum of 38.19 mm (1.5035 in). Replace pump body if bushing I.D. is greater than specified.

(6) Measure inside diameter of stator shaft bushing (Fig. 2). Take measurements at front and rear of bushing. Diameter should be maximum of 21.58 mm (.08496 in) at front and 27.08 mm (1.0661 in) at rear. Replace stator shaft if bushing diameter is greater than specified.

(7) Measure oil pump clearances (Fig. 3).

- Clearance between pump driven gear and pump body should be maximum of .3 mm (.012 in).
- Clearance between tips of pump gear teeth should be maximum of .3 mm (.012 in).
- Clearance between rear surface of pump housing and pump gears should be maximum of 0.1 mm (.004 in).

(8) Replace pump body and gears if any clearance is greater than specified.

(9) Remove old pump seal. Install new seal with installer tool B.Vi. FM. 38 (Fig. 4).

(10) Lubricate and install gears in pump body.

(11) Assemble stator shaft and pump body. Tighten shaft-to-body bolts to 10 N•m (7 ft-lbs) torque.

(12) Install new O-ring on pump body and new seal rings on stator shaft.

(13) Install pump in torque converter and check pump gear rotation. Gears must rotate smoothly when turned clockwise and counterclockwise.

(14) Lubricate pump O-ring and seal rings with petroleum jelly.

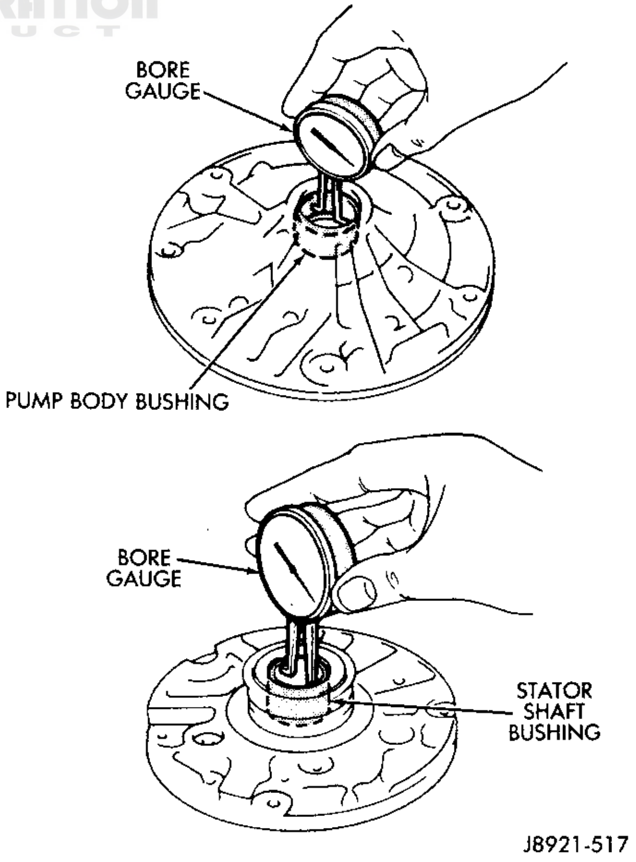


Fig. 2 Checking Pump/Stator Shaft Bushings

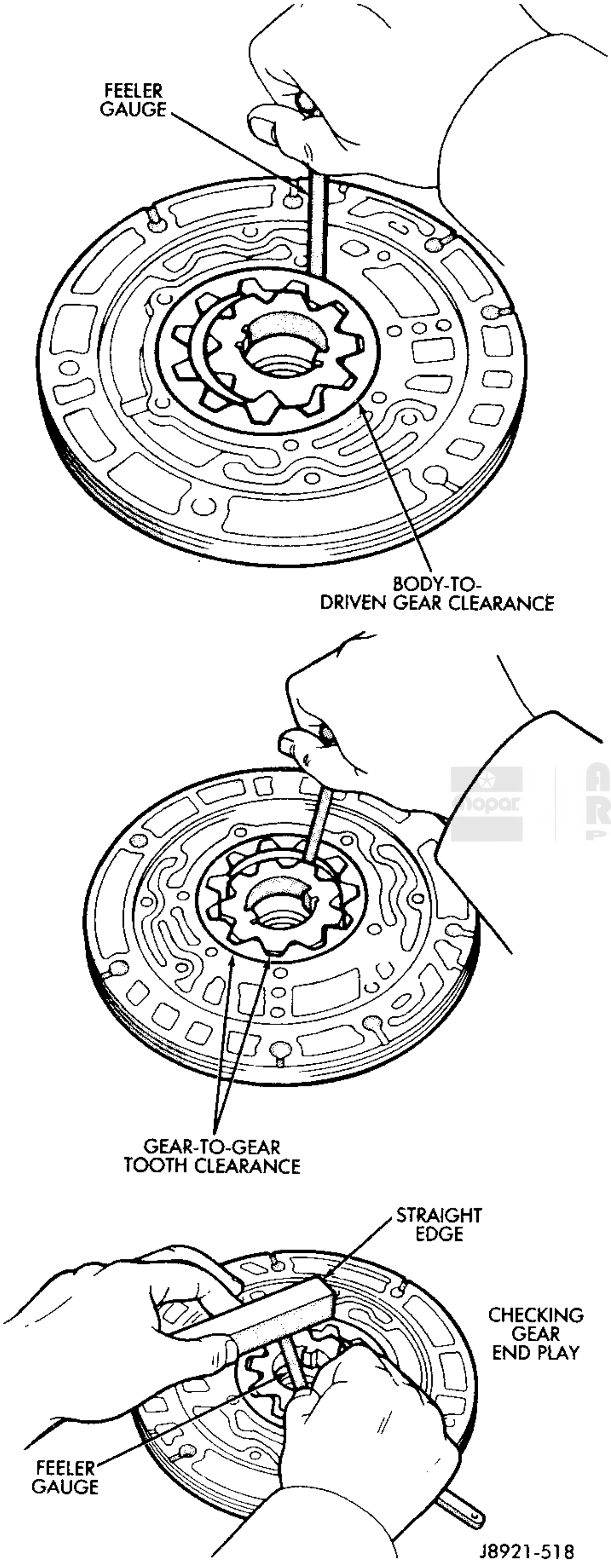


Fig. 3 Checking Pump Gear Clearances

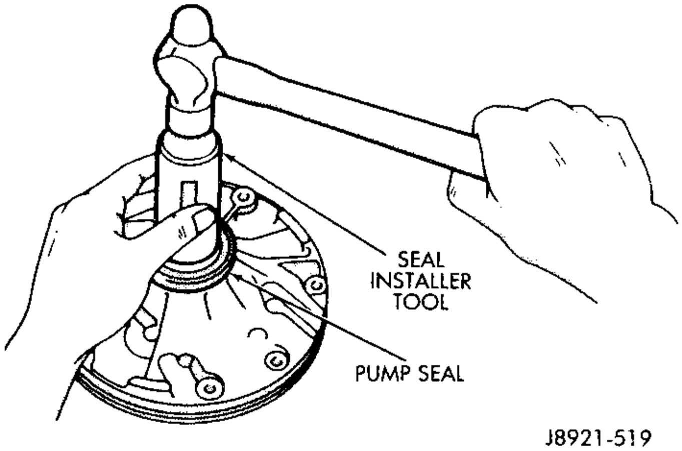


Fig. 4 Installing Pump Seal

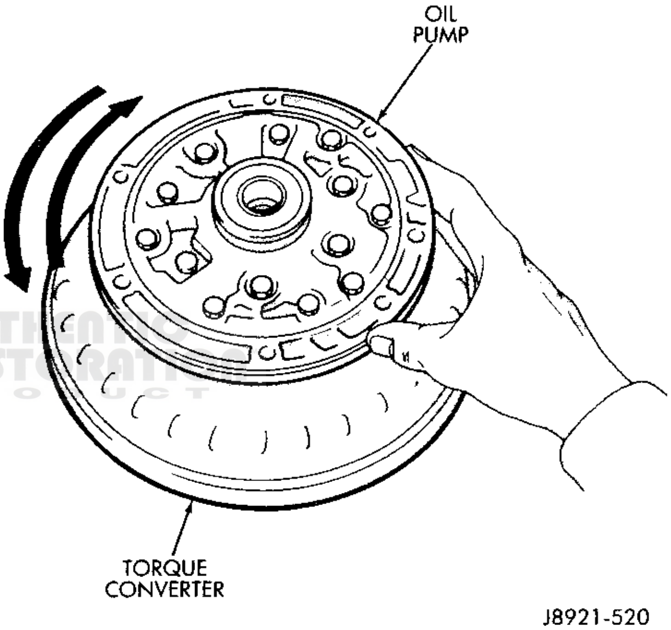


Fig. 5 Checking Pump Gear Rotation

OVERDRIVE PLANETARY GEAR AND CLUTCH OVERHAUL

Gear And Clutch Disassembly

(1) Check operation of one-way clutch in clutch drum. Hold drum and turn planetary shaft clockwise and counterclockwise. Shaft should turn clockwise freely but lock when turned counterclockwise. Replace one-way clutch if necessary.

(2) Remove overdrive clutch from planetary gear (Fig. 3).

(3) Remove thrust bearing and race assembly from clutch drum (Fig. 4).

(4) Measure stroke length of clutch piston as follows:

(a) Mount oil pump on torque converter. Then mount clutch on oil pump (Fig. 5).

(b) Mount dial indicator on clutch and position indicator stylus on clutch piston (Fig. 6).

(c) Apply compressed air through clutch feed hole in oil pump and note piston stroke length. Stroke length should be 1.85 to 2.15 mm (.0728 to .0846 in).

(5) Replace clutch pack retainer if stroke length is incorrect.Refer to chart in Specifications section for replacement retainer thicknesses.

(6) Remove clutch pack snap ring and remove the clutch pack.

(7) Compress piston return spring with tool B.Vi. FM. 27 and shop press and remove piston snap ring (Fig. 8).

(8) Remove compressor tool and piston return springs.

(9) Mount oil pump on converter. Then mount clutch on oil pump (Fig. 9).

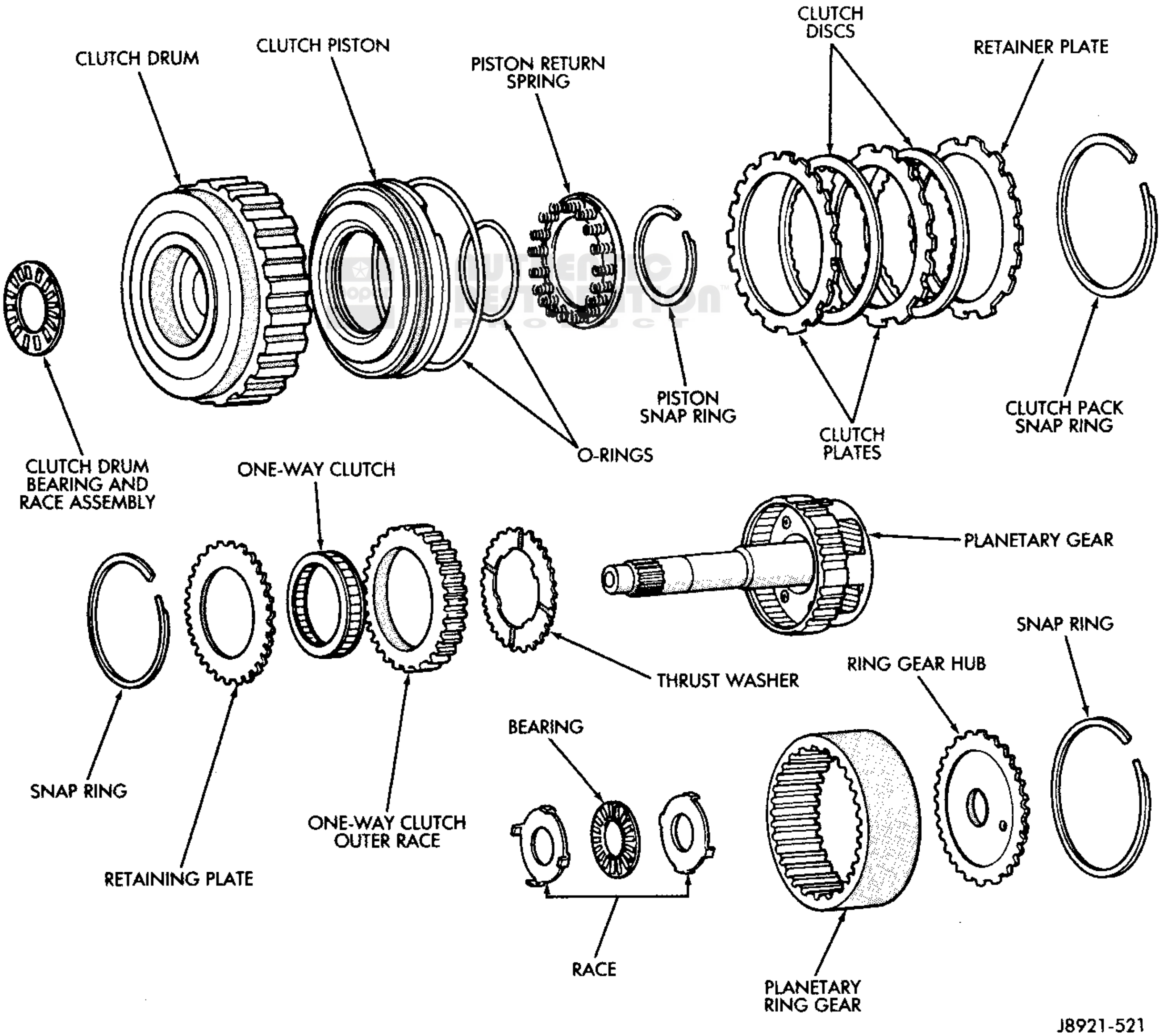


Fig. 1 Overdrive Planetary Gear And Clutch Components

(10) Hold clutch piston by hand and apply compressed air through oil pump feed hole to ease piston out (Fig. 9). Apply only enough air pressure to remove piston.

(11) Remove bearing and race from ring gear (Fig. 10).

(12) Remove snap ring from ring gear and remove ring gear hub (Fig. 11).

(13) Remove race from planetary gear (Fig. 12).

(14) Remove snap ring and remove retaining plate (Fig. 13).

(15) Remove one-way clutch and outer race as assembly. Then separate race from clutch (Fig. 14).

(16) Remove thrust washer (Fig. 15).

(17) Measure clutch disc thickness. Minimum allowable thickness is 1.84 mm (.0724 in).

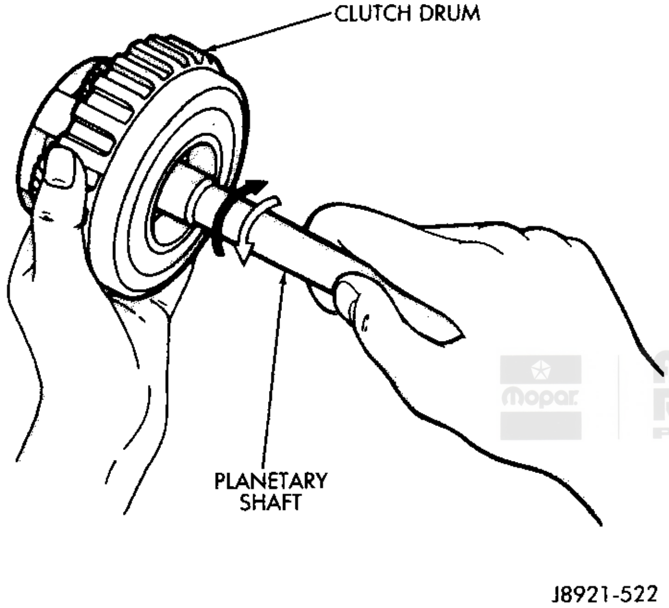


Fig. 2 Checking One-Way Clutch

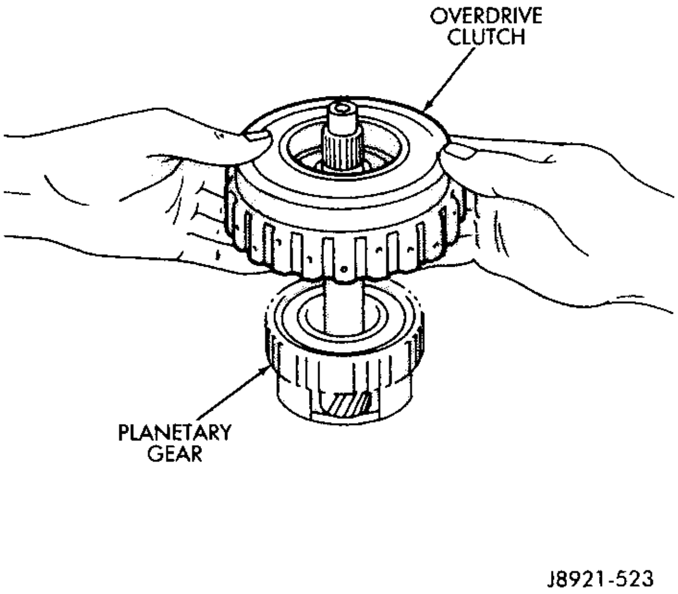


Fig. 3 Removing Overdrive Clutch From Gear

(18) Measure free length of piston return springs with springs in retainer (Fig. 16). Length should be 16.8 mm (.661 in).

(19) Check clutch piston check ball (Fig. 17). Shake piston to see if ball moves freely. Then check ball sealing by applying low pressure compressed air to ball inlet as shown. Air should not leak past check ball.

(20) Check inside diameter of clutch drum bushings with bore gauge (Fig. 18). Maximum inside diameter is 27.11 mm (1.0673 in). Replace drum if bushing inside diameter is greater than specified.

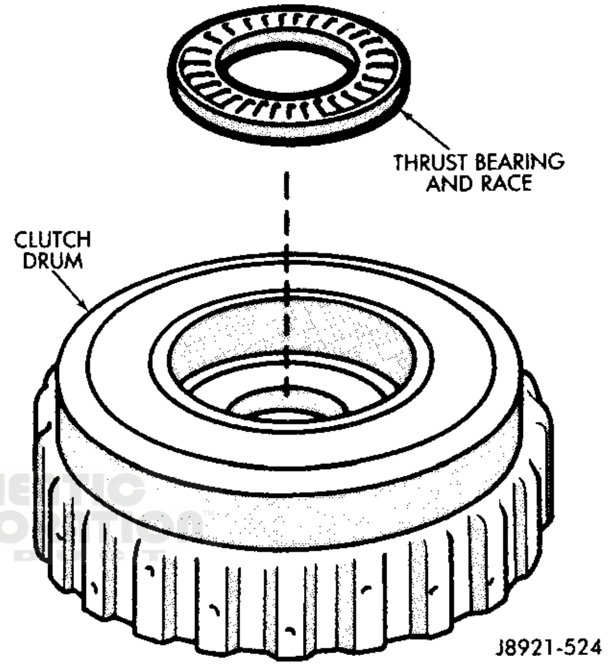


Fig. 4 Removing Clutch Drum Bearing And Race

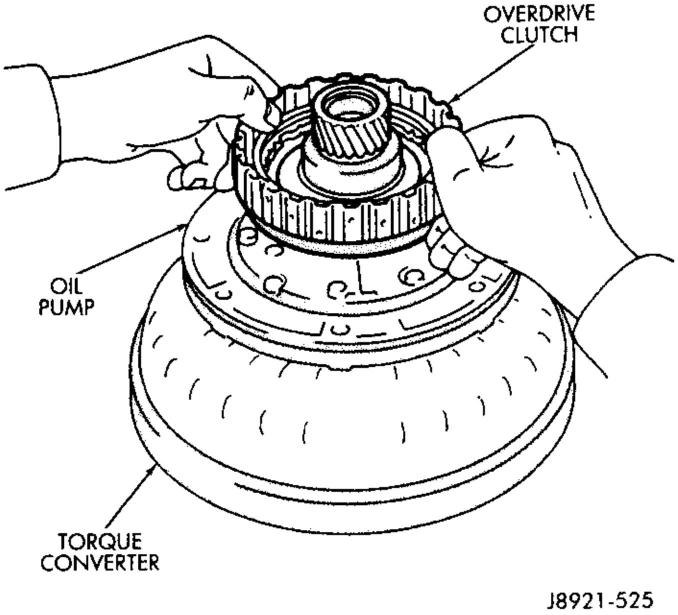


Fig. 5 Assembling Converter, Pump And Clutch For Test

(21) Check inside diameter of planetary gear bushing (Fig. 19). Maximum inside diameter is 11.27 mm (0.4437 in). Replace planetary gear if bushing inside diameter is greater then specified.

Gear And Clutch Assembly

(1) Install thrust washer in planetary gear (Fig. 20). **Grooved side of washer faces up and toward front.**

(2) Install one-way clutch in race (Fig. 21). Flanged side of clutch must face upward as shown.

(3) Install assembled one-way clutch and outer race in planetary gear. Be sure flanged side of clutch is facing upward.

(4) Install clutch pack retaining plate and snap ring in planetary gear.

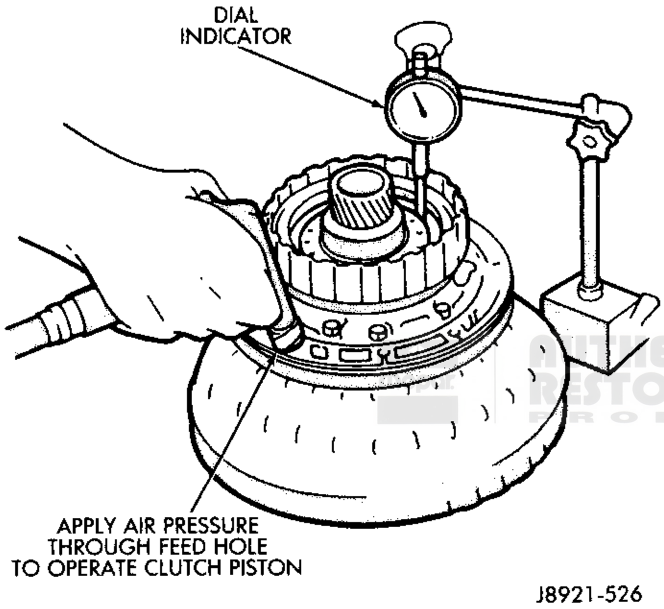


Fig. 6 Checking Overdrive Clutch Piston Stroke

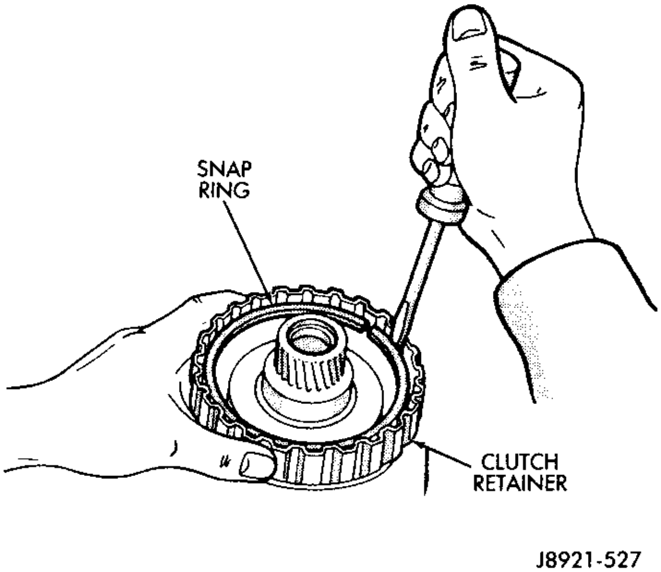


Fig. 7 Removing Clutch Pack Snap Ring

(5) Coat planetary race with petroleum jelly and install it on planetary gear. Outside diameter of race is 41.8 mm (1.646 in); inside diameter is 27.1 mm (1.067 in).

(6) Install hub in planetary ring gear and install snap ring.

(7) Coat race and bearing with petroleum jelly and install in planetary ring gear (Fig. 22).

(8) Verify bearing/race size. Outside diameter of race is 47.8 mm (1.882 in); inside diameter is 24.2 mm (.953 in). Outside diameter of bearing is 46.8 mm (1.843 in); inside diameter is 26 mm (1.024 in).

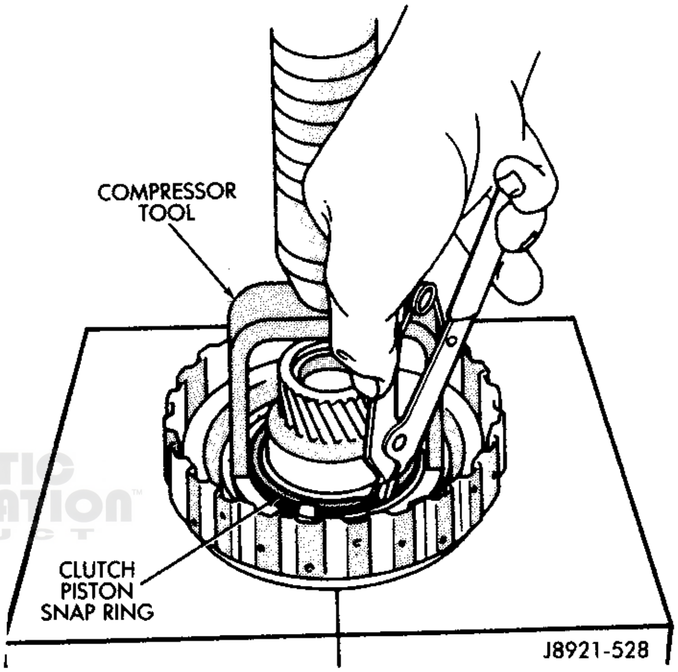


Fig. 8 Removing Clutch Piston Snap Ring

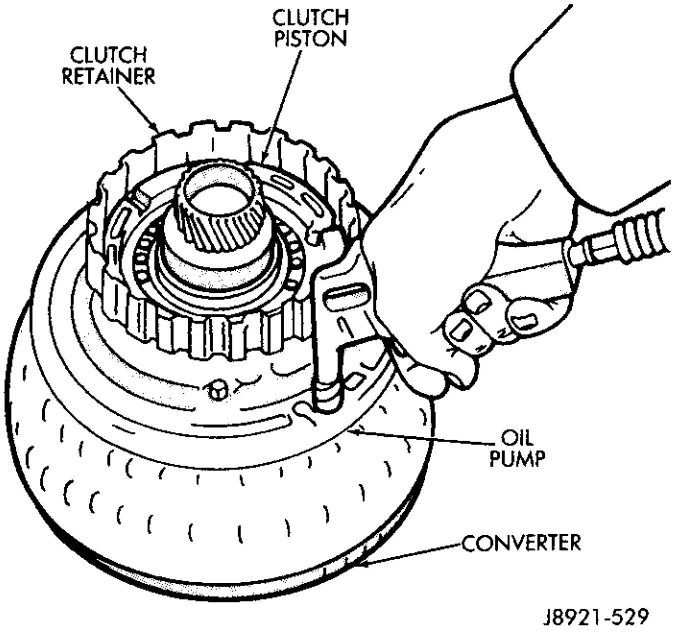


Fig. 9 Removing Overdrive Clutch Piston

(9) Lubricate and install new O-rings on clutch piston. Then install piston in clutch drum.

(10) Install piston return springs in clutch piston (Fig. 23).

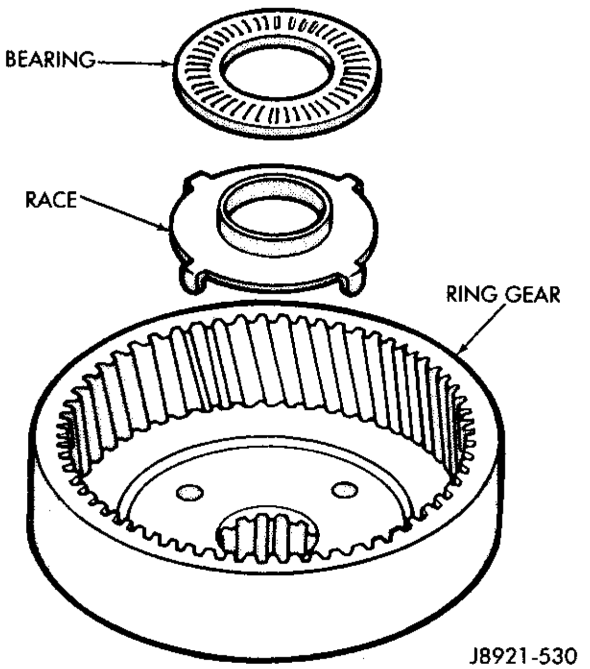


Fig. 10 Removing Ring Gear Bearing And Race

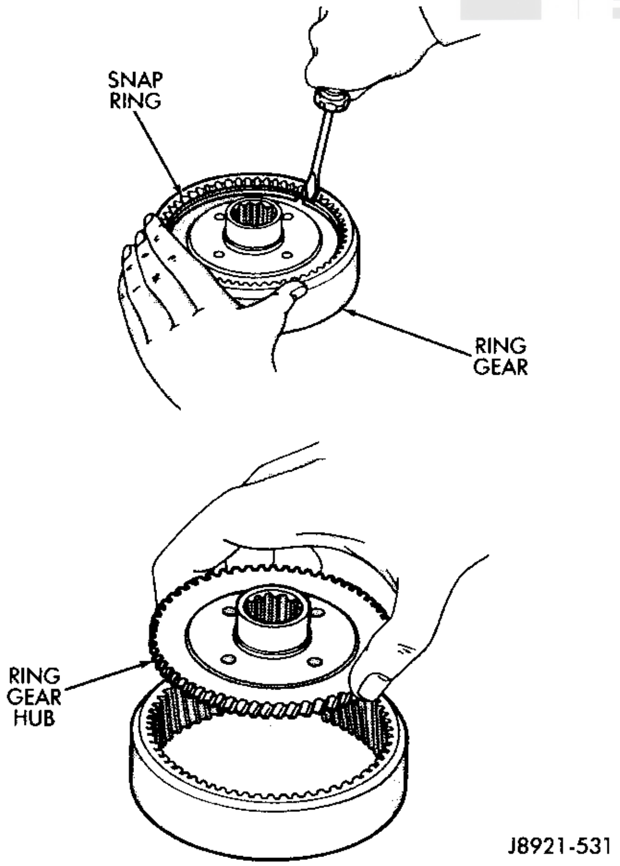


Fig. 11 Removing Ring Gear Hub

(11) Install piston snap ring. Compress piston return springs with compressor tool and shop press (Fig. 24).

(12) Install clutch pack in drum. Install steel plate first, then a disc (Fig. 25). Continue installation sequence until required number of discs and plates have been installed.

(13) Install clutch pack retainer with flat side facing downward. Then install retainer snap ring (Fig. 26). Compress springs with tool B.Vi. FM. 27.

(14) Measure clutch piston stroke length again (refer to procedure outlined in disassembly procedure). If stroke length is incorrect, install new clutch discs or select fit retainer. Retainer thicknesses are outlined in the Specifications section.

(15) Install clutch drum bearing and race assembly (Fig. 27). Be sure bearing rollers face upward as shown.

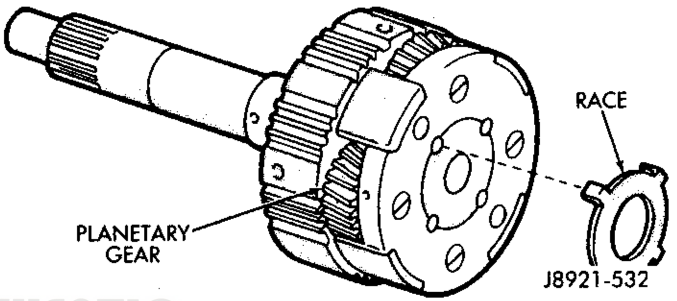


Fig. 12 Remove Planetary Gear Race

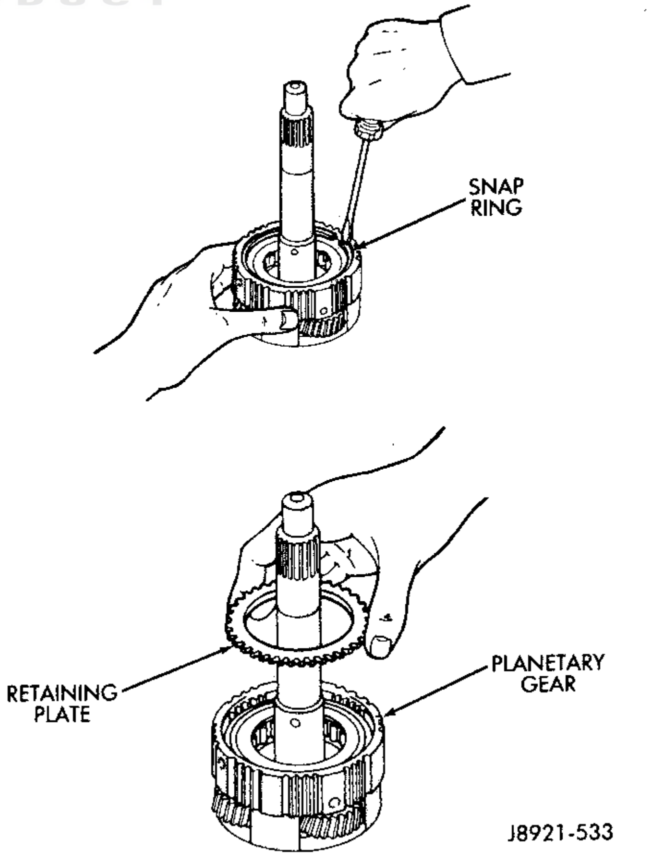


Fig. 13 Removing Snap Ring And Retaining Plate

Outside diameter of assembled bearing and race is 50.2 mm (1.976 in). Inside diameter is 28.9 mm (1.138 in).

(16) Install clutch on planetary gear.

(17) Verify one-way clutch operation. Hold drum and turn planetary shaft clockwise and counterclockwise. Shaft should turn clockwise freely but lock when turned counterclockwise.

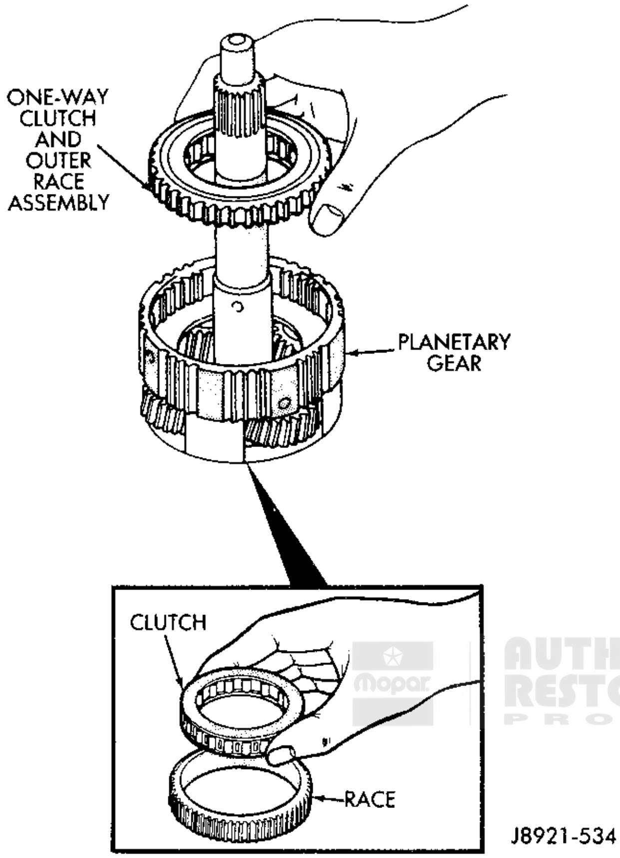


Fig. 14 Removing One-Way Clutch

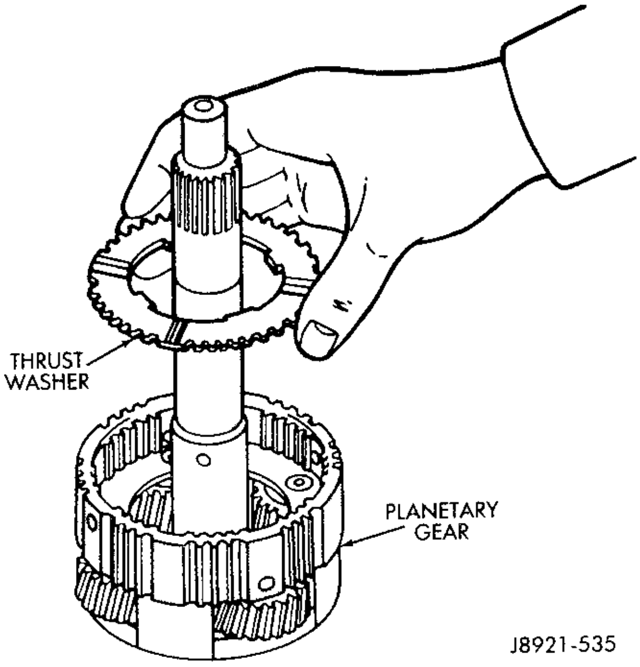


Fig. 15 Removing Planetary Thrust Washer

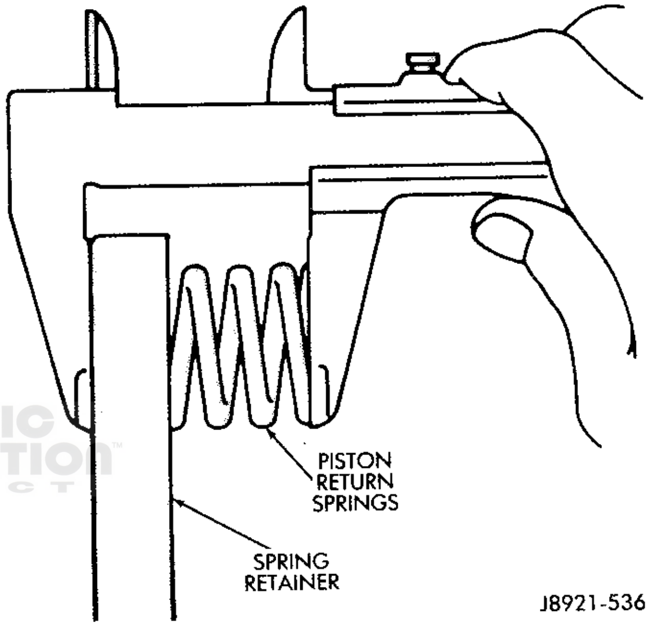


Fig. 16 Checking Piston Return Spring Length

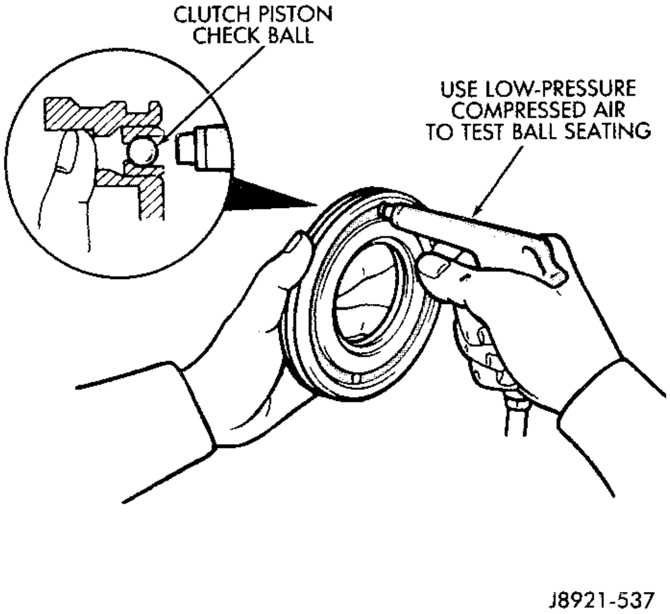


Fig. 17 Testing Clutch Piston Check Ball

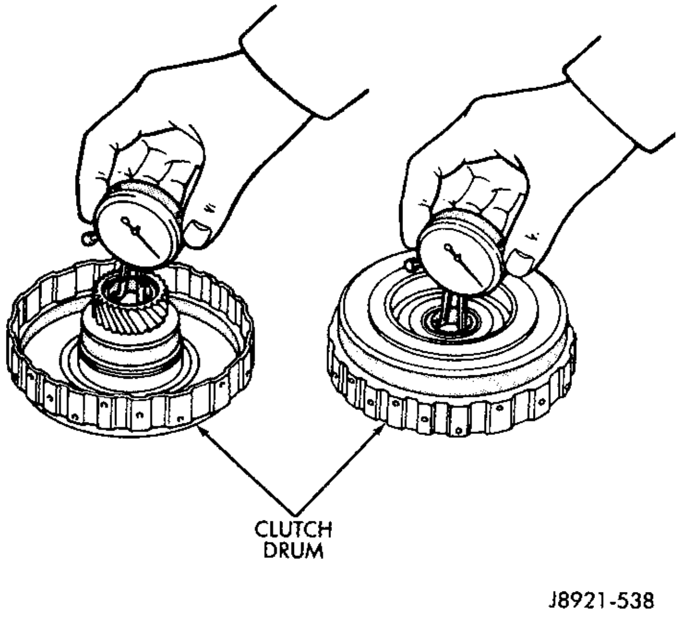


Fig. 18 Checking Clutch Drum Bushings

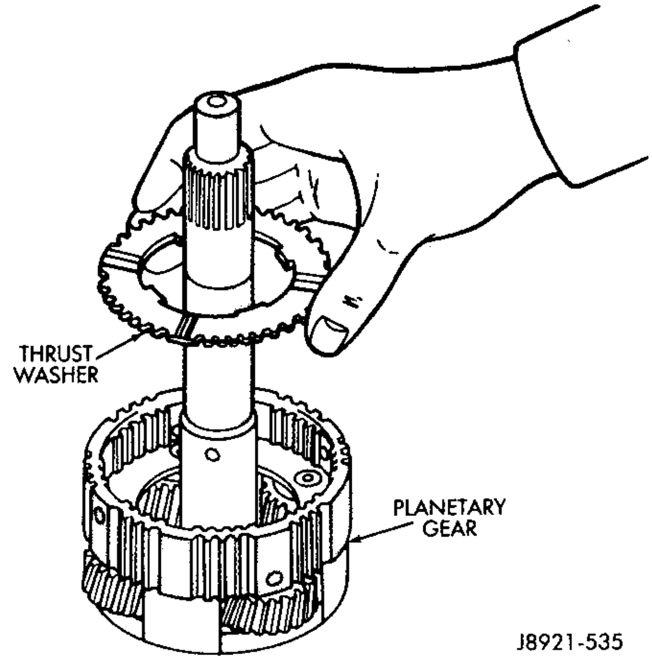


Fig. 20 Install Planetary Thrust Washer

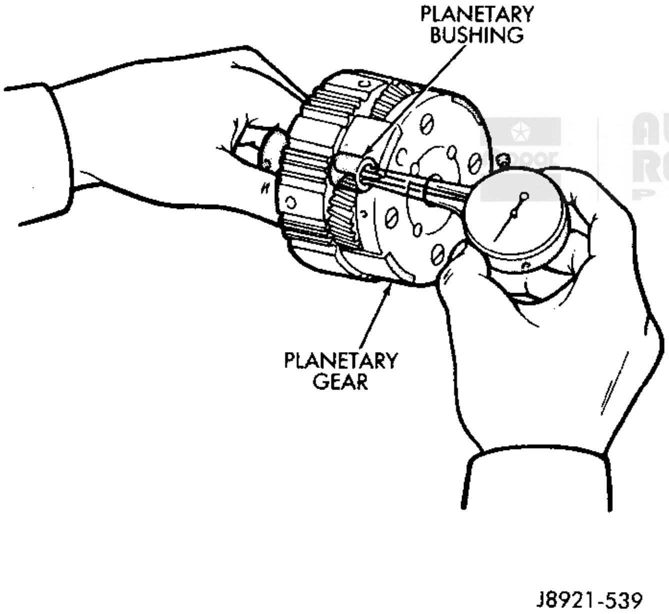


Fig. 19 Checking Planetary Bushing

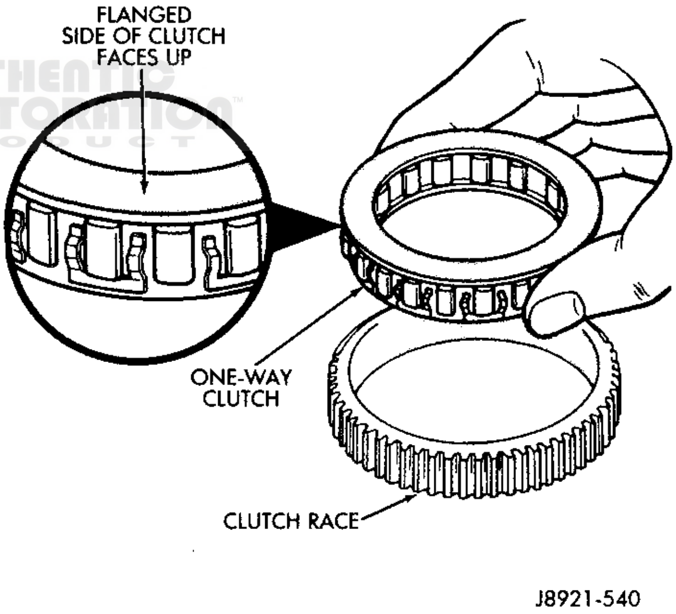


Fig. 21 Assembling One-Way Clutch And Race

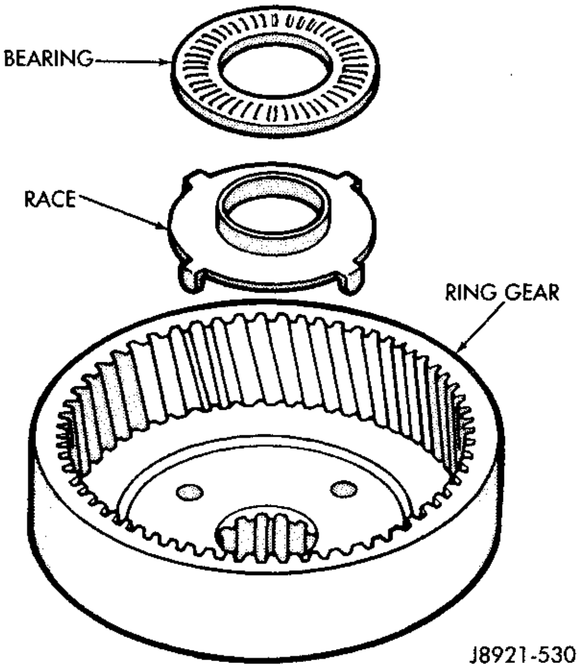


Fig. 22 Install Ring Gear Bearing And Race

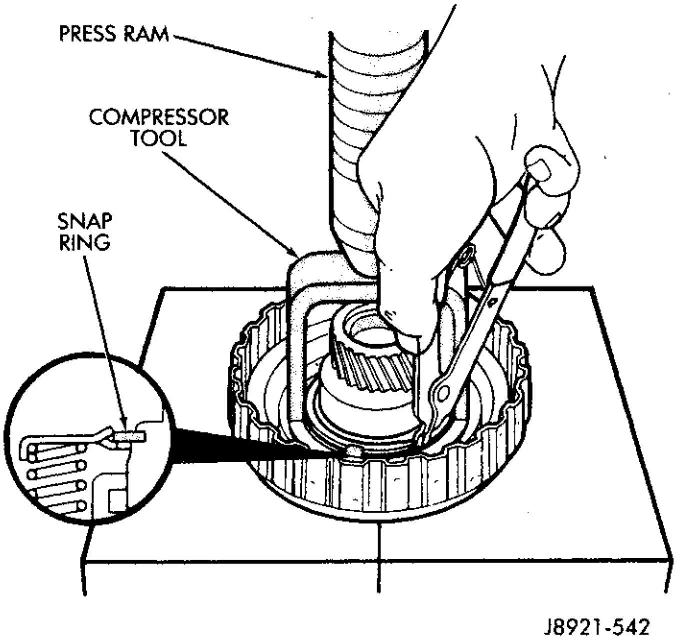


Fig. 24 Installing Clutch Piston Snap Ring

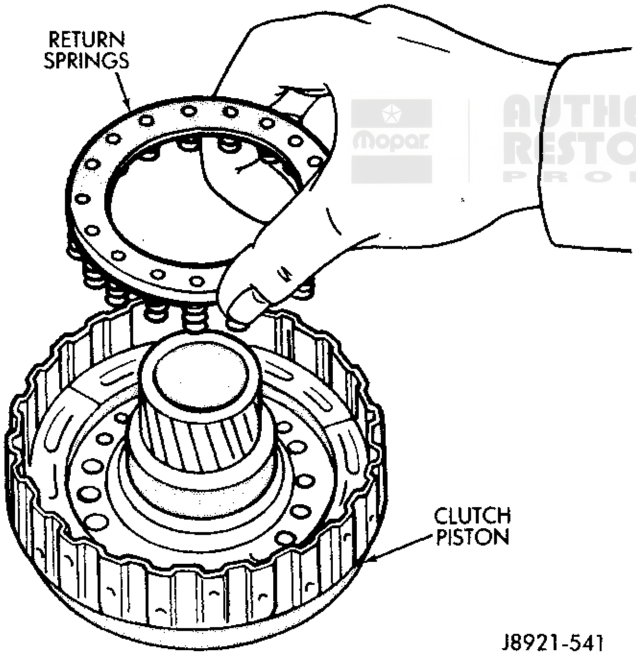


Fig. 23 Installing Piston Return Springs

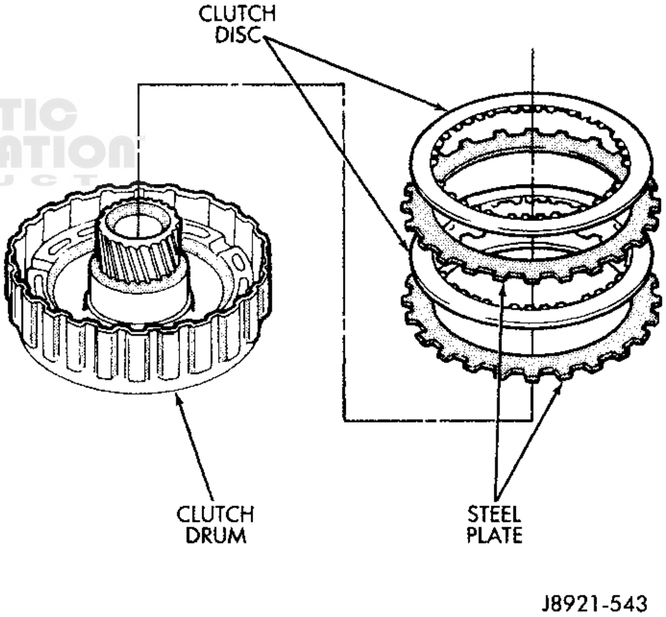


Fig. 25 Installing Clutch Discs And Plates

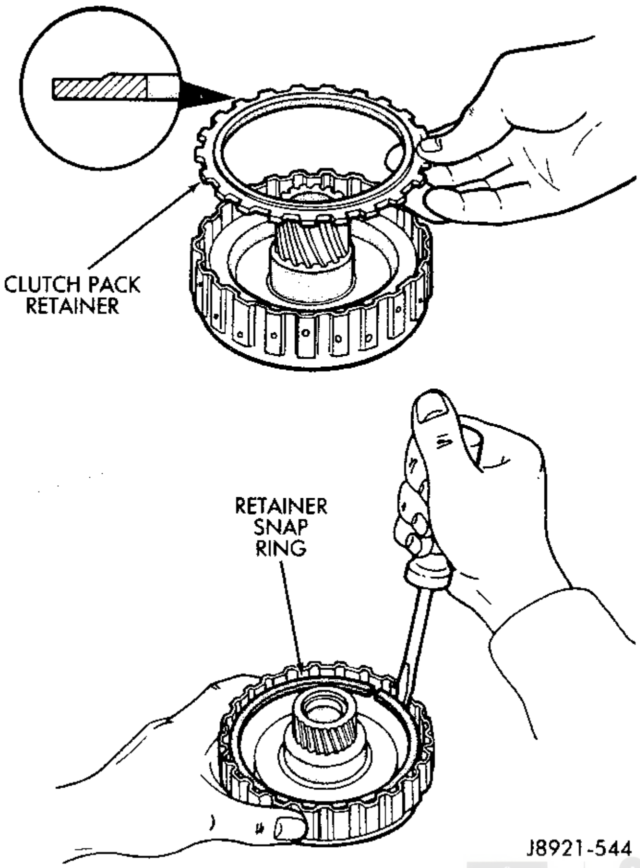


Fig. 26 Installing Retainer And Snap Ring

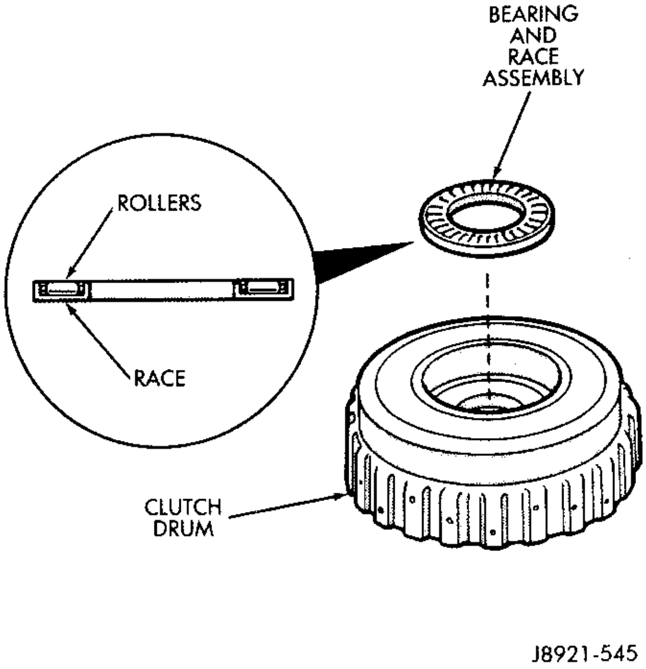


Fig. 27 Installing Clutch Drum Bearing And Race Assembly

OVERDRIVE SUPPORT OVERHAUL

Support Disassembly

(1) Check brake piston operation. Mount support on clutch (Fig. 2).

(2) Apply compressed air through support feed hole and observe brake piston movement (Fig. 2). Piston should move smoothly and not bind or stick. If operation is incorrect, replace piston and support.

(3) Remove thrust bearing front race, thrust bearing and rear race (Fig. 3).

(4) Turn overdrive support over and remove bearing race and clutch drum thrust washer (Fig. 4).

(5) Compress piston return spring with tool B.Vi. FM. 26 and remove piston snap ring (Fig. 5).

(6) Mount support in direct clutch and remove brake piston with compressed air. Apply air to same feed hole used when checking piston operation.

(7) Remove and discard support O-rings (Fig. 1).

(8) Remove support seal rings (Fig. 6).

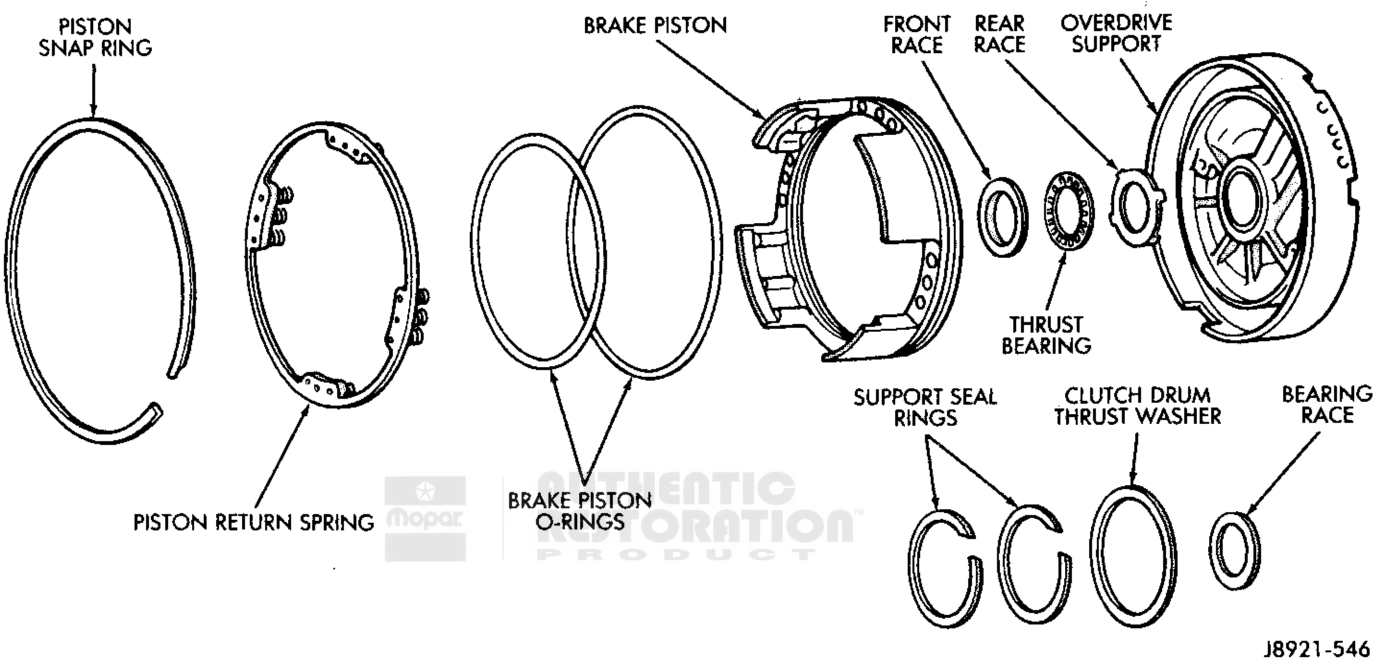


Fig. 1 Overdrive Support Components

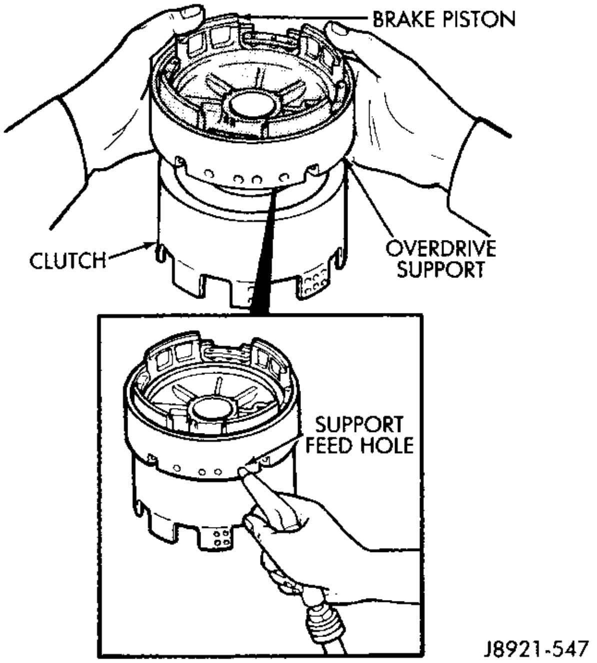


Fig. 2 Checking Brake Piston Movement

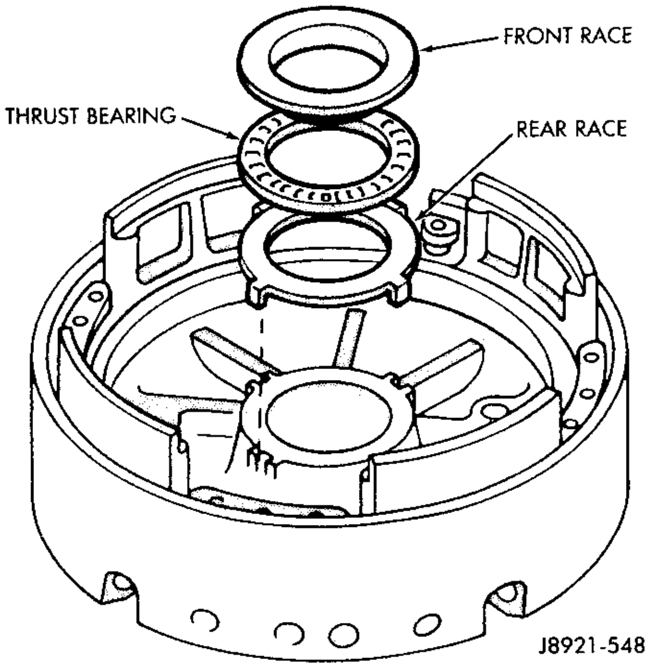


Fig. 3 Removing Support Thrust Bearing And Races

(9) Measure free length of piston return springs with springs mounted in retainer (Fig. 7). Length should be 18.61 mm (.733 in).

(10) Clean support components and dry them with compressed air.

(11) Inspect overdrive support and brake piston. Replace support and piston if either part is worn or damaged.

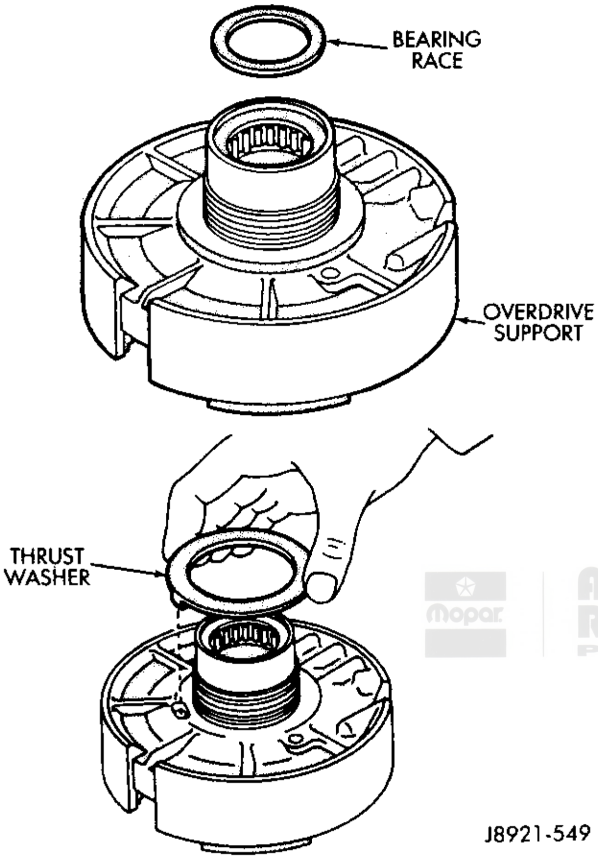


Fig. 4 Removing Clutch Drum Thrust Washer And Race

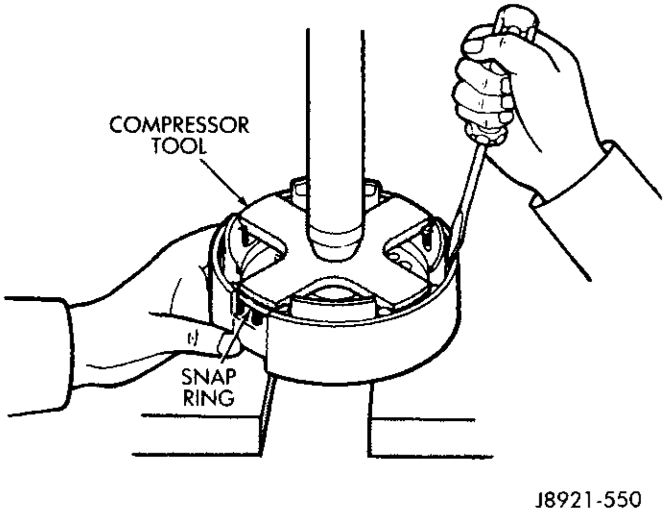


Fig. 5 Removing/Installing Piston Snap Ring

Assembling Overdrive Support

(1) Lubricate new support seal rings. Then compress rings and install them on support (Fig. 8).

(2) Lubricate and install new O-rings on brake piston. Then carefully seat piston in support.

(3) Install return springs on brake piston.

(4) Compress return springs with tool (Fig. 5) and install piston snap ring.

(5) Install support bearing race and clutch drum thrust washer (Fig. 4).

(6) Install thrust bearing and front and rear bearing races. Thrust bearing rollers should face upward as shown (Fig. 9).

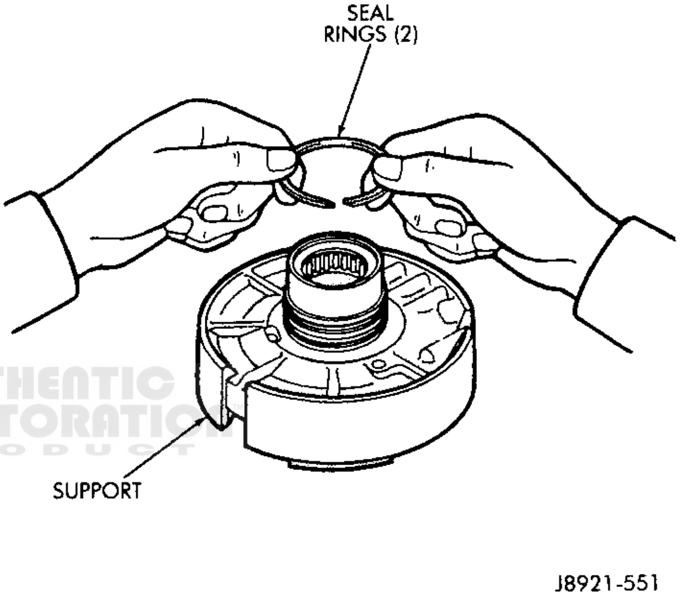


Fig. 6 Removing Support Seal Rings

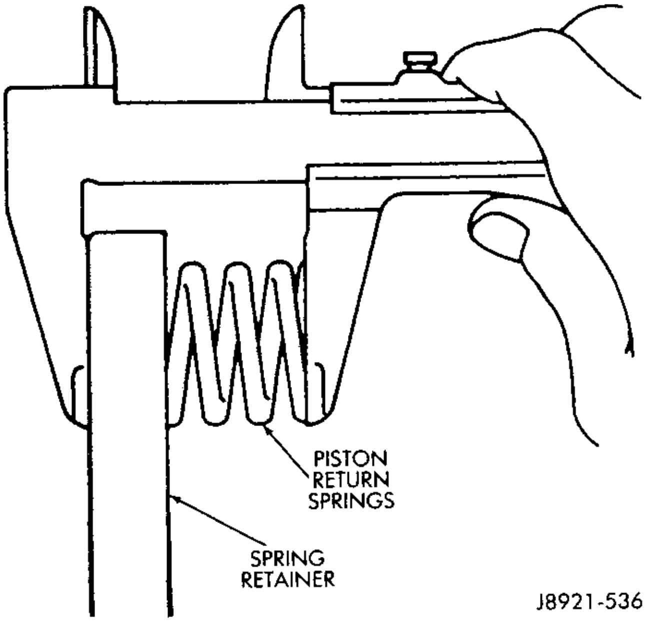


Fig. 7 Checking Piston Return Spring Length

(7) Verify thrust bearing/race sizes (Fig. 9). Front race outer diameter is 47.8 mm (1.882 in); inside diameter is 30.7 mm (1.209 in). Rear race outer diameter is 47.8 mm (1.882 in); inside diameter is 34.3 mm (1.350 in). Bearing outer diameter is 47.7 mm (1.878 in); inside diameter is 32.7 mm (1.287 in).

(8) Verify brake piston operation. Use same procedure described at beginning of disassembly. Piston should operate smoothly and not bind or stick.

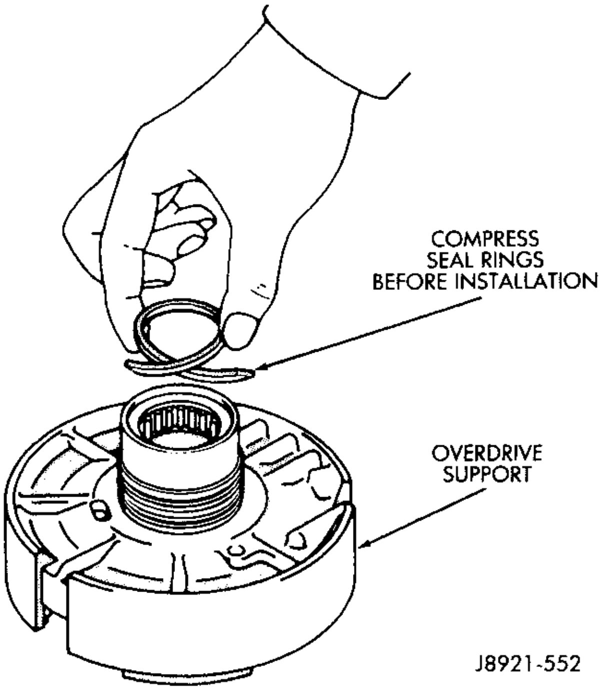


Fig. 8 Installing Support Seal Rings

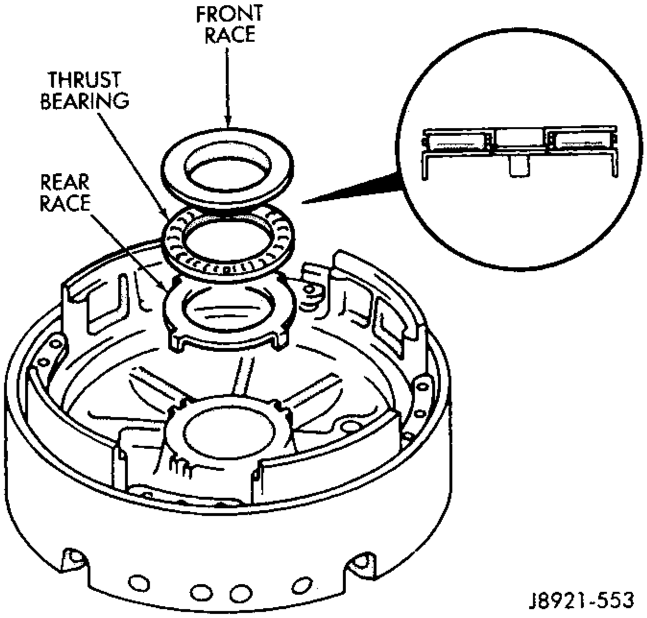


Fig. 9 Installing Support Thrust Bearing And Races

DIRECT CLUTCH OVERHAUL

Clutch Disassembly

(1)Remove direct clutch from forward clutch (Fig. 2).

(2) Remove clutch drum thrust washer (Fig. 3).

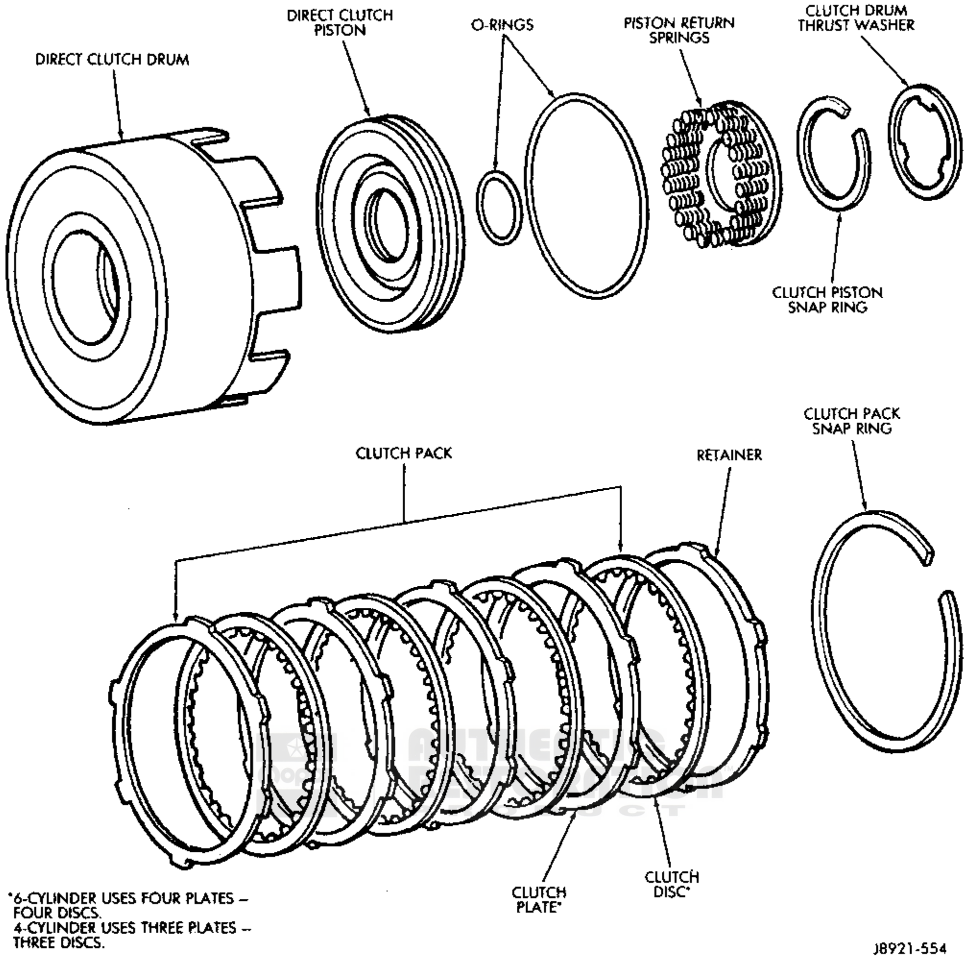


Fig. 1 Direct Clutch Components

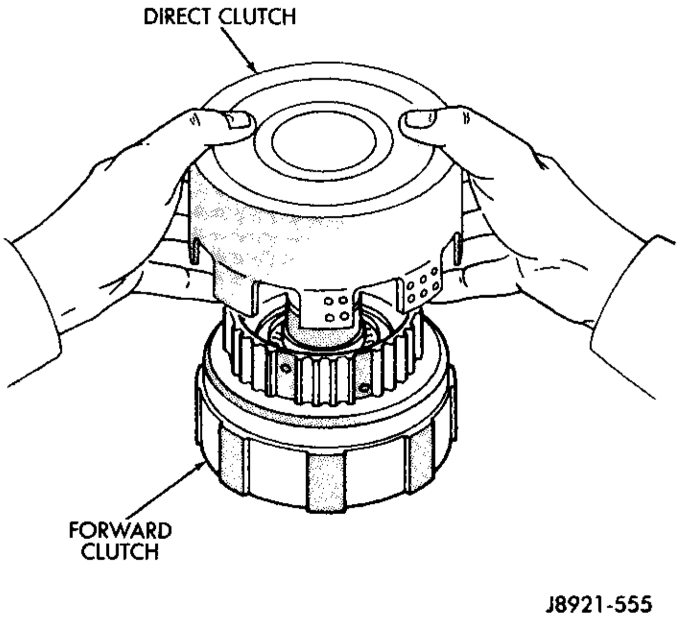


Fig. 2 Separate Direct Clutch From Forward Clutch

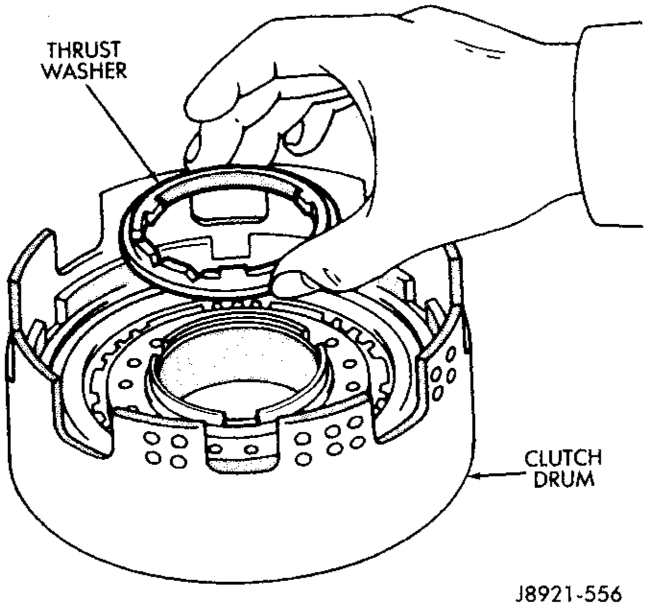


Fig. 3 Removing Clutch Drum Thrust Washer

(3) Check clutch piston stroke length as outlined in following steps.

(4) Mount direct clutch on overdrive support assembly (Fig. 4).

(5) Mount dial indicator on clutch and position indicator plunger on clutch piston (Fig. 4).

(6) Apply 57-114 psi air pressure through feed hole in overdrive support and note piston stroke length (Fig. 5). Check stroke at least twice.

(7) Piston stroke length should be 1.37 mm to 1.60 mm (.0539 to .0642 in). If stroke length is incorrect, either the clutch pack retainer or clutch discs will have to be replaced.

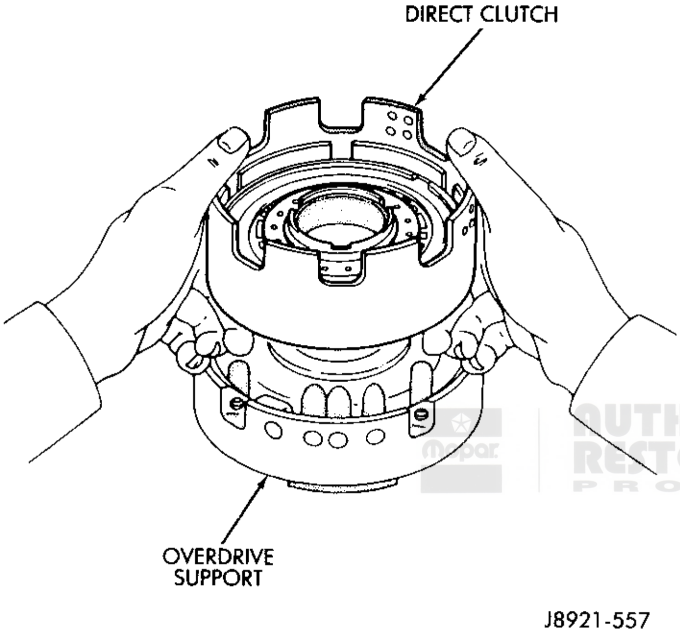


Fig. 4 Mount Direct Clutch On Overdrive Support

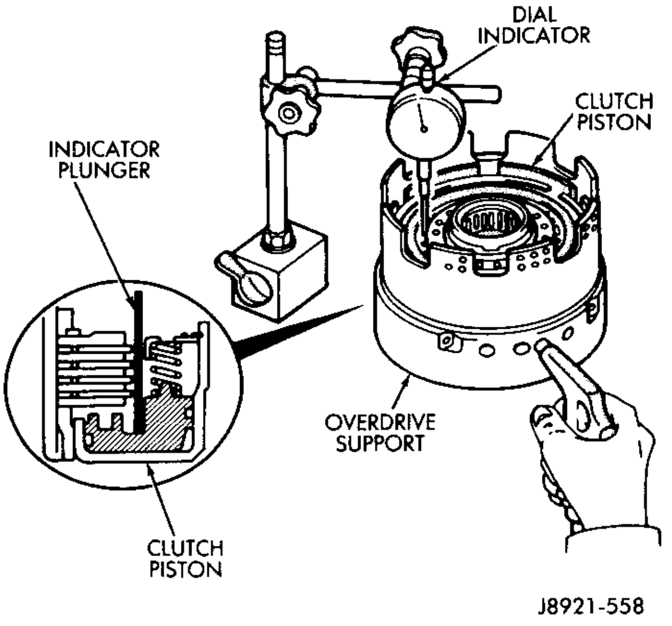


Fig. 5 Checking Direct Clutch Piston Stroke Length

(8) Compress clutch springs with tool B.Vi. FM. 27. Remove clutch pack snap ring and remove retainer and clutch pack from drum (Fig. 6).

(9) Compress clutch piston return springs with tool B.Vi. FM. 27 and remove clutch piston snap ring (Fig. 7).

(10) Remove compressor tool and return spring.

(11) Remove clutch piston. Remount clutch on overdrive support (Fig. 8). Apply compressed air through piston feed hole in support to remove piston. Use only enough air to ease piston out.

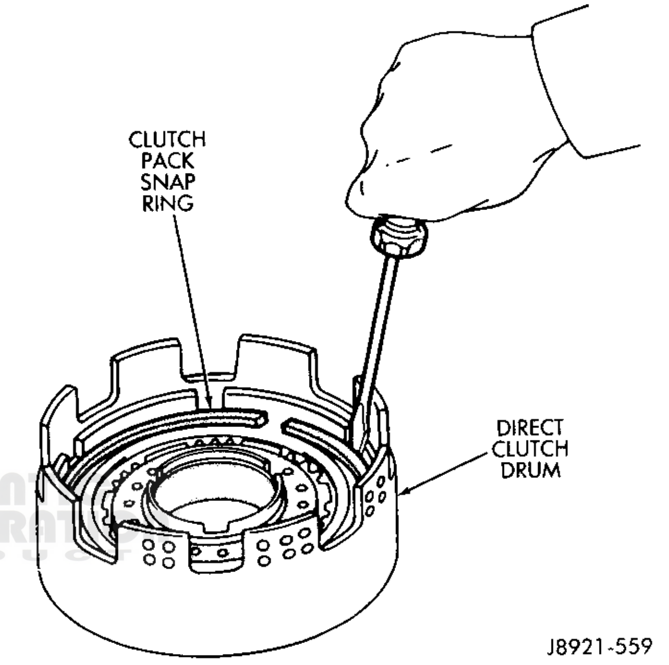


Fig. 6 Removing Clutch Pack Snap Ring

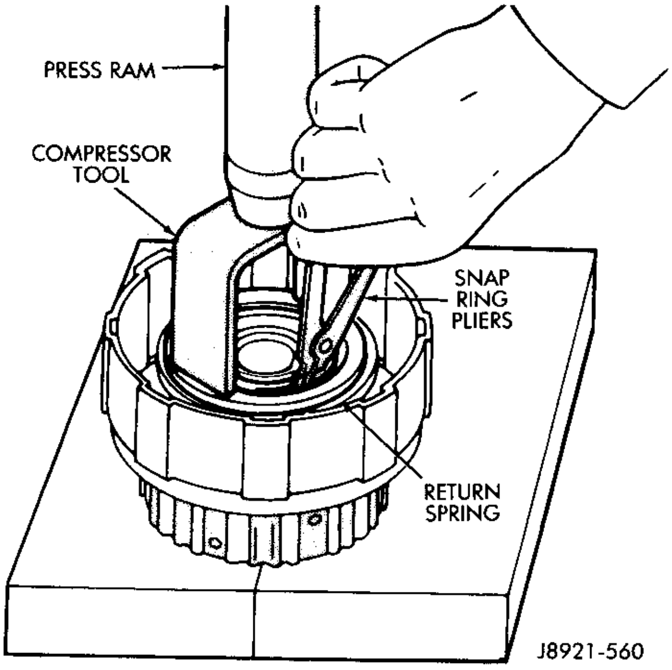


Fig. 7 Removing Piston Return Spring Snap Ring

(12) Remove and discard clutch piston O-rings.

(13) Measure clutch disc thickness. Minimum allowable thickness is 1.84 mm (.0724 in). Replace discs if below minimum thickness.

(14) Measure free length of piston return springs with springs in retainer (Fig. 9). Length should be 21.32 mm (.839 in). Replace return springs if not within specification.

(15) Check clutch piston check ball (Fig. 10). Shake piston to see if ball moves freely. Then check ball seating by applying low pressure compressed air to ball inlet as shown. Air should not leak past check ball.

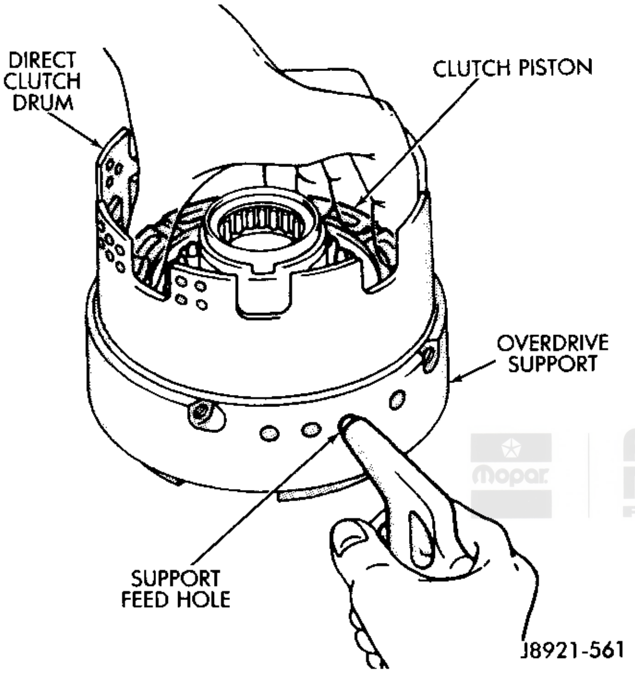


Fig. 8 Removing Direct Clutch Piston

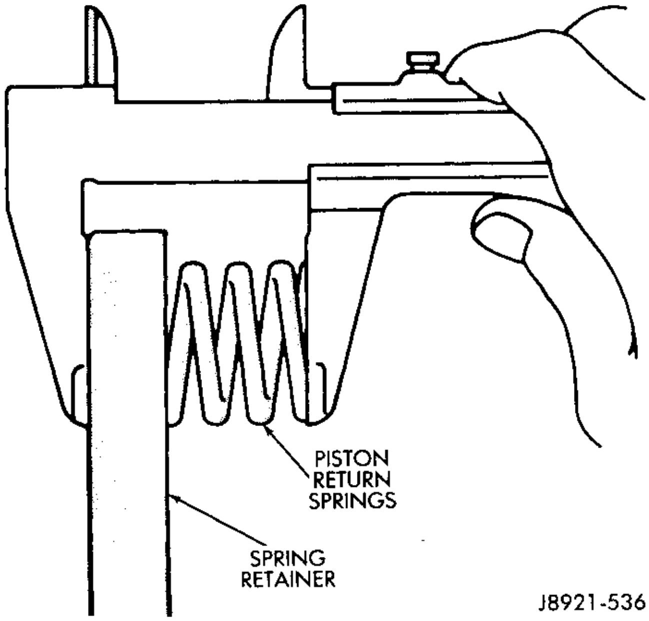


Fig. 9 Checking Piston Return Spring Length

(16) Measure inside diameter of clutch drum bushing. Inside diameter should be no more than 53.97 mm (2.1248 in). Replace drum if bushing inside diameter is greater than specified.

Direct Clutch Assembly

(1) Lubricate and install replacement O-rings on clutch piston.

(2) Install clutch piston in drum and install return springs on piston.

(3) Compress piston return springs and install snap ring (Fig. 7). Be sure snap ring end gap is not aligned with spring retainer tab.

(4) Install clutch discs and plates (Fig. 11). Install plate then disc until all plates and discs are installed. Use four plates and discs in 6-cyl. transmissions and three plates and discs in 4-cyl. transmissions.

(5) Install clutch pack retainer in drum (Fig. 12).

(6) Install clutch pack snap ring (Fig. 12).

(7) Check snap ring position. If necessary, shift snap ring until end gap is **not** aligned with any notches in clutch drum (Fig. 12).

(8) Check clutch piston stroke length a second time. If length is OK, continue with assembly. If stroke length is incorrect, replace clutch discs or use different thickness clutch pack retainer (Fig. 12). See Specifications section for retainer thicknesses.

(9) Lubricate clutch drum thrust washer with petroleum jelly and install it in drum (Fig. 3).

(10) Mount direct clutch assembly on forward clutch assembly and check assembled height (Fig. 14). Height should be 70.3 to 71.5 mm (2.767 to 2.815 in).

(11) If assembled height is incorrect, clutches are not seated.

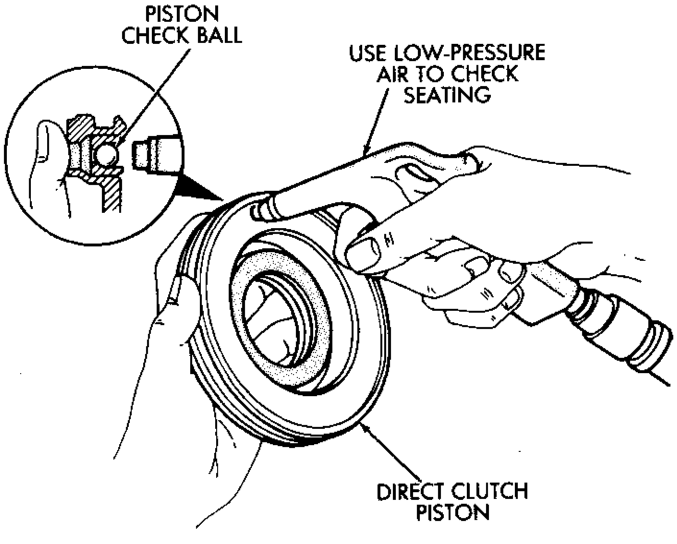


Fig. 10 Testing Piston Check Ball Seating

(12) If clutch height is OK, remove direct clutch from forward clutch and proceed to forward clutch overhaul.

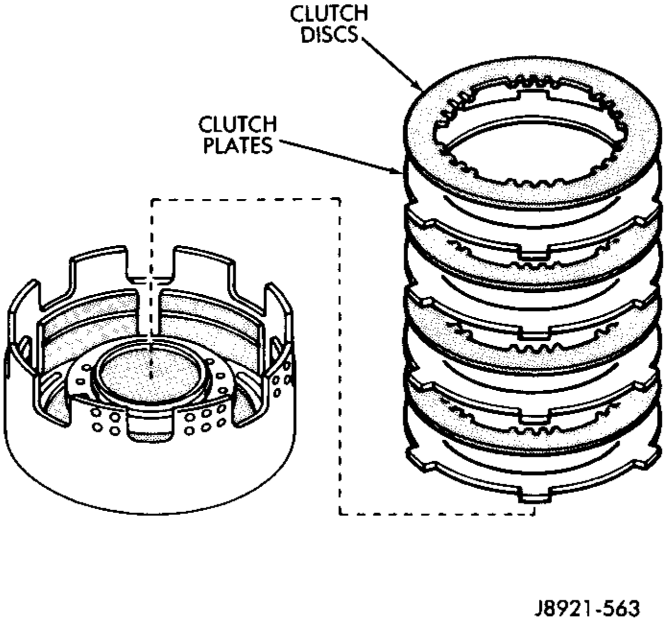


Fig. 11 Installing Direct Clutch Discs And Plates

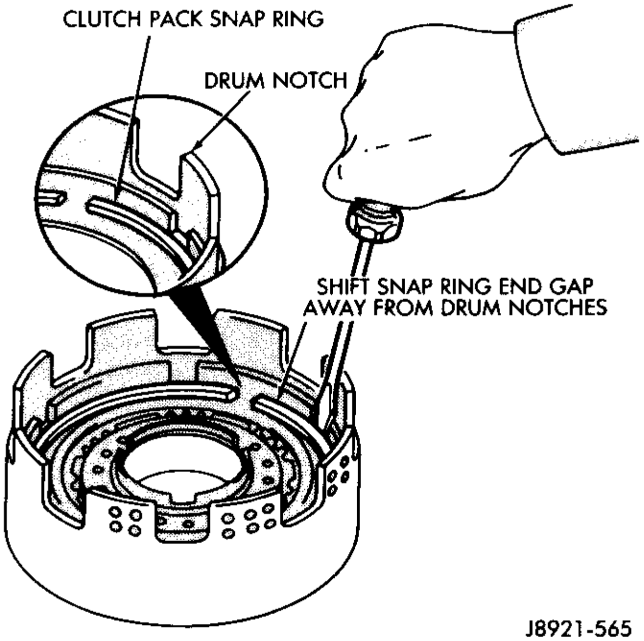


Fig. 13 Adjusting Clutch Pack Snap Ring Position

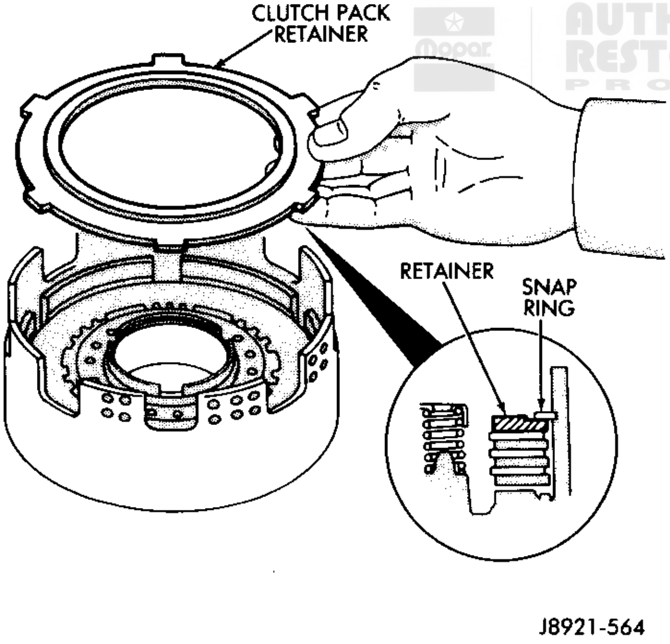


Fig. 12 Install Clutch Pack Retainer

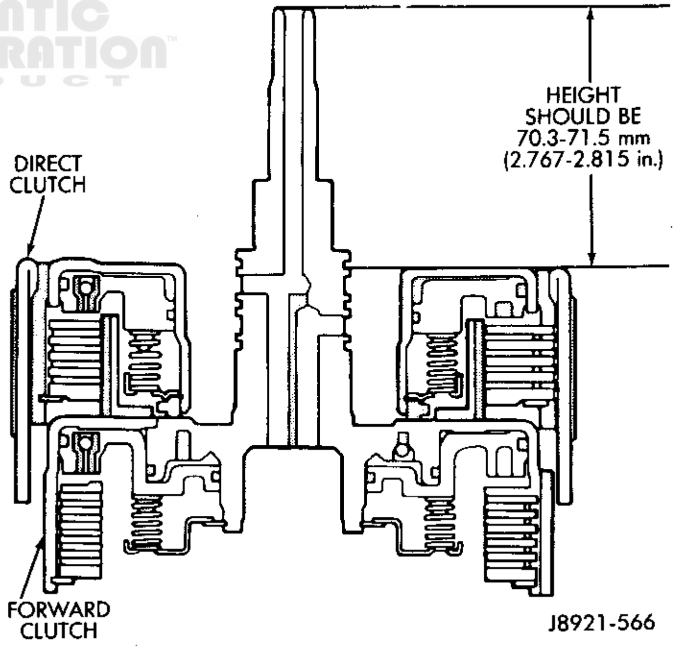
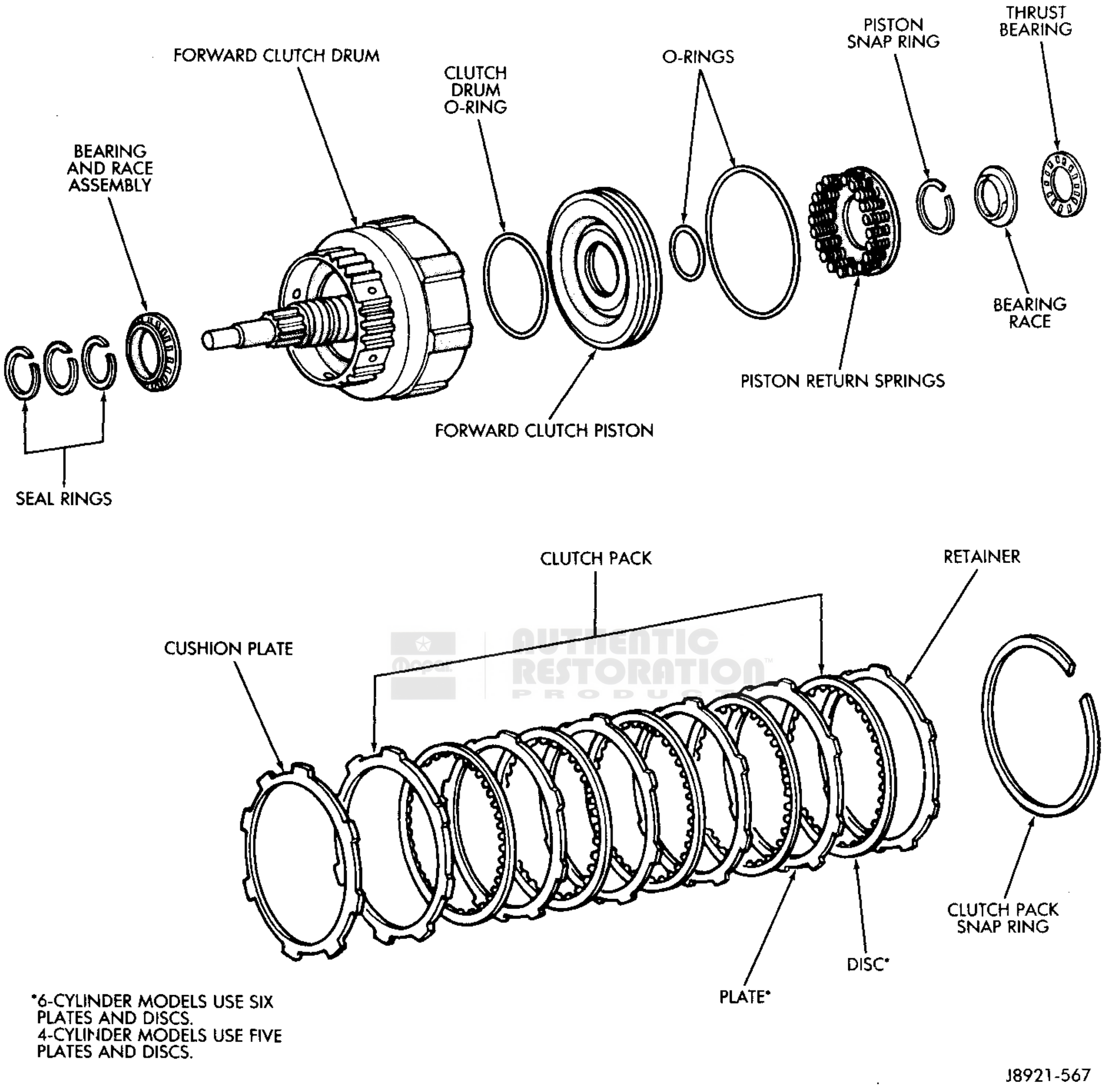


Fig. 14 Checking Direct Clutch Assembled Height

FORWARD CLUTCH OVERHAUL



*6-CYLINDER MODELS USE SIX PLATES AND DISCS.
4-CYLINDER MODELS USE FIVE PLATES AND DISCS.

Fig. 1 Forward Clutch Components

Forward Clutch Disassembly

(1) Check clutch piston stroke as outlined in following steps.

(2) Position overdrive support on wood blocks and mount forward clutch drum on support (Fig. 2).

(3) Remove bearing and race from forward clutch drum (Fig. 2).

(4) Mount dial indicator on clutch drum. Position dial indicator plunger against clutch piston (Fig. 3).

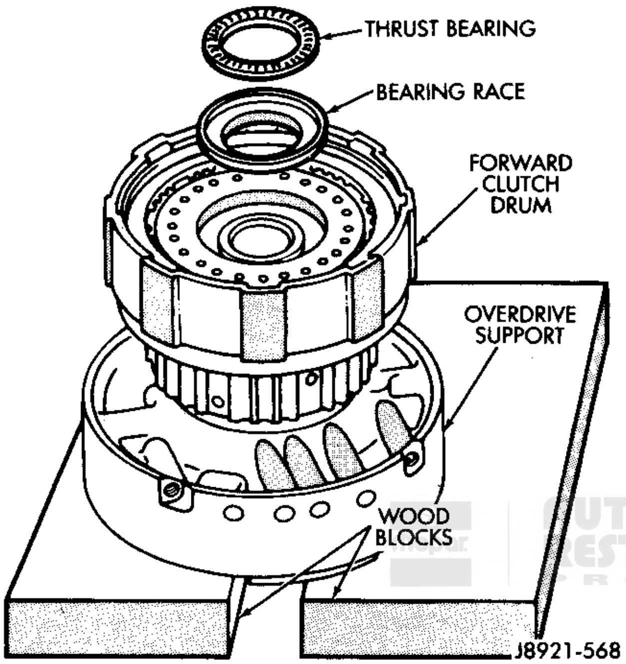


Fig. 2 Positioning Drum And Support On Wood Blocks

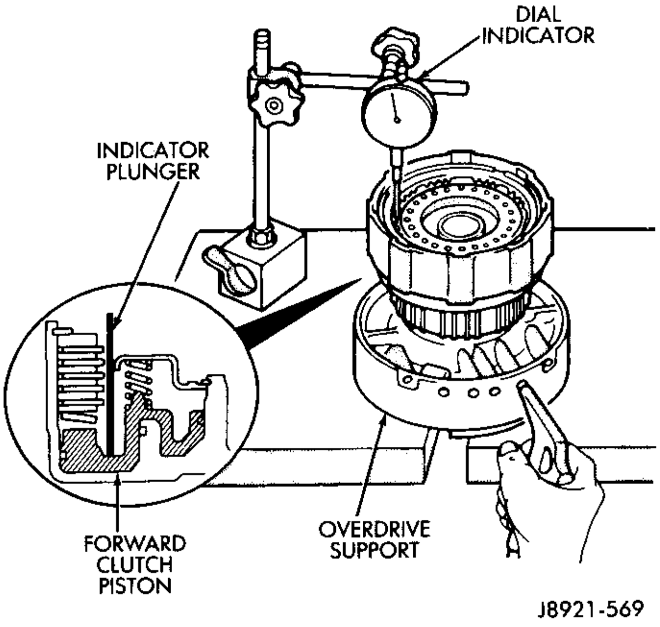


Fig. 3 Checking Forward Clutch Piston Stroke Length

(5) Apply compressed air through right side feed hole in support and note piston stroke length on dial indicator.

(6) Stroke length should be: 3.73 to 4.59 mm (.1469 to .1807 in) on 6-cyl. transmissions and 3.42 to 4.23 mm (.1346 to .1665 in) on 4-cyl. transmissions.

(7) Replace clutch discs if stroke length is incorrect.

(8) Remove clutch pack snap ring and remove retainer and clutch pack (Fig. 4).

(9) Remove clutch pack cushion plate (Fig. 5).

(10) Compress clutch springs with tool B.Vi. FM. 27 and remove piston snap ring.

(11) Remove spring compressor tool and piston return springs.

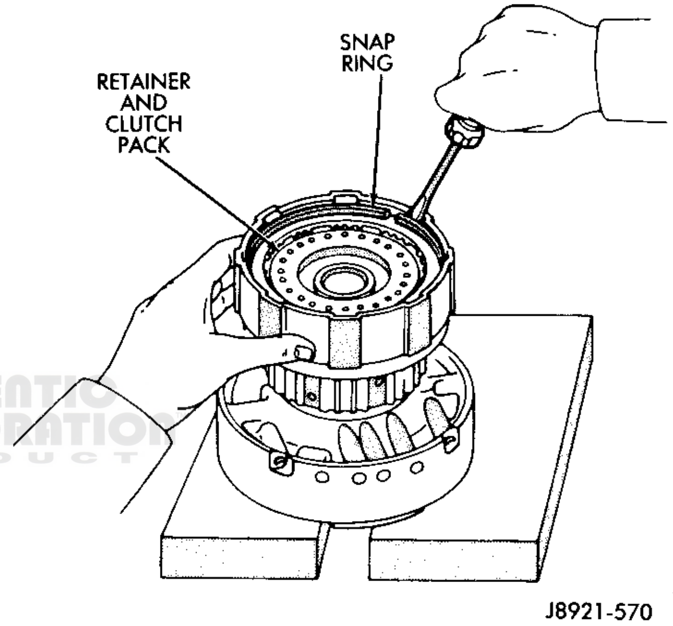


Fig. 4 Removing Retainer And Clutch Pack

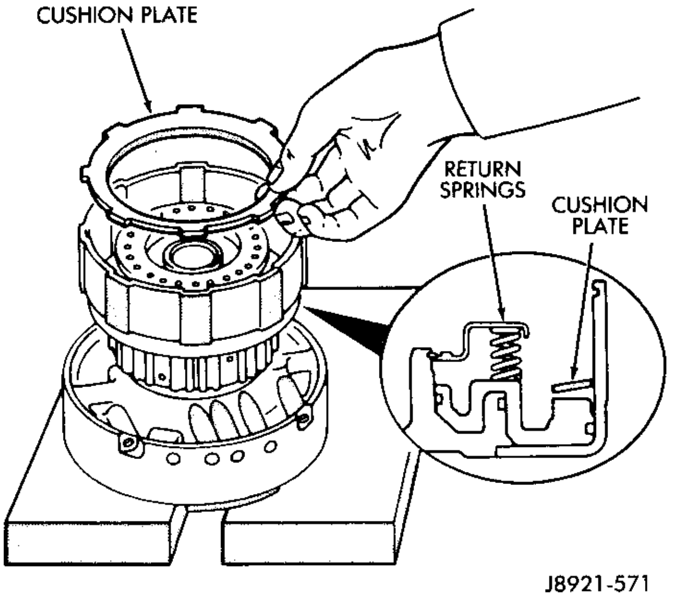


Fig. 5 Removing Cushion Plate

(12) Remount forward clutch drum on overdrive support (Fig. 6).

(13) Apply compressed air through feed hole in support to remove piston (Fig. 6). Use only enough air pressure to ease piston out of drum.

(14) Remove and discard clutch piston O-rings.

(15) Remove clutch drum O-ring from rear hub (16) of the drum.

(16) Remove three seal rings from clutch drum shaft (Fig. 8).

(17) Remove thrust bearing and race assembly from clutch drum (Fig. 9).

(18) Measure clutch disc thickness (Fig. 10). Minimum allowable thickness is: 1.84 mm (.0724 in) on 4-cyl. transmissions and 1.51 mm (.0595 in) on 6-cyl. transmissions.

(19) Measure free length of piston return springs with springs mounted in retainer (Fig. 11). Length should be 19.47 mm (.767 in). Replace springs and retainer if length is incorrect.

(20) Inspect clutch piston check ball (Fig. 12). Ball should move freely within piston. Check ball seating by

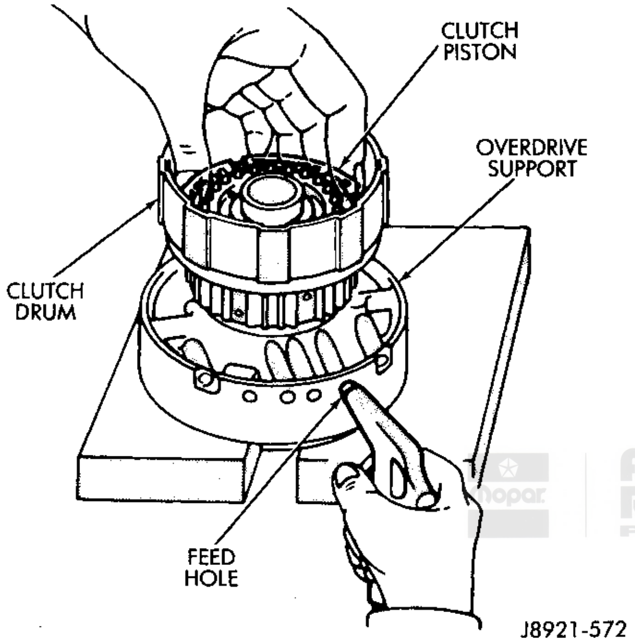


Fig. 6 Removing Forward Clutch Piston

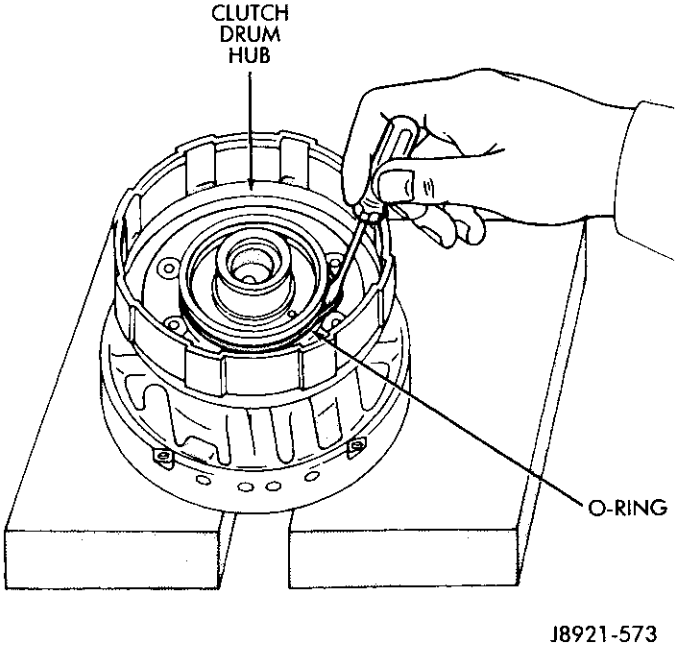


Fig. 7 Removing/Installing Clutch Drum O-Ring

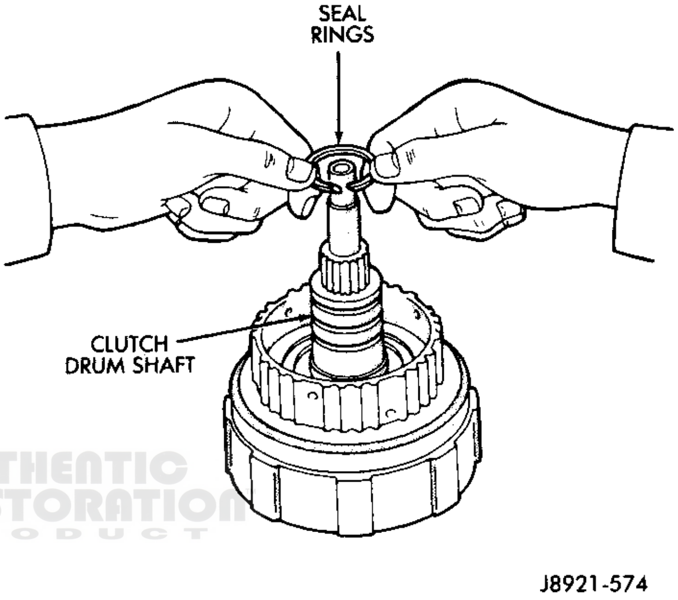


Fig. 8 Removing Clutch Drum Seal Rings

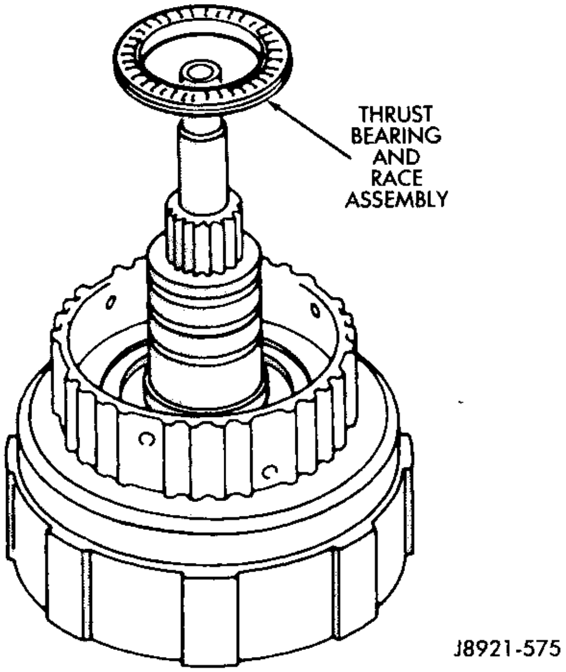


Fig. 9 Removing Clutch Drum Thrust Bearing Assembly

applying low pressure compressed air to ball feed hole. Ball should seat firmly and not leak air.

(21) Measure inside diameter of bushing in clutch drum hub. Maximum allowable diameter is 24.08 mm (.9480 in). Replace clutch drum if bushing inside diameter is greater than specified.

Forward Clutch Assembly

(1) Lubricate bearing and race assembly with petroleum jelly and install it in clutch drum (Fig. 13). Race side of assembly faces downward and toward drum. Bearing rollers face up (Fig. 13)

(2) Coat new clutch drum shaft seal rings with petroleum jelly.Before installing drum shaft seal rings, squeeze (contract) each ring so ring ends overlap (Fig. 14). This tightens ring making clutch installation easier.

(3) Install seal rings on shaft. Keep rings closed as tightly as possible during installation. Avoid overspreading them.

(4) Mount clutch drum on overdrive support.

(5) Lubricate and install new O-ring on clutch drum hub (Fig. 7).

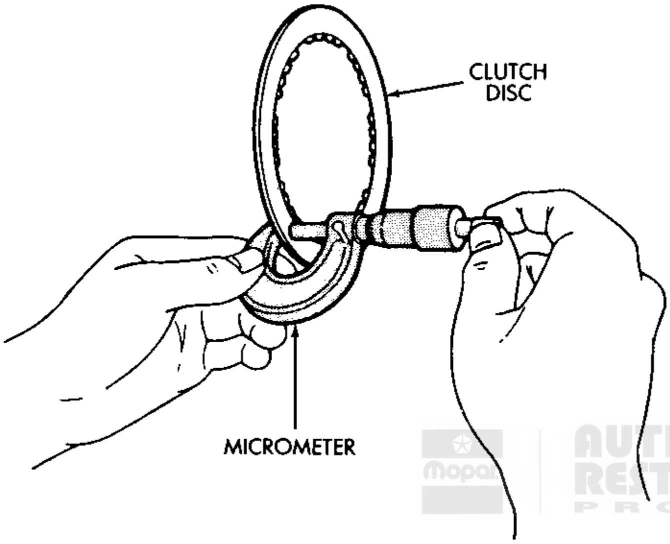


Fig. 10 Measuring Clutch Disc Thickness

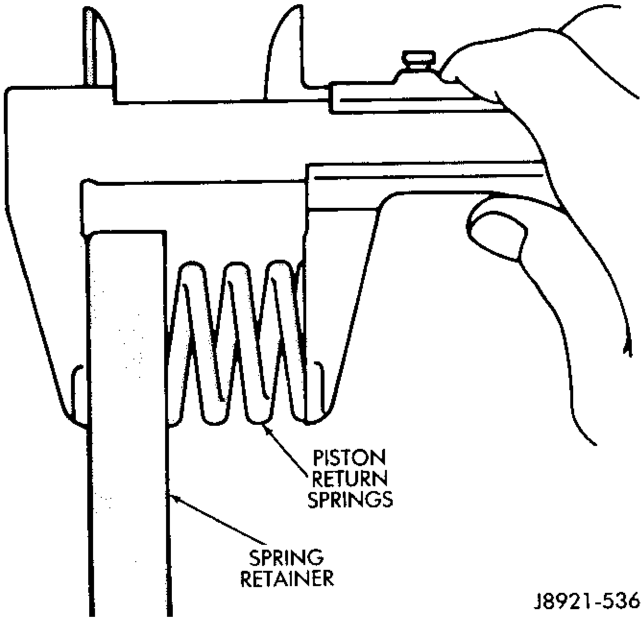


Fig. 11 Checking Return Spring Length

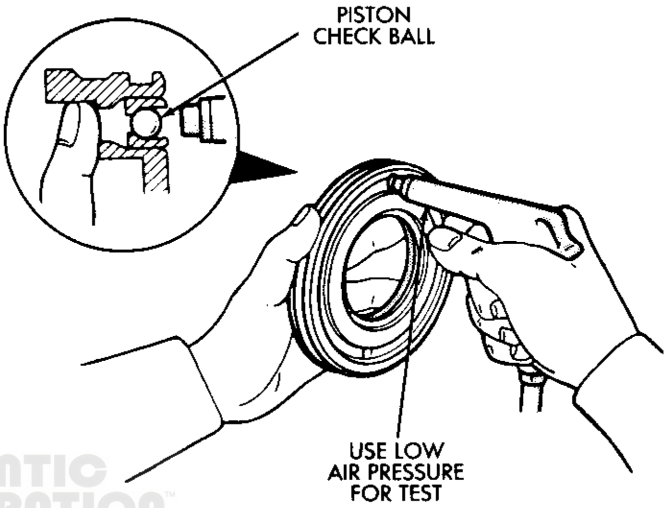


Fig. 12 Testing Piston Check Ball

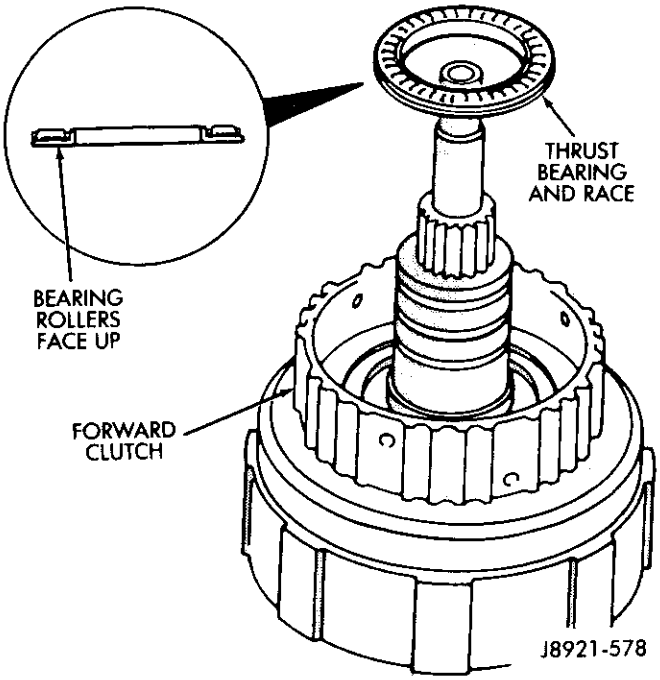


Fig. 13 Installing Thrust Bearing And Race

(6) Lubricate and install new O-rings on clutch piston and install piston in drum.

(7) Install piston return springs.

(8) Compress piston return springs with tool B.Vi. FM-27 and shop press and install piston snap ring. Be sure snap ring end gap is not aligned with any notches in drum.

(9) Install cushion plate in drum. Concave side of plate faces downward (Fig. 5).

(10) Install clutch discs, plates and retainer (Fig. 15). Install tabbed plate followed by disc until required number of plates and discs are installed. **Use six plates and discs in a 6-cyl. transmission and five plates and discs in a 4-cyl. transmission.**

(11) Install clutch pack snap ring.

(12) Recheck clutch piston stroke length using same method outlined at beginning of disassembly procedure. If stroke length is not within specified limits, replace clutch discs.

(13) Lubricate race and bearing with petroleum jelly and install them in clutch drum (Fig. 16). Be sure bearing rollers face up and race lip seats in drum as shown.

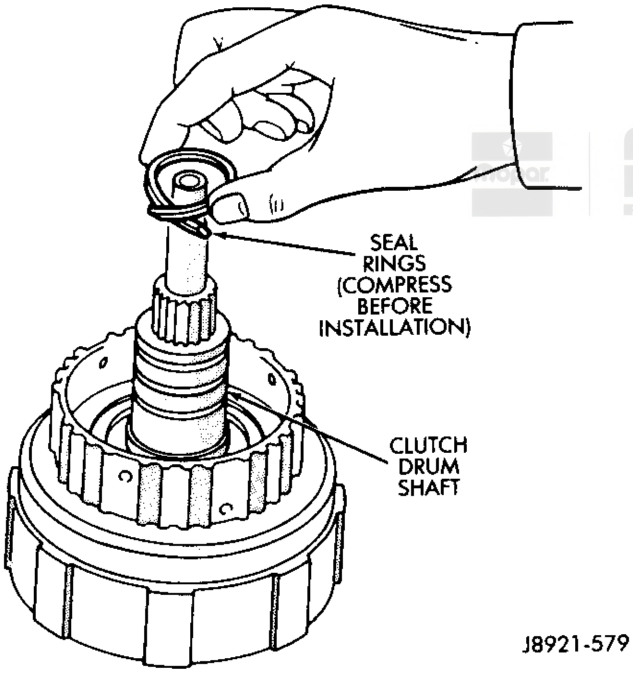


Fig. 14 Installing Clutch Drum Shaft Seal Rings

(14) Verify bearing and race size. Outer diameter of bearing is 46.7 mm (1.839 in). Outer diameter of race is 48.9 mm (1.925 in). Inner diameter of bearing and race is 26.0 mm (1.024 in).

(15) Mount forward clutch on direct clutch and check assembled height (Fig. 17). Height should be 70.3 to 71.5 mm (2.767 to 2.815 in).

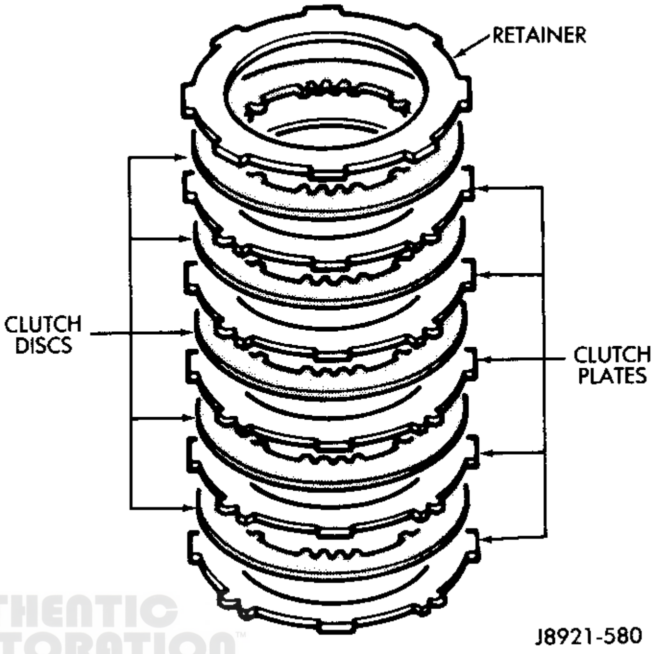


Fig. 15 Installing Forward Clutch Discs And Plates

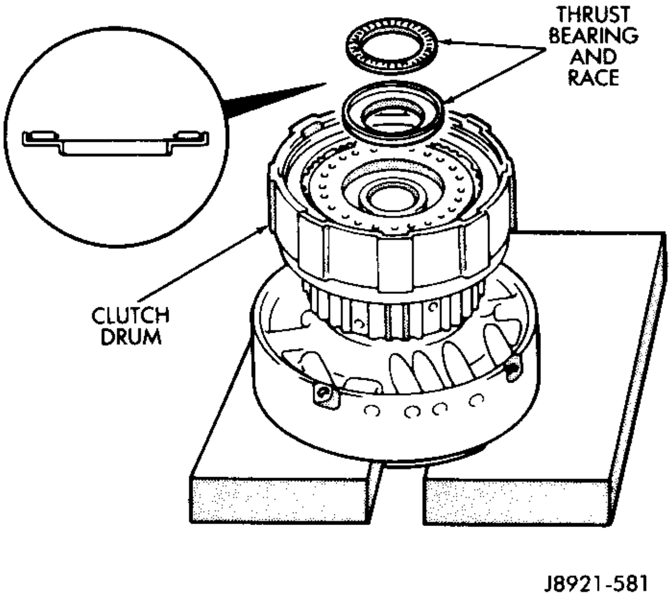


Fig. 16 Installing Thrust Bearing And Race

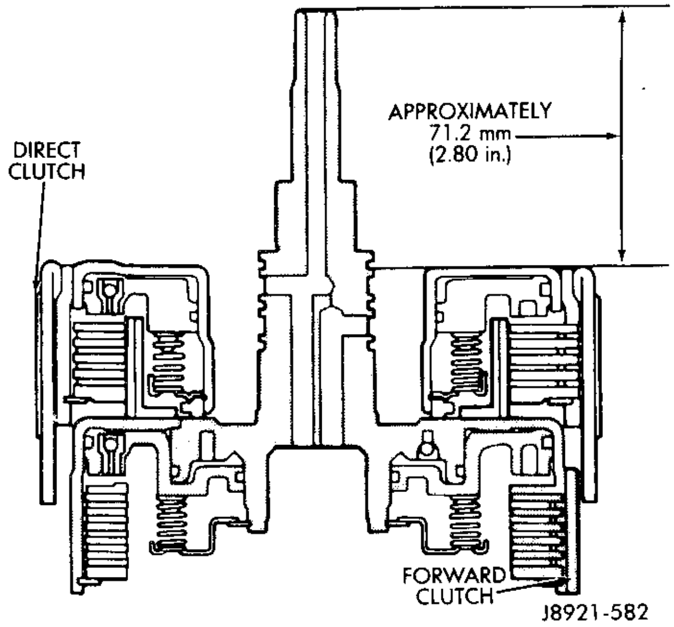


Fig. 17 Checking Forward Clutch Assembled Height

FRONT PLANETARY GEAR OVERHAUL

Front Planetary Disassembly

(1) Remove ring gear from planetary gear (Fig. 1).

(2) Remove front bearing and the two races from ring gear (Fig. 1).

(3) Remove tabbed thrust race from planetary gear (Fig. 1).

(4) Remove snap ring attaching planetary gear to shaft and remove gear.

(5) Remove rear bearing and race from planetary gear.

(6) Measure inside diameter of ring gear bushing. Maximum allowable diameter is 24.08 mm (.9480 in). Replace ring gear if bushing inside diameter is greater than specified.

Front Planetary Assembly

(1) Lubricate planetary and ring gear bearings and races with petroleum jelly.

(2) Identify planetary bearings and races before installation. (Fig. 1). Bearings and races can be identified by following dimensions:

- Outer diameter of rear bearing is 47.7 mm (1.878 in); inner diameter is 35.5 mm (1.398).

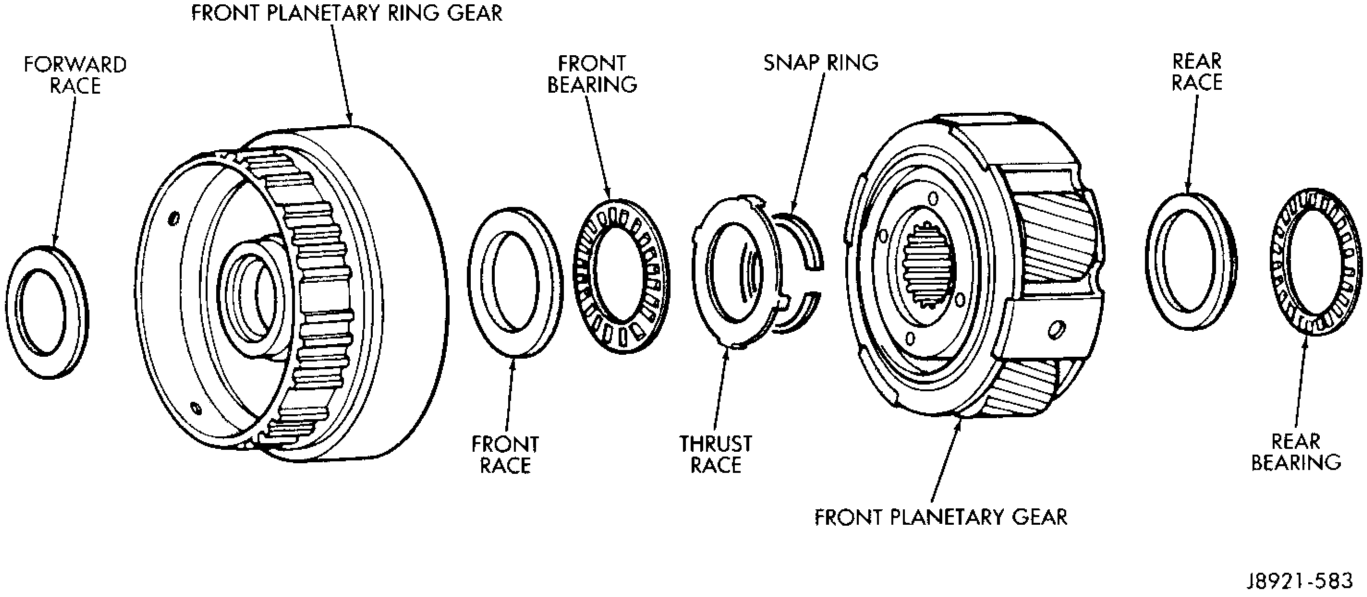


Fig. 1 Front Planetary Gear Components

- Outer diameter of rear race 47.6 mm (1.874 in); inner diameter is 33.7 mm (1.327 in).
- Outer diameter of front race is 53.6 mm (2.110 in); inner diameter is 30.5 mm (1.201 in).
- Outer diameter of front bearing is 47.7 mm (1.878 in); inner diameter is 32.6 (1.283 in).
- Outer diameter of forward race is 47.0 mm (1.850 in); inner diameter is 26.5 mm 1.043 in).

(3) Install rear race and bearing in gear (Fig. 2).

(4) Turn planetary over and install race thrust race (Fig. 3).

(5) Install front race and bearing and forward race in ring gear (Fig. 4).

(6) Set planetary gear assembly aside for final assembly.

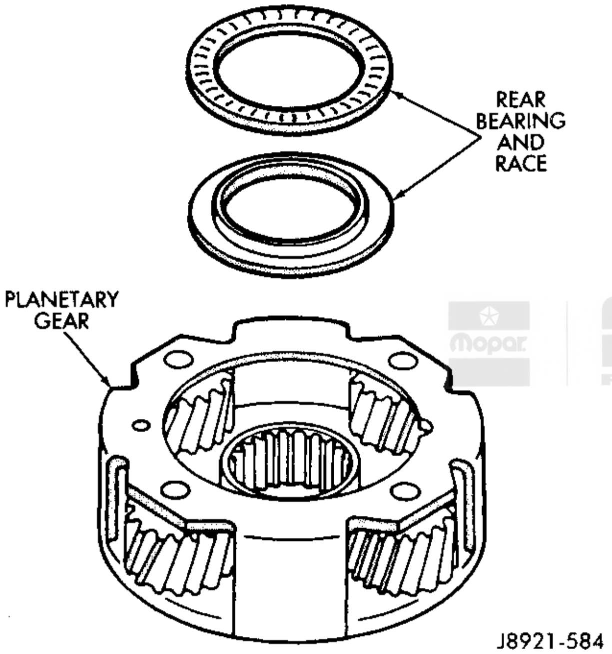


Fig. 2 Installing Front Planetary Rear Bearing and Race

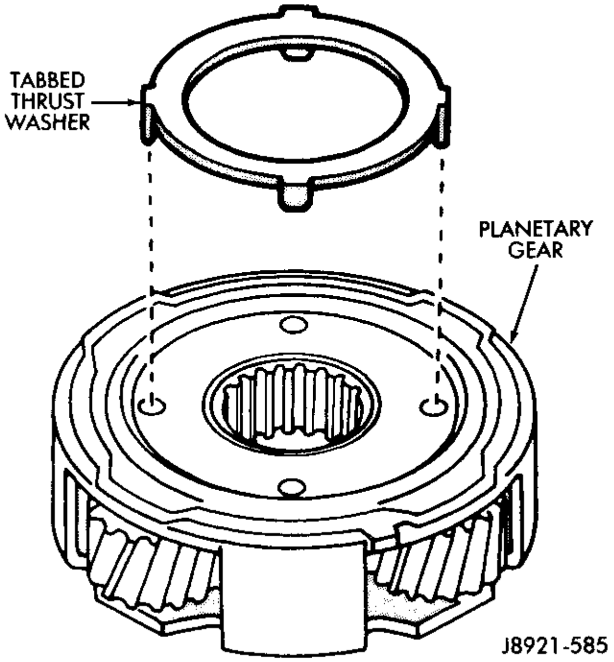


Fig. 3 Installing Front Planetary Thrust Race

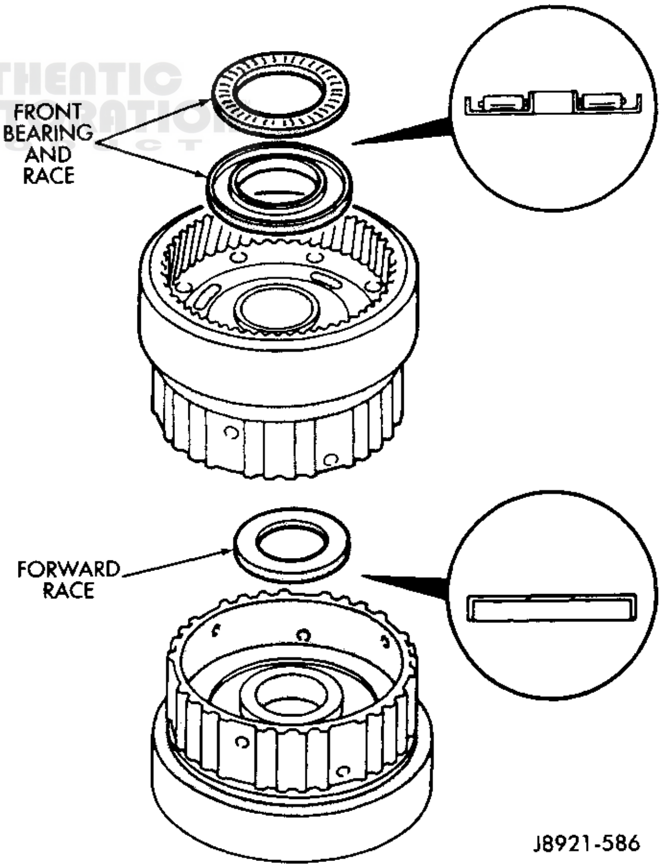


Fig. 4 Installing Front Planetary Front Bearing And Races

SUN GEAR AND NO. 1 ONE-WAY CLUTCH OVERHAUL

Sun Gear-Clutch Disassembly

(1) Hold sun gear and turn second brake hub clockwise and counterclockwise (Fig. 2). Hub should rotate freely clockwise, but lock when turned counterclockwise. Replace one-way clutch and hub if it does not operate properly.

(2) Remove one-way clutch/second brake hub assembly from drum (Fig. 3).

(3) Remove thrust washer from drum (Fig. 4).

(4) Remove two seal rings from sun gear (Fig. 5).

(5) Support sun gear on wood block (Fig. 6). Then remove first sun gear snap ring and separate drum from gear.

(6) Remove remaining snap ring from sun gear (Fig. 7).

(7) Measure inside diameter of sun gear bushings with bore gauge or inside micrometer (Fig. 8). Maximum allowable diameter is 27.08 mm (1.0661 in). Replace sun gear if bushing inside diameter is greater than specified.

Sun Gear-Clutch Assembly

(1) Install first snap ring on sun gear.

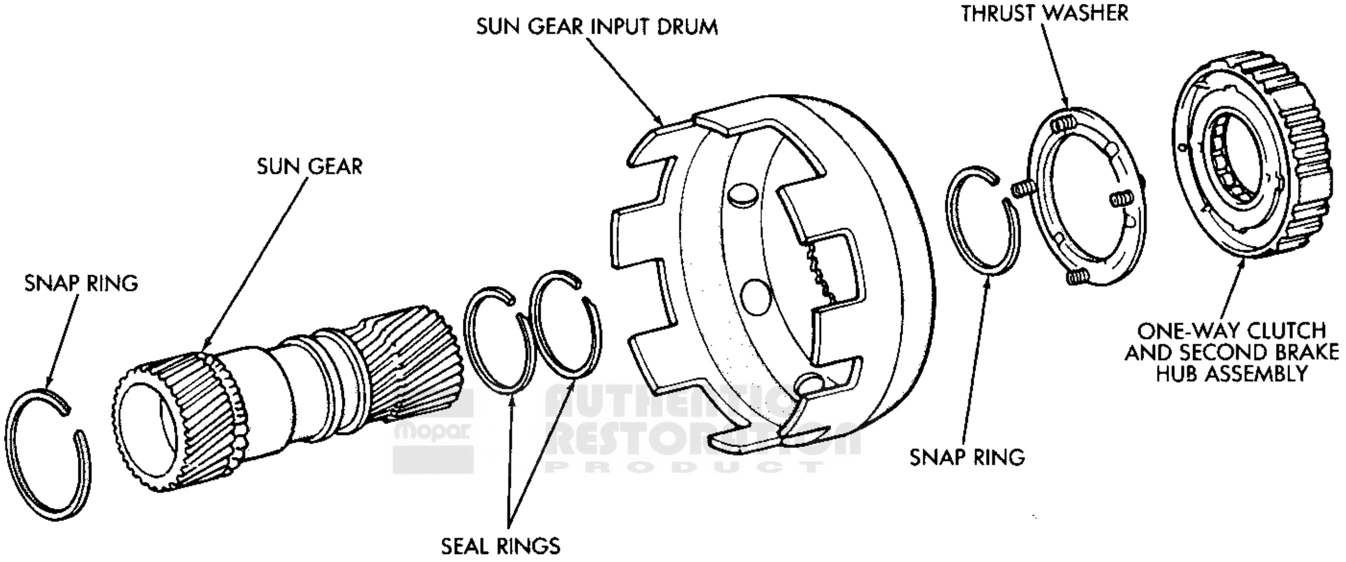


Fig. 1 Sun Gear And One-Way Clutch Components

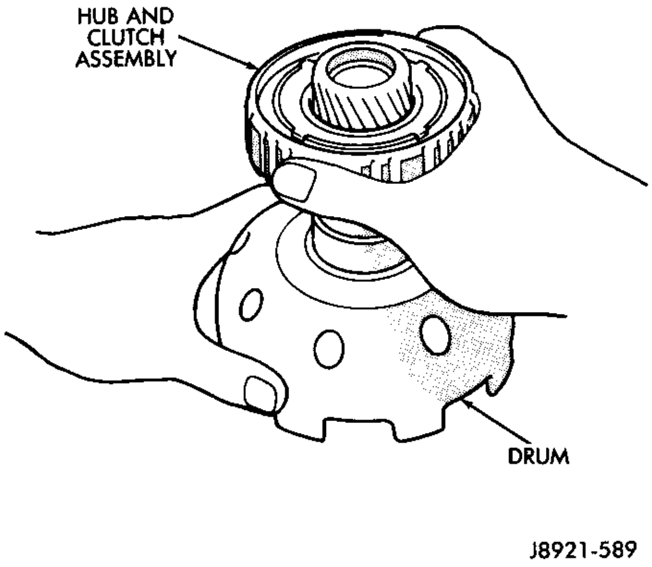


Fig. 3 Removing/Installing Brake Hub And Clutch Assembly

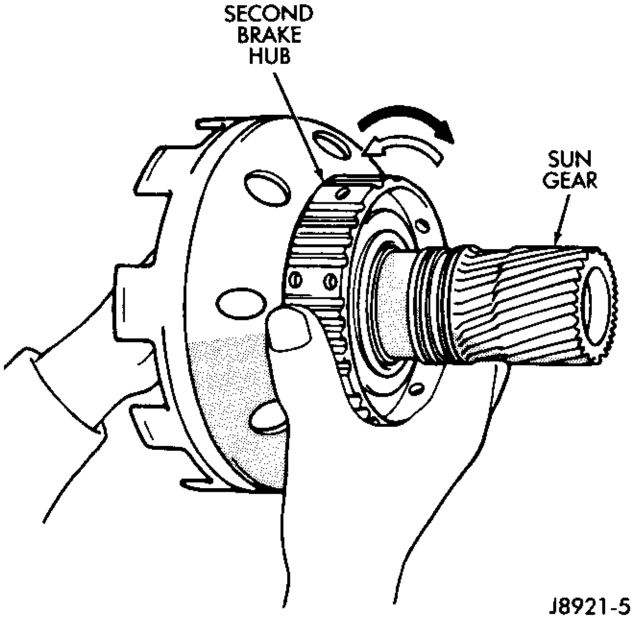


Fig. 2 Checking One-Way Clutch Operation

(2) Install sun gear in drum and install remaining snap ring.

(3) Coat replacement seal rings with petroleum jelly and install them on sun gear. **Be sure seal ring ends are interlocked.**

(4) Install thrust washer. Be sure washer tabs are seated in drum slots.

(5) Install one-way clutch/second brake hub assembly on sun gear. Deep side of hub flange faces upward (Fig. 9).

(6) Check one-way clutch operation again (Fig. 2). Hold sun gear and turn second brake hub clockwise and counterclockwise. Hub should turn clockwise freely, but lock when turned counterclockwise.

(7) Set sun gear/clutch assembly aside for final assembly.

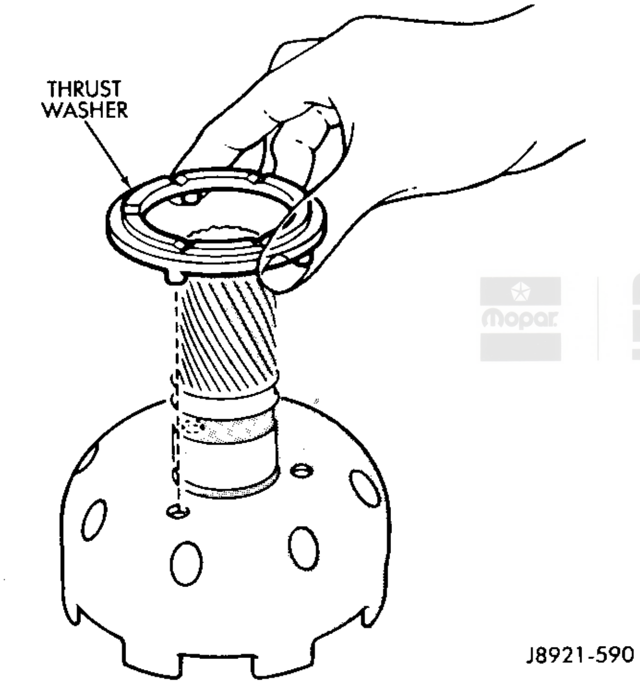


Fig. 4 Removing/Installing Thrust Washer

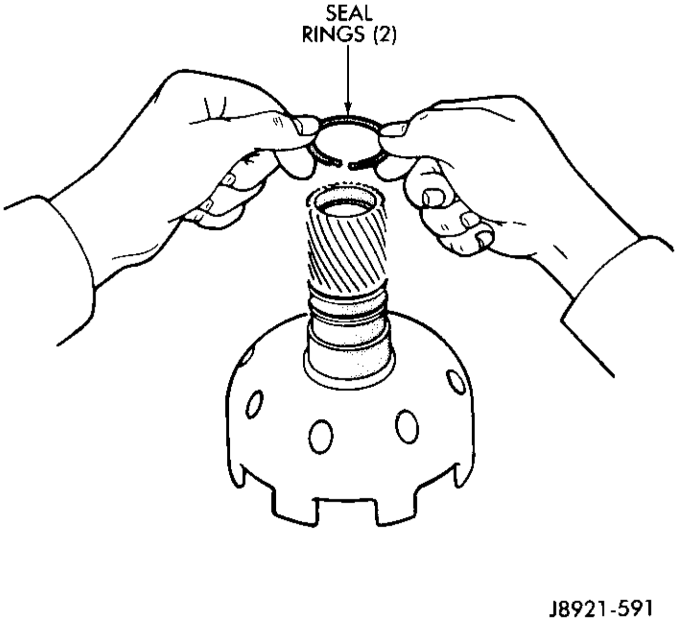


Fig. 5 Removing/Installing Sun Gear Seal Rings

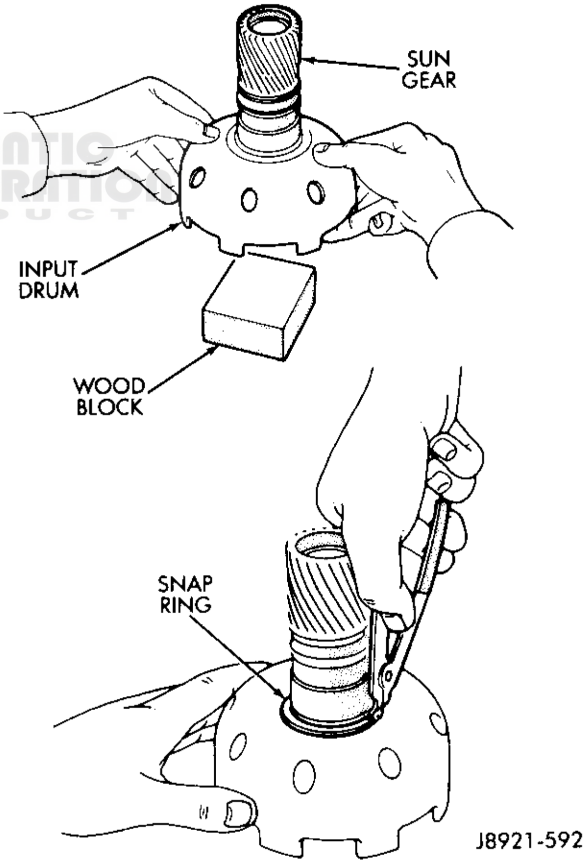


Fig. 6 Removing/Installing Sun Gear

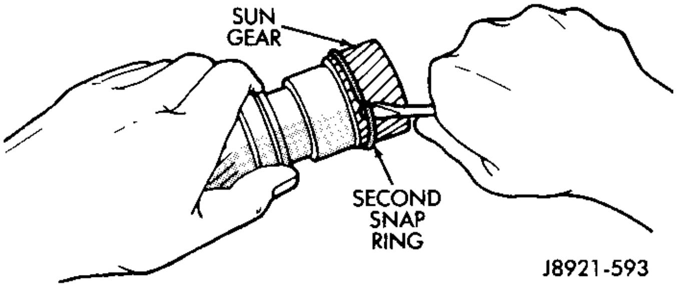


Fig. 7 Removing/Installing Second Snap Ring

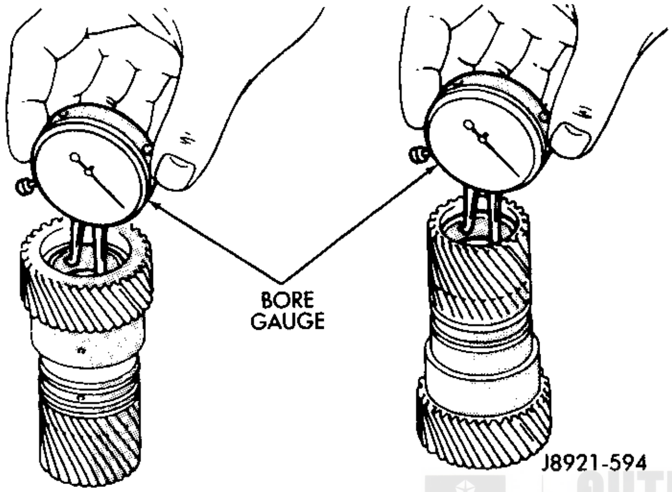


Fig. 8 Checking Sun Gear Bushings

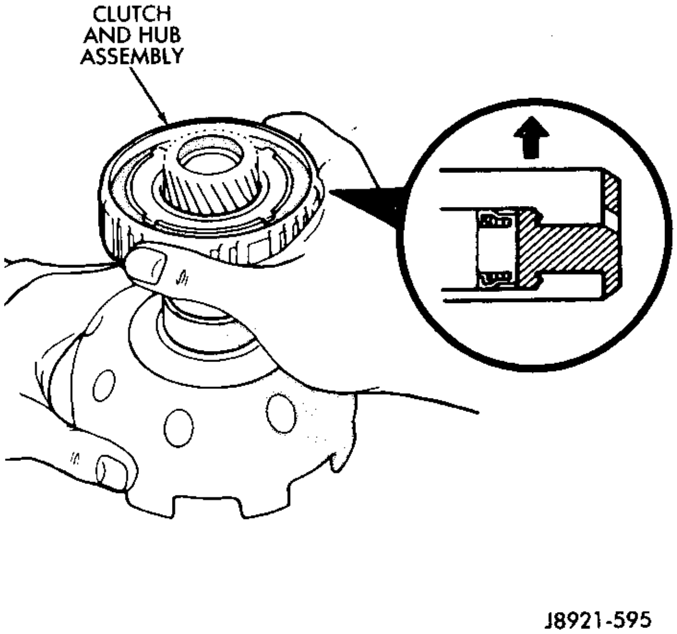


Fig. 9 Installing Clutch And Hub Assembly

SECOND BRAKE OVERHAUL

Brake Disassembly

(1) Remove second brake drum from output shaft (Fig. 2).

(2) Set output shaft assembly aside for overhaul. Refer to Rear Planetary Gear and Output Shaft Overhaul procedures.

(3) Remove thrust washer from second brake drum (Fig. 3).

(4) Compress piston return springs with tool B.Vi. FM-27 and shop press. Then remove piston snap ring (Fig. 4).

(5) Remove compressor tool and remove spring retainer and return springs.

(6) Remove second brake piston and sleeve from drum with compressed air (Fig. 5). Use only enough air pressure to ease piston out of drum.

(7) Remove and discard brake piston O-rings.

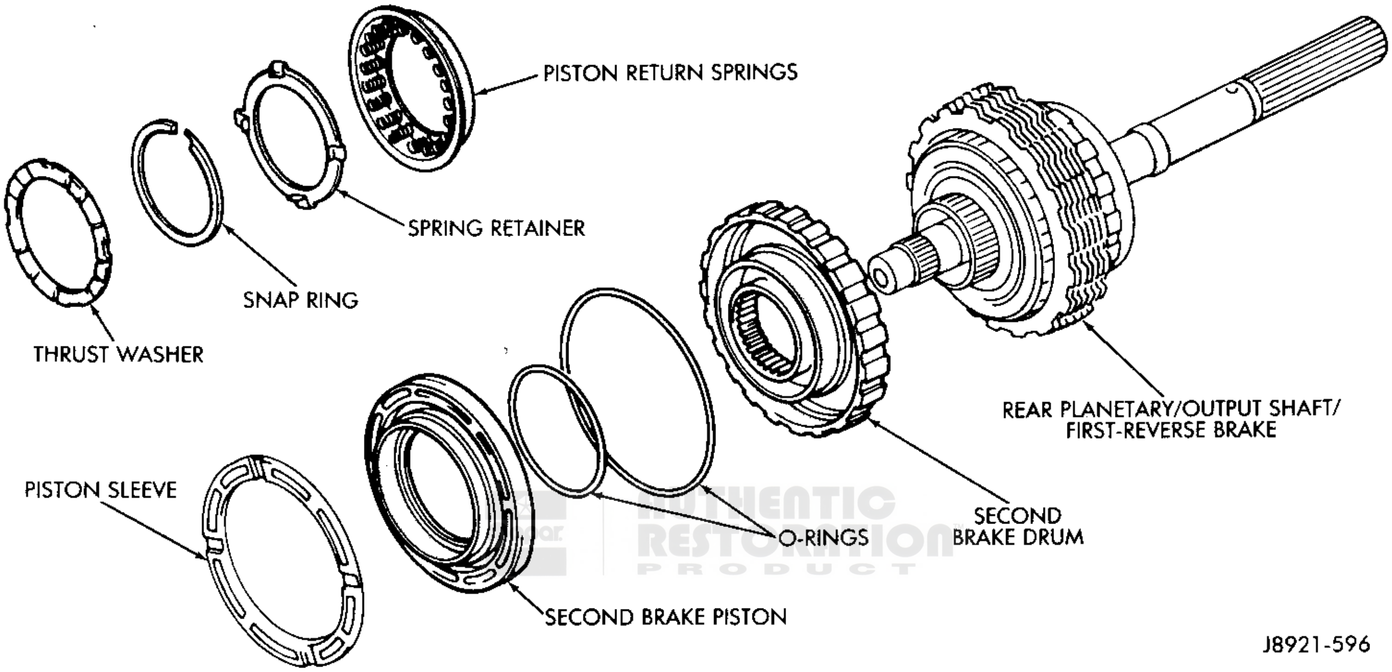


Fig. 1 Second Brake Components

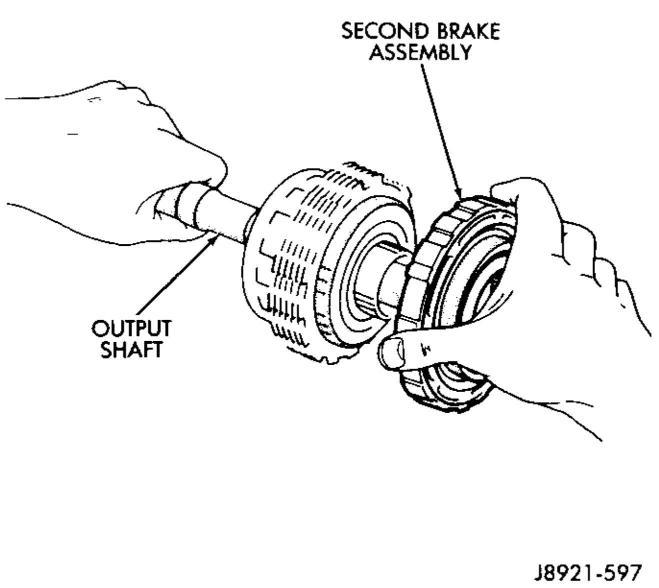


Fig. 2 Removing/Installing Second Brake Assembly

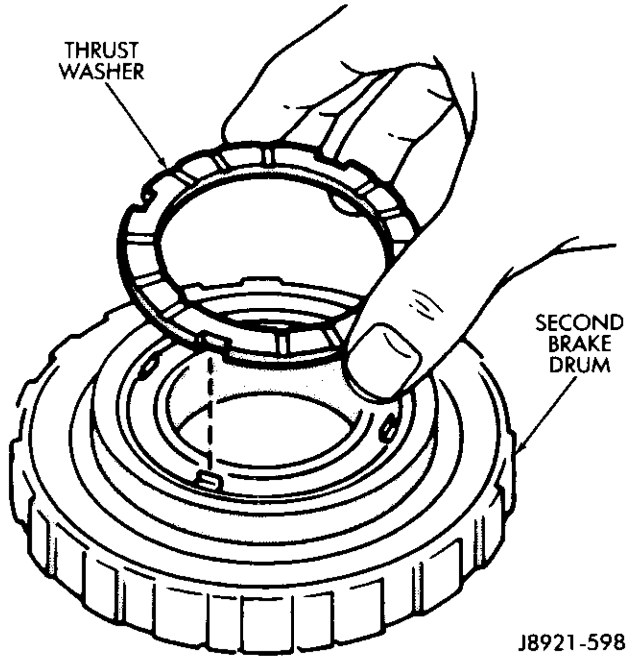


Fig. 3 Removing/Installing Drum Thrust Washer

(8) Measure free length of piston return springs with springs mounted in retainer (Fig. 6). Length should be 16.05 mm (.632 in). Replace return springs if length is less than specified.

Second Brake Assembly

(1) Lubricate and install new O-rings on brake piston. Then install brake piston in drum.

(2) Install return springs and retainer on brake piston.

(3) Compress return springs with tool B.Vi. FM-27 and install piston snap ring.

(4) Check brake piston operation with low pressure compressed air (Fig. 7). Apply air pressure through feed hole in drum. Piston should move smoothly when applying-releasing air pressure.

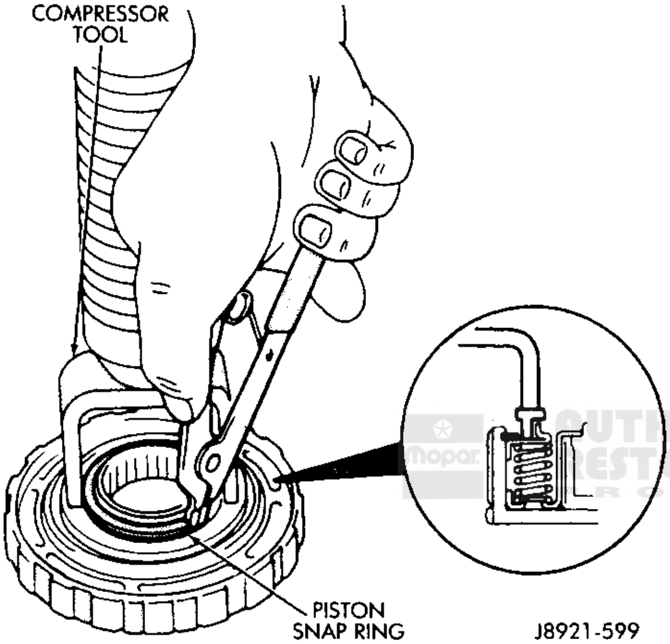


Fig. 4 Removing/Installing Piston Snap Ring

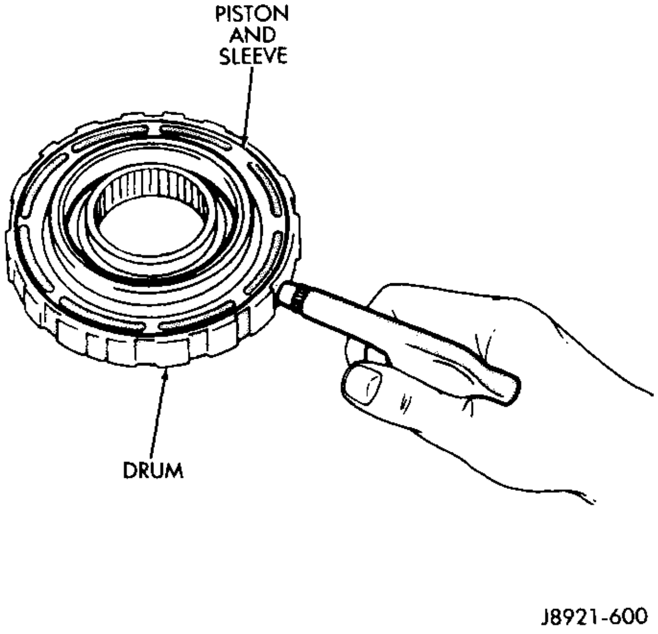


Fig. 5 Removing/Installing Piston And Sleeve

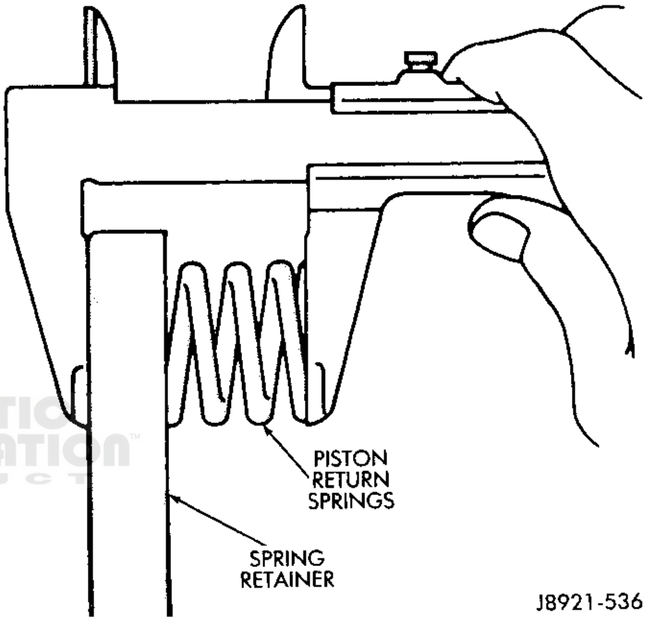


Fig. 6 Measuring Piston Return Springs

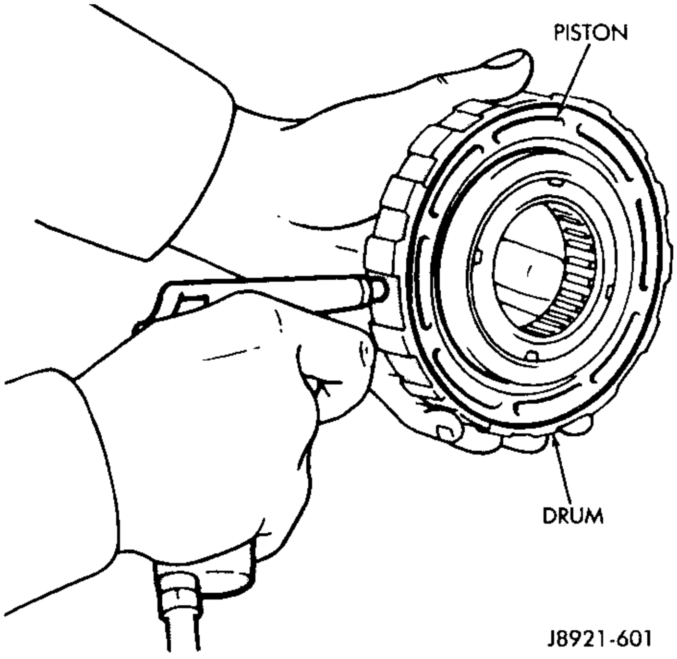


Fig. 7 Checking Piston Operation

(5) Coat thrust washer with petroleum jelly and install it in drum. Be sure washer notches are aligned with tabs on spring retainer (Fig. 8).

(6) Set brake components aside for final assembly.

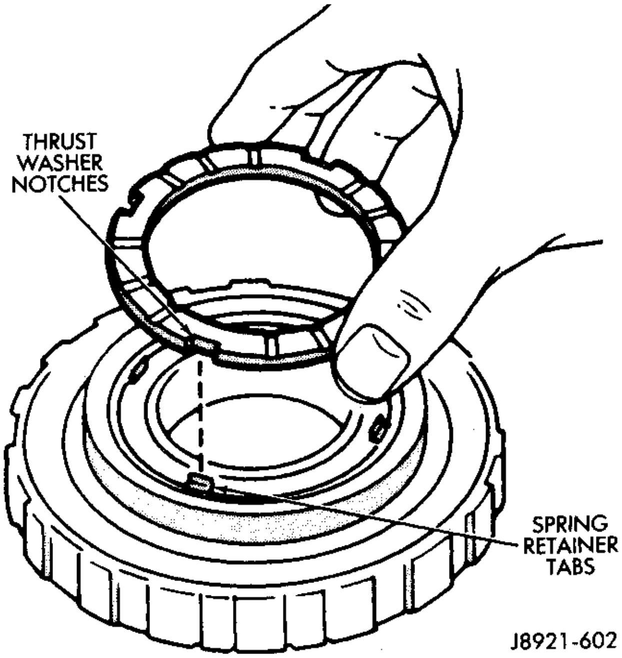


Fig. 8 Installing Thrust Washer

REAR PLANETARY, NO. 2 ONE-WAY CLUTCH AND OUTPUT SHAFT OVERHAUL

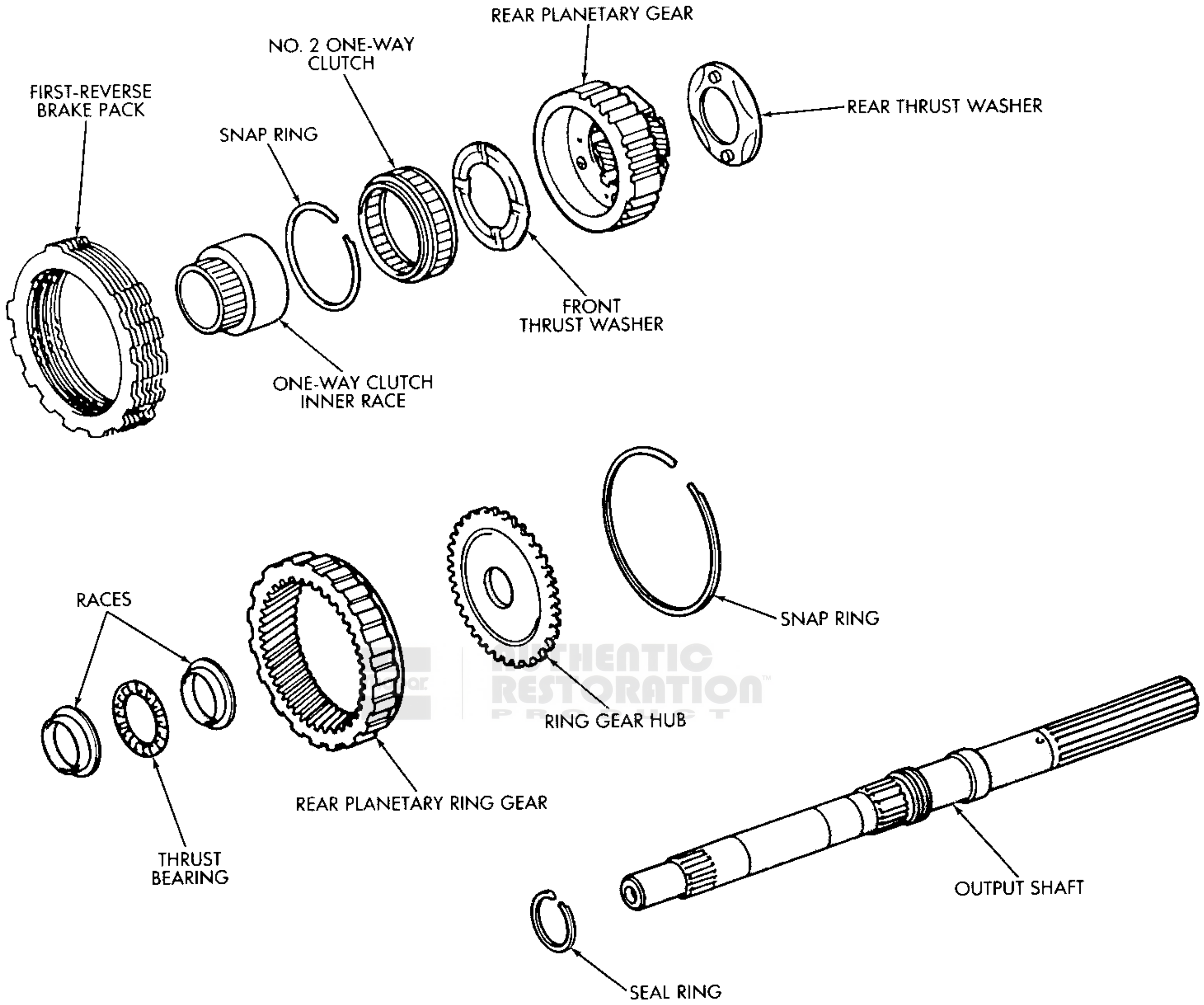


Fig. 1 Rear Planetary, Brake Pack, Clutch And Output Shaft Components

Planetary-Brake Pack-Shaft Disassembly

(1) Remove output shaft from gear assembly (Fig. 2).

(2) Remove and discard shaft seal ring (Fig. 4).

(3) Remove brake pack from planetary gear (Fig. 4).

(4) Measure thickness of each brake pack disc. Minimum thickness is 1.51 mm (.0594 in). Replace all discs if any disc is thinner than specified.

(5) Remove planetary gear from ring gear (Fig. 5).

(6) Check No. 2 one-way clutch. Hold planetary gear and turn clutch inner race in both directions. Race should turn freely counterclockwise, but lock when turned clockwise. Replace one-way clutch if necessary.

(7) Remove clutch inner race from planetary gear (Fig. 7).

(8) Remove clutch snap ring and remove No. 2 one-way clutch from planetary (Fig. 8).

(9) Remove front and rear thrust washers from planetary gear (Fig. 9).

(10) Remove thrust bearing and washers from ring gear (Fig. 10).

(11) Remove ring gear snap ring and remove ring gear hub (Fig. 11).

(12) Inspect and replace any worn or damaged planetary gear components.

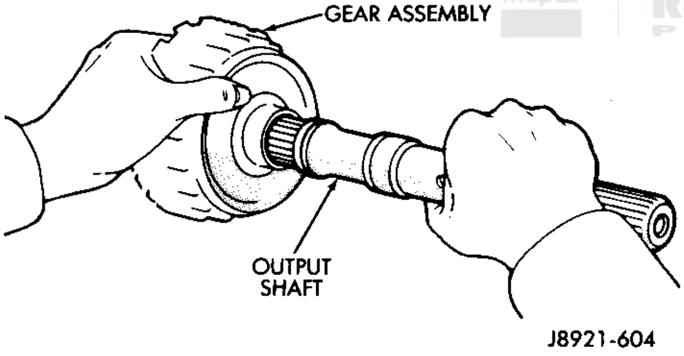


Fig. 2 Removing/Installing Output Shaft

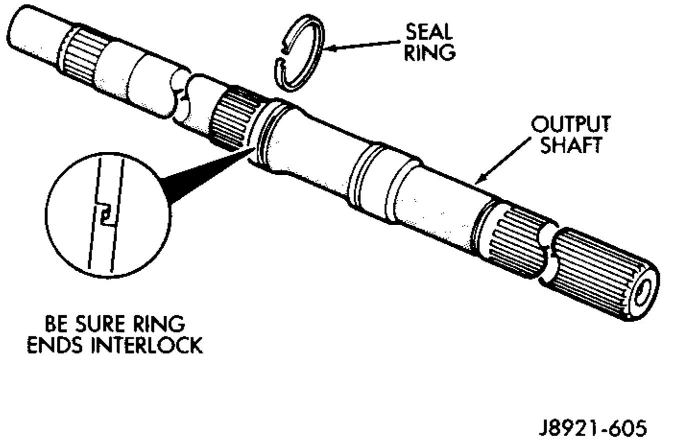


Fig. 3 Removing/Installing Shaft Seal Ring

Assembling Rear Planetary, Brake Pack, Clutch And Shaft

(1) Install hub and snap ring in ring gear (Fig. 11)

(2) Identify ring gear thrust bearing and races races by following dimensions:

- Outer diameter of bottom race (Fig. 10) is 44.8 mm (1.764 in); inner diameter is 27.6 mm (1.087 in).
- Outer diameter of bearing (Fig. 10) is 44.7 mm (1.760 in); inner diameter is 30.1 mm (1.185 in).
- Outer diameter of upper race Fig. 10) is 44.8 mm (1.764 in); inner diameter is 28.8 mm (1.134 in).

(3) Lubricate ring gear thrust bearing and races with petroleum jelly and install them in ring gear (Fig. 10).

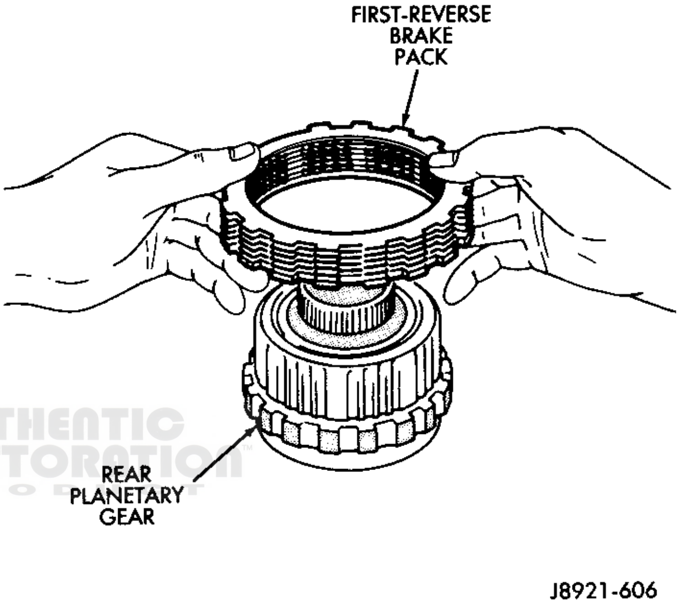


Fig. 4 Removing/Installing First-Reverse Brake Pack

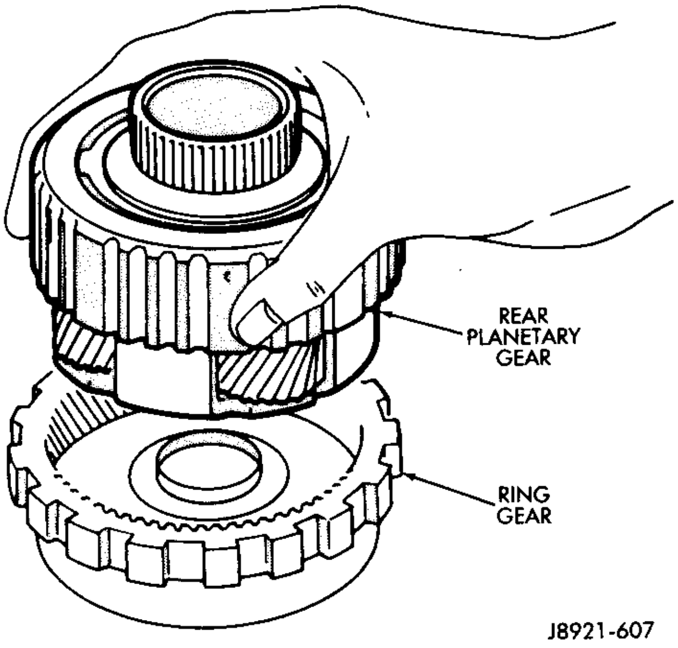


Fig. 5 Removing/Installing Rear Planetary

(4) Coat planetary thrust washers with petroleum jelly and install them in gear (Fig. 9).

(5) Install No. 2 one-way clutch in planetary gear. Be sure flanged side of clutch faces upward (Fig. 12).

(6) Install clutch retaining snap ring and install clutch inner race (Fig. 7). Turn race counterclockwise to ease installation.

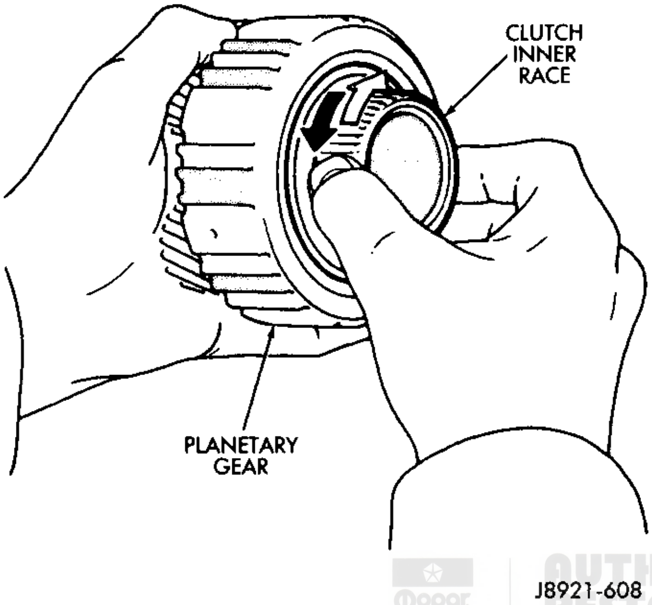


Fig. 6 Checking No. 2 One-Way Clutch Operation

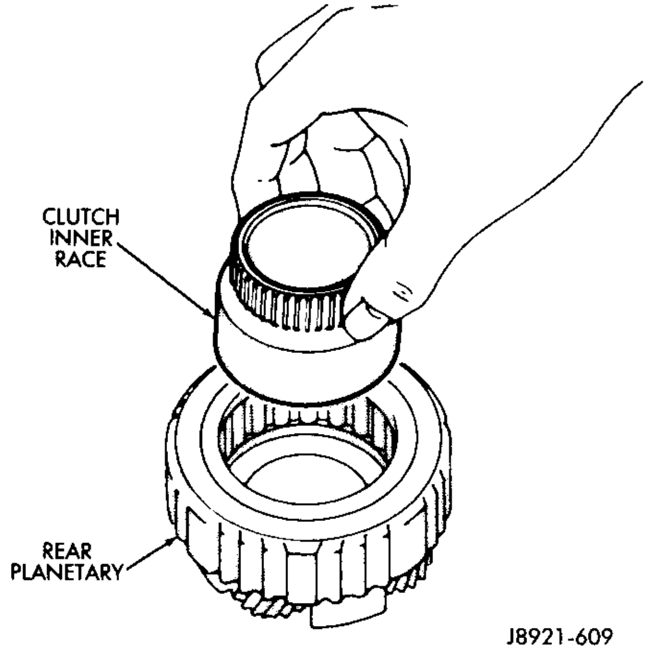


Fig. 7 Removing/Installing Clutch Inner Race

(7) Verify one-way clutch operation. Hold gear and turn inner race in both directions. Race should turn freely counterclockwise, but lock when turned clockwise.

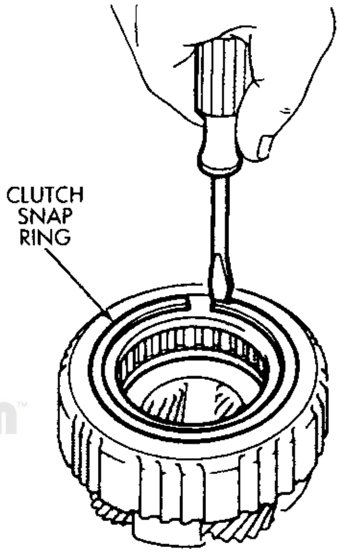
(8) Install planetary gear in ring gear.

(9) Assemble clutch discs and clutch plates (Fig. 4). Sequence is disc first, then a plate. **Use seven discs and plates in a 6-cyl. transmission and six discs and plates in a 4-cyl. transmission.**

(10) Install brake pack on planetary gear (Fig. 4).

(11) Install new seal ring on output shaft (Fig. 3). Be sure ring ends are interlocked as shown.

(12) Set assembled components aside for final assembly.



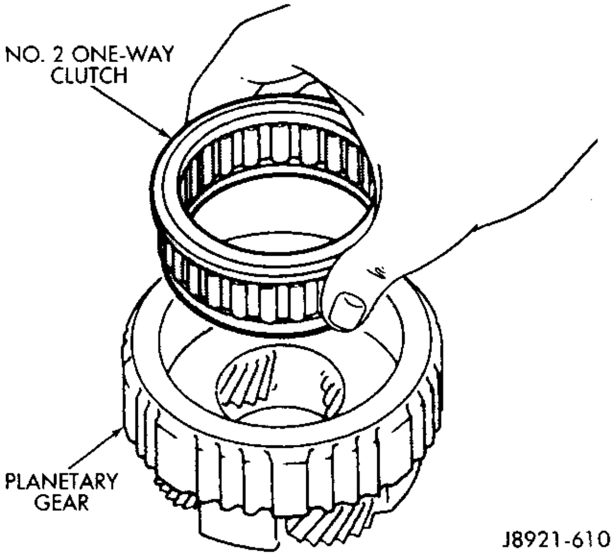


Fig. 8 Removing.Installing One-Way Clutch

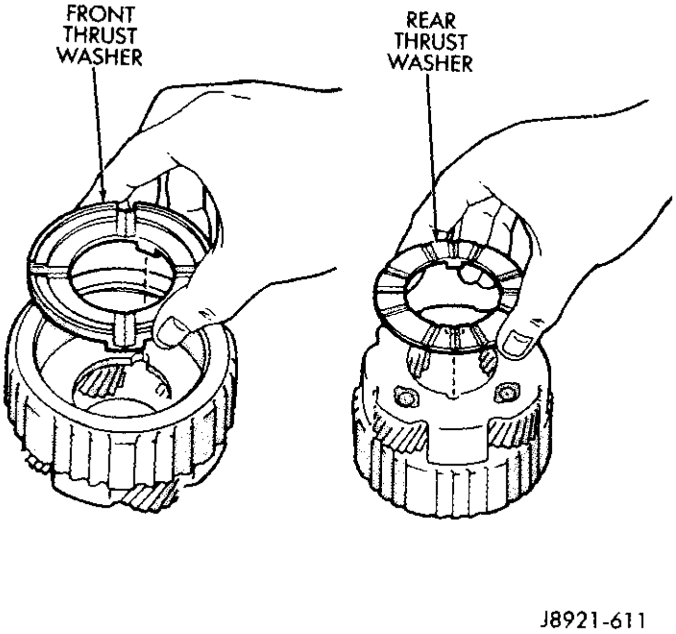


Fig. 9 Removing/Installing Rear Planetary Thrust Washers

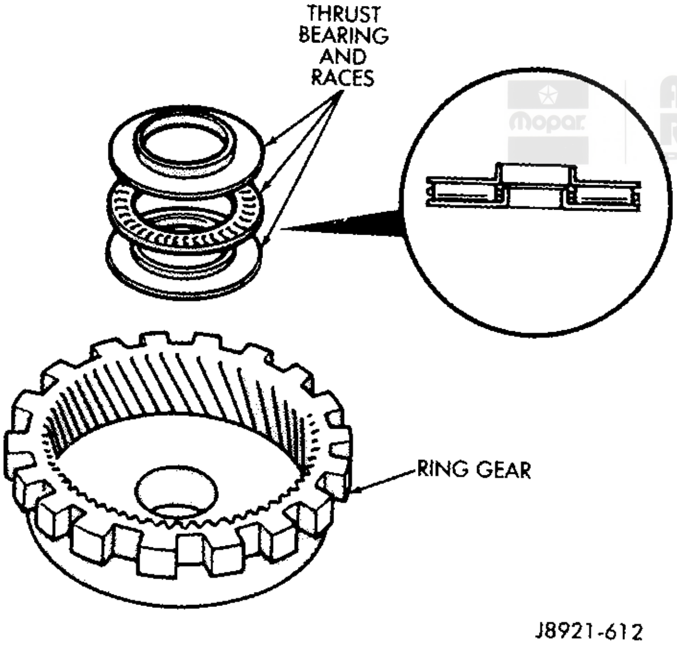


Fig. 10 Removing/Installing Ring Gear Thrust Bearing And Races

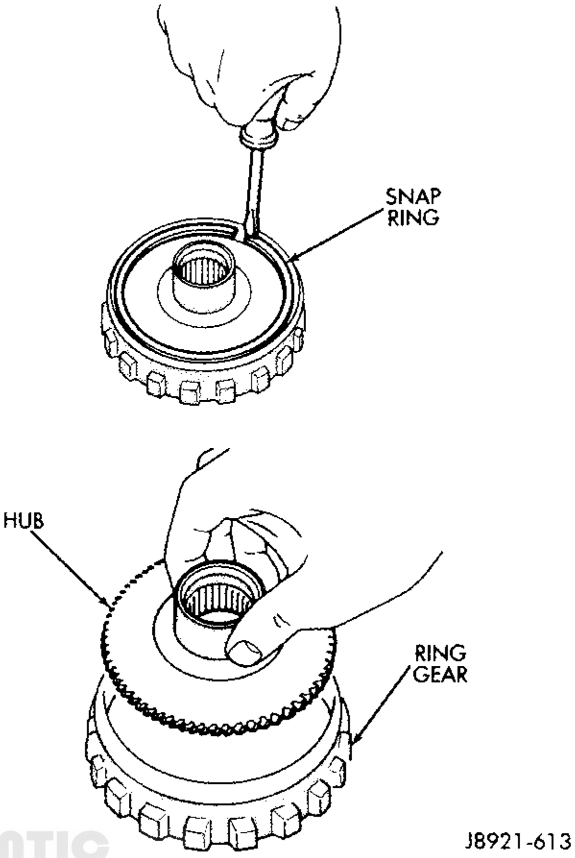


Fig. 11 Removing/Installing Ring Gear Hub

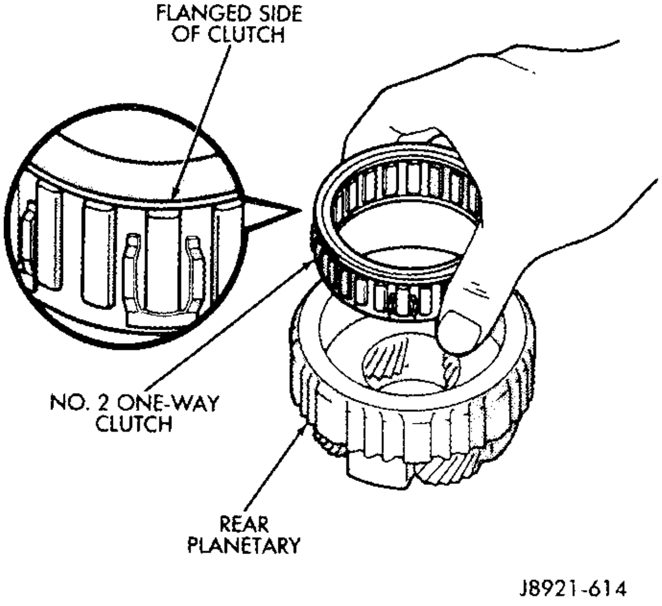


Fig. 12 Installing No. 2 One-Way Clutch

FIRST-REVERSE BRAKE PISTON AND TRANSMISSION CASE OVERHAUL

Brake Disassembly-Inspection

(1) Remove bearing and race assembly from transmission case (Fig. 2).

(2) Check first/reverse brake piston operation with compressed air (Fig. 3). Piston should move smoothly and not bind or stick. If piston operation is incorrect, case or piston may require replacement.

(3) Compress piston return springs with tool B.Vi. FM-28 and remove piston snap ring (Fig. 4).

(4) Remove tool B.Vi. FM-28 and remove piston return springs.

(5) Remove No. 2 first-reverse brake piston with compressed air. Apply air through same transmission feed hole used for checking piston operation.

(6) Remove reaction sleeve with tool B.Vi. FM-31 (Fig. 5). Insert tool flanges under sleeve and lift tool and sleeve out of case.

(7) Remove No. 1 first/reverse brake piston with tool B.Vi. FM- 32 (Fig. 6). Slip tool under piston and lift tool and piston out of case.

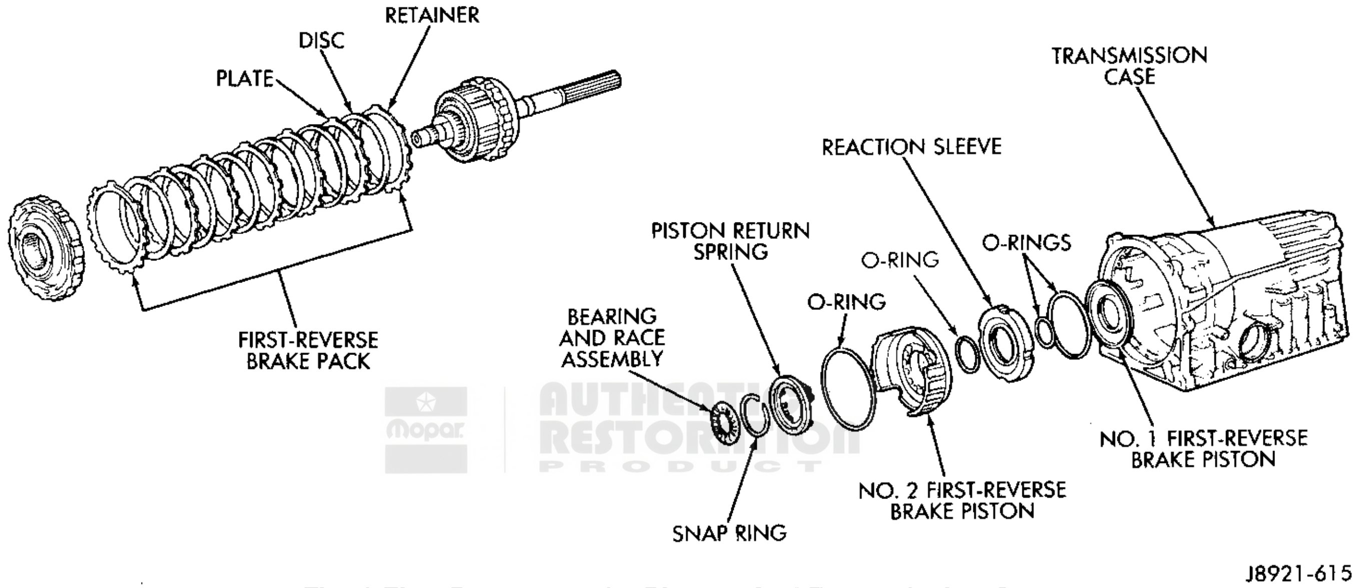


Fig. 1 First-Reverse Brake Pistons And Transmission Case

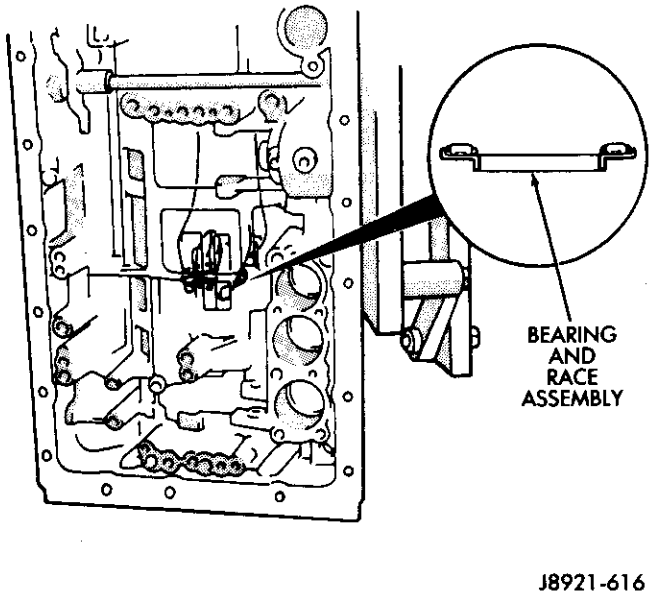


Fig. 2 Removing/Installing Bearing And Race Assembly

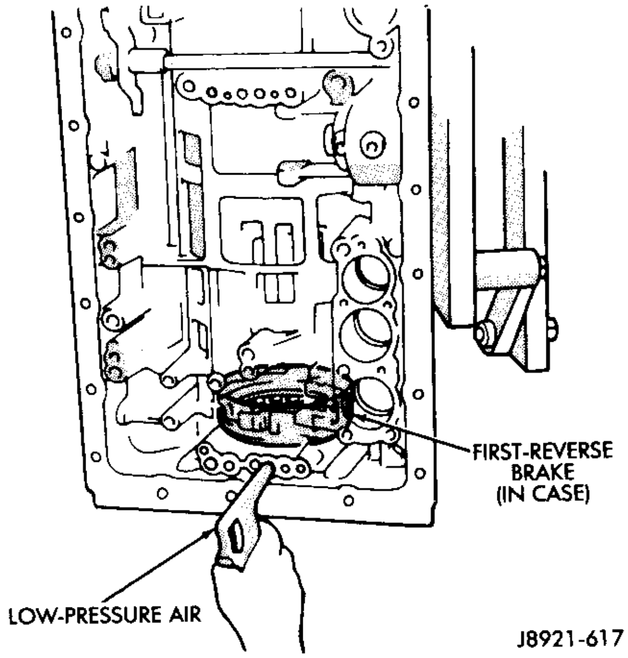


Fig. 3 Checking First-Reverse Brake Piston Operation

(8) Measure free length of piston return springs with springs mounted in retainer. Length should be 18.382 mm (.724 in). Replace springs if length is less than this.

(9) Clean transmission case thoroughly with solvent and dry it with compressed air. Blow compressed air through oil feed passages to remove solvent residue and ensure that passages are clear. Inspect the case for wear or damage. Replace case if necessary.

Assembling First/Reverse Brake Piston

(1) Lubricate and install new O-rings on No. 1 first/reverse brake piston and on reaction sleeve (Fig. 7). Then install piston in sleeve.

(2) Lubricate and install new O-ring on No. 2 brake piston.

(3) Install assembled No. 1 piston and reaction sleeve on No. 2 piston (Fig. 8).

(4) Lubricate and install piston assembly in case (Fig. 9). Align piston and case slots and press piston assembly into case with hand pressure.

(5) Position piston return springs on No. 2 piston.

(6) Compress piston return springs with tool B.Vi. FM-28 and install piston snap ring. Be sure snap ring end gap is not aligned with any tangs on return spring retainer.

(7) Verify piston operation with compressed air as outlined in disassembly procedure.

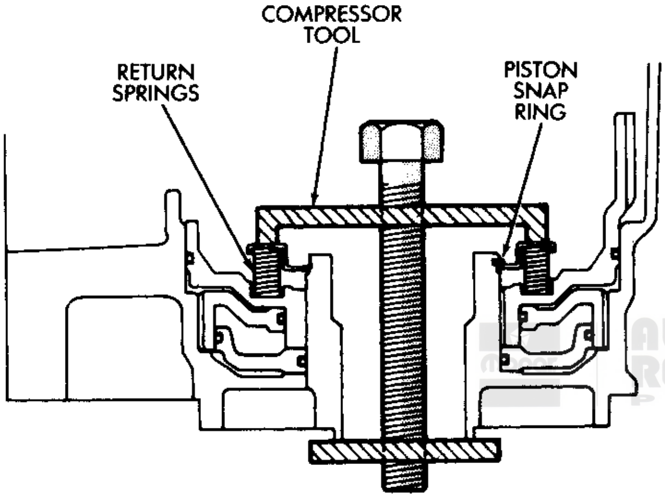


Fig. 4 Removing/Installing Piston Snap Ring

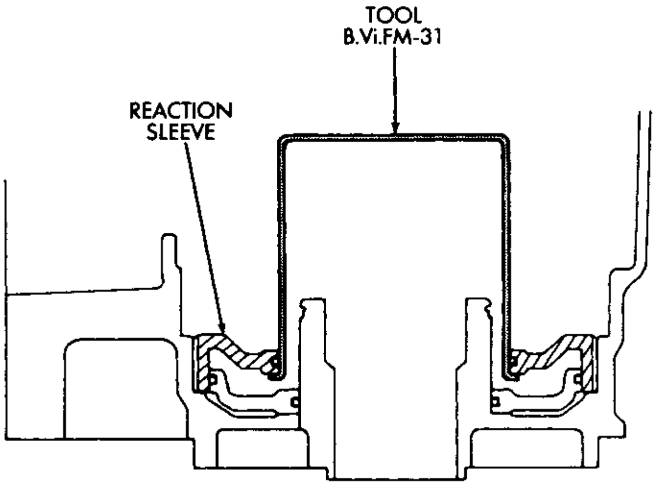


Fig. 5 Removing/Installing Reaction Sleeve

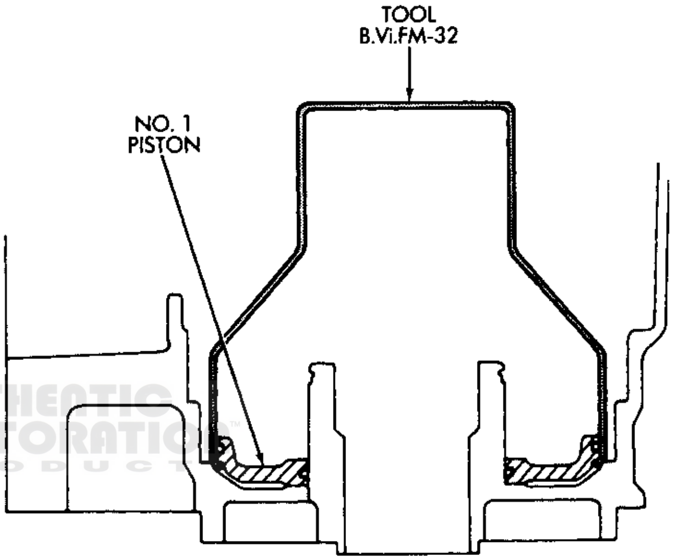


Fig. 6 Removing/Installing First- Reverse Brake No.1 Piston

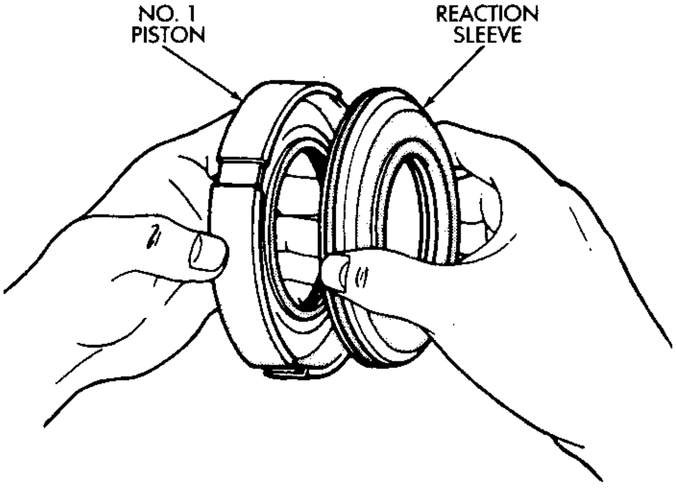


Fig. 7 Assembling No. 1 Piston And Sleeve

(8) Coat bearing and race assembly with petroleum jelly and install it in piston assembly (Fig. 2). Bearing and race assembly outer diameter is 57.7 mm (2.272 in); inner diameter is 39.2 mm (1.543 in).

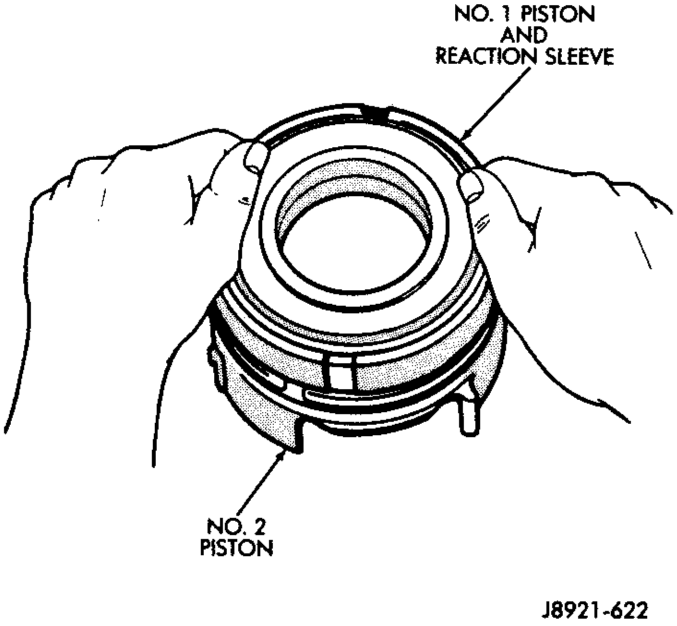


Fig. 8 Assembling First-Reverse Brake Pistons

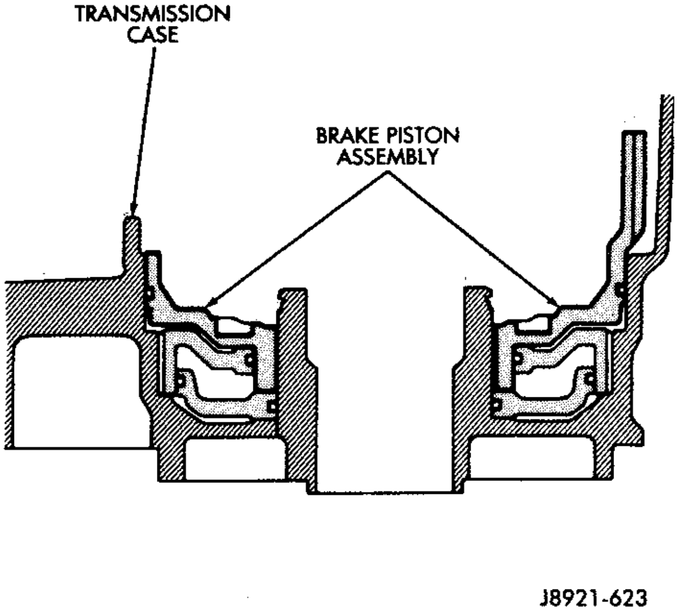
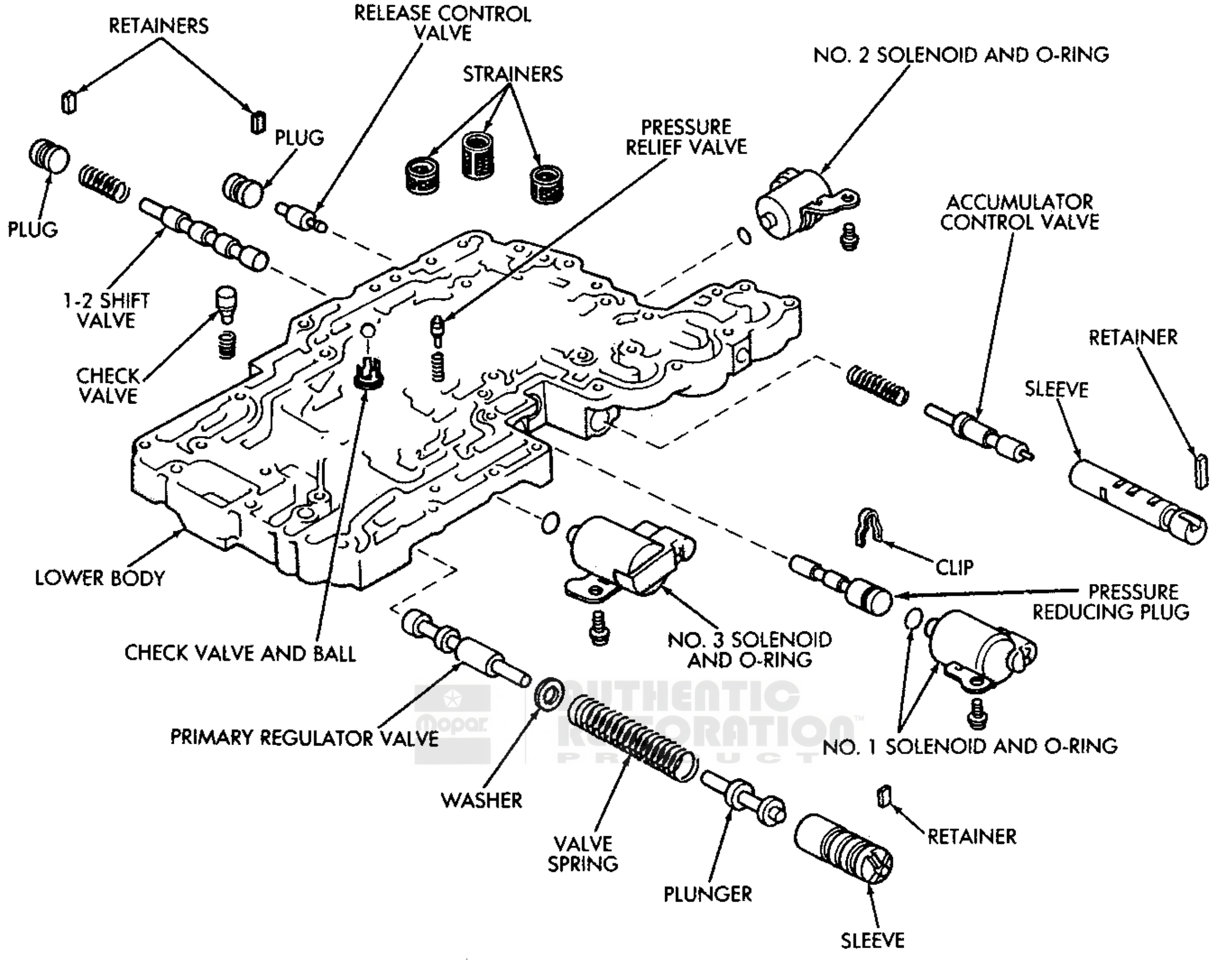


Fig. 9 Installing First-Reverse Brake Piston Assembly

VALVE BODY OVERHAUL

The valve body assembly consists of two sections which are the upper body and lower body (Figures 1 and 2). Disassembly, inspection and overhaul procedures for each section are outlined separately. Refer to the appropriate procedure as needed.



J8921-624

Fig. 1 Lower Body Components (Valve Body)

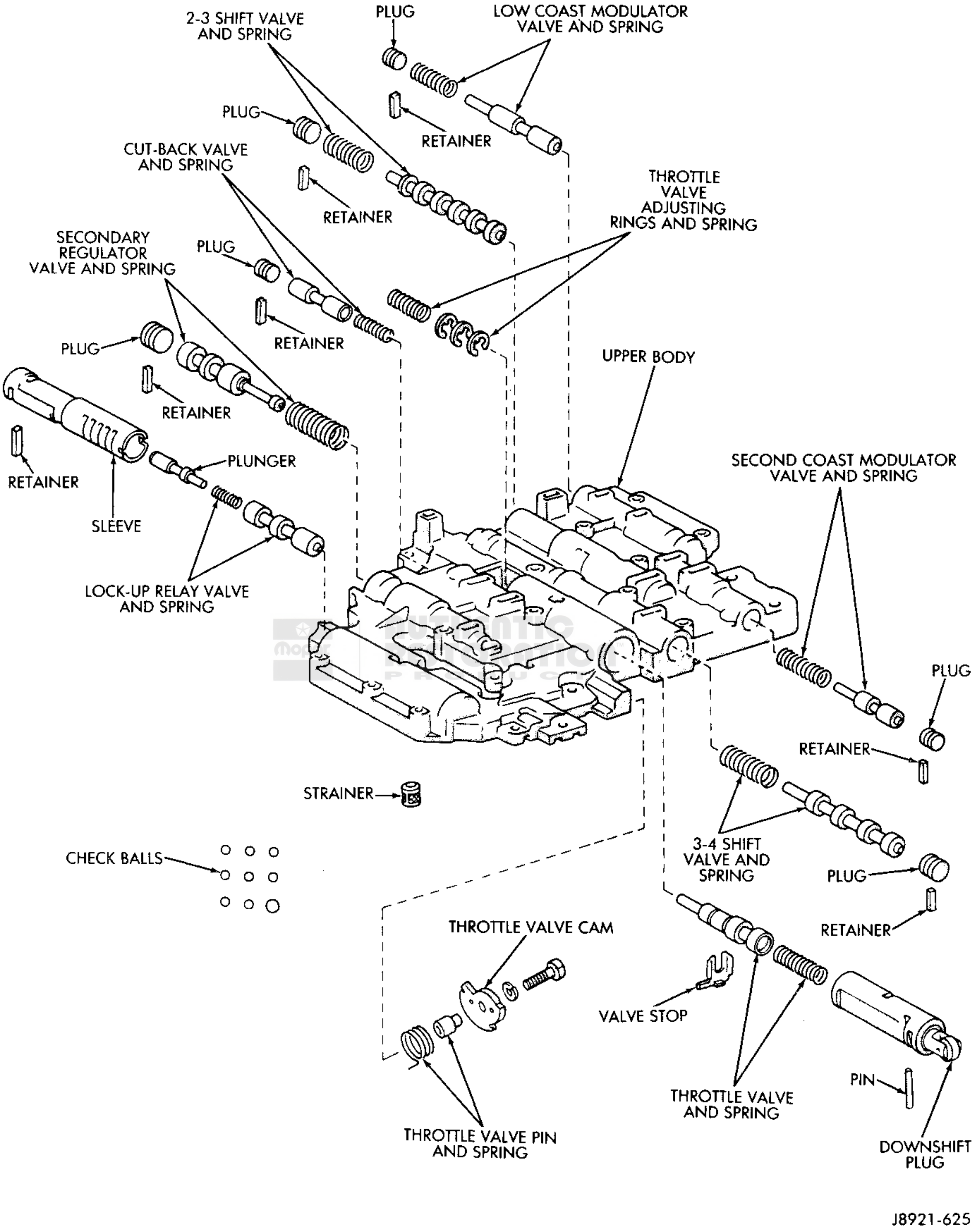


Fig. 2 Upper Body Components (Valve Body)

Removing Upper Body From Lower Body

(1) Remove two-piece detent spring (Fig. 3). Note position of spring sections for assembly reference.

(2) Remove manual valve from lower body (Fig. 4).

(3) Remove bolts attaching upper body to lower body (Fig. 5).

(4) Carefully lift and remove upper body, plate and gaskets from lower body (Fig. 6).

(5) Disassemble and overhaul upper and lower body sections as outlined in following procedures.

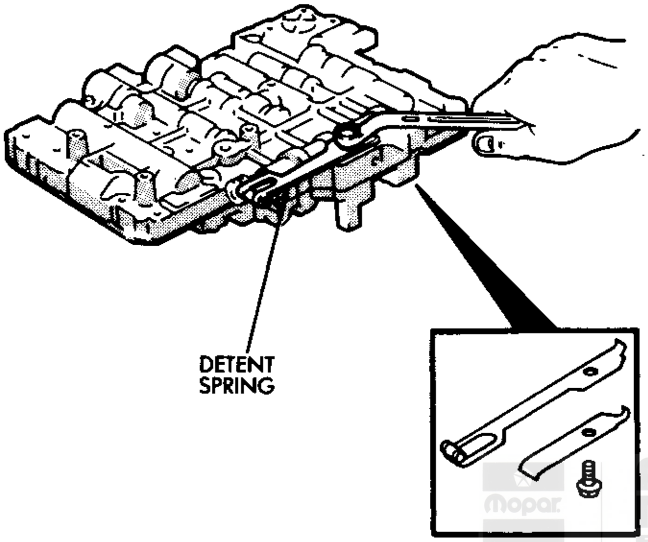


Fig. 3 Removing/Installing Detent Spring

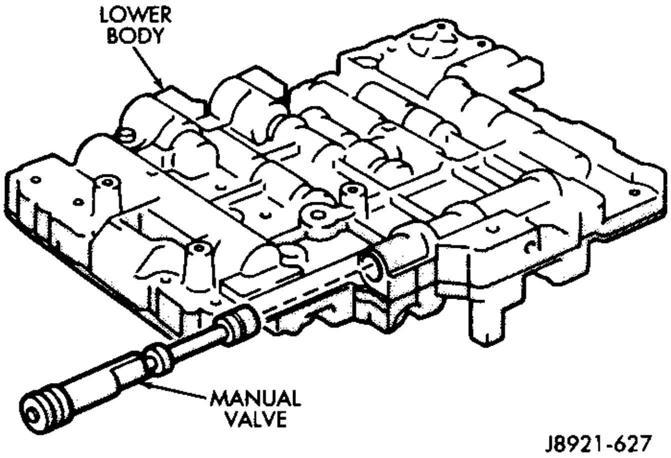


Fig. 4 Removing/Installing Manual Valve

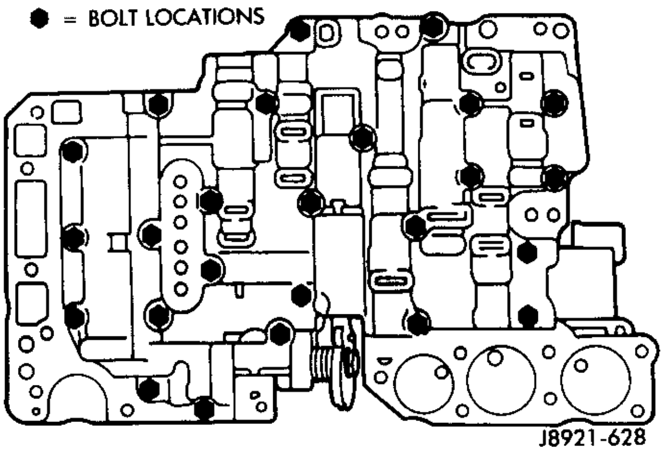


Fig. 5 Valve Body Bolt Locations

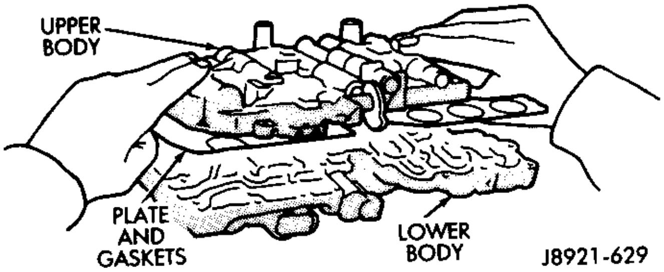


Fig. 6 Upper Body, Plate And Gaskets

Lower Body Disassembly

(1) Remove check valve and spring, pressure relief valve and spring and ball check and seat from lower body. Note location of each valve for assembly reference.

(2) Remove the oil strainers (Fig. 2).

(3) Note or mark position of valve retainers and pressure reducing plug clip for assembly reference. Do not remove the retainers at this time.

(4) Remove solenoid No. 1, 2 and 3. Discard solenoid O-rings.

(5) Remove release control valve retainer with magnet and remove release control valve and plug (Fig. 4).

(6) Remove 1-2 shift valve retainer and remove valve plug, valve spring and valve (Fig. 5).

(7) Remove primary regulator valve as follows:

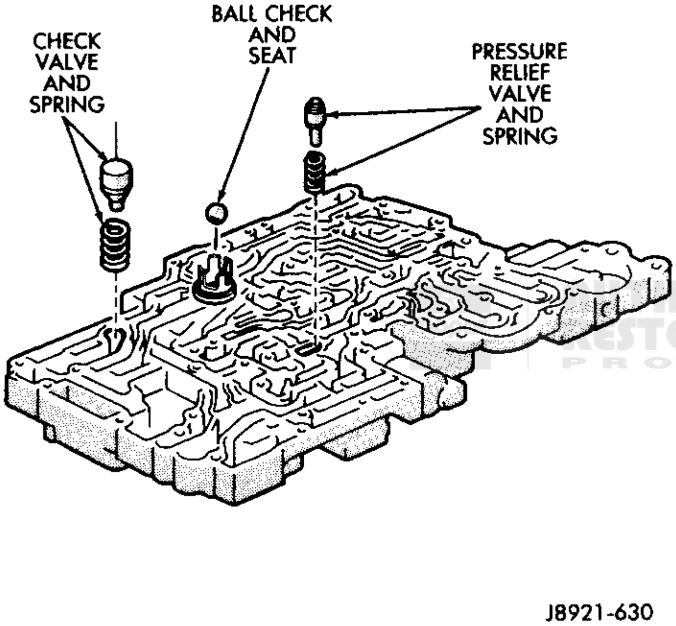


Fig. 1 Removing/Installing Lower Body Check Valves

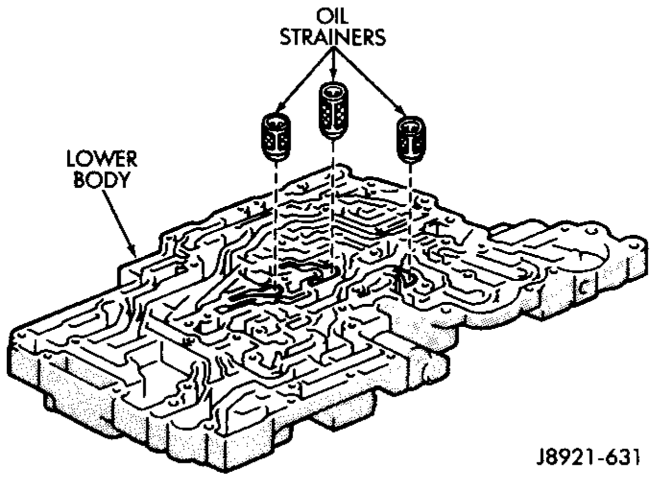


Fig. 2 Removing/Installing Lower Body Oil Strainers

WARNING: THE PRIMARY REGULATOR VALVE SLEEVE AND PLUNGER ARE UNDER TENSION FROM THE VALVE SPRING. EXERT COUNTERPRESSURE ON THE SPRING WHILE REMOVING THE VALVE RETAINER TO PREVENT COMPONENTS FROM FLYING OUT.

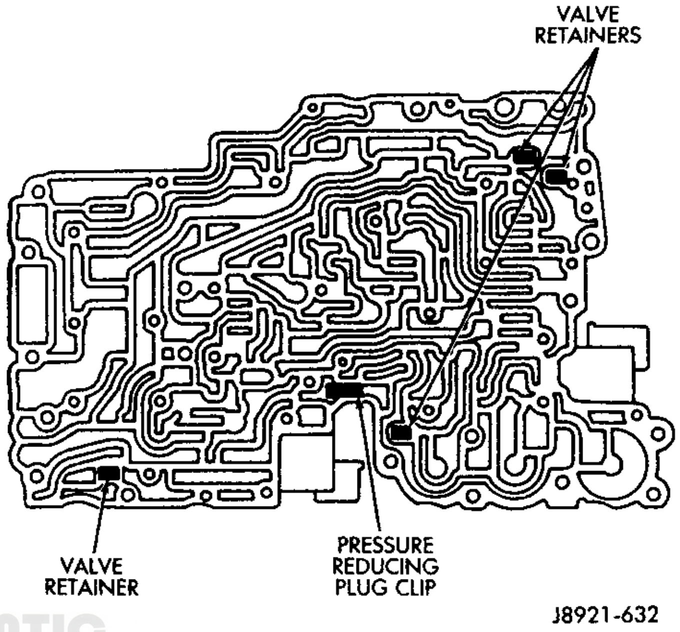


Fig. 3 Valve Retainer And Clip Location

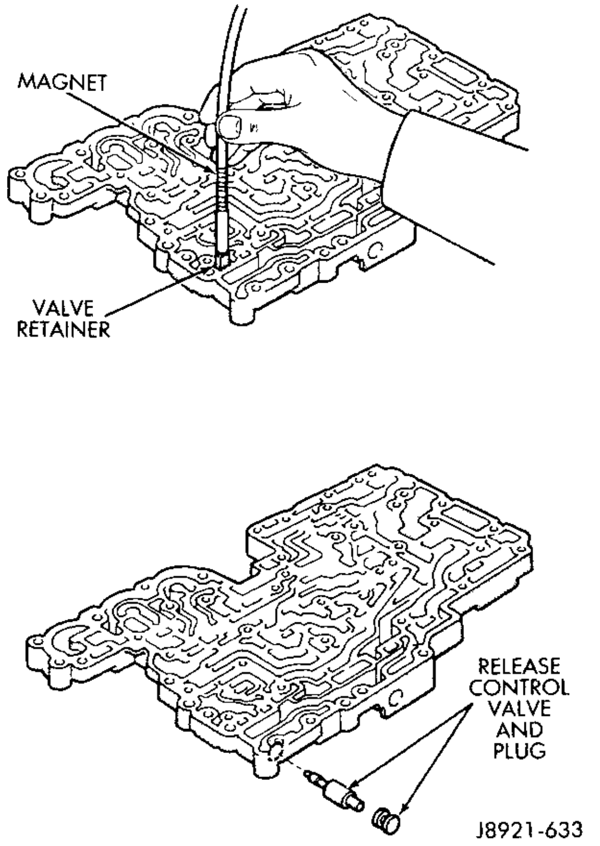


Fig. 4 Removing/Installing Release Control Valve

(a) Note position of valve retainer for assembly reference (Fig. 6). Then press valve sleeve inward with your thumb and remove retainer with magnet.

(b) Slowly release thumb pressure on sleeve and remove sleeve, spring and washer and valve (Fig. 7). Use magnet to remove valve if necessary.

(8) Remove regulator valve plunger from sleeve (Fig. 8).

(9) Remove retaining clip and remove pressure reducing plug (Fig. 9). Cover screwdriver blade with tape to avoid scratching valve body surface.

(10) Remove accumulator control valve retainer and remove control valve assembly (Fig. 10).

(11) Remove spring and control valve from valve sleeve (Fig. 11).

(12) Clean lower body valve components with solvent and dry them with compressed air only. Do not use shop towels or rags. Lint or foreign material from towels or rags can interfere with valve operation.

(13) Inspect condition of lower body components. Replace lower body if any bores are scored or corroded. Replace valves, plugs or sleeves that are scored or worn. Replace oil strainers if cut, torn or damaged in any way.

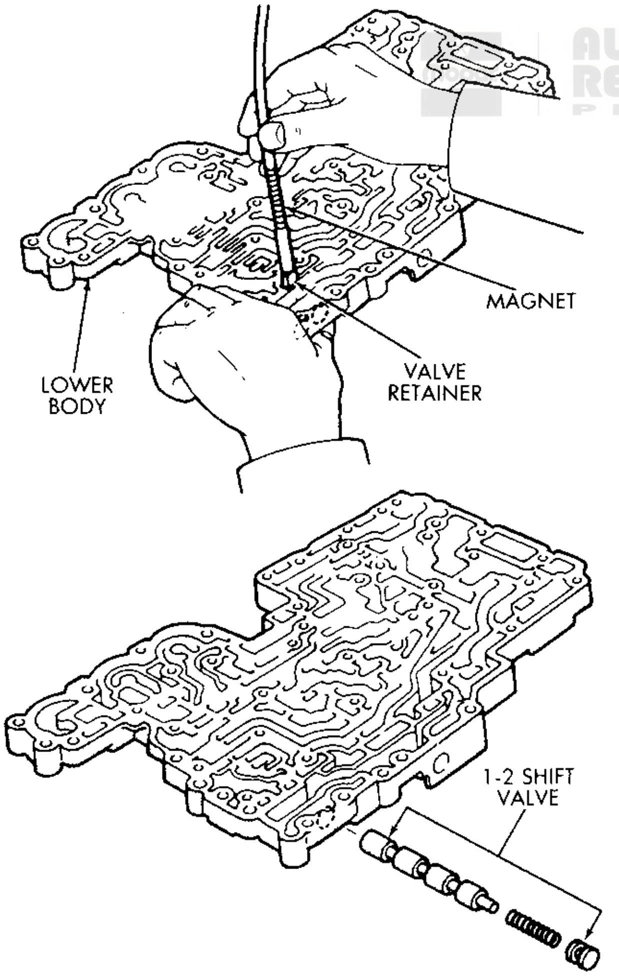
(14) Inspect the valve body springs. Replace any spring having rusted, distorted, or collapsed coils. Measure the length of each valve body spring. Replace any spring if free length is less than the length specified in the following chart (Fig. 12).

Lower Body Assembly

(1) Lubricate lower body components with automatic transmission fluid.

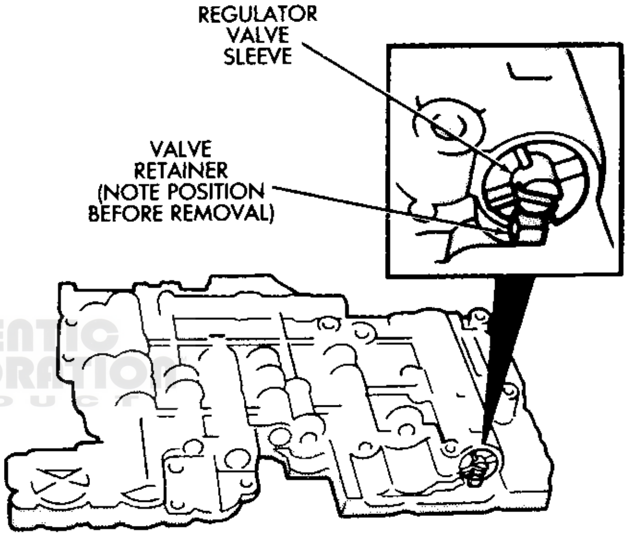
(2) Install spring and accumulator control valve in sleeve (Fig. 11). Then install assembled components in lower body (Fig. 10).

(3) Press accumulator control valve assembly into valve bore and install retainer (Fig. 10).



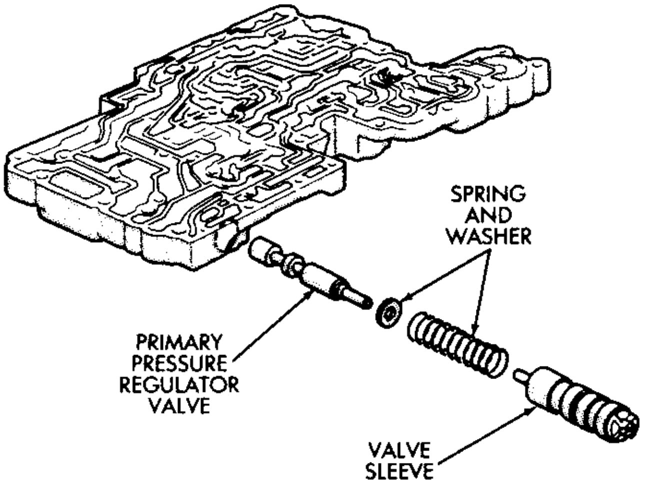
J8921-634

Fig. 5 Removing/Installing 1-2 Shift Valve



J8921-635

Fig. 6 Regulator Valve Retainer Position



J8921-636

Fig. 7 Removing/Installing Primary Pressure Regulator Valve

(4) Install pressure reducing plug in plug bore. Then secure plug with retaining clip (Fig. 9).

(5) Install washer on primary regulator valve plunger (Fig. 13).

(6) Install primary regulator valve plunger in valve sleeve (Fig. 8).

(7) Install valve spring and regulator valve sleeve and plunger.

(8) Press regulator valve sleeve into bore and install retainer (Fig. 6 and 7). Be sure retainer is positioned in sleeve lugs as shown.

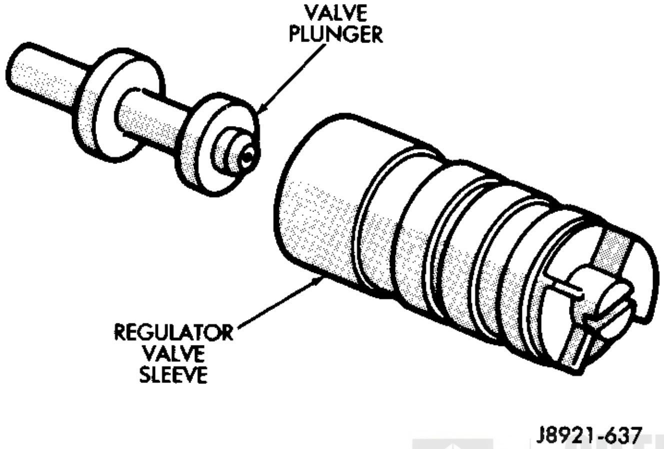


Fig. 8 Removing/Installing Regulator Valve Plunger

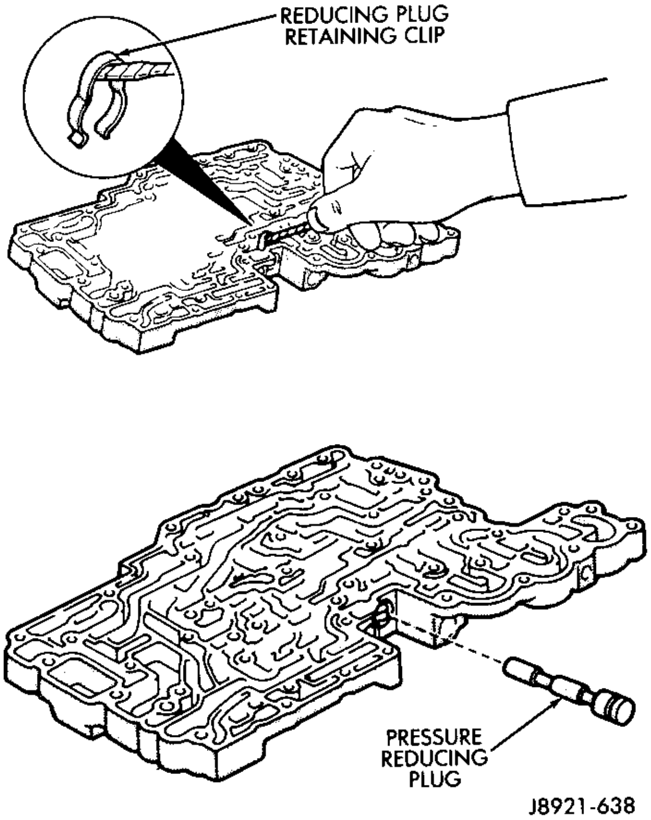


Fig. 9 Removing/Installing Pressure Reducing Plug

(9) Install 1-2 shift valve, spring and plug (Fig. 5). Then press valve assembly into bore and install retainer.

(10) Install release control valve and plug in bore and install valve retainer (Fig. 4).

(11) Install replacement O-rings on solenoids and install solenoids on valve body. Tighten solenoid attaching bolts to 10 N•m (7 ft-lbs) torque.

(12) Install oil strainers (Fig. 14). **Identify strainers before installation. The three strainers are all the same diameter but are different lengths. Two strainers are 11.0 mm (.443 in) long while one strainer is 19.5 mm (.76 in) long (Fig. 14).**

(13) Install check valves and springs/seats (Fig. 1)

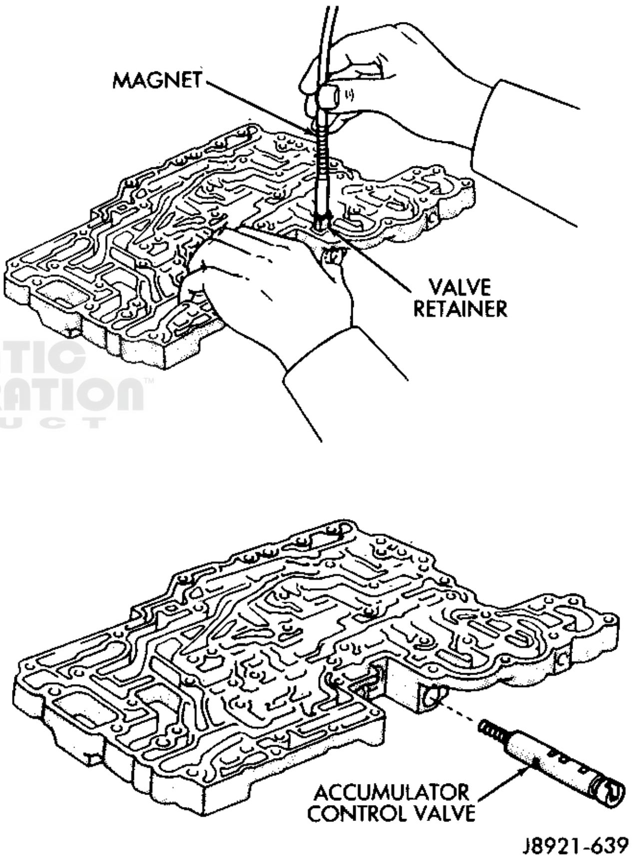


Fig. 10 Removing/Installing Accumulator Control Valve Assembly

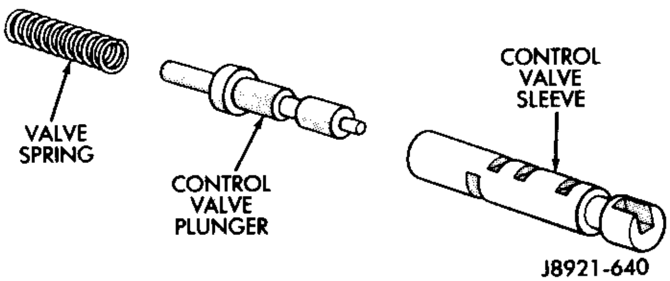
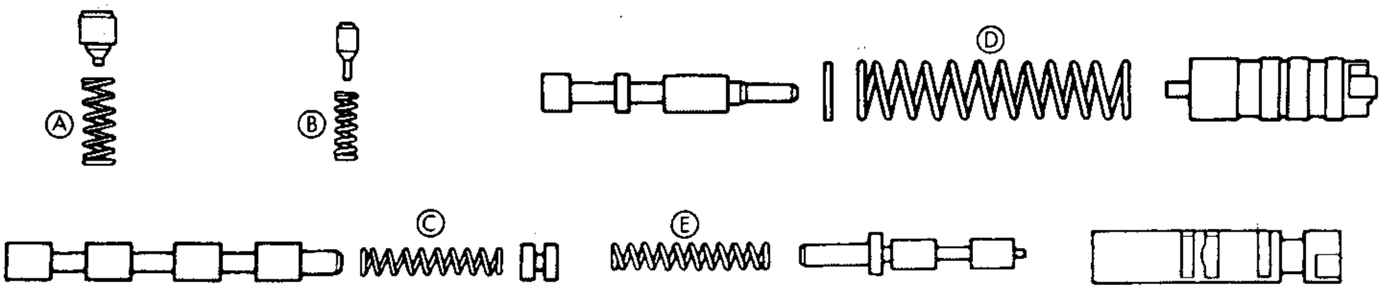


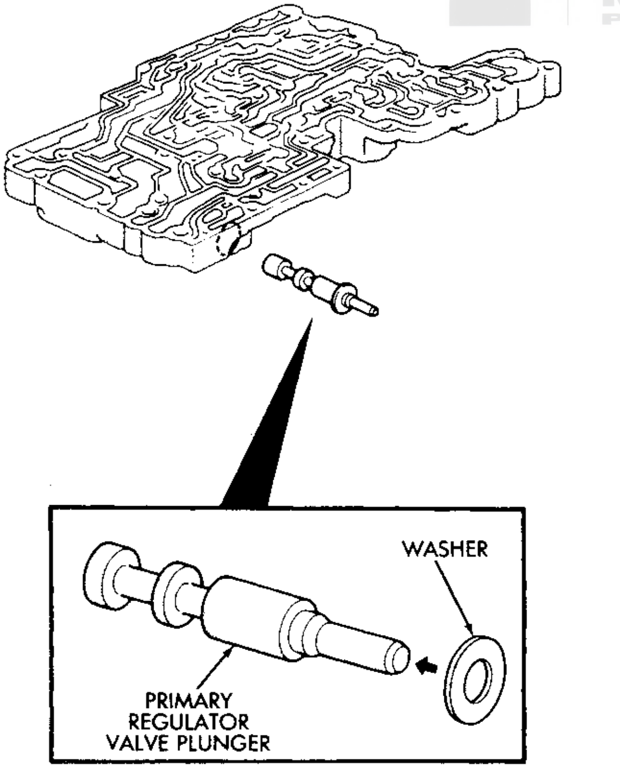
Fig. 11 Accumulator Control Valve Components



Spring	Free Length
(A) Check Valve	20.2 mm (0.801 in.)
(B) Pressure Relief Valve	11.2 mm (0.441 in.)
(C) 1-2 Shift Valve	30.8 mm (1.213 in.)
(D) Primary Regulator Valve	66.7 mm (2.626 in.)
(E) Accumulator Control Valve	36.1 mm (1.421 in.)

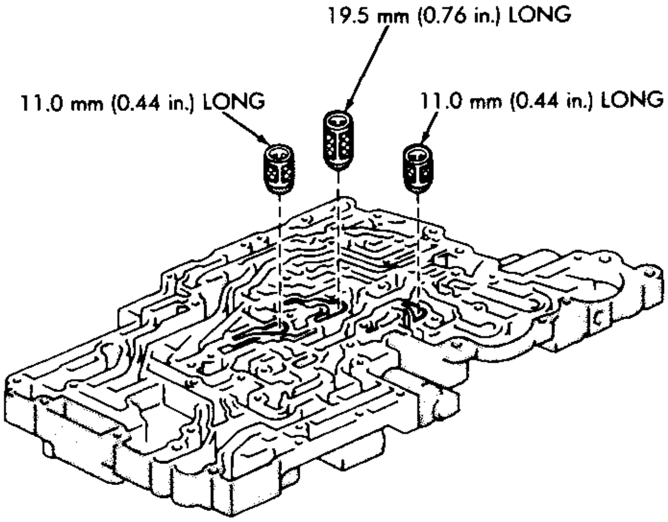
J8921-641

Fig. 12 Lower Body Valve Spring Dimensions



J8921-642

Fig. 13 Installing Washer On Regulator Valve Plunger



J8921-643

Fig. 14 Oil Strainer Identification

Upper Body Disassembly and Inspection

(1) Remove valve body plate and gaskets (Fig. 1). Discard gaskets.

(2) Remove strainer and nine check balls (Fig. 2). Note check ball and strainer position for assembly reference.

(3) Remove valve stop and throttle cam (Fig. 3).

(4) Remove throttle valve pin with magnet and remove downshift plug, valve spring and throttle valve (Fig. 4).

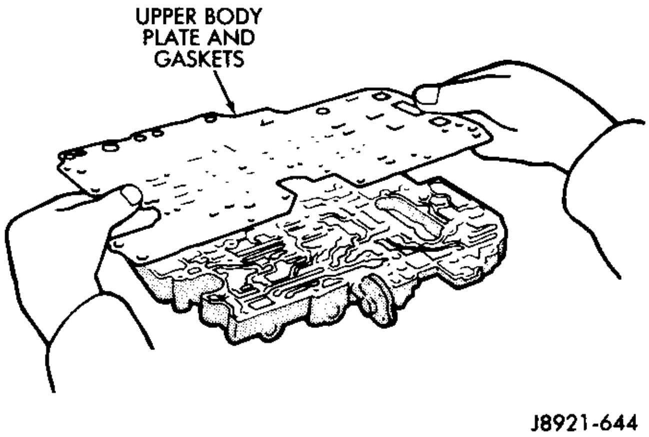


Fig. 1 Removing/Installing Upper Body Plate And Gaskets

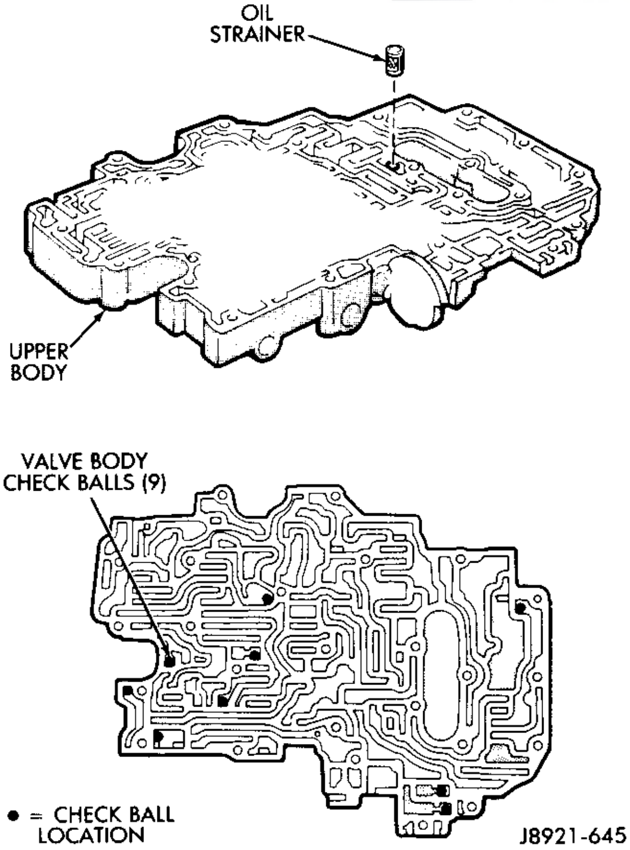


Fig. 2 Check Ball And Strainer Location

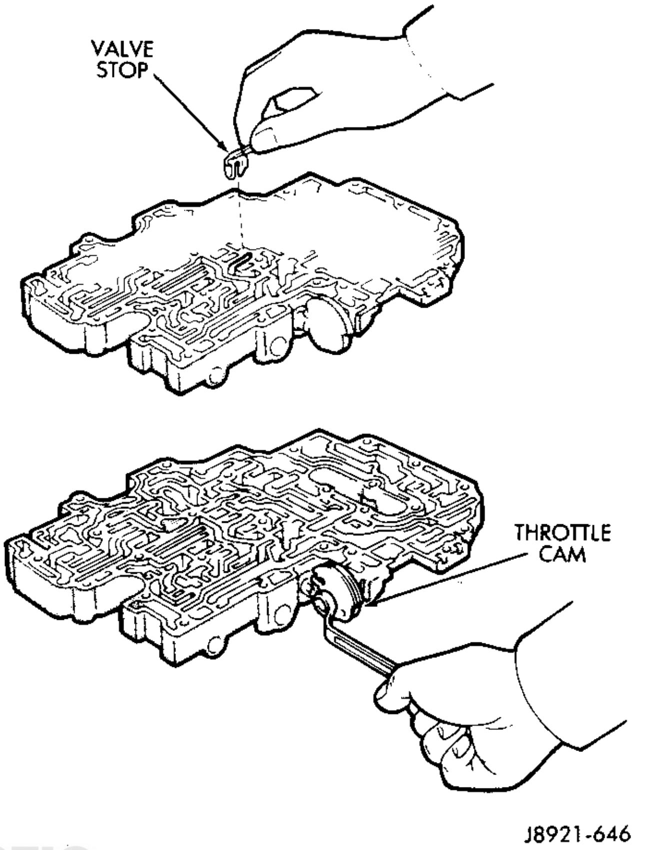


Fig. 3 Removing/Installing Valve Stop And Throttle Cam

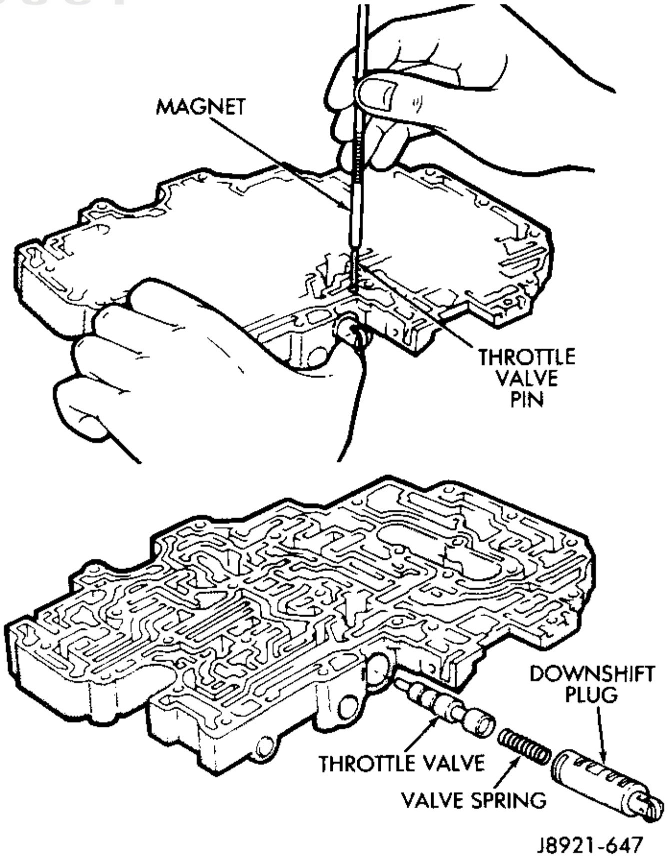


Fig. 4 Removing/Installing Throttle Valve

(5) Turn upper body over and remove throttle valve adjusting rings and spring (Fig. 5). Note number of adjusting rings if valve is equipped with them.

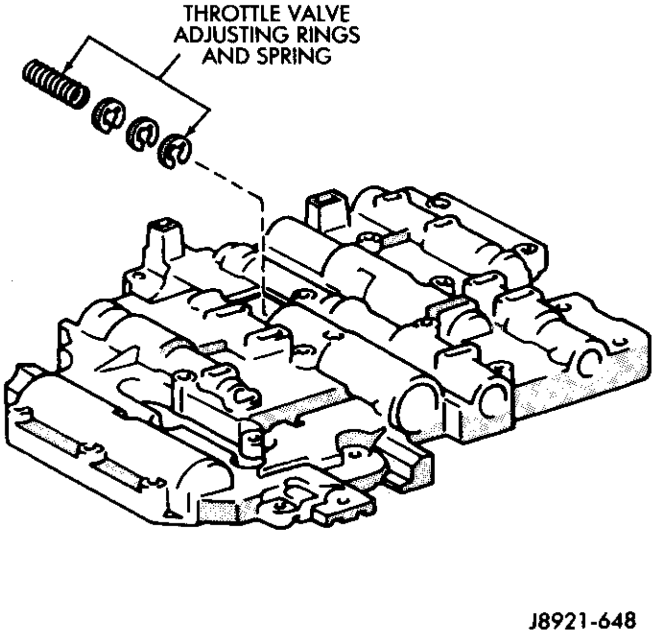


Fig. 5 Throttle Valve Adjusting Ring Location (If Equipped)

(6) Remove 3-4 shift valve retainer with magnet and remove valve plug, spring and 3-4 shift valve (Fig. 6).

(7) Remove second coast modulator valve retainer and remove valve plug, spring and valve.

(8) Remove lock-up relay valve retainer and remove relay valve and sleeve assembly (Fig. 8).

(9) Remove lock-up relay valve, spring and plunger fromtalve sleeve (Fig. 9).

(10) Remove secondary pressure regulator valve retainer and remove plug, regulator valve and spring (Fig. 10).

(11) Remove cut-back valve retainer and remove plug, cut-back valve and spring (Fig. 11).

(12) Remove 2-3 shift valve retainer and remove plug, spring and 2-3 shift valve (Fig. 12).

(13) Remove low coast modulator valve retainer and remove valve plug, spring and low coast modulator valve (Fig. 13).

(14) Clean the upper body components with solvent and dry them with compressed air only. Do not use shop towels or rags. Lint or foreign material from towels or rags can interfere with valve operation.

(15) Inspect condition of the upper body components. Replace the upper body if any of the bores are scored or corroded. Replace any valves, plugs or sleeves if scored or worn. Replace the oil strainer if cut, torn or damaged in any way.

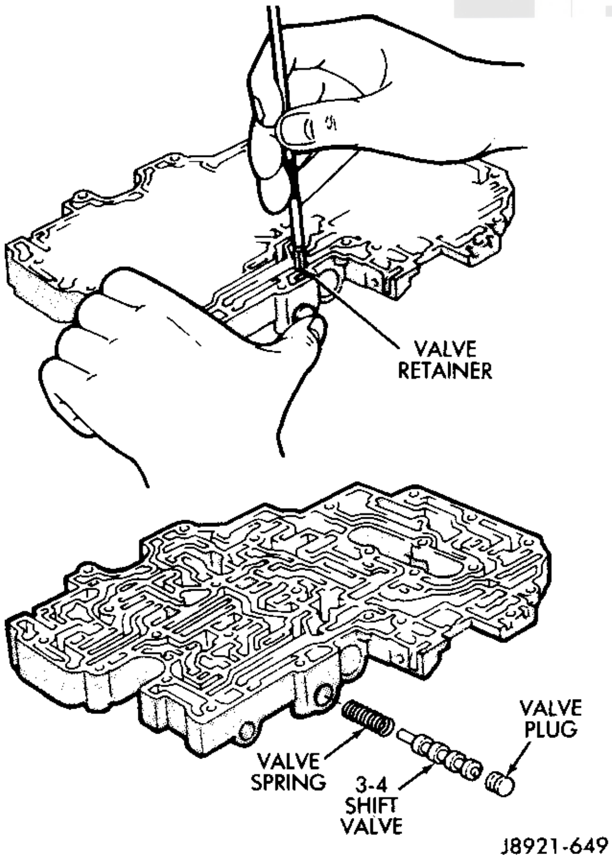


Fig. 6 Removing/Installing 3-4 Shift Valve

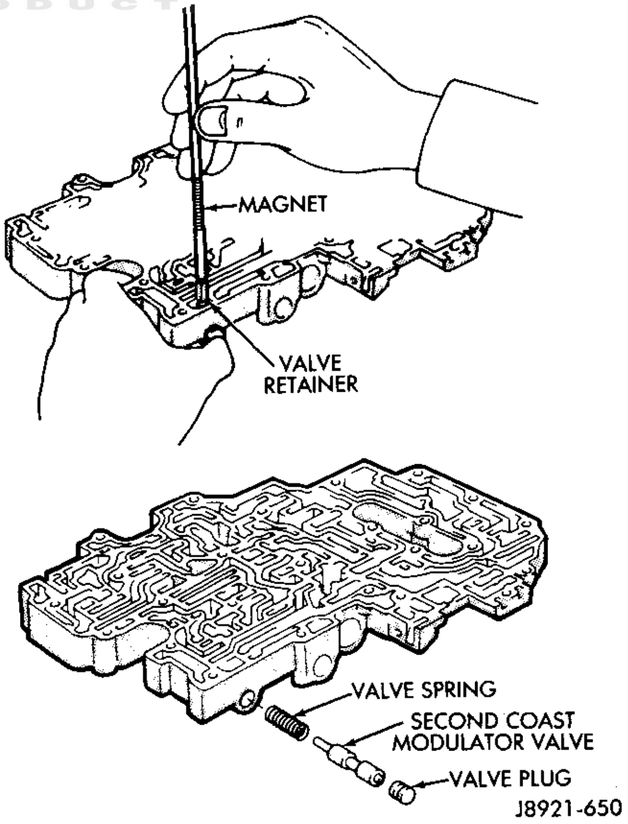


Fig. 7 Removing/Installing Second Coast Modulator Valve

(16) Inspect the valve body springs. Replace any spring having rusted, distorted, or collapsed coils. Measure length of each spring. Replace any spring if free length is less than specified in the chart (Fig. 14).

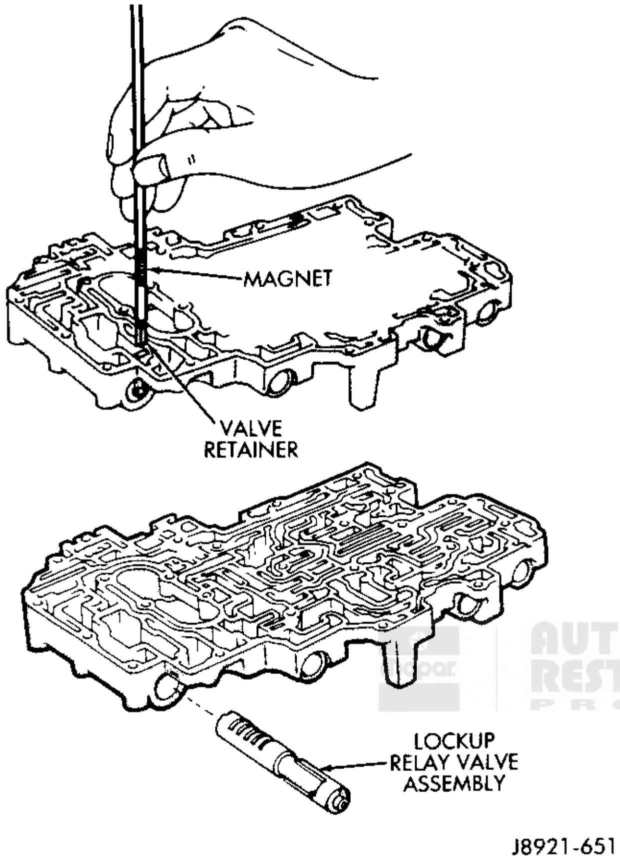


Fig. 8 Removing/Installing Lockup Relay Valve

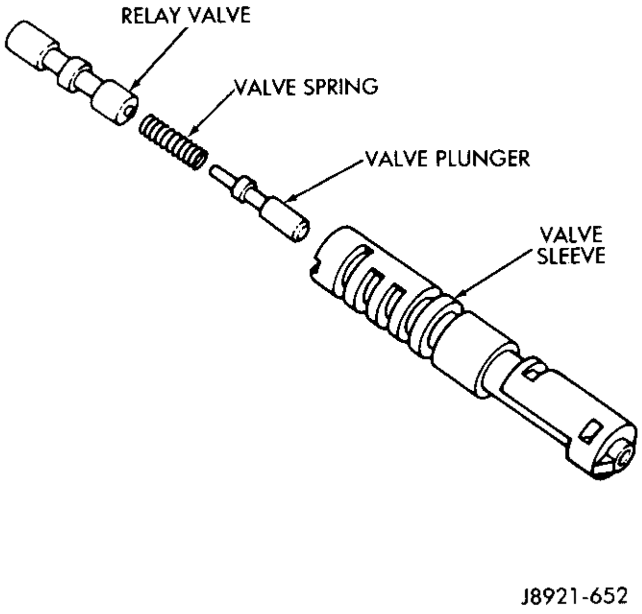


Fig. 9 Lockup Relay Valve Components

Upper Body Assembly

(1) Lubricate the valves, springs, plugs, sleeves and the valve bores in the upper body with automatic transmission fluid.

(2) Note position of the valve retainers (A) and stop (B) for assembly reference (Fig. 15).

(3) Install low coast modulator valve, spring and plug in valve bore. Press valve plug inward and install retainer (Fig. 13).

(4) Install 2-3 shift valve, spring and plug in valve bore. Press plug inward and install retainer (Fig. 12).

(5) Install cut-back valve spring, valve and plug (Fig. 11). Press plug inward and install retainer.

(6) Install secondary regulator valve spring, valve and plug in valve bore. Press plug inward and install retainer (Fig. 10).

(7) Assemble lock-up relay valve. Install spring and plunger in valve sleeve (Fig. 9). Then install assembled valve in sleeve.

(8) Install assembled lock-up relay valve in valve bore and install retainer (Fig. 8).

(9) Install second coast modulator valve, spring and plug in valve bore. Press plug inward and install retainer (Fig. 7).

(10) Install 3-4 shift valve, spring and plug in bore. Press plug inward and install retainer (Fig. 6).

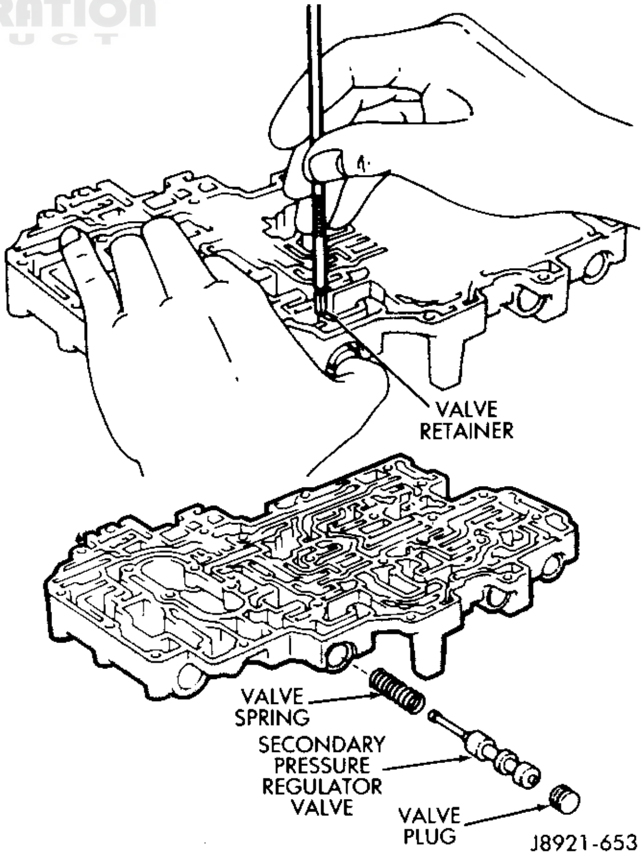


Fig. 10 Removing/Installing Secondary Pressure Regulator Valve

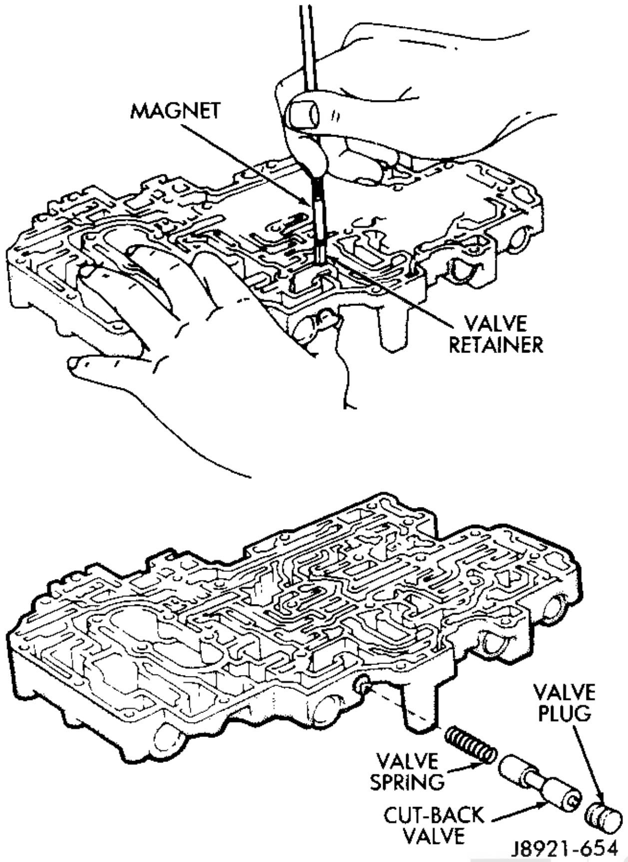


Fig. 11 Removing/Installing Cut-Back Valve

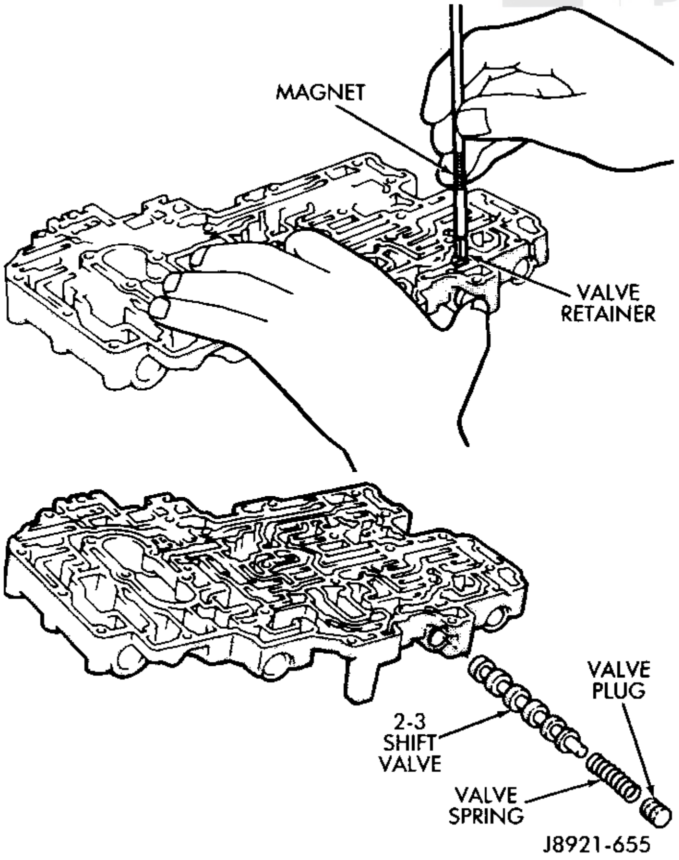


Fig. 12 Removing/Installing 2-3 Shift Valve

(11) Install throttle valve in valve bore. Push valve into place and install valve stop (Fig. 16).

(12) On models with adjusting rings, turn upper body over and install adjusting rings (Fig. 17). Be sure to install same number of rings as were removed.

(13) Install throttle valve adjusting spring in bore and onto end of throttle valve (Fig. 18).

(14) Install downshift spring and plug in throttle valve bore. Press plug inward against throttle valve and spring and install the retainer pin (Fig. 19).

(15) Install sleeve in throttle cam (Fig. 20).

(16) Install spring on cam (Fig. 20). Hook curved end of spring through hole in cam as shown.

(17) Mount cam on upper body and install cam attaching bolt and spacer (Fig. 20). Tighten bolt to 10 N•m (7 ft-lbs) torque.

(18) Be sure straight end of spring is seated in upper body slot as shown (Fig. 20).

(19) Install check balls in upper body (Fig. 21). Refer to illustration for check ball identification and location.

(20) Install oil strainer (Fig. 2).

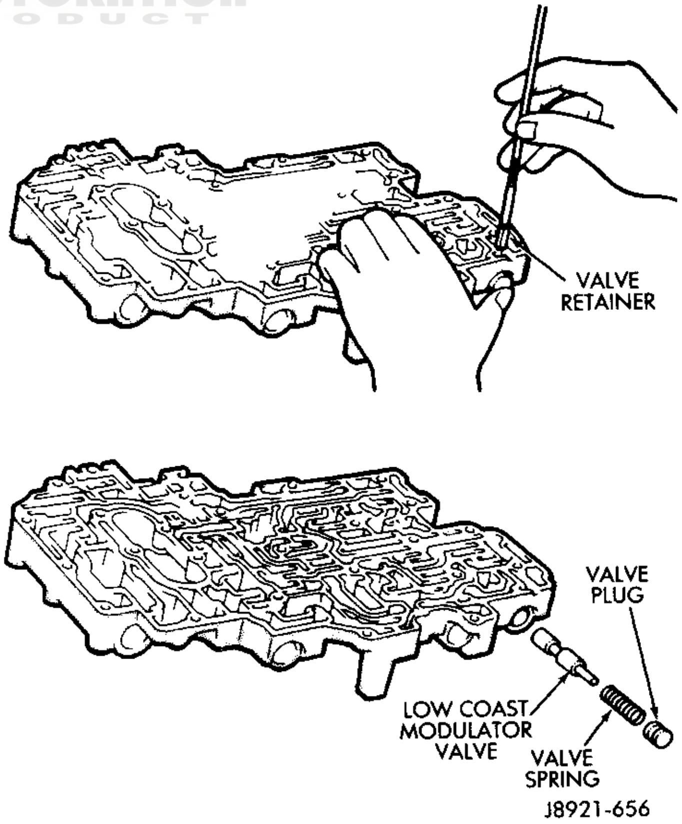
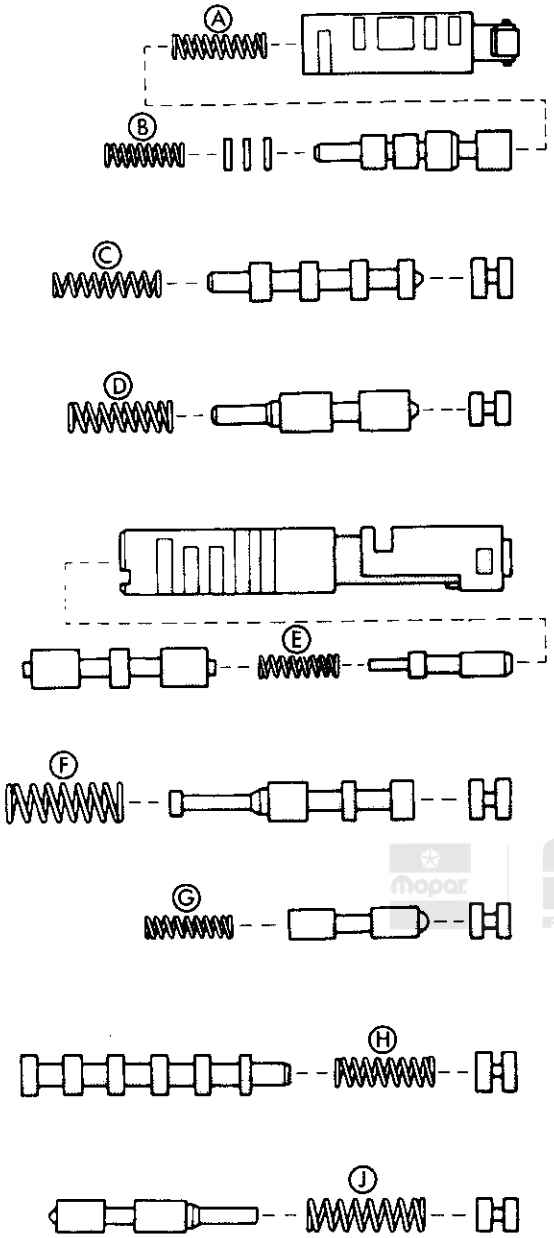


Fig. 13 Removing/Installing Low Coast Modulator Valve



Spring	Free Length
(A) Downshift Plug	27.3 mm (1.074 in.)
(B) Throttle Valve	20.6 mm (0.811 in.)
(C) 3-4 Shift Valve	30.8 mm (1.212 in.)
(D) Second Coast Modulator Valve	25.3 mm (0.996 in.)
(E) Lockup Relay Valve	21.4 mm (0.843 in.)
(F) Second Regulator Valve	30.9 mm (1.217 in.)
(G) Cut-Back Valve	21.8 mm (0.858 in.)
(H) 2-3 Shift Valve	30.8 mm (1.212 in.)
(J) Low Coast Modulator Valve	27.8 mm (1.094 in.)

J8921-657

Fig. 14 Upper Body Spring/Valve Identification

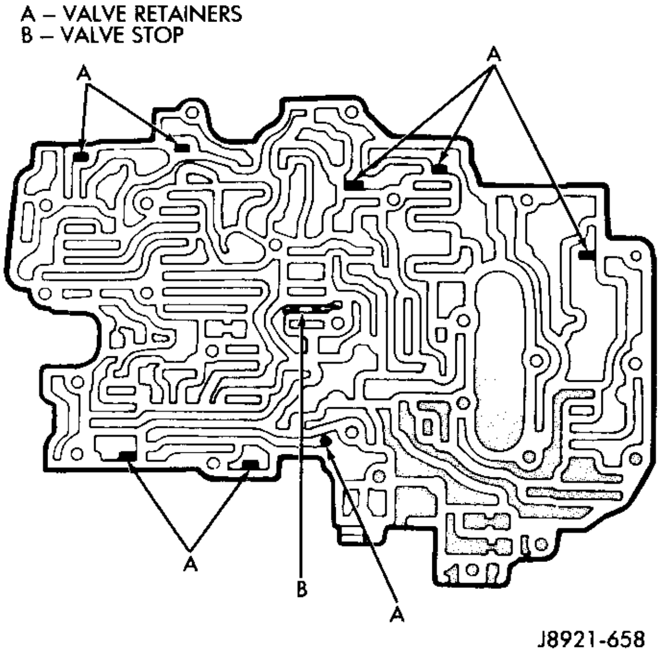


Fig. 15 Valve Retainer And Stop Locations

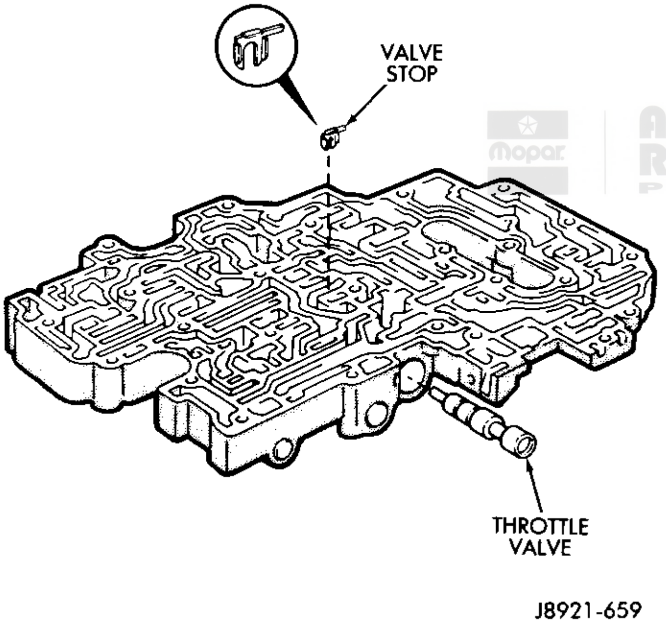


Fig. 16 Installing Throttle Valve And Stop

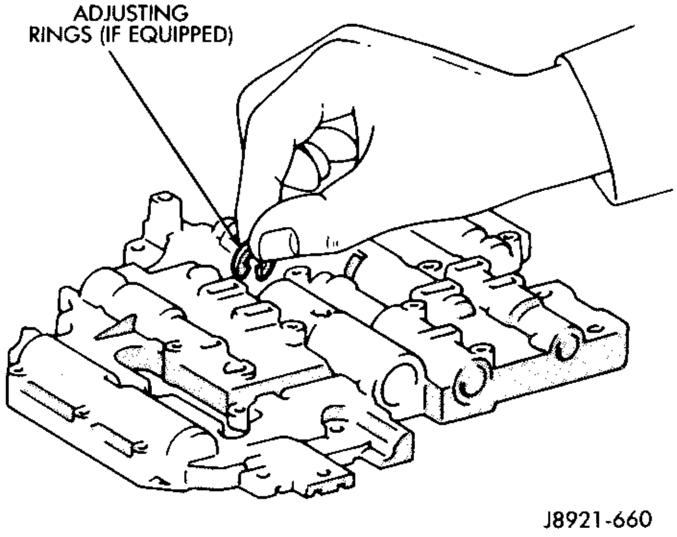


Fig. 17 Install Throttle Valve Adjusting Rings — If Equipped

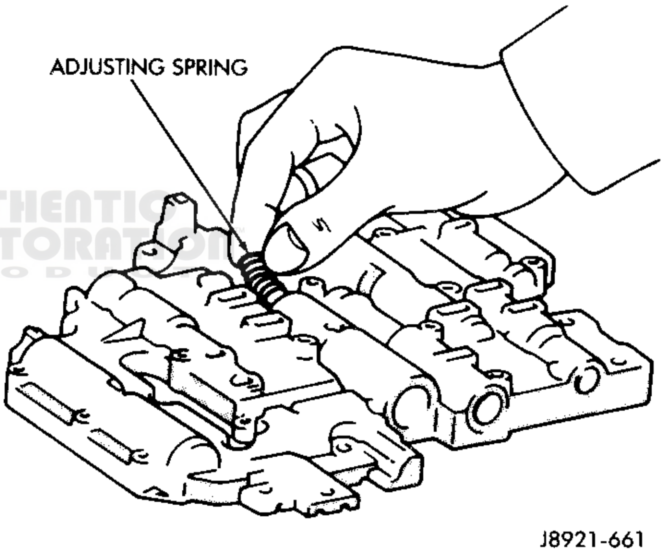


Fig. 18 Installing Throttle Valve Adjusting Spring

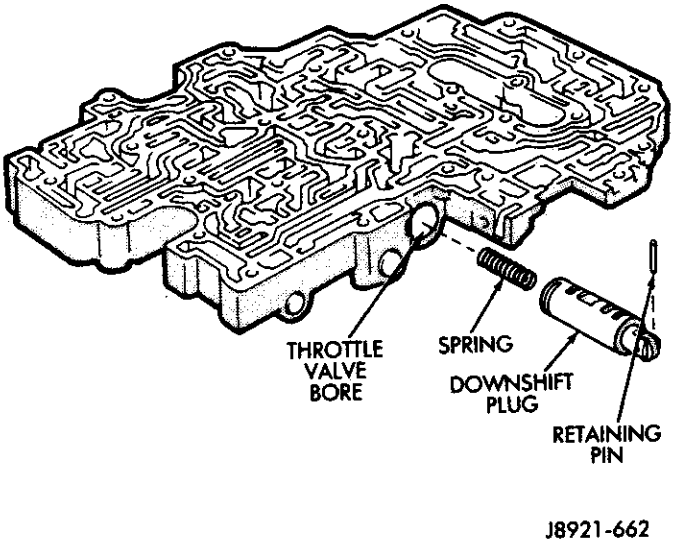


Fig. 19 Installing Downshift Plug

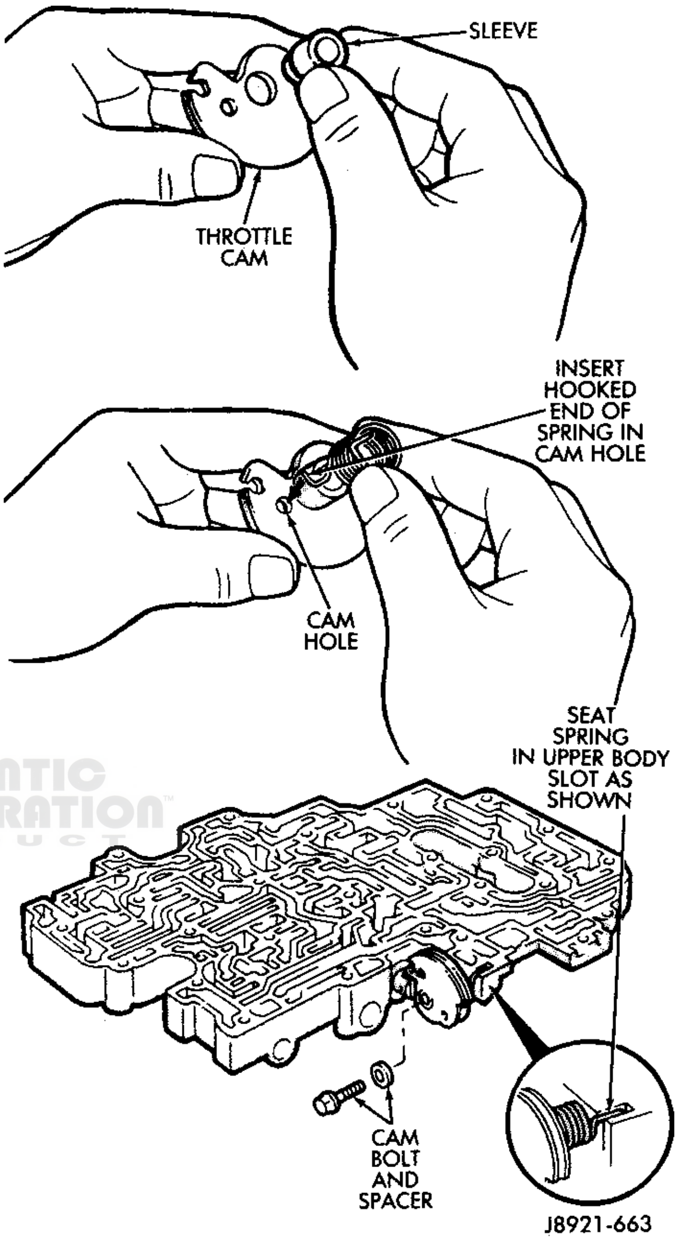
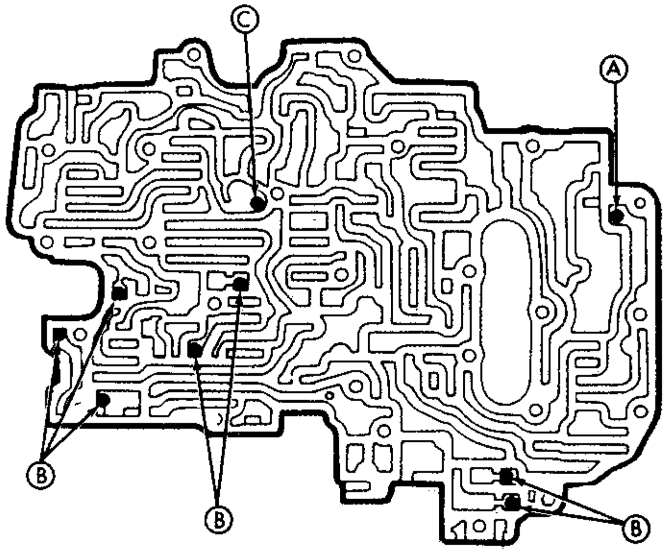


Fig. 20 Installing Throttle Cam



Check Ball	Diameter
Ⓐ Rubber Ball	6.35 mm (0.2500 in.)
Ⓑ Steel Ball	5.56 mm (0.2189 in.)
Ⓒ Steel Ball	7.14 mm (0.2811 in.)

J8921-664

Fig. 21 Upper Body Check Ball Location/Identification

Installing Upper Body On Lower Body

(1) Position new No. 1 gasket (Fig. 1) on upper body.

(2) Position valve body plate on No. 1 gasket.

(3) Position new No. 2 gasket (Fig. 2) on valve body plate and align gaskets and plate using bolt holes as guides.

(4) Install valve body bolts. **Three different length bolts are used. Refer to the Figure 3 for bolt locations. Chart symbols indicate bolt location and length in millimeters.**

(5) Tighten valve body bolts to 6.4 N•m (56 in-lbs) torque.

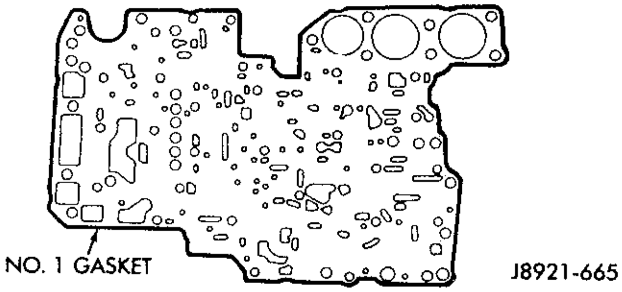


Fig. 1 Valve Body Gasket No. 1

(6) Install manual valve (Fig. 4).

(7) Install two-piece detent spring (Fig. 5). Tighten spring attaching bolt to 10 N•m (7 ft-lbs) torque.

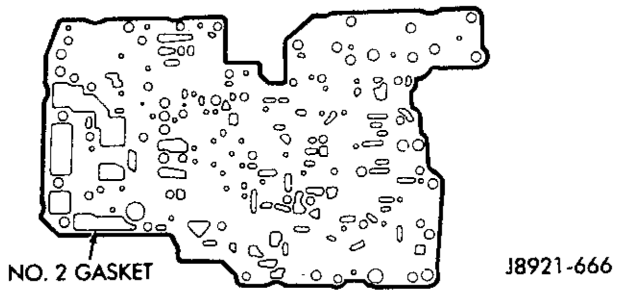


Fig. 2 Valve Body Gasket No. 2

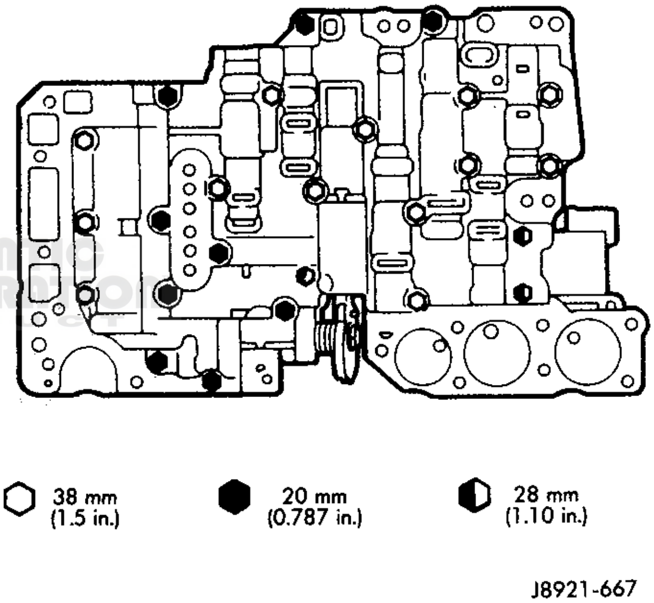


Fig. 3 Valve Body Bolt Location/Size

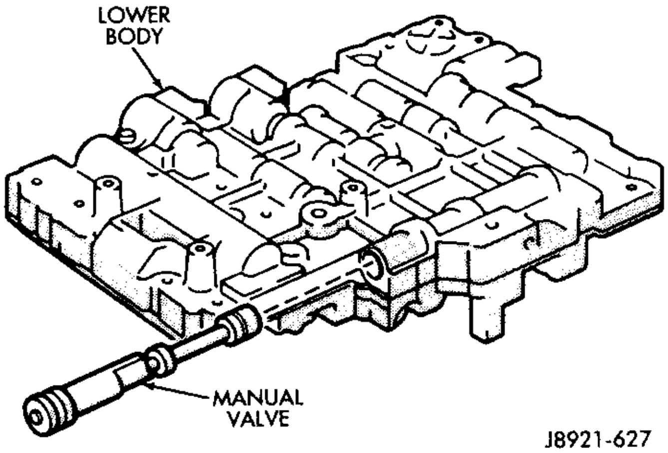


Fig. 4 Installing Manual Valve

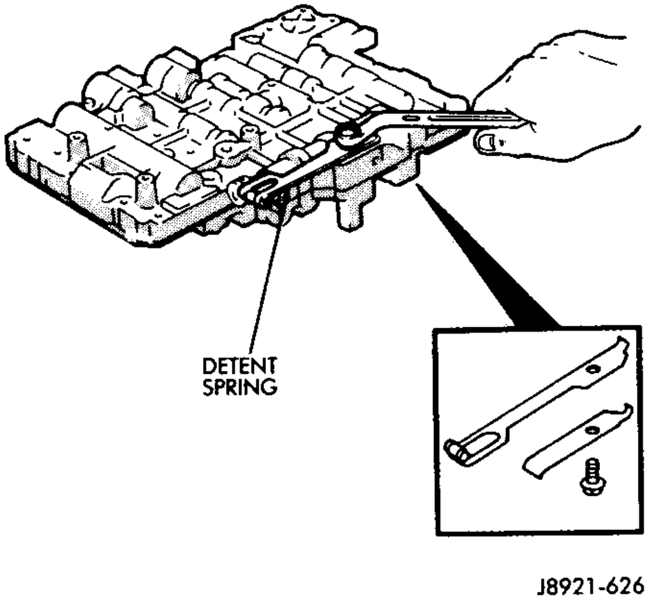


Fig. 5 Installing Detent Spring

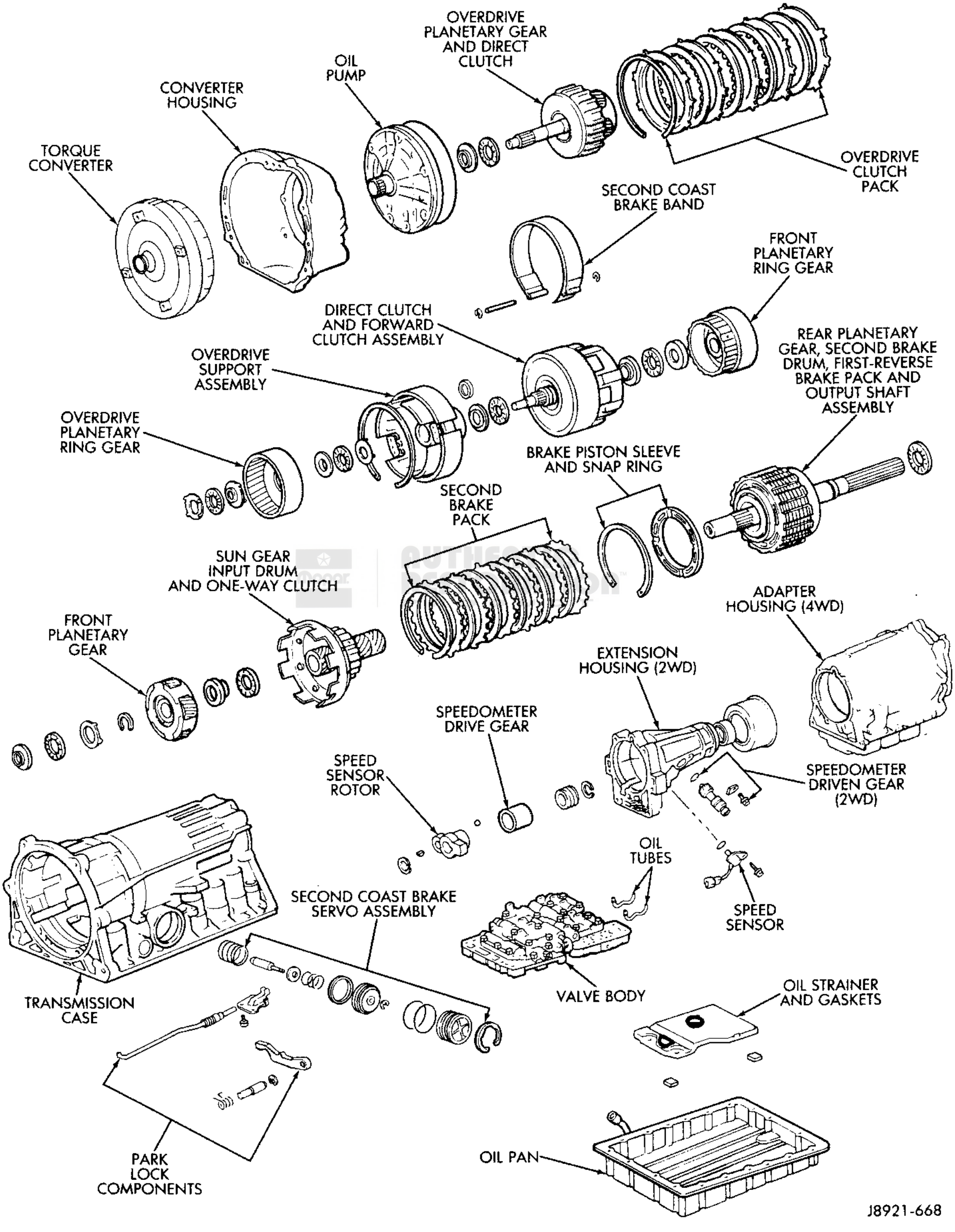


Fig. 1 AW-4 Transmission Components

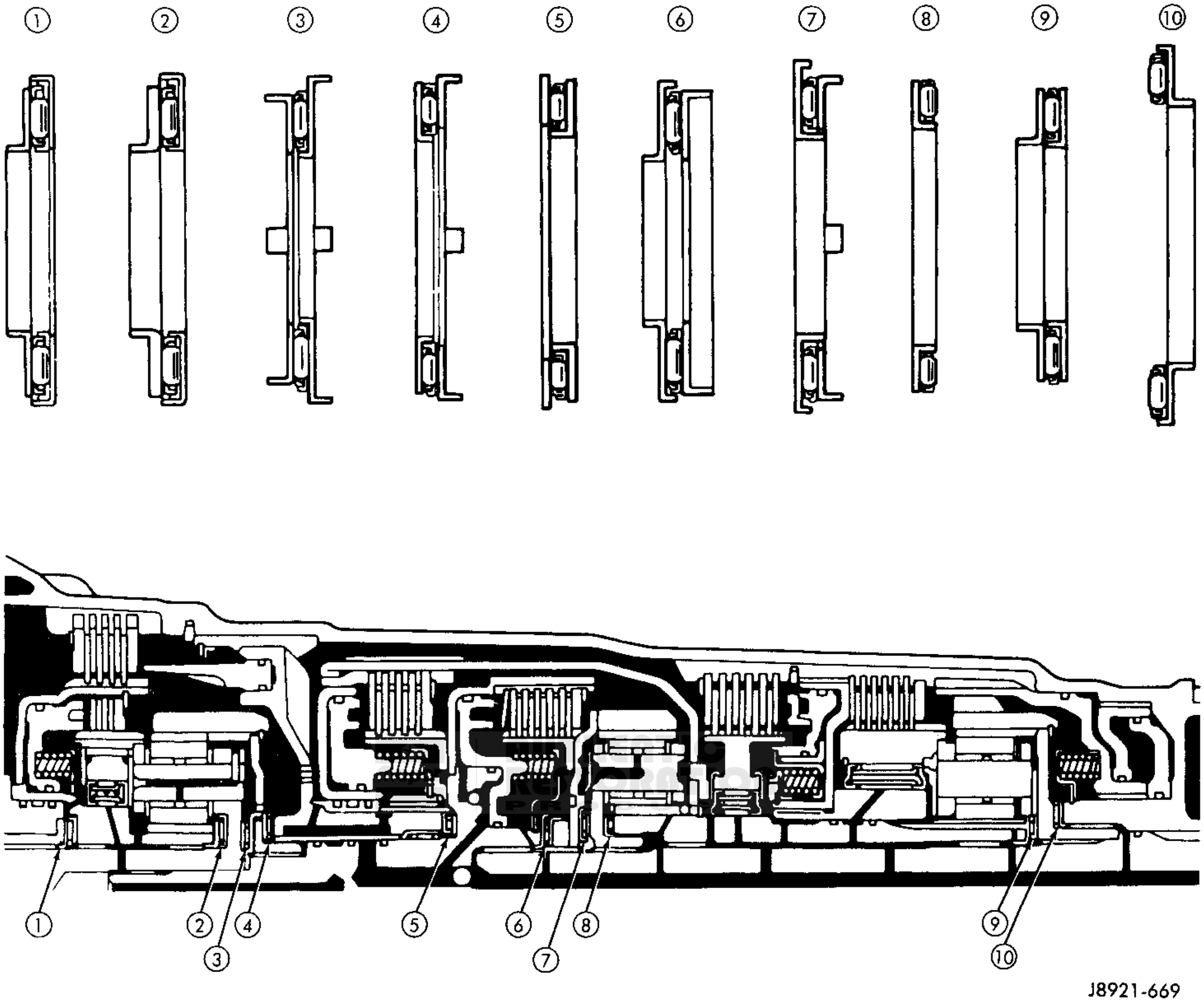


Fig. 2 Thrust Bearing Chart

TRANSMISSION ASSEMBLY

(1) During assembly, lubricate components with transmission fluid or petroleum jelly as indicated.

(2) If any of the transmission components are still assembled after overhaul checking procedures, disassemble as necessary in preparation for transmission assembly.

(3) Verify thrust bearing and race installation during assembly. Refer to the Thrust Bearing Chart (Fig. 2) for bearing and race location and correct positioning.

(4) Install rear planetary gear, second brake drum and output shaft as outlined in following steps:

(5) Verify No. 10 thrust bearing and race (Fig. 2). Bearing and race outer diameter is 57.7 mm (2.272 in); inside diameter is 39.2 mm (1.543 in).

(6) Coat thrust bearing and race assembly with petroleum jelly and install in case (Fig. 3). Race faces down. Bearing rollers face up.

(7) Align teeth of second brake drum and clutch pack (Fig. 4).

(8) Align rear planetary-output shaft assembly teeth with case slots and install assembly in case (Fig. 5).

(9) Install rear planetary snap ring with snap ring pliers B.Vi. FM- 29. Chamfered side of snap ring faces up and toward case front (Fig. 6).

(10) Check first-reverse brake pack clearance with feeler gauge.Clearance should be: 0.6 to 1.74 mm (.024 to .069 in) on 4-cyl. transmissions and .70 to 2.00 mm (.028 to .079 in) on 6-cyl. transmissions. If clearance is incorrect, planetary assembly, thrust bearing or snap ring is not properly seated in case. Remove and reinstall components if necessary.

(11) Install second brake piston sleeve (Fig. 8). Sleeve lip faces up and toward case front as shown.

(12) Install second brake drum gasket with tool B.Vi. FM-33 (Fig. 9). Gasket depth is 43.7 mm (1.720 in).

(13) Install park lock pawl, spring and pin (Fig. 10).

(14) Connect park lock rod to manual valve shift sector (Fig. 11).

(15) Position park lock rod bracket on case and tighten bracket attaching bolts to 10 N•m (7 ft-lbs) torque (Fig. 12).

(16) Verify park lock operation. Move shift sector to Park position. Park pawl should be firmly engaged (locked) in planetary ring gear (Fig. 13).

(17) Install No. 1 one-way clutch (Fig. 14). Short flanged side of clutch faces up and toward case front.

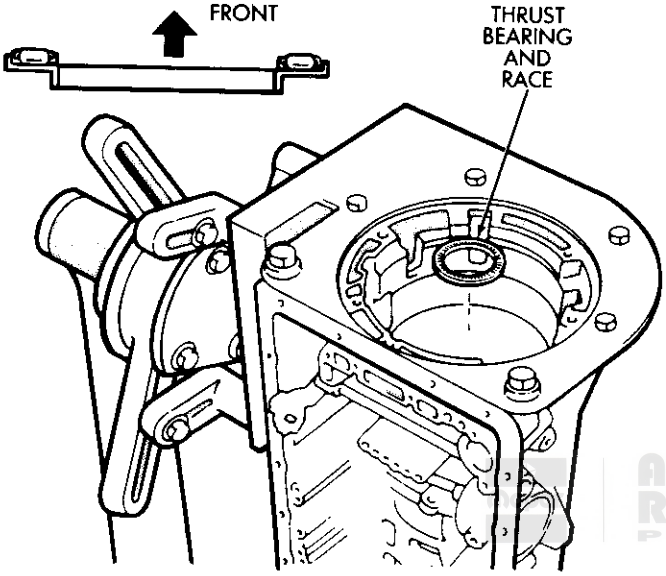


Fig. 3 Installing Thrust Bearing And Race (No. 10)

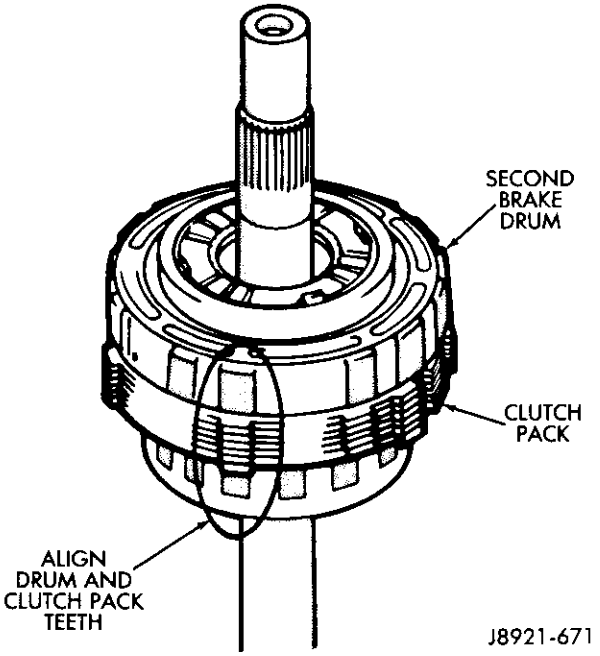


Fig. 4 Align Drum And Clutch Pack Teeth

(18) Install second brake pack (Fig. 15). Install disc then plate. Continue installation sequence until correct number of discs-plates are installed. **Use five discs and five plates in 6-cyl. transmissions and four discs and four plates in 4-cyl. transmissions.**

(19) Install second brake pack retainer with rounded edge of retainer facing disc.

(20) Install second brake pack snap ring.

(21) Check brake pack clearance with feeler gauge (Fig. 16). Clearance should be: .89 to 2.15 mm (.035 to .084 in) on 4-cyl. transmissions and .062 to 1.98 mm (.024 to .078 in) on 6-cyl. transmissions. If brake pack clearance is not correct, brake pack components are not seated. Reassemble brake pack if necessary.

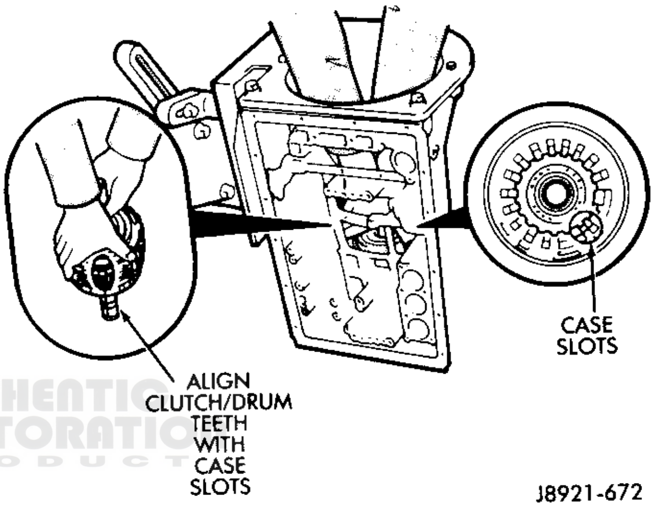


Fig. 5 Installing Output Shaft/Rear Planetary Assembly

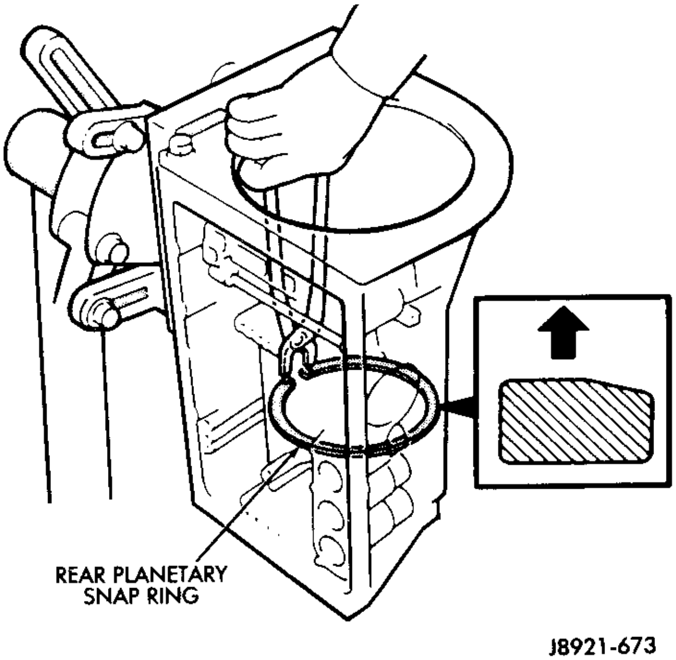


Fig. 6 Installing Planetary Snap Ring

(22) Install planetary sun gear and input drum (Fig. 17). Be sure drum thrust washer tabs are seated in drum. Use petroleum jelly to hold thrust washer in position if necessary.

(23) Install front planetary gear on sun gear (Fig. 18).

(24) Support output shaft with wood blocks (Fig. 19).

(25) Install planetary snap ring on sun gear with tool B.Vi. FM-30.

(26) Install tabbed thrust race on front planetary gear (Fig. 21). Washer tabs face down and toward gear. Race outer diameter is 47.8 mm (1.882 in); inside diameter is 34.3 mm (1.350 in).

(27) Install second coast brake band (Fig. 22).

(28) Install pin in second coast brake band. Then install retaining ring on pin (Fig. 23).

(29) Install thrust bearing and race in forward-direct clutch (Fig. 24). Coat bearing/race with petroleum jelly to hold them in place.

(30) Verify forward-direct clutch thrust bearing size. Race outer diameter is 48.9 mm (1.925 in); inside diameter is 26.0 mm (1.024 in). Bearing outer diameter is 46.7 mm (1.839 in); inside diameter is 26.0 mm (1.024 in).

(31) Coat front planetary ring gear race with petroleum jelly and install it in ring gear (Fig. 25).

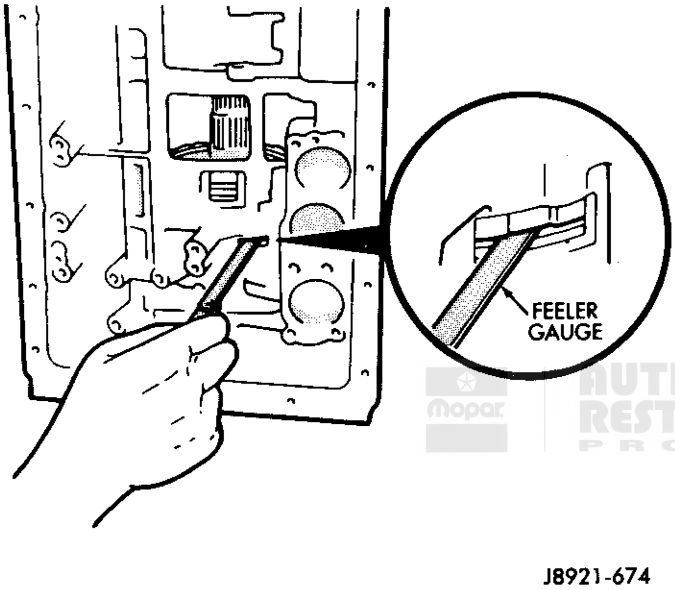


Fig. 7 Checking First-Reverse Brake Pack Clearance

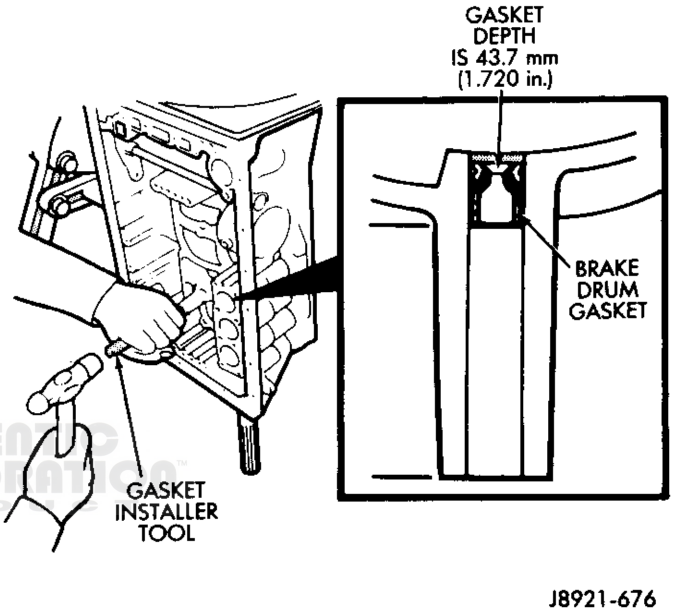


Fig. 9 Installing Second Brake Drum Gasket

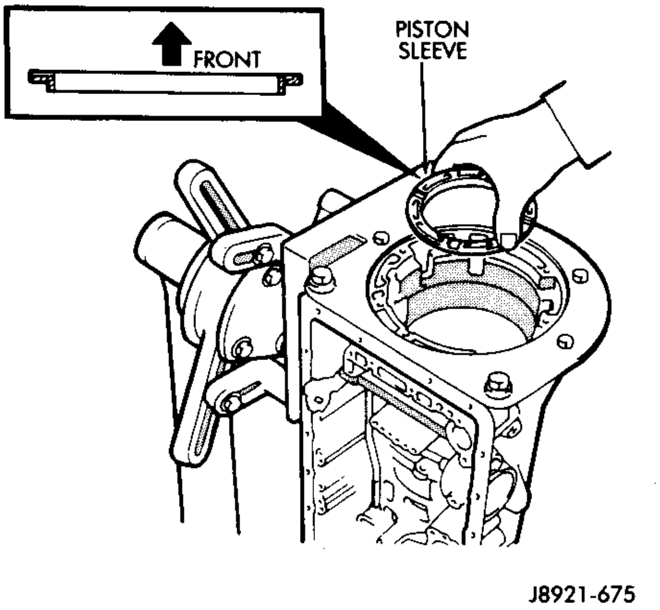


Fig. 8 Installing Second Brake piston Sleeve

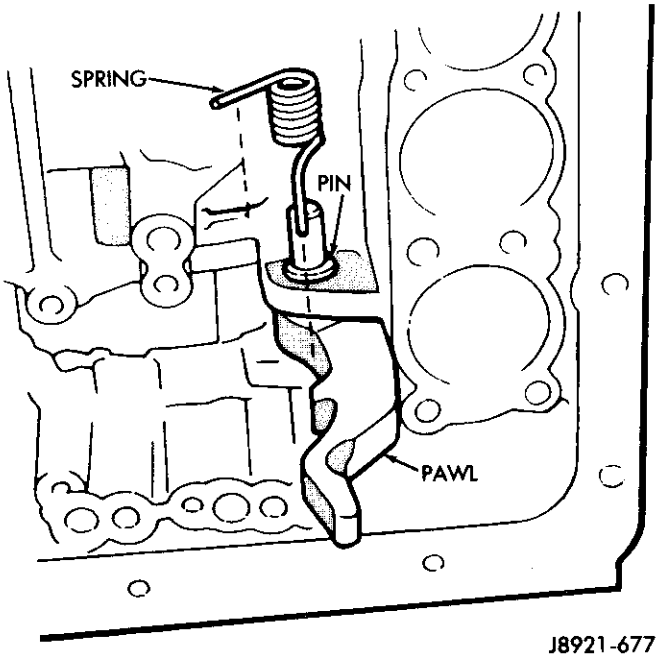


Fig. 10 Installing Park Lock Pin/Spring/Pawl

(32) Verify ring gear race size. Outer diameter is 47.0 mm (1.850 in); inside diameter is 26.5 mm (1.045 in).

(33) Align forward-direct clutch disc splines with screwdriver (Fig. 26).

(34) Align and install front planetary ring gear in forward-direct clutch (Fig. 27).

(35) Coat bearing and race with petroleum jelly and install them in ring gear (Fig. 28). Verify bearing/race size. Bearing outer diameter is 47.7 mm (1.878 in); inside diameter is 32.6 mm (1.283 in). Race outer diameter is 53.6 mm (2.110 in); inside diameter is 30.6 mm (1.205 in).

(36) Rotate front of transmission case downward and install assembled planetary gear/forward-direct clutch (Fig. 29).

(37) Check clearance between sun gear input drum and direct clutch drum (Fig. 30). Clearance should be 9.8 to 11.8 mm (.386 to .465 in). If clearance is incorrect, planetary gear/forward-direct clutch assembly is not seated or is improperly assembled. Remove, and correct if necessary.

(38) Coat thrust bearing and race assembly with petroleum jelly and install it on clutch shaft. Bearing faces up and toward case front as shown (Fig. 31). Verify bearing/race size. Bearing and race outer diameter is 47.8 mm (1.882 in); inside diameter is 33.6 mm (1.301 in).

(39) Assemble second coast brake piston components (Fig. 32).

(40) Install assembled second coast brake piston in case.

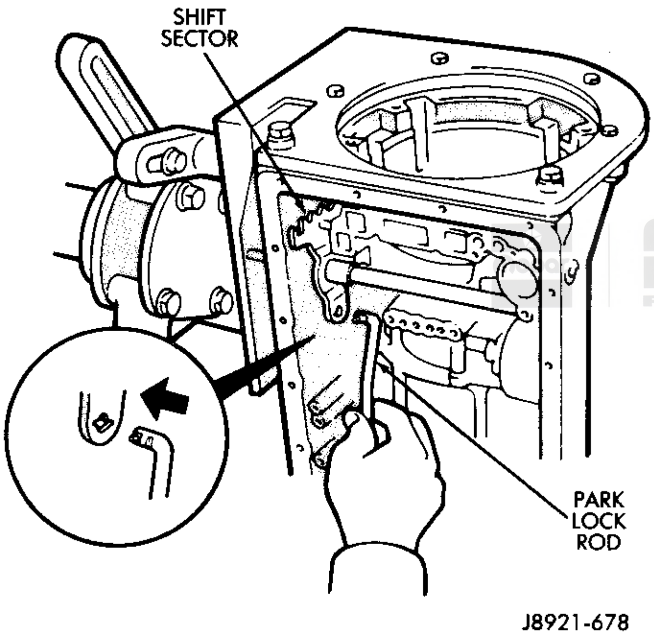


Fig. 11 Installing Park Lock Rod

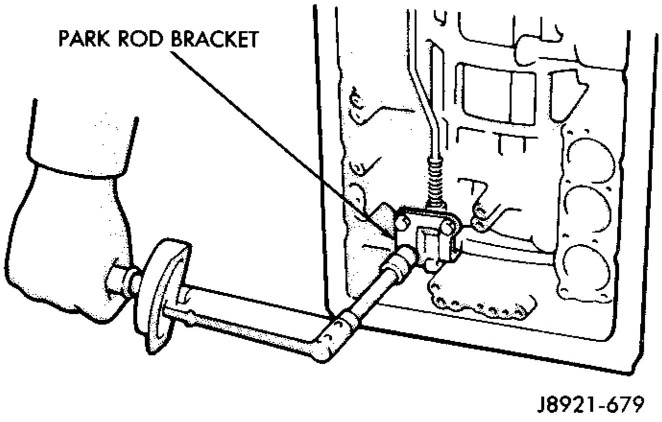


Fig. 12 Installing Park Rod Bracket

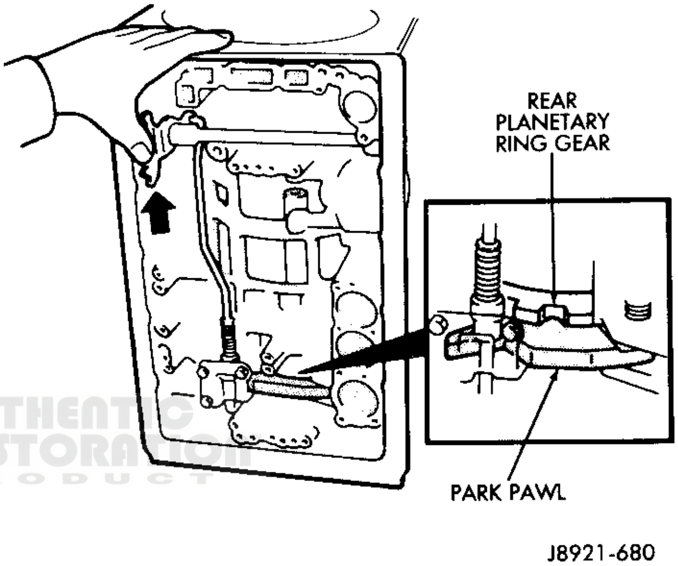


Fig. 13 Checking Park Pawl Engagement

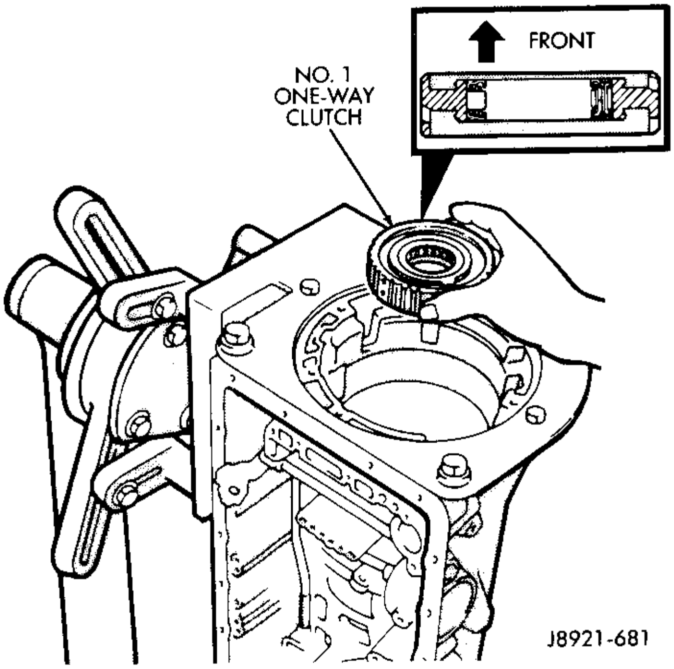


Fig. 14 Installing No. 1 One-Way Clutch

(41) Install replacement seals on second coast brake piston cover and install cover in case.

(42) Install second coast brake piston snap ring with tool B.Vi. FM-29 (Fig. 33).

(43) Check second coast brake piston stroke as follows:

(a) Make reference mark on brake piston rod (Fig. 34).

(b) Apply 57-114 psi air pressure through feed hole (Fig. 34). Alternately apply and release air pressure to operate piston.

(c) Check stroke with gauge (Fig. 35). Use gauge B.Vi.FM. 40 with 4-cyl. transmission. Use gauge B.-Vi.FM. 41 with 6-cyl. transmission.

(d) If stroke length is incorrect, piston, cover or snap ring is not seated. Reassemble and check stroke again if necessary.

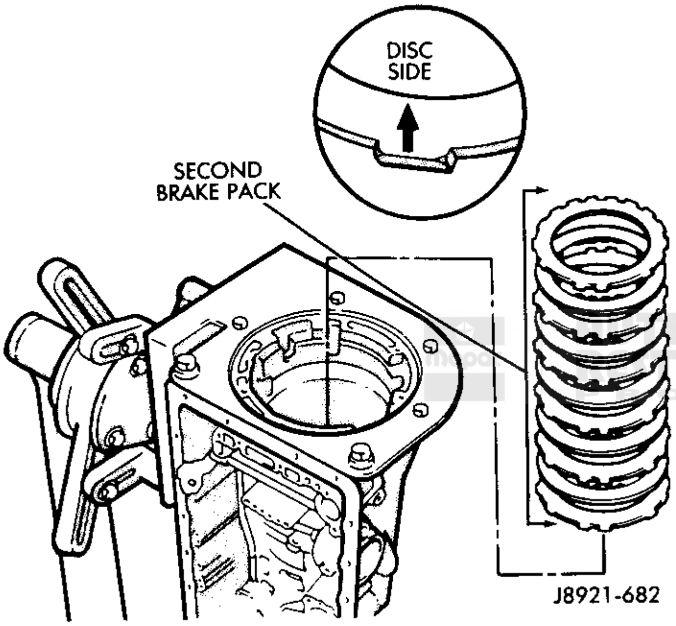


Fig. 15 Installing Second Brake Pack

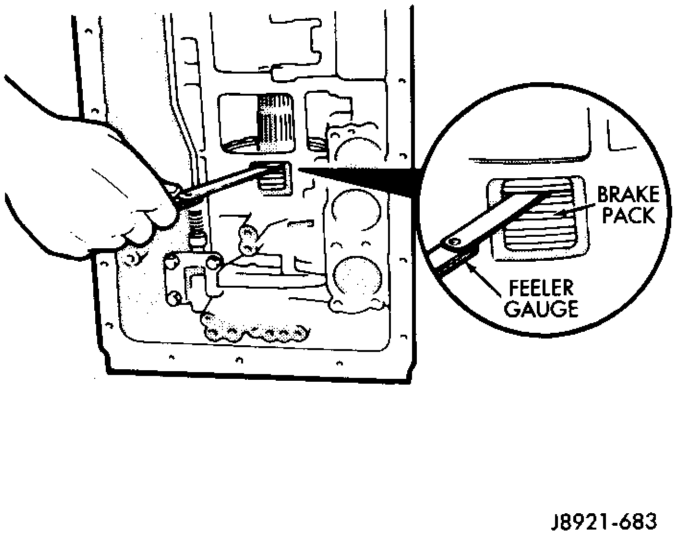


Fig. 16 Checking Second Brake Pack Clearance

(44) Coat thrust race and tabbed washer with petroleum jelly and install them on overdrive support (Fig. 36). Verify race size. Race outer diameter is 50.9 mm (2.004 in); inside diameter is 36.2 mm (1.426 in).

(45) Install overdrive support in case. Use two long bolts to help align and guide support into position (Fig. 37).

(46) Install overdrive support snap ring with tool B.Vi. FM-29 (Fig. 38). Chamfered side of snap ring faces up and toward case front. **Snap ring ends must be**

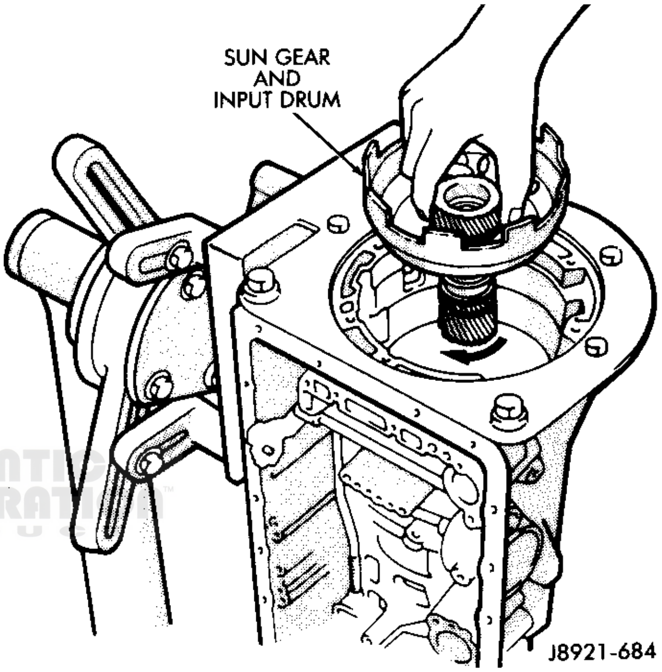


Fig. 17 Installing Sun Gear And Input Drum

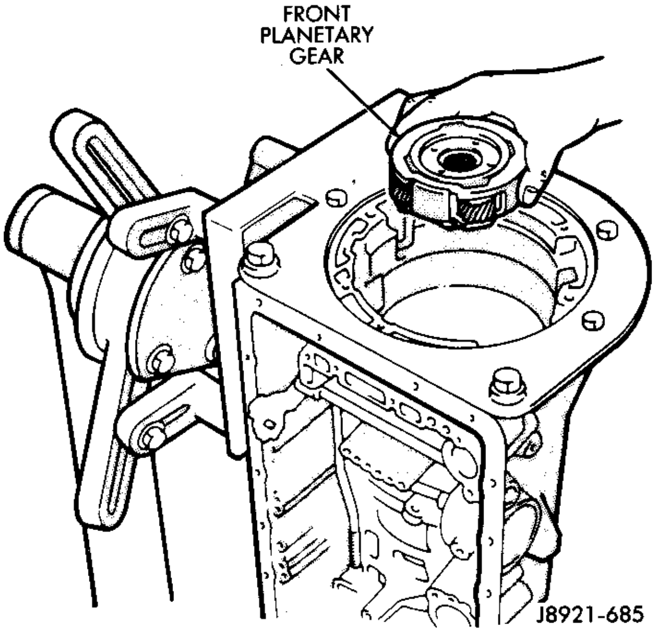


Fig. 18 Installing Front Planetary Gear

aligned with case opening with ring ends approximately 24 mm (0.94 in) from centerline of case opening.

(47) Install and tighten overdrive support bolts to 25 N•m (19 ft-lbs) torque (Fig. 39).

(48) Check output shaft end play with dial indicator (Fig. 40). End play should be .27 to 0.86 mm (.0106 to .0339 in).

(49) If output shaft end play is incorrect, one or more of installed components is not seated. Reassemble as necessary and check end play again.

(50) Install overdrive clutch pack (Fig. 41).Install thickest clutch plate first. Rounded edge of plate faces up. Install first disc followed by another plate until correct number of discs-plates are installed. Install four discs and three plates in a 6-cyl. transmission and three discs and two plates in a 4-cyl. transmission.

(51) Install stepped ring retainer plate with flat side facing disc. Then install brake pack snap ring (Fig. 42).

(52) Check overdrive brake piston stroke as follows:

(a) Mount tool B.Vi. FM-35 in dial indicator and position gauge tool B.Vi. FM. 35 against overdrive brake piston (Fig. 43).

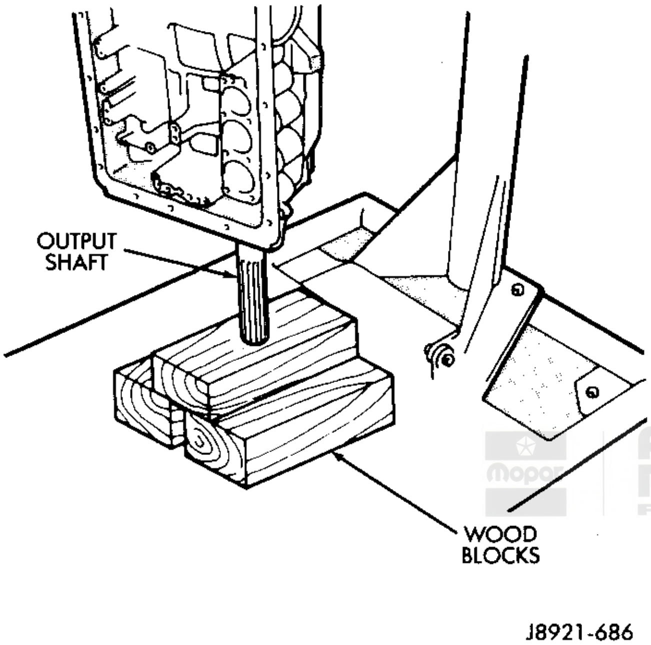


Fig. 19 Supporting Output Shaft

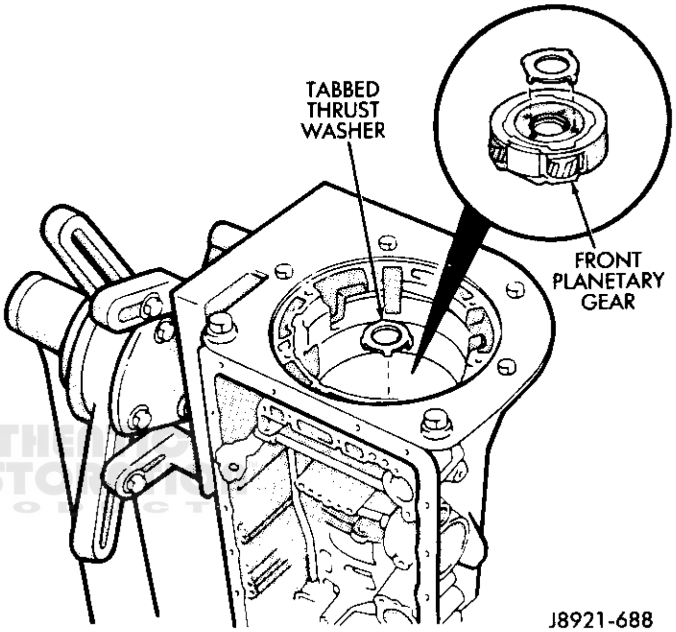


Fig. 21 Installing Planetary Thrust Race

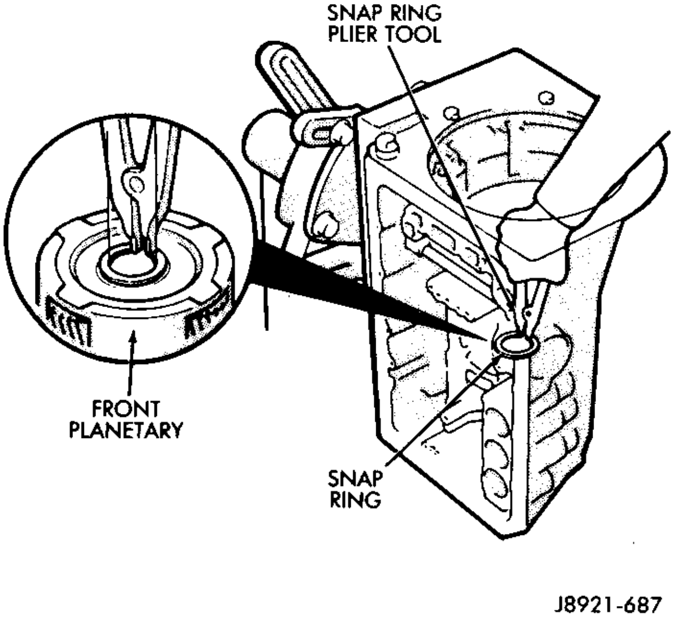


Fig. 20 Installing Front Planetary Snap Ring

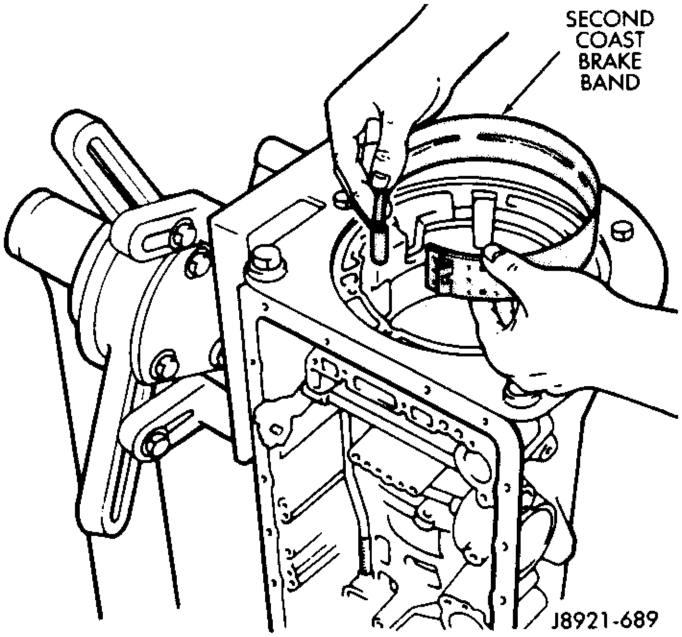


Fig. 22 Installing Second Coast Brake Band

(b) Apply and release brake piston with compressed air. Apply air pressure through feed hole in case (Fig. 44).

(c) Piston stroke length should be 1.32 to 1.62 mm (.052 to .063 in) on 4-cyl. transmissions and 1.40 to 1.70 mm (.55 to .66 in) on 6-cyl. transmissions.

(d) If stroke is incorrect, brake pack or piston is installed incorrectly. Check and correct as necessary and measure piston stroke again.

(53) Remove dial indicator and gauge tool.

(54) Remove overdrive brake piston snap ring and remove overdrive clutch pack components.

(55) Coat overdrive lower race, thrust bearing and upper race with petroleum jelly and install them in overdrive support (Fig. 45). Be sure races and bearing are assembled and installed as shown.

(56) Verify bearing/race sizes before proceeding. Bearing-race sizes are: Outer diameter of lower race is 47.8 mm (1.882 in); inside diameter is 34.3 mm (1.350 in). Outer diameter of bearing is 47.7 mm (1.878 in); inside diameter is 32.7 mm (1.287 in). Outer diameter of upper race is 47.8 mm (1.882 in); inside diameter is 30.7 mm (1.209 in).

(57) Install overdrive planetary ring gear in support (Fig. 46).

(58) Coat ring gear thrust race and thrust bearing assembly with petroleum jelly and install them in gear (Fig. 47).

(59) Verify bearing/race size before proceeding. Outer diameter of ring gear race-bearing is 47.8 mm (1.882 in); inside diameter is 24.2 mm (0.953 in). Outer diameter of bearing (61) is 46.8 mm (1.844 in); inside diameter is 26.0 mm (1.024 in).

(60) Coat tabbed thrust race with petroleum jelly and install it on planetary gear (Fig. 48). Race outer diameter is 41.8 mm (1.646 in); inside diameter is 27.1 mm (1.067 in).

(61) Install assembled overdrive planetary gear and clutch (Fig. 49).

(62) Coat thrust bearing and race assembly with petroleum jelly and install it on clutch input shaft (Fig.

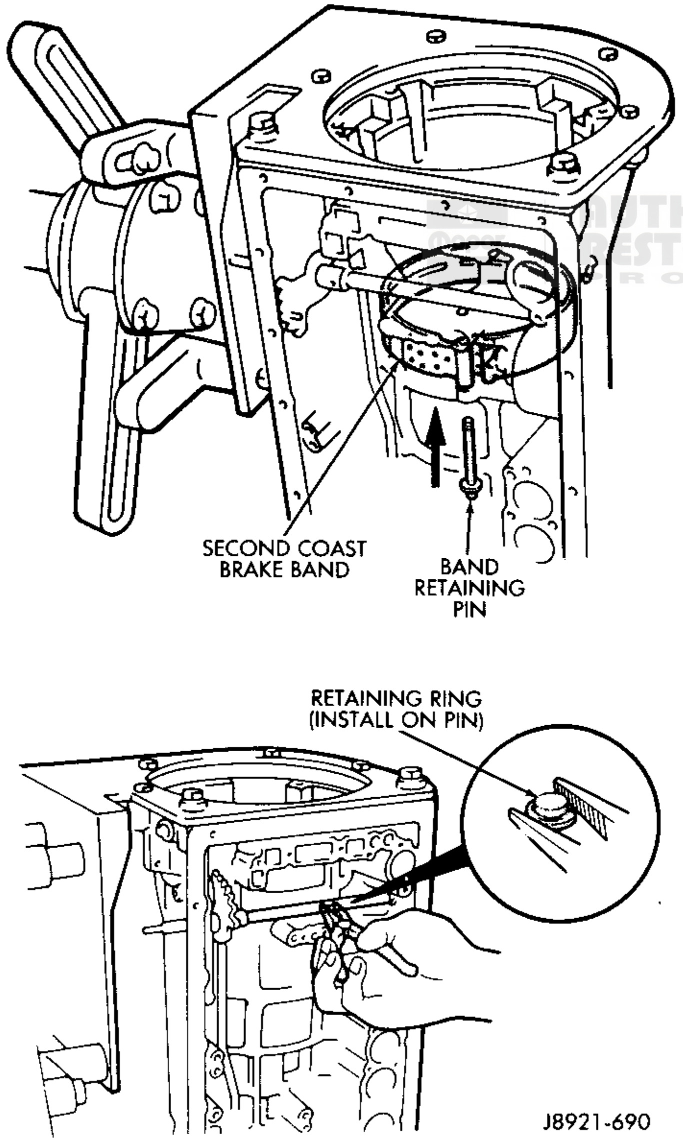


Fig. 23 Installing Band Retaining Pin

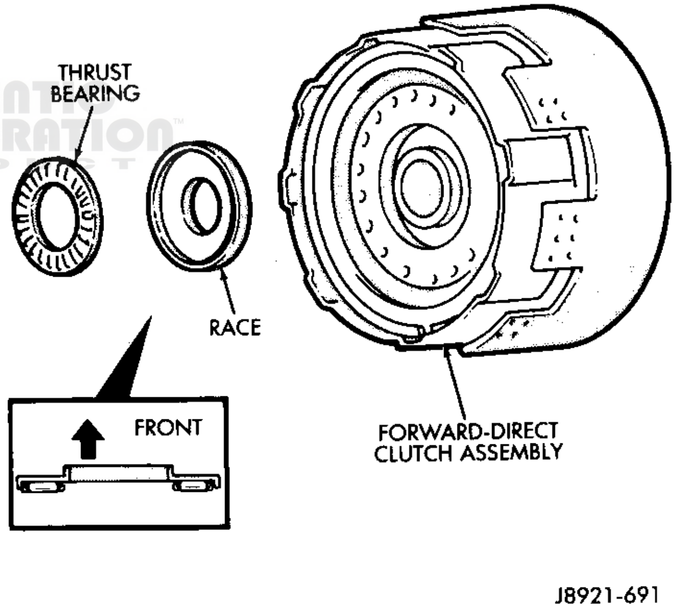


Fig. 24 Installing Forward-Direct Clutch Thrust Bearing And Race

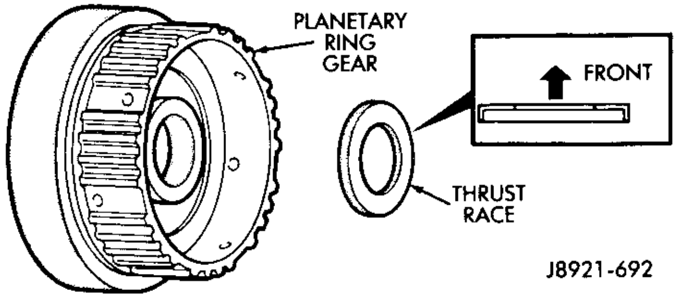


Fig. 25 Installing Planetary Ring Gear Race

50). Bearing and race outer diameter is 50.2 mm (1.976 in); inside diameter is 28.9 mm (1.138 in).

(63) Install overdrive brake pack as follows:

(a) Install 4.0 mm (.157 in) thick plate first. Rounded edge of plate must face upward.

(b) Install a disc followed by a plate until the required number of discs and plates are installed. Be sure to install the stepped plate last with the flat side of the plate facing the disc (Fig. 51).

(c) Install four discs and three plates in 6-cyl. transmissions. Install three discs and two plates in 4-cyl. transmissions.

(64) Install clutch pack snap ring (Fig. 52).

(65) Coat thrust bearing race with petroleum jelly and install it in oil pump (Fig. 53). Bearing race outer diameter is 47.2 mm (1.858 in); inside diameter is 28.1 mm (1.106 in).

(66) Lubricate and install replacement O-ring on oil pump body.

(67) Install oil pump in case. Align pump and case bolt holes and carefully ease pump into place (Fig. 54).

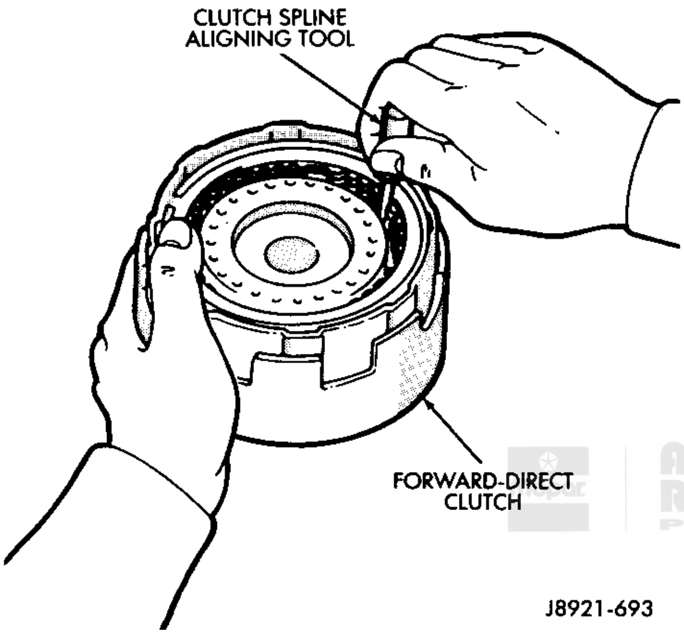


Fig. 26 Aligning Forward-Direct Clutch Splines

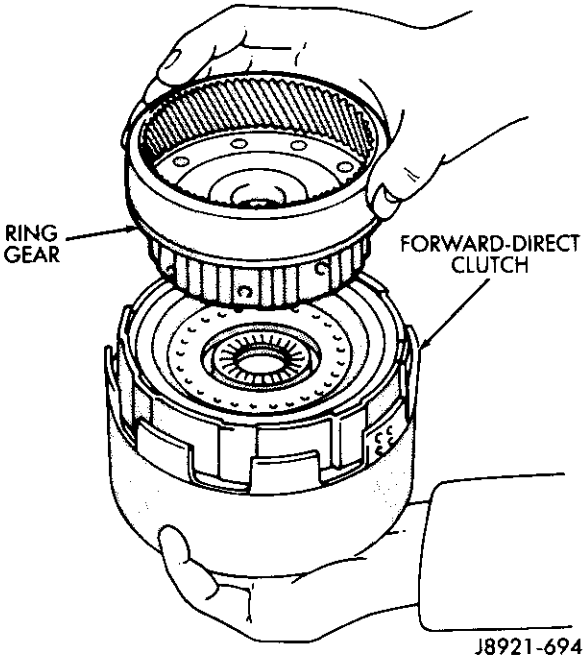


Fig. 27 Installing Front Planetary Ring Gear

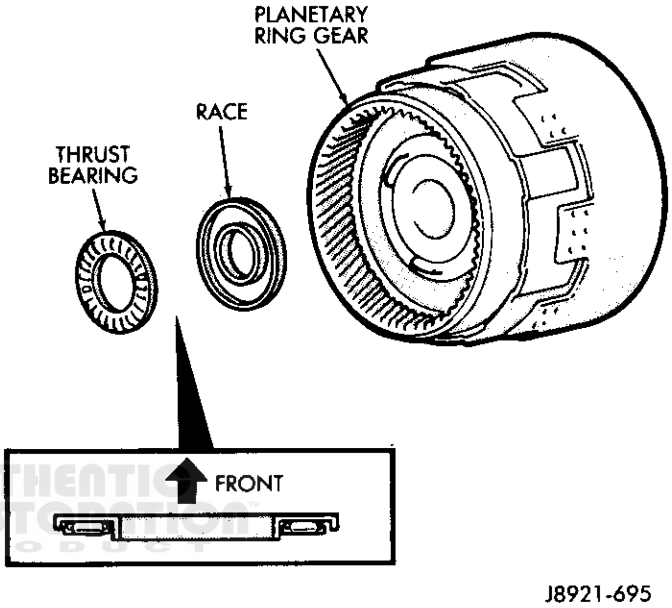


Fig. 28 Installing Ring Gear Bearing And Race

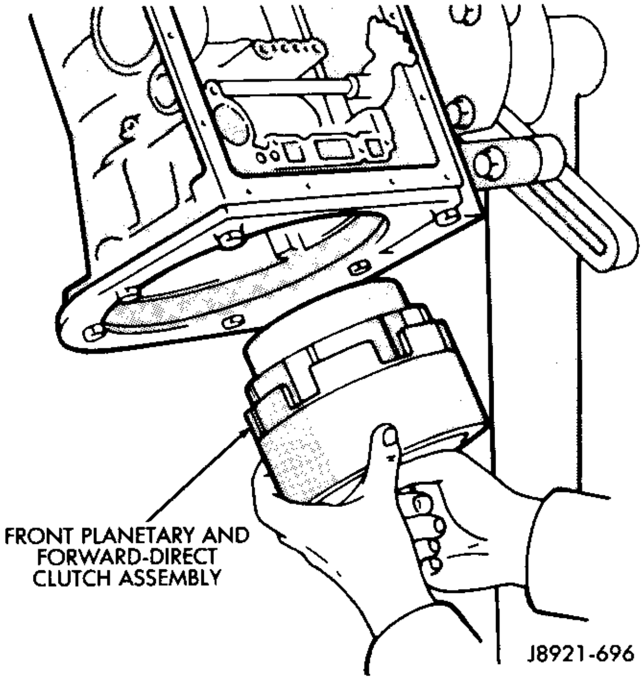


Fig. 29 Installing Front Planetary And Forward-Direct Clutch Assembly

CAUTION: Do not use force to seat the pump. The seal rings on the stator shaft could be damaged if they bind or stick to the direct clutch drum.

(68) Tighten oil pump bolts to 22 N•m (16 ft-lbs) torque.

(69) Verify input shaft rotation. Shaft should rotate smoothly and not bind.

(70) Lubricate and install new O-ring on throttle cable adapter and install cable in case (Fig. 55).

(71) Check clutch and brake operation. Operate clutches and brakes with compressed air applied through feed holes in case (Fig. 56). Listen for clutch and brake application. If you do not hear a clutch or brake apply, disassemble transmission and repair fault before proceeding. **It is necessary to block the overdrive clutch accumulator feed hole No. 8 (Fig. 56) in order to check direct clutch operation.**

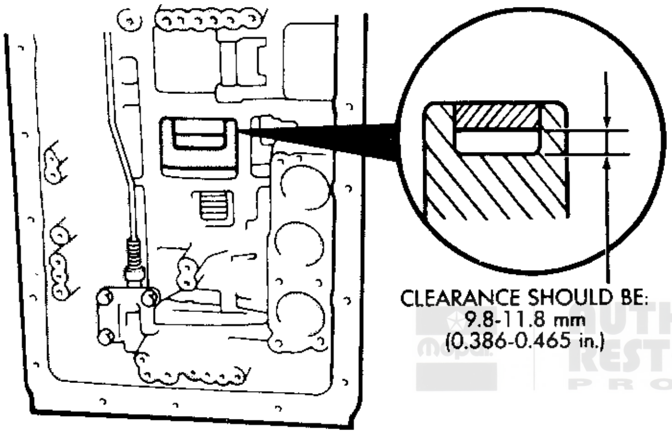


Fig. 30 Checking Input Drum-To-Direct Clutch Drum Clearance

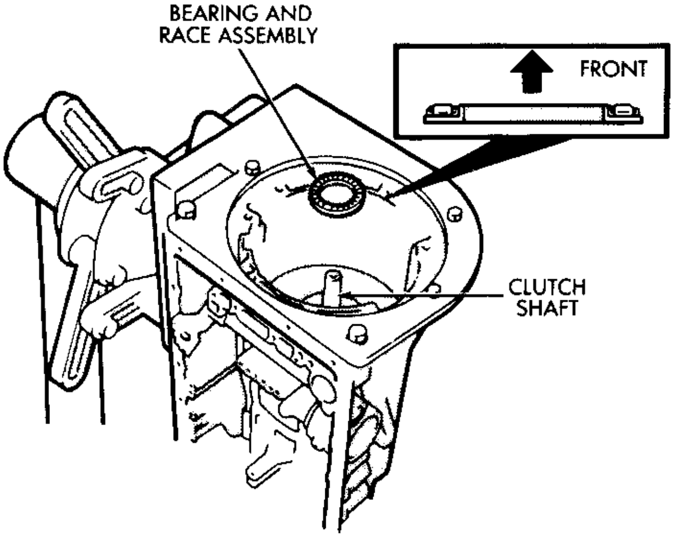


Fig. 31 Installing Clutch Shaft Thrust Bearing-Race Assembly

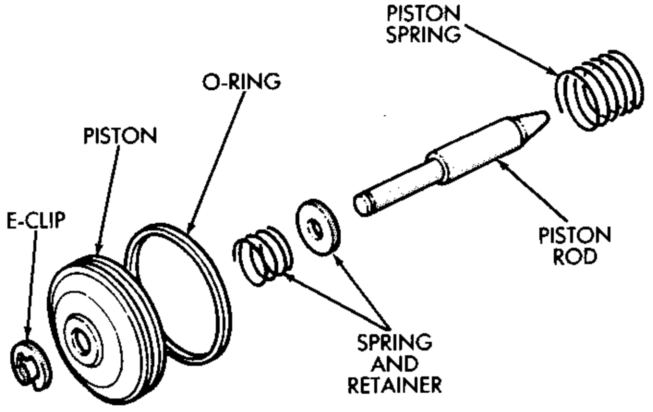


Fig. 32 Assembling Second Coast Brake Piston

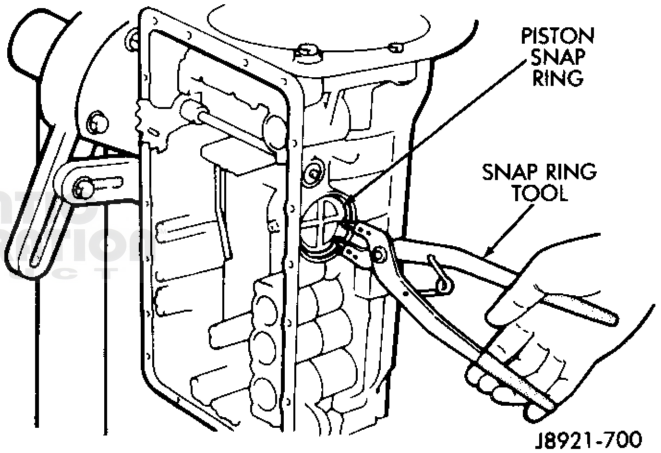


Fig. 33 Installing Second Coast Brake Piston Snap Ring

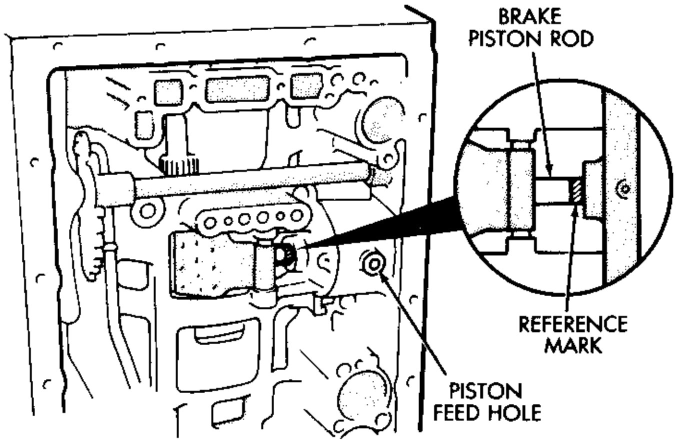


Fig. 34 Marking Brake Piston Rod

(72) Lubricate and install new O-rings on accumulator pistons (Fig. 57).

(73) Assemble and install accumulator piston components (Fig. 57). Refer to Accumulator Component Identification Chart in Specifications section for piston, spring and pin sizes.

(74) Install new check ball body and spring (Fig. 58).

(75) Position valve body on case (Fig. 59).

(76) Install detent spring (Fig. 59).

(77) Align manual valve, detent spring and shift sector (Fig. 59).

(78) Connect throttle cable to throttle valve cam (Fig. 60).

(79) Install and tighten valve body-to-case bolts to 10 N•m (7 ft-lbs) torque.

(80) Connect valve body solenoid wires to solenoids (Fig. 61).

(81) Install new O-ring on solenoid harness adapter and secure adapter to case.

(82) Install valve body oil tubes (Fig. 62). Tap tubes into place with a plastic mallet. Be sure the flanged tube ends and straight tube ends are installed as shown.

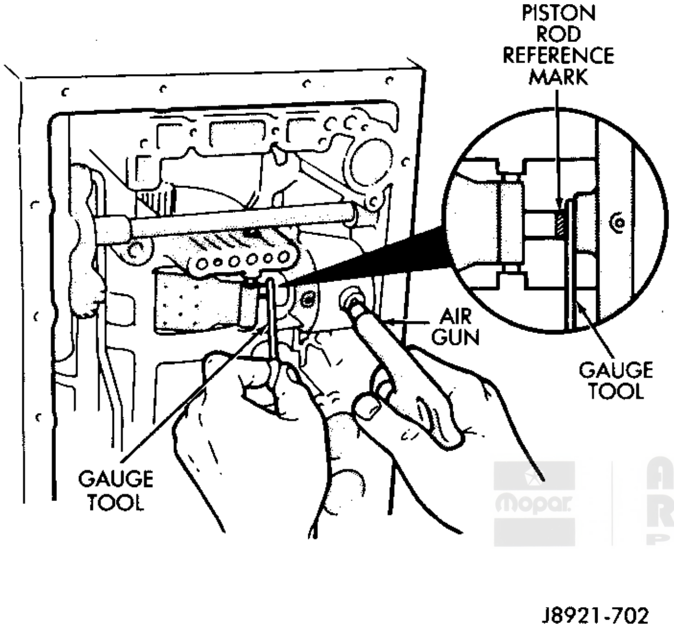


Fig. 35 Checking Second Coast Brake Piston Stroke

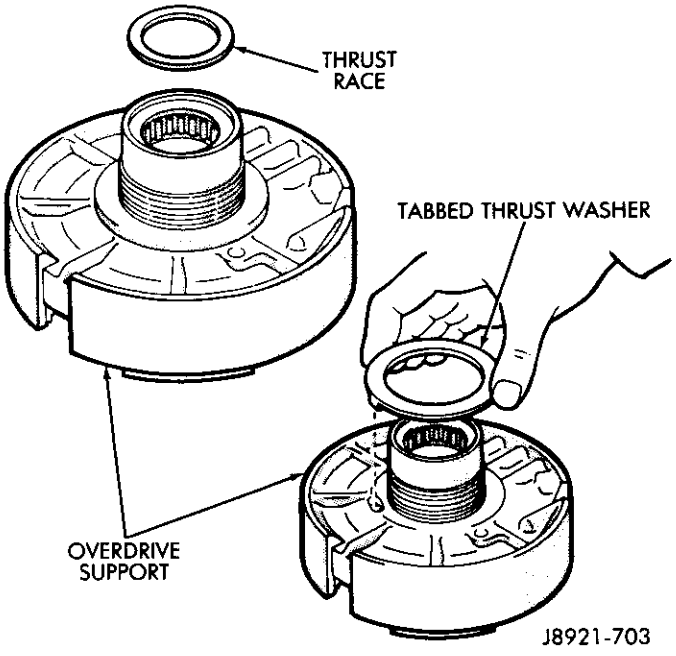


Fig. 36 Installing Overdrive Support Thrust Race And Washer

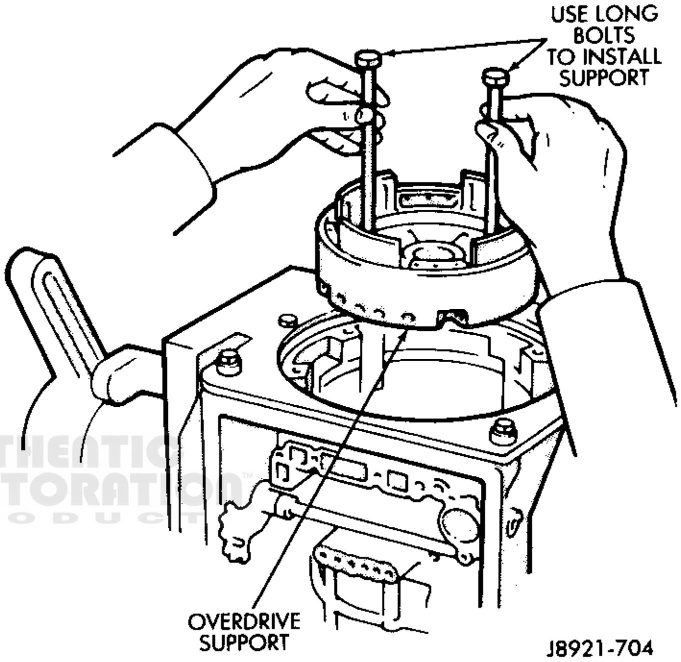


Fig. 37 Installing Overdrive Support

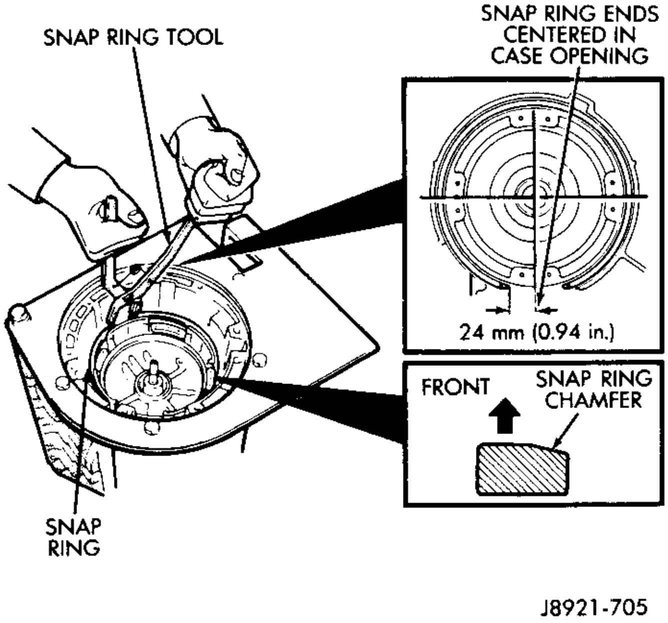


Fig. 38 Installing Overdrive Support Snap Ring

(83) Install new gaskets on oil screen and install screen on valve body. Tighten screen bolts to 10 N•m 7 ft-lbs) torque.

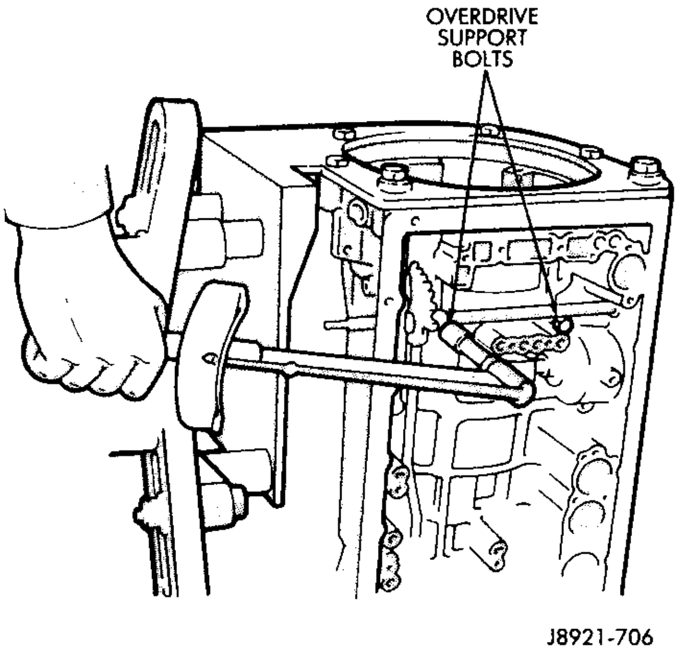


Fig. 39 Installing Overdrive Support Bolts

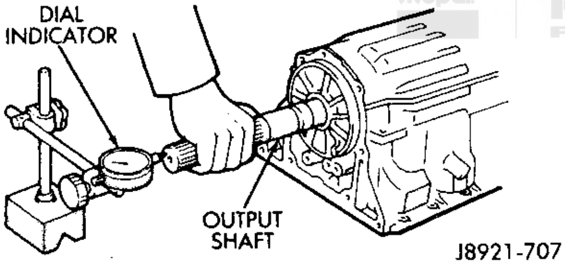


Fig. 40 Checking Output Shaft End Play

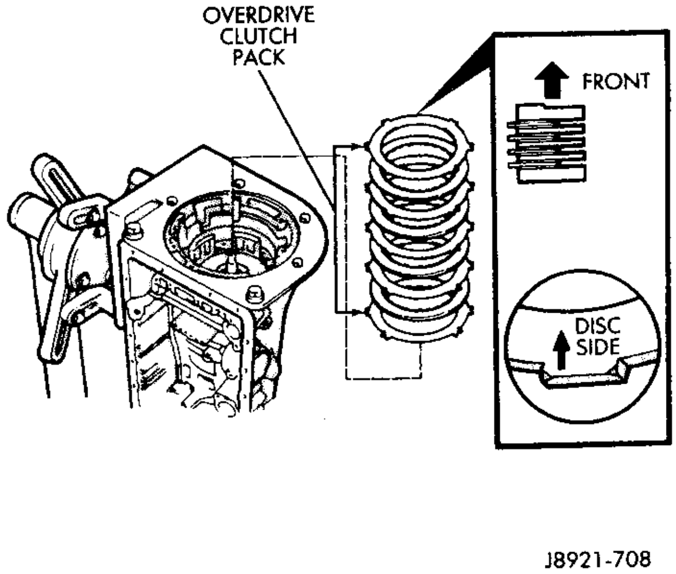


Fig. 41 Install Overdrive Clutch Pack

(84) Install magnet in oil pan. Be sure magnet does not interfere with valve body oil tubes.

(85) Apply Three-Bond TB 1281 or equivalent sealer, to sealing surface of oil pan. Sealer bead should be at least 1 mm (.040 in) wide. Install pan on case and tighten pan bolts to 7.4 N•m (65 in-lbs) torque.

(86) Install speed sensor rotor and key on output shaft (Fig. 63).

(87) Install spacer and speedometer drive gear on output shaft. Then install retaining snap ring (Fig. 64).

(88) Apply bead of sealer to sealing surface at rear of case (Fig. 65). Use Three Bond TB 1281, Loctite 518 or an equivalent sealer.

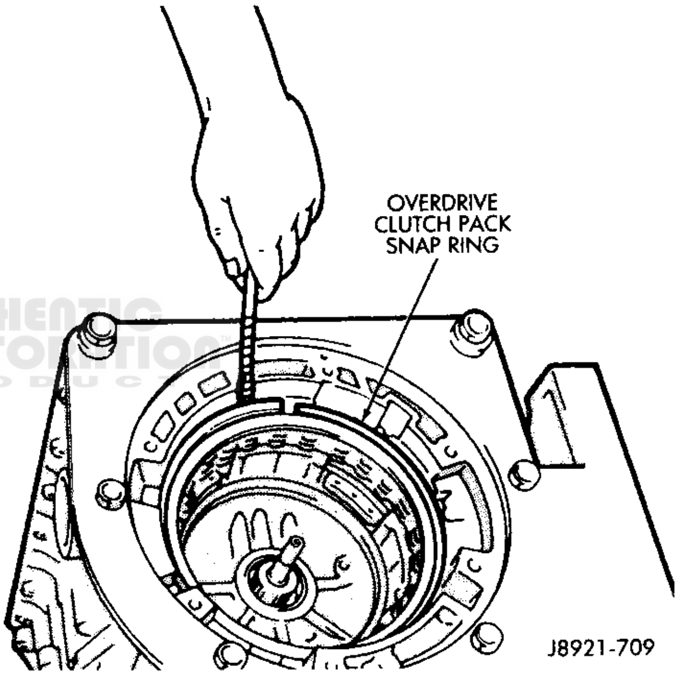


Fig. 42 installing Overdrive Brake Snap Ring

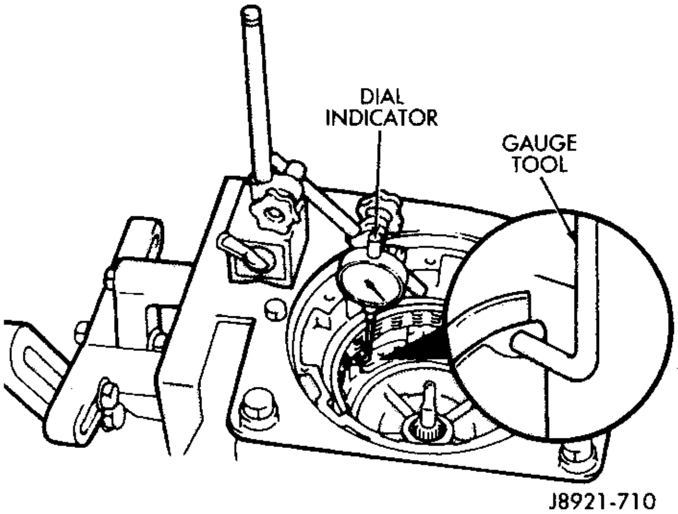


Fig. 43 Positioning Gauge Tool And Dial Indicator

(89) Install extension or adapter housing on transmission. Tighten housing/adapter bolts to 34 N•m (25 ft-lbs) torque.

(90) Install speed sensor (Fig. 66). Tighten sensor bolt to 7.4 N•m (65 in-lbs) torque and connect sensor wire harness connector.

(91) Install speedometer driven gear (Fig. 67). Tighten gear attaching bolt to 19 N•m (175 in-lbs) torque.

(92) Install converter housing (Fig. 68). Tighten 12 mm diameter housing bolts to 57 N•m (42 ft-lbs) torque. Tighten 10 mm diameter housing bolts to 34 N•m (25 ft-lbs) torque.

(93) Install transmission shift control lever on manual valve shaft. Do not install the lever attaching nut at this time.

(94) Move shift control lever all the way to rear. Then move it two detent positions forward.

(95) Mount neutral safety switch on manual valve shaft and tighten switch adjusting bolt just enough to keep switch from moving (Fig. 69).

(96) Install neutral switch tabbed washer and retaining nut (Fig. 69). Tighten nut to 6.9 N•m (61 in-lbs) torque, but do not bend any of the washer tabs against the nut at this time.

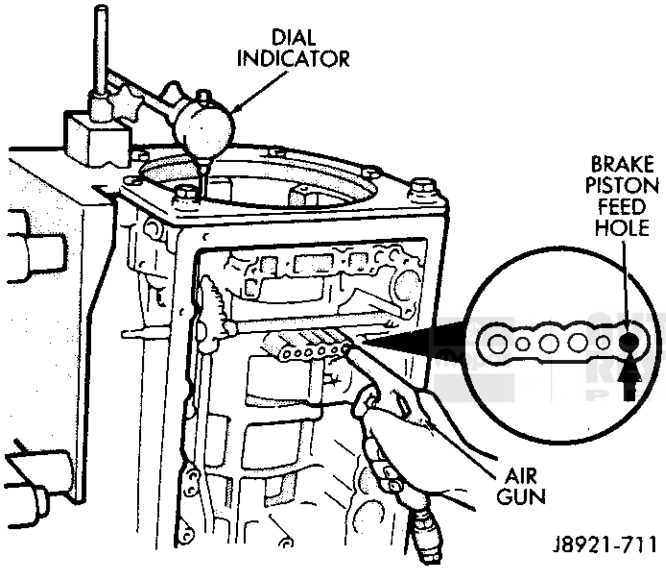


Fig. 44 Checking Overdrive Brake Piston Stroke

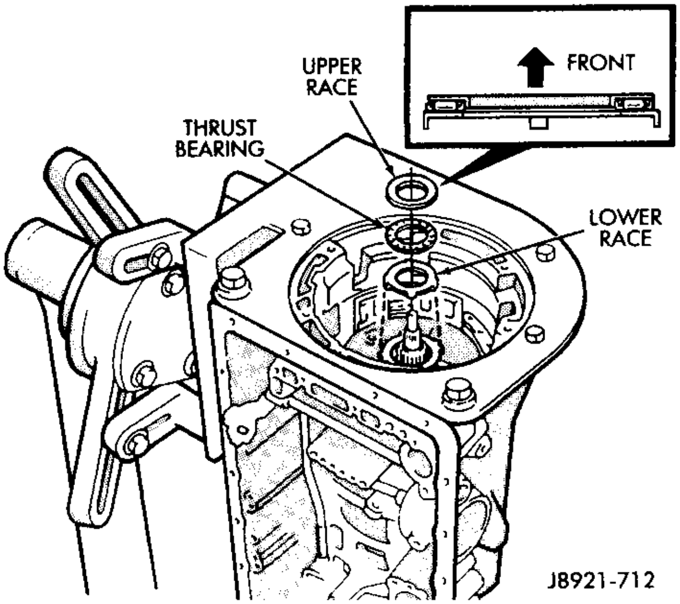


Fig. 45 Installing Overdrive Support Thrust Bearing And Races

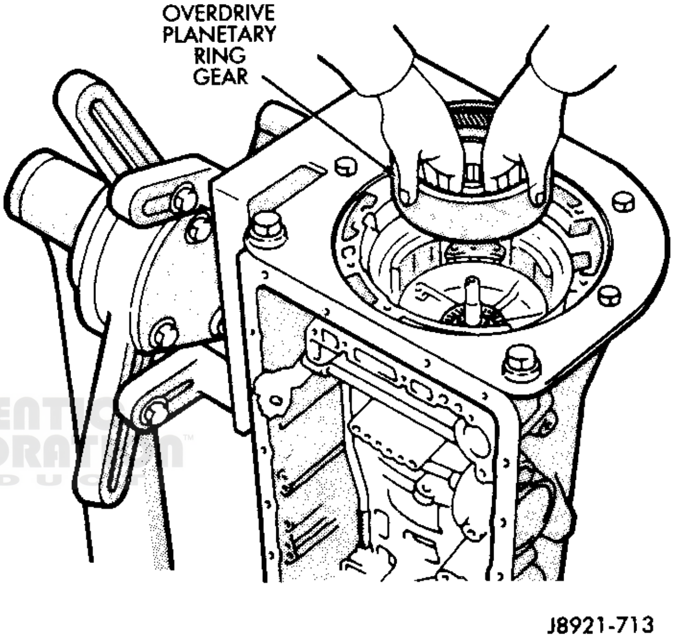


Fig. 46 Installing Overdrive Planetary Ring Gear

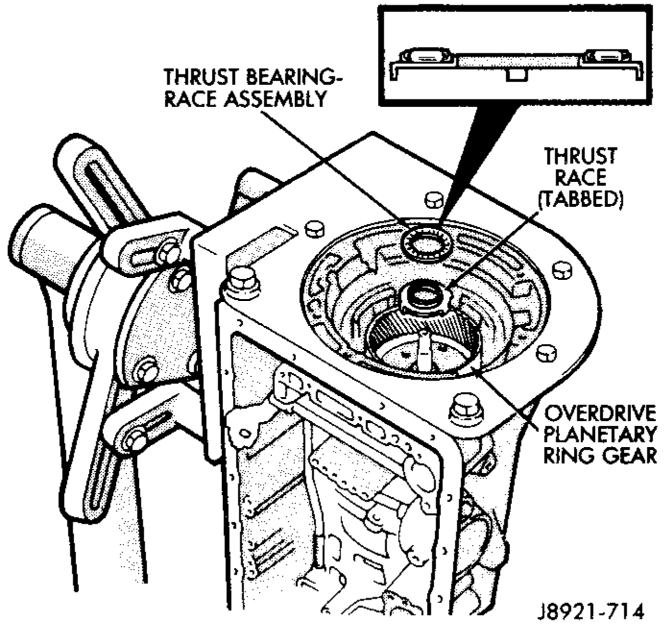


Fig. 47 Installing Ring Gear Thrust Bearing And Race

(97) Align neutral switch standard line with groove or flat on manual shaft (Fig. 69).

(98) Tighten neutral switch adjusting bolt to 13 N•m (9 ft-lbs) torque.

(99) Install shift control lever on manual valve shaft. Tighten lever attaching nut to 16 N•m (12 ft-lbs) torque.

(100) Install retaining clamp for wire harness and throttle cable (Fig. 70).

(101) Install torque converter.

(102) Verify that converter is seated by measuring distance between converter housing flange and one of the converter mounting pads (Fig. 71). Use straightedge and vernier calipers to measure distance. On 4-cyl. transmissions, distance should be 17.5 mm (.689 in). On 6-cyl. transmissions, distance should be 16.5 mm (.650 in).

(103) Install lower half of transmission fill tube (install upper half after transmission is in vehicle).

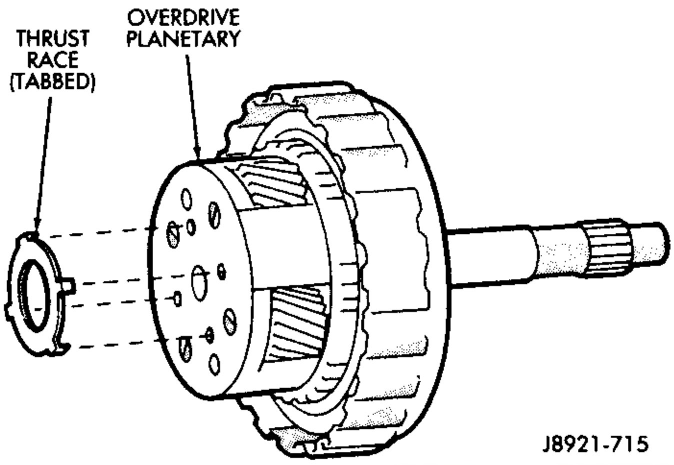


Fig. 48 Installing Planetary thrust Race

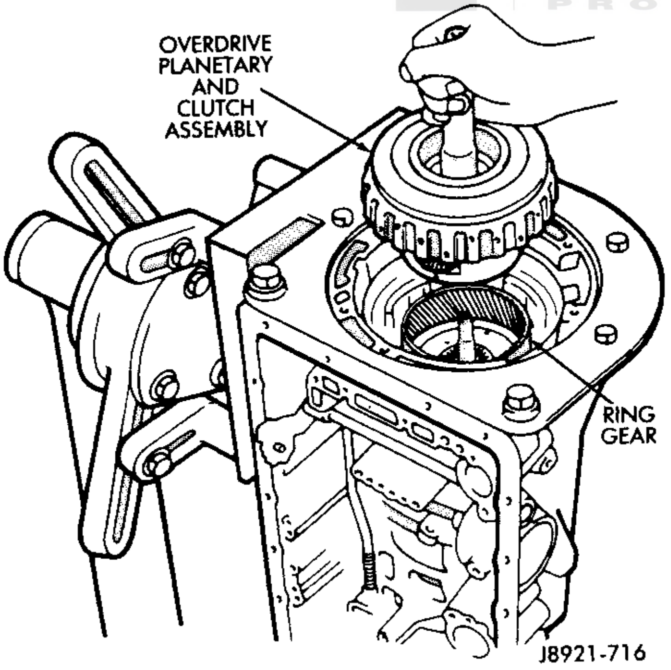


Fig. 49 Installing Overdrive Planetary And Clutch Assembly

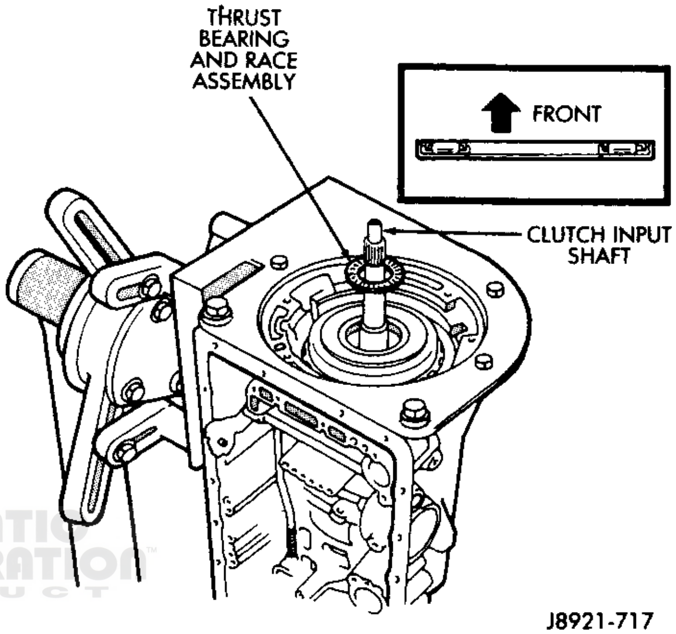


Fig. 50 Installing Input Shaft Thrust Bearing And Race Assembly

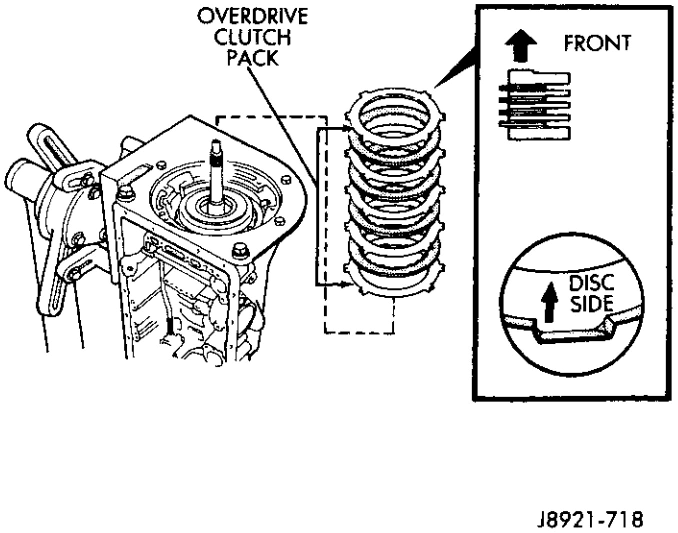


Fig. 51 Installing Overdrive Clutch Pack

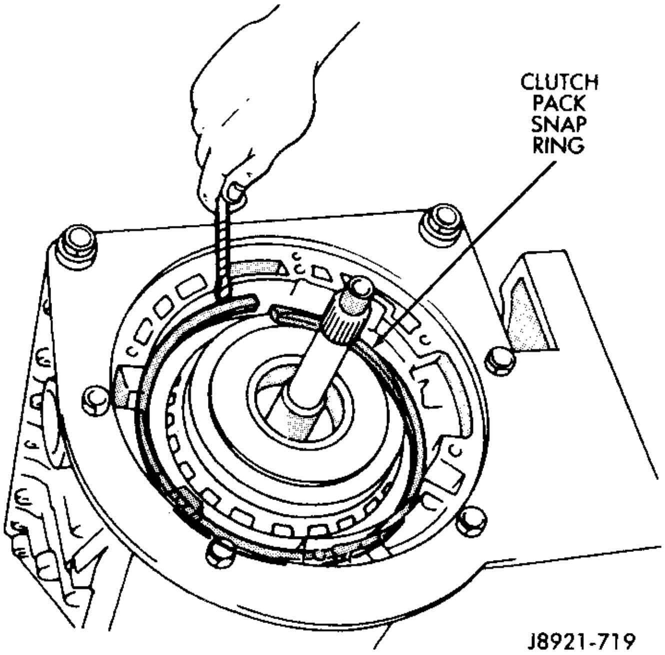


Fig. 52 Installing Clutch Pack Snap Ring

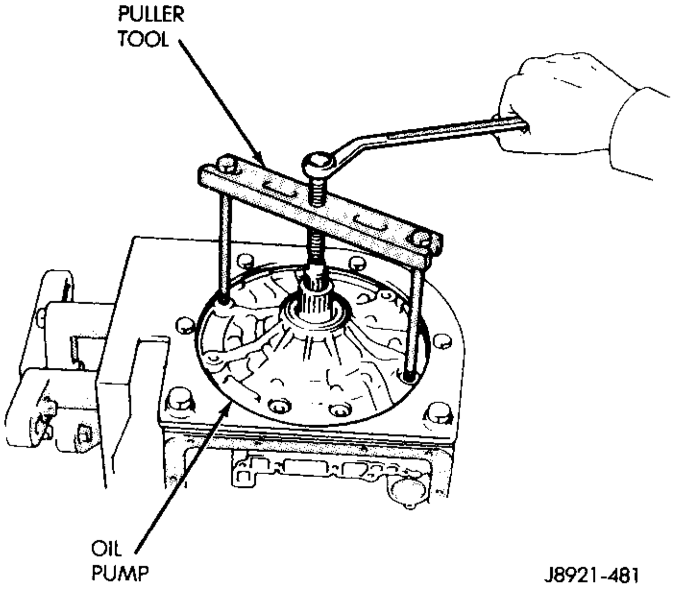


Fig. 54 Installing Oil Pump

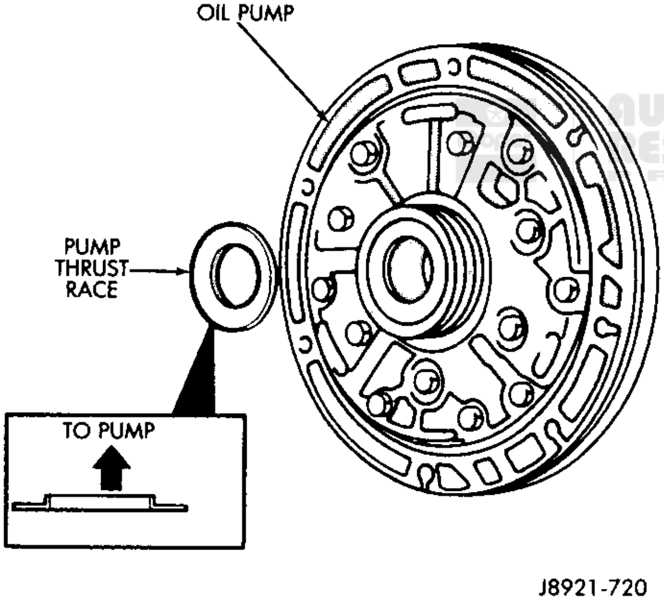


Fig. 53 Installing Oil Pump Thrust Race

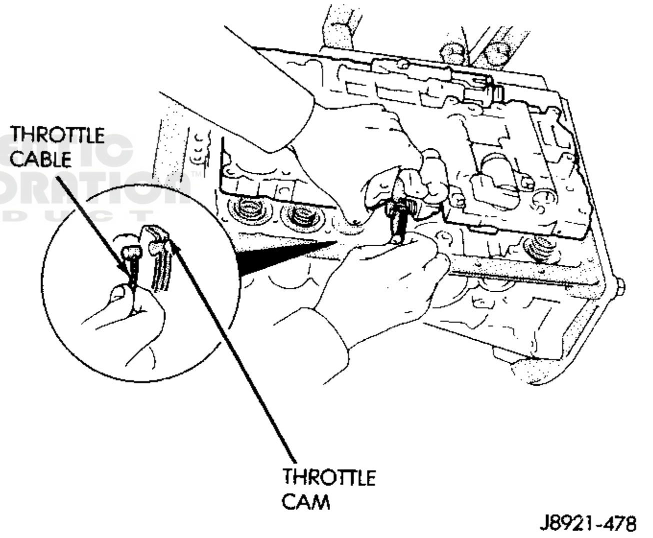
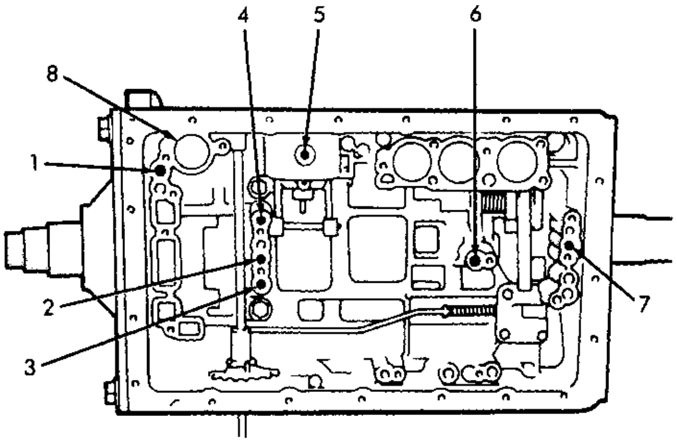


Fig. 55 Installing Throttle Cable

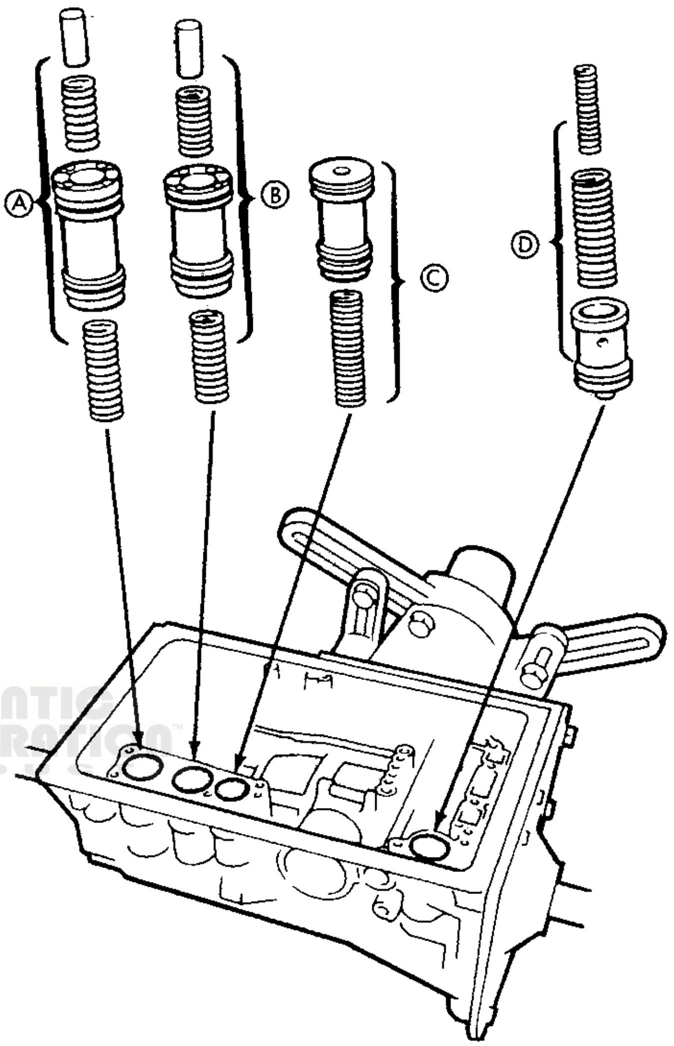


1. OVERDRIVE DIRECT CLUTCH FEED
2. DIRECT CLUTCH FEED
3. FORWARD CLUTCH FEED
4. OVERDRIVE BRAKE FEED
5. SECOND COAST BRAKE FEED
6. SECOND BRAKE FEED
7. FIRST-REVERSE BRAKE FEED
8. OVERDRIVE CLUTCH ACCUMULATOR PISTON HOLE (BLOCK THIS HOLE WHEN CHECKING DIRECT CLUTCH OPERATION)

J8921-721

Fig. 56 Clutch And Brake Feed Hole Locations

Ⓐ SECOND BRAKE ACCUMULATOR PISTON
Ⓑ SECOND CLUTCH ACCUMULATOR PISTON
Ⓒ OVERDRIVE BRAKE ACCUMULATOR PISTON
Ⓓ OVERDRIVE CLUTCH ACCUMULATOR PISTON



J8921-722

Fig. 57 Installing Accumulator Pistons

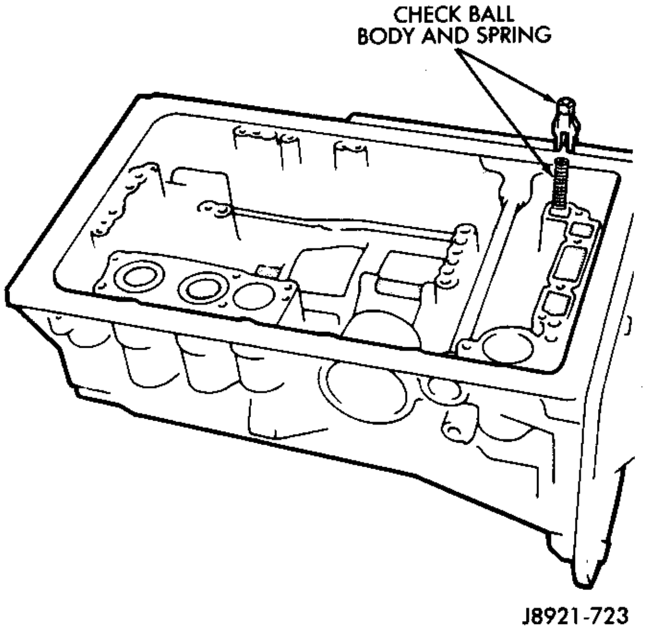


Fig. 58 Installing Check Ball Body And Spring

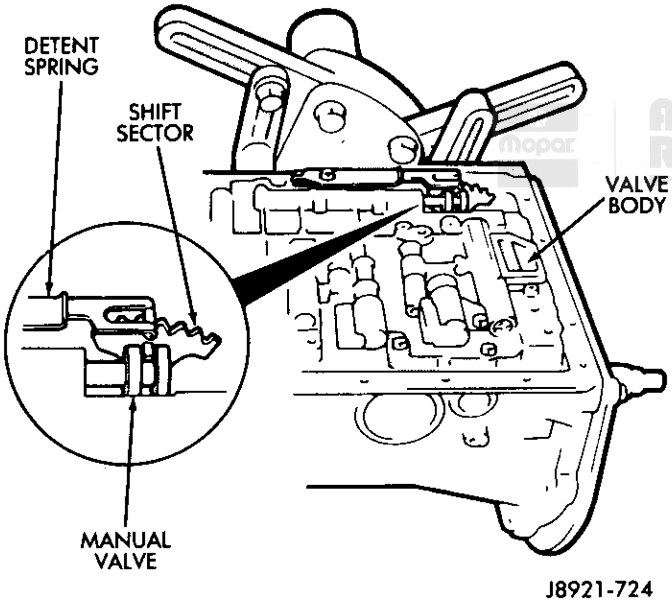


Fig. 59 Aligning Manual Valve, Shift Sector And Detent Spring

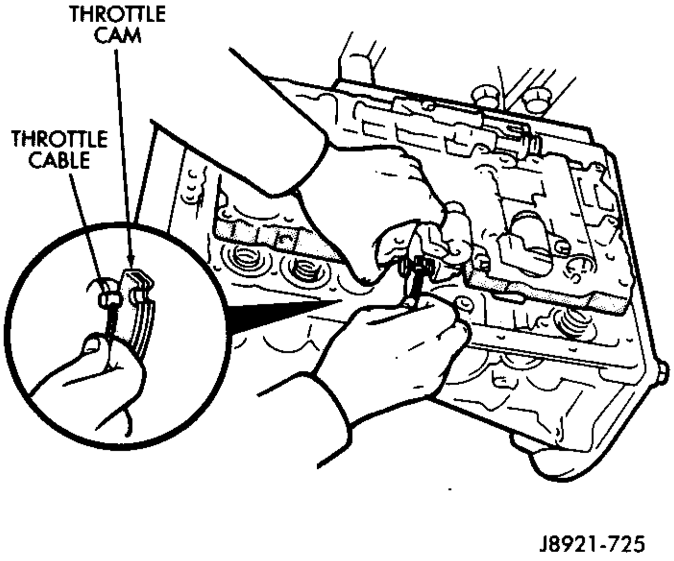


Fig. 60 Connecting Throttle Cable

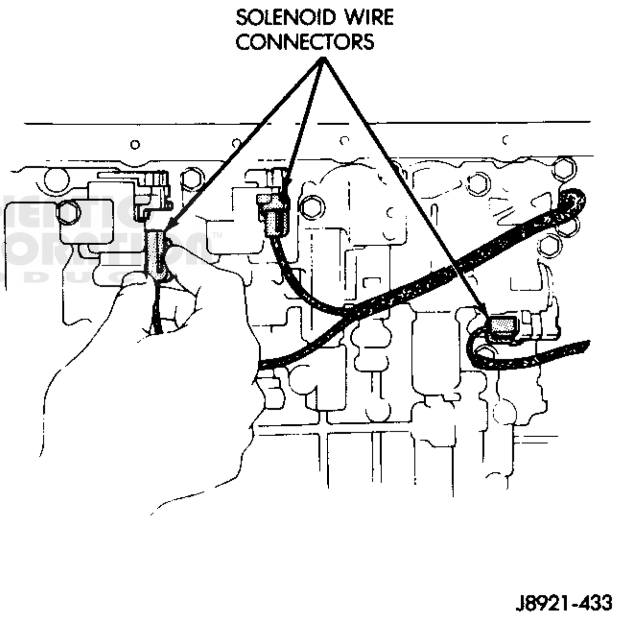


Fig. 61 Connecting Valve Body Solenoid Wires

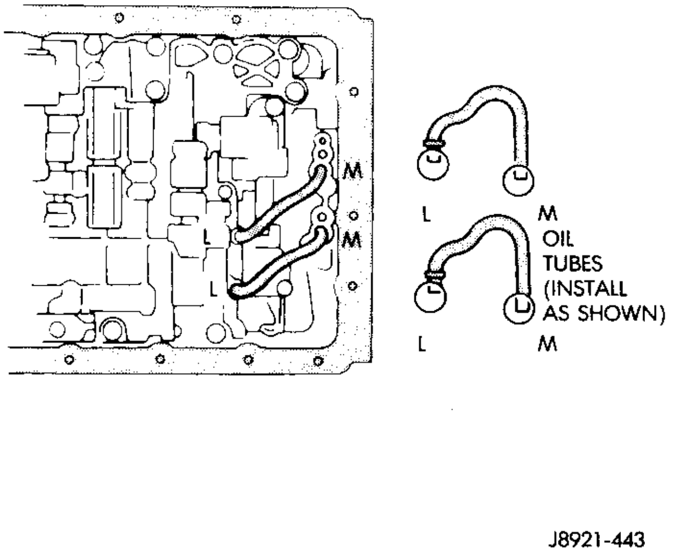


Fig. 62 Installing Valve Body Oil Tubes

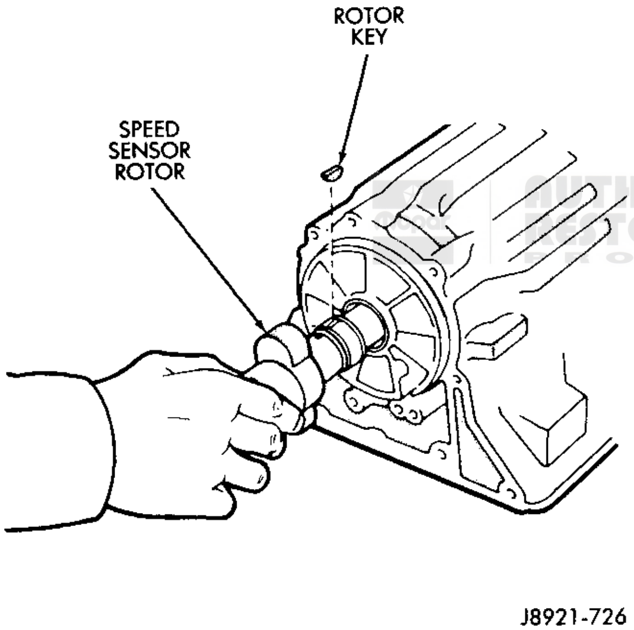


Fig. 63 Installing Speed Sensor Rotor And Key

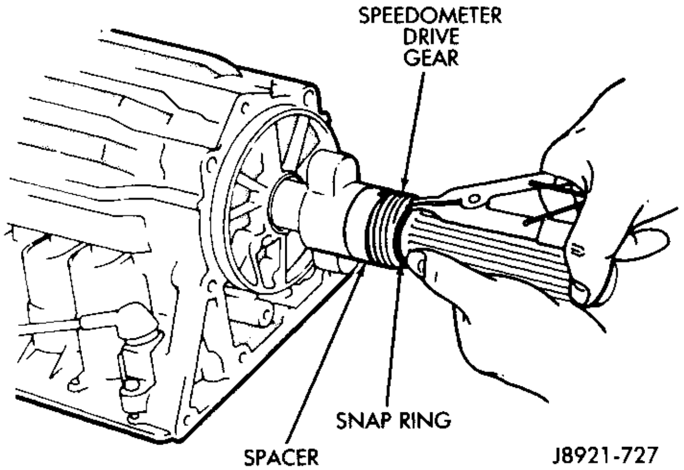


Fig. 64 Installing Spacer And Speedometer Drive Gear

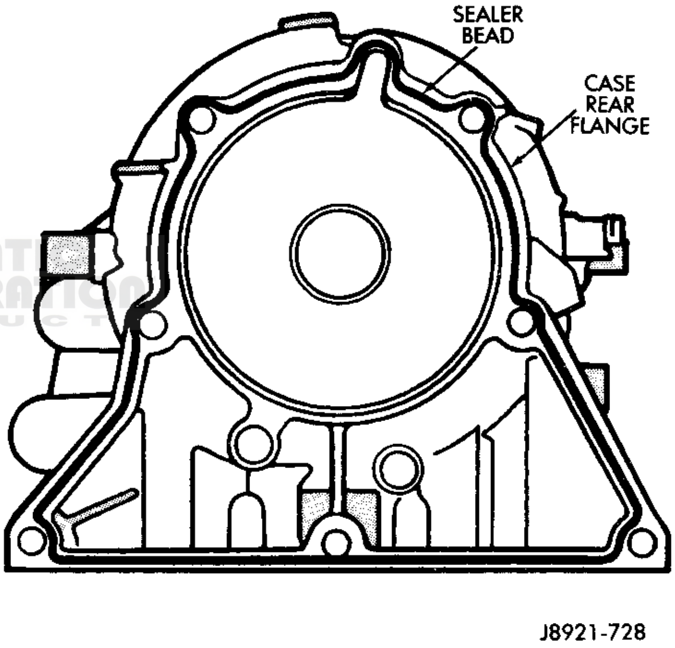


Fig. 65 Applying Sealer To Case Rear Flange

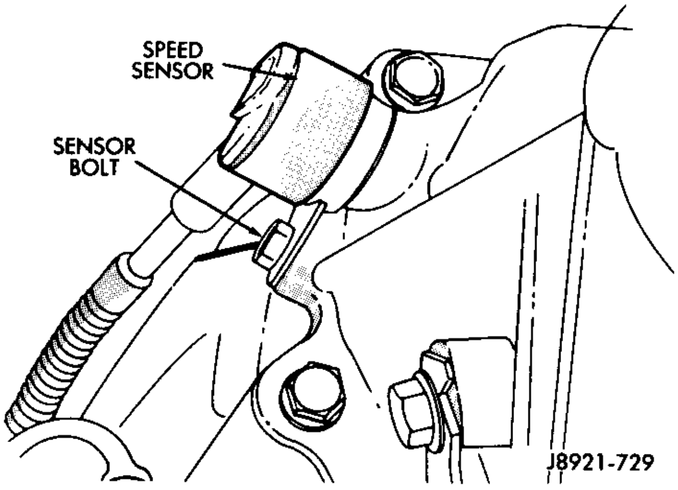


Fig. 66 Installing Speed Sensor

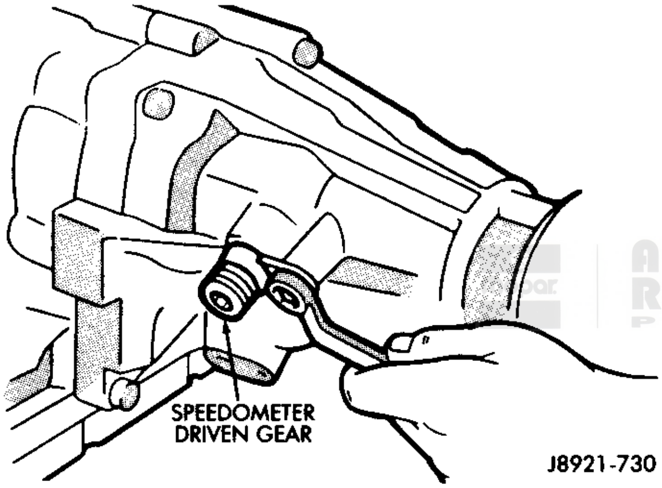


Fig. 67 Installing Speedometer Driven Gear

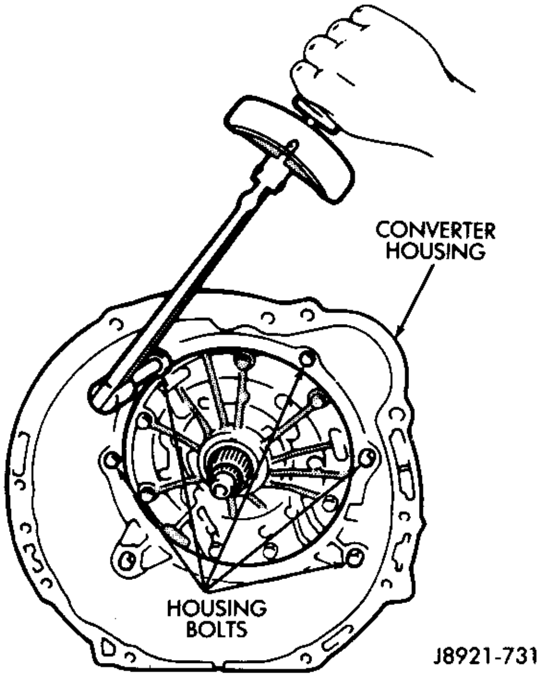


Fig. 68 Installing Converter Housing

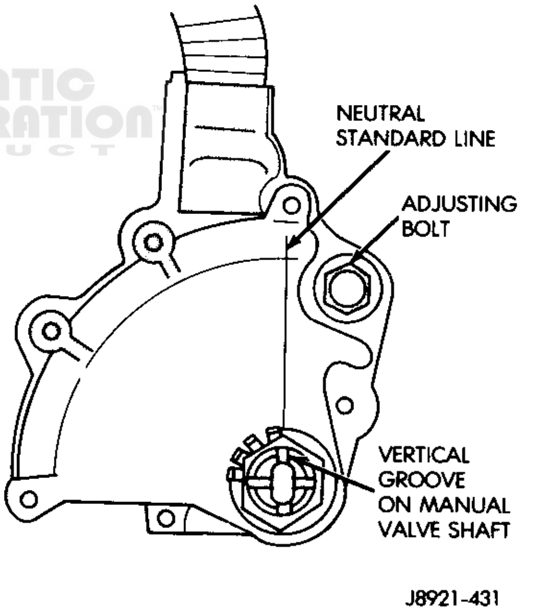


Fig. 69 Neutral Switch Installation/Adjustment

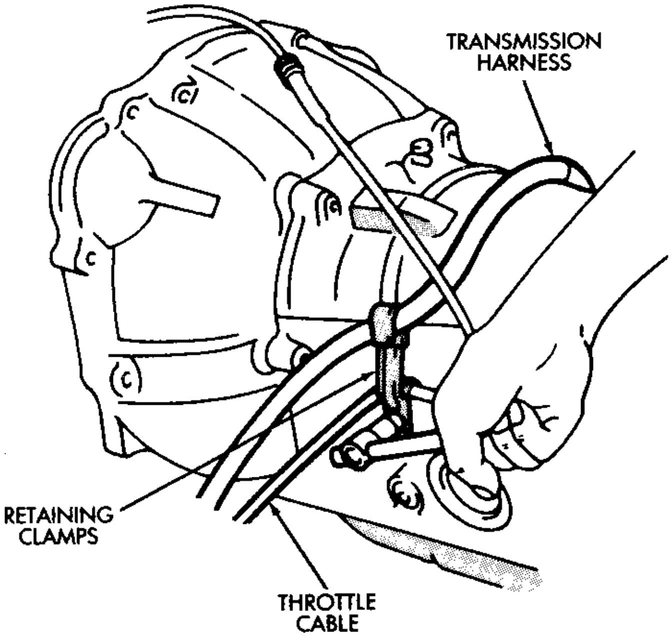


Fig. 70 Installing Cable/Harness Clamps

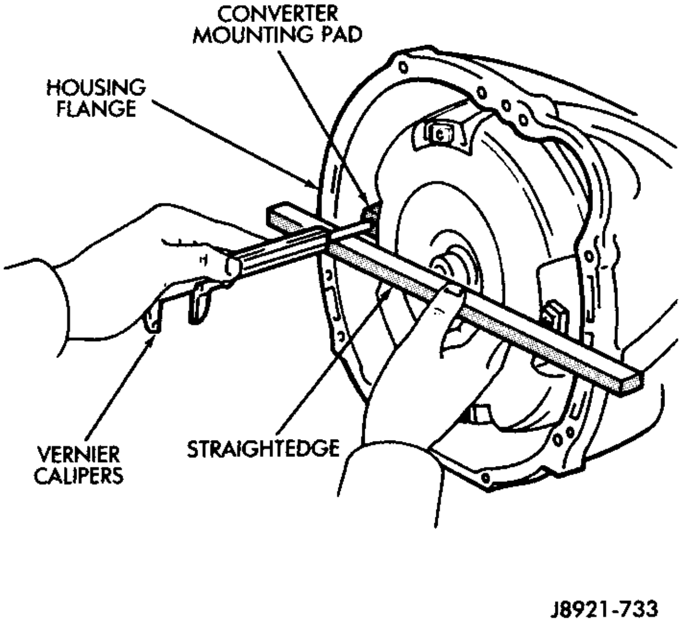


Fig. 71 Checking Converter Installation

GENERAL SPECIFICATIONS

Gear Ratios:

First	2.804:1
Second	1.531:1
Third	1.000:1
Fourth (Overdrive)	0.705:1
Reverse	2.393:1

Fluid Level	To "Full" mark with fluid hot (normal operating temperature)
Fluid Capacity (all models)	8.0 Liters (8.45 qts.)

Test Specifications

Stall Speed:

In D Range and Reverse	2100-2400 rpm

Line Pressure:

In D at Curb Idle	53-61 psi (363-422 kPa)
In D at WOT	161-196 psi (1108-1353 kPa)
In Reverse at Curb Idle	73-87 psi (500-598 kPa)
In Reverse at WOT	223-273 psi (1540-1883 kPa)

Time Lag Test:

Engagement in D Range	1.2 seconds
Engagement in Reverse	1.5 seconds

Valve Body Solenoid Resistance	11-15 ohms
Transmission Fluid Normal Operating Temperature	50-80°C (122-176°F)

J8921-739

OIL PUMP WEAR LIMITS

Drive Gear	
Tip Clearance:	
Standard	0.11-0.14 mm (0.0043-0.0055 in.)
Maximum Allowance	0.3 mm (0.012 in.)
Gear-to-Pump Body	
End Clearance:	
Standard	0.02-0.05 mm (0.0008-0.0020 in.)
Maximum Allowance	0.1 mm (0.004 in.)
Driven Gear-to-Pump	
Body Clearance:	
Standard	0.07-0.15 mm (0.0028-0.0059 in.)
Maximum Allowance	0.3 mm (0.012 in.)

J8921-740

CLUTCH DISC AND PLATE THICKNESS

Component	**Minimum Allowable Thickness**
Clutch Disc (all except first-reverse and forward clutch discs)	1.84 mm (0.0724 in.)
Forward Clutch Disc:	
6-Cylinder	1.51 mm (0.0594 in.)
4-Cylinder	1.84 mm (0.0724 in.)
6-Cylinder Direct Clutch Plates:	
Thin Plate (1)	2.3 mm (0.905 in.)
Thick Plates (3)	3.0 mm (0.118 in.)
4-Cylinder Direct Clutch Plates:	
Thin Plate (1)	3.0 mm (0.118 in.)
Thick Plates (2)	4.0 mm (0.1574 in.)
Forward Clutch Plate:	
6-Cylinder	1.8 mm (0.070 in.)
4-Cylinder	2.0 mm (0.078 in.)
First-Reverse Brake Disc	1.51 mm (0.0594 in.)

J8921-741

BUSHING AND PISTON CLEARANCE

BUSHING INSIDE DIAMETER (MAXIMUM)

Bushing Location	Maximum Allowance Inside Diameter
Extension Housing	38.09 mm (1.4996 in.)
Direct Clutch Drum	53.97 mm (2.1248 in.)
Overdrive Planetary Gear	11.27 mm (0.4437 in.)
Overdrive Direct Clutch Drum	27.11 mm (1.0673 in.)
Stator Shaft (Front)	21.58 mm (0.8496 in.)
Stator Shaft (Rear)	27.08 mm (1.0661 in.)
Oil Pump Body	38.19 mm (1.5035 in.)
Transmission Case	38.18 mm (1.5031 in.)

PISTON STROKE LENGTH

Piston Location	Specification
Direct Clutch (all)	1.37-1.60 mm (0.0539-0.0642 in.)
Overdrive Brake:	
6-Cylinder	1.40-1.70 mm (0.0551-0.0669 in.)
4-Cylinder	1.32-1.62 mm (0.0520-0.0638 in.)
Second Coast Brake (all)	1.5-3.0 mm (0.059-0.118 in.)
Forward Clutch:	
6-Cylinder	3.73-4.59 mm (0.1469-0.1807 in.)
4-Cylinder	3.42-4.23 mm (0.1346-0.1665 in.)
Overdrive Direct Clutch (all)	1.85-2.15 mm (0.0728-0.0846 in.)

END PLAY AND CLEARANCE

Component	Specification
Output Shaft End Play	0.27-0.86 mm (0.0106-0.0339 in.)
First-Reverse Brake Pack Clearance:	
6-Cylinder	0.70-2.00 mm (0.028-0.079 in.)
4-Cylinder	0.6-1.74 mm (0.024-0.069 in.)
Second Brake Pack Clearance:	
6-Cylinder	0.62-1.98 mm (0.024-0.078 in.)
4-Cylinder	0.89-2.15 mm (0.035-0.084 in.)

J8921-742

RETAINER AND PISTON SPECIFICATIONS

OVERDRIVE BRAKE RETAINER SELECTION

Retainer No.	Thickness	Retainer No.	Thickness
26	3.3 mm (0.130 in.)	11	3.8 mm (0.150 in.)
25	3.5 mm (0.138 in.)	23	3.9 mm (0.154 in.)
12	3.6 mm (0.142 in.)	Not Marked	4.0 mm (0.157 in.)
24	3.7 mm (0.146 in.)	———	———

DIRECT CLUTCH RETAINER SELECTION

Retainer No.	Thickness	Retainer No.	Thickness
33	3.0 mm (0.118 in.)	29	3.4 mm (0.134 in.)
32	3.1 mm (0.122 in.)	28	3.5 mm (0.138 in.)
31	3.2 mm (0.126 in.)	27	3.6 mm (0.142 in.)
30	3.3 mm (0.130 in.)	34	3.7 mm (0.146 in.)

OVERDRIVE CLUTCH RETAINER SELECTION

Retainer No.	Thickness	Retainer No.	Thickness
16	3.6 mm (0.142 in.)	19	3.3 mm (0.130 in.)
17	3.5 mm (0.138 in.)	20	3.2 mm (0.126 in.)
18	3.4 mm (0.134 in.)	21	3.1 mm (0.122 in.)

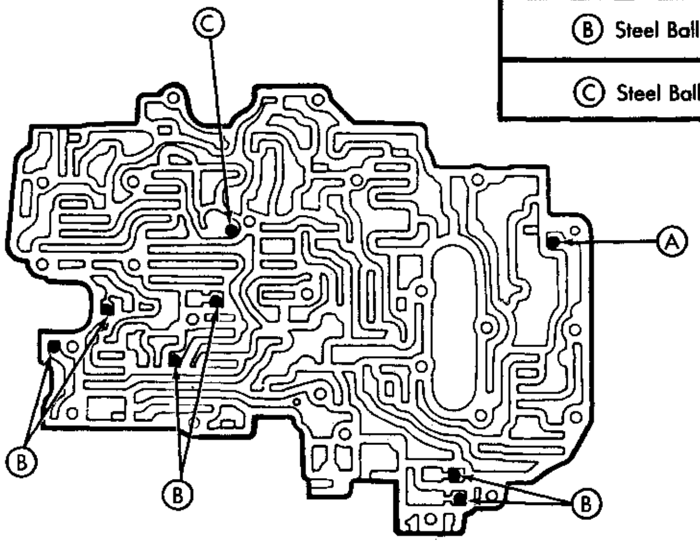
SECOND COAST BRAKE PISTON ROD SELECTION

Rod	Rod Length
No. 1	71.4 mm (2.811 in.)
No. 2	72.9 mm (2.870 in.)

J8921-743

VALVE BODY CHECK BALL DIMENSIONS

Check Ball	Diameter
Ⓐ Rubber Ball	6.35 mm (0.250 in.)
Ⓑ Steel Ball	5.56 mm (0.218 in.)
Ⓒ Steel Ball	7.14 mm (0.281 in.)



J8921-744

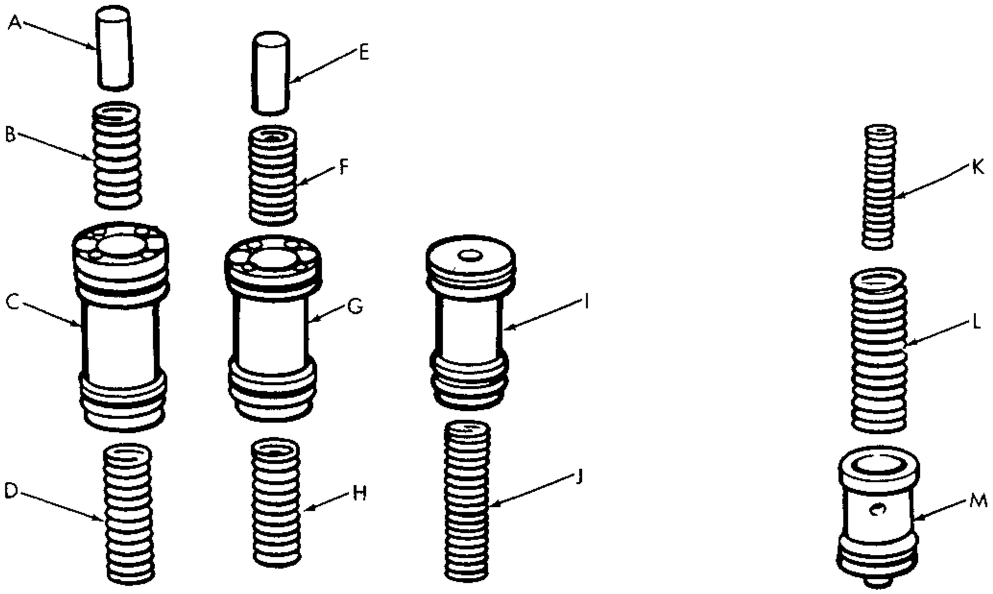
CLUTCH/BRAKE PACK REQUIREMENTS

Component	Discs Required	Plates Required	Retainers Required
Overdrive Brake:			
6-Cylinder	4	3	2
4-Cylinder	3	2	2
Second Brake:			
6-Cylinder	5	5	1
4-Cylinder	4	4	1
Overdrive Direct Clutch:			
6-Cylinder	2	2	1
4-Cylinder	2	2	1
Direct Clutch:			
6-Cylinder	4	4	1
4-Cylinder	3	3	1
Forward Clutch:			
6-Cylinder	6	6	1
4-Cylinder	5	5	1
First-Reverse Brake:			
6-Cylinder	7	7	1
4-Cylinder	6	6	1

J8921-745

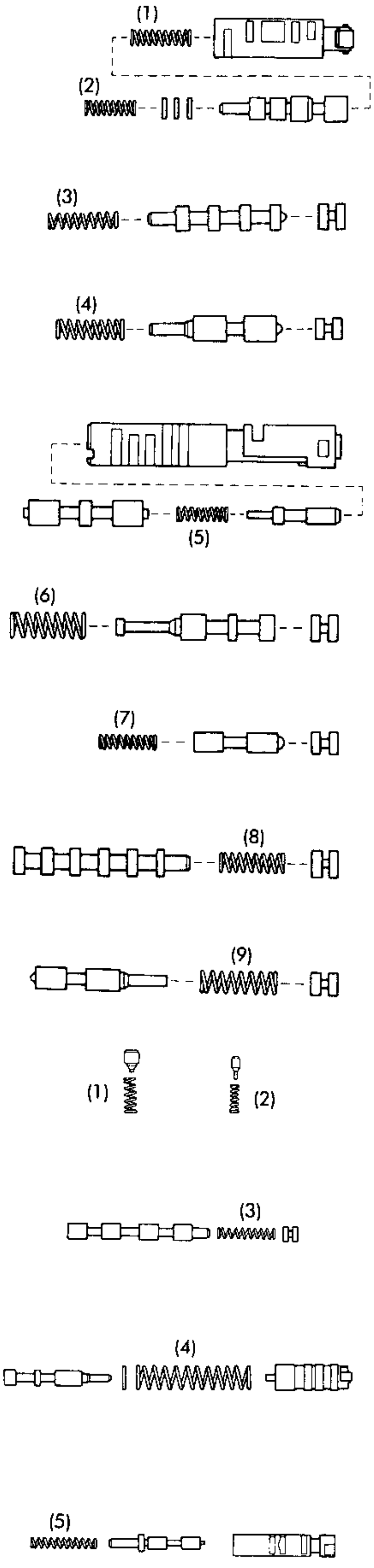
ACCUMULATOR COMPONENT DIMENSIONS

	Component	Outside Diameter	Length
SECOND BRAKE ACCUMULATOR	Pin A	12.0 mm (0.472 in.)	35.2 mm (1.386 in.)
	Spring B 4-Cylinder	19.0 mm (0.748 in.)	42.0 mm (1.653 in.)
	Spring B 6-Cylinder	19.4 mm (0.764 in.)	38.0 mm (1.496 in.)
	Piston C	36.9 mm (1.453 in.)	68.5 mm (2.697 in.)
	Spring D 4-Cylinder	19.6 mm (0.772 in.)	53.5 mm (2.106 in.)
	Spring D 6-Cylinder	19.7 mm (0.775 in.)	53.5 mm (2.106 in.)
DIRECT CLUTCH ACCUMULATOR	Pin E	13.7 mm (0.539 in.)	33.2 mm (1.307 in.)
	Spring F 4-Cylinder	20.8 mm (0.819 in.)	39.0 mm (1.535 in.)
	Spring F 6-Cylinder	21.1 mm (0.831 in.)	36.4 mm (1.433 in.)
	Piston G	36.9 mm (1.453 in.)	62.6 mm (2.465 in.)
	Spring H	20.3 mm (0.799 in.)	48.1 mm (1.893 in.)
OVERDRIVE BRAKE ACCUMULATOR	Piston I	31.9 mm (1.256 in.)	52.0 mm (2.047 in.)
	Spring J	15.9 mm (0.626 in.)	66.0 mm (2.598 in.)
OVERDRIVE CLUTCH ACCUMULATOR	Spring K	14.0 mm (0.551 in.)	46.0 mm (1.811 in.)
	Spring L	20.3 mm (0.799 in.)	74.6 mm (2.937 in.)
	Piston M	29.9 mm (1.177 in.)	49.0 mm (1.929 in.)



J8921-746

VALVE AND SPRING IDENTIFICATION



Spring	Free Length
(1) Downshift Plug	27.3 mm (1.074 in.)
(2) Throttle Valve	20.6 mm (0.811 in.)
(3) 3-4 Shift Valve	30.8 mm (1.212 in.)
(4) Second Coast Modulator Valve	25.3 mm (0.996 in.)
(5) Lockup Relay Valve	21.4 mm (0.843 in.)
(6) Secondary Regulator Valve	30.9 mm (1.217 in.)
(7) Cut-Back Valve	21.8 mm (0.858 in.)
(8) 2-3 Shift Valve	30.8 mm (1.212 in.)
(9) Low Coast Modulator Valve	27.8 mm (1.094 in.)

Spring	Spring Length
(1) Check Valve	20.2 mm (0.797 in.)
(2) Pressure Relief Valve	11.2 mm (0.441 in.)
(3) 1-2 Shift Valve	30.8 mm (1.213 in.)
(4) Primary Regulator Valve	66.7 mm (2.626 in.)
(5) Accumulator Control Valve	36.1 mm (1.421 in.)

J8921-747

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Converter Housing Bolt		
10mm	34 N·m (25 ft-lbs)	32-36 N·m (23-27 ft-lbs)
12mm	57 N·m (42 ft-lbs)	55-59 N·m (40-43 ft-lbs)
Extension Housing Bolt	34 N·m (25 ft-lbs)	32-36 N·m (23-27 ft-lbs)
Speed Sensor Bolt	7.4 N·m (65 in-lbs)	6.4-8.4 N·m (57-75 in-lbs)
Speedometer Housing Bolt	19 N·m (175 in-lbs)	18-20 N·m (160-185 in-lbs)
Shift Lever Nut	16 N·m (12 ft-lbs)	15-17 N·m (11-13 ft-lbs)
Neutral Safety Switch		
Bolt	13 N·m (9 ft-lbs)	12-14 N·m (8-10 ft-lbs)
Nut	6.9 N·m (61 in-lbs)	5.9-7.9 N·m (53-70 in-lbs)
Solenoid Harness Bolt	7.4 N·m (65 in-lbs)	6.4-8.4 N·m (57-75 in-lbs)
Oil Pan Bolts	7.4 N·m (65 in-lbs)	6.4-8.4 N·m (57-75 in-lbs)
Oil Pan Drain Plug	20 N·m (15 ft-lbs)	19-21 N·m (14-16 ft-lbs)
Oil Screen Bolt	10 N·m (88 in-lbs)	9-11 N·m (80-96 in-lbs)
Valve Body Bolt (To Case)	10 N·m (88 in-lbs)	9-11 N·m (80-96 in-lbs)
Valve Body Bolt (To Valve Body)	6.4 N·m (56 in-lbs)	6-6.8 N·m (54-58 in-lbs)
Detent Spring Bolt	10 N·m (88 in-lbs)	9-11 N·m (80-96 in-lbs)
Oil Pump Bolt (To Case)	22 N·m (17 ft-lbs)	21-23 N·m (16-18 ft-lbs)
Oil Pump Bolt (To Stator Shaft)	10 N·m (88 in-lbs)	9-11 N·m (80-96 in-lbs)
OD Support Bolt (To Case)	25 N·m (19 ft-lbs)	23-27 N·m (18-20 ft-lbs)
Park Pawl Bracket	10 N·m (88 in-lbs)	9-11 N·m (80-96 in-lbs)

J8921-748

MODEL 231 TRANSFER CASE

INDEX

GENERAL INFORMATION

The Model 231 is a part-time transfer case with a built-in low range reduction gear system (Fig. 1). A front axle disconnect mechanism is used for two-wheel drive operation. The 231 is used in XJ, MJ, YJ models with Command Trac.

The 231 has three operating ranges plus a Neutral position. A low range system provides a reduction ratio for increased low speed torque capability.

Two versions of the Model 231 are used. On YJ models, the vacuum switch is located at the front of the transfer case and the range lever is positioned upward (Fig. 1). On XJ and MJ models, the vacuum switch is at the rear of the transfer case and the range lever faces downward. These are the only differences in the two transfer versions.

Operating Ranges

Model 231 operating ranges are two-wheel drive high; four-wheel drive high and four-wheel drive low (Fig. 2). The four-wheel drive operating ranges are undifferentiated.

Shift Mechanism

Operating ranges are selected with a floor mounted shift lever. The shift lever is connected to the transfer case range lever by an adjustable linkage rod.

A straight line shift pattern is used (Fig. 2). Range positions are marked on the shifter bezel cover plate. A synchronizer assembly in the transfer case allows the unit to be shifted between two and four high ranges while in motion.

Two-Wheel Drive Operation

Two-wheel drive operation is provided by a disconnect mechanism in the front axle. A vacuum operated shift motor on the axle disconnects the right hand axle shaft when two-wheel drive range is selected. The axle shift motor is controlled by a vacuum switch that is actuated by the transfer case shift sector on Wrangler/YJ models or rail on Cherokee, Wagoneer and Comanche models.

Four Wheel Drive Operation

Two mechanisms provide four wheel drive operation. A vacuum shift motor connects the right hand axle shaft and a synchronizer assembly engages the transfer case

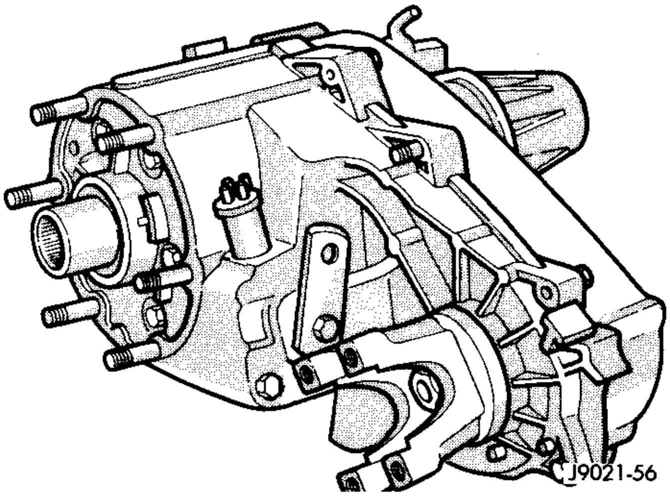


Fig. 1 Model 231 Transfer Case (YJ Version Shown)

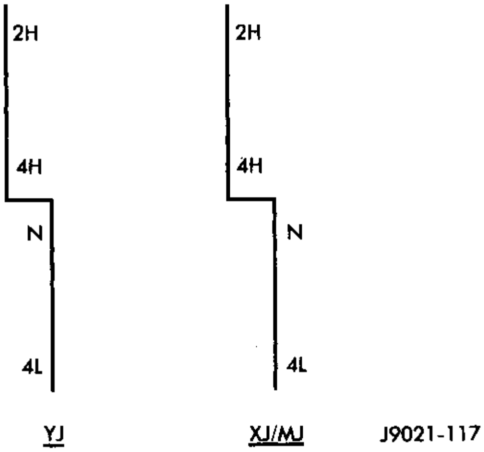


Fig. 2 Model 231 Shift Pattern

front output shaft. The shift motor is operated by a vacuum switch mounted on the transfer case. The switch is actuated by the transfer case shift sector on Wrangler/YJ models and the rail on Cherokee, Wagoneer and Comanche models.

TRANSFER CASE IDENTIFICATION

A circular ID tag is attached to the rear case of each Model 231 transfer case (Fig. 3). The ID tag provides the transfer case model number, assembly number, serial number and low range ratio.

The transfer case serial number also represents the date of build. For example, a serial number of 8-7-89 would represent August 7, 1989.

TRANSFER CASE LUBRICANT

Lubricant Type-Capacity

Use Mopar Mercon™ or Dexron II™ automatic transmission fluid in the Model 231 transfer case.

Mercon™ and Dexron II™ are compatible and can be used to top off a transfer case previously filled with either fluid.

Model 231 lubricant capacity is:

- 1.54 liters (3.25 pints) - YJ
- 1.04 liters (2.2 pints) - XJ/MJ

Fill Level

The correct fill level is to the bottom edge of the fill plug hole.

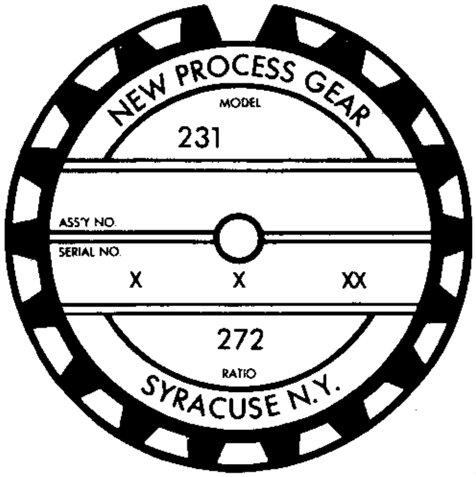


Fig. 3 Transfer Case Identification

SERVICE DIAGNOSIS-MODEL 231

Condition	Possible Cause	Correction
TRANSFER CASE DIFFICULT TO SHIFT OR WILL NOT SHIFT INTO DESIRED RANGE	(1) Vehicle speed too great to permit shifting. (2) If vehicle was operated for extended period in 4H mode on dry paved surface, driveline torque load may cause difficulty. (3) Transfer case external shift linkage binding. (4) Insufficient or incorrect lubricant. (5) Internal components binding, worn or damaged.	(1) Stop vehicle and shift into desired range. Or reduce speed to 3-4 km/h (2-3 mph) before attempting to shift. (2) Stop vehicle, shift transmission to Neutral, shift transfer case to 2H mode and operate vehicle in 2H on dry paved surfaces. (3) Lubricate, repair or replace linkage bushings or tighten loose components as necessary. (4) Drain and refill to edge of fill hole with DEXRON II® or MOPAR-MERCON® Automatic Transmission Fluid. (5) Disassemble unit and replace worn or damaged components as necessary.
TRANSFER CASE NOISY IN ALL DRIVE MODES	(1) Insufficient or incorrect lubricant.	(1) Drain and refill to edge of fill hole with DEXRON II® or MOPAR-MERCON® Automatic Transmission Fluid. Check for leaks and repair if necessary. **Note: If unit is still noisy after drain and refill, disassembly and inspection may be required to locate source of noise.**
NOISY IN – OR JUMPS OUT OF – FOUR WHEEL DRIVE LOW RANGE	(1) Transfer case not completely engaged in 4L position. (2) Shift linkage out of adjustment. (3) Shift linkage loose or binding. (4) Range fork damaged, inserts worn, or fork is binding on shift rail. (5) Low range gear worn or damaged.	(1) Stop vehicle, shift transfer case to Neutral, then shift back into 4L position. (2) Adjust linkage. (3) Tighten, lubricate or repair linkage as necessary. (4) Disassemble unit and repair as necessary. (5) Disassemble and repair as necessary.
LUBRICANT LEAKING FROM OUTPUT SHAFT SEALS OR FROM VENT	(1) Transfer case overfilled. (2) Vent closed or restricted. (3) Output shaft seals damaged or installed incorrectly.	(1) Drain to correct level. (2) Clear or replace vent if necessary. (3) Replace seals. Be sure seal lip faces interior of case when installed. Also be sure yoke seal surfaces are not scored or nicked. Remove scores and nicks with fine sandpaper or replace yoke(s) if necessary.
ABNORMAL TIRE WEAR	(1) Extended operation on dry hard surface (paved) roads in 4H range.	(1) Operate in 2H on hard surface (paved) roads. J9021-118

SHIFT LINKAGE ADJUSTMENT

Linkage Adjustment—YJ

(1) Remove the transfer case shift knob locknut and remove the knob (Fig. 4).

(2) Remove the boot attaching screws and remove the boot (Fig. 5).

(3) Move the shift lever into 4L position.

(4) Insert a 3 mm (1/8 inch) spacer between the shift lever and forward edge of the shift lever gate (Fig. 6).

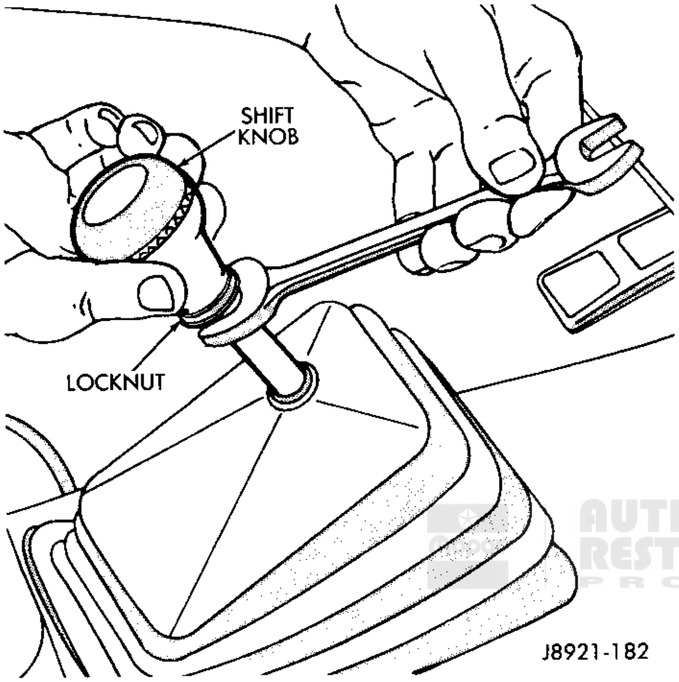


Fig. 4 Shift Knob Removal

(5) Secure the shift lever and spacer with tape or wire.

(6) Raise the vehicle.

(7) Loosen the lock bolt on the adjusting trunnion (Fig. 7). The linkage rod should now slide freely in the trunnion.

(8) Verify that range lever is in 4L position (Fig. 7).

(9) Position linkage rod so it is a free fit in the range lever. Then tighten the trunnion locknut (Fig. 7).

(10) Lower the vehicle.

(11) Remove the shift lever spacer and install the boot and shift knob.

Linkage Adjustment—XJ/MJ

(1) Remove the shift lever bezel.

(2) Move the shift lever into 4L position.

(3) Insert a 3 mm (1/8 inch) spacer between the shift lever and forward edge of the shift lever gate (Fig. 8). Secure the lever and spacer in place with tape or wire.

(4) Raise the vehicle.

(5) Loosen the trunnion lock bolt (Fig. 9). Linkage rod should now slide freely in the trunnion.

(6) Verify that the transfer case range lever is in 4L position.

(7) Position the linkage rod so it is a free fit in the range lever (Fig. 9). Then tighten the trunnion locknut.

(8) Lower the vehicle.

(9) Remove the shift lever spacer and install the bezel.

TRANSFER CASE REMOVAL

(1) Shift the transfer case into Neutral.

(2) Raise the vehicle.

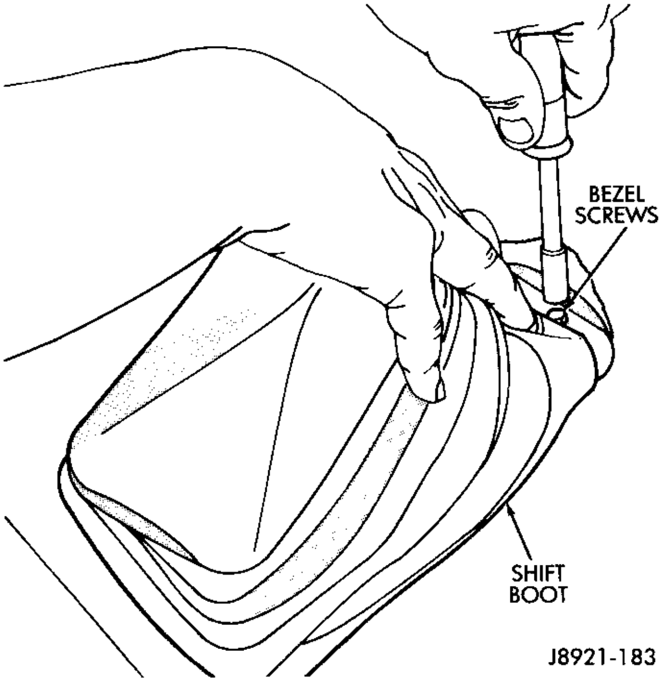


Fig. 5 Shift Boot Removal

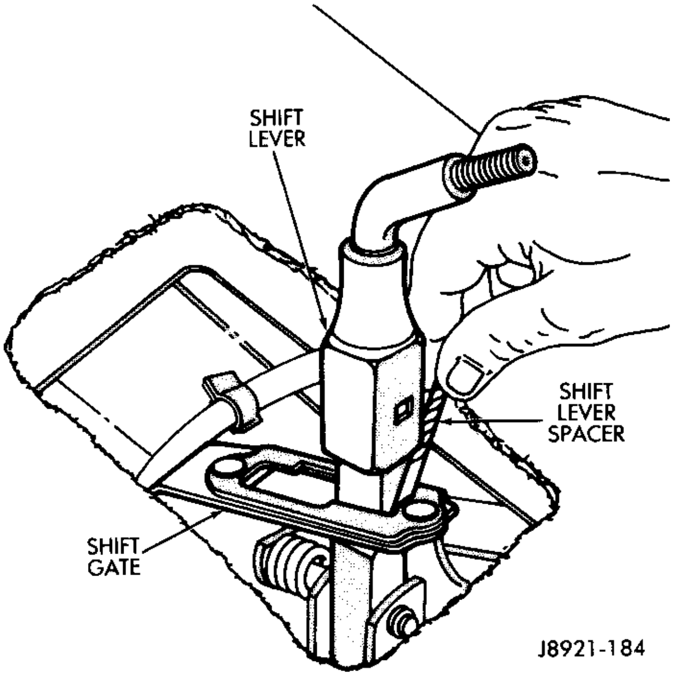


Fig. 6 Installing Shift Lever Spacer—YJ

(3) Drain the transfer case lubricant.

(4) Mark front and rear propeller shaft yokes for alignment reference.

(5) Place a support stand under the transmission.

(6) Remove the rear crossmember.

(7) Disconnect the front/rear propeller shafts at the transfer case.

(8) Disconnect the speedometer cable.

(9) Disconnect the transfer case linkage rod from the range lever.

(10) Disconnect the vent and vacuum hoses.

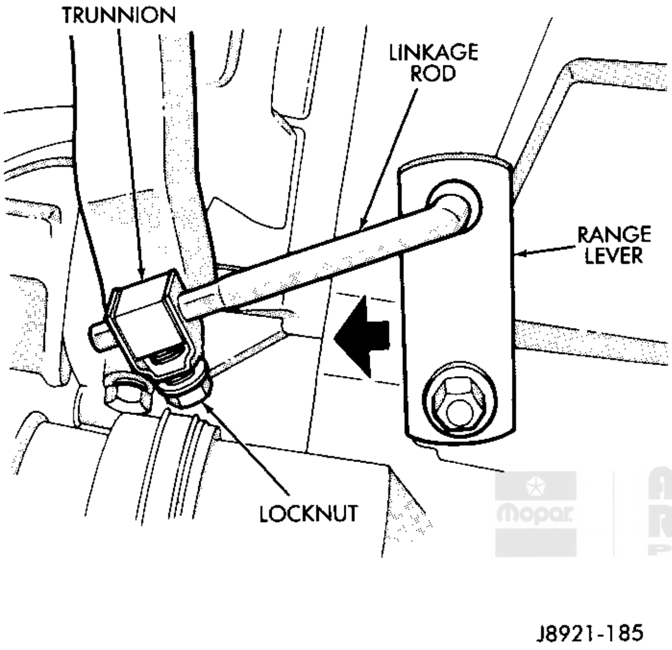


Fig. 7 Shift Linkage—YJ

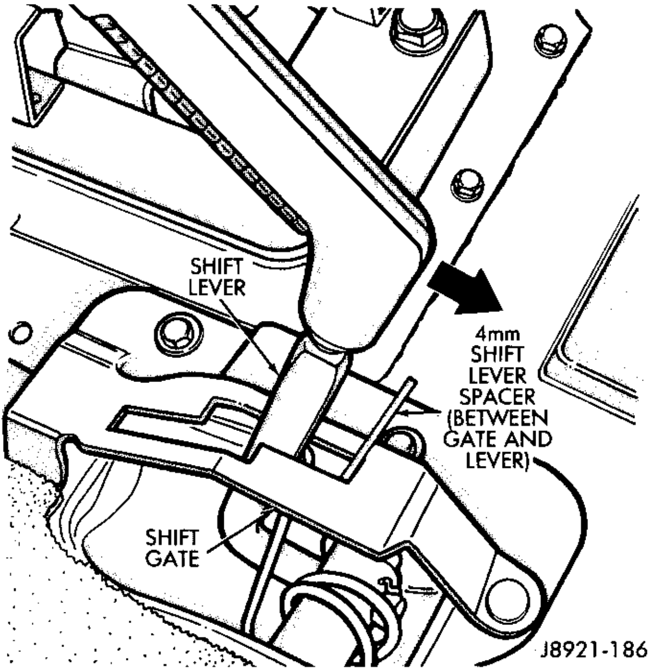


Fig. 8 Installing Shift Lever Spacer—XJ/MJ

(11) Support the transfer case with a transmission jack.

(12) Remove the bolts attaching the transfer case to the transmission.

(13) Secure the transfer case to the jack with chains.

(14) Pull the transfer case and jack rearward to disengage the transfer case.

(15) Remove the transfer case from under the vehicle.

TRANSFER CASE INSTALLATION

(1) Mount the transfer case on a transmission jack. Secure the transfer case to the jack with chains.

(2) Position the transfer case under the vehicle.

(3) Align the transfer case and transmission shafts

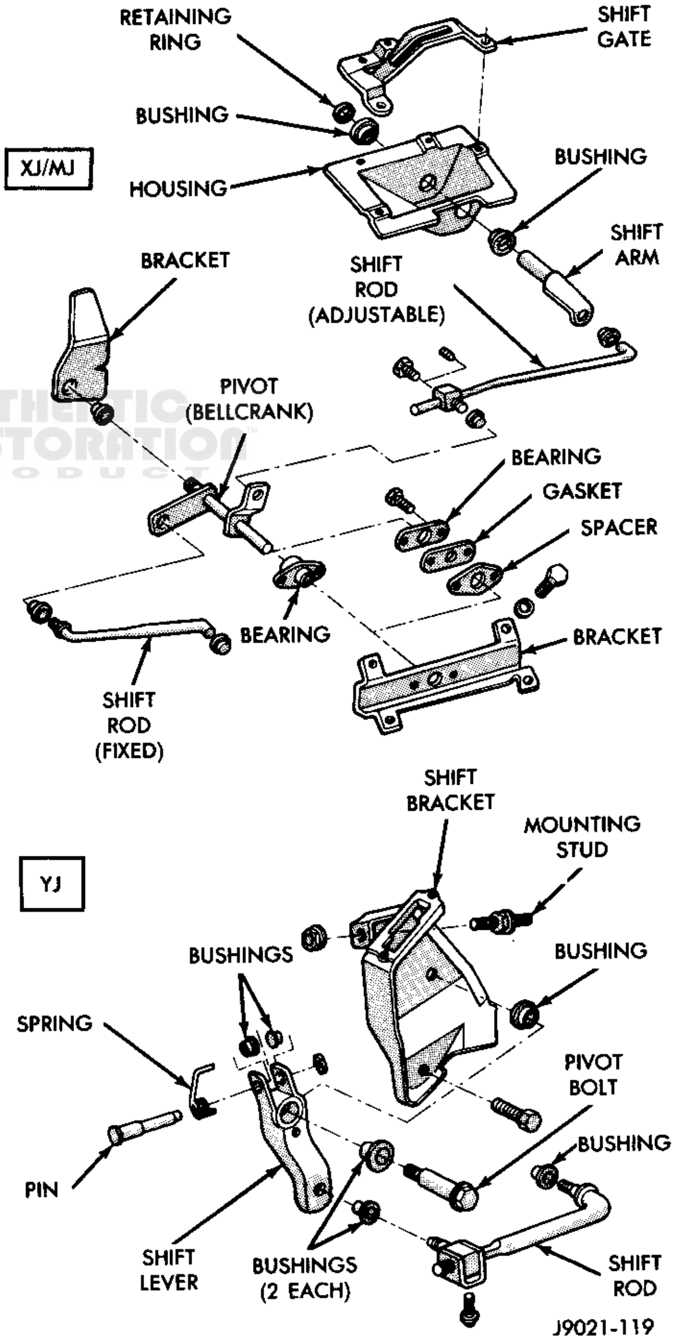


Fig. 9 Shift Linkage—XJ/MJ/YJ

and install the transfer case on the transmission.

(4) Install and tighten the transfer case attaching nuts to 26 ft-lbs (35 N•m) torque.

(5) Connect the speedometer cable, vacuum and vent hoses.

(6) Align and connect the propeller shafts. Tighten the shaft attaching bolts to 170 in-lbs (19 N•m) torque.

(7) Fill the transfer case with Mopar Dexron II™ or Mercon™ automatic transmission fluid.

(8) Install the rear crossmember. Tighten the crossmember bolts to 30 ft-lbs (41 N•m) torque.

(9) Remove the transmission jack and the transmission support stand.

(10) Connect the transfer case range lever to the linkage rod.

(11) Lower the vehicle.

TRANSFER CASE OVERHAUL

Disassembly

(1) Remove the fill and drain plugs.

(2) Remove the front yoke. Discard the yoke seal washer and nut. They are not reusable.

(3) Move the transfer case range lever rearward to 4L position.

(4) Remove the extension housing attaching bolts.

(5) Tap the extension housing in a clockwise direction to break the sealer bead. Then remove the housing (Fig. 10).

CAUTION: To avoid damaging the sealing surfaces of the extension housing and rear retainer, do not attempt to pry or wedge the housing off the retainer.

(6) Remove and discard the rear bearing snap ring (Fig. 11).

(7) Remove the rear retainer attaching bolts.

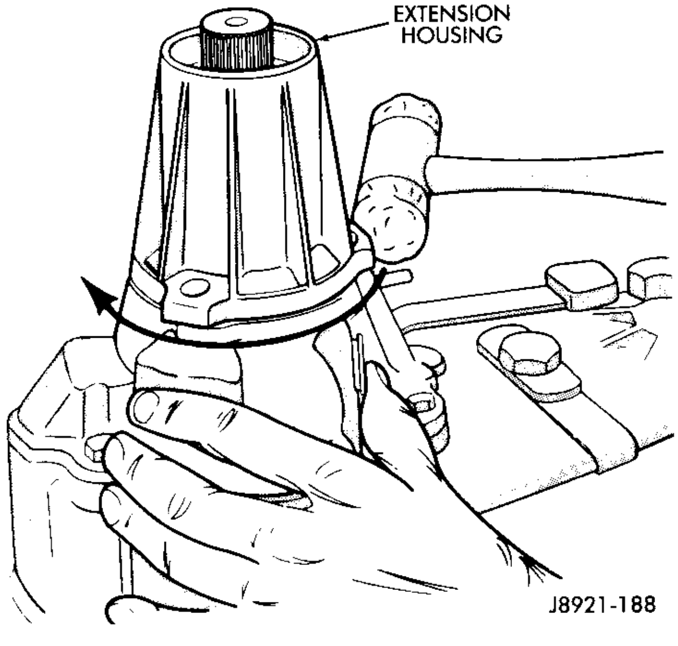


Fig. 10 Extension Housing Removal

(8) Remove the rear retainer. Position a screwdriver under each of the tabs on the retainer housing (Fig. 12). Then carefully pry the retainer upward and off the rear case.

CAUTION: Do not pry against the sealing surfaces of the retainer or rear case. The surfaces could be damaged.

(9) Remove the bolts attaching the rear case to the front case. Retain the bolts and the washers.

(10) Separate the rear case from the front case (Fig. 13) Insert screwdrivers into the slots cast in the case ends. Then gently pry upward to break the sealer bead and loosen the rear case.

CAUTION: Do not pry against the sealing surfaces of the retainer or rear case. The surfaces could be damaged.

(11) Remove the oil pump and rear case as an assembly (Fig. 14).

(12) Slide the oil screen out of the case pocket. Disconnect the screen from the pickup tube and remove the screen (Fig. 15).

(13) Remove the pickup tube from the oil pump (Fig. 15).

(14) Remove the oil pump from the rear case.

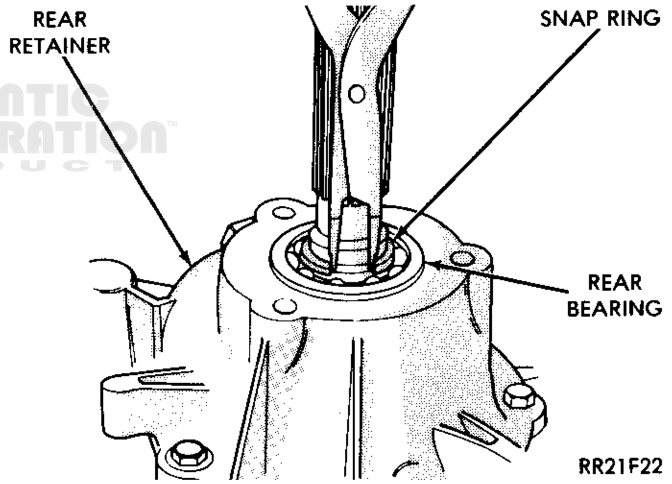


Fig. 11 Rear Bearing Snap Ring Removal

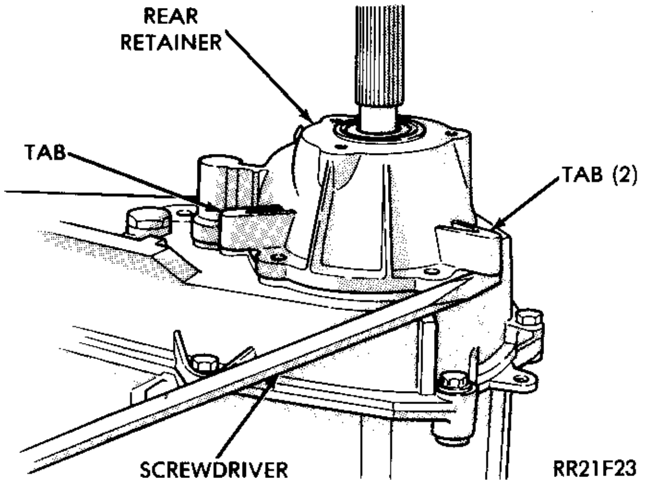


Fig. 12 Rear Retainer Removal

(15) Remove the pickup tube O-ring from the oil pump (Fig. 16).

(16) Mark position of the oil pump housings for reference (Fig. 17).

(17) Remove the screws that attach the two halves of the pump. Remove the feed housing from the gear housing (Fig. 17).

(18) Note position of the pump gears and remove them from the housing (Fig. 17).

(19) Remove the mode spring (Fig. 18).

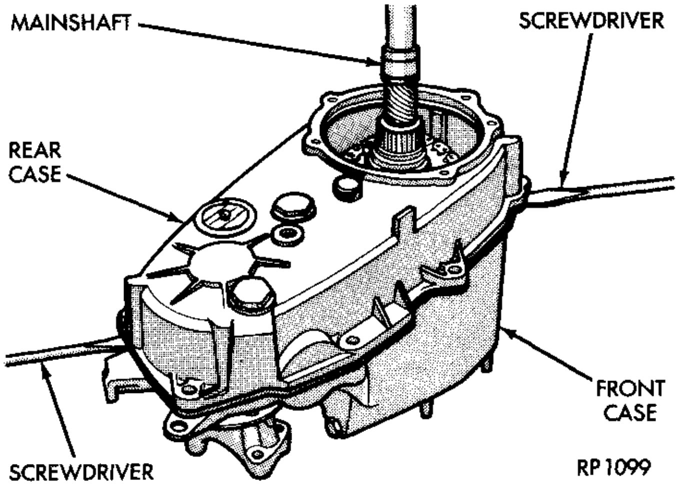


Fig. 13 Loosening Rear Case

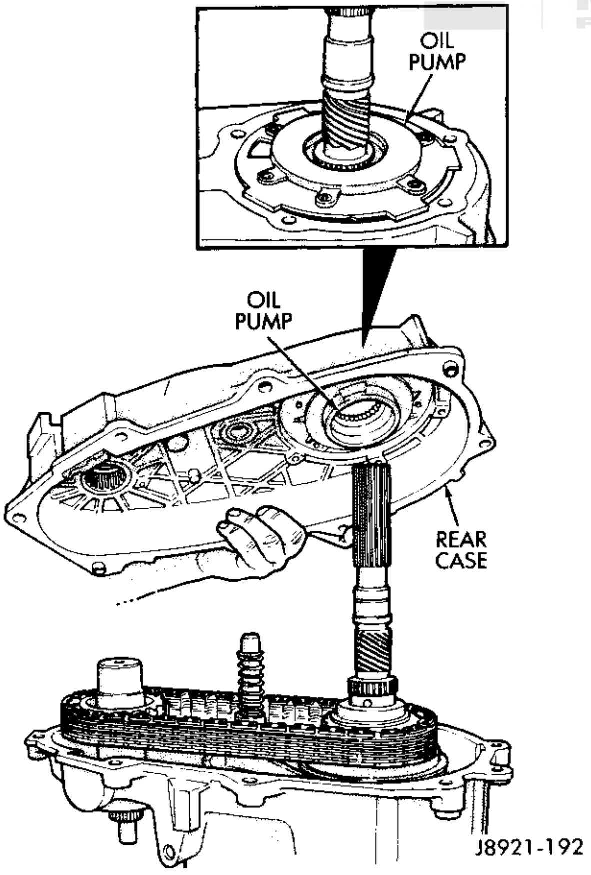


Fig. 14 Rear Case And Oil Pump Removal

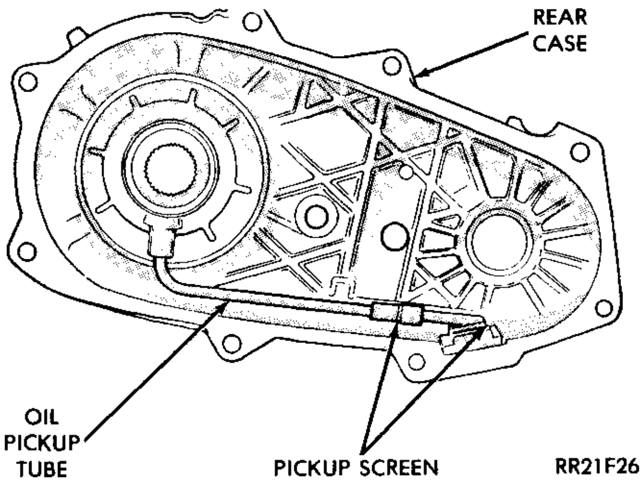


Fig. 15 Removing Oil Screen And Pickup Tube

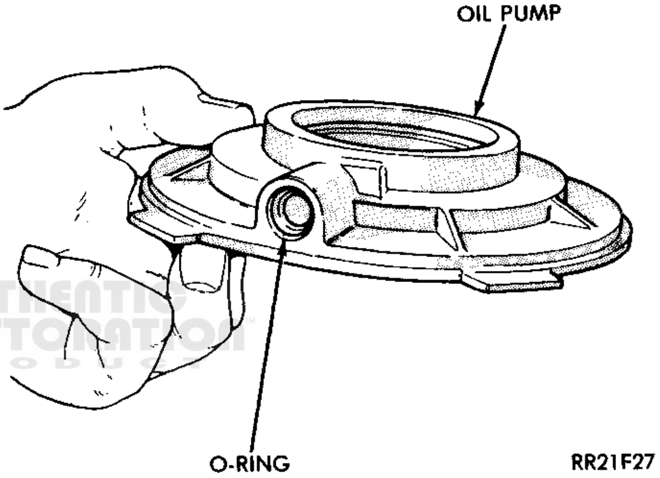


Fig. 16 Pickup Tube O-Ring Location

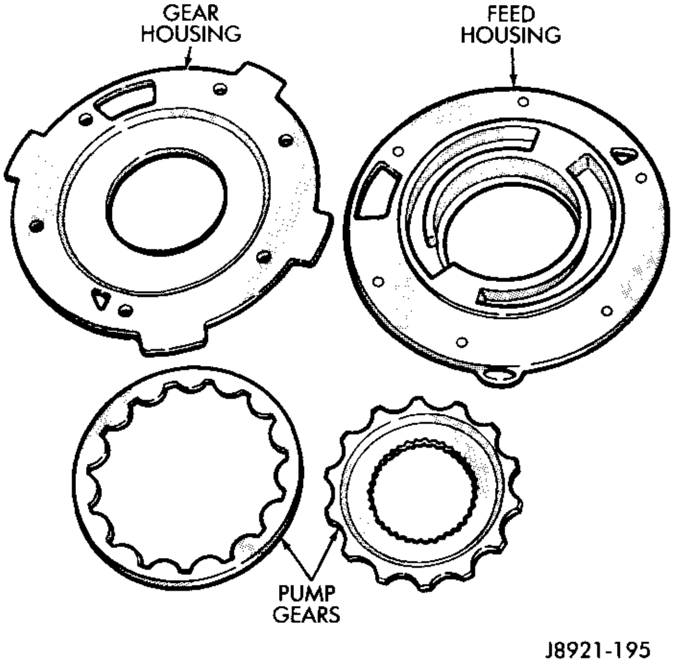


Fig. 17 Oil Pump Components

(20) Tap the front output shaft upward with a rawhide mallet to free it from the shaft bearing.

(21) Remove the front output shaft and drive chain as an assembly (Fig. 19).

(22) Remove the mainshaft, mode fork and shift rail as an assembly (Fig. 20).

(23) Remove the mode fork and shift rail from the synchro sleeve (Fig. 21).

(24) Remove the synchro hub snap ring (Fig. 22).

(25) Remove the synchro sleeve and struts (Fig. 23).

(26) Remove the synchro hub and stop ring (Fig. 24).

(27) Remove the drive sprocket (Fig. 25).

(28) Slide the range fork pin out of the shift sector (Fig. 26).

(29) Remove the range fork and shift hub (Fig. 27).

(30) Remove the transfer case range lever from the sector shaft.

(31) Remove the shift sector (Fig. 28).

(32) Remove the sector shaft bushing and O-ring (Fig. 29).

(33) Remove shift detent pin, spring and plug (Fig. 30).

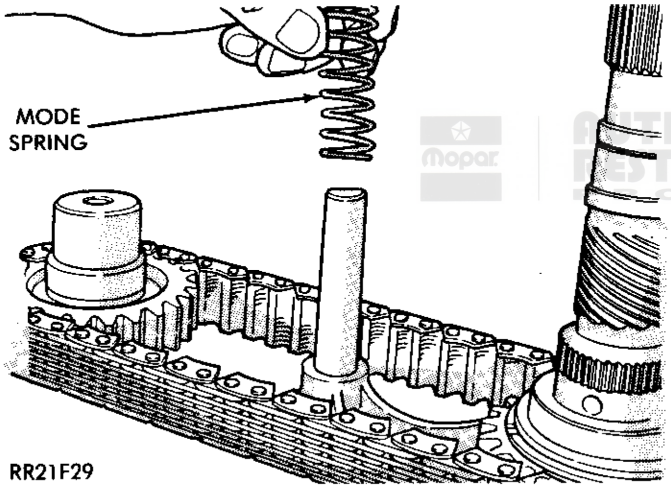


Fig. 18 Mode Spring Removal

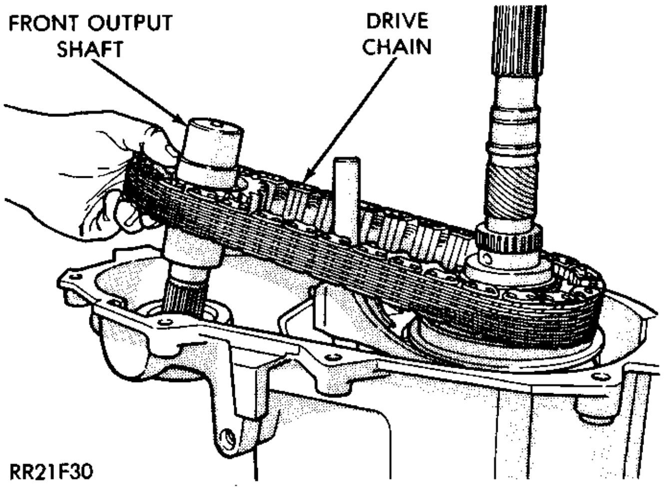


Fig. 19 Front Output Shaft And Drive Chain Removal

(34) Turn the front case over and remove the front bearing retainer bolts (Fig. 31).

(35) Remove the front bearing retainer. Position screwdrivers in the retainer slots and lift upward to loosen and remove the retainer (Fig. 32).

(36) Remove the input gear snap ring (Fig. 33).

(37) Press the input and low range gear assembly out of the input gear bearing with a shop press (Fig. 34).

(38) Remove the low range gear snap ring (Fig. 35).

(39) Remove the retainer, thrust washers and input gear from the low range gear (Fig. 36).

(40) Remove the oil seals from the rear retainer, rear extension housing, oil pump feed housing and case halves.

(41) Remove the magnet from the front case.

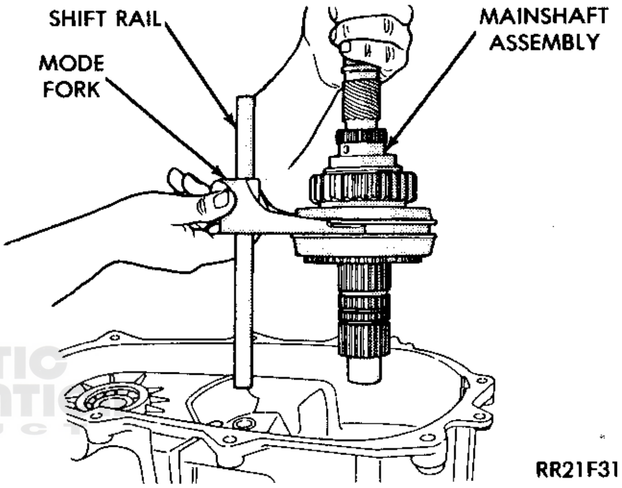


Fig. 20 Removing Mainshaft, Mode Fork And Shift Rail

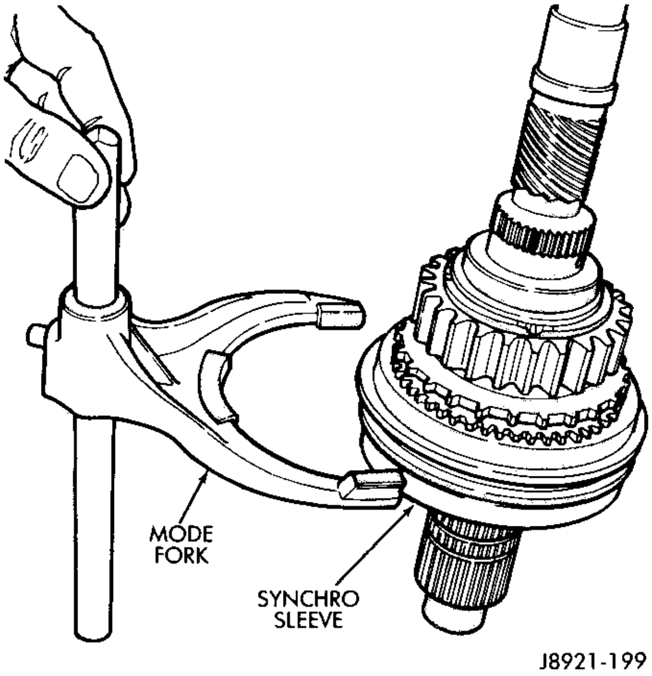


Fig. 21 Removing Mode Fork From Sleeve

(42) Remove the speedometer driven gear, seals and adaptor.

Cleaning And Inspection

Clean the transfer case components thoroughly with solvent. Remove all traces of sealer from the case and retainer seal surfaces.

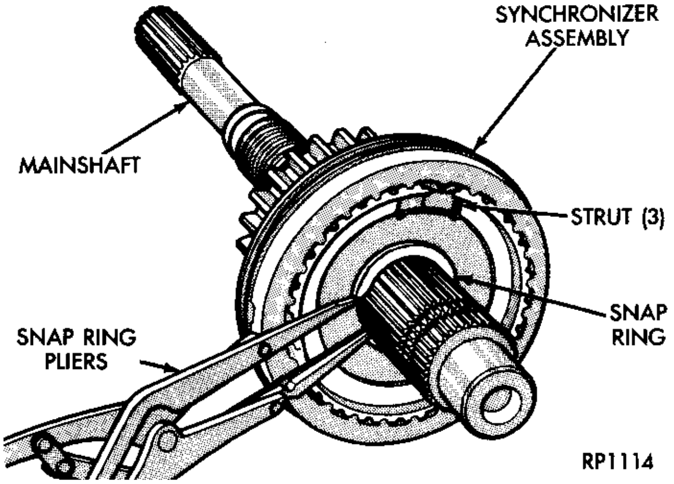


Fig. 22 Synchro Hub Snap Ring Removal/Installation

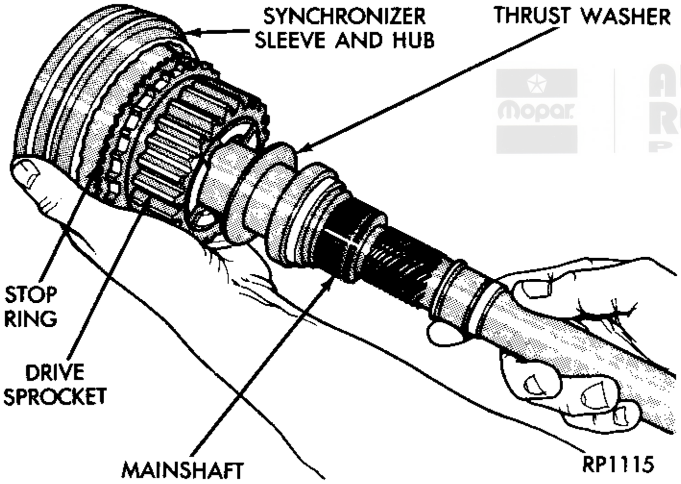


Fig. 23 Remove Synchro Sleeve And Struts

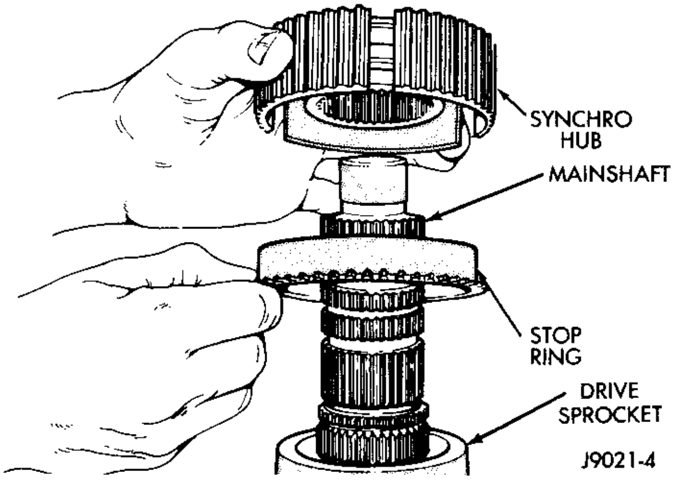


Fig. 24 Removing Synchro Hub And Stop Ring

Clean the oil pickup screen with solvent and dry it with compressed air. Also use compressed air to remove solvent residue from all oil feed passages and channels.

Inspect the low range annulus gear (Fig. 37). **If the gear is damaged, replace the gear and front case as an assembly. Do not attempt to remove the gear.**

Inspect the case halves, extension housing and retainers for cracks, porosity, or damaged sealing surfac-

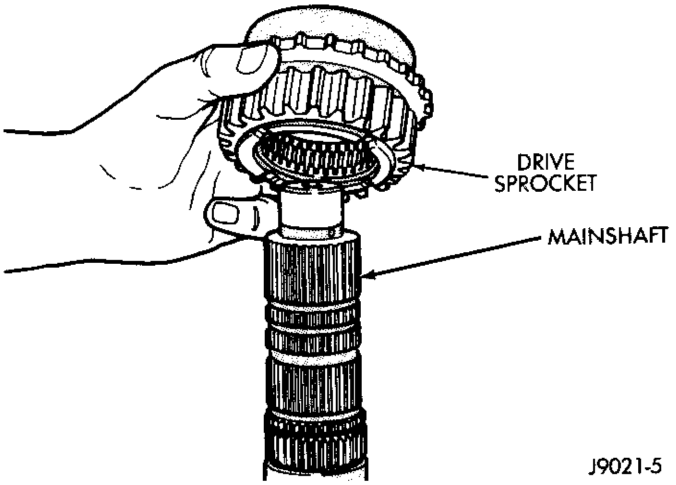


Fig. 25 Drive Sprocket Removal/Installation

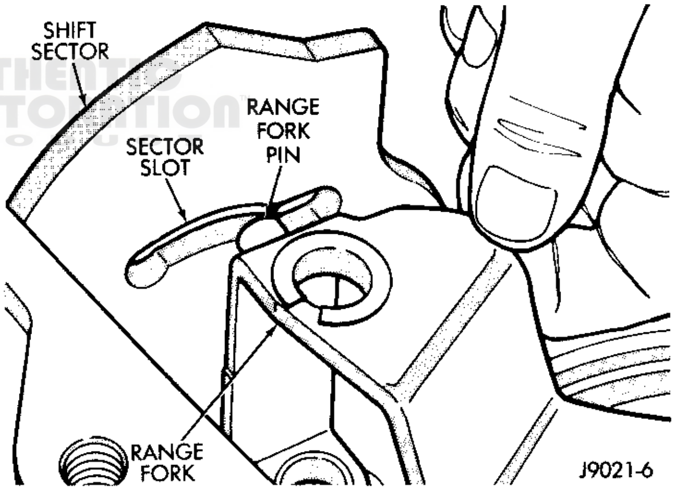


Fig. 26 Disengaging Range Fork

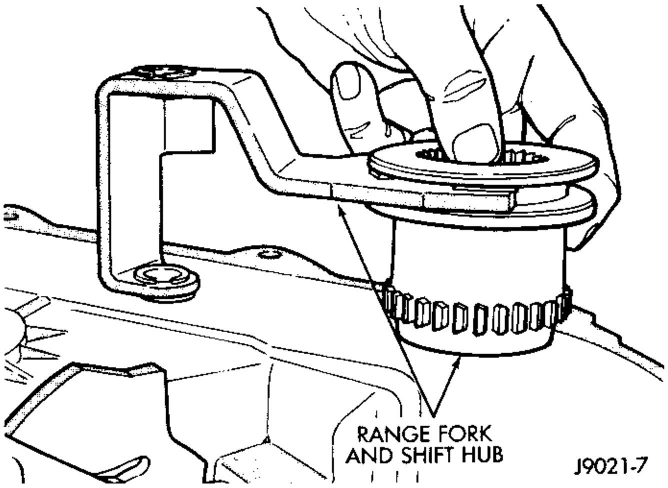


Fig. 27 Range Fork And Hub Removal/Installation

Inspect the shafts, gears, chain and shift components or wear or damage.

Inspect all of the transfer case bearings for wear, roughness, pitting, or galling. Replace worn or damaged bearings as outlined in the assembly section.

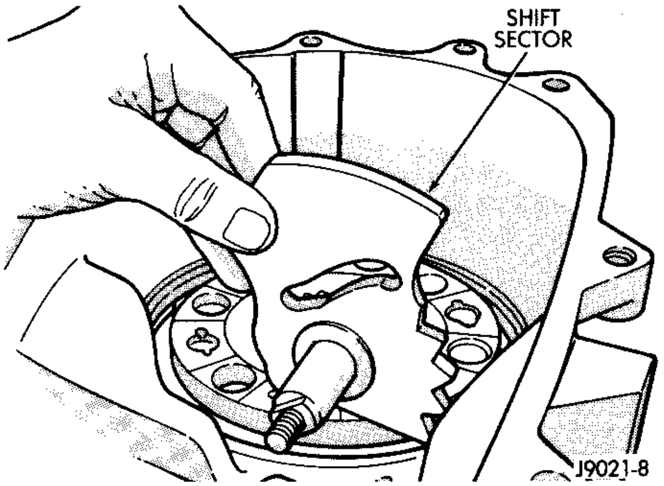


Fig. 28 Shift Sector Removal/Installation

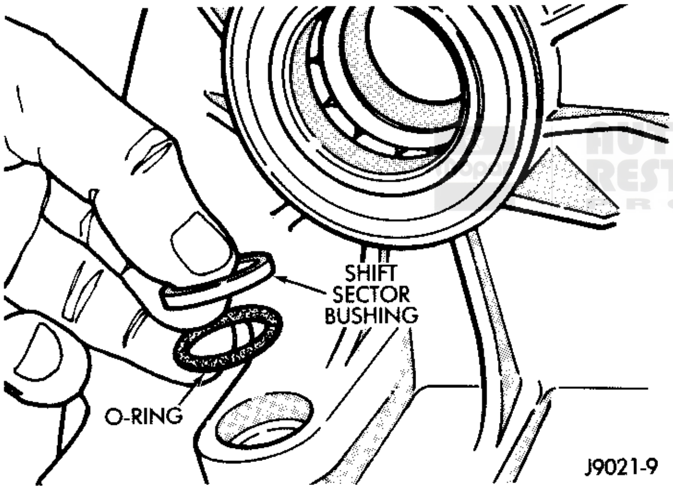


Fig. 29 Removing/Installing Sector Shaft Bushing And O-Ring

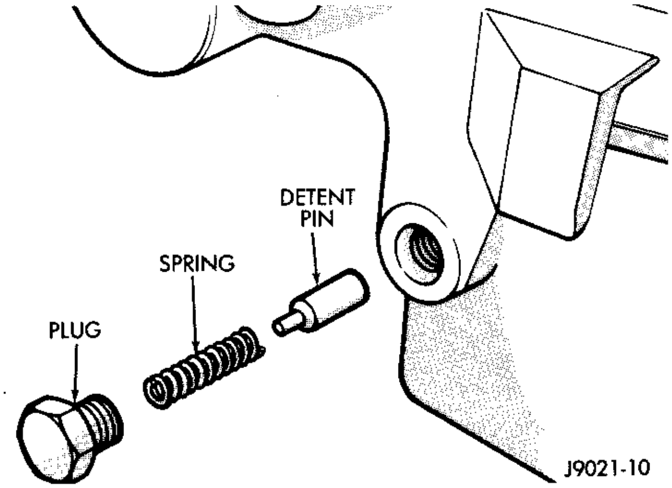


Fig. 30 Detent Removal

Transfer Case Assembly

CAUTION: The bearing bores in various transfer case components contain oil feed holes. Be sure replacement bearings do not block these feed holes.

(1) Lubricate components with automatic transmission fluid (or petroleum jelly where indicated) during assembly.

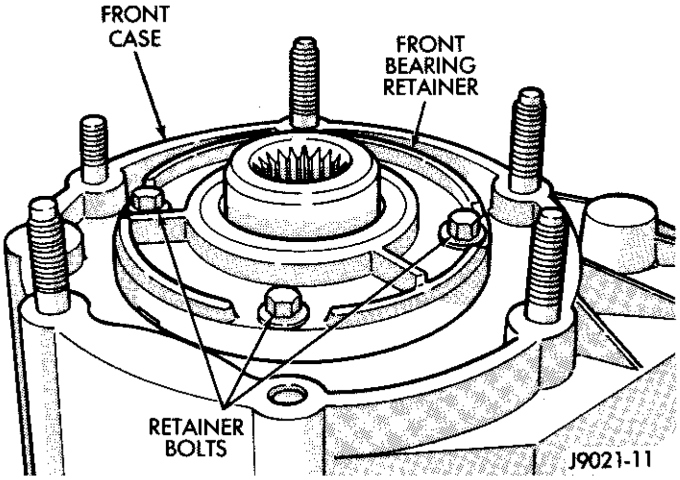


Fig. 31 Front Bearing Retainer Bolt Locations

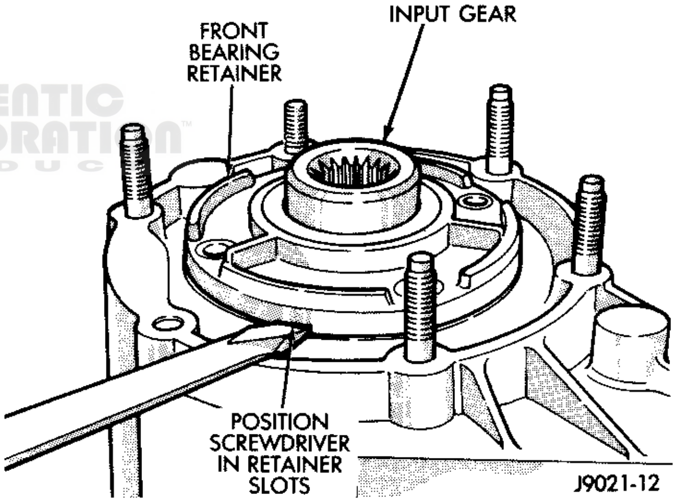


Fig. 32 Removing Front Bearing Retainer

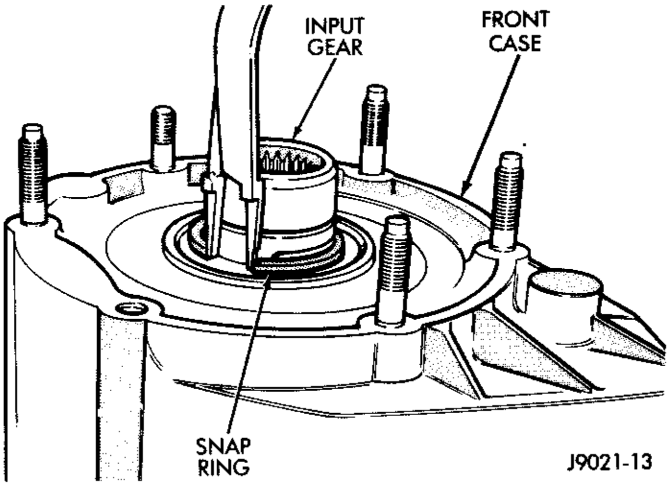


Fig. 33 Removing Input Gear Snap Ring

(2) Remove the front output shaft seal from the front case.

(3) Remove the front output shaft bearing snap ring (Fig. 38).

(4) Tap the old front output shaft bearing out of the front case with a plastic mallet. Then install the ne bearing with driver handle C-4171 and installer to 5064 (Fig. 39).

(5) Secure the front output shaft bearing in the fron case with a new snap ring (Fig. 38).

(6) Install a new front output shaft seal in the front case.

(7) Press the input gear bearing from the front case with handle C-4171 and tool C-4210 (Fig. 40). Then turn the front case over.

(8) Install a snap ring on the new input gear bearing and start the bearing in the case.

(9) Carefully press the input gear bearing into the case until the bearing snap ring seats against the case (Fig. 41).

(10) Remove the mainshaft pilot bearing from the input gear with tool MD-998346 and two suitable size open end wrenches (Fig. 42).

(11) Install the new pilot bearing in the input gear with a shop press and tools C-4171 and 5065 (Fig. 43).

(12) Assemble the low range gear, input gear thrust washers, input gear and input gear retainer (Fig. 44).

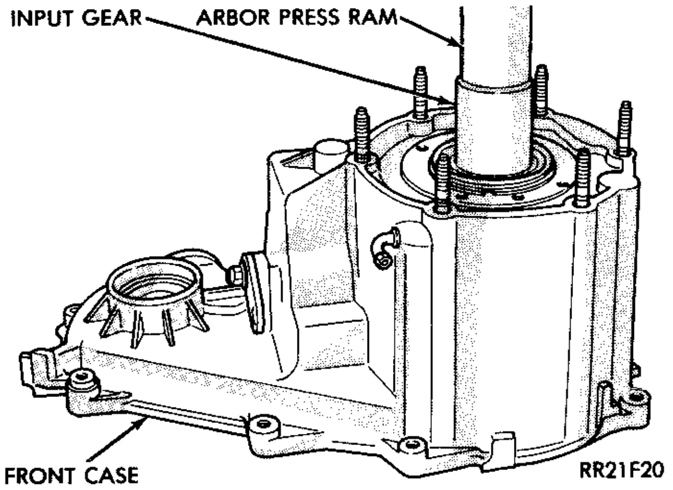


Fig. 34 Removing Input And Low Range Gear Assembly

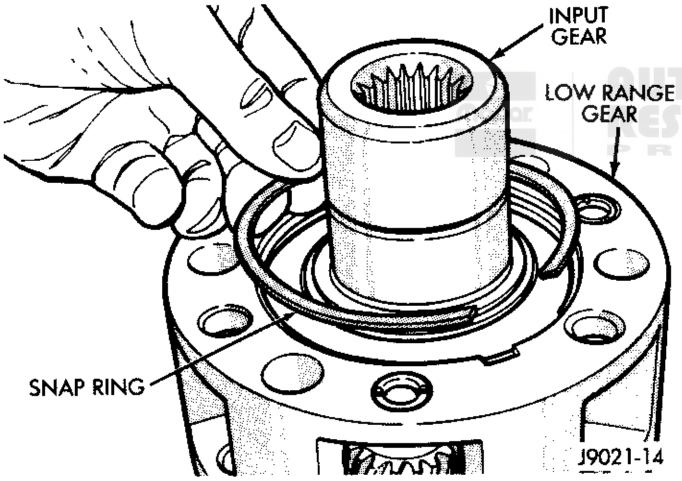


Fig. 35 Removing Low Range Gear Snap Ring

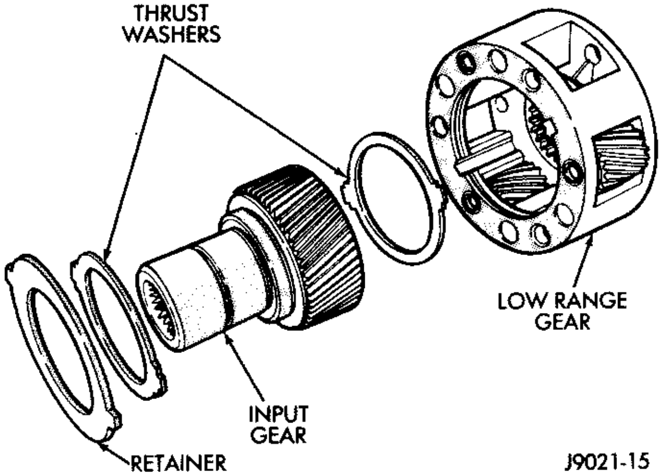


Fig. 36 Input And Low Range Gear Components

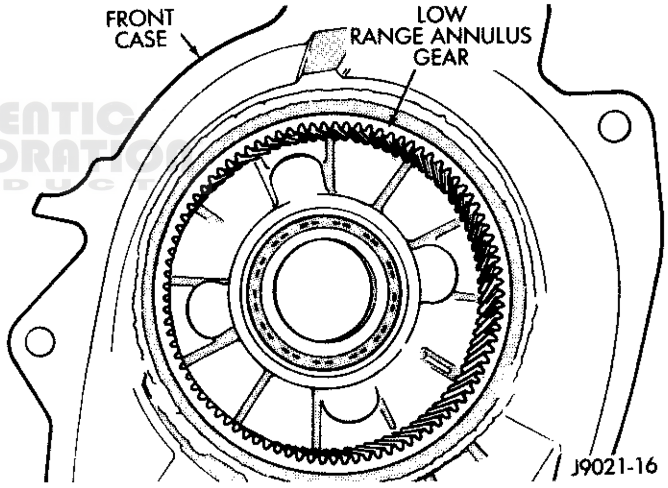


Fig. 37 Inspect Low Range Annulus Gear

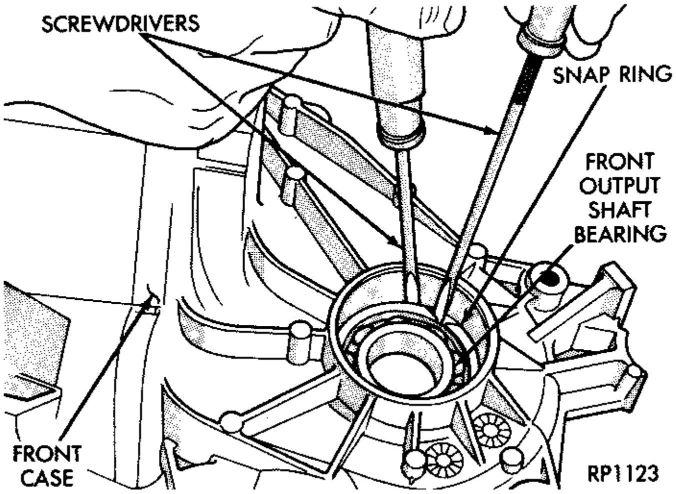


Fig. 38 Removing/Installing Front Output Shaft Bearing Snap

(13) Install the input gear snap ring (Fig. 35).

(14) Lubricate the input gear with automatic transmission fluid.

(15) Start the input gear in the front bearing.

(16) Press the input gear into the front bearing (Fig. 45).

CAUTION: Use a proper size tool to press the input gear into the front bearing. An incorrect tool could push the input gear pilot bearing too far into the gear bore (Fig. 45). Also, do not press against the end surfaces of the low range gear. The gear case and thrust washers could be damaged.

(17) Install the input gear snap ring (Fig. 46).

(18) Install a new oil seal in the front bearing retainer.

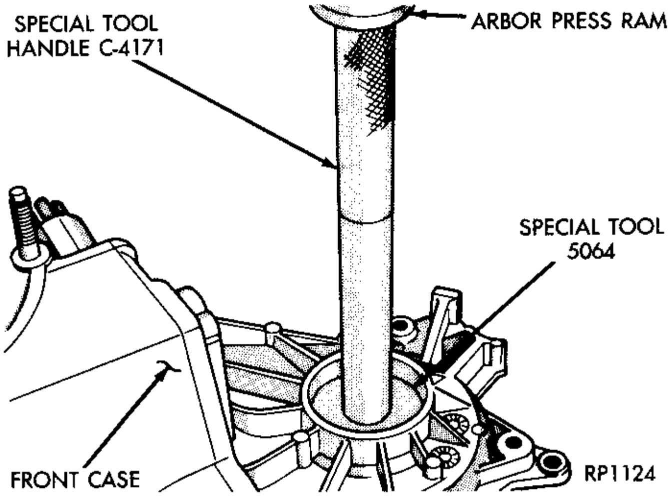


Fig. 39 Installing Output Shaft Front Bearing

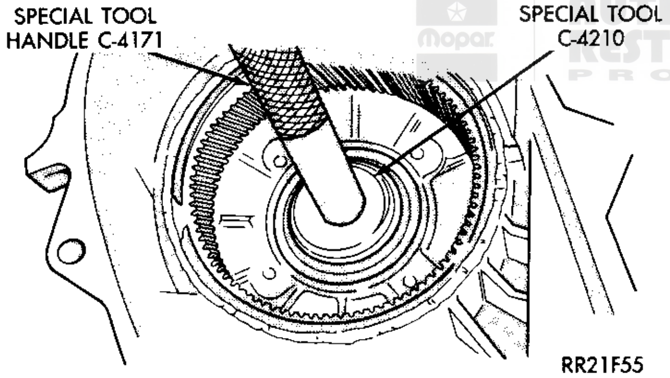


Fig. 40 Removing Input Gear Bearing

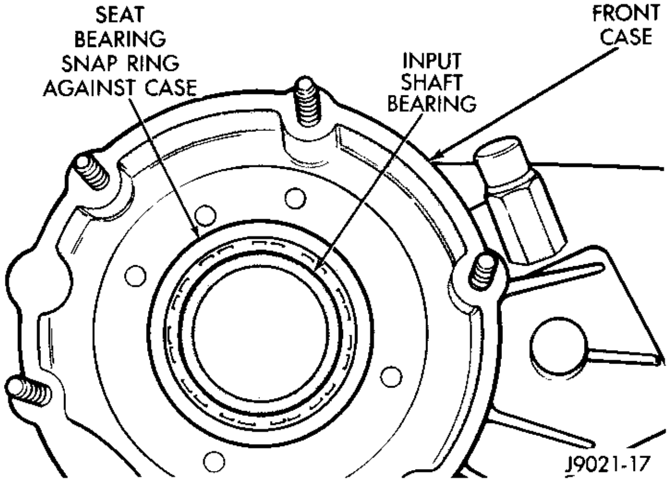


Fig. 41 Input Gear Bearing Installation

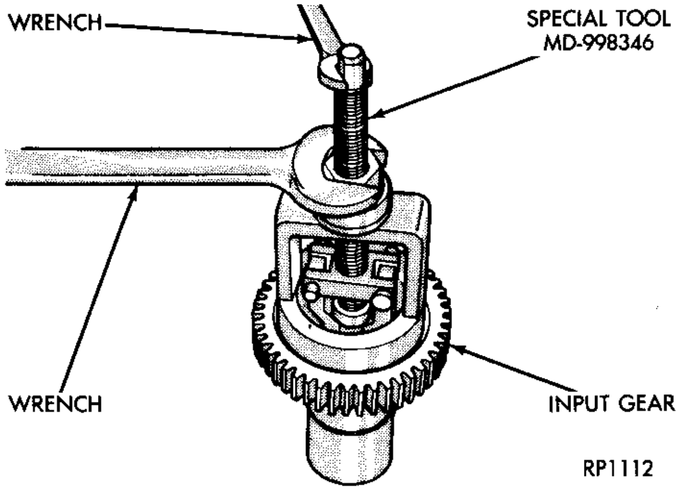


Fig. 42 Removing Mainshaft Pilot Bearing From Input Input Gear

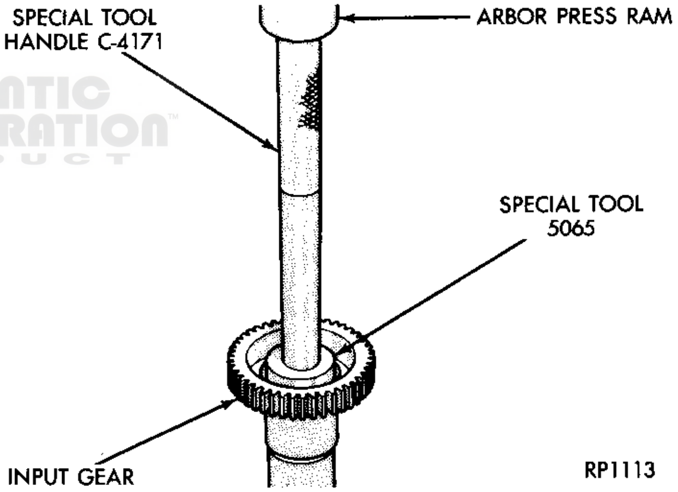


Fig. 43 Installing Mainshaft Pilot Bearing In Input Gear

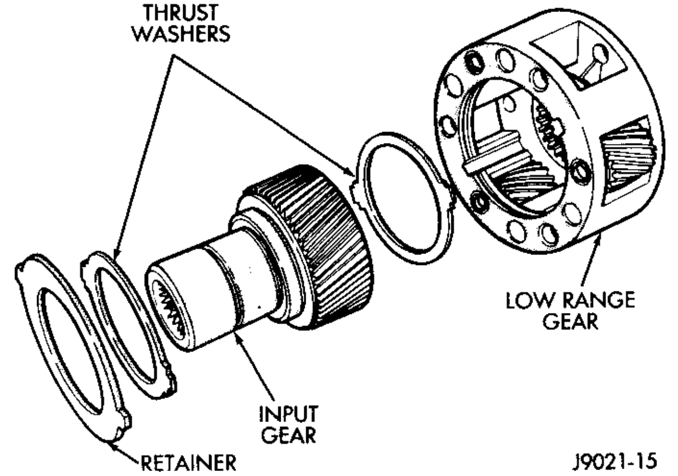


Fig. 44 Input And Low Range Gear Assembly

(19) Apply a 3 mm (1/8 inch) wide bead of Mopar silicone sealer to the front bearing retainer seal surface (Fig. 47).

(20) Install the front bearing retainer on the front case (Fig. 31). Tighten the retainer bolts to 16 ft-lbs (21 N•m) torque.

(21) Install a new sector shaft O-ring and bushing (Fig. 48).

(22) Install the shift sector in the case (Fig. 49).

(23) Install the range lever and lever attaching nut on the shift sector. Tighten the attaching nut to 22 ft-lbs (30 N•m) torque.

(24) Install the detent pin, spring and plug (Fig. 50). Tighten the plug to 15 ft-lbs (20 N•m) torque.

(25) Install new pads and shift rail bushings in the range fork (Fig. 51).

(26) Assemble the range fork and shift hub (Fig. 52).

(27) Engage the range fork pin in the sector slot (Fig. 53).

(28) If the drive sprocket bearings are to be replaced, install them as follows:

(a) Press both bearings out of the sprocket simultaneously with tool C-4667, or with tool 5066 and driver handle C-4171 (Fig. 54).

(b) Before installing the new bearings, refer to Figure 55 and note correct bearing position in the sprocket. The bearings must be also be installed in the proper sequence. Install the front bearing first and the rear bearing last.

CAUTION: Do not press the bearings any farther into the sprocket than indicated in Figure 55. The bearings could block the mainshaft oil feed hole if pressed too deeply into the sprocket.

(c) Install the new **front** bearing first. Press the bearing flush with the edge of the sprocket bore (Fig. 56).

(d) Install the new **rear** bearing (Fig. 57). Press the bearing in until it is 4.6 mm (3/16 inch) below the edge of the bore as shown in Figure 55.

(29) Install the spring and three struts in the synchro hub (Fig. 58).

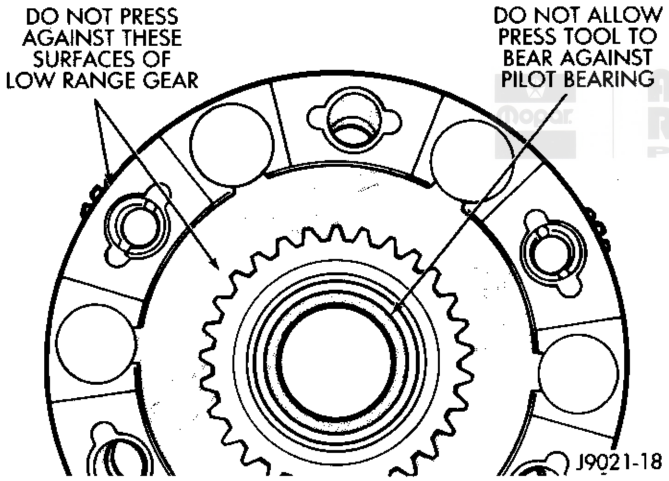


Fig. 45 Input And Low Range Gear Installation

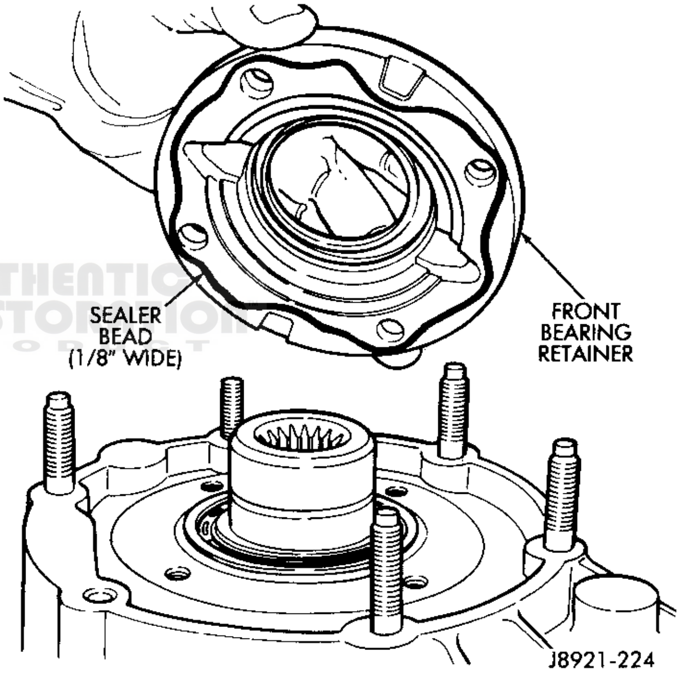


Fig. 47 Applying Sealer To Front Bearing Retainer

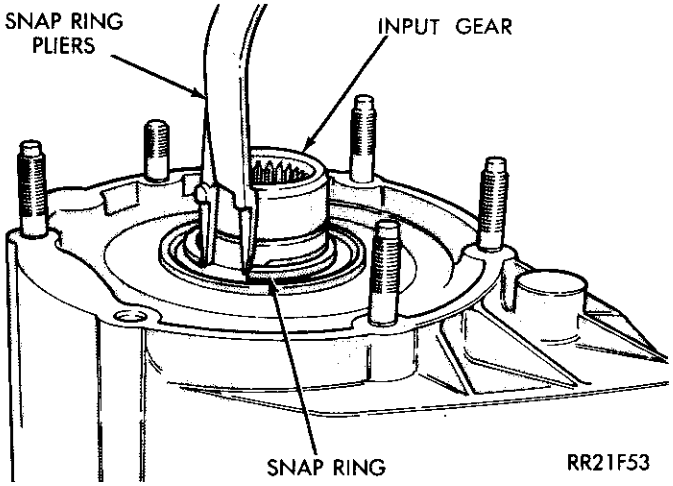


Fig. 46 Installing Input Gear Snap Ring

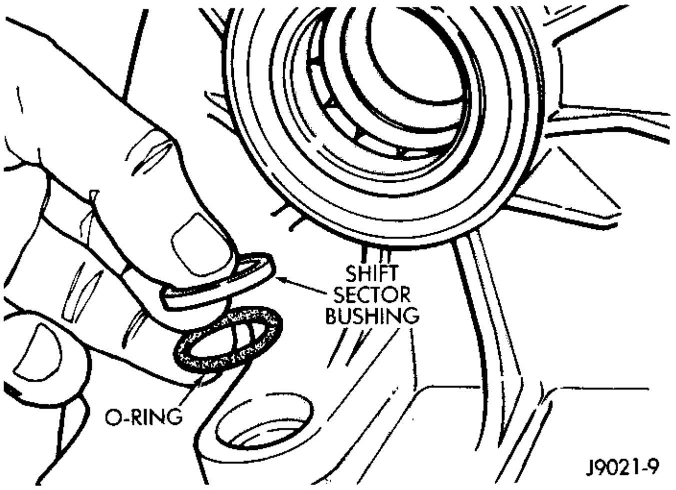


Fig. 48 Installing Sector O-Ring And Bushing

(30) Lubricate the drive sprocket bearings, the stop ring and the synchro hub with automatic transmission fluid.

(31) Install the sprocket, stop ring and synchro hub on the mainshaft (Fig. 59). **Be sure to seat the hub struts on the stop ring lugs.**

(32) Install a new synchro hub snap ring (Fig. 60).

(33) Install the sleeve on the synchro hub. Be sure the sleeve is installed with the beveled spline ends facing the stop ring.

(34) Install new pads on the mode fork and install the shift rail in the fork.

(35) Engage the mode fork in the synchro sleeve (Fig. 61).

(36) Install the mode fork-mainshaft assembly in the case (Fig. 61). Be sure the mode fork rail is seated in

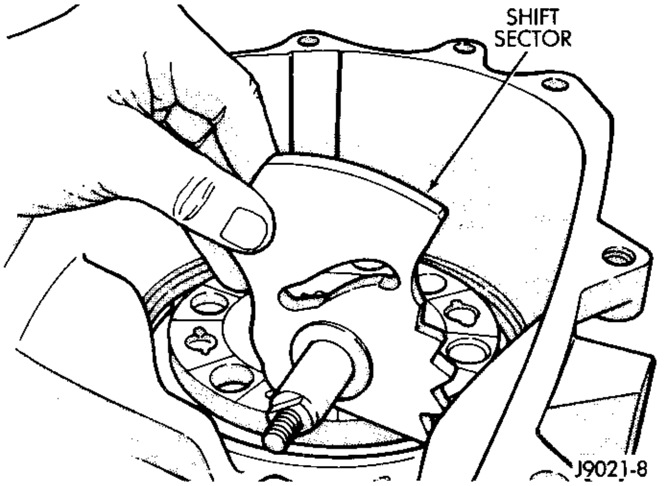


Fig. 49 Installing Shift Sector

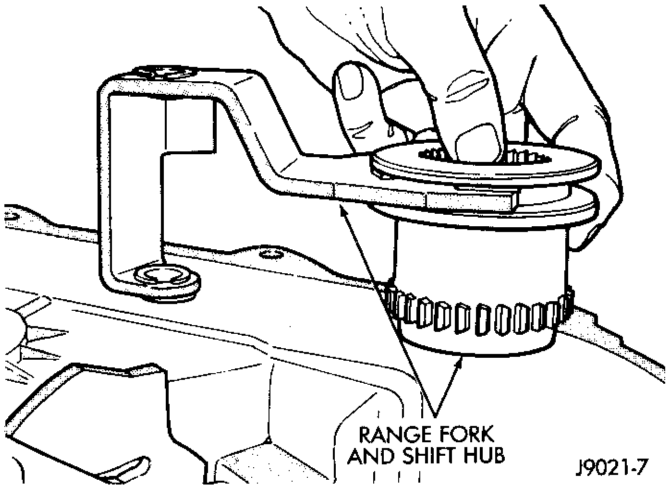


Fig. 52 Assembling Range Fork And Shift Hub

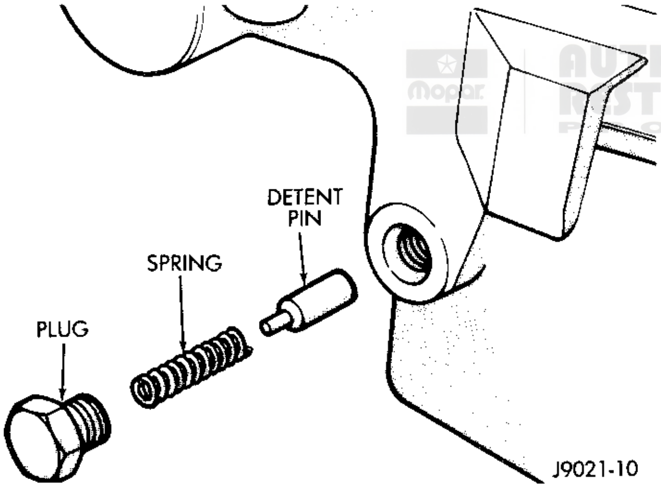


Fig. 50 Installing Detent Pin-Spring-Plug

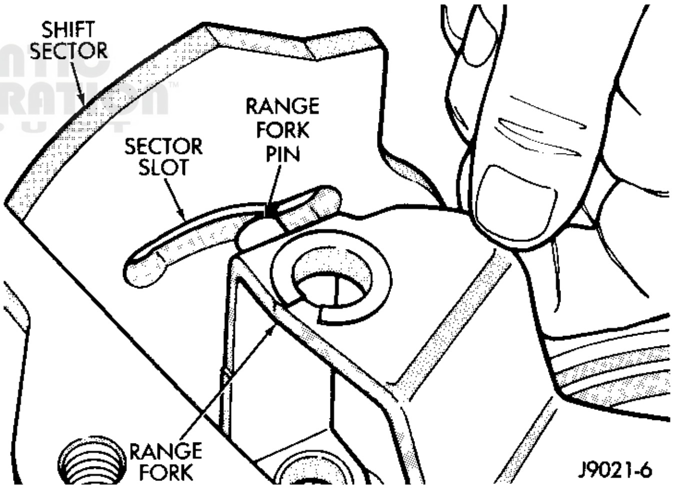


Fig. 53 Seating Range Fork In Sector

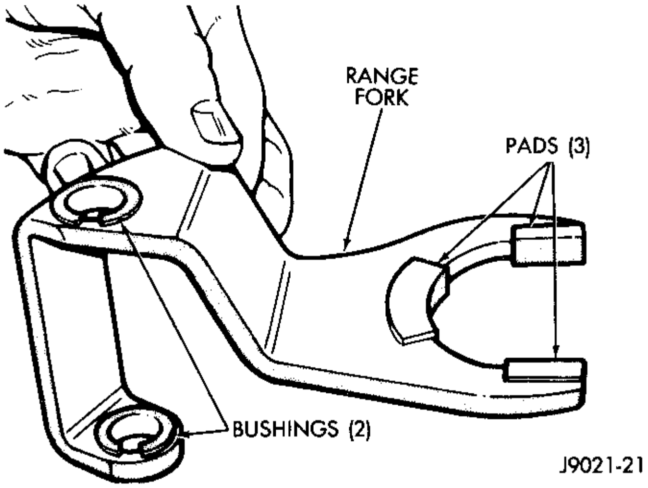


Fig. 51 Installing Range Fork Pads And Bushings

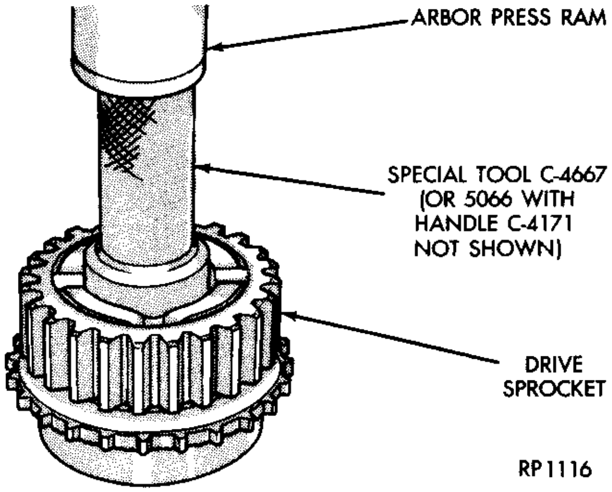


Fig. 54 Removing Drive Sprocket Bearings

both of the range fork bushings.

(37) Assemble and install the output shaft and drive chain (Fig. 62). Lift the mainshaft slightly to ease chain and shaft installation.

(38) Install the mode spring on the shift rail (Fig. 63).

(39) If the front output shaft rear bearing is to be replaced, install the new bearing as follows:

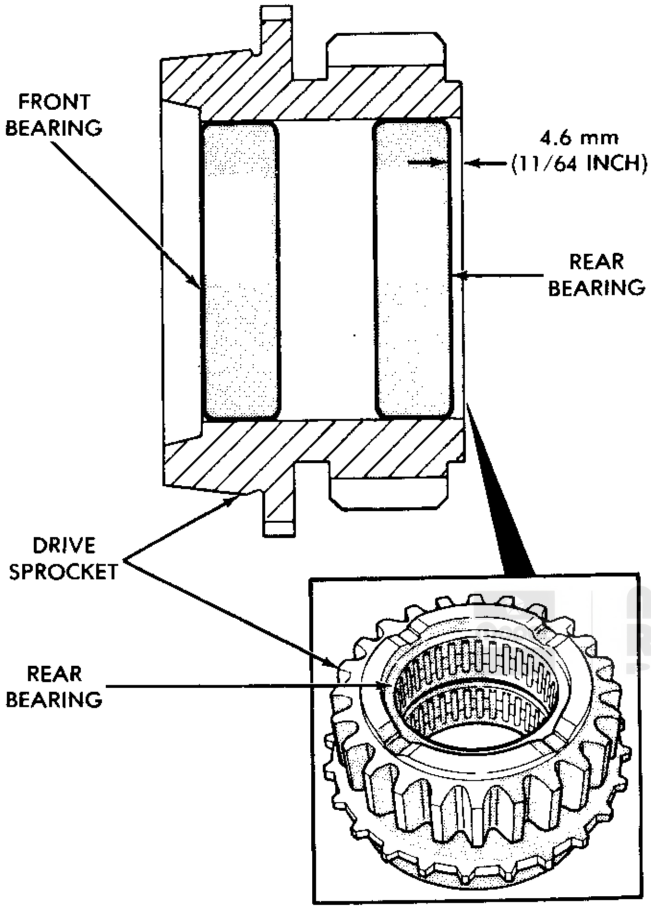


Fig. 55 Correct Position Of Bearings In Sprocket

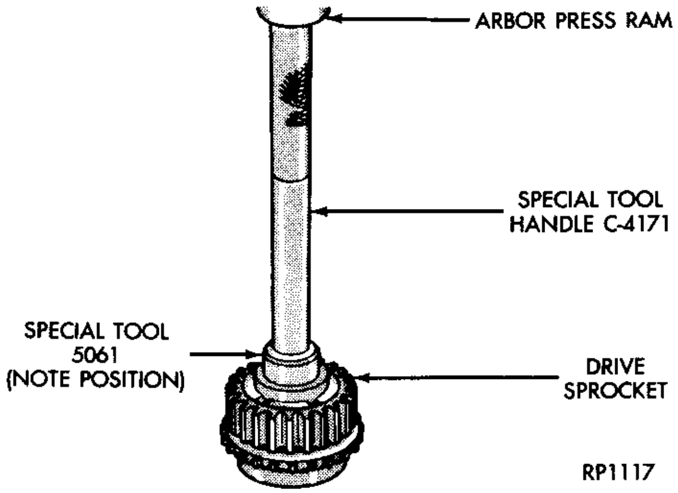


Fig. 56 Installing Drive Sprocket Front Bearing

(a) Remove the bearing from the rear case with tool MD-998346 and two suitable size wrenches (Fig. 64).

(b) Seat the new bearing in the rear case with driver handle C-4171 and installer tool 5063 (Fig. 65).

(40) Install a new seal in the oil pump feed housing (Fig. 66).

(41) Assemble the oil pump. Lubricate and install the two gears in the gear housing. Align and install the feed housing on the gear housing (Fig. 67).

(42) Install and tighten the oil pump screws to 14 in-lbs (1.6 N•m) torque.

(43) Install a new pickup tube O-ring in the oil pump (Fig. 68).

(44) Insert the oil pickup tube in the oil pump. Then attach the oil screen and connecting hose to the pickup tube (Fig. 69).

(45) Install the assembled oil pump, pickup tube and screen in the rear case. Be sure the screen is seated in the case slot as shown (Fig. 69).

(46) Install the magnet in the front case.

(47) Apply 3 mm (1/8 inch) wide bead of Mopar silicone sealer to the seal surface of the front case.

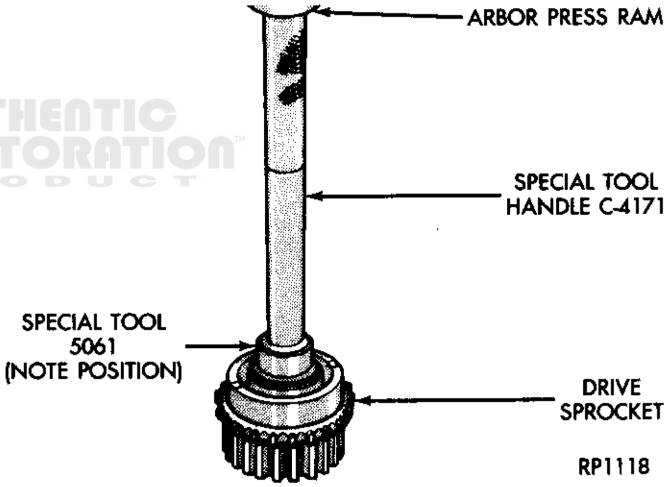


Fig. 57 Installing Drive Sprocket Rear Bearing

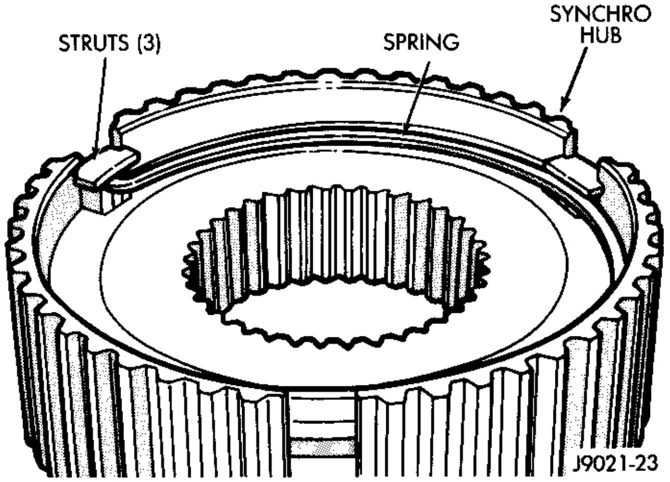


Fig. 58 Installing Synchro Hub Spring And Struts

(48) Align and install the rear case on the front case (Fig. 70). Be sure case locating dowels are in place and that mainshaft splines are engaged in the oil pump inner gear.

(49) Install and tighten the front case-to-rear case attaching bolts to 30 ft-lbs (41 N•m) torque. **Be sure to install a washer under each of the bolts used at the case dowel locations.**

(50) Install the mainshaft rear bearing in the rear retainer (Fig. 71). Tap the old bearing out of the retainer with a hammer and brass drift. Then install the new bearing with handle C-4171 and installer 5064.

(51) Apply 3 mm (1/8 inch) wide bead of Mopar silicone sealer to the flange surface of the rear retainer.

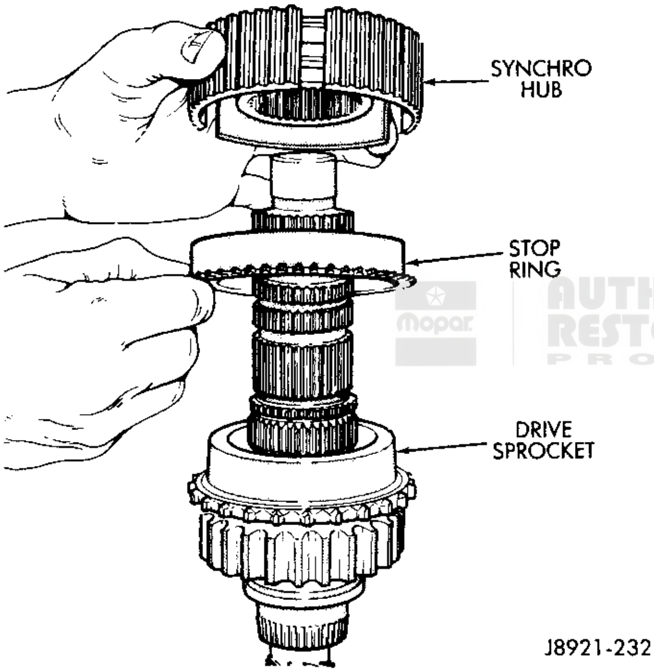


Fig. 59 Drive Sprocket, Stop Ring And Synchro Hub Installation

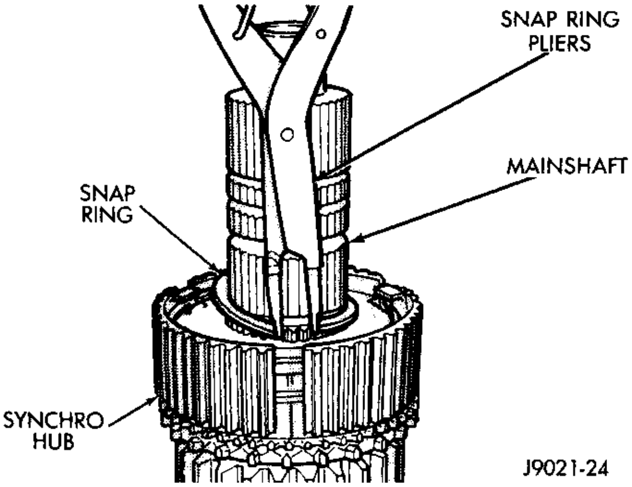


Fig. 60 Installing Synchro Hub Snap Ring

(52) Install the locating dowel in the rear retainer and install the retainer on the case. Tighten the retainer bolts to 18 ft-lbs (24 N•m) torque.

(53) Install a new rear bearing snap ring (Fig. 72). Lift the mainshaft slightly to seat the snap ring in the shaft groove.

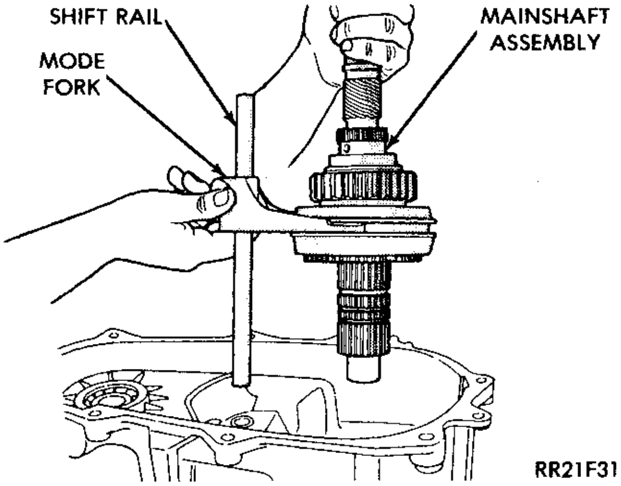


Fig. 61 Installing Mainshaft And Mode Fork Assembly

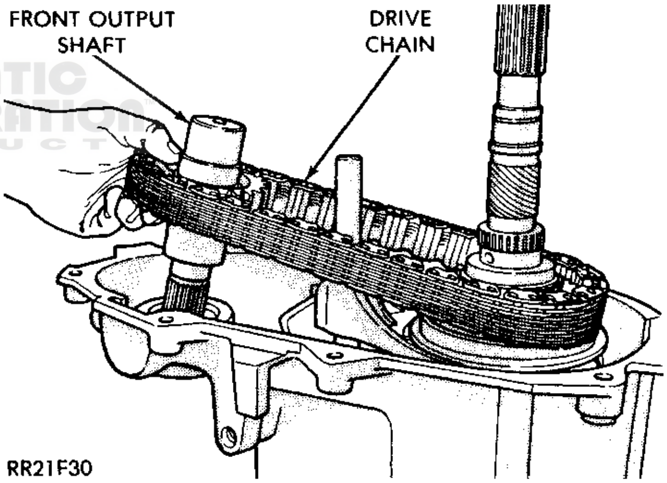


Fig. 62 Drive Chain And Front Output Shaft Installation

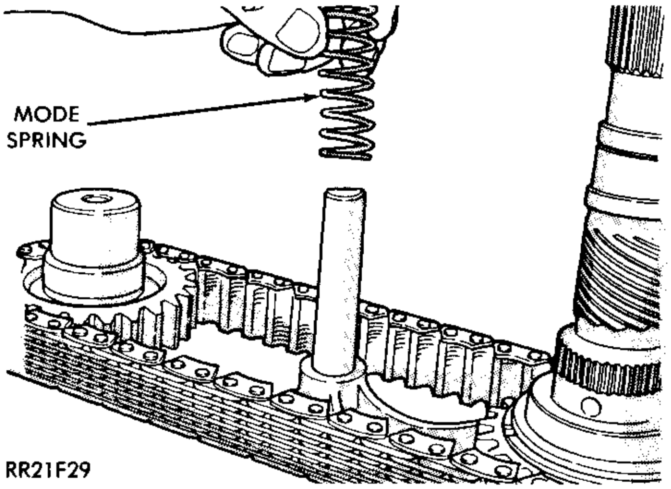


Fig. 63 Installing Mode Spring

(54) Remove the extension housing seal if not removed previously.

(55) Remove the extension housing bushing with bushing driver tools C-4171 and C-4338-A (Fig. 73).

(56) Install a new extension housing with tools C-4171 and 5066 (Fig. 74).

(57) Install new seal in the extension housing.

(58) Apply 3 mm (1/8 inch) wide bead of Mopar silicone sealer to the mating surface of the extension housing.

(59) Install the extension housing on the case and tighten the housing bolts to 30 ft-lbs (41 N•m) torque.

(60) Install the front yoke. Secure the yoke with a replacement seal washer and nut. Tighten the nut to 110 ft-lbs (149 N•m) torque.

(61) Install a replacement gasket on the vacuum switch and install the switch in the case.

(62) Install and tighten the drain plug to 35 ft-lbs (47 N•m) torque.

(63) Install the vacuum switch in the case. Tighten the switch to 35 ft-lbs (47 N•m) torque.

(64) Install the speedometer driven gear, seals and adapter (Fig. 75).

(65) Fill the transfer case with Mopar Dexron II™ or Mercon™ automatic transmission fluid after installation.

(66) Install and tighten the fill plug to 35 ft-lbs (41 N•m) torque.

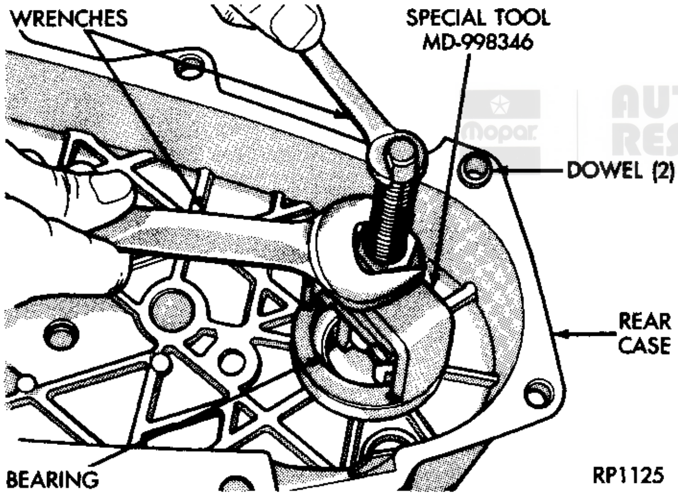


Fig. 64 Removing Front Output Shaft Rear Bearing

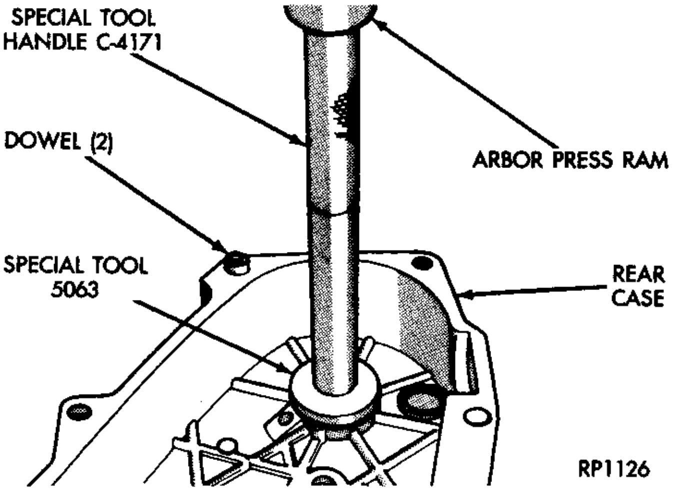


Fig. 65 Installing Front Output Shaft Rear Bearing

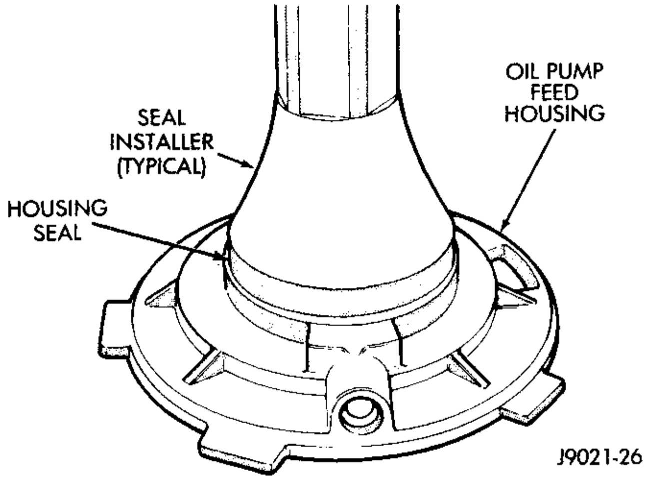


Fig. 66 Installing Oil Pump Feed Housing Seal

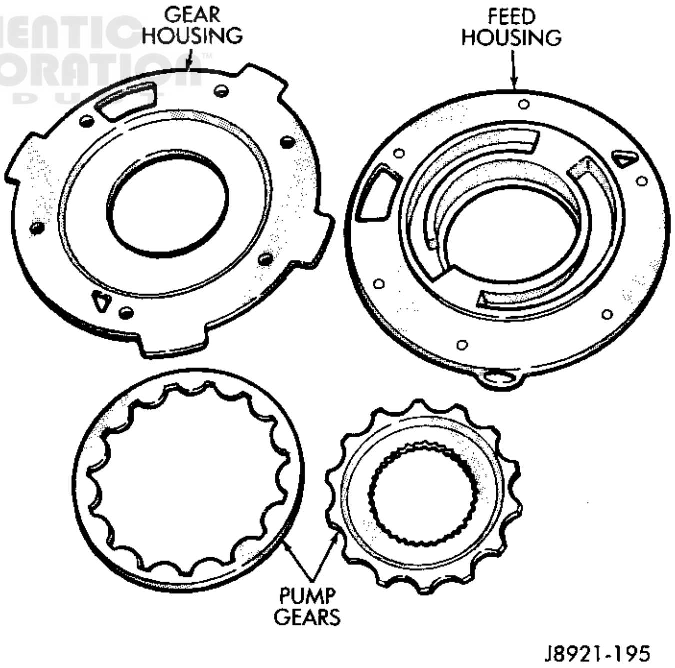


Fig. 67 Oil Pump Assembly

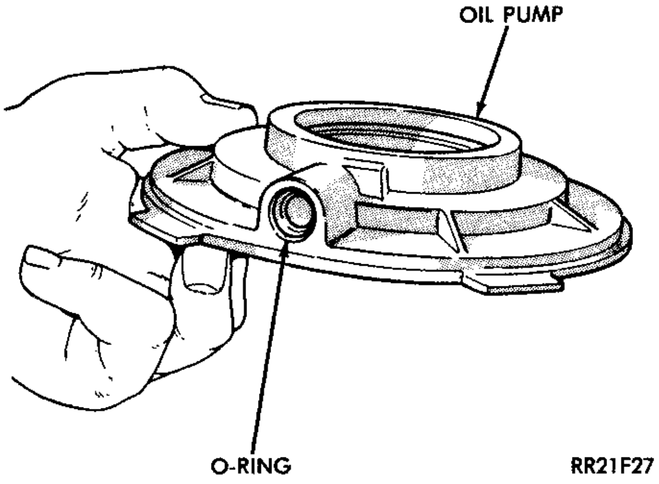


Fig. 68 Install Pickup Tube O-Ring

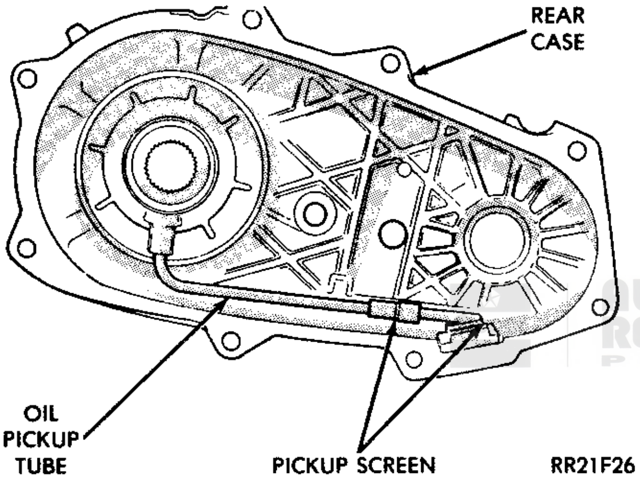


Fig. 69 Install Pickup Tube, Oil Screen And Pump

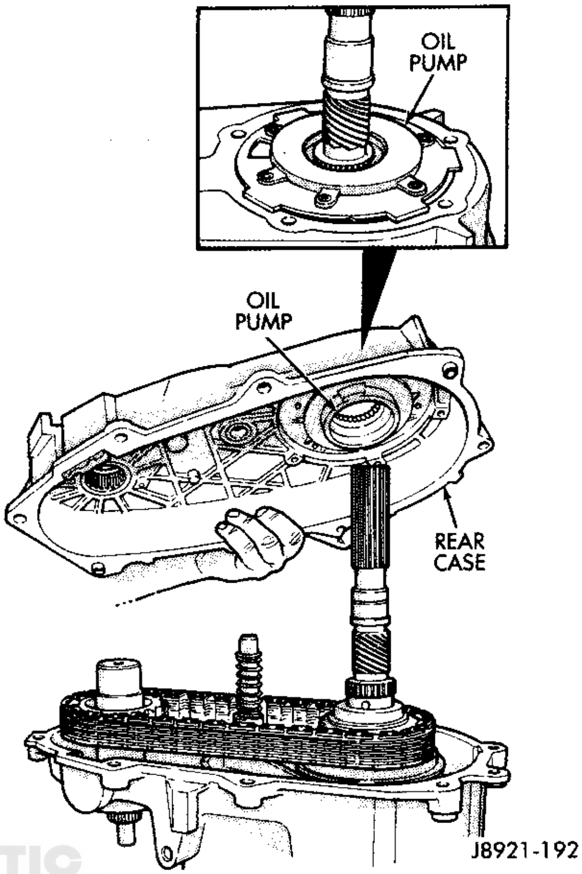


Fig. 70 Installing Rear Case On Front Case

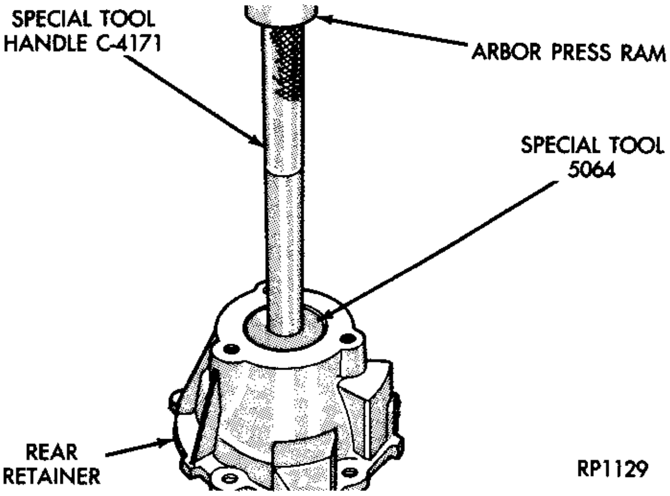


Fig. 71 Installing Mainshaft Rear Bearing In Rear Retainer

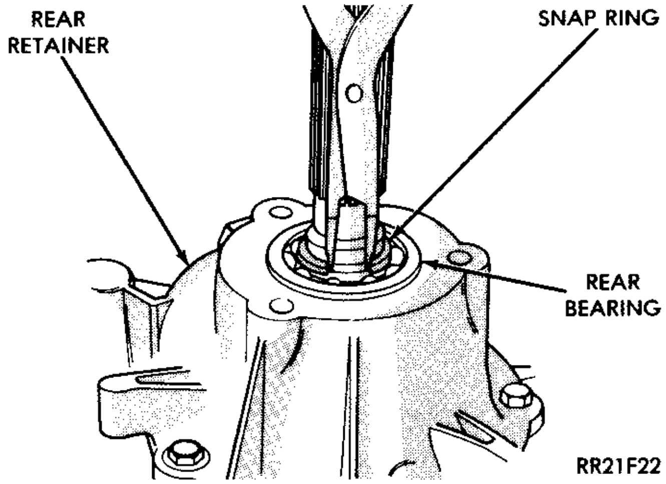


Fig. 72 Installing Rear Bearing Snap Ring

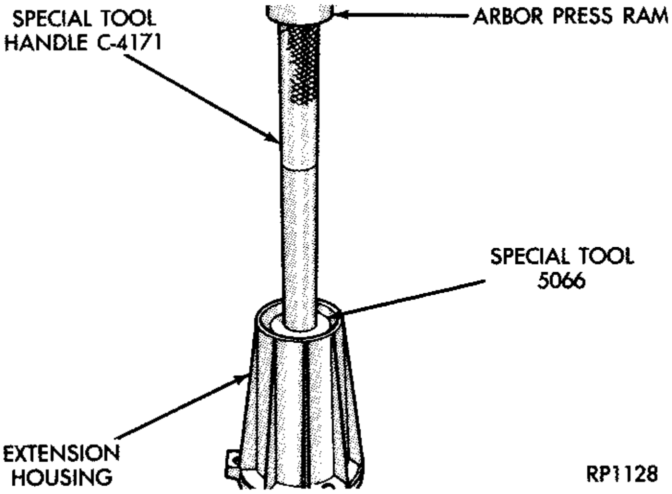


Fig. 74 Installing Extension Housing Bushing

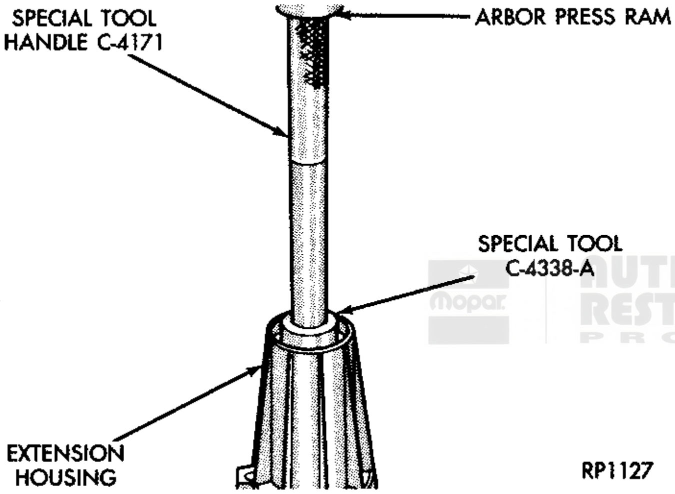


Fig. 73 Removing Extension Housing Bushing

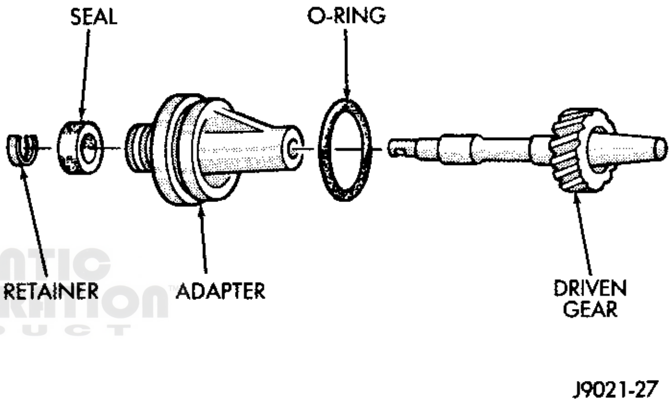
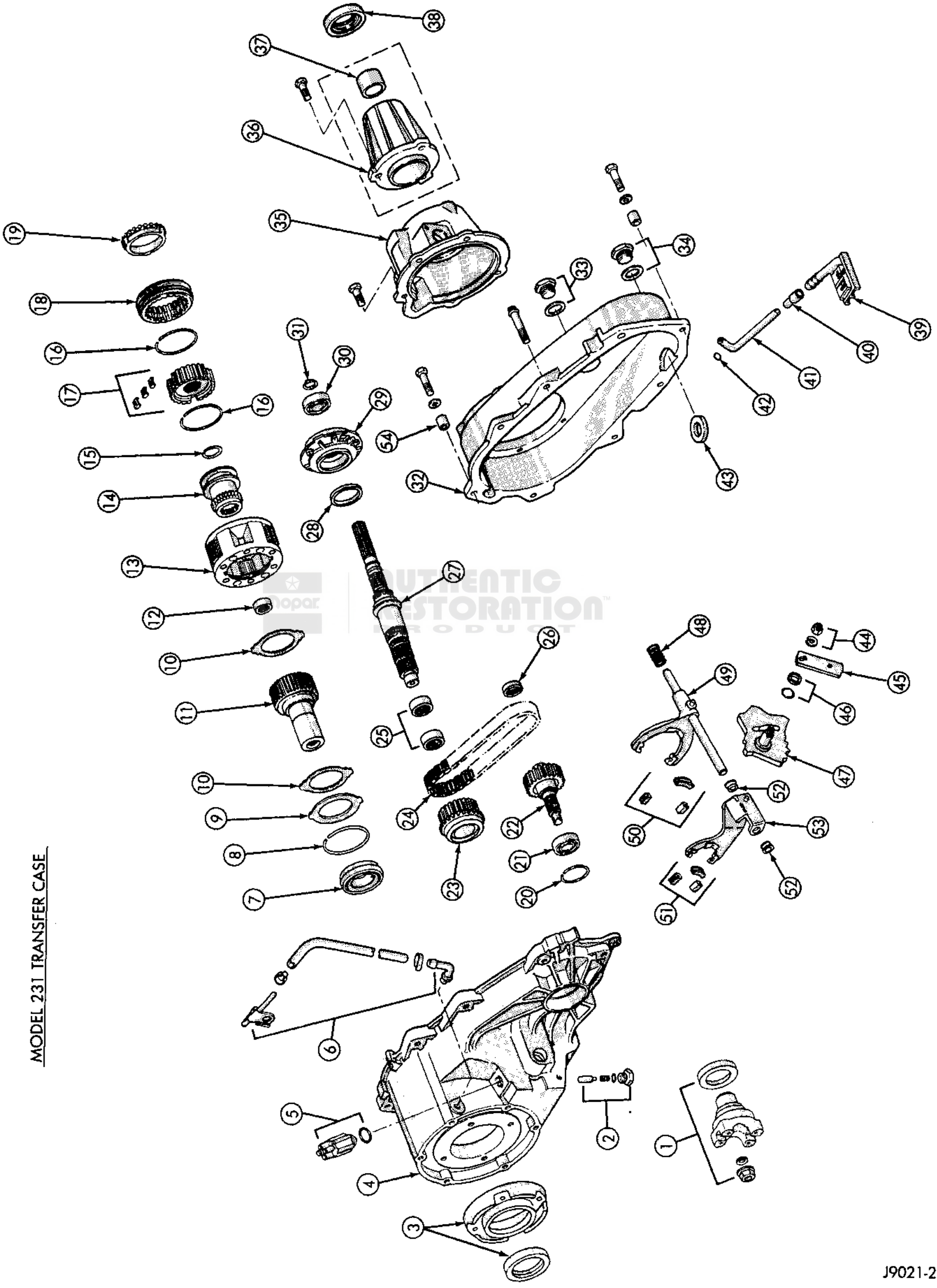


Fig. 75 Speedometer Assembly



MODEL 231 TRANSFER CASE

J9021-28

1 FRONT YOKE, NUT, SEAL WASHER, AND OIL SEAL
2 SHIFT DETENT PLUG, SPRING AND PIN
3 FRONT RETAINER AND SEAL
4 FRONT CASE
5 VACUUM SWITCH AND SEAL
6 VENT ASSEMBLY
7 INPUT GEAR BEARING AND SNAP RING
8 LOW RANGE GEAR SNAP RING
9 INPUT GEAR RETAINER
10 LOW RANGE GEAR THRUST WASHERS
11 INPUT GEAR
12 INPUT GEAR PILOT BEARING
13 LOW RANGE GEAR
14 RANGE FORK SHIFT HUB
15 SYNCHRO HUB SNAP RING
16 SYNCHRO HUB SPRINGS
17 SYNCHRO HUB AND STRUTS
18 SYNCHRO SLEEVE
19 STOP RING
20 SNAP RING
21 OUTPUT SHAFT FRONT BEARING
22 FRONT OUTPUT SHAFT
23 DRIVE SPROCKET
24 DRIVE CHAIN
25 DRIVE SPROCKET BEARINGS
26 OUTPUT SHAFT REAR BEARING
27 MAINSHAFT
28 OIL SEAL
29 OIL PUMP ASSEMBLY
30 MAINSHAFT REAR BEARING
31 SNAP RING
32 REAR CASE
33 FILL PLUG AND GASKET
34 DRAIN PLUG AND GASKET
35 REAR RETAINER
36 EXTENSION HOUSING
37 BUSHING
38 OIL SEAL
39 OIL PICKUP SCREEN
40 TUBE CONNECTOR
41 OIL PICKUP TUBE
42 PICKUP TUBE O-RING
43 MAGNET
44 RANGE LEVER NUT AND WASHER
45 RANGE LEVER
46 SECTOR O-RING AND SEAL
47 SECTOR
48 MODE SPRING
49 MODE FORK
50 MODE FORK INSERTS
51 RANGE FORK INSERTS
52 RANGE FORK BUSHINGS
53 RANGE FORK
54 ALIGNMENT BUSHINGS

J9021-29

SERVICE SPECIFICATIONS

Transfer Case Type	Part-time, dual range with low range reduction. Four-wheel-drive range is undifferentiated.
Torque Transfer Mode	Output shaft and sprocket driven by interconnecting drive chain.
Operating Ranges	2H, 4H, 4L, and Neutral. Low range reduction ratio is 2.72:1.
Case Configuration	Two-piece aluminum with removable extension and rear retainer housings.
Required Lubricant	MOPAR MERCON® automatic transmission fluid or equivalent marked DEXRON® II.
Transfer Case Fill Level	To bottom edge of fill plug hole.

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Oil Pump Screws	1.6 N·m (14 in-lbs)	1.4-1.8 N·m (12-15 in-lbs)
Yoke Nut	149 N·m (110 ft-lbs)	122-176 N·m (90-130 ft-lbs)
Vacuum Switch	27 N·m (20 ft-lbs)	20-34 N·m (15-25 ft-lbs)
Range Lever Nut	30 N·m (22 ft-lbs)	27-34 N·m (20-25 ft-lbs)
Front Case-to-Rear Case Bolts	41 N·m (30 ft-lbs)	35-46 N·m (26-34 ft-lbs)
Rear Retainer Bolts	24 N·m (18 ft-lbs)	20-27 N·m (15-20 ft-lbs)
Extension Housing Bolts	41 N·m (30 ft-lbs)	35-46 N·m (26-34 ft-lbs)
Drain/Fill Plugs	47 N·m (35 ft-lbs)	41-54 N·m (30-40 ft-lbs)
Detent Plug	20 N·m (15 ft-lbs)	16-24 N·m (12-18 ft-lbs)
Front Bearing Retainer Bolts	21 N·m (16 ft-lbs)	16-27 N·m (12-20 ft-lbs)

J8921-750

MODEL 242 TRANSFER CASE

INDEX

GENERAL INFORMATION

The Model 242 is a full time transfer case with four operating ranges plus a Neutral position (Fig. 1). It is used in XJ/MJ models only.

The Model 242 provides two-wheel drive and full-time four wheel drive operation. An interaxle differential is used to control torque transfer to the front and rear axles.

The differential has a locking mechanism for undifferentiated four-wheel drive in high and low ranges. A low range gear reduction system provides increased low speed torque capability.

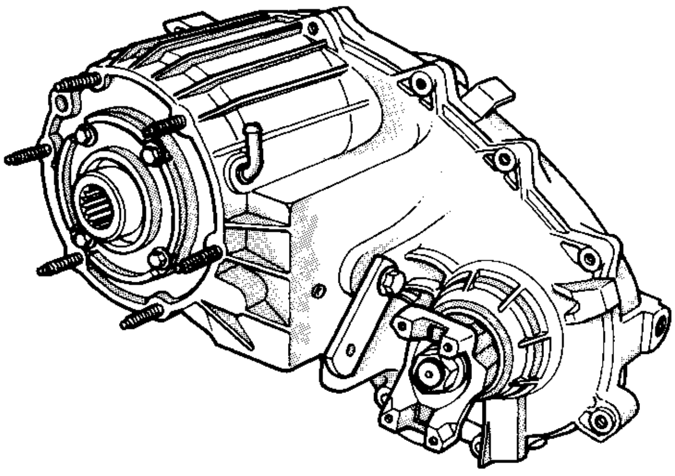
Operating Ranges

The Model 242 transfer case provides four operating ranges which are: 2WD; 4 x 4 part-time; 4 x 4 full-time; and 4 Lo.

The 4 x 4 full-time range is fully differentiated and is a full-time operating range.

The 4 x 4 part-time and 4 Lo ranges are not differentiated. They are for part-time operation only.

The low range reduction gear system is operative in the 4 Lo position only. Low range reduction ratio is 2.72:1.



J8921-243

Fig. 1 Model 242 Transfer Case

Two-wheel drive and full-time four wheel drive ranges are for normal on-road, highway operation. The 4 x 4 part-time high and low lock ranges are for off-road operation or when the vehicle is driven on surfaces covered by snow, ice or similar low traction elements.

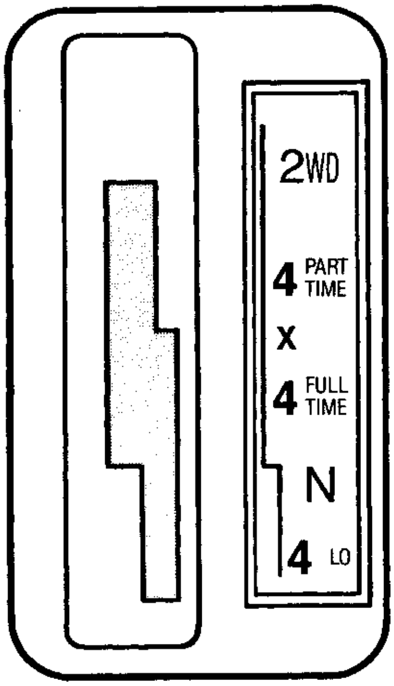
Shift Mechanism

Transfer case operating ranges are selected with a floor mounted shift lever. The shift lever is connected to the transfer case range lever by an adjustable linkage rod. Range positions are marked on the shifter bezel plate (Fig. 2).

TRANSFER CASE IDENTIFICATION

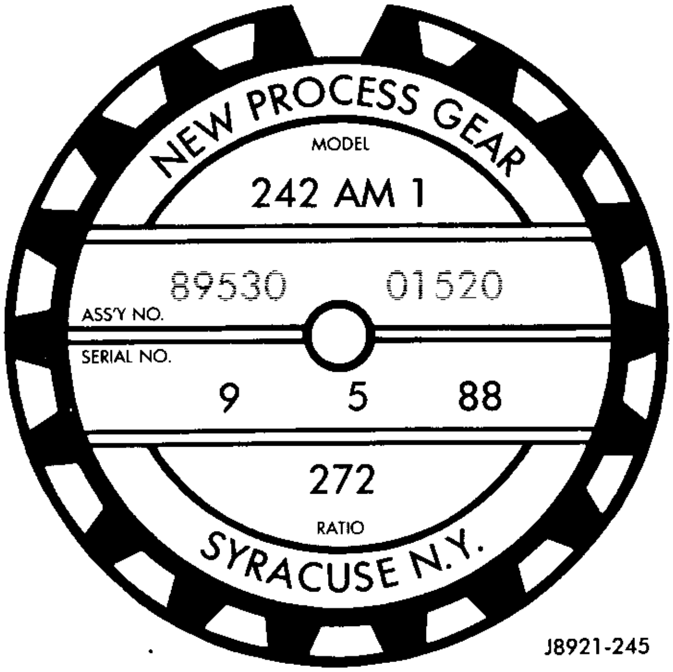
A circular I.D. tag is attached to the rear case of each Model 242 transfer case (Fig. 3). The tag provides the transfer case model number, assembly number, serial number and low range ratio.

The transfer case serial number also represents the date of build. For example, a serial number of 9-5-88 would represent September 5, 1988.



J9021-113

Fig. 2 Model 242 Shift Pattern



J8921-245

Fig. 3 Transfer Case I.D. Tag

TRANSFER CASE LUBRICANT

Lubricant Type-Capacity

Mopar Mercon™ or Dexron II™ automatic transmission fluid is recommended for use in Model 242 transfer cases.

Mercon™ and Dexron II™ are compatible and can be used to top off a transfer case previously filled with either type fluid.

Lubricant capacity of the Model 242 transfer case is: 1.4 liters (1.48 gts).

Fill Level

The correct fill level for the 242 transfer case is to the bottom edge of the fill plug hole.

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
TRANSFER CASE DIFFICULT TO SHIFT OR WILL NOT SHIFT INTO DESIRED RANGE	(1) Transfer case external shift linkage binding. (2) Insufficient or incorrect lubricant. (3) Internal components binding, worn or damaged.	(1) Lubricate, repair or replace linkage, or tighten loose components as necessary. (2) Drain and refill to edge of fill hole with DEXRON II® or MOPAR-MERCON® Automatic Transmission Fluid. (3) Disassemble unit and replace worn or damaged components as necessary.
TRANSFER CASE NOISY IN ALL DRIVE POSITIONS	(1) Insufficient or incorrect lubricant.	(1) Drain and refill to edge of fill hole with DEXRON II® or MOPAR-MERCON® Automatic Transmission Fluid. Check for leaks and repair if necessary. **Note: If unit is still noisy after drain and refill, disassembly and inspection may be required to locate source of noise.**
LUBRICANT LEAKING FROM OUTPUT SHAFT SEALS OR FROM VENT	(1) Transfer case overfilled. (2) Vent closed or restricted. (3) Output shaft seals damaged or installed incorrectly.	(1) Drain to correct level. (2) Clear or replace vent if necessary. (3) Replace seals. Be sure seal lip faces interior of case when installed. Also be sure yoke seal surfaces are not scored or nicked. Remove scores and nicks with fine sandpaper or replace yoke(s) if necessary.
TRANSFER CASE WILL NOT SHIFT THROUGH 4 X 4 PART-TIME RANGE (Light Remains On).	(1) Incomplete shift due to drivetrain torque load. (2) Incorrect tire pressure(s). (3) Excessive tire wear. (4) Excessive vehicle loading.	(1) Driver must momentarily release the accelerator pedal to complete the shift. (2) Inflate all tires equally to correct pressure. (3) Switch tires — Install the two tires with the most wear (one on the front/one on the rear). (4) Check vehicle loading — **Do not exceed the vehicle's GVW.**

J8921-246

SHIFT LINKAGE ADJUSTMENT

(1) Remove the shift lever bezel.

(2) Move the shift lever into 4L position.

(3) Insert a 3 mm (1/8 inch) spacer between the shift lever and forward edge of the shift lever gate (Fig. 4). Secure the lever and spacer in place with tape or wire.

(4) Raise the vehicle.

(5) Loosen the trunnion lock bolt (Fig. 5). Linkage rod should now slide freely in the trunnion.

(6) Verify that transfer case range lever is in 4L position.

(7) Position the linkage rod so it is a free fit in the range lever (Fig. 5). Then tighten the trunnion locknut.

(8) Lower the vehicle.

(9) Remove the shift lever spacer and install the bezel.

TRANSFER CASE REMOVAL

(1) Shift the transfer case into Neutral.

(2) Raise the vehicle.

(3) Drain the transfer case lubricant.

(4) Mark the front and rear propeller shaft yokes for alignment reference.

(5) Place a support stand under the transmission.

(6) Remove the rear crossmember.

(7) Disconnect the front/rear propeller shafts at the transfer case.

(8) Disconnect the speedometer cable.

(9) Disconnect the transfer case linkage rod from the range lever.

(10) Disconnect the vent and vacuum hoses.

(11) Support the transfer case with a transmission jack.

(12) Remove the bolts attaching the transfer case to the transmission.

(13) Secure the transfer case to the jack with chains.

(14) Pull the transfer case and jack rearward to disengage the transfer case.

(15) Remove the transfer case from under the vehicle.

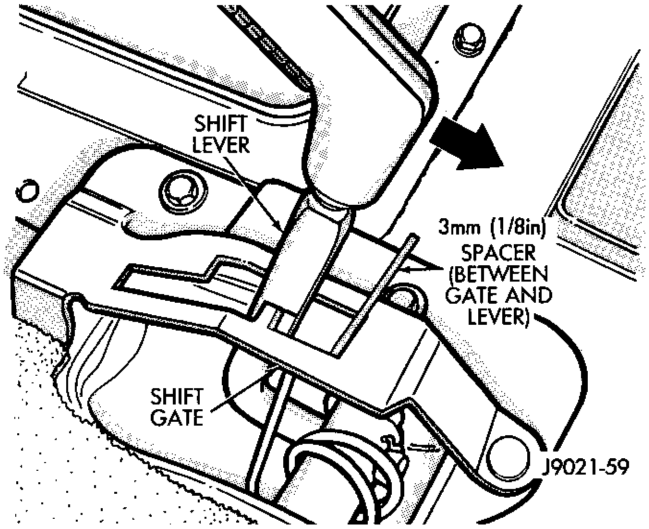


Fig. 4 Installing Shift Lever Spacer

TRANSFER CASE INSTALLATION

(1) Mount the transfer case on a transmission jack. Secure the transfer case to the jack with chains.

(2) Position the transfer case under the vehicle.

(3) Align the transfer case and transmission shafts and install the transfer case on the transmission.

(4) Install and tighten the transfer case attaching nuts to 26 ft-lbs (35 N•m) torque.

(5) Connect the speedometer cable, vacuum and vent hoses.

(6) Align and connect the propeller shafts. Tighten the shaft

(7) Fill the transfer case with Mopar Dexron II™ or Mercon™ automatic transmission fluid.

(8) Install the rear crossmember. Tighten the crossmember bolts to 30 ft-lbs (41 N•m) torque.

(9) Remove the transmission jack and the transmission support stand.

(10) Connect the transfer case range lever to the linkage rod.

(11) Lower the vehicle.

TRANSFER CASE OVERHAUL

Disassembly

(1) Remove the fill and drain plugs.

(2) Remove the front yoke. Discard the yoke seal washer and nut.

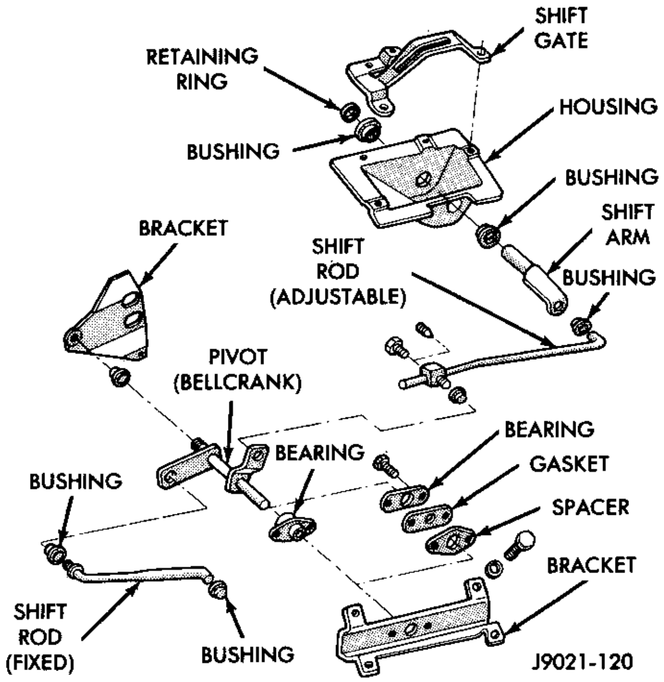


Fig. 5 Shift Linkage Components

(3) Move the range lever rearward to four low-lock position.

(4) Remove the extension housing attaching bolts.

(5) Tap the extension housing in a clockwise direction to break the sealer bead (Fig. 6). Then remove the housing.

CAUTION: To avoid damaging the sealing surfaces of the extension housing and rear retainer, do not attempt to pry or wedge the housing off the retainer.

(6) Remove the rear bearing snap ring from the mainshaft (Fig. 7). Discard the snap ring.

(7) Remove rear retainer attaching bolts.

(8) Loosen rear retainer (Fig. 8). Position long screwdriver under each of the tabs on the retainer housing and pry retainer upward.

CAUTION: Do not pry against the sealing surfaces of the retainer or rear case. The surfaces could be damaged.

(9) Lift rear retainer up and off case and mainshaft (Fig. 9).

(10) Remove bolts attaching rear case to front case. Retain bolts and the washers.

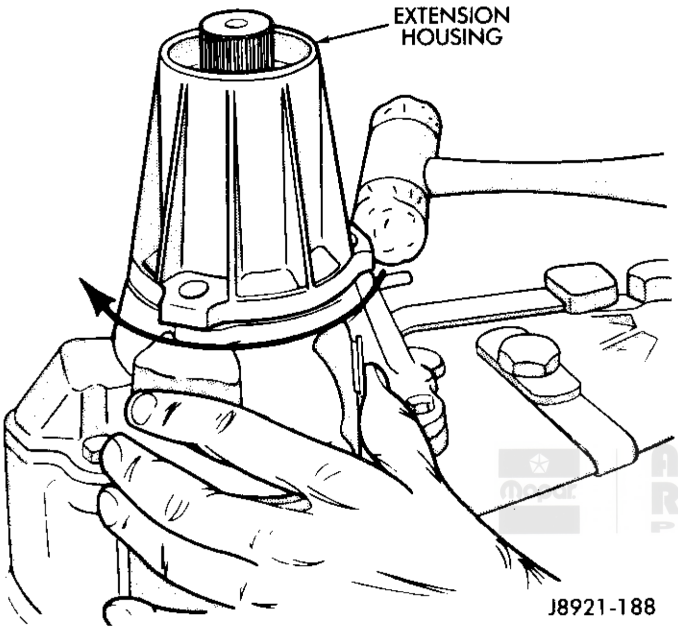


Fig. 6 Extension Housing Removal

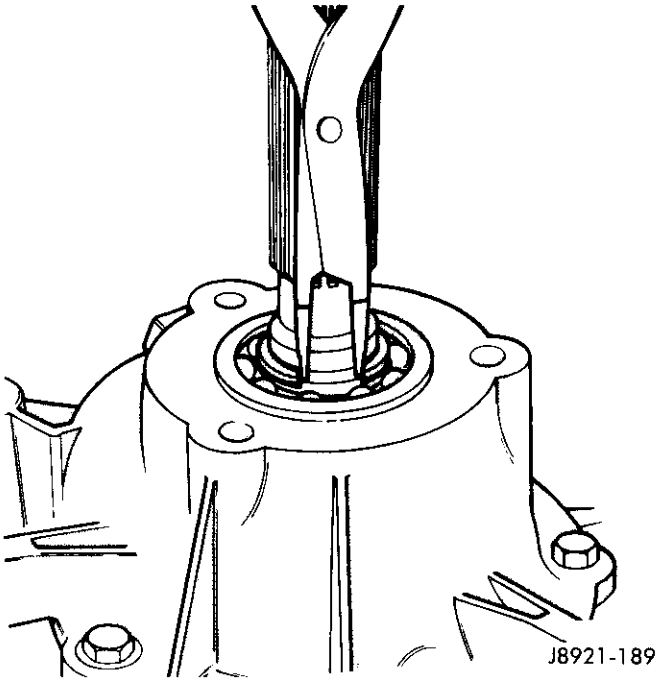


Fig. 7 Removing Rear Bearing Snap Ring

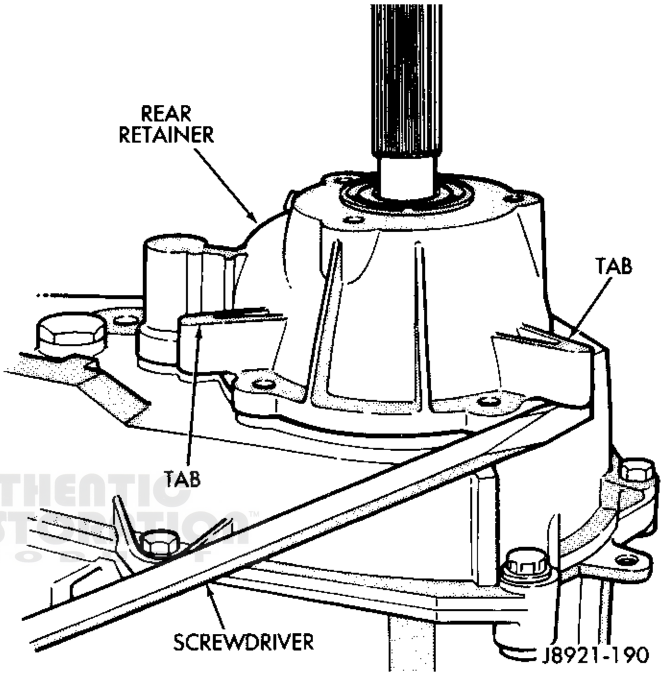


Fig. 8 Loosening Rear Retainer

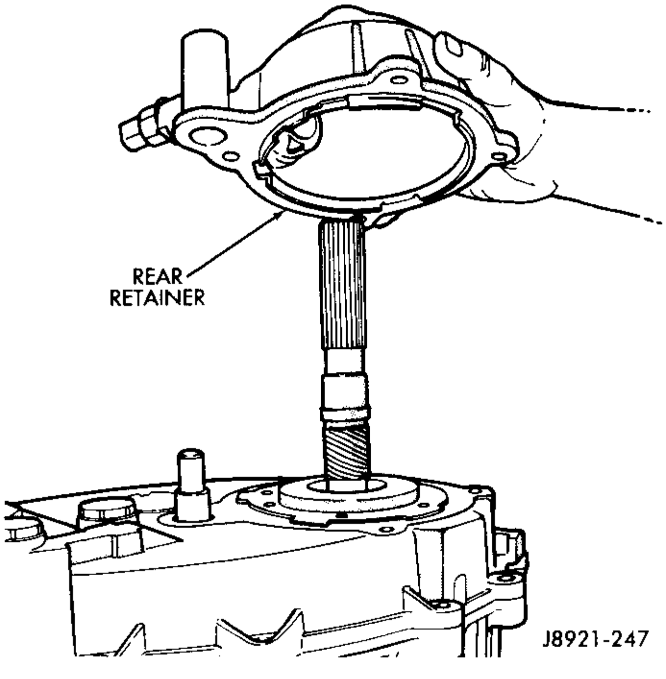


Fig. 9 Remove Rear retainer

(11) Loosen rear case with two screwdrivers (Fig. 10). Insert screwdrivers into slots cast in case ends. Then gently pry upward to break sealer bead.

CAUTION: Do not pry against the sealing surfaces of the front case or rear case. The surfaces could be damaged.

(12) Remove rear case and oil pump as assembly (Fig. 11).

(13) Slide the oil screen (Fig. 12) out of the case pocket.

(14) Remove oil pump, pickup tube and oil screen from the rear case (Fig. 13).

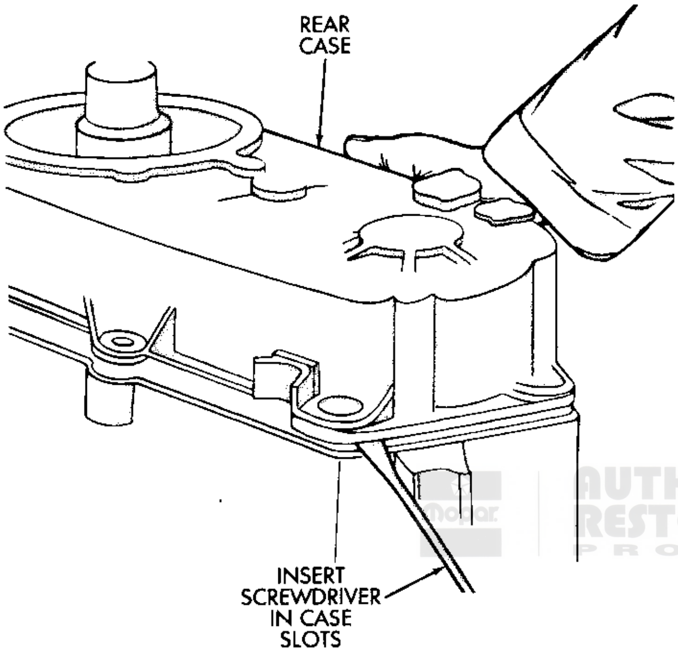


Fig. 10 Loosening Rear Case

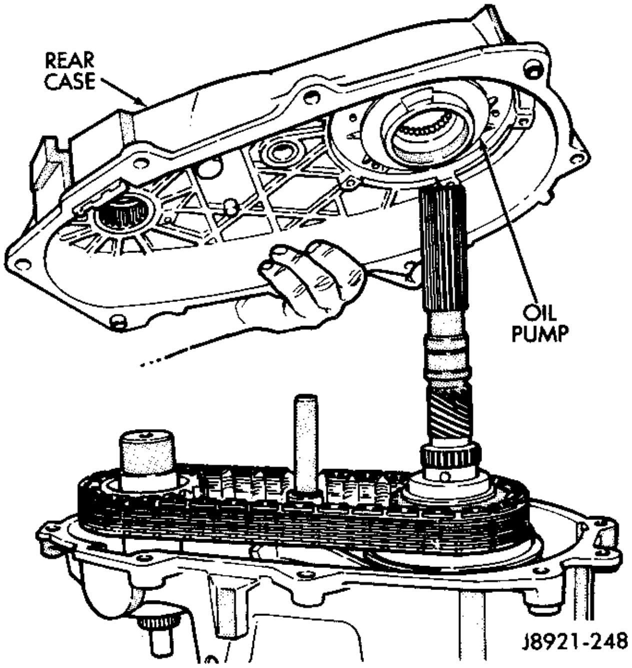


Fig. 11 Removing Rear Case And Oil Pump

(15) Remove the pickup tube and screen from the pump.

(16) Remove pickup tube O-ring from the oil pump (Fig. 14).

(17) Remove and discard oil pump seal.

(18) Mark pump housings for assembly reference and remove screws that attach two halves of pump.

(19) Remove the feed housing from the gear housing. Note position of pump gears and remove them (Fig. 15).

(20) Remove the magnet from the front case.

(21) Remove the drive sprocket snap ring (Fig. 16).

(22) Remove drive sprocket and chain (Fig. 17).

(23) Remove front output shaft (Fig. 18).

(24) Remove transfer case shift lever nut and lever.

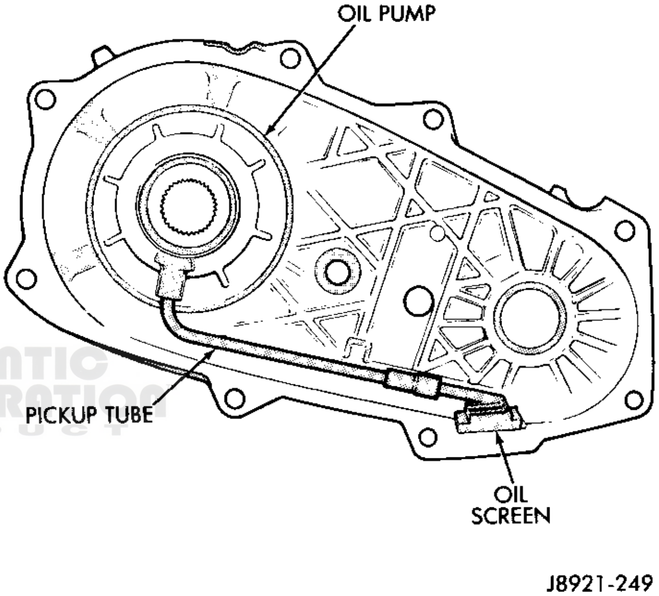


Fig. 12 Unseating Oil Screen

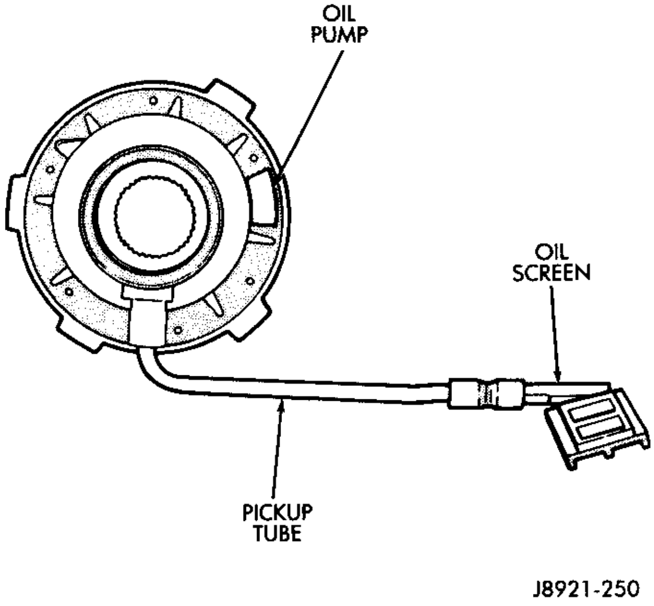


Fig. 13 Removing Oil Pump, Tube And Screen

(25) Remove the shift detent plug, spring and pin (Fig. 19)

(26) Remove seal plug from low range fork lockpin access hole. Then move shift sector to align low range fork lockpin with access hole (Fig. 20).

(27) Remove the range fork lockpin with a size number one easy-out tool. Grip easy-out tool with locking pliers and remove pin with counterclockwise, twist and pull motion (Fig. 20).

(28) Remove shift rail by pulling it straight up and out of the fork (Fig. 21).

(29) Remove mode fork and mainshaft as assembly (Fig. 22).

(30) Remove mode shift sleeve and mode fork assembly from mainshaft (Fig. 23). Note position of mode sleeve in the fork and remove the sleeve.

(31) Remove the intermediate clutch shaft snap ring (Fig. 24).

(32) Remove clutch shaft thrust ring (Fig. 25).

(33) Remove intermediate clutch shaft (Fig. 26).

(34) Remove differential snap ring (Fig. 27).

(35) Remove the differential (Fig. 28).

(36) Remove the differential needle bearings and the two needle bearing thrust washers from the mainshaft.

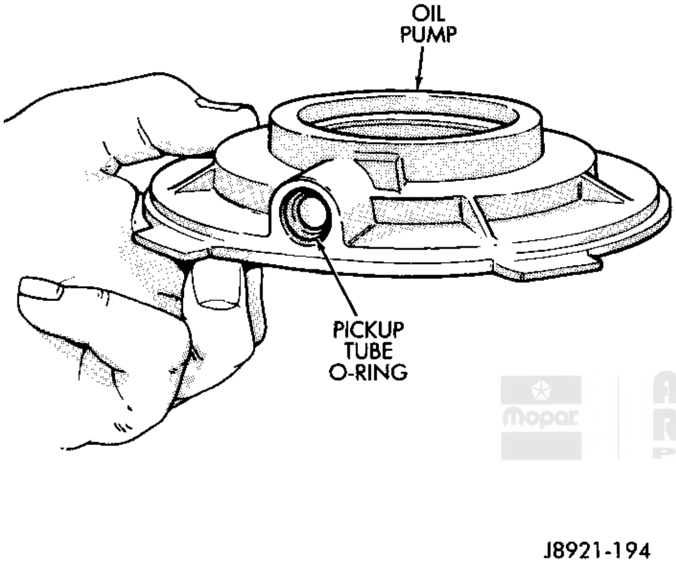


Fig. 14 Removing Pickup Tube O-Ring

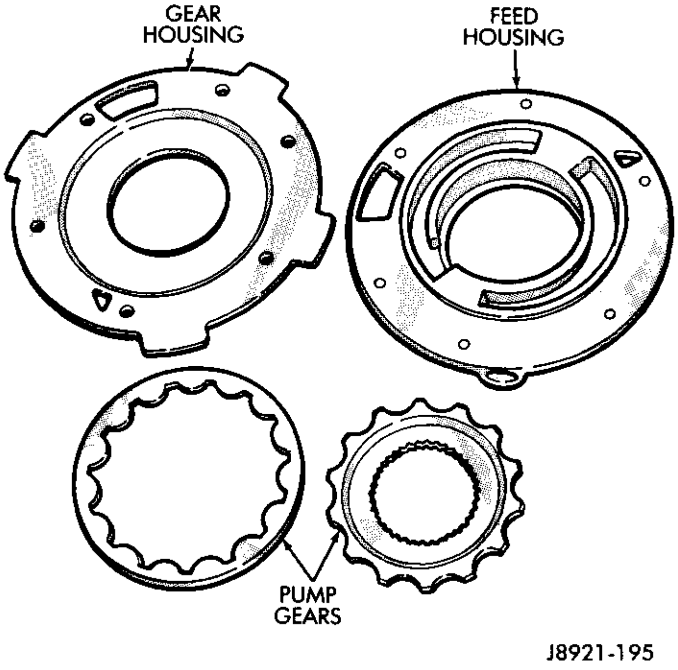


Fig. 15 Oil Pump Disassembly

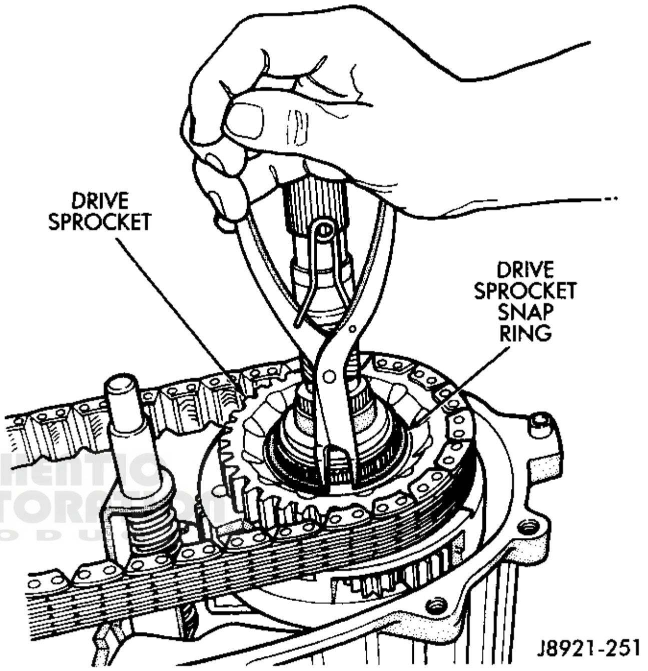


Fig. 16 Removing Drive Sprocket Snap Ring

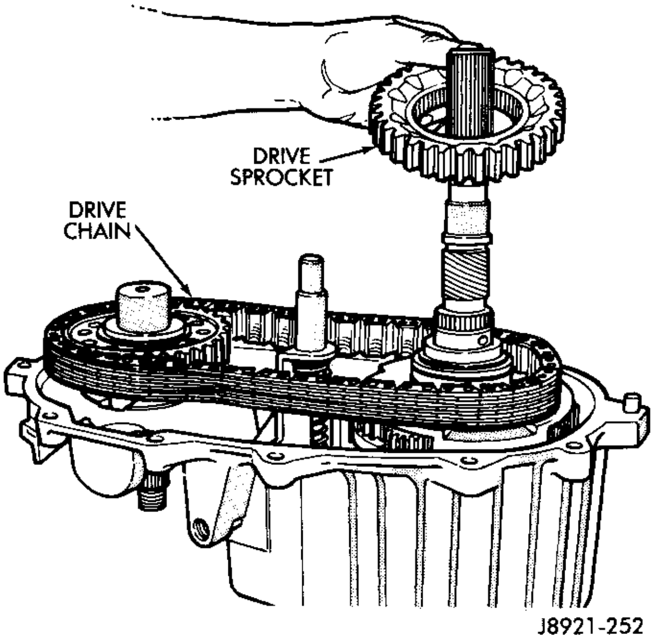


Fig. 17 Removing Drive Sprocket And Chain

(37) Slide low range fork pin out of shift sector slot (Fig. 29)

(38) Remove low range fork and hub (Fig. 30).

(39) Remove the shift sector (Fig. 31).

(40) Remove shift sector bushing and O-ring (Fig. 32).

(41) Remove front bearing retainer bolts.

(42) Remove front bearing retainer. Carefully pry retainer loose with screwdriver (Fig. 33). Position the screwdriver in the slots cast into retainer.

(43) Remove the input gear snap ring (Fig. 34).

(44) Press input and low range gears out of input gear bearing and case (Fig. 35).

(45) Remove the low range gear snap ring (Fig. 36).

(46) Remove input gear retainer, thrust washers and input gear from low range gear (Fig. 37).

(47) Inspect the low range annulus gear (Fig. 38). **The gear is not a serviceable component. If damaged, replace the gear and front case as an assembly.**

(48) Remove the oil seals from the rear retainer, extension housing, oil pump and case halves.

(49) Mark differential case halves for reference.

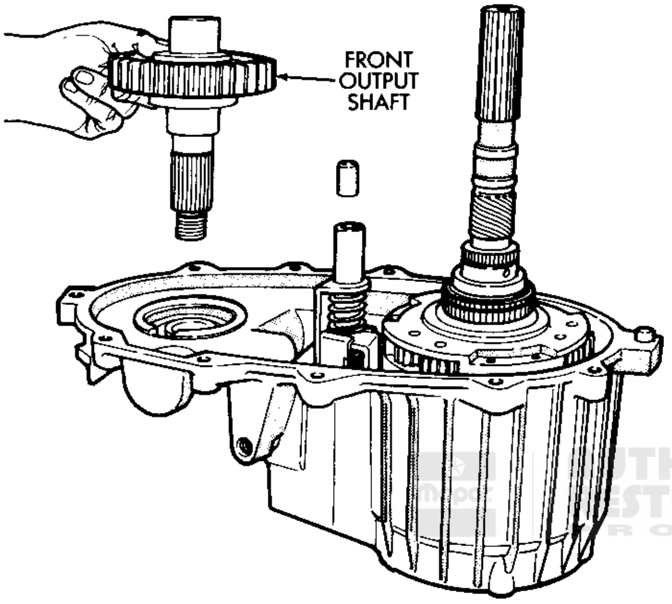


Fig. 18 Removing Front Output Shaft

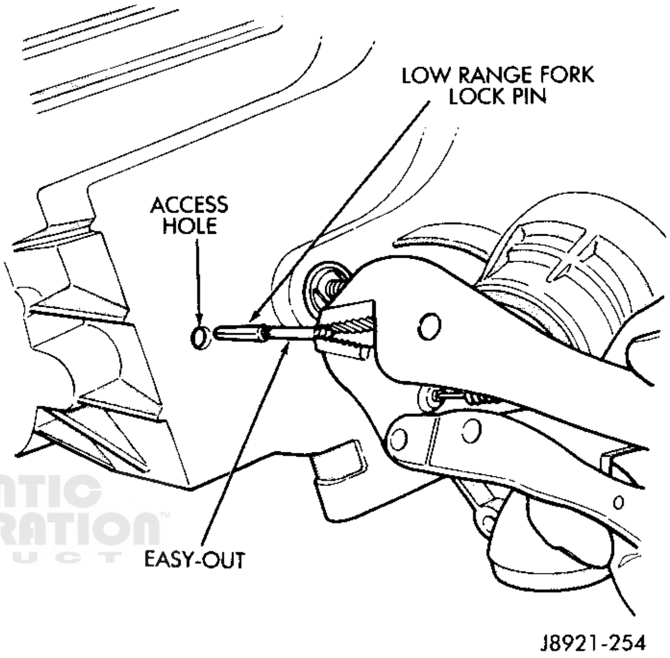


Fig. 20 Removing Low Range Fork Lockpin

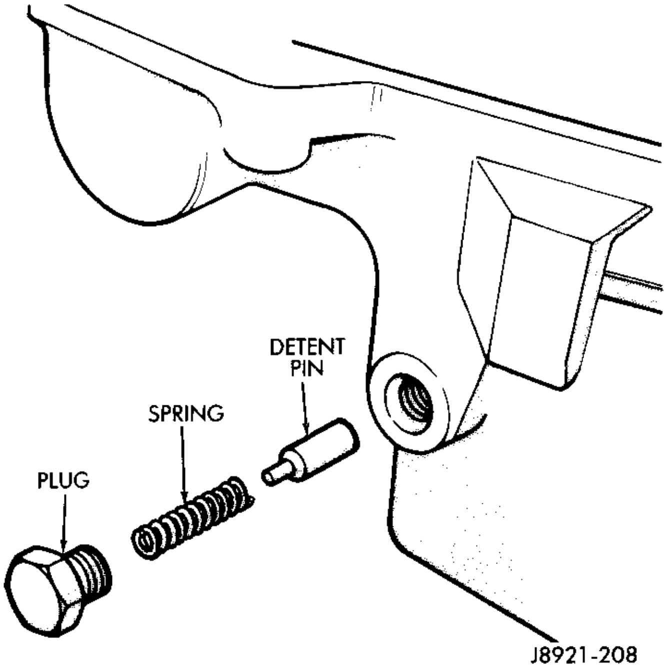


Fig. 19 Removing Detent Pin-Spring-Plug

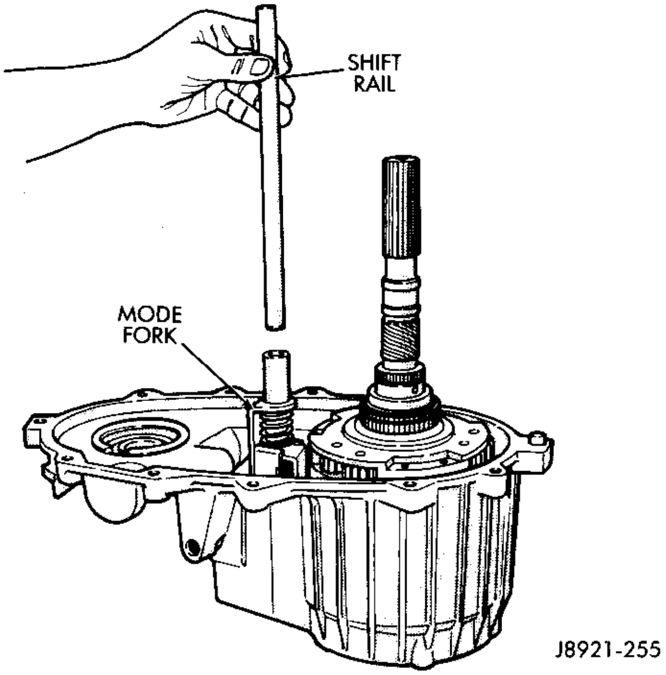


Fig. 21 Removing Shift Rail

(50) Remove differential case bolts and separate top case from bottom case. Use slots in case halves to pry them apart (Fig. 39).

(51) Remove thrust washers and planet gears from case pins (Fig. 40).

(52) Remove mainshaft and sprocket gears from bottom case (Fig. 41). Note gear position for reference before separating them.

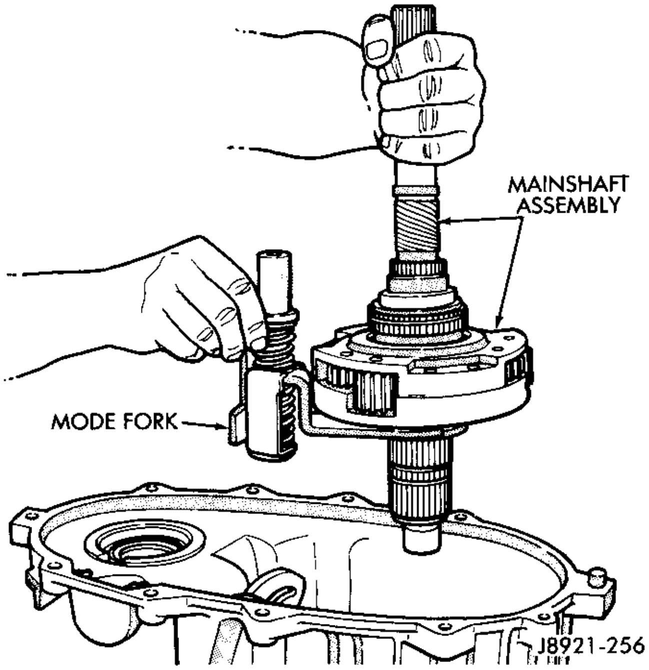


Fig. 22 Removing Mode Fork And Mainshaft

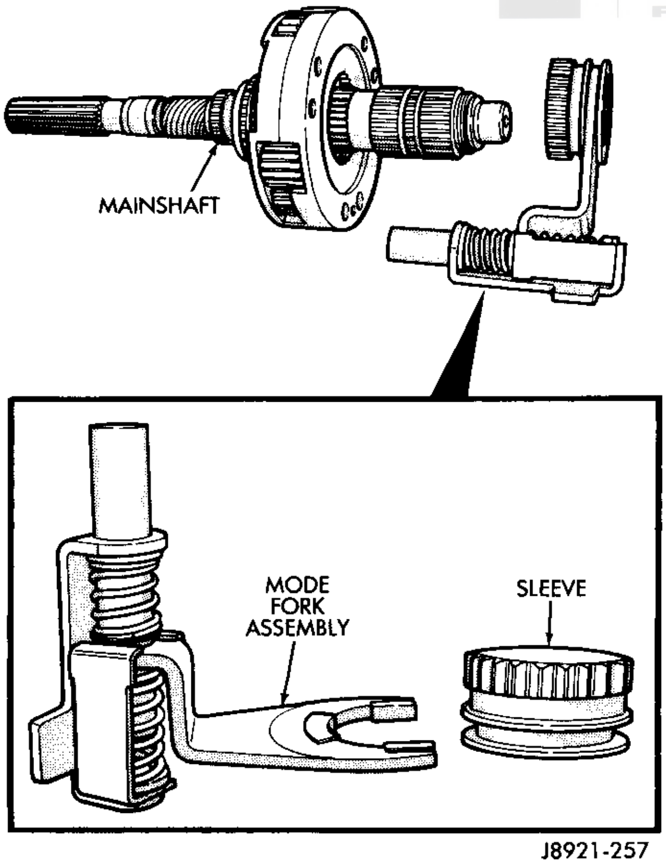


Fig. 23 Removing Mode Fork And Sleeve

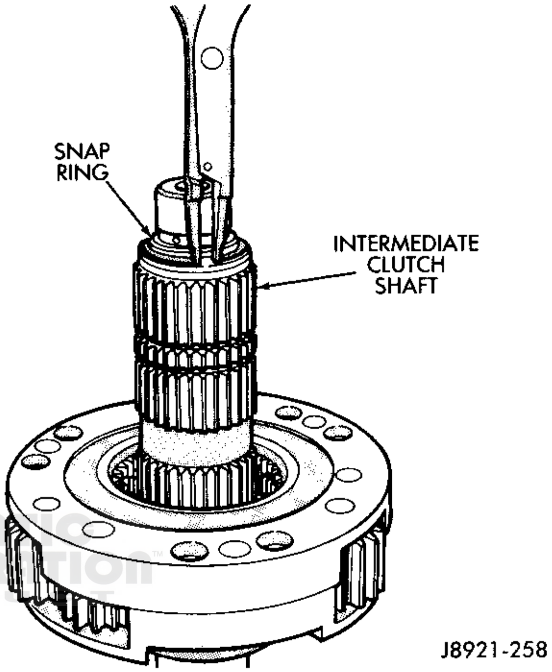


Fig. 24 Removing Intermediate Clutch Shaft Snap Ring

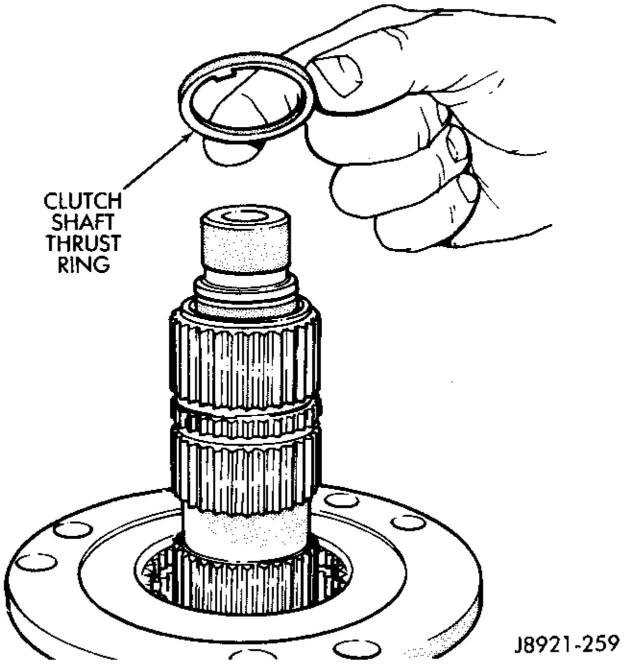


Fig. 25 Removing Clutch Shaft Thrust Ring

Cleaning And Inspection

Clean the transfer case components thoroughly with solvent. Remove all traces of sealer from the case and retainer seal surfaces.

Clean the oil pickup screen with solvent and dry it with compressed air. Also use compressed air to remove solvent residue from all oil feed passages and channels.

Inspect the differential gears, thrust washers and case halves. Replace the mainshaft gear if the gear teeth or the brass ring on the underside of the gear are damaged. Replace the differential as an assembly if the gears, case halves, or the pins in the lower case half are damaged.

Inspect the case halves, extension housing and retainers for cracks, porosity, or damaged sealing surfaces. Inspect the shafts, gears, chain and shift components for wear or damage.

Inspect all of the transfer case bearings for wear, roughness, pitting, or galling. Replace worn or damaged bearings as outlined in the assembly section.

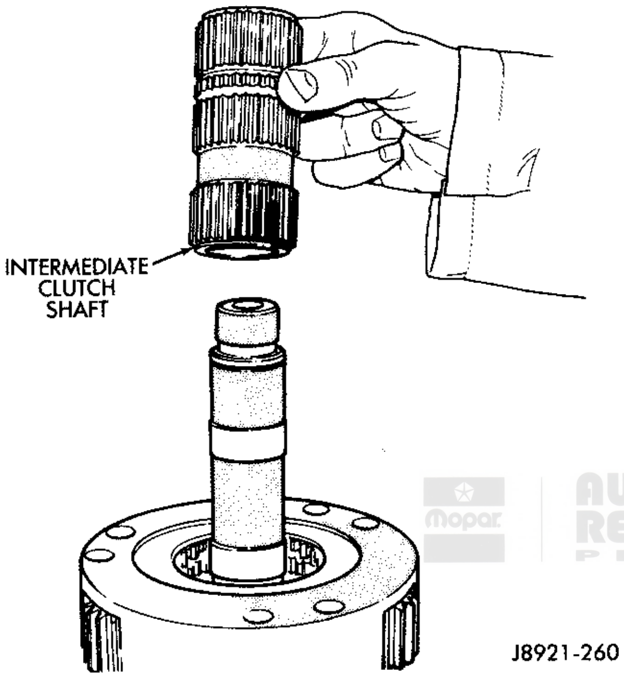


Fig. 26 Removing Intermediate Clutch Shaft

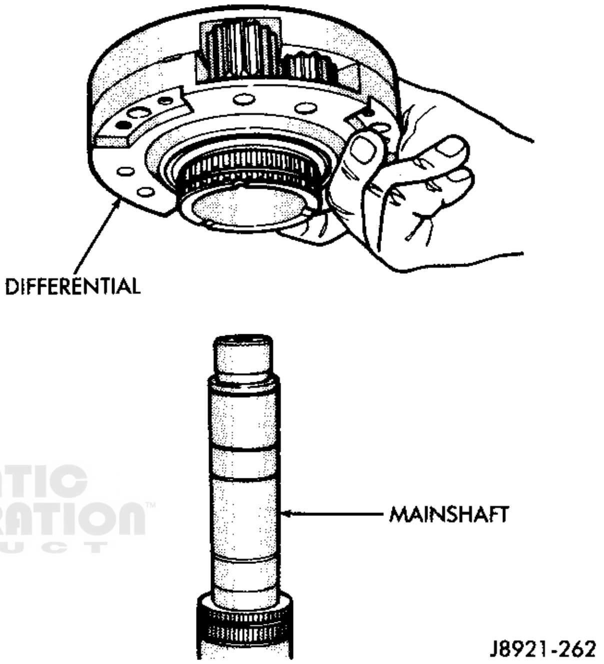


Fig. 28 Differential Removal

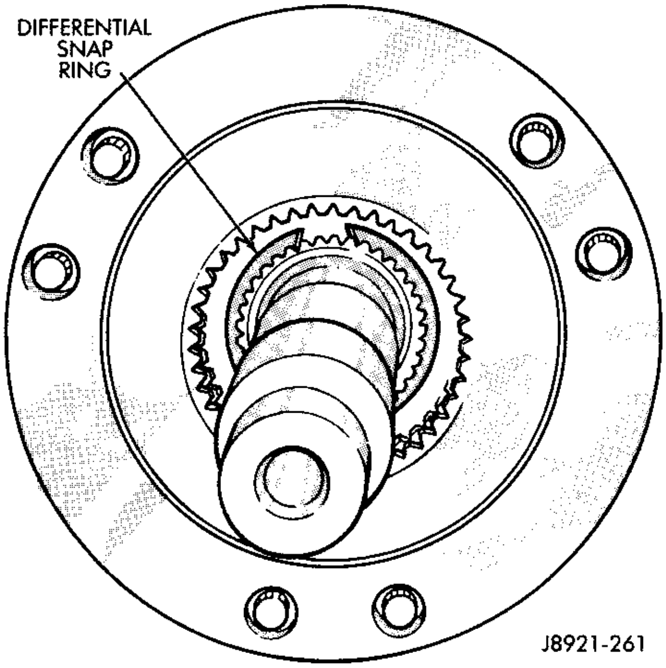


Fig. 27 Removing Differential Snap Ring

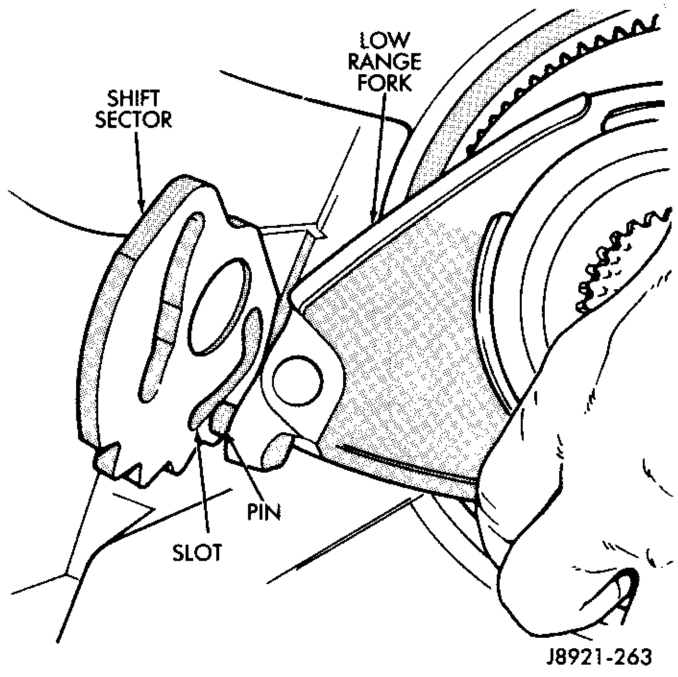


Fig. 29 Disengage Low Range Fork

Transfer Case Assembly

(1) Lubricate the transfer case components with automatic transmission fluid or petroleum jelly (where indicated) during assembly.

CAUTION: The bearing bores in various transfer case components contain oil feed holes. Be sure replacement bearings do not block these feed holes.

(2) Remove the front output shaft, front bearing snap ring (Fig. 42).

(3) Remove the old bearing and install the new bearing with a driver handle and installer tool (Fig. 43).

(4) Install the front bearing snap ring (Fig. 42).

(5) Install new front output shaft oil seal (Fig. 44).

(6) Press input gear bearing out of front case with driver tool and shop press (Fig. 45).

(7) Install the snap ring on the new bearing.

(8) Install the new input gear bearing with a shop press and wood block. Install the bearing far enough to seat the snap ring against the case (Fig. 46).

(9) Remove input gear pilot bearing with slide hammer and internal puller (Fig. 47).

(10) Install new pilot bearing with driver tools (Fig. 48).

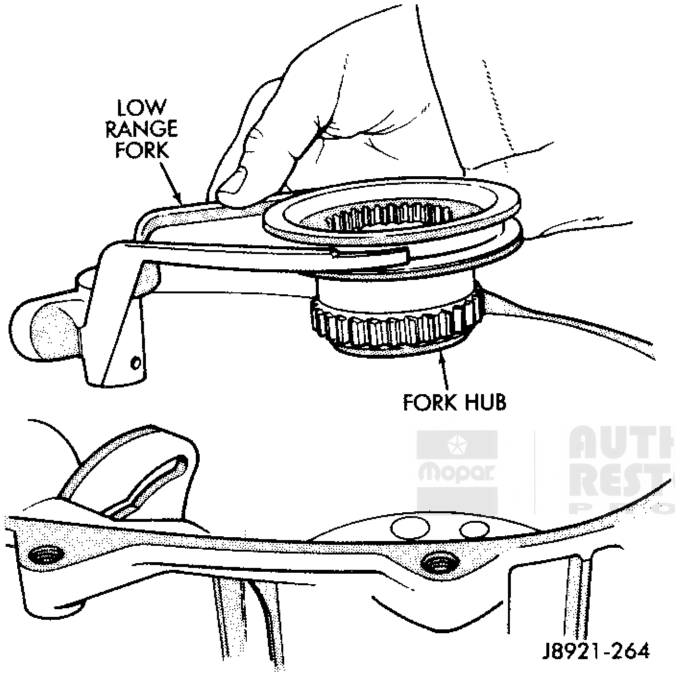


Fig. 30 Removing Low Range Fork And Hub

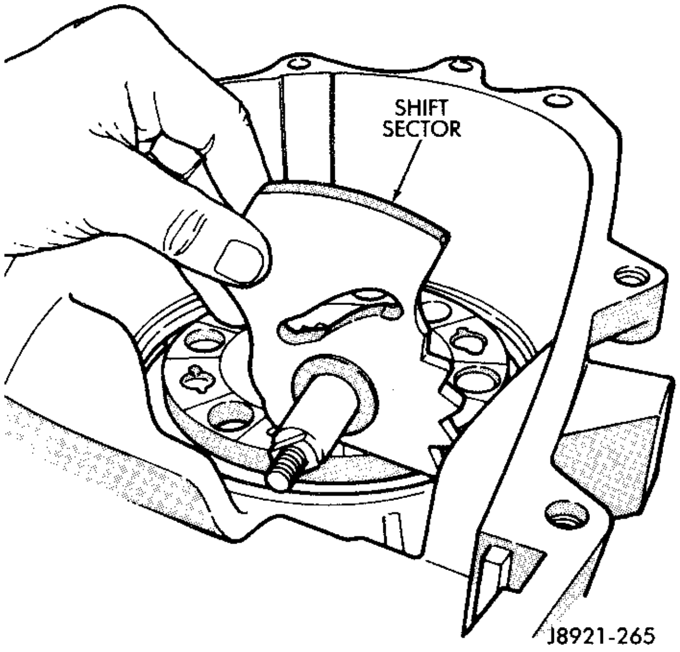


Fig. 31 Removing Shift Sector

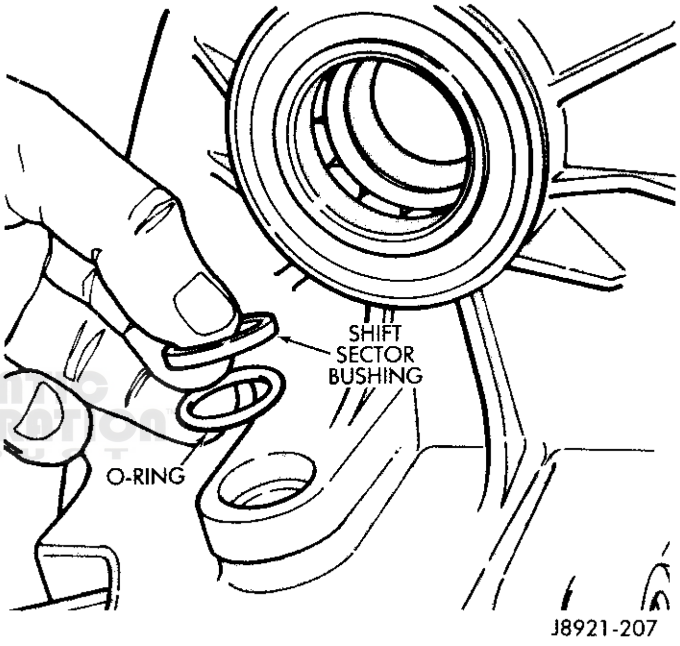


Fig. 32 Removing Sector Bushing And O-Ring

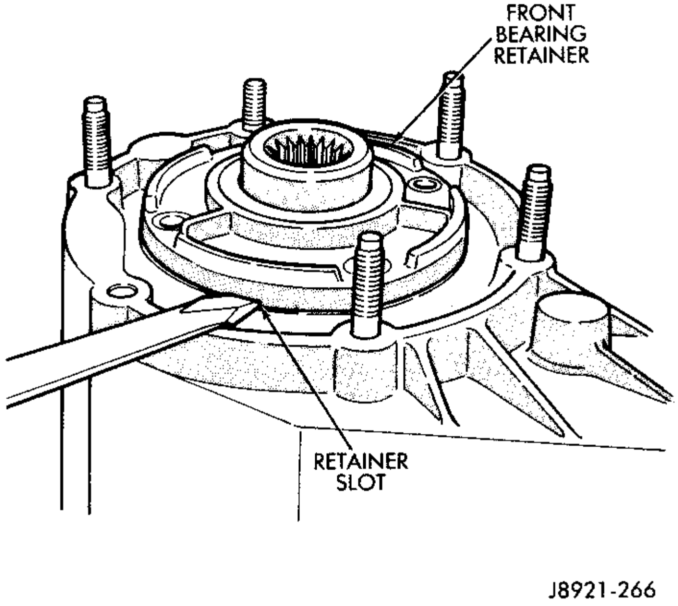


Fig. 33 Removing Front Bearing Retainer

(11) Assemble low range gear, input gear thrust washers, input gear and input gear retainer (Fig. 49).

(12) Install low range gear snap ring (Fig. 50).

(13) Lubricate input gear and low range gears with automatic transmission fluid.

(14) Start the input gear shaft into the front case bearing.

(15) Press the input gear shaft into the front bearing.

CAUTION: Be sure the input gear installer tool is the proper size. The wrong size tool could push the input gear pilot bearing too far into the gear bore (Fig. 51). Also, do not press against the end surfaces of the low range gear. The gear case and thrust washers could be damaged.

(16) Install new input gear snap ring (Fig. 52).

(17) Install new seal in front bearing retainer (Fig. 53).

(18) Apply 3 mm (1/8 inch) wide bead of Mopar silicone sealer to seal surface of front bearing retainer.

(19) Install the front bearing retainer (Fig. 54). Tighten the retainer bolts to 16 ft-lbs (21 N•m) torque.

(20) Install new sector shaft O-ring and bushing (Fig. 55).

(21) Install the shift sector (Fig. 56).

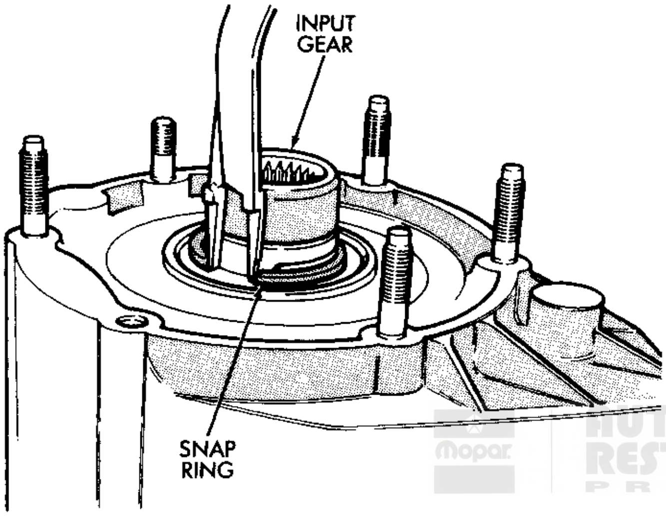


Fig. 34 Removing Input Gear Snap Ring

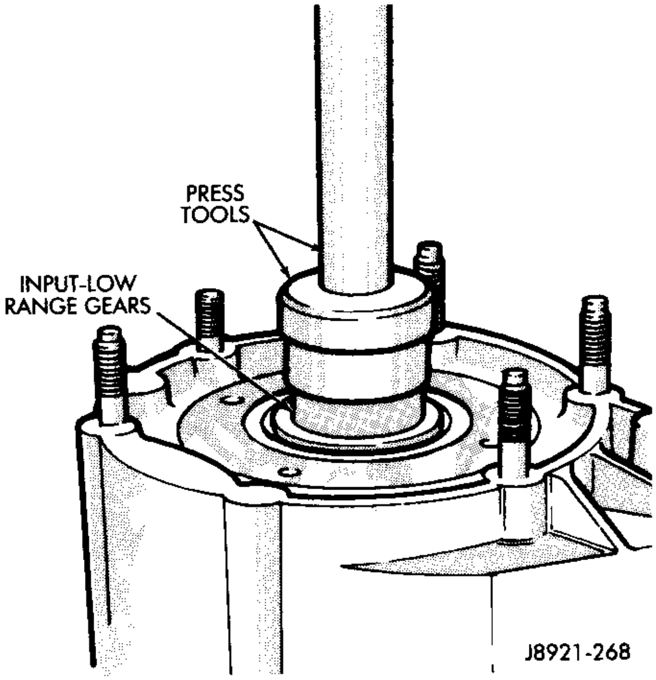


Fig. 35 Removing Input And Low Range Gears

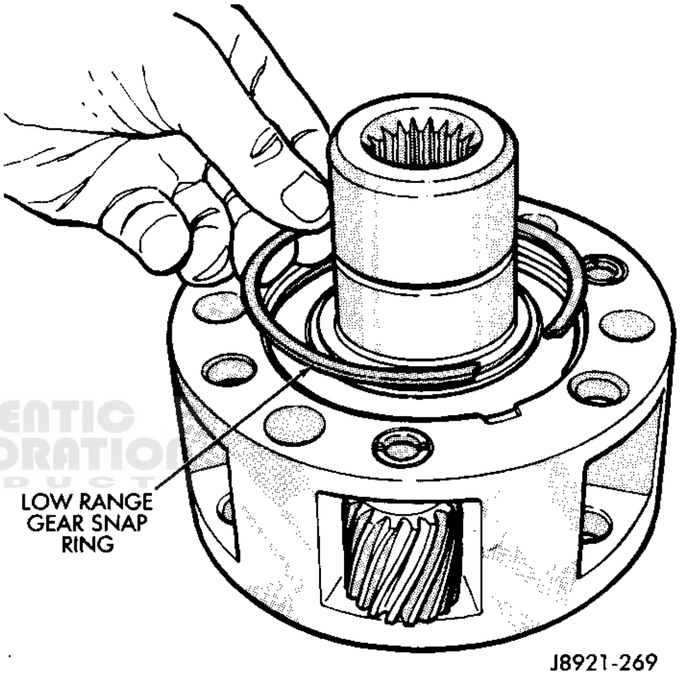


Fig. 36 Removing/Installing Low Range Gear Snap Ring

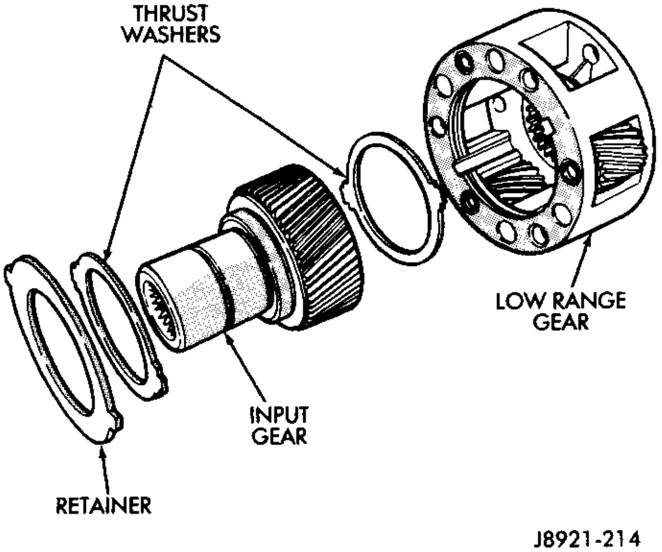


Fig. 37 Low Range Gear Disassembly

(22) Install new pads in low range fork (Fig. 57).

(23) Assemble low range fork and hub (Fig. 57).

(24) Position low range fork and hub in case. Be sure low range fork pin is engaged in the shift sector slot (Fig. 58).

(25) Lubricate differential components with automatic transmission fluid.

(26) Install sprocket gear in differential bottom case (Fig. 59).

(27) Install differential planet gears and new thrust washers (Fig. 60). **Be sure thrust washers are installed at top and bottom of each planet gear.**

(28) Install differential mainshaft gear (Fig. 60).

(29) Align and position differential top case on bottom case (Fig. 61). Align using scribe marks made at disassembly.

(30) Install and tighten the differential case bolts to specified torque.

(31) Install first mainshaft bearing spacer on mainshaft (Fig. 62).

(32) Install bearing rollers on mainshaft (Fig. 62). **Coat bearing rollers with generous quantity of petroleum jelly to hold them in place.**

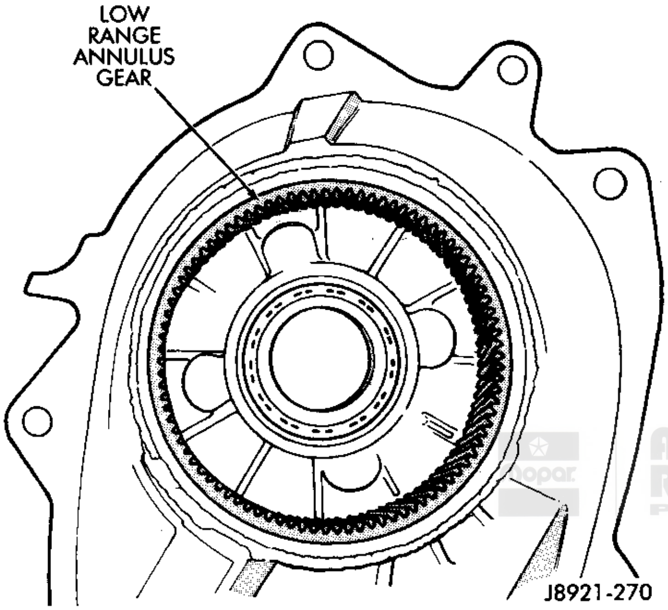


Fig. 38 Inspecting Low Range Annulus Gear

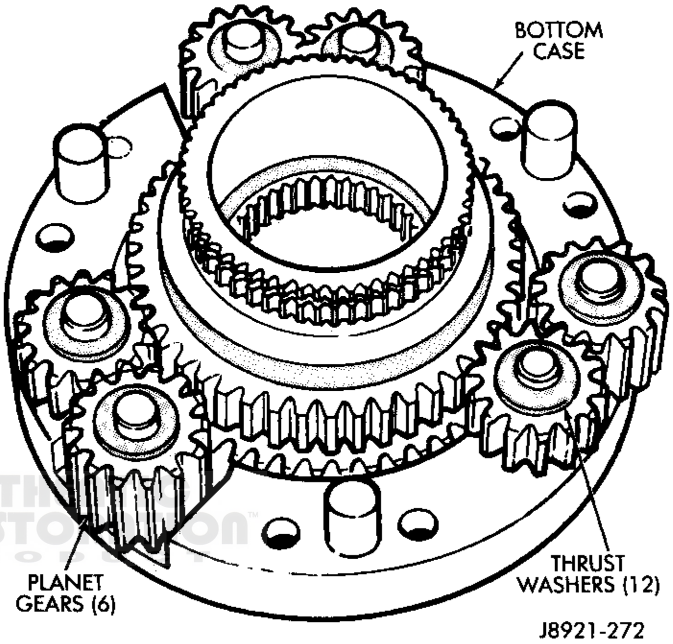


Fig. 40 Removing Planet Gears And Thrust Washers

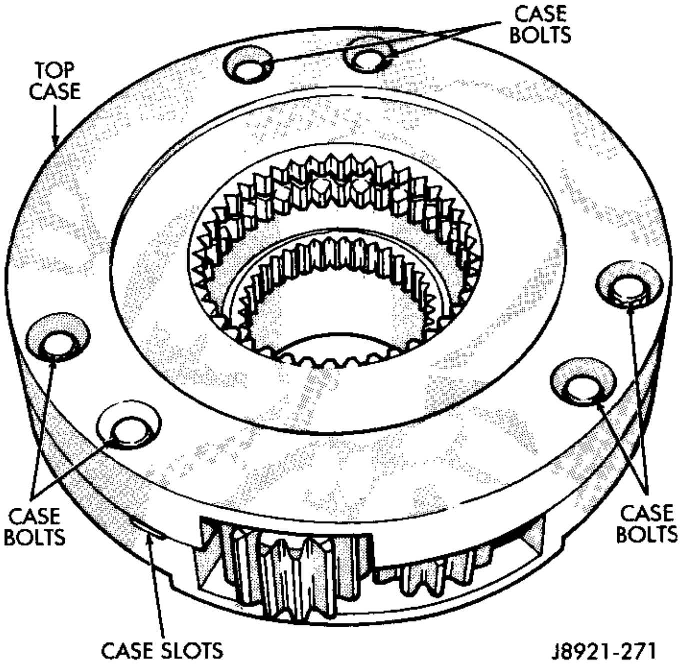


Fig. 39 Separating Differential Case Halves

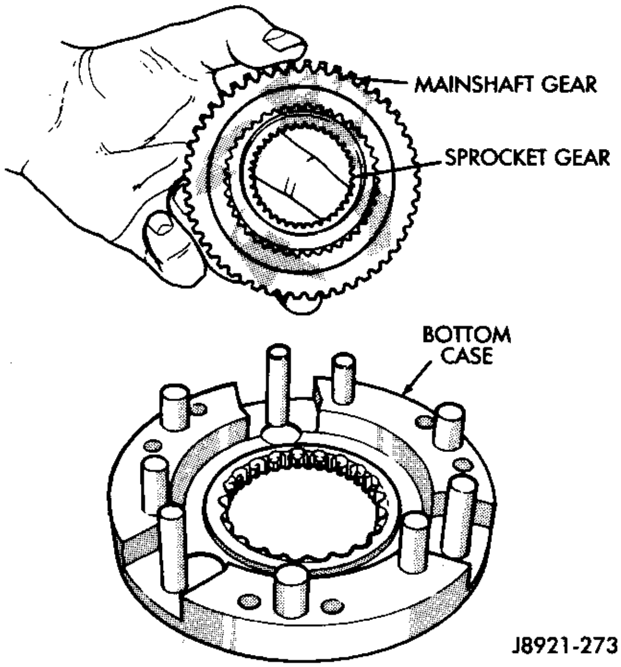


Fig. 41 Removing Mainshaft And Sprocket Gears

(33) Install remaining bearing spacer on mainshaft (Fig. 62). Do not displace any bearings while installing spacer.

(34) Install the differential (Fig. 63). **Do not displace the mainshaft bearings when installing the differential.**

(35) Install the differential snap ring (Fig. 64).

(36) Install the intermediate clutch shaft (Fig. 65).

(37) Install clutch shaft thrust washer (Fig. 66).

(38) Install clutch shaft snap ring (Fig. 67).

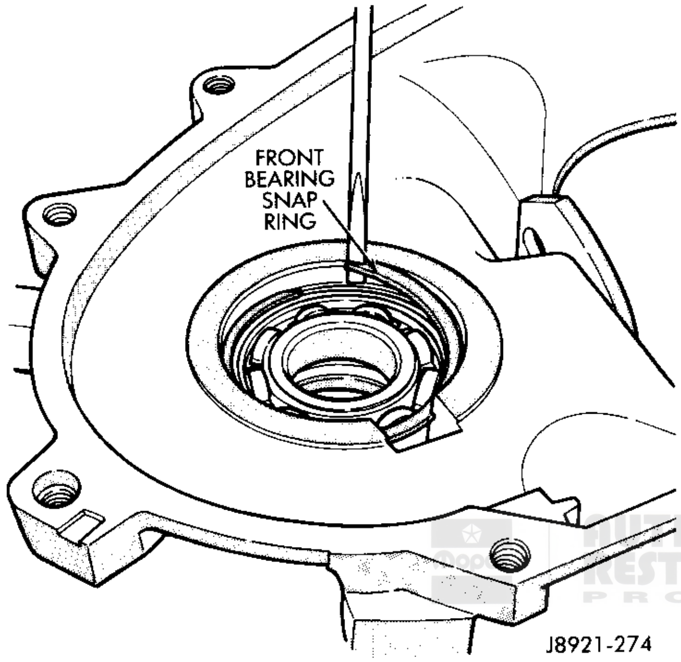


Fig. 42 Removing/Installing Front Output Shaft Front Bearing Snap Ring

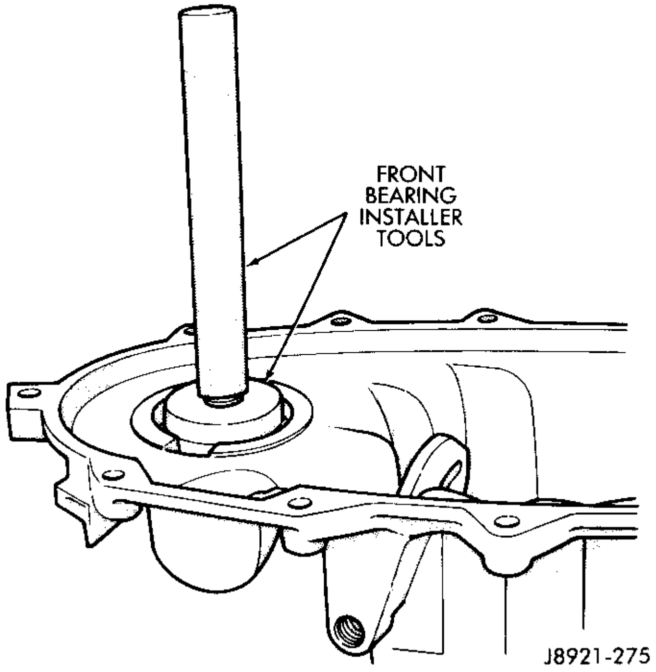


Fig. 43 Replacing Output Shaft Front Bearing

(39) Inspect mode fork assembly (Fig. 68). Replace pads and bushing if necessary. Replace fork tube if bushings inside tube are worn or damaged. Also check springs and slider bracket (Fig. 68). Replace worn, damaged components.

(40) Install mode sleeve in mode fork (Fig. 69). Then install assembled sleeve and fork on mainshaft (40). Be sure mode sleeve splines are engaged in differential splines.

(41) Install mode fork and mainshaft assembly in case (Fig. 70). Rotate mainshaft slightly to engage shaft with low range gears.

(42) Rotate mode fork pin into shift sector slot.

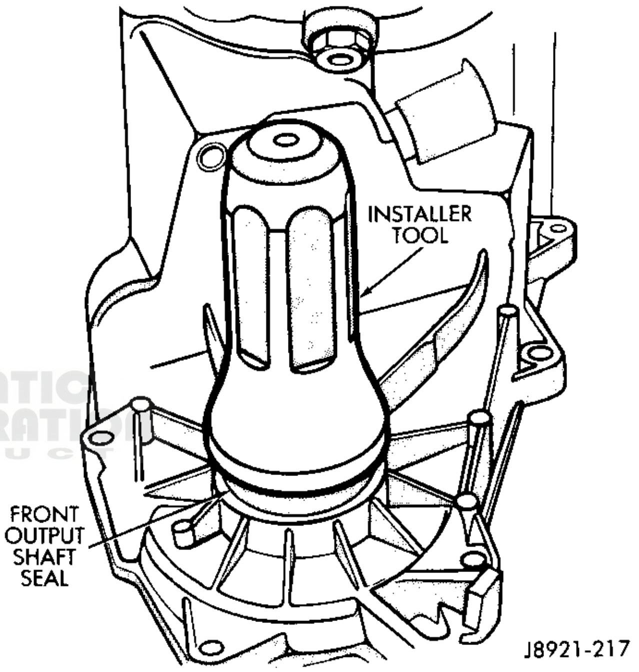


Fig. 44 Installing Front Output Shaft Seal

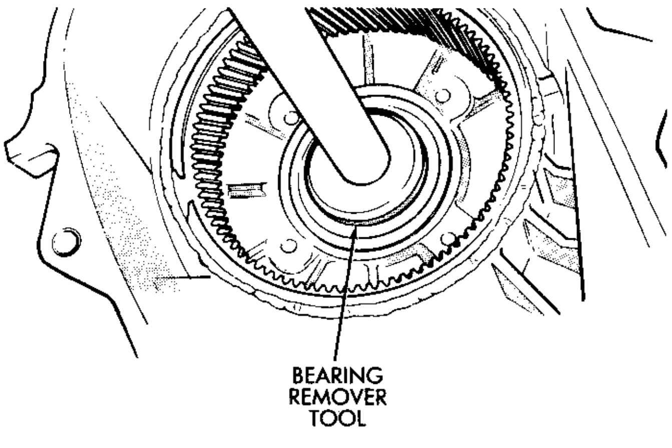


Fig. 45 Removing Input Gear Bearing

(43) Install shift rail (Fig. 71). **Be sure rail is seated in both shift forks.**

(44) Rotate shift sector to align lockpin hole in low range fork with access hole in case.

(45) Insert an easy-out in range fork lockpin to hold it securely for installation (Fig. 72). **Lockpin is slightly tapered on one end. Insert tapered end into fork and rail.**

(46) Insert lockpin through access hole and into shift fork (Fig. 72). Then remove the easy-out and seat the pin with pin punch.

(47) Install plug in lockpin access hole.

(48) Install transfer case shift lever and attaching nut. Tighten nut to 22 ft-lbs (30 N•m) torque.

(49) Install detent plunger, detent spring and detent plug in the case (Fig. 73).

(50) Install front output shaft (Fig. 74).

(51) Install drive chain (Fig. 74). Engage chain with front output shaft sprocket teeth.

(52) Install drive sprocket (Fig. 74).

(53) Engage drive sprocket teeth with chain. Then engage sprocket splines with mainshaft splines.

(54) Install drive sprocket snap ring (Fig. 75).

(55) Replace front output shaft rear bearing. Remove bearing with internal puller and slide hammer (Fig. 76).Install new bearing with bearing driver tools (Fig. 76). Lubricate bearing after installation.

(56) Assemble oil pump (Fig. 77). Replace any pump components that are worn or damaged.

(57) Install new seal in oil pump feed housing (Fig. 78).

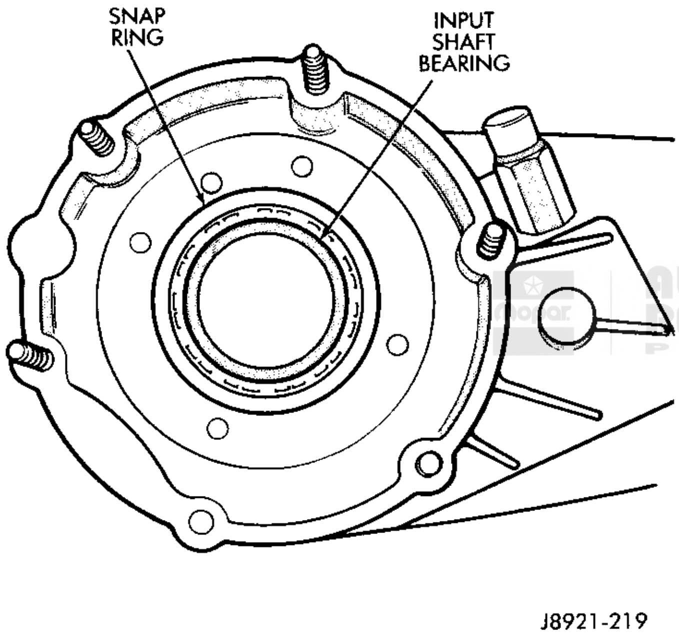


Fig. 46 Seating Input Gear Bearing

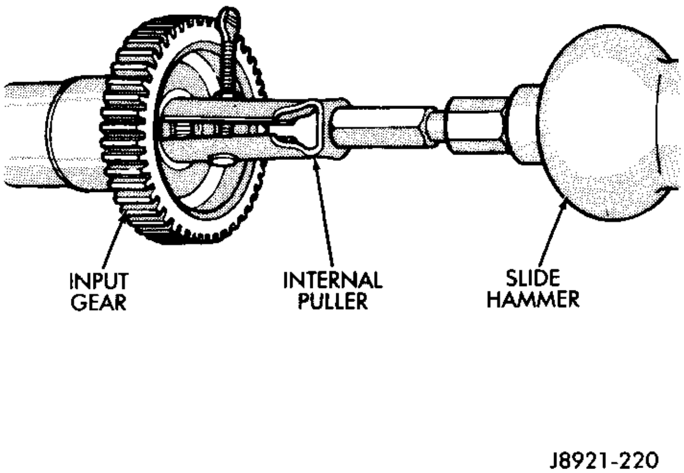


Fig. 47 Removing Input Gear Pilot Bearing

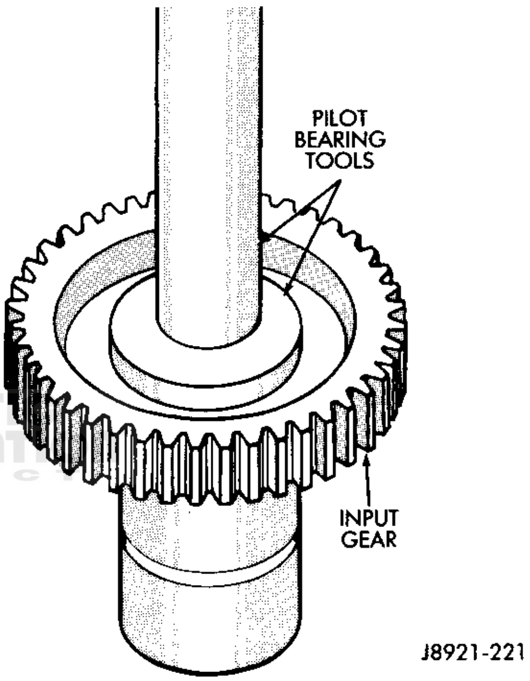


Fig. 48 Installing Input Gear Pilot Bearing

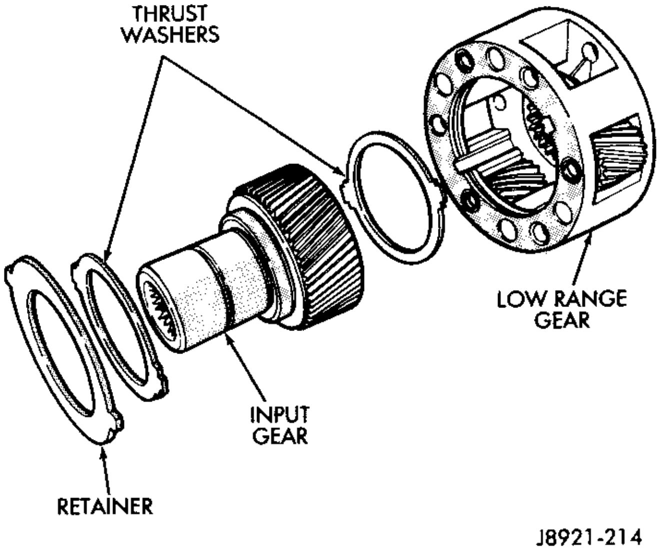


Fig. 49 Low Range And Input Gear Assembly

(58) Install new pickup tube O-ring in oil pump (Fig. 79).

(59) Insert oil pickup tube in oil pump and attach oil screen and connecter hose to pickup tube. Then install assembled pump, tube and screen in rear case (Fig. 80). Be sure screen is seated in case slot as shown.

(60) Install magnet (54) in front case pocket.

(61) Apply 3 mm (1/8 inch) wide bead of Mopar silicone sealer to seal surface of front case.

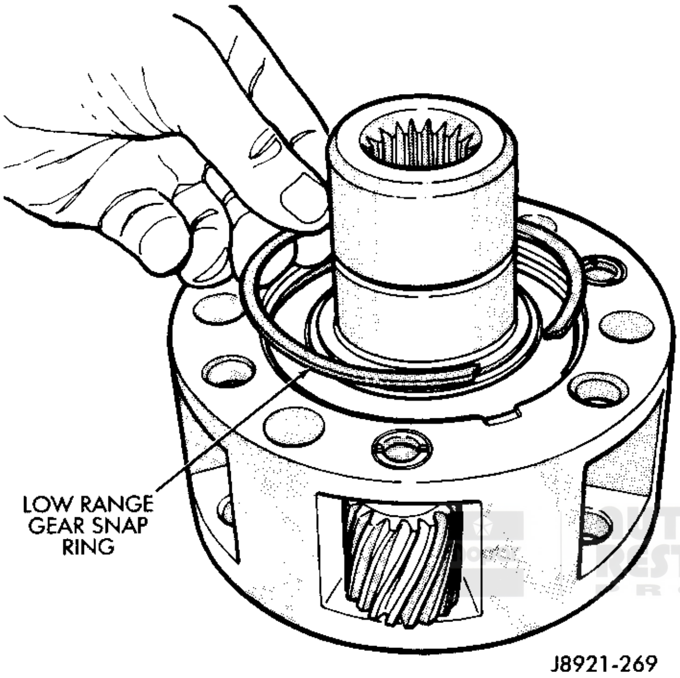


Fig. 50 Install Low Range Gear Snap Ring

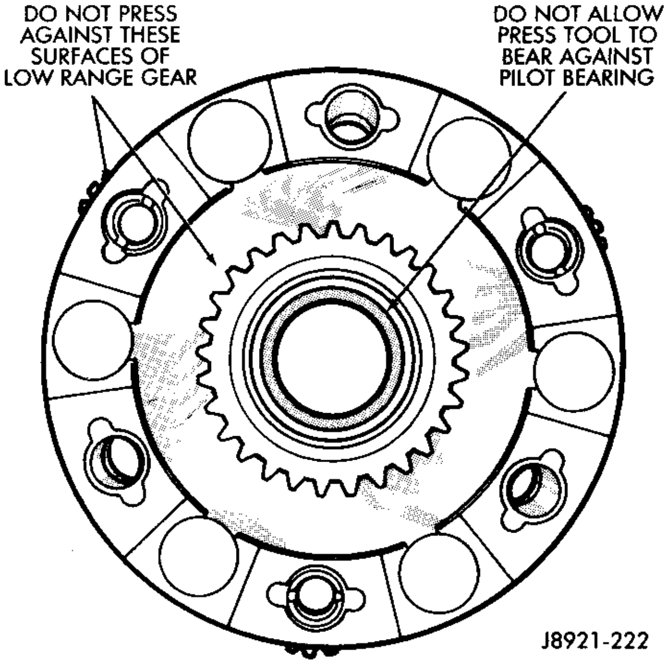


Fig. 51 Input Gear Installation

(62) Align and install rear case on front case. Be sure case locating dowels are in place and that mainshaft splines are engaged in oil pump inner gear.

(63) Install and tighten the front case-to-rear case bolts to 30 ft-lbs (41 N•m) torque. **Be sure to install a washer under each of the bolts used at the case dowel locations.**

(64) Tap rear retainer bearing out of retainer with hammer and brass drift.

(65) Install new bearing in rear retainer with driver tools (Fig. 82).

(66) Apply 3 mm (1/8 inch) wide bead of Mopar silicone sealer to seal surface of rear retainer.

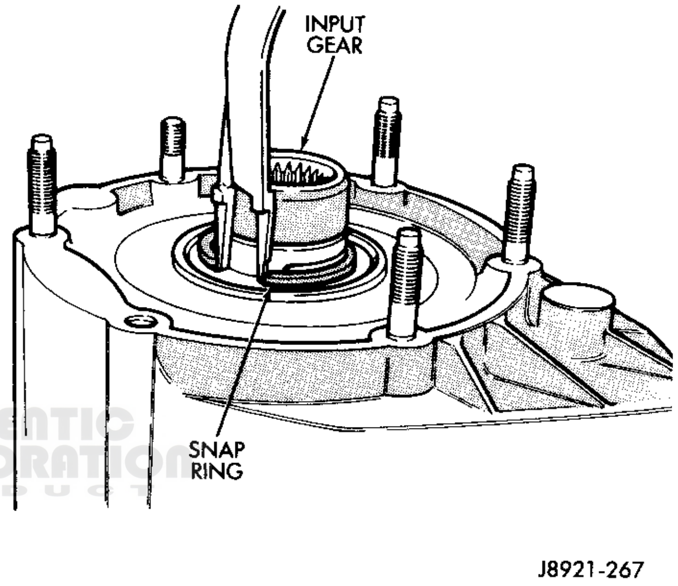


Fig. 52 Install Input Gear Snap Ring

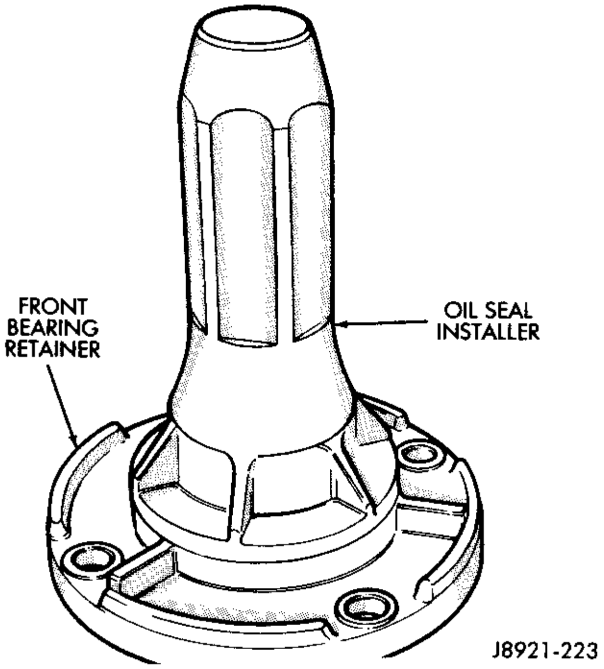


Fig. 53 Install Front Bearing Retainer Seal

(67) Install locating dowel in rear retainer (if removed) and install the retainer on the case. Tighten the retainer bolts to 30 ft-lbs (41 N•m) torque.

(68) Install new rear bearing snap ring (Fig. 83). Lift mainshaft slightly to seat the snap ring if necessary.

(69) Remove extension housing seal if not removed previously.

(70) Replace extension housing bushing with driver tools (Fig. 84).

(71) Install new extension housing oil seal (Fig. 85).

(72) Apply 3 mm (1/8 inch) wide bead of Mopar silicone sealer to seal surface of extension housing.

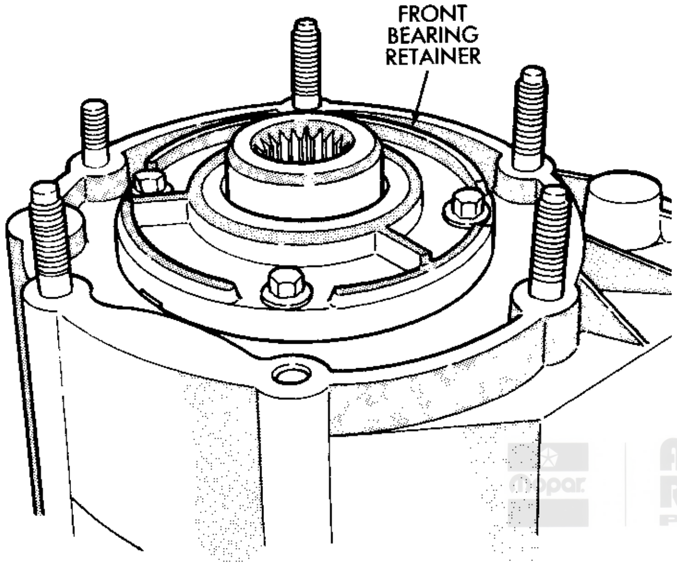


Fig. 54 Installing Front Bearing Retainer

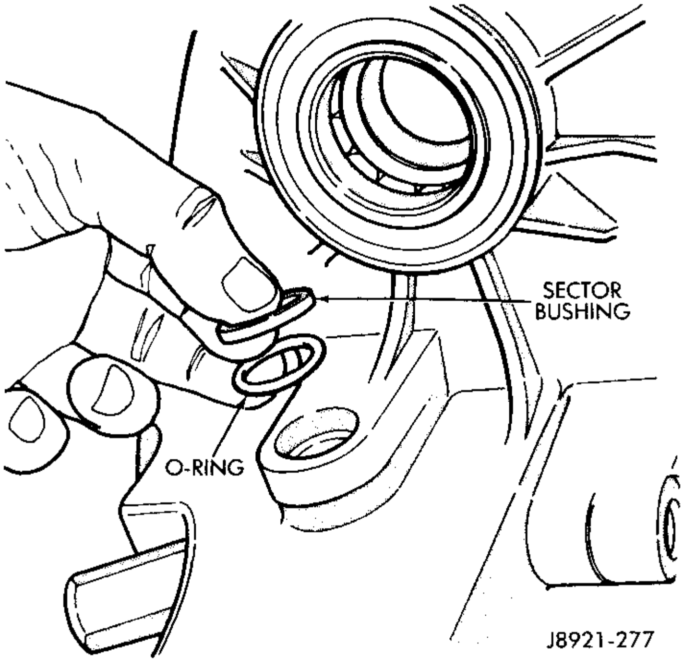


Fig. 55 Installing Sector O-Ring And Bushing

(73) Install extension housing on case. Tighten housing bolts to 30 ft-lbs (41 N•m) torque.

(74) Install front yoke. Secure yoke with new seal washer and nut. Tighten the nut to 110 ft-lbs (149 N•m) torque.

(75) Install new gasket on vacuum switch and install the switch in the case. Tighten the switch to 20 ft-lbs (27 N•m) torque.

(76) Install speedometer components (Fig. 86).

(77) Install and tighten the drain plug to 35 ft-lbs (47 N•m) torque.

(78) After installing transfer case, refill with Mopar Dexron II™ or Mercon™ automatic transmission fluid.

(79) Tighten the fill plug to 35 ft-lbs (47 N•m) torque.

(80) Adjust the transfer case shift linkage.

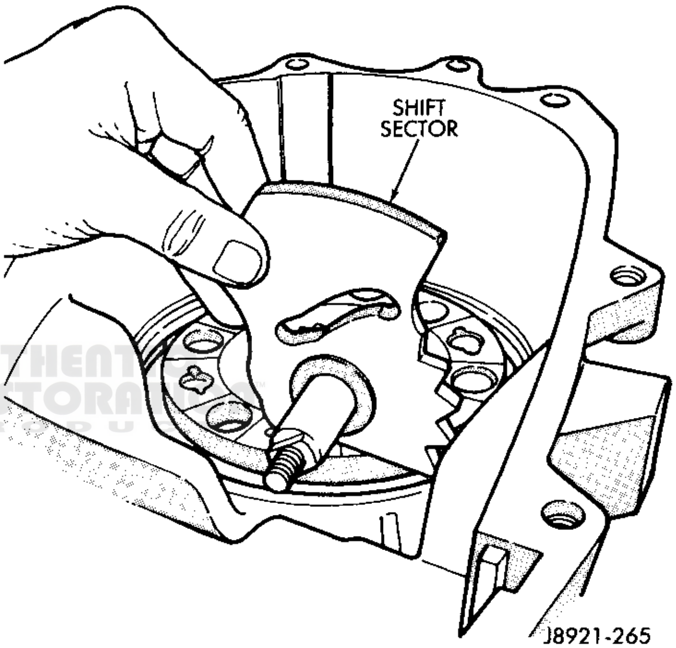


Fig. 56 Installing Shift Sector

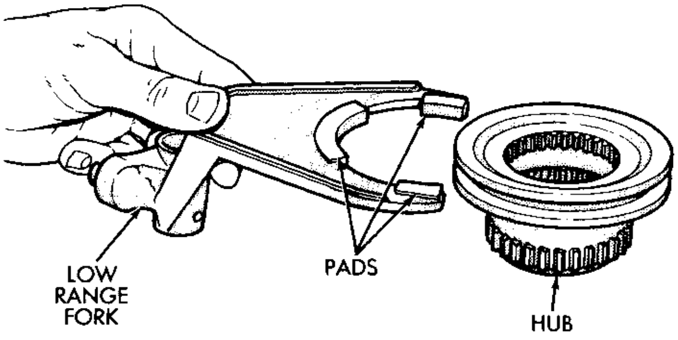


Fig. 57 Assembling Low Range Fork And Hub

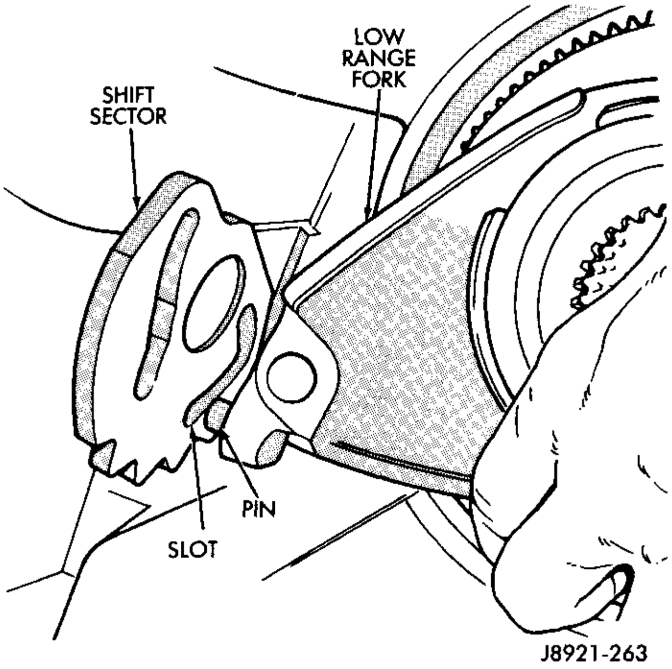


Fig. 58 Positioning Low Range Fork

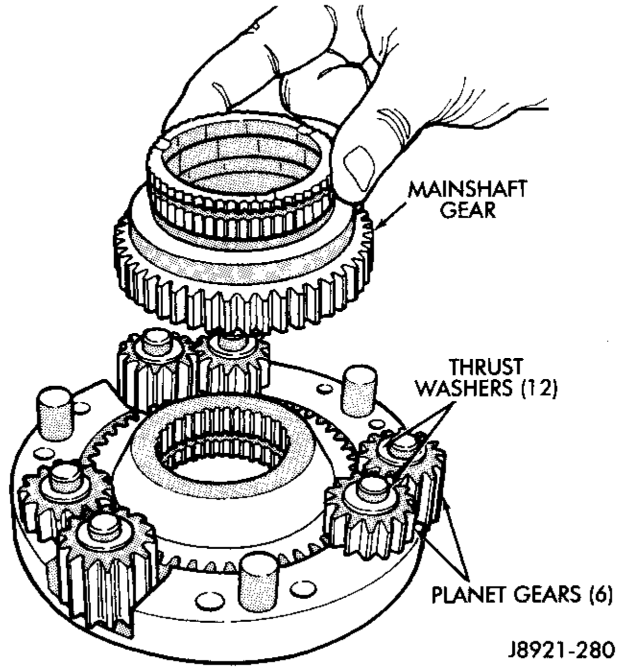


Fig. 60 Installing Mainshaft And Planet Gears

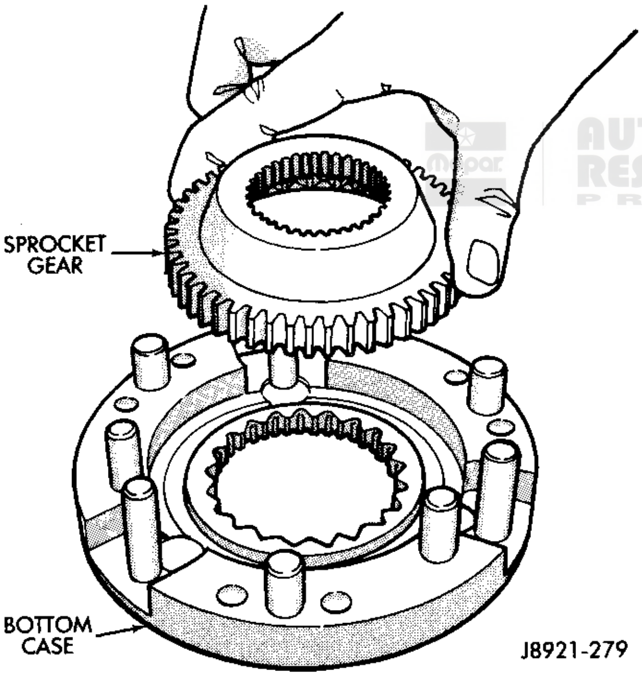


Fig. 59 Installing Differential Sprocket Gear

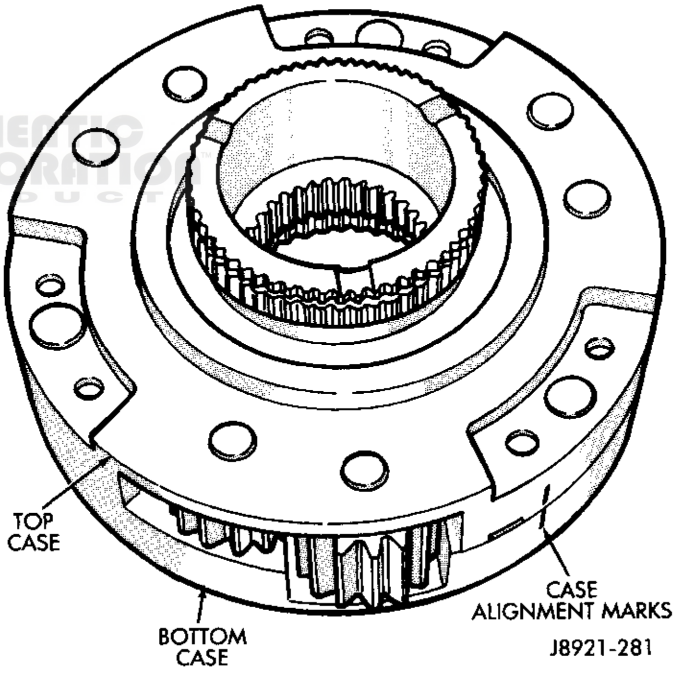


Fig. 61 Differential Case Assembly

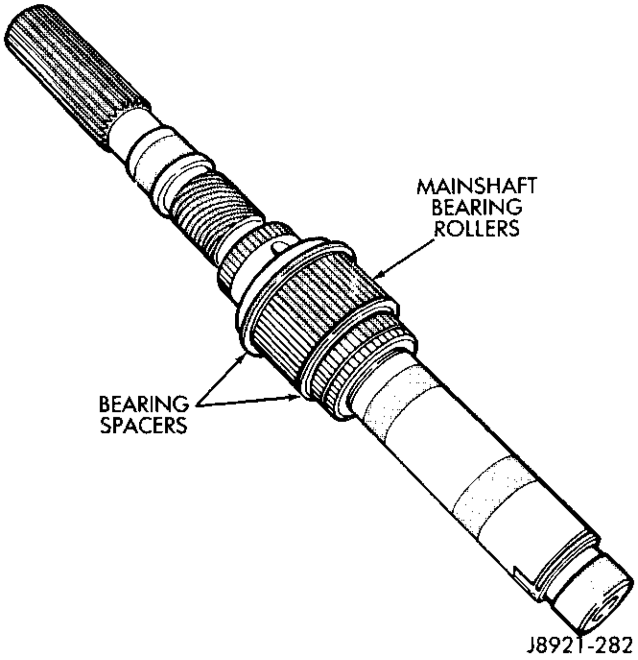


Fig. 62 Installing Mainshaft Bearing Rollers and Spacers

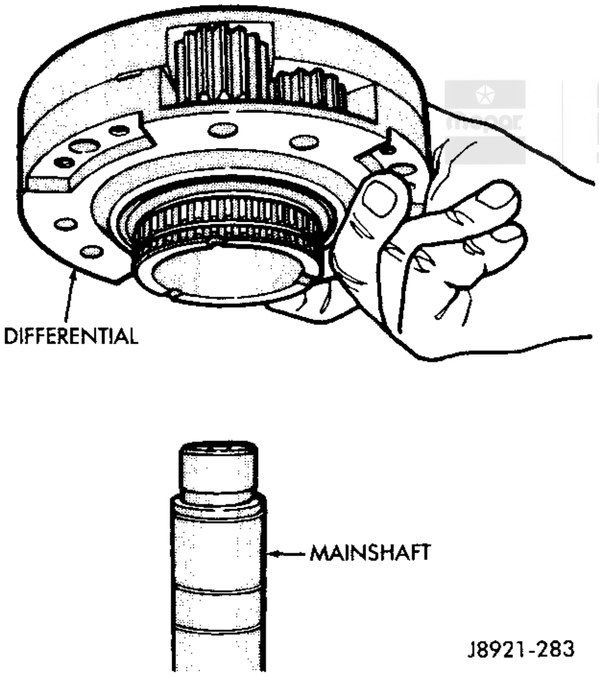


Fig. 63 Differential Installation

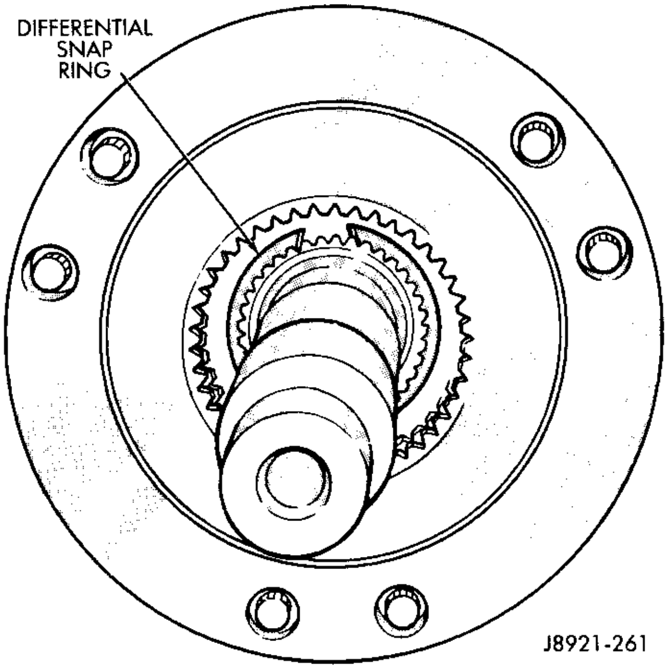


Fig. 64 Installing Differential Snap Ring

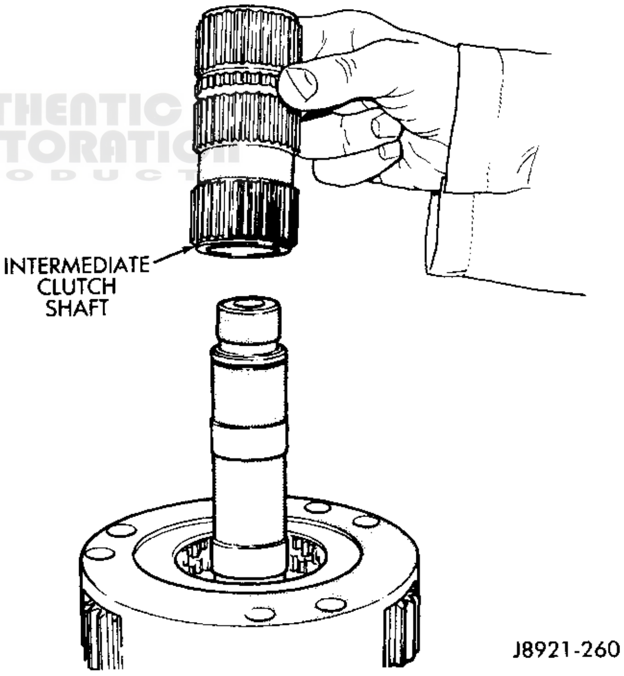


Fig. 65 Installing Intermediate Clutch Shaft

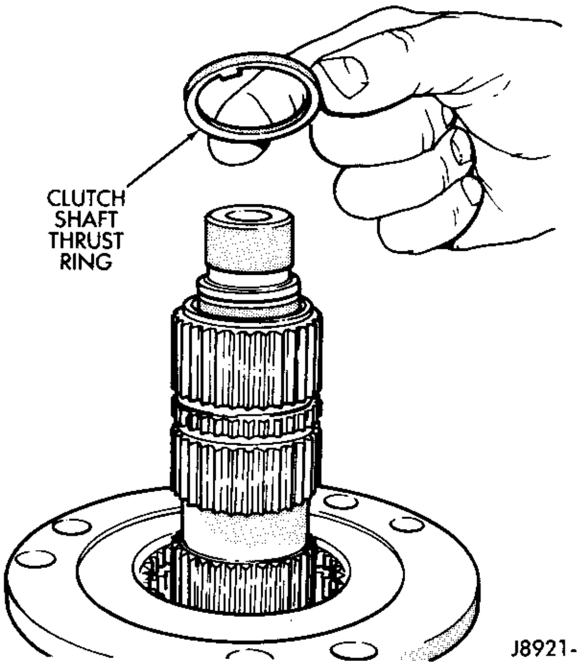


Fig. 66 Installing Clutch Shaft Thrust Washer

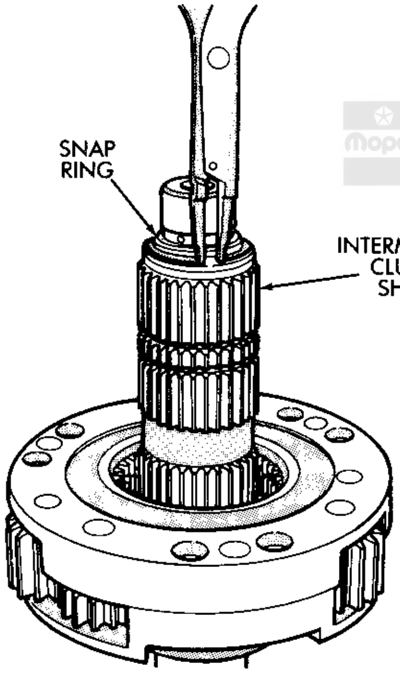


Fig. 67 Installing Clutch Shaft Snap Ring

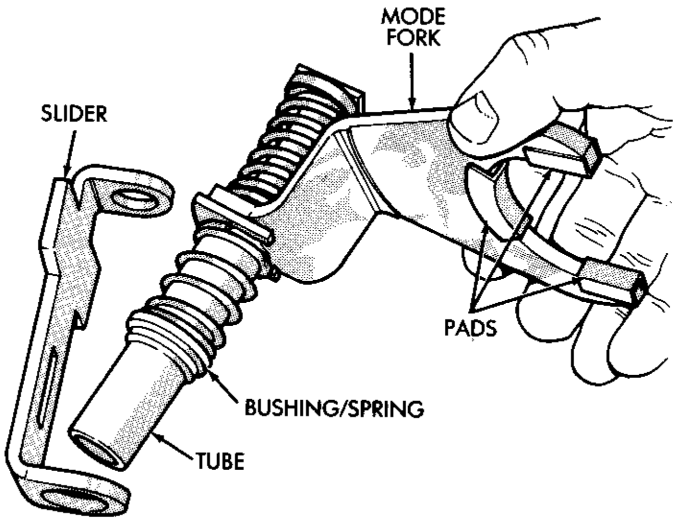


Fig. 68 Inspect Mode Fork Assembly

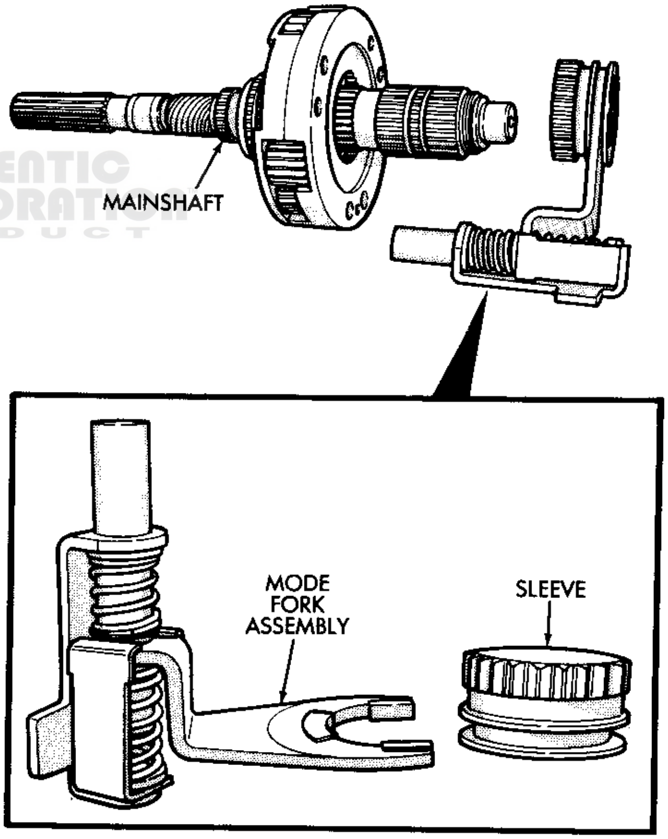


Fig. 69 Installing Mode Fork And Sleeve

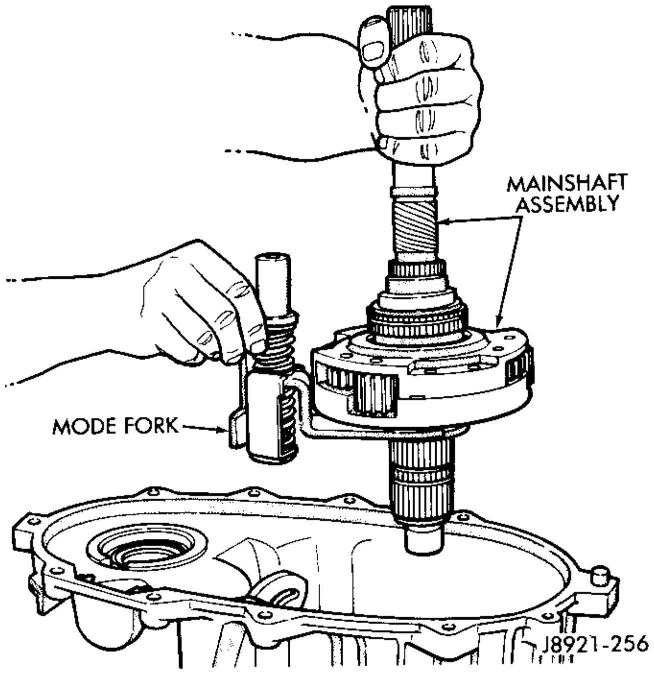


Fig. 70 Installing Mainshaft And Mode Fork

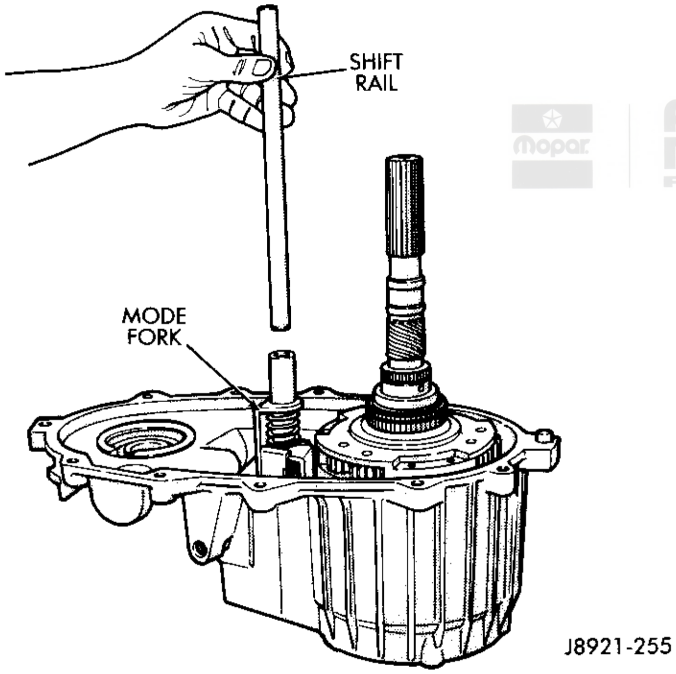


Fig. 71 Installing Shift Rail

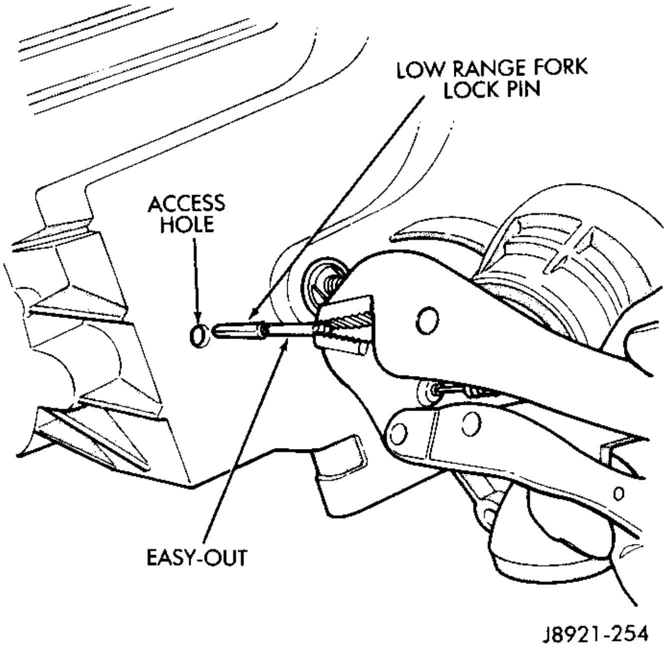


Fig. 72 Installing Low Range Fork Lockpin

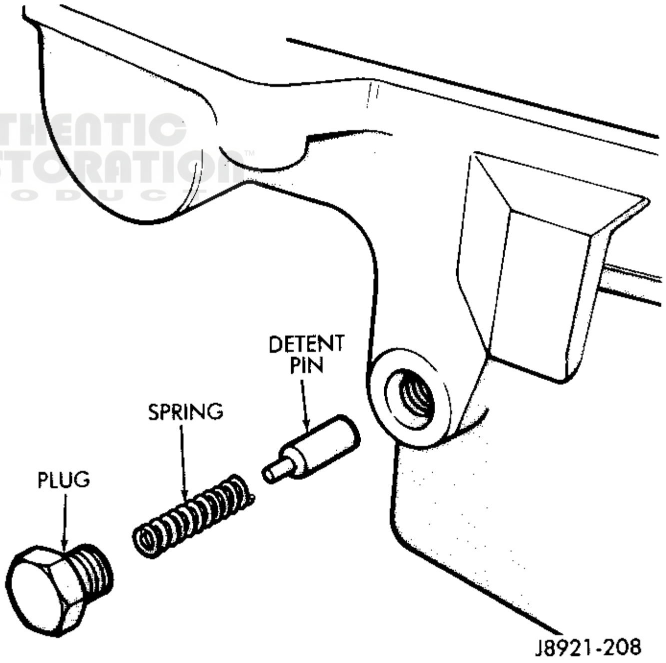


Fig. 73 Installing Detent Pin-Spring-Plug

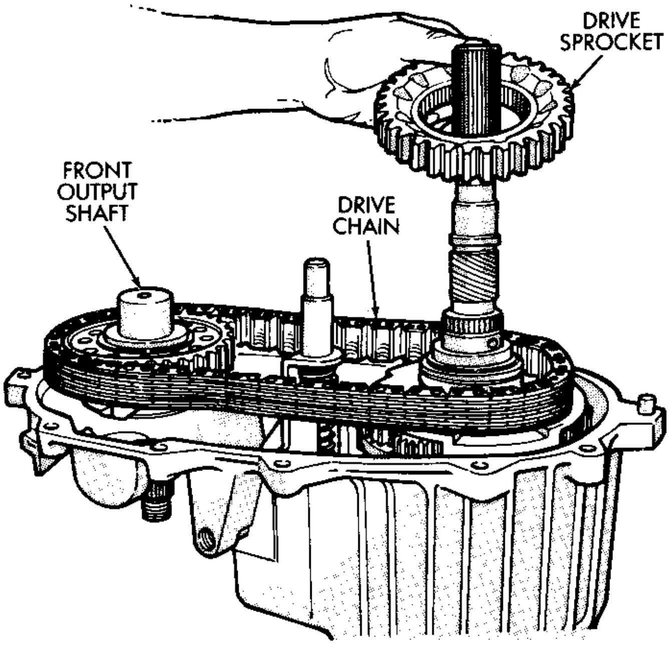


Fig. 74 Installing Drive Chain And Sprocket

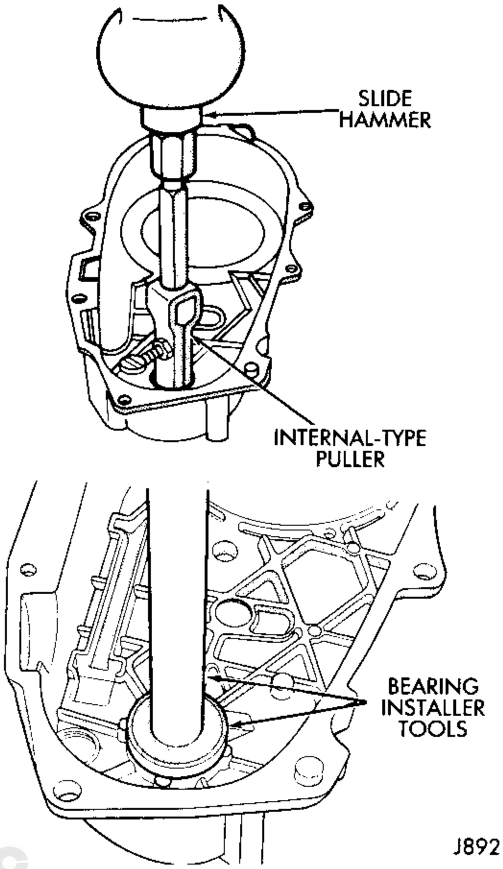


Fig. 76 Installing Front Output Shaft Rear Bearing

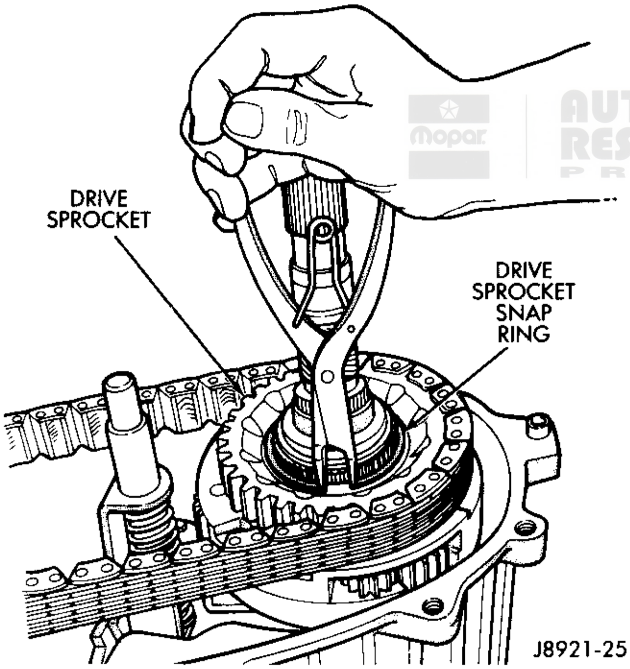


Fig. 75 Installing Drive Sprocket Snap Ring

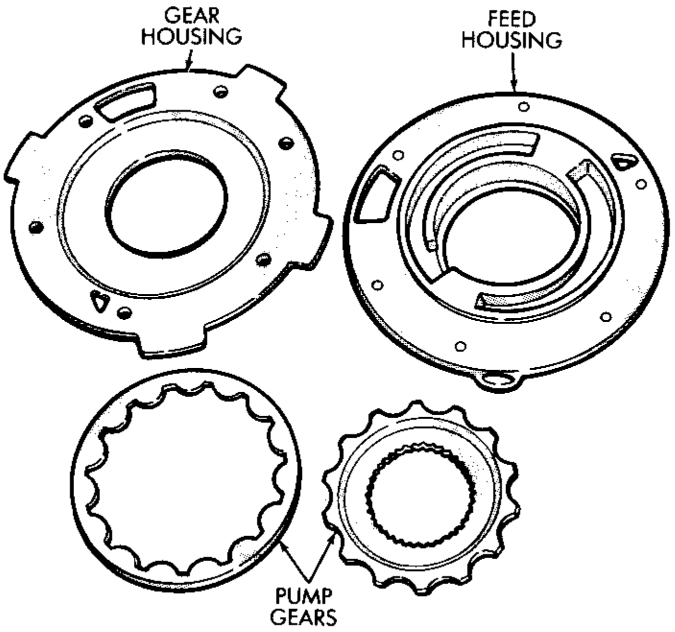


Fig. 77 Oil Pump Assembly

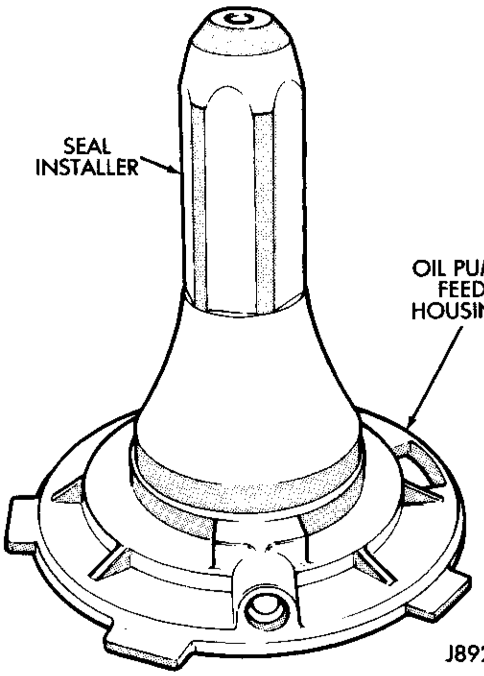


Fig. 78 Installing Oil Pump seal

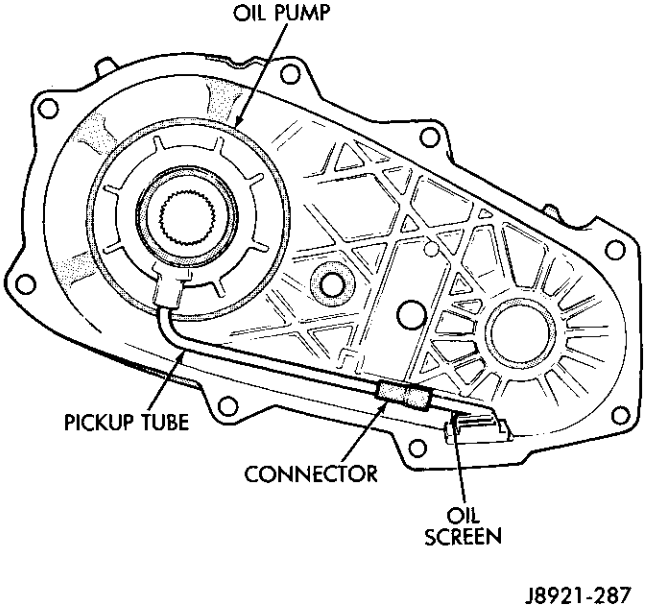


Fig. 80 Installing Oil Screen And Pickup Tube

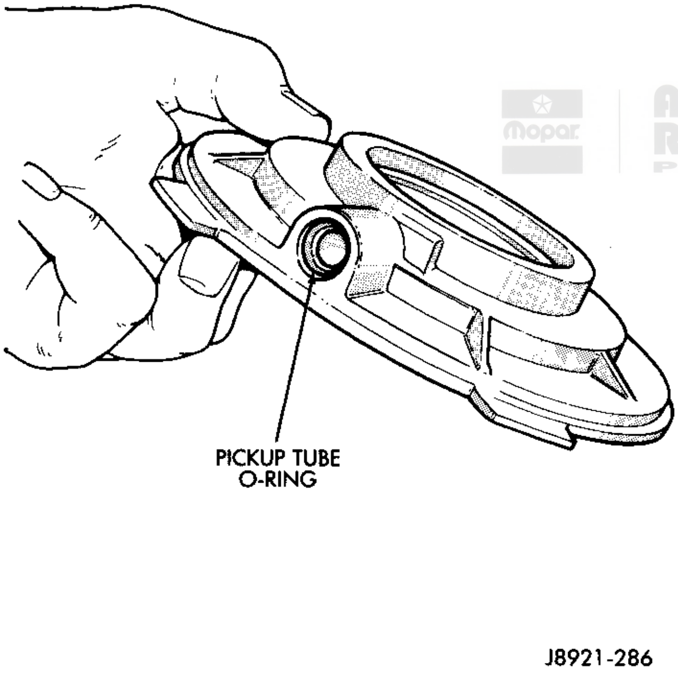


Fig. 79 Installing Pickup Tube O-Ring

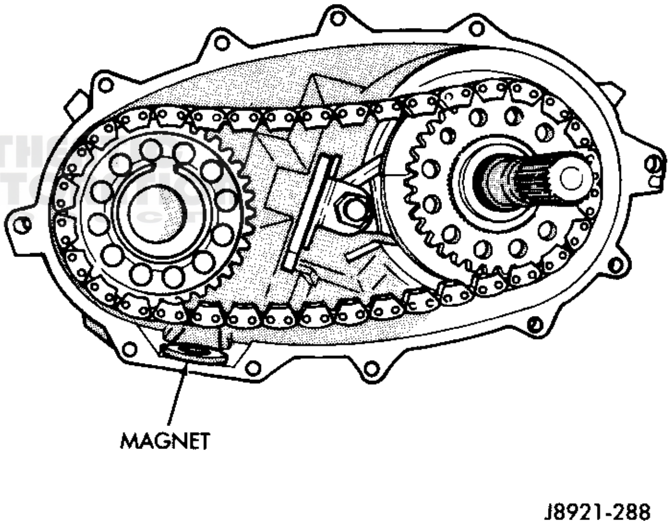


Fig. 81 Installing Case Magnet

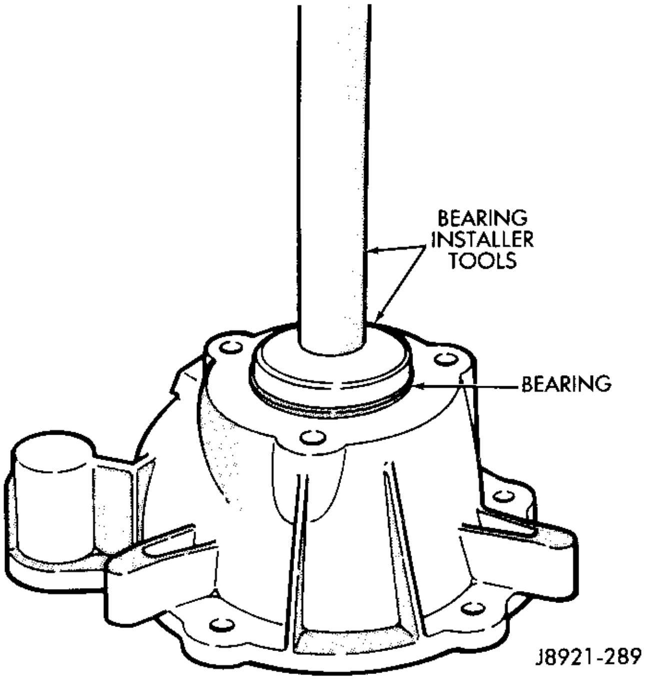


Fig. 82 Installing Rear Bearing In Retainer

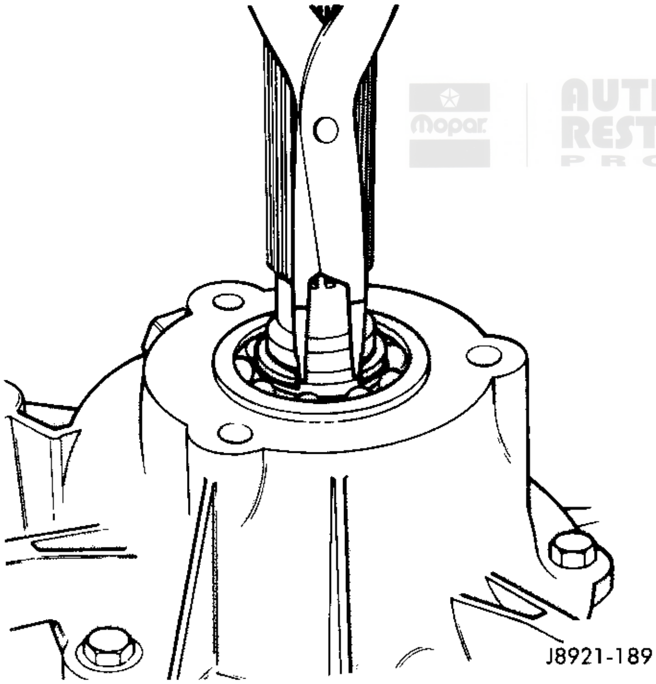


Fig. 83 Installing Rear Bearing Snap Ring

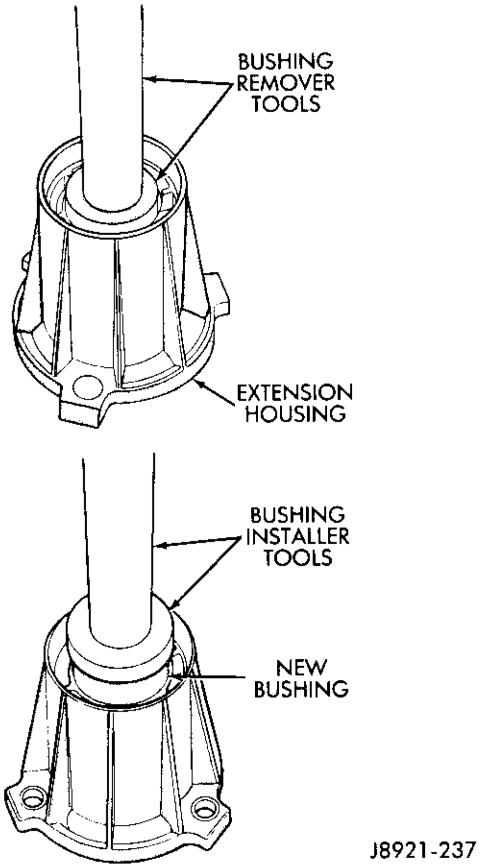


Fig. 84 Replacing Extension Housing Bushing

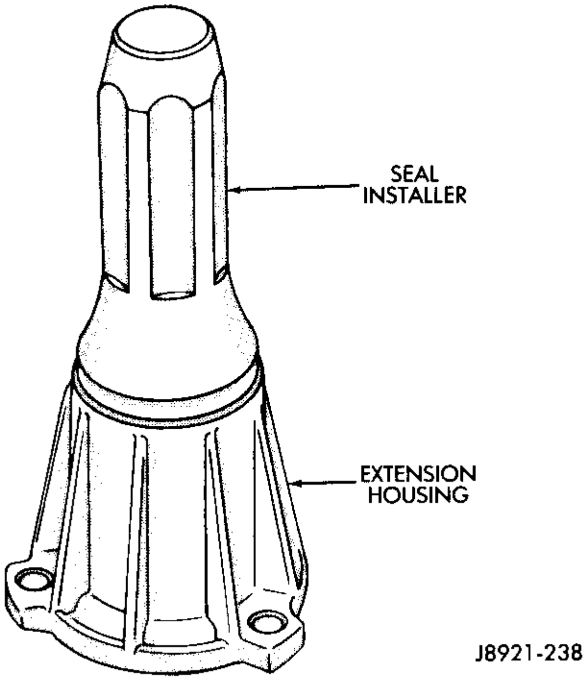


Fig. 85 Replacing Extension Housing Seal

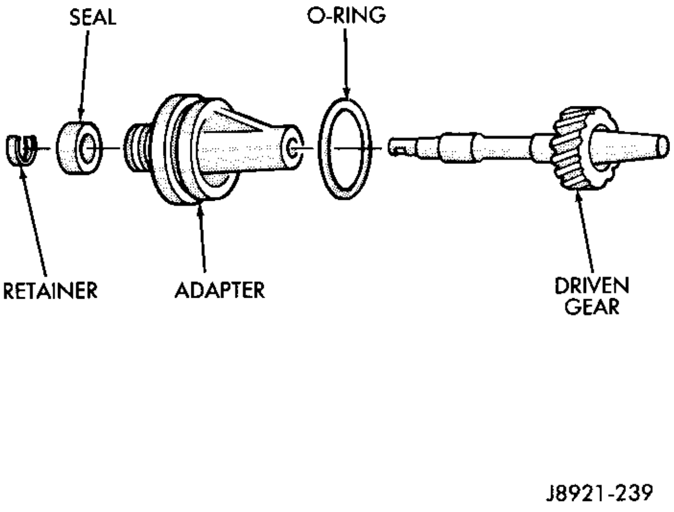
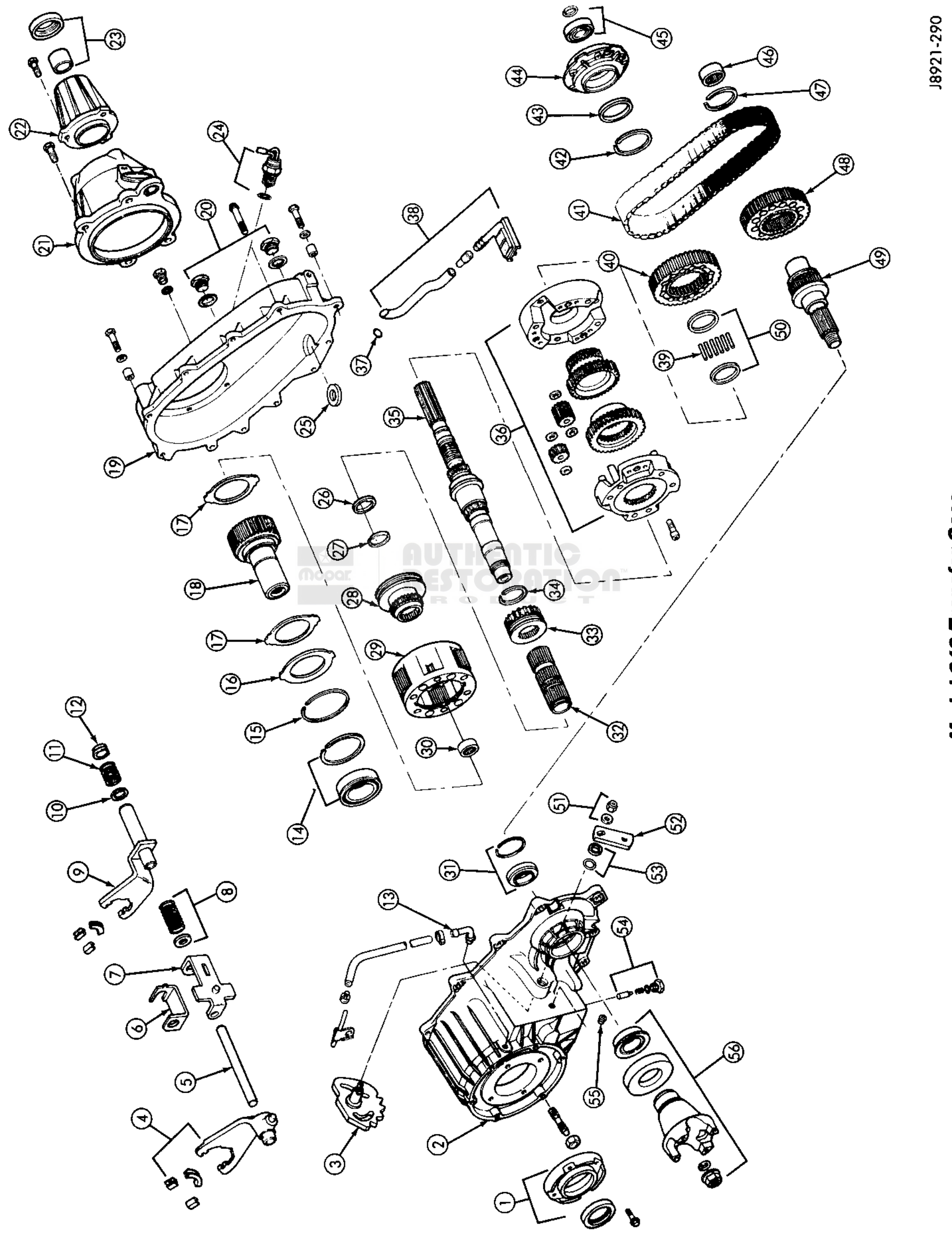


Fig. 86 Speedometer Assembly



Model 242 Transfer Case

1 FRONT BEARING RETAINER AND SEAL
2 FRONT CASE
3 SHIFT SECTOR
4 LOW RANGE FORK AND INSERTS
5 SHIFT RAIL
6 SHIFT BRACKET
7 SLIDER BRACKET
8 BUSHING AND SPRING
9 MODE FORK AND INSERTS
10 BUSHING
11 FORK SPRING
12 BUSHING
13 VENT TUBE ASSEMBLY
14 INPUT GEAR BEARING AND SNAP RING
15 LOW RANGE GEAR SNAP RING
16 RETAINER, LOW RANGE GEAR
17 THRUST WASHER, LOW RANGE GEAR
18 INPUT GEAR
19 REAR CASE
20 DRAIN/FILL PLUGS
21 REAR BEARING RETAINER
22 EXTENSION HOUSING
23 BUSHING AND OIL SEAL
24 VACUUM SWITCH
25 MAGNET
26 THRUST RING
27 SNAP RING
28 SHIFT SLEEVE
29 LOW RANGE GEAR
30 PILOT BUSHING (INPUT GEAR/MAINSHAFT)
31 FRONT OUTPUT SHAFT FRONT BEARING AND SNAP RING
32 INTERMEDIATE CLUTCH SHAFT
33 SHIFT SLEEVE
34 SNAP RING
35 MAINSHAFT
36 DIFFERENTIAL ASSEMBLY
37 OIL PUMP TUBE O-RING
38 OIL PUMP PICKUP TUBE AND SCREEN
39 MAINSHAFT BEARING ROLLERS
40 DRIVE SPROCKET
41 DRIVE CHAIN
42 SNAP RING
43 OIL PUMP SEAL
44 OIL PUMP
45 REAR BEARING AND SNAP RING
46 FRONT OUTPUT SHAFT REAR BEARING
47 SNAP RING
48 DRIVEN SPROCKET
49 FRONT OUTPUT SHAFT
50 MAINSHAFT BEARING SPACERS
51 SHIFT LEVER WASHER AND NUT
52 SHIFT LEVER
53 SECTOR O-RING AND SEAL
54 DETENT PIN, SPRING AND PLUG
55 SEAL PLUG
56 FRONT YOKE NUT, SEAL WASHER, YOKE, SLINGER AND OIL SEAL

J8921-291

SERVICE SPECIFICATIONS

Transfer Case Type	Full-time dual range – Model 242.
Torque Transfer Mode	Dual sprocket, interconnecting drive chain and interaxle differential. Low range ratio is 2.72:1.
Operating Ranges	2WD High, 4WD High, 4WD High Lock, 4WD Low Lock and a Neutral position.
Case Configuration	Two-piece aluminum with removable extension and retainer housings.
Lubricant Capacity	1.4 liters
Required Lubricant	MOPAR MERCON® Automatic Transmission Fluid or equivalent marked DEXRON® II.
Transfer Case Fill Level	To bottom edge of fill plug hole.

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Extension Housing Bolt	41 N·m (30 ft-lbs)	35-46 N·m (26-34 ft-lbs)
Rear Retainer Bolt	41 N·m (30 ft-lbs)	35-46 N·m (26-34 ft-lbs)
Front Case-to-Rear Case Bolt	41 N·m (30 ft-lbs)	35-46 N·m (26-34 ft-lbs)
Front Yoke Nut	149 N·m (110 ft-lbs)	122-176 N·m (90-130 ft-lbs)
Front Bearing Retainer Bolt	21 N·m (16 ft-lbs)	16-27 N·m (12-20 ft-lbs)
Differential Housing Bolt	N/A	N/A
Shift Lever Nut	30 N·m (22 ft-lbs)	27-34 N·m (20-25 ft-lbs)
Switch	27 N·m (20 ft-lbs)	20-34 N·m (15-25 ft-lbs)
Detent Spring Cover	20 N·m (15 ft-lbs)	16-24 N·m (12-18 ft-lbs)
Drain and Fill Plug	47 N·m (35 ft-lbs)	40-54 N·m (30-40 ft-lbs)
Oil Pump Screw	1.6 N·m (14 in-lbs)	1.4-1.8 N·m (12-15 in-lbs)

J8921-751

MODEL 229 TRANSFER CASE

INDEX

GENERAL INFORMATION

Description

The Model 229 transfer case (Fig. 1) is used in SJ models. It provides three operating ranges plus a Neutral position.

Shift Controls

The 229 transfer case is shifted by both mechanical and vacuum control mechanisms.

High and low ranges are selected with a floor shift lever (Fig. 2). The lever is connected to the transfer case by linkage rods.

A vacuum shift mechanism is used to shift the transfer case into two-wheel drive or four-wheel drive mode (Fig. 3).

The vacuum shift controls consist of the mode switch on the instrument panel, a vacuum storage tank, the vacuum shift motor, a check valve and the necessary connecting lines/hoses (Fig. 3).

The vacuum shift motor shifts the transfer case into two and four-wheel drive modes. The storage tank provides the system vacuum supply. The check valve ensures correct shift sequence.

Drive Modes

The mode switch controls two-wheel and four-wheel mode. Range selection is by a floor mounted shift lever. Drive ranges are: 2WD high; 4WD high; 4WD low; and Neutral.

TRANSFER CASE IDENTIFICATION

A circular I.D. tag is attached to the rear case of each Model 229 transfer case (Fig. 4). The tag provides the transfer case model number, assembly number, serial number and low range ratio.

The transfer case serial number also represents the date of build. For example, a serial number of 9-5-88 would represent September 5, 1988.

TRANSFER CASE LUBRICANT

Lubricant Type-Capacity

Use Mopar Mercon™ or Dexron II™ automatic transmission fluid in the Model 229 transfer case.

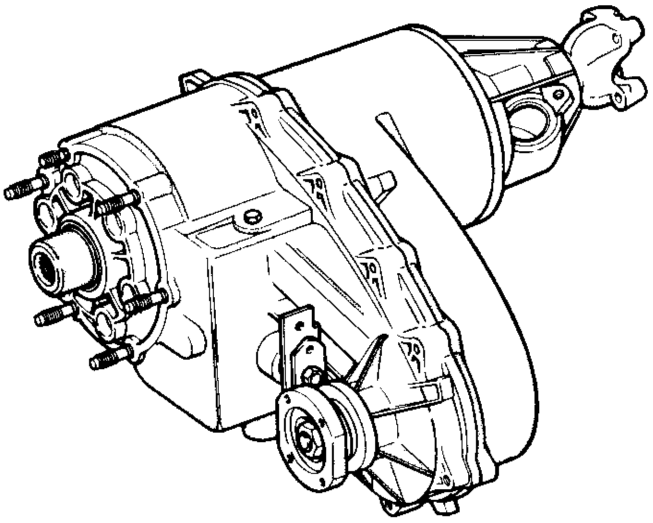


Fig. 1 Model 229 Transfer Case

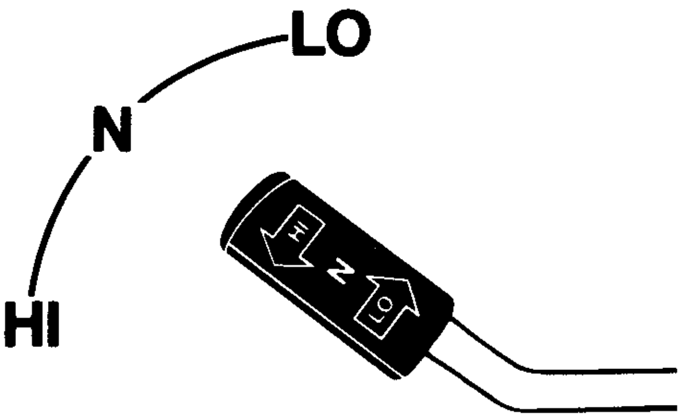


Fig. 2 High-Low Range Lever

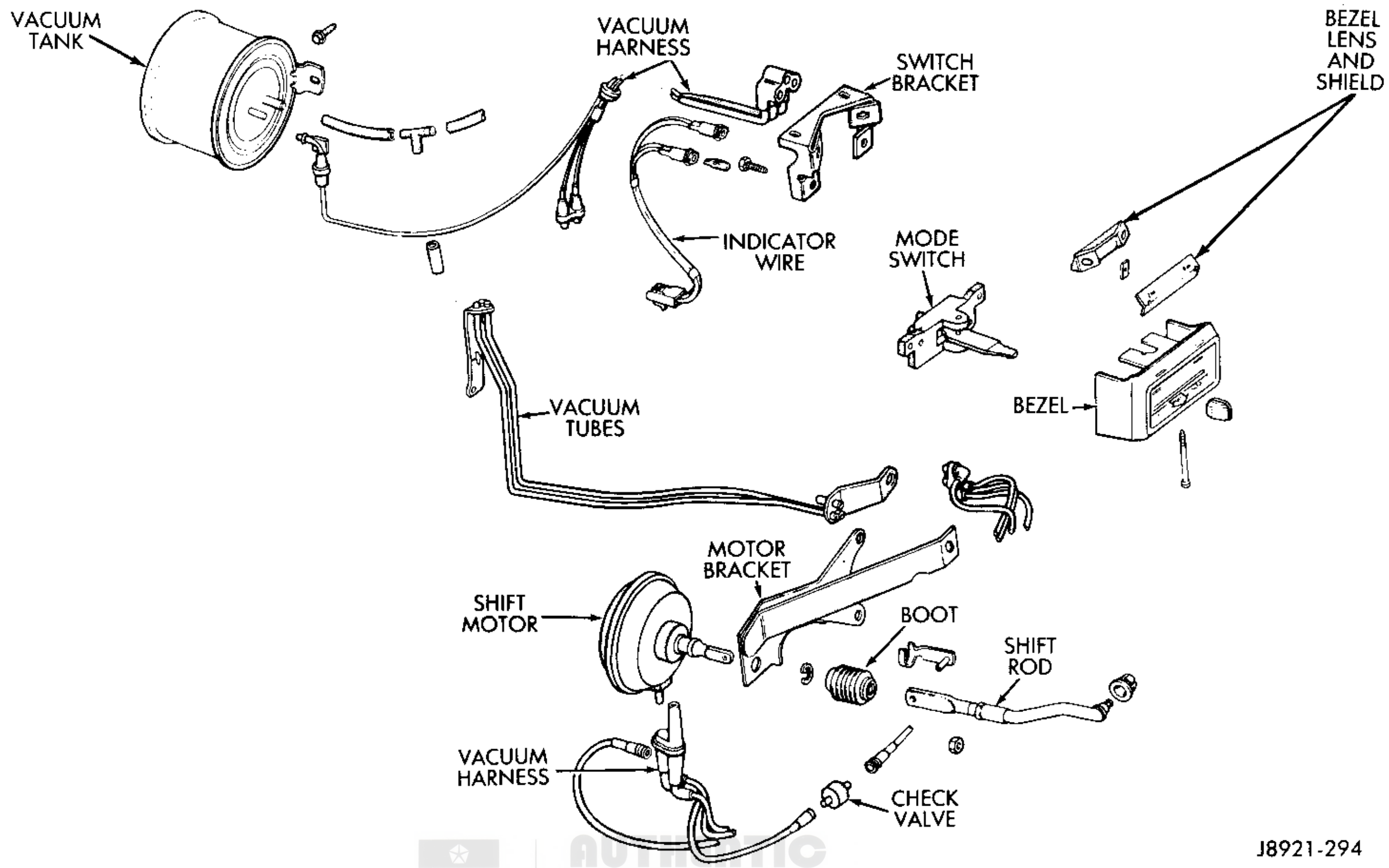


Fig. 3 Vacuum Shift Components

Dexron II™ and Mercon™ are compatible and can be used to top off a transfer case previously filled with either fluid.

Model 229 lubricant capacity is: 2.82 liters (6.0 pints).

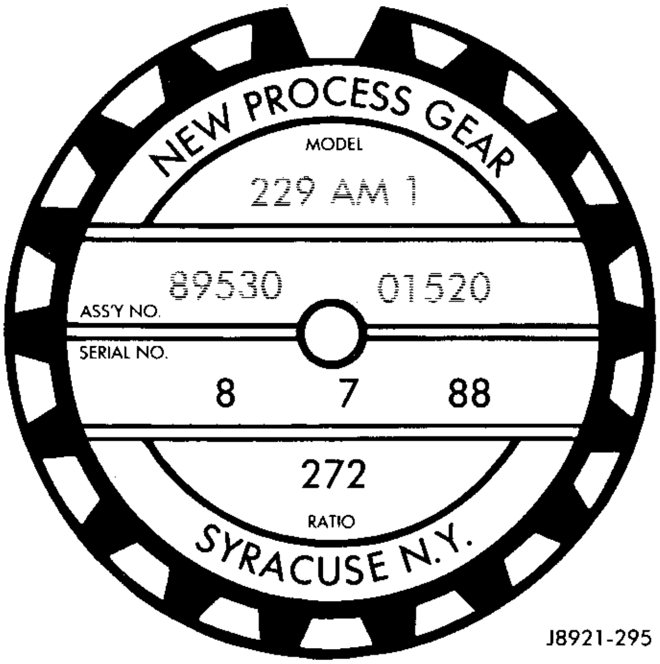


Fig. 4 Transfer Case I.D. Tag

Fill Level

The correct fill level is to the bottom edge of the fill plug hole.

SERVICE DIAGNOSIS

Before attempting to correct a suspected transfer case problem, check all other driveline components.

The actual cause of a problem may instead be related to an axle, propeller shaft, U-joint, wheel and tire, or transmission. or the engine.

If all driveline components are in good condition and operating properly, refer to the Service Diagnosis charts for further information.

Refer to the Vacuum Shift Motor Function Test if diagnosis indicates a test is necessary.

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
TRANSFER CASE WILL NOT SHIFT INTO 2WD OR 4WD MODE	(1) Vacuum leak in harness, connecting lines or tank.	(1) Locate/repair leak.
	(2) Shift motor malfunction.	(2) Test and replace motor, if necessary.
	(3) Check valve stuck/leaking.	(3) Replace valve.
	(4) Mode switch malfunction.	(4) Check switch operation. Replace if necessary.
	(5) Transfer case shift mechanism worn/damaged.	(5) Disassemble and repair as needed.
TRANSFER CASE WILL NOT SHIFT INTO HI OR LO RANGE	(1) Range lever misadjusted.	(1) Adjust lever shift rod.
	(2) Insufficient lubricant.	(2) Check and correct lubricant level.
	(3) Incorrect lubricant.	(3) Drain and refill.
	(4) Internal damage.	(4) Disassemble and repair as needed.
NOISY IN ALL RANGES	(1) Insufficient or incorrect lubricant.	(1) Drain and refill with DEXRON II® or MOPAR-MERCON® automatic transmission fluid.
	(2) Worn/damaged internal components.	(2) Disassemble and repair.
LUBRICANT LEAKS FROM OUTPUT SHAFT SEALS OR FROM VENT	(1) Transfer case overfilled.	(1) Drain to correct level.
	(2) Vent restricted.	(2) Replace/clear vent.
	(3) Output shaft seals damaged or incorrectly installed.	(3) Replace seals. Also replace yokes if seal surfaces are damaged.

J8921-296

SHIFT MOTOR FUNCTION TEST

(1) Disconnect vacuum harness at transfer case shift motor.

(2) Connect a hand operated vacuum pump to the shift motor front port.

(3) Apply 50.5 kPa (15 inches) of vacuum to shift motor and rotate rear propeller shaft to engage transfer case in four-wheel drive mode.

(4) Shift motor should hold applied vacuum for a minimum of 30 seconds. Replace motor if it does not hold vacuum. If motor does hold vacuum, proceed to next step.

(5) Disconnect vacuum pump from shift motor front port. Connect pump to shift motor rear port and apply 50.5 kPa (15 inches) of vacuum.

(6) Shift transmission into Park.

(7) The shift motor should hold applied vacuum a minimum of 30 seconds. If the motor does not hold vacuum, replace the motor.

SHIFT MOTOR REPLACEMENT

Removal

(1) Disconnect the shift motor link from the range lever.

(2) Remove and discard the lever grommet.

(3) Remove the nut and bolt attaching the shift motor bracket to the transfer case and remove the bracket and motor as an assembly.

(4) Slide the shift motor boot aside and remove the E-ring that retains the motor in the bracket.

(5) Disconnect the vacuum lines from the motor.

(6) Remove the motor.

Installation

(1) Position the motor in the bracket and install the E-ring.

(2) Install the boot, if removed.

(3) Connect the vacuum lines to the motor.

(4) Position the motor and bracket assembly on the transfer case and install the bracket attaching nut and bolt.

(5) Install new grommet in range lever.

(6) Connect the shift motor link to the range lever.

RANGE LEVER ADJUSTMENT

(1) Place range lever in Hi position.

(2) Move carpeting aside for access to range lever.

(3) Insert 3 mm (1/8 inch) diameter spacer between lever and shift gate. Tape or tie spacer in place.

(4) Raise the vehicle.

(5) Verify that the range lever is in high range position.

(6) Loosen locknut on range lever linkage rod (Fig. 5).

(7) Adjust rod to free fit in the transfer case range lever. Then toghten the locknut

(8) Lower the vehicle.

(9) Remove the spacer and reposition the carpeting.

TRANSFER CASE REMOVAL

(1)Raise the vehicle.

(2) Drain the transfer case lubricant.

(3) Disconnect the speedometer cable and indicator switch wires. Then disconnect the shift motor vacuum lines and the range lever.

(4) Place a support stand under the transmission and remove the rear crossmember.

(5) Mark the transfer case front and rear output shaft yokes and propeller shafts for assembly alignment reference.

(6) Disconnect the front and rear propeller shafts at the transfer case yokes. Secure the shafts to the frame rails with wire.

(7) Disconnect the parking brake cable guide from the pivot located on the right frame rail.

(8) Remove the bolts attaching the exhaust pipe support bracket to the transfer case.

(9) Remove the transfer case-to-transmission bolts.

(10) Move the transfer case assembly rearward until free of the transmission output shaft and remove the assembly.

(11) Remove all the gasket material from the rear of the transmission adapter housing.

TRANSFER CASE INSTALLATION

(1) Align and install the transfer case on the transmission.

(2) Be sure the transfer case input gear splines are aligned with the transmission output shaft. Align the splines by rotating the transfer case rear yoke.

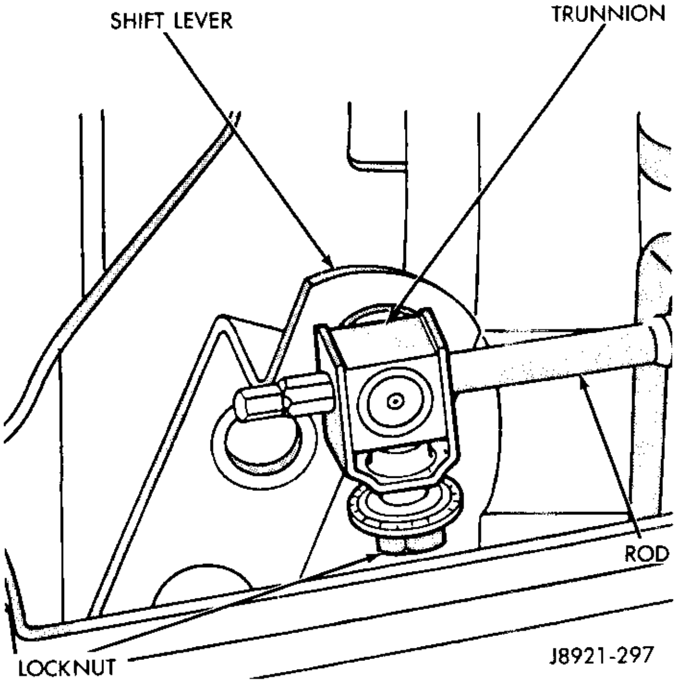


Fig. 5 Range Lever Adjustment

(3) Install the transfer case attaching bolts/nuts. Tighten the bolts/nuts to 40 ft-lbs (54 N•m) torque.

(4) Attach the exhaust pipe support bracket to the transfer case.

(5) Align and connect the propeller shafts.

(6) Connect the parking brake cable guide to the pivot bracket on the frame rail.

(7) Connect the speedometer cable and indicator switch wires. Then connect the shift motor vacuum lines and the range lever.

(8) Install the rear crossmember and remove the transmission support stand.

(9) Fill the transfer case with Mopar Mercon™ or Dexron II™ automatic transmission fluid.

(10) Lower the vehicle.

TRANSFER CASE OVERHAUL

Transfer Case Disassembly

(1) Remove the shift motor and bracket.

(2) Remove the front and rear yoke nuts and seal washers.

(3) Remove the front and rear yokes.

(4) Mount the transfer case on wood blocks. Cut V-notches in the blocks to clear the front case mounting studs.

(5) Mark the rear retainer and rear case for assembly reference.

(6) Remove the rear retainer (Fig. 6). Use two pry bars or screwdrivers to loosen the retainer. Position the bars/screwdrivers in the retainer slots.

(7) Remove the end play shims (Fig. 7).

(8) Remove the speedometer drive gear (Fig. 7).

(9) Remove the front case-to-rear case bolts. Note that the bolts at each end of the case require flat washers.

(10) Remove the rear case from the front case with pry bars or two screwdrivers (Fig. 8).

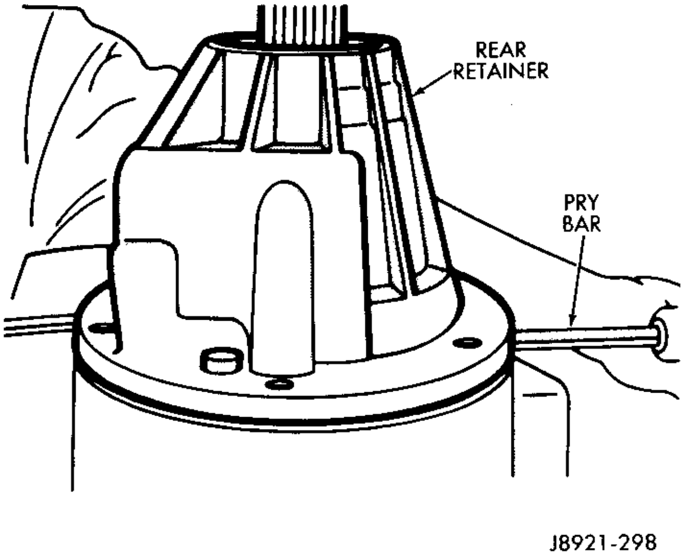


Fig. 6 Removing Rear Retainer

(11) Remove the thrust bearing and races from the front output shaft (Fig. 9).

(12) Remove the oil pump from the rear output shaft (Fig. 10). Note position of pump. Recessed side faces case interior.

(13) Remove the rear output shaft from the viscous coupling (Fig. 11).

(14) Remove the 15 pilot bearing rollers (Fig. 11).

(15) Remove the mainshaft O-ring (Fig. 11).

Bearing Rollers And O-Ring

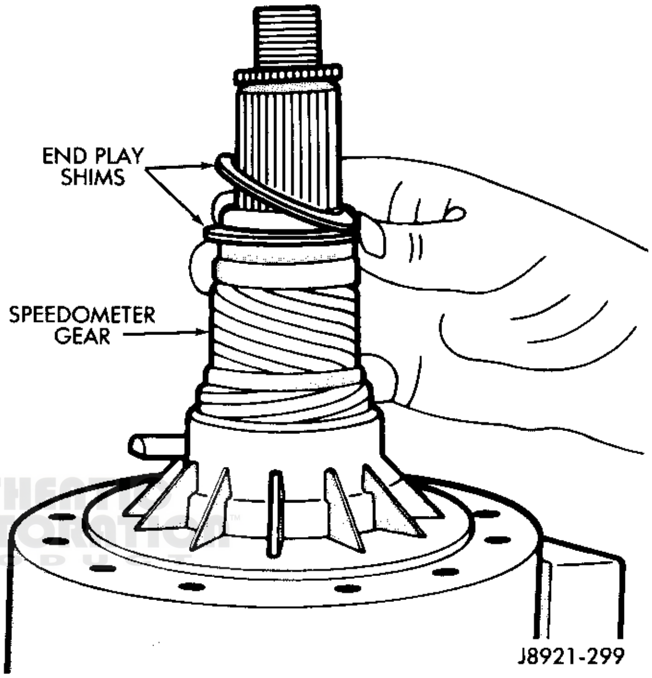


Fig. 7 Removing End Play Shims And Speedometer Gear

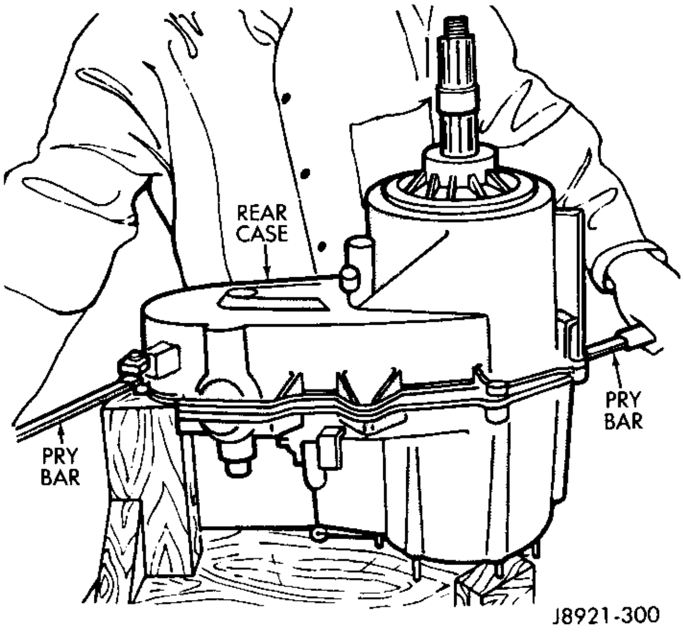


Fig. 8 Removing Rear Case

(16) Remove the viscous coupling (Fig. 12).

(17) Remove the front output shaft and drive chain (Fig. 13).

(18) Remove the front output shaft front thrust bearing assembly from the case or shaft.

(19) Remove the drive chain from the front output shaft sprocket.

(20) Remove the snap ring retaining the driven sprocket on the front output shaft (Fig. 14). Mark the sprocket and shaft for reference and remove the sprocket.

(21) Remove the mainshaft, side gear, clutch gear, drive sprocket and spline gear as an assembly (Fig. 15). Set the assembly aside until front case disassembly is completed.

(22) Remove the mode fork, shift rail and mode sleeve as an assembly (Fig. 16). Mark the sleeve and fork for reference and remove the sleeve. **The mode fork and**

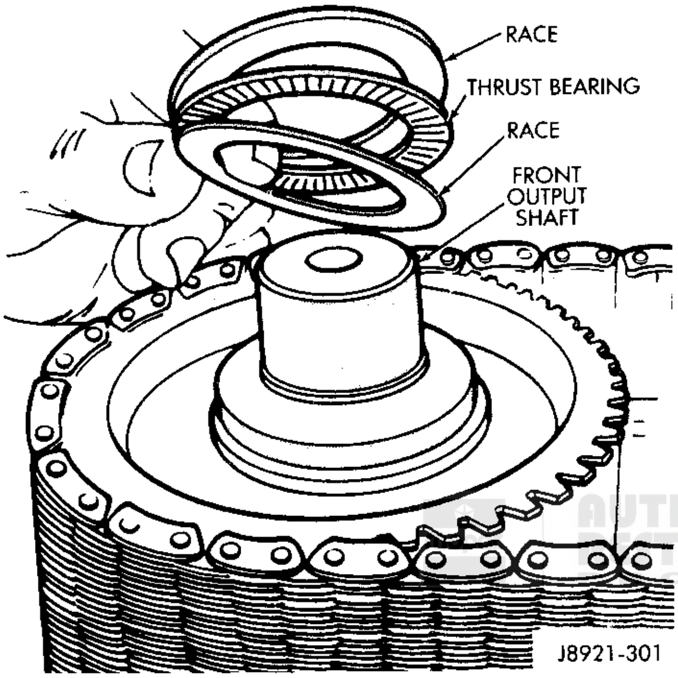


Fig. 9 Removing Thrust Bearing And Races

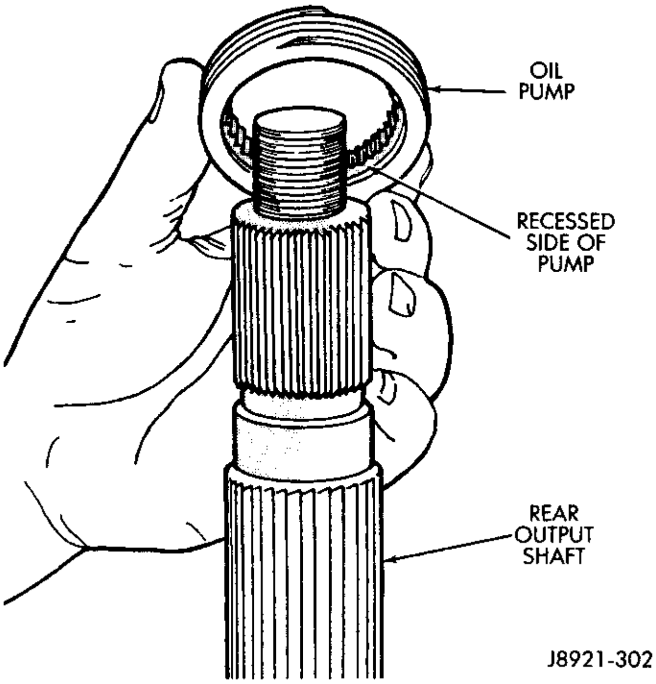


Fig. 10 Removing Oil Pump

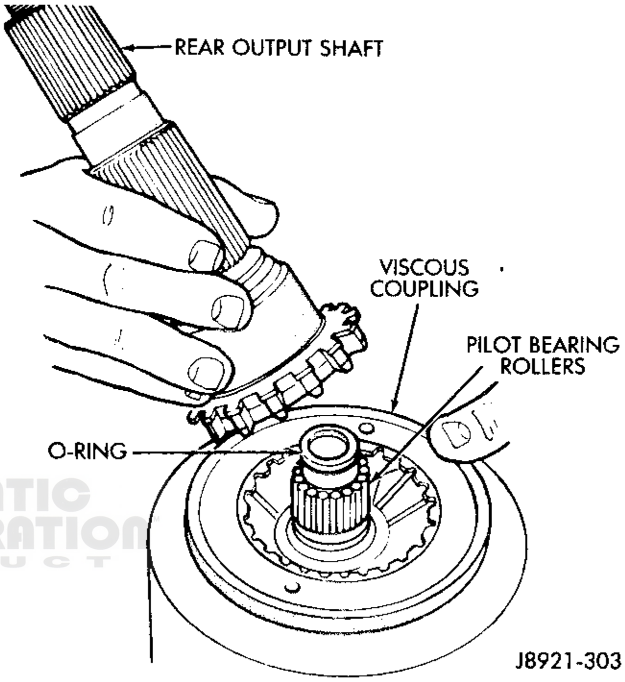


Fig. 11 Removing Rear Output Shaft

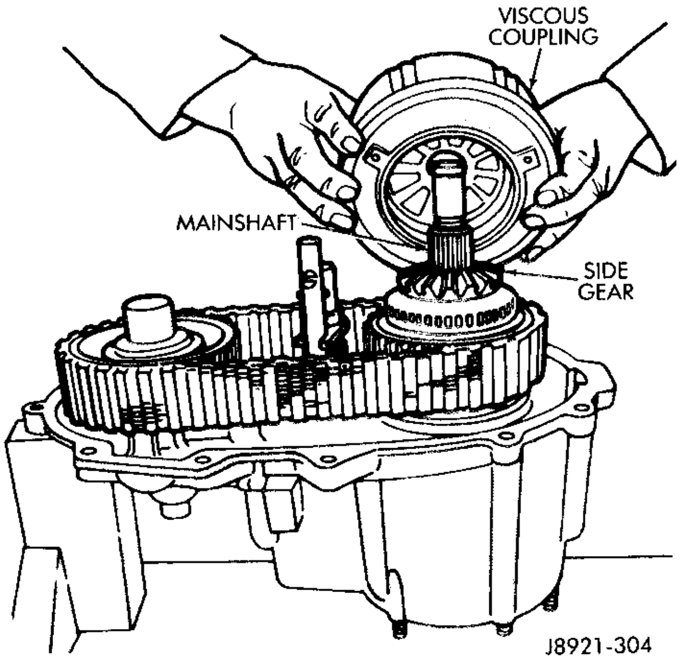


Fig. 12 Removing Viscous Coupling

rail are pinned together. Remove the pin to separate the two components if necessary.

(23) Remove the locking fork, range sleeve, fork brackets and fork springs as an assembly (Fig. 17). Note component position for reference and disassemble for cleaning and inspection.

(24) Remove the shift rail detent plug, spring and plunger (Fig. 18). The interlock pin will be removed after the shift rails are out of the case.

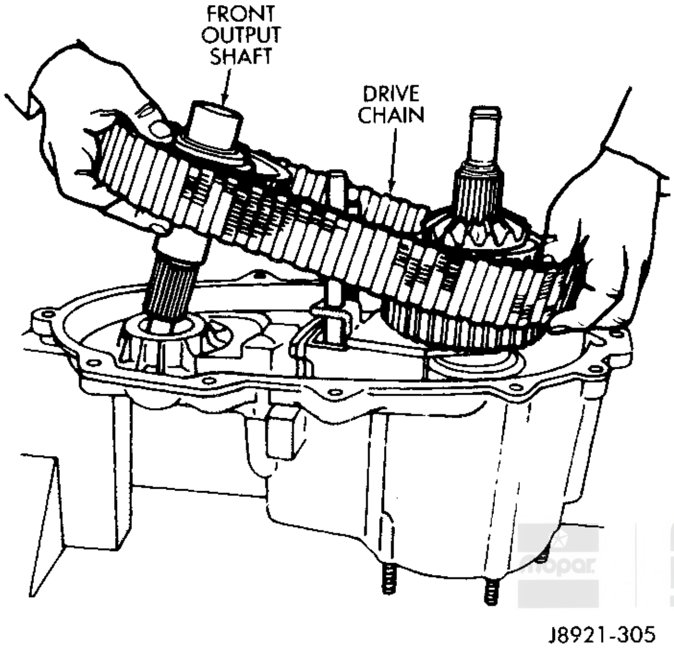


Fig. 13 Removing Front Output Shaft And Drive Chain

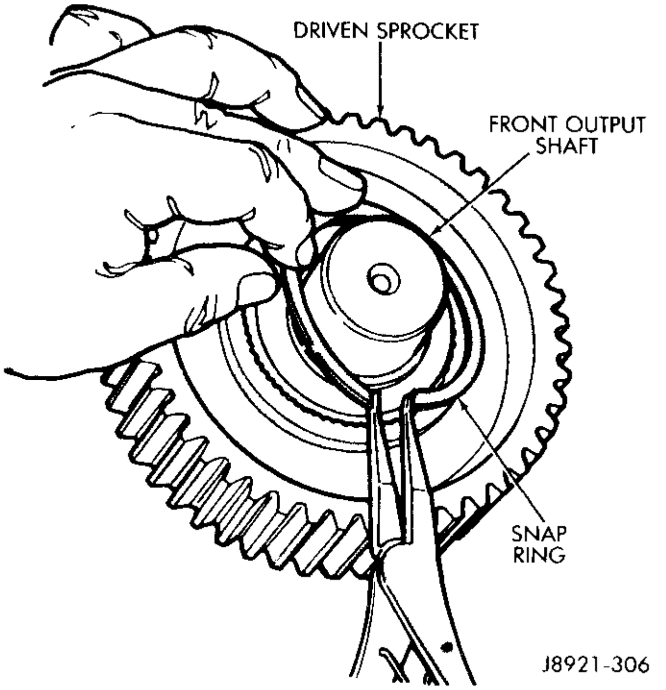


Fig. 14 Removing Snap Ring And Driven Sprocket

(25) Move the range lever downward to the last detent.

(26) Disengage the range fork lug from the range sector slot.

(27) Remove the annulus gear snap ring and thrust washer (Fig. 19).

(28) Remove the annulus gear, range fork and shift rail as an assembly (Fig. 20). Separate the components for cleaning and inspection.

(29) Remove the interlock pin from the case bore after removing the last shift rail (Fig. 18).

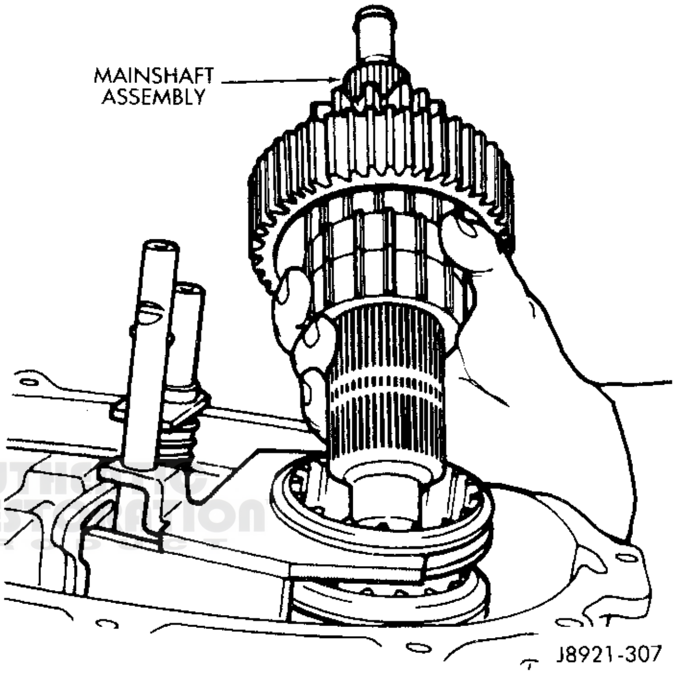


Fig. 15 Removing Mainshaft Assembly

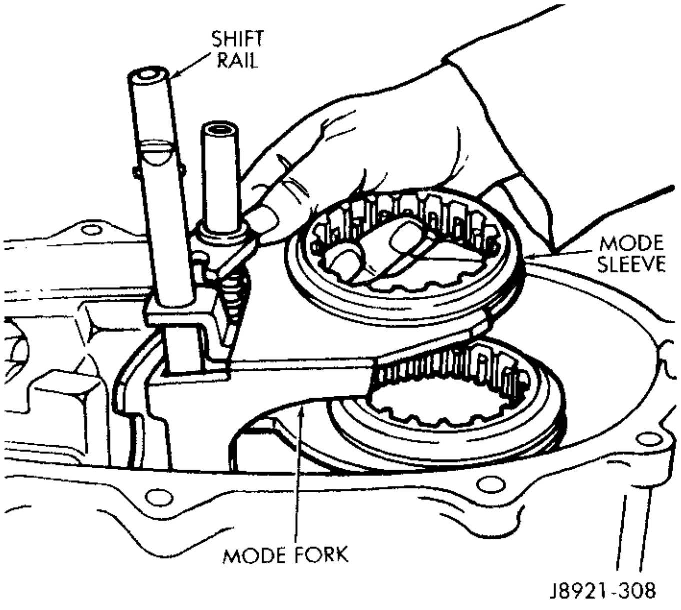


Fig. 16 Removing Mode Fork, Shift Rail And Mode Sleeve

(30) Remove thrust washer from planetary gear hub (Fig. 21).

(31) Remove the planetary gear (Fig. 22).

(32) Remove the mainshaft thrust bearing from the input gear (Fig. 22).

(33) Remove the input gear and the gear thrust bearing and race (Fig. 23).

(34) Remove the range and mode levers from the sector shaft.

(35) Remove the range sector and shaft from the front case.

(36) Remove the range sector O-ring and retainer.

(37) Remove side gear, clutch gear and drive sprocket (Fig. 24).

(38) Remove the side gear, clutch gear and thrust washer from the drive sprocket (Fig. 25).

(39) Remove the needle bearings and two bearing spacers from the mainshaft. Total of 82 bearings are used.

(40) Remove one sprocket carrier snap ring and remove the drive sprocket from the carrier (Fig. 26).

(41) Remove the three bearing spacers and all the needle bearings from the sprocket carrier. Total of 120

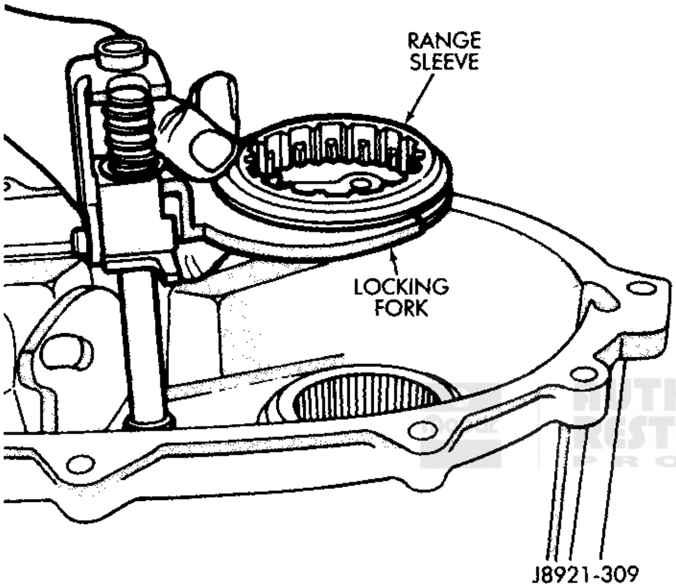
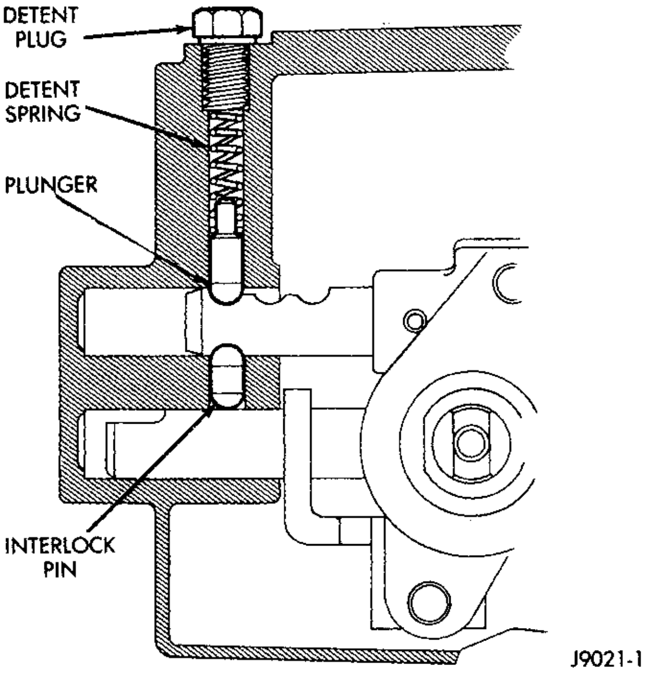


Fig. 17 Removing Locking Fork And Range Sleeve



Fig, 18 Detent Plug, Spring, Plunger Location

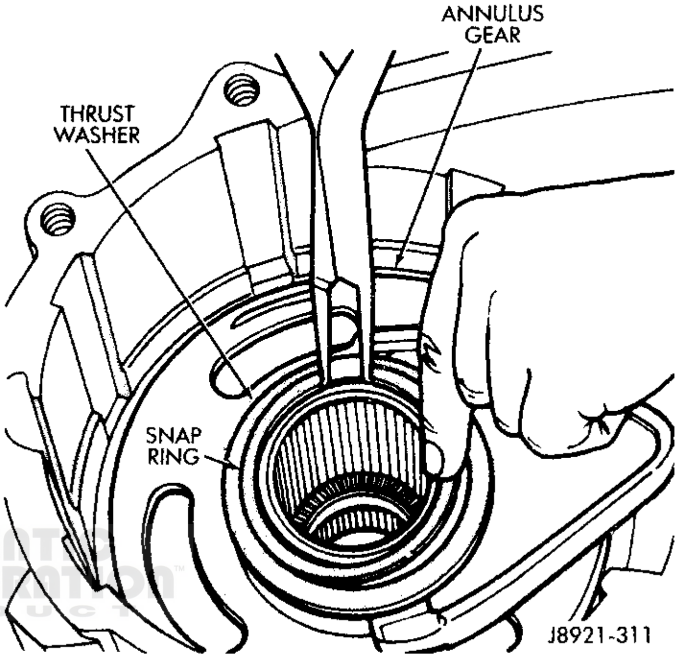


Fig. 19 Removing Annulus Gear Snap Ring And Thrust Washer

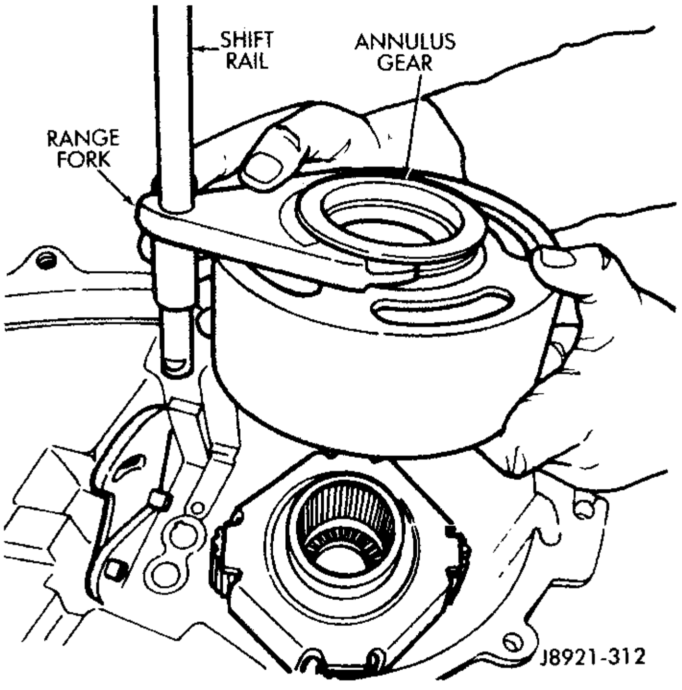


Fig. 20 Removing Annulus Gear, Range Fork And Shift Rail

needle bearings are used. **The sprocket carrier and mainshaft needle bearings are different sizes. Do not intermix them.**

(42) Remove the rear output bearing and rear yoke seal from the rear retainer. Note bearing position for assembly reference.

(43) Remove the input gear and front yoke seals from the front case.

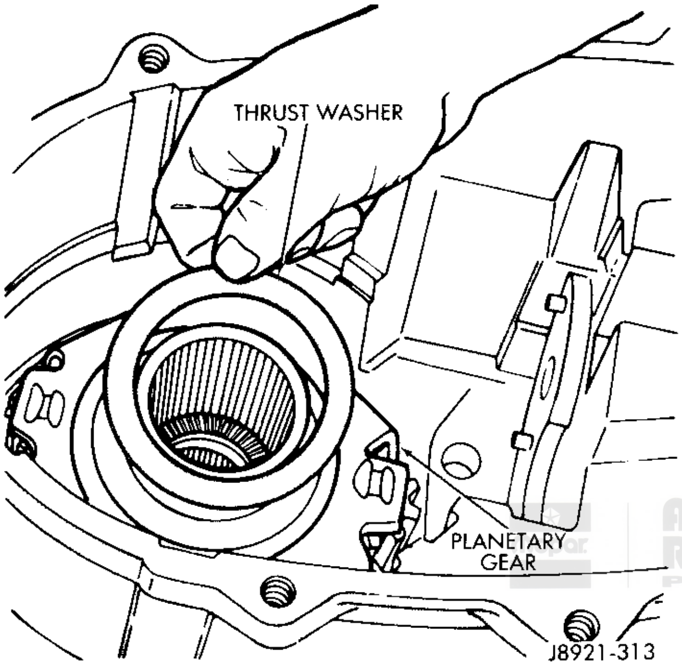


Fig. 21 Removing Planetary Thrust Washer

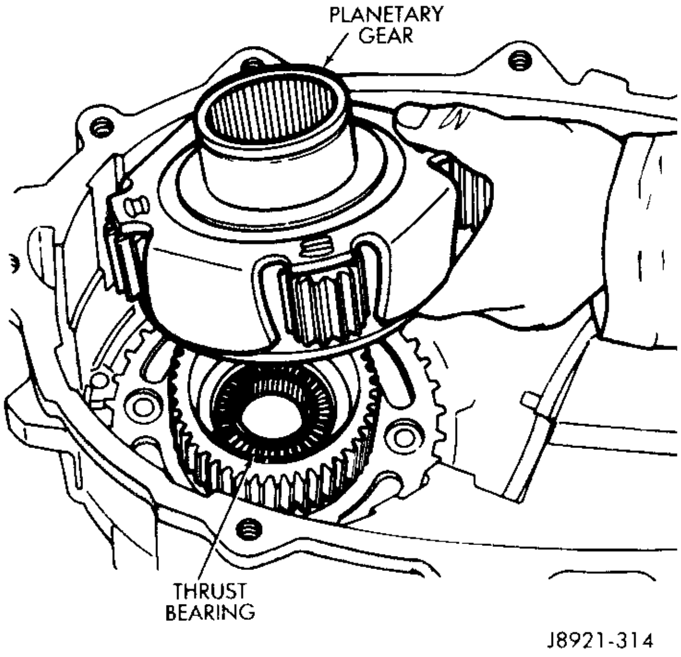


Fig. 22 Removing Planetary Gear And Thrust Washer

Cleaning And Inspection

Clean all parts thoroughly in solvent. Be sure all old lubricant, metallic particles, dirt or foreign material are removed from the surfaces of every part. Apply compressed air to each oil feed port and channel in each case half to remove solvent residue.

Inspect the gear teeth for signs of excessive wear or damage and check all the gear splines for burrs, nicks,

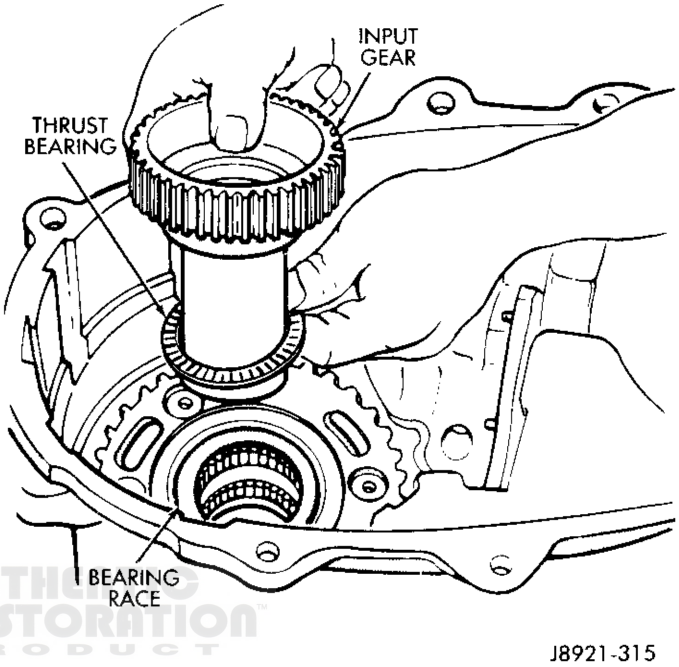


Fig. 23 Removing Input Gear, Thrust Bearing And Race

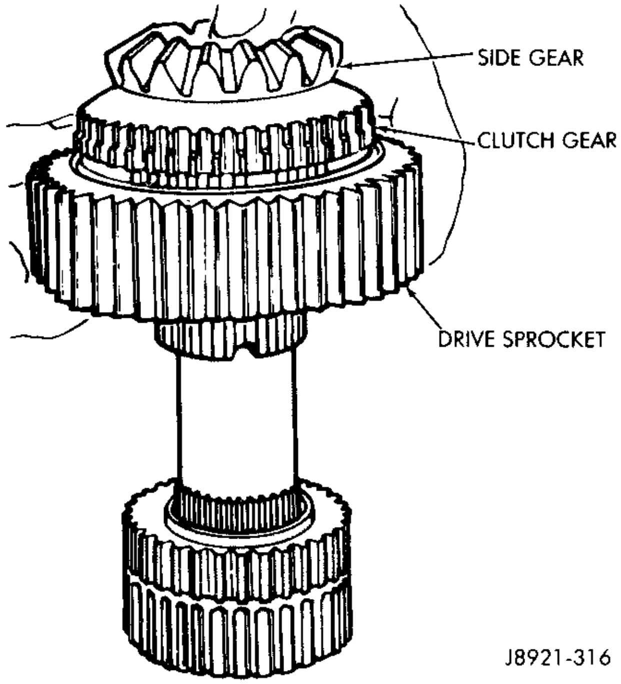


Fig. 24 Removing Side Gear, Clutch Gear And Drive Sprocket

wear or damage. Remove minor nicks or scratches with an oilstone. Replace any part exhibiting excessive wear or damage.

Inspect all the snap rings and thrust washers. Replace these parts if worn or damaged.

Inspect the case halves and rear retainer for cracks, porosity, damaged mating surfaces, stripped bolt threads or distortion. Replace any part exhibiting these conditions.

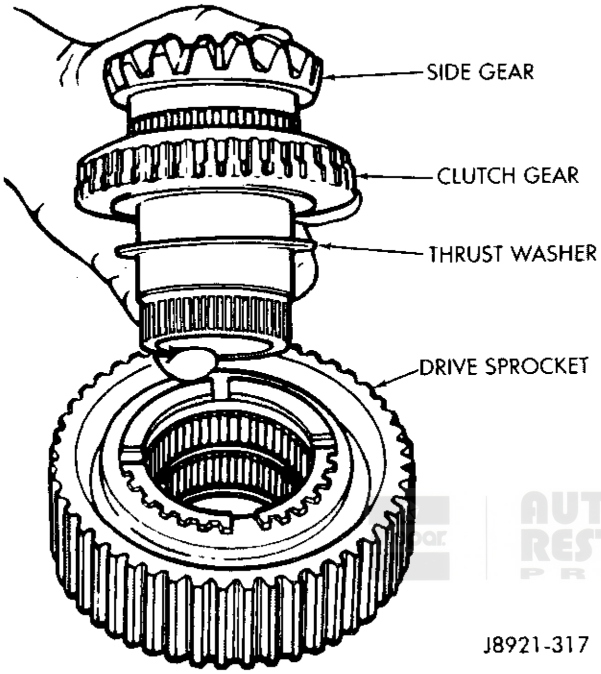


Fig. 25 Disassembling Gears And Sprocket

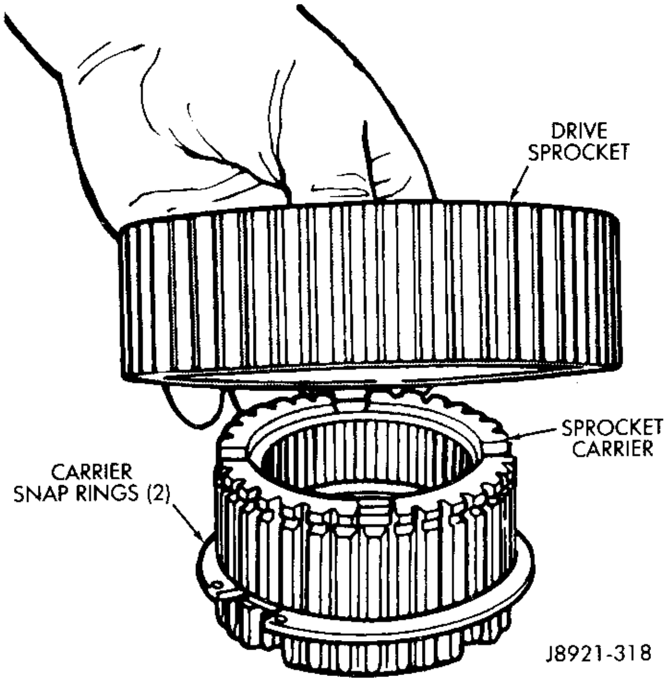


Fig. 26 Disassembling Sprocket And Carrier

Inspect the viscous coupling and differential pinions. If the pinions or carrier are damaged or worn excessively, replace the coupling as an assembly only. If the coupling is cracked, leaking or damaged, replace the coupling as an assembly only.

Inspect the condition of all needle, roller, ball and thrust bearings in the front and rear case halves. Also check the condition of the bearing bores in both cases and in the input gear, rear output shaft, side gear and rear retainer. Replace any part that exhibits signs of excessive wear or damage.

The front output shaft thrust bearing race surfaces are heat treated during manufacture. Heat treatment causes a brown or blue discoloration of these surfaces. Do not replace a front output shaft because of this type of discoloration.

Transfer Case Assembly

CAUTION: The transfer case bearings must be correctly positioned to avoid blocking the bearing oil feed holes. After replacing a bearing, check bearing position to be sure the feed hole is not covered by the bearing.

(1) Remove the rear output shaft bearing with an internal puller and slide hammer (Fig. 27).

(2) Remove the rear shaft seal with a small screwdriver.

(3) Install a new rear shaft seal.

(4) Install a new rear shaft bearing with bearing driver tools (Fig. 28).

(5) Remove the tools and check the oil feed hole. **The rear shaft bearing must not cover the feed hole.**

(6) Remove the shaft front bearing from the case with bearing driver tools (Fig. 29).

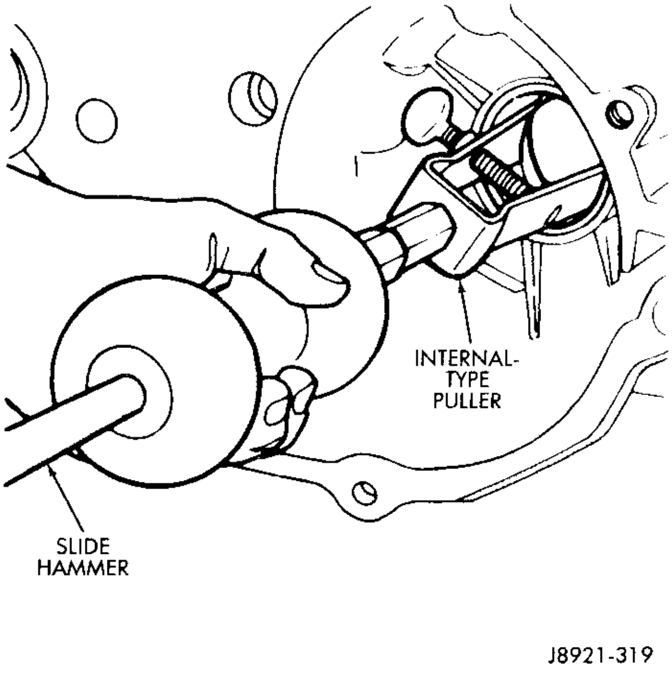


Fig. 27 Removing Rear Output Shaft Bearing

(7) Install the new front output shaft front bearing (Fig. 30).

(8) Remove the tools and check the oil feed hole. **The bearing must not cover the feed hole.**

(9) Remove the front output shaft rear bearing from the rear case with an internal puller and slide hammer. Secure the case to a workbench with a C-clamp and wood block (Fig. 31).

(10) Install the new front output shaft rear bearing with bearing driver tools (Fig. 32).

(11) Check bearing position. **Be sure the bearing does not block the oil feed hole.**

(12) Remove the input shaft seal from the front case.

(13) Remove the two input gear bearings from the front case simultaneously with driver tools (Fig. 33).

(14) **Install the new input gear bearings one at a time.** Install the rear bearing first; then install the front bearing (Fig. 34).

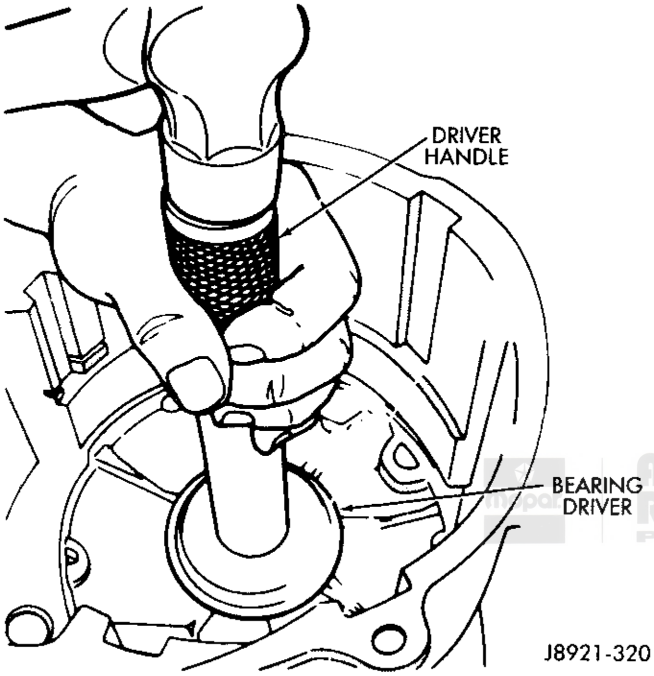


Fig. 28 Installing Rear Output Shaft Bearing

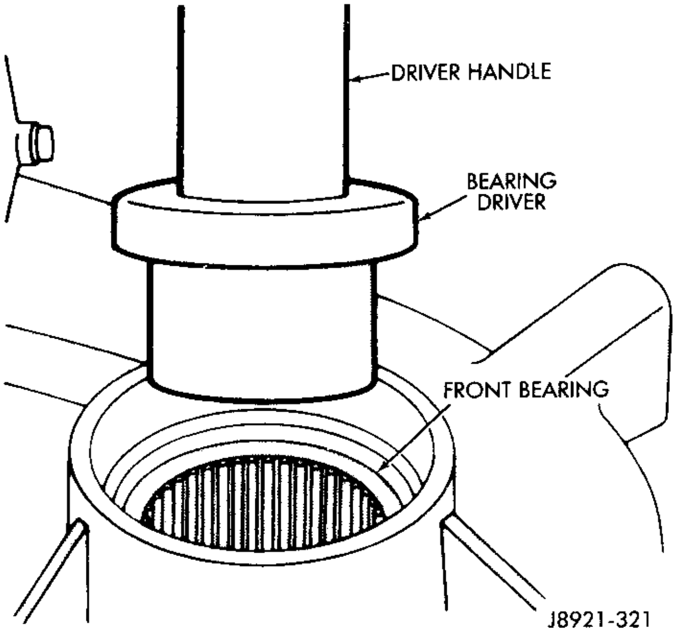


Fig. 29 Removing Front Output Shaft Front Bearing

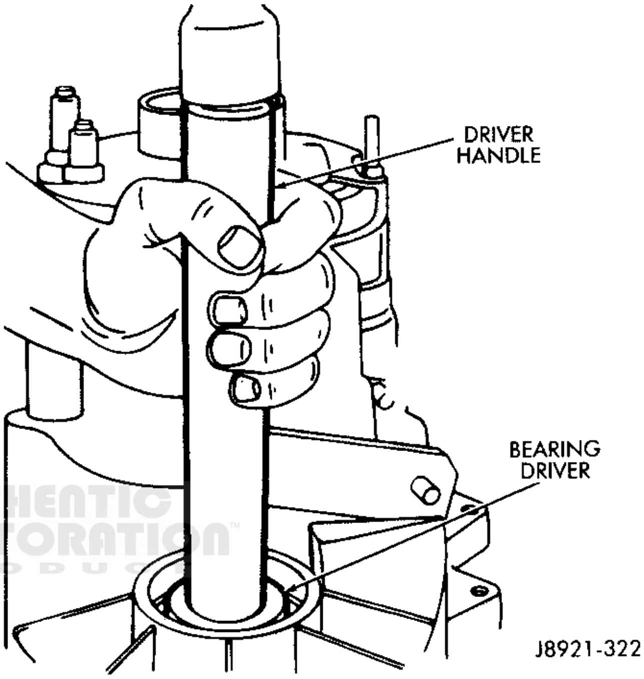


Fig. 30 Installing Front Output Shaft Front Bearing

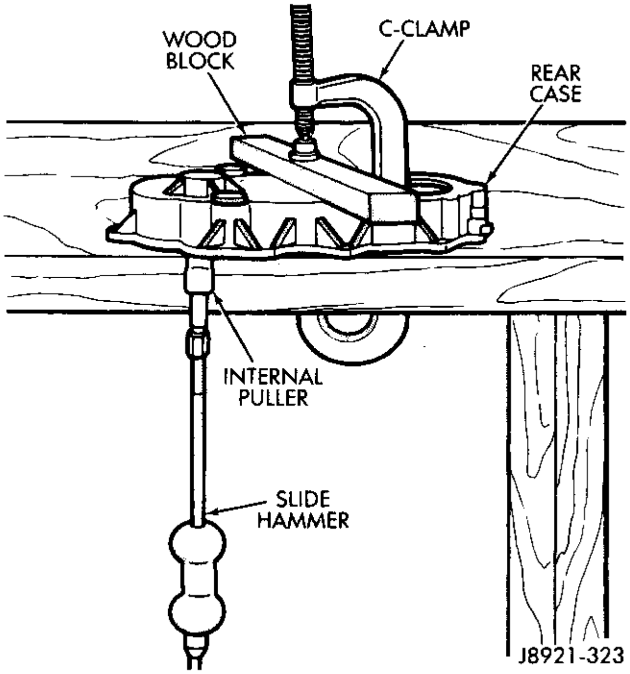


Fig. 31 Removing Front Output Shaft Rear Bearing

(15) Remove the installer tools and check bearing position. Be sure the oil feed holes are not covered. Also be sure the bearings are flush with the case bore surfaces.

(16) Install a new input gear oil seal in the front case.

(17) Remove the mainshaft pilot bearing from the input gear. Support the gear on wood blocks and remove the bearing with a slide hammer and internal puller (Fig. 35).

(18) Install the new pilot bearing (Fig. 36).

(19) Check bearing position and verify that the oil feed hole is not blocked.

(20) Replace the annulus gear bushing (Fig. 37). Seat the new bushing flush with the gear. **Be sure the bushing and gear oil feed holes are aligned.**

(21) Remove the rear bearing and seal from the rear retainer with a brass drift and hammer.

(22) Install a new rear bearing in the rear retainer (Fig. 38). **The bearing is shielded on one side. Be sure the shielded side faces the case interior after installation.**

(23) Install a new seal in the rear retainer (Fig. 39).

(24) **Lubricate the transfer case bearings and gears with automatic transmission fluid.**

(25) Install the input gear thrust bearing race in the front case bearing bore and on top of the input gear inner bearing (Fig. 40).

(26) Install the thrust bearing in the input gear. Then install the gear and bearing in case (Fig. 40).

(27) Install the mainshaft thrust bearing in the input gear (Fig. 41).

(28) Install the planetary gear on the input gear (Fig. 41).

(29) Install the thrust washer on the planetary hub (Fig. 42).

(30) Lubricate and install new O-rings on the range and mode sectors (Fig. 43).

(31) Install the interlock pin in the case bore (Figs. 18 and 48). **The pin must be in place before installing either of the shift forks.**

(32) Install the mode sector in the range sector and install the assembly in the case (Fig. 43).

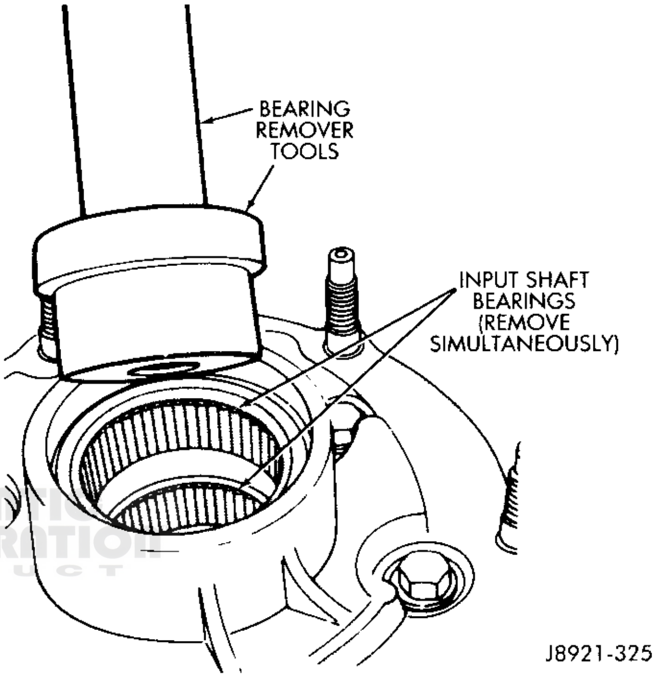


Fig. 33 Removing Input Gear Bearings

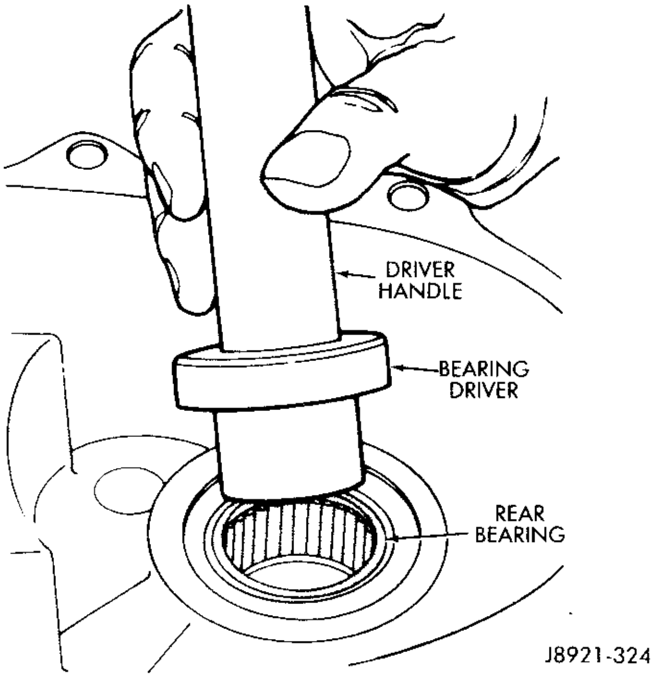


Fig. 32 Installing Front Output Shaft Rear Bearing

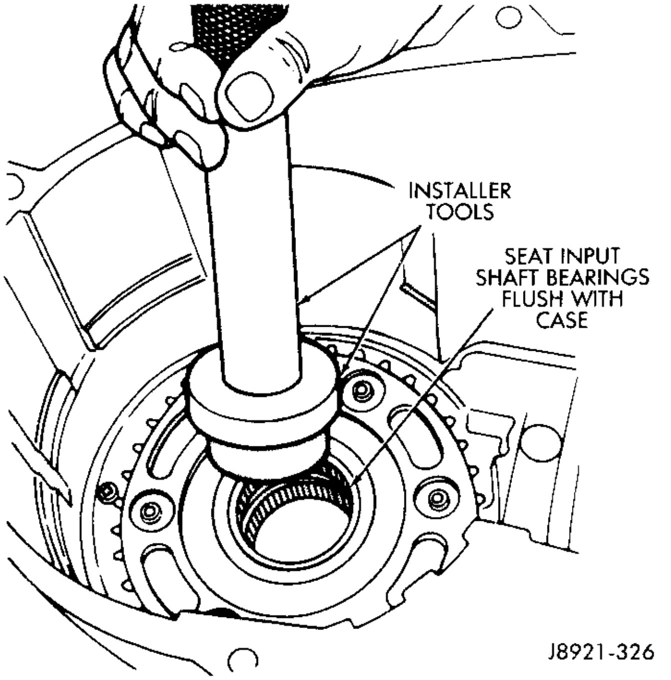


Fig. 34 Installing Input Gear Bearings

(33) Install the retainer, range lever, retaining ring, mode lever, washer and nut on the sector shafts (Fig. 44). Tighten the nut to 18 ft-lbs (24 N•m) torque.

(34) Assemble the range fork and shift rail. Coat the shift rail pin with petroleum jelly and insert the pin in the rail. Then clean the range fork shift rail bore in the case bottom. **The bore must be completely dry or the shift rail will not go all the way to the bottom.**

(35) Insert the range fork in the annulus hub. Then install the fork, rail and gear in the case (Fig. 45). Be sure the annulus is fully engaged with the planetary gear and that the shift rail is bottomed in the case bore.

(36) Engage the range fork pin in the range sector slot (Fig. 46).

(37) Install the annulus thrust washer and snap ring (Fig. 47).

(38) Install the detent plunger, spring and plug (Fig. 48). Tighten the plug to 22 ft-lbs (30 N•m) torque. **Be sure the interlock pin has been installed in the case as shown in Figure 48.**

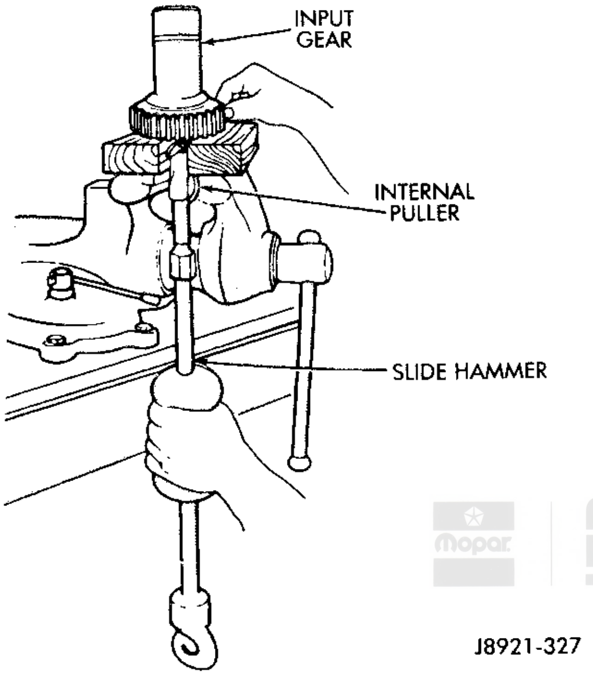


Fig. 35 Removing Mainshaft Pilot Bearing

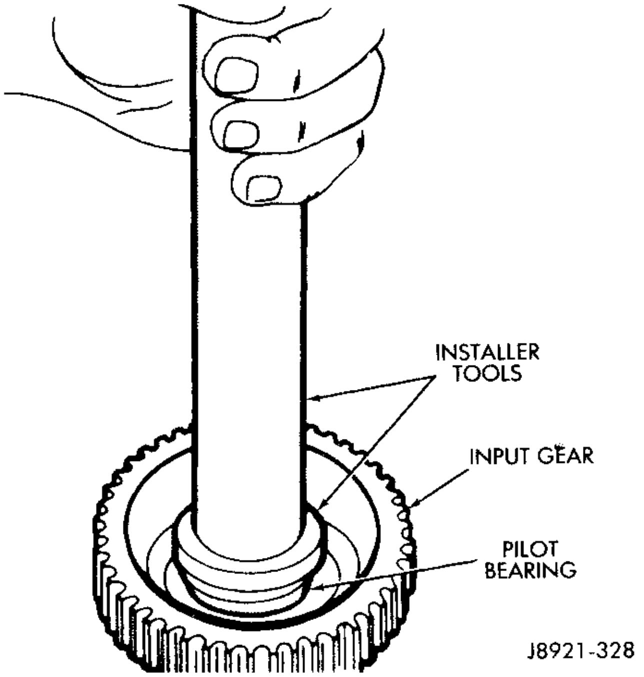


Fig. 36 Installing Mainshaft Pilot Bearing

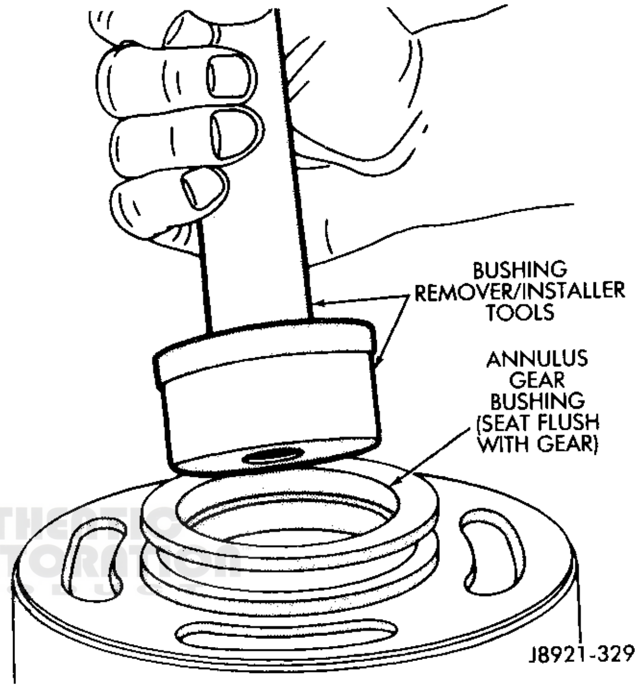


Fig. 37 Annulus Gear Bushing Replacement

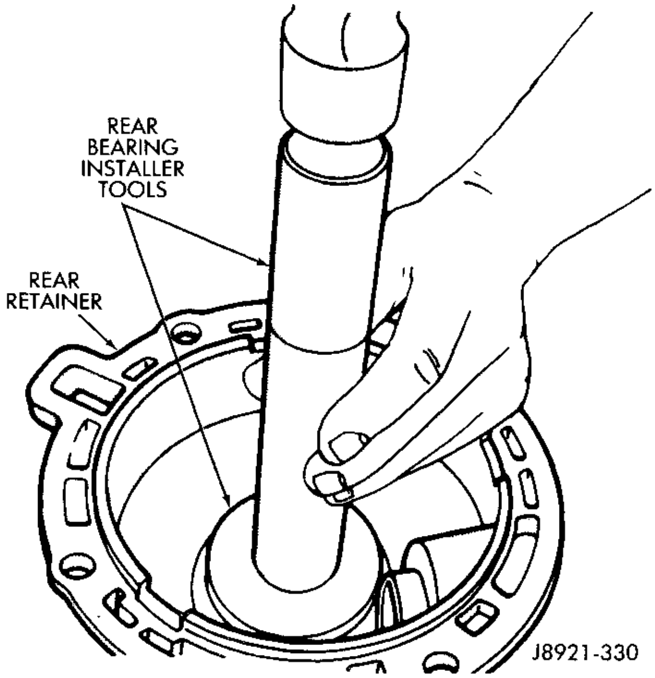


Fig. 38 Rear Bearing Installation

(39) Identify the range and mode sleeves before intallation (Fig. 49). The sleeves have different splines and are not interchangeable.

(40) Assemble the shift forks and rails (Fig. 50).

(41) Install the range sleeve in the locking fork (Fig. 51).

(42) Install the locking fork and sleeve on the shift rail (Fig. 51). Be sure the fork pin is engaged in the sector.

(43) Move the range sector to high range position. Then assemble and install the mode fork, shift rail and mode sleeve (Fig. 52).

(44) Lubricate and install a new O-ring and thrust washer on the mainshaft (Fig. 53).

(45) Coat the mainshaft needle bearing surface, needle bearings and the two bearing spacers with a liberal quantity of petroleum jelly.

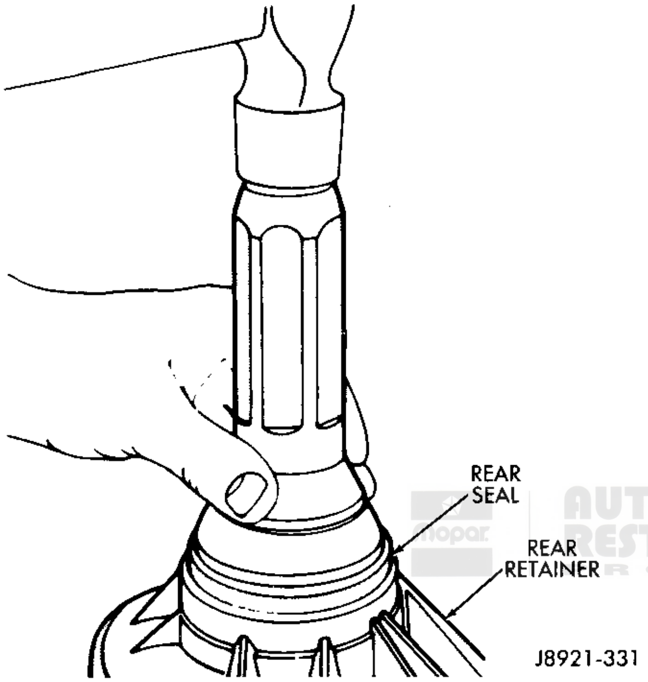


Fig. 39 Rear Retainer Seal Installation

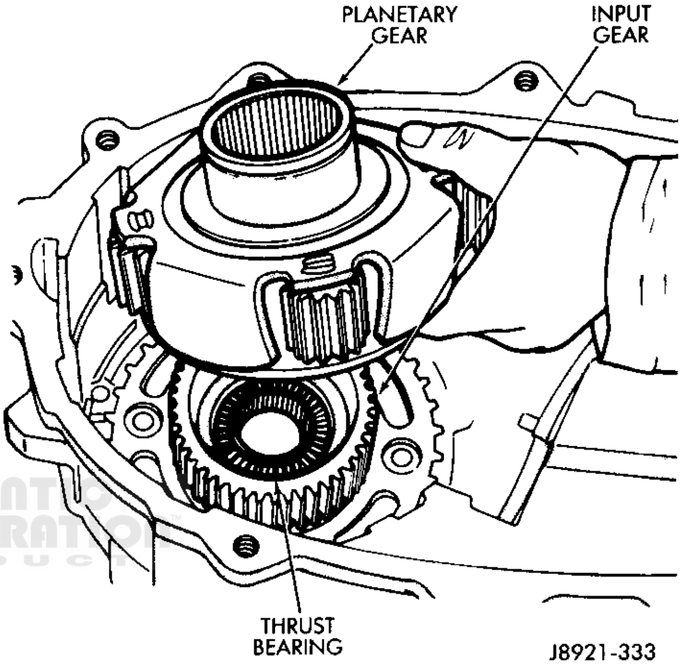


Fig. 41 Installing Thrust Bearing And Planetary Gear

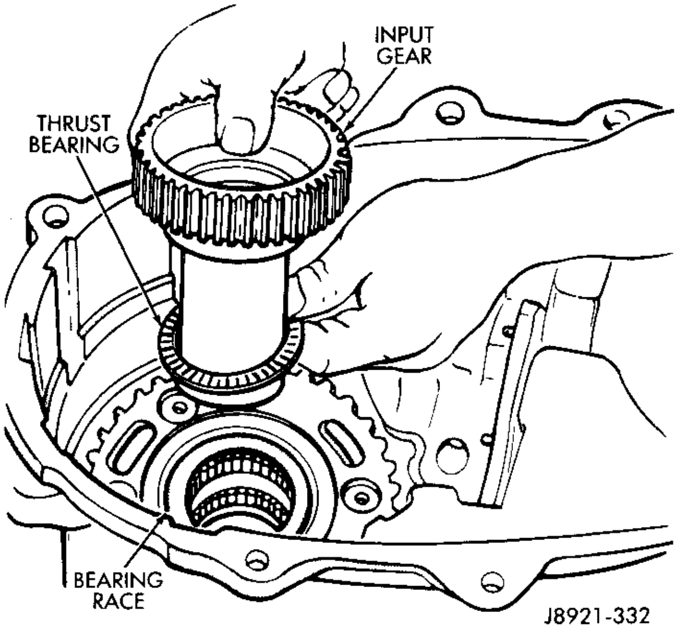


Fig. 40 Installing Input Gear, Thrust Bearing And Race

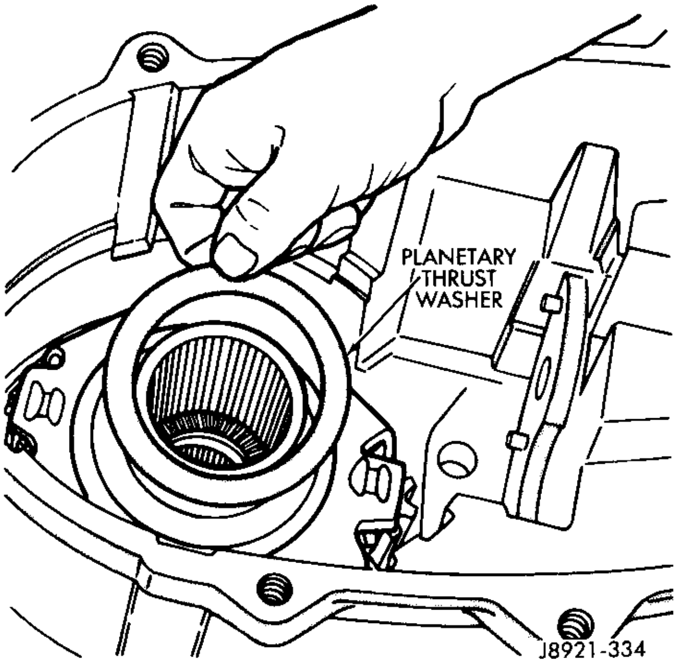


Fig. 42 Installing Planetary Thrust Washer

(46) Install the first set of needle bearings on the shaft and against the shaft shoulder. Install the long spacer. Then install the second set of needle bearings and the short spacer (Fig. 53).

(47) Install the carrier in the drive sprocket. Then install the carrier snap rings (Fig. 54).

(48) Coat the carrier bore and needle bearings with a liberal quantity of petroleum jelly.

(49) Install the center bearing spacer in carrier bore. Then install the needle bearings and two outer spacers (Fig. 54). Use extra petroleum jelly to hold the outer spacers in place.

(50) Install the spline gear on the mainshaft. Then install the assembled drive sprocket and carrier on mainshaft (Fig. 55).

(51) Install the clutch gear thrust washer on the mainshaft. Position the washer on the carrier (Fig. 55).

(52) Assemble the side and clutch gears (Fig. 56).

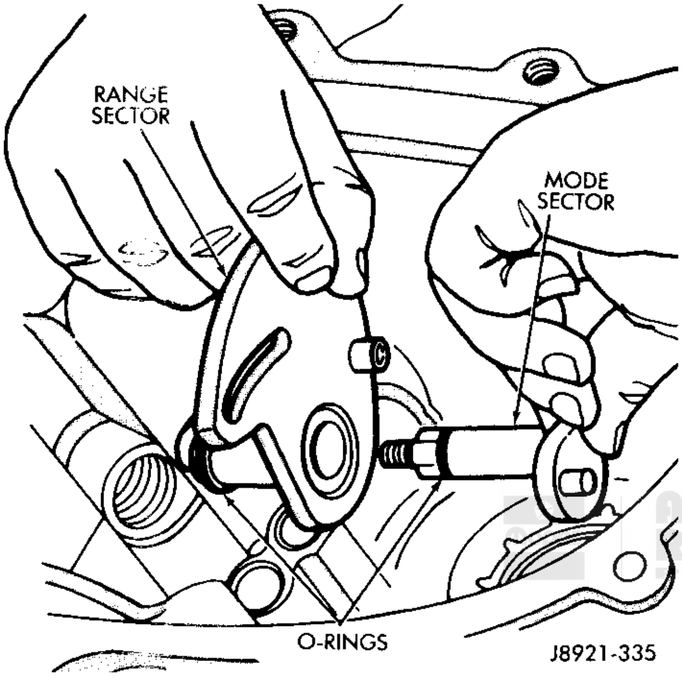


Fig. 43 Installing Range And Mode Sectors

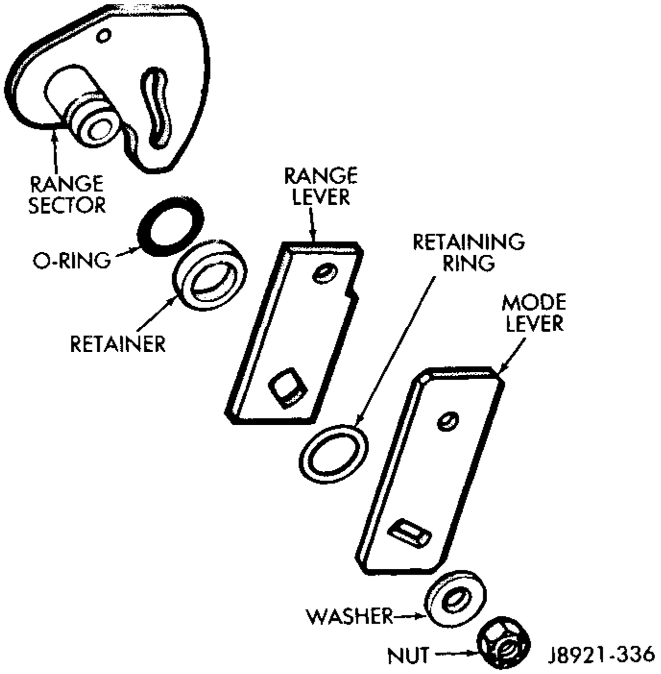


Fig. 44 Installing Range And Mode Levers

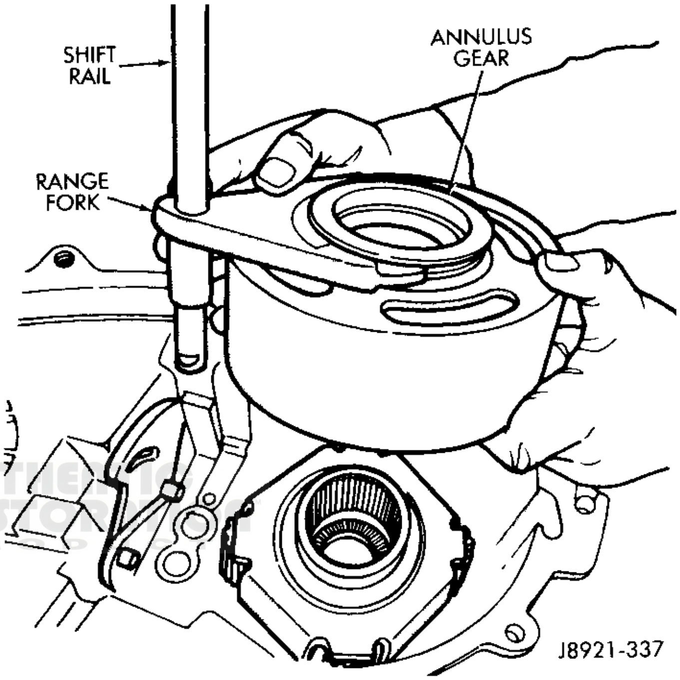


Fig. 45 Installing Range Fork And Annulus Gear

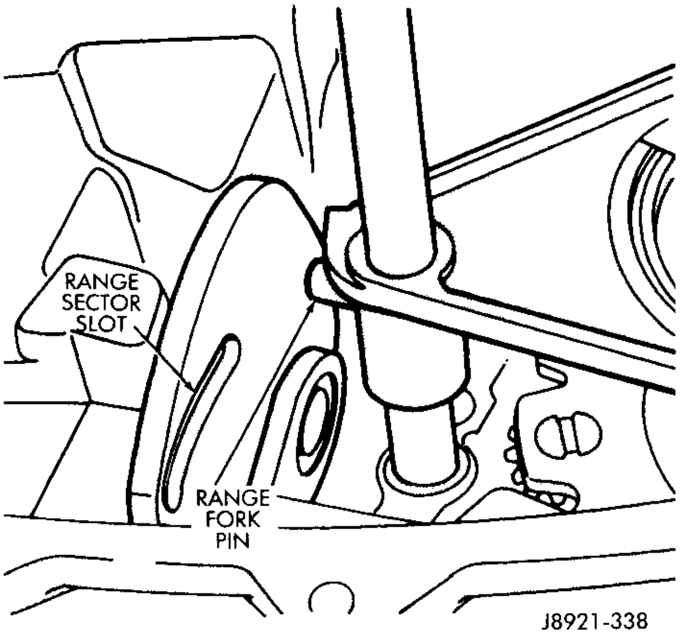


Fig. 46 Engaging Range Fork And Sector

(53) Install the assembled side and clutch gear on the mainshaft. Be sure the shaft and carrier needle bearings are not displaced during installation.

(54) Install the mainshaft assembly (Fig. 57). Be sure the shaft is seated in the input gear.

(55) Install the drive sprocket on the front output shaft. Secure the sprocket with new snap ring (Fig. 58).

(56) Install the front output shaft front thrust bearing and races (Fig. 59). Install the **thick** race in the front case. Then install the **thin** race and bearing on the front shaft. Use petroleum jelly to hold the parts in place.

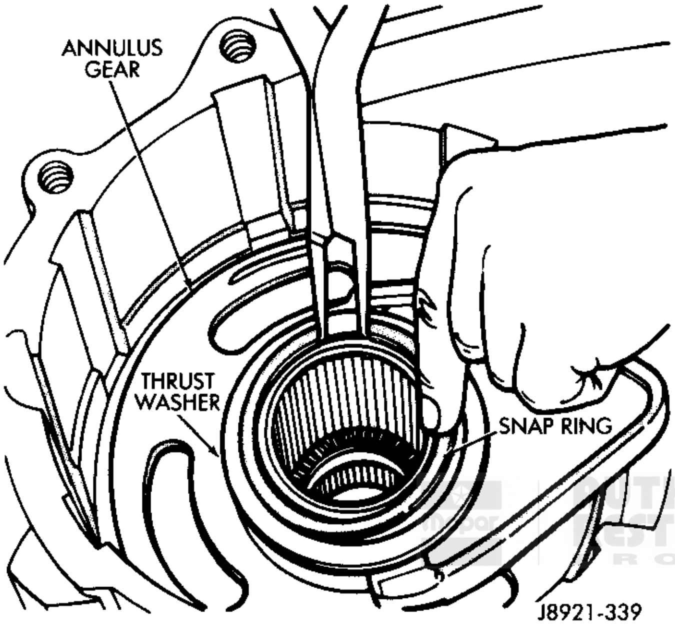


Fig. 47 Installing Annulus Thrust Washer And Snap Ring

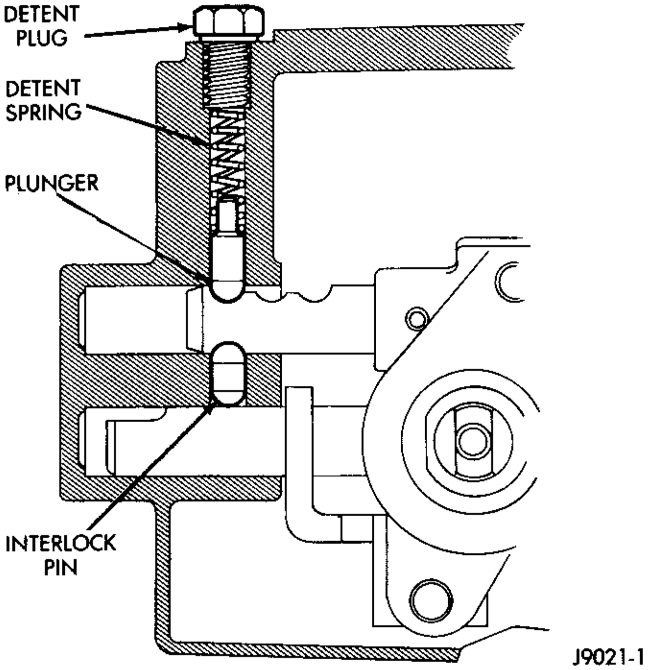


Fig. 48 Installing Detent Plunger, Spring And Plug

Front Thrust Bearing And Races

(57) Install the drive chain and front output shaft (Fig. 60).

(58) Install the front output shaft rear thrust bearing races (Fig. 61).

(59) Install the viscous coupling (Fig. 62). Seat the coupling on the side and clutch gears.

(60) Coat the mainshaft pilot bearing rollers and shaft bearing surface with a liberal quantity of petroleum jelly.

(61) Install the pilot roller bearings on the mainshaft (Fig. 63). Use additional petroleum jelly to hold the rollers in place.

(62) Install the rear output shaft on the mainshaft (Fig. 63). Seat the rear shaft in the viscous coupling.

(63) Install the oil pump on the rear output shaft. Recessed side of the pump faces down (Fig. 64).

(64) Install the magnet in the rear case.

(65) Apply bead of Loctite 515 or equivalent sealer to the mating surface of the rear case.

(66) Install the rear case on the front case. **If the rear case will not fully seat on the front case, problem may be due to oil in the range rail bore, front output shaft thrust bearings are not seated, the mainshaft is not seated in the input gear, or the rear case is not aligned with the oil pump.**

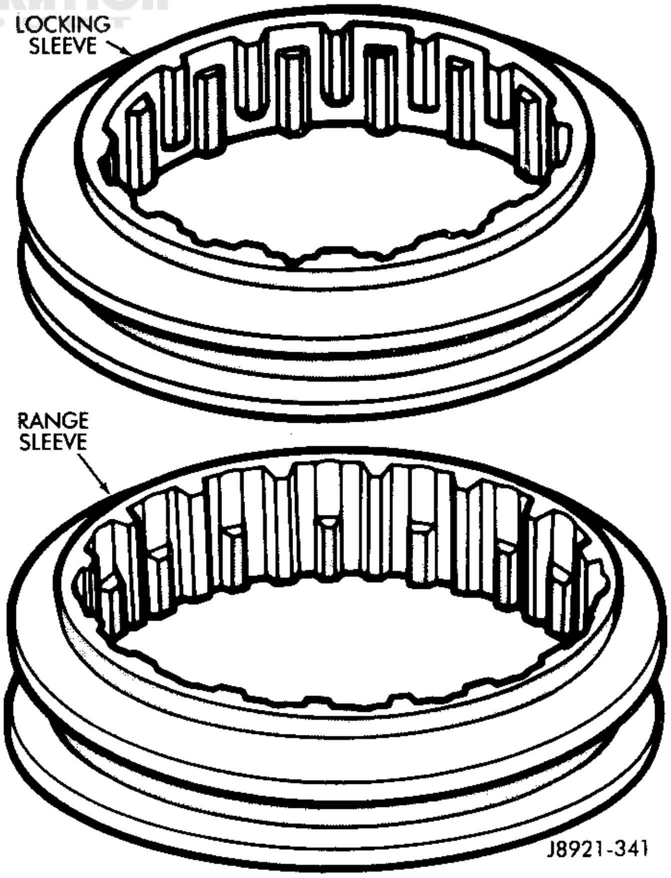


Fig. 49 Clutch Sleeve Identification

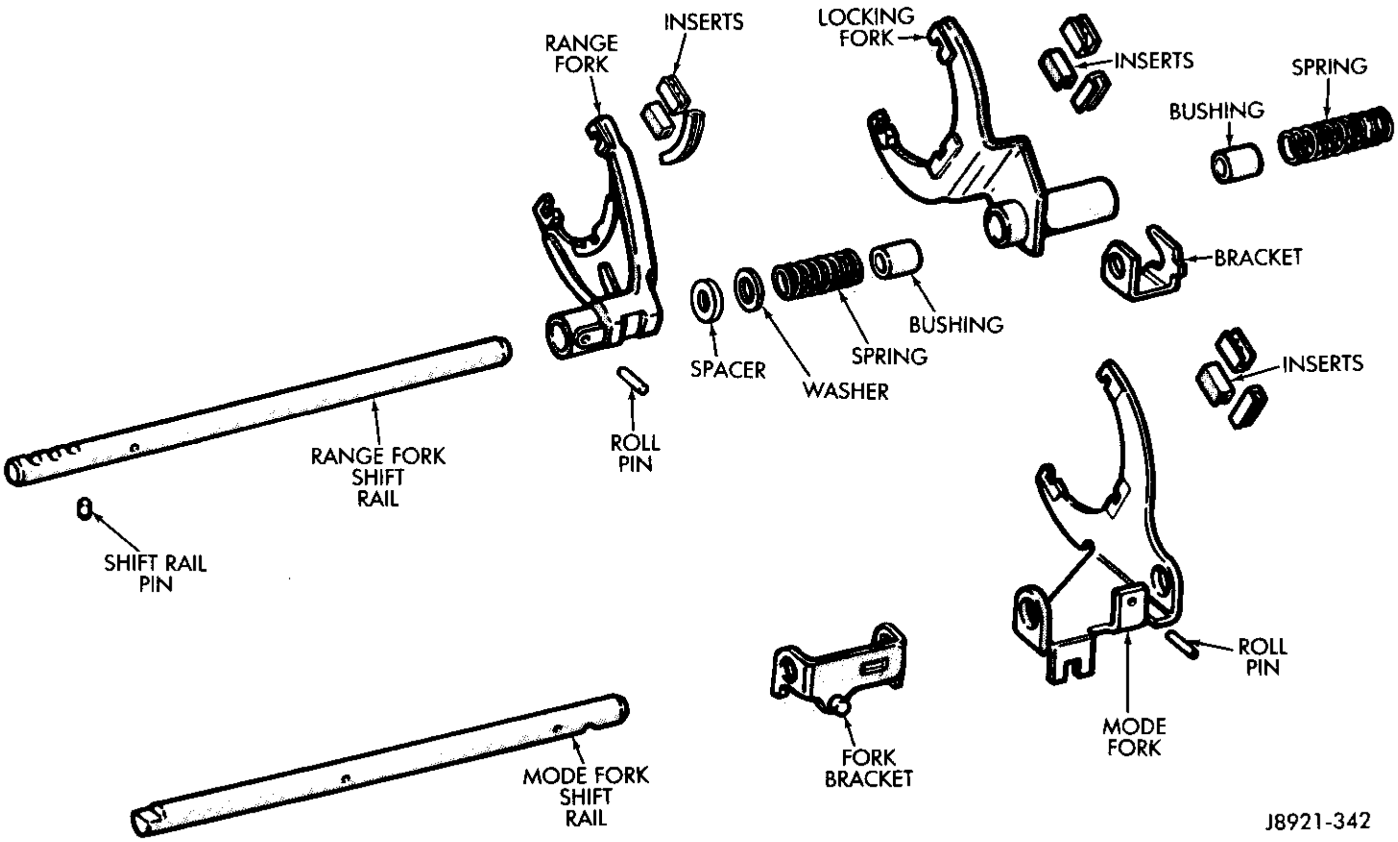


Fig. 50 Shift Fork Assemblies

(67) Install the rear case-to-front case bolts. Tighten the bolts to 23 ft-lbs (31 N•m) torque. **Be sure flat washers are used on the bolts at the alignment dowel locations.**

(68) Install the speedometer drive gear (Fig. 65).

(69) Measure thickness of the original end play shims. Then install the shims on the rear output shaft (Fig. 65).

(70) Install the rear retainer (Fig. 66) but do not tighten the retainer bolts completely at this time.

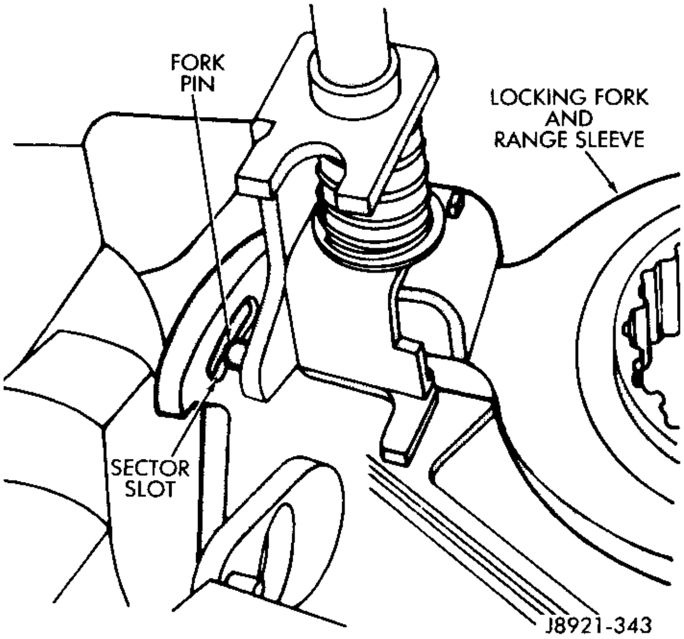


Fig. 51 Installing Locking Fork And Range Sleeve

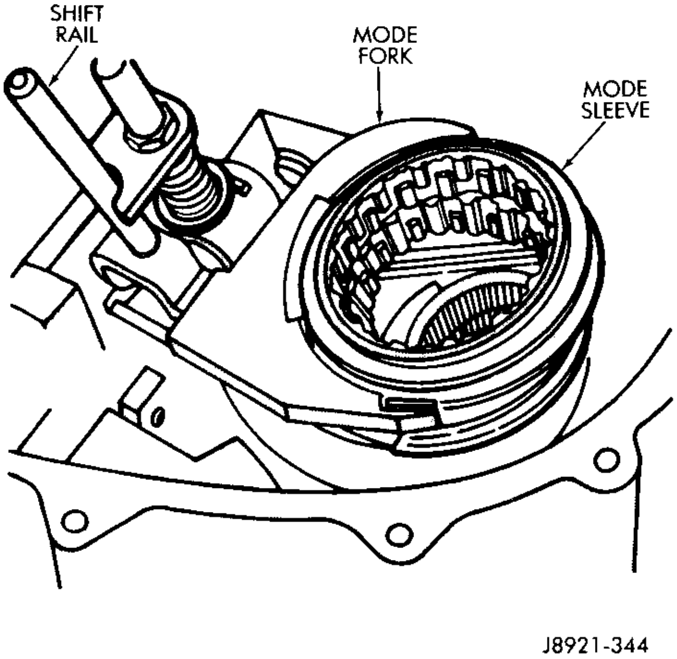


Fig. 52 Installing Mode Fork, Shift Rail And Mode Sleeve

(71) Install the front yoke. Secure the yoke with a new seal washer and nut. Tighten the yoke nut finger tight only.

(72) Install the rear yoke and original yoke nut (Fig. 66). Tighten nut but do not tighten the nut completely at this time.

(73) Mount a dial indicator on the rear retainer. Position the indicator plunger on the yoke nut and zero the indicator (Fig. 66).

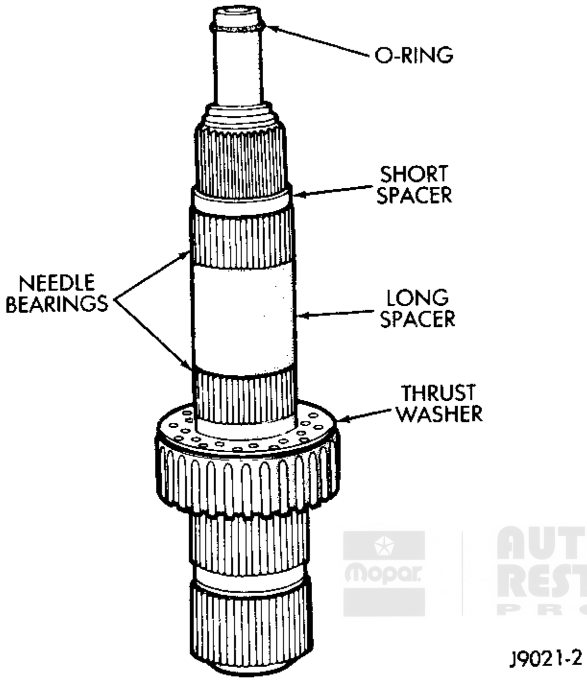


Fig. 53 Installing Mainshaft Thrust Washer, O-Ring, Needle Bearings And Spacers

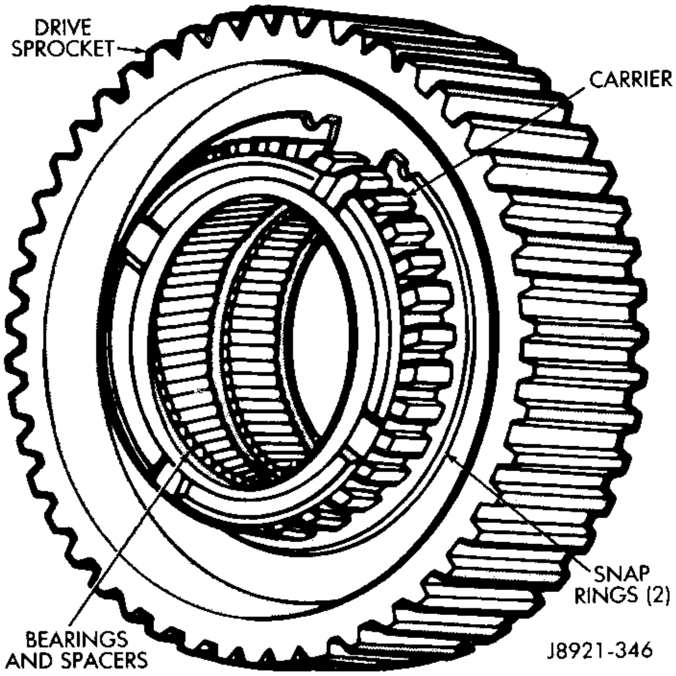


Fig. 54 Assembling Drive Sprocket And Carrier

(74) Install a yoke holding tool on the front yoke to prevent it from turning.

(75) Rotate the rear output shaft through two full revolutions and note maximum runout on the dial indicator.

(76) Set dial indicator at maximum runout position and zero the dial indicator again.

(77) Pull upward on the rear output shaft and note shaft end play on the dial indicator. End play should be between .002 and .010 inch (.05 and .25 mm).

(78) Remove the dial indicator, rear yoke and rear retainer. Discard the old yoke nut.

(79) Change end play shims as needed to obtain correct end play.

(80) Apply Loctite 515 or an equivalent sealer to the mating surface of the rear retainer and to the retainer bolts.

(81) Install the rear retainer on the case. Tighten the retainer bolts to 23 ft-lbs (31 N•m) torque.

(82) Install the rear yoke. Secure the yoke with a new seal washer and nut.

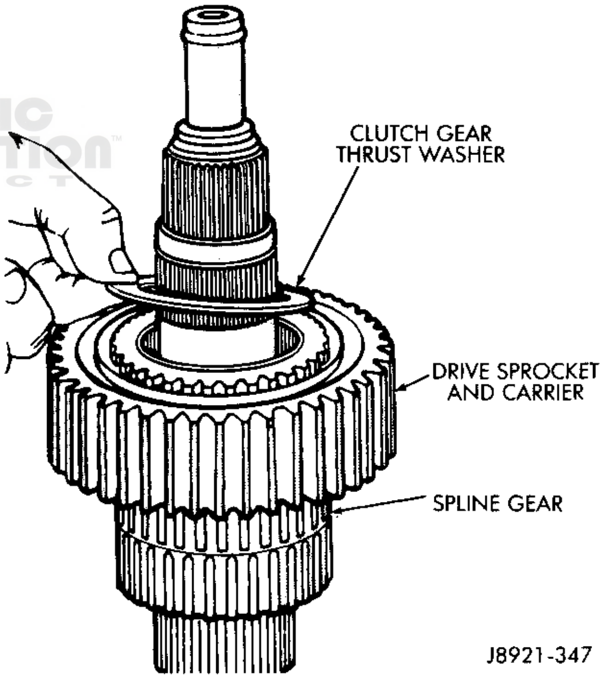


Fig. 55 Installing Drive Sprocket, Carrier And Clutch Gear Thrust Washer

(83) Tighten the front and rear yokes to 120 ft-lbs (163 N•m) torque.

(84) Install the drain plug. Tighten the plug to 18 ft-lbs (24 N•m) torque.

(85) Fill the transfer case with Mopar Dexron II™ or Mercon™ automatic transmission fluid.

(86) Install and tighten the fill plug to 18 ft-lbs (24 N•m) torque.

(87) Install the shift motor and bracket and the transfer case vent.

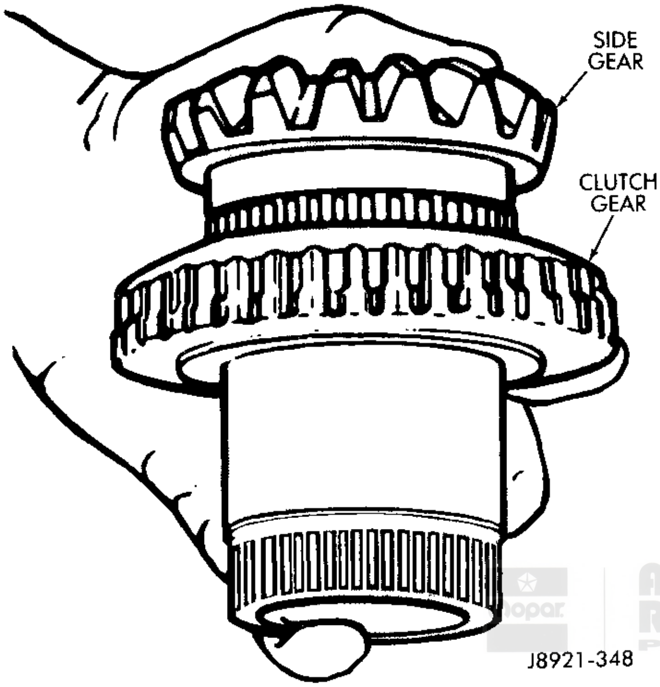


Fig. 56 Assembling Clutch And Side Gears

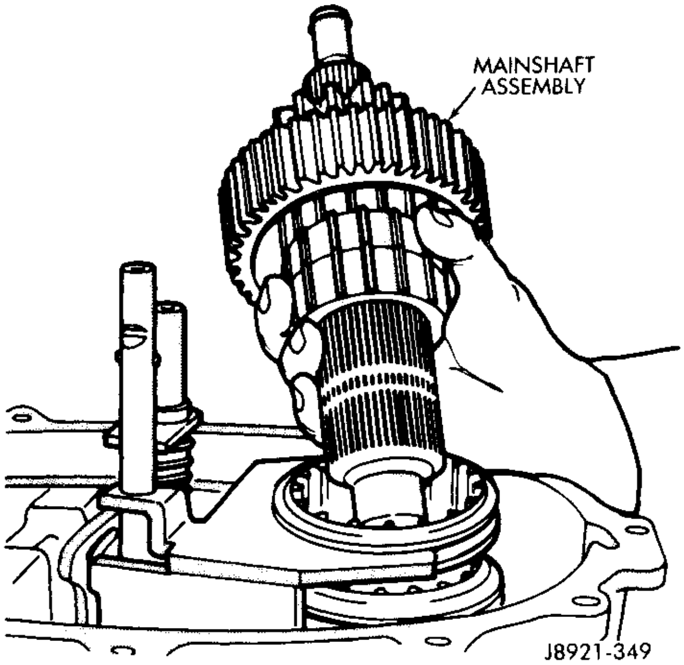


Fig. 57 Installing Mainshaft Assembly

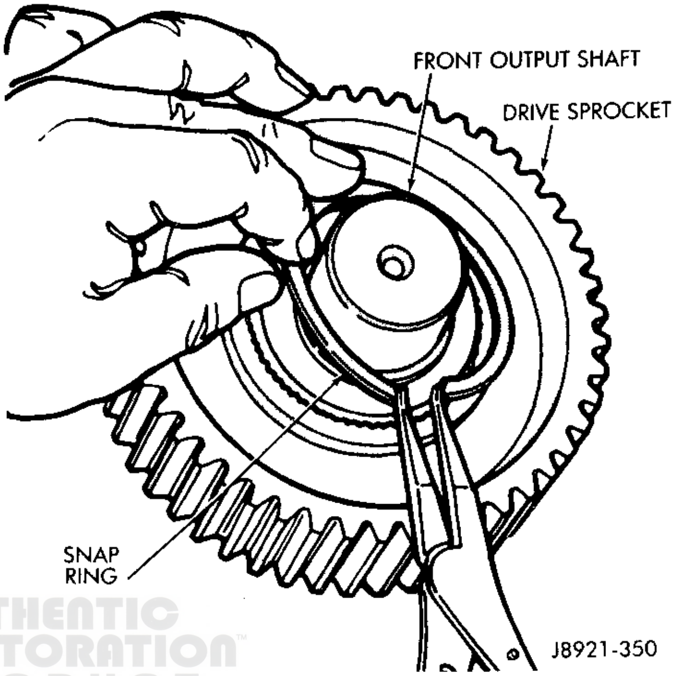


Fig. 58 Assembling Drive Sprocket And Front Output Shaft

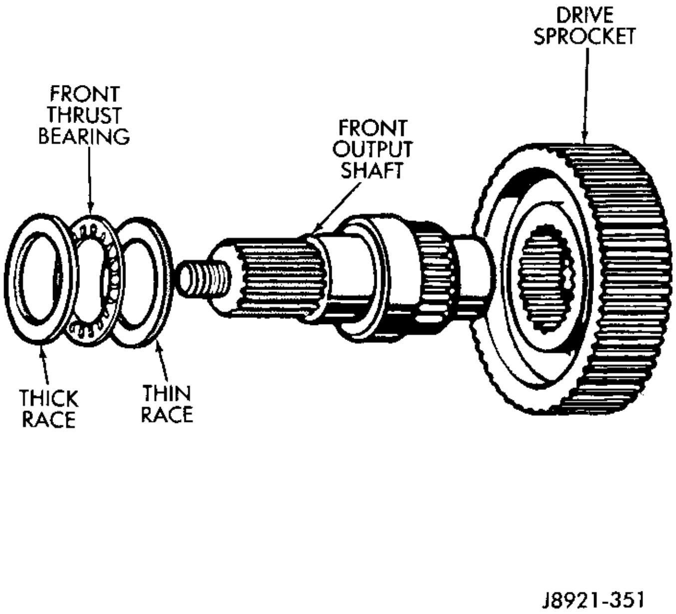


Fig. 59 Installing Front Output Shaft

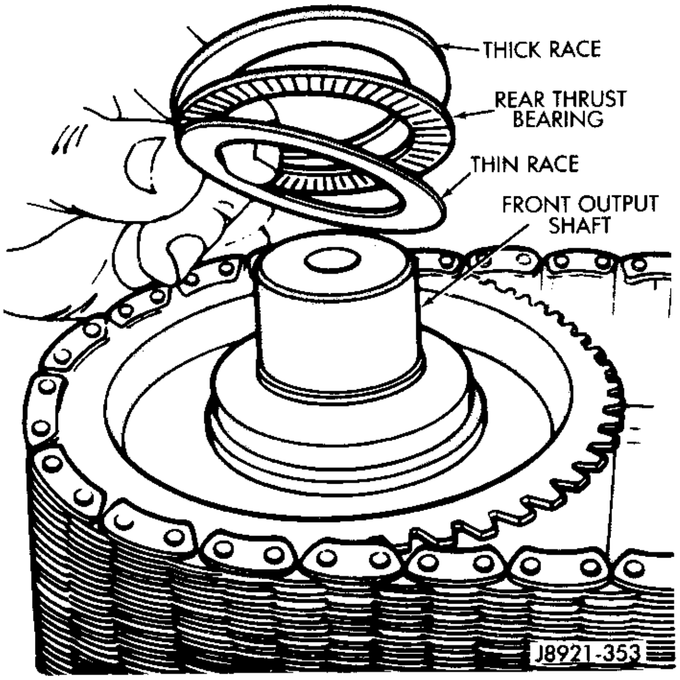


Fig. 60 Installing Drive Chain And Front Output Shaft

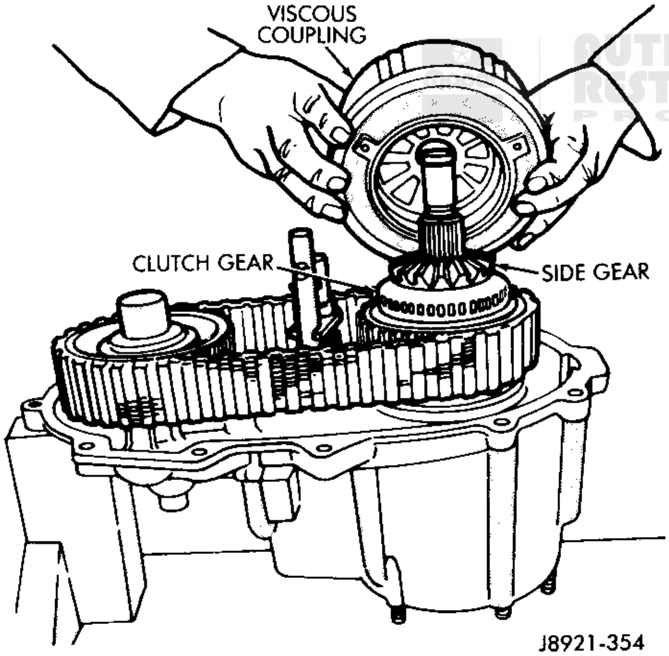


Fig. 61 Installing Front Output Shaft Rear Thrust Bearing And Races

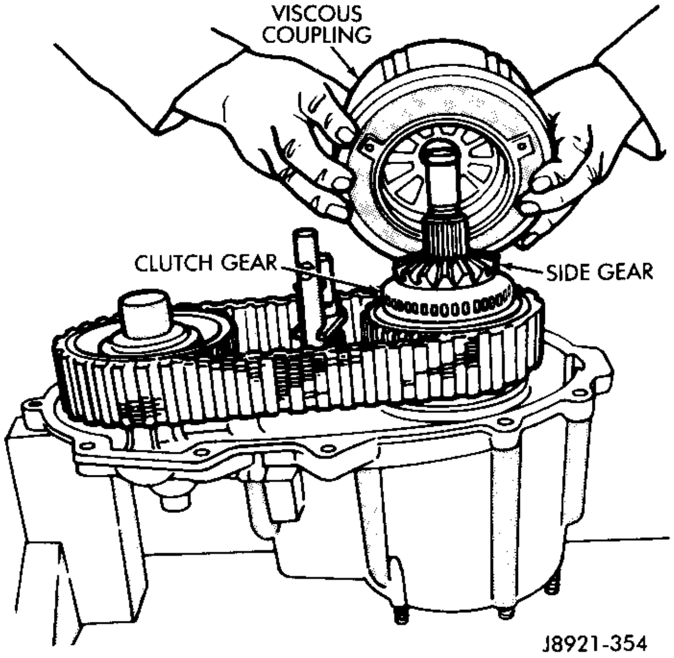


Fig. 62 Installing Viscous Coupling

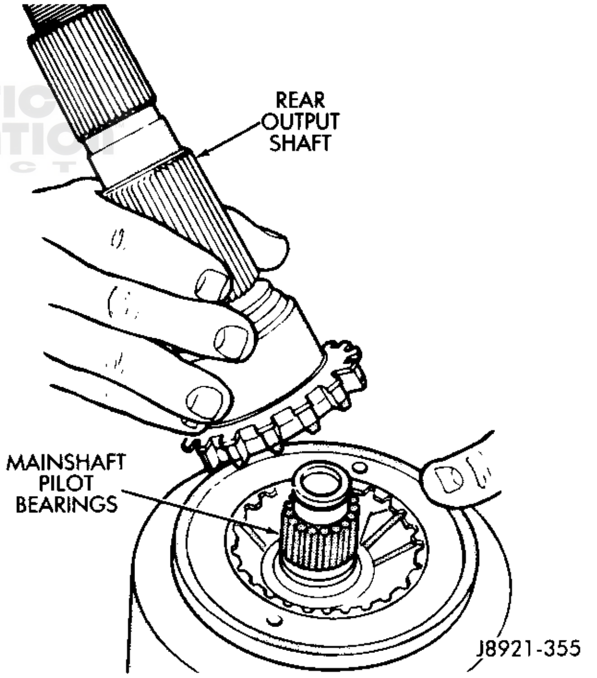


Fig. 63 Installing Rear Output Shaft And Mainshaft Pilot Bearings

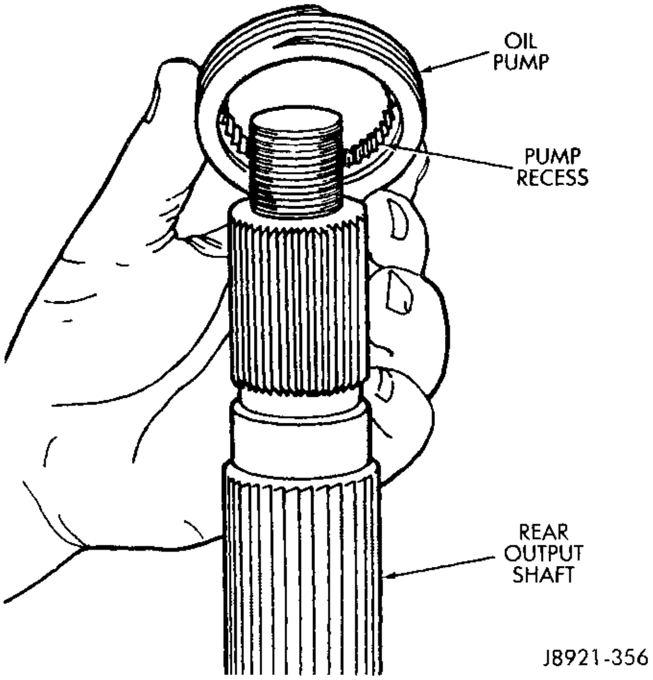


Fig. 64 Installing Oil Pump

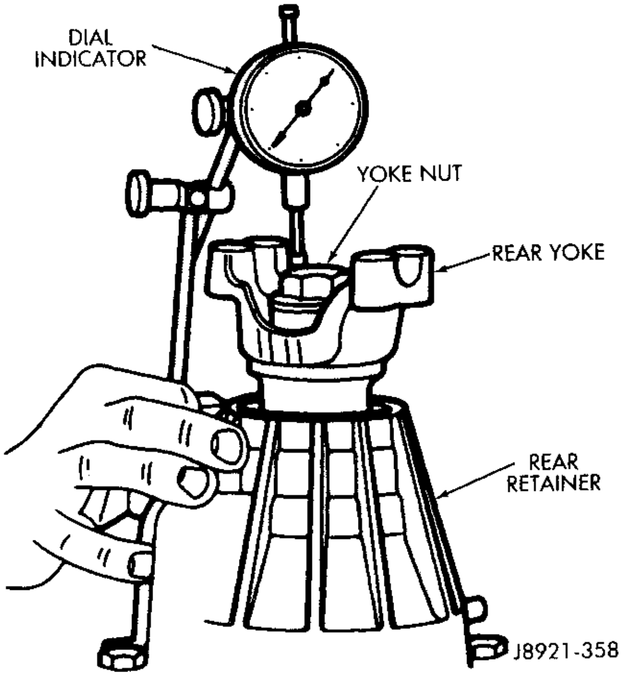


Fig. 66 Checking Output Shaft End Play

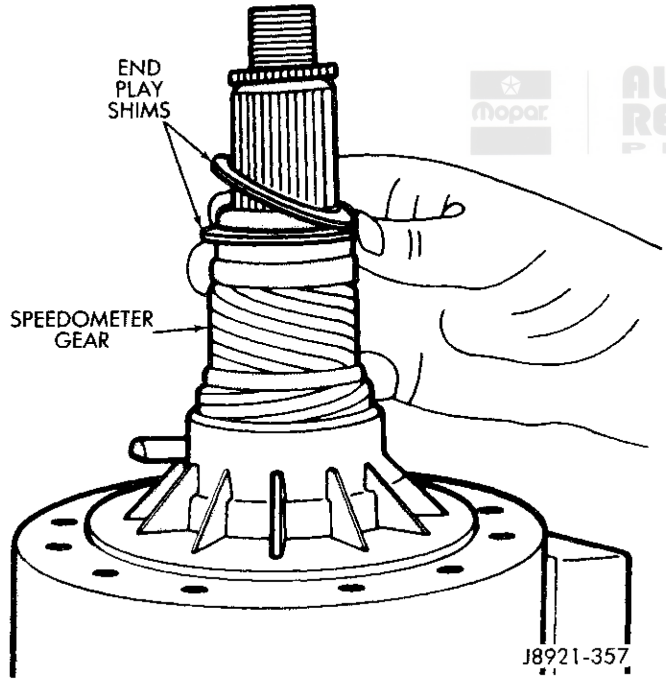
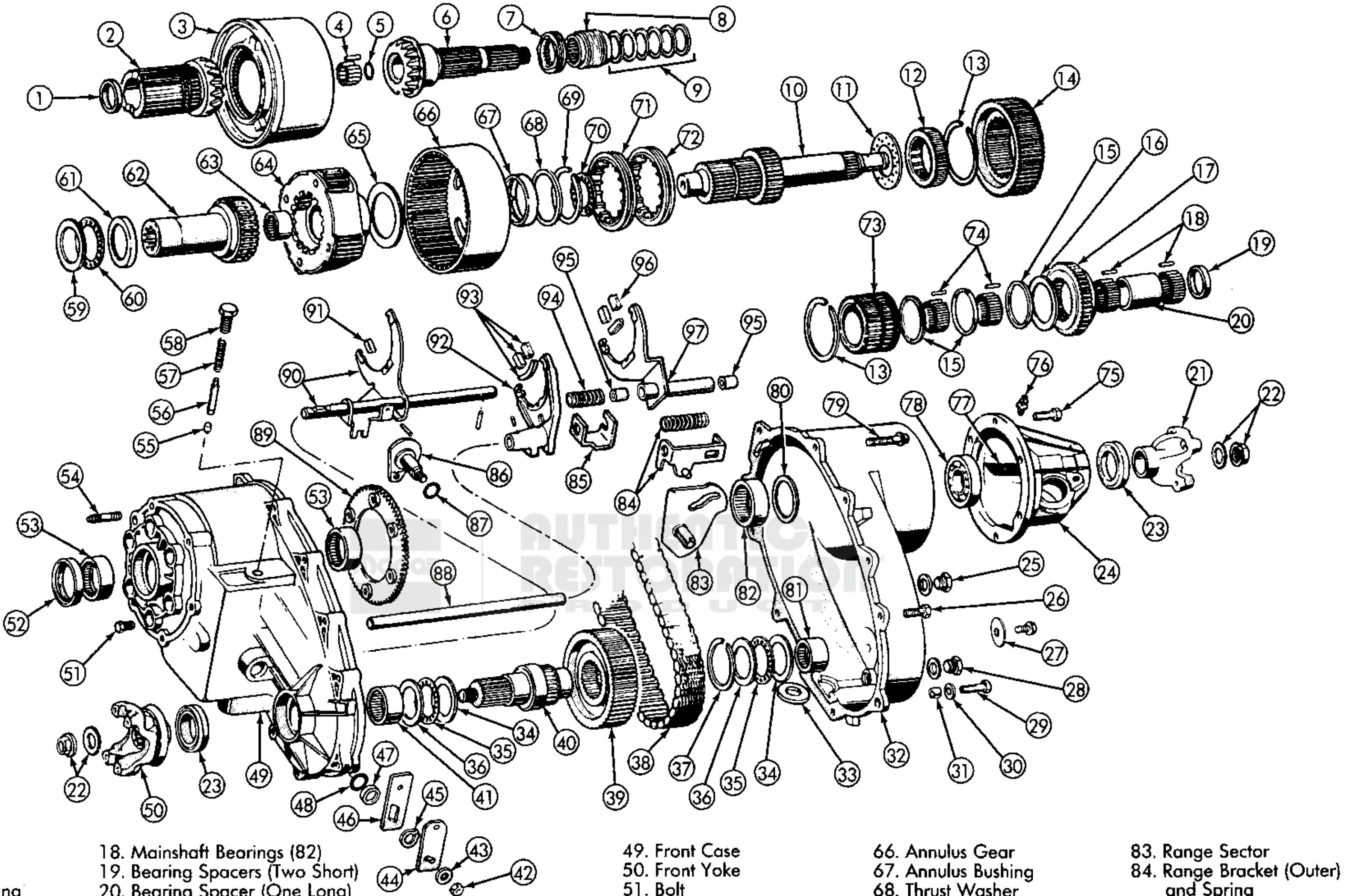


Fig. 65 Installing Speedometer Gear And End Play Shims



1. Spacer
2. Side Gear
3. Viscous Coupling
4. Pilot Bearing Rollers (15)
5. O-Ring
6. Rear Output Shaft
7. Oil Pump
8. Speedometer Drive Gear
9. Shims
10. Mainshaft
11. Mainshaft Thrust Washer
12. Spline Gear
13. Retaining Ring
14. Sprocket
15. Spacer
16. Sprocket Thrust Washer
17. Clutch Gear
18. Mainshaft Bearings (82)
19. Bearing Spacers (Two Short)
20. Bearing Spacer (One Long)
21. Rear Yoke
22. Nut and Seal Washer
23. Seal
24. Rear Retainer
25. Plug Assembly
26. Bolt
27. Identification Tag
28. Plug
29. Dowel Bolt
30. Dowel Bolt Washer
31. Case Half Dowel
32. Rear Half Case
33. Magnet
34. Bearing Race (Thick)
35. Bearing
36. Bearing Race (Thin)
37. Retaining Ring
38. Drive Chain
39. Driven Sprocket
40. Front Output Shaft
41. Front Output Front Bearing
42. Nut
43. Washer
44. Mode Lever
45. Snap Ring
46. Range Lever
47. O-Ring Retainer
48. O-Ring
49. Front Case
50. Front Yoke
51. Bolt
52. Input Gear Oil Seal
53. Input Gear Bearing
54. Stud
55. Detent Ball
56. Pin
57. Spring
58. Screw
59. Bearing Race (Thin)
60. Thrust Bearing
61. Bearing Race (Thick)
62. Input Gear
63. Pilot Bearing
64. Planetary Gear
65. Input Gear Thrust Washer
66. Annulus Gear
67. Annulus Bushing
68. Thrust Washer
69. Retaining Ring
70. Thrust Bearing
71. Range Sleeve
72. Mode Sleeve
73. Carrier
74. Carrier Bearings (120)
75. Rear Retainer Bolt
76. Vent
77. Vent Seal
78. Output Bearing
79. Bolt
80. Seal
81. Front Output Rear Bearing
82. Output Shaft Bearing
83. Range Sector
84. Range Bracket (Outer) and Spring
85. Range Bracket (Inner)
86. Mode Sector
87. O-Ring
88. Range Rail
89. Low Range Lockout Plate
90. Mode Fork, Rail and Pin
91. Mode Fork Pad
92. Range Fork
93. Range Fork Pads
94. Range Bracket Spring (Inner)
95. Locking Fork Bushing
96. Locking Fork Pads
97. Locking Fork

J8921-359

SERVICE SPECIFICATIONS

Model 229	Three-position, dual range, full-time/part-time unit, with integral low range, and a Neutral position.
Torque Transmittal Mode	Dual sprockets with connecting drive chain and an interaxle differential – viscous coupling unit.
Low Range Reduction Ratio and Mode	2.60:1 through annulus gear and planetary carrier assembly.
Drive Positions and Shift Controls	4H, 4L, and Neutral. Ranges selected via floor-mounted shift lever. (4H range is fully differentiated; 4L range is undifferentiated.)
Lubricant Capacity and Type	3.82 liters (6 pints) MOPAR MERCON® automatic transmission fluid or equivalent labeled DEXRON II®.

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Detent Retainer Bolt	31 N·m (23 ft-lbs)	27-34 N·m (20-25 ft-lbs)
Drain and Fill Plugs	24 N·m (18 ft-lbs)	20-34 N·m (15-20 ft-lbs)
Front/Rear Yoke Nuts	163 N·m (120 ft-lbs)	122-176 N·m (90-130 ft-lbs)
Operating Lever Locknut	24 N·m (18 ft-lbs)	19-27 N·m (14-20 ft-lbs)
Rear Case-to-Front Case Bolts (all)	31 N·m (23 ft-lbs)	27-34 N·m (20-25 ft-lbs)
Rear Retainer Bolts	31 N·m (23 ft-lbs)	27-34 N·m (20-25 ft-lbs)
Transfer Case-to-Transmission Adapter Nuts	35 N·m (26 ft-lbs)	38-41 N·m (22-30 ft-lbs)
Universal Joint Strap Bolt-to-Transfer Case	19 N·m (170 in-lbs)	16-23 N·m (140-200 in-lbs)

J8921-749

TIRES AND WHEELS

CONTENTS

GENERAL INFORMATION

INDEX

TIRES

Construction

Radial-ply tires (Fig. 1) have belts under the tread that encircle the tire and extend from the tread shoulder-to-tread shoulder. Radial-ply tires are also constructed with the carcass cord plies at a right angle (perpendicular) to the tread centerline (Fig. 1). The cord plies cross the centerline at an angle of approximately 90 degrees. Because the carcass cord plies radiate from the centerline of the tread, this type of tire carcass design was designated radial-ply.

Performance-type tires also have a nylon-belt overlay on the cord plies to provide increased dimensional stability during high-speed operation.

Identification

Radial-ply tires are identified by the code letter **R** (e.g., P195/75**R**15) that appears in the tire identification imprinted on the tire sidewall.

As a result of their unique carcass design, radial-ply tires have a highly flexible sidewall. This flexibility allows the characteristic sidewall "bulge" that causes the tire to appear to be under-inflated. This is a normal condition for radial-ply tires. Do not attempt to reduce the "bulge" by over-inflating a tire. To ensure that a tire is properly inflated, use an accurate and reliable tire pressure gauge. Test and adjust tire inflation pressure in accordance with the information listed on the tire inflation pressure decal affixed to the interior surface of the glove box door.

Size, Aspect Ratio And Speed Rating

The tire type, size, aspect ratio and speed rating are encoded in the combination of letters and numbers imprinted on the tire sidewall (e.g., P225/75SR15).

The first letter-number combination indicates the tire type and size:

- the letter **P** indicates the tire is for passenger vehicles (**T** indicates temporary spare); and
- **225** is the section width (including the 24-hour growth) of the tire when new.

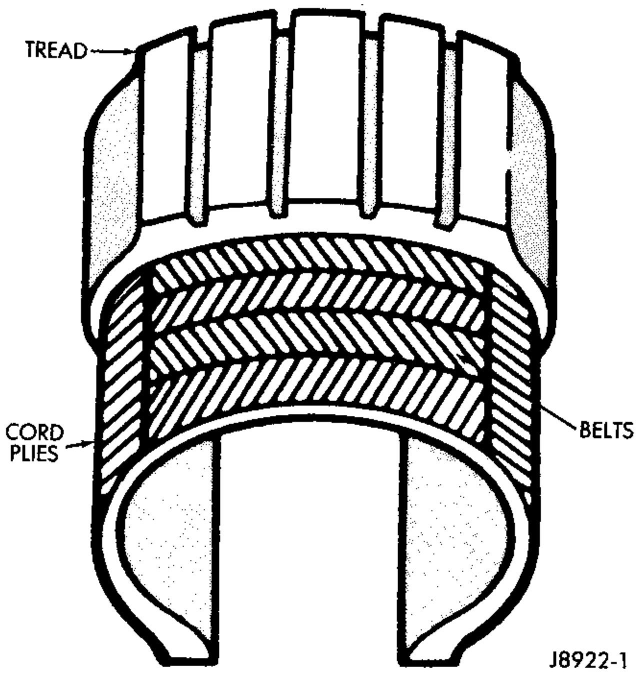


Fig. 1 Radial-Ply Carcass Design Tire

The section width that is imprinted on a tire sidewall (e.g., 225) is only valid when the tire is mounted on a wheel with a rim width that conforms to the tire's design specifications.

After the slash, the aspect ratio (Fig. 2):

- **75** is the aspect ratio (i.e., the section height of the tire equals 75 percent of the section width).

The speed rating:

- the letter **S** indicates that the tire is "speed-rated" up to 112 mph,
- **Q** up to 100 mph,
- **T** up to 118 mph,
- **U** up to 124 mph,
- **H** up to 130 mph,
- **V** up to 149 mph, and
- **Z** more than 149 mph (consult the tire manufacturer for the specific speed rating).

The speed rating is not always imprinted on the tire sidewall.

The rim size:

- **15** is the tire bead/wheel rim diameter in inches.

Tread Life, Traction And Heat Resistance Ratings

The tread wear/traction/heat (temperature) resistance ratings are also imprinted on the tire sidewall (e.g., 250 AB).

The tread wear rating is expressed as a 3-digit number and is a comparative value based on the wear rate of a tire when tested under controlled conditions on a U.S. Government designated test course. For example, in theory, a tire with a tread wear rating of 300 would have a 50 percent better tread life than a tire with a rating of 200. In reality, the relative tread wear performance of the various tires also greatly depends upon the driving habits of the owner and upon the actual driving conditions, including tire service attention, the climate and the road/street surfaces that the tires usually encounter.

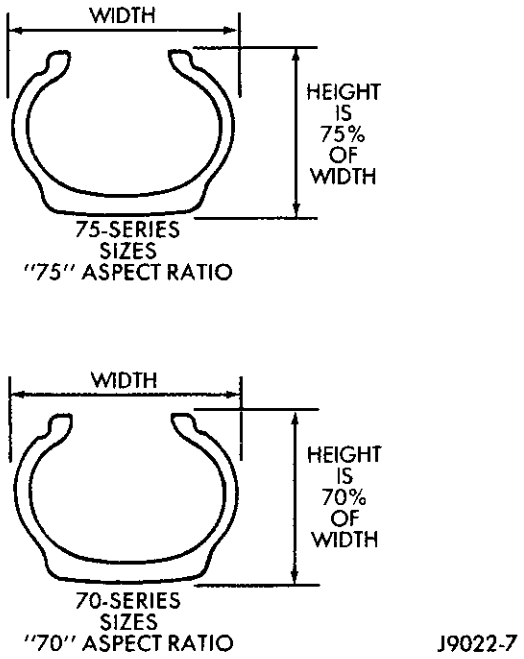


Fig. 2 Tire Aspect Ratio

The tire traction and the heat (temperature) resistance ratings follow the tread wear rating. They are encoded either **A, B or C.** An **A** code represents the best rating in either category.

The traction ratings are based upon a tires's ability to stop a vehicle on wet pavement when tested under controlled conditions on U.S. Government designated asphalt and concrete test surfaces.

The traction rating assigned to a specific tire is based on straight-ahead braking traction tests and does not include cornering/turning traction.

The heat (temperature) resistance rating represents a tire's resistance to temperature increases from rolling friction and its ability to dissipate heat under controlled conditions on a specified indoor laboratory test wheel. Sustained high tire temperature can cause the construction material of a tire to degenerate and this will greatly reduce the life of the tire. A C rating represents the minimum acceptable heat (temperature) resistance performance for a tire in accordance with FMVSS Number 109.

The heat (temperature) resistance rating assigned to a specific tire is based on the tire being properly inflated and not overloaded. Excessive speed, underinflation and an excessive load, either separately or combined, can cause the temperature of a tire to increase well above normal and potentially cause tire failure.

Load Range/Ply Rating

The load range/ply rating indicates the load capacity (i.e., supporting ability) of a tire.

Load Range-To-Ply Rating

Load Range	Replaces Ply Rating
A	2
B	4
XL	4
C	6
D	8
E	10
F	12

J9022-2

All Season Tires

An "All Season" tire will have either **M + S, M & S or M - S** (i.e., mud and snow) imprinted on the tire sidewall.

Inflation Pressures

The original equipment tires installed on Jeep vehicles are selected and tested for conformance with the operating conditions normally encountered by Jeep vehicles and for the tire load capacity. The recommended inflation pressures for different load conditions are listed on the tire inflation pressure decal affixed to the interior surface of the glove box door.

When sustained, Interstate highway operation is anticipated, the tires can be inflated to the recommended inflation pressure plus an additional 2 psi (14 kPa). **The inflation pressure must never exceed the maximum recommended air pressure imprinted on the tire sidewall.**

The tire air pressure should be measured and, if necessary, adjusted to the recommended air pressure on a weekly basis. This is especially important if extreme changes (20°F/7°C or more) in the average seasonal temperature occurs.

Inflation Pressure Adjustment

Measure and adjust the inflation pressure only when either the tires are cold, have been driven less than 2 miles (3.2 km) at a speed less than 40 mph (64 km/h), or after the vehicle has been parked for 3 hours (or more).

Do not reduce the inflation pressure if the tires are hot, or have been driven more than 2 miles (3.2 km) at a speed exceeding 40 mph (64 km/h). Heat and high speed can cause the tire air pressure to increase as much as 6 psi (41 kPa) more than the cold inflation pressure because of the air expansion caused by the increased heat in the tire.

When measuring and adjusting a tire inflation pressure, always use a reliable and accurate gauge to ensure the proper inflation pressure.

Spare Tires

A Polyspare (lightweight) tire is standard equipment for SJ and YJ vehicles, and a compact spare tire is standard equipment for MJ/XJ vehicles. Both types of spare tires are designed for emergency use only. Operation of either tire at a speed exceeding 50 mph (80 km/h) and travel in excess of 100 continuous miles (160 km) for Polyspare tires and 50 continuous miles (80 km) for compact spare tires is not recommended.

The Polyspare tire is mounted on a standard-type 15 X 6-inch steel wheel. The correct Polyspare tire inflation pressure is 35 psi (241 kPa) and the correct compact spare tire inflation pressure is 60 psi (414 kPa). Both spare tires can be inflated with conventional inflation equipment.

Installation and removal of compact spare and Polyspare tires does not require special tools. The anticipated tread life for a Polyspare tire is approximately 3,000 miles (4 800 km).

Abnormal Tire Tread Wear

Abnormal tire tread wear can be caused by incorrect inflation pressure, tire/wheel unbalance, worn suspen-

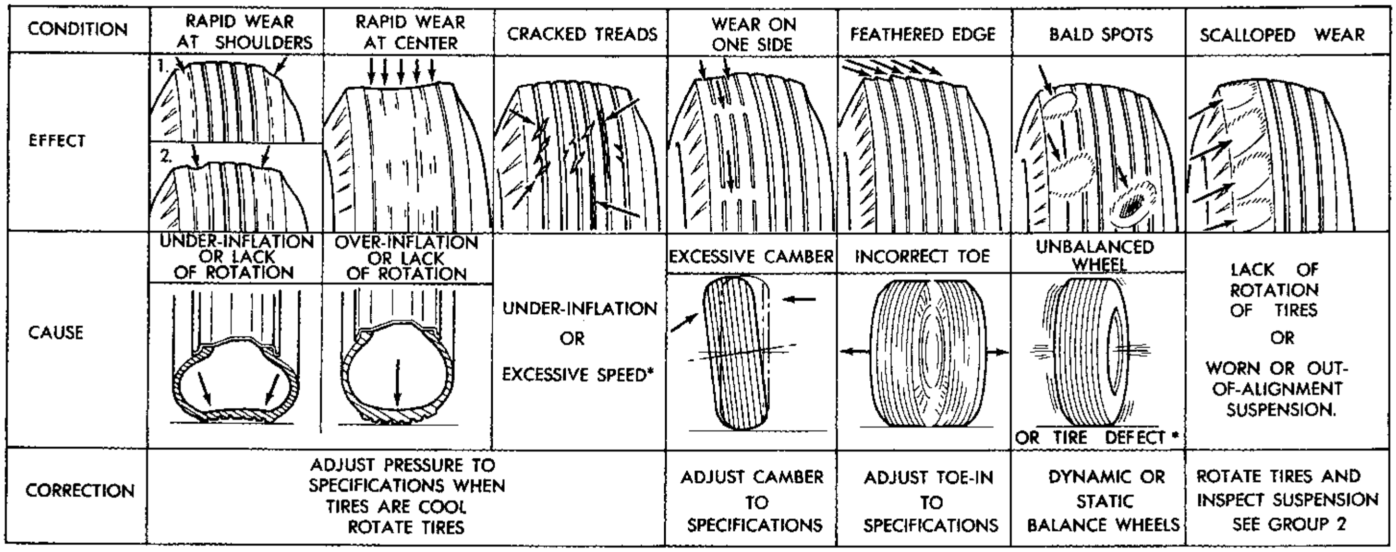
Tire & Wheel Specifications

Vehicle	GVW Rating		Tire Size	Load Range	Tire Pressure (psi)				Wheel Sizes (Inches)		Tire Runout		Wheel Runout	
					Normal Load[1]									
					Sustained Driving 65 mph (105 km/h)		Under 65 mph (105 km/h)				Radial	Lateral	Radial	Lateral
	lbs	kg			Front	Rear	Front	Rear						
SJ	6025	2733	P235/75R15 Polyspare	SL/B	35	35	35 35	35 35	15 x 6 15 x 7	Aluminum Wheel is 15 x 7	0.08 in. (2.03 mm)	0.10 in. (2.54 mm)	0.045 in. (1.14 mm)	0.045 in. (1.14 mm)
MJ	4850	2200	P195/75R15 P205/75R15 P215/75R15 P225/70R15 Compact Spare	SL/B	33 30 30 30 30	33 30 30 30 35	33 30 30 30 30 60	33 30 30 30 35 60	15 x 6 15 x 7	Aluminum Wheel is 15 x 7	0.08 in. (2.03 mm)	0.10 in. (2.54 mm)	0.035 in. (0.889 mm)	0.045 in. (1.143 mm)
XJ	4640	2105	P195/75R15 P205/75R15 P215/75R15 P225/75R15 P225/70R15 Compact Spare	SL/B	33 30 30 30 30	33 30 30 30 35	33 30 30 30 30 60	33 30 30 30 35 60	15 x 6 15 x 7	Aluminum Wheel is 15 x 7	0.08 in. (2.03 mm)	0.10 in. (2.54 mm)	0.035 in. (0.889 mm)	0.045 in. (1.143 mm)
YJ	4150	1882	P215/75R15 P225/75R15 Polyspare	SL/B	30 30	30 30	30 30 35	30 30 35	15 x 6 15 x 7	Aluminum Wheel is 15 x 7	0.08 in. (2.03 mm)	0.10 in. (2.54 mm)	0.035 in. (0.889 mm)	0.045 in. (1.143 mm)

NOTE: Inflate tires while cold, before running. Do not reduce pressure if tires are warm.

[1] Normal Load: Driver plus 2-3 passengers.

J9022-1



CONDITION	RAPID WEAR AT SHOULDERS	RAPID WEAR AT CENTER	CRACKED TREADS	WEAR ON ONE SIDE	FEATHERED EDGE	BALD SPOTS	SCALLOPED WEAR
EFFECT	1. 2.						
CAUSE	UNDER-INFLATION OR LACK OF ROTATION	OVER-INFLATION OR LACK OF ROTATION	UNDER-INFLATION OR EXCESSIVE SPEED*	EXCESSIVE CAMBER	INCORRECT TOE	UNBALANCED WHEEL OR TIRE DEFECT *	LACK OF ROTATION OF TIRES OR WORN OR OUT-OF-ALIGNMENT SUSPENSION.
CORRECTION	ADJUST PRESSURE TO SPECIFICATIONS WHEN TIRES ARE COOL ROTATE TIRES			ADJUST CAMBER TO SPECIFICATIONS	ADJUST TOE-IN TO SPECIFICATIONS	DYNAMIC OR STATIC BALANCE WHEELS	ROTATE TIRES AND INSPECT SUSPENSION SEE GROUP 2

*HAVE TIRE INSPECTED FOR FURTHER USE.

RN797

Fig. 3 Abnormal Tire Tread Wear Patterns

sion components, improper brake operation, bent wheels, incorrect front wheel alignment and excessive speed when turning the vehicle.

In most situations, inspection of the tire tread wear will reveal the cause of the abnormal wear. The illustration below (Fig. 3) depicts the various types of tire tread wear patterns and the recommended corrective action.

Rapid wear from the tread shoulders is usually caused by under-inflation or an excessive mileage interval between tire rotation, or a combination of both incidents. If this type of wear occurs and the tires are serviceable, rotate them and inflate them with the recommended air pressure when they are cool.

Rapid wear from the tread center is usually caused by over-inflation or an excessive mileage interval between tire rotation, or a combination of both incidents. If this type of wear occurs and the tires are serviceable, rotate them and inflate them with the recommended air pressure when they are cool.

Cracked treads are usually caused by under-inflation or excessive high-speed operation, or a combination of both incidents. Tires with cracked treads should be replaced and the replacement tires should be properly maintained to avoid a recurrence of the failure.

Excessive wear from one tread shoulder can be caused by excessive speed on turns or by an incorrect camber angle. An incorrect negative camber angle will cause excessive wear from the inside tire shoulder while an incorrect positive camber angle will cause excessive wear outside tire shoulder. If this type of tread wear occurs, measure the camber angle. If the camber angle is within the specified limits, caution the owner about excessive speed when turning. If the tires are serviceable, rotate them and adjust them with the recommended air pressure.

An incorrect wheel "toe" position will cause the tire tread surface to develop a feathered edge. One side of the tread will be rounded while the opposite side will have a feathered edge. This type tread wear indicates that the tire is side slipping and scuffing as it moves over the street/road surface.

A feathered tread edge that faces toward the vehicle indicates excessive "toe-in". A feathered tread edge that faces away from the vehicle indicates excessive "toe-out". The direction that a feathered edge has developed can be determined by passing your hand over the tire tread surface. Bent steering knuckle arms can also cause this type of wear.

If a feathered edge develops, measure and correct the "toe" position as necessary and rotate the tires if they are serviceable.

WHEELS

The standard equipment wheels installed on Jeep vehicles are drop center, J-type, steel wheels with safety rims. Optional wheels include styled-steel, wide-rim and spoke-type cast aluminum wheels.

The steel wheels are the two-piece type that consist of a rim and center section (spider). The two sections are welded together to form a seamless, air-tight unit.

A wheel safety rim has a "ridge" (i.e., a raised edge) located inboard of each rim flange and at the top of the rim well (Fig. 4). When a tire is initially inflated, the air pressure forces the tire beads over the "ridges" and "seats" them in the "valleys" and against the rim flanges. During extreme "cornering" (i.e., turning a vehicle at high speed), tire and wheel rim separation is prevented because the tire air pressure retains each tire bead "seated" in the "valley" between the "ridge" and the rim flange. In addition, when tire failure occurs, the "ridges" also aid in retaining the tire beads in the "valleys" until the vehicle is safely stopped.

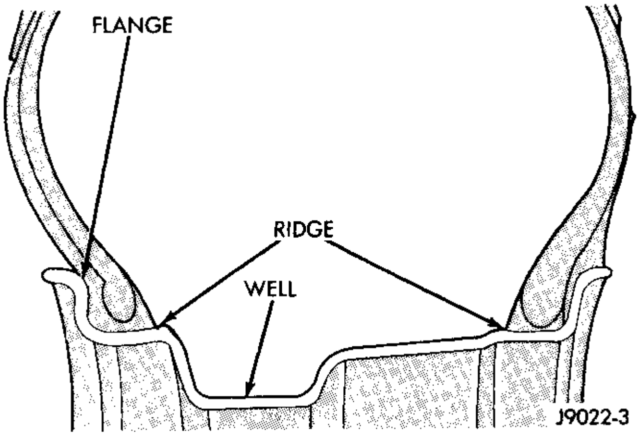


Fig. 4 Wheel Safety Rim

TIRE SERVICE

INDEX

INSPECTION

To maximize tire longevity, inspect tires frequently for the effects of incorrect inflation and other causes of uneven wear, which can also indicate a need for tire/wheel balancing, tire rotation or front-end alignment. Tires should also be inspected frequently for cuts, abrasions, stone bruises, blisters and for objects imbedded in the tire tread. Weekly inspection is recommended as the minimum interval of time. More frequent inspections are recommended when extreme temperature changes occur and when the street/road surfaces are rough (or littered with debris).

For an additional visual reminder of tire condition, tread wear indicators are molded into the bottom of the tire tread grooves. These indicators appear in the form of 1/2-inch (13-mm) wide bands across the tread when it has worn down to a thickness of 1/16 of an inch (1.58 mm) or less. The tire should be replaced when these bands become visible. The illustration below (Fig. 5) depicts tire tread that is still acceptable and tire tread that has worn down to a indicator (unacceptable).

CLEANING

Clean tires with a mild soap and water solution only and rinse them thoroughly with water. Do not use caustic solutions or abrasive materials. To clean white sidewalls and raised letters/numbers, use an approved whitewall cleaner only. Do not use steel wool, wire brushes or cleaning solutions that have a mineral oil base (e.g., gasoline, paint thinner and turpentine). These solutions are harmful to the tires and will also discolor white sidewalls and raised letters/numbers.

REPAIR

Punctured tires should be removed from the wheel and permanently repaired on the inside with a combination of a repair plug and a vulcanizing patch. When repairing punctures, always follow the manufacturer's instructions for a repair kit installation. Only punctures in the **tread area** are repairable (Fig. 6).

Never attempt to repair punctures in the tire shoulders or sidewalls.

In addition, never attempt to repair any tire that has any of the following damage conditions:

- bulges or blisters;
- ply separations;
- broken, cut or cracked beads;

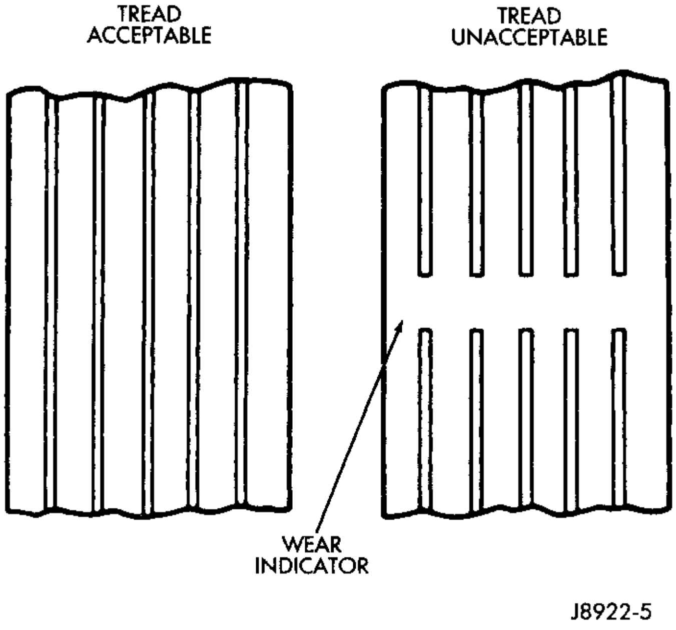


Fig. 5 Tire Tread Condition

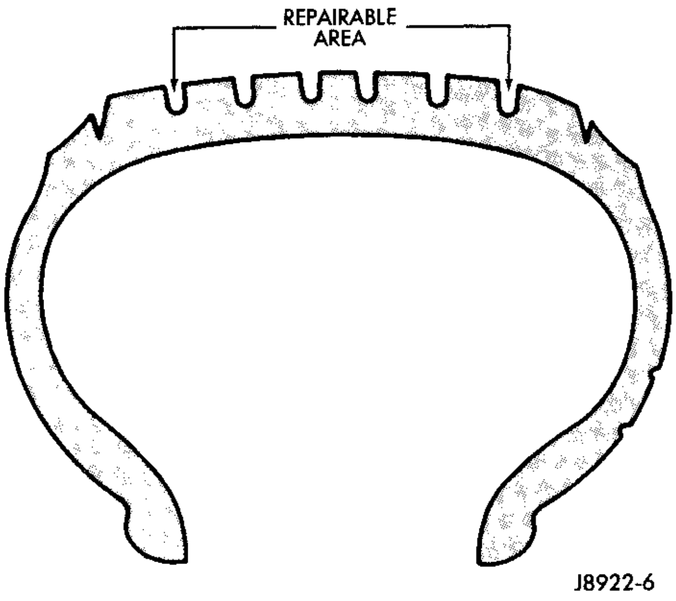


Fig. 6 Repairable Puncture Area

- fabric cracks cuts;
- tread worn to the fabric or to the wear indicators; or
- punctures larger than 1/4 of-an-inch in diameter.

Externally applied repair plugs, “blowout” patches and aerosol sealants should be considered as **emergency-type** repairs only. Tires repaired by any of these methods should not be driven at a speed exceeding 40 mph (64 km/h) or for more than 75 miles (121 km) before permanent tire repair or replacement of the tire.

ROTATION

To equalize tread wear, tires should be rotated at the specified interval. The first tire rotation is the most important for establishing the prevention of uneven tread wear. After rotation, adjust the tire inflation to the air pressure recommended on the decal affixed to the interior surface of the glove box door.

The suggested method for the tire rotation for a Jeep vehicle is the “cross” pattern (Fig. 7). This method is completely compatible with the tire industry's currently recommended procedure for cross-rotation of radial-ply tires. Other rotation patterns/methods can be used, but they may not necessarily provide all the tire longevity benefits that are derived from the “cross” pattern method (Fig. 7).

WIDE-TREAD TIRES

Radial-ply, wide-tread tires must be installed in complete sets and only when there is adequate clearance for the tire in the wheel well. Refer to the Tire & Wheel Specifications chart for the tire sizes that are acceptable for each vehicle. **Tires with different widths must never be intermixed.**

CAUTION: The tires installed on Jeep vehicles must all have the same circumference to maintain satisfactory operation. They must also be the same size, construction and have the same inflation pressure. Intermixing tires of different size or construction will cause unusual handling, noisy operation and accelerated wear of the driveline components.

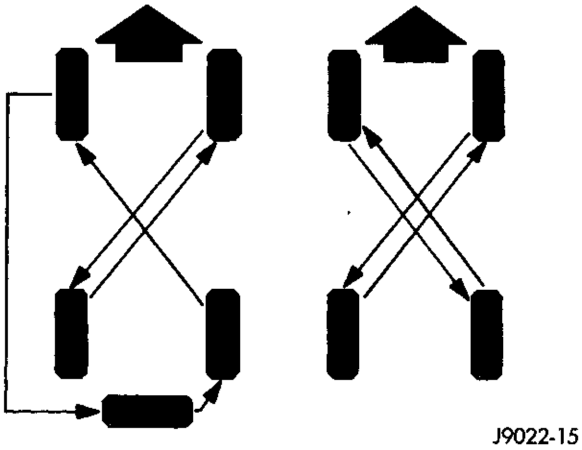


Fig. 7 Tire Rotation Pattern

TIRE DIAGNOSIS

General Information

Roughness, vehicle vibration, tire “tramp”, wheel “shimmy” and tire “thump/wheel hop” are usually the result of either excessive tire/wheel “runout”, “cupped” tires or tire/wheel unbalance. These problem conditions can also be caused by driving over rough or irregular street/road surfaces. Test driving a vehicle on different street/road surfaces will usually help determine if the street/road surfaces or the tires are causing the undesirable ride condition.

Always road test a vehicle to determine the exact nature of a problem. Drive the vehicle for at least 10 miles (16 km) to warm the tires and remove temporary “flat” spots that could have formed while the vehicle was parked. Note the tire condition and wear, and measure and adjust the inflation pressure before road testing.

Performance Characteristics

As a result of their unique construction, radial-ply tires have **ride, handling and appearance** characteristics that are noticeably different from the tires previously used.

If the low-speed ride quality or “feel” of the tires appears harsh, this is a normal characteristic and is caused by the stiff belts used in radial-ply tire construction. Harshness often leads to the assumption that the tires are over-inflated. Do not under-inflate radial-ply tires in an attempt to correct this condition. Inflate radial-ply with the recommended air pressure only.

Because the radial tire plies are positioned at a 90 degree angle to the tread centerline, they have highly flexible sidewalls. It is this flexibility that produces the characteristic sidewall “bulge” and causes the tire to appear under-inflated. This is a normal condition. Do not attempt to reduce the “bulge” by over-inflating the tire. Measure the inflation pressures with an accurate gauge and inflate the tires with the recommended air pressure only.

At a speed of 15 mph (24 km/h) or less, radial-ply tires can cause a side-to-side or “waddle” motion. Wheel balancing will not correct this condition.

Proper installation of radial-ply tires is very important. Incomplete “seating” of the tire bead on the wheel rim can produce a high frequency vibration at a speed above 45 mph (72 km/h). Incomplete bead “seating” can be determined by visually inspecting the tire. Correction involves removing and “re-seating” the tire on the wheel rim.

Because of the construction, radial-ply tires are sometimes less responsive to certain methods of wheel balancing. Radial-ply tire balancing is best accomplished using dynamic, two-plane, off-vehicle balancing equipment.

Tire Thump

Tire "thump" (noise) is caused by the tire moving over irregularities in the streets/roads or by irregularities in the tire itself. The "thump" sound coincides with each wheel rotation.

To identify the tire that is causing the **thump**, inflate all the tires with 45 psi (310 kPa) of air pressure temporarily and drive over the same streets/roads. If the "thump" noise does not exist, reduce the air pressure in one tire at a time repeat the road test. Each road test is accomplished with three of the tires with high air pressure and one with the recommended air pressure. When the **thump** develops again, the tire that was the most recently reduced to normal inflation pressure is the defective tire.

Tire Tramp

Tire "tramp" is caused by either tire/wheel static unbalance or by excessive tire/wheel lateral runout.

Static unbalance occurs when a disproportional amount of weight (mass) is concentrated at a small area on the tire/wheel (Fig. 8). This causes a vibratory-type pounding action that is commonly referred to as tire **tramp** or wheel hop. Static balance is achieved by an equal distribution of weight (mass) around the circumference of the tire/wheel.

The most effective method of determining static unbalance is by the use of off-vehicle wheel balancing equipment.

Wheel Shimmy

Wheel "shimmy" is caused by tire/wheel dynamic unbalance.

Dynamic unbalance results from unequal forces being concentrated at opposing locations on the circumference of the tire/wheel during wheel rotation (Fig. 9). This condition causes wheel **shimmy** and vibration at medium and high wheel rotation speeds. Dynamic balance is achieved by an equal distribution of tire/wheel weight (mass) around the plane of rotation (Fig. 9). This equalizes the forces and allows the wheel to rotate smoothly around the axis that bisects the tire and wheel centerline.

The most effective method for balancing tires/wheels is by the use of equipment that will detect both static and dynamic unbalance. Dynamic, two-plane balancing equipment is recommended.

CAUTION: DO NOT balance a tire/wheel that has been removed from a vehicle that has not been recently driven at least 10 miles (16 km) to eliminate any existing "flat spot". The "flat spot" results from the weight of the vehicle being supported by a small area of the tire for an extended period of time. The extent of the "flat spot" on a tire is usually more severe during cold weather.

Because balancing procedures vary with different types of equipment, follow the manufacturer's operating instructions explicitly to obtain satisfactory results.

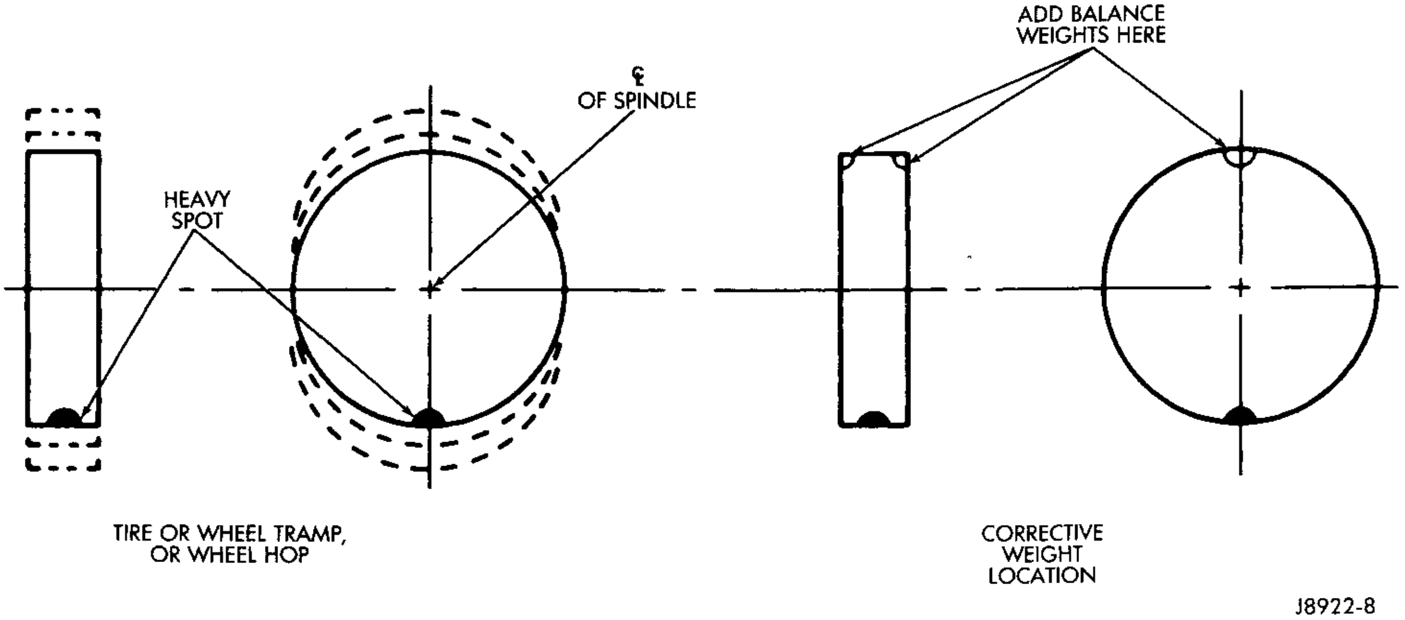


Fig. 8 Static Unbalance & Balance

WARNING: On-vehicle type tire/wheel balancing equipment can be used on the rear wheels of vehicles equipped with a "limited-slip" (Trac-Lok) differential, but only after raising the rear end and removing the wheel opposite the one to be balanced. In addition, do not exceed 35 mph (56 km/h) when rotating the wheels. As a result of the differential action, the actual wheel angular velocity is twice the speed indicated on the vehicle speedometer. The centrifugal force produced by a tire rotating at high speed could cause damage and personal injury.

Tire And Wheel Runout

Excessive radial or lateral "runout" of a tire or wheel can cause roughness, vehicle vibration, tire "tramp", wheel "hop", excessive tire tread wear and wheel tremor.

Before measuring the tire/wheel **"runout"**, drive the vehicle for at least 10 miles (16 km) to remove any temporary flat spots that could have formed in the tires when parked. Flat spots must be removed to avoid false indications when measuring the runout.

Measure the tire "runout" with either a dial indicator or with wheel alignment equipment. All measurements should be accomplished with the tires inflated with the recommended air pressure and with the wheel bearings properly adjusted (if applicable).

Measure the tire radial "runout" (i.e., the tire perimeter eccentricity) at both the center and outside ribs of the tire tread face. Measure the tire lateral "runout" (i.e., the tire horizontal deviation) at the tire sidewall immediately above the buffing rib on the sidewall (Fig. 10). Identify and mark the tire radial and lateral major "runouts" for reference.

The tire radial "runout" should not exceed 0.08 of-an-inch (2.03 mm) and the tire lateral "runout" should not exceed 0.10 of-an-inch (2.54 mm). If the tire radial and/or lateral "runout" exceeds the specified limit, it will be necessary to measure the wheel radial and/or lateral "runout" to determine whether the tire or the wheel is causing the excessive runout.

Wheel radial "runout" (i.e., the wheel perimeter eccentricity) is measured on the wheel rim immediately inside the location where the wheel cover retaining "nibs" are normally "seated" (Fig. 11). Wheel lateral "runout" (i.e., the wheel horizontal deviation) is measured on the wheel rim flange immediately above the curved lip/J-hook (Fig. 11). Identify and mark the wheel radial and lateral major "runouts" for reference.

The wheel radial "runout" should not exceed 0.035 of-an-inch (0.88 mm). The wheel lateral "runout" should not exceed 0.045 of-an-inch (1.14 mm).

If the tire "runout" (either radial or lateral) exceeds the specified limit but the corresponding wheel "runout" is within the specified limit, the tire "runout" can be reduced to an acceptable amount by changing the tire position on the wheel so that the previously marked major "runouts" on the tire and on the wheel are 180 degrees apart.

With disc brakes, excessive wheel lateral "runout" can also be caused by excessive rotor hub-to-bore "runout". Refer to the rotor inspection procedure in Group 5—Brakes.

Vehicle Vibration

Vehicle vibration can be caused by tire/wheel unbalance or excessive "runout"; defective or tires with extreme tread wear; nylon overlay "flat spots" (performance tires only); incorrect wheel bearing ad-

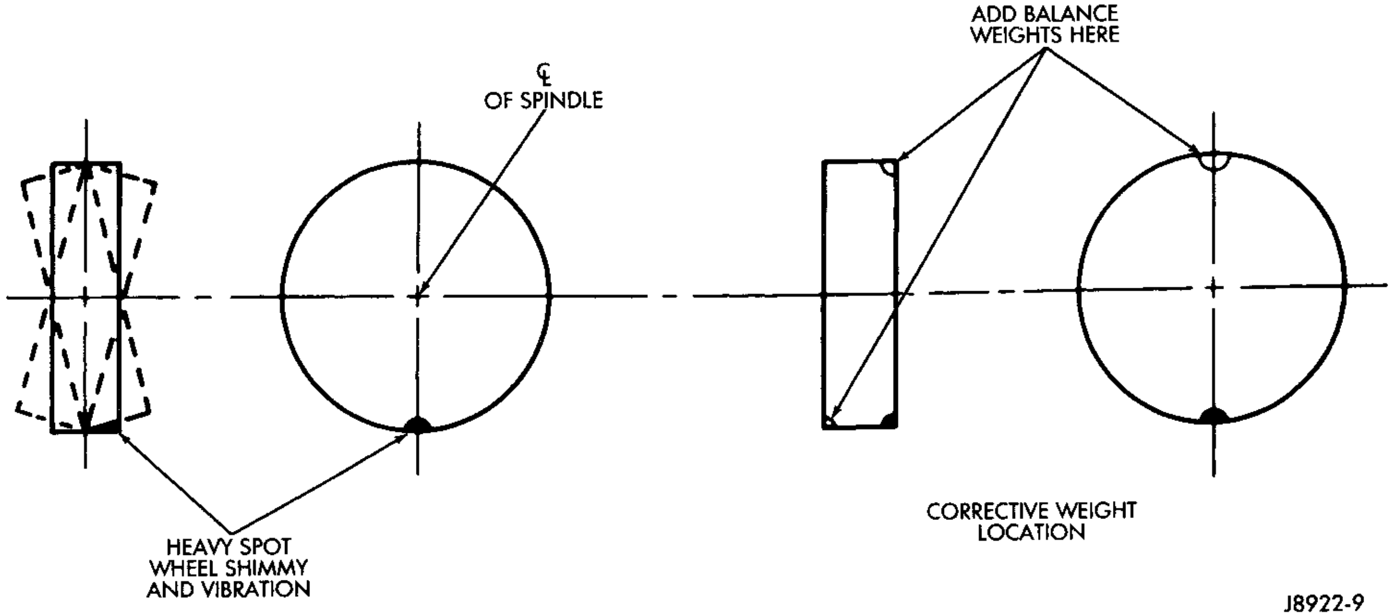


Fig. 9 Dynamic Unbalance & Balance

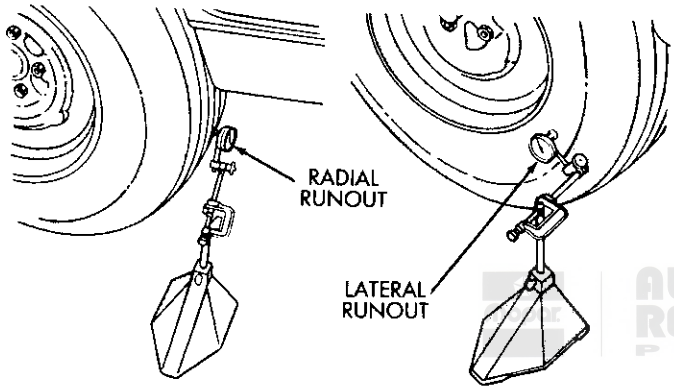
justment (if applicable); loose or worn suspension/steering components; certain tire tread patterns; incorrect drive shaft angles or excessive drive shaft/yoke "runout"; defective or worn U-joints; excessive brake rotor or drum "runout"; loose engine or transmission supports/mounts; and by engine operated accessories.

Vibration Types

There are two types of vehicle vibration:

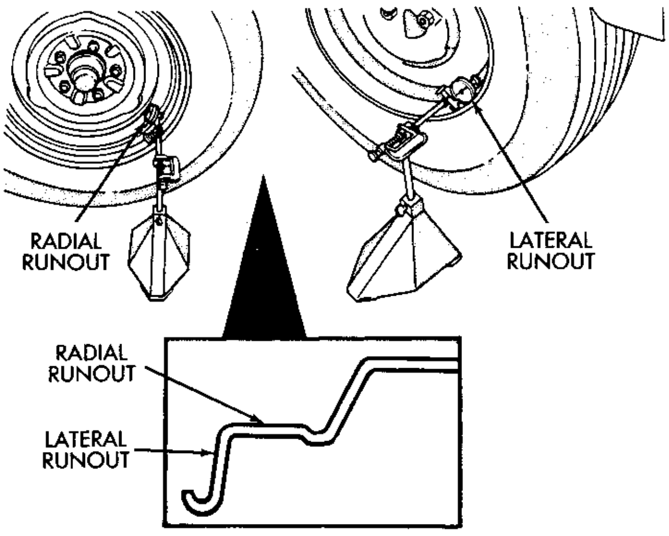
- mechanical and
- audible.

Mechanical vehicle vibration can be "felt" through the seats, floor pan and/or steering wheel. It will usually produce some visible motion in the rear view mirror, fenders, instrument panel and steering wheel.



J9022-4

Fig. 10 Tire Radial/Lateral "Runout" Measurement



J8922-11

Fig. 11 Wheel Radial/Lateral "Runout" Measurement

Audible vehicle vibration is heard or "sensed" above normal background noise and, in some circumstances, it occurs as a "droning or drumming" noise, while in other situations it produces a buffeting sensation that is "felt or sensed" by the vehicle occupants rather than being heard.

Mechanical and audible vehicle vibrations are sensitive to changes in the engine torque, the vehicle speed and/or the engine speed (rpm). They usually occur within one (or sometimes within two) well-defined range of conditions in terms of vehicle speed, engine speed (rpm) and engine torque application.

Engine Torque Sensitive Vibration

This vibration condition can be improved or caused to be more severe by either accelerating, decelerating, coasting, or maintaining a constant vehicle speed and constant engine torque.

Vehicle Speed Sensitive Vibration

This vibration condition always occurs at the same vehicle speed regardless of the engine torque, engine speed (rpm) or the transmission gear selected.

Engine Speed (RPM) Sensitive Vibration

This vibration condition occurs at varying vehicle speeds when a different transmission gear is selected. It can sometimes be isolated by increasing or decreasing the engine speed (rpm) with the transmission in **NEUTRAL** position.

Vibration Diagnosis

A vibration diagnosis should always begin with a preliminary 10 mile (16 km) trip (to "warm" the vehicle and tires) and then a road test to identify the characteristics of the vibration. Corrective action **should** not be attempted until the vibration type, magnitude and speed range have been identified via a road test.

During the road test, drive the vehicle on a street/road that is smooth and free of irregular surface areas. If vibration exists, note and record the following information:

- identify the vehicle speed range when the vibration occurs;
- identify the type of vibration (i.e., mechanical or audible);
- identify the vibration sensitivity (i.e., engine torque sensitive, engine speed (rpm) sensitive or vehicle speed sensitive); and
- determine if the vibration is affected by changes in vehicle speed, engine speed (rpm) and engine torque.

When the vibration type, the sensitivity, the vehicle speed range and the source of any vibration changes have been identified, refer to the Vibration Diagnosis chart for probable causes. Consider correcting only those causes coded in the chart that are related to the vibration condition.

Refer to the following cause codes and descriptions for explanations when referring to the chart.

TRR—Tire and Wheel Radial Runout.

Vehicle speed sensitive, mechanical vibration. The "runout" will not cause vibration below 20 mph (32 km/h). The vehicle speed that is required to cause vibration will increase as the amount of "runout" decreases.

WH—Wheel Hop.

Vehicle speed sensitive, mechanical vibration. The wheel "hop" generates rapid up-down movement in the steering wheel and the instrument panel. The vibration is most noticeable in the 20 - 40 mph (32 - 64 km/h) vehicle speed range. The wheel "hop" will not cause vibration below 20 mph (32 km/h). Wheel "hop" is caused by a tire/wheel that has a radial "runout" of more than 0.045 of-an-inch (1.14 mm). If the wheel "runout" is acceptable and the combined "runout" cannot be reduced by repositioning the tire on the wheel, replace the defective tire.

TB—Tire/Wheel Balance.

Vehicle speed sensitive, mechanical vibration. Static tire/wheel unbalance will not cause vibration below 30 mph (46 km/h). Dynamic tire/wheel unbalance will not cause vibration below 40 mph (64 km/h).

TLR—Tire/Wheel Lateral runout.

Vehicle speed sensitive, mechanical vibration. The "runout" will not cause vibration below 50 - 55 mph (80 - 88 km/h) unless it extremely excessive. Extremely excessive lateral "runout" will also cause front-end "shimmy".

TW—Tire Wear.

Vehicle speed sensitive, audible vibration. Abnormal tire wear causes small vibration in the 30 - 55 mph (88 km/h) vehicle speed range and will produce a "whine" noise at high speed. The whine will change to a "growl" noise when the speed is reduced.

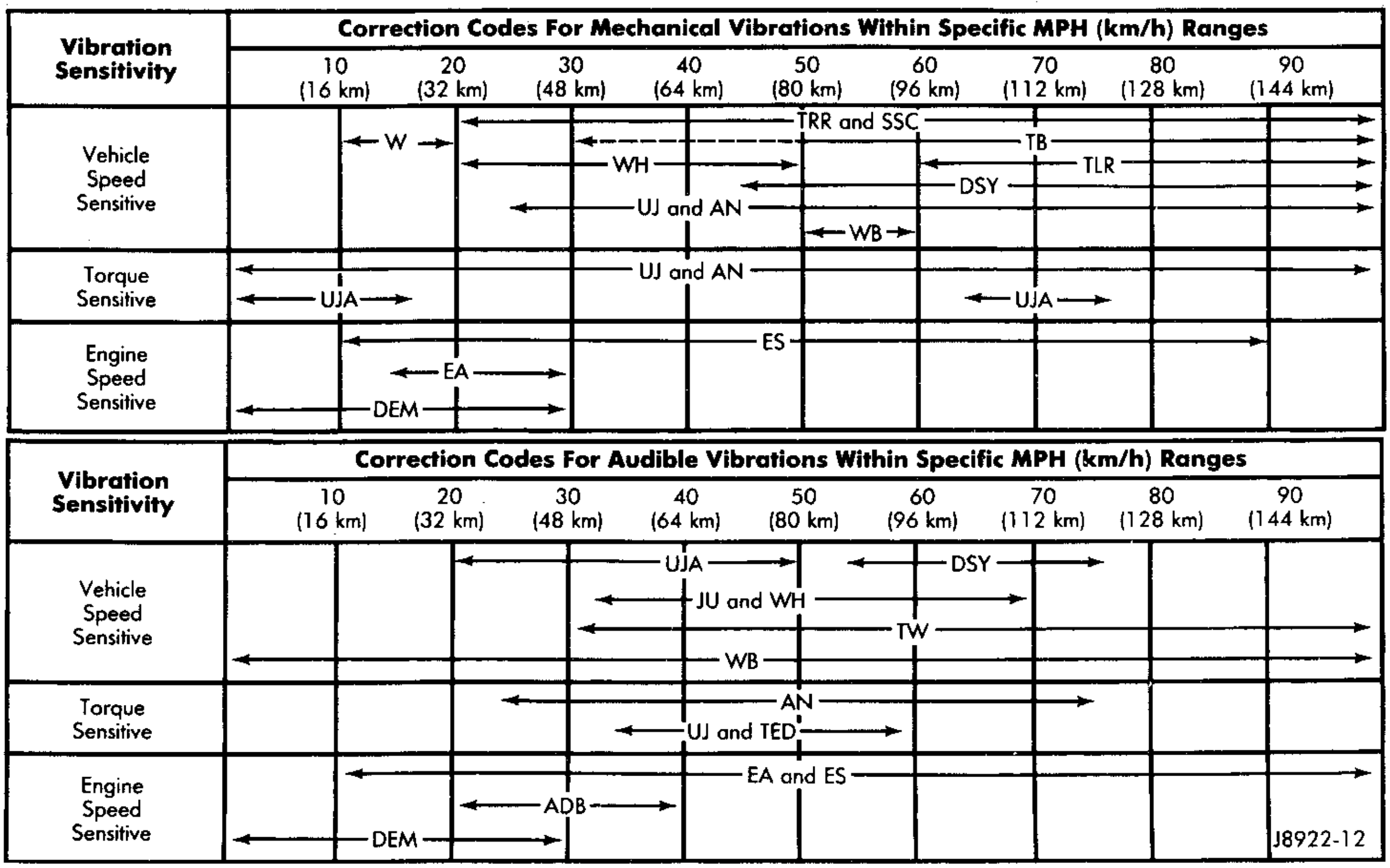
W—Tire Waddle.

Vehicle speed sensitive, mechanical vibration. Irregular tire uniformity can cause "waddle" (side-to-side) motion during speeds up to 15 mph (24 km/h). If the motion (waddle) is excessive: identify the defective tire(s) by removing each tire (one at a time); substituting it with a known good tire; and road testing. When identified, replace the defective tire(s).

UAJ—Universal Joint (Drive Shaft) Angles.

Torque/vehicle speed sensitive, mechanical/audible vibration. Incorrect drive shaft angles cause mechanical vibration below 20 mph (32 km/h) and in the 70 mph (112 km/h) range. The incorrect angles can also produce

Vibration Diagnosis



an audible vibration in the 20 - 50 mph (32 - 80 km/h) range. Caster adjustment/correction could be required to correct the angles.

UJ—Universal Joints.

Engine torque/vehicle speed sensitive, mechanical/audible vibration. If the needle bearings, bearing cups or bearing ends of the spiders are either worn, damaged, over-tightened or loose, they will cause vibration with almost any vehicle speed/engine torque condition.

DSY—Drive Shaft and Yokes.

Vehicle speed sensitive, mechanical/audible vibration. The condition will not cause vibration below 35 mph (56 km/h). Excessive "runout", unbalance, missing balance weights, undercoating on the shaft tube, dents and bends in the shaft tube will cause the vibration. Identify the actual cause and repair/replace as necessary.

WB—Wheel Bearings.

Vehicle speed sensitive, mechanical/audible vibration. Loose wheel bearings cause "shimmy-like" vibration at 35 mph (56 km/h) and above. Rough or damaged bearings will also produce a "growl" noise at low vehicle speed and/or a "whine" noise at high vehicle speed. The wheel bearings must be adjusted or replaced, as applicable.

AN—Axle Noise.

Engine torque/vehicle speed sensitive, mechanical/audible vibration. The axle will not cause mechanical vibration unless the axle shaft is bent or the front axle shaft U-joint is damaged. Worn or damaged axle pinion shaft or differential gears and bearings will cause noise at varying speed ranges in relation to the amount of engine torque applied. Replace the defective component(s) as necessary.

SSC—Suspension and Steering Components.

Vehicle speed sensitive, mechanical vibration. Worn, damaged or loose suspension/steering components (i.e., steering dampener, steering knuckles, pitman arm, springs, spring U-bolts or center bolts, shock absorbers, tie rod ball-stud ends, etc.) can cause mechanical vibration at speeds above 20 mph (32 km/h). Identify and repair or replace the defective component(s).

EA—Engine Driven Accessories.

Engine speed sensitive, mechanical/audible vibration. Vibration can be caused by loose or broken A/C compressor (or bracket), PS pump (or bracket), water pump, alternator (or bracket), etc. Usually more noticeable when the transmission is shifted into the NEUTRAL position and the engine speed (rpm) increased. Inspect the engine driven accessories in the engine compartment and repair/replace as necessary.

ADB—Accessory Drive Belts.

Engine speed sensitive, audible vibration. Loose/worn drive belts can cause a vibration that produces either a "droning, fluttering or rumbling" noise. Inspect the drive belt(s) and tighten/replace as necessary.

DEM—Damaged Engine or Transmission Support Mounts.

Engine speed sensitive, mechanical/audible vibration. If a support mount is either loose, worn or broken, noise or vehicle vibration will be the result if either the engine, transmission or an engine accessory contacts the vehicle body. Inspect the support mounts and repair/replace as necessary.

ES—Exhaust System.

Engine speed sensitive, mechanical/audible vibration. If loose or broken exhaust components contact the vehicle body they will cause noise and, in some instances, vehicle vibration. In addition, if mis-aligned exhaust components (e.g., muffler, converter, pipes, or hangers) contact the vehicle body or the driveline components, the result will be noise and/or vehicle vibration. Inspect the exhaust system for loose, broken and mis-aligned components and repair/replace as necessary.

WHEEL SERVICE

INDEX

INSPECTION

The wheels should be inspected on a frequent basis. Replace any wheel that is cracked, is bent, is severely dented, has excessive "runout" or has broken welds. The tire inflation valve should also be inspected frequently for wear, leakage, cuts and looseness. The valve should be replaced if defective or its condition is doubtful.

Clean the wheels with a mild soap and water solution only and rinse thoroughly with water. Never use abrasive or caustic materials, especially on aluminum or chrome-plated wheels because the surface will be etched or the plating severely damaged. After cleaning aluminum or chrome-plated wheels, apply a coating of protective wax to preserve the finish and the lustre.

Always tighten wheel lug nuts in a crisscross pattern (Fig. 12) with the specified torque.

WHEEL BALANCING

Wheel balancing can be accomplished with either on- or off-vehicle equipment. However, when using on-vehicle balancing equipment, observe the following precautions:

- for vehicles with a "limited-slip" (Trac-Lok) rear axle differential, do not use on-vehicle equipment to balance a rear wheel/tire unless the opposite wheel/tire is removed from the hub; and
- before balancing the wheels on a vehicle equipped with a transfer case, disconnect the front or rear drive shaft, as applicable.

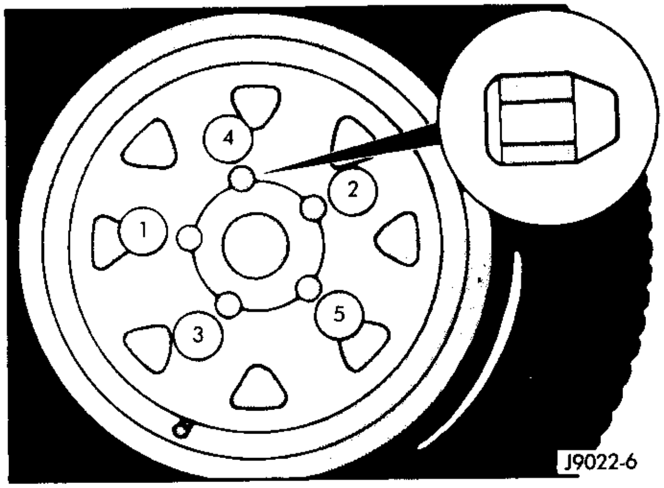


Fig. 12 Wheel Lug Nut Tightening Pattern

When balancing aluminum or chrome-plated wheels, use care to avoid damaging the wheel surface when installing the balance weights. **Use only self-adhering type weights on aluminum wheels and install them on the back side of the wheel (whenever possible).**

WHEEL COVERS

To avoid damaging a wheel cover during removal or installation, care should be used to ensure that force is applied only at the correct areas on the wheel cover.

CAUTION: Do not pry outward or apply inward force to a wheel cover at the immediate area of the tire valve stem hole. A wheel cover is structurally stronger and will withstand the force required for removal and installation around the perimeter of the wheel cover away from the tire valve stem hole.

WARNING: Handle wheel covers with extreme care during removal and installation because the sharp edges can cause personal injury.

Removal

(1) To remove a wheel cover, start by prying it loose (with a pry bar) from the wheel rim 180 degrees opposite the tire valve stem hole.

(2) Continue prying alternately around the perimeter of the wheel cover and toward the tire valve stem hole until the wheel cover is completely detached from the wheel rim.

Installation

(1) Use a rubber mallet to install a wheel cover.

(2) To install a wheel cover, insert the tire valve stem through the wheel cover valve stem hole and then "seat" this portion of the wheel cover on the wheel rim.

(3) Continue applying inward force with a rubber mallet alternately around the perimeter of the wheel cover and away from the tire valve stem hole until the wheel cover is completely "seated" on the wheel rim.

(4) Finally, apply inward force with a rubber mallet to the wheel cover 180 degrees opposite the tire valve stem hole to complete the installation.

WHEEL BEARINGS

Adjustment—SJ Vehicles

Wheel bearing adjustment (and repacking) is a very important function because it provides the optimum operating clearance for the wheel bearings. A "tight" bearing clearance "preloads" the bearings excessively and causes them to over-heat. A "loose" bearing clearance allows the hub to shift position as the bearing load changes during vehicle acceleration, braking and turning. A loose bearing clearance can also cause front-end "shimmy", vehicle vibration and low brake pedal height as a result of the disc brake pad "knock-back" caused by the rotor wobble.

Front Wheel Bearings

(1) Raise and support the vehicle.

(2) Remove the wheel cover and drive gear cap (Fig. 13).

(3) Remove the drive gear retaining ring (Fig. 13).

(4) Remove the drive gear, pressure spring and spring cup (Fig. 13).

(5) Remove the outer locknut and lockwasher (Fig. 13).

If necessary, repack the wheel bearings.

(6) "Seat" the bearings (Fig. 13) by loosening, then tightening the inner locknut with 68 N•m (50 ft-lbs) torque. Use Wheel Bearing Wrench Tool 8000 (J6893-D).

(7) Rotate the wheel while tightening the locknut to "seat" the bearings uniformly.

(8) Loosen the inner locknut (Fig. 13) 1/6 of-a-turn (55° - 65°) while rotating the wheel.

(9) Install the lockwasher (Fig. 13). Align one of the lockwasher holes with the peg on the inner locknut and mate the washer with the nut.

(10) Install the outer locknut (Fig. 13). Tighten the outer locknut with a minimum of 68 N•m (50 ft-lbs) torque with Wheel Bearing Wrench Tool 8000 (J6893-D).

(11) Test the bearing adjustment. The wheel must rotate freely and must not have any lateral movement.

CAUTION: The spring cup (Fig. 13) must be installed so that the recessed side faces the bearing and the flat side faces the pressure spring. The pressure spring should contact the flat side of the cup only.

(12) Install the spring cup (Fig. 13) and pressure spring (Fig. 13).

(13) Install the drive gear and the drive gear retaining ring (Fig. 13).

(14) Apply Permatex Form-A-Gasket No. 3, or an equivalent sealant, to the drive gear cap rim and install the cap (Fig. 13).

(15) Install the wheel cover, remove the supports and lower the vehicle.

Rear Wheel Bearings

The axle shafts for SJ vehicles are equipped with tapered roller wheel bearings that are capable of accepting lateral thrust from either direction. The wheel bearings do not require adjustment.

Replacement—SJ Vehicles

Front Wheel Bearings—Removal

(1) Raise and support the vehicle.

(2) Remove the wheel cover and the drive gear cap (Fig. 13).

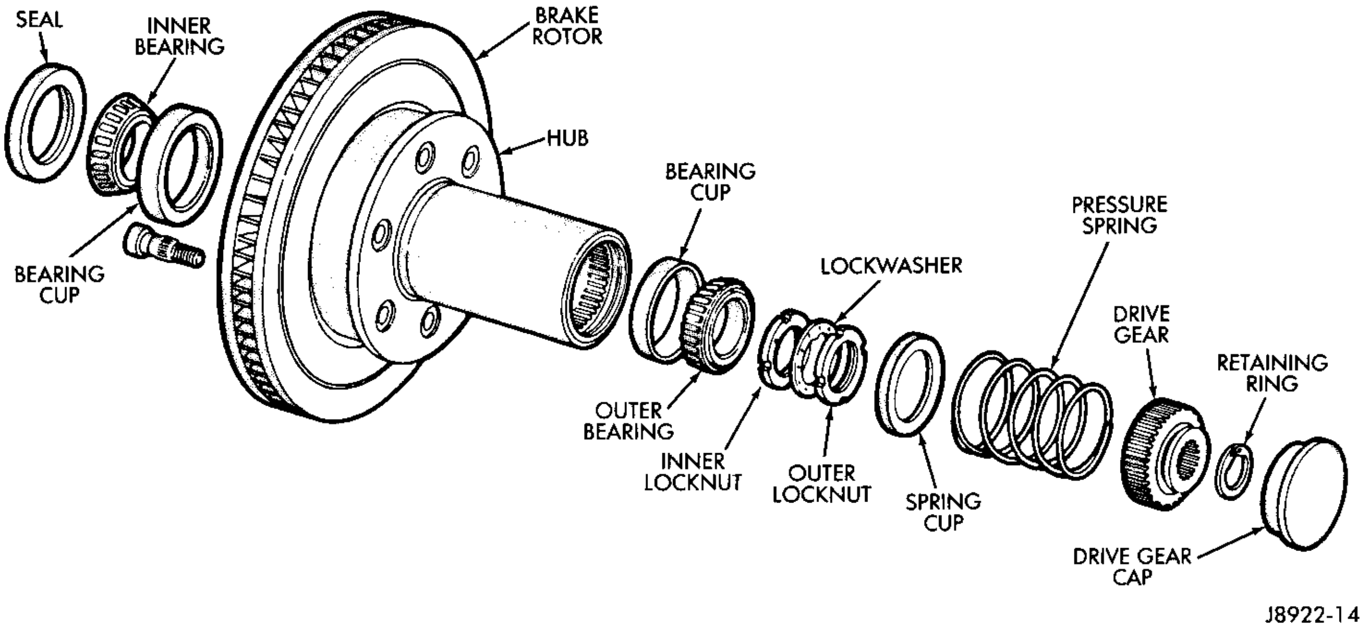


Fig. 13 Front Wheel Bearings (Exploded View)

(3) Remove the disc brake caliper.

(4) Remove the drive gear retaining ring (Fig. 13).

(5) Remove the drive gear, the pressure spring and the spring cup (Fig. 13).

(6) Remove the outer locknut, the lockwasher and the inner locknut (Fig. 13) with Wheel Bearing Wrench Tool 8000 (J6893-D).

(7) Remove the hub/rotor with the bearing cup and the outer bearing (Fig. 13).

(8) Remove the inner bearing cup, the bearing and the seal (Fig. 13).

Front Wheel Bearings—Installation

(1) Pack the replacement bearings with wheel bearing lubricant.

(2) Install the replacement inner bearing cup, the bearing and the seal (Fig. 13).

(3) Install the hub/rotor and the replacement outer bearing cup and bearing (Fig. 13).

(4) Install the inner locknut (Fig. 13).

(5) "Seat" the bearings (Fig. 13) by loosening, then tightening the inner locknut with 68 N•m (50 ft-lbs) torque with Wheel Bearing Wrench Tool 8000 (J6893-D).

(6) Rotate the wheel while tightening the locknut to "seat" the bearings uniformly.

(7) Loosen the inner locknut (Fig. 13) 1/6 of-a-turn (55° - 65°) while rotating the wheel.

(8) Install the lockwasher (Fig. 13). Align one of the lockwasher holes with the peg on the inner locknut and mate the washer with the nut.

(9) Install the outer locknut (Fig. 13). Tighten the outer locknut with a minimum of 68 N•m (50 ft-lbs) torque with Wheel Bearing Wrench Tool 8000 (J6893-D).

(10) Test the bearing adjustment. The wheel must rotate freely and must not have any lateral movement.

(11) Install the spring cup (Fig. 13) and pressure spring (Fig. 13).

CAUTION: The spring cup (Fig. 13) must be installed so that the recessed side faces the bearing and the flat side faces the pressure spring. The pressure spring should contact the flat side of the cup only.

(12) Install the drive gear and the drive gear retaining ring (Fig. 13).

(13) Apply Permatex Form-A-Gasket No. 3, or an equivalent sealant, to the drive gear cap rim and install the cap (Fig. 13).

(14) Install the disc brake caliper.

(15) Install the wheel cover, remove the supports and lower the vehicle.

Rear Wheel Bearings

Refer to Group 3—Rear Axles for rear wheel bearing service for SJ vehicles.

Replacement—MJ/XJ And YJ Vehicles

If the front hub has ball bearings, it can not be serviced and, if defective, the complete unit must be replaced. If the hub has tapered roller bearings, its internal components can be serviced or replaced as necessary.

4WD Front Wheel Bearings—Removal

(1) Raise and support the vehicle.

(2) Remove the wheel/tire.

CAUTION: Do allow the brake hose to support the caliper. Secure the caliper to the chassis with wire or twine to avoid damage to the hose.

(3) Remove the disc brake caliper but do not disconnect the brake hose. **Secure the caliper to the chassis with a wire or twine.**

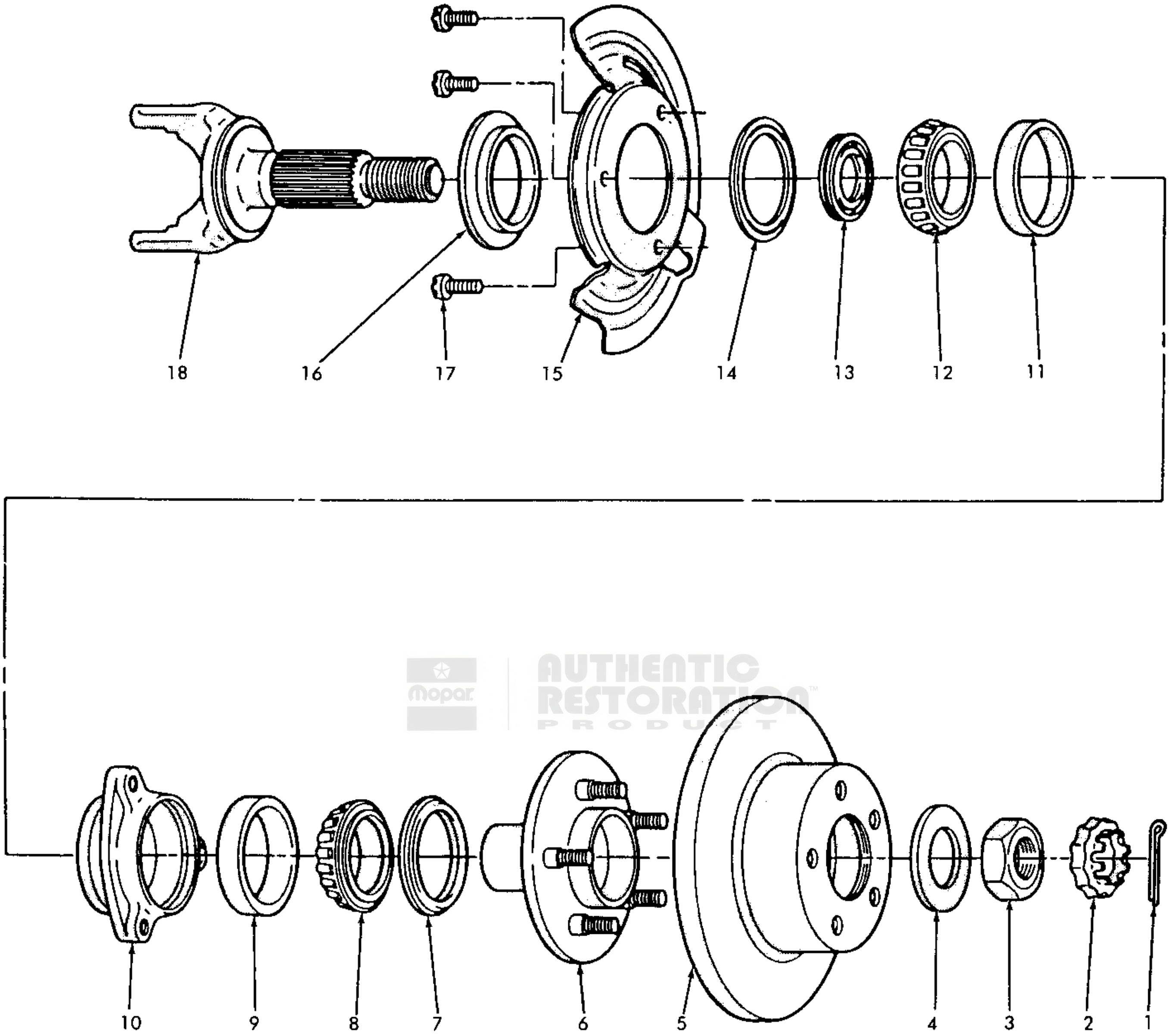
(4) Remove the disc brake rotor (Fig. 14).

(5) Remove the cotter pin (and discard), the nut retainer, the axle nut and the washer (Fig. 14).

(6) Remove the three steering knuckle-to-bearing carrier bolts (Fig. 14).

(7) Remove the hub/bearing carrier, disk brake rotor shield and axle shaft dust "slinger" as a unit from the steering knuckle (Fig. 14).

(8) Remove the axle shaft dust "slinger" and the disc brake rotor shield from the bearing carrier (Fig. 14).



1. COTTER PIN
2. NUT RETAINER
3. NUT
4. WASHER
5. BRAKE ROTOR
6. HUB
7. OUTER BEARING SEAL
8. OUTER BEARING
9. OUTER BEARING RACE
10. BEARING CARRIER
11. INNER BEARING RACE
12. INNER BEARING
13. INNER BEARING SEAL
14. CARRIER SEAL
15. ROTOR SHIELD
16. AXLE SHAFT DUST SLINGER
17. BEARING CARRIER BOLTS
18. AXLE SHAFT

J8902-12

Fig. 14 Front Wheel Hub & Bearings (4WD)

4WD Front Wheel Bearings—Disassembly (Hub With Tapered Roller Bearings)

CAUTION: The bearing removal tools are designed to be used with an arbor or hydraulic press and a bearing separator tool. They must not be used with any type of impact tool (e.g., machinist hammer or slide hammer).

(1) Attach Press Plate Tool 5073 to the rear of the hub/bearing carrier. Secure the press plate with M12 X 1.75 X 40 mm bolts (Fig. 15).

(2) Position the hub/bearing carrier and the press plate in an arbor or hydraulic press.

(3) Press the hub out of the bearing carrier with Press Pin Tool 5074 (Fig. 16).

(4) Cut and remove the plastic cage from the hub inner bearing (Fig. 17). Use diagonal pliers or tin snips to cut the bearing cage. Discard the bearing tapered rollers after removing the cage.

(5) Remove the remaining portion of the inner bearing from the hub according to the following instructions:

- install a bearing separator tool on the inner bearing (Fig. 18),
- position the separator tool and hub in an arbor or hydraulic press, and

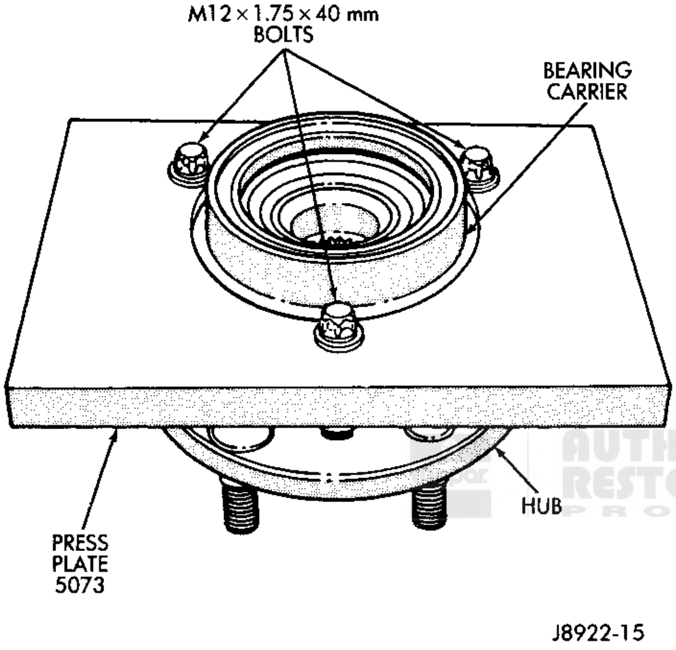


Fig. 15 Press Plate Tool 5073

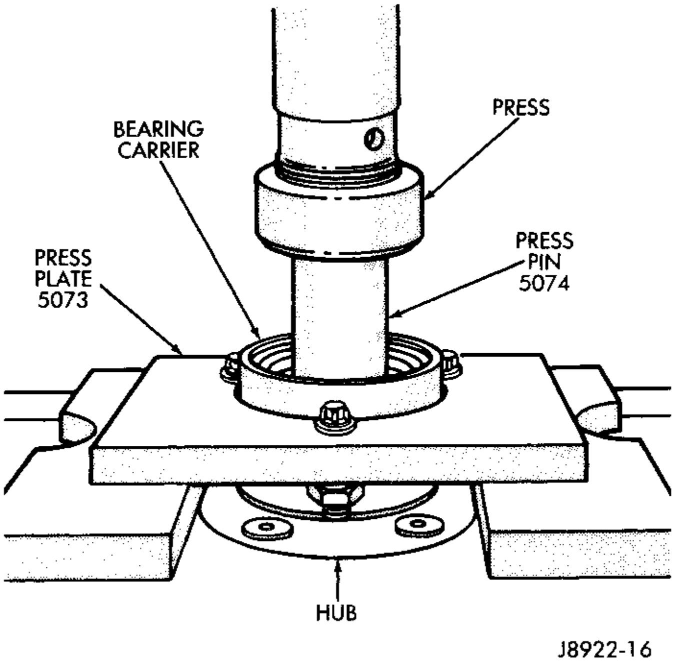


Fig. 16 Hub & Bearing Carrier Separation

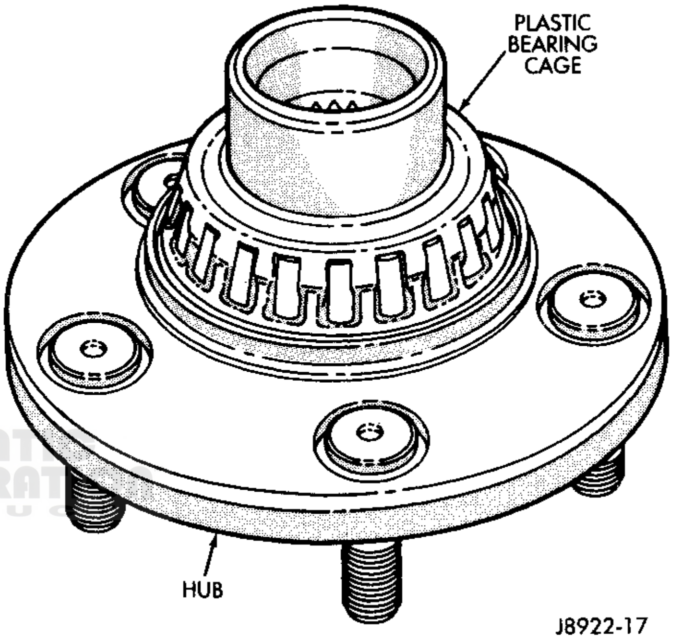


Fig. 17 Inner Bearing Cage Removal

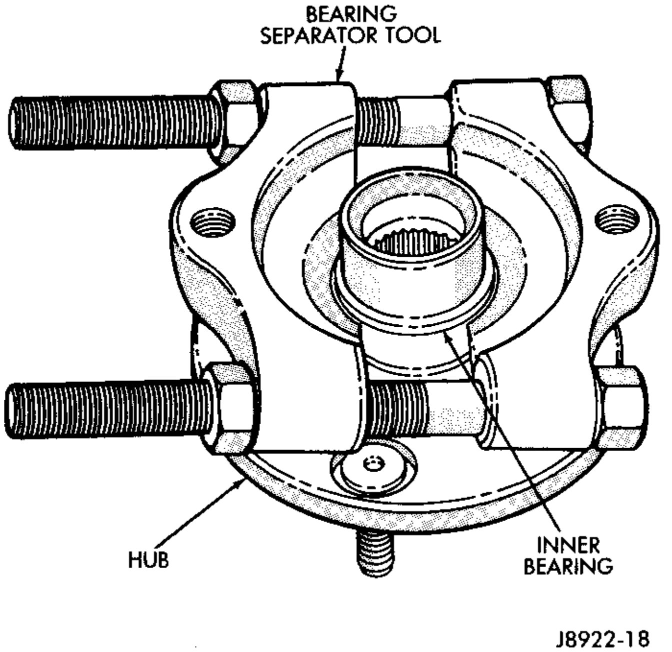


Fig. 18 Bearing Separator Tool

- force the hub out of the inner bearing with Press Pin Tool 5074 (Fig. 19).

(6) Remove the bearing carrier (outer) seal (Fig. 14) and discard it. It is not reusable.

(7) Force the inner bearing seal from the bearing carrier with Bearing Installation Tool 5078 (Fig. 20).

Ensure that the word "JEEP" on Tool 5078 is facing downward toward the bearing carrier before forcing the seal from the carrier.

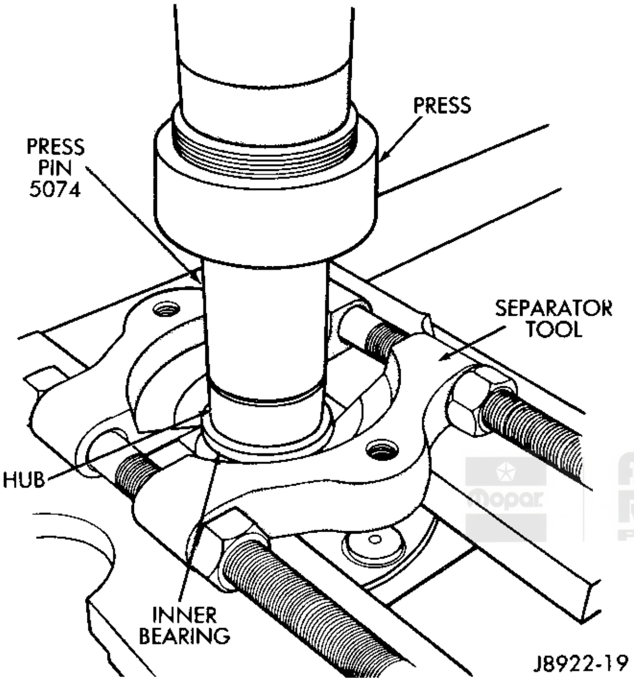


Fig. 19 Hub & Inner Bearing Separation

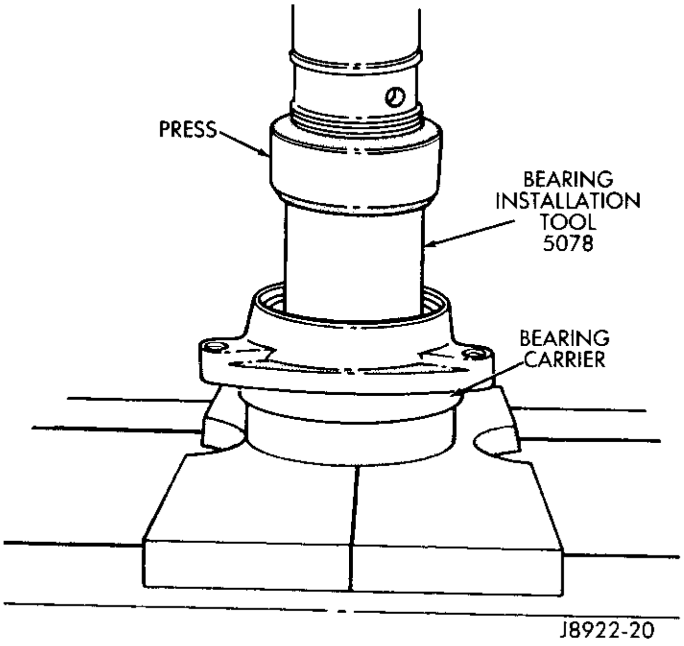


Fig. 20 Inner Bearing Seal Removal

(8) Attach Press Plate Tool 5073 to the rear of the bearing carrier. Secure the press plate with M12 X 1.75 X 40 mm bolts.

CAUTION: Never use tools or mechanisms other than the tools specified for the removal of the bearing races. Otherwise, damage to the internal machined shoulder of the bearing carrier is probable.

(9) Position Bearing Race Removal Tool 5076 in the bearing carrier bore between the inner and the outer bearing races (Fig. 21).

(10) Position Press Pin Tool 5074 on Tool 5076 (Fig. 21).

(11) Place the bearing carrier on an arbor or hydraulic press and force the inner bearing race from the carrier bore (Fig. 22). Reverse the position of the bearing carrier and removal tools and force the outer bearing race from the carrier bore with the press.

4WD Front Wheel Bearings—Assembly (Hub With Tapered Roller Bearings)

(1) Thoroughly clean the hub and the bearing carrier (Fig. 14) with mineral spirits. Dry them with compressed air.

(2) Attach Press Plate Tool 5073 to the bearing carrier. Secure the press plate with M12 X 1.75 X 40 mm bolts (Fig. 23).

(3) Position the replacement outer bearing race in the bearing carrier bore (Fig. 23).

Ensure that the word "JEEP" on Tool 5077 is facing downward toward the bearing carrier before forcing the bearing races into the carrier bore.

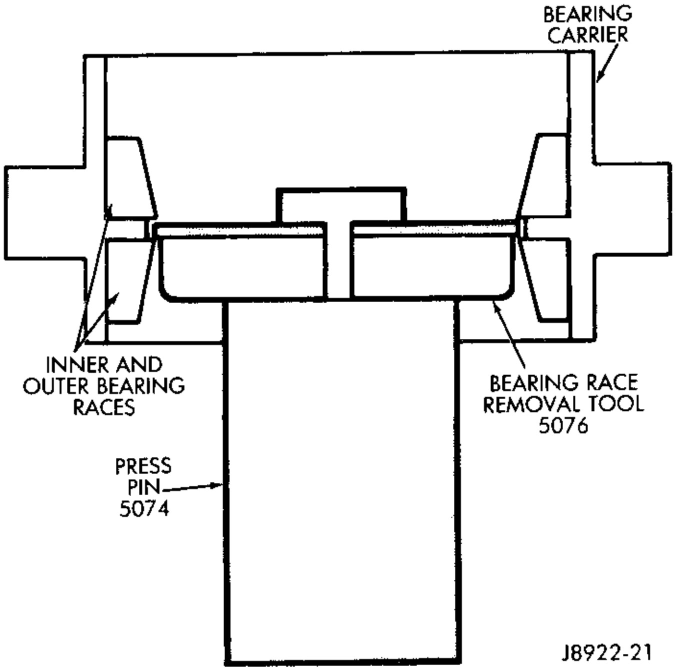


Fig. 21 Bearing Race Removal Tools

CAUTION: Do not overload the press when installing the bearing races. The bearing races should be flush with the machined shoulder of the bearing carrier when properly installed.

(4) Position Bearing Race Installation Tool 5077 on the replacement outer bearing race. Place the bearing carrier on an arbor or hydraulic press and force the outer bearing race into the bearing carrier bore (Fig. 23).

(5) Position the replacement inner bearing race in the bearing carrier bore. Reverse the position of the bearing carrier and the installation tools and force the inner bearing race into the bearing carrier bore with the press.

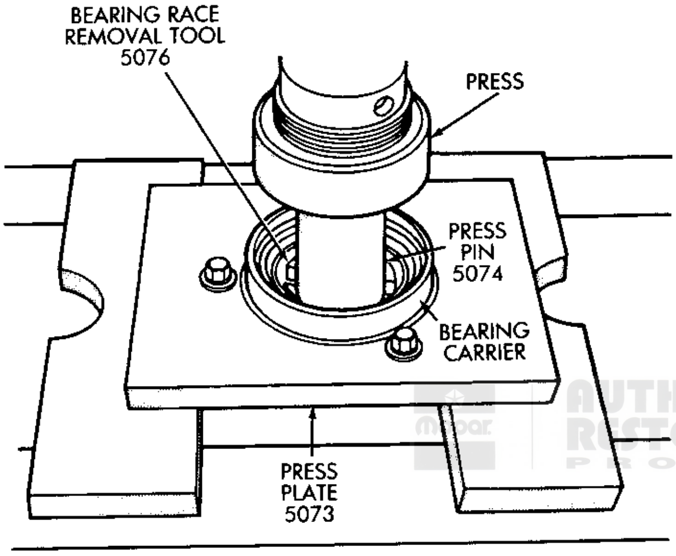


Fig. 22 Inner & Outer Bearing Race Removal

(6) Pack the replacement outer bearing with all-purpose wheel bearing lubricant.

(7) Apply all-purpose wheel bearing lubricant to the outer bearing race and position the outer bearing in the bearing carrier bore (Fig. 24).

(8) Place the replacement outer seal on the outer bearing. Position Bearing Seal Installation Tool 5079 on the seal and place the bearing carrier on an arbor on hydraulic press. Force the seal into the bearing carrier bore with the press (Fig. 25).

(9) Apply all-purpose wheel bearing lubricant to the seal lip surface.

(10) Insert the hub through the seal and outer bearing and into the bearing carrier bore (Fig. 26).

(11) Insert Bearing Installation Tool 5078 into the rear of the bearing carrier bore and place Bearing Race Installation Tool 5077 on the front of the hub (Fig. 26). **Ensure that the word "JEEP" on Tool 5077 is facing toward the hub before forcing the hub into the carrier bore.**

(12) Place the hub/bearing carrier on an arbor or hydraulic press and force the hub shaft into the bearing carrier bore (Fig. 26).

(13) Pack the replacement inner bearing (Fig. 27) with all-purpose wheel bearing lubricant.

(14) Apply all-purpose wheel bearing lubricant to the replacement inner bearing seal lip surface and place the seal on the inner bearing (Fig. 27).

(15) Apply all-purpose wheel bearing lubricant to the inner bearing race.

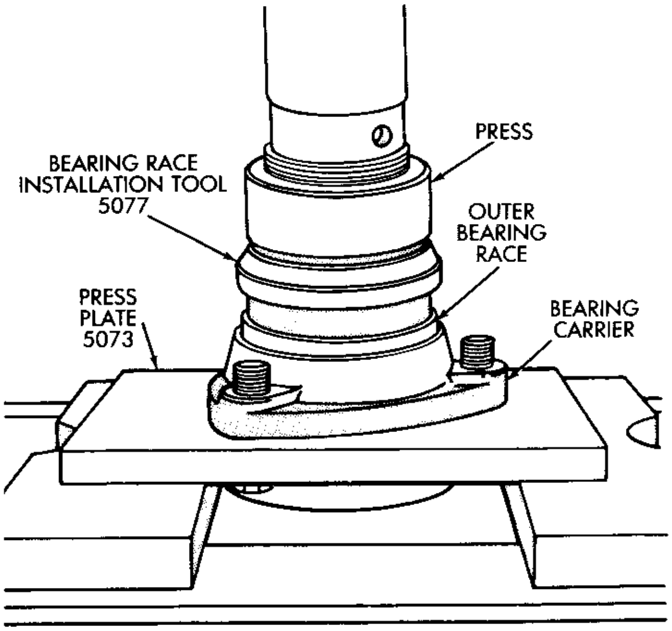


Fig. 23 Outer Bearing Race Installation

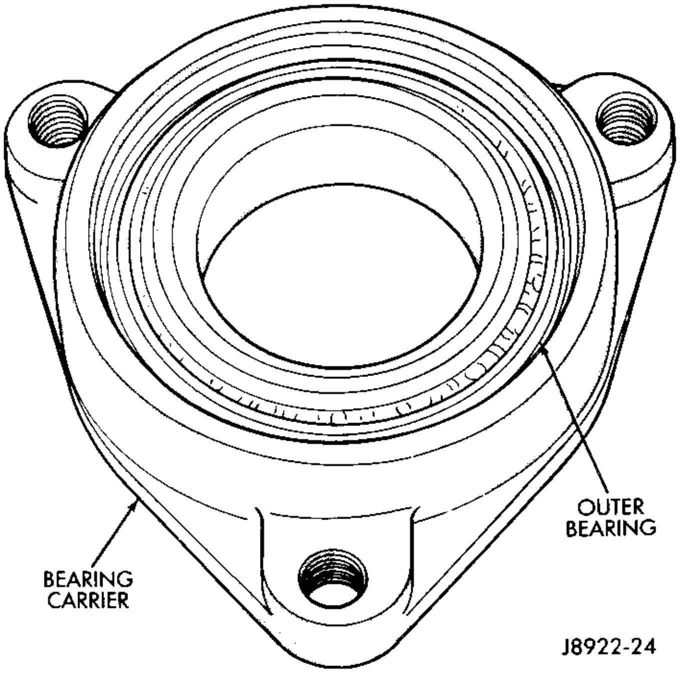


Fig. 24 Outer Bearing Installation

(16) Place the hub/bearing carrier and Bearing Race Installation Tool 5077 on an arbor or hydraulic press (Fig.28).

Ensure that the word "JEEP" on Tool 5077 is facing toward the hub.

(17) Position the replacement inner bearing and seal in the bearing carrier bore. Place Seal Installation Tool 5080 on the inner bearing seal (Fig. 28).

CAUTION: Use extreme care when forcing the replacement inner bearing and seal onto the hub shaft. The bearing carrier should rotate freely after the inner bearing and seal are installed. Do not attempt to eliminate all the bearing lash with the press. The final bearing preload will be obtained by tightening the drive axle nut (Fig. 14). Ensure that the inner bearing seal is "seated" squarely on the machined surface of the bearing carrier when installed.

(18) Force the replacement inner bearing and seal into the bearing carrier bore and onto the hub shaft with the press (Fig. 28).

(19) Install the replacement (outer) seal on the bearing carrier (Fig. 14).

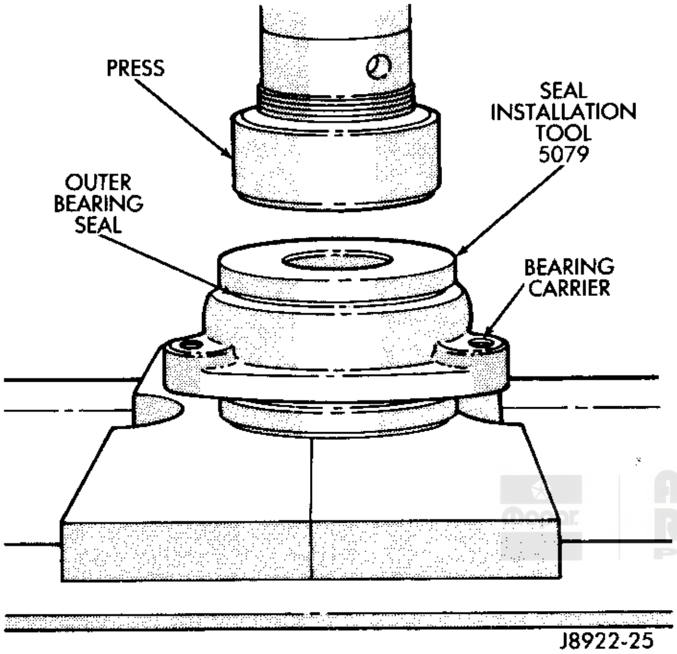


Fig. 25 Outer Bearing Seal Installation

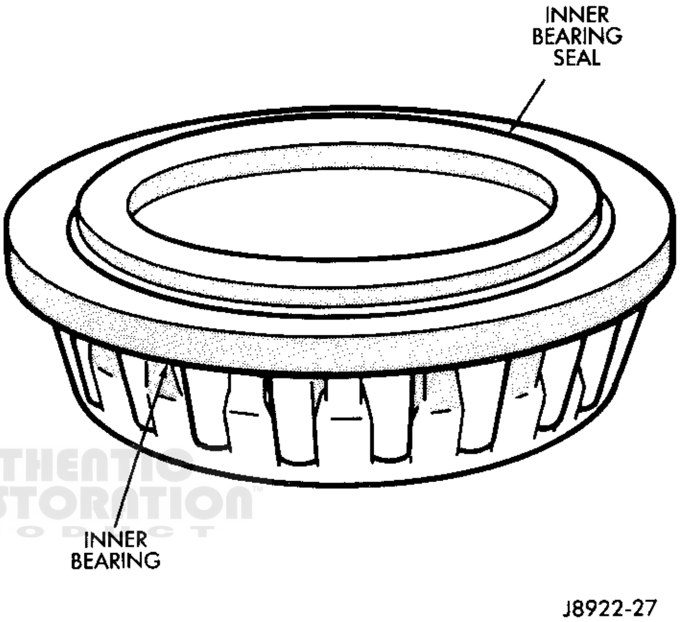


Fig. 27 Inner Bearing & Seal

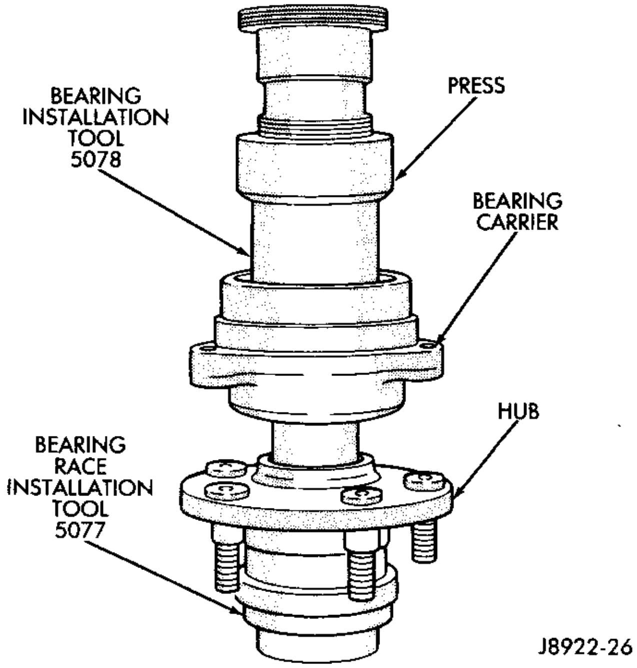


Fig. 26 Joining Hub & Bearing Carrier

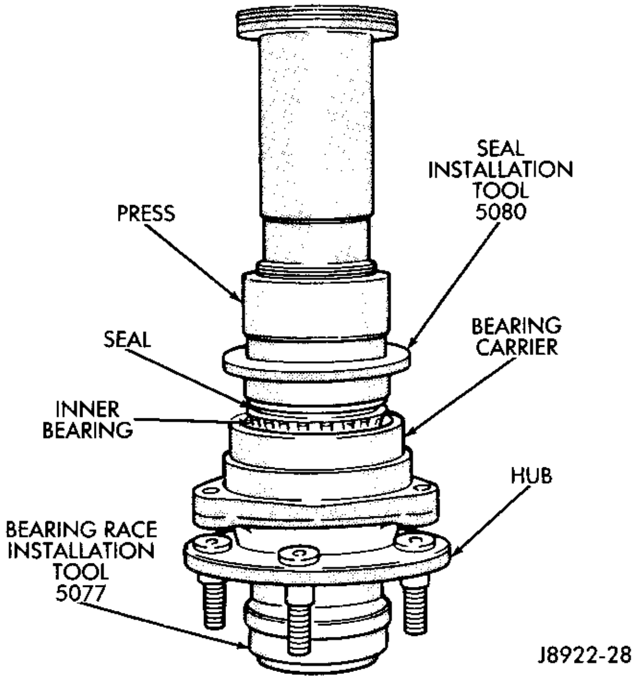


Fig. 28 Inner Bearing & Seal Installation

4WD Front Wheel Bearings—Installation

(1) Position the disc brake rotor shield and the axle shaft dust "slinger" on the bearing carrier (Fig. 14).

(2) Thoroughly clean the axle shaft (Fig. 14) and apply a thin film of EP-type (extreme pressure), lithium base, waterproof wheel bearing lubricant to the shaft splines and seal contact surface.

(3) Apply a coating of EP-type (extreme pressure), lithium base, waterproof wheel bearing lubricant to the hub bore in the steering knuckle and install the hub and bearings.

(4) Apply Loctite, or an equivalent product, to the threads and install the steering knuckle-to-bearing carrier bolts (Fig. 14). Tighten the bolts with 102 N•m (75 ft-lbs) torque.

(5) Install the disc brake rotor (Fig. 14) and the caliper. If necessary, refer to Group 5—Brakes for the procedure.

(6) Install the washer and the axle nut (Fig. 14). Tighten the axle nut with 237 N•m (175 ft-lbs) torque.

(7) Install the nut retainer and a replacement cotter pin (Fig. 14).

(8) Install the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(9) Remove the supports and lower the vehicle.

2WD Front Wheel Bearings—Removal

(1) Raise and support the front of the vehicle.

(2) Remove the wheel/tire and the brake caliper.

Do not disconnect the caliper hose unless the caliper is also being removed for service. Suspend the caliper with wire or another appropriate type hanger to prevent brake hose damage.

(3) Remove the dust cap, the cotter pin, the nut retainer, the adjustment nut, and the thrust washer from the spindle (Fig. 29). Discard the cotter pin.

(4) Remove the outer wheel bearing from the hub (Fig. 29).

(5) Remove the hub/rotor, the inner bearing and the seal from the spindle (Fig. 29).

2WD Front Wheel Bearings—Installation

(1) Partially fill the hub/rotor spindle bore with all-purpose wheel bearing lubricant.

(2) Pack both replacement wheel bearings with all-purpose wheel bearing lubricant.

(3) Install the replacement inner wheel bearing in the hub/rotor spindle bore and install a replacement oil seal (Fig. 29).

(4) Clean the rotor disc contact surface, if necessary.

(5) Position the hub/rotor on the spindle.

(6) Install the replacement outer wheel bearing, the thrust washer, and the adjustment nut (Fig. 29).

(7) Tighten the adjustment nut with 28 N•m (21 ft-lbs) torque while rotating the hub/rotor to "seat" the bearings.

(8) Loosen the adjustment nut 1/2 of-a-turn and, while rotating the hub/rotor, tighten the adjustment nut with 2 N•m (19 in-lbs) torque.

(9) Install the nut retainer and a replacement cotter pin (Fig. 29).

(10) Clean the dust cap and apply all-purpose wheel bearing lubricant to the inside surface. Do not fill the cap. Install the cap.

(11) Install the brake caliper and the wheel/tire. Tighten the wheel lug nuts with 102 N•m (75 ft-lbs) torque.

(12) Remove the supports and lower the vehicle.

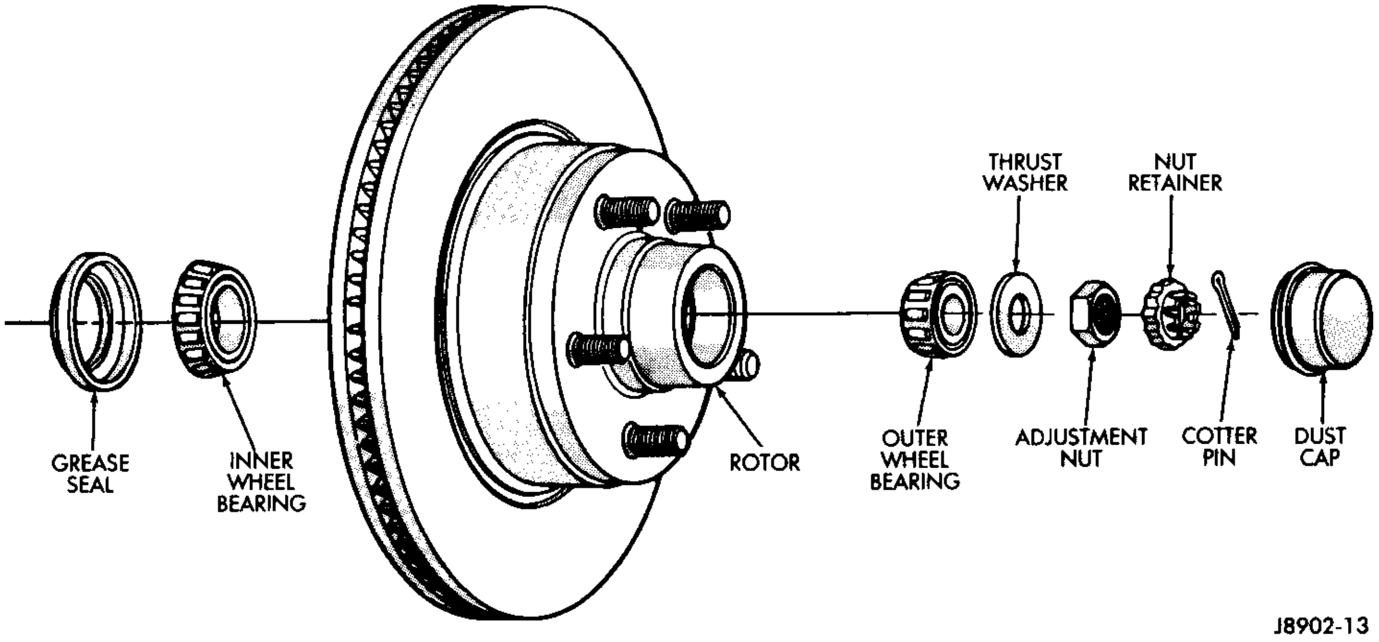


Fig. 29 Front Wheel Bearings (2WD)

Rear Wheel Bearings

Refer to Group 3—Rear Axles for rear wheel bearing service for MJ/XJ and YJ vehicles.

TORQUE SPECIFICATIONS

Component	Service Set-To Torque	Service Recheck Torque
Wheel Retaining Nut	102 N·m (75 ft-lbs)	88-122 N·m (65-90 ft-lbs)
Wheel Bearing Adjustment		
Outer Locknut	68 N·m (50 ft-lbs)*	68 N·m min. (50 ft-lbs min.)
Inner Locknut	68 N·m (50 ft-lbs)	
Bearing Carrier Bolt	102 N·m (75 ft-lbs)	88-122 N·m (65-90 ft-lbs)
Axle Nut	237 N·m (175 ft-lbs)	203-271 N·m (150-200 ft-lbs)

*Loosen 1/6 turn (55°-65°) while rotating the wheel

J8922-29

BODY

CONTENTS

BODY COMPONENTS-XJ MODEL

INDEX

FRONT BUMPER

Bumper Removal And Disassembly

(1) The bumper guards and extensions can be removed with the bumper mounted on the vehicle. Do not remove the bumper if only these components are to be serviced.

(2) Disconnect and remove the fog lamps (Fig. 1).

(3) Disconnect the vacuum reservoir harness (Fig. 2).

(4) Remove the bolts attaching the bumper mounting brackets (Fig. 3) to the right and left sillmembers.

(5) Remove the bumper assembly from the vehicle.

(6) Remove the mounting brackets, extensions, bumper guards and license plate bracket from the bumper rail (Fig. 3).

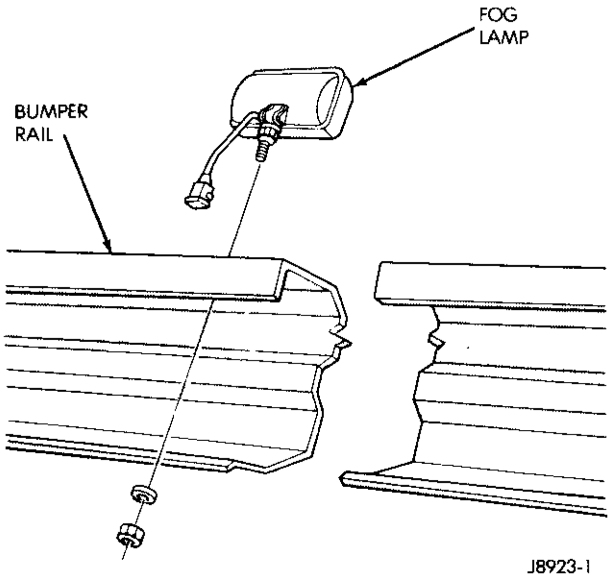


Fig. 1 Fog Lamp Removal/Installation

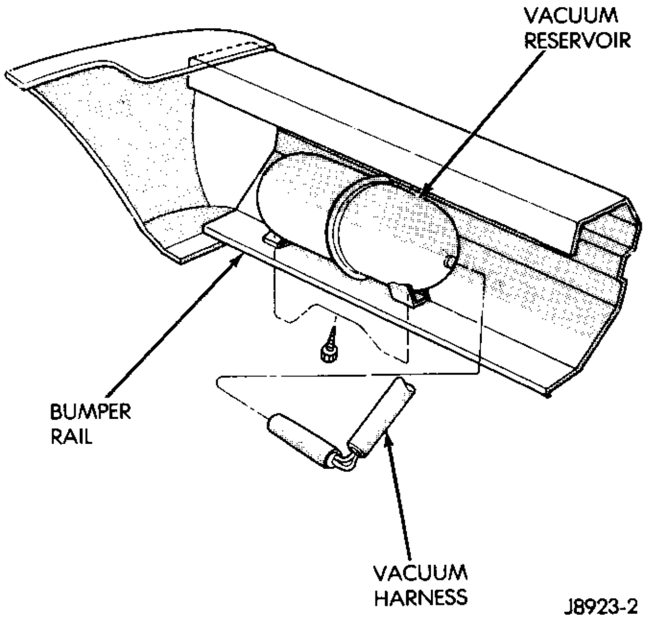


Fig. 2 Vacuum Reservoir

(7) Remove the vacuum reservoir if necessary (Fig. 2).

Bumper Assembly And Installation

(1) Install the guards, extensions and brackets on the bumper rail.

(2) Install the reservoir on the bumper rail.

(3) Mount the bumper assembly on the vehicle.

(4) Attach the mounting brackets to the right and left sillmembers.

(5) Install and connect the fog lamps.

REAR BUMPER

Bumper Removal And Disassembly

(1) On models with a rear-mounted spare tire and/or a trailer hitch, remove the hitch or spare tire carrier before removing the bumper.

(2) Remove the bolts attaching the bumper brackets to the frame rails (Fig. 1).

(3) Remove the bumper assembly from the vehicle.

(4) Remove the brackets, guards, extensions and tow hook from the bumper rail (Fig. 1).

Bumper Assembly And Installation

(1) Install the bumper extensions.

(2) Install the bumper guards. Tighten nuts and bolt that attach each guard to the rail in the sequence shown (Fig. 2).

(3) Install the tow hook and brackets if equipped.

(4) Install the bumper assembly on the vehicle.

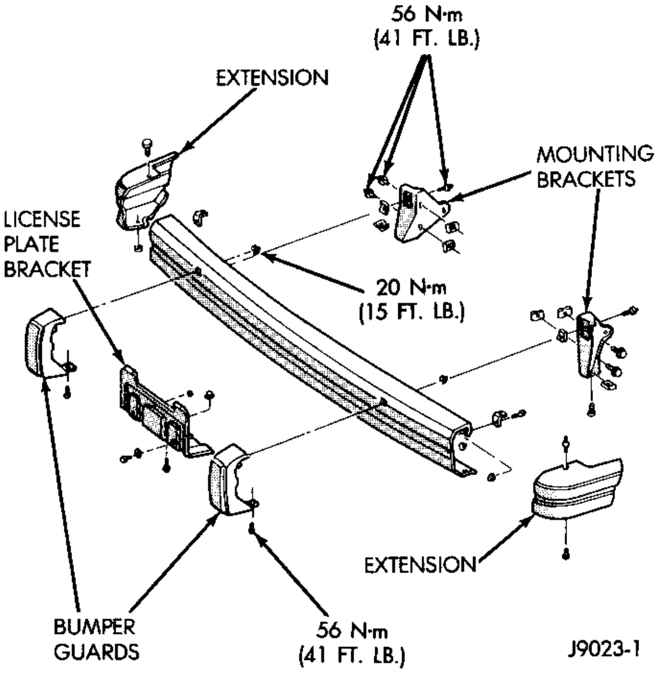


Fig. 3 Front Bumper Assembly

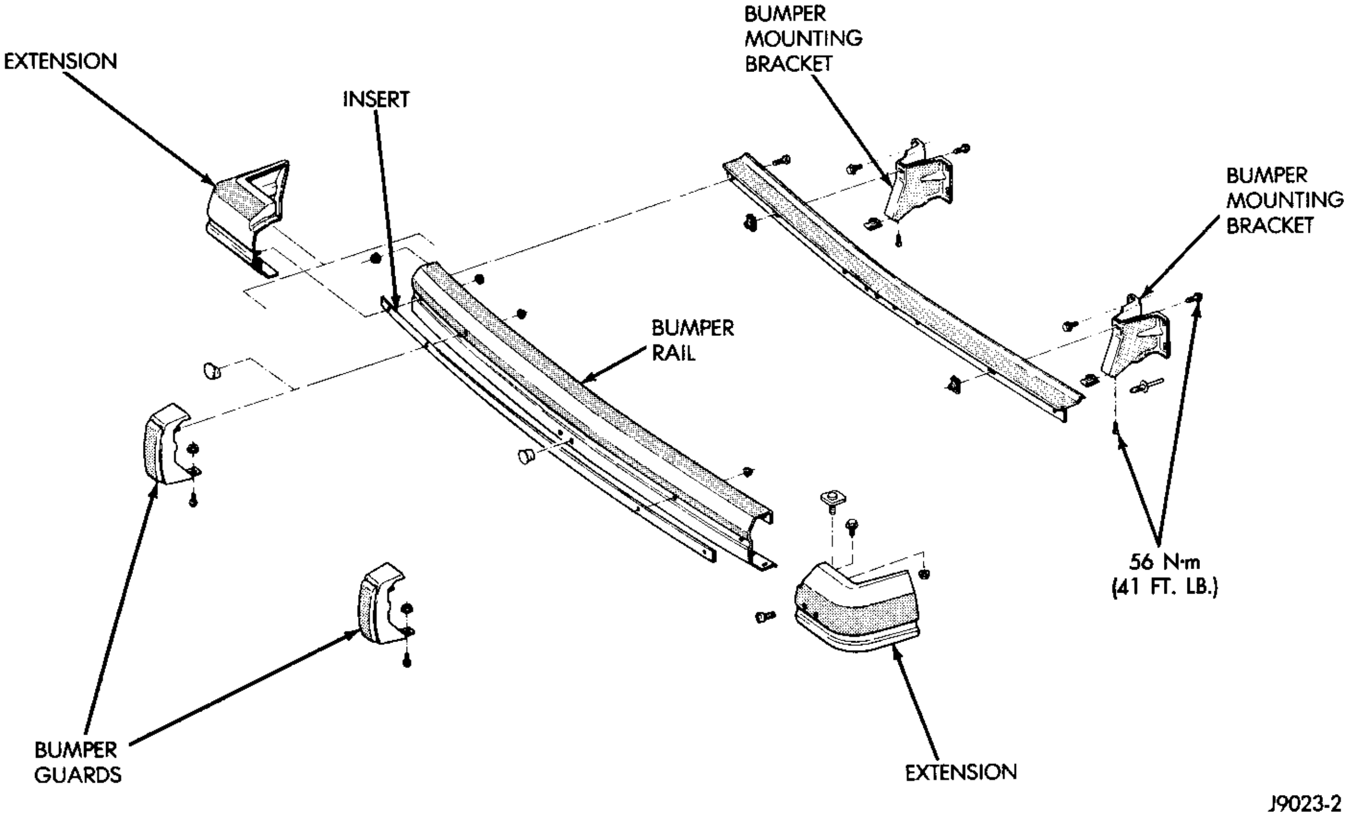


Fig. 1 Rear Bumper Assembly

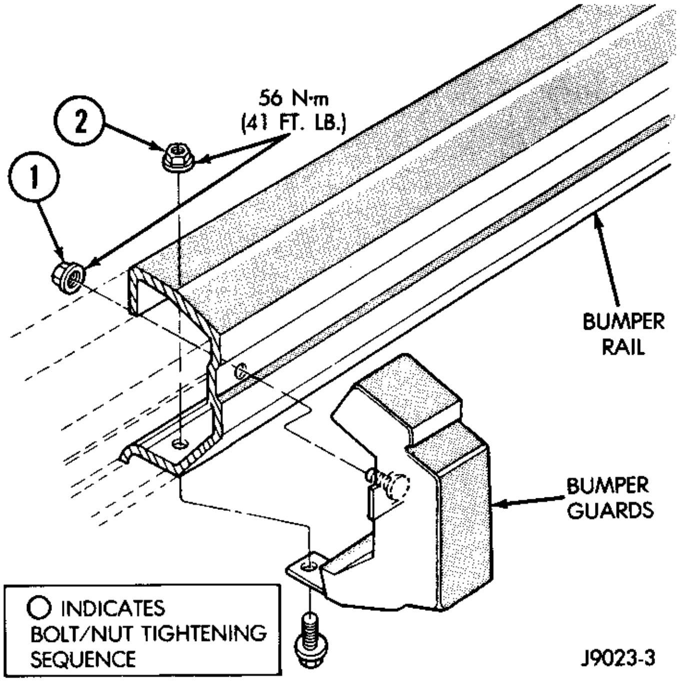


Fig. 2 Installing Rear Bumper Guards

HOOD

Hood service procedures covered in this section include: removal and installation; hood adjustment; hinge-latch-striker service; and release cable service. Refer to Figure 1 for hood attaching components.

Hood Removal

(1) Raise the hood.

(2) Disconnect the hood lamp, if equipped.

(3) Mark location of the hood hinges and hinge shims for reference.

(4) Remove bolts attaching hinges to hood.

(5) Remove hood with aid of helper.

Hood Installation

(1) Position hood on hinges and finger-tighten the hinge bolts.

(2) Align hinges and shims with reference marks and tighten the hinge bolts to 30 N•m (22 ft. lbs.) torque.

(3) Connect the hood lamp.

(4) Inspect the hood for proper alignment and adjust as necessary.

Hood Adjustment

The hood mounting holes are slotted to allow fore, aft and side-to-side adjustment.

If the hood is low in relation to the cowl top, insert shims between the hinge and hood at the rear hinge bolts.

Adjust the hood bumper (Fig. 2) up or down to provide proper hood- to-fender height alignment.

Adjust the hood latches by moving them up or down as needed. Tighten the latch bolts to 21 N•m (115 in. lbs.) torque after adjustment.

Align each latch and striker so the striker enters the

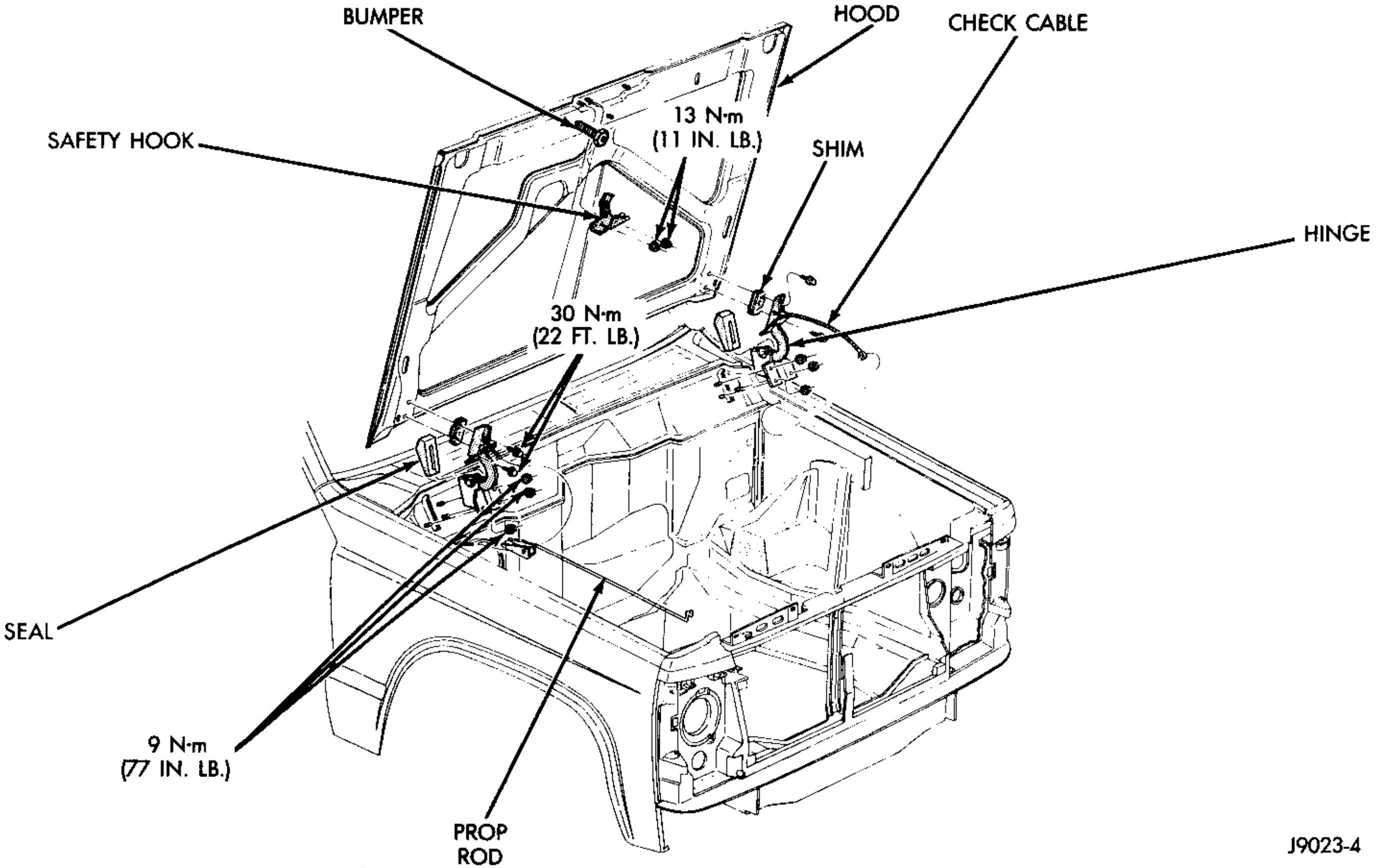
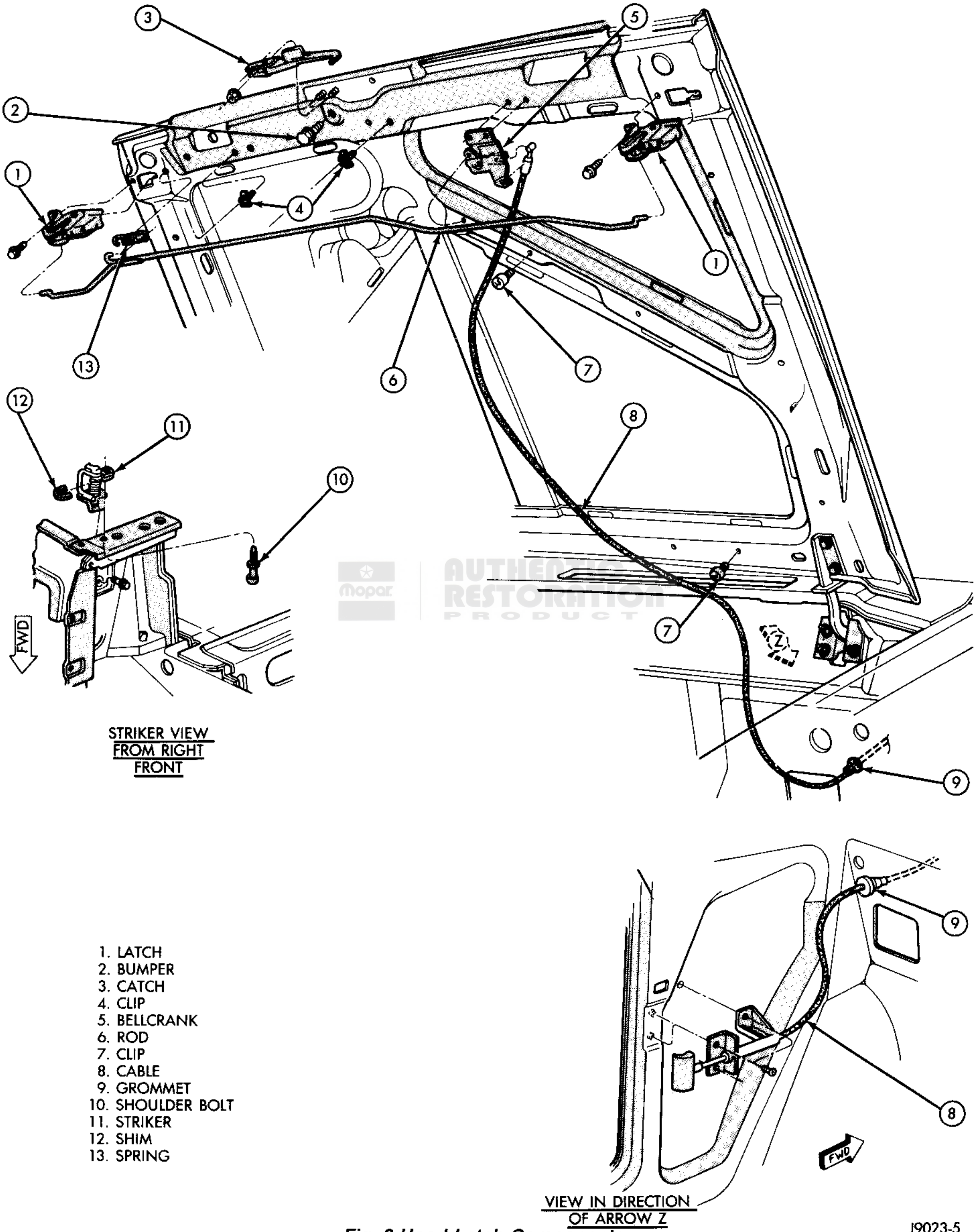


Fig. 1 Hood Components



1. LATCH
2. BUMPER
3. CATCH
4. CLIP
5. BELLCRANK
6. ROD
7. CLIP
8. CABLE
9. GROMMET
10. SHOULDER BOLT
11. STRIKER
12. SHIM
13. SPRING

Fig. 2 Hood Latch Components

latch squarely and without binding.

Hood Hinge Removal

(1) Remove the hood.

(3) Remove the hinge nuts.

(4) Remove the hinge and seal.

Hood Hinge Installation

(1) Position the hinge on the studs and install the hinge nuts. Tighten the nuts to 39 N•m (77 in. lb.) torque.

(3) Install the hinge seal if removed.

(4) Install the hood.

(5) Adjust the hood as needed.

Hood Latch Replacement

(1) Remove screw attaching the latch to the hood (Fig. 2).

(2) Disconnect the latch from the hood and the rod. Remove the latch.

(3) Connect the latch to the rod and the hood.

(4) Install the screw attaching the latch to the hood.

(5) Tighten the screw to 9 N•m (77 in. lbs.) torque.

Hood Latch Striker Replacement

(1) Remove grille opening panel.

(2) Remove the shoulder bolt and screw attaching the striker to the radiator baffle (Fig. 2).

(3) Remove the striker and shims.

(4) Position the striker and shims on the radiator baffle and install the shoulder bolt and screw.

(5) Tighten the bolt and screw to 21 N•m (15 ft. lbs.).

(6) Check striker/hood alignment by opening and closing the hood. Adjust the striker if necessary.

Hood Release Cable Replacement

(1) Drill out the rivets attaching the bellcrank to the hood (Fig. 2).

(2) Disconnect the bellcrank from the rod and release cable. Remove the bellcrank.

(3) Disconnect the release cable from the clips.

(4) Remove the left kick trim panel.

(5) Remove the cable bracket attaching screws.

(6) Remove the cable assembly from under the dash.

(7) Insert the cable end through the hole in the dash panel into the engine compartment.

(8) Pull the cable forward and seat the grommet in the dash panel.

(9) Position the cable bracket on the body and install the attaching screws. Tighten the screws to 13 N•m (111 in. lbs.) torque.

(10) Install the trim panel.

(11) Connect the cable and rod to the bellcrank.

(12) Position the bellcrank on the hood and install the rivets.

(13) Install the cable in the clips.

(14) Check the cable operation.

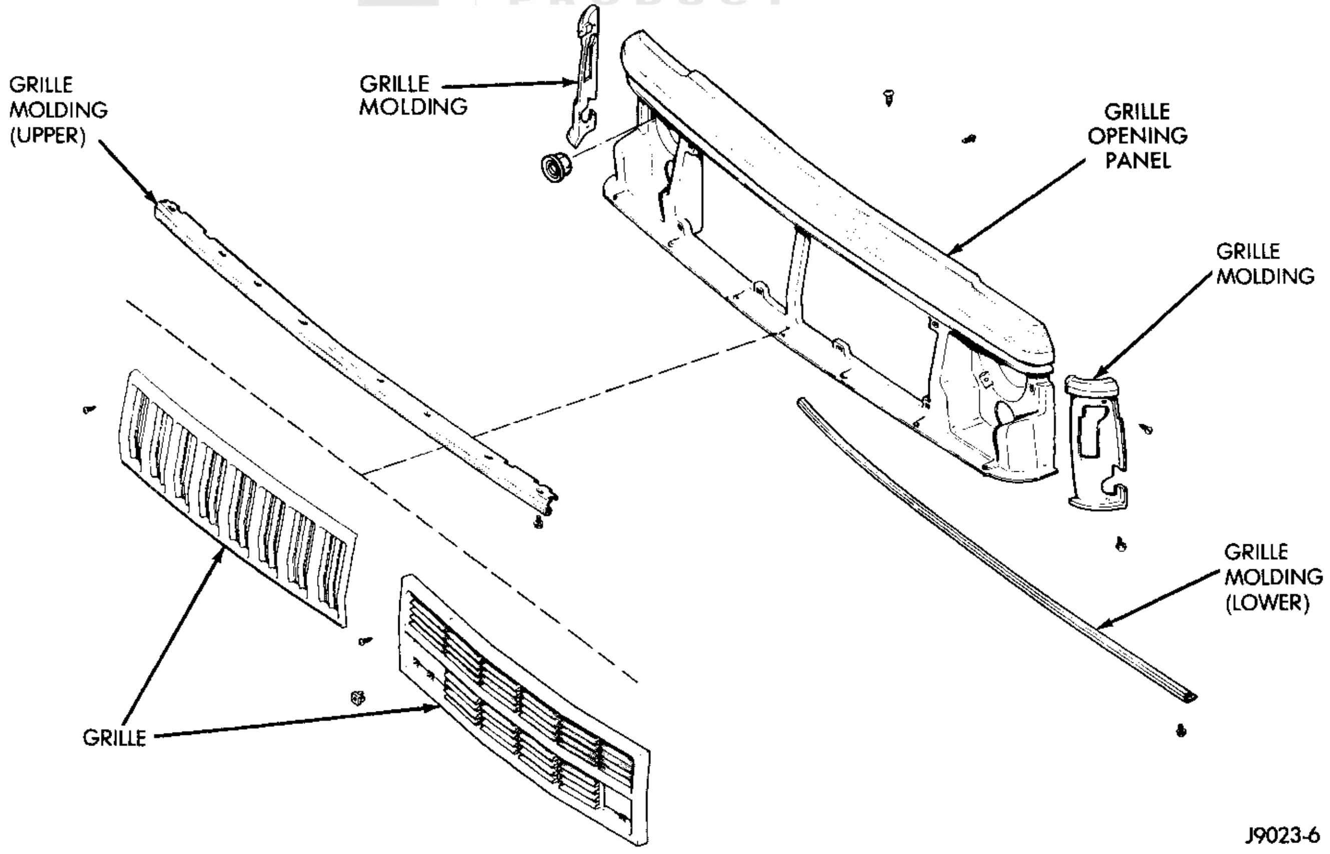


Fig. 1 Grille And Grille Opening Panel Components

GRILLE AND GRILLE OPENING PANEL

Removal

(1) Remove the grille (Fig. 1) from the grille opening panel.

(2) Remove the side marker lamps (Fig. 2 and 3).

(3) Remove the side grille moldings.

(4) Open the hood.

(5) Remove the nuts attaching the grille opening panel to the crossmember (Fig. 4).

(6) Remove the nuts attaching the grille opening panel to the front fenders (Fig. 5).

(7) Pull grille opening panel forward and disconnect the front wire harness.

(8) Remove the grille opening panel.

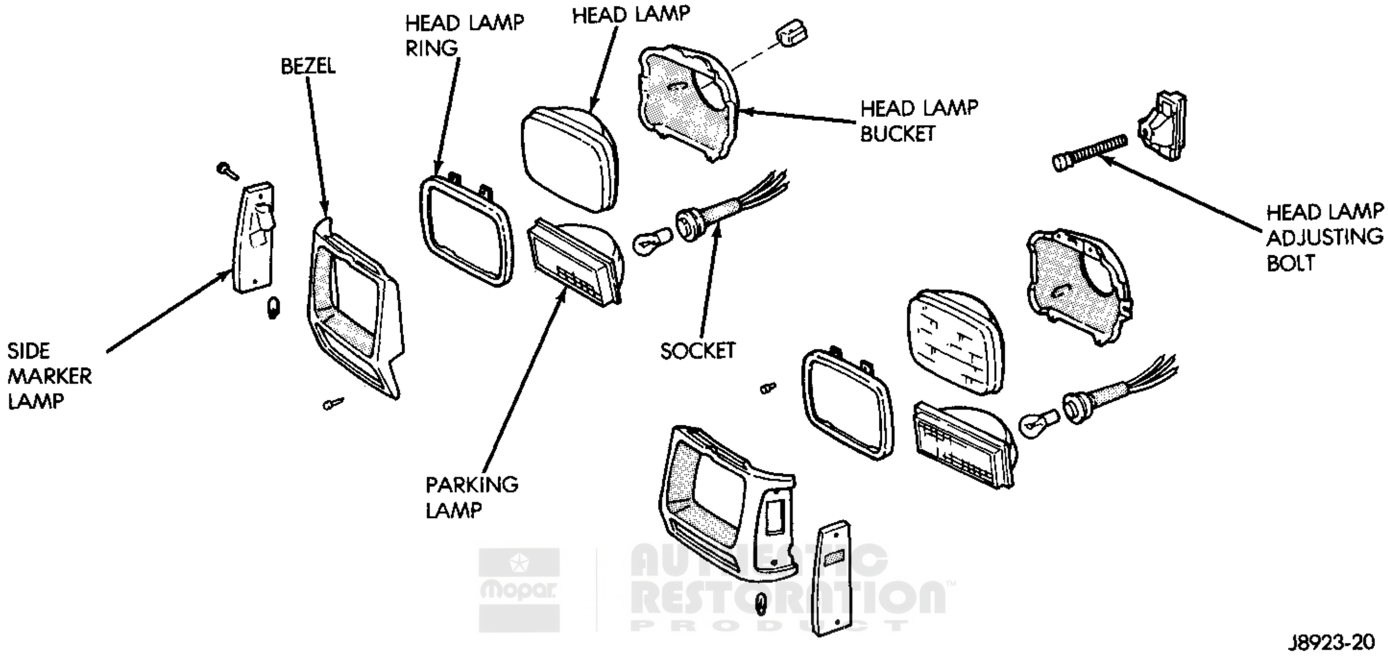


Fig. 2 Marker, Turn and Headlamps—All except Wagoneer Models

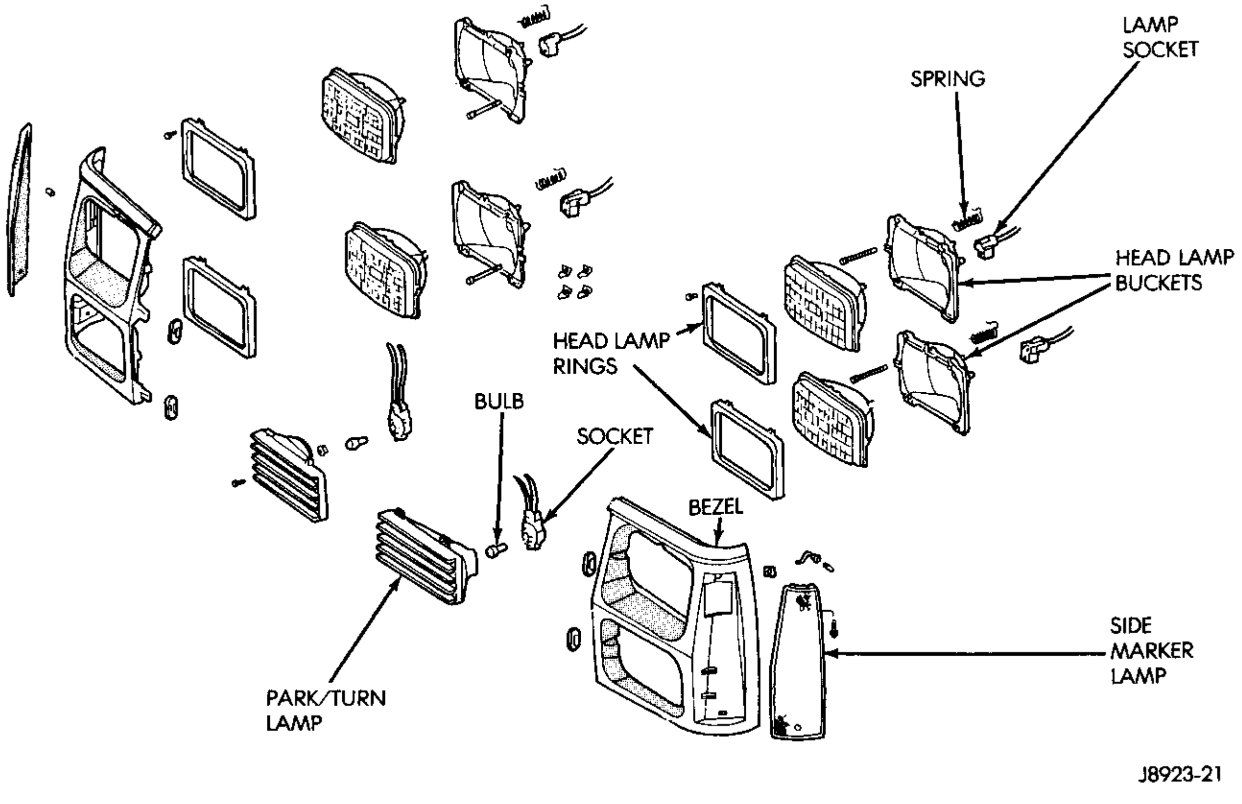


Fig. 3 Marker Turn and Headlamps—Wagoneer Models

Disassembly

(1) Remove the grille if not removed previously.

(2) Remove the headlamp assemblies.

(3) Remove the wiring harness.

(4) Reverse above procedures for assembly.

Installation

(1) Place the grille opening panel on bumper and connect front wiring harness.

(2) Position the grille opening panel on the vehicle and install side and upper attaching nuts.

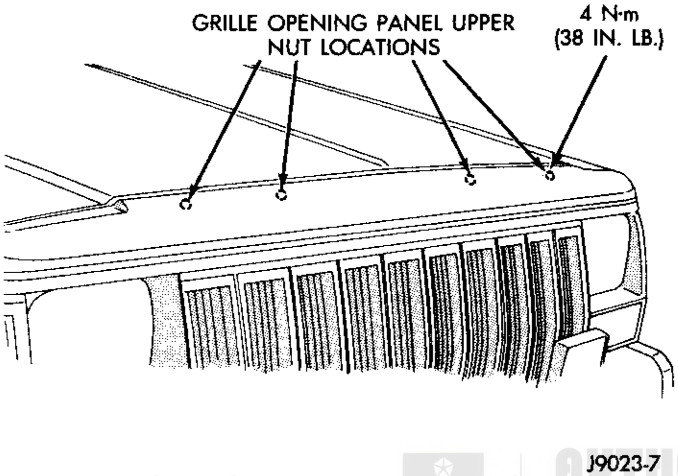


Fig. 4 Grille Opening Panel Upper Fastener Locations

(3) Install the side grille moldings and the side marker lamps.

(4) Install the grille.

(5) Re aim headlamps if necessary. Refer to the headlamp adjustment procedure in Group 8.

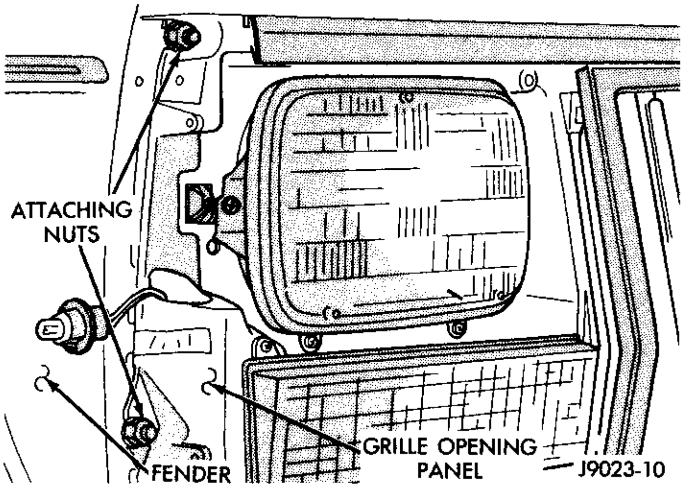


Fig. 5 Grille Opening Panel to Fender Attaching Nuts

FRONT FENDER

This section includes procedures for removing/installing the front fender flares and retainers, fender liners and front fenders (Fig. 1).

Front Fender Removal

(1) Remove the front bumper.
(2) Raise and support the vehicle.
(3) Remove the front wheel.
(3) Remove the fender flare and retainer, fender inner liner and grille panel. Refer to the Grille Opening Panel Removal procedure.
(4) Remove the rocker panel molding (Fig. 2).
(5) Remove the fender braces and support (Fig. 1).
(6) Remove the fender lower attaching bolts (Fig. 2).
(7) Remove the rocker panel molding (Fig. 2).
(8) Remove the fender top, front and rear bolts (Fig. 2).
(9) Remove the front fender.

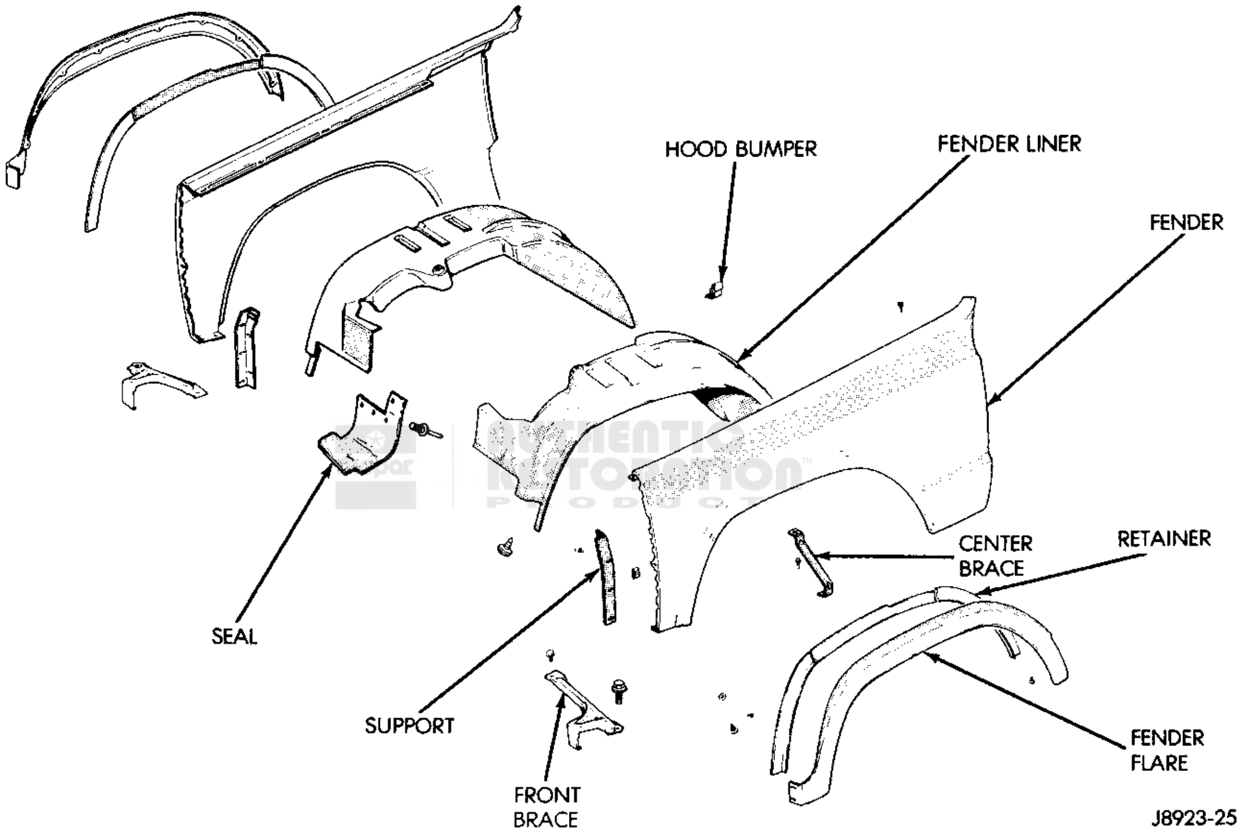


Fig. 1 Front Fenders-Liners-Flares

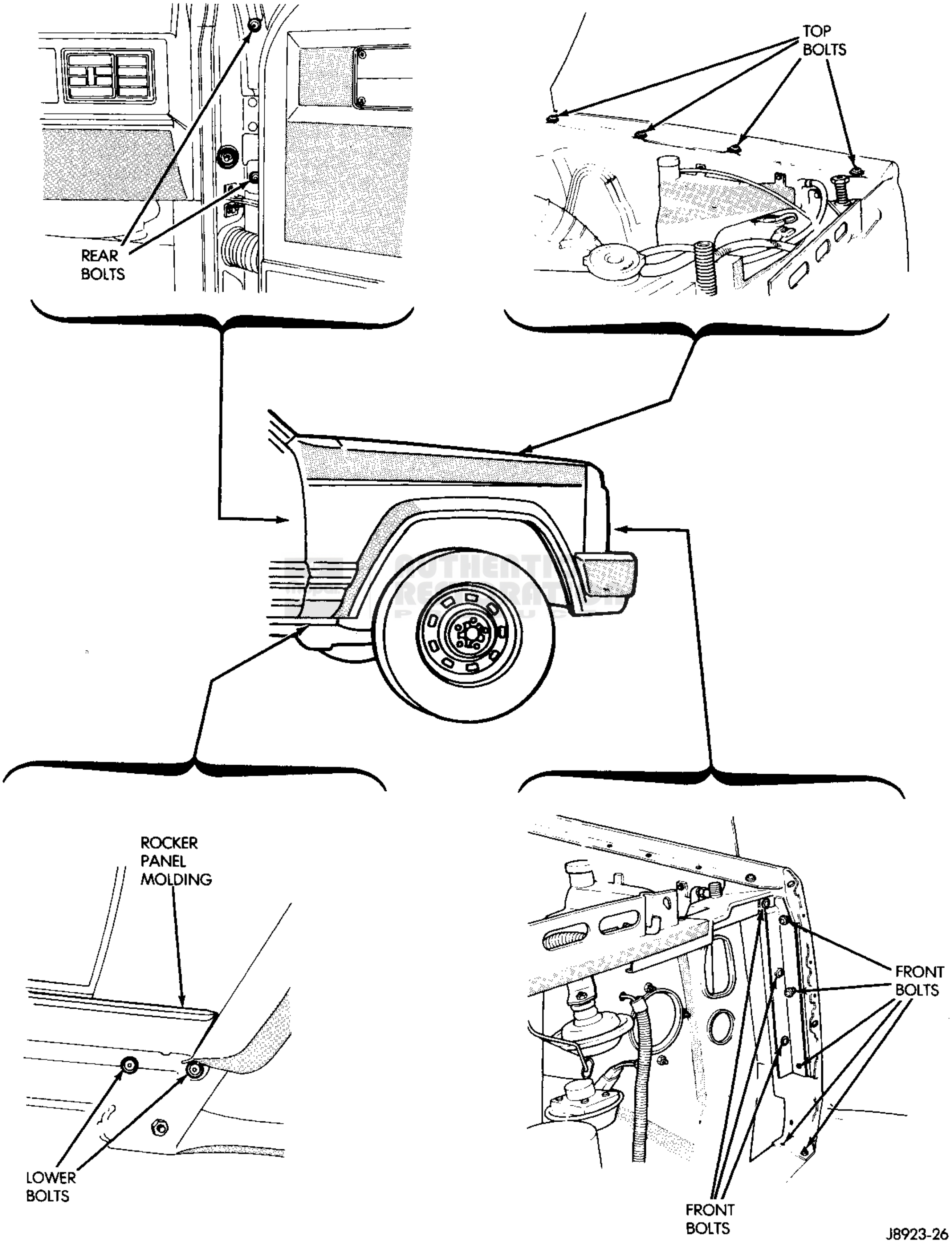


Fig. 2 Front Fender Bolt Locations

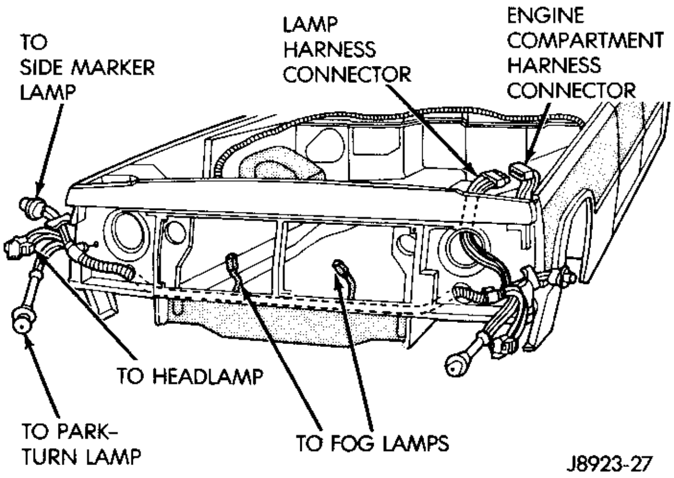


Fig. 3 Front Wiring Harness Connectors

Front Fender Installation And Adjustment

(1) Position the fender on the vehicle.

(2) Install all of the fender bolts finger tight.

(3) Install the fender braces and support.

(4) Align the fender with the adjacent body panels and tighten the fender bolts to 8.5 N•m (76 in-lbs) torque.

(5) Install the fender liner and the fender flare and retainer.

(6) Install the grille panel. Connect the lamp harness to the engine compartment harness (Fig. 3).

(7) Install the grille panel moldings, and lamp assemblies.

(8) Install the air deflector.

(9) Install the front bumper.

(10) Install the wheel and lower the vehicle.

FRONT DOORS

Front door service procedures covered in this section include removal, installation and/or replacement of the following door components:

- front door
- door handles
- window regulator
- door hinges
- door check
- lock cylinder
- trim panel
- vent and door glass
- moldings and weatherstrips
- side view mirrors

Front Door Removal

(1) Remove the door check pin (Figs 1 and 3).

(2) On models with power windows and electric door locks, remove the trim panel and disconnect the window and door lock wiring harnesses. Then slide the body harness out of the boot and the door (Fig. 2).

(3) Remove the door hinge bolts and remove the door.

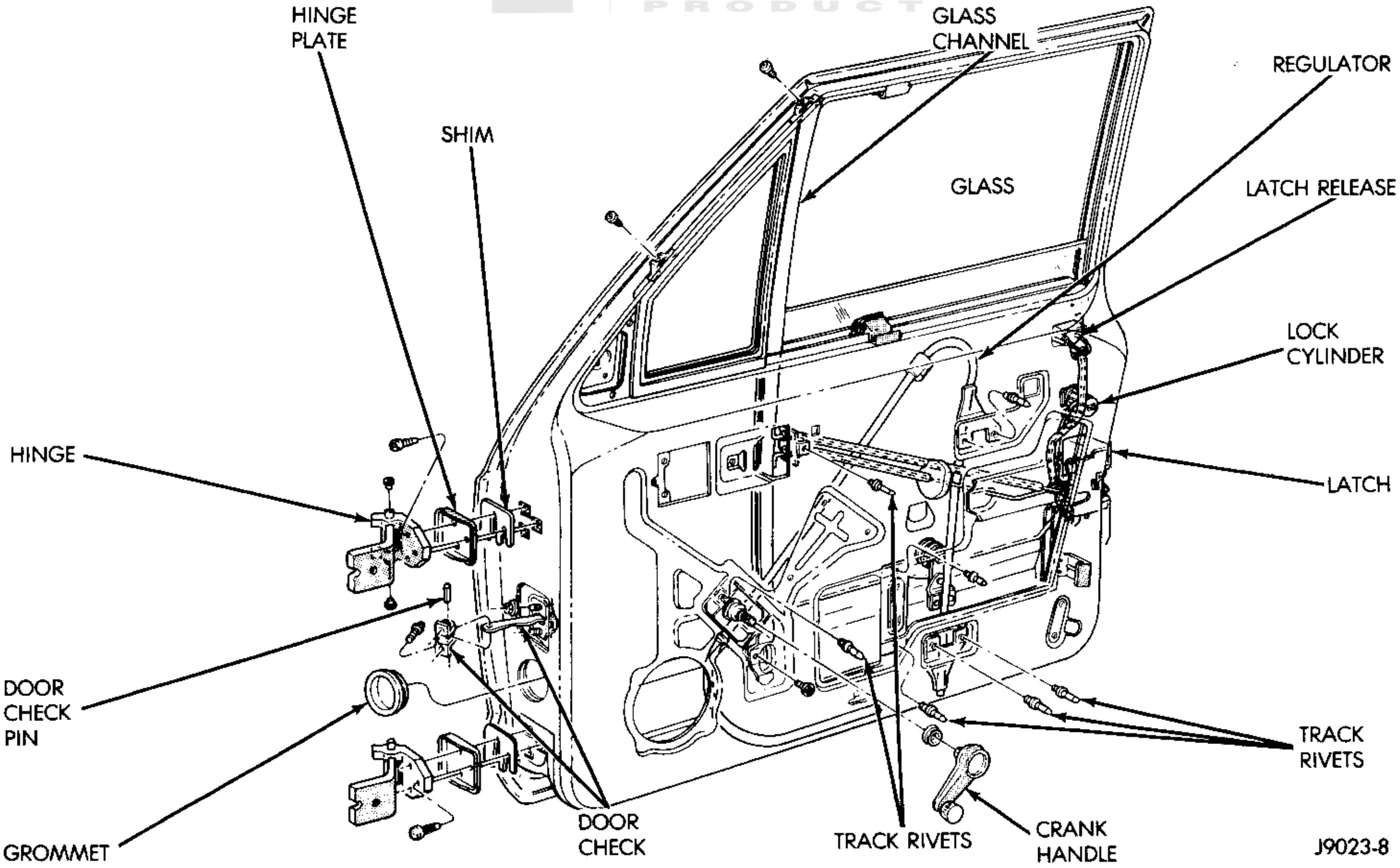


Fig. 1 Front Door-With Manual Window

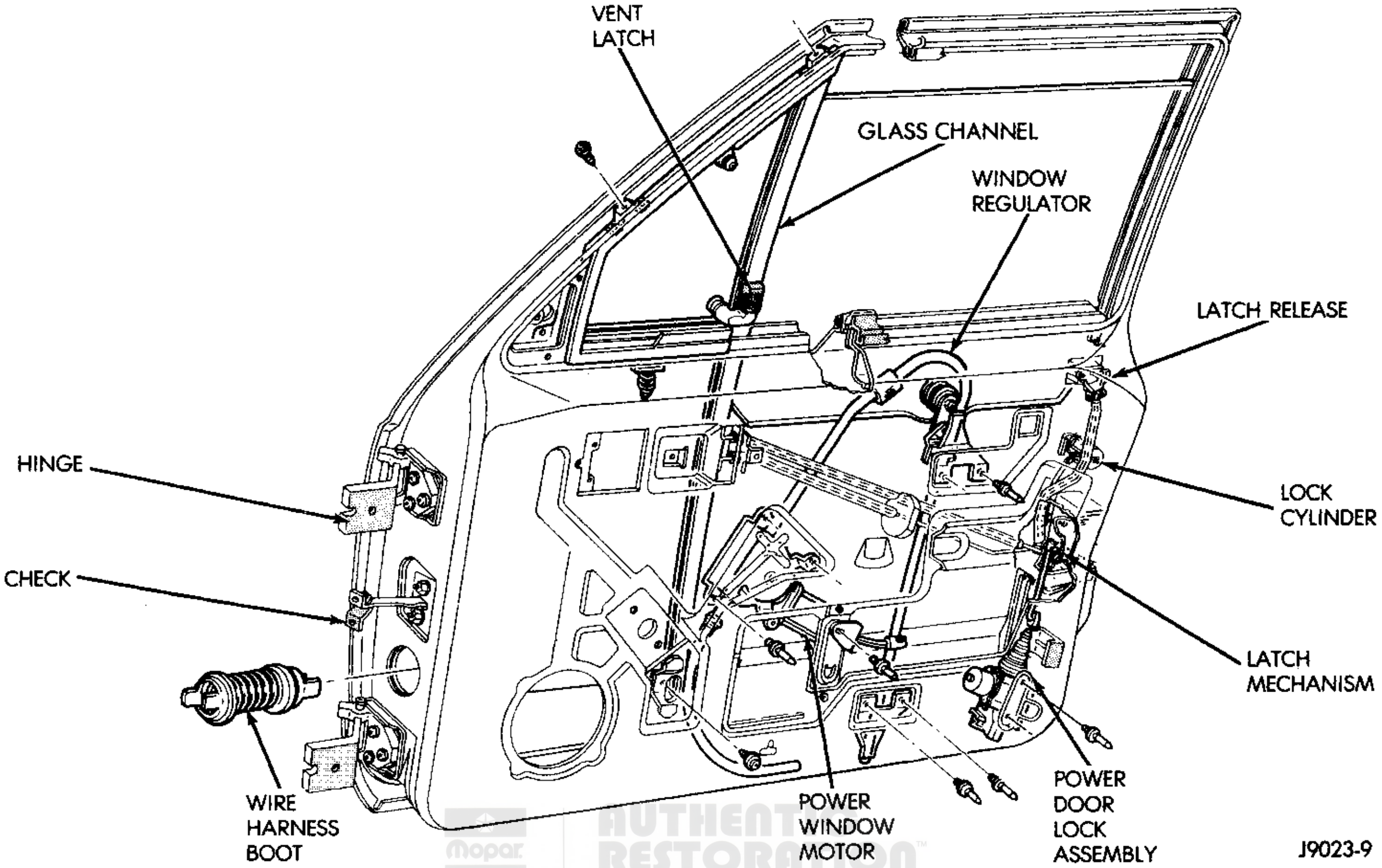


Fig. 2 Front Door-With Power Window And Lock

(4) Retain the door hinge plates and shims (Figs. 1 and 2).

Front Door Installation

(1) If a new front door is being installed, coat the door interior with 3M 08892 anti-corrosion wax. Then seal the door hem flange with 3M 08505 or 08646 sealer (Fig. 4).

(2) Before installing a new door, transfer the original glass, motors, lock, handle, moldings and other components to the new door. Refer to the individual procedures in this section.

(3) Position the door in the body opening.

(4) Align the hinges and install (but do not tighten) the hinge bolts.

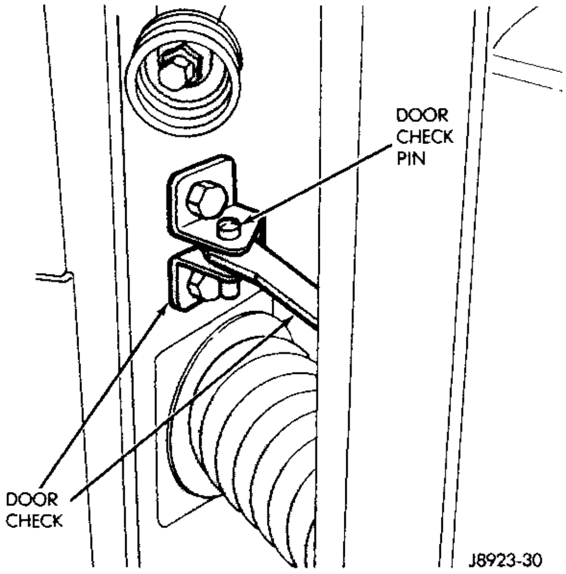


Fig. 3 Removing/Installing Door Check Pin

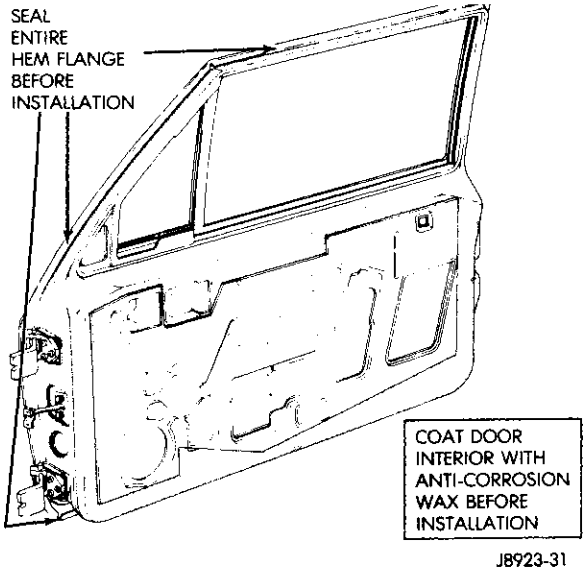


Fig. 4 Seal Replacement Door Before Installation

(5) Install the door check pin (Fig. 3).

(6) Align/adjust the door as necessary and tighten the hinge bolts to 35 N•m (26 ft-lbs) torque.

(7) Adjust the lock striker and latch as necessary.

(8) Connect the power window and door lock harness connectors to the body harness.

(9) Install the door trim panel and crank handle.

Front Door Adjustment

Door position in the body opening is determined by shims installed between the door plates and door sheet metal (Fig. 5).

Add or remove shims as needed to obtain the desired door fit.

Tighten the door hinge screws to 35 N•m (26 ft-lbs) torque after door adjustment.

Door Trim Panel Removal

(1) Remove the interior door latch handle screws (Fig. 6).

(2) Move the door handle outward and disconnect the control rods (Fig. 6). On models with power door locks, also disconnect the wire harness.

(3) Remove the window crank handle or power window switch and bezel.

(4) Remove the armrest lower retaining screws.

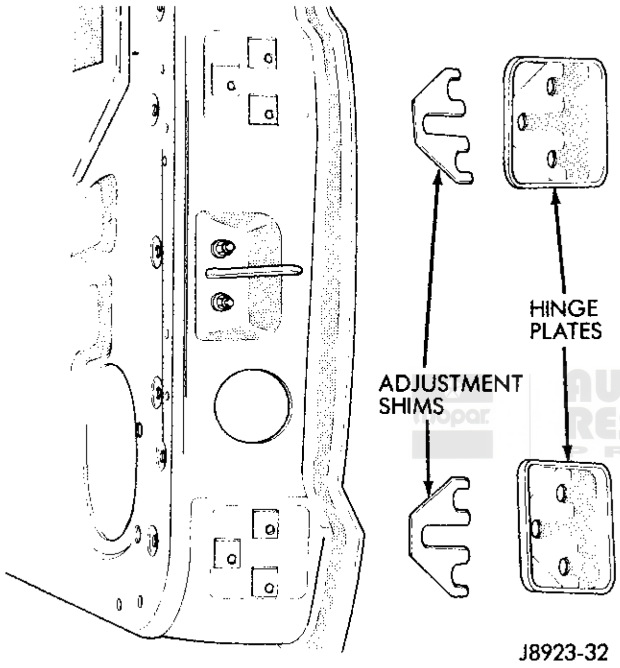


Fig. 5 Door Hinge Shim Locations

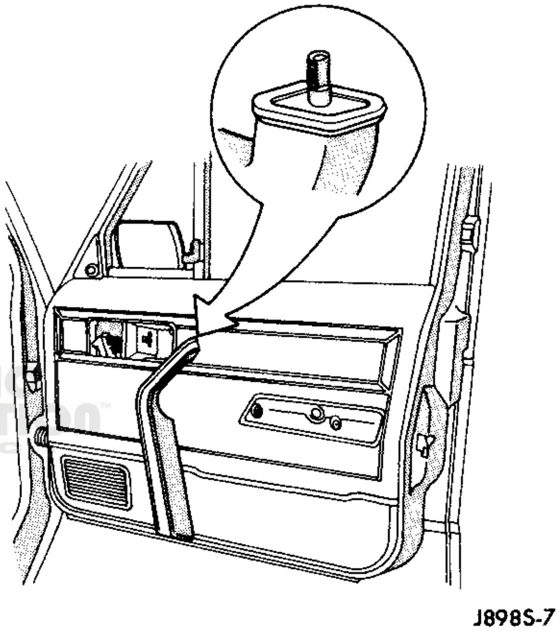


Fig. 7 Removing/Installing Armrest

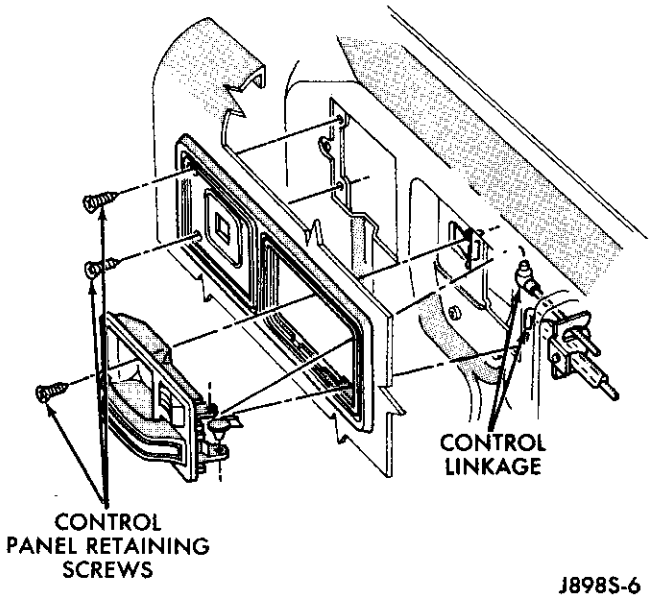


Fig. 6 Removing/Installing Interior Latch Handle

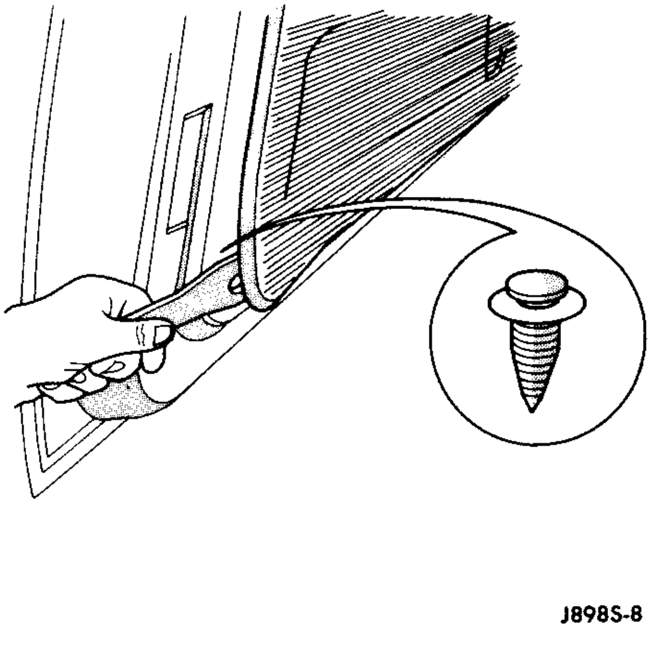


Fig. 8 Removing Trim Panel Retainers

(5) Swing the armrest downward to a vertical position for access to the upper retaining clip (Fig. 7). Remove the clip and pull the armrest straight out from the panel.

(6) Remove the trim panel retainers with tool (Fig. 8).

Trim Panel Installation

(1) If the plastic water dam sheet was removed, apply 3M 08044 or 08041 adhesive/sealant to the sheet before installing it.

(2) Position the trim panel on the door and press the nylon retainers into place to secure the panel.

(3) Install the armrest, crank handle or power window switch, and bezel.

(4) Connect the link rods to the interior latch handle and install the handle.

Door Glass-Vent Window-Regulator Removal

(1) Remove the trim panel and plastic water dam sheet.

(2) Remove the window frame hardware and mouldings.

(3) Remove the glass channel bottom screw (Fig. 9).

(4) Remove the vent window frame screws (Fig. 10).

(5) Tilt the vent window and glass channel rearward and remove it from the door (Fig. 10).

(6) Remove the door glass mounting stud nut and spring washer (Fig. 11).

(7) Lift the door glass upward and out of the door.

(8) Remove the window regulator rivets by knocking out the rivet center with a punch. Then drill out the rivet body with a 1/4 inch drill bit (Figs. 12 and 13).

(9) Remove the window regulator.

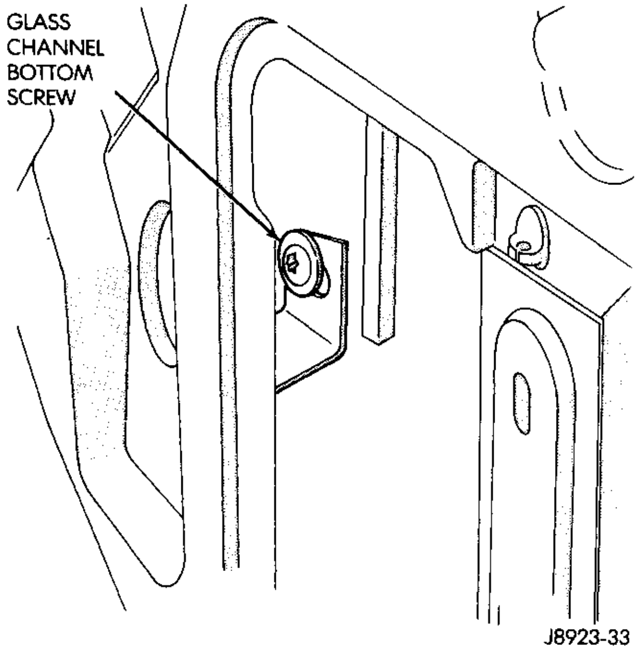


Fig. 9 Removing/Installing Glass Channel Bottom Screw

Door Glass-Vent Window-Regulator Installation

(1) Install the regulator in the door. Secure the regulator with new rivets or screws and nuts which are available in a parts kit.

(2) Install the window in the door and install the spring washer and nut (Fig. 11). **The spring washer must be used to maintain proper tension on the stud nut.**

(3) Tighten the door glass stud nut to 6 N•m (4 ft-lbs) torque.

(4) Install the vent window and channel (Fig. 10).

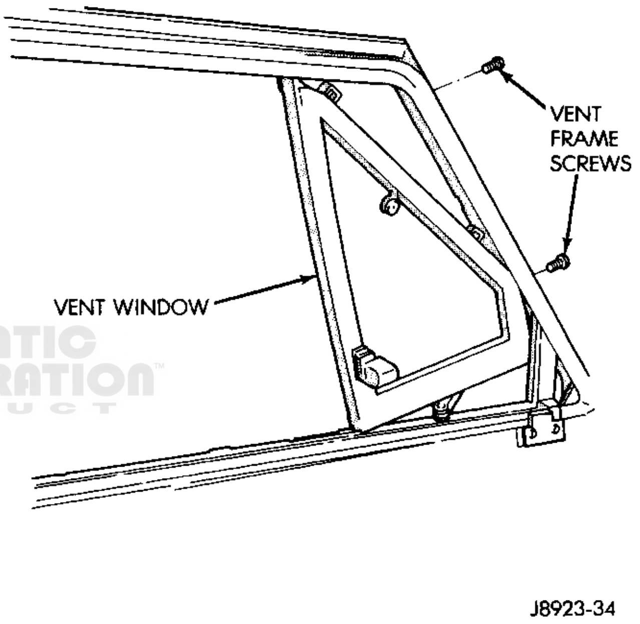


Fig. 10 Removing/Installing Vent Window And Channel

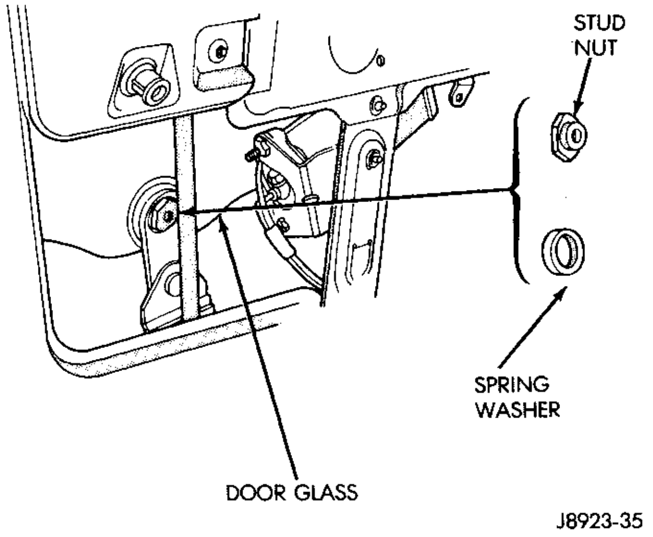


Fig. 11 Removing/Installing Door Glass Stud

(5) Install the glass channel bottom screw (Fig. 9). Tighten the screw to 9 N•m (7 ft-lbs) torque.

(6) Attach the plastic water dam sheet to the door panel with 3M 08044 or 08041 adhesive/sealant.

(7) Install the trim panel.

Vent Window Replacement

(1) Remove the door trim panel and the plastic water dam sheet.

(2) Remove the window channel bottom screw (Fig. 9).

(3) Remove the vent window frame screws (Fig. 10).

(4) Tilt the vent window and channel rearward and remove the assembly.

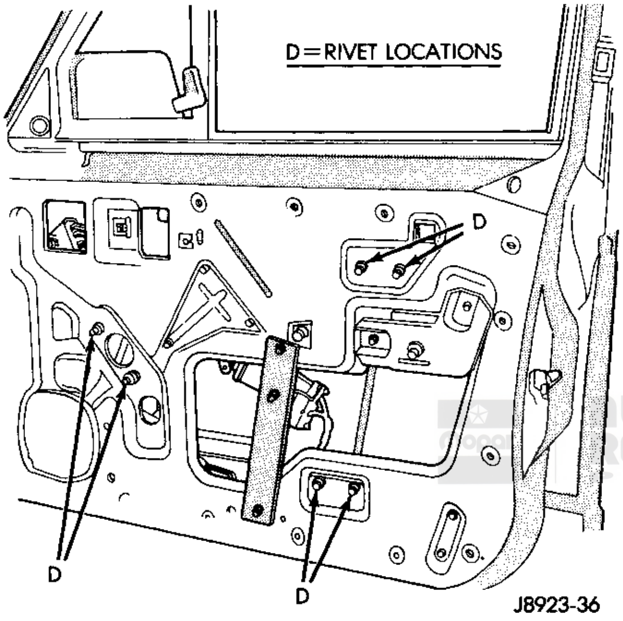


Fig. 12 Regulator Rivet Locations-Manual Window

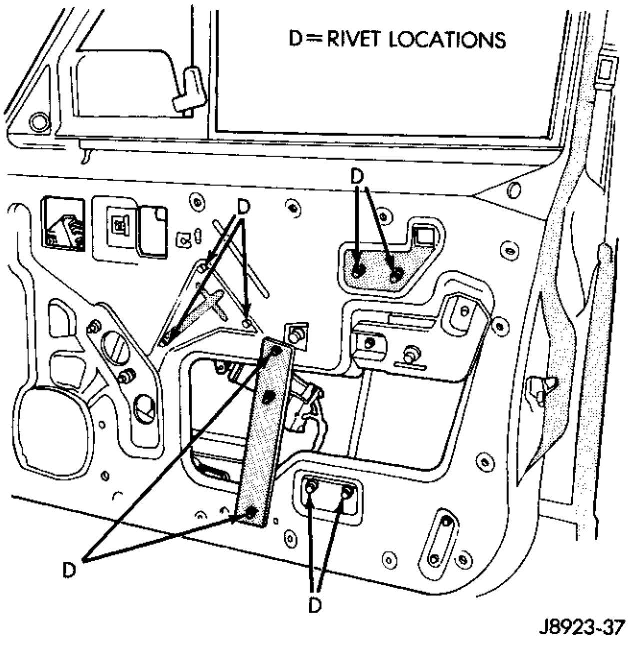


Fig. 13 Regulator Rivet Locations-Power Window

(5) Remove the latch pin and latch (Fig. 14).

(6) Remove the hinge screw.

(7) Remove the pivot nut and spring.

(8) Remove the glass from the frame.

(9) Position the new vent window in the door and install the hinge screw, pivot spring and nut.

(10) Install the window latch and pin.

(11) Install the vent window and channel in the door.

(12) Install the door glass channel bottom screw (Fig. 9).

(13) Install water dam sheet and door trim panel.

Lock Cylinder Replacement/Adjustment

(1) Remove the trim panel and water dam sheet.

(2) Disconnect the latch and cylinder links at the latch (Fig. 15).

(3) Remove the lock cylinder retaining clip and remove the cylinder, gasket and clip (Fig. 16).

(4) Connect the latch link to the new lock cylinder.

(5) Install the new cylinder and gasket in the door. Then secure the cylinder with the retaining clip (Fig. 16).

(6) Connect the latch and cylinder links.

(7) Check and adjust latch link free play as follows:

(a) Press the door handle release button inward and observe latch link movement. The link should start to move after the button travels no more than 3 mm (.012 in).

(b) If adjustment is necessary, loosen the adjusting screw on the latch (Fig. 15). Reduce link free play as needed and retighten the screw.

(8) Install the water dam sheet and the door trim panel.

Exterior Door Handle Replacement

(1) Remove the door trim panel and water dam sheet.

(2) Remove the access hole cover and remove door handle retaining nuts (Fig. 17).

(3) Disconnect the latch link (Fig. 17).

(4) Remove the door handle.

(5) Remove the gaskets from the door surface if necessary.

(6) Assemble the replacement door handle if necessary (Fig. 18). Apply silicone spray lube to the button spring, collet and release arm.

(7) Position the new gaskets on the handle and mount the handle on the door. Then install and tighten the handle retaining screws (Fig. 18).

(8) Connect the latch link to the handle and latch.

(9) Install the water dam sheet and trim panel.

Door Latch Removal

(1) Remove the access plug at the upper end of the door (Fig. 19).

(2) Remove the trim panel and water dam sheet.

(3) Remove the exterior door handle.

(4) Remove the latch screws (Fig. 20).

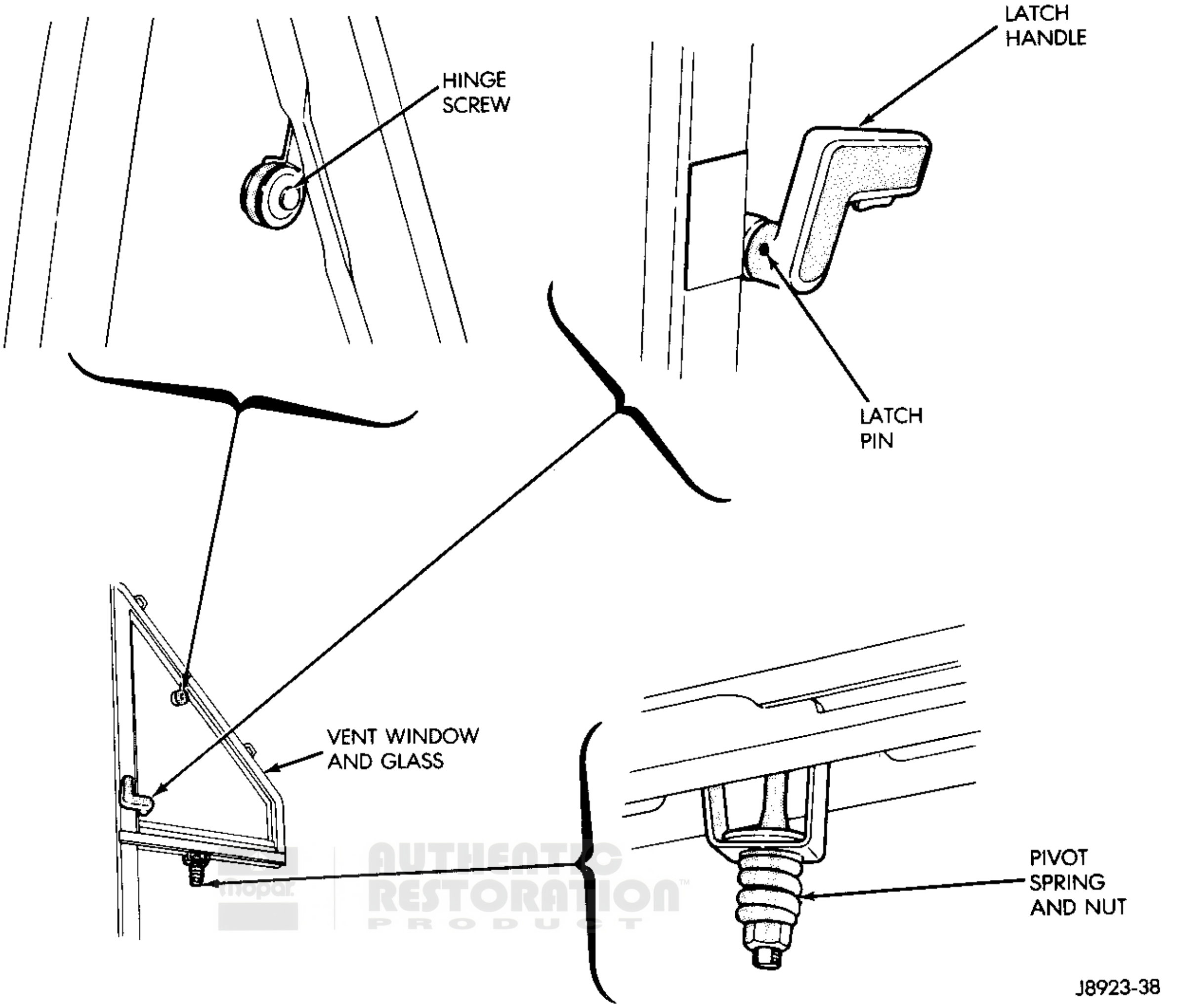


Fig. 14 Removing/Installing Vent Window

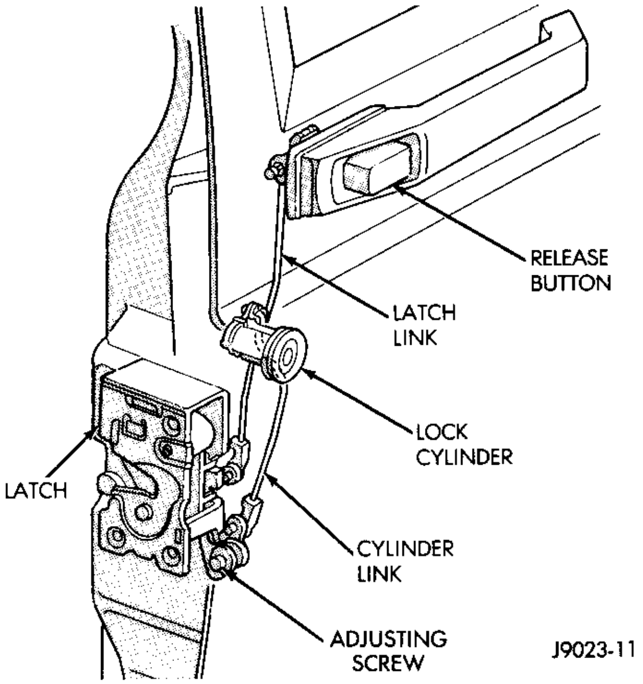


Fig. 15 Lock Cylinder Mounting

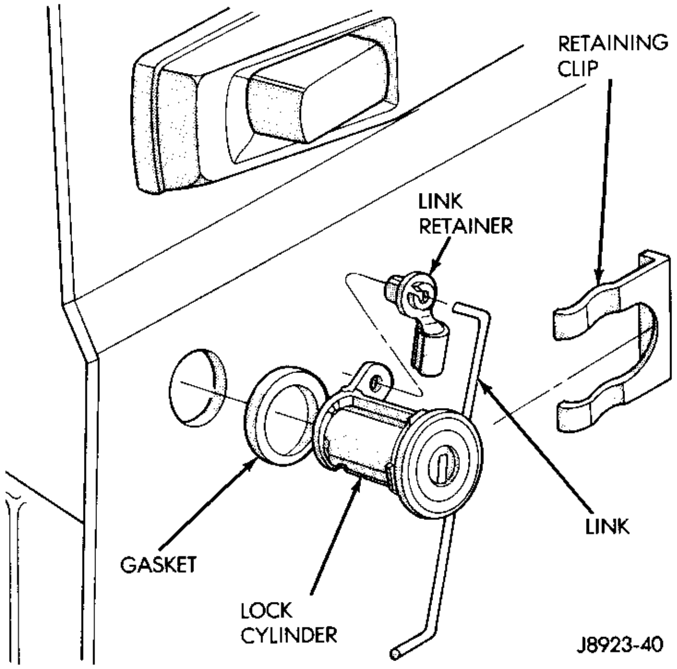


Fig. 16 Removing/Installing Lock Cylinder

(5) Disconnect the links from the latch.

(6) On models with non-power locks, remove the latch assembly. On models with power door locks, grind or drill out the lock motor rivets and remove the motor along with the latch assembly.Remove the door latch screws (Fig. 20).

(7) Remove the latch assembly.

Door Latch Installation

(1) Install a new striker if necessary (Fig. 21).

(2) On models with power locks, attach the motor with new rivets or screws and nuts.

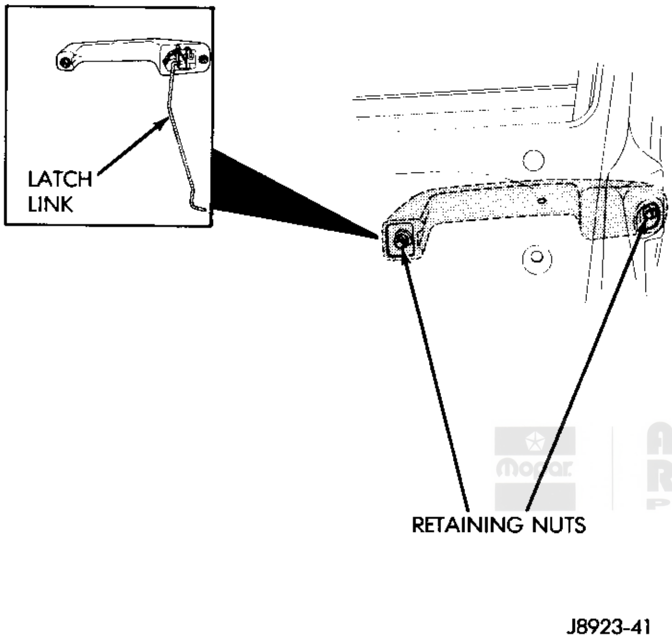


Fig. 17 Removing/Installing Door Handle

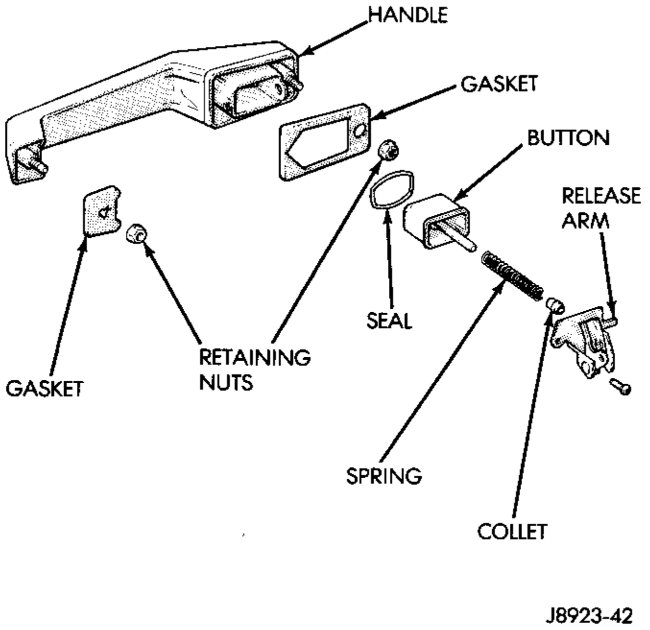


Fig. 18 Door Handle Components

(3) Install and connect the latch assembly.

(4) Attach the latch screws (Fig. 20). Tighten the screws to 9 N•m (7 ft-lbs) torque.

(5) Install and connect the exterior door handle.

(6) Install the lock cylinder and retaining clip (Fig. 16).

(7) Install the water dam sheet and trim panel.

(8) Install the door access plug.

Door Check Replacement

(1) Remove the door trim panel.

(2) Remove the door speaker.

(3) Remove the check pin with a punch (Fig. 24).

(4) Remove the door check attaching nuts and remove the check through the speaker opening in the door (Fig. 24).

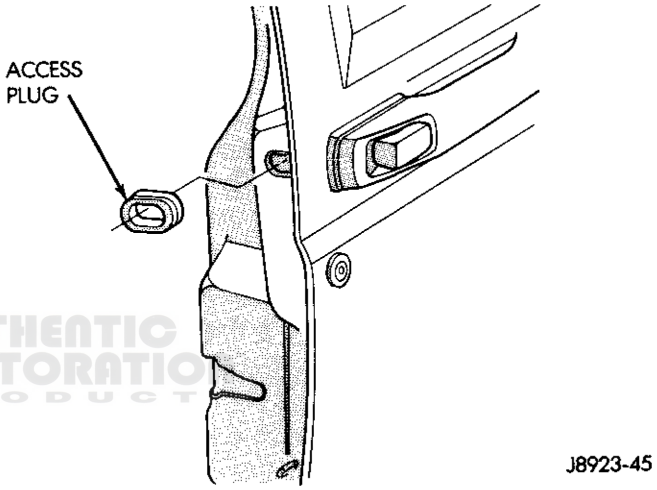


Fig. 19 Door Access Plug

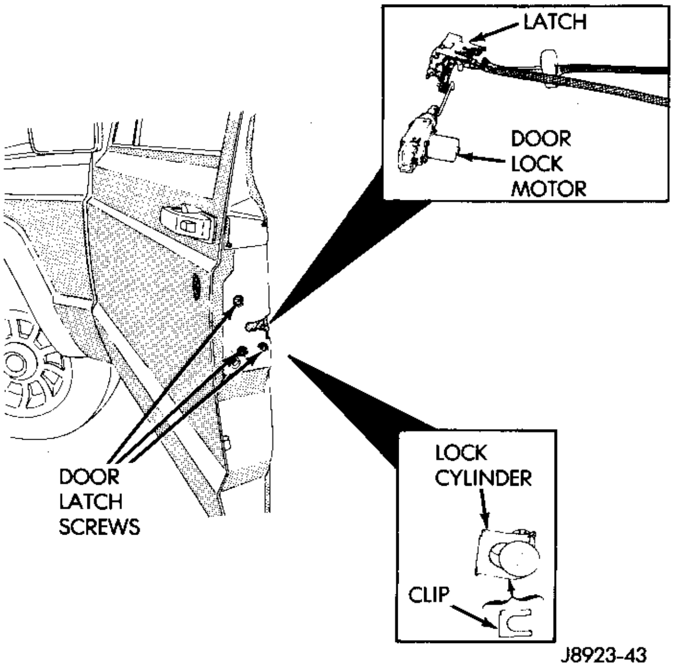


Fig. 20 Door Latch Removal/Installation

(5) Position the new check in the door and install the attaching nuts. Tighten the nuts to 10 N•m (7 ft-lbs) torque.

(6) Tap the check pin into place.

(7) Install the speaker and door trim panel.

Moldings And Weatherstrips

To remove the two-piece window exterior molding, roll the window down. Then carefully pull and pry the molding halves from the door flange (Fig. 25).

To install the moldings, start at the forward end of the top molding. Press the molding onto the door flange and continue work rearward until the molding is seated. Engage the rear molding with the top molding and press the molding edge in to start it. Then continue downward to complete installation (Fig. 25).

The glass channel weatherstrip can be removed by hand or with the aid of a small putty knife or similar tool. To install a new weatherstrip, start at the upper corner. Then work forward and down evenly until the weather strip is fully seated in the frame (Fig. 26). A

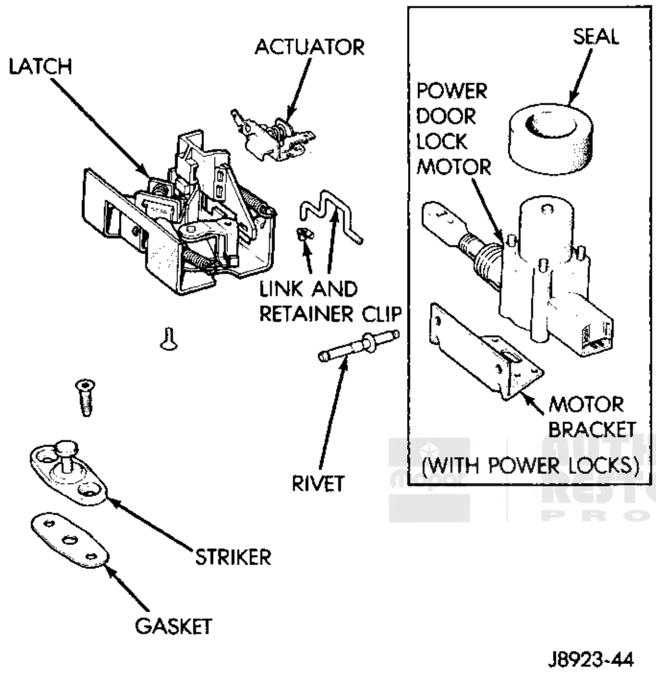


Fig. 21 Door Latch Components

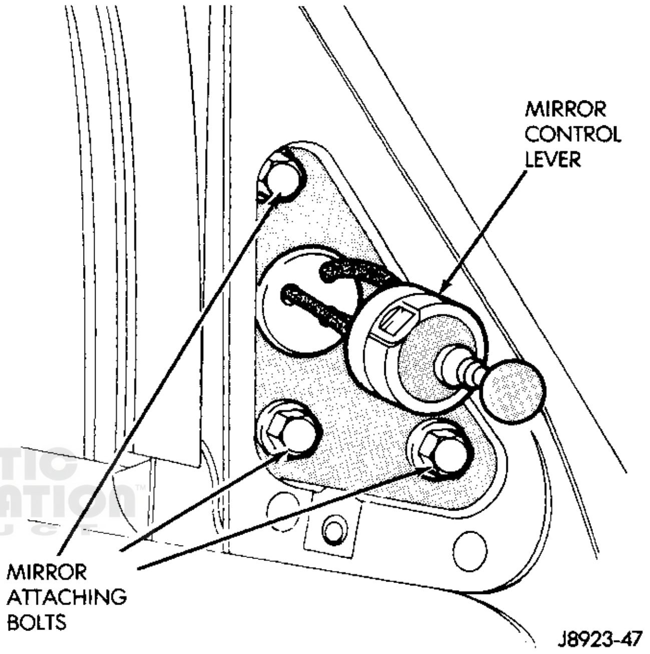


Fig. 23 Mirror Removal/Installation

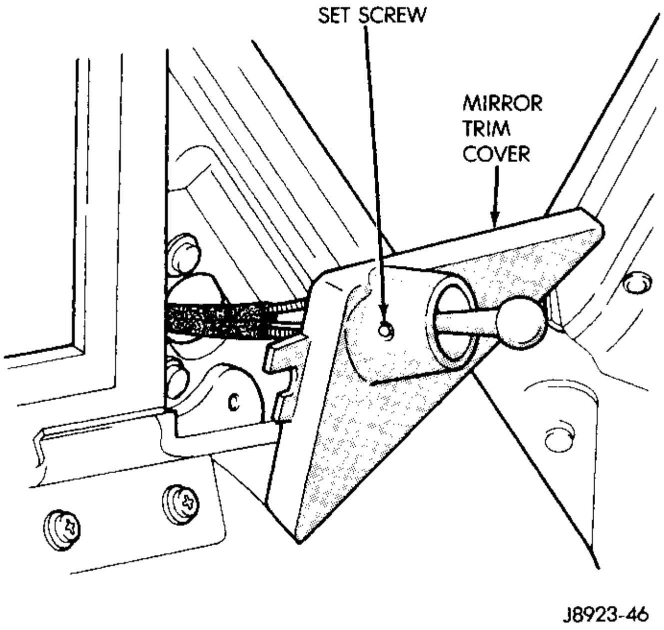


Fig. 22 Mirror Trim Cover Removal/Installation

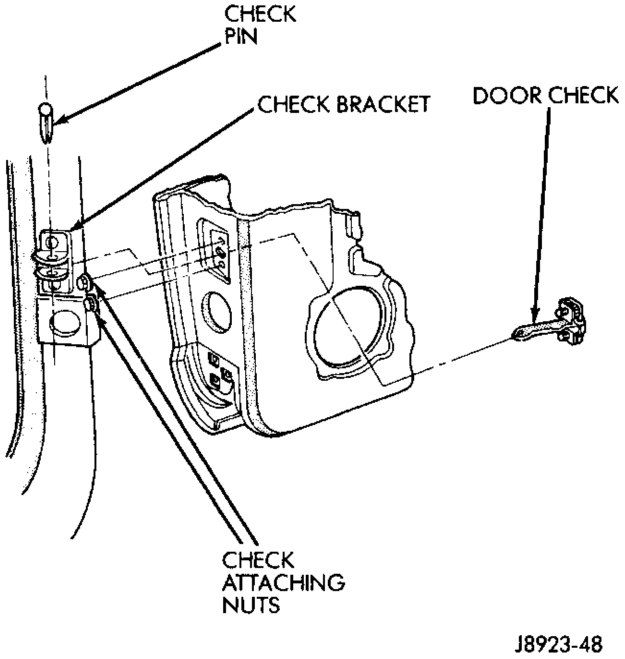


Fig. 24 Door Check Replacement

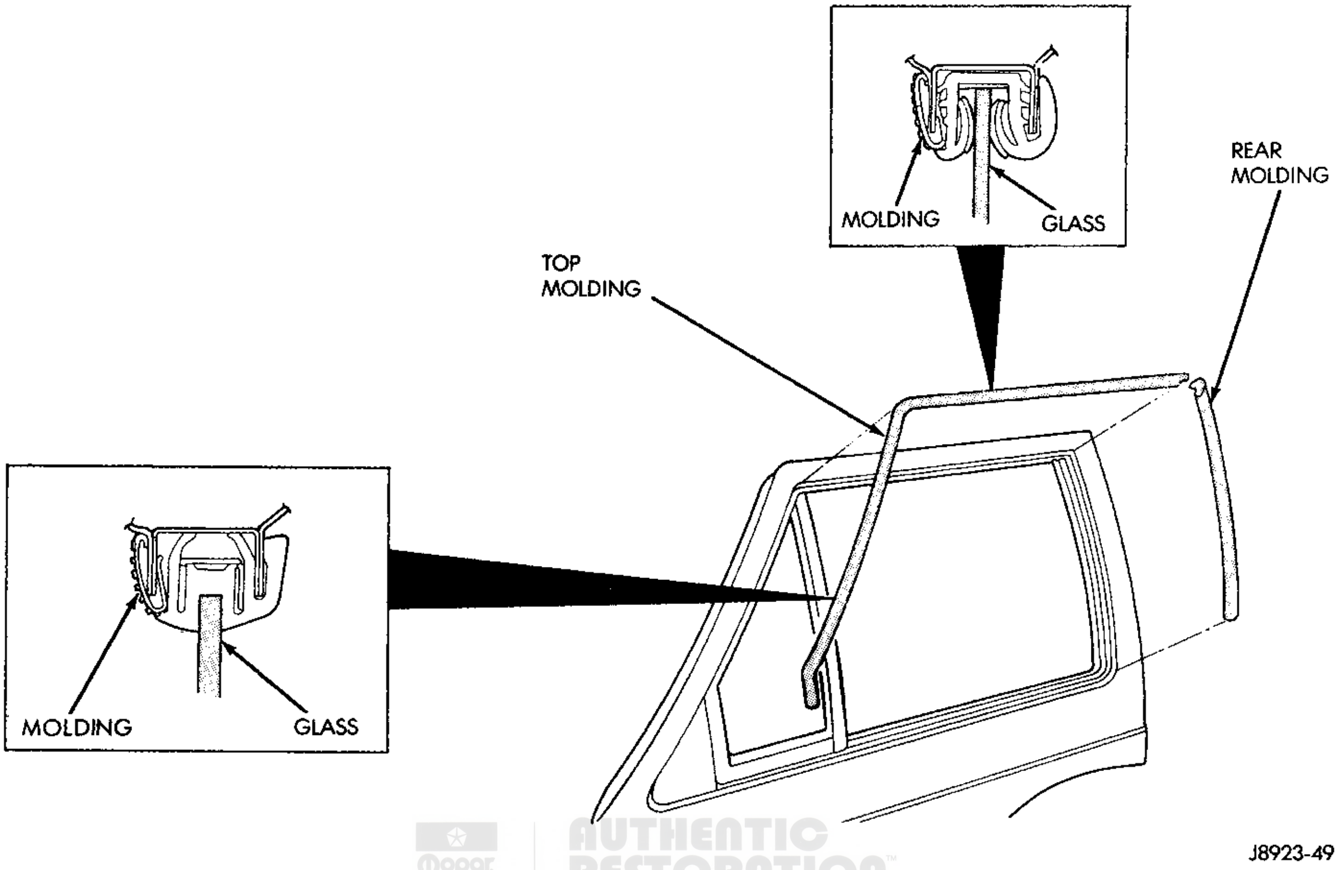


Fig. 25 Exterior Molding Replacement

small amount of adhesive can be used to hold the weatherstrip in position if desired.

The front door weatherstrip is attached to the periphery of the door opening in the body. The weatherstrip is secured with adhesive and plastic push studs. The push studs can be removed with the same type of tool used to remove the fender liner push rivets. Use adhesive along with the push studs to help secure a replacement weatherstrip.

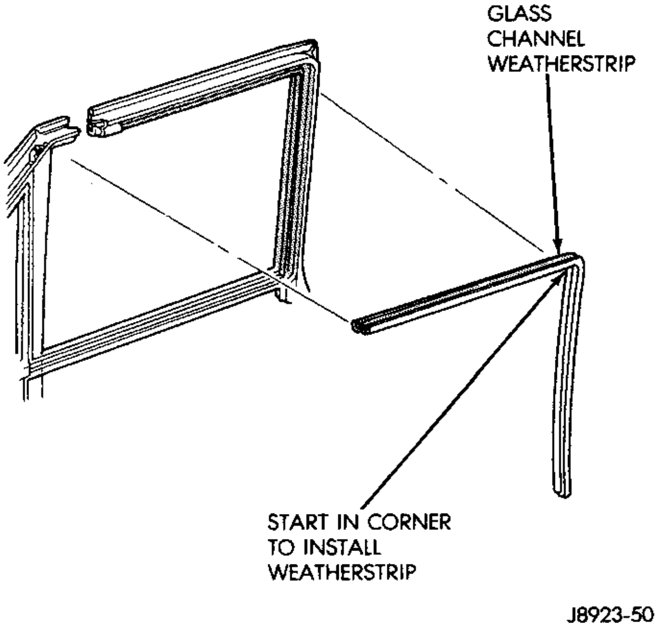


Fig. 26 Replacing Glass Channel Weatherstrip

Mirrors

Standard and low profile side view mirrors are covered in this section. Procedures include removal and installation for both mirror types. A procedure for installing low profile mirrors on a replacement door is also provided.

Side View Mirror Removal

(1) Remove the trim panel.
(2) Remove the mirror trim cover attaching screw.
(3) Loosen the trim cover setscrew (Fig. 22).
(4) Remove the trim cover.
(5) Remove the mirror retaining bolts (Fig. 23).
(6) Remove the mirror.

Side View Mirror Installation

(1) Mount the mirror assembly.
(2) Install the mirror attaching bolts (Fig. 23).
(3) Install the mirror trim cover and the setscrew.
(4) Install the trim cover attaching screw and tighten the setscrew.
(5) Install the door trim panel.

Low Profile Mirrors

Two procedures are provided for low profile mirrors. One procedure covers mirror and bracket removal only. The other procedure is for installing the mirrors and reinforcements in a replacement door.

Mirror And Bracket Removal/Installation

(1) Remove the mirror bracket bolts (Fig. 27).

(2) Remove the mirror and bracket as an assembly (Fig. 27).

(3) Remove the gaskets (Fig. 27).

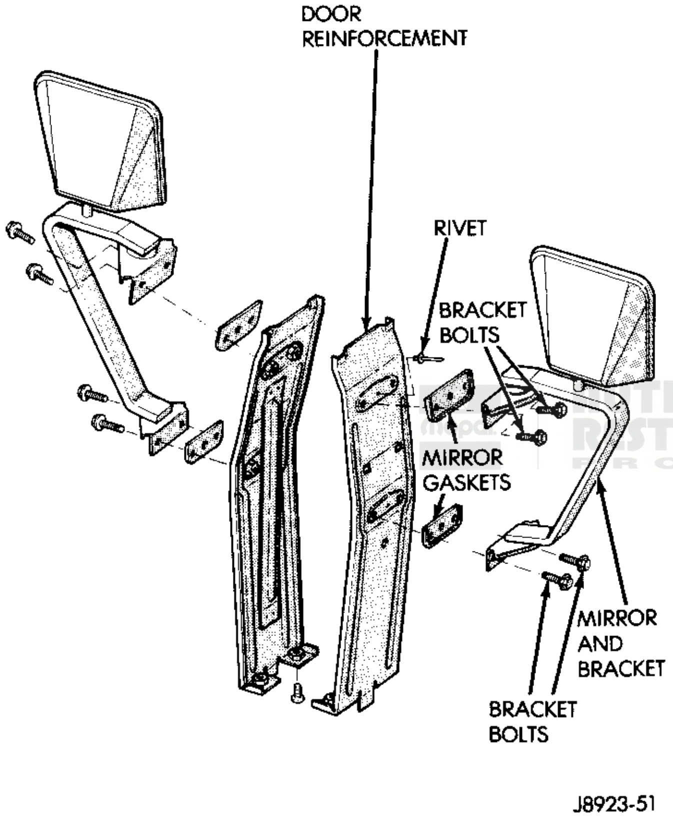


Fig. 27 Low Profile Mirror Components

(4) Clean the mirror gaskets and the body surface where the gaskets will be positioned.

(5) Place the gaskets on the mirror bracket.

(6) Position the mirror and bracket on the door.

(7) Install and tighten the mirror mounting bolts.

Installing Low Profile Mirrors On A New Door

(1) Remove the mirror and bracket, mirror gaskets and the reinforcement from the old door.

(2) Measure and mark location of the mirror upper and lower mounting bolt and rivet holes on the new door (Fig. 28). Use chalk or grease pencil to layout hole locations.

(3) Center punch and drill the bolt and rivet holes.

(4) Install the mirror reinforcement in the door. Insert the reinforcement through the lower opening. Then rotate it in the direction shown until it is upright (Fig. 29).

(5) Align the reinforcement with mounting bolt and rivet holes already drilled in the door. Then **temporarily** secure the reinforcement with one or two bolts.

(6) From inside the door panel, center punch locations of the reinforcement bottom mounting bolts (Fig. 30).

(7) Remove the reinforcement and drill the bottom mounting bolt holes in the door (Fig. 30).

(8) Seal the door hem flange and prime the door, reinforcement and door jams. Cover the bare edges of all drilled holes with an expoxy chromate, zinc base primer or 3M08892.

(9) Coat the threads of all the mounting bolts with sealer prior to installation.

(10) Reinstall the reinforcement in the door.

(11) Align the reinforcement and install the bottom mounting bolts and the top and center rivets (Fig. 30).

(12) Apply anti-corrosion material to the door interior 3M08892.

(13) Assemble, refinish and install the door but do not install the trim panel at this time.

(14) Place the mirror gaskets on the mirror bracket (Fig. 30).

(15) Install the mirror and bracket on the door (Fig. 30).

(16) Install the trim panel.

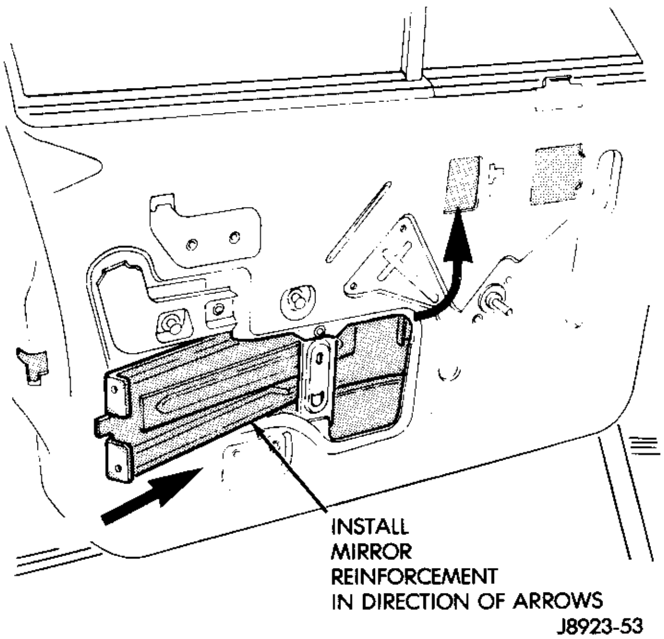


Fig. 29 Installing Mirror Reinforcement

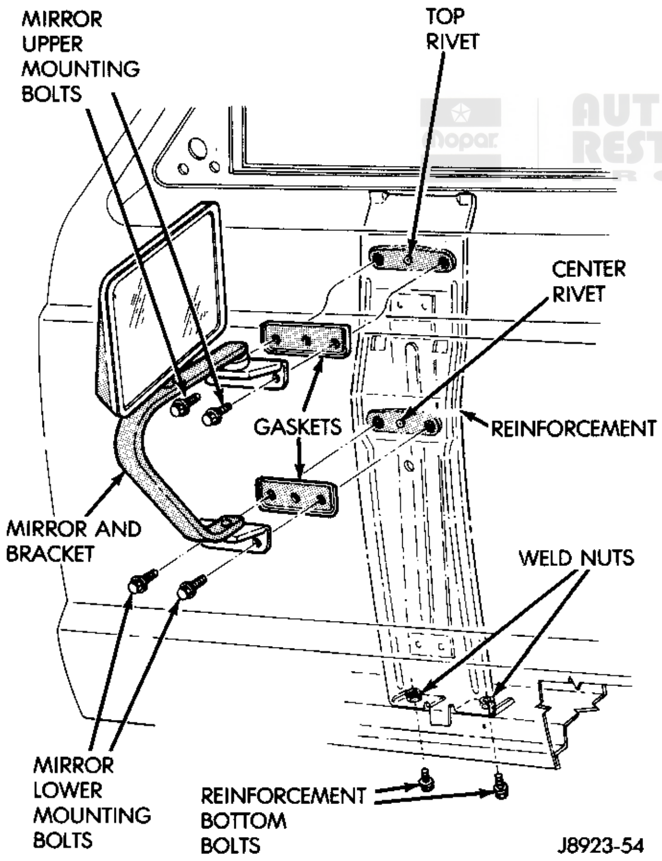


Fig. 30 Installing Low Profile Mirror

REAR DOORS

Rear door service procedures in this section include: removal and installation of the door, hinges, trim panel, door glass, latch and window regulator. Lock cylinder, door handle and latch rod adjustment are the same as for a front door. Refer to the front door service procedures where applicable.

Rear Door Removal

(1) Remove the trim panel and water dam sheet.

(2) Remove the door check pin (Fig. 1).

(3) Disconnect the wire harness.

(4) Remove the hinge bolts and remove the door. Retain the hinge bolts and shims.

(5) If the door will be replaced, remove the door components (Figs. 2 and 3).

Rear Door Installation

(1) If a replacement door is being installed, coat the door interior with 3M 08892 anti-corrosion wax and seal the entire door hem flange with 3M 08505 or 08646 sealer. Then transfer the components from the old door to the new door.

(2) Position the door on the vehicle and install the hinge bolts finger tight.

(3) Install the door on the hinges but do not tighten the hinge screws (Fig. 4) at this time.

(4) Check door fit in the body opening. If adjustment is required, install shims between the hinge plates and door as needed (Fig. 4).

(5) Connect the electrical wire harnesses.

(6) Install the trim panel and water dam sheet.

(7) Install the door check pin.

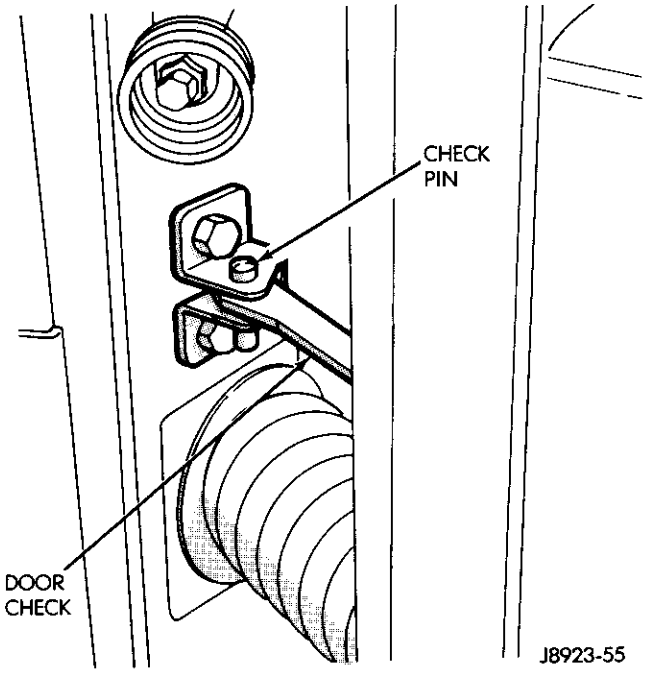


Fig. 1 Removing/Installing Door Check Pin

Trim Panel Removal

(1) Remove the interior door handle (Fig. 5).

(2) Remove the bezel, armrest and window crank handle (Fig. 5).

(3) Remove the trim panel retainers with tool J-21104-01 as described in the front door trim panel removal procedure.

(4) Remove the trim panel.

(5) Remove the water dam sheet.

Trim Panel Installation

(1) Install the plastic water dam sheet if removed.

(2) Install the trim panel and panel retainers.

(3) Install the armrest.

(4) Install the window crank handle.

(5) Install the interior door handle and bezel.

Door Window Glass Removal

(1) Lower the window.

(2) Remove the window weatherstrip.

(3) Remove the trim panel and water dam sheet.

(4) Remove the stationary glass frame screws and rivet (Fig. 6).

(5) Remove the window channel screws (Fig. 6).

(6) Tilt the window channel and stationary glass forward and remove them from the door.

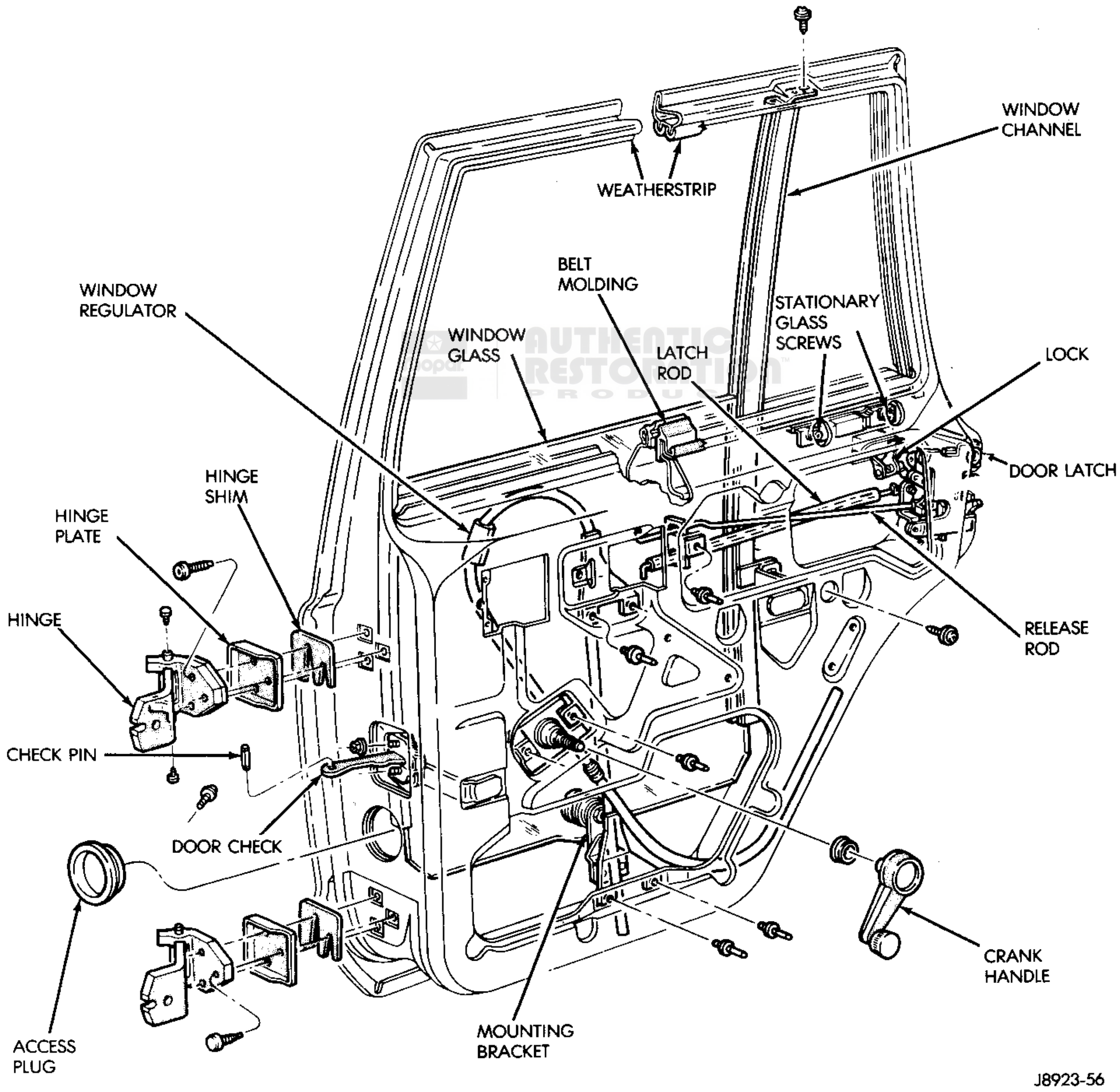


Fig. 2 Rear Door-Standard

(7) Remove the door glass stud nut (Fig. 7).

(8) Remove the window glass from the door.

Door Window Glass Installation

(1) Position the window glass in the door. Install and tighten the stud nut to 6 N•m (5 ft-lbs) torque.

(2) Install the window channel and stationary glass in the door.

(3) Install the window channel screws, rivet and the stationary glass frame screws (Fig. 6). Tighten the screws to 6 N•m (5 ft-lbs) torque.

(4) Install the window weatherstrip.

(5) Install the water dam sheet and the trim panel.

Window Regulator Removal

(1) Remove the trim panel and plastic water dam sheet.

(2) Remove the window glass.

(3) Remove the regulator rivets by driving out the rivet center with a punch. Then drill out the rivet body with a 1/4 inch drill bit (Fig. 8).

(4) Disconnect the wire harness, if equipped.

(5) Remove the regulator and window motor, if equipped.

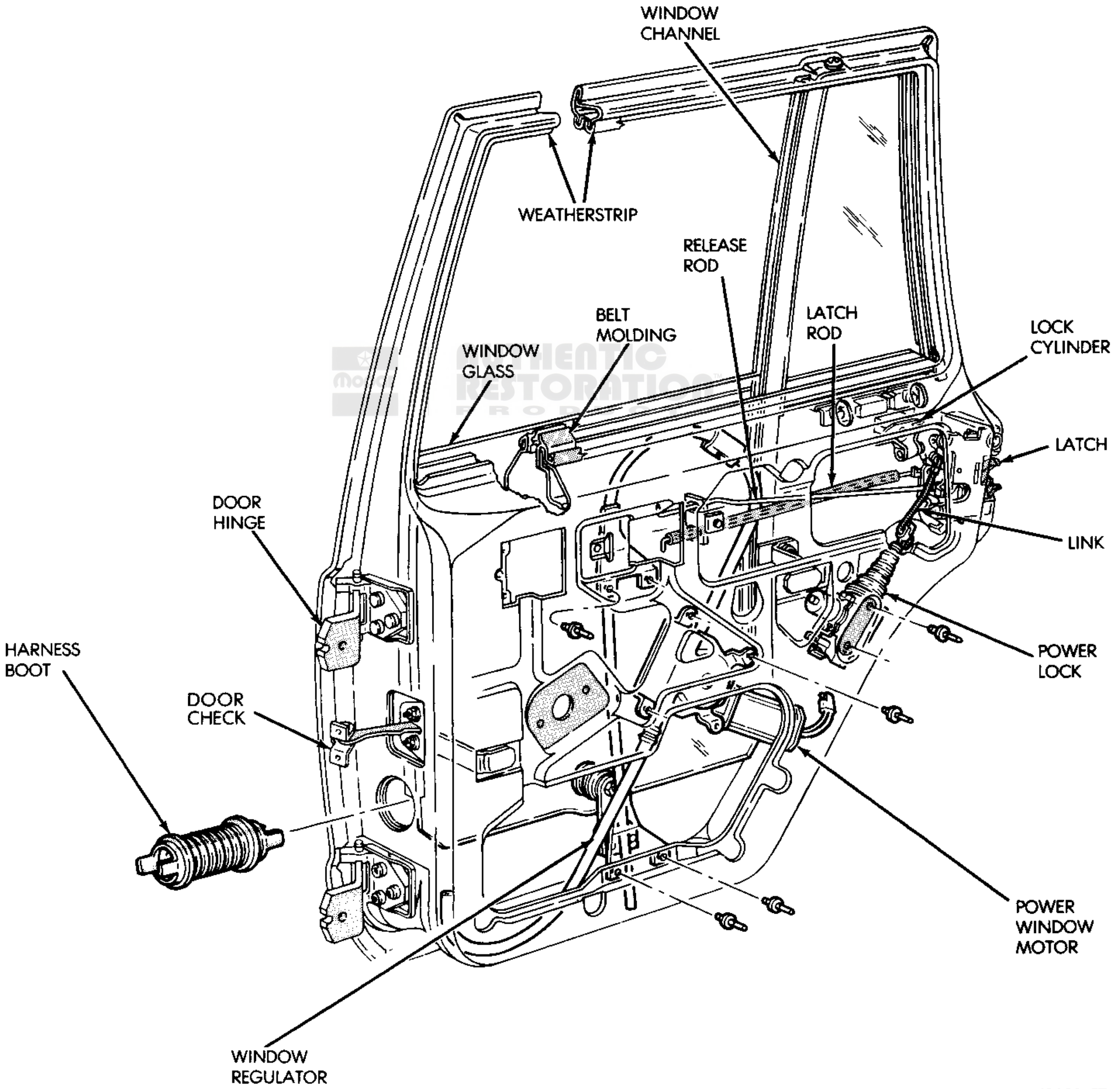


Fig. 3 Rear Door-With Power Lock And Window

Window Regulator Installation

(1) Position the window regulator and window motor in the door.

(2) Attach the regulator with new rivets or with screws and nuts available in a parts kit.

(3) Connect all electrical wires.

(4) Install the door glass and channel.

(5) Install the weatherstrip and trim panel.

Door Latch Removal

(1) Remove the trim panel and plastic water dam sheet.

(2) Remove the window weatherstrip, window channel and stationary glass.

(3) Remove the window glass.

(4) Remove the lock cylinder and door handle as described in the Front Door Lock Cylinder and Latch Removal procedures.

(5) Remove the latch assembly and linkage.

(6) On models with power locks, remove the attaching rivets and remove the lock solenoid.

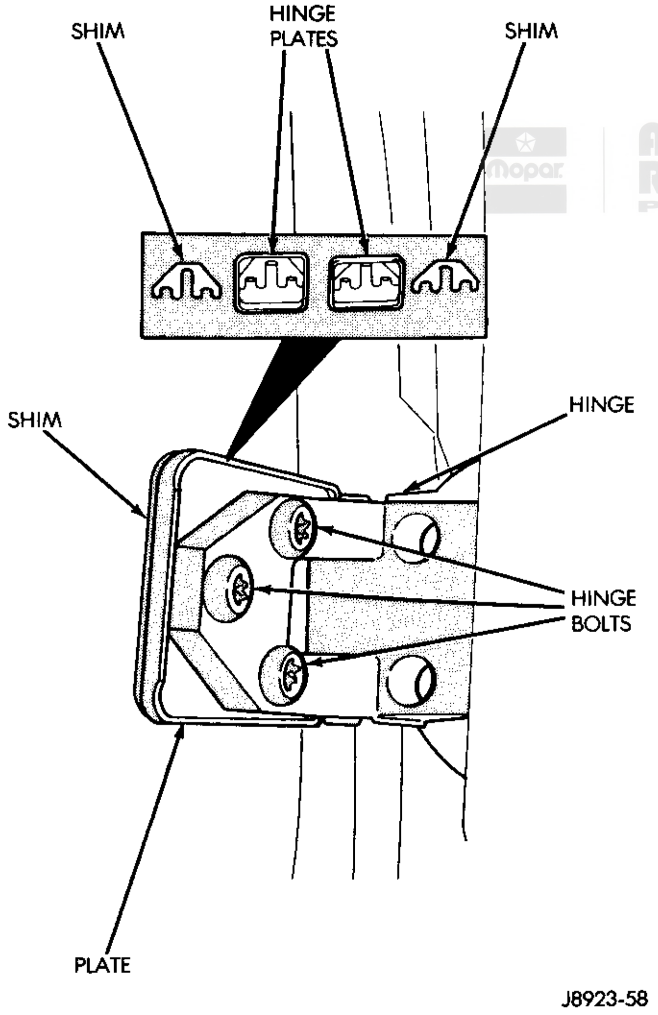


Fig. 4 Hinge-Plate-Shim Installation

Door Latch Installation

(1) Install and connect the latch assembly (Fig. 9).

(2) On models with power locks, install the power lock solenoid.

(3) Install the lock cylinder and door handle.

(4) Check and adjust lock cylinder link free play as described in the Front Door Latch Installation And Adjustment procedure.

(5) Install the water dam sheet and trim panel.

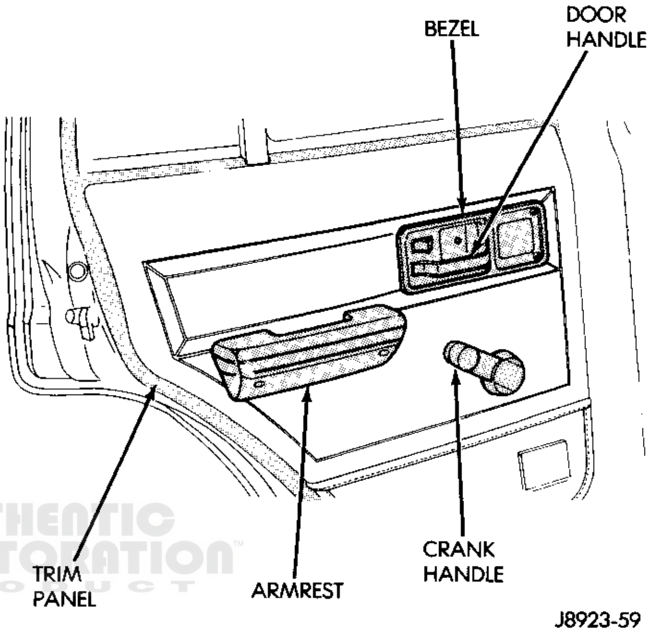


Fig. 5 Trim Panel Removal/Installation

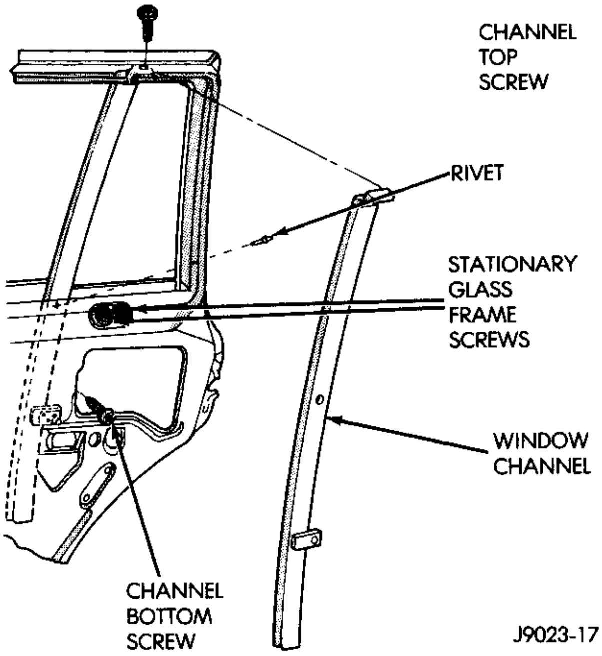


Fig. 6 Channel And Frame Screw Locations

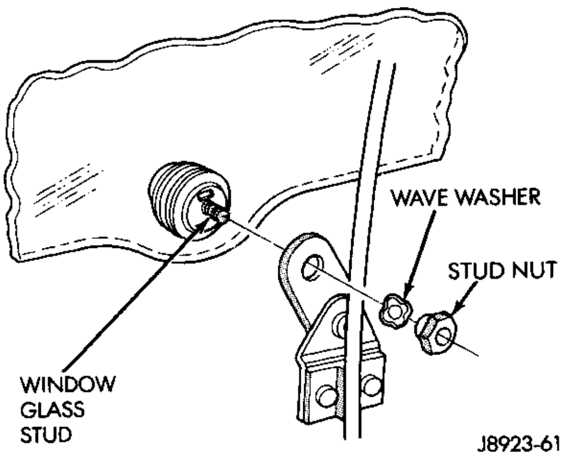


Fig. 7 Window Glass Stud Nut Removal/Installation

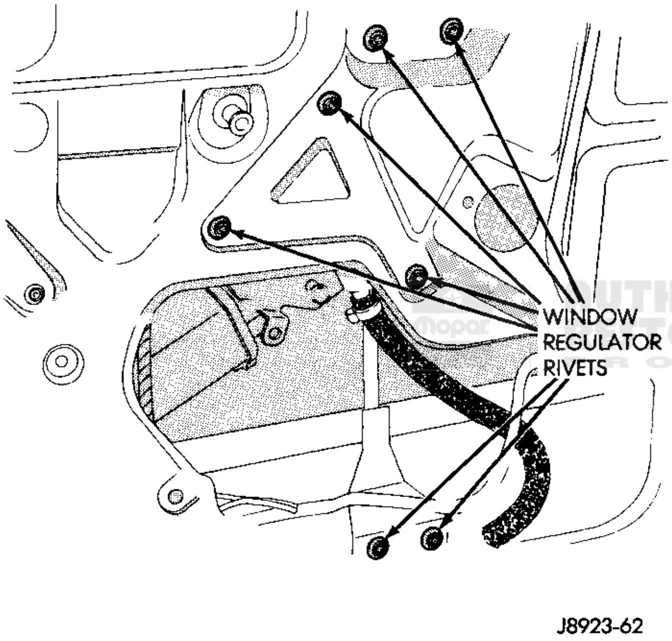


Fig. 8 Window Regulator Rivet Locations

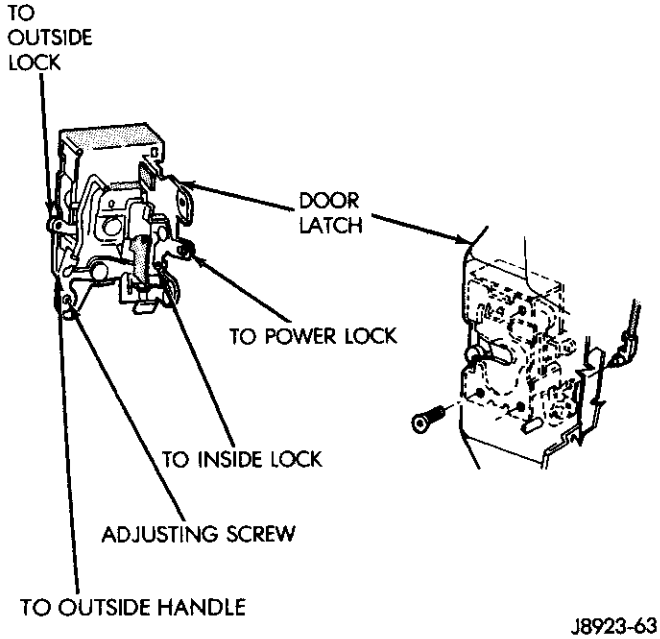


Fig. 9 Door Latch Linkage Connections

LIFTGATE

Procedures covered in this section include liftgate adjustment and removal and installation of the liftgate assembly, gas support cylinders, hinges and latch and striker. Typical liftgate components are shown in Figure 1.

Liftgate Removal

WARNING: NEVER DISCONNECT THE SUPPORT CYLINDERS WITH THE LIFTGATE CLOSED. THE SUPPORTS ARE OPERATED BY HIGH PRESSURE GAS AND COULD CAUSE DAMAGE OR PERSONAL INJURY IF REMOVED WHILE THEY ARE STILL COMPRESSED.

(1) Open the liftgate (Fig.1).

(2) Remove the liftgate trim panel.

(3) Remove the retainer clips that secure the support cylinders to the ball studs (Fig. 2).

(4) Remove the supports from the ball studs.

(5) Disconnect and remove the wire harness (Fig. 3).

(6) Remove the liftgate hinge screws (Fig. 3).

(7) Remove the liftgate.

Liftgate Installation

(1) Position the liftgate on the body and install the hinge screws (Fig. 3).

(2) Adjust the liftgate to the body opening. Refer to the Liftgate Adjustment information.

(3) Tighten the hinge screws to 9 N•m (7 ft-lbs) torque.

(4) Connect the liftgate support cylinders to the ball studs and install the support retainer clips (Fig. 2).

(5) Insert and connect the wire harness (Fig. 3).

(6) Install the trim panel.

Liftgate Hinge Removal

It is not necessary to remove the liftgate to replace one or both the hinges. The hinges can be replaced one at a time.

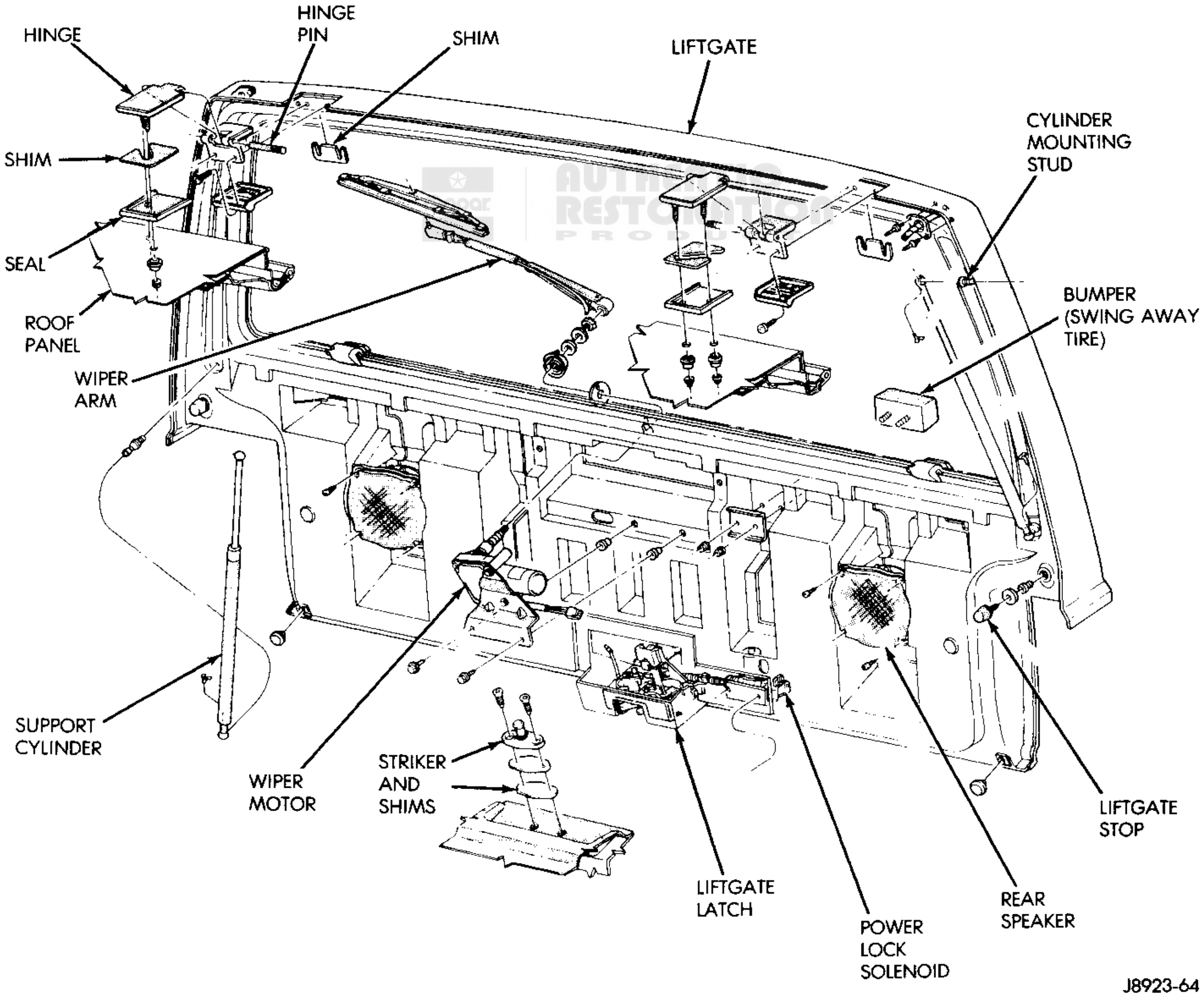


Fig. 1 Liftgate Components

(1) Remove the headliner rear trim molding.

(2) Remove the hinge-to-roof panel nuts (Fig. 4).

(3) Remove the hinge-to-liftgate screws and remove the hinge.

Liftgate Hinge Installation

(1) Position the hinge on the liftgate and roof panel.

(2) Install and tighten the hinge-to-roof panel nuts to 9 N•m (7 ft-lbs) torque.

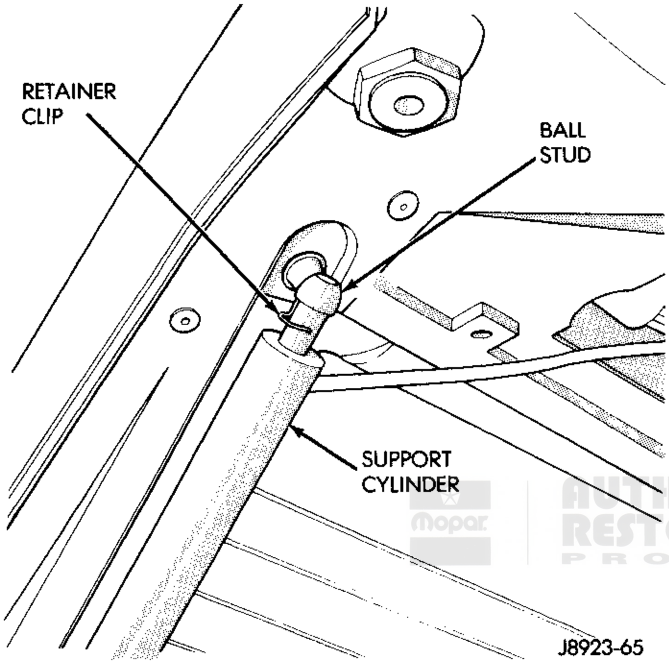


Fig. 2 Removing/Installing Support Cylinder Retainer Clips

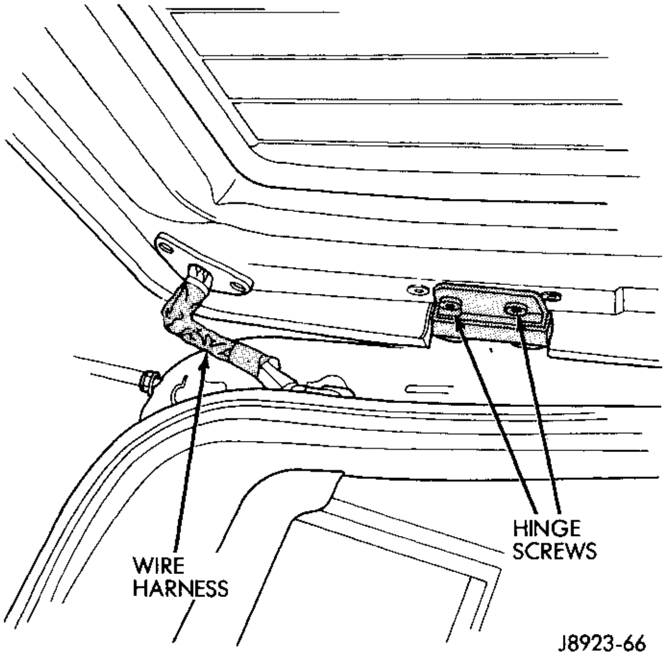


Fig. 3 liftgate Wire Harness And Hinge Screws

(3) Install the liftgate-to-hinge screws. Tighten the screws to 9 N•m (7 ft- lbs) torque.

(4) Install the headliner rear trim molding.

Latch-Lock-Striker Removal

(1) Raise the liftgate and remove the latch screws (Fig. 5).

(2) Disconnect the latch rod (Fig. 6).

(3) Remove the latch.

(4) Remove the lock cylinder clip (Fig. 6).

(5) Remove the lock cylinder (Fig. 6).

(6) Remove the striker screws.

(7) Remove the striker and shims (Fig. 1).

Latch-Lock-Striker Installation

(1) Install the lock cylinder. Secure the cylinder with the retaining clip (Fig. 6).

(2) Connect the latch rod (Fig. 6).

(3) Install and tighten the latch screws to 9 N•m (7 ft-lbs) torque.

(4) Install the striker, shims, and striker screws. Tighten the screws to 30 N•m (22 ft-lbs) torque.

Liftgate Support Cylinder Replacement

WARNING: NEVER REMOVE THE SUPPORT CYLINDERS WITH THE LIFTGATE CLOSED. THE SUPPORTS ARE OPERATED BY HIGH PRESSURE GAS AND MAY CAUSE DAMAGE OR PERSONAL INJURY IF REMOVED WHILE STILL COMPRESSED. DO NOT ATTEMPT TO DISASSEMBLE OR REPAIR THE SUPPORTS. WHEN SUPPORT REPLACEMENT IS NECESSARY, THEY MUST BE DEPRESSURIZED AS DESCRIBED IN THE DISPOSAL PROCEDURE INCLUDED IN THIS SECTION.

(1) Open the liftgate.

(2) Prop the liftgate in the open position.

(3) Remove the retainer clips that attach the cylinders to the ball studs (Fig. 2).

(4) Disconnect the cylinders from the ball studs and remove the supports.

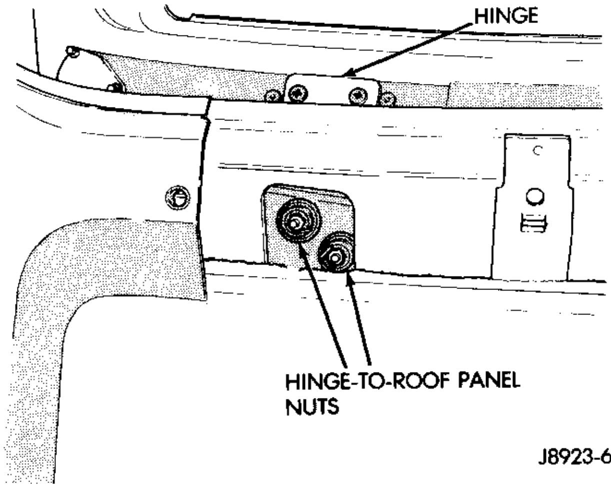


Fig. 4 Liftgate Hinge Removal/Installation

(5) Depressurize the old cylinders before disposal. Refer to the procedure in this section.

(6) Connect the new cylinders to the ball studs.

(7) Secure the cylinders to the ball studs with the retainer clips (Fig. 2).

Support Cylinder Disposal Procedure

WARNING: SAFETY GOGGLES MUST BE WORN DURING THE DISPOSAL PROCEDURE. THE HIGH PRESSURE GAS CHARGE IN THE SUPPORT CYLINDERS WILL BE RELEASED (DEPRESSURIZED) AS PART OF THE PROCEDURE. DO NOT ATTEMPT DEPRESSURIZATION WITHOUT WEARING SAFETY GOGGLES OR WITHOUT WRAPPING THE CYLINDER WITH 4-5 LAYERS OF SHOP TOWELS BEFOREHAND.

(1) Remove the support cylinder(s).

(2) Position the cylinder horizontally in a vise and clamp the cylinder securely.

(3) Wrap the cylinder with 4-5 layers of shop towels. Tape the towels in place.

(4) Measure 1-1/2 inches in from the fixed end of the cylinder. Mark this point on the towels with chalk. The cylinder will be punctured at this point to release the gas charge.

(5) Using a sharpened punch hammer, drive the punch through the towels and into the cylinder at the 1-1/2 inch mark. Continue striking the punch until gas begins to escape **but do not remove the punch.**

(6) Hold the towels and punch in position until all gas has escaped. Depressurizing should take about 4-10 seconds. Then, slowly remove the punch. Escaping oil will be absorbed by the towels.

(7) Hold a towel over the hole in the cylinder and press the cylinder rod all the way into the cylinder to purge the remaining oil.

(8) Remove the cylinder from the vise and discard the cylinder.

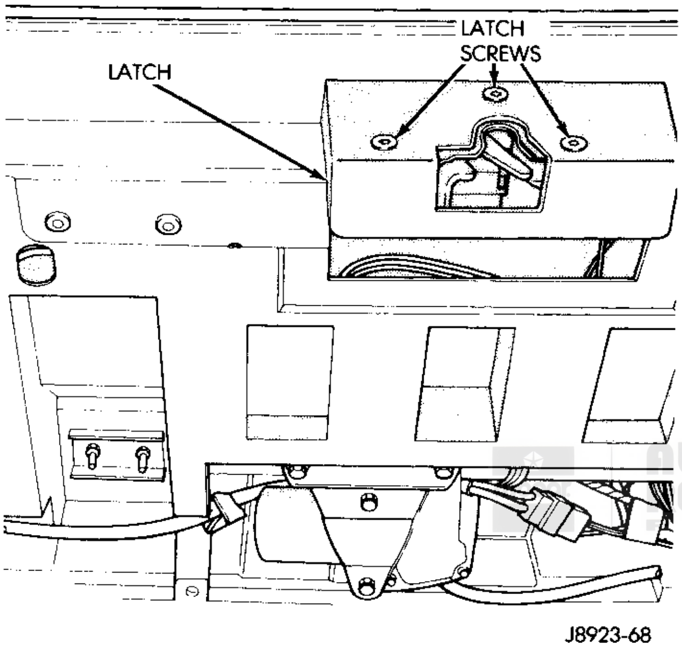


Fig. 5 Latch Screw Removal/Installation

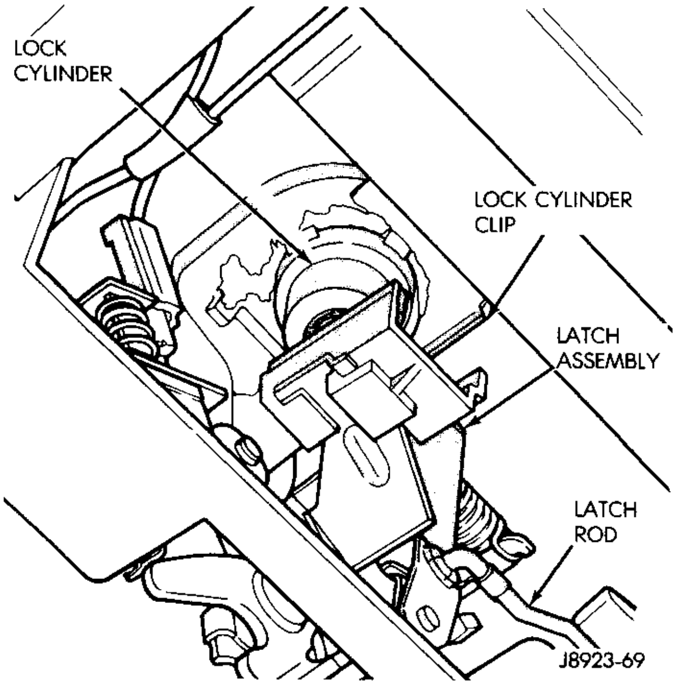


Fig. 6 Removing/Installing Latch And Lock Cylinder

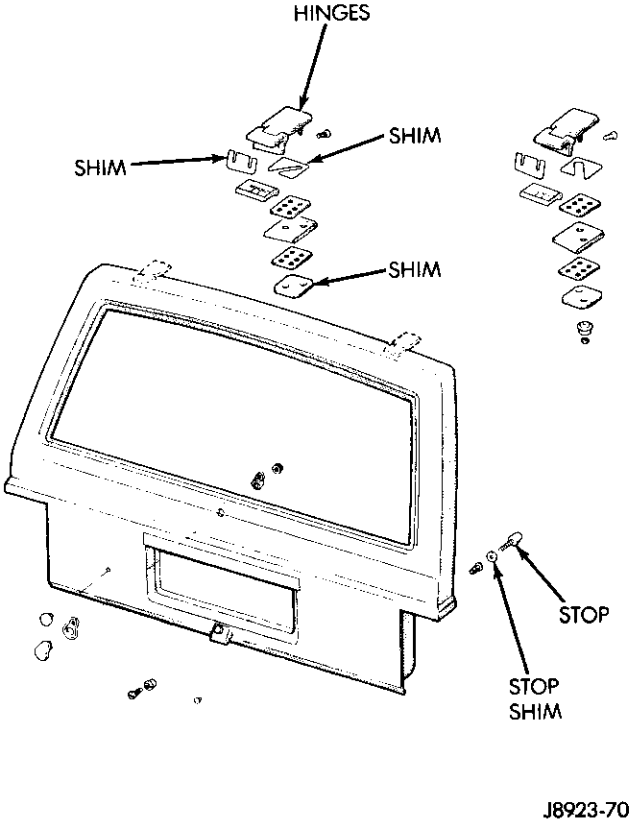


Fig. 7 Liftgate Adjustment Shims

Liftgate Adjustment

The liftgate can be adjusted up, down, in, or out with the use of shims (Fig. 7). The liftgate stop will also require adjustment if a liftgate adjustment is necessary. The stop can also be shimmed for correct fit (Fig. 7).

To move the liftgate in or out, remove or install shims between the hinge and liftgate. To move the liftgate up or down, remove or install shims between the hinges and vehicle roof panel.

STATIONARY GLASS

Procedures covered in this section include removal/ installation procedures for: quarter and vent window glass, windshield reveal molding and the windshield using the short or extended installation procedure.

Windshield Reveal Molding Removal/Installation

(1) Disengage the molding clips with tool J-21549-3 (Fig. 1).

(2) Remove the moldings.

(3) Attach the molding to the clips by tapping the molding with a rubber mallet to seat it.

Windshield Service Information

Urethane Bonding

The windshield glass is bonded to the body pinchweld flange with urethane adhesive (Fig. 2). This method of attachment complies with Federal Motor Vehicle Safety Standards and provides structural support and improved glass retention.

Removal/Installation Procedures

Windshield removal is performed with a razor knife and an electric hot knife to cut through the urethane bead. This removal method applies in all cases.

Two windshield installation procedures are required which are; the short procedure and the extended procedure.

The short procedure is used when the windshield is removed intact and the body opening and pinchweld flange do not require repair.

The extended procedure must be used when the body opening or flange is damaged. The extended procedure must also be used when the urethane adhesive no longer adheres to either the windshield or the pinchweld flange.

Windshield Removal

(1) If the windshield short installation method will be used, be sure to leave an even, uniform bead of urethane adhesive on the pinchweld flange. This adhesive bead is needed as a base for the replacement glass.

(2) Cover adjacent interior and exterior areas with protective covering to avoid paint damage and extra cleanup.

(3) Remove the windshield wiper arms, reveal molding, interior finish mouldings and rearview mirror.

(4) Make an initial cut around the **edge** of the glass with a razor knife (Fig. 3). The idea is to cut urethane away from the edge of the glass to expose the urethane bead between the glass and flange.

(5) Clean the blade of hot knife tool 4386 with solvent and a cloth. Sharpen the blade with a fine-tooth file.

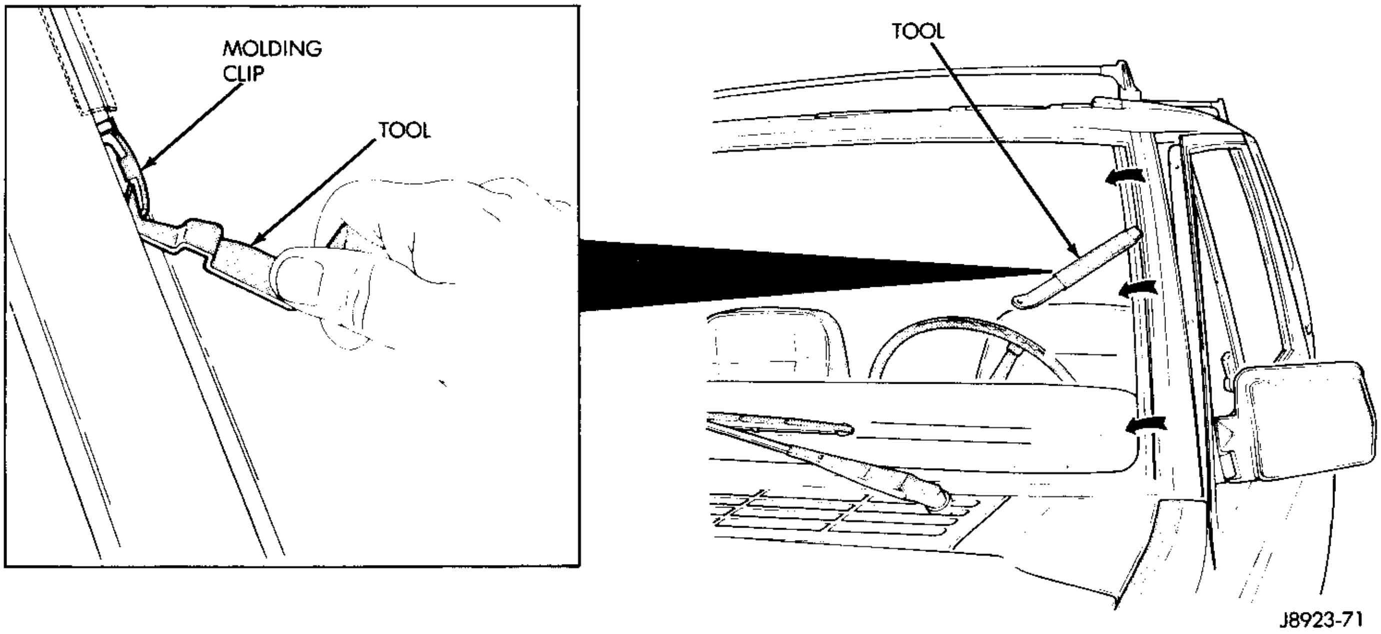


Fig. 1 Disengaging Windshield Reveal Molding Clips

CAUTION: When cutting through the urethane adhesive with the hot knife, do not allow the knife blade to remain stationary at any point. Excessive heat will permanently soften the adhesive making complete replacement necessary.

(5) Start the hot knife blade between the glass and adhesive bead. Then cut the adhesive bead as close to the glass surface as possible (Fig. 4). Leave as much adhesive on the pinchweld flange as possible. **For best cutting results, clean the knife blade frequently with steel wool while the blade is still hot.**

(6) Remove the windshield.

(7) If the hot knife blade has cooled down, clean the blade with solvent and a clean cloth.

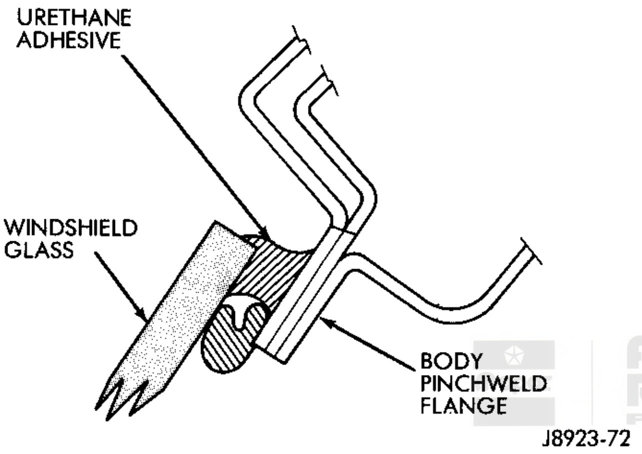


Fig. 2 Windshield Attachment With Urethane Adhesive

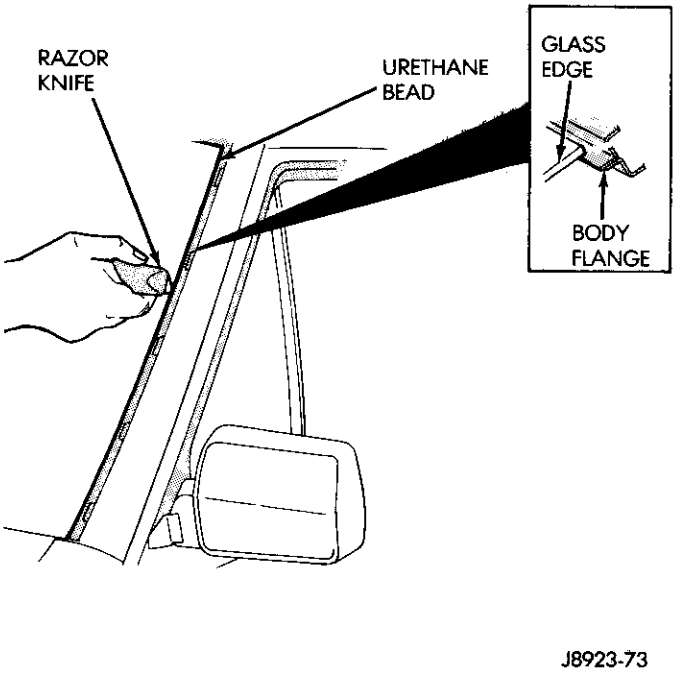


Fig. 3 Cutting Adhesive Away From Edge Of Windshield Glass

Windshield Installation-Short Method

(1) When a replacement windshield is installed, a replacement rear view mirror bracket may also have to be installed. Refer to the rear view mirror replacement procedure in this section. However, do not install the mirror until after windshield installation.

(2) Inspect the pinchweld flange. Prime any bare spots with urethane primer. Allow a minimum of 18 minutes dry time.

(3) Inspect the urethane bead for high spots. Level the bead by shaving off high spots with a razor knife. This is necessary for flush installation of the windshield.

(4) Inspect the reveal molding clips. Replace broken, distorted or excessively loose clips.

(5) Clean the outer edge of the windshield glass with naptha or a similar product.

(6) Prime the outer periphery of the interior side of the glass 5/8 inch (15.8 mm) from the edge. Use a wipe-off type urethane primer and wipe the glass dry after primer application.

(7) Install two support spacers at bottom of windshield (Fig. 5).

(8) Place the windshield on the pinchweld flange and check for gaps in the urethane adhesive. Gaps in excess of 1/8 inch must be filled with additional urethane adhesive.

(9) Adjust windshield position until it is aligned with the flange and adhesive bead. Then make alignment marks on the glass and body with grease pencil or masking tape to use as alignment reference.

(10) Remove the windshield (but not the support spacers) and position it on a flat surface.

(11) Apply one-inch wide masking tape around the interior side of the glass 5/8 inch from the edge of the glass (Fig. 6). Do not apply tape along the bottom of the glass.

To Inside Of Glass

(12) Thoroughly mix and apply blackout primer to the 5/8 inch area around the interior side of the glass. Allow primer to dry for at least 10-12 minutes.

(13) Apply a continous, 1/4 inch diameter bead of new urethane adhesive to the masked off area on the interior side of the glass.

CAUTION: Be prepared to install the windshield shortly after applying the adhesive. The adhesive begins to cure within 10-15 minutes.

(14) Align the windshield using the reference tape strips or pencil marks and install the windshield on the pinchweld flange. Be sure the windshield is seated on the support spacers.

(15) Press the windshield inward just enough to wet-out and set the adhesive. Take care to avoid excessive squeeze-out of adhesive.

(16) Water test the windshield with a cold water spray after installation. Do not direct hard streams of water

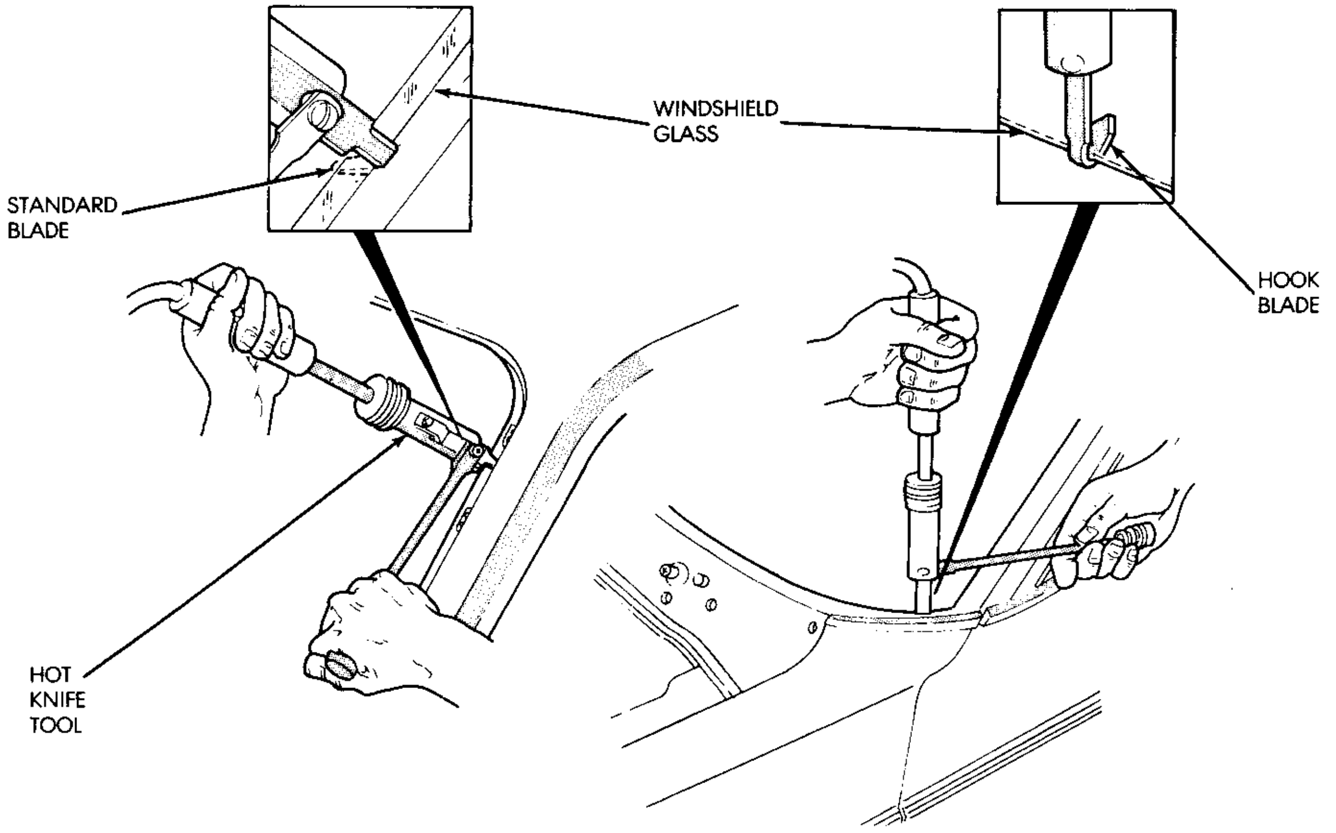


Fig. 4 Cutting Windshield Adhesive Bead With Electric Hot Knife

directly at the adhesive bead. Use a spray only. If any leaks are encountered, use additional adhesive as required.

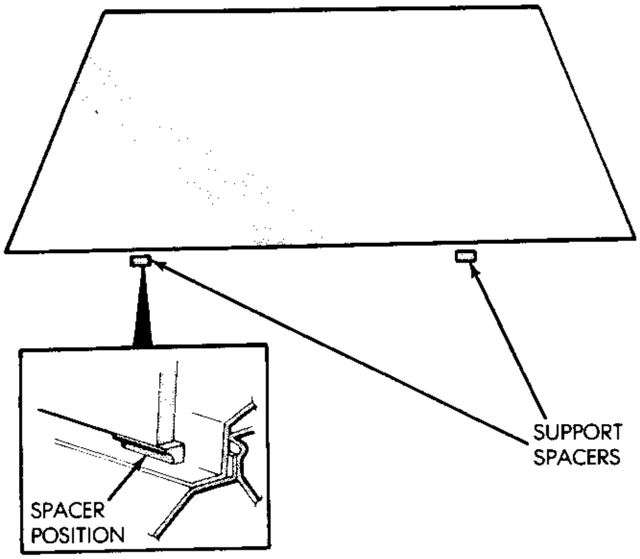


Fig. 5 Installing Windshield Support Spacers

(17) Install the windshield reveal mouldings and remove the masking tape from the inner surface of the glass.

(18) Install all other previously removed parts and clean up.

(19) Open the vehicle windows to prevent interior pressure buildup while the urethane is curing.

Windshield Installation-Extended Method

(1) Remove all of the old urethane adhesive from the entire pinchweld flange. Use the electric hot knife and the plow-type knife blade to remove the adhesive.

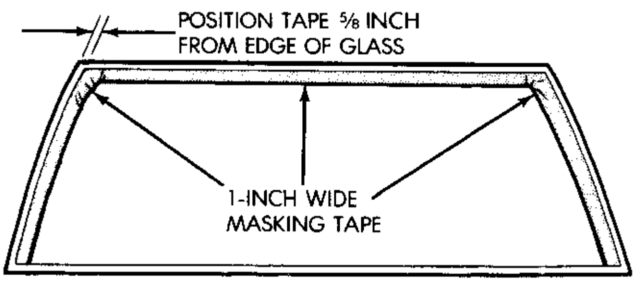


Fig. 6 Applying Masking Tape

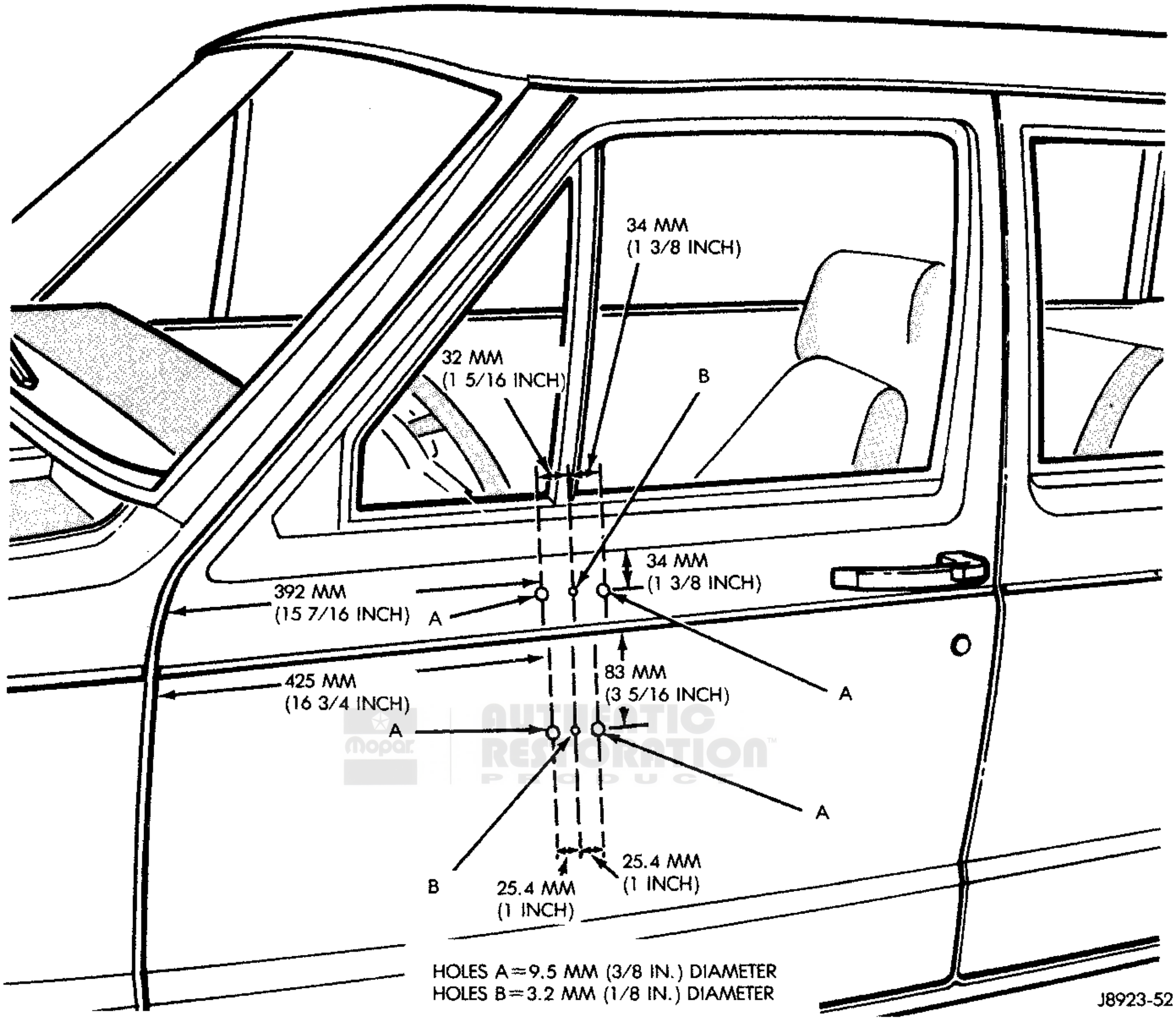


Fig. 28 Mirror Mounting Bolt And Rivet Hole Locations

(2) Repair the body opening and pinchweld flange as required.

(3) inspect and replace the reveal molding clips if bent, distorted, broken or loose.

(4) Prime the pinchweld flange with a urethane base primer. However, if the flange has been top coated, prime the flange with a paint finish primer. This is important as the urethane adhesive may not adhere to some top coat paints.

(5) Install the lower support spacers and the standoff spacers on the pinchweld flange (Fig. 7). Be sure all the spacers are water soluble.

(6) Check fit of windshield on pinchweld flange as follows:

(a) Install the windshield on the spacers and adjust windshield position until aligned with the body opening.

(b) Check gap between pinchweld flange and glass around entire perimeter of glass and flange.

(c) Gap should be at least 1/8 inch but no more than 1/4 inch at any point around perimeter. Flange should also overlap glass equally around perimeter.

(7) If pinchweld flange needs repair, remove windshield and straighten, align, or repair flange as necessary.

(8) Position windshield on flange and check windshield fit again. If fit is OK, mark windshield final position on glass and body with masking tape or grease pencil. Marks will be used as installation reference.

(9) Clean perimeter of interior side of windshield glass with isopropyl alcohol. Clean glass in from edge for a distance of at least one inch.

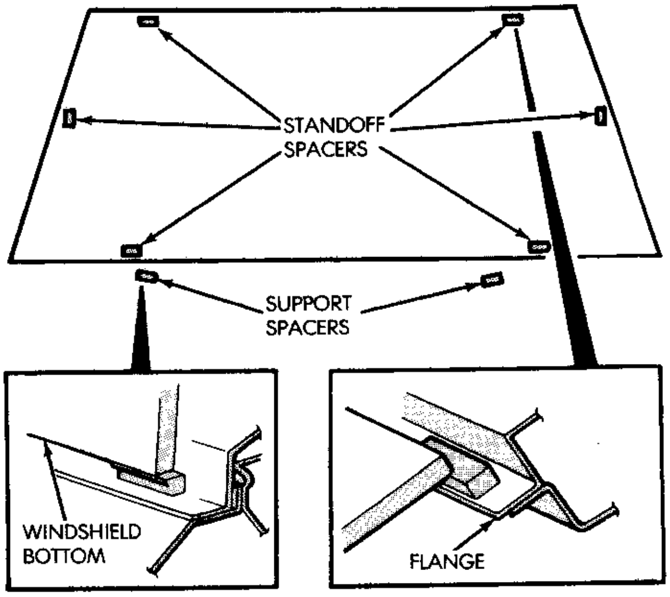


Fig. 7 Installing Support And Standoff Spacers

(10) Apply one-inch wide masking tape around the interior side of the glass 5/8 inch from the edge of the glass (Fig. 6). Do not apply tape along the bottom of the glass.

(11) Wipe the 5/8 inch taped off area of glass with a shop towel dampened in isopropyl alcohol.

(12) Thoroughly mix and apply blackout primer to the 5/8 inch area around the interior side of the glass (Fig. 8). Allow primer to dry for at least 10-12 minutes.

(13) Cut the adhesive applicator nozzle as shown for the extended procedure (Fig. 9). Make nozzle opening large enough to provide a 1/4 inch wide bead of adhesive.

(14) Apply a continous bead of new urethane adhesive to the taped off area of the glass. Adhesive bead should be 1/4 wide by 3/8 inch high for best results.

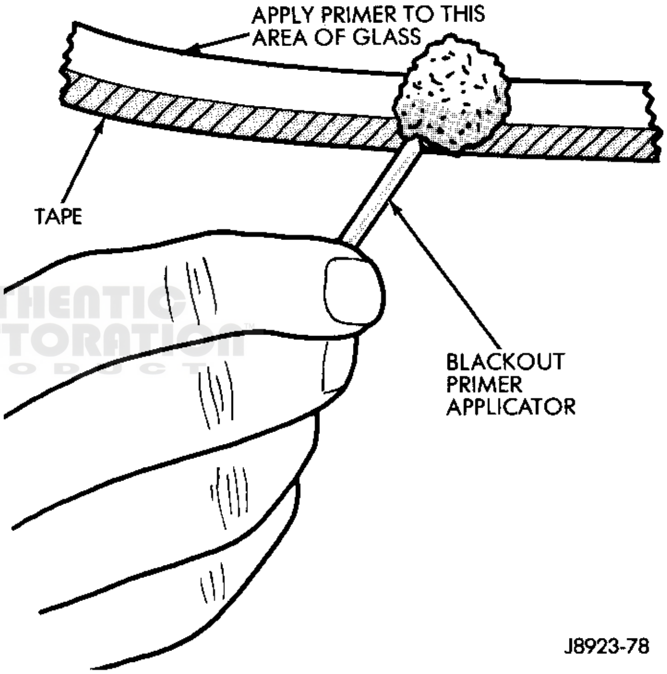


Fig. 8 Applying Blackout Primer

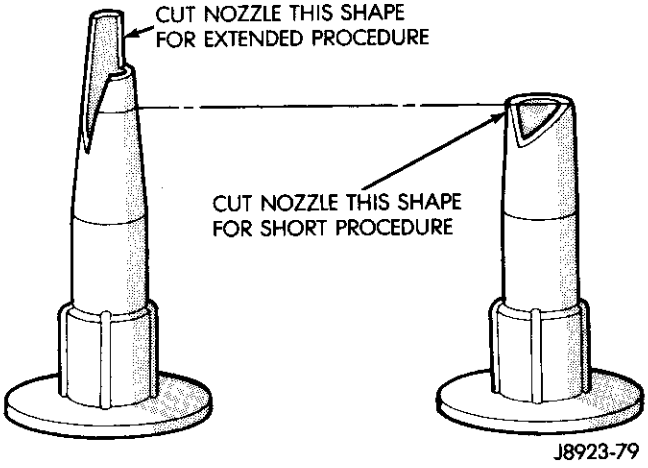


Fig. 9 Preparing Adhesive Applicator Nozzle

CAUTION: Be prepared to install the windshield shortly after applying adhesive. The adhesive begins to cure within 10-15 minutes.

(15) Align the windshield using the reference tape strips or grease pencil marks. Then install the windshield on the pinchweld flange and spacers. Be sure the windshield is seated on the two bottom spacers.

(16) Press the windshield inward just enough to wet-out and set the adhesive. Take care to avoid excessive squeeze-out of adhesive.

(17) Water test the windshield with a cold water spray after installation. Do not direct hard streams of water directly at the adhesive bead. Use a spray only. If any leaks are encountered, use additional adhesive as required.

(18) Install the windshield reveal moldings and remove the masking tape from the inner surface of the glass.

(19) Install all other previously removed parts and clean up with a cloth dampened in Grow Chemical Solvent GS-35, or equivalent.

(20) Install the rearview mirror on the bracket and tighten the mirror setscrew to 2N•m (15 in-lbs) torque.

Rear View Mirror

Mirror Removal/Installation

(1) Loosen the mirror set screw and slide the mirror up and off the mounting button (Fig. 10).

(2) To install the mirror, slide the mirror onto the mounting button and tighten the set screw.

CAUTION: Do not overtighten the setscrew as glass chipping or breakage could occur.

Mirror Mounting Button Replacement

(1) Mark location of the mirror button on the **outside** of the windshield glass with a grease pencil. Make horizontal and vertical position lines for accurate placement.

(2) If the vinyl pad remained on the windshield, soften and remove it with a heat gun. Low heat setting is enough to soften the pad.

(3) Thoroughly clean the button mounting area of the glass. Use a mild abrasive powder (Ajax, Comet, etc) on a cloth saturated with isopropyl alcohol. Final clean the glass with a paper dampened with alcohol.

(4) Lightly sand the mounting surface of the new button with fine grit paper. Then wipe clean the button mounting surface clean with a paper towel and alcohol.

(5) Apply adhesive accelerator to the mounting surface of the mirror button as follows:

(a) Crush the vial in the plastic housing of the accelerator to saturate the felt applicator.

(b) Remove the paper sleeve.

(c) Apply a generous amount of accelerator to the mounting surface of the mirror button.

(d) Allow the accelerator to dry for at least five minutes. Do not touch the button surface covered with accelerator.

(6) Apply adhesive accelerator to the button mounting surface of the windshield glass. Allow the accelerator to dry for one minute. Do not touch the glass surface covered with accelerator.

(7) Attach the mirror button as follows:

(a) Apply one drop of adhesive at the center of the button surface on the windshield.

(b) Immediately apply an even coat of adhesive to the mounting surface of the button.

(c) Align the button with the reference lines. Then press and hold the button in place for at least one minute. **Be sure the button is correctly aligned as the adhesive sets up rapidly.**

(8) Let the adhesive set up for 8-10 minutes. Then remove any adhesive residue with an alcohol dampened cloth.

(9) Allow the adhesive to cure for an additional 8-10 minutes before installing the mirror.

Vent Window Glass Replacement

(1) Remove the vent window handle retaining pin and nut (Fig. 11).

(2) Remove the two hinge-to-glass retaining screws and remove the glass. If the glass sticks to the hinges, remove the glass by carefully pushing out the hinge screw inserts.

(3) Attach the glass to the hinges and install the retaining screws.

(4) Install the handle, pin and retaining nut (Fig. 11).

(5) Test the window for water leaks.

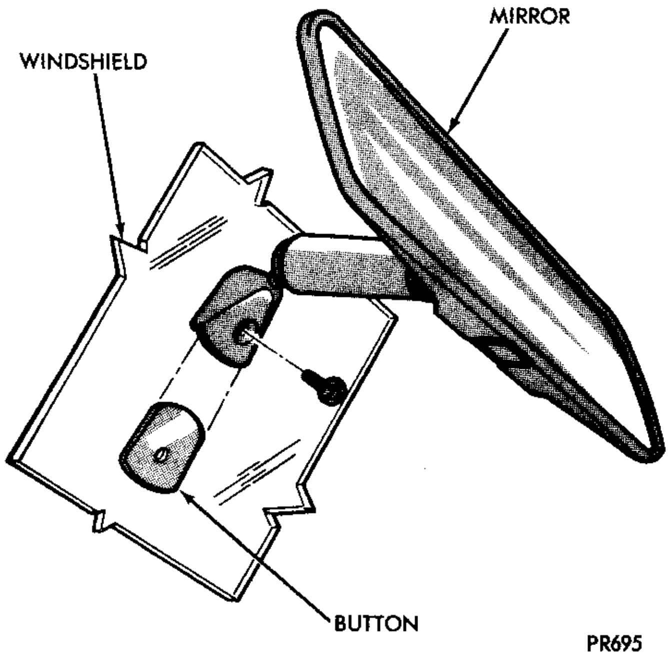


Fig. 10 Rear View Mirror Mounting

Rear Quarter Window Glass Removal

(1) Remove the interior quarter window trim.

(2) Carefully push the glass outward and remove the glass weatherstrip with a wood or plastic tool.

Rear Quarter Glass Installation

(1) Clean the old sealer from the glass opening in the body.

(2) Apply 3M 08511 sealer or equivalent to the glass mounting surface of the weatherstrip.

(3) Install the weatherstrip on the glass.

(4) Install the quarter glass and weatherstrip with a length of cord as follows:

(a) Moisten a length of 1/4-inch diameter cord with a soap and water solution. Make the cord long enough to go all the way around the weatherstrip with about 14-18 inches extra at each end (Fig. 12).

(b) Insert the cord into the weatherstrip flange channel (Fig. 12).

(c) Position the glass and weatherstrip in the window opening with the free ends of the cord inside the vehicle (Fig. 12).

(d) Pull on each end of the cord to pull the lip of the weatherstrip over the body flange.

(5) Install interior trim.

(6) Seal the body flange-to-weatherstrip mating surface with 3M 08509 sealant or equivalent.

Liftgate Glass Removal

(1) Remove the interior trim.

(2) Push the glass from the top toward the outside of the vehicle. Use a wooden or nylon tool to start the removal process.

(3) Remove the glass from the gasket.

(4) Clean the mating surfaces.

(5) Apply 3M 08511 or an equivalent sealer to the gasket/glass mating surface.

Liftgate Glass Installation

(1) Insert glass in the gasket.

(2) With the glass installed in the gasket, and before installing the glass and weatherstrip into the opening, insert a 1/4-inch cord completely around the weatherstrip in the flange cavity with a soap and water solution.

(3) Place the glass and weatherstrip into position in the window opening with the free ends of the cord inside the vehicle.

(4) Pull on the ends of the cord to pull the lip of the weatherstrip over the body panel.

(5) Install the trim.

(6) Seal the body flange-to-gasket mating surface with 3M 08509 or equivalent sealer.

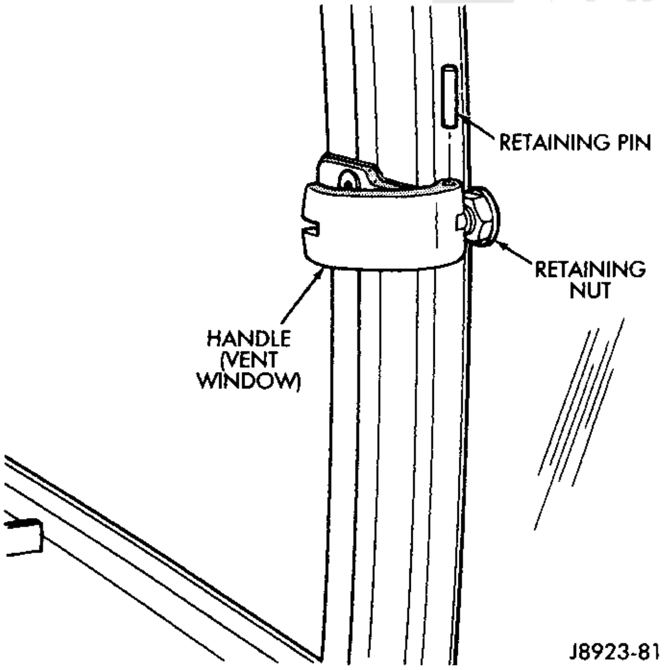


Fig. 11 Removing/Installing Vent Window Handle

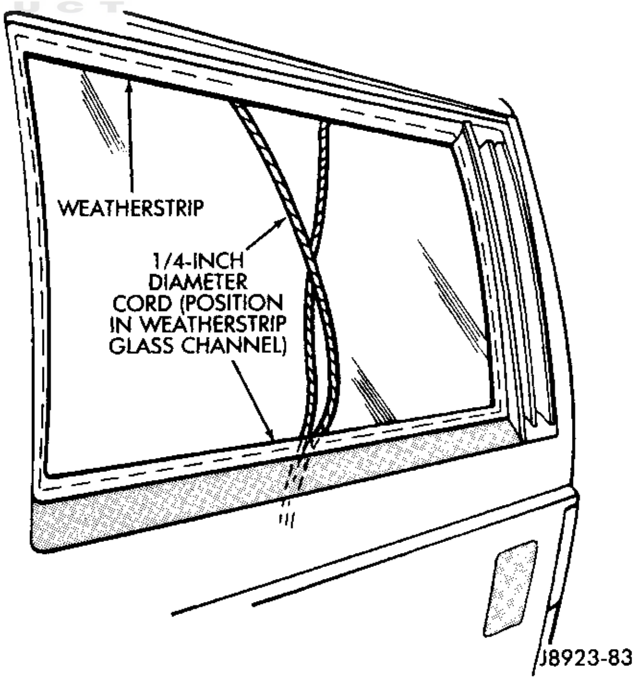


Fig. 12 Installing Rear Quarter Window

EXTERIOR BODY MOLDINGS

Vinyl Molding Replacement (Fig.1)

(1) Loosen the molding with a heat gun.

(2) Lift one edge of molding with a putty knife and peel the molding from the panel. Apply additional heat at any point where the molding sticks to ease removal.

(3) Remove the old adhesive from the body with 3M All Purpose Cleaner, Ditzler DX-330, Dupont Prep-Sol, Acrysol, or an equivalent cleaner. If the original molding will be reused, remove all old adhesive from the molding also.

(4) Install 3M 06379 double sided tape on the molding.

(5) To ensure proper horizontal alignment, use masking tape or string (secured with tape) to outline molding position on the body.

(6) Position the molding on the vehicle. Remove the protective backing from the double sided tape and press the molding onto the body with a roller or hand pressure.

(7) Remove the alignment tape or string and verify molding alignment.

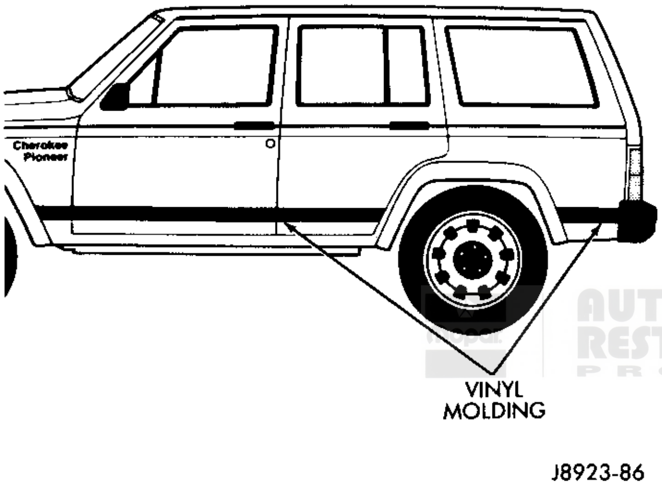


Fig. 1 Vinyl Body Side Molding

Vinyl Clad Metal Molding Replacement

(1) Carefully pry the molding off the body (Fig. 2).

(2) Install the clips in the molding (if removed).

(3) Align the molding clips with the holes in the body and snap the molding into place.

SEATS

Front Seat Removal

(1) Disengage the seat frame trim panel clips and remove the trim panels.

(2) Remove the seat frame attaching bolts and nuts (Fig. 1).

(3) Remove the seat assembly.

Front Seat Installation

(1) position the seat on the floorpan.

(2) Install and tighten the seat attaching bolts and nuts to 25 N•m (18 ft-lbs) torque

(3) Install the seat frame trim panels.

Front Seat Cushion And Cover Removal

(1) Remove the seat assembly from the vehicle.

(2) Unhook the bottom cover elastic bands (Fig. 2).

(3) Remove the bottom seat cushion retaining screws and remove the cover from the frame (Fig. 2).

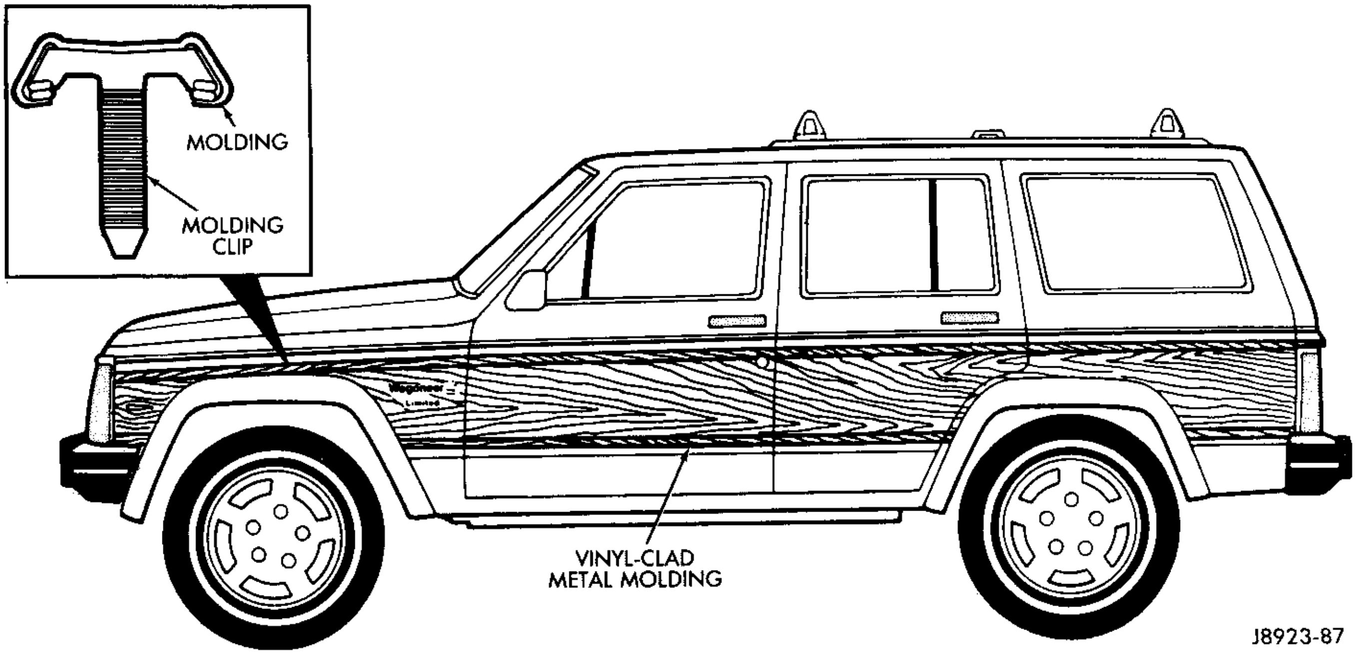


Fig. 2 Vinyl Clad Metal Molding

(4) Remove the seat cushion screws and remove the cushion from the seat frame (Fig. 3).

Front Seat Cushion And Cover Installation

(1) Mount the cushion on the seat frame.

(2) Install the cushion screws.

(3) Install the cover on the cushion and install the cover screws and elastic bands (Fig. 1).

(4) Install the seat in the vehicle.

(5) Install the seat trim.

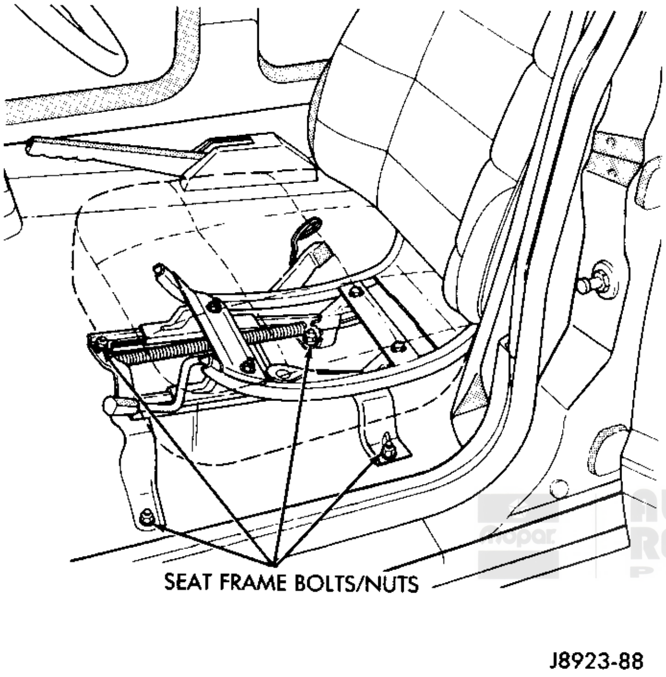


Fig. 1 Removing/Installing Front Seat

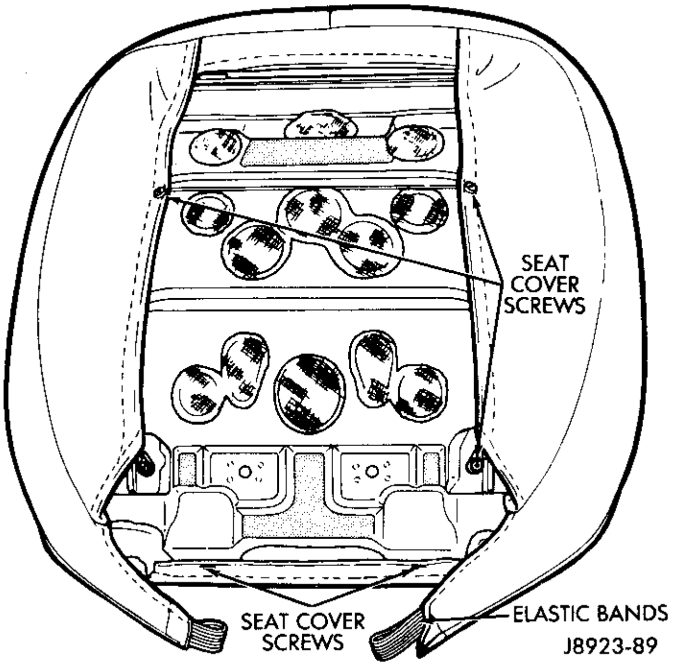


Fig. 2 Removing/Installing Front Seat Cover

Front Seat Back Cover Removal

(1) Remove the seat assembly from the vehicle.

(2) Remove the seat back from the cushion.

(3) Loosen the headrest retainers and remove the headrest by pulling it up and out of the seat back (Fig. 3).

(4) Remove the recliner lever by pulling it outward (Fig. 4).

(5) Remove the release lever handle roll pin and remove the lever (Fig. 4).

(6) Remove the lever bezel screw and remove the bezel (Fig. 4).

(7) Pry the seat back insert upward to release the insert clips (Fig. 5).

(8) Release the Velcro strip or elastic band at the bottom of the cover.

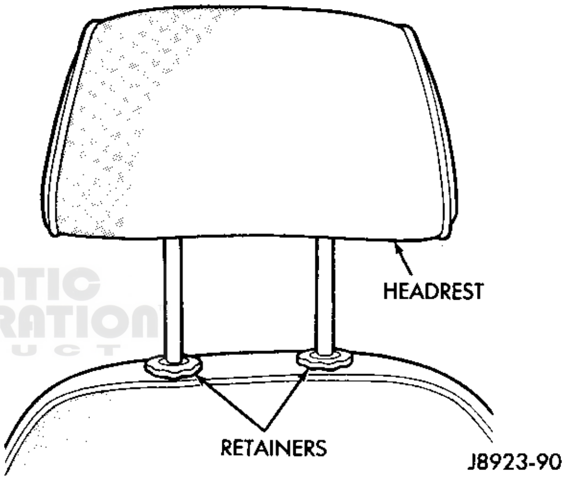


Fig. 3 Headrest Removal/Installation

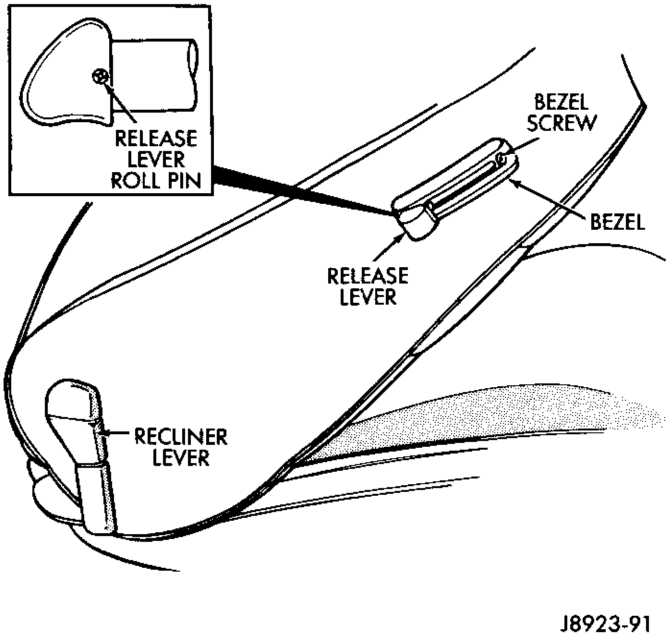
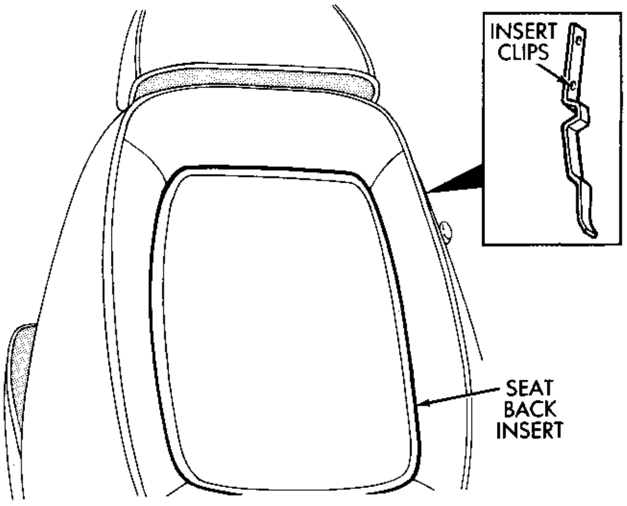


Fig. 4 Removing/Installing Seat Levers



J8923-92

Fig. 5 Removing/Installing Seat Back Insert

(9) Remove the seat cover fasteners and remove the cover (Fig. 6).

Front Seat Back Cover Installation

(1) Install the cover on the seat back.

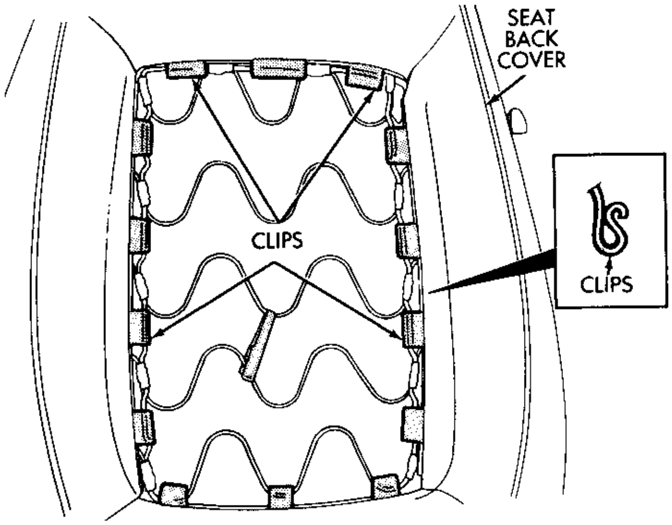
(2) Secure the cover to the seat frame with the clips (Fig. 6).

(3) Attach the cover bottom elastic band or Velcro strip.

(4) Install the seat back insert (Fig. 5).

(5) Install the seat back levers (Fig. 4).

(6) Install the head rest.



J8923-93

Fig. 6 Seat Back Cover Removal/Installation

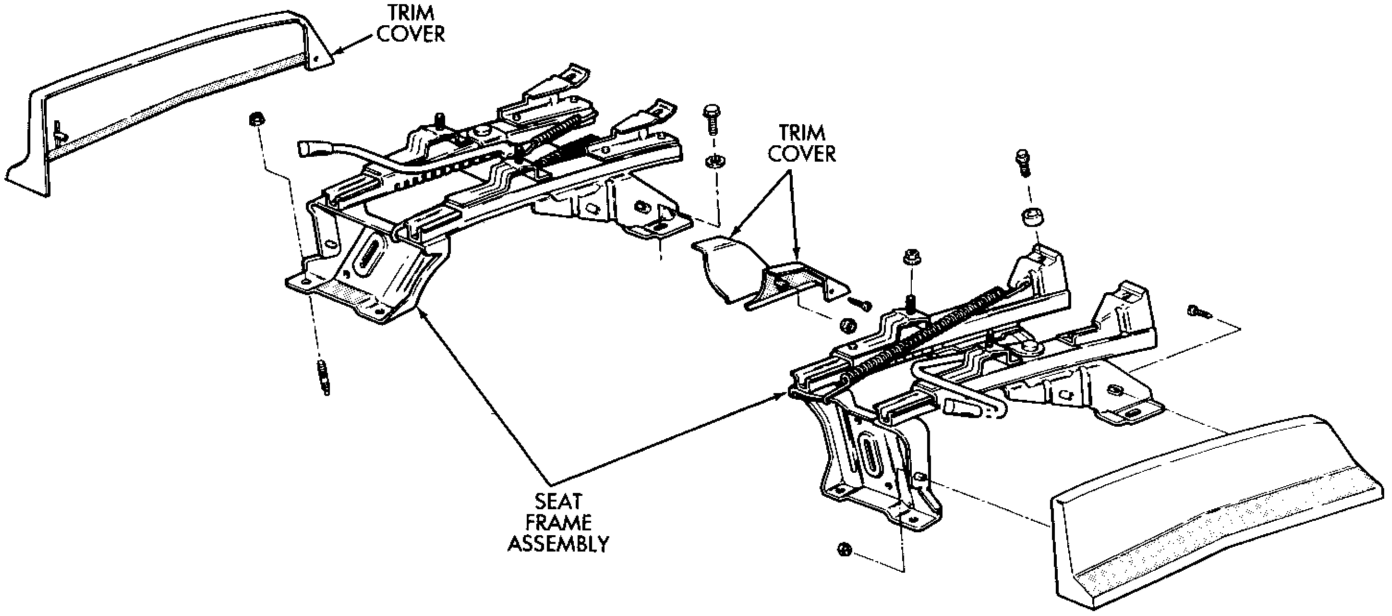
(7) Install the seat back and install the seat assembly.

SEAT FRAME AND TRACK ASSEMBLIES

The front seat frame and track assemblies are not repairable components. If a seat frame or track is damaged, replace the frame and track as an assembly.

The standard seat frame has a straight track (Fig. 1). The rocker recliner seat frame has a curved track (Fig. 2).

The front seat frame and track assemblies are attached to the floorpan with studs at the front and bolts at the back. The trim covers are attached with push



J8923-100

Fig. 1 Standard Front Seat Frame Assembly

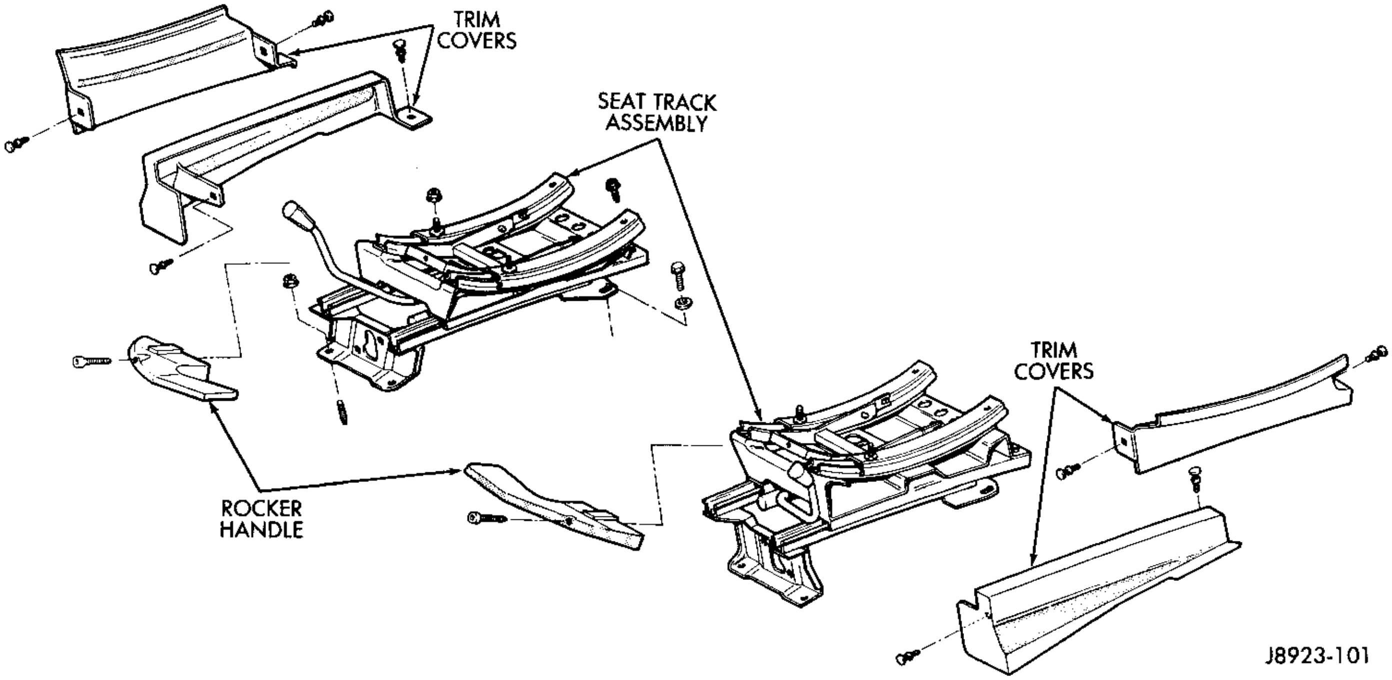


Fig. 2 Rocker/Recliner Seat Frame Assembly

rivets, plastic clips and/or screws (Figs. 1 and 2).

REAR SEATS

Procedures covered in this section include rear seat cushion and seat back removal/installation and seat cover replacement.

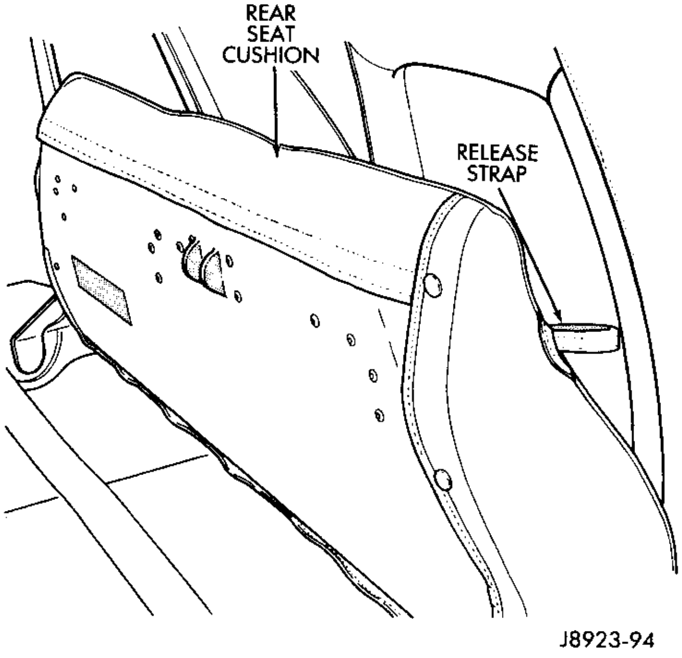


Fig. 1 Releasing Rear Seat Cushion

Rear Seat Cushion Removal

(1) Disengage the cushion by pulling upward on the release strap (Fig. 1).

(2) Tilt the seat cushion forward.

(3) Unlock the cushion release lever and remove the cushion (Fig. 2).

Rear Seat Cushion Installation

(1) Position the seat in the vehicle.

(2) Insert the left pivot shaft in the lock receptacle.

(3) Snap the seat release lever in place and swing the seat down.

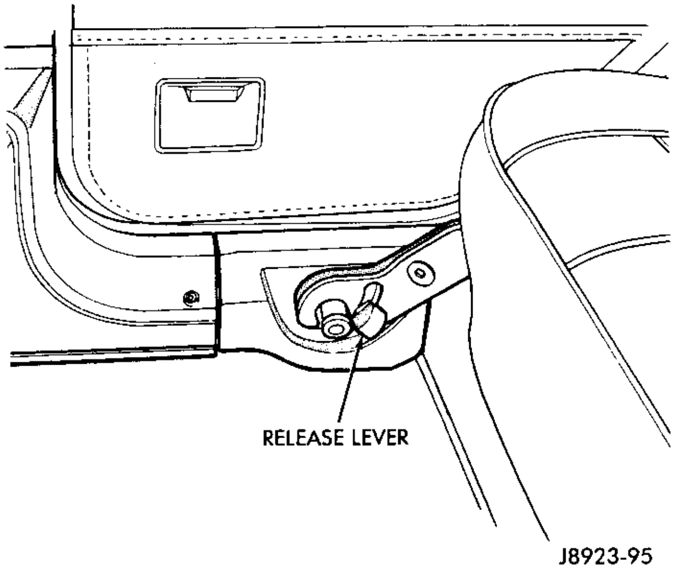


Fig. 2 Unlocking Cushion Frame Release Lever.

(4) Lock the seat in place by pressing firmly on the center of the cushion until the latch engages.

Rear Seat Back Removal

(1) Release the seat cushion and tilt the cushion forward.

(2) Remove the seat belts from the elastic straps.

(3) Release the seat back lock.

(4) Remove pivot bolts and washers (Fig. 3).

(5) Tilt the seat back forward, lift it upward and remove it from the vehicle.

Rear Seat Back Installation

(1) Position the seat back in the vehicle.

(2) Install the pivot bolts and washers. Tighten the bolts to 43 N•m (38 ft-lbs) torque.

(3) Lock the seat back in place.

(4) Insert the seat belts in the elastic straps.

(5) Swing the seat cushion down and lock it in place.

Rear Seat Cushion Cover Replacement

(1) Remove the side, front and rear retaining clips with a remover tool (Fig. 4).

(2) Insert the clip remover tool between the clips and upholstery rods and pry upward at each clip (Fig. 5).

(3) Remove the seat cover.

(4) Place the new cover on the cushion.

(5) Attach the cover to the front and rear edges of the seat frame.

(6) Install the retaining clips (Fig. 4).

(7) Install the cushion on the seat.

Seat Back Cover Replacement

(1) Remove the seat back from the vehicle.

(2) Remove the side latch trim from the seat.

(3) Open the cover zipper and remove the cover (Fig. 6).

(4) Install the new cover on the seat back and close the cover zipper.

(5) Install the side latch trim and install the seat back.

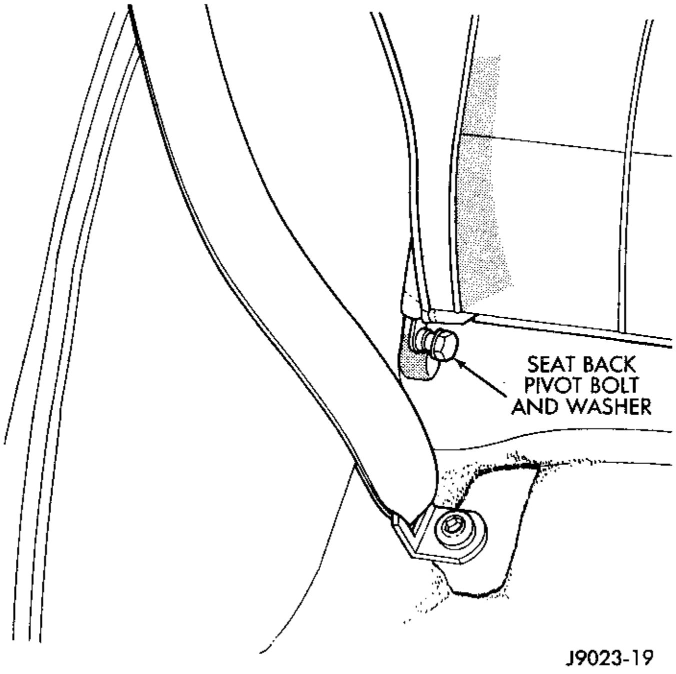


Fig. 3 Remove/Install Seat Back Pivot Bolts

SEAT BELTS

Front Seat And Shoulder Belt Removal

(1) Move the seat all the way forward.

(2) Disconnect the harness wire (Fig. 1).

(3) Remove the seat belt anchor bolt with a Torx Bit (Fig. 1).

(4) Remove the seat belt (Fig. 1).

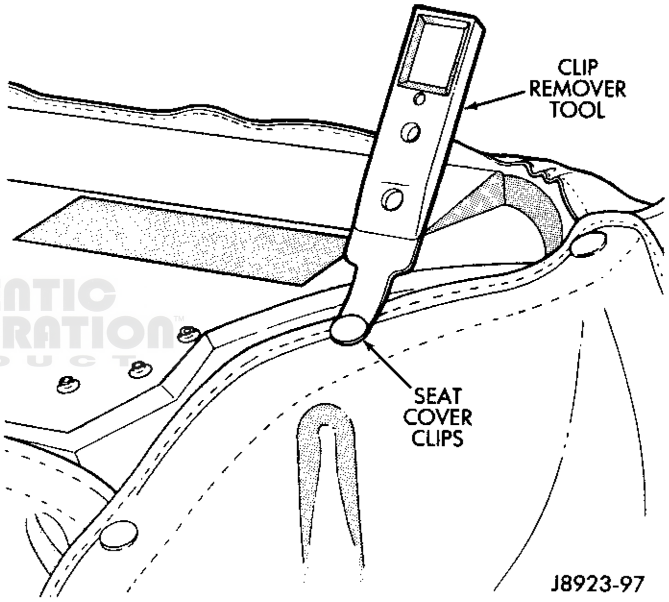


Fig. 4 Removing Seat Cover Clips

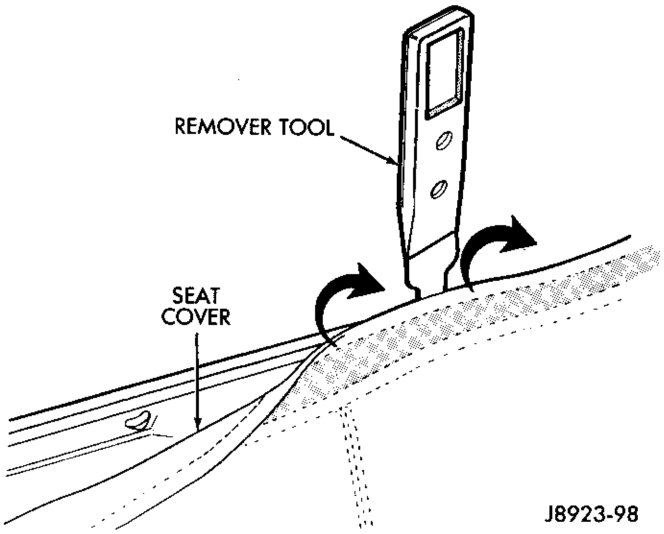


Fig. 5 Removing Seat Cushion Cover

(5) Remove the bezel covering the shoulder belt upper anchor bolt.

(6) Remove the upper anchor bolt (Fig. 2).

(7) Remove the interior trim around the sill and remove the shoulder belt lower anchor bolt (Fig. 3).

(8) Remove the shoulder belt and retractor.

Belt Inspection

Inspect the front seat and shoulder belts (Figs. 4 and 5). Replace any belt that is cut, frayed, torn or damaged in any way. Replace the shoulder belt if the retractor is damaged or inoperative.

Front Seat And Shoulder Belt Installation

(1) Position the shoulder belt retractor on the body and install the lower anchor bolt.

(2) Position the shoulder belt upper anchor plate on the body and install the upper anchor bolt.

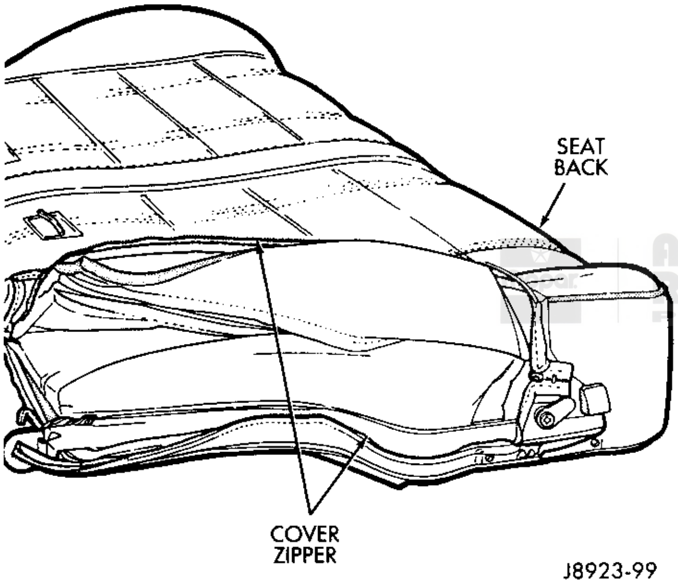


Fig. 6 Removing/Installing Seat Back Cover

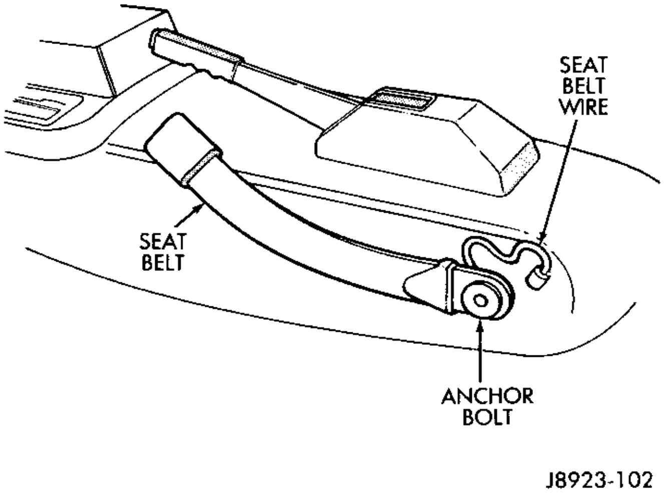


Fig. 1 Removing/Installing Seat Belt

(3) Tighten the upper and lower anchor bolts to 37 N•m (27 ft-lbs) torque.

(4) Install the sill trim and install the bezel on the belt anchor plate.

(5) Install the seat belt and connect the harness wires. Tighten the belt anchor bolt to 37 N•m torque.

Rear Seat Belt Removal

(1) Pull the rear seat release strap and tilt the seat forward.

(2) Remove the mounting bracket bolts (Fig. 6).

(3) Remove the seat belt anchor bolts (Fig. 6).

(4) Remove the rear retractor and seat belts (Fig. 6).

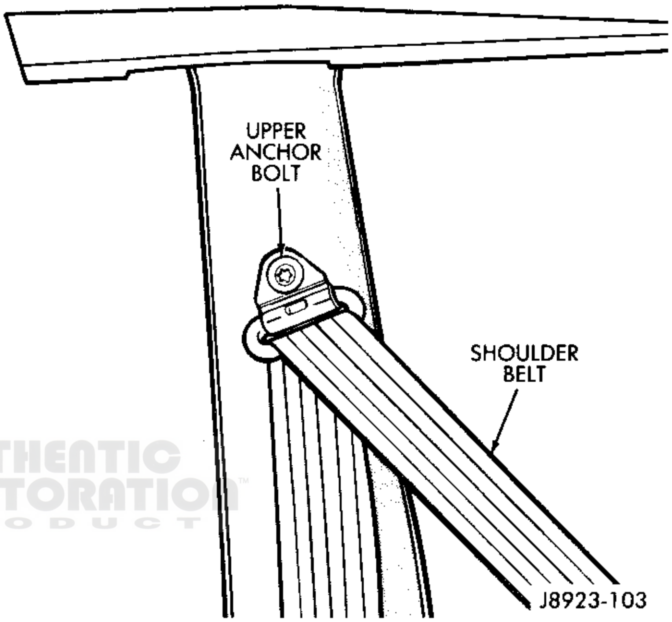


Fig. 2 Removing/Installing Upper Anchor Bolt

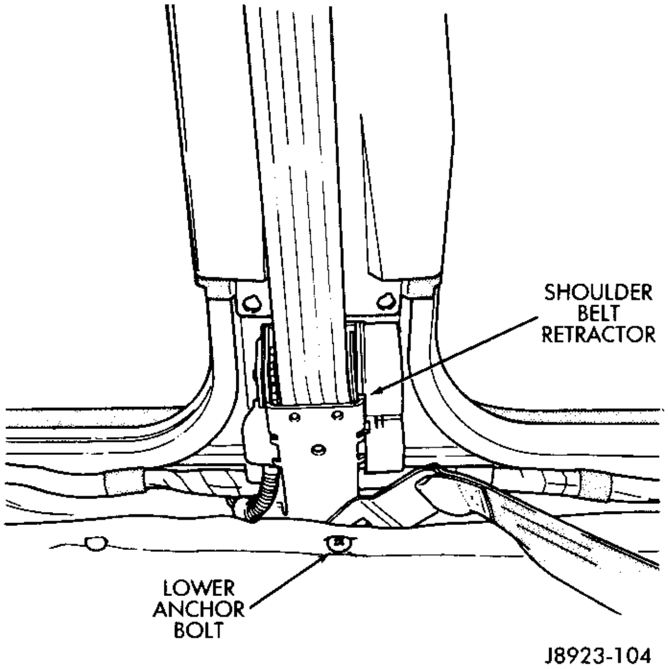


Fig. 3 Removing/Installing Lower Anchor Bolt

Belt Inspection

Inspect the rear belts. Replace any belt that is cut, frayed, torn or damaged in any way. Replace the retractor belt if the retractor is damaged or inoperative.

Rear Seat Belt Installation

(1) position the belts on the floorpan.

(2) Install the anchor bolts. Tighten the bolts to 34-47 N•m (25-35 ft-lbs) torque.

(3) Latch the rear seat cushion in place.

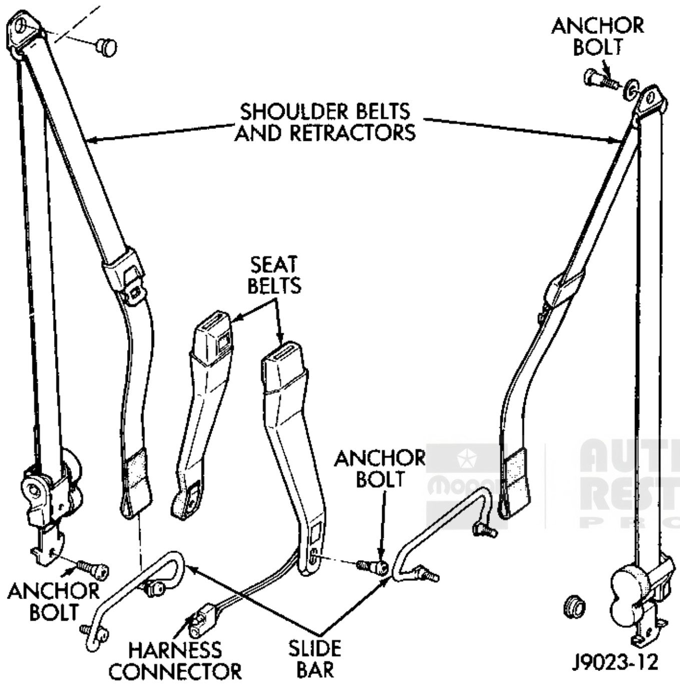


Fig. 4 Front Seat Belts-Two Door Models

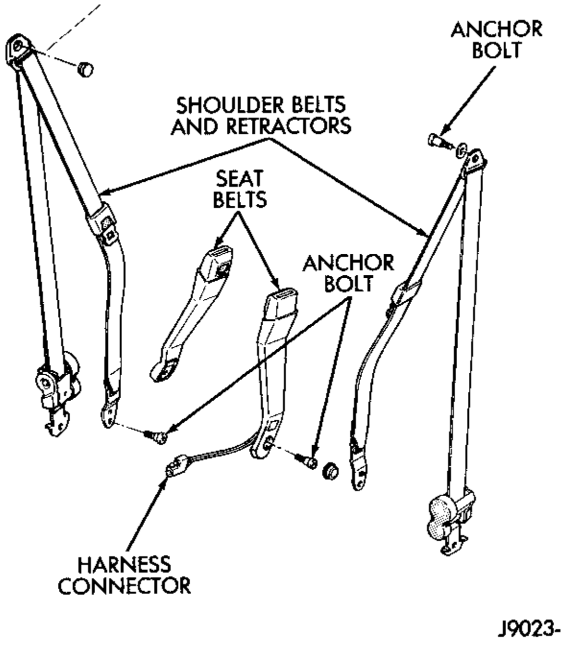


Fig. 5 Front Seat Belts-Four Door Models

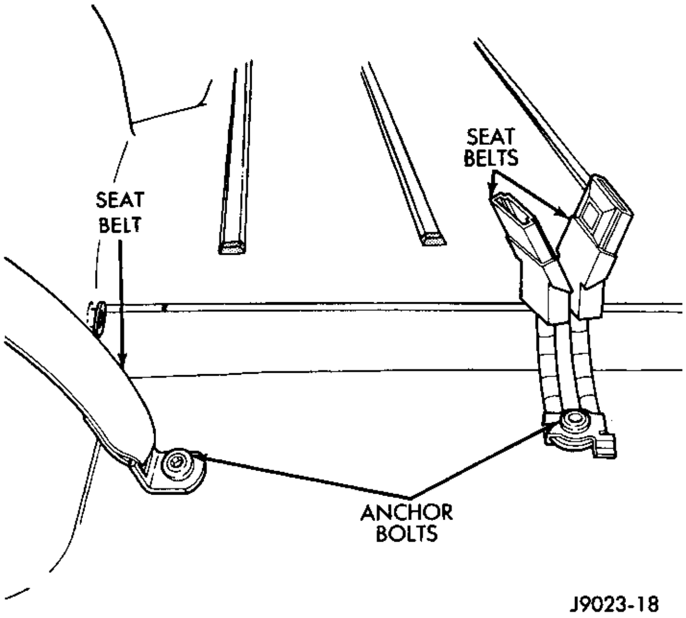


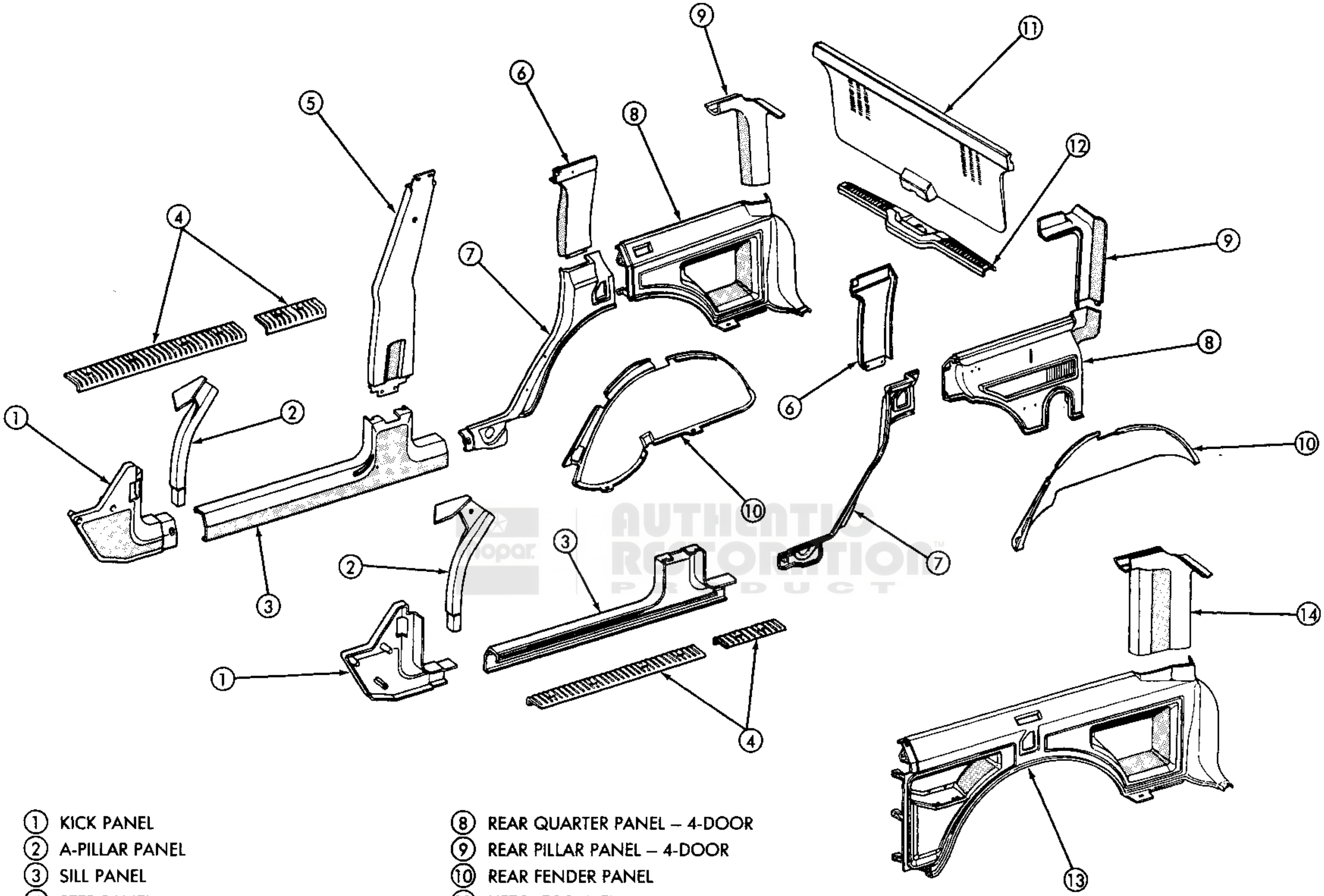
Fig. 6 Removing/Installing Rear Seat Belts

INTERIOR TRIM PANELS

The interior trim panels are shown in Figure 1. Most of the panels are attached with push screws or Phillips head screws. Trim clips are used to attach rear quarter trim panels. The liftgate trim panels are attached with spring clips.

CAUTION: Do not attempt to remove trim panels without removing necessary adjacent panels, interior lamps, or similar items.

To avoid damaging panels, be sure all screws and clips are removed before removing the trim panel. Trim panels are somewhat flexible but can be damaged if handled inproperly.



① KICK PANEL
② A-PILLAR PANEL
③ SILL PANEL
④ STEP PANEL
⑤ B-PILLAR PANEL
⑥ C-PILLAR PANEL (UPPER)
⑦ C-PILLAR PANEL (LOWER) – 4-DOOR
⑧ REAR QUARTER PANEL – 4-DOOR
⑨ REAR PILLAR PANEL – 4-DOOR
⑩ REAR FENDER PANEL
⑪ LIFTGATE PANEL
⑫ LIFTGATE FLOOR PANEL
⑬ REAR QUARTER PANEL – 2-DOOR
⑭ REAR PILLAR PANEL – 2-DOOR

J9023-14

Fig. 1 Interior Trim Panels

HEADLINER

Headliner Removal

The headliner and trim moldings are attached with a combination of screws, velcro strips and trim clips.

To remove the headliner, all of the trim moldings must be removed along with the dome lamps, assist handle and other attached components.

CAUTION: The headliner is a one-piece, molded component. It has limited flexibility and must not be bent during service as damage may occur.

Be sure all trim clips, screws and Velcro strips are disengaged before headliner removal (Fig. 1).

CONSOLE

Parking Brake Handle Trim Cover Removal/ Installation

(1) Unclip the rear section of the trim cover and swing it up.

(2) Drill out the cover push screws or rivets (Fig. 1).

(3) Remove the trim cover.

(4) Attach the cover with new pop rivets.

(5) Close the cover and snap it in place.

Standard Console Removal

(1) Remove the transmission gearshift lever handle. On models with automatic transmission, pull the handle straight up. On models with manual transmission, loosen the lock nut and remove the shift knob.

(2) Remove the transmission and transfer case shift indicator bezels by prying upward to release them (Fig. 2).

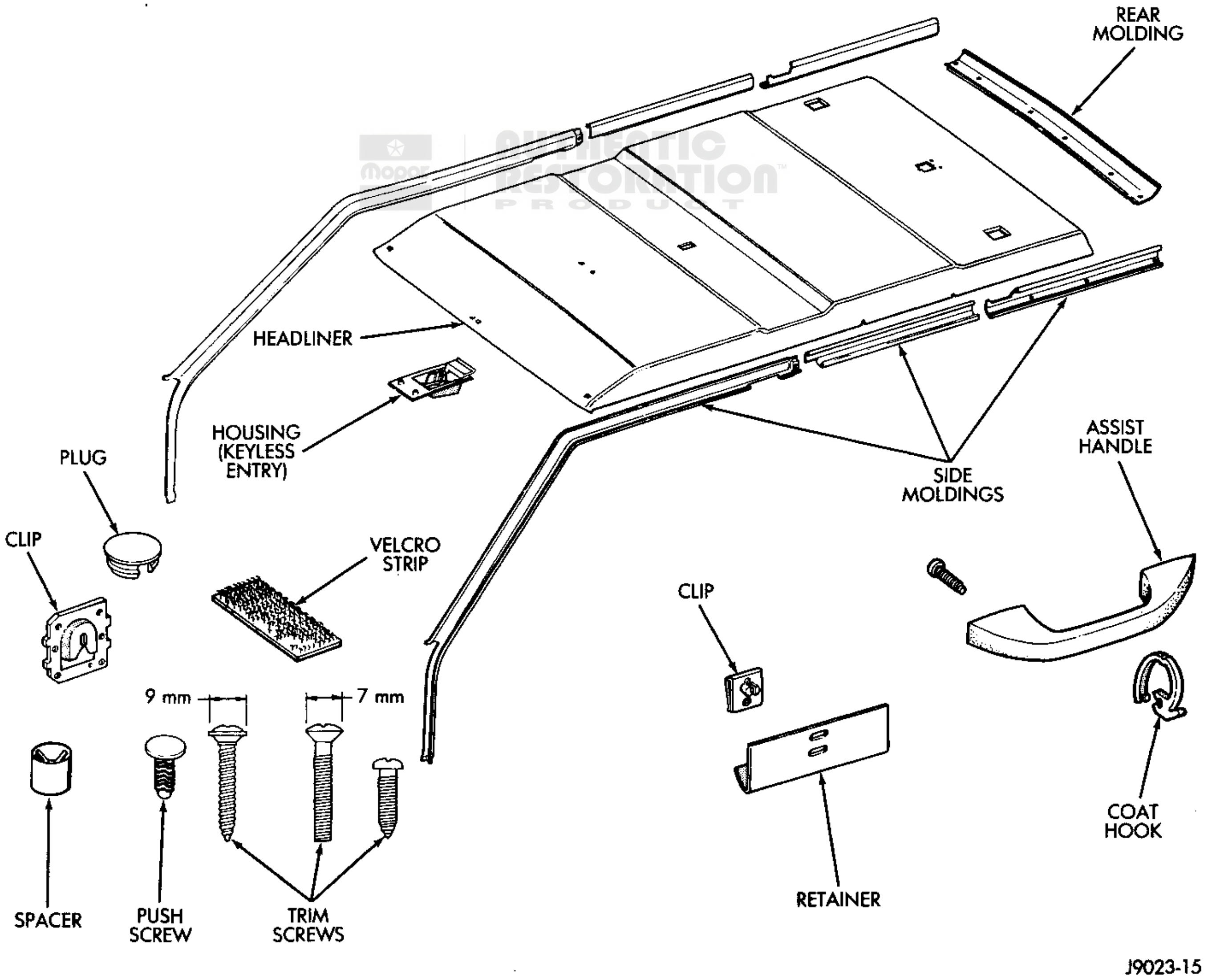


Fig. 1 Headliner And Moldings

(3) Remove the console retaining screws (Fig. 3).

(4) Remove the console (Fig. 4).

Standard Console Installation

(1) Position the console on the floorpan and install the console screws.

(2) Snap the shift indicator bezels into the console.

(3) Install the gearshift lever handle. On automatic transmission models, push the handle downward and snap in place. On manual transmission models, screw the knob on and tighten the lock nut

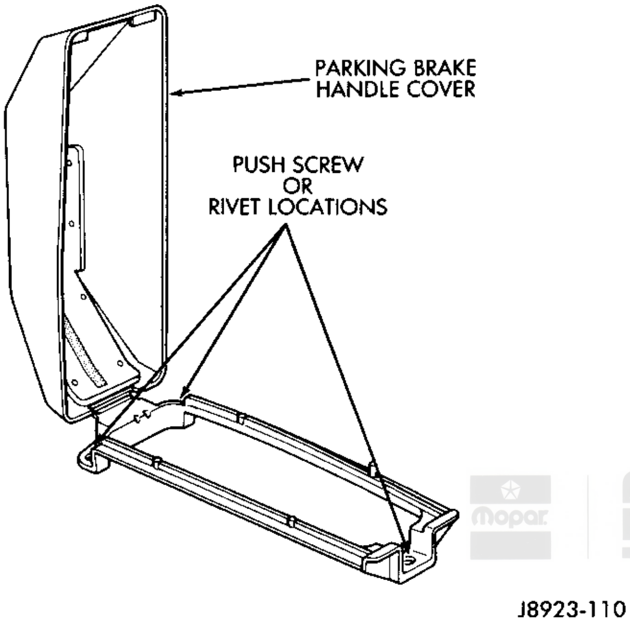


Fig. 1 Removing/Installing Parking Brake Trim Cover

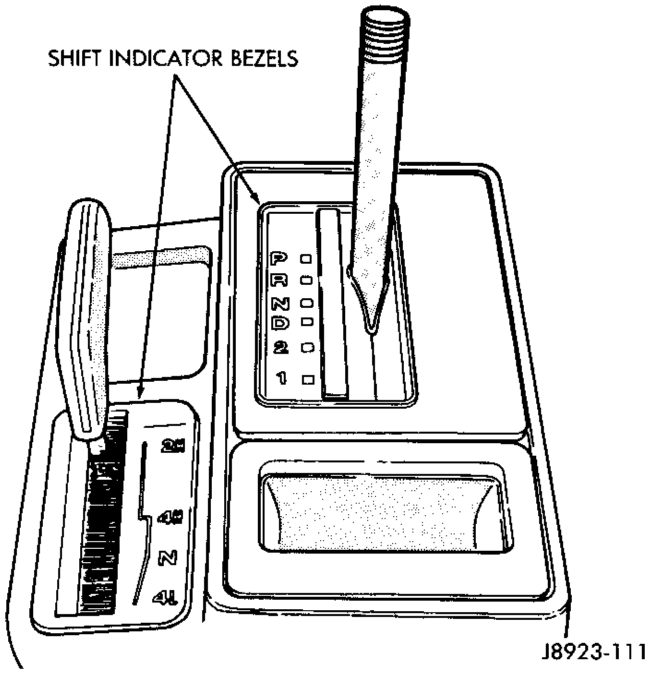


Fig. 2 Removing/Installing Shift Bezels

Deluxe Console Removal

(1) Remove the transmission gearshift lever. On automatic transmission, pull the handle straight up to remove it. On manual transmission, loosen the locknut and unscrew the knob.

(2) Remove the transmission and transfer case shift indicator bezels.

(3) Remove the shift cover attaching screws and remove the cover (Fig. 5).

(4) Remove the remainder of the console attaching screws.

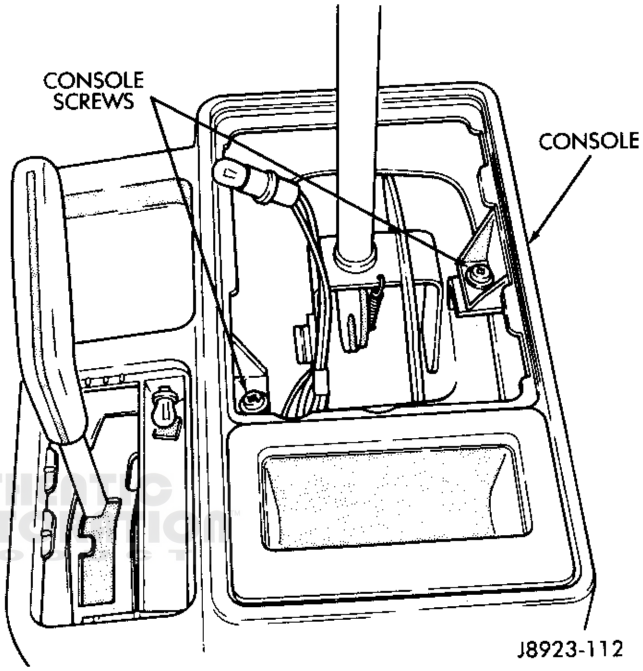


Fig. 3 Removing/Installing Console Screws

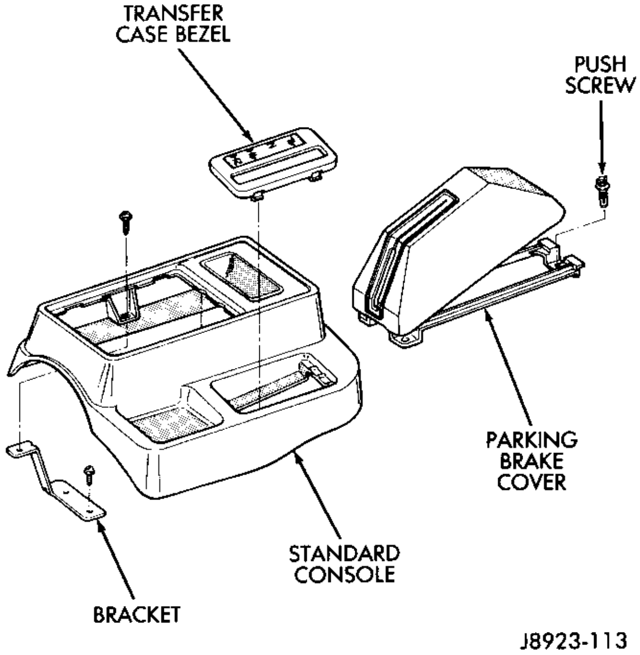


Fig. 4 Standard Console

(5) Remove the console base and heater duct (Fig. 5).

(6) Remove the reinforcement, storage cover, and remaining console components if necessary (Fig. 5).

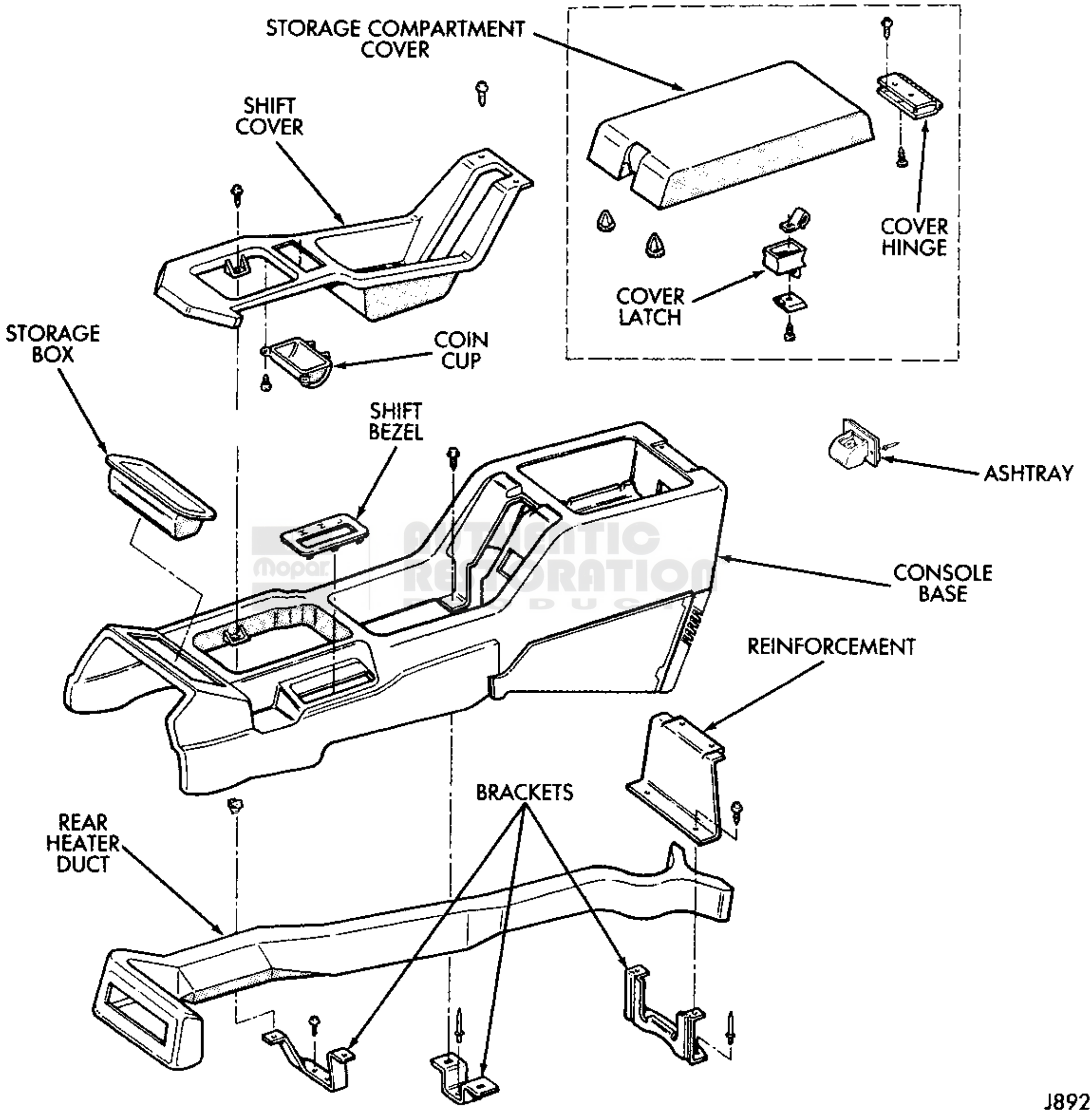
Deluxe Console Installation

(1) Attach the following components if removed:
- console brackets
- heater duct
- reinforcement
- storage cover
- ashtray
- storage box

(2) Mount the console on the floorpan and install the console screws.

(3) Install the shift cover and shift bezels.

(4) Install the shift lever handle.



J8923-114

Fig. 5 Deluxe Console Components

DOME LAMP

Dome Lamp Removal

(1) Remove the dome lamp lens by squeezing both sides to release the retaining clips. Then pull downward to remove the lamp.

(2) Remove the retaining clips (Fig. 1).

(3) Disconnect the wire harness.

(4) Remove the lamp assembly.

Dome Lamp Installation

(1) Connect the dome lamp wires.

(2) Position the dome lamp in the panel and install the retaining clips.

(3) Install the dome lamp lens.

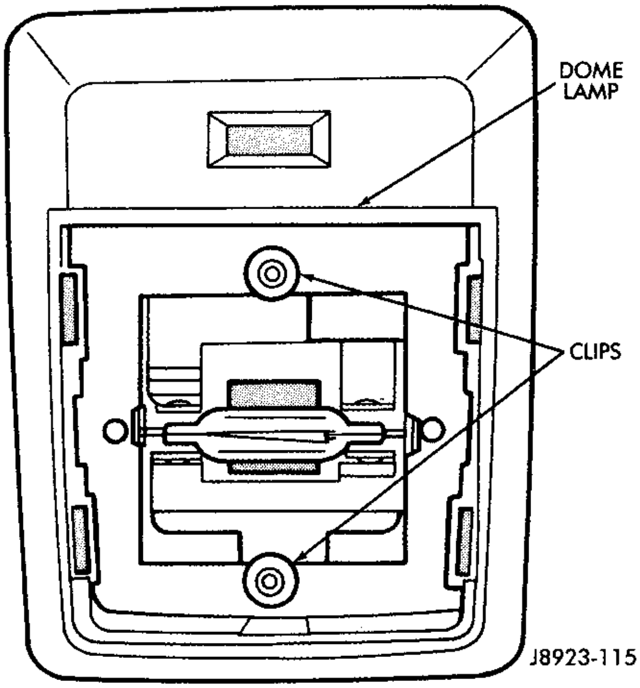


Fig. 1 Dome Lamp Removal/Installation

BODY COMPONENTS-MJ MODELS

INDEX

GENERAL SERVICE INFORMATION

Many of the service procedures for MJ models are the same as for XJ models.

Service procedures in this section only cover components that are unique to MJ models.

Unless otherwise indicated, refer to the appropriate service procedure in the XJ Body Components section.

MJ body components that are serviced the same as XJ models include:

- front bumpers and fog lamps
- grille and grille panel
- hood, hood hinges and hood adjustment
- front fenders
- fender flares and fender liners
- front doors and door glass
- mirrors (side, low profile, rear view)
- windshield (see stationary glass)
- exterior body side moldings
- window moldings and weatherstrip
- front bucket seat covers and cushions
- console

REAR BUMPER

Bumper Removal

(1) Raise the rear of the vehicle.

(2) Disconnect the license plate lamp wires.

(3) Remove the bolts attaching the bumper brackets to the sill members.

(3) Remove the bumper.

(4) Remove the mounting brackets, skid plates, end caps and license plate lamps and cover plates from the bumper if necessary (Fig. 1).

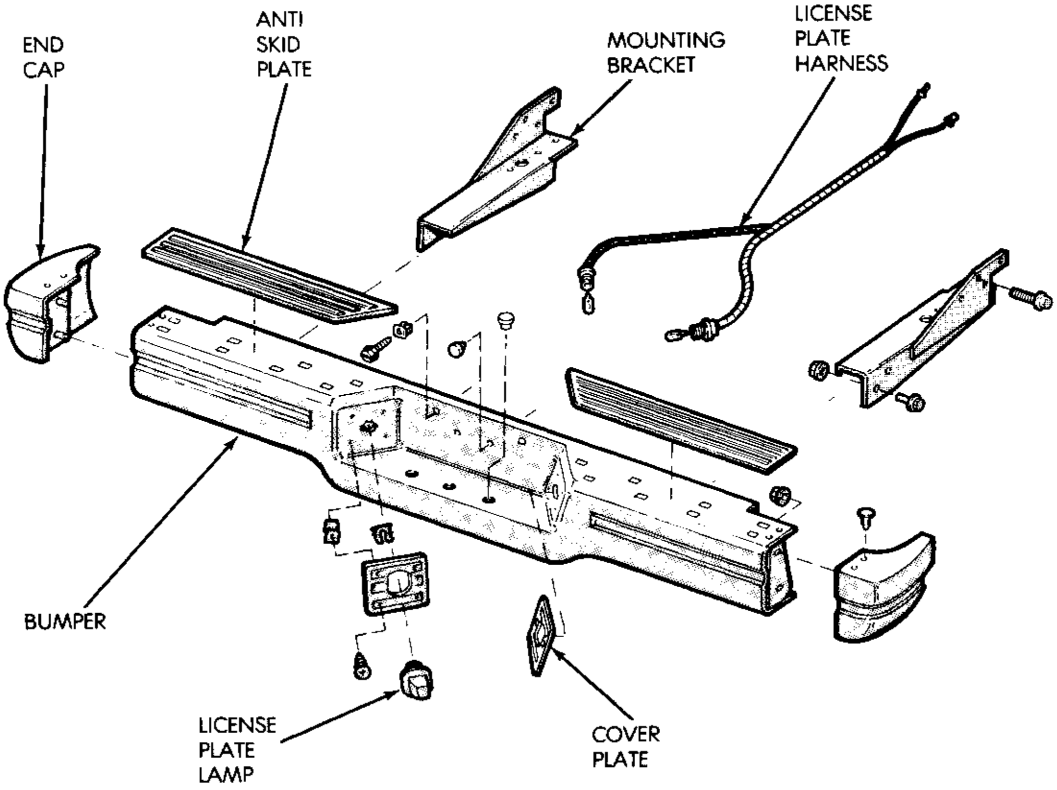


Fig. 1 Rear Bumper Components

Rear Bumper Installation

(1) Install the rear bumper components if removed.

(2) Position the rear bumper brackets on the sill members and install the bracket-to-sill bolts.

(3) Connect the license plate lamp wires.

REAR WINDOW

General Information

The rear window glass is bonded to the window frame flange with urethane sealant (Fig. 1). The urethane sealant is applied cold and seals the area between the window frame and glass (Fig. 1). The primer bonds the urethane sealant to the glass. The window molding is retained by the rubber seal (Fig. 1).

The rear window can be removed with piano wire or a hot knife. Rear window installation is the same as described for windshields in the 70 Series Stationary Glass section. The short or extended installation procedure is used as applicable.

Rear Window Removal

The rear window glass can be removed with either a hot knife or with piano or throttle wire. Although the hot knife method is preferred, **only the wire removal method is presented in this section. Refer to the 70 Series stationary Glass section for glass removal with a hot knife.**

(1) If the window is broken or shattered, cover the seat and cargo box to prevent damage to the seat material and paint.

(2) Remove the window interior trim.

(3) Remove the molding and rubber seal.

(4) Use a pointed tool to bore a hole through the urethane adhesive.

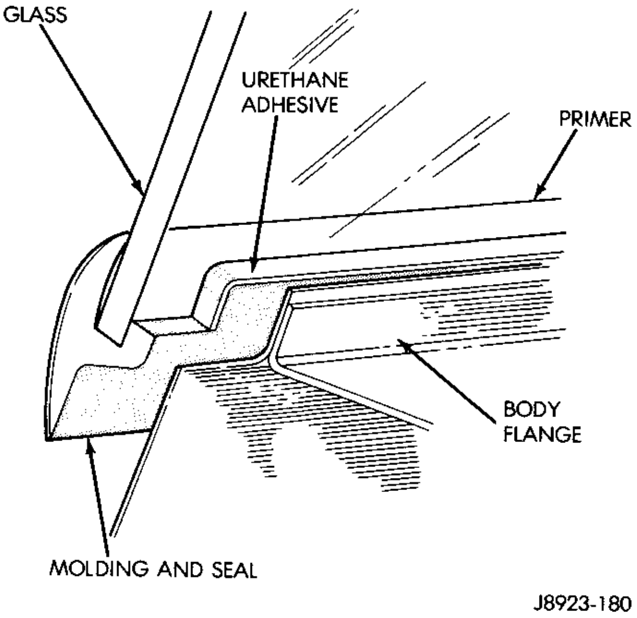


Fig. 1 Rear Window Attachment

(5) Protect the window glass with tape

(6) Insert the piano or throttle cable wire through the adhesive. Grasp the wire end with pliers and pull it through the hole in the adhesive (Fig. 2).

(7) Inside the vehicle, twist one end of the wire around or through a pointed metal tool (Fig. 3).

(8) Outside the vehicle, attach the other end of the wire to a wood or metal pull handle (Fig. 3).

(9) Have a helper dig the pointed end of the metal tool into the adhesive about 12 inches (30 cm) from where the wire goes through the adhesive (Fig. 3).

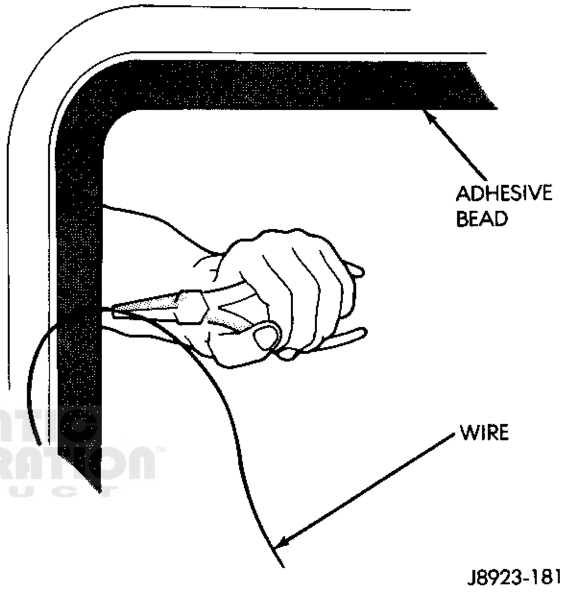


Fig. 2 Inserting Wire Through Adhesive Bead

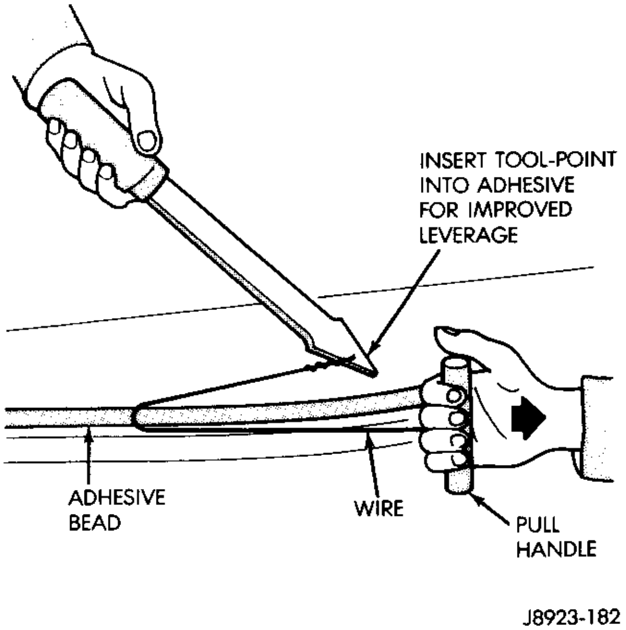


Fig. 3 Cutting Adhesive Bead With Wire And Pointed Tool

(10) While the helper holds the pointed tool in place, slowly but firmly pull the wire toward the tool to cut the sealant.

(11) When the wire is level with the pointed tool, have the helper move the pointed tool 12 inches away from the wire. Then repeat the cuuting process. Continue cutting until the window glass is free of the bead.

Rear Window Installation

Prepare the window glass and body flange for installation. Refer to the procedures described in the 70 Series Stationary Glass section. Use the short or extended procedure as needed.

Prime the glass around the entire periphery. Then install the rubber seal on the glass (Fig. 4).

Cut the adhesive nozzle to produce a 1/4 inch diameter adhesive bead (Fig. 4). Use the rubber seal as a guide for the adhesive bead.

After installation, secure the glass firmly in the frame with strips of duct or masking tape (Fig. 5). Apply tape at the top, sides and bottom of the glass as shown.

Be sure to open the vehicle windows while the adhesive is curing. Pressure buildup will interfere with proper bonding if internal pressure is not vented.

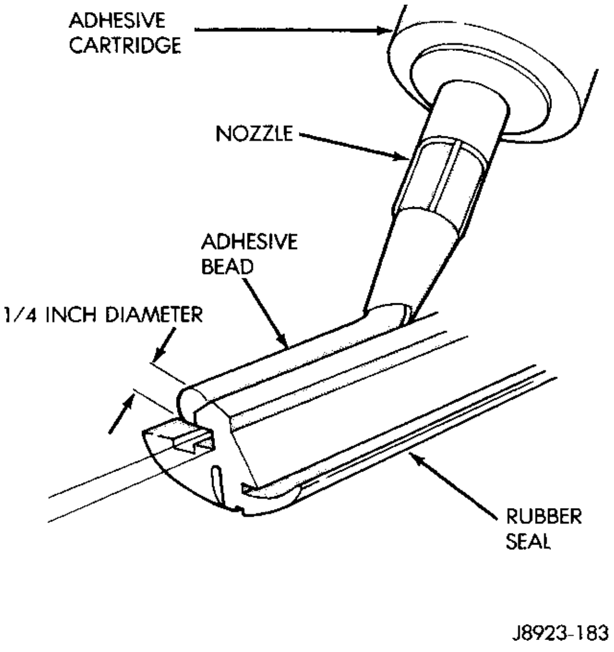


Fig. 4 Applying Urethane Adhesive

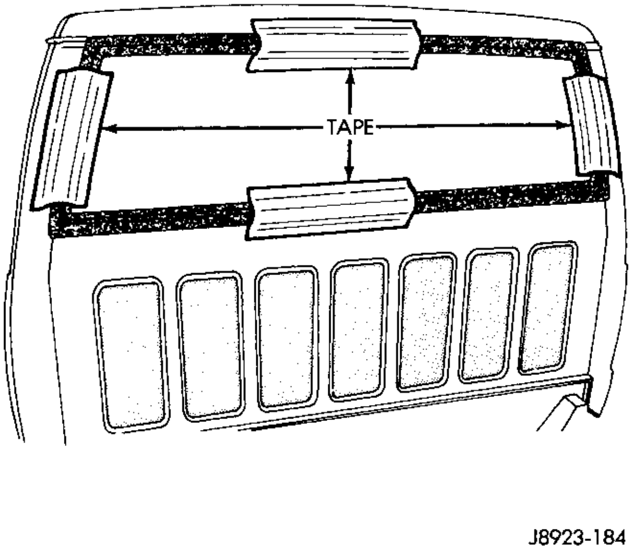


Fig. 5 Securing Glass While Adhesive Cures

INTERIOR TRIM PANELS-HEADLINER-LAMPS

General Information

Procedures in this section cover removal, installation and/or replacement of the interior trim panels, headliner and interior lamps.

The trim panels and headliner are attached with either retaining brackets, push screws, or Phillips head screws and trim covers.

CAUTION: Do not bend or attempt to remove a trim panel until adjacent panels and attached components have been removed. The panels are molded components and have limited flexibility.

Kick, Pillar And Sill Trim Panels

Removal/Installation

(1) Remove the trim covers (if applicable).
(2) Remove the panel attaching screws.
(4) Remove the trim panel.
(5) Place the trim panel at the installation position.
(6) Install the panel attaching screws.
(7) Install the trim covers (if applicable).

Cab Rear Trim Panels

Panel Removal/Installation

(1) Fold the seat forward for access. Remove the seat if necessary.

(2) Pull the trim panel outward slightly for access to the push screws (Fig. 2).

(3) Detach the push screws with a tool or carefully pull the panel and screws out of the cab sheet metal (Fig. 2).

(4) Remove the upper panel.

(5) Remove the jack.

(6) Move the carpet flaps for access to the lower panel bolts (Fig. 3).

(7) Remove the lower panel bolts and remove the panel (Fig. 4).

(8) Position and install the lower panel first. Then install the upper panel. Be sure the upper panel push screws are all seated.

(9) Install the jack, fold over the carpet flaps and reposition the seat.

Cab Side Trim Panels

Panel Removal/Installation

(1) Remove the cab rear upper and lower trim panels. Refer to the procedure in this section.

(2) Remove the trim cover concealing the shoulder belt anchor bolt (Fig. 4).

(3) Remove the upper and lower shoulder belt anchor bolts (Fig. 4).

(4) Remove the trim cover that conceals the uppermost trim panel retaining screw and remove the screw (Fig. 4).

(5) Disconnect the interior lamp wire connectors.

(6) Slide the belt out of the panel and remove the trim panel.

(7) Insert the belt in the panel.

(8) Position the panel on the body and install the panel screws (Fig. 4).

(9) Connect the interior lamp wire connectors.

(10) Install the shoulder belt anchor bolts and the bolt trim covers. Tighten the bolts to 34 - 47 N•m (25 - 35 ft-lbs) torque.

(11) Install the rear lower and upper cab trim panels.

Assist Handles

Handle Removal/Installation

(1) Fold back the covers that conceal the handle retaining screws (Fig. 5).

(2) Remove the handle retaining screws (Fig. 5).

(3) Remove the assist handle.

(4) Position the handle on the body and install the handle screws.

(5) Fold the covers over the handle screws.

Headliner

The headliner is a molded, one-piece component and only has limited flexibility. Do not bend the headliner during removal and installation as it could be damaged.

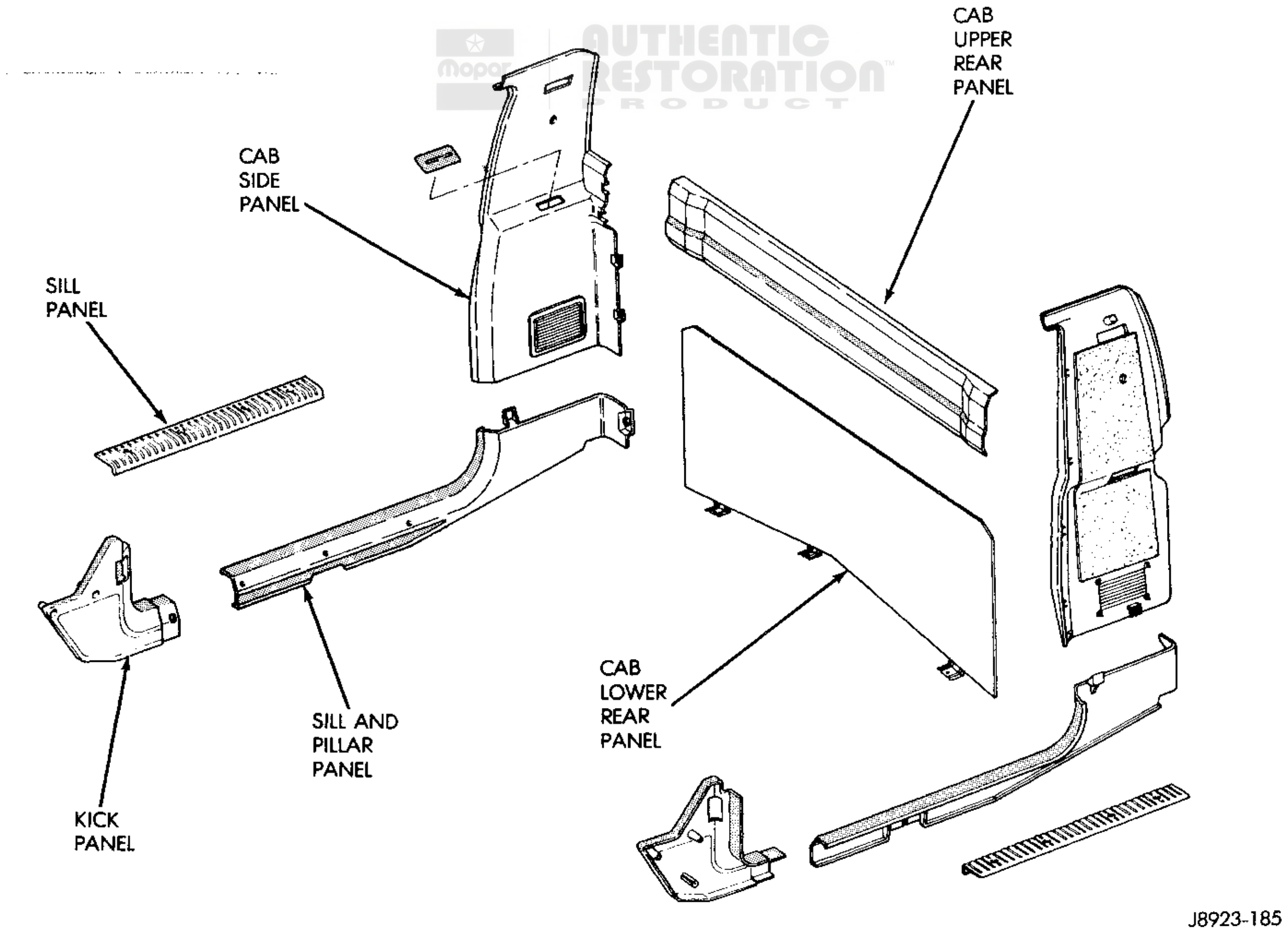


Fig. 1 Interior Trim Panels

Headliner Replacement

(1) Remove the dome lamps and all other attached components.

(2) Remove the side and rear trim moldings.

(3) Disengage the headliner from the retaining clips (Fig. 6).

(4) Remove the headliner.

(5) Position the new headliner on the roof panel and secure it with the retaining clips (Fig. 6).

(6) Intall the side and rear trim moldings and the dome lamps and other removed components.

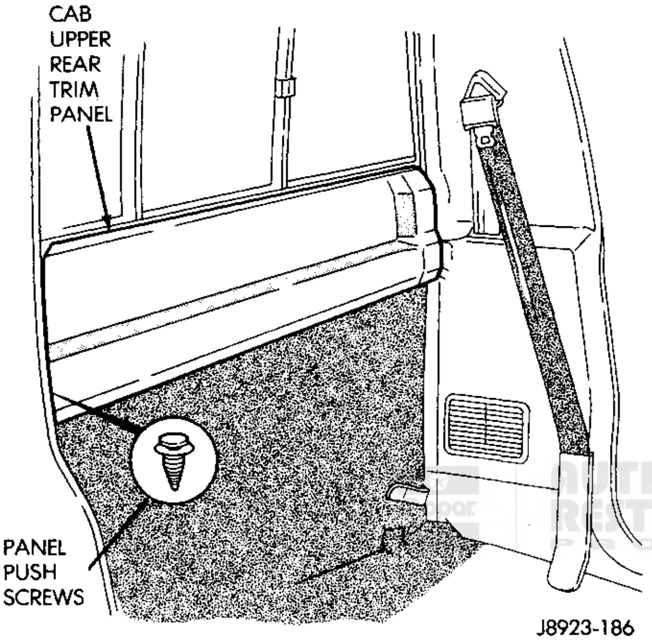


Fig. 2 Cab Upper Rear Panel Attachment

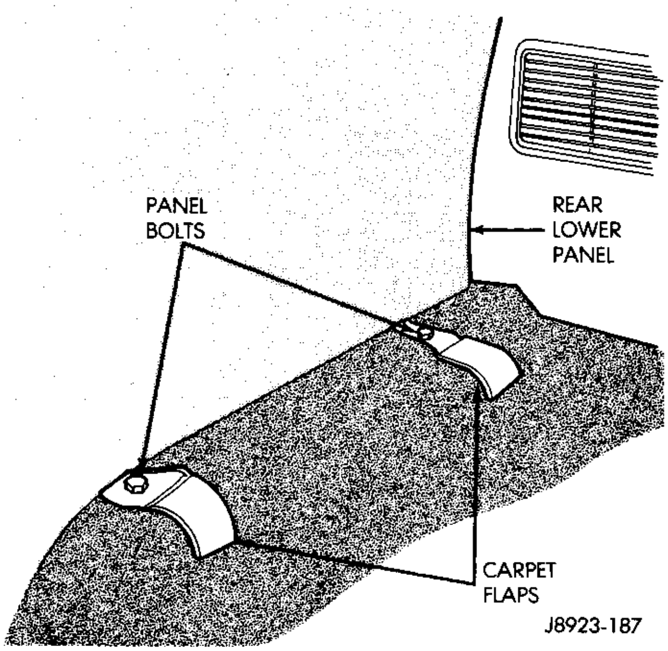


Fig. 3 Cab Lower Panel Attachment

Interior Lamp Removal/Installation

(1) Insert a thin-blade tool under the edge of the interior lamp assembly and pry outward to detach the retaining clips from the side trim panel.

(2) Pull the lamp assembly outward for access to the wire connectors.

(3) Disconnect the wire connectors and remove the lamp.

(4) Hold the interior lamp assembly near the installation position in the side trim panel.

(5) Connect the wire connectors.

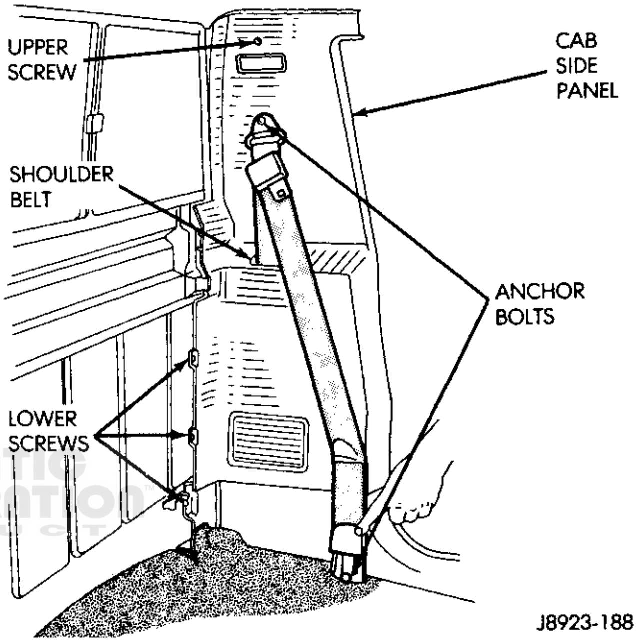


Fig. 4 Removing/Installing Cab Side Panel

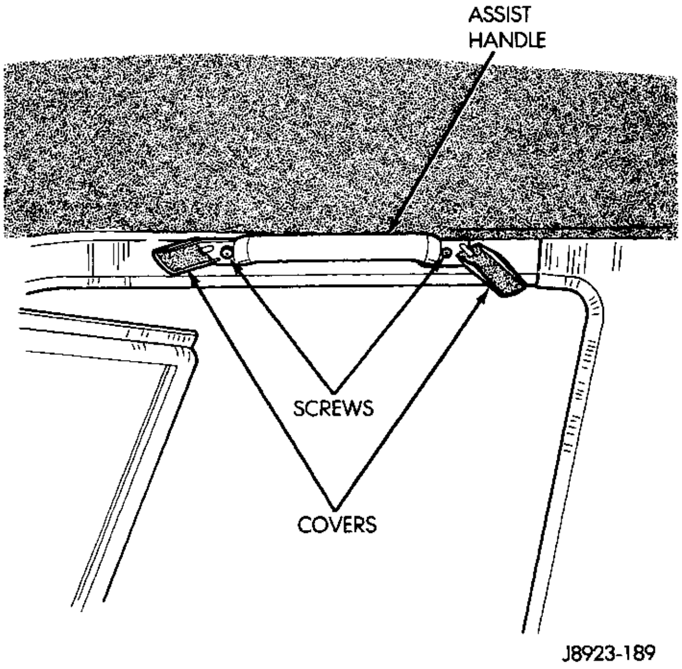


Fig. 5 Assist Handle Removal/Installation

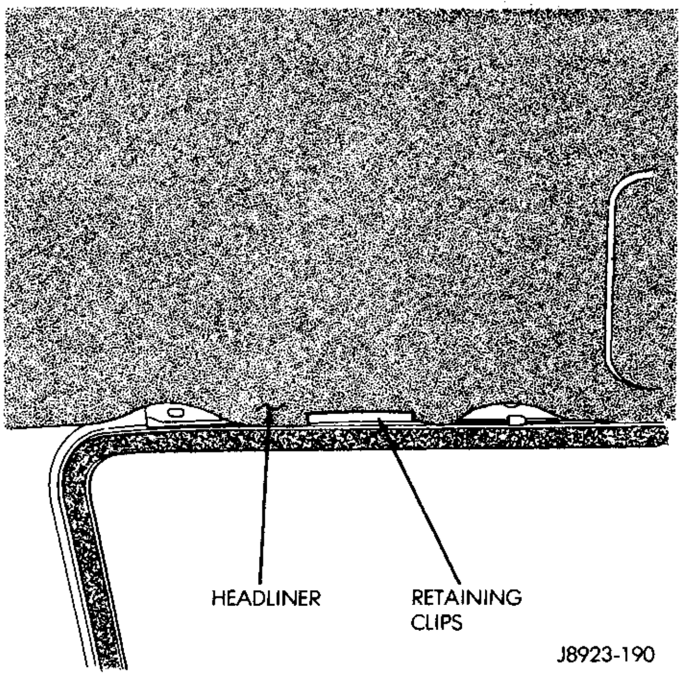


Fig. 6 Headliner Attachment

(6) Insert the lamp assembly into the side trim panel and push inward to engage the lamp retaining clips.

SEAT AND TRACK ASSEMBLIES

Only the bench type seat is covered in this section. Bucket seat cover and cushion replacement and seat removal/installation are covered in the XJ Model section under Seat And Frame Assemblies.

Seat Tracks

The bench seat tracks (Fig. 1) are not serviceable. If either track is damaged, it must be replaced as an assembly. The bucket seat tracks are also not serviceable and should be replaced as an assembly if inoperative (Fig.2).

Bench Seat Removal/Installation

(1) Disengage the seat frame trim panel clips and remove the trim panels.

(2) Remove the seat track front stud nuts and rear bolts (Fig. 3).

(3) Remove the seat.

(4) Remove the seat tracks if necessary.

(5) Install the seat tracks if removed.

(6) Install the seat belts if removed.

(7) Position the seat in the vehicle and install the stud nuts and rear bolts.

Bench Seat Back Cover Replacement

It is not necessary to remove the seat cushion and frame from the vehicle for seat back cover removal.

(1) Remove the trim covers (Fig. 4).

(2) Remove the seat back retaining bolts (Fig. 4).

(3) Remove the seat back from the cushion and frame.

(4) Place the seat back on a work bench.

(5) Fabricate a zipper opening/closing tool from 1/8 inch diameter welding rod (Fig. 5).

(6) Open the seat back cover zipper with the fabricated tool (Fig. 6).

(7) Remove the cover from the seat back.

(8) Slide the new cover onto the seat back.

(8) Close the cover zipper with the tool (Fig. 6).

(9) Install the seat back on the cushion frame (Fig. 4).

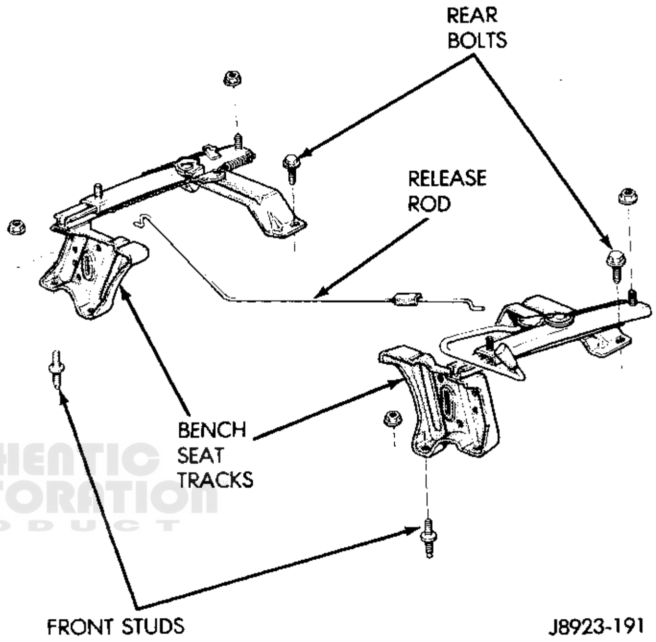


Fig. 1 Bench Seat Tracks

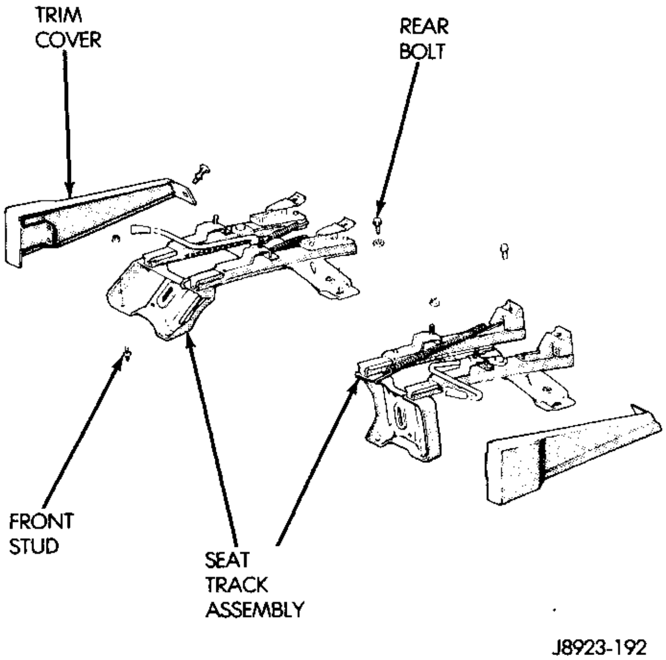


Fig. 2 Bucket Seat Tracks

Bench Seat Cushion Cover Replacement

(1) Remove the bench seat from the vehicle.

(2) Remove the seat back.

(3) Remove the clips and hog rings attaching the cover to the cushion frame (Fig. 7).

(4) Remove the cover from the cushion.

(5) Install the new cover on the cushion.

(6) Secure the cover with the clips and hog rings (Fig. 7).

(7) Assemble and install the bench seat.

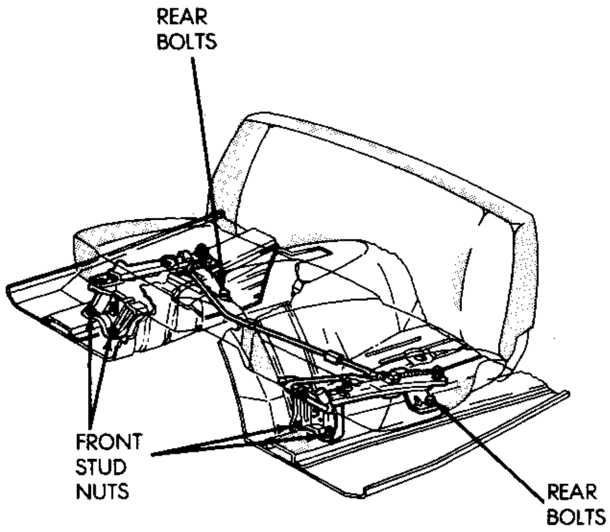


Fig. 3 Bench Seat Removal/Installation

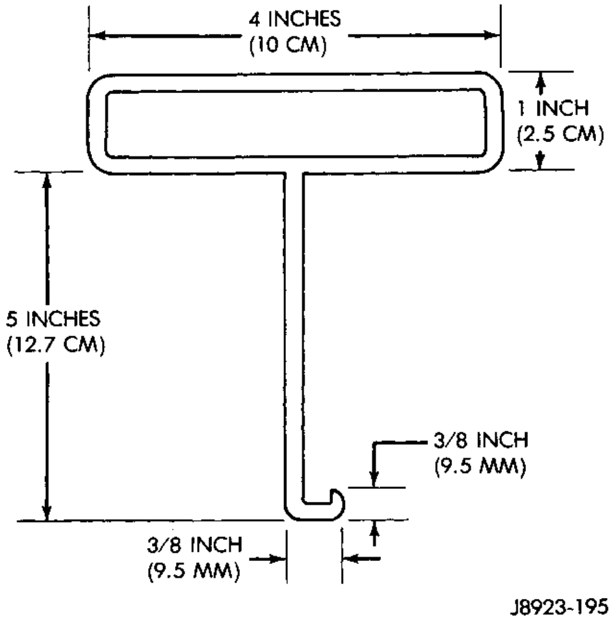


Fig. 5 Zipper Tool Dimensions

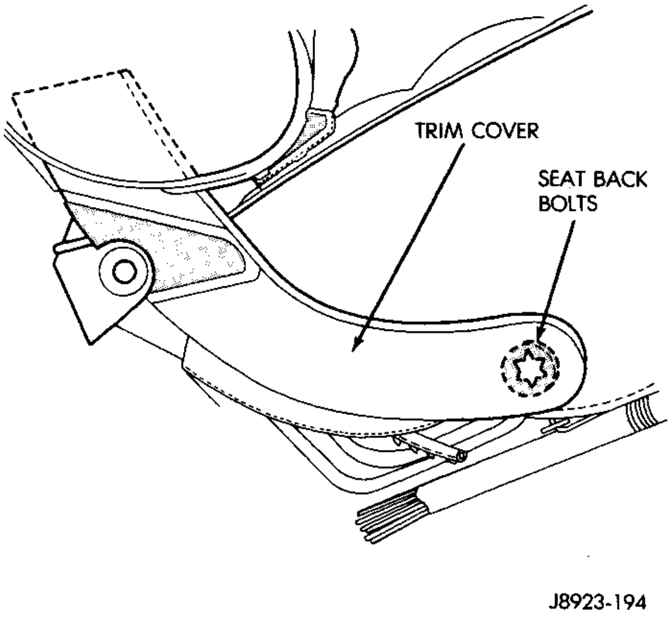


Fig. 4 Seat Back Removal/Installation

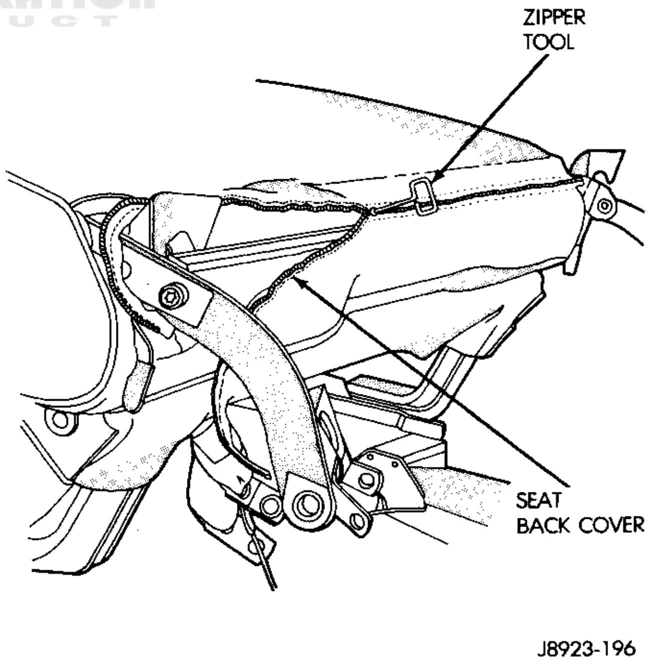


Fig. 6 Removing/Installing Seat Back Cover

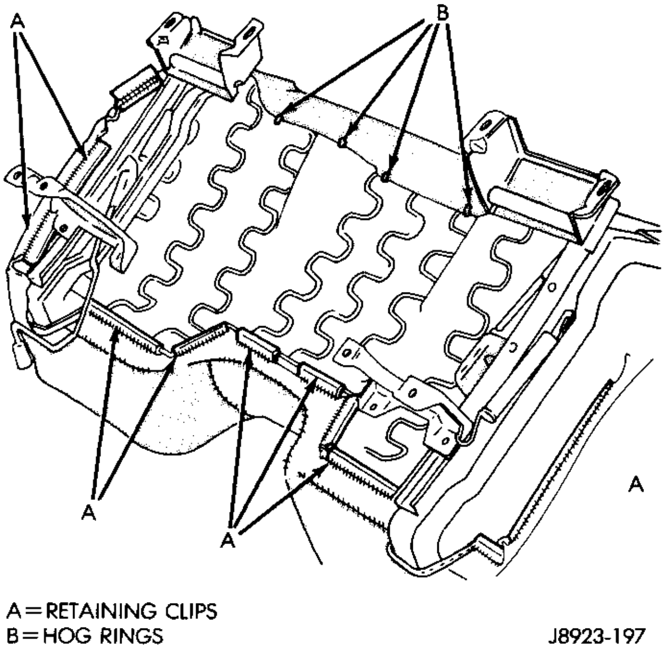


Fig. 7 Cushion Cover Removal/Installation

SEAT BELTS

The same type shoulder belts are used in all MJ models (Fig. 1). Different seat belts are used for models with bench seats and bucket seats (Fig. 1).

All the belts are attached with anchor bolts. On bucket seat models, the seat belts can be removed with the seats in place. On bench seat models, the seat must be removed for access to the seat belt anchor bolts.

The side and rear trim panels must be removed on all models for access to the shoulder belts and anchor bolts.

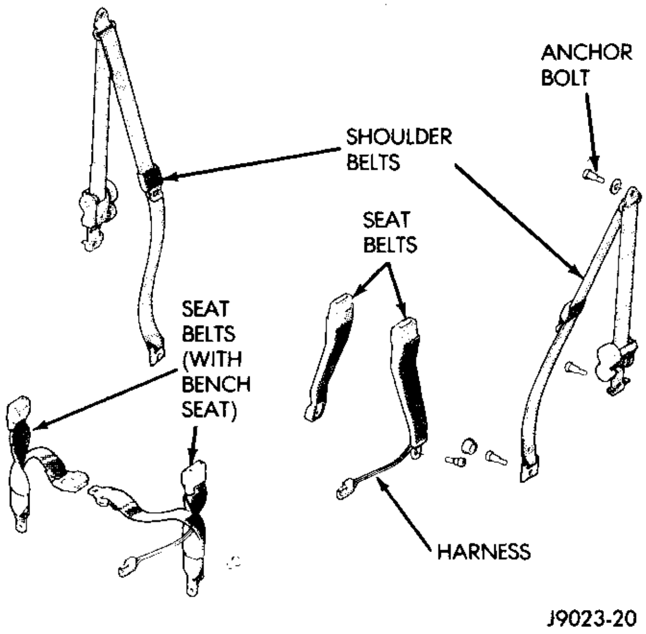


Fig. 1 Seat And Shoulder Belts

CARGO BOX

Cargo Box Removal

The cargo box is attached to the vehicle unit body structure with bolts and nuts (Fig.1). The box can removed for repair, service access, or replacement if necessary.

(1) Remove the left tail lamp assembly and disconnect the wire harness connector (Fig. 2).

(2) Disconnect the license plate lamp wire harness connector.

(3) Support the fuel tank and remove the fuel tank support strap retaining nuts (Fig. 3).

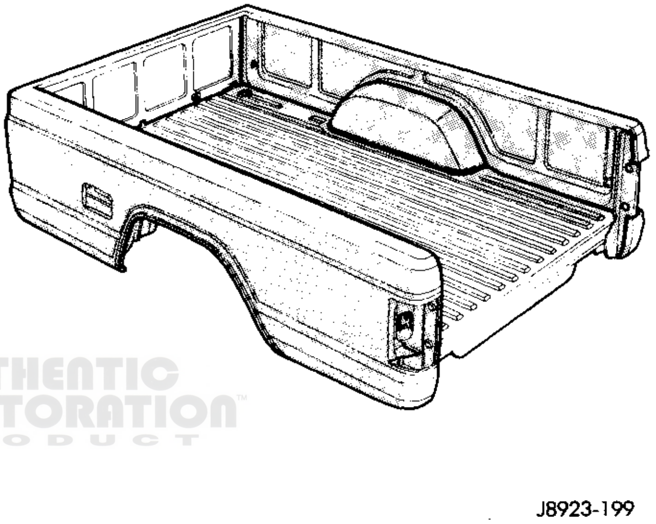


Fig. 1 Cargo Box

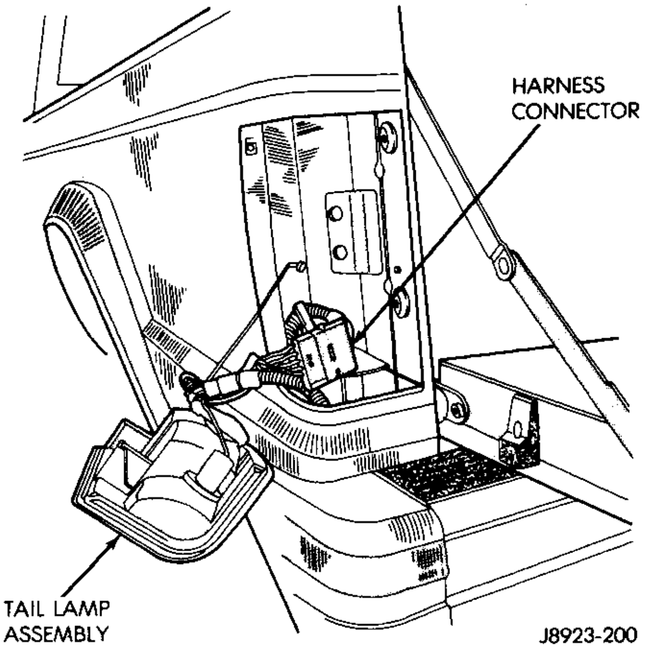


Fig. 2 Tail Lamp Removal/Installation

(4) Remove the parking brake cable housing bolts (Fig. 3).

(5) Support the exhaust system and disconnect the support hanger (Fig. 3).

(6) Remove the cotter pin from the spare tire winch rod (Fig. 4).

(7) Remove the six cargo box retaining nuts and bolts. The retaining nuts and bolts are accessible from the underside of the cargo box at the following locations:

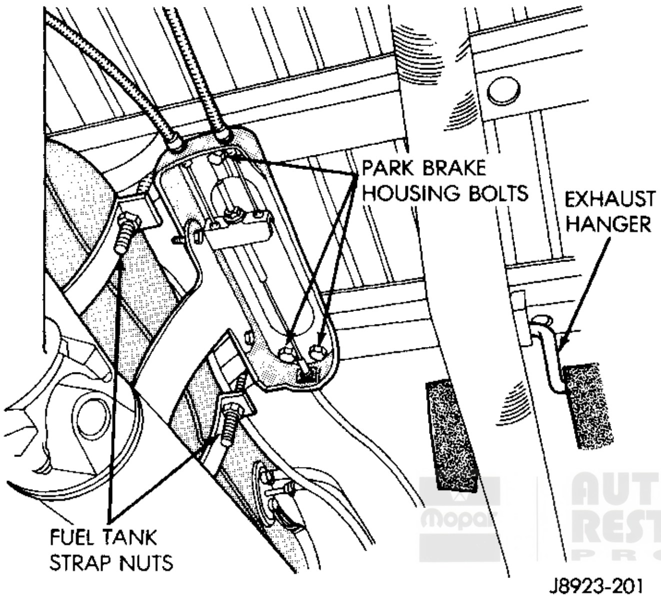


Fig. 3 Brake Cable Housing, Fuel Tank Strap And Exhaust Hanger Bolt Locations

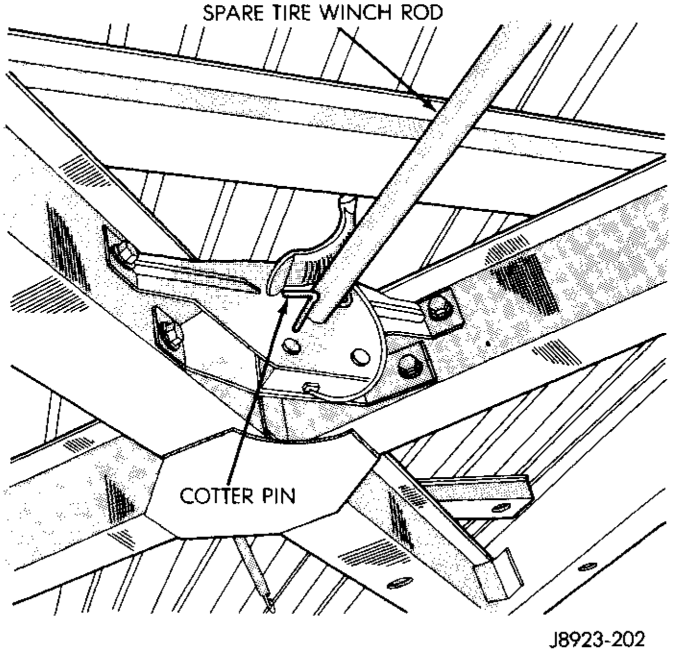


Fig. 4 Remove/Install Winch Rod Cotter Pin

- A nut and bolt at the rear of each sillmember. Remove through sillmember access hole (Fig. 5)
- Two nuts and bolts at each side of the cargo box (Fig. 6).

(8) Remove the cargo box.

Cargo Box Installation

(1) Mount the cargo box on the body.

(2) Install the cargo box attaching bolts/nuts.

(3) Install the exhaust hanger, fuel tank strap and parking brake housing bolt/nuts (Fig. 3).

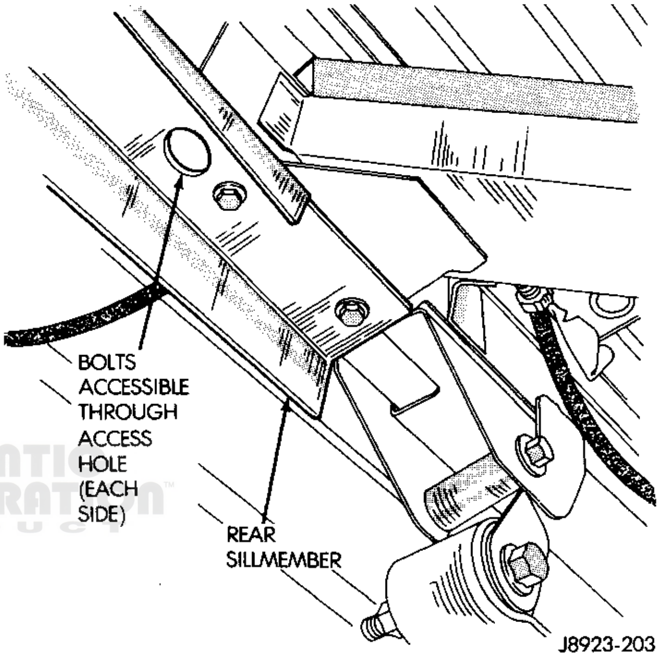


Fig. 5 Sillmember-To-Cargo Box Bolt Locations

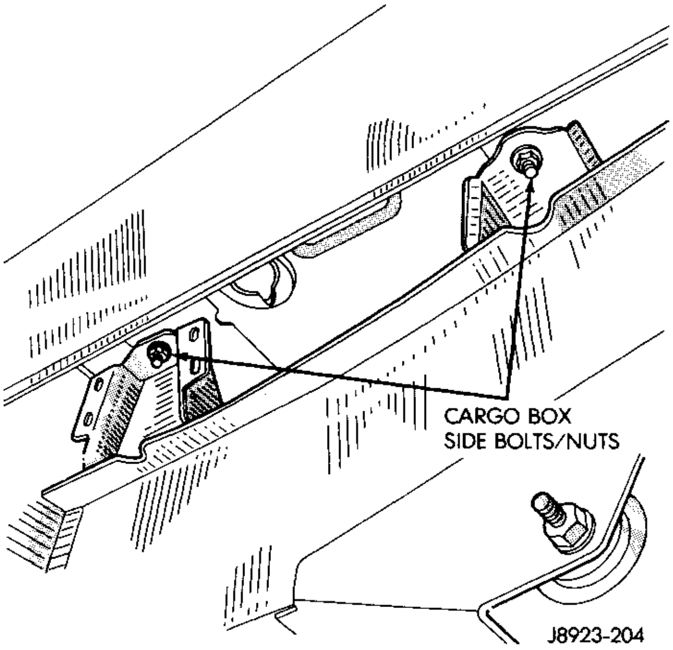


Fig. 6 Cargo Box Side Bolt Locations

(4) Install the cotter pin in the spare tire winch rod (Fig. 4).

(5) Connect the wire harness connector and install the left tail lamp assembly (Fig. 2).

(6) Connect the license plate lamp wire harness connector.

TAILGATE

The tailgate is a serviceable assembly. The tailgate, latches, release rods and handle, latch and linkage arms, hinges and strikers are all replaceable components (Fig. 1).

Refer to the following procedures for tailgate and component part removal and installation procedures.

Tailgate Removal

(1) Lower the tailgate.

(2) Pull each tailgate linkage arm upward and over center (Fig. 2).

(2) Push each linkage arm rearward and disengage the arm from the mounting pin (Fig. 3).

(3) Pull the right side of the tailgate rearward and disengage the right hinge.

(4) Pull the left side of the tailgate to the right and disengage the left hinge.

(5) Remove the tailgate.

Tailgate Hinges

The tailgate hinges are two-piece assemblies. They consist of the hinges and pivots (Fig. 4). The hinges are attached to the tailgate. The pivots are attached to the cargo box sides.

The hinges and pivots are not interchangeable. The right hinge is slotted to allow removal/installation of the tailgate (Fig. 4).

Hinge Replacement

(1) Remove the tailgate.

(2) Place the tailgate on a protective cover in the cargo box to facilitate hinge removal.

(3) Remove the hinge screws and remove the hinge (Fig. 5).

(4) Remove the pivot screws and remove the pivot (Fig. 6).

(5) Position the pivot on the cargo box and install the pivot attaching screws.

(6) Position the hinge on the tailgate and install the hinge attaching screws. **The hinges and pivots are not interchangeable. Be sure the slotted hinge is installed on the right side of the tailgate.**

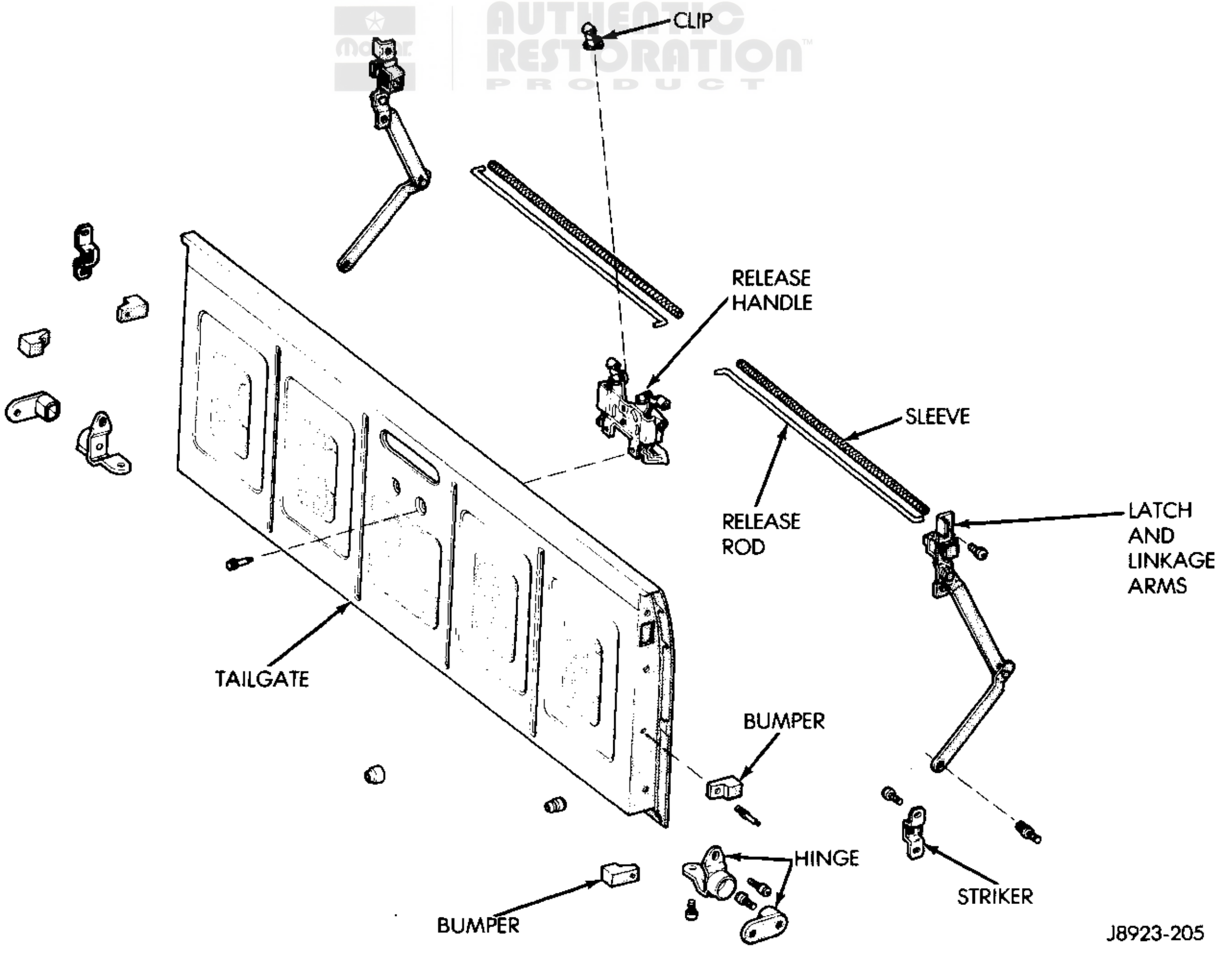


Fig. 1 Tailgate Components

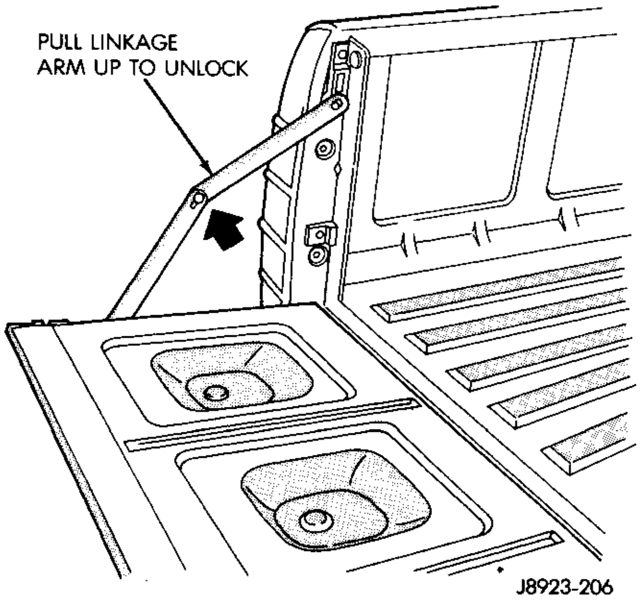


Fig. 2 Unlocking Tailgate Linkage Arm

(7) Install the tailgate.

Tailgate Latch And Release Mechanism Removal

(1) Remove the screws attaching the release handle (Fig. 7) and pull the handle forward for access to the release rods.

(2) Remove the release rod retaining clips and disconnect the rods from the handle (Fig. 8).

(3) Remove the release handle.

(4) Lower the tailgate.

(5) Pull the tailgate linkage arms over center and disconnect them from the mounting pin (Figs. 2 and 3).

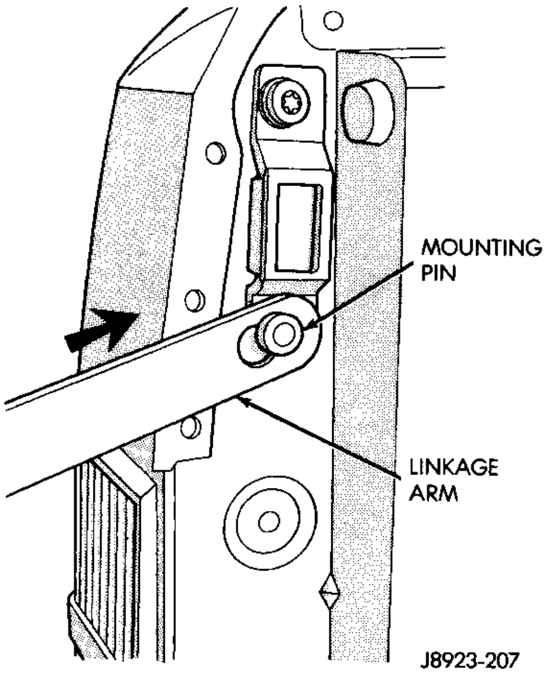


Fig. 3 Connecting/Disconnecting Linkage Arm

(6) Remove the latch screws and remove the latch and linkage arms and the release rods from the tailgate (Fig. 9).

(7) Remove the striker screws and remove the striker (Fig. 10).

Tailgate Latch And Release Mechanism Installation

(1) Position the striker on the cargo box and install the attaching screws (Fig. 10). Do not tighten the striker screws completely at this time.

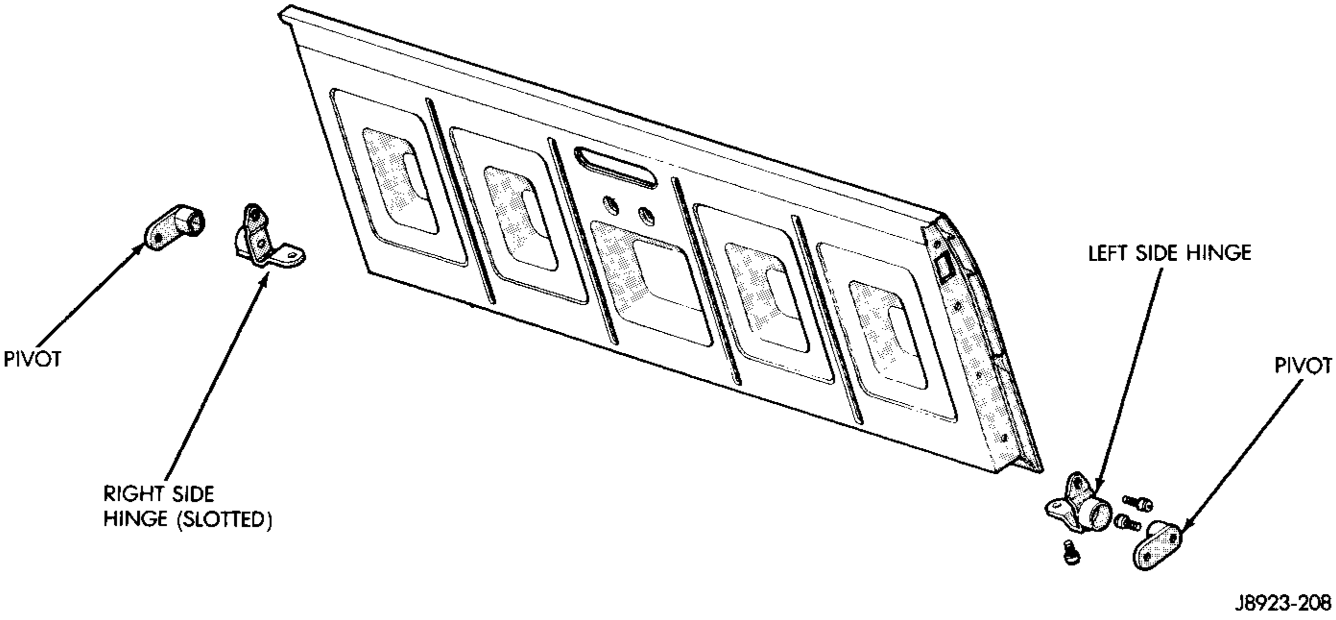


Fig. 4 Tailgate Hinges

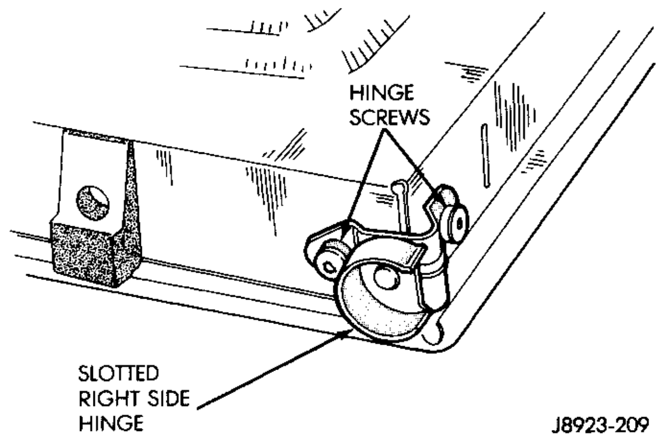


Fig. 5 Hinge Removal/Installation

(2) Connect the release rod to the latch.

(3) Install the latch and linkage arm and the release rod in the tailgate. Tighten the latch screws finger tight.

(4) Install the release handle in the tailgate and connect the release rods to the handle.

(5) Install the release handle screws. Then tighten the latch and release handle screws.

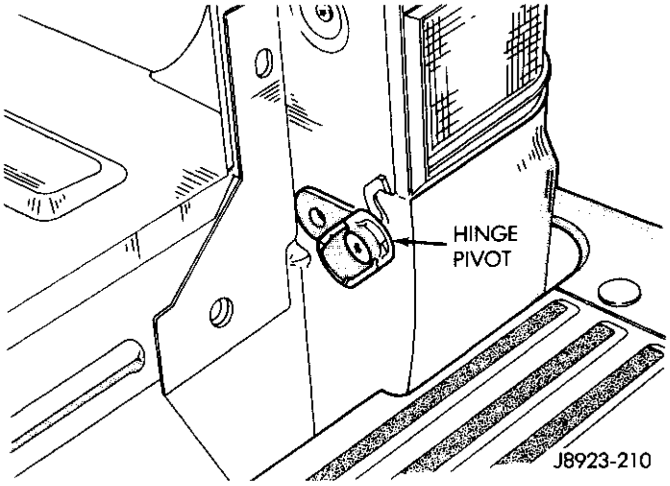


Fig. 6 Hinge Pivot Removal/Installation

(6) Connect the linkage arms to the mounting pins and close the tailgate.

(7) Adjust the latch striker and tighten the striker screws.

Latch Striker Adjustment

Loosen the striker screws. Then move the striker up or down as necessary to obtain desired adjustment.

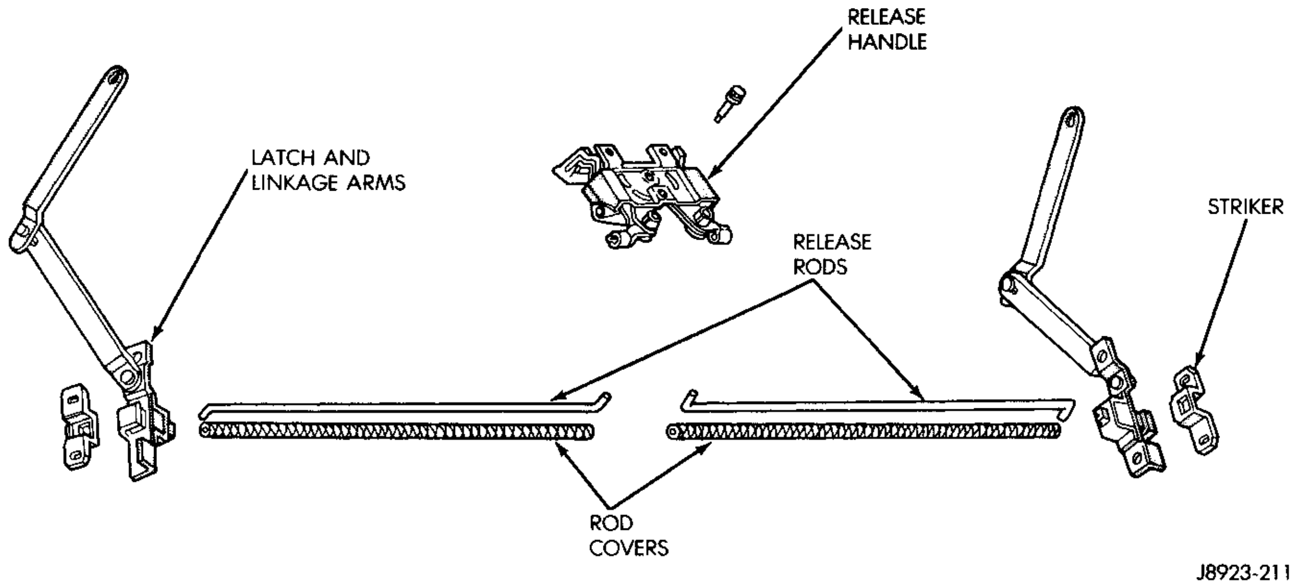


Fig. 7 Hinge Pivot Removal/Installation

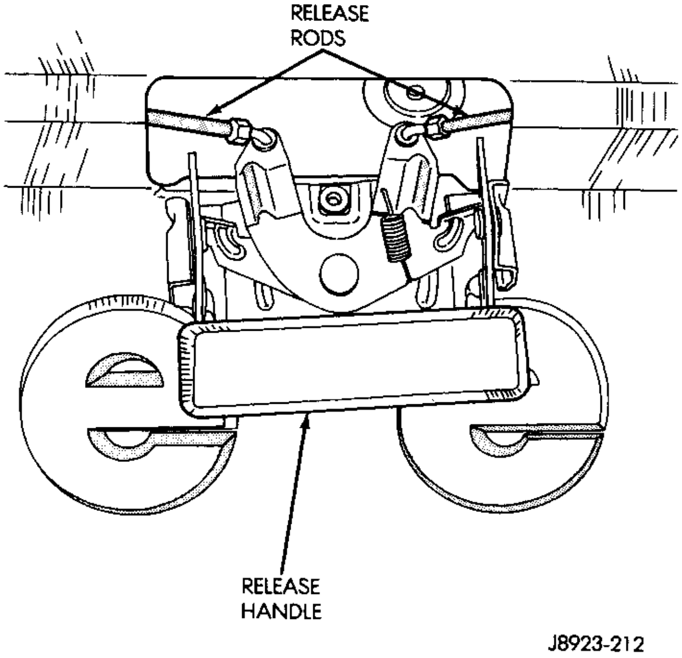


Fig. 8 Connecting/Disconnecting Release Rods

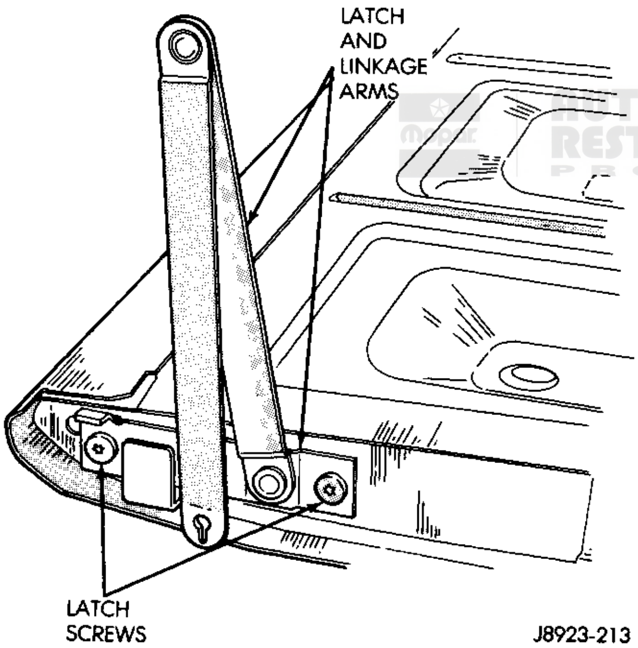


Fig. 9 Latch And Arm Removal/Installation

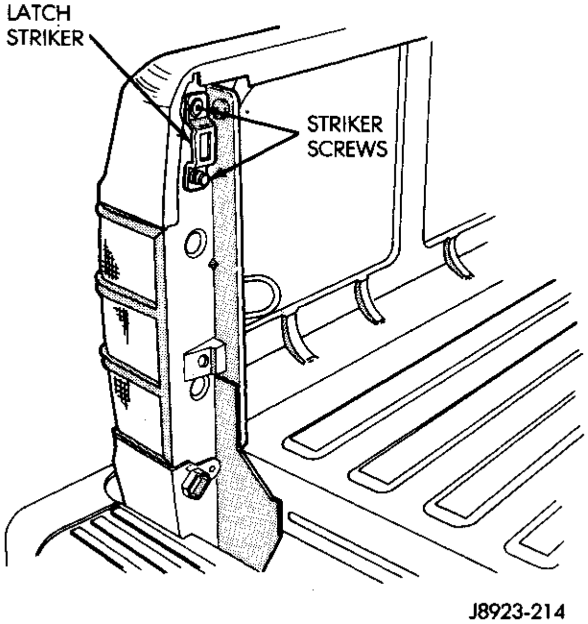


Fig. 10 Latch Striker Removal/Installation

UNDERBODY SPARE TIRE WINCH

The underbody spare tire winch is mounted on a bracket which is bolted to unit body X-member. The winch rod is secured to the winch with a cotter pin and retained in the rear crossmember with a bushing (Fig. 1). The lug wrench is used to operate the winch.

The winch is serviced as an assembly only. However, the mounting bracket and winch rod can be serviced separately.

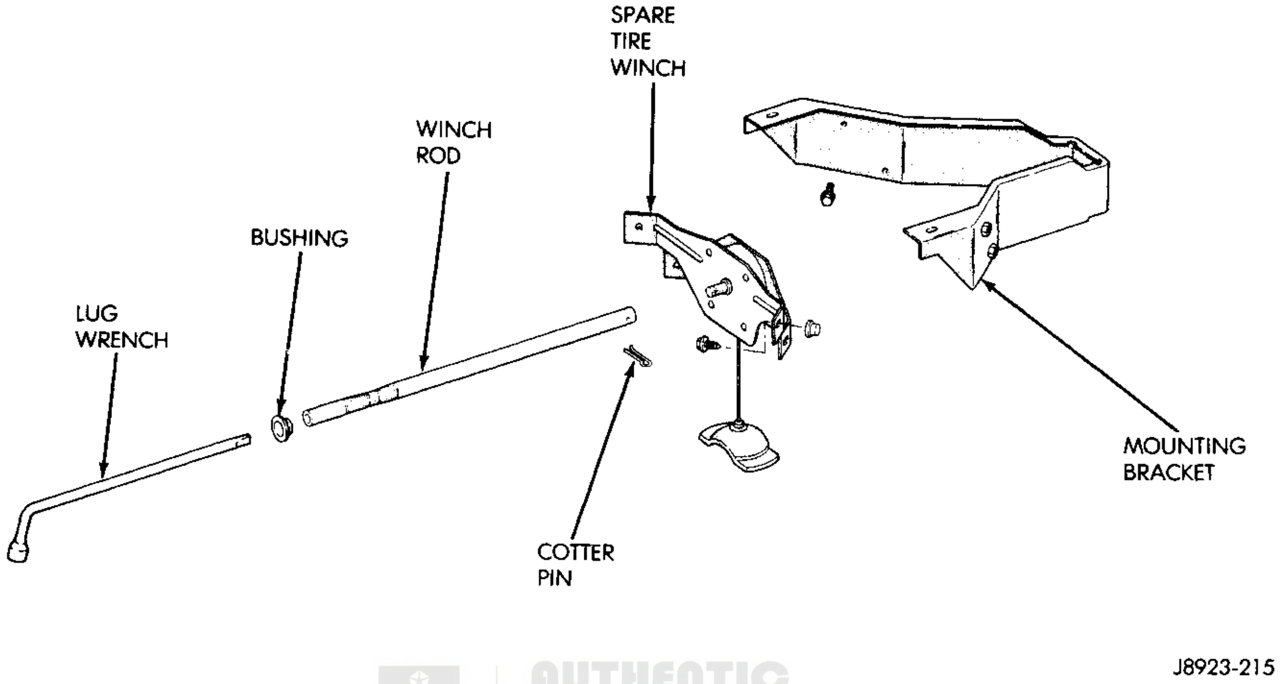


Fig. 1 Underbody Spare Tire Winch

BODY

BODY COMPONENTS-YJ MODELS

INDEX

WINDSHIELD

General Information

The one-piece windshield (Fig. 1) is constructed of two sheets of laminated glass. The glass is bonded to the windshield frame with urethane adhesive.

Windshield Removal/Installation Procedures

Windshield removal is performed with a razor knife and an electric hot knife to cut through the urethane bead. This removal method applies in all cases.

Two windshield installation procedures are required which are; the short procedure and the extended procedure.

The short procedure is used when the windshield is removed intact and the windshield frame pinchweld flange does not require repair.

The extended procedure must be used when the pinchweld flange is damaged. The extended procedure must also be used when the urethane adhesive no longer adheres to either the windshield or the pinchweld flange.

Remove the windshield as described in this section. Then determine condition of the adhesive bond and windshield frame flange and select the installation method required. Refer to the installation procedures in the XJ Models Body Components section under Stationary Glass.

Windshield Removal

(1) Cut away the trim molding around the windshield periphery with a packing knife or razor knife. This is necessary to expose the adhesive bead.

(2) Cut the adhesive bead with a hot knife and the straight or hooked knife blade. Wipe the blade clean frequently with steel wool while cutting.

CAUTION: Do not allow the knife blade to remain stationary during the cutting operation. Excessive heat can cause permanent softening of the adhesive material.

(4) Remove the windshield.

(5) If the extended windshield installation method will be used, remove and discard the interior garnish molding.

Windshield Installation

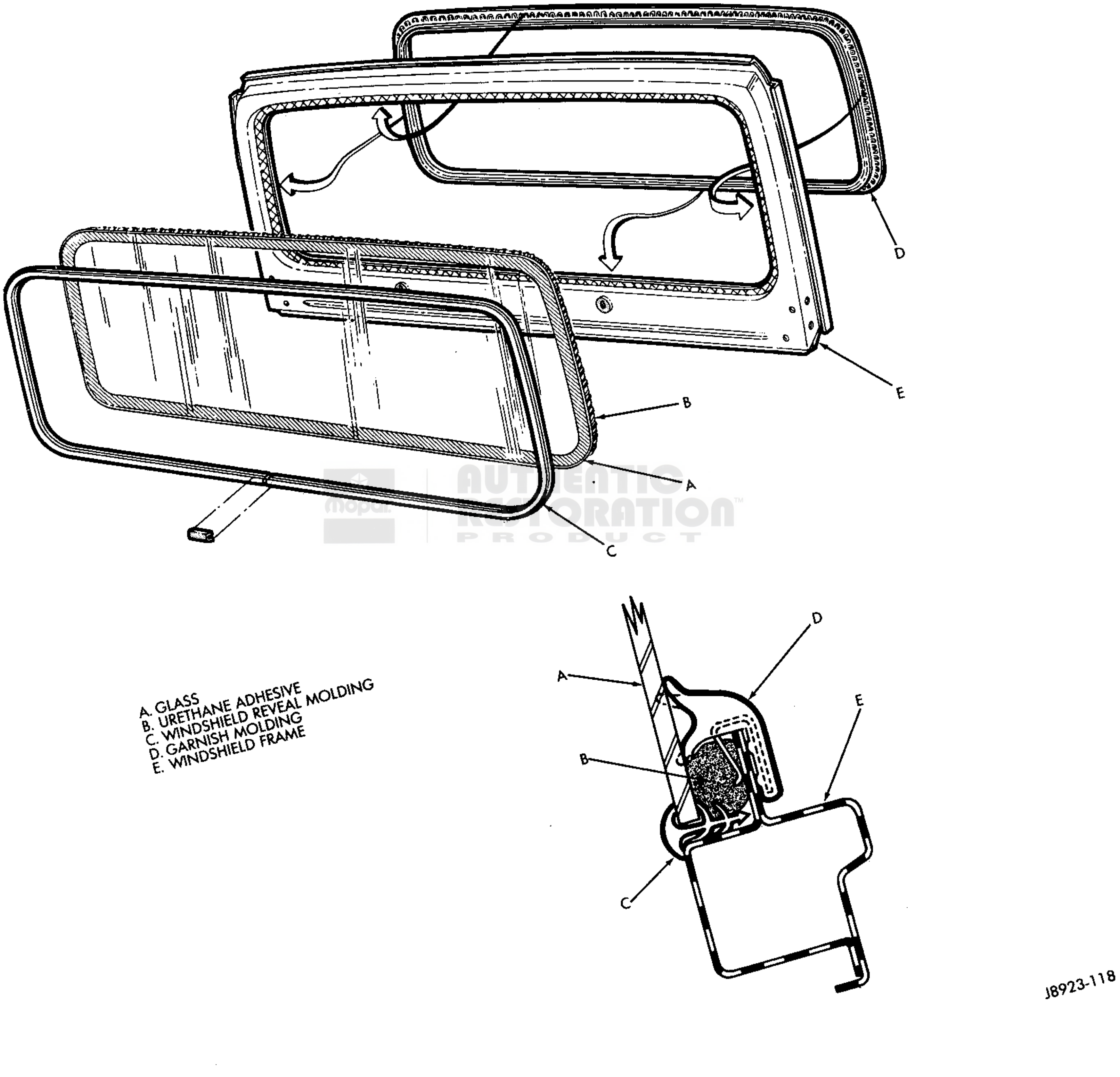
Except for some differences which are noted below, YJ Model windshield installation is basically the same as for XJ Models vehicles. Refer to the short and/or extended installation procedures under Stationary Glass in the XJ Models Body Components section.

Installation Differences

When applying the urethane adhesive, apply it to the windshield frame flange instead of the glass. The adhesive bead should be a minimum of 1/8 inch in diameter. This applies to both the short and extended installation procedures.

If the extended installation procedure is used, the original interior garnish molding must be removed and discarded. The old adhesive cannot be removed from the original molding.

Be sure to leave the vehicle doors and/or windows open while the urethane is curing. This is especially important if the shop area is warm. Heat and pressure buildup inside the vehicle will interfere with proper bonding.



A. GLASS
B. URETHANE ADHESIVE
C. WINDSHIELD REVEAL MOLDING
D. GARNISH MOLDING
E. WINDSHIELD FRAME

Fig. 1 Windshield Components

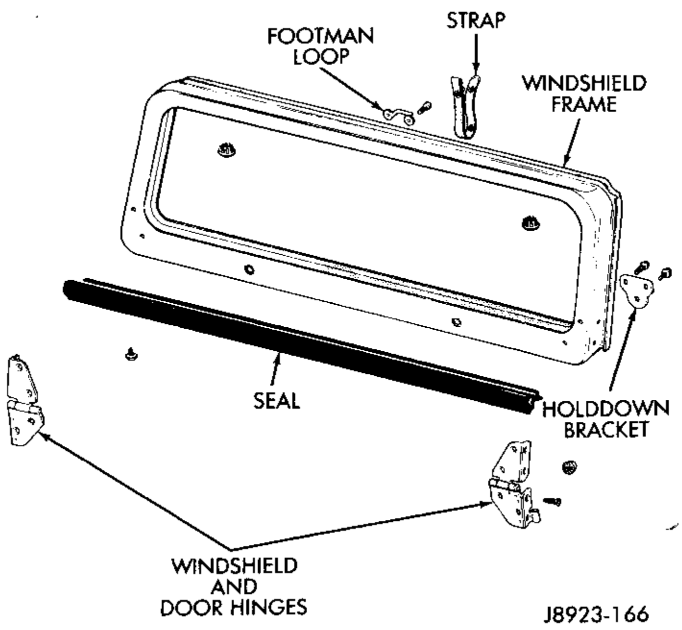


Fig. 2 Windshield Frame Components

Removable Body Components

Windshield Frame

The windshield frame and glass can be removed as an assembly for service access. Removal involves disconnecting the top from the windshield frame, removing the interior retainers and hinges and removing the frame and glass as an assembly (Fig. 2). The windshield can also be tilted forward to a full horizontal position when complete removal is not needed.

REAR VIEW MIRROR

Mirror Removal/Installation

(1) Loosen the mirror set screw and slide the mirror up and off the mounting button (Fig. 1).

(2) To install the mirror, side the mirror onto the mounting button and tighten the set screw.

CAUTION: Do not overtighten the setscrew as glass chipping or breakage could occur.

Mirror Mounting Button Replacement

(1) Mark location of the mirror button on the **outside** of the windshield glass with a grease pencil. Make horizontal and vertical position lines for accurate placement.

(2) If the vinyl pad remained on the windshield, soften and remove it with a heat gun. Low heat setting is enough to soften the pad.

(3) Thoroughly clean the button mounting area of the glass. Use a mild abrasive powder (Ajax, Comet, etc) on a cloth saturated with isopropyl alcohol. Final clean the glass with a paper dampened with alcohol.

(4) Lightly sand the mounting surface of the new button with fine grit paper. Then wipe clean the button mounting surface clean with a paper towel and alcohol.

(5) Apply adhesive accelerator to the mounting surface of the mirror button as follows:

(a) Crush the vial in the plastic housing of the accelerator to saturate the felt applicator.

(b) Remove the paper sleeve.

(c) Apply a generous amount of accelerator to the mounting surface of the mirror button.

(d) Allow the accelerator to dry for at least five minutes. Do not touch the button surface covered with accelerator.

(6) Apply adhesive accelerator to the button mounting surface of the windshield glass. Allow the accelerator to dry for one minute. Do not touch the glass surface covered with accelerator.

(7) Attach the mirror button as follows:

(a) Apply one drop of adhesive at the center of the button surface on the windshield.

(b) Immediately apply an even coat of adhesive to the mounting surface of the button.

(c) Align the button with the reference lines. Then press and hold the button in place for at least one minute. **Be sure the button is correctly aligned as the adhesive sets up rapidly.**

(8) Let the adhesive set up for 8-10 minutes. Then remove any adhesive residue with an alcohol dampened cloth.

(9) Allow the adhesive to cure for an additional 8-10 minutes before installing the mirror.

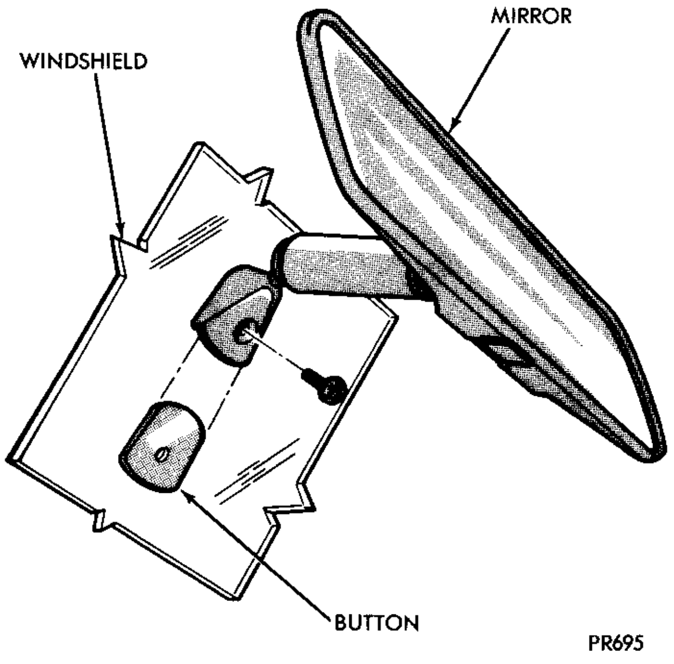


Fig. 1 Rear View Mirror Mounting

TAILGATE

Procedures covered in this section include: tailgate removal/installation, tailgate seal replacement, and latch and lock cylinder removal/installation.

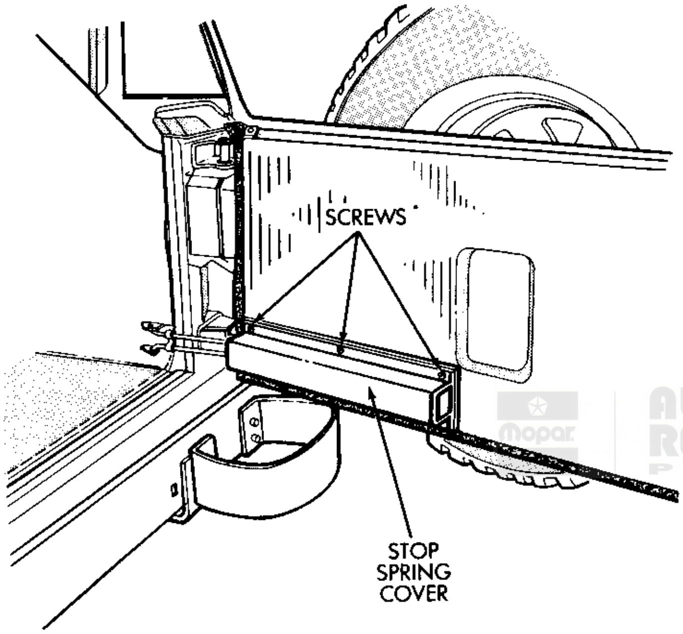
Tailgate Removal

(1) Open the tailgate.

(2) Remove the tailgate stop spring cover by removing the screws at the outer edge of the cover (Fig.1).

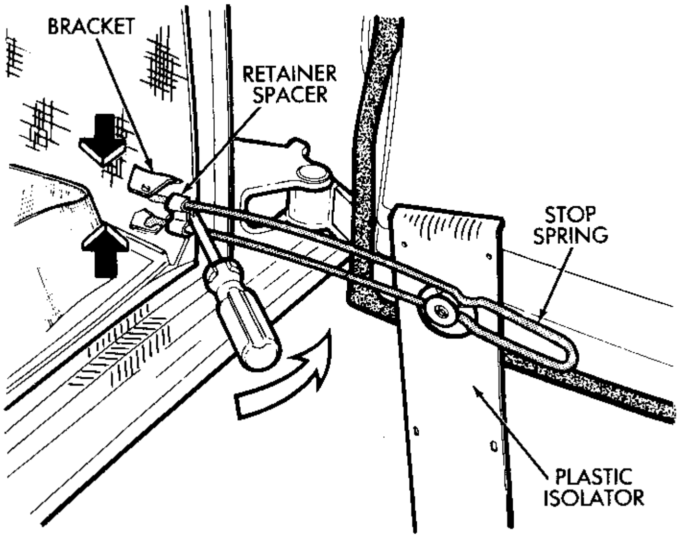
(3) Using a screwdriver, pry out the retainer spacer that holds the stop spring in the bracket (Fig. 2).

(4) Apply pressure on the spring to release the spring from the bracket.



J8923-119

Fig. 1 Removing/Installing Stop Spring Cover



J8923-120

Fig. 2 Removing/Installing Stop Spring

(5) Remove the spring (Fig. 2).

(6) Remove the plastic isolator (Fig. 2).

(7) Close the tailgate.

(8) Remove the tailgate hinge screws with a Torx bit.

(9) Disengage the latch and remove the tailgate.

Tailgate Installation

(1) Position and align the tailgate in the body opening and engage the latches.

(2) Install the hinge attaching screws.

(3) Install the stop spring, isolator and retainer (Fig. 2).

(4) Install the stop spring cover (Fig. 1).

Tailgate Adjustment

(1) Loosen the hinge-body-attaching screws.

(2) Align the tailgate in the body opening and tighten the hinge screws.

Tailgate Hinge Replacement

(1) Remove the hinge screws and remove the hinge.

(2) Prepare and paint the new hinge to match the body.

(3) Lubricate the hinge with 3M 4-Way spray lubricant or equivalent.

(4) Position the hinge on the body and install the screws.

(5) Position the tailgate and install the hinge-to-tailgate screws.

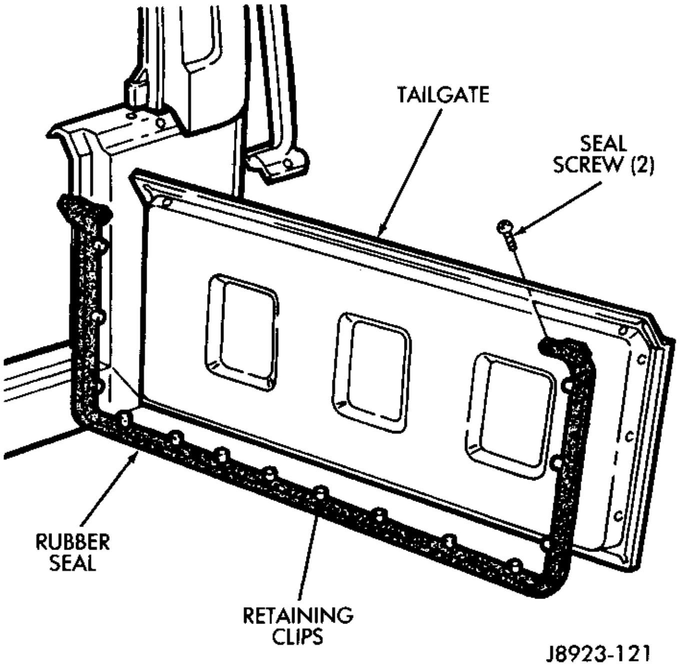


Fig. 3 Tailgate Seal

Tailgate Rubber Seal Replacement

(1) Remove the seal retaining screws (Fig. 3).

(2) Remove the seal from the retaining clips (Fig. 4).

(3) If the original seal will be reused, clean it with a dampened cloth.

(4) Clean the seal surface of the tailgate.

(5) Check the seal clips. Replace any that are loose or damaged.

(6) Position the seal on the clips and press the seal onto the clips.

(7) Install the seal screws.

CAUTION: Do not use graphite, brake fluid or wax on the seal.

Tailgate Latch Removal

(1) Open the tailgate and remove the latch cover.

(2) Remove the tailgate latch rod clip and disconnect the rod (Fig.6).

(3) Remove the latch-to-tailgate screws.

(4) Remove the retaining clip from the lock cylinder rod and disconnect the rod (Fig. 6).

(5) Remove the latch handle screws.

(6) Disengage the handle from the latch.

(7) Remove the latch mechanism.

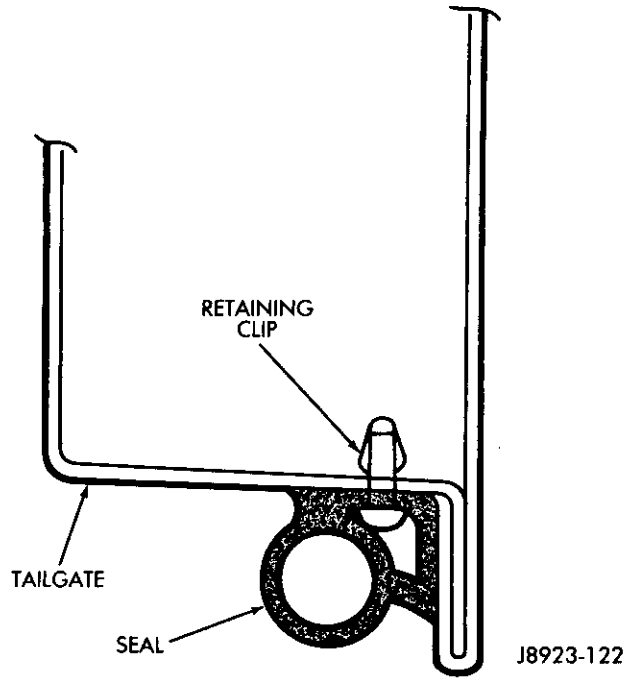


Fig. 4 Seal Retaining Clips

Tailgate Latch Installation

(1) Position the latch in the tailgate.

(2) Install the latch release handle.

(3) Install the latch retaining screws and connect the latch rods and rod clips (Fig. 6).

(4) Install the latch cover.

Tailgate Lock Cylinder Removal

(1) Open the tailgate.

(2) Remove the latch cover (Fig.5).

(3) Remove the cylinder retaining clip (Fig.7).

(4) Disengage the lock cylinder.

(5) Remove the E-clip and disengage the cylinder from the lever (Fig. 7).

Tailgate Lock Cylinder Installation

(1) Inspect the retaining clips. Replace the clips if distorted or damaged.

(2) Connect the cylinder and lever and install the cylinder in the latch and tailgate.

(3) Install the cylinder retaining clip (Fig. 7).

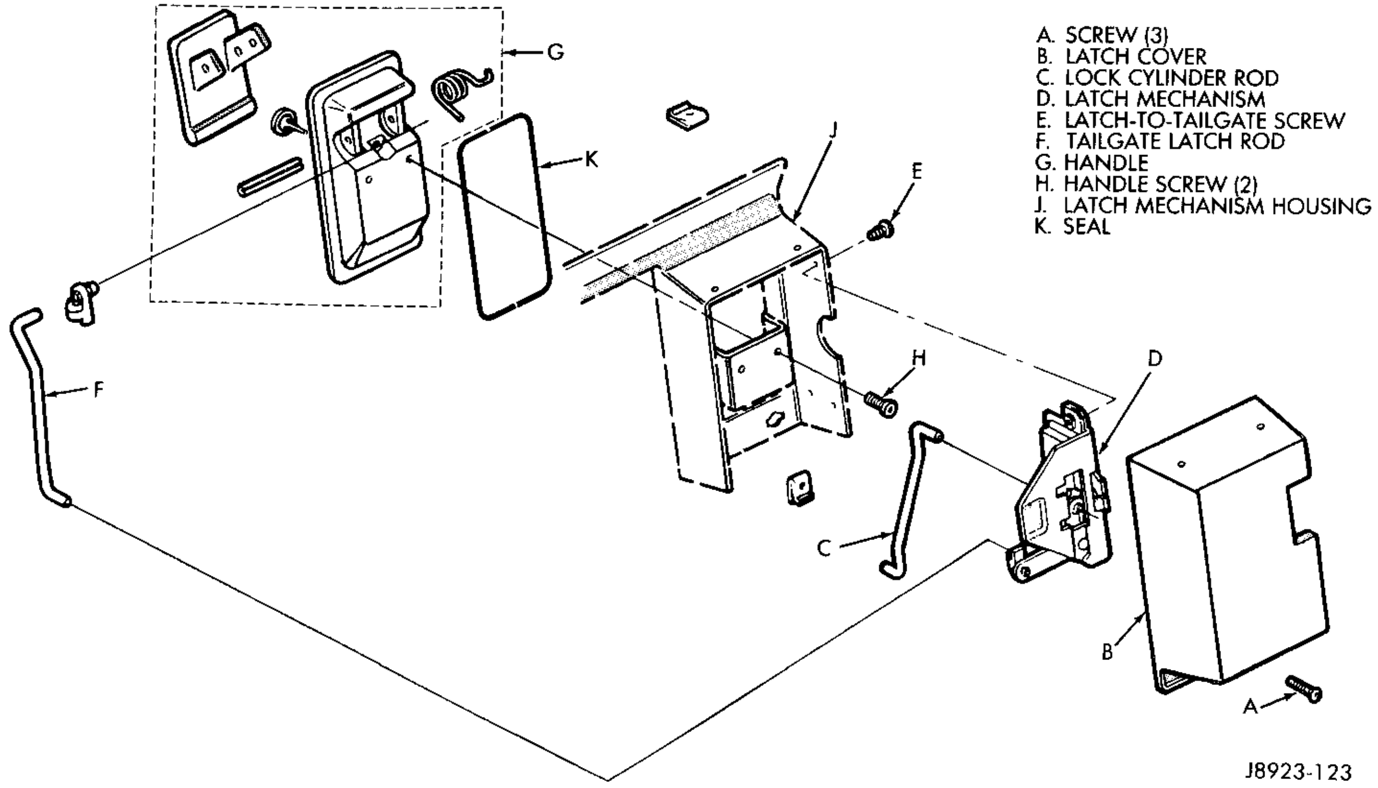


Fig. 5 Tailgate Latch Mechanism

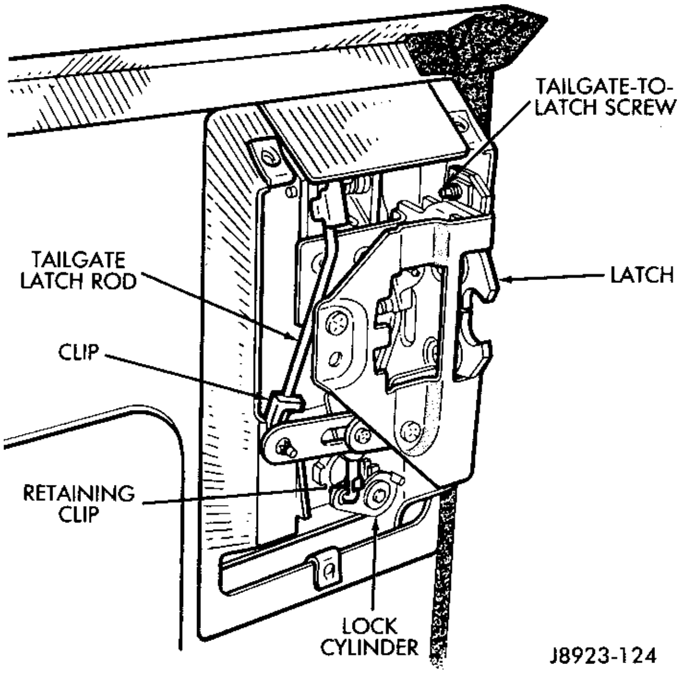


Fig. 6 Latch Removal/Installation

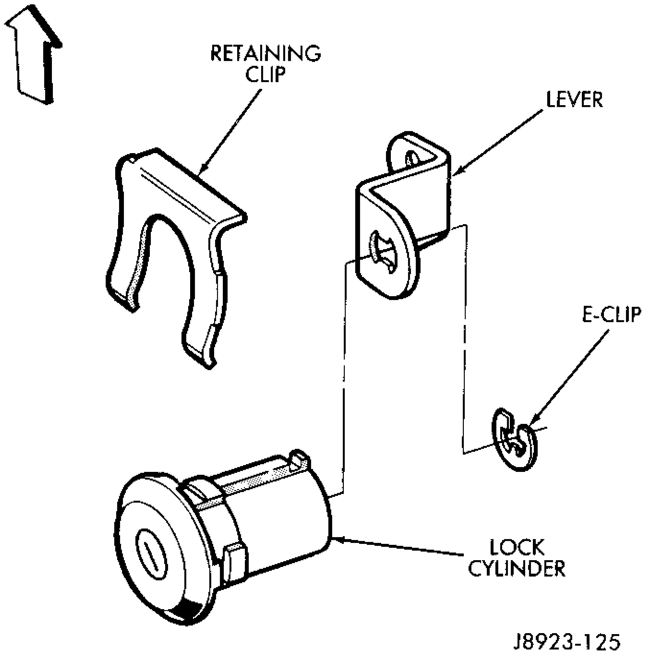


Fig. 7 Lock Cylinder Removal/Installation

HARD TOP

Procedures covered in this section include hard top and tailgate window removal/installation and hard top repair procedures.

The hard top is constructed of compressed molded fiberglass and painted with a special spatter paint (Fig. 1). The hard top can be removed for service access or other purposes.

Hard Top Removal

CAUTION: When removing the hard top, avoid damaging the foam sealer between the hard top and body panels.

(1) Remove the screws attaching the hard top to the windshield frame (Fig.2).

(2) Remove the nuts, washers and screws attaching the hard top to the rear body panels (Fig.3).

(3) Disconnect the electrical connections, if equipped (Fig. 4).

(4) Remove the hard top from the vehicle.

Hard Top Installation

(1) Inspect the hard top seal for damage and replace it if necessary.

(2) Carefully position the hard top on the vehicle.

CAUTION: When installing the hard top, avoid damaging the foam sealer between the top and body panels.

(3) Install the screws, washers and nuts attaching the hard top to the rear body panels (Fig. 3).

(4) Connect the electrical connections, if equipped.

(5) Install the screws attaching the top to the windshield frame (Fig. 2).

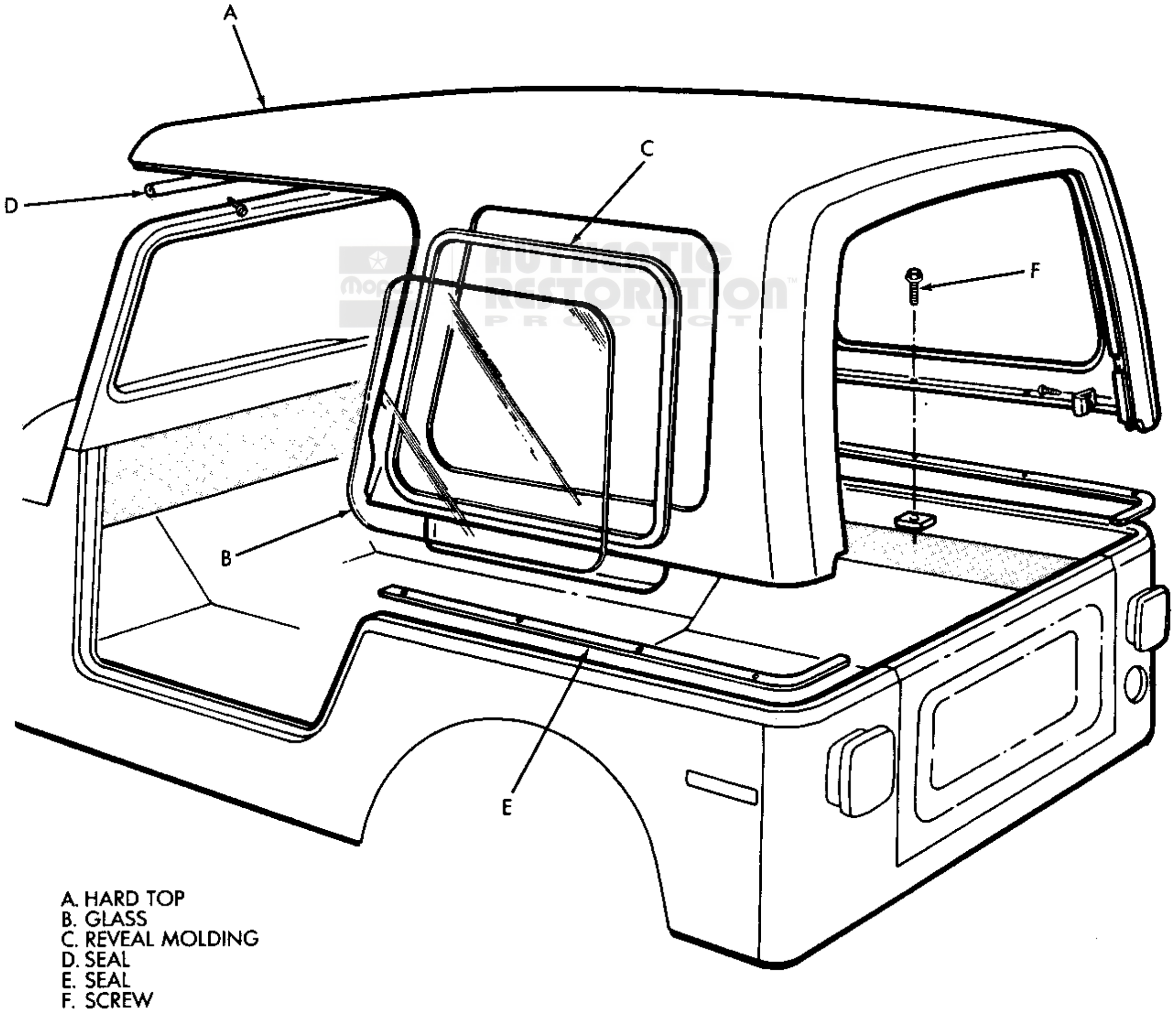


Fig. 1 Hard Top Components

Hard Top Repair

The hard top material can be repaired. Repair materials needed include:

- fiberglass mat or cloth
- fiberglass resin and hardener
- structural adhesive (3M brand or equivalent)
- glazing putty
- aluminum foil
- plastic spreader

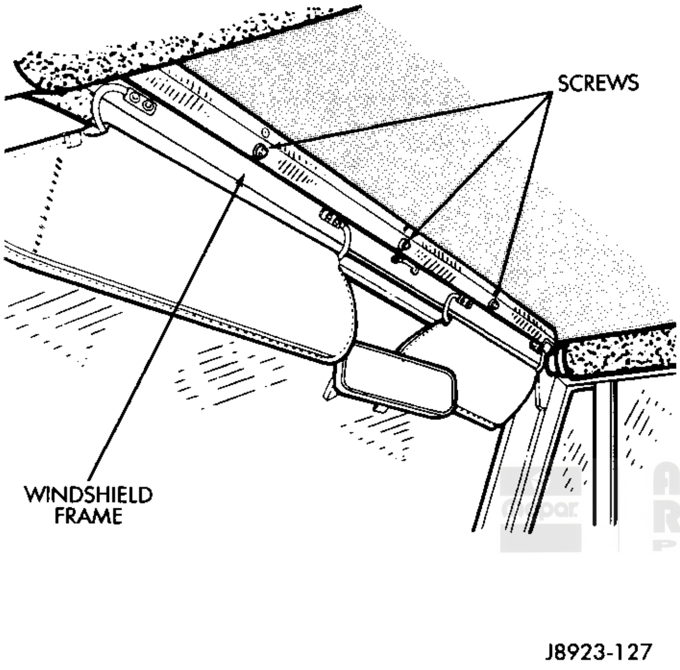


Fig. 2 Hard Top-To-Windshield Frame Screws

Hard Top Hole Repair

(1) Use a grinder to remove paint and outline the damaged area. Use a grade 24 grit disc for this.

(2) Grind the outlined area again with a 50 grit disc to prevent coarse scratches from showing up in the final finish.

(3) If cracks extend from the hole, it will be necessary to stop-drill the crack(s) with a 1/8 inch diameter drill bit.

(4) Position a fiberglass mat or cloth on the repair area. Cut out the mat to allow a 2.54 cm (1 inch) overlap of the repair area.

(5) Clean the repair area.

(6) Place the fiberglass cloth on aluminum foil.

(7) Pour the fiberglass resin into a clean container.

(8) Mix the appropriate amount of hardener and resin. Follow the manufacturers instructions.

(9) Apply the hardnener/resin mixture to both sides of the fiberglass cloth.

(10) Place the fiberglass cloth over the repair area. Then place the aluminum foil over the cloth. Smooth the cloth and resin with a plastic spreader. Use firm pressure to remove air bubbles and smooth the cloth.

(11) Allow the resin to cure.

(12) Smooth the area to contour using a 50 grit disc.

(13) Apply plastic filler to complete the repair, and finish the area with 80 grit paper.

(14) Repeat the previous step on the inside of the top.

(15) Featheredge the repaired area.

(16) Prime the repaired area with Ditzler Epoxy Chromate Primer (DP-40/401).

(17) Apply surface primer.

(18) Sand the area for paint preparation; reprime if necessary.

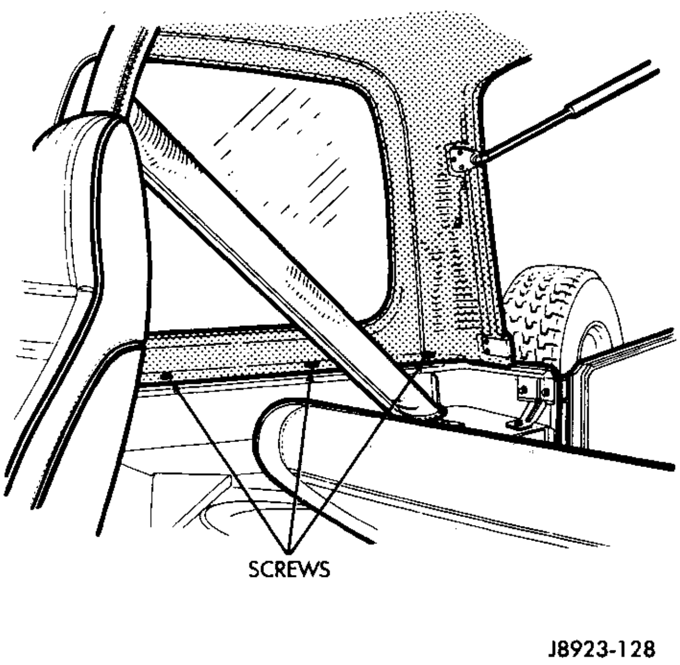


Fig. 3 Hard Top Rear Attaching Screws

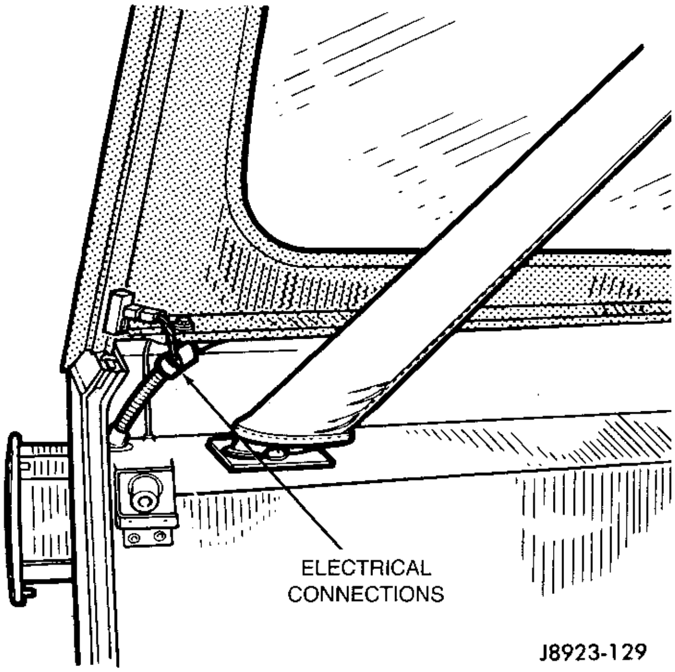


Fig. 4 Electrical Connections — Typical

(19) Prime the area for color coat.

(20) Color coat the repair area.

Fracture Repair

(1) Use a grinder to remove the paint, from both sides, and to outline the damaged area.

(2) Stop-drill the crack(s) with a 1/8 inch diameter drill bit.

(3) Bevel the edges of the crack(s) on both sides with a rotary file.The edges should be beveled on the inside and outside of the top to ensure sufficient surface area for good bonding.

(4) Complete repairs with fiberglass cloth and resin as outlined in the hard top hole repair procedure.

Textured Paint Repair

The textured paint used on 80 Series hard tops is available through the Mopar parts group. The paint supplied will duplicate the original texture on the top.

Tailgate Window Removal

(1) Disconnect the rear defogger/dome lamp wires.

WARNING: Do not remove the tailgate window support cylinders with the tailgate closed. The cylinders are operated by high pressure gas and could cause personal injury or vehicle damage if removed with the tailgate closed. Once removed, do not attempt to disassemble or repair the cylinders.

(2) Open the tailgate (Fig. 5).

(3) Remove the support cylinder retaining clips at both ends of each support (Fig. 5)

(4) Pull the support cylinders off the ball studs (Fig. 5).

(5) Remove the window hinge screws (Fig. 5).

(6) Remove the tailgate window.

(7) Remove the window seal if necessary.

Tailgate Window Installation

(1) Assemble the window components if necessary (Fig. 6).

(2) Install the window and the window hinge screws.

(3) Adjust the window to fit the body opening.

(4) Tighten the hinge screws.

(5) Position the support cylinders on the ball studs.

(6) Install the cylinder retaining clips.

(7) Connect the rear window defogger/dome lamp wires.

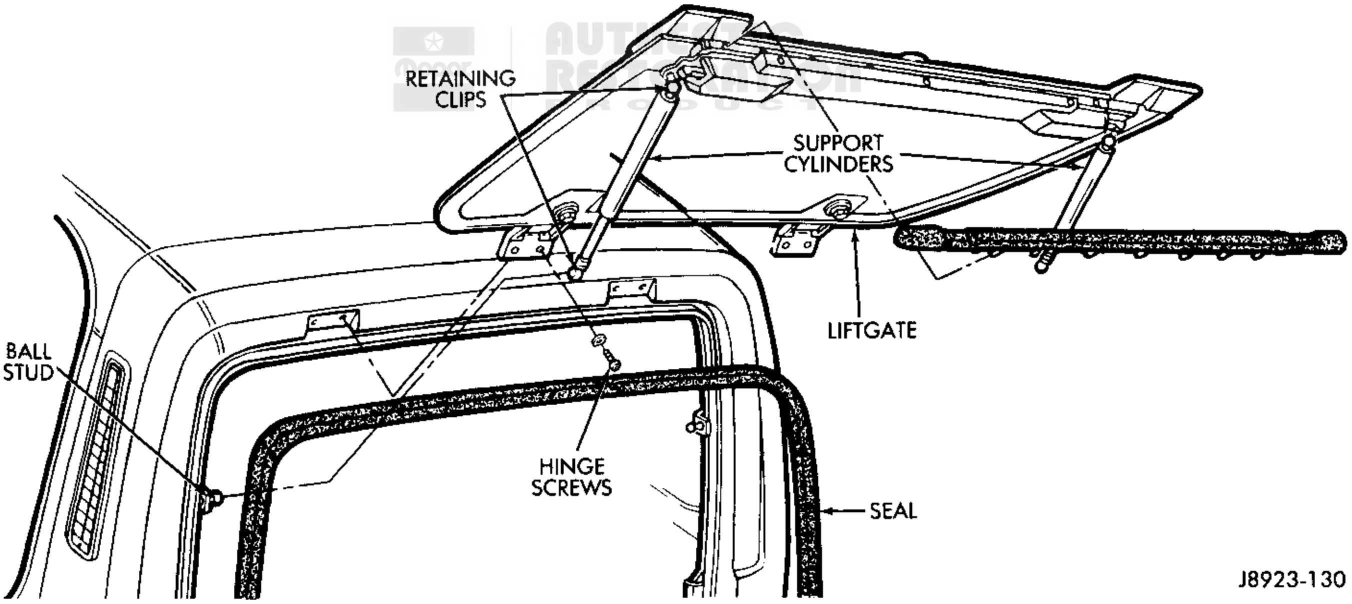


Fig. 5 Removing/Installing Tailgate Window

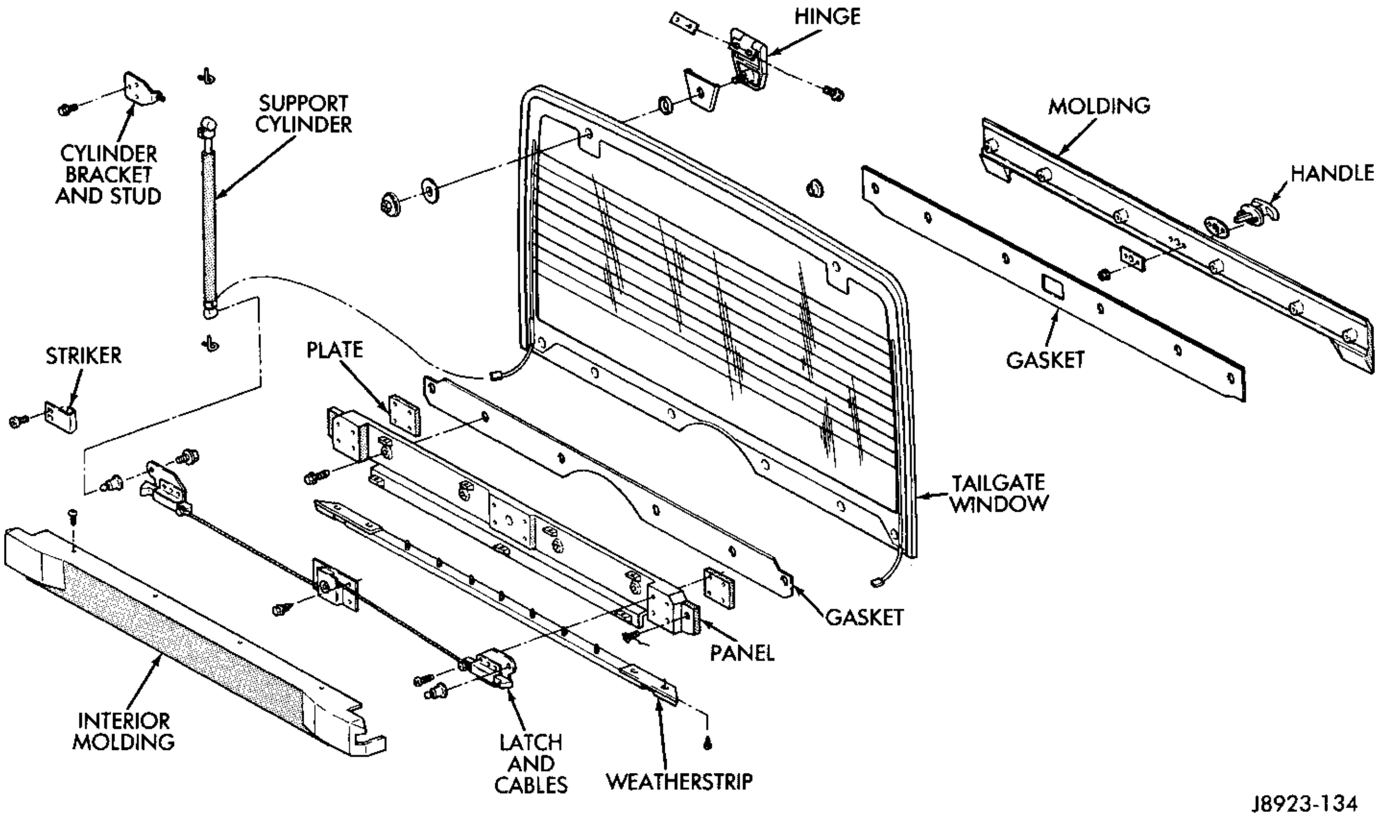


Fig. 6 Tailgate Window Components

SOFT TOP

The soft top consists of the top fabric and the side and rear curtains (Fig. 1). The top is supported by a tubular frame and attached to the front and side retainers with snap fasteners (Fig. 2). Procedures included in this section include soft top removal and installation. Refer to the section on Doors for soft top door service.

Soft Top Removal

(1) Unsnap the top at the front corner fasteners (Fig. 3).

(2) Disconnect the upper frame from the door flange (Fig. 4).

(3) Unsnap the fasteners, turn the retainers and remove the door windows (Fig. 5).

(4)Unzip the side curtain front and rear zippers (Fig. 6).

(5) Unsnap the interior snap tab and pull the bottom edge of each side curtain out of the bottom retaining channel (Fig. 7).

(6) Slide the front edge of the side curtain down and remove it from the retainer on the front support bar (Fig. 8).

(7) Pull down on the spreader bar to release tension on the front and rear support bars (Fig. 9).

(8) Open the tailgate.

(9) Unzip the rear curtain top and side zippers (Fig. 10).

(10) Push the bottom of the rear support bows forward 3-5 cm (1-2 inches) and out of the notch in the side rails (Fig. 11).

(11) Disconnect the top from the drip rails above the doors. Then pull the top from the retainer along the upper edge of the windshield frame (Fig. 12)

(12) Fold the top back from the windshield so that the fold is at the front support bow (Fig. 13).

(13) Slide the lock on the drip rail forward. Then pull the drip rail off the lock pin on the windshield frame (Fig. 14).

(14) Slide the entire top assembly rearward (Fig. 15). The bottom of the rear support bows should slide forward and fold under the front support bows and drip rails (Fig. 15).

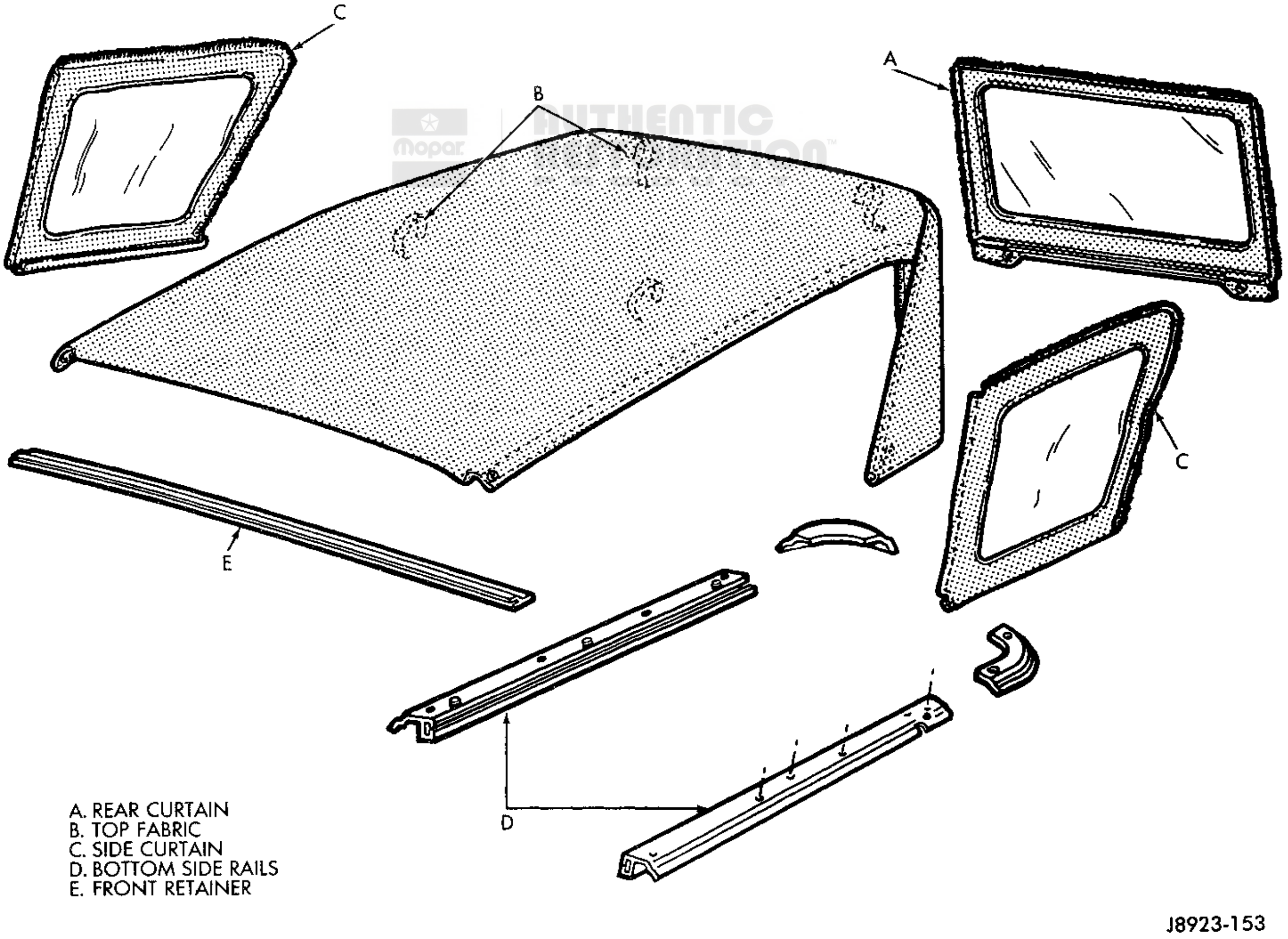


Fig. 1 Soft Top Components

(15) Slide the front support bow out of the side rail and remove the top assembly.

Soft Top Installation

(1) Unhook the elastic straps holding the top assembly.

(2) Install the front bows in the side rails.

(3) Grasp the side rails and pull the entire top assembly up and forward.

(4) Push the front of the drip rail onto the lock pin on the windshield frame, then slide the lock rearward.

(5) Insert the front edge of the top into the retainer on the windshield frame, then attach the snap at each corner of the windshield.

(6) Make certain the front support bow is pushed all the way forward.

(7) Be sure the rear corners of the top are completely inserted into the retaining rail.

(8) Pull the bottom of the rear support bows back until they snap into the notch in the side rails. Be sure the rear zippers of the side windows are not caught or folded behind the rear support bow.

(9) Push the spreader bars upward until they snap into place.

(10) Slide the front edge of each curtain up into the retainer channel on the front support bow.

(11) Start the top zipper on each side curtain, but zip only 2-3 inches (5-8 cm). Then start the rear zipper at the bottom corner. Again, zip it only 2-3 inches (5-8 cm).

(12) Fasten the front and rear snap tabs on the side curtains to the inside rail.

(13) Completely close both zippers in the side window curtains.

(14) Pull down firmly on the side curtains and use your thumbs to press the bottom edge of the side curtain up and under the retainer rail. Start at one end and work toward the opposite end. The bottom edge must be completely inserted into the retainer rail.

(15) Unroll the rear curtain and insert the bottom edge into the retainer channel. Close the zippers on the rear window curtain and fasten the side snaps.

(16) Fasten all snaps to the drip rails above both doors. Slide the snaps on the rails to line up with the snaps on the top as necessary. Tuck the edge of the fabric inside the drip rail.

(17) Install the fabric upper doors by inserting the pins into the lower door grommets. Fasten the 6 snaps along the bottom edge.

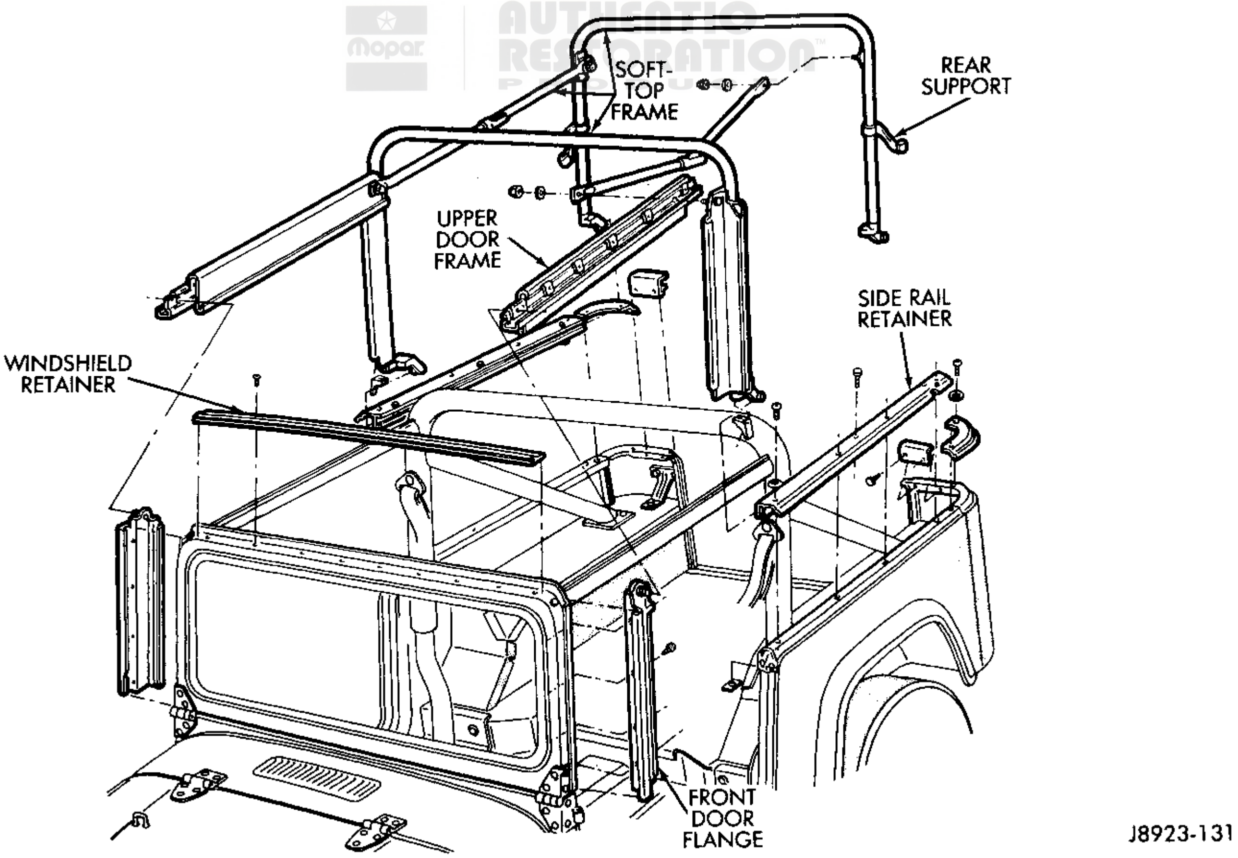


Fig. 2 Soft Top Frame And Retainers

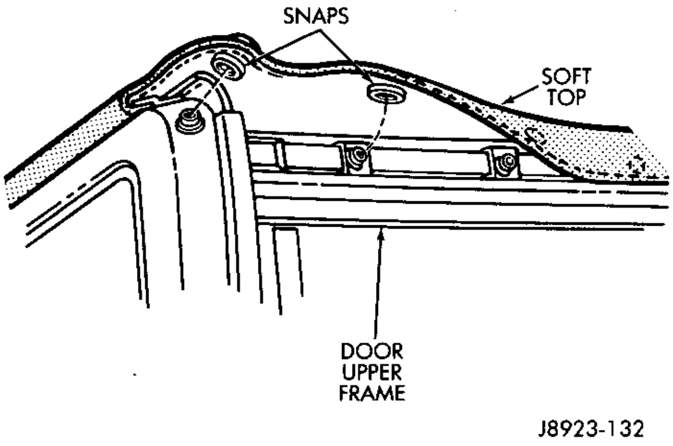


Fig. 3 Front Corner Snap Fasteners

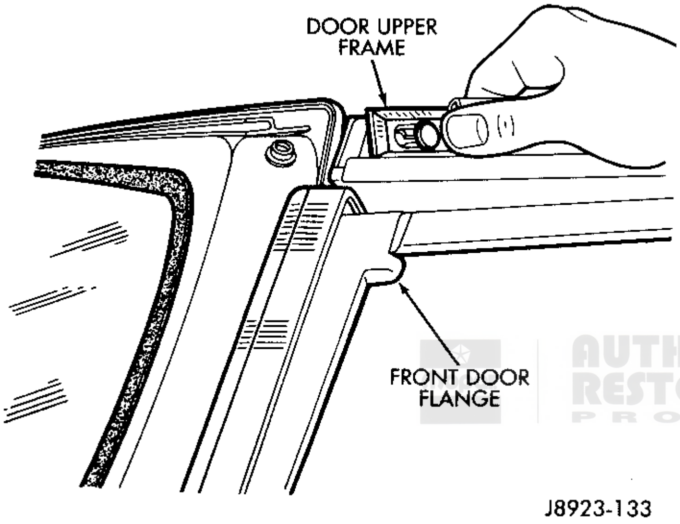


Fig. 4 Upper Frame Attachment

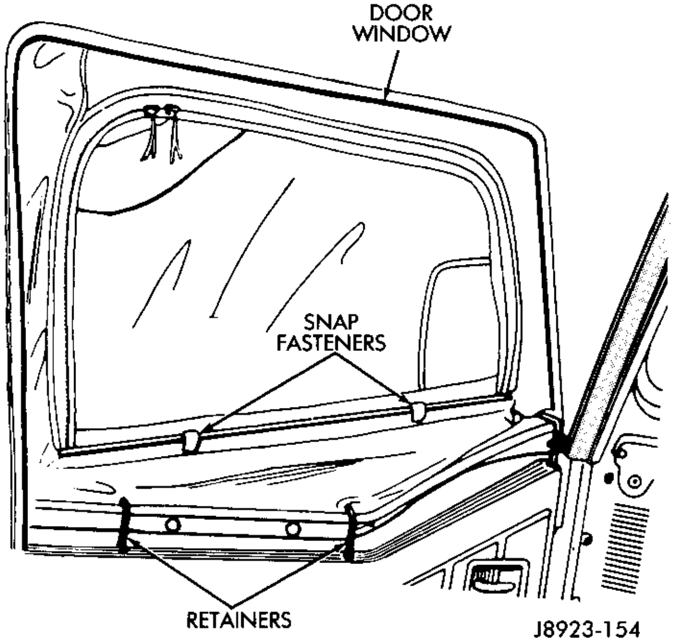


Fig. 5 Door Window Removal/Installation

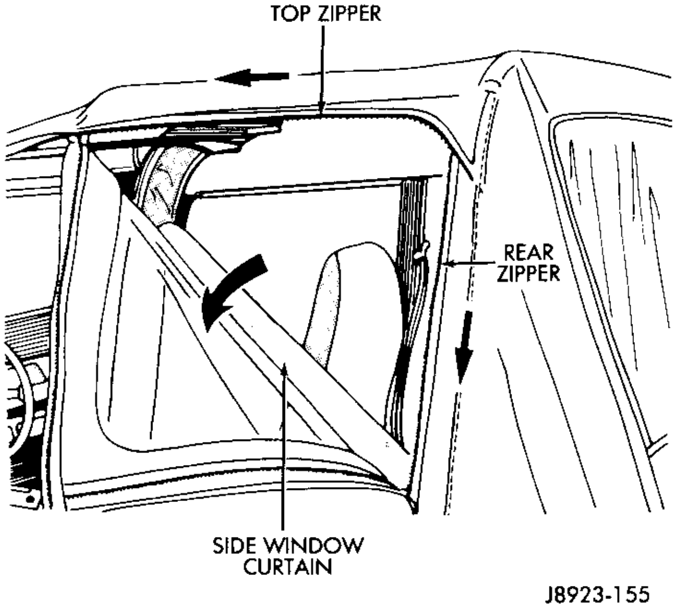


Fig. 6 Side Curtain Front And Rear Zippers

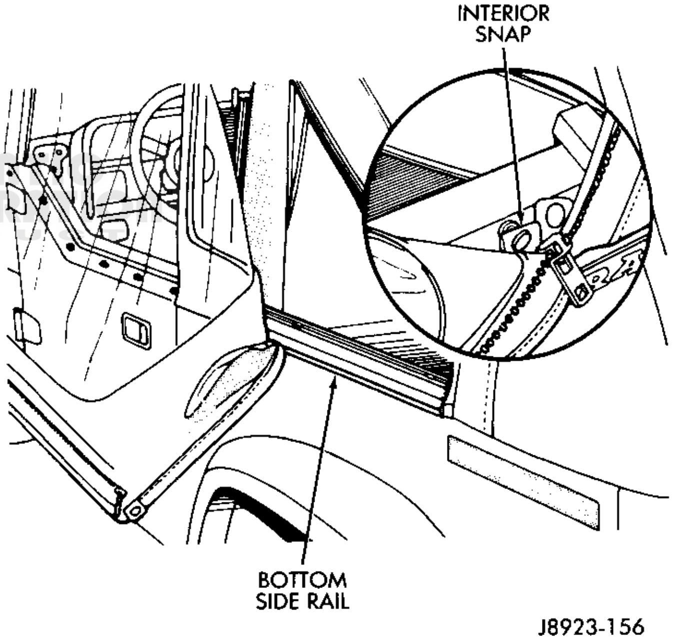


Fig. 7 Side Curtain Channel Attachment

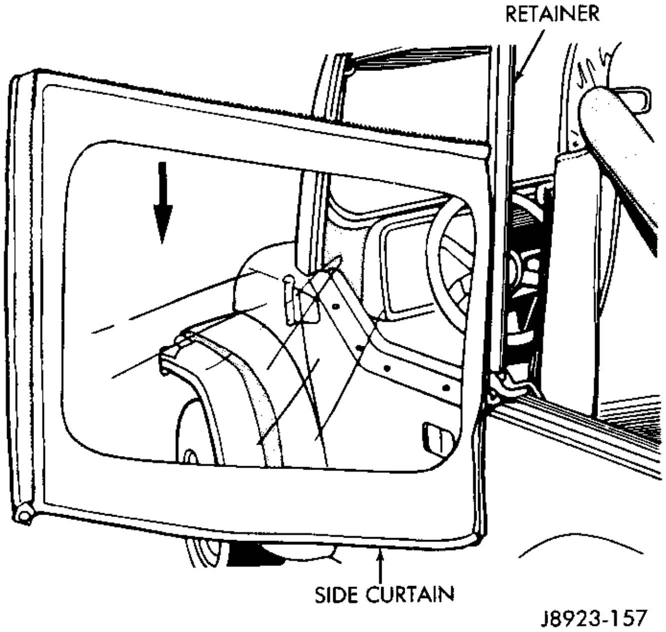


Fig. 8 Side Curtain Removal/Installation

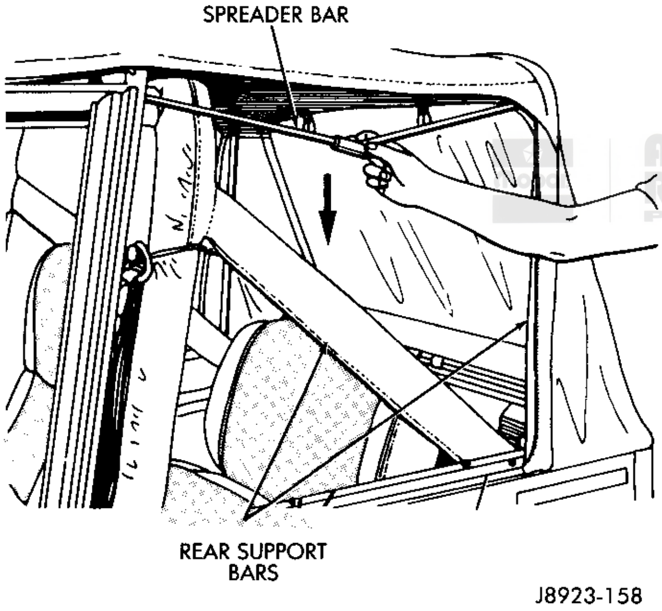


Fig. 9 Releasing Spreader Bar

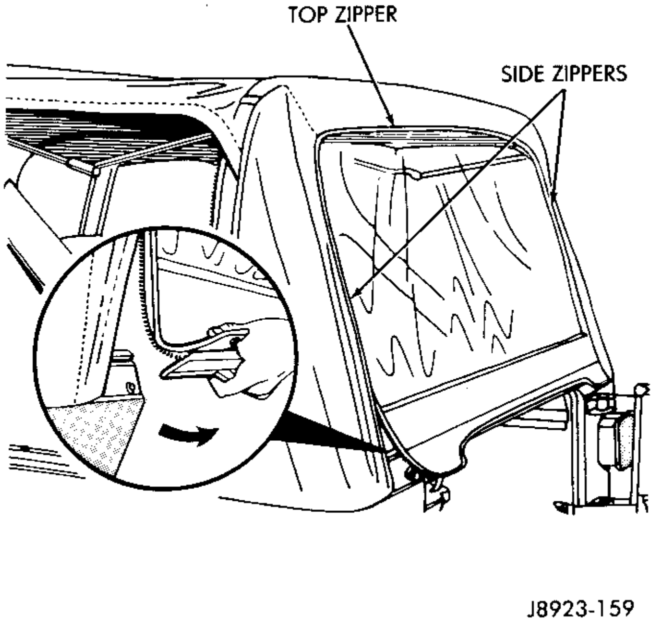


Fig. 10 Rear Curtain Top And Side Zippers

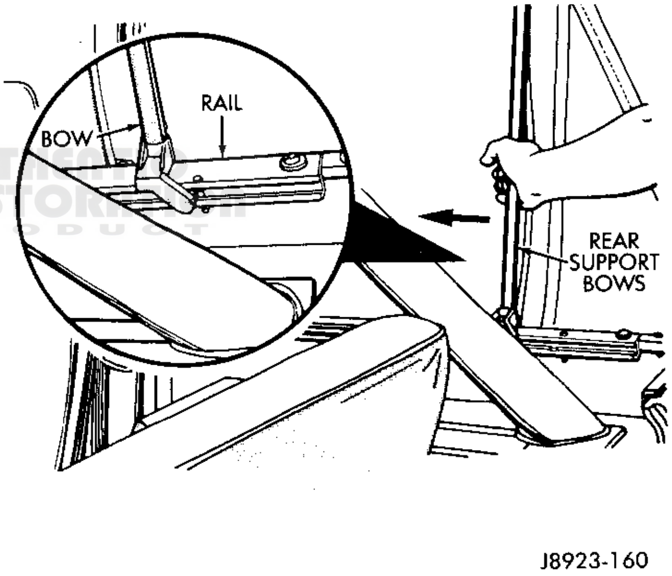


Fig. 11 Releasing Rear Support Bows

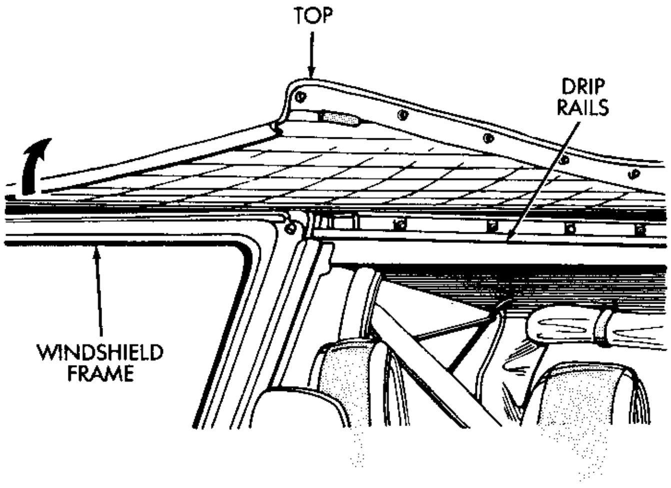


Fig. 12 Unfastening Top

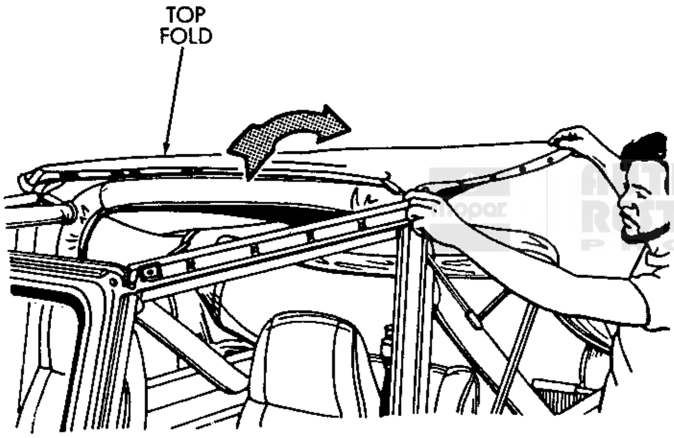


Fig. 13 Folding Top Rearward

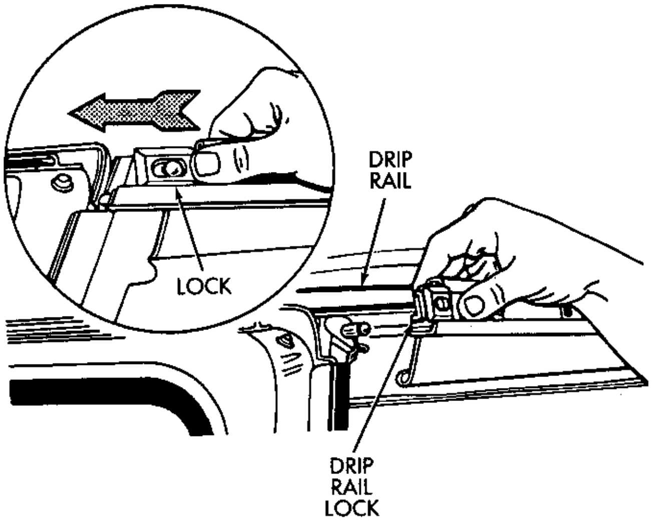


Fig. 14 Disengaging Drip Rail Lock

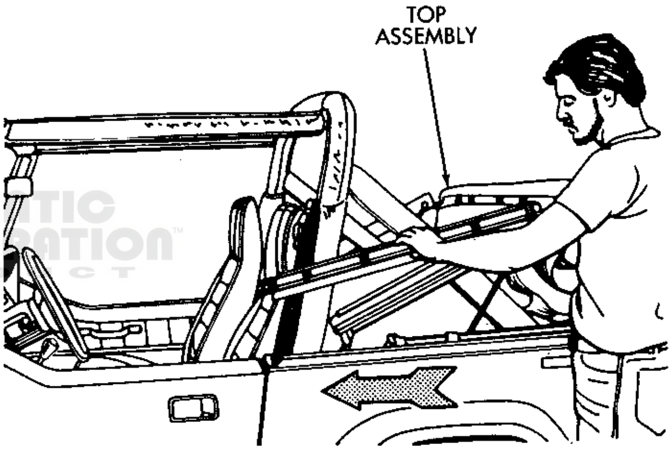


Fig. 15 Folding The Top Rearward

DOORS

Soft Top Door Removal

(1) Open the door.

(2) Disconnect the restraint strap (Fig. 1).

(3) Remove the window by releasing the soft top-to-door snaps and pulling the window assembly up and out of the door (Fig. 2).

(4) Turn the window retaining sleeves 1/4 turn to the left and pull them up and out of the door.

(5) Remove the door handle.

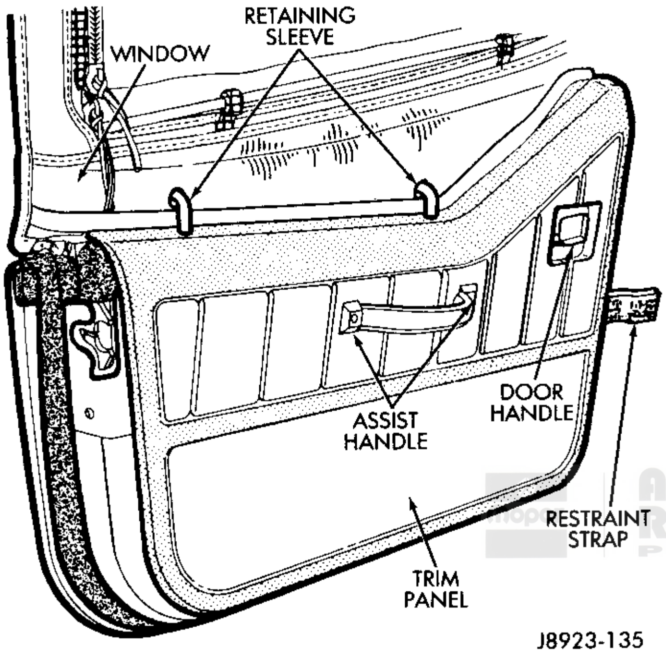


Fig. 1 Soft Top Door Removal

(6) Remove the assist handle.

(7) Remove the trim panel by releasing the clips around the edge of the trim panel.

(8) Remove the screw from the outside door handle (Fig. 3), disconnect the linkage and remove the handle.

(9) Remove the door latch screws.

(10) Remove the door latch assembly with the latch-to-handle linkage.

(11) Remove the weatherstrip retaining screws and carefully remove the weatherstrip from the retaining clips. Leave the weatherstrip retaining clips in the door.

(12) Remove the door hinge-to-body screws and remove the door.

Soft Top Door Installation

(1) Position the door on the vehicle and install the hinge-to-body screws.

(2) Install the weatherstrip on the retaining clips and install the screw at each end.

(3) Position the latch-to-handle linkage and door latch and install the screws.

(4) Install the trim panel.

(5) Position the outside door handle, connect the linkage and install the retaining screws.

(6) Connect the linkage to the inside door handle and install the door handle.

(7) Install the assist handle.

(8) Install the window retaining sleeves.

(9) Install the window assembly.

(10) Attach the restraint strap.

Door Latch And Handles

The door latch and handle components are shown in Figure 3. Removing the door trim panel will provide access to these components.

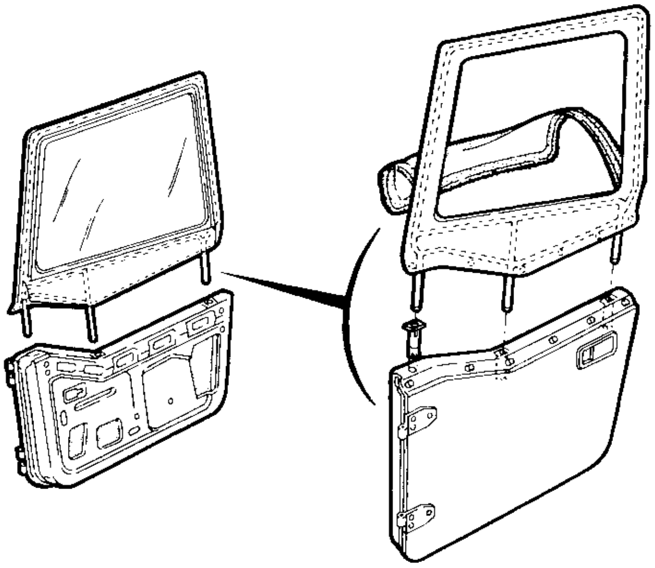


Fig. 2 Removing/Installing Soft Top Door Window

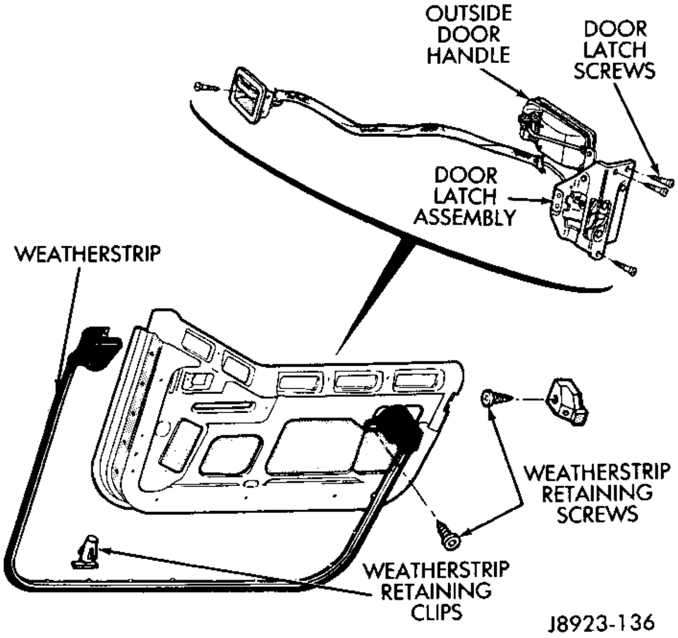


Fig. 3 Soft Top Door Disassembly

Hard Top Door Removal

(1) Remove the restraint strap.

(2) Remove the door hinge screws and remove the door assembly.

(3) Remove the door components if necessary (Fig. 4).

Hard Top Door Installation

(1) Assemble and install the door components if necessary.

(2) Position the door on the body and install the hinge screws.

(3) Adjust door position and tighten the hinge screws.

(4) Install the restraint strap.

DOOR TRIM

Window Regulator Handle

Window regulator handles are attached to the splined shaft of the window regulator with a Allen head screw. To remove the handle, remove the screw and pull the handle straight off the shaft.

Install the handle with the knob forward, the handle horizontal and the glass all the way up.

Door Assist Handle

Removal

(1) Remove screws attaching door assist handle.

(2) Remove handle from door.

Installation

(1) Position handle on door.

(2) Install attaching screws.

Trim Panel

Trim panels consist of fiber composition covered with a vinyl material. They are fastened to the door with plastic clips inserted into holes in the door inner panel.

Removal

(1) Remove door assist handle.

(2) Remove window regulator handle.

(3) Pry trim panel-to-door clips along sides loose and remove panel.

Installation

(1) Position trim panel on door and install clips in holes in inner door panel.

To prevent creasing the trim panel cover, do not hammer or exert excessive force on the clips.

(2) Install window regulator handle.

(3) Install door assist handle.

SEALING SYSTEM

Water Shield

The water shield is attached to the door inner panel with adhesive. To remove water shield, use a putty knife between shield and door inner panel to break adhesive bond.

When installing water shield, be sure the slit lower portion is tucked inside the door panel at the access opening and that the shield is bonded securely to the door inner panel.

Rubber Sealer

The door rubber sealer is made of molded latex foam with a smooth rubber skin on the outside.

Plastic retainers are used to retain the rubber sealer to the door below the belt line. Barbs on the retainer depress when inserted in the holes and spread when fully inserted. Above the belt line, the sealer is retained in a channel formed in the upper door frame.

Maintenance of Rubber Sealers

Cold weather may cause the rubber sealer to harden and lose resiliency. This may cause the door to loosen in its opening, resulting in noise. When servicing, use a dampened claoth to clean rubber sealer. Remove dirt from all points where the rubber sealer contacts the body. Apply Silicone Lubricant, or equivalent, to sealer.

CAUTION: Do not use graphite, brake fluid, or wax on rubber sealer.

Replacement

Replacement rubber sealers are coated with powder to prevent stickiness in storage. Before installation, remove all powder with cloth dampened in 3M General Purpose Adhesive Cleaner, or equivalent.

(1) Carefully remove rubber sealer from door using Weatherstrip Remover to remove plastic retainers from panel holes. Remove upper portion from upper door frame with fingers or wooden wand.

(2) Remove dust and dirt from rubber sealer, door and body.

(3) Install upper front corner of sealer to door first using fingers or wooden wand to engage sealer intochannel. Place inner shoulder of sealer in channel-to-window frame above belt line.

(4) Press retainers, starting at rear edge of door, into door panel holes.

WINDOW SYSTEM

Door Glass

Adjustment

One adjustment point is available which regulates the amount of effort required to raise and lower the door

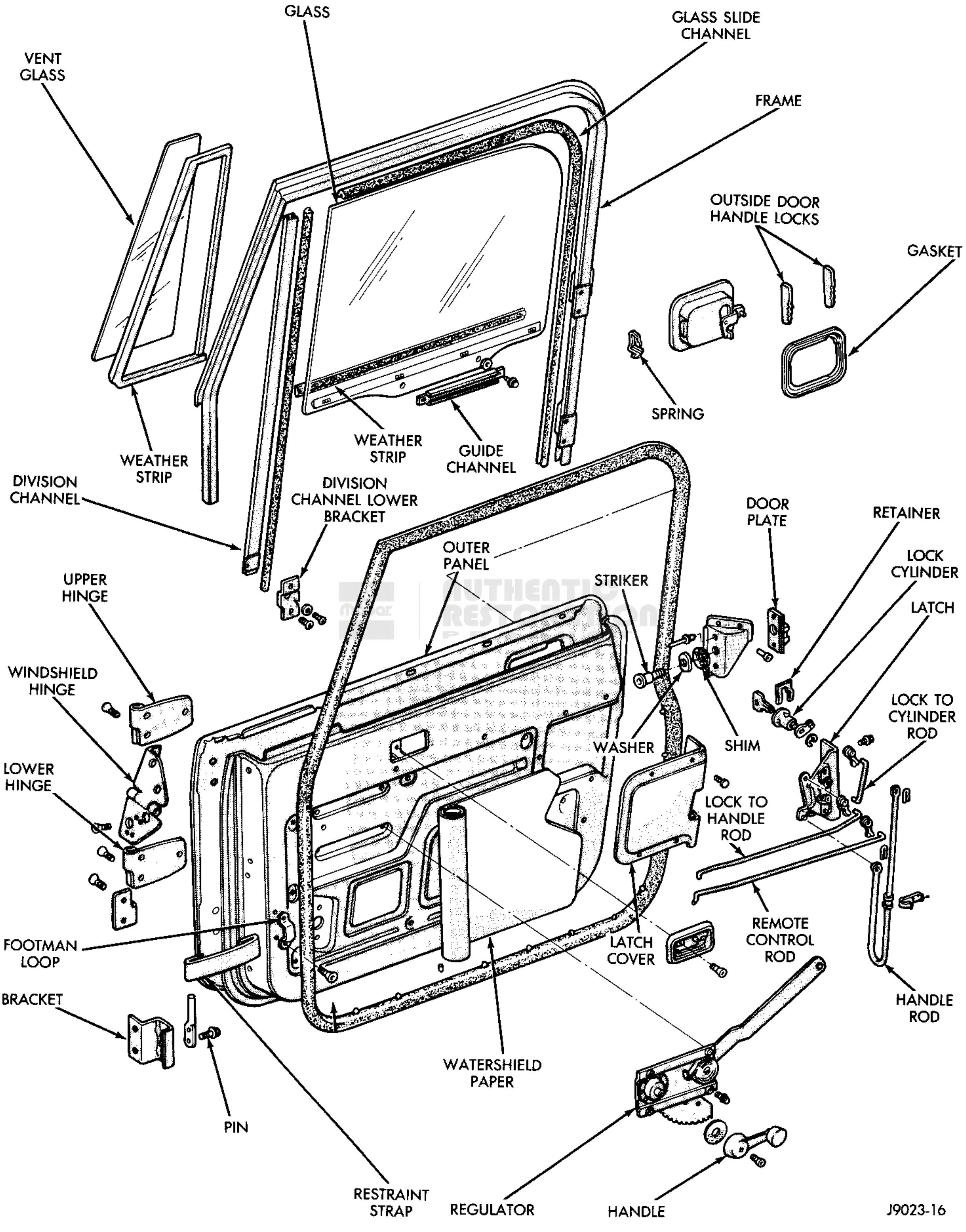


Fig. 4 Hard Top Door

glass. The door glass division channel is adjustable fore and aft at the lower attachment point.

(1) Remove door trim panel and water shield.

(2) loosen division channel lower adjusting screw and move division channel fore or aft to obtain desired door glass operation.

Movement of division channel fore and aft reduces or increases free play between channels.

(3) Tighten division channel lower adjusting screw.

(4) Install water shield and door trim panel.

Removal

(1) Remove door trim panel and water shield.

(2) Remove glass down-stop.

(3) Remove screws attaching guide channel to plastic fasteners. Remove guide channel and plastic fasteners.

(4) Lower glass to bottom of door.

(5) Remove division channel upper attaching screw and lower adjusting screw. Disengage front three inches of glass weatherstrip from upper door frame.

(6) Separate division channel from front glass rubber. Pull division channel up and in toward inside of vehicle.

(7) Raise and tilt glass toward hinge side of door and disengage from rear channel.

(8) Pull glass up and out of door panel.

Installation

(1) Lower glass into door, while positioning glass into front and rear channels.

(2) Install plastic fasteners into glass.

(3) Slide glass down into bottom of door panel.

(4) Lower division channel into door and position glass securely in channel.

(5) Engage weatherstrip in upper door frame and install upper attaching screw and lower adjusting screw.

(6) Slide guide channel onto regulator arm and positionchannel on glass. Install attaching screws.

(7) Install glass down-stop.

(8) Check operation and adjustment.

(9) Install water shield and door trim panel.

Stationary Vent Window

Removal

(1) Remove door trim panel and water shield.

(2) Lower glass to down-stop.

(3) Remove division channel upper attaching screw and lower adjusting screw.

(4) Disengage front three inches of weatherstrip from upper door frame. Lower division channel and tilt toward rear of door.

(5) Remove stationary vent glass from weatherseal.

Installation

(1) Install stationary vent glass into weatherseal.

It is necessary to seat front edge of weatherstrip into door frame. Then, seat vent glass into weatherstrip.

(2) Install division channel into door and position channel on glass.

(3) Install upper attaching screw and lower adjusting screw.

(4) Engage weatherstrip in upper door frame.

(5) Water test and check for leaks.

(6) If water leakage is evident, apply 3M Windshield Sealer, or equivalent, or realign weatherseal.

(7) Check operation and adjustment of door glass.

(8) Install water shield and door trim panel.

Window Regulator

Removal

(1) Remove trim panel and water shield.

(2) Lower glass to expose guide channel fasteners. Remove fasteners and guide channel. Raise window to full up osition and apply masking tape to glass and over top of window frame.

(3) Remove division channel lower adjusting screw.

(4) Remove regulator attaching screws. Push division channel outward and remove regulator through access hole in inner door panel.

Installation

(1) Position regulator in door and install attaching screws.

(2) Remove masking tape from glass and lower glass.

(3) Slide guide channel onto regulator arm and position channel on glass. Install attaching screws.

(4) Install division channel lower adjusting screw.

(5) Check operation.

(6) Install water shield and door trim panel.

LOCK SYSTEM

Door Lock Cylinder

Removal

(1) Remove door trim panel and watershield paper.

(2) Remove door latch cover screws and remove cover.

(3) Remove retaining clip and remove lock-to-cylinder rod.

(4) Remove lock cylinder spring retainer and remove lock cylinder and gasket.

Installation

(1) Install gasket and lock cylinder in door.

(2) Install lock cylinder spring retainer and install locka to cylinder rod and clip.

(3) Install door latch cover and cover screws.

(4) Install watershield paper and door trim panel.

Outside Handle Replacement

Removal

(1) Remove door handle assist and window regulator handle.

(2) Remove door trim panel and watershield paper from door.

(3) Remove door latch cover attaching screws.

(4) Disconnect lock-to-handle rod from outside door handle.

(5) Close window completely, pry lock spring to outside and tap handle locks upward (fig. 3J-1).

(6) Disconnect window door glass from regulator.

(7) Remove division channel upper and lower attaching screws.

(8) Separate division channel from front glass rubber.

(9) Pull division channel upward and remove window glass from door..

(10) Remove locks from outer door handle using needlenose pliers and remove handle from door.

Installation

(1) Install outside door handle and slide locks into door handle from top.

(2) Tap locks downward lightly to tighten handle.

(3) Install lock-to-handle rod and lock pin.

(4) Position window glass in door and channels.

(5) Install division channel and attaching screws.

(6) Attach window glass to regulator.

(7) Install door latch cover.

(8) Install watershield paper and door trim panel.

(9) Install window regulator handle.

(10) Install door handle assist.

Latch Replacement

(1) Remove door trim panel and watershield paper.

(2) Remove latch cover.

(3) Disconnect remote control rod and lock-to-handle rod from latch.

(4) Remove latch attachiang screws and remove latch.

(5) Install latch and attaching screws.

(6) Connect remote control rod and lock-to-handle rod from latch.

(7) Install latch cover and tighten cover screws.

(8) Install watershield paper and door trim panel.

HINGE SYSTEM

Adjustments

The doors are adjusted at the hinge mounting points on the body or door.

Enlarged holes are provided in the body, lower hinge only, for fore, aft and tilt adjustments. Enlarged holes are also provided in the door, upper and lower hinges, for up, down, fore, aft and tilt adjustments.

Prior to any door adjutment or alignment, the door latch must be removed to allow the door to close freely in proper alignment.

The door latch striker should be adjusted in or out to allow the door latch to be fully engaged. The door should be flush with the adjacent body panels.

Replacment

(1) Mark outline of existing hinge on body and door with wax pencil.

NOTE: *When removing door or hinge DO NOT lose the plastic shims on the hinge pin.*

(2) Remove hinge-to-body screws and hinge-to-door screws and remove hinge.

Upper hinge is part of windshield hinge assembly. When replacing, adequately support the windshield frame prior to removal and check alignment after installation.

(3) Clean replacement hinge in suitable solvent and blow dry with compressed air.

(4) Color-coat hinge to match body using Jeep exterior spray paint, or equivalent.

(5) Lubricate hinge with 3M 4-Way Spray lubricant, or equivalent.

(6) Position hinge or door, align carefully with wax pencil marks, and install screws.

(7) Position hinge on body, align carefully with pencil marks, and install screws.

(8) Check door alignment. Adjust if necessary. Refer to Door Adjustment.

INSTRUMENT PANEL AND COMPONENTS

The instrument panel is constructed of formed sheet metal and is attached to the cowl panel. The dash pad is attached to the instrument panel (Fig. 1).

Instrument Cluster Bezel Replacement

(1) Remove the instrument cluster bezel attaching screws (Figs. 2 and 3).

(2) Remove the bezel.

(3) To install the bezel, reverse the removal procedures.

Glove Box Door and Hinge Replacement

The glove box door hinge mounting holes are elongated to allow adjustment. The hinge screws may be loosened and the door moved in the desired direction to best fit the door opening.

Remove the hinge-to-instrument panel attaching screws. Then remove the door and hinge assembly.

To install the door, position the door and hinge assembly on the instrument panel. Then install the hinge-to-instrument panel attaching screws and adjust the door.

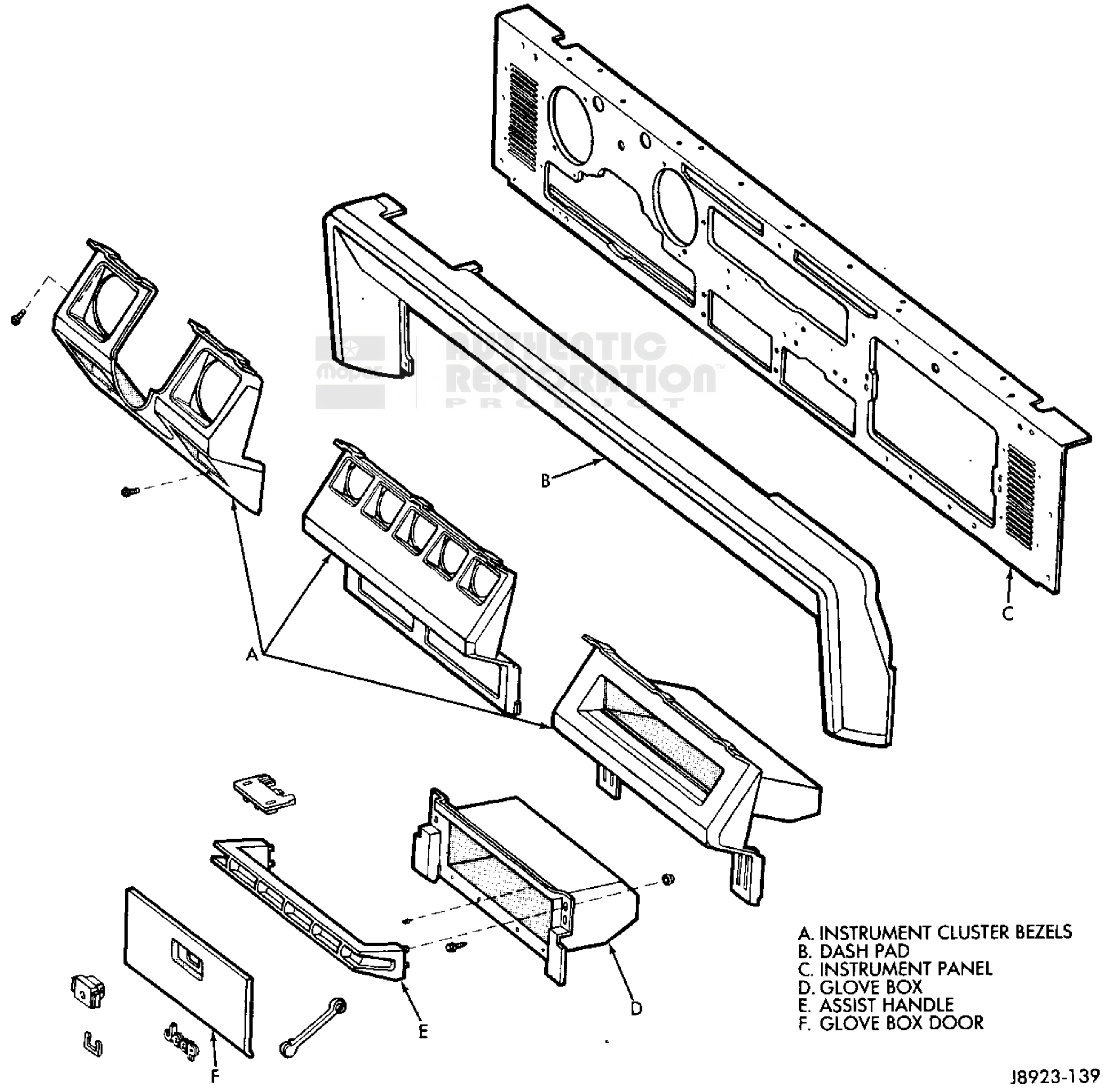


Fig. 1 Instrument Panel Components

Glove Box Door Striker Adjustment

The glove box door lock striker is attached to the instrument panel opening with sheet metal screws. The striker can be moved in or out for door closing adjustment.

Glove Box Removal/Installation

(1) Remove the glove box-to-instrument panel attaching screws.

(2) Remove the striker.

(3) Remove the assist handle.

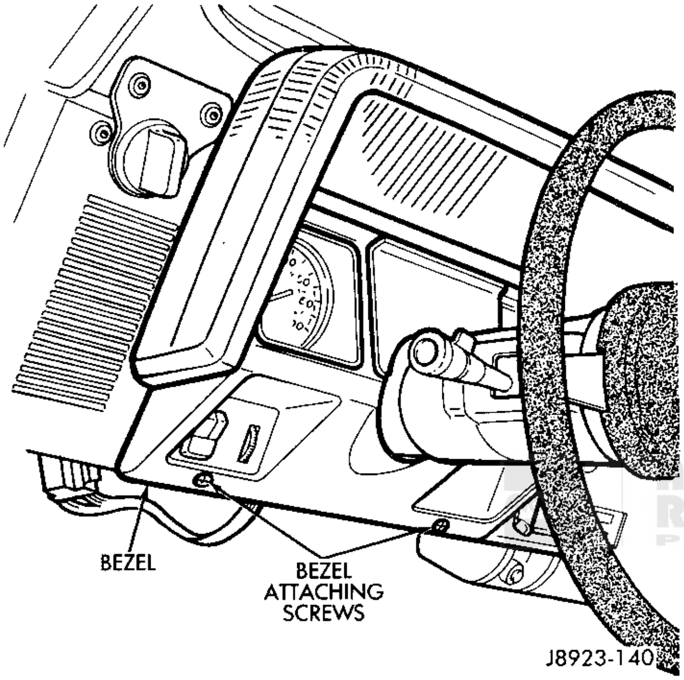


Fig. 2 Bezel Attaching Screws (Lower)

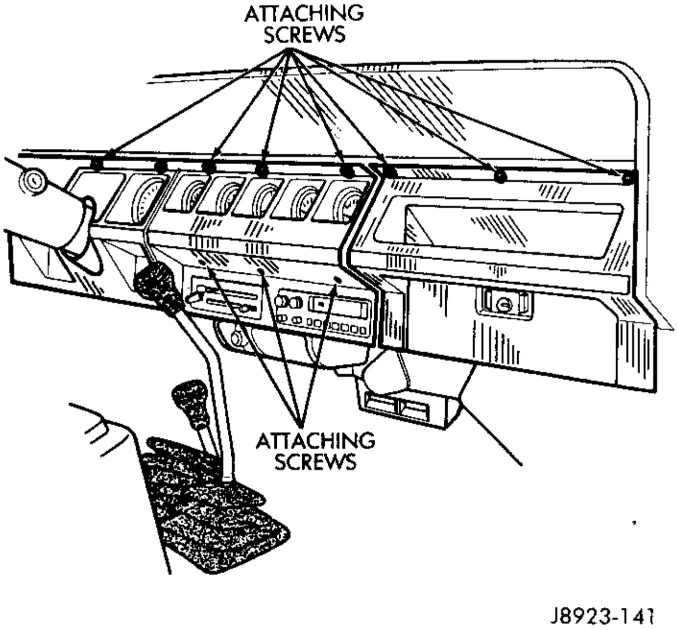


Fig. 3 Bezel Attaching Screws (Upper and Lower)

(4) Pull the glove box out of the instrument panel opening.

(5) Position the glove box in the opening.

(6) Install the glove box-to-instrument panel attaching screws.

(7) Install the assist handle.

(8) Install and adjust the striker.

Instrument Panel Removal

(1) Disconnect the battery.

(2) On models with soft top, disconnect the top from the windshield frame, drip rails and door flanges.

(3) On models with hard top, disconnect the top from the windshield frame. Then loosen the retainer screws, tilt the top rearward and prop the top away from the windshield (Fig. 4).

(4) Cover the hood area in front of the windshield. Then remove the windshield-to-instrument panel retainers (Fig. 5) and tilt the windshield forward onto the hood.

(5) Remove the instrument cluster bezels.

(6) Remove the assist handle, glove box door, hinge and box assembly.

(7) Remove the screws attaching the pad to the instrument panel and remove the pad (Fig. 6).

(8) On models with air conditioning, remove the screws attaching the evaporator assembly to the instrument panel and lower the evaporator assembly.

(9) Remove the screws attaching the steering column bezel to the dash panel amd remove the bezel.

(10) Disconnect the parking brake bracket from the dash panel.

(11) Disconnect the speedometer cable and the instrument cluster wires.

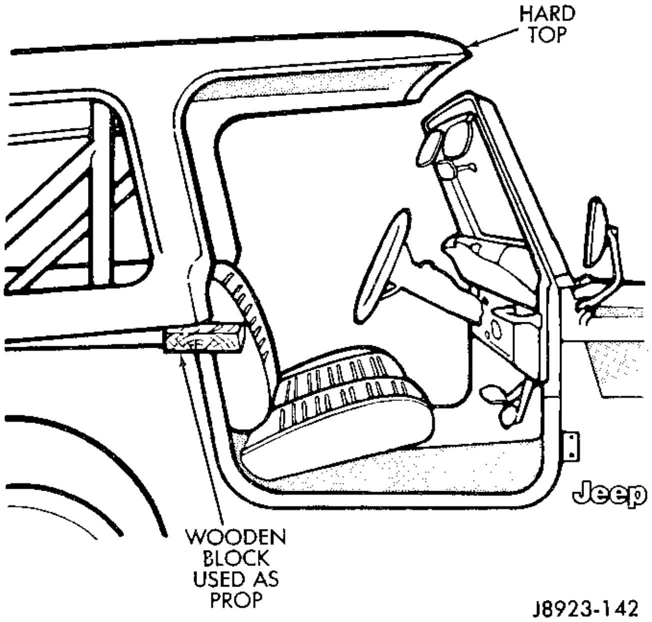


Fig. 4 Holding Hard Top Away From Windshield

(12) Disconnect the heater control cables from the damper door levers.

(13) Place the automatic transmission shift lever in Park.

(14) Remove the steering wheel.

(15) Remove the roll pin attaching the shift lever to the shift bowl and remove the shift lever.

(16) Remove the instrument panel-to-cowl panel attaching screws and remove the instrument panel.

Installation

(1) Install the instrument panel and install the panel attaching screws.

(2) Install the instrument panel pad.

(3) Connect the speedometer cable and the cluster wires.

(4) Install the cluster bezels.

(5) Raise and install the evaporator.

(6) Install the heater control cables.

(7) Install the parking brake braket.

(8) Install the shift lever and steering wheel.

(9) Install the steering column bezel.

(10) Install the glove box, hinges and door.

(11) Move the windshield to the upright position and install the windshield retainers.

(12) On hard top models, remove the prop. Position the top on the body and install the attaching screws.

(13) On soft top models, attach the top to the windshield and side retainers.

(14) Connect the battery.

FENDERS

Front Fender Removal

(1) Remove or disconnect all components attached to the fender apron.

(2) Disconnect the side marker lamp and hood hold-down (Fig. 1).

(3) Disconnect the antenna, if required.

(4) Remove the fender front attaching bolts/nuts (Fig. 2).

(5) Remove the bolts and washers attaching the fender and rear supports to the cowl panel.

(6) Remove the splash shields (Fig. 3).

(7) Pull the fender outward and lift it from the vehicle.

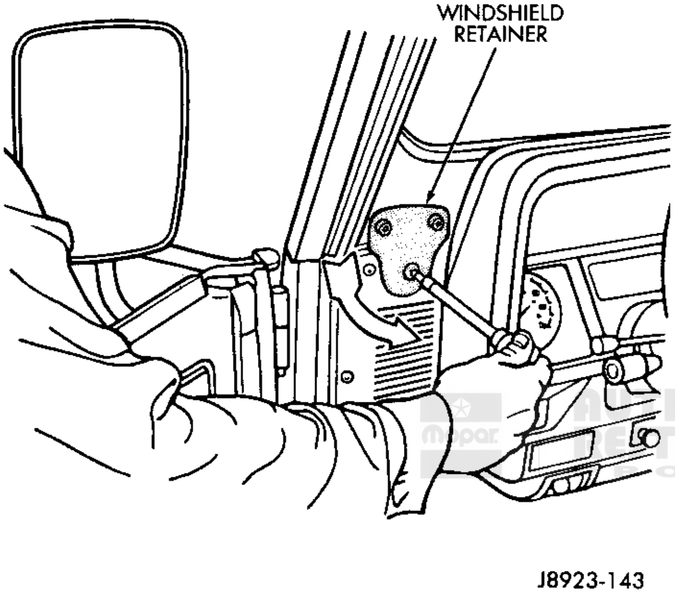


Fig. 5 Removing/Installing Windshield Retainers

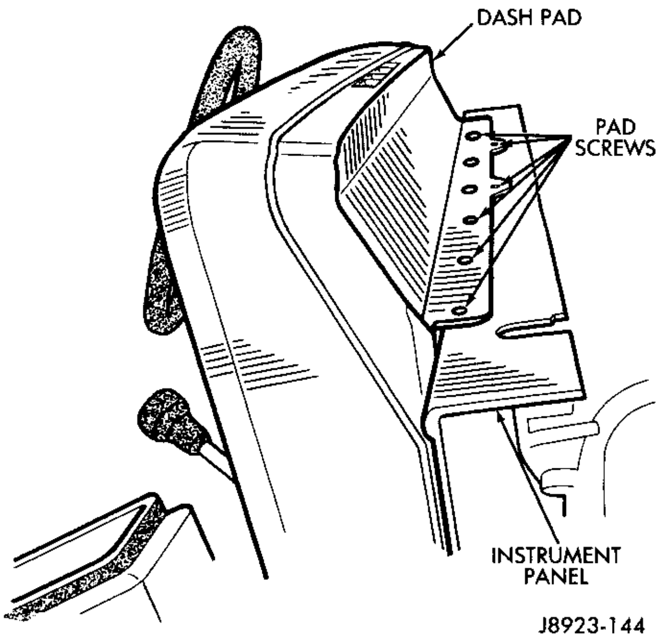


Fig. 6 Instrument Panel Pad Attachment

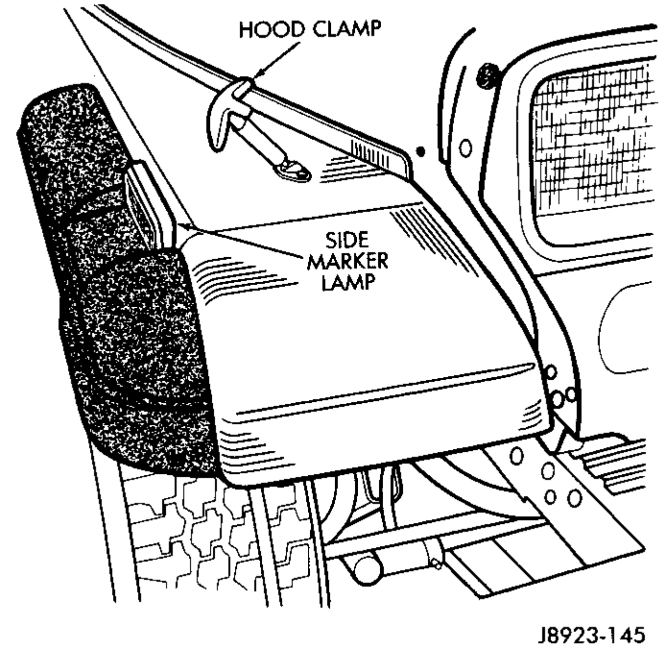


Fig. 1 Marker Lamp And Hood Clamp

Front Fender Installation

(1) Position the fender and supports on the body and install the attaching bolts and washers.

(2) Install the fender front bolts (Fig. 2).

(3) Connect the side marker lamp.

(4) Connect the antenna, if equipped.

(5) Install all components removed from the fender apron.

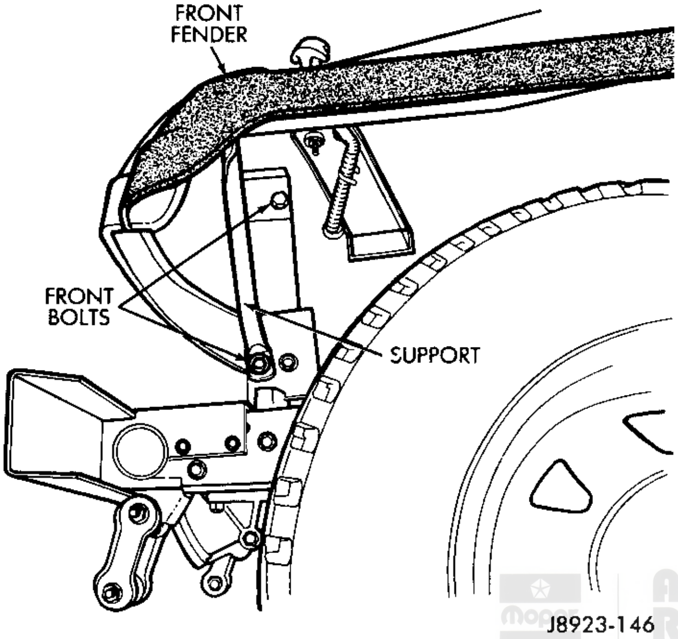


Fig. 2 Fender Front Attaching Bolt Locations

Fender Flare Removal/Installation

(1) Remove the screws and plastic nuts attaching the flare to the front or rear fender (Fig. 4).

(2) Remove the flare and clean the body surface.

(3) Inspect the flare screws and plastic nuts (Fig. 5). Replace any that are loose or damaged.

(4) Clean the mounting surface of the flare and position it on the body.

(5) Install and tighten the flare attaching screws and nuts.

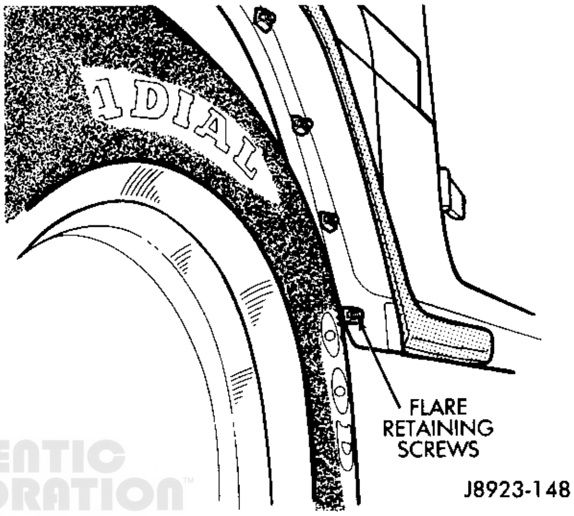


Fig. 4 Fender Flare Screw Locations (Typical)

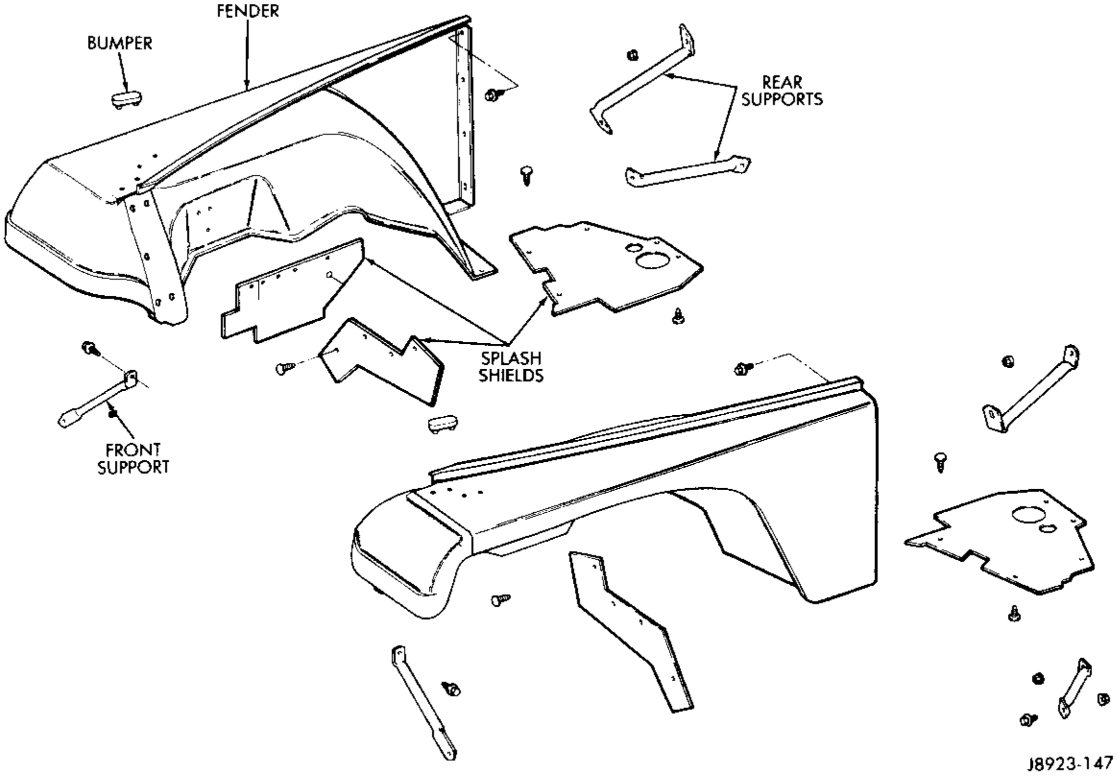


Fig. 3 Front Fender Components

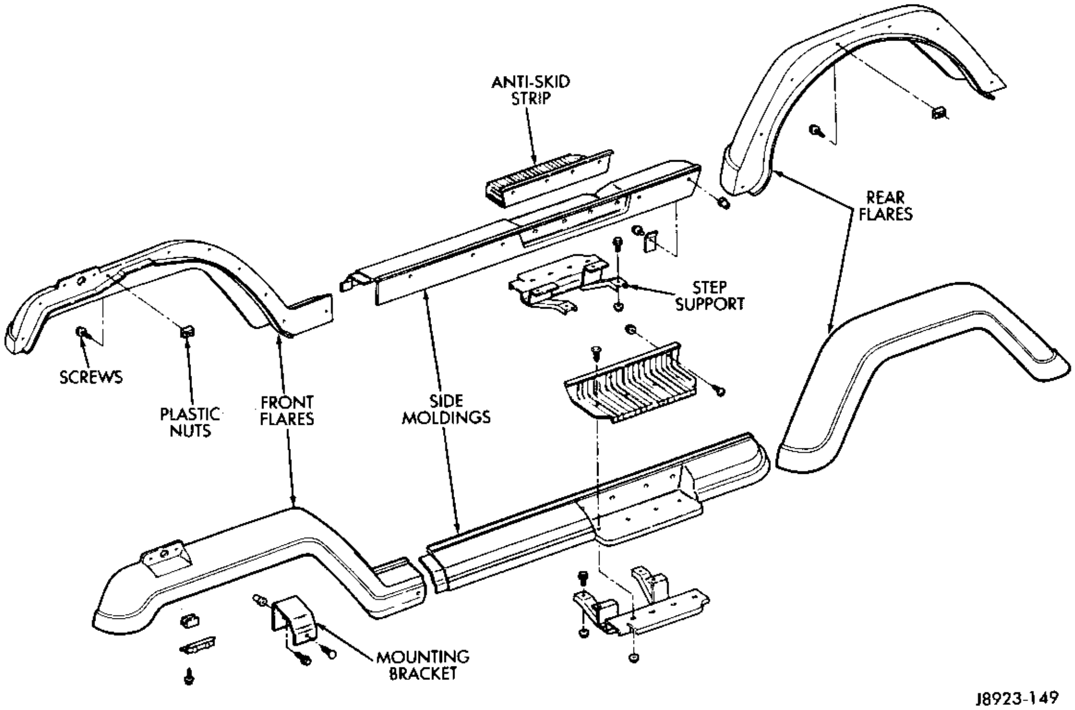


Fig. 5 Fender Flares And Side Moldings

Side Moldings

The side moldings are attached to the molding step supports and body sides.

The moldings are designed to fit under the front fender flares for improved fit and appearance (Fig. 5). To remove the moldings, it will be necessary to loosen the flare screws before removing the side moldings.

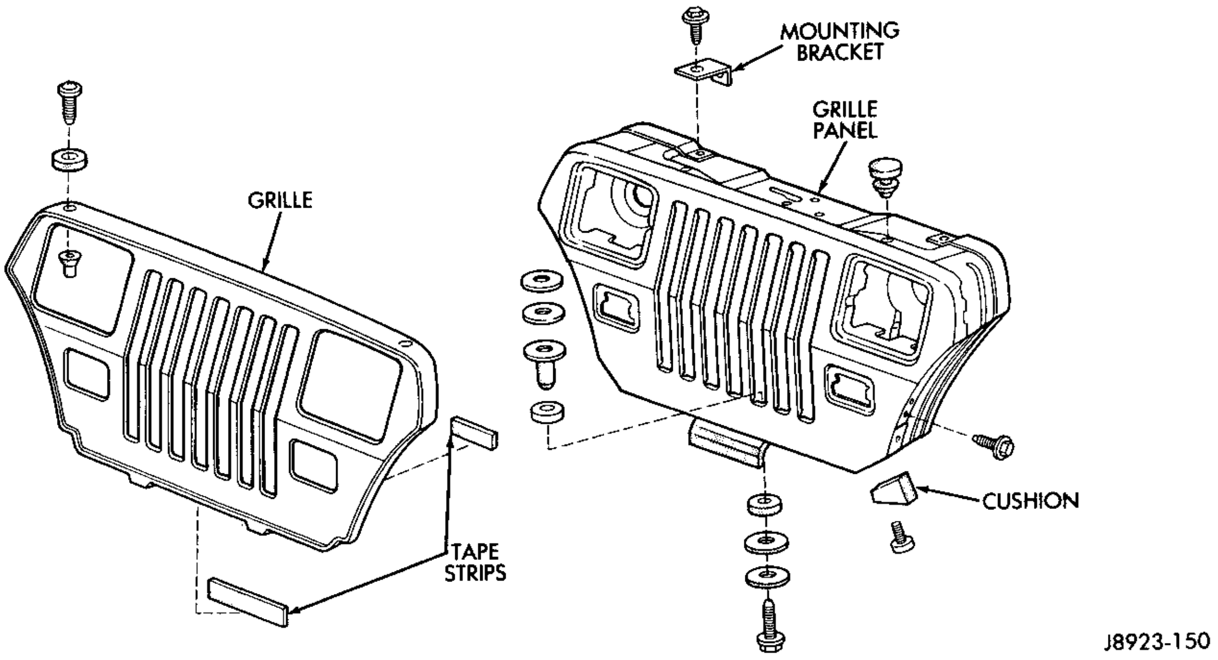


Fig. 1 Grille And Grille Panel

GRILLE AND GRILLE PANEL

Grille Removal

(1) Raise the hood.

(2) Remove the headlamp bezels.

(3) Remove the headlamp body retaining screws.

(4) Disconnect and remove the headlamp and body assemblies.

(5) Remove the parking lamp retaining screws.

(6) Disconnect and remove the parking lamp assemblies.

(7) Remove the front crossmember cover, if equipped.

(8) Remove the screws and bumpers at the top of the grille panel.

(9) Remove the grille.

(10) Remove the double faced tape at the bottom of the grille (Fig. 1).

Grille Installation

(1) Install the double face tape at the bottom rear side of the grille.

(2) Position the grille over the grille panel and press along the bottom.

(3) Install the grille screws and bumpers.

(4) Connect and position the headlamp and body assemblies.

(5) Install the retaining screws.

(6) Install the headlamp bezels.

(7) Position and connect the parking lamp assemblies.

(8) Install the parking lamp retaining screws.

(9) Close the hood.

(10) Install the front crossmember cover, if equipped.

Grille Panel Removal

(1) Remove the front crossmember cover, if equipped.

(2) Remove the screws and washers attaching the radiator and shroud to the grille panel.

(3) Remove the bolts and washers attaching the grille panel to the fenders (Fig. 2).

(4) Remove the bolts, washers and spacers attaching the grille panel to the front crossmember (Fig. 1).

(5) Remove the nuts attaching the radiator support rods (Fig.3).

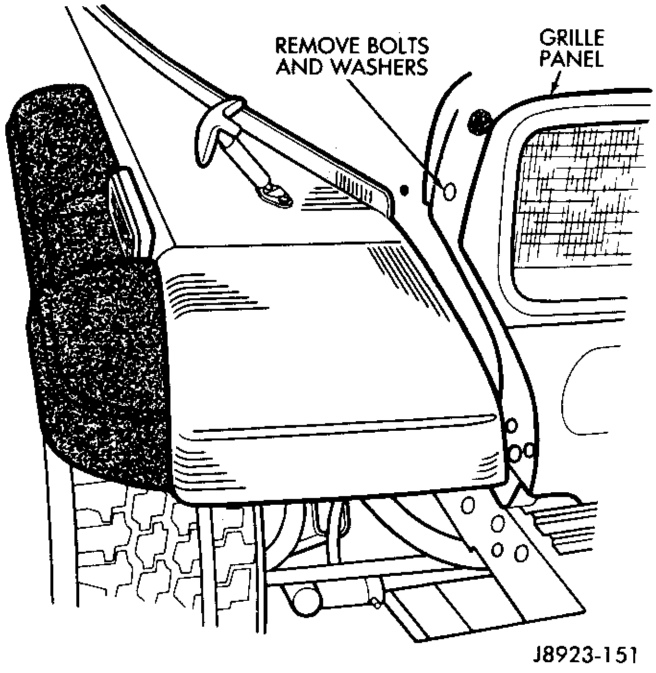


Fig. 2 Grille Panel Front Bolt Locations

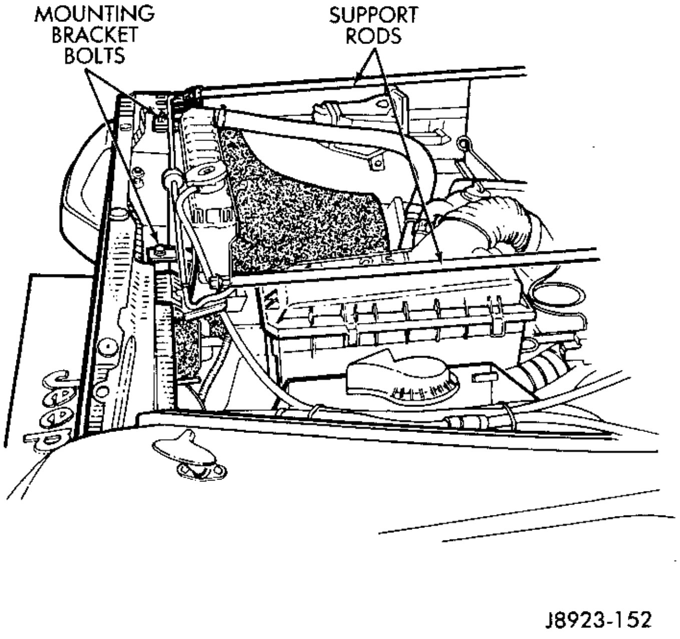


Fig. 3 Support Rods And Mounting Bracket Attachment

(6) Remove the rods from the brackets.

(7) Tilt the grille panel forward and disconnect the head lamp, turn signal and marker lamp wiring.

(8) On models with air conditioning, discharge the **A/C system.** Disconnect the high pressure hose at the sight glass connection and and compressor. Cap the hose and fittings to prevent dirt entry.

(9) Remove the grille panel from the vehicle.

(10) If a new panel is to be installed, remove and transfer the lamp assemblies, headlamp buckets and mounting brackets.

Grille Installation

(1) Install the grille panel on the vehicle.

(2) Connect the marker, park and head lamp wiring.

(3) Connect the support rods and mounting brackets (Fig. 3).

(4) Attach the grille panel to the front crossmember.

(5) On models with A/C, reconnect the high pressure hose.

(6) Attach the grille panel-to-front fender bolts (Fig. 2).

(7) Install the front crossmember cover, if equipped.

(8) Install the grille.

(9) Evacuate and recharge the A/C system.

BUMPERS

Front bumpers are one-piece construction. When a vehicle is equipped with a rear mounted spare, two separate bumperettes are used.

A front crossmember cover is used on all vehicles; It covers the area between the grille panel and front rail.

Front Bumper Removal

(1) Disconnect and remove the fog lamps, if equipped.

(2) Remove the nuts and bolts from the bumper extensions and remove the extensions.

(3) Remove the nuts and bolts attaching the front bumper to the frame.

Front Bumper Installation

(1) Position the front bumper on the frame extension.

(2) Install the bolts and nuts attaching the front bumper to the frame extension.

(3) Install the fog lamps, if equipped.

Front Crossmember Cover Removal/Installation

(1) Remove the nuts and bolts attaching the front crossmember cover to the frame extensions.

(2) Remove the front crossmember cover from the frame extensions.

(3) Reverse the removal procedures for cover installation.

Rear Bumperette Removal/Installation

(1) Remove the nuts and bolts attaching the rear bumperettes to the vehicle frame (Fig. 2).

(2) Remove the rear bumperettes from the vehicle frame.

(3) Position the rear bumperettes on the vehicle frame.

(4) Install the bolts and nuts attaching the rear bumperettes to the vehicle frame.

Rear Bumper Removal/Installation

The rear bumper end caps and tow hooks can be removed with the bumper in place. The bumper itself is

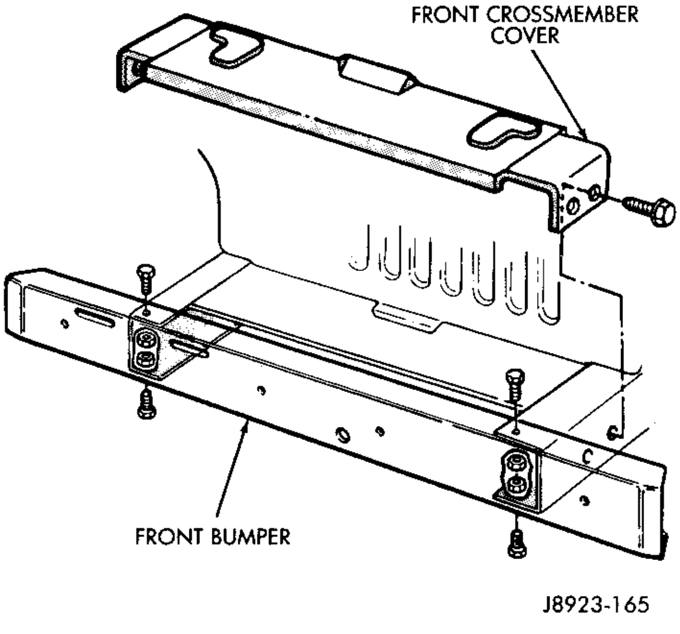


Fig. 1 Front Bumper And Crossmember Cover

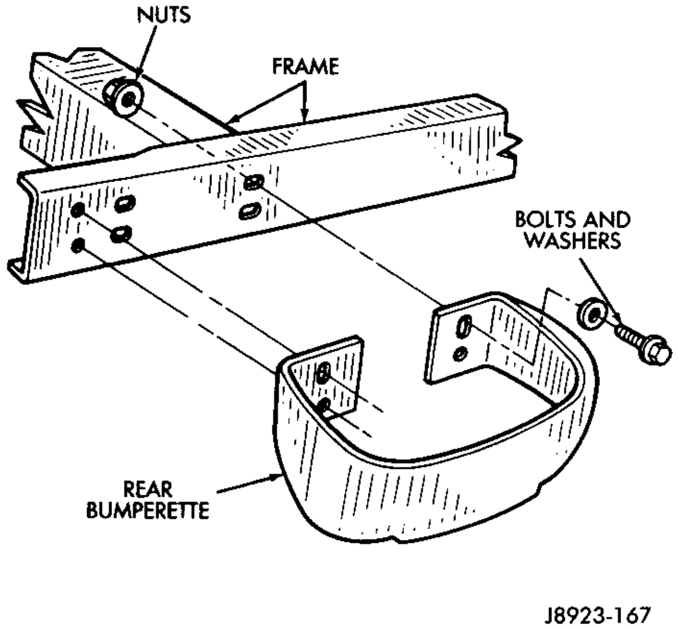


Fig. 2 Rear Bumperette Attachment

attached to the frame with screws and nuts. These fasteners are accessible from the face of the bumper.

HOOD

Hood Removal/Installation

(1) Mark position of the hinges before removing the hood (Fig. 1).

(2) Remove the hinge screws and remove the hood.

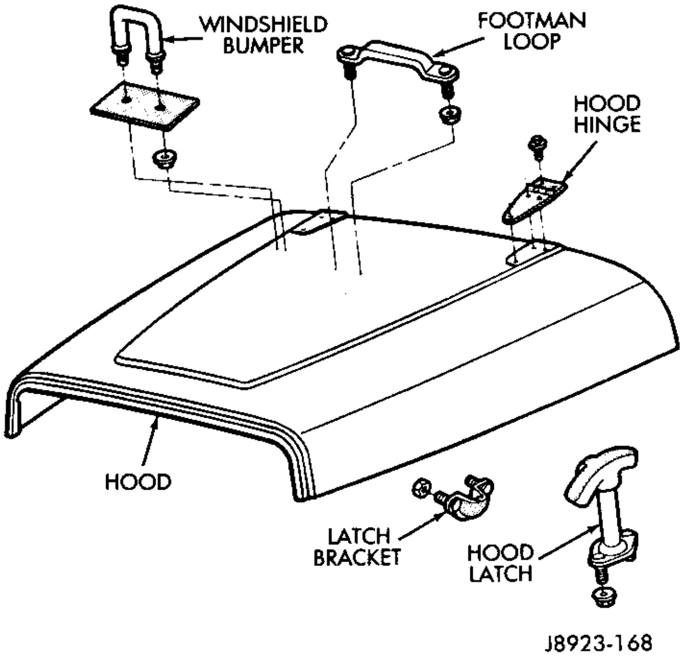


Fig. 1 Hood Components

(3) If the hood is to be replaced, remove and transfer the hinges, latches, bumper, brackets, loop, hood lamp, prop rod, and safety catch to the new hood (Figs. 2 and 3).

(4) Position the hood on the vehicle and install the hinge screws.

(5) Align the hinges and hood with the reference marks and tighten the hinge screws.

Hood Alignment

The hood hinge mounting holes are oversized to allow adjustment.

To adjust hood alignment, loosen the hinge screws, move the hood in the direction required and tighten the hinge screws.

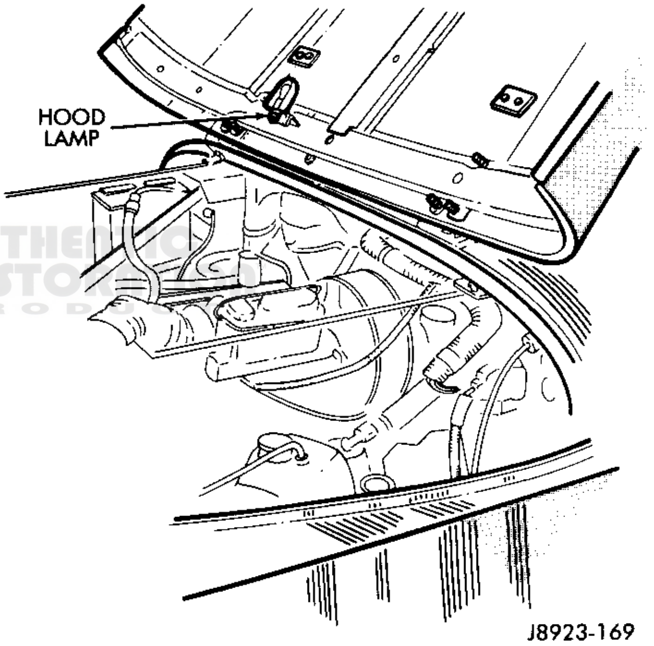


Fig. 2 Hood Lamp

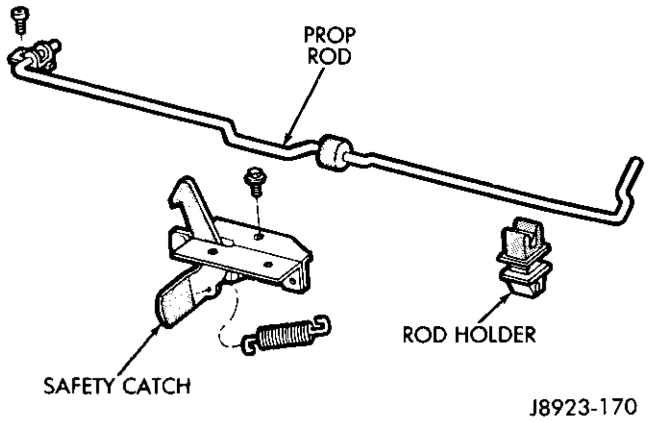


Fig. 3 Hood Safety Catch And Prop Rod

SEATS

Bucket-type front seats (Fig. 1) are standard on 80 Series models. A bench type seat is used for rear seating (Fig. 2).

The front seat frame is a tilt type and can be folded forward for access to the rear cargo or seat area (Fig. 3). However, only the drivers side seat has a fore-and-aft adjuster mechanism. The passenger seat tilts but is otherwise fixed in position.

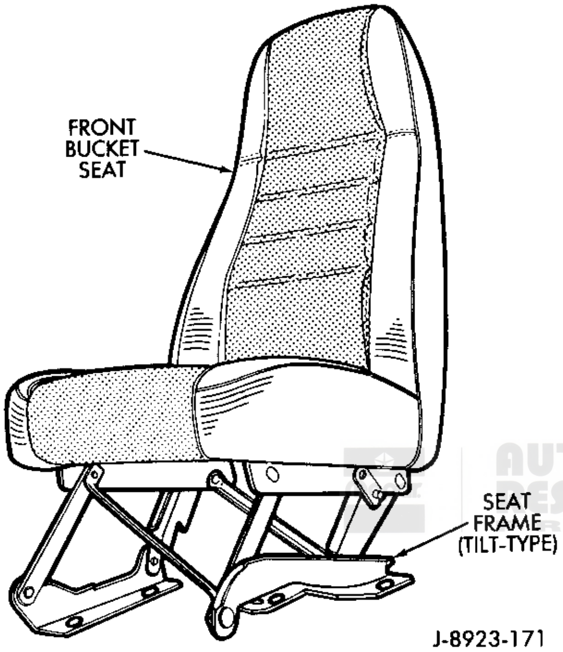


Fig. 1 Front Seat

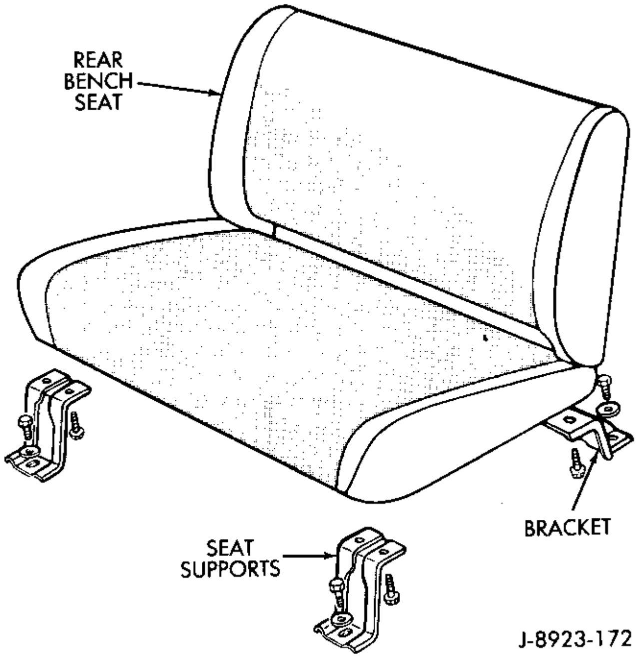


Fig. 2 Rear Seat

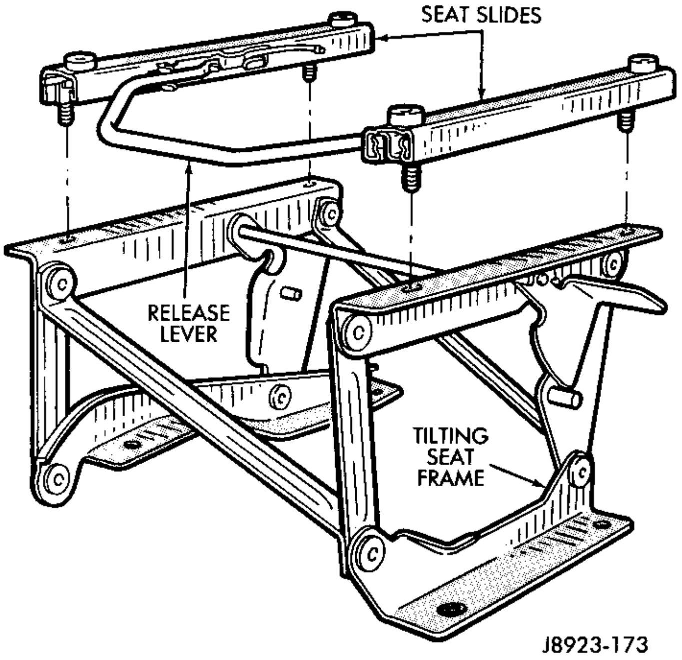


Fig. 3 Front Seat Frame

Seat Removal/Installation

The front seat frames are attached to the floorpan. Seat removal only involves removing the frame-to-floor pan fasteners and removing the seat from the vehicle. The rear bench seat brackets/supports are also attached to the floorpan and are removed in the same manner.

CONSOLE

The console (Fig.1) is fabricated from molded plastic material. The console cover has a locking top and provisions for beverage containers. A drain is also provided which allows liquid spills to drain out of the vehicle through a drain hole in the floor pan.

Console Removal/Installation

(1) Open the console cover.

(2) Remove the screws attaching the console to the floorpan.

(3) Remove the console assembly from the vehicle.

(4) Position the console assembly in the vehicle.

(5) Align the drain hole with the hole in the floorpan and install the attaching screws.

(6) Close and latch the console cover.

Console Cover And Seal

The seal can be replaced once the cover is open. Cover replacement only involves opening the cover and removing the hinge and lock (Fig. 1).

Console Cover Lock Replacement

(1) Open the console cover.

(2) Remove the screw attaching the retainer to the lock and remove the retainer (Fig. 2).

(3) Remove the lock, cylinder and key as an assembly.

(4) Manually set the latch to simulate a closed cover position.

(5) Insert the key and cylinder into the lock and turn clockwise. Release the latch and remove the key.

(6) Position the assembled lock in the cover and install the retainer and attaching screw.

SEAT BELTS

Seat And Shoulder Belt Removal/Installation

(1) Remove the seat belt anchor bolt (Fig.1).

(2) Remove the seat belt.

(3) Remove the shoulder belt trim cover, anchor bolt and washers (Fig. 1).

(4) Remove the door sill trim cover for access to the retractor anchor bolts.

(5) Remove the anchor bolts attaching the lower part of the shoulder belt to the floorpan and body side (Fig. 1).

(6) Remove the belts.

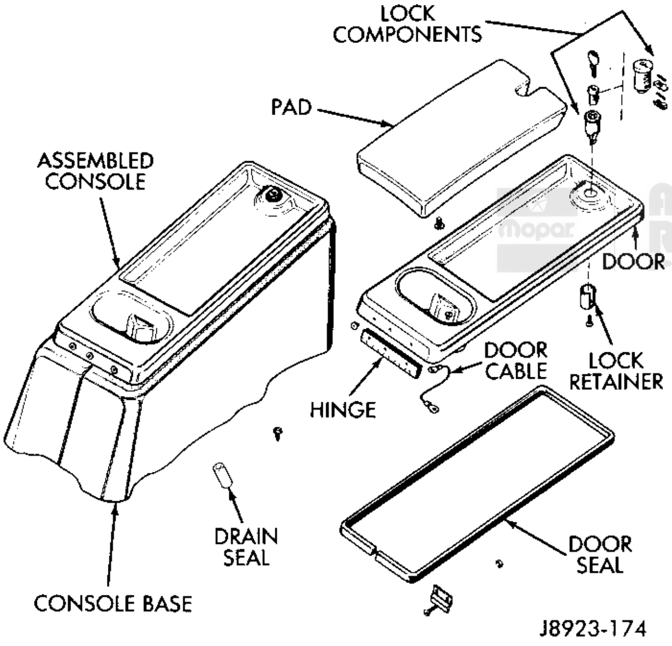


Fig. 1 Console

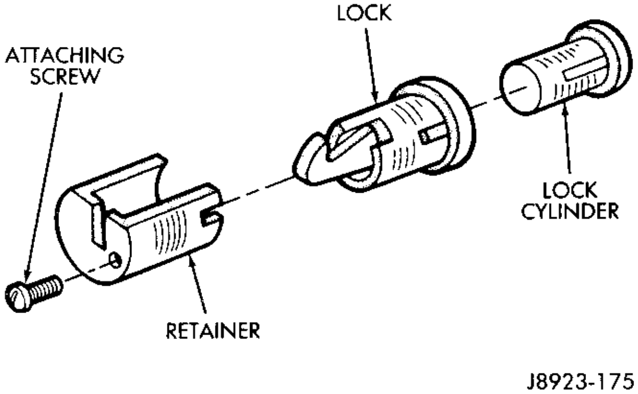


Fig. 2 Console Cover Lock Cylinder

(7) Inspect the seat belt material for evidence of wear, cuts or fraying. Replace any belt if worn or damaged.

(8) Install the seat belt and shoulder belt anchor bolts. Tighten to 34-47 N•m (25-35 ft.lbs) torque.

(9) Position the shoulder belt guide on the B-pillar or sport bar and install the bolt.

(10) Install the belt trim covers.

(11) Install the door sill trim cover.

CARPETING

Rear Floor Carpet

The rear floor carpet is held in position by the seats, center console, seat belts, sill plates and other components. When removing and installing the rear floor carpet, it will be necessary to remove and install these components.

Front Floor Carpet

The front floor carpet is held in position by velcro strips. When replacing the carpet, position the new carpet in the vehicle and cut openings in the carpet with a razor knife for such things as the floor shifter, if equipped.

Wheelhouse and Rear Compartment Carpet

These carpets are held in position with glue and velcro strips. Replacement carpet may require some modifications to accommodate these attaching components.

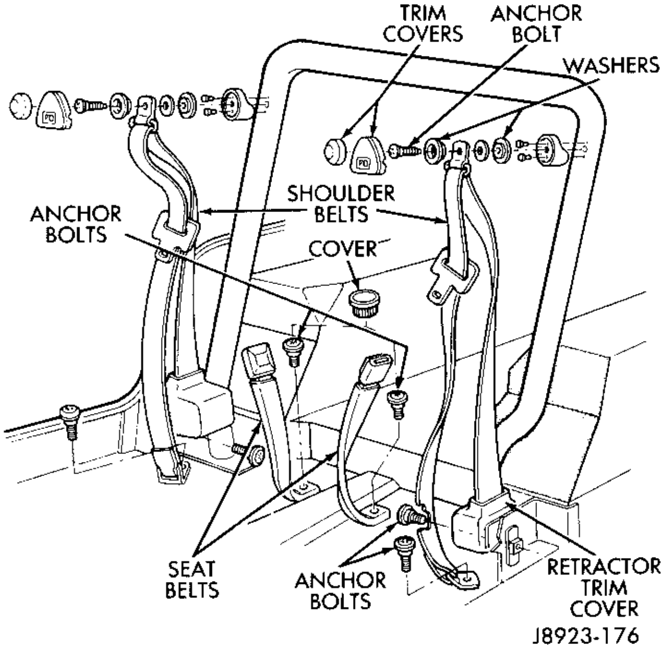


Fig. 1 Seat Belt Removal/Installation

BODY COMPONENTS-SJ MODELS

INDEX

FRONT BUMPER

Front Bumper Removal

(1) Disconnect and remove the fog lamps, if equipped.

(2) Remove the bumper face and end guards (Fig. 1).

(3) Remove the air deflector (Fig. 1).

(4) Remove the nuts/bolts attaching the bumper to the mounting brackets and remove the bumper (Fig. 1).

(5) If the bumper will be replaced, transfer the mounting brackets to the new bumper.

Front Bumper Replacement

Some replacement front bumpers may not have bolt holes for the bumper end or face guards. If a new bumper lacks these bolt holes, simply position the guards on the bumper. Then mark and drill holes for the guards with a suitable size drill bit.

Front Bumper Installation

(1) Install the bumper face and end guards.

(2) Install the air deflector.

(3) Position the bumper on the mounting brackets and install the bumper attaching bolts.

(3) Install the fog lamps if equipped.

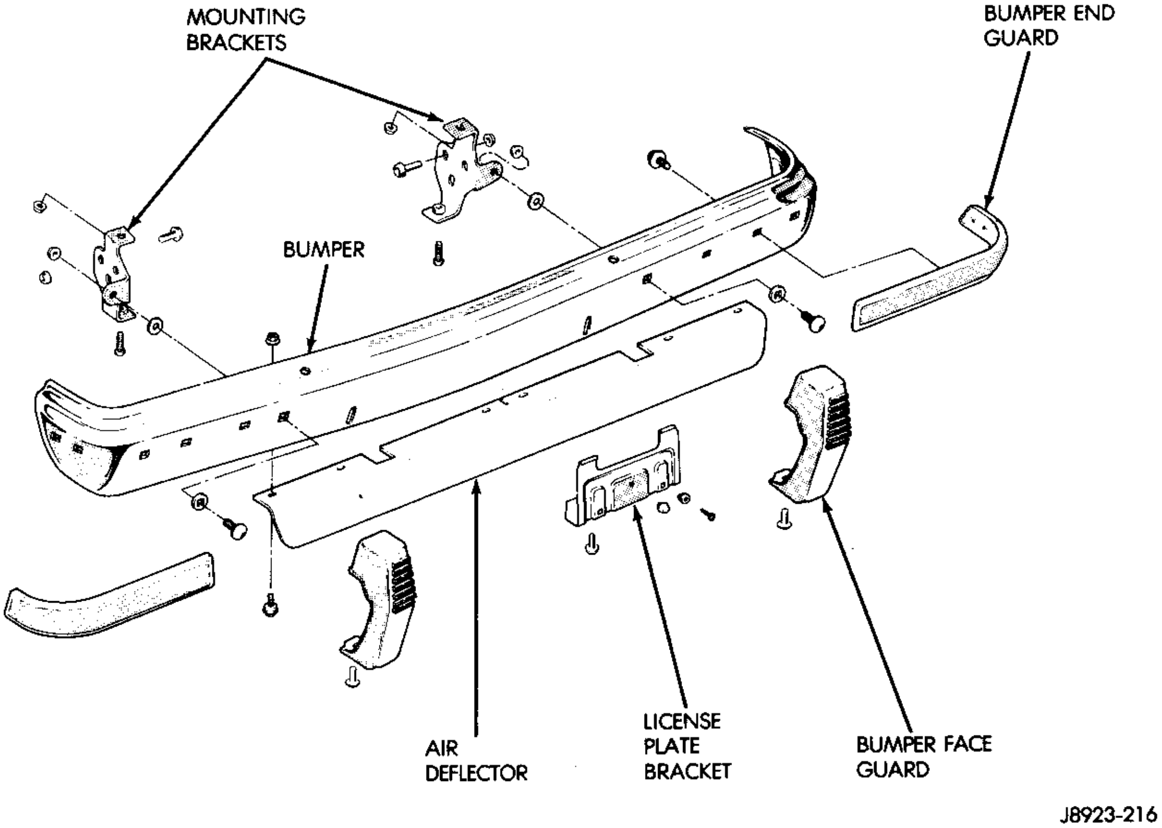


Fig. 1 Front Bumper Components

REAR BUMPER

Rear Bumper Removal

(1) Remove the bumper guards (Fig. 1).

(2) Remove the bolts attaching the bumper mounting brackets to the frame and remove the bumper (Fig. 1).

(3) Remove the air deflector (Fig. 1).

(4) If a new bumper will be installed, transfer the mounting brackets to the new bumper.

Rear Bumper Replacement

Some replacement rear bumpers may not have bolt holes for the bumper guards. If a new bumper lacks these bolt holes, simply position the guards on the new bumper. Then mark and drill holes for the guards with a suitable size drill bit.

Rear Bumper Installation

(1) Install the air deflector.

(2) If a new bumper is being installed, install the mounting brackets on the bumper.

(3) Position the bumper brackets on the frame rails and install the attaching bolts.

(4) Install the bumper end and face guards.

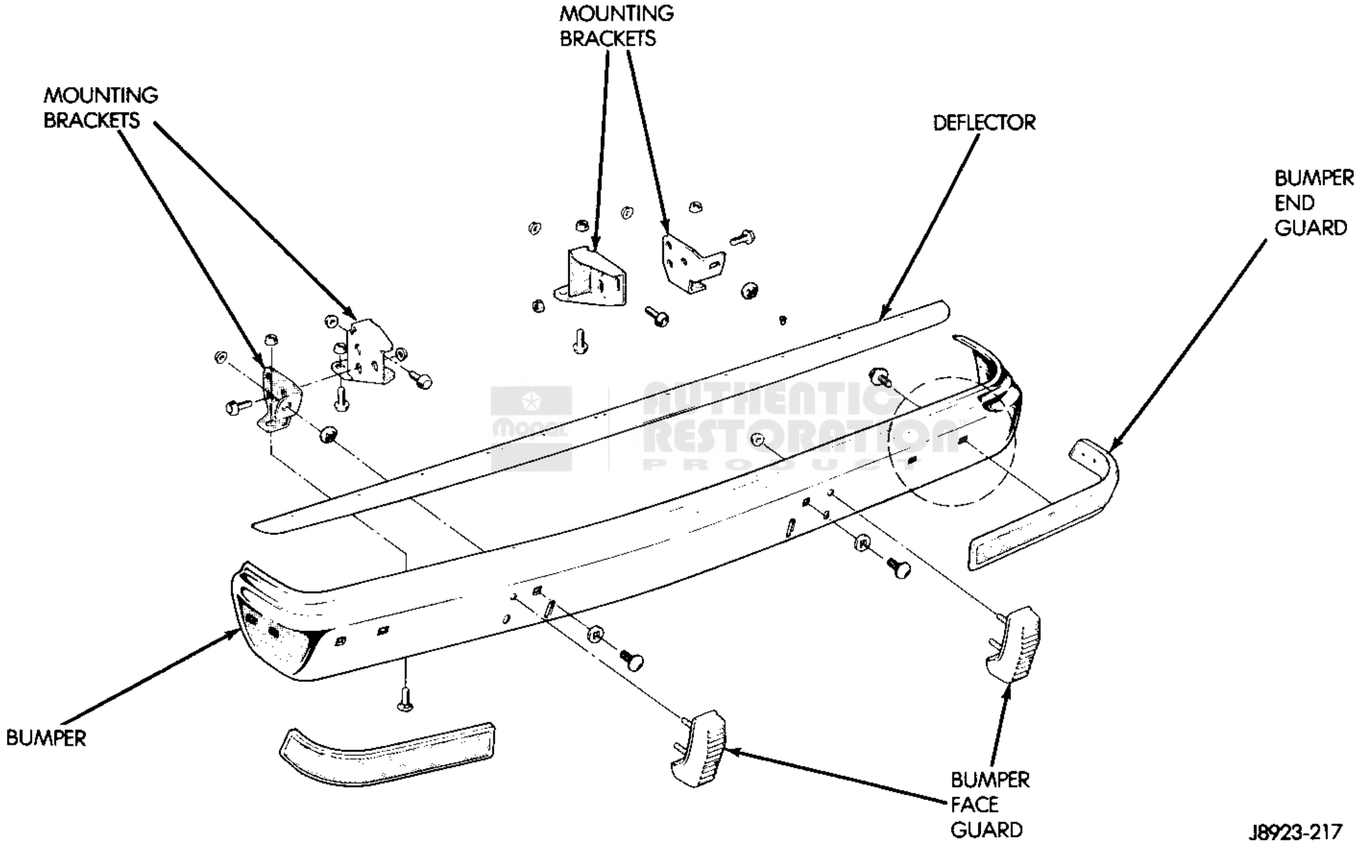


Fig. 1 Rear Bumper Components

GRILLE AND RADIATOR SUPPORT

Grille Removal/Installation

(1) Remove the fog lamps if equipped.

(2) Remove the screws attaching the grille to the shell (Fig. 1).

(3) Remove the grille (Fig. 1).

(4) Position the grille in the shell and install the attaching screws.

(5) Install the fog lamps if equipped.

Grille Shell Removal/Installation

(1) Remove the grille.

(2) Remove the screws attaching the shell to the grille face panel (Fig. 1).

(3) Remove the shell and welting (Fig. 1)

(4) Position the grille shell on the face panel and install the shell attaching screws.

(5) Install the grille.

Grille Face Panel-Radiator Support Removal

(1) Remove the front bumper.

(2) Remove the grille and grille shell.

(3) Remove the battery and the washer and coolant reservoirs.

(4) Remove the headlamps, marker lamps and park/turn lamps.

(5) Discharge the A/C system and drain the radiator.

(6) Remove the fan, radiator, A/C condenser and air intake hoses.

(7) Remove the stone shield and air deflector.

(8) Remove the fasteners attaching the face panel and support to the fenders, braces, and frame rails.

(9) Remove the fasteners attaching the support to the face panel.

(10) Remove the face panel and support (Fig. 2).

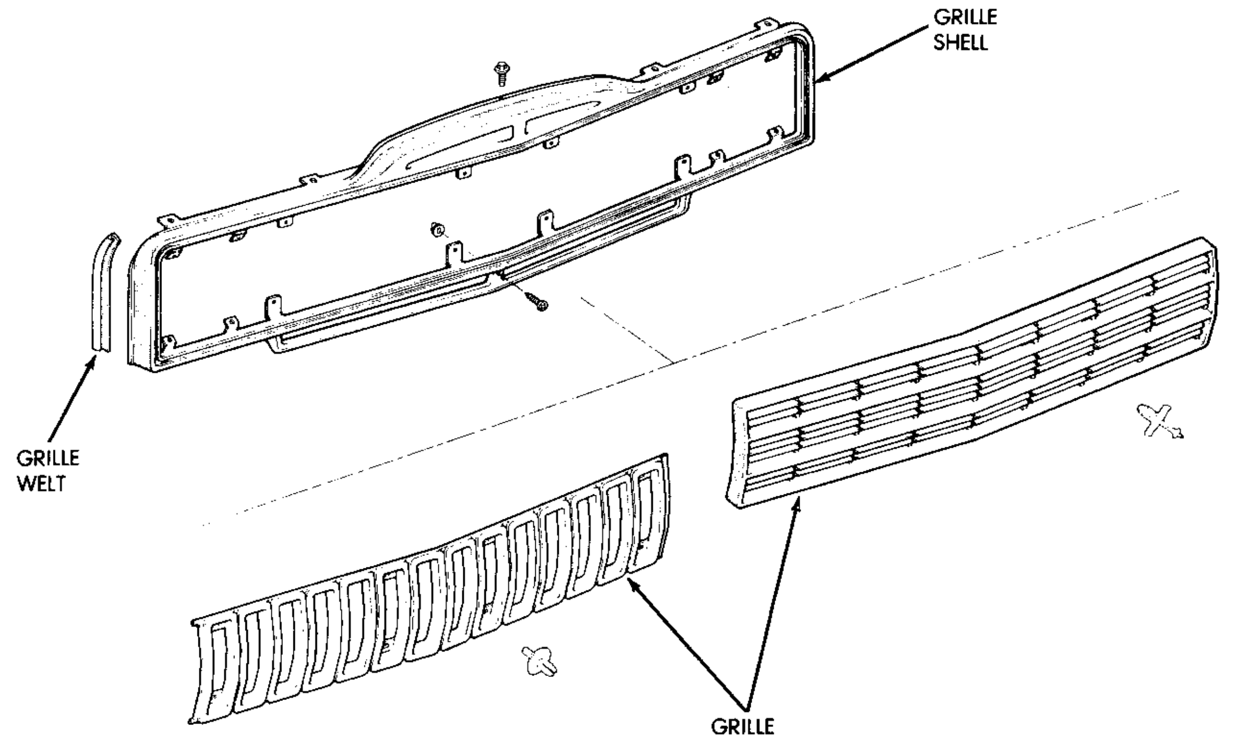


Fig. 1 Grille And Grille Shell

Grille Face Panel-Radiator Support Installation

(1) Position the support on the frame rail spacers and install the support bolts.

(2) Install the face panel on the support and install the support-to-panel fasteners.

(3) Install the radiator, A/C condenser, fan and fan shroud.

(4) Install the stone shield and air deflector.

(5) Install the remaining support and face panel fasteners.

(6) Install the fluid reservoirs.

(7) Refill the cooling system.

(8) Install the air intake hose.

(9) Install the grille shell and grille.

(10) Install the head lamps, marker lamps and park/turn lamps.

(11) Install front bumper and deflector.

(12) Install the battery.

(13) Evacuate and recharge the A/C system.

(14) Run the engine until warm and top off the engine coolant level.

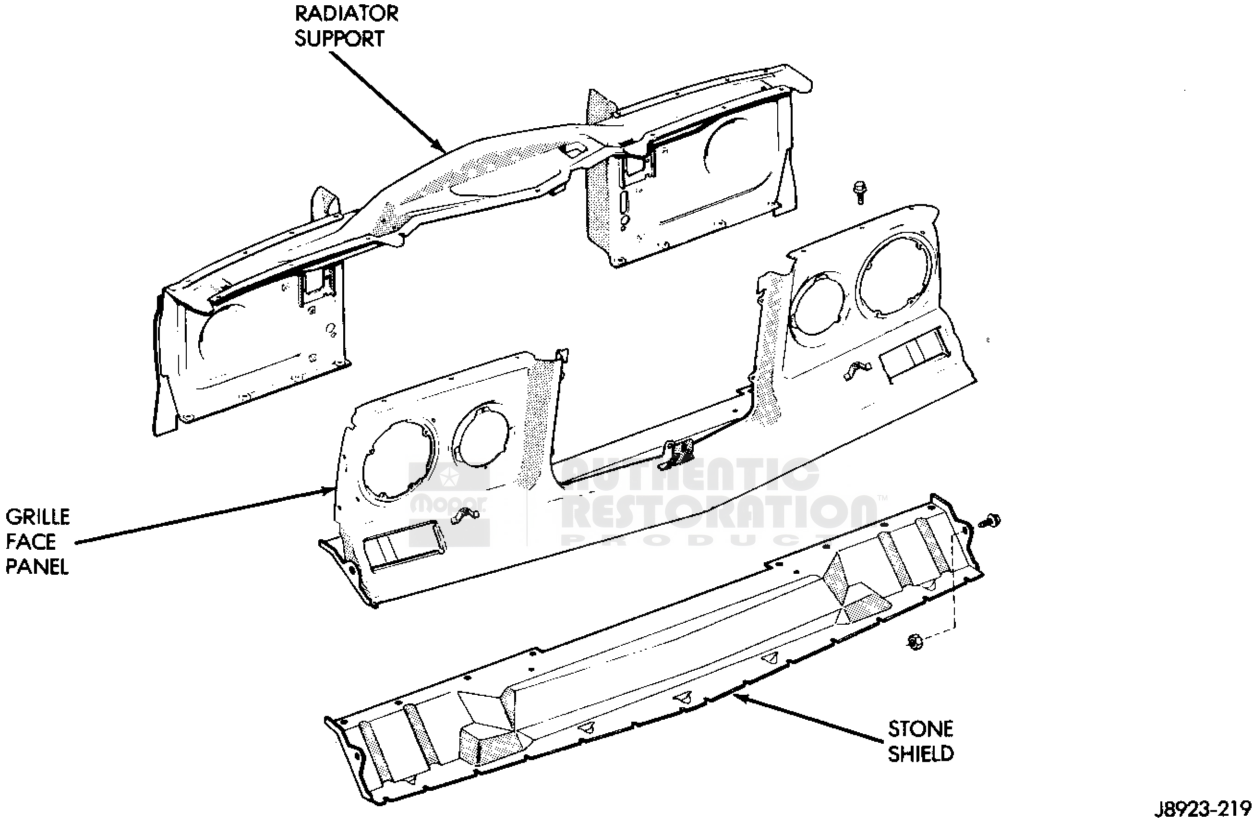


Fig. 2 Grille Panel And Radiator Support

FRONT FENDER

Front Fender Removal

(1) Remove the front bumper.

(2) Remove the headlamp to gain access through the opening.

(3) Working through the headlamp opening, remove the bolts attaching the fender to the grille face panel.

(4) Remove the side marker lamp reflector lens and disconnect the lamp socket assembly from the lens.

(5) Remove the bolts and washers attaching the fender to the grille face panel.

(6) Disconnect the fender brace (Fig. 1).

(7) Remove the bolts attaching the fender to the rocker panel (just below the hinge pillars).

(8) Remove the bolts attaching the top of the fender to the fender apron, hood hinge support bracket, and fender-to-dash panel bracket.

(9) Note the number and position of the shims between the fender and rocker panels so they can be assembled in the same position.

(10) Open the door and remove the fender from the vehicle.

(11) Remove/disconnect all items attached to the fender apron.

(12) Remove the bolts and washers attaching the fender apron to the radiator support and the two brackets on the dash panel.

Front Fender Installation

(1) Spread sealer evenly over and along the surfaces where the fender and fender apron make contact.

(2) Position the fender on the vehicle and install all of the fender bolts finger-tight.

(3) Tighten the fender bolts only after all bolts are installed.

(4) Install and reconnect all the items removed from the fender and apron (wiring harness, electrical components, etc.).

(5) Connect the fender brace and bracket.

(6) Install the headlamp, grille, front bumper, and remaining components which were removed.

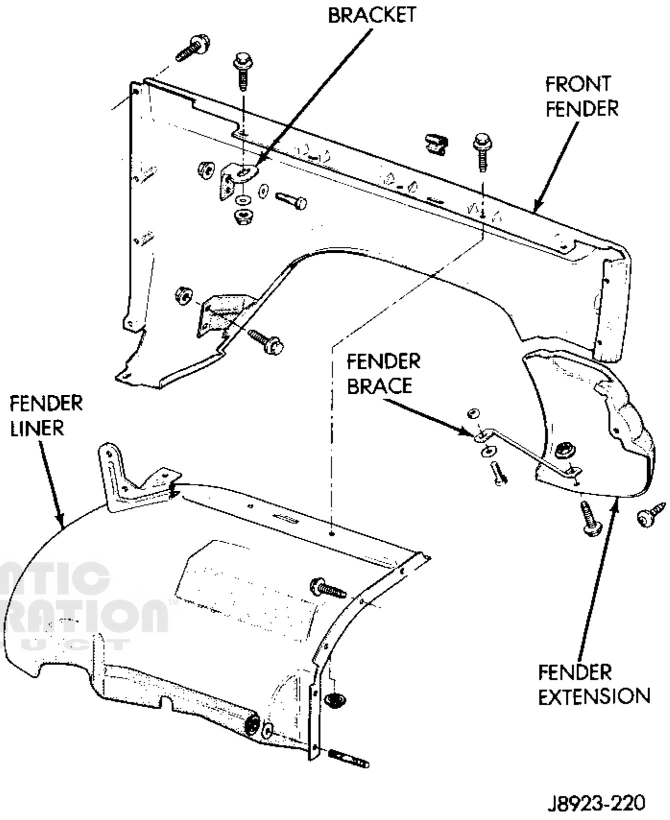


Fig. 1 Front Fender And Liner

HOOD

Hood Removal

(1) Mark position of the hinges before removing the hood (Fig. 1).

(2) Disconnect the hood release cable from the lock assembly and remove the cable bracket and lower cable (Fig. 2).

(3) Remove the tie straps (Fig. 2).

(4) Detach the hood panel from the hinges by removing the attaching screws, lockwashers, and flat washers.

(5) If the hood wil be replaced, remove and transfer the hood lock mechanism, brace rods, insulation, lamp (if equipped) and release cable components to the new hood.

Hood Installation

(1) Position the hood on the hinges.

(2) Align the hinges with the reference marks and install the hinge bolts.

(3) Position the hood release cable on the brace rod and secure with tie straps.

(4) Install the cable assembly and cable support bracket. Tighten the bracket screws to 20 N•m (15 ft-lbs) torque.

(5) Attach the cable end to the lock assembly.

(6) Check and adjust hood alignment if necessary.

Hood Alignment

The hood hinge mounting holes are oversized to permit adjustment. The hood strikers and hood bumpers are also adjustable to allow lock adjustment and hood alignment.

If a hood adjustment is required, loosen the hinge bolts and move the hood side to side, or fore and aft as needed. If the lock mechanism requires adjustment, loosen and move the strikers up or down as necessary for adjustment.

Install shims between the hinge and hood at the rear hinge bolts if the hood is low in relation to the cowl top.

Install shims between the hinge and hood at the front bolts if the hood is too high at the cowl.

Manual Release of Hood Lock

The hood lock can be released manually if a cable failure should occur. To release the locvk, insert a long, flat blade screwdriver through the grille and push the lock lever rearward.

Release Cable Replacement

(1) Remove the screws attaching the cable bracket to the cowl panel.

(2) Raise the hood.

(3) Disconnect the release cable from the lock assembly and remove the cable bracket.

(4) Remove the hood cable tie straps.

(5) Remove the cable and grommet from the dash

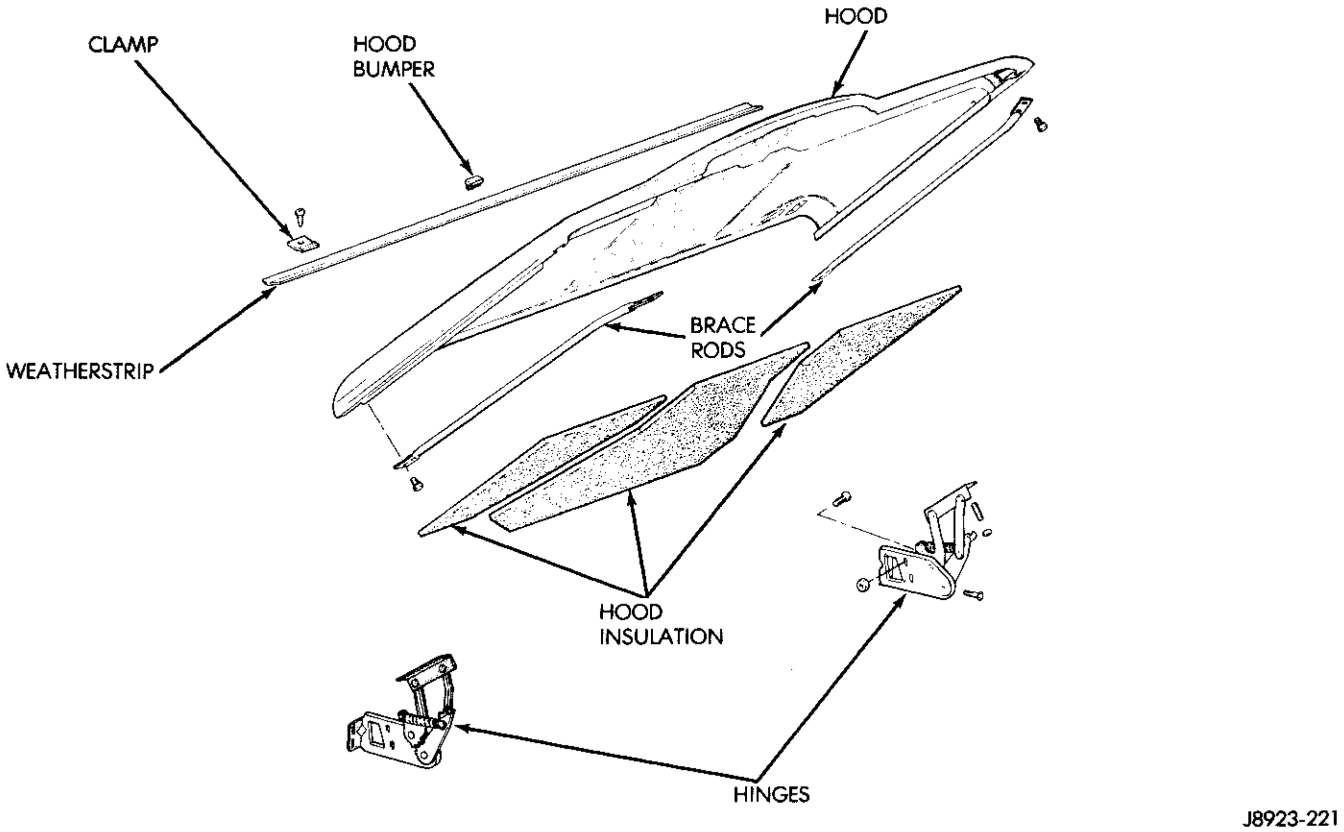


Fig. 1 Hood Components

panel and remove the cable.

(6) Insert the cable through the dash panel and seat the cable grommet.

(7) Install the screws attaching the cable bracket to the cowl panel.

(8) Route the cable along the hood brace rod and attach the cable with tie straps.

(9) Install the cable assembly in the cable bracket and tighten the bracket screws.

(10) Attach the cable end to the lock assembly.

(11) Close the hood.

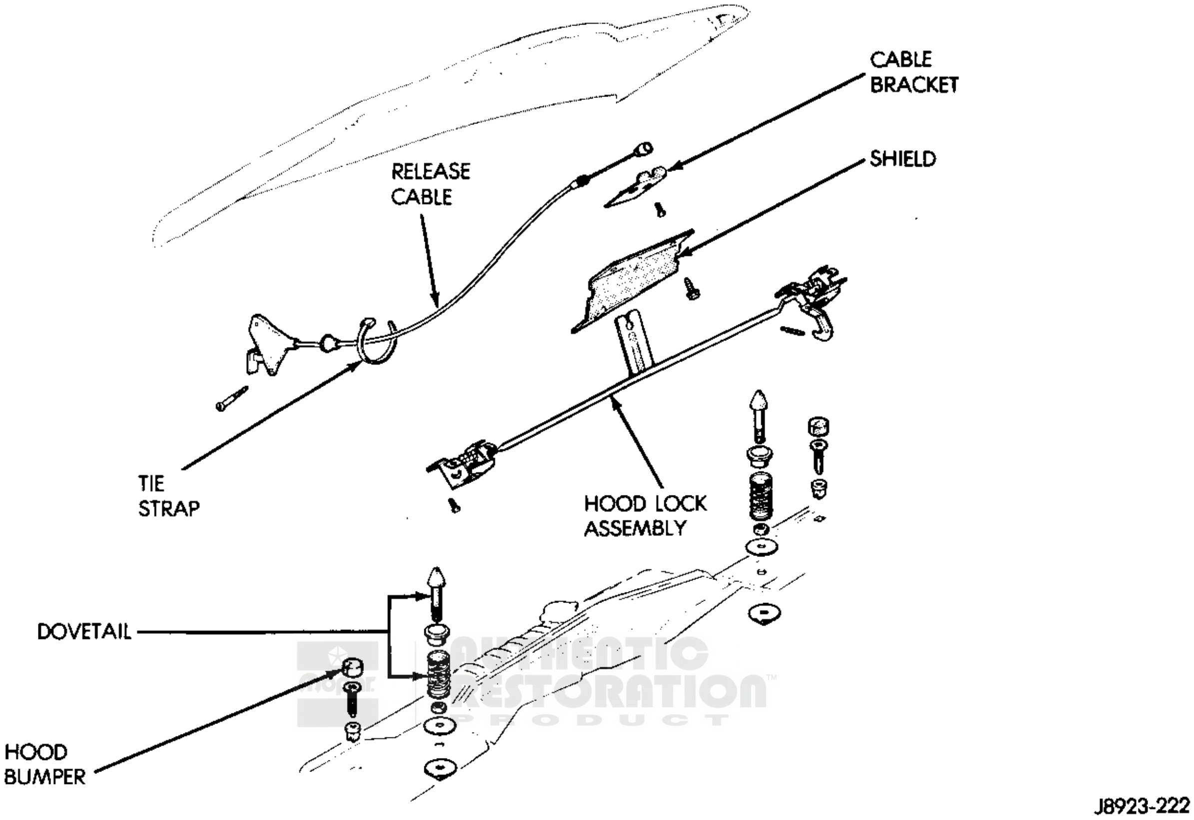


Fig. 2 Hood Lock Mechanism

INSTRUMENT PANEL AND COMPONENTS

Procedures covered in this section include: removal/installation of the instrument cluster, instrument panel and bezel, panel pad and glove box (Fig. 1).

The 10 Series instrument panel is made of formed sheet metal and is further reinforced with braces and fastened to adjacent body panels with bolts. A vinyl-covered polyurethane pad is attached to the instrument panel on all models.

Instrument Cluster Removal

(1) Disconnect the battery negative cable.

(2) Remove the cluster overlay.

(3) Disconnect the speedometer cable.

(4) Cover the steering column to prevent damaging the paint.

(5) Remove the cluster attaching screws and tilt the top of the cluster toward the interior of the vehicle.

(6) Mark the electrical connectors and hoses, and disconnect the electrical connectors and heater vacuum hoses.

(7) Disconnect the blend air door control cable.

(8) Remove the cluster.

Instrument Cluster Installation

(1) Position the cluster on the instrument panel.

(2) Connect the blend air door control cable.

(3) Connect the electrical connectors and vacuum hoses.

(4) Install the cluster attaching screws.

(5) Connect the speedometer cable and install the cluster overlay.

(6) Connect the battery negative cable.

(7) Remove the covering on the steering column.

Instrument Panel Removal

(1) Disconnect the battery negative cable.

(2) Remove the instrument panel crash pad. Refer to the procedure in this section.

(3) Remove the evaporator assembly and ducts.

(4) Remove the instrument cluster.

(5) Remove the radio and amplifier fader switch.

(6) Remove the parking brake lever assembly.

(7) Remove the air vent cables.

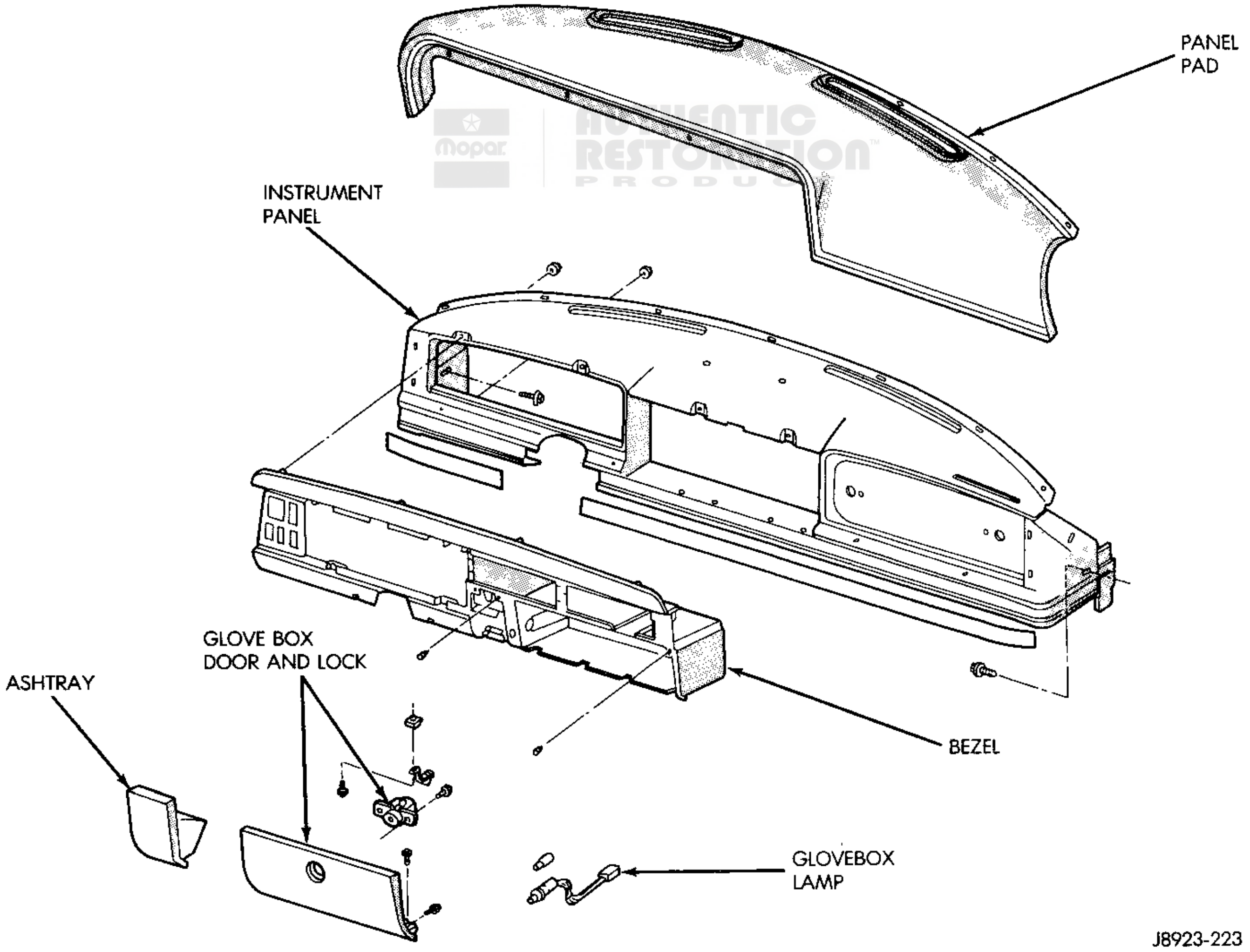


Fig. 1 Instrument Panel Components

(8) Disconnect the electrical connectors and remove the courtesy lights.

(9) Disconnect the defroster hoses.

(10) Remove the steering column trim panel.

(11) Remove the bolt from the center of the brace and lower the steering column.

(12) Remove the instrument panel attaching screws and remove the panel and bezel.

Instrument Panel Installation

(1) Position the instrument panel and bezel and install the attaching screws.

(2) Raise the steering column and install the bolt in the center of the brace.

(3) Install the steering column trim panel.

(4) Connect the defroster hoses.

(5) Connect the electrical connectors and courtesy lights.

(6) Install the air vent cables.

(7) Install the parking brake lever assembly.

(8) Install the instrument cluster.

(9) Install the radio and amplifier fader switch, if removed.

(10) Install the evaporator assembly and ducts, if removed.

(11) Install the instrument panel pad.

(12) Connect the battery negative cable.

Instrument Panel Pad Replacement

(1) Remove the windshield and windshield weatherstrip to expose the pad retaining screws at the base of the windshield.

(2) Remove the instrument cluster.

(3) Remove the glove box.

(4) Remove the ashtray and retainer.

(5) Remove the radio.

(6) Remove the pad-to-instrument panel attaching screws and nuts. The nuts are accessible through the cluster, ashtray, and glove box openings.

(7) Position the new pad on the instrument panel and install the pad attaching screws and nuts.

(8) Install the radio.

(9) Install the ashtray and retainer.

(10) Install the glove box.

(11) Install the instrument cluster.

(12) Install the windshield weatherstrip and windshield.

Glove Box Removal

(1) Remove the glove box-to-instrument-panel attaching screws.

(2) Remove the striker.

(3) Remove the lockout control switch, if equipped.

(4) Move the glove box downward. Compress the glove box at the crease lines and remove the box through the opening.

Glove Box Installation

(1) Position the glove box in the glove box opening.

(2) Install the glove box-to-instrument panel attaching screws.

(3) Install the lockout control switch, if removed.

(4) Install and adjust the striker.

Glove Box Door, Hinge And Lock

The glove box door hinge mounting holes are elongated to provide adjustment. The hinge screws may be loosened and the door moved in the desired direction to fit the door opening.

To remove the door, remove the hinge-to-instrument panel attaching screws and remove the door. It may also be necessary to lower the evaporator housing for access to the door screws.

The glove box door lock striker is attached to the instrument panel opening with sheet metal screws. The striker can be moved in or out for door closing adjustment.

The glove box lock cylinder is inserted through the glove box door from the outside. The assembly is held in place by a screw through the mlock clamp cup and into the lock case.

Insert the key in the lock and rotate the cylinder counterclockwise to expose the tumblers. Remove the key and press the retainer tumbler down. Then insert the key and remove the lock cylinder.

If a replacement lock cylinder is being installed, insert the original key into the replacement cylinder and file the tumblers flush with the cylinder. Stake the tumblers into the cylinder.

Press the retainer tumbler down on the lock cylinder and insert the key in the cylinder. Insert the cylinder into the lock case, hold the cylinder in place and remove the key.

Cigarette Lighter

The lighter can be removed by disconnecting the battery feed wire and unscrewing the shell that surrounds the lighter. The lighter circuit is protected with a 10-amp fuse located at the fuse panel.

TAILGATE

The tailgate is a horizontally hinged unit equipped with an electrically operated window regulator. An access hole in the inner panel provides access to the regulator and latch assemblies (Fig. 1). Torque rods are used to counterbalance and assist in opening and closing the tailgate (Fig. 2). The tailgate hinges are accessible at the body side for adjustment or replacement.

Service procedures in this section include: removal/installation of the tailgate, hinges, latch, window glass, power window motor and window regulator.

Tailgate Adjustment

Tailgate adjustment is accomplished by repositioning the tailgate hinges and adjustable studs. The stops and adjustable studs stabilize the tailgate and function as an overslam bumper. They are adjusted by bringing the studs into alignment with the alignment stop. The studs are located on the body pillars near the striker plates. The alignment stops are located on the tailgate and are not adjustable (Fig. 2).

(1) Remove the adjustable studs from the body pillars.

(2) Move the trim panel and carpeting for access to the hinge cover plates.

(3) Remove the hinge covers (Fig. 3).

(4) Loosen the hinge bolts (Fig. 4). Move the hinges until the the tailgate closes flush with the body and compresses the weatherseal.

(5) Tighten the hinge bolts to 20-27 N•m (15-20 ft-lbs) torque.

(6) Install the hinge covers, trim panel and carpeting.

(7) Install the adjustable studs.

(8) Reset the adjustable studs as follows:

(a) Loosen the stud locking nuts.

(b) Close the tailgate.

(c) Adjust the studs in or out with a Torx bit and tighten the stud nuts.

(9) Check the tailgate for proper alignment and adjustment. Be sure the tailgate latches properly.

Tailgate Hinge Replacement

(1) Open the tailgate. Remove the moldings and roll back the carpeting.

(2) Remove the access hole cover plates from the body and tailgate.

(3) Raise the tailgate to a vertical position to unload the torque rods. Then pry the rods out of the brackets bolted to the body half of the hinge (Fig. 4).

WARNING: DO NOT REMOVE THE TORQUE ROD BRACKET BOLTS WITH THE TAILGATE IN THE OPEN (HORIZONTAL) POSITION. THE TORQUE RODS ARE UNDER TENSION AND COULD CAUSE INJURY IF THE BRACKETS ARE REMOVED WHEN THE TAILGATE IS OPEN.

(4) Using a grease pencil, mark the outline of the hinges on the body and the tailgate for reference.

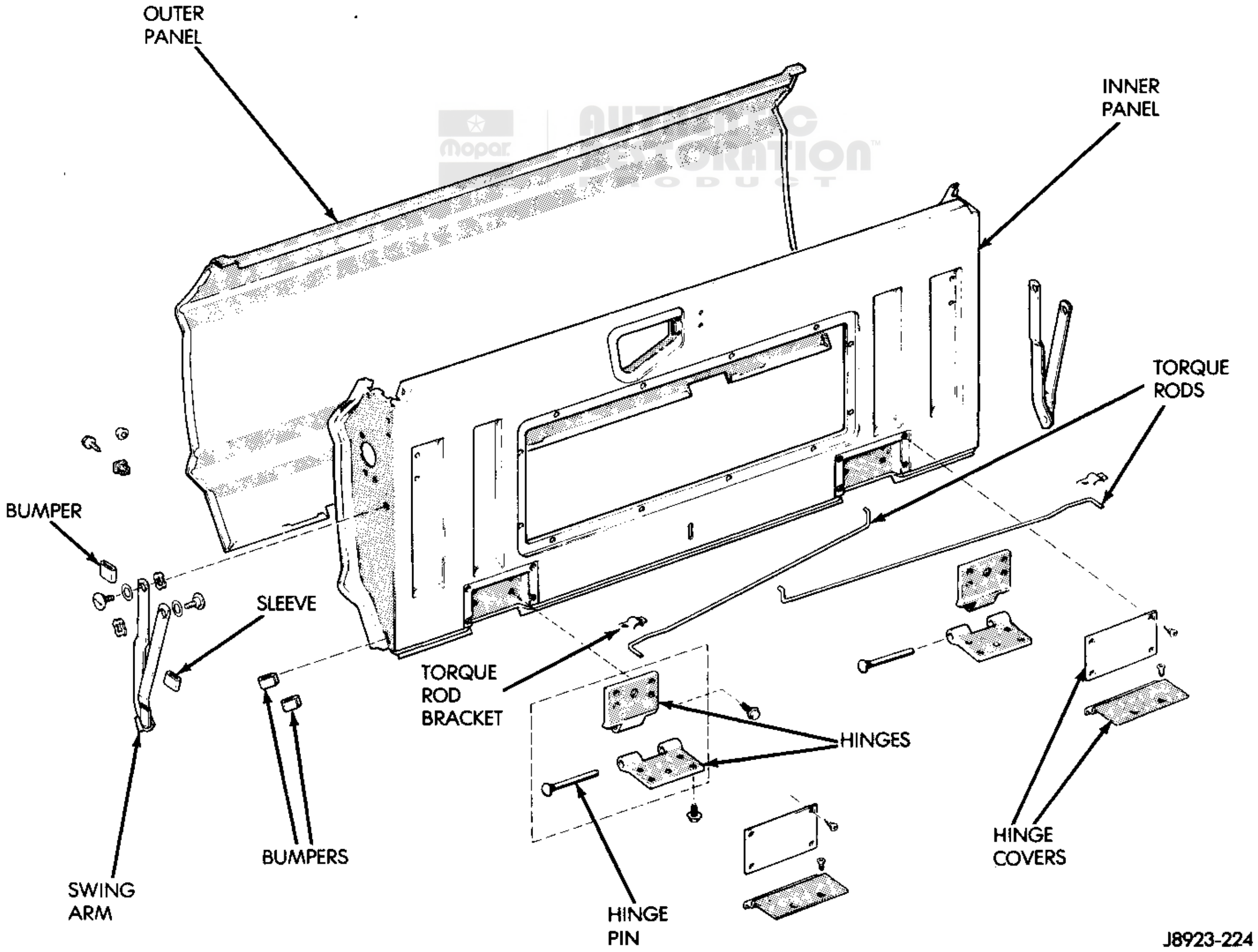


Fig. 1 Tailgate Components

(5) Support the tailgate in a horizontal position.

(6) Remove the hinge bolts and remove the hinges.

(7) Color coat the new hinges to match the body color. Wipe the surfaces of the new hinges with Acrysol or 3M All Purpose cleaner before color coating.

(8) When the hinges are dry, lubricate them with 3M 4-Way Spray lubricant or equivalent.

(9) Align and install the new hinges according to the reference marks made at removal.

(10) Raise the tailgate to a vertical position and install the torque rods in the brackets (Fig. 4).

(11) Check and adjust tailgate alignment if necessary.

(12) Install the access hole cover plates on the body and tailgate and replace the cargo area floor covering and moldings.

Tailgate Removal

(1) Remove the carpet panel from the tailgate.

(2) Remove the tailgate access cover and disconnect the wiring.

(3) Roll the floor carpet back for access to the hinge covers.

(4) Remove the hinge covers (Fig. 3).

(5) Close the tailgate.

(6) Remove the hinge pins with a drift and hammer.

WARNING: DO NOT REMOVE THE TORQUE RODS OR THE BRACKET BOLTS WITH THE TAILGATE IN THE OPEN (HORIZONTAL) POSITION. THE TORQUE RODS ARE UNDER TENSION AND COULD CAUSE INJURY IF THE RODS AND/OR BRACKETS ARE REMOVED WHEN THE TAILGATE IS OPEN.

(7) Raise the tailgate to the vertical position and pry the torque rods out of the brackets (Fig. 4).

(8) Remove the screws attaching the swing arms to the tailgate (Fig. 5).

(9) Remove the tailgate.

Tailgate Installation

(1) Attach the swing arms to the tailgate and raise the tailgate to the vertical position.

(2) Install the torque rods. Insert the rods in the holes at the bottom edge of the tailgate and the right-angle tapered end of each rod in the torque rod bracket.

(3) Lubricate and install the hinge pins. The head of each pin should face the inboard side of the hinge.

(4) Install the hinge covers.

(5) Install the floor carpeting.

(6) Connect the wiring and install the tailgate access cover and carpeting.

(7) Adjust the tailgate.

Latch And Latch Arm Replacement

(1) Lower the tailgate.

(2) Raise the tailgate window glass to full up position. Use the safety switch at the left side of the tailgate to raise the window (Fig. 6).

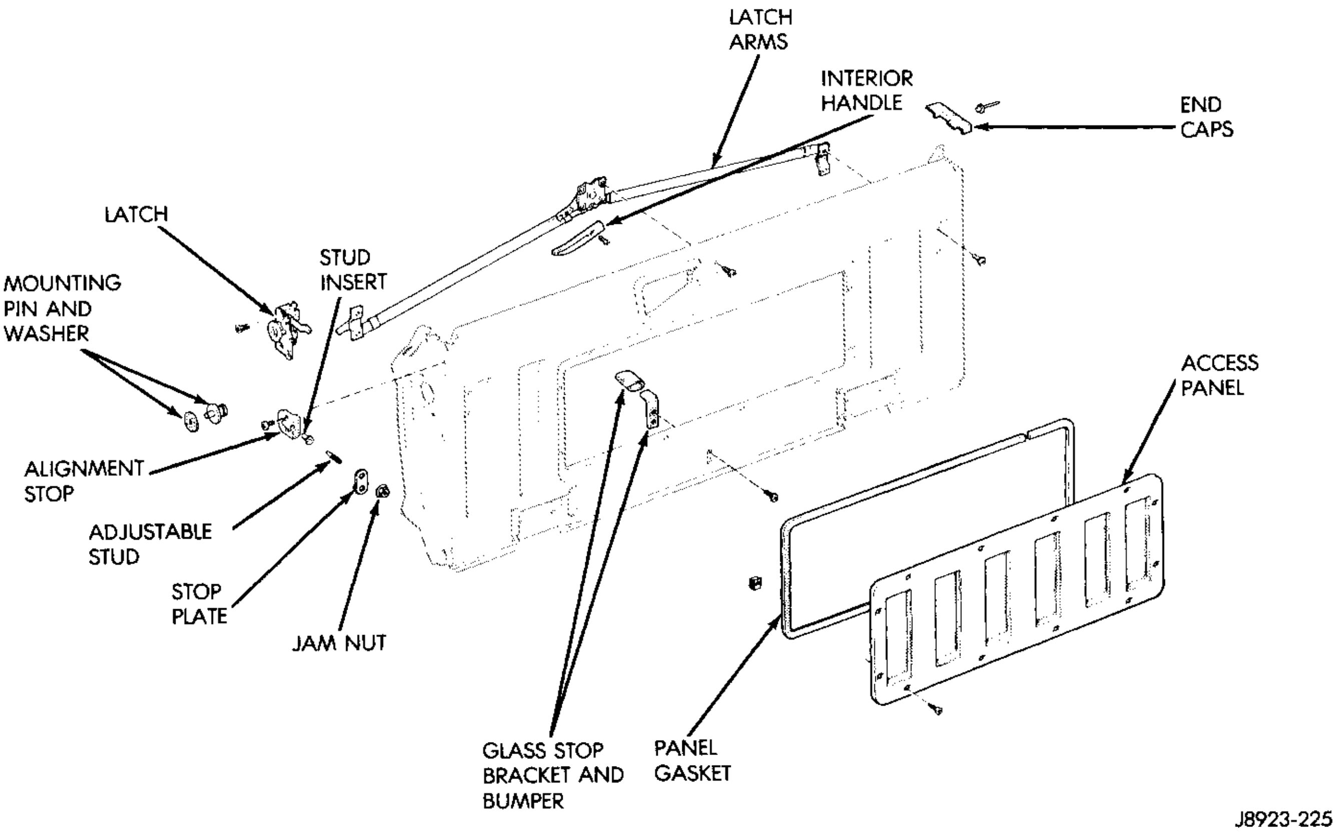


Fig. 2 Tailgate Hardware

(3) Support the tailgate and the window glass.

(4) Remove the tailgate carpet.

(5) Remove the access cover and the tailgate release handle.

(6) Remove the screws attaching the latch arms.

(7) Remove the screws attaching the latch to the tailgate (Fig. 5).

(8) Pull the latch arms toward the bottom of the tailgate.

(9) Move the latch arms toward the side of the tailgate and disconnect them from the latches.

(10) Remove the latches and remove the arms through the tailgate access opening.

(11) Install the new latch components in the tailgate.

(12) Attach the arms to the latches and secure the latches to the tailgate sides.

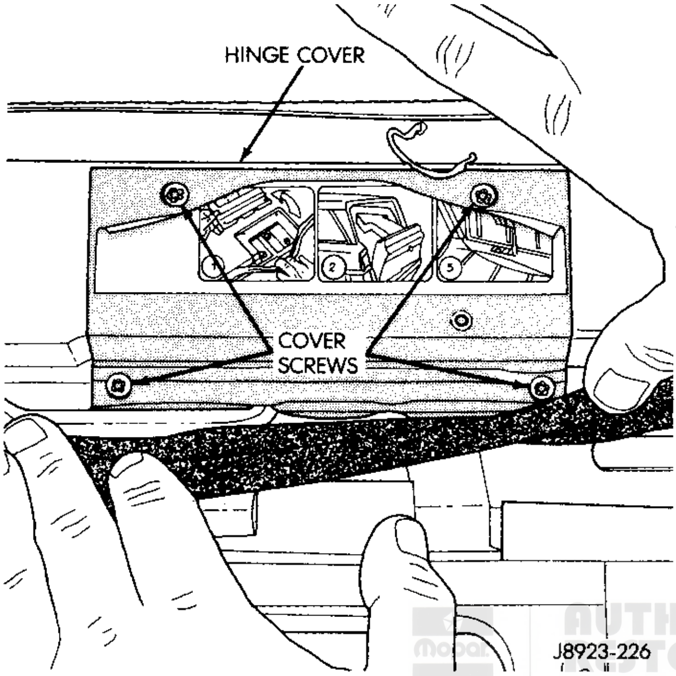


Fig. 3 Hinge Cover Removal/Installation

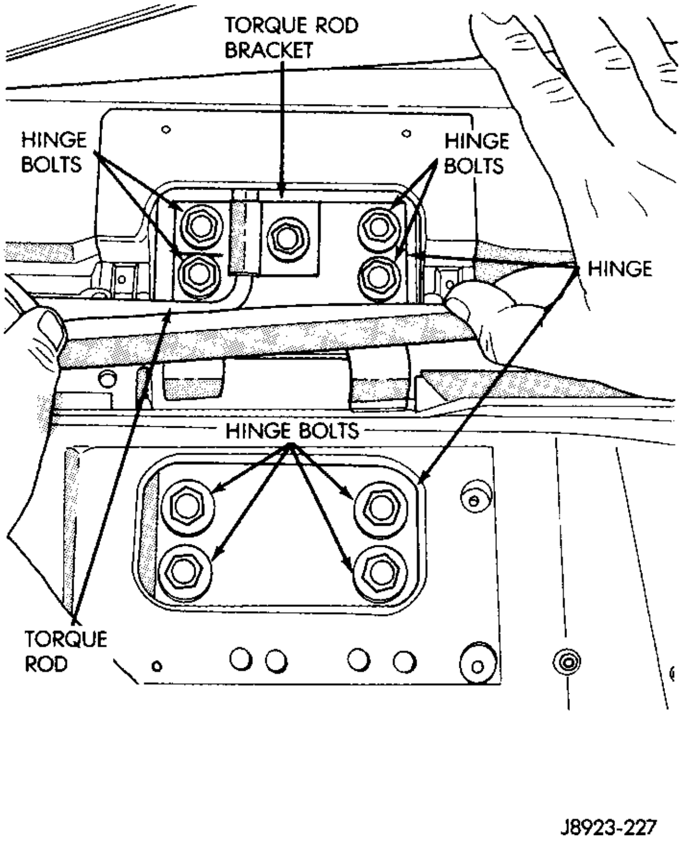


Fig. 4 Tailgate Hinge And Torque Rod Mounting

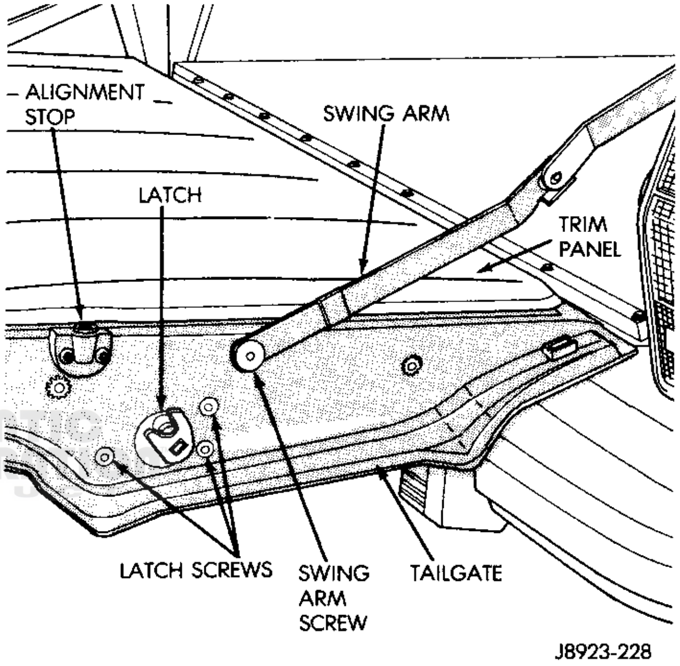


Fig. 5 Swing Arm And Latch Attachment

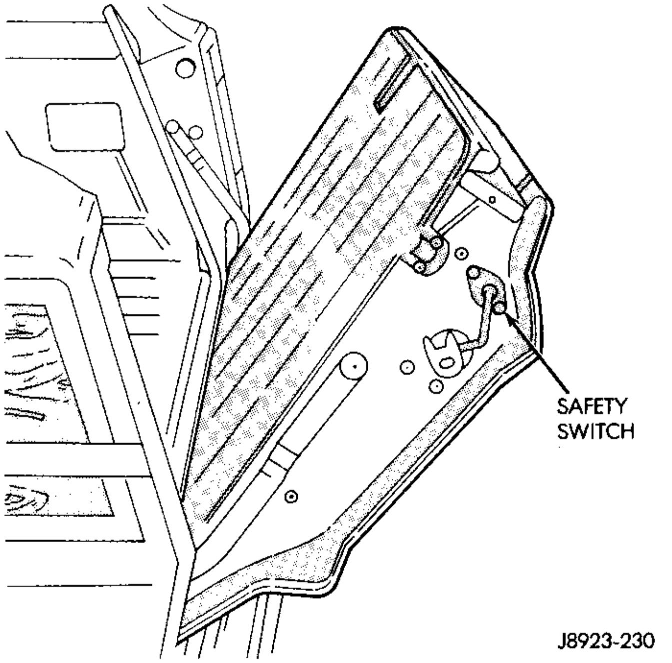


Fig. 6 Tailgate Safety Switch Location

(13) Position the latch arms in the tailgate and install the attaching screws.

(14) Install the tailgate access cover and carpet.

Tailgate Window Glass Replacement

(1) Lower the tailgate.

(2) Remove the tailgate carpet and access cover.

(3) Remove the stud retainers from the regulator arm studs.

(4) Disconnect the window regulator arm studs from the channel (Fig. 7).

(5) Disconnect the tailgate window defogger and window motor wires.

(6) Remove the tailgate glass and channels.

(7) Clean the lower section of the new tailgate glass with isopropyl alcohol. **Do not wipe or rub the defogger grid area when cleaning the glass.**

(8) Clean the glass channel.

(9) Bond the seal to the bottom edge of the glass with 3M weatherstrip adhesive.

(10) Apply weatherstrip adhesive to the channel groove and seat the glass and seal in the channel. Allow the adhesive to cure for 20-30 minutes before installing the window.

(11) Clean any excess adhesive from the window glass if necessary.

(12) Install the side channels.

(13) Install the window in the tailgate and attach the regulator arms to the channel.

(14) Connect the motor and defogger wires.

(15) Install the tailgate access panel and carpet.

(16) Adjust the window glass if necessary. Refer to the procedure in this section.

Tailgate Window Regulator And Motor Removal

(1) Remove the tailgate access panel and carpeting.

(2) Carefully support the glass in the raised position.

(3) Disconnect the wiring harness from the safety switch.

(4) If the regulator attaching screws are accessible, remove the regulator attaching screws and regulator. If the sector gears are covering the attaching screws, proceed as follows:

(a) place the jumper wire between the two terminals of the safety switch connector

(b) Place the key in the tailgate switch and operate the motor until the sector gears allow access to the regulator attaching screws

(c) While holding the regulator in this position, wedge the screw between the meshing teeth, using the other hand

(d) Remove the regulator attaching screws, regulator and motor

(5) Release spring tension by using a large screwdriver to snap the spring from under the tension bracket.

(6) Remove the motor attaching screws and remove the motor from the regulator (Fig. 8).

Tailgate Window Regulator And Motor Installation

(1) Position the spring on the regulator and snap the spring over the tension bracket with a large screwdriver.

(2) Position the motor on the regulator and install the attaching screws.

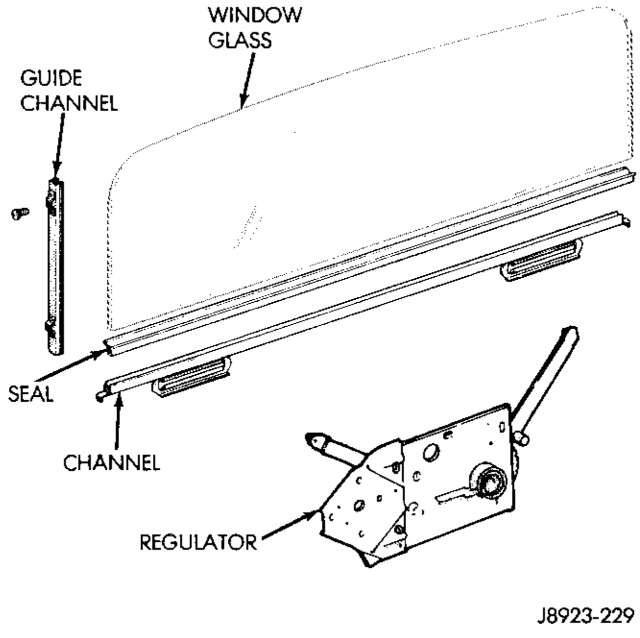


Fig. 7 Tailgate Window Glass And Channels

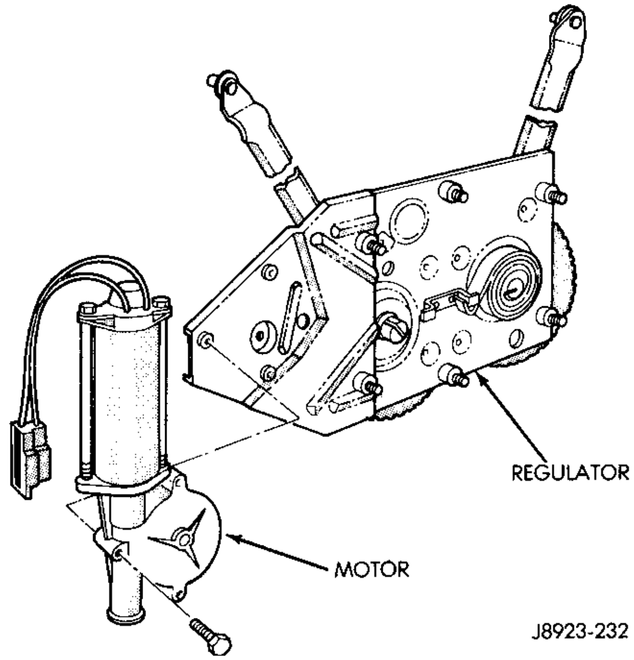


Fig. 8 Tailgate Power Window Regulator And Motor

(3) Position the regulator in the tailgate and install the attaching screws.

(4) Connect the wiring harness to the motor.

(5) Position the channel over the regulator arm pins and install the replacement retainers.

(6) Raise and lower the window to check window fit. The regulator can be adjusted by loosening the attaching screws and moving the regulator assembly in the slotted screw holes until the proper fit is obtained.

(7) Install the tailgate access panel and carpet.

Tailgate Window Glass Adjustment

The tailgate window glass should seat fully in the upper glass channel for proper sealing. If the glass does not seat properly, check the upper channel to be certain it is bottomed in the body opening. Also check alignment of the tailgate glass side channel.

If window glass adjustment is necessary, loosen the side channel screws at each side of the tailgate (Fig. 9). Close the tailgate and raise and lower the window several times to align the glass with the channels.

Open the tailgate slightly and tighten the adjusting screws with the tailgate in the vertical position.

Tailgate Lock And Switch

The tailgate lock is secured by screws under the key hole cover. Remove the screws with a Torx bit.

The switch is at the bottom, left side of the regulator mounting bracket. It is attached with screws which are accessible after removing the regulator.

FRONT DOORS

Procedures covered in this section include: door, weatherstrip and trim panel removal, installation, replacement or adjustment, door glass replacement, regulator/motor removal and/or replacement, and lock mechanism replacement.

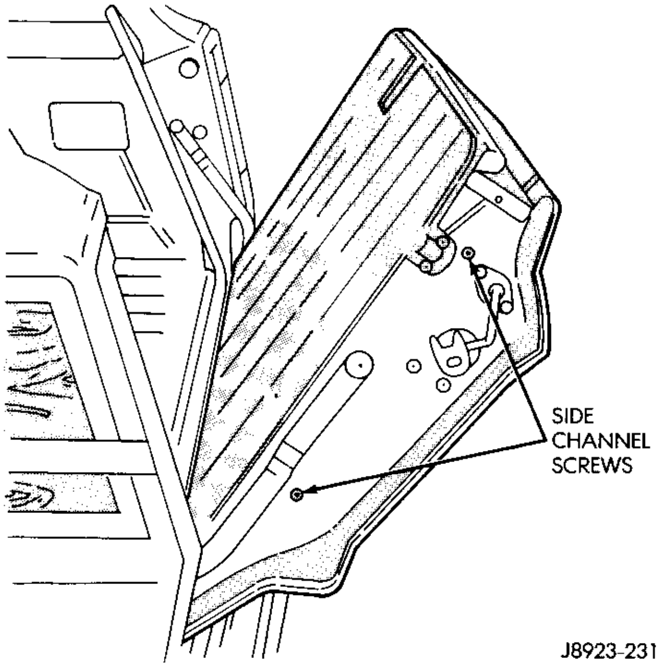


Fig. 9 Side Channel Screw Locations

Trim Panel Removal

(1) Remove the armrest overlay. Remove the armrest attaching screws and armrest.

(2) Remove the door latch remote control handle.

(3) Remove the assist handle. Remove the woodgrain insert at both ends of the assist handle and remove the attaching screws and assist handle.

(4) Remove the power door lock/window switch bezel.

(5) Remove the trim panel attaching screws at the panel bottom.

(6) Pry the trim panel clips out of the door.

(7) Loosen the setscrew securing the remote control mirror cable to the escutcheon.

(8) Remove the trim panel but leave the water dam sheet in place.

(9) If the panel will be replaced, remove the speakers, switches, other components.

Trim Panel Installation

(1) If a new trim panel is being installed, cut openings in the new panel for the speakers, switches, other components. Use the old panel as a guide. Then transfer these components to the new panel.

(2) Insert the remote control mirror cable in the escutcheon and tighten the setscrew.

(3) Position the trim panel on the door and install the panel retaining clips. To prevent creasing the trim panel cover, do not exert excessive force on the clips.

(4) Install the panel bottom screws.

(5) Install the door latch remote control handle.

(6) Install the armrest and overlay and assist handle.

(7) Install the woodgrain inserts

(8) Install the power door lock/window bezel.

Door Weatherstrip

The door weatherstrip is made of molded latex foam with a smooth rubber skin on the outside. The weatherstrip is attached to the body opening.

Cold weather may cause the rubber weatherstrip to harden and lose resiliency. When servicing, use a dampened cloth to clean the weatherstrip. Apply a silicone lubricant to the sealer to help preserve it. **Do not use graphite, brake fluid, or wax on the weatherstrip.**

Weatherstrip Replacement

(1) Replacement weatherstrips are coated with powder to prevent sticking in storage. Remove this powder with a cloth dampened with 3M General Purpose Adhesive Cleaner or similar product.

(2) Carefully remove the old weatherstrip from the body.

(3) Remove dust and dirt from the body.

(4) Install the upper front corner of the weatherstrip first.

(5) Work the rubber sealer onto the flange completely around the door opening.

Front Door Glass Removal

(1) Remove the door trim panel and water shield.

(2) Remove the glass stop bracket (Fig. 1).

(3) Remove the lower division channel attaching bracket.

(4) Remove the division channel upper bracket-to-door panel attaching screws.

(5) Remove the lock rod bushing and knob (Fig. 1). Move the lock rod aside so the glass can be lowered to the bottom of the door.

(6) Remove the screws attaching the remote control rod to the door panel and move the rod aside.

(7) Lower the door glass and remove the screws and plastic nuts attaching the glass to the lift bracket.

(8) Push the lower end of the division channel toward the front of the door to release the glass from the channel.

(9) Move the glass toward the front of the door to release it from the rear channel.

(10) Rotate the glass vertically 90°. Guide it between the inner and outer door panels and remove the glass from the door.

Front Door Glass Installation

(1) Position the door glass in the lower part of the door.

(2) Position the glass On the lift bracket and install the retaining nuts and screws.

(3) Guide the glass into the channels.

(4) Move the regulator arm up or down to align it with the lift bracket and install the retainer on the regulator arm.

(5) Position the remote control assembly and install the attaching screws.

(6) Install and attach the lock rod, bushing and push button (Fig. 1).

(7) Install the upper and lower division bar attaching brackets.

(8) Install the glass stop bracket.

(9) Check glass operation and adjustment.

(10) Install the water shield and trim panel.

Vent Window Removal

(1) Remove the door trim panel and water shield.

(2) Remove the door window glass.

(3) Remove the glass slide channel along the top and outside beltline weatherstrip.

(4) Remove the vent assembly attaching screws on the leading edge of the door frame and the base of the channel.

(5) Move the vent assembly toward the rear of the door and tilt it down to clear the upper door frame.

(6) Pull the ventilator assembly straight out until the upper attaching bracket is above the opening between the outer and inner door panels.

(7) Rotate the vent assembly 90° to position the lower attaching bracket on the run channel to clear the opening between the door panels.

(8) Remove the vent window assembly (Fig. 2).

Vent Window Installation

(1) Position the vent window assembly in the door.

(2) Install the vent assembly attaching screws through the door frame (Fig. 2).

(3) Install the upper glass slide channel and outside beltline weatherstrip.

(4) Install the door window glass.

(5) Install the water dam sheet and trim panel.

Door Handle Removal/Installation

(1) Remove the trim panel.

(2) Raise the window to the full up (closed) position.

(3) Remove the door handle attaching screws through the opening in the door inner panel.

(4) Remove the handle and handle gaskets (Fig. 3).

(5) Inspect the handle components. Replace the door handle as an assembly if the handle, release button or plunger are damaged in any way. Do not disassemble the door handle.

(6) Install the gaskets on the door handle and position the handle on the door.

(7) Verify that the release plunger is seated in the latch and install the handle attaching screws.

(8) Install the water dam sheet and the trim panel.

Lock Cylinder Replacement

(1) open the door and remove the rubber seal that covers the edge of the cylinder retaining clip.

(2) Remove the clip by prying it out or pulling it out with pliers.

(3) Remove the lock cylinder.

(4) Lubricate the new cylinder with Mopar lock lubricant.

(5) Install the cylinder in the door. Be sure the cylinder lock rod is engeged in the latch.

(6) Install the cylinder retaining clip.

(7) Install the seal over the clip.

Door Latch Removal

(1) Remove the door trim panel and water shield.

(2) Remove the lock cylinder.

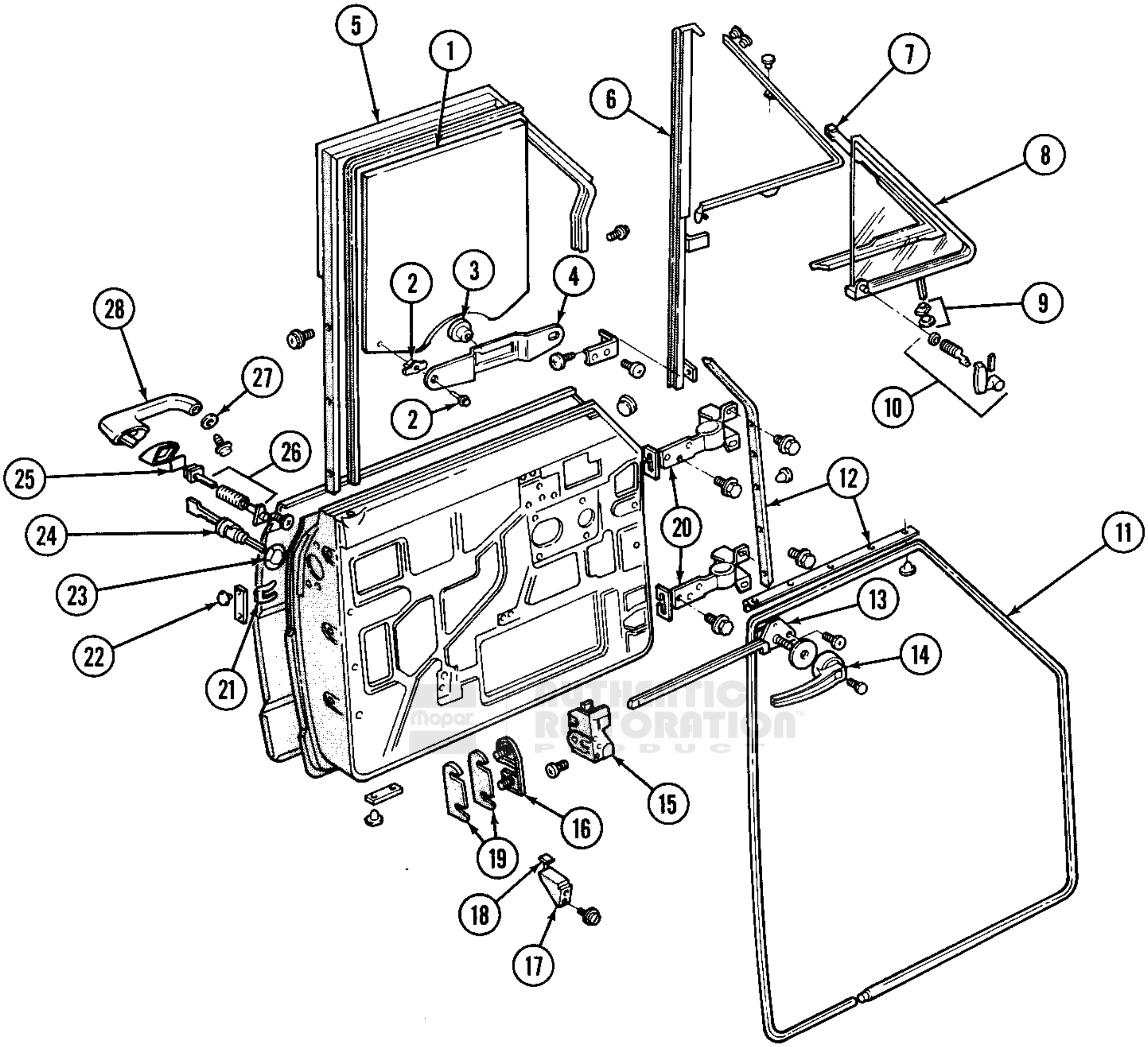
(3) Disconnect the latch rod.

(4) Remove the screws attaching the door latch to the door panel.

(5) Push the door latch in. Turn it 90° to free it from the lock rod and remove the latch.

Door Latch Installation

(1) Connect the lock rod to the door latch.



① Door Glass
② Glass Retaining Screw and Nut
③ Track Retainer
④ Lift Bracket
⑤ Frame
⑥ Division Channel and Bracket
⑦ Weatherstrip
⑧ Vent Glass and Frame
⑨ Pivot Assembly
⑩ Vent Handle Assembly
⑪ Weatherstrip
⑫ Shields
⑬ Remote Control
⑭ Handle
⑮ Latch
⑯ Striker
⑰ Stop Bracket
⑱ Bumper
⑲ Shims
⑳ Hinge
㉑ Lock Cylinder Retainer
㉒ Pin
㉓ Gasket
㉔ Lock Cylinder
㉕ Gaskets
㉖ Push Button Mechanism
㉗ Handle Gasket
㉘ Door Handle

J8923-233

Fig. 1 Front Door Components

(2) Position the latch on the door panel and install the latch screws.

(3) Connect the latch rod.

(4) Install the lock cylinder.

(5) Install the water dam sheet and trim panel.

Door Lock Actuator Replacement

(1) Remove the trim panel and water dam paper.

(2) Raise the window.

(3) Disconnect the battery.

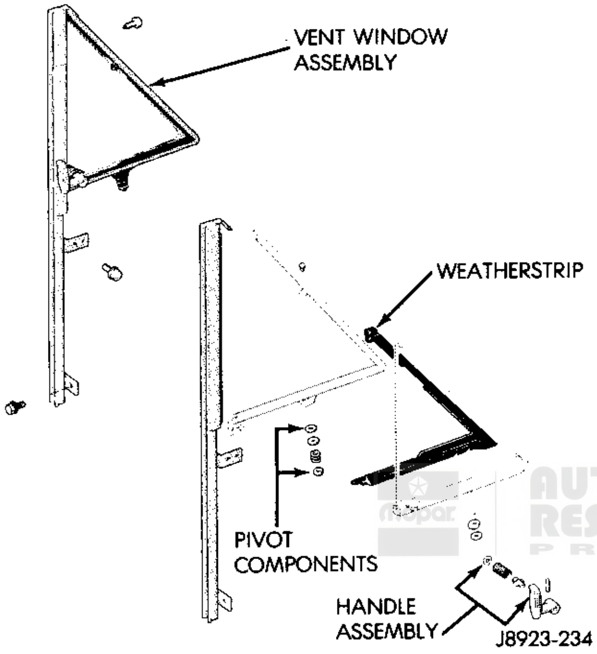


Fig. 2 Vent Window Assembly

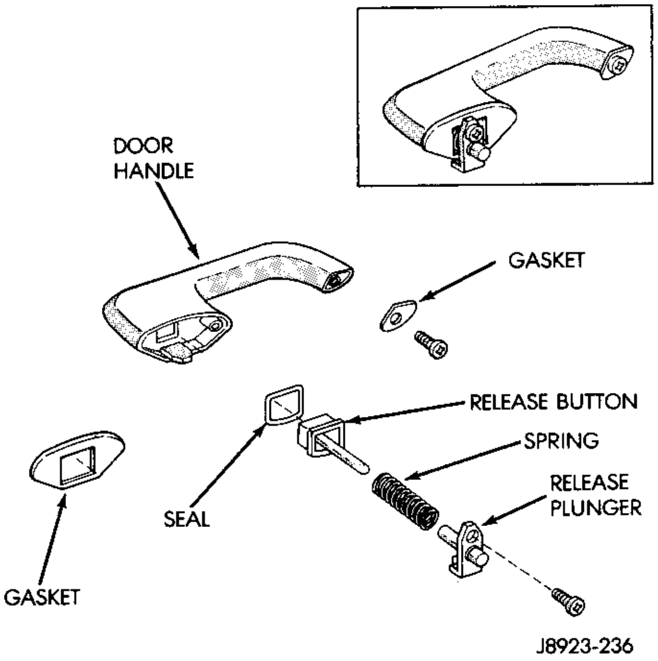


Fig. 3 Front Door Handle

(4) Disconnect the lock rod at the actuator.

(5) Remove the screws attaching the actuator to the bracket and remove the actuator.

(6) Position the new actuator on the bracket and install the attaching screws.

(7) Connect the actuator wires and lock rod.

(8) Connect the battery and check actuator operation.

(9) Install the water dam sheet and trim panel.

Front Door And Hinge Removal

(1) Remove the trim panel and water shield.

(2) Disconnect and remove the power window and lock wire harnesses.

(3) Mark the outline of the existing hinges on the body pillar and door for reference.

(4) Position the door in a holding fixture.

(5) Remove the hinge-to-body bolts.

(6) Remove the door from the vehicle.

(7) Remove the hinge-to-door bolts and remove the hinges.

Front Door And Hinge Installation

(1) Clean the replacement hinges in a suitable solvent and blow dry with compressed air.

(2) Color coat the hinges to match the body.

(3) Lubricate the hinges with 3M 4-Way Spray lubricant, or an equivalent.

(4) Position the hinges on the door and install the hinge-to-door bolts. Use the reference marks to align the hinges.

(5) Position the door in the body opening and align the hinges with the reference marks made on the body pillar.

(6) Install and tighten the two outer hinge-to-body bolts first. Then install and tighten the inner bolt last.

(7) Remove the door holding fixture.

(8) Install and connect the window motor and door lock wire harnesses.

(9) Check and adjust door alignment if necessary.

(10) Install the water dam sheet shield and trim panel.

Door Adjustment

The doors can be moved up, down, in or out by adjusting hinge or door striker position.

Loosen the hinge bolts and move the door as needed. The door striker can be shimmed in or out. It can also be moved up or down as necessary for proper door closure and adjustment.

Be careful when adjusting the striker. It is possible to set the striker in so far that the door is closed tightly but only the safety catch is engaged.

REAR DOORS

Procedures covered in this section include: rear door removal and installation, window glass replacement, regulator/motor removal/installation, weatherstrip replacement and door lock component removal and installation.

Trim Panel Removal

(1) Remove the armrest overlay.

(2) Remove the armrest attaching screws and the armrest.

(3) Remove the woodgrain inserts at both ends of the assist handle. Remove the attaching screws and the assist handle.

(4) Remove the power window switch bezel.

(5) Remove the trim panel attaching screws at the bottom of the panel.

(6) Pry the trim panel-to-door clips out.

(7) Remove the trim panel.

(8) If the panel will be replaced, transfer the panel components to the new panel.

Trim Panel Installation

(1) If a new panel is being installed, mark and cut holes in it for the switches and other panel components.

(2) Position the trim panel on the door and install the panel clips.

(3) Install panel bottom screws.

(4) Install the armrest and overlay.

(5) Install the assist handle.

(6) Install the power window switch bezel.

Door Weatherstrip

The door weatherstrip is made of molded latex foam with a smooth rubber skin on the outside. The weatherstrip is attached to the body opening.

Cold weather may cause the rubber weatherstrip to harden and lose resiliency. When servicing, use a dampened cloth to clean the weatherstrip. Apply a silicone lubricant to the sealer to help preserve it. **Do not use graphite, brake fluid, or wax on the weatherstrip.**

Weatherstrip Replacement

(1) Replacement weatherstrips are coated with powder to prevent sticking in storage. Remove this powder with a cloth dampened with 3M General Purpose Adhesive Cleaner or similar product.

(2) Carefully remove the old weatherstrip from the body.

(3) Remove dust and dirt from the body.

(4) Install the upper front corner of the weatherstrip first.

(5) Work the weatherstrip onto the flange around the door opening.

Door Window Removal

(1) Remove the door trim panel and water shield.

(2) Remove the glass stop bracket (Fig. 1).

(3) Remove the division channel lower attaching bracket (Fig. 1).

(4) Lower the door glass.

(5) Remove the screws and plastic nuts attaching the glass to the lift bracket (Fig. 1).

(6) Lower the glass to the bottom of the door.

(7) Remove the inner and outer belt weatherstrips.

(8) Remove the upper slide channel.

(9) Remove the vent window attaching screws.

(10) Tilt the vent window forward about an inch.

(11) Push the lower end of the division channel toward the rear of the door to release the glass.

(12) Move the glass toward the rear of the door.

(13) Rotate the glass 90°.

(14) Guide the glass between the inner and outer door panels and out of the door.

Door Window Installation

(1) Position the door glass in the lower section of the door panel.

(2) Position the door glass in the front slide channel and push the division channel over the glass.

(3) Align the glass with the lift bracket and install the glass attaching screws and plastic nuts.

(4) Position the vent window in the door and install the vent frame screws.

(5) Install the upper slide channel.

(6) Install the inner and outer belt weatherstrip.

(7) Install the division channel lower attaching bracket.

(8) Install the glass stop bracket.

(9) Check window operation.

(10) Install the water shield and door trim panel.

Vent Window Removal

(1) Remove the door glass.

(2) Apply a soap solution under the vent weatherstrip and along the inner and outer door panels.

(3) Slide the vent assembly forward to the center of the door glass opening.

(4) Push the vent assembly down through the opening between the inner and outer door panels to disengage the assembly from the upper door frame.

(5) Lower the top of the vent assembly down to clear the upper door frame.

(6) Pull the vent assembly straight up until the weatherseals are clear of the door panel and the vent assembly can be rotated.

(7) Rotate the assembly to position the lower attaching bracket on the channel and pull the assembly up and out between the panels.

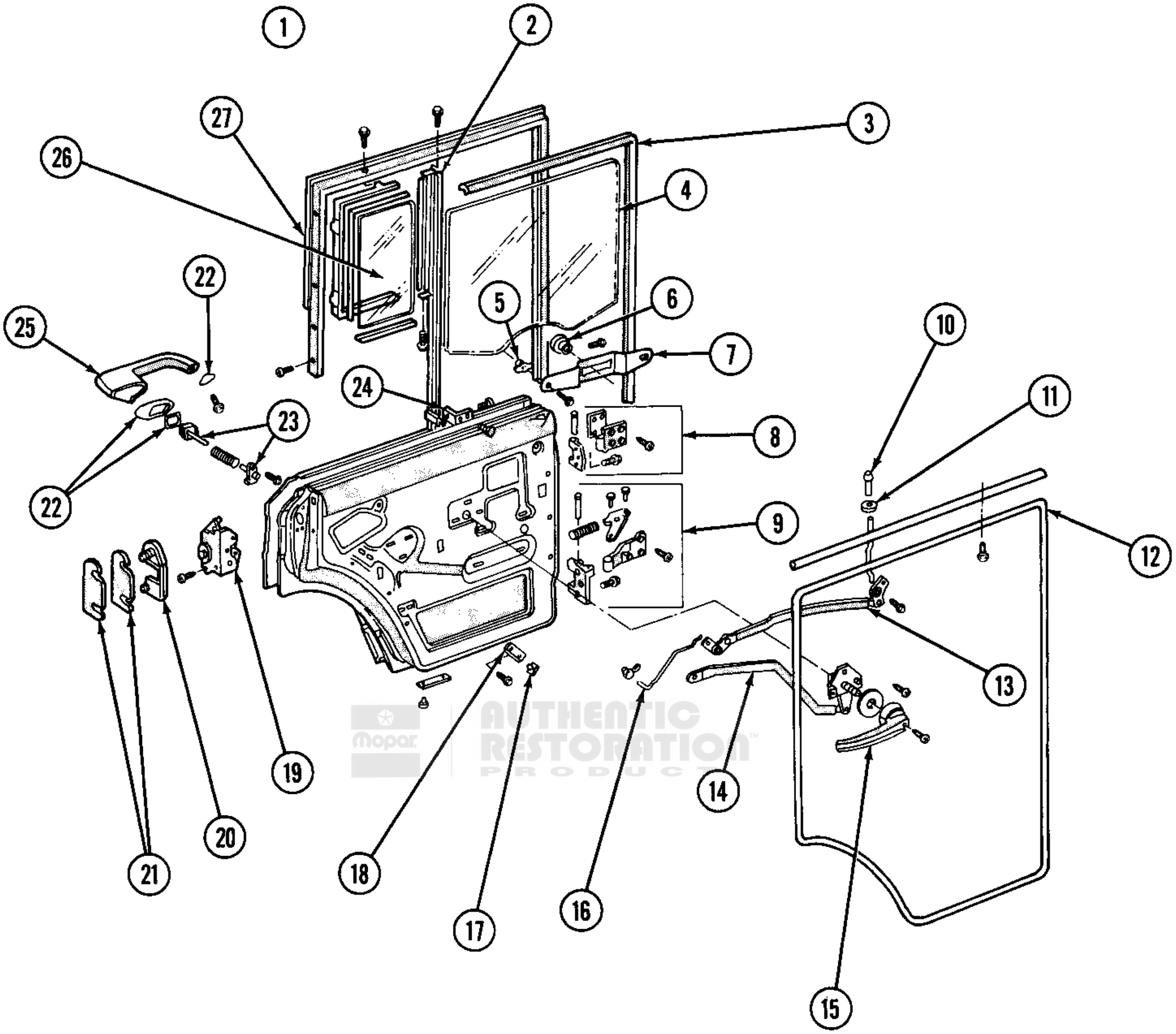
Vent Window Installation

(1) Install the vent assembly in the door.

(2) Engage the vent assembly in the upper door frame and slide the vent into position.

(3) Install the attaching hardware.

(4) Install the door glass.



① Stationary Glass Frame
② Division Channel
③ Glass Slide Channel
④ Door Glass
⑤ Grommet
⑥ Track Retainer
⑦ Lift Bracket
⑧ Hinge-Upper
⑨ Hinge-Lower
⑩ Knob
⑪ Lock Rod 2nd Bushing
⑫ Weatherstrip
⑬ Latch Rod
⑭ Remote Control Rod
⑮ Door Handle
⑯ Rod
⑰ Bumper
⑱ Stop Bracket
⑲ Latch
⑳ Striker
㉑ Shims
㉒ Gaskets
㉓ Push Button Mechanism
㉔ Bracket
㉕ Handle
㉖ Glass
㉗ Window Frame

J8923-238

Fig. 1 Rear Door Components

Rear Door Handle Replacement

(1) Remove the door trim panel and water shield.

(2) Raise the window to the fully closed position.

(3) Working through the opening in the inner door panel, remove the handle attaching screws and remove the handle and gaskets.

(4) Position the gaskets and handle on the door and secure with the attaching screws.

(5) Install the water shield and door trim panel.

Door Latch And Linkage Removal

(1) Remove the door trim panel and water shield.

(2) Remove the door lock push knob, door outer handle and lock cylinder (Fig. 1).

(3) Remove the screws attaching the latch rod to the door panel.

(4) Remove the actuator lock rod.

(5) Remove the door latch attaching screws.

(6) Disconnect the latch rod and turn the latch 90°.

(7) Remove the latch rod and latch.

Door Latch And Linkage Installation

(1) Position the latch in the door and install the latch and lock rods.

(2) Connect the latch rod to the latch. Secure the latch to the door panel with the attaching screws.

(3) Connect the lock rod to the actuator.

(4) Position the lock control arm on the inner door panel and install the attaching screws.

(5) Install the door lock push knob, lock cylinder and door handle.

(6) Install the water shield and trim panel.

Door And Hinge Removal

(1) Remove the door trim panel and water shield.

(2) Raise the door glass to the closed position.

(3) Disconnect the electrical harnesses inside the door and remove the harnesses.

(4) Position the door in a holding fixture.

(5) Mark hinge position on the door and body for reference.

(6) Remove the hinge bolts and remove the door and any hinge shims. Mark the shims for reference.

(7) Remove the hinges if they are to be replaced.

Door And Hinge Installation

(1) Install the hinges on the door. Align the hinges according to the reference marks made during removal.

(2) Position the door in the body opening.

(3) Align the hinges and shims with the reference marks made during removal.

(4) Install the hinge bolts.

(5) Remove the door holding fixture.

(6) Install and connect the window and lock electrical harnesses.

(7) Check and adjust door alignment if necessary.

(8) Install the water shield and trim panel.

Rear Door Adjustments

The doors are adjusted at the hinge mounting points on the body or door.

Shims can be installed between the hinges and door or body to move the door in or out. The hinge bolts can be loosened and the door moved up or down as needed for adjustment.

Prior to any door adjustment or alignment, the adjustable striker must be removed to allow the door to close freely in proper alignment without striker interference.

The door lock striker is adjustable up, down, in or out and can be shimmed forward or back to hold the door in the proper alignment position.

The door latch striker should be set so that the latch enters the striker without binding, yet provides secure retention for the lock and prevents up and down or in and out movement of the door.

The striker should also be adjusted in or out to allow the door latch to be fully engaged. The door should be flush with the adjacent body panels. Be careful when adjusting striker position. It is possible to set the striker in so far that the door will appear to close tightly but only the safety catch is engaged.

WINDSHIELD

A urethane adhesive is used to bond the windshield to the rubber weatherstrip and the rubber weatherstrip to the body flange. This material provides the strength necessary to meet Federal regulations covering windshield retention.

Windshield Water Leak Detection and Repair

Water leaks around the windshield can be corrected without removing the windshield. If the windshield is firmly bonded and only has small leak points, seal the leaks with a liquid butyl sealer such as 3M Windo-Weld Resealant. However, if the windshield bond has large breaks, a urethane adhesive/sealer will be required.

Leak Test

Water test the windshield with a spray only. Do not use heavy streams of water. Work from the bottom to the top of the windshield.

If a leak is between the glass and weatherstrip, or between the rubber weatherstrip and body, push the glass outward in the leak area to determine the extent of the leak. Do this while a helper sprays the windshield.

Repairing Minor Leaks

Clean the leak area of all dirt or foreign material and dry the area with compressed air.

Seal the leak area with a butyl sealer. Allow the sealer to set up for 1/2 hour or so. Then water test to be sure the leak is stopped.

Repairing Major Leaks

(1) Clean the glass area to be resealed.

(2) Apply primer to the either the glass or weatherstrip leak area. Use blackout primer on glass and rubber primer on the weatherstrip.

(3) Apply urethane adhesive to the leak area. Use the pointed nozzle on the sealer cartridge.

(4) Water test the windshield immediately using a cold water spray. Allow the water to spill over the edge of the glass and rubber weatherstrip. **Do not direct a hard stream of water on fresh urethane adhesive.**

(5) Apply additional sealer if necessary.

(6) Remove any excess adhesive.

Windshield Removal

(1) Cover the adjoining painted surfaces to protect the finish.

(2) Remove the windshield wiper arms.

(3) On vehicles with stainless steel moldings, perform the following steps. Remove the moulding screws on the top and bottom of the side moldings. Remove the top corner moulding by lifting the bottom and pulling outboard. Tip the side mouldings toward the center of the vehicle and lift off the top moulding

(4) Slide the center molding clip to the left or right and remove the bottom mouldings. This will expose the locking type weatherstrip.

(5) Use a wedge-shaped fiber or hardwood stick or wand to unlock the weatherstrip (Fig. 1). Unlock the rubber weatherstrip starting at the bottom.

(6) Remove the inside rear view mirror from the bracket.

(7) Using a razor knife, cut the rubber weatherstrip in the locking lip groove between the glass and body flange.

(8) Remove the windshield from the body opening.

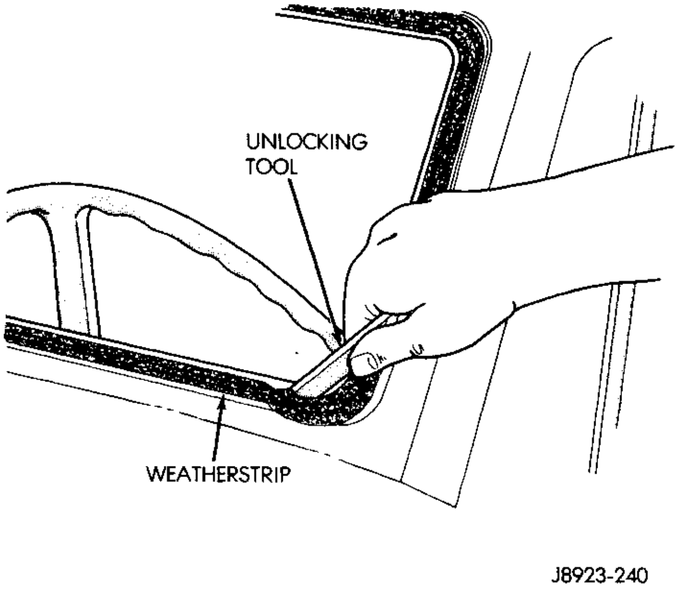


Fig. 1 Unlocking Windshield Weatherstrip

(9) Remove the rubber weatherstrip from the body opening flange.

(10) Check for uneven surfaces or irregularities in the windshield mounting flange that might cause stress damage to the windshield glass.

(11) On models with vinyl roof, remove the silicone sealer from the weatherstrip and vinyl roof.

(12) Remove the old urethane adhesive from the body flange with a razor knife or electric hot knife tool with a plow-type blade. Do not damage the painted surface of the body during the procedure.

Windshield Installation

(1) Windshield installation should be performed in a warm area to keep the weatherstrip pliable.

(2) When a replacement windshield is being installed, a new rear view mirror bracket must be installed if the replacement windshield is not equipped with one. Refer to the procedure in the XJ Body Components section.

(3) Apply 1-inch wide (25.4 mm) masking tape around the outer portion of the windshield 1/2-inch (12.7 mm) in from the edge of the glass (Fig. 2). Apply the tape to the interior side of the windshield.

(4) Clean the 1/2-inch wide area around the glass with isopropyl alcohol.

(5) Apply blackout primer to the 1/2 inch wide, masked off area around the windshield. Use the applicator supplied in the windshield installation kit to apply the primer.

(6) Allow the blackout primer to dry for at least 10-15 minutes.

CAUTION: Avoid spilling or dripping primer on painted surfaces. Clean spills or drips immediately. The primer will damage the paint if it remains on the surface for any length of time.

(7) Clean the windshield mounting flange surfaces (on the body) with isopropyl alcohol (Fig. 3).

(8) Wipe clean the glass and body flange channels of the new weatherstrip. Then apply rubber primer to the

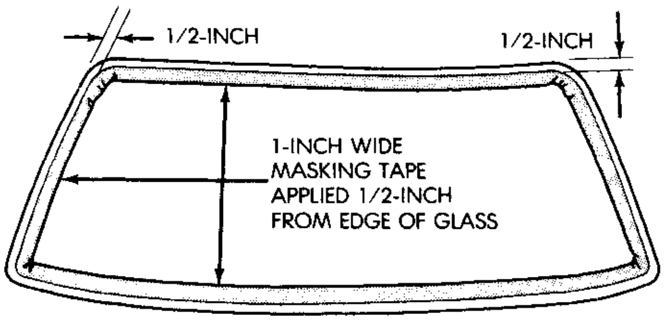


Fig. 2 Masking Off Blackout Primer Area

weatherstrip channels with a dauber. Allow the rubber primer to dry for at least 30 minutes.

(9) Apply 2-inch wide (5.08 cm) masking tape around the windshield opening at the roof, A-pillars and cowl top. The tape is needed to protect the body opening painted surfaces.

(10) Apply paint finish primer to the body flange. Allow this primer to dry for a minimum of 25 minutes. **Do not use glass blackout primer on the body opening flange.**

(11) Apply continuous, 1/8 inch diameter bead of urethane adhesive to the weatherstrip channel that goes on the body flange. **Do not apply adhesive to the weatherstrip channel that goes on the windshield.**

(12) Install the rubber weatherstrip on the mounting flange of the body.

(13) Apply a liberal quantity of a soap and water solution to the edge of the windshield glass.

(14) Insert a 1/8 inch diameter cord in the windshield channel of the weatherstrip. Leave a short length of cord outside the weatherstrip.

(15) Remove the masking tape from the windshield glass.

(16) With the aid of one or two helpers, work the top and sides of the windshield into the weatherstrip.

(17) Position a wood or plastic tool under the windshield bottom. Then lift the windshield up and press it into the lower part of the weatherstrip.

(18) Check windshield fit. Side clearance should be equal.

(19) Clean the soap and water solution from the windshield glass and rubber weatherstrip.

(20) Apply a smooth, continuous bead of urethane adhesive around the entire outside edge of the windshield glass and weatherstrip. The bead should be 1/8 inch (3.18 mm) in diameter.

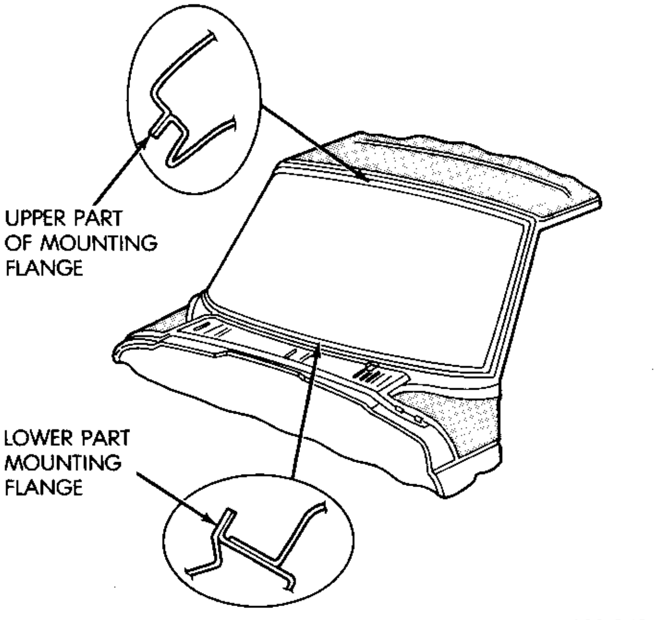


Fig. 3 Windshield Mounting Flanges

(21) Immediately lock the weatherstrip on the windshield with a wood or plastic tool after applying adhesive. Do not delay as urethane adhesive will begin curing within 15 minutes after exposure to air.

(22) Remove the masking tape from the body and apply 3M Super Silicone Sealer, or an equivalent, along the weatherstrip and vinyl roof, if equipped.

(23) Water test the windshield with a cold water spray. Do not direct hard stream of water against the adhesive. If leaks are encountered, apply extra urethane adhesive.

(24) Insert the 1/8 inch diameter cord in the molding channel of the weatherstrip. Leave two lengths of cord outside the molding.

(25) Install the windshield top and bottom moldings one at a time. Place the moulding in the groove. Then starting at the outside corner of the weatherstrip, pull up on the cord while lightly tapping the top of the moulding with a rubber mallet to lock the molding in the weatherstrip. Continue the process until the moldings are seated in the weatherstrip.

(26) Install the center moulding clip to cover the gap between the left and right bottom moldings. Then insert the upper corner moldings retaining groove and secure them with screws.

(27) Clean the excess urethane adhesive from the windshield, body and mouldings with a cloth dampened with Grow Chemical Solvent GS-35, or an equivalent.

(28) Install the side moulding screws.

(29) Install the windshield wiper arms.

(30) Install the inside rear view mirror on the bracket.

HEADLINING

Headlining Removal

(1) Remove the sun visors, escutcheons and center support.

(2) Remove the headlining retainer, end caps, moldings and coat hooks (Figs. 1 and 2).

(3) Remove the overhead console.

(4) On models with sun roof, remove the sun roof switch, trim welt and motor cap.

(5) Spray 3M Release Agent or equivalent across the headlining at the windshield and around the sun roof opening. Allow several minutes for the release agent penetration.

CAUTION: When removing the headlining, use care to avoid separating the foam backing from the fabric. If the fabric begins to separate from the backing, make a second application of the release agent.

(6) Remove the headlining from the roof panel and sun roof opening.

(7) Remove the lens from the dome lamp. Remove the screws attaching the lamp and remove the lamp.

(8) Remove the lens from the cargo lamp. Then remove the screws attaching the lamp to the roof bow and remove the lamp and switch.

(9) Remove the tailgate opening molding and end caps.

(10) Spray 3M Release Agent, or an equivalent, across the headlining at the tailgate opening moulding. Allow several minutes for the release agent penetration.

CAUTION: When removing the headlining, use care to avoid separating the foam backing from the fabric. If the fabric begins to separate from the backing, make a second application of the release agent.

(11) Remove the headlining through the tailgate opening.

Headlining Installation

(1) Install the headlining side moldings/retainers.

(2) Install the headlining in the vehicle through the tailgate opening.

(3) Insert the headlining in the moldings/retainers and slide the headlining in place.

(4) Spray 3M General Trim Adhesive, or equivalent, across at the roof panel at the tailgate opening.

(5) Install the tailgate opening molding and end caps.

(6) Move the headlining up to the coat hook locations.

(7) Connect and install the cargo lamp and lens.

(8) Connect and install the cargo lamp switch.

(9) Spray 3M General Trim Adhesive or equivalent on the sun roof opening flange.

(10) Install the coat hooks.

(11) Pull the headlining forward and attach it to the sun roof opening flange.

(12) Install the sun roof opening trim welt.

(13) Connect and install the dome lamp and lens.

(14) Place a strip of masking tape across the top of the windshield at the roof panel.

(15) Spray 3M General Trim Adhesive or equivalent, on the roof panel along the top of the windshield.

(16) Using the sun visor holes as guides, pull the headlining forward and attach it along the windshield.

(17) Install the headlining along both sides.

(18) Connect and install the sun roof switch.

(19) Install the windshield molding, end caps and motor cap.

(20) Install the overhead console.

(21) Install the sun visors, escutcheons and center support.

(22) Remove the masking tape.

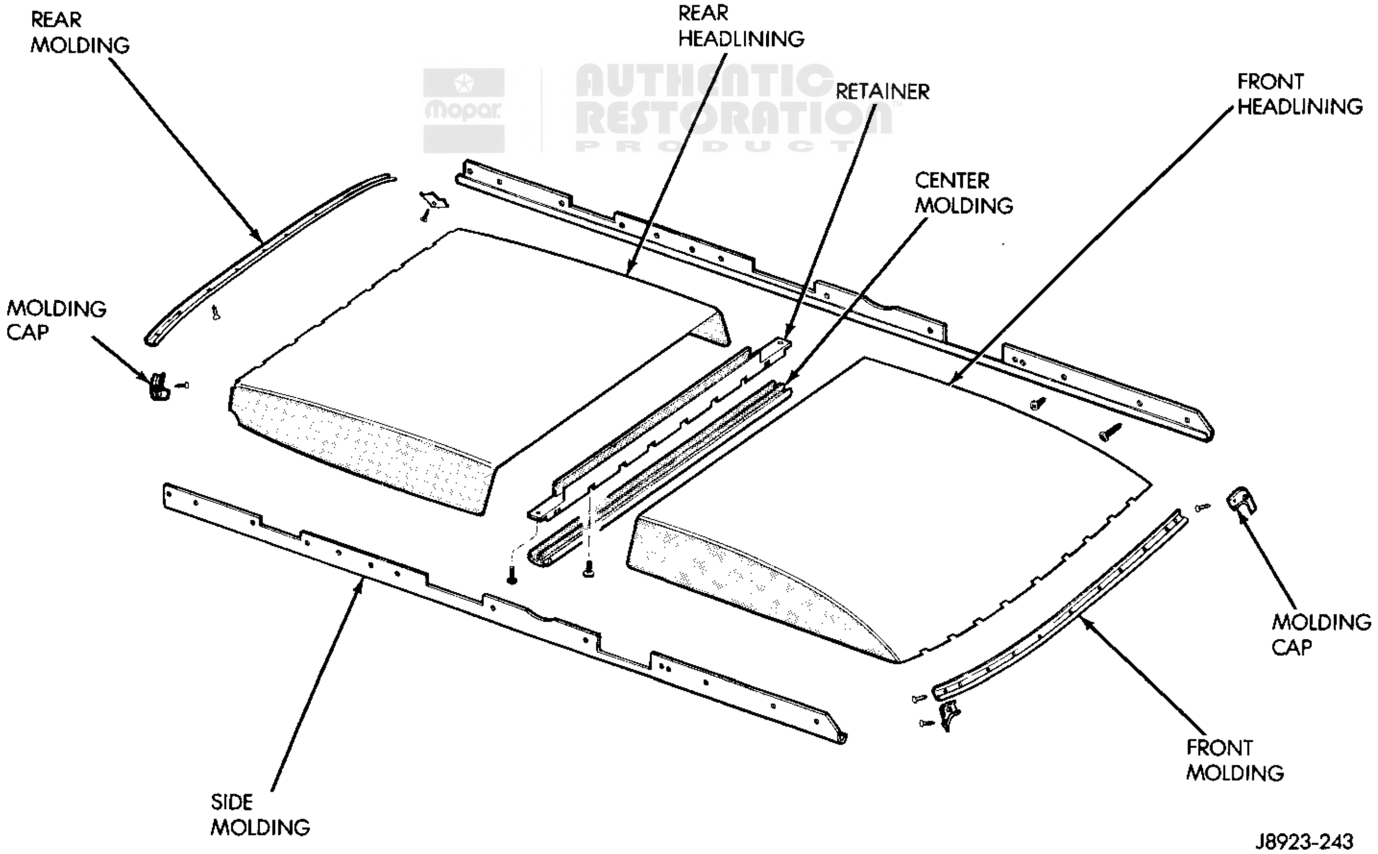


Fig. 1 Headlining-Without Sun Roof

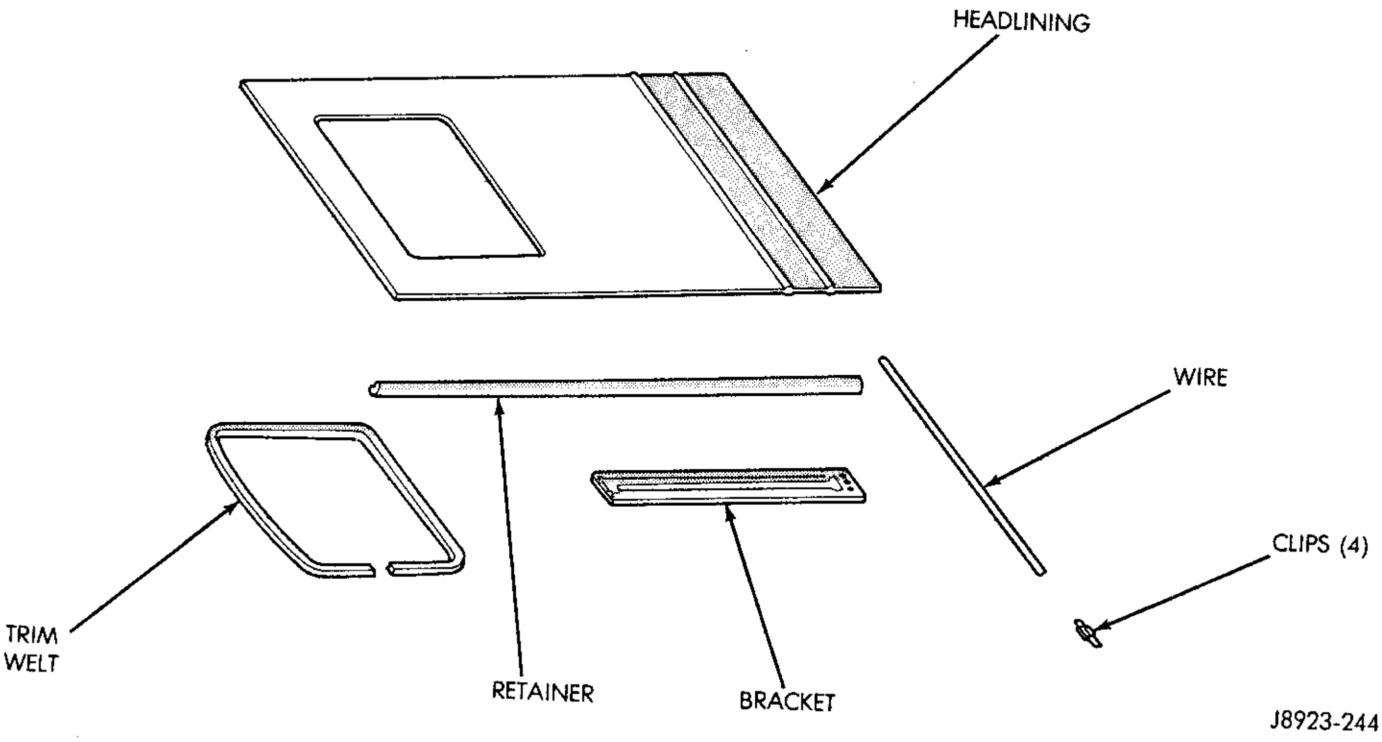
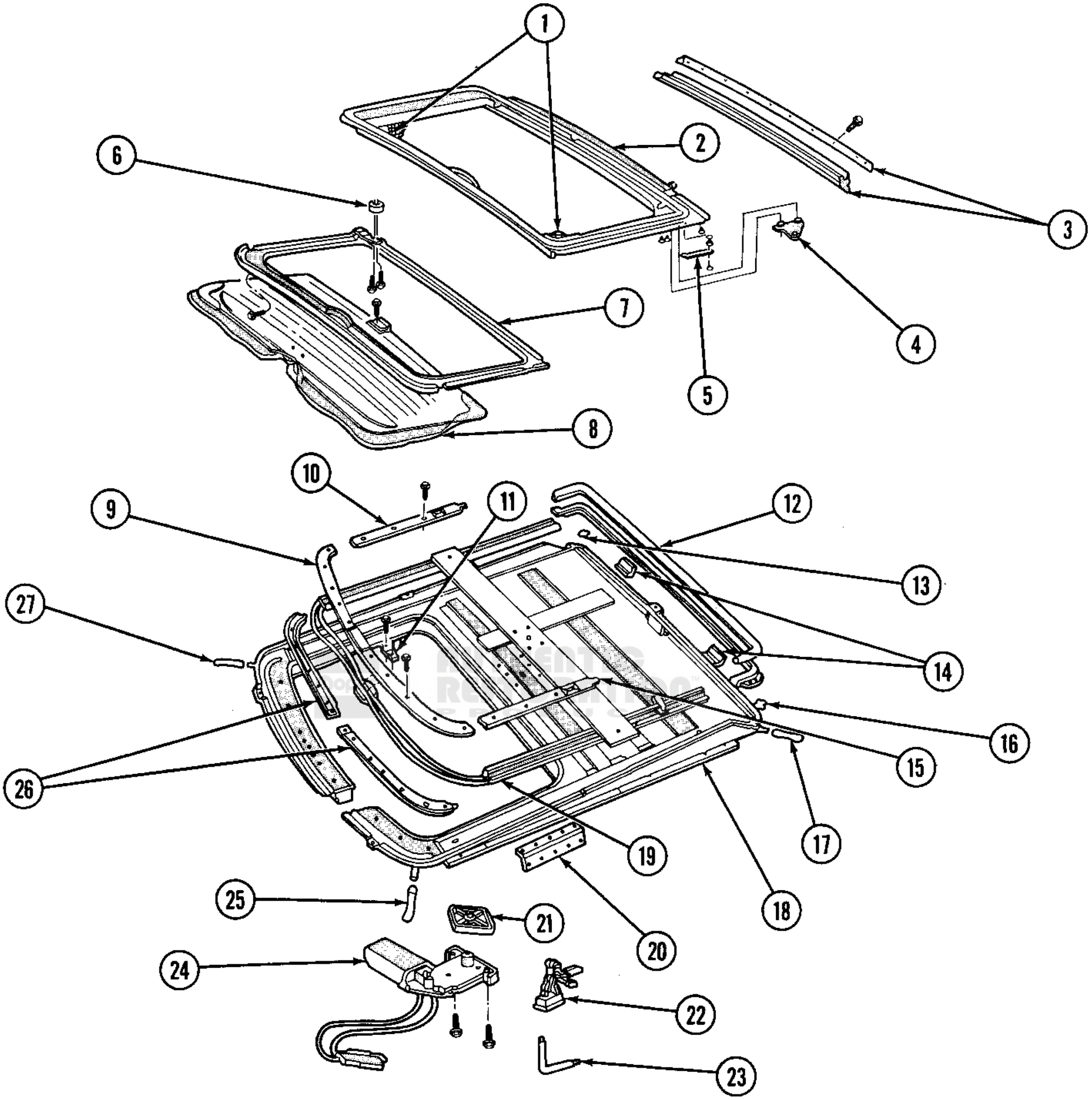


Fig. 2 Headlining-With Sun Roof

SUN ROOF



① Front Guide Shoe
② Glass Panel
③ Glass Panel Seals
④ Rear Guide
⑤ Rear Slide Tension Spring
⑥ Knurled Adjusting Nut
⑦ Halo Assembly
⑧ Sun Screen
⑨ Cable Front Cover
⑩ Side Track Cover
⑪ Drive Gear Plate
⑫ Seal
⑬ Track Retainer
⑭ Bracket
⑮ Side Track Cover
⑯ Track Retainer
⑰ Drain Hose
⑱ Housing Assembly
⑲ Cable and Side Track
⑳ Bracket
㉑ Spacer
㉒ Sun Roof Control Switch
㉓ Auxiliary Crank Tool
㉔ Electric Motor
㉕ Drain Hose
㉖ Front Track
㉗ Drain Hose

J8923-245

Fig. 1 Power Sun Roof Components

Halo Removal

(1) Open the glass panel partially and remove the halo attaching screws (Fig. 2).

(2) Grasp the center of the halo and pull the assembly downward to disengage the front tabs from the track.

(3) Close the glass panel fully, slide the halo assembly forward and out (Fig. 3).

Halo Installation

(1) Close the glass panel and position the rear portion of the halo assembly on the glass panel.

(2) Open the glass panel partially.

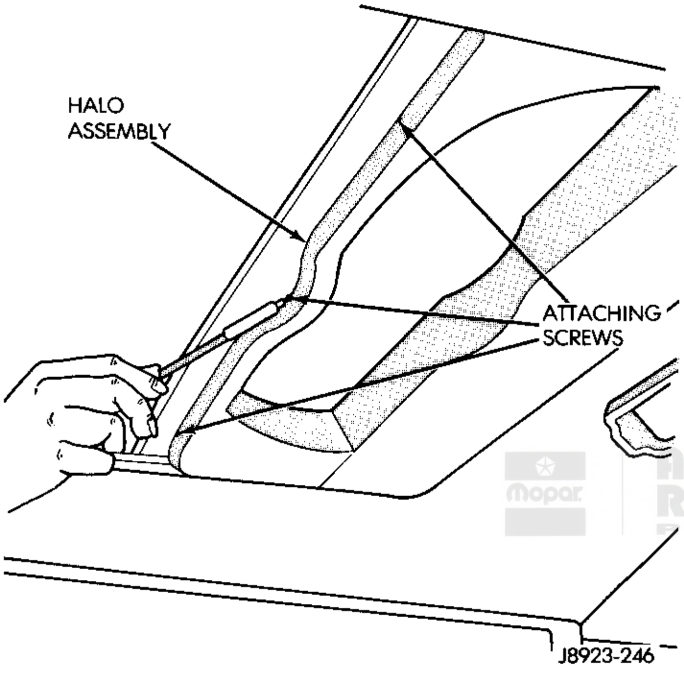


Fig. 2 Halo Attaching Screw Removal/Installation

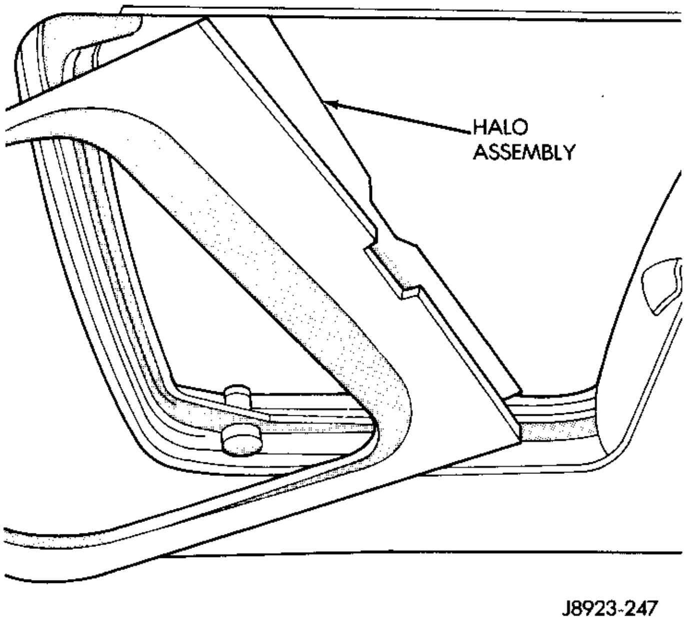


Fig. 3 Halo Removal/Installation

(3) Install the halo assembly attaching screws and close the glass panel.

Glass Panel Removal

(1) Remove the halo assembly.

(2) Close the glass panel and remove the outboard screws from the front guide shoe assemblies.

(3) Loosen the inboard screws and rotate the guide shoes to disengage the slide portion from the track.

(4) Release the rear slide tension springs by rotating them to the inboard position (Fig. 4).

(5) Remove the screws attaching the rear guide shoes and retainers to the tabs in the glass panel and remove the retainers (Fig. 4).

(6) Working from outside the vehicle, raise the front of the glass panel and slide the panel forward and out of the vehicle.

Glass Panel Installation

(1) Position the glass panel in the vehicle.

(2) Install the rear guide shoes and retainer brackets on the glass panel.

(3) Install the guide shoe and retainer bracket attaching screws.

(4) Install the rear slide tension springs. Be sure the spring is positioned under the spring lock roller (Fig. 4).

(5) Engage the slide portion of the front shoe assemblies in the track and install the guide shoe attaching screws.

(6) Install the halo assembly.

Sun Screen Removal

(1) Remove the halo assembly and glass panel.

(2) Open the sunscreen fully.

(3) Working from outside the vehicle, pull the sun-

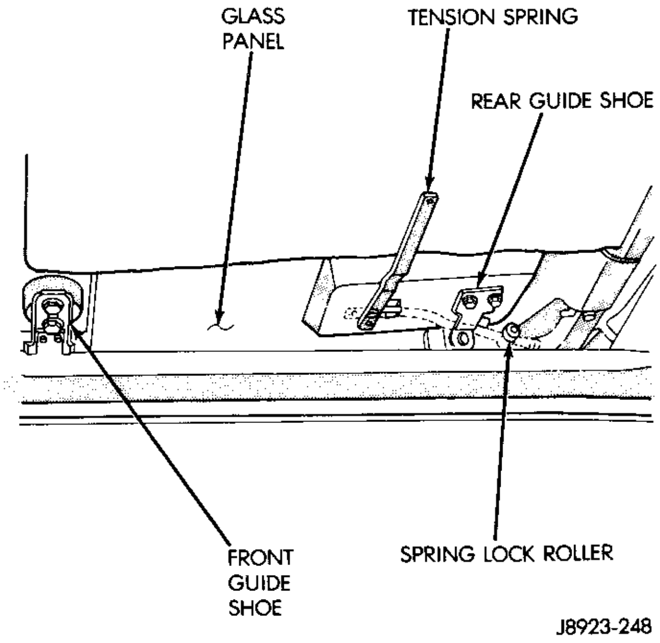


Fig. 4 Glass Panel Removal/Installation

screen upward at the center of the screen and slide the screen forward and upward to remove it (Fig. 5).

Sun Screen Installation

(1) Working from outside the vehicle, curve the sunscreen upward at the center of the screen and slide the screen rearward and downward into the sun roof opening.

(2) Install the glass panel and halo assembly.

Cable And Side Track Removal

(1) Remove the halo assembly, glass panel and sunscreen.

(2) Remove the screws that attach the cable front cover and remove the cover (Fig. 1).

(3) Remove the drive gear plate.

(4) Remove the side track cover screws and remove the side track cover.

(5) Disengage the cable from the front track and motor gear and remove the cable by pulling it upward and outward.

(6) If necessary, reposition the front cable guide so the cable can be removed from the track.

(7) Lift the side track upward and remove the side track.

Cable And Side Track Installation

(1) Position the side track in the sun roof housing. Be sure the track retainer is seated in the hole at the rear of the housing.

(2) Slide the cable assembly into the side track and install the cover on the side track.

(3) Pull the cable until the rear guide shoe contacts the side track cover.

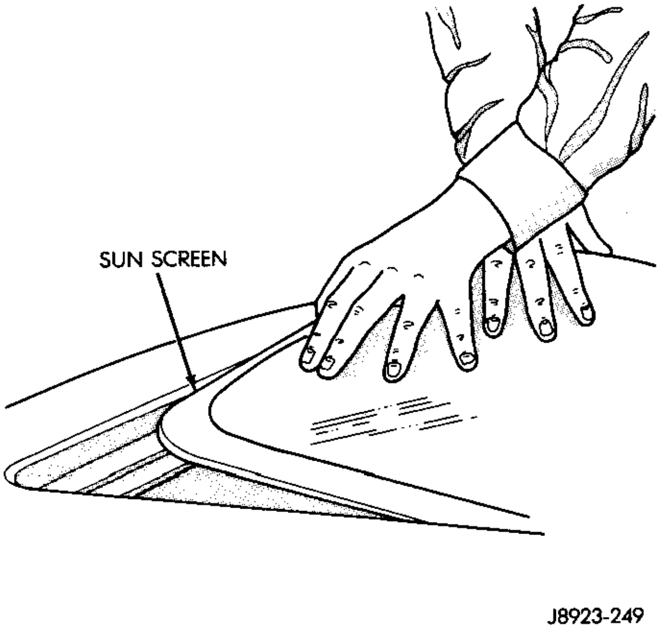


Fig. 5 Sun Screen Removal/Installation

(4) If both cables have been disengaged from the motor gear, be sure both rear guide shoes are in contact with the side track covers before proceeding.

(5) Position the cables in the front track and engage the cables with the teeth of the drive gear.

(6) Install the drive gear plate.

CAUTION: Do not operate the motor at this time as the cables could be damaged.

(7) Install the cable front cover.

(8) Install the sunscreen, glass panel and halo assembly.

Housing Removal

(1) Remove the halo assembly, glass panel and sunscreen.

(2) Remove the headlining.

(3) Disconnect the ground wire at the right A-pillar and move the wire away from the housing assembly.

(4) Disconnect the sun roof switch from the motor harness.

(5) Disconnect the drain tubes from the sun roof housing.

(6) Remove the housing attaching nuts.

(7) Remove the shims, if equipped.

(8) Support the housing and remove the housing attaching hardware from the brackets.

(9) Lower the housing assembly away from the reinforcement ring and remove the housing from the vehicle.

Housing Installation

(1) Position the housing assembly in the vehicle.

(2) Raise and support the housing on the reinforcement ring.

(3) Install the shims, if equipped, and tighten the housing attaching hardware.

(4) Connect the drain tubes to the housing assembly.

(5) Connect the sun roof switch to the motor harness.

(6) Position the ground wire on the housing assembly and connect the wire to the right A-pillar.

(7) Install the headlining. Refer to Headlining Installation.

(8) Install the sunscreen, glass panel and halo assembly. Refer to installation procedures outlined in this section.

Sun Roof Switch Replacement

(1) Pull the switch downward and disconnect the switch wires.

(2) Connect the switch wires and install the switch in the switch opening.

Sun Roof Motor Removal

(1) Open the sun roof glass panel; then disconnect the battery negative cable.

(2) Remove the sun visors, escutcheons, center support, and windshield moulding and end caps.

(3) Remove the sun roof switch and motor cap.

(4) Spray 3M Release Agent, or an equivalent, across the headlining at the windshield. Allow several minutes for release agent penetration.

CAUTION: When removing the headlining, use care to avoid separating the foam backing from the fabric. If the fabric begins to separate from the backing, make a second application of the release agent.

(5) Pull the front edge of the headlining downward.

(6) Remove the motor mounting screws and remove the motor.

Sun Roof Motor Installation

(1) Position the motor in the housing and install the motor mounting screws.

(2) Place a strip of masking tape across the top of the windshield at the roof panel.

(3) Spray 3M General Trim Adhesive, or an equivalent, on the roof panel along the top of the windshield.

(4) Pull the headlining forward and attach it along the windshield. Use the sun visor holes as guides when attaching the headlining.

(5) Connect the wires to the sun roof switch and install the switch and motor cap.

(6) Install the sun visors, escutcheons, windshield trim moulding and end caps, and center support.

(7) Connect the battery negative cable, and check the sun roof operation.

(8) If the motor slips and does not open and close the glass panel, the motor clutch located in the gear portion of the motor may have to be adjusted. Refer to Motor Clutch Adjustment.

Motor Clutch Adjustment

(1) Remove the motor cap to gain access to the adjusting screw. The cap is located in the headlining just above and at the center of the windshield.

(2) Loosen the clutch plate adjusting screw jamnut using a deep socket.

(3) Tighten the adjusting screw with 5.6 N•m (50 in-lbs) torque.

(4) Tighten the jamnut and install the motor cap.

Glass Parallel Alignment

CAUTION: Do not operate the electric motor while the glass panel or cables are removed from the track as cable damage could occur.

(1) Open the glass panel approximately 1/4 to 1/2 inch (6.35 - 12.7 mm).

(2) Determine how much forward edge of the glass panel is out of parallel with the forward edge of the opening in the roof panel and note the variation.

(3) Open the panel approximately 8 inches (20.3 cm) for access to the cable and drive gear mechanism.

(4) Remove the cable front cover and drive gear plate.

(5) Remove one cable from the track.

(6) Move one side of the glass panel slightly fore or aft as required to obtain parallel alignment with the forward edge of the roof panel opening (Fig. 6).

(7) Install the cable in the front track and insert the cable in the drive gear teeth.

(8) Install the drive gear plate and cable front cover.

(9) Position the glass panel approximately 6.35 mm (1/4 in) from the fully closed position.

(10) Check the parallel alignment. Repeat the second through the last steps to obtain the proper alignment if necessary.

Glass Panel Height Adjustment

Adjusting Front of Panel

(1) Remove the halo assembly.

(2) Loosen the front guide shoe attaching screws (Fig. 7).

(3) Turn the knurled nut on each front guide shoe clockwise to lower the glass panel - or - counterclockwise to raise the panel (Fig. 7).

(4) Tighten the front guide shoe attaching screws after adjusting the panel height.

CAUTION: Do not adjust the glass panel too high as it could be damaged when the panel is opened or closed.

(5) Check the glass panel alignment and operation in open and closed positions. Repeat the second through the fourth steps to obtain proper height if necessary.

(6) Install the halo assembly.

Adjusting Rear of Panel

(1) Remove the halo assembly.

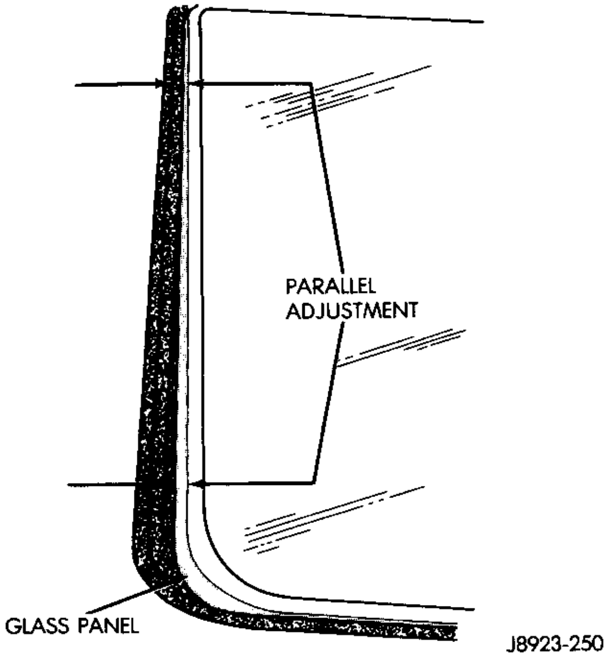


Fig. 6 Glass Parallel Adjustment

(2) Release the rear slide tension spring and rotate the spring to the inboard position.

(3) Loosen the rear guide adjuster screw and raise or lower the panel as required to obtain the desired adjustment (Fig. 8).

(4) Tighten the rear guide adjuster nut after completing adjustment.

(5) Install the halo assembly.

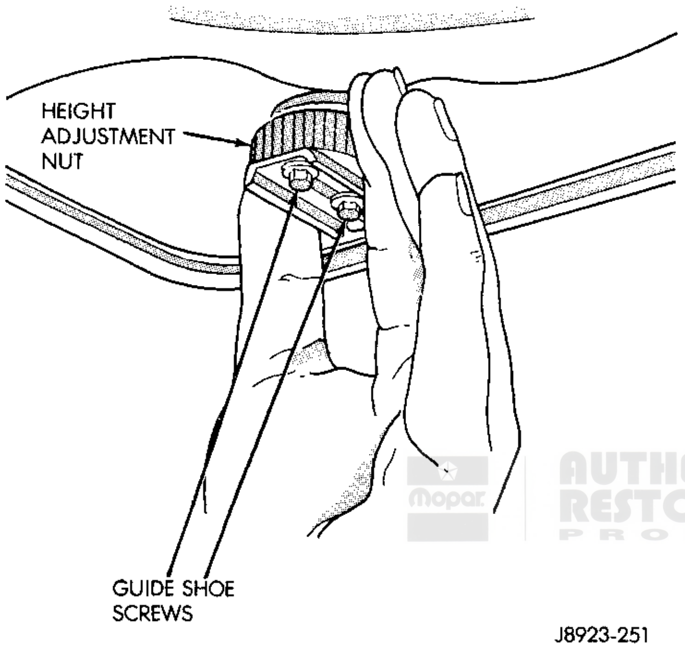


Fig. 7 Glass Panel Front Height Adjustment

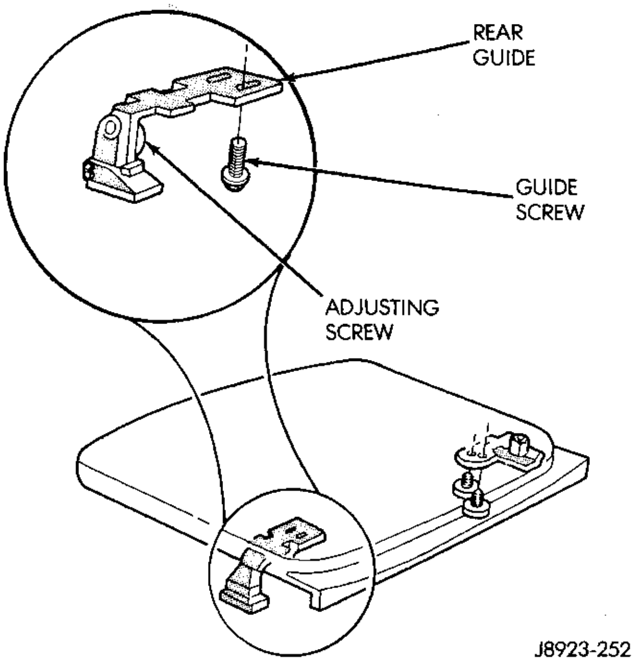


Fig. 8 Glass Panel Rear Height Adjustment

Manual Operation Of Glass Panel

If an electrical malfunction occurs, the glass panel can be opened or closed manually as follows:

(1) Remove the small round motor cap located in the center of the windshield header near the front edge of the sun roof opening. Cap removal will provide access to the motor driveshaft.

(2) Remove the screw in the driveshaft with a screwdriver or sun roof cranking tool.

(3) Rotate the motor driveshaft clockwise to close the glass panel, or counterclockwise to open the panel.

(4) Install the screw in the driveshaft and install the access plug in the windshield header after opening/closing the glass panel.

VINYL TOP

Vinyl Top Removal

(1) Remove the moulding clips and remove the moldings around the vinyl roof.

(2) Remove all sealing material around the openings to expose the vinyl top edges.

(3) Mask the cowl top, sides and rear of the vehicle, and the windows with paper. Insert the paper in the windows, then close the windows to hold the paper in place.

(4) Remove the luggage rack.

(5) Loosen the vinyl material at the front pillars and along the windshield header.

(6) It may be easier to remove the vinyl material and padding simultaneously.

(7) Remove the material and sealer from the drip rail. Pry the sealer loose using a screwdriver or other suitable tool if necessary.

(8) If the vinyl material and padding is difficult to remove, soak the adhesive next to the fabric using a rag dampened with 3M General Purpose Adhesive Cleaner or an equivalent.

(9) It is not necessary to remove the old vinyl top adhesive. However, it is important that the roof surface be smooth and free of irregularities to prevent highlighting after a new cover is installed.

(10) Remove the vinyl material from the foam padding using 3M General Purpose Adhesive Cleaner, or equivalent.

WARNING: Always use rubber gloves when working with solvents and be sure the work area is well ventilated.

Vinyl Top Installation

(1) Remove all dust and foreign material from the roof panel.

(2) Position the padding on the roof panel and cut away the foam padding at the sun roof opening and luggage rack attaching screw holes.

(3) Remove the paper backing from the foam padding to expose the padding adhesive and bond the padding to the roof panel. Use a roller or soft cloth to ensure positive bond.

(4) Be sure the foam padding is smooth and free from any irregularities to prevent highlighting after a new cover is installed.

(5) Mark the centerline of the roof panel above the windshield and rear window openings.

(6) Align the center of the vinyl cover with the centerline mark above the windshield and rear window.

(7) Secure the cover to the pinch weld flange at the centerline locations with tape.

(8) Check the cover for alignment at both sides and at the roof extension panels.

(9) Fold the cover in half at the centerline.

(10) Apply a smooth, even coat of 3M Vinyl Trim Adhesive, or an equivalent, to a 38.1 cm (15 inch) wide strip of one side of the foam padding and to the vinyl cover. Start at the center when applying the adhesive and work from the front to the rear.

(11) Allow the adhesive applied to the vinyl material and foam padding to dry until tacky.

(12) Bond the cover to the foam padding using a roller or soft cloth to ensure a positive bond and to eliminate air pockets. Bond the cover by starting at the centerline and working toward the side.

(13) To prevent wrinkles caused by folding, keep the cover fabric taut while installing it.

(14) Apply the adhesive to the remainder of the cover and foam padding and in the drip moulding at the side of the cover being installed. Allow the adhesive to dry until tacky.

(15) Apply a smooth, even coat of adhesive to a 38.1-cm (15-in) wide strip of foam padding and to the vinyl cover on the opposite side of the vehicle. Start at the center and work from the front to the rear when applying the adhesive. Allow the adhesive to dry until tacky.

(16) When applying the cover to the foam padding, always work from the center to the outside to eliminate air pockets to ensure positive bonding.

(17) Brush the adhesive onto the cover, the ledge of the windshield, and the rear window opening. Allow the adhesive to dry until tacky before bonding.

(18) Work the vinyl cover into the crease line areas around the roof using a smooth fiber stick.

(19) Trim the excess cover material from around the drip rails, windshield and rear window.

(20) Trim the vinyl material around the sun roof opening and luggage rack attaching screw holes.

(21) Brush the adhesive onto the cover and ledge of the sun roof opening. Allow the adhesive to dry until tacky before bonding.

(22) Position and work the vinyl cover into the sun roof opening using a smooth fiber stick.

(23) Install the luggage rack.

(24) Apply a bead of 3M Super Silicone Sealer (black preferred), or an equivalent, along the top of the windshield rubber weatherstrip and vinyl cover. Apply sealer to the drip rails also.

(25) Remove the excess sealer using 3M General Purpose Adhesive Cleaner, or equivalent, and remove all masking tape and paper.

(26) Install the moldings and clips.

Vinyl Top Repair

Repairing Bulges or Blisters

Bulges or blisters in the top indicate poor bonding or trapped air. Eliminate bulges/blisters as follows:

(1) Pierce the bulge or blister with a pin and flatten it to expel trapped air.

(2) Inject adhesive into the bulge with a syringe.

(3) Heat the bulge with a heat gun.

(4) Immediately press and hold the vinyl material flat against the padding and roof with felt pad or roller until the vinyl cools. Do not rub the vinyl. Rubbing will result in a polished area.

Wrinkles

Minor wrinkles in the vinyl top material may be removed with the application of moist heat as follows.

(1) Wash the vinyl top surface thoroughly with Mopar Vinyl Cleaner, or an equivalent.

(2) Set the heat control of a household-type flat iron to warm.

(3) Dampen a clean cloth with clean water and position it over the wrinkled area.

(4) With the iron at the proper operating temperature, move the iron continuously over the dampened cloth until the wrinkle is removed.

(5) Maintain pressure on the vinyl top material until the material cools.

CAUTION: Apply pressure to the vinyl top material only. Do not rub the vinyl top repair area as this could impair the finish of the vinyl.

SEATS

Front Seat Removal/Installation

(1) Remove the screws attaching the seat frame the floorpan.

(2) Disconnect the seat switch wires.

(3) Remove the seat assembly from the vehicle.

(4) Position the seat assembly in the vehicle.

(5) Install the screws attaching the seat frame to the floorpan.

(6) Connect the seat switch wires.

Rear Seat

The full width rear seat is attached to the floorpan by hinges allowing the seat to be folded forward or removed to provide an enlarged rear cargo area.

A latch on each side of the rear seat back engages a striker bolted into cage nuts on the rear wheelhouse panels (Fig. 1). The cage nuts allow movement for striker adjustment.

To tilt the seat back forward, release the latches on the right and left side by raising the latch lever and simultaneously pulling the seat back forward.

A rear seat holding strap attached to the right door pillar, secures the seat when folded down. The strap should always be connected to the mounting stud whenever the seat is in the folded position.

Rear Seat Removal

(1) Release the latch at the lower right side of the seat back. Raise the complete seat assembly forward.

(2) Lift the complete seat assembly from the two floor mounting hinges (Fig. 2).

(3) Remove the seat assembly from the vehicle.

Rear Seat Installation

(1) Install the seat assembly onto the hinges.

(2) Position the seat back in the proper location.

(3) Secure the seat back latch.

Rear Seat Adjustment

(1) Tilt the seat back forward and loosen the striker bolt (Fig. 1).

(2) Raise the seat back to the upright position and tap the striker into position for maximum latch/striker engagement.

(3) Unlatch the seat back carefully so as not to change the striker position and tighten the striker securely.

(4) Check striker and latch operation.

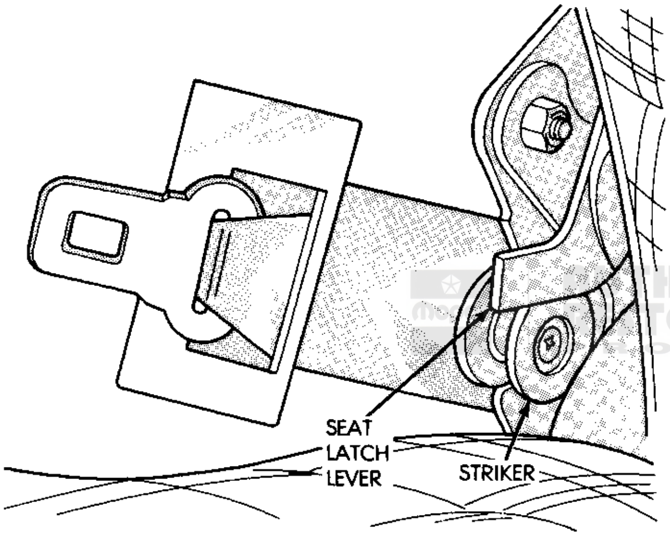


Fig. 1 Rear Seat Latch And Striker

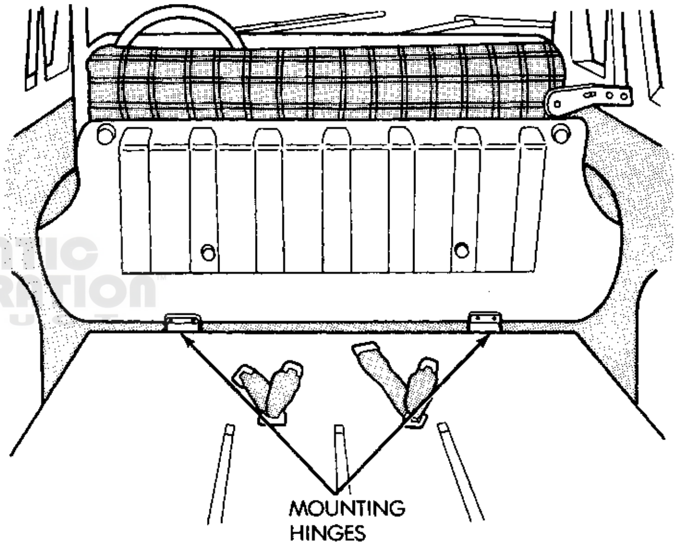


Fig. 2 Rear Seat Hinges

SEAT BELTS

The front and rear seat belts are attached to the pillars and floorpan with Torx-type anchor bolts (Fig. 1). The upper anchor bolts for the shoulder belts are covered with trim caps and/or bezels which must be removed for access to the bolts.

The bottom anchor bolts for the shoulder belts are attached to the sills. On some models it may be necessary to remove the sill trim for access to the bolts.

The rear seat belt anchor bolts are more accessible once the seat is folded forward.

Always inspect the seat belt material during service operations. Replace any belt that has frayed, cut, torn, or ripped material.

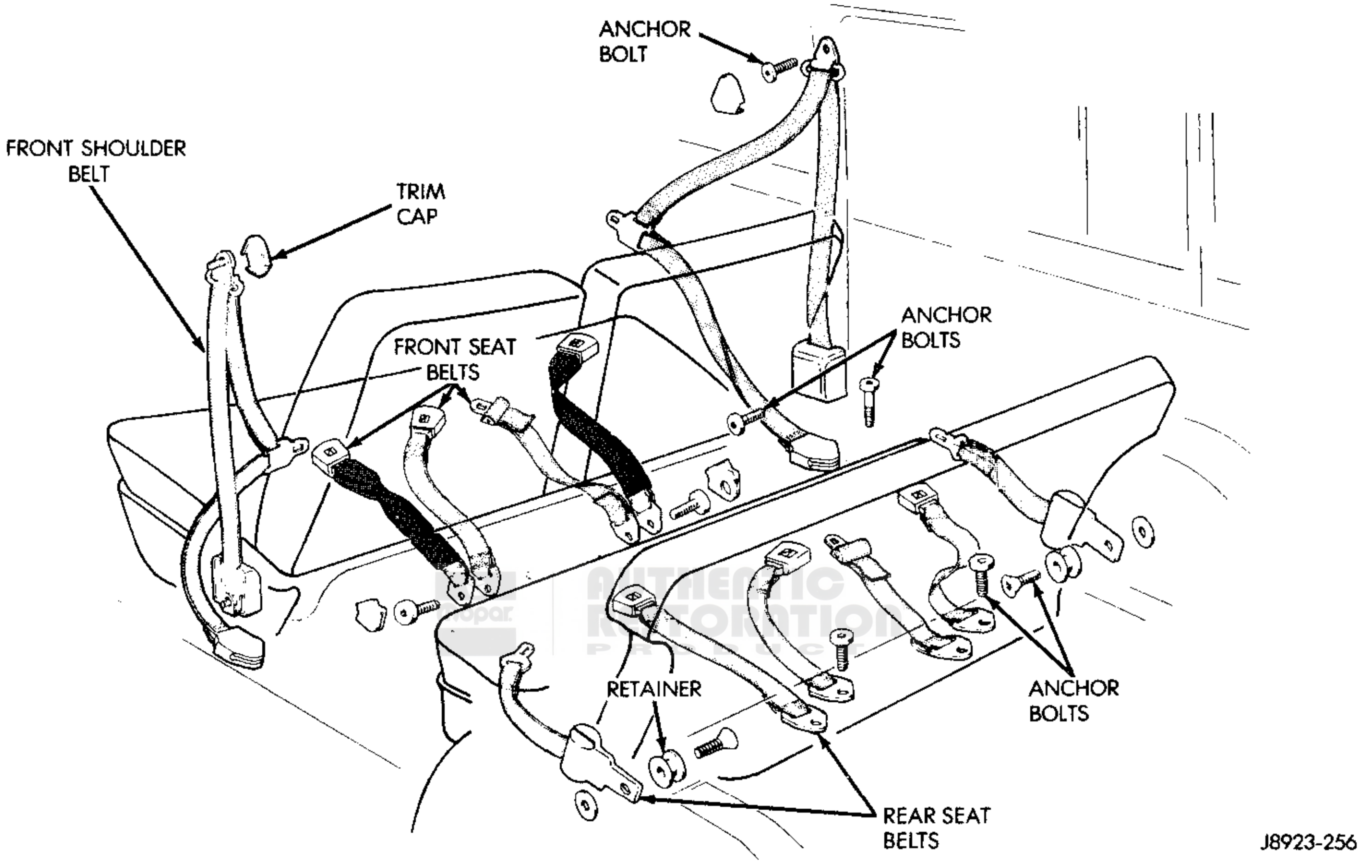


Fig. 1 Seat And Shoulder Belts

CARPETING

The carpeting is in four sections which are: front, rear cargo area and tailgate carpet (Fig. 1).

Trim covers are used on the wheel house panels and between the front and rear floor carpet (Fig. 1).

The carpet and trim pieces are secured with trim screws, push screws, tape and by some interior trim panels.

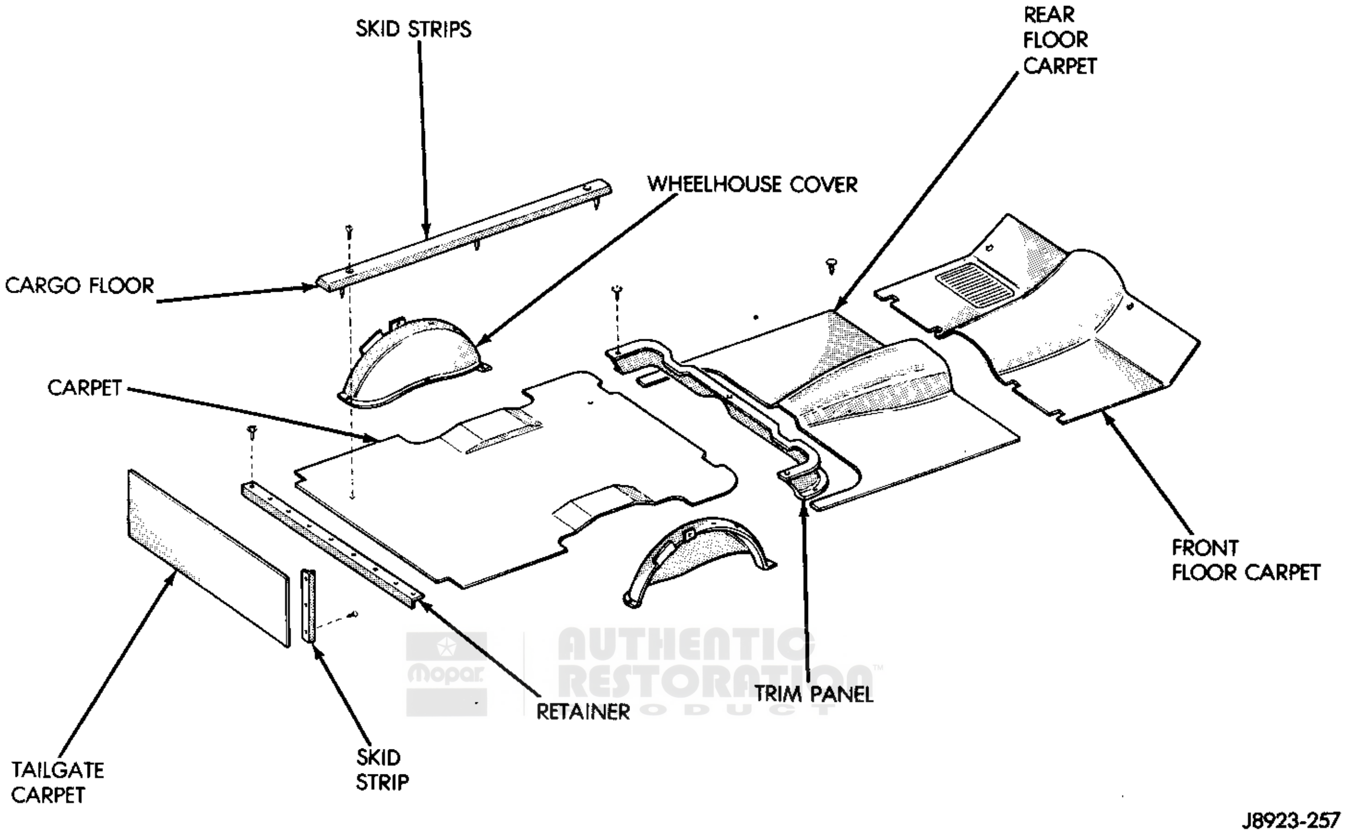


Fig. 1 Carpeting

REFINISHING PROCEDURES

INDEX

BASE COAT/CLEAR COAT FINISH

Base/clear finishes should be applied in an exceptionally clean environment to eliminate dirt, dust, foreign material. Top loader guns are preferable for applying base/clear paints.

Base/clear application is a two-stage process. The high solids base coat is applied over the final primer coat which is usually an expoxy base primer. The clear coat is then applied over the base coat. The clear coat gives the paint finish its high gloss and durability.

The work area should be well ventilated for application of base/clear paints; Especially when applying the clear coat.

TECHNICAL TERMS

Single Coat

A single coat is a spray pattern applied from left to right. The returning right to left pattern is applied so it covers 1/2 the previous pattern. This process is repeated until complete coverage is achieved.

Double Coat

A double coat is a spray pattern applied from left to right then back again over the same area. A panel is covered by overlapping each double coat by at least 1/2 the pattern.

Drying

Drying or hardening of the paint film goes through several stages.

The first stage is called dust-free. At this stage, the paint has hardened sufficiently to prevent dust from becoming embedded in the paint film.

The second stage is called tack-free. At this point, the paint film can actually be touched with light finger pressure.

The third and final stage is referred to as hard-dry. At this point, the paint film is hard enough to polish, rub, or buff.

Degrease-Dewax

Degreasing-dewaxing involves cleaning the surface with Prep-sol, Acrysol, 3M All purpose cleaner, Ditzler cleaner solvent or similar products. This step removes the surface grease, wax, dirt and especially the silicones that create refinish problems.

Featheredgeing

Tapering and blending the edges of repair spots with the surrounding substrate is called featheredging. The idea is to prevent break lines from showing. Generally, the process involves sanding the defect or repair area with wet paper and a sanding block.

Ferrous And Non Ferrous Metals

Ferrous metals are those made of iron or steel. Non ferrous metals include aluminum, brass, copper and magnesium.

Flash Time

This is the time required for most of the solvent to escape from an applied paint coat.

Mist Coat

Mist coats are frequently used as the final color coat. Mist coats are overthinned and sprayed wet.

Primer Coats

Primer coats are applied over the repaired or bare substrate. They serve as a bond between the metal and the color coat and provide the proper surface for the color coat. Various ytpes of primer surfacers and primer sealers are available. Primers are also supplied in sandable or non sandable form.

Glazing or spot putty is applied to primer covered surfaces. The putty is used to fill the small inperfections that a normal primer is not designed to cover.

Reducers/Thinners

Enamel reducers and lacquer thinners are mixtures of volatile liquids used to reduce primers and color coat paints. Reducers and thinners are used to convert the primers/top coats to the proper consistency for application. Use only the type of reducer or thinner specified by the paint manufacturer; Do not intermix them.

Tack Rag

Tack rags are used to wipe dust off the surface prior to paint application. The rags are made of cheesecloth that is impregnated with varnish which creates the tacky surface. Dust particles will adhere to the sticky surface of the rag when it is wiped over the surface.

PAINT REPAIR OF GALVANIZED METALS

Many body panels such as fascia, cowl and rocker panels are made of galvanized metal. Proper surface preparation of galvanized panels is important in regard to rust protection and the finish coat.

Repaired areas on galvanized panels should be sanded, cleaned and recoated with Galva Prep or a similar product to restore the protective coating. In some cases, an additional conversion or adhesion promoter coating may be required to ensure primer/top coat adhesion.

Use only those primers recommended for use on galvanized panels. Consult the paint suppliers product and application instructions if unsure. Do not apply top coats directly over galvanized material

BUFFING AND POLISHING

Minor paint imperfections in the color coat can frequently be removed by light sanding, buffing and polishing.

Wet sand the imperfection with 600 grit paper soaked in mineral spirits. Then clean the sanded area and wipe down with a tag rag to remove any remaining residue.

Buff the area with a fine grade buffing compound. Finish the repair with a quality polishing compound to blend in and restore gloss.

SURFACE PREPARATION

Proper surface preparation is the key to a quality refinishing job. Bare metal must be clean, degreased/dewaxed and treated with phosphate and/or conversion coatings as needed.

The primer used is dependent on the condition of the surface. Bare metal should be primed with an expoxy base or zinc rich primer surfacer. In some cases, a primer sealer will also be necessary to ensure top coat adhesion and flow out. A sealer is recommended when applying a new color coat over an existing color coat. Sealers are also important in preventing bleed through of some colors. An adhesion promotor should also be used if the new top coat is a different type of paint (e.g. lacquer over enamel). When surface build is required, use a high solids, high blend primer.

Always clean the surface with a wax and grease remover and tack rag the surface before applying paint. Thorough cleaning will also remove any silicone on the surface.

Use glazing/spot putties that are compatible with the primer. Putties from the major suppliers are recommended. Synthetic body fillers should also be a quality product. Here again, fillers from major suppliers are recommended. Some low cost fillers can shrink, absorb moisture, or even lose adhesion ruining an otherwise solid refinish job.

COLOR COATING

Color coats should be reduced/thinned and applied according to the manufacturers recommendations. Most paint manufacturers also provide basic application information related to gun pressure, gun type and spray pattern (single/double coat, etc.). These recommendations should be followed for best results.

Do not assume that similar products from different manufacturers are applied alike. Frequently, these similar products require different techniques and methods of application. Check the suppliers instructions beforehand to be sure.

FLEXIBLE COMPONENTS

Flexible components are prepared and painted in the same manner as metal components with one exception: a special flexible component additive must be added to the paint before application. The additive is available from most of the major suppliers under various brand names. The additive prevents actually makes the paint film slightly elastic in nature. This allows the paint film to bend and flex along with the component without cracking and flaking off.

PLASTIC COMPONENTS

Plastic components are supplied from three different plastic compounds. The three compounds are: ABS (acrylo-nitrile, butadiene, styrene); polypropylene and vinyl. Minor cracks in all three can be repaired with 3M 8101 structural adhesive or equivalent.

The three compounds can be identified with a flame test (Fig. 1). To perform the test, first cut a small sample of the material from a non visible portion of the plastic component. Then apply an open flame to the sample and observe the smoke or flame color.

ABS and polypropylene only require an open flame for testing. However, vinyl must be burned in the presence of copper.

To test vinyl, heat a length of solid copper wire red hot. Immediately apply the hot wire to the plastic sample until some of the material sticks to the copper. Then expose the copper wire and sample to an open flame (Fig. 1).

- ABS material will produce black smoke when burned.
- Polypropylene will produce little or no smoke at all.
- Vinyl will produce a blue green flame when burned in the presence of copper.

SAFETY MEASURES

Repeated exposure to solvents in refinishing materials can severely irritate the eyes, skin and lungs if protective gear is not used.

Perform painting operations in a well ventilated area. Wear a good quality, high capacity respirator and wear protective goggles and clothing. Use rubber or latex gloves when mixing paint products.

For maximum protection from paint solvent vapors, use a fresh air-type, compressor powered respirator.

Do not allow any type of open flame or other source of combustion in the painting area. Paint vapors can be quite flammable when vapors are concentrated. Keep paint containers in a protective cabinet or locker. And keep the paint storage area well ventilated.

EXTERIOR COLORS

Exterior colors are identified on the body I.D. plate located on either the door pillar, dash panel or fender panel. The color code location is described in Group 1.

O.E.M. paint colors are generally available from all of the major paint manufacturers. They are supplied in the form of mixing formulas or factory package (pre-mixed) paint.

Exterior colors and Eagle/Jeep paint codes are outlined in the following chart.

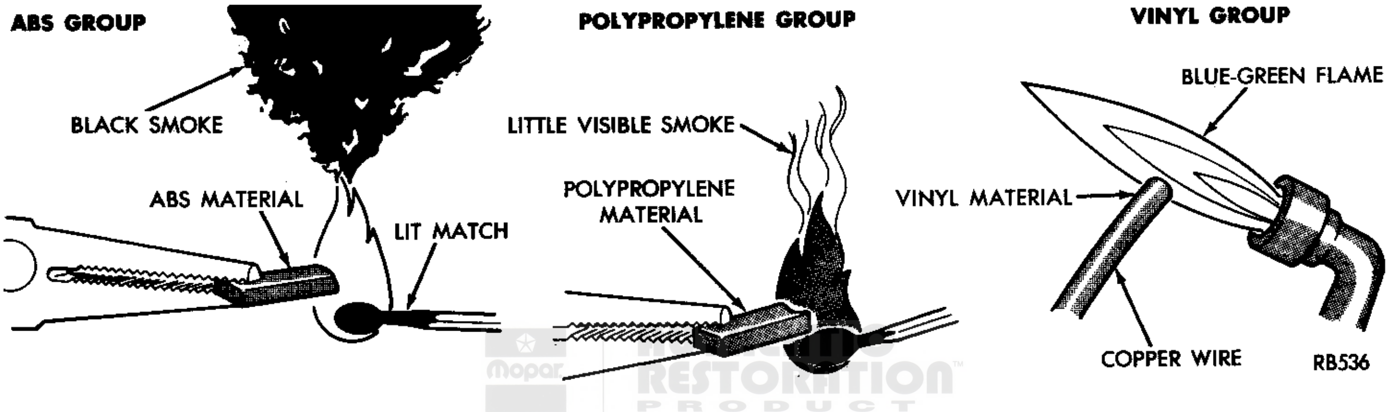


Fig. 1 Flame Test To Identify Plastic Materials

Paint Codes

Jeep Code	Paint Color	Vehicle Model
GW7	Bright White Clear-Coat	MJ/XJ/SJ
HB3	Spinnaker Blue Metallic Clear-Coat	
FM9	Black Cherry Pearl-Coat	
HA2	Sterling Silver Metallic Clear-Coat	
HQ9	Dark Baltic Metallic Clear-Coat	
HB8	Midnight Blue Metallic Clear-Coat	
HY3	Sand Metallic Clear-Coat	
HE4	Colorado Red	
DX8	Black Clear-Coat	
HS3	Dover Gray Metallic Clear-Coat	
GW6	Bright White	YJ
TX9	Black	
HJ4	Malibu Yellow	
TR4	Graphic Red	
HY5	Sand	
AC8	Navy Blue Metallic	
HJ5	Khaki Metallic	
AA9	Charcoal Gray Metallic	
HQ3	Pacific Blue	

J9023-21

Torque Specifications—SJ Models

Component	Service Set-To Torque	Service Recheck Torque
Body Holddown #1, #3, #4, #5	49 N•m (36 ft-lbs)	37-61 N•m (27-45 ft-lbs)
Holddown #1 & #2	49 N•m (36 ft-lbs)	37-61 N•m (27-45 ft-lbs)
Radiator Guard Holddown	49 N•m (36 ft-lbs)	37-61 N•m (27-45 ft-lbs)
Body Holddown #1, #3, #4	76 N•m (55 ft-lbs)	65-84 N•m (48-62 ft-lbs)
Body Holddown #2	49 N•m (36 ft-lbs)	37-61 N•m (27-45 ft-lbs)
Roof Bow Assy-to-Roof Side Inner Rail	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Front End Assy-to-Dash	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Hood Lock Lower Assy-to-Radiator Support Assy	76 N•m (55 ft-lbs)	65-84 N•m (48-62 ft-lbs)
Hood Hinge Assy-to-Splash Pan Support	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Hood Hinge Assy-to-Rr Reinforcement Assy	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Hood Hinge Assy-to-Front Plenum Reinforcement	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Hood Lock Upper Assy-to-Hood Panel Assy	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Tailgate Window Regulator Assy-to Tailgate Assy	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Tailgate Hinge Assy & Torque Rod-to-Tailgate Assy	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Tailgate Hinge Assy-to-Tailgate Hinge Reinforcement	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Windshield Wiper Pivot Body Assy-to-Cowl Top Inner Panel	3 N•m (30 in-lbs)	3-4 N•m (24-36 in-lbs)
Windshield Wiper Motor-to-Dash Panel	3 N•m (30 in-lbs)	3-4 N•m (24-36 in-lbs)
Outside Rearview Mirror Attachment	2 N•m (18 in-lbs)	1-3 N•m (12-24 in-lbs)
Instrument Panel Assy-to-Cowl Top Inner Panel Cowl Side Inner & Pillar	8 N•m (72 in-lbs)	5-11 N•m (48-96in-lbs)
Frt Door Glass Frame Assy-to-Frt Door Inner Panel	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)

J8923-259

Torque Specifications—SJ Models

Component	Service Set-To Torque	Service Recheck Torque
Frt Door Upper & Lower Assy-to-Frt Body Hinge Pillar Assy & Frt Door Assy	33 N•m (24 ft-lbs)	24-41 N•m (18-30 in-lbs)
Outside Rearview Mirror-to-Door Panel	2 N•m (18 in-lbs)	1-3 N•m (12-24 in-lbs)
Outside Rearview Assy-to-Frt Door Welded Assy	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Door Striker Plate Assy-to-Body Side Pillar & Body Rr Lower Pillar	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Door Striker Plate Assy-to-Body Side Pillar	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Rear Seat Holddown Latch Spool-to-Inner Wheelhouse Panel Assy	53 N•m (39 ft-lbs)	43-62 N•m (32-46 in-lbs)
Rr Side Door Window Frame - Frt Rr Face	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Rr Side Door Upr & Lwr Hinge Assy-to-Rr Side Door Inr Pnl	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Rr Side Door Upr & Lwr Hinge Assy-to-Body Cntr Pllr Assy & Rr Side Door Inr Pnl	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Seat Track Support Bracket-to-Floor (Full Frt Seat)	33 N•m (24 ft-lbs)	24-41 N•m (18-30 ft-lbs)
Hinge Bracket-to-Front of Rear Riser (Rr Seat)	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Shoulder Bolt Outer-to-Inner Hnge Half (Rr Seat)	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Seat Back Latch Hook Guide-to-Rt Rr Seat Latch Inner Half Rr Seat	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Seat Support-to-Floor (Bucket Type)	33 N•m (24 ft-lbs)	24-41 N•m (18-30 ft-lbs)
Seat Track-to-Support Bracket (Full & Bucket Frt Seat)	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Seat-to-Seat Adjuster Assy (Full & Bucket Frt Seat)	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Seat Belt Retractor Assy-to-Pillar	53 N•m (39 ft-lbs)	43-62 N•m (32-46 ft-lbs)

J8923-260

Torque Specifications—SJ Models

Component	Service Set-To Torque	Service Recheck Torque
Seat Supports-to-Floor (Bucket)	33 N•m (24 ft-lbs)	24-41 N•m (18-30 ft-lbs)
Support-to-Track Assy (Bucket)	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Seat-to-Adjuster (Bucket)	15 N•m (11 ft-lbs)	11-20 N•m (8-15 ft-lbs)
Shoulder Bolt Assy-to-Roof Rail	53 N•m (39 ft-lbs)	43-62 N•m (32-46 ft-lbs)
Headlamp Assy Attachment	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Tail, Stop & Marker Lamp Assy-to-Body (Hex Nut)	3 N•m (30 in-lbs)	3-4 N•m (24-36 in-lbs)
Tail, Stop & Back-Up Lamp Assy-to-Body (Hex Nut)	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Marker & Reflector Lamp Assy Attachment	2 N•m (18 in-lbs)	1-3 N•m (12-24 in-lbs)
Rr License Lamp Assy-to-Housing	1 N•m (72 in-lbs)	.05-1 N•m (6-12 in-lbs)
Upper Forward & Lower Forward Tail, Stop & Marker Lamp Assy Attachment-to-Body	3 N•m (30 in-lbs)	3-4 N•m (24-36 in-lbs)
Tail & Stop Lamp Assy-to-Tail Stop Bracket Assy (Hex Nut)	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
License Lamp Assy-to-Rr License Plate Bracket	3 N•m (30 in-lbs)	3-4 N•m (24-36 in-lbs)
Back-Up Lamp Assy-to-Tail Stop Bracket Assy (Hex Nut)	3 N•m (30 in-lbs)	3-4 N•m (24-36 in-lbs)
Rr License Plate Bracket-to-Rr Crossmember	8 N•m (72 in-lbs)	5-11 N•m (48-96 in-lbs)
Tail, Stop & Back-up Lamp Bracket Assy-to-Frame	15 N•m (11 in-lbs)	11-20 N•m (8-15 ft-lbs)
Parking & Turn Signal Lamp Assy Attachment (Hex Nut)	3 N•m (30 in-lbs)	3-4 N•m (24-36 in-lbs)
Marker & Reflector	2 N•m (18 in-lbs)	1-3 N•m (12-24 in-lbs)
Lamp Assy Attachment (Amber)	2 N•m (18 in-lbs)	1-3 N•m (12-24 in-lbs)
Dome/Reading Lamp-to-Roof Bow	2 N•m (18 in-lbs)	1-3 N•m (12-24 in-lbs)

J8923-261

Torque Specifications—XJ/MJ Models

Component	Service Set-To Torque	Service Recheck Torque
Hood Hinge-to-Hood Screws	31 N•m (23 ft-lbs)	24-37 N•m (18-27 ft-lbs)
Hood Hinge-to-Cowl Nuts	31 N•m (23 ft-lbs)	24-37 N•m (18-27 ft-lbs)
Hood Lock Assembly Attaching Screws	16 N•m (138 in-lbs)	14-27 N•m (125-235 in-lbs)
Hood Lock Striker-to-Hood Screws	16 N•m (138 in-lbs)	14-27 N•m (125-235 in-lbs)
Inside Hood Release Handle-to-Instrument Panel	8 N•m (78 in-lbs)	7-11 N•m (65-95 in-lbs)
Door Hinge Screws	35 N•m (26 ft-lbs)	30-40 N•m (22-30 ft-lbs)
Door Latch Screw	9 N•m (7 ft-lbs)	7-11 N•m (5-9 ft-lbs)
Exterior Door Handle Nut	5 N•m (4 ft-lbs)	4-6 N•m (3-5 ft-lbs)
Vent Window-to-Door Screw	1 N•m (1 ft-lb)	0.7-21 N•m (.5-1.5 ft-lb)
Door Check-to-A-pillar Screw	9 N•m (7 ft-lbs)	7-11 N•m (5-9 ft-lbs)
Door Check-to-Front Door Screw	10 N•m (7 ft-lbs)	10-11 N•m (7.4-8.1 ft-lbs)
Glass Channel Bottom Screw	9 N•m (7 ft-lbs)	7-11 N•m (5-8 ft-lbs)
Vent Window Upper Screws	1.2 N•m (1 ft-lb)	0.7-1 N•m (.5-1.5 ft-lbs)
Door Glass Stud Nut	6 N•m (4 ft-lbs)	5-7 N•m (4-6 ft-lbs)
Glass Panel Bottom Screw	9 N•m (7 ft-lbs)	7-11 N•m (5-8 ft-lbs)
Vent Window Upper Screws	1.2 N•m (1 ft-lb)	0.7-2 N•m (.5-1.5 ft-lbs)
Door Latch Screws	9 N•m (7 ft-lbs)	7-11 N•m (5-9 ft-lbs)
Exterior Door Handle Nut	5 N•m (4 ft-lbs)	4-6 N•m (3-5 ft-lbs)
Liftgate Hinge Screw	9 N•m (7 ft-lbs)	5-7 N•m (4-5 ft-lbs)
Liftgate Hinge Nut	9 N•m (7 ft-lbs)	5-7 N•m (4-5 ft-lbs)
Support Ball Stud	7 N•m (5 ft-lbs)	4-7 N•m (3-5 ft-lbs)
Liftgate Latch Screw	9 N•m (7 ft-lbs)	5-7 N•m (4-5 ft-lbs)
Striker Screw	30 N•m (22 ft-lbs)	18-26 N•m (13-18 ft-lbs)

J8923-262

HEATING AND AIR CONDITIONING

CONTENTS

GENERAL INFORMATION

INDEX

TORQUE SPECIFICATIONS

MJ/XJ MODELS

Component	Service Set-To-Torque	Service Recheck Torque
A/C Service Valve To Compressor	47.5 N•m (35 ft-lbs) (Wet torque*)	41-54 N•m (30-40 ft-lbs) (Wet torque*)
A/C Compressor And Bracket Mounting Bolts/Nuts		
M-8 Size	27 N•m (20 ft-lbs)	23-31 N•m (17-23 ft-lbs)
M-10 & ⅜ inch Sizes	40 N•m (30ft-lbs)	37-44 N•m (27-33 ft-lbs)
A/C Condenser Screws 2.5L	6 N•m (55 in-lbs)	4.5-8 N•m(40-70 in-lbs)
A/C Condenser Screws 4.0L - Into Well Nuts	2 N•m (20 in-lbs)	2-3 N•m (16-25 in-lbs)
A/C Condenser Nuts 4.0L	3 N•m (26 in-lbs)	2.5-3 N•m (24-29 in-lbs)
A/C Receiver Screws 4.0L	7 N•m (62 in-lbs)	6.5-7 N•m (59-65 in-lbs)
A/C Receiver Screws 2.5L	3.7 N•m (33 in-lbs)	3.5-4 N•m (30-36 in-lbs)
A/C Evaporator-To-Receiver Hose Coupling	14 N•m (10 ft-lbs)	11-16 N•m (8-12 ft-lbs)
Magnetic Clutch Nut	37 N•m (27 ft-lbs)	34-40 N•m (25-30 ft-lbs)
Compressor Cylinder Head Bolts	33 N•m (24 ft-lbs)	30-34 N•m (22-25 ft-lbs)
Discharge and Suction Hose Fittings "O" Ring Type	33 N•m (24 ft-lbs)	28.5-36.5 N•m (21-27 ft-lbs)
Heater Hose Clamps Worm Type	3.4 N•m (30 in-lbs)	3-4 N•m (25-35 in-lbs)
Heater Housing-To-Dash Panel Stud Nuts	6 N•m (55 in-lbs)	5-8 N•m (40-70 in-lbs)
Compressor Oil Fill Plug	10 N•m (7 ft-lbs)	8-12 N•m (6-9 ft-lbs)

*Wet Torque is with service valve coupling threads and O-rings lubricated with compressor oil.

J8924-64

YJ MODEL

Component	Service Set-To-Torque	Service Recheck Torque
A/C Service Valve To Compressor	47.5 N•m (35 ft-lbs) (Wet torque*)	41-54 N•m (30-40 ft-lbs) (Wet torque*)
A/C Compressor And Bracket Mounting Bolts/Nuts		
M-8 Size	27 N•m (20 ft-lbs)	23-31 N•m (17-23 ft-lbs)
M-10 & ⅜ inch Sizes	40 N•m (30ft-lbs)	37-44 N•m (27-33 ft-lbs)
A/C Condenser Screws - Into Well Nuts	2 N•m (20 in-lbs)	2-3 N•m (16-25 in-lbs)
A/C Receiver Screws - Into Well Nuts	1 N•m (9 in-lbs)	1-2 N•m (6-12 in-lbs)
A/C Evaporator-To-Receiver Hose Coupling	14 N•m (10 ft-lbs)	11-16 N•m (8-12 ft-lbs)
Magnetic Clutch Nut	37 N•m (27 ft-lbs)	34-40 N•m (5-30 ft-lbs)
Compressor Cylinder Head Bolts	33 N•m (24 ft-lbs)	45-53 N•m (33-39 ft-lbs)
Discharge and Suction Hose Fittings Flare Type	49 N•m (36 ft-lbs)	24-30 N•m (18-22 ft-lbs)
Heater Hose Clamps Worm Type	3.4 N•m (30 in-lbs)	2-4 N•m (2-3 ft-lbs)
Heater Housing-To-Dash Panel Stud Nuts	5 N•m (46 in-lbs)	5-5.5 N•m (43-49 in-lbs)
Compressor Oil Fill Plug	10 N•m (7 ft-lbs)	8-12 N•m (6-9 ft-lbs)

*Wet Torque is with service valve coupling threads and O-rings lubricated with compressor oil.

J8924-125

SJ MODEL

Component	Service Set-To-Torque	Service Recheck Torque
A/C Service Valve To Compressor	47.5 N•m (35 ft-lbs) (Wet torque*)	41-54 N•m (30-40 ft-lbs) (Wet torque*)
A/C Compressor And Bracket Mounting Bolts/Nuts		
M-8 Size	27 N•m (20 ft-lbs)	23-31 N•m (17-23 ft-lbs)
M-10 & ⅜ inch Sizes	40 N•m (30ft-lbs)	37-44 N•m (27-33 ft-lbs)
A/C Condenser Screws	4.5 N•m (41 in-lbs)	4-5 N•m (38-44 in-lbs)
A/c Receiver Screws	3.7 N•m (33 in-lbs)	3.5-4 N•m (30-36 in-lbs)
A/C Evaporator-To-Receiver Hose Coupling	14 N•m (10 ft-lbs)	11-16 N•m (8-12 ft-lbs)
Magnetic Clutch Nut	37 N•m (27 ft-lbs)	34-40 N•m (5-30 ft-lbs)
Compressor Cylinder Head Bolts	33 N•m (24 ft-lbs)	45-53 N•m (33-39 ft-lbs)
Discharge and Suction Hose Fittings Flare Type	49 N•m (36 ft-lbs)	5-53 N•m (33-39 ft-lbs)
Heater Hose Clamps Worm Type	3.4 N•m (30 in-lbs)	2-4 N•m (2-3 ft-lbs)
Heater Housing-To-Dash Panel Stud Nuts	5.7 N•m (50 in-lbs)	5-6 N•m (47-53 in-lbs)
Compressor Oil Fill Plug	10 N•m (7 ft-lbs)	8-12 N•m (6-9 ft-lbs)

*Wet Torque is with service valve coupling threads and O-rings lubricated with compressor oil.

J8924-126

SYSTEM OPERATION

The compressor increases the pressure and temperature of the system refrigerant. The heated refrigerant vapor is then pumped into the condenser where it cools by giving off heat to air passing over the condenser fins. As the refrigerant cools in the condenser, it condenses into a liquid. Still under high pressure, the liquid refrigerant passes into the receiver. The receiver acts as a reservoir to furnish refrigerant to the expansion valve at all times. From the receiver, the high pressure liquid refrigerant passes to the expansion valve. The expansion valve meters refrigerant into the evaporator where a low pressure is maintained by the suction side of the compressor. As it enters the evaporator, the refrigerant immediately begins to boil by absorbing heat from the air passing over the evaporator core. Having given up its heat to boil the refrigerant, the air is cooled and passes into the passenger compartment of the vehicle. From the evaporator the vaporized refrigerant is drawn back to the compressor to repeat the cycle.

REFRIGERANT SAFETY PRECAUTIONS

The refrigerant used in the air conditioner system is Refrigerant-12 (R-12). R-12 is nonexplosive, nonflammable, non-corrosive, has practically no odor, and is heavier than air. Although it is classified as a safe refrigerant, certain precautions must be observed to protect the parts involved and the person who is working on the unit. Use only R-12 such as Jeep/Eagle PN 8982 200 738 or equivalent. Liquid R-12, at normal atmosphere pressures and temperatures, evaporates so quickly that it has the tendency to freeze anything it contacts.

WARNING: EXTREME CARE MUST BE TAKEN TO PREVENT ANY LIQUID REFRIGERANT FROM COMING IN CONTACT WITH THE SKIN AND ESPECIALLY THE EYES. ALWAYS WEAR SAFETY GOGGLES WHEN SERVICING ANY PART OF THE REFRIGERANT SYSTEM. IF EYE CONTACT IS MADE, APPLY A FEW DROPS OF MINERAL OIL TO THE EYES AND FLUSH WITH WATER FOR SEVERAL MINUTES. SEEK MEDICAL ATTENTION IMMEDIATELY.

The R-12 in the system is always under pressure. Because the system is tightly sealed, heat applied to any part could cause this pressure to build up excessively.

WARNING: TO AVOID A DANGEROUS EXPLOSION, NEVER WELD OR STEAM CLEAN NEAR AIR CONDITIONING LINES OR COMPONENTS.

WARNING: LARGE AMOUNTS OF REFRIGERANT RELEASED IN A CLOSED WORK AREA WILL DISPLACE THE OXYGEN AND CAUSE SUFFOCATION. ALWAYS MAINTAIN GOOD VENTILATION SURROUNDING THE WORK AREA.

R-12 gas, under normal conditions, is non-poisonous. The discharge of R-12 gas near an open flame can produce a very poisonous gas called phosgene. Phosgene is generated when a flame-type leak detector is used.

CAUTION: When charging an A/C system always keep the tank in an upright position. If the tank is on its side or upside down, liquid refrigerant will enter the system and may damage the compressor.

WARNING: DO NOT HEAT R-12 ABOVE 52°C (125°F).

In most instances, moderate heat is required to bring the pressure of the refrigerant in its container above the pressure of the system when charging or adding refrigerant. A bucket or large pan of hot water not over 52°C (125°F) is all the heat required for this purpose. Do not heat the refrigerant container with a blow torch or any other means that would raise the temperature and pressure above this temperature.

CAUTION: Do not allow liquid refrigerant to touch bright metal.

Refrigerant will tarnish bright metal and chrome surfaces. Avoid splashing the refrigerant on any surface. Refrigerant in combination with moisture is very corrosive and can cause extensive damage to all metal surfaces.

Refrigerant Recycling

R-12 refrigerant is a chloroflorocarbon (CFC) that can contribute to the depletion of the ozone layer in the upper atmosphere. Ozone filters out harmful radiation from the sun. To assist in protecting the ozone layer, Chrysler Motors recommends that a R-12 refrigerant recycling device that meets SAE standard J1991 be used. Contact an automotive service equipment supplier for refrigerant recycling equipment that is available in your area. Refer to the operating instructions provided with the recycling equipment for proper operation.

SERVICE PRECAUTIONS

Never open or loosen a connection before discharging the system refrigerant.

When loosening a connection, if any residual pressure is evident, allow it to leak off before opening the fitting.

A system which has been opened to replace a component or one which has discharged through leakage must be evacuated before charging.

Immediately after disconnecting a component from the system, seal the open fittings with a cap or plug.

Before disconnecting a component from the system, clean the outside of the fittings thoroughly.

Do not remove the sealing caps from a replacement component until ready to install.

Refrigerant oil will absorb moisture from the atmosphere if left uncapped. Do not open an oil container until ready to use and install the cap immediately after using. Store the oil only in a clean moisture-free container.

Before connecting an open fitting always install a new seal ring. Coat the fitting and seal with clean refrigerant oil before connecting.

When installing a refrigerant line avoid sharp bends. Position the line away from the exhaust or any sharp edges which may chafe the line.

Tighten fittings only to the specified torque. The copper and aluminum fittings used in the A/C system will not tolerate over tightening.

When disconnecting a fitting use a wrench on both halves of the fitting to prevent twisting of the refrigerant lines or tubes.

Do not open a refrigerant system or uncap a replacement component unless it is as close as possible to room temperature. This will prevent condensation from forming inside of a component which is cooler than the surrounding air.

Keep service tools and the work area clean. Contamination of A/C system through careless work habits must be avoided.

PRESSURE GAUGE AND MANIFOLD ASSEMBLY

Pressure Gauge and Manifold Assembly Tool J-23575 (Fig. 1) is the most important tool used to service the air conditioning system. The gauge assembly is used to determine system high and low side gauge pressures, the correct refrigerant charge, and for system diagnosis. It is designed to provide simultaneous high and low side pressure indications, because these pressures must be compared to determine the correct system operation.

Low Side Gauge

The low side gauge is a compound gauge (1), which means that it will register both pressure and vacuum. The compound gauge is calibrated 0 - 1 034 kPa (0 - 150 psi pressure) and 0 - 76 cm (0 - 30 in) of mercury vacuum. It is connected to the suction service valve to check the low side pressure or vacuum.

High Side Gauge

The high side gauge (2) is used to check the pressure in the discharge side of the air conditioning system.

Manifold

The gauges are connected into the air conditioning systems through a manifold. The manifold (4) has three connections. The low side hose and fitting is connected directly below the low side gauge. The high side hose and fitting is connected below the high side gauge.

The center connection (5) of the manifold is used for charging, discharging, evacuating and any other necessary service. Both the high and low sides of the manifold have hand shutoff valves. The hand shutoff valves open or close the respective gauge connections to the center service connection or to each other. The manifold is constructed so that pressure will be indicated on the gauges regardless of the hand valve position.

Connecting the Pressure Gauge and Manifold Assembly

Remove the protective caps from the service valve gauge ports and valve stems.

Close both of the hand valves on the gauge manifold set.

Connect the compound gauge hose to the compressor suction service valve gauge port (low-side).

Connect the high pressure gauge hose to the discharge service valve gauge port (high-side).

If necessary, to facilitate installation of the gauge set, loosen the service valve-to-compressor fitting and rotate the service valve slightly. Do not allow the hose to contact the engine or body components. Tighten the service valve-to-compressor fitting with 34 N•m (25 ft-lbs) torque or 20 N•m (15 ft-lbs) torque for flange-type service valve screws.

Set both the service valve stems to the mid- or cracked-position. The gauges will indicate high and low side pressure respectively.

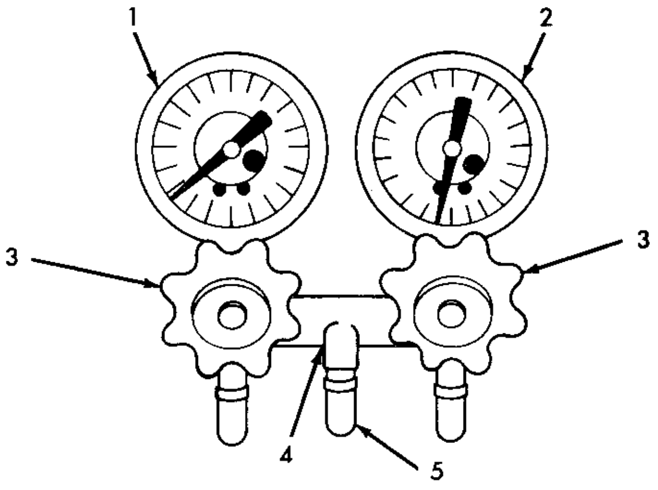
Purge any air from the high side test hose by opening the high side hand valve on the manifold for three to five seconds (the center connection on the manifold must be open).

Purge any air from the low side test hose by opening the low side hand valve on the manifold for three to five seconds (the center connection on the manifold must be open).

The air conditioning system may be operated with the gauge manifold assembly connected in this manner. The gauges will indicate respective operative pressures.

CHECKING SYSTEM PRESSURES

The pressure developed on the high side and low side of the compressor indicates whether the system is operating properly.



1. Compound Gauge (Suction)
2. High Side Gauge (Discharge)
3. Hand Valves
4. Manifold
5. Center Service Fitting

J8924-121

Fig. 1 Manifold and Gauge Set

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(1) Attach the pressure gauge and manifold assembly.

(2) Close both of the hand valves on the gauge and manifold assembly.

(3) Set both the service hand valve stems to the mid-position.

(4) Operate the air conditioning system with the engine running at 1500 rpm and the controls set for full cooling but not into the MAX or COLD detent.

(5) Insert a thermometer into the discharge air outlet and observe the air temperature. The temperature should be approximately 7.1°C (45°F) or less.

(6) Observe the high and low side pressures.

(7) If pressures are abnormal, refer to the Pressure and Performance Diagnosis Charts.

TEMPERATURE-PRESSURE RELATIONSHIP CHART (FOR REFRIGERANT 12)

Temp. °F	Press. PSI	Temp. °F	Press. PSI	Temp. °F	Press. PSI	Temp. °F	Press. PSI	Temp. °F	Press. PSI
0	9.1	35	32.5	60	57.7	85	91.7	110	136.0
2	10.1	36	33.4	61	58.9	86	93.2	111	138.0
4	11.2	37	34.3	62	60.0	87	94.8	112	140.1
6	12.3	38	35.1	63	61.3	88	96.4	113	142.1
8	13.4	39	36.0	64	62.5	89	98.0	114	144.2
10	14.6	40	36.9	65	63.7	90	99.6	115	146.3
12	15.8	41	37.9	66	64.9	91	101.3	116	148.4
14	17.1	42	38.8	67	66.2	92	103.0	117	151.2
16	18.3	43	39.7	68	67.5	93	104.6	118	152.7
18	19.7	44	40.7	69	68.8	94	106.3	119	154.9
20	21.0	45	41.7	70	70.1	95	108.1	120	157.1
21	21.7	46	42.6	71	71.4	96	109.8	121	159.3
22	22.4	47	43.6	72	72.8	97	111.5	122	161.5
23	23.1	48	44.6	73	74.2	98	113.3	123	163.8
24	23.8	49	45.6	74	75.5	99	115.1	124	166.1
25	24.6	50	46.6	75	76.9	100	116.9	125	168.4
26	25.3	51	47.6	76	78.3	101	118.8	126	170.7
27	26.1	52	48.7	77	79.2	102	120.6	127	173.1
28	26.8	53	49.8	78	81.1	103	122.4	128	175.4
29	27.6	54	50.9	79	82.5	104	124.3	129	177.8
30	28.4	55	52.0	80	84.0	105	126.2	130	182.2
31	29.2	56	53.1	81	85.5	106	128.1	131	182.6
32	30.0	57	55.4	82	87.0	107	130.0	132	185.1
33	30.9	58	56.6	83	88.5	108	132.1	133	187.6
34	31.7	59	57.1	84	90.1	109	135.1	134	190.1

J8924-122

PERFORMANCE DIAGNOSIS

Condition	Possible Cause	Correction
COMPRESSOR NOISE	(1) Broken valves. (2) Overcharged. (3) Incorrect oil level. (4) Piston slap. (5) Broken rings. (6) Drive belt pulley bolts are loose.	(1) Replace the valve plate. (2) Discharge, evacuate and install the correct charge. (3) Isolate the compressor and check the oil level. Correct as necessary. (4) Replace the compressor. (5) Replace the compressor. (6) Tighten with the correct torque specification.
EXCESSIVE VIBRATION	(1) Incorrect belt tension. (2) Clutch loose. (3) Overcharged. (4) Pulley is misaligned.	(1) Adjust the belt tension. (2) Tighten the clutch. (3) Discharge, evacuate and install the correct charge. (4) Align the pulley.
CONDENSATION DRIPPING IN THE PASSENGER COMPARTMENT	(1) Drain hose plugged or improperly positioned. (2) Insulation removed or improperly installed.	(1) Clean the drain hose and check for proper installation. (2) Replace the insulation on the expansion valve and hoses.
FROZEN EVAPORATOR COIL	(1) Faulty thermostat. (2) Thermostat capillary tube improperly installed. (3) Thermostat not adjusted properly.	(1) Replace the thermostat. (2) Install the capillary tube correctly. (3) Adjust the thermostat.

J8924-72

PRESSURE DIAGNOSIS

Condition	Possible Cause	Correction
LOW SIDE LOW – HIGH SIDE LOW	(1) System refrigerant is low. (2) Expansion valve is restricted.	(1) Evacuate, leak test and charge the system. (2) Replace the expansion valve.
LOW SIDE HIGH – HIGH SIDE LOW	(1) Internal leak in the compressor – worn. (2) Cylinder head gasket is leaking. (3) Expansion valve is defective. (4) Drive belt slipping.	(1) Remove the compressor cylinder head and inspect the compressor. Replace the valve plate assembly if necessary. If the compressor pistons, rings or cylinders are excessively worn or scored, replace the compressor. (2) Install a replacement cylinder head gasket. (3) Replace the expansion valve. (4) Adjust the belt tension.
LOW SIDE HIGH – HIGH SIDE HIGH	(1) Condenser fins obstructed. (2) Air in the system. (3) Expansion valve is defective. (4) Loose or worn fan belts.	(1) Clean the condenser fins. (2) Evacuate, leak test and charge the system. (3) Replace the expansion valve. (4) Adjust or replace the belts as necessary.
LOW SIDE LOW – HIGH SIDE HIGH	(1) Expansion valve is defective. (2) Restriction in the refrigerant hose. (3) Restriction in the receiver/drier. (4) Restriction in the condenser.	(1) Replace the expansion valve. (2) Check the hose for kinks – replace if necessary. (3) Replace the receiver/drier. (4) Replace the condenser.
LOW SIDE AND HIGH SIDE NORMAL (INADEQUATE COOLING)	(1) Air in the system. (2) Moisture in the system.	(1) Evacuate, leak test and charge the system. (2) Evacuate, leak test and charge the system.

J8924-73

DISCHARGING THE SYSTEM

The refrigerant must be discharged before replacing any system component except the compressor. The compressor can be isolated with the service valves.

Discharge Procedure

(1) Connect the pressure gauge and manifold to the service valves.

(2) Open both manifold hand valves fully.

CAUTION: Do not allow the refrigerant to discharge rapidly. The oil in the compressor and system will be forced out along with the refrigerant.

(3) Open both of the service valves slightly (from back-seated to mid-position) and allow the refrigerant to discharge slowly.

EVACUATING THE SYSTEM

The system must be evacuated whenever refrigerant has been discharged or when system refrigerant level has become abnormally low. A vacuum pump is used for the evacuation process.

The system must be evacuated to remove any moisture or air that may have collected in the system. If moisture is not removed from the system, it will combine with R-12 to form a highly corrosive substance.

The vacuum pump decreases system pressure by creating a vacuum within the system. The pressure drop causes the boiling point of moisture in the system to decrease also. The moisture then boils into a vapor which is easily drawn off by the vacuum.

At an ambient temperature of 23.9°C (75°F) and a vacuum of 99 kPa (29.5 in. Hg), water will boil at approximately 12°C (54°F). This will produce complete vaporization of all moisture in the system.

At elevations above sea level, it may not be possible to obtain a vacuum of 99 kPa (29.5 in. Hg) on the low side. For each 300 meters (1000 ft) increase in altitude, the vacuum must be corrected by 3.37 kPa (1 in. Hg) to compensate for the change in atmospheric pressure.

For example, at an of altitude of 300 meters (1000 ft), a vacuum of 96 kPa (28.5 in. Hg) will be equivalent to 99 kPa (29.5 in. Hg) at sea level. When this vacuum level is attained, a minimum evacuation time of 30 minutes should be allowed to ensure total moisture removal.

Evacuation With Vacuum Pump J 26695B

The J 26695 Vacuum Pump and motor must be kept upright at all times to prevent oil spills.

(1) Connect the pressure gauge and manifold to the service valves.

(2) Discharge the system.

(3) Connect the center service hose on the gauge and manifold to the vacuum pump inlet fitting.

(4) Turn both manifold hand valves to the wide open position.

(5) Start the vacuum pump and observe the vacuum gauge reading.

(6) Test the system for leaks as follows:

- Close the manifold hand valves.
- Stop the vacuum pump and observe the vacuum reading.
- If the system is leak-free, vacuum will hold steady at the level indicated when the pump was stopped. If vacuum remains steady for 3-5 minutes, resume and continue evacuation for a minimum of 30 minutes.
- If the system has a leak, vacuum will fall off or rapidly drop to a zero reading. If a leak exists, partially charge the system. Find and repair the leak and resume evacuation.

(7) Continue operating the pump for a minimum of 30 minutes after attaining lowest vacuum indicated on the gauge.

(8) Close the manifold hand valves and stop the vacuum pump.

(9) Disconnect the center service hose from the vacuum pump. The system is now ready for charging.

Evacuation With Portable Service Station

The air conditioner service station is a self contained, portable unit equipped with a vacuum pump, metering-charging cylinder, refrigerant supply, pressure and vacuum gauges, service hoses and control valves (Fig.2).

(1) Turn the station vacuum pump control switch Off (the switch is at the front of the station). The pump control switch must be OFF before connecting the station to an electrical power source.

(2) Close all the hand valves.

(3) Connect the red charging hose to the discharge service valve.

(4) Connect the blue charging hose to the inlet (suction) service valve.

(5) Discharge the system. Leave the suction and discharge service valves in the mid-position.

CAUTION: The system must be completely discharged before evacuating. If the system is still charged, refrigerant can enter and damage the vacuum pump.

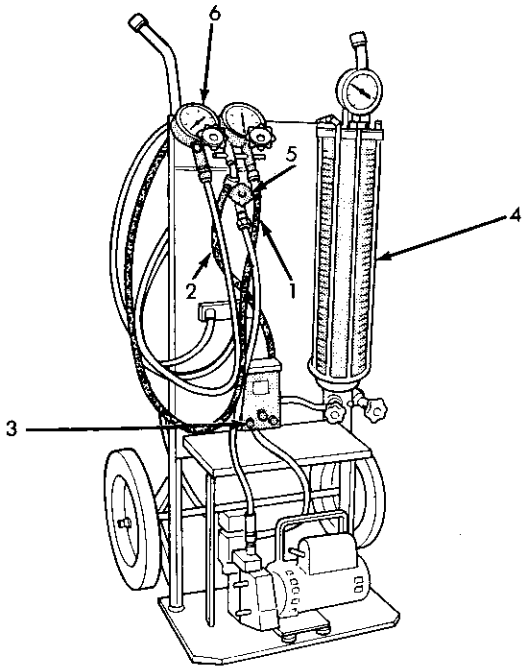
(6) Connect the vacuum pump hose to the vacuum pump inlet.

(7) Open the low and high pressure control valves on the charging station.

(8) Start the vacuum pump. Open the vacuum control valve and note the vacuum reading.

(9) Test the system for leaks as follows:

- Close the manifold hand valves.
- Stop the vacuum pump and observe the vacuum reading.
- If the system is leak-free, vacuum will hold steady at the level indicated when the pump was stopped. If vacuum remains steady for 3-5 minutes, resume and continue evacuation for a minimum of 30 minutes.



1. RED CHARGING HOSE
2. BLUE CHARGING HOSE
3. VACUUM PUMP SWITCH
4. CHARGING CYLINDER
5. VACUUM CONTROL VALVE
6. LOW PRESSURE GAUGE

J9024-1

Fig. 2 Portable Service Station

- If the system has a leak, vacuum will fall off or rapidly drop to a zero reading. If a leak exists, partially charge the system. Find and repair the leak and resume evacuation.

(10) Continue evacuating the system for a minimum of 30 minutes after attaining the lowest vacuum level.

(11) Fill the station charging cylinder while the system is evacuating.

(12) Close the vacuum control valve and stop the vacuum pump.

(13) Observe low pressure gauge to determine if a system leak exists. If the system is leak-free, the system is now ready for charging.

CHARGING THE SYSTEM

Charge Capacity

The recommended system charge is 0.9 kg (32 oz.) of R-12 refrigerant for SJ and YJ models. The recommended system charge is 1.1 kg (38 oz.) of R-12 refrigerant for MJ and XJ models.

Replacement of a hose, receiver-drier, condenser, expansion valve or evaporator core will require that an additional 28 grams (one ounce) of compressor oil be added to the system.

Charging With Multi-Refrigerant Dispenser

The following charging procedure is based on the use of pressure gauge and manifold J 23575 and multi-refrigerant dispenser J 6272-02.

WARNING: WEAR GOGGLES TO PROTECT THE EYES.

(1) Connect pressure gauge and manifold.

(2) Mid-position the service valves.

(3) Evacuate the system.

(4) Close both manifold hand valves.

(5) Disconnect the service hose from the vacuum pump and reconnect it to the center fitting of multi-refrigerant dispenser.

(6) Close all of the petcock valves on the dispenser.

(7) Attach the necessary number of refrigerant cans to the dispenser. Refer to Charge Capacity for the amount of R-12 required to charge the system.

(8) Bleed air from the manifold and dispenser. Loosen the center service hose at the manifold. Open one dispenser petcock and allow refrigerant to purge air from the components. Tighten the service hose and close the petcock after all air is purged.

(9) Open the low pressure (suction) gauge hand valve and one petcock valve. Do not open the discharge (high pressure) gauge hand valve at this time.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(10) Start the engine. Set the air conditioner controls at maximum cooling. Compressor operation will charge the inlet (suction) side of the system.

The refrigerant containers may be placed upright in warm water (at a maximum temperature of 51.7°C (125°F) to cut down charging time.

(11) When the first refrigerant can is empty, open another petcock valve to continue charging the system.

(12) Continue adding R-12 until the system is fully charged. The frost line on the refrigerant container will indicate how much refrigerant has entered the system.

If an accurate scale is available, weigh the refrigerant cans during the charging procedure to verify the amount of refrigerant added.

(13) When the system is fully charged, close the manifold low pressure gauge hand valve and all the dispenser petcock valves.

(14) Start the engine. Operate the A/C system 5-10 minutes so it will stabilize.

(15) Check system operation.

Charging With The Portable Service Station

(1) Fill the station charging cylinder. Refrigerant should be observed rising in the cylinder sight glass.

(2) Slightly open the valve at the top of the cylinder when pressure in the charging cylinder and refrigerant

supply tank are equal (this relieves head pressure allowing refrigerant to continue filling the cylinder).

(3) Observe the pressure gauge at the top of the cylinder. Rotate the plastic cover on the cylinder until the pressure heading column corresponds with the gauge pressure in line with the sight glass.

For example: if the pressure gauge at the top of the cylinder indicates 483 kPa (70 psi), locate the column with the pressure heading of 483 (70) and rotate the cover so the 483 (70) column aligns with the sight glass.

(4) When refrigerant reaches the correct level in the sight glass, close the right hand valve at the base of the cylinder and valve on the refrigerant drum.

(5) Close the valve at the top of the charging cylinder.

(6) Check for bubbles in the refrigerant using the cylinder sight glass. If bubbles appear in the refrigerant, tilt the charging station rearward momentarily.

(7) Connect the heating element cord to the power pack receptacle and turn the heater switch ON.

(8) Allow the refrigerant to warm for about 10 minutes while the vacuum pump is operating.

WARNING: WEAR GOGGLES TO PROTECT THE EYES.

(9) Discharge and evacuate the system.

(10) Close the low pressure valve on the charging station.

(11) Fully open the left hand refrigerant control valve at the base of the cylinder and the high pressure valve on the charging station.

(12) Charge the system.

(13) Close the refrigerant control valve and the high pressure valve on the charging station.

CAUTION: Do not permit the liquid level to drop below zero on the cylinder sight glass.

(14) Close the manifold gauges after completion of the charging operation and check the high and low side pressures.

(15) Check system operation.

CAUTION: Do not check system pressures until the high and low pressure valves on the charging station are closed. The low pressure gauge could be damaged if the valves are open.

(16) Close all the valves on the charging station and close the refrigerant drum valve when all the operations are completed.

(17) Back-seat the service valves by turning them fully counterclockwise. Install the quick seal caps on the valves afterward.

(18) Disconnect the charging hoses from the service valves. A small amount of refrigerant remaining in the hoses will escape.

(19) Discharge any R-12 left in the charging cylinder. The cylinder is not designed to store refrigerant.

OIL LEVEL FILLING AND CHECKING

The compressor oil level must be checked and adjusted if the system has been discharged rapidly, or when a component has been replaced. If a replacement compressor is being installed, it must be filled with new compressor oil (Suniso 5GS or equivalent).

The normal quantity of oil required for the compressor and entire system is (175cc 6 oz.±0. oz. for SD 508 compressor) (135cc 4.6 oz. for SD 709 compressor).

CAUTION: The compressor is a high speed unit. Satisfactory operation is dependent on sufficient lubrication; however, excess oil will hinder cooling efficiency.

CAUTION: DO NOT overfill the compressor. Excessive amounts of oil in the system will hinder compressor operation and reduce cooling efficiency.

Two oil level checking procedures are necessary. Use procedure A when the compressor is being replaced and the system was discharged properly (no oil loss). Use procedure B for routine maintenance or when checking oil level after replacing a system component.

In cases where rapid loss of refrigerant and oil occurred, the system must be evacuated and purged and the compressor refilled with the necessary amount of oil for the entire system.

Oil Level Check-Procedure A

(1) Remove the oil filler plug and discharge and suction port caps from original and replacement compressor.

(2) Drain the oil from the replacement compressor through oil filler plug hole and discharge and suction ports into a clean container. Then rotate clutch fron plate several times to push the oil on cylinder out to diacharge chamber of cylinder head and drain the oil from discharge port.

(3) Drain the oil from the original compressor into a measuring cup or graduated beaker in the same way as the step 2. Note the amount of oil drained.

(4) Refill the replacement compressor with the same amount of oil drained from the original compressor plus one additional fluid ounce. For example, if the old compressor contained 3.5 ounces of oil, fill the replacement compressor with a total of 4.5 ounces of oil.

Oil Level Check-Procedure B

(1) Start the engine and operate the engine at idle.

(2) Operate the air conditioning system for 10 minutes to return the maximum amount of oil in the system to the compressor.

(3) Stop the engine and disconnect the magnetic clutch feed wire.

(4) Front-seat the discharge and suction service valves.

(5) Determine the mounting angle. Position an Angle Gauge across the flat surfaces of the front mounting ears. Center the bubble. Read the mounting angle to the closest degree. MJ, XJ and YJ Models have 0° mounting angle. SJ Model has a 65° mounting angle.

(6) Remove the oil filler plug. For SD 508 compressor, look through the oil filler plug hole and rotate the clutch

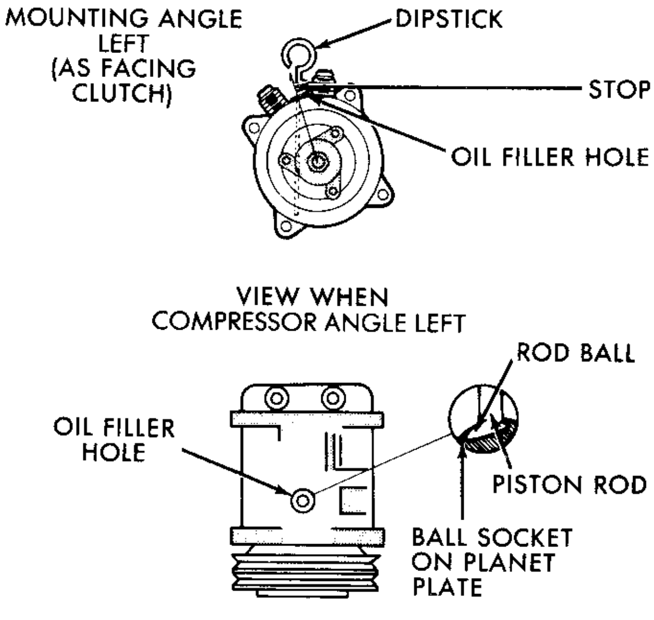


Fig. 3 Oil Level Checking SD 508 Only

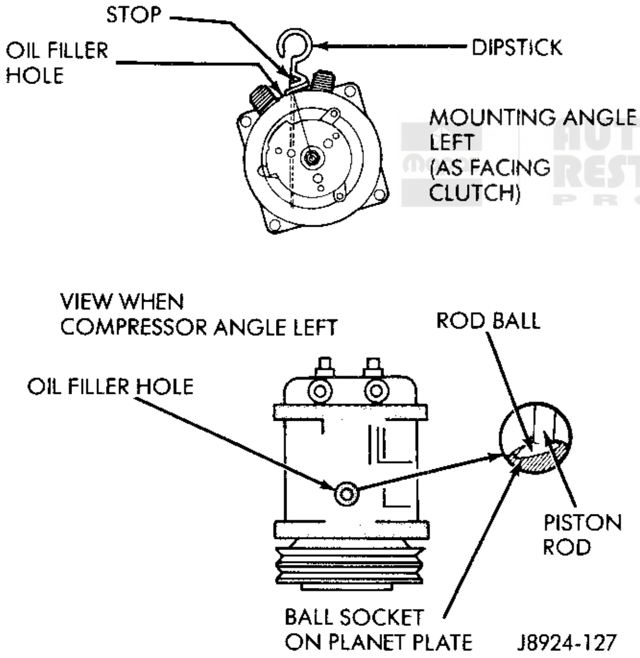


Fig. 4 Oil Level Checking SD 709 Only

front plate to position the internal parts (Fig.3). This step is necessary to clear the dipstick of internal parts and allow its insertion to full depth. For SD 709 compressor, position internal parts by rotation of front plate counterweight to 30° angle (Fig.4).

(7) Insert the dipstick tool J29642-12 to its STOP position. The stop is the angle near the top of the dipstick. The bottom surface of the angle must be flush with the surface of the oil filler hole.

(8) Remove dipstick. Count increments of oil.

(9) Use mounting angle table to determine correct oil level for the compressor.

(10) If the increments read on the dipstick do not match the table, add or subtract oil to the mid-range value. For example, if the mounting angle is 10°, and the dipstick increment is 3, add oil in one fluid ounce increments until 7 is read on the dipstick.

(11) Check that the sealing O-ring is not twisted.

(12) Seat and O-ring must be clean.

(13) Install oil filler plug. Torque plug to 8-12 N•m (6-9 ft lbs). Do not overtighten the plug to stop a leak.

PURGING COMPRESSOR OF AIR

The compressor must be purged of air whenever it has been isolated for an oil level check or other service procedures without discharging the entire system.

(1) Cap the service gauge ports on both of the service valves.

(2) Back-seat the suction service valve to allow the system refrigerant to enter the compressor.

(3) Place the discharge service valve in the mid- or cracked-position.

(4) Loosen the discharge service valve gauge port cap to permit the refrigerant to force any air out of the compressor.

(5) Back-seat the discharge service valve and tighten the gauge port cap.

(6) The compressor is now ready for service.

SERVICE VALVES

The discharge (high pressure) and inlet (suction) service valves are used for diagnosis, charging, discharging and evacuating the system. They are also used to isolate the system during component removal/installation.

The service valves are three-position valves (Fig.5). Normal operating position for the valve stem is the back-seated (full-out) position. The stem is turned counterclockwise to place it in this position.

The front seated (full-in) position is used to isolate the compressor from the system. The stem is turned clockwise to place it in this position.

In the mid-position the gauge port is open. This position is used for pressure testing and for charging, discharging and evacuating the system.

Compressor Valve Leak Test

The compressor should be at operating temperature for an accurate test.

(1) Install pressure gauge and manifold J 23575.

(2) Front-seat the suction and discharge service valves by turning them clockwise.

(3) Discharge refrigerant remaining in the compressor by slowly opening the suction service valve.

(4) Open the low pressure gauge hand valve and close the high pressure gauge hand valve.

Mounting Angle/Degree	Acceptable Oil Level In Increments	
	SD-508	SD-709
0	4-6	3-5
10	6-8	4-6
20	7-9	5-7
30	8-10	6-8
40	9-11	7-9
50	9-11	8-10
60	9-12	9-11
90	9-12	10-12

J8924-115

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

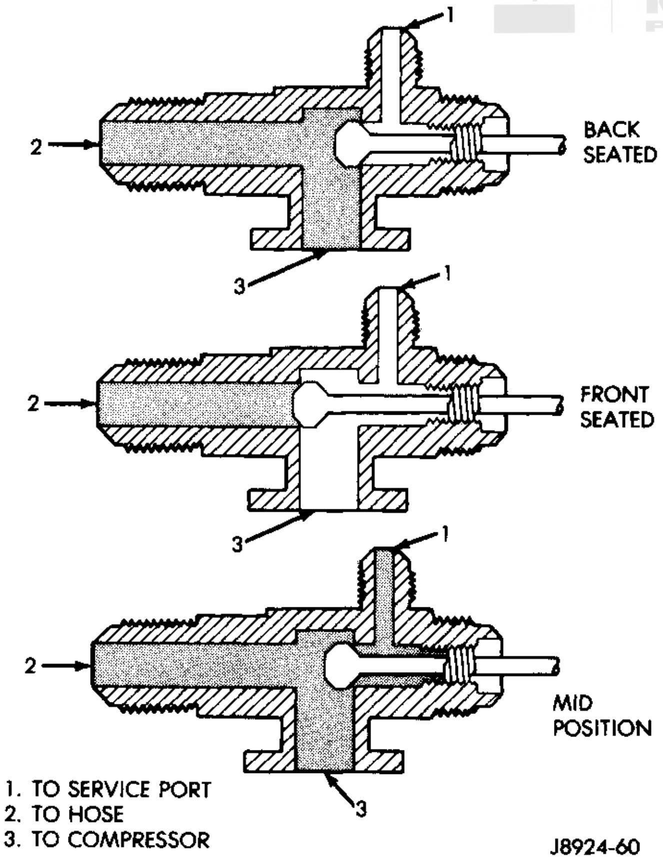


Fig. 5 Service Valve

(5) Start the engine and operate the compressor. Pressure will build up rapidly. Stop the engine and compressor at 1 035-1 380 kPa (150-200 psi).

Pressure should hold steady if the discharge service valve is operating properly. A loss of pressure indicates a leaking discharge valve or compressor head gasket.

Discharge Service Valve Adapters

On occasion, a service hose may not fit a service valve fitting. The adapters shown in Fig. 6 are available and can be used to achieve service valve connection.

MANUFACTURER	PART NUMBER		
	Straight	Right Angle	Flex
Kent Moore	J-25498	J-25499	—
K-D Tools	KD-2409	—	—
Draf Tools	AC 354	—	AC 355
Miller Tools	C-4803	C-4843	—

J8924-61

Fig. 6 Discharge Service Valve Adapters

COMPRESSOR SERVICE

Shaft Turning Smoothness Test

(1) Front-seat the service valves and remove the valves from the compressor.

(2) Disengage the clutch.

(3) Rotate the compressor shaft using a socket and wrench on the shaft nut.

If severe rough spots or "catches" are felt while rotating the compressor shaft be sure to replace the compressor.

Compressor Isolation

It is not necessary to discharge the system for compressor removal. The compressor can be isolated from the remainder of the system and eliminate the need for recharging when performing compressor service.

(1) Connect pressure gauge and manifold.

(2) Close both gauge hand valves.

(3) Mid-position both service valves.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(4) Start the engine and operate the air conditioning system.

(5) Turn the suction service valve slowly clockwise toward the front seated position.

(6) When pressure drops to zero, stop the engine and compressor and quickly finish front-seating the suction service valve.

(7) Front-seat the discharge service valve.

(8) Loosen the oil level check plug slowly to release any internal pressure in the compressor.

The compressor is now isolated from the remainder of system.

The service valves can be removed from the compressor.

Removal

(1) Disconnect the battery negative cable.

(2) Isolate the compressor as previously described.

(3) Remove the discharge and inlet (suction) service valves from the compressor. Plug or tape all the openings.

(4) Remove the drive belt(s) by loosening the alternator (SJ and YJ Models); power steering pump (MJ/XJ Models) (Figs.7 thru 12).

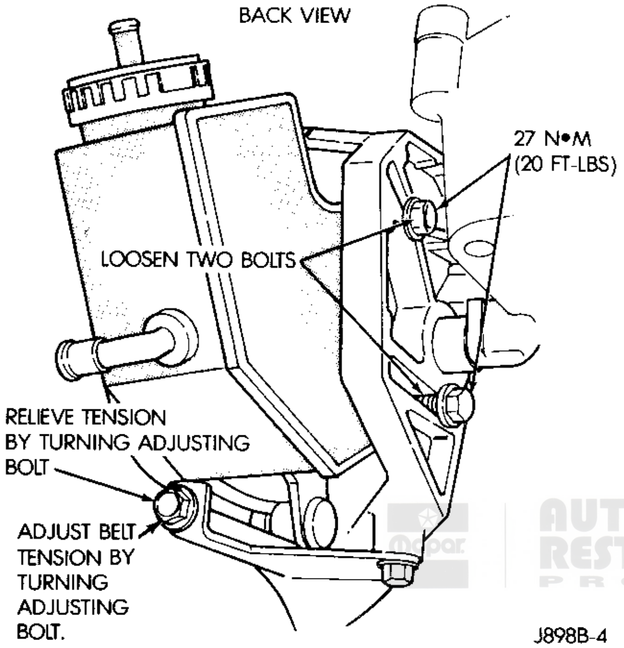


Fig. 7 Serpentine Belt Removal/Installation—Front View 4.0L

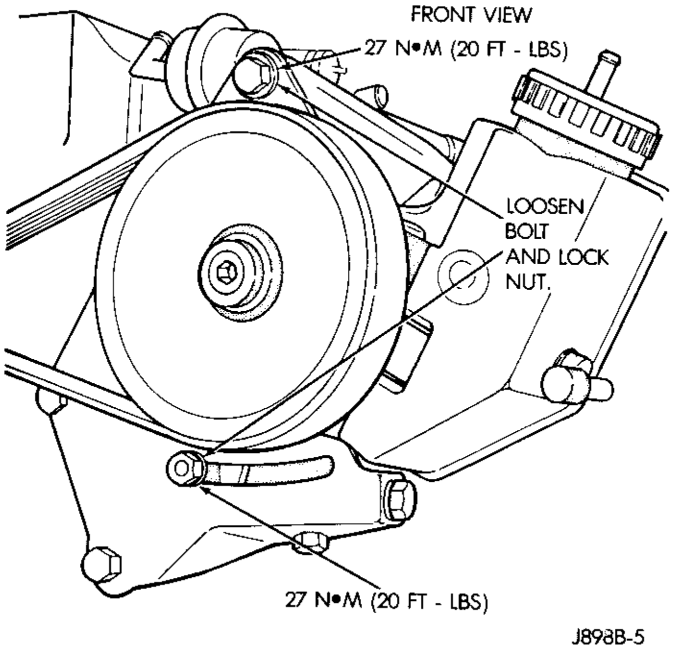


Fig. 8 Serpentine Belt Removal/Installation—Back View 4.0L

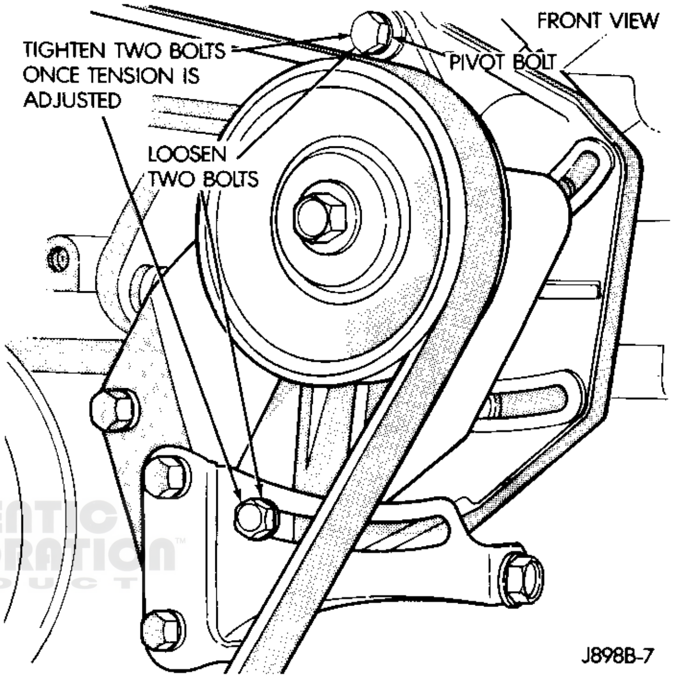


Fig. 9 Serpentine Belt Removal/Installation—Front View 2.5L

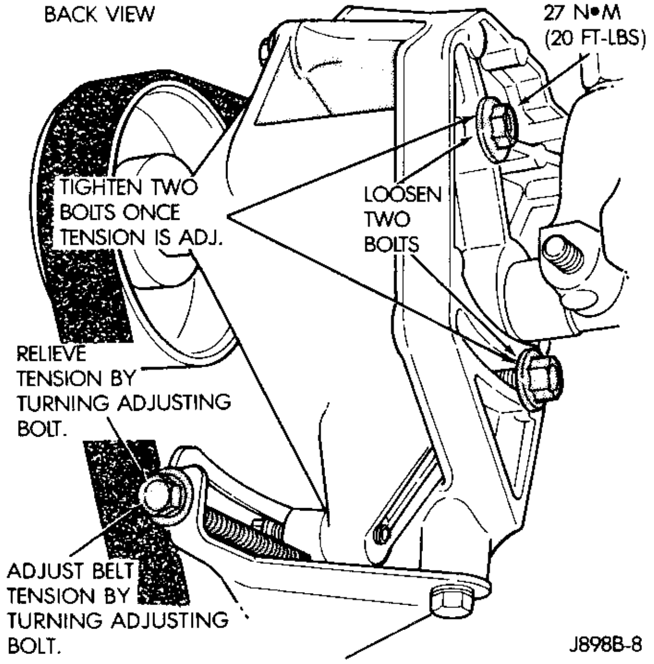


Fig. 10 Serpentine Belt Removal/Installation—Back View 2.5L

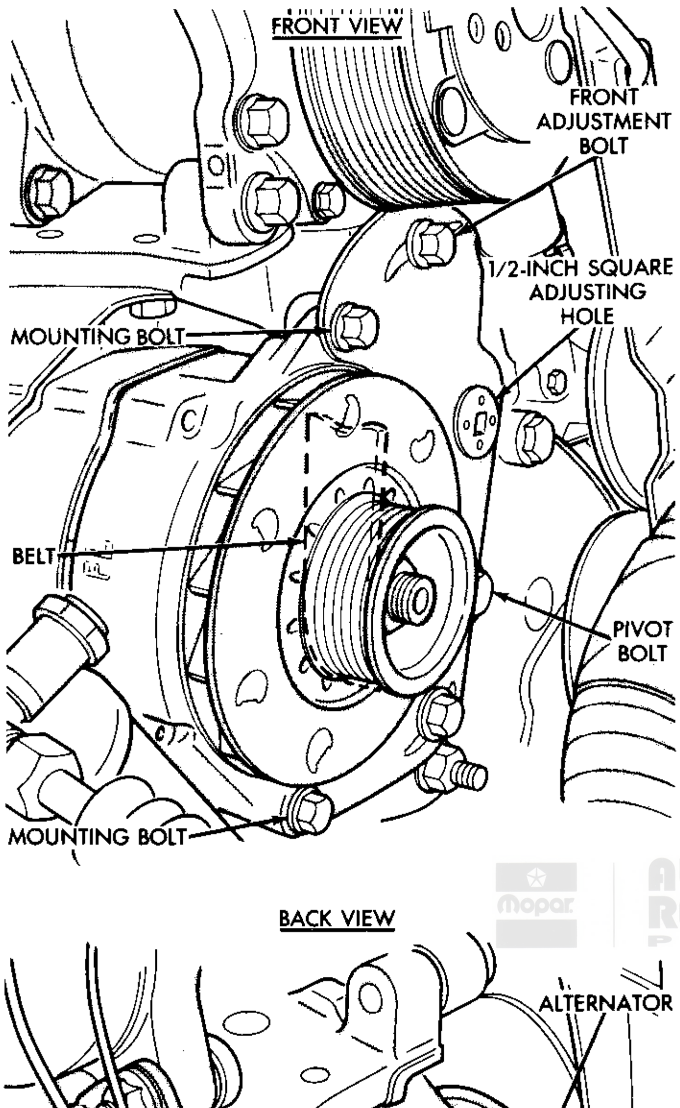


Fig. 11 Alternator Removal/Installation — YJ 4.2L

(5) Remove the bolts and remove the compressor from the mounting bracket (Fig.13).

Installation

If a replacement compressor is being installed: check the oil (see oil level filling and checking procedure), add or subtract oil as necessary and install the magnetic clutch on the compressor.

(1) Install the compressor on the mounting bracket.

(2) Install the drive belt(s).

(3) Tighten the drive belt(s) to the specified tension.

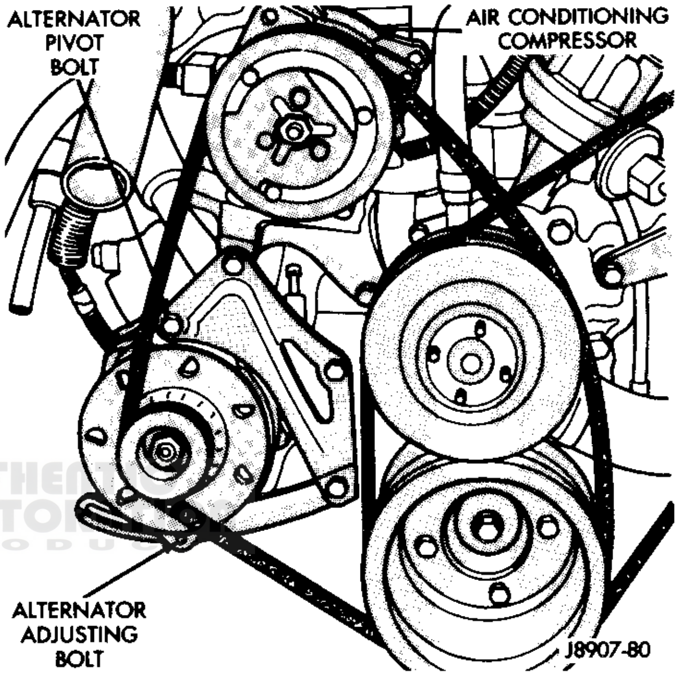


Fig. 12 Loosen Alternator — SJ

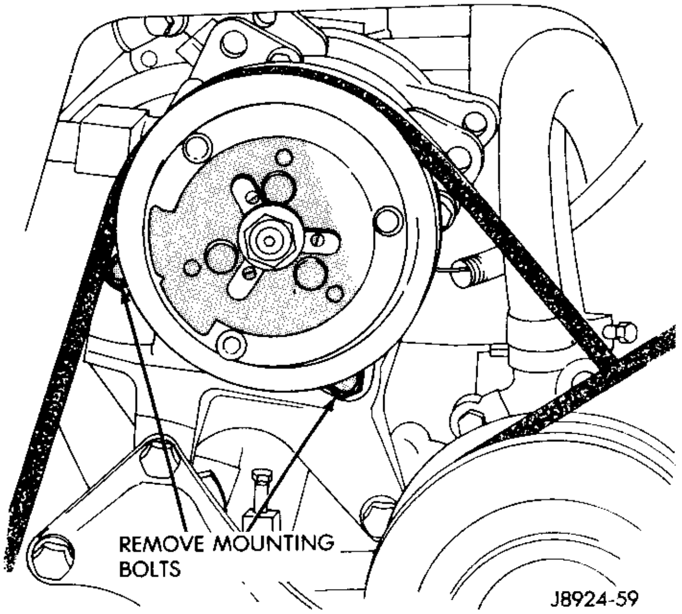


Fig. 13 Remove Compressor Mounting Bolts — SJ

TYPE OF BELT	NEW BELT N(lbs-f)	USED BELT
Serpentine Belt	800-900 (180-200)	623-712 (140-160)
V-Belt	533-711 (120-160)	400-511 (90-115)

(4) Remove the tape or plastic plugs from all the suction and discharge openings and install the service valves on the compressor.

(5) Connect the battery negative cable.

(6) Evacuate, charge and test the system for leaks as described in General Information - System Charging.

LEAK TESTING

External leaks in the system can be located using an electronic detector.

The electronic leak detector is recommended because it is light, accurate and most important, does not expose the user to toxic gas fumes. The halide torch requires an open flame for leak detection. When R-12 is exposed to an open flame, it turns into Phosgene gas which is poisonous.

Leak Testing With Electronic Detector

An electronic leak detector will locate R-12 leaks as small as 1/2 ounce per year.

(1) Calibrate the detector as outlined in the manufacturer's instructions.

(2) Remove the flexible detector probe from the case.

(3) Turn the detector control switch On.

(4) Prepare the detector for use.

- Place the flexible probe tip near the leak port on the detector.
- Adjust the BAT thumbwheel a few teeth at a time, until the light illuminates-then goes out when the tip is removed from the leak port.

(5) Begin leak testing. Move the flexible probe slowly under all suspect connections, joints and seals.

Because R-12 refrigerant is heavier than air, leaks are more readily detected on the lower side of components being checked.

The leak indicator light will illuminate when a leak is detected.

The indicator light will go out if the probe tip is held near the leak point for an extended period.

(6) Repair leaks as required.

(7) Evacuate and recharge the system after leaks are corrected.

COMPRESSOR OVERHAUL

INDEX

A/C COMPRESSOR TORQUE SPECIFICATIONS

COMPONENTS	TORQUE
A/C clutch spindle nut	34-40 N•m (25-30 ft lbs)
A/C cylinder head bolts	30-34 N•m (22-25 ft lbs)
A/C drain/fill plug	8-12 N•m (6-9 ft lbs)

MAGNETIC CLUTCH

The magnetic clutch consists of a stationary electromagnetic coil and a rotating pulley and plate assembly.

The electromagnetic coil is retained on the compressor with a snap ring and is dimpled to maintain its position.

The pulley and plate assembly are mounted on the compressor shaft.

When the compressor is not in operation, the pulley freewheels on the clutch hub bearing. When the coil is energized the plate is magnetically engaged with the pulley and turns the compressor shaft.

Magnetic Clutch Noise Diagnosis

When a magnetic clutch assembly is suspected of being the source of unusual noises, follow the sequence given on the Troubleshooting Chart.

CLUTCH REMOVAL

(1) Insert the two pins of the front plate spanner into any two threaded holes of the clutch front plate (Fig.1). Hold clutch plate stationary. Remove hex nut with 19mm (3/4 in.) socket.

(2) Remove clutch front plate using puller. Align puller center bolt to compressor shaft (Fig.2). Thumb tighten the three puller bolts into the threaded holes.

(3) Turn center bolt clockwise with 19mm (3/4 in) socket until front plate is loosened.

(4) Remove shaft key by lightly tapping it loose with a slot screw driver and hammer (Fig.3).

(5) Remove the external front housing snap ring by using spread type snap ring pliers (Fig.4).

Remove the internal bearing snap ring by using pinch type snap ring pliers (SD 508 only) (Fig.5).

(6) Insert the lip of the jaws of the rotor puller into the snap ring groove exposed in the previous step (Fig.6).

(7) Place rotor puller shaft protector over the exposed shaft.

(8) Install the puller plate and bolt (Fig.7). Two bolts go through the plate and into the jaws. Finger tighten bolts.

(9) Turn puller center bolt clockwise using 3/4 inch socket until rotor pulley is free.

(10) Loosen coil lead wire from clip on top of compressor front housing (Fig.8).

(11) Using spread type snap ring pliers, remove snap ring and field coil (Fig.9).

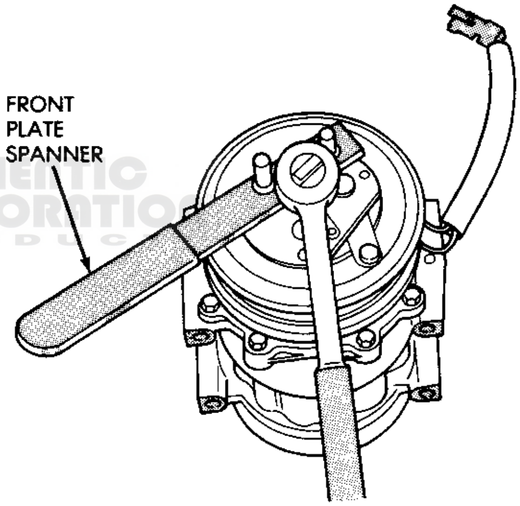


Fig. 1 Remove Hex Nut

CLUTCH INSTALLATION

(1) Install the field coil with the snap ring.

(2) Place coil lead wire under clip on top of compressor front housing and tighten the retaining screw.

(3) Support the compressor on the four mounting ears at the compressor rear. If a vise is being used, clamp only on the mounting ears. Never clamp on the compressor body.

(4) Align rotor assembly squarely on the front housing hub.

(5) Using Rotor Installer Set, place the ring part of the set into the bearing cavity (Fig.10). Make certain the outer edge rests firmly on the rotor bearing inner race.

(6) Place the tool set driver into the ring as shown (Fig.11).

(7) With a hammer, tap the end of the driver while guiding the rotor to prevent binding. Tap until the rotor bottoms against the compressor front housing hub. Listen for a distinct change of sound during the tapping process.

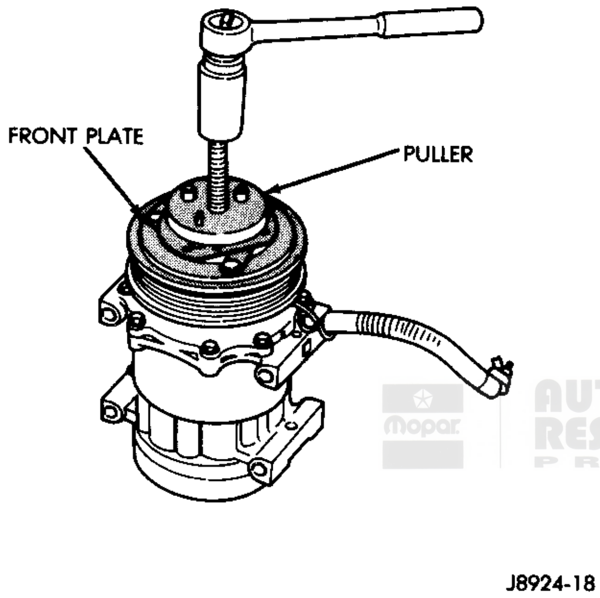


Fig. 2 Remove Clutch Front Plate

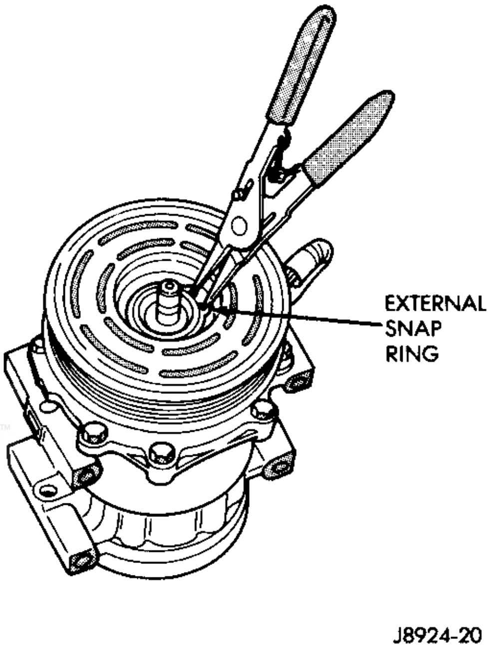


Fig. 4 Remove External Snap Ring

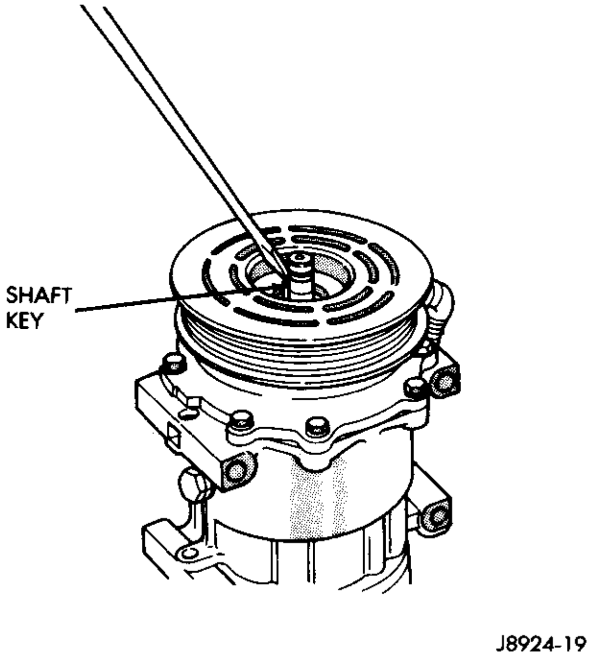


Fig. 3 Remove Shaft Key

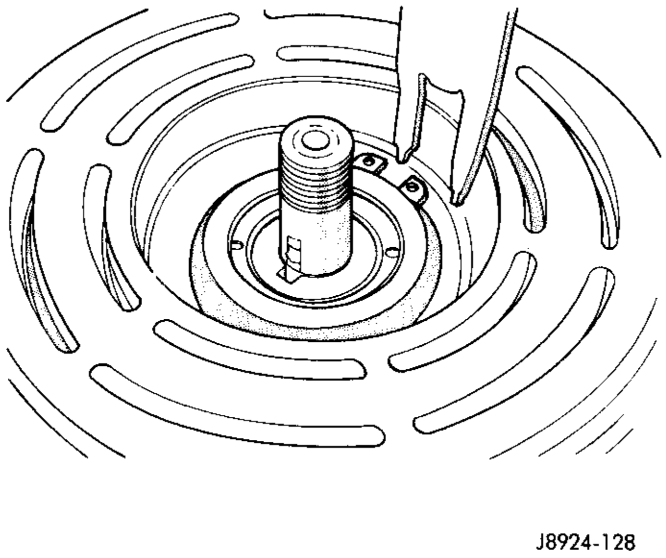


Fig. 5 Remove Internal Snap Ring SD 508 Only

(8) Install the internal bearing snap ring with pinch type pliers (SD 508 only).

(9) Install external front housing snap ring with spread type snap ring pliers.

(10) Install front plate assembly.

- Check that original clutch shims are in place on compressor shaft.
- Replace compressor shaft key.
- Align front plate keyway to compressor shaft key.

(11) Using Shaft Protector, tap front plate to shaft until it has bottomed to the clutch shims (Fig.12). Listen for a distinct change of sound during the tapping process.

(12) Replace shaft hex nut. Torque to 34-40 N•m (25-30 ft lbs).

(13) Check air gap with feeler gauge to 0.016 to 0.031 inch. If air gap is not consistent around the circumference, lightly pry up at the minimum variations (Fig.13). Lightly tap down at points of maximum variation.

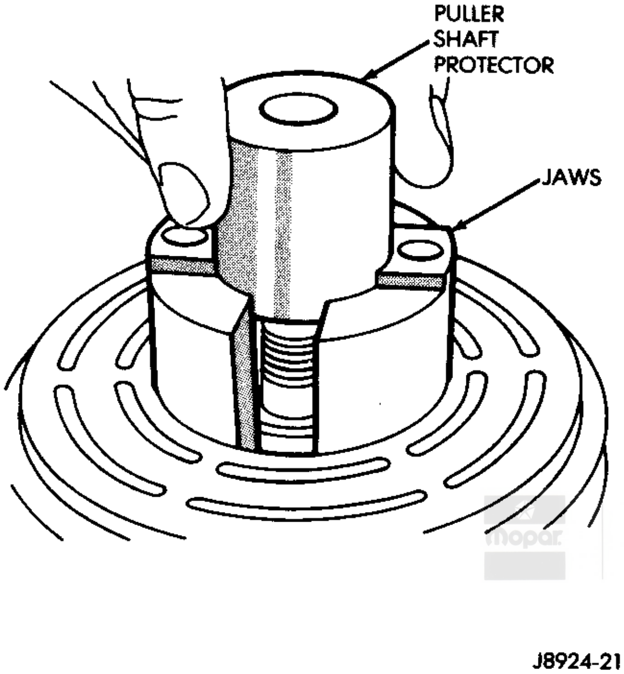


Fig. 6 Install Shaft Protector

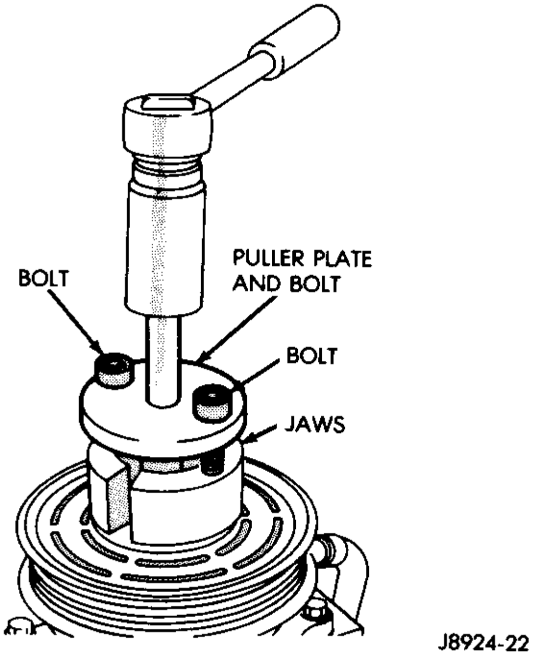


Fig. 7 Install Puller Plate

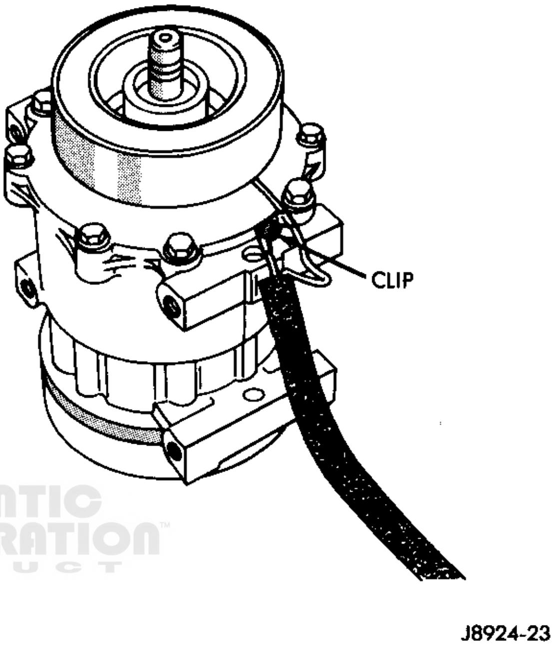


Fig. 8 Loosen Coil Lead Wire

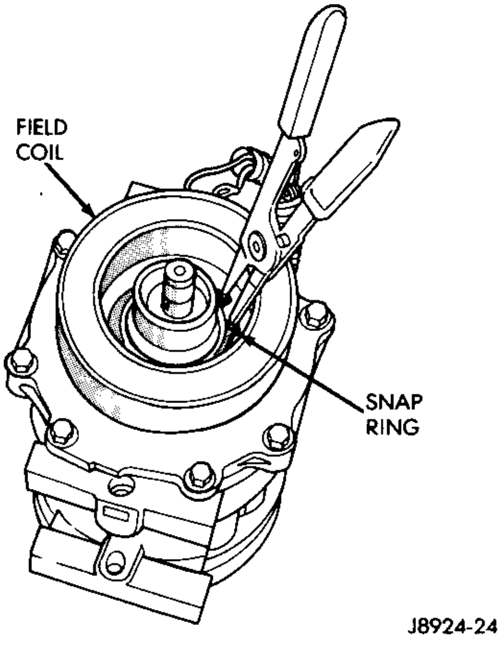
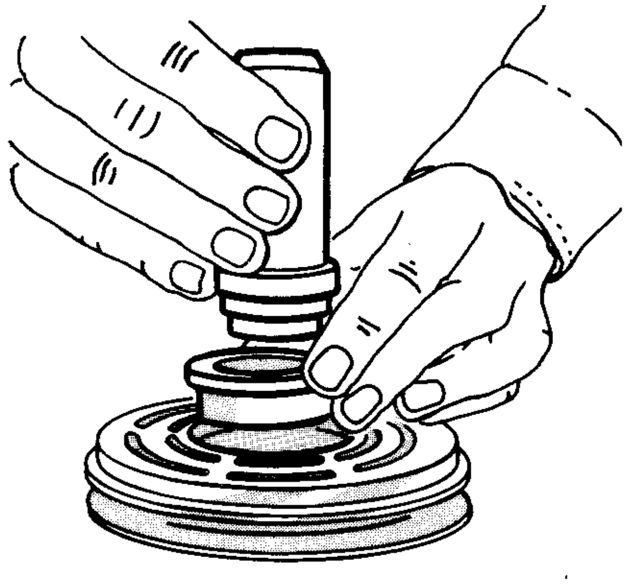


Fig. 9 Remove Snap Ring and Field Coil

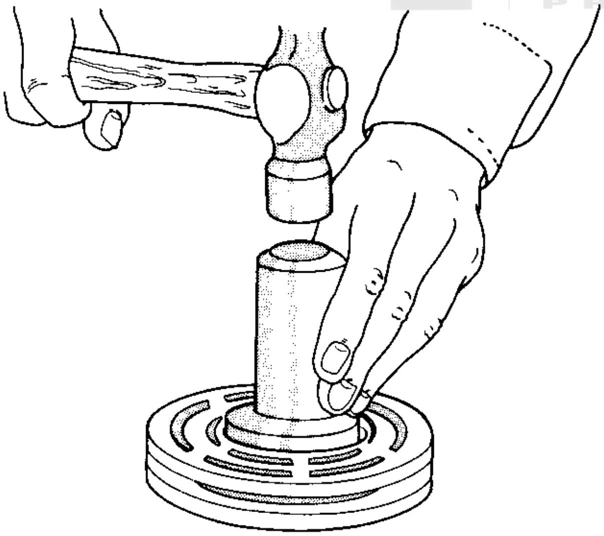
The air gap is determined by the spacer shims. When reinstalling or installing a new clutch assembly, try the original shims first. When installing a new clutch onto a compressor that previously did not have a clutch, use 0.040, 0.020, and 0.005 shims from the clutch accessory sack.

(14) If the air gap does not meet the specification given, add or subtract shims as required.



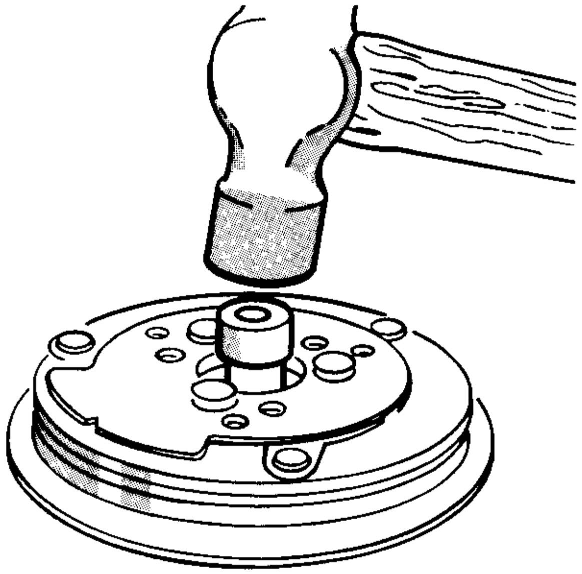
J8924-25

Fig. 10 Install Rotor Installer Set



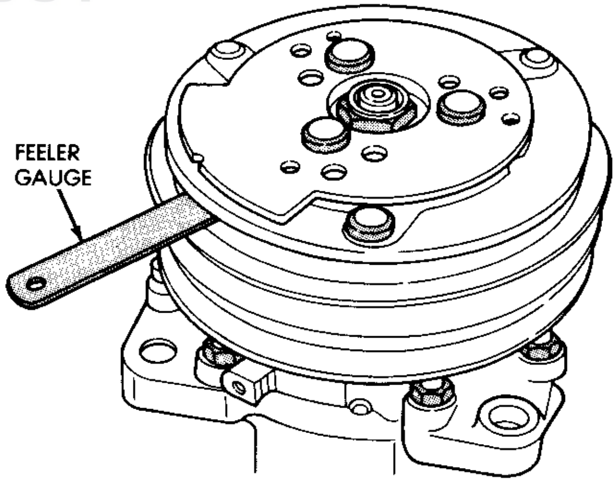
J8924-26

Fig. 11 Install Rotor



J8924-27

Fig. 12 Install Front Plate to Shaft



J8924-28

Fig. 13 Check Air Gap

COMPRESSOR SHAFT SEAL REMOVAL

(1) Insert the two pins of the front plate spanner into any two threaded holes of the clutch front plate (Fig.14). Hold clutch plate stationary. Remove hex nut with 19mm (3/4 inch) socket.

(2) Remove clutch front plate using puller (Fig.15). Align puller center bolt to compressor shaft. Thumb tighten the three puller bolts into the threaded holes.

(3) Turn center bolt clockwise with 19mm (3/4 inch) socket until front plate is loosened.

Shaft seal replacement should be done on the bench. Never use any old parts of the shaft seal assembly. Rebuild the complete assembly.

(4) Using either of the snap ring tools, insert the tool points into the two holes of the felt ring metal retainer and lift out the felt ring (Fig.16).

(5) Remove the clutch shim. Use O-ring hook and a small screwdriver to prevent shim from binding on shaft (Fig.17).

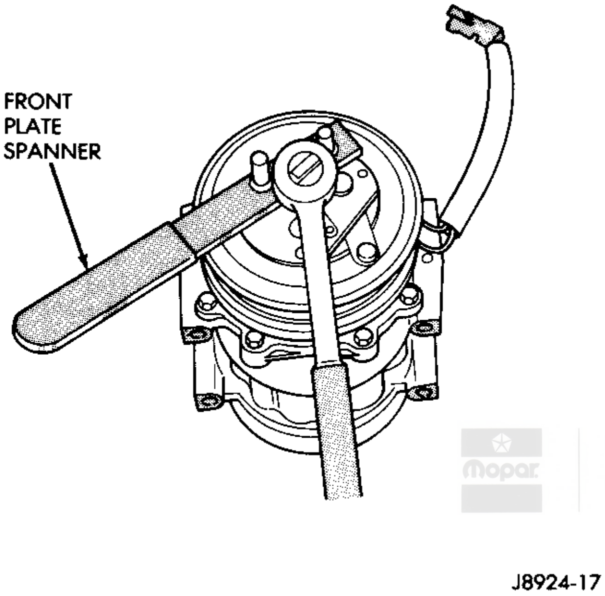


Fig. 14 Remove Hex Nut

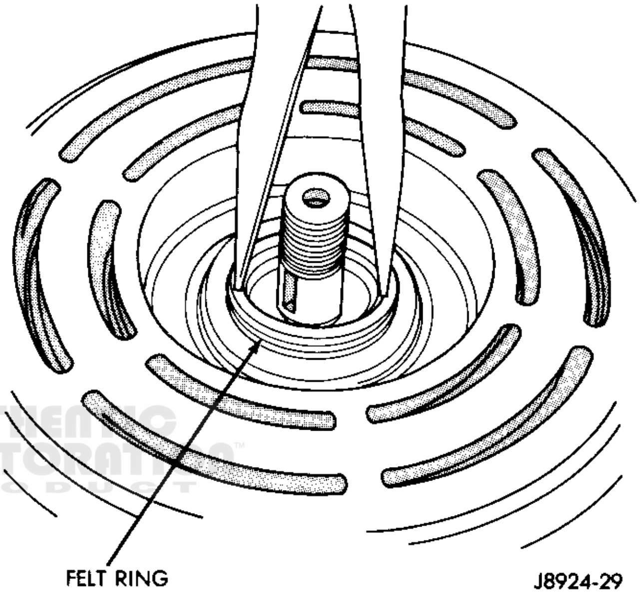


Fig. 16 Remove Felt Ring

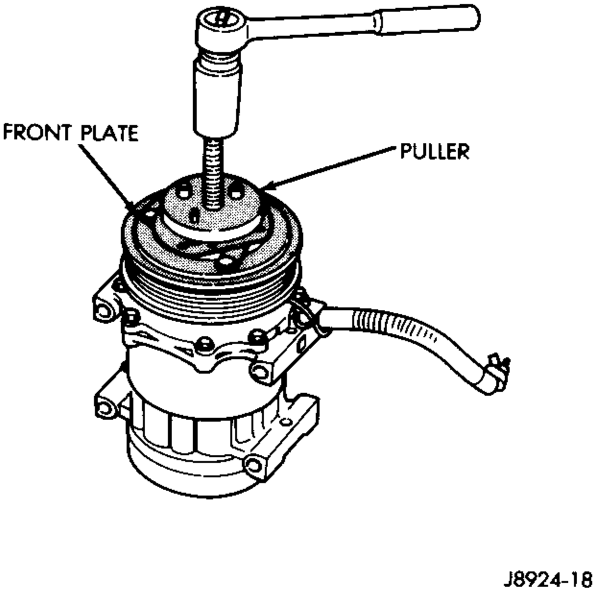


Fig. 15 Remove Clutch Front Plate

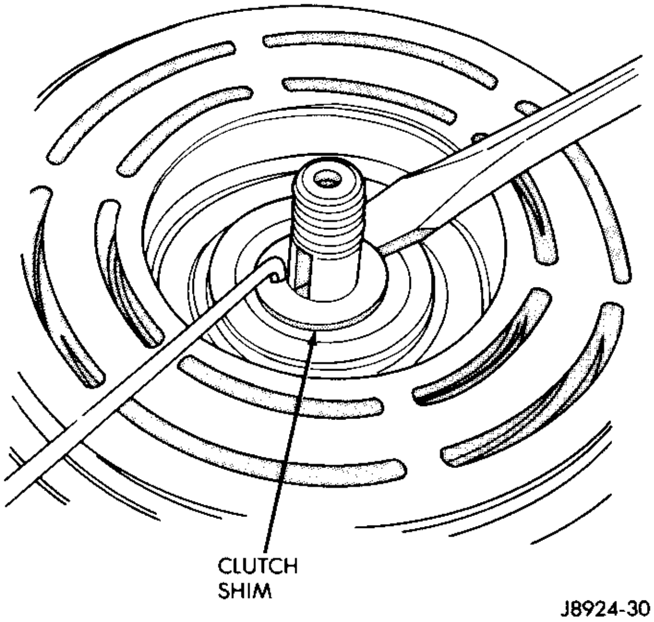


Fig. 17 Remove Clutch Shim

(6) Remove shaft seal seat retaining snap ring with pinch type snap ring pliers (Fig.18).

(7) Remove the shaft seal seat, using seal seat tool (Fig.19).

(8) Insert the Seal Remover and Installer Tool against the seal assembly. Press down against the seal spring and twist the tool until it engages the slots of the seal cage (Fig.20). Lift out seal assembly.

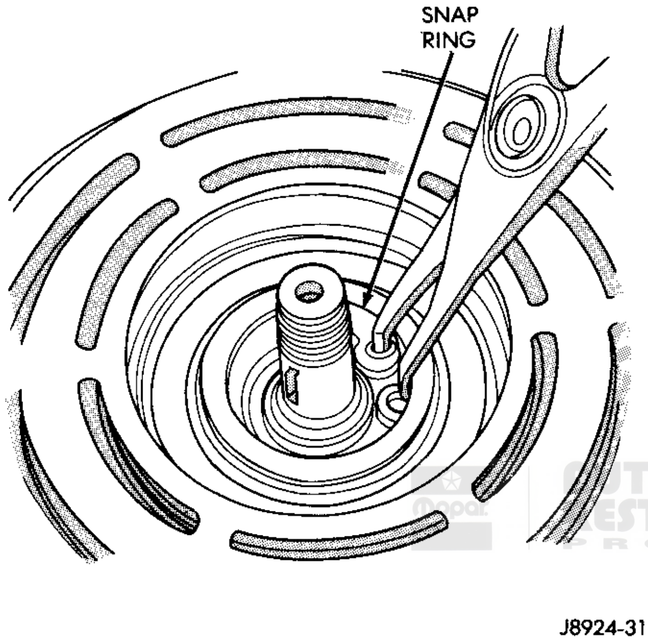


Fig. 18 Remove Snap Ring

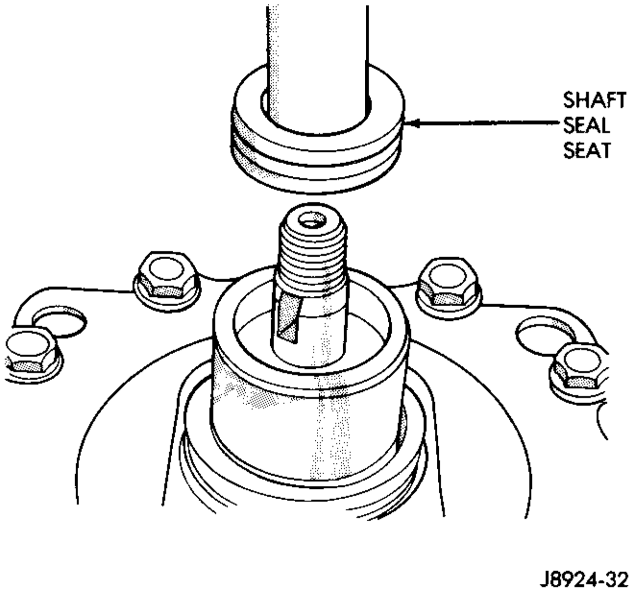


Fig. 19 Remove Shaft Seal Seat

COMPRESSOR SHAFT SEAL INSTALLATION

(1) Clean seal cavity thoroughly:

- Clean thoroughly with a lint-free or synthetic cloth and clean refrigerant oil. Then blow out with dry pressurized vapor.
- Clean with R-11 or R-12. Blow out with dry pressurized vapor.

(2) Make sure all foreign substances are thoroughly removed.

(3) Insert Seal Sleeve Protector over compressor shaft (Fig.21).

(4) Do not touch the new seal lapping surfaces. Dip the mating surfaces in clean refrigerant oil before proceeding.

(5) Engage slots of Seal Remover and Installer to new seal cage and insert seal assembly firmly into place in the compressor seal cavity (Fig.22). Twist tool in opposite direction to disengage tool from seal cage. Remove tool.

(6) Coat seal retainer with clean refrigerant oil. Use seal seat tool to install (Fig.23). Press lightly against seal.

(7) Install snap ring. Beveled edge lies outward from compressor. Flat side lies toward compressor. It may be necessary to lightly tap the snap ring to securely position it in its groove.

(8) Replace clutch spacer shims.

(9) Tap new felt ring into place (Fig.24).

(10) Align front plate keyway to compressor shaft key.

(11) Using Shaft Protector, tap front plate to shaft until it has bottomed to the clutch shims (Fig.25). Listen for a distinct change of sound during the tapping process.

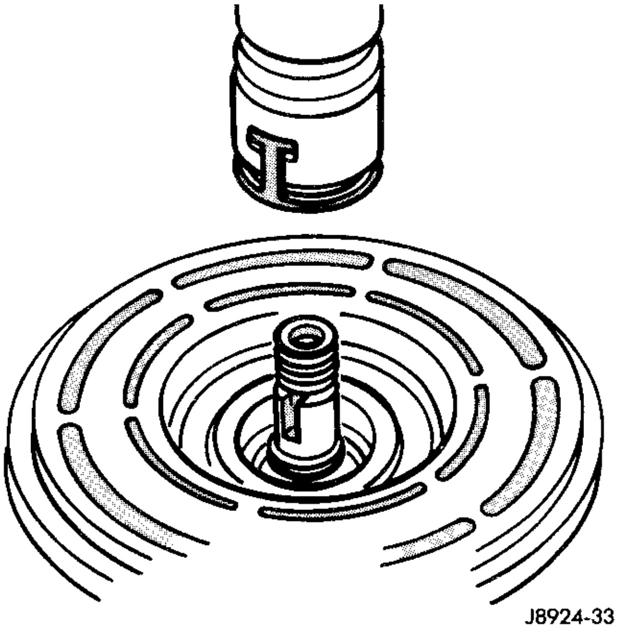


Fig. 20 Remove Seal Assembly

(12) Replace shaft hex nut. Torque to 34-40 N•m (25-30 ft lbs).

(13) Check air gap with feeler gauge to 0.016 to 0.032 inch. If air gap is not consistent around the circumference, lightly pry up at the minimum variations (Fig.26). Lightly tap down at points of maximum variation.

The air gap is determined by the spacer shims. When reinstalling or installing a new clutch assembly, try the original shims first. When installing a new clutch onto a compressor that previously did not have a clutch, use 0.040, 0.020, and 0.005 shims from the clutch accessory sack.

If the air gap does not meet the specification given, add or subtract shims as required.

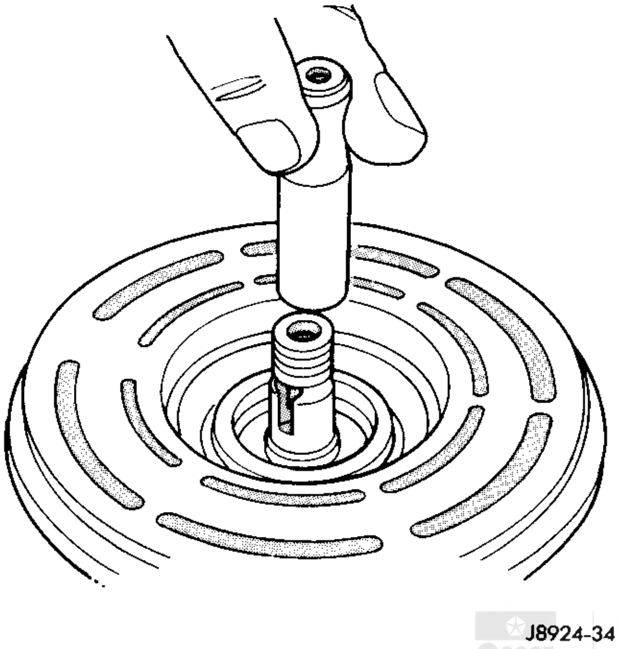


Fig. 21 Insert Seal Sleeve Protector

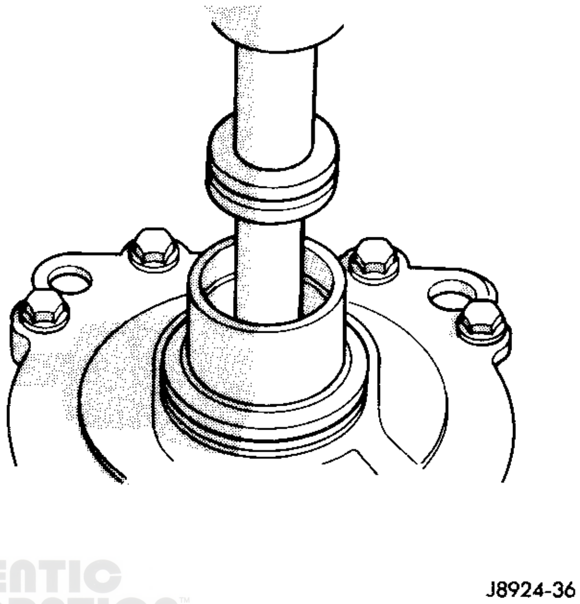


Fig. 23 Install Seal Retainer

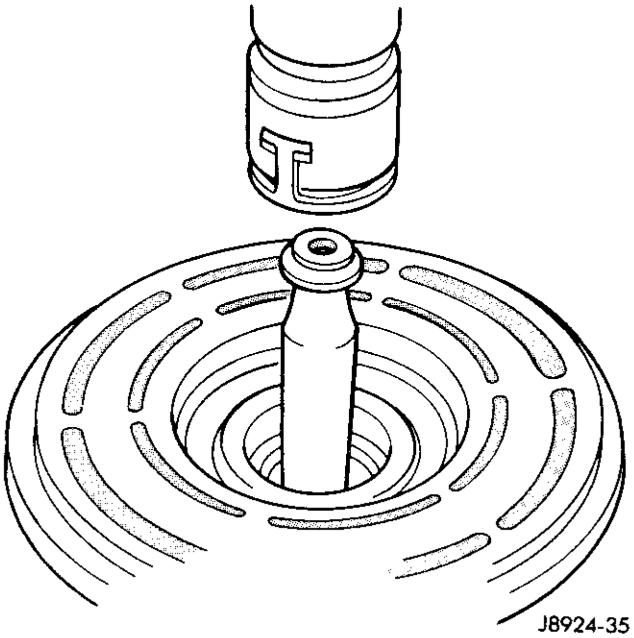


Fig. 22 Install Seal Assembly

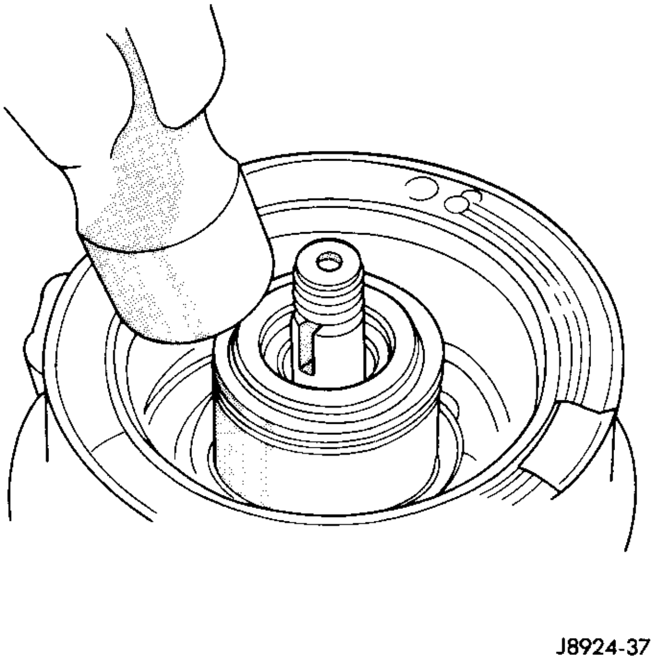


Fig. 24 Install New Felt Ring

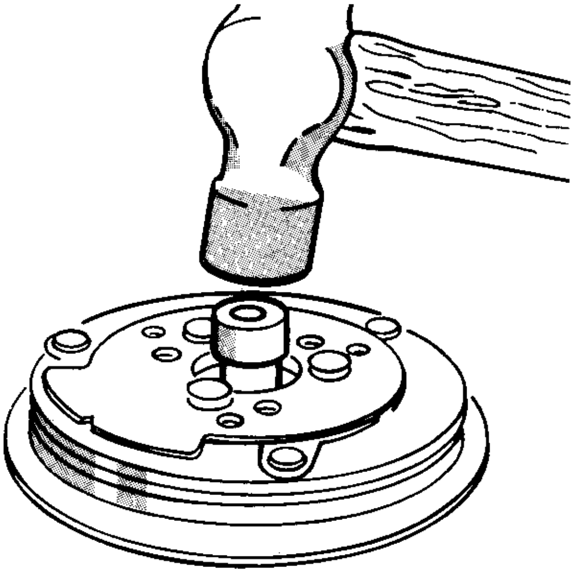


Fig. 25 Install Front Plate to Shaft

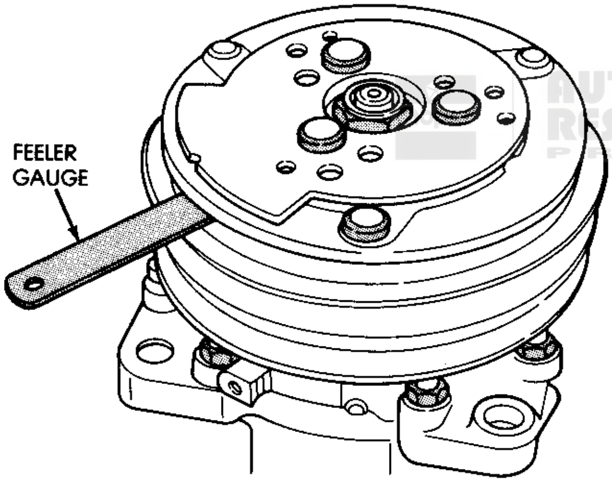


Fig. 26 Check Air Gap

CYLINDER HEAD/VALVE PLATE REMOVAL

(1) Remove cylinder head cap screws.

(2) Using a small hammer and a gasket scraper separate the cylinder head from the valve plate (Fig.27).

(3) Visually inspect all parts for damage.

(4) Separate the valve plate from the cylinder block (Fig.28).

(5) Visually inspect the rear valves and discharge retainer for damage. Discard any component if any portion is damaged.

If valve plate and/or cylinder head are to be reused, carefully remove gasket materials using the gasket scraper. Do not damage cylinder block or valve plate surfaces.

CYLINDER HEAD/VALVE PLATE INSTALLATION

When installing the cylinder head valve plate, use the new gaskets in the parts kit.

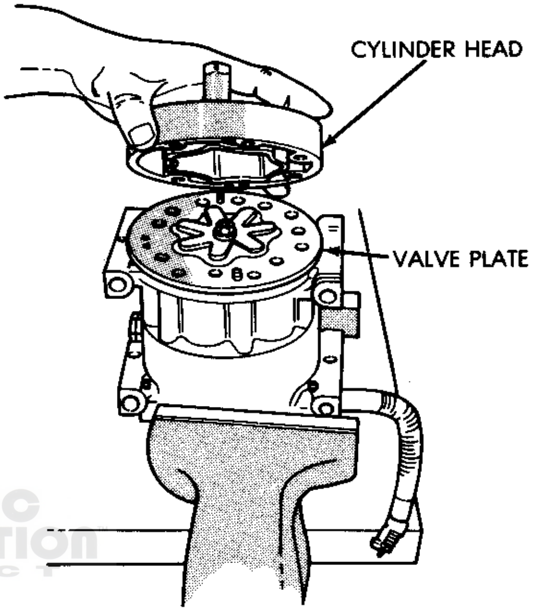


Fig. 27 Remove Cylinder Head

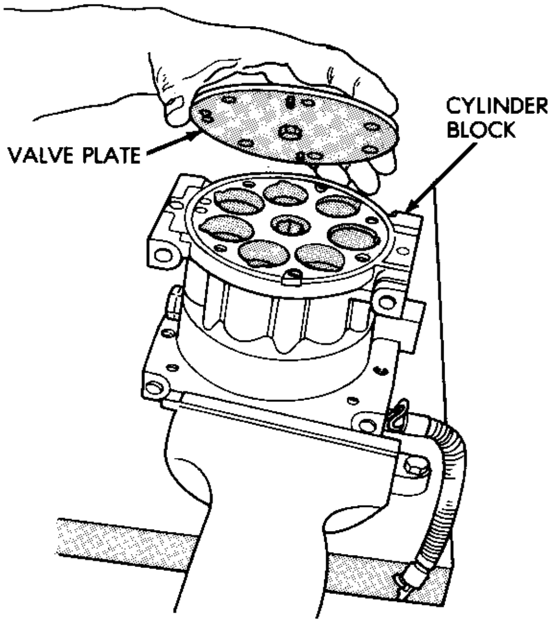


Fig. 28 Remove Valve Plate

(1) Coat new valve plate gasket with clean refrigerant oil.

(2) Install valve plate gasket by aligning valve plate gasket to locating pin holes and oil orifice in cylinder block. (For easy reference, the gaskets have a notch at the bottom outside edge).

(3) Install valve plate by aligning valve plate locating pins to the pin holes in the block and position valve plate.

(4) Install cylinder head and tighten cap screws to 30-33 N•m (22-25 ft lbs) in the order shown (Fig.29).

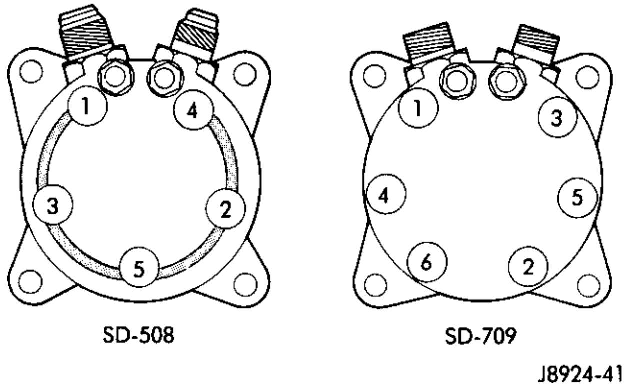


Fig. 29 Cylinder Head Cap Screws Torque Sequence

MJ/XJ MODELS

INDEX

GENERAL INFORMATION

The Climate Control System is a integrated assembly combining air conditioning, heating, and ventilating capabilities for models with air conditioning. Models without air conditioning utilize a similar assembly, without the air conditioning evaporator, to perform heating and ventilating functions.

Both systems consist basically of two parts:

- Blower and Air Inlet Assembly
- Heater Core and Air Distribution Assembly

These assemblies, initially installed as a single unit, may be removed separately from under the instrument panel as required for service.

Heater System

The heater system is a blend air type in which outside air is heated and then blended in varying amounts with cooler outside air to obtain the desired discharge temperature. A heater coolant valve provides full flow to the heater core for all heating modes. The heater coolant valve remains closed for the ventilation mode, allowing discharge air to approach the outside ambient air temperature.

Air Conditioning System

In addition to the above function, the air conditioning system provides an evaporator for cooling and dehumidification of incoming outside air prior to blending with the heated air and is thus referred to as a "reheat system" system. The evaporator is in operation during the A/C mode and also in the defrost mode for defogging purposes. The evaporator is not in operation at ambient temperatures below approximately -1°C (30°F). Evaporator temperature is controlled by a fixed setting thermostat switch which cycles the compressor clutch to maintain minimum evaporator temperature. The blower is automatically in operation in all models for heater or air conditioning systems, except in the OFF mode in which case the blower and the outside air are shut off.

The cooling unit is mounted on the dash panel and the cooled air is discharged from the instrument panel registers. The registers are adjusted to provide general or localized cooling.

Sight Glass/Low Pressure Switch

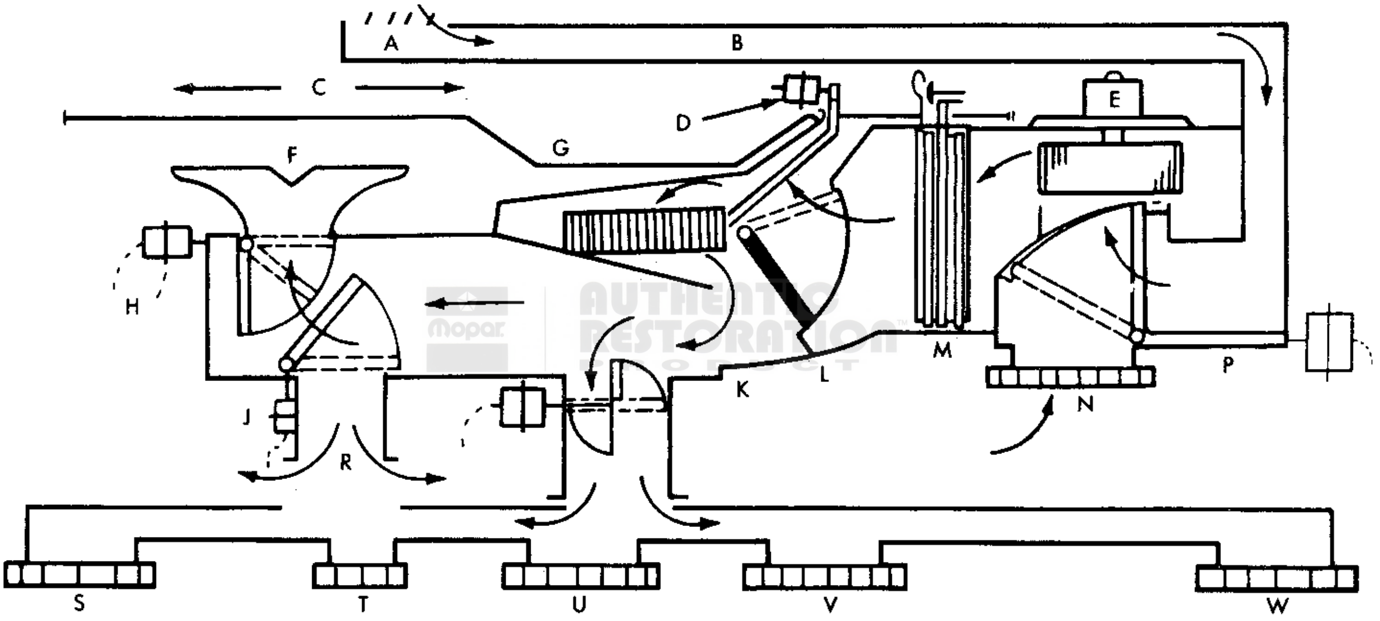
The sight glass provides a visual check of the system, while the low pressure switch disengages the magnetic clutch if the pressure in the system drops below 193 kPa (28 psi).

Heater Valve

The heater valve regulates coolant flow to the heater core. It requires vacuum to shut off flow to the heater core.

MJ/XJ Model vehicles only are equipped with a bypass-type heater water valve. When the heater valve is closed, coolant flow to the heater core is bypassed back to the engine. When the heater valve is open, coolant is directed through the heater core and back to the engine.

Airflow Diagram

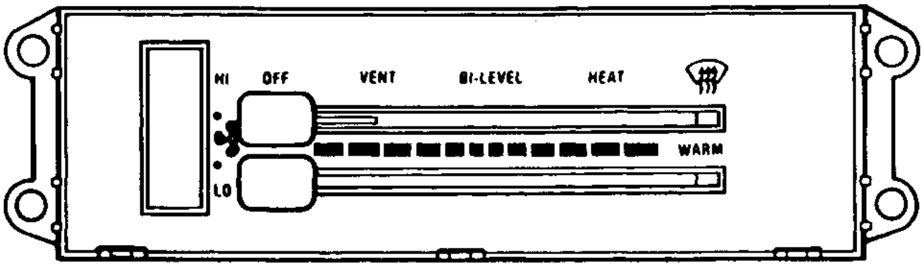


A - OUTSIDE AIR INLET
B - COWL
C - DASH PANEL
D - WATER VALVE
E - BLOWER ASSEMBLY
F - DEFROSTER
G - HEATER CORE
H - DEFROSTER DOOR
J - FLOOR DOOR
K - PANEL DOOR

L - BLEND DOOR
M - EVAPORATOR CORE
N - RECIRCULATION AIR INLET
P - RECIRCULATION DOOR
R - FLOOR OUTLET
S - LEFT HAND REGISTER
T - LEFT HAND LAP COOLER
U - LEFT CENTER REGISTER
V - RIGHT CENTER REGISTER
W - RIGHT HAND REGISTER

J8924-81

HEATER CONTROL UNIT

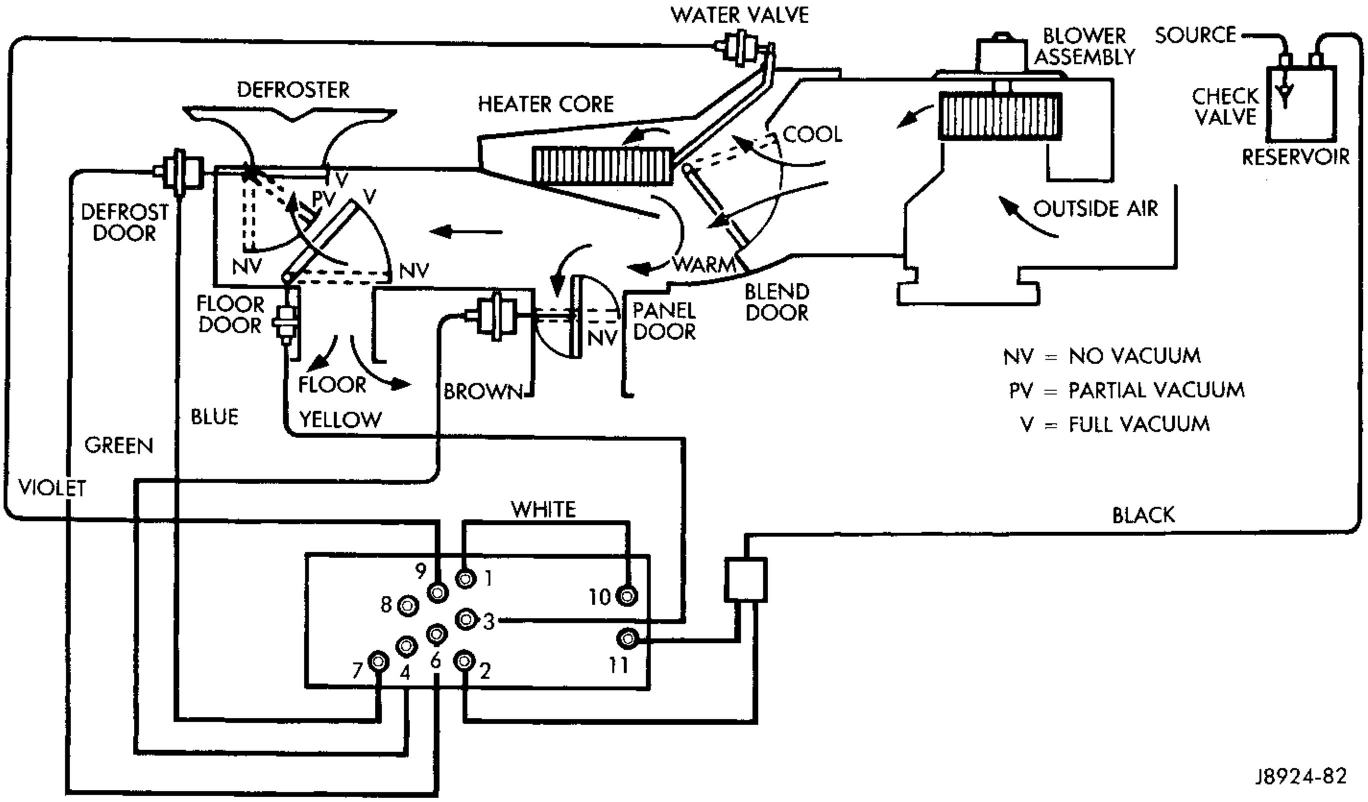


HEATER SYSTEM OPERATION

Mode Lever Position	Air Discharge	Blower Speeds	Panel Door	Floor Door	Defrost Door	Water Valve
Off	Closed	None	Closed	Closed	Closed	Closed
Vent	Panel Registers	4	Open	Closed	Closed	Closed
Bi-Level	Panel Registers and Floor With Def. Bleed	4	Open	Open	Bleed	Open (1)
Heat	Floor With Def. Bleed	4	Closed	Open	Bleed	Open (1)
	Defroster	4	Closed	Closed	Open	Open (1)

(1) WATER VALVE CLOSES IN FULL "COOL" TEMPERATURE LEVER POSITION.

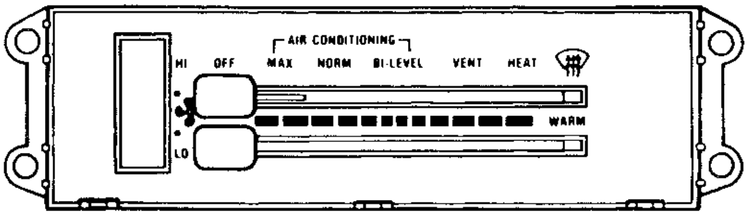
HEATER CONTROL SYSTEM VACUUM SCHEMATIC



NV = NO VACUUM
PV = PARTIAL VACUUM
V = FULL VACUUM

J8924-82

A/C CONTROL UNIT

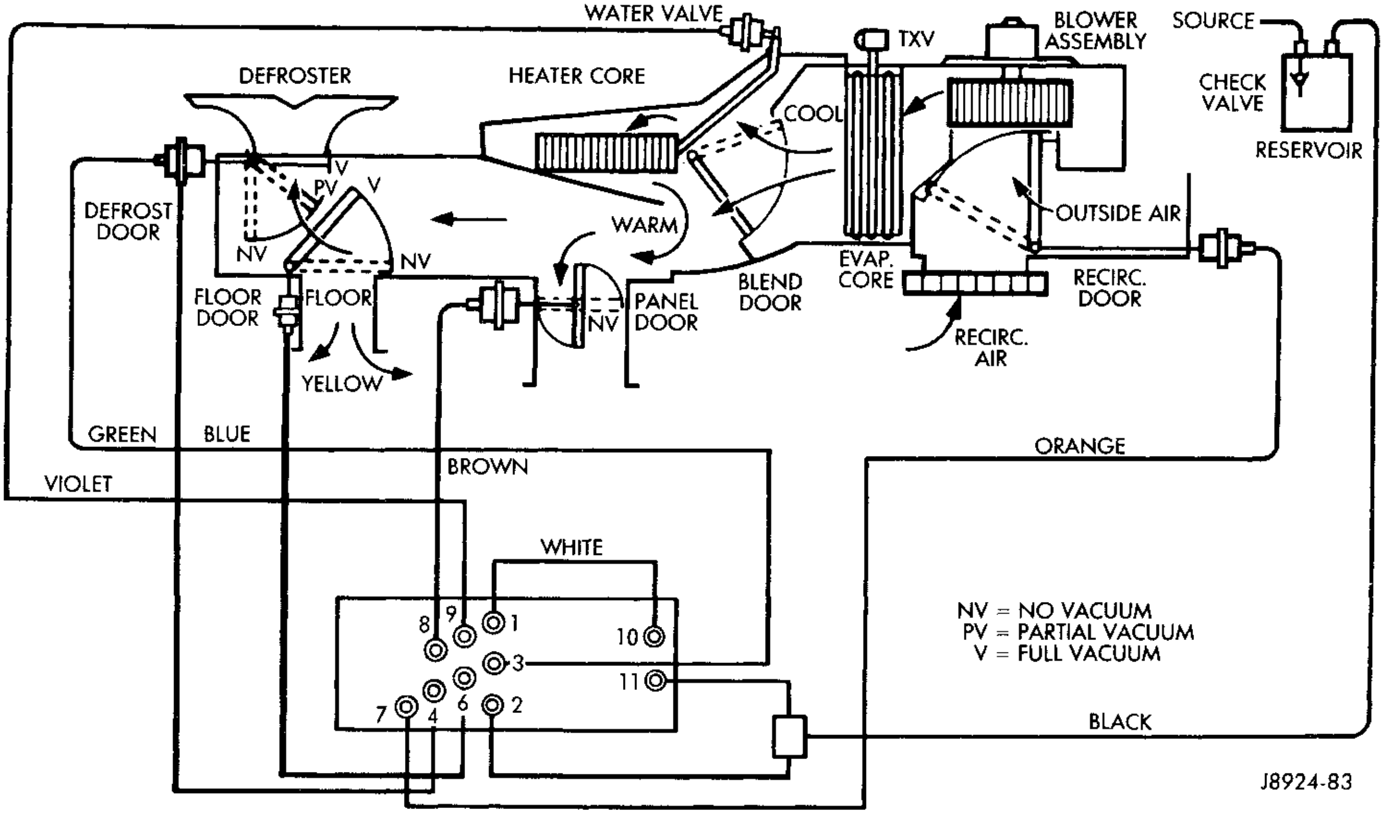


A/C SYSTEM OPERATION

Mode Lever Position	Air Discharge	Blower Speeds	Recirc. Door	Panel Door	Floor Door	Defrost Door	A/C Cmp.	Water Valve
Off	Closed	None	Recirc.	Open	Indeterminate	Open	Off	Closed
Max A/C	Panel Registers With Floor Bleed	4	Recirc.	Open	Bleed	Closed	On	Open (1)
Norm A/C	Panel Registers With Floor Bleed	4 (2)	Outside	Open	Bleed	Closed	On	Open (1)
Bi-Level	Panel Registers and Floor With Def. Bleed	4 (2)	Outside	Open	Open	Bleed	On	Open (1)
Vent	Panel Registers With Floor Bleed	4	Outside	Open	Bleed	Closed	Off	Closed
Heat	Floor With Def. Bleed	4	Outside	Closed	Open	Bleed	Off	Open (1)
♨	Def. With Floor Bleed	4	Outside	Closed	Bleed	Open	On	Open (1)

(1) WATER VALVE CLOSES IN FULL "COOL" TEMPERATURE LEVER POSITION. (2) SPEEDS ARE REDUCED BY APPROXIMATELY 2.0 VOLTS.

AIR CONDITIONING CONTROL SYSTEM VACUUM SCHEMATIC



HEATER AND A/C CONTROL PANEL REPLACEMENT

(1) Disconnect the battery negative cable.

(2) Remove the four instrument panel bezel attaching screws and remove the instrument panel bezel (Fig.1). Bezel is snap fit at locations shown.

(3) Remove the radio attaching screws (Fig.2).

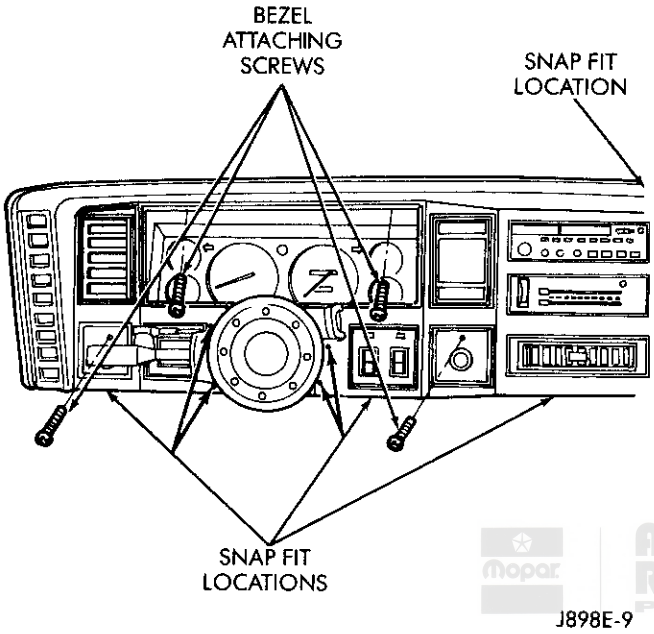


Fig. 1 Instrument Bezel Removal/Installation — MJ/XJ

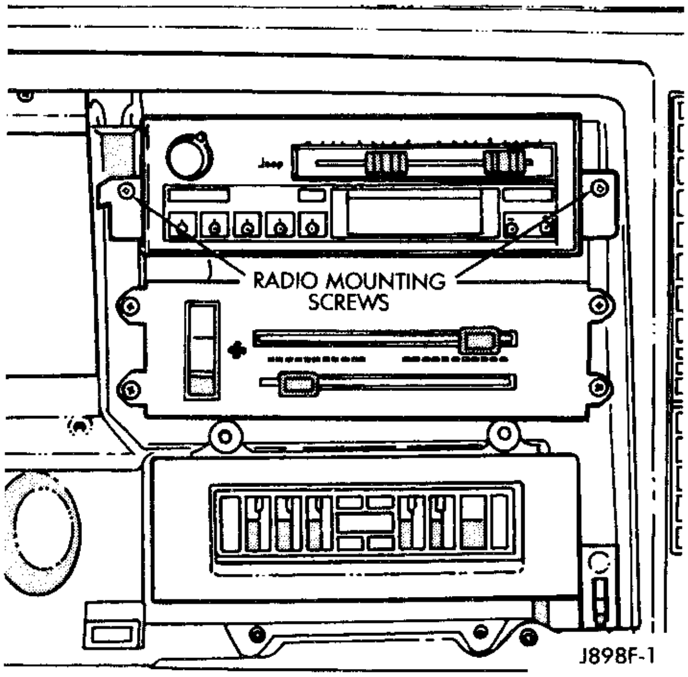


Fig. 2 Remove/Install Radio Mounting Screws

(4) Disconnect the radio electrical connector, ground lead and antenna lead (Fig.3).

(5) Remove the A/C-heater control panel screws (Fig.4).

(6) Remove the electrical connectors (Fig.5).

(7) Disconnect the vacuum hoses by releasing the locking tabs (Fig.6).

(8) Remove the control cable locking tab by using a screwdriver to release the tab (Fig.7).

(9) Remove the ring on the end of the cable from the arm on the bottom of the control panel (Fig.8).

(10) To Install the A/C-heater control panel, reverse the removal procedures.

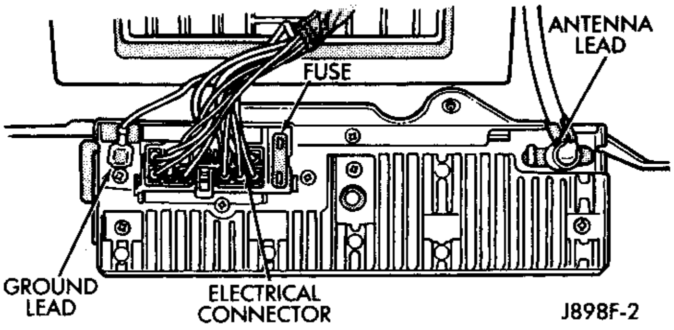


Fig. 3 Disconnect/Connect Radio Wiring Harnesses

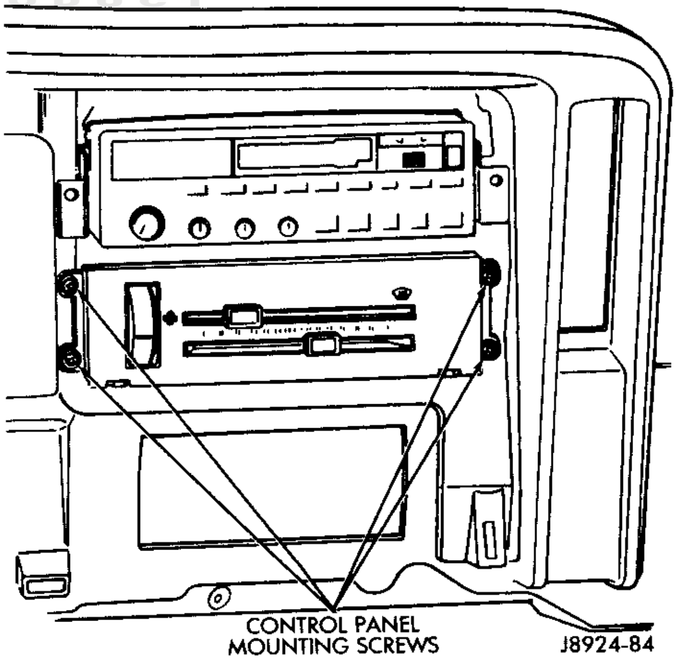


Fig. 4 Remove/Install Control Panel Mounting Screws

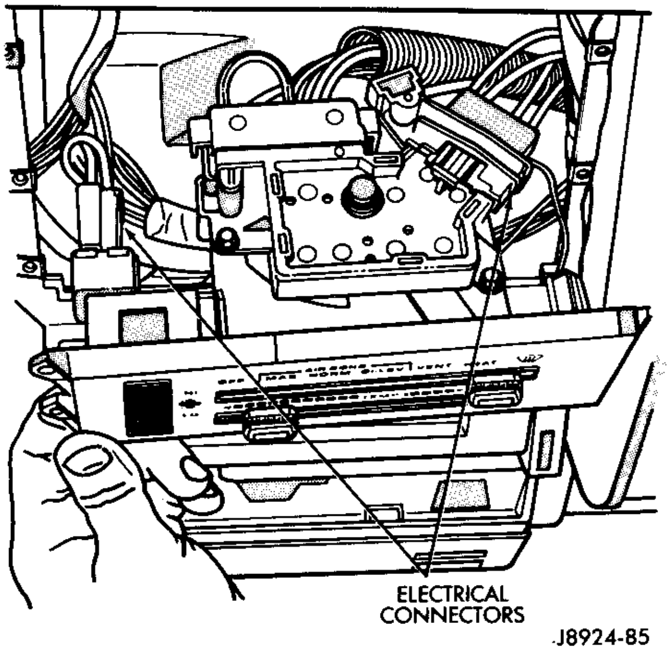


Fig. 5 Remove/Install Electrical Connectors

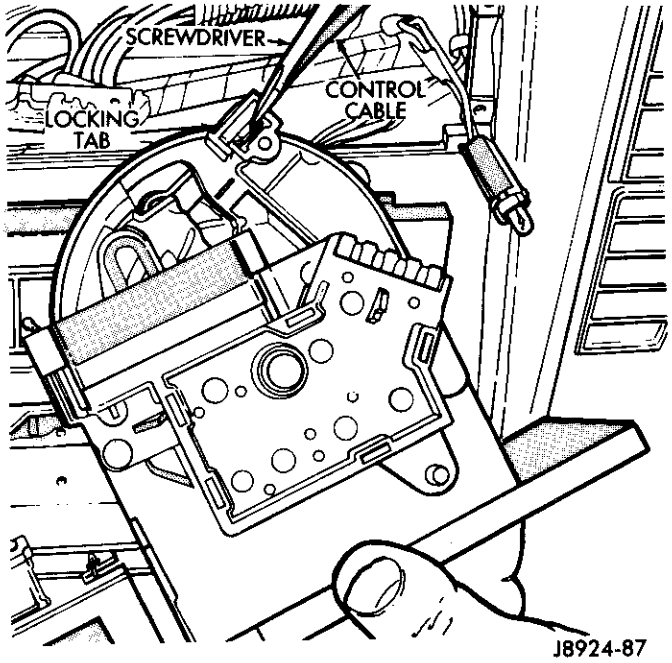


Fig. 7 Disconnect Control Cable Locking Tab

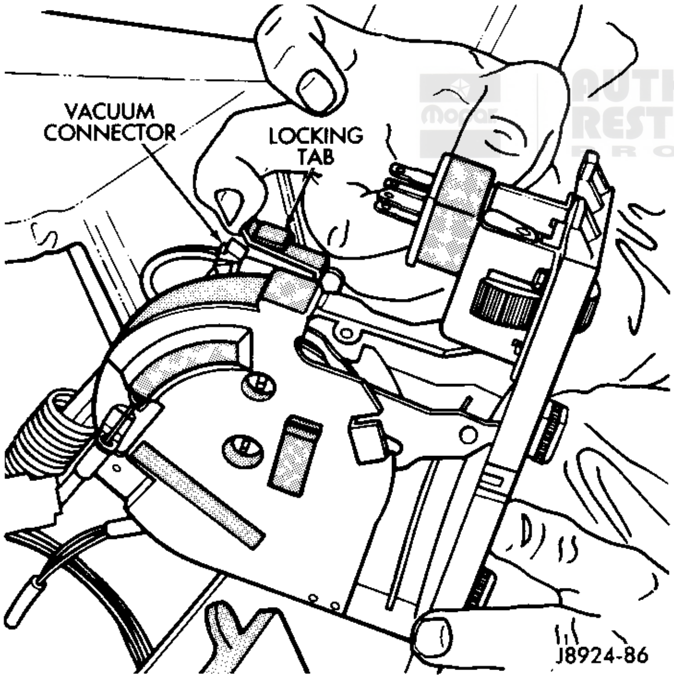


Fig. 6 Remove Vacuum Hose Connector

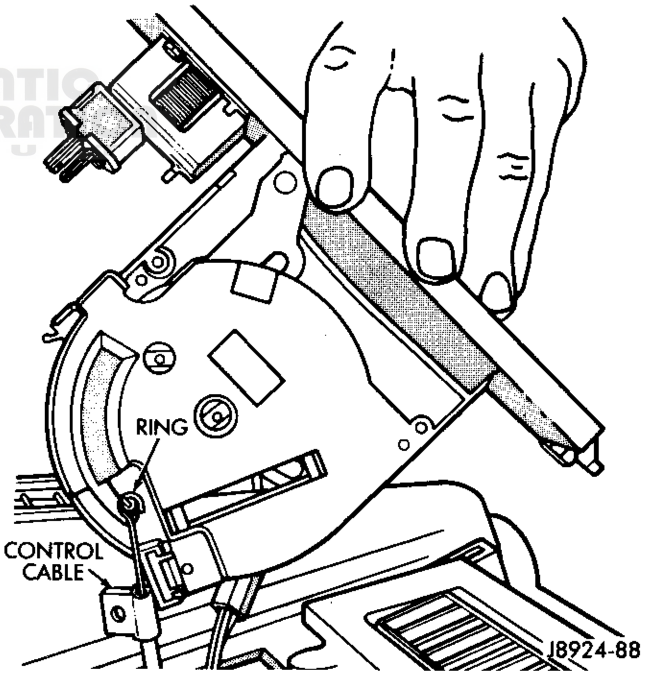


Fig. 8 Remove Control Cable From Controller

BLOWER MOTOR/FAN REPLACEMENT

The blower motor and fan are accessible and may be removed from the engine compartment.

4.0L

(1) Remove the coolant bottle retaining strap and move bottle aside.

(2) Remove the coolant bottle bracket.

(3) Remove the anti-lock brake pump and bracket as an assembly (if equipped) and move the pump aside.

(4) Disconnect the blower motor wires (Fig.9).

(5) Remove the blower motor and fan assembly mounting screws (Fig.10).

(6) Remove the blower motor and fan assembly.

(7) Remove the blower motor fan from the motor shaft for access to the motor attaching nuts (Fig.11).

Ears (A) and (B) of retainer clip 3 must be over flat surface (C) on motor shaft 1.

(8) To install the blower fan and motor, reverse the removal procedures.

2.5L

(1) Disconnect the blower motor wires (Fig.9).

(2) Remove the blower motor and fan assembly mounting screws (Fig.10).

(3) Remove the blower motor and fan assembly.

(4) Remove the blower motor fan from the motor shaft for access to the motor attaching nuts (Fig.11).

(5) To install the blower fan and motor, reverse the removal procedures.

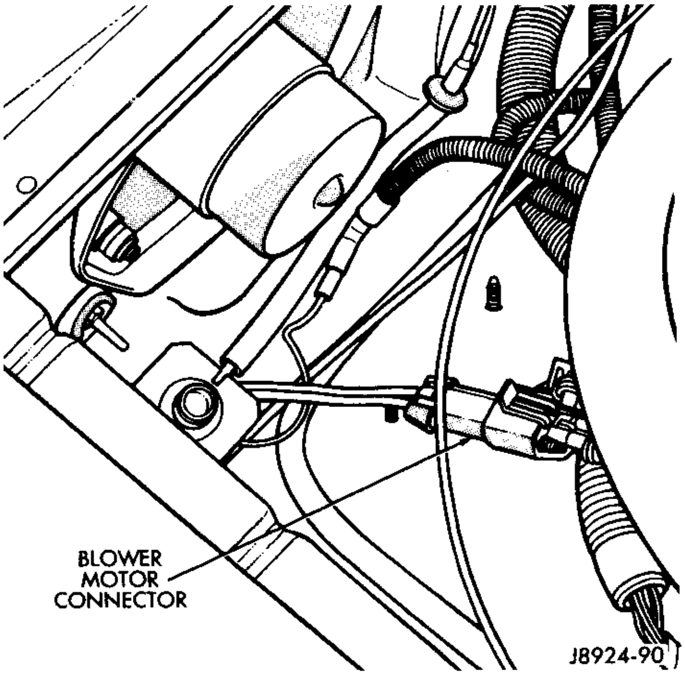


Fig. 9 Disconnect/Connect Blower Motor Connector

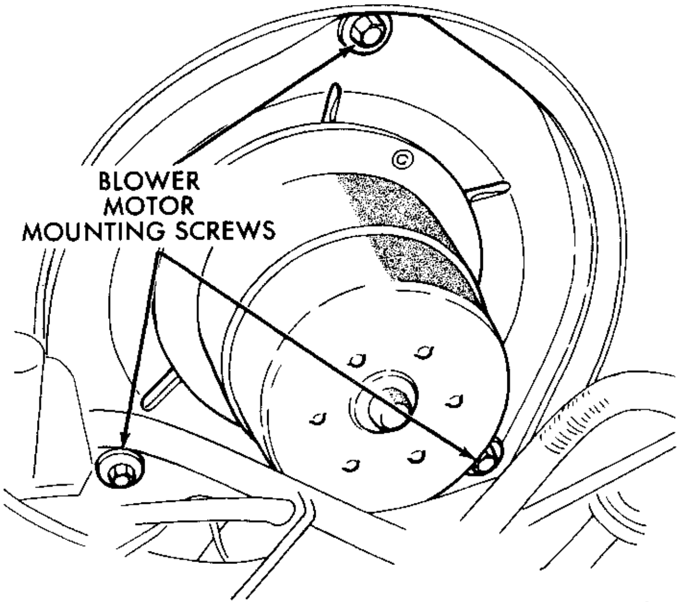


Fig. 10 Remove/Install Blower Motor Mounting Screws

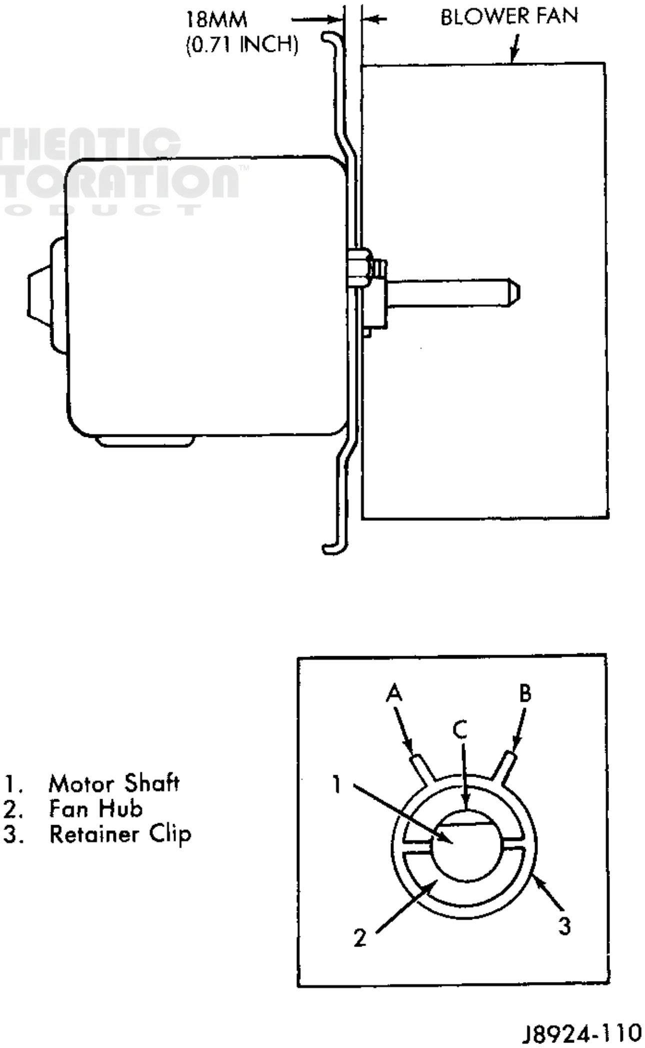


Fig. 11 Blower Fan Installation

HEATER CORE

Removal

(1) Drain the radiator.

(2) Disconnect the heater hoses at the heater core inlet and outlet tubes.

(3) Remove the evaporator/blower housing as described in this section.

(4) Remove the retaining screws and remove the heater core by pulling it straight out of the housing (Fig.12).

Installation

(1) Install the heater core into the housing and install the screws.

(2) Install the evaporator/blower housing as outlined in this section.

(3) Cement the seal into place in order to keep it from moving when the blower assembly is installed.

(4) Connect the heater hoses to the heater core.

(5) Fill the cooling system.

HEATER CORE HOUSING REPLACEMENT

(1) Remove the evaporator/blower housing as described in this section.

(2) Remove the heater core as described in this section.

(3) Remove the defroster duct as described in this section.

(4) Disconnect the vacuum hoses from the heater core housing vacuum motors.

(5) Remove the two heater housing retaining nuts in the engine compartment and remove the heater core housing.

(6) Transfer the vacuum motors, etc. to the replacement housing.

(7) To install the heater core housing, reverse the removal procedure.

(8) Tighten the steering column retaining nuts to 28 N•m (20 ft-lbs) torque.

(9) Install the heater core as described in this section.

(10) Install the evaporator/blower housing as described in this section.

DEFROSTER DUCT REPLACEMENT

(1) Disconnect the battery negative cable.

(2) If equipped with center console remove the console as follows:

(a) On models with manual transmission, remove shift knob, boot and bezel.

(b) On models with automatic transmission floor shift, remove shift handle cap, plunger, spring, T-lock, shift handle and shift bezel (Fig.13).

(c) If equipped with power mirrors, pry mirror switch out of console cover and disconnect switch connector (Figs.14 and 15).

(d) Remove console cover screws (Fig.15).

(e) Remove console cover from base (Fig.16).

(f) Remove console base.

(3) Remove the lower instrument panel.

(4) Remove the left kick panel and remove the instrument panel retaining bolt.

(5) Remove the two instrument panel retaining bolts located at the steering column.

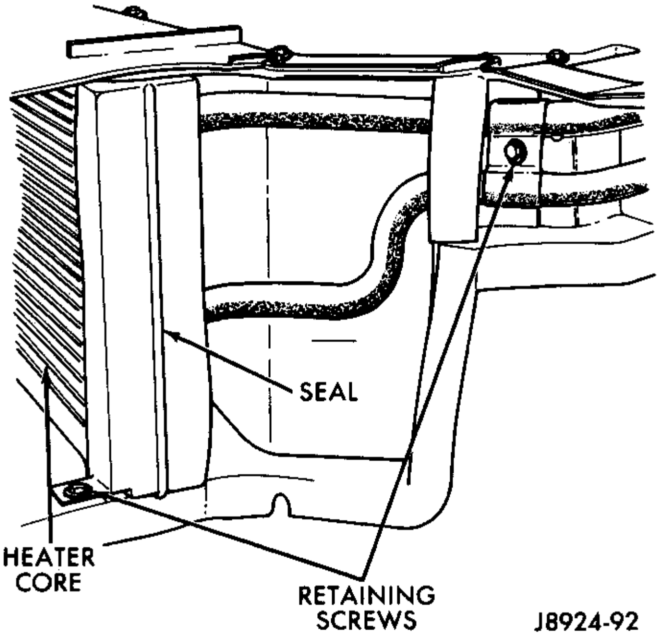


Fig. 12 Remove/Install Heater Core

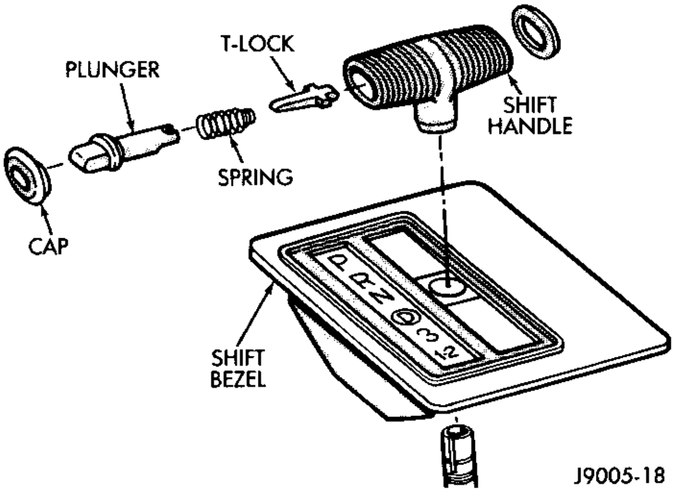


Fig. 13 Shift Handle Components With Automatic Transmission

(6) Remove the right and left A-pillar trim.

(7) Remove the defroster bezel attaching screws and bezel.

(8) Remove the instrument panel retaining screws.

(9) Lower the steering column.

(10) Pull the instrument panel, approximately 3 inches, away from the dash panel.

(11) Remove the defroster duct retaining screws and then remove the defroster duct and disconnect the hoses.

(12) To install the defroster duct reverse the removal procedure.

(13) Tighten the steering column retaining nuts to 28 N•m (20 ft-lbs) torque.

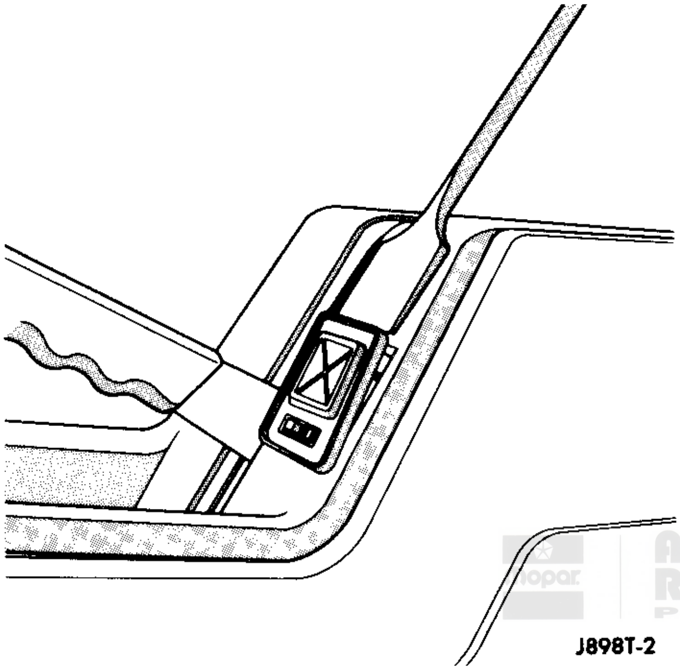


Fig. 14 Power Mirror Switch

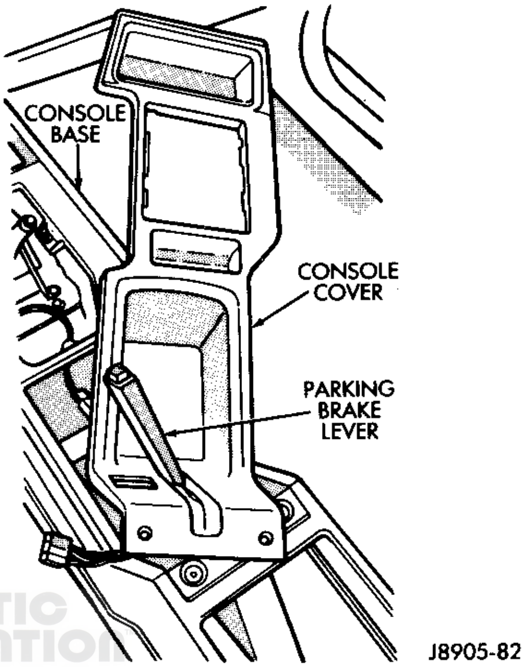


Fig. 16 Remove Console Cover and Base

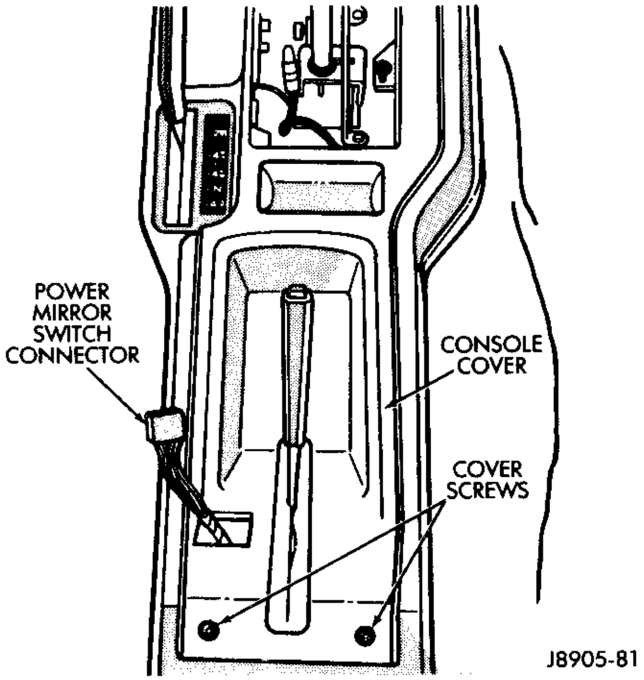


Fig. 15 Console Cover Screws and Power Mirror Switch Connector

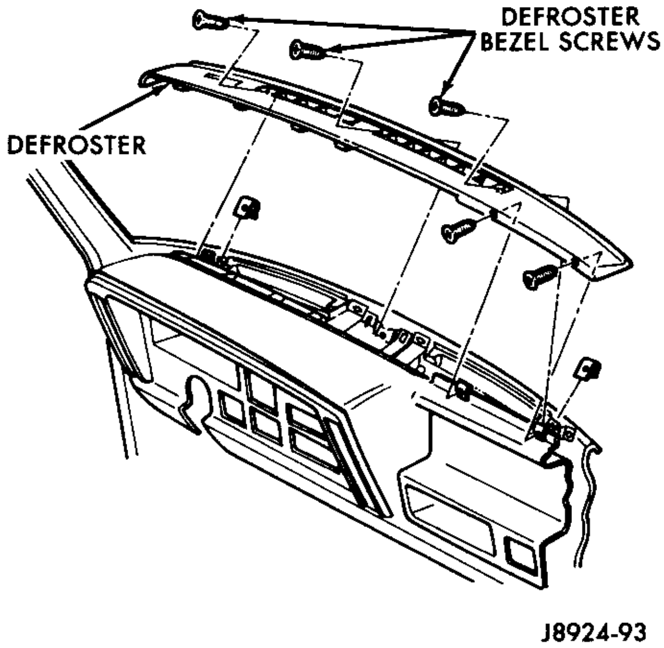


Fig. 17 Remove/Install Defroster Bezel

HEATER CONTROL CABLE REPLACEMENT

(1) Remove the heater control panel as described in this section.

(2) Remove the clip and the cable self-adjusting clip from the blend air door lever at the bottom of the evaporator/blower housing (Fig.18). Then remove the cable by squeezing the tabs with needle nose pliers being careful not to break the housing.

(3) To install the heater control cable, reverse the removal procedure.

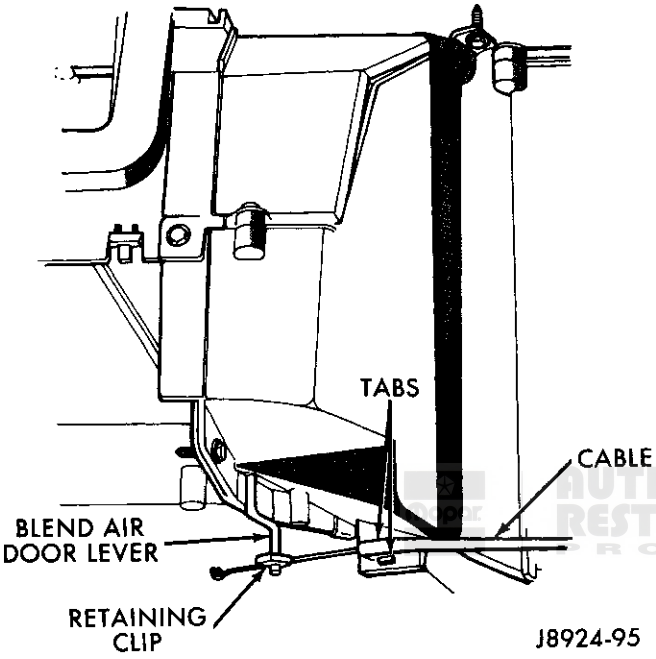


Fig. 18 Heater Control Removal/Installation

HEATER/DEFROSTER/INSTRUMENT PANEL OUTLET DOOR VACUUM MOTOR

(1) If equipped with center console remove the console as follows:

(a) On models with manual transmission, remove shift knob, boot and bezel.

(b) On models with automatic transmission floor shift, remove shift handle cap, plunger, spring, T-lock, shift handle and shift bezel (Fig.19).

(d) If equipped with power mirrors, pry mirror switch out of console cover and disconnect switch connector (Figs.20 and 21).

(c) Remove console cover screws (Fig.21).

(e) Remove console cover from base (Fig.22).

(f) Remove console base.

(2) Remove the lower instrument panel.

(3) Disconnect the vacuum hose(s) from the vacuum motor.

(4) Remove the vacuum motor attaching nuts and remove the vacuum motor from the bracket.

(5) Remove the vacuum motor linkage retaining clip and remove the rod from the door actuating lever (Fig.23).

(6) To install a vacuum motor, reverse the removal procedure.

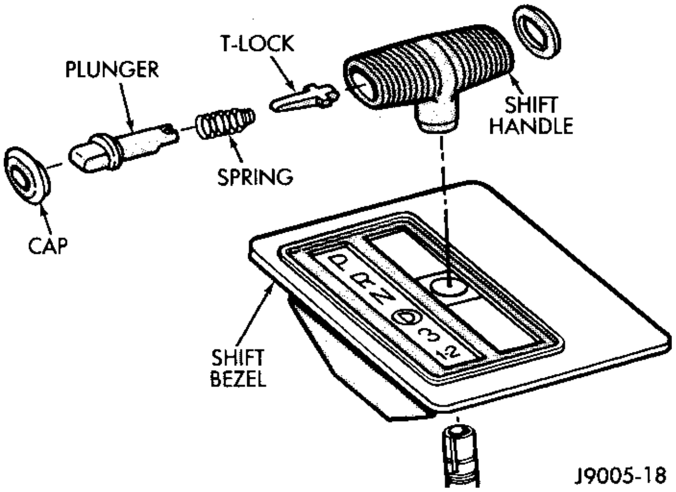


Fig. 19 Shift Handle Components With Automatic Transmission

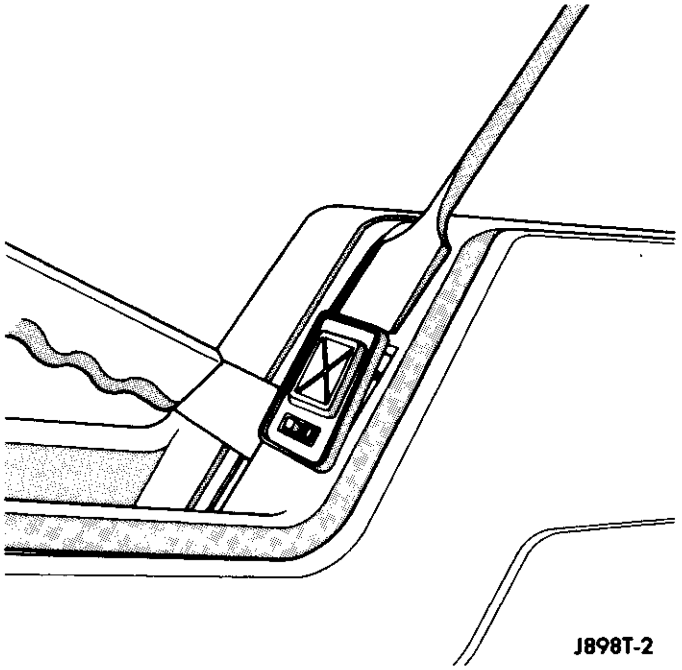


Fig. 20 Power Mirror Switch

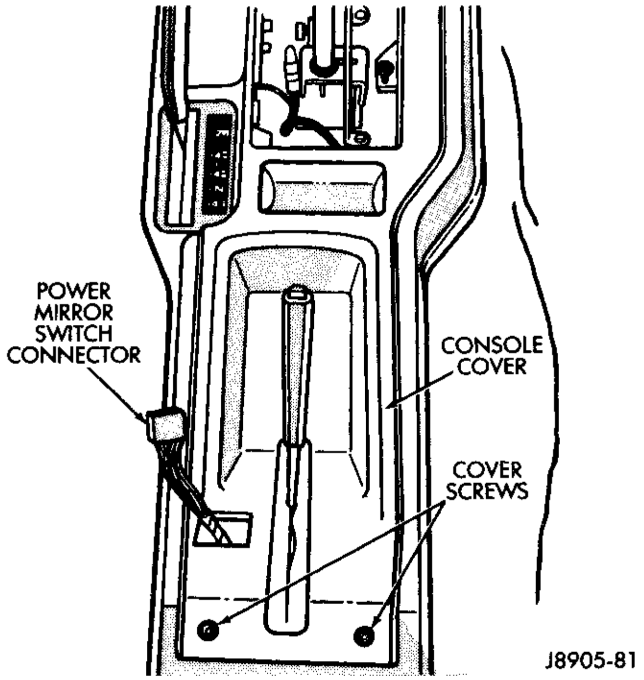


Fig. 21 Console Cover Screws and Power Mirror Switch Connector

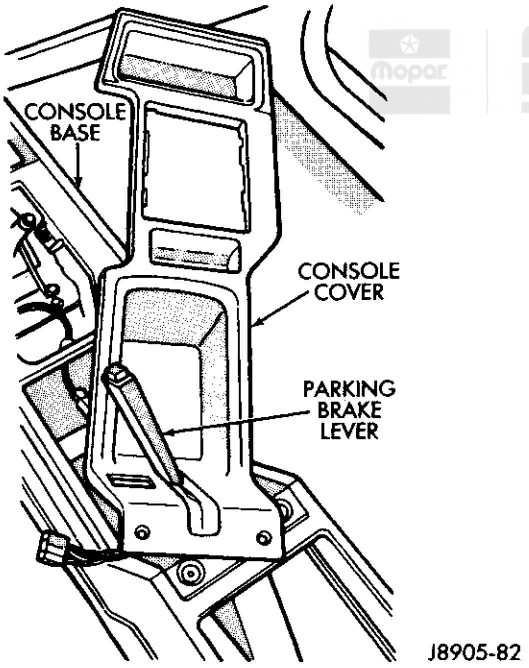


Fig. 22 Remove Console Cover and Base

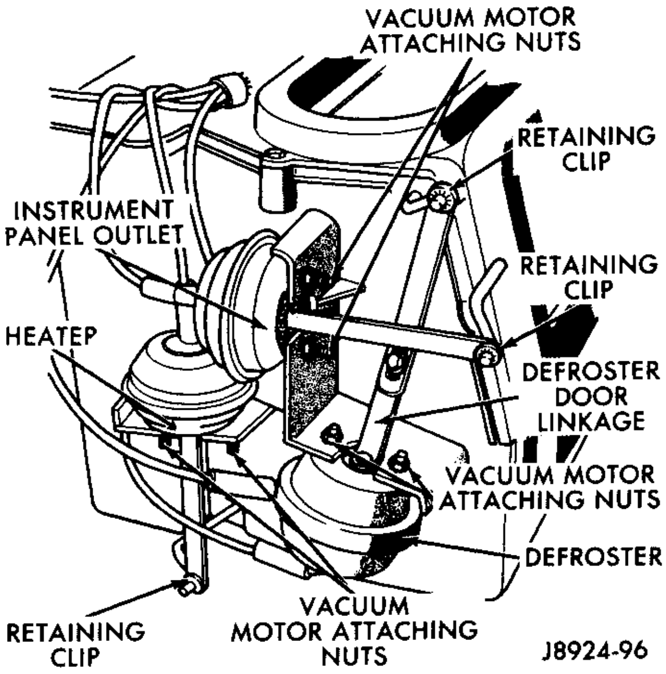


Fig. 23 Vacuum Motor Removal/Installation

A/C RECIRCULATING AIR DOOR VACUUM MOTOR

(1) Remove the vacuum motor cover (Fig.24).

(2) Disconnect the vacuum hose (Fig.25).

(3) Remove the actuating rod clip and disengage the rod from the door lever.

(4) Remove the vacuum motor retaining nuts and then remove the vacuum motor.

(5) To install the motor, reverse the removal procedures.

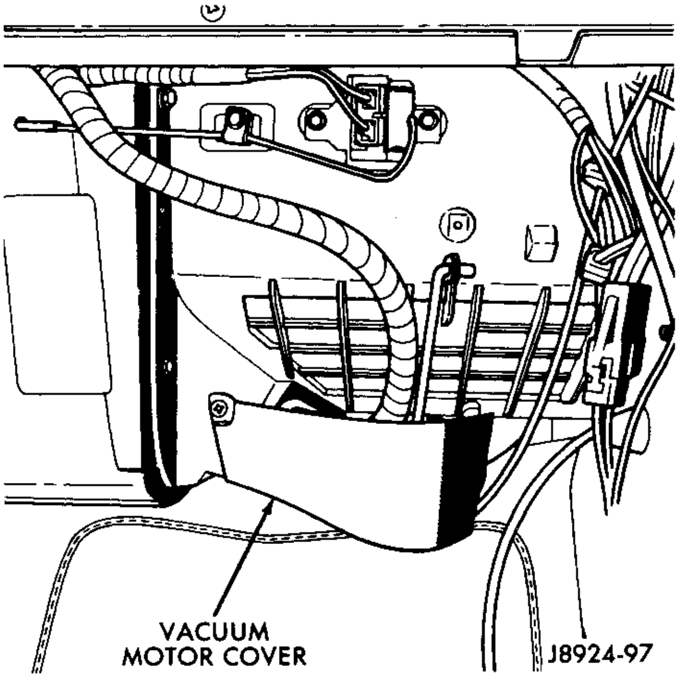


Fig. 24 Remove/Install Vacuum Door Motor Cover

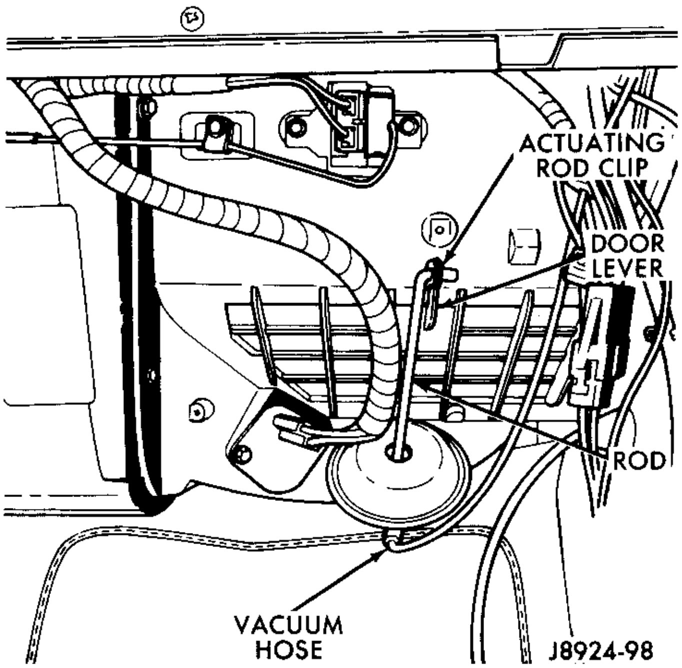


Fig. 25 Remove/Install Vacuum Door Motor

CONDENSER/RECEIVER DRIER

Removal 2.5L

(1) Drain the radiator.

(2) Disconnect the fan shroud and the radiator hoses.

(3) Disconnect the transmission cooler lines (if equipped with automatic transmission).

(4) Evacuate the A/C system and disconnect the A/C hoses from the condenser.

(5) Unplug the harness from the low pressure switch (Fig.26).

(6) Remove the radiator and condenser as an assembly.

(7) Remove the retaining bolts and separate the condenser from the radiator.

(8) Remove the receiver/drier from the condenser.

Keep receiver/drier openings plugged at all times to prevent moisture from entering the receiver/drier.

(9) To install the receiver/drier and condenser, reverse the removal procedures.

Add one ounce of refrigerant oil to the system when replacing the condenser.

(10) Fill the cooling system.

(11) Charge the A/C system as described in this section.

Condenser Removal 4.0L

(1) Disconnect the fan shroud and electric fan from the radiator.

(2) Remove the upper crossmember and bracket.

(3) Evacuate the A/C system, disconnect the A/C hoses from the condenser and plug the openings.

(4) Remove the attaching hardware and brackets securing the condenser to the radiator.

(5) Remove the condenser.

(6) To install the condenser, reverse the above procedures.

(7) Add one ounce of refrigerant oil to the A/C system when replacing the condenser.

(8) Charge the A/C system.

Receiver Dryer Removal 4.0L

(1) Evacuate the A/C system, disconnect the A/C hoses from the receiver dryer and plug the openings (Fig.).

(2) Unplug the harness from the low pressure switch.

(3) Remove the nut attaching the receiver dryer to the side sill weld stud.

(4) Remove the receiver dryer.

(5) To install the receiver dryer, reverse the above procedures.

(6) Charge the A/C system.

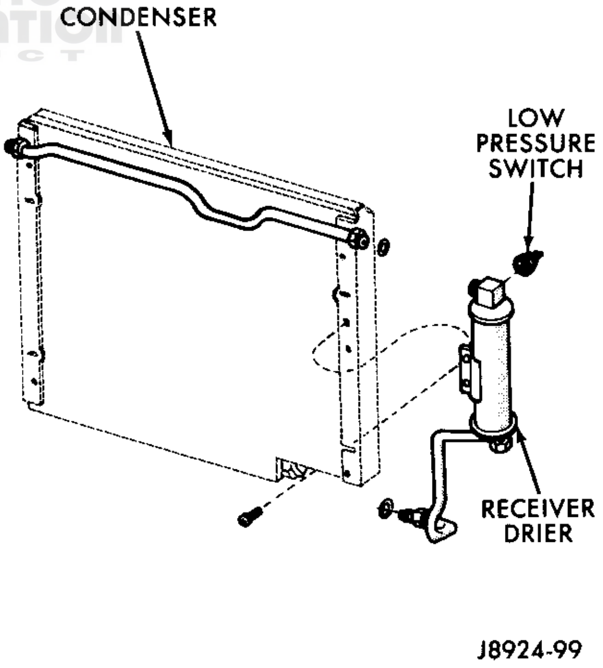


Fig. 26 Remove/Install Condenser Receiver Drier — 2.5L

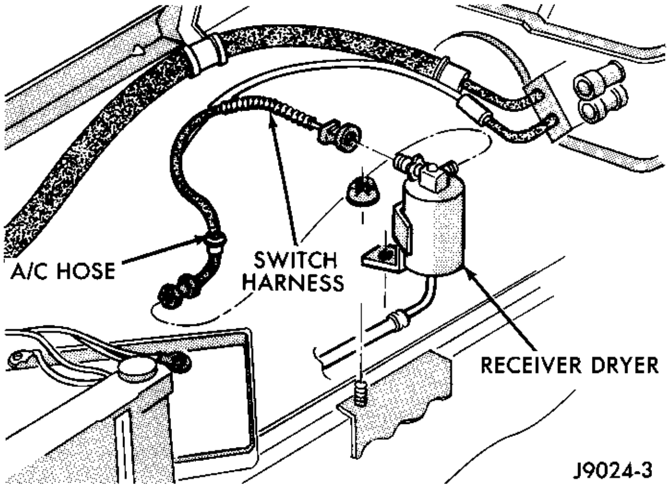


Fig. 27 Remove/Install Receiver Dryer — 4.0L

EVAPORATOR/BLOWER HOUSING

Removal

(1) Disconnect the battery negative cable.

(2) Discharge the A/C system as described in this section and disconnect the A/C hoses from the expansion valve.

(3) Disconnect the blower motor wires and the vent tube.

(4) If equipped with center console remove the console as follows:

  (a) On models with manual transmission, remove shift knob, boot and bezel.

  (b) On models with automatic transmission floor shift, remove shift handle cap, plunger, spring, T-lock, shift handle and shift bezel (Fig.28).

  (c) If equipped with power mirrors, pry mirror switch out of console cover and disconnect switch connector (Figs.29 and 30).

  (d) Remove console cover screws (Fig.30).

  (e) Remove console cover from base (Fig.31).

  (f) Remove console base.

(5) Remove the lower instrument panel.

(6) Disconnect the electrical connections at the blower motor resistors and the A/C thermostat. Disconnect the vacuum hose at the vacuum motor (Fig.32).

(7) Cut the plastic retaining strap that retains the evaporator/blower housing to the heater core housing (Fig.33).

(8) Disconnect and remove the heater control cable.

(9) Remove the clip at the rear of the blower housing flange and remove the retaining screws.

(10) Remove the housing attaching nuts from the studs on the engine compartment side of the dash panel (Fig.34). Remove the evaporator drain tube.

(11) Remove the right kick panel and then remove the instrument panel support bolt.

(12) Gently pull out on the right side of the dash and rotate the housing downward and toward the rear of the vehicle to disengage the housing studs from the dash panel. Then remove the evaporator/blower housing.

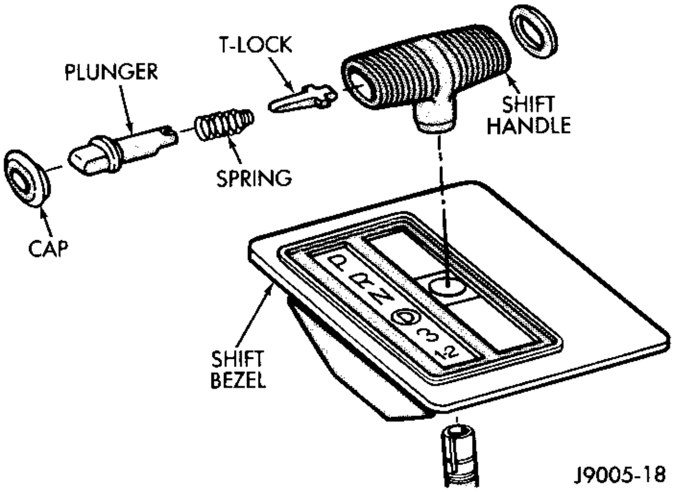


Fig. 28 Shift Handle Components With Automatic Transmission

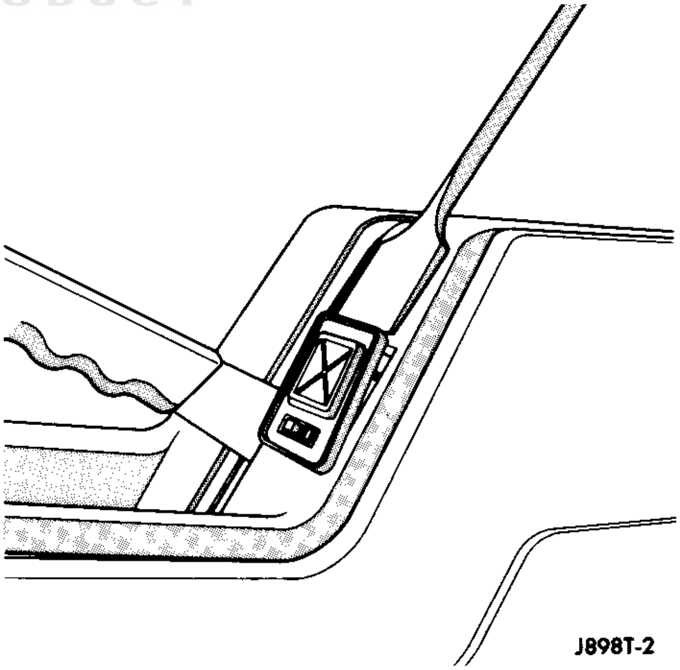


Fig. 29 Power Mirror Switch

Installation

(1) Position the evaporator/blower housing into place, being sure to line up the housings using the provided alignment tabs (Fig.35 and 36).

(2) Install the housing retaining screws and the rear housing clip (Fig.34).

CAUTION: When installing the evaporator/blower housing, care must be taken so as not to trap wires between the housing fresh air inlet and the dash panel on the right side of the housing.

(3) Install the housing retaining nuts on the engine compartment side of the dash panel (Fig.34).

(4) Connect the A/C hoses to the expansion valve and connect the heater blower motor wires.

(5) Attach the wire connections at the blower motor resistors and the A/C thermostat (Fig.32).

(6) Connect the vacuum hose at the vacuum motor and attach the heater control cable.

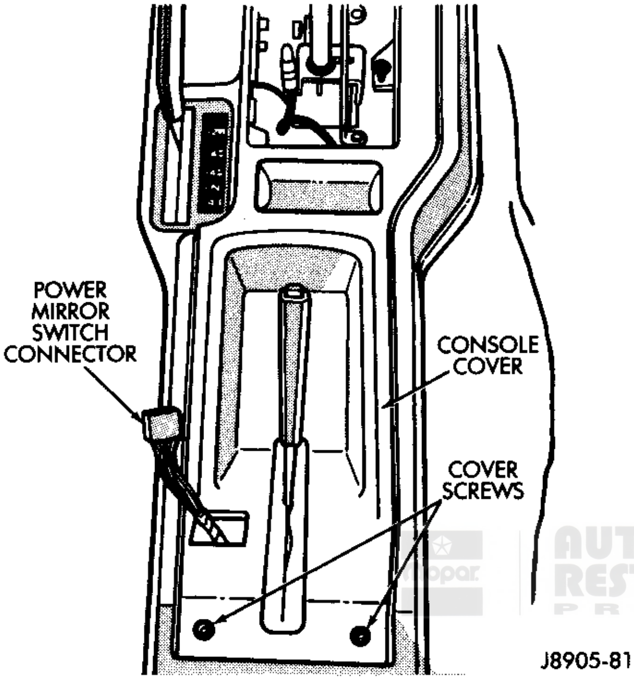


Fig. 30 Console Cover Screws and Power Mirror Switch Connector

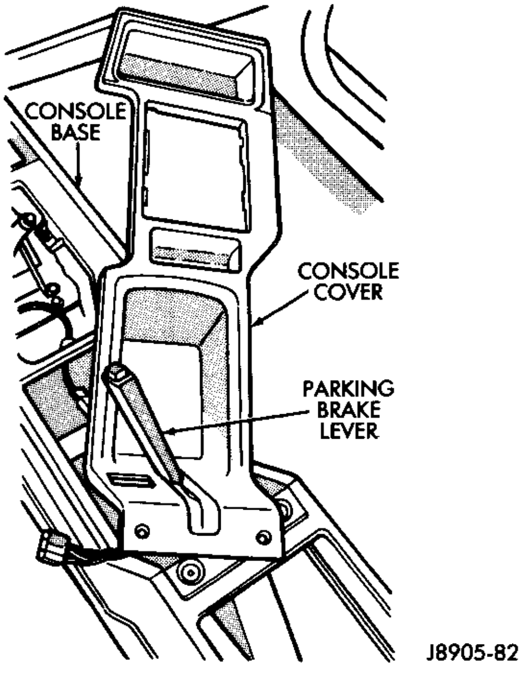


Fig. 31 Remove Console Cover and Base

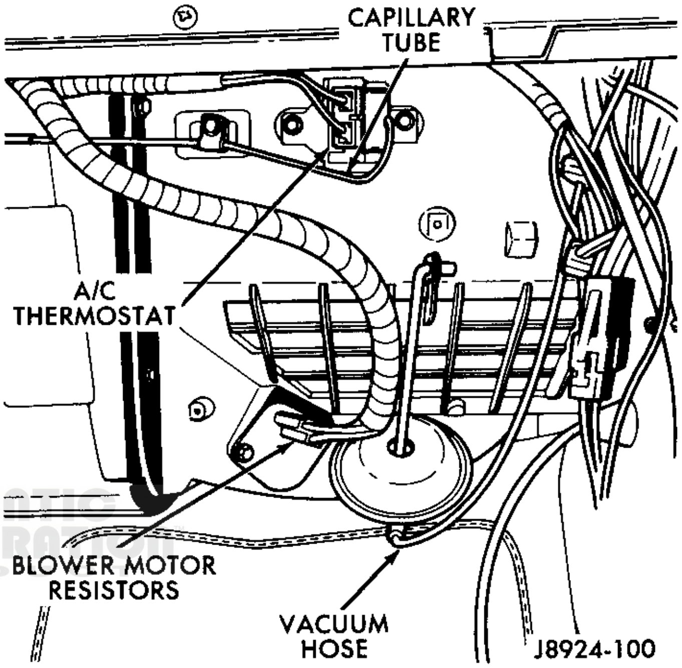


Fig. 32 Evaporator Housing Components

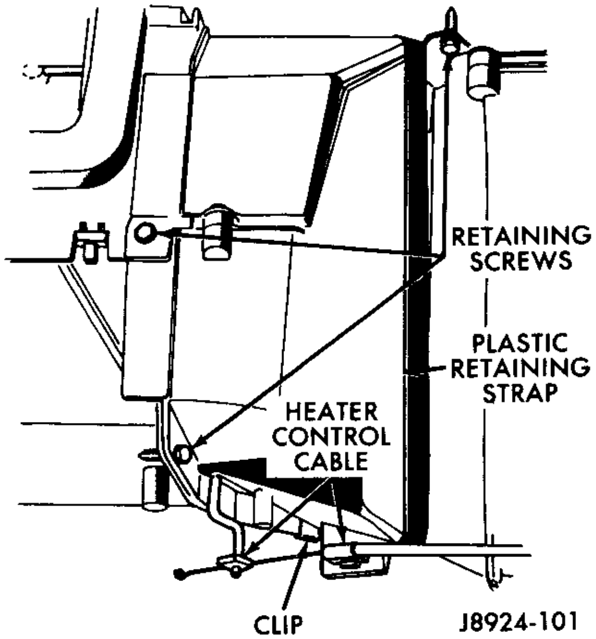


Fig. 33 Evaporator Housing Removal

(7) Install the instrument panel bolt and the kick panel.

(8) Install the lower instrument panel and screws.

(9) Install the console (if equipped).

(10) Connect the battery negative cable.

(11) Evacuate and charge the A/C system as outlined in this section.

(12) Start the vehicle and check for proper operation at all vacuum motors.

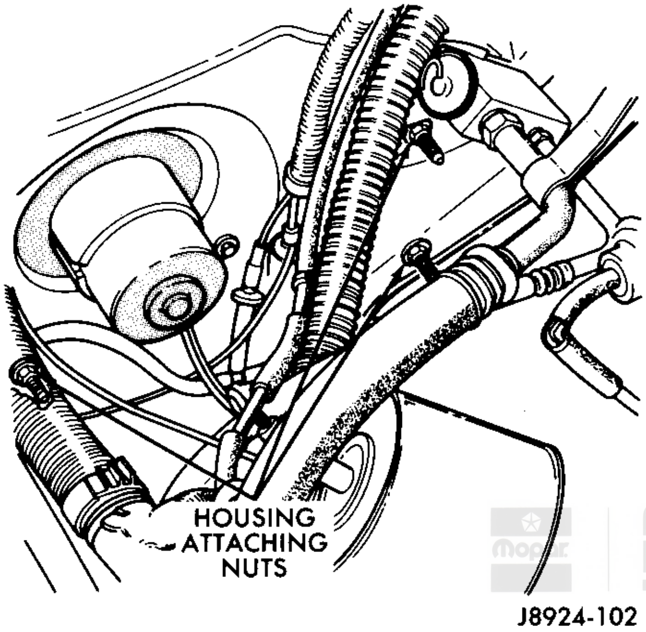


Fig. 34 Evaporator Housing Mounting

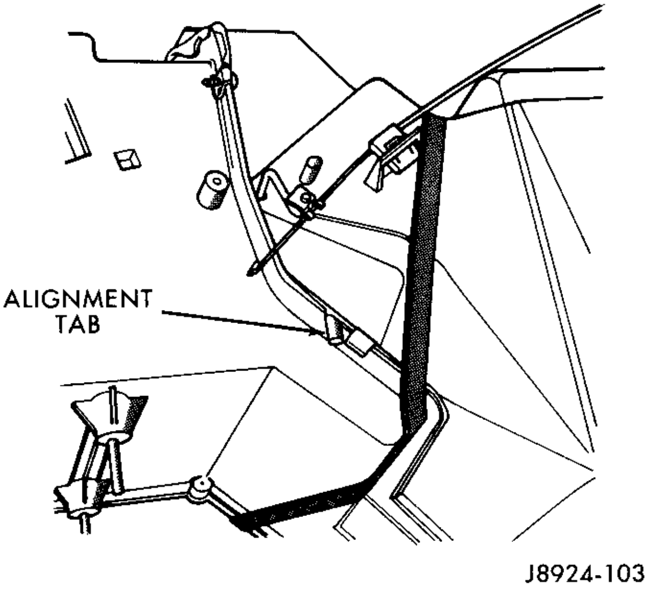


Fig. 35 Evaporator Housing Alignment Tab

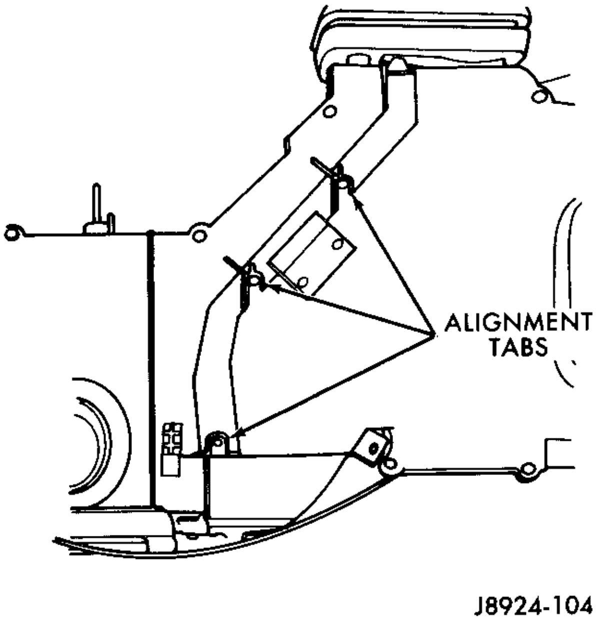


Fig. 36 Evaporator Housing Installation

EVAPORATOR CORE REPLACEMENT

(1) Remove the evaporator/blower housing as described in this section.

(2) Remove the top housing retaining screws and remove the top of the evaporator housing (Fig.37).

(3) Remove the thermostatic switch and capillary tube after removing the top of the evaporator housing.

(4) Remove the two evaporator retaining screws and lift the evaporator out of the housing (Fig.38).

(5) Remove the expansion valve from the evaporator.

(6) To install the evaporator core, reverse the removal procedures.

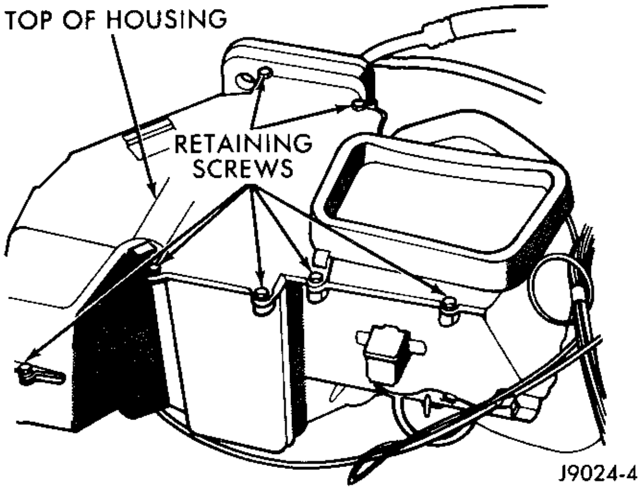


Fig. 37 Remove/Install Top of Housing

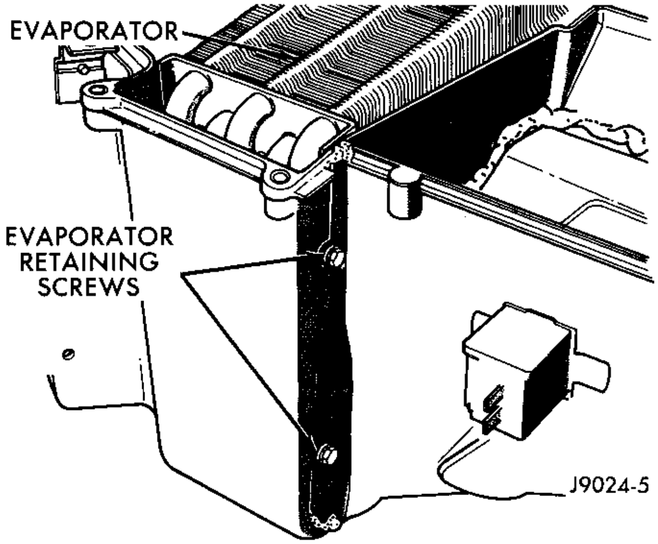


Fig. 38 Remove/Install Evaporator

Add one ounce of refrigerant oil to the air conditioning system when replacing the evaporator.

EXPANSION VALVE

(1) Discharge the A/C system as described in this section.

(2) Remove the coolant bottle and bracket.

(3) Disconnect A/C hoses from the expansion valve (Fig.39).

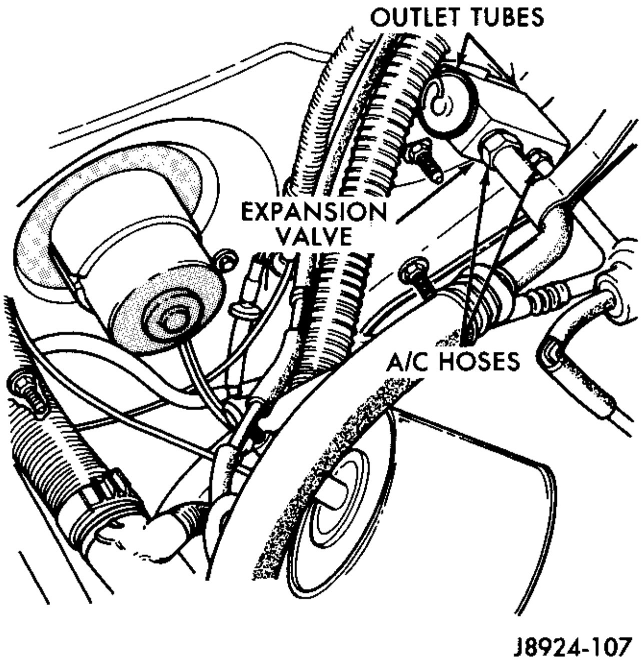


Fig. 39 Remove/Install Expansion Valve

(4) Disconnect the expansion valve from the evaporator core inlet and outlet tubes and remove the expansion valve.

(5) To install an expansion valve, reverse the removal procedures.

(6) Charge the A/C system and leak test as described in this section.

BLOWER MOTOR RESISTORS REPLACEMENT

(1) Remove the vacuum motor cover retaining screw and lower the cover.

(2) Remove the blower motor resistor connector, remove the resistor retaining screws, and then remove the resistor (Fig.40).

(3) To install the blower motor resistor reverse the removal procedures.

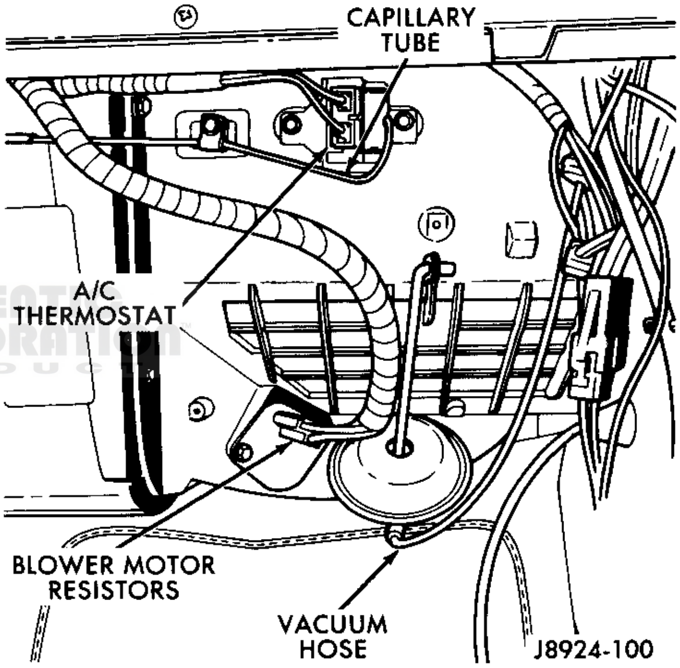


Fig. 40 Evaporator Housing Components

TEMPERATURE CONTROL THERMOSTAT

Removal

(1) Disconnect the battery negative cable.

(2) If equipped with center console remove the console as follows:

(a) On models with manual transmission, remove shift knob, boot and bezel.

(b) On models with automatic transmission floor shift, remove shift handle cap, plunger, spring, T-lock, shift handle and shift bezel (Fig.41).

(c) If equipped with power mirrors, pry mirror switch out of console cover and disconnect switch connector (Figs.42 and 43).

(d) Remove console cover screws (Fig.43).

(e) Remove console cover from base (Fig.44).

(f) Remove console base.

(3) Remove the lower instrument panel.

(4) Disconnect the electrical connection at the thermostat (Fig.45).

(5) Remove the capillary tube retaining screw and then remove the thermostat retaining screws.

(6) Remove the capillary tube from the tube guide hole.

Installation

(1) Feed the capillary tube through the tube guide hole until the red tape on the capillary tube just enters the hole in the housing. Install the capillary tube retaining screw and clip.

(2) Reverse the removal procedures for the remainder of the installation.

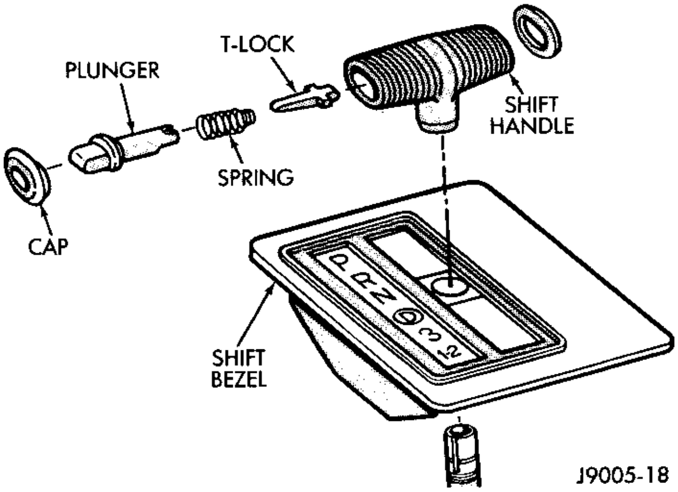


Fig. 41 Shift Handle Components With Automatic Transmission

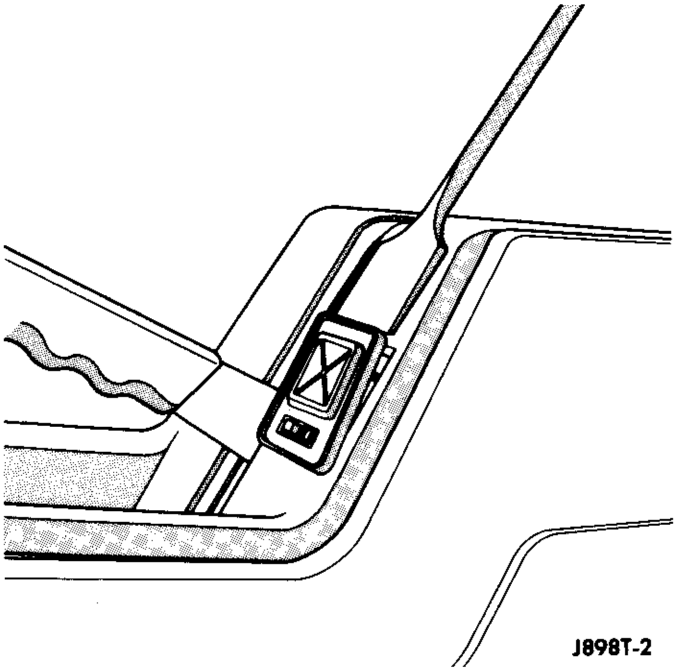


Fig. 42 Power Mirror Switch

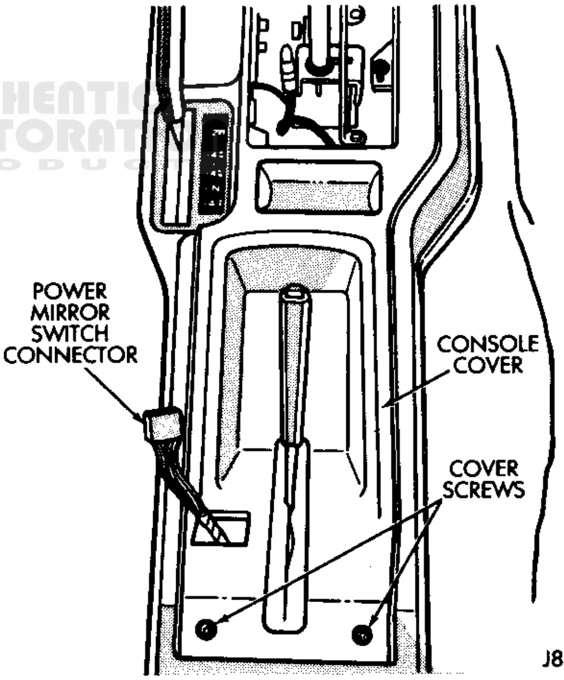


Fig. 43 Console Cover Screws and Power Mirror Switch Connector

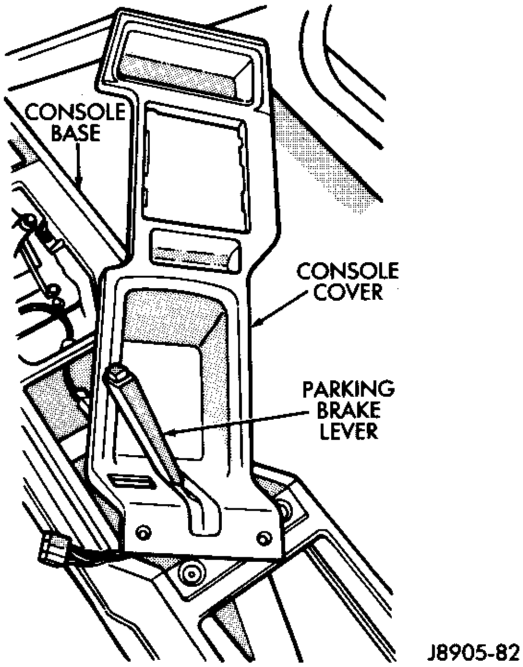


Fig. 44 Remove Console Cover and Base

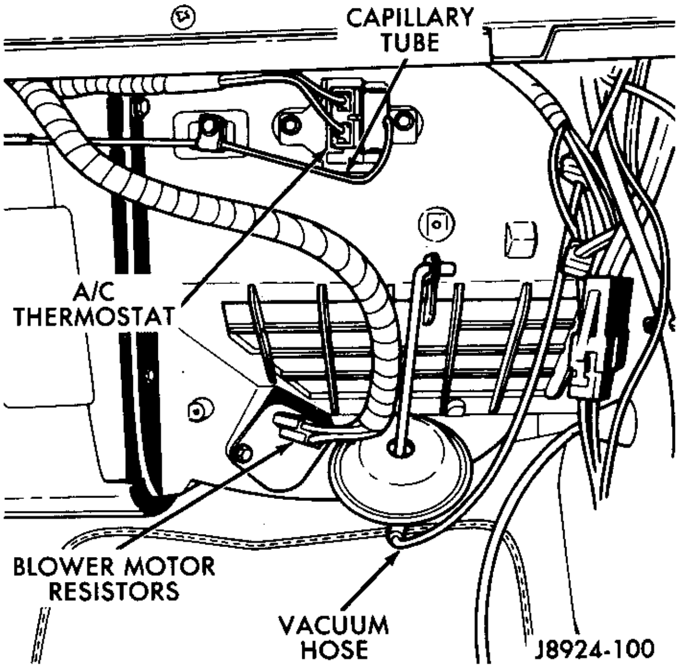
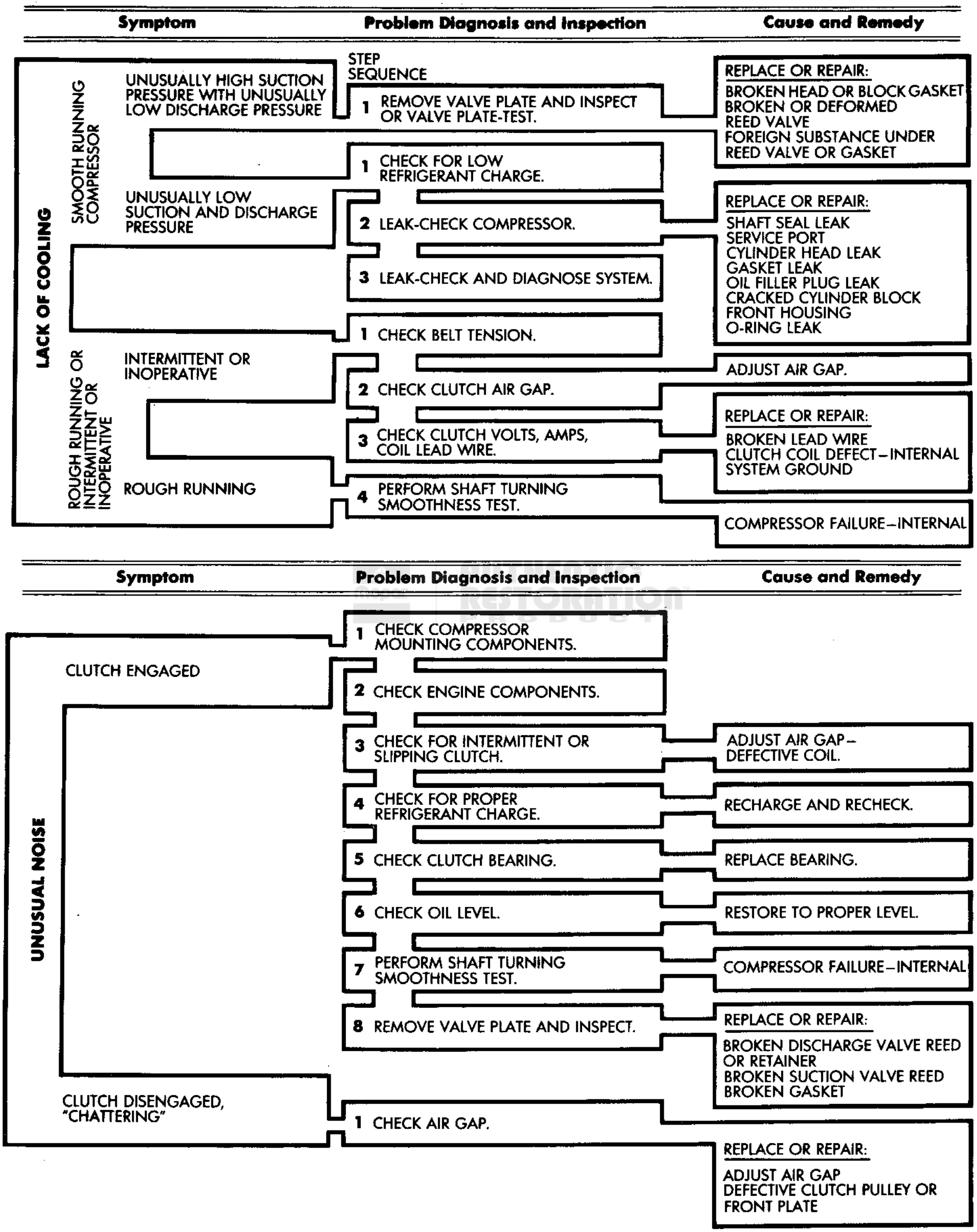


Fig. 45 Evaporator Housing Components

SERVICE DIAGNOSIS



J8924-74

BLOWER CONTROLS ELECTRICAL TESTING

Description

The blower motor delivers air to the inside of the vehicle. Its speed is controlled by the blower switch and the blower resistors. With the switch in LO, part of the battery voltage is supplied to the motor through all of the resistors. The motor runs slowly. As the blower switch is moved to select a higher speed, the switch allows more voltage to be applied to the blower motor, which will increase its speed. When the switch is in HI, the blower resistors are by passed. Battery voltage is applied directly to the blower motor. the motor runs at the fastest speed.

Troubleshooting

1. BLOWER MOTOR INOPERATIVE—Remove and inspect fuse

TEST	OK	NOT OK
Blower fuse	Not blown	Replace fuse

2. BLOWER MOTOR INOPERATIVE IN HI—Ignition switch in RUN, select switch in HEAT, blower switch on HI

TEST	OK	NOT OK
Blower motor connector terminal A	Battery voltage	Next step
Blower motor connector terminal B ignition switch off	Zero ohms	Repair wire to ground
Blower motor connector terminal C	Battery voltage If OK, replace blower switch	Replace select switch

3. BLOWER MOTOR INOPERATIVE IN LO, M1 AND M2—Ignition switch in RUN, select switch in HEAT

TEST	OK	NOT OK
Blower resistors connector terminal 3	Battery voltage	Replace select switch
Blower resistors connector terminal 2	Battery voltage	Replace blower switch
Blower resistors connector terminal 1	Battery voltage	Replace blower switch
Blower resistors connector terminal 6	Battery voltage	Replace blower resistor

A/C ELECTRICAL TESTING

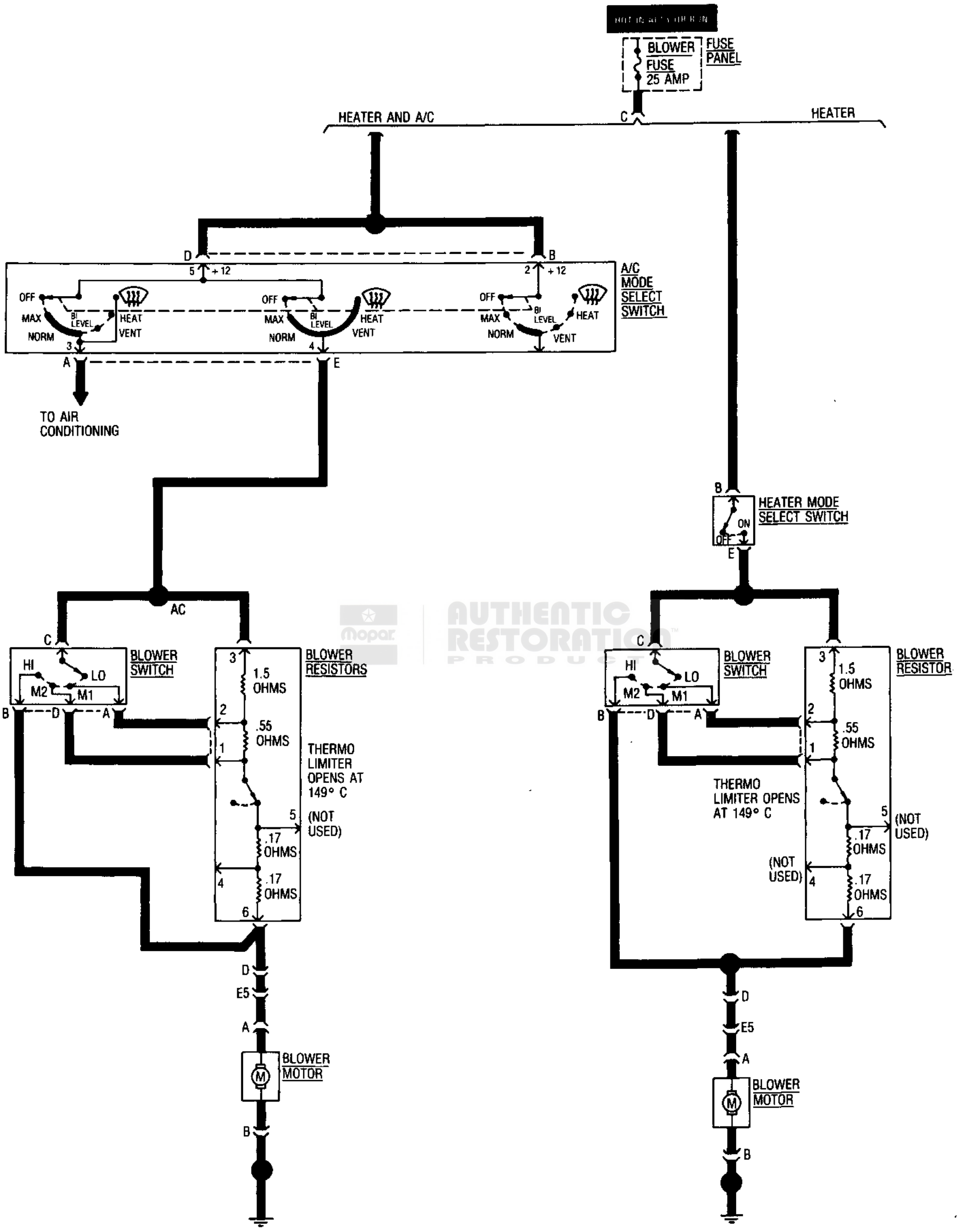
Description

The A/C Compressor Clutch is belt-driven by the engine. A clutch, operated by a solenoid, automatically turns the compressor on and off to control evaporator icing.

The A/C Compressor Clutch operation is controlled by several components: the A/C Low-Pressure Switch, Thermostat Switch, Fuel Pump Relay, A/C Clutch Relay and the Electronic Control Unit (ECU).

The A/C low pressure switch opens when there is not enough refrigerant in the system. When this happens, voltage is no longer present at the ECU. The ECU will turn off the A/C clutch relay. With the proper refrigerant level in the system, the low pressure switch remains closed.

When the evaporator temperature is low enough to ice the cooling coils, the thermostat switch opens. The ECU will turn off the A/C clutch. The thermostat switch closes when the temperature rises. The ECU will then turn the A/C clutch relay on again.



J8924-124

Blower Control Wiring Schematic

Troubleshooting

With engine running ECU may delay A/C clutch up to 30 seconds

1. A/C COMPRESSOR CLUTCH INOPERATIVE—Clutch connector terminal S disconnected

TEST	OK	NOT OK
Jumper fused test lead, battery to clutch connector terminal S	Clutch operates	Replace compressor assembly clutch

2. A/C LOW PRESSURE SWITCH—Ignition in RUN, A/C controls in MAX or NORM

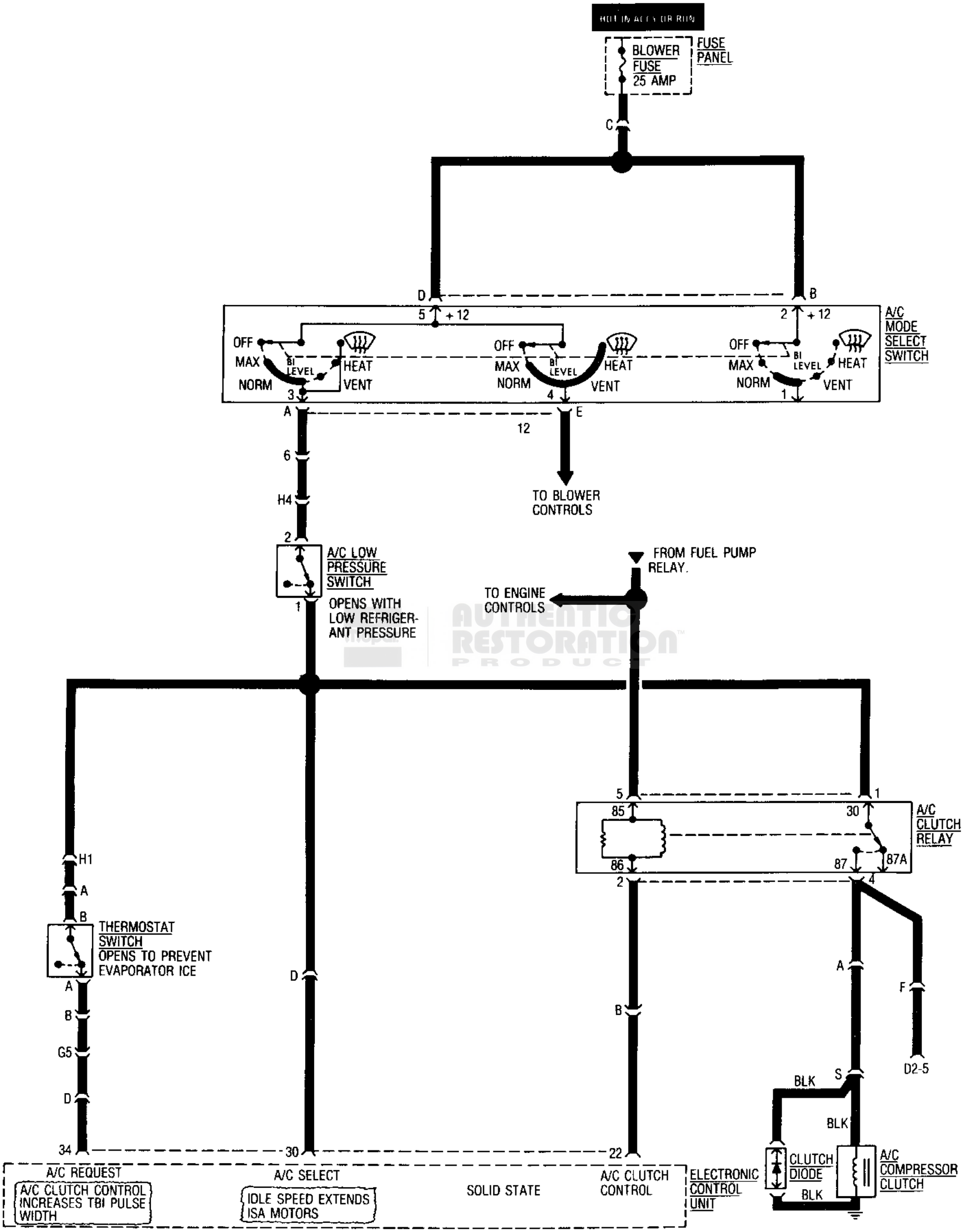
TEST	OK	NOT OK
Low Pressure switch connector terminal 2	Battery voltage	Repair open to select switch
Low Pressure switch connector terminal 1	Battery voltage	Check switch resistance Check freon pressure

3. THERMOSTAT SWITCH—Ignition in RUN, A/C controls in MAX or NORM

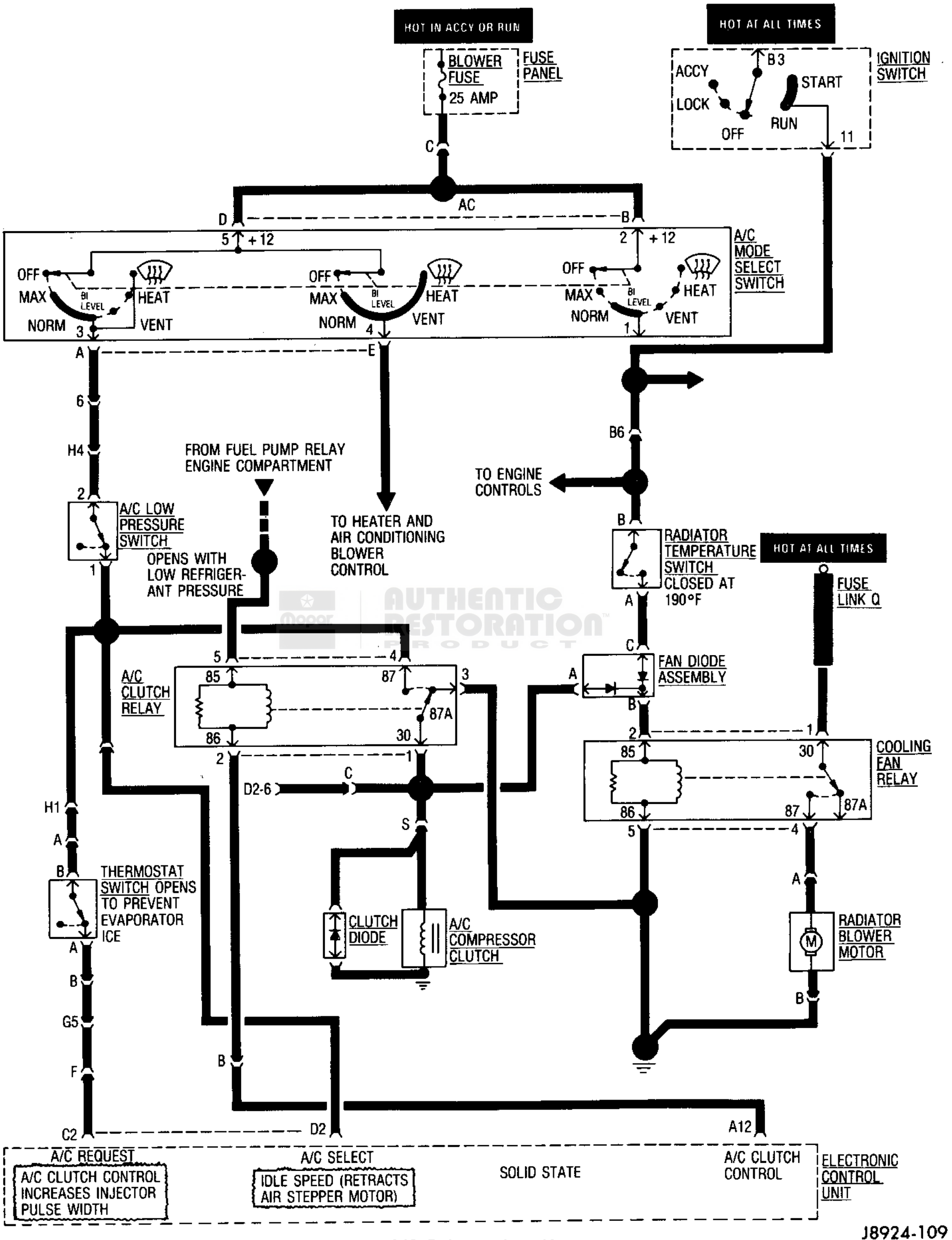
TEST	OK	NOT OK
Thermostat switch terminal B	Battery voltage	Repair open to splice B
Thermostat switch terminal A	Battery voltage	Check thermostat switch resistance Check for evaporator icing; no icing, replace switch

4. A/C CLUTCH RELAY—Engine RUNNING, A/C controls in MAX or NORM

TEST	OK	NOT OK
D1-6 to ground	Battery voltage	Check fuel pump relay Check ECU terminals 2.5L-6/4.0L-A5
Ground A/C clutch relay terminal 2	A/C compressor clutch engages	Check ECU terminals, 2.5L 22,30 and 34; 4.0L A12, C2 and D2



A/C Schematic 2.5L



J8924-109

A/C Schematic 4.0L

HEATING SYSTEM—YJ MODEL
INDEX

GENERAL

A blend-air heating system is used in YJ vehicles. The blend-air system provides a constant flow of engine coolant through the heater core.

The temperature of heated air entering the passenger compartment is controlled by regulating the quantity of air flow through the heater core. This is accomplished by blending a controlled amount of unheated air from outside the vehicle with heated air from the heater core.

HEATER AND DEFROSTER OPERATION

The heater core is connected to the engine cooling system. It operates on the circulation of heated engine coolant through the core and a supply of fresh air drawn in through the intake grille on the cowl. Engine coolant flows through the heater core at all times.

The heater controls are on the heater control panel (Fig.1).

The air control lever (Fig.1) operates a door in the fresh air intake duct. The door controls the amount of fresh air flow into the heater housing and core. When the lever is in the Off position, the intake door is closed preventing air flow into the housing.

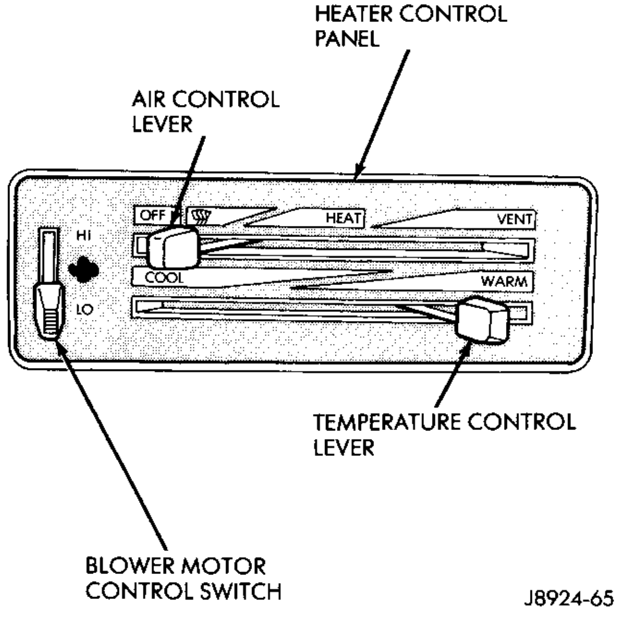


Fig. 1 Heater Control Panel

The temperature control lever (Fig.1) determines air flow through the heater core. The lever operates the heater housing blend-air door which controls air flow through the core.

The blower motor is operated by the control switch (Fig.1). The switch provides three blower speeds for increased air flow in heat or defrost mode.

Heating (Fig.2)

Maximum air flow and heater output occurs when the air control lever is in Heat position and the temperature control lever is in Warm position. The blend-air door is closed and all intake air is directed through the core in this operating mode.

Temperature regulation of the heated air is determined by position of the temperature control lever. Moving the control lever from Warm to an in-between position, opens the blend-air door in the heater housing. As the door opens, unheated outside air is drawn into the system and blended with heated air from the core.

Defrosting (Fig. 2)

The heater housing contains a defroster door to divert heated air to the defroster duct and windshield outlets. Defrost air flow is controlled by the air control lever.

For defroster operation, the air control lever must be moved to the defrost detent. The detent is identified by the defrost symbol on the control panel. In this position, the defroster door in the heater housing diverts all heated air (from the core) to the defroster duct windshield outlets.

If the air control lever is moved to any position between the heat and defrost detents, the defroster door does not close completely. In this mode, the door remains partially open causing heated air to be divided equally between the heat and defrost outlets.

FRESH AIR VENTILATION (Fig.3)

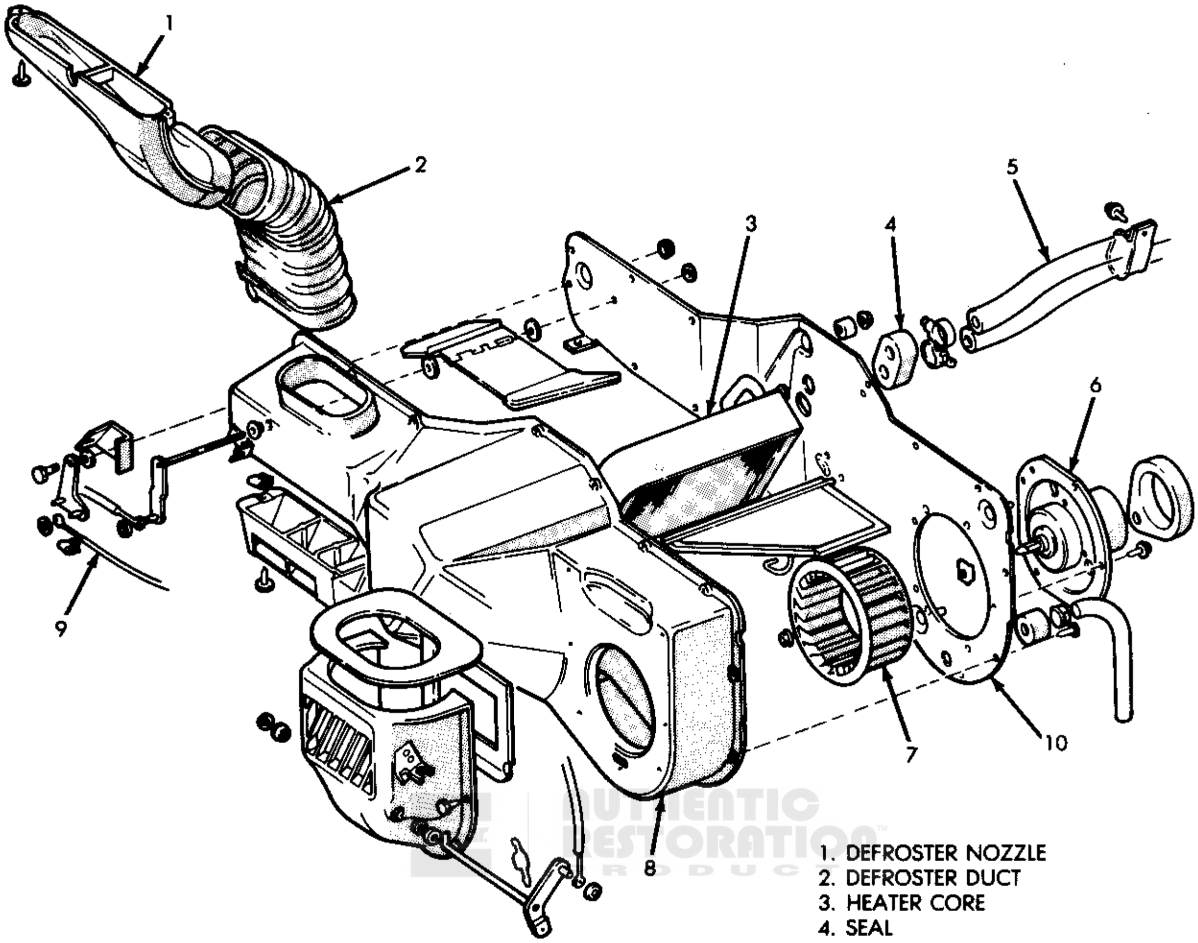
The fresh air ventilating system is operated by the air control lever. When the lever is moved to Vent position, outside air from the cowl intake flows into the heater housing. Incoming air is directed into the vehicle interior through vent doors in the housing.

A door in the intake duct controls air flow into the duct. The door is operated by a vacuum motor. The motor is controlled by a vacuum switch in the heater control panel. The vent air doors are opened and closed by a cable and linkage operated by the air control lever. Fresh air intake occurs only when the lever is in the Vent position.

HEATING SYSTEM DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTION
BLOWER MOTOR WILL NOT TURN AT ANY SPEED	(1) Blown fuse.	(1) Replace fuse.
	(2) Loose connection.	(2) Inspect and tighten.
	(3) Defective ground.	(3) Clean and tighten.
	(4) Faulty switch.	(4) Replace switch.
	(5) Faulty motor.	(5) Replace motor.
	(6) Faulty resistor.	(6) Replace resistor.
BLOWER MOTOR TURNS AT ONE SPEED ONLY	(1) Faulty switch.	(1) Replace switch.
	(2) Faulty resistor.	(2) Replace resistor.
BLOWER MOTOR TURNS BUT DOES NOT CIRCULATE AIR	(1) Intake blocked.	(1) Clean intake.
	(2) Fan not secured to the motor shaft.	(2) Tighten securely.
HEATER WILL NOT HEAT	(1) Coolant does not reach proper temperature.	(1) Check and replace thermostat if necessary.
	(2) Heater core blocked internally.	(2) Flush or replace core if necessary.
	(3) Heater core air-bound.	(3) Purge air from core.
	(4) Blend-air door not in proper position.	(4) Adjust cable.
HEATER WILL NOT DEFROST	(1) Control cable adjustment incorrect.	(1) Adjust control cable.
	(2) Defroster hose damaged.	(2) Replace defroster hose.

J8924-66



1. DEFROSTER NOZZLE
2. DEFROSTER DUCT
3. HEATER CORE
4. SEAL
5. HOSE
6. BLOWER MOTOR
7. FAN
8. HEATER HOUSING
9. CABLE
10. HEATER HOUSING COVER

J8924-67

Fig.2 Heating System Components

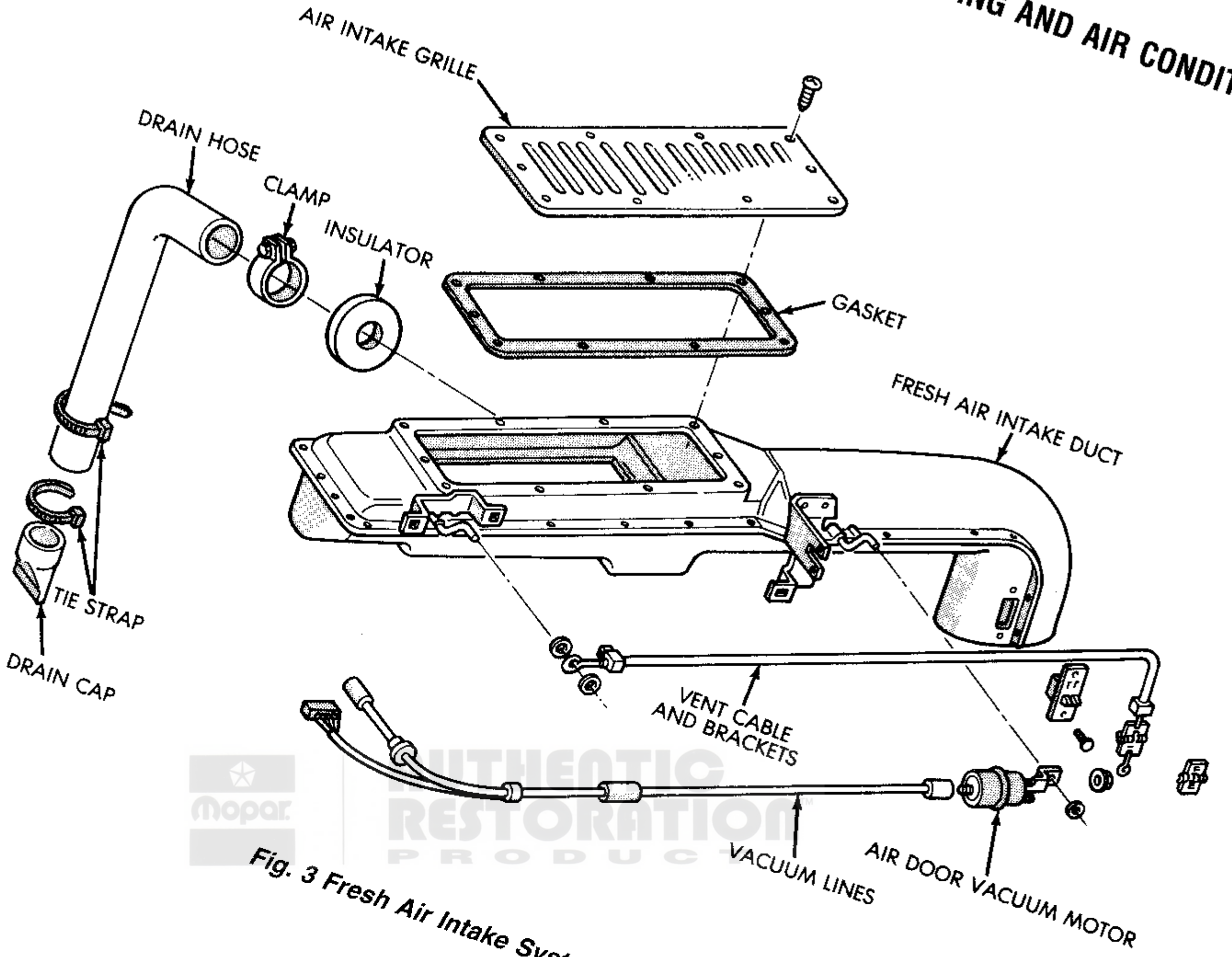


Fig. 3 Fresh Air Intake System Components

HEATER CONTROL PANEL REPLACEMENT

(1) Remove the instrument cluster bezel attaching screws (Fig.4).

(2) Remove the instrument cluster bezel.

(3) Remove the screws attaching the heater control panel to the instrument panel.

(4) Slide the control panel outward and disconnect the cables, vacuum hoses and electrical wires from the control panel.

(5) Remove the control panel.

(6) To install the control panel, reverse the removal procedures.

BLOWER MOTOR AND AIR DOOR MOTOR SWITCHES

(1) Remove the heater control panel (Fig.5).

(2) Remove the air door motor switch.

(3) Remove the control knob from the blower switch.

(4) Remove the screws that attach the switch to the control panel.

(5) Remove the switch from the control panel.

(6) To install the switches, reverse the removal procedures.

VENT DOOR CONTROL CABLES REPLACEMENT

(1) Disconnect the cable from the vent door.

(2) Disconnect the cable from the heater control panel lever.

The cables are attached to the control panel levers with plastic tabs. Press the tabs together and lift the cable upward to disengage it from the lever.

(3) Remove the cable.

The clip on the cable wire has two functions. It attaches the cable to the vent door and is also the self adjusting mechanism. Because the left cable operates the right cable, the cables must be installed as outlined to maintain the self adjusting feature and ensure proper vent door operation.

(4) To install the cables, connect the cables to the heater control panel.

(5) Connect the only the right vent door cable. Do not connect the left door cable at this time.

(6) Open and close the right vent door (one time) using the air control lever on the heater control panel.

(7) Connect the left vent door cable.

(8) Open and close both vent doors with the air control lever. Verify that both vent doors open at the same time.

HEATER CORE AND HOUSING

Removal

WARNING: HOT ENGINE COOLANT CAN CAUSE SEVERE BURNS. DO NOT OPEN THE RADIATOR DRAINCOCK WHEN THE COOLING SYSTEM IS HOT AND PRESSURIZED. ALLOW THE COOLANT TO DECREASE TO ROOM TEMPERATURE BEFORE STARTING REPAIR OPERATIONS.

(1) Drain approximately 1.9 liters (2 qts) of coolant from the radiator. Drain the coolant into a clean container.

(2) Disconnect the heater hoses.

(3) Disconnect the vent door cables.

(4) Disconnect the blower motor wire.

(5) Disconnect the defroster duct.

(6) Remove the nuts that attach the heater housing studs to the engine compartment side of the dash panel.

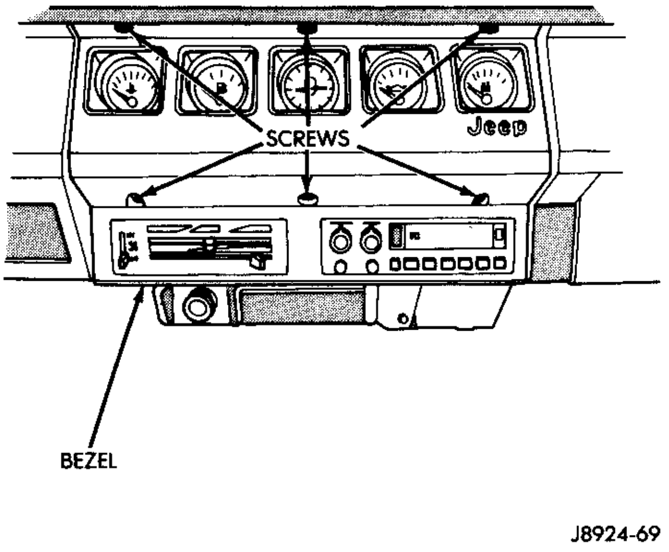


Fig. 4 Remove Instrument Cluster Bezel

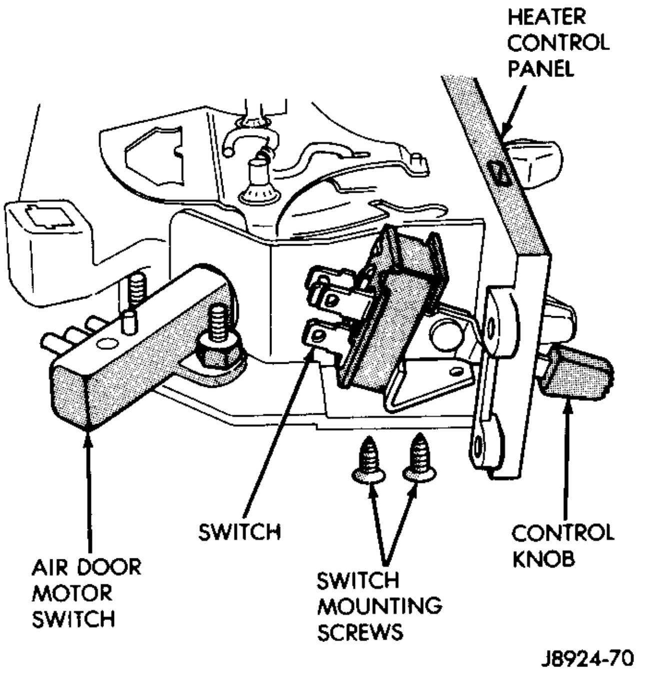


Fig. 5 Control Switches Removal/Installation

(7) Remove the heater housing assembly by tilting it downward, to disengage it from the defroster duct, and pulling it rearward and out from under the instrument panel. (8) Remove the heater hosing cover from the housing.

(9) Remove the heater core from the housing.

Installation

(1) Install the heater core in the housing and install the cover on the housing.

(2) Position the heater housing on the dash panel. Be sure the housing studs all extend through the dash panel.

(3) Install the seals on the heater core outlet and inlet tubes and over the blower motor housing.

(4) Install the attaching nuts on the housing studs.

CAUTION: Do not over tighten the attaching nuts. The housing could become distorted causing air leaks and improper heater door operation. Tighten the nuts alternately and evenly until two stud threads are visible beyond each nut.

(5) Connect the defroster duct to the housing.

(6) Connect the blower motor wire.

(7) Connect the vent door control cables.

(8) Connect the heater hoses.

(9) Refill and bleed the cooling system.

(10) Check system operation.

BLOWER MOTOR REPLACEMENT

(1) Remove the heater housing. Refer to Heater Core and Housing Removal.

(2) Remove the blower motor-to-heater housing attaching screws/nuts.

(3) Remove the blower motor from the housing.

(4) To install the blower motor, reverse the removal procedure.

(5) Check blower motor and heater operation.

DEFROSTER NOZZLE AND DUCT

Removal

WARNING: HOT ENGINE COOLANT CAN CAUSE SEVERE BURNS. DO NOT OPEN THE RADIATOR DRAINCOCK WHEN THE COOLING SYSTEM IS HOT AND PRESSURIZED. ALLOW THE COOLANT TO DECREASE TO ROOM TEMPERATURE BEFORE STARTING REPAIR OPERATIONS.

(1) Drain approximately 1.9 liters (2 qts) of coolant from the radiator. Drain the coolant into a clean container.

(2) Disconnect the heater hoses.

(3) Remove the nuts attaching the heater housing studs to the engine compartment side of the dash panel.

(4) Disconnect the speedometer cable.

(5) Remove the glove box.

(6) Tilt the heater housing back and pull it rearward and out from under the instrument panel.

(7) Disconnect the vent control cables.

(8) Remove the fresh air intake grille from the cowl.

(9) Remove the fresh air intake duct.

(10) Lower the windshield.

(11) Remove the defroster nozzle attaching screws and remove the nozzle and duct.

Installation

(1) Install the defroster nozzle and duct.

(2) Raise and secure the windshield.

(3) Install the fresh air intake duct.

(4) Install the fresh air intake grille on the cowl.

(5) Install the vent cables.

(6) Position the heater housing on the dash panel. Be sure all the housing studs extend through the dash panel.

(7) Install the seals on the blower motor and the heater core inlet and outlet tubes.

(8) Install the attaching nuts on the housing studs.

CAUTION: Do not over tighten the attaching nuts. The housing could become distorted causing air leaks and improper heater door operation. Tighten the nuts alternately and evenly until two stud threads are visible beyond each nut.

(9) Install the glove box.

(10) Connect the speedometer cable.

(11) Connect the heater hoses.

(12) Refill and bleed the cooling system.

FRESH AIR DOOR VACUUM MOTOR

Removal

(1) Remove the glove box and assist handle.

(2) Disconnect the vacuum hose from the motor.

(3) Remove the motor lever retaining clip.

(4) Remove the motor attaching nuts and remove the motor from the fresh air duct.

Installation

(1) Position the motor on the fresh air duct and install the motor attaching nuts.

(2) Align the motor lever with the air door lever and install the lever retaining clip.

(3) Connect the vacuum hose to the motor.

(4) Install the glove box and assist handle.

FRESH AIR INTAKE DUCT

Removal

WARNING: HOT ENGINE COOLANT CAN CAUSE SEVERE BURNS. DO NOT OPEN THE RADIATOR DRAINCOCK WHEN THE COOLING SYSTEM IS HOT AND PRESSURIZED. ALLOW THE COOLANT TO DECREASE TO ROOM TEMPERATURE BEFORE STARTING REPAIR OPERATIONS.

(1) Drain approximately 1.9 liters (2 qts) of coolant from the radiator. Drain the coolant into a clean container.

(2) Disconnect the heater hoses.

(3) Remove the nuts attaching the heater housing studs to the dash panel from inside the engine compartment.

(4) Disconnect the speedometer cable.

(5) Remove the glove box and assist handle.

(6) Tilt the heater housing back and pull it rearward and out from under the instrument panel.

(7) Disconnect the vent cables.

(8) Remove the fresh air intake grille from the cowl.

(9) Remove the fresh air intake duct.

Installation

(1) Install the fresh air intake duct.

(2) Install the defroster nozzle and duct.

(3) Raise and secure the windshield.

(4) Install the fresh air grille on the cowl.

(5) Install the vent cables.

(6) Position the heater housing on the dash panel. Be sure all the housing studs extend through the dash panel.

(7) Install the seals on the blower motor and heater core inlet and outlet tubes.

(8) Install the attaching nuts on the heater housing studs.

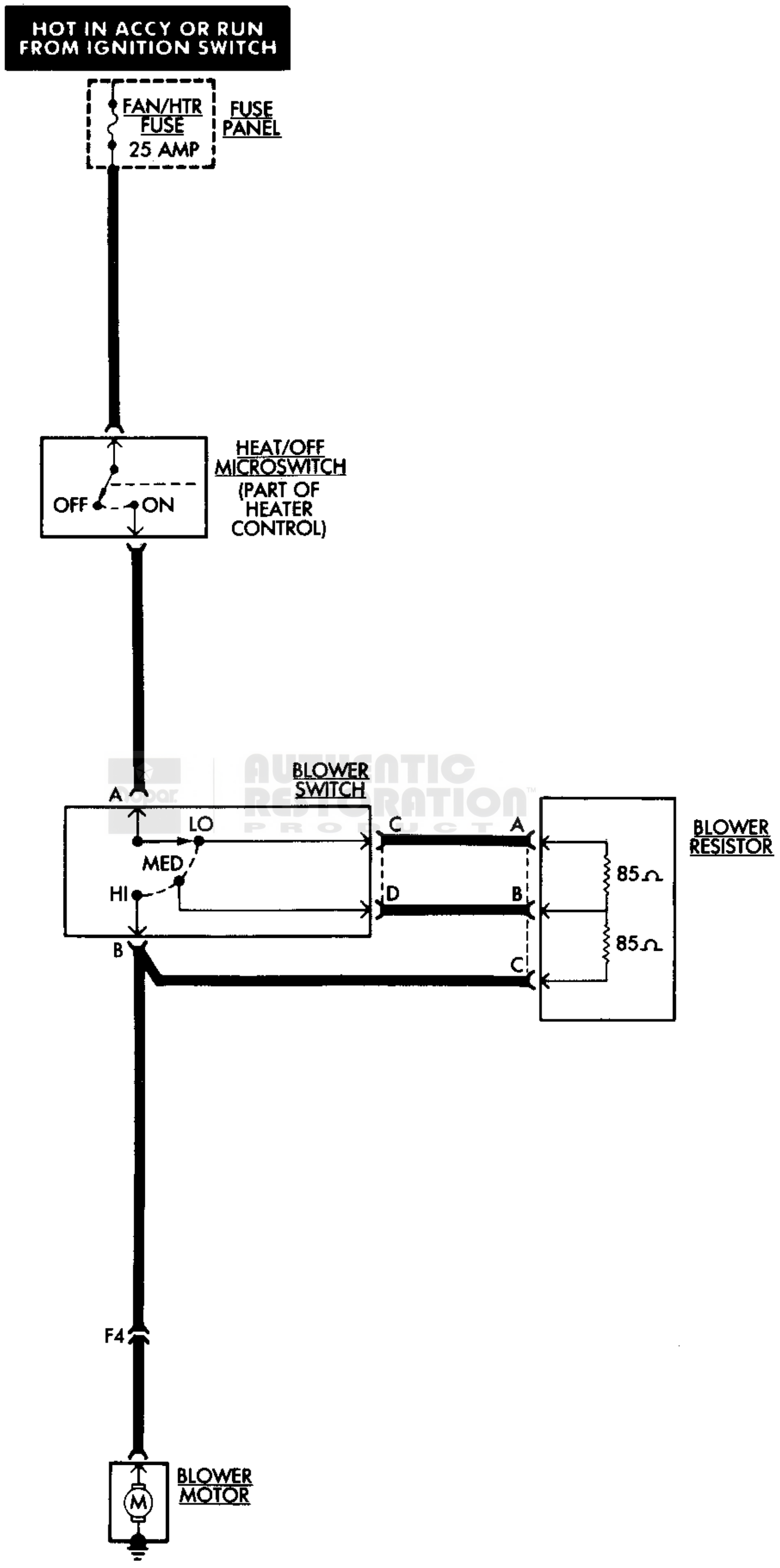
CAUTION: Do not over tighten the attaching nuts. The housing could become distorted causing air leaks and improper heater door operation. Tighten the nuts alternately and evenly until two stud threads are visible beyond each nut.

(9) Install the glove box and assist handle.

(10) Connect the speedometer cable.

(11) Connect the heater hoses.

(12) Refill and bleed the cooling system.



J8924-79

Fig. 6 Heater Wiring Schematic — YJ

TROUBLESHOOTING

The blower motor circuit begins at a 25 amp fuse that receives its battery feed from the ignition switch. From the fuse the circuit extends to a microswitch mounted on the heater control.

The microswitch is opened and closed by a cam attached to the heater control lever. In all heater control lever positions except OFF and VENT, the cam is positioned to close the microswitch and complete the blower motor circuit.

The blower switch allows the driver to select one of three blower speeds—low, medium and high. In the high speed position, the switch connects the motor directly to the battery source. The remaining two slower speeds are accomplished by routing the battery source through a resistor assembly.

The resistor and switch are wired in such a way that only a single wire is needed to operate the blower motor at three different speeds. A separate ground wire is not needed because the blower motor housing serves as the ground connection.

1. HEAT/OFF MICROSWITCH: Place selector lever in heat mode; turn ignition switch to RUN

TEST	OK	NOT OK
Measure voltage at Heat/Off Microswitch connector supply side	Battery Voltage	Repair open from FAN/HTR fuse
Measure voltage at Heat/Off Microswitch connector output side	Battery Voltage	Replace heat/off microswitch

2. BLOWER SWITCH: Turn ignition switch to RUN; place selector lever in heat mode

TEST	OK	NOT OK
Measure voltage at Blower Switch terminal A	Battery voltage	Repair open from Heat/Off Microswitch connector output side to Blower Switch
Measure voltage at Blower Switch terminal B - blower switch in HI	Battery voltage	Replace blower switch
Measure voltage at Blower Switch terminal C - blower switch in LO	Battery voltage	Replace blower switch
Measure voltage at Blower Switch terminal D - blower switch in MED	Battery voltage	Replace blower switch

TEST	OK	NOT OK
Measure voltage at Blower Resistor terminal A - Blower switch in LO	Battery voltage	Repair open between Blower Switch and Blower Resistor
Measure voltage at Blower Resistor terminal B - Blower switch in MED	Battery voltage	Repair open between Blower Switch and Blower Resistor
Measure voltage at Blower Resistor terminal C - Blower switch in HI	Battery voltage	Repair open between Blower Switch and Blower Resistor
Measure resistance between Blower resistor terminal A and B	0.85 ohms	Replace blower resistor
Measure resistance between Blower resistor terminal B and C	0.85 ohms	Replace blower resistor
Measure resistance between Blower resistor terminal A and C	1.7 ohms	Replace blower resistor

4. BLOWER MOTOR: Turn blower motor switch to HI; place selector lever in heat mode; turn ignition switch to RUN for voltage tests; turn ignition switch to OFF for resistance tests

TEST	OK	NOT OK
Measure voltage at Blower Motor	Battery voltage	Repair open from blower switch
Measure resistance from blower motor case to a clean chassis ground	Zero ohms	Repair blower motor If zero ohms, replace blower motor

AIR CONDITIONING SYSTEM—YJ MODEL

INDEX

GENERAL

The evaporator, blower fan and motor, thermostat, expansion valve, capillary tube, air outlets and system controls are located in the evaporator housing. The evaporator housing is mounted under the instrument panel. The compressor, condenser, receiver-dryer and refrigerant lines are located in the engine compartment.

A rotary-type compressor with magnetic clutch operated drive pulley is used for all YJ models equipped with air conditioning.

OPERATIONAL CHECK

Turn the ignition key to the run position, set the thermostat control to maximum cooling and turn the blower switch to the LO position. When the blower motor is switched on, a loud click will be heard as the compressor clutch engages.

Start the engine and set the blower switch on HIGH. After a short period of time, cold air should discharge from the registers.

Rotate the thermostat control from maximum cool to minimum cool and listen for the compressor clutch to disengage. Rotate the thermostat from minimum to maximum several times and listen for engagement and disengagement of the clutch.

SERVICE DIAGNOSIS

General Diagnosis Information

The air conditioning system generally operates at peak efficiency at normal highway speeds. However, a slight reduction in cooling efficiency may be experienced in congested city driving conditions; especially when ambient temperatures are high.

Driving at relatively high speeds for extended periods may cause the evaporator coils to frost over. If frosting is severe, a temporary loss of cooling may occur. To correct a frost-over condition, turn the control temperature knob off and operate the blower fan for a few minutes.

When diagnosing a gradual decrease in cooling efficiency, remember to check condition of the condenser and radiator fins. Air flow blockage of either component, caused by dirt, foreign material or insects, will affect the air conditioning and engine cooling systems equally. Also note if the vehicle is equipped with a protective screen. Some screens can restrict air flow to the radiator and condenser.

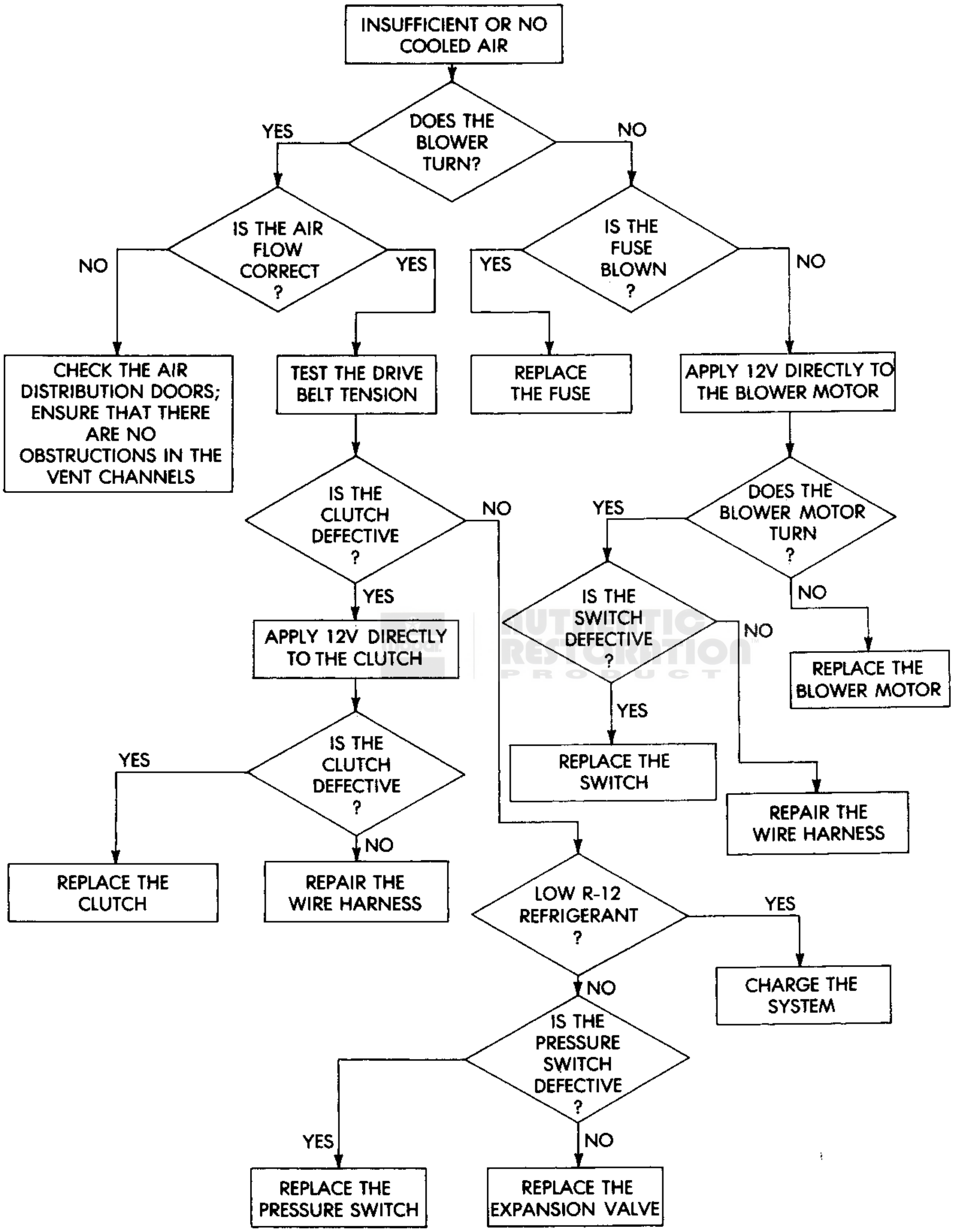
During high ambient temperature operation, a slight increase in engine coolant temperature is a normal occurrence when the air conditioner system is operating.

Diagnosis Procedures

Refer to the following charts for basic system diagnosis procedures.

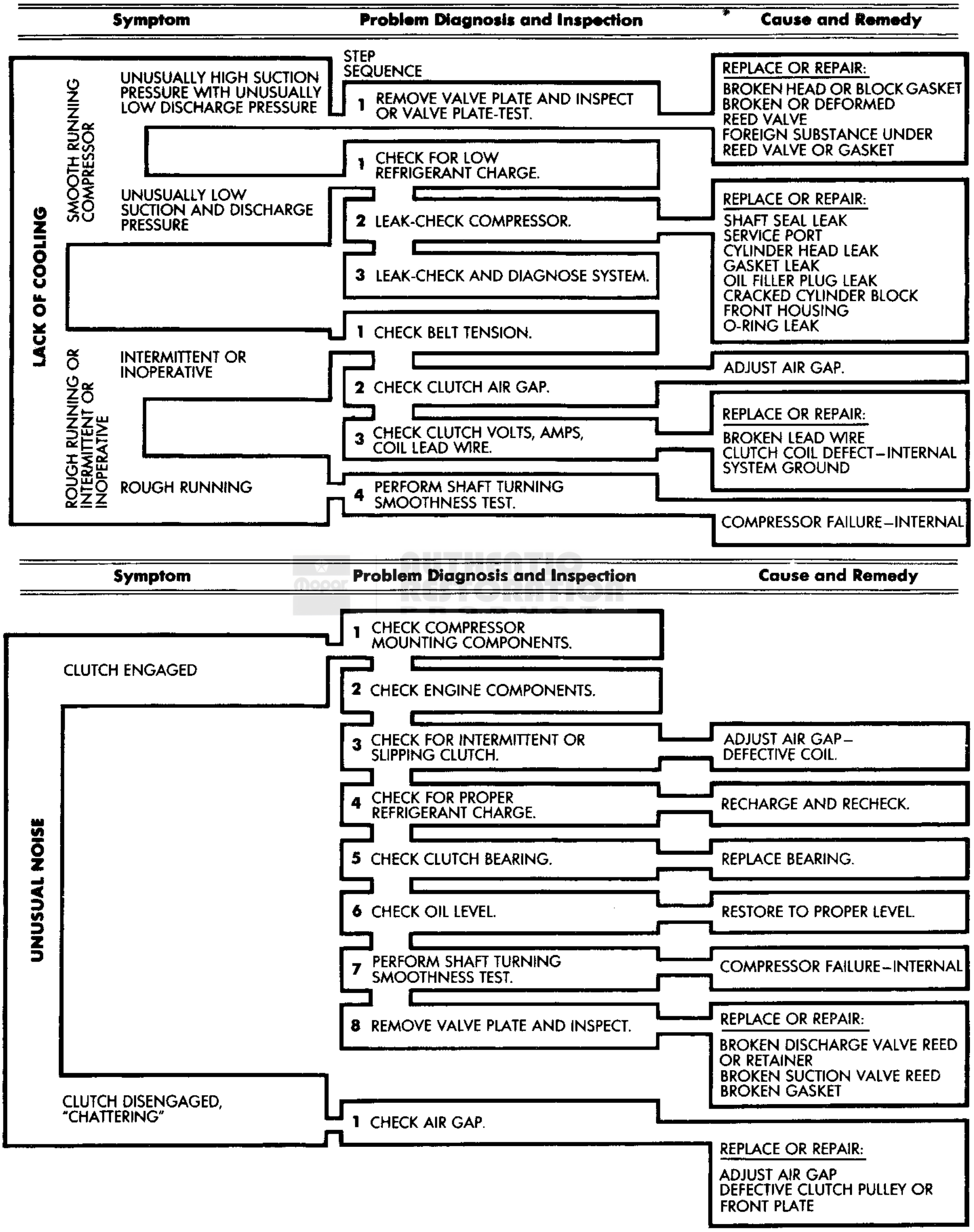
Diagnosis Chart A outlines general performance diagnosis information. Chart B outlines diagnosis information exclusive to the air conditioning compressor.

DIAGNOSIS CHART A



J8924-71

DIAGNOSIS CHART B



J8924-74

ELECTRICAL TESTING

Description

The air conditioning circuit consists of three segments—battery supply, blower motor and compressor clutch. The three segments have a common connection point at the blower switch.

The power supply segment of the circuit extends from the 25 amp HTR/FAN fuse to the blower switch. From the blower switch, battery feed is routed to the blower motor and compressor clutch segments of the circuit.

The blower motor segment consists of the three wires from the blower switch to the motor, the motor itself and the motor ground wire. Through the switch, the three wires connect the motor brushes to battery supply. When connected to battery feed, the separate brushes provide the three blower speeds—LO, MED, and HIGH.

In all blower switch positions except OFF, the compressor clutch segment of the circuit also receives battery feed. ON and OFF cycling of the compressor and therefore the temperature of the outlet air is regulated by the thermostatic control. A thermal sensor extends from the control to the evaporator housing. When the temperature of the evaporator drops below the set temperature, the thermostatic control opens the clutch circuit. The circuit remains open until evaporator temperature rises above the set temperature.

The compressor clutch segment of the circuit also contains a low pressure switch. If the pressure in the refrigerant system drops due to a leak, the circuit is opened to prevent damage to the compressor.

The last component in the compressor clutch segment of the circuit is the clutch coil. When the coil is connected to battery feed, its windings form an electromagnet that pulls the clutch hub against the clutch pulley.

Blower Inoperative

1. Fuse: Ignition in RUN

TEST	OK	NOT OK
Check operation of heater blower motor	Blower operates	Check FAN/HTR fuse
Measure voltage at battery side of FAN/HTR fuse	Battery voltage	Repair open from ignition switch
Measure voltage at A/C Blower Switch terminal A	Battery voltage	Repair open from FAN/ HTR fuse

2. BLOWER SWITCH: Ignition in RUN; blower switch position as indicated

TEST	OK	NOT OK
Measure voltage at A/C Blower Switch terminal A—blower switch in any position	Battery Voltage	Repair open from fuse panel
Measure voltage at A/C Blower Switch terminal E—blower switch in LO	Battery Voltage	Replace switch
Measure voltage at A/C Blower Switch terminal D—blower switch in MED	Battery Voltage	Replace switch
Measure voltage at A/C Blower Switch terminal C—blower switch in HIGH	Battery Voltage	Replace switch

3. BLOWER MOTOR: Blower switch position as indicated; turn ignition switch to RUN for voltage tests; turn ignition switch to OFF for resistance tests.

TEST	OK	NOT OK
Measure resistance from A/C blower housing to a chassis ground	Zero ohms	Repair ground connection; If zero ohms, replace motor
Measure voltage at A/C Blower Motor connector terminal C—blower switch in LO	Battery voltage	Repair open from blower switch; If battery voltage, replace motor
Measure voltage at A/C Blower Motor connector terminal B—blower switch in MED	Battery voltage	Repair open from blower switch; If battery voltage, replace motor
Measure voltage at A/C Blower Motor connector terminal A—blower switch in HIGH	Battery voltage	Repair open from blower switch; If battery voltage, replace motor

Compressor Clutch Inoperative

1. A/C COMPRESSOR CLUTCH

TEST	OK	NOT OK
Jumper wire from battery positive post to A/C compressor clutch connector terminal A	Clutch engages	Next step with jumper installed
Jumper wire from clutch coil frame to clean chassis ground	Clutch engages	Repair clutch coil ground If clutch does not engage, replace coil

2. LOW PRESSURE SWITCH: Turn ignition switch to RUN; A/C blower switch ON; thermostatic control set to MAX cool

TEST	OK	NOT OK
Measure voltage at A/C Low Pressure Switch connector terminal A	Battery voltage	Proceed to thermostatic control tests
Jumper wire across A/C Low Pressure Switch connector terminals A and B	Clutch engages	Check system refrigerant charge; If system is properly charged, replace A/C low pressure switch

3. THERMOSTATIC CONTROL: Turn ignition switch to RUN; A/C blower switch ON; thermostatic control set to MAX cool

TEST	OK	NOT OK
Measure voltage at Thermostatic Control connector terminal A	Battery voltage	Repair open from blower switch
Measure voltage at Thermostatic Control connector terminal B	Battery voltage	Replace thermostatic control
Measure voltage at A/C Low Pressure Switch connector terminal A	Battery voltage	Repair open from thermostatic control

A/C CONTROL PANEL

Fan Switch

The fan switch may be serviced by removing the access plate located on the lower evaporator core housing.

Temperature Control Thermostat

The evaporator housing must be removed and disassembled to service the temperature control thermostat. Refer to the evaporator housing removal/installation procedures.

When installing a replacement temperature control thermostat, insert the capillary tube (1) into the evaporator coil (2) a minimum of 5 cm (2 in) (Fig.2).

CAUTION: Handle the tube with care to avoid bends or kinks that could cause the thermostat to malfunction.

CONDENSER REPLACEMENT

Removal

(1) Discharge the system.

Discharge the system slowly to prevent loss of compressor oil.

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WHEN THE COOLING SYSTEM IS HOT AND PRESSURIZED. HOT COOLANT CAN CAUSE SERIOUS BURNS.

(2) Drain the radiator. Drain the coolant into a clean container.

(3) Remove the fan shroud and radiator.

(4) Disconnect the pressure pipe fitting from the condenser.

(5) Remove the condenser attaching screws and tilt the bottom of the condenser toward the engine.

Plug all the condenser openings to prevent entry of dirt or moisture.

(6) Working from under the vehicle, disconnect the receiver-drier to- evaporator hose fitting from the receiver-drier.

(7) Remove the condenser and receiver-drier as an assembly.

(8) Remove the receiver-drier from the condenser if necessary.

Installation

Add one ounce of refrigerant oil to the system when replacing the condenser.

(1) Attach the receiver-drier to the condenser.

(2) Place the condenser in position and connect the hose fitting to the receiver-drier.

(3) Install the condenser attaching screws.

(4) Connect the condenser pressure pipe fitting.

(5) Install the radiator and fan shroud.

(6) Fill the cooling system.

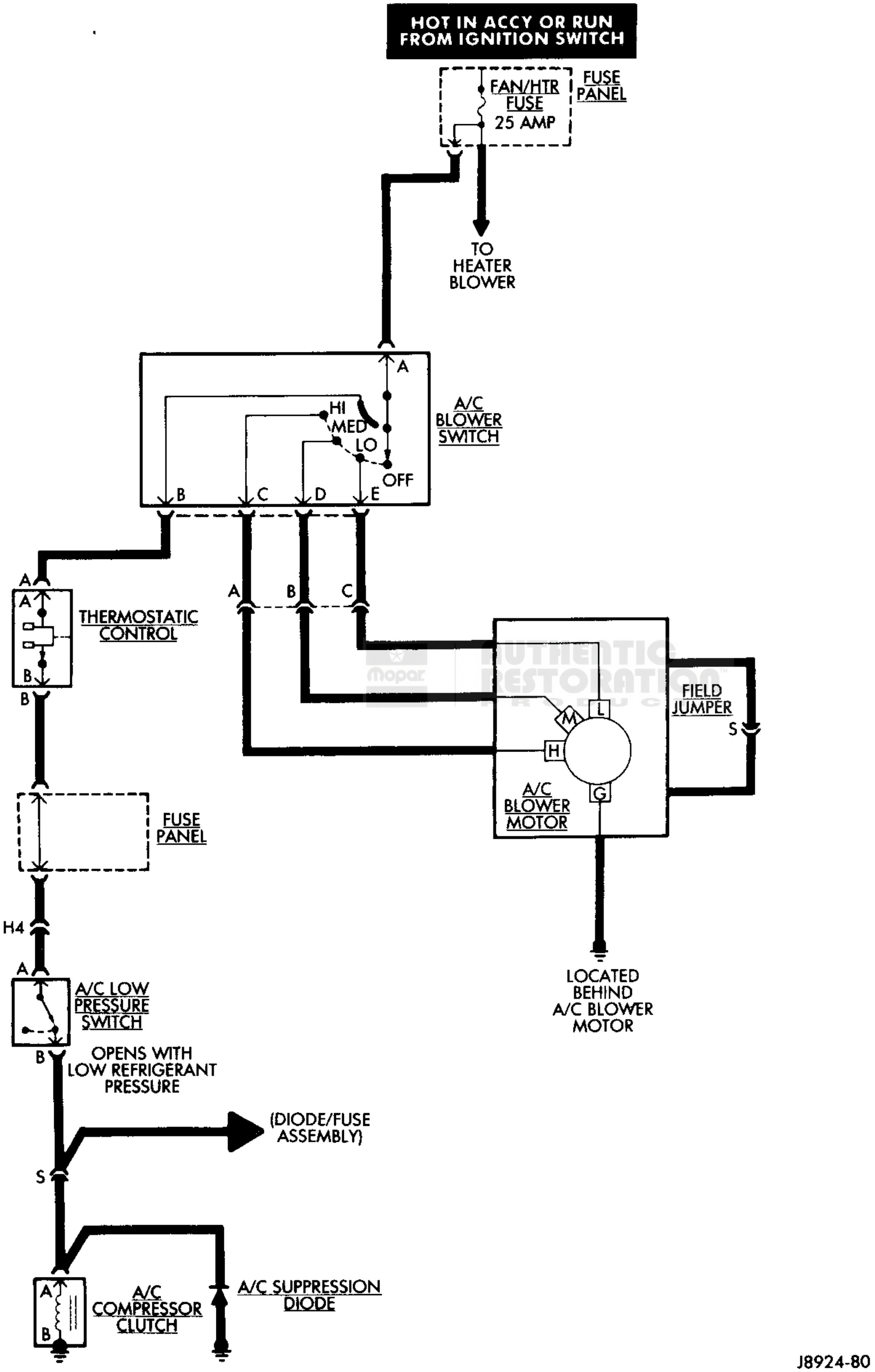


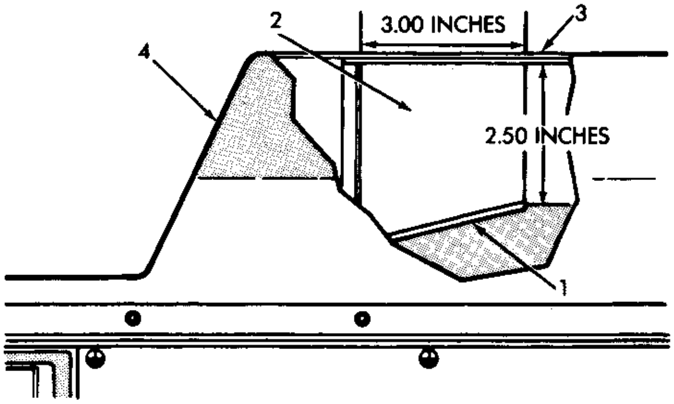
Fig. 1 A/C Wiring Schematic — YJ

(7) Evacuate, charge and leak test the air conditioning system.

SIGHT GLASS

A sight glass is located in the hose attached to the receiver- drier (Fig.3). The sight glass provides a visual check of system refrigerant level.

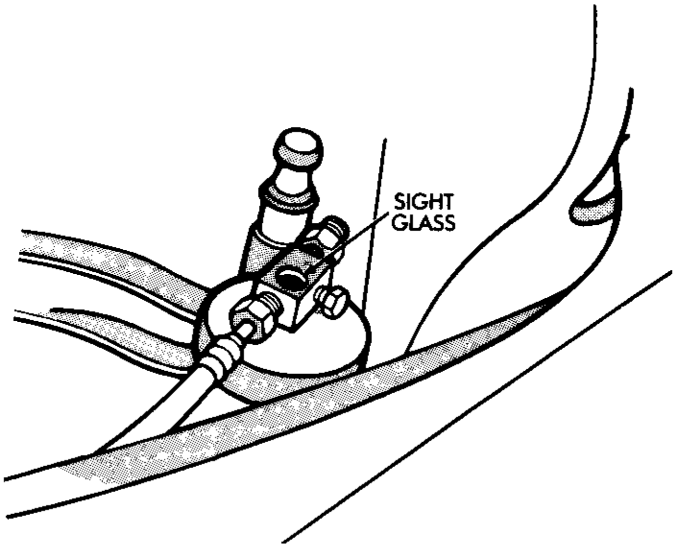
A continuous stream of bubbles will appear in the sight glass when system charge is low. Bubbles will not appear when the system is fully charged.



1. CAPILLARY TUBE – INSERT INTO COIL A MINIMUM OF 5.1 CM (2 IN.)
2. EVAPORATOR COIL
3. INSULATION
4. UPPER PART OF CASE

J8924-75

Fig. 2 Temperature Control Thermostat Removal/ Installation



J8924-76

Fig. 3 Sight Glass

RECEIVER-DRIER REPLACEMENT

(1) Discharge the system.

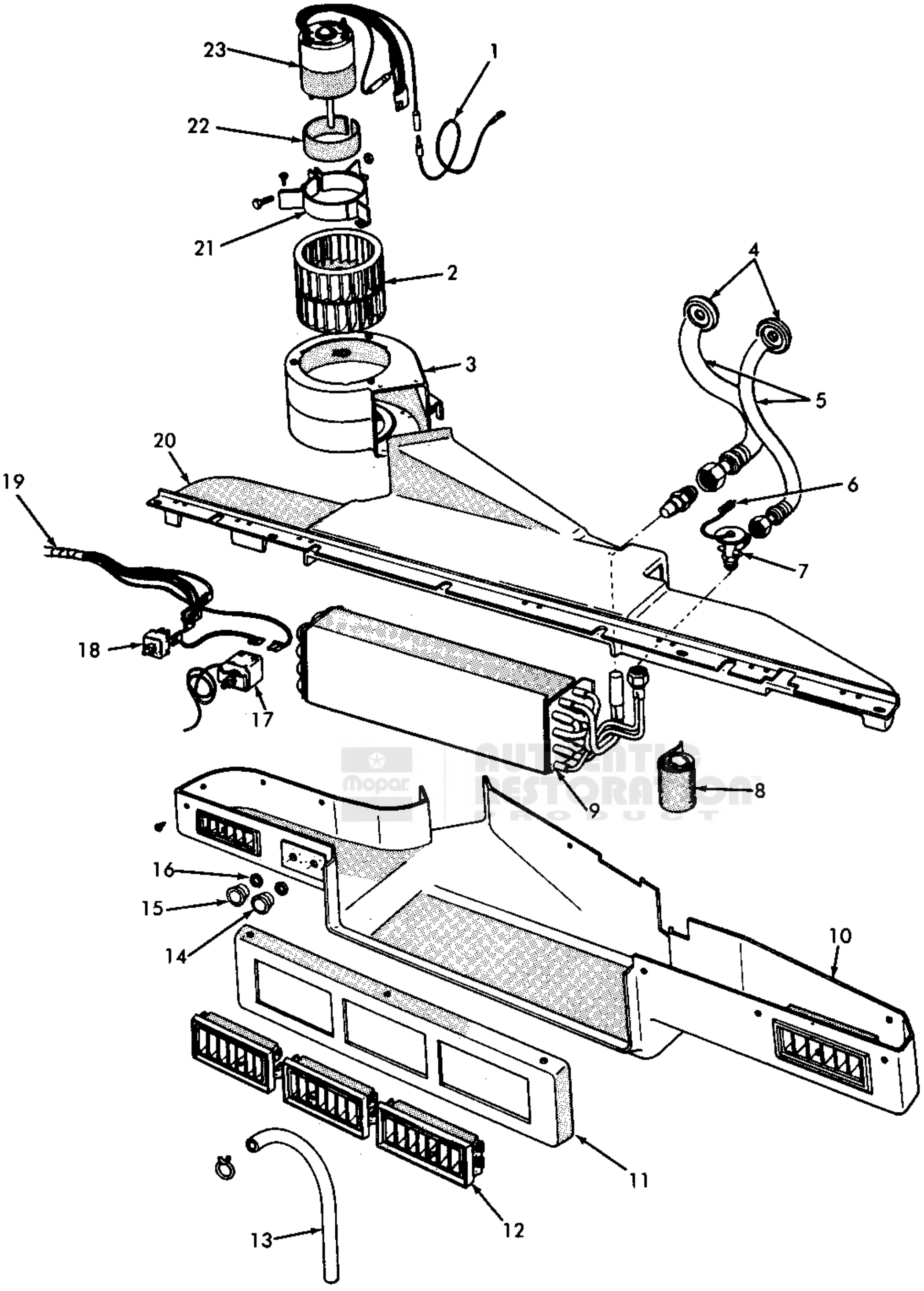
Discharge the system slowly to prevent loss of compressor oil.

(2) Disconnect the evaporator and condenser hose fittings from the receiver-drier.

(3) Remove the receiver-drier attaching screws and remove the receiver-drier.

(4) To install the receiver-drier, reverse the removal procedure.

(5) Evacuate, charge and leak test the system.



1. FEED WIRE
2. BLOWER FAN
3. BLOWER HOUSING
4. GROMMET
5. HOSE
6. CAPILLARY TUBE
7. EXPANSION VALVE
8. INSULATION
9. EVAPORATOR CORE
10. LOWER HOUSING
11. LOUVER PANEL
12. LOUVER
13. DRAIN TUBE
14. TEMPERATURE CONTROL KNOB
15. FAN CONTROL KNOB
16. NUT
17. THERMOSTAT
18. FAN CONTROL SWITCH
19. SWITCH HARNESS
20. UPPER HOUSING
21. BRACKET
22. INSULATION
23. BLOWER MOTOR

Fig. 4 Evaporator Housing and Components

EVAPORATOR AND HOUSING REPLACEMENT

Removal (Fig.4)

(1) Discharge the system.

Discharge the system slowly to prevent loss of compressor oil.

(2) Disconnect the inlet (suction) hose.

(3) Disconnect the receiver-drier-to-evaporator hoses.

(4) Remove the hose clamps and dash grommet retaining screws.

(5) Remove the evaporator housing-to-instrument panel attaching screws and the housing mounting bracket screw (Fig. 5).

(6) Lower the evaporator housing and pull the hoses and hose grommet through the dash opening.

The blower motor, blower motor housing, evaporator core, control switches and expansion valve can all be serviced after removing the evaporator housing.

Installation

Add one ounce of refrigerant oil to the system when replacing the evaporator.

(1) Push the hoses through the grommet openings and install the hose grommet by pushing it toward the engine compartment.

(2) Install the hose grommet attaching screws.

(3) Raise the evaporator housing. Install the evaporator housing-to- instrument panel attaching screws and the evaporator housing mounting bracket screw.

(4) Install the hose clamps.

(5) Connect the receiver-drier hoses.

(6) Connect the inlet (suction) hose.

(7) Evacuate, charge and leak test the system.

EXPANSION VALVE

Removal

Discharge the system slowly to prevent loss of compressor oil.

(1) Discharge the system.

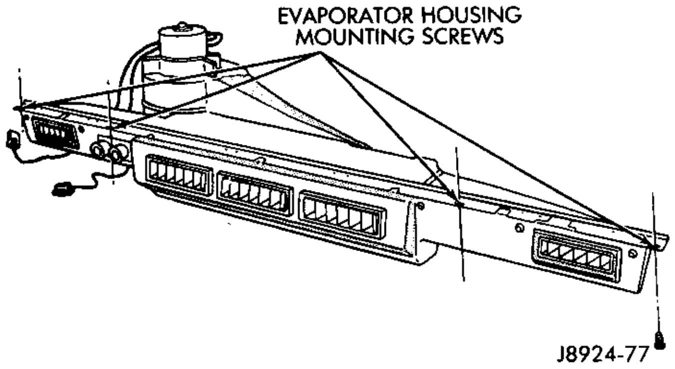


Fig. 5 Remove Evaporator Housing

(2) Remove the evaporator housing. Refer to the removal procedure.

(3) Remove the insulation wrapped around the suction hose fitting, expansion valve and evaporator tubing.

(4) Mark the capillary tube location on the evaporator tubing.

(5) Disconnect the inlet and outlet hose fittings, and remove the capillary tube clamp.

(6) Disconnect and remove the expansion valve.

Installation

(1) Clean the evaporator tubing to provide a positive metal-to-metal contact for the replacement expansion valve capillary tube.

(2) Install the replacement expansion valve.

(3) Clamp the capillary tube at the marked location on the evaporator tubing.

(4) Connect the inlet and outlet hose fittings.

The capillary tube must be securely clamped and have positive metal-to-metal contact with the evaporator tubing.

(5) Wrap the expansion valve, inlet hose fitting and capillary tube with insulation.

(6) Install the evaporator housing. Refer to the installation procedure.

(7) Evacuate, charge and leak test the system.

BLOWER MOTOR

It is not necessary to discharge the system to service the blower motor. The evaporator housing need only be lowered for access to the blower motor attaching screws.

SJ MODEL

INDEX

GENERAL INFORMATION

Heater

The SJ model uses a blend-air type heater and defroster system. The blend-air method of heating uses a constant flow system with engine coolant continuously flowing through the heater core. The temperature of the heated air entering the passenger compartment is controlled by regulating the quantity of air which flows through the heater core air passages, then blending it with a controlled amount of cool, fresh air which bypasses the heater core. System controls and operation are described in this section.

When servicing a malfunctioning heater system, refer to Service Diagnosis for a list of the possible causes and recommended service procedures.

Compressor

The A/C system uses a Sanden compressor. This compressor is a seven piston design. Designated the SD-709, the compressor is mounted on the front right side of the engine and is driven by two V-belts. System lubrication is provided by 240cc ± 15cc of 500 viscosity refrigerant oil.

The clutch used on the compressor consists of three basic components: the pulley, front plate and the field coil. The pulley and field coil are attached to the front head of the compressor with tapered snap rings. The hub is keyed to the compressor shaft and is retained on the shaft with a self-locking nut. Special service tools are required to remove and install the clutch plate on the compressor shaft. Refer to Compressor Disassembly for compressor and clutch service procedures.

Blower Motor

The SJ Model uses a four-speed blower motor. Blower speeds are selected with the control wheel located at the left side of the panel. Blower speeds are controlled by a resistor that provides the four separate speeds.

Temperature Control Lever

The temperature control lever has two functions. In heat or defrost mode, the lever operates the blend air door in the heater core housing to regulate heat. In A/C mode, the lever activates a potentiometer in the control panel to regulate compressor cycling and A/C output temperatures.

HEATER—A/C RELAY

An A/C relay is used to activate the blower motor in the heat/defrost or A/C modes. The relay is taped into the wire harness located behind the A/C housing.

A/C COMPRESSOR CONTROLS

An electronic control module is used to control compressor operation.

The electronic control module is located on A/C duct under the instrument panel above the accelerator pedal (Fig.1).

Input signals to the control module are from a thermistor located in the evaporator housing, and a potentiometer actuated by the temperature control lever. The control module energizes the compressor clutch while the potentiometer regulates A/C output. The thermistor monitors evaporator temperatures. Thermistor signals are relayed to the module which energizes or de-energizes the compressor clutch as needed.

Heater and Defroster Operation

The heater is part of the engine cooling system and depends on normal engine operating temperature and airflow through the cowl fresh air intake to heat the interior of the vehicle. During heater operation, close the fresh air vents.

When the function lever is moved to Off, Heat/Def or defrost it operates a vacuum control switch which controls two vacuum motors.

When the lever is moved to Off , the vacuum switch shuts off vacuum to the air inlet door vacuum motor. A spring closes this door, preventing any outside air from entering the heater.

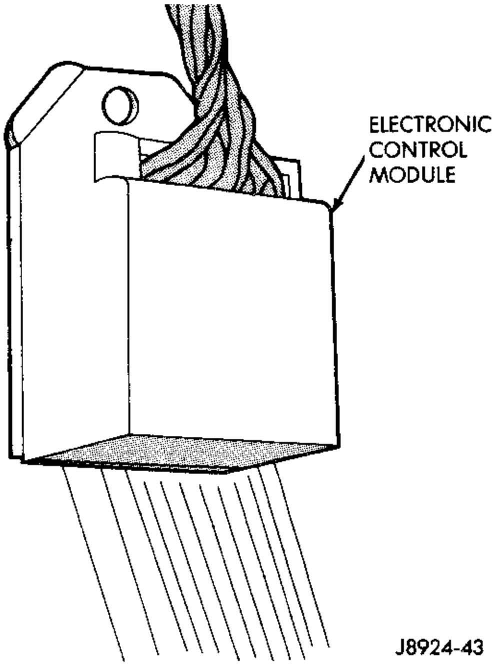


Fig. 1 Electronic Control Module

When the lever is moved to Heat/Def, the air inlet door is opened by the air inlet vacuum motor and air will flow through the heat transition housing and out of the floor heat distributor.

When the Defrost button is pressed, the vacuum switch directs vacuum to the defrost vacuum motor (Fig.2), which closes the door to the floor heat distributor. Airflow is then directed through the defroster duct onto the windshield. The air inlet door remains open to allow airflow through the heat transition housing.

The temperature control lever operates the blend air door in the heater core housing. At the full right position, all air is directed through the heater core providing maximum heat flow. At the full left position, all air is directed around the heater core providing unheated fresh air. The temperature control lever may be placed in any in-between position to provide a blend of cool, fresh, outside air and heater air. However, the function lever must be moved to either the Heat or Heat/Def position before any air can enter the vehicle.

If additional airflow is required, the blower motor should be operated at one of the four available speeds.

Fresh Air Ventilation

The ventilating system has two fresh air vents; one in the right cowl trim panel and one in the left cowl trim panel. Both vents are cable controlled with the control knobs mounted on the instrument panel to the right and

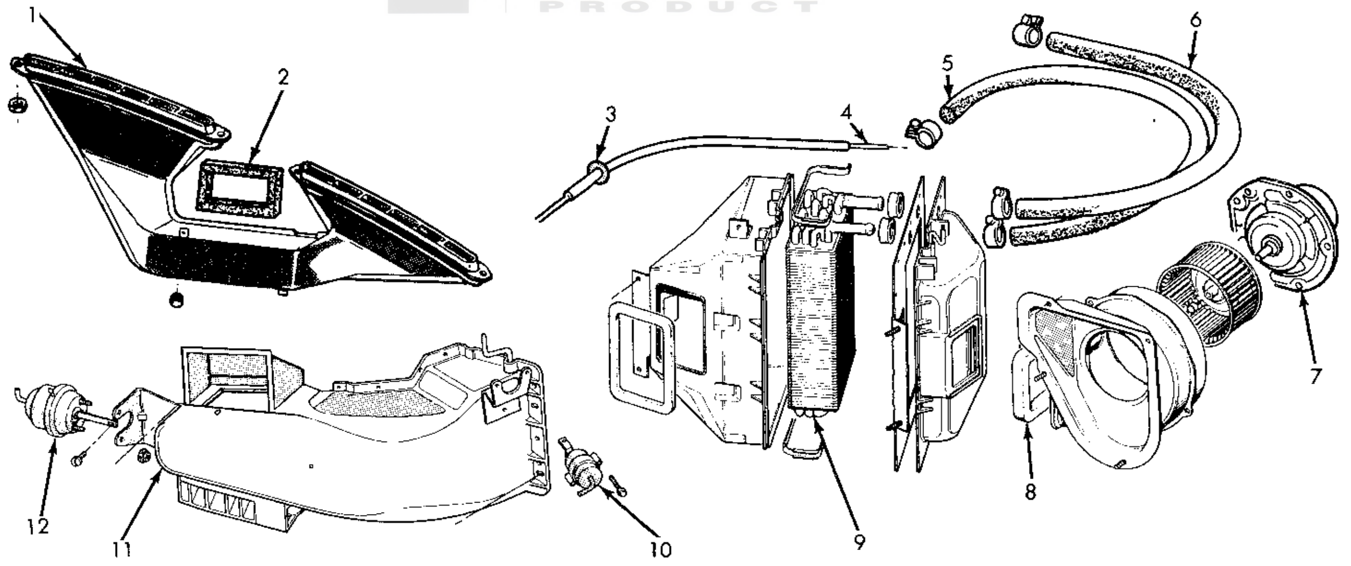


Fig. 2 Heater Core Housing And Components

left of the steering column.

HEAT A/C CONTROL PANEL REPLACEMENT

(1) Remove the instrument panel bezel (Fig.3).

(2) Remove the control panel retaining screws (Fig.4).

(3) Remove the control panel and disconnect all electrical and vacuum connections (Fig.5).

Tag the hoses according to their numbered locations for ease of assembly.

(4) Remove the control cable from the control panel by pressing in the retaining tab and removing the cable.

(5) To install the control panel, reverse the removal procedure. Make sure the square tab on control cable is locked into the control panel.

POTENTIOMETER REPLACEMENT

(1) Remove the heat A/C control panel.

(2) Bend the potentiometer retaining tabs upward and remove the potentiometer assembly from the control panel (Fig.6).

(3) To install the potentiometer, position it in the control panel making sure the pin engages with the temperature lever actuator.

(4) Wrap the potentiometer wires around the bottom of the control panel and lock them in the retaining tabs (Fig.7).

(5) Install the heat A/C control panel.

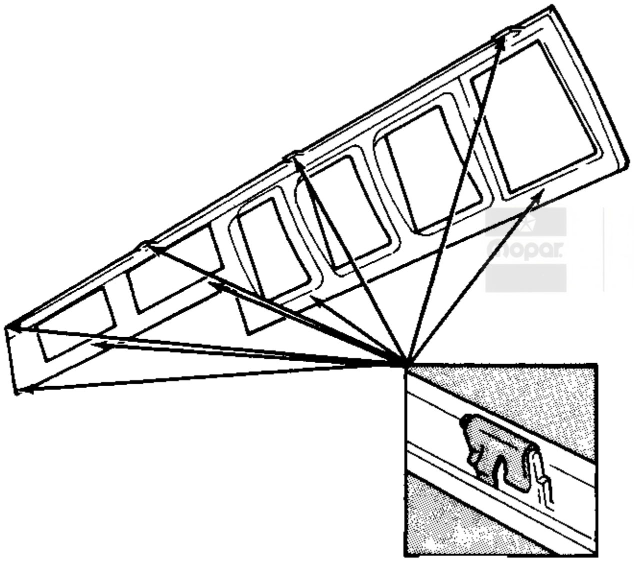


Fig. 3 Remove Instrument Panel Bezel

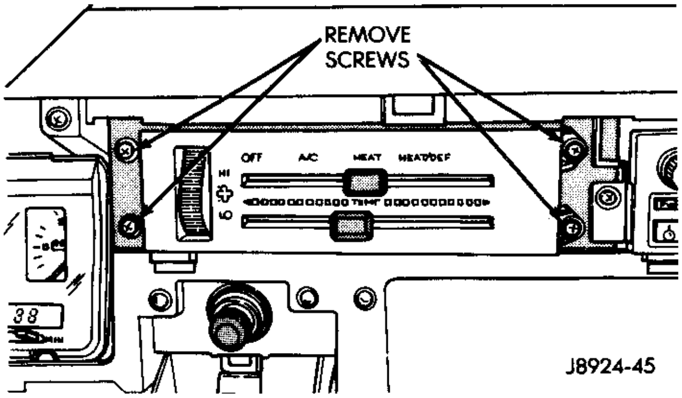


Fig. 4 Control Panel Removal

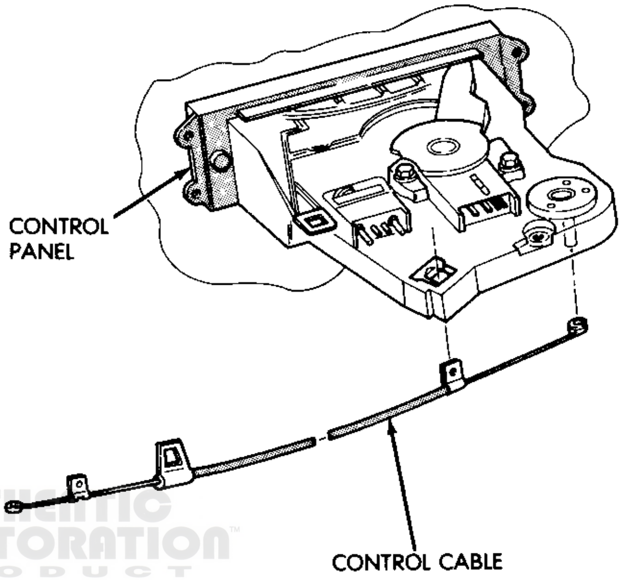


Fig. 5 Remove Control Cable (Typical)

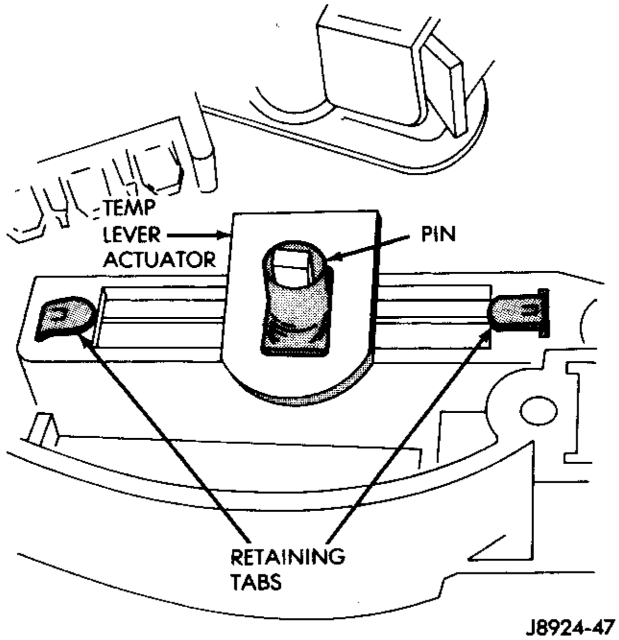


Fig. 6 Potentiometer Removal/Installation

HEAT A/C BLOWER SWITCH REPLACEMENT

(1) Remove the heat A/C control panel.

(2) Remove the blower switch retaining screws and remove the switches (Fig.8).

(3) Remove the control wheel from the switch assembly.

(4) To install a blower switch, position the control wheel in the replacement switch assembly. Make sure the control wheel tabs engage between the centering blocks inside the switch assembly (Fig.9).

(5) Install the switch assembly in the control panel and attach retaining screws.

(6) Install the heat A/C control panel.

ELECTRONIC CONTROL MODULE REPLACEMENT

(1) Remove the electronic module from under the instrument panel.

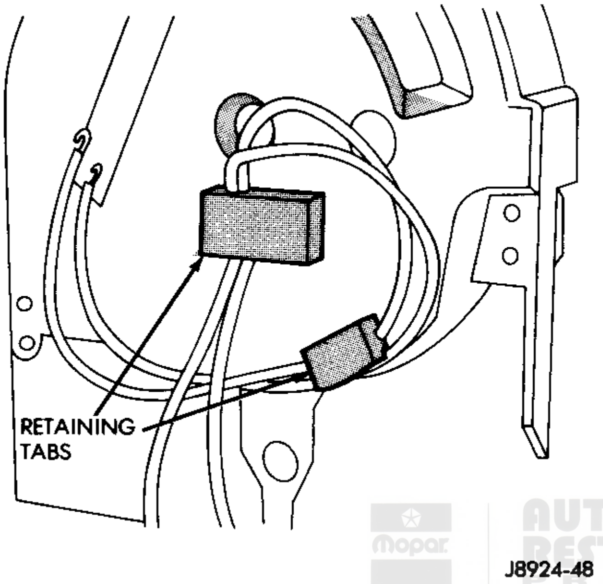


Fig. 7 Position Potentiometer Wires

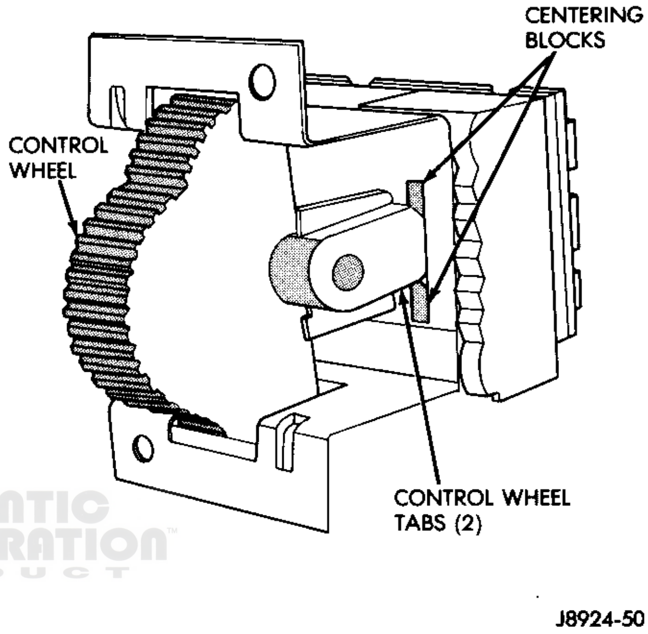


Fig. 9 Heat A/C Blower Switch Installation

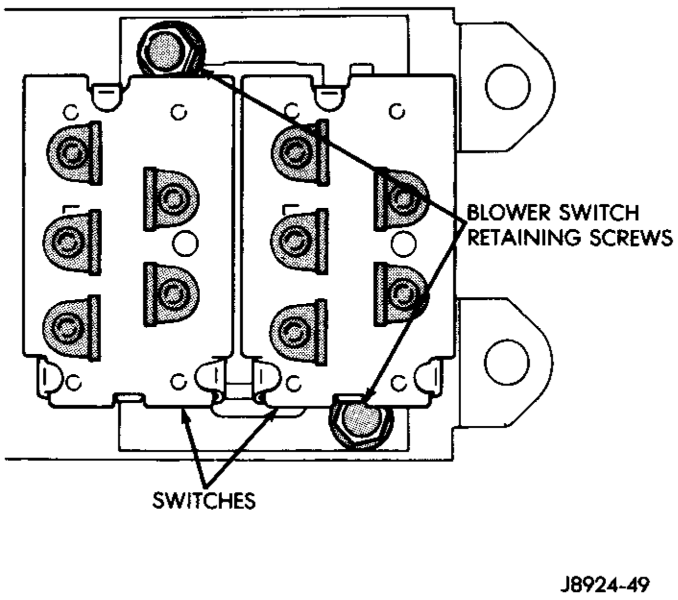


Fig. 8 Heat A/C Blower Switch Removal

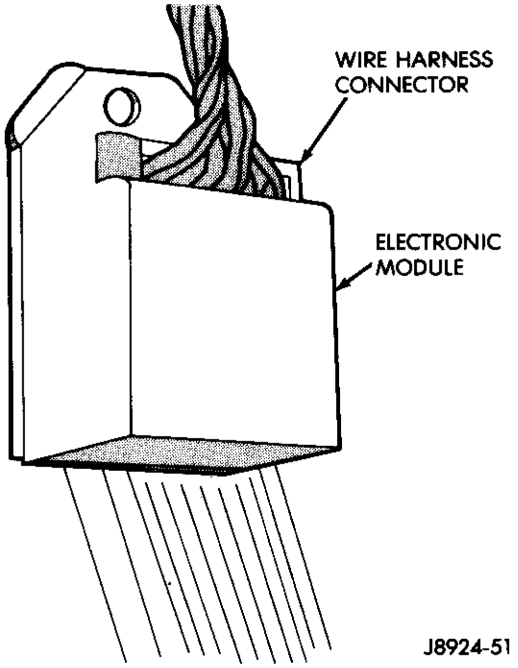


Fig. 10 Electronic Module Removal/Installation

(2) Disconnect the wire harness connector from the module (Fig.10).

(3) Remove the module.

(4) To install the module, reverse the removal procedure.

THERMISTOR REPLACEMENT

(1) Remove the 4WD Selection Switch mounting screws and lower the switch housing (Fig.11).

(2) Remove the lower evaporator housing mounting screws and ground wire screw (Fig.12).

(3) Lower the evaporator housing. This will allow access to the evaporator housing cover (Figs.13 and 14).

(4) Remove the insulation material (Fig.15).

(5) Remove the mounting screws retaining the evaporator housing cover (Fig.16). Remove cover.

(6) Drill a 4.76 mm (3/16 in.) hole through the cover of the evaporator housing (Fig.17).

(7) Install the cover on the housing and install insulating material.

(8) Install the thermistor probe by pushing it through the hole until the plastic end is seated on the evaporator housing.

(9) Tape the thermistor probe electrical lead securely to the cover as shown in Figure 7.

(10) Disconnect the original thermistor probe from the electrical harness and cut the connector from the probe. Leave the original probe in the evaporator.

(11) Connect the new thermistor probe to the harness.

(12) Install the evaporator housing.

(13) Install the 4WD selector switch.

(14) Start the engine and verify correct operation of the A/C system.

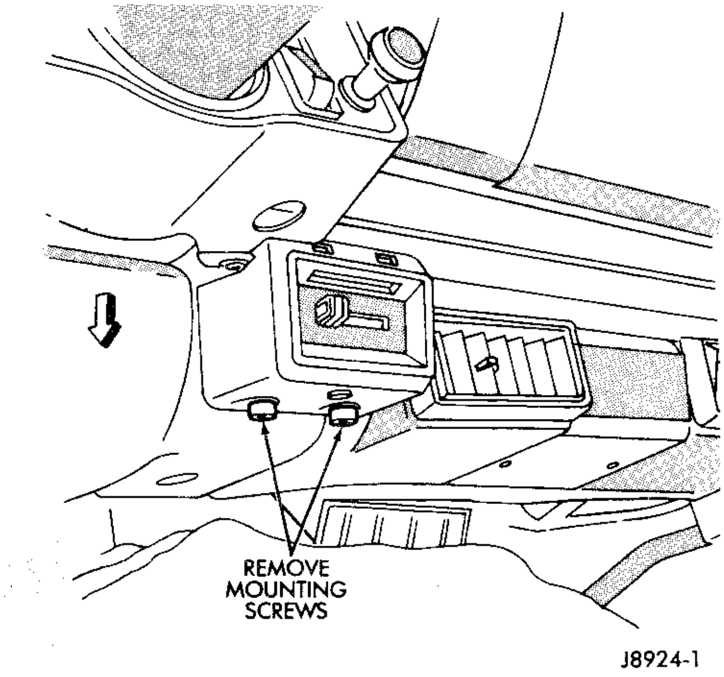


Fig. 11 Remove/Install 4WD Switch Housing

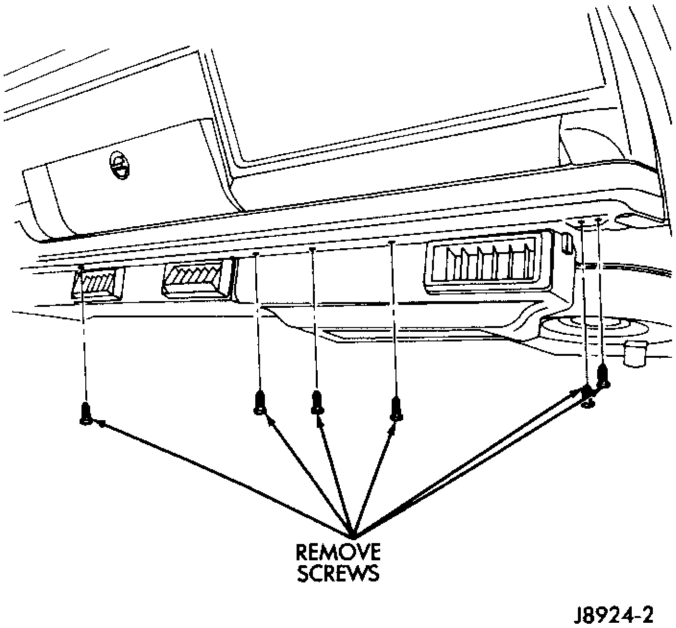


Fig. 12 Remove/Install Lower Evaporator Housing Screws

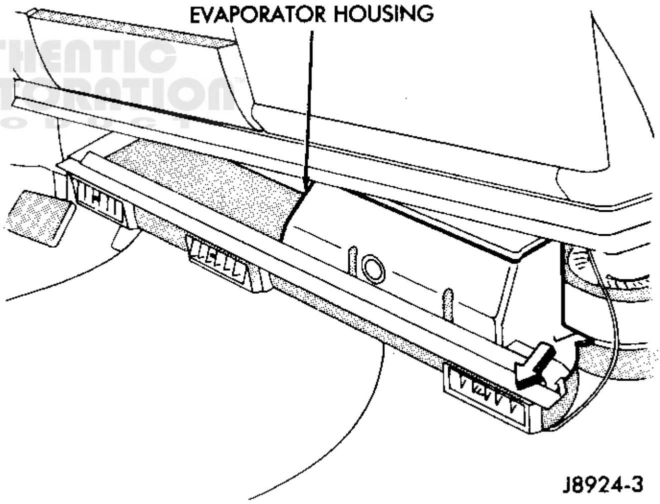


Fig. 13 Lower Evaporator Housing

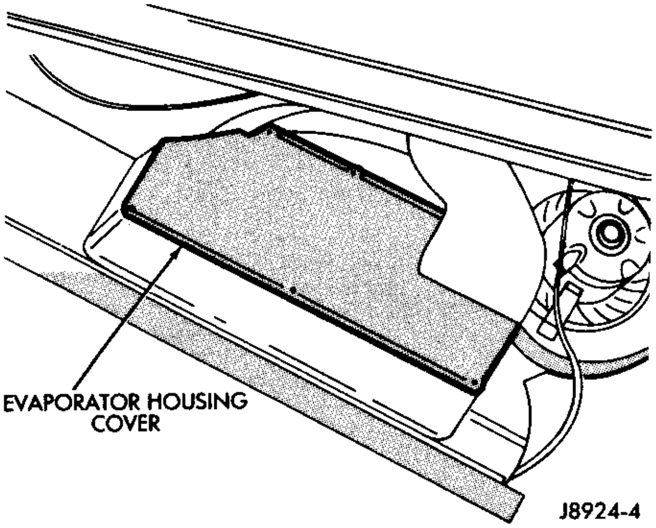


Fig. 14 Evaporator Housing Cover

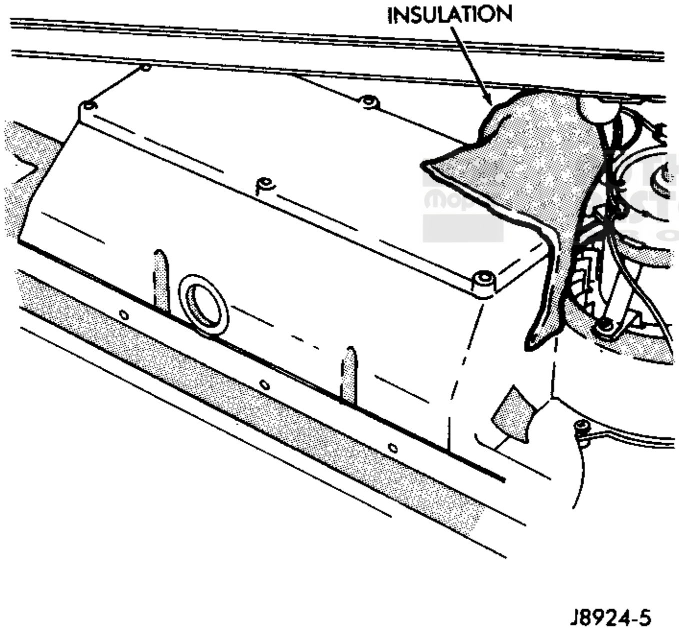


Fig. 15 Remove/Install Insulation

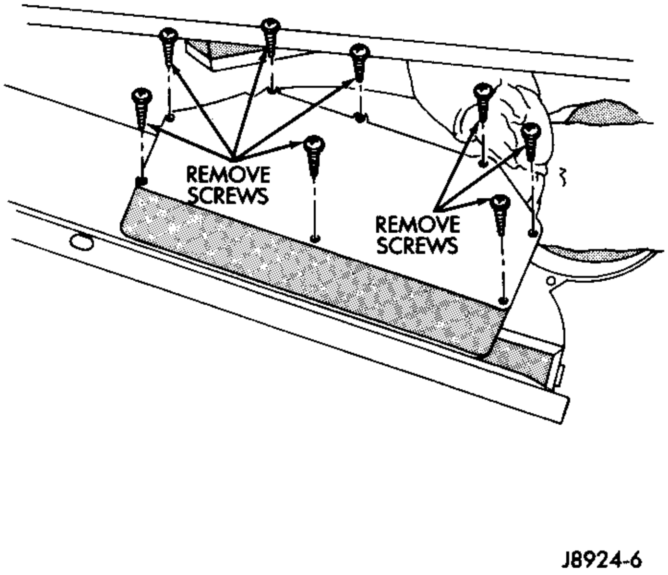


Fig. 16 Remove Evaporator Housing Cover Screws

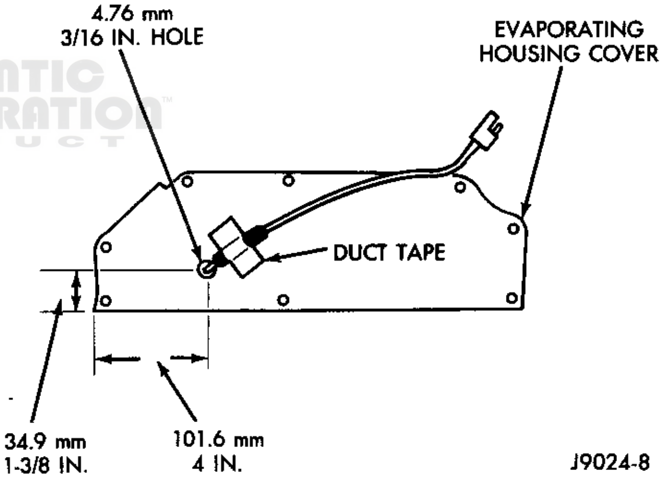


Fig. 17 Drill Hole In The Evaporator Housing Cover

Defroster Duct Replacement

(1) Disconnect the battery negative cable.

(2) Unsnap the tabs that retain the instrument panel bezel and remove the bezel (Fig.18).

(3) Remove the radio retaining screws.

(4) Slide the radio out far enough for access to the antenna and wiring harness connections.

(5) Disconnect the radio wiring harness connectors and antenna cable and remove the radio.

(6) Remove the Heat and A/C control panel retaining screws.

(7) Remove the control panel and disconnect all electrical and vacuum connections.

Tag the hoses according to their numbered locations for ease of assembly.

(8) Remove the control cable from the control panel by pressing in the retaining tab and removing the cable.

(9) Remove the 4WD Selection Switch mounting screws and lower the switch housing (Fig.19).

(10) Remove the left A/C duct extension.

(11) Remove the bolt holding the lower right corner of the IP.

(12) Loosen the steering column mounting bolts.

(13) Remove the evaporator housing mounting screws and ground wire screw (Fig.20).

(14) Lower the evaporator housing (Fig.21).

(15) Remove the bolt holding the lower right corner of the IP.

(16) Remove the four nuts holding the top of the defroster duct to the studs at the top of the IP.

(17) Carefully pry off the spring nuts holding the defroster duct to the back of the glove box.

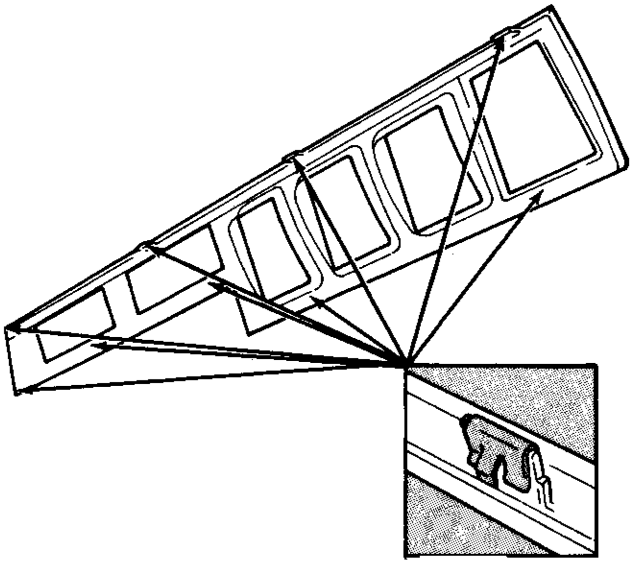


Fig.18 Instrument Panel Bezel Retaining Clips

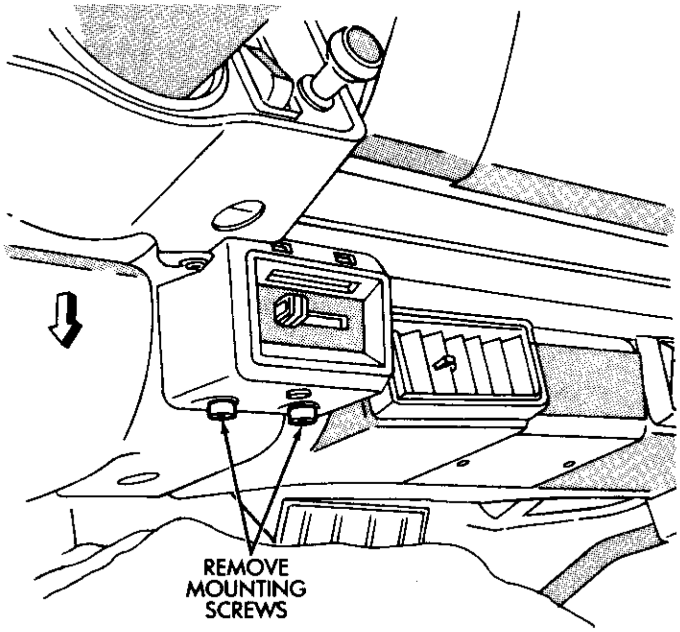


Fig.19 Remove/Install 4WD Switch Housing

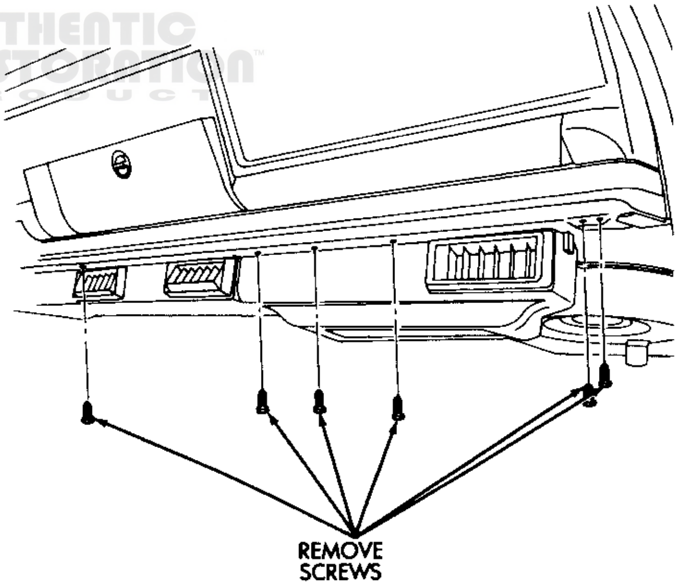


Fig.20 Remove Evaporator Housing Screws

(18) Disconnect electrical connectors behind glove box.

(19) Carefully pull the bottom of the IP toward the rear of the vehicle and remove the defroster duct.

(20) Reverse the removal procedures to install the defroster duct.

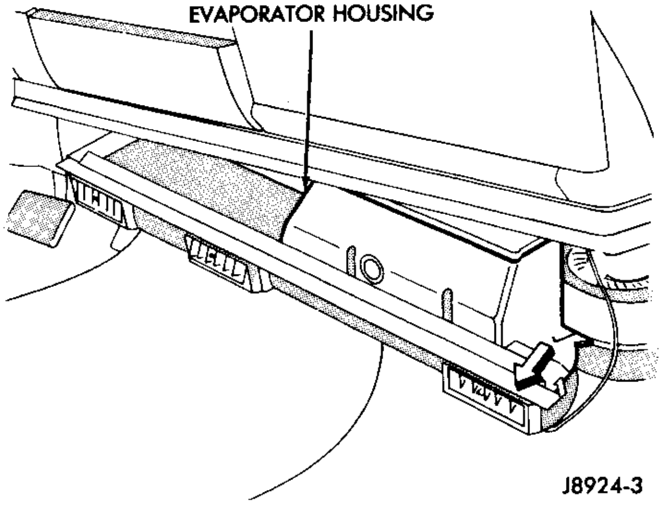


Fig.21 Lower Evaporator Housing

BLOWER MOTOR RESISTOR REPLACEMENT

The A/C and heater systems have a single blower motor resistor. The resistor is located in the cowl plenum chamber adjacent to the power brake booster/master cylinder.

(1) Disconnect the resistor wire electrical connectors.

(2) Remove the retaining screws.

(3) Remove the resistor.

(4) To install the resistor, reverse the removal procedure.

HEATER CORE REPLACEMENT

(1) Drain approximately two quarts of coolant from the radiator.

(2) Disconnect the temperature control cable from the blend-air door.

(3) Disconnect the heater hoses at the heater core.

(4) Remove the heater core housing-to-dash-panel attaching nuts.

(5) Remove the heater core housing assembly.

(6) Remove the attaching screws holding the housing halves together and separate the housing.

(7) Remove the heater core-to-housing attaching screws and remove the core.

(8) To install a heater core, reverse the removal procedures.

(9) Replace the coolant.

(10) Check the heater operation.

BLOWER MOTOR REPLACEMENT

(1) Disconnect the blower motor electrical connector.

(2) Remove the blower motor-to-blower motor housing attaching screws and remove the blower motor and fan assembly.

(3) To install the blower motor, position the blower motor and fan assembly on the blower motor housing and install the attaching screws.

(4) Connect the blower motor electrical connector.

(5) Check the blower motor operation.

SIGHT GLASS

A sight glass is incorporated in the receiver-to-evaporator hose at the receiver end (Fig.22). The sight glass provides a visual check of the system refrigerant level. A continuous stream of bubbles will appear in the sight glass of a system which is not properly charged. Properly charged and completely discharged systems will appear similar through the sight glass because of a lack of bubbles. To distinguish between the two situations, cycle the magnetic clutch off and on with the engine running at 1500 rpm. During the time the clutch is off, bubbles will appear if the refrigerant is in the system and will disappear when the clutch is on. If no bubbles appear when cycling the magnetic clutch, there is no refrigerant in the system since some bubbles would appear in a fully charged system. If the system is dis-

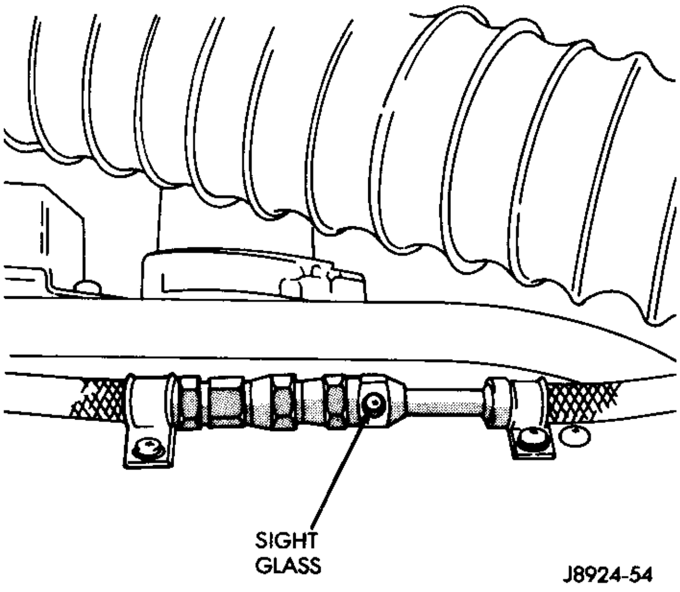


Fig.22 Sight Glass Location

charged, it will be necessary to leak test, repair as required, evacuate and charge the system.

CONDENSER REPLACEMENT

(1) Discharge the refrigerant from the system as described in System Discharge.

Discharge the system slowly to prevent loss of compressor oil.

(2) Drain the radiator.

(3) Remove the fan shroud and radiator.

(4) Disconnect the pressure line at the condenser.

(5) Remove the condenser attaching screws and tilt the bottom of the condenser toward the engine.

Plug all the open connections to prevent entry of dirt and moisture.

(6) From the underside of the vehicle, disconnect the receiver/drier-to-evaporator hose at the receiver/drier.

(7) Remove the condenser and receiver/drier assembly.

(8) Remove the receiver/drier from the condenser, if necessary.

(9) If removed, install the receiver/drier to the condenser.

(10) Place the condenser in position and connect the receiver/drier-to- evaporator hose at the receiver/drier.

(11) Install the condenser attaching screws.

(12) Connect the pressure line at the condenser.

(13) Install the radiator and fan shroud.

(14) Fill the radiator.

(15) Evacuate, leak test, and charge the system as described in General Information and Refrigerant Handling.

RECEIVER/DRIER REPLACEMENT

Removal

(1) Discharge the refrigerant from the system as described in System Discharge.

Discharge the system slowly to prevent the loss of compressor oil.

(2) Remove the headlamp trim ring.

(3) Remove the headlamp assembly.

(4) Remove the grille.

(5) Remove the bolt from the top of the inner panel. Pull the panel back and block.

(6) Remove the evaporator and condenser line from the receiver/drier.

(7) Remove the screws from the receiver/drier bracket and remove the receiver/drier.

Installation

(1) To install the receiver/drier to the radiator support bracket.

(2) Install the evaporator and condenser lines to the receiver/drier.

(3) Remove the block and install the inner panel bolt.

(4) Install the grille.

(5) Install the headlamp assembly.

(6) Install the headlamp trim ring.

(7) Evacuate, charge the system and leak test as described in General Information and Refrigerant Handling.

EVAPORATOR HOUSING ASSEMBLY REPLACEMENT (Fig. 23)

Removal

(1) Discharge the system as described in System Discharge.

(2) Disconnect the inlet (suction) line at the compressor.

(3) Disconnect the receiver/drier-to-evaporator hose at the quick-disconnect coupling (Fig.24).

(4) Remove the hose clamps and dash grommet retaining screws.

(5) Remove the evaporator housing-to-instrument panel attaching screws and the evaporator housing-to-mounting bracket screw (Fig.25).

(6) Lower the evaporator housing and pull the hoses and grommet through the opening.

(7) The blower motor, blower motor housing and evaporator core may be serviced after the evaporator housing is removed.

It is not necessary to discharge the system to service the blower motor. The evaporator housing may be lowered from the instrument panel to gain access to the blower motor attaching screws.

Installation

(1) Push the hoses through the grommet opening, and install the grommet by pushing toward the engine compartment of the vehicle; fasten it to the dash panel with two attaching screws.

(2) Raise the evaporator and install the evaporator housing-to-instrument panel attaching screws and the evaporator-to-mounting bracket screw.

(3) Install the hose clamps and grommet attaching screws.

(4) Connect the receiver-to-evaporator hose at the quick-disconnect coupling.

(5) Connect the inlet (suction) line to the compressor.

(6) Evacuate, leak test and charge the system as described in General Information and Refrigerant Handling.

EXPANSION VALVE SERVICE

(1) The expansion valve is preset and should not be adjusted. A defective valve requires replacement.

(2) Discharge the system as described in General Information and Refrigerant Handling.

(3) Remove the evaporator housing assembly.

(4) Remove the insulation wrapped around the suction line and expansion valve. Mark the capillary tube location on the suction line.

(5) Disconnect the inlet and outlet connections, capillary tube clamp and equalizer tube.

(6) Remove the expansion valve.

(7) Clean the suction line to provide positive contact with the replacement expansion valve capillary tube.

(8) Connect the inlet and outlet hoses. Clamp the capillary tube at the marked position and connect the equalizer tube.

Clamp the capillary tube securely so that a firm contact with the suction line is formed.

(9) Wrap the expansion valve and line with insulation.

(10) Install the evaporator housing assembly.

(11) Evacuate, leak test and charge the system as described in General Information and Refrigerant Handling.

ELECTRICAL DIAGNOSIS

A/C Circuit Testing with AMGN 19-010 (Fig. 26)

(1) Disconnect the control module from the A/C harness.

(2) Connect tester harness to the control module.

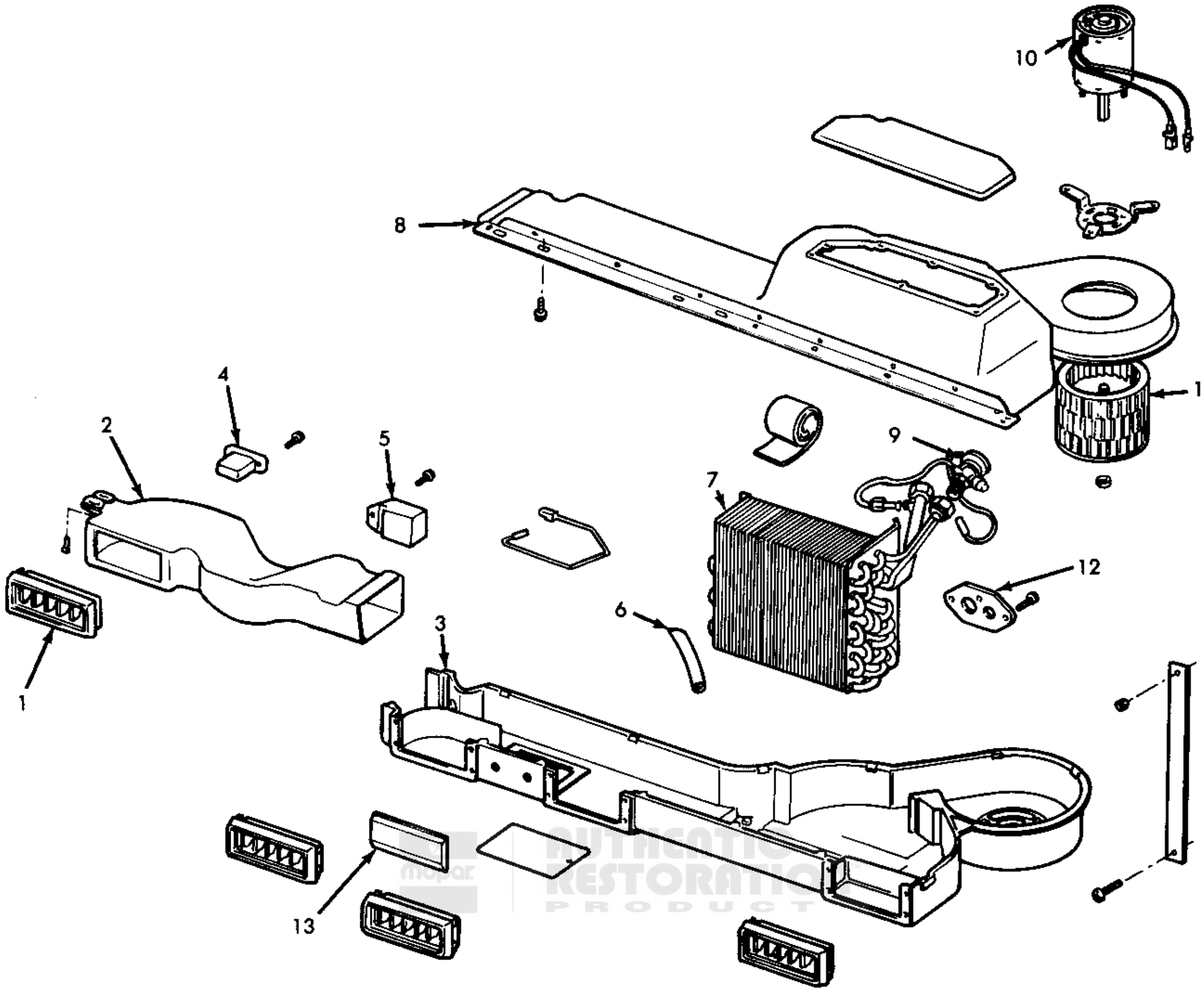
(3) Connect the A/C harness to tester connection.

(4) Turn the ignition switch to ON.

(5) Turn the A/C system ON and set the temperature control lever at cold position.

(6) Turn the tester knob to desired position to test the A/C circuit and components. Observe the light on the tester. If the light fails to illuminate in one or more of the test positions, refer to the following diagnosis and test procedures.

Before performing the power failure check, be sure the module wiring connector is firmly seated. Disconnect and reconnect the wiring harness connector at the module and recheck system operation.



1. LOUVER AND BEZEL
2. LEFT DUCT EXTENSION
3. LOWER EVAPORATOR
4. RESISTOR
5. THERMOSTAT
6. DRAIN TUBE
7. EVAPORATOR CORE
8. UPPER EVAPORATOR CORE HOUSING
9. EXPANSION VALVE
10. BLOWER MOTOR
11. FAN
12. GROMMET
13. CONTROL FACE PLATE

J8924-57

Fig. 23 Evaporator Housing and Components

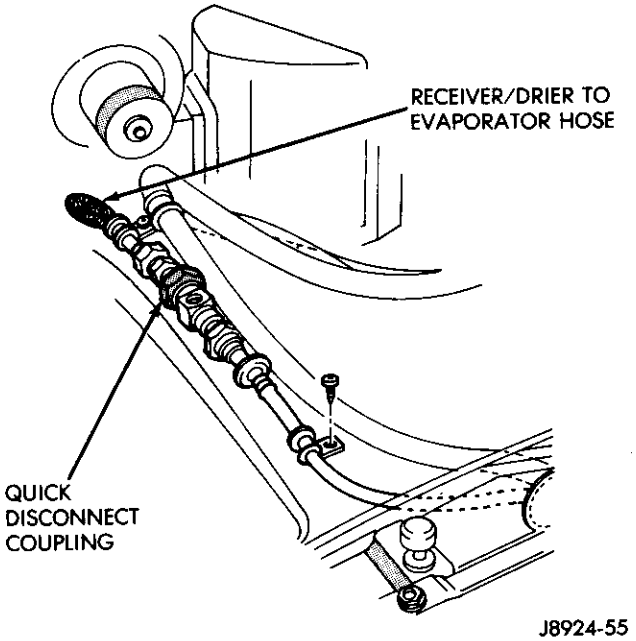


Fig. 24 Disconnect Hose

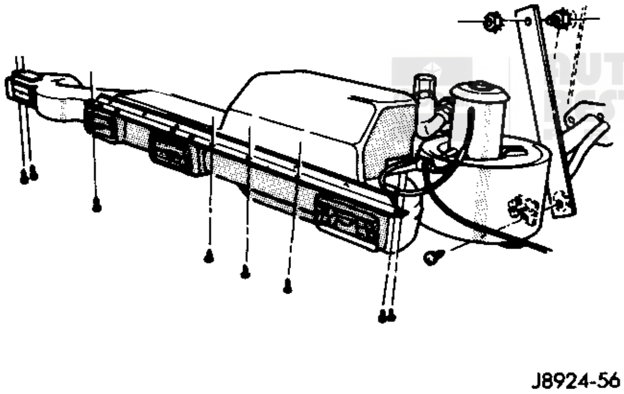


Fig. 25 Remove Evaporator Housing Mounting Screws

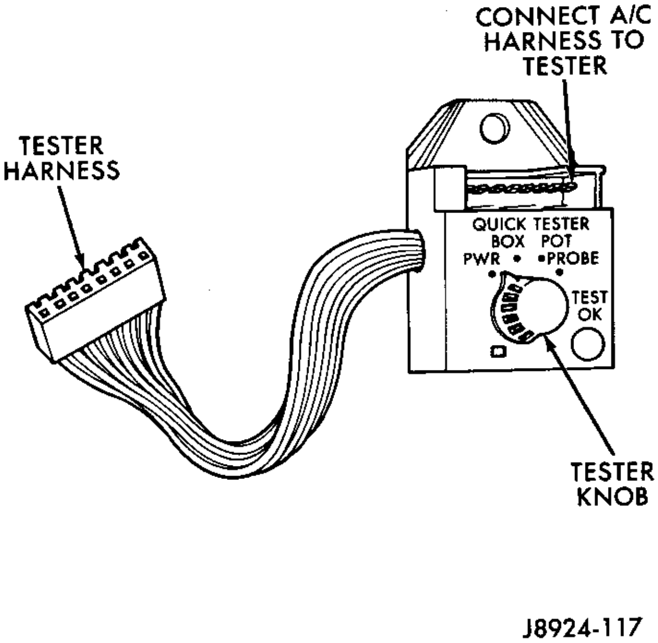
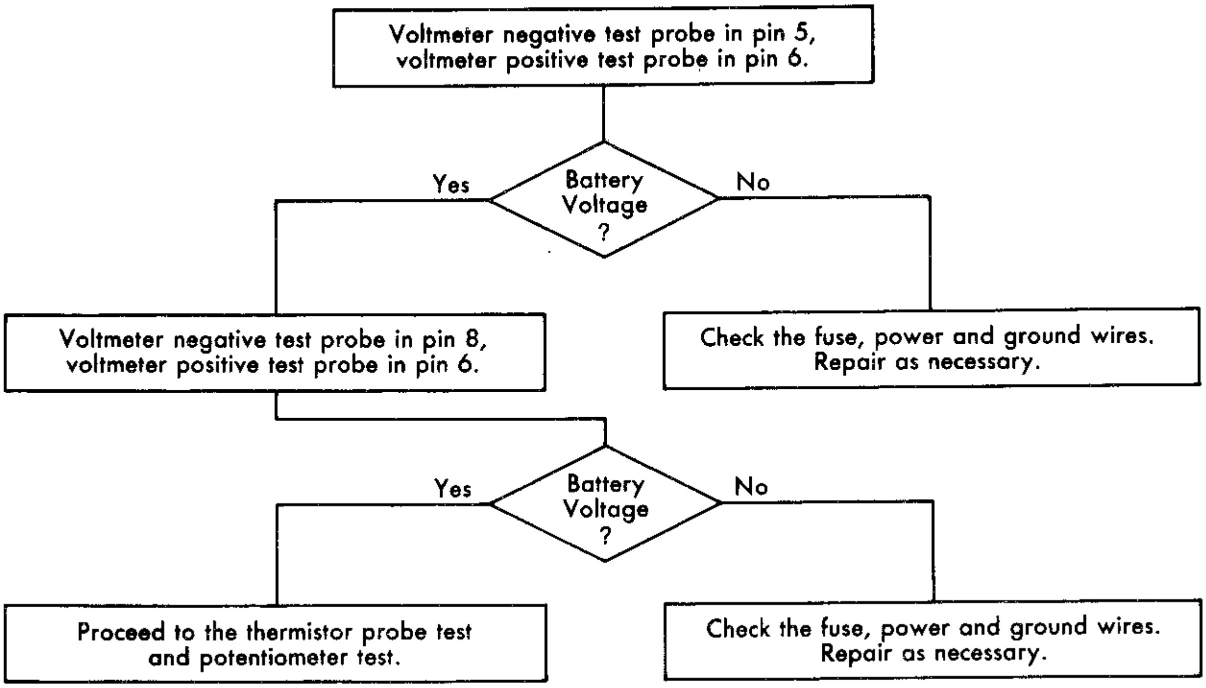


Fig. 26 A/C Circuit Tester

A/C POWER FAILURE DIAGNOSIS



J8924-118

Potentiometer Test

(1) Place the ohmmeter test probes across pin 3 and pin 4 of the control module wire harness connector.

(2) Check resistance with temperature control lever in:

- Cold Position = 0 to 100 ohms
- Warm Position = Approx. 10,000 ohms
- Hot Position = infinite ohms

If resistance is not infinite in the hot position, check for a short circuit in the wires before replacing the potentiometer.

Thermistor Probe Test

(1) Place the ohmmeter test probes across the control module wire harness connector pins 1 and 2.

(2) Refer to the resistance chart.

Example: If the ambient temperature is 26.6°C (80°F), probe resistance should be approximately 4,649 ohms ±550 ohms.

Thermistor probe replacement can only be accomplished by removing evaporator housing.

A/C Wiring Diagrams

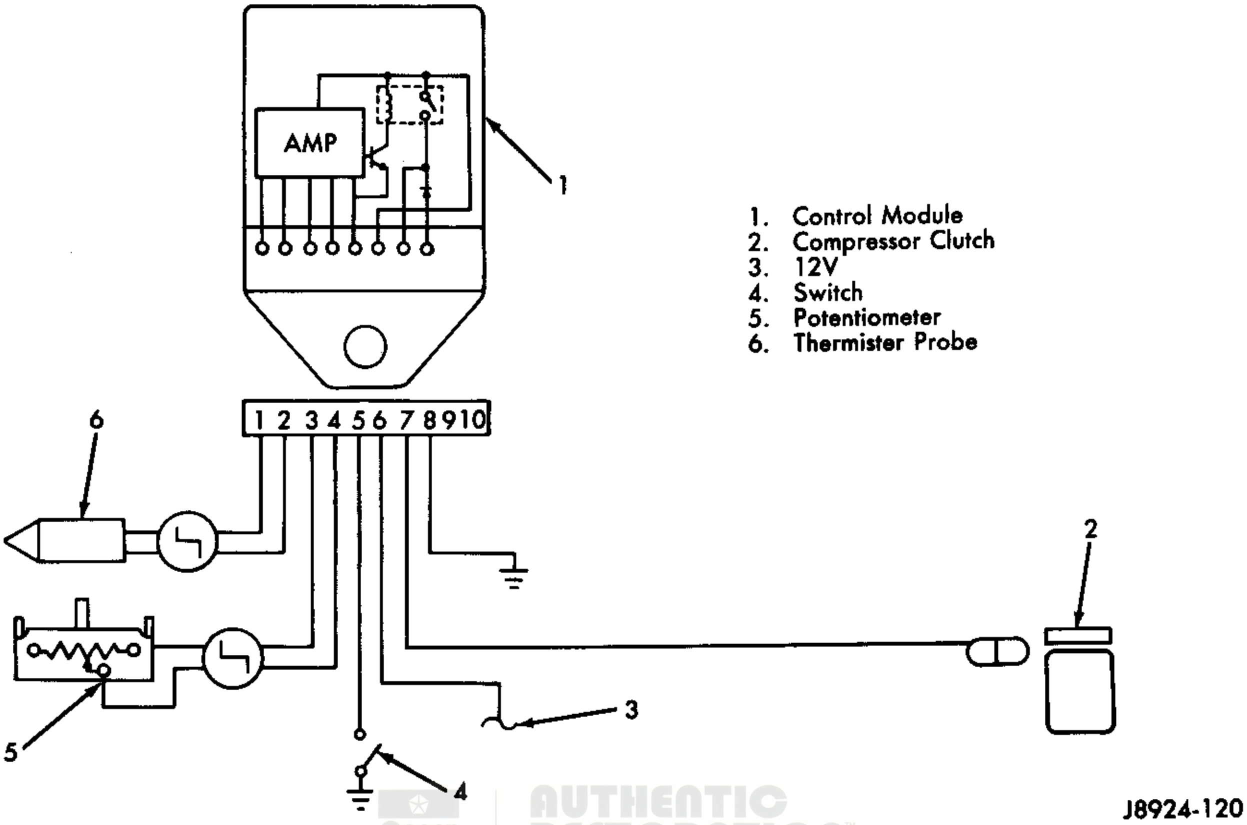
See Group 8W, Wiring Diagrams for the A/C wiring.

THERMISTOR TEMPERATURE/RESISTANCE CHART

Ambient Temperature C (°F)	Resistance (ohms)	Ambient Temperature C (°F)	Resistance (ohms)
−5.0° (23°)	21147	23.9° (75°)	5250
−4.5° (24°)	20538	24.4° (76°)	5123
−4.0° (25°)	19949	25.0° (77°)	5000
−3.5° (26°)	19379	25.5° (78°)	4880
−3.0° (27°)	18827	26.1° (79°)	4763
−2.2° (28°)	18294	26.6° (80°)	4649
−1.5° (29°)	17777	27.2° (81°)	4538
−1.1° (30°)	17277	27.8° (81°)	4431
−0.5° (31°)	16793	28.3° (83°)	4326
0 (32°)	16325	28.9° (84°)	4224
0.5° (33°)	15867	29.4° (85°)	4125
1.1° (34°)	15423	30.0° (86°)	4029
1.7° (35°)	14994	30.5° (87°)	3920
2.2° (36°)	14578	31.1° (88°)	3830
20.0° (68°)	6245	31.6° (89°)	3750
20.5° (69°)	6090	32.2° (90°)	3650
21.1° (70°)	5940	32.8° (91°)	3560
21.6° (71°)	5794	33.3° (92°)	3500
22.2° (72°)	5652	33.9° (93°)	3410
22.7° (73°)	5514	34.4° (94°)	3325
23.3° (74°)	5380	35.0° (95°)	3265

J8924-119

A/C SIMPLIFIED WIRING DIAGRAM



1. Control Module
2. Compressor Clutch
3. 12V
4. Switch
5. Potentiometer
6. Thermister Probe

J8924-120

EMISSION CONTROL SYSTEMS

CONTENTS

EVAPORATIVE EMISSION CONTROLS

INDEX

GENERAL INFORMATION

Emission Timers

MJ/XJ and YJ vehicles are equipped with an Emission Maintenance Timer and Indicator Light. The timer and light are used to inform the owner when oxygen sensor and PCV valve replacement and other scheduled emission maintenance is required.

The indicator light is located in the instrument cluster. On MJ/XJ vehicles the timer is mounted on the dash panel to the right of the steering column (Fig. 1). On YJ vehicles the timer is mounted on the dash panel to the right of the accelerator pedal (Fig. 2).

The timer is operated by the ignition system. It activates the indicator light when vehicle mileage reaches the scheduled maintenance interval of approximately 133,000 kilometers (82,500 miles).

Emission Maintenance Timer Service

The life cycle of the timer coincides with the emission maintenance interval of approximately 133,000 kilometers (82,500) miles. The timer can not be reset after reaching this mileage interval. The timer can only be replaced or disconnected.

The oxygen sensor and timer are interdependent. If the timer should fail prematurely, the ox

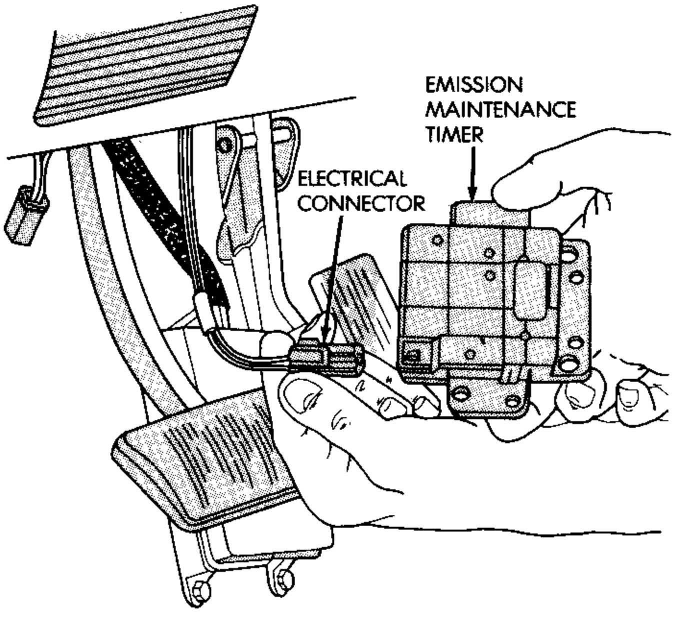


Fig. 1 Emission Maintenance Timer—MJ/XJ Vehicles

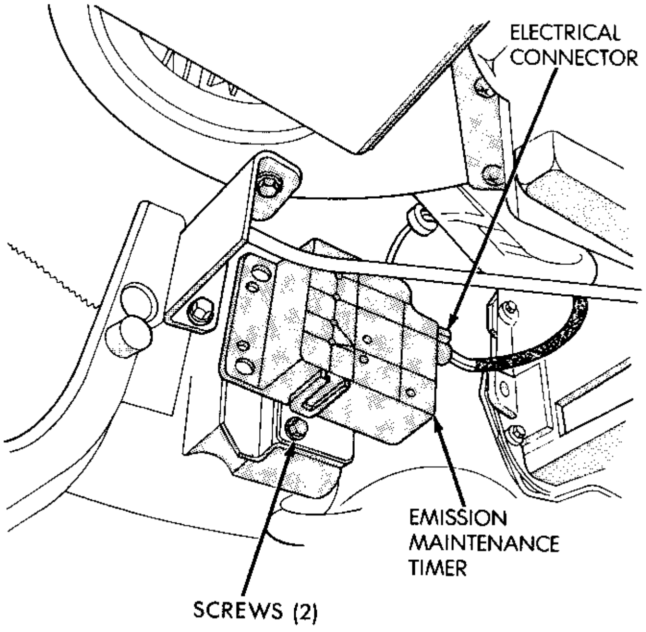


Fig. 2 Emission Maintenance Timer—YJ Vehicles

ygen sensor must be replaced along with the timer. This is important in preserving the correct sensor replacement interval and ensuring proper engine performance.

Emission Maintenance Timer Replacement

MJ/XJ Vehicles

- On models equipped with cruise control, remove the cruise control module mounting screws and remove the module (Fig. 3).

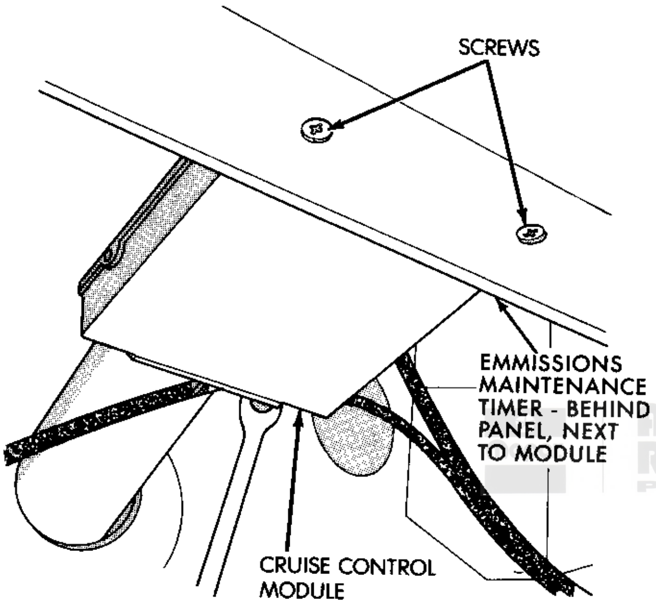


Fig. 3 Cruise Control Module

The emission maintenance timer is mounted on the dash panel to the right of the steering column (Fig.1).

- Remove the screws attaching the emission maintenance timer to the dash bracket.
- Disconnect the timer electrical connector. Remove the timer.
- Connect the timer electrical connector to the replacement timer.
- Mount the timer on the dash panel bracket with the screws.
- Install the cruise control module.

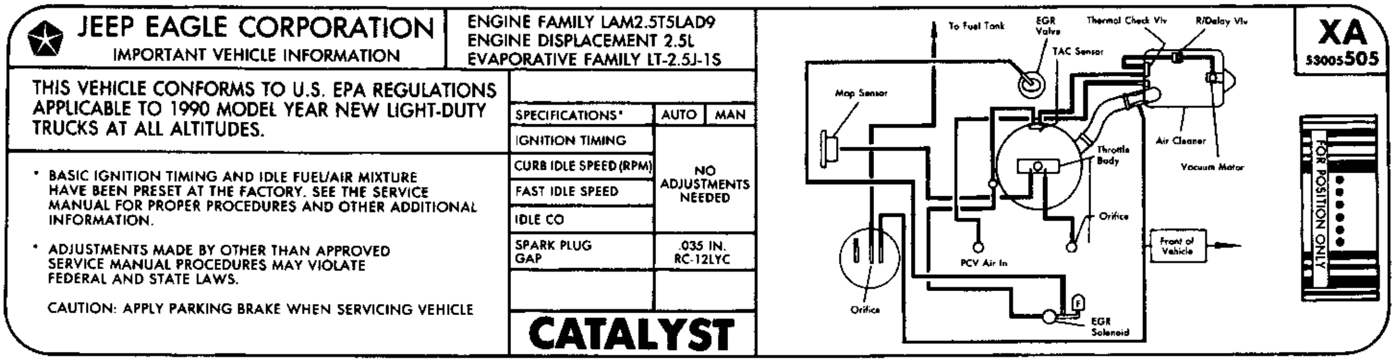
YJ Vehicles

The emission maintenance timer is mounted on the dash panel to the right of the accelerator pedal (Fig.2).

- Remove emission timer mounting screws.
- Disconnect the timer electrical connector and remove the timer.
- Connect the electrical connector to the replacement timer.
- Mount the timer on the dash panel with the screws.

Vehicle Emissions Control Information Label

All vehicles are equipped with a Vehicle Emission Control Information label (Fig. 4). The label, which is located in the engine compartment, lists the vehicles' engine family and displacement, evaporative family, emission control system, certification application, engine timing specifications, idle speeds (if adjustable), and spark plug gap. Additionally, the label of vehicles built for sale in the state of California (Fig. 5) have an emission system schematic included. The information on the labels of vehicles built for sale in the country of Canada (Fig. 6) are written in both English and French languages. If any differences occur between the information on the Vehicle Emission Control Information label and the service manual, the information on the label should be used.



JEEP EAGLE CORPORATION
IMPORTANT VEHICLE INFORMATION

ENGINE FAMILY LAM2.5T5LAD9
ENGINE DISPLACEMENT 2.5L
EVAPORATIVE FAMILY LT-2.5J-1S

THIS VEHICLE CONFORMS TO U.S. EPA REGULATIONS APPLICABLE TO 1990 MODEL YEAR NEW LIGHT-DUTY TRUCKS AT ALL ALTITUDES.

- * BASIC IGNITION TIMING AND IDLE FUEL/AIR MIXTURE HAVE BEEN PRESET AT THE FACTORY. SEE THE SERVICE MANUAL FOR PROPER PROCEDURES AND OTHER ADDITIONAL INFORMATION.
- * ADJUSTMENTS MADE BY OTHER THAN APPROVED SERVICE MANUAL PROCEDURES MAY VIOLATE FEDERAL AND STATE LAWS.

CAUTION: APPLY PARKING BRAKE WHEN SERVICING VEHICLE

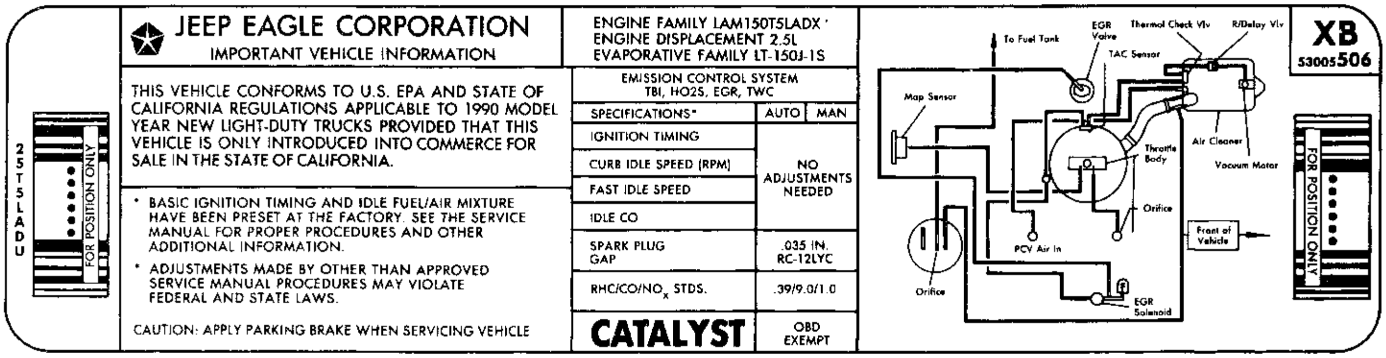
SPECIFICATIONS*	AUTO	MAN
IGNITION TIMING	NO ADJUSTMENTS NEEDED	
CURB IDLE SPEED (RPM)		
FAST IDLE SPEED		
IDLE CO		
SPARK PLUG GAP	.035 IN. RC-12LYC	

CATALYST

XA
53005505

J9025-3

Fig. 4 Federal Vehicle Emission Control Information Label—Typical



JEEP EAGLE CORPORATION

IMPORTANT VEHICLE INFORMATION

ENGINE FAMILY LAM150T5LADX
ENGINE DISPLACEMENT 2.5L
EVAPORATIVE FAMILY LT-150J-1S

THIS VEHICLE CONFORMS TO U.S. EPA AND STATE OF CALIFORNIA REGULATIONS APPLICABLE TO 1990 MODEL YEAR NEW LIGHT-DUTY TRUCKS PROVIDED THAT THIS VEHICLE IS ONLY INTRODUCED INTO COMMERCE FOR SALE IN THE STATE OF CALIFORNIA.

- * BASIC IGNITION TIMING AND IDLE FUEL/AIR MIXTURE HAVE BEEN PRESET AT THE FACTORY. SEE THE SERVICE MANUAL FOR PROPER PROCEDURES AND OTHER ADDITIONAL INFORMATION.
- * ADJUSTMENTS MADE BY OTHER THAN APPROVED SERVICE MANUAL PROCEDURES MAY VIOLATE FEDERAL AND STATE LAWS.

CAUTION: APPLY PARKING BRAKE WHEN SERVICING VEHICLE

EMISSION CONTROL SYSTEM
TBI, HO2S, EGR, TWC

SPECIFICATIONS*	AUTO	MAN
IGNITION TIMING	NO ADJUSTMENTS NEEDED	
CURB IDLE SPEED (RPM)		
FAST IDLE SPEED		
IDLE CO		
SPARK PLUG GAP	.035 IN. RC-12LYC	
RHC/CO/NO$_x$ STDS.	.39/9.0/1.0	
CATALYST	OBD EXEMPT	

XB
53005506

J9025-4

Fig. 5 California Vehicle Emission Control Information Label—Typical

CHRYSLER CANADA

VEHICLE EMISSION CONTROL INFORMATION

ENGINE FAMILY LAM2.5T5LAD9
ENGINE DISPLACEMENT 2.5L

THIS VEHICLE WAS BUILT FOR SALE IN CANADA AND WAS DESIGNED TO MEET THE EMISSION REQUIREMENTS OF THE CANADA MOTOR VEHICLE SAFETY ACT.

IT WAS NOT DESIGNED TO COMPLY WITH THE REQUIREMENTS OF OTHER COUNTRIES.

LE PRÉSENT VÉHICULE A ÉTÉ FABRIQUÉ POUR ÊTRE VENDU AU CANADA ET IL A ÉTÉ CONCU DE MANIÈRE À SE CONFORMER AUX NORMES ANTIPOLLUTION DE LA LOI SUR LA SÉCURITÉ DES VÉHICULES AUTOMOBILES DU CANADA.

IL N'EST PAS DESTINÉ À SE CONFORMER AUX NORMES D'AUTRES PAYS.

SEE SERVICE MANUAL FOR DETAILED INSTRUCTIONS.

CAUTION: APPLY PARKING BRAKE WHEN SERVICING VEHICLE.

POUR PLUS DE RENSEIGNEMENTS, VEUILLEZ VOUS REPORTER AU MANUEL D'ENTRETIEN.

AVERTISSEMENT: SERBEZ LE FREIN DE STATIONNEMENT POUR FAIRE L'ENTRETIEN OU LA RÉPARATION DU VÉHICULE.

SPECIFICATIONS	AUTO	MAN
IGNITION TIMING	NOT ADJUSTABLE	
CURB IDLE SPEED (RPM)		
FAST IDLE SPEED		
IDLE CO		
SPARK PLUG GAP	0.9MM RC-12LYC	

YP
53005504

J9025-5

Fig. 6 Canadian Vehicle Emission Control Information Label—Typical

Vacuum Hose Routing Schematics

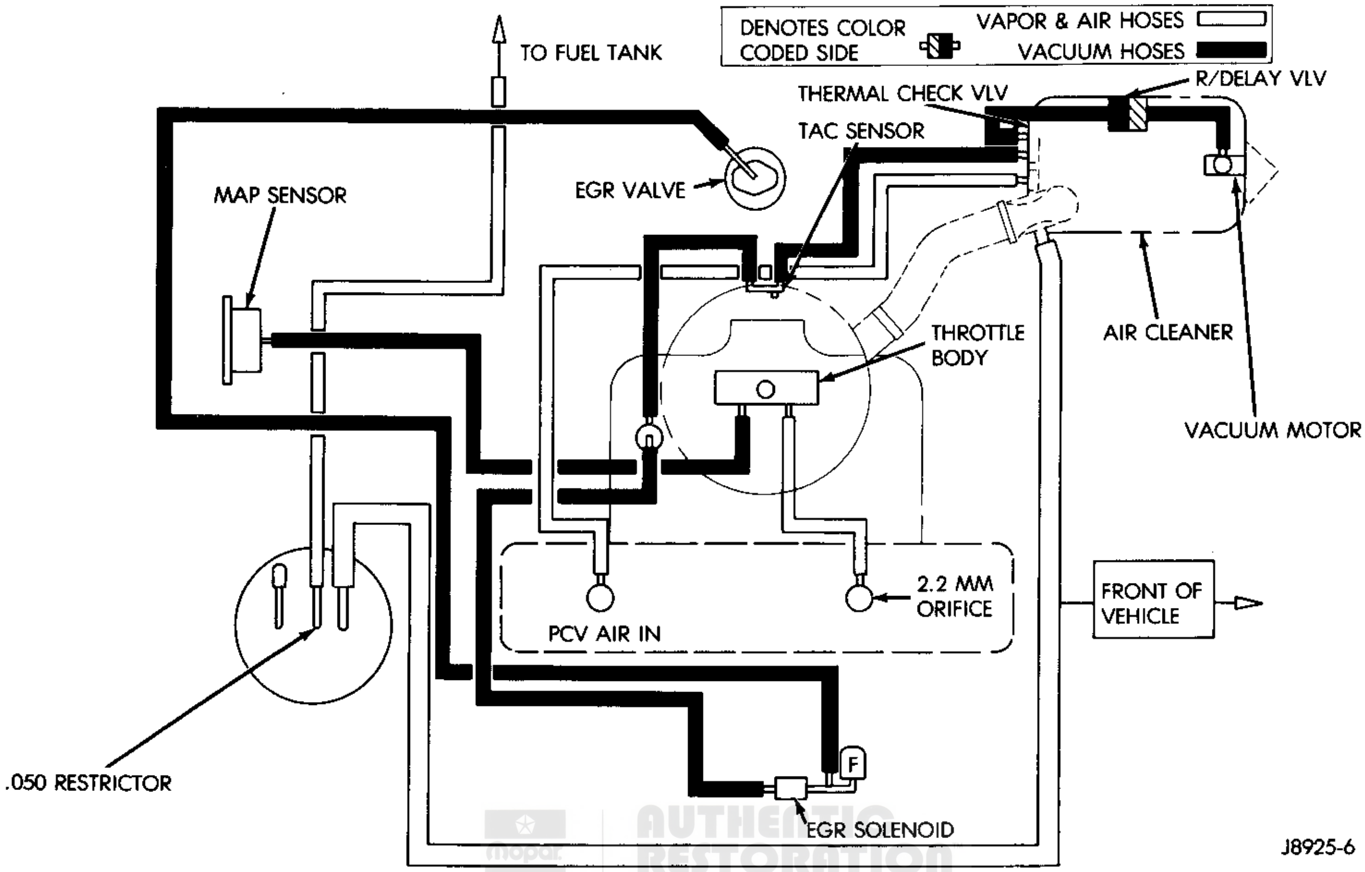


Fig. 7 Emissions Schematic—MJ/XJ Vehicles with 2.5L Engine

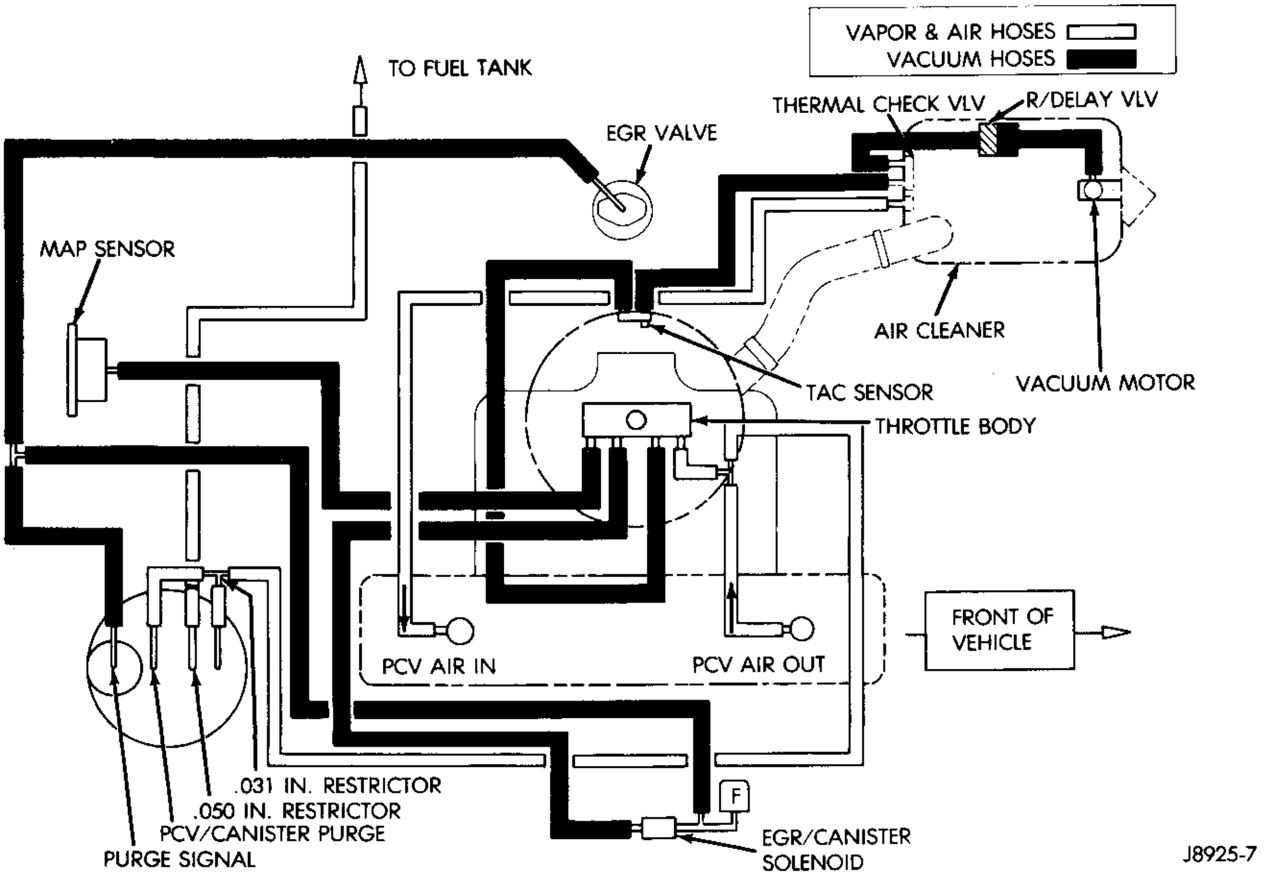


Fig. 8 Emissions Schematic—YJ Vehicles with 2.5L Engine

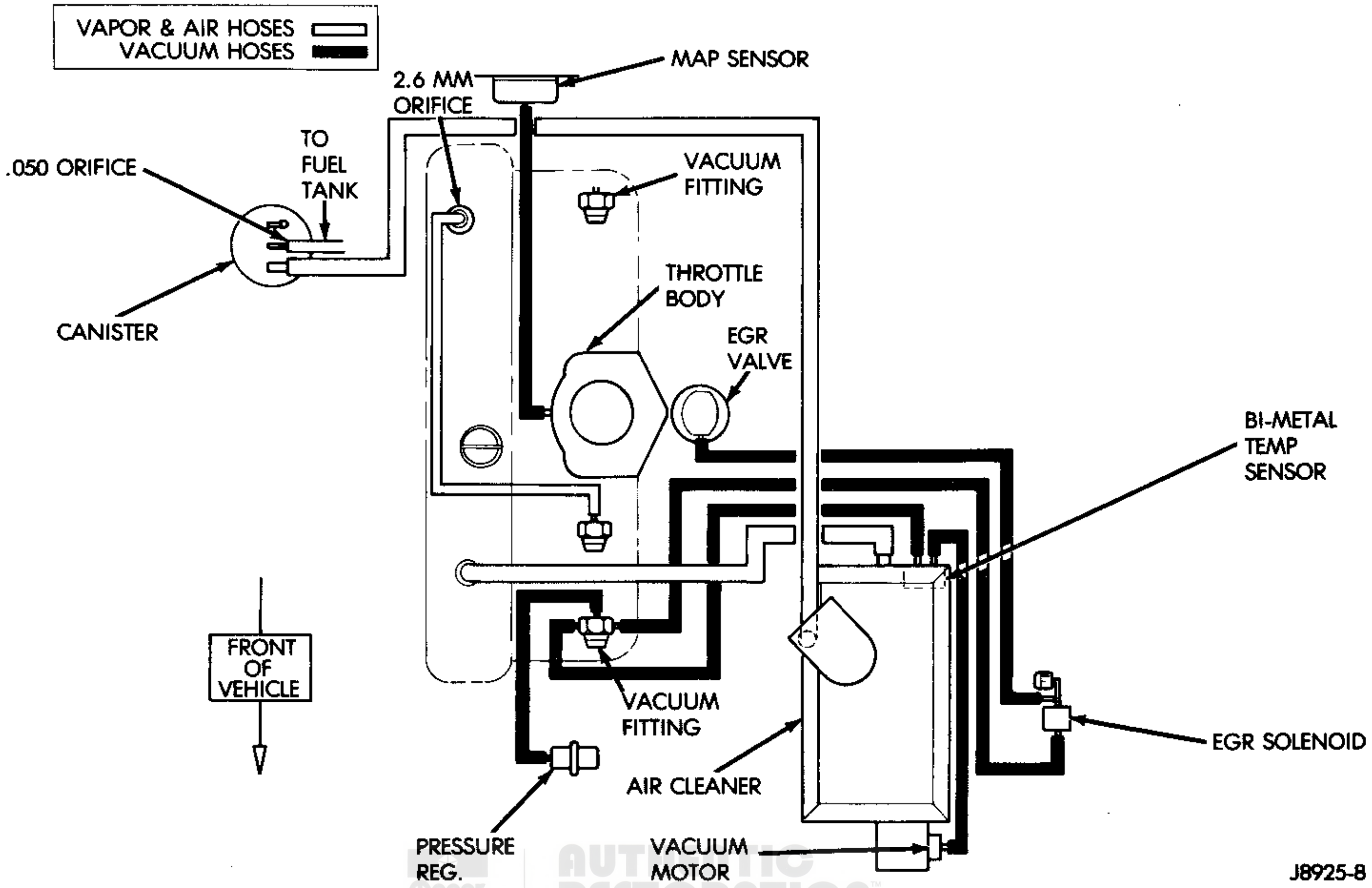


Fig. 9 Emissions Schematic—4.0L Engine

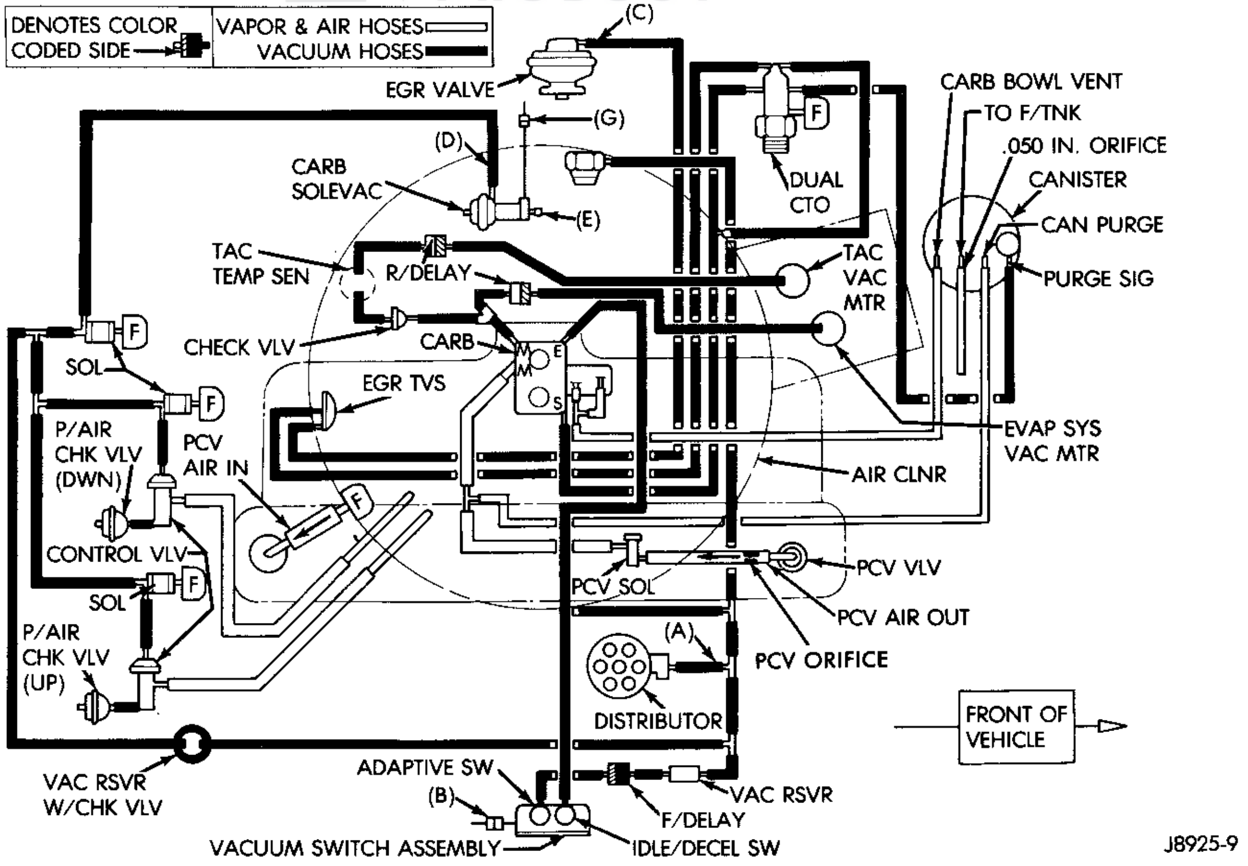


Fig. 10 Emissions Schematic—YJ Vehicles 4.2L Engine and Auto. Trans.

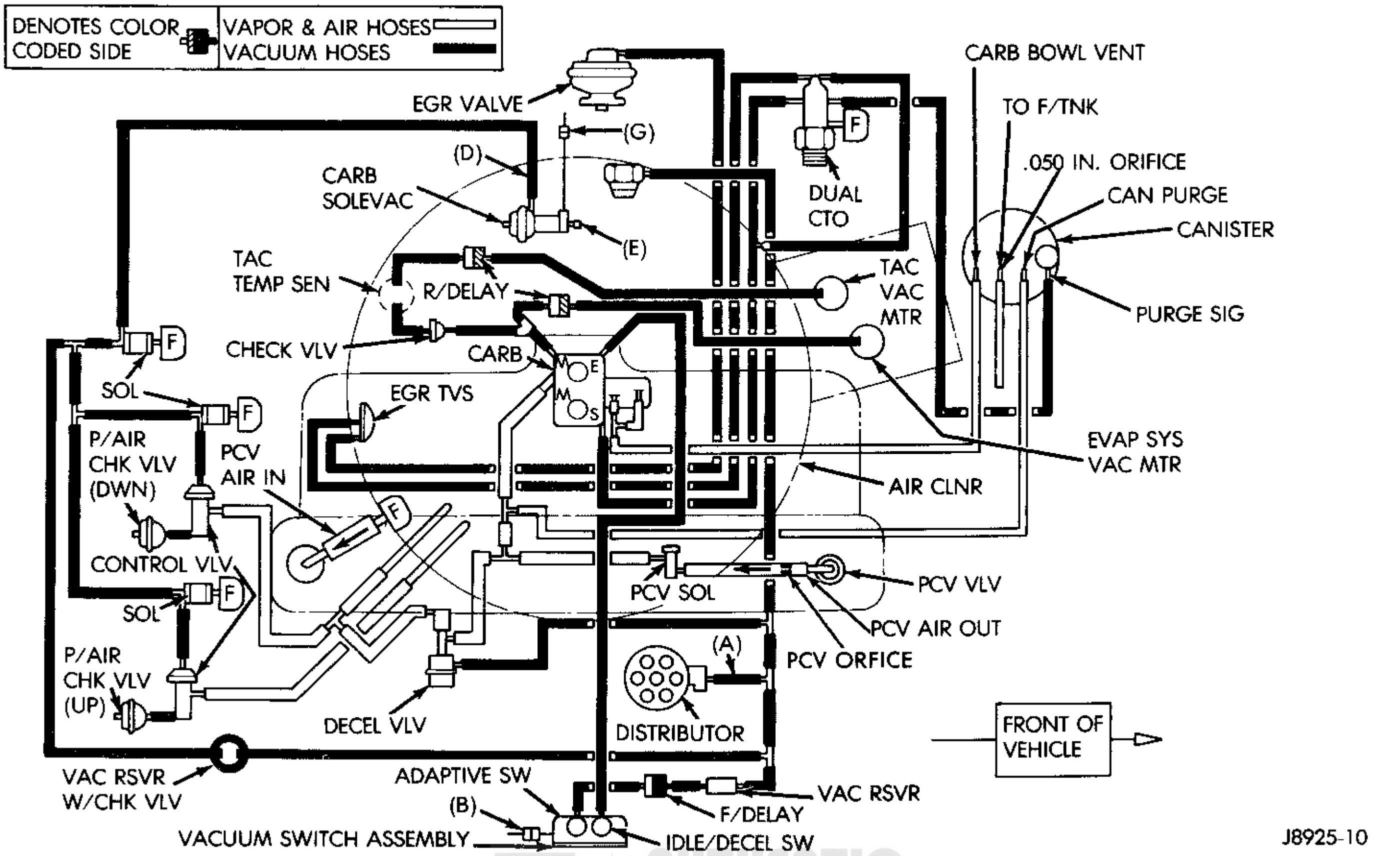


Fig. 11 Emissions Schematic—YJ Vehicles with 4.2L Engine and Manual Trans.

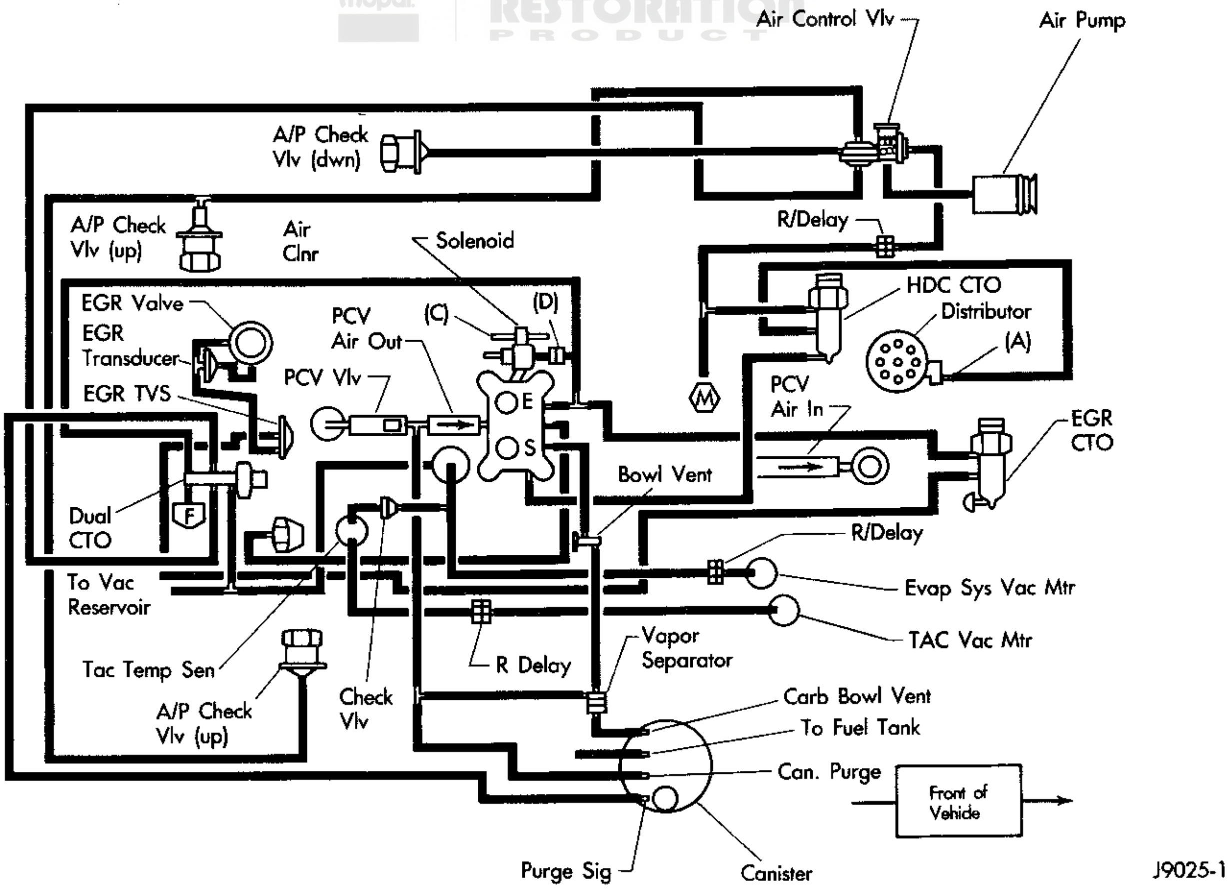


Fig. 12 Emissions Schematic—SJ Vehicles with 5.9L Engine

EVAPORATION CONTROL SYSTEM

The evaporative emission control system prevents the release of unburned hydrocarbons, from liquid gasoline or gasoline vapor, into the atmosphere. When pressure in the fuel tank is below 21 kPa (3 psi), the pressure relief/rollover valve(s) open allowing fuel vapors to flow to the evaporative canister where they are absorbed by a charcoal mixture. This prevents excessive pressure build-up in the fuel tank. Most canisters are equipped with a calibrated orifice at the inlet to the canister. Refer to the appropriate vacuum hose routing schematic for orifice size and location.

YJ vehicles equipped with 4.2L engines and SJ vehicles equipped with 5.9L engines have carbureted fuel systems. In these systems, vapors from the carburetor fuel bowl are also vented to the evaporative canister.

Fuel vapors stored in the canister are used during combustion once the vehicle is again operated. The manner in which the vapors are drawn out of the canister (canister purge function) and into the engine for combustion varies with each engine and vehicle application.

Canister Purge Function

2.5L, 4.0L Engine—MJ/XJ Vehicles

The 2.5L and 4.0L engines used in MJ/XJ vehicles utilize a venturi in the air cleaner assembly as a purge line vacuum source (Fig. 13).

The effect of the venturi increases the speed of the intake air flowing by slots in the venturi wall. This creates a low pressure area at the slots that draws vapors from the canister through the slots and into the airstream flowing through the venturi (Fig. 14). The vapors pass through the intake manifold into the combustion chambers where they are consumed during combustion.

YJ Vehicles with 2.5L Engine

The canister purge function is controlled by the Engine Electronic Control Unit (ECU) through a dual function solenoid.

Vacuum for the evaporative canister and the EGR valve is controlled by the EGR Valve/Evaporative Canister Purge Solenoid (Fig. 15). When energized by the ECU, the solenoid prevents vacuum from reaching the canister and the EGR valve. When not energized the solenoid allows vacuum to flow through to the canister and EGR valve. The solenoid is energized during engine warm-up, closed throttle (idle), wide open throttle and rapid acceleration/deceleration. **If the solenoid wire connector is disconnected, the EGR valve and evaporative canister purge function will be operational at all times.**

When the solenoid is not energized, vacuum flows through the Purge Signal line to the canister. Vacuum from the purge signal opens a one-way valve in the canister. When the valve is open, fuel vapors stored in the canister are drawn into the engine by intake manifold vacuum. A small amount of vapors are also purged at all times through a .78 mm (.031 in) orifice.

YJ Vehicles with 4.2L Engine and SJ Vehicles with 5.9L Engine

The vacuum supply for the canister purge signal is controlled by coolant temperature. A coolant temperature operated (CTO) valve restricts the purge signal vacuum flow to the canister until the engine coolant

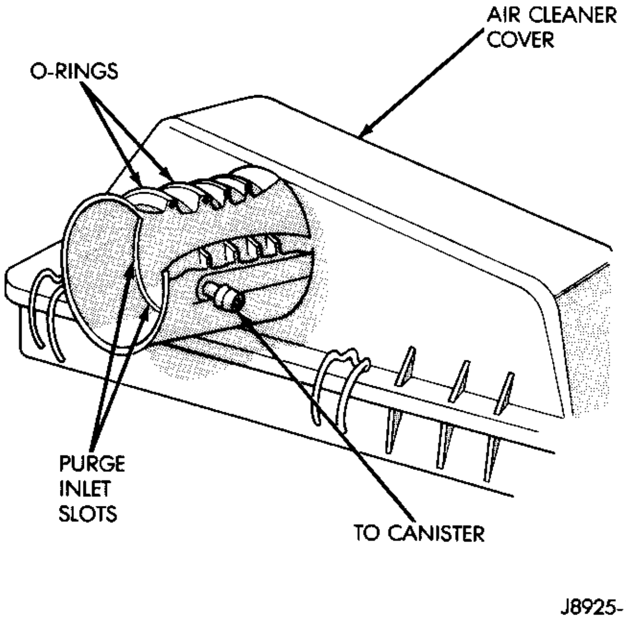


Fig. 13 Air Cleaner Venturi

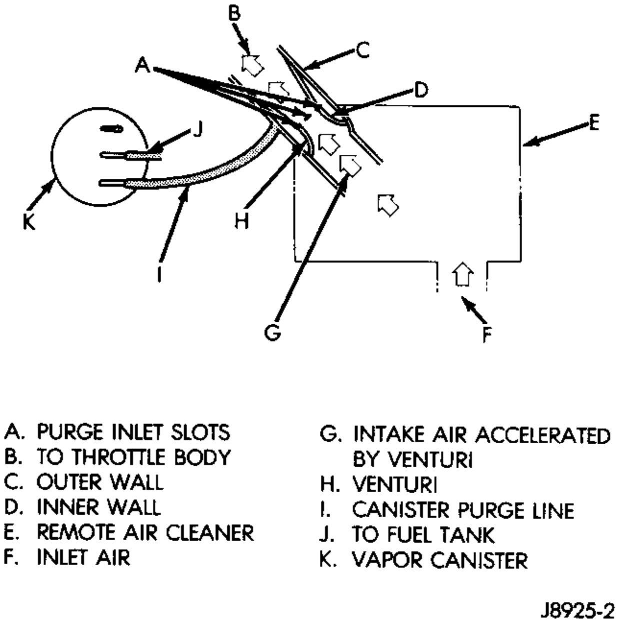


Fig. 14 Air Cleaner Venturi and Canister Purge Operation

reaches a predetermined temperature. The CTO used with 4.2L engines opens at 67 -68° C (153 - 157° F). The CTO used with 5.9L engines opens at 51 - 53° C (123 - 127° F).

Once the CTO valve has opened purge signal vacuum flows through the Purge Signal line to the canister. Vacuum from the purge signal opens a one-way valve in the canister. When the valve is open, fuel vapors stored in the canister are drawn into the engine by intake manifold vacuum.

Rollover and Pressure Relief Valve

The fuel tanks of all 1989 Jeep vehicles are equipped with one or two pressure relief/rollover valves. The dual function valves relieve fuel tank pressure and prevent fuel flow through the fuel tank vent hoses in the event of vehicle rollover.

The valve consists of a plunger, spring, and orifice and guide plate (Fig. 16). The valve is normally open allowing fuel vapor to vent to the canister where it is stored until it can be consumed by the engine under controlled conditions. If the bottom of the plunger is contacted by fuel sloshing in the tank when the vehicle is cornering, the plunger seats in the guide plate at the orifice preventing liquid fuel from reaching the canister.

In vehicle rollover the valve is inverted. In this position the plunger is forced against the guide plate and raw fuel is prevented from flowing through the valve orifice into the fuel tank vent tube.

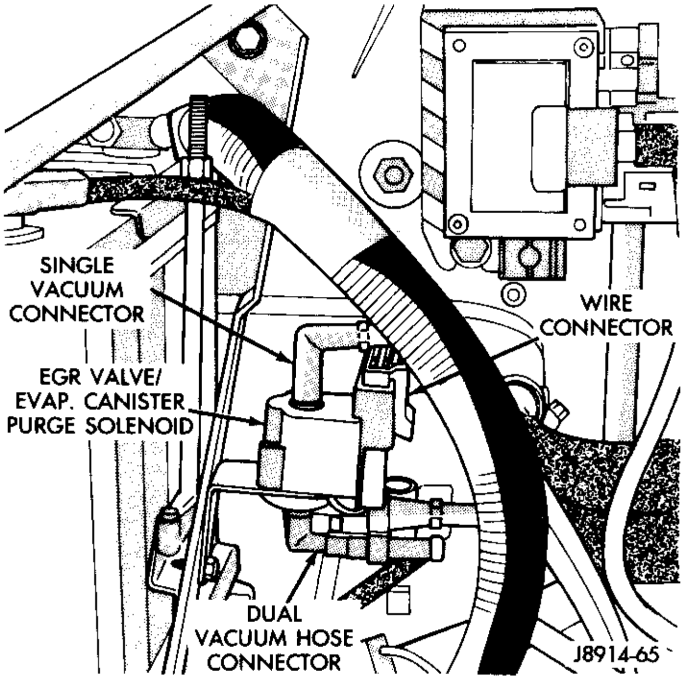


Fig. 15 EGR/Evaporative Canister Purge Solenoid—YJ Vehicles with 2.5L Engine Only

Removal

(1) Disconnect battery negative cable.

(2) Remove the fuel filler cap and drain fuel tank. Refer to Draining Fuel Tank.

(3) Remove fuel tank. Refer to Fuel Tank Removal.

(4) The rollover valve is seated in a grommet. Remove by prying one side upward and then roll the grommet out of tank (Fig. 17).

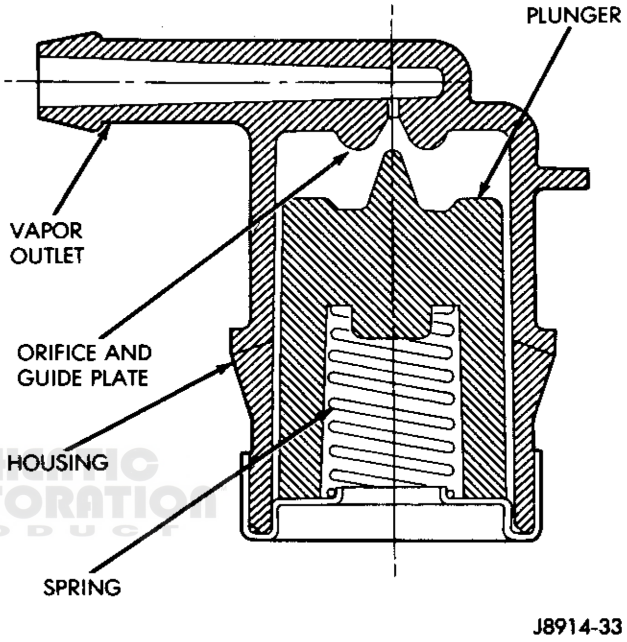


Fig. 16 Pressure Relief/Rollover Valve Operation

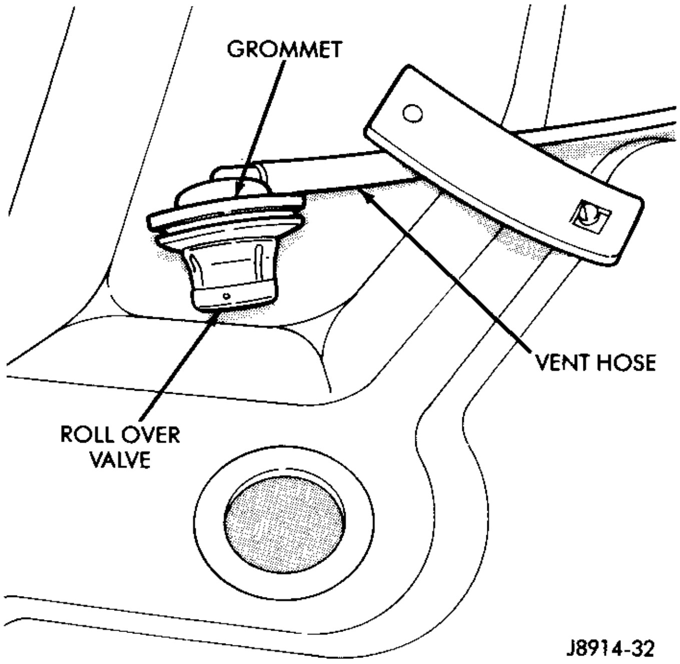


Fig. 17 Pressure Relief/Rollover Valve

Installation

(1) Start one side of grommet into opening in fuel tank. Using finger pressure only, press valve/grommet into place.

(2) Install fuel tank. Refer to Fuel Tank Installation.

(3) Fill fuel tank. Install fuel tank filler cap.

(4) Connect battery negative cable.

(5) Start vehicle and check for leaks.

Evaporative Canister

The evaporative canisters used with Jeep vehicles are filled with granules of an activated carbon mixture. Fuel vapors entering the canister are absorbed by the granules.

2.5L and 4.0L Engines—MJ/XJ Vehicles Only

The evaporative canisters used on vehicles equipped with fuel injected engines (TBI or MPI) have one inlet that is connected to the rollover/pressure relief valves of the fuel tank through hose and tubes. The canister is connected to the air cleaner snorkel.

When the engine is operating, the canister purge function draws fresh air through the filter at the bottom of the canister causing the stored vapors to be drawn out of the canister into the airstream in the air cleaner snorkel (Fig. 14).

2.5L Engine—YJ Vehicles Only

The evaporative canisters used on YJ vehicles equipped with the 2.5L engine have one inlet that is connected to the rollover/pressure relief valves of the fuel tank through hoses and tubes. The canister has two outlet ports, one of which has .8 mm (.031 in) diameter orifice in it, that are connected to intake manifold vacuum.

When the engine is operating and EGR/Evaporative Canister Purge Solenoid is not energized, manifold vacuum draws fresh air through the filter at the bottom of the canister causing the stored vapors to be drawn out of the canister and into the intake manifold along with crankcase vapors from the PCV outlet. The vapors are then consumed during combustion.

4.2L and 5.9L Engines

The evaporative canisters used on vehicles equipped with 4.2L or 5.9L engines have two inlet ports. One port connects to the fuel tank rollover/pressure relief valves and the other connects to the carburetor bowl vent valve.

When the engine is operating and the canister purge function is activated, manifold vacuum draws fresh air through the filter at the bottom of the canister causing the stored vapors to be drawn out of the canister and into the intake manifold along with crankcase vapors from the PCV outlet. The vapors are then consumed during combustion.

Pressure-Vacuum Fuel Tank Filler Cap

The fuel filler cap incorporates a two-way relief valve that is closed to atmosphere during normal operating conditions. The relief valve used in the filler caps of SJ and YJ vehicles are calibrated to open only when a pressure of 7.7 kPa (1.1 psi) or a vacuum of 5 kPa (1.5 in. Hg) occurs within the fuel tank. The relief valve used in fuel filler caps of all other Jeep vehicles is calibrated at a pressure of 10 kPa (1.5 psi) or a vacuum of 6 kPa (1.8 in. Hg). When the pressure or vacuum is relieved the valve returns to the normally closed position.

CAUTION: The fuel filler cap must be removed prior to disconnecting any fuel system component.

Positive Crankcase Ventilation (PCV) Systems

Positive Crankcase Ventilation (PCV) systems, equipped with a PCV valve, are used on all 4.2L engines (Fig. 19), all 5.9L engines (Fig. 20), and 2.5L engines in YJ vehicles (Fig. 18). 2.5L and 4.0L engines in MJ/XJ vehicles employ a fixed orifice Crankcase Vent (CCV) system.

The PCV system prevents crankcase vapors from entering the atmosphere. Filtered air from the crankcase is routed through the PCV inlet hose and into the crankcase forcing crankcase vapors through the PCV outlet hose into the intake manifold. The vapors are then drawn into the engine cylinders where they are consumed during combustion. An added feature of the PCV system is that it constantly ventilates the crankcase to help prevent sludge formation.

The PCV system used on vehicles with 4.2L engines employs a PCV Shut-Off Solenoid that is controlled by the engine MCU. A 2 mm (.080 in) orifice is installed between the PCV valve and PCV shutoff solenoid.

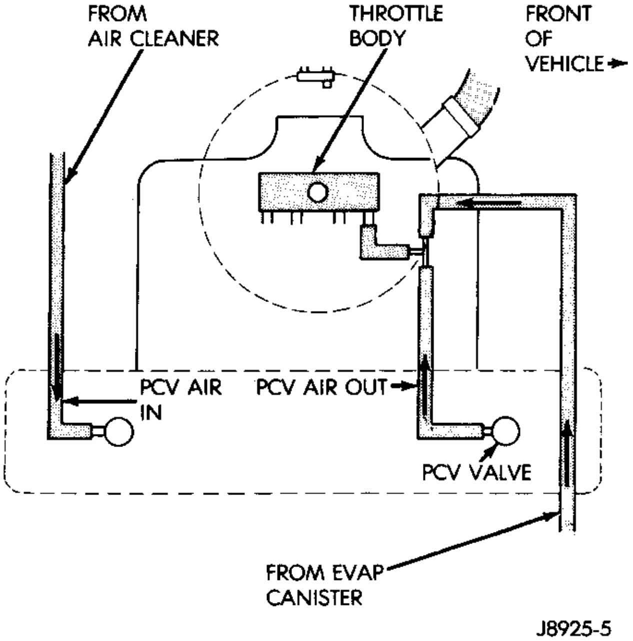


Fig. 18 PCV System—YJ Vehicles with 2.5L Engine

PCV Shut-Off Solenoid Operation—4.2L Engine Only

Airflow through the PCV valve is controlled by the PCV Valve Shut-Off Solenoid and manifold vacuum (Fig. 21).

The solenoid is controlled by the engine Micro Computer Unit (MCU) and is installed in the hose between the PCV valve and where the hose connects to intake manifold vacuum. When energized by the MCU, the solenoid blocks the flow of vacuum to the PCV valve preventing crankcase ventilation. The PCV valve shut-off solenoid is energized when the engine is at idle and momentarily energized when the ignition key is turned off to prevent air from entering below the throttle plate and causing the engine to diesel.

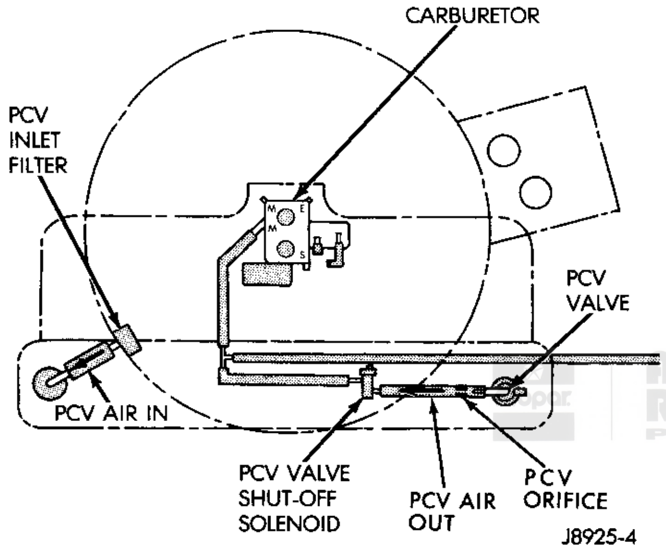


Fig. 19 PCV System—4.2L Engine

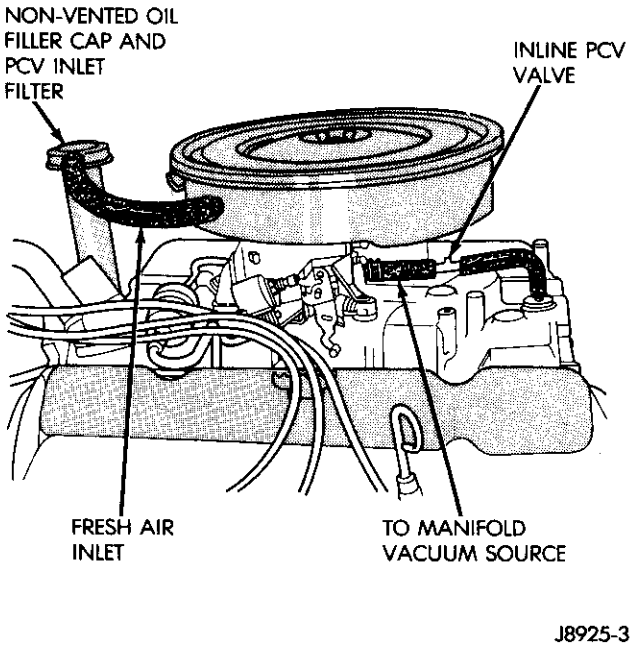


Fig. 20 PCV System—5.9L Engine

When the PCV valve shut-off solenoid is not energized crankcase ventilation is not blocked. Refer to PCV Operation.

PCV Operation—4.2L, 5.9L Engines and YJ Vehicles with 2.5L Engine

There are two basic operating modes:

(1) When intake manifold vacuum is relatively high such as during cruising or at idle speed, fresh air is drawn through an air intake filter into the crankcase. After circulating through the crankcase, the vapor-filled air is drawn through the PCV valve into the intake manifold. The vapor mixes with the air-fuel mixture and is burned in the combustion chamber. The PCV valve is calibrated to control airflow at a rate acceptable to the intake system.

(2) If the pressure of combustion gases that blow past the pistons and rings causes vapor flow to exceed the capacity of the PCV, air flow in the system reverses. Crankcase vapors are drawn through the air cleaner element and are burned along with the air fuel mixture.

PCV Valve

The Positive Crankcase Ventilation valve contains a spring loaded plunger that meters the amount of crankcase vapors routed into the combustion chamber based on intake manifold vacuum.

When the engine is not operating or during an engine backfire, the spring forces the plunger back against the seat preventing vapors from flowing through the valve (Fig. 22).

During periods of high manifold vacuum, such as idle or cruising speeds, manifold vacuum is sufficient to completely compress the spring and pull the plunger to

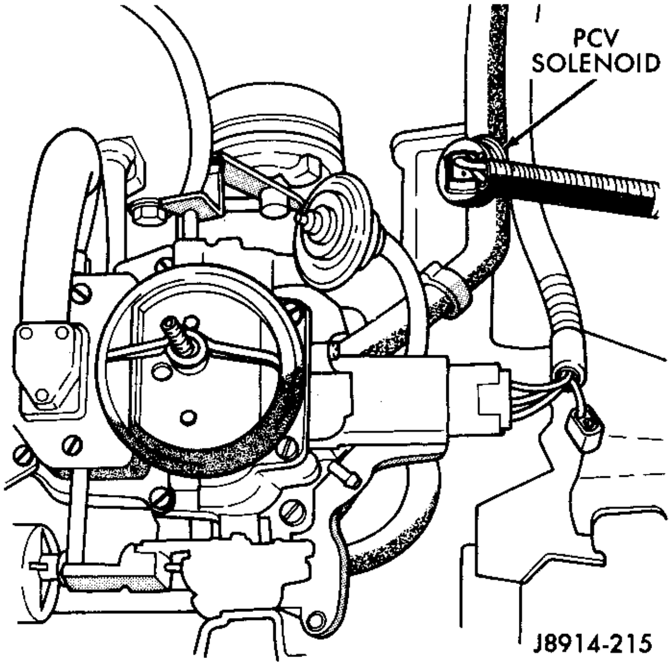


Fig. 21 PCV Shut-Off Solenoid

the top of the valve (Fig. 23). In this position there is minimal vapor flow through the valve.

During periods of moderate intake manifold vacuum the plunger is only pulled part way back from the inlet, resulting in maximum vapor flow through the valve (Fig. 24).

Crankcase Vent Filter

4.2L and 5.9L engines that are equipped with a PCV system have a crankcase vent filter. The filter is used to filter outside air before it enters the crankcase through the PCV system. On 4.2L engines the filter is located in the air cleaner and the PCV air inlet hose connects to it. On 5.9L engines the filter is located in the oil fill cap.

Crankcase Ventilation (CCV) Systems

2.5L and 4.0L engines used in MJ/XJ series vehicles are equipped with a Crankcase Ventilation System (Fig. 25 and Fig. 26). The CCV system performs the same function as a conventional PCV system, but does not use a vacuum controlled valve.

A molded vacuum tube connects manifold vacuum to a grommet on top of the cylinder head cover at the dash panel end. The grommet contains a metered orifice of a calibrated size that meters the amount of crankcase vapors drawn out of the engine. A fresh air supply hose from the air cleaner is also connected to the front of the cylinder head cover on 4.0L engines and to the rear of the cover on 2.5L engines. When the engine is operating, fresh air enters the engine and mixes with crankcase vapors. Manifold vacuum draws the vapor/air mixture through the metered orifice and into the intake manifold. The vapors are consumed during combustion.

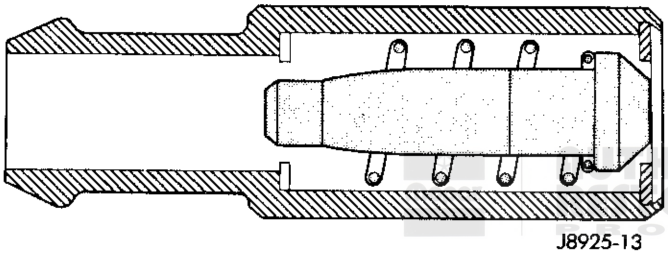


Fig. 22 Engine Off or Engine Backfire—No Vapor Flow

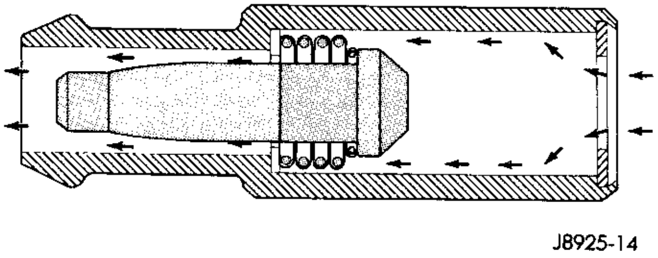


Fig. 23 High Intake Manifold Vacuum—Minimal Vapor Flow

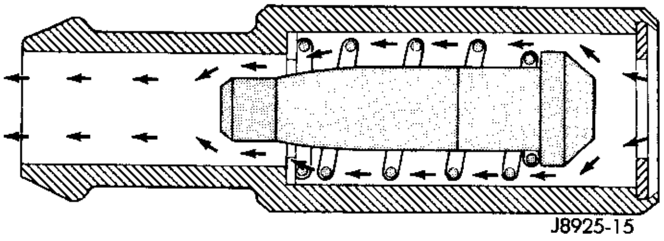


Fig. 24 Moderate Intake Manifold Vacuum—Maximum Vapor Flow

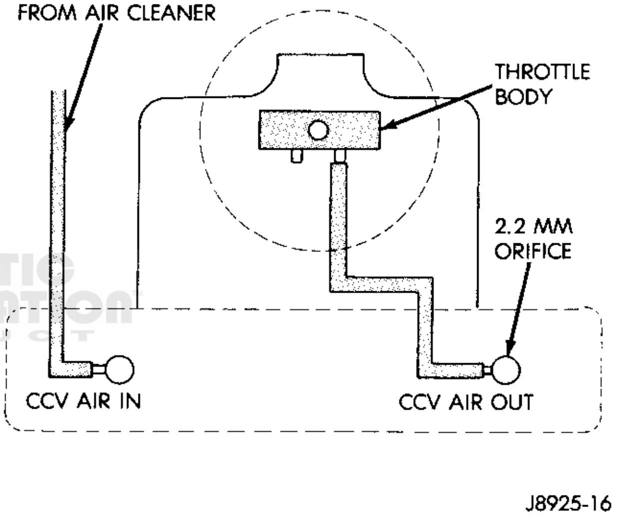


Fig. 25 CCV System—MJ/XJ Vehicles with 2.5L Engine

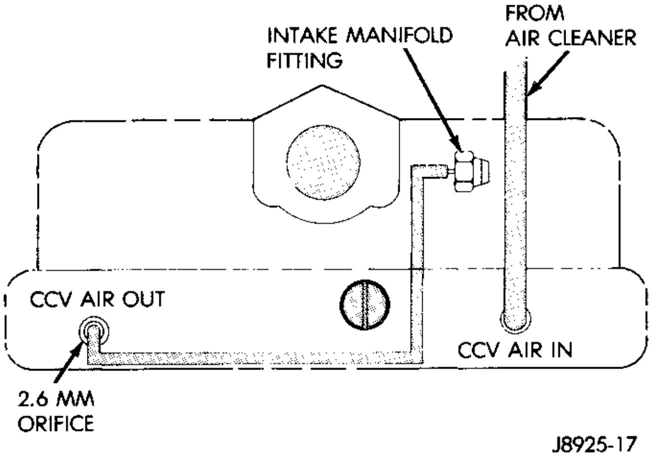


Fig. 26 CCV System—MJ/XJ Vehicles with 4.0L Engine

EXHAUST EMISSION CONTROLS

INDEX

THERMOSTATIC AIR CLEANER (TAC)

The thermostatically controlled air cleaner (TAC) system provides heated air for the carburetor or throttle body (depending upon vehicle application) during engine warm-up.

2.5L Engine

The TAC system used on vehicles equipped with 2.5L engines is comprised of a heat stove that wraps around the exhaust manifold, a heated air tube, an air temperature sensor, thermal check valve, reverse delay valve, and a vacuum motor operated air valve.

The air valve in the air cleaner blends air warmed from the heat stove on the exhaust manifold with ambient (outside) air. The air valve can close the opening to either air source, depending upon operating conditions, or blend a mixture of both.

The air valve in the air cleaner is open to ambient air when vacuum is not applied to the air valve vacuum motor. When the engine is started, temperature of the air in the throttle body bonnet is monitored by the TAC sensor. If the air temperature is below the calibrated opening point of the sensor, vacuum will be applied to the air valve vacuum motor (through the thermal check valve and reverse delay valve) causing the air valve to move towards the ambient air opening and only warmed air from the heat stove on the exhaust manifold will enter the air cleaner. As the exhaust manifold warms up and the temperature of the air entering the throttle body bonnet from the heat stove rises, the TAC sensor switches. Vacuum is then removed from the vacuum motor. This causes the air valve to move away from the heat stove source and towards the ambient air opening. In this way, ambient air and heated air from the heat stove are blended for optimum engine performance and emission control.

4.0L Engine

The TAC system used on vehicles equipped with 4.0L engines is comprised of a heat stove that wraps around the exhaust manifold, heated air tube, bi-metal air temperature sensor, and a vacuum motor operated air valve.

The air valve in the air cleaner blends air warmed from the heat stove on the air cleaner with ambient (outside) air. The air valve can close the opening to either air source, depending upon operating conditions, or blend a mixture of both.

When the engine is started, temperature of the air in the air cleaner is monitored by the TAC sensor. If the air temperature is below the calibrated opening point of the sensor, vacuum will be applied to the vacuum motor. The air valve will close off the duct to ambient air and only warmed air from the heat stove on the exhaust manifold will enter the air cleaner. As the exhaust manifold warms up and the temperature of the air entering the air cleaner from the heat stove rises, the air temperature sensor begins to open. Vacuum is then bled off by the air temperature sensor. This causes the air valve to move away from the ambient air opening towards the heat stove air opening. In this way, ambient air and heated air from the heat stove are blended for optimum engine performance and emission control.

Air Valve Vacuum Motor Functional Test—2.5L, 4.0L Engines

- With the engine not operating, observe the ambient air inlet duct at the air cleaner and observe the position of the air valve. The air valve should be fully open to incoming ambient air (heat OFF position—Fig. 27).

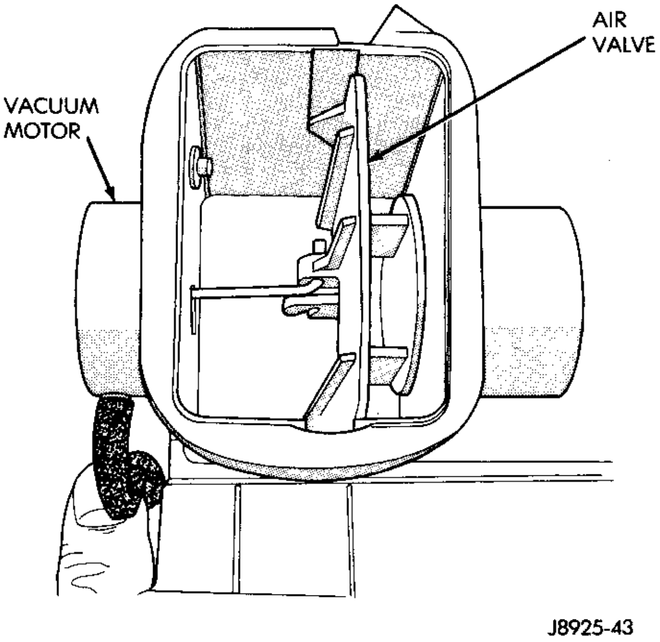


Fig. 27 Air Cleaner In Heat Off Position—2.5L, 4.0L Engine

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE FITTING CLOTHING.

- Start the engine and observe the position of the air valve. It should be fully closed to incoming ambient air (heat ON position—Fig. 28) below approximately 13°C (55°F) on 4.0L engines and 29°C (85°F) on 2.5L engines.
- Depress the throttle rapidly (1/2-3/4 position) and release. The air valve should briefly remain stationary and then move toward the heat OFF position and then back to the heat ON position.
- Warm the engine to normal operating temperature. Observe the ambient air duct and air valve. The air valve should be fully open to ambient air above 13°C (55°F).
- Stop the engine.
- If the air valve does not function as described in the previous test, inspect for a mechanical bind in the snorkel, disconnected or leaking vacuum hoses, and vacuum leaks at the vacuum motor, air temperature sensor, or intake manifold.
- If the air valve manually operates freely and the hoses are not leaking or disconnected, connect a vacuum hose from an intake manifold vacuum source directly to the vacuum motor and start the engine.

2.5L Engines

If the air valve closes, the TAC sensor, thermal check valve or delay valve is defective and must be replaced. If the air valve does not close, replace the vacuum motor.

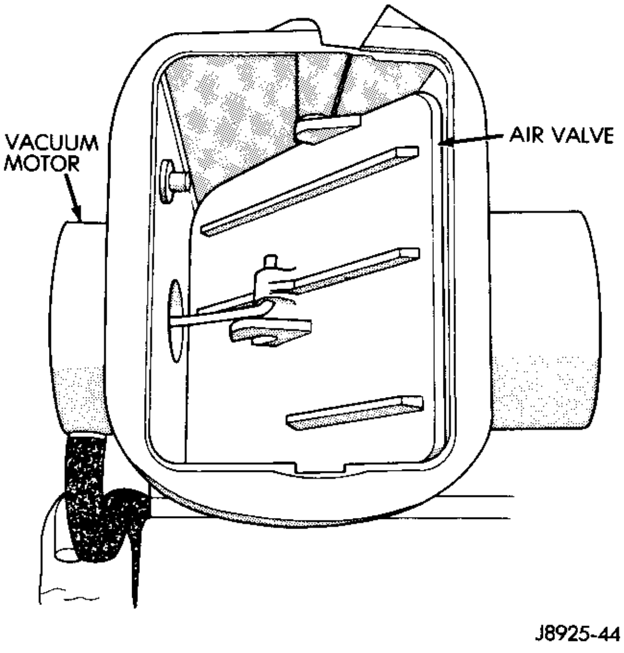


Fig. 28 Air Cleaner In Heat On Position—2.5L, 4.0L Engine

4.0L Engines

If the air valve closes, the air temperature sensor is defective and must be replaced. If the air valve does not close, replace the vacuum motor.

Air Temperature Sensor Functional Test—2.5L, 4.0L Engine

- Disconnect the vacuum hoses from the air temperature sensor at the throttle body bonnet on 2.5L engines or at the air cleaner on 4.0L engines.
- Connect a hand operated vacuum pump to the vacuum source of the sensor and a vacuum gauge to the vacuum motor side of the sensor.
- Apply 47 kPa (14 in. Hg) vacuum to the sensor.
- With the sensor at temperature below 5°C (40°F) on 4.0L engines and 29°C (85°F) on 2.5L engines, vacuum should maintained.
- Warm the sensor to above 13°C (55°F) on 4.0L engines and 29°C (85°F) on 2.5L engines. The vacuum should not be maintained by the sensor. Replace the sensor if defective.

Reverse Delay Valve Functional Test—2.5L Engines

The reverse delay valve provides approximately 100 seconds delay before allowing the air valve to completely close. Test the valve according to the following procedure.

- Remove the vacuum hose from the end of the valve that is not black in color and apply an external vacuum of approximately 6.8 - 13.5 kPa (2 - 4 in. Hg).
- Using a stopwatch, note the time required for atmospheric pressure to pass through valve and eliminate the vacuum.
- Replace the valve if the time required to eliminate the vacuum is less than 4.5 seconds or more than 13.2 seconds.

Install a replacement reverse delay valve with the black end toward the air valve vacuum motor.

4.2L and 5.9L Engines

The TAC systems used on YJ vehicles with the 4.2L engine and SJ vehicles with the 5.9L engine, are comprised of a heat stove that partially encloses the exhaust manifold, a heated air tube, a special air cleaner assembly equipped with a thermal switch, a reverse delay valve, a check valve and a vacuum motor and air valve assembly (Fig. 29 and Fig. 30).

Air Valve Vacuum Motor Functional Test

(1) With the engine off, detach the ambient air duct at the air cleaner and observe the position of the air valve. It should be fully open to incoming ambient air (heat in the OFF position).

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

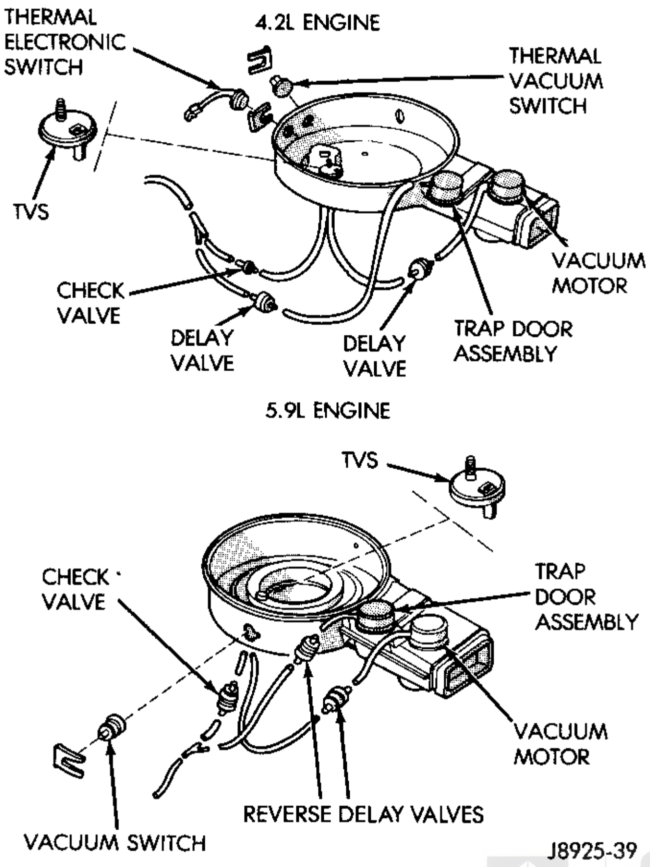


Fig. 29 TAC System Components—4.2L, 5.9L Engines

(2) Start the engine and observe the position of the air valve. It should be fully closed to incoming ambient air (heat in the ON position).

(3) Depress the throttle rapidly (1/2 - 3/4-position) and release. The air valve should briefly remain stationary and then move toward the heat OFF position and back to heat ON position.

(4) Loosely attach the ambient air duct to the air cleaner and warm the engine to the normal operating temperature.

(5) Remove the ambient air duct and observe the air valve. It should be either fully open to ambient air or at a mixture position that provides the correct inlet air temperature to the carburetor.

(6) Stop the engine and connect the ambient air duct to the air cleaner.

If the air valve does not function as described, inspect for:

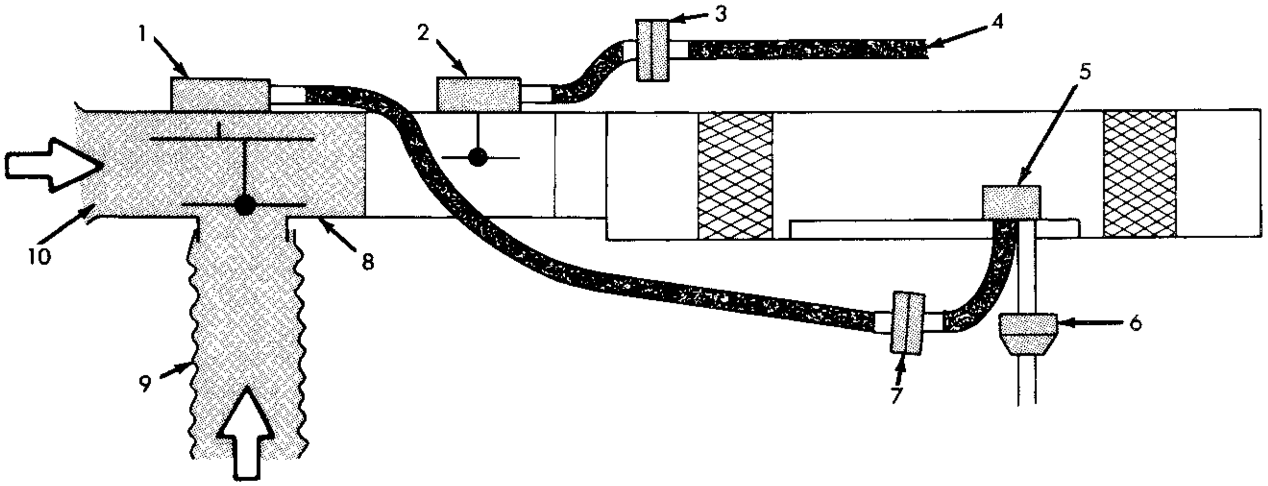
- A mechanical bind in the snorkel
- Vacuum hoses being disconnected
- Air leaks either at the vacuum motor, thermal switch, reverse delay valve, check valve, intake manifold or vacuum hoses

(7) If the air valve manually operates freely and no hose disconnections or air leaks are detected, connect a hose from the intake manifold vacuum source directly to the vacuum motor and the start engine. If the air valve closes, either the thermal switch, reverse delay or check valve is defective and must be replaced. If the air valve does not close, replace the vacuum motor.

Air Valve Vacuum Motor Removal

CAUTION: The heated air tube is connected to the air cleaner snorkel by a clamp. If the duct is not detached prior to air cleaner removal, the tube and stove may be damaged.

- Remove the air cleaner.



1. TAC VACUUM MOTOR
2. TRAP DOOR VACUUM MOTOR
3. REVERSE DELAY VALVE
4. VACUUM SOURCE
5. THERMAL SWITCH
6. CHECK VALVE
7. REVERSE DELAY VALVE
8. AIR VALVE
9. HEATED AIR
10. AMBIENT AIR

Fig. 30 TAC System Operation—4.2L, 5.9L Engines

- Disconnect the vacuum hoses from the air valve motor, thermal switch and trap door motor, if equipped.
- Remove the rivet attaching the air valve vacuum motor to the snorkel.
- Lift the motor, tilt it to one side to disconnect the motor linkage from the air valve assembly and remove the motor.

Air Valve Vacuum Motor Installation

- Insert the replacement vacuum motor linkage into the air valve assembly and position it in the snorkel.
- Attach the motor to the snorkel with a rivet.

Ensure that the rivet does not interfere with the movement of the air valve. Correct as necessary.

- Connect the vacuum hoses. Install the air cleaner assembly and test for proper operation of the TAC system.

Thermal Switch Functional Test

- Disconnect the vacuum hoses from the thermal switch.
- Connect the vacuum pump to the vacuum source side of the sensor and a vacuum gauge to the vacuum motor side of the switch.
- Apply 47 kPa (14 in. Hg) vacuum to the switch.
- With the switch below 35°C (95°F), vacuum should be maintained.
- Heat the switch to above 35°C (95°F). The air vent valve should open and decrease the vacuum to zero. Replace the switch if defective. **The temperatures listed above are nominal switching values.**

Thermal Switch Removal

CAUTION: The heated air tube is attached to the snorkel by a clamp. If the tube is not detached prior to air cleaner removal, the heated air tube and heat stove may be damaged.

- Remove the air cleaner housing.
- Disconnect the hoses from the thermal switch (Fig. 31).
- Pry the tabs up on the switch retaining clip. Remove the clip, gasket and switch from the air cleaner housing. Note the position of the switch for installation reference.

Thermal Switch Installation

- Install a replacement switch and gasket assembly in the air cleaner.
- Press the retainer clip on the hose nipple connectors.
- Connect the vacuum hoses and install the air cleaner housing on the engine.
- Test for proper operation of the TAC system.

Air Cleaner Trap Door

Vehicles equipped with 4.2L engines have air cleaners with spring-loaded trap doors to close-off the air cleaner/carburetor when the engine is inoperative.

Air Cleaner Trap Door Functional Tests

- With the engine off, remove the air cleaner cover and observe the position of the trap door (Fig. 32). It should be closed.
- Remove the vacuum hose from the intake manifold vacuum source and apply an external vacuum of approximately 6.8 - 13.5 kPa (2 - 4 in. Hg). The trap door should open.
- If the door does not open, apply vacuum directly to the vacuum motor on air cleaner intake duct. If the door still does not open, inspect for binding/distortion and adjust as necessary. Replace the motor if the door swings freely.
- If the door opens during the step above, inspect the vacuum hose for obstruction, cracks and kinks. Correct as necessary and retest.
- If the vacuum hose is not defective, remove the reverse delay valve, join the vacuum hose with an adapter and retest as described above. If the door opens, replace the reverse delay valve.

Reverse Delay Valve Functional Test

The reverse delay valve provides approximately 100 seconds delay before allowing the trap door to completely close. Test the valve according to the following procedure.

- Remove the vacuum hose from the end of the valve that is not black in color and apply an external vacuum of approximately 6.8 - 13.5 kPa (2 - 4 in. Hg).
- Using a stopwatch, note the time required for atmospheric pressure to pass through valve and eliminate the vacuum.
- Replace the valve if the time required to eliminate the vacuum is less than 4.5 seconds or more than 13.2 seconds.

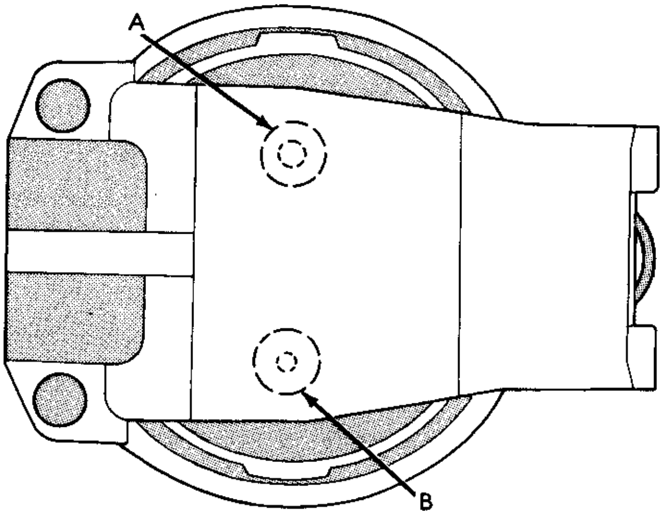


Fig. 31 Thermal Switch

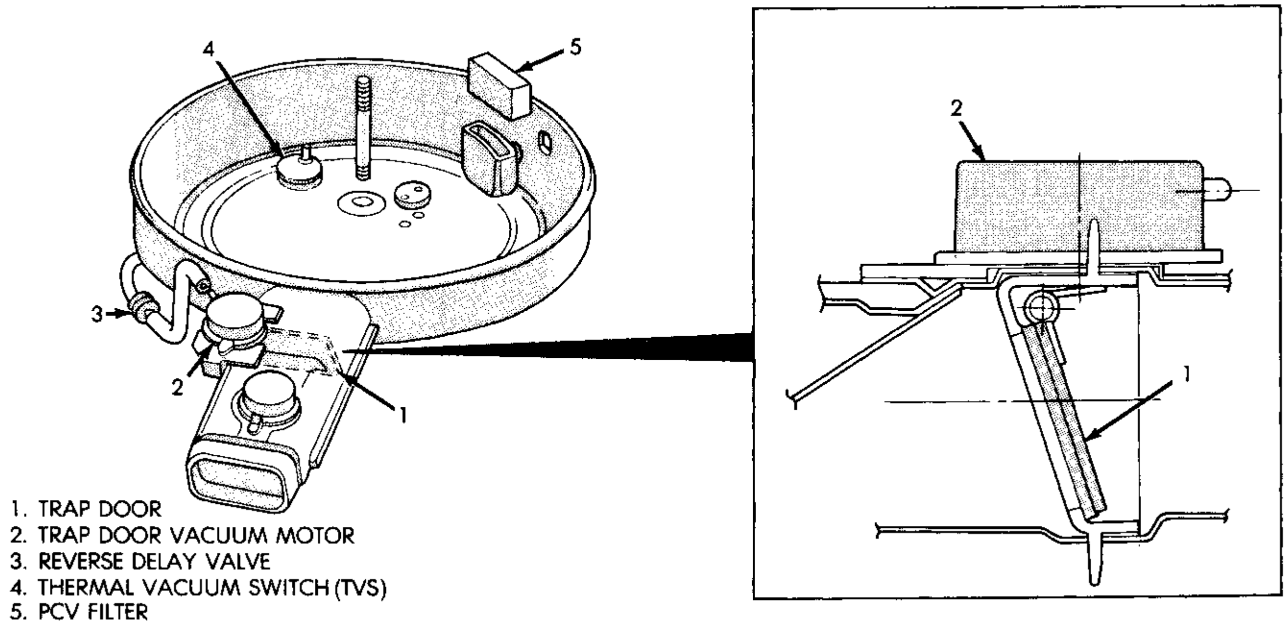


Fig. 32 Air Cleaner Trap Door Testing

Install a replacement reverse delay valve with the black end toward the trap door vacuum motor.

Trap Door Vacuum Motor Removal

- Disconnect the vacuum hoses, heated and ambient air ducts, and remove the air cleaner housing.
- Remove the trap door vacuum motor attaching rivet from the bracket.
- Lift the motor away from the bracket. Rotate it to clear the door arm and remove.
- Rotate the replacement motor to clear the door arm and lower it into the bracket.
- Secure the replacement motor to the bracket with a rivet.
- Install the air cleaner, ducts and vacuum hoses.
- Test the operation of the trap door.

HEATED OXYGEN SENSOR (O_2 SENSOR)

The oxygen sensor (Fig. 33) is located in the exhaust manifold and provides an input voltage to the ECU relating the oxygen content of the exhaust gas. The ECU uses this information to vary the air-fuel ratio. A lean air/fuel mixture causes a greater oxygen content in the exhaust gas and a rich air/fuel mixture causes less oxygen content.

The oxygen sensors used on the 2.5L and 4.0L engines are equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. The sensor used on the 4.2L engine is not equipped with a heater and uses exhaust gases to reach operating temperature. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner and to remain in closed loop operation during periods of extended idle. Refer to the Modes of Operation sections in group 14 for an explanation of OPEN and CLOSED LOOP operation.

Heated Oxygen Sensor (O_2 Sensor) Service

Removal

WARNING: EXHAUST MANIFOLD BECOMES VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

(1) Raise and support the vehicle.

(2) Disconnect the wire connector from the O_2 sensor.

(3) Remove the O_2 sensor from the exhaust manifold (Fig. 34).

Installation

Threads of new oxygen sensors are coated with anti-seize compound to aid in removal.

(1) Install the O_2 sensor into the exhaust manifold and tighten to 30 N•m (22ft.-lbs.).

(2) Connect the O_2 sensor wire connector.

(3) Lower the vehicle.

EXHAUST GAS RECIRCULATION (EGR) SYSTEMS

2.5L Engines

The vacuum supply for the EGR valve is controlled by the EGR Valve Solenoid on MJ/XJ vehicles and by the EGR/Evaporative Canister Purge Solenoid on YJ vehicles. The solenoid of either system is controlled by the vehicles' engine Electronic Control Unit (ECU). When energized by the ECU the solenoid closes and prevents vacuum from reaching the EGR valve. When not ener-

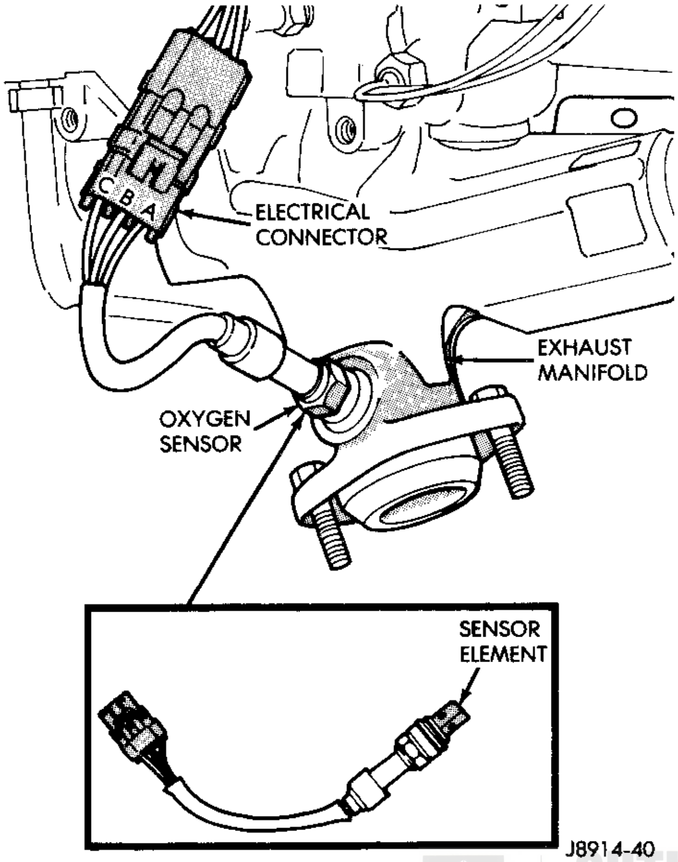


Fig. 33 Heated Oxygen Sensor—Typical

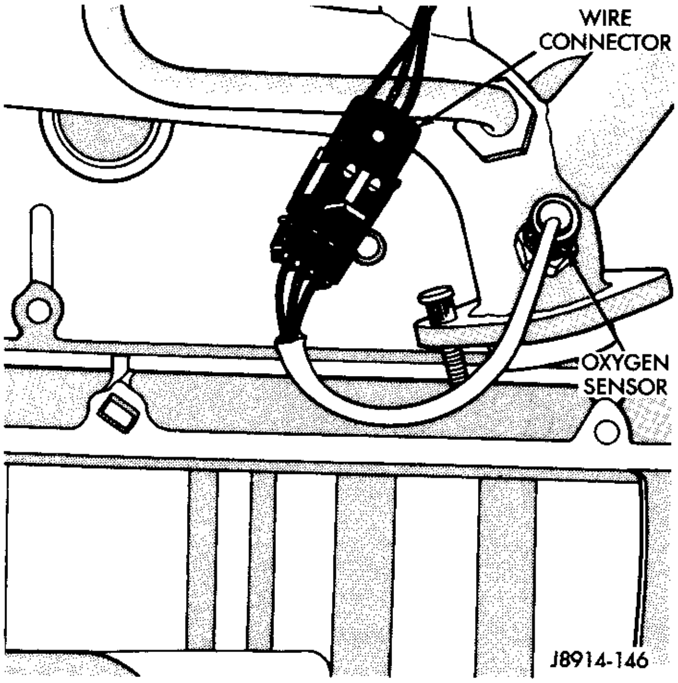


Fig. 34 Oxygen Sensor Remove/Install

gized, the solenoid is open and vacuum is applied to the EGR valve. The ECU monitors engine coolant temperature and other operating conditions to determine when EGR operation is desired. Refer to TBI Modes of Operation in Group 14 for a description of solenoid operation based on engine operating conditions.

EGR System Component Testing—MJ/XJ Vehicles with 2.5L Engine

Bring the engine to normal operating temperature. Operate at idle speed. Test the EGR solenoid as follows:

- Check vacuum at solenoid vacuum source hose (Fig. 35). Disconnect the line and attach a vacuum gauge to it.
- Vacuum should be a minimum of 15 inches.
- If vacuum is low, check the line for kinks, twists, or a loose connection at manifold fitting.
- If vacuum is OK, remove gauge, reconnect the line and proceed to next step.
- Check vacuum at solenoid output port.
- Disconnect the line and attach a vacuum gauge to output port. Vacuum reading should be zero (no vacuum) at this side of solenoid.
- If vacuum reading is zero, leave the gauge connected and proceed to next step. However, if vacuum is present, check solenoid/ECU operation with the DRB II Service Diagnostic Tester and repair as necessary.
- Disconnect electrical connector at solenoid and note vacuum at solenoid output port. Vacuum should now be present at output port.
- If vacuum is present, proceed to EGR valve test. However, if vacuum is not present, replace the solenoid.

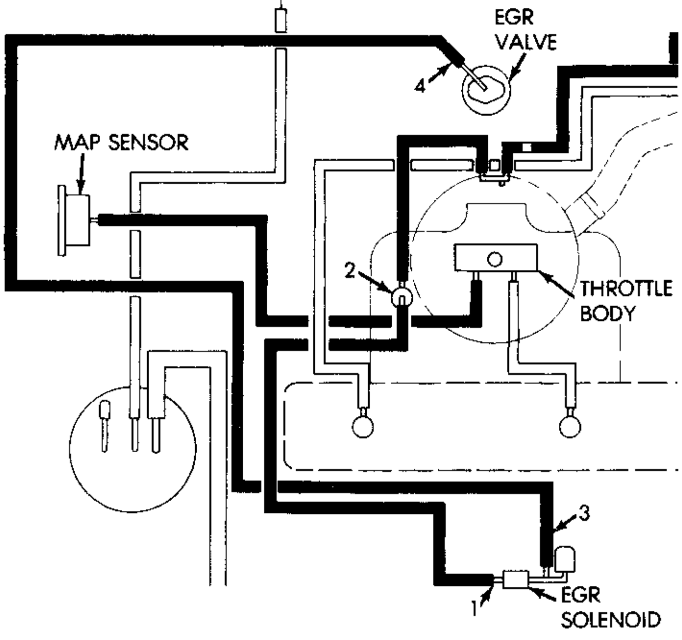


Fig. 35 EGR System Testing—MJ/XJ Vehicles with 2.5L Engine

EGR System Component Testing—YJ Vehicles with 2.5L Engine

Bring the engine to normal operating temperature. Operate at idle speed. Test the EGR solenoid as follows:

- Check vacuum at solenoid vacuum source hose (Fig. 36). Disconnect the line and attach a vacuum gauge to it.
- Vacuum should be a minimum of 15 inches.
- If vacuum is low, check the line for kinks, twists, or a loose connection at the throttle body vacuum port.
- If vacuum is OK, remove gauge, reconnect the line and proceed to next step.
- Check vacuum at solenoid output port (Fig. 36).
- Disconnect the line and attach a vacuum gauge to output port. Vacuum reading should be zero (no vacuum) at this side of solenoid.
- If vacuum reading is zero, leave the gauge connected and proceed to next step. However, if vacuum is present, check solenoid/ECU operation with the DRB II Service Diagnostic Tester and repair as necessary.
- Disconnect electrical connector at solenoid and note vacuum at output port. Vacuum should now be present at output port.
- If vacuum is present, proceed to EGR valve test. However, if vacuum is not present, replace the solenoid.

4.0L Engine

The EGR system on 4.0L engines consists of the EGR valve, vacuum transducer, EGR solenoid, and connecting hoses (Fig. 37).

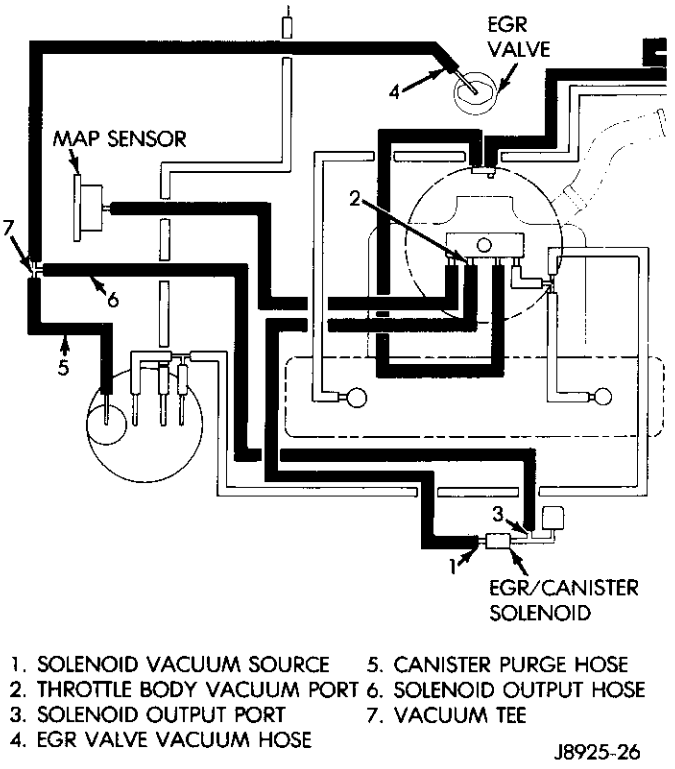


Fig. 36 EGR System Testing—YJ Vehicles with 2.5L Engine

The EGR solenoid is controlled by the vehicles' engine Electronic Control Unit (ECU). The ECU monitors engine coolant temperature and other operating conditions to determine when the solenoid is energized. Refer to MPI Modes of Operation in Group 14 for a description of solenoid operation based on engine operating conditions. When energized by the ECU, the solenoid prevents vacuum from reaching the EGR valve transducer. When the solenoid is not energized, vacuum flows through the solenoid to the vacuum transducer.

The vacuum transducer is controlled by exhaust system back-pressure. When back-pressure is high enough it will close a bleed valve in the transducer allowing vacuum to actuate the EGR valve. If back-pressure does not close the bleed valve vacuum will be bled off.

Operation

Engine Vacuum flows through the EGR valve solenoid to the vacuum transducer through a connecting hose. Vacuum flows only when the solenoid is not energized (no voltage applied). The transducer is connected to the EGR valve by a vacuum hose and a back-pressure hose. The transducer is controlled by exhaust back pressure and is ported to the exhaust manifold through a hose connecting it to the bottom of the EGR valve (Fig. 38).

When the solenoid is not energized and exhaust gas back-pressure entering EGR valve inlet is high enough, back pressure holds transducer bleed valve closed. This allows vacuum to activate and operate the EGR valve.

4.0L EGR System Component Testing

Bring the engine to normal operating temperature. Operate at idle speed. Test the EGR solenoid as follows:

- Check vacuum at solenoid vacuum source (Fig. 39).

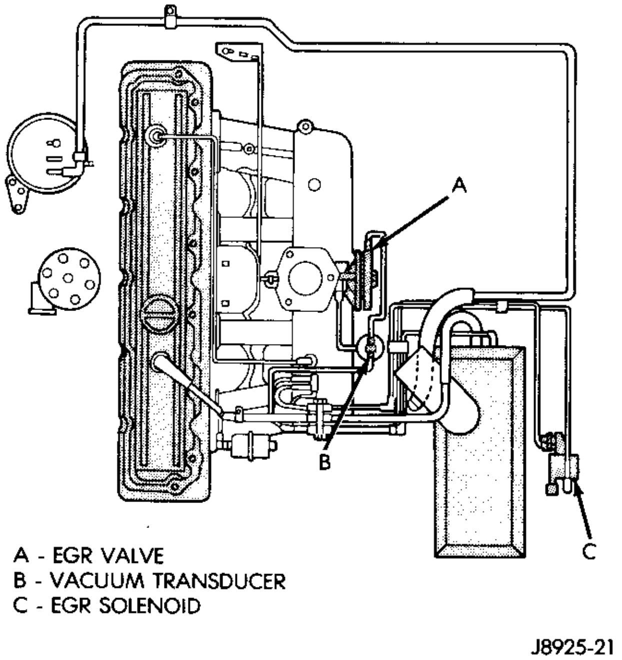


Fig. 37 4.0L EGR System—4.0L Engine

Disconnect the hose and attach a vacuum gauge to it.

- Vacuum should be a minimum of 15 inches.
- If vacuum is low, check the line for kinks, twists, or a loose connection at vacuum connector on intake manifold (Fig. 39).
- If vacuum is OK, remove gauge, reconnect the line and proceed to next step.
- Check vacuum at solenoid output port (Fig. 39).
- Disconnect the line and attach a vacuum gauge to output port (Fig. 39). Vacuum reading should be zero (no vacuum) at this side of solenoid.

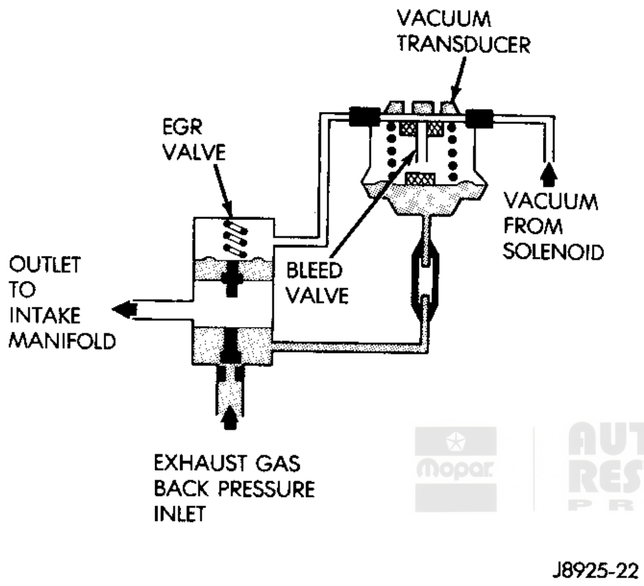
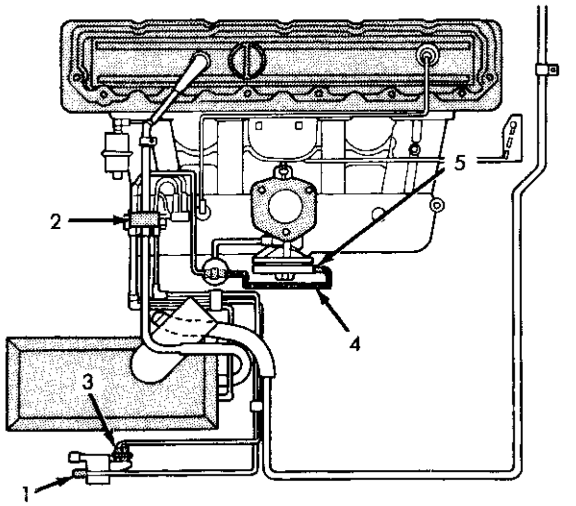


Fig. 38 EGR System Operation—4.0L and 5.9L Engines



1. SOLENOID VACUUM SOURCE
2. VACUUM CONNECTOR
3. SOLENOID OUTPUT PORT
4. EGR VACUUM HOSE
5. EGR VALVE NIPPLE

J8925-23

Fig. 39 EGR System Testing—4.0L Engine

- If vacuum reading is zero, leave the gauge connected and proceed to next step. However, if vacuum is present, check solenoid/ECU operation with the DRB-ii Service Diagnostic Tester and repair as necessary.
- Disconnect electrical connector at solenoid and note vacuum at solenoid output port. Vacuum should now be present at output port (Fig. 39).
- If vacuum is present, proceed to EGR valve test. However, if vacuum is not present, replace the solenoid.

Test the EGR valve as follows:

- Leave solenoid electrical connector disconnected. Bypass the vacuum transducer and connect the EGR valve solenoid output hose directly to the nipple on the EGR valve and note engine idle.
- The engine should now idle roughly or stall. If this occurs, the valve is OK. Proceed to Vacuum Transducer Test. However, if idle does not change, proceed to next step.
- Disconnect hose from EGR valve and connect a hand vacuum pump to EGR valve nipple (Fig. 39).
- Apply a minimum of 12 inches vacuum to the valve and note engine idle. If engine now idles roughly, inspect vacuum lines between vacuum connector on intake manifold (Fig. 39) and EGR valve, and backpressure hose from EGR valve base to transducer for leaks. If no leaks are found proceed to vacuum transducer test.
- If the idle did not change, remove the EGR valve and inspect the valve and the exhaust passage in the manifold for blockage, repair as necessary. If no blockage is present replace the EGR valve.

Test the Vacuum Transducer as follows:

- Disconnect the transducer vacuum lines and backpressure line. Remove transducer.
- Plug transducer output port (Fig. 40).

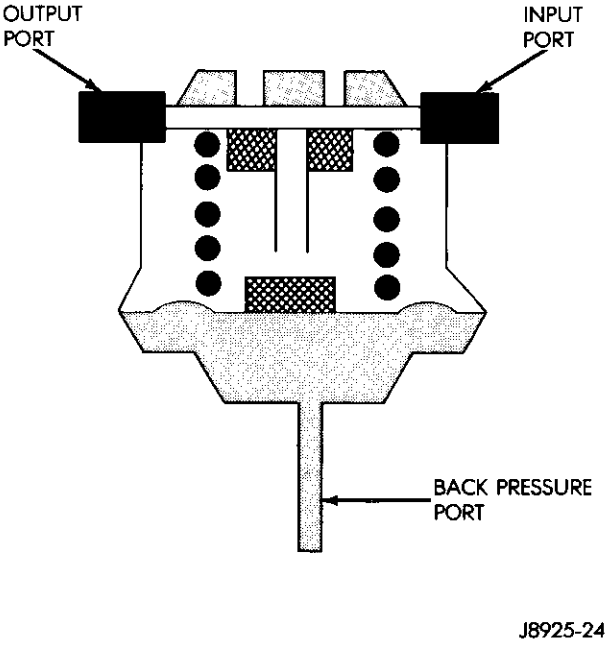


Fig. 40 Transducer Testing

- Apply 1-2 pounds air pressure to transducer backpressure port. Air pressure can be supplied with a hand operated air pump or compressed air (regulated to correct psi).
- Apply a minimum of 12 inches vacuum to input port.
- Replace the transducer if it will not hold vacuum.

4.2L Engines

The exhaust gas recirculation (EGR) system used on 4.2L engines consists of a diaphragm actuated exhaust flow control valve (EGR valve), coolant temperature override (CTO) valve, thermal vacuum switch (TVS), and connecting hoses. Vacuum is supplied by a timed signal from the carburetor.

The vacuum supply for the EGR valve is controlled by coolant temperature and air cleaner air temperature. A coolant temperature override (CTO) valve restricts vacuum flow to the TVS until the engine coolant reaches 46°C (115°F). Once the CTO opens, vacuum flows to the TVS (located in the air cleaner). If air in the air cleaner has reached 13°C (55°F) the TVS will open permitting vacuum to flow to the EGR valve. When vacuum is applied to the EGR valve, a metered amount of exhaust gas will be drawn into the intake manifold and mixed with air/fuel mixture.

CAUTION: Engine preignition and severe engine damage can result from disconnecting the EGR valve vacuum hose or any change to the EGR system that causes the valve not operate in the manner in which it was designed.

EGR CTO Valve

The EGR CTO valve (Fig. 41) is located on the intake manifold on 4.2L engines. The dual function valve is also used for distributor vacuum advance control.

When the coolant temperature is below the calibrated rating of the CTO valve, there is no vacuum applied to the EGR valve. For 4.2L engines the CTO valve opens at 46°C (115°F). **The temperature ratings are nominal values and the actual valve opening temperature will vary slightly from unit to unit.**

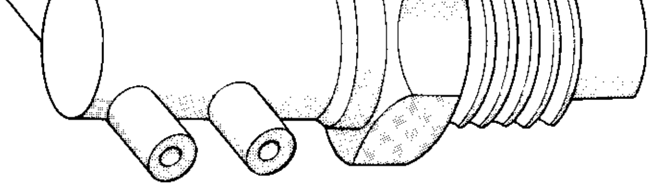


Fig. 41 Dual Function CTO—Typical

EGR CTO Valve Functional Test—4.2L Engine

The engine coolant temperature must be 5.6°C (10°F) below the calibrated opening temperature of the valve.

- Inspect the vacuum hoses for air leaks and correct the routings/connections.
- Disconnect the hose at the TVS and connect it to a vacuum gauge.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

- Operate the engine at approximately 1500 rpm. No vacuum should be indicated on the gauge. If vacuum is indicated, replace the EGR CTO valve.
- Operate the engine until the coolant temperature exceeds 46°C (115°F).
- Accelerate the engine to 1500 rpm. The carburetor ported vacuum should be indicated on the vacuum gauge. If not, replace the EGR CTO valve.

EGR Thermal Vacuum Switch (TVS)—4.2L Engines

The thermal vacuum switch (TVS) is located in the air cleaner and functions as an on-off switch controlled by air cleaner intake air temperature.

On 4.2L engines, the TVS (Fig. 42) controls the vacuum between the EGR CTO valve and the EGR valve. At air temperatures below 4° - 10°C (40° - 50°F) the TVS prevents vacuum from opening the EGR valve. This improves cold engine driveability. **The temperature ratings are nominal values and actual switching temperature will vary slightly from unit to unit.**

A TVS may also used for other engine related systems to control operations that require air cleaner intake air to be at the proper temperature before system operation is activated. Refer to the appropriate vacuum hose routing schematic in this section for proper identification.

TVS Functional Test

Cool the air cleaner intake air below the TVS calibrated temperature, 4°C (40°F).

- Disconnect the vacuum hoses from the TVS and connect a vacuum pump to the inner port.
- Apply vacuum to the TVS. Vacuum should be maintained by TVS check valve. If vacuum is not maintained, replace the TVS.
- Start the engine and warm the air cleaner intake air to above 13°C (55°F). Vacuum should not be maintained. If vacuum is maintained, replace the TVS.

EGR System Tests—4.2L Engine

The condition of the exhaust system can affect EGR system operation. Excessive back-pressure caused by exhaust system restrictions may create driveability problems. Refer to Restricted Exhaust System Diagnosis in Group 11. Exhaust system leaks may decrease back-pressure enough to prevent proper EGR operation. This will increase undesirable exhaust emissions. Visually inspect the exhaust system if leaks are suspected.

EGR Valve Opening Test—4.2L Engine

With the engine at normal operating temperature and curb idle speed, rapidly open and close the throttle. The throttle should be opened sufficiently to allow the engine speed to reach 1500 rpm. A distinct movement should be noticed in the EGR control diaphragm (Fig. 43).

If the diaphragm does not move, the probable causes are:

- A faulty vacuum hose to the EGR valve
- A defective EGR valve diaphragm
- A defective back-pressure sensor diaphragm
- Leaking vacuum hoses

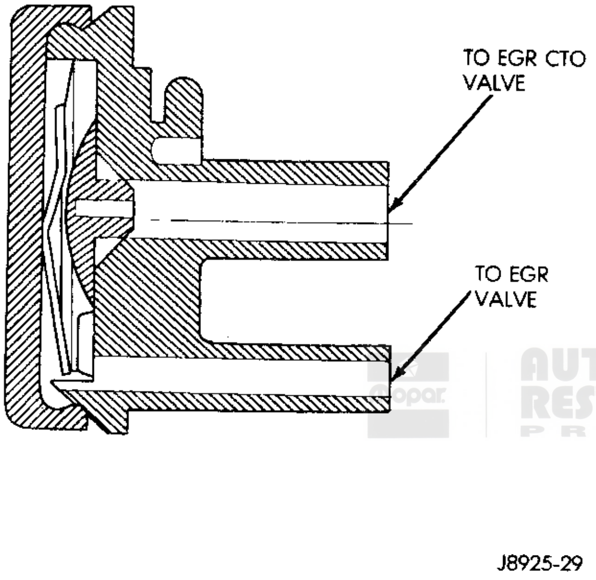


Fig. 42 EGR Valve TVS—4.2L and 5.9L Engines

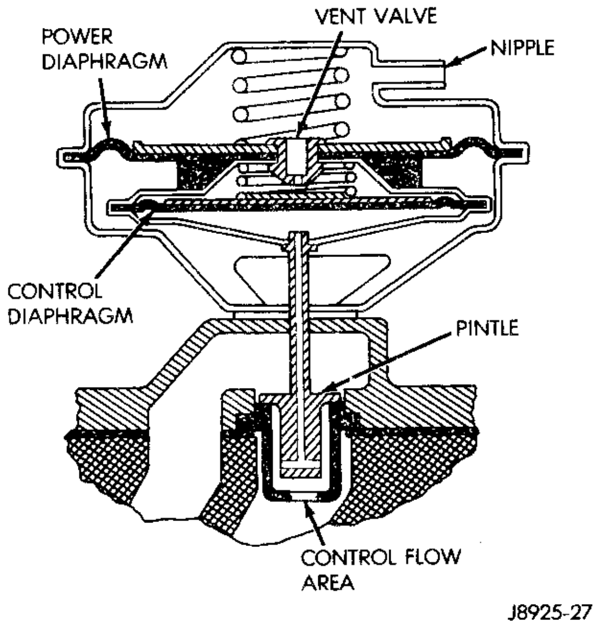


Fig. 43 EGR Valve Testing—4.2L Engine

EGR Valve Closing Test—4.2L Engine

With the engine at normal operating temperature and curb idle speed, manually depress the EGR valve diaphragm. There should be an immediate drop in engine RPM (indicating that the EGR valve has been properly preventing the flow of exhaust gas to the intake manifold at idle speed).

If there is no change in engine RPM and the engine is idling properly, exhaust gases are not reaching the combustion chamber. The probable malfunction is a restricted passage between the EGR valve and the intake manifold.

If the engine idles improperly and rpm is not greatly affected by depressing the EGR valve diaphragm, the EGR valve is not preventing the flow of exhaust gases to the intake manifold. There is either a fault in the vacuum hoses, improper hose connection or the valve is defective.

5.9L Engines

The exhaust gas recirculation (EGR) system used on 5.9L engines consists of the EGR valve and EGR valve transducer (Fig. 44), coolant temperature override (CTO) valve, thermal vacuum switch (TVS), and connecting hoses.

The transducer is connected to the EGR valve by a vacuum hose and a back-pressure nose. The transducer is controlled by exhaust system back-pressure and is ported to the exhaust manifold through a hose connecting it to the bottom of the EGR valve (Fig. 38).

Operation

A coolant temperature override (CTO) valve restricts vacuum flow to the TVS until the engine coolant reaches 52° C (125° F). Once the CTO opens, vacuum

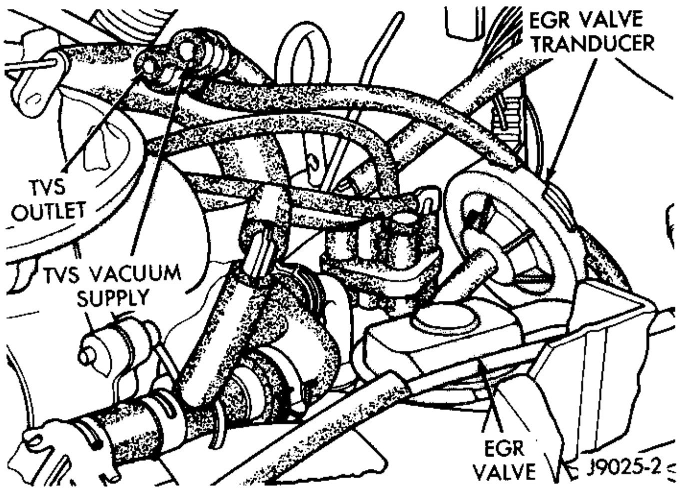


Fig. 44 EGR Transducer and Valve—5.9L Engine

flows to the TVS (located in the air cleaner). If air in the air cleaner has reached 12.8°C (55°F) the TVS will open permitting vacuum to flow to the EGR valve transducer. When exhaust system back-pressure is high enough, a bleed valve in the transducer will close allowing vacuum to actuate the EGR valve. If back-pressure does not close the bleed valve in the transducer, vacuum will be bled off.

When vacuum is applied to the EGR valve, a metered amount of exhaust gas will be drawn into the intake manifold and mixed with air/fuel mixture.

EGR CTO Valve—5.9L Engine

The EGR CTO valve is located at the front of the intake manifold between oil filler tube and the thermostat (the spark CTO is mounted in the thermostat housing). Refer to the appropriate vacuum schematic for system vacuum routing.

When the coolant temperature is below 68.2°C (155°F), the opening rating of the CTO valve, there is no vacuum applied to the EGR valve. **The temperature rating is a nominal value and the actual valve opening temperature will vary slightly from unit to unit.**

EGR CTO Valve Functional Test—5.9L Engine

The engine coolant temperature must be 5.6°C (10°F) below the calibrated opening temperature of the valve.

- Inspect the vacuum hoses for air leaks and correct the routings/connections.
- Disconnect the hose at the TVS and connect it to a vacuum gauge.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

- Operate the engine at approximately 1500 rpm. No vacuum should be indicated on the gauge. If vacuum is indicated, replace the EGR CTO valve.
- Operate the engine until the coolant temperature exceeds 68.2°C (155°F) for 5.9L engines.
- Accelerate the engine to 1500 rpm. The carburetor ported vacuum should be indicated on the vacuum gauge. If not, replace the EGR CTO valve.

EGR Thermal Vacuum Switch (TVS)—5.9L Engines

The thermal vacuum switch (TVS) is located in the air cleaner and functions as an on-off switch controlled by air cleaner intake air temperature (Fig. 42).

The TVS controls the vacuum between the EGR CTO and the EGR valve transducer. At air temperatures below 4° - 10°C (40° - 50°F) the TVS prevents vacuum from opening the EGR valve. This improves cold engine driveability. **The temperature ratings are nominal values and actual switching temperature will vary slightly from unit to unit.**

TVS Functional Test

Cool the air cleaner intake air below the TVS calibrated temperature, 4°C (40°F).

- Disconnect the vacuum hoses from the TVS and connect a vacuum pump to the inner port.
- Apply vacuum to the TVS. Vacuum should be maintained by TVS check valve.If vacuum is not maintained, replace the TVS.
- Start the engine and warm the air cleaner intake air to above 13°C (55°F). Vacuum should not be maintained. If vacuum is maintained, replace the TVS.

5.9L EGR System Component Testing

Bring the engine to normal operating temperature. Operate at idle speed. Test the EGR valve as follows:

- Bypass the vacuum transducer and apply manifold vacuum (or an outside vacuum source of at least 12 inches) directly to the nipple on the EGR valve and note engine idle.
- The engine should now idle roughly or stall. If this occurs, the valve is OK. Proceed to Vacuum Transducer Test. However, if idle does not change, proceed to next step.
- Disconnect hose from EGR valve and connect a hand vacuum pump to EGR valve nipple.
- Apply a minimum of 12 inches vacuum to the valve and note engine idle. If engine now idles roughly, inspect vacuum lines between vacuum connector on intake manifold and EGR valve, and back-pressure hose from EGR valve base to transducer for leaks. If no leaks are found proceed to vacuum transducer test.
- If the idle did not change, remove the EGR valve and inspect the valve and the exhaust passage in the manifold for blockage, repair as necessary. If no blockage is present replace the EGR valve.

Test the Vacuum Transducer as follows:

- Disconnect the transducer vacuum lines and back-pressure line. Remove transducer.
- Plug transducer output port (Fig. 40).
- Apply 1-2 pounds air pressure to transducer back-pressure port. Air pressure can be supplied with a hand operated air pump or compressed air (regulated to correct psi).
- Apply a minimum of 12 inches vacuum to input port.
- Replace the transducer if it will not hold vacuum.

EGR SYSTEM SERVICE

EGR Valve Removal

2.5L, and 4.2L Engines

The EGR valve is located on the intake manifold (Fig. 45), (Fig. 46).

- Disconnect vacuum hose from EGR valve.

- Remove EGR valve mounting bolts.
- Remove EGR valve and gasket. Discard gasket.

EGR Valve Installation

2.5L, and 4.2L Engines

Use a new gasket when installing the EGR valve.

- Clean the gasket mating surfaces of the EGR valve and intake manifold.
- Install the EGR valve and new gasket.
- Tighten the mounting bolts to 27 N•m (20 ft-lbs).

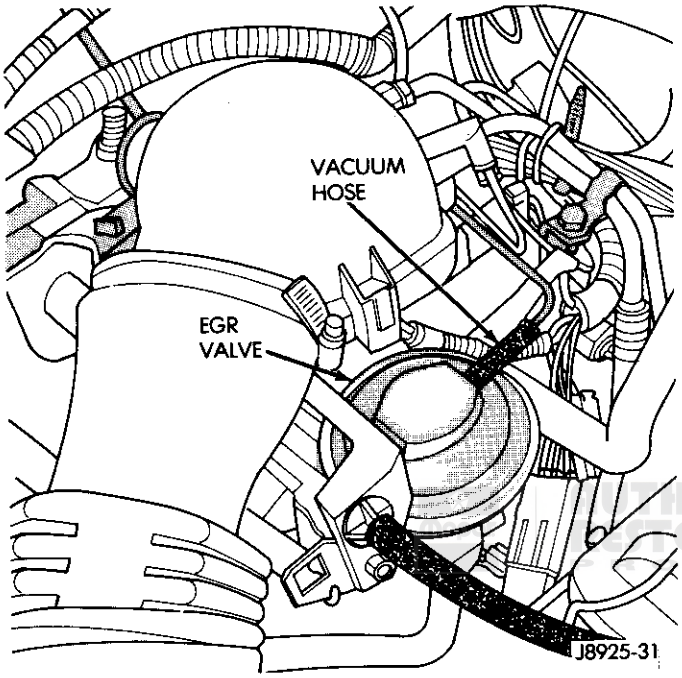


Fig. 45 EGR Valve—2.5L Engine

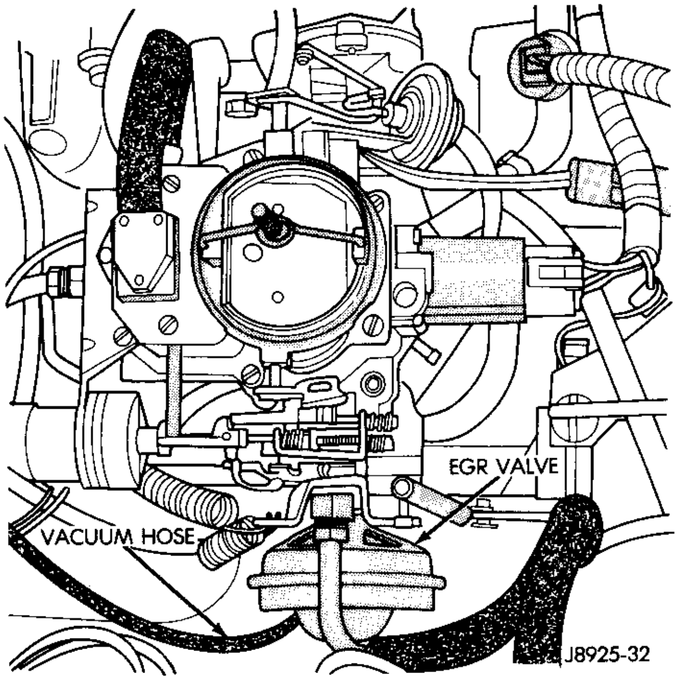


Fig. 46 EGR Valve—4.2L Engine

- Connect vacuum hose to EGR valve.

EGR Valve and Transducer—4.0L and 5.9L Engines

Removal

- Disconnect EGR valve transducer vacuum inlet hose.
- Remove EGR valve mounting bolts.
- Remove EGR valve, gasket and transducer assembly. Discard gasket (Fig. 47—4.0L or Fig. 44—5.9L).

Installation

Install the EGR Valve with a new gasket.

- Clean the gasket mating surfaces of the EGR valve and Intake manifold.
- Install the EGR valve/transducer assembly.
- Tighten the mounting bolts to 27 N•m (20 ft-lbs) torque.
- Connect transducer vacuum inlet hose to transducer.

EGR Tube Removal—2.5L Engine

The EGR tube is connected to the intake and exhaust manifolds.

- Remove EGR tube to exhaust manifold bolts.
- Unscrew EGR tube line nut at intake manifold.
- Remove EGR tube and gasket (Fig. 48).

EGR Tube Installation—2.5L Engine

Install the EGR tube with a new EGR tube to exhaust manifold gasket.

- Clean the exhaust manifold to EGR tube gasket surfaces.
- Install EGR tube with new gasket but do not tighten mounting nuts or line nut at this time.

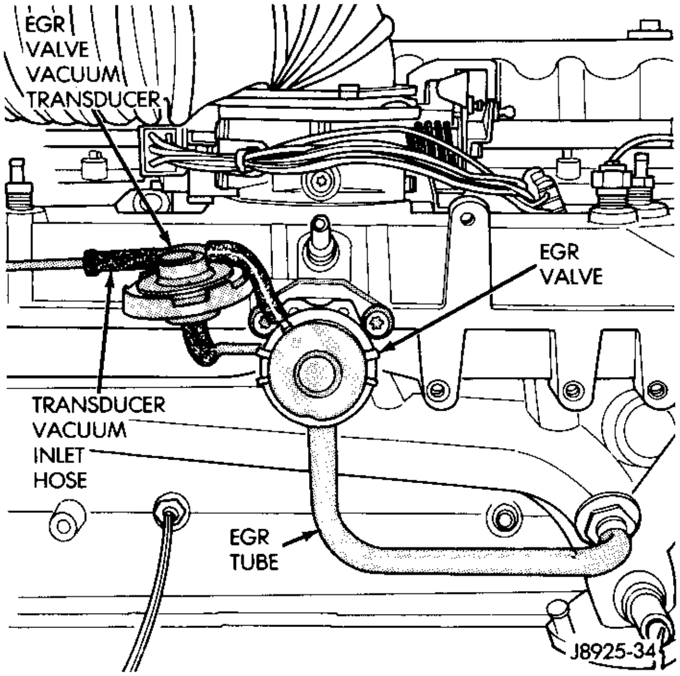


Fig. 47 EGR Valve and Transducer—4.0L Engine

- Tighten EGR tube to intake manifold line nut to 41 N•m (30 ft-lbs) torque.
- Tighten EGR tube to exhaust manifold nuts to 19 N•m (14 ft-lbs) torque.

EGR Tube Removal—4.0L and 4.2L Engines

The EGR tube is connected to the intake and exhaust manifolds. **To Remove the EGR tube it may be necessary to loosen the exhaust manifold mounting bolts.**

- If necessary, loosen the exhaust manifold mounting bolts.
- Loosen the EGR tube line nuts at the intake and exhaust manifolds.
- Remove the EGR tube (Fig. 49, Fig. 50).

EGR Tube Installation—4.2L Engine

- Install the EGR tube but, do not tighten the line nuts at this time.
- Tighten EGR tube to intake manifold nut to 41 N•m (30 ft-lbs) torque.
- Tighten EGR tube to exhaust manifold nut to 41 N•m (30 ft-lbs) torque.
- If the exhaust manifold was loosened tighten the mounting bolts the correct torque. Refer to Group 11 for exhaust manifold tightening toques and procedures.

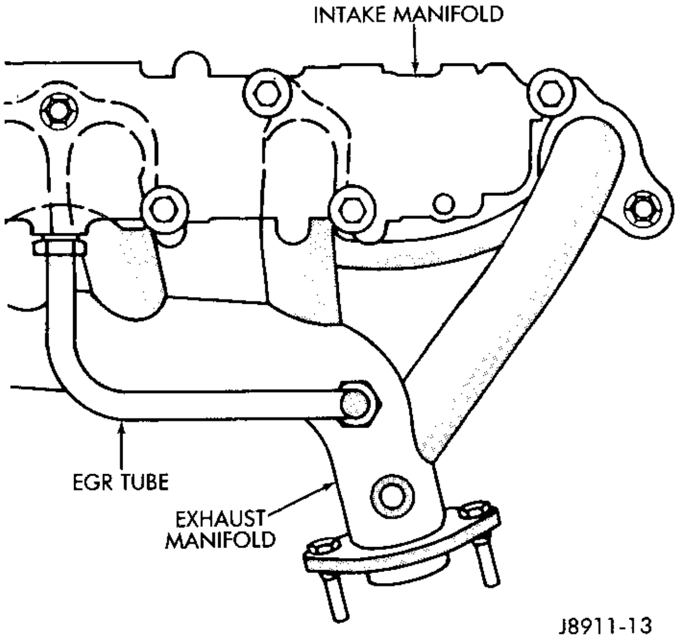


Fig. 49 EGR Tube Remove/Install—4.0L Engine

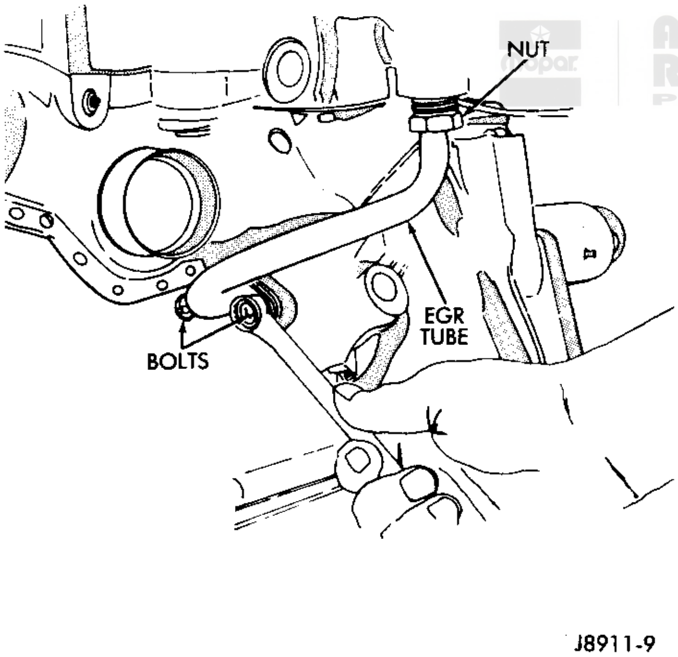


Fig. 48 EGR Tube Remove/Install—2.5L Engine

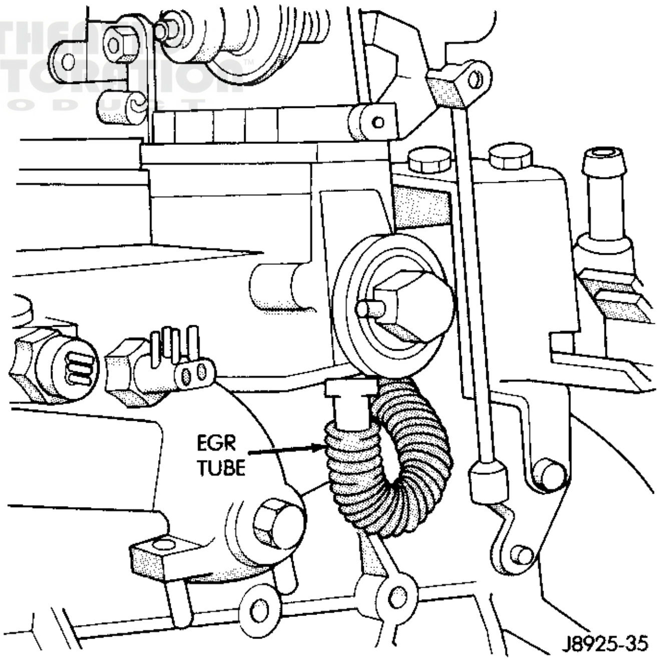


Fig. 50 EGR Tube Remove/Install—4.2L Engine

COMPONENT AND SYSTEM INDEX