HUMMER H1

MODEL 1994

- Click here to order Hummer H1 Parts

Section 1 General Information, Lubrication and Maintenance

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SAFETY SUMMARY

Individuals who decide to perform their own repairs should have some training and limit repairs to components which could not affect the safety of the vehicle or its occupants.

When replacement parts are required, it is strongly recommended that they are purchased through an authorized HUMMER dealer. It is essential that replacement parts meet or exceed manufacturer's specifications. Vehicle performance and personal safety may be impaired if other than original factory components are installed.

The installation of nonapproved accessories or conversions is not recommended as they could affect the vehicle's driving characteristics and personal safety. AM General Corporation will not be liable for personal injury or damage to property resulting from the installation of nonapproved accessories or conversions to the HUMMER.

Following the safety precautions as prescribed throughout this manual may greatly reduce the risks of personal injury and damage to the vehicle. However, it is unlikely that AM General Corporation will account for all possibilities.

Warnings, cautions, and notes are used throughout this service manual to assist service personnel in the performance of maintenance actions. These statements are designed as reminders for trained and experienced service personnel.

WARNINGS — Indicate potential safety hazards and must be followed to avoid personal injury. Warnings appear as follows:

WARNING: To avoid injury, do not remove surge tank filler cap before depressurizing cooling system when engine temperature is above 190° F (88° C).

CAUTIONS — Indicate potential equipment damage, and must be followed to avoid damage to components or systems. An example of a caution is shown below:

CAUTION: To avoid starter damage, do not operate starter continuously for more than 20 seconds. Wait 10 to 15 seconds between periods of operation.

NOTES — Indicate methods or actions that may simplify vehicle maintenance or help maintain vehicle performance. An example of a note is shown below:

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

CARBON MONOXIDE

WARNING: Carbon monoxide (exhaust gases) can be fatal.

WARNING: Brain damage or death can result from heavy exposure to carbon monoxide. The following precautions must be followed to ensure personal safety.

1. Do not operate vehicle engine in enclosed areas. Do not idle the vehicle engine with vehicle windows closed. Be alert at all times for exhaust odors. Be alert for exhaust poisoning symptoms. They are:
   - Headache
   - Dizziness
   - Sleepiness
   - Loss of muscular control
2. If you see another person with exhaust poisoning symptoms:
   - Remove person from area
   - Expose to open air
   - Keep person warm
   - Do not permit physical exercise
   - Administer artificial respiration, if necessary
   - Notify medical personnel

The best defense against exhaust poisoning is adequate ventilation.

ABOUT THIS MANUAL

This service manual contains instructions for maintaining the 1995 commercial HUMMER. Spend some time looking through this manual. Features to improve the usefulness of this manual and increase your efficiency are:

Accessing Information - These include physical entry features, such as tabulated sections for quick reference and extensive troubleshooting guides for specific systems that lead directly to step-by-step directions for problem solving and maintenance tasks.

Illustrations - A variety of methods are used to make locating and repairing components easy. Locator illustrations, exploded views, and cut-away diagrams make the information in this manual easy to understand.

The service manual is the best source available for providing information and data critical to vehicle operation and maintenance. In this manual you will find the following information:

- Safety Summary
- General Information
- General Maintenance Procedures
- Detailed Maintenance Procedures
- Torque Ranges
- Wiring Diagrams and Schematics

EQUIPMENT/PUBLICATION RECOMMENDATIONS

AM General Corporation encourages HUMMER owners and service personnel to help improve the vehicle and these publications by submitting their recommendations. All recommendations will be answered in writing. To submit a recommendation, please write to:

AM General Corporation
Commercial Publications Department
31744 Enterprise Drive
P.O. Box 3330
Livonia, Michigan 48151-3330

Revisions

In order to receive future revisions to this service manual, please write to:

AM General Corporation
Commercial Publications/Customer Service
408 South Byrkit Avenue
P.O. Box 728
Mishawaka, Indiana 46544-0728

Please be sure to specify publication number 05714160.

HUMMER SERVICE HOTLINE

Problems often arise during maintenance performance. If solutions cannot be found in this service manual, please call the **AM General Hummer Service Hotline** at:

1-800-732-5493 (1-800-REAL 4WD)

SAFETY CERTIFICATION DECAL

The safety certification decal is located on the driver's side B-pillar. The decal is required by the National Highway Traffic Safety Administration and includes a self-destructive, tamper-proof feature. If the decal is tampered with, a void pattern will appear across the decal (Figure 1-1).

The decal contains the name of the manufacturer, the month and year the vehicle was manufactured, the certification statement, the vehicle identification number (VIN), and the vehicle model type. It also contains the Gross Vehicle Weight Rating (GVWR), Gross Axle Weight Ratings (GAWR), and wheel and tire information. For more information on the GVWR and GAWR, refer to "VEHICLE LOADING INFORMATION" in the Hummer Owner's Manual.

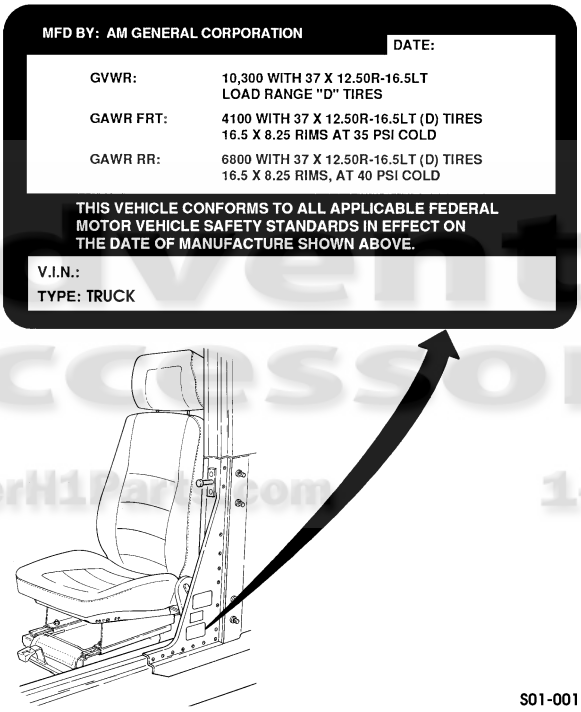

Figure 1-1: Safety Certification Decal

ENVIRONMENTAL PROTECTION AGENCY (EPA) NOISE EMISSION CONTROL INFORMATION LABEL

The EPA noise emission control information label is located on the passenger's side B-pillar rabbet assembly. The label is required by the EPA and includes a self-destructive, tamper-proof feature. If the label is tampered with, a void pattern will appear across the label. Notify the dealer or the manufacturer if the label is missing or displays a void pattern (Figure 1-2).

The label contains the name of the manufacturer, the month and year the vehicle was manufactured, a statement regarding vehicle conformance to applicable U.S. EPA regulations, and a description of acts prohibited by the Noise Control Act of 1972.

Figure 1-2: EPA Noise Emission Control Information Label

COMPONENT IDENTIFICATION

The automatic 4L80-E transmission serial number is located on the light blue plate on the right side of the transmission (Figure 1-3).

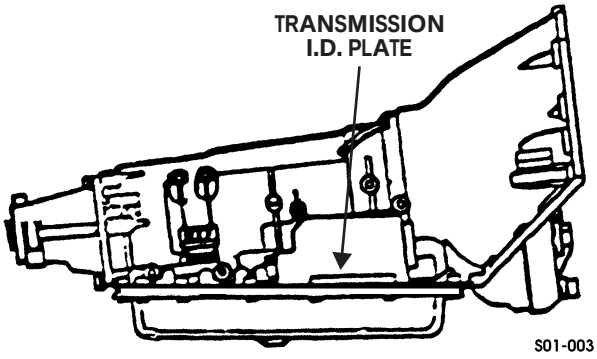

Figure 1-3: Transmission I.D. Plate

The New Venture Gear 242 transfer case serial number is located on the rear half case next to the rear extension (Figure 1-4).

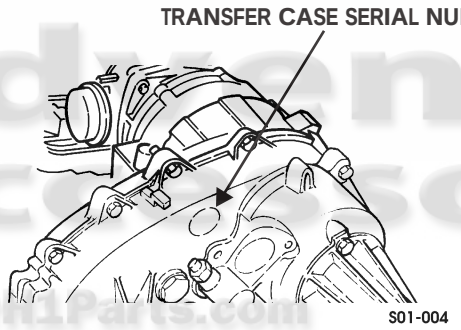

Figure 1-4: Transfer Case Serial Number

The 6.5 liter diesel engine serial number bar code decal is located at the rear of the left cylinder head (Figure 1-5).

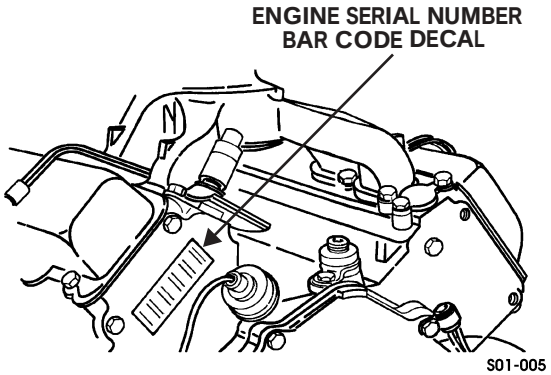

Figure 1-5: Engine Serial Number Bar Code Decal

VIN SYSTEM IDENTIFICATION

The VIN data plate is located on the left front corner of the dashpad (Figure 1-6).

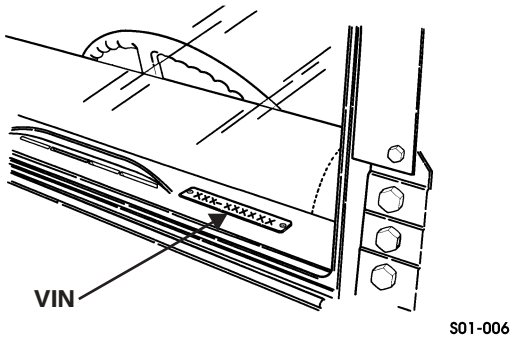

Figure 1-6: Vehicle Identification Number

The twelve digits of the VIN are explained in the chart on the following page (Figure 1-7).

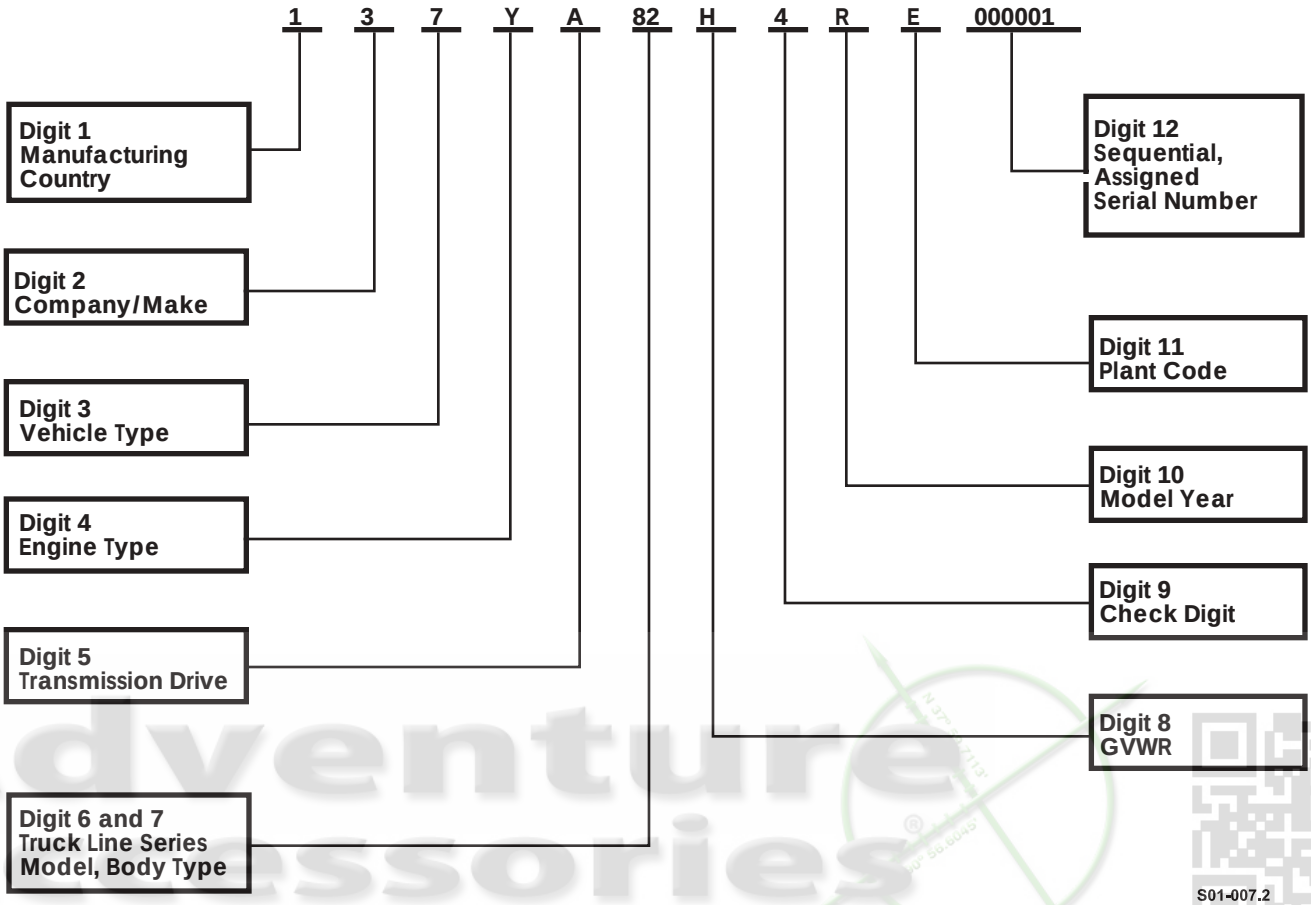

Figure 1-7: Vehicle Identification Number Chart

Vehicle Identification Number Code and Code Definition

Digit	Code	Code Definition
1	1	United States
2	3	AM General Corporation
3	7	Commercial Vehicles
4	D	5.7 L (350 in.^{3}), Unleaded Gas, GM, 8 cyl., 180 hp
	L	5.7L Leaded Gas, GCC
	X	6.2 L (378 in.^{3}), Diesel, GM, 8 cyl., 160 hp
	Y	6.5 L (395 in.^{3}), Diesel, GM, 8 cyl., 165 hp
	Z	TBD
5	E	3-Speed, Auto/LHD
	A	4-Speed, Auto/LHD

Digit	Code	Code Definition		
6 & 7	6	6	2-door	Truck, utility
	83	1-1/4 ton	4-door	Truck, utility

	84	1-1/4 ton	Station wagon	Truck, utility
	85	1-1/4 ton	Open body	Truck, utility
	86	1-1/4 ton	2-door fleet/industrial	Truck, utility
	87	1-1/4 ton	2-door Recruit	Truck, utility
	88	1-1/4 ton	Open body Recruit	Truck, utility
	89	1-1/4 ton	2-door enlarged cab	Truck, utility
	90	1-1/4 ton	Open body w/full hard doors	Truck, utility
8	Class B	3,001 lb - 4,000 lb (1,362 kg - 1,816 kg)		
	Class C	4,001 lb - 5,000 lb (1,817 kg - 2,270 kg)		
	Class D	5,001 lb - 6,000 lb (2,271 kg - 2,724 kg)		
	Class E	6,001 lb - 7,000 lb (2,275 kg - 3,178 kg)		
	Class F	7,001 lb - 8,000 lb (3,179 kg - 3,632 kg)		
	Class G	8,001 lb - 9,000 lb (3,633 kg - 4,086 kg)		
	Class H	9,001 lb - 10,000 lb (4,087 kg - 4,540 kg)		
	Class 3	10,001 lb - 14,000 lb (4,541 kg - 6,356 kg)		
	Class 4	14,001 lb - 16,000 lb (6,357 kg - 7,264 kg)		
	Class 5	16,001 lb - 19,500 lb (7,265 kg - 8,853 kg)		
9	—	Check Digit		
10	M	1991		
	N	1992		
	P	1993		
	R	1994		
	S	1995		
	T	1996		
	V	1997		
	W	1998		
	X	1999		
11	E	Mishawaka, Indiana		
	U	Livonia, Michigan		
12	—	Sequential Serial Number		

COMPONENT SPECIFICATIONS

Engine:

Manufacturer . . . . . GM Powertrain
Model . . . . . 6.5 L (395 in.^{3})
Type . Four Cycle, Diesel, Liquid-Cooled, Naturally Aspirated
. . . . . 165 hp (Net) @ 3,400 RPM
. . . . . 290 lb-ft (Net), 393 N•m @ 1,700 RPM Torque

Engine Dimensions:

Length . . . . . 35 in. (89 cm)
Width . . . . . 28 in. (71 cm)
Height . . . . . 28 in. (71 cm)
Net Weight, Dry . . . . . 701 lb (318 kg)

Governed Speed:

Full Load . . . . . 3,400 RPM
No Load . . . . . 3,750 RPM
Idle Speed . . . . . 200 RPM
Operating Speed . . . . . 1,500-2,300 RPM

Cylinders:

Number 8
Arrangement . . . . . 90° V
Firing Order . . . . . 1-8-7-2-6-5-4-3 (Clockwise)
Bore . . . . . 4.06 in. (103.12 mm)
Stroke (Nominal) . . . . . 3.82 in. (9.7 cm)
Displacement . . . . . 6.5 L (395 in.^{3})
Compression Ratio 21.5:1

Lubricating System:

Type . . . . . Pressure Feed
Operating Pressure (Normal) . 40-45 psi (276-310 kPa) @ 2000 RPM
Operating Pressure (Idle) . . . . . 10 psi (69 kPa)
System Capacity (Filter Included) . . . . . 8 qt (7.6 L)
Operating Temperature (Normal) . 180°-275° F (82°-135° C)
Oil Pump . . . . . Gear-Driven
Filter . . . . . Paper Element, Spin On

Fuel/Air System:

Fuel Lift Pump
Type . . . . . Electronic
Fuel Filter
Type . . . . . Two Stage Fuel Filter /Water Separator
Glow Plug
Type . . . . . Fast Start

Cooling System:

Type . . . . . Liquid w/Fan and Radiator
Operating Temperature (max).. 190°-235° F (88°-113° C)
Filler Cap Pressure . . . . . 15 psi (103 kPa)
Radiator
Type . . . . . 4 Core Downflow
Fan (Seven Blade)
Type . . . . . Suction w/Viscous Drive
Diameter . . . . . 19.5 in. (495 mm)
Thermostat
Starts to Open . . . . . 190° F (88° C)
Fully Open . . . . . 212° F (100° C)

Starter:

Manufacturer . . . . . Prestolite
Model . . . . . MMO
Capacity (Peak) . . . . . 6.0 hp
Voltage . . . . . 12 V

Alternator (Standard):

Manufacturer . . . . . Delco
Part No. 6003163
Output . . . . . 124 AMP @ 1842 RPM (engine)
Rated Voltage . . . . . 13.35 -15.9 V

Batteries:

Manufacturer . . . . . Delco or East Penn Group 78
Model 78-770
Type . . . . . Side Post, Maintenance-Free
Number 2
Voltage . . . . . 12 V
Amperage . . . . . 770 Cold Cranking AMPS Each Battery

Transmission:

Manufacturer . . . . . GM Powertrain
Model 4L80-E
Type . . . . . 4-Speed, Automatic
Converter Stall Torque Ratio 2.2:1
Gear Ratios
First 2.482:1
Second 1.482:1
Third 1.000:1
Fourth 0.75:1
Reverse 2.077:1
Oil Type . . . . . Dexron® III
Oil Pressure . . . . . 35-324 psi (241-2,234 kPa)

Transfer Case:

Manufacturer . . . . . New Venture Gear
Model 242
Type . . . . . Full Time Four-Wheel Drive
Gear Ratios
High and High Lock 1:1
Low Lock 2.72:1
Oil Type . . . . . Dexron® III

Axle/Differential:

Manufacturer . . . . . Dana
Type
Axle . . Mounted Differential W/ Independent Half Shafts
Differential .Hypoid Torque Biasing (Paired Worm Gears)
Gear Ratio 2.73:1

Geared Hub:

Manufacturer . . . . . AM General Corporation
Type . . . . . Spur Gears
Gear Ratio 1.92:1

Service Brake Caliper (Front):

Manufacturer . . . . . Kelsey-Hayes
Piston Diameter . . . . . 2.6 in. (6.6 cm)

Service/Parking Brake Caliper (Rear):

Manufacturer . . . . . Kelsey-Hayes
Piston Diameter . . . . . 2.6 in. (6.6 cm)

Service Brake Rotor (Front):

Manufacturer . . . . . Kelsey-Hayes
Diameter . . . . . 10.5 in. (266.7 mm)
Thickness . . . . . 0.87 in. (22 mm)

Service/Parking Brake Rotor (Rear):

Manufacturer . . . . . Kelsey-Hayes
Diameter . . . . . 10.5 in. (266.7 mm)
Thickness . . . . . 0.87 in. (22 mm)

Steering System:

Steering Gear
Manufacturer . . . . . Saginaw
Type . . . . . Recirculating Ball, Worm and Nut
Ratio 13/16:1
Power Steering Pump
Manufacturer . . . . . Saginaw
Model 185
Output Pressure (Max) . . . . . 1,450 psi (9,998 kPa)
Flow Rate (Max) . . . . . 2.6 gpm (9.8 Lpm)
Capacity (@ 1500 RPM) . . . . . 2.6 gpm (9.8 Lpm)

Frame:

Manufacturer . . . . . AM General Corporation
Type . . . . . Steel Box
No. of Crossmembers 5

Winch:

Manufacturer . . . . . Warn
Model . . . . . 12000 12VDC HUMMER
Type . . . . . Electric Drive, Thermal Cutoff Switch
Capacity . . . . . 12,000 lb (5,448 kg)

Air Conditioner (Optional):

Manufacturer (Compressor) . . . . . Harrison
Model . . . . . HD-6 HE
Field (Coil) . . . . . 12 V
Oil Capacity . . . . . 8 fl oz (237 ml)
Refrigerant R-134a
Capacity:
. . . . . W/O Auxiliary Air Conditioning 1 lb (.45 kg)
. . . . . W/ Auxiliary Air Conditioning 1.2 lb (.54 kg)

ABBREVIATIONS

a.c. . . . . Alternating Current
AMP . . . . . Ampere
CO . . . . . Carbon Monoxide
C . . . . . Celsius (centigrade)
cm . . . . . Centimeter
CDR . . . . . Crankcase Depression Regulator
cm^3 . . . . . Cubic Centimeter
$in.^3$ . . . . . Cubic Inch
cyl. . . . . Cylinder
° . . . . . Degree (angle or temperature)
dia . . . . . Diameter
d.c. . . . . Direct Current
F . . . . . Fahrenheit
ft . . . . . Feet
ft/min . . . . . Feet Per Minute
fl oz . . . . . Fluid Ounce
gal. . . . . Gallon
g . . . . . Gram
hp . . . . . Horsepower
in. . . . . Inch
INC. . . . . Include
I.D. . . . . Internal Diameter
km . . . . . Kilometer
km/h . . . . . Kilometers Per Hour
lh . . . . . Left Hand
L . . . . . Liter
max. . . . . Maximum
m . . . . . Meter
mpg . . . . . Miles Per Gallon
mph . . . . . Miles Per Hour
mm . . . . . Millimeter
min . . . . . Minimum
– . . . . . Minus
– . . . . . Negative
N•m . . . . . Newton-meters
No. . . . . Number
Ohm . . . . . Ohms
oz . . . . . Ounce
O.D. . . . . Outside Diameter
P/N . . . . . Part Number
% . . . . . Percentage
pt . . . . . Pint
+ . . . . . Plus
+ . . . . . Positive
lb . . . . . Pound
lb-ft . . . . . Pound-feet
lb-in. . . . . Pound-inch
psi . . . . . Pounds Per Square Inch
qt. . . . . Quart
: . . . . . Ratio
ref. . . . . Reference
RPM . . . . . Revolutions Per Minute
rh . . . . . Right-Hand
cm^2 . . . . . Square Centimeters
$in.^2$ . . . . . Square Inches
VIN . . . . . Vehicle Identification Number
V . . . . . Volts
W . . . . . Watts
UNC . . . . . Unified Coarse
UNF . . . . . Unified Fine

THE METRIC SYSTEM AND EQUIVALENTS

Metric Conversions

MULTIPLY	BY	TO GET
INCHES	2.54	CENTIMETERS
FEET	0.305	METERS
MILES	1.609	KILOMETERS
SQUARE INCHES	6.451	SQUARE CENTIMETERS
CUBIC INCHES	16.39	CUBIC CENTIMETERS
FLUID OUNCES	29.573	MILLIMETERS
PINTS	0.473	LITERS
QUARTS	0.946	LITERS
GALLON	3.785	LITERS
POUNDS	0.454	KILOGRAMS
SHORT TONS	0.907	METRIC TONS
POUND-INCHES	0.113	NEWTON-METERS
POUND-FEET	1.356	NEWTON-METERS
POUNDS PER SQUARE INCH	6.895	KILOPASCALS
MILES PER GALLON	0.425	KILOMETERS PER LITER
MILES PER HOUR	1.609	KILOMETERS PER HOUR

U.S. Standard Conversions

MULTIPLY	BY	TO GET
CENTIMETERS	0.394	INCHES
METERS	3.280	FEET
KILOMETERS	0.621	MILES
SQUARE CENTIMETERS	0.155	SQUARE INCHES
CUBIC CENTIMETERS	0.061	CUBIC INCHES
MILLILITERS	0.034	FLUID OUNCES
LITERS	2.113	PINTS
LITERS	1.057	QUARTS
LITERS	0.264	GALLONS
KILOGRAMS	2.205	POUNDS
METRIC TONS	1.102	SHORT TONS
NEWTON-METERS	0.738	POUND-FEET
NEWTON-METERS	8.851	POUND-INCHES
KILOPASCALS	0.145	POUNDS PER SQUARE INCH
KILOMETERS PER LITER	2.354	MILES PER GALLON
KILOMETERS PER HOUR	0.621	MILES PER HOUR

Temperature

32° FAHRENHEIT = 0° CELSIUS212° FAHRENHEIT = 100° CELSIUS
5/9 (°F - 32) = °C . . . . . 9/5 °C + 32 = °F

TORQUE LIMITS

1. Special torque limits are indicated in the maintenance procedures for applicable components. The general torque limits shall be used when specific torque limits are not indicated in the maintenance procedure. These general torque limits cannot be applied to screws that retain rubber components. The rubber components will be damaged before the correct torque limit is reached. If a special torque limit is not given in the maintenance instruction, tighten the screw or nut until it touches the metal bracket, then tighten it one more turn.
2. Measure the diameter of the screw you are installing (Figure 1-8).

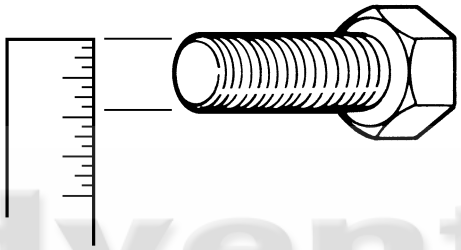

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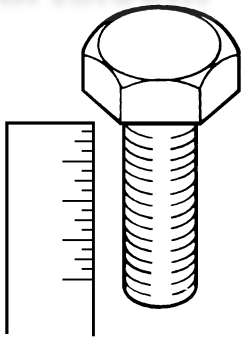
Figure 1-8: Diameter of the Screw

3. Count the number of threads per inch (Figure 1-9).



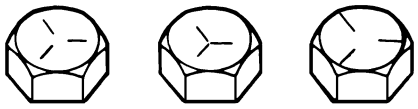
S01-009

Figure 1-9: Threads Per Inch

4. Under the heading SIZE, look down the left hand column until you find the diameter of the screw you are installing (there will usually be two lines beginning with the same size).
5. In the second column under size, find the number of threads per inch that matches the number of threads you counted in step 3.

Capscrew Head Markings

Manufacturer's marks may vary. These are all SAE Grade 5 (3-line) (Figure 1-10).



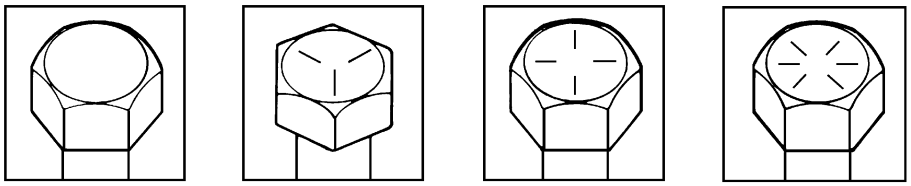
S01-010

Figure 1-10: SAE Grade 5 screws

6. To find the grade screw you are installing, match the markings on the head to the correct picture of CAP-SCREW HEAD MARKINGS on the torque table.
7. Look down the column under the picture you found in step 6 until you find the torque limit (in lb-ft or N•m) for the diameter and threads per inch of the screw you are installing.
8. Table 1-1 lists dry torque limits. Dry torque limits are used on screws that do not have lubricants applied to the threads. Table 1-2 lists wet torque limits. Wet torque limits are used on screws that have high pressure lubricants applied to the threads.

Capscrew Head Markings

Table 1-1. Torque Limits for Dry Fasteners

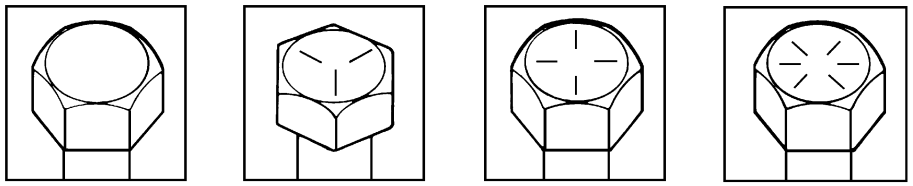


S01-011

TORQUE SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	5 (7)	8 (11)	10 (14)	12 (16)
1/4	6	28	6 (8)	10 (14)	— —	14 (19)
5/16	8	18	11 (15)	17 (23)	19 (26)	24 (33)
5/16	8	24	13 (18)	19 (26)	— —	27 (37)
3/8	10	16	18 (24)	31 (42)	34 (46)	44 (60)
3/8	10	24	20 (27)	35 (47)	— —	49 (66)
7/16	11	14	28 (38)	49 (66)	55 (75)	70 (95)
7/16	11	20	30 (41)	55 (75)	— —	78 (106)
1/2	13	13	39 (53)	75 (102)	85 (115)	105 (142)
1/2	13	20	41 (56)	85 (115)	— —	120 (163)
9/16	14	12	51 (69)	110 (149)	120 (163)	155 (210)
9/16	14	18	55 (75)	120 (163)	— —	170 (231)
5/8	16	11	63 (85)	150 (203)	167 (226)	210 (285)
5/8	16	18	95 (129)	170 (231)	— —	240 (325)
3/4	19	10	105 (142)	270 (366)	280 (380)	375 (509)
3/4	19	16	115 (156)	295 (400)	— —	420 (570)
7/8	22	9	160 (217)	395 (536)	440 (597)	605 (820)
7/8	22	14	175 (237)	435 (590)	— —	675 (915)
1	25	8	235 (319)	590 (800)	660 (895)	910 (1234)
1	25	14	250 (339)	660 (895)	— —	990 (1342)
1-1/8	29	—	— —	800 - 880 (1085 - 1193)	— —	1280 - 1440 (1736 - 1953)
1-1/4	32	—	— —	—	— —	1820 - 2000 (2468 - 2712)
1-3/8	35	—	— —	1460 - 1680 (1980 - 2278)	— —	2380 - 2720 (3227 - 3688)
1-1/2	38	—	— —	1940 - 2200 (2631 - 2983)	— —	3160 - 3560 (4285 - 4827)

Capscrew Head Markings

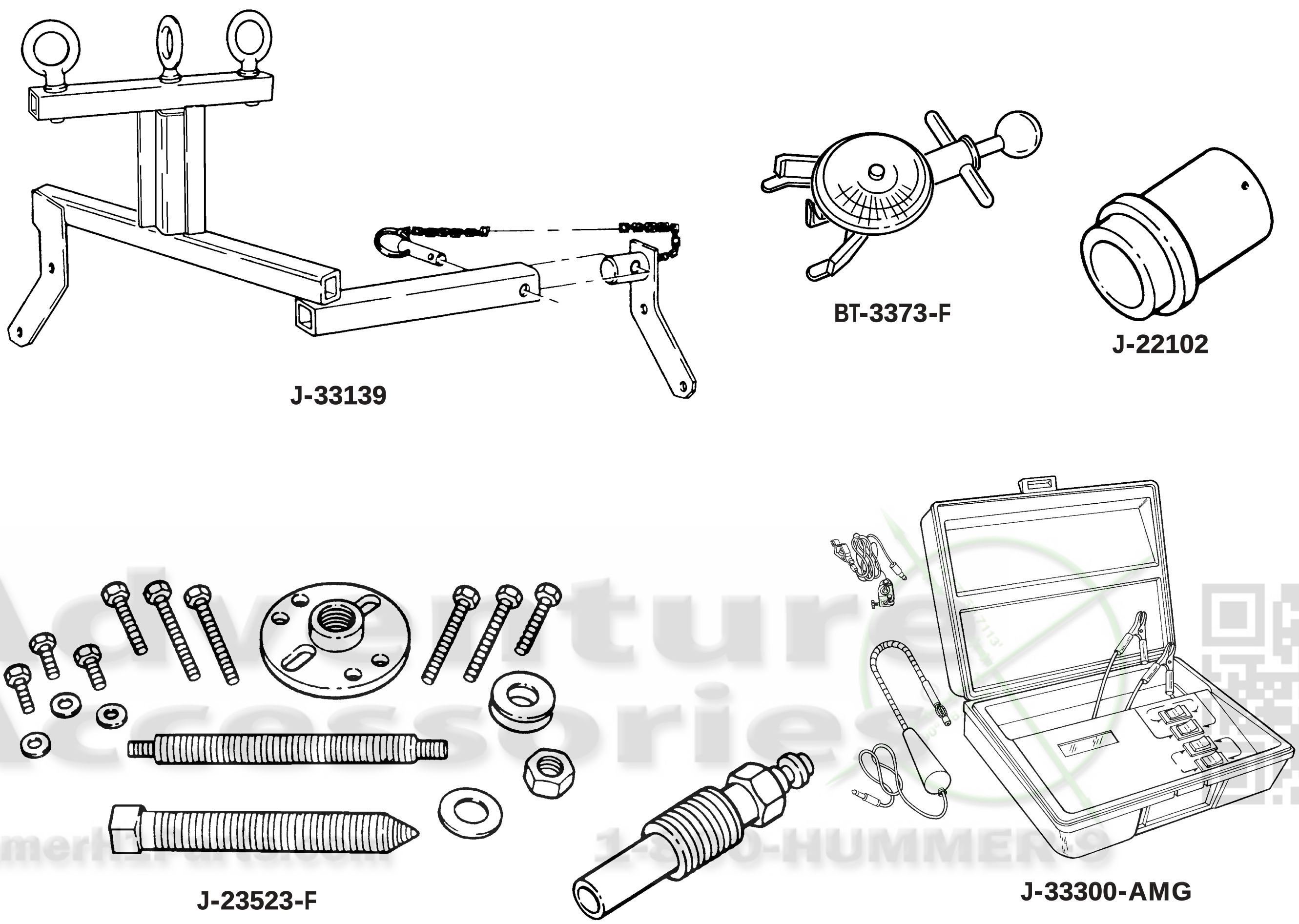
Table 1-2. Torque Limits for Wet Fasteners



S01-011

TORQUE SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	4 (5)	7 (10)	9 (12)	11 (15)
1/4	6	28	5 (7)	9 (12)	— —	13 (17)
5/16	8	18	10 (14)	15 (20)	17 (23)	22 (30)
5/16	8	24	12 (16)	17 (23)	— —	24 (33)
3/8	10	16	16 (22)	28 (38)	31 (42)	40 (54)
3/8	10	24	18 (24)	32 (43)	— —	44 (60)
7/16	11	14	25 (34)	44 (60)	50 (68)	63 (85)
7/16	11	20	27 (37)	50 (68)	— —	70 (95)
1/2	13	13	35 (48)	68 (92)	77 (104)	95 (129)
1/2	13	20	37 (50)	77 (104)	— —	108 (146)
9/16	14	12	46 (62)	99 (134)	108 (146)	140 (190)
9/16	14	18	50 (67)	108 (146)	— —	153 (207)
5/8	16	11	57 (77)	135 (183)	150 (203)	189 (256)
5/8	16	18	85 (115)	153 (207)	— —	216 (293)
3/4	19	10	95 (129)	243 (330)	252 (342)	338 (458)
3/4	19	16	104 (141)	266 (361)	— —	378 (513)
7/8	22	9	144 (195)	356 (483)	396 (537)	545 (739)
7/8	22	14	158 (214)	392 (532)	— —	608 (824)
1	25	8	212 (287)	531 (720)	594 (805)	819 (1111)
1	25	14	225 (305)	594 (805)	— —	891 (1208)
1-1/8	29	—	— —	720 - 792 (976 - 1074)	— —	1152 - 1296 (1562 - 1757)
1-1/4	32	—	— —	— —	— —	1638 - 1800 (2221 - 2441)
1-3/8	35	—	— —	1314 - 1512 (1782 - 2050)	— —	— —
1-1/2	39	—	— —	1746 - 1980 (2368 - 2685)	— —	2844 - 3204 (3857 - 4345)

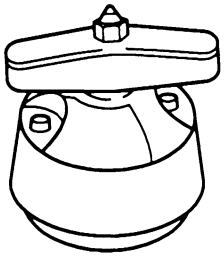
SPECIAL TOOLS



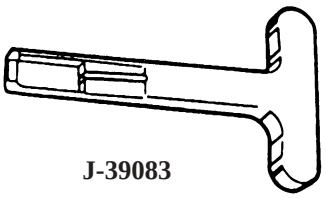
S01-013.1

SPECIAL TOOLS, ENGINE AND DRIVEBELTS

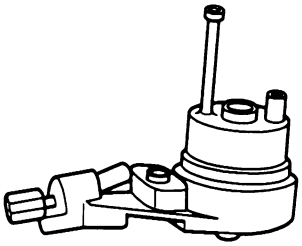
TOOL	DESCRIPTION
J-23523-F	Harmonic Balancer Remover and Installer
J-33300-AMG	Timing Tach. Meter, Lumy/Mag II
J-33139	Sling, Engine Lifter
J-22102	Front Seal Installer
BT-3373-F	Belt Tension Gauge
J-26999-30	Compression Gauge Adapter



J-39084



J-39083



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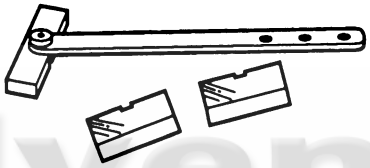
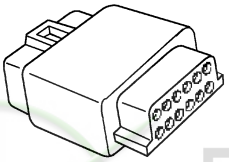


J-33043-2



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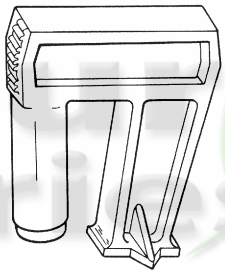
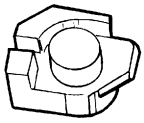


5735122

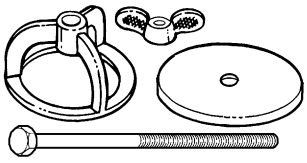
S01-021.2

SPECIAL TOOLS, ENGINE AND DRIVEBELTS (CONT'D)

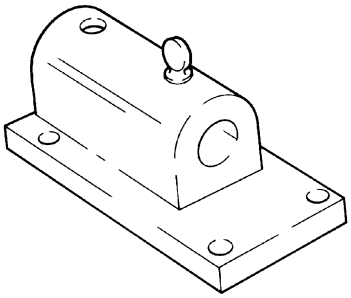
TOOL	DESCRIPTION
J-39084	Rear Main Seal Installer (6.5 L Only)
J-39083	Glow Plug Connector (Remover/Installer)
J-33042	Static Timing Gauge
J-43160	Tech 1 Data Link Connector Adapter
J-33043-2	Gauge Block, Throttle Position Sensor
5735122	Diesel Timing Gauge



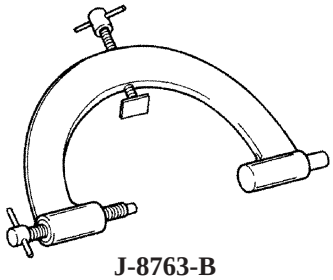
J-38655



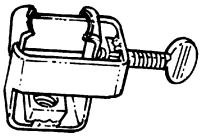
J-23327



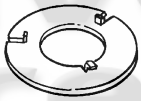
J-03289-20



J-8763-B



J-38868-A



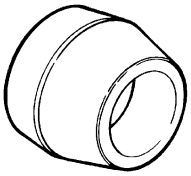
J-25018-A

J-23093

S01-012.2

SPECIAL TOOLS, TRANSMISSION

TOOL	DESCRIPTION
J-38655	Adapter, Transmission Holding Fixture
J-23327	Clutch Spring Compressor
J-03289-20	Transmission Holding Fixture Base
J-8763-B	Holding Fixture
J-38868-A	Installer/Remover, Gear Unit Assembly
J-25018-A	Clutch Spring Compressor Adapter
J-23093	Center Support Tool



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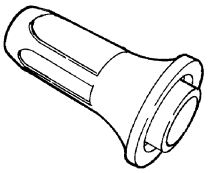
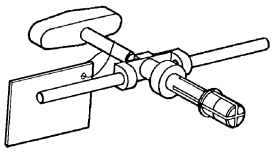


J-41505



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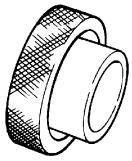

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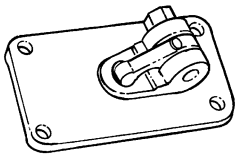

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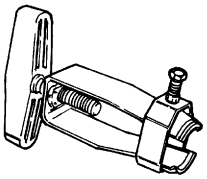
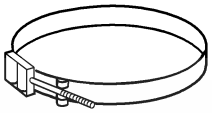
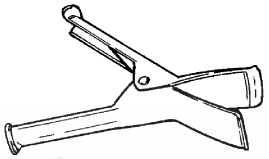


J-37789-A



J-21368-A



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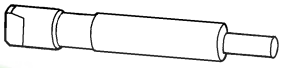
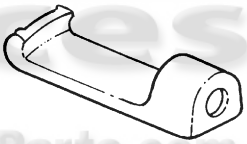


J-21370-10



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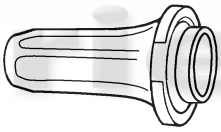
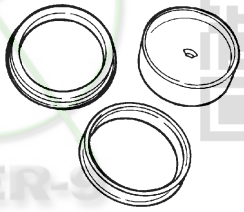


J-38694

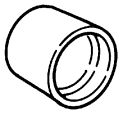


J-38731

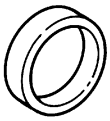
S01-058.2

SPECIAL TOOLS, TRANSMISSION (CONT'D)

TOOL	DESCRIPTION
J-38729	Seal Protector, Overrun Clutch Piston
J-41505	Seal Installer, Rear Lube
J-39195	Tool, Converter End-Play
J-38695	Snapring Placer, Direct Clutch Spiral
J-38737	Band, Apply Pin Checking Tool
J-37789-A	Pump Remover
J-21368-A	Alignment Band, Pump Body and Cover
J-38358	Remover/Installer, Forward Clutch Assembly
J-21370-10	Band (To Apply Pin Gauge)
J-23129	Remover, Seal
J-38694	Seal Installer, Oil Pump and Rear Extension Housing
J-38371	Protector/Spacer, Fourth Clutch Piston and Housing Seal



J-21363



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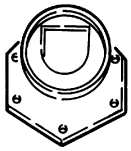
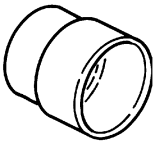
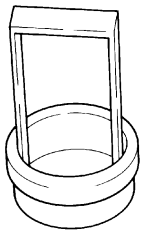
J-21364-A



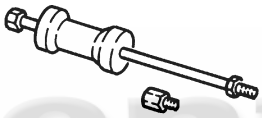
J-06116-A



J-21362



J-24396



J-6125-B

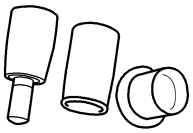
J-8092

S01-059.2

SPECIAL TOOLS, TRANSMISSION (CONT'D)

TOOL	DESCRIPTION
J-21363	Center Seal Protector
5740777	Outer Seal Protector
J-21364-A	Gear Unit Fixture Adapter
J-06116-A	Rear Gear Holding Fixture
J-21362	Inner Seal Protector
J-24396	Intermediate Clutch Alignment Tool
J-6125-B	Slide Hammer, Set of 2
J-8092	Drive Handle

J-38734



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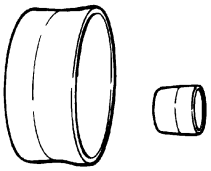

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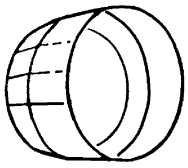
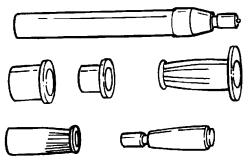


J-21409



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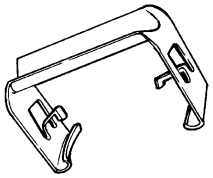

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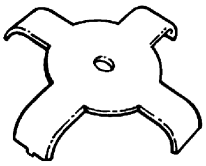
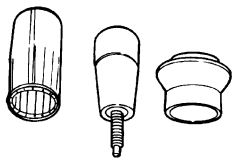


J-38882

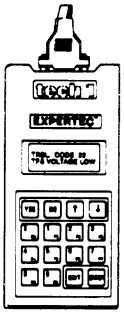


J-38735

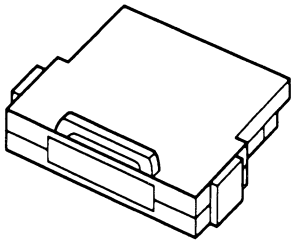
J-28585

SPECIAL TOOLS, TRANSMISSION (CONT'D)

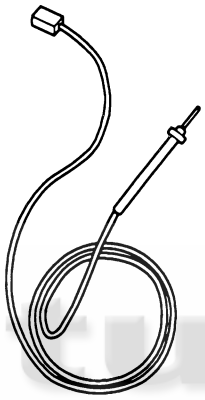
TOOL	DESCRIPTION
J-38734	Adapter, Intermediate Clutch Piston Compressor
J-38739	Installer/Sizer/Pusher, Oil Pump Assembly Seal Ring
J-38732	Protector, Direct and Forward Clutch Piston and Seal, Outer
J-21409	Protector, Direct and Forward Clutch Piston and Seal, Inner
J-38736	Installer/Sizer/Pusher, Center Support Seal
J-38733	Adapter, Fourth Clutch Spring and Retainer Assembly
J-38882	Remove/Installer, Direct Clutch Assembly
J-38735	Installer/Sizer/Pusher, Turbine Shaft Seal
J-28585	Remover, Snapring



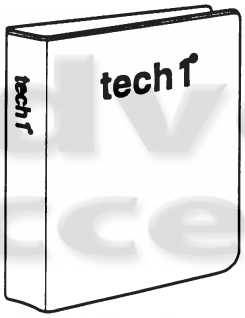
TK-O-AE



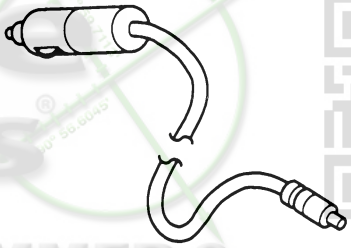
J-42645-B



TM-1152



TM-1189-A

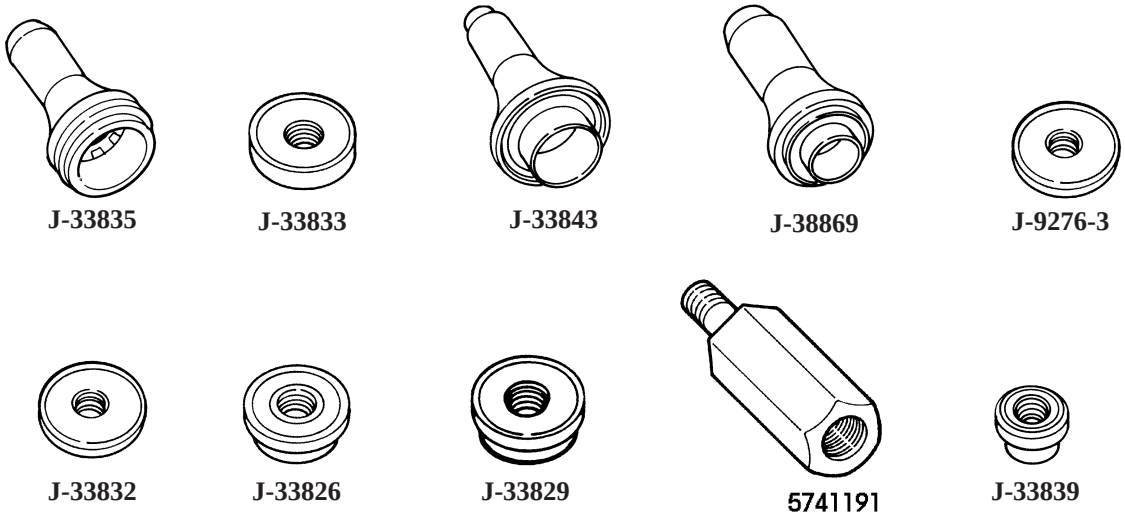


3000053E

S01-023

SPECIAL TOOLS, TRANSMISSION (CONT'D)

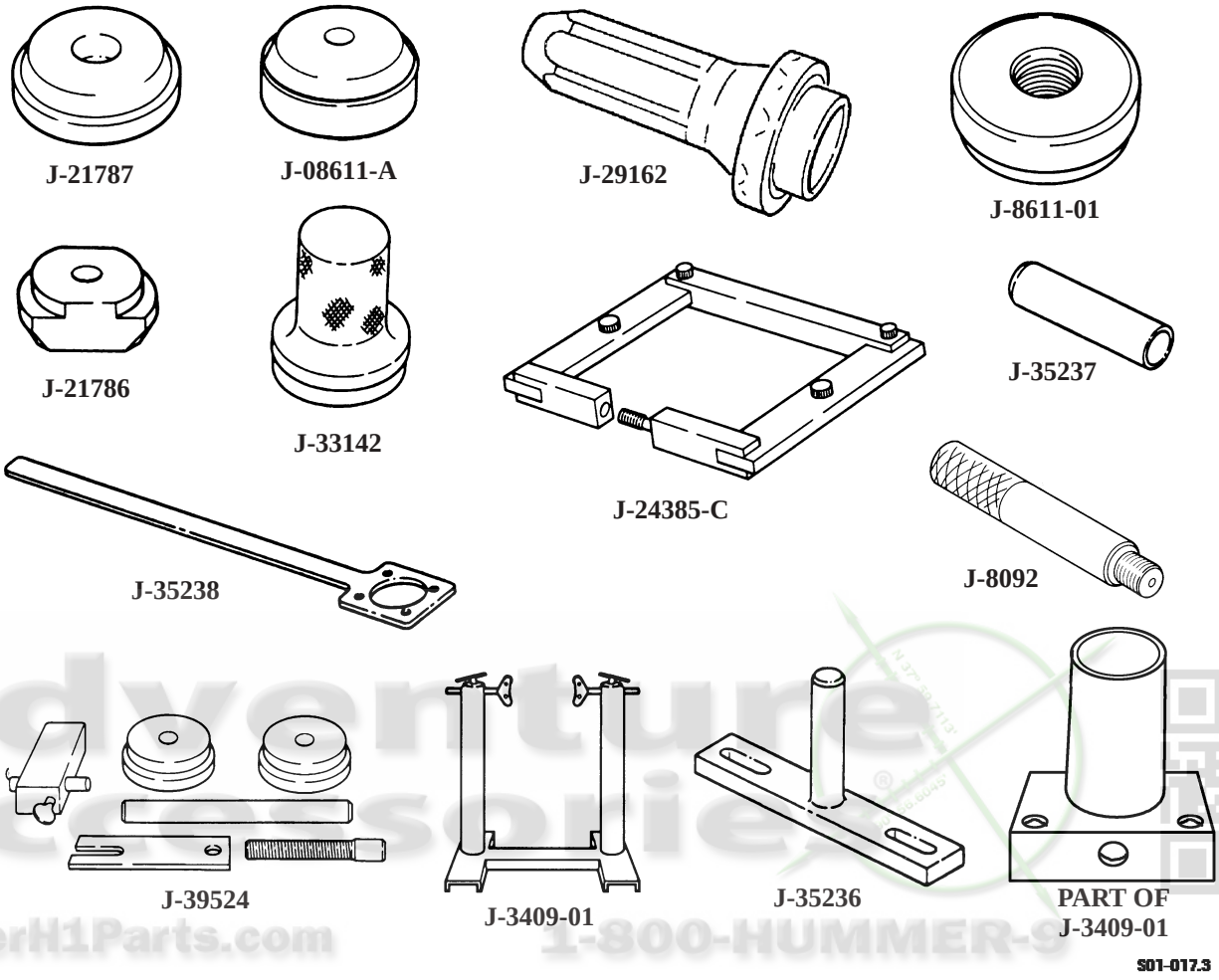
TOOL	DESCRIPTION
TK-O-AE	Tech 1 (Diagnostic Scanner)
J-42645-B	Powertrain Cartridge
TM-1189-A	Operator's Manual (Tech 1)
TM-1152	Test Lead
300053E	DC Power Cable



S01-016.3

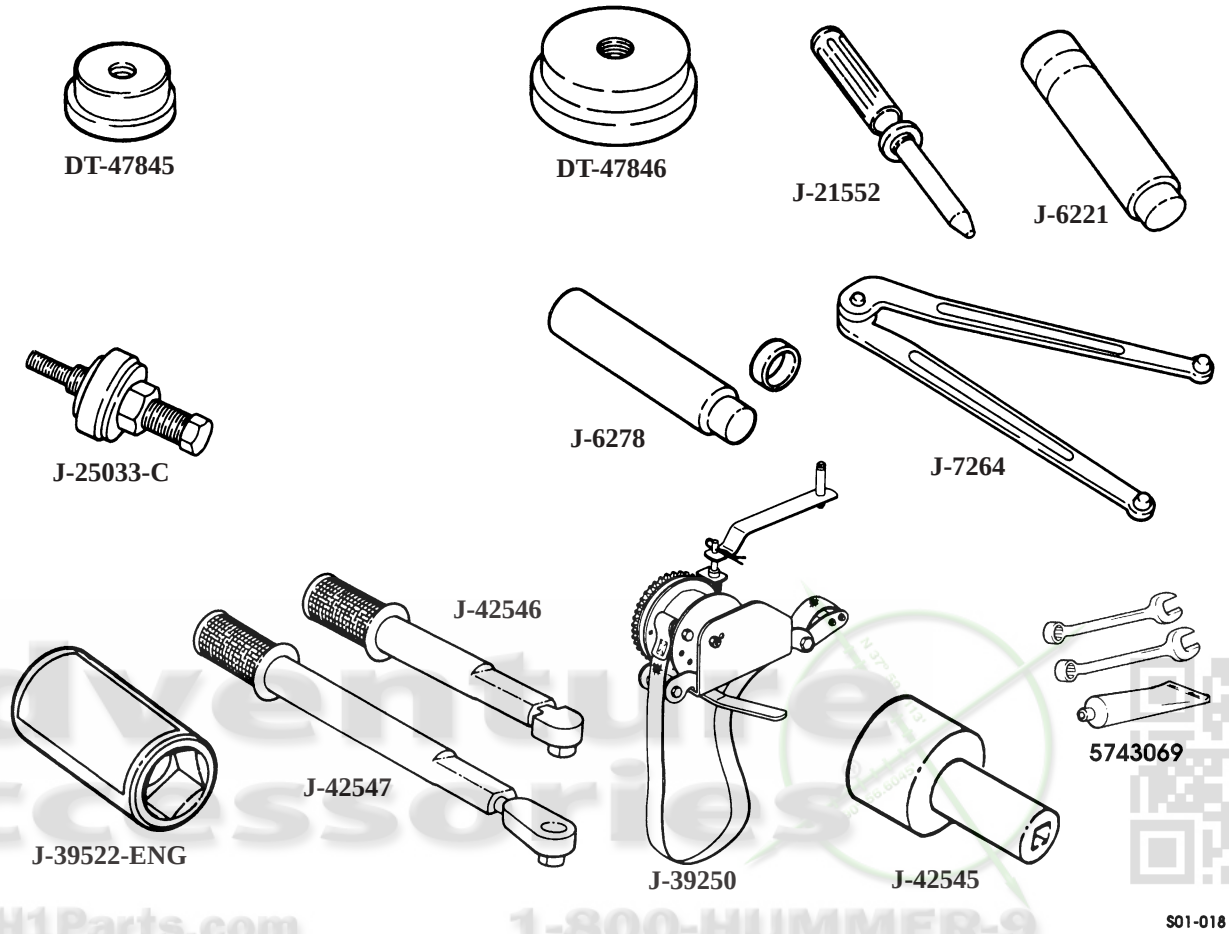
SPECIAL TOOLS, TRANSFER CASE

TOOL	DESCRIPTION
J-33835	Pump Housing Seal Installer
J-33833	Output Shaft Front Bearing Installer
J-33843	Input Gear Seal Installer
J-33869	Output Shaft Seal Installer
J-9276-3	Bearing Cup Tool
J-33832	Output Shaft Rear Bearing Installer
J-33826	Bushing Remover/Bearing Installer
J-33829	Mainshaft Pilot Bearing Installer
5741191	Slide Hammer Adapter
J-33839	Extension Housing Bushing Remover
J-29170	Bearing Tool
J-29369-1	Bearing Remover Set



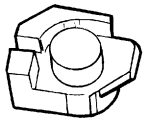
SPECIAL TOOLS, DIFFERENTIAL

TOOL	DESCRIPTION
J-21787	Front Pinion Bearing Cup Remover
J-08611-A	Front Pinion Bearing Cup Installer
J-29162	Yoke Seal Installer
J-8611-01	Rear Pinion Bearing Cup Installer
J-21786	Rear Pinion Bearing Cup Remover
J-33142	Axle Shaft And Seal Installer
J-24385-C	Rear Axle Housing Spreader
J-35237	Bearing Installer
J-35238	Pinion Holding Tool
J-8092	Driver Handle
J-39524	Pinion Gauge Set
J-3409-01	Stand, with Holding Fixtures
J-35236	Flange Holding Tool
c/w J-3409-01	Axle Holding Fixture Adapter (part of J-3409-01)



SPECIAL TOOLS, GEARED HUB, WHEEL/TIRE ASSEMBLY, AND STEERING

TOOL	DESCRIPTION
DT-47845	Input Seal Installer
DT-47846	Spindle Seal Installer
J-21552	Rack Piston Arbor
J-6221	Stub Shaft Bearing Tool
J-25033-C	Power Steering Pump Pulley Installer
J-6278	Pitman Shaft Bearing Installer/Remover
J-7264	Spanner Wrench
J-39522-ENG	Wheel Assembly Socket, 5 Sided
J-42547	Torque Wrench, 1/2 in. Drive, Preset
J-42546	Torque Wrench, 1/4 in. Drive, Preset
J-39520	Runflat Tool
J-42545	Clampnut Socket
5743069	Kit, CTIS Tools



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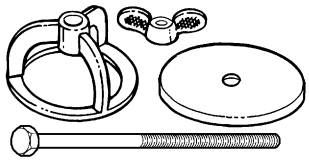

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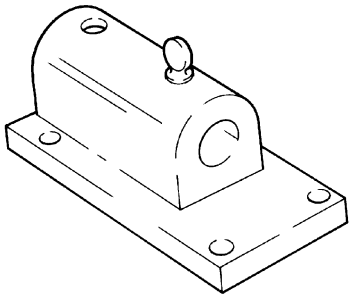

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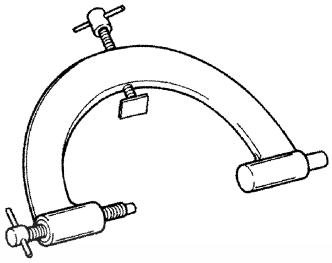

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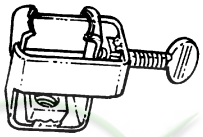

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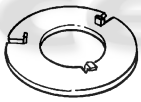

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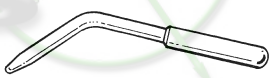

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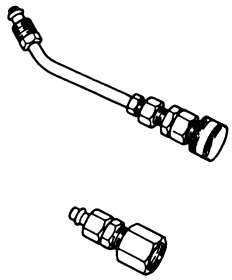
S01-012.2

SPECIAL TOOLS, FUEL INJECTION PUMP, AND INJECTOR

TOOL	DESCRIPTION
5743110	Injection Pump Service Kit
5743111	Face Cam Setting Tool
5743112	Pump Adjusting Tool
5740748	Nozzle, Socket 30 mm
5740757	Pressure Gauge
5735209	Pressure Gauge, Adapter Injection Pump
5743142	Housing Pressure Adapter



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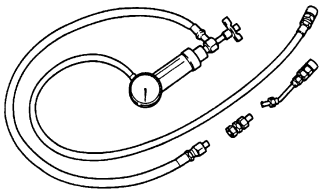

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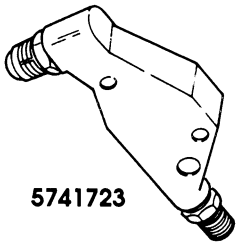

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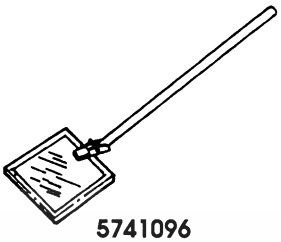

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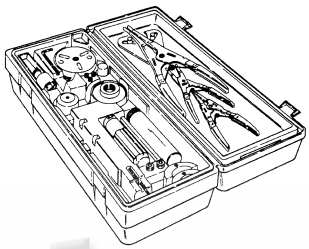

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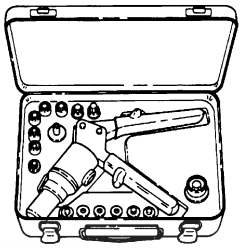

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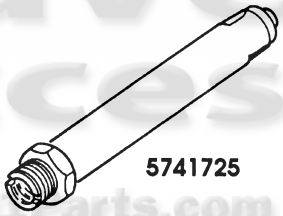

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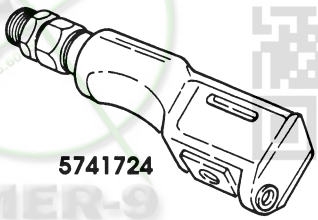

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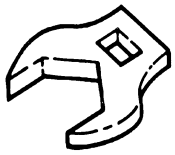
SPECIAL TOOLS, STEERING PUMP, BODY AND SPEEDOMETER DRIVE

TOOL	DESCRIPTION
5740941	Power Adapter
5740813	Analyzer Tool Kit
5741723	Right-Angle Head Puller
5741096	Inspection Mirror
5741725	Straight Head Puller
5741320	Riveter Tool Kit
5743017	Air Conditioner Compressor Tool Kit
5741724	Offset Head Puller



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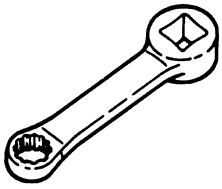

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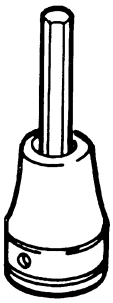

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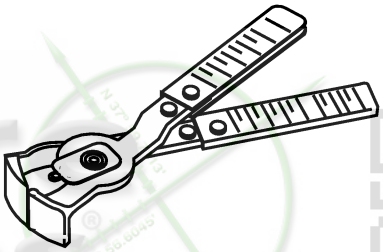
11655788-2

5732210



5743141

S01-020

SPECIAL TOOLS, MULTIPURPOSE

TOOL	DESCRIPTION
5741199	Crowfoot 9/16 in., 3/8 in. Drive
5741198	Crowfoot 11/16 in., 3/8 in. Drive
5741197	Crowfoot 5/8 in., 3/8 in. Drive
5741196	Crowfoot 7/8 in., 3/8 in. Drive
5740989	Crowfoot 1/2 in., 3/8 in. Drive
5741195	Crowfoot 5/16 in., 3/8 in. Drive
5741070	Adapter, Torque Wrench, 9/16 in.
5741071	Adapter, Torque Wrench, 3/4 in.
5741812	Hexagon Head Driver, 3/16 in., 3/8 in. Drive
5742742	Hexagon Head Driver, 7 mm, 3/8 in. Drive
11655788-2	Socket Adapter, 3/8 in. Drive to 1/2 in. Drive
5732210	Torx Socket
5743141	Boot Clamp Pliers

GENERAL REMINDERS

Cover seats and carpet before working inside vehicle.
Using water, immediately clean spilled hydraulic fluid or battery acid from paint.
Never rely on the jack to support the weight of the vehicle. Place jack stands under the vehicle in appropriate locations.
Always have a fire extinguisher nearby when working on fuel/electrical systems.
Plug or cap all fuel, oil, and hydraulic lines immediately after disconnection to prevent fluid loss or contamination.
Disconnect the battery ground cable before working on fuel or electrical components.

Cleaning

Use care in all cleaning operations. Dirt and foreign material are a constant threat to satisfactory vehicle operation.

1. Keep your hands clean and free from grease which can accumulate dirt, dust, and grit.

WARNING: Improper cleaning methods and use of unauthorized cleaning solutions will cause personal injury and damage to equipment.

2. Clean all parts before inspection, after repair, and before assembly.
3. After cleaning, all parts must be covered or wrapped to protect them from dust and/or dirt.
4. All parts subject to rust must be lightly oiled and covered.
5. Keep all related parts and components together. Do not mix parts.

WARNING: Compressed air used for cleaning shall not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles, shield, gloves, etc.).

Particular attention must be given to all oil passages in castings and machined parts. Oil passages must be clean and free of any obstructions. Clean passages with wire probes, then flush with solvent. Dry with compressed air.

CAUTION: *Do not allow solvents to come in contact with seals, cables, or flexible hoses. These cleaners cause leather, rubber, and synthetic materials to dry out, rot, and lose pliability, making them unserviceable. Clean hoses and other nonmetallic parts with soap and water.*

Bearings require special cleaning after removing surface oil and gum deposits. Place bearings in hot oil 140° F (60° C) to loosen congealed oil and grease. Wipe bearings dry with a clean, lint-free cloth. Do not use compressed air.
Clean electrical components with a clean cloth, dampened with cleaning solvent. Be careful not to damage protective insulation. Use compressed air to dry electrical components.

Inspection

Exercise extreme care in all phases of inspection. Dimensional standards for parts have been fixed at very close tolerances, so be sure to use specification tables. Use specified inspection equipment for inspection where cracks and other damage cannot be spotted visually.
Inspect all ferrous and nonferrous castings for cracks using appropriate method. Particularly check areas around studs, pipe plugs, threaded inserts, and sharp corners. Replace if damaged.
Inspect machined surfaces for nicks, burrs, and raised metal. Mark damaged areas for repair or replacement.
Check all gasket mating surfaces, flanges on housings, and supports for warpage with a straight-edge or surface plate. Inspect mating surfaces for discolorations, which may indicate leakage.
Check all bushings and bearings for secure fit, evidence of heating, wear, burrs, nicks, and out-of-round condition.
When inspecting gears, look for the following:

1. Missing, cracked, worn, burred, or pitted gear teeth.
2. Worn, burred, or pitted splines.
3. Worn or damaged keyway slots.

Repair

Repair of most parts and components is limited to general procedures outlined in this service manual and the following detailed instructions:

1. Replace all cracked castings.
2. Repair damaged threaded pipe plug and/or capscrew holes with a thread tap. Repair oversize holes with threaded inserts.

NOTE: Replacement studs have a special coating and must have a small amount of antiseize compound applied before installation.

3. Replace all bent or stretched studs. Repair minor damage with a thread-restorer file.
4. Repair of drive gears should be limited to removal of minor nicks, burrs, or scratches on gear teeth. If keyways are worn or enlarged, replace gear.
5. Remove oil seals, being careful not to damage casting or adapter bore. Always install new seal using proper seal replacing tool.

Assembly

Cleanliness is essential in all component assembly operations. Dirt and dust, even in small amounts, are abrasive. Parts must be cleaned as specified and covered during storage. Coat all bearing and contact surfaces with the assembly working lubricant to ensure lubrication of parts during initial operation.
Ensure new torque nuts and items such as lockwashers, cotter pins, and woodruff keys are used where required in all assembly procedures.

LUBRICATION LOCATIONS AND SCHEDULES

NOTE: All lubrication intervals are based on normal operations.

Service intervals may be shortened if lubricants are contaminated, or if the equipment is operated under adverse conditions. Refer to Table Fluid/Lubricant Capacities and Recommended Temperatures on page 1–33 for fluid/lubricant capacities and recommended temperatures.

For Operation of Equipment in Protracted Cold Temperatures Below -15° F (-26° C)

Remove lubricants prescribed in table 1-3 for temperatures above -15° F (-26° C). Relubricate with lubricants specified in key for temperatures below -15° F (-26° C). Use the correct lubricant as required to meet the temperature ranges prescribed in the key.

Crankcase

NOTE: If oil level is above "FULL," it may be due to oil cooler drain-back. Operate the engine for one minute, shut it down, wait one minute, and recheck oil level (Figure 1-11).

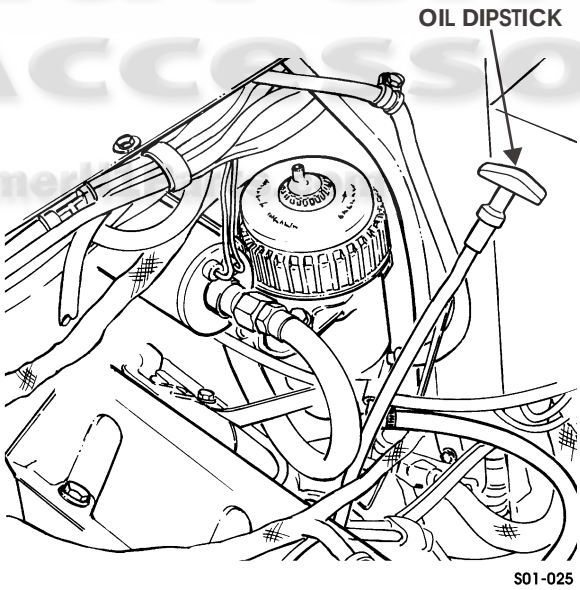


Figure 1-11: Engine Oil Dipstick

Replace oil filter each time crankcase is drained (Figure 1-12). Fill crankcase with 8 qt (7.6 L) of engine oil. Crankcase capacity is 7 qt (6.6 L) and oil filter capacity is 1 qt (0.95 L).
Oil is added to crankcase through the fill tube which is located on top of engine (Figure 1-13).

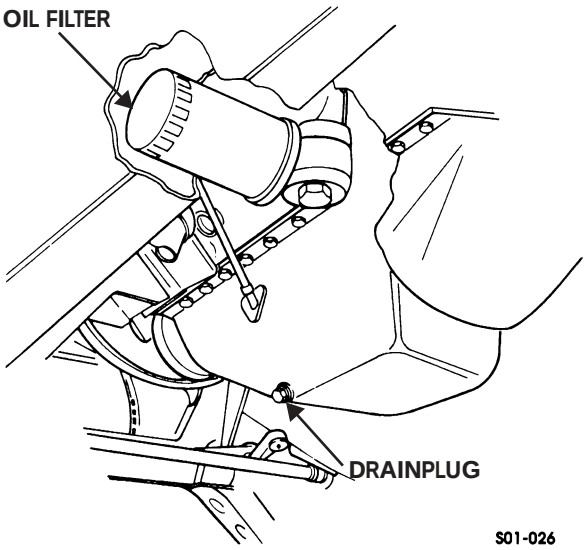


Figure 1-12: Engine Oil Filter

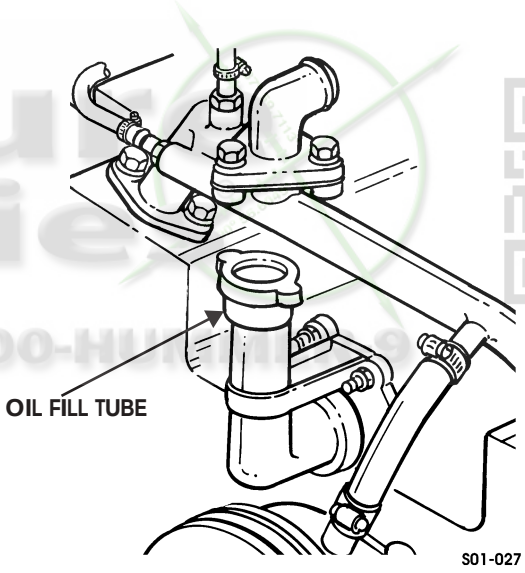


Figure 1-13: Engine Oil Fill Tube

Check crankcase oil level at each fuel fill. Start engine and visually check for oil leaks at drainplug and oil filter. Stop engine and allow approximately one minute for oil to drain back into oil pan, then recheck oil level with dipstick. Change oil every 3,000 mi (4 800 km), or semiannually, whichever occurs first.

Engine Oil Filter

Change oil filter every 3,000 mi (4 800 km), or semiannually, whichever occurs first.

Fuel Filter

Replace filter element every 6,000 mi (9 600 km), or annually, whichever occurs first (Figure 1-14).

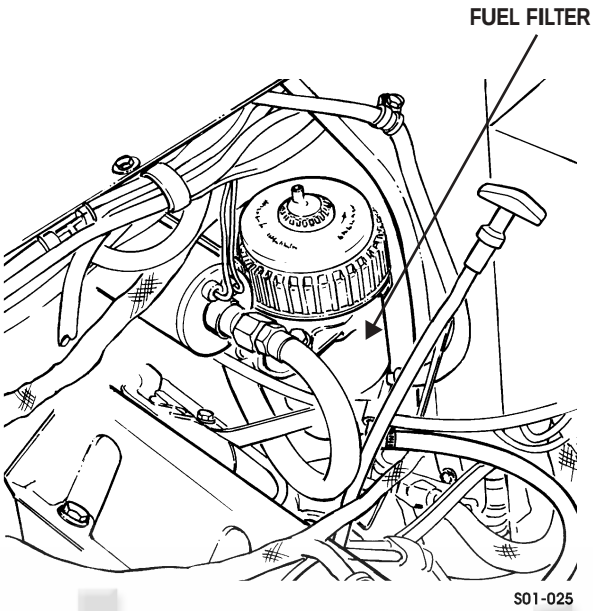


Figure 1-14: Fuel Filter

Transmission

***CAUTION**: Do not overfill transmission. The fluid level rises as the fluid temperature increases; therefore, do not check level before the transmission has reached normal operating temperature. The safe operating level is within the crosshatch marks on the dipstick. Overfilling will result in damage to the transmission. Use Dexron® III for filling transmission. Failure to do so will cause damage to the transmission.*

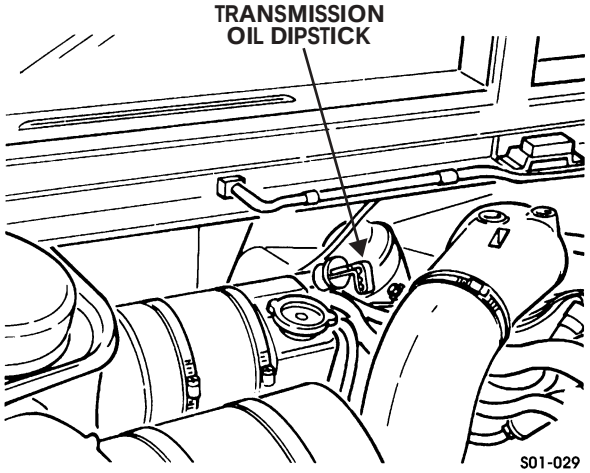


Figure 1-15: Transmission Dipstick

NOTE: Replace transmission oil filter each time transmission is drained. Fill transmission with 7.7 qt (7.3 L) of Dexron® III.

Weekly, check and fill transmission to proper level. Operate transmission through all operating ranges to fill cavities and fluid passages. With vehicle positioned on level ground, allow engine to idle, shift transmission to neutral, and apply parking brake. Check fluid level on dipstick. Level should register within the crosshatch marks under the conditions as stated in the caution. Change fluid every 12,000 mi (19 200 km), or annually, whichever occurs first (Figure 1-15).

Transfer Case

NOTE: Fill transfer case with 7 pt (3 L) of Dexron® III.

Check transfer case fluid level every 3,000 mi (4 800 km), or semiannually, whichever comes first. Remove fill plug and gasket. Level should be within 1/2 in. (12.7 mm) of fill plug opening when vehicle is level. Install fill plug and gasket, and tighten to 35 lb-ft (48 N•m). Change fluid every 12,000 mi (19 000 km) or annually, whichever occurs first (Figure 1-16).

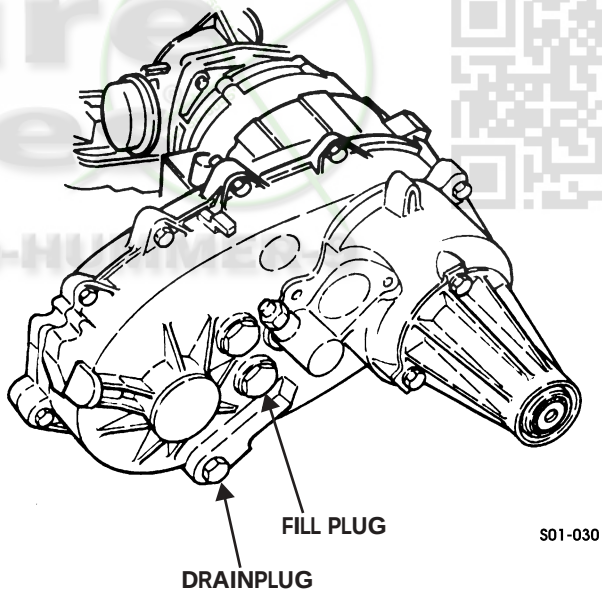


Figure 1-16: Transfer Case

Axle and Geared Hub

Check axle and hub lubricant condition and level every 3,000 mi (4 800 km) or semiannually, whichever occurs first.
Geared hub level should be within 1/2 in. (12.7 mm) of fill plug opening when lubricant is cold, or to plug level when hot.
Axle level should be within 1/4 in. (6.4 mm) of fill plug opening when lubricant is cold, or to plug level when hot (Figures 1-17, and 1-18).
Change axle and hub lubricant when contaminated by water or foreign material.
Use GL-5, SAE 80W-90 or 75W-90 gear lubricant only.

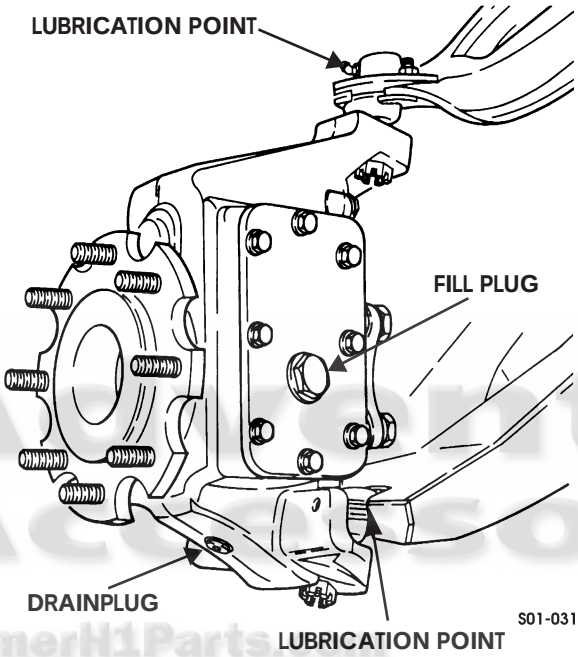


Figure 1-17: Geared Hub Fill/Drain Plug Locations

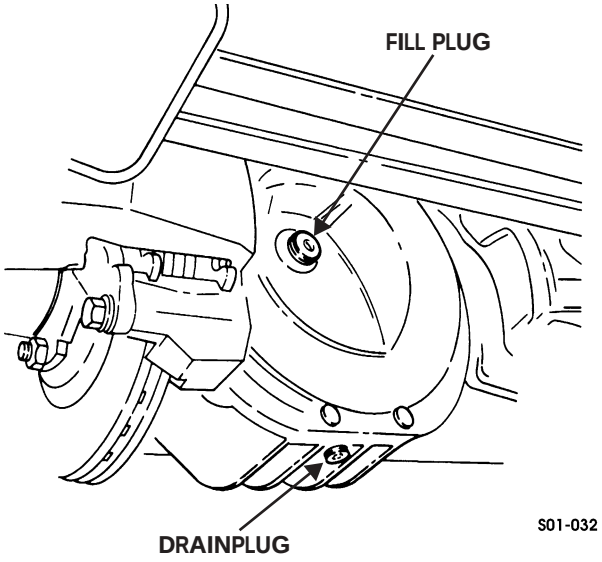


Figure 1-18: Axle Fill/Drain Plug Locations

Universal and Slip Joint Lubrication

Lubricate U-joints with a multipurpose, NLGI-LB grade chassis grease.
Lubricate propeller shaft universal and slip joints every 3,000 mi (4 800 km), or semiannually, whichever occurs first. Use a hand operated or low-pressure air powered lubrication gun. If operating conditions are severe service at 1,000 mi. (1 600 km) intervals.
The rear propeller shaft U-joints have two grease fitting locations (Figure 1-19). The front shaft has four fitting locations (Figure 1-20)

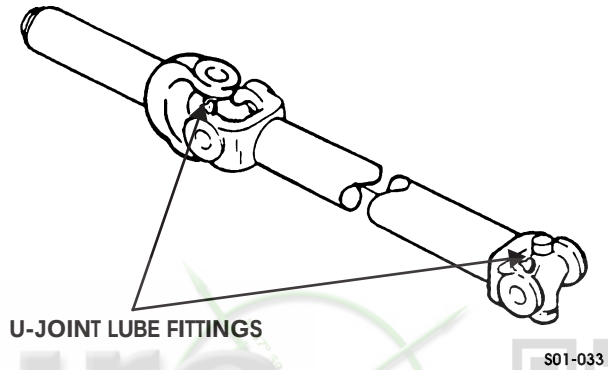


Figure 1-19: Rear Propeller Shaft Lube Points

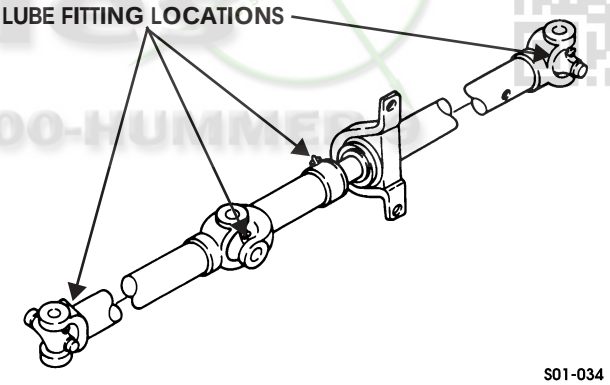
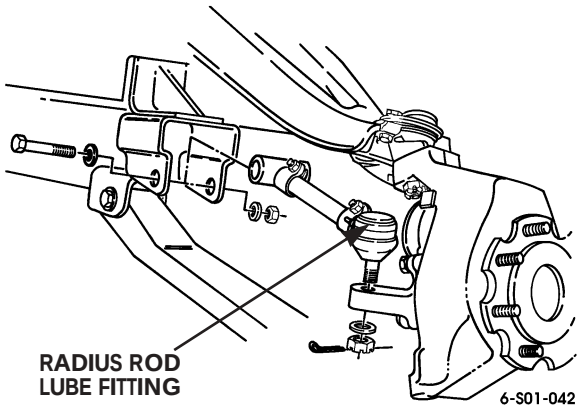


Figure 1-20: Front Propeller Shaft Lube Points

Steering and Suspension Lubrication Points

Lubricate steering and suspension components every 3,000 mi. (4 800 km), or semiannually, whichever occurs first. If operating conditions are severe, service at 1,000 mi. (1 600 km) intervals.



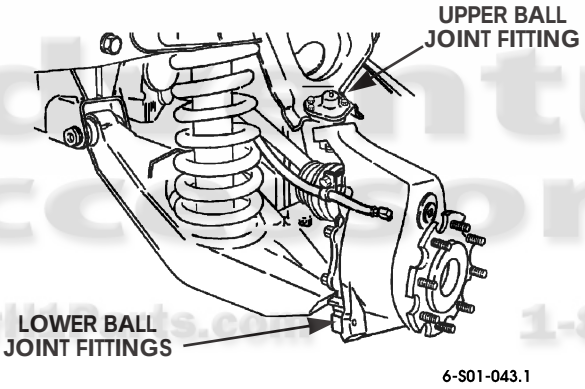


Figure 1-21: Ball Joint/Radius Rod Lube Points

Suspension lube points include the upper and lower ball joints and the rear suspension radius rods (Figure 1-21). Steering lube points include the tie rod ends, idler arm, steering arm, and intermediate steering shaft (Figures 1-22, 1-23, and 1-24). Use a hand operated or low pressure air powered lube gun filled with a multipurpose chassis grease. NLGI-LB classification lubricating grease is recommended.

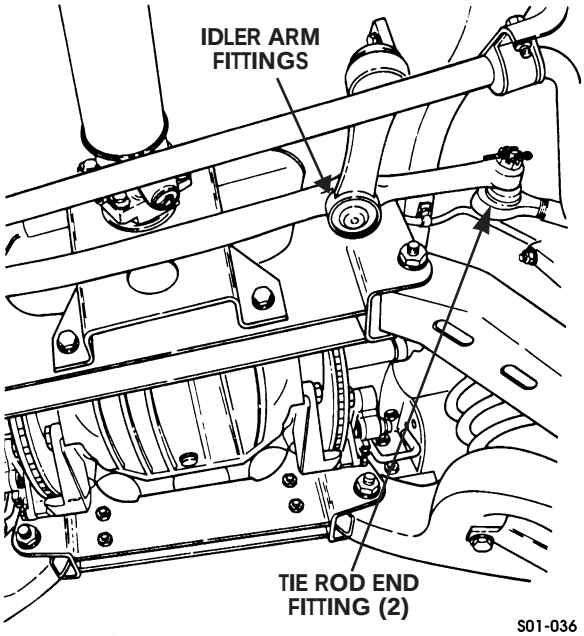


Figure 1-22: Idler Arm and Tie Rod Lube Points

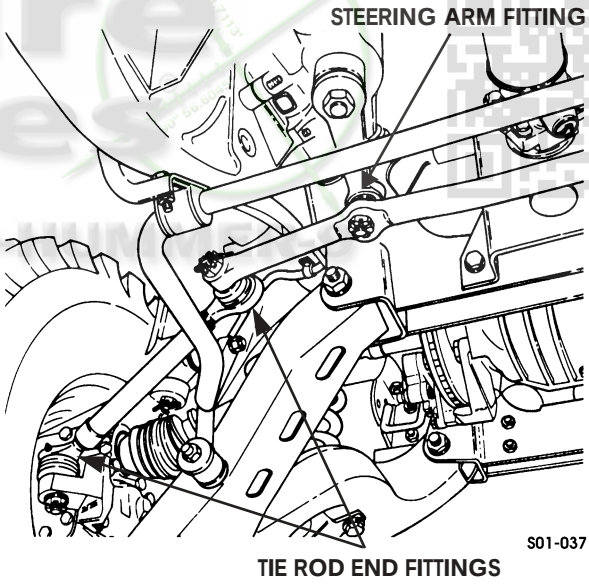


Figure 1-23: Tie Rod and Steering Arm Lube Points

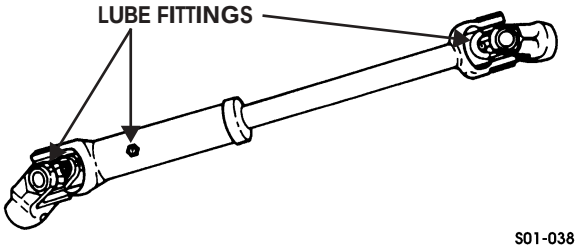


Figure 1-24: Intermediate Steering Shaft Lube Points

Steering Hydraulic System

***CAUTION**: Use Dexron® III for filling power steering reservoir. Failure to use Dexron® III will cause damage to power steering system.*

Check the fluid level in the power steering reservoir monthly and adjust level as necessary. If fluid is hot, level should be between "HOT" and "COLD" marks on the cap indicator. If fluid is cool, level should be between "ADD" and "COLD" marks. In either condition, level must be above "ADD" mark (Figure 1-25).

NOTE: Fluid does not require periodic changing.

The steering system with steering cooler has a 1 qt (0.95 L) capacity.

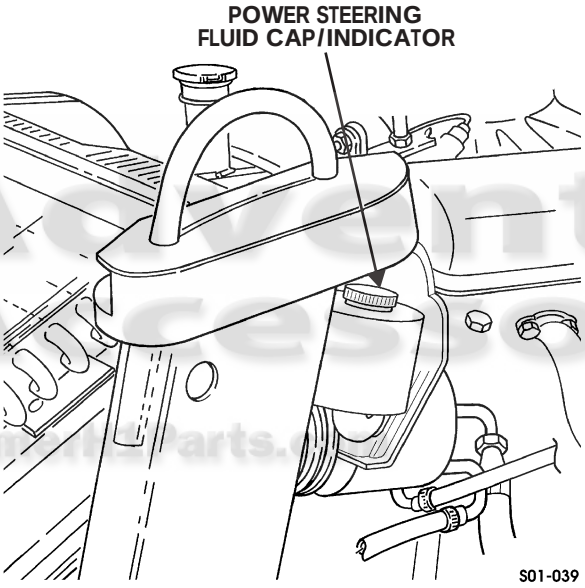


Figure 1-25: Steering Hydraulic System

Cooling System

***CAUTION**: Use the proper antifreeze solution when filling the surge tank. Failure to do so may cause damage to engine.*

Check the fluid level in the surge tank monthly and adjust level as necessary. Level should be at or above the "FULL COLD" line (Figure 1-26).
The cooling system has a 26 qt (25 L) capacity.

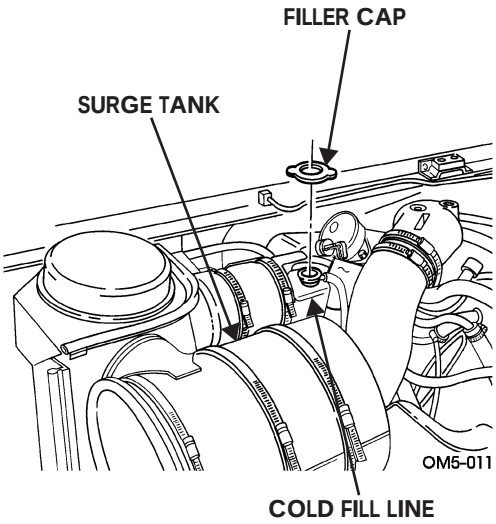


Figure 1-26: Surge Tank

Brake Master Cylinder

***CAUTION**: Use DOT 5 silicone brake fluid for filling brake master cylinder. Failure to use proper fluid may affect brake performance, or cause damage to the brake system.*

NOTE: Fluid does not require periodic changing.

Monthly, check the fluid level in the brake master cylinder. Fill to approximately 1/8 in. (3.2 mm) from top of master cylinder reservoirs (Figure 1-27).

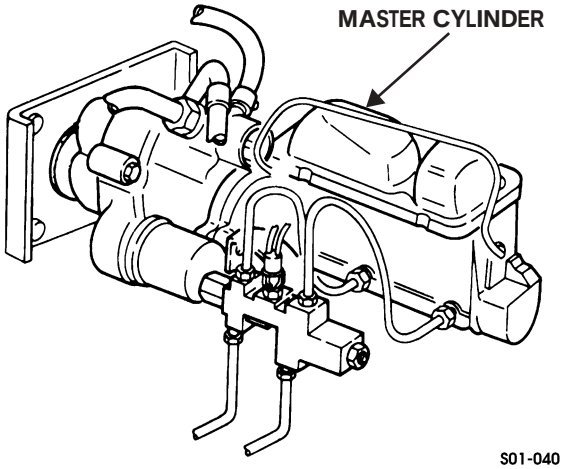


Figure 1-27: Master Cylinder

"Oil Can" Points

Every 3,000 mi (4 800 km), or semiannually, whichever occurs first, perform the following: lubricate hood hinges, hood stops, tailgate hinges, door hinges, door handles, parking brake lever, service brake pedal push rod stud, transfer case shift linkage, and transmission shift linkage with seasonal grade oil (Figure 1-28).

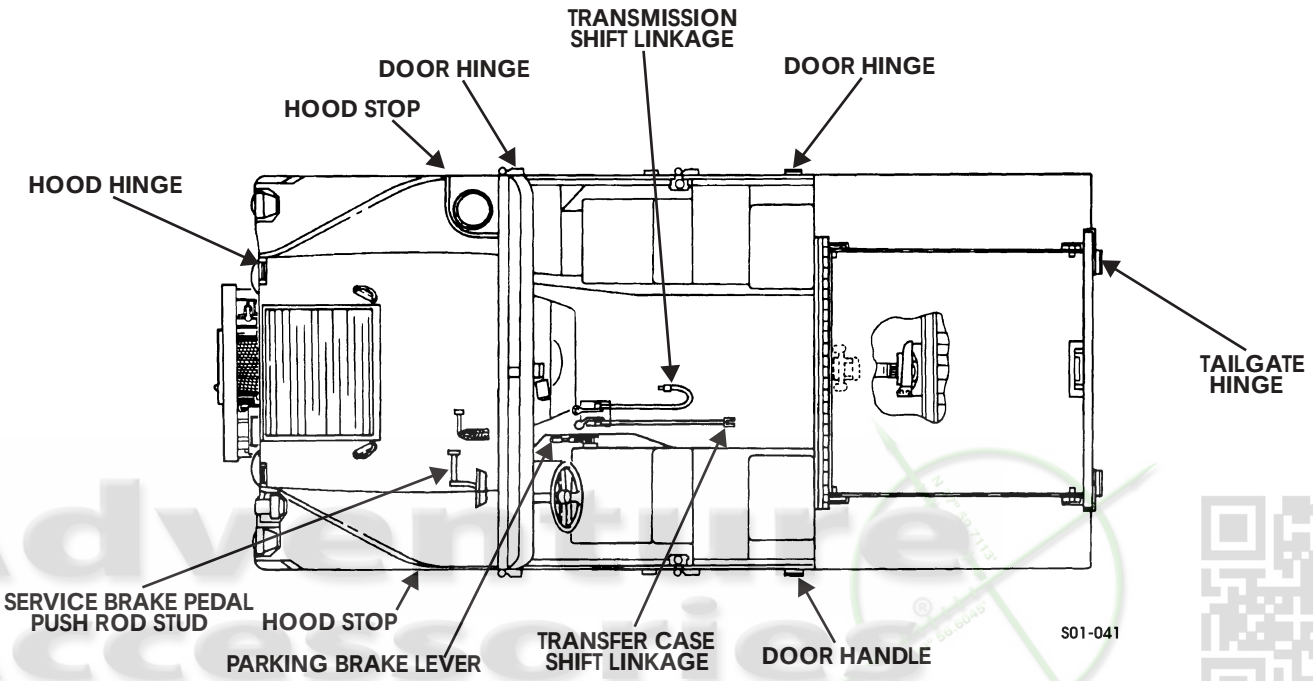


Figure 1-28: "Oil Can" Points

Table 1-3: Fluid/Lubricant Capacities and Recommended Temperatures

USAGE	FLUID/LUBRICANT	CAPACITIES	EXPECTED TEMPERATURE
Engine Oil	SAE 30 SAE 10w-30 SAE 15w-40 SG, CE Preferred	Crankcase: W/O filter 7 qt (6.6 L) W/ filter 8 qt (7.6 L) Dry System 10 qt (9.5 L) (INC.: oil cooler)	Hot ambient Cold ambient Most
Engine Coolant	Mixture of Good Quality Antifreeze (Ethylene Glycol Base) and Water 60% Antifreeze/40% Water	Radiator: 7 qt (6.6 L) Complete System: 26 qt (25 L)	 40° to -65° F (4° to -54° C)
Brake System	DOT 5 Silicone Brake Fluid	Master Cylinder: 0.69 pt (0.33 L) Complete System: 1.2 pt (0.56 L)	All Temperatures
Transmission	Dexron® III	Dry: 13.5 qt (12.8 L) Drain & Refill: 7.7 qt (7.3 L)	All Temperatures

Transfer Case	Dexron® III	7 pt (3 L)	All Temperatures
Steering System	Dexron® III	1 qt (0.95 L)	All Temperature
Geared Hub (4)	Multipurpose Gear Oil, SAE 80w-90	1 pt ea (0.47 L)	All Temperatures
Axles (2)	Multipurpose Gear Oil, SAE 80w-90	2 qt ea (1.9 L)	All Temperatures
Ball Joints, Tie Rod Ends, Pitman Arm, Propeller Shafts, etc.	General Automotive Chassis Grease	As Required	All Temperatures
Hinges, Cables, and Linkages	General Purpose Lubricating Oil	As Required	All Temperatures
A/C System	Refrigerant Oil—Polyalkylene Glycol (PAG) oil R134a	Complete System 8 fl oz (237 ml) System W/O Aux A/C 1 lb (.45 kg) W/ Aux A/C 1.2 lb (.54 kg)	All Temperatures All Temperatures

NOTE: All intervals are based on normal operations.

GENERAL MAINTENANCE INFORMATION

This section explains the maintenance services necessary for proper operation, safety, and performance of the HUMMER. It is very important to perform these services at the proper scheduled interval. In addition to the scheduled maintenance, it is also necessary to perform maintenance at unscheduled intervals. All scheduled and unscheduled intervals may be affected by the type of environment in which the vehicle has been driven. For example, if the vehicle is operated in severe or unusual conditions, more frequent attention should be paid to all servicing requirements.

Operating in Severe Conditions

Operating the HUMMER in severe or unusual conditions, such as fording operations, rough terrain, or on dusty, wet, or muddy surfaces will require more frequent maintenance. The following maintenance should be performed on a daily basis immediately after vehicle operation, or as soon as possible.

1. Using low pressure water, wash all underbody components, including brake components. Inspect all underbody components for general condition and security of mounting.
2. Check all fluids levels. If evidence of contamination is present, drain and replenish fluid and check seals and gaskets for damage.
3. Lubricate all grease fittings and "oil can" points.
4. Clean or replace the air filter assembly and dump valve.
5. After fording, lubricate zerk fitting on accelerator linkage.

RECOMMENDED MAINTENANCE SCHEDULE

NOTE: When performing the recommended maintenance, refer to the appropriate section of this service manual for proper instructions on repair, lubrication, and specifications.

Routine maintenance performed periodically will greatly improve the longevity and reliability of the vehicle. It is very important to perform these services at the recommended intervals. The service intervals may be affected by the type of environment in which the vehicle is operated. For example, operating in mud or sand will require more frequent lubrication and fluid servicing. When performing the following maintenance services, be sure that all necessary replacement parts are installed and that the proper fluid and lubricants are used.

Maintenance "A" consists of the following checks and inspections:

- Check fluid levels of power steering pump, cooling system, brakes, transmission and transfer case.
- Check CDR valve for oil saturation.
- Inspect control arms, springs, and shock absorbers for damage.
- Check tire and runflat wheel balance.
- Check and lubricate all grease fittings and "oil can" points.
- Check geared hubs for leaking seals and damage; check fluid level.
- Check axle for leaking seals and damage; check fluid level.
- Check wheel bolt and nut torque.
- Inspect geared hub and axle vent lines for cracks and deterioration.
- Inspect transmission and transfer case vent lines for deterioration.
- Inspect U-joints for free play and missing or damaged grease fittings.
- Inspect transmission and transfer case shift linkages for bends or excessive play.
- Inspect accelerator linkage for bends or excessive play.
- Inspect engine mounts and insulators for poor fit, wear, or damage.

Maintenance "B" consists of the following checks and inspections:

- Inspect fuel injection pump, lines, and fittings for leaks or damage.
- Check and clean batteries.
- Inspect all belts and hoses.
- Inspect exhaust system and shields.
- Inspect and rotate tires.
- Check wheel alignment.
- Inspect halfshaft boots and ball joint seals.
- Inspect steering column, U-joints, tie rods or radius rods, pitman arm, center link, and idler arm for wear or damage.
- Check fuel tank vent line filter.
- Inspect frame rails and crossmembers for cracks, breaks, bends, and missing or loose fasteners.

Maintenance "C" consists of the following checks and inspections:

- Inspect surge tank, radiator and shroud, power steering cooler, and all hoses and fittings for security of mounting, leaks, or damage.
- Inspect fuel tank, lines, and cap.
- Inspect all wiring harnesses for frays, splits, missing insulation, or poor connections.
- Inspect power steering pump, power steering gear, hoses, lines, and fittings for leaks or damage.

WARNING: Perform maintenance on the HUMMER only if you have both the required skill and the necessary tools.

NOTE: Clean all dirt from caps and surrounding areas before opening to check fluids.

3,000 Miles (4 800 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

6,000 Miles (9 600 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”

9,000 Miles (14 400 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

12,000 Miles (19 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Service cooling system/change coolant
❒ Change transmission fluid and transfer case fluid
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”
❒ Perform items in Maintenance “C”

15,000 Miles (24 000 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

18,000 Miles (29 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”

21,000 Miles (33 500 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

24,000 Miles (38 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Service cooling system/change coolant
❒ Change transmission fluid and transfer case fluid
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”
❒ Perform items in Maintenance “C”

27,000 Miles (43 000 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

30,000 Miles (48 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”

33,000 Miles (53 000 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

36,000 Miles (58 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Service cooling system/change coolant
❒ Change transmission fluid and transfer case fluid
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”
❒ Perform items in Maintenance “C”

39,000 Miles (62 500 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

42,000 Miles (67 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”

45,000 Miles (72 000 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

48,000 Miles (77 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Service cooling system/change coolant
❒ Change transmission fluid and transfer case fluid
❒ Perform items in Maintenance “A”
❒ Perform items in Maintenance “B”
❒ Perform items in Maintenance “C”

51,000 Miles (81 000 km)

❒ Change engine oil and replace filter
❒ Perform items in Maintenance “A”

54,000 Miles (85 000 km)

❒ Change engine oil and replace filter
❒ Clean or replace air filter
❒ Replace fuel filter
❒ Perform items in Maintenance “A”

❒ Perform items in Maintenance “B”

UNSCHEDULED MAINTENANCE

Unscheduled maintenance is any maintenance not mentioned in the section called “Recommended Maintenance Schedule” that is necessary to preserve the performance, dependability, and appearance of the HUMMER. Unscheduled maintenance is usually indicated by a change in the handling, performance, or appearance of the vehicle. Prompt action on unscheduled maintenance can save on costly repairs later. The following are some inspections and services that can help detect when unscheduled maintenance is necessary.

While Driving the Vehicle

1. Check to see if the starter engages smoothly.
2. Listen for unusual engine noise at idle, at operating speeds, and under acceleration.
3. Check to see if the transmission shifts smoothly in all speed ranges.
4. Notice if the transfer case shifts smoothly in all gear ranges.
5. Notice any vibrations of the steering wheel while driving at highway speeds. If vibration is noticed, wheel balancing or front end work may be needed. Notice any pulling of the vehicle to either side of the road. This could indicate a tire with low pressure or the need for a wheel alignment.
6. Notice any changes in steering, such as excess sway, difficult turning, or unstable handling. Any of these conditions could indicate a problem with the steering system and should be inspected and repaired immediately.
7. Notice any abnormal sounds or if vehicle pulls to one side while braking. Also, notice any increase in brake pedal travel or if brake pedal is hard to push. Any of these conditions could indicate a problem in the brake system and should be inspected and repaired immediately.
8. Check parking brake operation by bringing vehicle to a full stop, engaging parking brake while transmission is still in D (drive), and letting off service brake. Vehicle should remain stationary. If vehicle moves, adjust parking brake lever.
9. Listen for any changes in the sound of the exhaust system be wary of any exhaust odors. Either of these situations may indicate a leak in the exhaust system.

Dealer/Owner Inspection and Services

The following are vehicle inspections and services that should be performed periodically by the owner of the vehicle or by a qualified technician whenever the vehicle is brought in for service.

1. Check fluid level in power steering pump reservoir and add as necessary.
2. Check fluid level in brake master cylinder reservoir and add as necessary. A low fluid level suggests worn disc brake pads that may need to be serviced.
3. Check alignment of head lamps and adjust as necessary.
4. Inspect all seatbelts for any noticeable damage. Check all attaching hardware for security of mounting. Check all retractors, latch plates, belt buckles, and release buttons for proper operation. Inspect belts for any rips, tears, or signs of wear. If damaged, have authorized service center perform repair immediately.

WARNING: Engage parking brake and apply service brake before performing the following operational check. Also, ensure there is adequate room around the vehicle. Be prepared to turn off ignition if engine starts. If these precautions are not followed, vehicle could move without warning, causing personal injury or damage to equipment.

5. Check operation of neutral safety switch by attempting to start the vehicle in all forward gears and reverse. Vehicle should only start when transmission is in neutral or park positions.
6. Check operation of steering column lock by attempting to turn the key to the LOCK position in each gear range. The key should turn to LOCK only when the gear selector is in the park position. The ignition key should only come out when the gear selector is in the park position.

RAISING AND SUPPORTING THE VEHICLE

WARNING: Hydraulic jacks are used for raising and lowering, and are not used to support vehicle. Never work under vehicle unless wheels are blocked and vehicle is properly supported. Personal injury or damage to equipment may result if vehicle suddenly shifts or moves.

Raising Corner of Vehicle

1. Block wheels.
2. Place jack under lower control arm on corner to be raised (Figure 1-29).
3. Raise vehicle high enough to place jack stand under flat portion of frame rail, and lower the jack until vehicle weight is supported (Figure 1-30).

Lowering Corner of Vehicle

1. Raise vehicle and remove jack stand (Figure 1-29).
2. Lower vehicle.
3. Remove blocks from wheels.

Raising Front of Vehicle

1. Block rear wheels.
2. Center jack under front suspension front crossmember. Use a wood block between jack and crossmember.
3. Raise vehicle high enough to place jack stands under flat portion of frame rails, and lower the jack until vehicle weight is supported (Figure 1-30).

Lowering Front of Vehicle

1. Raise vehicle and remove jack stands (Figure 1-30).
2. Lower vehicle.
3. Remove blocks from rear wheels.

Raising Rear of Vehicle

1. Block front wheels.
2. Center jack under rear suspension rear crossmember. Use a wood block between jack and crossmember (Figure 1-29).
3. Raise vehicle high enough to place jack stands under flat portion of frame rails, and lower the jack until vehicle weight is supported (Figure 1-30).

Lowering Rear of Vehicle

1. Raise vehicle and remove jack stands (Figure 1-29).
2. Lower vehicle.
3. Remove blocks from front wheels.

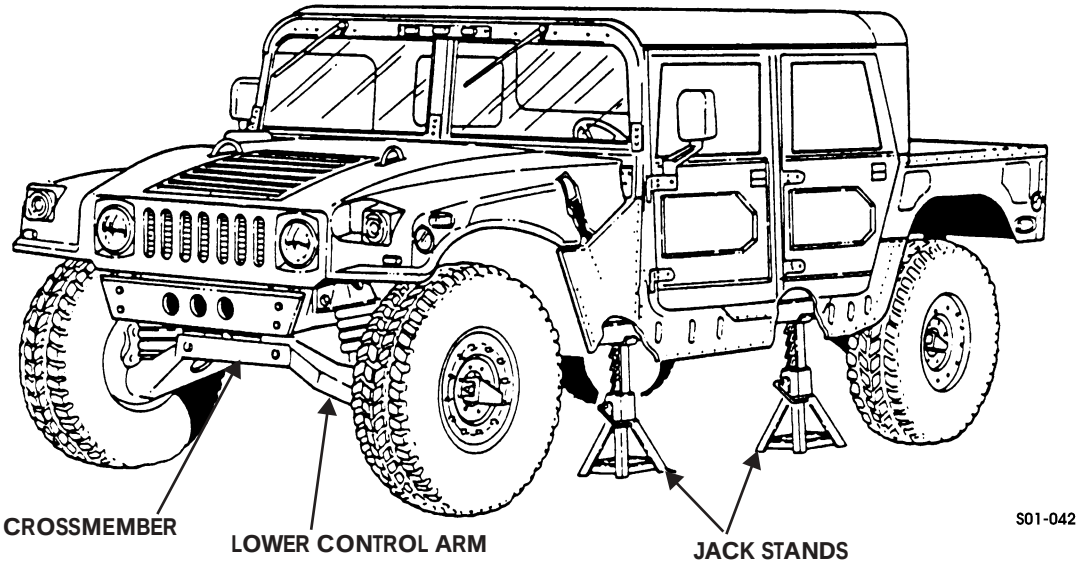


Figure 1-29: Placement of Jack Stands

Raising Entire Vehicle

1. Raise front of vehicle.
2. Center jack under rear suspension rear crossmember. Use a wood block between jack and crossmember (Figure 1-30).
3. Raise vehicle high enough to place jack stands under flat portion of frame rails, and lower the jack until vehicle weight is supported.

Lowering Entire Vehicle

1. Raise rear of vehicle and remove jack stands (Figure 1-30).
2. Lower rear of vehicle and block rear wheels.
3. Lower front of vehicle.

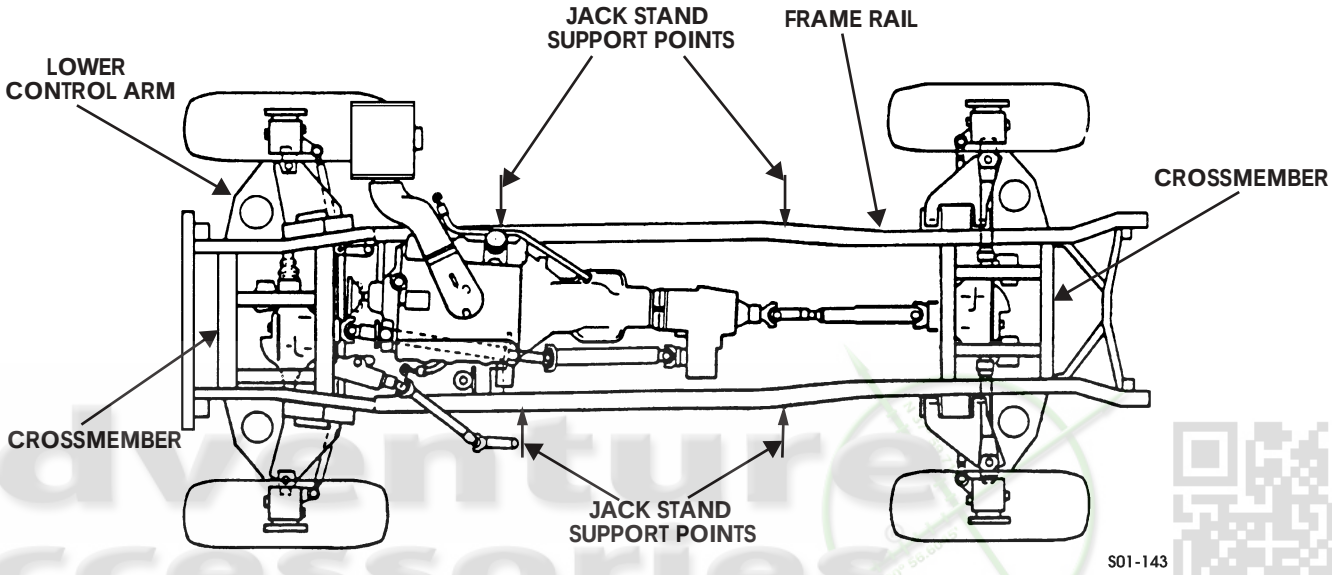


Figure 1-30: Jack Stand Support Points and Frame Overview

TOWING

***CAUTION**: HUMMERS are equipped with full-time, four-wheel drive. Ensure transmission and transfer case are in neutral during all towing operations. Do not exceed a towing speed of 30 mph (48 kph), or a towing distance of 30 mi (48 km), without first removing the front propeller shaft and/or rear propeller shaft as specified in Table1-4. Failure to remove the necessary propeller shafts may result in damage to the transmission and/or transfer case.*

It is recommended that the HUMMER be towed by a vehicle carrier or a wheel lift tow truck. These types of towing are least likely to cause any damage to the vehicle during towing operation. If necessary, however, the vehicle may be towed by a conventional sling tow truck. This section outlines the recommended front and rear lift points and sling towing instructions.

***CAUTION**: If possible, always unload the vehicle before towing to prevent any load movement or shifting. If the vehicle must be towed with a load, ensure the load is properly secured.*

***CAUTION**: Although multiple towing methods exist, always use safety chains and towbars whenever possible to help prevent vehicle damage if the wrecker lifting devices fail.*

Table 1-4

Vehicle Towing Mode	Prop Shafts
Rear wheels up	Front off
Front wheels up	Rear off
Four wheels on ground	Front and rear off

Towing Vehicle From Front (Front Wheels Up)

***CAUTION**: If the vehicle is equipped with tiedown shackles on the front bumper, do not use the shackles as lifting points. The shackles do not provide solid structural lifting points and the vehicle could be damaged.*

NOTE: Ensure the sling assembly is tight against the front bumper of the vehicle before attaching the wrecker chain assemblies.

1. Loop the wrecker chain assembly around both front lower control arms and secure the chain assemblies to the sling assembly (Figure 1-31).
2. Slide a 4 in. x 4 in. x 48 in. wood crossbeam between the underbody of the vehicle and the chain assembly. This will help prevent any damage caused by the chain assembly.
3. If the towing speed is over 30 mph (48 kph), or the towing distance is expected to exceed 30 mi (48 km), remove the rear propeller shaft.

***CAUTION**: Prior to towing the vehicle, ensure transmission and transfer case shift levers are in NEUTRAL. Failure to do this will damage the transmission and transfer case.*

4. Place the transmission and transfer case shift levers in N.

***CAUTION**: Prior to towing the vehicle, ensure the parking brake lever is released. Failure to do this will result in rapid brake wear.*

5. Release the parking brake lever.
6. Proceed with towing operation.

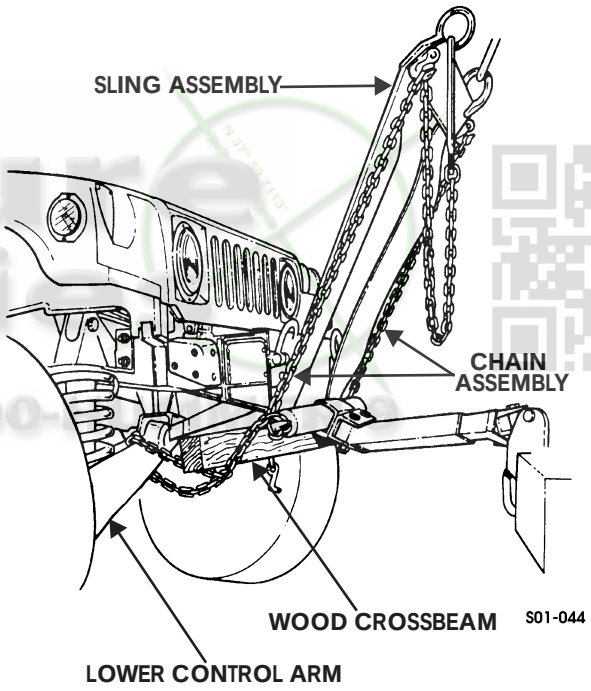


Figure 1-31: Towing From the Front

Towing Vehicle From Rear (Rear Wheels Up)

***CAUTION**: If the vehicle is equipped with tiedown shackles on the rear bumper, do not use the shackles as lifting points. The shackles do not provide solid structural lifting points, and the vehicle could be damaged.*

NOTE: If the vehicle is equipped with a spare tire and wheel assembly mounted to the carrier, remove the spare tire and wheel assembly before attaching towing components.

NOTE: Ensure the sling assembly is tight against the rear bumper of the vehicle before attaching the wrecker chain assemblies.

1. Loop the wrecker chain assemblies around both rear lower control arms and secure the chain assemblies to the sling assembly. If the vehicle is loaded, loop the chain assemblies around the frame rails (Figure 1-32).
2. Slide a 4 in. x 4 in. x 48 in. wood crossbeam between the rear bumper of the vehicle and the chain assemblies. This will help prevent any damage caused by the chain assemblies.
3. If the towing speed is over 30 mph (48 kph), or the towing distance is expected to exceed 30 mi (48 km), remove the front propeller shaft.

***CAUTION**: Prior to towing the vehicle with the rear wheels up, secure the steering wheel to prevent the front wheels from turning. Failure to do this may cause damage to the vehicle.*

4. Secure the steering wheel.

***CAUTION**: Prior to towing the vehicle, ensure transmission and transfer case shift levers are in NEUTRAL. Failure to do this will damage the transmission and transfer case.*

5. Place the transmission and transfer case shift levers in N.

***CAUTION**: Prior to towing the vehicle, ensure the parking brake lever is released. Failure to do so will result in rapid brake wear.*

6. Release the parking brake lever.
7. Proceed with towing operation.

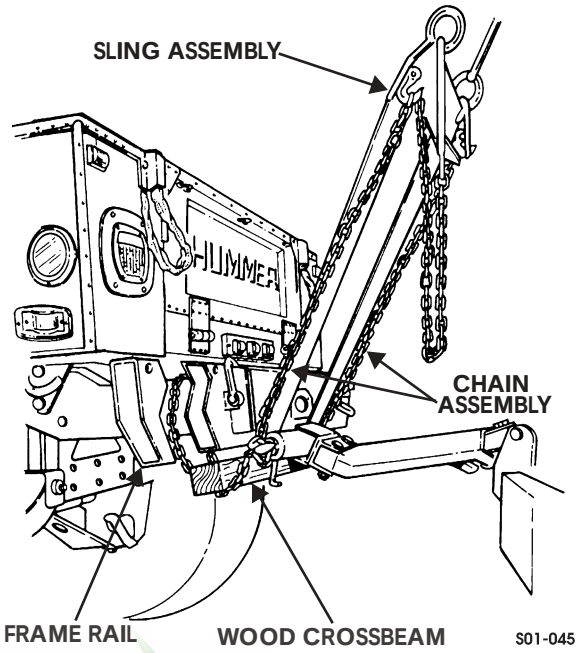


Figure 1-32: Towing From the Rear

JUMP STARTING

WARNING: Batteries emit explosive hydrogen gas. Keep flames or sparks away from batteries. Battery acid is extremely harmful. If acid contacts eyes or skin, flush affected area(s) liberally with clear water and seek medical help immediately. If acid contacts clothing, remove and discard affected clothing. Remove all jewelry before working on vehicle.

1. Set parking brake and place transmission in PARK. Turn off the ignition, lights, and all other electrical loads.

***CAUTION**: When jump starting the vehicle with charging equipment, ensure equipment used is 12-volt and negative ground. Do not use 24-volt charging equipment. Using such equipment can cause serious damage to the electrical system or electronic parts.*

2. Connect one end of the positive (+) jumper cable to the positive (+) battery cable bolt or terminal of the booster battery (Figure 1-33).

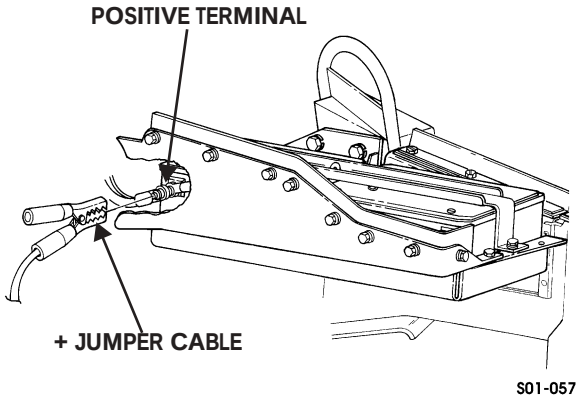


Figure 1-33: Jumper Cable

3. Connect the other end of the positive (+) jumper cable to the positive (+) battery cable bolt or terminal of the discharged battery or power stud.
4. Connect one end of the negative (–) jumper cable to the negative (–) battery cable bolt or terminal of the booster battery.

NOTE: Do not connect jumper cable directly to the negative terminal of the dead battery.

5. Connect the other end of the negative (–) jumper cable to a solid ground (such as the alternator mounting bracket (Figure 1-34).
6. Start the engine of the vehicle that is providing the jump start and turn off electrical accessories. Then start the engine in the vehicle with the discharged battery.
7. Reverse steps 2 through 5 exactly when removing the jumper cables. The negative cable must be disconnected from the engine that was jump started first.

***CAUTION**: If the vehicle fails to start within a maximum time of 12 seconds, turn the ignition off and investigate the cause. Failing to follow this instruction could result in damage to equipment.*

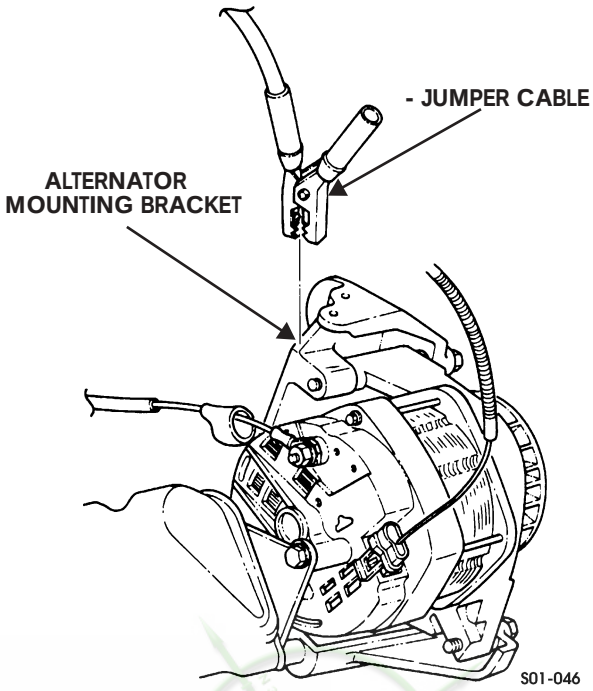


Figure 1-34: Alternator Mounting Bracket

Transporting Vehicle by Trailer

***CAUTION**: Underbody components must not be used as tiedown points.*

NOTE: Any of the four loops located on each frame rail may be used to secure the vehicle to a trailer. Do not use bumper shackles or trailer hitch.

Load vehicle on trailer and secure. Ensure vehicle has parking brake applied, transmission lever is in PARK, and transfer case shift lever is in NEUTRAL (Figure 1-35).

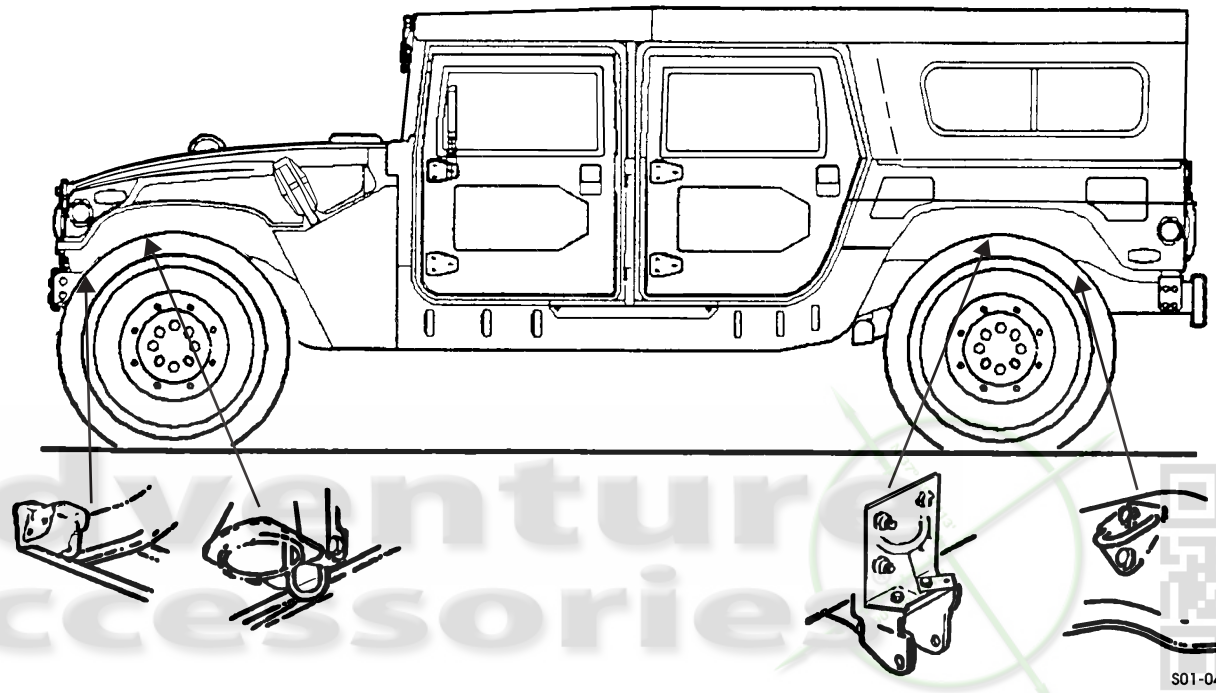


Figure 1-35: Transporting Vehicle By Trailer

ENGINE OIL DIPSTICK TUBE REPLACEMENT

Removal

1. Remove dipstick from dipstick tube (Figure 1-36).
2. Remove nut and lockwasher assembly, capscrew, and harness clamp from upper dipstick tube bracket. Discard nut and lockwasher assembly.
3. Remove two screw-assembled washers and upper dipstick tube bracket from fuel line bracket.
4. Remove socket-head screw, washer, and lower dipstick tube bracket from exhaust manifold.
5. Remove dipstick tube from oil pan. Discard O-ring seal.

Installation

1. Apply silicone sealant to O-ring seal, and install O-ring seal on dipstick tube (Figure 1-36).
2. Position dipstick tube in oil pan.
3. Install lower dipstick tube bracket on exhaust manifold with washer and socket-head screw. Tighten screw to 18-25 lb-ft (24-34 N•m).
4. Install upper dipstick tube bracket on fuel line bracket with two screw-assembled washers. Tighten screw-assembled washers to 3-4 lb-ft (4-5 N•m).
5. Install harness clamp on upper dipstick tube bracket with capscrew and nut and lockwasher assembly.
6. Install dipstick in dipstick tube.
7. Start engine and check for oil leaks.

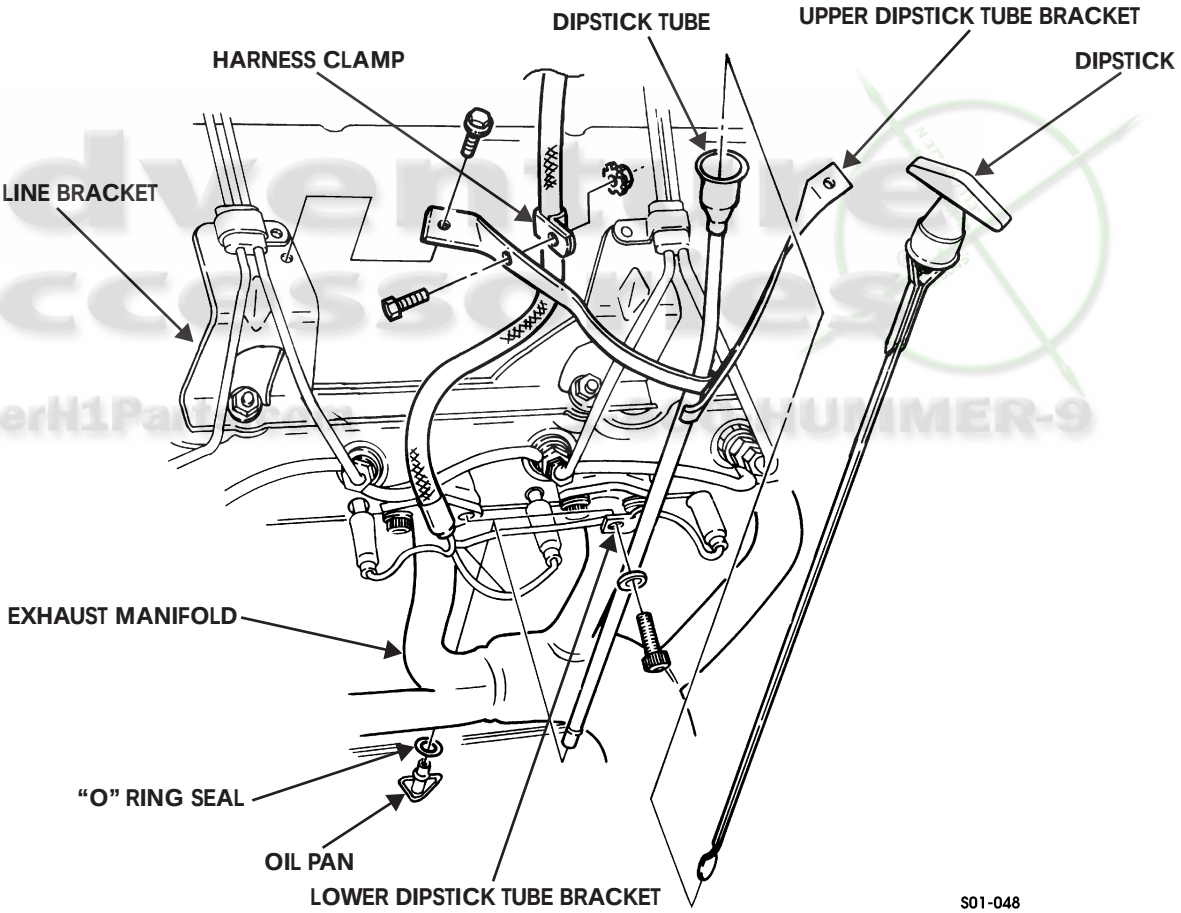


Figure 1-36: Engine Oil Dipstick Tube

ENGINE OIL FILLER TUBE MAINTENANCE

Removal

Remove two nuts, washers, and oil filler tube from timing chain cover (Figure 1-37).

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect grommet for breaks or cracks.

Installation

1. Coat grommet with lubricating oil (Figure 1-37).
2. Install oil filler tube on timing chain cover with two washers and nuts. Tighten nuts to 13-20 lb-ft (18-27 N•m).

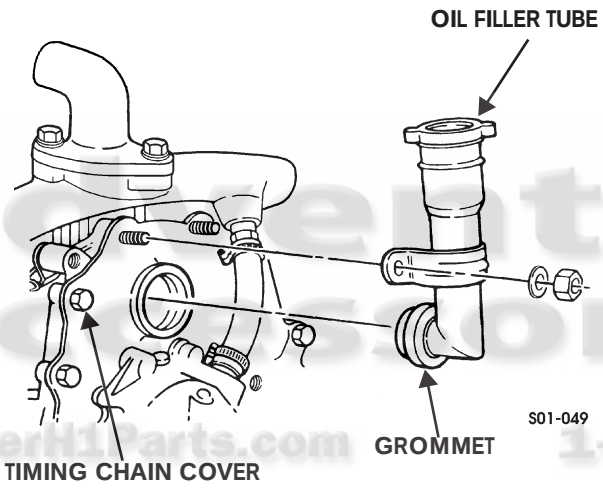


Figure 1-37: Engine Oil Filler Tube

ENGINE OIL FILTER ADAPTER MAINTENANCE

Removal

1. Remove engine oil filter.
2. Remove adapter bolt, gasket, and two O-ring seals securing oil filter adapter to cylinder block. Discard gasket and O-ring seals (Figure 1-38).
3. Remove oil filter adapter and seal. Discard seal.
4. Remove reducer boss from oil filter adapter.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect reducer boss for damaged threads or cracks (Figure 1-38).

Installation

1. Install reducer boss into oil filter adapter. Tighten boss to 25 lb-ft (34 N•m) (Figure 1-38).
2. Install seal and oil filter adapter on cylinder block. Secure with two O-ring seals, gasket, and adapter bolt. Tighten adapter bolt to 50 lb-ft (68 N•m).
3. Install engine oil filter.

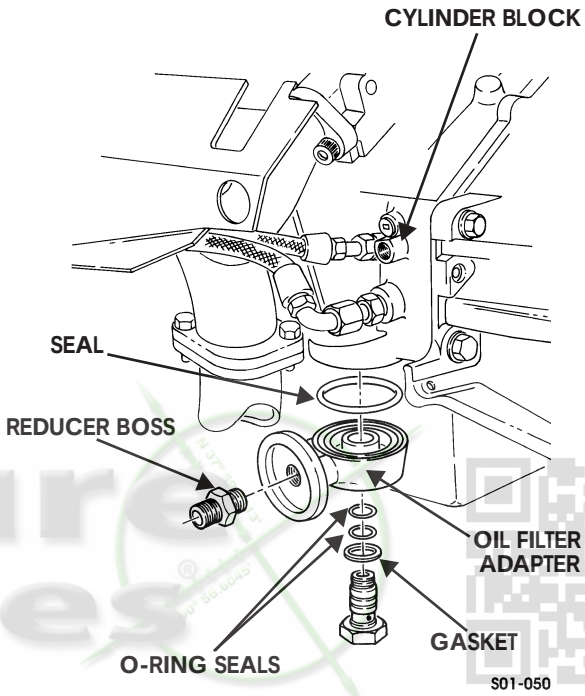


Figure 1-38: Engine Oil Filler Adapter

ENGINE OIL SERVICE

Draining

1. Remove drainplug and gasket from oil pan. Drain oil completely (Figure 1-39).
2. Install gasket and drainplug. Tighten drainplug to 20 lb-ft (27 N•m).

Filter Removal

Remove oil filter from filter adapter. Discard oil filter (Figure 1-39).

Filter Installation

1. Apply a light coat of oil to filter gasket (Figure 1-39).
2. Install oil filter on filter adapter. Tighten by hand until gasket contacts filter adapter. Tighten an additional 1/2 to 3/4 turn by hand.

Replenishing

Fill engine with oil to proper level.

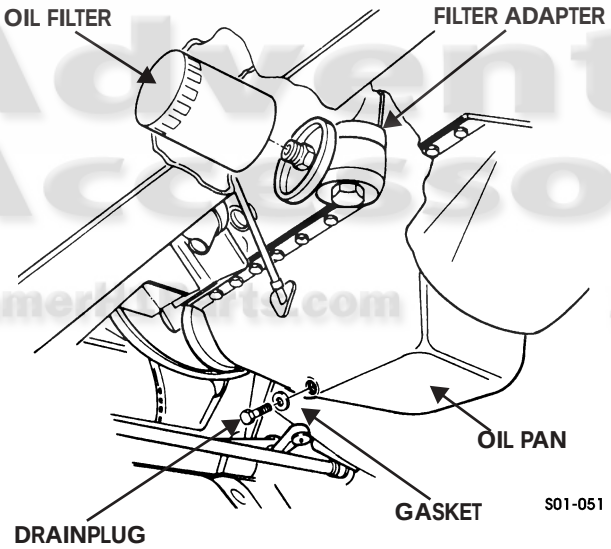


Figure 1-39: Oil Filter

OIL PAN MAINTENANCE

Removal

1. Remove starter (Section 2).
2. Remove oil dipstick tube.
3. Remove torque converter housing cover (Section 5).
4. Drain engine oil.
5. Remove two nut and lockwasher assemblies and starter cable support bracket from studs. Discard nut and lockwasher assemblies (Figure 1-40).

NOTE: Mark location of screws for installation.

6. Remove twenty capscrews, two large capscrews, studs, and oil pan from cylinder block.
7. Remove oil pan rear seal. Discard seal.

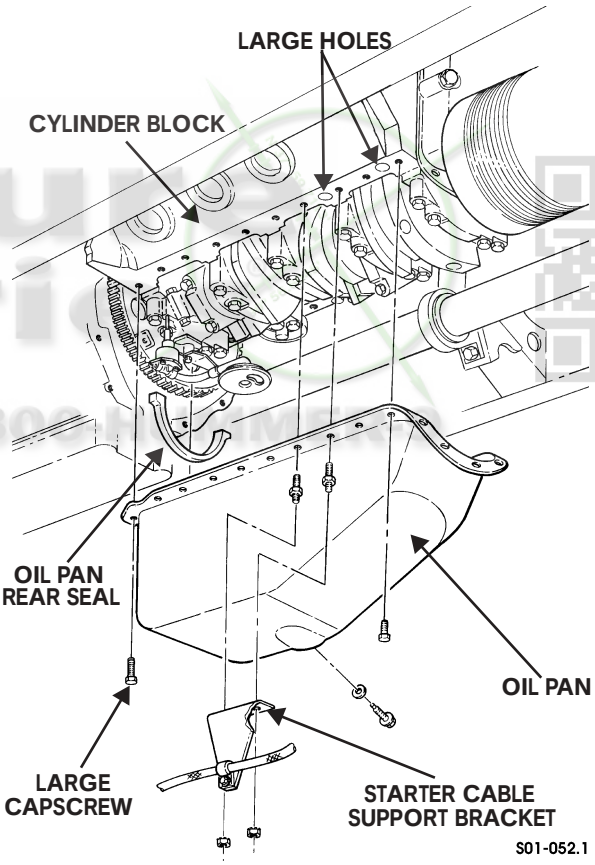


Figure 1-40: Oil Pan

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Clean any sealant remains from oil pan and cylinder block mounting surfaces (Figure 1-40).

Installation

1. Install oil pan rear seal on oil pan (Figure 1-40).

NOTE: Install oil pan immediately after sealant application.

2. Apply a 3/16 in. (5 mm) bead of silicone sealant around two large holes on cylinder block and around oil pan sealing surface (Figures 1-40, and 1-41).
3. Install oil pan on cylinder block with two studs, large capscrews, and twenty capscrews. Tighten large capscrews to 13-20 lb-ft (18-27 N•m). Tighten studs and capscrews 4-10 lb-ft (5-14 N•m) (Figure 1-40).
4. Install starter cable support bracket on studs with two nut and lockwasher assemblies.
5. Install torque converter housing cover (Section 5).
6. Install oil dipstick tube.
7. Install starter (Section 2).
8. Replenish engine oil to proper level.

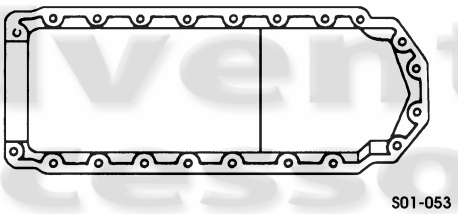


Figure 1-41: Sealant Diagram

ENGINE OIL COOLER SUPPLY AND RETURN LINES MAINTENANCE

Removal

1. Remove engine left splash shield (Section 10).
2. Remove engine access covers.
3. Disconnect supply and return line connectors from adapters. Drain engine oil (Figure 1-42).
4. Disconnect supply and return line connectors from oil cooler ports.
5. Remove locknut, two washers, and capscrew securing supply line, return line, and brake line clamps to frame bracket. Discard locknut.
6. Remove capscrew, lockwasher, and two clamps securing supply and return lines to engine mount bracket. Discard lockwasher.
7. Remove and discard tiedown strap securing supply and return lines.
8. Remove supply and return lines.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect adapters for damaged threads or cracks (Figure 1-42).

Installation

1. Position supply and return lines in approximate mounting location (Figure 1-42).
2. Install supply line, return line, and brake line clamps on frame bracket with washer, capscrew, washer, and locknut. Tighten locknut to 6 lb-ft (8 N•m).
3. Connect supply and return line connectors to oil cooler ports and adapters.
4. Install supply and return lines and two clamps on engine mount bracket with lockwasher and capscrew.
5. Secure supply and return lines with tiedown strap.
6. Install engine left splash shield (Section 10).
7. Fill oil to proper level.
8. Start engine and check for leaks at engine oil cooler supply and return lines.
9. Install engine access covers.

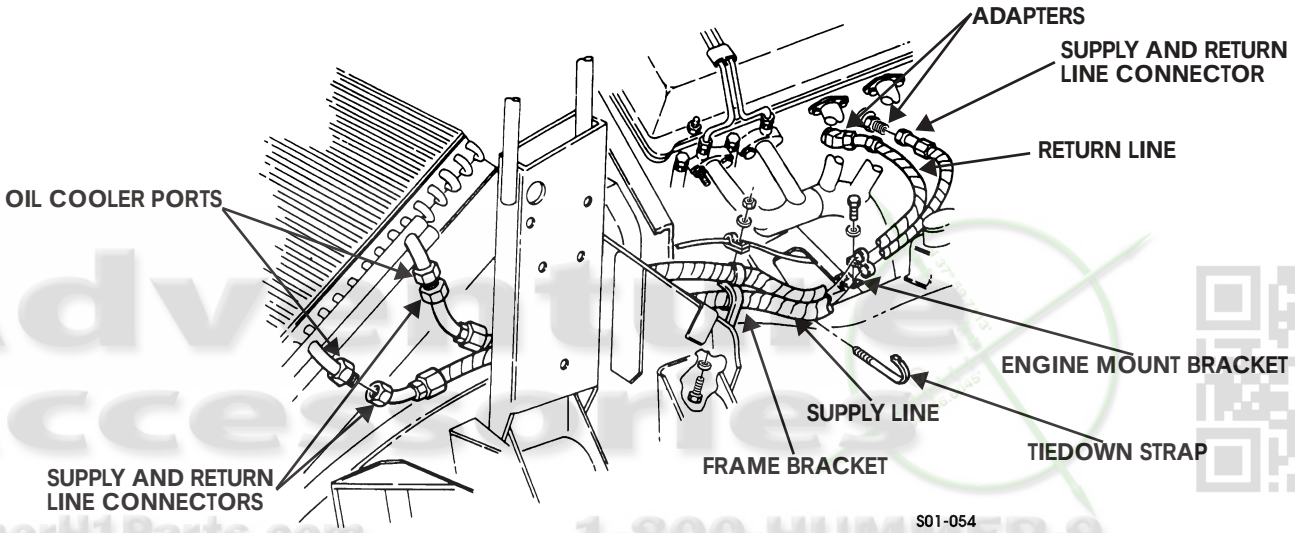


Figure 1-42: Engine Oil Cooler Supply and Return Lines

ENGINE/TRANSMISSION OIL COOLER ASSEMBLY REPLACEMENT

Removal

1. Remove engine left splash shield (Section 10).
2. Remove power steering cooler (Section 8).
3. Disconnect engine oil cooler supply and return lines from oil cooler ports. Drain oil (Figure 1-43).
4. Disconnect transmission oil cooler connector hoses from oil cooler ports.
5. Remove four socket-head screw and washer assemblies, washers, and oil cooler from radiator.

Installation

1. Install oil cooler on radiator with four washers and socket-head screw and washer assemblies (Figure 1-43).
2. Connect transmission oil cooler connector hoses to oil cooler ports.
3. Connect engine oil cooler supply and return lines to oil cooler ports.
4. Install power steering cooler (Section 8).
5. Replenish transmission and engine oils to proper levels.
6. Install engine left splash shield (Section 10).
7. Start engine and check for leaks.

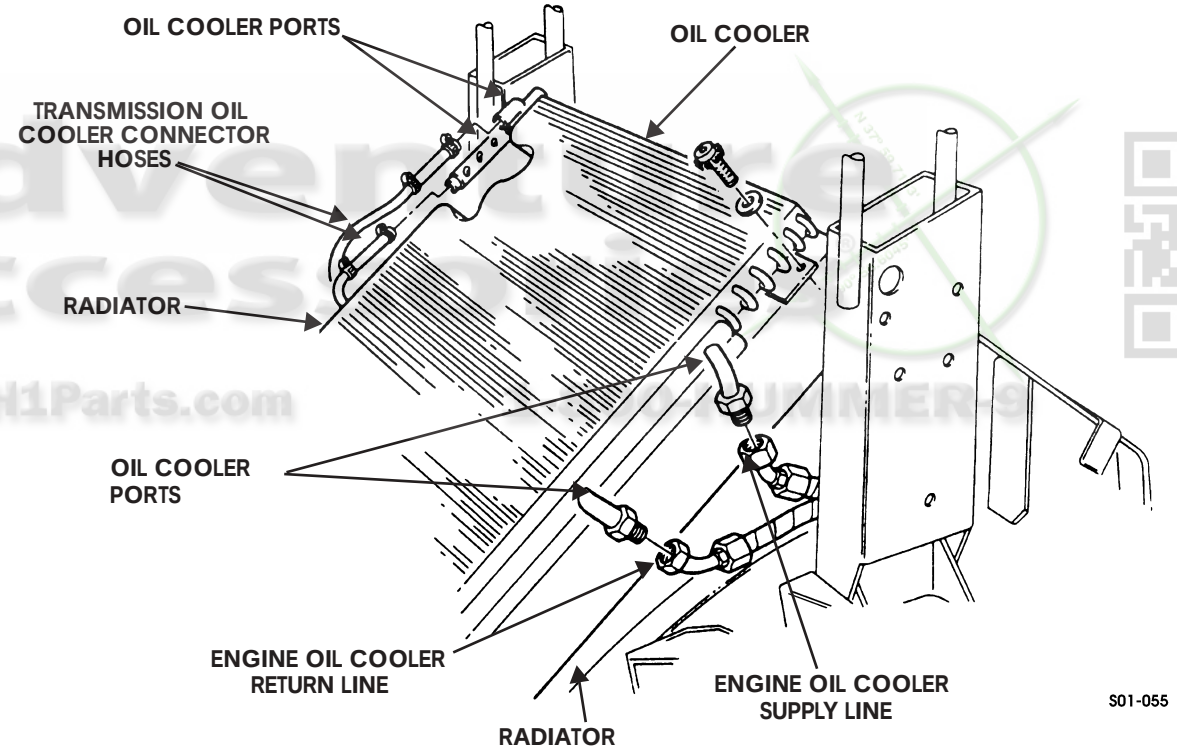


Figure 1-43: Engine/Transmission Oil Cooler Assembly

CRANKCASE DEPRESSION REGULATOR (CDR) VALVE AND HOSE MAINTENANCE

Removal

1. Remove engine access covers.
2. Remove CDR valve from rocker arm cover (Figure 1-44).
3. Remove hose from CDR valve and intake manifold adapter.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect intake manifold adapter for breaks or cracks.

Installation

1. Install hose on intake manifold adapter and CDR valve (Figure 1-44).
2. Install CDR valve on rocker arm cover.
3. Install engine access covers.

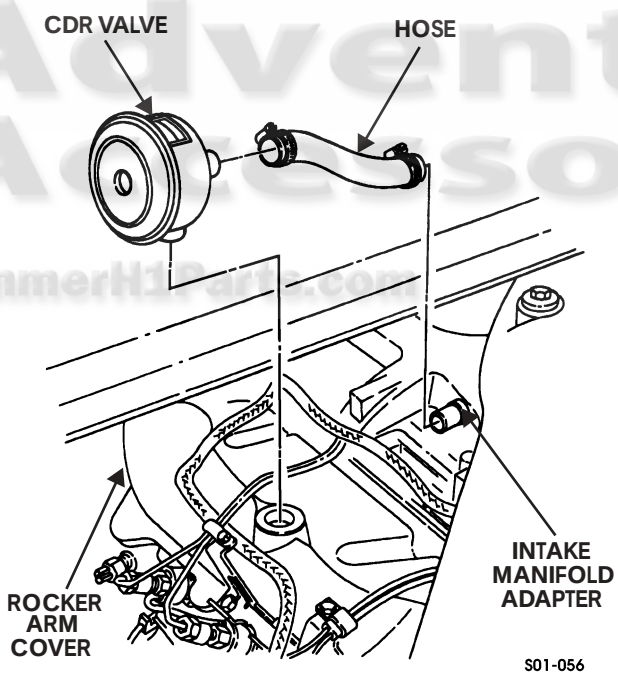


Figure 1-44: Crankcase Depression Regulator Valve

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Section 2 ENGINE

TABLE OF CONTENTS

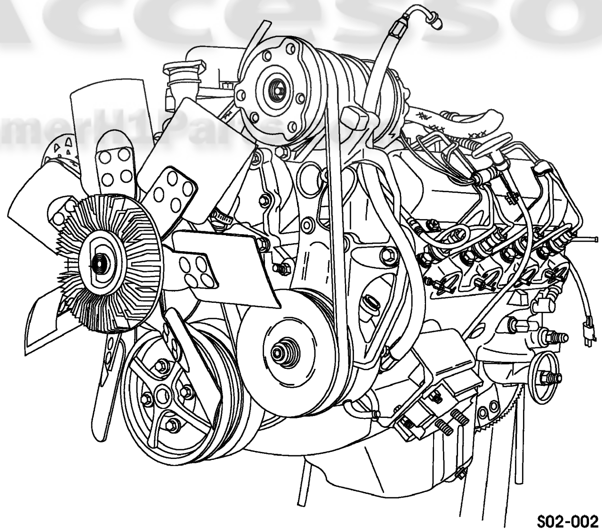
6.5L DIESEL ENGINE OPERATION

Some 1995 HUMMER models are equipped with the 6.5L naturally-aspirated diesel engine (Figure 2-1). A diesel engine can offer many features which are not available with gasoline engines:

- More power at lower engine speeds for increased control
- Greater fuel efficiency
- Less maintenance required (due to compression ignition instead of spark ignition)
- Heavy-duty construction

Unlike gasoline engines which require both compression of the air-fuel mixture and a spark to cause combustion, diesel engines rely solely on high compression to cause combustion. A diesel engine does not require a spark plug to ignite the air-fuel mixture. Air is drawn into the cylinder and is highly compressed. After the piston has completed the compression stroke, diesel fuel is injected into the combustion chamber where it ignites and causes combustion.

Diesel engines use electrically-operated devices called glow plugs to help heat the air-fuel mixture in the pre-combustion chamber. Glow plugs protrude into the precombustion chamber and heat to a dull red when energized. Under most starting conditions the plugs are utilized for a very short period and the engine can be started as soon as the wait-to-start light goes off.



S02-002

Figure 2-1: Diesel Engine

The 4-cycle, liquid-cooled, 6.5L engine provides better fuel economy and is more durable than gasoline-powered engines. It offers 160 hp at 3,400 rpm and delivers 290 lb-ft of torque for greater performance when under a heavy load.

New Environmental Protection Agency (EPA) regulations require emission control devices on diesel engines. The HUMMER's exhaust system was rerouted to allow the addition of a catalytic converter. The fuel injection system on the 6.5L diesel engine precisely controls the fuel, which also reduces emissions.

ENGINE TROUBLESHOOTING

1. ENGINE WILL NOT CRANK
   a. Perform Electrical Troubleshooting (Section 12).
   b. Remove serpentine belt (Section 4).
   c. Remove all glow plugs. Using socket and breaker bar at crankshaft pulley, rotate engine clockwise and check for mechanical or hydraulic seizure.
      (1) If crankshaft will not turn, check for bearing failure.
      (2) If crankshaft turns and liquid is discharged, determine if liquid is coolant or fuel.
      (3) If coolant is discharged, remove cylinder heads and check for cracked cylinder heads or leaking head gaskets.
      (4) If fuel is discharged, remove and test fuel injection nozzles for breaks or leakage.
   d. Remove converter housing cover and check for damaged flywheel. Replace flywheel if damaged.
   e. Check starting system; refer to Electrical Troubleshooting (Section 12).
2. ENGINE CRANKS BUT WILL NOT START
   a. Using tachometer, check engine cranking speed. Ensure speed is 180 rpm minimum.
      (1) If cranking speed is too low, proceed to step b.
      (2) If cranking speed is OK, proceed to step c.
   b. Ensure battery is fully charged and starting circuit connections are connected. Refer to Electrical Troubleshooting (Section 12).

NOTE: Bubbles in fuel stream, and white exhaust smoke seen during cranking may indicate the presence of air in the fuel system.

   c. Drain fuel filter a maximum of 30 seconds while cranking engine.
      (1) If water and/or contamination are present, wait two minutes and repeat test twice more.
      (2) If water and/or contamination are still present, drain and clean fuel tank and refuel vehicle.
   d. Check pressure at fuel pump outlet. If pressure is not at least 4 psi (28 kPa), replace fuel pump.
   e. Check fuel supply pressure at fuel lift pump outlet using pressure gauge. Pressure should be 4 psi (28 kPa) minimum.
      (1) If pressure is not at least 4 psi (28 kPa), clean or replace fuel filter and repeat test.
      (2) If pressure is still not at least 4 psi (28 kPa), check fuel supply lines and hoses for restrictions and obvious damage. Replace any damaged lines or hoses.

f. Check electrical connections on injection pump. Ensure lead is connected to fuel solenoid terminal (front terminal) and cold-advance solenoid terminal (right rear terminal).

g. Check for voltage at fuel solenoid; perform Electrical Troubleshooting (Section 12).

h. Check operation of fuel solenoid. Disconnect lead from terminal on top of injection pump. Turn ignition switch to ACC. Touch lead to fuel solenoid terminal and remove; audible clicking sound should be heard from within pump. If no sound is heard, repair or replace as required.

i. Check operation of glow plug system; refer to Electrical Troubleshooting (Section 12).

j. Loosen fuel injection lines at nozzles, and crank engine. If no fuel leaks from fuel injection lines while cranking engine, replace fuel injection pump.

k. Remove and test fuel injection nozzles for correct operating pressure. Opening pressure of nozzle must be between 2,030 psi (13,997 kPa) and 2,204 psi (15,197 kPa). If operating pressure is below 2,030 psi (13,997 kPa), replace fuel injection nozzles.

l. Using compression tester, check compression of each cylinder following steps 1 through 7:

NOTE: Compression reading may exceed 450 psi (3,102 kPa).

(1) Remove all glow plugs.

(2) Remove air cleaner element.

(3) Disconnect fuel solenoid lead from fuel injection pump.

***CAUTION**: Do not add oil to any cylinder when checking compression or damage to engine may result.*

(4) Install compression gauge adapter in glow plug hole of cylinder being tested and connect compression gauge.

(5) Crank engine, allow engine to crank long enough to accumulate six compression pulses, and record highest reading.

(6) Repeat steps (4) and (5) for remaining cylinders.

NOTE: If any cylinder measures below the 80% variable, the following components may be at fault: damaged valves, warped or cracked cylinder heads, or worn or damaged pistons or piston rings.

(7) All cylinders should build up quickly and evenly to a minimum of 300 psi (2,068 kPa), and lowest reading should not be less than 80% of highest reading cylinder.

3. ENGINE STOPS DURING NORMAL OPERATION
   a. Check for restrictions in air intake system. Check air cleaner-to-air horn elbow and air horn for damage that would restrict air flow. Replace damaged parts.
   b. Check for restrictions in exhaust system. Inspect for any damage that would restrict exhaust flow. Replace damaged parts.
   c. Perform steps 2c through 2j.
4. ENGINE KNOCKS (MECHANICAL)
   a. Remove converter housing cover, and torque capscrews securing torque converter to 35 lb-ft (48 N•m).
   b. Remove fuel injection nozzles and test for chatter. Injectors will chatter when working properly.
   c. Check for worn or damaged connecting rod bearings and main bearings. Replace worn or damaged connecting rod and main bearings.
   d. Check for worn or damaged crankshaft. Replace worn or damaged crankshaft.
   e. Check for worn or damaged pistons and connecting rods. Replace worn or damaged pistons and connecting rods.
5. ENGINE SMOKES DURING NORMAL OPERATION

   Perform steps 3a through 3c.
6. EXCESSIVE OIL LOSS OR CONSUMPTION

NOTE: Blue smoke coming from exhaust, in conjunction with excessive oil consumption, may indicate the engine is burning oil.

   a. Check for oil leaks at pan, drainplug, valve covers, timing gear cover seal, oil filter and adapter, oil dipstick tube, oil cooler, and oil cooler lines and fittings. Tighten any loose connections, or replace any damaged parts.
   b. Check for defective valve seals. Replace defective valve seals.
   c. Check for worn valve guides. Repair worn valve guides.
   d. Check for worn or damaged piston rings. Replace worn or damaged piston rings.
7. LOW OIL PRESSURE (ACCORDING TO GAUGE)
   a. Check for oil leaks at pan, drainplug, valve covers, timing gear cover seal, oil filter and adapter, oil dip-

stick tube, and oil cooler lines and fittings. Tighten any loose connections, or replace any damaged parts.

b. Check operation of oil pressure gauge; refer to Electrical Troubleshooting (Section 12).

c. Check for defective oil pump. Replace defective oil pump.

d. Check for worn or damaged main bearings and rod bearings. Replace worn or damaged main bearings and rod bearings.

e. Check for worn or damaged crankshaft. Replace worn or damaged crankshaft.

8. EXCESSIVE ENGINE VIBRATION

a. Check engine mounts and insulators for looseness or damage. Tighten any loose fasteners, and replace damaged parts.

b. Check for air in fuel lines. Bleed air from fuel lines and check for air source.

c. Remove and test fuel injection nozzles for chatter. Injectors will chatter when working properly.

d. Remove converter housing cover, and torque capscrews securing torque converter to 35 lb-ft (48 N•m).

e. Check for damaged flywheel or missing counterweight on flywheel. Replace flywheel if damaged or if counterweight is missing.

f. Check for loose or damaged torsion damper. Replace torsion damper if damaged.

9. EXCESSIVE EXHAUST SMOKE

a. Black Smoke

(1) Check for restricted exhaust pipe, intake manifold or dirty air filter. Replace exhaust pipes or intake manifold if restricted. Clean or replace dirty filter.

(2) Remove and perform pressure check and leak check on fuel injection nozzles.

(3) Check fuel injection pump timing.

(4) Check for defective fuel injection pump. Replace defective fuel injection pump.

b. White Smoke (Hot)

(1) Check for leaking or defective water pump.

(a) If water pump checks OK, go to step 2.

(b) If water pump is leaking or defective, replace.

(2) Remove surge tank cap, and with engine running, check for excessive bubbles in surge tank.

If bubbles are present, remove cylinder heads and check for defective head gaskets, cracked cylinder heads, or cracked block.

(3) Remove and test fuel injection nozzles.

(4) Check for defective fuel injection pump. Replace defective fuel injection pump.

c. Blue Smoke

(1) Perform Electrical Troubleshooting.

(2) Check for defective valve seals. Replace defective valve seals.

(3) Check for worn valve guides. Repair worn valve guides.

(4) Check for worn or damaged pistons, piston rings, and cylinder block. Repair or replace as necessary.

10. ACCELERATOR PEDAL STICKS OR FULL THROTTLE CANNOT BE OBTAINED

a. Inspect accelerator pedal bushing for binding or damage that would limit pedal travel. Replace bushing if damaged.

b. Inspect accelerator cable for kinks, corrosion, or damage which would restrict cable movement. Replace accelerator cable if damaged.

c. Inspect throttle bracket return spring on left side of injection pump for damage which would restrict accelerator cable movement. Replace spring if damaged.

d. Disconnect accelerator cable from fuel injection pump. Move throttle lever on injection pump to wide open throttle. If throttle lever does not move freely, replace injection pump.

11. ENGINE DOES NOT DEVELOP FULL POWER

a. Check vehicle electrical system for battery voltage throughout the starting and charging systems; refer to Electrical Troubleshooting.

b. Check fuel filter for obstructions. Replace fuel filter if clogged or dirty.

c. Check lift pump operation. Replace if damaged.

d. Check for air in injection lines. Bleed air from injection lines if present.

e. Check fuel injection pump timing. Adjust as necessary.

f. Remove and test fuel injection nozzles for correct spray pattern and nozzle opening pressure. Opening pressure must be between 2,030 psi (13,997 kPa) and 2,204 psi (15,197 kPa).

g. Check for defective fuel injection pump. Inspect drive gear for broken or missing teeth. Check injector pump housing for cracks or damage. Replace injector pump if damaged.

h. Perform cylinder compression test; refer to step 2k.

i. Check for burned or cracked valves. Replace burned or cracked valves.

j. Check for worn or damaged pistons and piston rings. Replace worn or damaged pistons or piston rings.

k. Check for damaged camshaft or lifters. Ensure lifters are not collapsed. With a dial indicator, measure camshaft lobes for wear. Intake and exhaust lift will measure 0.280 ± 0.002 in. (7.112 ± 0.05 mm). Replace camshaft if any lobe is worn or damaged.

12. LUBRICATING OIL DILUTED

a. Remove and test for leaking fuel injection nozzles.

b. Perform cylinder compression test; refer to step 2k.

c. Check for broken piston rings. Leaking injector nozzles may allow fuel to run down into cylinder. Replace broken piston rings.

13. AUXILIARY DRIVE SYSTEM NOISE

a. Check drivebelt for frays, cracks, or fluid contamination. Replace damaged or contaminated belt.

b. Check drivebelt tension.

c. Check grooves in drive pulleys for scoring or damage. Check pulleys for looseness. Tighten loose pulleys or replace damaged pulleys.

d. Check for defective water pump, power steering pump, air conditioning compressor (if so equipped), and alternator.

ENGINE MOUNTING BRACKET/INSULATOR

Removal

1. Disconnect air cleaner hoses at air horn. Then remove air horn from intake manifold.
2. Remove upper half of fan shroud extension (for fan clearance when engine is raised).
3. Remove nuts/bolts attaching front propeller shaft center bearing to bracket.
4. Mark front propeller shaft U-joint and yoke position with paint or chalk. Then remove front propeller shaft and center bearing as assembly.
5. Remove bolts attaching starter cable bracket to engine. Move bracket aside for working clearance.
6. Remove nuts attaching transmission mount to transmission crossmember (Figure 2-2).

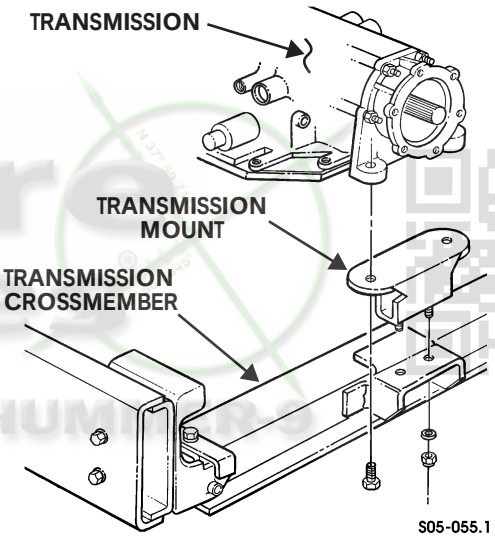


Figure 2-2: Transmission-To-Crossmember Mounting

7. Disconnect transmission and transfer case shift rods at shift lever arms.
8. Disconnect exhaust pipes, brackets, or hangers as needed.
9. Support engine with floor jack and wood block, or safety stand if vehicle is on hoist. Position block or stand under pan rail at rear main.
10. Remove nuts/bolts attaching insulators, or brackets to engine and frame.
11. Remove nut securing engine bracket to stud on starter motor (Figure 2-3).
12. Raise engine enough to remove insulator, or bracket (Figure 2-3).

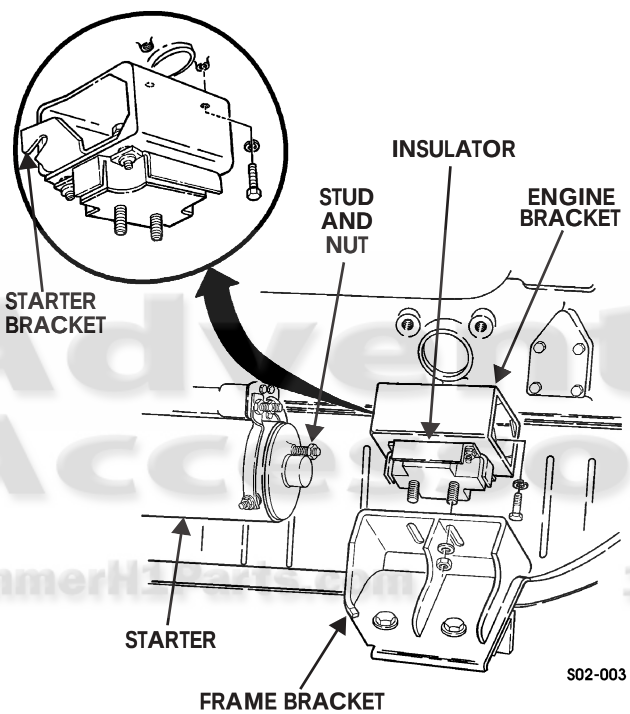


Figure 2-3: Engine Mounting Bracket and Insulator (Driver Side)

Installation

1. Position insulator on engine bracket (Figure 2-4).

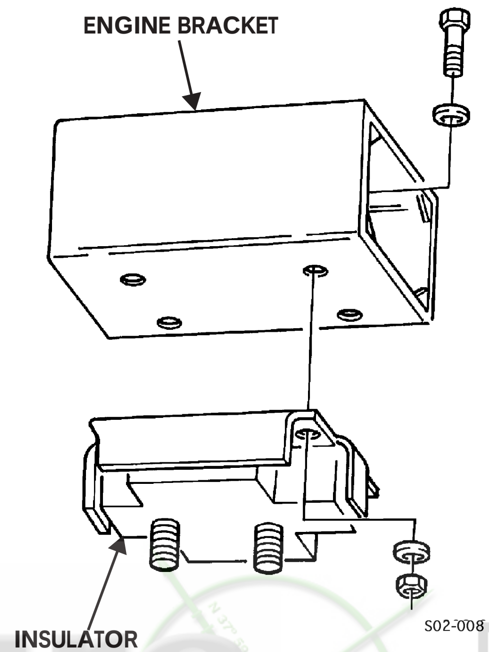


Figure 2-4: Engine Bracket and Insulator Assembly

2. Install engine bracket and insulator. Tighten engine bracket-to-block bolts to 30 lb-ft (41 N•m) torque. Tighten insulator stud nuts to 90 lb-ft (122 N•m) torque.
3. Install nut that secures engine bracket to stud on starter motor (Figure 2-3). Tighten nut to 24 lb-ft (33 N•m) torque.
4. Align and install bolts/nuts that attach transmission to transmission crossmember (Figure 2-2).
5. Connect transmission and transfer case shift rods to floor shift levers. Use new spring clips to secure shift rod trunnions to shift lever arms (Figure 2-5).
6. Align and install front propeller shaft and center bearing. Tighten center bearing attaching bolts to 60 lb-ft (81 N•m) torque. Tighten U-joint clamp strap nuts to 13-18 lb-ft (18-24 N•m) torque.

7. Install starter cable bracket.
8. Connect exhaust pipes, brackets, or hangers if loosened/removed for service access.
9. Install upper half of fan shroud.
10. Install air horn on intake manifold and connect air cleaner hoses.

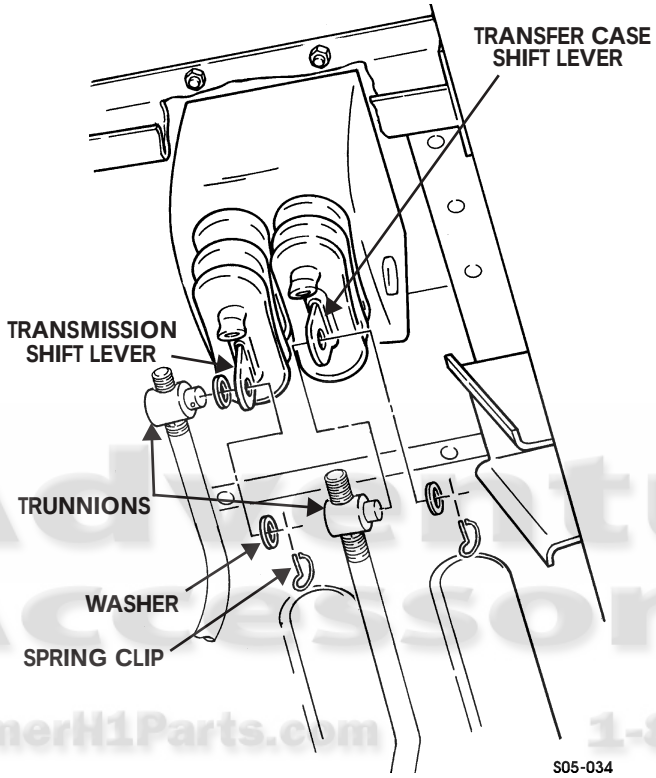


Figure 2-5: Shift Rod Attachment

CRANKSHAFT PULLEY

Removal

1. Loosen (but do not remove) crankshaft pulley bolts (Figure 2-6).
2. Remove serpentine accessory drive belt as follows:
   a. Loosen drive belt by rotating belt tensioner in counterclockwise direction (Figure 2-7). Use 1/2 in. drive breaker bar to rotate pulley.
   b. Slide belt off tensioner and other pulleys. Then remove belt.
3. Remove crankshaft pulley screws and remove pulley.

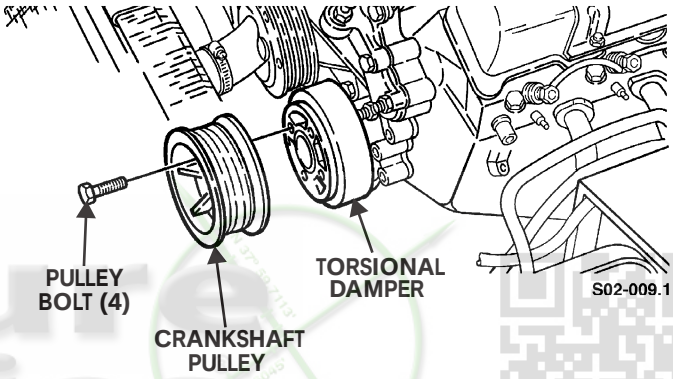


Figure 2-6: Crankshaft Pulley Mounting

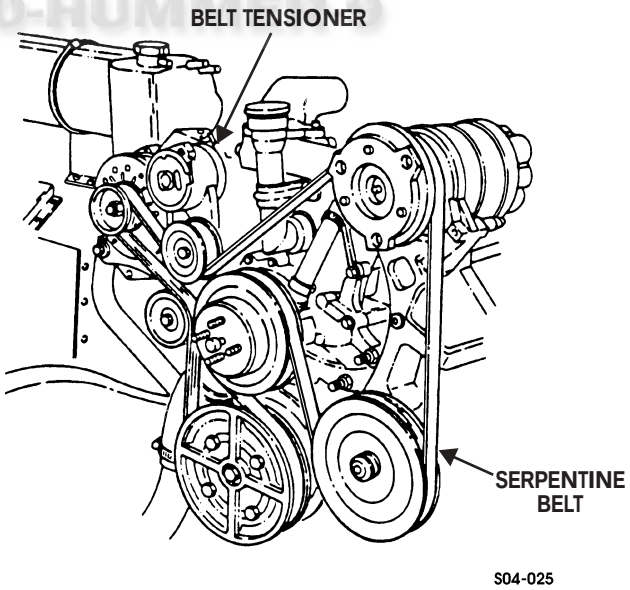


Figure 2-7: Serpentine Belt Tensioner Location

Installation

1. Clean face of torsional damper with brake cleaner. Smooth surface with file, or 280 grit paper, if necessary.
2. Install pulley on damper and install pulley bolts. Tighten bolts until snug.
3. Install serpentine belt on all pulleys except belt tensioner (Figure 2-8). Turn tensioner counterclockwise with breaker bar and slide belt onto tensioner. Then release breaker bar so tensioner can rotate clockwise to adjust belt.
4. Tighten crankshaft pulley bolts to 48 lb-ft (65 N•m) torque.

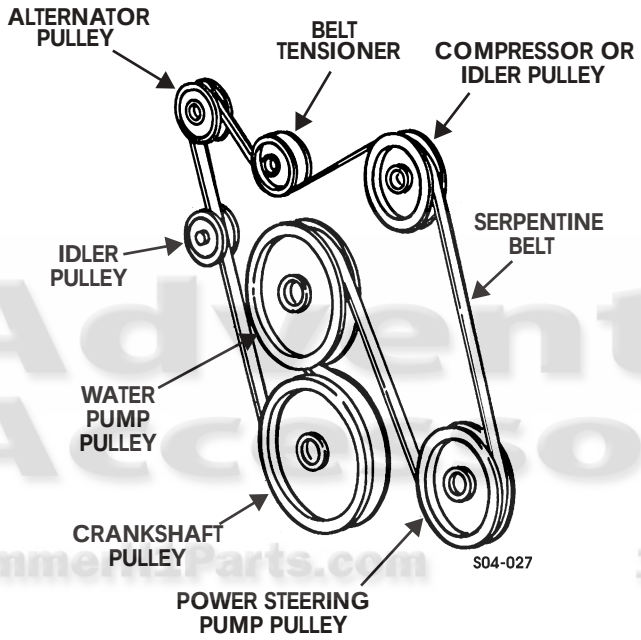


Figure 2-8: Serpentine Belt Installation

TORSIONAL DAMPER

Removal

1. Remove crankshaft pulley and serpentine belt. Refer to procedure in this section.
2. Remove damper bolt and nut (Figure 2-9).
3. Remove torsional damper with special tool 5740755 (Figure 2-10).
4. Remove and inspect crankshaft keys. Replace keys if worn, chipped, or distorted.

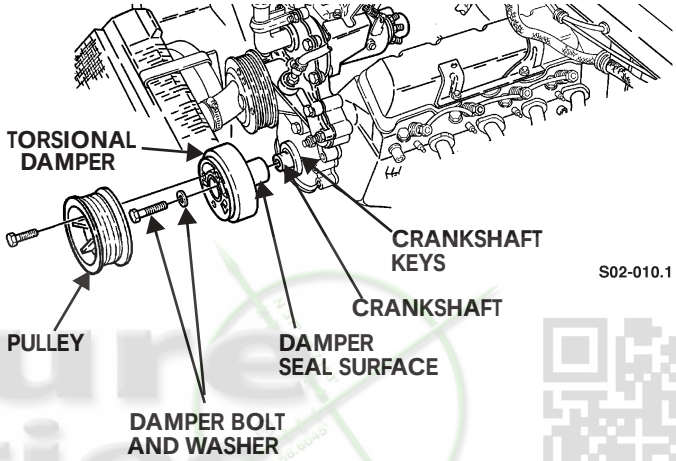


Figure 2-9: Torsional Damper and Crankshaft Pulley Mounting

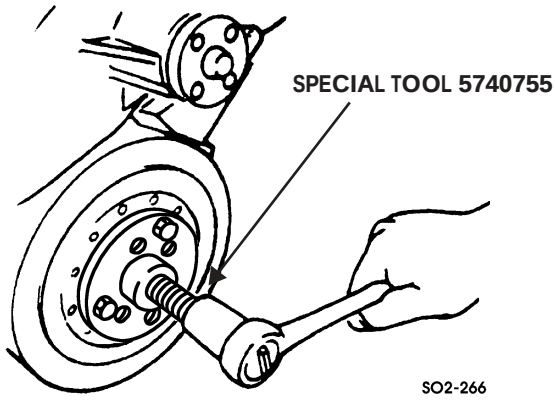


Figure 2-10: Torsional Damper Removal

Installation

1. Check seal contact surface of damper. Surface must be clean and smooth to avoid damaging timing cover seal. Smooth surface with 180 grit emery if necessary. Then polish surface with 220 grit emery coated with engine oil.
2. Inspect condition of front cover seal. Replace seal if worn, cut, cracked, or hardened. Use pry tool to remove oil seal and special tool 5740754 to install new seal.

3. Install crankshaft keys. Be sure keys are fully seated in crankshaft key slots.
4. Lubricate crankshaft nose, front cover seal, and seal surface of torsional damper with engine oil.
5. Install torsional damper on crankshaft. Be sure crankshaft keys are not displaced during damper installation.
6. Install damper washer and bolt. Tighten bolt to 140-160 lb-ft (190-217 N•m) torque.
7. Install crankshaft pulley. Tighten pulley bolts to 48 lb-ft (65 N•m) torque.
8. Install serpentine belt (Figure 2-8).

FRONT COVER OIL SEAL REPLACEMENT

1. Remove crankshaft pulley and torsional damper. Refer to procedures in this section.
2. Remove oil seal front cover with pry tool (Figure 2-11).
3. Clean seal contact surface of torsional damper. Smooth surface, if necessary, with 180 grit emery. Then polish with 220 grit emery coated with engine oil. Seal surface must be smooth to avoid damaging new seal.
4. Install new seal in cover with special tool 5740754. Open end of seal goes toward interior of cover.
5. Lubricate new seal and seal surface of torsional damper, with engine oil, petroleum jelly, or light chassis grease.
6. Install keys in crankshaft. Then align and install torsional damper. Install damper belt and washer. Tighten bolt to 140-160 lb-ft (190-217 N•m).
7. Install crankshaft pulley and serpentine belt. Refer to procedure in this section.

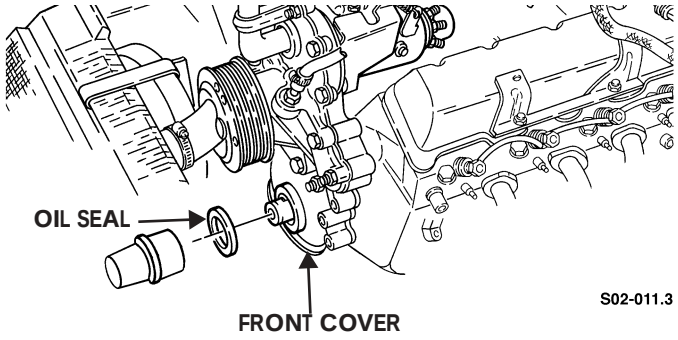


Figure 2-11: Front Cover Oil Seal Location

OIL PUMP DRIVE

Removal

1. Remove engine cover/console for access to rear of engine.
2. Clean surface of drive, block and drive clamp with carb cleaner.
3. Remove bolt that secures oil pump drive clamp to block (Figure 2-12).
4. Remove oil pump drive with turn and lift motion. Use channel lock or use grip pliers to remove drive.
5. Remove gasket from block or drive.
6. Cover pump drive opening in block to prevent dirt entry.

Installation

1. Install new gasket on oil pump drive.
2. Position and insert oil pump drive in block. Turn drive back and forth to seat it as needed.
3. Install drive clamp and bolt. Tighten bolt to 25-37 lb-ft (34-50 N•m) torque.
4. Install engine console/cover.

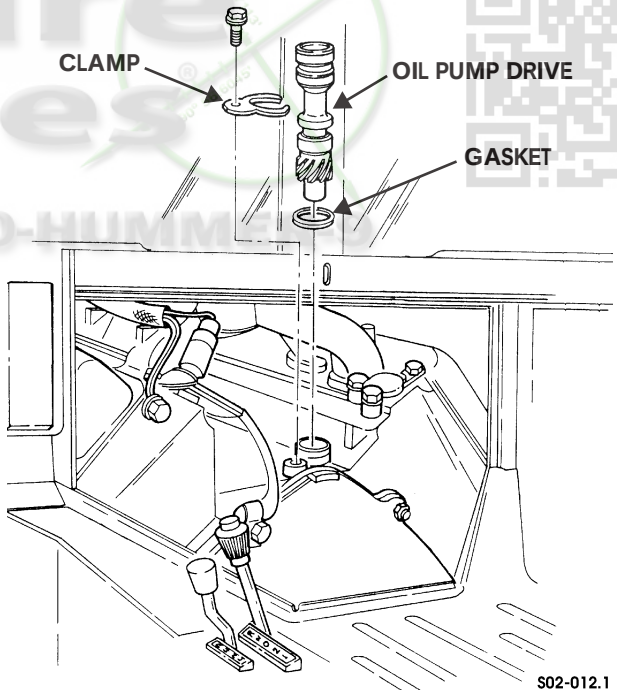


Figure 2-12: Oil Pump Drive

FRONT COVER AND TIMING CHAIN

Removal

1. Disconnect and remove batteries and tray.
2. Drain engine coolant.
3. Remove radiator upper and lower hoses.
4. Loosen crankshaft pulley belts.
5. Remove left and right splash shields.
6. Disconnect hood harness then remove hood with aid of helper. Place hinge pins in hinges after removal to avoid losing them.
7. Remove air conditioning condenser and power steering fluid cooler. Then remove radiator and fan shroud (Figure 2-13).
8. Loosen and remove serpentine drive belt. Use 1/2 in. drive breaker bar to rotate belt tensioner counterclockwise to loosen belt (Figure 2-7).
9. Disconnect heater, bypass and inlet tube/hose at water pump and coolant crossover (Figure 2-14).
10. Remove oil filler neck and coolant crossover (Figure 2-14).

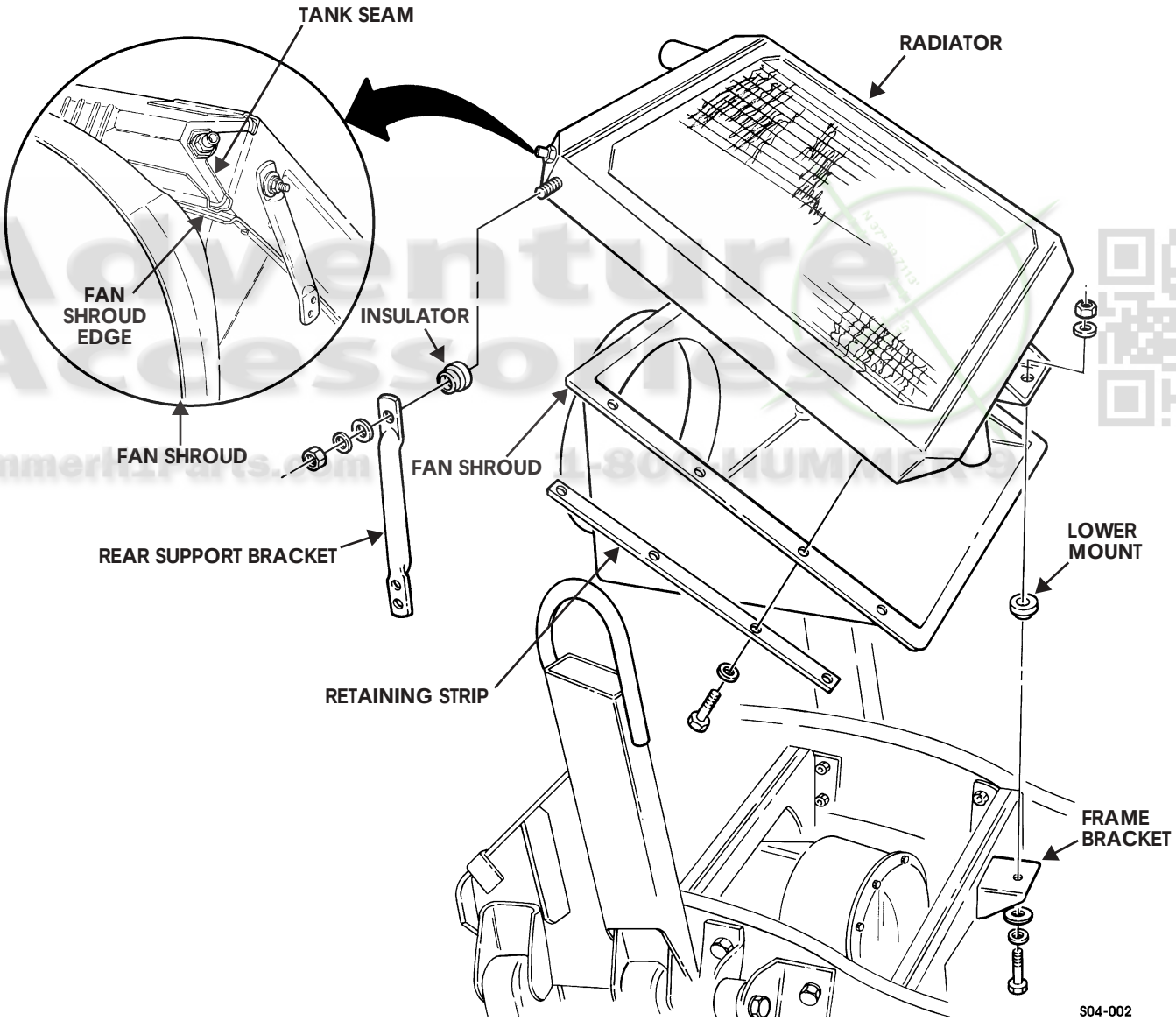


Figure 2-13: Radiator and Shroud Removal/Installation

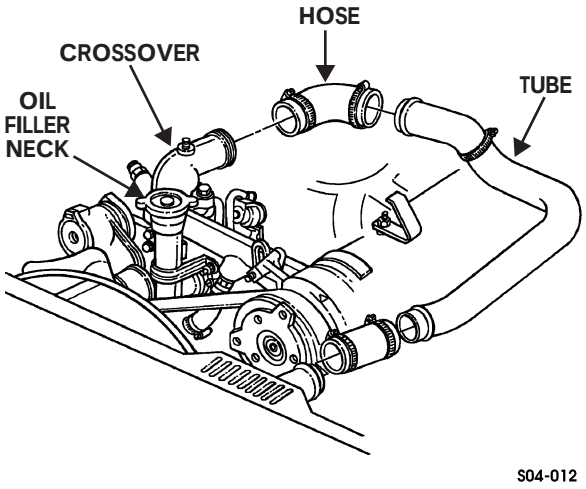


Figure 2-14: Crossover Tube/Hose Connections

11. Remove fan and fan clutch.
12. Remove crankshaft pulley (Figure 2-6).
13. Remove torsional damper attaching bolt and washer (Figure 2-9).
14. Remove torsional damper with tool 5740755 (Figure 2-10).
15. Remove drive keys from crankshaft. Replace keys if worn, chipped, or distorted.
16. Remove water pump and adapter plate as assembly (Figure 2-15).
17. Remove bolts that attach front cover to oil pan (Figure 2-16).
18. Rotate crankshaft until timing marks on sprockets and gears are aligned and number one piston is at TDC.
19. Remove injection pump driven gear (Figure 2-16).
20. Remove baffle from front cover (Figure 2-16).
21. Remove nuts and washers attaching fuel injection pump to studs on front cover (Figure 2-16).

NOTE: There are timing marks on the front cover and injection pump. Note position of these marks for installation reference.

22. Remove bolts that attach front cover to engine block. Then break sealer bead with putty knife and remove cover.
23. Cover oil pan opening to prevent dirt entry.
24. Check timing chain deflection with dial indicator. Measure deflection mid-way between crankshaft and cam sprockets. Maximum allowable deflection is 0.810 in. (20.5 mm). Replace chain and sprockets if deflection is greater than specified.
25. Check camshaft end play with dial indicator. Maximum allowable end play is 0.012 in. (0.3 mm). Replace cam thrust plate and spacer if end play is greater than specified.

NOTE: Note position of timing marks on drive gear and crank and cam sprocket for installation reference.

26. Remove bolt and washer attaching injection pump drive gear to camshaft. Then remove gear (Figure 2-17).
27. Slide timing chain and sprockets off camshaft and crankshaft (Figure 2-17).
28. Remove drive keys from camshaft and crankshaft.
29. Replace keys if chipped, cracked, or distorted. Minor burrs
30. can be removed with a stone or fine tooth file.
31. Clean all old sealer off engine block, front cover, and water pump/adapter plate with scraper.

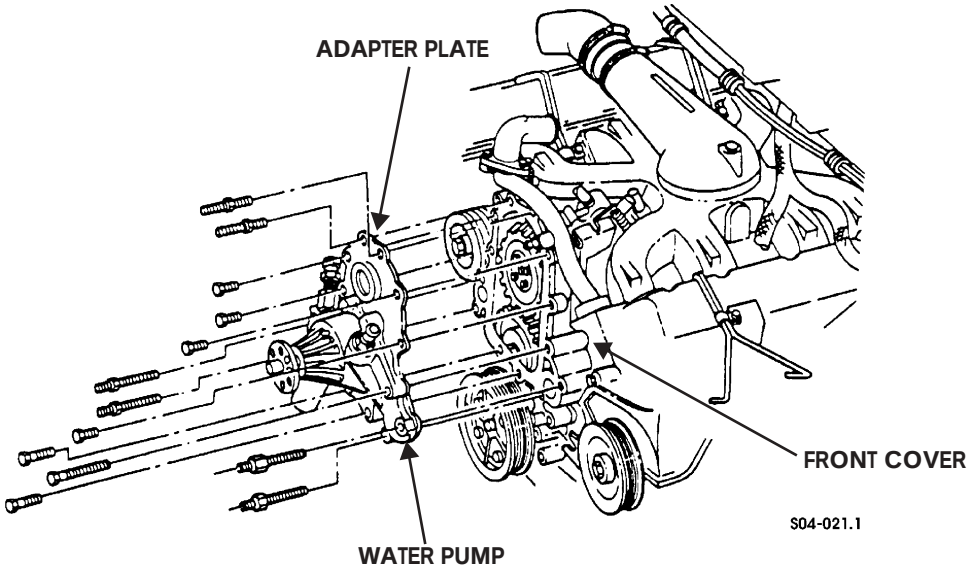


Figure 2-15: Water Pump and Adapter Plate Removal/Installation

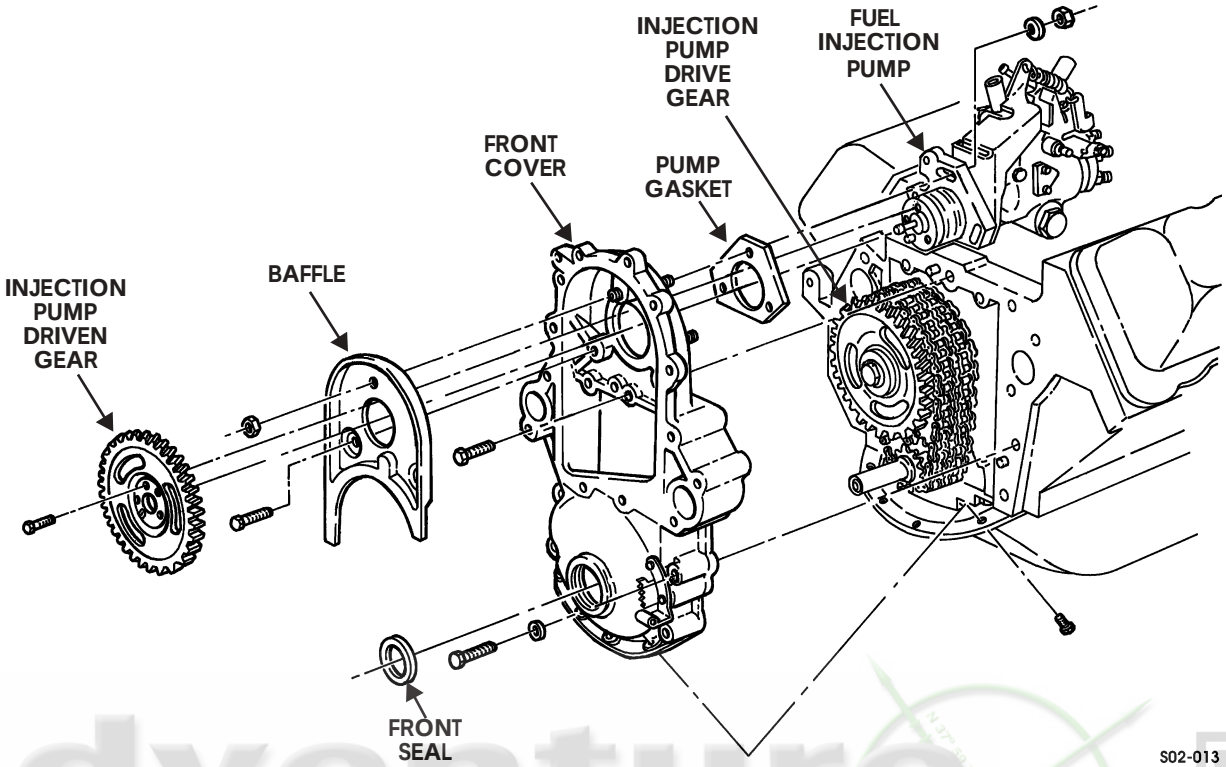


Figure 2-16: Drive Gear, Baffle, and Front Cover Removal

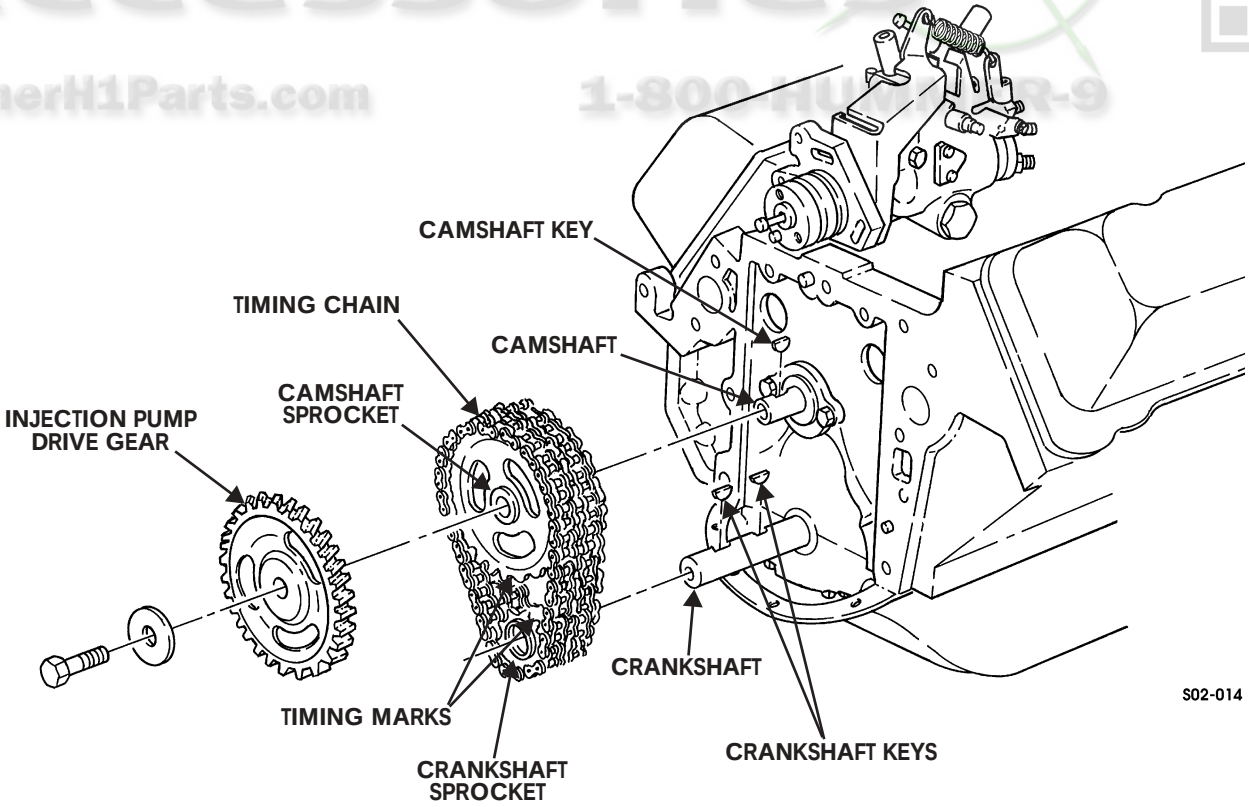


Figure 2-17: Drive Gear, Timing Chain, and Sprocket Removal

Installation

1. Install new camshaft thrust plate and spacer if required.
2. Clean front cover and engine block sealing surfaces with carb cleaner and wipe dry.
3. Install drive keys in camshaft and crankshaft. Be sure keys are seated.
4. Assemble and install timing chain and sprockets (Figure 2-18). Check timing mark alignment before proceeding.
5. Install injection pump drive gear on camshaft (Figure 2-18). Timing mark on gear should be facing upward (12 o'clock position). Then install drive gear attaching washer and bolt. Tighten bolt to 55-60 lb-ft (75-81 N•m) torque.

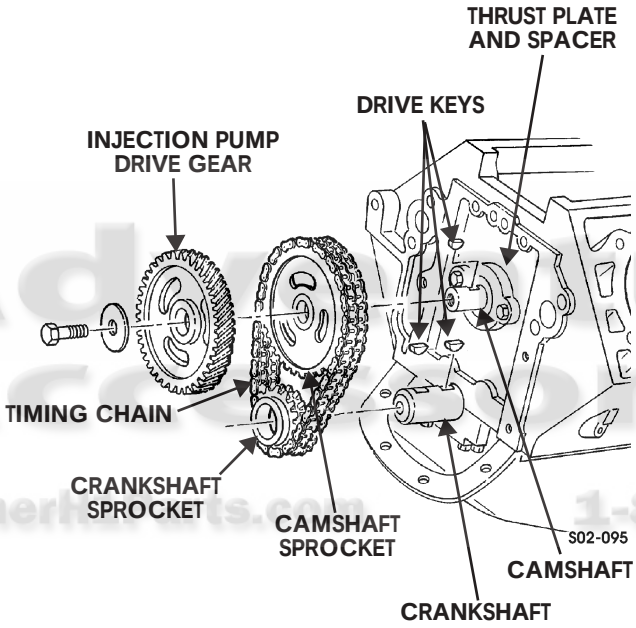


Figure 2-18: Timing Chain, Sprockets, and Drive Gear Installation

6. Install new seal in front cover with tool 5740754.
7. Apply sealer to front cover as follows:
   - Use anaerobic sealer, such as Loctite 510, on cover surfaces that contact engine block and on engine block.
   - Use RTV-type sealer, such as Loctite 592, on oil pan and oil pan contact surface of front cover.
   - Refer to Figure 2-19 for sealer application diagram.

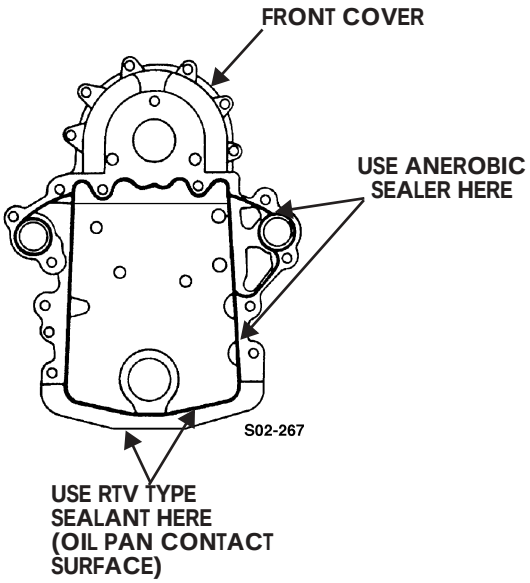


Figure 2-19: Front Cover Sealer Application Diagram

8. Install front cover on engine block (Figure 2-20). Be sure cover is fully seated on engine block dowels, engine block, and oil pan, before installing cover bolts.
9. Install front cover attaching bolts. Then tighten bolts as follows:
   - Tighten cover-to-engine block bolts to 33 lb-ft (45 N•m) torque.
   - Tighten oil pan-to-front cover bolts to 4-10 lb-ft (5-14 N•m) torque.
10. Install injection pump gasket on front cover studs (Figure 2-20).

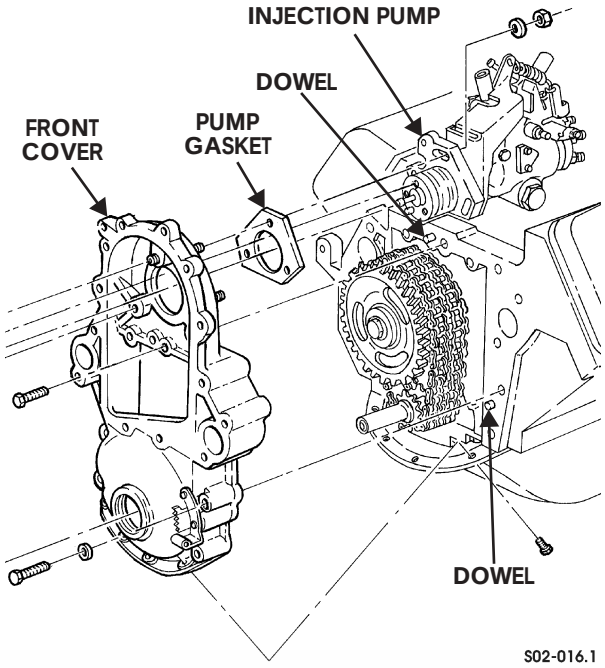


Figure 2-20: Front Cover Mounting

11. Install baffle in front cover (Figure 2-21). Maintain minimum clearance of 0.040 in. (1.02 mm) between baffle and injection pump drive gear. Tighten baffle attaching bolts/nuts to 33 lb-ft (45 N•m) torque.
12. Install fuel injection pump driven gear on pump shaft as follows:
    a. Align timing marks on drive and driven gears and install driven gear on pump shaft.
    b. Verify timing mark alignment. Drive gear mark should be at 12 o'clock position and driven gear mark at 6 o'clock position.

NOTE: If timing marks are not perfectly aligned, turn the pump shaft to correct alignment. Do not turn the gears.

    c. Install and tighten driven gear attaching bolts to 13-20 lb-ft (18-27 N•m) torque.
13. Check alignment of timing marks on front cover and injection pump flange. Rotate pump to align if necessary. Then install pump attaching nuts.
14. Secure fuel injection pump to front cover. Tighten pump attaching nuts to 13-20 lb-ft (18-27 N•m) torque.
15. Lubricate front cover seal lip with engine oil, or petroleum jelly. Then lubricate seal contact surface of torsional damper with engine oil. Be sure seal contact surface of damper is smooth and free of burrs, nicks, or corrosion.
16. Install damper drive key in crankshaft slot. Be sure key is fully seated.

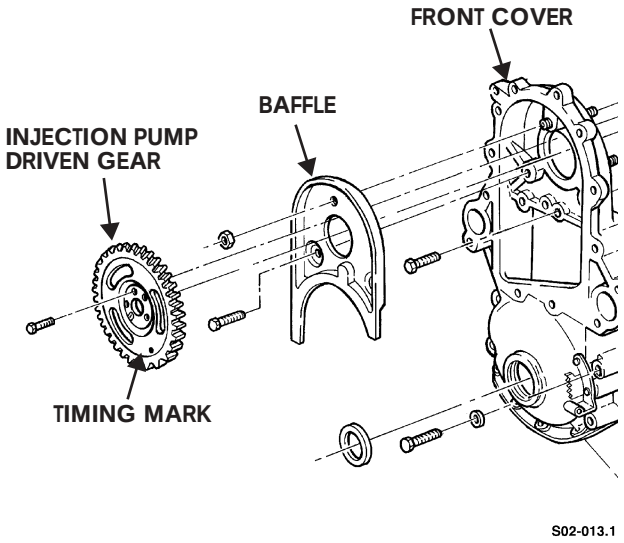


Figure 2-21: Baffle and Pump Driven Gear Installation

17. Install torsional damper. Then install damper attaching washer and bolt. Tighten bolt to 140-160 lb-ft (190-217 N•m) torque.
18. Install crankshaft pulley. Tighten pulley bolts to 48 lb-ft (65 N•m) torque.
19. Install coolant crossover and oil filler neck. Tighten crossover bolts to 31 lb-ft (42 N•m) torque and filler neck attaching nut to 13-20 lb-ft (18-27 N•m) torque.
20. Apply bead of anaerobic sealer, such as Loctite 510, to water pump and adapter plate. Refer to Figure 2-14.7 for sealer application.
21. Install water pump and adapter plate. Apply Permatex/ Loctite pipe sealing compound, to fastener that goes in hole "A" (Figure 2-22). Tighten pump/adapter bolts to 13-20 lb-ft (18-27 N•m) torque.

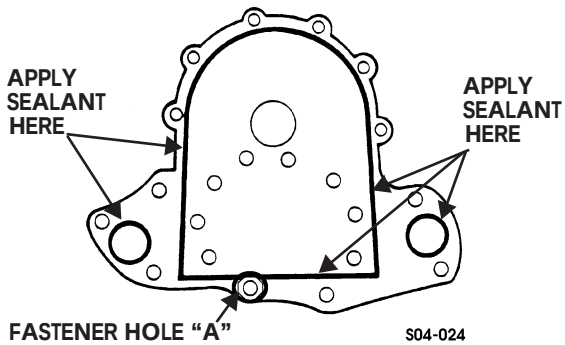


Figure 2-22: Water Pump Adapter Plate Sealer Application Diagram

22. Install fan pulley fan, and fan clutch. Tighten attaching nuts to 15-20 lb-ft (20-27 N•m).

23. Install and adjust serpentine drive belt.
24. Connect heater and bypass hoses at water pump and crossover. Then attach radiator upper inlet hoses to inlet tube.
25. Install radiator and shroud (Figure 2-13). Then install air conditioning condenser and power steering fluid cooler.
26. Connect radiator upper and lower hoses.
27. Fill cooling system.
28. Connect battery negative cables.
29. Evacuate and recharge air conditioning system if necessary.
30. Start and run engine to verify proper operation. Purge air from cooling system (if necessary), and top off coolant level at surge tank.

OIL PUMP SERVICE

Removal

1. Drain engine oil and remove oil filter.
2. Remove oil pan bolts.
3. Tap oil pan with rubber mallet to break sealer bead. Use putty knife to help separate sealer bead if necessary. Then remove pan.
4. Loosen screw that secures bracket on oil pump pickup tube.
5. Remove nut that secures tube bracket to oil pump mounting stud (Figure 2-16). Then rotate bracket off stud.
6. Remove oil pump mounting stud (Figure 2-16).
7. Remove oil pump and pump shaft.

Inspection And Replacement

The oil pump can be disassembled for inspection but not repaired. The oil pump is only serviced as an assembly. Individual parts are not available.

Replace the pump if the oil pickup strainer and tube are loose, cracked, or distorted. Also replace the pump if the housing is damaged or the pump gears are worn, chipped, or cracked.

Check the pump shaft and pressure relief valve and spring. Replace the pump if the spring is collapsed or broken, the valve is damaged, the retaining pin is loose, or damaged, or the pump shaft is worn or damaged.

The oil pickup strainer can be cleaned with spray-type carb cleaner if necessary. However, replace the pump if heavy accumulations of oil sludge, grit, foreign material, or metal chips are present.

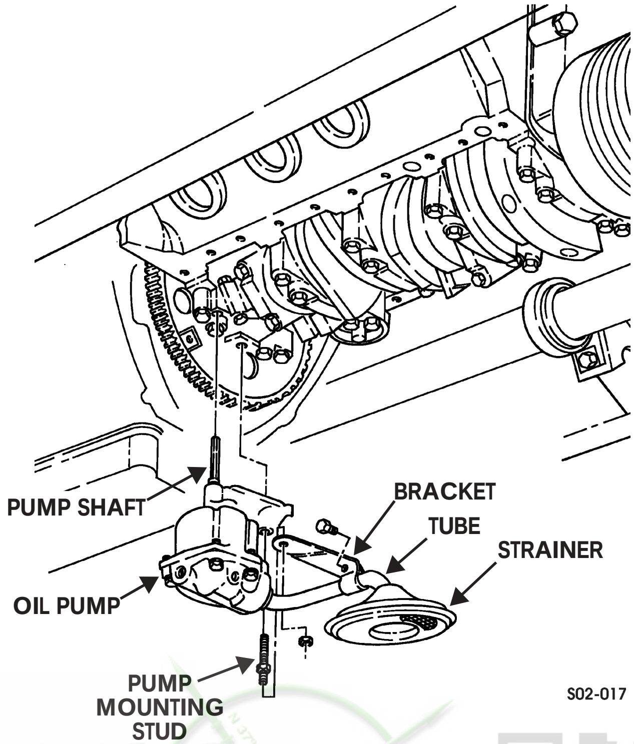


Figure 2-23: Oil Pump Mounting

Installation

1. Prime oil pump. Pour about four ounces of engine oil into pump through strainer and rotate shaft to coat gears.
2. Insert pump shaft into block. Then align and seat pump.
3. Install and tighten pump mounting stud to 59-74 lb-ft (80-100 N•m) torque.
4. Rotate pickup tube bracket onto pump mounting stud (Figure 2-23). Then install and tighten bracket retaining nut to 35 lb-ft (47 N•m).
5. Tighten clamp screw on pickup tube bracket to 12 lb-ft (16 N•m) torque.
6. Clean oil pan and engine block sealing surfaces with scraper and solvent. Final clean surfaces with brake or electrical contact cleaner to remove all residue. Otherwise, RTV sealer will not adhere properly.
7. Apply RTV-type sealer to front cover, oil pan, and engine pan rail surfaces. Sealers such as Loctite 592, Permatex ultra gray, or black are equally acceptable.
8. Install rear seal in oil pan.
9. Position oil pan on engine and front cover. Then install and tighten oil pan bolts as follows:
   - Tighten rear two bolts to 89 lb-in (10 N•m) torque.
   - Tighten remaining bolts to 17 lb-ft (23 N•m) torque.
10. Install oil filter and refill with recommended grade engine oil.

REAR MAIN OIL SEAL REPLACEMENT

1. Remove transmission and transfer case assembly.
2. Remove flywheel.

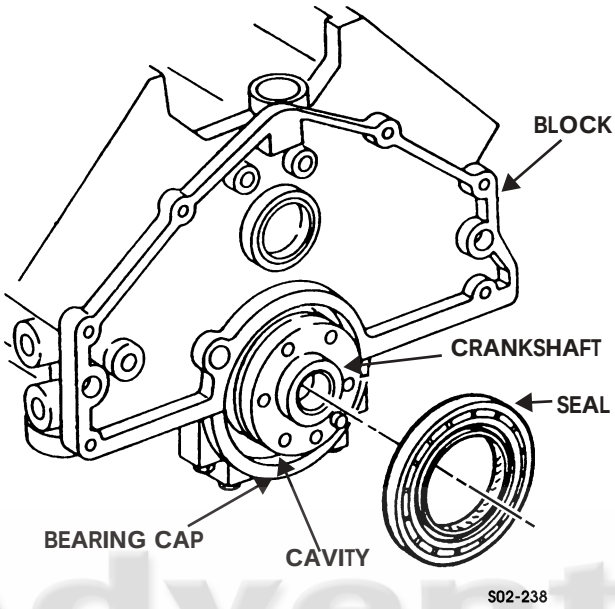


Figure 2-24: Rear Main Oil Seal Removal

CAUTION: Do not damage crankshaft seal surface when removing old seal (Figure 2-24).

3. Using small screwdriver or seal puller, remove old seal from cylinder block and main bearing cap cavity.
4. Clean old sealant or oil build-up from seal cavity.
5. Lightly coat crankshaft and inner lip of seal with engine oil.
6. Lightly coat outer circumference of seal with Permatex No. 2 or equivalent.
7. Position seal on crankshaft with seal lip toward block. Ensure seal lip does not flip on installation.
8. Position seal installer 05743108 on crankshaft, press seal into cavity in block, then remove installer tool (Figure 2-25).
9. Wipe excess sealant from block.
10. Install flywheel on crankshaft. Tighten bolts to 66 lb-ft (90 N•m).
11. Install transmission and transfer case assembly.
12. Run engine and check for leaks after assembly.

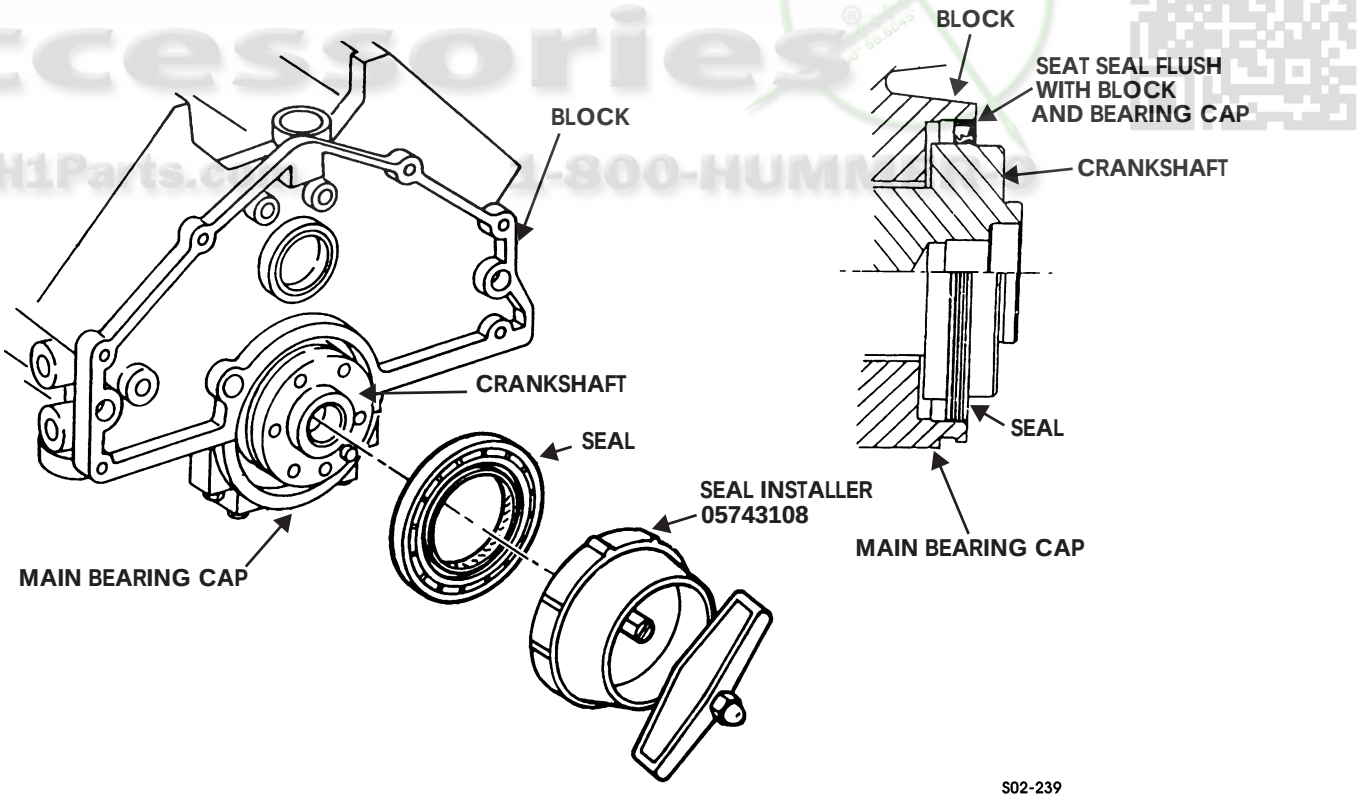


Figure 2-25: Rear Main Oil Seal Installation

INTAKE MANIFOLD SERVICE

Removal

1. Disconnect battery negative cables.
2. Remove engine cover and front console.
3. Remove air horn and air intake hose. Then remove air horn rubber gasket from intake manifold.
4. Remove nuts and washers attaching harness brackets (Figure 2-26) and barometric pressure sensor bracket to intake manifold studs.
5. Remove CDR valve and hose.
6. Remove nut and washer attaching heater water valve to manifold. Then move bracket, valve, and hose aside.
7. Remove glow plug relay bracket nuts and washers, and move relay, wires, and cables aside.
8. Remove nuts attaching injector line brackets to manifold studs.

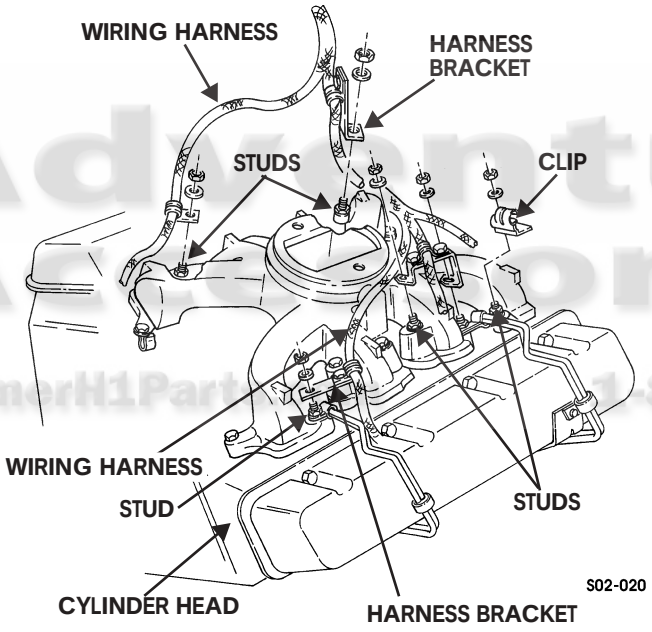


Figure 2-26: Wire Harness Attachment

9. Remove studs and bolts attaching intake manifold to cylinder heads (Figure 2-27).
10. Tap manifold with rubber mallet to loosen it. Then move manifold rearward and remove it through engine cover opening in passenger compartment.
11. Remove manifold gaskets. If gaskets are stuck on heads, cover intake openings in heads with shop towels. Then remove gaskets with scraper and solvent if necessary.
12. If intake manifold is only being removed for access to another component, clean old gasket material from manifold if necessary.

Cleaning/inspection/replacement

Clean the manifold with standard parts cleaning solvents and dry with compressed air. Stubborn carbon deposits can be removed with carb cleaner, or a gasket remover product.

Inspect the manifold for cracks, flange damage, or evidence of porosity. Replace the manifold if necessary.

If the manifold will be reused, smooth off any burrs or nicks on the gasket surfaces. Use an oil stone or fine tooth file for this purpose.

If a new manifold will be installed, be sure to either transfer the old, or install a new CDR valve hose nipple before hand.

Check the manifold fastener threads in each cylinder head. Clean the threads with a tap if necessary.

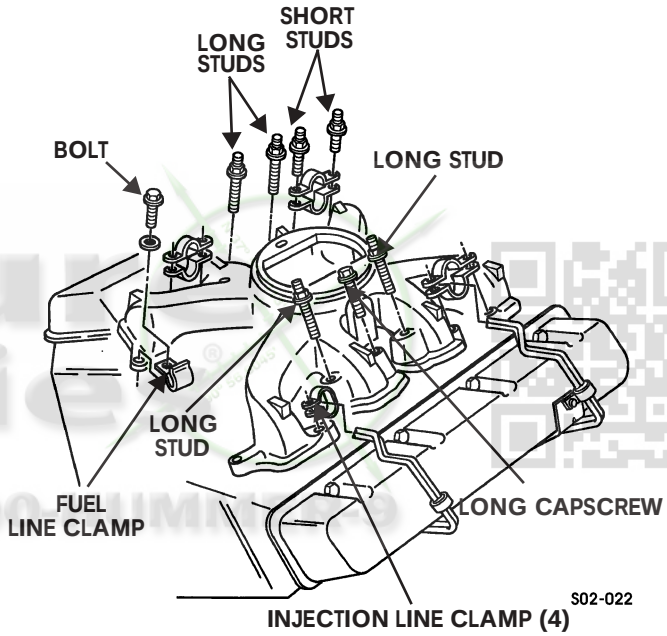


Figure 2-27: Intake Manifold Stud/Bolt Locations

Installation

1. Verify that cylinder head intake port gasket surfaces are clean and smooth. Smooth any nicks or burrs with an oil stone. Then re-clean area. Remove shop towels from intake ports afterward.
2. Position new intake manifold gasket on each cylinder head (Figure 2-28). A gasket dressing, such as Permatex High Tack, can be used to hold gaskets in place during manifold installation.
3. Align and position intake manifold on gaskets. Then install and finger tighten 2-3 studs to hold manifold in place.
4. Verify correct manifold and gasket seating and position. Adjust position if necessary.
5. Install remaining manifold attaching bolts and studs. Tighten bolts and studs in sequence outlined in Figure 2-29. This is necessary to avoid leaks, or cracking the manifold. Correct stud and bolt is set to 31 lb-ft (42 N•m) torque.
6. Install wire harness and barometric pressure sensor brackets on manifold studs. Tighten bracket attaching nuts to 28-30 lb-ft (38-41 N•m) torque.
7. Install glow plug relay. Connect relay wires and cables (if disconnected).
8. Install fuel injector line clamps on manifold studs and secure with washers and nuts. Tighten clamp nuts to 28-30 lb-ft (38-41 N•m) torque.
9. Attach heater water valve bracket to manifold stud and secure with washer and nut. Tighten nut to 28-30 lb-ft (38-41 N•m) torque.
10. Install CDR valve and hose.

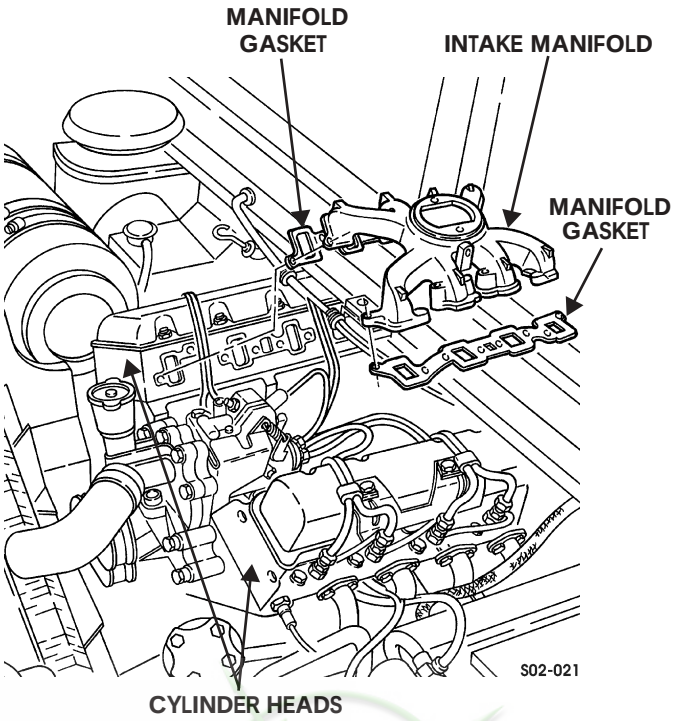


Figure 2-28: Intake Manifold and Gaskets

11. Install rubber gasket on intake manifold air inlet flange.
12. Position air horn on intake manifold and gasket. Install flat washer and rubber washer on each air horn bolt. Then apply sealer to bolt threads before installing them. Tighten bolts to 15-19 lb-ft (20-26 N•m) torque.
13. Connect air intake hose to air horn and air cleaner. Tighten clamp screws to 44-53 lb-in (5-6 N•m) torque.
14. Install engine cover and front console.
15. Connect battery negative cables.

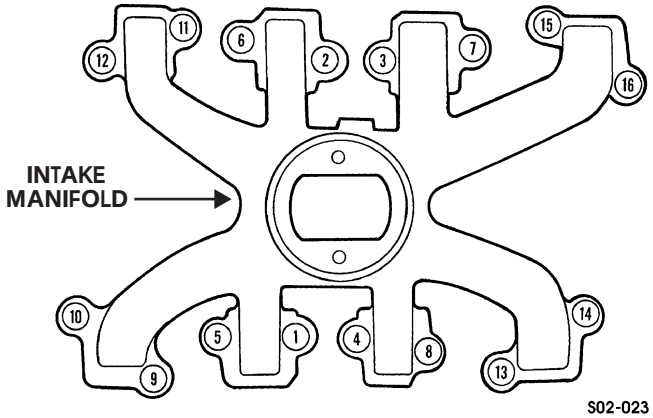


Figure 2-29: Manifold Bolt and Stud Tightening Sequence

ROCKER ARM COVER SERVICE

Removal (Passenger Side)

1. Remove front console and engine cover.
2. Remove air horn and inlet hose. Then remove air cleaner assembly.
3. Drain radiator.
4. Remove surge tank.
5. Disconnect and remove water control valve, hoses, and bracket.
6. Remove CDR valve and hose.
7. Remove bolt that attaches transmission fill tube to cylinder head.
8. Remove brackets attaching electrical wire harnesses and sensors to intake manifold.
9. Remove nuts attaching fuel injector line clamps to intake manifold studs.
10. Remove intake manifold and gaskets. Cover cylinder head intake ports to prevent dirt entry.
11. Disconnect lines at fuel injectors. Cover injectors and cap lines immediately to prevent dirt entry.
12. Loosen lines at fuel injection pump.
13. Remove studs and bolts attaching rocker arm cover to cylinder head.
14. Tap rocker arm cover with rubber mallet to break sealer head and loosen cover. Do not pry cover loose.
15. Move fuel injector lines aside (rotate them out of way). Or remove necessary injector lines if unable to move aside.

***CAUTION**: Do not bend the fuel lines. The internal coating could fracture, peel off, and clog the injectors.*

16. Remove rocker arm cover.
17. Scrape old silicone sealer off cover. Then clean cover with parts cleaning solvent. Final-clean sealing surfaces with brake or electrical contact cleaner. This is necessary to remove residue left from cleaning solvent and ensure proper adhesion of new sealer.
18. Clean gasket surfaces of intake manifold and cylinder head. Be sure surfaces are clean and smooth. Remove minor nicks or scratches with 220 grit emery or paper.

Installation (Passenger Side)

1. Clean cover mounting surface of cylinder head with brake or contact cleaner and shop towels. This product will remove residue from the surface and ensure proper adhesion of new sealer.
2. If new rocker arm cover is being installed, clean seal surface with brake or contact cleaner.
3. Apply sealer to rocker arm cover sealing surface. Make sealer bead 3/16 in. wide by 1/16 in. thick. Use Loctite 592, Permatex Ultra Copper, or similar quality silicone sealer. Allow sealer to cure slightly (skin over) before installation.
4. Align and install rocker arm cover on cylinder head.
5. Install rocker arm cover attaching studs and bolts (Figure 2-30). Tighten cover fasteners evenly to 13-25 lb-ft (18-34 N•m) torque. Start at center and work toward ends when tightening.
6. Remove protective covering from injectors and lines. Then connect lines to injectors and to pump, if removed. Tighten line fittings to 20-22 lb-ft (27-30 N•m).
7. Install intake manifold and new gaskets. A gasket dressing such as, perfect seal, or Permatex High Tack, can be used to hold gaskets in place. Tighten manifold bolts and studs to 31 lb-ft (42 N•m) torque in sequence (Figure 2-29).
8. Install fuel injector line clamps and wire harness brackets on manifold studs. Tighten retaining nuts to 26 lb-ft (35 N•m) torque.
9. Install CDR valve and hose.
10. Install bolt that secures transmission fill tube to cylinder head.
11. Install water control valve and hoses.
12. Install surge tank.
13. Refill cooling system
14. Start engine and check cover for leaks. Then bleed each injector by loosening fuel line fitting (at injector), just enough to purge any trapped air. Stop engine when complete.
15. Install air cleaner, inlet hose, and air horn.
16. Install engine cover and front console.
17. Top off engine coolant and oil levels if required.

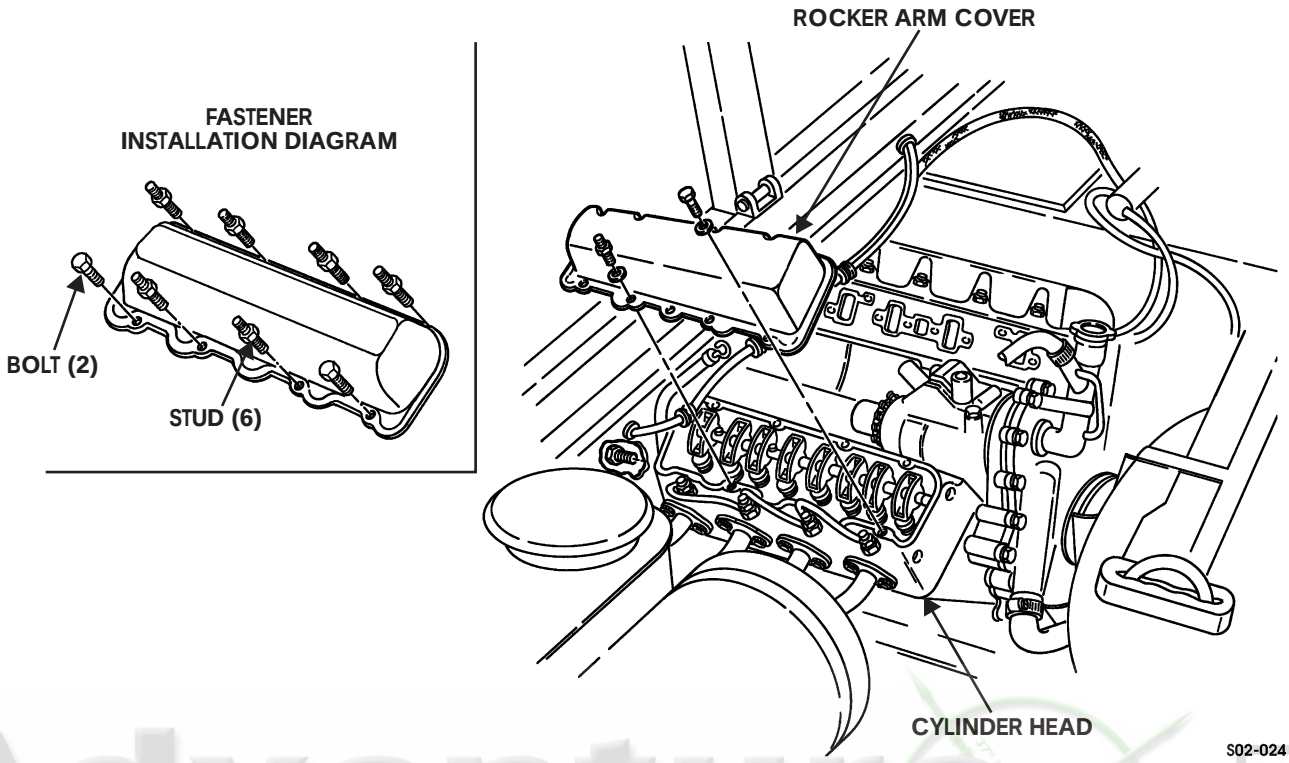


Figure 2-30: Rocker Arm Cover Removal/Installation (Passenger Side)

LEFT ROCKER ARM COVER

Removal (Driver Side)

1. Remove front console and engine cover.
2. Drain engine coolant.
3. Remove driver side splash shield.
4. Remove air inlet hose and air horn.
5. Disconnect radiator upper hoses at thermostat housing and radiator. Then remove hoses and inlet tube as assembly.
6. Disconnect fuel pump, remove it from clamp and move pump aside for working clearance.
7. Remove nuts attaching harness and sensor brackets to intake manifold studs.
8. Remove nuts attaching water valve and bracket. Then move valve and bracket aside for working clearance.
9. Remove nuts and washers attaching fuel injection line clamps to manifold studs. Remove and retain clamps and fasteners.
10. Remove studs and bolts attaching intake manifold to cylinder heads. Remove manifold and gaskets. Cover cylinder head intake ports with shop towels to prevent dirt entry.
11. Remove screws attaching oil dipstick and tube to cover. Then rotate tube away from engine for working clearance.
12. Disconnect fuel lines at driver side injectors. Then loosen (or remove) lines at pump. Rotate lines aside for working clearance. Cover lines and injectors to prevent dirt entry.

***CAUTION**: Do not bend the fuel injector lines. The internal coating could fracture, peel off, and clog the injectors.*

13. Remove rocker arm cover attaching bolts and studs. Then tap cover with rubber mallet to break sealer bead. Do not pry cover loose.
14. Remove rocker arm cover.
15. Clean cover in parts cleaning solvent and scrape all traces of old silicone sealer off cover seal surfaces. Final clean cover seal surfaces with brake or contact cleaner. This is necessary to remove residue from cleaning solvent, and ensure proper adhesion of new sealer.
16. Clean gasket surfaces of intake manifold and cylinder heads. Be sure surfaces are clean and smooth. Remove minor nicks or scratches with 220 grit emery or paper.

Installation (Driver Side)

1. Clean cover mounting rails on cylinder head with brake or contact cleaner and shop towels. This product will remove residue from surface and ensure proper adhesion of new sealer.
2. If new rocker arm cover is being installed, clean seal surface with brake or contact cleaner.
3. Apply sealer to rocker arm cover sealing surface. Make sealer bead 3/16 in. wide by 1/16 in. thick. Use Loctite 592, Permatex Ultra Copper, or similar quality silicone sealer. Allow sealer to cure slightly (skin over) before installation.
4. Align and install rocker arm cover on cylinder head.
5. Install rocker arm cover attaching bolts and studs (Figure 2-31). Tighten cover fasteners evenly to 13-25 lb-ft (18-34 N•m) torque.
6. Remove protective covering from injectors and lines. Then connect lines to pump and injectors. Tighten line fittings to 20-22 lb-ft (27-30 N•m) torque.
7. Install intake manifold and new gaskets. A gasket dressing such as Perfect Seal, or Permatex High Tack, can be used to hold gaskets in place. Tighten manifold bolts and studs to 31 lb-ft (42 N•m) torque in sequence shown (Figure 2-31).
8. Install fuel injector line clamps and harness and sensor brackets on manifold studs. Tighten retaining nuts to 26 lb-ft (35 N•m) torque.
9. Attach oil dipstick and tube to cover bracket.
10. Attach water control valve bracket to manifold.
11. Install and connect fuel pump.
12. Connect radiator upper hoses and inlet tube.
13. Refill engine cooling system.
14. Install air inlet hose and air horn.
15. Start engine and check cover for leaks. Then bleed each injector by loosening fuel line fitting (at injector), just enough to purge trapped air. Stop engine when complete.
16. Install engine cover and console.
17. Top engine coolant and oil levels if required.

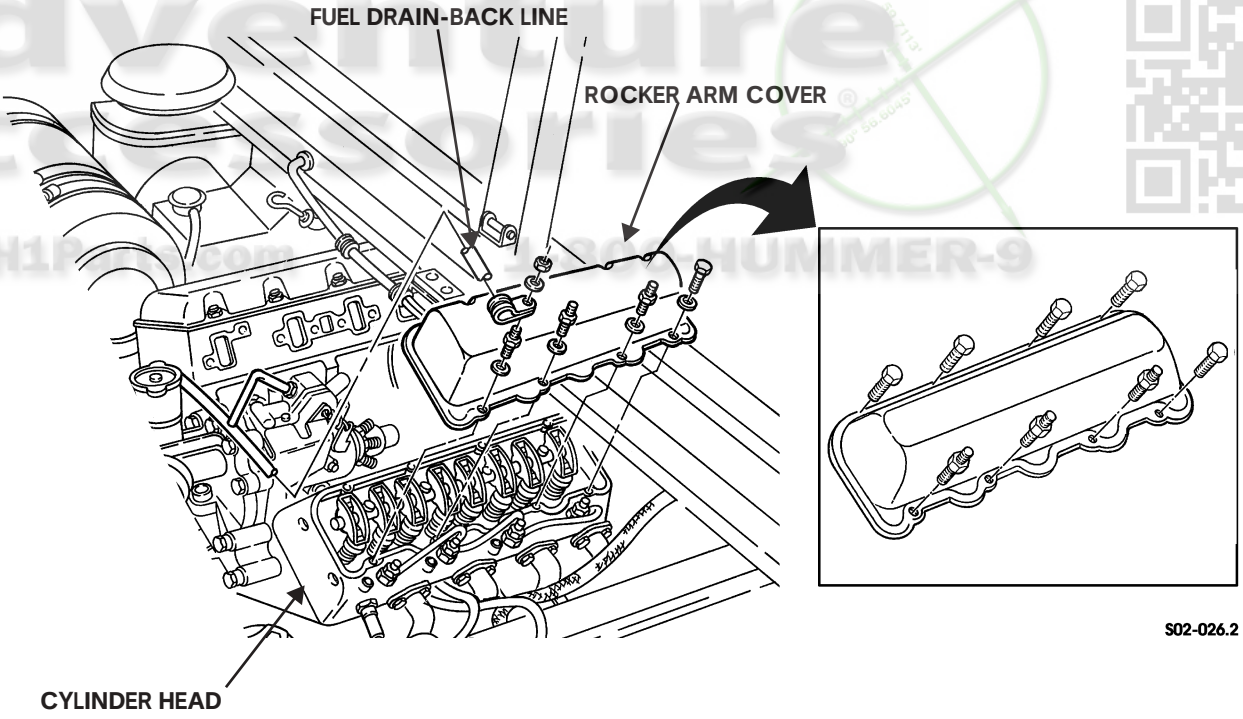


Figure 2-31: Left Rocker Arm Cover

ROCKER ARM/SHAFT/PUSHROD SERVICE

Removal

1. Remove one or both rocker arm covers as needed. Refer to procedures in this section.
2. Remove bolts and retainers that attach rocker arm shafts to cylinder head (Figure 2-32). Note position of bolts for installation reference. Bolts must be reinstalled in same threaded holes.
3. Lift and remove each rocker arm and shaft assembly (Figure 2-32). Do not intermix assemblies if they will be reused. Each assembly must be reinstalled in same position.
4. Remove pushrods in sequence. Keep them in order of removal. Also note which end of push rod goes in rocker arm. This end of rod is heat treated and usually identified with a scribe or paint mark.
5. Remove serpentine belt and crankshaft pulley. Pulley must be removed for access to torsional damper bolt. Refer to procedure in this section.

Cleaning and Inspection

Clean the valve train components in parts cleaning solvent. Carb cleaner or a spray type gasket remover can be used to remove stubborn deposits.

Mark position of the rocker arms on the shafts. Remove the rocker arm retainers with pliers. Then remove the arms and examine the shafts for wear, grooving, or surface cracks. Check the rocker arms for cracks at the shaft bores and for wear at the valve and push rod contact points. Replace worn, or damaged parts as needed.

Check the pushrods for wear, or distortion. Replace any push rod exhibiting wear (at either end), or if bent, or kinked.

Installation

1. Lubricate all parts with engine oil, or with a quality assembly lube.
2. Install pushrods in same sequence as when removed. Verify that heat treated end is facing up toward rocker arm.
3. Assemble rocker arms and shaft if necessary. Secure arms with new retainers but be sure reused arms are installed on same shafts and in same position. Do not intermix parts.

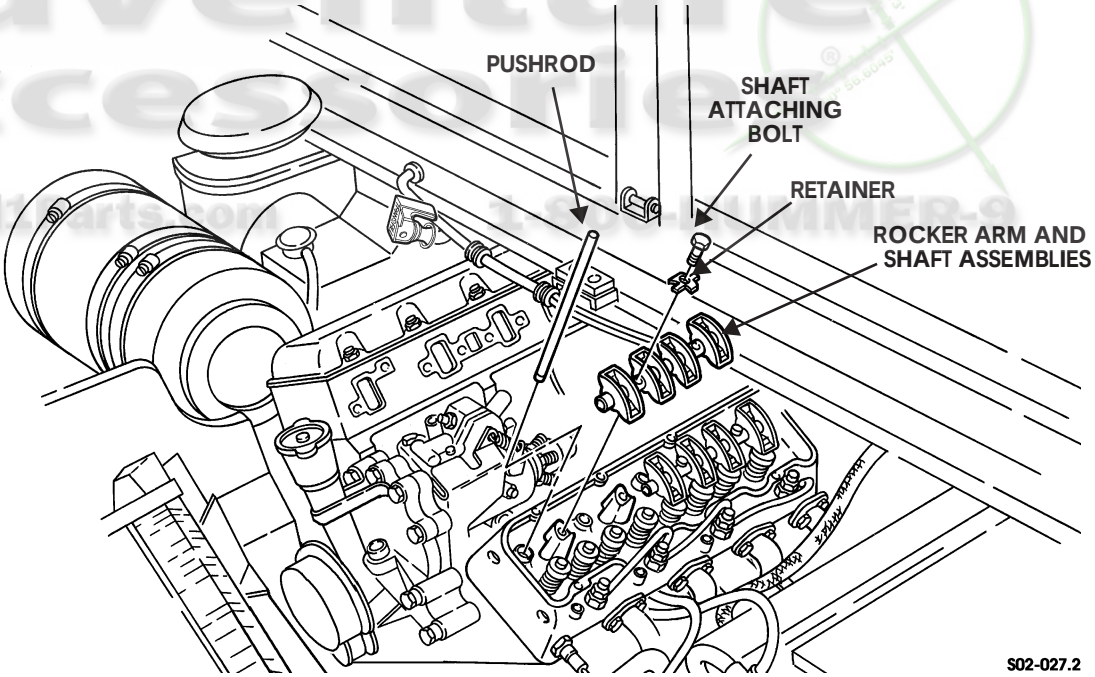


Figure 2-32: Rocker Arm Shafts and Pushrods

4. Index crankshaft and pistons for rocker arm shaft installation as follows:
   a. Position breaker bar and socket on crankshaft damper bolt. Do not use starter to rotate crankshaft. Turn shaft with hand tools only.
   b. Rotate crankshaft counterclockwise, and align mark on torsional damper with "O" mark on front cover timing tab.
   c. Rotate engine counterclockwise an additional 3 1/2 inches (89 mm), measured at mark on torsional damper. Damper mark should align with water pump first, lower attaching bolt at this point.
5. Align and install rocker arm and shaft assemblies (Figure 2-33). Be very sure pushrods are seated in lifters and in rocker arms.
6. Install rocker arm shaft retainers and bolts. Tighten bolts in small increments until snug, with socket and ratchet or nut runner.

***CAUTION**: Do not use an air wrench to tighten the bolts. In addition, stop tightening if the bolts become hard to turn before they are seated. If this condition occurs, the crankshaft and pistons are not properly indexed, allowing the valves to contact the pistons.*

7. Verify that pushrods are properly seated in rocker arms and lifters. Then final-tighten rocker arm shaft bolts to 41 lb-ft (56 N•m) torque.
8. Install rocker covers and intake manifold as described in this section.

EXHAUST MANIFOLDS

WARNING: To avoid injury, do not touch hot exhaust system components.

Removal (Passenger Side)

1. Remove front console and engine cover for access to manifold rear bolts and heat shields.
2. Remove bolt attaching transmission filler tube to cylinder head.
3. Working under vehicle, remove bolt attaching transmission filler tube to transmission case. Then remove filler tube. Cover tube opening in case to prevent dirt entry.
4. Remove heat shield guard.
5. Remove socket head bolts attaching heat shield to cylinder head and remove shield. Bolts are accessible from under vehicle.
6. Remove bolts/nuts attaching exhaust manifold to crossover pipe (Figure 2-33).
7. Remove socket head bolts attaching manifold to cylinder head and remove manifold and gasket. Also remove crossover pipe gasket if it remained in manifold.
8. Clean cylinder head exhaust port surfaces with wire brush and scraper. If manifold will be reused, clean manifold gasket surfaces as well.

Installation (Passenger Side)

1. Position new gasket on manifold. Insert one or two socket head bolts in manifold to hold new gasket in place.
2. Position manifold and gasket on cylinder head. Tighten previously installed screws finger tight to hold manifold in place.
3. Verify that gasket is properly positioned and install remaining manifold attaching bolts. Tighten bolts to 18-25 lb-ft (24-34 N•m) torque.
4. Install heat shield. Tighten heat shield bolts to 18-25 lb-ft (24-34 N•m) torque.
5. Install gasket in crossover pipe. Then connect crossover pipe to exhaust manifold. Tighten attaching bolts/nuts to 37 lb-ft (50 N•m) torque.
6. Install heat shield guard.
7. Install transmission filler tube.
8. Install engine cover and front console.

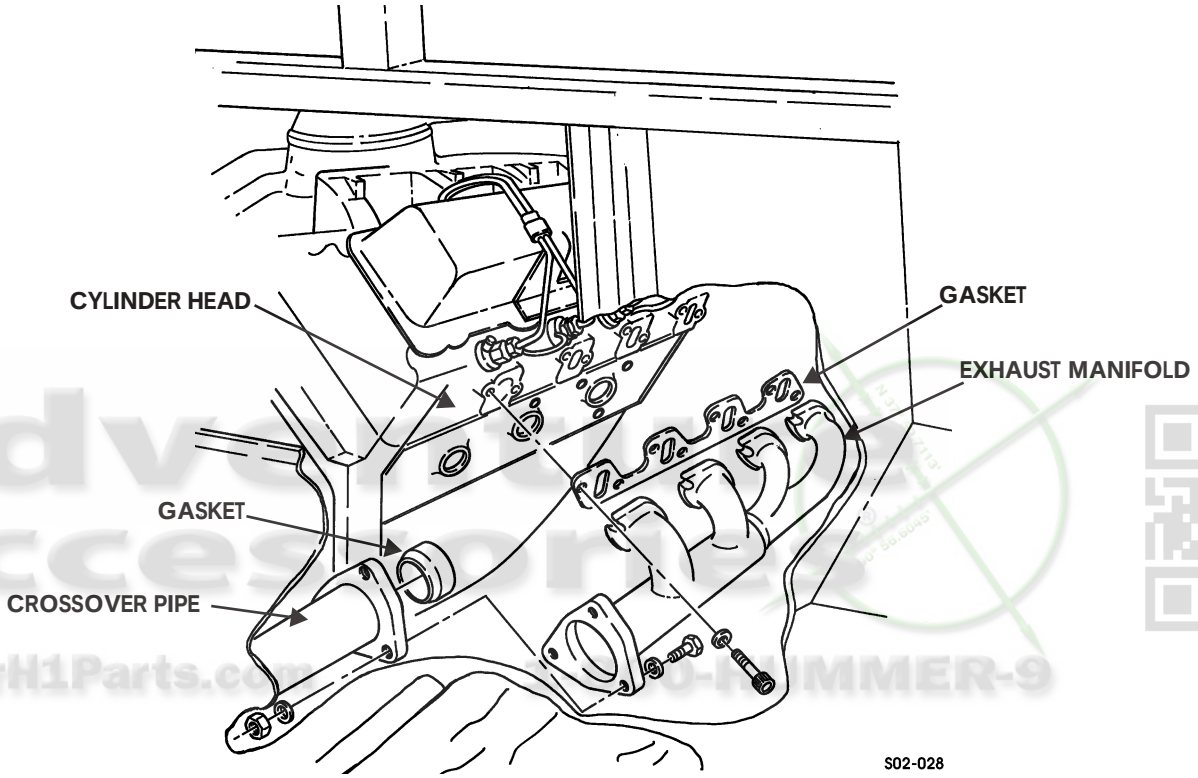


Figure 2-33: Exhaust Manifold Removal/Installation (Passenger Side)

LEFT EXHAUST MANIFOLD REPLACEMENT

WARNING: To avoid injury, do not touch hot exhaust system components with bare hands.

Removal

1. Remove oil dipstick tube (Section 1).
2. Remove locknut, washer, and alternator support bracket from manifold stud.
3. Remove stud from exhaust manifold.
4. Remove three locknuts, six washers, and three capscrews from crossover pipe and exhaust manifold (Figure 2-34).
5. Remove seven socket-head screws and washers from exhaust manifold and cylinder head. Discard socket-head screws.
6. Remove exhaust manifold and two gaskets from cylinder head and crossover pipe. Discard gaskets.

Installation

1. Position gasket in crossover pipe (Figure 2-34).
2. Install gasket and exhaust manifold on cylinder head with seven washers and socket-head screws. Tighten socket-head screws to 18-25 lb-ft (24-34 N•m).
3. Align crossover pipe and gasket with exhaust manifold and install with three capscrews, six washers, and three locknuts. Tighten locknuts to 31-39 lb-ft (42-53 N•m).
4. Install stud in manifold.
5. Install alternator support bracket on stud with washer and locknut.
6. Install oil dipstick tube (Section 1).

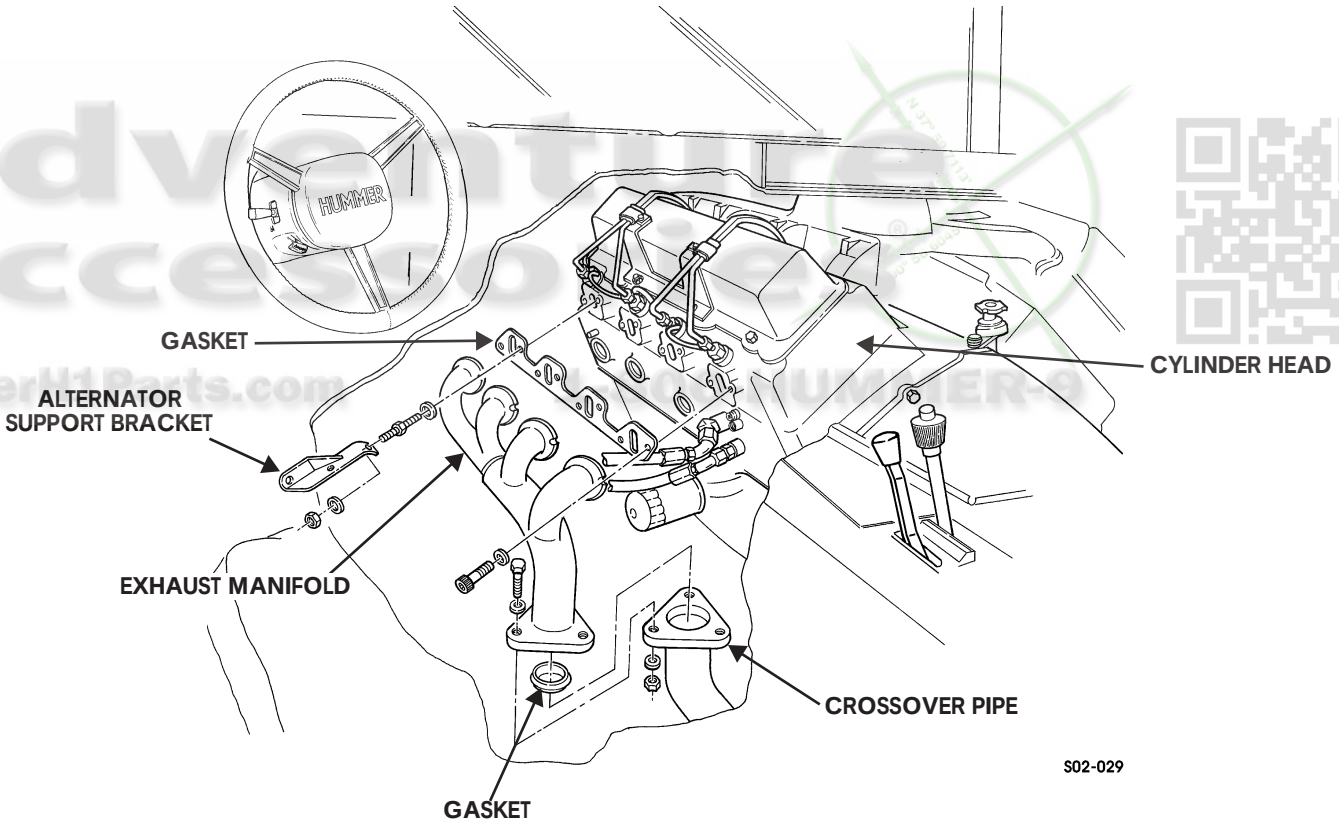


Figure 2-34: Left Exhaust Manifold

LEFT CYLINDER HEAD REPLACEMENT

Removal

1. Remove fuel drain-back tube (Section 3).
2. Remove A/C or idler brackets (Section 12).
3. Remove left exhaust manifold.
4. Remove water crossover (Section 4).
5. Remove rocker arm shafts and pushrods.
6. Remove fuel injection return hoses (Section 3).
7. Remove fuel injection nozzles (Section 3).

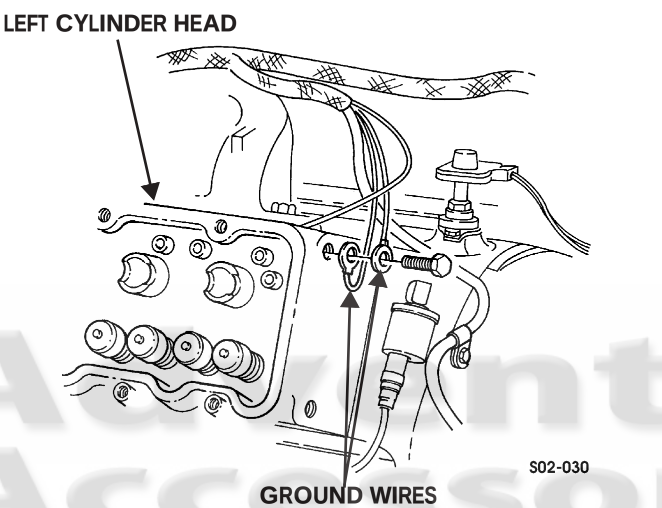


Figure 2-35: Left Cylinder Head

8. Remove glow plugs (Section 3).
9. Tag wires and remove capscrew and ground wires from left cylinder head (Figure 2-35).
10. Disconnect harness lead from temperature sender (Figure 2-36).

WARNING:* *To avoid injury, support cylinder head during removal.

CAUTION: *To prevent entry of foreign matter, cover all openings into engine or lines.*

11. Remove seventeen capscrews, left cylinder head, and gasket from cylinder block. Discard gasket.

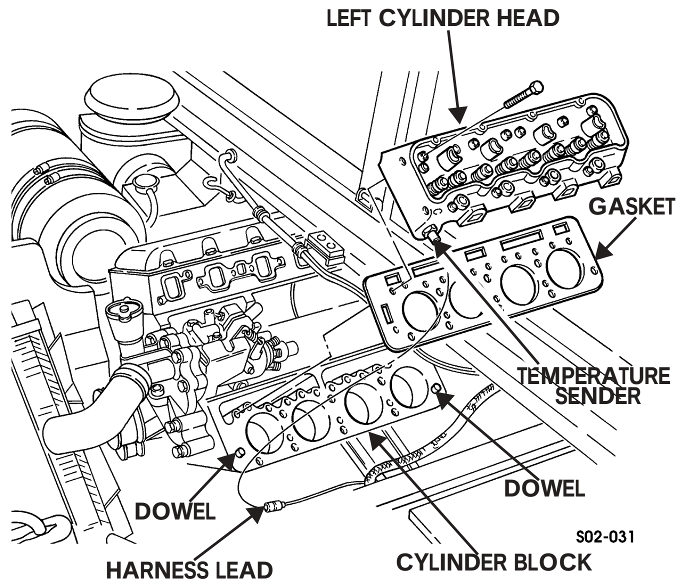


Figure 2-36: Cylinder Head and Gasket

Installation

CAUTION: *To avoid engine damage, do not use any type of sealer on cylinder head gasket or contact surfaces. Gasket may not seal properly.*

1. Position head gasket over dowels on cylinder block. Ensure no foreign matter is on gasket or engine (Figure 2-36).
2. Position left cylinder head on gasket and over dowels.
3. Clean capscrew threads and coat with light coat of pipe thread sealer.
4. Secure left cylinder head to cylinder block with seventeen capscrews. Following torque sequence, tighten capscrews to 20 lb-ft (27 N•m) (Figure 2-37).
5. Repeating torque sequence, tighten capscrews to 50 lb-ft (68 N•m).
6. Repeating torque sequence, tighten each capscrew an additional 90° turn.
7. Apply antiseize compound to two ground wires and install on left cylinder head with capscrew (Figure 2-36).
8. Connect harness lead to temperature sender (Figure 2-36).
9. Install glow plugs (Section 3).
10. Install fuel injection nozzles (Section 3).
11. Install fuel injection return hoses (Section 3).
12. Install rocker arm shaft and pushrods.
13. Install water crossover (Section 4).

14. Install left exhaust manifold.
15. Install A/C or idler brackets (Section 12).
16. Install fuel drain-back tube (Section 3).

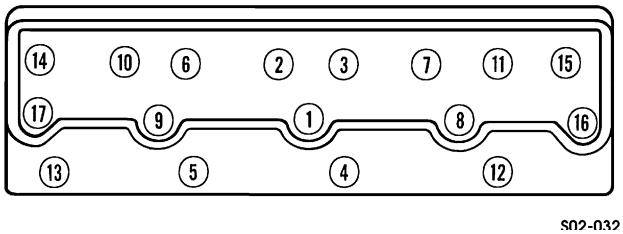


Figure 2-37: Cylinder Head Screws Torque Sequence

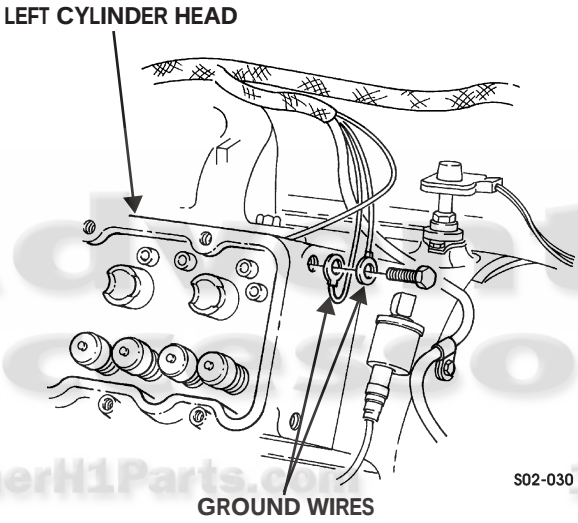


Figure 2-38: Left Cylinder Head

RIGHT CYLINDER HEAD REPLACEMENT

Removal

1. Remove fuel return lines (Section 3).
2. Remove right exhaust manifold.
3. Remove fuel injection lines (Section 3).
4. Remove water crossover (Section 4).
5. Remove rocker arm shafts and pushrods.
6. Remove fuel injection return hoses (Section 3).

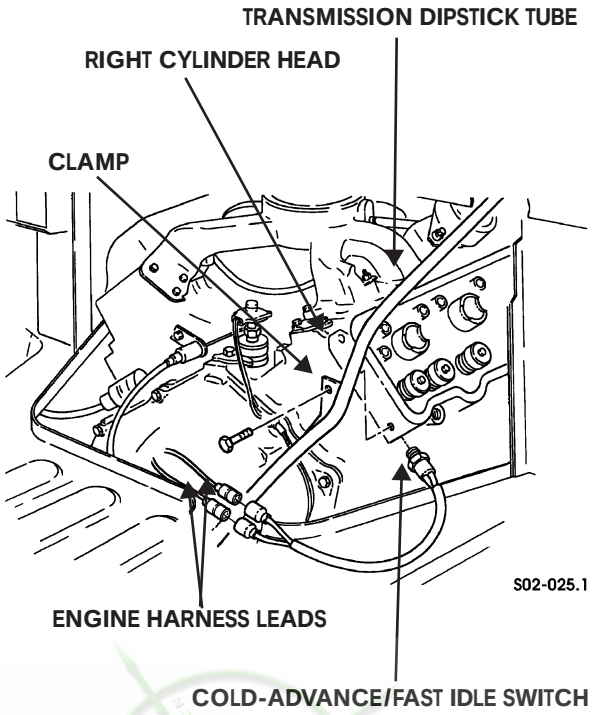


Figure 2-39: Right Cylinder Head

7. Remove fuel injection nozzles (Section 3).
8. Disconnect harness leads from engine harness and remove cold-advance/fast-idle switch (Figure 2-39).
9. Remove capscrew holding clamp on transmission dipstick tube to right cylinder head.

WARNING: To avoid injury, support cylinder head during removal.

CAUTION: *To prevent entry of foreign matter, cover all openings into engine or lines.*

10. Remove seventeen socket-head screws, right cylinder head, and gasket from cylinder block. Discard gasket (Figure 2-40).

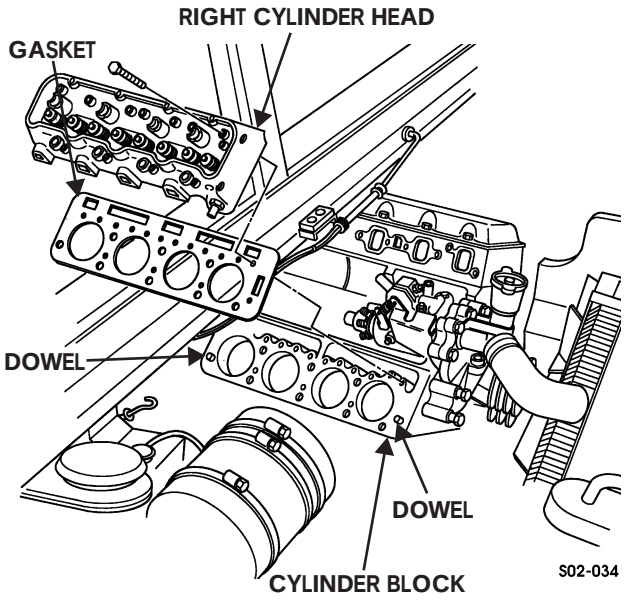


Figure 2-40: Cylinder Head and Gasket

Installation

CAUTION: *To avoid engine damage, do not use any type of sealer on cylinder head gasket or contact surfaces. Gasket may not seal properly.*

1. Position gasket over dowels on cylinder block. Ensure no foreign matter is on gasket or block (Figure 2-40).
2. Position right cylinder head over dowels and on gasket.
3. Clean socket-head screw threads and coat with light coat of pipe thread sealer.
4. Secure right cylinder head to cylinder block with seventeen socket-head screws. Tighten screws to 20 lb-ft (27 N•m) following torque sequence (Figure 2-41).

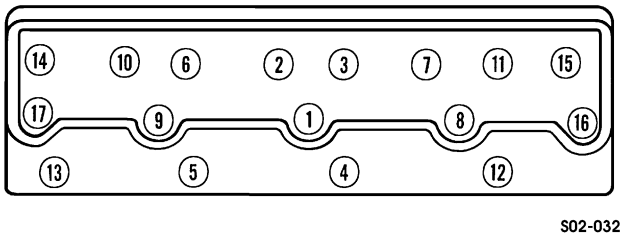


Figure 2-41: Cylinder Head Screws Torque Sequence

5. Repeating torque sequence, tighten socket-head screws to 50 lb-ft (68 N•m).
6. Repeating torque sequence, tighten socket-head screws an additional 90° turn.
7. Install transmission dipstick tube clamp on right cylinder head with capscrew. Tighten screw to 25-37 lb-ft (34-50 N•m) (Figure 2-42).
8. Install cold-advance/fast-idle switch and connect to engine harness (Figure 2-42).
9. Install fuel injection return hoses (Section 3).
10. Install rocker arm shaft and pushrods.
11. Install fuel injection nozzles (Section 3).
12. Install fuel injection lines (Section 3).
13. Install right exhaust manifold.
14. Install water crossover (Section 4).
15. Install glow plugs (Section 3).

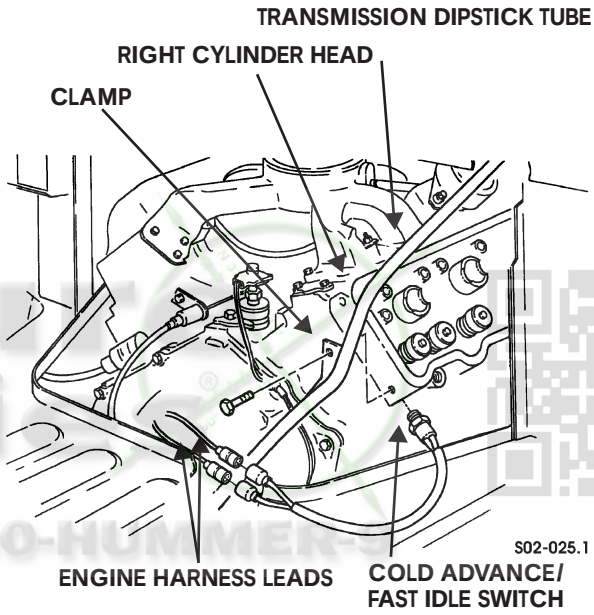


Figure 2-42: Transmission Dipstick Tube

HYDRAULIC VALVE LIFTER REPLACEMENT

Removal

1. Remove left or right side cylinder head.
2. Remove capscrew and guide plate clamp from cylinder block (Figure 2-43).
3. Remove guide plates from cylinder block.

NOTE: Tag valve lifters for assembly if more than one lifter is removed.

4. Using hydraulic valve lifter tool, remove lifter(s) from cylinder block.

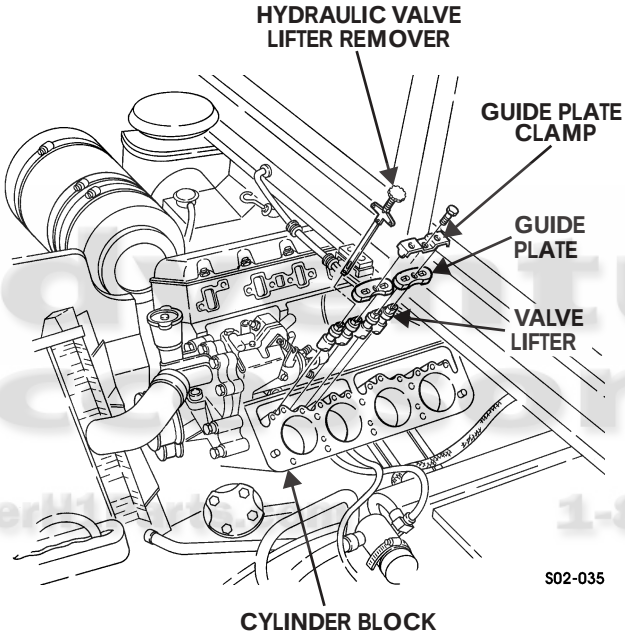


Figure 2-43: Hydraulic Valve Lifter

Installation

WARNING: Diesel fuel and kerosene are flammable. To avoid injury, do not perform procedure near fire, flame, or sparks.

1. Prime lifter(s) in clean diesel fuel or kerosene; work plunger with pushrod (Figure 2-43).
2. Apply oil to lifter(s) (Figure 2-43).
3. Install lifter(s) into proper bore(s) of cylinder block (Figure 2-42).
4. Install guide plate(s) over lifter(s).
5. Position guide plate clamp on guide plate(s) and install with capscrew. Tighten capscrew to 15-20 lb-ft (20-27 N•m).
6. Install cylinder head.

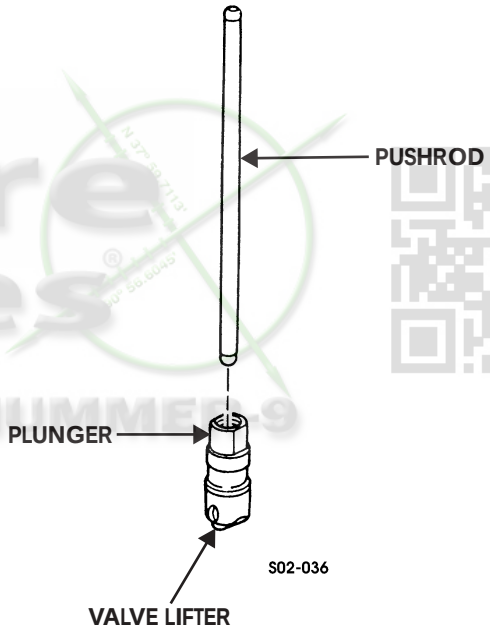


Figure 2-44: Pushrod and Valve Lifter

GLOW PLUG TIP REMOVAL (DAMAGED OR BROKEN)

Removal

1. Remove fuel injector nozzle (Section 3).
2. Loosen serpentine drivebelt (Section 4).
3. Using torsion damper bolt, rotate crankshaft to bring affected piston to TDC position closing valves (Figure 2-45).

NOTE: Perform steps 4 and 5 if glow plug is still installed in cylinder head. Perform step 6 if tip is broken free of glow plug body and is in prechamber.

4. Using pliers, reach through injector nozzle port, break off expanded tip, and remove from prechamber (Figure 2-38).
5. Remove glow plug (Section 3).

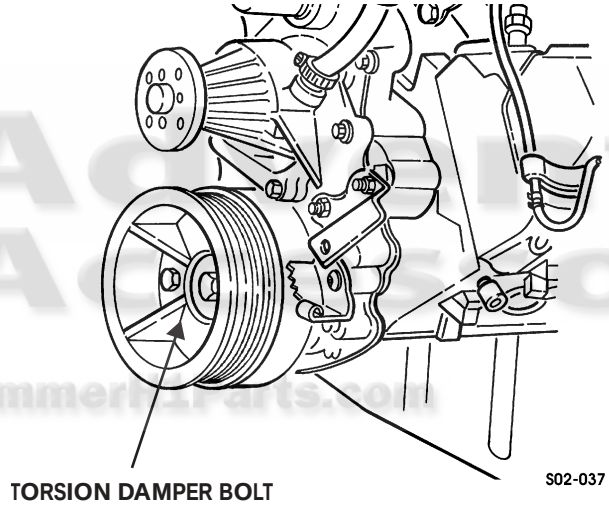


Figure 2-45: Torsion Damper Bolt

6. Direct a stream of low-pressure compressed air into glow plug port to expel broken tip through injector nozzle port.

NOTE: If the preceding methods fail to remove glow plug remains from prechamber, the cylinder head must be removed to clear broken pieces. Any remains will damage engine if engine is operated.

7. Install new glow plug (Section 3).
8. Install fuel injector nozzle (Section 3).
9. Tighten drivebelts (Section 1).

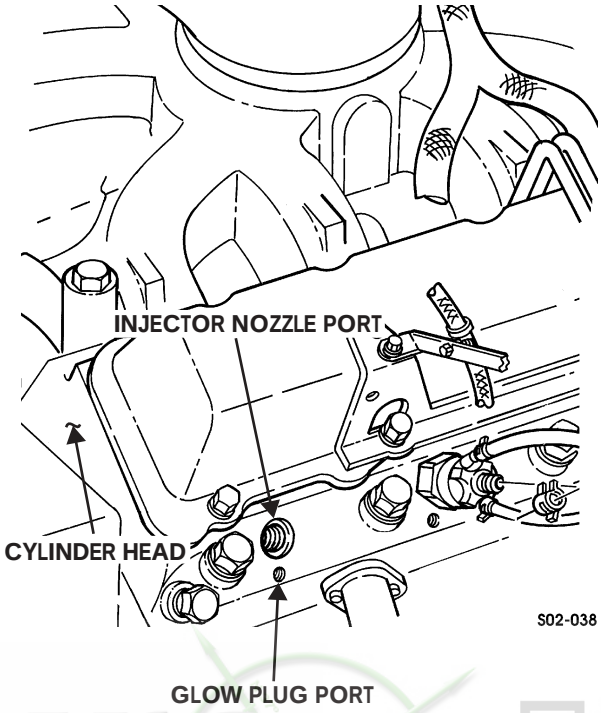


Figure 2-46: Glow Plug Port and Injector Nozzle Port

FUEL INJECTION PUMP TIMING

Timing Check

1. Connect timing meter following manufacturer's instructions (Figure 2-47).
2. Start engine and warm up to operating temperature.
3. Set engine speed to 1300 rpm.
4. Correct reading is 5° BTDC. If reading is incorrect, go to timing adjustment.

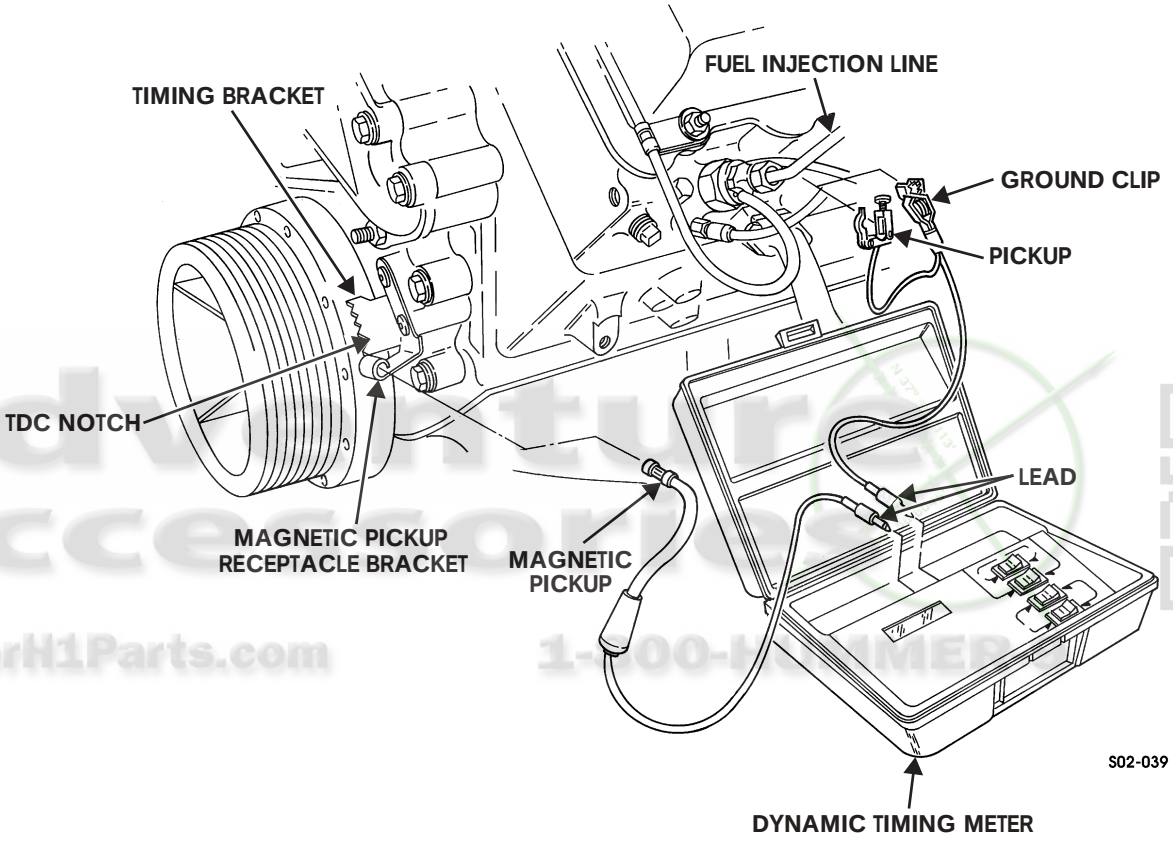


Figure 2-47: Magnetic Pickup Dynamic Timing Meter

Timing Adjustment

WARNING: To avoid injury or engine damage, never adjust injection pump timing with engine running.

1. Loosen three nuts holding fuel injection pump to timing chain cover (Figure 2-48).

NOTE: Referencing timing marks on fuel injection pump and on timing chain cover; moving injection pump timing mark, 0.03 in. (0.8 mm) is approximately a 1° change in timing.

2. Rotate injection pump clockwise to retard timing, and counterclockwise to advance timing to desired 5° BTDC.
3. Tighten three nuts securing injection pump to timing chain cover.
4. Repeat timing check steps, as necessary, for best operation.

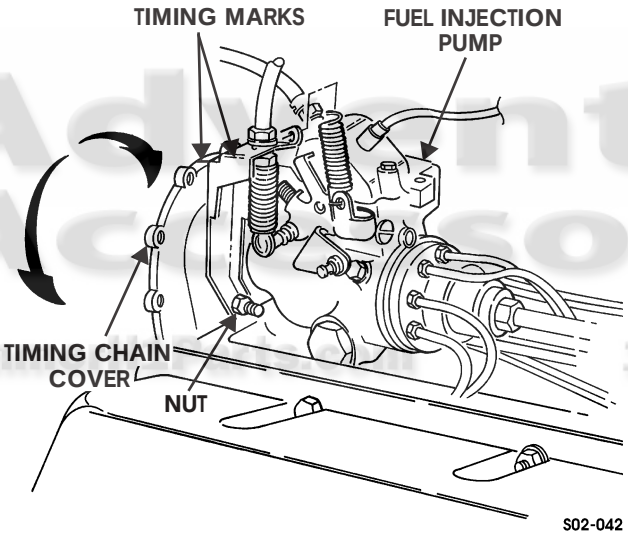


Figure 2-48: Timing Marks Location

ENGINE RUN-IN

In-Chassis Run-In

WARNING: To avoid injury or engine damage, ensure engine compartment is free of all tools and working material before starting engine.

CAUTION: *If any leak or abnormal noise is noted, stop engine immediately and correct as necessary. Any abnormalities must be corrected before proceeding.*

1. Start engine and idle for 5-10 minutes.
2. Stop engine and check for correct oil and coolant levels. Add if necessary.
3. Check for leaks. Correct any leaks.
4. Start engine and run at 1/4-1/2 throttle until coolant temperature reaches 165°-195° F (74°-90°C).
5. Repeat steps 2 and 3.
6. Reset throttle to normal idle speed.

ENGINE REMOVAL

NOTE: Refer to engine decal on left rocker arm cover for model number before ordering replacement parts.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove crossover pipe (Section 3).
3. Drain cooling system (Section 4).
4. Remove left and right engine splash shields (Section 10).
5. Remove radiator, upper and lower radiator hoses, and fan shroud (Section 4).
6. Remove torque converter covers (Section 5).
7. Remove two cover plates and seals from airlift brackets (Figure 2-49).
8. Remove serpentine belt from pulleys (Section 4).

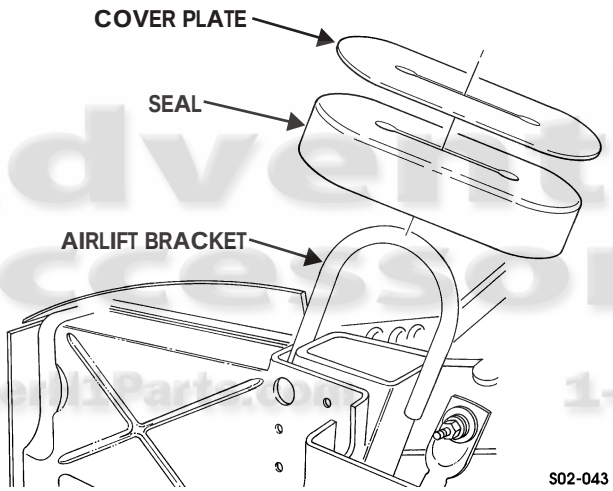


Figure 2-49: Cover Plate and Seal

9. Remove four nuts, fan drive with fan, water pump pulley, and four studs from water pump (Figure 2-50).

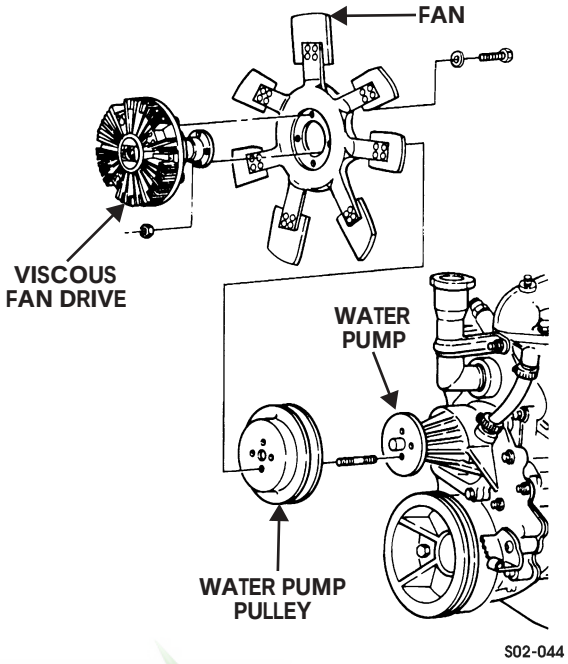


Figure 2-50: Fan and Drive Clutch

10. Remove pivot bolt and two adjusting capscrews from bracket (Figure 2-51).

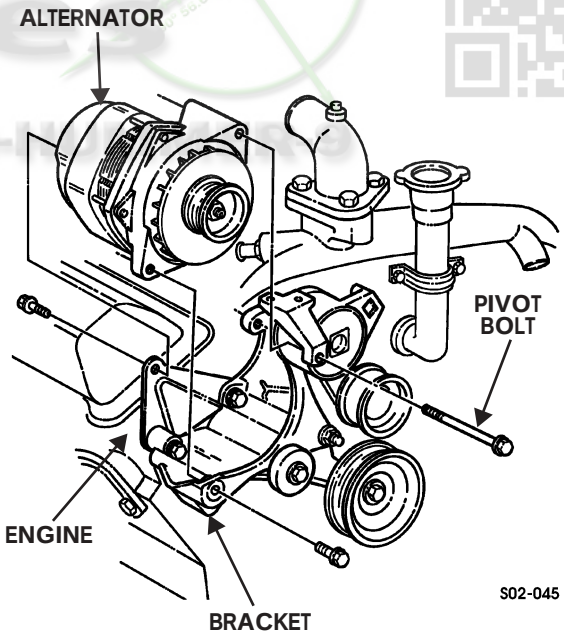


Figure 2-51: Pivot Bolt and Capscrews

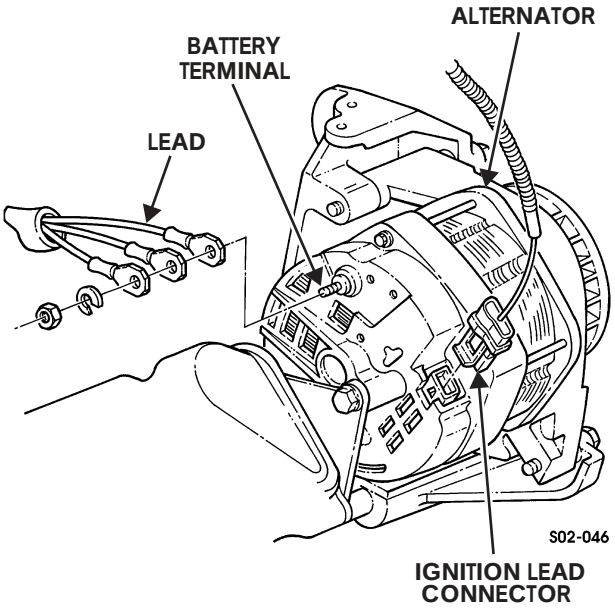


Figure 2-52: Alternator Component Location

11. Pull alternator away from engine. Remove nut, lockwasher, and lead from alternator battery terminal. Discard lockwasher (Figure 2-52).
12. Unlock and disconnect ignition lead connector from side of alternator.
13. Remove two screws, washers, rubber washers, and air horn from intake manifold. Discard rubber washers (Figure 2-53).

CAUTION: *To avoid damage, cover opening of intake manifold to prevent entry of foreign matter.*

14. Loosen clamps on air horn and air intake elbow. Slide clamps from air horn support bracket and air intake elbow. Disconnect air horn and air intake elbow from air cleaner.
15. Remove and discard gasket from intake manifold.
16. Remove nut, lockwasher, wiring harness with clamp, and air horn support bracket from stud on cylinder head. Discard lockwasher (Figure 2-54).

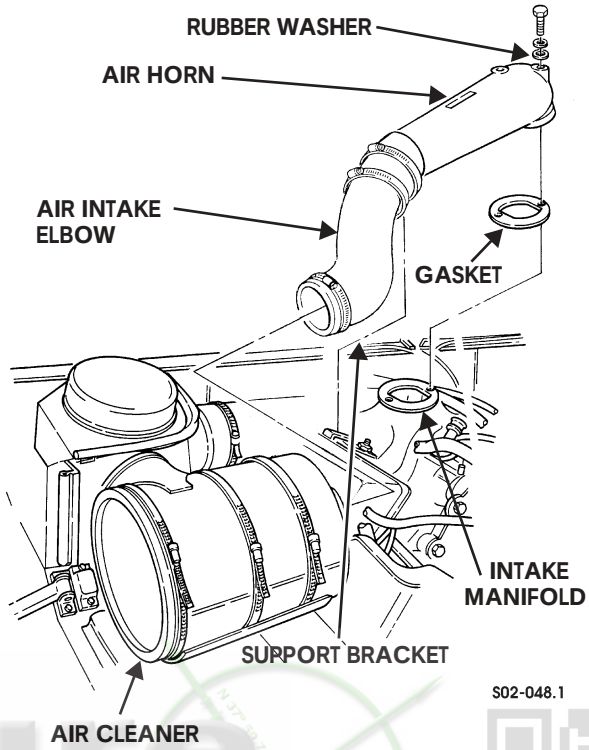


Figure 2-53: Air Horn

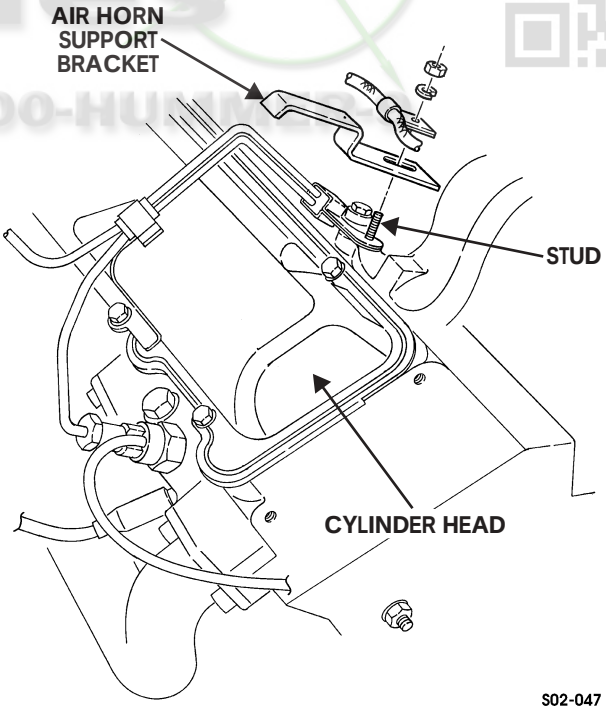


Figure 2-54: Air Horn Support Bracket

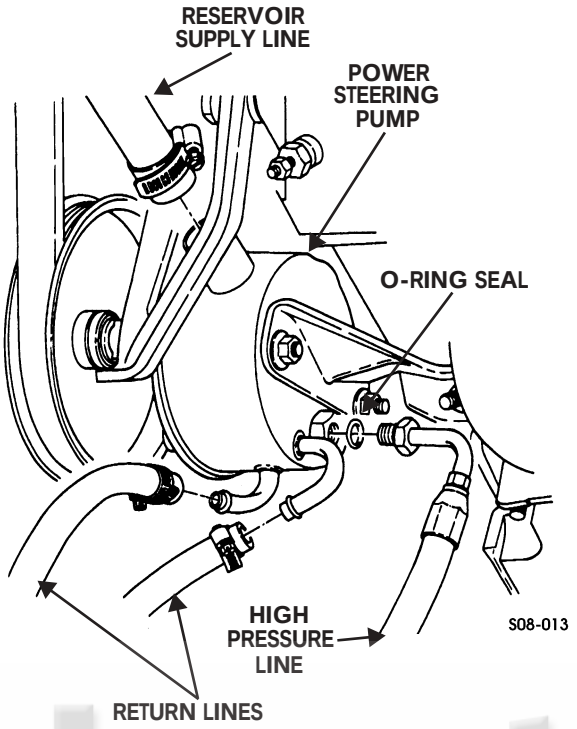


Figure 2-55: Power Steering Pump Lines

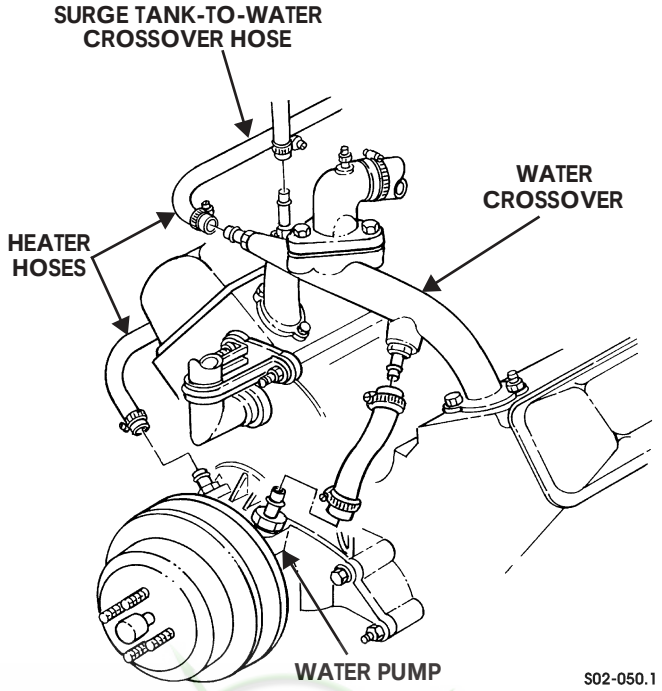


Figure 2-56: Surge Tank-to-Water Crossover Hose

17. Disconnect two return lines and high pressure line from power steering pump. Remove and discard O-ring seal from high pressure line. Loosen clamp and disconnect reservoir supply line from power steering pump (Figure 2-55).
18. Disconnect surge tank-to-water crossover hose from water crossover (Figure 2-56).
19. Disconnect heater hoses at water crossover and water pump.

WARNING: To avoid injury, do not touch hot exhaust system components with bare hands.

20. Remove nut, lockwasher, washer, capscrew, washer, clamp, and transmission dipstick tube from rear heat shield. Discard lockwasher (Figure 2-57).
21. Remove capscrew and rear heat shield from front heat shield.

CAUTION: *To prevent contamination, plug open transmission port.*

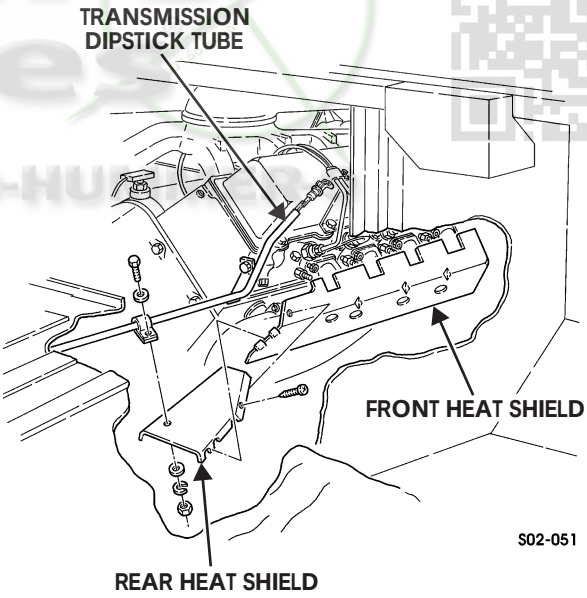


Figure 2-57: Rear Heat Shield

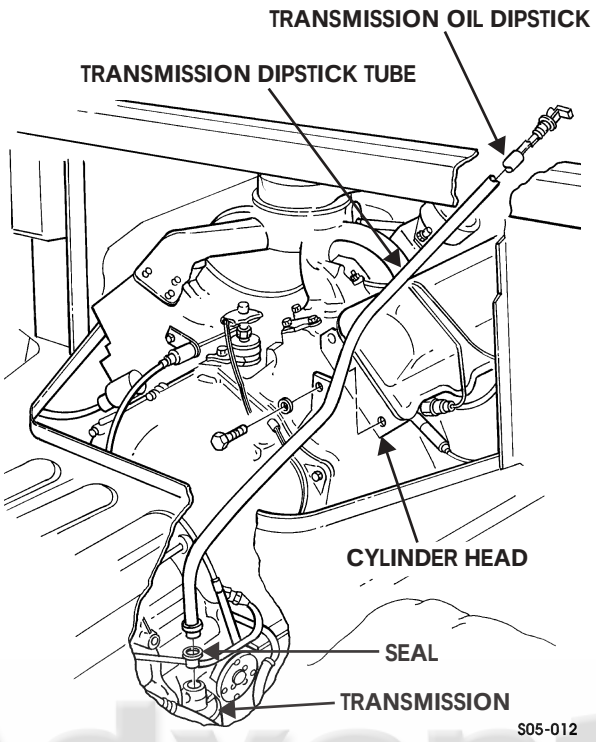


Figure 2-58: Transmission Dipstick Tube

22. Remove transmission oil dipstick from dipstick tube (Figure 2-58).
23. Remove capscrew and washer from dipstick tube and cylinder head.
24. Remove dipstick tube from transmission.
25. Remove and discard seal from dipstick tube.

WARNING: Diesel fuel is highly flammable. To avoid injury, do not perform this procedure near fire, flames, or sparks.

26. Loosen clamp and disconnect hose from fuel return line (Figure 2-59).
27. Remove nut, washer, clamp, and fuel return line from stud.

CAUTION: *To prevent contamination, cover or plug all hoses and connections immediately after disconnection.*

28. Disconnect oil cooler supply and return lines from engine (Figure 2-60).

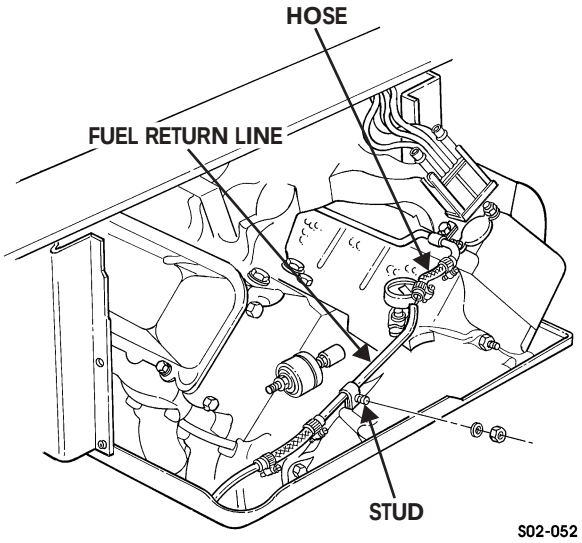


Figure 2-59: Fuel Return Line

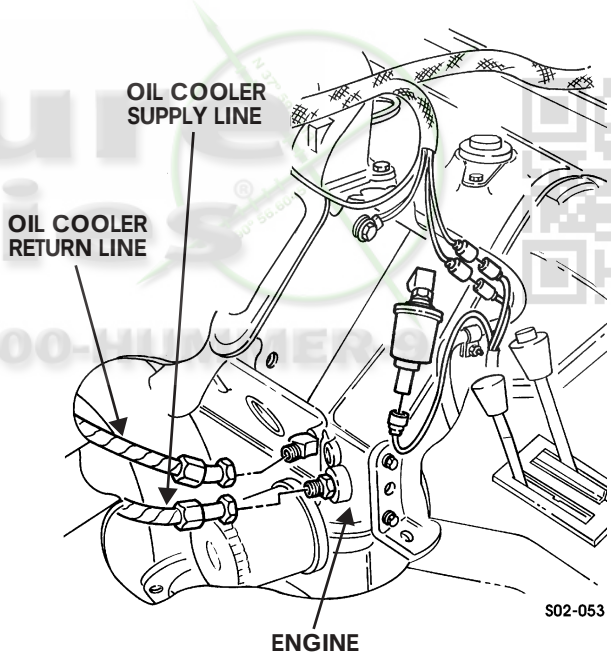


Figure 2-60: Oil Cooler Lines

29. Loosen clamp and disconnect fuel supply line from fuel injection pump adapter (Figure 2-61).

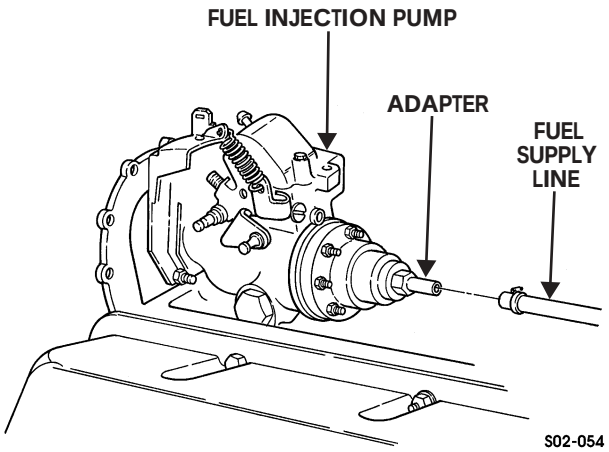


Figure 2-61: Fuel Supply Line

30. Disconnect throttle return spring from bracket and throttle shaft lever (Figure 2-62).
31. Remove cable clip from fuel pump throttle shaft stud.
32. Loosen adjusting nuts and remove throttle cable from throttle shaft stud and bracket.

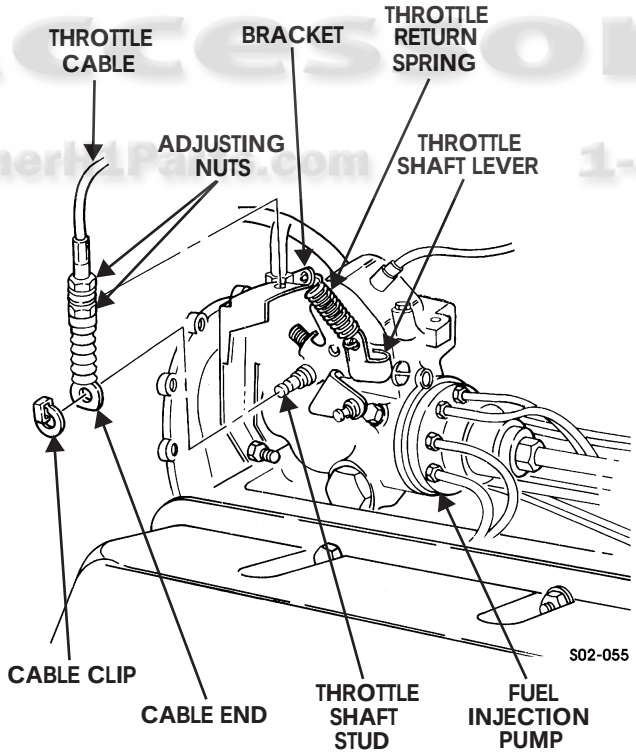


Figure 2-62: Throttle Return Spring

NOTE: Tag leads prior to removal for installation.

33. Remove nut, lockwasher, clamp, and wiring harness from transmission stud. Discard lockwasher (Figure 2-63).
34. Remove two clamps from wiring harness and transmission.
35. Disconnect wiring harness connector from transmission connector, and remove harness from clamp.
36. Remove locknut, washer, capscrew, and washer from clamp and bracket. Discard locknut.
37. Disconnect connector from transmission input speed sensor.
38. Disconnect connector from transmission output speed sensor.
39. Disconnect lock switch connector and speedometer sensor connector from transfer case.
40. Remove screw, clip, and engine wiring harness from starter solenoid (Figure 2-64).
41. Remove nut, lockwasher, and capscrew from clamp securing engine wiring harness to bracket. Discard lockwasher.

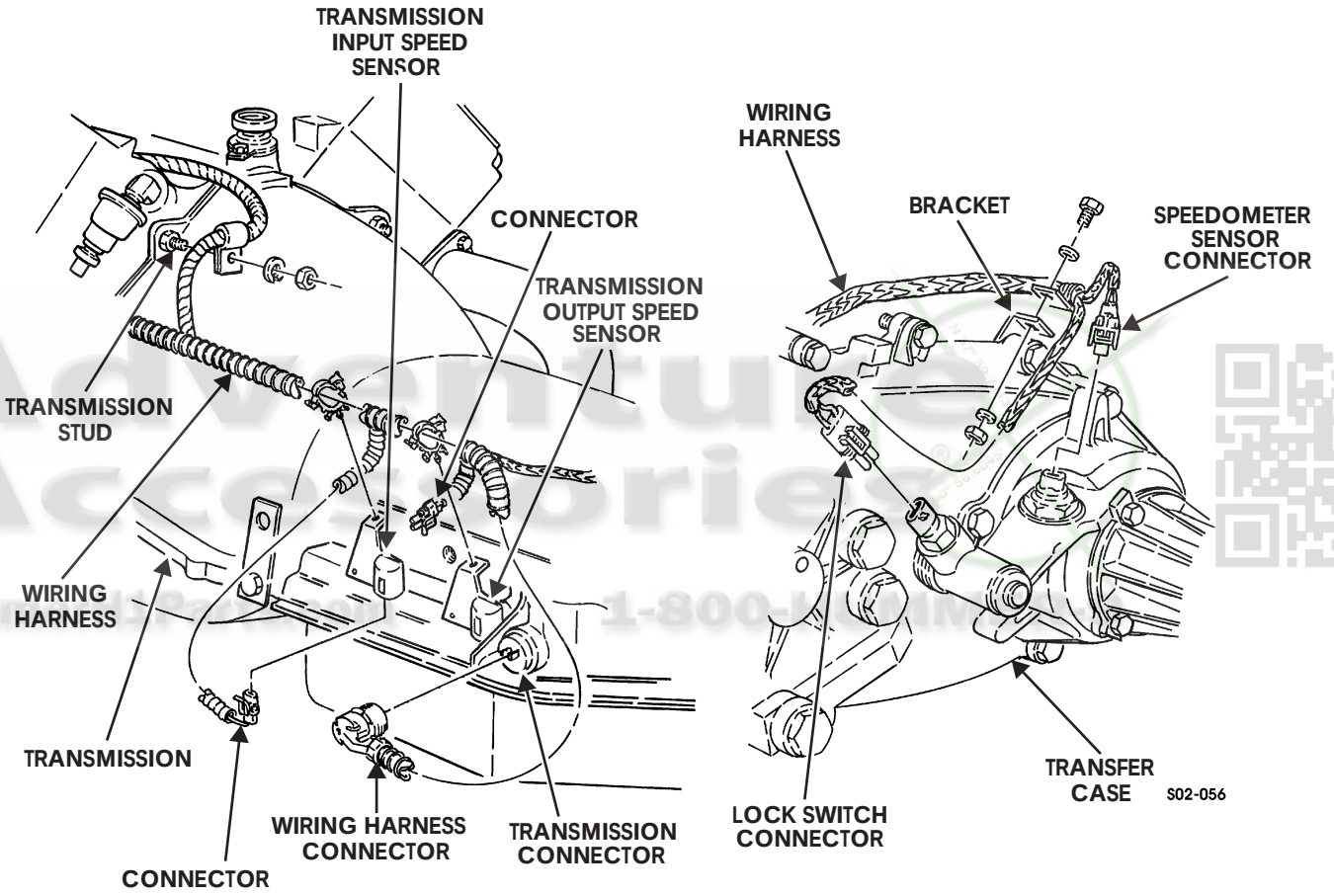


Figure 2-63: Sensor and Switch Connectors

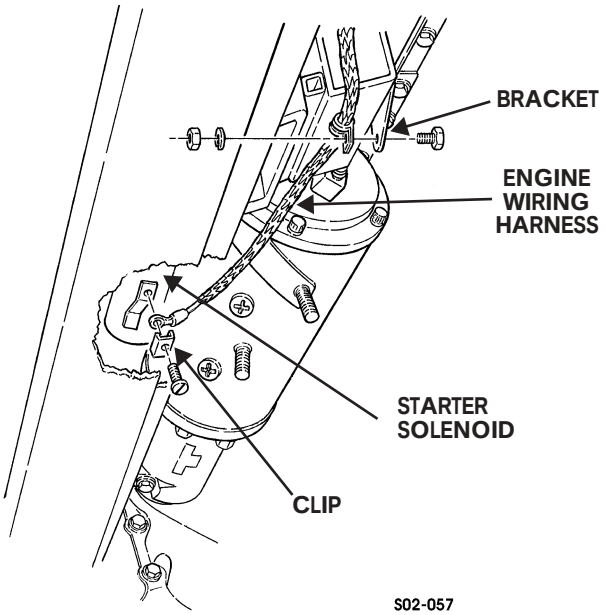


Figure 2-64: Engine Wiring Harness To Starter Solenoid

42. Disconnect two engine wiring harness connectors from horns (Figure 2-65).
43. Remove engine harness quick-disconnect (Figure 2-66).
44. Disconnect harness connector from fuel pump fuse cover.
45. Disconnect harness connector from fuel pump relay.
46. Disconnect two harness connectors from fuel filter.
47. Disconnect harness connector from fuel pump.
48. Remove cover from junction block on left inside of engine compartment.
49. Remove two nuts, lockwashers, and washers from junction block posts. Discard lockwashers.
50. Remove two capscrews and clamp from engine wiring harness and bracket.

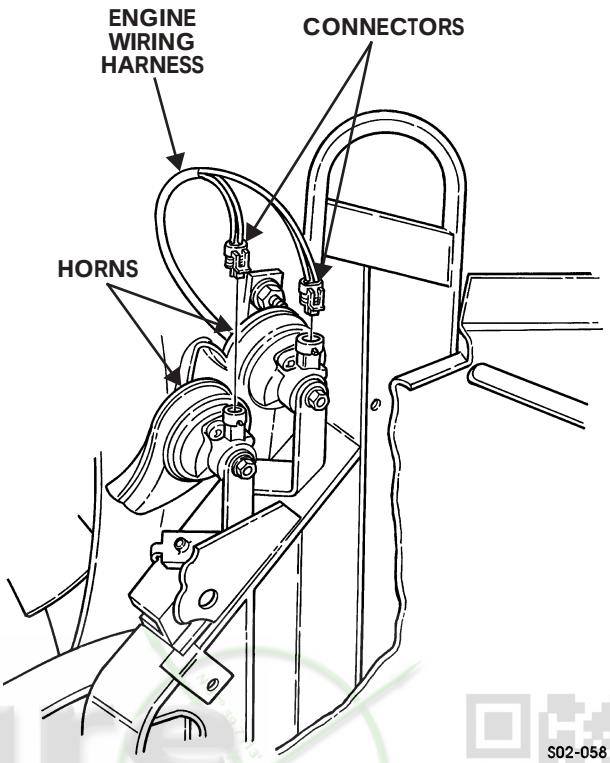


Figure 2-65: Horn Connections

51. Disconnect four harness connectors from left side glow plugs.
52. Disconnect CTI jumper harness from engine harness.
53. Remove clamp from oil dipstick tube bracket.
54. Remove nut, lockwasher, and lead from engine temperature sending unit. Discard lockwasher.
55. Remove only cables and leads that are part of engine wiring harness. Install all cables and leads which are not part of engine wiring harness back on respective posts, and secure with two washers, lockwashers, and nuts. Tighten nuts finger tight and install cover on junction block.

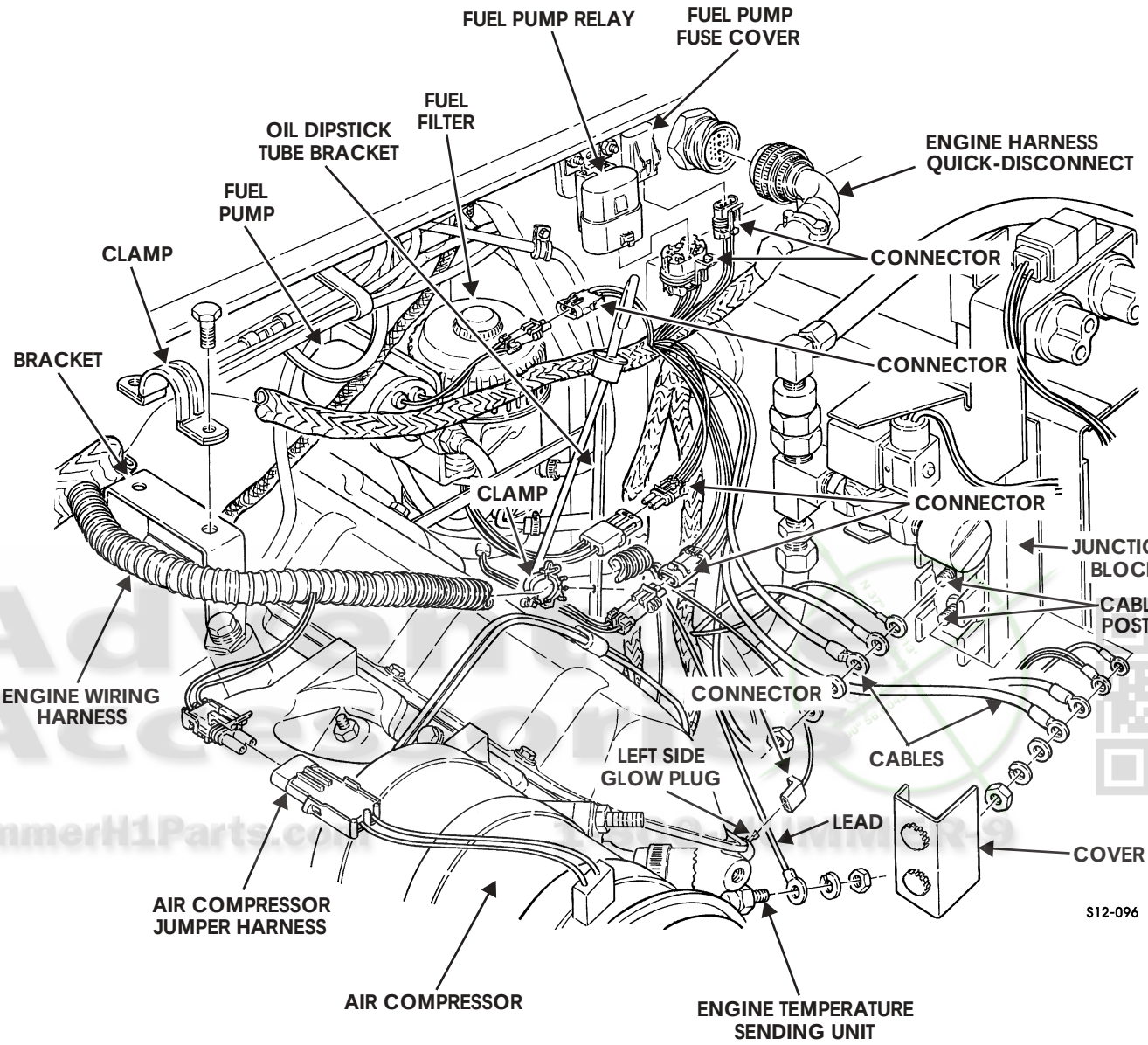


Figure 2-66: Engine Harness Quick-Disconnect

NOTE: Install sling bracket on rear of engine first. Use four 15 x 25 mm capscrews to install lifting sling on engine.

56. Install sling bracket on left cylinder head with two capscrews (Figure 2-67).
57. Position engine lifting sling on engine and secure to right cylinder head with two capscrews.
58. Tighten capscrews and lock sling bracket to sling with pin.

NOTE: To gain access to capscrews securing torque converter to flywheel, it will be necessary to rotate flywheel clockwise by turning capscrew in front of crankshaft.

59. Remove six capscrews securing torque converter to flywheel (Figure 2-68).

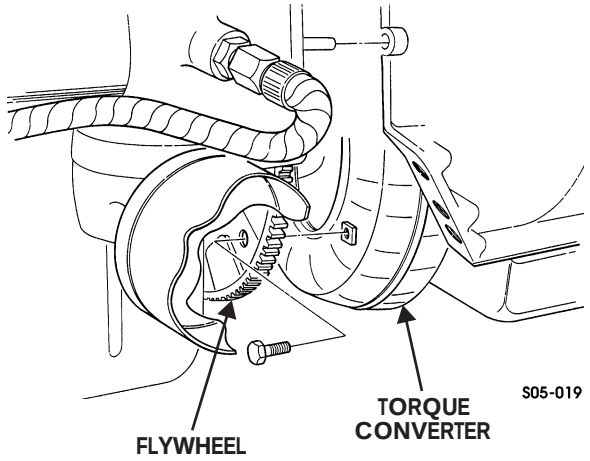


Figure 2-68: Torque Converter Capscrews

NOTE: Hoist must be attached to intermediate eyelet when lifting engine and to rear eyelet when lifting engine and transmission together.

60. Raise engine only enough to take pressure off mounting brackets.
61. Remove two locknuts and washers securing right engine mount to engine mount frame bracket. Discard locknuts. Repeat for left engine mount (Figure 2-69).

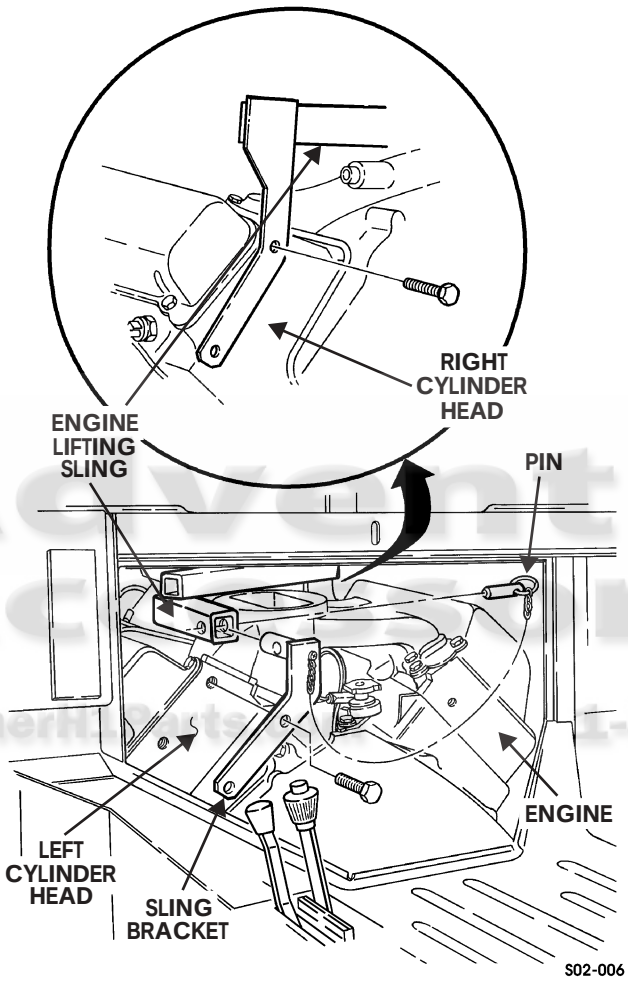


Figure 2-67: Sling Bracket

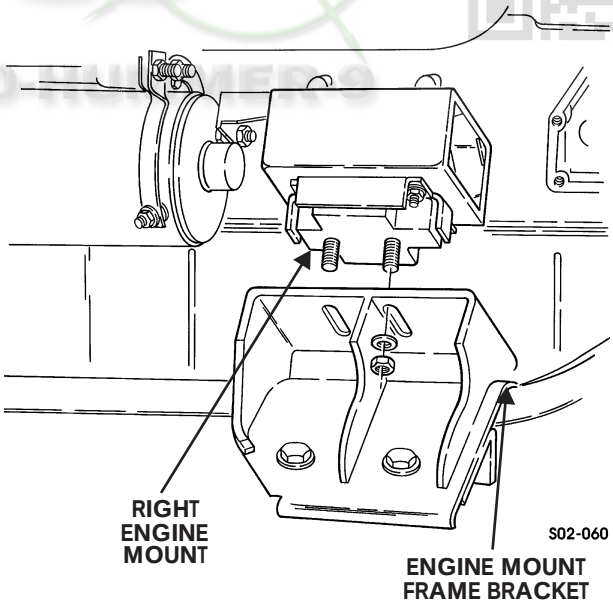


Figure 2-69: Engine Mount and Frame Bracket

WARNING: To avoid injury or damage, transmission must be supported during engine removal.

NOTE: Heat may be needed to loosen capscrews and studs due to the use of LOCTITE 271.

62. Support transmission and remove four capscrews and two studs from transmission and engine (Figure 2-70).

WARNING: To avoid injury, direct all persons not participating in engine removal to stand clear during hoisting operation. Use prybars, not hands, to free engine of hangups or snags.

CAUTION: *Always remove engine slowly and watch for the following conditions. A binding or hard to move engine means that something may still be connected to engine. Ensure wiring, lines, cables, and rods are not in path of removal.*

63. Lift engine slowly out of vehicle.

Disassembly

WARNING: To avoid injury, direct everyone to stand clear during hoisting operation.

1. Install engine on repair stand and disconnect hoist.
2. Remove pin securing sling bracket to engine lifting sling (Figure 2-67).
3. Remove two capscrews and sling from right cylinder head.
4. Remove two capscrews and sling bracket from left cylinder head.

NOTE: Perform steps 5 through 8 if reinstalling used engine. Tag all leads prior to removal for installation.

5. Remove two nuts, lockwasher, and three leads from glow plug controller. Discard lockwasher (Figure 2-71).
6. Remove two nuts and controller from right cylinder head.
7. Replace nuts on studs. Remove engine electrical harness (Section 12).

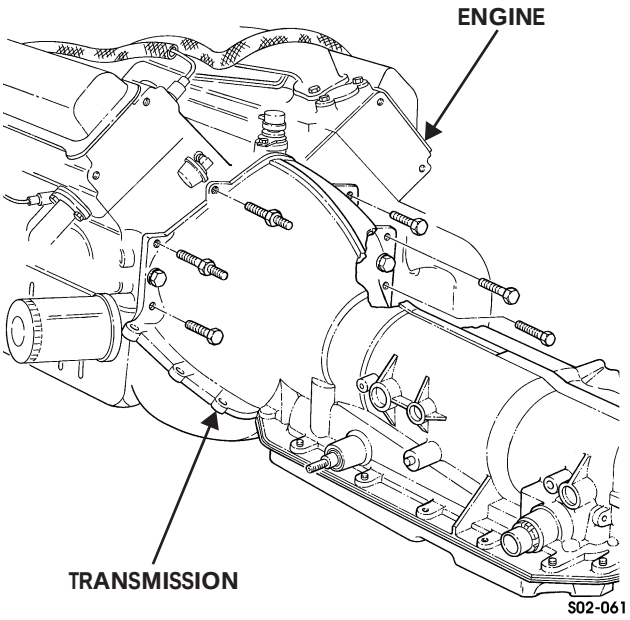


Figure 2-70: Transmission to Engine Capscrews and Studs

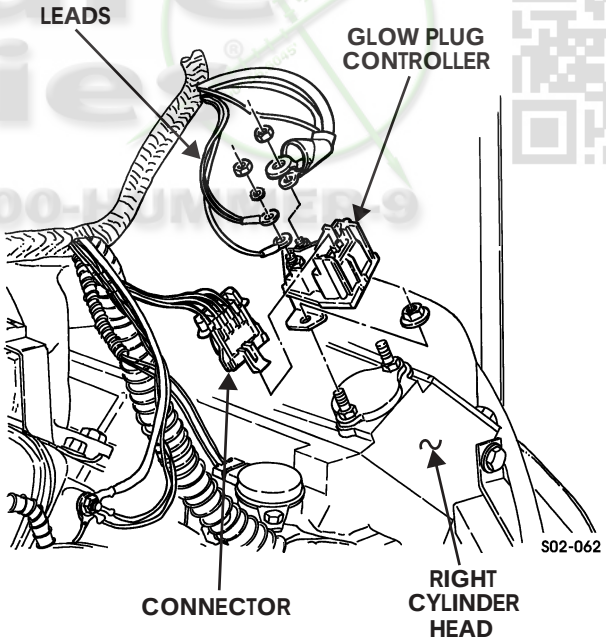


Figure 2-71: Glow Plug Controller Leads

8. Disconnect CDR valve hose from intake manifold (Figure 2-72).
9. Remove CDR valve from right rocker arm cover.
10. Disconnect hose from CDR valve.
11. Remove engine electrical harness (Section 12).

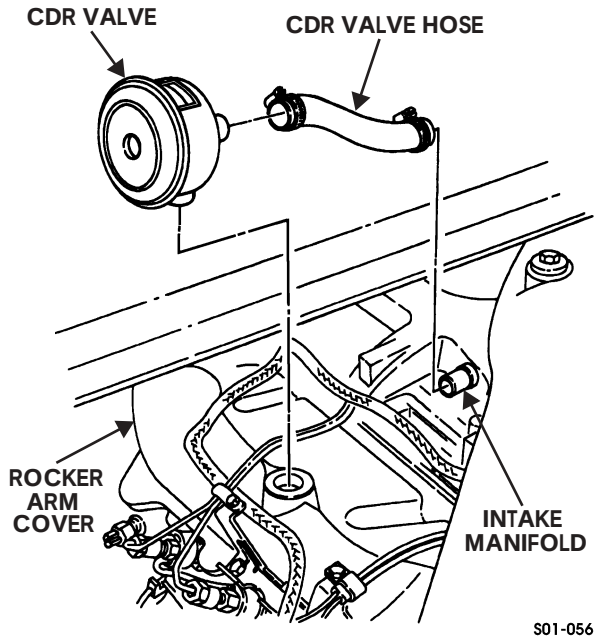


Figure 2-72: CDR Valve Hose

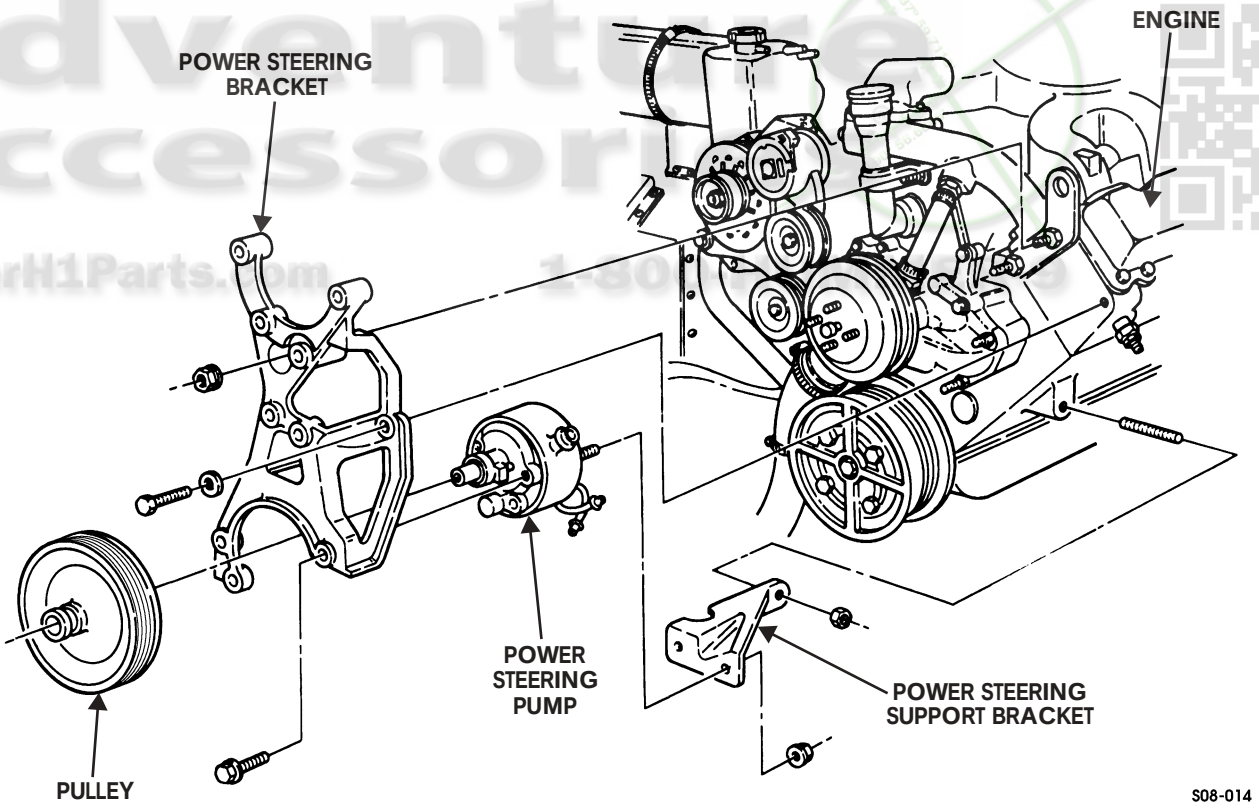


Figure 2-73: Power Steering Pump

12. Remove locknut from power steering bracket. Discard locknut (Figure 2-73).
13. Remove screw and washer securing power steering bracket to engine.
14. Remove nut from stud and support bracket, and remove stud from engine.
15. Remove two capscrews, locknuts, support bracket, and power steering pump from power steering bracket. Discard locknuts.
16. Remove oil dipstick from oil dipstick tube (Figure 2-74).
17. Remove screw and washer securing upper bracket to lower bracket.

18. Remove screw, locknut, clamp, and upper bracket from oil dipstick tube. Discard locknut.
19. Remove oil dipstick tube from engine oil pan. Remove and discard O-ring seal.

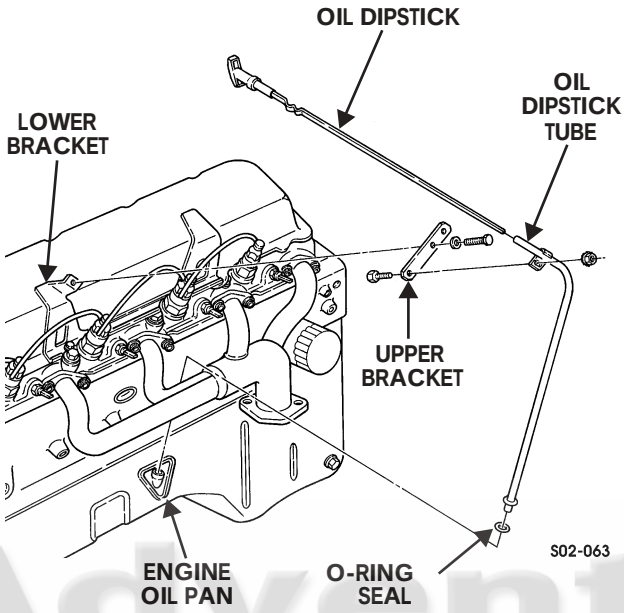


Figure 2-74: Dipstick and Dipstick Tube

20. Loosen three socket-head screws securing heat shield to exhaust manifold, and remove heat shield (Figure 2-76).
21. Remove two nuts, lockwashers, and wiring harness bracket from oil pan. Discard lockwashers (Figure 2-75).

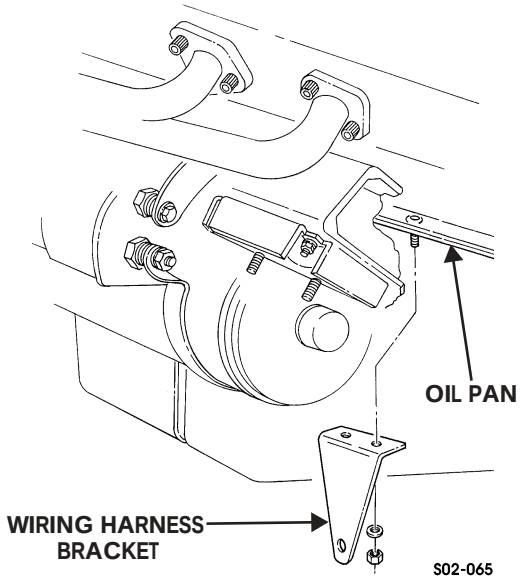


Figure 2-75: Wiring Harness Bracket

22. Remove locknut and washer from starter stud and support bracket. Discard locknut (Figure 2-77).

WARNING: To avoid injury or damage, starter must be supported during removal.

23. While supporting starter, remove two capscrews and washers securing starter to engine.
24. Remove starter and shim(s), if present, from engine.

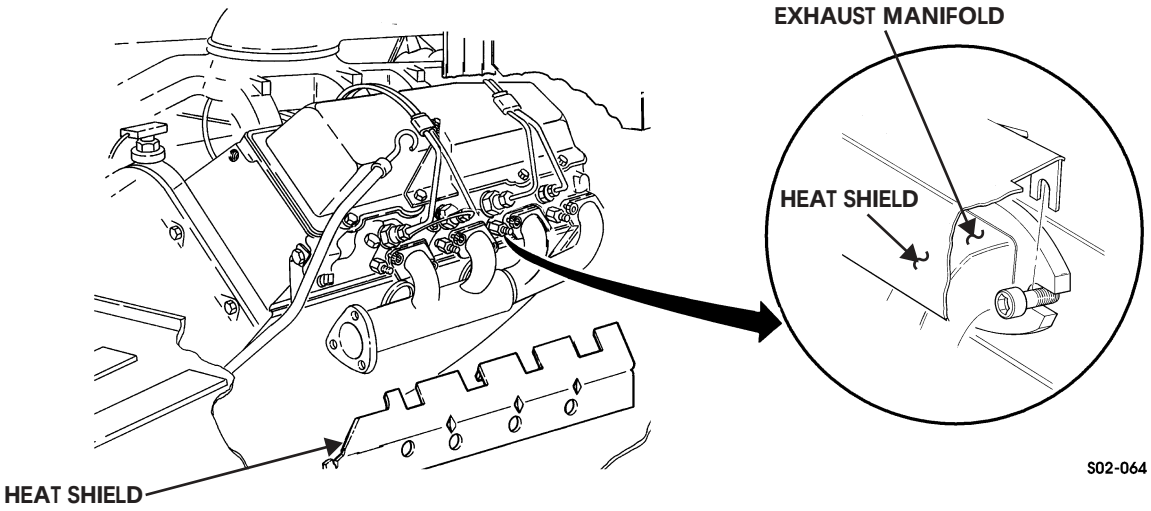


Figure 2-76: Exhaust Manifold Heat Shield

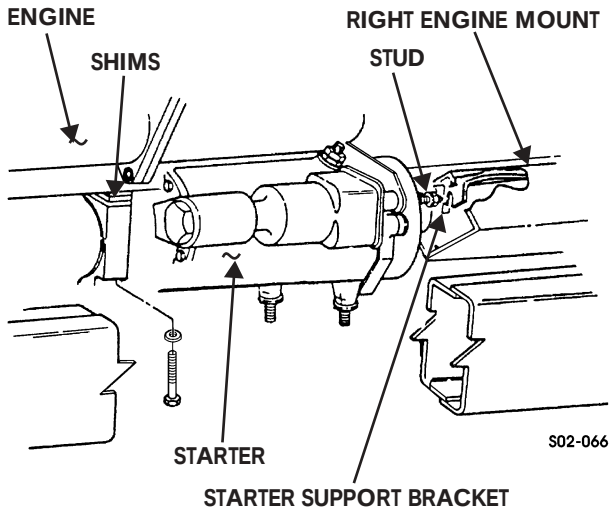


Figure 2-77: Starter Support Bracket

25. Remove six capscrews, lockwashers, and left and right engine mounts from engine. Discard lockwashers (Figure 2-78).
26. Remove two plugs, and drain coolant from engine (Figure 2-79).

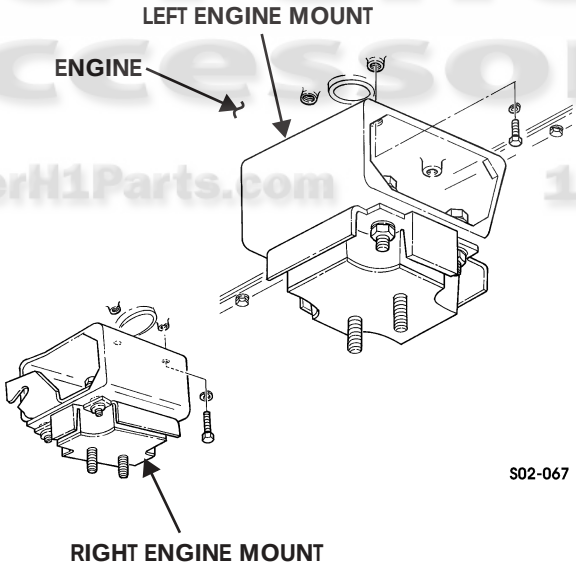


Figure 2-78: Engine Mount

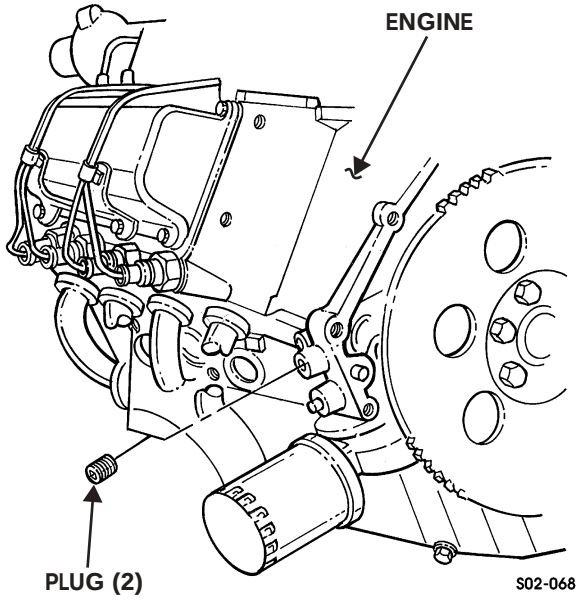


Figure 2-79: Coolant Drainplug

Assembly

1. Install right and left engine mounts on engine with six capscrews and lockwashers. Tighten capscrews to 30 lb-ft (41 N•m) (Figure 2-78).

WARNING: To avoid injury or damage, starter must be supported during installation.

2. Position shim(s), if present, and starter on engine (Figure 2-77).
3. Slide front starter stud into bracket, ensuring bracket is between washer and starter.
4. Install starter on engine with two washers and capscrews. Tighten capscrews to 40 lb-ft (54 N•m).
5. Secure starter to bracket with locknut and washer. Using crowfoot, tighten locknut to 24 lb-ft (33 N•m).
6. If starter, engine block, crankshaft, or flywheel was replaced, starter pinion gear-to-ring gear clearance must be checked (Section 12).
7. Install wiring harness bracket on oil pan with two lockwashers and nuts (Figure 2-80).

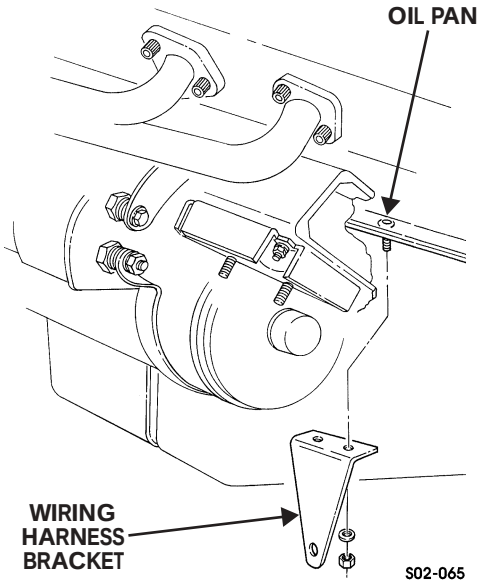


Figure 2-80: Wiring Harness Bracket

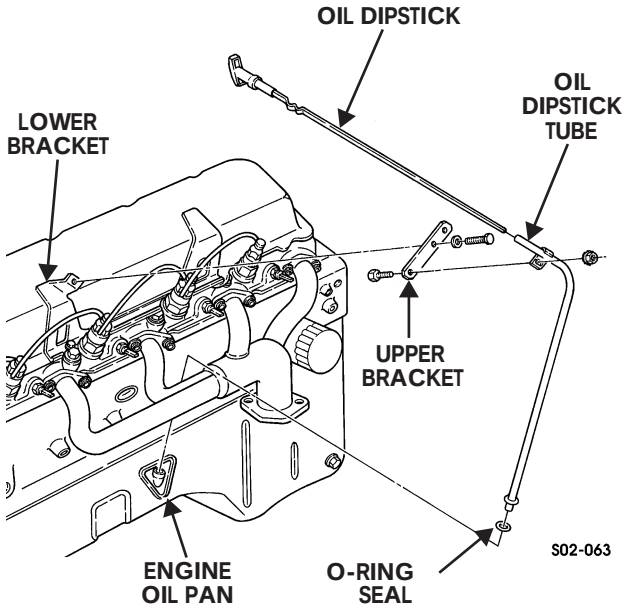


Figure 2-81: Oil Dipstick Tube Assembly

8. Install O-ring seal on oil dipstick tube (Figure 2-81).
9. Insert oil dipstick tube into engine oil pan.
10. Install upper bracket to oil dipstick tube and clamp with screw and locknut.
11. Install upper bracket on lower bracket with screw and washer.
12. Install oil dipstick into oil dipstick tube.
13. Position right heat shield on exhaust manifold, and tighten three socket-head screws to 25 lb-ft (34 N•m) (Figure 2-82).

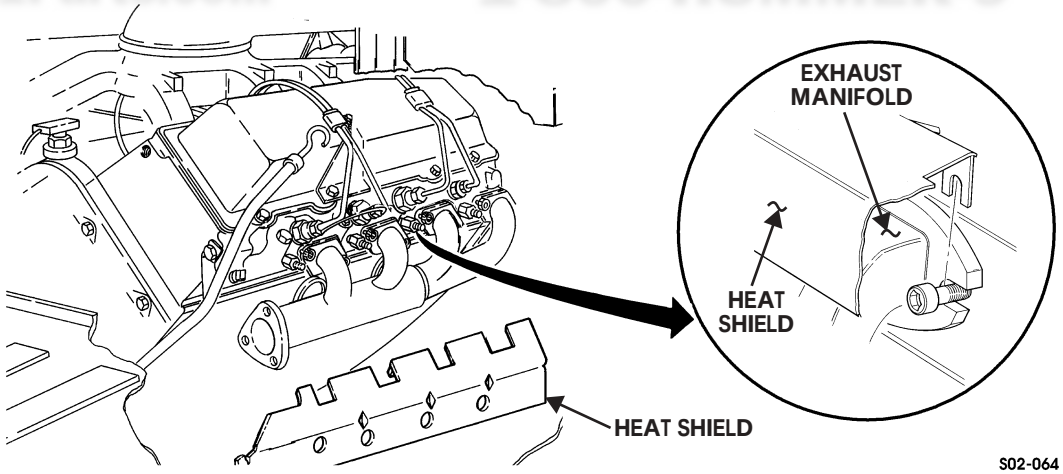


Figure 2-82: Right Heat Shield

NOTE: Perform steps 14 and 15 only if pulley, power steering bracket, or power steering pump was replaced.

14. Apply sealing compound to threads of two capscrews, and install power steering pump on power steering bracket with two capscrews. Tighten capscrews to 37 lb-ft (50 N•m) (Figure 2-83).

15. Install support bracket on power steering pump with two locknuts. Using pulley installer, install pulley on power steering pump.

16. Install stud on engine. Apply sealing compound to stud, and install support bracket on stud with nut. Tighten nut to 45 lb-ft (61 N•m).

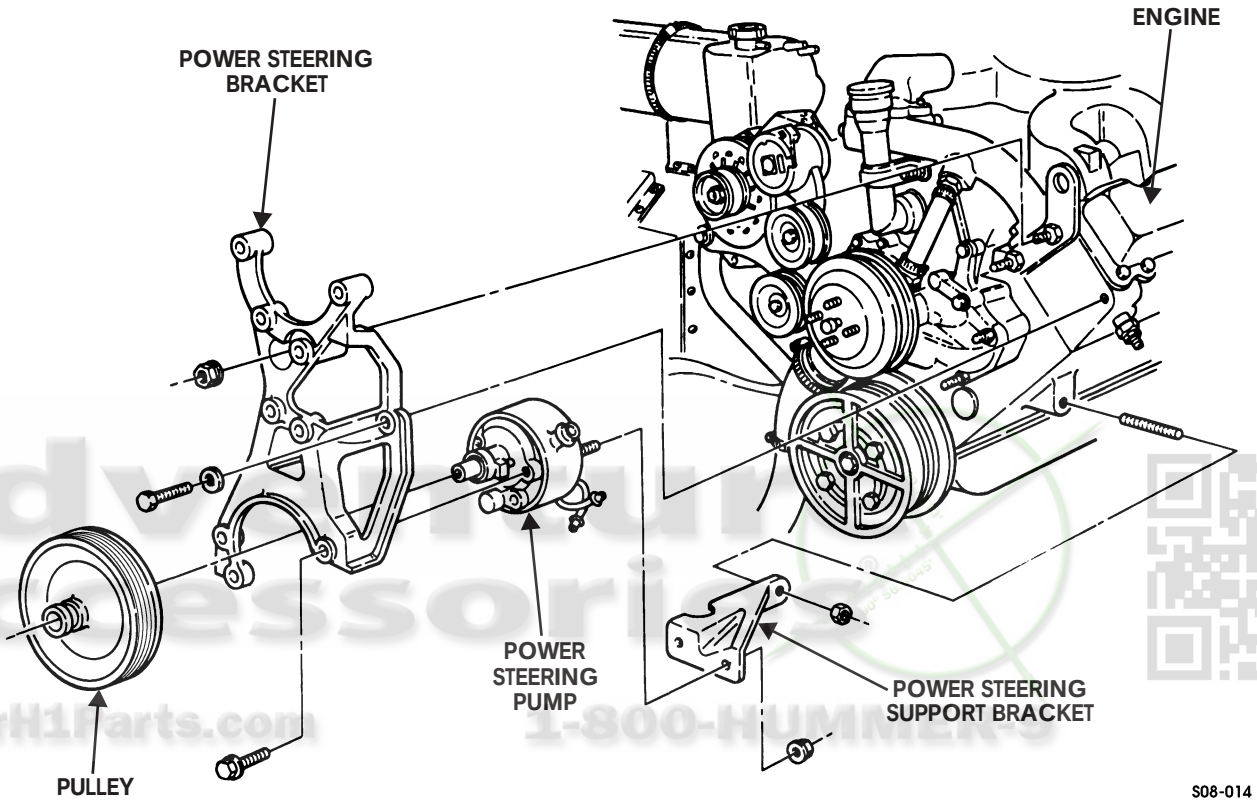


Figure 2-83: Power Steering Pump

17. Install power steering bracket on engine with screw and washer.
18. Install locknut on power steering bracket.
19. Install engine electrical harness (Section 12).

NOTE: Perform steps 17 through 23 if reinstalling glow plug controller.

20. Remove nuts from studs (Figure 2-84).
21. Install glow plug controller on right cylinder head with two lockwashers and nuts.
22. Install connector on controller.
23. Install three leads on controller with lockwasher and two nuts.

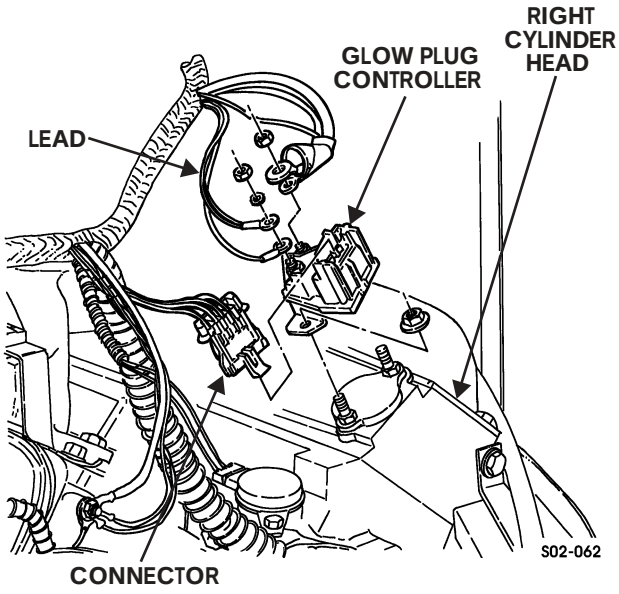


Figure 2-84: Glow Plug Controller

24. Connect hose to CDR valve (Figure 2-85).

NOTE: Perform step 22 if hose or CDR valve was replaced.

25. Connect hose to intake manifold nipple.
26. Install CDR valve in grommet in right rocker arm cover.

CAUTION: *To avoid damage when using front eyelet on lifting sling, engine oil pan must be supported during engine installation.*

NOTE: Hoist must be attached to intermediate eyelet when lifting engine, or to rear eyelet when lifting engine and transmission together. Sling bracket must be installed on rear of engine.

27. Install sling bracket on left cylinder head with two capscrews (Figure 2-86).
28. Install engine lifting sling on right cylinder head with two capscrews.
29. Secure sling bracket to sling with pin.

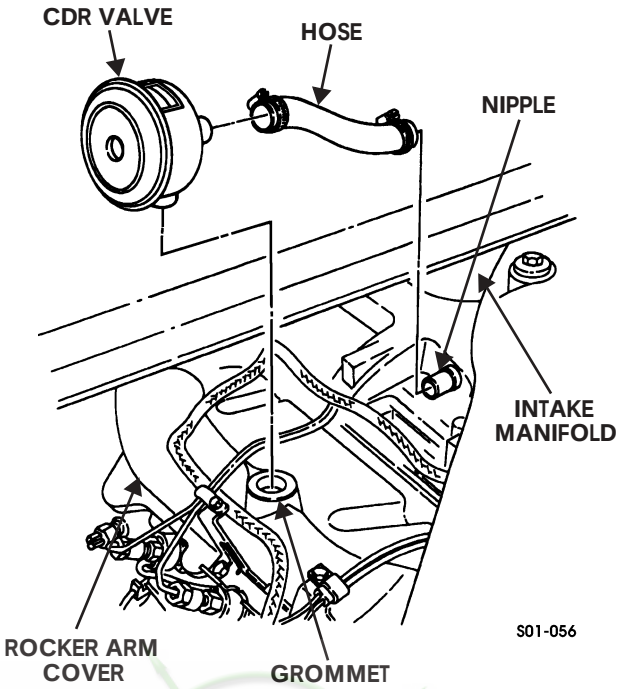


Figure 2-85: CDR Valve and Hose

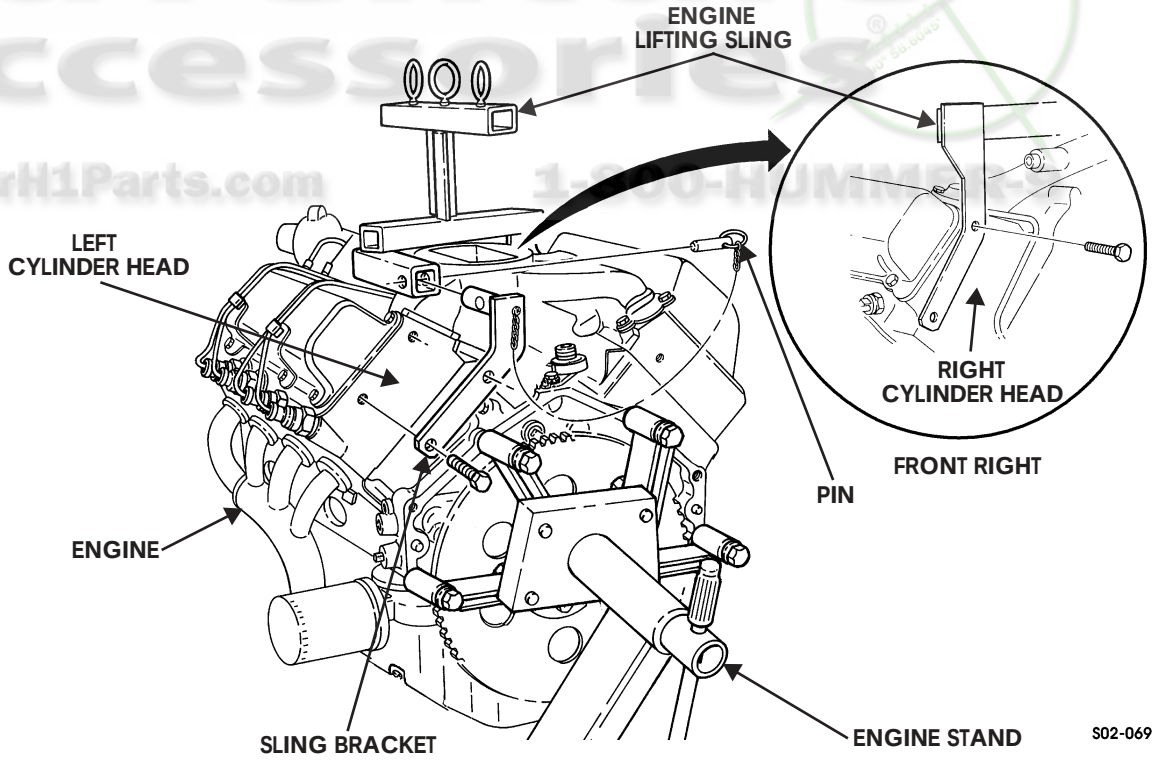


Figure 2-86: Engine Lifting Sling Bracket

ENGINE INSTALLATION

Installation

WARNING: To avoid injury, direct all personnel not participating in engine installation to stand clear during hoisting operation. Use prybars, not hands, to free engine of hangups or snags.

CAUTION: *To prevent damage, always install engine slowly. Lower engine into chassis carefully and closely observe all engine components.*

1. Lower engine into vehicle (Figure 2-90).

WARNING: To avoid injury or damage, transmission must be supported during engine installation.

NOTE: Assistant will be needed for steps 2 through 8.

2. Raise and support transmission (Section 5).
3. Install transmission on engine with four capscrews and two studs. Tighten capscrews and studs to 35 lb-ft (48 N•m) (Figure 2-87).

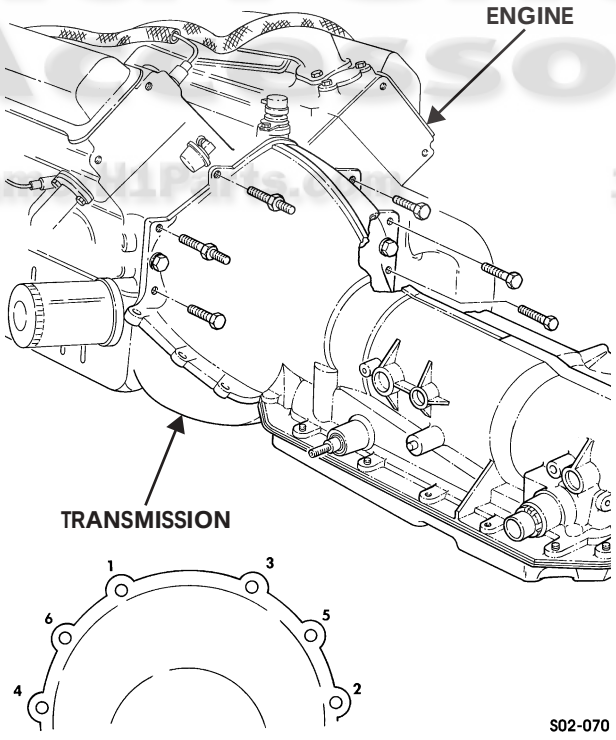


Figure 2-87: Engine to Transmission Torque Sequence

NOTE: To align holes for six capscrews securing torque converter to flywheel, it will be necessary to rotate flywheel clockwise by turning capscrew in front of crankshaft.

4. Install torque converter on flywheel with six capscrews. Tighten capscrews to 32 lb-ft (43 N•m) (Figure 2-88).

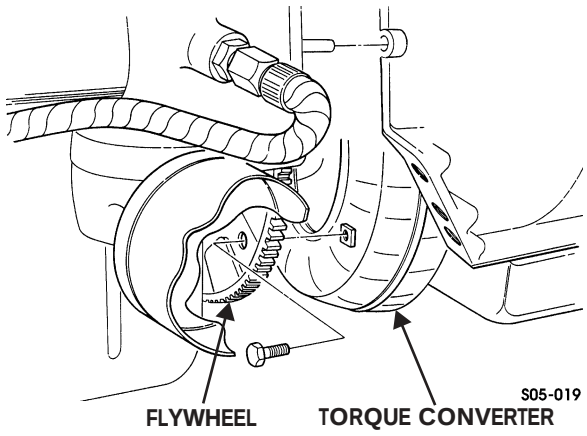


Figure 2-1

Figure 2-88: Torque Converter/Flywheel

5. Lower engine and transmission. Align and secure right engine mount on engine mount frame bracket with two washers and locknuts. Repeat for left engine mount. Using torque adapter, tighten locknuts to 90 lb-ft (122 N•m) (Figure 2-89).

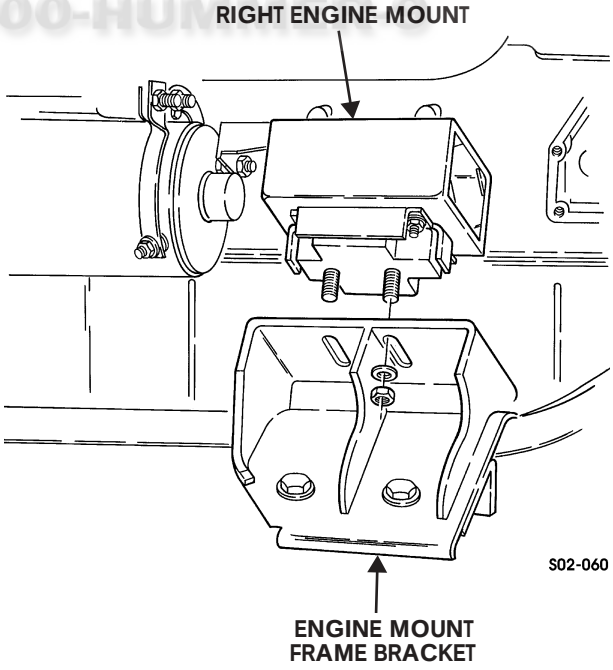


Figure 2-89: Engine Mount and Frame Bracket

6. Remove lifting device from engine lifting sling (Figure 2-90).

7. Remove two capscrews and sling bracket from left cylinder head.
8. Remove pin from sling bracket and sling. Remove sling bracket.
9. Remove two capscrews and sling from right cylinder head.
10. Install wiring harness and clamp on transmission stud with lockwasher and nut (Figure 2-91).
11. Connect lock switch connector and speedometer sensor connector to transfer case.
12. Connect connector to transmission output speed sensor.
13. Connect connector to transmission input speed sensor.
14. Install harness clamp on bracket with capscrew, washer, locknut, and washer.
15. Install two clamps on wiring harness and transmission.
16. Connect wiring harness connector to transmission connector.

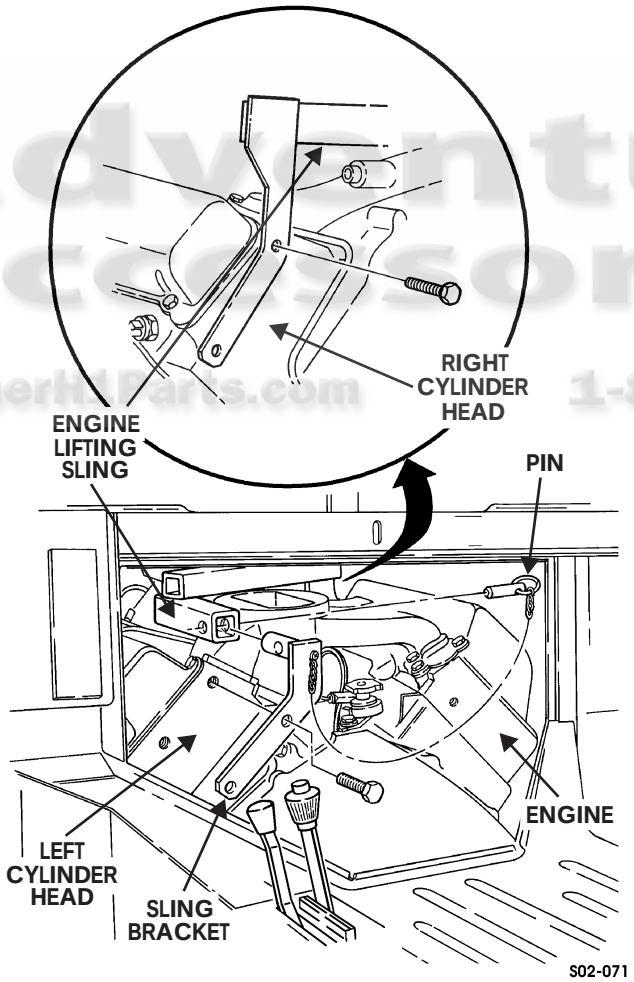


Figure 2-90: Lowering Engine Into Vehicle

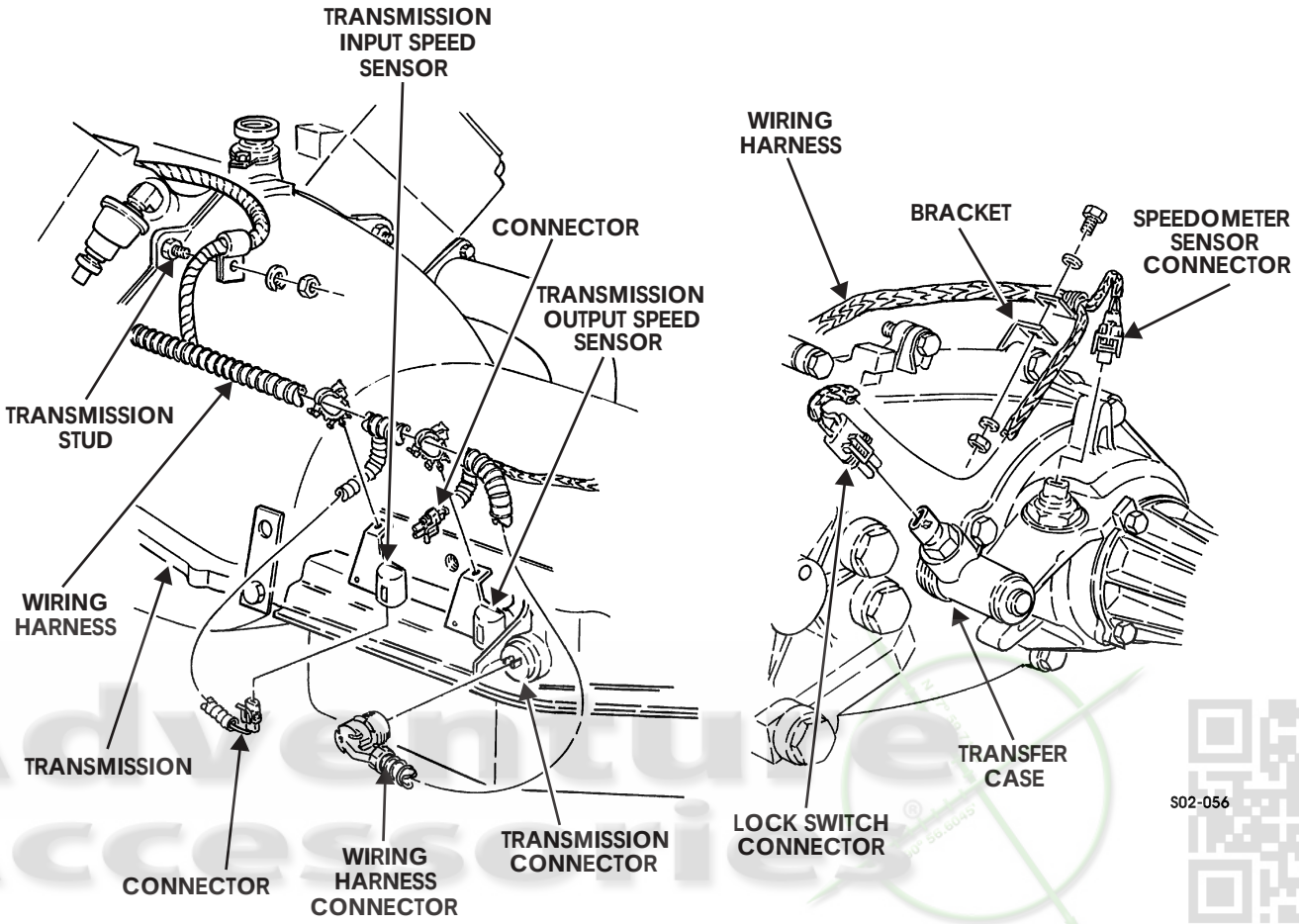


Figure 2-91: Wiring Harness Connectors

17. Install clip and engine wiring harness on starter solenoid with screw (Figure 2-92).
18. Install clamp and engine wiring harness on bracket with capscrew, lockwasher, and nut.
19. Connect oil cooler supply and return lines to engine (Figure 2-93).

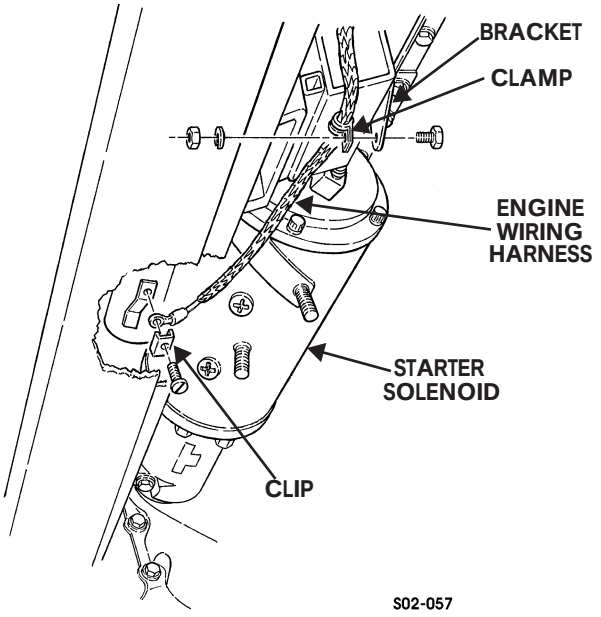


Figure 2-92: Engine Wiring Harness

20. Install O-ring seal on transmission dipstick tube (Figure 2-94).
21. Insert end of dipstick tube into transmission port.
22. Position dipstick tube bracket on right cylinder head and secure with washer and capscrew. Tighten capscrew to 25-37 lb-ft (34-50 N•m).
23. Install transmission oil dipstick in dipstick tube.

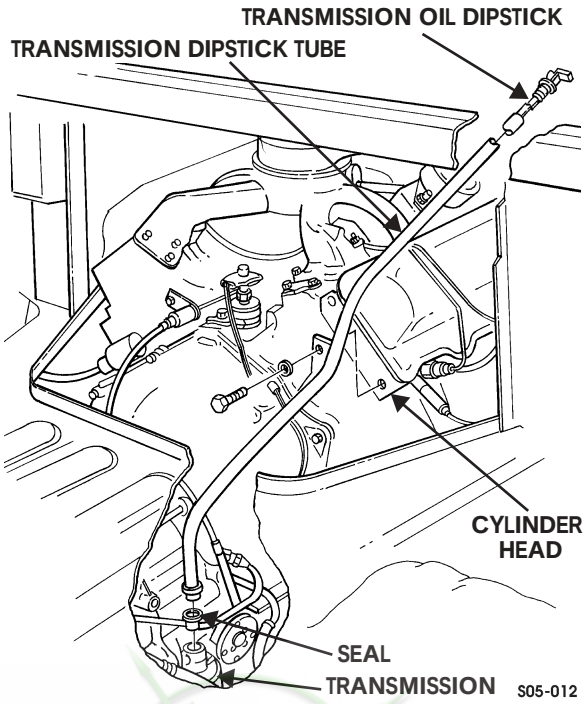


Figure 2-94: Transmission Dipstick Tube O-Ring Seal

24. Install rear heat shield on front heat shield with capscrew (Figure 2-95).
25. Install clamp and dipstick tube on rear heat shield with capscrew, two washers, lockwasher, and nut (Figure 2-95).

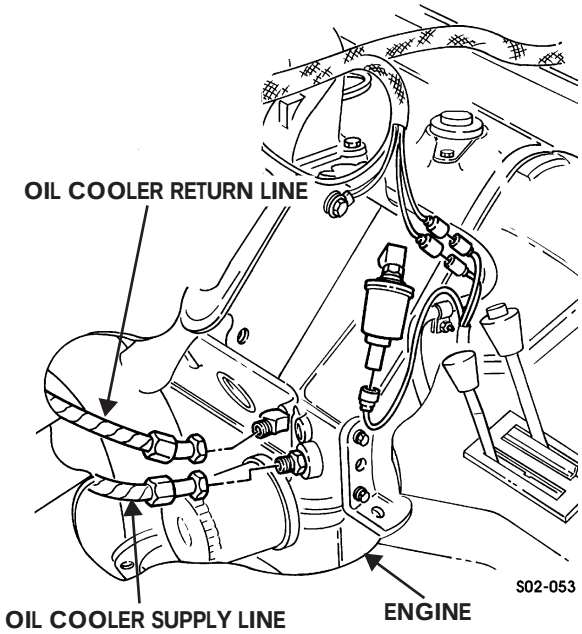


Figure 2-93: Engine Oil Cooler Lines

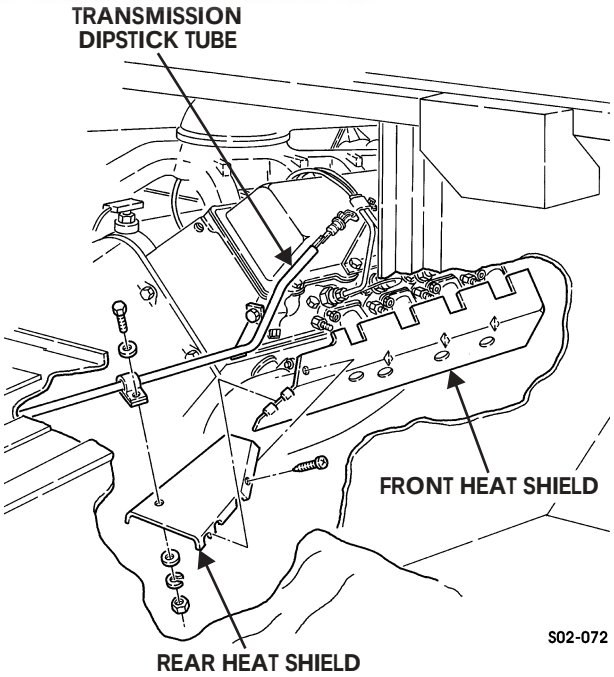


Figure 2-95: Rear Heat Shield

26. Connect throttle return spring to throttle shaft lever (Figure 2-96).
27. Loosen upper adjusting nut as necessary to position throttle cable on bracket. Finger tighten adjusting nut.
28. Connect cable end to throttle shaft stud with cable clip.
29. Connect throttle return spring to bracket.
30. Adjust accelerator linkage (Section 3).

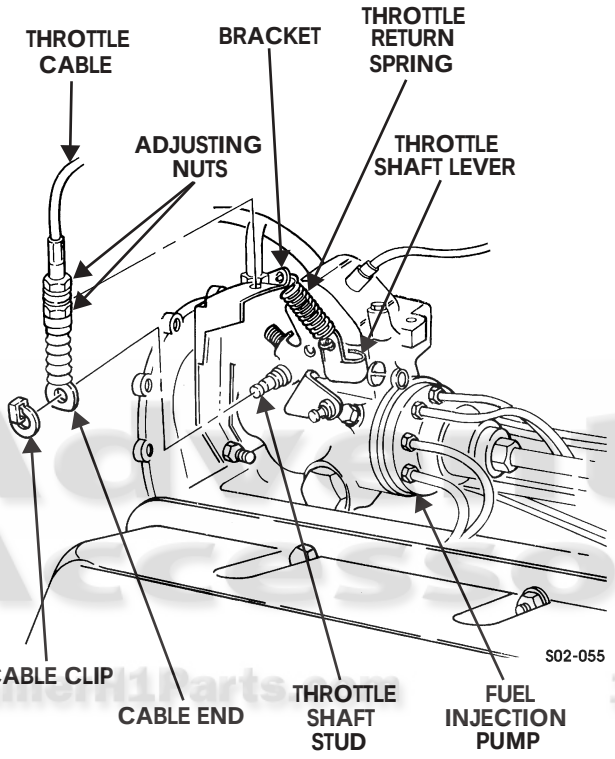


Figure 2-96: Throttle Return Spring

31. Install wiring harness with clamp and air horn support bracket on cylinder head with nut and lockwasher (Figure 2-97).
32. Position gasket on intake manifold (Figure 2-98).
33. Position air horn and air intake elbow on air horn support bracket.
34. Install air horn on intake manifold with two rubber washers, washers, and capscrews. Tighten capscrews to 53- 63 lb-in. (6-7 N•m).
35. Connect air intake elbow to air cleaner with clamp.

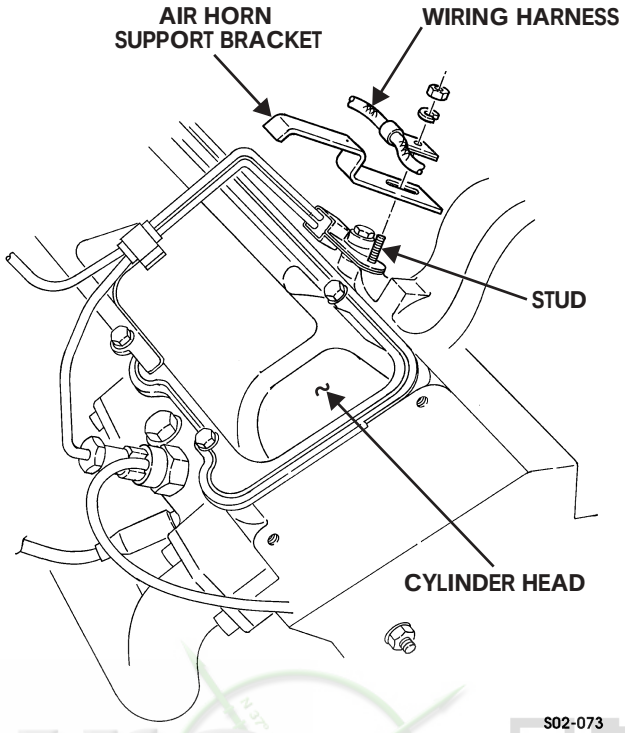


Figure 2-97: Air Horn Support Bracket

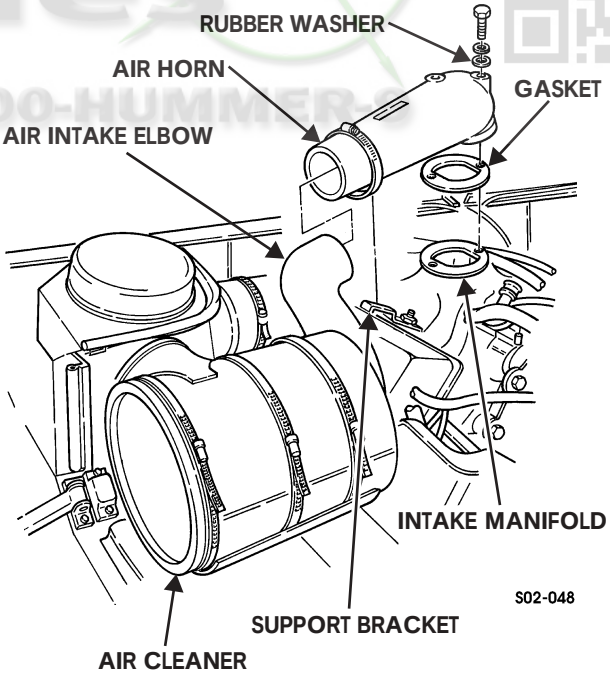


Figure 2-98: Air Horn and Gasket

36. Connect two return lines to power steering pump, and O-ring seal and high pressure line to pump. Connect reservoir supply line to power steering pump and tighten clamp (Figure 2-99).

37. Connect heater hoses to water crossover and water pump (Figure 2-100).
38. Connect surge tank-to-water crossover hose to water crossover. Tighten clamp to 10-20 lb-in. (1-2 N•m).
39. Connect hose to fuel return line (Figure 2-101).
40. Install fuel return line and clamp on stud with washer and nut.
41. Install fuel supply line on fuel injection pump adapter with clamp (Figure 2-101).

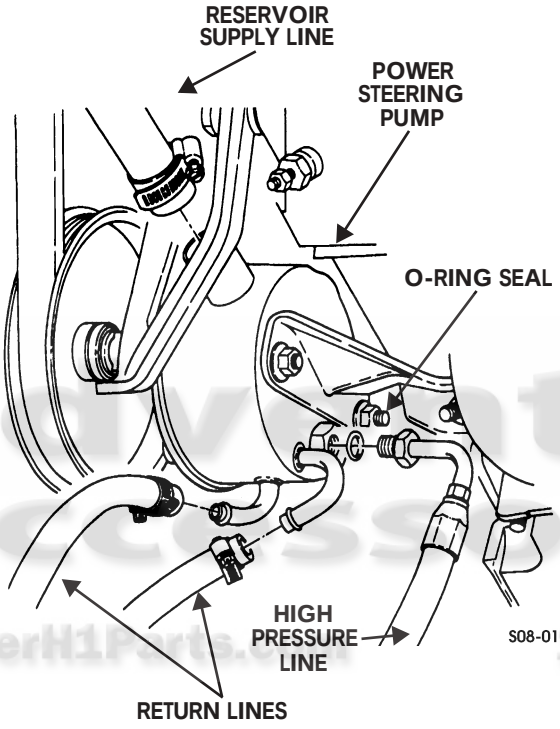


Figure 2-99: Power Steering Pump

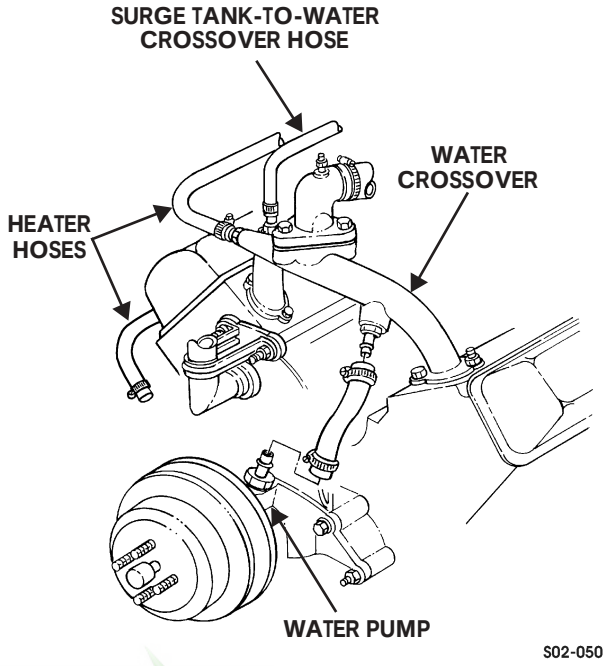


Figure 2-100: Surge Tank-to-Water Crossover Hose

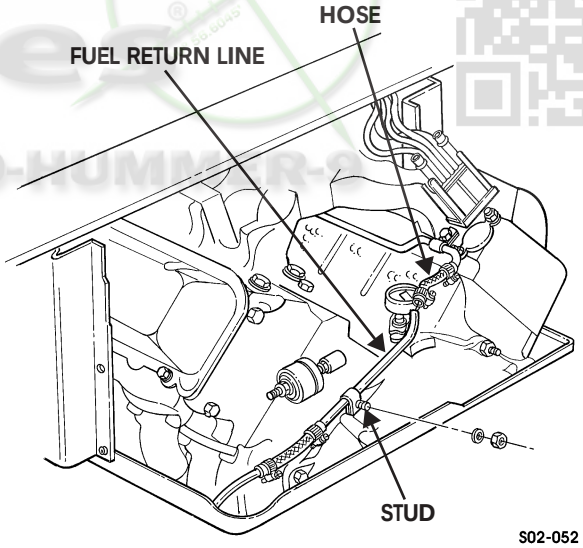


Figure 2-101: Return Line and Hose

NOTE: Perform step 42 if new fan or fan clutch is installed.

42. Apply thread-locking compound to four capscrews and install fan on fan drive with four capscrews and washers. Tighten capscrews to 45 lb-ft (61 N•m) (Figure 2-102).
43. Install four studs, viscous fan drive with fan, and water pump pulley on water pump with four nuts. Tighten nuts to 27 lb-ft (37 N•m).

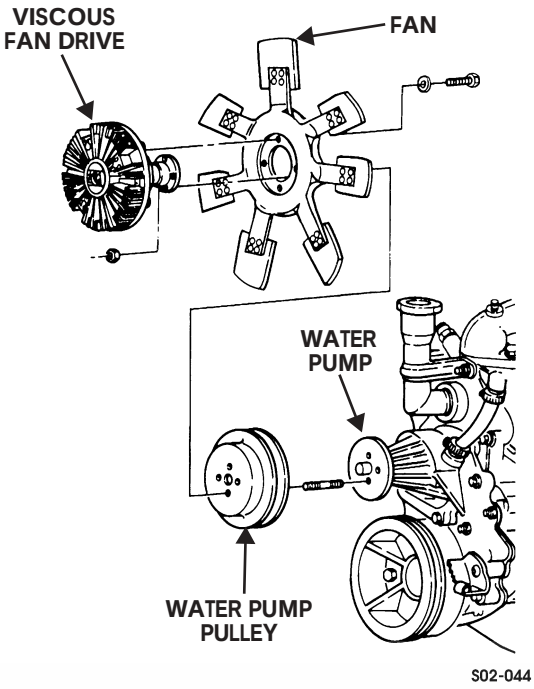


Figure 2-102: Fan and Drive Components

44. Connect lead to battery terminal on back of alternator with lockwasher and nut (Figure 2-103).
45. Connect ignition lead connector to recess on side of alternator. Ensure connector lock engages.
46. Push alternator in toward engine and bracket until adjusting capscrew aligns with slot (Figure 2-104).
47. Install pivot bolt and two adjusting capscrews on alternator.
48. Install serpentine belt on pulleys (Section 4).

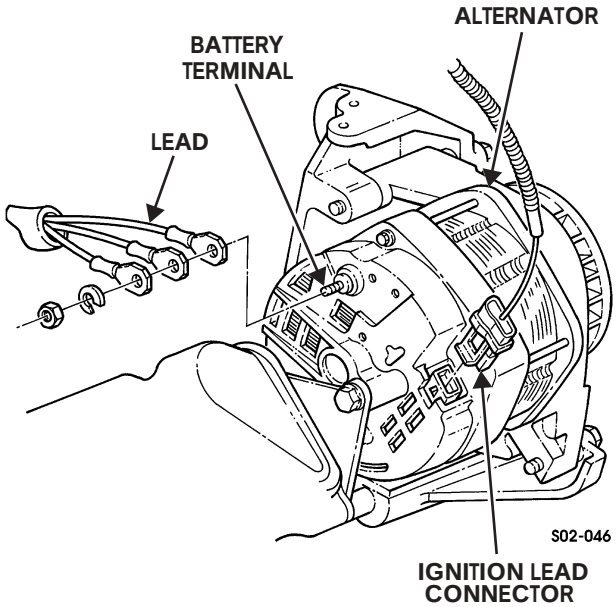


Figure 2-103: Alternator Connections

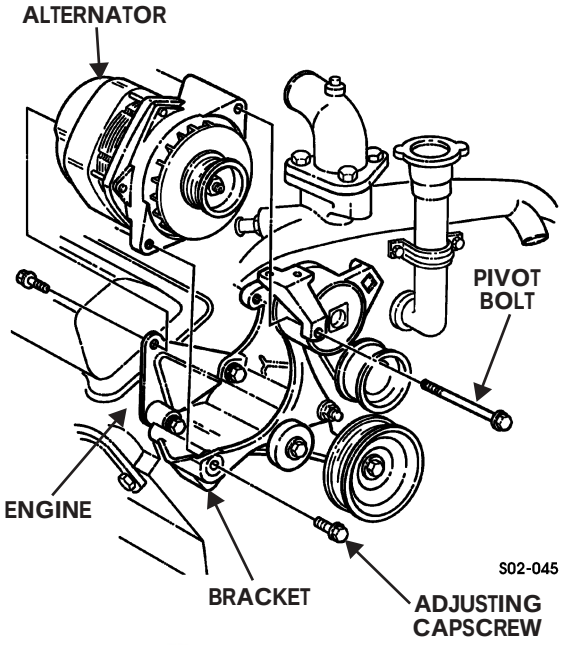


Figure 2-104: Alternator Bracket

49. Connect two engine wiring harness connectors to horns. Ensure connectors are locked into horns (Figure 2-105).

NOTE: Check that locks on connectors latch to avoid disconnect problems.

50. Connect engine wiring harness connector to fuel pump connector (Figure 2-106).
51. Connect two harness connectors to fuel filter.
52. Connect harness connector to fuel pump relay.
53. Connect harness connector to fuel pump fuse cover.
54. Install engine harness quick-disconnect.
55. Install clamp on oil dipstick tube bracket.
56. Connect CTI jumper harness to engine harness.
57. Connect four harness connectors to left side glow plugs.
58. Install engine wiring harness on bracket with two capscrews and clamp.
59. Install lead on engine temperature sending unit with nut and lockwasher.
60. Remove junction block cover and two nuts, lockwashers, and washers from junction block posts. Discard lockwashers.

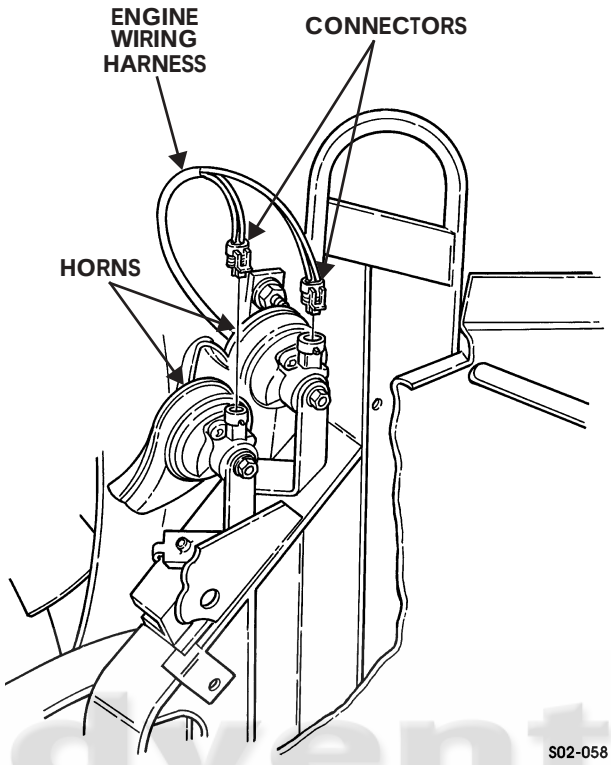


Figure 2-105: Horn Connectors

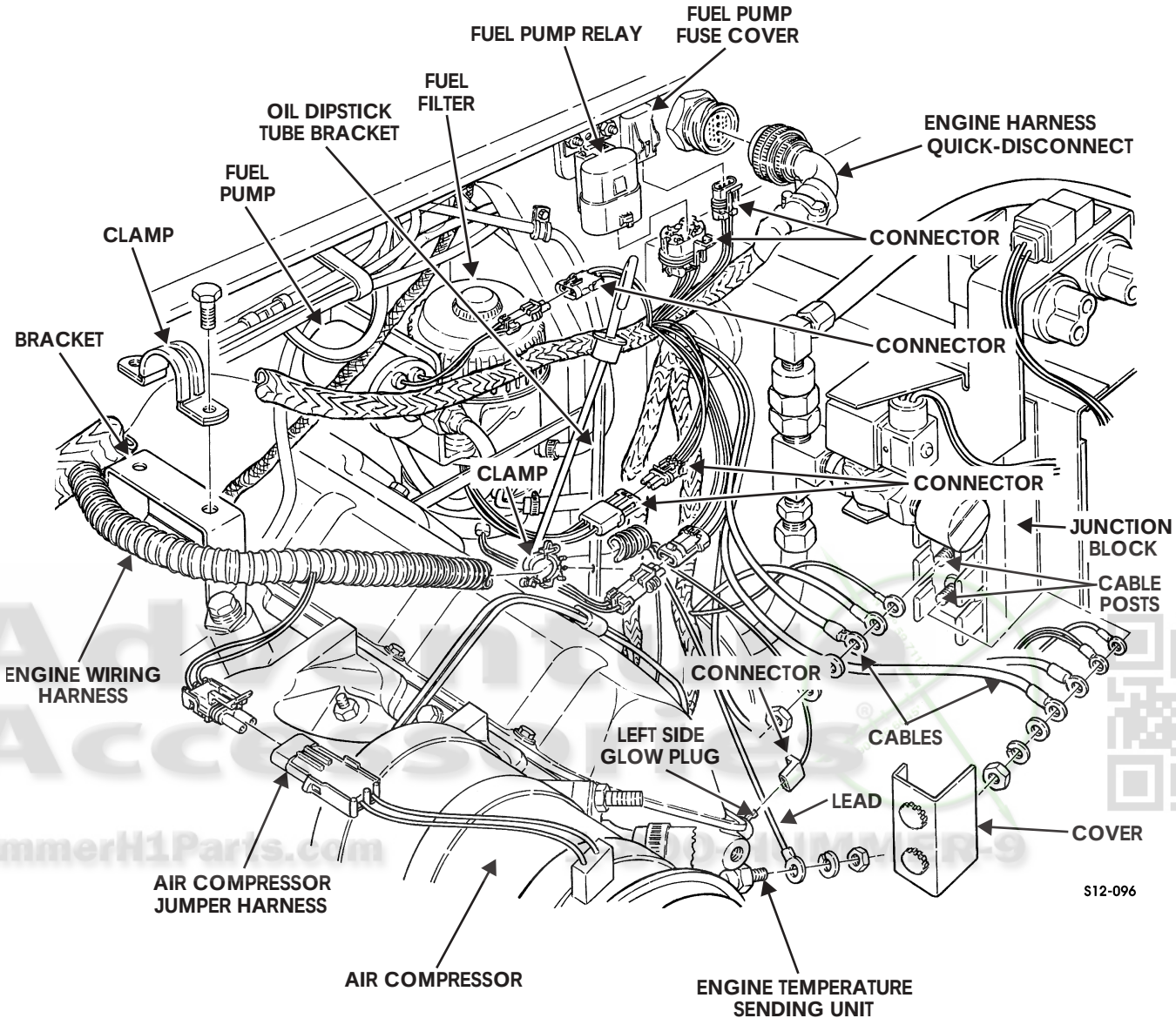


Figure 2-106: Engine Wiring Harness

61. Remove body wiring harness leads from posts.
62. Place engine wiring harness cables on posts, then install with two washers, lockwashers, and nuts.
63. Install cover on junction block.
64. Install two seals and cover plates on airlift brackets (Figure 2-107).
65. Install crossover pipe (Section 3).
66. Install radiator, upper and lower radiator hoses, and fan shroud (Section 4).
67. Install left and right engine splash shields (Section 10).

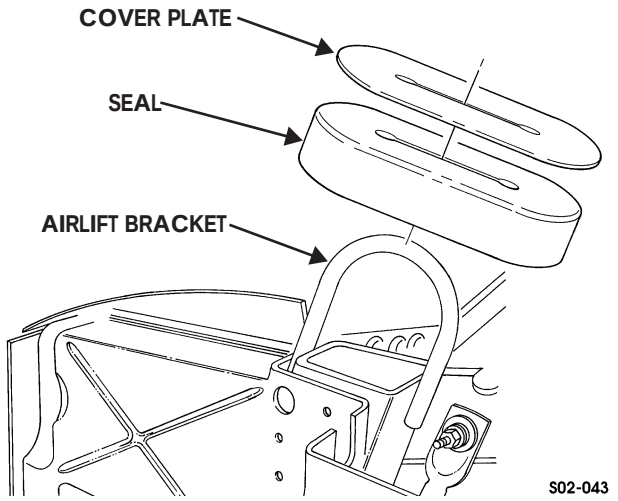


Figure 2-107: Airlift Bracket, Cover Plate, and Seal

68. Fill cooling system (Section 4).
69. Fill engine oil, transmission oil, and power steering fluid to proper levels (Section 1).
70. Connect battery ground cable.
71. Perform engine run-in (Section 1).
72. Recharge air conditioner (Section 11).

MOUNTING ENGINE ON REPAIR STAND

Installation

1. If engine lifting sling is on engine, go to step 5.
2. Attach engine lifting sling to front of right cylinder head with two capscrews (Figure 2-108).
3. Attach sling bracket to rear of left cylinder head and lifting sling with two capscrews and pin.
4. Attach lifting device to lifting sling.

WARNING: Direct persons to stand clear during hoisting. Failure to do so may cause injury.

5. Lift engine into position over engine repair stand.
6. Loosen capscrews securing engine repair stand arms and align arms with holes in cylinder block.
7. Install arms on cylinder block with four washers and capscrews. Tighten screws.
8. Tighten arm pivot capscrews on repair stand.
9. Disconnect lifting device and remove four capscrews, pin, bracket, and lifting sling.

Removal

1. Attach lifting sling to engine (refer to installation steps 2 and 3).
2. Attach lifting device to lifting sling. Take up slack.
3. Loosen arm pivot capscrews.
4. Remove four capscrews and washers from arms and cylinder block (Figure 2-108).

WARNING: Direct persons to stand clear during hoisting. Failure to do so may cause injury.

5. Lift engine from stand.

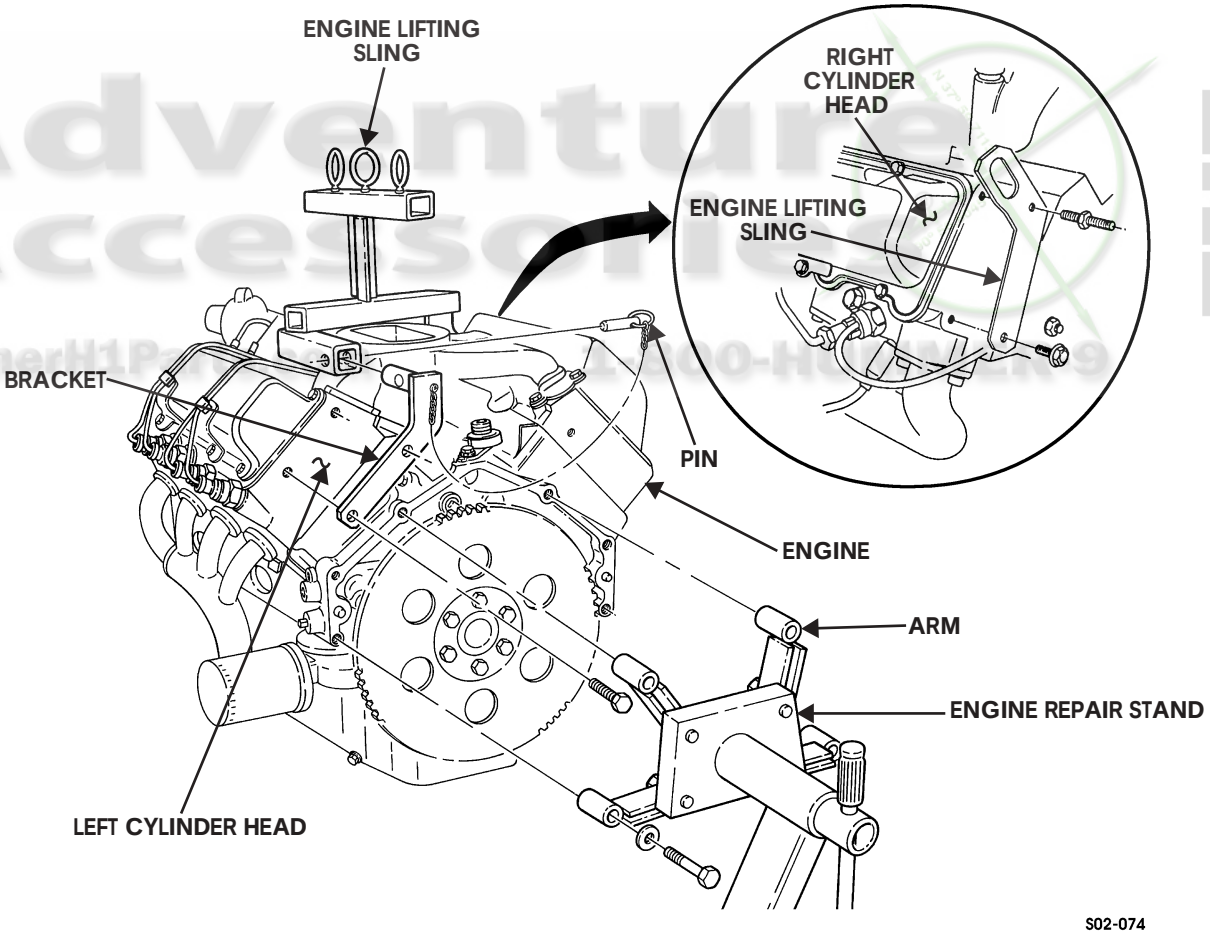


Figure 2-108: Engine Lifting Sling

ENGINE DISASSEMBLY INTO SUBASSEMBLIES

CAUTION: *Some parts and fasteners used with engine are metric. Improper fasteners can cause damage to parts.*

Subassembly Index

a. Fan Drive and Water Pump Pulley

1. Remove four nuts, fan drive with fan blades, four studs, and water pump pulley from water pump (Figure 2-109).
2. Remove four capscrews, washers, and fan from viscous fan drive.

b. Crankshaft Pulley

Remove four capscrews and crankshaft pulley from torsional damper (Figure 2-109).

c. Torsional Damper

1. Hold flywheel, and remove capscrew and washer from crankshaft (Figure 2-110).
2. Install puller and pull torsional damper from crankshaft.
3. Remove woodruff key from crankshaft. Discard woodruff key.

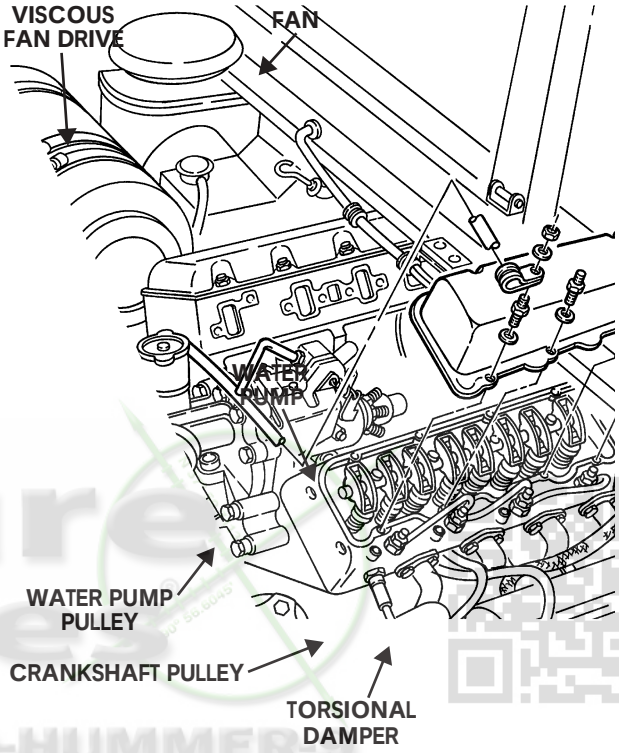


Figure 2-109: Water Pump and Drive

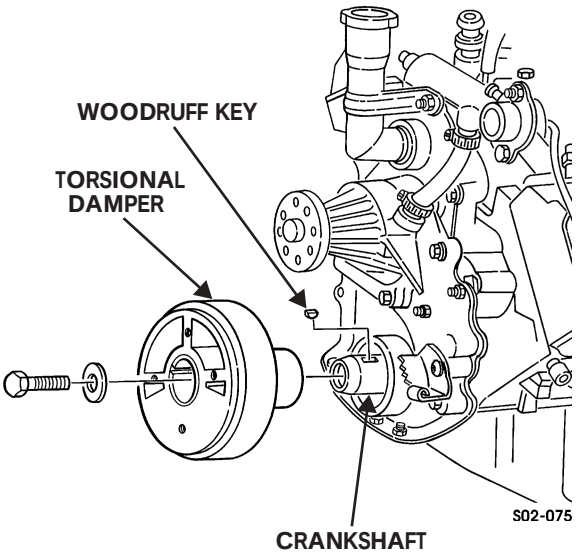


Figure 2-110: Crankshaft Torsional Damper

d. Exhaust Manifolds

1. Remove stud and washer from left exhaust manifold (Figure 2-111).
2. Using 8 mm hex-head driver, remove seven socket-head screws, washers, left exhaust manifold, and gasket from left cylinder head. Discard gasket.

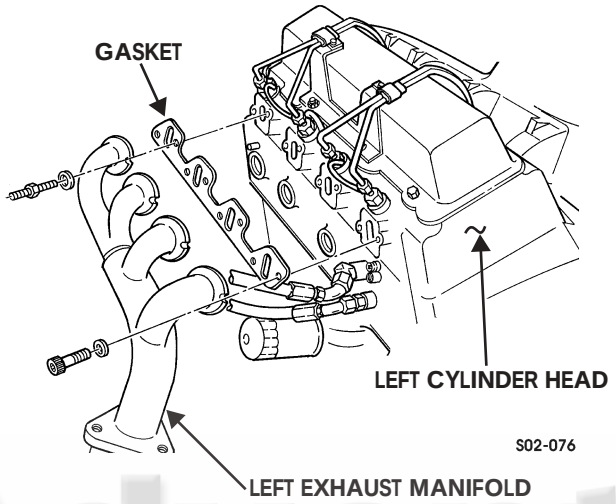


Figure 2-111: Left Exhaust Manifold and Gasket

3. Using metric tools, remove eight socket-head screws, washers, right exhaust manifold, and gasket from right cylinder head. Discard gasket (Figure 2-112).

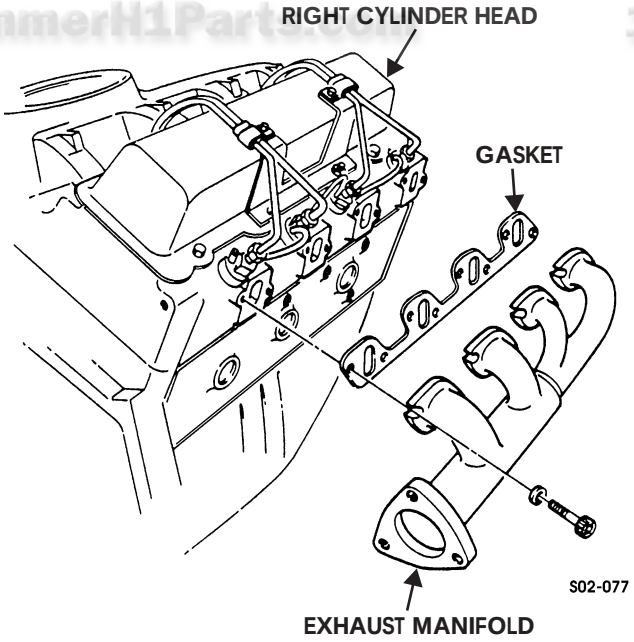


Figure 2-112: Right Exhaust Manifold

e. Intake Manifold

1. Remove six capscrews, ten studs, four injector line clips, and sixteen washers from intake manifold (Figure 2-113).

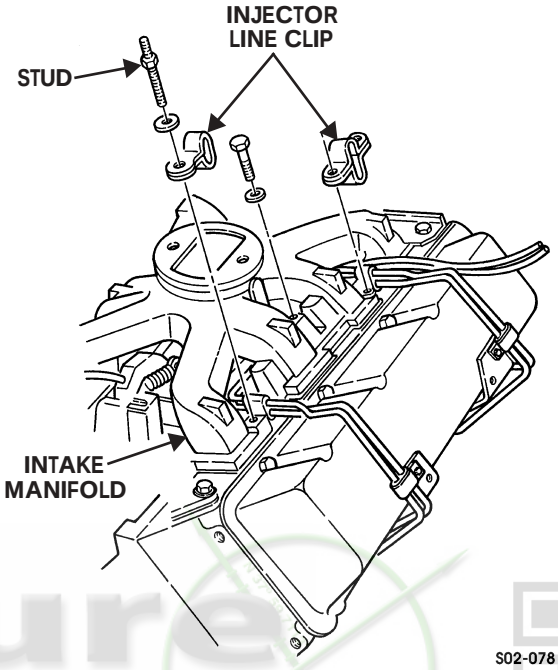


Figure 2-113: Intake Manifold Fasteners

2. Remove intake manifold and two gaskets from cylinder heads. Discard gaskets (Figure 2-114).

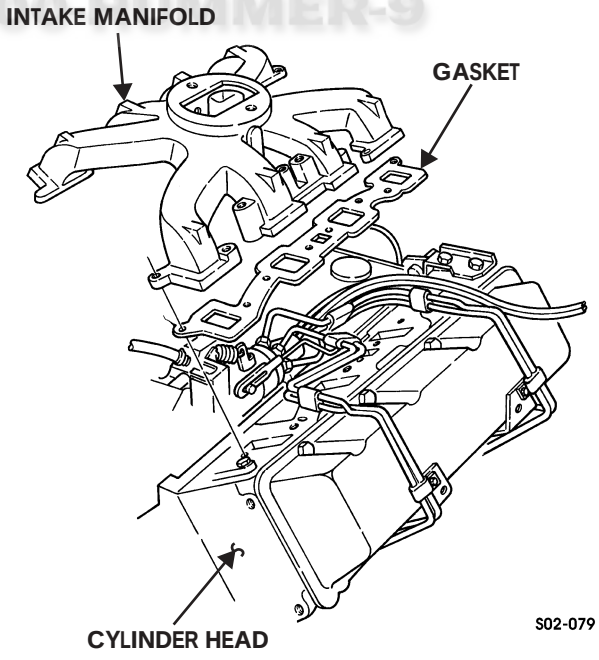


Figure 2-114: Intake Manifold and Gasket

f. Water Crossover

1. Loosen clamp and remove thermostat bypass hose from water crossover (Figure 2-115).
2. Remove two stud nuts, wiring harness ground cable, air conditioner mounting bracket, and two studs from cylinder head.
3. Remove two capscrews, gaskets, and water crossover from cylinder head. Discard gaskets.

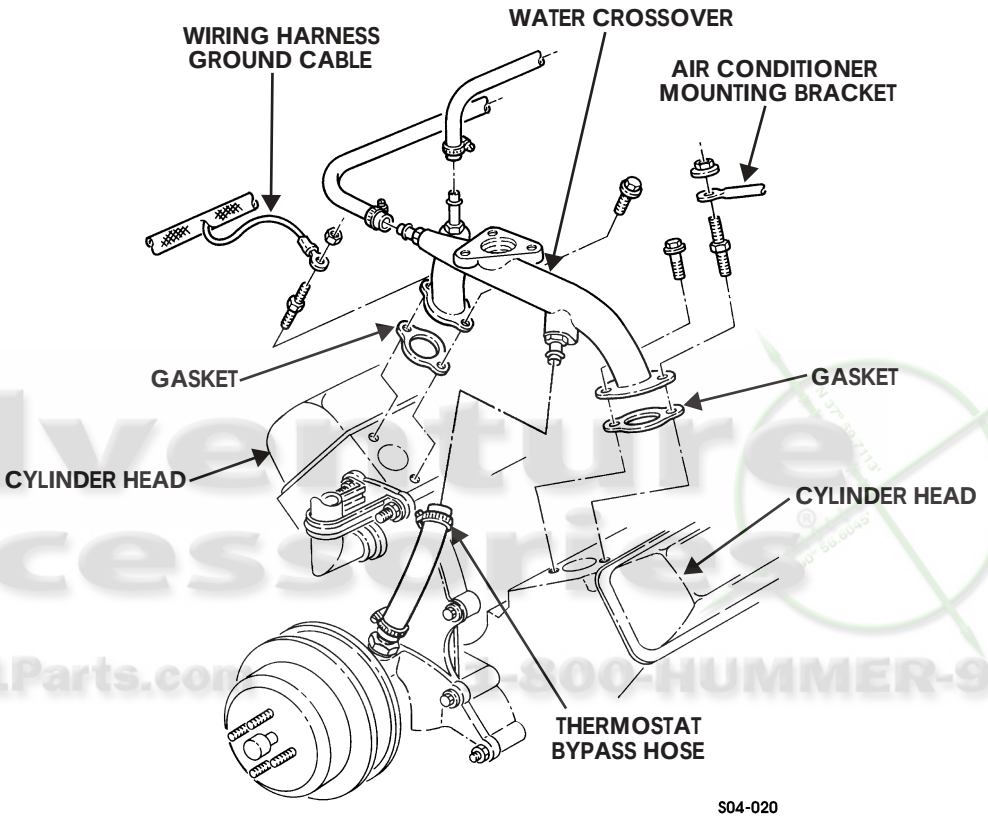


Figure 2-115: Water Crossover

g. Fuel Injection Lines

WARNING: Diesel fuel is highly flammable. Do not perform this procedure near fire, flames, or sparks. Injury could result.

NOTE: Mark or tag fuel injection lines for installation. Plug all fuel connection openings.

1. Loosen eight tube nuts and disconnect eight fuel injection lines from fuel injection nozzles (Figure 2-116).
2. Remove clamp and boot from fuel injection lines at fuel injection pump.
3. Disconnect eight fuel injection lines from fuel injection pump.

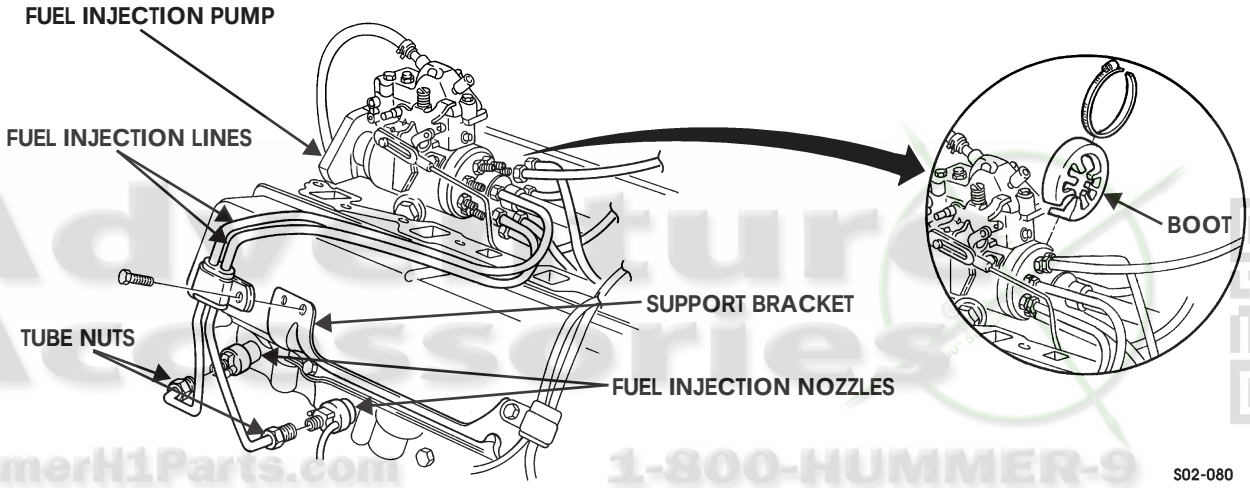


Figure 2-116: Fuel Injection Lines

h. Fuel Supply and Return Lines

1. Loosen clamp and disconnect fuel supply hose from fuel injection pump. Remove fuel supply hose from engine (Figure 2-117).
2. Loosen two clamps and disconnect fuel return hose from fuel injection pump and fuel return line.
3. Remove two nuts, washers, clamps, and fuel return line from right and left valve cover studs.
4. Loosen four clamps securing fuel return line to two hoses on two front fuel injectors.
5. Loosen two clamps and disconnect the hose from front-to-rear fuel return line and across-the-engine return line. Remove both fuel return lines from engine.
6. Loosen clamps and remove six fuel return jumper hoses and two plugs from eight fuel injectors.

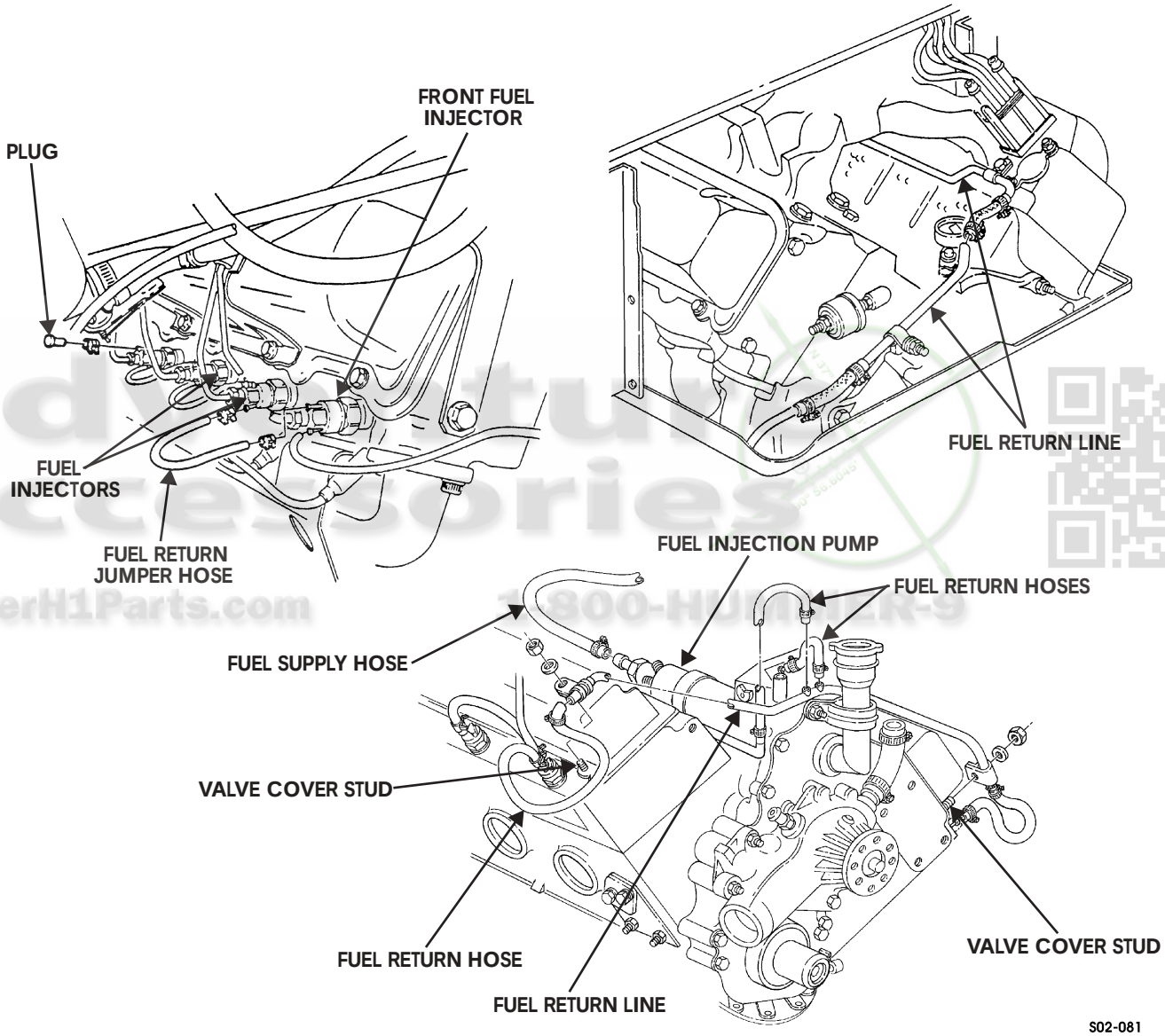


Figure 2-117: Fuel Supply and Return Lines

i. Rocker Arm Cover

NOTE: Record stud and screw pattern for each side to aid installation.

1. Remove two nuts and injection line support bracket from studs (Figure 2-118).
2. Remove combination of eight capscrews and studs and eight washers from rocker arm cover and cylinder head.
3. Remove rocker arm cover from cylinder head.
4. Repeat steps 1 through 3 for other side.

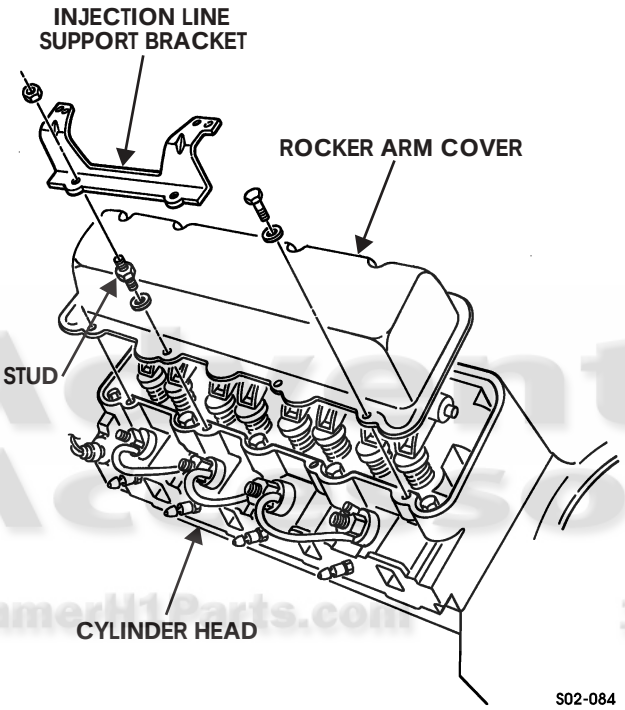


Figure 2-118: Rocker Arm Cover

j. Rocker Arm Shafts and Pushrods

NOTE: Mark top of cylinder head parts for installation in same locations.

1. Remove four capscrews and retainers from rocker arm and shaft assemblies (Figure 2-119).
2. Remove two rocker arm and shaft assemblies from cylinder head.
3. Remove eight pushrods.
4. Repeat steps 1 through 3 for other side.

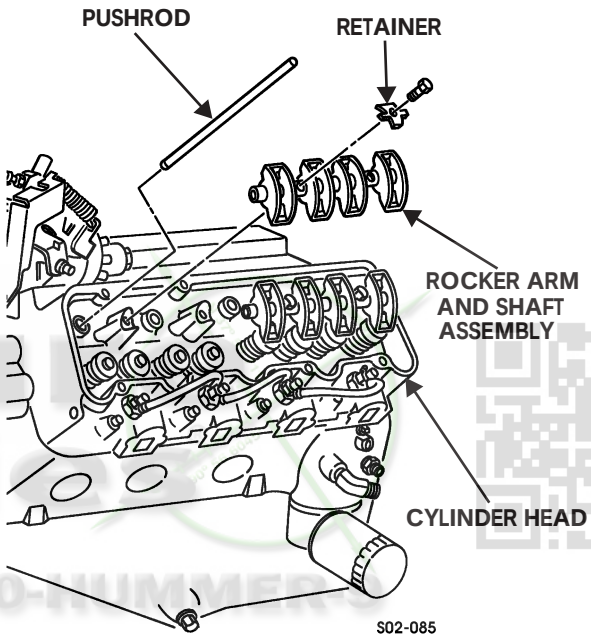


Figure 2-119: Rocker Arm and Shaft Assembly

k. Fuel Injection Nozzles

1. Remove seven clamps, three hoses, and plug from fuel injection nozzles (Figure 2-120).
2. Remove four fuel injection nozzles and gaskets from each cylinder head. Discard gaskets.

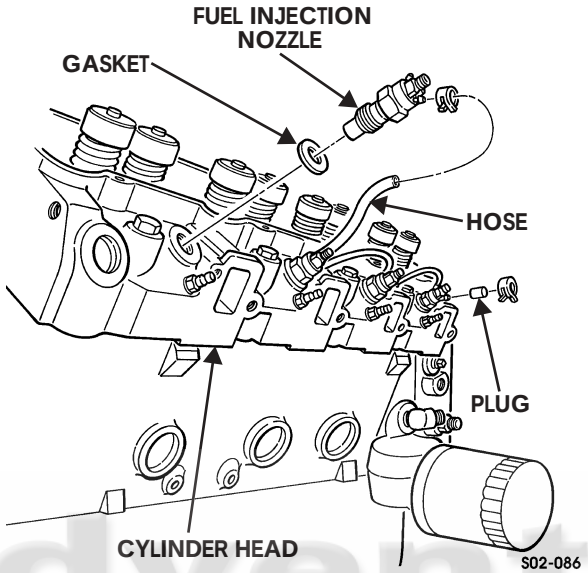


Figure 2-120: Fuel Injection Hoses

l. Glow Plugs

1. Remove four glow plugs from cylinder head (Figure 2-121).
2. Repeat step 1 for other side.

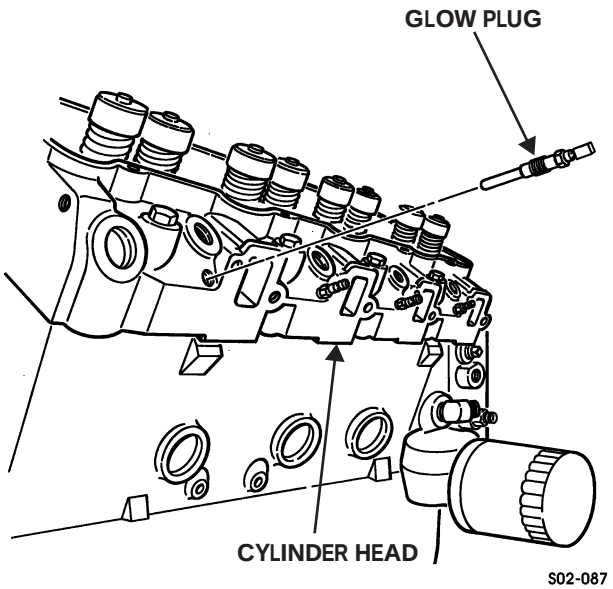


Figure 2-121: Glow Plugs

m. Cylinder Head

1. Remove seventeen capscrews from cylinder head and cylinder block (Figure 2-122).
2. Remove cylinder head and gasket from cylinder block. Discard gasket.
3. Repeat steps 1 and 2 for other side.

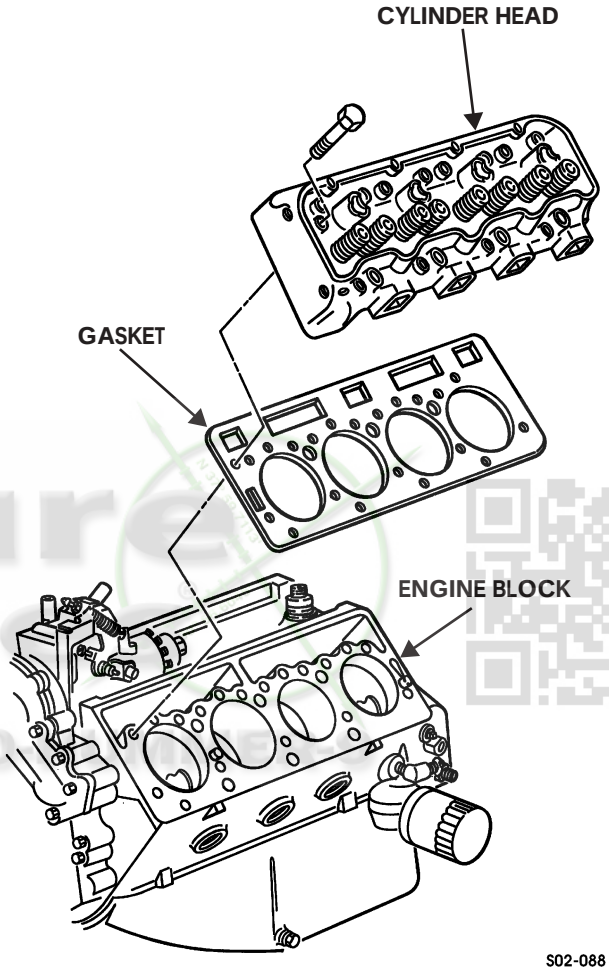


Figure 2-122: Cylinder Head and Gasket

n. Valve Lifters

1. Remove two capscrews and two clamp plates from cylinder block (Figure 2-123).
2. Remove four guide plates from block.
3. Repeat steps 1 and 2 for other side of block.

NOTE: Tag valve lifters for assembly.

4. Using hydraulic valve lifter remover, remove eight valve lifters from block.
5. Repeat step 4 for other side of block.

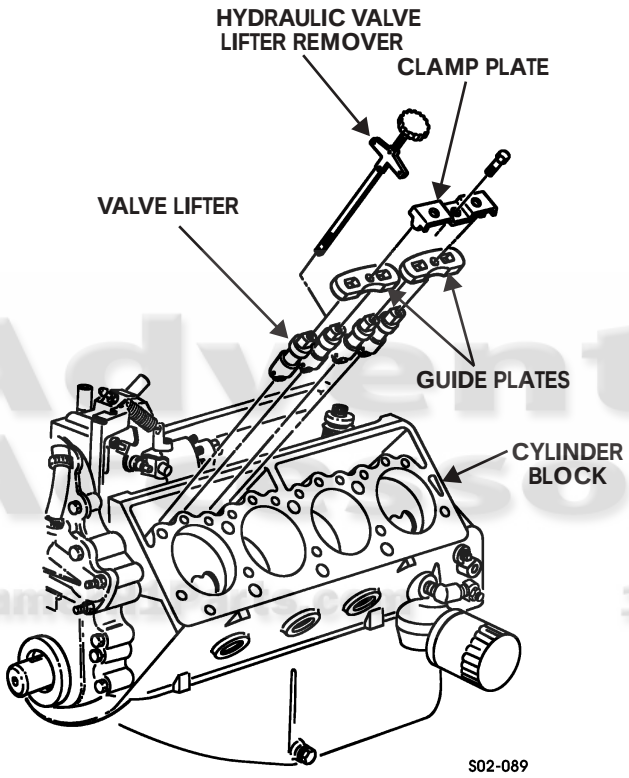


Figure 2-123: Valve Lifters

o. Water Pump and Adapter Plate

1. Remove two nuts, washers, and oil fill tube from adapter plate (Figure 2-124).

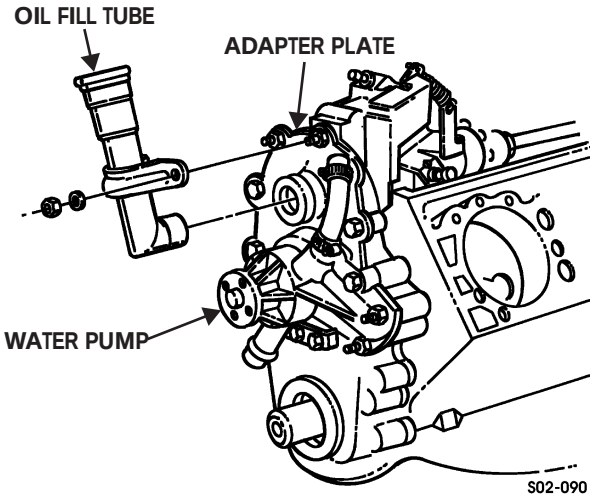


Figure 2-124: Water Pump and Adapter Plate

NOTE: Tag studs and screws for installation.

2. Remove six studs, seven capscrews, and water pump and adapter plate from timing gear cover (Figure 2-125).

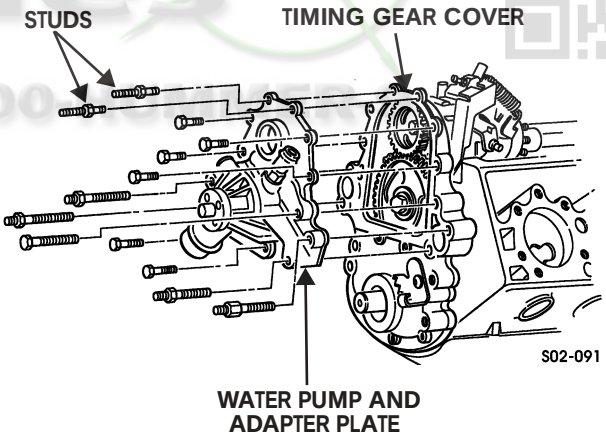


Figure 2-125: Water Pump and Adapter Plate

3. Remove seven capscrews, water pump, and gasket from adapter plate (Figure 2-126).
4. Separate gasket from water pump. Discard gasket.

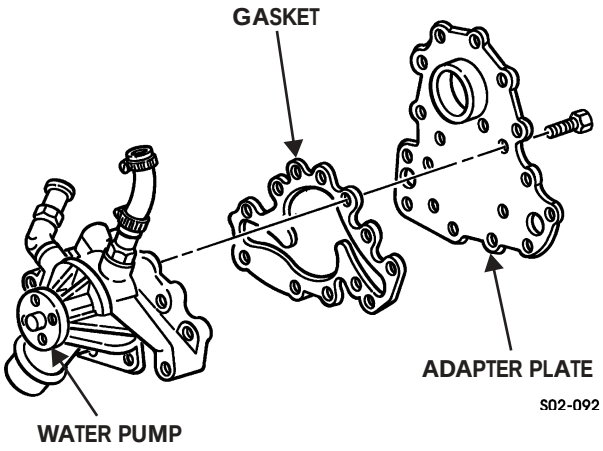


Figure 2-126: Water Pump, Adapter Plate, and Gasket

p. Fuel Injection Pump

1. Remove three capscrews and driven gear from fuel injection pump (Figure 2-127).
2. Remove three nuts and washers from studs.
3. Remove spring from cable bracket and throttle lever.
4. Remove two capscrews and cable bracket from fuel injection pump.
5. Remove fuel injection pump and gasket from timing gear cover. Discard gasket.

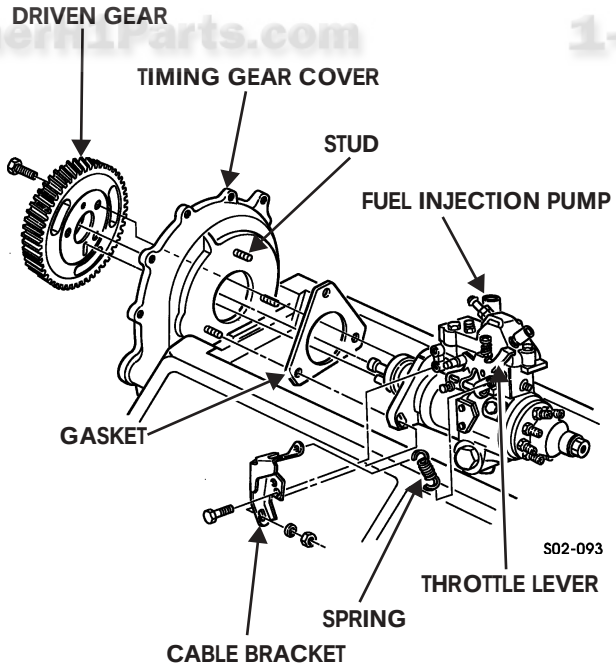


Figure 2-127: Fuel Injection Pump and Driven Gear

q. Timing Gear Cover

1. Remove two capscrews, nut, and baffle plate from timing gear cover (Figure 2-128).
2. Remove four capscrews from oil pan.
3. Remove five capscrews, four washers, and timing gear cover from cylinder block.
4. Remove front oil seal from timing gear cover.

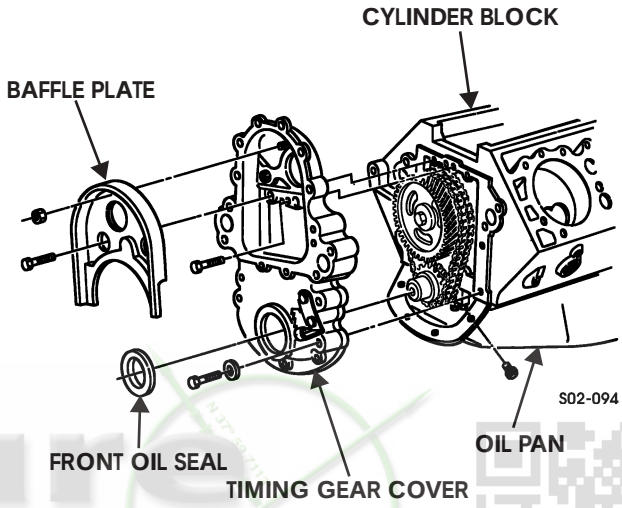


Figure 2-128: Timing Gear Cover

r. Timing Chain and Drive Sprockets

NOTE: When measuring timing chain deflection, slack should be removed from one side before measurement is taken on opposite side.

1. Measure timing chain deflection. Deflection must not exceed 0.810 in. (21 mm) (Figure 2-129).
2. Measure camshaft end play. End play should not exceed 0.012 in. (0.3 mm). If end play exceeds 0.012 in. (0.3 mm), examine camshaft sprocket, thrust plate, and spacer for wear after removal.
3. Remove capscrew, washer, and fuel pump drive gear from camshaft.
4. Remove crankshaft sprocket, camshaft sprocket, and timing chain as an assembly.
5. Remove woodruff key from camshaft and crankshaft.

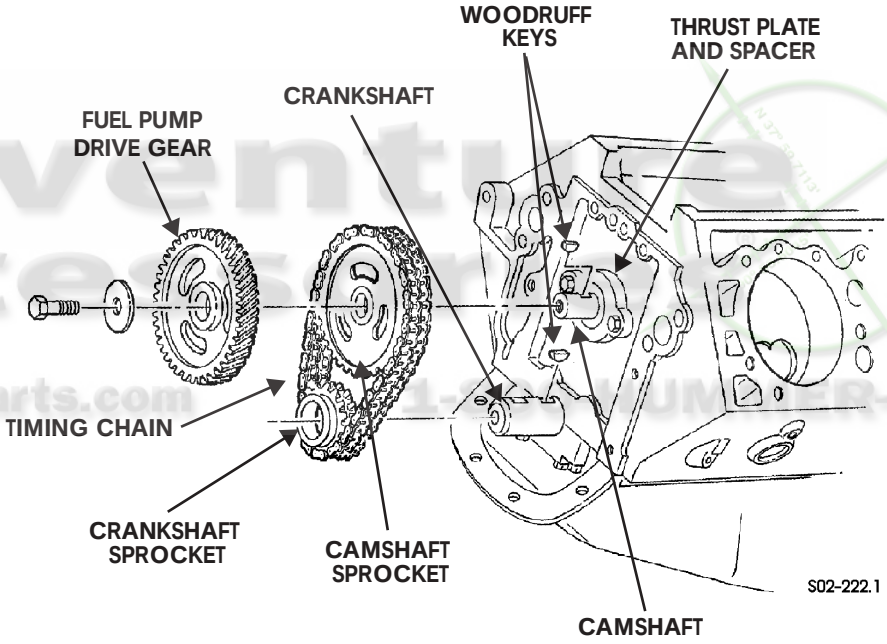


Figure 2-129: Timing Chain and Drive Sprocket

s. Oil Filter, Adapter, and Oil Pressure Sending Unit

1. Remove oil filter from adapter (Figure 2-130). Discard oil filter.
2. Remove bolt, washer, and adapter from cylinder block. Discard washer.
3. Remove two seals from bolt. Discard seals.
4. Remove seal from adapter. Discard seal.

NOTE: Tag fittings for assembly.

5. Remove two oil cooler line fittings from cylinder block.
6. Remove oil pressure sending unit and elbow from cylinder block.
7. Remove elbow, fitting and oil pressure switch from cylinder block.
8. Remove elbow and fitting from oil pressure switch.

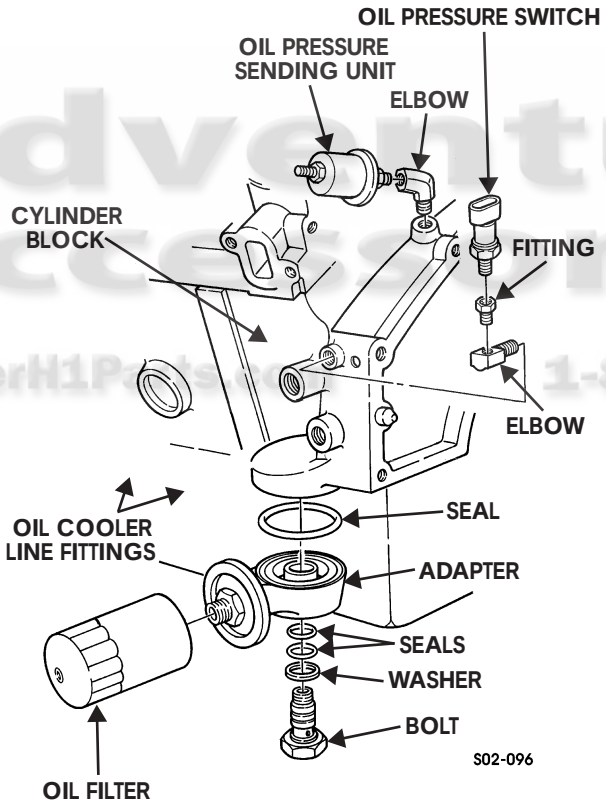


Figure 2-130: Oil Filter, Adapter, and Oil Pressure Sending Unit

t. Oil Pan

NOTE: Have drainage container ready to catch oil.

1. Remove oil drainplug and gasket from oil pan and drain oil before turning engine over. Discard gasket (Figure 2-131).
2. Rotate cylinder block 180°.
3. Remove eighteen capscrews, two studs, and oil pan from cylinder block.
4. Remove rear seal from oil pan. Discard seal.

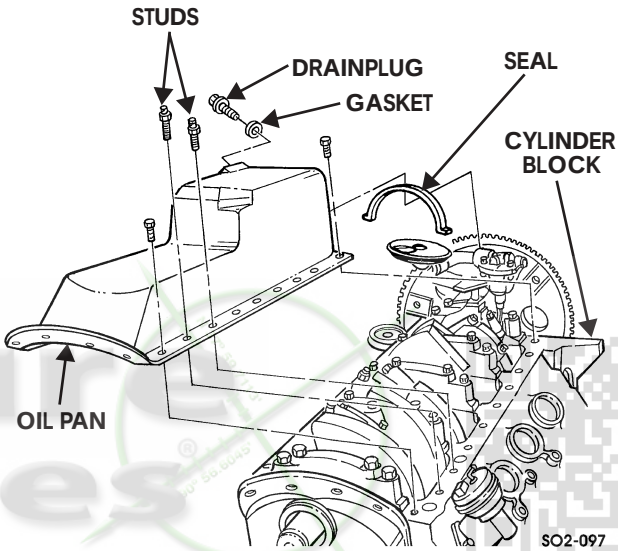


Figure 2-131: Oil Pan

u. Oil Pump

1. Remove nut from stud and bracket (Figure 2-132).
2. Loosen clamp capscrew and remove bracket and oil screen from oil pump.
3. Remove stud from oil pump and rear main bearing cap.
4. Remove oil pump and hex-drive pin from cylinder block.

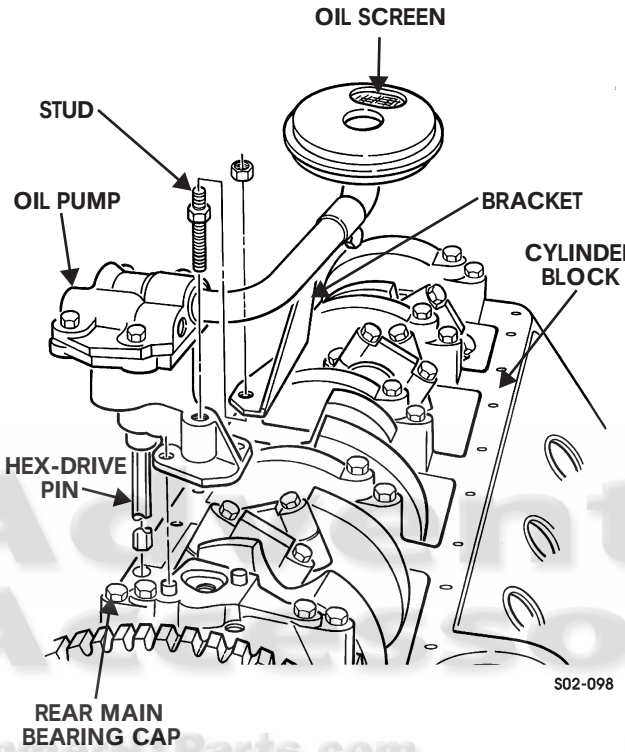


Figure 2-132: Oil Pump

v. Oil Pump Drive

1. Disconnect electrical connector from engine speed sensor (Figure 2-133).
2. Remove capscrew and clamp from cylinder block.
3. Remove oil pump drive/speed sensor and gasket from cylinder block. Discard gasket.

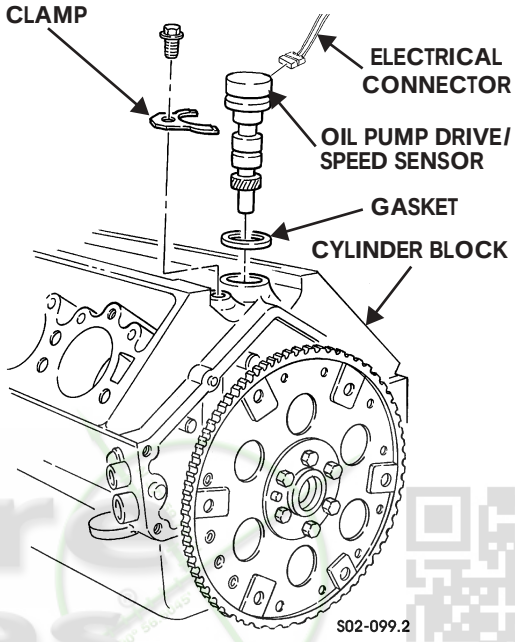


Figure 2-133: Oil Pump Drive

w. Camshaft

NOTE: Refer to paragraph r, step 2 for inspection of thrust plate and spacer.

1. Remove two capscrews, thrust plate, and spacer from cylinder block (Figure 2-134).

CAUTION: *Support camshaft during removal to prevent damage to bearings.*

2. Remove camshaft from cylinder block.

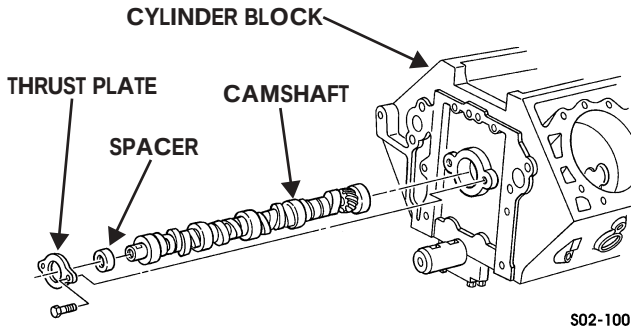


Figure 2-134: Camshaft

x. Pistons and Connecting Rods

1. Remove ridge inside top of each cylinder (Figure 2-135).
2. Rotate cylinder block 90°.
3. Rotate crankshaft to gain access to rod cap nuts.

NOTE: Rod caps and rods must be identified and replaced as a set. If not marked, tag for assembly.

4. Remove rod cap nuts, rod cap, and two bearings. Discard bearings.

CAUTION: Protect rod bolts from damage. Ensure all ridges are removed from cylinder bores before removing pistons.

5. Push connecting rod and piston out of top of cylinder block.
6. Assemble connecting rod, rod cap, and rod nuts.
7. Repeat steps 4, 5, and 6 for remaining seven pistons and rods.

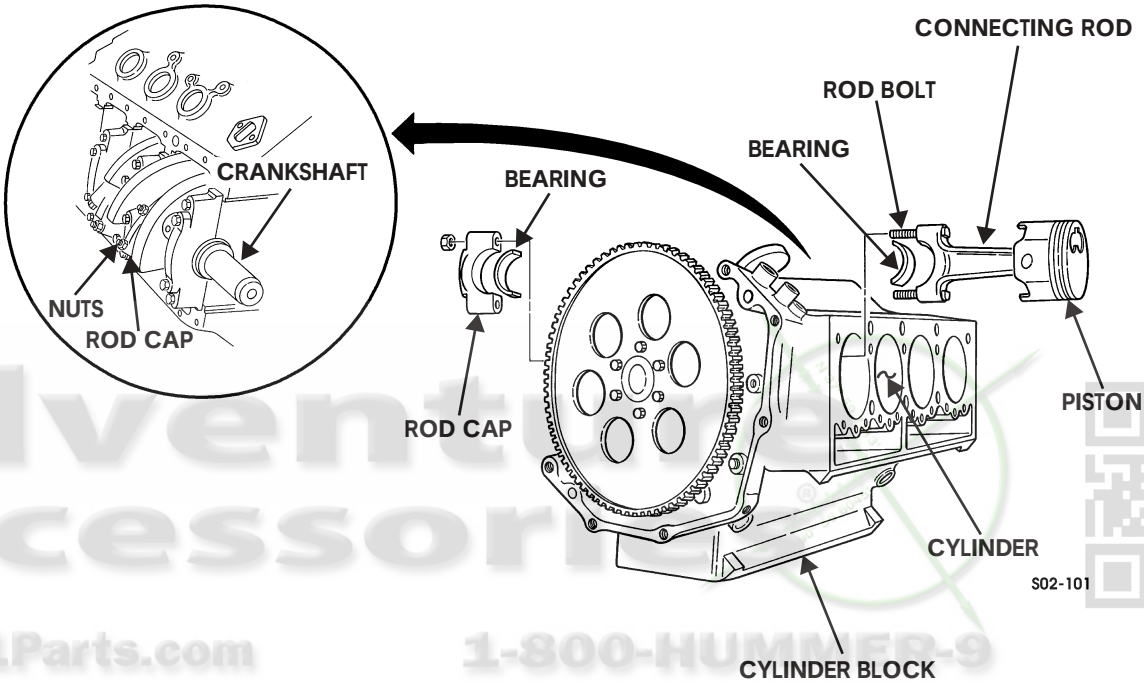


Figure 2-135: Pistons and Connecting Rods

y. Flywheel

Holding crankshaft, remove six capscrews and flywheel from crankshaft (Figure 2-136).

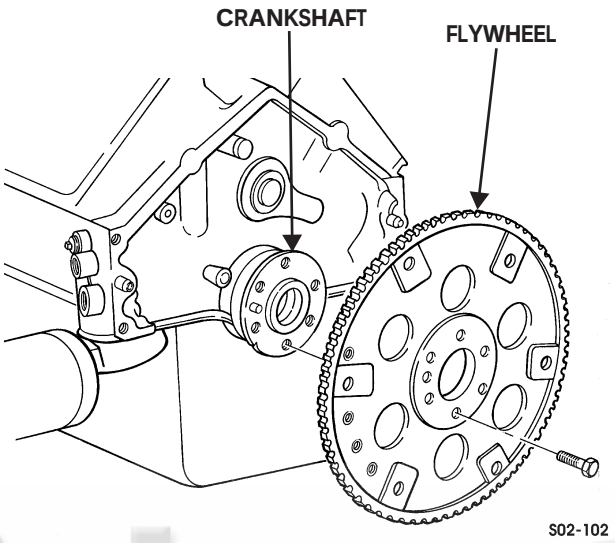


Figure 2-136: Crankshaft and Flywheel

z. Crankshaft and Main Bearings

1. Rotate cylinder block so crankshaft is up (Figure 2-137).

CAUTION: *Main bearing caps must be installed in same place. If not marked, tag for assembly.*

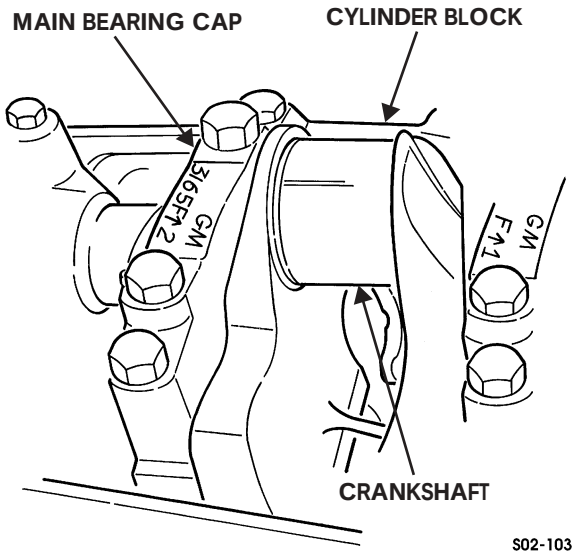


Figure 2-137: Main Bearing Cap

2. Remove four capscrews, main bearing cap, and bearings. Discard bearings (Figure 2-138).
3. Repeat step 2 for remaining main bearing caps.

WARNING: Crankshaft is heavy and must be supported during removal. Failure to do so may cause personal injury or damage to equipment.

4. Remove crankshaft and lower bearings from cylinder block. Discard bearings.
5. Remove oil seal from rear bearing cap and rear main area of cylinder block. Discard oil seal.

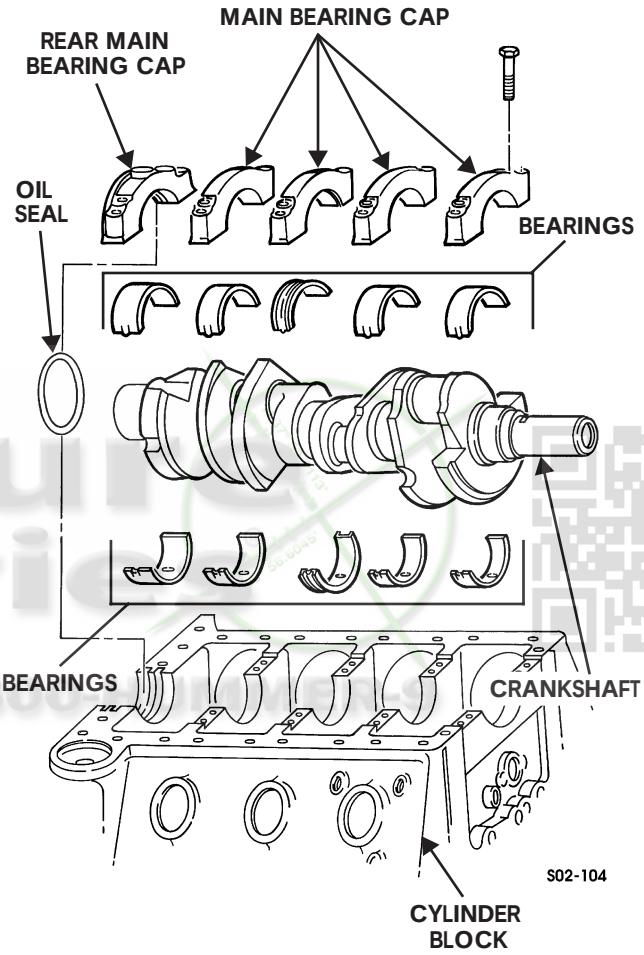


Figure 2-138: Main Bearing Caps and Crankshaft Bearings

CYLINDER BLOCK REPAIR

Pre-Inspection

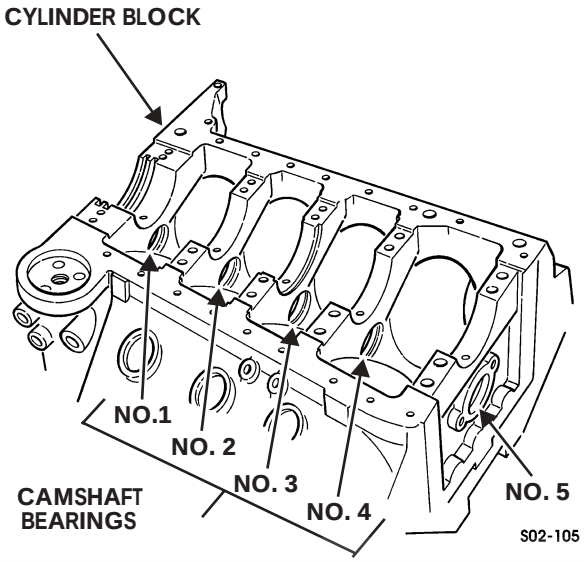


Figure 2-139: Inspecting Camshaft Bearings

1. Wipe camshaft bearings clean with clean cloth.
2. Inspect camshaft bearings for cracks, breaks, scoring, galling, and discoloration due to overheating (80% of surface). Any one of above conditions is reason to remove and discard all bearings (Figure 2-139).
3. Measure the I.D. of camshaft bearings. Wear limit for nos. 1 through 4 bearings is 2.167-2.170 in. (55.04-55.12 mm). No. 5 bearing wear limit is 2.009-2.012 in. (51.03-51.10 mm). Camshaft bearings are replaced as a set.
4. Inspect expansion plugs for seepage stains or evidence of corrosion (Figure 2-140).

Cleaning

CAUTION: *If camshaft bearings are to be reused (remain installed), use steam cleaning or room temperature solvent cleaning processes only.*

NOTE: Refer to Section 1 for general cleaning instructions.

NOTE: Replace all expansion plugs if evidence of corrosion or seepage stains is on any one plug.

1. Remove seven pipe plugs (Figure 2-140).
2. If there is evidence of seepage, remove one small and six large expansion plugs. Discard expansion plugs.
3. Remove block plug (Figure 2-141).
4. Remove oil safety valve, cap, and oil pressure regulator valve.
5. Clean cylinder block (Section 1).
6. Coat cylinder bores, valve lifter bores, and all other machined surfaces with oil as soon as dry.

Inspection

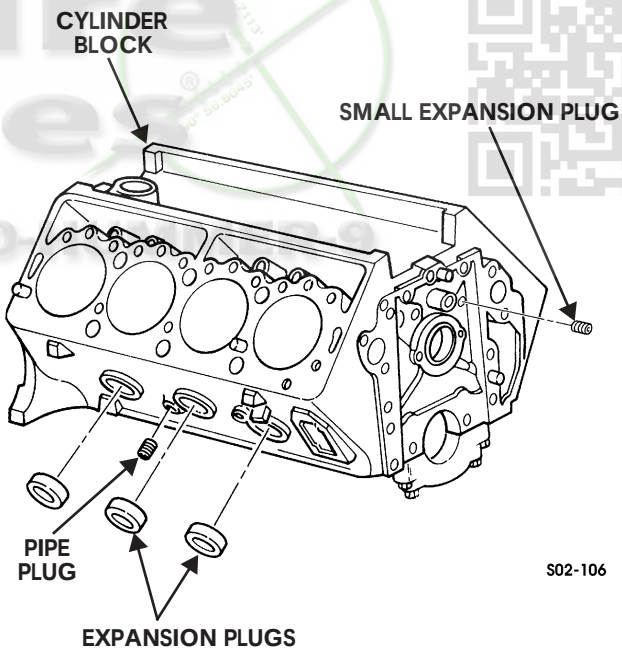


Figure 2-140: Cylinder Block Plugs

Inspection

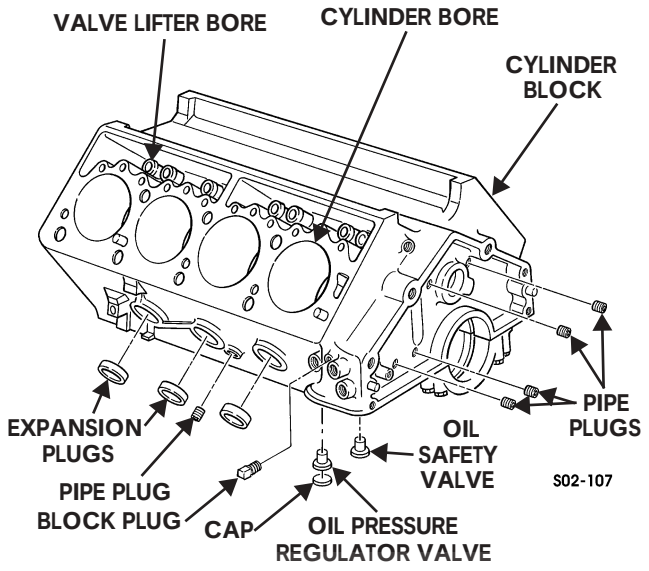


Figure 2-141: Cylinder Block

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect cylinder block overall for cracks, breaks, and chipping on machined surfaces and bearing journals (Figure 2-141).
2. Inspect cylinder and valve lifter bores for cracks, pitting, grooving, and scoring. Light scoring is repairable, all other conditions require part replacement (Figure 2-143).
3. Inspect main bearing caps for cracks, breaks, and scoring. Any defects require part replacement (Figure 2-142).
4. Inspect main bearing cap bolts for bends, cracks, and damaged threads. Replace if damaged.

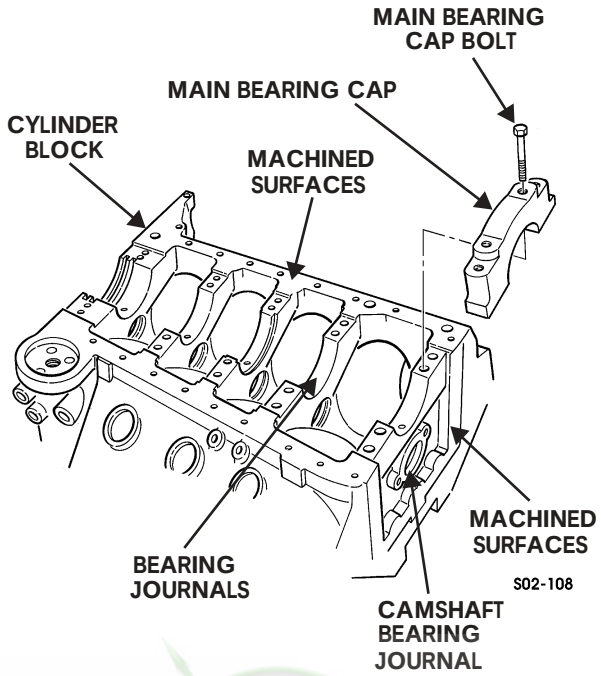


Figure 2-142: Main Bearing Cap Bolt

5. Inspect dowel pins for looseness, damage, or if part is missing parts. Replace if damaged or missing (Figure 2-143).
6. Using a straight-edge and feeler gauge, check cylinder head sealing surfaces. Head surfaces should be flat to 0.002 in. (0.05 mm) over any 6 in. (15 cm) distance or 0.006 in. (0.15 mm) overall. Repair or replace part if not as specified.

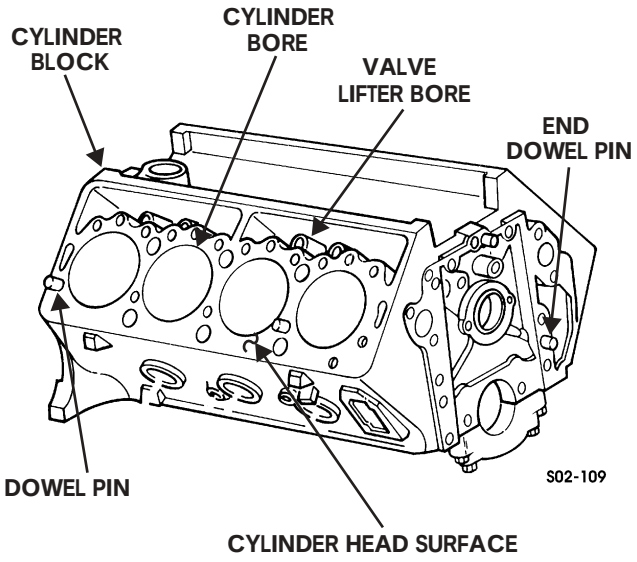


Figure 2-143: Cylinder Block

7. Measure each cylinder bore for wear, taper, and out-of-round condition (Figure 2-145).

a. Measure across points “A” and points “B”.

b. Measure at top and bottom for taper and wear. If differences are more than 0.005 in. (0.13 mm), replace or rebore block. (Refer to tabulated data at end of the section for actual dimensions).

c. Measure out-of-round 2.5 in. (64 mm) from top edge of cylinder. If out-of-round exceeds 0.005 in. (0.13 mm), replace or rebore block.

Repair

Honing Cylinders

1. Measure cylinder diameter 2.5 in. (64 mm) below upper edge of cylinder (Figure 2-145).
2. Measure corresponding piston diameter across center and perpendicular to pin (Figure 2-144).
3. Subtract piston diameter (obtained in step 2) from cylinder diameter (obtained in step 1) to give piston-to-cylinder bore clearance.
4. Proper clearance is 0.004-0.005 in. (0.10-0.13 mm).
5. Measure the remaining cylinders and pistons.
6. If one or more cylinders are worn, a 0.003 in. (0.076 mm) oversize piston is available to meet size conditions of Step 4.

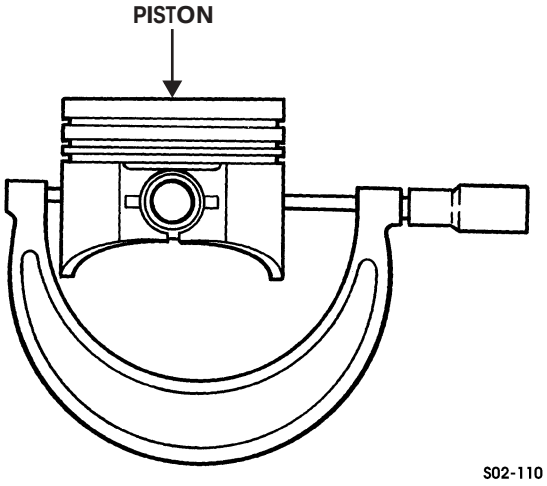


Figure 2-144: Measure Piston Diameter

7. Refinish each cylinder by honing, cleaning, and establishing proper piston-to-cylinder bore fit. If oversize piston(s) are fitted, permanently mark piston with cylinder identification.
8. If one cylinder is honed, all cylinders must be honed and piston-to-cylinder fit checked (step 4).
9. Proper size piston rings must be used with oversize pistons. Refer to piston and connecting rod procedure.

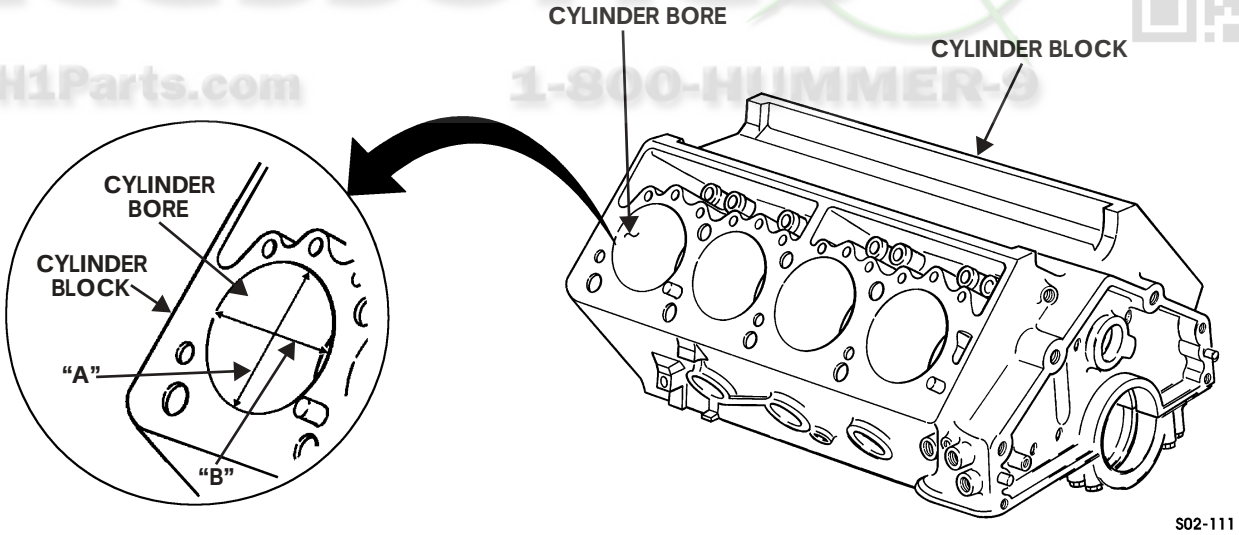


Figure 2-145: Measuring Cylinder Diameter

CAMSHAFT BEARINGS REPLACEMENT

WARNING: Support cylinder block when installing or removing from engine stand. Heavy block could cause personal injury or damage to equipment.

NOTE: Ready access to front and rear surfaces of cylinder block is necessary when replacing camshaft bearings.

Removal

1. Remove cylinder block from engine stand, and remove and discard camshaft plug (Figure 2-146).

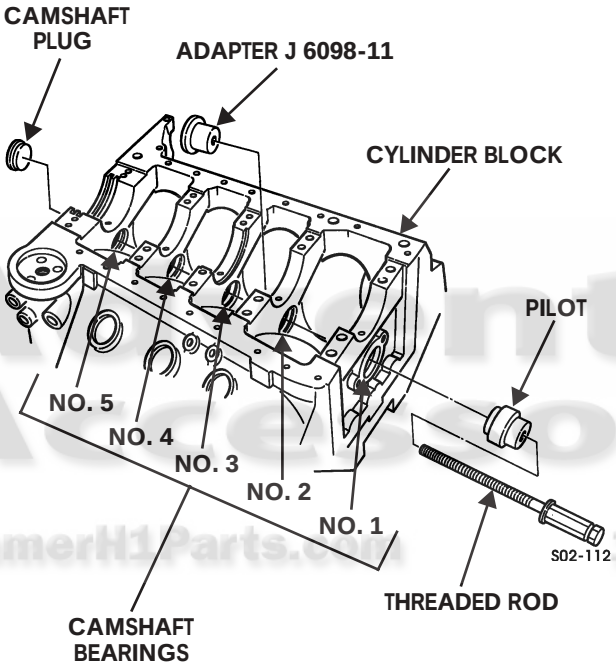


Figure 2-146: Camshaft Plug and Bearing

2. Install pilot in no. 1 bearing and then using threaded rod and J-6098-11 adapter, remove no. 2 camshaft bearing.
3. Repeat procedure for no. 3 bearing.
4. Working from rear through no. 5 bore of cylinder block, remove no. 4 bearing.
5. Using driver handle and J-6098-12 adapter, remove no. 5 and no. 1 bearings (Figure 2-147).
6. Discard all camshaft bearings.

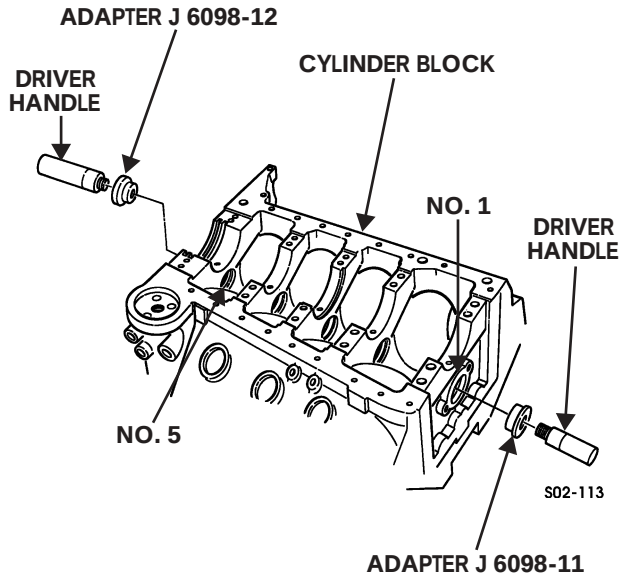


Figure 2-147: Bearing Removal Tools

Installation

CAUTION: *All five bearings must have an oil hole at approximately the ten o'clock position when viewed from the front with the block in an upside down position, or engine damage will result. The seam in the bearing must always be located in the lower half of the block face when viewed with the block in an upside down position, or engine damage will result. The front bearing has an additional oil hole which will be located between the six and seven o'clock positions toward the front of the block, or engine damage will result. All oil holes in camshaft bearings must be aligned with grooves in camshaft bearing bores after installation, or engine damage will result.*

1. Using driver handle and J-6098-11 adapter, install no. 1 bearing so oil holes are at six and ten o'clock positions and notch is toward the front. Oil holes must be over groove in bore (Figure 2-148).
2. Using driver and J-6098-12 adapter, install no. 5 bearing so oil hole is at ten o'clock and over groove in bore.

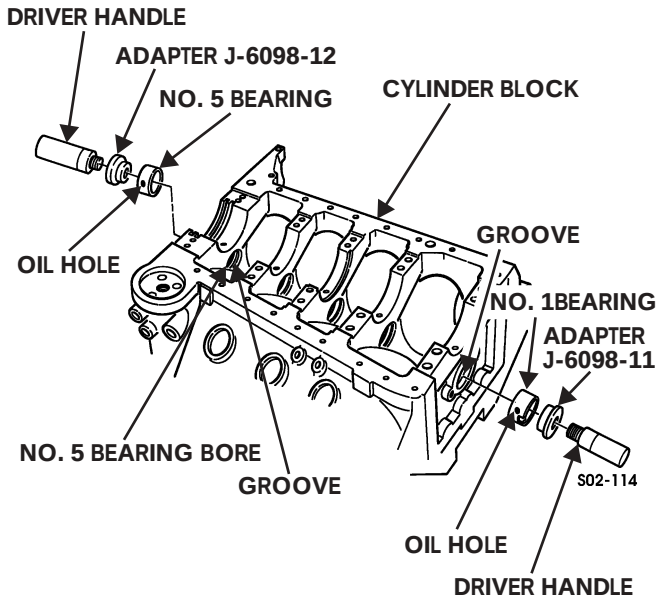


Figure 2-148: Position Oil Hole Over Groove In Bore

3. Place pilot in no. 1 bearing and put threaded rod through pilot to no. 2 bore (Figure 2-149).
4. Position no. 2 bearing on J-6098-11 adapter and align bearing with bore. Ensure oil hole is at ten o'clock position. Connect adapter on threaded rod and pull bearing into bore.
5. Install no. 3 bearing in same way into no. 3 bore.
6. Install no. 4 bearing in same way, working through no. 5 bore.
7. Apply sealing compound to rear plug, and install in rear of cylinder block.
8. Install cylinder block on engine stand (Section 1).

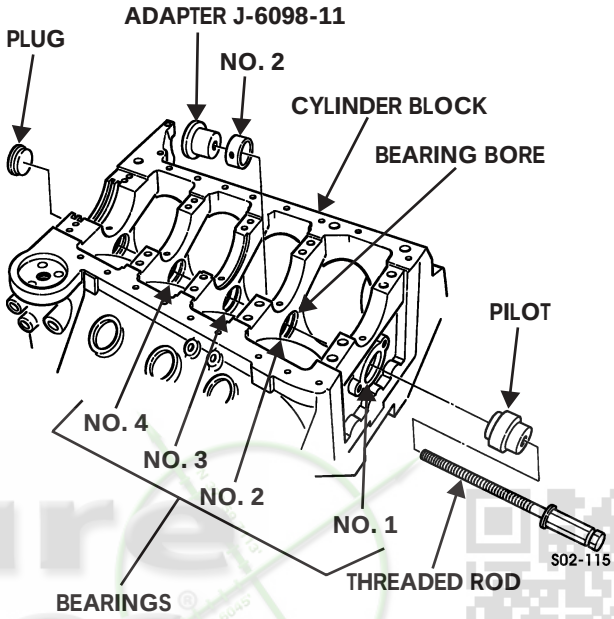


Figure 2-149: Threaded Rod

CRANKSHAFT REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: The crankshaft is made of cast iron and has integral counterweights. The main bearing and crankpin journals are machined with deep, rolled fillets for added strength. No machining of the crankshaft during service is allowed, since the fillets may be disturbed.

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect by measuring all main and connecting rod journals for wear, taper, and out-of-round condition (refer to specifications at end of this section) (Figure 2-150).
2. Inspect seal surfaces for corrosion, scoring, grooving, pitting, and galling. Repair minor scoring and surface pitting. Replace crankshaft if grooved or galled, badly scored, pitted, or corroded.

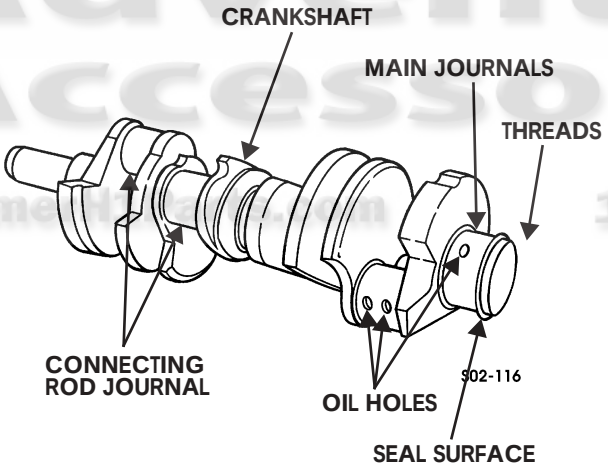


Figure 2-150: Connecting Rod Journal

3. Inspect for crossed or stripped threads. Repair minor thread damage.

Repair

1. Seal areas can be conditioned using crocus cloth in direction of seal (Figure 2-151).
2. Minor thread damage can be repaired using the correct tap. For other thread damage, replace crankshaft.
3. Minor nicks and scratches can be repaired by using fine crocus cloth. For nicks and scratches on sealing surfaces or journals, use fine crocus cloth only. On other surfaces, repair is unnecessary.

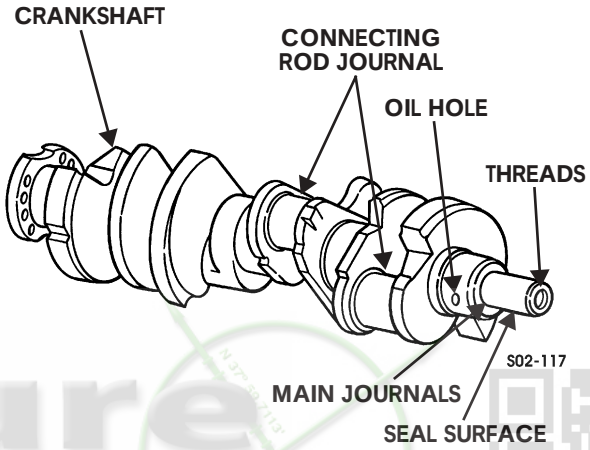


Figure 2-151: Sealing Surface and Journals

CONNECTING ROD AND PISTON REPAIR

Disassembly

1. Remove three rings from piston (Figure 2-152).
2. Remove two snaprings and wrist pin from piston and connecting rod. Discard snaprings.
3. Remove rod cap from connecting rod.
4. Repeat steps 1, 2, and 3 for other pistons.

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect piston for cracks, breaks, chipped ring groove lands and pin bosses, scoring, galling, or scuffing. Repair minor scoring; otherwise replace piston.
2. Measure skirt diameter at points “A” and “B”. If “B” is smaller, discard piston.
3. Inspect connecting rod for cracks, twisting, and damaged bushing. Replace rod if damaged.
4. Measure pin boss I.D. and wrist pin O.D. Clearance should be 0.0003-0.0006 in. (0.0076-0.0152 mm). Refer to specification at end of this section to determine if part is worn.
5. Measure rod bushing I.D. and wrist pin O.D. at rod location. Clearance should be 0.0003-0.001 in. (0.0076-0.025 mm). Refer to specifications at end of this section to determine if part is worn.
6. Check piston ring groove clearance with new rings.

NOTE: First compression ring is thicker than second compression ring.

   a. First compression ring-to-groove clearance is 0.003-0.007 in. (0.076-0.178 mm).
   b. Second compression ring-to-groove clearance is 0.002- 0.003 in. (0.051-0.076 mm).
   c. Oil ring-to-groove clearance is 0.002-0.004 in. (0.051-0.102 mm).
   d. If any measurement in steps a, b, or c determines a groove exceed limits, discard piston.

7. Inspect remaining pistons, connecting rods, and wrist pins.
8. Inspect bolts and nuts (Section 1).

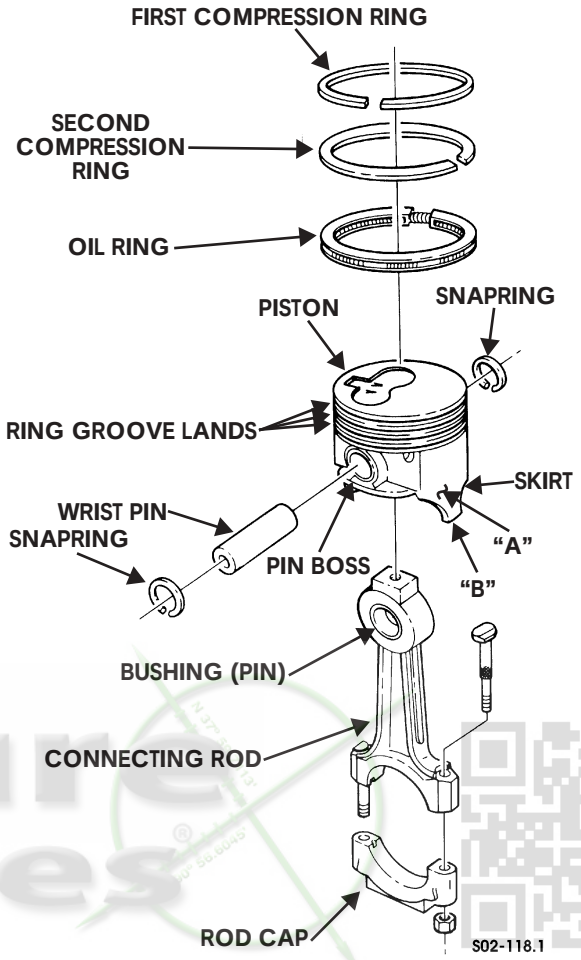


Figure 2-152: Connecting Rod and Piston Assembly

Assembly

NOTE: Refer to Section 1 for general assembly instructions.

1. Check piston ring gaps (Figure 2-153).
   a. Place ring in matching cylinder, slide 1 in. (2.54 cm) into cylinder bore, and ensure ring is level and square.
   b. Measure compression rings gap. Gap must be 0.012-0.22 in. (0.30-0.56 mm) for first compression ring; 0.030-0.039 in. (0.76-.99 mm) for second compression ring; remove rings.
   c. To measure oil ring gap, remove spring and proceed as for compression rings. Gap must be 0.010-0.020 in. (0.25-0.51 mm). Remove ring and install spring.
   d. Repeat steps a, b, and c for remaining ring sets.
   e. If ring gap values are exceeded, install new rings. If gaps are still excessive, recheck cylinder bore dimensions.

NOTE: Connecting rod I.D. number and piston depression are on same side of assembly.

2. Coat wrist pin with oil (Figure 2-154).
3. Position connecting rod in piston and insert wrist pin.
4. Install two snaprings in wrist pin bores to retain wrist pin.

NOTE: The marked side first compression ring must face top of piston.

5. Using ring expander, install oil ring, second compression ring, and first compression ring on piston.
6. Coat rings and piston with light coat of oil. Protect from dust and dirt until assembly.
7. Assemble bolts in connecting rod, and install rod cap with two nuts. Tighten nuts only finger tight.
8. Repeat steps 1 through 7 for remaining pistons and connecting rods.

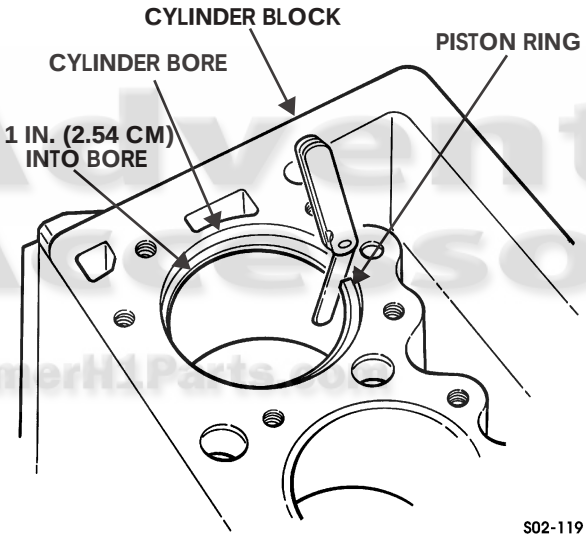


Figure 2-153: Checking Piston Ring

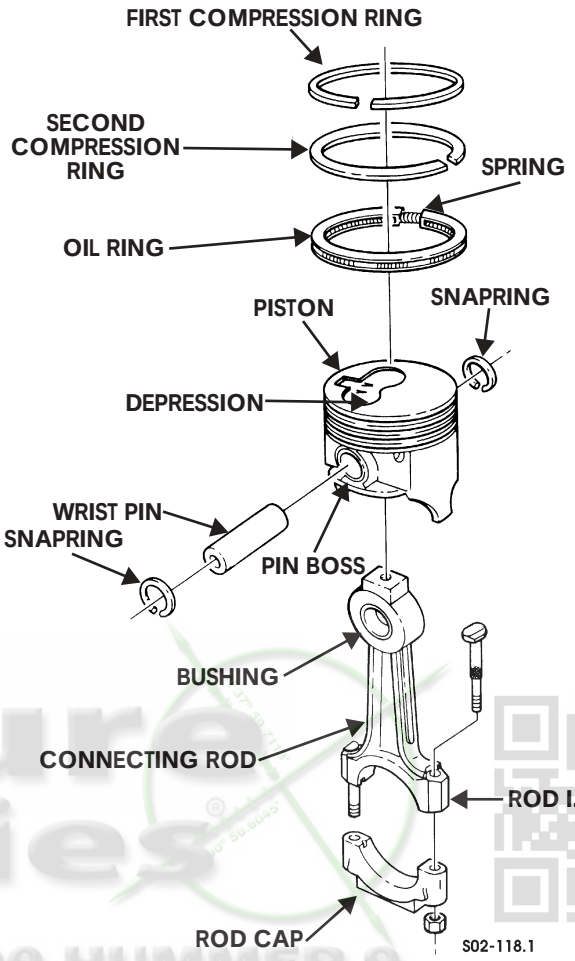


Figure 2-154: Connecting Rod and Piston Assembly

CAMSHAFT, TIMING CHAIN, AND DRIVE GEARS REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Camshaft inspection.
   a. Inspect bearing journals for any damage or discoloration due to overheating. Replace camshaft if damaged or discolored (Figure 2-155).
   b. Inspect oil pump drive gear for damage. Replace camshaft if damaged.
   c. Measure bearing journals for wear. Journals 1, 2, 3, and 4 should be 2.164-2.166 in. (54.975-55.025 mm). Journal 5 should be 2.007-2.009 in. (50.975-51.025 mm).
   d. Mount camshaft on "V" blocks and measure lift. Lift for both intake and exhaust valve lobes should be 0.281 ± 0.002 in. (7.133 ± 0.050 mm). Replace camshaft if lobe is worn out of specified range.
2. Inspect crankshaft sprocket and camshaft sprocket for cracks, breaks, or missing teeth. Replace sprockets if damaged.

NOTE: Camshaft end play was checked for end free play during disassembly. If end play exceeded limits, spacer should be discarded.

3. Inspect timing chain for cracks, breaks, missing link elements, and binding. Replace if damaged.
4. Inspect fuel injection pump drive and driven gears for cracks, breaks in gear web and teeth, and wear (loose mesh of gear teeth). Replace any damaged or worn gears.
5. Inspect thrust plate and spacer for damage. Replace if damaged.

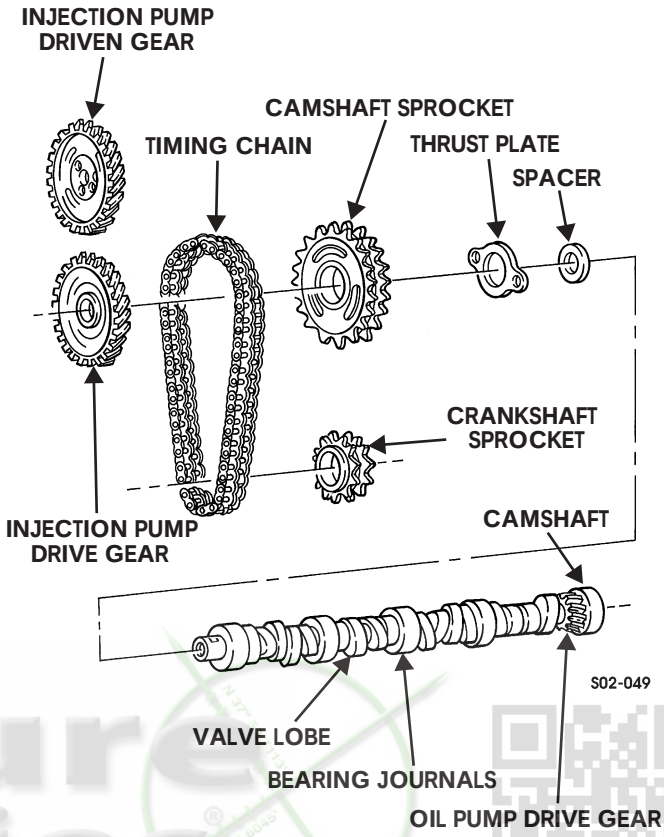


Figure 2-155: Camshaft, Timing Chain and Drive Gears

TIMING GEAR COVER REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect timing gear cover for cracks, breaks, scratches, and nicks on sealing surfaces, and damaged threads. Repair minor scratches, nicks, and thread damage. Replace part if damaged (Figure 2-156).
2. Inspect adapter plate for cracks, scratches on mating and sealing surfaces, dents, pitting, and corrosion. Repair minor scratches. Replace part if damaged (Figure 2-157).

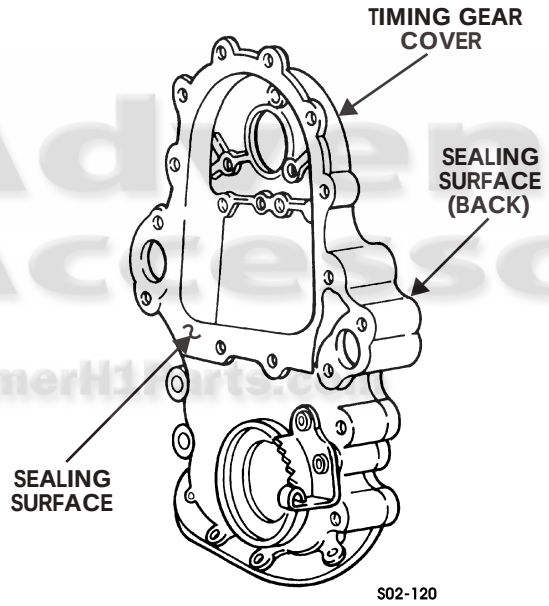


Figure 2-156: Timing Gear Cover

3. Inspect oil filler tube grommet for breaks and cracks. Replace if damaged.
4. Inspect oil filler tube for cracks, breaks, and bends. Replace if damaged (Figure 2-158).
5. Inspect cap for bends and breaks. Check if sealing gasket is missing or damaged. Replace cap if damaged.

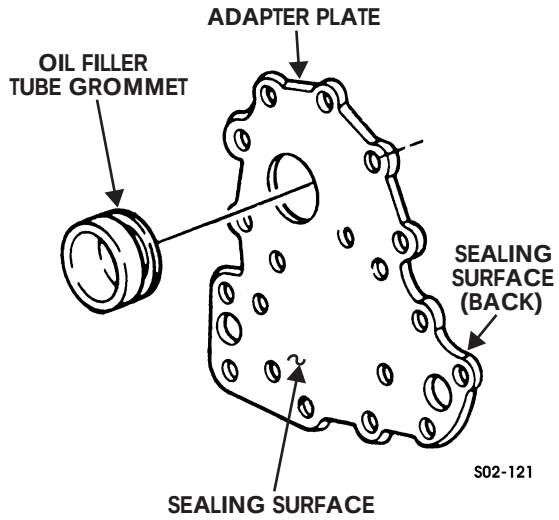


Figure 2-157: Adapter Plate

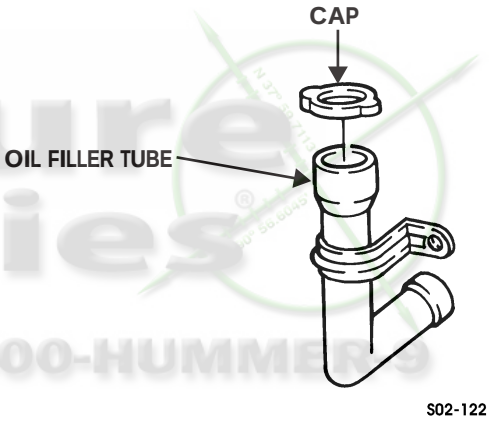


Figure 2-158: Oil Filler Tube

CYLINDER HEAD AND VALVE REPAIR

NOTE: Refer to engine decal on rocker arm cover before ordering replacement parts.

Disassembly

1. Compress intake valve spring and remove key. Release tension slowly (Figure 2-159).
2. Remove valve cap, seal, shield, spring, and shim from intake valve. Discard seal.

NOTE: Valves must be installed in the same location from which they were removed. As each valve is removed, place on numbered board or stand.

3. Remove intake valve from cylinder head.
4. Repeat steps 1 through 3 for remaining intake valves.
5. Compress exhaust valve spring and remove key. Release tension slowly.

NOTE: Valve caps on exhaust valves are rotator type.

6. Remove valve cap, seal, shield, valve stem seal, spring, and shim from exhaust valve. Discard seals.
7. Remove exhaust valve.
8. Repeat steps 5 through 7 for remaining exhaust valves.

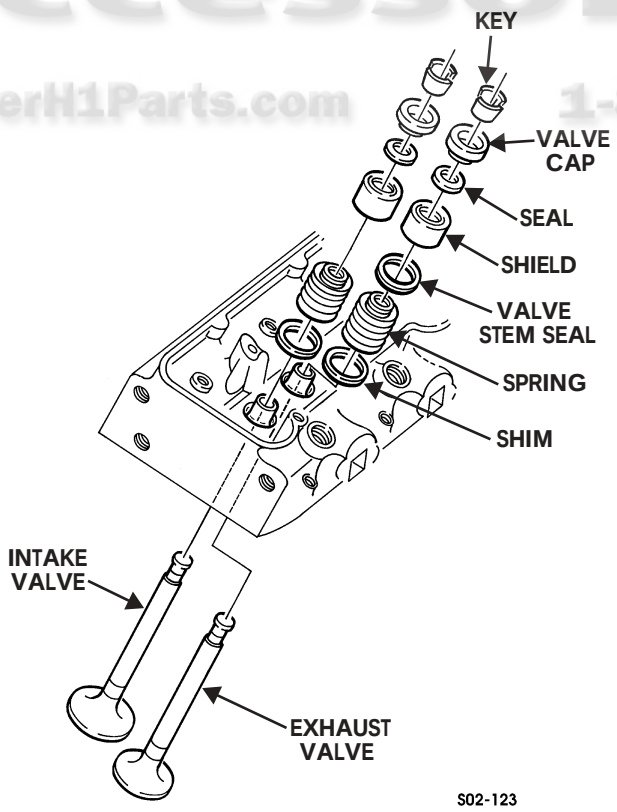


Figure 2-159: Intake and Exhaust Seals

NOTE: Precombustion chambers must be installed in the same location from which they were removed. Mark precombustion chambers for assembly.

9. Mark and remove four precombustion chambers from cylinder head (Figure 2-160).

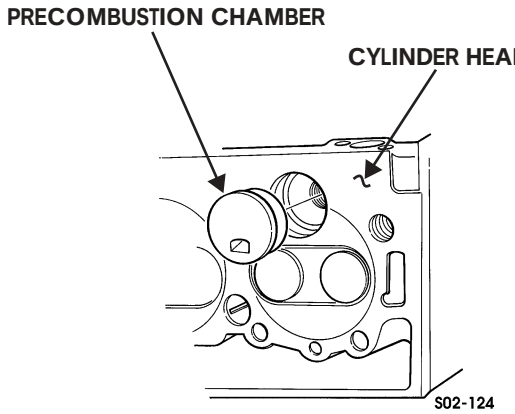


Figure 2-160: Precombustion Chamber

10. Remove temperature sending unit from left cylinder head (Figure 2-161).

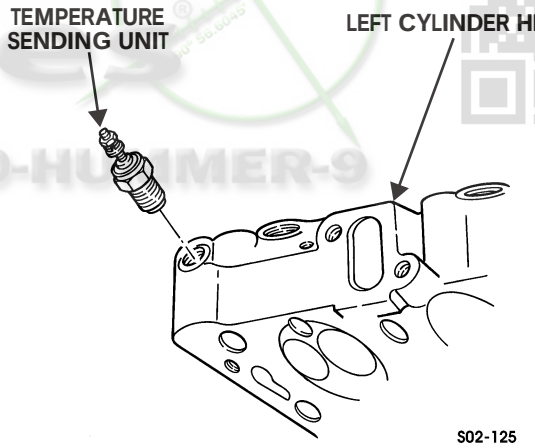


Figure 2-161: Temperature Sending Unit

11. Remove cold-start advance switch from right cylinder head (Figure 2-162).

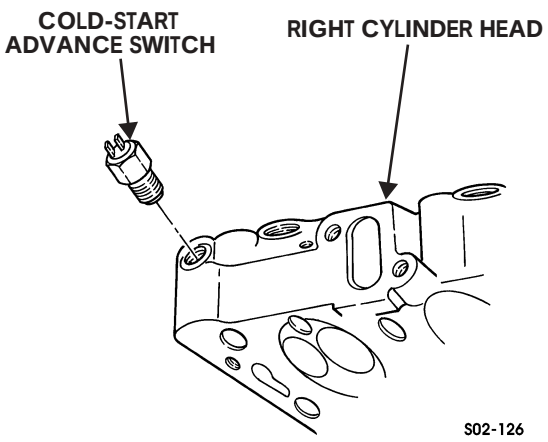


Figure 2-162: Cold-Start Advance Switch

12. Remove two capscrews, water jacket cover, and gasket from right cylinder head. Discard gasket (Figure 2-163).

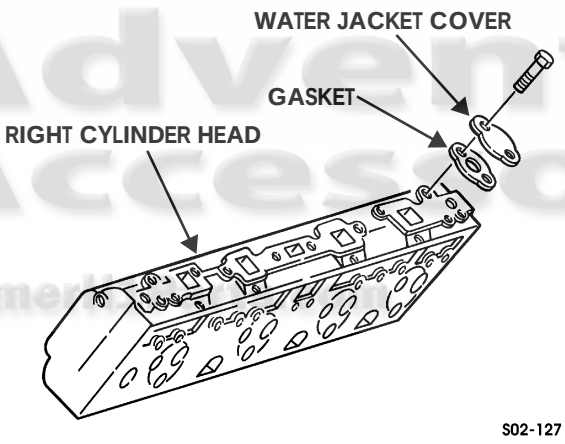


Figure 2-163: Right Cylinder Head

Cleaning

1. Use buffing wheel to clean cylinder heads and valves (Figure 2-162) and (Figure 2-163).
2. Clean precombustion chambers with rotary brush (Figure 2-167).

Inspection

1. Inspect valves for cracks, breaks, scoring, and galling on shank, and chipped or burned heads. Replace valve if damaged (Figure 2-164).
2. Inspect springs and dampers for damage. Replace damaged parts (Figure 2-165). Test springs as follows:
   a. Remove dampers from springs.
   b. Use tester to compress springs to 1.812 in. (46 mm) and measure force required.
   c. If force required is less than 70 lb (95 N•m), spring is defective. Replace spring.
   d. Compress spring to 1.39 in. (35 mm) and measure force required.
   e. If force required is less than 220 lb (298 N•m), spring is defective. Replace spring.
   f. Install dampers back into springs that pass test.
3. Inspect valve caps, shields, shims, and keys for damage. Replace damaged parts (Figure 2-165).

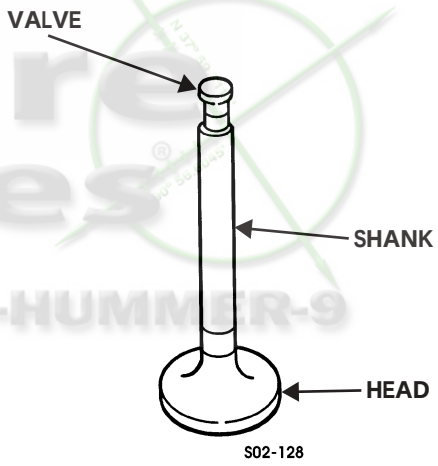


Figure 2-164: Valve Assembly

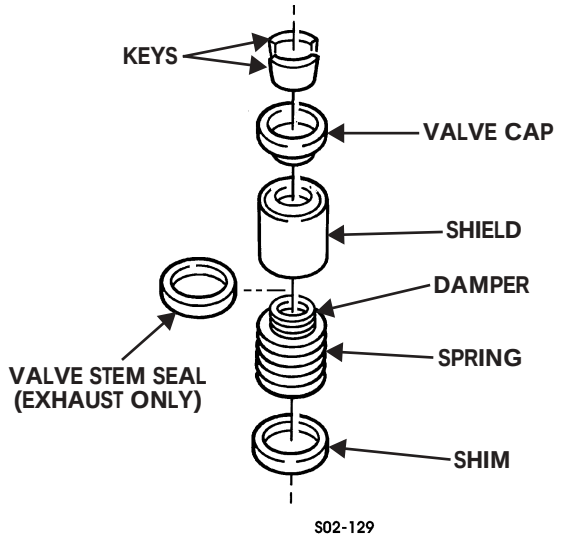


Figure 2-165: Spring and Damper

4. Inspect cylinder heads for cracks into ports or holes, chipped valve seats, or scratches on gasket sealing surfaces. Light scoring on surfaces, except head- to-cylinder block, can be repaired. All other damage requires cylinder head replacement (Figure 2-166), (Figure 2-167), and (Figure 2-169).
5. Inspect cylinder head-to-cylinder block flatness. Using straight edge and feeler gauge check various areas on mating surfaces.
   a. Overall flatness limit is 0.006 in. (0.152 mm).
   b. In any 6 in. (15.2 cm) interval, flatness may not exceed 0.002 in. (0.051 mm).
   c. If either limit in step a or b is exceeded, replace cylinder head. Precombustion chambers are available in standard and oversize. If replacing a precombustion chamber, check for marking "08" on precombustion chamber. If marking is present, oversize precombustion chamber must be used (Figure 2-167).
6. Inspect precombustion chamber for cracks or other damage. Replace if unacceptably cracked or damaged.

CAUTION: *Valve stem clearance must be 0.001-0.003 in (0.026-0.076 mm) Excessive valve stem clearance will cause excessive oil consumption and may cause valve breakage.*

7. Install valve in valve guide from which it was removed (Figure 2-169). Check clearance with wire gauge or dial indicator. Clearance should be 0.001-0.003 in. (0.026-0.076 mm). Valve can be replaced with oversize valve, and valve guide reamed to fit.

NOTE: Intake and exhaust valves are available with 0.0035 in. (0.089 mm) and 0.0138 in. (0.349 mm) oversize stems. If valve stem clearance is more than 0.003 in. (0.076 mm), valve guide must be reamed to next size and oversize valve installed. If unable to produce clearance with oversize valve, replace cylinder head.

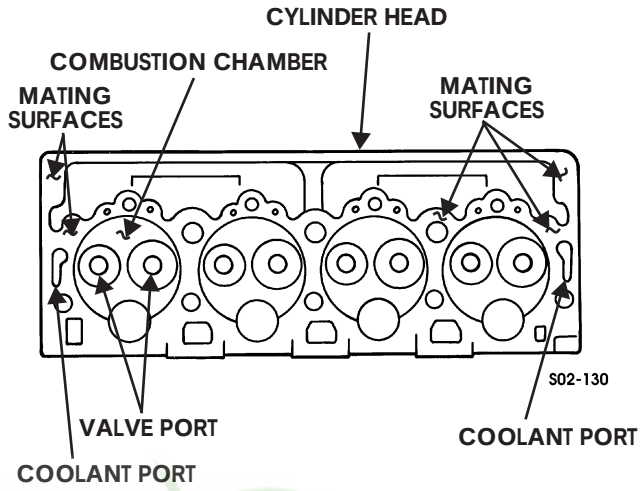


Figure 2-166: Cylinder Head

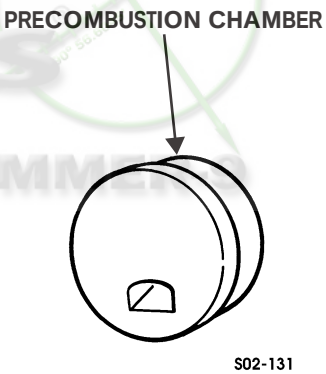


Figure 2-167: Precombustion Chamber

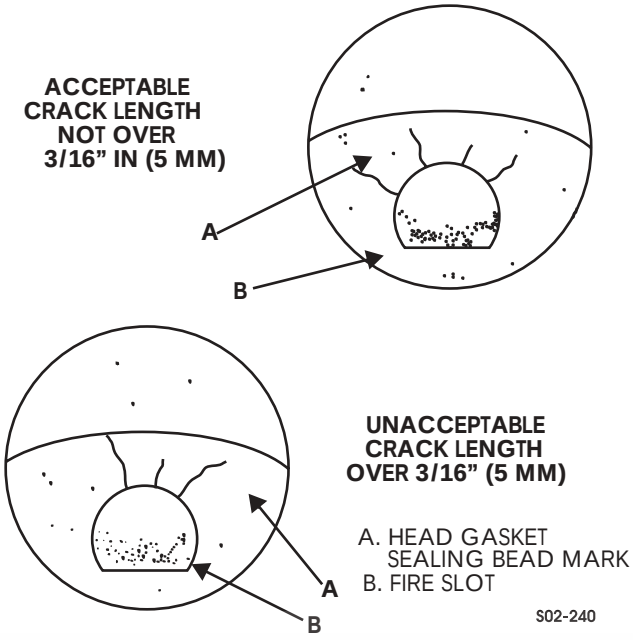


Figure 2-168: Prechamber Inspection

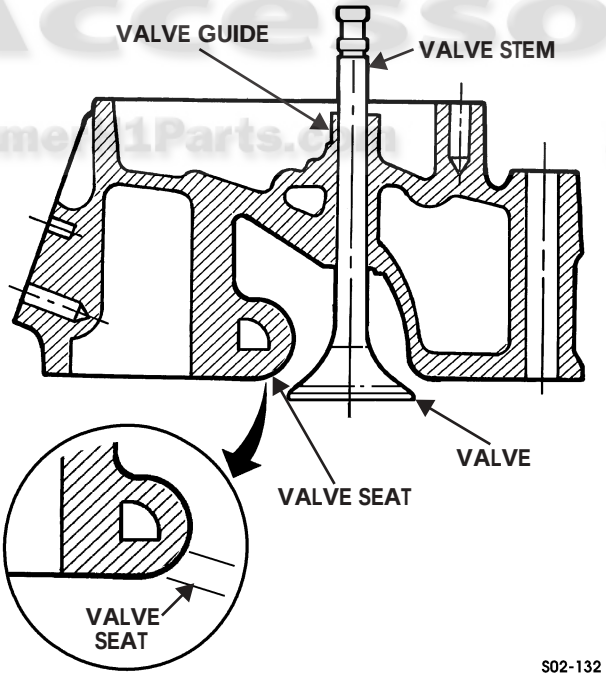


Figure 2-169: Valve Assembly

8. Inspect temperature sending unit and cold-start advance switch for damage. Replace damaged part (Figure 2-170)

.

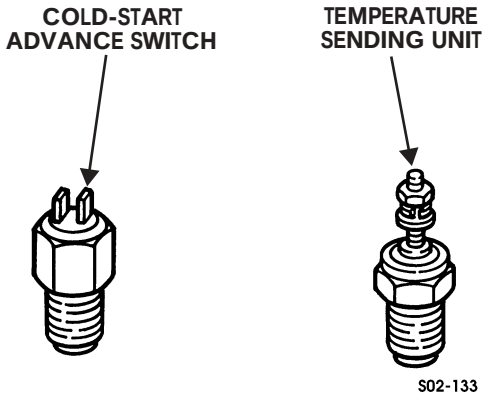


Figure 2-170: Temperature Sending Unit

Refacing Valves

1. Grind valve face on all valves to 45° (Figure 2-171).
2. Margin must not be less than 0.003 in. (0.080 mm) on all valves. If refacing reduces margin more than this, replace valve.

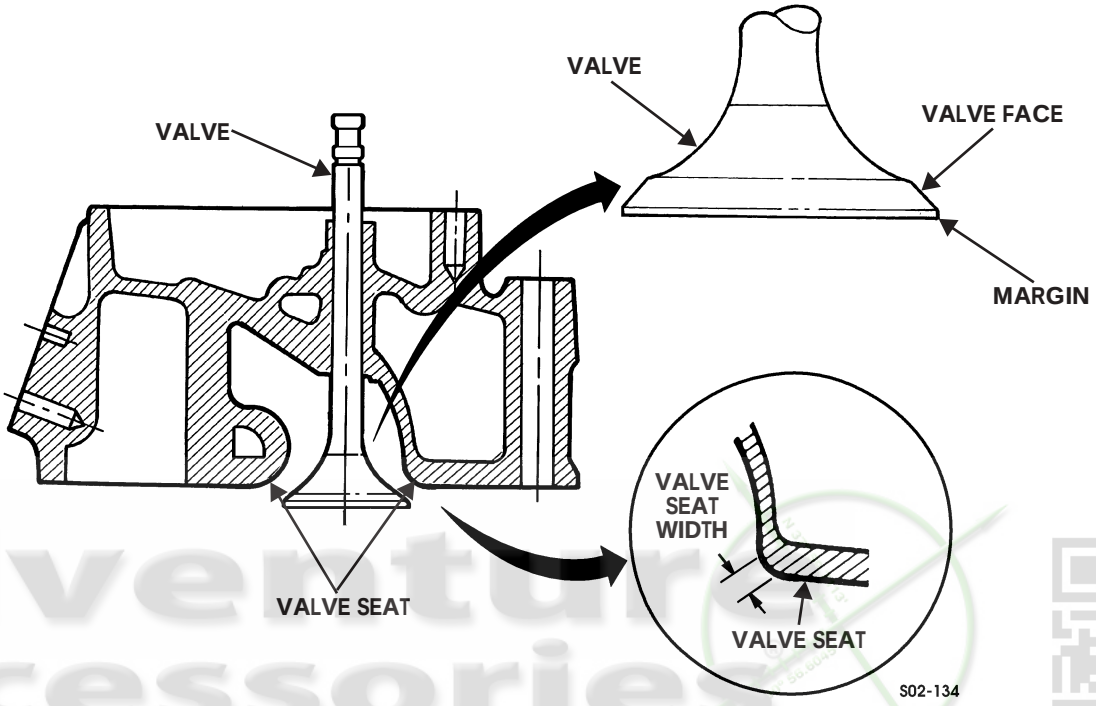


Figure 2-171: Refacing Valves

Grinding Valve Seats

1. Grind valve seats to a 46° angle (Figure 2-171).
2. Intake valve seat width should be 0.035-0.060 in. (0.89-1.53 mm).
3. Exhaust valve seat width should be 0.062-0.093 in. (1.57-2.36 mm).
4. If any valve seat is wider, grind off on inner shoulder.

Assembly

NOTE: Refer to Section 1 for general assembly instructions. Coat stems of valves with oil before installing in valve guides from which they were removed. Valve caps on exhaust valves are rotators.

1. Place exhaust valves in correct positions in cylinder head, and assemble shim, spring, valve stem seal, shield, seal, and valve cap on valve (Figure 2-172).
2. Using compressor, compress spring and install seal over valve and keys on valve. Release compressor slowly, ensuring that keys are seated.
3. Place intake valves in correct positions, and assemble shim, spring, shield, seal, and cap on valve.
4. Repeat step 2 for intake valves.

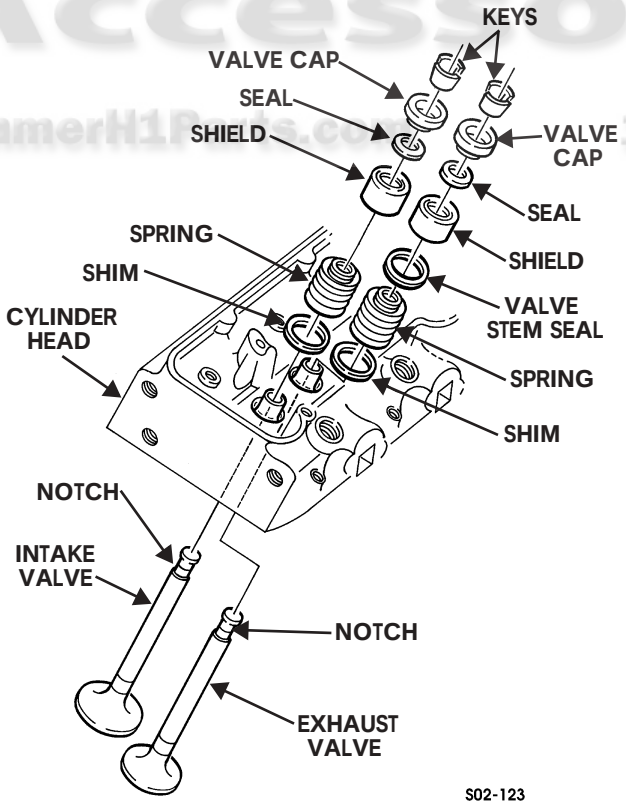


Figure 2-172: Valve Assemblies

5. Check installed height of spring measured from top of shim to top of shield (Figure 2-173).
6. Spring height must be 1.8 in. (46 mm). If height is greater, remove spring and add shims to bring to specified height.
7. Repeat steps 5 and 6 for all other valves.

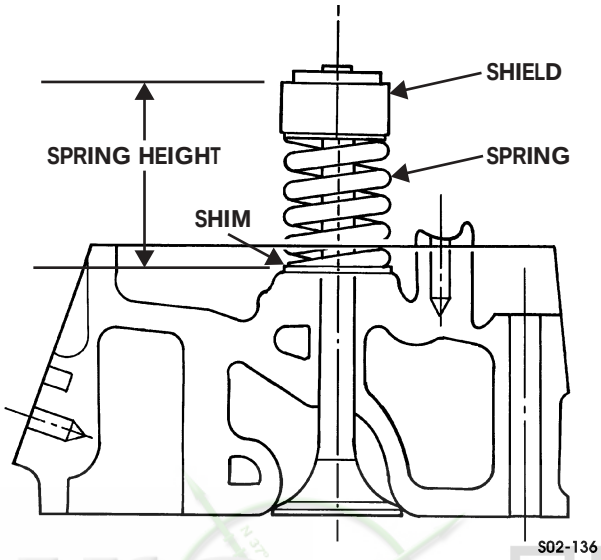


Figure 2-173: Installed Height of Spring

8. Apply pipe sealing compound to threads of cold-start advance switch and install switch in right cylinder head (Figure 2-174).

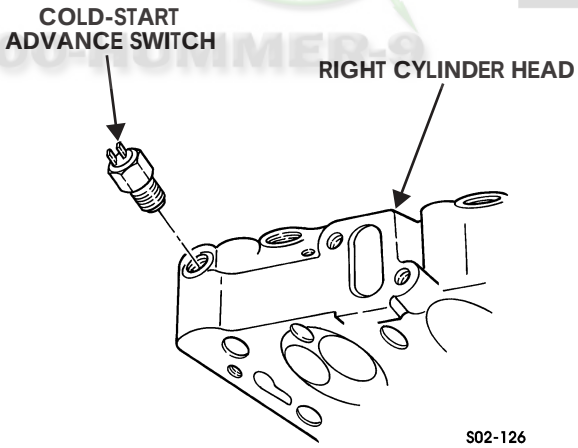


Figure 2-174: Cold-Start Advance Switch

9. Install water jacket cover and gasket on right cylinder head with two capscrews. Tighten capscrews to 25-37 lb-ft (34-50 N•m) (Figure 2-175).

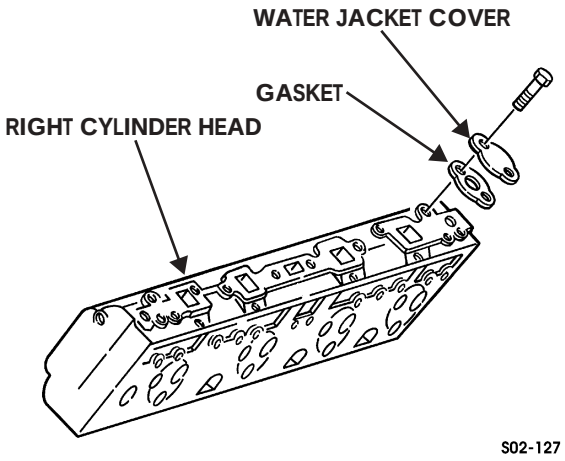


Figure 2-175: Water Jacket Cover and Gasket

10. Apply pipe sealing compound to threads of temperature sending unit and install unit in left cylinder head (Figure 2-176).

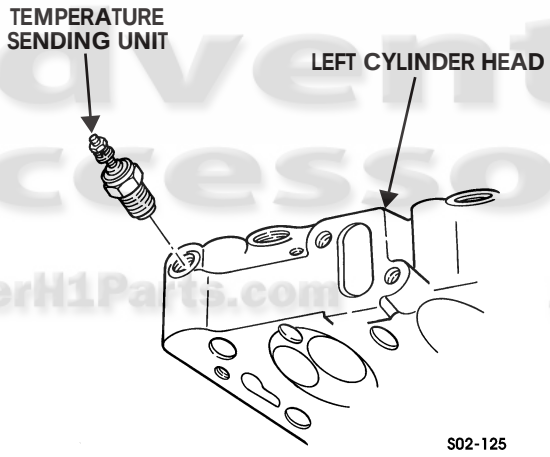


Figure 2-176: Temperature Sending Unit

11. Install four precombustion chambers in each cylinder head. Seat chambers flush with head to 0.002 in. (0.05 mm) above head surface (Figure 2-177).

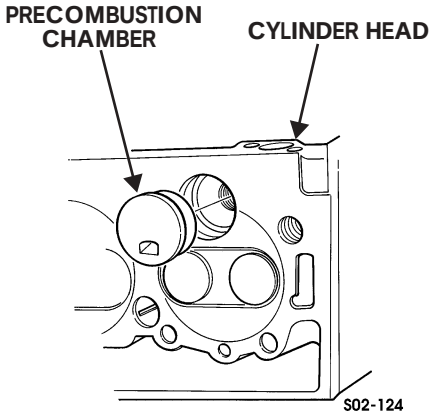


Figure 2-177: Precombustion Chamber

VALVE TRAIN REPAIR

NOTE: All four sets of rocker arms and shafts are repaired the same. One set is shown.

Disassembly

Remove four retainers and rocker arms from shaft (Figure 2-178).

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect rocker arms for cracks and breaks. Replace if damaged (Figure 2-178).

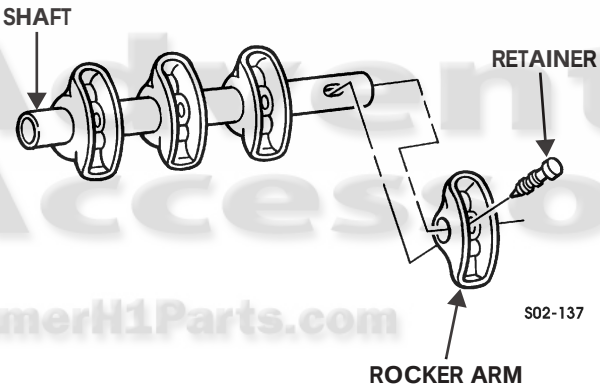


Figure 2-178: Removing Rocker Arm From Shaft

2. Inspect shafts for cracks, breaks, and damaged threads. Replace if damaged.
3. Inspect pushrods for bends, breaks, plugged oil passages, and flattened or worn top ends. Clear oil passages. Replace if otherwise damaged or worn (Figure 2-179).

NOTE: Top of pushrod has a hardened spherical surface.

4. Inspect valve lifters for cracks, breaks, and frozen or scored roller. Replace if damaged.

Assembly

Place four rocker arms on shaft and install with retainers (Figure 2-178).

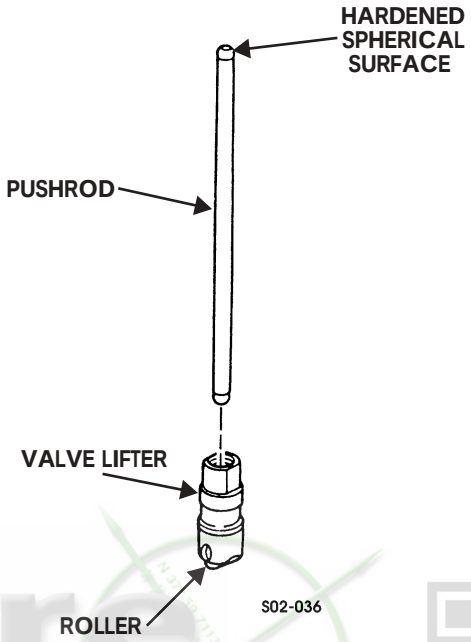


Figure 2-179: Valve Lifter and Pushrod

TORSIONAL DAMPER REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect capscrew holes for damaged threads. Repair minor thread damage. Replace torsional damper if otherwise damaged (Figure 2-180).
2. Inspect front seal surface for pitting, scoring, and grooving. Repair minor pitting and scoring. Replace damper if pitted, scored, or grooved.
3. Inspect rubber insulator for cracks or other damage. Replace damper if insulator is damaged.

Repair

1. Remove minor pitting or scoring with crocus cloth. Replace damper if damaged (Figure 2-180).
2. Use a tap to correct minor thread damage. Replace damper if damaged.

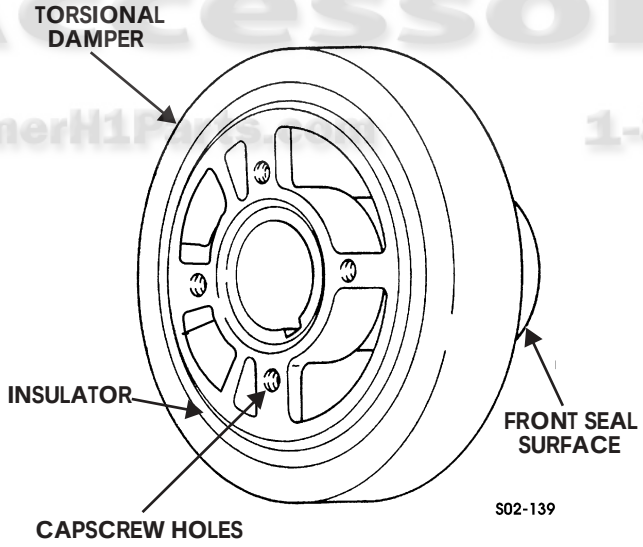


Figure 2-180: Torsional Damper

FLYWHEEL REPAIR

NOTE: The flywheel is often referred to as a flexplate.

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect flywheel for cracks and breaks. Replace flywheel if damaged (Figure 2-181).
2. Inspect gear teeth for chipped, burred, or missing teeth. Replace flywheel if damaged.

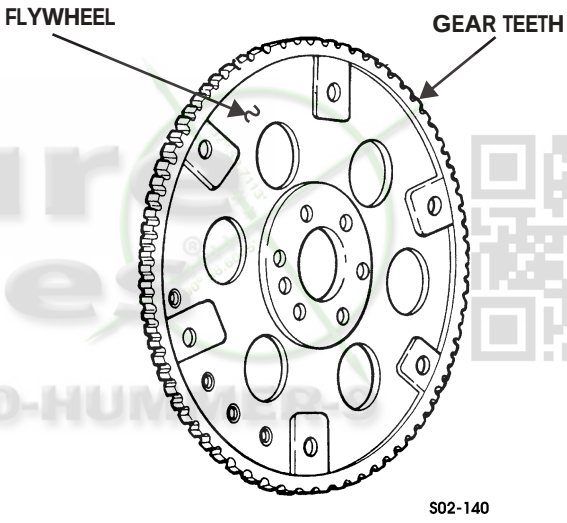


Figure 2-181: Flywheel

ROCKER ARM COVER REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

Inspect rocker arm cover for cracks, sealing surface distortion, and dents. Repair minor dents. Replace cover if otherwise damaged (Figure 2-182).

Repair

Minor dents can be hammered out if sealing surface is not affected.

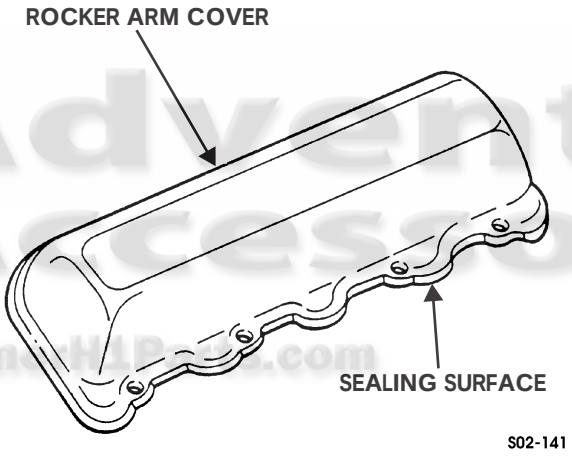


Figure 2-182: Rocker Arm Cover

OIL PAN REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect oil pan for cracks, sealing surface distortion, dents, and damaged threads (Figure 2-183).

NOTE: Small dents, not involving stretched metal, can remain. Larger dents involving stretched or creased metal will leak.

2. Inspect drainplug for crossed or stripped threads and burred flats. Discard gasket. Replace drainplug if damaged.

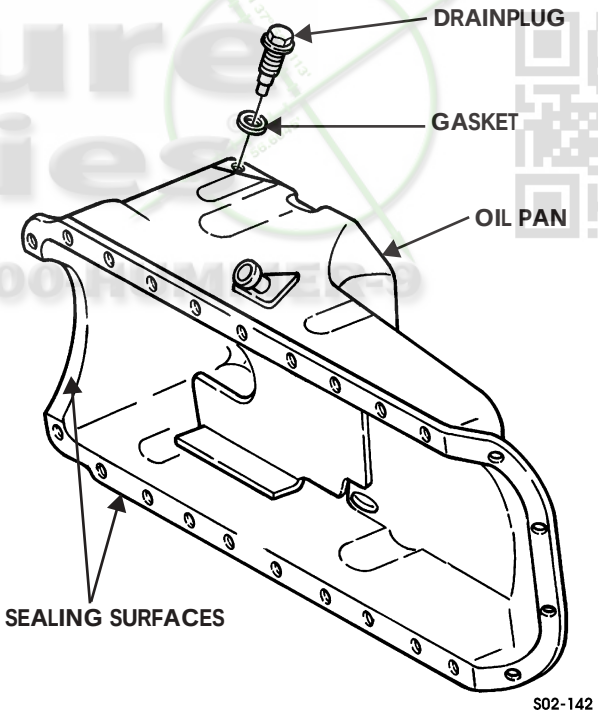


Figure 2-183: Oil Pan

OIL PUMP REPAIR

Disassembly

1. Remove coupling and shaft extension from oil pump body (Figure 2-184).
2. Remove four capscrews and pump cover from body.
3. Remove drive gear and idler gear from body.
4. Remove pin, regulator spring, relief valve, and pressure regulator valve from cover.

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

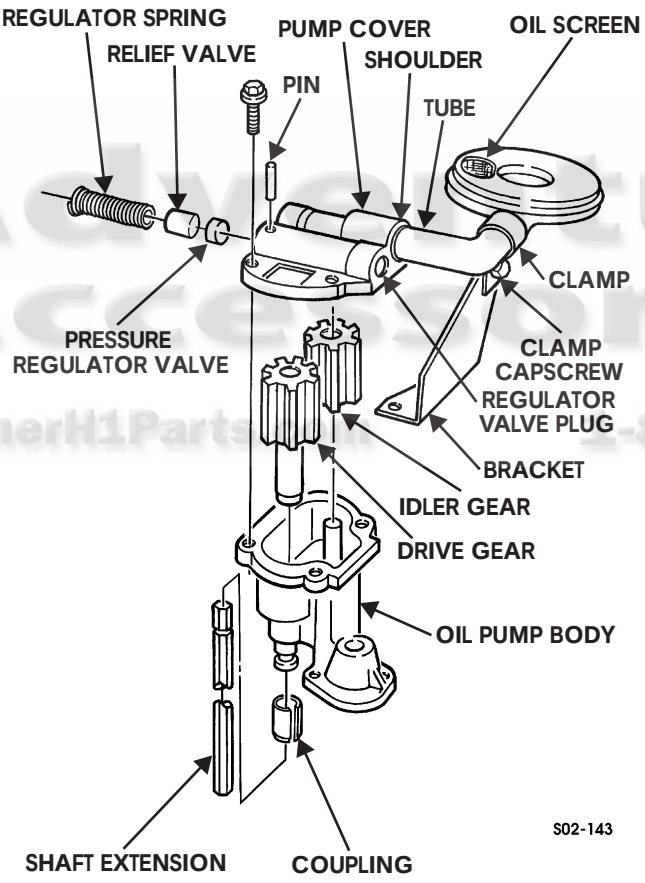


Figure 2-184: Oil Pump Assembly

Inspection

NOTE: Refer to Section 1 for general inspection instructions. If oil pump body, cover, or gears are defective, replace entire pump.

1. Inspect oil pump body, gears, and cover for any damage. Replace oil pump assembly if any one of these parts is damaged (Figure 2-184).
2. Inspect regulator and relief valves for nicks, burrs, and scoring. Replace valves if damaged.
3. Inspect regulator spring for kinks or breaks. Replace if damaged.
4. Inspect shaft extension and coupling for damage. Replace if damaged.
5. Inspect regulator valve plug in cover for looseness or damage. Replace plug if loose or damaged.
6. Inspect oil screen for holes, tears, or blockage and tube for punctures or collapse. Replace oil screen and tube if damaged.
   a. Tap tube with soft-nosed hammer to loosen, as necessary, and twist out of cover.
   b. If a new oil screen and tube are to be installed, remove capscrew from clamp, then open and slide clamp off tube.
   c. Position clamp and bracket on new tube. Start capscrew into clamp, but do not tighten capscrew.
   d. Start tube in cover, and tap and twist tube into cover. Seat to shoulder on tube.

Assembly

1. Place pressure regulator valve, relief valve, and regulator spring in cover, and lock in with pin (Figure 2-184).

NOTE: Liberally coat gears and shaft extension with oil and add a small amount of oil in pump body before assembling with cover.

2. Place drive gear and idler gear in oil pump body and install cover with four capscrews. Tighten capscrews to 124 lb-in. (14 N•m).
3. Install shaft extension on end of drive gear with coupling.

NOTE: If oil pump is not installed immediately, protect oil ports from dust and dirt.

OIL FILTER ADAPTER AND OIL PRESSURE SENDING UNIT REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect adapter reducer and adapter bolt for damaged threads (Figure 2-185). Replace if damaged.
2. Inspect oil filter adapter for stripped or crossed threads, cracks, and chipped sealing surfaces. Replace if damaged.

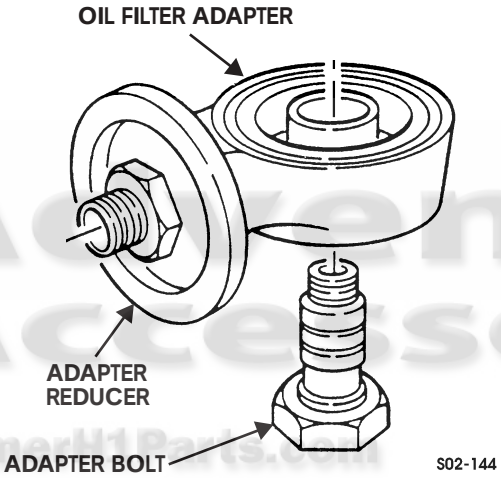


Figure 2-185: Oil Filter Adapter

3. Inspect oil pressure sending unit and elbow for damaged threads and damage to sending unit. Replace if damaged (Figure 2-186).

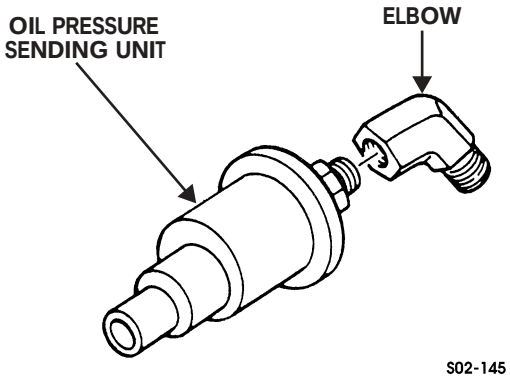


Figure 2-186: Oil Pressure Sending Unit

FLUSHING ENGINE COOLER

NOTE: Whenever the engine is repaired or replaced due to component failure or excessive wear that contaminates the oil with metal or similar particles, the cooler should be flushed. A fresh oil filter and new oil should be used when through with flushing.

1. Remove oil cooler lines at block and allow oil to drain into suitable container.
2. With one line positioned in container, introduce air pressure (no more than 100 psi [689.5 kPa]) into the other line to force oil and contaminates out of cooler.
3. When cooler is clear of old oil, use pump or vacuum unit to either pump or draw fresh oil through cooler. Continue until oil is free of contaminants.
4. Reconnect cooler lines to engine block adapters.
5. Change engine oil and filter if this was not already done with reparir or replacement or worn components.

EXHAUST MANIFOLD REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

Inspect exhaust manifold for cracks and breaks. Replace if damaged (Figure 2-187).

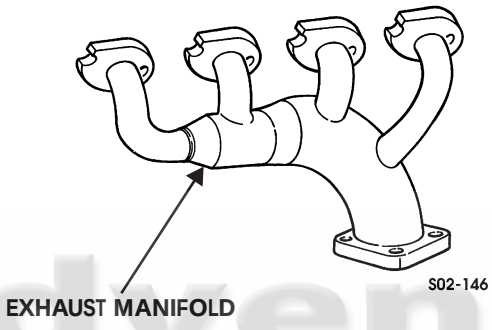


Figure 2-187: Exhaust Manifold

INTAKE MANIFOLD REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect intake manifold for cracks, breaks, damaged threads, and damaged sealing surfaces. Repair minor thread damage; otherwise replace intake manifold (Figure 2-188).
2. Inspect nipple, in manifold, for damage or looseness. Replace if damaged or loose.

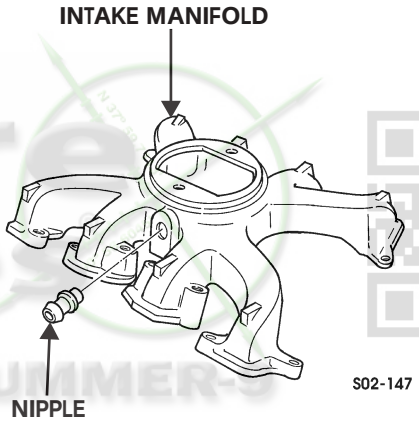


Figure 2-188: Intake Manifold

FUEL INJECTION NOZZLE REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

Inspect fuel injection nozzles for damaged nipples, cracks, breaks, thread damage, and heat discoloration. Replace if damaged.

Testing

NOTE: This procedure generally describes tests to be done. Follow equipment manufacturer's directions on connections and equipment manipulation. (Refer to equipment manufacturer's manual.)

1. Connect fuel injection nozzle to test equipment and prime nozzle (Figure 2-189).

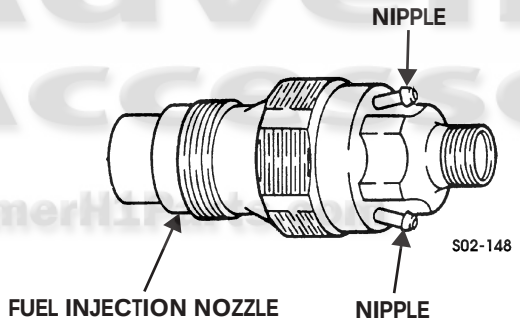


Figure 2-189: Fuel Injection Nozzle

WARNING: Do not place hands or arms near nozzle during pressure testing. Leaks or spray has sufficient force to cause serious injury.

2. Apply pressure slowly to obtain opening pressure. Pressure should be 2,030-2,204 psi (13,997-15196 kPa). If pressure is out of specification, replace nozzle.
3. Leakage check:
   a. Reduce pressure.
   b. Clean and blow-dry end of nozzle.
   c. Apply 1,400 psi (9,653 kPa) of pressure to nozzle and hold for 10 seconds.
   d. If droplet forms and drops off nozzle, replace nozzle.
4. Chatter test (hiss or squeal is also satisfactory):
   a. Starting slowly, apply pressure and listen for chatter. If there is no chatter, increase speed of application of pressure until chatter is heard.
   b. If nozzle does not chatter, replace.
5. Spray pattern:
   a. Apply pressure quickly and observe spray pattern. Look for uniform pattern.
   b. If streams are evident in pattern, replace nozzle.

GLOW PLUG REPAIR

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

Inspect glow plug for breaks, cracks, swelling, or bulges in probe, and damaged threads. Replace if damaged (Figure 2-190).

Testing

Connect multimeter, set for R1 ohms, across terminal and body in threaded area. Resistance should be 0.8-1.0 ohms. Replace glow plug if damaged.

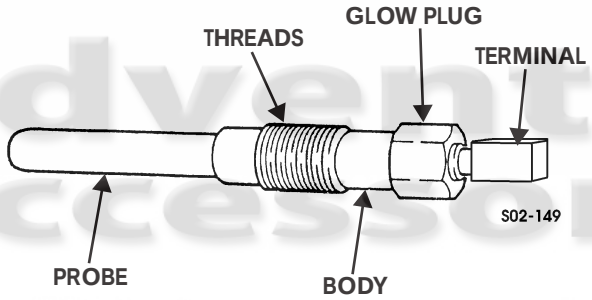


Figure 2-190: Glow Plug

WATER PUMP REPAIR

NOTE: Adapter plate, usually removed with water pump, is treated here as part of timing gear cover.

Disassembly

NOTE: Perform this procedure if a new water pump is to be installed.

1. Remove heater hose adapter from water pump (Figure 2-191).
2. Remove bypass hose adapter from water pump.

Cleaning

NOTE: Refer to Section 1 for general cleaning instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect water pump for cracks, breaks, damaged threads, leaking or loose vent plug, and chipped or broken impeller blades. Repair minor thread damage, and replace loose or leaking plug (Figure 2-191). Replace water pump if damaged (Section 4).
2. Refer to Section 1 for inspection of fittings.
3. Check shaft for end and radial free play. Replace water pump if shaft has any free play.

Repair

1. Remove loose or leaking vent plug (Figure 2-191).
2. Coat new vent plug with sealing compound and install in water pump.
3. Using a tap, repair minor thread damage.

Assembly

1. Coat threads of heater hose adapter with pipe sealing compound and install on water pump (Figure 2-191).
2. Coat threads of bypass hose adapter with pipe sealing compound and install on water pump.

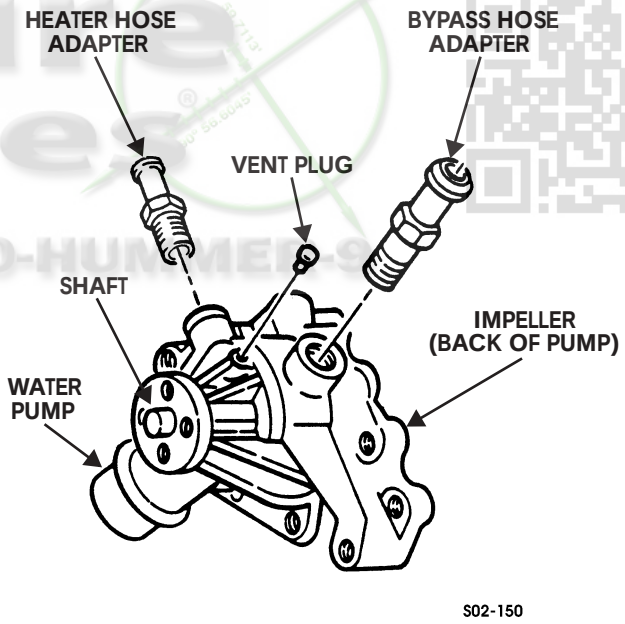


Figure 2-191: Heater Hose Adapters and Water Pump

WATER CROSSOVER REPAIR

Disassembly

1. Remove three capscrews, water outlet, gasket, and thermostat from water outlet. Discard gasket (Figure 2-192).

NOTE: Perform the next step only if replacing the crossover with a new crossover. Record the position of vent hose adapter for assembly.

2. Remove bypass hose nipple, heater hose nipple, and vent hose adapter from water crossover.
3. Remove breather from water outlet.

Cleaning

NOTE: Refer to Section 1 for general inspection instructions.

Inspection

NOTE: Refer to Section 1 for general inspection instructions.

1. Inspect water crossover for cracks, breaks, damaged threads, and damaged sealing surfaces. Using a tap, repair minor thread damage (Figure 2-192).
2. Test thermostat (Section 1).
3. Inspect other fittings (Section 1).

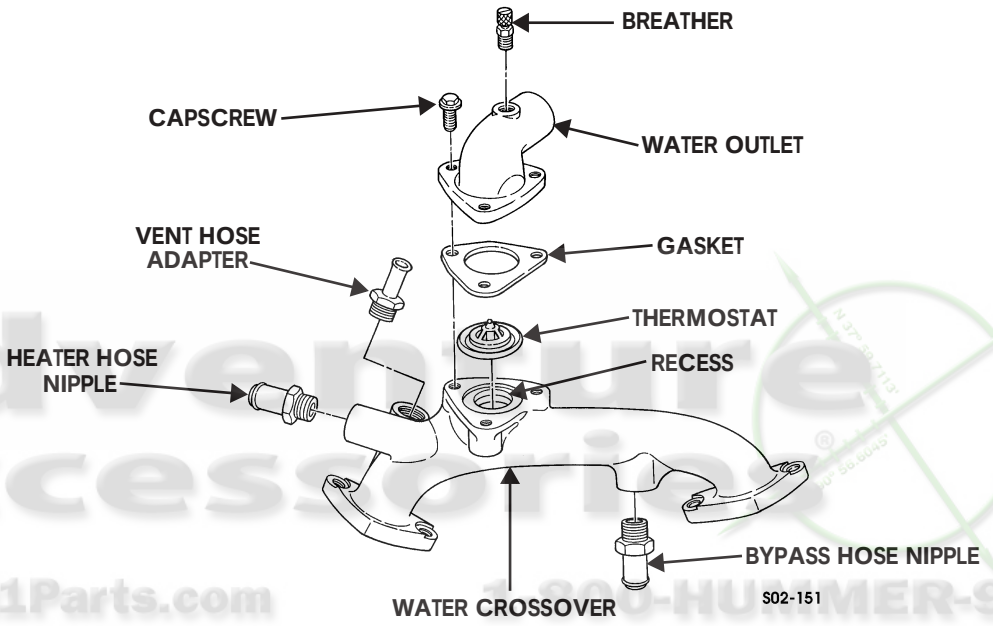


Figure 2-192: Water Crossover

Assembly

CAUTION: *Thermostat must be correctly installed, or engine damage may result.*

NOTE: Refer to Section 1 for general assembly instructions.

1. Install thermostat, gasket, and water outlet on water crossover with three capscrews. Ensure thermostat is in recess before tightening capscrew to 25 lb-ft (34 N•m) (Figure 2-192).

NOTE: Align vent hose adapter as recorded.

2. Coat threads of bypass hose nipple, heater hose nipple, and vent hose adapter with pipe sealing compound and install in crossover.
3. Install breather on water outlet.

ENGINE ASSEMBLY FROM SUBASSEMBLIES

CAUTION: *Some parts and fasteners used with engine are metric. Improper fasteners can cause damage to parts.*

Subassembly Index

- **a. Crankshaft and Main Bearings**
- **b. Flywheel**
- **c. Pistons and Connecting Rods**
- **d. Oil Pump**
- **e. Camshaft**
- **f. Timing Chain and Drive Sprockets**
- **g. Timing Gear Cover**
- **h. Oil Pan**
- **i. Oil Filter, Adapter, and Oil Pressure Sending Unit**
- **j. Oil Pump Drive**
- **k. Fuel Injection Pump**
- **l. Water Pump and Adapter Plate**
- **m. Valve Lifters**
- **n. Cylinder Heads**
- **o. Glow Plugs**
- **p. Fuel Injection Nozzles**
- **q. Rocker Arm Shafts and Pushrods**
- **r. Rocker Arm Covers**
- **s. Fuel Supply and Return Lines**
- **t. Fuel Injection Lines**
- **u. Water Crossover**
- **v. Intake Manifold**
- **w. Exhaust Manifolds**
- **x. Torsional Damper**
- **y. Crankshaft Pulley**
- **z. Fan Drive and Water Pump Pulley**

NOTE: Do not use oil on parts when fitting bearings.

a. Crankshaft and Main Bearings

NOTE: Measure crankshaft bearing journals to determine bearing thickness.

1. Remove all capscrews and main bearing caps from cylinder block (Figure 2-193).
2. Install upper main bearings on cylinder block, ensuring oil holes are aligned.

WARNING: Crankshaft is heavy and must be supported during installation. Failure to do so may cause personal injury or damage to equipment.

3. Carefully position crankshaft into cylinder block onto upper bearings.
4. Place plastigage on crankshaft front main journal parallel to crankshaft centerline and extending the full bearing width.
5. Install main bearing cap and lower main bearing on cylinder block with two long capscrews and two short capscrews. Tighten capscrews finger tight.
6. Tighten long capscrews to 111 lb-ft (150 N•m) and short capscrews to 100 lb-ft (136 N•m).
7. Remove four capscrews and bearing cap.
8. Using envelope scale, compare plastigage width, which should indicate a 0.002-0.004 in. (0.051-0.102 mm) clearance and even width across journal.
   a. If plastigage indicates uneven width (greater than 0.005 in. (0.013 mm) variation), re-measure crankshaft journal. If width is uneven, repair journal or replace crankshaft.
   b. Undersize bearings, 0.005-0.01 in. (0.013 or 0.025 mm), may be used to achieve specified clearance.
   c. Repeat steps 4-8 to refit bearings.
9. Repeat steps 4-8 for other main bearings in sequence.

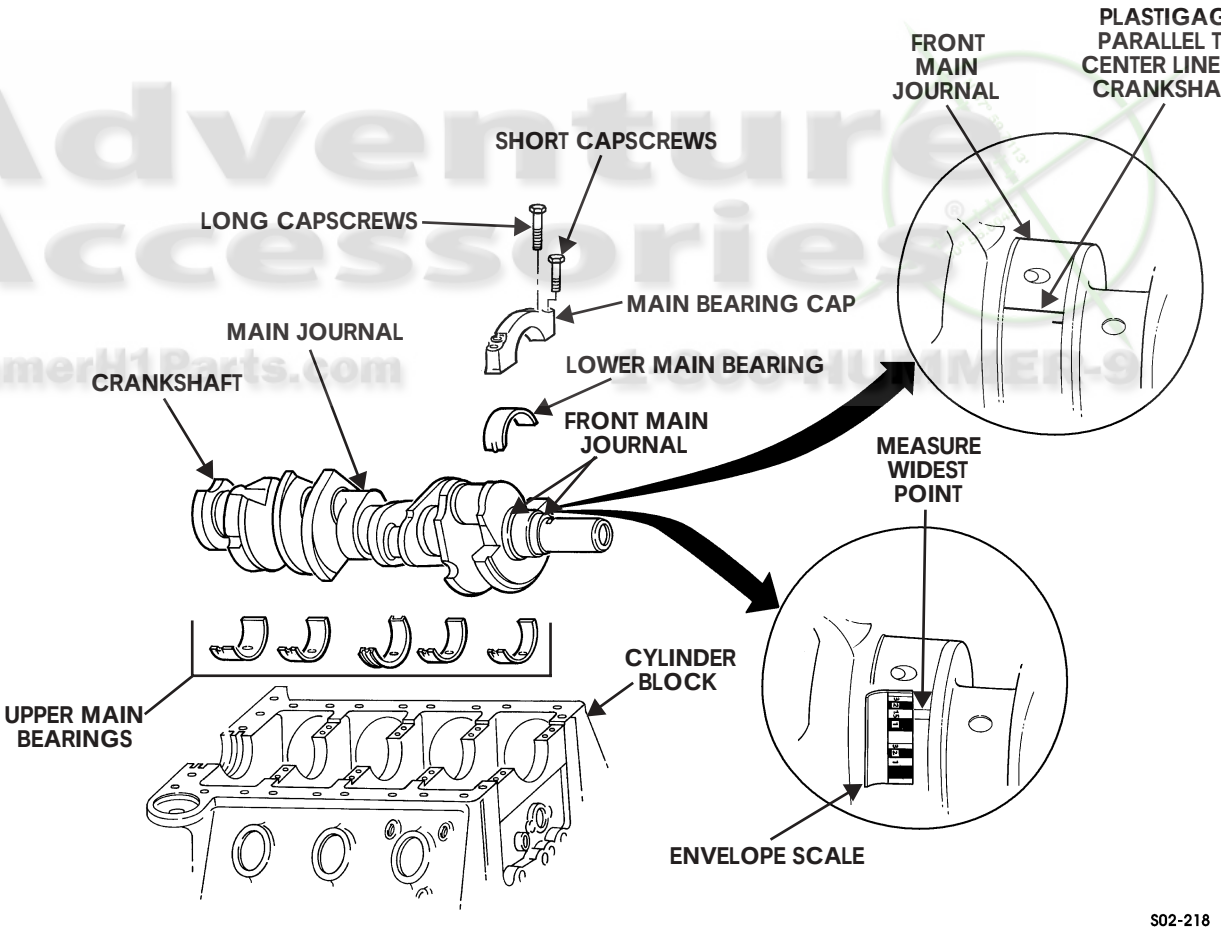


Figure 2-193: Main Bearings and Bearing Caps

10. After checking all main bearing clearances, remove crankshaft, and apply oil to bearings and journals (Figure 2-194).
11. Install main bearing caps nos. 1, 2, and 3. Tighten short capscrews and long capscrews to 12 lb-ft (16 N•m).
12. Tap crankshaft to rear and then toward the front to seat main bearings.
13. Tighten long capscrews to 111 lb-ft (150 N•m) and short capscrews to 100 lb-ft (136 N•m).
14. Ensure that crankshaft rotates freely.
15. Force crankshaft to front and hold. Measure clearance at front of #3 main bearing. Clearance should be 0.04-0.1 in. (0.101-0.250 mm).
    a. If clearance is greater, check for excessive wear at rear surfaces.
    b. If clearance is less, check for correct size bearings and wear on thrust surface of crankshaft at rear main.
16. Remove capscrews, main caps nos. 1, 2, and 3, and crankshaft from cylinder block.
17. Coat journal and bearing with oil and install no. 3 main bearing cap with four capscrews. Tighten to 12 lb-ft (16 N•m).
18. Tap crankshaft forward and rearward to align bearing.
19. Tighten four capscrews on no. 3 main bearing cap to 40 lb-ft (54 N•m).
20. Apply a thin coat of sealant to block metal contact surface of rear main cap, and immediately install with four capscrews. Tighten capscrews to 40 lb-ft (54 N•m).
21. Install remaining bearing caps, and tighten capscrews to 40 lb-ft (54 N•m).
22. Evenly tighten long capscrews to 111 lb-ft (150 N•m).
23. Evenly tighten short capscrews to 100 lb-ft (136 N•m).
24. Ensure that crankshaft still turns freely.
25. Coat rear crankshaft surface with engine oil, and lightly coat lip of rear main oil seal with engine oil.
26. Install oil seal, with spring cavity toward cylinder block on crankshaft.
27. Using seal installer, drive oil seal in until tool bottoms against cylinder block and rear main bearing cap.

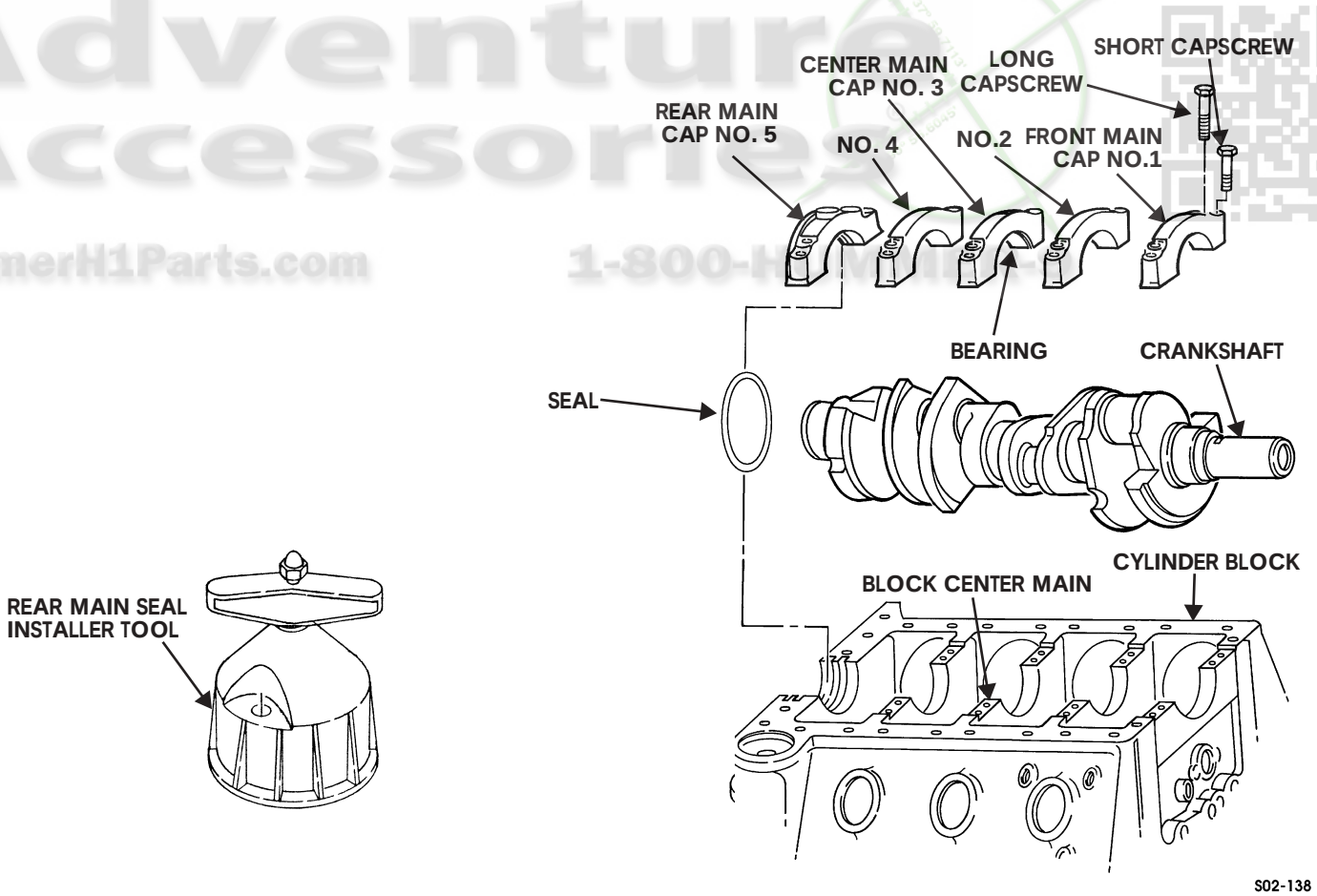


Figure 2-194: Main Bearings and Rear Seal

b. Flywheel

1. Position flywheel on crankshaft flange, with converter pads away from cylinder block (Figure 2-195).
2. Install flywheel with six capscrews. Tighten capscrews to 65 lb-ft (88 N•m).

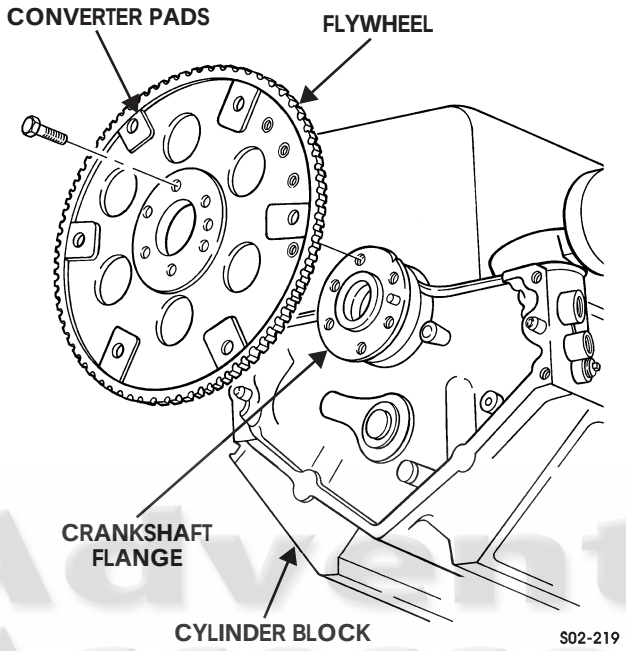


Figure 2-195: Flywheel

c. Pistons and Connecting Rods

1. Rotate cylinder block to position one set of cylinders horizontally (Figure 2-196).
2. Measure each connecting rod journal to determine size of bearings.
3. Protect rod bolts while installing piston in cylinder.
4. Ensure that piston ring gaps are staggered and not aligned with wrist pin.

NOTE: The piston must be installed so that the depression in the piston crown is towards the outside of the engine.

5. Apply clean oil to piston rings, piston, and cylinder, and using a ring compressor, install piston in cylinder.
6. Check I.D. of rod caps, and install proper size bearings in connecting rod and rod cap.

NOTE: Bearings are gauged dry; do not oil. I.D. numbers on rod and cap must be on same side.

7. Mate connecting rod and upper bearing half over rod journal on crankshaft (Figure 2-197).
8. Apply plastigage to rod journal as in main bearing gauging.

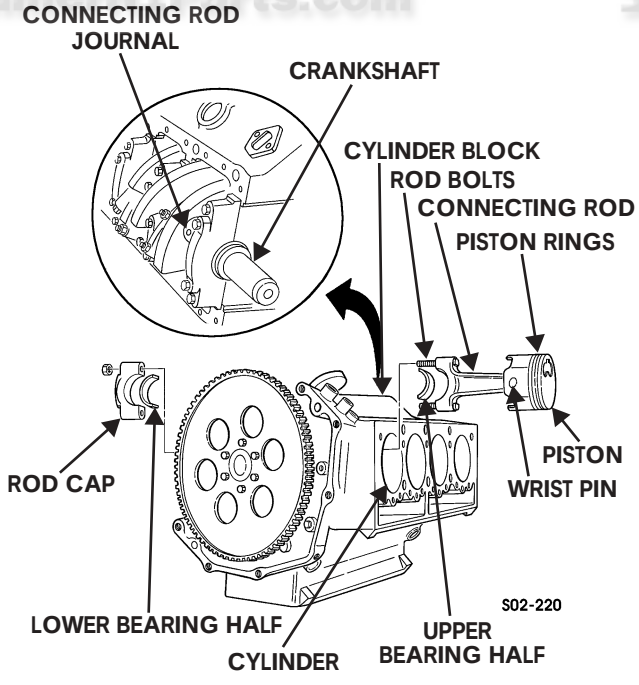


Figure 2-196: Cylinder Block

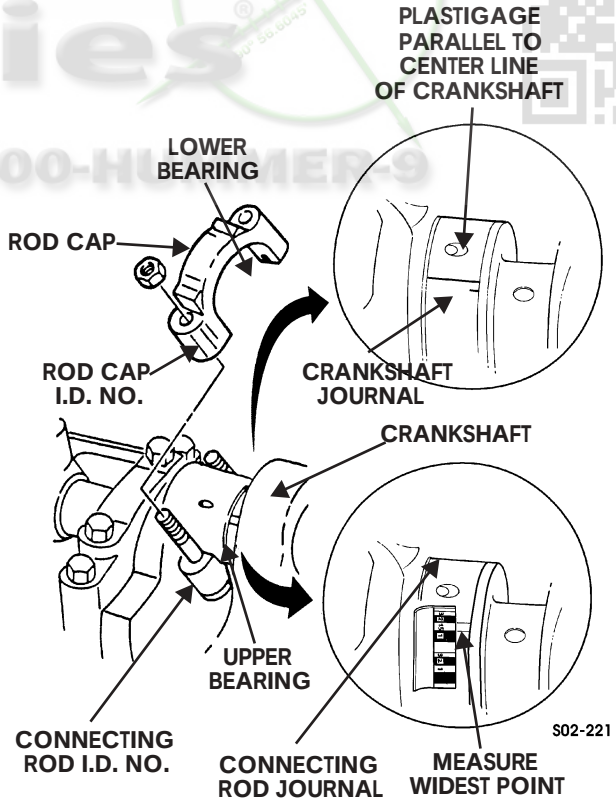


Figure 2-197: Crankshaft Journal

9. Assemble lower bearing half and correct rod cap on connecting rod and install with two nuts. Tighten nuts 44-52 lb-ft (60-70 N•m).
10. Remove nuts, rod cap, and lower bearing half from crankshaft journal.
11. Using envelope scale on plastigage, check bearing clearance. Normal clearance is 0.002-0.004 in. (0.051-0.102 mm).
    a. If plastigage indicates a taper or narrowing of 0.001 in. (0.025 mm), remeasure rod journal. If journal is tapered, repair or replace crankshaft.
    b. If clearance is slightly oversize, a 0.001 in. (0.025 mm) bearing may be substituted. Repeat steps 8 through 11.
12. Remove plastigage.
13. Apply oil to both bearings and install rod cap with two nuts. Tighten nuts 44-52 lb-ft (60-70 N•m).
14. Ensure that crankshaft turns freely.
15. Repeat procedure for other pistons and connecting rods.

d. Oil Pump

1. Rotate cylinder block so crankshaft is up (Figure 2-198).
2. Ensure hex-drive pin is in oil pump and install oil pump on rear main cap with stud. Tighten stud to 59-74 lb-ft (80-100 N•m).

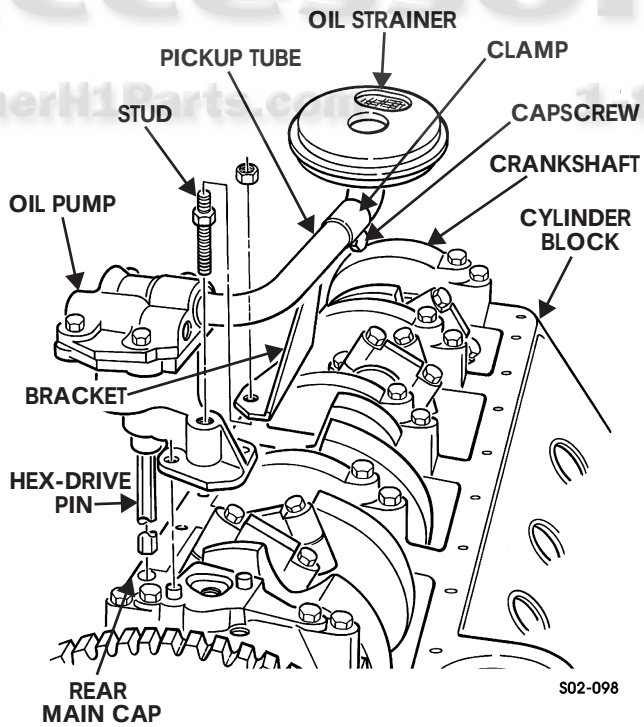


Figure 2-198: Oil Pump

3. Set bracket over stud and insert pickup tube in oil pump. Install bracket with nut. Tighten nut to 35 lb-ft (47 N•m).
4. Rotate pickup tube so oil strainer is horizontal and tighten clamp capscrew to 12 lb-ft (16 N•m).

e. Camshaft

1. Rotate cylinder block so that crankshaft is down (Figure 2-199).
2. Oil all camshaft bearings and camshaft lobes and journals.

CAUTION: *Support camshaft during installation to avoid damaging bearings.*

3. Carefully position camshaft in cylinder block.
4. Place beveled edge of spacer toward bearing journal and install spacer and thrust plate with two capscrews. Tighten capscrews to 18 lb-ft (24 N•m).

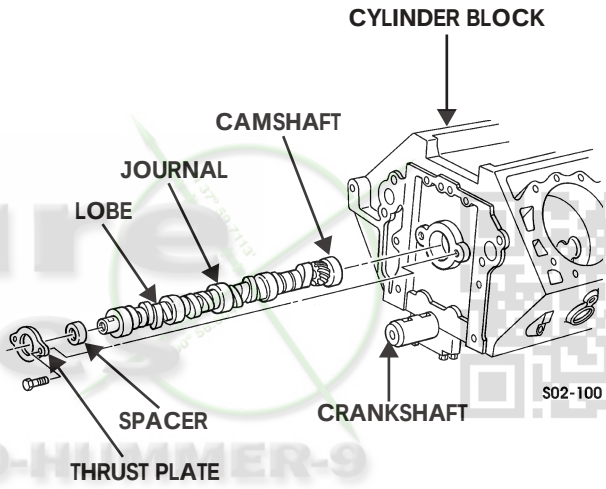


Figure 2-199: Camshaft

f. Timing Chain and Drive Sprockets

1. Install woodruff keys in camshaft and crankshaft (Figure 2-200).
2. Turn camshaft so sprocket will align with key when timing mark is down, and crankshaft sprocket will align with key when timing mark is up.
3. Assemble timing chain, camshaft sprocket, and crankshaft sprocket aligning timing marks as shown.
4. Slide camshaft sprocket, timing chain, and crankshaft sprocket over respective shafts as a unit. Check that timing marks still align.
5. Install fuel pump drive gear on camshaft with washer and capscrew. Tighten capscrew to 55-66 lb-ft (75-90 N•m).

NOTE: Do step 6 only if timing chain was replaced.

6. Check timing chain deflection midway between sprockets. Deflection must not exceed 0.5 in. (12.7 mm). If a new chain was installed and deflection exceeds 0.51 in. (13 mm), carefully check both sprockets for wear. Replace if worn.
7. Thoroughly oil timing chain.

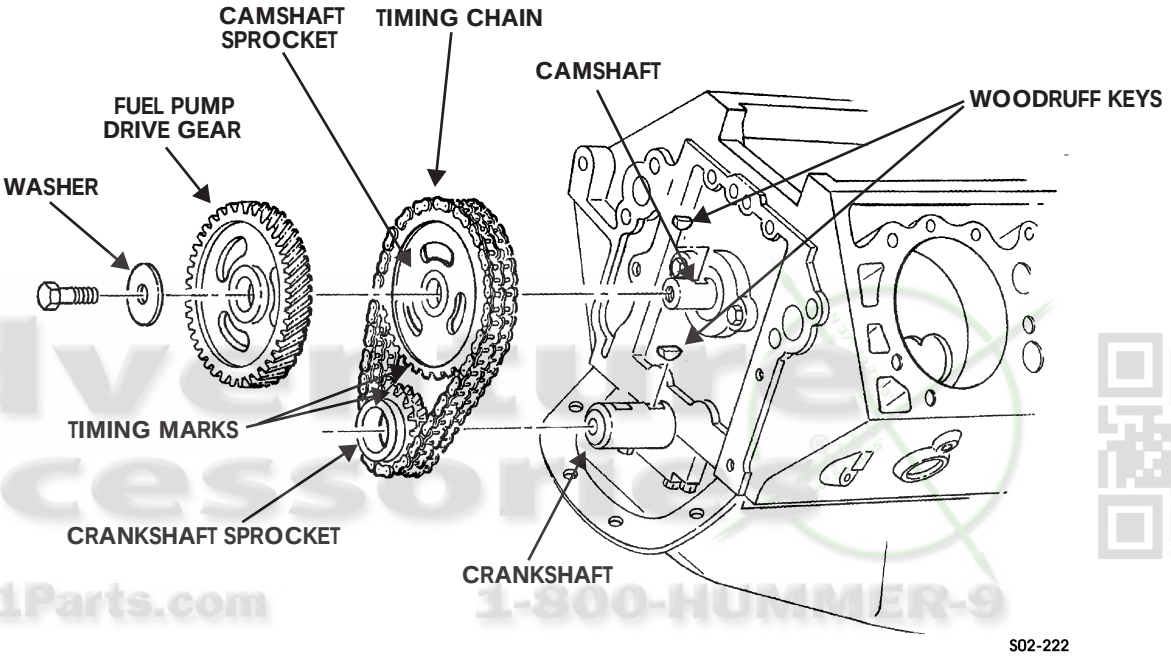


Figure 2-200: Timing Chain

g. Timing Gear Cover

1. Position seal, with lip facing in, on timing gear cover and install seal (Figure 2-201).
2. Apply 0.08 in. (2 mm) bead of sealant on sealing surface of timing gear cover in pattern shown. Use aerobic on block and RTV on pan.
3. Install timing gear cover on cylinder block with four washers, one short and four long capscrews. Tighten capscrews to 33 lb-ft (45 N•m).

NOTE: Maintain at least 0.040 in. (1.02 mm) clearance between baffle plate and fuel pump drive gear.

4. Install baffle plate on timing gear cover with two capscrews and nut. Tighten capscrews and nut to 33 lb-ft (45 N•m).

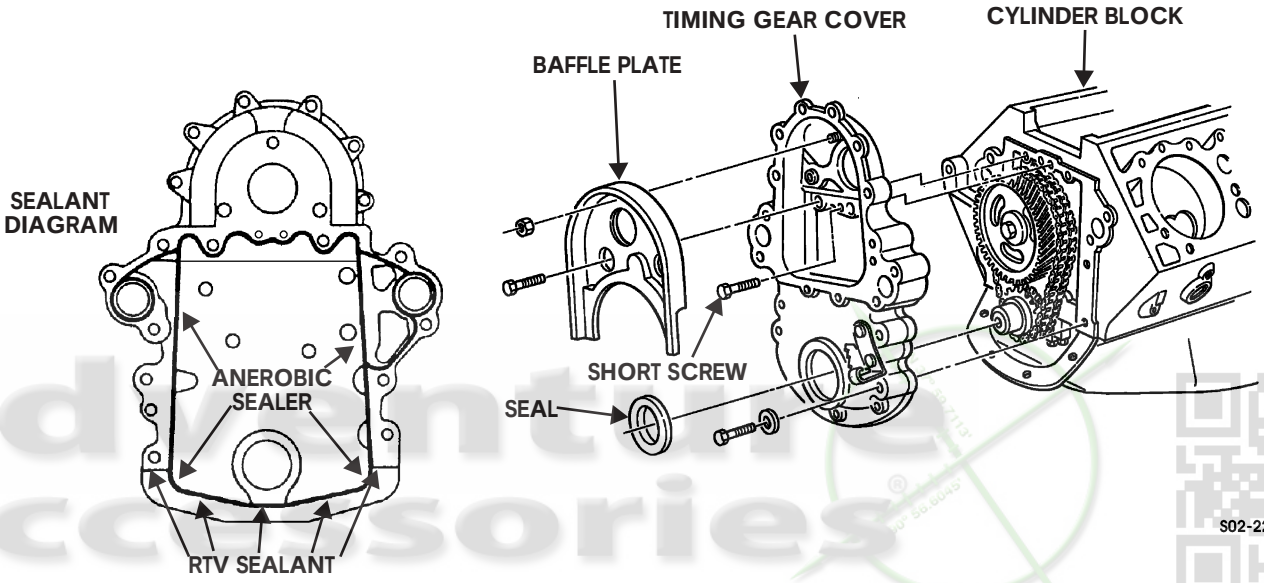


Figure 2-201: Timing Gear Cover

h. Oil Pan

1. Rotate cylinder block so crankshaft is up (Figure 2-202).
2. Install rear seal in rear main cap. Apply a drop of sealant at ends of seal.
3. Apply 0.197-in. (5-mm) beads of sealant around two large holes in cylinder block and oil pan as shown.
4. Immediately install oil pan on cylinder block with eighteen capscrews and two studs. Tighten studs and capscrews to 48-120 lb-in. (5-14 N•m) and two large screws to 156-240 lb-in. (18-27 N•m).
5. Install drainplug and gasket in oil pan. Tighten drainplug to 20 lb-ft (27 N•m).

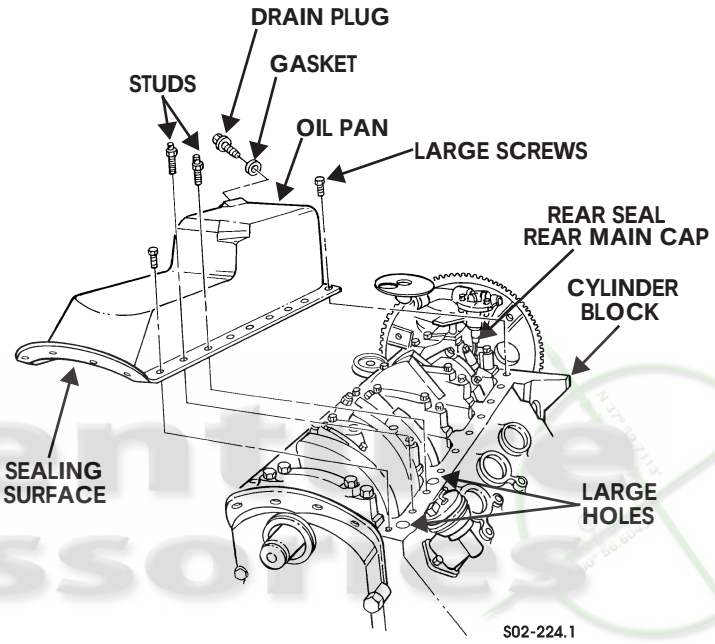


Figure 2-202: Oil Pan

i. Oil Filter, Adapter, and Oil Pressure Sending Unit

1. Place washer and two seals on bolt (Figure 2-203).
2. Place seal on adapter and install adapter on cylinder block with bolt. Tighten bolt to 40 lb-ft (54 N•m).
3. Install oil filter on adapter. Tighten until parts make contact, then 1/2- to 3/4-turn more.

NOTE: Install elbow fitting and elbow adapter in position noted in disassembly.

4. Coat threads of elbow fitting and two oil cooler line fittings with pipe sealing compound and install in cylinder block.
5. Coat threads of oil pressure switch as above and install in elbow fitting.
6. Install fitting on elbow and oil pressure switch, and install oil pressure switch on cylinder block.

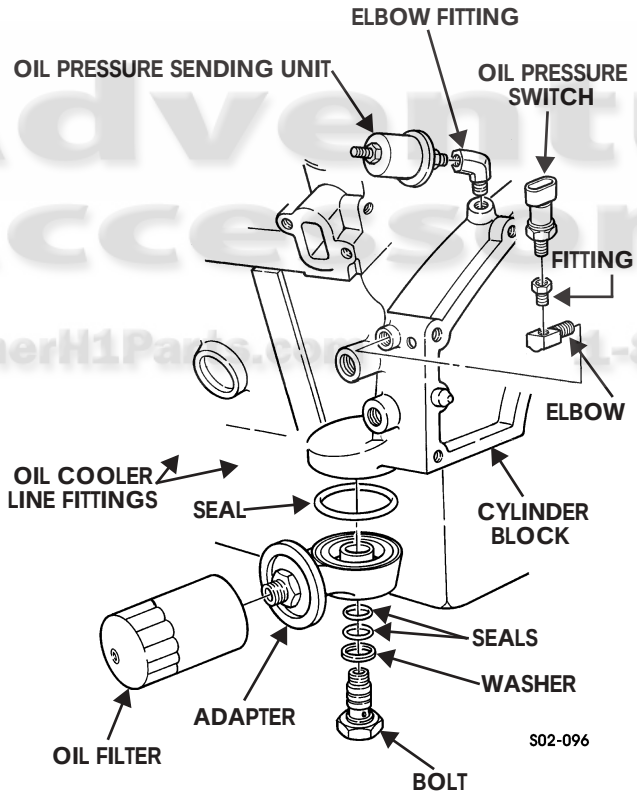


Figure 2-203: Oil Filter, Adapter, and Oil Pressure Sending Unit

j. Oil Pump Drive

1. Rotate cylinder block so crankshaft is down (Figure 2-204).
2. Install gasket and oil pump drive into cylinder block with clamp and capscrew. Tighten capscrew to 25-37 lb-ft (34-50 N•m).
3. Connect electrical connector to engine speed sensor.

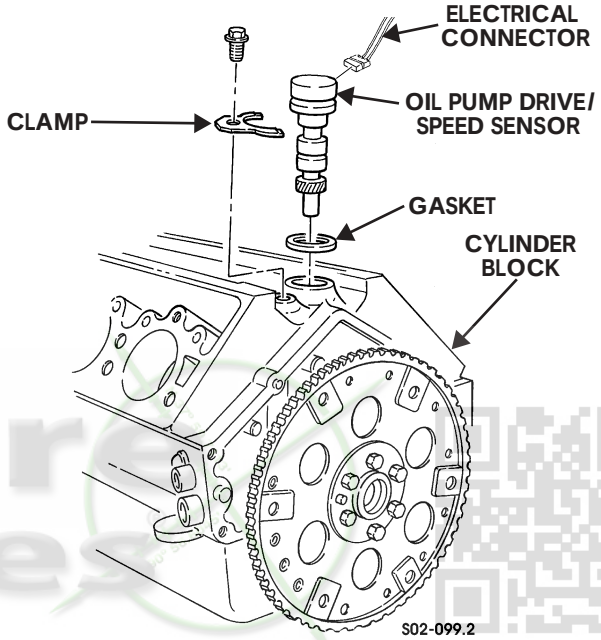


Figure 2-204: Oil Pump Drive

k. Fuel Injection Pump

1. Position fuel injection pump and gasket on timing gear cover (Figure 2-205).
2. Align timing gear cover timing mark and pump timing mark, and install pump with top and right side washers and nuts.
3. Install cable bracket on left side stud over pump flange and start two capscrews through bracket into pump.
4. Ensuring timing marks are aligned, tighten nuts.
5. Tighten bracket capscrews to 13 lb-ft (18 N•m).
6. Install idle return spring on cable bracket and throttle lever.
7. Rotate crankshaft to bring timing mark on drive gear to top dead center.
8. Align driven gear timing mark to mark on drive gear.
9. Turn fuel injection pump hub so that peg lines up with slot in driven gear.
10. Install driven gear on hub with three capscrews. Tighten capscrews to 13-20 lb-ft (18-27 N•m).
11. Ensure that timing marks of steps 2 and 7 are in alignment.

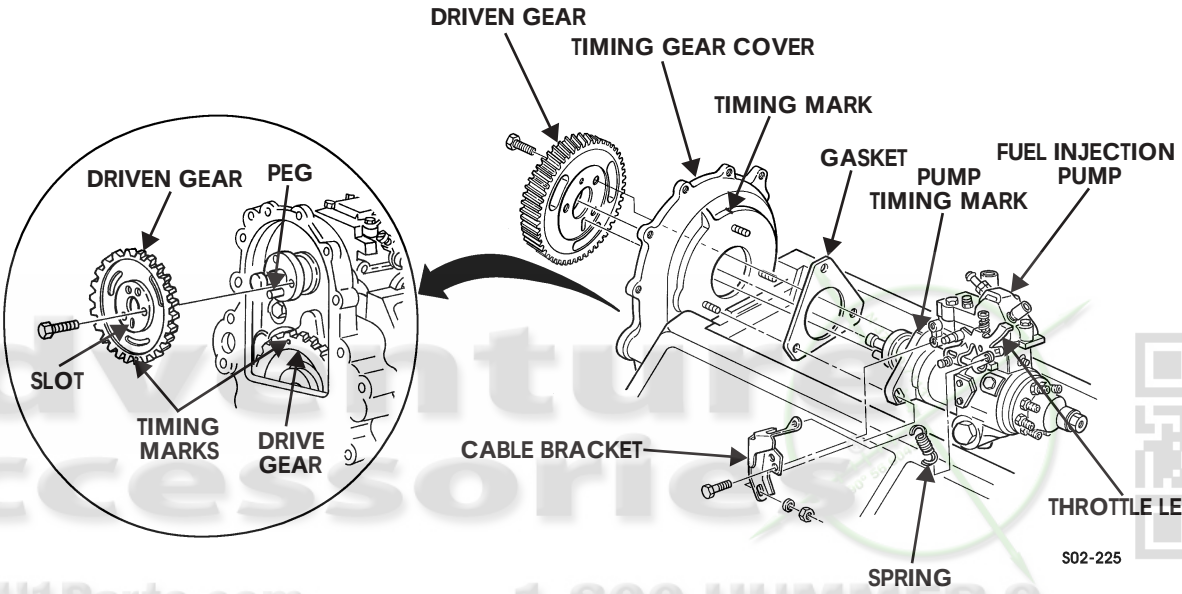


Figure 2-205: Fuel Injection Pump

l. Water Pump and Adapter Plate

1. Install gasket and water pump on adapter plate with seven capscrews. Tighten capscrews to 13-20 lb-ft (18-27 N•m) (Figure 2-206).

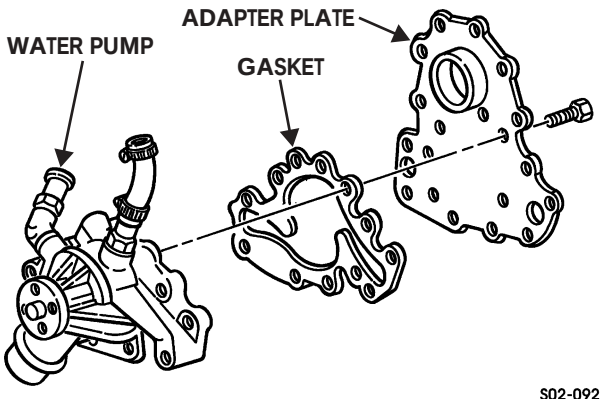


Figure 2-206: Water Pump and Adapter Plate

2. Apply anaerobic sealant to contact area of adapter plate as shown (Figure 2-207).

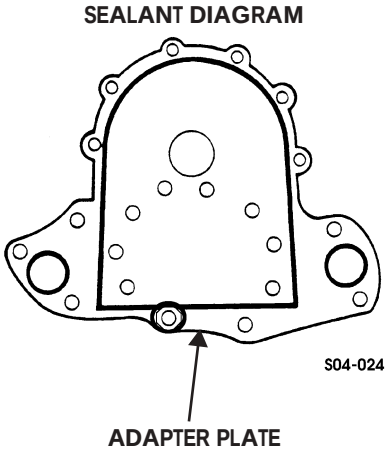


Figure 2-207: Adapter Plate

3. Install adapter plate and water pump on timing gear cover with five studs, short stud (wide hex), long capscrew, and six short screws. Tighten all studs and short screws (marked A) to 13-20 lb-ft (18-27 N•m). Tighten large studs and large capscrew (marked B) to 25-37 lb-ft (34-50 N•m) (Figure 2-208).

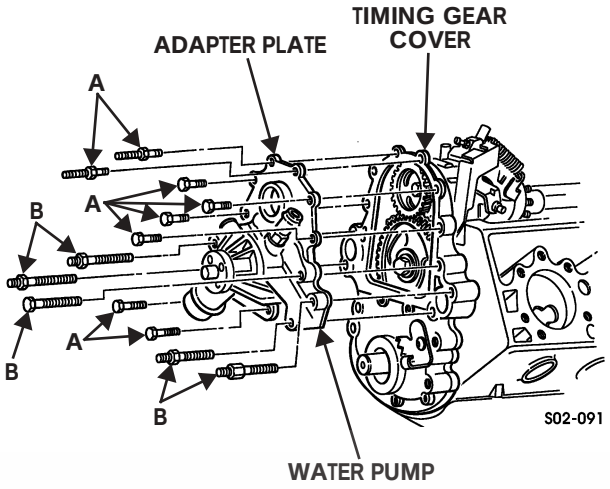


Figure 2-208: Adapter Plate and Water Pump

4. Install oil fill tube on adapter plate with two washers and nuts. Tighten nuts to 13-20 lb-ft (18-27 N•m) (Figure 2-209).

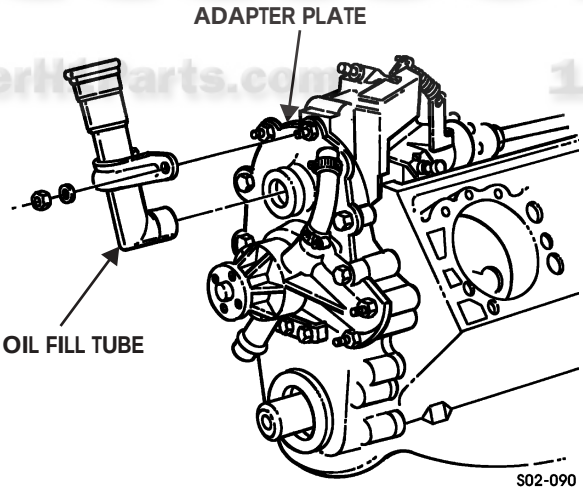


Figure 2-209: Oil Fill Tube

m. Valve Lifters

WARNING: Diesel fuel is flammable. Keep away from fire, flames, and sparks, or injury could result.

1. Prime valve lifters in diesel fuel or kerosene by working plunger (Figure 2-210).
2. Coat lifters with oil and install in cylinder block.
3. Position four guide plates on lifters and install with two clamp plates and capscrews. Tighten capscrews to 15-20 lb-ft (20-27 N•m).
4. Repeat steps 1 through 3 for remaining side.
5. Rotate crankshaft several turns to ensure lifters move freely.

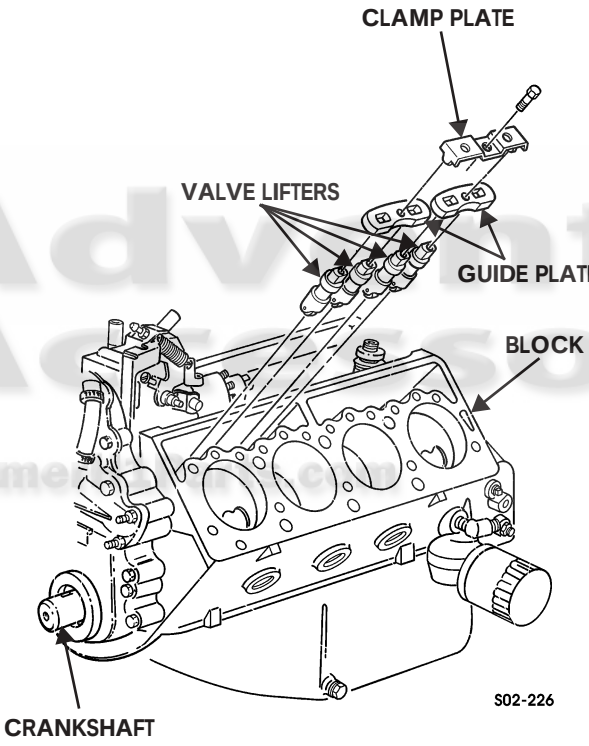


Figure 2-210: Valve Lifters

n. Cylinder Heads

CAUTION: *Do not use any type of sealant with head gasket. Sealants may cause leaks and damage to engine.*

1. Place head gasket over dowels on cylinder block (Figure 2-211).
2. Clean threads of capscrews and apply pipe sealant to threads.
3. Carefully position cylinder head over dowels and on gasket and cylinder block.

CAUTION: *Follow torque sequence for head bolts. This is necessary for correct compression of head and gasket. Failure to do so will cause leaks.*

4. Install head on cylinder block with seventeen capscrews. Tighten capscrews, in sequence, to 20 lb-ft (27 N•m) (Figure 2-212).
5. Repeat capscrew tightening sequence for a torque of 50 lb-ft (68 N•m).
6. Tighten capscrews, in sequence, 90° or 1/4-turn more.
7. Repeat steps 1 through 6 for remaining side.

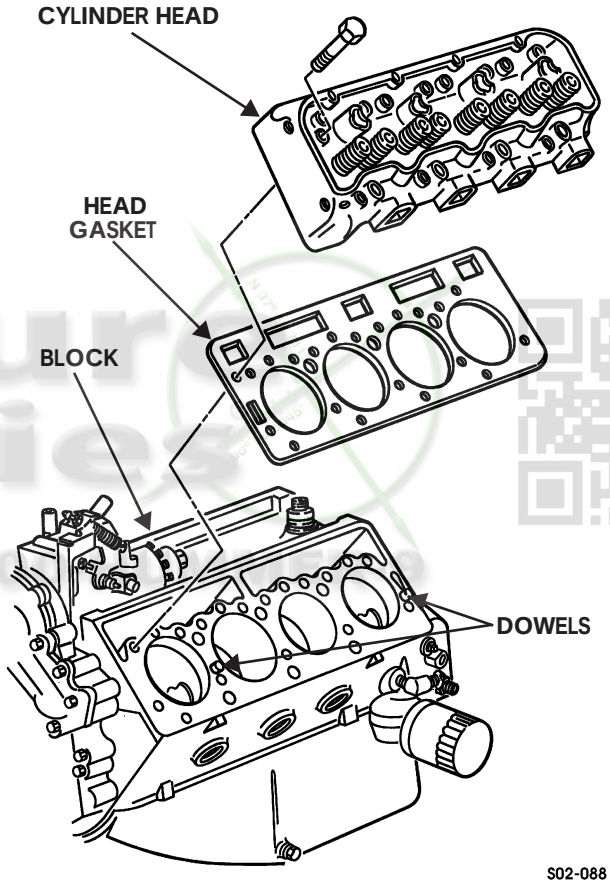


Figure 2-211: Head Gasket and Dowels

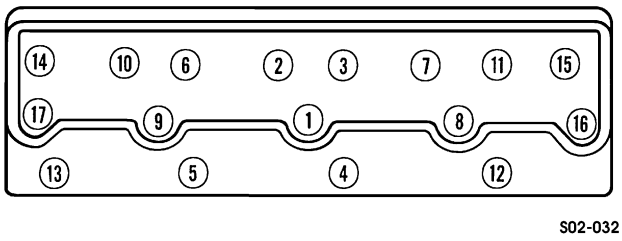


Figure 2-212: Torque Sequence

o. Glow Plugs

1. Install four glow plugs into cylinder head. Tighten glow plugs to 8-12 lb-ft (11-16 N•m) (Figure 2-213).
2. Repeat step 1 for remaining side.

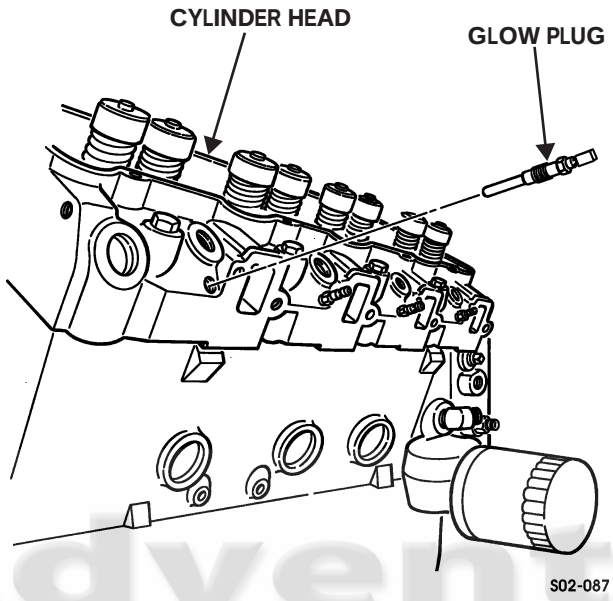


Figure 2-213: Glow Plug

p. Fuel Injection Nozzles

1. Using injection nozzle tool, install four gaskets and fuel injection nozzles in cylinder head. Tighten nozzles to 44-60 lb-ft (60-81 N•m) (Figure 2-214).
2. Install three hoses between nozzles with clamps.
3. Install plug on rear nozzle with clamp.
4. Repeat steps 1 through 3 for remaining side.

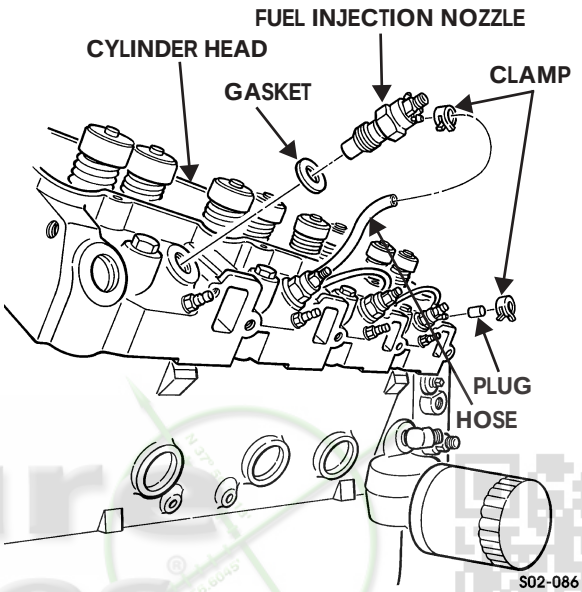


Figure 2-214: Fuel Injection Nozzle

q. Rocker Arm Shafts and Pushrods

CAUTION: *Marked end of pushrod must point up when installed. Failure to do so can damage engine during operation. Position crankshaft at 3-1/2in. (88 mm) BTDC (counterclockwise) to avoid damage to valves and/or pistons.*

1. Install eight pushrods in cylinder block in same locations and seat on valve lifters (Figure 2-215).
2. Position two rocker arm and shaft assemblies on head and install with four retainers and capscrews. Ensure upper ends of pushrods are seated in rocker arms. Tighten capscrews to 41 lb-ft (56 N•m).
3. Repeat steps 1 and 2 for remaining side.

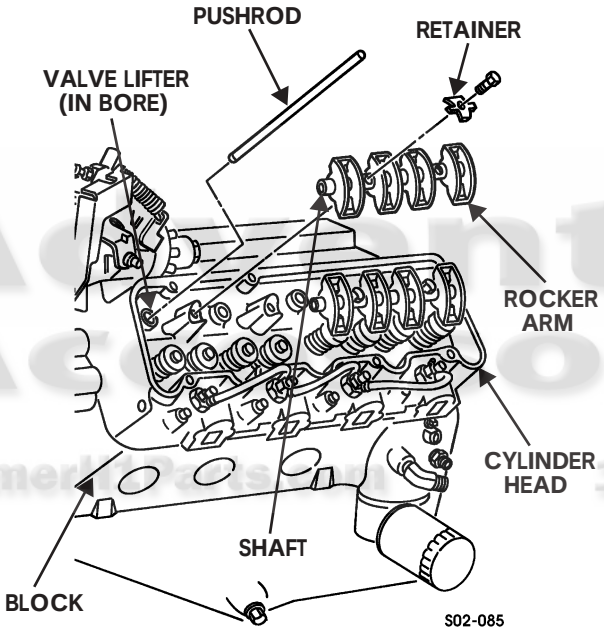


Figure 2-215: Rocker Arm and Shaft Assemblies

r. Rocker Arm Covers

NOTE: Keep sealant out of screw holes.

1. Apply 0.158-in. (4-mm) bead of RTV sealant on sealing surface of two rocker arm covers (Figure 2-216).
2. Install rocker arm covers on cylinder heads with sixteen washers, seven capscrews, and nine studs. Follow screw and stud location diagrams for each cover. Tighten capscrews and studs to 13-25 lb-ft (18-34 N•m) (Figure 2-217).
3. Install two fuel injection line support brackets on rocker arm covers with four nuts. Tighten nuts to 13-20 lb-ft (18-27 N•m).

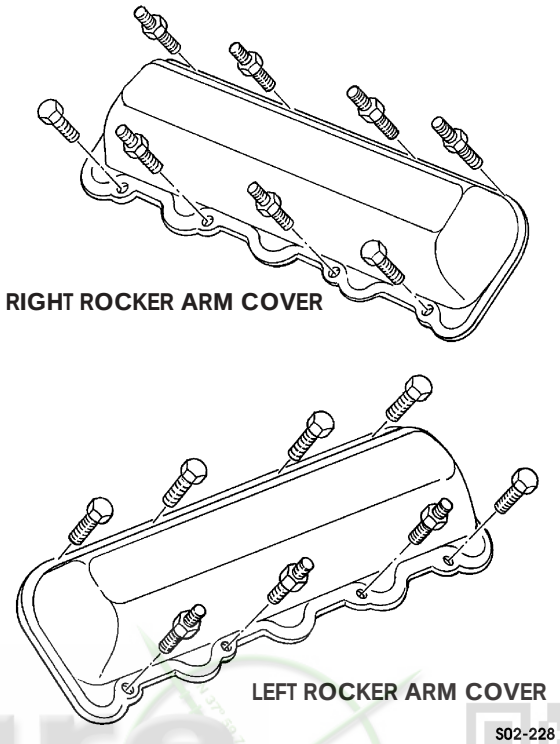


Figure 2-216: Rocker Arm Covers

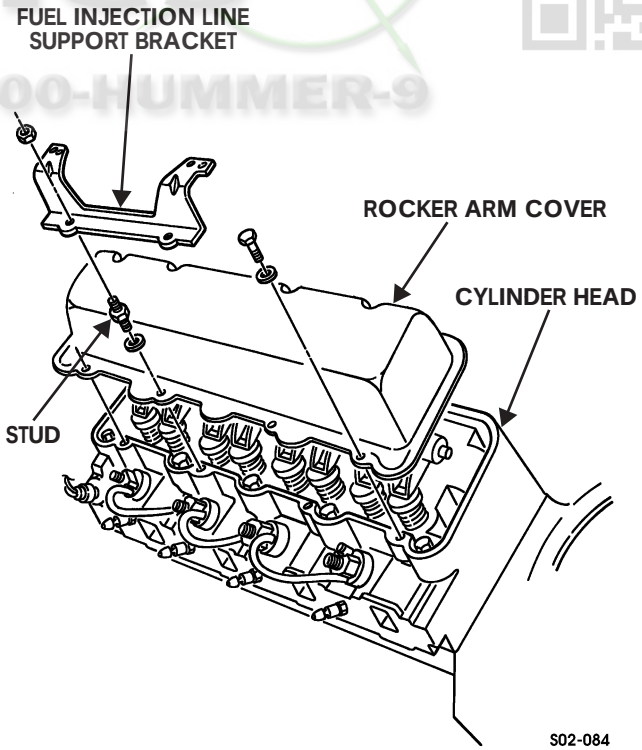


Figure 2-217: Fuel Injection Line Support Bracket

s. Fuel Supply and Return Lines

1. Position front-to-rear and across-the-engine fuel return lines on engine and connect with hose and two clamps (Figure 2-218).
2. Install two clamps and fuel return line to front of left and right valve cover studs with two washers and nuts.
3. Connect two hoses from two front fuel injectors to fuel return line with four clamps.
4. Install fuel return hose on fuel return line and fuel injection pump with two clamps.
5. Connect fuel supply hose to fuel injection pump with clamp.
6. Connect six fuel return jumper hoses and two plugs on fuel injectors with clamps.

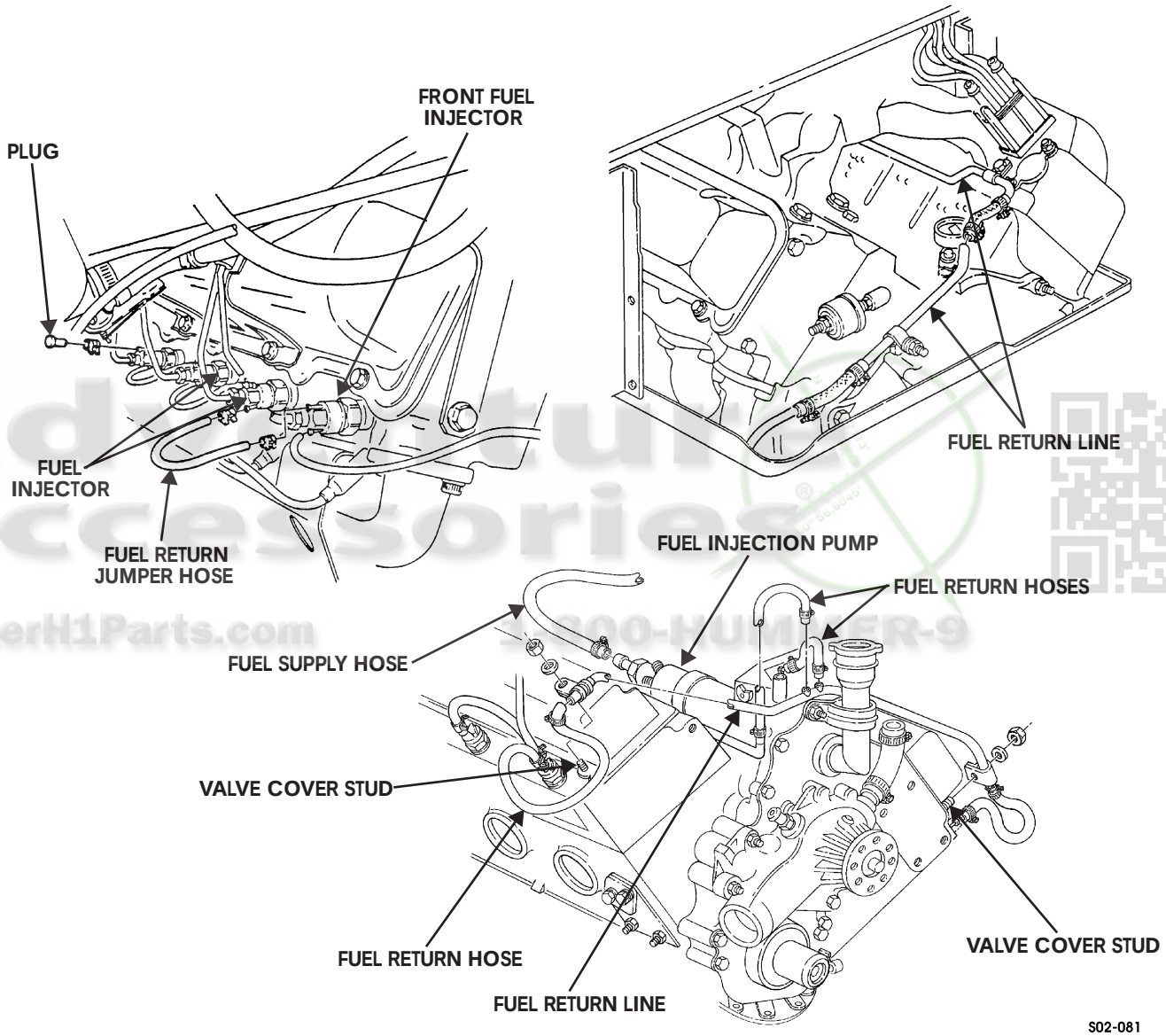


Figure 2-218: Fuel Return Lines

t. Fuel Injection Lines

1. Connect fuel injection lines to nos. 1 and 3 fuel injection nozzles and fuel injection pump with tube nuts. Tighten nuts 2 lb-ft (27 N•m) after lines are positioned (Figure 2-219), (Figure 2-220), and (Figure 2-221).
2. Secure fuel injection lines to bracket with two capscrews and clamp.
3. Connect other three injection line sets.
4. Install boot over tube nuts at fuel injection pump. Retain with clamp (Figure 2-221).

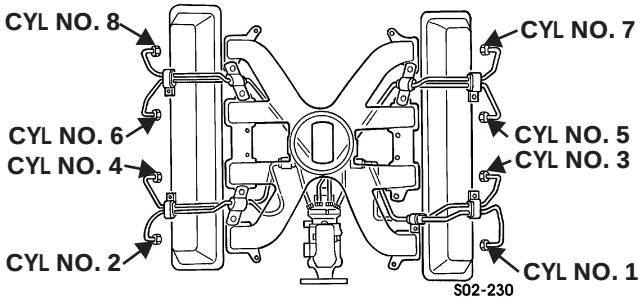


Figure 2-219: Fuel Injection Lines

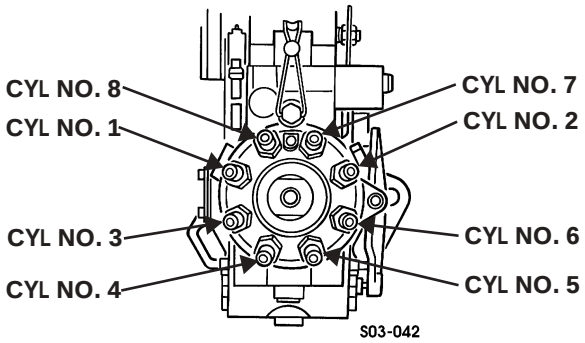


Figure 2-220: Cylinders

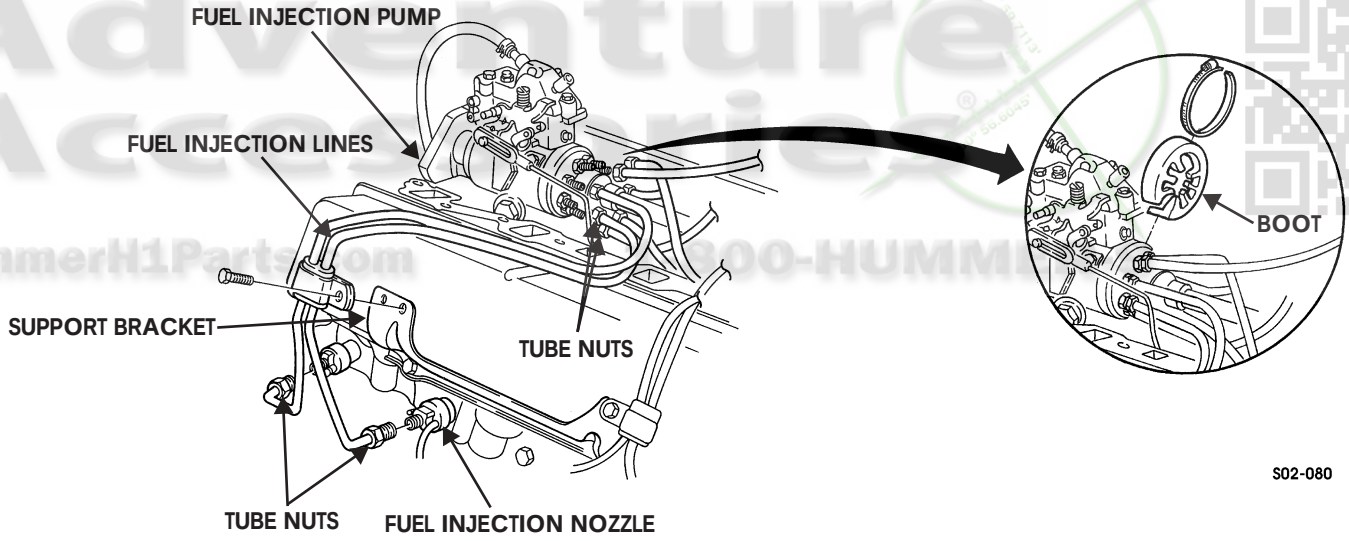


Figure 2-221: Pump Boot Location

u. Water Crossover

1. Align two gaskets and water crossover on cylinder heads and install with two capscrews and studs. Tighten capscrews and studs to 25-37 lb-ft (34-50 N•m) (Figure 2-222).
2. Connect thermostat bypass hose on cross-over nipple with clamp.
3. Install air conditioner mounting bracket and wiring harness ground cable on two studs with two nuts.

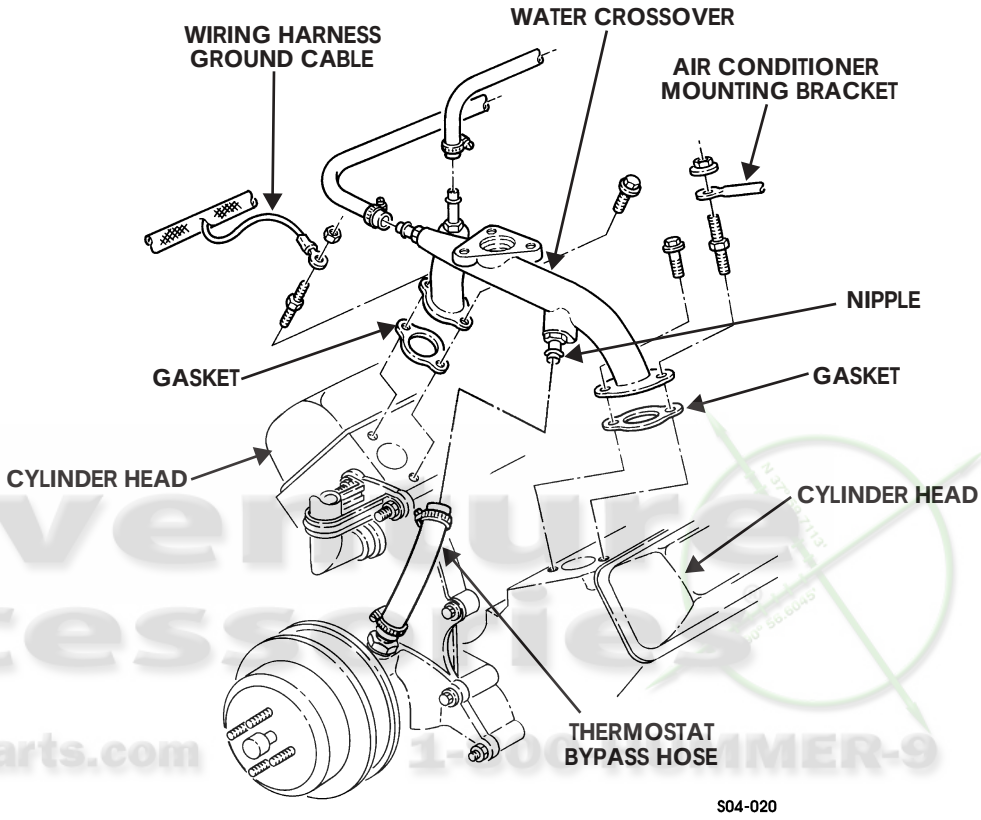


Figure 2-222: Water Crossover

v. Intake Manifold

1. Install two gaskets, intake manifold, clamps, and clips on cylinder heads with sixteen washers, long capscrew, five capscrews, four long studs, and six short studs as shown in (Figure 2-223) (Figure 2-224), and (Figure 2-226).

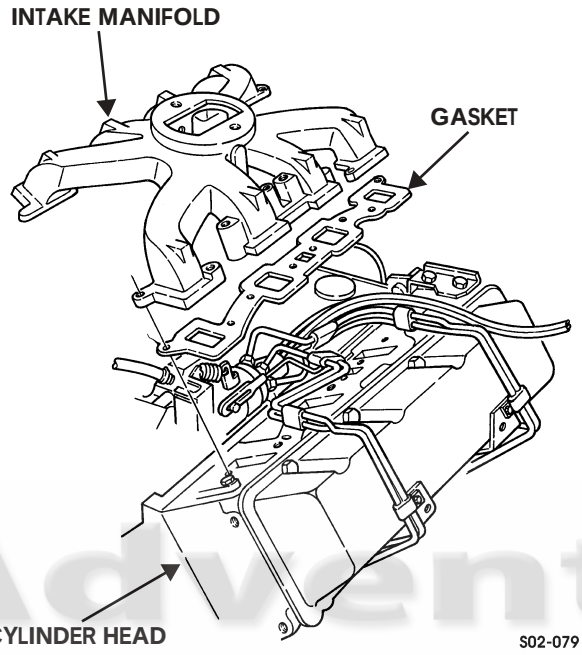


Figure 2-223: Intake Manifold and Gasket

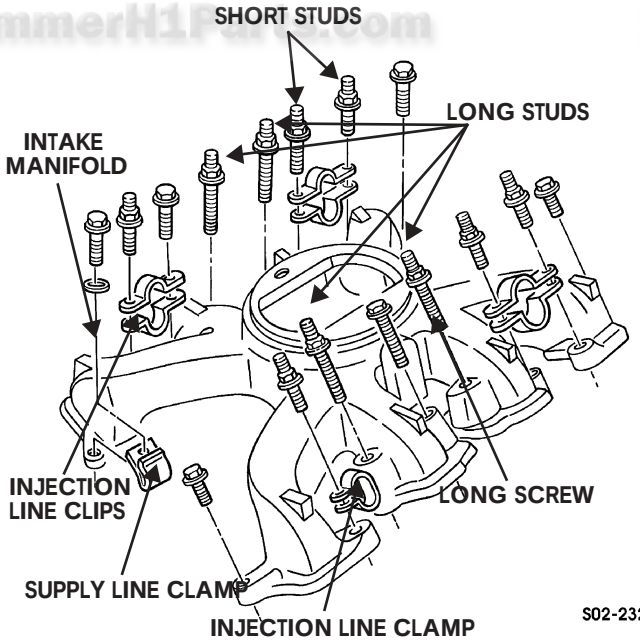


Figure 2-224: Intake Manifold Attaching Hardware

2. Tighten capscrews and studs to 30 lb-ft (41 N•m). Follow torque sequence (Figure 2-225).

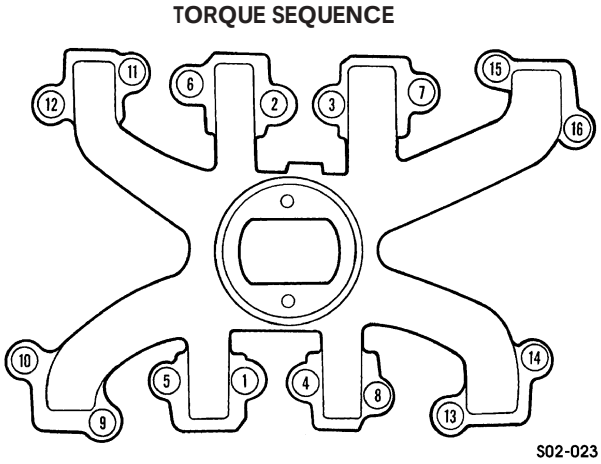


Figure 2-225: Capscrew and Stud Torque Maintenance

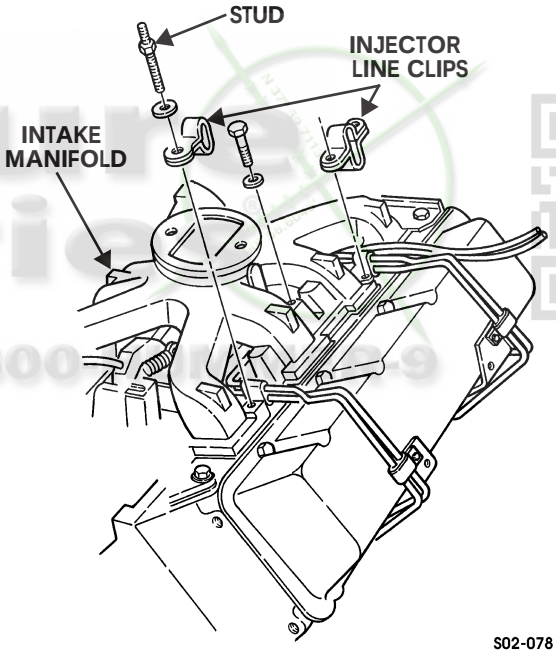


Figure 2-226: Injector Line Clips

w. Exhaust Manifolds

1. Install gasket and left exhaust manifold on left cylinder head with eight washers, seven metric socket-head screws, and stud. Tighten socket-head screws and stud to 18-25 lb-ft (24-34 N•m) (Figure 2-227).

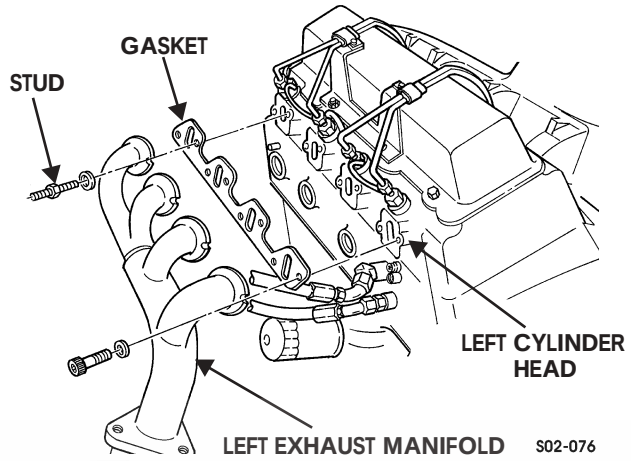


Figure 2-227: Left Exhaust Manifold

2. Install gasket and right exhaust manifold on right cylinder head with eight washers and metric socket-head screws. Tighten socket-head screws to 18-25 lb-ft (24-34 N•m) (Figure 2-228).

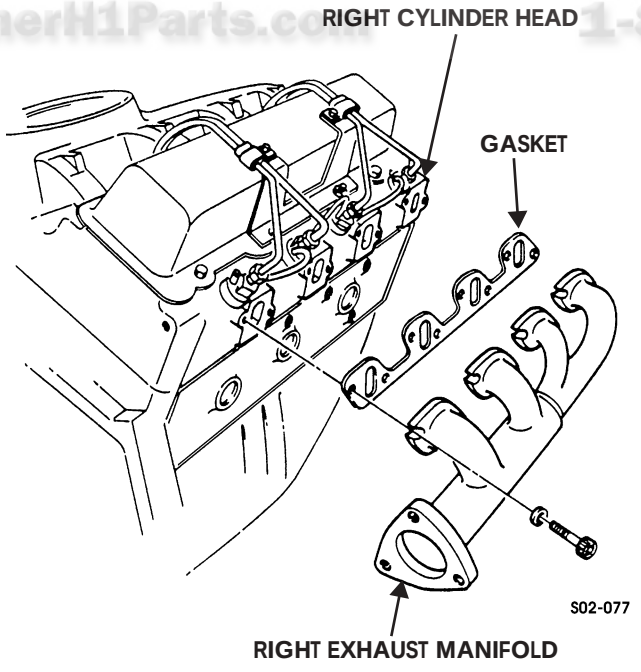


Figure 2-228: Right Exhaust Manifold

x. Torsional Damper

1. Install woodruff key in crankshaft (Figure 2-229).
2. Apply oil to sealing surface and install torsional damper on crankshaft with washer and capscrew. Tighten capscrew to 140-162 lb-ft (190-220 N•m).

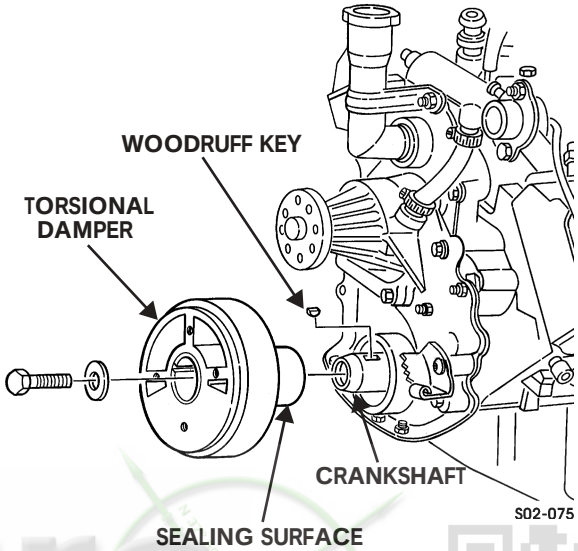


Figure 2-229: Torsional Damper

y. Crankshaft Pulley

1. Apply sealing compound to screw threads (Figure 2-230).
2. Install crankshaft pulley on torsional damper with four capscrews. Tighten capscrews to 48 lb-ft (65 N•m).

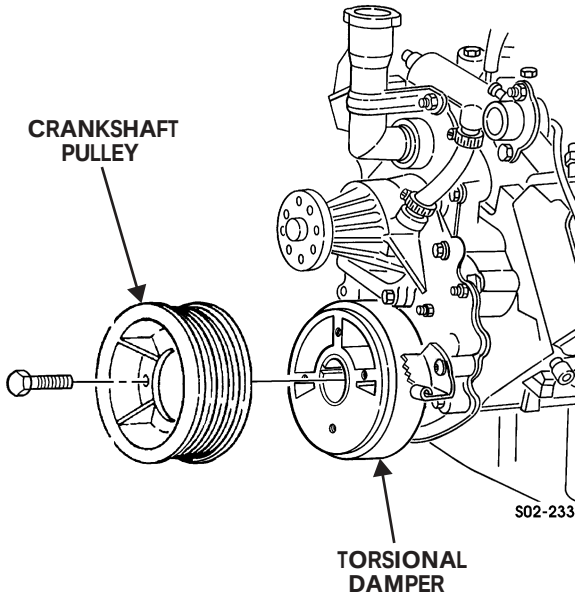


Figure 2-230: Crankshaft Pulley

z. Fan Drive and Water Pump Pulley

1. Apply thread-locking compound to four capscrews, and install fan blade, on viscous fan drive with four washers and capscrews. Tighten capscrews to 45 lb-ft (61 N•m) (Figure 2-231).
2. Install four studs, water pump pulley, viscous fan drive with fan blade, on water pump with four nuts. Tighten nuts to 27 lb-ft (37 N•m).

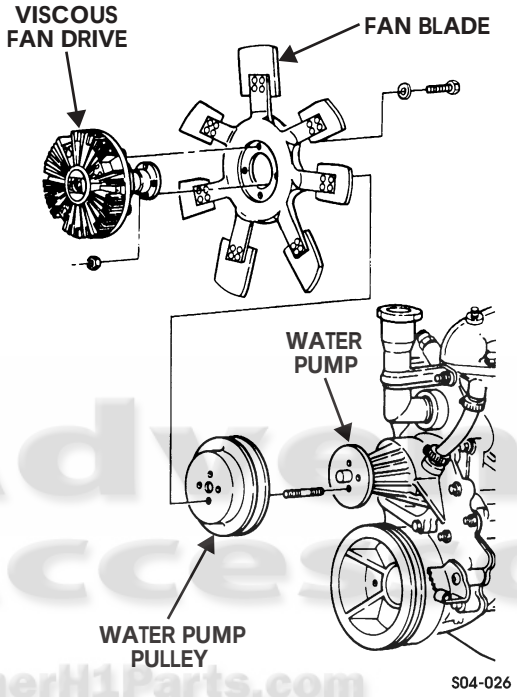


Figure 2-231: Fan Drive and Fan Blade

ENGINE TEMPERATURE SENDING UNIT REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove nut, lockwasher, lead, and sending unit from engine. Discard lockwasher (Figure 2-232).

Installation

1. Apply teflon sealant to sending unit threads, and install sending unit, lead, lockwasher, and nut on engine (Figure 2-232).
2. Connect battery ground cable.
3. Start engine and check for leaks.

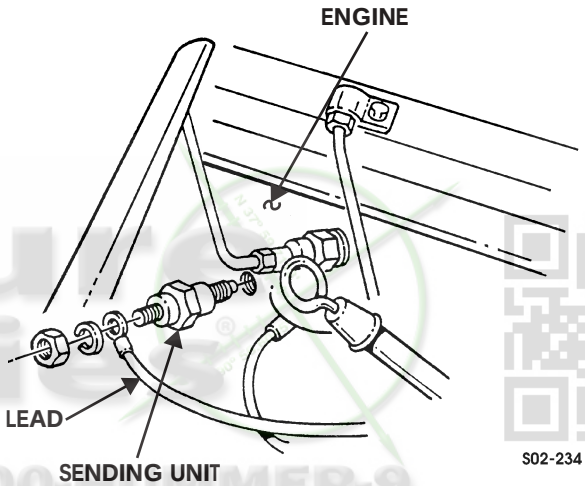


Figure 2-232: Engine Temperature Sending Unit

COLD-ADVANCE/FAST-IDLE SWITCH REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Disconnect connector from switch (Figure 2-233).
3. Remove switch from engine.

Installation

1. Apply teflon sealant to switch threads and install switch in engine (Figure 2-233).
2. Connect connector to switch.
3. Connect battery ground cable.

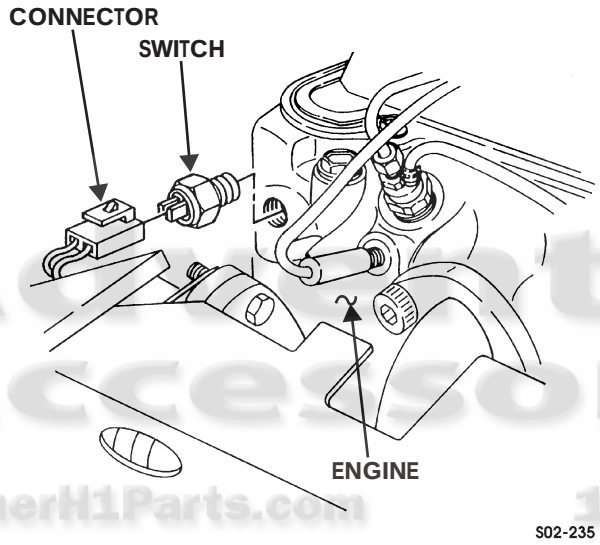


Figure 2-233: Cold-Advance/Fast-Idle Switch

GLOW PLUG CONTROLLER REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove engine access covers (Section 10).
3. Remove two nuts, lockwashers, and three leads from glow plug controller. Discard lockwashers (Figure 2-234).
4. Remove connector from glow plug controller.
5. Remove two nuts, lockwashers, and glow plug controller from engine. Discard lockwashers.

Installation

1. Install glow plug controller on engine with two lockwashers and nuts (Figure 2-234).
2. Install connector on glow plug controller.
3. Install three leads on glow plug controller with two lockwashers and nuts.
4. Install engine access covers (Section 10).
5. Connect battery ground cable.

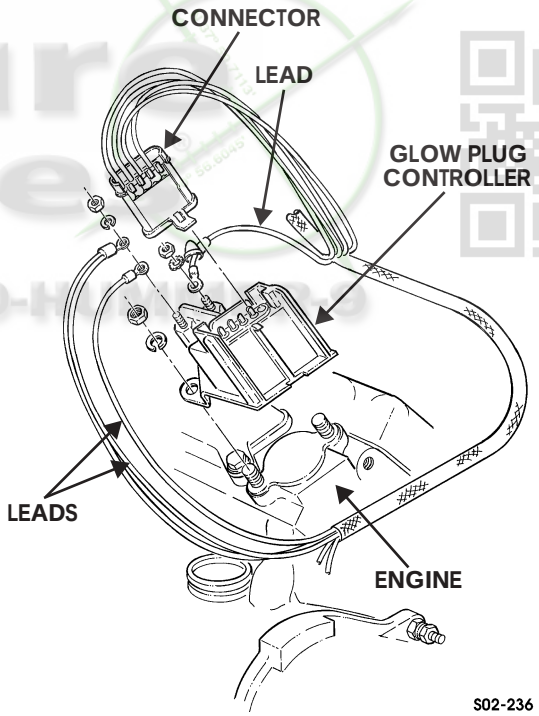


Figure 2-234: Glow Plug Controller

OIL PRESSURE SENDING UNIT REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove engine access covers (Section 10).
3. Remove nut, lockwasher, washer, and lead from sending unit. Discard lockwasher (Figure 2-235).
4. Remove sending unit from reducer.

Installation

1. Apply teflon sealant to sending unit threads, and install sending unit on reducer (Figure 2-235).
2. Install lead, washer, lockwasher, and nut on sending unit.
3. Connect battery ground cable.
4. Start engine and check sending unit for leaks.
5. Install engine access covers (Section 10).

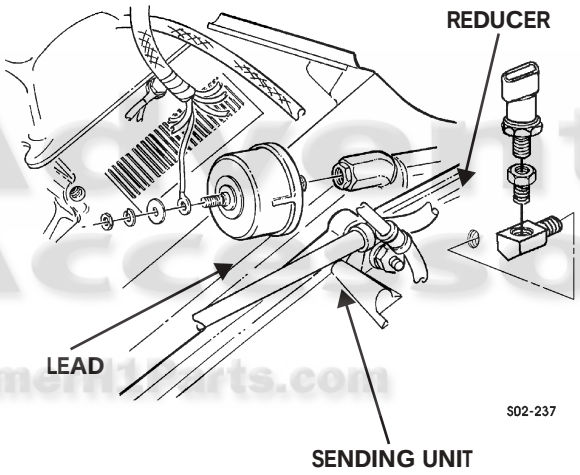


Figure 2-235: Oil Pressure Sending Unit

IGNITION SWITCH REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove steering column (Section 8).
3. Remove multi-switch (Section 8).
4. Remove screw and interlock cable from ignition switch. (Figure 2-236)
5. Remove two capscrews and ignition switch from steering column.

Installation

1. Apply thread-locking compound to capscrew threads and install ignition switch on steering column with two capscrews (Figure 2-236).
2. Install interlock cable on ignition switch with screw.
3. Install multi-switch (Section 8).
4. Install steering column (Section 8).
5. Connect battery ground cable.
6. Ensure ignition switch operates properly.

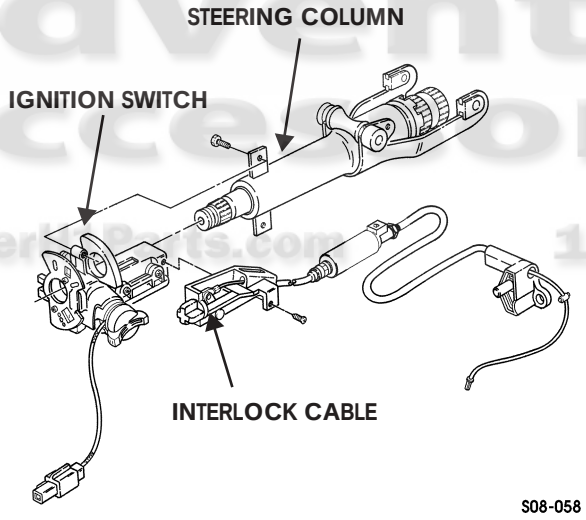


Figure 2-236: Ignition Switch

REPAIR AND REPLACEMENT STANDARDS

All parts, components, or assemblies which do not meet the standards specified in this section or listed in repair procedure, will be replaced with new material. Parts must be closely inspected to ensure that there is no damage in areas not listed which would make them unfit for further use.

Table 3. SPECIFICATIONS

Fastener Tightening Specifications

Item	Lb-Ft.	Lb-In.	N•m
Block drainplugs	16	—	22
Camshaft gear bolt	126	—	171
Camshaft thrust plate	17	—	23
Connecting rod cap nuts	48	—	65
Coolant crossover/thermostat housing bolts	31	—	42
Crankshaft pulley bolts	30	—	41
Cylinder head bolts	50 *	—	68
Exhaust manifold bolts	25	—	34
Flywheel bolts	66	—	90
Front cover to block bolts	33	—	45
Glow plugs	—	144	16
Hydraulic lifter guide plate clamp bolts	19	—	26
Intake manifold bolts	31	—	42
Injection lines	19	—	26
Injection nozzles	50	—	68
Injection pump gear bolts	17	—	23
Injection pump nuts	31	—	42
Oil filter adapter bolt	47	—	64
Main bearing cap bolts — Inner	111	—	151
Outer	100	—	136
Oil pan bolts (all except rear two bolts)	—	89	10
(rear two bolts)	17	—	23

Item	Lb-Ft.	Lb-In.	N•m
Oil pump bolt	66	—	89
Oil pan drainplug	20	—	27
Oil pump cover screws	12	—	16
Oil pump drive clamp bolt	31	—	42
Rocker arm cover bolts	16	—	22
Rocker arm shaft bolts	41	—	56
Torsional damper bolt	200	—	271

* Tighten bolts in sequence an additional 1/4 turn.

ENGINE SPECIFICATIONS

(All specifications are in millimeters (mm) unless otherwise noted.)

GENERAL DATA:

Displacement	6.5 L
RPO	L57
Type	90-degree V8 Diesel
Bore	103
Stroke	97
Compression Ratio	21.3:1
Firing Order	1-8-7-2-6-5-4-3
Oil Pressure	10 psi at idle (hot); 40-45 psi @2000 RPM

CYLINDER BORE[1]:

Diameter	103.00 - 130.53
Out-of-Round (Maximum)	0.02
Taper (Thrust Side) (Maximum)	0.02

PISTON DIAMETER:

Piston to Bore Clearance	
Bohn Pistons	
Bores 1 through 6	.094-0.120
Bores 7 and 8	0.107-0.133

PISTON RING:

Compression	
Groove Clearance	
Top	Keystone Type
2nd	0.039-0.079
Gap[2]	
Top	0.26-0.51
2nd	0.75-1.00
Oil	
Groove Clearance	0.040-0.090
Gap	0.25-0.51

PISTON PIN:

Diameter	30.9961-31.0039
Clearance (Piston Pin to Piston Bore)	0.0101-0.0153
Fit in Rod (Piston Pin to Rod Pin Bushing)	0.0081-0.0309

CRANKSHAFT:

Main Journal	
Diameter	74.91-74.94
Taper (Maximum)	0.005
Out-of-Round (Maximum)	0.005
Main Bearing Clearance	
No. 1, No. 2, No. 3, No. 4	0.045-0.083
No. 5	0.055-0.093
Crankshaft End Play	0.10-0.25

[1]NOTE: Add 0.013 mm to cylinder bore diameters to determine proper bore size for cylinders no. 7 and no. 8.

[2]NOTE: Ring end gap specifications are for new bores; worn bores will generate larger ring end gaps.

ENGINE SPECIFICATIONS (Continued)

(All specifications are in millimeters (mm) unless otherwise noted.)

CRANKSHAFT (Continued):

Crankpin	
Diameter	60.913-60.939
Taper (Maximum)	0.005
Out-of-Round (Maximum)	0.005
Rod Bearing Clearance (Select Fit)	0.045-0.100
Rod Side Clearance	0.17-0.63

CAMSHAFT

Lobe Lift ± 0.05	
Intake	.7.133
Exhaust	7.133
Journal Diameter	
No. 1, No. 2, No. 3, No. 4	54.970-55.025
No. 5	50.970-51.025
Journal Clearance No. 1, No. 2, No. 3, No. 4	0.025-0.118
Journal Clearance No. 5	0.020-0.113
Camshaft End Play	0.051-0.305

VALVE SYSTEM:

Lifter	Hydraulic Roller
Rocker Arm Ratio	1.5:1
Valve Lash (Intake and Exhaust)	Not Adjustable
Valve Protrusion (Negative because valve is recessed in head)	
Intake	-.034
Exhaust	-.048
Face Angle (Intake and Exhaust)	45°
Seat Angle (Intake and Exhaust)	46°
Seat Runout (Intake and Exhaust)	0.05
Seat Width	
Intake	0.89-1.53
Exhaust	1.57-2.36
Stem Clearance	
Intake	0.026-0.069
Exhaust	0.026-0.069
Valve Spring	
Pressure	
Closed	356 N @ 46.0 mm
Open	1025 N @ 35.3 mm
Installed Height	46
Timing Chain Free Play	
New Chain	0.500-in. (12.7 mm)
Used Chain	0.800-in. (20.3 mm)

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Section 3 Fuel, Emissions, and Exhaust

TABLE OF CONTENTS

FUEL SYSTEM DESCRIPTION

The fuel lift pump draws fuel from the 25 gallon (94.6 liter) fuel tank through the supply line and pumps it to the fuel filter/water separator where any sediment or water is filtered out. The check valves prevent fuel from flowing backward toward the tank (Figure 3-1).

Fuel leaves the fuel filter/water separator and travels to the injection pump, which pressurizes the fuel and directs the correct amount to each fuel injector. The fuel injectors spray fuel directly into the pre-combustion chambers. Any unused fuel is directed back to the fuel tank through the fuel return lines.

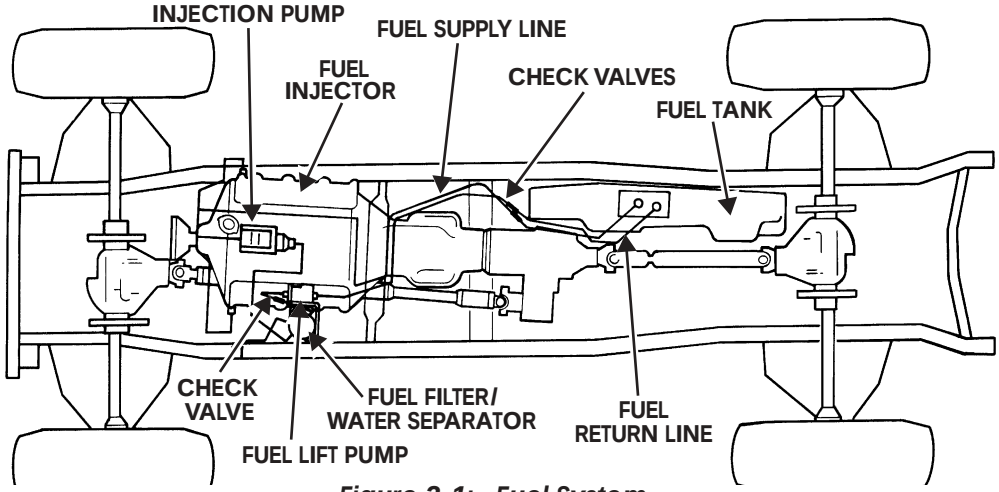

Figure 3-1: Fuel System

AIR CLEANER ASSEMBLY AND DUST UNLOADER MAINTENANCE

Removal

NOTE: To remove dust unloader only, perform steps 1 and 2.

1. Remove four screws and dust unloader cover from support brackets (Figure 3-2).
2. Loosen clamp and remove dust unloader from air cleaner assembly.
3. Loosen clamp and disconnect elbow from engine side of air cleaner assembly.
4. Disconnect vent line from elbow.
5. Loosen clamp and remove weathercap from air intake duct.
6. Remove three capscrews and washers from air intake duct.
7. Loosen three strap clamps around air cleaner assembly.
8. Raise air intake duct from air intake support, loosen clamp, and remove air intake duct and gasket from elbow and air intake support. Discard gasket.
9. Remove air cleaner assembly from support brackets.
10. Remove clamp and elbow from air cleaner assembly.
11. Remove elbow, adapter, and tube from air cleaner assembly.
12. Remove hood seal from air intake support.
13. Remove seal from air intake support.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect hood seal and air intake support seal for cracks or breaks (Figure 3-2).
2. Inspect elbow and adapter for damaged threads or cracks.
3. Inspect all clamps for rust.

Installation

1. Install tube, adapter, and elbow on air cleaner assembly (Figure 3-2).
2. Install dust unloader on air cleaner assembly. Tighten clamp to 44-53 lb-in. (5-6 N•m).
3. Install elbow and clamp on air cleaner assembly. Do not tighten clamp.
4. Position air cleaner assembly into air intake support and align elbow to top of air intake support.
5. Pull air cleaner assembly back several inches and tighten clamp on elbow to 44-53 lb-in. (5-6 N•m).
6. Position air cleaner assembly and strap clamps on support brackets and rotate until elbow clears air intake support.
7. Install air intake duct on elbow with clamp. Align screw holes of air intake duct with holes of air intake support.
8. Install air intake duct on air intake support with three screws and washers. Tighten clamp to 45-53 lb-in. (5-6 N•m).
9. Install air cleaner assembly on support brackets with three strap clamps.
10. Install gasket and use clamp to connect elbow to engine side of air cleaner assembly.
11. Connect vent line to elbow on air cleaner assembly.
12. Install weathercap on air intake duct and tighten clamp to 45-53 lb-in. (5-6 N•m).
13. Install dust unloader cover on support brackets with four screws.
14. Install hood seal on air intake support.

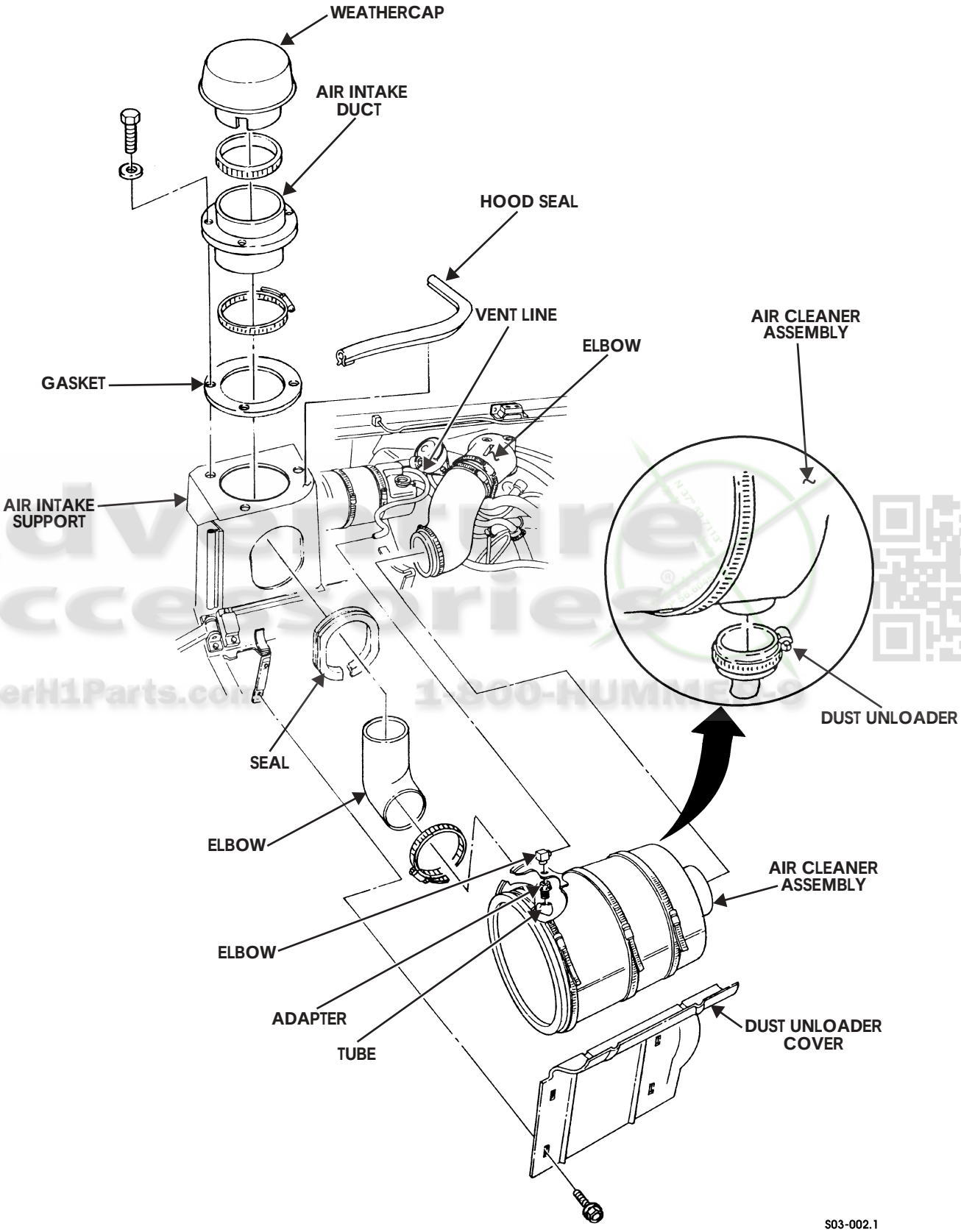

Figure 3-2: Air Cleaner Assembly and Dust Unloader

AIR CLEANER FILTER ELEMENT SERVICE

Removal

1. Remove ring clamp, cover, and gasket from air cleaner (Figure 3-3).
2. Remove nut and washer assembly and filter element from air cleaner stud.

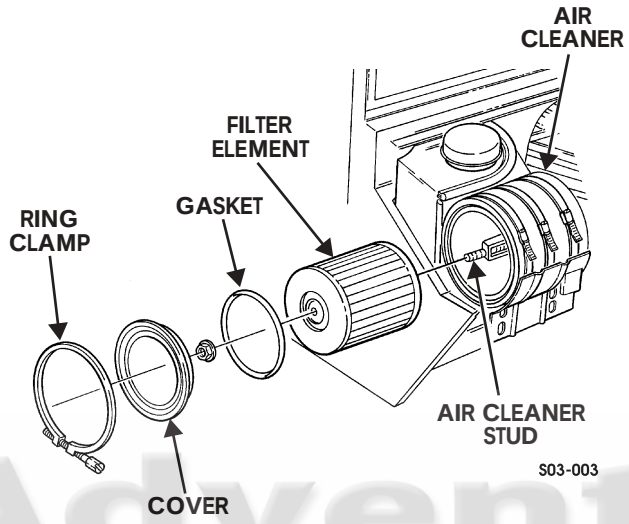

Figure 3-3: Air Cleaner Filter Element

Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect filter element for tears or contaminants (Figure 3-3).
2. Inspect gasket.

Emergency Cleaning

CAUTION: *To avoid damage to filter element, do not strike ends on a hard surface.*

Hold filter element so neither end faces the ground. Remove dust or sand by gently tapping around filter element (Figure 3-3).

Detergent Cleaning

Gently hand-wash filter element in warm water with non-sudsing detergent. Rinse with warm water, and allow to air dry (Figure 3-3).

Air Cleaning

Remove oily dirt and dust from filter element by directing flow of compressed air from inside to outside of filter element. Hold nozzle 6 in. (15 cm) from filter element, and blow away loosened dirt or dust (Figure 3-3).

Installation

1. Install filter element on air cleaner stud with nut and washer assembly. Tighten nut and washer assembly to 18-35 lb-in. (2-4 N•m) (Figure 3-3).

NOTE: To avoid damage to hood, ensure ring clamp bolt is between the three and six o'clock positions.

2. Install gasket, cover, and ring clamp on air cleaner assembly. Tighten ring clamp bolt to 27-35 lb-in. (3-4 N•m).

AIR HORN REPLACEMENT

Removal

NOTE: To avoid engine contamination, cover opening of intake manifold.

1. Loosen clamp and remove air intake elbow from air horn (Figure 3-4).

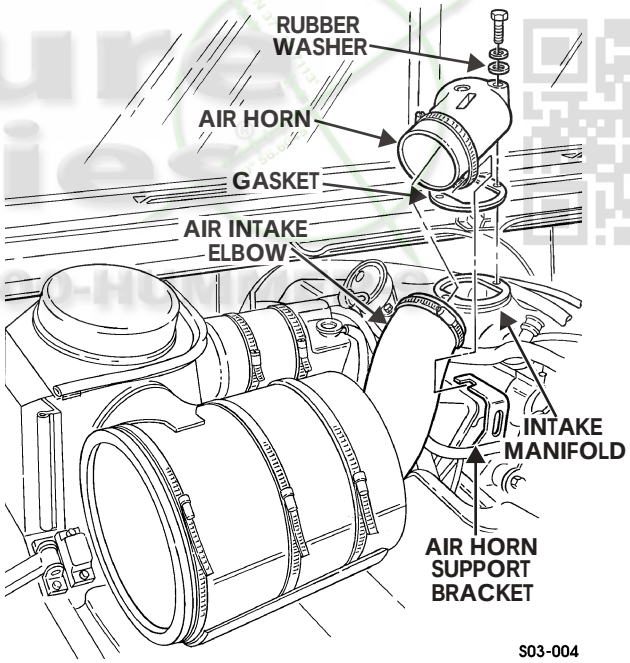

Figure 3-4: Air Horn

2. Remove two screws, washers, and rubber washers from air horn and intake manifold. Discard rubber washers.
3. Loosen clamp and remove air horn from air horn support bracket.
4. Remove gasket from intake manifold. Discard gasket.

Installation

Install gasket on intake manifold (Figure 3-4).

5. Install clamp on air horn.

6. Apply elastomeric sealing compound to air horn mounting screws, and install air horn on intake manifold with two rubber washers, washers, and screws. Tighten screws to 44 lb-in. (5 N•m).
7. Connect air intake elbow to air horn. Tighten clamp to 44-53 lb-in. (5-6 N•m).
8. Install air horn clamp on air horn support bracket. Tighten clamp to 44 lb-in. (5 N•m).

AIR INTAKE ELBOW REPLACEMENT

Removal

Remove air intake elbow from air horn and air cleaner assembly (Figure 3-5).

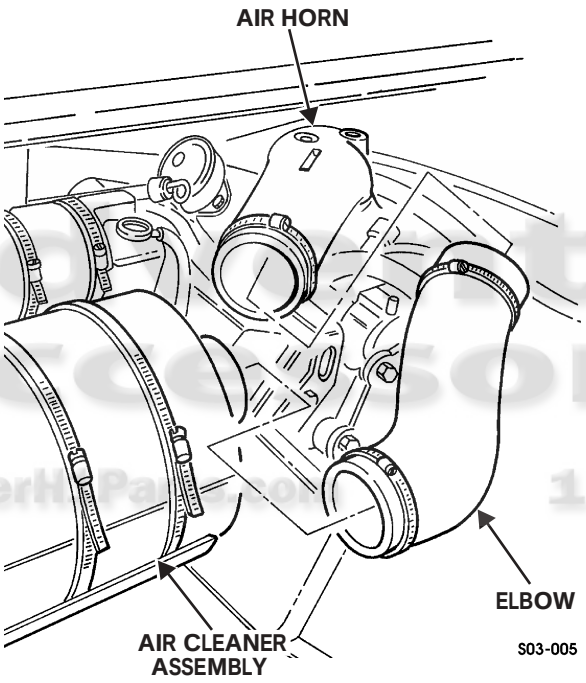

Figure 3-5: Air Intake Cleaner Elbow

Installation

Install air intake elbow on air horn and air cleaner assembly. Tighten clamps to 44 lb-in. (5 N•m) (Figure 3-5).

AIR HORN SUPPORT BRACKET REPLACEMENT

Removal

1. Remove air horn.
2. Remove nut, lockwasher, two clamps, and stud from air horn support bracket and cylinder head. Discard lockwasher (Figure 3-6).
3. Remove capscrew and air horn support bracket from cylinder head.

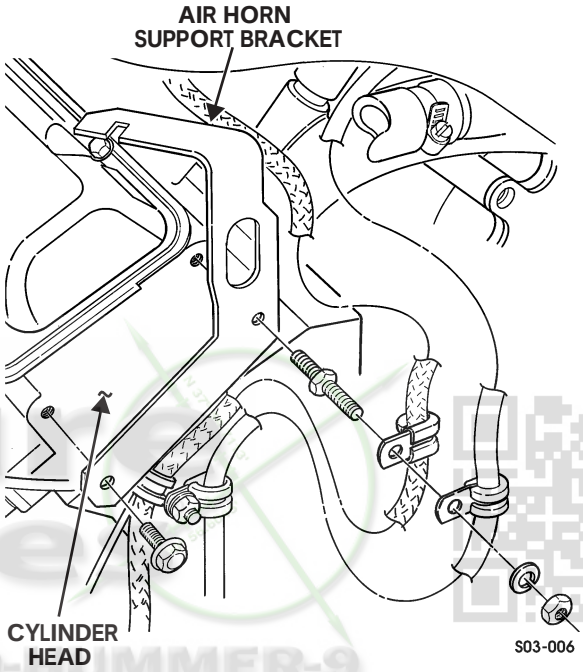

Figure 3-6: Air Horn Support Bracket

Installation

1. Install air horn support bracket on cylinder head with capscrew and stud. Tighten capscrew and stud to 40 lb-ft (54 N•m) (Figure 3-6).
2. Install two clamps, lockwasher, and nut on stud.
3. Install air horn.

WEATHERCAP REPLACEMENT

Removal

Remove clamp and weathercap from air intake duct (Figure 3-7).

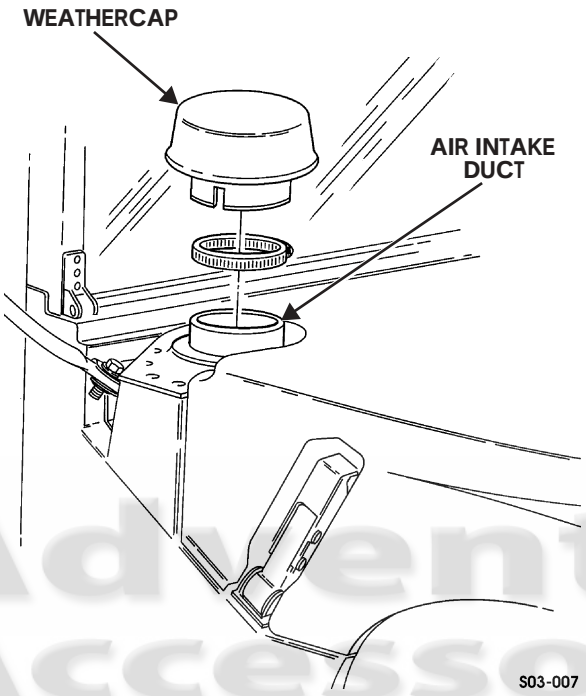

Figure 3-7: Weathercap

Installation

Install weathercap on air intake duct with clamp. Tighten clamp to 44-53 lb-in. (5-6 N•m) (Figure 3-7).

DRAINAGE BRACKET REPLACEMENT

Removal

1. Remove air cleaner assembly.
2. Remove three screws and drainage bracket from body (Figure 3-8).

Installation

1. Install drainage bracket on body with three screws (Figure 3-8).
2. Install air cleaner assembly.

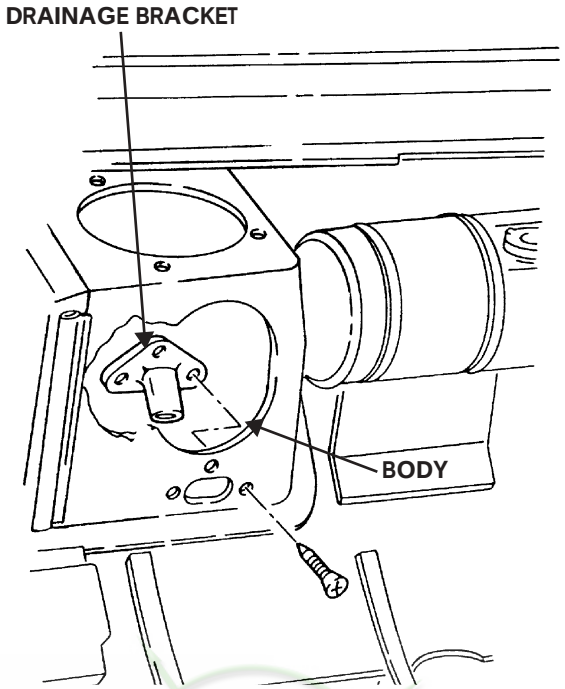

Figure 3-8: Drainage Bracket

AIR INTAKE VENT LINE REPLACEMENT

Removal

Remove air intake vent line from tee fitting and air cleaner fitting (Figure 3-9) and (Figure 3-10).

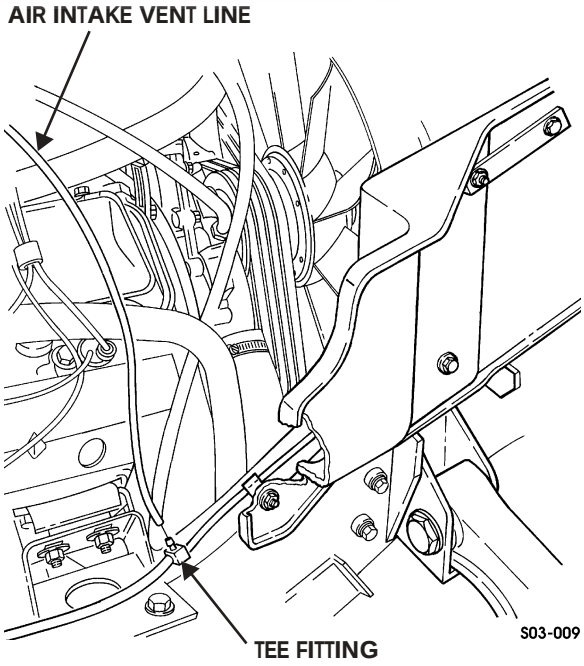

Figure 3-9: Air Intake Vent Line

Installation

Install air intake vent line on tee fitting and air cleaner fitting (Figure 3-9) and (Figure 3-10).

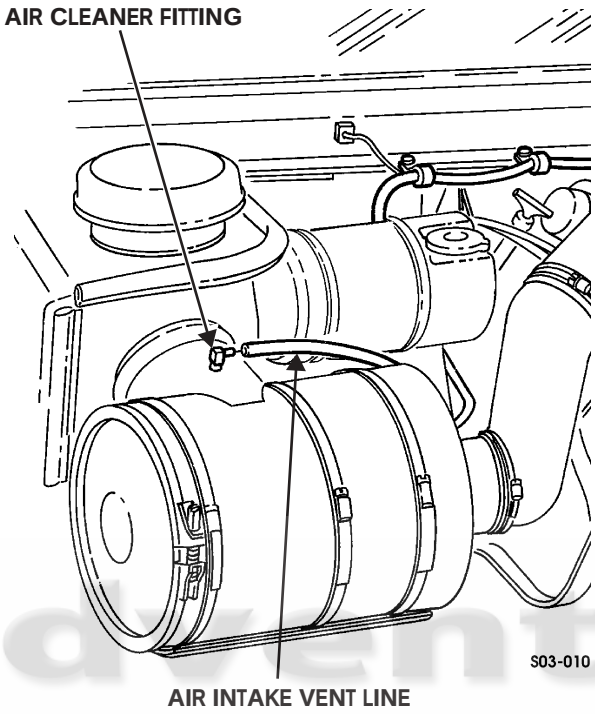

Figure 3-10: Air Cleaner Fitting

FUEL PUMP REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Disconnect connector from wiring harness (Figure 3-11).
3. Disconnect two hoses from fuel pump.
4. Remove clamp and pump from bracket.
5. Remove two adapters and O-rings from fuel pump. Discard O-rings.

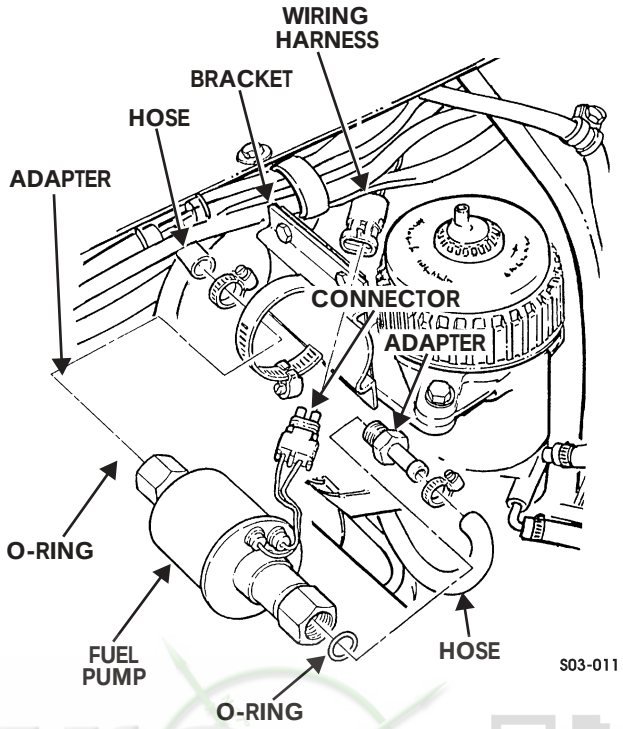

Figure 3-11: Fuel Pump

Installation

1. Install two O-rings and adapters on fuel pump (Figure 3-11).
2. Install fuel pump on bracket with clamp.
3. Connect two hoses to fuel pump.
4. Connect connector to wiring harness.
5. Connect battery ground cable.
6. Start engine and check fuel pump and hoses for leaks.

FUEL INJECTION PUMP BOOT REPLACEMENT

Removal

Remove clamp and injection pump boot from injection pump (Figure 3-12).

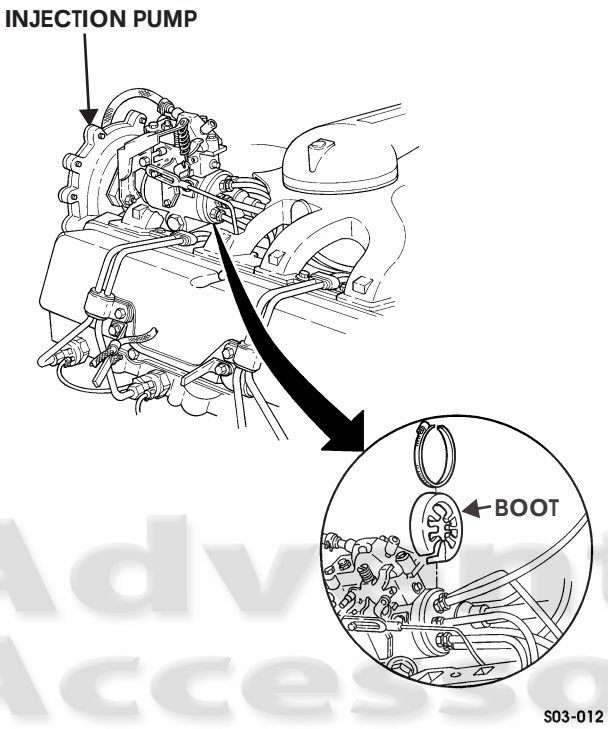

Figure 3-12: Fuel Injection Pump Boot

Installation

Install injection pump boot on injection pump with clamp (Figure 3-12).

FUEL TANK MAINTENANCE

Draining

1. Disconnect battery ground cable.
2. Remove fuel tank filler cap (Figure 3-13).
3. Remove fuel tank drainplug and drain fuel completely (Figure 3-14).

NOTE: Avoid overtightening drainplug. Sharp edge of drain hole may cut rubber drainplug.

4. Install and tighten drainplug until flush with bottom of hole.

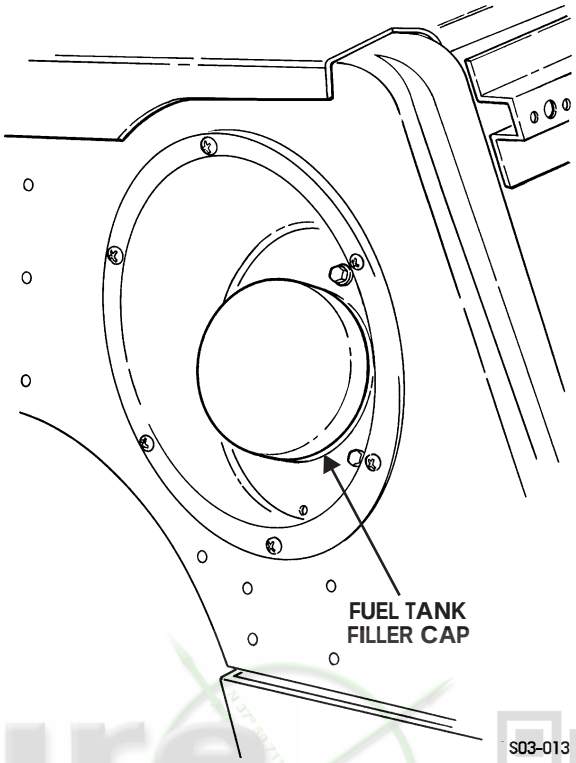

Figure 3-13: Fuel Tank Filler Cap

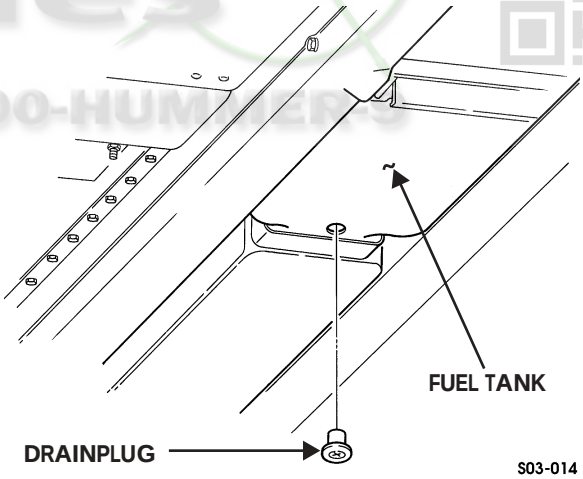

Figure 3-14: Drainplug

Removal

1. Remove rear propeller shaft (Section 5).
2. Disconnect vent line from fill tube (Figure 3-15).
3. Remove locknut, washer, capscrew, washer, and clamp securing vent line to body. Discard locknut.
4. Remove locknut, washer, capscrew, washer, and clamp securing fill tube to body. Discard locknut.
5. Remove fill tube hose from fill tube.
6. Remove two locknuts, washers, capscrews, and lower straps from fuel tank support straps. Discard locknuts (Figure 3-16).
7. Disconnect fuel supply and return lines from hoses.
8. Remove locknut, washer, capscrew, and rear strap from strap bracket. Discard locknut.

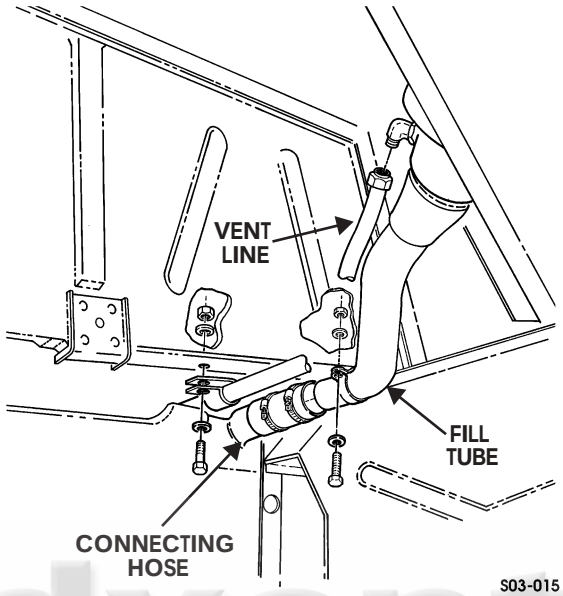

Figure 3-15: Fuel Tank To Fill Tube Connecting Hose Location

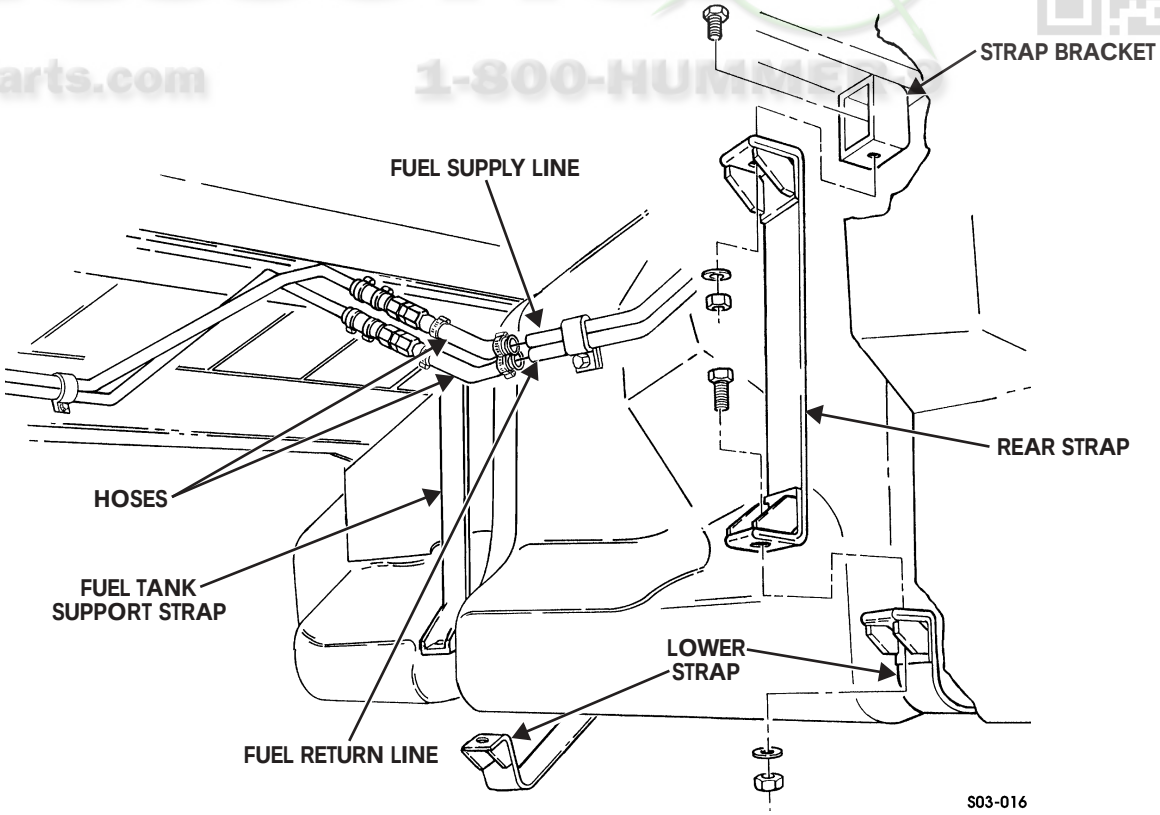

Figure 3-16: Fuel Supply Lines

9. Remove capscrew, clamp, and vent line from body (Figure 3-17).
10. Disconnect vent line from tee.

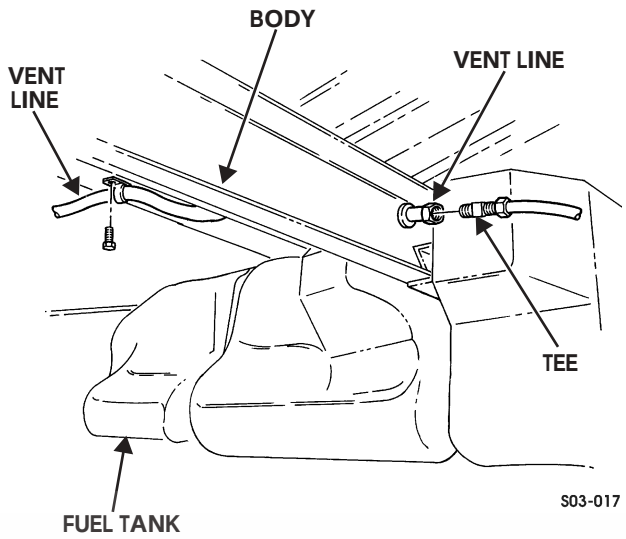

Figure 3-17: Vent Lines

11. Lower fuel tank and disconnect vent line from fuel tank fitting (Figure 3-18).

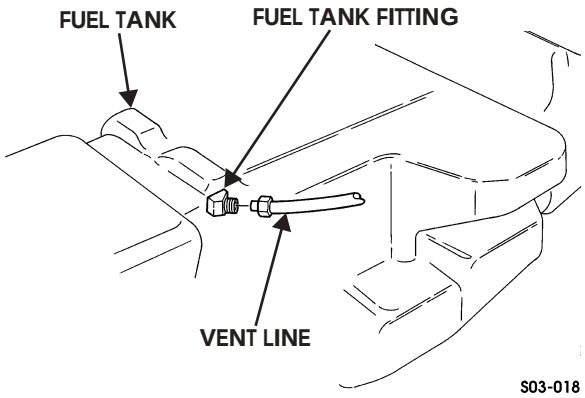

Figure 3-18: Fuel Tank Fitting

12. Remove locknut, washer, clamp, and vent line from fuel tank and vent valve. Discard locknut (Figure 3-19)
13. Disconnect jumper harness leads from body wiring harness.
14. Bend clamp open and remove jumper harness from frame.
15. Remove fuel tank from vehicle.

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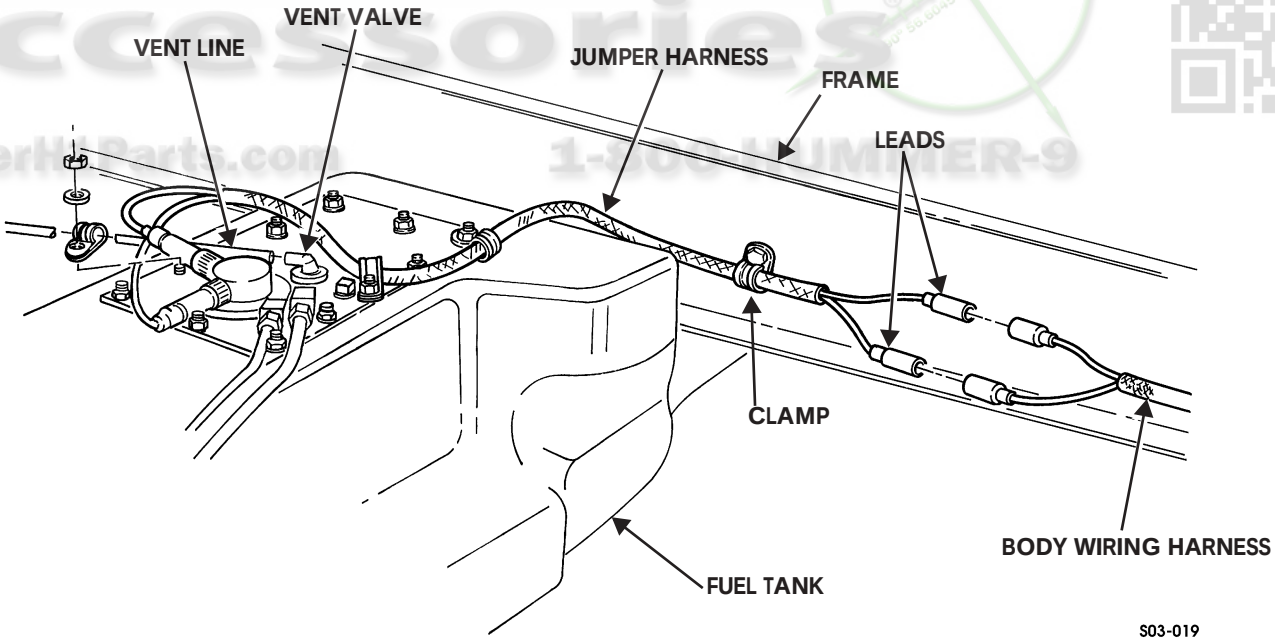

Figure 3-19: Vent Valve

Disassembly

NOTE: Clean outside of fuel tank thoroughly before disassembling.

1. Disconnect fuel supply and return lines from fuel supply and return tubes (Figure 3-20).
2. Remove capscrew, clamp, fuel supply and return lines, and shield from fuel tank.
3. Remove two locknuts, washers, clamps, and jumper harness from access cover. Discard locknuts.
4. Disconnect jumper harness leads from fuel level sender.
5. Remove ten locknuts, washers, access cover, gasket, and retainer from fuel tank. Discard locknuts and gasket.
6. Remove fuel strainer from fuel supply tube.
7. Mark positions of fuel supply and return tubes, and remove tubes from access cover.
8. Remove vent valve and grommet from access cover.
9. Remove vent line from tee.
10. Remove fuel level sending unit from access cover.
11. Remove fill tube hose from fuel tank.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean the following parts with solvent: (Figure 3-20)
   - Access cover
   - Fuel supply line
   - Fuel return line
   - Fuel supply tube
   - Fuel return tube
   - Inside of fuel tank
2. Inspect the following parts for cracks, wear, or breaks:
   - Access cover
   - Fuel supply line
   - Fuel return line
   - Fuel supply tube
   - Fuel return tube
   - Strainer
   - Tee
   - Fitting
   - Vent valve
   - Grommet

Assembly

NOTE: Use fittings from old fuel tank if installing new fuel tank. Apply pipe sealant to all vent line and fuel line connector threads.

1. Install vent line on tee (Figure 3-20).
2. Install fill tube hose on fuel tank.
3. Install and align fuel supply and return tubes on access cover.
4. Install grommet and vent valve on access cover.
5. Install fuel strainer on fuel supply tube.
6. Apply adhesive to locknut threads and install retainer, gasket, and access cover on fuel tank with ten washers and locknuts. Tighten locknuts to 71 lb-in. (8 N•m).
7. Connect jumper harness leads to fuel level sender.
8. Apply adhesive to locknut threads, and install jumper harness on access cover with two clamps, washers, and locknuts. Tighten locknuts to 71 lb-in. (8 N•m).
9. Connect fuel supply and return lines to supply and return tubes.
10. Install shield and supply and return lines on fuel tank with clamp and capscrew.

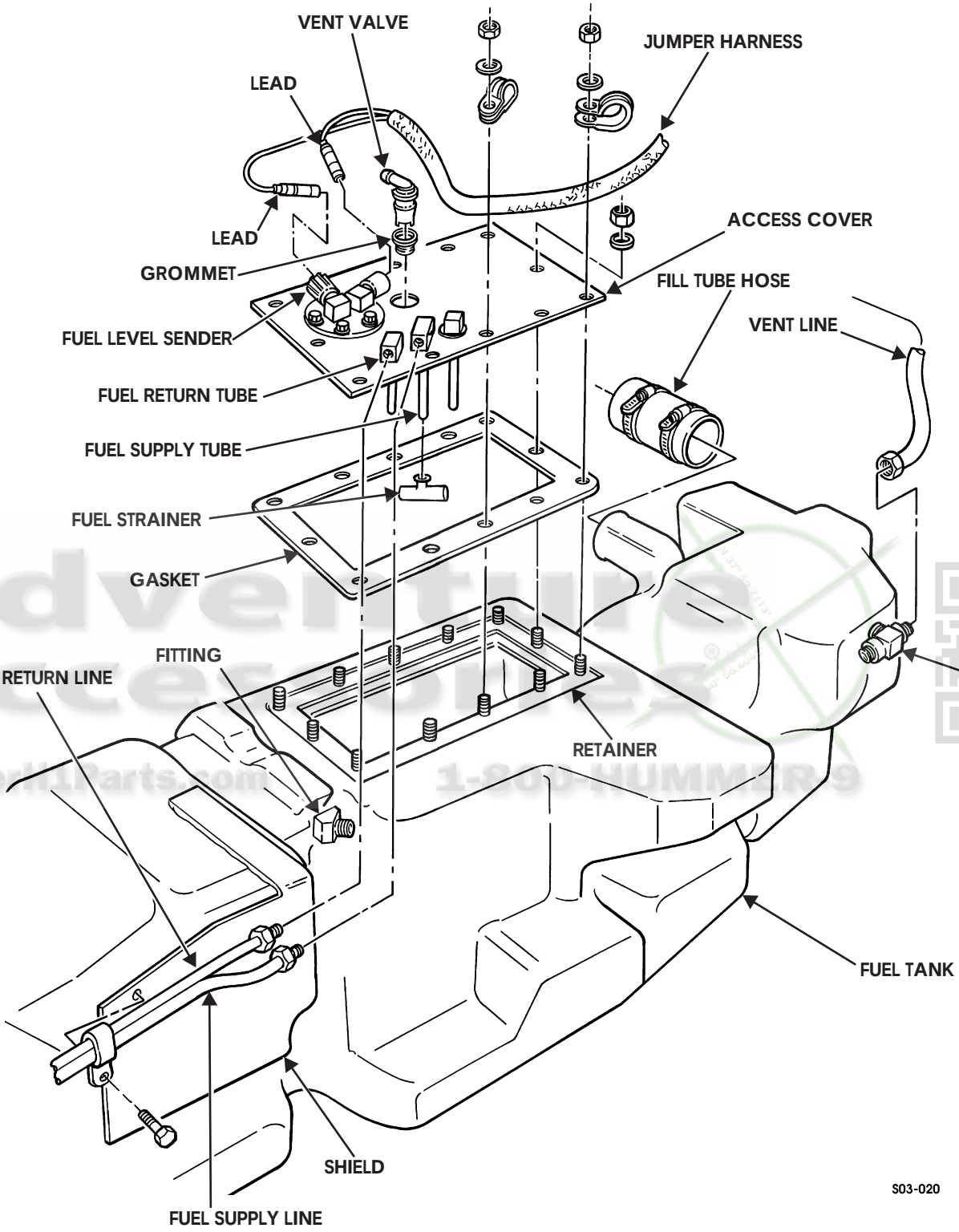

Figure 3-20: Fuel Tank

Installation

1. Position fuel tank under vehicle.
2. Connect jumper harness leads to body wiring harness (Figure 3-22).
3. Insert jumper harness into clamp on frame. Bend clamp close around jumper harness.
4. Install vent line on vent valve and fuel tank with clamp, washer, and locknut. Tighten locknut to 6 lb-ft (8 N•m).
5. Connect vent line to fuel tank fitting (Figure 3-21). Install capscrew, washer, locknut, and rear strap on strap bracket. Tighten locknut to 23-27 lb-in. (2.6-3.1 N•m) (Figure 3-23).
6. Raise fuel tank, and install fuel tank support straps on lower straps with two capscrews, washers, and locknuts. Do not tighten locknuts.
7. Connect vent line to tee (Figure 3-24).
8. Secure vent line to body with clamp and capscrew.
9. Connect fuel supply and return lines to hoses (Figure 3-23).

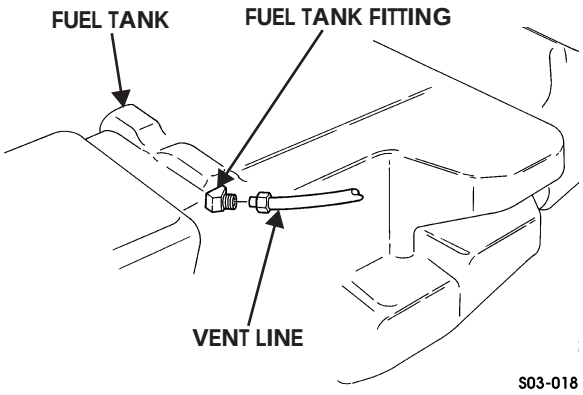

Figure 3-21: Vent Line and Fuel Tank Fitting

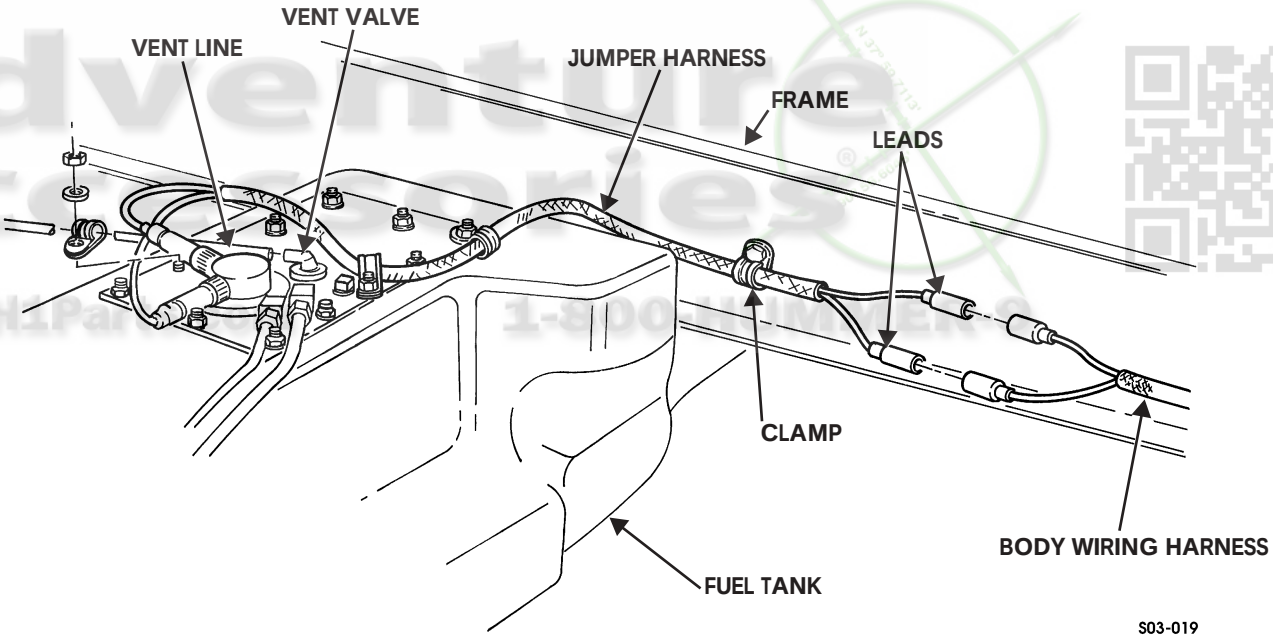

Figure 3-22: Vent Lines and Fuel Tank Locations

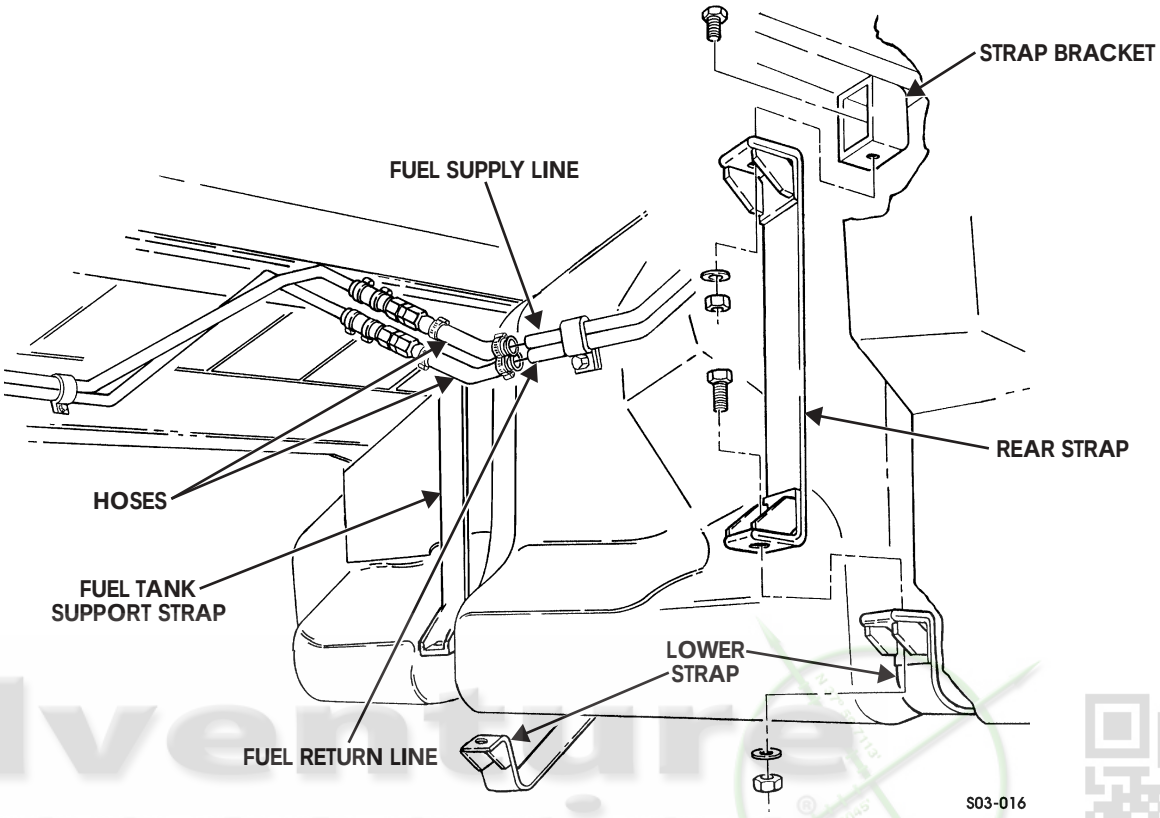

Figure 3-23: Fuel Tank Support Strap

10. Tighten locknuts securing upper and lower support straps to 27 lb-in. (3 N•m) (Figure 3-23).

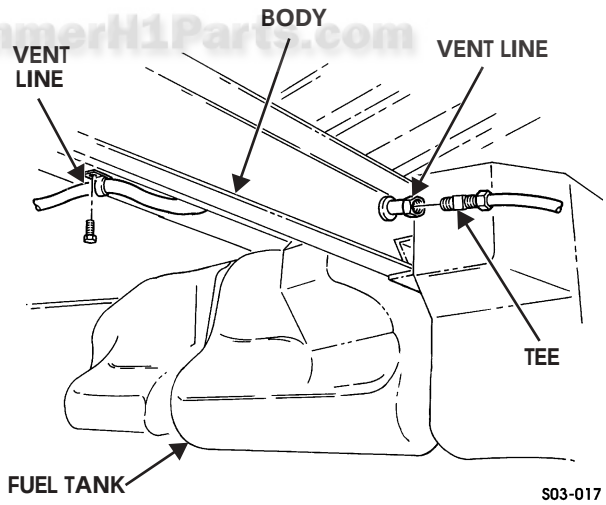

Figure 3-24: Vent Line Tee Connection

NOTE: Tighten the fuel tank retainer straps to 23-27 lb-in. (2.6-3.1 N•m). There should not be metal-to-metal contact. If there is contact (strap-to-strap), replace with new straps.

11. Connect vent line to elbow on fill tube (Figure 3-25).

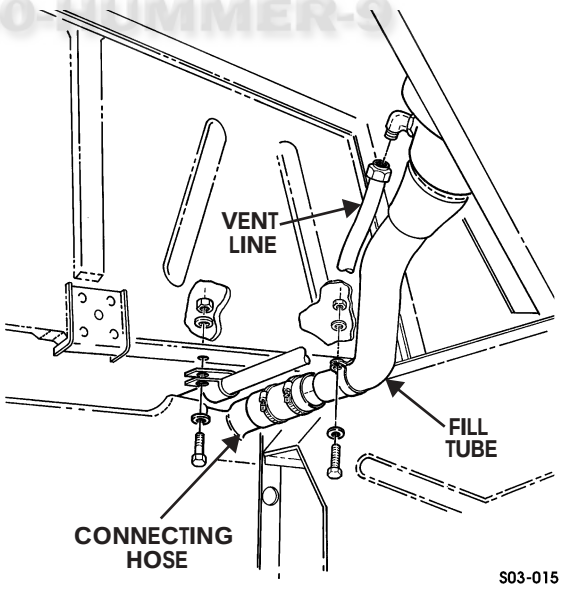

Figure 3-25: Fuel Fill Tube and Hose

12. Install vent line on body with clamp, washer, capscrew, washer, and locknut.
13. Install fill tube into hose.

14. Install fill tube on body with clamp, washer, capscrew, washer, and locknut. Tighten locknut to 6 lb-ft (8 N•m).
15. Install rear propeller shaft (Section 5).
16. Connect battery ground cable.
17. Fill fuel tank and check for leaks.

CHECK VALVE REPLACEMENT

Removal

CAUTION: *Cover or plug all openings immediately after disconnecting to prevent system contamination.*

NOTE: Clean all components before disconnecting.

There are three fuel line check valves: fuel supply, and one fuel return at the fuel tank, and fuel supply at the fuel filter. Perform steps 1-3 for the fuel tank check valves, and steps 4-8 for the fuel filter check valve.

1. Loosen eight clamps.
2. Remove four hoses from fuel lines (Figure 3-26).
3. Remove four hose barbs and hoses from two check valves and lines. Discard hose barbs and hoses.
4. Remove two sections of spiral wrap (Figure 3-27).
5. Loosen four clamps.
6. Remove hose from fuel pump.
7. Remove hose from fuel filter supply line.
8. Remove two hose barbs and hoses from check valve. Discard hose barbs and hoses.

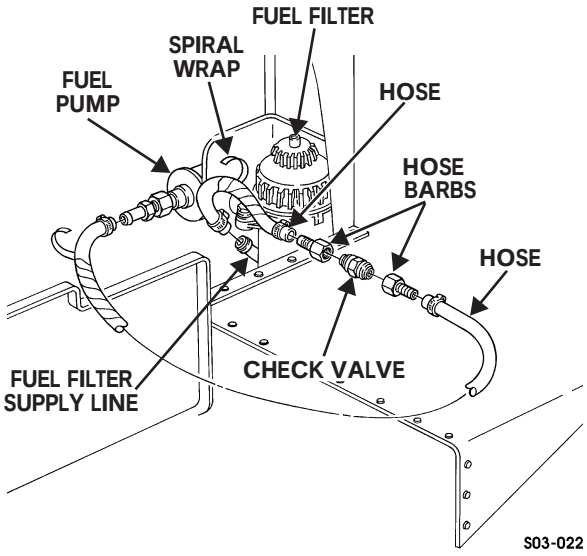

Figure 3-26: Fuel Pump and Hose Assembly

Installation

NOTE: Perform steps 1-3 for fuel tank check valves and steps 4-6 for fuel filter check valve.

1. Install four new hose barbs on two check valves (Figure 3-26).
2. Install four new hoses on hose barbs.
3. Install four hoses on fuel lines with clamps. Tighten clamps to 10-20 lb-in. (1-2 N•m).
4. Install two new hoses on hose barb with clamps (Figure 3-27).
5. Install two hoses on fuel pump and fuel filter with clamps.
6. Install spiral wrap on two hoses.
7.

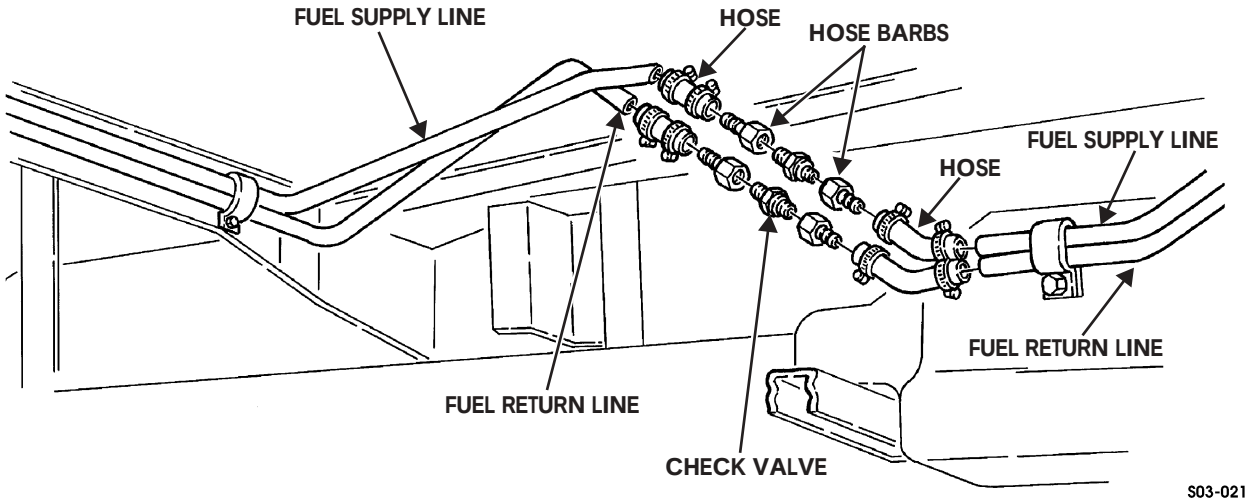

Figure 3-27: Fuel Lines and Hose Barbs

FUEL TANK SUPPLY AND RETURN LINES REPLACEMENT

Removal

1. Remove right engine splash shield.
2. Loosen clamps, and disconnect fuel tank return and supply lines from hoses and hose barbs (Figure 3-28) and (Figure 3-29).
3. Remove two locknuts, capscrews, washers, clamps, and return and supply lines from front and rear body brackets. Discard locknuts (Figure 3-28) and (Figure 3-29).
4. Remove return and supply lines and three clips from vehicle (Figure 3-29).

Installation

1. Install fuel tank return and supply lines on front and rear body brackets with two clamps, washers, capscrews, and locknuts (Figure 3-28) and (Figure 3-29).
2. Connect return and supply line hoses to hose barbs.
3. Secure return and supply lines with three clips (Figure 3-29).
4. Install right engine splash shield.
5. Fill fuel tank and check for leaks.

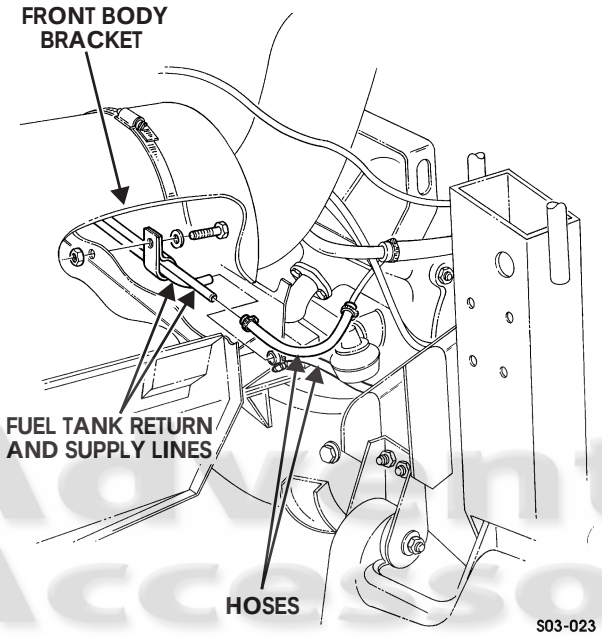

Figure 3-28: Fuel Lines and Front Body Bracket

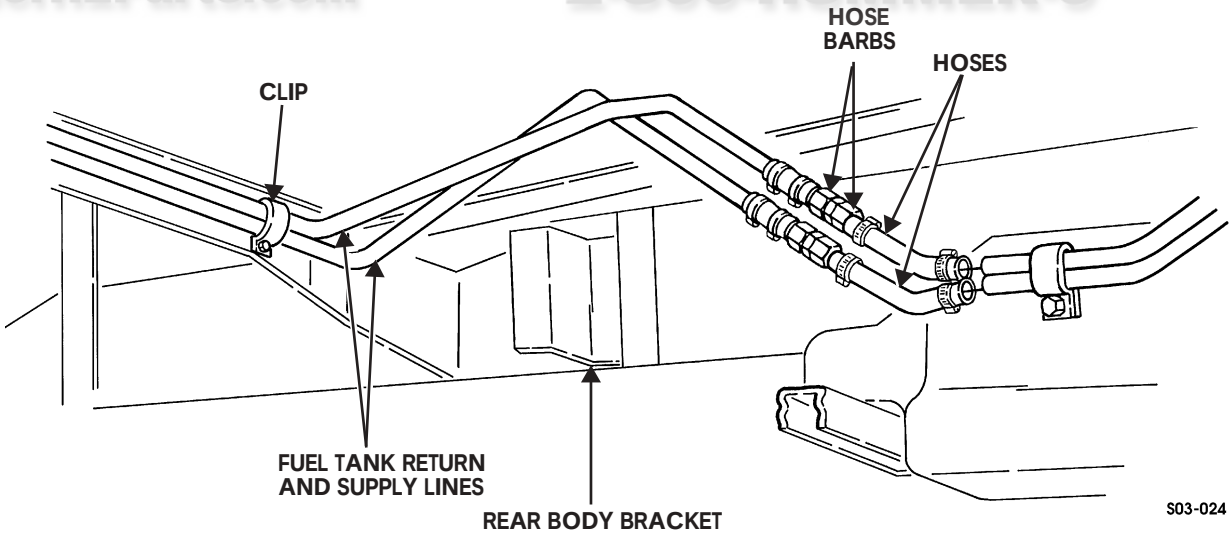

Figure 3-29: Fuel Lines and Rear Body Bracket

FUEL TANK VENT LINE AND FILTER REPLACEMENT

Removal

NOTE: To remove fuel tank vent line filter only, perform steps 6 and 7.

1. Remove fuel tank.
2. Remove clip and fuel tank vent line hose from vent line (Figure 3-30).

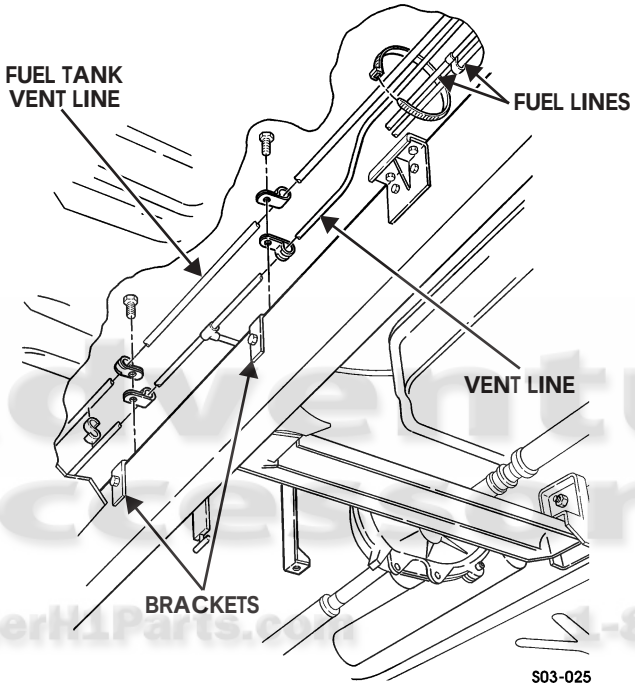

Figure 3-30: Fuel Tank Vent Lines

3. Remove two capscrews, four clamps, and two vent lines from brackets.
4. Remove tiedown strap securing fuel tank vent line and vent line to fuel lines. Discard tiedown strap.
5. Disconnect fuel tank vent line from elbow (Figure 3-31).

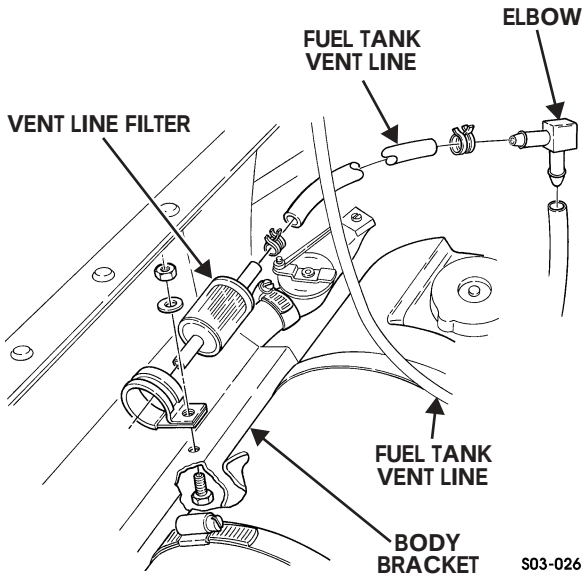

Figure 3-31: Fuel Tank Vent Line Filter

6. Remove fuel tank vent line from vent line filter and elbow.
7. Remove locknut, washer, capscrew, clamp, and vent line filter from body bracket. Discard locknut.

Installation

NOTE: To install fuel tank vent line filter only, perform steps 1 and 2.

1. Install vent line filter on body bracket with clamp, capscrew, washer, and locknut (Figure 3-31).
2. Install fuel tank vent line on vent line filter and elbow.
3. Connect fuel tank vent line to elbow.
4. Secure fuel tank vent line and vent line to fuel lines with tiedown strap (Figure 3-30).
5. Install two vent lines on brackets with four clamps and two capscrews.
6. Secure fuel tank vent line and vent line with clip.
7. Install fuel tank.

FUEL TANK FILLER CAP AND SPOUT MAINTENANCE

Removal

1. Drain fuel tank.
2. Detach filler cap chain clip and remove filler cap from fill tube (Figure 3-32).
3. Disconnect vent line from fitting.
4. Remove three locknuts, six washers, and three capscrews securing fill tube mounting ring to body. Discard locknuts.
5. Remove locknut, two washers, capscrew, clamp, and fill tube from body. Discard locknut.
6. Remove fill tube from hose.
7. Remove fill tube mounting ring.
8. Remove fitting from fill tube.
9. Using handle, remove screen from fill tube.

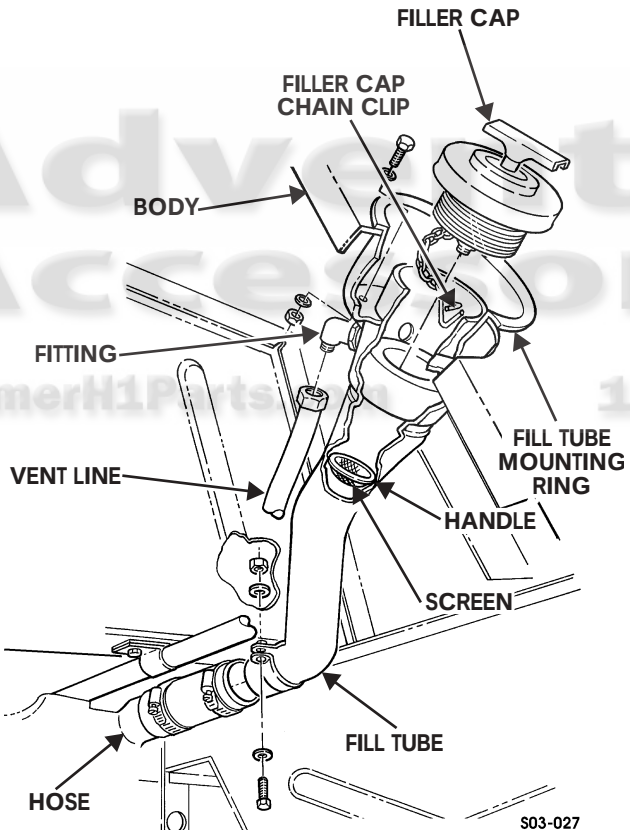

Figure 3-32: Fuel Tank Filler Cap and Spout

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect screen for damage, debris, or blockage (Figure 3-32).

Installation

1. Apply teflon sealing compound to fitting, and install fitting on fill tube (Figure 3-32).
2. Using handle, install screen into fill tube.
3. Place fill tube and mounting ring in approximate vehicle location.
4. Install fill tube on hose.
5. Secure fill tube mounting ring to body with three washers, capscrews, washers, and locknuts.
6. Install fill tube on body with clamp, washer, capscrew, washer, and locknut. Tighten locknut to 6 lb-ft (8 N•m).
7. Apply teflon sealing compound to fitting, and connect vent line to fitting.
8. Install filler cap chain clip on fill tube, and install filler cap on fill tube.
9. Fill fuel tank and check fill tube for fuel leaks.

Fuel Tank Fill Tube Vent Line Replacement

Removal

1. Drain fuel tank.
2. Remove rear propeller shaft.
3. Disconnect vent line from fuel fill tube fitting (Figure 3-33).

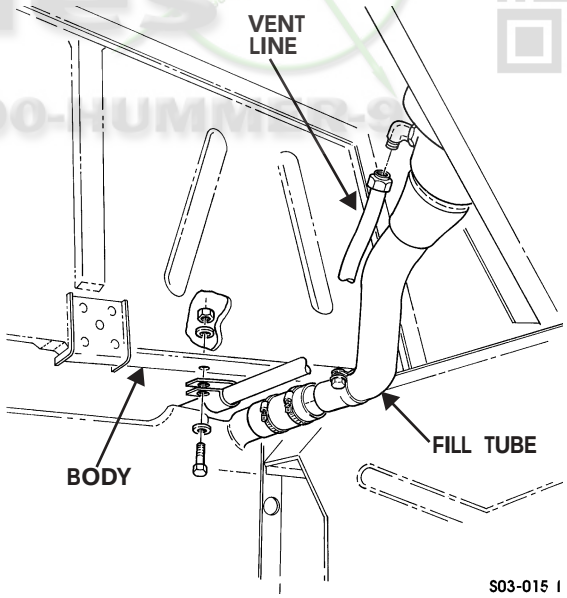

Figure 3-33: Fuel fill tube Fitting

4. Remove locknut, washer, capscrew, washer, clamp, and vent line from body. Discard locknut.
5. Disconnect vent lines from tee (Figure 3-34).

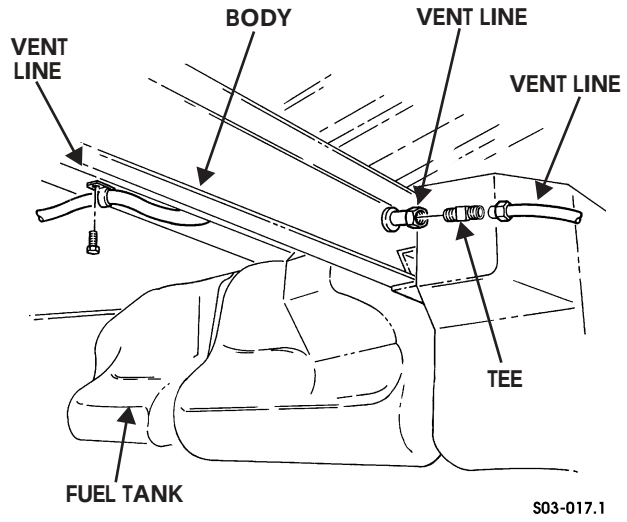

Figure 3-34: Vent Lines and Tee

6. Remove capscrew, clamp, and vent line from body.
7. Loosen two fuel tank strap retaining nuts to allow access to fuel tank elbow (Figure 3-33) and (Figure 3-35).
8. Disconnect vent line from fuel tank elbow, cut vent line, and remove from crossmember.

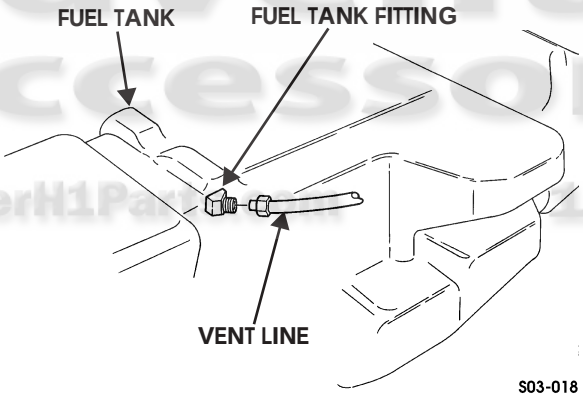

Figure 3-35: Fuel Tank Elbow

Installation

NOTE: Apply elastomeric sealing compound to all vent line connector threads.

1. Install vent line on fuel tank elbow (Figure 3-35).
2. Install vent line on body with clamp and capscrew.
3. Route vent line through crossmember, and connect to tee.
4. Connect vent line to tee.
5. Install vent line on body with clamp, washer, capscrew, washer, and locknut. Tighten locknut to 6 lb-ft (8 N•m) (Figure 3-33).
6. Connect vent line to fill tube fitting.
7. Install rear propeller shaft (Section 5).
8. Fill fuel tank and check for leaks.

Fill Tube Hose Replacement

Removal

1. Drain fuel tank.
2. Remove fill tube hose from fuel tank and fill tube (Figure 3-36).

Installation

1. Install fill tube hose on fuel tank and fill tube (Figure 3-36).
2. Fill fuel tank and check for leaks.

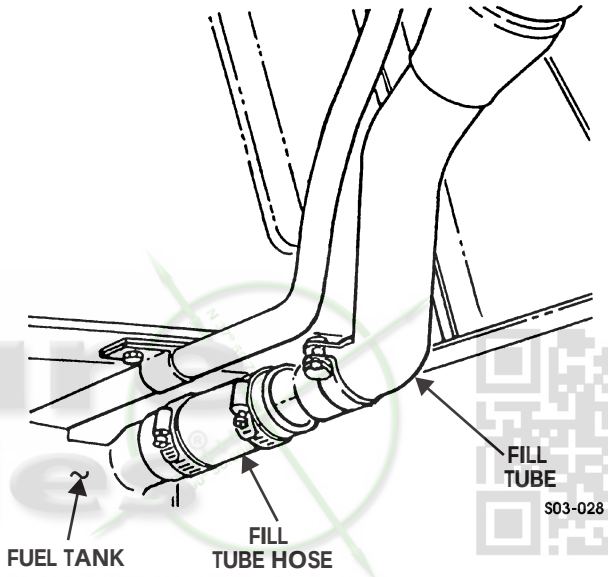

Figure 3-36: Fill Tube Hose

FUEL TANK HANGERS REPLACEMENT

Removal

1. Remove fuel tank.
2. Remove two locknuts, washers, screws, and rear hangers from supports. Discard locknuts (Figure 3-37).
3. Turn two front hangers one-quarter turn and remove from supports.

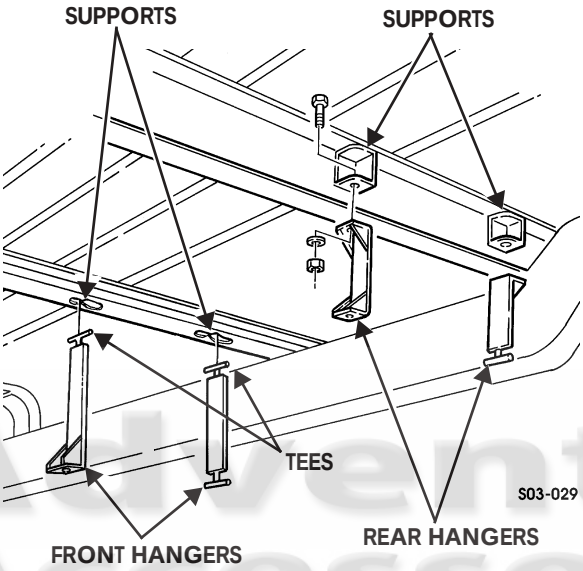

Figure 3-37: Fuel Tank Hangers

Installation

NOTE: Be sure the front hangers are placed in the detents of the supports to assure fuel tank cannot shift inward and make contact with the rear propeller shaft.

1. Insert two tees of front hangers into slots of supports and turn one quarter turn to secure in place (Figure 3-37).
2. Install two rear hangers on supports with screws, washers, and locknuts. Tighten locknuts to 37 lb-ft (50 N•m).
3. Install fuel tank.

FUEL FILTER MAINTENANCE

Removal

1. Disconnect fuel inlet and outlet hoses from fuel filter (Figure 3-40).
2. Disconnect drain hose from fuel filter.
3. Disconnect two connectors from wiring harness.
4. Remove two capscrews, washers, and fuel filter from bracket (Figure 3-38).

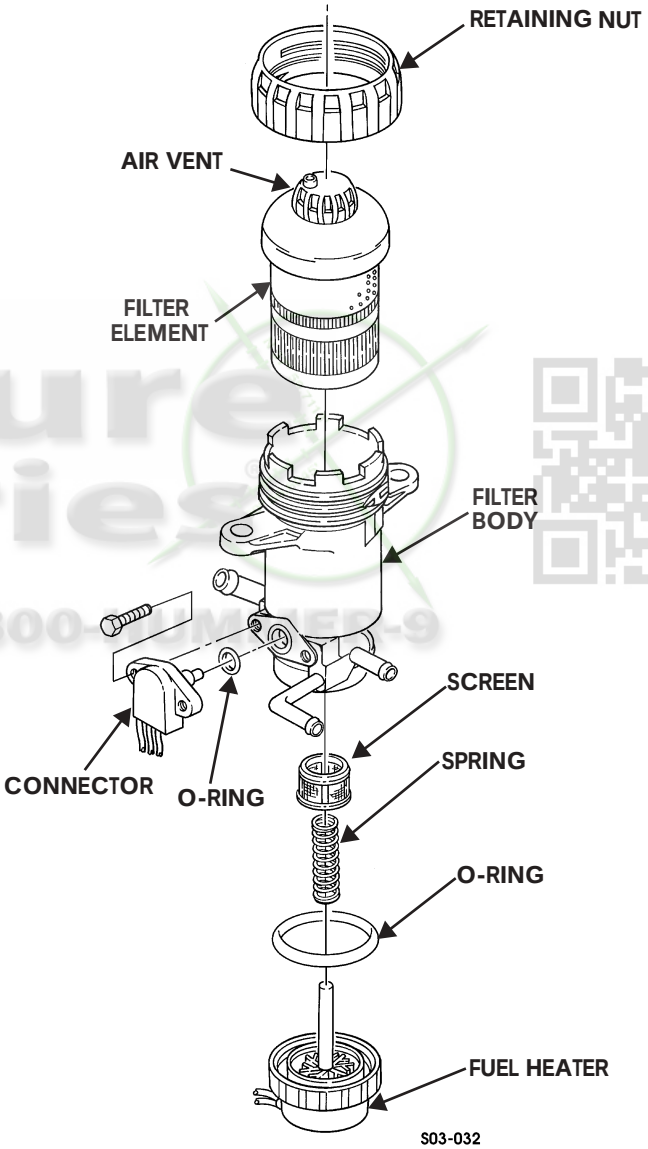

Figure 3-38: Fuel Filter Components

Disassembly

1. Remove retaining nut and filter element from filter body assembly. Drain fuel from filter body assembly. Discard filter element (Figure 3-38).
2. Remove two capscrews, connector, and O-ring from filter body assembly. Discard O-ring.
3. Loosen nut and remove fuel heater, O-ring, spring, and screw from filter body assembly .
4. Discard O-ring and screen.

Assembly

1. Install screen, spring, O-ring, and fuel heater on filter body assembly. Tighten nut (Figure 3-38).
2. Install O-ring and connector on filter body assembly with two capscrews.
3. Install filter element on filter body assembly with retaining nut.

Installation

1. Install fuel filter on bracket with two washers and capscrews (Figure 3-39).
2. Connect two connectors to wiring harness (Figure 3-39).
3. Connect drain hose to fuel filter.
4. Connect inlet and outlet hoses to fuel filter.

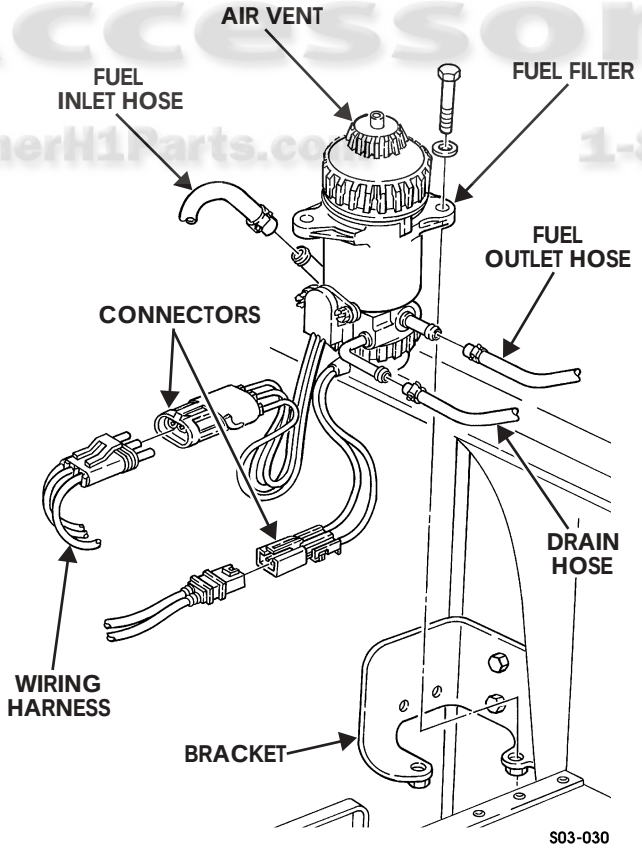

Figure 3-39: Fuel Filter Connections

Bleeding

1. Loosen fuel filter air vent screw one-half turn (Figure 3-38).
2. Disconnect run solenoid lead (Figure 3-40).

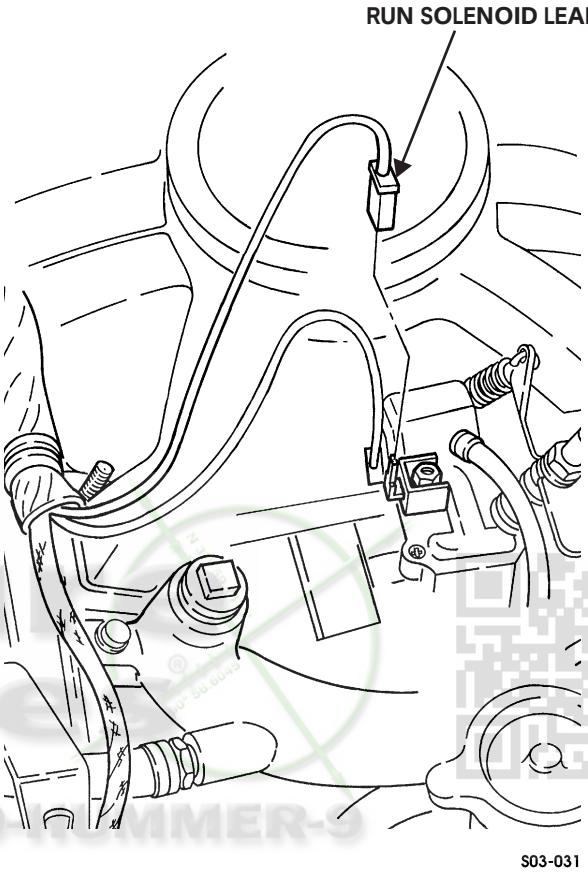

Figure 3-40: Run Solenoid Lead

CAUTION: *To avoid starter damage, do not operate starter continuously for more than 20 seconds. Wait 10 to 15 seconds between periods of operation.*

3. Crank engine until fuel exits from air vent (Figure 3-39).
4. Tighten air vent screw.
5. Connect run solenoid lead (Figure 3-40).
6. Start engine and check for fuel leaks.

FUEL FILTER ELEMENT REPLACEMENT

Removal

1. Loosen fuel filler cap to release pressure from fuel tank
2. Remove retaining nut and filter element from filter body assembly. Use oil filter-type strap wrench if necessary. Discard filter element (Figure 3-41).

NOTE: It is not necessary to drain the fuel from the filter body assembly to change the filter element. Fuel will remain in the filter body assembly cavity.

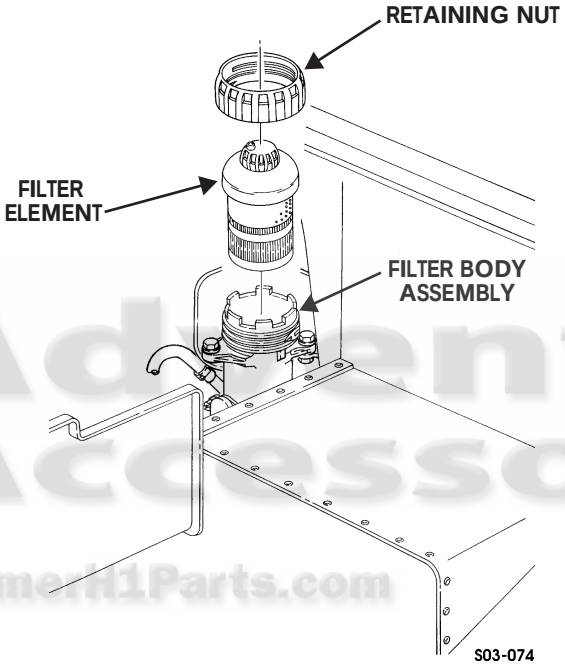

Figure 3-41: Fuel Filter Element

Installation

NOTE: Be sure filter element mating surface in filter body assembly is clean before installing filter element.

1. Align widest key of filter element with widest key slot of filter body assembly and install filter element in filter body assembly (Figure 3-41).
2. Install retaining nut on filter body assembly. Tighten retaining nut to 115-120 lb-in. (13-14 N•m).
3. Bleed air from fuel.

FUEL FILTER DRAIN HOSE AND VALVE REPLACEMENT

Removal

NOTE: To remove fuel filter drain valve only, perform steps 3 and 4.

1. Disconnect fuel filter drain hose from fuel filter (Figure 3-42).
2. Remove two tiedown straps and drain hose from transmission oil cooler lines.
3. Disconnect drain hose from drain valve.
4. Remove nut and drain valve from body

Installation

NOTE: To install fuel filter drain valve only, perform steps 1 and 2.

1. Install drain valve on body with nut (Figure 3-42).
2. Connect drain hose to drain valve.
3. Connect drain hose to fuel filter.
4. Secure drain hose to transmission oil cooler lines with two tiedown straps.
5. Start engine and check for fuel leaks.

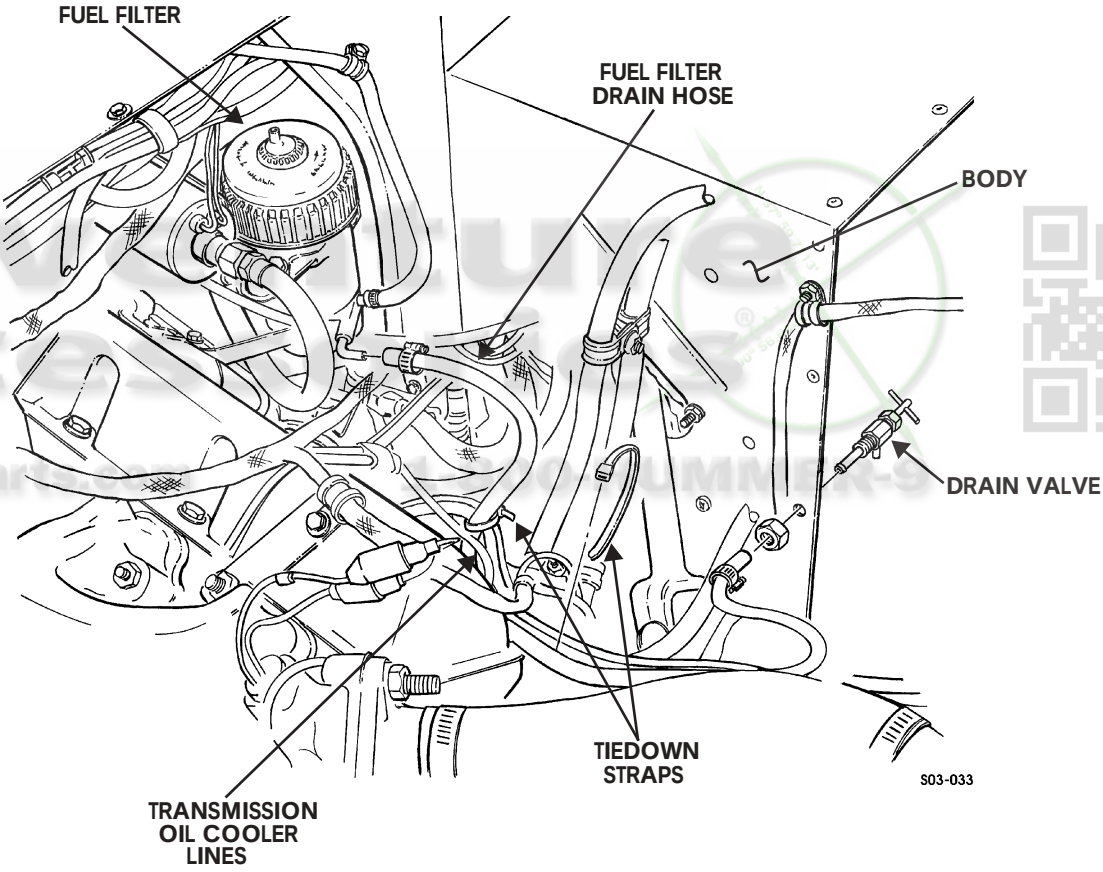

Figure 3-42: Fuel Filter Drain Hose And Valve

FUEL INJECTION RETURN HOSES REPLACEMENT

Removal

1. Remove engine access covers.
2. Remove air horn.
3. Remove fuel drain-back hose from injection pump and fuel drain-back tube (Figure 3-43).
4. Remove tube-to-nozzle hose from fuel drain-back tube and nozzle.
5. Remove nozzle-to-nozzle hose from two nozzles (Figure 3-44).
6. Remove nozzle cap from rear nozzle nipple.

Installation

1. Install cap on rear nozzle nipple (Figure 3-44).
2. Install nozzle-to-nozzle hose on two nozzles.
3. Install tube-to-nozzle hose on fuel drain-back tube and nozzle (Figure 3-43).
4. Install fuel drain-back hose on fuel drain-back tube and injection pump.
5. Install air horn.
6. Install engine access covers.
7. Start engine and check for fuel leaks.

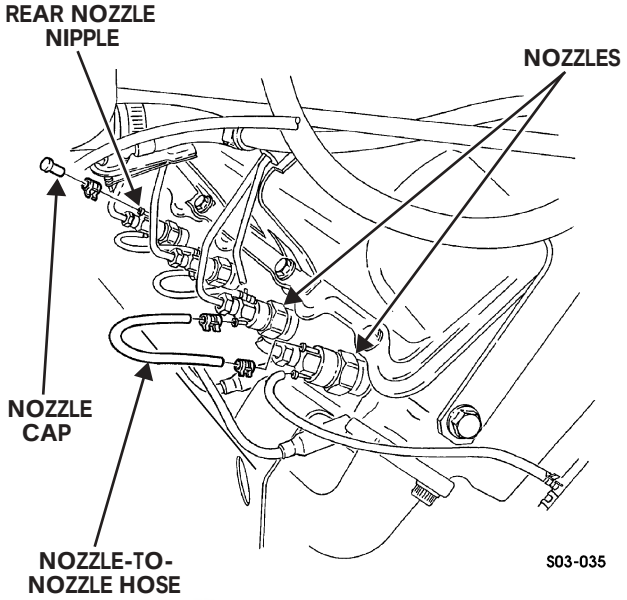

Figure 3-43: Nozzle-to-Nozzle Hose

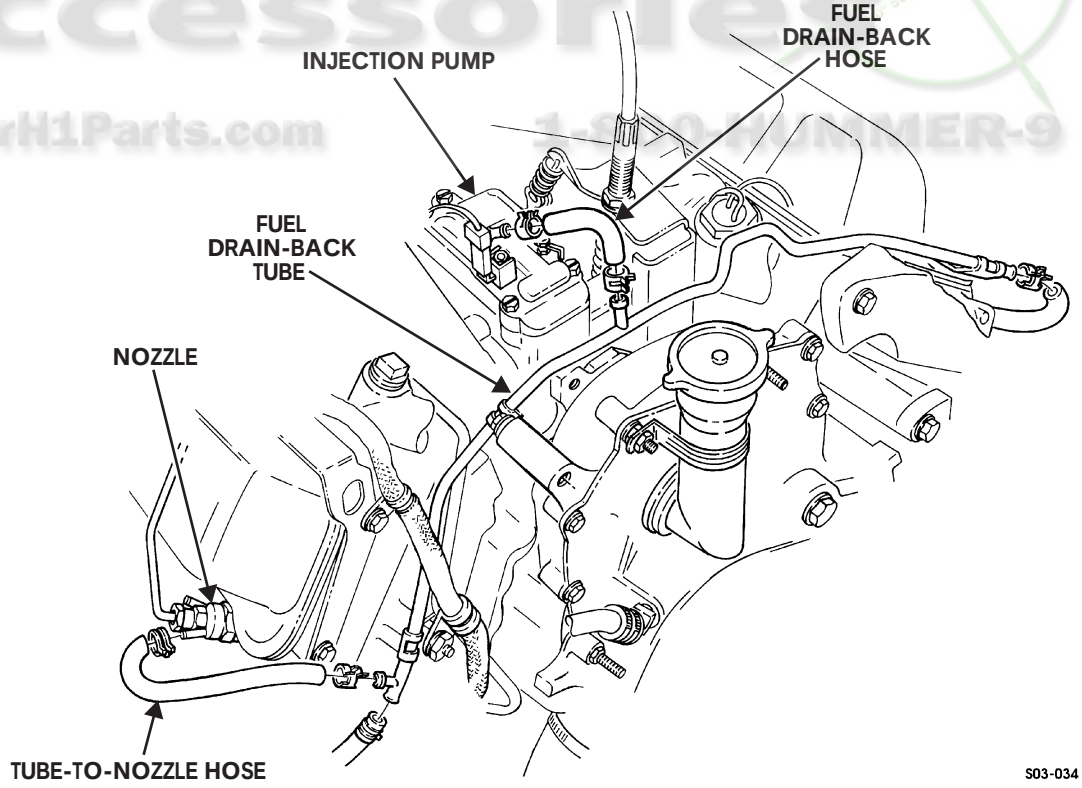

Figure 3-44: Fuel Injection Return Hoses

FUEL DRAIN-BACK TUBE REPLACEMENT

Removal

1. Remove air horn.
2. Remove nut, lockwasher, clamp, and engine wiring harness from stud. Discard lockwasher (Figure 3-45).
3. Remove stud, clamp, fuel supply line, clamp, and fuel drain-back tube from cylinder head.
4. Disconnect two hoses, fuel return hose, and fuel drain-back hose from fuel drain-back tube.
5. Remove nut, washer, clamp, and fuel drain- back tube from valve cover stud.
6. Remove capscrew, washer, clamp, and fuel drain-back tube from front engine cover.

Installation

1. Position fuel drain-back tube in front of injection pump (Figure 3-45).
2. Connect fuel return hose, two hoses, and fuel drain-back hose to fuel drain-back tube.
3. Install fuel drain-back tube on valve cover stud with clamp, washer, and nut. Tighten nut to 13-20 lb-ft (18-27 N•m).
4. Install fuel drain-back tube on front engine cover with clamp, washer, and capscrew. Tighten capscrew to 40 lb-ft (54 N•m).
5. Install fuel drain-back tube, clamp, fuel supply line, clamp, and stud on cylinder head.
6. Install engine wiring harness on stud with clamp, lockwasher, and nut.
7. Install air horn.
8. Start engine and check for fuel leaks.

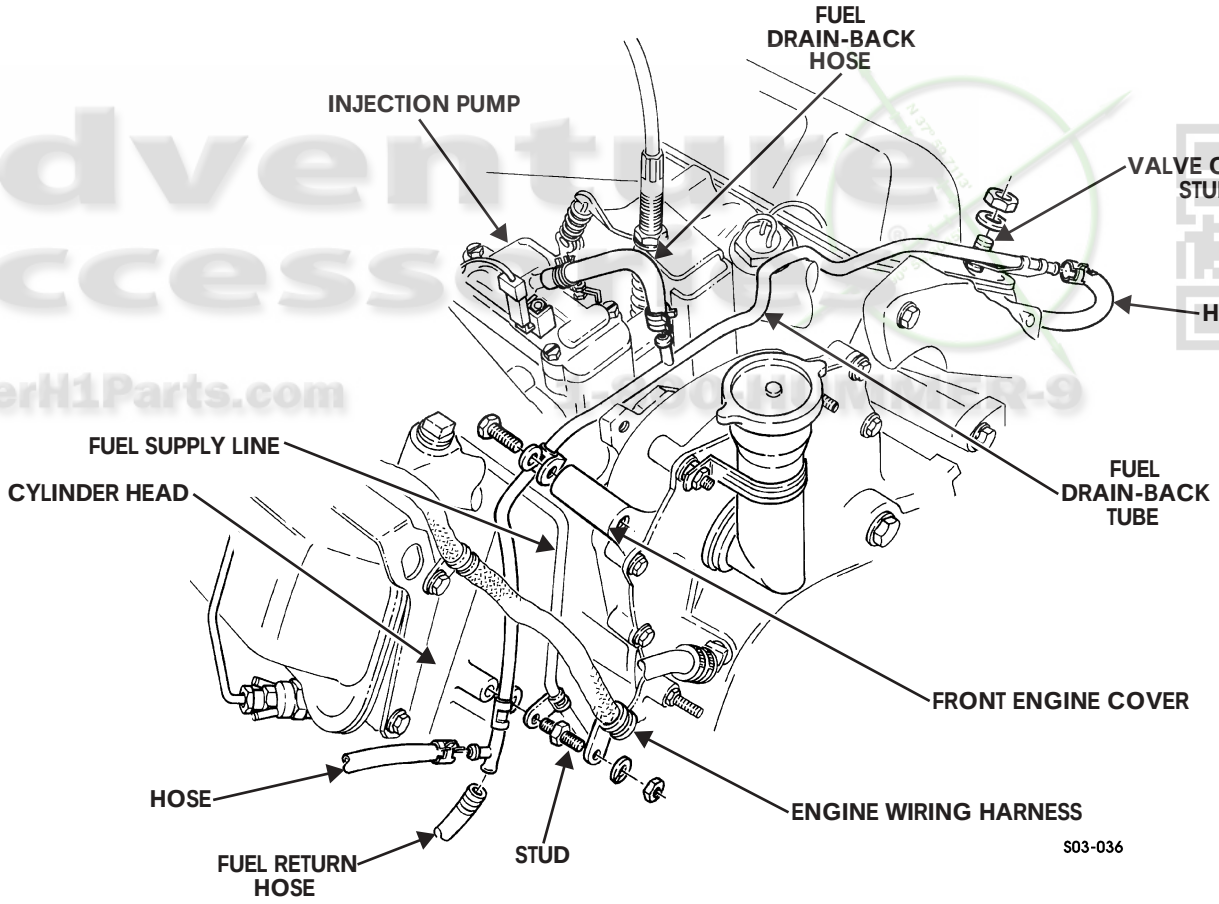

Figure 3-45: Fuel Drain-Back Tube

GLOW PLUG REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Disconnect connector from glow plug (Figure 3-46).
3. Remove glow plug from cylinder head.

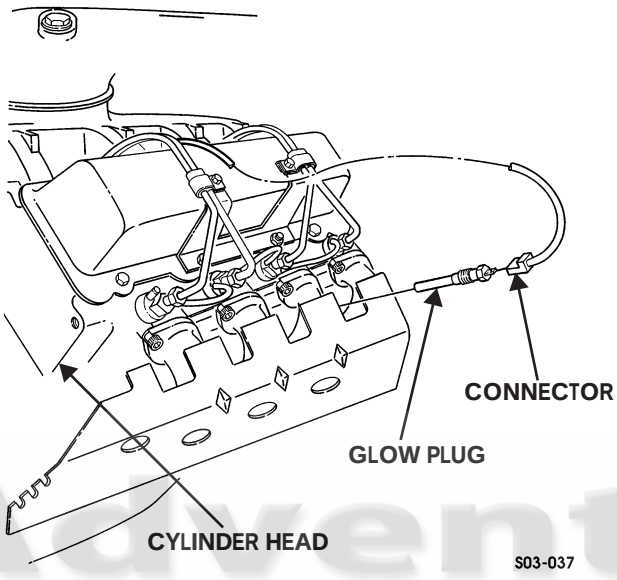

Figure 3-46: Glow Plug

Installation

1. Install glow plug on cylinder head. Tighten glow plug to 8-12 lb-ft (11-16 N•m) (Figure 3-46).
2. Connect connector to glow plug.
3. Connect battery ground cable.

FUEL INJECTION LINES BRACKET REPLACEMENT

Right Fuel Injection Lines Bracket Replacement

Removal

1. Remove engine access covers.
2. Remove air horn.
3. Remove two screw-assembled washers and three clamps from bracket (Figure 3-47).
4. Remove two nuts, washers, and bracket from valve cover studs.

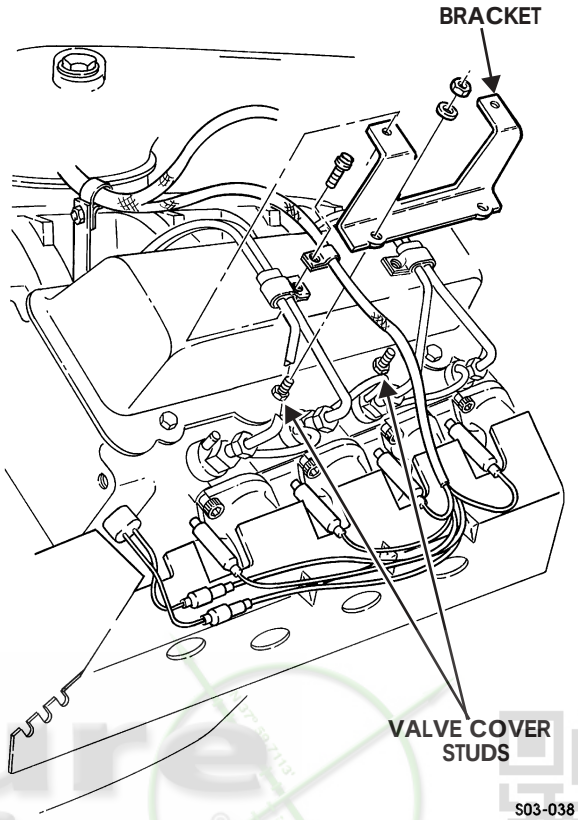

Figure 3-47: Right Fuel Injection Lines Bracket

Installation

1. Install bracket on valve cover studs with two washers and nuts. Tighten nuts to 13-20 lb-ft (18-27 N•m) (Figure 3-47).
2. Install three clamps on bracket with two screw-assembled washers. Tighten screw-assembled washers to 3-4 lb-ft (4-5 N•m).
3. Install air horn.
4. Install engine access covers.

Left Fuel Injection Lines Bracket Replacement

Removal

1. Remove engine access covers.
2. Remove two screw-assembled washers and clamps from bracket (Figure 3-48).

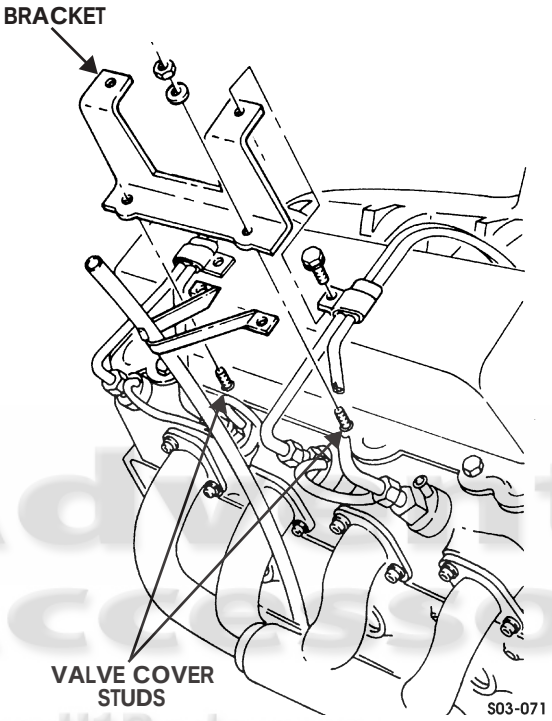

Figure 3-48: Left Fuel Injection Lines Bracket

3. Remove two screw-assembled washers and oil dipstick tube from bracket (Figure 3-49).

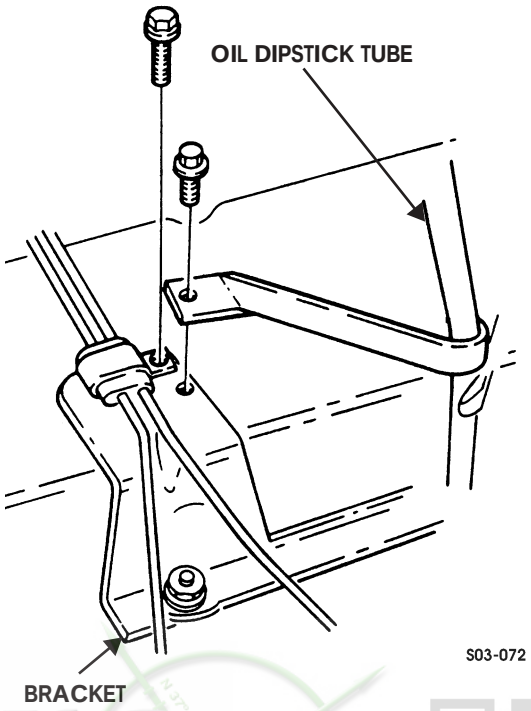

Figure 3-49: Oil Dipstick Tube and Bracket

4. Remove two nuts, washers, and bracket from valve cover studs (Figure 3-48).

Installation

1. Install bracket on valve cover studs with two washers and nuts. Tighten nuts to 13-20 lb-ft (18-27 N•m) (Figure 3-48).
2. Install oil dipstick tube on bracket with two screw-assembled washers. Tighten screw-assembled washers to 3-4 lb-ft (4-5 N•m) (Figure 3-49).
3. Install clamps on bracket with two screw-assembled washers. Tighten screw-assembled washers to 3-4 lb-ft (4-5 N•m) (Figure 3-48).
4. Install engine access covers.

FUEL INJECTION NOZZLE REPLACEMENT

Removal

1. Disconnect battery ground cables.

NOTE: If removing rear injection nozzle, perform steps 2 and 3.

2. Remove engine access covers.
3. Remove fuel return hose and cap from rear fuel injection nozzle (Figure 3-50).
4. Disconnect fuel return hoses from fuel injection nozzles (Figure 3-51).
5. Remove screw-assembled washer, clamp, and fuel injection lines from support bracket.
6. Disconnect fuel injection line nuts from fuel injection nozzles.
7. Using injection nozzle socket, remove fuel injection nozzle and gasket from cylinder head. Discard gasket.

Installation

NOTE: Apply antiseize compound to threads of injection nozzle and fuel return hose. Tighten rear fuel injection nozzles in accordance with step 2. Tighten rear fuel injection line nuts in accordance with step 4.

1. Install gasket and fuel injection nozzle into cylinder head. Using injection nozzle socket, tighten nozzle to 44-60 lb-ft (60-81 N•m) (Figure 3-51).

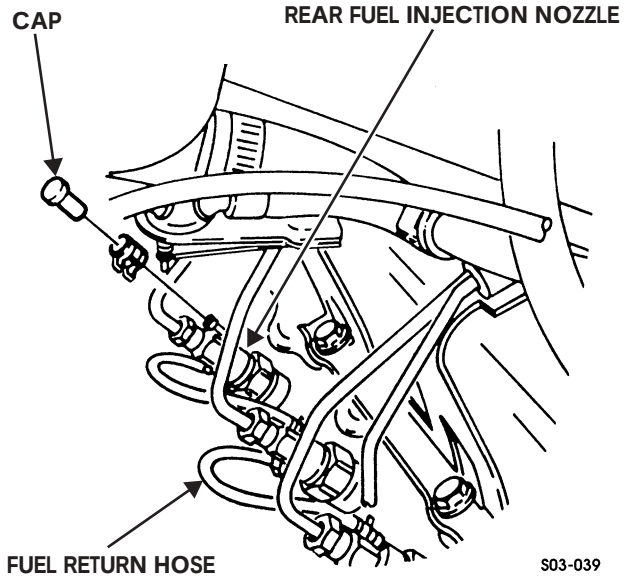

Figure 3-50: Rear Fuel Injection Nozzle

NOTE: If installing rear injection nozzles, perform steps 2, 6, and 11.

2. Using injection nozzle socket and 7/8-in. crowfoot wrench, tighten fuel injection nozzle to 44-60 lb-ft (60-81 N•m).
3. Install two fuel injection line nuts on fuel injection nozzles.
4. Using 19 mm crowfoot wrench, tighten fuel injection line nuts to 20 lb-ft (27 N•m).
5. Install clamp and fuel injection lines on support bracket with screw-assembled washer.
6. Install fuel return hose and cap on rear fuel injection nozzle (Figure 3-50).
7. Connect two fuel return hoses to fuel injection nozzles (Figure 3-51).
8. Bleed lines.
9. Connect battery ground cable.
10. Start engine and check for fuel leaks.
11. Install engine access covers.

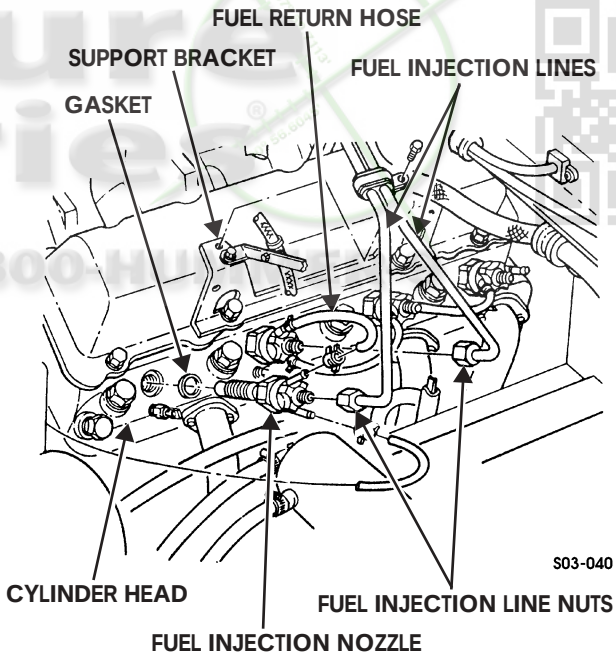

Figure 3-51: Fuel Return Hoses and Injection Nozzles

FUEL INJECTION LINES MAINTENANCE

Removal

1. Remove intake manifold.
2. Remove fuel injection pump boot.
3. Disconnect eight fuel injection lines from fuel injection nozzles (Figure 3-52).

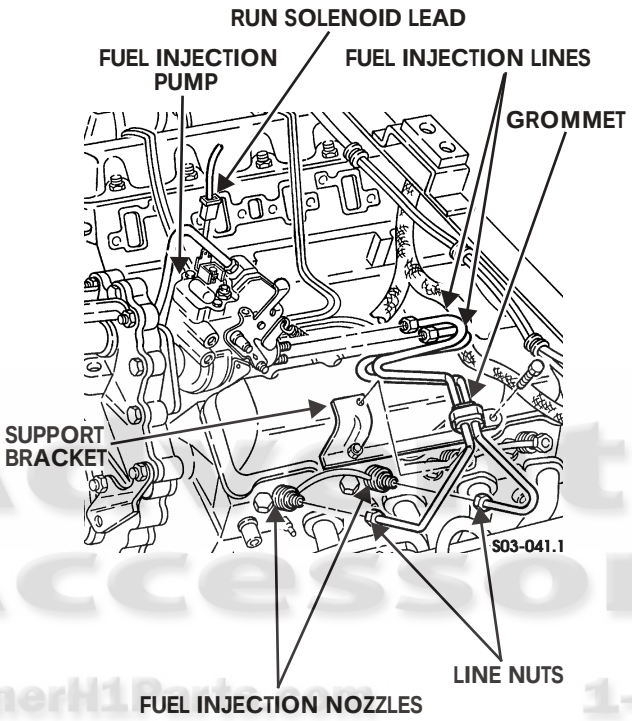

Figure 3-52: Fuel Injection lines

4. Remove screw-assembled washer, clamp, and fuel injection lines from support bracket.

NOTE: Tag fuel injection lines by cylinder number.

5. Disconnect fuel injection lines from fuel injection pump (Figure 3-52).
6. Remove clamp and two grommets from fuel injection lines.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect fuel injection lines for cracks, bends, or damage (Figure 3-52).
2. Inspect grommets.

Installation

1. Install two grommets and clamp on fuel injection lines (Figure 3-52).
2. Install eight fuel injection lines on fuel injection pump and fuel injection nozzles (Figure 3-52).

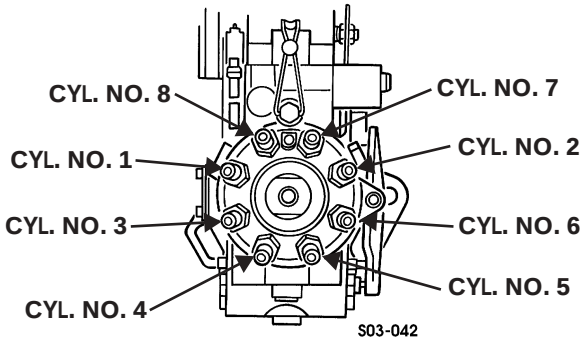

Figure 3-53: Fuel Injection Lines Hookup

3. Using 16 mm crowfoot, tighten fuel injection line nuts to 20 lb-ft (27 N•m) (Figure 3-52).
4. Install clamp and fuel injection lines on support bracket with screw-assembled washer. Tighten screw-assembled washer to 3-4 lb-ft (4-5 N•m).

Bleeding

1. Loosen eight fuel injection line nuts at injection nozzles (Figure 3-53).
2. Disconnect run solenoid lead (Figure 3-52).

CAUTION: *To avoid starter damage, do not operate starter continuously for more than 20 seconds. Wait 10 to 15 seconds between periods of operation.*

3. Crank engine until fuel exits from all fuel injection lines.
4. Using 19 mm crowfoot, tighten fuel injection line nuts to 20 lb-ft (27 N•m).
5. Connect run solenoid lead.
6. Install fuel injection pump boot.
7. Install intake manifold (Section 2).
8. Start engine and check for fuel leaks.

DIESEL FUEL INJECTION PUMP

Removal

1. Remove engine oil filler neck and cap.
2. Remove air horn and intake hoses at intake manifold.
3. Drain engine coolant.
4. Disconnect fuel lines at injectors. Then disconnect fuel line clamps and brackets from intake manifold and valve covers.
5. Remove intake manifold and gaskets. Discard gaskets as they are not reusable. Clean manifold and cylinder gasket surfaces
6. Remove clip attaching accelerator cable to pump lever (Figure 3-54).
7. Disconnect wires at kickdown switch, run solenoid, and cold advance solenoid (Figure 3-55). Then remove throttle position sensor.
8. Disconnect drainback and inlet hoses at injection pump (Figure 3-55).
9. Disconnect injector fuel lines at pump. Tag lines for assembly reference if desired.
10. Disconnect accelerator cable at pump throttle shaft.
11. Remove throttle return spring from throttle shaft lever.
12. Remove bolts attaching injection pump driven gear to pump. Remove bolts through oil filler neck opening in adapter plate. Rotate crankshaft to bring bolts into position for removal.

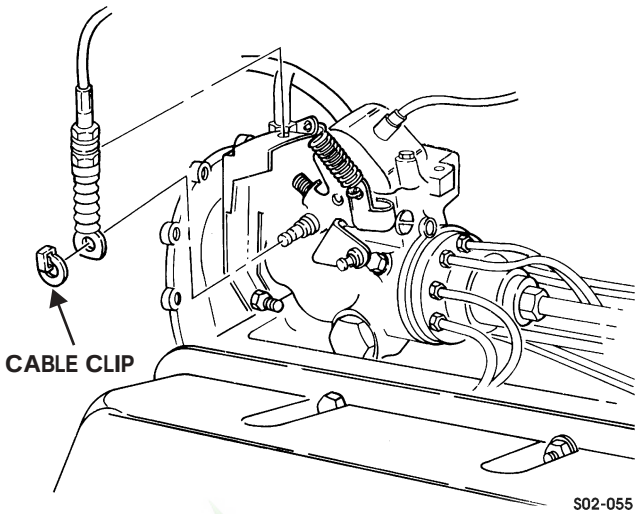

Figure 3-54: Cable Clip

13. Remove pump attaching nuts and washers. Then remove pump by sliding it off front cover studs (Figure 3-56). Remove pump gasket afterward.

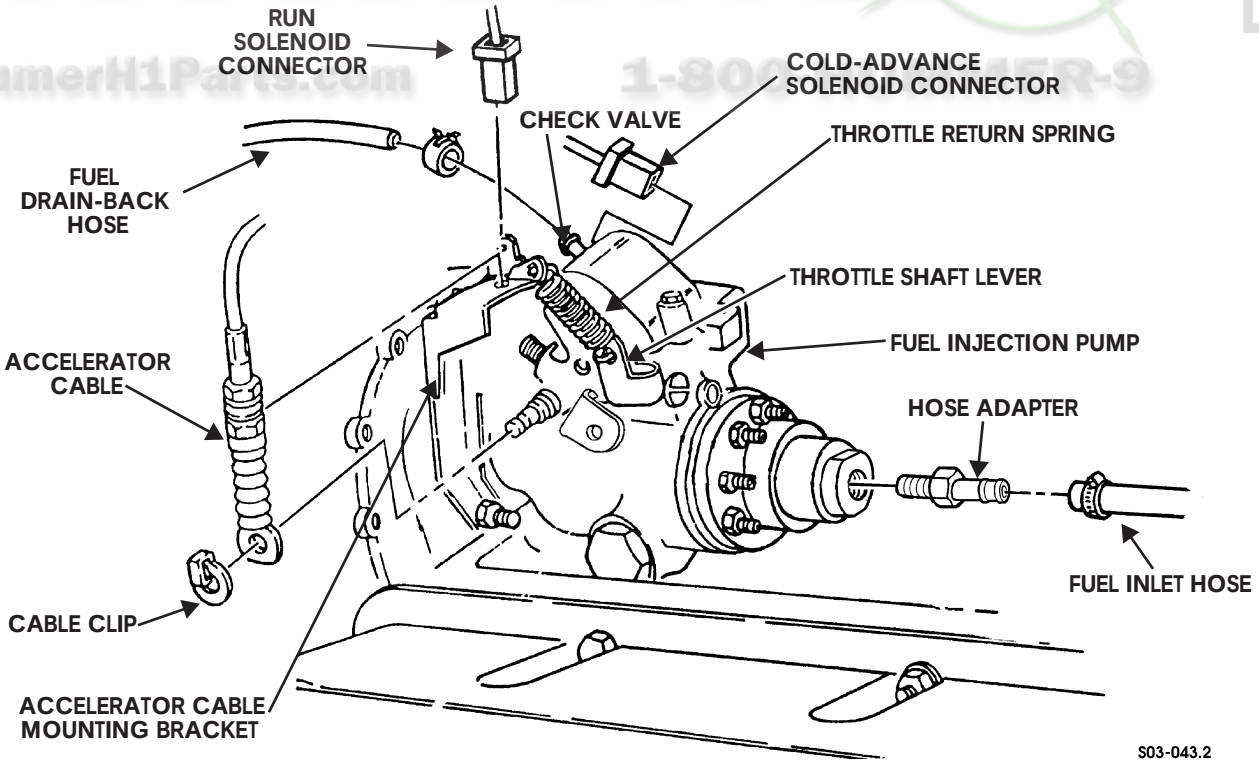

Figure 3-55: Fuel Injection Pump Connector

Installation

1. Install pump gasket on front cover studs. Then slide pump onto studs.
2. Align pin on pump shaft with slotted hole in pump driven gear.
3. Align timing marks on injection pump and front cover.
4. Install injection pump retaining washers and nuts. Tighten nuts to 20 lb-ft (25 N•m) torque. Be sure timing mark alignment is not disturbed as nuts are tightened.
5. Verify that timing marks on pump drive and driven gears are aligned. Also be sure slot at rear of driven gear is at 6 O'clock position (Figure 3-57).
6. Align pump driven gear and install gear attaching bolts. Tighten bolts to 17 lb-ft (23 N•m) torque.
7. Install throttle position sensor and connect solenoid wires.
8. Connect fuel drainback and inlet lines to pump.
9. Connect fuel injector lines to pump and injectors. Tighten line fittings to 19 lb-ft (26 N•m) torque.
10. Install throttle return spring and connect accelerator cable to throttle lever.
11. Coat new intake manifold gaskets with Permatex High Tack and position gaskets on cylinder heads. Allow gasket material to set up for a few minutes before proceeding.
12. Install intake manifold. Tighten manifold fasteners to 31 lb-ft (42 N•m) torque.

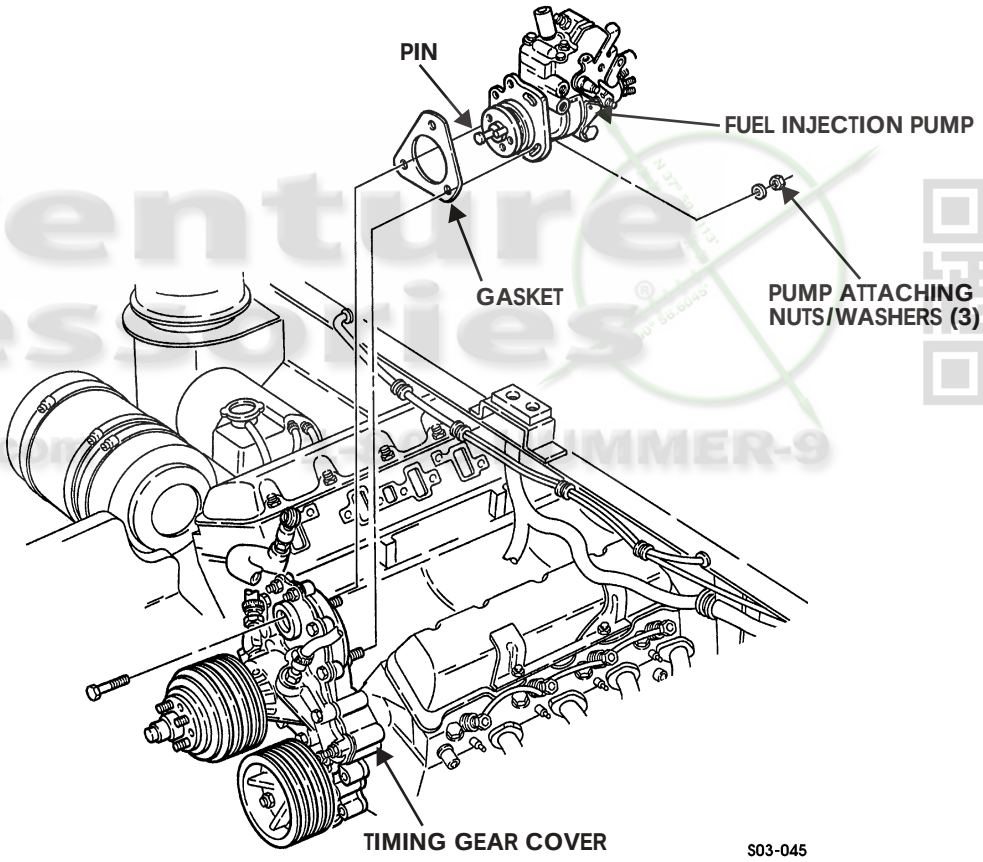

Figure 3-56: Injection Pump Remove/Installation

13. Install injector line clamps and clamp nuts. Tighten nuts to 19 lb-ft (25 N•m) torque.
14. Install air horn and air intake hoses.
15. Install oil filler neck and cap.
16. Fill and bleed cooling system.
17. Start engine and check operation. Bleed injectors if necessary.

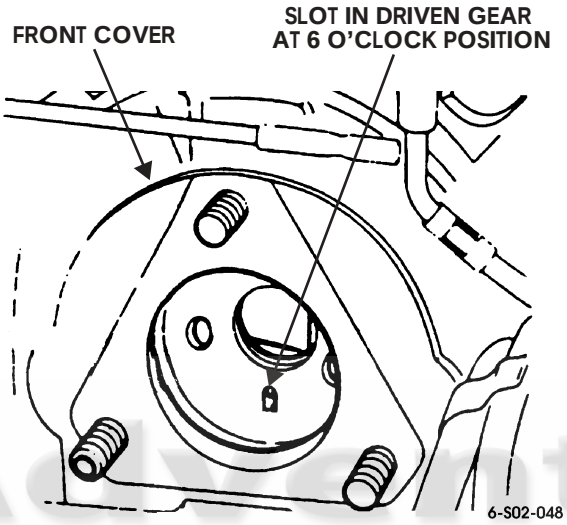

Figure 3-57: Checking Injection Pump Driven Gear Slot Position

FUEL INJECTION PUMP COVER MAINTENANCE

Removal

1. Disconnect battery ground cable.
2. Disconnect fuel drain-back hose from fuel injection pump (Figure 3-58).
3. Disconnect run and cold-advance solenoid leads from fuel injection pump.

CAUTION: *Clean fuel injection pump body thoroughly before removing attaching components to prevent pump contamination. Keep work area clean, well-ventilated, and free from blowing dirt or dust.*

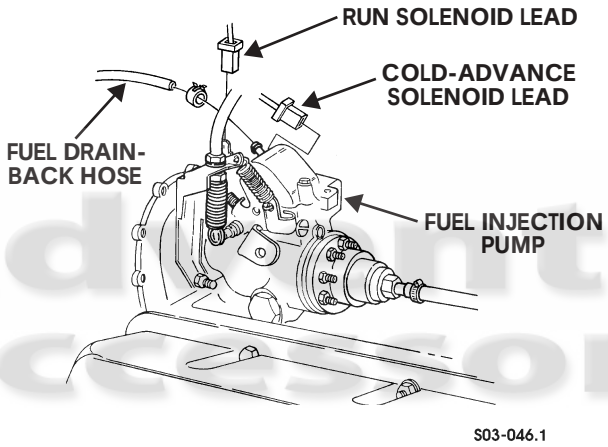

Figure 3-58: Fuel Drain-Back Hose Connection at Pump

4. Remove three screws, lockwashers, washers, cover, and gasket from pump housing. Disconnect ground strap. Discard lockwashers and gasket (Figure 3-59).

NOTE: Perform step 5 only if cover is being replaced.

5. Remove check valve and O-ring from cover. Discard O-ring.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect check valve (Figure 3-59).

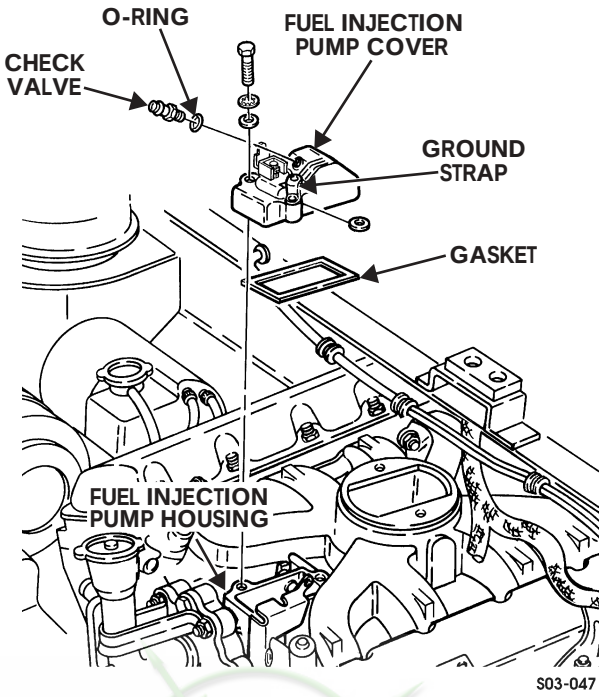

Figure 3-59: Fuel Injection Pump Housing

Installation

NOTE: Perform step 1 only if cover was replaced.

1. Install O-ring and check valve in cover (Figure 3-59).
2. Install gasket and cover on fuel injection pump housing with three washers, lockwashers, and screws, and secure ground strap. Tighten screws to 35-44 lb-in. (4-5 N•m).
3. Connect fuel drain-back hose to fuel injection pump (Figure 3-58).
4. Connect battery ground cable.

CAUTION: *If no clicking noise is present, the linkage may be jammed in the wide-open throttle position. Engine damage may result.*

5. Place keyed ignition in RUN position. Listen for a clicking noise when connecting and disconnecting run solenoid lead to fuel injection pump. If no clicking noise is present, remove and reinstall cover. If clicking noise is present, connect run and cold-advance solenoid leads to fuel injection pump.
6. Start engine and check for fuel leaks.

FUEL INJECTION PUMP RUN SOLENOID REPLACEMENT

Removal

NOTE: Keep work area clean, well-ventilated, and free from blowing dirt or dust.

1. Remove fuel injection pump cover (Figure 3-60).
2. Remove two locknuts, ground strap, terminal, two lockwashers, nuts, lockwashers, washers, and seals from two run solenoid studs. Discard locknuts and lockwashers.
3. Remove run solenoid from injection pump cover.

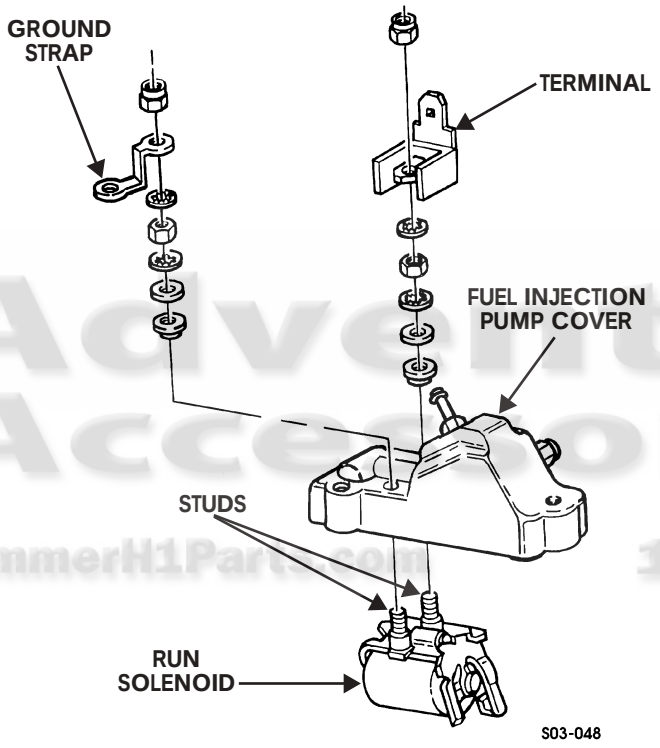

Figure 3-60: Fuel Injection Pump Run Solenoid

Installation

1. Install run solenoid in injection pump cover (Figure 3-60).
2. Secure run solenoid to injection pump cover with two seals, washers, lockwashers, nuts, lockwashers, terminal, ground strap, and two locknuts. Tighten locknuts to 35 lb-in. (4 N•m).
3. Install fuel injection pump cover.

FUEL INJECTION PUMP COLD-ADVANCE SOLENOID REPLACEMENT

Removal

NOTE: Keep work area clean, well-ventilated, and free from blowing dirt or dust.

1. Remove fuel injection pump run solenoid.
2. Remove fuel return fitting and O-ring from injection pump cover. Discard O-ring (Figure 3-61).
3. Remove locknut, terminal, lockwasher, nut, lockwasher, washer, and seal from cold-advance solenoid stud. Discard lockwasher, locknut, and seal.
4. Remove cold-advance solenoid from injection pump cover.

Installation

1. Install cold-advance solenoid in injection pump cover (Figure 3-61).
2. Secure cold-advance solenoid to injection pump cover with seal, washer, lockwasher, nut, lockwasher, terminal, and locknut. Tighten locknut to 35 lb-in. (4 N•m).
3. Install O-ring and fuel return fitting in injection pump cover.
4. Install fuel injection pump run solenoid.

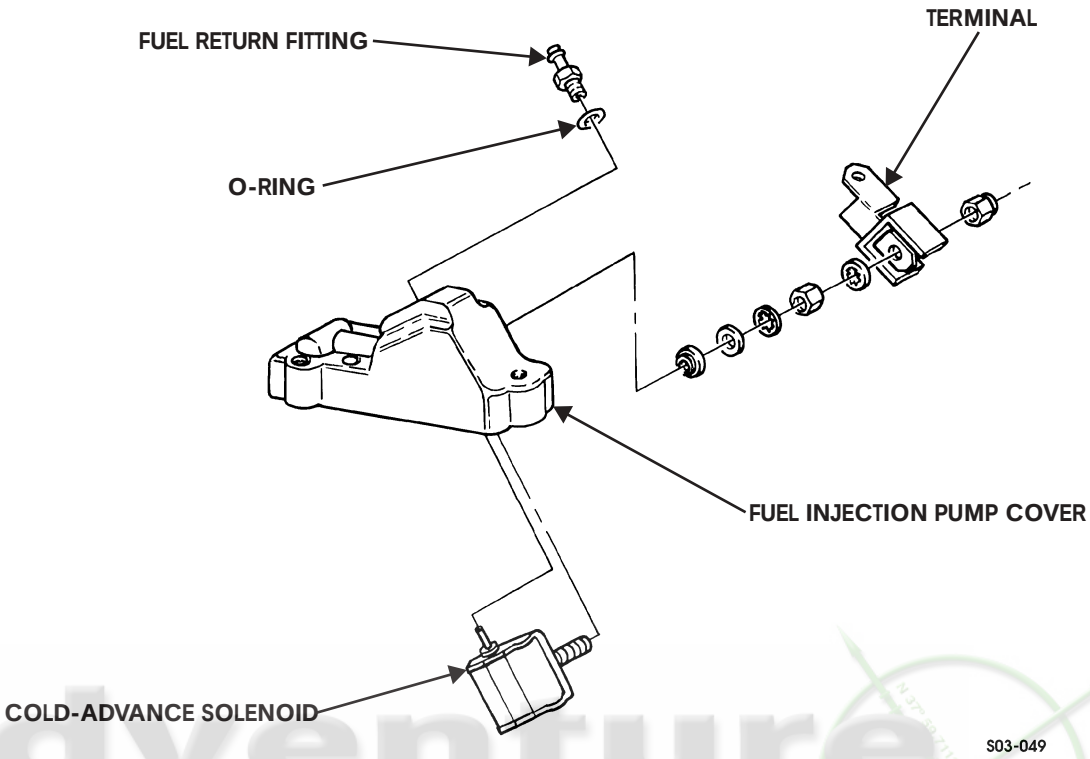

Figure 3-61: Fuel Injection Pump Cold-Advance Solenoid

ENGINE IDLE SPEED ADJUSTMENT

Adjustment

Engine idle speed should be set to 625-675 rpm. To adjust idle speed, turn idle speed adjusting screw on throttle shaft lever (Figure 3-62). Turn adjusting screw clockwise to increase rpm, or counterclockwise to decrease rpm.

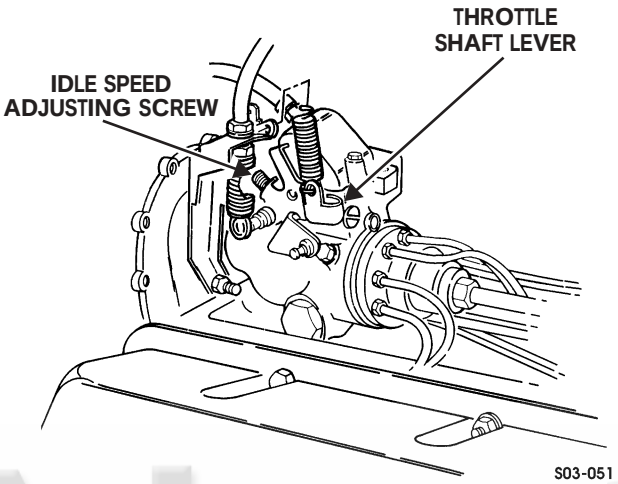

Figure 3-62: Idle Speed Adjusting Screw

FAST IDLE SOLENOID AND BRACKET REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Disconnect lead from top of fast idle solenoid (Figure 3-63).
3. Remove two capscrews, washers, solenoid, and bracket from accelerator cable bracket.

Installation

1. Install fast idle solenoid and bracket on accelerator cable bracket with two washers and capscrews (Figure 3-63).
2. Connect fast idle solenoid lead to top of solenoid.
3. Connect battery ground cable.

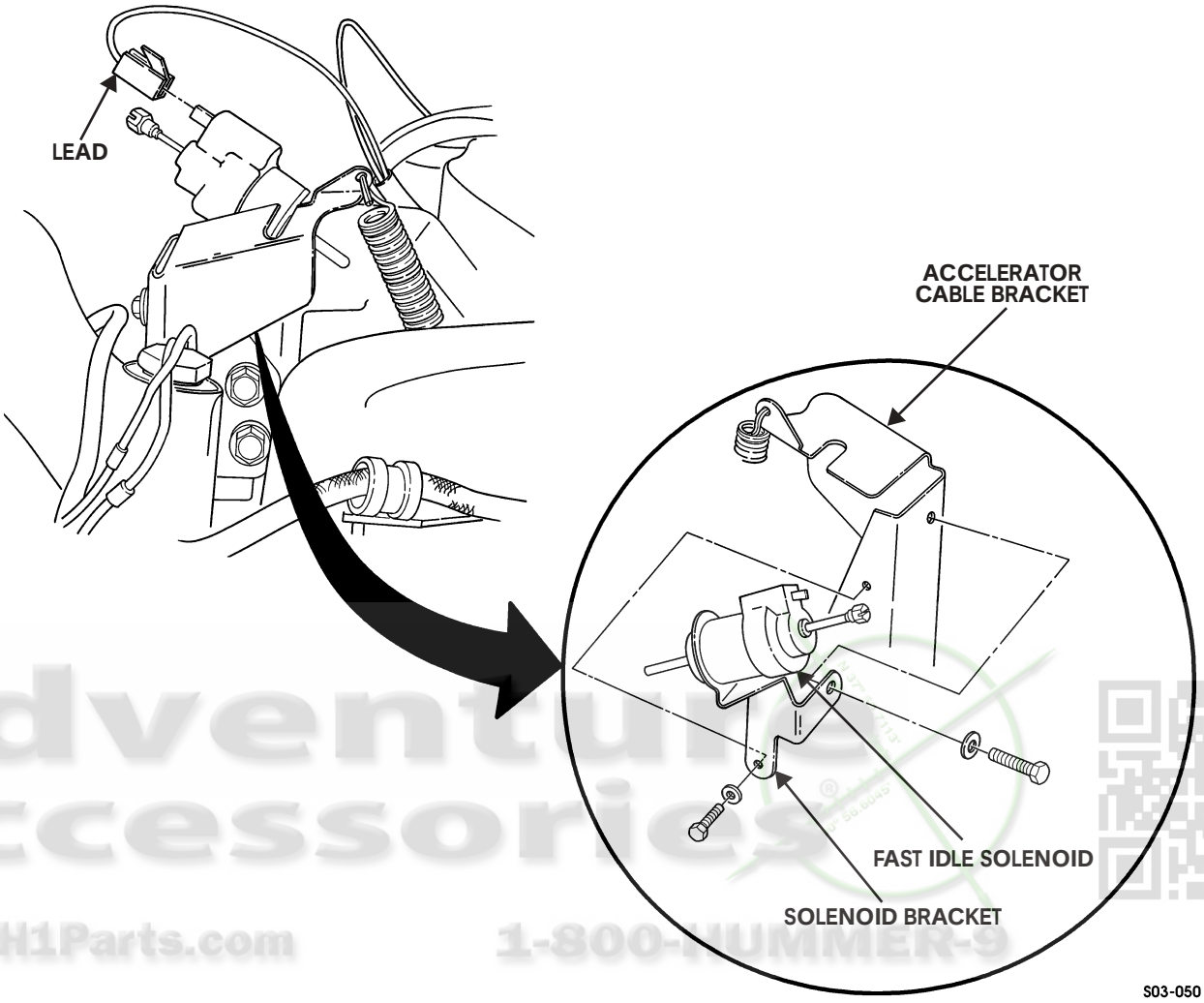

Figure 3-63: Fast Idle Solenoid and Bracket

ACCELERATOR PEDAL REPLACEMENT

Removal

1. Remove cotter pin, washer, pin, accelerator pedal, and spring from accelerator rod. Discard cotter pin (Figure 3-64).

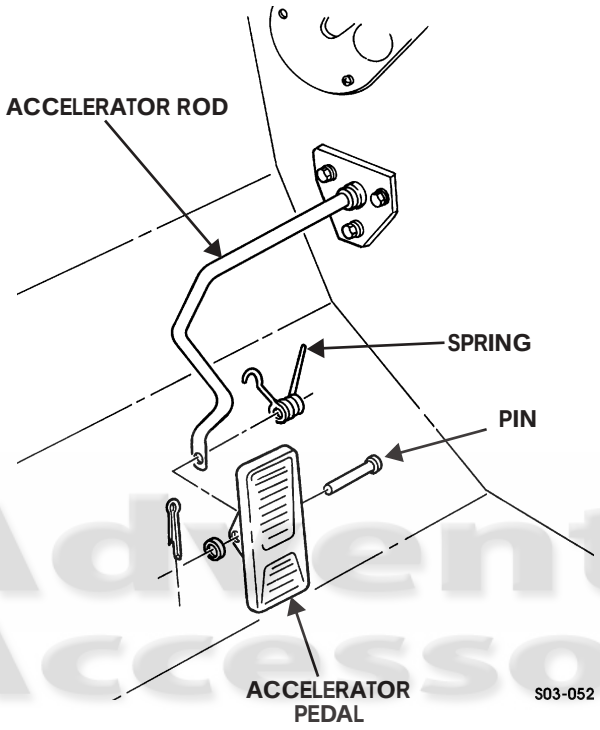

Figure 3-64: Accelerator Pedal

Installation

1. Install accelerator pedal and spring on accelerator rod with pin, washer, and cotter pin (Figure 3-64).
2. Start engine and check for proper accelerator operation.

ACCELERATOR PEDAL ASSEMBLY REPLACEMENT

1. Disconnect the driver door check strap.
2. Remove the driver seat from the vehicle.
3. Remove the steering column closeout panel.
4. Disconnect the accelerator cable at the pedal connecting arm (Figure 3-65).

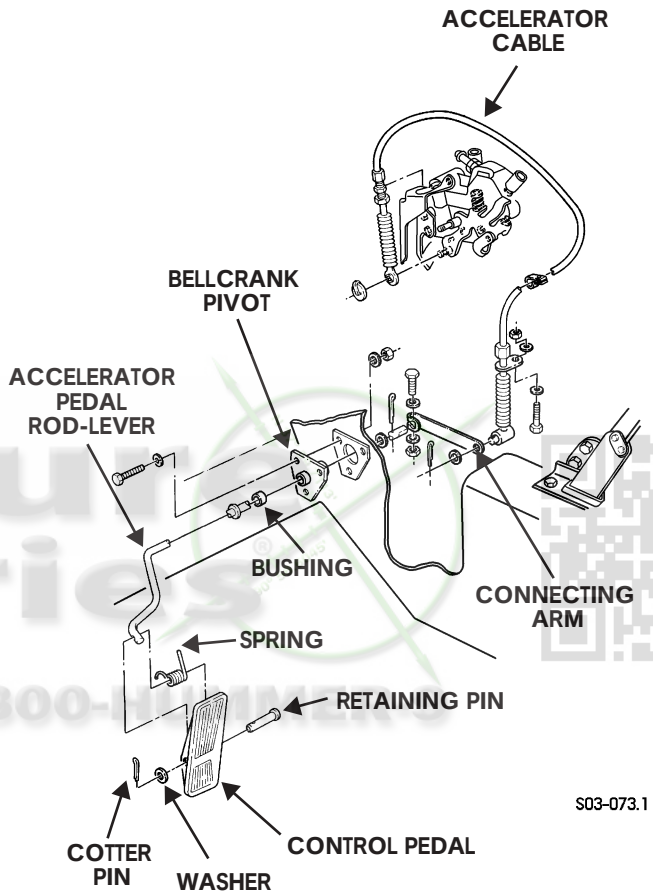

Figure 3-65: Accelerator Linkage

5. On models with CTIS, remove the CTI control knob.
6. Remove the parking brake and shift control panel. Move the parking brake lever and shift levers into an upright (vertical) position to allow panel removal.
7. Remove the right hand, inner front kick panel and seat belt latch.
8. Remove the bolts attaching the bellcrank pivot to the dash panel. On models where the bolts are secured by nuts, have a helper assist in bolt and nut removal. The nuts are accessible from under the vehicle.
9. Work the pedal rod and connecting arm through the hole in the dash and remove the pedal assembly from the vehicle.
10. Transfer the pedal, spring and pin to the replacement assembly.

11. Install the replacement accelerator pedal assembly. Tighten the bellcrank bolts to 10 lb-ft (14 N•m) torque.
12. Connect the accelerator cable to the pedal connecting arm with a new cotter pin.
13. Install the inner kick panel and seat belt latch.
14. Install the CTIS control knob, if equipped.
15. Install the parking brake and shift control panel.
16. Install the steering column closeout panel.
17. Install the driver seat.
18. Connect the driver door check strap.

Accelerator Cable Adjustment

1. Loosen two accelerator cable adjusting nuts on engine bracket (Figure 3-66).
2. Depress accelerator pedal, and hold throttle shaft lever in full throttle position.
3. Adjust accelerator cable adjusting nuts so cable end holds throttle shaft lever in full throttle position. Tighten adjusting nuts.
4. Release accelerator pedal. Ensure throttle shaft lever returns to idle position.
5. Install engine access covers.
6. Start engine and check for proper accelerator operation.

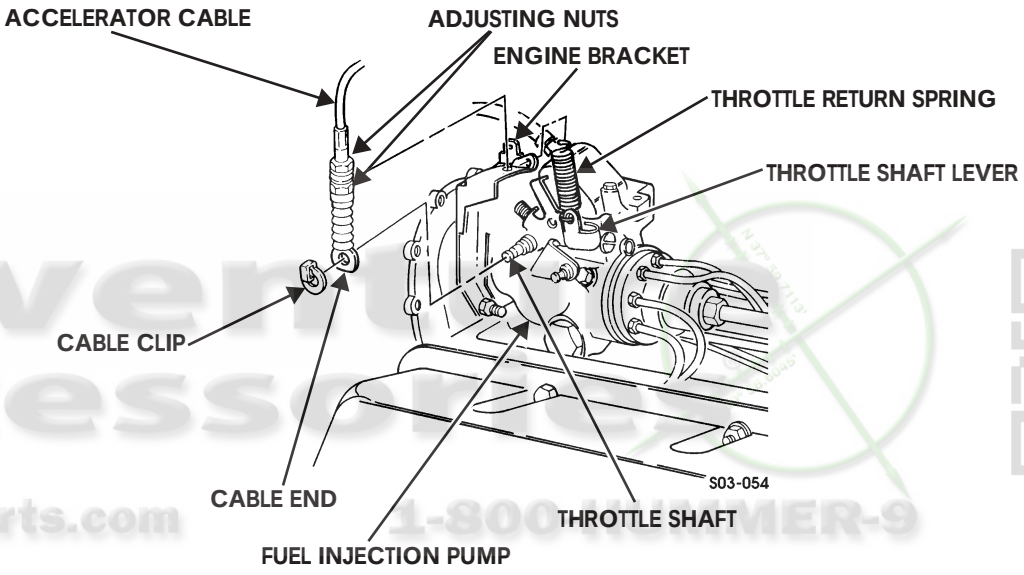

Figure 3-66: Throttle Shaft Lever

ACCELERATOR CABLE MOUNTING BRACKET MAINTENANCE

Removal

1. Loosen two adjusting nuts and disconnect accelerator cable from engine bracket (Figure 3-67).

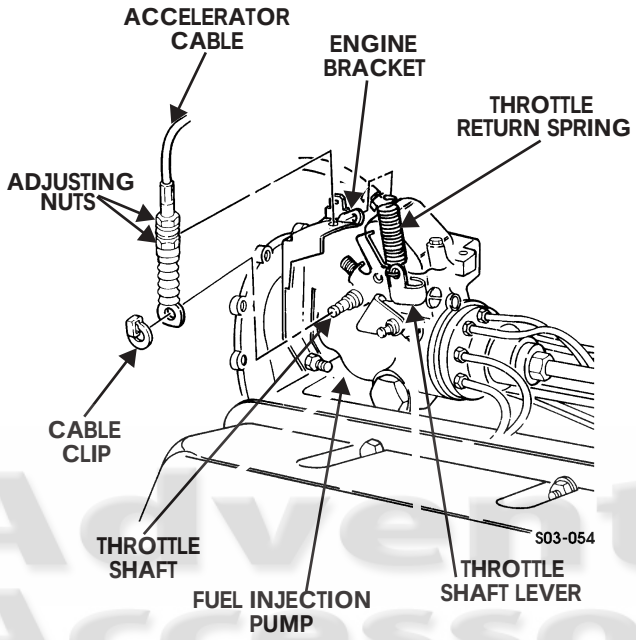

Figure 3-67: Accelerator Cable Mounting Bracket

2. Disconnect throttle return spring from engine bracket.
3. Remove cable clip and disconnect accelerator cable from throttle shaft.
4. Remove nut, washer, two capscrews, and bracket from fuel injection pump and stud (Figure 3-68).

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect throttle return spring (Figure 3-67).

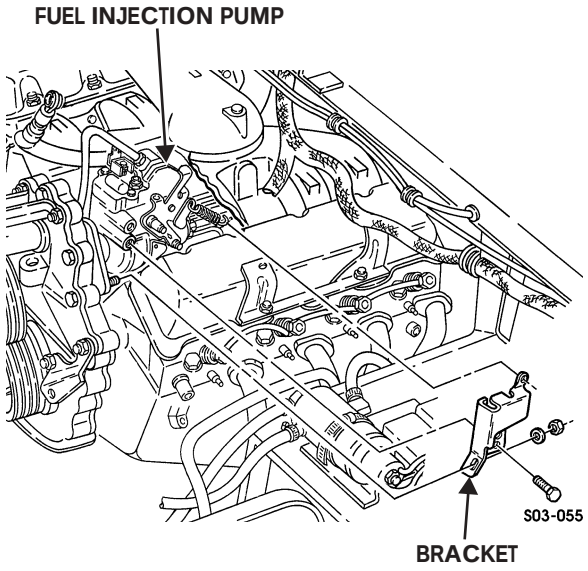

Figure 3-68: Fuel Injection Pump And Bracket

Installation

1. Install bracket on fuel injection pump and stud with two capscrews, washer, and nut. Tighten capscrews to 13 lb-ft (18 N•m) (Figure 3-68).
2. Position throttle shaft lever to full throttle position. Install accelerator cable on throttle shaft with cable clip (Figure 3-67).
3. Connect throttle return spring to engine bracket.
4. Install accelerator cable on engine bracket and tighten two adjusting nuts.
5. Adjust accelerator linkage.

FUEL SYSTEM CLEANING

Diesel Engine Fuel System Contamination

General

Diesel fuel systems are susceptible to fungi and other micro-organism infestation when water is present. These fungi can grow into long strings or large globules anywhere in the fuel system. Due to the amount of water, the most prevalent location to find these fungi is in the fuel tank.

The growths appear slimy and may be black, green, or brown. These are introduced through refueling with an unfiltered or aged fuel source.

Fungi feed on the fuel and need only trace amounts of minerals and water. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism.

The most common symptom is a loss of performance due to fuel filter clogging. Infestation can also show up as corrosion of metal parts such as injectors, fuel pumps, and steel lines.

Warning: To avoid personal injury do not come into physical contact with biocide agents, cleaners, or additives used to remove fungi or micro-organisms.

If fungi have caused fuel system problems, sterilize the system with a diesel fuel system biocide or cleaning agent. Follow manufacturer's instructions. Do not overdose the system.

Use of biocides while operating under heavy loads such as towing a trailer is not recommended. Such use is permissible, but no additional biocide should be used when refueling during such operations.

Contaminations that are severe or do not respond to biocides may require disassembly and steam-cleaning.

WARNING: Never drain or store diesel fuel in an open container due to the possibility of a fire or explosion.

Water Contamination

1. Disconnect battery to prevent accidental spark or prevent an attempt to start vehicle.
2. Remove fuel cap from filler tube.
3. Remove fuel tank drainplug, and drain fuel into appropriate container (Figure 3-69).

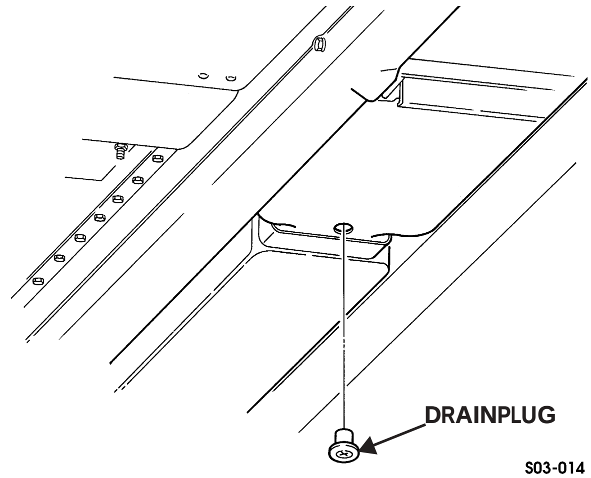

Figure 3-69: Fuel Tank

4. After fuel has drained, replace drainplug and tighten. Do not overtighten plug, as tank opening edges are sharp enough to damage drainplug if overtightened.
5. Remove fuel return line at engine and route into appropriate container (Figure 3-70).
6. Reconnect battery.
7. Add fresh fuel to tank.
8. Energize fuel pump by jumping oil pressure switch connector to flush fuel from filter and injection pump.
9. Allow fuel to flush for two minutes or until fuel appears clean and clear.
10. Remove jumper and reconnect oil pressure switch connection. Reconnect fuel return line.
11. Start engine and allow to idle for 10-15 minutes to bleed any air or water pockets from system.
12. Test drive vehicle to confirm proper performance.
13. Dispose of contaminated fuel properly.

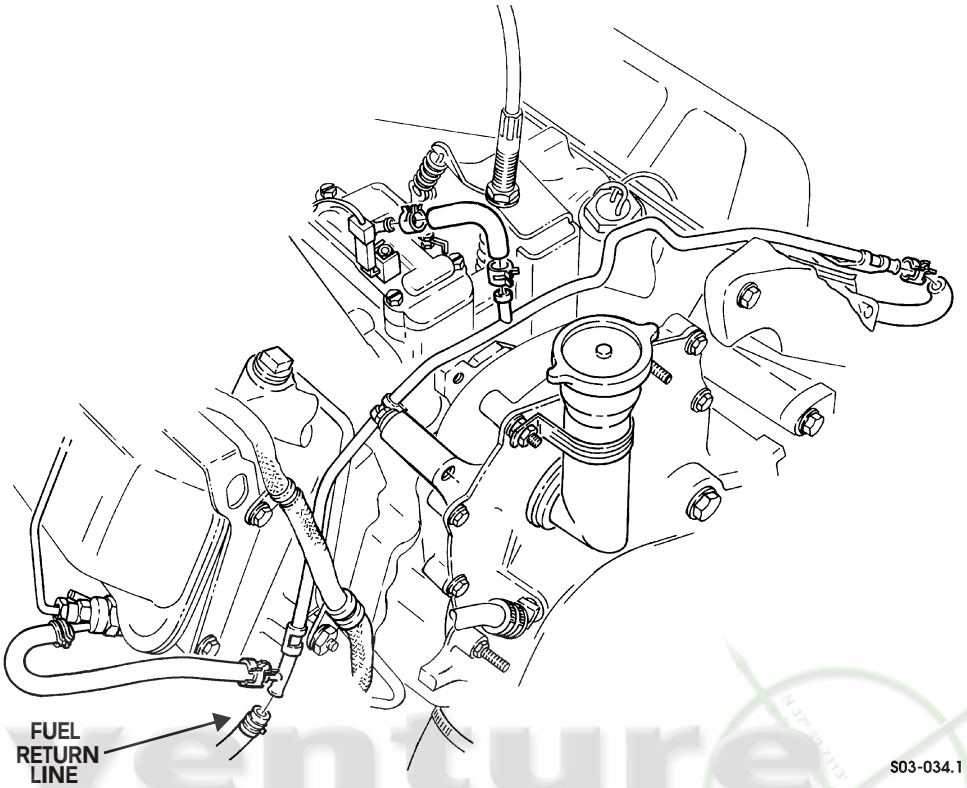

Figure 3-70: Fuel Return Line

Removal of Gasoline Contamination

Vehicle Runs

1. Follow procedure for draining tank detailed in Water Contamination.
2. Refill with fresh fuel and start engine. Allow to run at idle speed for 10-15 minutes to eliminate fuel in fuel filter and injection pump.

Vehicle Will Not Run

Completely drain and flush total system as detailed in Water Contamination.

System Cleaning and Flushing for Other Substances

1. Drain fuel tank as outlined for Water Contamination. Determine nature of contaminant if possible. If contaminant is soluble in solvents compatible with diesel fuel, flush with solvent, change fuel filter and flush with clean fuel to dilute solvent. If contaminant is not soluble in solvents compatible with diesel fuel, remove and clean or replace components as necessary.
2. After cleaning systems verify proper operation of vehicle fuel system by road test.

FUEL LEVEL SENDING UNIT REPLACEMENT

Removal

1. Remove fuel tank.
2. Remove five screws, lockwashers, and fuel level sending unit from fuel tank. Discard lockwashers (Figure 3-71).
3. Remove gasket from fuel level sending unit. Discard gasket.

Installation

1. Install gasket on fuel level sending unit (Figure 3-71).
2. Install fuel level sending unit into fuel tank. Do not bend float arm.
3. Align fuel level sending unit holes. Float must be pointed in same direction as fuel tank filler neck.
4. Secure fuel level sending unit to fuel tank with five lockwashers and screws. Tighten screws to 35 lb-in. (4 N•m).
5. Install fuel tank.
6. Check fuel gauge for proper operation.

EXHAUST SYSTEM DIAGNOSIS AND TROUBLESHOOTING

Leaking Exhaust Gases or Exhaust Noises

1. Check for rusted-through or damaged exhaust system components (pipes and muffler). Replace any damaged parts.
2. Check for loose or missing exhaust pipe fasteners. If fasteners are loose, torque to 37 lb-ft (50 N•m). Replace missing fasteners.
3. Check for leaking exhaust gaskets at crossover pipe and tailpipe. Replace leaking gaskets.
4. Check for leaking exhaust gases around exhaust manifolds. Replace any leaking exhaust manifold gaskets.

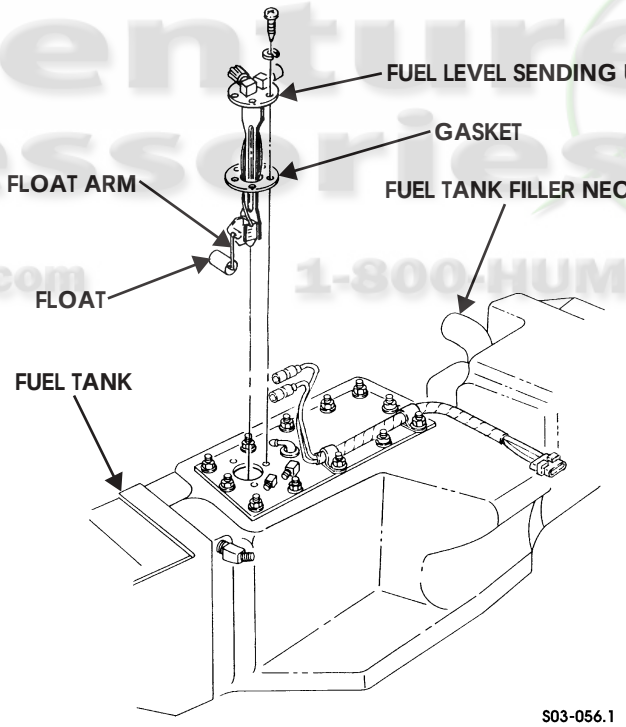

Figure 3-71: Fuel Level Sending Unit

MUFFLER

Muffler Replacement

Removal

1. Remove three locknuts, washers, capscrews, washers, muffler, and gasket from catalytic converter-to-muffler pipe assembly. Discard locknuts and gasket (Figure 3-72).
2. Remove four locknuts, washers, capscrews, washers, two retaining plates, muffler, and two reinforcements from insulators and mounting brackets. Discard locknuts.

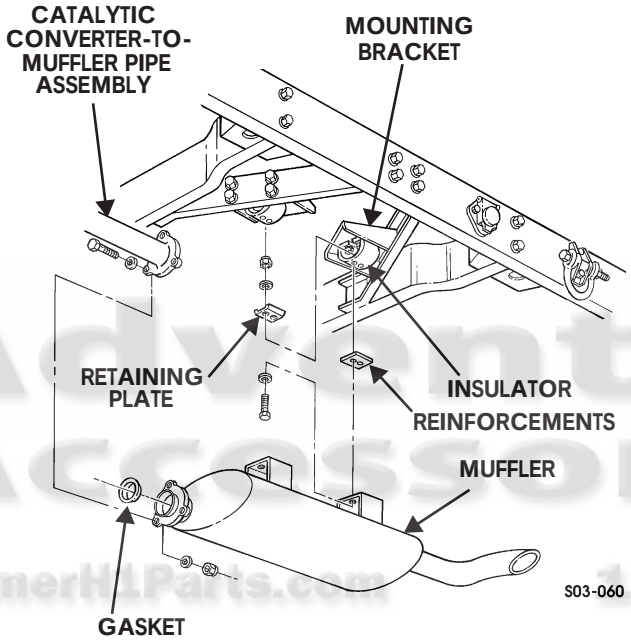

Figure 3-72: Muffler and Mounting Bracket

Installation

1. Install two reinforcements, muffler, and two retaining plates on insulators and mounting brackets with four capscrews, eight washers, and four locknuts. Tighten locknuts to 10 lb-ft (14 N•m) (Figure 3-72).
2. Install gasket and muffler on catalytic converter-to-muffler pipe assembly with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m).

Muffler Insulator Replacement

Removal

1. Remove muffler.
2. Remove four locknuts, washers, capscrews, washers, reinforcement plate, muffler insulator, and reinforcement from muffler bracket. Discard locknuts (Figure 3-73).

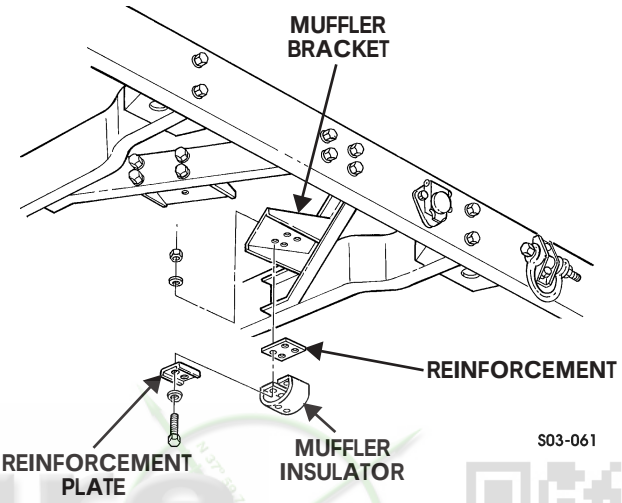

Figure 3-73: Muffler Insulator

Installation

1. Install reinforcement, muffler insulator, and reinforcement plate on muffler bracket with four capscrews, eight washers, and four locknuts. Tighten locknuts to 10 lb-ft (14 N•m) (Figure 3-73).
2. Install muffler.

Muffler Bracket Replacement

Removal

1. Remove muffler insulator.
2. Remove four locknuts, washers, capscrews, washers, and muffler bracket from frame rail. Discard locknuts (Figure 3-74).

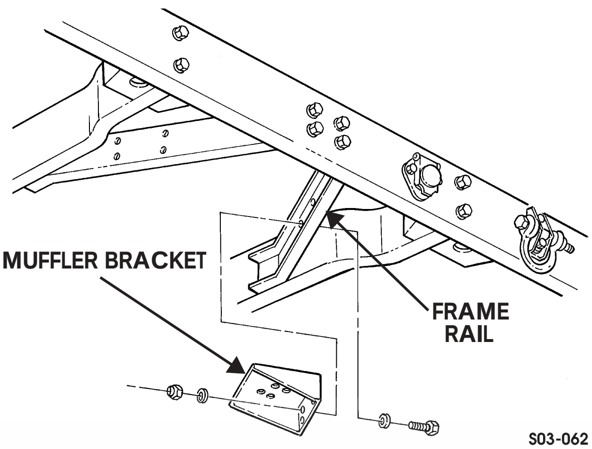

Figure 3-74: Muffler Bracket

Installation

1. Install muffler bracket on frame rail with four capscrews, eight washers, and four locknuts. Tighten capscrews to 26 lb-ft (35 N•m) (Figure 3-74).
2. Install muffler insulator.

CROSSOVER PIPE REPLACEMENT

Removal

1. Remove engine access covers.
2. Remove right exhaust manifold rear heat shield.
3. Remove three locknuts, washers, capscrews, washers, crossover pipe, and gasket from right exhaust manifold. Discard locknuts and gasket (Figure 3-75).
4. Remove three locknuts, washers, capscrews, washers, crossover pipe, and gasket from catalytic converter. Discard locknuts and gasket.
5. Remove three locknuts, washers, capscrews, washers, crossover pipe, and gasket from left exhaust manifold. Discard locknuts and gasket.

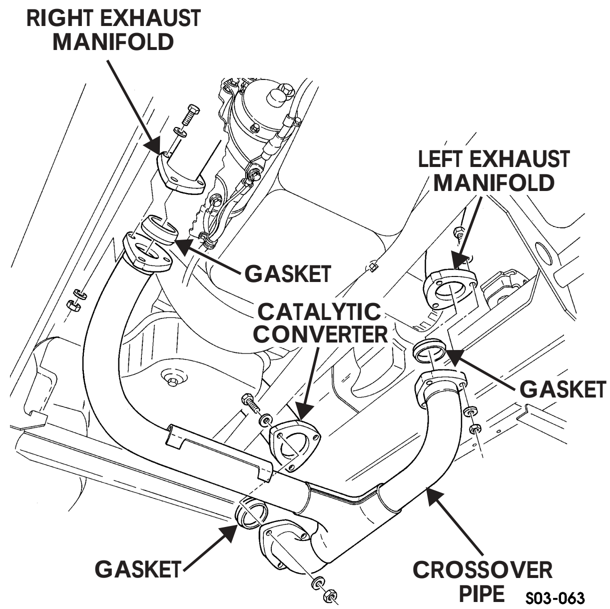

Figure 3-75: Crossover Pipe

Installation

1. Install gasket and crossover pipe on left exhaust manifold with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m) (Figure 3-75).
2. Install gasket and crossover pipe on catalytic converter with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m).
3. Install gasket and crossover pipe on right exhaust manifold with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m).
4. Start engine and check for exhaust leaks.
5. Install right exhaust manifold rear heat shield.
6. Install engine access covers.

CATALYTIC CONVERTER

Catalytic Converter Support Bracket Maintenance

Removal

1. Remove catalytic converter.

NOTE: To prevent changing torque or damaging transfer case seal, hold bolt heads on transfer case securely.

2. Remove two locknuts, washers, and support bracket assembly from transfer case. Discard locknuts (Figure 3-76).

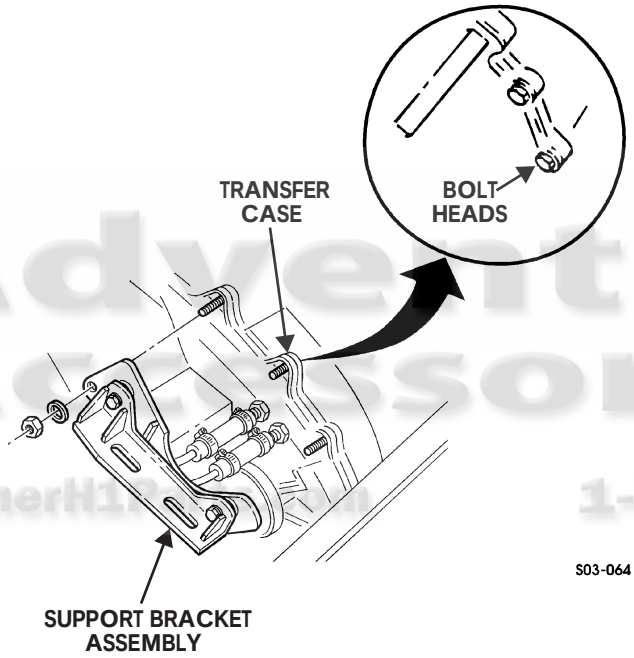

Figure 3-76: Catalytic Converter Support Bracket

Disassembly

1. Remove two locknuts, washers, capscrews, four washers, and mounting bracket from support plate. Discard locknuts (Figure 3-77).
2. Remove two insulators from mounting bracket.

Assembly

1. Install two insulators in mounting bracket (Figure 3-77).
2. Install mounting bracket and two washers on support plate with two capscrews, four washers and two locknuts. Tighten locknuts to 15 lb-ft (20 N•m).

Installation

NOTE: To prevent changing torque or damaging transfer case seal, hold bolt heads on transfer case secure.

1. Install support bracket assembly on transfer case with two washers and locknuts. Tighten locknuts to 15 lb-ft (20 N•m) (Figure 3-76).
2. Install catalytic converter.

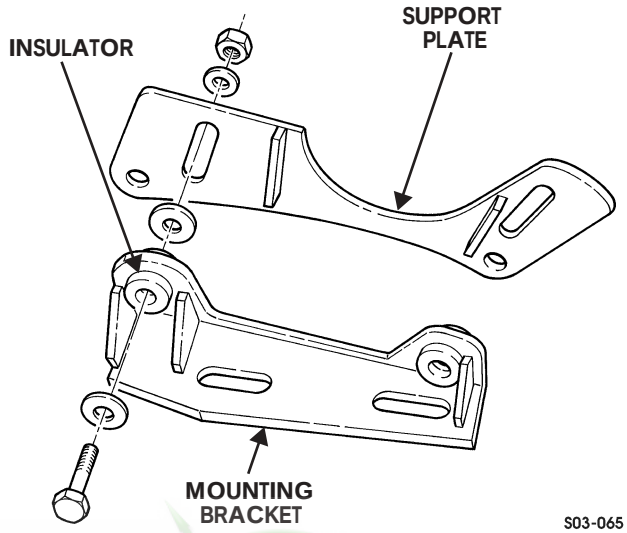

Figure 3-77: Support Plate and Mounting Bracket

Catalytic Converter Replacement

Removal

1. Remove two nuts, lockwashers, U-bolt, and clamp from mounting bracket. Discard lockwashers (Figure 3-78).
2. Remove four nuts, lockwashers, two U-bolts, heat shield, and two clamps from catalytic converter. Discard lockwashers.
3. Remove three locknuts, washers, capscrews, washers, catalytic converter, and gasket from crossover pipe. Discard locknuts and gasket.
4. Loosen clamp attaching exhaust heat shield to catalytic converter.
5. Remove two nuts, lockwashers, U-bolt, and clamp from support bracket on transfer case. Discard lockwashers.
6. Remove three locknuts, washers, capscrews, washers, catalytic converter, and gasket from catalytic converter-to-muffler pipe assembly. Discard locknuts and gasket.

Installation

1. Install gasket and catalytic converter on catalytic converter-to-muffler pipe with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m) (Figure 3-78).
2. Install catalytic converter on support bracket on transfer case with U-bolt, clamp, two lockwashers, and nuts.
3. Install gasket and catalytic converter on crossover pipe with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m).
4. Wrap exhaust heat shield clamp around catalytic converter and tighten clamp securely.
5. Install heat shield on catalytic converter with clamp, U-bolt, four lockwashers, and nuts. Tighten nuts to 10 lb-ft (14 N•m).
6. Install catalytic converter on mounting bracket with clamp, U-bolt, two lockwashers, and nuts.

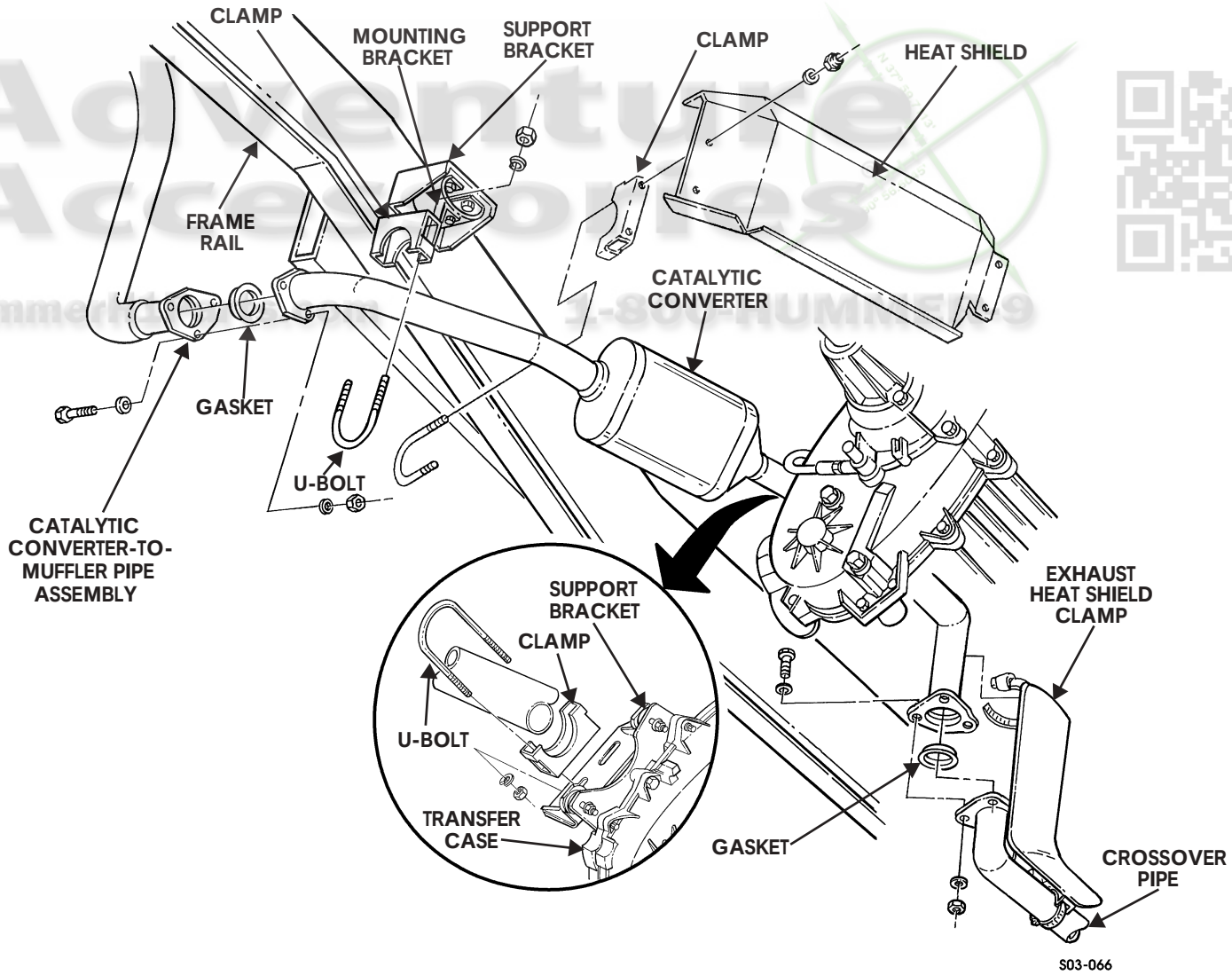

Figure 3-78: Catalytic Converter

Catalytic Converter-to-Muffler Pipe Assembly Replacement

Removal

1. Remove three locknuts, washers, capscrews, washers, converter-to-muffler pipe assembly, and gasket from catalytic converter. Discard locknuts and gasket (Figure 3-79).
2. Remove three locknuts, washers, capscrews, washers, converter-to-muffler pipe assembly, and gasket from muffler. Discard locknuts and gasket.

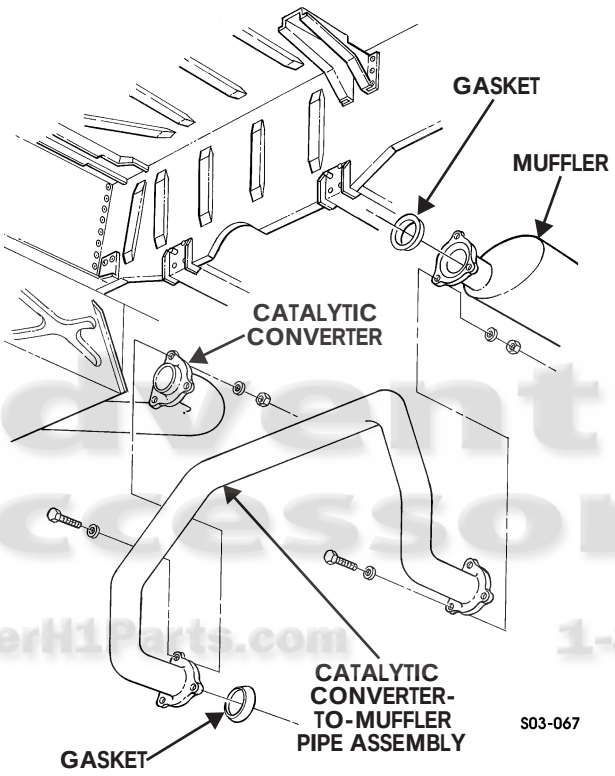

Figure 3-79: Catalytic Converter-to-Muffler Pipe Assembly

Installation

1. Install gasket and converter-to-muffler pipe assembly on muffler with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m) (Figure 3-79).
2. Install gasket and converter-to-muffler pipe assembly on catalytic converter with three capscrews, six washers, and three locknuts. Tighten locknuts to 26 lb-ft (35 N•m).

Catalytic Converter Insulator Replacement

Removal

1. Remove two nuts, lockwashers, U-bolt, and clamp from lower mounting bracket. Discard lockwashers (Figure 3-80).

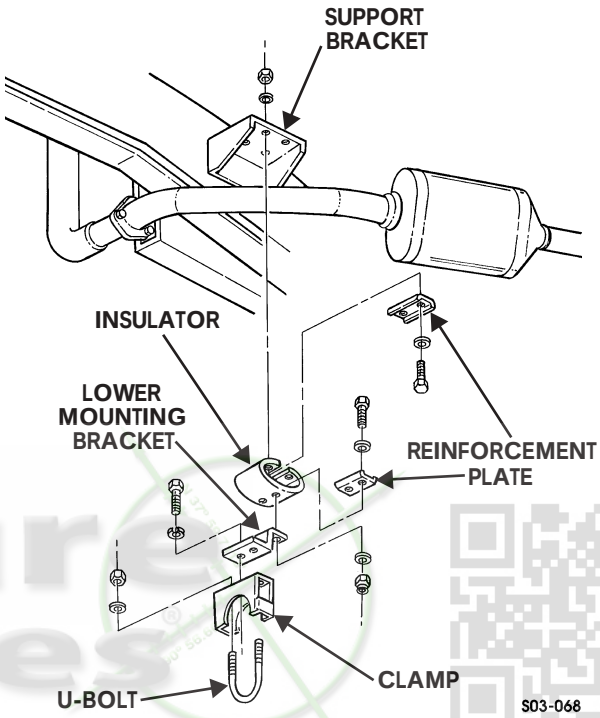

Figure 3-80: Catalytic Converter Insulator

2. Remove four locknuts, washers, capscrews, washers, two reinforcement plates, and insulator from support bracket. Discard locknuts.
3. Remove two nuts, washers, capscrews, washers, reinforcement plate, and insulator from lower mounting bracket.

Installation

1. Install reinforcement plate on insulator and lower mounting bracket with two capscrews, four washers, and two nuts. Tighten capscrews to 10 lb-ft (14 N•m) (Figure 3-80).
2. Install two reinforcement plates and insulator on support bracket with four capscrews, eight washers, and four locknuts.
3. Install U-bolt and clamp on lower mounting bracket with two lockwashers and nuts.

RIGHT EXHAUST MANIFOLD REAR HEAT SHIELD REPLACEMENT

Removal

1. Remove engine access covers.
2. Remove nut, lockwasher, washer, capscrew, washer, and rear heat shield from transmission dipstick tube clamp. Discard lockwasher (Figure 3-81).
3. Remove capscrew and rear heat shield from heat shield.

Installation

1. Install rear heat shield on heat shield with capscrew (Figure 3-81).
2. Install rear heat shield on transmission dipstick tube clamp with washer, capscrew, washer, lockwasher, and nut.
3. Install engine access covers.

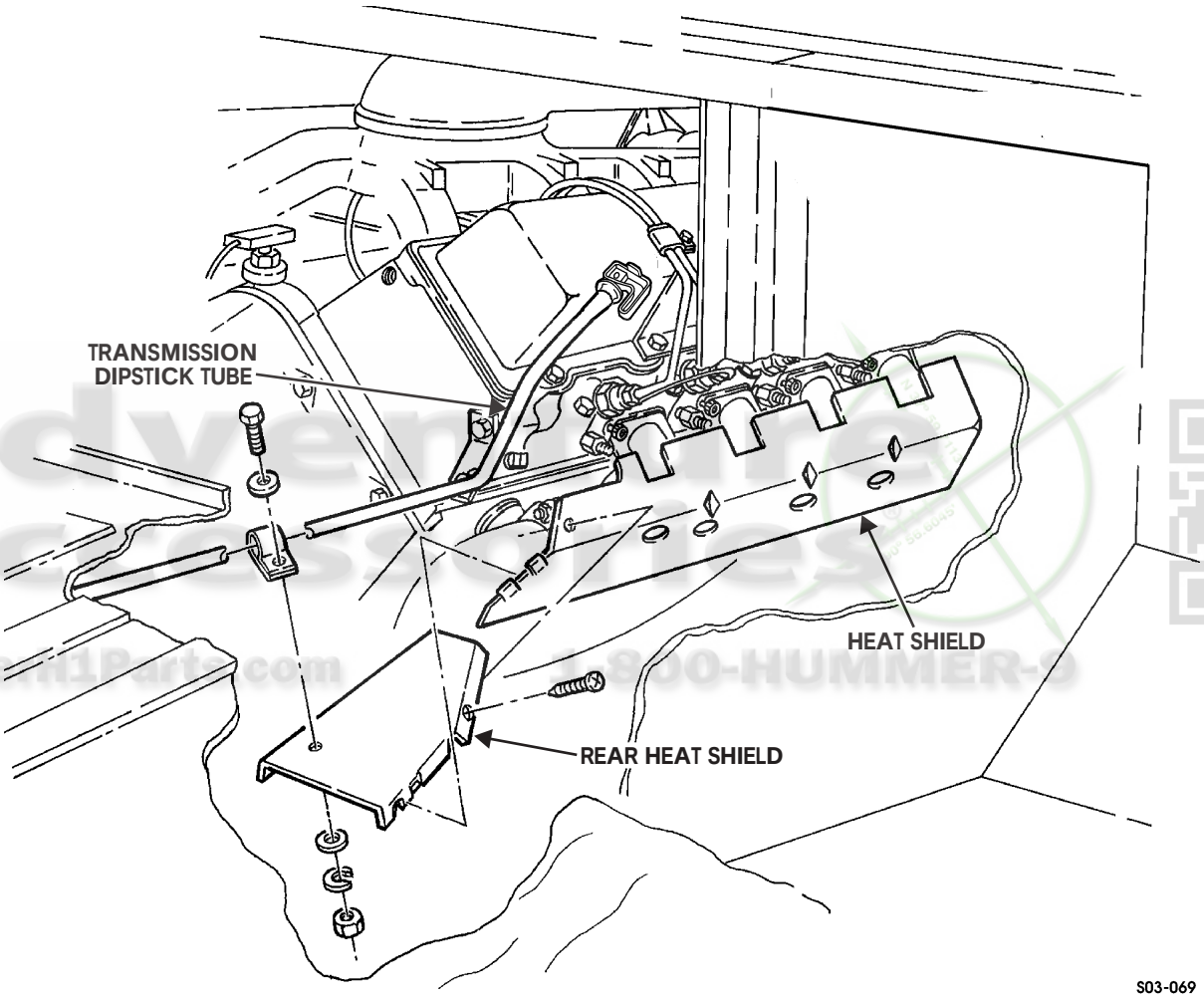

Figure 3-81: Right Rear Heat Shield

RIGHT EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT

Removal

1. Remove engine access covers.
2. Remove right exhaust manifold rear heat shield.
3. Loosen three capscrews securing heat shield and exhaust manifold to cylinder head (Figure 3-82).
4. Remove locknut, washer, capscrew, washer, and heat shield from crossover pipe and exhaust manifold. Discard locknut.

Installation

1. Position heat shield on crossover pipe and exhaust manifold (Figure 3-82).
2. Install heat shield and exhaust manifold on cylinder head and tighten capscrews to 25 lb-ft (34 N•m).
3. Install heat shield on exhaust manifold and crossover pipe with washer, capscrew, washer, and locknut. Tighten locknut to 37 lb-ft (50 N•m).
4. Install right exhaust manifold rear heat shield.
5. Install engine access covers.
6. Start engine and check for exhaust leaks.

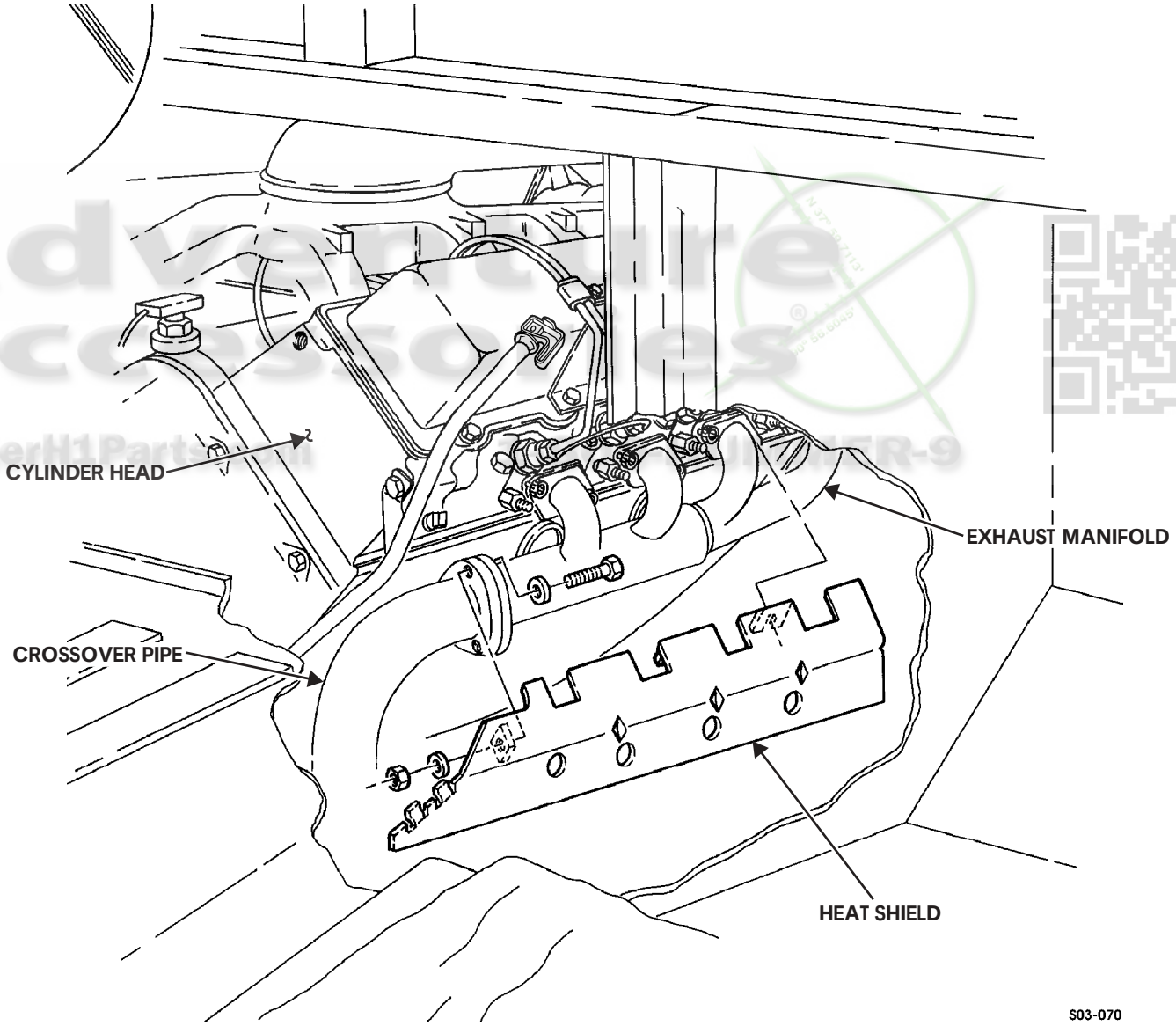

Figure 3-82: Right Exhaust Manifold Heat Shield

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Section 4 Cooling System

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ENGINE COOLING SYSTEM DESCRIPTION

The cooling system removes excess heat from the engine, engine oil, power steering fluid, transfer case fluid, and the transmission fluid. Some engine heat is beneficial, but excess heat can cause engine oil to break down. If lubrication is significantly reduced, it can cause engine damage. To keep the oil at the proper temperature, the cooling system dissipates some of the heat produced by the engine.

A serpentine belt drives the water pump which pumps coolant through the cooling system. Coolant travels through the engine block and circulates around the parts of the engine which generate heat: the cylinders, cylinder heads, combustion chambers, valve guides, valve seats, etc. As coolant is routed through the engine block, heat is transferred from the engine to the coolant.

The water crossover collects coolant from the cylinder heads and channels it to the thermostat housing. To prevent the engine from being over-cooled, the thermostat monitors the temperature of the coolant and prevents it from being routed to the radiator until it has reached a temperature high enough 190°F (88°C) to require cooling (Figure 4-1).

Like the radiator, the oil cooler also uses a series of fins and baffles to dissipate heat from fluid. The lower half of the oil cooler dissipates heat from the engine oil while the upper half cools transmission fluid.

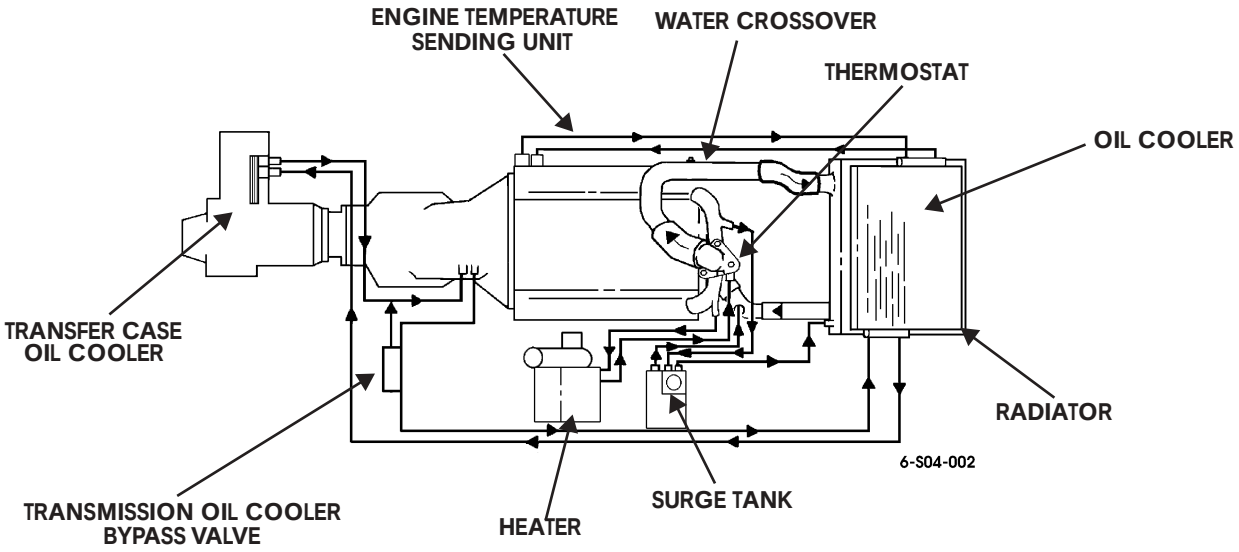


Figure 4-1: Cooling System

If the thermostat detects that the coolant is hot, it is pumped to the radiator where it is routed through a series of fins and baffles. A fan draws in outside air to help dissipate the heat before the coolant is recirculated back through the engine (Figure 4-2).

The heater provides heat to warm the interior of the vehicle for

passenger comfort. Hot coolant leaves the engine and passes through a heater coil. A fan draws air through the heated coil which heats the air. The air is then channeled through a plenum chamber that directs the flow of the heated air into the passenger compartment.

If the engine is generating more heat than the cooling system can effectively dissipate, there may be a problem with coolant or with the system itself. The engine temperature sending unit transmits a signal indicating the coolant temperature to the temperature gauge on the instrument panel to let the driver know that the system should be serviced as soon as possible. Engine coolant is added to the system through the filler cap in the surge tank. After adding or refilling the cooling system, open the valve on the water crossover and bleed the air from the system.

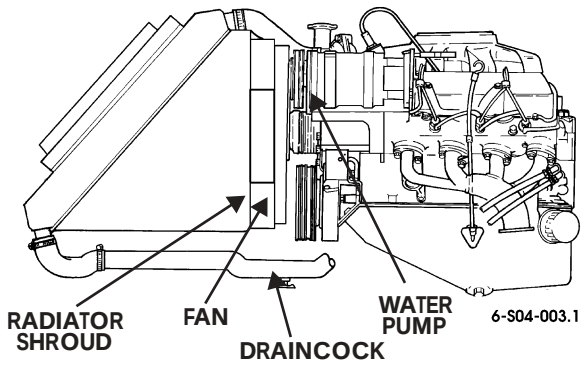


Figure 4-2: Cooling System

ENGINE COOLING SYSTEM DIAGNOSIS AND TROUBLESHOOTING

Loss of Coolant

1. Pressurize system and check for leaks at all cooling system hoses.
   a. Tighten loose clamps, fasteners, or fittings.
   b. Replace leaking hoses.
2. Pressurize coolant system and check for leaks at water pump or around cylinder heads. If any leakage is present, replace cylinder head gaskets, cylinder heads, or water pump.
3. Check cylinder block for cracks. Replace if cylinder block is cracked.
4. Check expansion plugs and block heater for leaks.

Engine Coolant Temperature Gauge Above 230°F (110° C), Engine Overheats

1. Inspect the drivebelt and pulleys for damage.
   a. Replace any damaged parts.
   b. Check belt tension. Replace if necessary.

WARNING: Use caution when testing thermostat. Hot water will cause burns.

2. Check thermostat for proper operation. Remove thermostat and place thermostat in container of water known to be 190°F (88°C). Observe valve. If valve does not open, replace thermostat.
3. Check for clogged or blocked radiator system. Clean and flush as required.
4. Check operation of temperature gauge. Refer to Electrical Troubleshooting (Section 12).
5. Check radiator for bent fins. Straighten fins or replace radiator if damaged beyond repair.
6. Inspect fan blade for damage. Replace fan blade if damaged.
7. Check fan clutch operation.
   a. Check for excessive bearing play. Using fingers only, press tip of fan blade toward and away from engine. Tip of blade total movement should not exceed 0.20 in. (5.1 mm). If movement is more, replace fan drive.
   b. With engine off and ambient temperature of 50°F (10° C) or higher, fan should turn evenly with noticeable drag. If fan turns hard, very easily, or with uneven resistance, replace fan drive.
   c. Fan noise is sometimes evident under the following normal conditions:
      - When the drive is engaged for maximum cooling.
      - During the first 15 seconds to one minute after start-up, until the drive can redistribute the silicone fluid back to its normal disengage operating condition (after overnight settling).

   Fan noise or an excessive roar will generally occur continuously under all engine high speed conditions (2400 RPM and up), if the drive assembly is locked up due to an internal failure. If the fan cannot be rotated by hand or there is a rough, grating feel as the fan is turned, replace the fan drive.
8. Check for leaking or defective water pump. Replace leaking or defective water pump.

WARNING: Do not release surge tank cap when engine is hot. Steam and/or coolant may cause serious injury.

9. Remove surge tank cap. With engine running, check for excessive bubbles in surge tank that may indicate leaking head gaskets or cracked cylinder heads. If bubbles are present, remove cylinder heads and check for defective head gaskets, cracked cylinder heads, or cracked cylinder block. Replace cylinder heads if damaged. Replace engine if cylinder block is cracked.
10. Off-road driving in extremely dusty conditions may result in debris entrapment between the radiator and oil cooler. Debris entrapment may, after a period of engine operation, increase coolant temperature. Cleaning requires the separation of the oil cooler from the radiator and both units thoroughly flushed with water and compressed air.

Fan Runs Continuously (Noisy)

1. Check that all fan capscrews are present and tightened to 45 lb-ft (61 N•m).
2. Perform steps 7a and 7b under *Engine Cooling System Diagnosis And Troubleshooting*.
3. Check for fan cut off (disengagement).
   a. Put tab or mark on fan blade. Use timing light to check RPM.
   b. With coolant temperature between 50° F (10° C) and 140°F (60°C), start engine and set speed to 2000 rpm.

4. Observe fan drive disengagement after 1 to 1-1/2 minutes. If fan speed does not drop and coolant temperature remains below 190° F (88° C), replace fan drive.

RADIATOR AND FAN SHROUD ASSEMBLY MAINTENANCE

Removal

1. Remove hood (Section 10).
2. Drain cooling system.
3. Remove oil cooler (Section 1).
4. Disconnect inlet hose from radiator (Figure 4-3).
5. If equipped with air conditioner, discharge system and remove condenser (Section 11).
6. Remove power steering reservoir (Section 8).
7. Disconnect ambient temperature switch, if equipped.
8. Disconnect surge tank-to-radiator vent hose from adapter.
9. Disconnect lower radiator hose from radiator.
10. Remove strap securing fan shroud to radiator.
11. Remove locknut, washer, capscrew, large washer, washer, and lower mount from radiator and frame bracket. Discard locknut (Figure 4-4).
12. Remove four locknuts, washers, capscrews, and two rear support brackets from airlift brackets. Discard locknuts (Figure 4-3).
13. Remove battery tray, and left splash shield. (Sections 10 and 12).
14. Remove the radiator from vehicle (Figure 4-4).
15. Remove eight capscrews, lockwashers, two retaining strips, and fan shroud from radiator. Discard lockwashers.

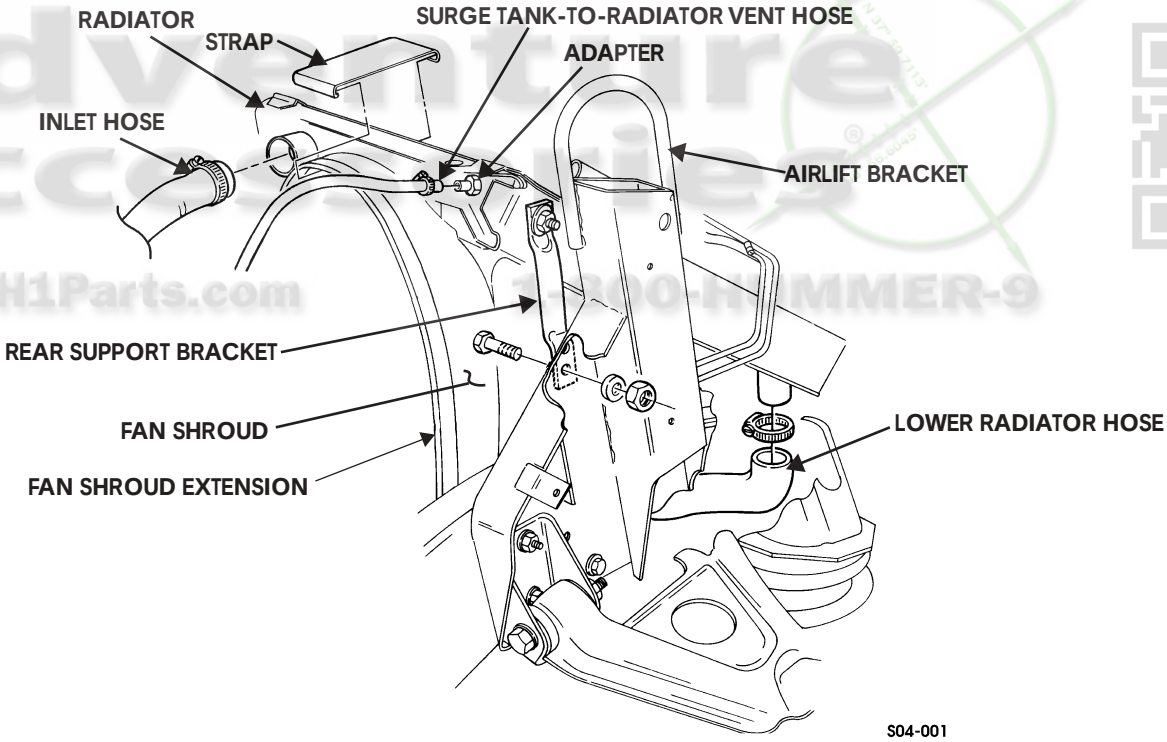


Figure 4-3: Radiator and Fan Shroud Assembly

16. Remove two locknuts, washers, large washers, rear support brackets, and insulators from radiator. Discard locknuts.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Remove debris embedded in radiator fins using water and compressed air.
2. Inspect radiator for breaks, punctures, cracks, or splits.
3. Inspect adapters and fan shroud.

Installation

***CAUTION**: To avoid equipment damage, upper edge of fan shroud must align with radiator top tank seam to ensure proper engine cooling.*

NOTE: Ensure fan shroud edge aligns with tank seam on radiator.

1. Install fan shroud on radiator with two retaining strips, eight lockwashers, and capscrews. Tighten capscrews to 6 lb-ft (8 N•m) (Figure 4-4).
2. Install two rear support brackets and insulators on radiator with two washers, large washers, and locknuts. Tighten locknuts to 26 lb-ft (35 N•m).

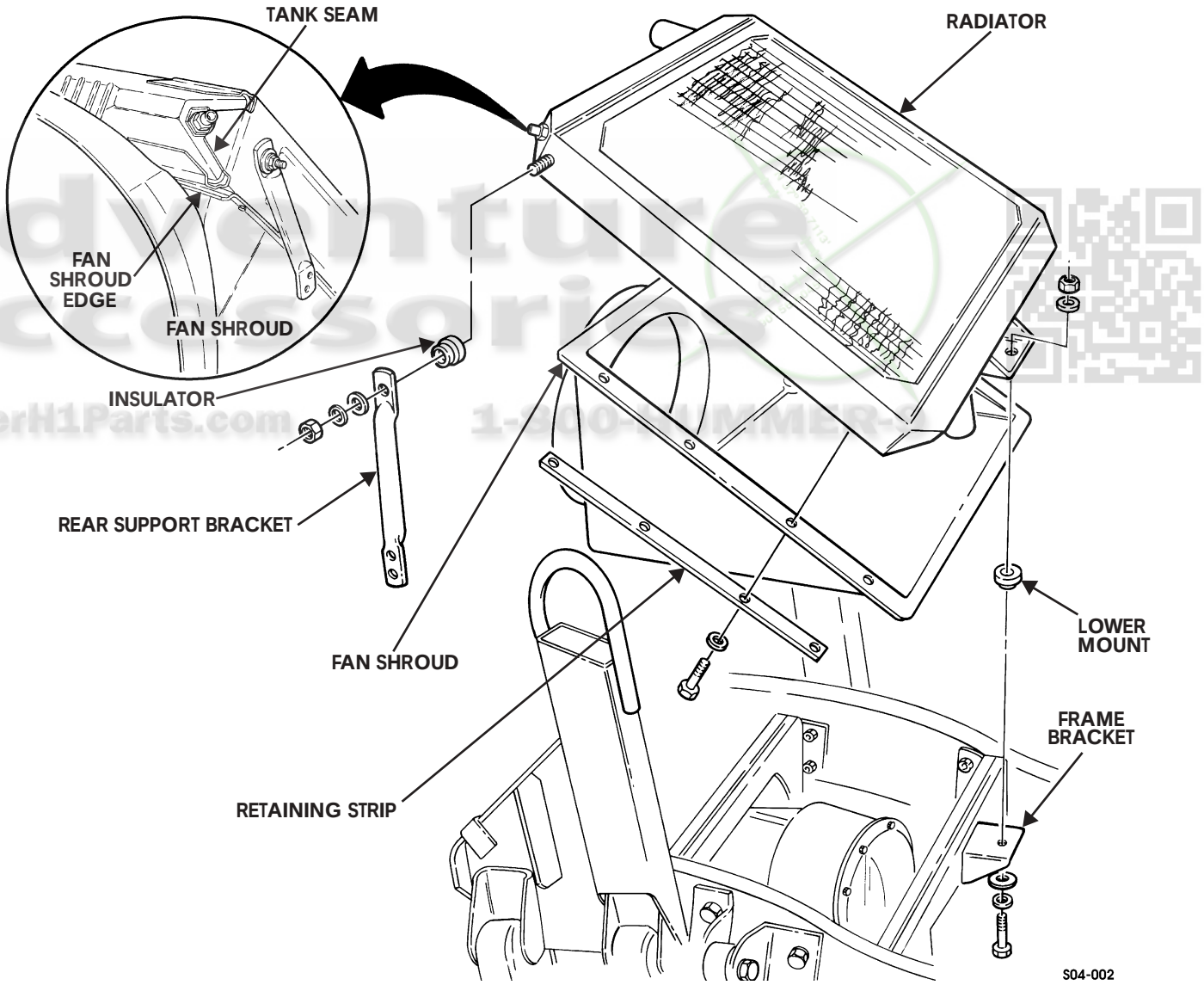


Figure 4-4: Radiator and Fan Shroud Assembly

3. Align radiator with frame bracket, and two rear support brackets with airlift brackets (Figures 4-3, and 4-4).
4. Install two rear support brackets on air lift brackets with four capscrews, washers, and locknuts. Do not tighten locknuts (Figure 4-3).
5. Install lower mount and radiator on frame bracket with washer, large washer, capscrew, washer, and locknut. Do not tighten capscrew (Figure 4-4).
6. Align fan shroud by sliding the radiator/shroud assembly to maintain 1-1/2 ± 1/8 in. (38.1 ± 3 mm) from edge of shroud ring and rear edge of fan. Measure at the 2, 4, 8, and 10 o'clock positions. The distance between the top of the fan blade and fan shroud must not be less than 1/4 in. (6 mm) at any position (Figure 4-5).
7. Tighten rear support bracket locknuts to 26 lb-ft (35 N•m). Tighten frame bracket capscrew to 30 lb-ft (41 N•m) (Figure 4-3) and (Figure 4-4).
8. Install left splash shield and battery tray (Section 12).
9. Install strap on radiator and shroud (Figure 4-3).
10. Connect lower radiator and inlet hoses to radiator.
11. Connect ambient temperature switch, if equipped.
12. Install power steering reservoir (Section 8).
13. Install condenser and charge system, if equipped with air conditioner (Section 11).
14. Connect surge tank-to-radiator vent hose to adapter.
15. Fill cooling system.
16. Install oil cooler (Section 1).
17. Start engine and check cooling system for leaks.
18. Install hood (Section 10).
19. Bleed power steering system (Section 8).

ENGINE COOLING SYSTEM SERVICE

Depressurizing/Draining

WARNING: To avoid injury, do not remove surge tank filler cap before depressurizing cooling system when engine temperature is above 190°F (88°C).

1. If engine is hot, remove surge tank filler cap by placing a thick cloth over cap. Turn counterclockwise to first stop to release internal pressure (Figure 4-6).
2. After pressure has escaped, remove cap.
3. Open draincock and drain system (Figure 4-7).
4. Close draincock.

Replenishing

NOTE: Ensure surge tank coolant level is 3/4 full before securing filler cap.

1. Ensure draincock is closed and heater control valve is open (Figure 4-6) and (Figure 4-7).
2. Fill system with proper antifreeze solution. See Antifreeze Preparation Guide table.
3. Install filler cap on surge tank (Figure 4-6).
4. Start engine and run at fast idle (1500 rpm) until engine temperature reaches 190° F (88° C). Stop engine.
5. Depressurize system.
6. Fill with proper antifreeze solution until surge tank is 3/4 full. See Antifreeze Preparation Guide table.
7. Install filler cap on surge tank (Figure 4-6).
8. Start engine and run at fast idle (1500 RPM) until engine temperature reaches 190° F (88° C). Stop engine.
9. Depressurize system. Use tester to ensure proper coolant protection is provided.
10. Install filler cap on surge tank.
11. Start engine and check cooling system for leaks.

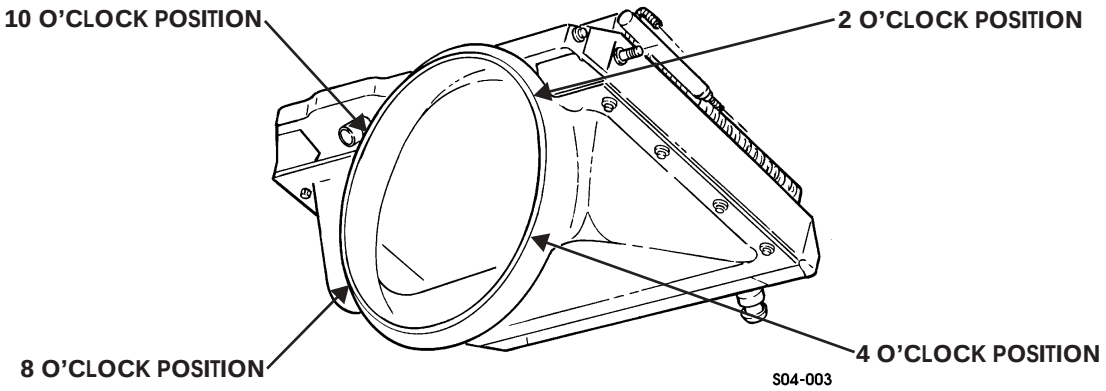


Figure 4-5: Fan Shroud

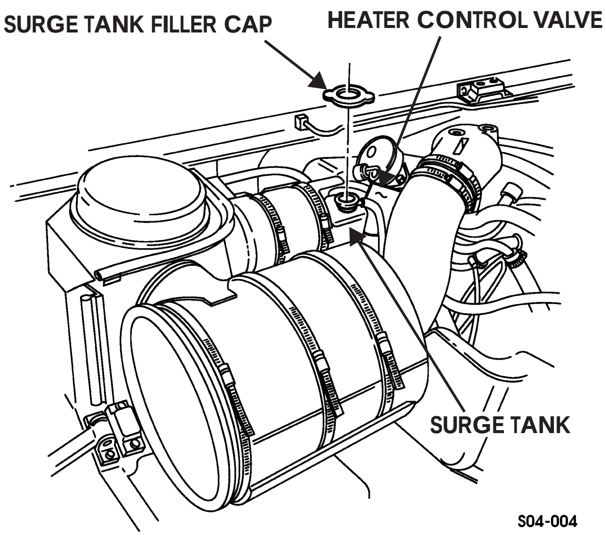


Figure 4-6: Surge Tank and Filler Cap

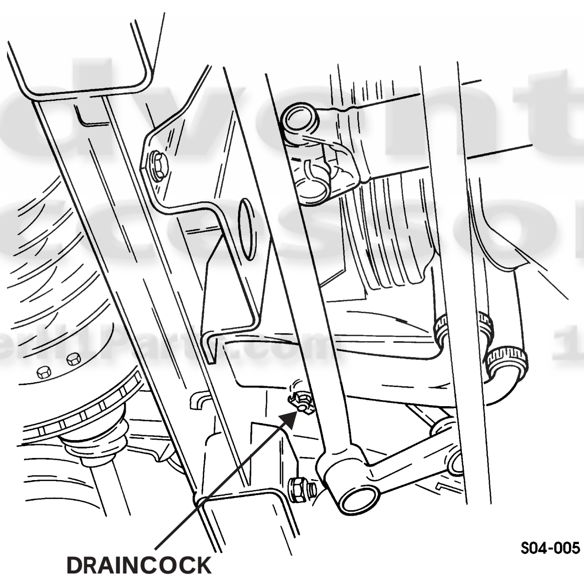


Figure 4-7: Draincock

Expected Temperature	Antifreeze/ Water Mixture
+40° to -65° F (+4° to -54° C)	60% antifreeze/ 40% water

Antifreeze Preparation Guide

SHROUD SHIELD ASSEMBLY REPLACEMENT

Removal

1. Remove radiator and fan shroud.
2. Remove three screws and shroud shield assembly from airlift bracket (Figure 4-8).

Installation

1. Install shroud shield assembly on airlift bracket with three screws (Figure 4-8).
2. Install radiator and fan shroud.

RADIATOR REAR SUPPORT BRACKET REPLACEMENT

Removal

1. Remove left splash shield (Section 10).
2. Remove battery tray and right splash shield (Section 12).
3. Remove locknut, washer, large washer, radiator rear support bracket, and insulator from radiator. Discard locknut (Figure 4-9).
4. Remove two locknuts, washers, capscrews, and support bracket from airlift bracket. Discard locknuts (Figure 4-10).

Installation

1. Install radiator rear support bracket on airlift bracket with two capscrews, washers, and locknuts. Do not tighten locknuts (Figure 4-10).
2. Install insulator and support bracket on radiator with washer, large washer, and locknut (Figure 4-9).
3. Tighten all locknuts to 26 lb-ft (35 N•m).
4. Install left splash shield (Section 10).
5. Install battery tray and right splash shield (Section 12).

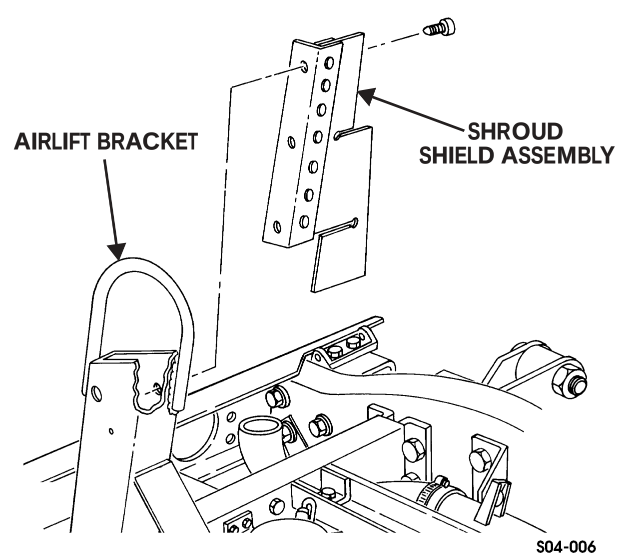


Figure 4-8: Shroud Shield Assembly

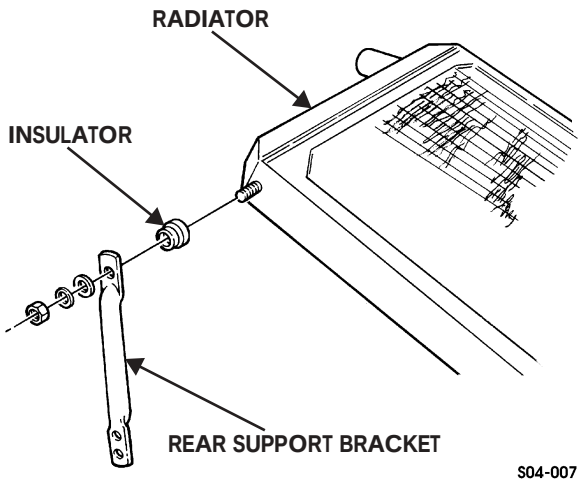


Figure 4-9: Rear Support Bracket to Radiator

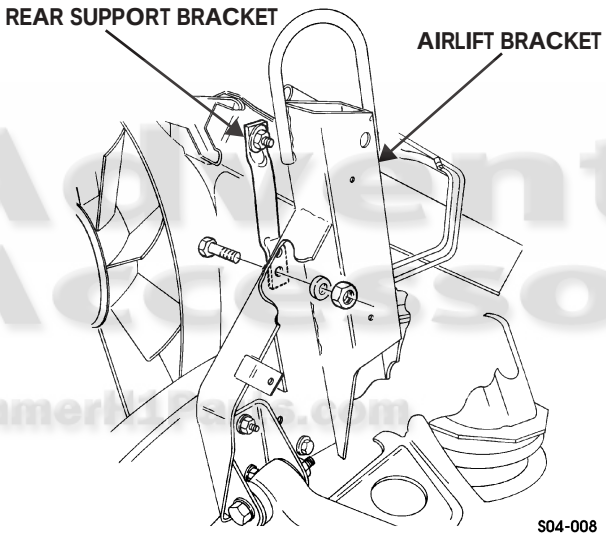


Figure 4-10: Rear Support Bracket to Airlift Bracket

SURGE TANK REPLACEMENT

Removal

1. Drain cooling system.
2. Disconnect radiator vent hose from surge tank (Figure 4-11).
3. Disconnect water crossover vent hose from surge tank.
4. Disconnect lower radiator hose from surge tank.
5. Disconnect overflow hose from surge tank.
6. Loosen two clamps and remove surge tank from bracket.

Installation

1. Install surge tank on bracket and tighten two clamps (Figure 4-11).
2. Connect lower radiator hose to surge tank.
3. Connect water crossover vent hose to surge tank.
4. Connect radiator vent hose to surge tank.
5. Connect overflow hose to surge tank.
6. Fill cooling system.

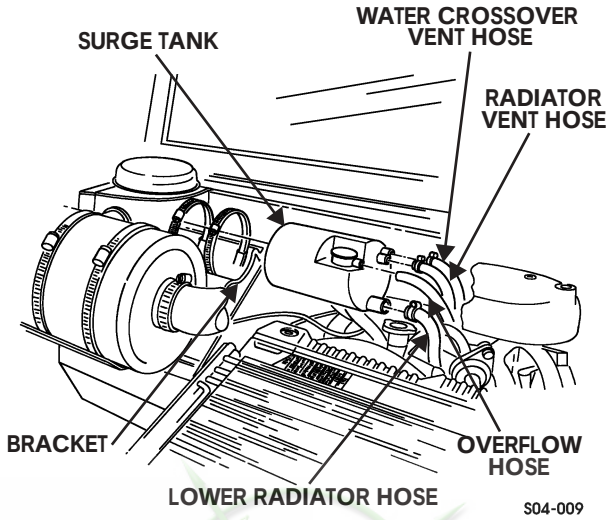


Figure 4-11: Surge Tank

SURGE TANK-TO-RADIATOR VENT HOSE REPLACEMENT

Removal

1. Depressurize cooling system.
2. Remove vent hose from radiator and surge tank (Figure 4-12).

Installation

1. Install vent hose on surge tank and radiator (Figure 4-12).
2. Tighten coolant filler cap.

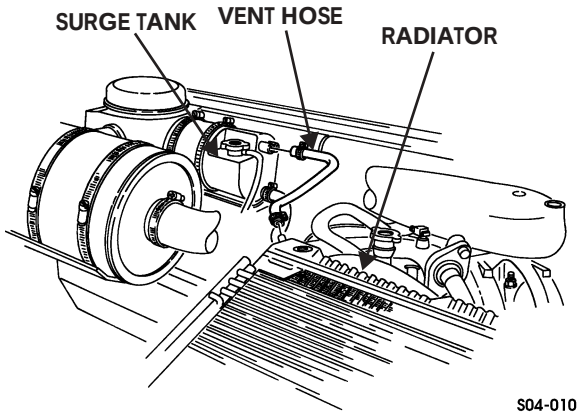


Figure 4-12: Surge Tank-to-Radiator Vent Hose

THERMOSTAT BYPASS HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Loosen two clamps and remove hose from thermostat bypass nipple and heater core adapter (Figure 4-13).

Installation

1. Install hose on heater core adapter and thermostat bypass nipple and tighten two clamps (Figure 4-13).
2. Fill cooling system.

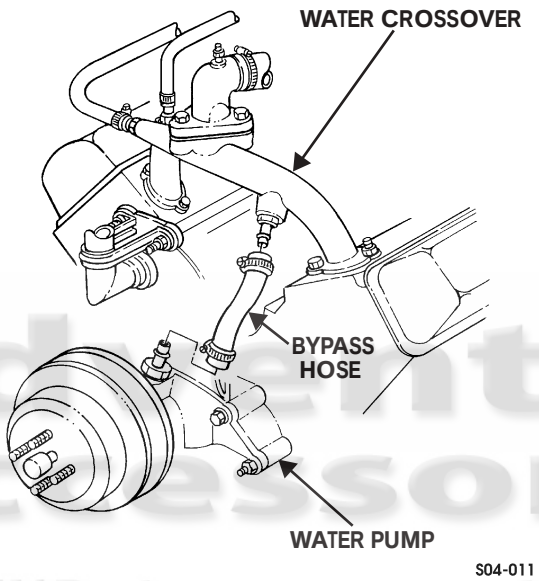


Figure 4-13: Thermostat Bypass Hose

RADIATOR INLET HOSES REPLACEMENT

Removal

1. Depressurize cooling system.
2. Remove inlet hose from inlet tube and water crossover (Figure 4-14).
3. Remove inlet hose from inlet tube and radiator.

Installation

1. Install inlet hose on inlet tube and radiator (Figure 4-14).
2. Install inlet hose on inlet tube and water crossover.
3. Tighten coolant filler cap.

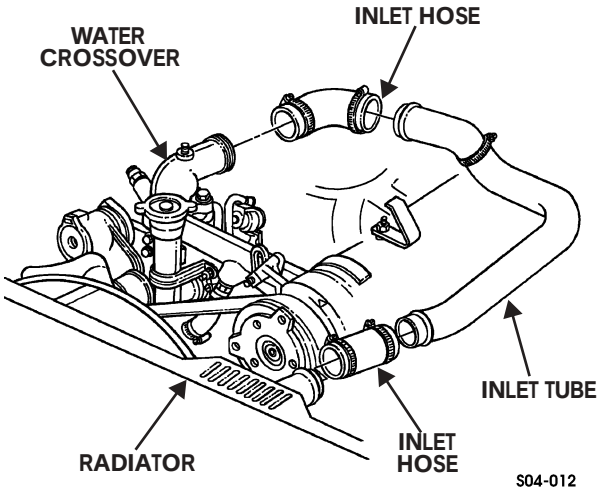


Figure 4-14: Radiator Inlet Hoses

LOWER RADIATOR HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Remove lower radiator hose from radiator and lower tube assembly (Figure 4-15).

Installation

1. Install lower radiator hose on lower tube assembly and radiator (Figure 4-15).
2. Fill cooling system.

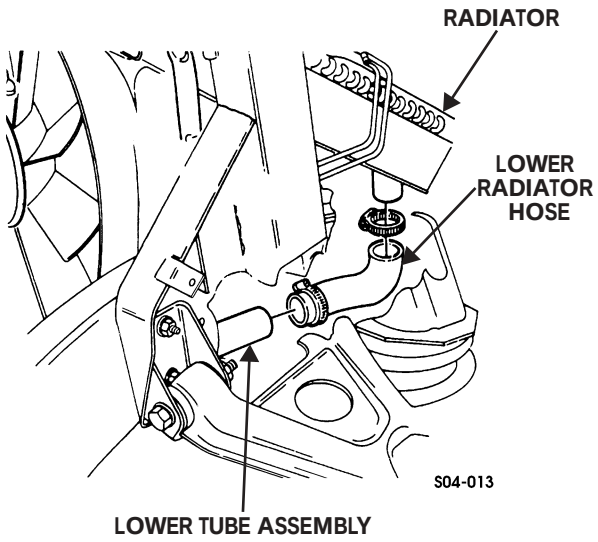


Figure 4-15: Lower Radiator Hose

RADIATOR LOWER TUBE ASSEMBLY REPLACEMENT

Removal

1. Drain cooling system.
2. Remove draincock from radiator lower tube assembly (Figure 4-16).
3. Remove two locknuts, four washers, two capscrews, and radiator lower tube assembly from frame bracket. Discard locknuts.
4. Disconnect water pump inlet hose from lower tube assembly.
5. Disconnect surge tank-to-lower radiator hose from lower tube assembly.
6. Disconnect lower radiator hose from lower tube assembly.
7. Remove lower tube assembly.

Installation

1. Install lower tube assembly on frame bracket with two washers, capscrews, washers, and locknuts. Tighten locknuts to 6 lb-ft (8 N•m) (Figure 4-16).
2. Connect lower radiator hose to lower tube assembly.
3. Connect surge tank-to-lower radiator hose to lower tube assembly.
4. Connect water pump inlet hose to lower tube assembly.
5. Apply sealant tape to threads of draincock and install draincock on lower tube assembly.
6. Fill cooling system.

WATER PUMP INLET HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Remove water pump inlet hose from water pump and lower tube assembly (Figure 4-17).

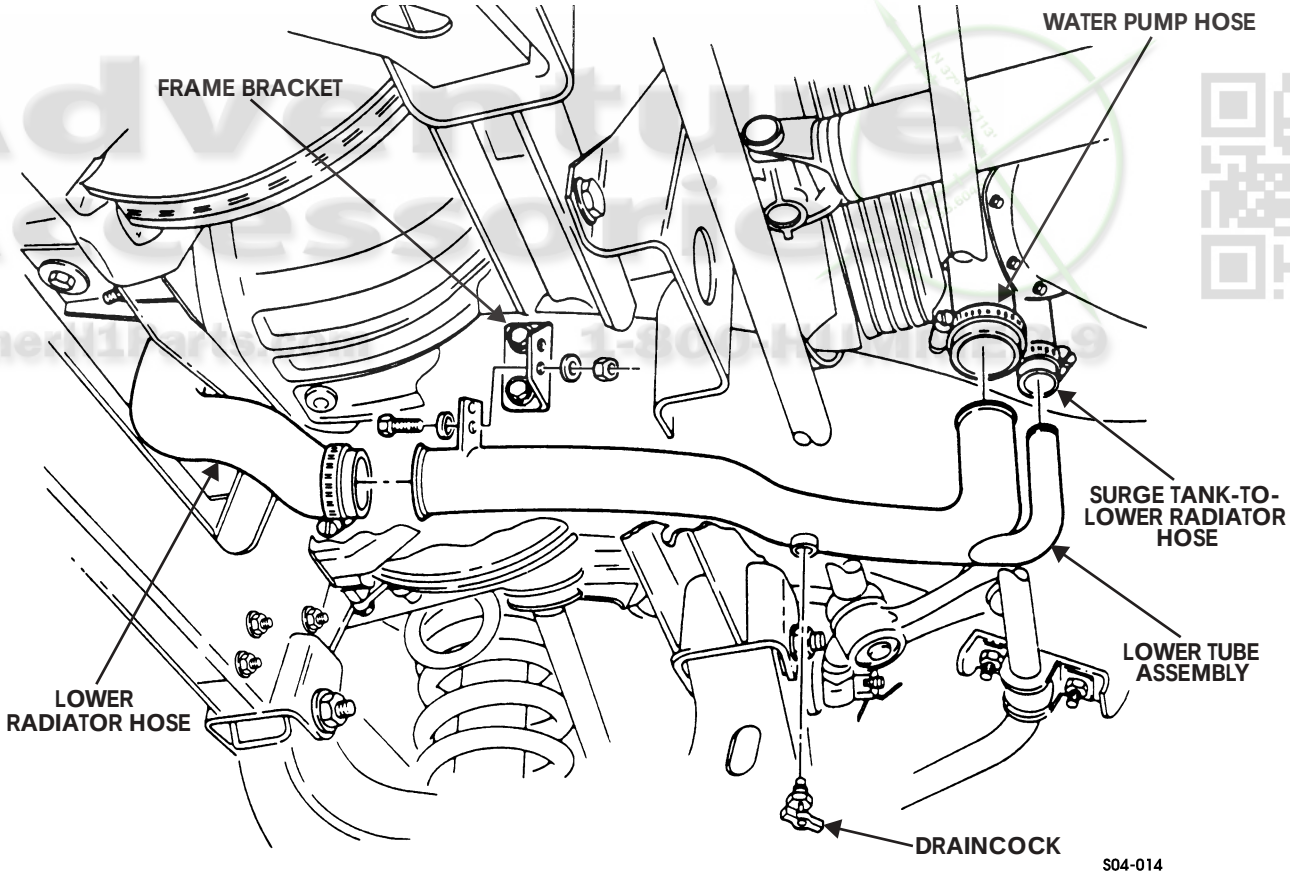


Figure 4-16: Radiator Lower Tube Assembly

Installation

1. Install water pump inlet hose on lower tube assembly and water pump (Figure 4-17).
2. Fill cooling system.

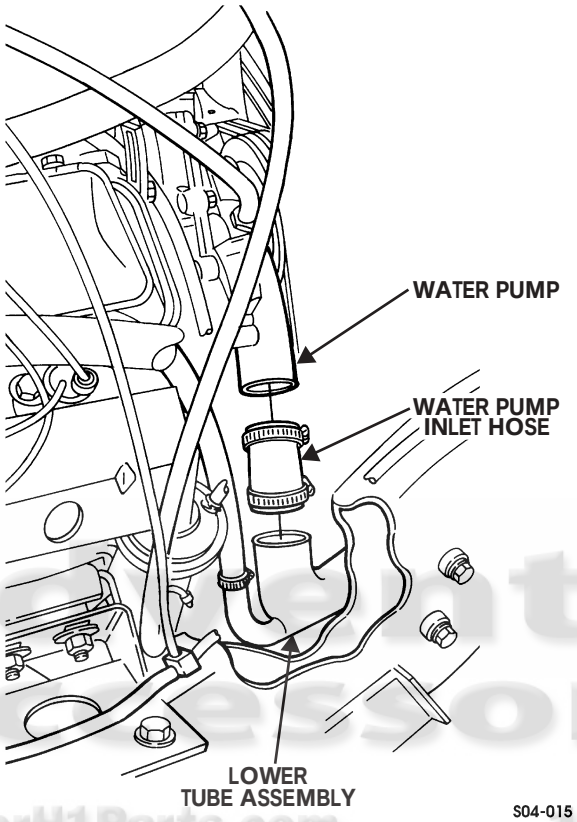


Figure 4-17: Water Pump Inlet Hose

SURGE TANK-TO-WATER CROSSOVER VENT HOSE REPLACEMENT

Removal

1. Depressurize cooling system.
2. Remove vent hose from water crossover and surge tank (Figure 4-18).

Installation

1. Install vent hose on surge tank and water crossover (Figure 4-18).
2. Tighten coolant filler cap.

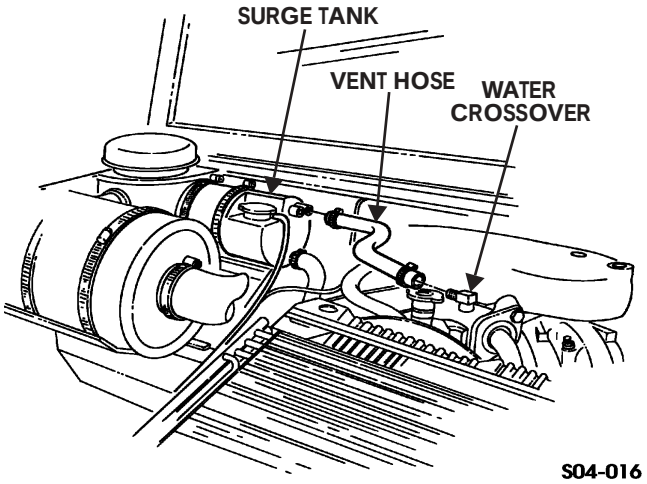


Figure 4-18: Surge Tank-to-Water Crossover Vent Hose

SURGE TANK-TO-LOWER RADIATOR TUBE HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Remove hose from surge tank and lower tube assembly (Figure 4-19).

Installation

1. Install hose on lower tube assembly and surge tank (Figure 4-19).
2. Fill cooling system.

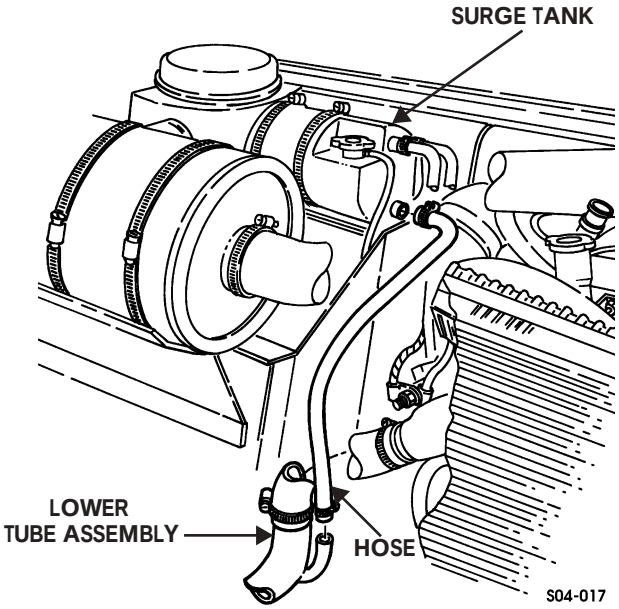


Figure 4-19: Surge Tank-to-Lower Radiator Tube Hose

SURGE TANK OVERFLOW HOSE REPLACEMENT

Removal

1. Remove overflow hose from surge tank filler neck (Figure 4-20).
2. Remove screw, clamp, and overflow hose from body.

Installation

1. Install overflow hose on surge tank filler neck (Figure 4-20).
2. Install overflow hose on body with clamp and screw.

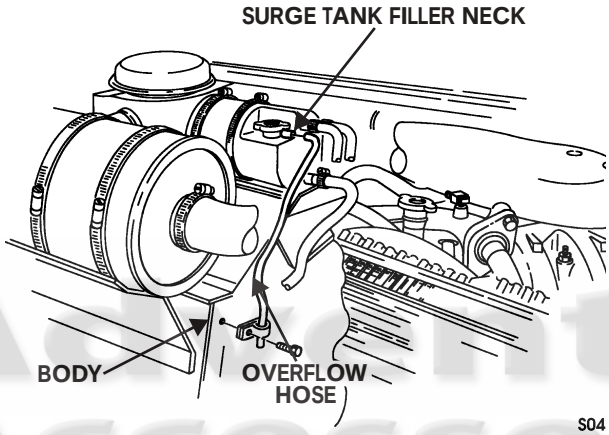


Figure 4-20: Surge Tank Overflow Hose

THERMOSTAT MAINTENANCE

Removal

1. Drain cooling system.
2. Remove three capscrews and thermostat housing from water crossover (Figure 4-21).
3. Remove thermostat and gasket from water crossover. Discard gasket.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Clean gasket surface on water crossover and thermostat housing (Figure 4-21).

Installation

1. Install thermostat into water crossover ensuring valve sensor points toward crossover (Figure 4-21).
2. Apply teflon sealing compound to three capscrew threads, and install gasket on water crossover.
3. Install thermostat housing on water crossover with three capscrews. Tighten capscrews to 20 lb-ft (27 N•m).
4. Fill cooling system.

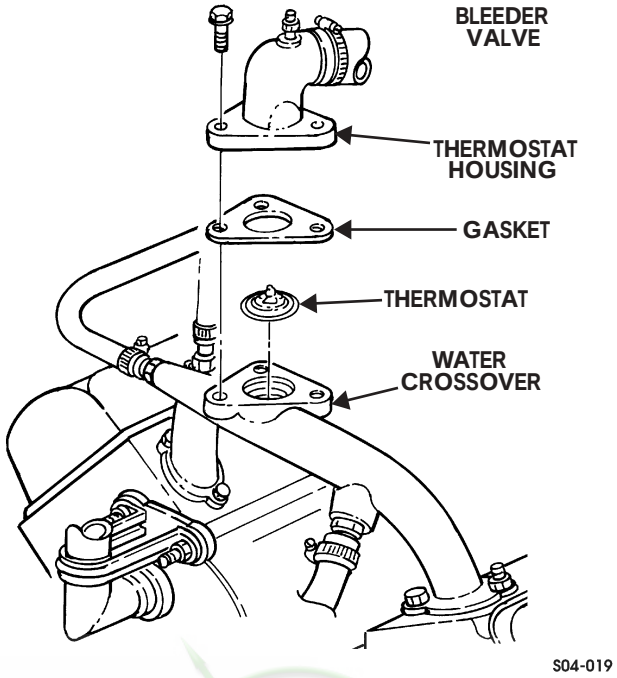


Figure 4-21: Thermostat

WATER CROSSOVER MAINTENANCE

Removal

1. Drain cooling system.
2. Remove thermostat.
3. Disconnect three hoses from water crossover (Figure 4-22).
4. Remove two nuts, wiring harness ground cable, air conditioner ground cable, and stud nuts from water crossover and cylinder head.
5. Remove two capscrews, water crossover, and two gaskets from cylinder heads. Discard gaskets.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean gasket surface on water crossover and cylinder heads (Figure 4-22).
2. Inspect thermostat bypass nipple, surge tank hose nipple, and water pump hose adapter for cracks or breaks.

Installation

1. Install two gaskets and water crossover on cylinder heads with two capscrews and stud nuts. Tighten capscrews to 25-37 lb-ft (34-50 N•m) (Figure 4-22).
2. Install air conditioner ground cable and wiring harness ground cable on stud nuts with two nuts.
3. Connect three hoses to water crossover.
4. Install thermostat.

5. Fill cooling system.

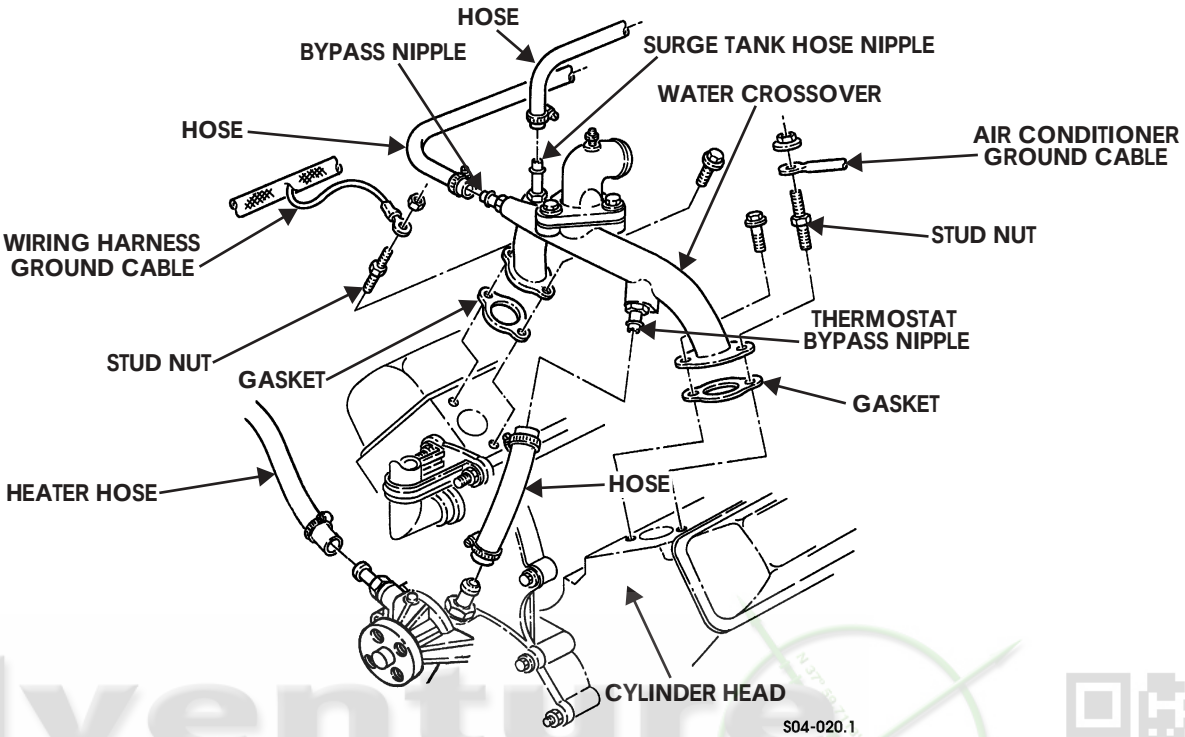


Figure 4-22: Water Crossover

WATER PUMP AND ADAPTER PLATE MAINTENANCE

Removal

1. Drain cooling system.
2. Remove fan drive, fan blade, and water pump pulley.
3. Remove oil fill tube (section 1).
4. Disconnect lower radiator hose at water pump inlet (Figure 4-17).
5. Disconnect heater and bypass hoses from water pump (Figure 4-22).
6. Remove six studs, seven capscrews, water pump and adapter plate from timing gear cover (Figure 4-23).
7. Remove sealant and/or gasket material from adapter plate and water pump.
8. If water pump is being replaced, remove heater and bypass hose adapters from water pump (Figure 4-24).

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean remaining gasket material and sealing compound from adapter plate, water pump, and timing gear cover (Figure 4-23) and (Figure 4-24).
2. Inspect water pump for cracks, breaks, or loose impeller (Figure 4-24).
3. Inspect adapter plate for excessive corrosion (Figure 4-24).
4. Inspect rivet (Figure 4-24).

Installation

1. Install gasket and water pump on adapter plate with seven capscrews. Tighten capscrews to 13-20 lb-ft (18-27 N•m) (Figure 4-24).
2. Apply flange sealant to adapter plate sealing surfaces (Figure 4-25).
3. Apply pipe sealing compound to capscrew to be installed in hole “A” (Figure 4-25).
4. Install adapter plate and water pump on timing gear cover with six studs and seven capscrews (Figure 4-23).
5. If removed, apply pipe sealing compound to threads of bypass hose and heater hose adapters and install in water pump (Figure 4-24).
6. Install bypass hose and heater hose on water pump and tighten clamps.
7. Install water pump pulley, fan blade, and fan drive.
8. Install water pump inlet hose.
9. Install engine oil filler tube (Section 1).
10. Fill cooling system.

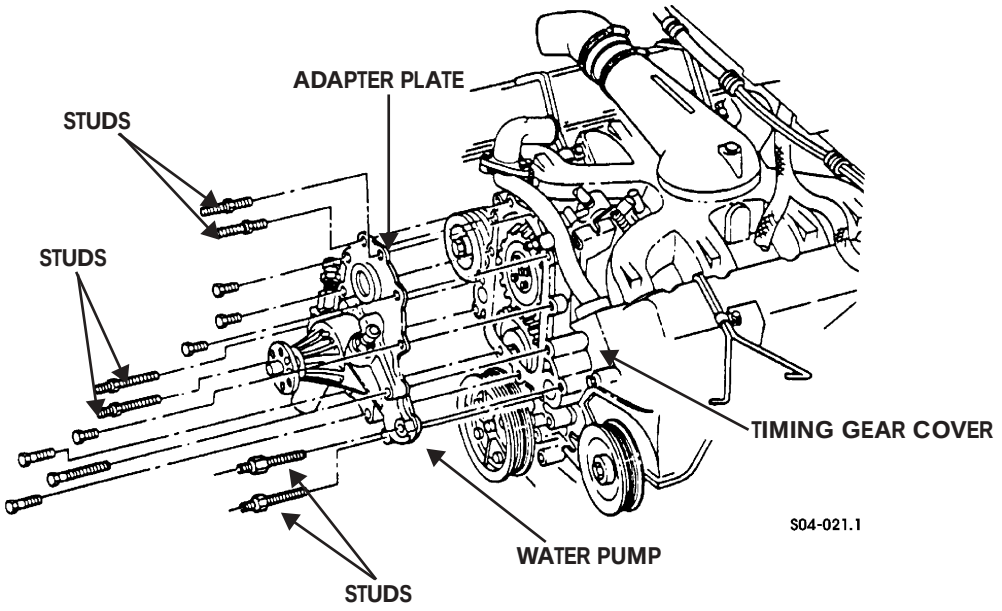


Figure 4-23: Water Pump and Adapter Plate

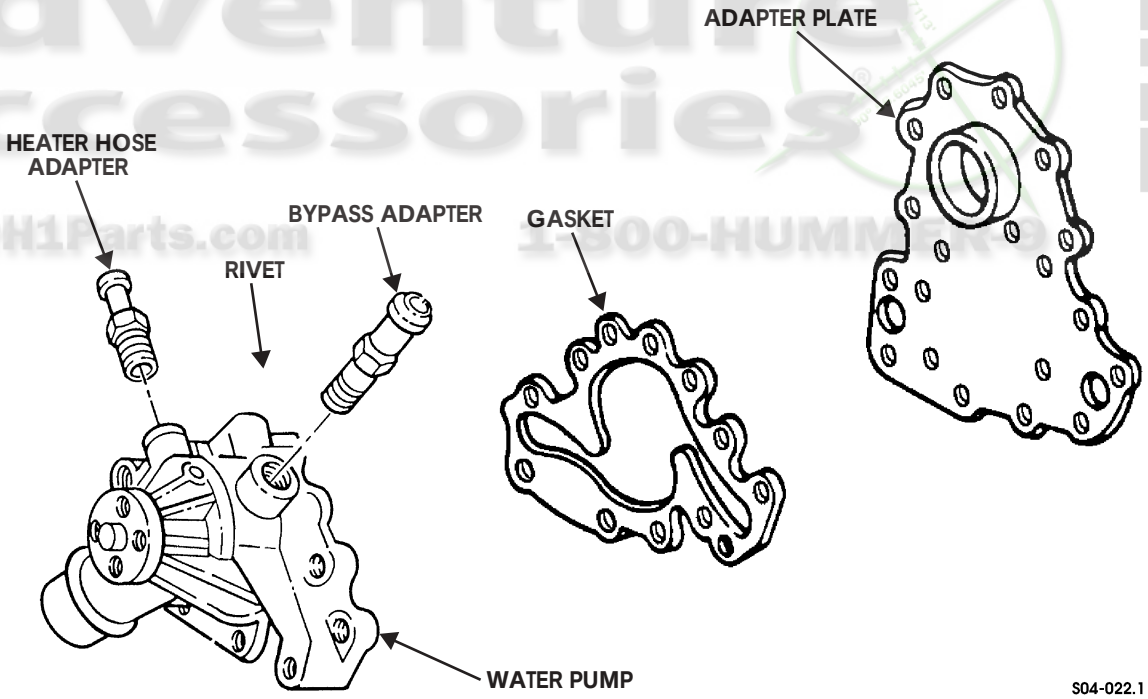


Figure 4-24: Water Pump

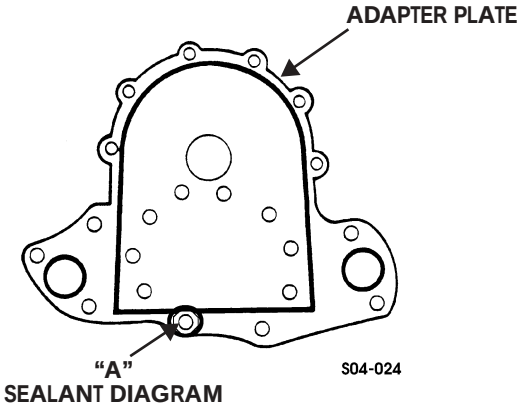


Figure 4-25: Adapter Plate

SERPENTINE BELT REPLACEMENT

Removal

1. Position a half-inch drive breaker bar on belt tensioner and move tensioner counterclockwise to loosen belt (Figure 4-26).
2. Remove belt from pulleys (Figure 4-27).

Installation

1. Position a half-inch drive breaker bar on belt tensioner and move tensioner counterclockwise and position serpentine belt on pulleys as shown (Figure 4-27) and (Figure 4-28).
2. Slowly release half-inch drive breaker bar on belt tensioner until serpentine belt is tight.

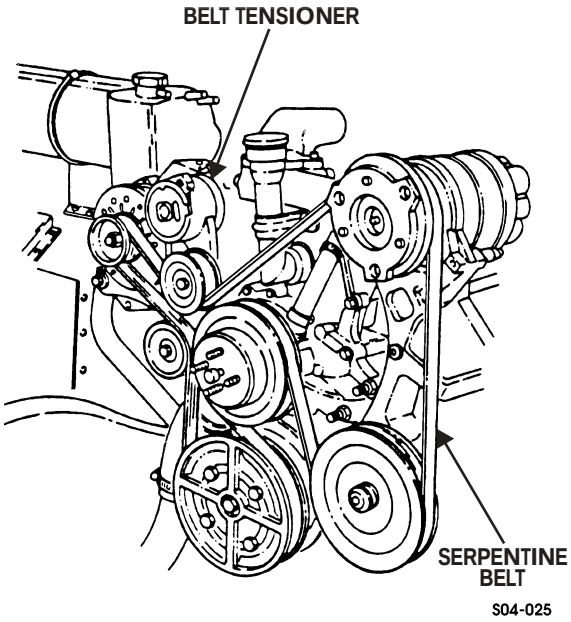


Figure 4-26: Serpentine Belt

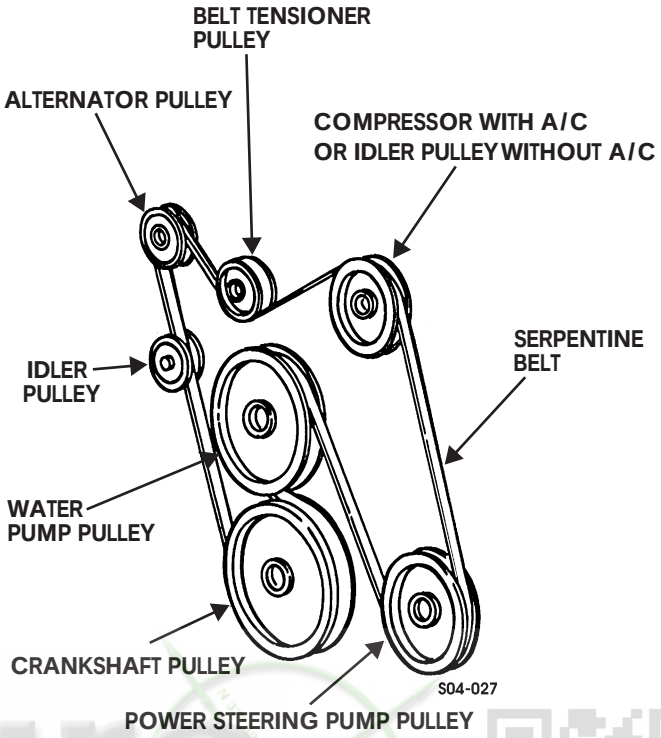


Figure 4-27: Belt Routing

FAN DRIVE, FAN BLADE, AND WATER PUMP PULLEY MAINTENANCE

Removal

1. Remove upper fan shroud extension.
2. Move the A/C hose out of the way, if equipped.
3. Remove serpentine belt.

NOTE: Mark position of fan blade for installation.

4. Remove four nuts, fan drive, fan blade, and water pump pulley from water pump (Figure 4-28).
5. Remove four capscrews, lockwashers, and fan blade from fan drive. Discard lockwashers.
6. Remove four studs from water pump.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect fan blade for cracks, bent blades, or breaks (Figure 4-28).

Installation

1. Apply thread-locking compound to four capscrews and install fan blade on fan drive with four lockwashers and

capscrews. Tighten capscrews to 45 lb-ft (61 N•m) (Figure 4-28).

2. Install four studs on water pump.
3. Install water pump pulley, fan blade, and fan drive on water pump with four nuts. Tighten nuts to 15-20 lb-ft (20-27 N•m).
4. Install serpentine belt.
5. Install upper fan shroud extension.

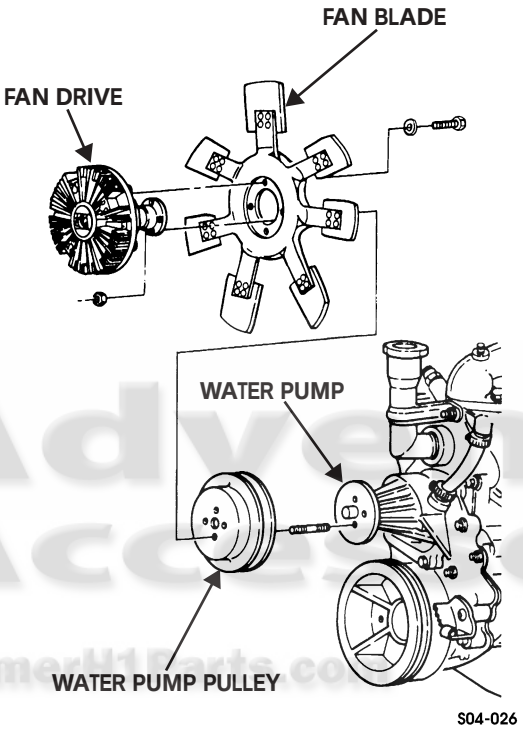


Figure 4-28: Fan Drive, Fan Blade, and Water Pump Pulley

Section 5 Transmission, Transfer Case and Propeller Shafts

TABLE OF CONTENTS

ELECTRONIC CONTROLLED AUTOMATIC TRANSMISSION

The Hydra-matic 4L80-E is a 4-speed automatic transmission which uses electronic control for smoother shifting. It offers a fourth gear, overdrive, for increased fuel efficiency. The torque converter clutch automatically engages at cruising speeds to improve fuel efficiency. Typically, transmission shifts are controlled hydraulically, however, the 4L80-E transmission uses electric signals to specific gear shift solenoids to produce smooth shifts and quiet operation.

A neutral safety switch prevents the vehicle from being started if the transmission shift lever is in a position other than P (park) or N (neutral). Another safety feature is an interlock which prevents the vehicle from being shifted out of P unless the key is in the RUN position and the service brake pedal is depressed. A transmission warning light on the instrument panel will illuminate if there is a problem with the transmission.

The Transmission Control Module (TCM) selects the appropriate gear ratio based on the input from the throttle position (TP) sensor and the vehicle speed input. Other input data may modify the shift points to some extent but the throttle position and vehicle speed data are the primary basis of gear ratio selection.

For increased power, depressing the accelerator to the floor will activate the throttle position sensor kick-down feature and will shift the transmission into a gear range lower than is selected on the gear range lever. The throttle position sensor is located on the fuel pump.

The major components of the transmission are (Figure 5-1):

- TWO BAND ASSEMBLIES
  - Front band
  - Rear band
- FIVE MULTIPLE DISC CLUTCH ASSEMBLIES
  - Forward clutch
  - Intermediate clutch
  - Direct clutch
  - Fourth clutch
  - Overrun clutch
- THREE OVERRUNNING CLUTCHES
  - Lo Roller clutch
  - Intermediate sprag
  - Overdrive Roller clutch
- THREE PLANETARY GEAR SETS
- CONTROL VALVE ASSEMBLY WITH TWO ELECTRONIC SHIFT SOLENOIDS
- INPUT AND OUTPUT SPEED SENSORS
- TORQUE CONVERTER CLUTCH

Oil pressure is supplied by a gear-type oil pump. Oil pressure is regulated by a pressure control solenoid, and shift points are controlled by shift solenoids via powertrain control module (PCM) operation. The torque converter clutch apply and release is controlled by a pulse width modulated (PWM) solenoid.

The 4L80-E automatic transmission has a metal identification nameplate attached to the case exterior. This information will assist in the servicing and determination of replacement parts.

***CAUTION**: When fasteners are removed, reinstall in same location. Replace if necessary with a fastener of equal size and equal or better quality. Fasteners which will be not reused or which require locking compound are noted in the procedures. Torque fasteners as required in text, or equipment malfunction or damage could result.*

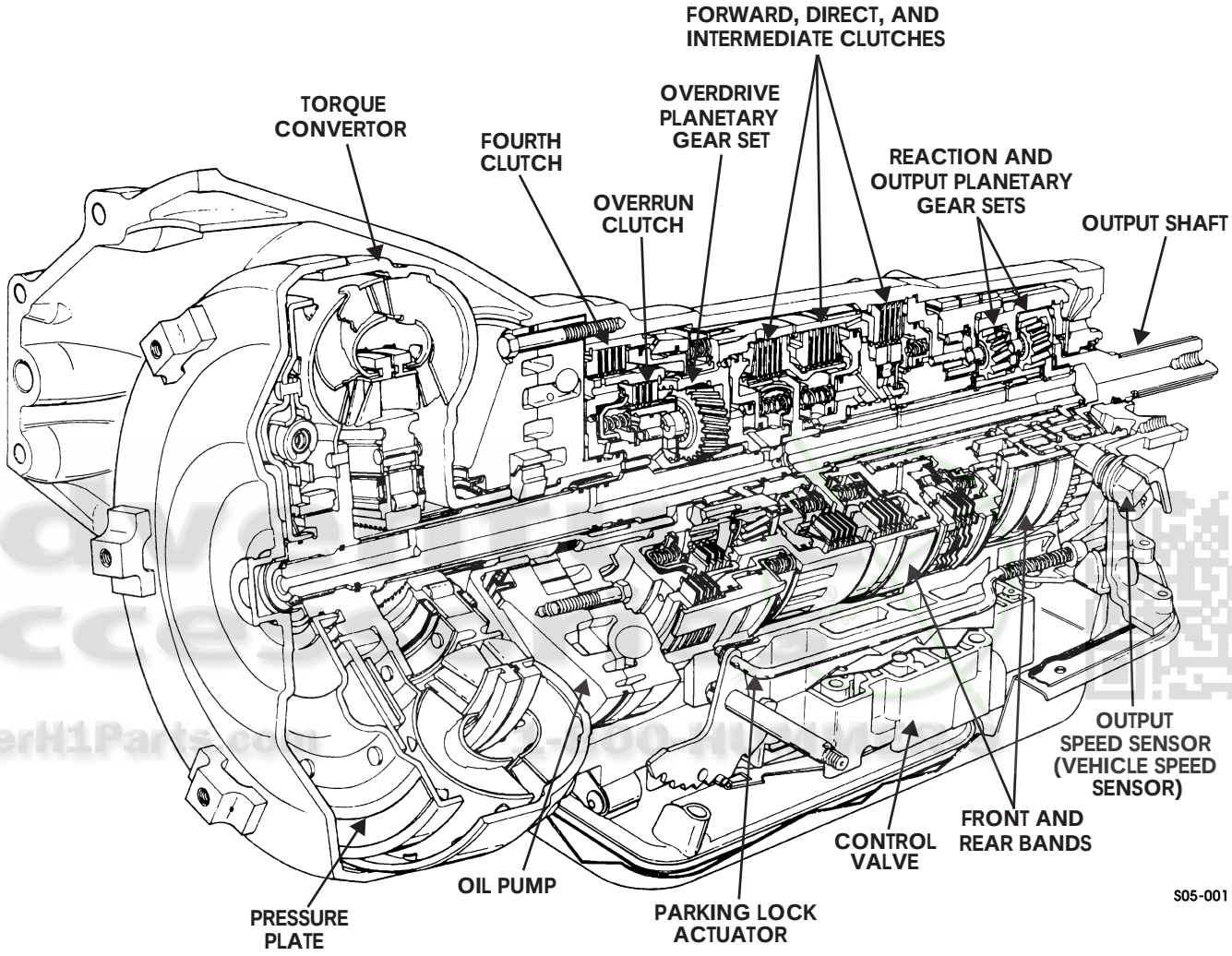


Figure 5-1: Transmission

***CAUTION**: Use of air powered tools is not recommended for assembling or disassembling transmissions. Incorrect bolt torquing can lead to misalignment of or breakage of parts and lead to malfunction of assemblies. This information, vital to diagnosis, can only be detected when using hand tools.*

TRANSMISSION CONTROL MODULE (TCM)

The Transmission Control Module (TCM) is an electronic device which monitors various inputs in order to control various transmission functions including shift quality and transmission diagnostics (Figure 5-3). The control module receives various input information from sensors, switches, and components to process for use within its control program. Based on this input information, the control module controls various transmission output functions and devices. The control module is located within the passenger compartment, underneath the engine access cover.

Data Link Connector (DLC)

The data link connector is the means of communicating with the TCM. This connector is mounted on a bracket on the left side of the steering column just below the instrument panel.

A scan tool (equivalent to the TECH-1) with appropriate adapters can be attached to the DLC and provide two-way communication with the TCM.

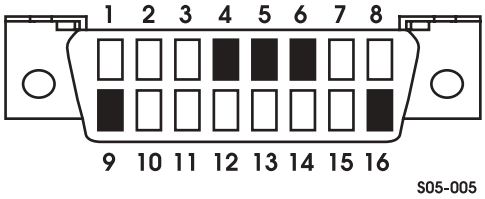


Figure 5-2: 16-Pin Connector

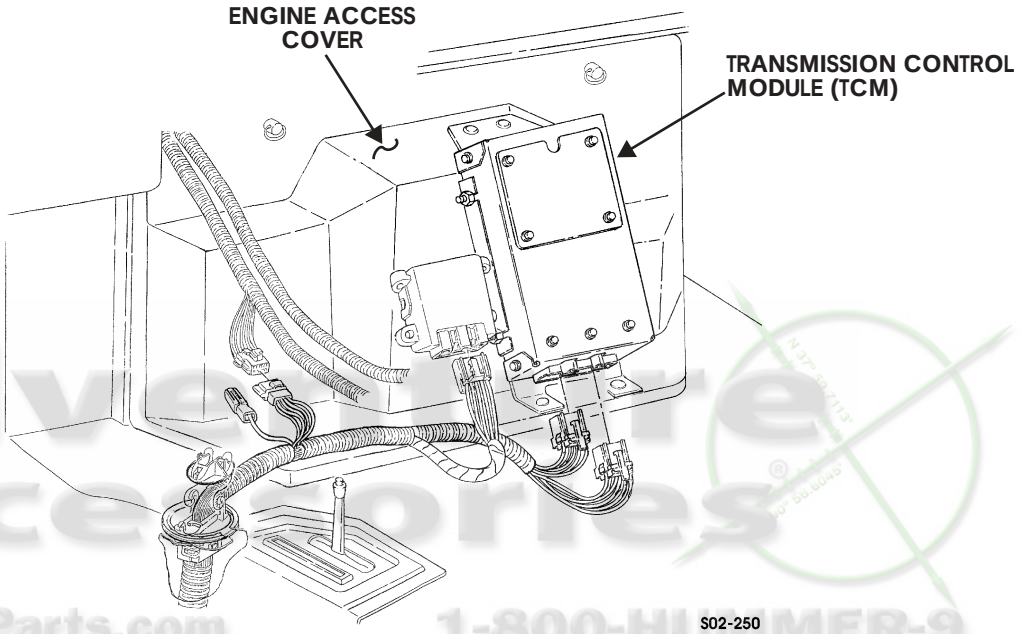


Figure 5-3: Transmission Control Module

To manually access information codes, locate the DLC connector. This connector contains 16 cavities (Figure 5-2). Trouble codes may be accessed by jumping across terminals 5 and 6 of the DLC connector with a wire spade connector, paper clip, or other suitable tool and turning the ignition key to the RUN position (the engine must not be running). The CHECK TRANS* lamp will flash three times (code 12) to indicate the TCM is capable of diagnostics. Following the code 12 display, each stored code will be displayed three times in numerical order from the lowest to the highest. When all codes have been displayed, code 12 will repeat to indicate the end of the code display.

*May be marked TRANS or have an ISO gear symbol. This lamp is also referred to as the MALFUNCTION INDICATOR LAMP (MIL).

SYSTEM OPERATION

In order to troubleshoot and service this transmission, it is important to understand how the TCM and transmission interact with their sensors and control elements.

The TCM receives data from various sensors, computes the optimum gear ratio based on the inputs, and causes the transmission to shift into the correct ratio at the best time.

Input sensors to the TCM:

- Throttle position (TP)
- Transmission Output Speed Sensor (TOSS) (Vehicle Speed Sensor)
- Transmission Input Speed Sensor (TISS)
- Transmission Range (TR) Pressure Switch Assembly
- Brake Switch
- Engine Coolant Temperature (ECT)
- Transmission Fluid Temperature (TFT)

Output Controls of the TCM:

- Shift Control Solenoids
- Pressure Control Solenoid
- Torque Converter Clutch Solenoid

Throttle Position (TP) Sensor

The Throttle Position (TP) sensor is a potentiometer (a device for measuring an unknown voltage or potential difference by comparison to a standard voltage). The TP sensor sends a voltage to the TCM, varying from approximately 0.5 volts to approximately 5 volts. This voltage signal to the TCM represents throttle shaft angle. At closed throttle, the signal voltage to the TCM is approximately 0.5 volts. As the throttle shaft angle increases, the signal voltage increases to greater than 4.5 volts at wide open throttle. The TP sensor is attached to the fuel injector pump assembly (Figure 5-4).

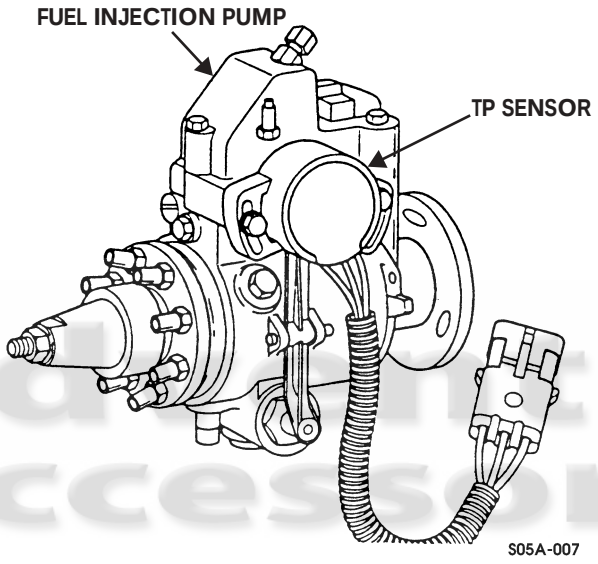


Figure 5-4: Throttle Position Senso

Transmission Output Speed Sensor (TOSS) (Vehicle Speed Sensor)

This device contains a permanent magnet surrounded by a coil of wire producing a magnetic field which is interrupted by rotor teeth on the output shaft. As the teeth interrupt the magnetic field, an AC voltage is generated in the circuit. This device is used to provide an output shaft speed signal to the control module. The TCM uses the TOSS signal input to:

- Calculate vehicle speed, trans output speed, and TCC slip speed.
- Control shift quality.

The TOSS is attached to the transmission output shaft housing (Figure 5-5).

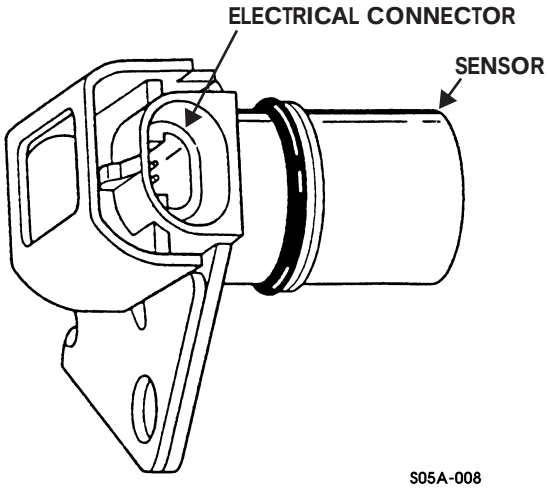


Figure 5-5: Input and Output Speed Sensors

Transmission Input Speed Sensor (TISS)

This device (Figure 5-6) contains a permanent magnet surrounded by a coil of wire producing a magnetic field which is interrupted by rotor teeth cut into the outside diameter of the forward clutch housing (Figure 5-5). As the serrations interrupt the magnetic field, an AC voltage is generated in the circuit. This device is used to provide an input speed signal to the control module. The TCM uses the TISS signal input to:

- Calculate TCC slip speed.
- Calculate gear ratios.

The TISS is attached to the transmission case over the forward clutch housing (Figure 5-6).

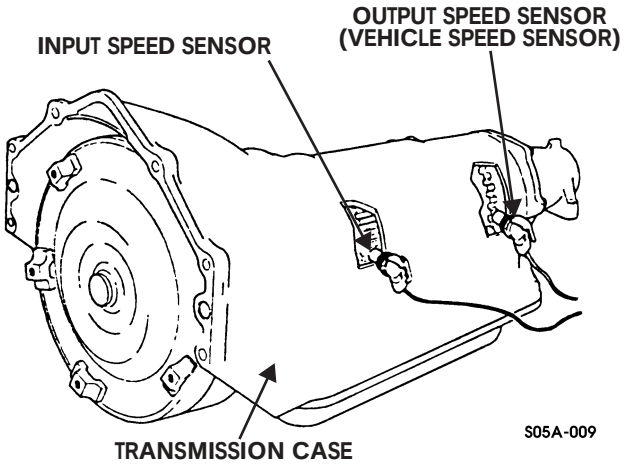


Figure 5-6: Locations of TISS and TOSS

Transmission Range (TR) Pressure Switch Assembly

This device is a set of five, normally open, pressure switches that detect fluid pressure within the control valve body passages (Figure 5-7). The five pressure switches are connected to three signal circuits referred to as range signals A, B, and C (Table 5-1).

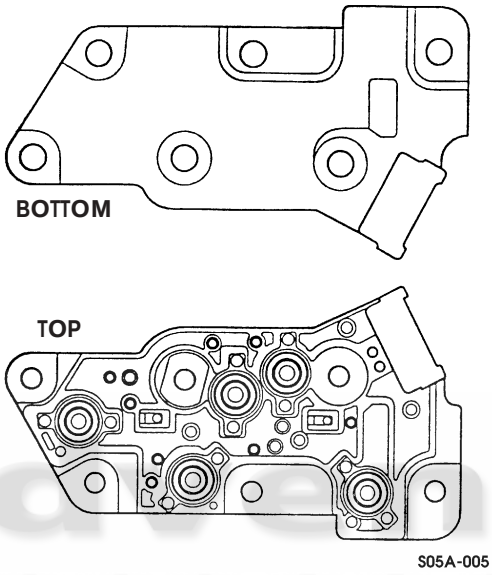


Figure 5-7: TR Pressure Switch Assembly

The combination of pressure switch states determine the voltage signal (B+ or 0) on each range signal circuit to the control module. These range signals are then interpreted by the TCM to indicate the transmission gear range selected. The transmission range fluid pressure switch assembly is attached to the control valve body within the transmission. The assembly is accessible by removing the oil pan.

Table 5-1: Valid Combination Chart

Range Signal	A	B	C
Park	ON	OFF	ON
Rev	OFF	OFF	ON
Neutral	ON	OFF	ON
D4	ON	OFF	OFF
D3	ON	ON	OFF
D2	ON	ON	ON
D1	OFF	ON	ON
Illegal	OFF	ON	OFF
Illegal	OFF	OFF	OFF

Expected Readings
ON = B+ OFF = 0 VOLTS

Brake Switch

This electrical switch is used to indicate brake pedal status. This switch is normally closed when the brake pedal is not applied. When the brake pedal is applied, the switch will open, changing the signal to the TCM. The TCM uses this signal to de-energize the TCC solenoid when the brake pedal is applied. The brake switch is located on the brake pedal mounting bracket.

Engine Coolant Temperature (ECT) Sensor

The Engine Coolant Temperature (ECT) sensor is a thermistor (a device that changes resistance according to change in temperature) used to indicate engine coolant temperature (Figure 5-8). High sensor resistance produces high signal input voltage which corresponds to low engine temperature. Low sensor resistance produces low signal input voltage which corresponds to high engine coolant temperature. The PCM uses the ECT sensor signal to determine the TCC apply and release schedules. The ECT sensor is attached to the engine assembly.

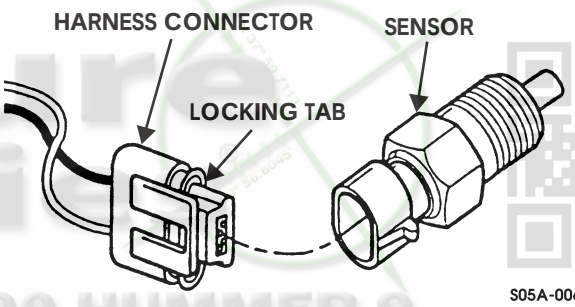


Figure 5-8: Engine Coolant Temperature (ECT) Sensor

Transmission Fluid Temperature (TFT) Sensor

The TFT sensor is a thermistor (a device that changes resistance according to changes in temperature) used to indicate transmission fluid temperature. High sensor resistance produces high signal input voltage which corresponds to low fluid temperature. Low sensor resistance produces low signal input voltage which corresponds to high fluid temperature. The TCM uses the TFT sensor signal input to determine the following:

- TCC apply and release schedules.
- Hot mode determination.
- Shift quality.

The TFT sensor is part of the internal wiring harness within the transmission (Figure 5-12).

OUTPUT CONTROLS OF TCM

The TCM determines the optimum gear ratio and TCC engagement. Signals are transmitted through a transmission wiring harness to control elements in the transmission, these are:

- l-2 Shift Solenoid.
- 2-3 Shift Solenoid.
- Pressure Control Solenoid (PCS).
- TCC PWM Solenoid.

NOTE: The transmission internal wiring harness ties the TR switch assembly and control solenoids together. The harness provides the wiring path through the transmission case (Figure 5-12).

1-2 Shift Solenoid

This electrical device is used to control fluid flow acting on the 1-2 and 3-4 shift valves (Figure 5-9). The solenoid is a normally open exhaust valve that is used with the 2-3 shift solenoid to allow four different shifting combinations. The solenoid is attached to the rear of the control valve body within the transmission, it is accessible by removing the oil pan.

2-3 Shift Solenoid

This electrical device is used to control fluid flow acting on the 2-3 shift valves (Figure 5-9). The solenoid is a normally open exhaust valve that is used with the l-2 shift solenoid to allow four different shifting combinations. The solenoid is attached to the rear of the control valve body within the transmission. It is accessible by removing the oil pan.

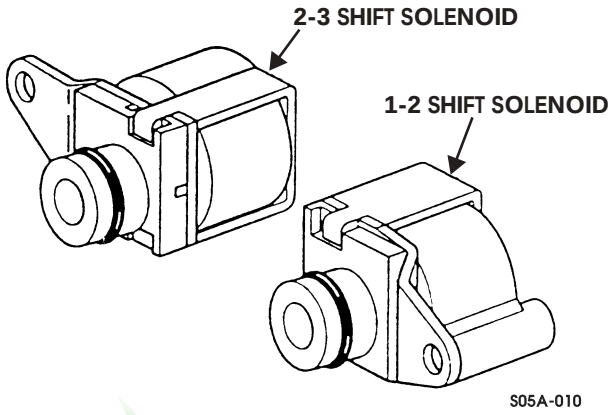


Figure 5-9: Shift Solenoids

Pressure Control Solenoid (PCS)

This electrical device is used to control fluid line pressure by controlling actuator feed limit fluid flow acting on an internal spool valve and spring pressure (Figure 5-10). The solenoid is a normally closed solenoid valve that controls fluid pressure when operating on a duty cycle. The solenoid is attached to the front of the control valve body within the transmission. It is accessible by removing the oil pan.

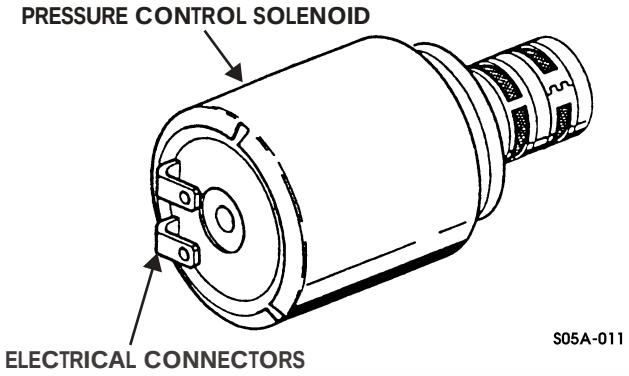


Figure 5-10: Pressure Control Solenoid

Torque Converter Clutch (TCC) PWM Solenoid

This electrical device is used to control fluid acting on the TCC converter clutch valve, which then controls TCC apply and release (Figure 5-11). The TCC PWM solenoid is used to provide smooth engagement of the torque converter clutch by operating on a negative duty cycle percent of ON time. This solenoid is attached to the front of the control valve body within the transmission. It is accessible by removing the oil pan.

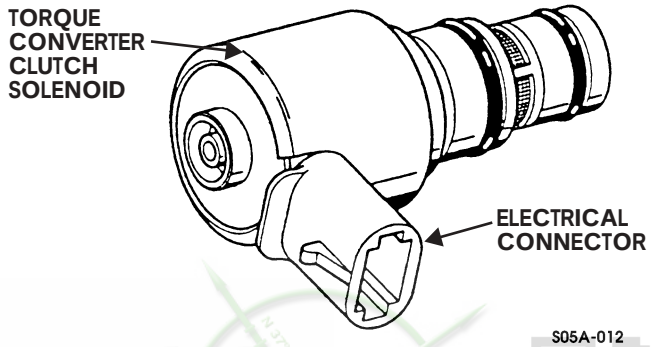


Figure 5-11: Torque Converter Clutch Solenoid

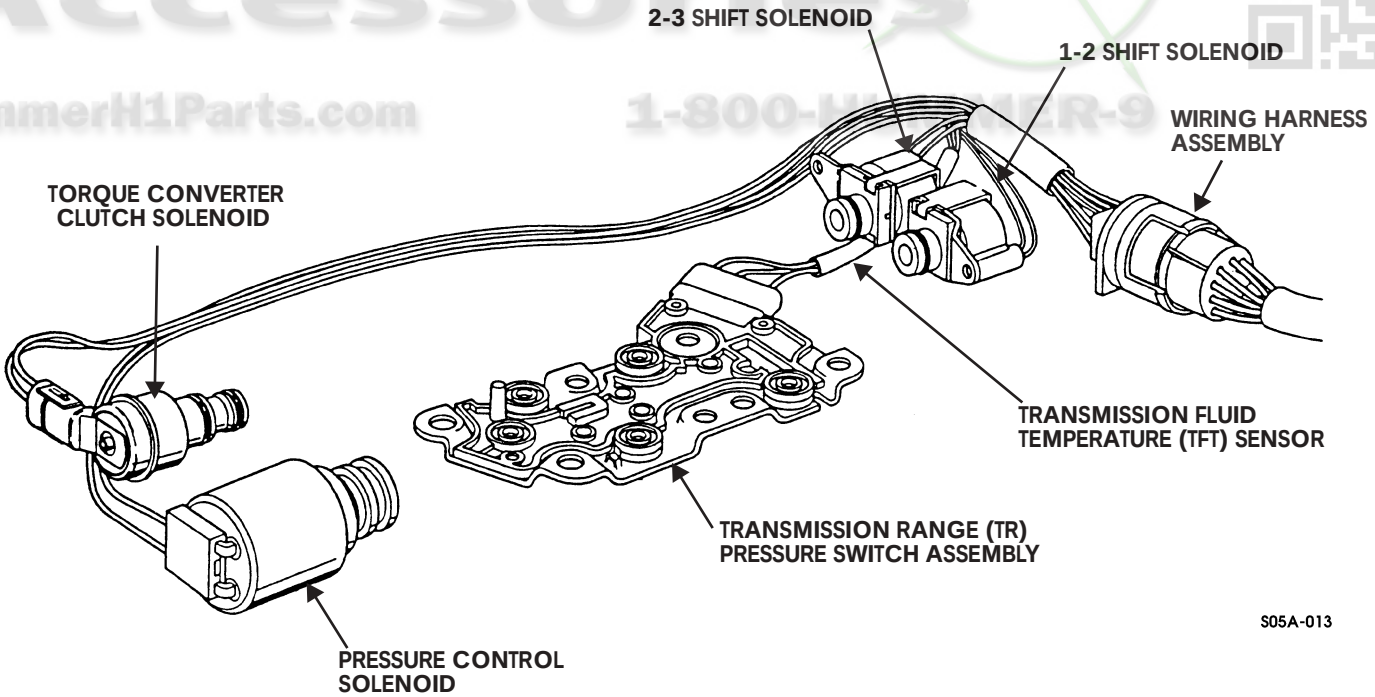


Figure 5-12: Transmission Internal Wiring Harness and Solenoids

TRANSMISSION DIAGNOSIS AND TROUBLESHOOTING

Initial Action

Obtain as much information as possible from the user. The technician may have to ask questions concerning the problem.

- When does it occur? Speed shifting up or down, loaded vehicle, full throttle, etc.
- Temperature? Transmission, engine, ambient, etc.
- Noise? Type, when, constant, intermittent, all gears, one gear, etc.
- Recent service? What and why?
- Refer to definitions to add more information

Transmission Definitions

The following definitions are being provided to establish a common language and assist the user in describing transmission related conditions.

Throttle Positions

Minimum Throttle - The least amount of throttle opening required for an upshift.

Light Throttle - Approximately 25% of accelerator pedal travel.

Medium Throttle - Approximately 50% of the accelerator pedal travel.

Heavy Throttle - Approximately 75% of the accelerator pedal travel.

Wide Open Throttle (WOT) - 100% travel of the accelerator pedal.

Full Throttle Detent Downshift - A quick application of the accelerator pedal to its full travel, forcing a downshift. Previously this was referred to as kickdown.

Zero Throttle Coastdown - A full release of the accelerator pedal while the vehicle is in motion and in drive range.

Engine Braking - A condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Shift Condition Definitions

Bump - A sudden and forceful application of a clutch or band.

Chuggle - a bucking or jerking condition that may be engine related. This condition may be most noticeable when the converter clutch is engaged. It is similar to the feel of towing a trailer.

Delayed (Late or Extended) - A condition in which a shift does not occur when expected. For example, a clutch or band engagement that hesitates during a part or wide open throttle acceleration or when manually downshifting.

Double Bump (Double Feel) - Two sudden and forceful applications of a clutch or band.

Early - A condition in which the shift occurs before the vehicle has reached a proper speed and tends to labor the engine after the upshift.

End Bump (End Feel or Slip Bump) - A firmer feel at the end of a shift than the feel at the start of the shift.

Firm - A noticeable quick application of a clutch or band that is considered normal with a medium to heavy throttle shift. Should not be confused with “harsh” (rough).

Flare (Slipping) - A quick increase in engine rpm accompanied by a momentary loss of torque. This most generally occurs during a shift.

Harsh (Rough) - A clutch or band application which is more noticeable than “firm”. This condition is considered undesirable at any throttle position.

Hunting (Business) - A repeating quick series of upshifts and downshifts that cause a noticeable change in engine rpm. An example could be described as a 4-3-4 shift pattern.

Initial Feel - A distinctly firmer feel at the start of a shift than at the end of a shift.

Late - A shift that occurs when the engine is at a higher than normal rpm for the current gear.

Shudder - A repetitious jerking sensation similar to “chuggle” but more severe and rapid. This condition may be most noticeable during certain speeds. The term shudder may also be used to define the condition experienced after converter clutch engagement.

Slipping - A noticeable increase in engine rpm without an increase in vehicle speed. A slip usually occurs during or after initial clutch or band engagement.

Soft - A slow, almost unnoticeable clutch application with very little shift feel.

Surge - A repeating engine-related feeling of acceleration and deceleration that is less intense than “chuggle.”

Tie-up - A condition where two opposing clutches are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine rpm.

Noise Conditions

Gear Noise - This noise is a whine which is related to vehicle speed and is most noticeable in first gear and reverse. A gear noise condition may become less noticeable or go away after an upshift.

Pump Noise - This noise is a high-pitched whine that increases in intensity with engine rpm. This condition may also be noticeable in PARK and NEUTRAL with the vehicle stationary.

Analysis Plan

Based on initial information and knowledge of transmission operation, a tentative plan of analysis should be made.

1. Is the problem of a mechanical nature? If so, is it internal or external?
2. Is the problem of an electrical nature? If so, is it internal or external?
3. Is the problem of an overheating nature? If so, is it internal or external?
4. Is a road test necessary?
5. If there was recent service, could the service have caused the problem?

Preliminary Checking Procedure

An automatic transmission which is not operating properly may be affected by one or more of the following conditions:

- Improper fluid level
- Improper manual linkage adjustment
- Internal and external fluid leaks
- Electrical system failure
- Mechanical component failure

Transmission Shift Linkage

Vehicle Starts In Shift Position Other Than N (Neutral) or P (Park)

1. Check operation of neutral safety switch. Disconnect harness leads 14A and 14B from neutral safety switch. Using ohmmeter, check for continuity in switch leads while moving shift lever through operating ranges. If continuity is indicated in any position other than N or P, replace neutral safety switch.
2. Check transmission shift linkage. Adjust transmission shift linkage so vehicle starts only in N or P. Adjustment is as follows:
   a. Position shift lever arm into N position.
   b. Remove cotter pin and washer securing shift rod trunnion to shift lever arm.
   c. Disconnect shift rod from shift lever arm. Ensure shift lever arm is in the N position. Turn shift rod trunnion forward or backward on shift rod so that it slips easily into hole in the shift lever arm.
   d. Connect shift rod to shift lever arm with washer and cotter pin.

Transmission Does Not Operate Properly According To Shift Lever Position

1. Check transmission shift linkage. Adjust shift linkage, if necessary.
2. Repair or replace transmission as required.

Transmission Slips In Any Gear

1. Check fluid level and condition. Service as indicated.
2. Test transmission oil pressures.
3. Repair or replace transmission as required.

Erratic Shift Points Or No Detent Downshifts

1. Check transmission fluid level. Add fluid, if necessary.
2. Check adjustment of throttle position sensor, adjust as necessary.
3. Replace transmission oil filter.
4. Test transmission oil pressure.
5. Repair or replace transmission.

Internal and External Fluid Leaks

Internal fluid leaks usually cause low pressure problems, improper control valve operation, slipping or failure of clutch packs (loss of a gear ratio).

External leaks cause poor performance due to loss of fluid, lowering pressure.

Electrical System Failure

This type failure can cause poor or erratic shifting, skipped gears, total transmission failure depending on which component failed.

Mechanical Failure

This type of failure can cause skipped gears, low pressure failure, total transmission failure.

Transmission Fluid Information

Check fluid level, color, and condition (refer to Transmission Fluid Check Chart) to diagnose transmission problems. Minor problems can result in major transmission repairs. Always check fluid level after it has reached a normal operating temperature of 180-200°F (82-93°C). Normal operating temperature is reached after approximately 15 miles (24 km) of driving. Use Dexron II E or Dexron III transmission fluid. Refer to Maintenance Intervals (Section 1) for maintenance information and servicing intervals.

***CAUTION**: Do not overfill. Overfilling will cause foaming, loss of fluid, and possible damage to the transmission.*

Transmission fluid is red when it is new. The red dye is added so technicians can distinguish it from engine oil or antifreeze. The red dye is not an indicator of the fluid quality and is not permanent. As the vehicle is driven, the transmission fluid will begin to look darker in color. The color may eventually appear light brown.

If the fluid is checked immediately after the vehicle has been operated under certain conditions, fluid level readings may be inaccurate. Driving in the following conditions may cause inaccurate readings:

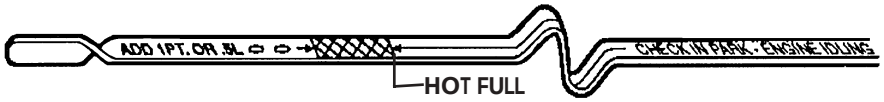
- Ambient temperature above 90 °F (32° C)
- Sustained high speed
- Heavy city traffic during hot weather
- Towing

Transmission Fluid Checking Procedure

NOTE: The automatic transmission fluid level must be checked with the vehicle at normal operating temperature 180-200° F (82-93° C). Temperature will greatly affect transmission fluid level. If the vehicle is not at normal operating temperature and the proper checking procedures are not followed, the result could be a false reading of the fluid level.

1. Start the engine and drive the vehicle for a minimum of 15 miles (24 km), or until normal operating temperature is reached.
2. Park the vehicle on level ground.
3. Move the gear selector to PARK.
4. Apply the parking brake.
5. Let the vehicle idle for 3 minutes with accessories off.
6. Check fluid level, color, and condition (refer to Transmission Fluid Check Chart).

Transmission Fluid Check Chart for Hydra-Matic 4L80-E



NOTE: Fluid level should be in crosshatched area on fluid level indicator blade. Check at operating temperature.

- CHECK FLUID COLOR
  - RED
    - CHECK FLUID LEVEL
      - HIGH
        - REMOVE EXCESS FLUID
      - OK
      - LOW
        - ADD FLUID TO OBTAIN PROPER LEVEL
        - CHECK FOR EXTERNAL LEAKS
        - CORRECT LEAK CONDITION
      - FOAM
        - FLUID LEVEL HIGH
        - REMOVE EXCESS FLUID
        - CONTAMINANTS IN FLUID
        - DRAIN FLUID TO DETERMINE SOURCE OF CONTAMINATION
        - TRANSMISSION OVERHAUL REQUIRED
        - FLUSH COOLER
        - ADD NEW FLUID
        - CHECK FLUID LEVEL
  - NONTRANSPARENT PINK
    - REPLACE COOLER
    - CHANGE FLUID AND FILTER
  - LT. BROWN
    - NOTE: TRANSMISSION FLUID MAY TURN DARK WITH NORMAL USE AND DOES NOT ALWAYS INDICATE CONTAMINATION OR OXIDATION
    - CONTAMINANTS IN FLUID
    - NOTICE: A VERY SMALL AMOUNT OF MATERIAL IN THE BOTTOM PAN IS A NORMAL CONDITION
    - LARGE PIECES OF METAL OR OTHER MATERIAL IN THE BOTTOM PAN
    - TRANSMISSION OVERHAUL REQUIRED
    - FLUSH COOLER
    - ADD NEW FLUID
    - CHECK FLUID LEVEL

PERFORM ROAD TEST

Noise And Vibration Analysis

A noise or vibration that is noticeable when the vehicle is in motion may not be from the transmission (refer to table 5-2).

If noise or vibration is noticeable in PARK and NEUTRAL with engine at idle, but it is less noticeable as rpm increases, the cause may be poor engine performance.

A screeching or clanking noise while cranking can usually be traced to a starter or flexplate problem. It may also occur when engine is shifting from driving the transmission to braking the transmission.

NOTE: Check engine accessory drive components: water pump, power steering pump, and alternator for the source of noise before checking transmission.

1. If noise is heard in neutral and all driving ranges:
   a. Check torque converter for loose mounting capscrews and damage. Tighten capscrews or replace torque converter if damaged.
   b. Check flywheel for damage. Replace flywheel if damaged (Section 2).

Table 5-2: Possible Causes of Noise and Vibration

Component to Inspect	Conditions to Check
Tires	• Uneven wear • Imbalance • Mixed sizes • Mixed radial and bias ply
Suspension components	• Alignment and wear • Loose fasteners
Engine/transmission mounts	• Damage • Loose bolts
Transmission case mounting holes	• Missing bolts, nuts, studs • Stripped threads • Cracks
Flywheel	• Missing or loose bolts • Cracks • Imbalance
Torque converter	• Missing or loose bolts or lugs • Missing or loose balance weights

PREPARING AND USING THE SCAN TOOL

Other scan tools can be used, however, the Tech-1A scan tool is preferred for quick and proper diagnosis of the 4L80-E transmission (Figure 5-13). The Tech-1A allows two-way communication between the operator and the vehicles' computerized transmission system and also allows for control of some transmission functions during testing.

WARNING: Before performing any checks or repairs on the vehicle:

- ***Always set the parking brake securely***
- ***Vent the exhaust***
- ***Shift the transmission into Neutral or Park***
- ***Block all driving wheels***

NOTE: Technicians should be familiar with scan tool operation before attempting to diagnose the transmission using the Tech-1A scan tool. Refer to the Tech-1A operating instructions if necessary.

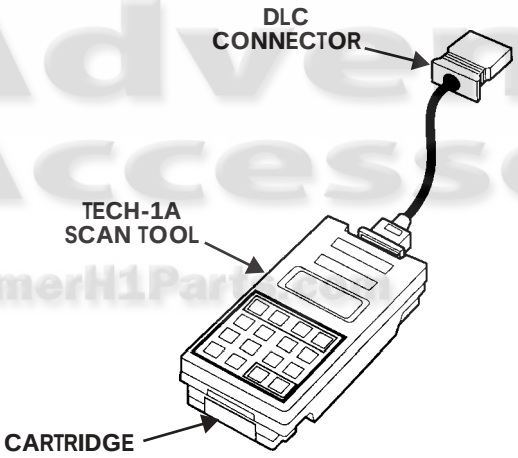


Figure 5-13: Scan Tool

1. Turn the ignition switch to the ON position and verify TRANS lamp operation. The lamp should illuminate. If it does not, for proper service procedures refer to Electrical Systems (Section 12).
2. Install a 1995 powertrain cartridge in the bottom slot of the Tech-1A by squeezing the tabs on the cartridge and sliding it into the connector. Do not force the cartridge in. It only fits in one way.
3. Make sure the ignition is off, then connect the power cord to the cigarette lighter receptacle. The Tech-1A display should become active.
4. If the Tech-1A display does not become active, inspect the cigarette lighter receptacle for damage or corrosion. If required, inspect fuse 4D in the lower mini-fuse box for proper operation. If you use the optional battery cable adapter, be sure the battery cable adapter polarity is correct. If the polarity is not correct, the scan tool could be damaged.
5. Connect the 14 to 12 pin adapter (supplied with the Tech-1A), and an additional 12 to 16 pin adapter to the Tech-1A DLC connector.
6. Locate the vehicle DLC connector under the left side dash near the steering column. Insert the Tech-1A DLC connector with adapters to the vehicle DLC diagnostic connector.
7. Turn the ignition on. Testing can begin by following the menu on the Tech-1A display.
8. Enter 95 for the model year. (Note that 1994 and 1995 are the same for this step.)
9. Select F6 for diesel.
10. Select NO until 6.5L VIN Y is displayed, then select ENTER.
11. Perform an on-board diagnostic check by selecting YES.
12. Continue following the Tech-1A display "menu" to perform additional testing as required. Refer to the Tech-1A operating instructions, as required, for proper procedures.

NOTE: If serial data is not displayed or the TRANS light fails to operate, disconnect the Tech-1A from the vehicle. Perform a self-diagnostic test on the scan tool. Refer to the Tech-1A operating instructions for proper procedures. If necessary, perform the following tests on the vehicle DLC diagnostic connector and fuse box.

***CAUTION**: Use only high impedance-type ohmmeters for electrical testing. If another type of meter is used, false readings and damage to the circuits may occur.*

NOTE: For more information, refer to Electrical System (Section 12).

13. With the ignition switch off and the TCM connectors disconnected, use a high-impedance ohmmeter to test the following vehicle DLC pin connections:
    - Vehicle DLC connector pin number 4 to ground. A low to zero resistance reading should be obtained. If not, repair vehicle DLC connector 4 to ground connection.
    - Vehicle DLC connector pin number 5 to ground. A low to zero resistance reading should be obtained. If not, repair vehicle DLC connector 5 to ground connection.
    - Vehicle DLC connector pin number 5 to TCM connector pin C1 and C2. A low to zero resistance reading should be obtained. If not, repair vehicle DLC connector 5 to TCM connector pin C1 and C2 connection.
    - Vehicle DLC connector pin number 6 to TCM connector pin A8. A low or zero resistance reading should be obtained. If not, repair vehicle DLC connector 6 to TCM connector pin A8 connection.

14. With the TCM connectors attached and ignition switch on, use a voltmeter to test the following vehicle DLC pin connections:
    - Connect the voltmeter negative probe to ground and the positive probe to vehicle DLC connector pin number 16. A reading of 12 volts should be obtained. If not, repair the connection between vehicle DLC connector and fuse H2 in the upper mini-fuse box.
    - Connect the voltmeter negative probe to ground and positive probe to vehicle DLC pin connector 6. A reading of 5 volts should be obtained. If not, back-probe TCM connector by removing connector pin retaining clip and testing for 5 volt diagnostic request signal directly from the TCM.

Electrical Shift Test

1. Move gear selector to PARK and set the parking brake.
2. Connect the scan tool to the DLC terminal.
3. Start the engine.
4. Verify that the following signals are present:
    - Input speed
    - Transmission output speed (TOSS)
    - Engine speed
    - Transmission range
    - Current gear
    - Desired pressure control solenoid
    - Actual pressure control solenoid
    - Transmission temperature
    - Throttle angle
    - TCC duty cycle
    - System voltage
    - Brake switch
5. Monitor the brake switch signal while tapping the brake pedal with your foot. The brake switch should be open when the brake pedal is depressed, and be closed when the brake pedal is released.
6. Monitor the transmission range switch signal and move the gear selector through all ranges. Verify that the transmission range switch value matches the gear range indicated on the instrument panel or console. Gear selections should be immediate and not harsh.
7. Move gear selector to NEUTRAL and monitor the throttle angle signal while increasing and decreasing engine rpm with the accelerator pedal. The throttle angle should increase with the engine rpm.

Road Test

Perform the electrical shift test prior to a road test.

This road test should only be performed when traffic and road conditions permit, observing all traffic regulations.

Upshifts and Torque Converter Clutch (TCC) Applications

The vehicle transmission control module calculates upshift points based on two inputs: percent throttle angle and transmission output speed. When the computer says a shift should occur, an electrical signal is sent to the shift solenoids which in turn move the valves to perform the upshift.

The shift speed chart; Table 5-3, has been updated to reference throttle angle instead of minimum throttle or wide open throttle (WOT) to make shift speed measurement more uniform and accurate. A scan tool is necessary to monitor throttle angle.

Scan tools like the Tech-1A have been programmed to measure and record shift point information. Check your scan tool instruction manual to see if this test is available with the scan tool you are using.

With the gear selector in D (overdrive):

1. Look at the shift speed charts and choose a 10 or 25 percent throttle angle.
2. Set up the scan tool to monitor throttle angle.
3. Accelerate to the chosen throttle angle and hold the throttle steady.
4. As the transmission upshifts, note the shift speed for:
    2nd gear
    3rd gear
    4th gear

NOTE: Shift speeds may vary due to slight hydraulic delays responding to electronic controls. A change from the original equipment tire size also affects shift speeds.

NOTE: Be alert to determine when the TCC applies. This should occur in third or fourth gear. If TCC application is not noticed by an rpm drop, refer to Torque Converter Clutch Diagnosis.

NOTE: The TCC will not apply unless the transmission fluid has reached a minimum operating temperature.

5. Repeat steps 1-4 using several different throttle angles.

Manual Downshifts

The shift solenoids do not control the initial downshift during manual downshifts. All manual downshifts are hydraulic. The solenoid states will change either during manual downshift selection or slightly afterward (Tables 5-4 through 5-11).

Table 5-3: Throttle Angle vs. Speed (VSS or TOSS)

Shift RPM (Transmission Output)					
Gear Change TPS%	**10%**	**25%**	**50%**	**100%**	**5 - 10%**
Upshift 1- 2 ± 150 rpm	455	600	1020	1260	—
Upshift 2 - 3 ± 200 rpm	800	1210	1810	—	—
Upshift 3 - 4 ± 250 rpm	1280	1400	2370	—	—
Downshift 3 - 2 ± 100 rpm	—	—	—	—	650
Downshift 2 - 1 ± 100 rpm	—	—	—	—	325

Table 5-4: 4-3 Downshift

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
40 to 45 mph (64 to 72 km/h)	4th	Release accelerator pedal while moving gear selector to D3	• TCC releases • Trans downshifts to 3rd gear immediately • Engine slows vehicle down

Table 5-5: 4-2 Downshift

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
40 to 45 mph (64 to 72 km/h)	4th	Release accelerator pedal while moving gear selector to D2	• TCC releases • Trans downshifts to 2nd gear immediately • Engine slows vehicle down

Table 5-6: 4-1 Downshift

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
30 mph (48 km/h)	4th	Release accelerator pedal while moving gear selector to D1	• TCC releases • Trans downshifts to 1st • Engine slows vehicle down

Coasting Downshifts

Table 5-7: Check Torque Converter Clutch Release

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
Coasting	4th	• Accelerate to 4th gear with TCC applied • Release accelerator pedal and lightly apply brakes	• TCC Releases • Downshifts occur at speeds shown on the shift speed chart

Manual Gear Range Selection

Upshifts in the manual gear range are controlled by the shift solenoids. Perform the following tests by accelerating at 10-15 percent TP Sensor.

Table 5-8: Manual Drive (D-Drive)

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
Vehicle stopped	3rd	Accelerate	• 1-2 shift • 2-3 shift • TCC does not apply

Table 5-9: Manual Second (2)

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
Vehicle stopped	2nd	Accelerate	• 1-2 shift
35 mph (56 km/h)	2nd	Accelerate to 35 mph (56 km/h)	• 2-3 shift does not occur • TCC does not apply

Table 5-10: Manual First (1)

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
Vehicle stopped	1st	Accelerate to 20 mph (32 km/h)	• No upshifts occur • TCC does not engage

Table 5-11: Reverse (R)

VEHICLE SPEED	GEAR	ACTION	CONDITIONS TO OBSERVE
Vehicle stopped	Reverse	Accelerate slowly	1-2 solenoid is on

Use a scan tool to see if any transmission malfunction codes have been set. After repairing the vehicle, perform the road test and verify that the code has not been set again.

If the transmission is not performing well and no trouble codes have been set, there may be an intermittent condition. Check all electrical connections for damage or a loose fit. Some scan tools have a snapshot test which can help catch an intermittent condition that does not occur long enough to set a code.

TORQUE CONVERTER CLUTCH (TCC) DIAGNOSIS

The torque converter clutch is applied by fluid pressure which is controlled by a pulse width modulated (TCC) solenoid located inside the automatic transmission assembly. The solenoid is energized by completing an electrical circuit through a combination of switches and sensors.

TCC Functional Check Procedure

Inspect:

1. Install a tachometer or scan tool.
2. Drive the vehicle until proper transmission operating temperature is reached.
3. Drive the vehicle at 50 to 55 mph (80 to 88 km/h) with light throttle.
4. Maintaining throttle, lightly touch the brake pedal and check for release of the TCC and slight increase in engine RPM.
5. Release the brake, slowly accelerate, and check for a re-apply of the TCC and a slight decrease in engine rpm

To properly diagnose the torque converter clutch (TCC) system, perform all electrical testing first and then test the hydraulic system.

Additional TCC diagnosis information is available in the wiring diagram, Diagnostic Trouble Codes (DTC) Table 5-20, and the Malfunction Code and Defaults Table 5-13.

***CAUTION**: Use only high impedance-type ohmmeters for electrical testing on the TCC circuit. If another type of meter is used, false readings and damage to the circuits may occur.*

NOTE: The pulse width modulated (TCC) solenoid is different than other TCC solenoids; it runs on 32 hertz and is not an on-off switch.

Torque Converter Evaluation

The torque converter should be replaced if any of the following conditions exist:

- External leaks in the hub area.
- Converter hub is scored or damaged.
- Converter pilot is broken, damaged, or fits poorly into crankshaft.
- Steel particles are found after flushing the cooler and cooler lines.
- Pump is damaged, or steel particles are found in the converter.
- Vehicle has TCC shudder and/or no TCC apply. Replace only after all hydraulic and electrical diagnosis has been made. (Converter clutch material may be glazed.) Refer to TCC shudder diagnosis.
- Converter has an imbalance which cannot be corrected.
- Converter is contaminated with engine coolant containing antifreeze.
- Internal failure of stator roller clutch.
- Excess end play.
- Heavy clutch debris due to overheating (blue converter).
- Steel particles or clutch lining material are found in fluid filter or on magnet when no internal parts in unit are worn or damaged (indicates that lining material came from converter).

The torque converter should not be replaced if:

- The oil has an odor, is discolored, and there is no evidence of metal or clutch facing particles.
- The threads in one or more of the converter bolt holes are damaged. Correct with thread insert.
- Transmission failure did not display evidence of damage or worn internal parts, steel particles or clutch plate lining material in unit and inside the fluid filter.
- Vehicle has been exposed to high mileage (only). The exception may be where the TCC dampener plate lining has seen excess wear by vehicles operated in heavy and/or constant traffic.

Noise

Torque converter whine is usually noticed when the vehicle is stopped and the transmission is in DRIVE or REVERSE. The noise will increase when engine rpm is increased. The noise will stop when the vehicle is moving or when the torque converter clutch is applied because both halves of the converter are turning at the same speed.

Perform a stall test to make sure the noise is actually coming from the converter.

1. Place foot on brake.
2. Put gear selector in DRIVE.
3. Depress accelerator to approximately 1200 rpm for no more than six seconds.

***CAUTION**: If the accelerator is depressed for more than six seconds, damage to the transmission may occur.*

IMPORTANT: This noise should not be confused with pump whine noise which is usually noticeable in PARK, NEUTRAL, and all other gear ranges. Pump whine will vary with pressure ranges.

Torque Converter Stator

The torque converter stator roller clutch can malfunction in two different ways. It can either remain locked up at all times, or freewheel in both directions.

If the stator is freewheeling at all times, the vehicle tends to have poor acceleration from the standstill. The vehicle may act normal at speeds above 30 to 35 mph (48 to 56 km/h). If poor acceleration is noted, it should first be determined that the exhaust system is not blocked, the engine timing is correct, and the transmission is in FIRST gear when starting out.

If the engine accelerated freely to high rpm in NEUTRAL, it can be assumed that the engine and exhaust are normal. Checking for poor performance in DRIVE and REVERSE will help determine if the stator is freewheeling at all times.

If the stator is locked up at all times, performance from a standstill appears normal, however, engine rpm and acceleration is restricted or limited at high speeds. The engine may overheat with this condition. Visual examination of the converter may reveal a blue color from overheating.

If the torque converter has been removed from the vehicle, the stator roller clutch can be checked by inserting a finger into the splined inner race of the roller clutch and trying to turn the race in both directions. The inner race should turn freely clockwise, but not turn or be very difficult to turn counterclockwise.

TCC Shudder Diagnosis

The key to diagnosing TCC shudder is to note when it happens and under what conditions.

TCC shudder should only occur during the applying and/or releasing of the converter clutch - never after the TCC plate is fully applied.

While TCC is Applying or Releasing

If the shudder occurs while the TCC is applying, the problem is within the transmission or torque converter. Something is not allowing the clutch to become fully engaged, not allowing clutch to release, or is trying to release and apply the clutch at the same time. This could be caused by leaking turbine shaft seals, a restricted release orifice, a distorted clutch, a damaged torque converter housing surface due to long converter bolts, or defective friction material.

After TCC Has Applied

If shudder occurs after the TCC has applied (often with engine under load such as climbing a hill), most of the time there is nothing wrong with the transmission. As mentioned before, once the TCC has been applied, it is very unlikely that it will slip. Engine problems that may go unnoticed under light throttle and load become noticeable when going up a hill, or when accelerating, due to the mechanical lockup between engine and transmission.

REMEMBER: Once TCC is applied, there is no torque converter (fluid coupling) assistance. Engine or driveline vibrations could be unnoticeable before TCC engagement.

LINE PRESSURE CHECK PROCEDURE (FIGURE 5-14)

This test should be performed during a shop or road test when leaks, clutch slippage, or low fluid pressures are suspected.

The hydra-matic 4L80-E uses a gear-type oil pump to produce hydraulic pressure, and a pressure control solenoid to control that pressure after it leaves the pump. The pressure control solenoid is controlled by an electrical signal that ranges from 0 to 1.1 amp. One amp corresponds to a minimum line pressure (not 0 psi) and zero amps corresponds to a maximum line pressure (Table 5-12).

For reverse, a reverse boost valve increases the line pressure.

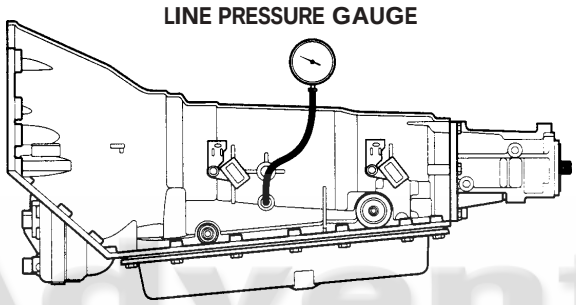


Figure 5-14: Line Pressure Gauge

Line pressures are calibrated for two sets of gear ranges – drive-park-neutral, and reverse. This allows the transmission line pressure to be appropriate for different pressure needs in different gear ranges:

Gear Range	Line Pressure Range
Drive, park, or neutral	35-171 PSI (241-1179 kPa)
Reverse	67-324 PSI (462-2334 kPa)

Before performing a line pressure check, verify that the pressure control solenoid is receiving the correct electrical signal from the vehicle computer:

1. Install a scan tool.
2. Start the engine and set parking brake.
3. Check for a stored pressure control solenoid malfunction code, and other malfunction codes.
4. Repair vehicle if necessary.

Inspect

- Fluid level
- Manual linkage

Install or connect

- Tech-1A scan tool
- Oil pressure gauge at line pressure tap (Figure 5-15)

5. Put gear selector in PARK and set the parking brake.
6. Start the engine and allow it to warm up at idle.
7. Access the override pressure control solenoid test on the Tech-1A scan tool.
8. Increase pressure control solenoid current in 0.1 amp increments and read the corresponding line pressure on the pressure gauge.

NOTE: Allow pressure to stabilize for 5 seconds after each current change.

9. Compare data to the drive-park-neutral line pressure, Table 5-12.

Line pressure will pulse either high or low every ten seconds to keep the pressure control solenoid plunger free. This is normal and will not harm the transmission.

***CAUTION**: Total test running time should not exceed 2 minutes, or transmission damage may occur. Increasing the engine speed above idle without vehicle movement (such as holding the brake) in a forward or reverse gear causes transmission stall. Continued operation in the stall condition can result in transmission overheat, malfunction, or fluid expulsion.*

If pressure readings differ greatly from the line pressure chart, refer to the diagnosis charts.

The Tech-1A scan tool is only able to control the pressure control solenoid in PARK and NEUTRAL with the vehicle stopped at idle. This protects the clutches from extremely high or low pressures in drive or reverse ranges

Table 5-12: Line Pressures

Pressure Control Solenoid (Amp)	PSI Line Pressure	kPa
0.02	157-177	1083-1220
0.10	151-176	1041-1214
0.20	140-172	965-1186
0.30	137-162	945-1117
0.40	121-147	834-1014
0.50	102-131	703-903
0.60	88-113	607-779
0.70	63-93	434-641
0.80	43-73	296-503
(Park, neutral) 0.90	37-61	255-421
0.98	35-55	241-379

DIAGNOSIS INFORMATION

Additional information useful for diagnosing trouble with the 4L80-E transmission.

Table 5-13 - Malfunction Code (DTC) and Defaults. This table, arranged in DTC numerical order, provides information relative to causes of a component failure and the resulting default action by TCM. This would be useful in may cases for running down an intermittent fault.

Transmission to TCM Connection Diagram. This diagram lays out the end connectors of the engine wiring harness to transmission harness connector.

TCM and Associated Wiring - External Components Diagrams. These two diagrams layout external input/output devices associated with TCM control.

Table 5-14 and Table 5-15 with Figure 5-15 and Figure 5-16 shows the end view of the connector and calls out the active circuit names.

Transmission range (TR) Pressure Switch Assembly Circuit Check (Figure 5-17). This procedure provides a systematic check of the TR pressure switch operation. In conjunction with the Pressure Switch Assembly Resistance Check in Figure 5-18 can diagnosis of TR PSA problems be found before disassembly.

Pressure Switch Assembly Resistance Check page 5-31. This check procedure can be used separately or with the previous two page module to diagnose suspected intermittent shift problems.

Internal Wiring Harness Check pages 5-32 and 5-33. This check describes the internal wiring harness and the continuity checks available to search for intermittent problems or component failure.

Clutch Application Chart page 5-34. This chart lists active mechanical parts in the transmission for each gear ratio condition. It is provided to indicate the relationship with the two shift solenoids.

Various testing maybe performed using the 05743196 DVM, or equivalent, high impedance volt-ohm meter.

Table 5-13: Malfunction Code and Defaults

DTC	SETTING PARAMETER(S)	DEFAULT
21 TP HIGH	• Engine operations • TP Signal > 4.9 V for one second	Maximum line pressure Use 35% TP as default Inhibit 4th gear in HOT Mode
22 TP LOW	• Engine operating • TP signal < 0.2 volt	Same as DTC 21
24 VSS/TOSS LOW	• Input speed at least 3,000 rpm • Output < 200 rpm for 1.5 seconds	Maximum line pressure 2nd gear Calculate output speed
28 TR FAULT	• Range signal on A + C at 0 (OFF) volt for 2 seconds	D4 shift pattern continued, No TCC No 4th gear in HOT mode
37 Brake Switch ON	Circuit 810 (TCM PIN B4) open VSS <5 mph (8 km/h)> 6 seconds Then VSS/TOSS between 5 & 20 mph (8 & 32 km/h) > 6 seconds Then VSS/TOSS > 20 mph (32 km/h)> 6 seconds Total of seven times	No 4th gear in HOT mode
38 Brake Switch OFF	Circuit 810 (TCM PIN B4) constant voltage (B+) VSS > 20 mph (32 km/h)> 6 seconds Then VSS between 5 & 20 mph (8 & 32 km/h)> 6 seconds Total of seven seconds	No 4th gear in HOT mode No TCC
39 TCC Stuck OFF	No DTC(s) 28, 71, 74 • TCC commanded on position • TCC slip speed > 65 rpm • TR in D3 or D4 position • 2nd or 3rd gear, all conditions for 2 seconds	No 4th gear in HOT mode
51 PROM ERROR	PROM internal fault	None System inoperative
52 System Voltage HIGH LONG	Ignition on, voltage > 16V for 109 minutes	Maximum line pressure 2nd gear No TCC
53 System Voltage HIGH	Ignition on, Voltage > 16V for 2 minutes	Same as DTC 52
58 TFT Circuit LOW	Signal voltage indicates trans fluid temp > 304°F (151°C) for 1 second	Use warm fluid values
59 TFT Circuit HIGH	Signal voltage indicates trans fluid temp < -40°F (-40°C) for 1 second	Same as DTC 58
63 BARO HIGH	BARO signal voltage > 4.9 V for more than 2 seconds	No altitude compensation

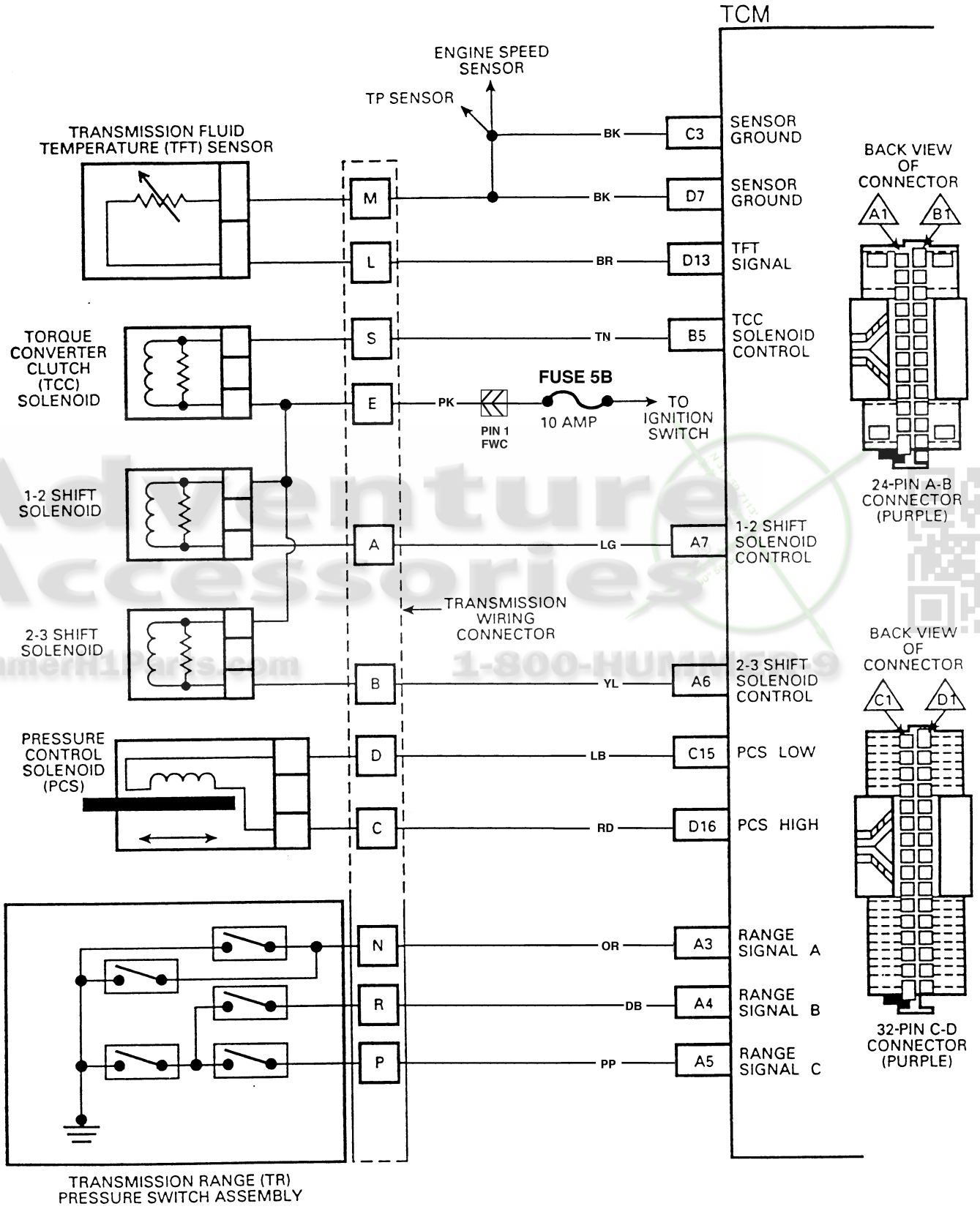
Table 5-13: Malfunction Code and Defaults

DTC	SETTING PARAMETER(S)	DEFAULT
64 BARO LOW	BARO signal voltage < 1.9 V for more than 2 seconds	Same As DTC 63
68 TRANS COMP SLIPPING	• No DTC(s) 28, 71, 74 present • TCC slip speed > 200 rpm FOURTH GEAR INDICATED • TCC locked • Not in PARK or NEUTRAL • Lasts longer than 2 seconds	No TCC No manual mode operation
69 TCC Stuck ON	No DTC(s) 21, 22, 71, or 74 present TCC slip rpm between -5 and +10 rpm TCC off TP Signal > 25% D3 or D4 on range SW Commanded gear indicated 2nd or 3rd gear • Lasts longer than 2 seconds	None
71 Cam Position Engine Speed Sensor	No DTC 28 • Trans in R, D, 1, 2, or O/D • Engine Speed < 50 rpm • Lasts longer than 2 minutes	No TCC
72 VSS/TOSS Circuit Loss	Not in PARK or NEUTRAL Transmission output speed change > 1000 rpm Engine speed > 300 rpm • Lasts longer than 2 seconds No DTC 28 in P/N Output speed change > 2050 rpm No DTC 28 Engine speed > 300 rpm	Soft shift to 2nd Maximum line pressure
73 PCS Circuit	No DTC 75 • Return current > 0.16A from commanded amp • Lasts longer than 1 second	Maximum line pressure
74 TISS Circuit	• No DTC(s) 24, 28, or 71 • TR not in PARK or NEUTRAL • Engine Speed > 300 rpm • TISS < 50 rpm • TOSS > 200 rpm • Lasts longer than 2 seconds	No TCC
75 System Voltage LOW	Ignition ON Ign feed is less than at 40°C = 7.3V at 90°C = 10.3V at 150°C = 11.7V Engine speed > 1000 All conditions for 4 seconds	Maximum line pressure 2nd gear No TCC Inhibit 4th gear

Table 5-13: Malfunction Code and Defaults

DTC	SETTING PARAMETER(S)	DEFAULT
79 TRANS FLUID OVERTEMP	No DTC 58 Trans fluid temp > 295°F (146°C) Met for 30 minutes	HOT MODE TCC in 2nd, 3rd, 4th
81 2-3 SHIFT SOL. CIRCUIT	TCM command: SOL. ON and voltage stays high TCM command: SOL. OFF and voltage stays low Lasts longer than 2 seconds	Maximum line pressure No TCC Second or 3rd gear only
82 1-2 SHIFT SOL. CIRCUIT	TCM command: SOL. ON and voltage stays high TCM command: SOL. OFF and voltage stays low Lasts longer than 2 seconds	Maximum line pressure Second or 3rd gear only or First or 2nd gear only
83 TCC PWM Circuit	TCM command: SOL. ON and voltage stays high TCM command: SOL. OFF and voltage stays low Lasts at least 2 seconds	NO TCC Inhibit 4th gear in HOT MODE
85 Undefined Ratio ERROR	No DTC(s) 11, 22, 24, 28, 71, 72, 87 TP > 25% Not in PARK, NEUTRAL, or 4th gear Engine speed > 300 rpm Vehicle speed > 7 mph	Line pressure to maximum No TCC
86 Low Ratio ERROR	No DTC(s) 21, 22, 24, 28, 72 and 74 Not in PARK, REVERSE, NEUTRAL Engine > 300 rpm TP > 25% Vehicle speed > 7 mph (11 km/h) Trans ratio < 1.06 in. (2.7 cm)1st or 2nd Lasts longer than 2 seconds	2nd gear Maximum line pressure No TCC
87 High Ratio ERROR	No DTC 21, 22, 24, 28, 71, 72 and 74 TP > 25% Not in P/R/N Engine speed > 300 rpm Vehicle speed > 7 mph (11 km/h) Transmission Temp > 68°F (20°C) Trans gear ratio > 1.42 in 3rd or 4th Lasts longer than 2 seconds	2nd gear Maximum line pressure No TCC

Transmission to TCM Connection Diagram



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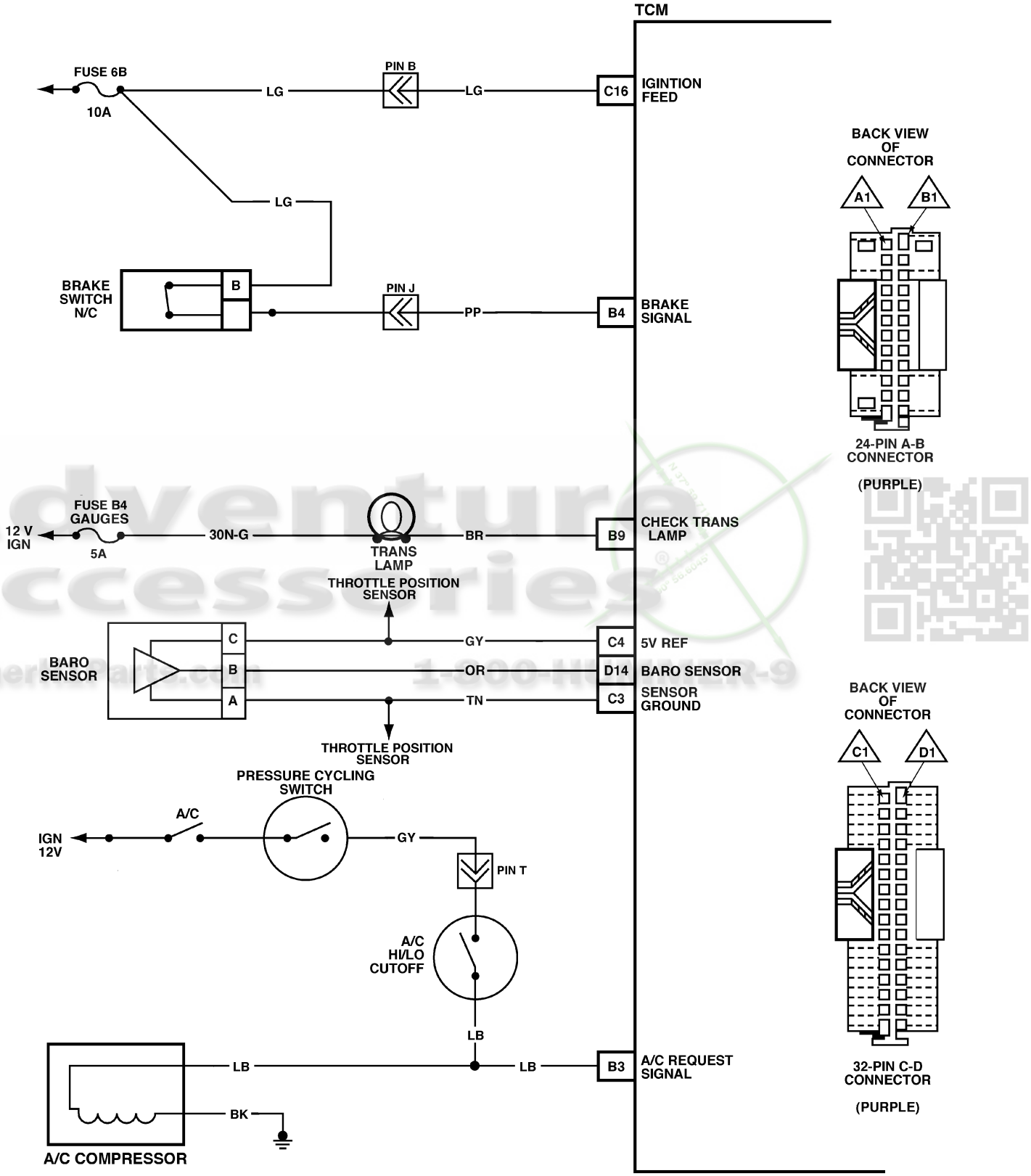
TCM and Associated Wiring - External Components Diagram



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TCM and Associated Wiring - External Components Diagram - Continued

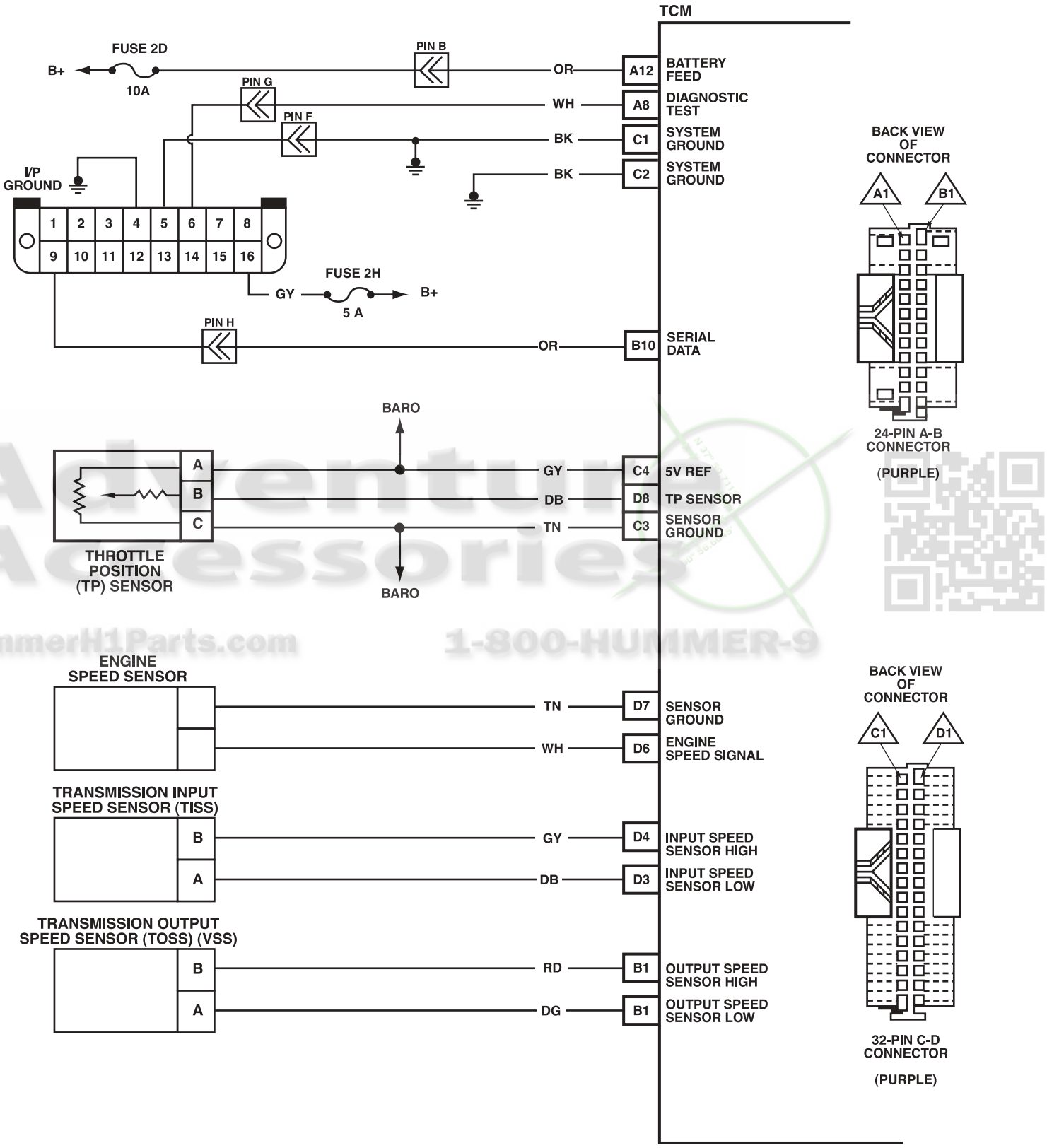


Table 5-14: Control Module - 24 Pin Chart

PIN	DESCRIPTION	WIRE	PIN	DESCRIPTION	WIRE
A1	—	—	B1	—	—
A2	—	—	B2	—	—
A3	Range sig A	18 OR	B3	A/C clutch	18 LB
A4	Range sig B	18 DB	B4	Brake SW	18 PP
A5	Range sig C	18PP	B5	TCC/PWM	18 TN
A6	2-3 solenoid	18YL	B6		—
A7	1-2 solenoid	18 LG	B7		—
A8	DLC* Pin 6	18 WH	B8		—
A9	—	—	B9	Check Trans Lamp	18 BR
A10	—	—	B10	DLC serial data	18 OR
A11	—	—	B11	VSS (TOSS) HI	18 RD
A12	BATT Feed	18 OR	B12	VSS (TOSS) LOW	18 DG

* DLC – Data Link Connector. This is the term used in the field and is replacing ALDS (Assembly Line Data Link).

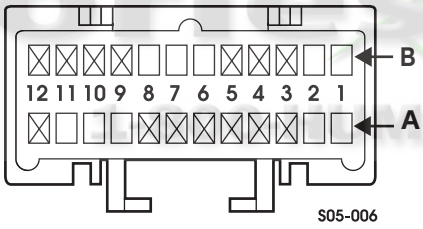


Figure 5-15: 24-Pin Connector

Table 5-15: Control Module – 32 Pin Chart

PIN	DESCRIPTION	WIRE	PIN	DESCRIPTION	WIRE
C1	DTC/SYS ground	18 BG	D1	—	—
C2	System ground	18 BG	D2	—	—
C3	Sensor ground	18 TN	D3	TISS LOW	18 DB
C4	TP + Baro +5V ref	18 GY	D4	TISS HIGH	18 GY
C5	—	—	D5	—	—
C6	—	—	D6	ENG SPEED	18 WH
C7	—	—	D7	Sensor ground	18 TN
C8	—	—	D8	TP signal	18 DB
C9	—	—	D9	—	—
C10	—	—	D10	—	—
C11	—	—	D11	—	—
C12	—	—	D12	—	—
C13	—	—	D13	TFT signal	18 BR
C14	—	—	D14	BARO signal	18 OR
C15	PCS LOW	18 LB	D15	—	—
C16	IGN FEED	18 LG	D16	PCS HIGH	18 RD

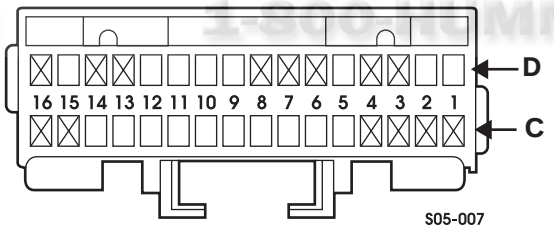


Figure 5-16: 32-Pin Connector

TTRANSMISSION RANGE (TR) PRESSURE SWITCH ASSEMBLY CIRCUIT CHECK (FIGURE 5-17)

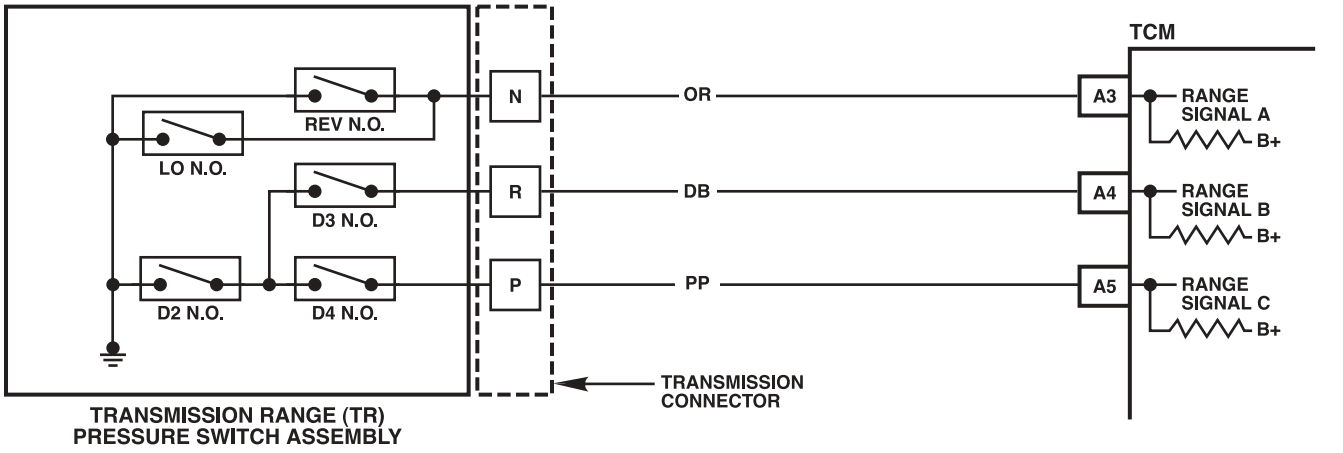


Figure 5-17: TTransmission Range (Tr) Pressure Switch Assembly Circuit Check

Circuit Description

The Transmission Range (TR) switch assembly consists of five normally open pressure switches and is attached to the valve body. The control module supplies battery voltage to each range signal. By grounding one or more of these circuits through various combinations of the pressure switches, the control module detects what manual valve position has been selected by the vehicle operator. With ignition ON and engine OFF, P/N will be indicated. When transmission electrical connector is disconnected, the ground potential for the three range signals to the control module will be removed, and with ignition ON, D2 will be indicated.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks the indicated range signal to the manual valve position actually selected.
2. This test checks for correct voltage from the control module to the transmission external connector.
3. This test checks for a short to ground from the control module to the transmission external connector in any one of the three circuits.

Diagnostic Aids

- Refer to accompanying chart for various A/B/C range combinations. Check all wiring connectors for proper terminal tension.
- Refer to Pressure Switch Assembly Resistance Check.

Table 5-16: Expected Readings

Range Signal	A	B	C
Park	ON	OFF	ON
Rev	OFF	OFF	ON
Neutral	ON	OFF	ON
D4	ON	OFF	OFF
D3	ON	ON	OFF
D2	ON	ON	ON
D1	OFF	ON	ON
Illegal	OFF	ON	OFF
Illegal	OFF	OFF	OFF

ON = B+/ OFF = 0 VOLTS
(Scan tool readings)

TRANSMISSION RANGE (TR) PRESSURE SWITCH ASSEMBLY CIRCUIT CHECK

This chart assumes that:
- The transmission linkage from the selector lever to the manual valve is adjusted properly.
- On-Board Diagnostic (OBD) system check has been performed.
- Fluid checking procedure has been performed.
- All DTC(s) have been recorded and then cleared.
- Scan tool still installed.

1
- Engine idling at normal operating temperature.
- Parking brake applied and wheels blocked.
- Apply brake pedal and select each transmission range D1, D2, D3, D4, N, R, P.
- Does each selected transmission range match the TECH-1A scan tool TRANS RANGE SW display?

NO

- Ignition OFF.
- Disconnect transmission wiring connector ASM.
- Install 05743732 Jumper Harness/Probe Kit on the external wiring connector.
- Ignition ON, engine OFF.
- With 05743196 DVM to ground, check voltage at vehicle harness connector terminals N, R, and P.
- Does 05743196 DVM display B+ at all three circuits?

NO

3
- Ignition OFF.
- Disconnect control module connector.
- With 05743196 DVM to ground, check resistance at vehicle harness connector terminals N, R, and P.
- Does 05743196 DVM display high resistance (greater than 50k Ohms) on all three circuits?

NO

- Check low resistance circuit A3, A4, or A5 for short to ground. Repair pinched or chaffed wires per wiring harness repair procedures (Section 12).

YES

- Ignition ON, Engine OFF.
- With 05743196 DVM to ground, check voltage at control module terminals A3, A4, and A5 (TCM). If 05743196 DVM does not display B+ at all three circuits, replace control module

YES

2
- Verify that CKT(s) A3, A4, or A5 are not shorted together. If OK, refer to Pressure Switch Assembly Resistance Check (Figure 5-18).

YES

- No trouble found.
- Refer to diagnostic aids.

PRESSURE SWITCH ASSEMBLY RESISTANCE CHECK (FIGURE 5-18)

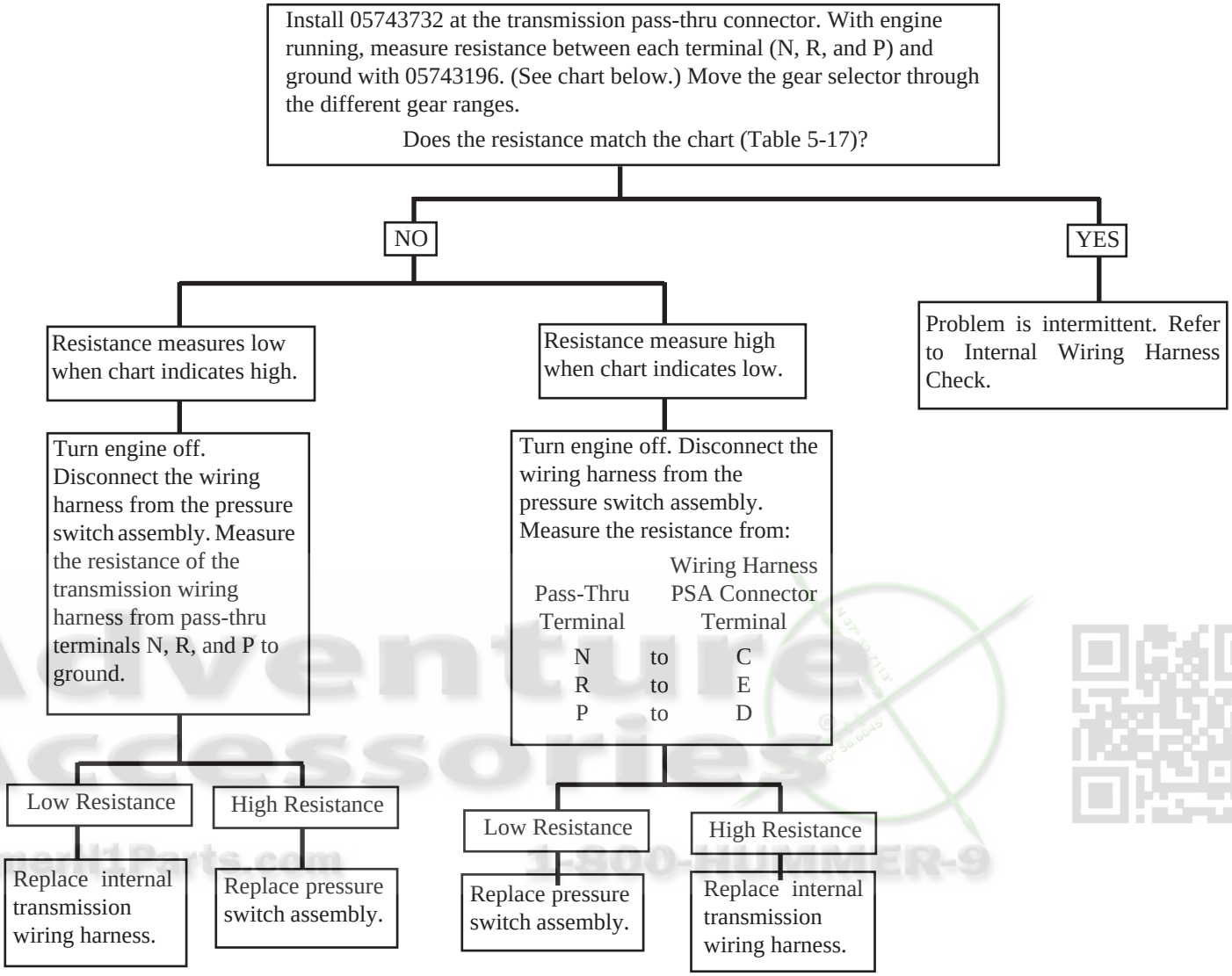


Table 5-17: Pressure Switch Assembly (PSA) Resistance Chart

Gear Selector Position	Range		
	A	B	C
Park	H	L	H
Reverse	L	L	H
Neutral	H	L	H
D4	H	L	L
D3	H	H	L
D2	L	H	H
D1	L	H	H

t

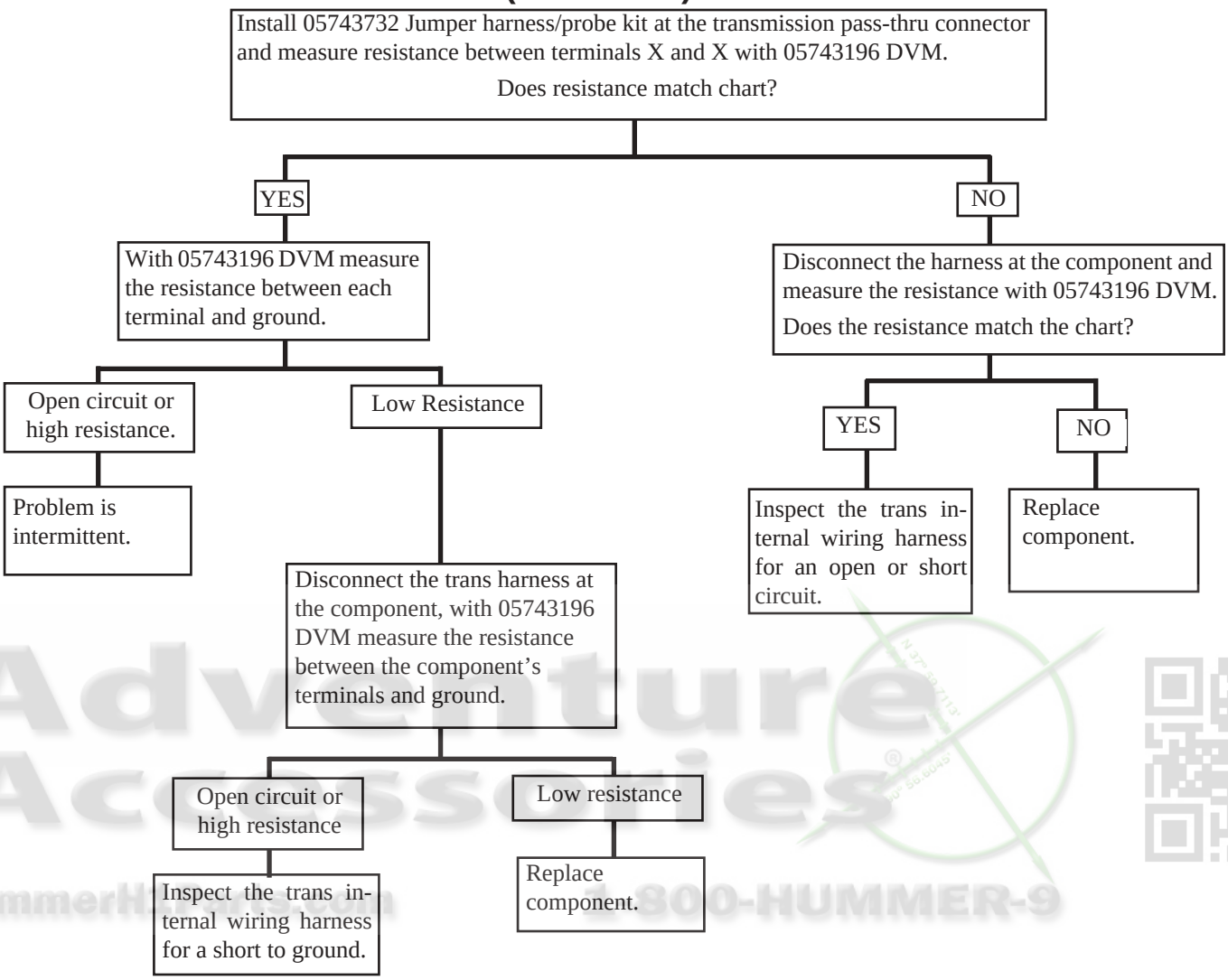
When range “X” is measured for resistance to ground,
H = High resistance (over 2000 Ohms) - open circuit
L = Low resistance (under 100 Ohms) - grounded circui

IMPORTANT:

Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple transmission Diagnostic Trouble Codes will set. Be sure to clear these codes when finished with this procedure.

Figure 5-18: Pressure Switch Assembly Resistance Check

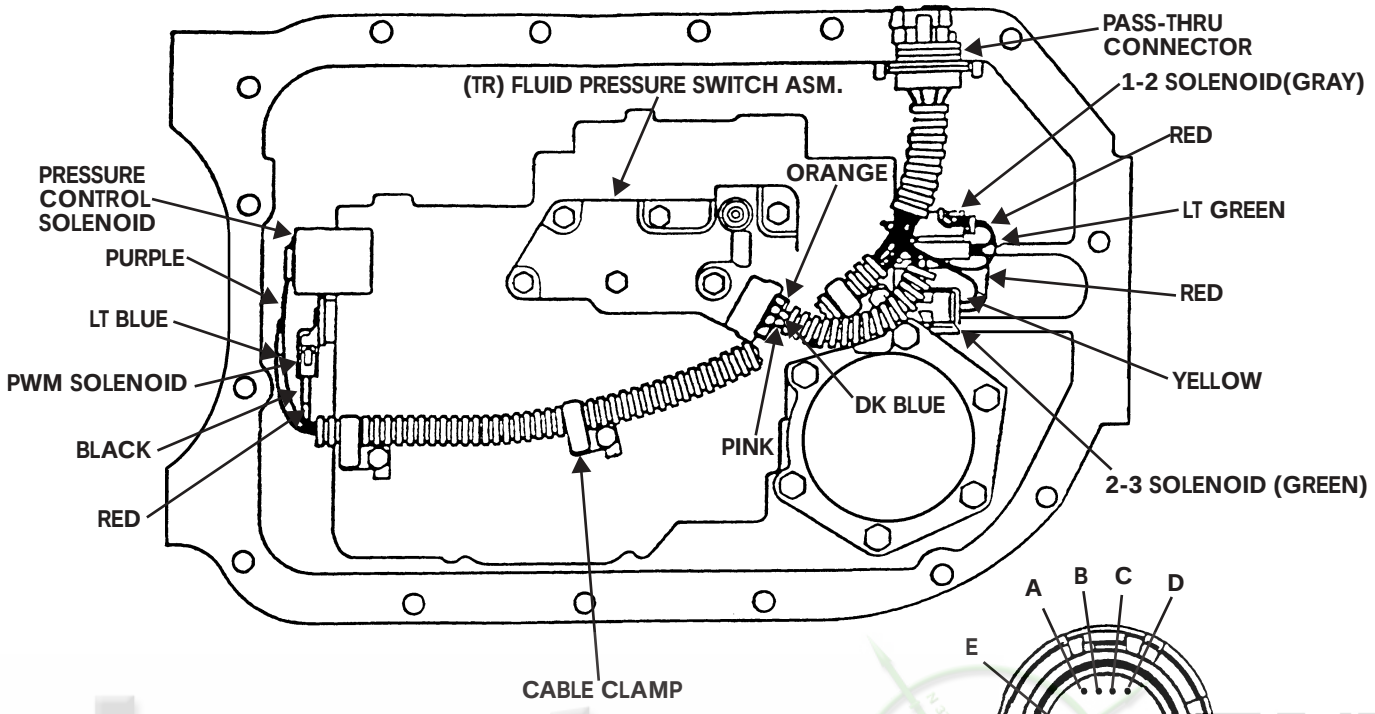
INTERNAL WIRING HARNESS CHECK. (FIGURE 5-19)

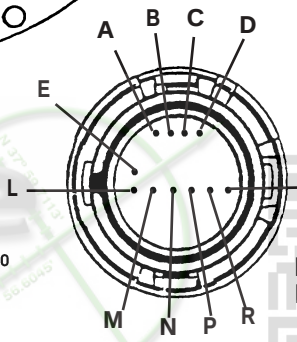


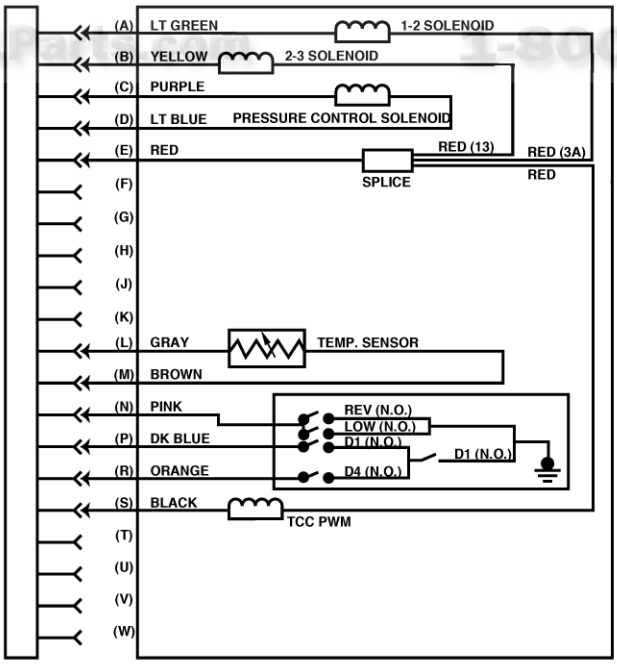
4L80-E COMPONENT RESISTANCE CHART			
Component	Wire Color	Pass-Thru Pin	Resistance @ 68°F (20°C)
1-2 Shift Solenoid	Red	E (1)	20-40 Ohms
	Lt. Green	A	
2-3 Shift Solenoid	Red	E(1)	20-40 Ohms
	Yellow	B	
Pressure Control Solenoid	Purple	C	3.5-8 Ohms
	Lt. Blue	D	
TCC Solenoid	Red	E (1)	20-40 Ohms
	Black	S	
(1) Spliced internally to Pin E. (2) Internal harness number.			

Figure 5-19: Internal Wiring Harness Testing

TRANSMISSION INTERNAL WIRING HARNESS ASSEMBLY (FIGURE 5-20)







CAVITY	FUNCTION
A	PCM TO TRANS 1-2 SHIFT SOL, A
B	PCM TO TRANS 2-3 SHIFT SOL, B
C	PCM TO PRESSURE CONTROL SOL (HIGH)
D	PCM TO PRESSURE CONTROL SOL (LOW)
E	+12 V, IGN, CRANK ON
L	PCM TO TRANS TEMP SENSOR
M	GROUND LEVEL LOW
N	PCM TO TRANS RANGE MODE A
P	PCM TO TRANS RANGE MODE C
R	PCM TO TRANS RANGE MODE B
S	PCC PWM TO TCM

S05A-040/B

Figure 5-20: Transmission Internal Wiring Harness Assembly

CLUTCH APPLICATION

The transmission clutch application chart provides valuable source information for explaining the overall function of the 4L80-E transmission.

This chart highlights the major components that function in a selected gear range, and the specific gear operation within that gear range.

If a component is active in a specific gear range, a word describing its action will be listed.

Table 5-18: Clutch Application Chart

	GEAR	1-2 SHIFT SOLE-NOID	2-3 SHIFT SOLE-NOID	FOURTH CLUTCH	OVER-RUN CLUTCH	OVER-DRIVE ROLLER CLUTCH	FOR-WARD CLUTCH	DIRECT CLUTCH	FRONT BAND	INTER-MEDIATE SPRAG CLUTCH	INTER-MEDIATE CLUTCH	LO ROLLER CLUTCH	REAR BAND
P-N		ON	OFF			Holding							
R	Rev.	ON	OFF			Holding		Applied					Applied
D	1st	ON	OFF			Holding	Applied			*		Holding	
	2nd	OFF	OFF			Holding	Applied			Holding	Applied	Over-running	
	3rd	OFF	ON			Holding	Applied	Applied		Over-running	Applied	Over-running	
	4th	ON	ON	Applied		Over-running	Applied	Applied		Over-running	Applied	Over-running	
D	1st	ON	OFF		Applied	Holding	Applied			*		Holding	
	2nd	OFF	OFF		Applied	Holding	Applied			Holding	Applied	Over-running	
	3rd	OFF	ON		Applied	Holding	Applied	Applied		Over-running	Applied	Over-running	
2	1st	ON	OFF		Applied	Holding	Applied			*		Holding	
	2nd	OFF	OFF		Applied	Holding	Applied		Applied	Holding	Applied	Over-running	
1	1st	ON	OFF		Applied	Holding	Applied			*		Holding	Applied

* Holding, but not effective

The shift solenoid's state follows a shift pattern which depends upon vehicle speed and throttle position. It does not depend upon the selected gear.

ON = Solenoid energized

OFF = Solenoid de-energized

NOTE: Descriptions above apply to component function during acceleration.

DIAGNOSIS USING THE SCAN TOOL

The control module is equipped with a self diagnostic feature that detects system failures and aids the technician in locating a faulty circuit. The control module has memory for comparing the various input information to programmed information. These conditions are described on the facing page of each Diagnostic Trouble Code (DTC) chart. If a value is not within the control module parameters, a DTC will set and default values will be used.

The control module will continually perform a self diagnosis check. The control module can be requested to display any stored DTC by using a scan tool or manually grounding the diagnostic test terminal. When the diagnostic test terminal of the Data Link Connector (DLC) is grounded, the control module will check the engine speed circuit input, if the voltage is zero, the control module will flash DTC 12 and any other DTC(s) stored*. If DTC 12 will not flash, refer to CHART A-1 or CHART A-2 for further diagnostic information.

***CAUTION**: Always perform the On-Board Diagnosis (OBD) System Check before proceeding to diagnose the system.*

The scan tool will display all stored DTC(s) in current or history status. A DTC 12 is not a fault condition with the ignition ON, engine, OFF. When the manual grounding procedure is used, the MIL will flash all DTC(s) stored in the TCM memory (current and history). The DTC charts assume the DTC is in current status. If the DTC is in history status, the fault may be an intermittent. An intermittent DTC is one which will not reset during the current ignition cycle. The facing page of a DTC chart will contain DIAGNOSTIC AIDS to help locate intermittent conditions.

If a visual (physical) check does not locate the cause of the fault, 05743196 DVM can be used to test the suspected circuit. The 05743196 DVM can be used to check.

- SHORT TO VOLTAGE–Connect 05743196 to a known good ground on the DC voltage scale.
- SHORT TO GROUND–Connect 05743196 to a known GOOD B+ on the DC voltage scale.
- OPEN CIRCUIT–Connect 05743196 to each end of the circuit on the ohms scale with voltage removed from the circuit. A very large or infinite reading is indicative of an open circuit.

* This method uses the flashing or blinking of the Malfunction Indicator lamp (MIL). This lamp may have either symbols or lettering. It may be referred to as CHECK TRANS lamp. It flashes in number series following DTC 12 any DTC's in order from the lowest number to the highest number. Each DTC is given three times.

TCM Intermittent Diagnostic Trouble Codes or Performance

The DTC charts will help to determine if there is a fault within the circuit. The fault must be present to locate the problem. If an intermittent condition occurs, a DTC will be stored in history status, but the circuit check will indicate a normal condition. Most intermittent conditions are usually a faulty connection or component. When diagnosing intermittents, thoroughly check the suspected circuit for:

- Poor terminal tension.
- Poor seating of connector halves.
- Poor terminal to wire connection.
- Improperly formed or damaged terminals.
- Improperly installed electrical options.
- Faulty control module power or ground connection.
- Intermittent short or open circuit.
- Electrical system surges caused by a defective relay, solenoid, or switch. Normally these conditions will occur when the faulty component is operated.

Clearing History DTC(s)

All history DTC(s) can be cleared after all repairs have been completed in the following ways:

- With a scan tool.
- By removing voltage from the control module.
- Fifty ignition cycles with fault not occurring or removed.

NOTES

ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK/TCM (WITH TECH-1A SCAN TOOL) (FIGURE 5-21)

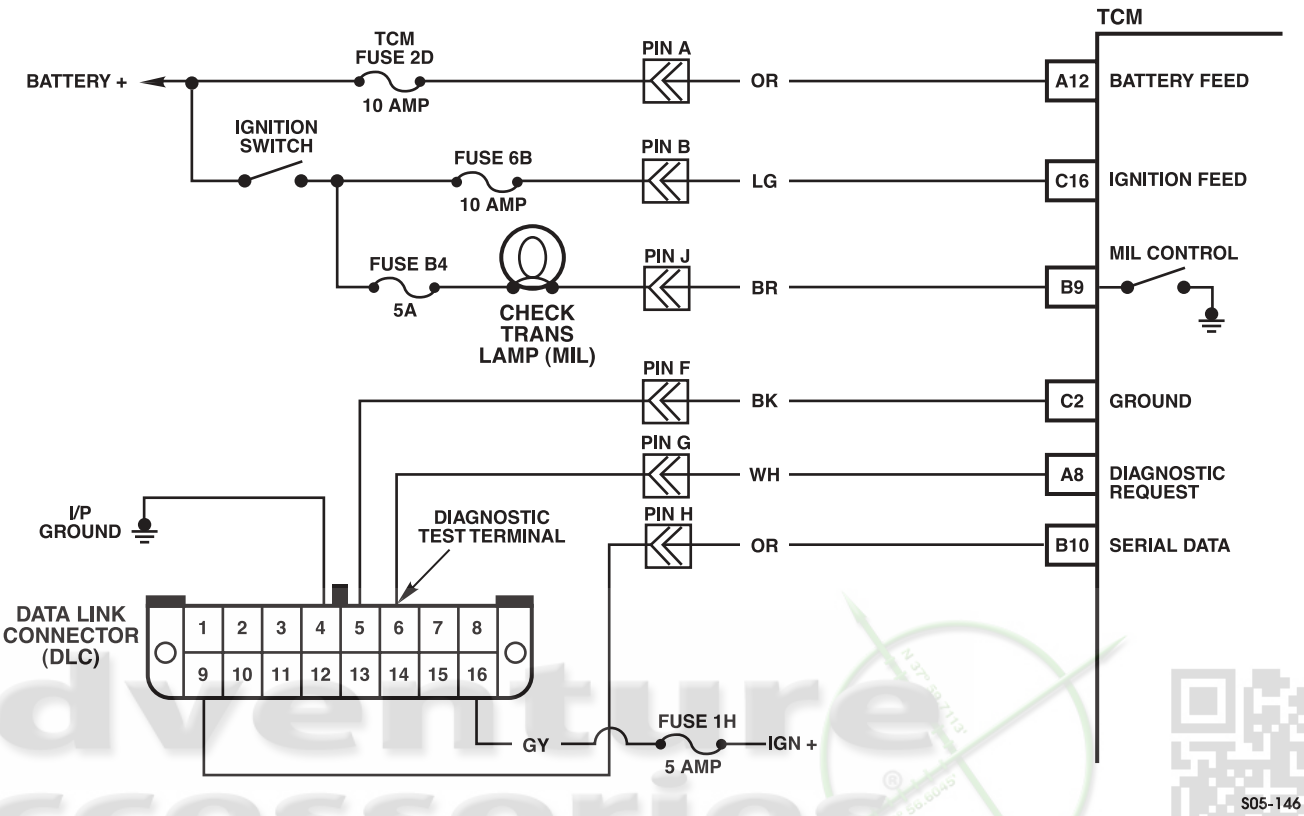


Figure 5-21: TCM OBD Check

Circuit Description

The On-Board Diagnostic (OBD) System Check is an organized approach to identifying a problem created by a control module system malfunction. It must be the starting point for any driveability complaint diagnosis, this will direct the service technician to the next logical step in diagnosing the complaint. Understanding the chart and using it properly will reduce diagnostic time and prevent the unnecessary replacement of good parts.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. When the ignition switch is cycled to ON, the MIL should turn ON briefly, then OFF briefly, then remain ON steady. This sequence will determine that the vehicle diagnostics are operational.
2. This step will isolate if the customer complaint is a MIL or driveability problem.
3. Although the control module is powered up, a symptom could exist because of a system fault.
4. To use Tech-1A to aid diagnosis, serial data must be available. If a PROM (MEM-CAL) error is present, the TCM may have been able to flash DTC 12-51, but not enable serial data.
5. This step will isolate if the customer complaint is a MIL or driveability problem with no MIL. (Refer to Diagnostic Trouble Code Identification (Table 5-20) for a list of valid DTC(s).) An invalid DTC may be the result of a faulty scan tool, PROM or TCM.
6. Comparison of actual control system data with the typical Tech-1A Data Values (Table 5-19) is a quick check to determine if any parameter is not within limits. A base engine problem (i.e., advanced cam timing) may substantially alter sensor values.

ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK/TCM (WITH TECH 1A SCAN TOOL)

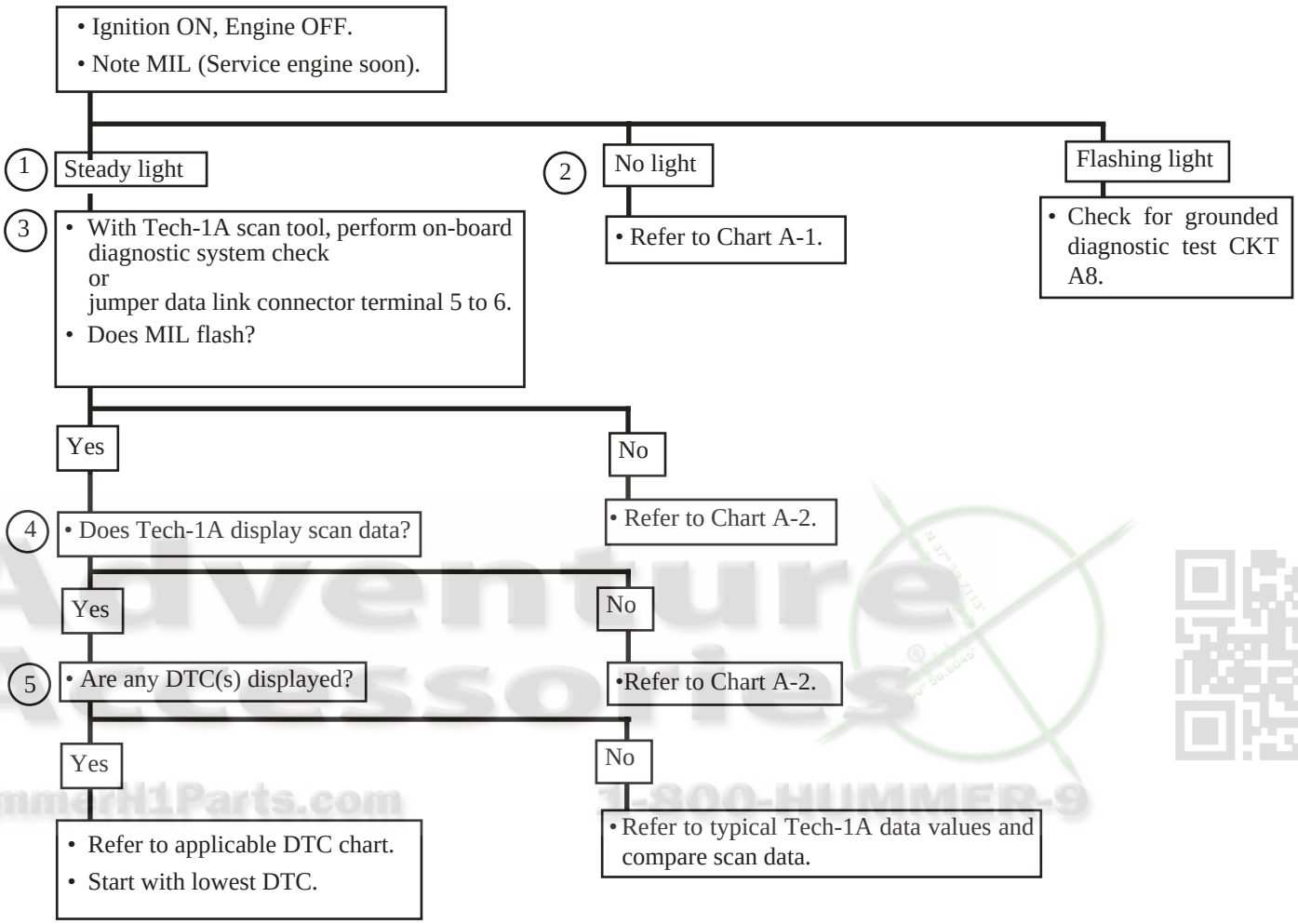


CHART A-1 /TCM

No Malfunction Indicator Lamp (MIL) (Check Trans Lamp) (Figure 5-22)

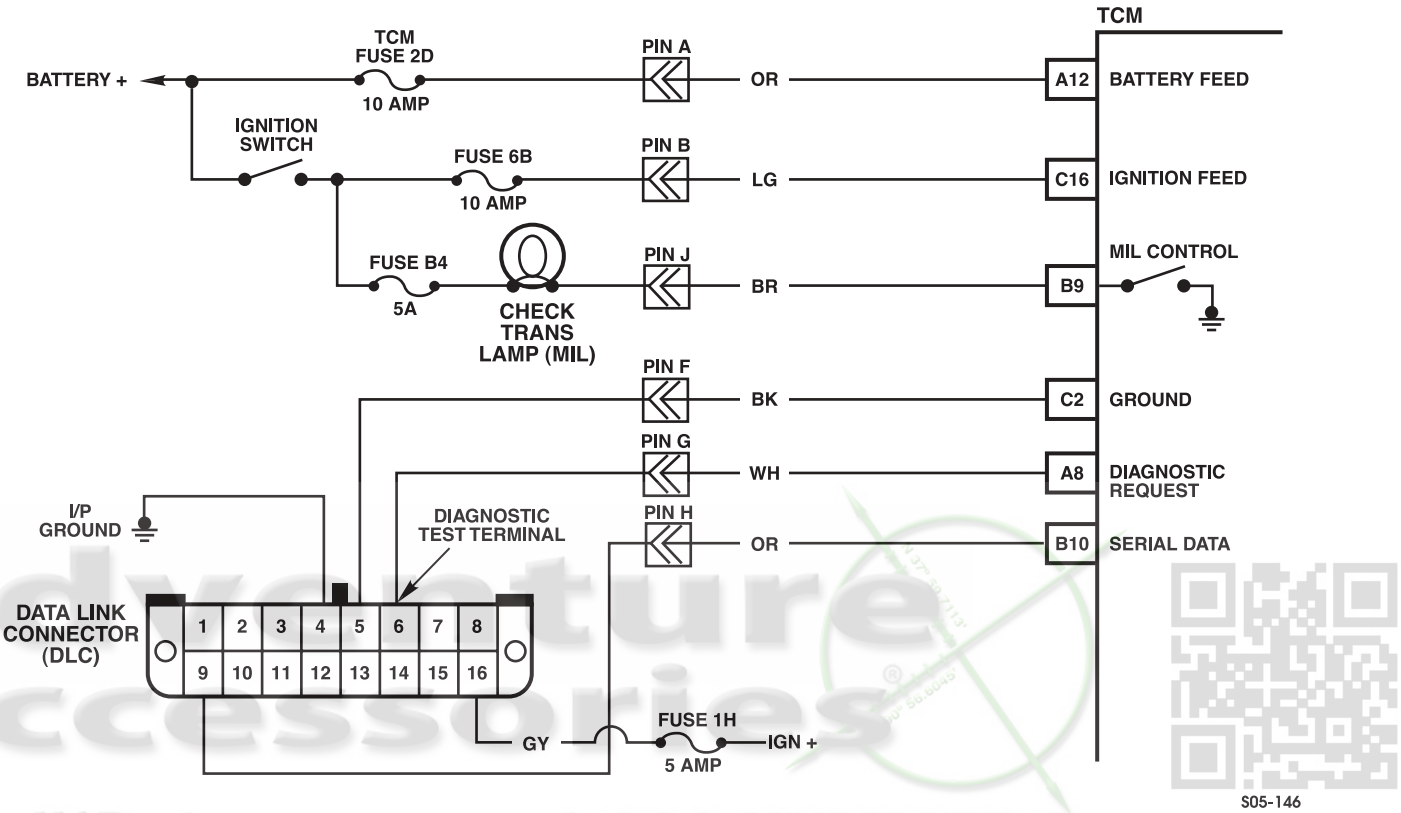


Figure 5-22: TCM Malifunction Indicator Lamp

Circuit Description

There should always be a steady Malfunction Indicator Lamp (MIL) with the ignition ON and engine OFF. Switched battery voltage is supplied to the lamp. The TCM will control the lamp and turn it ON by providing a ground path through CKT B9.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. If the TCM-B fuse 2D is open, refer to TCM Wiring Diagram for complete circuit.
2. Using a test light connected to 12 volts, probe each of the system ground circuits and check that a good ground is present. Refer to TCM Terminal End View (Table 5-14 and Table 5-15) (Figures 5-15 and 5-16) for TCM pin locations of ground circuits.

Diagnostic Aids

If the engine operates OK, check:

- Faulty light bulb.
- CKT B9 open.
- Gauges fuse open. This will result in no brake warning light, oil or generator lights, seatbelt reminder, etc.

If the engine cranks but will not operate, check:

- Continuous battery TCM fuse 2D open.
- TCM ignition In-Line fuse 6B open.
- Battery CKT A12 to TCM open.
- Ignition CKT C16 to TCM open.
- Poor connection to TCM.

CHART A-1/TCM

No Malfunction Indicator Lamp (MIL) (Check Trans Lamp)

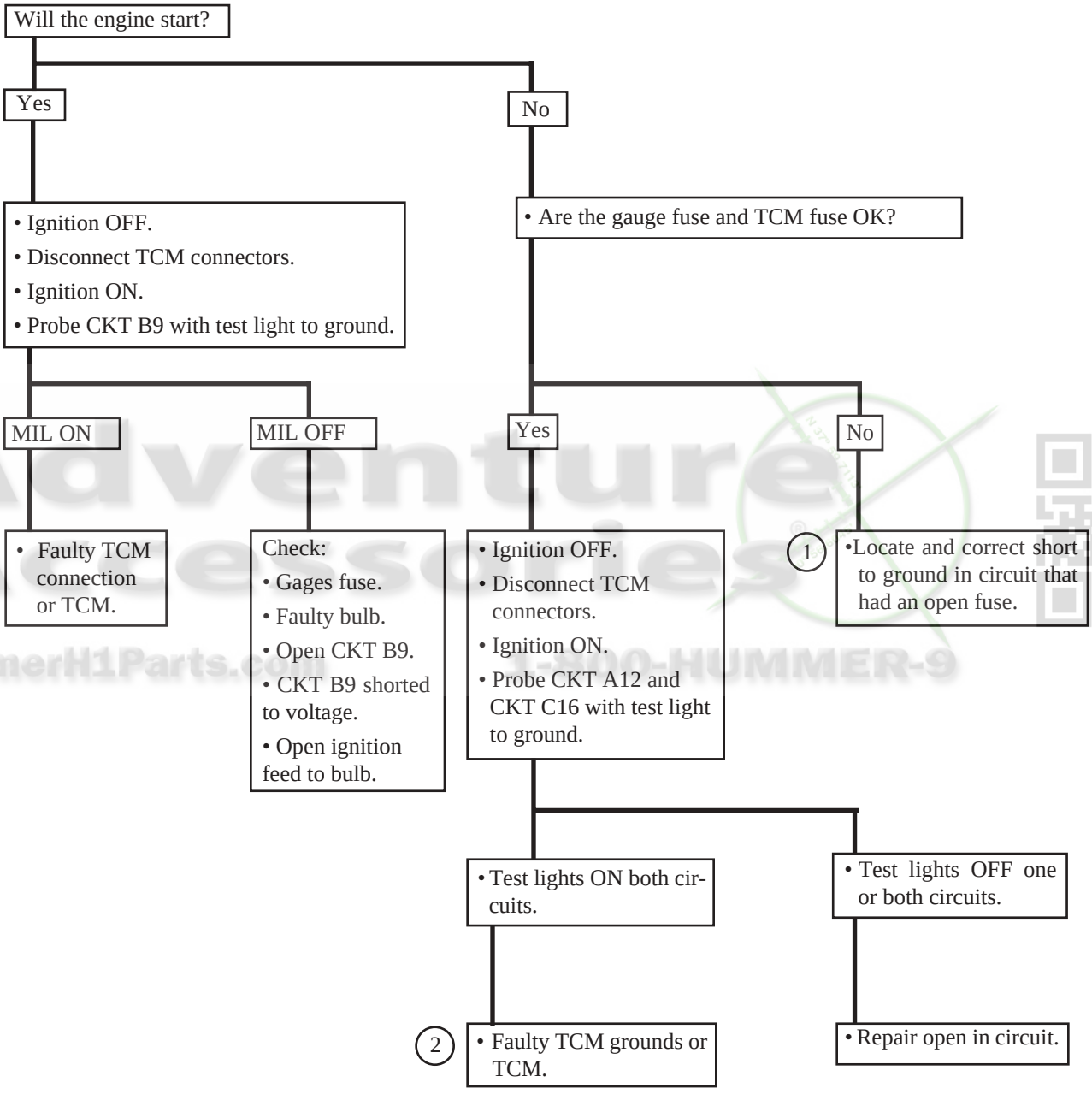


CHART A-2/TCM

No Data Link Connector (DLC) Data, Will Not Display Diagnostic Trouble Code (DTC) 12, or Malfunction Indicator Lamp (MIL) (Check Trans Lamp) On Steady (Figure 5-23)

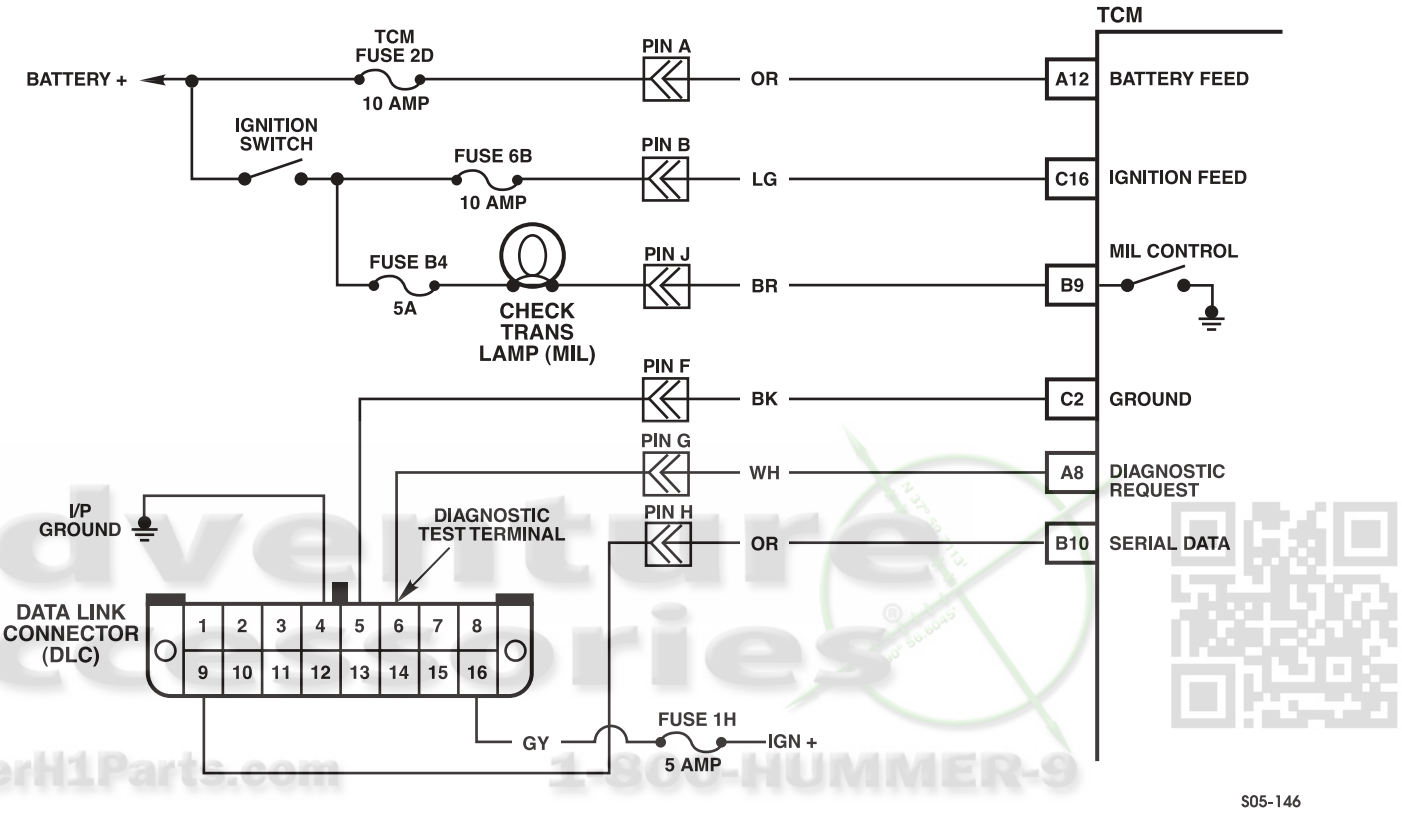


Figure 5-23: TCM OBD Check

Circuit Description

There should always be a steady Malfunction Indicator Lamp (MIL) when the ignition is ON and engine OFF. Switched battery voltage is supplied to the lamp. The TCM will control the lamp and turn it ON by grounding CKT B9.

With the diagnostic terminal grounded, the lamp should display a DTC 12, followed by any Diagnostic Trouble Code (DTC) stored in memory.

A steady lamp indicates a short to ground in the lamp control CKT B9, or an open in diagnostic CKT A8.

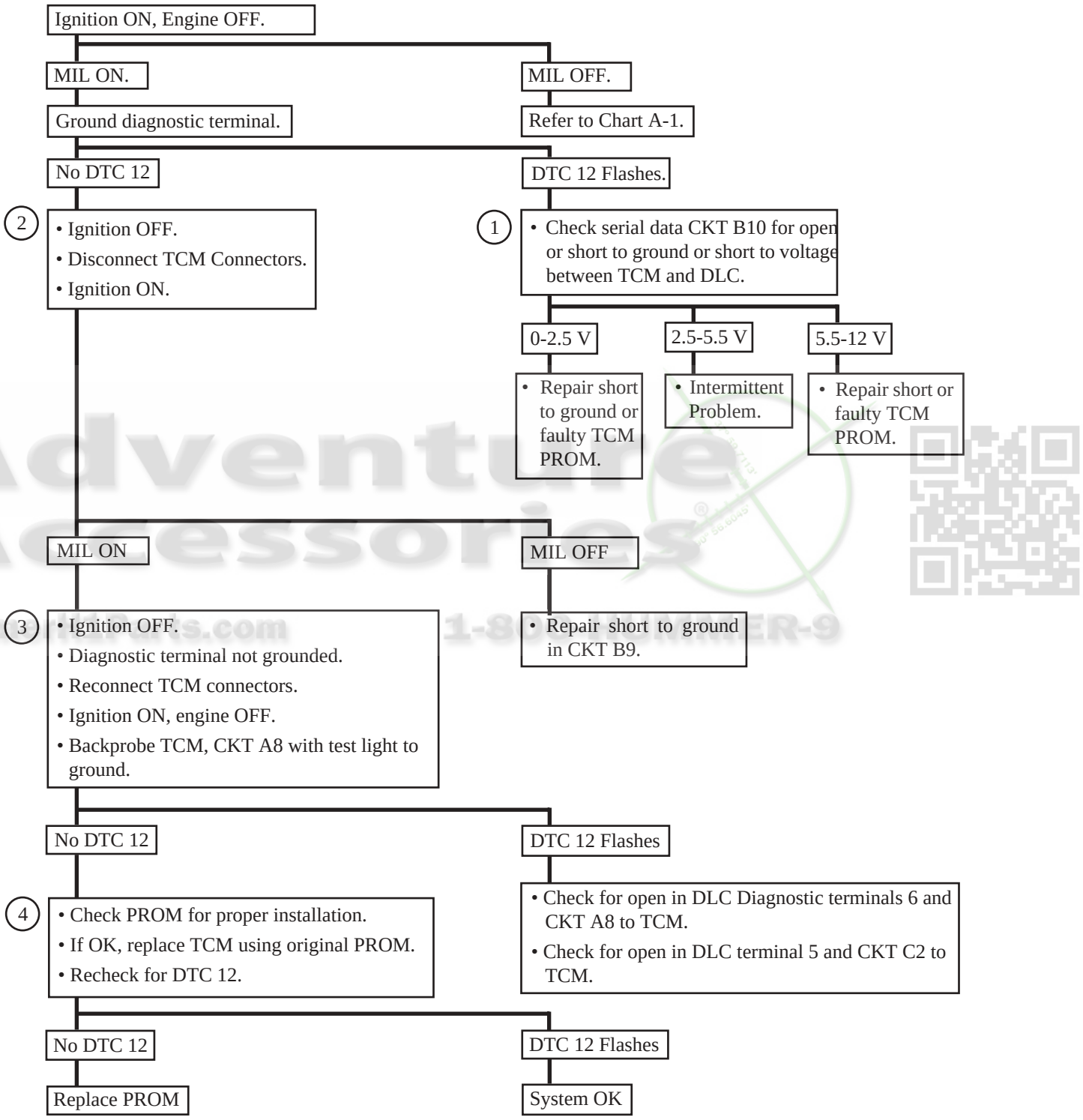
Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. If there is a problem with the TCM that causes a scan tool not to read serial data, then the TCM should not display a DTC 12. If DTC 12 does display, check that the scan tool is functioning properly on another vehicle. If the scan tool is functioning properly, and CKT B10 is OK, the PROM or TCM may be at fault for NO DLC symptom.
2. If the lamp turns OFF when the TCM connector is disconnected, then CKT B9 is not shorted to ground.
3. This step will check for an open diagnostic CKT A8.
4. At this point, the MIL wiring is OK. The problem is a faulty PROM. If DTC 12 does not display, the TCM should be replaced using the original PROM. Replace the PROM only after trying a TCM. A defective PROM usually is an unlikely cause of the fault.

CHART A-2/TCM

No Data Link Connector (DLC) Data, Will Not Display Diagnostic Trouble Code 12, or Malfunction Indicator Lamp (MIL) ON Steady



If after completing the On-Board Diagnostic (OBD) system check and finding the Tech-1A scan tool diagnostics functioning properly and no DTC(s) displayed, the Transmission Tech-1A scan tool Values may be used for comparison with values obtained on the vehicle being diagnosed. The Transmission Tech-1A Scan Tool Values are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would display (Table 5-19) .

A SCAN TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY SCAN TOOL CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed below are used in this manual for diagnosing If a scan tool displays other parameters, the values are not recommended by AM General for use in diagnosing. For further description on the values and use of the Tech-1A scan tool to diagnose TCM inputs, refer to General Description. If all values are within the range illustrated, refer to Road Test.

Definitions of scan tool data on following page.

Table 5-19: TRANSMISSION TECH-1A SCAN TOOL DATA

Idle/Lower Radiator Hose Hot/Closed Throttle/Park or Neutral/Closed Loop/Accessories Off			
SCAN Position	Units Displayed	Typical Data Value	Refer to Section
Engine Speed	RPM	±50 RPM from Desired	2
Trans Output Speed	RPM	0 RPM	5
Eng. Cool Tamp	F°/C°	185°F-221°F (85° - 105°C)	2
Trans Fluid Temp	F°/C°	180°F - 200°F (82°C - 93°C)	5
Throt Position	Volts	0.3 - 0.9V	2
Throttle Angle	Percentage	0%	2
A/B/C RNG	Off/On	On/Off/On	5
Trans Range Sw	Invalid, Rev, Drive 4, 3, 2, Low		
	Park/Neut	Park/Neut	5
Commanded Gear	1-4	1	5
Current Gear	1-4	1	5
1-2 Sol, 2-3 Sol	Off/On	On/On	5
CTR FDBK 1/2 2/3	Off/On	On/On	5
Trans Input Speed	RPM	±50 RPM of Engine Speed	5
Hot Mode	No, Yes	No	5
TCC PWM Solenoid	Percentage	0%	5
TCC Slip Speed	RPM	±50 RPM from Engine Speed	5
CTR FDBK TCC Sol	Off/On	Off	5
Desired PCS	Amps	0.1 - 1.1 Amps	5
Actual PCS	Amps	0.1 - 1.1 Amps	5
PSC Duty Cycle	Percentage	40% - 60%	5
MPH Km/h	0-255	0	5
4WD Low Switch	No, Yes	No	5
Cruise Engaged	No, Yes	No	12
TCC Brake Switch	Open/Closed	Closed	12
Kickdown Enabled	No, Yes	No	5
Trans Gear Ratio	Ratio	0.00	5
Turbine Speed	RPM	±50 RPM of Engine Speed	5
1-2Shift Time	Seconds	0	5
2-3 Shift Time	Seconds	0	5
Trans Calib ID	0-65535	Internal ID	5
System Voltage	Volts	12.0 - 14.5 V	12

TRANSMISSION TECH-1A SCAN TOOL DATA DEFINITIONS

ENGINE SPEED - Scan tool displays 0 RPM to 8191 RPM. - This parameter indicates the rotational speed of the engine expressed as revolutions per minute.

TRANS OUTPUT SPEED - Scan tool displays 0 RPM to 8191 RPM. - This parameter indicates the rotational speed of the transmission output shaft expressed as revolutions per minute.

ENGINE (ENG) COOLANT (COOL) TEMPERATURE (TEMP) - Scan tool displays a range of -40°C to 151°C and -40°F to 304°F. - This parameter is the input signal of the engine coolant temperature sensor. Engine coolant temperature is high(151 °C) when signal voltage is low (0 volt), and engine coolant temperature is low (-40°C) when signal voltage is high (5 volts).

TRANS FLUID TEMP - Scan tool displays a range of -40°C to 151°C and -40°F to 304°F. - This parameter is the input signal of the transmission fluid temperature sensor. Transmission fluid temperature is high (151°C) when signal voltage is low (O volt), and transmission fluid temperature is low (-40°C) when signal voltage is high (5 volts).

THROTTLE (THROT) POSITION - Scan tool displays a range of 0.00 volt to 5.10 volts. - This parameter indicates the signal input of the throttle position sensor circuit. Low voltage (approximately 0.3V to 1.3V) indicates closed throttle, high voltage (approximately greater than 4.5V) indicates wide open throttle.

THROTTLE ANGLE - The scan tool will display this value of 0% to 100%. - This parameter indicates the signal input of the throttle position sensor circuit. Low voltage (approximately l.3V) indicates closed throttle, high voltage (approximately greater than 4.5V) indicates wide open throttle.

A/B/C RANGE (RNG) - Scan tool displays ON/OFF, ON/OFF. - These parameters are the three inputs from the transmission range pressure switch assembly. ON represents a B+ voltage signal, OFF represents a 0 voltage signal.

TRANS RANGE SWITCH (SW) - Scan tool displays a range of invalid, Park/Neutral, Reverse, Drive 4, Drive 3, Drive 2, and Low. - This parameter is the decoded status of the three A/B/C range inputs from the transmission range pressure switch assembly and represents the position of the transmission manual valve.

COMMANDED GEAR - Scan tool displays a range of 1, 2, 3, or 4. - This parameter is the decoded commanded state of the l-2 and 2-3 shift solenoids.

CURRENT GEAR - Scan tool displays a range of 1, 2, 3, or 4. - This parameter is the decoded command state of the l-2 and 2-3 shift solenoids.

1-2 SOLENOID (SOL) / 2-3 SOLENOID (SOL) - Scan tool displays ON/OFF. - These parameters are the commanded status of the 1-2 and 2-3 shift solenoids. ON represents a commanded energized state (current flowing through solenoid). OFF represents a commanded non-energized state (current not flowing through solenoid).

CONTROL (CTR) FEEDBACK (FDBK) 1/2 2/3 - Scan tool displays ON/OFF. - These parameters are the actual states of the l -2 and 2-3 shift solenoid driver control circuits. ON represents a driver control signal at 0 voltage. OFF represents a driver control signal at B+ voltage.

TRANS INPUT SPEED - Scan tool displays 0 RPM to 8191 RPM - This parameter indicates the rotational speed of the transmission input shaft expressed as revolutions per minute.

HOT MODE - The scan tool will display this value either ON or OFF. - When displayed ON, the transmission fluid temperature has become greater than 295°F (146°C).

TCC SLIP SPEED - Scan tool displays a range of -4096 RPM to + 4095 RPM. - This parameter is the difference between transmission input speed and engine speed. A negative value indicates engine speed is less than input speed (deceleration). A positive value indicates engine speed is greater than input speed (acceleration). A value of zero indicates input speed is equal to engine speed (TCC applied).

TCC PWM SOLENOID - Scan tool displays a range of 0% to 100%. - This parameter is the commanded percentage of ON time of the TCC solenoid. 100% represents an ON (energized) commanded state. 0% represents (non-energized) commanded state.

CONTROL (CTR) FEEDBACK (FDBK) TCC SOL -Scan tool displays ON/OFF. - This parameter is the actual state of the TCC solenoid driver control circuit. ON indicates a driver control signal at 0 voltage. OFF indicates a driver control signal at B+ voltage.

DESIRED PRESSURE CONTROL SOLENOID (PCS) - Scan tool displays a range of 0.00 amp to 1.10 amps. - This parameter is the commanded current of the pressure control solenoid circuit. 0.00 amp (no current flow) indicates commanded higher line pressure. 1.10 amps (high current flow) indicates commanded lower line pressure.

ACTUAL PRESSURE CONTROL SOLENOID (PCS) - Scan tool displays a range of 0.00 amp to 1.10 amps. - This parameter is the actual current of the pressure control solenoid circuit at the control module. 0.00 amp (no current flow) indicates actual high line pressure.

PRESSURE CONTROL SOLENOID (PCS) DUTY CYCLE - Scan tool displays a range of 0% to 100% - This parameter is the commanded state of the pressure control solenoid expressed as a percent of energized on time. 0% indicates zero on time (nonenergized) or no current flow. 100% indicates maximum on time (energized) or high current flow.

MPH Km/h - Scan tool displays a range of 0 mph to 55 mph. - This parameter is the input signal from the vehicle speed sensor.

FOUR WHEEL DRIVE (4WD) LOW SWITCH - Scan tool displays NO/YES. - This parameter is the signal state of the four wheel drive low circuit. NO indicates a B+ voltage signal (4WD low not requested), YES indicates a 0 voltage signal (4WD low requested).

CRUISE ENGAGED - Scan tool displays NO/ YES. - This parameter is the signal state of the cruise control ON/OFF switch. NO indicates a 0 voltage signal (cruise control not requested). YES indicates a B+ voltage (cruise control requested).

TCC BRAKE SWITCH - Scan tool displays OPEN/ CLOSED. - This parameter indicates the state of the TCC brake switch circuit input. Open indicates a 0 voltage input (brake switch open, brake pedal applied). Closed indicates a B+ voltage input (brake switch closed, brake pedal released).

KICKDOWN ENABLED - (Above approximately 75YO TPS) - Scan tool displays NO/YES. - This parameter indicates whether enabling conditions exist for an acceleration mode downshift. NO indicates enabling conditions (throttle position, vehicle speed, input speed, etc.) do not exist for an acceleration mode downshift. YES indicates enabling conditions exist for an acceleration mode downshift.

1-2 SHIFT TIME - Scan Tool displays a range of 0.00 seconds to 6.38 seconds. -This parameter is the actual time of the last l-2 shift.

2-3 SHIFT TIME - Scan tool displays a range of 0.00 seconds to 6.38 seconds. **-** This parameter is the actual time of the last 2-3 shift.

TRANS GEAR RATIO - Scan tool displays a range of 0.00 to 5.00. -This parameter is the difference between input speed and output speed

TURBINE SPEED - Scan tool displays a range of 0 RPM to 8191 RPM. - This parameter indicates rotational speed of the turbine shaft expressed as revolutions per minute.

TRANS CALIBRATION (CALIB) ID - Scan tool displays a range of 0000 to 9999. - This parameter is the four digit identification of the transmission software calibration.

SYSTEM VOLTAGE - Scan tool displays 0.00 volt to 25.5 volts. - This parameter is the battery ignition voltage input to the control module.

PRESSURE CONTROL SOLENOID (PCS) DUTY CYCLE - Scan tool displays a range of 0 to 100%. - This parameter is the commanded state of the pressure control solenoid expressed as a percent of energized on time. 0% indicates zero on time (nonenergized) or no current flow. 100% indicates maximum on time (energized) or high current flow.

MPH Km/h - Scan tool displays a range of 0 mph to 255 mph. - This parameter is the input signal from the vehicle speed sensor.

TRANS GEAR RATIO - Scan tool displays a range of 0.00 to 5.00. - This parameter is the difference between input speed and output speed.

TURBINE SPEED - Scan tool displays a range of 0 RPM to 8191 RPM. - This parameter indicates rotational speed of the turbine shaft expressed as revolutions per minute.

Table 5-20: 4L80-E Diagnostic Trouble Codes

DTC	MALFUNCTION
21	Throttle position (TP) sensor circuit high
22	Throttle position (TP) sensor circuit low
24	Vehicle speed sensor (VSS)/(TOSS) circuit low
28	Transmission range (TR) pressure switch circuit
37	Torque converter clutch (TCC) brake switch stuck ON
38	Torque converter clutch (TCC) brake switch stuck OFF
39	Torque converter clutch (TCC) solenoid stuck OFF
51	Programmable read only memory (PROM) error
52	System voltage (BATT) high long (length of time)
53	System voltage (BATT) high
58	Transmission fluid temp (TFT) circuit low
59	Transmission fluid temp (TFT) circuit high
63	Barometric pressure sensor (BARO) circuit high
64	Barometric pressure sensor (BARO) circuit low
68	Transmission component slipping
69	Torque converter clutch (TCC) stuck ON
71	CAM Position (CMP) sensor (Engine Speed)
72	Vehicle speed sensor (VSS)/(TOSS) circuit open
73	Pressure control solenoid (PCS) circuit
74	Transmission input speed sensor (TISS) circuit
75	System voltage (BATT) low
79	Transmission fluid overtemp
81	2-3 shift solenoid circuit fault
82	1-2 shift solenoid circuit fault
83	Torque converter clutch (TCC PWM) solenoid circuit fault
85	Undefined ratio error
86	Low ratio error
87	High ratio error

DTC 21/22
Throttle Position (TP) Sensor Circuit High /Throttle Position (TP) Sensor Circuit Low (Figure 5-24)

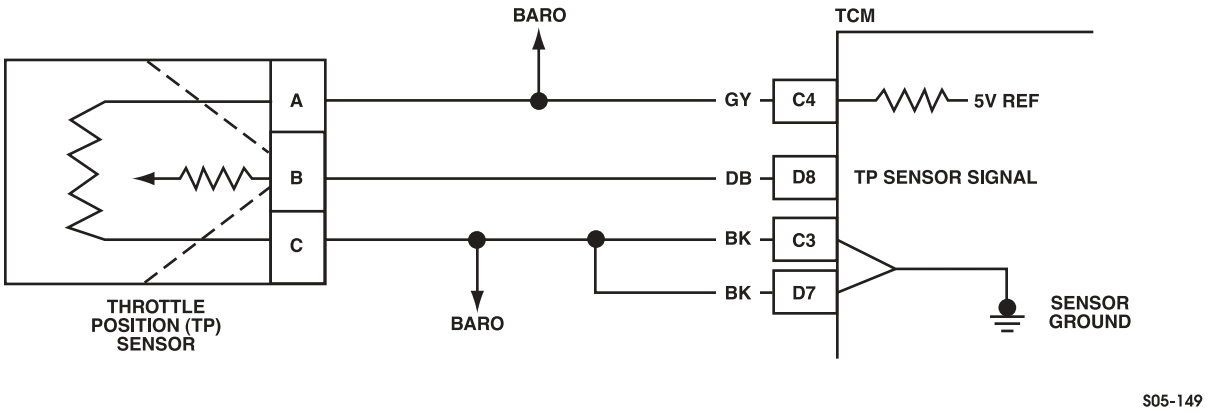


Figure 5-24: Throttle Position Sensor

Circuit Description

The TP sensor contains a resistor strip with one end connected to a 5volt supply and the other to ground.

The signal circuit is connected to a movable contact within the TP sensor. As the accelerator pedal is applied, the voltage signal will increase from approximately 0.5 volt to 4.5 volts.

DTC 21 Will Set When

- Engine operating.
- TP sensor signal voltage greater than 4.9 volts.
- Conditions met for one second.

DTC 22 Will Set When

- Engine operating.
- TP sensor signal voltage less than 0.2 volts.
- Conditions met for one second.

Action Taken (TCM will default to)

- Maximum line pressure.
- Use 35% throttle as default.
- Inhibit 4th gear if in hot mode.

DTC 21/22 Will Clear When: Fault condition(s) are removed, and the ignition is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks for presence of 5 volts at the TP sensor.
2. Scan tool should display the 5 volt reference to the TCM.

Diagnostic Aids

- The TP Sensor voltage should increase smoothly as the accelerator pedal is applied.
- If an intermittent is suspected, check terminal at TP sensor and TCM. Also, use snapshot mode on scan tool to trigger on is DTC.

DTC 21/22

Throttle Position (TP) Sensor Circuit High/Throttle Position (TP) Sensor Circuit Low

- Be sure TP sensor is properly adjusted before proceding.
- Install Tech-1A scan tool.
- Ignition ON, engine OFF.
- Observe throttle position on scan tool display, as accelerator pedal is applied to wide open throttle.
- Does scan display gradually increase from greater than 0.2 volts to less than 4.9 volts?

NOTE: TP sensor and Baro have wiring to ground and 5V reference respectively spliced together in wiring harness.

NO

1
- Ignition OFF.
- Disconnect TP sensor connector.
- Ignition ON.
- With J 39200 DVM, measure 5 volt supply voltage at TP sensor connector.
- Is voltage 5 volts ± 0.3 volts?

YES

- System checks OK.

Refer to Diagnostic Aids.

YES

- With test light to B+, probe ground CKT C3 or D7
- Is test light ON?

NO

- Repair 5 volt supply feed CKT C4 to TP sensor.

YES

2
- Jumper CKT's C4 and D8 together.
- Does scan tool display throttle position greater than 4.9 volts?

NO

- Repair sensor ground CKT C3 or D7 to TP sensor.

YES

- Verify proper terminal tension at the TP sensor connections.

If OK, replace TP sensor.

NO

- Check TP sensor signal CKT D8 for an open or short to ground. Also verify proper TCM terminal tension on this circuit at the TCM. If OK, replace TCM.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 24
Vehicle Speed Sensor (VSS) (TOSS) Circuit Low (Figure 5-25)

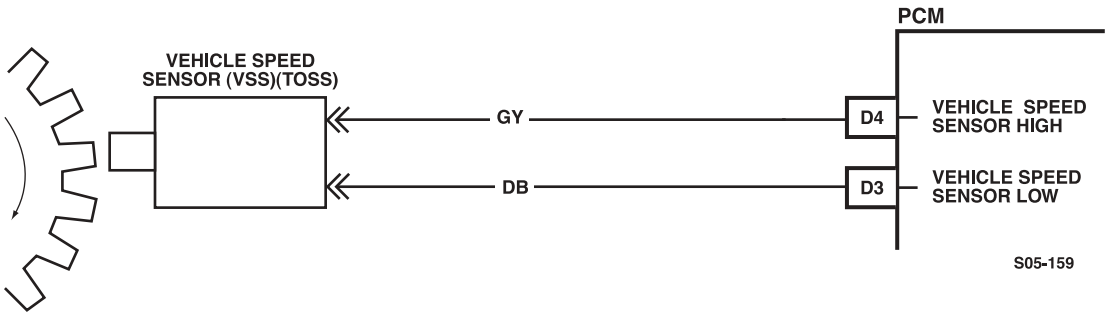


Figure 5-25: Vehicle Speed Sensor (VSS) (TOSS) Circuit

Circuit Description

The VSS/TOSS sensor consists of a permanent magnet surrounded by a coil of wire. As the transmission output shaft rotates, an AC voltage is induced in the circuit. The signal voltage and frequency will vary directly with the output shaft rotational speed.

DTC 24 Will Set When

- No DTC(s)
- Trans range not in PARK or NEUTRAL.
- Engine speed greater than 3000 RPM.
- Trans output speed less than 200 RPM.
- Throttle position 10% to 100%.
- No DTC(s) 21, 22, 28, and 72.
- All conditions met for 2 seconds.

Action Taken (TCM will default to)

No TCC operation.

DTC 24 Will Clear When

The fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This checks the entire circuit for continuity.
2. This checks the output of the output speed sensor.

Diagnostics Aids

- DTC 24 will set when no vehicle speed detected at start off.
- DTC 72 will set when vehicle speed was detected then lost.
- Refer to Control Module Intermittent DTC(s) or Performance.

DTC 24

Vehicle Speed Sensor (VSS) (TOSS) Circuit Loss

- Install Tech-1A.
- Record then clear DTC(s).
- Disconnect front and rear propeller shafts from transfer case.
- Engine operating.
- Transmission in any drive range.
- With transfer output shaft rotating, does Trans Output Speed increase with increased speed?

NO

1
- Disconnect harness connector from TOSS.
- With engine still running and transmission still in drive range, connect J 39200 DVM to sensor terminals. Measure on AC scale voltage at TOSS terminals. Voltage should vary proportionally to engine RPM. Does TOSS AC voltage vary above 7 VAC for engine RPM above 10 MPH equivalent?

YES

2
- Stop engine.
- Check wiring and connectors at TCM and TOSS for opens, shorts, grounds, or damaged pins.
- Was there a fault in connectors or wiring?

NO

- Replace faulty TCM or PROM.

YES

- Repair wiring or connector fault. Retest and check for DTC(s).

YES

- Problem is intermittent. Refer to Diagnostic Aids.

NO

- Replace defective TOSS.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 28

Transmission Range (TR) Pressure Switch Assembly Fault (Figure 5-26)

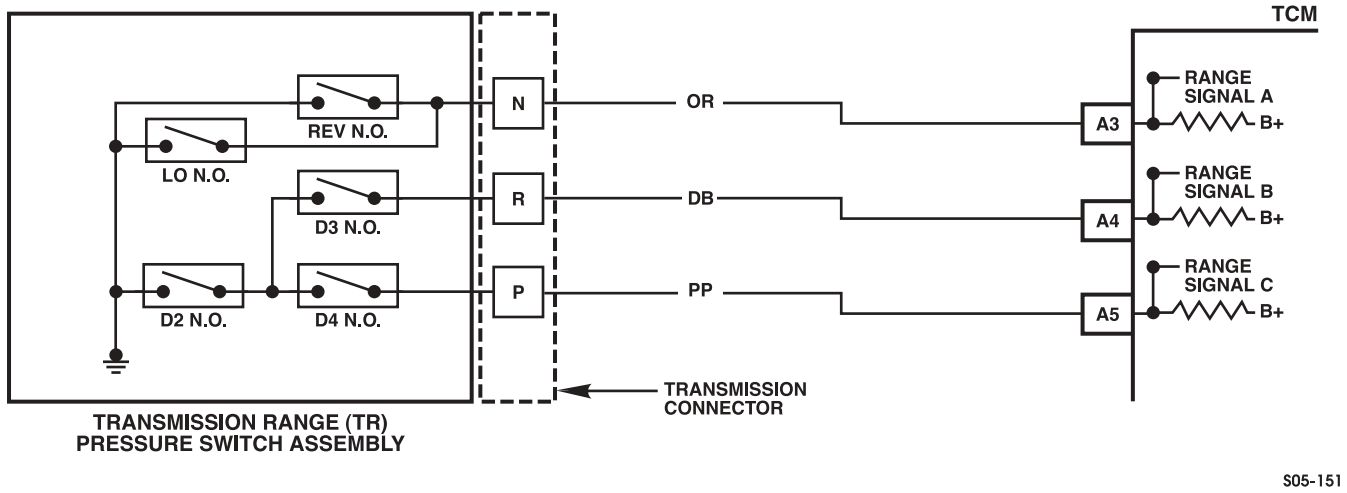


Figure 5-26: Transmission Range Pressure Switch Assembly

Circuit Description

The Transmission Range (TR) switch assembly consists of five normally open pressure switches and is attached to the valve body. The control module supplies battery voltage to each range signal. By grounding one or more of these circuits through various combinations of the pressure switches, the control module detects what manual valve position has been selected by the vehicle operator. With ignition ON and engine OFF, P/ N will be indicated. When the transmission electrical connector is disconnected, the ground potential for the three range signals to the control module will be removed, and with ignition ON, D2 will be indicated.

DTC 28 Will Set When

Range signals A and C are both zero volts OFF for 2 seconds.

Action Taken (TCM will default to)

Harsh shifts, drive 4 shift control. TCC will be inhibited, and if in hot mode, there will be no fourth gear. DTC 28 will be stored in the TCM memory but will not turn ON the Malfunction Indicator Lamp (MIL).

DTC 28 Will Clear When

The fault condition(s) no longer exist, and the ignition switch is cycled from OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks the indicated range signal to the manual valve position actually selected.
2. This test checks for correct voltage from the control module to the transmission external connector.
3. This test checks for a short to ground from the control module to the transmission external connector in any one of the three circuits.

Diagnostic Aids

- DTC 28 will set if the control module detects one of two illegal combinations.
- Refer to accompanying chart for various A/B/C range combinations. Check all wiring connectors for proper terminal tension.
- Refer to TR Pressure Switch Assembly Resistance Check or Functional Test Procedure.

Table 5-21: Expected Readings

Range Signal	A	B	C
Park	ON	OFF	ON
Rev	OFF	OFF	ON
Neutral	ON	OFF	ON
D4	ON	OFF	OFF
D3	ON	ON	OFF
D2	ON	ON	ON
D1	OFF	ON	ON
Illegal	OFF	ON	OFF
Illegal	OFF	OFF	OFF

ON = B+/OFF = 0 VOLTS
(Scan Tool Readings)

DTC 28 TRANSMISSION RANGE (TR) PRESSURE SWITCH ASSEMBLY FAULT

This chart assumes that:
- The transmission linkage from the selector to the manual valve is adjusted properly.
- OBD system check has been performed.
- Fluid checking procedure has been performed.
- All DTC(s) have been recorded and then cleared.
- Scan tool installed.

1
- Engine idling at normal operating temperature.
- Parking brake applied and wheels blocked.
- Apply brake pedal and select each transmission range D1, D2, D3, D4, N, R, P.
- Does each selected transmission range match the Tech-1A scan tool TRANS RANGE SW display?

NO

- Ignition OFF.
- Disconnect transmission wiring connector ASM.
- Install J 39775 Jumper Harness/Probe Kit on the external wiring connector.
- Ignition ON, engine OFF.
- With J 39200 DVM to ground, check voltage at vehicle harness connector terminals N, R, and P.
- Does J 39200 DVM Display B+ at all three circuits?

YES

- No trouble found.
- Refer to diagnostic aids.

NO

3
- Ignition OFF.
- Disconnect control module connector.
- With J 39200 to ground, check resistance at vehicle harness connector terminals N, R, and P.
- Does J 39200 DVM display high resistance (greater than 50k ohms) on all three circuits?

YES

2
- Verify that CKTs A3, A4, or A5 are not shorted together. If OK, refer to TR Pressure Switch Assembly Resistance Check.

NO

- Check low resistance circuit A3, A4, or A5 for short to ground. Repair pinched or chaffed wires per wiring harness repair procedures (Section 12).

YES

- Ignition ON, engine OFF.
- With J 39200 to ground, check voltage at control module terminals A3, A4, and A5 (TCM). If J 39200 DVM does not display B+ at all three circuits, replace control module.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 37/38

TCC Brake Switch Stuck ON/TCC Brake Switch Stuck OFF (Figure 5-27)

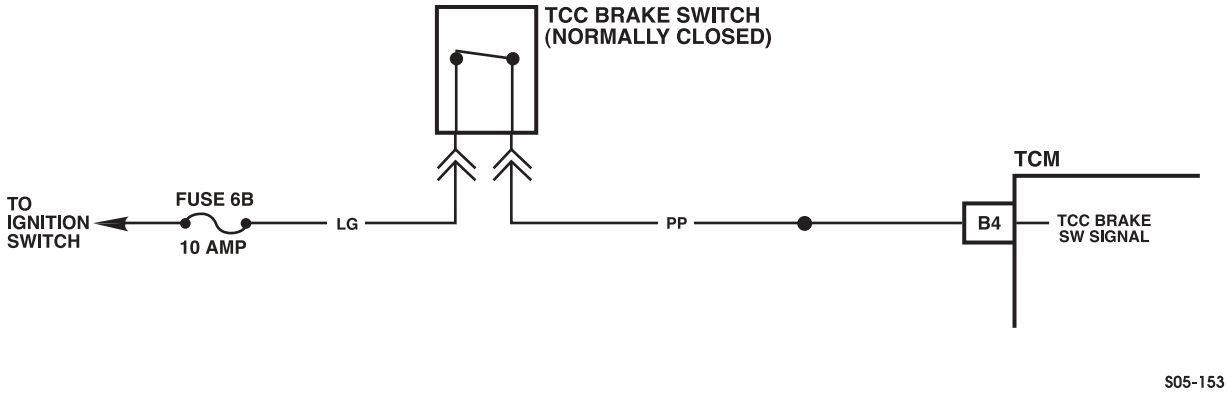


Figure 5-27: TCC Brake Switch

Circuit Description

The normally closed brake switch supplies a B+ signal on CKT B4 to the control module. The signal voltage drops to 0 volt when the TCC brake switch is opened (brake pedal applied).

DTC 37 Will Set When

- CKT B4 is open.
  - Vehicle speed is less than 5 mph for greater than 6 seconds.
  - Then vehicle speed is between 5 mph and 20 mph for greater than 6 seconds.
  - Then vehicle speed is greater than 20 mph for greater than 6 seconds.
  - For a total of seven times.

DTC 38 Will Set When

- CKT B4 has constant Voltage.
  - Vehicle speed is greater than 20 mph for greater than 6 seconds.
  - Then vehicle speed is between 5 mph and 20 mph for greater than 6 seconds.
  - For a total of seven times.

Action Taken (TCM will default to)

DTC 37:

- No fourth gear in hot mode.

DTC38:

- No fourth gear in hot mode.
- No TCC.

DTC 37/38 Will Clear When

Fault condition no longer exists.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks for voltage at the brake switch.
2. This test checks the brake switch.
3. This test checks CKT B4 at the control module.

Diagnostic Aids

- Refer to Control Module Intermittent Diagnostic Trouble Code or Performance.
- Check customer driving habits and/or unusual traffic conditions (i.e., stop and go, express way traffic).

DTC 37/38 - TCC BRAKE SWITCH STUCK ON/TCC BRAKE SWITCH STUCK OFF

- Install scan tool.
- Ignition switch ON, engine OFF.
- Record then clear DTC(s).
- Apply then release brake pedal.
- Does scan tool display TCC brake SW OPEN with brake pedal applied, and then display CLOSED when released?

NO

1

- With test light connected to ground, backprobe ignition feed circuit on brake switch.
- Is test light ON?

YES

- With test light connected to ground, backprobe harness CKT B4 at brake switch.
- Is test light ON?

YES

2

- Apply brake pedal.
- Is test light OFF when pedal is applied?

YES

- Ignition OFF.
- Disconnect control module connectors.
- Ignition ON, engine OFF.
- With a test light connected to ground, probe control module CKT B4 harness connector.
- Is test light ON?

YES

3

- Ignition OFF.
- Reconnect control module connections.
- Ignition ON.
- Apply then release brake pedal.
- Does scan tool display TCC brake SW OPEN with brake applied, and then displayed CLOSED when released?

YES

- Electrical system checks OK at this time. The malfunction may be intermittent or may have been corrected during the diagnostic procedure. Refer to Diagnostic Aids.

YES

- No trouble found. Refer to Diagnostic Aids.

NO

- Repair open in the ignition feed circuit to the brake switch. If the ignition voltage feed fuse 6B is open, also check CKT B4 for a short to ground.

NO

- Brake switch out of adjustment or faulty brake switch.

NO

- Check CKT B4 for short to B+. If OK, replace brake switch.

NO

- Repair open CKT B4 from TCC brake switch to control module.

NO

- Faulty control module.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 39

TCC Solenoid Stuck OFF (Figure 5-28)

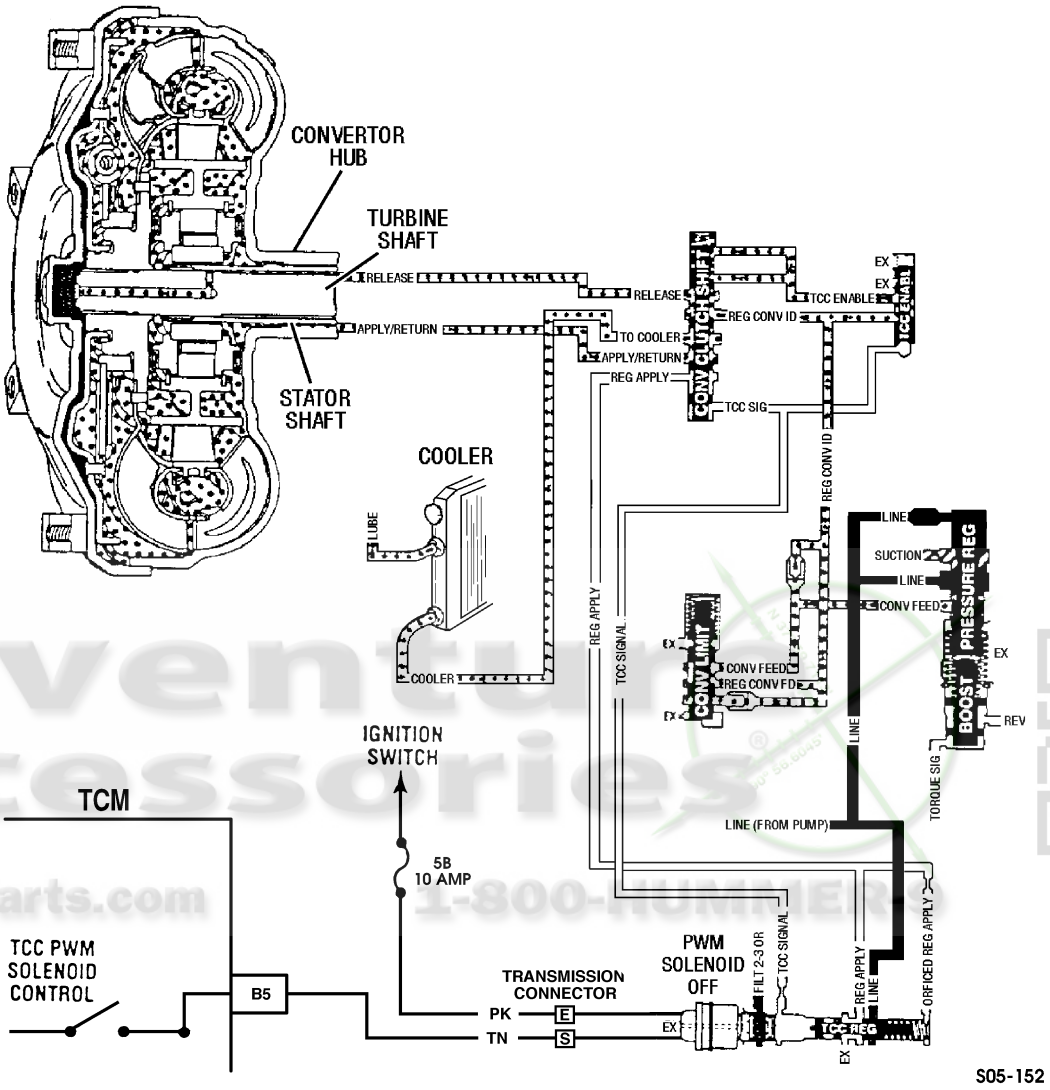


Figure 5-28: TCC Solenoid

Circuit Description

The control module commands the TCC PWM solenoid ON by modulating TCC signal fluid acting on the converter clutch shift valve. Then TCC apply fluid applies the torque converter clutch.

DTC 39 Will Set When

- No DTC(s) 28, 71, or 74.
- TCC is commanded ON.
- TCC slip speed greater than 65 RPM.
- Trans range in D3 or D4.
- 2nd or 3rd gear.
- All conditions are met for two seconds.

Action Taken (TCM will default to)

No 4th gear in hot mode.

DTC 39 Will Clear When

The fault condition no longer exists, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This checks the mechanical and hydraulic operation of the TCC, while commanded ON by the control module.

Diagnostic Aids

Snapshot mode will record 5 data parameters per second.

DTC 39

TCC Solenoid Stuck OFF

1

- If DTC is set, refer to that chart before proceeding.
- Install scan tool.
- Drive vehicle in D3 and in 3rd gear.
- Use snapshot mode to record data parameters.
- While reviewing data, is TCC slip speed greater than 65 rpm while TCC PWM solenoid is commanded ON (greater than 95%), for 2 seconds?

YES

- The torque converter clutch is mechanically stuck OFF refer to symptom diagnosis charts, NO TCC Torque Converter Clutch Diagnosis.

NO

- The condition may be intermittent, refer to Torque Converter Clutch Diagnosis.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 51

PROM Error (Faulty or Incorrect PROM)

Check that all pins are fully inserted in the socket. If OK, replace PROM, clear memory and recheck. If DTC 51 Reappears, replace control module.

NOTES

DTC 52/53

System Voltage High Long/System Voltage High (Figure 5-29)

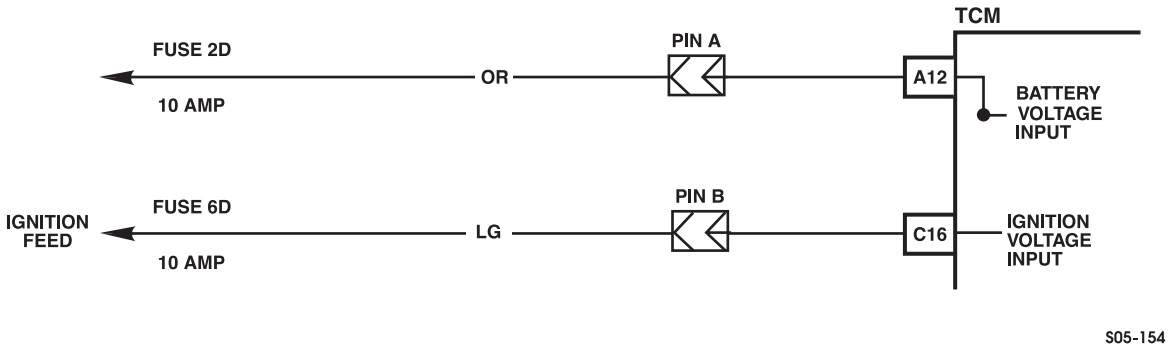


Figure 5-29: TCM Voltages

Circuit Description:

Ignition voltage is supplied to the control module to indicate the ignition status of the ignition switch.

Battery voltage is supplied to the control module to, in part, maintain memory of learned functions and parameters.

DTC 52 Will Set When

- The ignition is ON and the system voltage is greater than 16 volts.
- All conditions are met for 109 minutes.

DTC 53 Will Set When

- The ignition is ON and the system voltage is greater than 19.5 volts.
- All conditions are met for 2 minutes.

Action Taken (TCM will default to)

- Maximum line pressure.
- 2nd gear.
- Inhibit TCC.

DTC 52/53 Will Clear When

Fault condition no longer exists, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

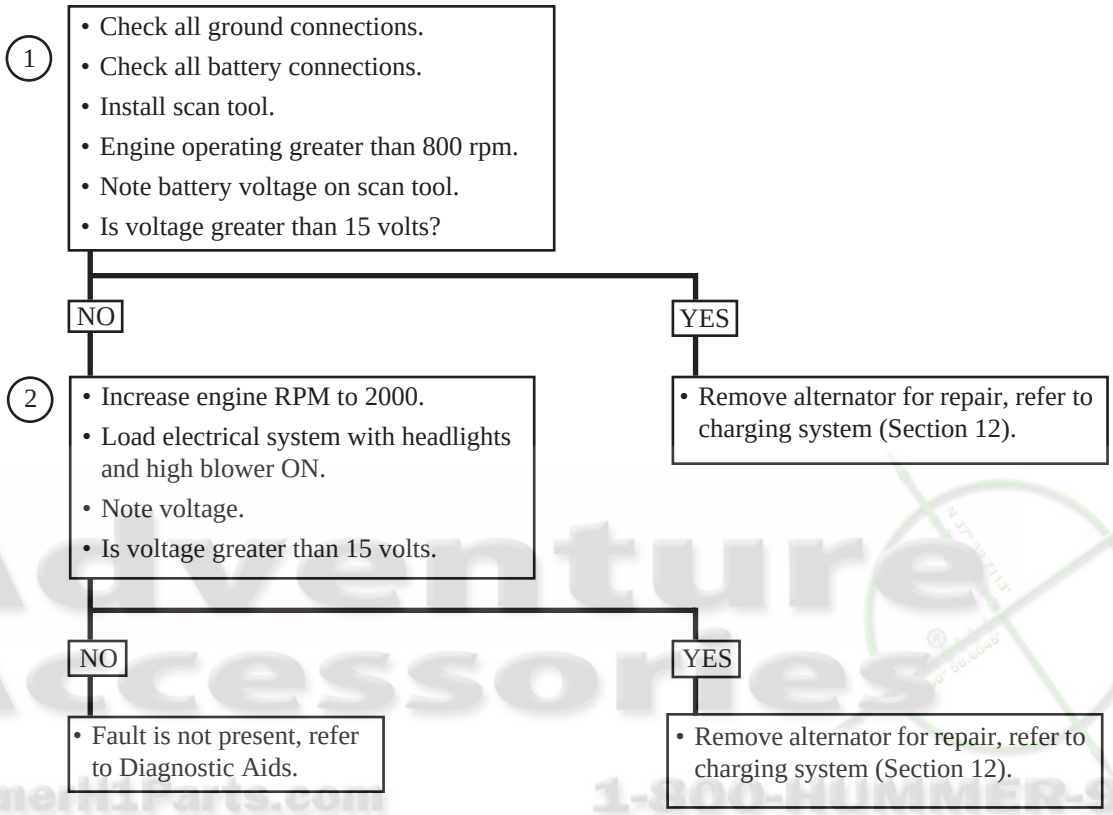
1. Normal battery voltage is between 9-l5 volts.
2. This test checks if the alternator is faulty under load conditions. If the voltage is greater than 15 volts, refer to SECTION 12 of this manual.

Diagnostic Aids

- Charging the battery and jumpstarting an engine may set DTC 52/DTC 53. If DTC(s) set when an accessory is operated, check for faulty connections or excessive current draw. Refer to Section 12 of this manual for circuit details.
- Check for faulty connections at the starter solenoid or fusible link.

DTC 52/53

System Voltage High Long/System Voltage High



When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 58

Transmission Fluid Temperature (TFT) Sensor Circuit Low (High Temperature Indicated) (Figure 5-30)

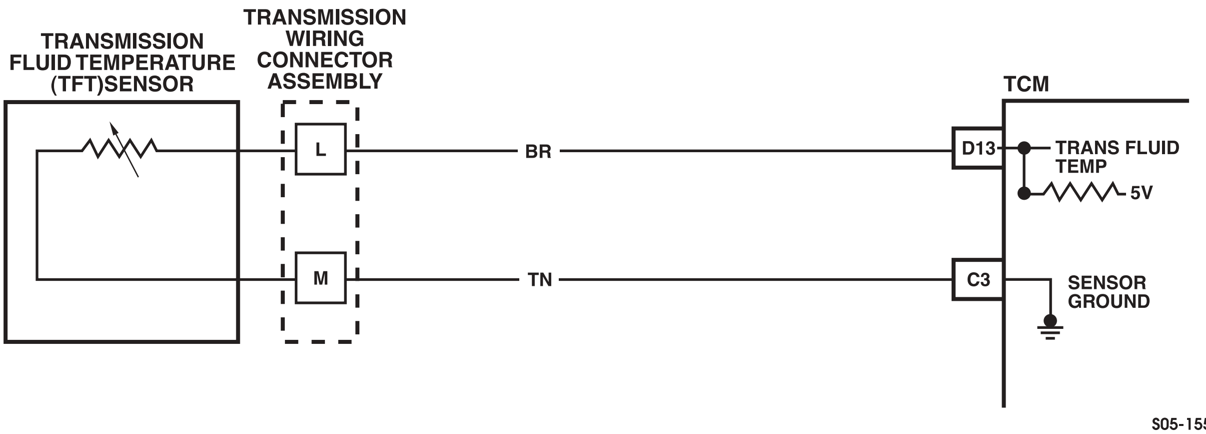


Figure 5-30: TFT Sensor

Circuit Description

The TFT sensor is a thermistor that controls the signal voltage to the control module. The control module supplies a 5 volt reference signal to the sensor on CKT D13. When the transmission fluid is cold, the sensor resistance is high and the control module will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts. With a DTC 79 also set, check the transmission cooling system.

DTC 58 Will Set When

- Signal voltage indicates TFT greater than 306°F (152 °C).
- All conditions are met for 1 second.

Action Taken (TCM will default to)

The control module will use a warm default transmission fluid temperature value.

DTC 58 Will Clear When

The fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks for a short to ground or a “skewed” sensor.
2. This test checks for an internal fault within the transmission by creating an open.

Diagnostic Aids

- Check harness routing for a potential short to ground in CKT D13.
- Scan tool TFT display should rise steadily to about 212°F (100°C) then stabilize.
- Refer to Control Module Intermittent Diagnostic Trouble Codes or Performance.
- The temperature to resistance value scale may be used to test the TFT sensor at the various temperature levels to evaluate the possibility of a “skewed” sensor. A “skewed” (mis-scaled) sensor could result in delayed shifts or TCC complaints.

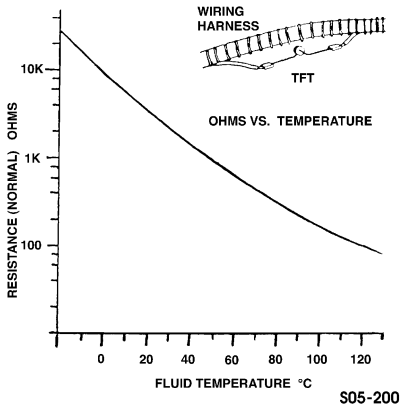
DTC 58

Transmission Fluid Temperature (TFT) Sensor Circuit Low (High Temperature Indicated)

- Has fluid checking procedure been performed?
  - YES
    1. Does scan tool display transmission fluid temperature of 306°F (152°C)?
       - YES
         2. Ignition OFF.
            - Disconnect transmission wiring connector assembly (additional DTC(s) will set).
            - Ignition ON, engine OFF.
            - Does scan tool display temperature of -40°F (-40°C)?
               - YES
                 - TFT sensor is indicating high temperature, refer to Internal Wiring Harness Check.
               - NO
                 - CKT D13 shorted to ground or faulty control module or connections.
            - NO
              - DTC is intermittent.
              - If no additional DTC(s) were stored, refer to Diagnostic Aids.
       - NO
         - Refer to Fluid Checking Procedure.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

Temperature vs. Resistance Chart



DTC 59

Transmission Fluid Temperature (TFT) Sensor Circuit High (Low Temperature Indicated) (Figure 5-31)

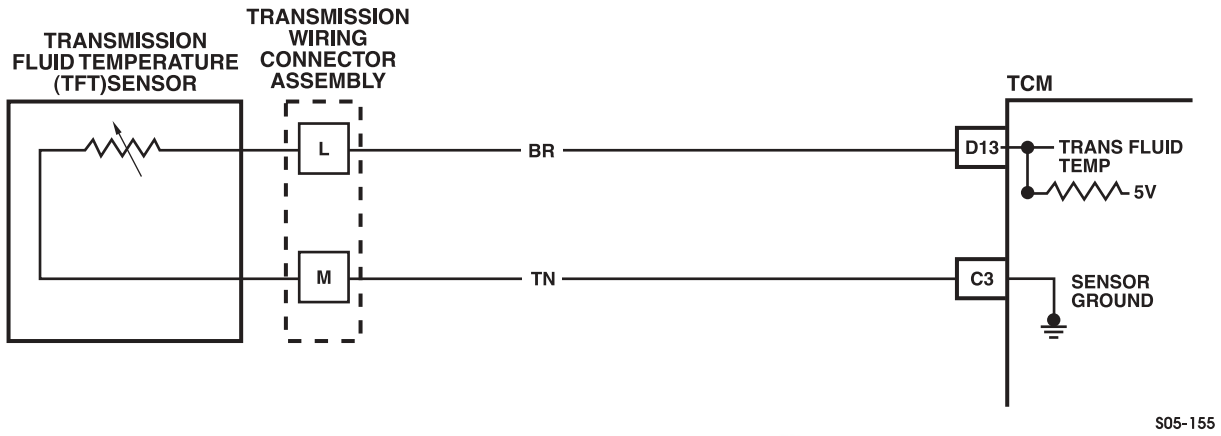


Figure 5-31: TFT Sensor

Circuit Description

The TFT sensor is a thermistor that controls the signal voltage to the control module. The control module supplies a 5 volt reference signal to the sensor on CKT D13. When the transmission fluid is cold, the sensor resistance is high and the control module will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts.

DTC 59 Will Set When

- Signal voltage indicates TFT less than -40°F (-40°C).
- All conditions are met for 1 second.

Action Taken (TCM will default to)

The control module will use a warm default transmission fluid temperature value.

DTC 59 Will Clear When

The fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

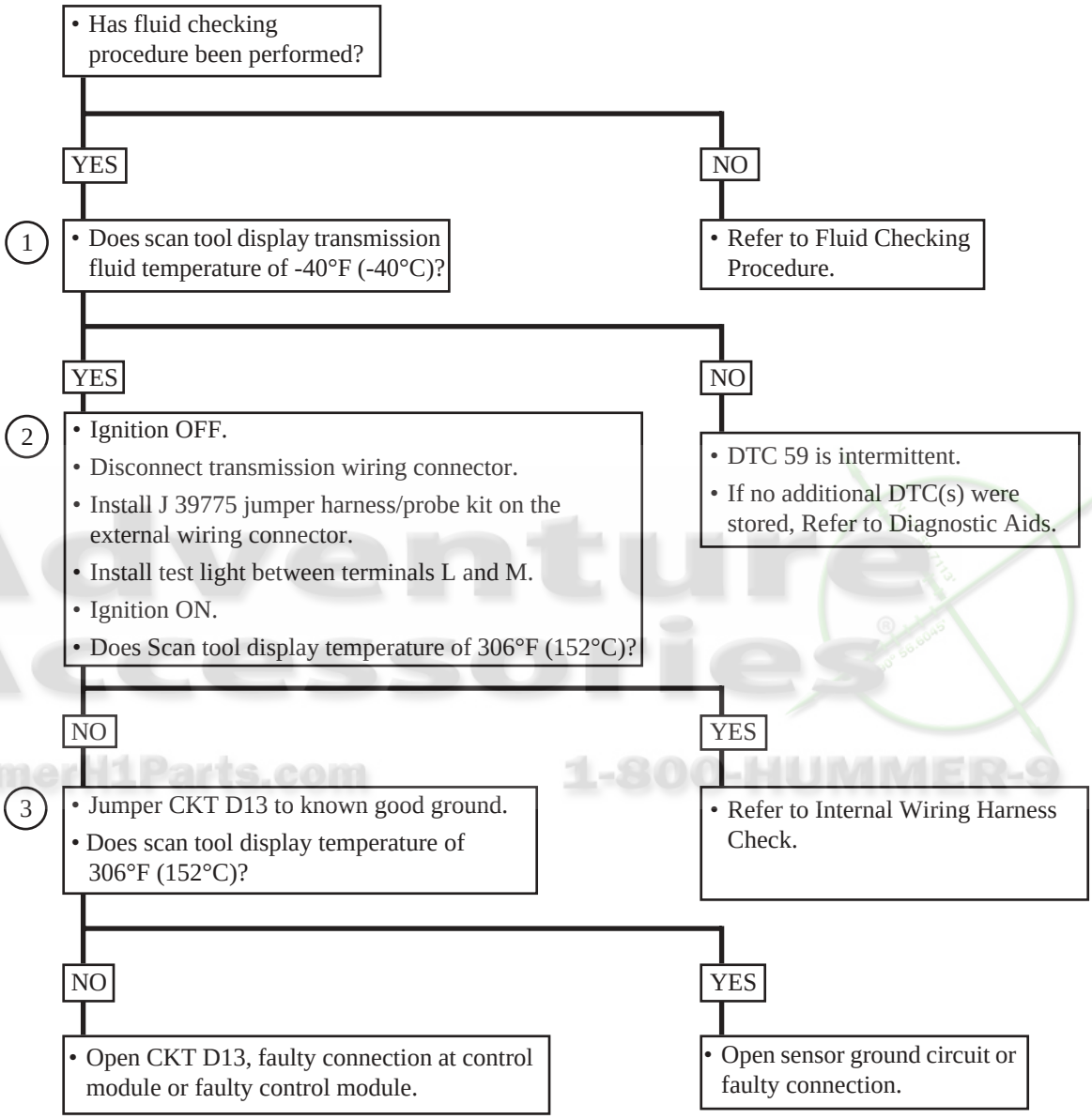
1. This checks the entire circuit and indicates whether the malfunction is present.
2. This test simulates a DTC 58. If the control module recognizes the low signal voltage (high temperature), and the scan tool displays 306°F (152°C) or greater, the control module and wiring are OK.
3. This test checks if CKT D13 is open. There should be 5 volts present at the sensor connector if measured with J 39200.

Diagnostic Aids

- Scan tool displays transmission fluid temperature in degrees. After transmission is operating, the temperature should rise steadily to about 212°F (100°C) then stabilize.
- A faulty connection or an open in CKT 452 or CKT 1227 can result in a DTC 59.
- The Temperature to Resistance Value scale in DTC 58 may be used to check the TFT sensor at various temperature levels to evaluate the possibility of a “skewed” (mis-scaled) sensor. A “skewed” sensor can result in firm shifts, or TCC complaints.

DTC 59

Transmission Fluid Temperature (TFT) Sensor Circuit High (Low Temperature Indicated)



When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 63/64

Baro Sensor Circuit High/Baro Sensor Circuit Low (Figure 5-32)

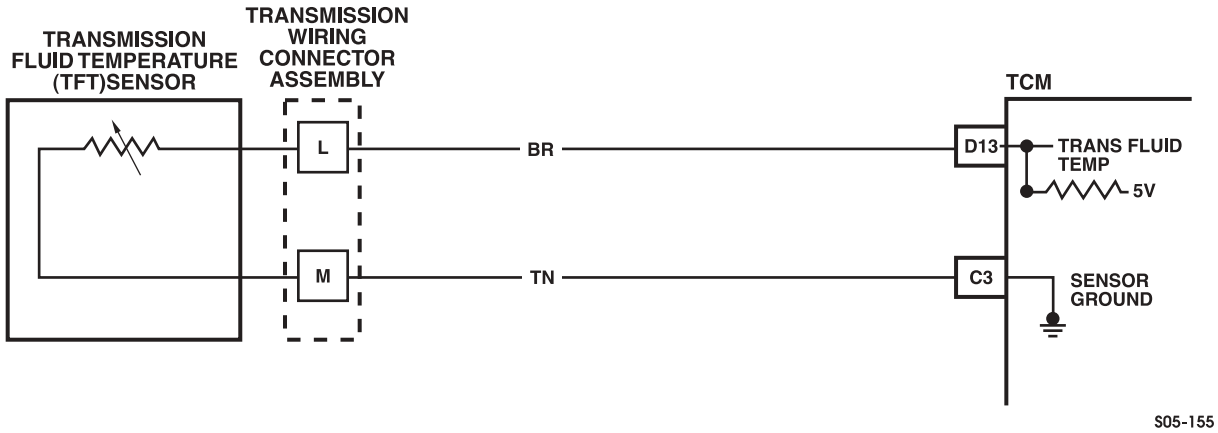


Figure 5-32: Baro Sensor

Circuit Description

The Transmission Control Module (TCM) supplies 5 volts to the BARO sensor. As the atmospheric pressure changes the resistance within the BARO sensor also changes, modifying the voltage on the BARO sensor input signal. When atmospheric pressure is high (14.5 psi) input signal voltage will also be high (approx. 4.5V). As atmospheric pressure decreases, so does the input signal voltage.

DTC 63 Will Set When

- BARO sensor signal voltage greater than 4.9 volts.
- Longer than 2 seconds.

DTC 64 Will Set When

- BARO sensor signal voltage less than 1.9 volts.
- Longer than 2 seconds.

Action Taken (TCM will default to)

No altitude compensation of shift patterns.

DTC 63/64 Will Clear When

Fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This verifies the 5 volt supply to the BARO sensor.
2. If the entire circuit is OK, the voltage measured will be 5 volts.

Diagnostic Aids

If the DTC will not set, use snapshot mode on scan tool to trigger ON this DTC, then review data to identify source.

DTC 63/64

BARO Sensor Circuit High/BARO Sensor Circuit Low

- Install scan tool.
- Ignition ON.
- Record then clear DTCs.
- Does DTC 63 or 64 set?

YES

1
- Ignition OFF.
- Disconnect BARO sensor connector.
- Ignition ON.
- With J 39200 DVM measure 5 volt supply voltage at BARO sensor connector.
- Is voltage 5 volts ± 0.3 volts?

YES

- With test light to B+, probe ground CKT D7 at TCM D7 and BARO sensor connector at B.
- Is test light ON at both connectors?

YES

2
- Jumper CKTs C4 and D14 together at BARO sensor connector.
- Backprobe CKT D14 at TCM with J 39200 DVM.
- Is voltage 5 volts ± 0.3 volts?

YES

- Check BARO sensor signal CKT D14 for a short to 5V.
- If OK, replace BARO sensor.

NO

- Check BARO sensor signal CKT D14 for an open or short to ground. Also check terminal tension in connectors on that circuit. If OK, replace TCM.

NO

- Repair sensor ground CKT D7.

NO

- Repair 5 volts supply feed CKT C4 to BARO sensor.

NO

- Malfunction is not present at this time. Refer to Diagnostic Aids

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 68

Transmission Component Slipping (Figure 5-33)

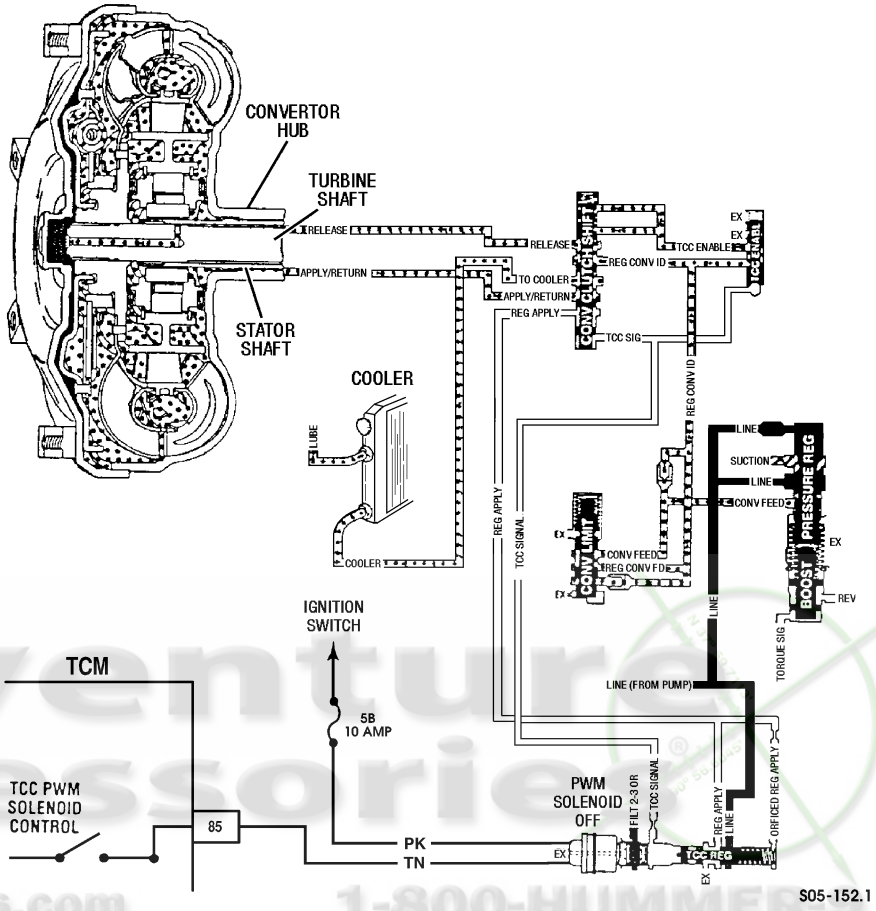


Figure 5-33: Torque Converter Clutch

Circuit Description

The control module monitors the difference in engine speed and input speed. With transmission in drive and TCC locked, the scan tool should display engine speed closely matching input speed.

DTC 68 Will Set When

- No DTC(s) 28, 71, and 74.
- TCC slip speed greater than 200 RPM.
- Fourth gear is indicated.

Action Taken (TCM will default to)

- Inhibit TCC operation.

68 Will Clear When

The fault condition(s) no longer exists and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks the indicated range signal to the actual selected range. A faulty switch could set DTC 68.
2. This test checks the torque converter for slippage while in a commanded lock-up state.
   - TCC is locked.
   - Not in park/neutral.
   - All conditions are met for 2 seconds.

Diagnostic Aids

- Check for deformed connectors at pass-thru connector.
- DTC 68 will set when going to default (second gear).
- Refer to Control Module Intermittent DTC(s) or Performance.
- Check for Internal Transmission Faults (i.e.: leaking seals, failed clutches, etc.).
- An intermittent incorrect engine speed signal will set a DTC 68 if the incorrect signal lasts for greater than 2 seconds.
- A mechanical failure in the 1-2 shift solenoid (stuck OFF) or 2-3 shift solenoid (stuck ON), could set DTC 68.

DTC 68

Transmission Component Slipping

1. • Install Scan Tool.
   • Engine Idling.
   • Record then clear DTC(s).
   • Apply brake pedal and select each transmission range D1, D2, D3, D4, N, R, P.
   • Does each selected trans range match trans range SW on scan tool?

   YES

2. • Drive vehicle in 4th gear and TCC engaged.
   • Use snapshot mode to record data parameters.
   • Is TCC slip speed ever greater than 200 rpm for 2 seconds while TCC is engaged?

   YES

   • The condition may be intermittent. Refer to Torque Converter Clutch (TCC) diagnosis.

   NO

   • Mechanical component failure.

NO

• Refer to DTC 28.

DTC 69

Torque Converter Clutch (TCC) Stuck ON (Figure 5-34)

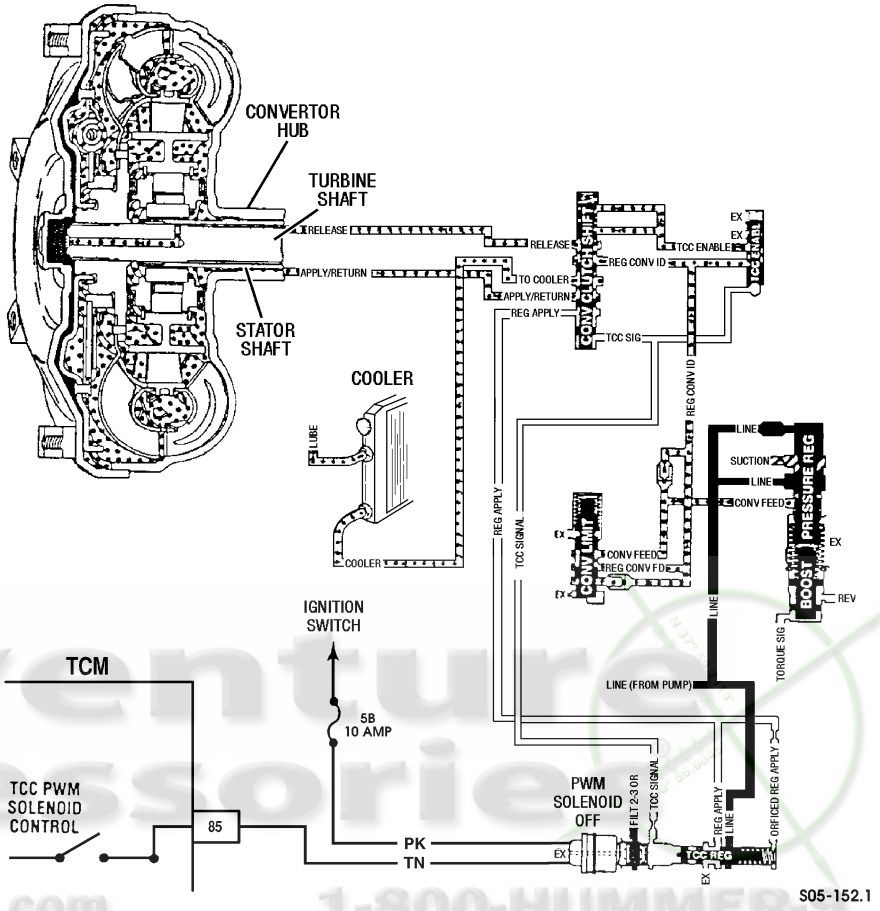


Figure 5-34: Torque Converter Clutch

Circuit Description

The control module commands the TCC PWM solenoid ON by modulating TCC signal fluid acting on the converter clutch shift valve. Then TCC apply fluid applies the torque converter clutch.

DTC 69 Will Set When

- No DTC(s) 21, 22, 28, 71, 74 are set.
- TCC slip speed RPM indicates between -5 and +10.
- TCC solenoid is commanded OFF.
- TP sensor signal is greater than 25%.
- Trans range switch indicates D3 or D4.
- Commanded gear indicates 2nd or 3rd gear.
- All conditions are met for 2 seconds.

DTC 69 Will Clear When

Fault condition no longer exists and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

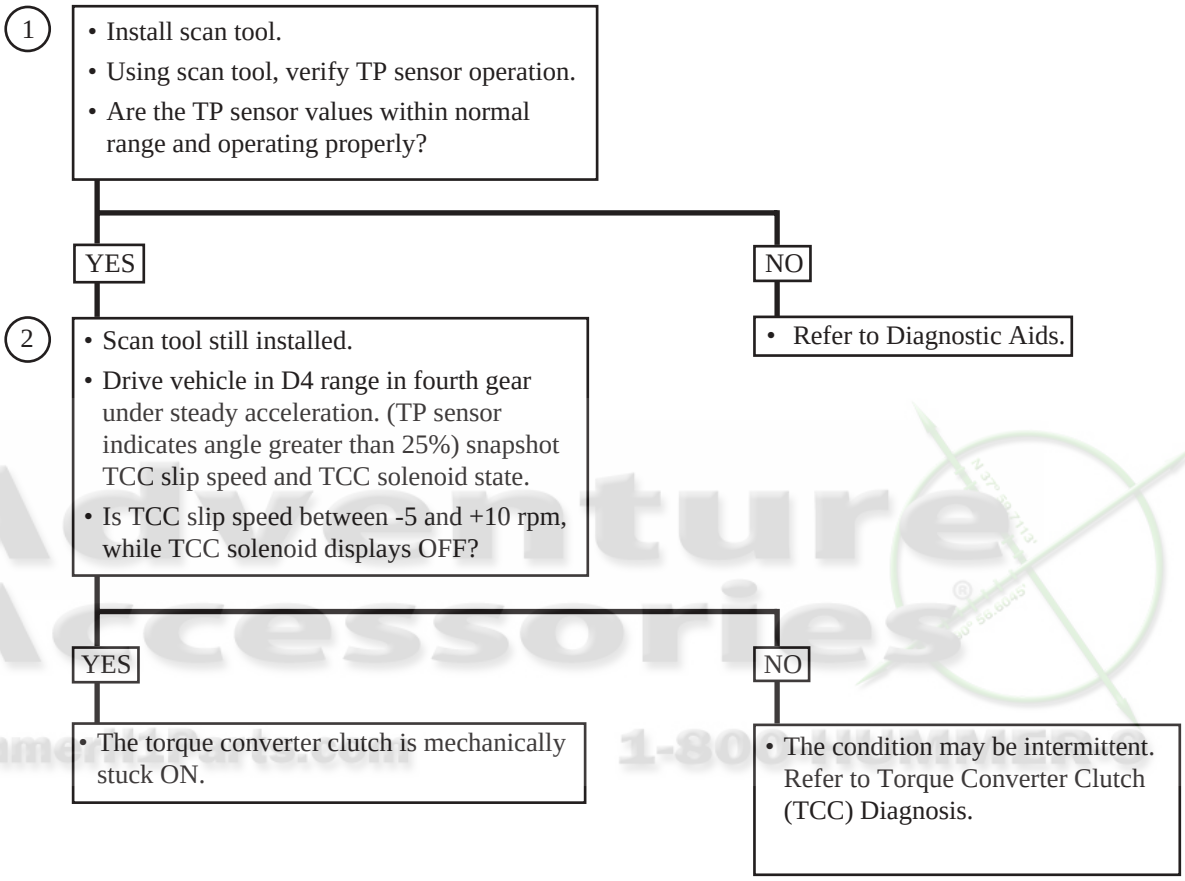
1. This test checks for proper throttle position sensor operation.
2. This test checks the mechanical state of the TCC. When the control module commands the TCC solenoid OFF. TCC slip speed should increase.

Diagnostic Aids

- If the TCC is mechanically stuck ON, vehicle speed is zero, brakes are applied, and D2 is selected, the TCC fluid will mechanically apply the TCC causing an engine stall.
- Scan TP signal while depressing accelerator pedal with engine OFF and ignition ON. Display should vary from below 0.85 volt when the throttle is closed to over 4.0 volts when the throttle is held at wide open throttle. Incorrect TP sensor values may affect TCC operation.

DTC 69

Torque Converter Clutch (TCC) Stuck ON



When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 71

Camshaft Position Sensor Circuit Low (Figure 5-35)

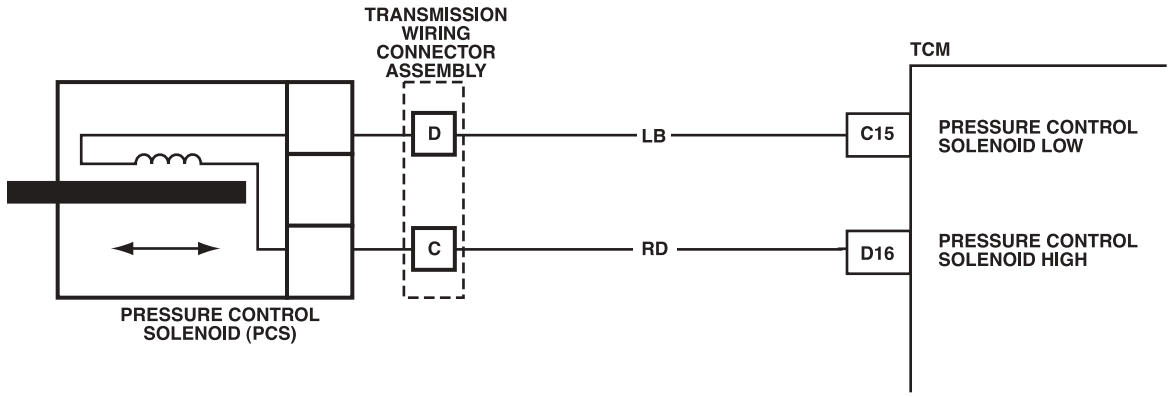


Figure 5-35: Camshaft Position Sensor

Circuit Description

The camshaft position sensor detects the rotational speed of the camshaft. As the camshaft rotates, an AC signal is generated in the circuit. This signal provides the input to determine engine speed, for use in various calculations including TCC slip speed and overdrive ratio.

DTC 71 Will Set When

- No DTC 28 set.
- Engine speed less than 50 RPM.
- Trans range indicates R, D4, D3, or D1.
- Conditions are met for 2 seconds.

Action Taken (TCM will default to)

Inhibit TCC.

DTC 71 Will Clear When

Fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A malfunctioning trans range pressure switch could indicate an inaccurate actual transmission range.
2. This checks the entire CMP sensor circuit for proper signal.
3. A signal at this point indicates that the sensor is capable of inducing an AC voltage in the circuit.

Diagnostic Aids

Refer to TCM Intermittent Diagnostic Trouble Code or Performance.

DTC 71

Camshaft Position Sensor Circuit Low

1. • Install scan tool.
   • Record then clear DTC(s).
   • Ignition ON, engine operating.
   • Apply brake pedal and select each transmission range D1, D2, D3, D4, N, R, P.
   • Does each selected transmission range match the scan tool TRANS RANGE SW display?
   - NO → • Improper transmission range input. Refer to DTC 28 for diagnosis.
   - YES →
2. • Trans shift selector in park.
   • Does Engine Speed on scan tool display increase as throttle increases?
   - YES → • System checks OK at this time. Refer to Diagnostic Aids.
   - NO →
3. • Ignition OFF.
   • Disconnect CMP engine speed sensor connector.
   • Connect J 39200 DVM (AC scale) to sensor.
   • Does J 39200 DVM display AC voltage while cranking engine?
   - NO → • Replace CMP engine speed sensor.
     • Refer to Diagnostic Aids.
   - YES →
• Ignition OFF.
• Reconnect CMP sensor connector.
• Disconnect TCM connectors.
• Connect J 39200 DVM (AC scale) to harness terminals D7 and D6.
• Does J 39200 DVM display AC voltage while cranking engine?
   - NO → • Circuit malfunction in CKT D6 or CKTs D7 or C3.
     • Repair as necessary.
   - YES →
• Ignition OFF.
• Reconnect TCM sensor connectors.
• Engine operating
• Does Engine Speed on scan tool increase as throttle increases?
   - NO → • Verify proper terminal tension on CKTs D6, C3, or D16 at the TCM connectors and CMP sensor connector.
     • If OK, replace TCM.
   - YES →
• System checks OK at this time. Malfunction may be intermittent or repaired during this procedure.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 72

Vehicle Speed Sensor (VSS) (TOSS) Circuit Open (Trans Output Speed Signal) (Figure 5-36)

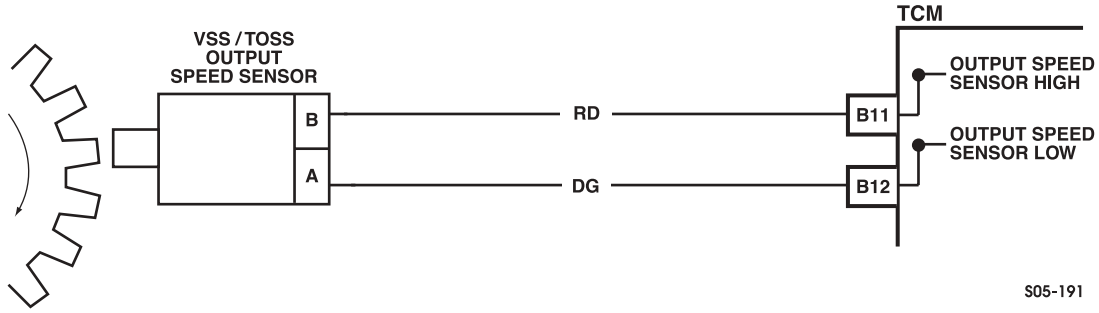


Figure 5-36: VSS/TOSS

Circuit Description

The VSS/TOSS sensor consists of a permanent magnet surrounded by a coil of wire. As the transmission output shaft rotates, an AC voltage is induced in the circuit. The signal voltage and frequency will vary directly with the output shaft rotational speed.

DTC 72 Will Set When

Not in P/N.

- Transmission output speed change is greater than 1000 RPM.
- Engine speed is greater than 200 RPM.
- Conditions met for 2 seconds.
- No DTC 28 set.

In P/N.

- Transmission output speed change is greater than 2050 RPM.
- Engine speed is greater than 200 RPM.
- Conditions met for 2 seconds.
- No DTC 28 set.

Action Taken (TCM will default to)

Delayed soft shift second gear and second gear start.

DTC 72 Will Clear When

The fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This checks the entire circuit for continuity.
2. This checks the output of the VSS/TOSS sensor.

Diagnostic Aids

- DTC 24 will set if no vehicle speed at start off.
- DTC 72 will set if vehicle speed was detected then lost.
- Refer to Control Module Intermittent DTC(s) or Performance.

DTC 72

Vehicle Speed Sensor (VSS) (TOSS) Circuit Open

- Install Tech-1A scan tool.
- Record then clear DTC(s).
- Disconnect both propeller shafts at transfer case.
- Engine operating.
- Transmission in any drive range.
- With transmission output shaft rotating, does Trans Output Speed increase with increased speed?

NO

1

- Disconnect connector from TOSS.
- With engine still running and transmission still in drive range, connect J 39200 DVM to sensor terminals. Measure on AC scale voltage at TOSS terminals. Voltage should vary proportionally to engine RPM (for same trans range).
- Does TOSS AC voltage vary above 7 VAC for engine RPM above 10 MPH equivalent?

YES

2

- Stop engine.
- Check wiring and connectors at TCM and TOSS for opens, shorts, grounds, or damaged pins.
- Was there a fault in connectors or wiring?

NO

- Replace faulty TCM or PROM.

YES

- Repair wiring or connector fault. Retest and check for DTC(s).

YES

- Problem is intermittent. Refer to Diagnostic Aids.

NO

- Replace defective TOSS.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 73

Pressure Control Solenoid (PCS) Circuit (Current Error) (Figure 5-37)

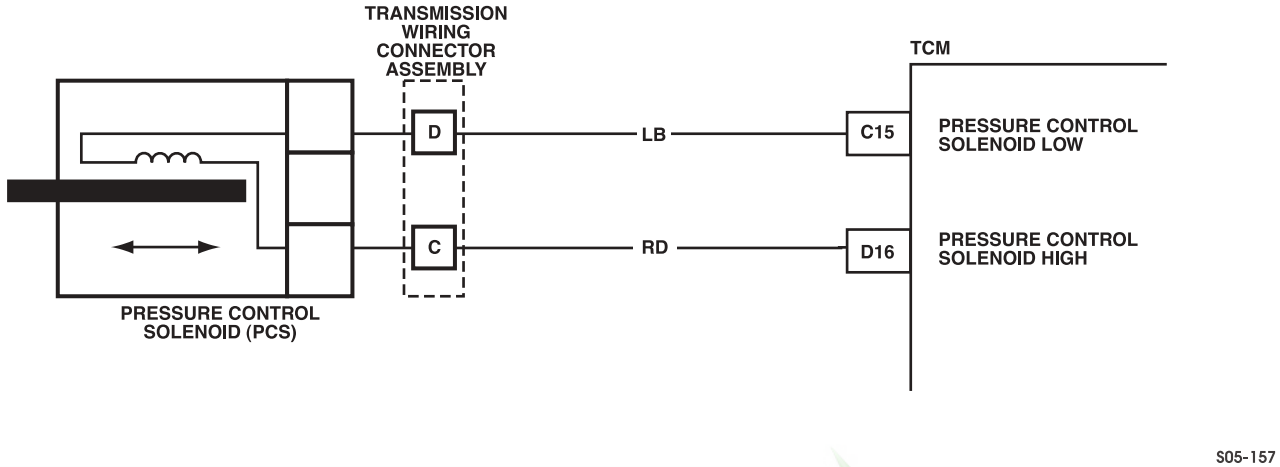


Figure 5-37: Pressure Control Solenoid

Circuit Description

The pressure control solenoid is a TCM controlled device used to regulate transmission line pressure. The TCM compares TP voltage, engine RPM, and other inputs to determine the line pressure appropriate for a given load. The TCM will regulate the pressure by applying a varying amperage to the pressure control solenoid. The applied amperage can vary from 0.1 to 1.1 amps. The TCM then monitors the amperage at the return line.

DTC 73 Will Set When

The return amperage varies greater than 0.16 amp from the commanded amperage, for at least one second, and no DTC 75 stored.

Action Taken (TCM will default to)

Full line pressure will be applied causing harsh shifts. DTC 73 will be stored in the TCM memory but will not turn ON the MIL (Malfunction Indicator Lamp).

DTC 73 Will Clear When

The fault condition(s) no longer exist, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks the ability of the TCM to command the pressure control solenoid.
2. This test checks internal transmission harness and the pressure TCM for incorrect resistance.

Diagnostic Aids

- Check for poor connections at PCM and at transmission connector.
- If pressure readings differ greatly from the line pressure chart, repair transmission.

Line Pressure Chart

Pressure Control Solenoid Current (Amp)	Line Pressure (PSI)
0.02	157-177
0.10	151-176
0.20	140-172
0.30	137-162
0.40	121-147
0.50	102-131
0.60	88-113
0.70	63-93
0.80	43-73
0.90	37-61
0.98	35-55

DTC 73

Pressure Control Solenoid (PCS) Circuit (Current Error)

1
- Install Tech-1A scan tool.
- Record then clear DTC(s).
- Engine operating, transmission in PARK.
- Enter Misc. Tests/Transmission/PCS Control.
- Using scan tool, apply 1.0 amps thru 1.1 amps while observing desired PCS and actual PCS.
- Is actual PCS reading always within 0.16 amps of desired PCS?

NO

2
- Ignition OFF.
- Connect oil pressure gauge at transmission line pressure tap.
- Set parking brake/transmission in PARK.
- Start engine and allow it to warm at idle.
- Scan tool still installed, enter Misc. Test/ Transmission/PCS Control.
- Using scan tool, increase desired PCS in 0.1 amp increments (allow pressure to stabilize for 5 seconds after each current charge).
- Compare actual line pressure and current readings to line pressure chart.

  CAUTION: Total time should not exceed 2 minutes, or transmission damage could occur.
- Do readings match chart?

YES

- Ignition OFF.
- Check trans wiring connector terminal tension on the PCS circuits.
- If OK, refer to internal PCS circuit diagnosis.

NO

- Disconnect control module connector
- With J 39200 DVM, check resistance between vehicle harness terminals C15 and D16 (TCM).
- Does J 39200 DVM display resistance between 3.5 and 8 ohms?

NO

- Transmission electrical connector disconnected, check vehicle harness circuits C15 and D16 for open or short to ground.
- If no trouble is found, replace PCS.

YES

- Replace control module.

YES

- Problem is intermittent. Refer to Diagnostic Aids.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 74

Transmission Input Speed (TISS) Sensor Circuit (Figure 5-38)

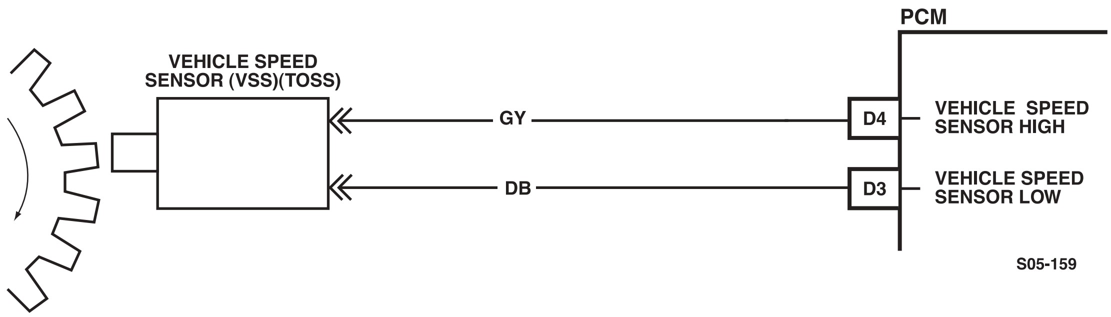


Figure 5-38: Input Speed Sensor

Circuit Description

The TISS sensor consists of a permanent magnet surrounded by a coil of wire. As the forward clutch housing rotates, an AC voltage is induced in the circuit. The signal voltage and frequency will vary directly with the forward clutch rotational speed.

DTC 74 Will Set When

- No DTC(s) 24, 28, or 71.
- Trans range not in park or neutral.
- Engine speed greater than 300 RPM.
- Trans output speed greater than 200 RPM.
- Trans input speed less than 50 RPM.
- All conditions met for 2 seconds.

Action Taken (TCM will default to)

No TCC operation.

DTC 74 Will Clear When

The fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This checks the entire circuit for continuity.
2. This checks the output of the input speed sensor.

Diagnostic Aids

Refer to Control Module Intermittent DTC(s) or Performance.

DTC 74

Transmission Input Speed Sensor (TISS) Circuit

1. Backprobe across CKT D4 and D3 at control module connector.
2. Engine at normal operating temperature and transmission in Drive.
3. J 39200 DVM on A/C voltage scale.
4. Does voltage increase above 7 volts with engine speed increase above approximately 10 mph?

NO

2. Ignition OFF.
3. Disconnect input speed sensor connector.
4. Engine operating and transmission in gear.
5. J 39200 DVM on A/C voltage scale.
6. With jumper wire and J 39200, measure voltage across sensor terminals.
7. Does voltage increase above 7 volts with drive wheel speed increase above approximately 10 mph?

NO

- Replace input speed sensor.

YES

- Check for open or shorted CKTs D3 and D4. Also check terminal tension of these circuits at the control module and the input speed sensor connector.
- If OK, replace control module.

YES

- Problem is intermittent or internal transmission.
- Refer to Diagnostic Aids.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 75

System Voltage Low (Figure 5-39)

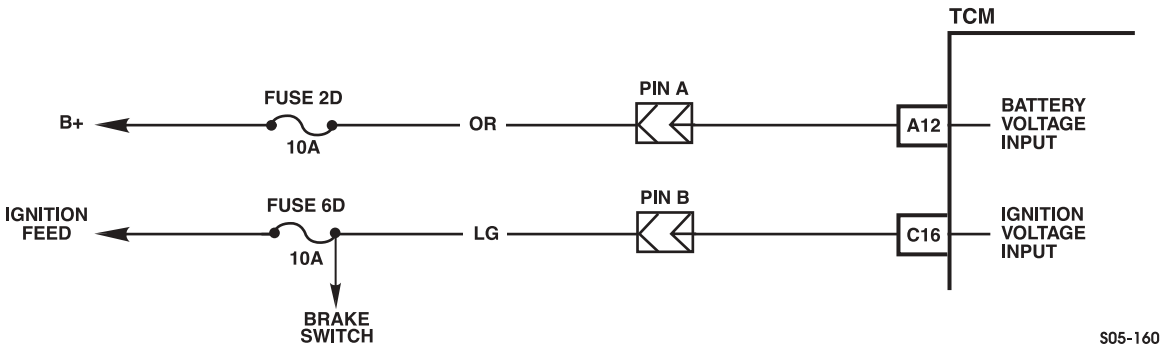


Figure 5-39: Voltage Inputs

Circuit Description

CKT A12is the battery feed for the control module. CKT C16 is the ignition voltage feed for the TCM.

DTC 75 Will Set When

The ignition is ON and TCM terminal A12 voltage is less than the graduated scale of: -40°F (-40°C) = 7.3 volts, 194°F (90°C) = 10.3 volts, or 304°F (151°C) = 11.7 volts, with engine speed greater than 1000 RPM for 4 seconds.

Action Taken (TCM will default to)

During the time the failure is present, the pressure control solenoid is turned OFF, soft landing to default second gear and TCC operation is inhibited. (The setting of additional diagnostic trouble codes may result.) DTC 75 will be stored in the TCM memory but will not turn ON the MIL (Malfunction Indicator Lamp).

DTC 75 Will Clear When

The fault condition(s) no longer exist.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

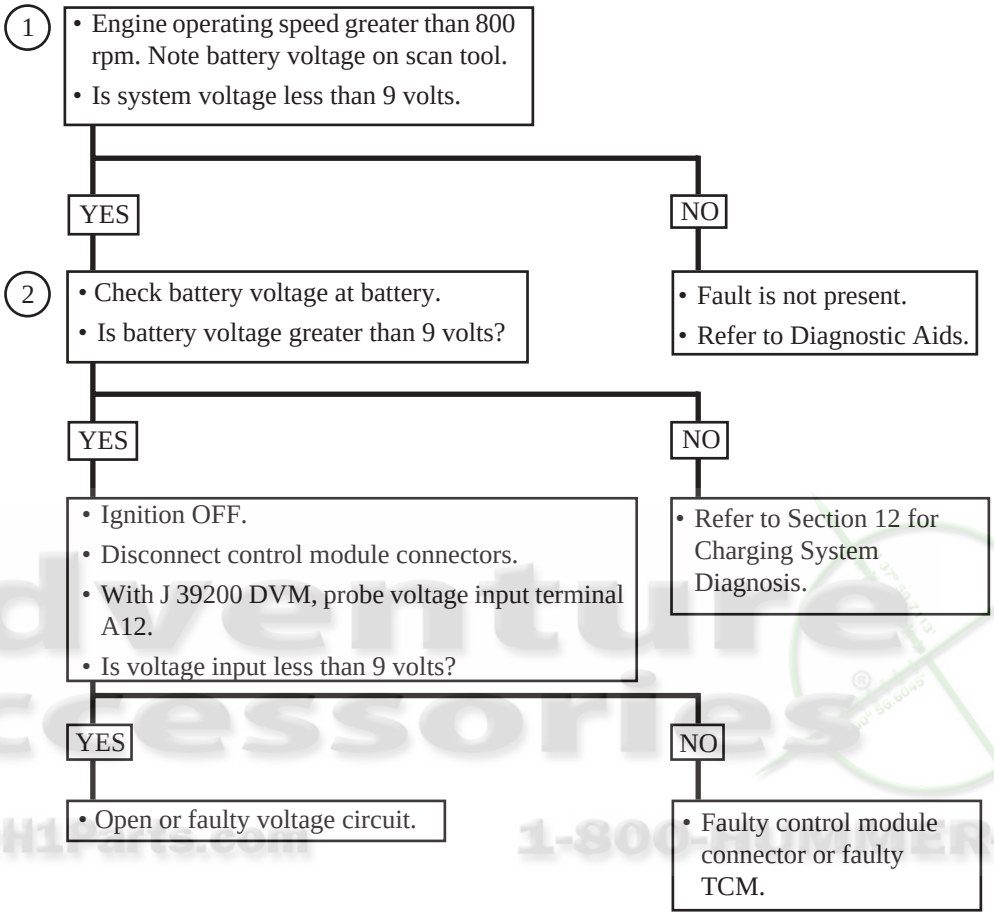
1. This test checks for normal battery voltage between 9 to 15 volts.
2. This test checks if the low voltage display is due to the alternator, CKT A12,or TCM, while the engine is running. If the voltage is less than 8.6 volts, the control module is OK.

Diagnostic Aids

- CKT A12 supplies battery voltage to the control module.
- Charging battery with a battery charger and jump starting engine may set DTC 52/DTC53. If diagnostic trouble code sets when an accessory is operated, check for poor connections or excessive current draw. Refer to Section 12 for circuit details. Also, check for poor connections at starter solenoid or fusible link.

DTC 75

System Voltage Low



When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 79

Transmission Fluid Overtemp (Figure 5-40)

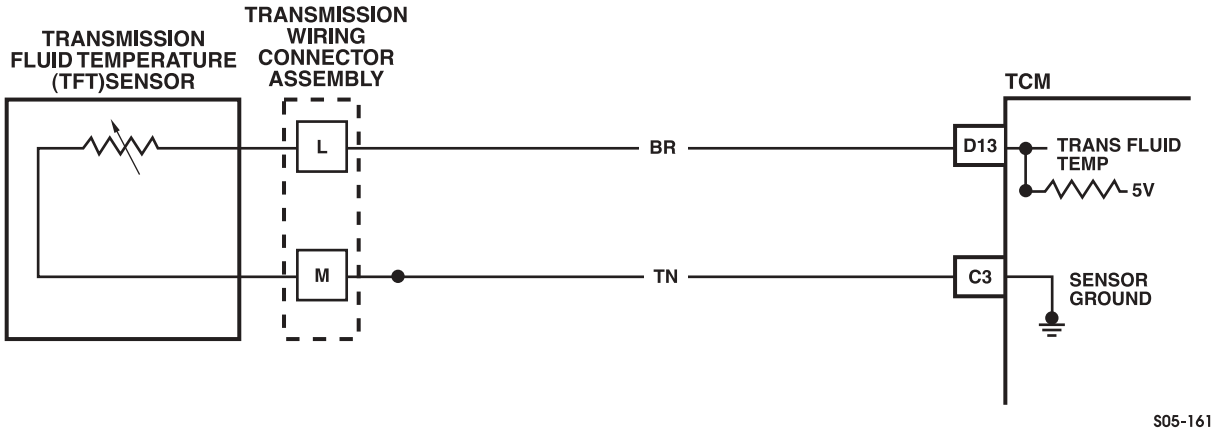


Figure 5-40: TFT Sensor

Circuit Description

The Transmission Fluid Temperature (TFT) sensor is a thermistor that controls the signal voltage to the TCM. The control module supplies a 5 volt reference signal to the sensor on CKT D13. When the transmission fluid is cold, the sensor resistance is high and the control module will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts.

DTC 79 Will Set When

- No DTC 58.
- Trans fluid temp greater than 295°F (146°C).
- All conditions met for 30 minutes.

DTC 79 Will Clear When

The fault condition(s) no longer exists.

Chart Test Description

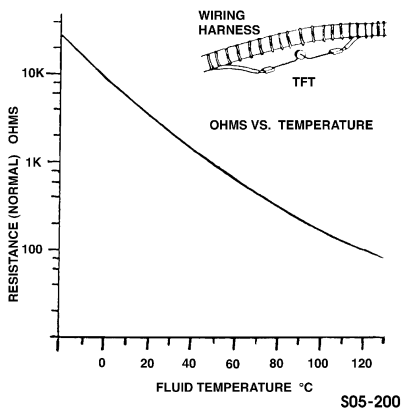
Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test checks for a skewed sensor or shorted circuit.
2. This test simulates a DTC 59.

Diagnostic Aids

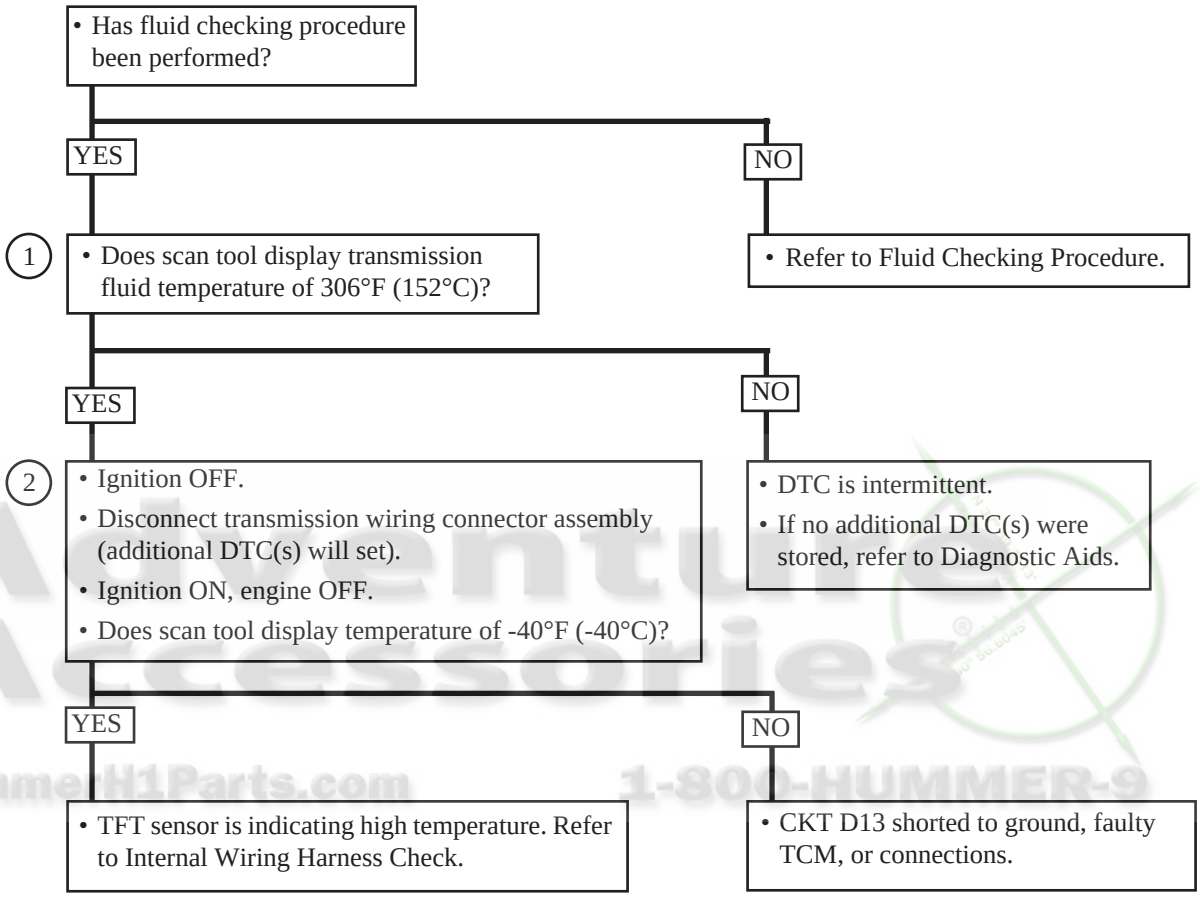
- Check harness routing for a potential short to ground in CKT D13.
- Scan tool TFT display should rise steadily to about 212°F (100°C) then stabilize.
- Refer to Control Module Intermittent Diagnostic Trouble Codes or Performance.
- The temperature to resistance value scale may be used to test the transmission sensor at the various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in delayed shifts or TCC complaints.
- Check transmission fluid. Refer to Fluid Checking Procedure.

Temperature vs. Resistance



DTC 79

Transmission Fluid Overtemp



When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 81

2-3 Shift Solenoid Circuit Fault (Figure 5-41)

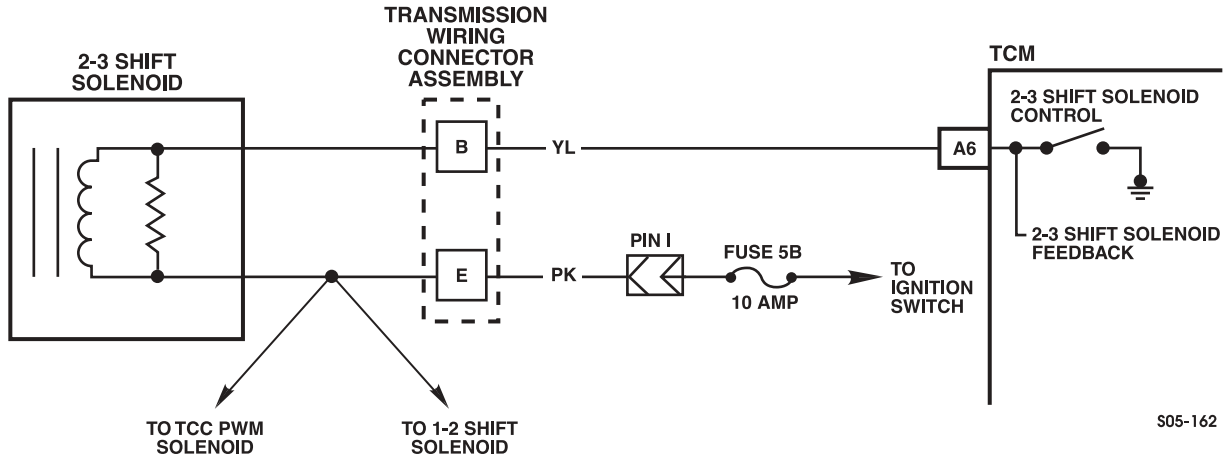


Figure 5-41: Shift Solenoid

Circuit Description

Ignition voltage is supplied directly to the 2-3 shift solenoid. The TCM controls the solenoid by providing the ground path through CKT A6.

DTC 81 Will Set When

The TCM commands the solenoid ON and voltage remains high for 2 seconds. The TCM commands the solenoid OFF and voltage remains low for 2 seconds.

Action Taken (TCM will default to)

If the solenoid is shorted OFF third gear only will occur. If the solenoid is shorted ON second gear only will occur, maximum line pressure, and no TCC. DTC 81 will be stored in the TCM memory but will not turn ON the MIL (Malfunction Indicator Lamp).

DTC 81 Will Clear When

The fault condition(s) no longer exist, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

If the voltage remains high for at least 2 seconds, DTC 8l will set. If the voltage drops for more than two seconds, DTC 81 will set.

1. This test checks the function of the 2-3 shift solenoid and the internal transmission wiring.
2. This test checks for power to 2-3 shift solenoid from the ignition through the fuse.

Diagnostic Aids

- Check all connections at the transmission.
- Refer to Control Module Intermittent Diagnostic Trouble Codes or Performance.
- An open in the ignition feed circuit can cause multiple DTC(s) to set.

Shift Solenoids Chart

GEAR	1-2 SHIFT SOLENOID	2-3 SHIFT SOLENOID
1	ON	OFF
2	OFF	OFF
3	OFF	ON
4	ON	ON

DTC 81

2-3 Shift Solenoid Circuit Fault

1
- Install Tech-1A scan tool.
- Record then clear DTC(s).
- Ignition ON, engine OFF.
- Enter Misc. Tests/Transmission/2-3 Solenoid.
- Command 2-3 shift solenoid ON/OFF three times while listening at bottom of transmission pan (use stethoscope if necessary).
- Does solenoid click when commanded?

NO

2
- Ignition OFF.
- Disconnect transmission wiring connector assembly. (Additional DTCs will set.)
- Install J 39775 Jumper Harness/Probe Kit on the external wiring connector.
- Ignition ON, engine OFF.
- Connect test light from cavity E of J 39775 to ground.
- Is test light ON?

YES

- Install test light from cavities E to B of J 39775.
- Command 2-3 shift solenoid ON/OFF three times.
- Is test light ON when commanded ON, and OFF when commanded OFF?

NO

- Check CKT A6 for an open or short from control module to transmission wiring connector.
- If OK, replace TCM.

YES

- External transmission wiring check OK.
- Refer to Internal Wiring Harness Check.

NO

- Repair open or short to ground in the ignition voltage feed circuit to the transmission.
- If the fuse 5B is open, check the transmission internal wiring harness or solenoid for short to ground.

YES

- Electrical system check OK.
- Refer to Diagnostic Aids.

When all diagnosis and repairs are completed, clear DTC(s) and verify operation.

DTC 82

1-2 Shift Solenoid Circuit Fault (Figure 5-42)

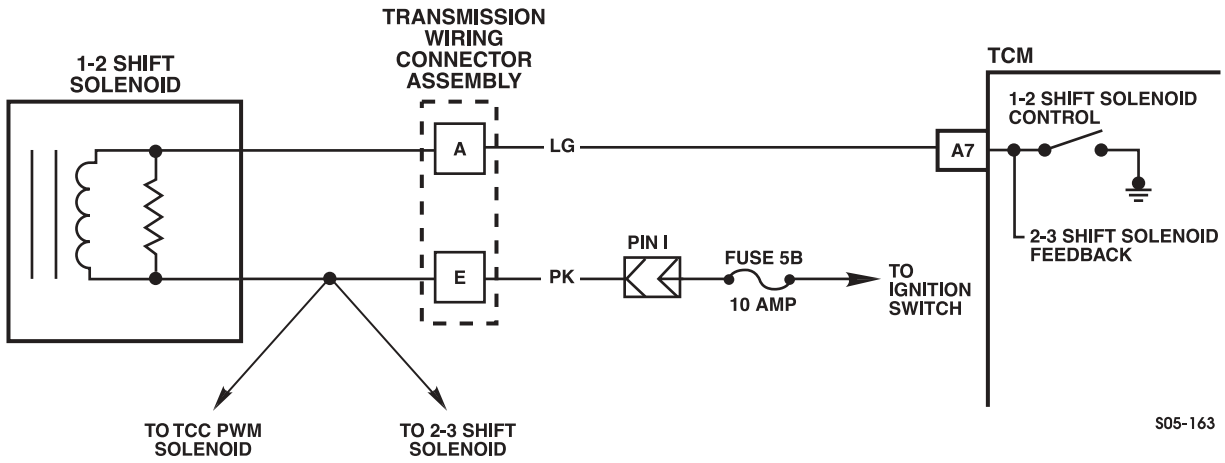


Figure 5-42: Shift Solenoid

Circuit Description

Ignition voltage is supplied directly to the 1-2 shift solenoid. The TCM controls the solenoid by providing the ground path through CKT A7.

DTC 82 Will Set When

The TCM commands the solenoid ON and voltage remains high for 2 seconds. The TCM commands the solenoid OFF and voltage remains low for 2 seconds.

Action Taken (TCM will default to)

The transmission will only allow second and third gear, or first and fourth gear and maximum line pressure. DTC 82 will be stored in the TCM memory but will not turn ON the MIL (Malfunction Indicator Lamp).

DTC 82 Will Clear When

The fault condition(s) no longer exist, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

If the voltage remains high for at least 2 seconds, DTC 82 will set. If the voltage drops for more than 2 seconds, DTC 82 will set.

1. This test checks the function of the 1-2 shift solenoid and the internal transmission wiring harness.
2. This test checks for power to 1-2 shift solenoid from the ignition through the fuse.

Diagnostic Aids

- Check all connections for the transmission.
- Refer to Control Module Intermittent Diagnostic Trouble Codes or Performance.
- An open in the ignition feed circuit can cause multiple DTC(s) to set.

Shift Solenoids Chart

GEAR	1-2 SHIFT SOLENOID	2-3 SHIFT SOLENOID
1	ON	OFF
2	OFF	OFF
3	OFF	ON
4	ON	ON

DTC 82

1-2 Shift Solenoid Circuit Fault

1
- Install Tech-1A scan tool.
- Record then clear DTC(s).
- Ignition ON, engine OFF.
- Enter Misc. Tests/Transmission/1-2 Solenoid.
- Command 1-2 shift solenoid ON/OFF three times while listening at bottom of transmission pan (use stethoscope if necessary).
- Does solenoid click when commanded?

NO

2
- Ignition OFF.
- Disconnect transmission wiring connector ASM. (Additional DTCs will set.)
- Install J 39775 Jumper Harness/Probe Kit on the external harness connector.
- Ignition ON, engine OFF.
- Connect test light from cavity E of J 39775 to ground.
- Is test light ON?

YES

- Install test light from cavities E to A of J 39775.
- Command 1-2 shift solenoid ON/OFF three times.
- Is test light ON when commanded ON, and OFF when commanded OFF?

NO

- Check CKT A7 for an open or short from the transmission external wiring connector to the control module connector.
- If OK, replace TCM.

YES

- External transmission wiring check OK.
- Refer to Internal Wiring Harness Check.

YES

- Electrical system check OK.
- Refer to Diagnostic Aids.

NO

- Repair open or short to ground in the ignition voltage feed circuit to the transmission. If the fuse is open, check the transmission internal wiring harness or solenoid for short to ground.

When all diagnosis and repairs are completed, clear DTC(s) and verify proper operation.

DTC 83

TCC PWM Solenoid Circuit Fault (Figure 5-43)

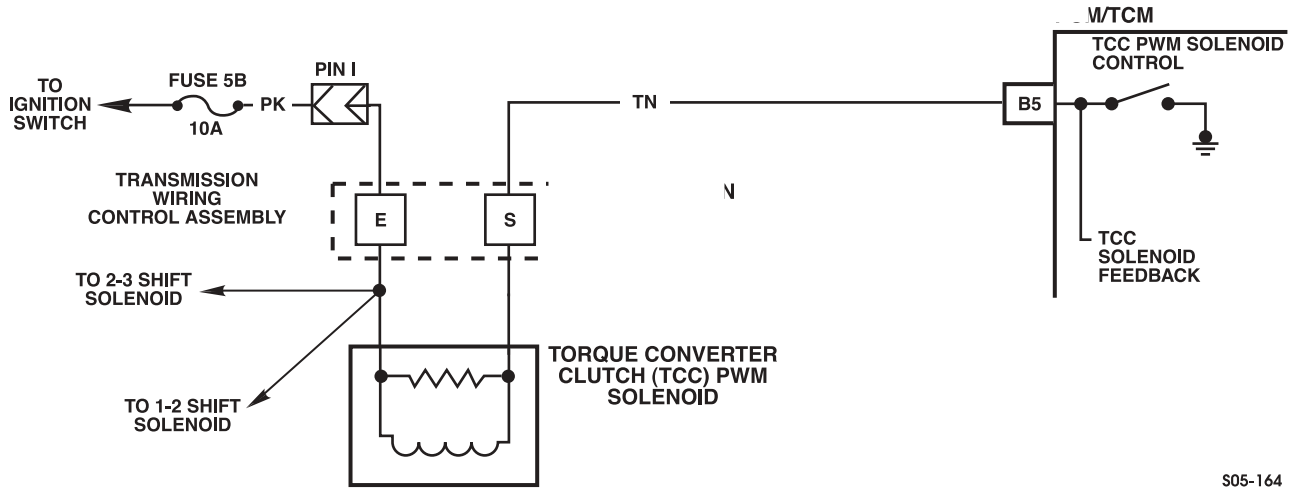


Figure 5-43: TCC PWM Solenoid

Circuit Description

The TCM supplies a ground, through an internal Quad-Driver Module (QDM), allowing current to flow through the solenoid coil according to the duty cycle (percentage of ON and OFF time). This current flow through the solenoid coil creates a magnetic field that magnetizes the solenoid core. The magnetized core attracts the checkball to seat against spring pressure. This blocks the exhaust for the TCC signal fluid and allows 2-3 drive fluid to feed the TCC signal circuit. The TCC signal fluid pressure acts on the TCC regulator valve to regulate line pressure and to apply fluid pressure to the torque converter clutch shift valve. When the TCC shift valve is in the apply position, regulated apply fluid pressure is directed through the TCC valve to apply the torque converter clutch.

DTC 83 Will Set When

• The TCM commands the solenoid ON and voltage remains high (B+).

Or

• The TCM commands the solenoid OFF and voltage remains low (zero volts).

• All conditions met for 2 seconds.

Action Taken (TCM will default to)

- Inhibit TCC operation.
- Inhibit 4th gear operation if in hot mode.

DTC 83 Will Clear When

The fault condition(s) no longer exist, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This test will check if the TCM is commanding the TCC solenoid ON.

2. This test will check for voltage to the solenoid.

Diagnostic Aids

- Check all connections at the transmission pass-thru connector.
- If they are OK, refer to Control Module Intermittent DTC(s) or Performance.

DTC 83

TCC PWM Solenoid Circuit Fault

1
- Install Tech-1A scan tool.
- Record then clear DTC(s).
- Enter Misc. Tests/Transmission/TCC PWM Solenoid.
- With engine at normal operating temperature, select D4 and accelerate to indicated speed of 75 mph (40 km/h).
- Command TCC PWM solenoid ON, then OFF while observing TCC slip speed on scan tool display.
- Is TCC slip speed less than 10 RPM while commanded ON, or is TCC slip speed greater than 10 RPM while commanded OFF?

NO

2
- Ignition OFF.
- Disconnect transmission wiring connector assy. (Additional DTCs will set.)
- Install J 39775 Jumper Harness/Probe Kit on the external wiring connector.
- Ignition ON, engine OFF.
- Connect test light from cavity E of J 39775 to ground.
- Is test light ON?

YES

- Install test light from cavities E to S of J 39775.
- Command TCC PWM solenoid ON/OFF three times.
- Is test light ON when commanded ON, and OFF when commanded OFF?

NO

- Check CKT B5 for an open or short from the control module to the transmission wiring connector.
- If OK, replace TCM.

YES

- External transmission wiring checks OK.
- Refer to Internal Wiring Harness Check.

YES

- Electrical system check OK.
- Refer to Diagnostic Aids.

NO

- Repair open or short to ground in the ignition voltage feed circuit to the transmission. If the fuse 5B is open, check the transmission internal wiring harness or solenoid for short to ground.

When all diagnosis and repairs are completed, clear DTC(s) and verify proper operation.

DTC 85

Undefined Ratio Error (Figure 5-44)

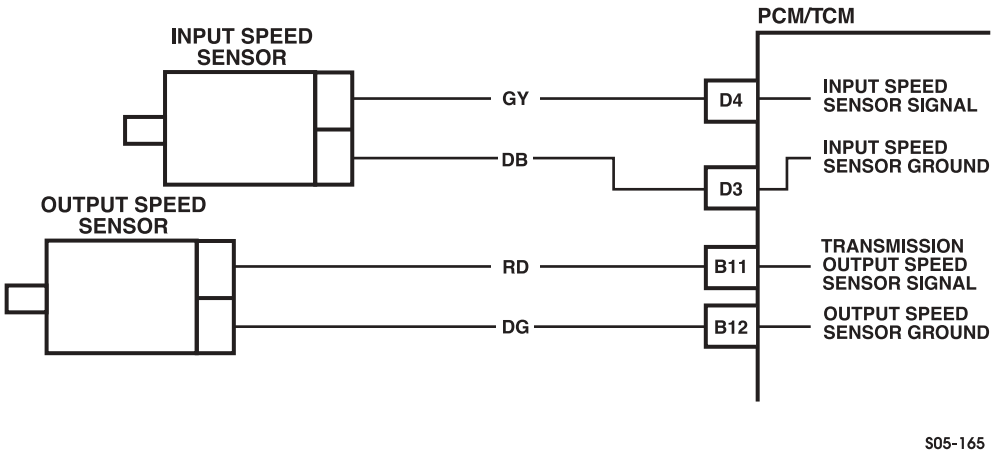


Figure 5-44: Gear Ratio Circuits

Circuit Description

The TCM calculates the actual gear ratio based on the transmission input speed and output speed sensor readings. The TCM compares the known transmission ratio to the calculated ratio, for the particular gear range selected.

DTC 85 Will Set When

- No DTC(s) 21, 22, 24, 28, 71, 72 and 87.
- TP is greater than 25%.
- Not in P/N or 4th gear.
- Engine speed is greater than 300 RPM.
- Vehicle speed is greater than 7 mph.
- All conditions are met for 2 seconds.

Action Taken (TCM will default to)

- Line pressure set to maximum.
- Inhibits TCC operation.

Gear Ratios Chart

COMMANDED GEAR	IF CALCULATED RATIO IS	
	LESS THAN	MORE THAN
1st	2.38	2.63
2nd	1.43	1.58
3rd	0.95	1.05
REV	1.97	2.17

DTC 85 Will Clear When

The condition no longer exists, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A malfunctioning trans range pressure switch could indicate an incorrect transmission range.
2. This test checks the calculated ratio to determine if the ratio is within the parameters.

Diagnostic Aids

DTC 85 will set when an unknown gear ratio is detected for any gear but 4th. Note commanded gear and incorrect ratio. Check transmission fluid level.

DTC 85

Undefined Ratio Error

1. Install scan tool.
   - Record then clear DTC(s).
   - Engine idling.
   - Apply parking brake and select each transmission range D1, D2, D3, D4, N, R, P.
   - Enter Misc. Tests/Transmission/TCC PWM Solenoid.
   - Does each selected range match transmission range SW on scan tool?

YES

2. Drive vehicle in 1st, 2nd, and 3rd gear.
   - TP greater than 25%.
   - Vehicle speed greater than 7 mph.
   - Conditions met for 2 seconds.
   - Use snapshot mode to record transmission gear ratio for commanded gear 1, 2, or 3.
   - Are the gear ratios displayed within the parameters of the gear ratios chart?

YES

- No trouble found, refer to Diagnostic Aids.

NO

- Repair transmission.

NO

- Refer to DTC 28 Chart.

When all diagnosis and repairs are completed, clear DTC(s) and verify proper operation.

DTC 86

Low Ratio Error (Figure 5-45)

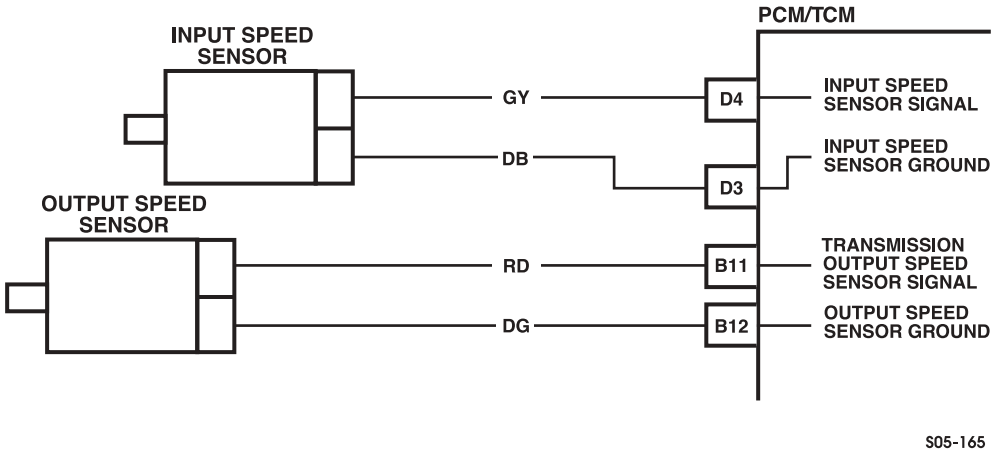


Figure 5-45: Gear Ratio Circuits

Circuit Description

The TCM calculates ratio based on the transmission input speed and output speed sensor readings. The TCM compares the known transmission ratio to the calculated ratio, for the particular gear range selected.

DTC 86 Will Set When

- No DTC(s) 21, 22, 24, 28, 71, 72, and 74.
- Engine speed greater than 300 RPM.
- TP greater than 25%.
- Vehicle speed greater than 7 mph.
- Trans gear ratio is less than 1.06 in first or second gear.
- All conditions met for 2 seconds.

Action Taken (TCM will default to)

- 2nd gear.
- Line pressure set to maximum.
- Inhibit TCC operation.

DTC 86 Will Clear When

The fault no longer exists, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A malfunctioning trans range pressure switch could indicate an incorrect transmission range.
2. This test compares the known ratio for a commanded gear to the calculated ratio displayed on the scan tool.

Diagnostic Aids

This DTC will set when transmission commanded gear is 1or 2 and transmission is mechanically in 3rd or 4th gear. DTC 81 is used to detect a 2-3 shift solenoid circuit malfunction.

DTC 86

Low Ratio Error

1. • Install scan tool.
   • Record then clear DTC(s).
   • Engine idling.
   • Apply park brake and select each transmission range D1, D2, D3, D4, N, R, P.
   • Enter Misc. Tests/Transmission/TCC PWM Solenoid.
   • Does each selected range match transmission range SW on scan tool?

YES

2. • Drive vehicle with 1st then 2nd gear commanded.
   • TP greater than 25%.
   • Vehicle speed greater than 7 mph.
   • Conditions met for 2 seconds.
   • Use snapshot mode to record transmission gear ratio for commanded gear ratio on scan tool display for commanded gear 1 and 2.
   • Is transmission gear ratio displayed less than 1.06 while commanded gear is 1 or 2?

YES

• Repair transmission.

NO

• No trouble found, refer to Diagnostic Aids.

NO

• Refer to DTC 28.

Gear Ratios Chart		
Commanded Gear	If Calculated Ratio Is	
	Less Than	More Than
1st	2.38	2.63
2nd	1.43	1.58
3rd	0.95	1.05
REV	1.97	2.17

When all diagnosis and repairs are completed, clear DTC(s) and verify proper operation.

DTC 87

High Ratio Error (Figure 5-46)

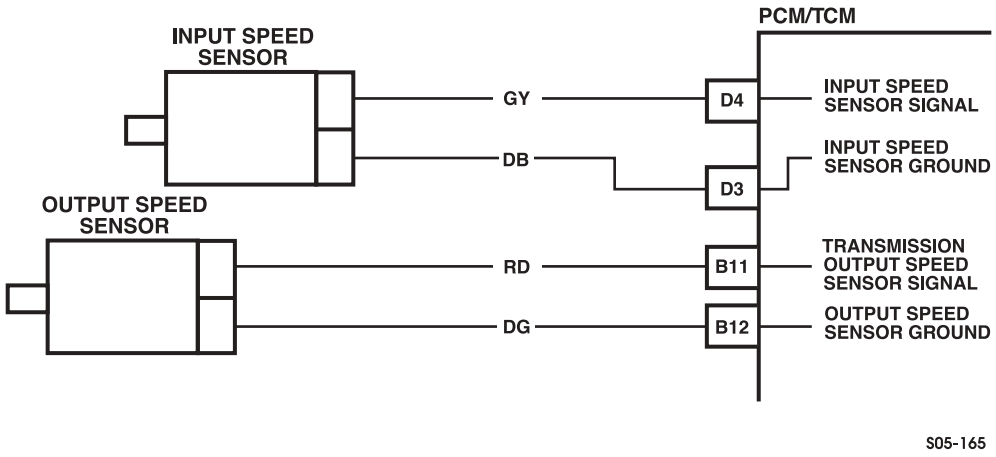


Figure 5-46: Gear Ratio Circuits

Circuit Description

The TCM calculates ratio based on the transmission input speed and output speed sensor readings.

The TCM compares the known transmission ratio to the calculated ratio for the particular gear range selected.

DTC 87 Will Set When

- No DTC(s) 21, 22, 24, 28, 71, 72, and 74.
- TP greater than 25%.
- Not in P, R, N.
- Engine speed greater than 300 RPM.
- Vehicle speed greater than 7 mph.
- Transmission temperature is greater than 68°F (20°C).
- Transmission gear ratio is greater than 1.42 in 3rd or 4th gear.
- All conditions met for 2 seconds.

Action Taken (TCM will default to)

- 2nd gear.
- Line pressure set to maximum.
- Inhibit TCC operation.

DTC 87 Will Clear When

The fault condition(s) no longer exists, and the ignition switch is cycled OFF then ON.

Chart Test Description

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A malfunctioning transmission range pressure switch could indicate an incorrect transmission range.
2. This test compares the known ratio for a commanded gear to the calculated ratio displayed on the scan tool.

Diagnostic Aids

This DTC will set when transmission commanded gear is 3 or 4 and transmission is mechanically in 1st or 2nd gear. DTC 81 is used to detect a 2-3 shift solenoid circuit malfunction.

DTC 87

Low Ratio Error

1. Install scan tool.
   - Record then clear DTC(s).
   - Engine idling.
   - Apply park brake and select each transmission range D1, D2, D3, D4, N, R, P.
   - Enter Misc. Tests/Transmission/TCC PWM Solenoid.
   - Does each selected range match transmission range SW on scan tool?

YES

2. Drive vehicle with D3 or D4 selected. Vehicle speed greater than 45 MPH.
   - TP greater than 25%.
   - Trans fluid temp greater than 68°F (20°C).
   - Use snapshot mode to record transmission gear ratio on scan tool display.
   - Is the transmission gear ratio displayed greater than 1.42 while commanded gear displays 3 or 4?

YES

- Repair transmission.

NO

- No trouble found, refer to Diagnostic Aids.

NO

- Refer to DTC 28.

Gear Ratios Chart		
Commanded Gear	If Calculated Ratio Is	
	Less Than	More Than
1st	2.38	2.63
2nd	1.43	1.58
3rd	0.95	1.05
REV	1.97	2.17

When all diagnosis and repairs are completed, clear DTC(s) and verify proper operation.

TCM CONNECTOR IDENTIFICATION

This TCM voltage chart is for use with a J 39200 DVM to further aid in diagnosis. These voltages were derived from a known good vehicle. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

The "B+" symbol indicates a nominal system voltage of 12-14 volts.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION ON	ENGINE OPERATING		
A1	Not Used	—	—	—	—	—	—
A2	Not Used	—	—	—	—	—	—
A3	Range Signal A	OR	Transmission N	B+	B+ (1)	28	
A4	Range Signal B	DB	Transmission R	0*	0* (1)	28	
A5	Range Signal C	PP	Transmission P	B+	B+ (1)	28	
A6	2-3 Shift Solenoid Control	YL	Transmission B	B+	B+	81	Incorrect Gear State
A7	1-2 Shift Solenoid Control	LG	Transmission A	B+	0*	82	Incorrect Gear State
A8	DLC Diagnostic	WH	Data Link Connector	5V	5V	None	No Change
A9	Not Used	—	—	—	—	—	—
A10	Not Used	—	—	—	—	—	—
A11	Not Used	—	—	—	—	—	—
A12	Battery Feed	OR	Battery	B+	B+	None	

* Less than 0.5 VOLT (500 mV).

(1) Readings in the P/N position.

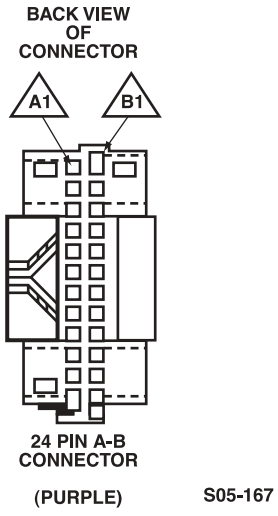


Figure 5-47: TCM Connector Identification

TCM CONNECTOR IDENTIFICATION

This TCM voltage chart is for use with a J 39200 DVM to further aid in diagnosis. These voltages were derived from a known good vehicle. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

The "B+" symbol indicates a nominal system voltage of 12-14 volts.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded
- Scan tool not installed

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION ON	ENGINE OPERATING		
B1	Not Used	—	—	—	—	—	—
B2	Not Used	—	—	—	—	—	—
B3	A/C Signal	LB	A/C Switch	(1)	(1)	None	Incorrect Idle
B4	Brake Signal	PP	Brake Switch	(2)	(2)	None	No TCC
B5	TCC Control	TN	Transmission S	B+	B+	39, 83	No TCC
B6	Not Used	—	—	—	—	—	—
B7	Not Used	—	—	—	—	—	—
B8	Not Used	—	—	—	—	—	—
B9	Trans Lamp Control	BR	Instrument Panel	0*	B+	None	MIL Inoperative
B10	Serial Data	OR	Data Link Connector	(3)	(3)	None	No Serial Data
B11	Trans Output Speed Sensor (TOSS)	RD	TOSS	(3)	(3)	85, 86, 87	No Output
B12	Trans Output Speed Sensor (TOSS)	DG	TOSS	(3)	(3)	85, 86, 87	Speed

* Less than 0.5 VOLT (500 mV).

(1) 0 Volts A/C OFF.Battery Voltage A/C ON.

(2) Battery voltage brakes released and 0 Volts brakes applied.

(3) Varies.

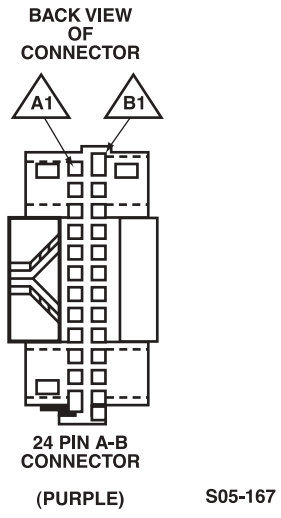


Figure 5-48: TCM Connector Identification

TCM CONNECTOR IDENTIFICATION

This TCM voltage chart is for use with a J 39200 DVM to further aid in diagnosis. These voltages were derived from a known good vehicle. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

The "B+" symbol indicates a nominal system voltage of 12-14 volts.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded
- Scan tool not installed

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION ON	ENGINE OPERATING		
C1	System Ground	BK	Engine Block	0*	0*	None	
C2	System Ground	BK	Engine Block	0*	0*	None	—
C3	Sensor Ground	TN	Splice	0*	0*	21, 59	Lack of Power
C4	TP Reference	GY	TP Sensor	5V	5V	22	Lack of Power
C5	Not Used	—	—	—	—	—	—
C6	Not Used	—	—	—	—	—	—
C7	Not Used	—	—	—	—	—	—
C8	Not Used	—	—	—	—	—	—
C9	Not Used	—	—	—	—	—	—
C10	Not Used	—	—	—	—	—	—
C11	Not Used	—	—	—	—	—	—
C12	Not Used	—	—	—	—	—	—
C13	Not Used	—	—	—	—	—	—
C14	Not Used	—	—	—	—	—	—
C15	Pressure Control Solenoid Low	LB	Transmission D	0*	0.85V	73	Harsh Shifts
C16	Ignition Feed	LG	Splice	B+	B+	None	No Start

* Less than 0.5 VOLT (500 mV).

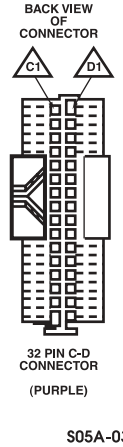


Figure 5-49: TCM Connector Identification

TCM CONNECTOR IDENTIFICATION

This TCM voltage chart is for use with a J 39200 DVM to further aid in diagnosis. These voltages were derived from a known good vehicle. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

The “B+” symbol indicates a nominal system voltage of 12-14 volts

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for “Engine Operating” column)
- Test terminal not grounded
- Scan tool not installed

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION ON	ENGINE OPERATING		
D1 or D2	Not Used	—	—	—	—	—	—
D3	Transmission Input Speed Sensor Low	DB	Input Speed Sensor	0*	0*	None	—
D4	Transmission Input Speed Sensor Low	GY	TP Sensor	5V	5V	22	Lack of Power
D5	Not Used	—	—	—	—	—	—
D6	Engine Speed Signal	WH	Engine Speed Sensor	0*	(2)	12	—
D7	Sensor Ground	TN	Splice	0*	0*	21, 59	Harsh Shifts
D8	TP Signal	DB	TP Sensor	0.67V (1)	(2)	21, 22	Harsh Shifts
D9	Not used	—	—	—	—	—	—
D10	Not Used	—	—	—	—	—	—
D11	Not Used	—	—	—	—	—	—
D12	Not Used	—	—	—	—	—	—
D13	Transmission Fluid Temperature Signal	BR	Transmission L	(2) 2V	(2) 2V	58, 59	Early TCC
D14	Baro	OR	Baro B	(2)	(2)	None	—
D15	Not Used	—	—	—	—	—	—
D16	Pressure Control Solenoid High	RD	Splice	B+	B+	None	No Start

* Less than 0.5 VOLT (500 mV).

(1) Readings in the P/N position.

(2) Varies

S05A-038

Figure 5-50: TCM Connector Identification

TRANSMISSION/TRANSFER CASE ASSEMBLY REPLACEMENT

WARNING: Allow transmission/transfer case to cool before performing this task. Failure to do this may cause injury.

CAUTION: *Cover or plug all open lines, ports, and connections immediately after disconnection to prevent contamination. Remove all plugs prior to connection.*

NOTE: Drain transmission before removal. Examine or save oil for later examination. Look for metal debris, burned clutch material, and contaminants.

Removal

1. Remove catalytic converter and crossover pipe (Section 3).
2. Remove rear propeller shaft.
3. Remove front propeller shaft.
4. Remove converter housing covers.
5. Remove cotter pin, washer, and shift rod and trunnion from relay lever. Discard cotter pin (Figure 5-51).

WARNING: Brakes must be applied at all times to prevent unexpected vehicle motion. Failure to do this may cause injury.

6. Remove cotter pin, washer, and transfer case shift rod from range lever. Discard cotter pin (Figure 5-52).
7. Disconnect range switch.

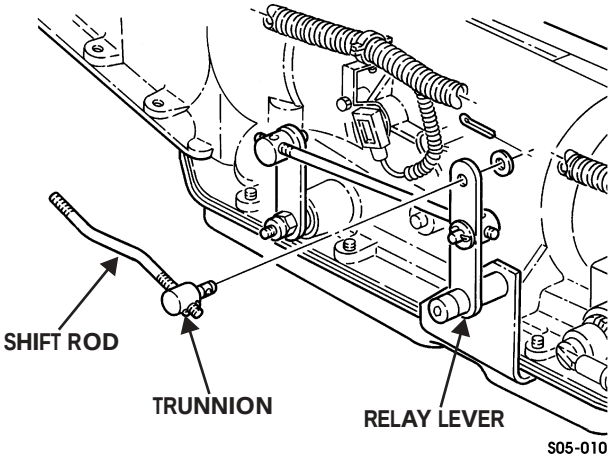


Figure 5-51: Relay Lever

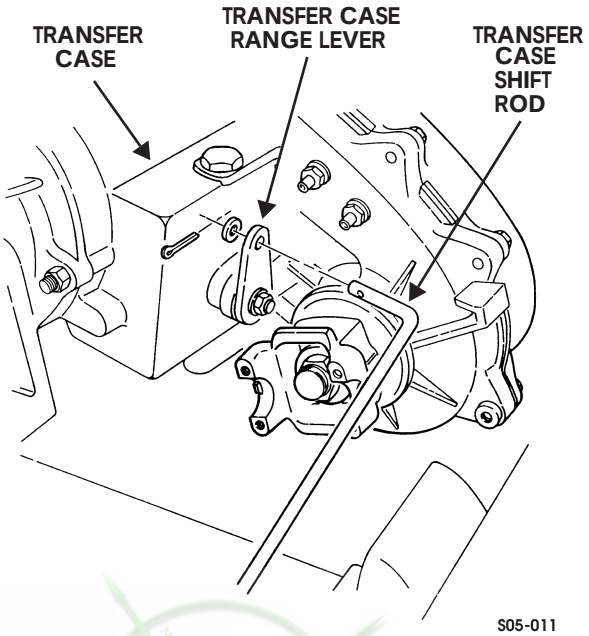


Figure 5-52: Shift Rod and Range Lever

8. Remove capscrew and washer from dipstick tube bracket and cylinder head (Figure 5-53).
9. Remove dipstick tube and multi-lip seal from transmission. Discard seal only if damaged.

NOTE: Have drainage container ready to catch fluid. Tag hoses for installation.

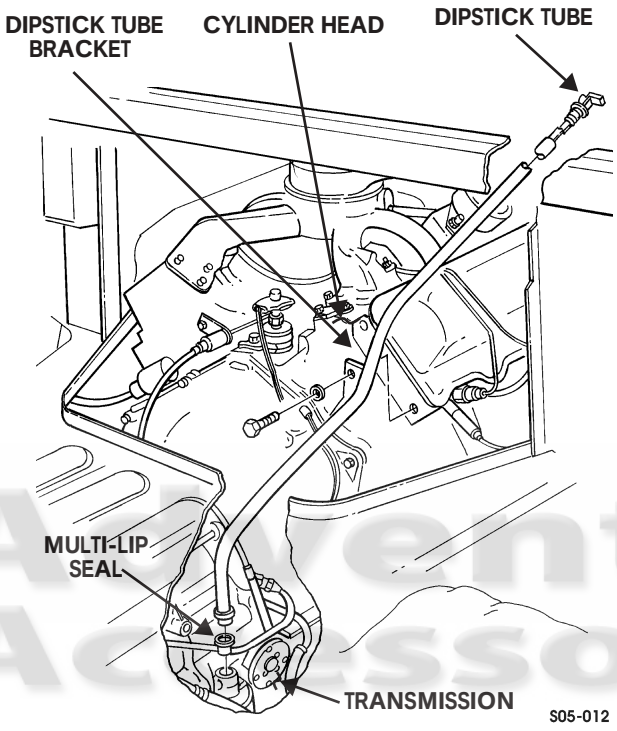


Figure 5-53: Dipstick Tube

10. Loosen hose clamps and disconnect oil cooler lines from transmission/transfer case cooler line hoses (Figure 5-54).
11. Disconnect main vent line from transmission/transfer case vent line (Figure 5-54).

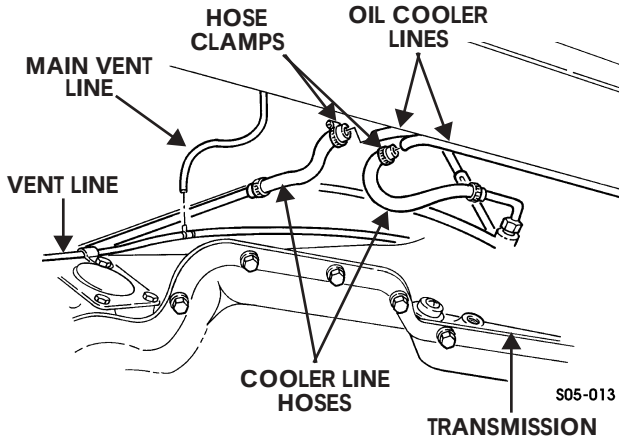


Figure 5-54: Oil Cooler Lines

NOTE: Some connector plugs have a soft multi-lip seal for environmental protection. Unless damaged, these seals are reusable.

12. Disconnect connector from vehicle speed sensor on transfer case (Figure 5-55).

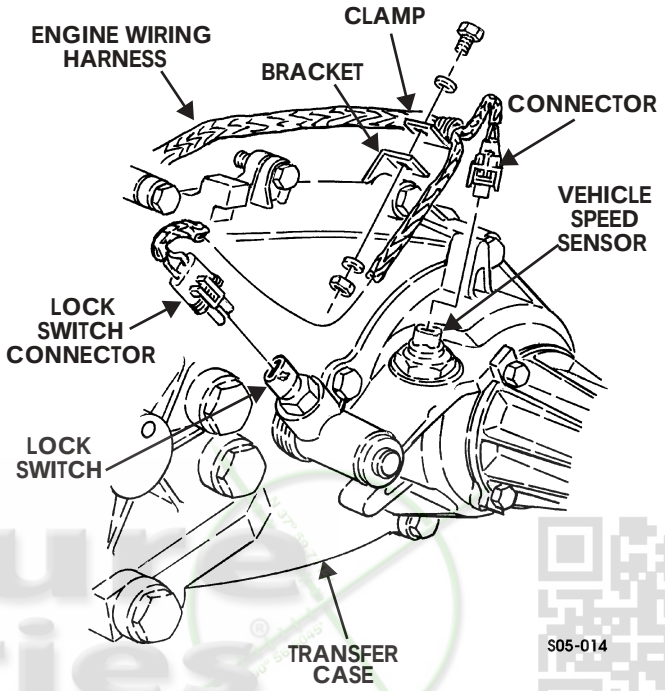


Figure 5-55: Vehicle Speed Sensor and Lock Switch Harness

13. Disconnect lock switch connector from lock switch on transfer case.

***CAUTION**: Protect connectors, switch, and speed sensor from dust, dirt, and damage.*

14. Remove nut, lockwasher, capscrew, washer, and engine wiring harness clamp from bracket.

***CAUTION**: Remove engine wiring harness connector by pressing both tabs and pulling straight away from transmission case connector. Do not twist, wiggle, or pry connectors apart. Damage to pins or loosening of wires could result and cause inoperative or malfunctioning transmission.*

15. Remove wiring harness connector from transmission case connector. Squeeze two tabs together and pull straight apart (Figure 5-56).
16. Remove connectors from input speed sensor and output speed sensor (Figure 5-57). Tag connectors for front or rear installation.
17. Remove two plastic harness clips from sensor brackets

NOTE: Protect connectors and sensor connections from dust, dirt, and damage.

18. Remove tow plastic harness clips from sensor brackets.

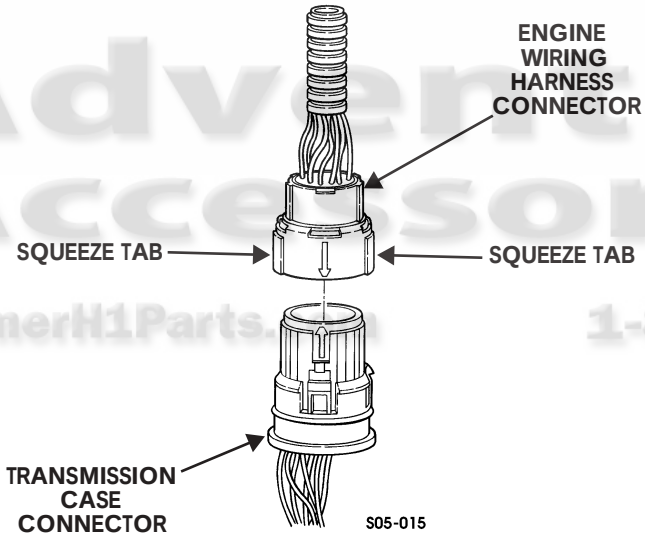


Figure 5-56: Wiring Harness Connector

19. Support transmission and transfer case with transmission jack and secure with safety chain (Figure 5-58).

***CAUTION**: Safety chain must be routed under transmission oil cooler and vent lines and away from speed sensors, or damage may result.*

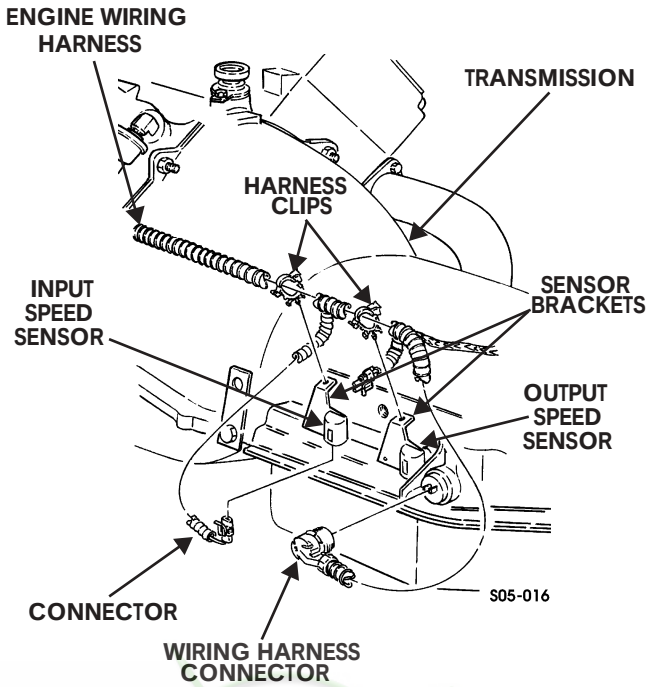


Figure 5-57: Speed Sensor

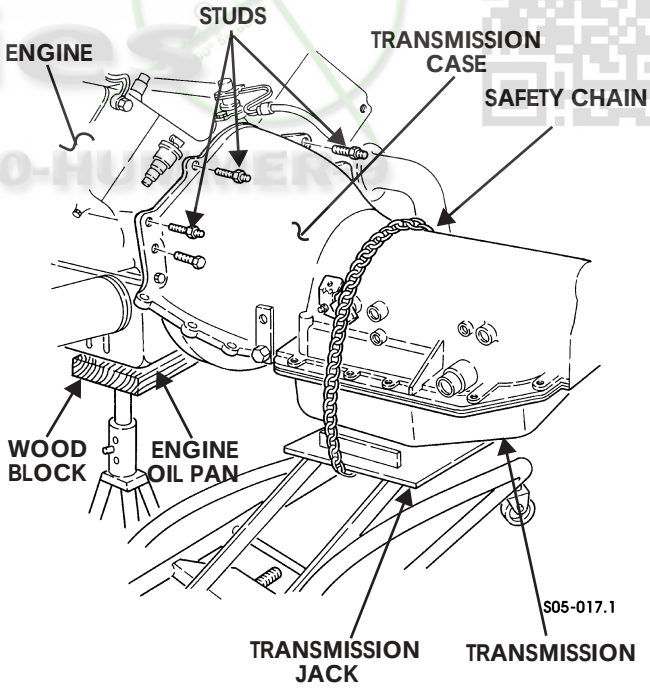


Figure 5-58: Transmission Supported on Jack

20. Remove four capscrews and three studs from transmission case and engine.

21. Remove two capscrews from transmission adapter and transmission mount (Figure 5-59).

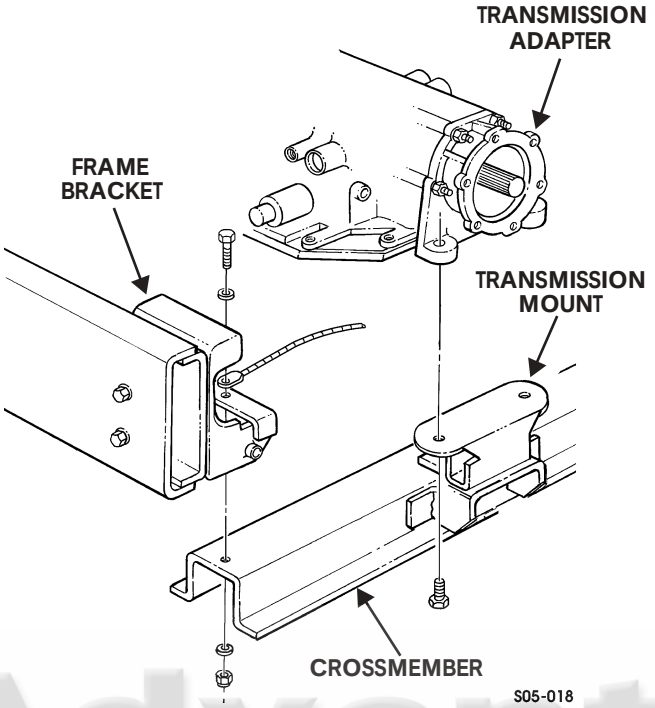


Figure 5-59: Transmission Adapter

22. Remove two locknuts, washers, capscrews, washers, and crossmember from frame brackets. Discard locknuts.
23. Remove six capscrews from flexplate (flywheel) and torque converter (Figure 5-60).

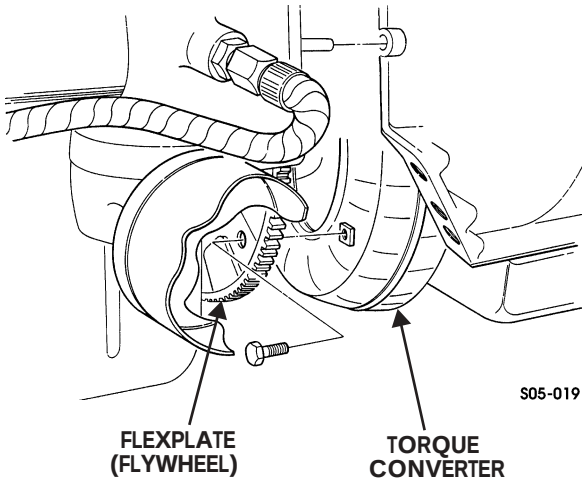


Figure 5-60: Torque Converter and Flexplate

***CAUTION**: If transmission is lowered too far, cooling fan damage will result. Wood block must completely cover bottom of engine oil pan, or oil pan damage will result.*

24. Support engine under oil pan with wood block and stand, and lower transmission slightly (Figure 5-58).

WARNING: Torque converter must be removed with the transmission as an assembly. Keep transmission tipped slightly, with front high. The converter may slide off front of transmission and cause injury or damage to converter. Do not use hands to free transmission/transfer case assembly. Use prybar to avoid injury.

***CAUTION**: Always remove the transmission/transfer case assembly slowly and watch for transmission binding. If it is hard to move, something may be connected, which must be removed. Ensure that wiring, lines, cables, and rods are not in the path of the transmission removal.*

25. Move transmission and transfer case rearward so it is clear of engine.
26. Lower transmission and transfer case slowly.

Disassembly

1. Remove transmission/transfer case assembly to work area.
2. Disconnect two cooler lines from transmission (Figure 5-61).
3. Remove capscrew securing vent line clamp to transmission.
4. Disconnect vent line from transmission vent line nipple.
5. Remove six locknuts securing transmission to transfer case adapter. Discard locknuts.
6. Separate transmission from transfer case adapter.
7. Clean old sealer from transfer case adapter and transmission mounting surface.

Assembly

1. Apply flange sealant to transmission mounting surface (Figure 5-61).
2. Install transmission on transfer case adapter and secure with six locknuts. Using torque adapter, tighten locknuts to 37 lb-ft (50 N•m).
3. Connect vent line to transmission vent line nipple.
4. Secure vent line to transmission with clamp and capscrew. Tighten capscrew to 11 lb-ft (15 N•m).
5. Connect two cooler lines to transmission.

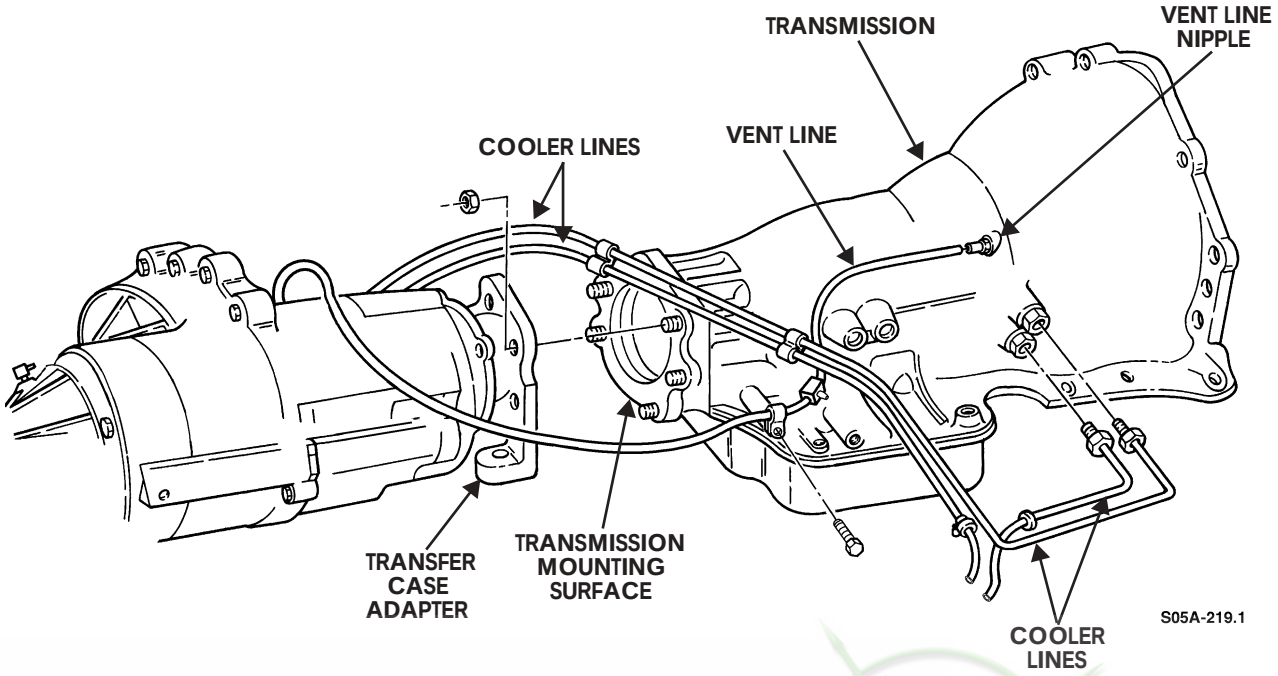


Figure 5-61: Transmission/Transfer Case Assembly

Installation

WARNING: Torque converter must be installed with transmission as an assembly. Keep transmission tipped slightly, with front high. The torque converter may slide off front of transmission and cause injury or damage to converter.

***CAUTION**: Torque converter must be properly installed in transmission, or transmission damage will result. Safety chain must be routed under transmission oil cooler and vent lines, or damage to cooler lines will result.*

1. Prepare transmission/transfer case assembly for installation.
2. Place transmission and transfer case assembly on transmission jack and secure with safety chain (Figure 5-62).
3. Tip transmission slightly to a front-high position to retain torque converter during movement.

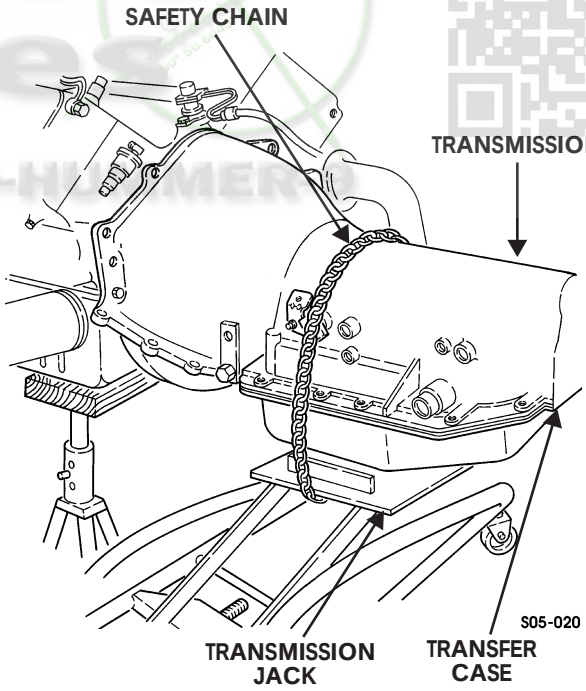


Figure 5-62: Transmission/Transfer Case Assembly

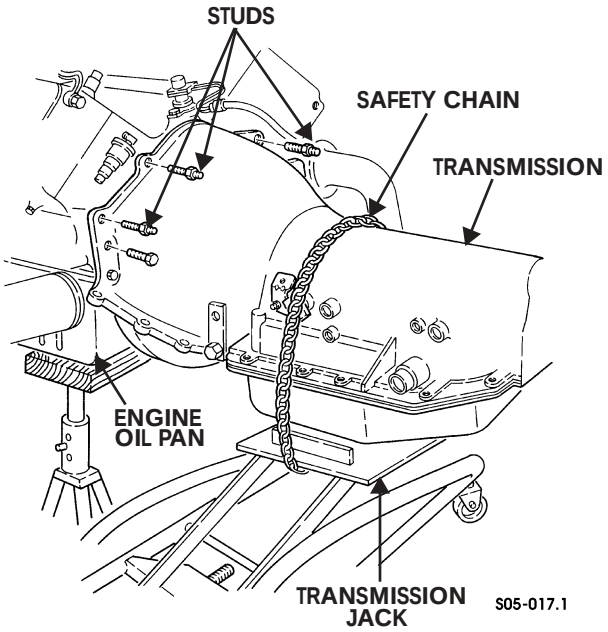


Figure 5-63: Transmission Support

WARNING: Do not use hands to free transmission/transfer case assembly of hang-ups or snags. Use pry-bar to avoid injury.

***CAUTION**: Always install transmission/transfer case assembly slowly. Raise into chassis carefully and closely observe all components to prevent damage.*

4. Position transmission and transfer case under vehicle and raise transmission into position against engine, align converter pilot into crankshaft, and align transmission case with engine (Figures 5-63 and 5-64).

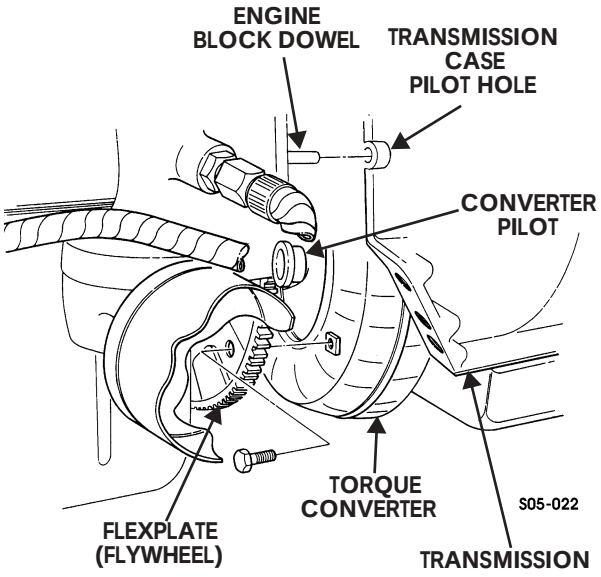


Figure 5-64: Converter Pilot

5. Carefully align transmission case pilot holes with engine block dowels as they meet.
6. Install transmission case on engine with four capscrews and three studs. Tighten capscrews and studs to 35 lb-ft (47 N•m).
7. Align holes and secure torque converter to flexplate (flywheel) with six capscrews. Tighten capscrews to 32 lb-ft (43 N•m) (Figure 5-64).
8. Install crossmember on frame brackets with two capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 5-65).

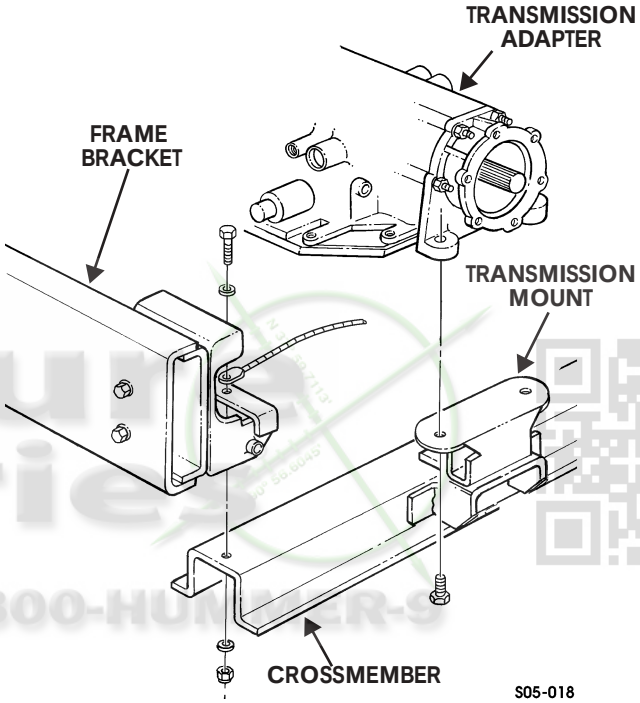


Figure 5-65: Crossmember on Frame Brackets

9. Install two capscrews through mount on crossmember and into transmission adapter. Tighten capscrews to 65 lb-ft (88 N•m).

***CAUTION**: Use care when connecting engine wiring harness connector to transmission case connector. Plugs can be easily misaligned, bent, or broken. This could result in erratic or inoperative transmission.*

10. Carefully align arrows on wiring harness connector and transmission case connector and push connectors straight together until a solid click is felt (Figure 5-66).

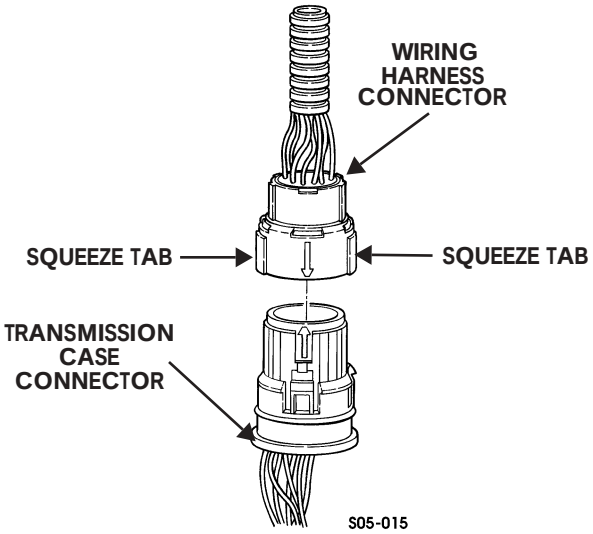


Figure 5-66: Wiring Harness Connector

11. Connect, as tagged, input speed sensor and output speed sensor connectors from engine wiring harness to sensors on transmission (Figure 5-67).

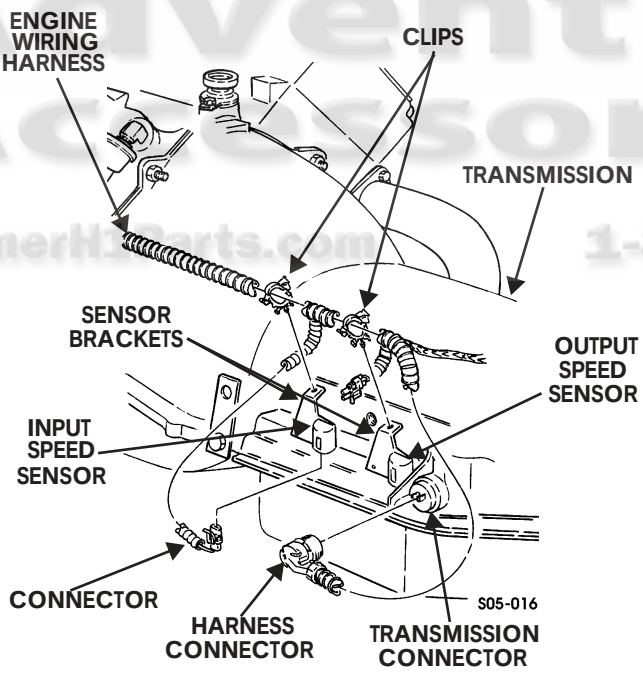


Figure 5-67: Engine Wiring Harness Connectors

12. Install engine wiring harness on transmission by reseating two plastic wiring clips in sensor brackets.
13. Connect transfer case shift rod to transfer case range lever with washer and cotter pin. Connect low range switch (Figure 5-68).

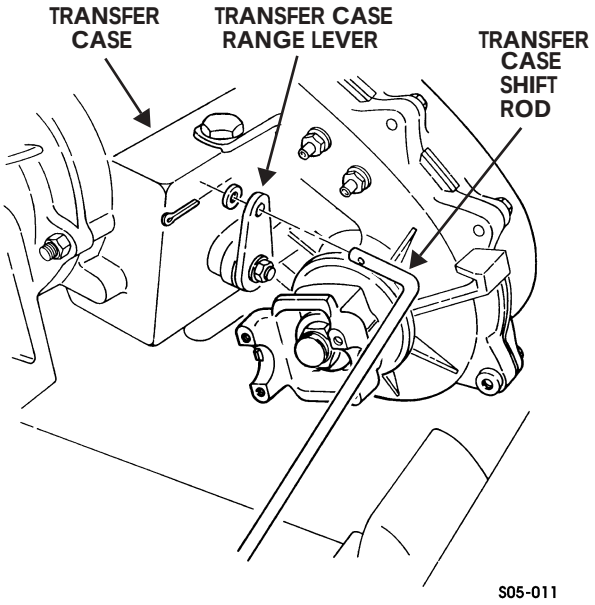


Figure 5-68: Shift Rod and Range Lever

14. Connect connector to vehicle speed sensor on transfer case (Figure 5-69).

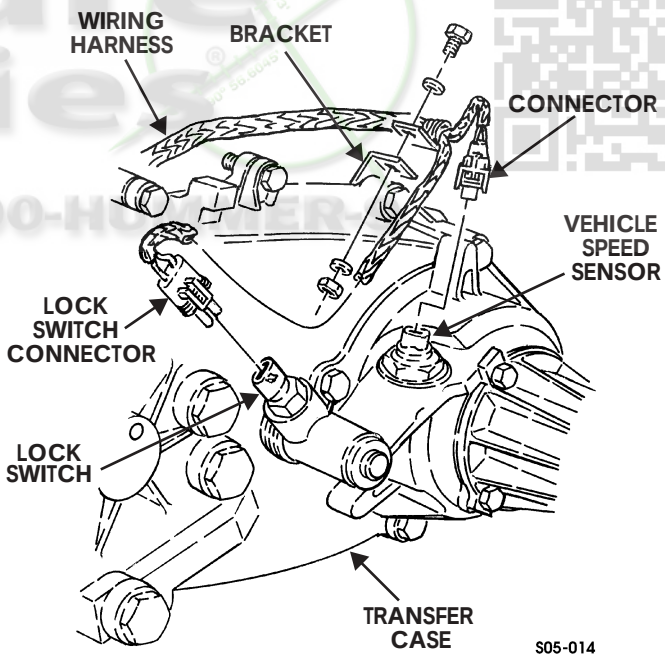


Figure 5-69: Vehicle Speed Sensor and Lock Switch Harness

15. Connect lock switch connector to lock switch.
16. Connect wiring harness clamp to bracket with washer, capscrew, lockwasher, and nut.
17. Connect main vent line to transmission/transfer case vent line (Figure 5-70).

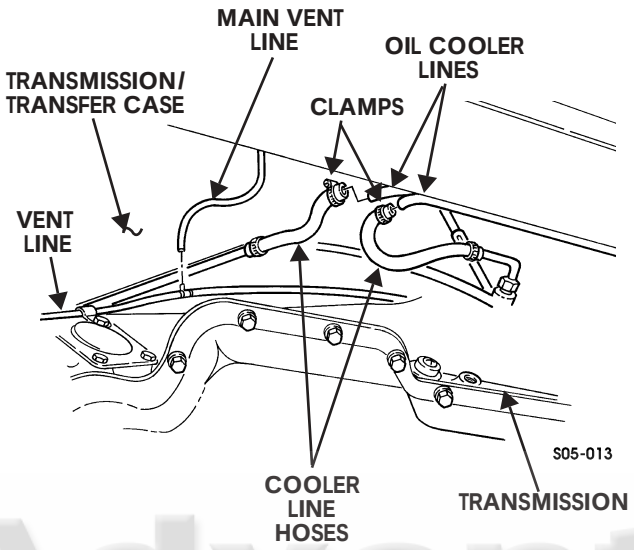


Figure 5-70: Oil Cooler Lines

18. Connect cooler line hoses to oil cooler lines and tighten clamps.
19. Install shift rod and trunnion on relay lever with washer and cotter pin (Figure 5-71).

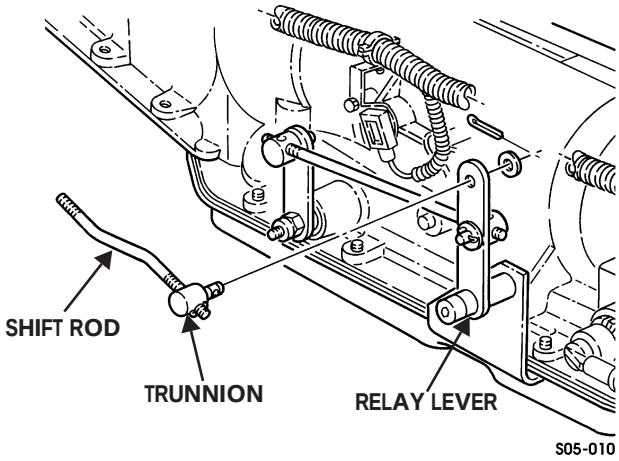


Figure 5-71: Relay Lever

20. Install multi-lip seal and dipstick tube in transmission. Secure dipstick tube bracket to cylinder head with capscrew and washer. Tighten capscrew to 25-37 lb-ft (34-50 N•m) (Figure 5-72).

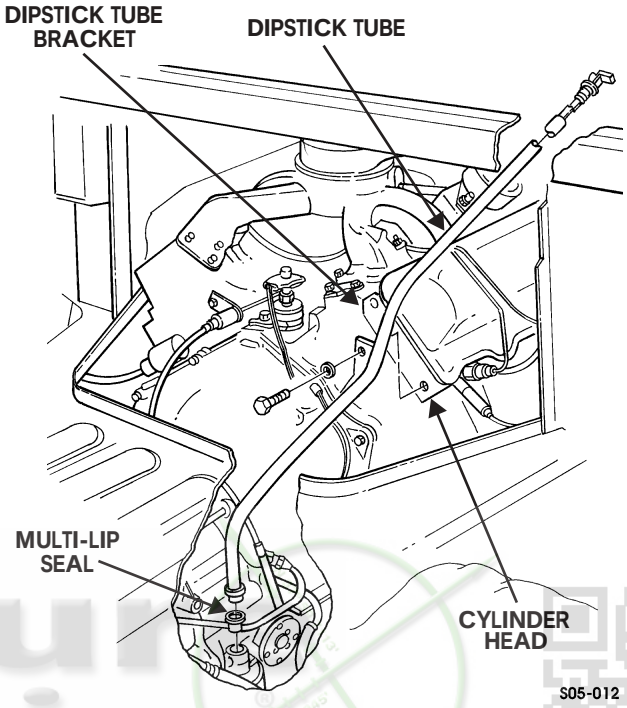


Figure 5-72: Dipstick Tube

21. Install converter housing covers.
22. Install front propeller shaft.
23. Install rear propeller shaft.
24. Install catalytic converter and crossover pipe (Section 3).
25. Fill transmission to proper fluid level.
26. Start engine and check for leaks.
27. Road test vehicle and check for proper transmission/transfer case operation.

TRANSMISSION SERVICE

Draining Fluid

NOTE: Do not shift through driving gears when warming transmission fluid for removal. Shifting through driving gear ranges is only done when refilling transmission. Transmission should be warm when draining fluid. Have an adequate size drainage container ready to catch fluid.

NOTE: Observe fluid for chips, grittiness, foaminess, or milkiness. All these indicate potential problems.

1. Remove two capscrews from transmission adapter and transmission mount (Figure 5-73).
2. Support transmission and transfer case assembly with jack under transfer case.
3. Remove two capscrews, washers, locknuts, and crossmember from frame brackets. Discard locknuts.

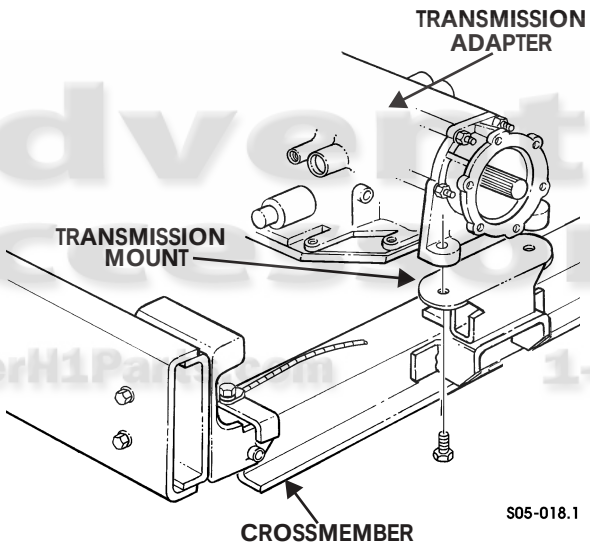


Figure 5-73: Transmission Adapter and Crossmembe

4. Loosen seventeen capscrews on transmission oil pan, and allow fluid to drain (Figure 5-74).
5. Complete oil drainage by removing seventeen capscrews, relay lever, gasket, and oil pan from transmission. Pan gasket is reusable. Replace if damaged. Position relay lever to side.

Transmission Filter

Removal

1. Remove oil filter from transmission. Discard oil filter (Figure 5-75).
2. Undamaged multi-lip seal is reusable. Inspect and replace if damaged.
3. Remove magnet, and clean oil pan and magnet (Figure 5-74) (Section 1).

Installation

1. Rotating oil filter, install pipe on filter in multi-lip seal. Align filter with control valve (Figure 5-75).
2. Position magnet in oil pan (Figure 5-74).
3. Install gasket, relay lever, and oil pan on transmission with seventeen capscrews. Tighten capscrews to 12 lb-ft (16 N•m).
4. Install crossmember capscrews, retainer cable, and relief valve, lockwashers, and washers. Tighten to 90 lb-ft (122 N•m) (Figure 5-73).
5. Lower transmission adapter onto transmission mount, install capscrews and tighten to 65 lb-ft (88 N•m) (Figure 5-73).

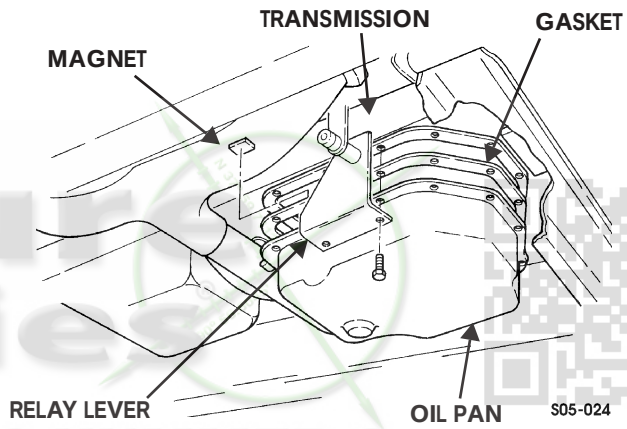


Figure 5-74: Oil Pan

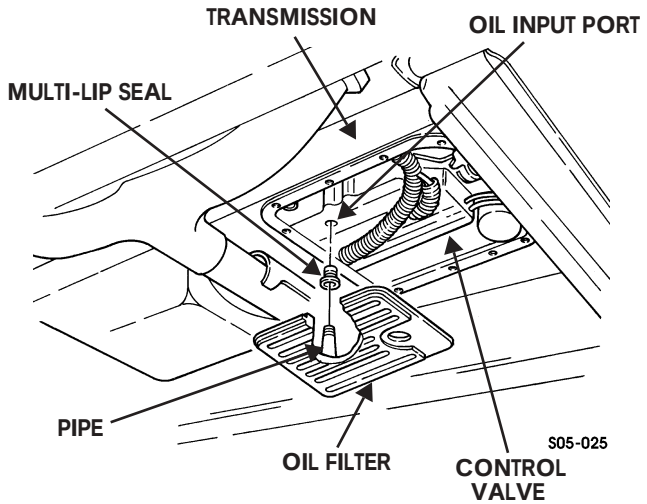


Figure 5-75: Oil Input Port

Refilling Fluid

1. Remove transmission oil dipstick and add transmission fluid. Fill only to full level marked on dipstick (Section 1).
2. Check fluid level when warm and after shifting through gears.
3. Install oil dipstick and check for external leaks.

TRANSMISSION OIL COOLER LINES REPLACEMENT

WARNING: Allow transmission to cool before performing this task. Hot oil will cause injury.

***CAUTION**: Plug all ports after removal of oil cooler lines from transmission and oil cooler.*

NOTE: Oil cooler lines are in sections connected by rubber hoses. Each section can be removed independently of others.

Removal

1. Remove right splash shield only when replacing lines connected to oil cooler (Section 10).
2. Remove oil cooler lines and retaining clamps from frame rail (Figure 5-76).

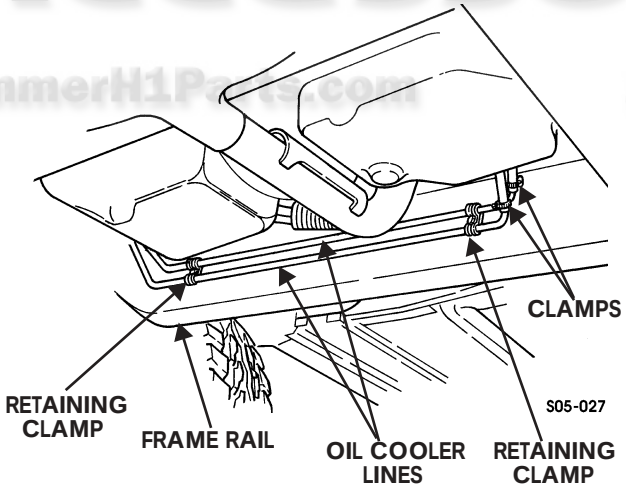


Figure 5-76: Oil Cooler Lines at Frame

NOTE: Have drainage container ready to catch fluid.

3. Loosen clamps and disconnect rubber hoses from fittings on transfer case (Figure 5-77).
4. Disconnect oil cooler lines from fittings on transmission (Figure 5-78).

NOTE: Steps 5 and 6 are performed only if oil cooler lines are to be removed from oil cooler.

5. Loosen clamps and disconnect tee fittings in oil cooler lines from hoses to check valve (Figure 5-78).

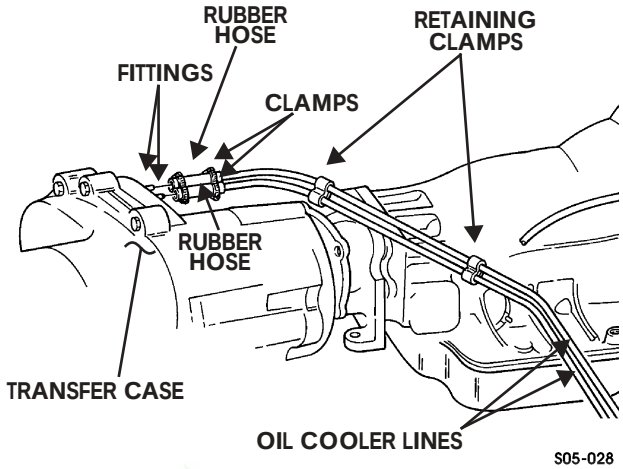


Figure 5-77: Transfer Case Cooler Lines

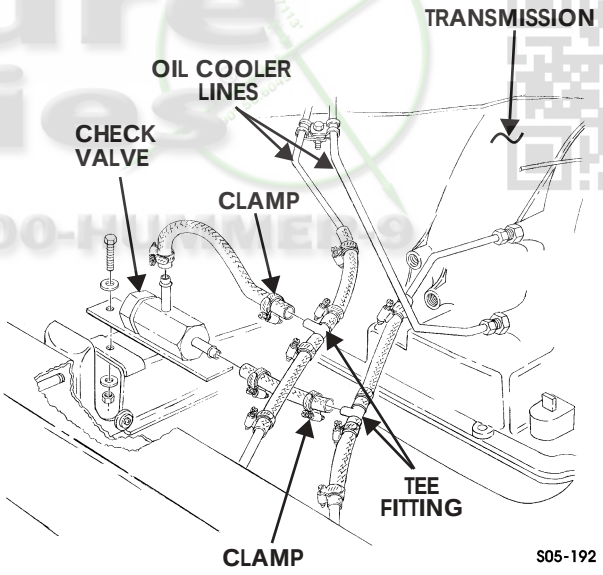


Figure 5-78: Check Valve And Transmission Oil Cooler LIne

6. Remove four locknuts, washers, and capscrews securing radiator supports to airlift bracket (Figure 5-79). Discard locknuts.

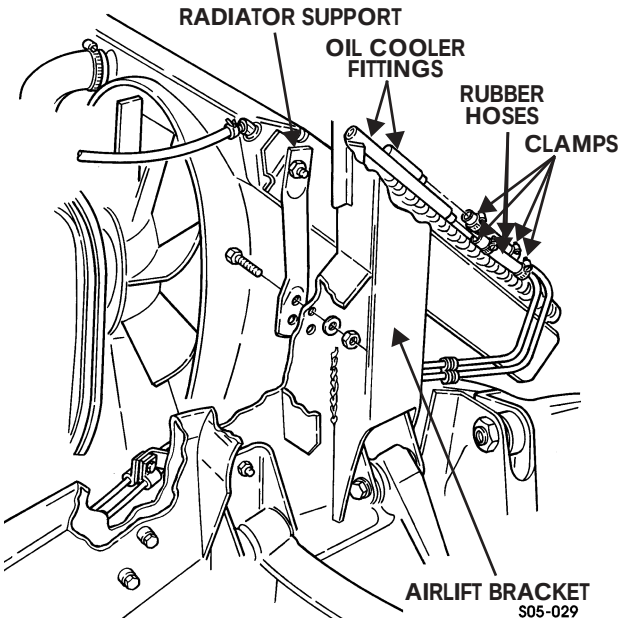


Figure 5-79: Radiator Supports

7. Remove locknut, two washers, large washer, mount, and capscrew from mounting bracket and radiator (Figure 5-80). Discard locknut.

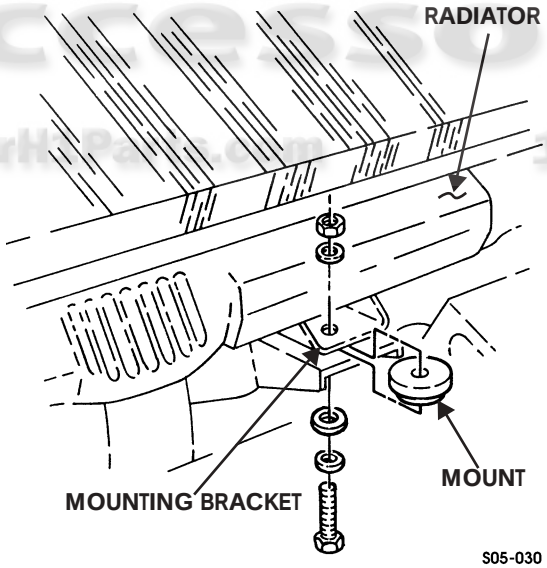


Figure 5-80: Radiator Mounting Bracke

8. Loosen clamps and disconnect rubber hoses from oil cooler fittings (Figure 5-79).
9. Remove oil cooler lines from vehicle.

Installation

NOTE: Oil cooler lines are in sections connected by rubber hoses. One section can be installed independently of others.

1. Position rubber hoses and oil cooler lines in approximate mounting location on vehicle.
2. Connect oil cooler lines to transmission fittings, and secure rubber hoses on oil cooler fittings and transfer case fittings with clamps. Tighten clamps to 35-45 lb-in. (4-5 N•m) (Figures 5-78 and 5-81) .

NOTE: Steps 3 and 4 are performed only if oil cooler lines are to be connected to oil cooler.

3. Connect hoses to tee fittings in oil cooler lines and tighten clamps.
4. Secure radiator on mounting bracket with mount, large washer, two washers, capscrew, and locknut. Tighten locknut to 30 lb-ft (41 N•m) (Figure 5-80).
5. Install radiator supports on airlift brackets with four capscrews, washers, and locknuts. Tighten locknuts to 31 lb-ft (42 N•m) (Figure 5-79).
6. Install retaining clamps and oil cooler lines on frame rail (Figures 5-82 and 5-83).
7. Start engine and check for leaks.
8. Install right splash shield (if removed) (Section 10).
9. Check fluid level and replenish as necessary.

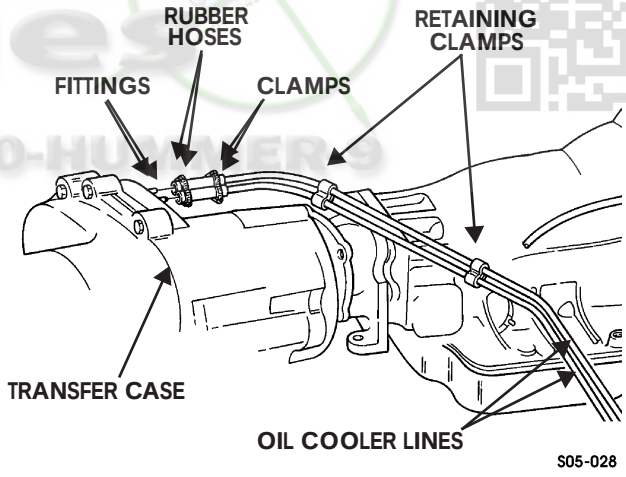


Figure 5-81: Transfer Case Oil Cooler Lines

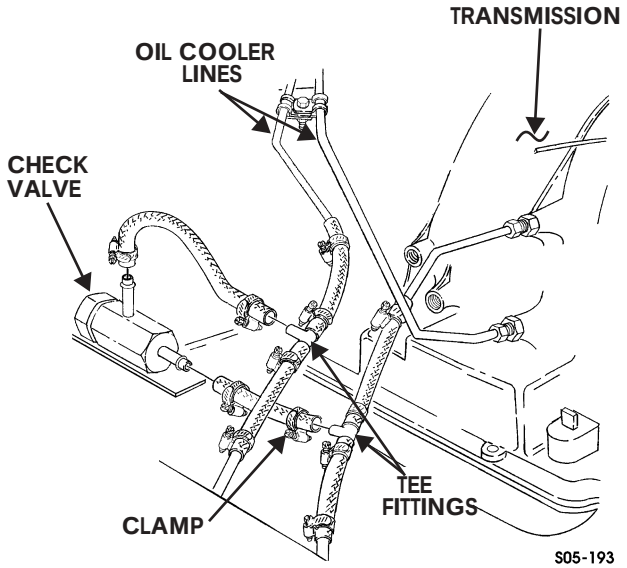


Figure 5-82: Check Valve and Transmission Oil Cooler Lines

TRANSMISSION COOLER CHECK RELIEF VALVE REPLACEMENT

CAUTION: *Do not bypass check-relief valve, or pressure damage to transfer case cooler or transmission cooler may result.*

Removal

1. Loosen clamps and disconnect two oil cooler hoses from check-relief valve (Figure 5-84).
2. Support transmission crossmember. Remove nut, two washers, and capscrew and check-relief valve from crossmember.

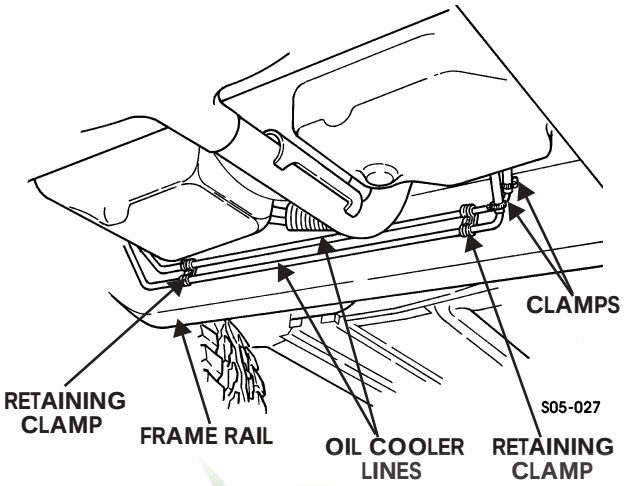


Figure 5-83: Oil Cooler Lines at Frame

Installation

1. Install check-relief valve on frame with two washers, capscrew, and nut. Tighten capscrew to 90 lb-ft (122 N•m) (Figure 5-84).
2. Connect oil cooler hoses to check-relief valve. Tighten clamps to 35-45 lb-in. (4-5 N•m).
3. Refill fluid (Section 1).
4. Operate transmission and check for leaks.

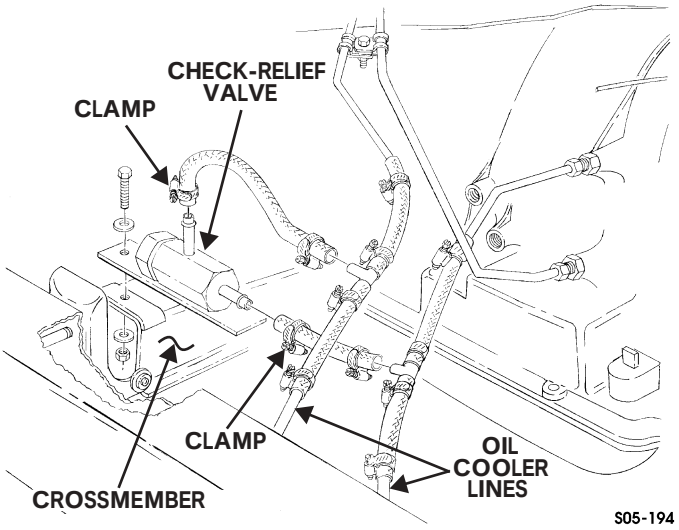


Figure 5-84: Transmission Check-Relief Valve

FLUSHING OIL COOLER

This procedure is only to be done when servicing transmission to correct a heavy level of contamination (metal or clutch material).

1. Loosen clamps and disconnect front cooler lines at frame rail (Figure 5-85).
2. Using compressed air and a drain hose placed into a suitable container, blow fluid from cooler and lines.
3. Using a pump gun or vacuum unit, either pump or draw clean transmission fluid through cooler to flush remaining contaminants.
4. Connect cooler lines at frame rail and tighten clamps.
5. Follow above procedure to flush transfer case cooler and lines, if required.

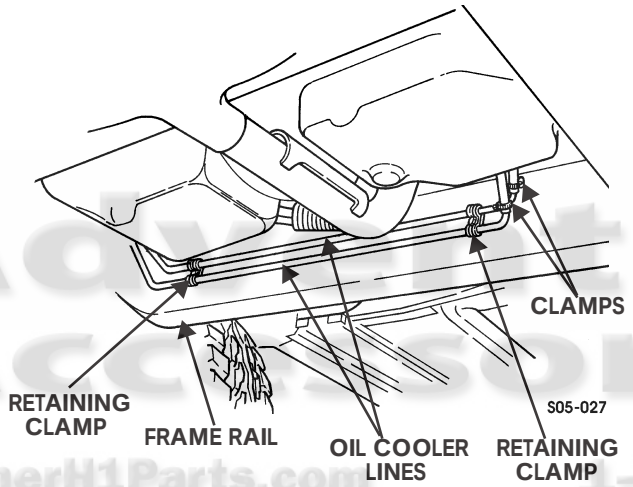


Figure 5-85: Oil Cooler Lines

TRANSMISSION OIL DIPSTICK TUBE REPLACEMENT

NOTE: Plug transmission port to prevent contamination. Have drainage container ready to catch fluid.

Removal

1. Remove right side exhaust manifold heat shield (Section 3).
2. Remove transmission oil dipstick from dipstick tube.
3. Remove capscrew, washer, and dipstick tube from cylinder head (Figure 5-86).
4. Remove dipstick tube from transmission.
5. Remove multi-lip seal from dipstick tube or port. Inspect seal and discard if damaged.

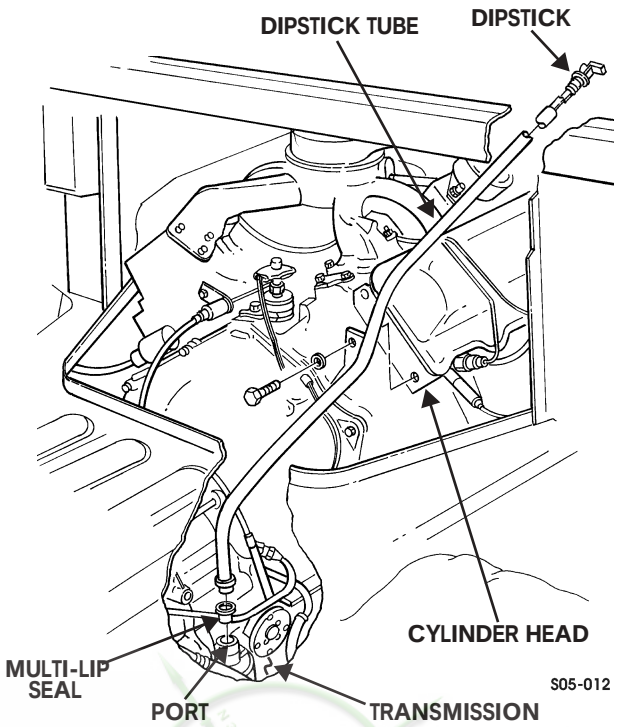


Figure 5-86: Transmission Oil Dipstick Tube

Installation

1. Install multi-lip seal in port in transmission (Figure 5-86).
2. Push dipstick tube into port in transmission.
3. Install dipstick tube on cylinder head with capscrew and washer. Tighten bolt to 25-37 lb-ft (34-50 N•m).
4. Install transmission oil dipstick in dipstick tube.
5. Install right side exhaust manifold rear heat shield (Section 3).
6. Start engine, fill transmission as indicated on transmission oil dipstick, and check for transmission fluid leaks.

NEUTRAL START SWITCH REPLACEMENT

NOTE: Tag electrical leads for installation.

Removal

1. Remove driver's inner kick panel (Section 10).
2. Remove shift controls housing assembly (Figure 5-87).
3. Remove rubber boot from shift controls housing assembly.
4. Remove two screws, lockwashers and neutral start switch from housing. Discard lockwashers.
5. Remove tiedown strap and neutral start switch leads from backup light switch leads. Discard tiedown strap.

Installation

1. Secure neutral start switch leads to backup light switch leads with tiedown strap (Figure 5-87).
2. Install neutral start switch on shift control housing with two lockwashers and screws.
3. Position neutral start switch leads, backup light switch leads, and light lead through boot, and install boot on housing assembly.
4. Install shift controls housing assembly.

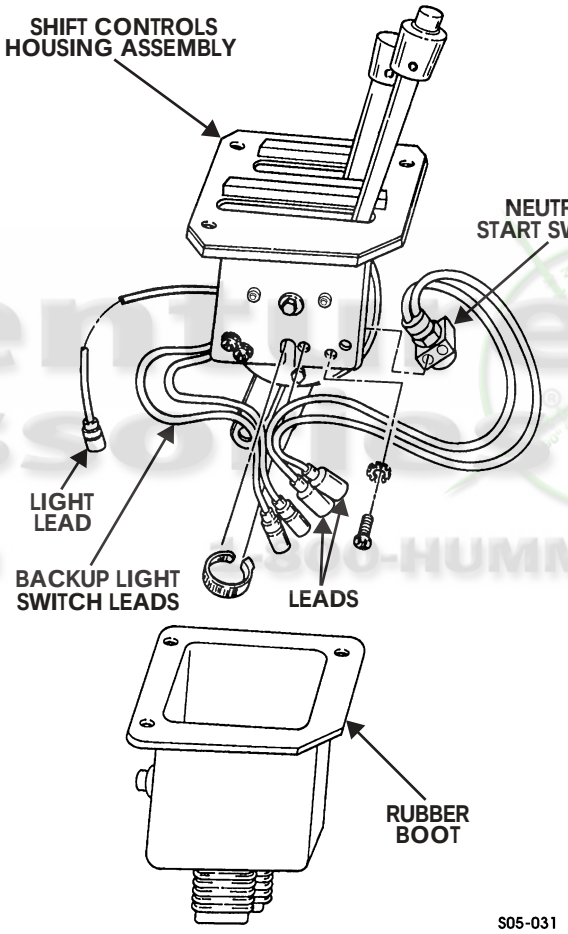


Figure 5-87: Neutral Start Switch

TRANSMISSION SHIFT ROD MAINTENANCE

Removal

1. Place transmission shift arm in neutral (Figure 5-88).
2. Remove cotter pin, washer, and trunnion from shift arm. Discard cotter pin.
3. Remove cotter pin and washer from rear trunnion. Remove trunnion, wave washer, and shift rod from relay lever. Discard cotter pin.

NOTE: Mark positions of trunnions on shift rod for installation.

4. Remove two cotter pins and two trunnions from shift rod. Discard cotter pins.

Installation

1. Install two trunnions and cotter pins on shift rod to positions marked (Figure 5-88).
2. Install trunnion on relay lever with wave washer, washer, and cotter pin. Do not spread cotter pin.
3. Install trunnion on shift arm with washer and cotter pin. Do not spread cotter pin.
4. Check shift rod adjustment.

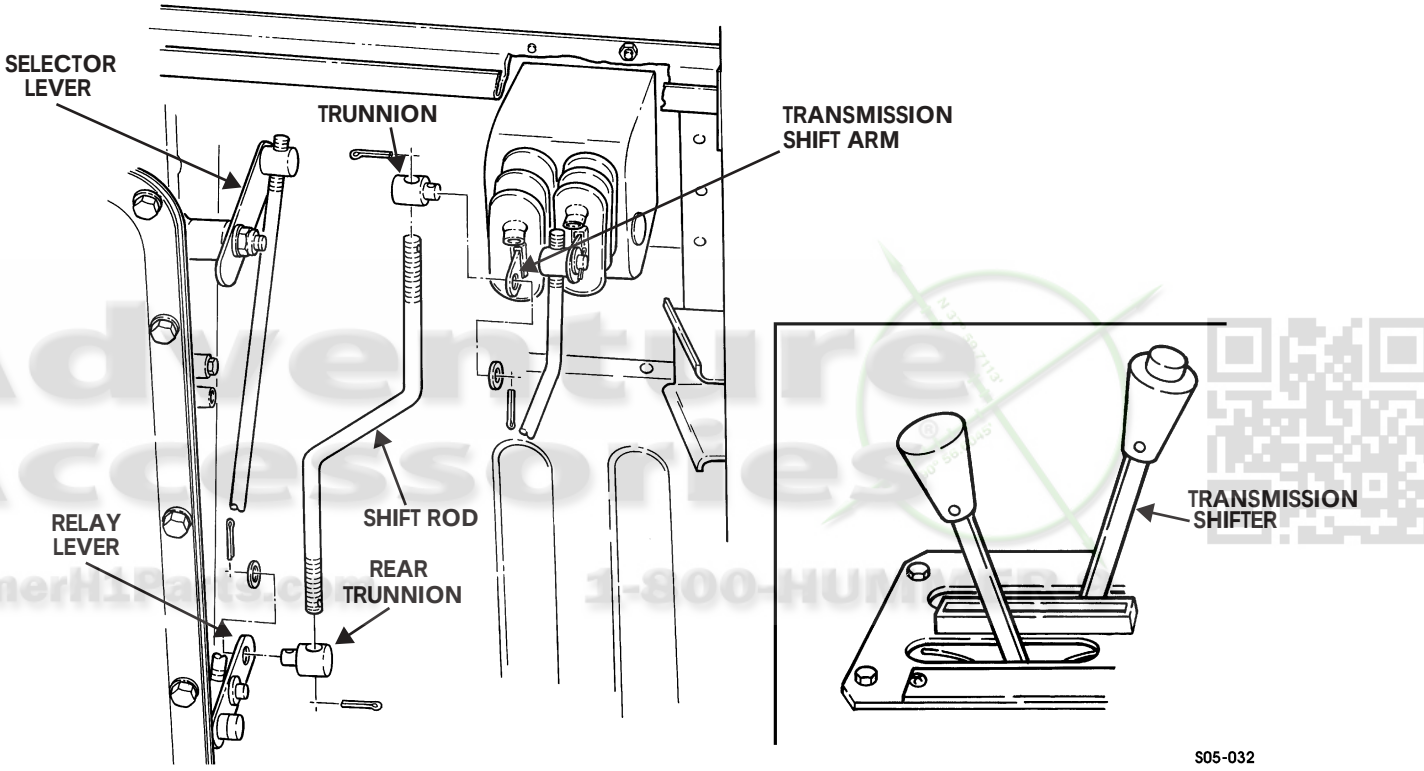


Figure 5-88: Transmission Shift Rod

Adjustment

***CAUTION**: If the manual control linkage is not in proper detent for selector lever position, transmission will be damaged.*

NOTE: Proper adjustment ensures end of shift rod movement is parallel to relay lever movement (Figure 5-88).

1. Move shifter to 1 (LOW) position and ensure selector lever is in forward detent position 1 or LOW. If not, remove cotter pin and washer, and turn trunnion until trunnion aligns with shift arm. Install cotter pin and washer (Figure 5-88).
2. To align shift rod, turn one trunnion in one direction and opposite trunnion same amount in opposite direction.
3. When adjustment is correct, spread four cotter pins.

SHIFT CONTROLS HOUSING ASSEMBLY REPLACEMENT

Removal

NOTE: If the shift controls housing assembly is to be reinstalled, tape trunnions to shift rods to prevent loss of adjustment. Shift rod trunnions are removed from shift rods only if damaged, or if shift rods are replaced.

1. Remove the driver's side front inner kick (Section 10).
2. Remove cotter pin, washer, and trunnion from transmission shift lever arm. Discard cotter pin (Figure 5-89).

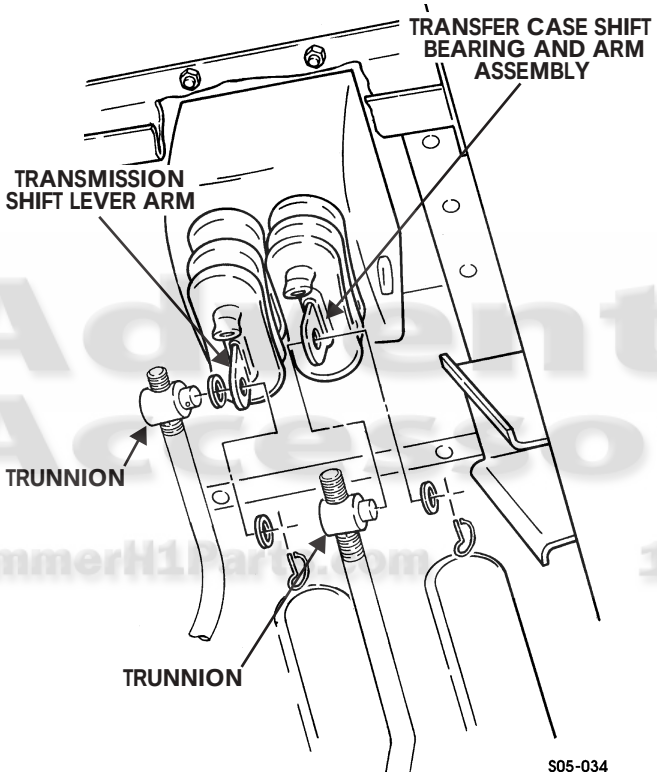


Figure 5-89: Shift Trunnions

3. Remove cotter pin, washer, and trunnion from transfer case shift bearing and arm assembly. Discard cotter pin.
4. Remove four locknuts, washers, bolts, and shift controls housing assembly from body (Figure 5-90).

NOTE: Tag leads for installation.

5. Disconnect two body harness leads from backup light switch leads.
6. Disconnect two body harness leads from neutral start switch leads.

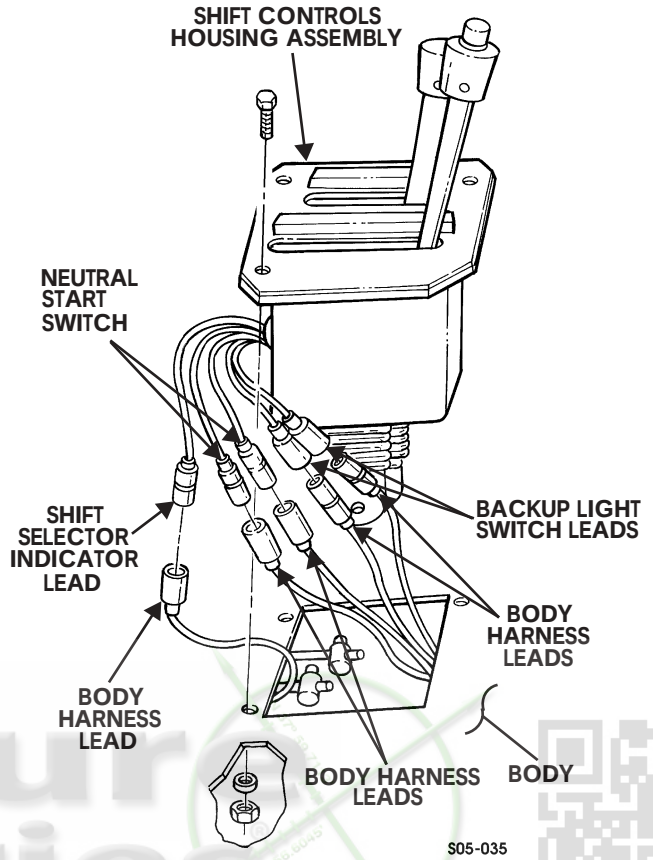


Figure 5-90: Shift Controls Housing Assembly

7. Disconnect body harness lead from shift selector indicator lead.
8. Remove boot from shift control housing assembly.
9. Remove nut, screw and interlock cable from shifter (Figure 5-91).

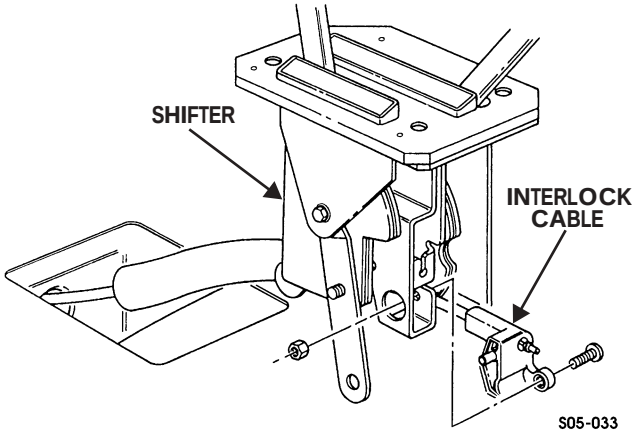


Figure 5-91: Interlock Cable and Shifter

Installation

1. Feed interlock cable end through boot and install on shifter housing assembly (Figure 5-91).
2. Work boot onto shifter housing assembly passing wire leads through boot. Install external tie strap (Figure 5-92).
3. Position shift controls housing assembly in body, with transmission lever to the right, and install with four bolts, washers, and locknuts. Tighten locknuts to 6 lb-ft (8 N•m) (Figure 5-90).
4. Connect two body harness leads to backup light switch leads.
5. Connect two body harness leads to neutral start switch leads.
6. Connect body harness lead to shift selector indicator lead.
7. Install transfer case shift rod trunnion on transfer case shift bearing and arm assembly with washer and cotter pin (Figure 5-89).
8. Install transmission shift rod trunnion on transmission shift lever arm with washer and cotter pin.
9. Start engine and check shift controls for proper operation. Adjust as needed.
10. Install the driver's side front inner kick panel (Section 10).

SHIFT CONTROLS HOUSING ASSEMBLY MAINTENANCE

Disassembly

1. Remove shift controls housing assembly.
2. Drive out pin and remove knob from transfer case shift tube.
3. Drive out pin and remove knob from transmission shift tube.

NOTE: Tag leads for installation.

4. Cut tie straps, if present, and work boot off neutral start switch, backup light switch, and shift indicator leads, and down interlock cable, if present (Figures 5-91 and 5-92).
5. Slide rubber boot from shift controls housing assembly.
6. Remove two transmission selector lens covers.
7. Remove two fiber optic indicator strips from bulbs.
8. Remove two bulbs.
9. Remove four screws, cover plate, and rubber gasket from

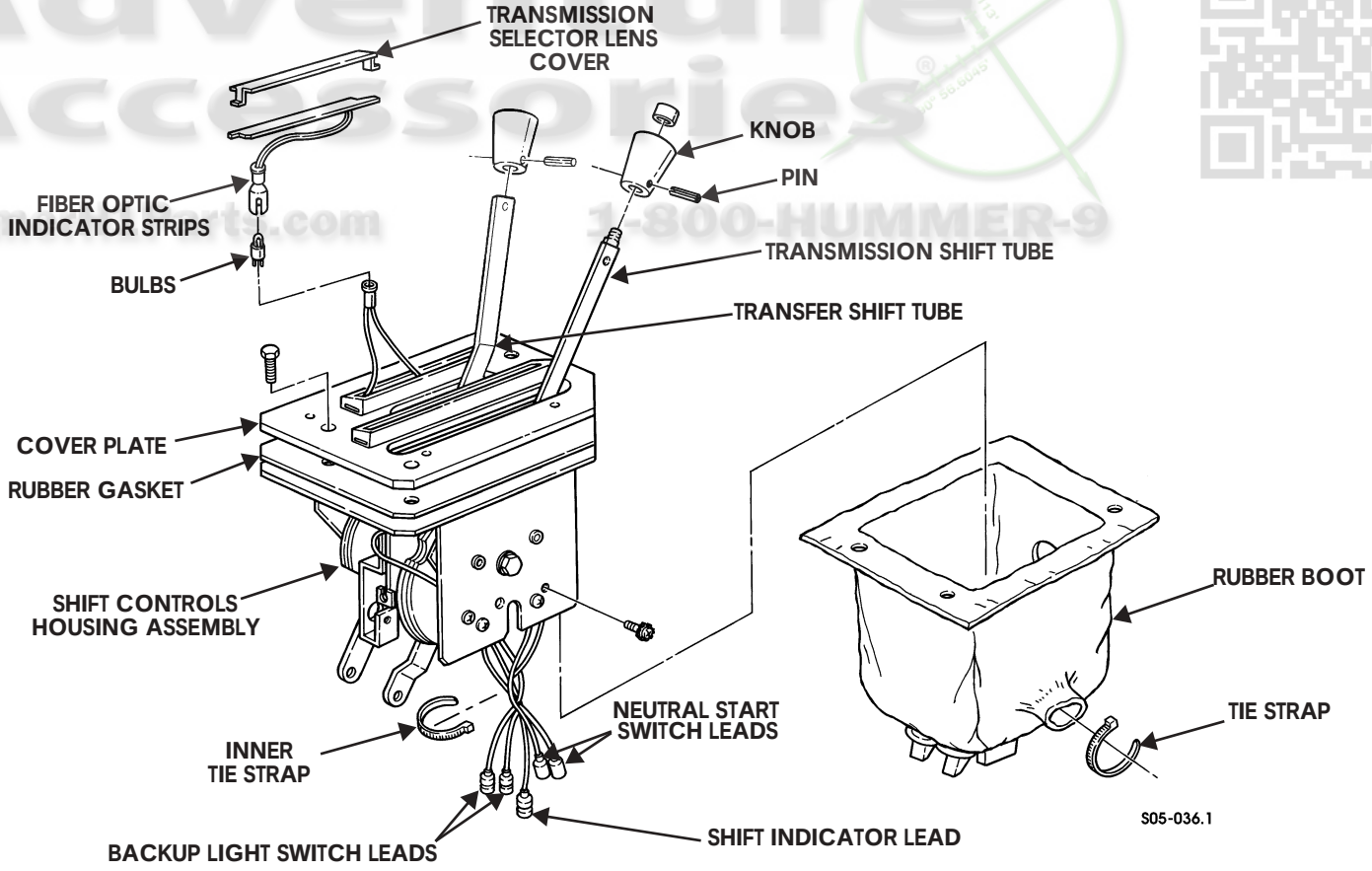


Figure 5-92: Shift Controls Housing Assembly

Assembly

1. Install rubber gasket and cover plate on shift controls housing assembly with four screws (Figure 5-92).
2. Install two bulbs.
3. Install two fiber optic indicator strips on bulbs.
4. Install two transmission selector lens covers.
5. Install inner tiestrap.
6. Start installation of rubber boot on shift controls housing assembly, placing two neutral start switch backup light switch leads, interlock cable (if present) and shift indicator lead through openings in rubber boot.
7. Complete sliding rubber boot onto shift controls housing assembly, ensuring mounting screw holes align.
8. Place outer tiestrap on wires and boot.
9. Install knob onto transmission shift tube and secure with pin.
10. Install knob onto transfer case shift tube and secure with pin.
11. Install shift controls housing assembly.

TRANSMISSION VENT LINE REPLACEMENT

Removal

1. Disconnect vent line from transmission and tee fitting and remove vent line (Figure 5-93).
2. Disconnect vent line at two tee fittings and remove vent line.
3. Remove bolt, clamp, and main vent line from engine mount bracket.
4.

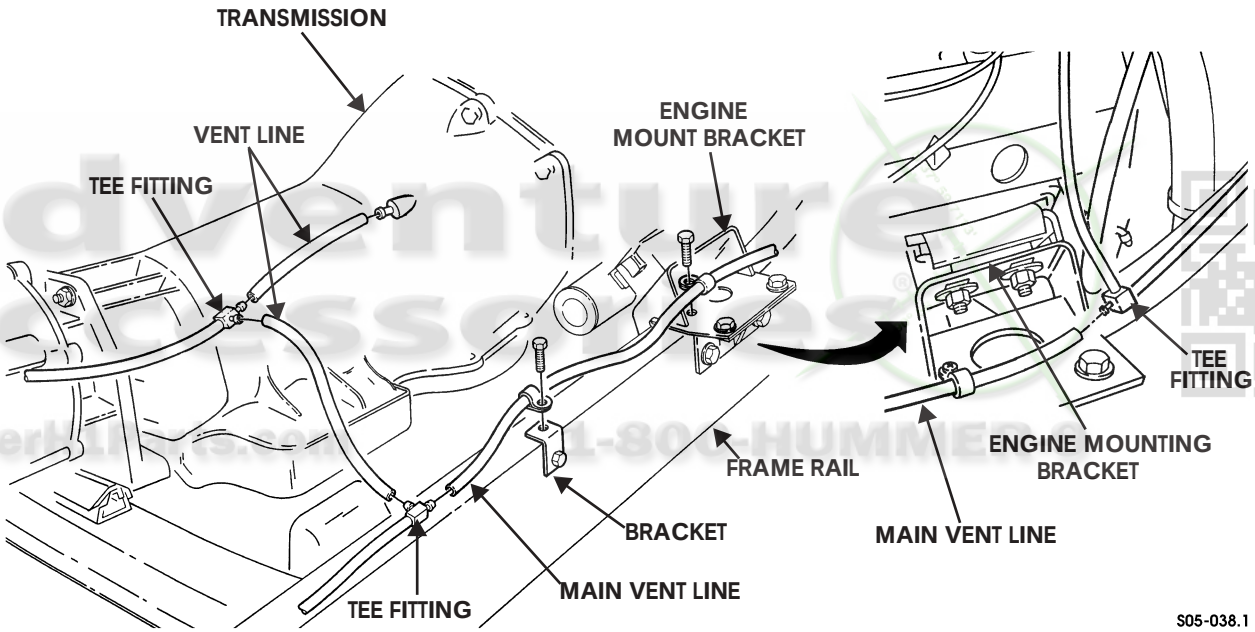


Figure 5-93: Transmission Vent Line

5. Remove bolt, clamp, and main vent line from bracket on frame rail.
6. Remove main vent line from tee fitting near engine mount bracket and tee fitting on frame rail.
7. Remove main vent line.

Installation

1. Install vent line on tee fitting and transmission (Figure 5-93).
2. Install vent line on two tee fittings.
3. Install clamps on main vent line.
4. Install clamp and main vent line on engine mount bracket with bolt.
5. Install clamp and main vent line on bracket on frame rail with bolt.
6. Connect main vent line on tee fittings near engine mount bracket and frame rail.

SEALED LOWER CONVERTER HOUSING COVER REPLACEMENT

Removal

1. Remove crossover pipe (Section 3).
2. Remove sealed upper converter housing cover.
3. Remove four bolts and lower converter housing cover from transmission flange (Figure 5-94).
4. Remove gasket from lower converter housing cover. Discard gasket.
5. Clean any adhesive or gasket remains from flange of transmission.

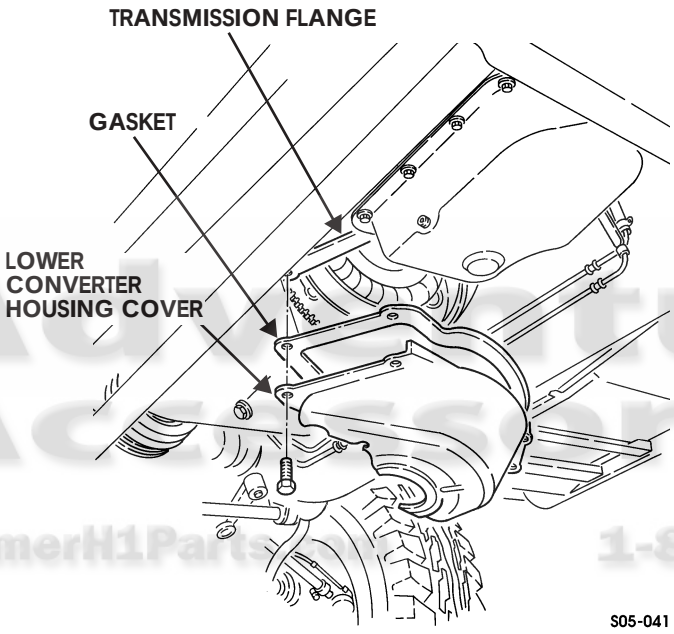


Figure 5-94: Lower Converter Housing Cover

Installation

NOTE: Gasket may require bending over edge of converter housing cover to make gasket seat properly.

1. Apply adhesive to gasket and install on lower converter housing cover (Figure 5-94).
2. Apply adhesive to lower converter housing cover.
3. Install lower converter housing cover on transmission flange with four bolts.
4. Install sealed upper converter housing cover.
5. Install crossover pipe (Section 3).

SEALED UPPER CONVERTER HOUSING COVER REPLACEMENT

Removal

1. Remove two bolts and upper converter housing cover from transmission flange (Figure 5-95).
2. Remove gasket from upper converter housing cover. Discard gasket.
3. Clean any gasket or adhesive remains from flange of transmission.

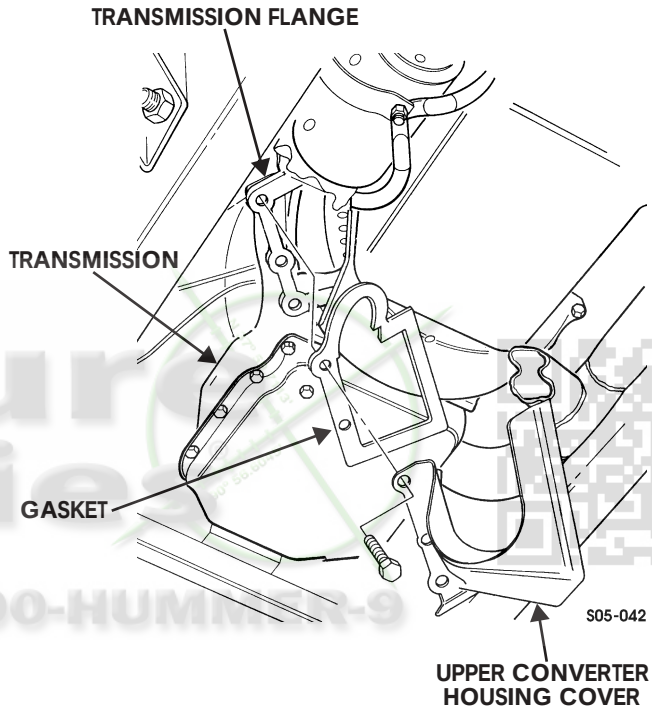


Figure 5-95: Upper Converter Housing Cover

Installation

NOTE: Gasket may require bending over edge of converter housing cover to make gasket seat properly.

1. Apply adhesive to gasket and install gasket on upper converter housing cover (Figure 5-95).
2. Install upper converter housing cover on transmission with two bolts.

TRANSMISSION OIL PUMP SEAL REPLACEMENT

WARNING: Torque converter must be supported during removal and installation. Failure to do this may cause injury or damage to equipment.

Removal

1. Remove transmission/transfer case assembly.

NOTE: Have drainage container ready to catch fluid.

2. Remove torque converter from transmission (Figure 5-96).
3. Remove oil seal from oil pump and discard (Figure 5-97).

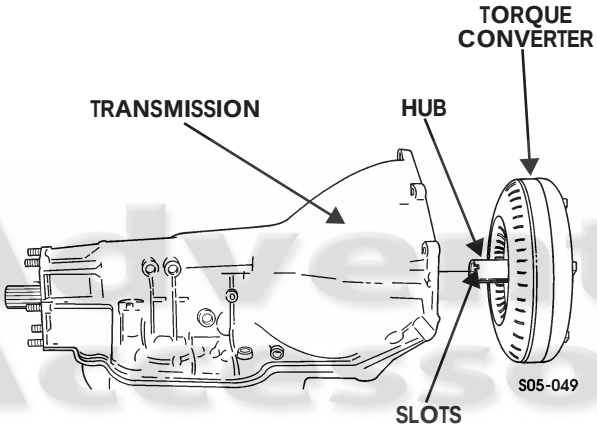


Figure 5-96: Transmission and Torque Converter

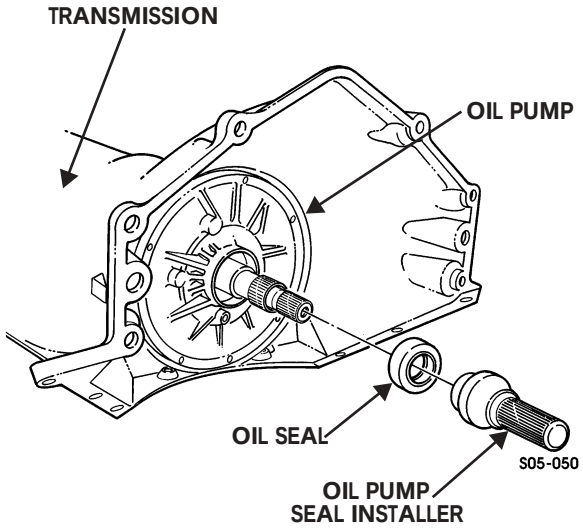


Figure 5-97: Oil Seal Removed From Oil Pump

Installation

1. Apply sealing compound to outside diameter of oil seal (Figure 5-97).
2. Using oil pump seal installer, install oil seal in oil pump.
3. Install torque converter in transmission. Ensure drive lugs of inner pump rotor in oil pump are properly engaged with drive slots of torque converter hub (Figures 5-96 and 5-97).
4. Install transmission/transfer case assembly.

TRANSMISSION MOUNT REPLACEMENT

Removal

1. Support transmission with jack.
2. Remove two capscrews from transmission mount and adapter, and raise transmission slightly.
3. Remove two nuts, lockwashers, and transmission mount from crossmember. Discard lockwashers (Figure 5-98).

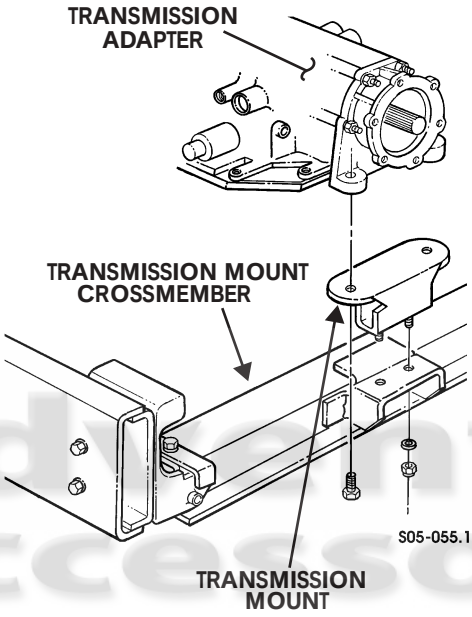


Figure 5-98: Transmission Adapter and Crossmember

Installation

1. Install transmission mount on crossmember with two lockwashers and nuts. Tighten nuts to 65 lb-ft (88 N•m) (Figure 5-98).
2. Install transmission mount with two bolts, but do not tighten. Lower transmission.
3. Tighten adapter bolts to 28 lb-ft (38 N•m).

TRANSMISSION CONTROL MODULE (TCM) AND BRACKET REPLACEMENT

***CAUTION**: Ensure that ignition switch is OFF before disconnecting or reconnecting the transmission control module (TCM). Failure to do this may cause internal damage to TCM.*

Removal

1. Turn ignition switch OFF.
2. Remove front console cover (Section 10).
3. Disconnect two multi-pin connectors from TCM. Protect connectors from dust, dirt, and damage (Figure 5-99).
4. Remove four nuts and washers from clip studs.

NOTE: Perform step 5 only if bracket is to be replaced.

5. Carefully pry out four trim buttons and remove bracket from engine cover. Discard trim buttons.

NOTE: Perform step 6 only if replacing TCM.

6. Remove four nuts and clip studs from TCM bracket slots.

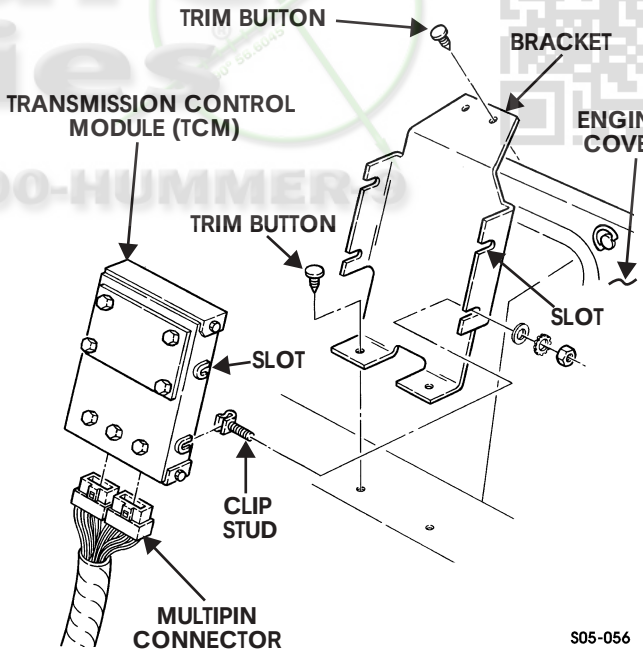


Figure 5-99: TCM and Bracke

Installation

NOTE: The new TCM does not contain a Programmable Read Only Memory (PROM). If old PROM is to be used, refer to PROM replacement. Ensure replacement unit part number is the same as old part number.

1. Refer to PROM Replacement to install PROM in new TCM.

NOTE: Perform step 2 only if bracket is being replaced.

2. Install bracket on engine cover with four trim buttons.

NOTE: Perform step 3 if TCM is being replaced.

3. Install four clip studs and nuts on TCM.
4. Connect two multi-pin connectors to bottom of TCM.
5. Secure TCM to bracket with four washers and nuts.

PROM REPLACEMENT

Removal

1. Remove transmission control module (TCM) from the vehicle.

***CAUTION**: Do not remove any other screws from TCM. Do not remove cover from PROM. Any other method of removal may cause damage to the PROM or PROM socket in TCM.*

2. Remove four screws and access cover from TCM (Figure 5-100).

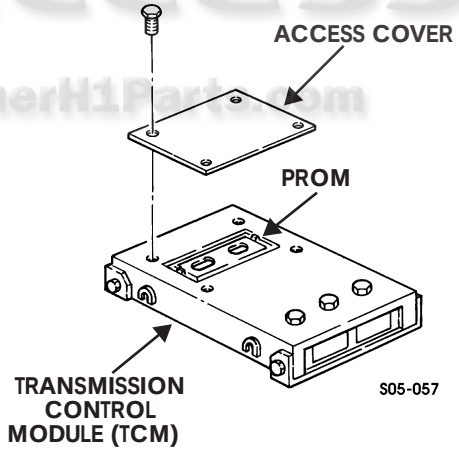


Figure 5-100: CM Access Cover

3. Using two fingers, push both retaining clips away from PROM. While grasping PROM at both ends, lift it straight up out of socket (Figure 5-101).

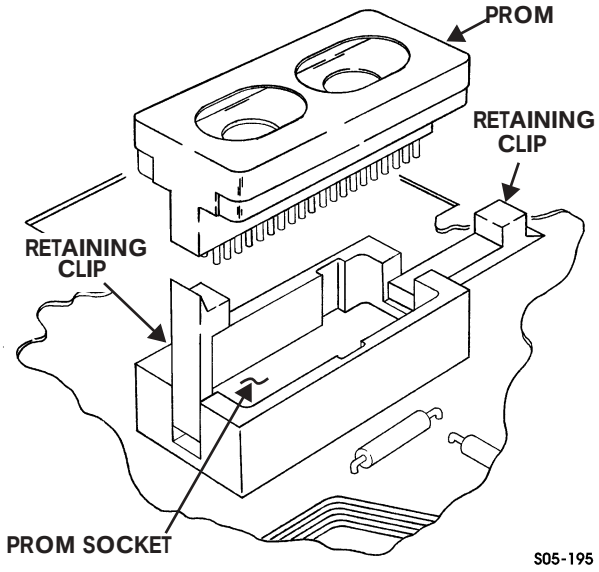


Figure 5-101: Retaining Clip

***CAUTION**: To prevent possible electrostatic discharge damage to the TCM, do not touch the connector pins or soldered components on the circuit board. Also, do not remove cover from PROM.*

4. Inspect alignment nodes and pins of the PROM for damage or contaminants (Figure 5-102). Inspect socket notches and connectors for damage and contaminants (Figure 5-103). Remove any contaminants. Replace PROM if pins or nodes are bent, burred, or dented. Carefully set aside.

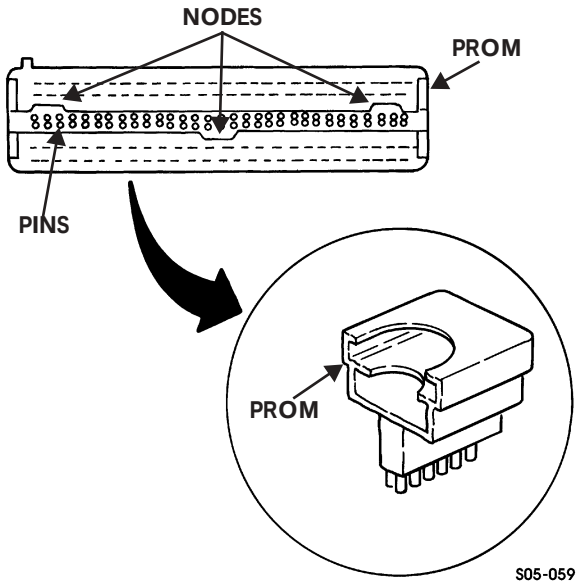


Figure 5-102: Alignment Nodes and Pins

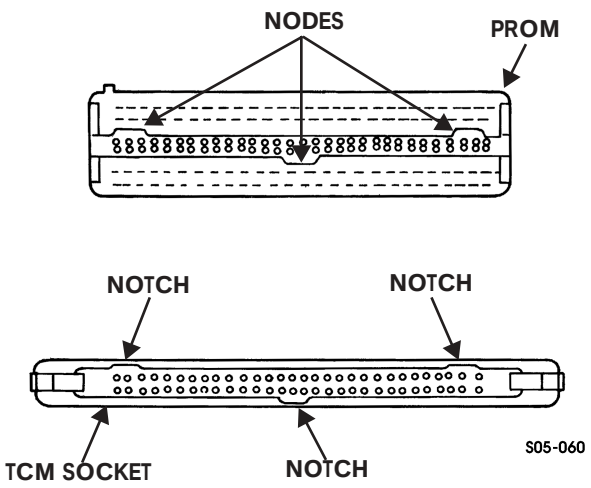


Figure 5-103: Notches and Connectors

Installation

NOTE: Check that the replacement TCM part number is the same as old TCM.

1. Align nodes of the PROM with mating notches on TCM socket (Figure 5-103).

***CAUTION**: Do not press on the ends of the PROM until the clips snap into place because the controller circuit board and/or clips may be damaged.*

2. Press straight down gently on ends of PROM until retaining clips are against side of PROM (Figure 5-104).
3. Press in on both retaining clips until they snap into place. A click should be heard as the clips lock onto PROM.

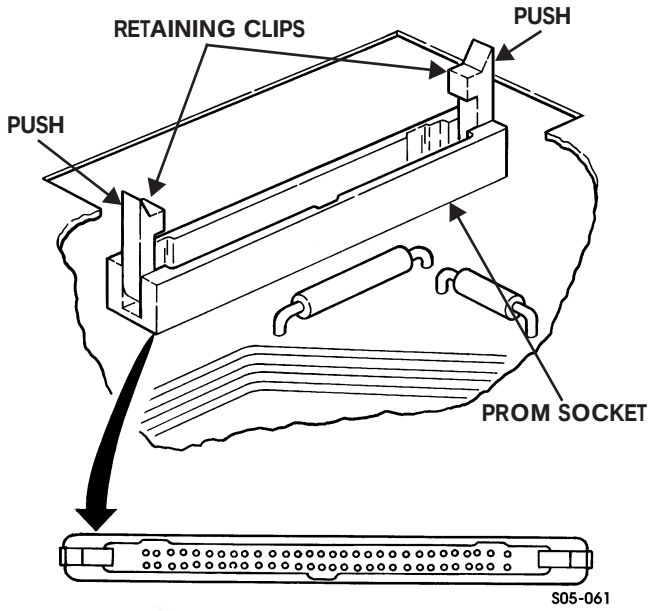


Figure 5-104: Lock Retaining Clips Onto PROM

4. Install access cover on TCM with four screws (Figure 5-100).
5. Install TCM in vehicle.

Functional Check

1. Turn ignition ON.
2. Enter diagnostics (i.e., ground DLC pin B). DTC 12 should flash four times on MIL light (if no other DTC(s) are present). This indicates the PROM is installed properly, and is functioning.

If DTC 51 occurs, or if the MIL light is ON constantly with no DTC(s), the PROM is not fully seated, or is defective.

a. Turn ignition off and disconnect TCM.

b. If not fully seated, remove access cover and press firmly on the ends of the PROM.

c. If necessary, remove the PROM, and reinstall.

THROTTLE POSITION (TP) SENSOR REPLACEMENT

***CAUTION**: The throttle position (TP) sensor is an electrical component and must not be soaked in any liquid cleaner or solvent, as damage may result.*

Removal

1. Ensure ignition switch is off.
2. Release locking tab on socket of engine wiring harness and disconnect plug from engine wiring harness (Figure 5-105).
3. Remove two screws, washers, and TP sensor from fuel injection pump.

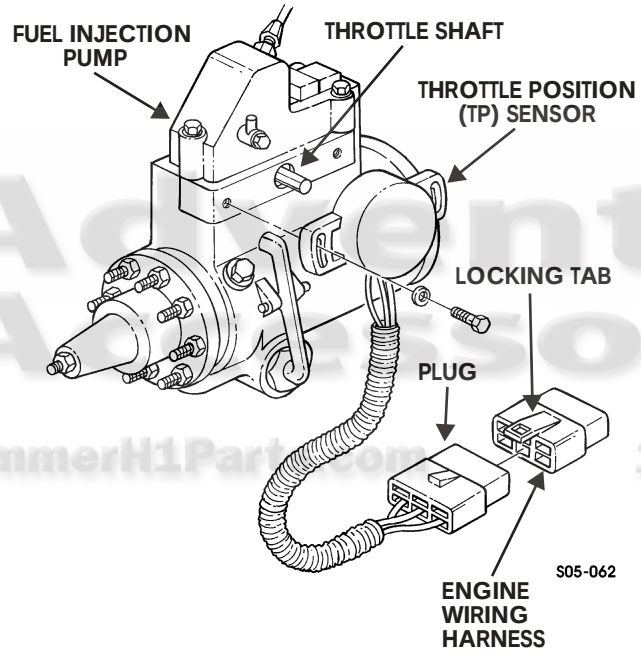


Figure 5-105: Throttle Position Sensor

Installation

1. Ensure throttle is closed, and place TP sensor on throttle shaft of fuel injection pump (Figure 5-105).
2. Rotate TP sensor counterclockwise to align screw holes in sensor with holes in injection pump.
3. Secure TP sensor with two screws and washers.
4. Connect TP sensor plug and engine wiring socket. Ensure locking tab is secure.
5. Adjust TP sensor.

THROTTLE POSITION (TP) SENSOR ADJUSTMENT PROCEDURE

To adjust the throttle position (TP) sensor, perform the following steps:

1. Disconnect TP sensor connector from engine wiring harness connector and install the jumper wires between the TP sensor and the engine wiring harness (Figure 5-106).
2. Turn the ignition switch to the RUN position.
3. Using a voltmeter, measure the voltage between terminals A and C of the TP sensor connector, and multiply the measurement by 0.33 to obtain the desired TP sensor voltage.

   Example: 5.05 volts x 0.33 = 1.66 (± 1%)
4. Install a 0.646 in. (16.4 mm) gauge block between the throttle adjusting screw and the boss on the fuel injection pump housing (Figure 5-107).
5. Rotate the fuel injection pump throttle lever so that the throttle adjusting screw holds the gauge block against the housing boss.

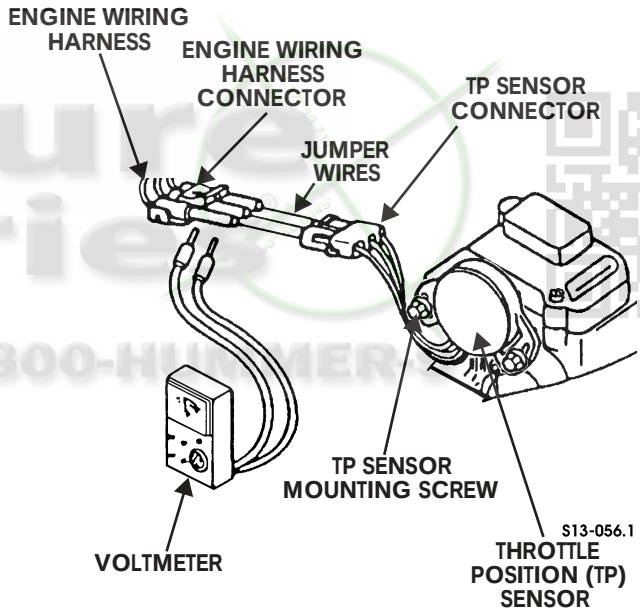


Figure 5-106: Throttle Position Sensor

NOTE: Keep the fuel injection pump throttle lever in this position during the rest of the procedure.

6. Measure the voltage between terminals B and C of the TP sensor connector:
   - If the voltage is within the calculated specification (from step 3), proceed to step 10.
   - If the voltage is not within the calculated specification (from step 3), go to the next step.
7. Loosen the TP sensor mounting screws and rotate the TP sensor toward the rear of the vehicle (counterclockwise) (Figure 5-106).
8. With the voltmeter connected to terminals B and C of the TP sensor connector, rotate the TP sensor slowly toward the front of the vehicle (clockwise) until the voltmeter indicates the correct voltage (for example: 1.65 to 1.67 volts). Hold the sensor in this position and tighten the TP sensor mounting screws.
9. Confirm that the adjustment did not change. Voltage should be approximately 90 percent (± 5%) of the voltage measured in step 3.

   Example: 5.05 (measured voltage) x 0.33 (ratio) = 1.66 volts (sensor voltage).
10. Reconnect the TP sensor connector to engine wiring harness and remove gauge block.

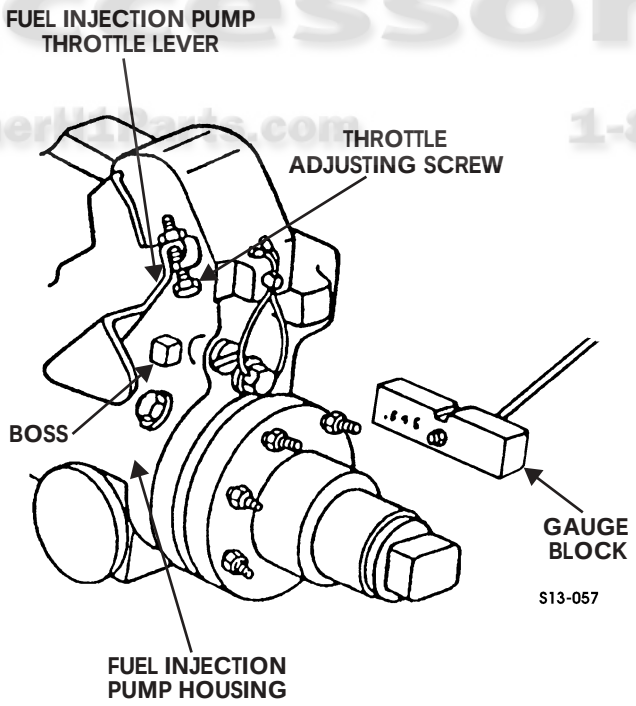


Figure 5-107: Throttle Adjusting Screw

TRANSMISSION INPUT SPEED SENSOR (TISS) AND OUTPUT SPEED SENSOR (TOSS) REPLACEMENT

NOTE: Both the input and output speed sensors are replaced the same way.

Removal

1. Ensure ignition switch is off.
2. Disconnect TOSS harness connector from sensor body. Environmental seal is reusable if not damaged (Figure 5-108).
3. Remove bolt from TOSS and transmission.
4. Using a twisting motion, remove sensor from transmission.
5. Remove and discard O-ring seal from barrel of TOSS.

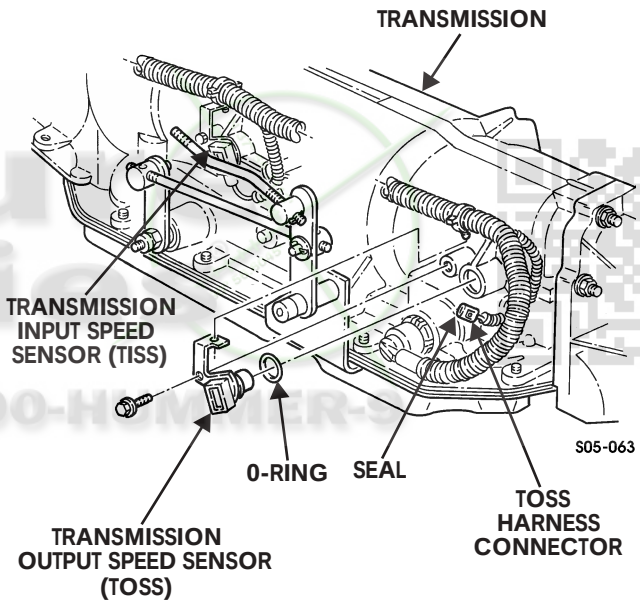


Figure 5-108: Transmission Input and Output Speed Sensors

Installation

1. Lubricate O-ring seal with ATF and place it on TOSS barrel (Figure 5-108).
2. Using a twisting motion, install sensor in transmission and secure with bolt.
3. Ensure that environmental seal is on harness connector and install connector on TOSS.
4. Start engine and:
   a. Check for TISS signal.
   b. Drive vehicle slowly and check for TOSS signal.

TRANSFER CASE

Description

The transfer case used with this vehicle is the new departure model 242. It is a chain driven internally, two speed, locking, and differentiated gearing system that provides a front axle and rear axle drive output through front and rear transfer output shafts. The transfer case is bolted to an adapter on the rear of the automatic transmission. The output shaft of the transmission is splined to the transfer case input gear.

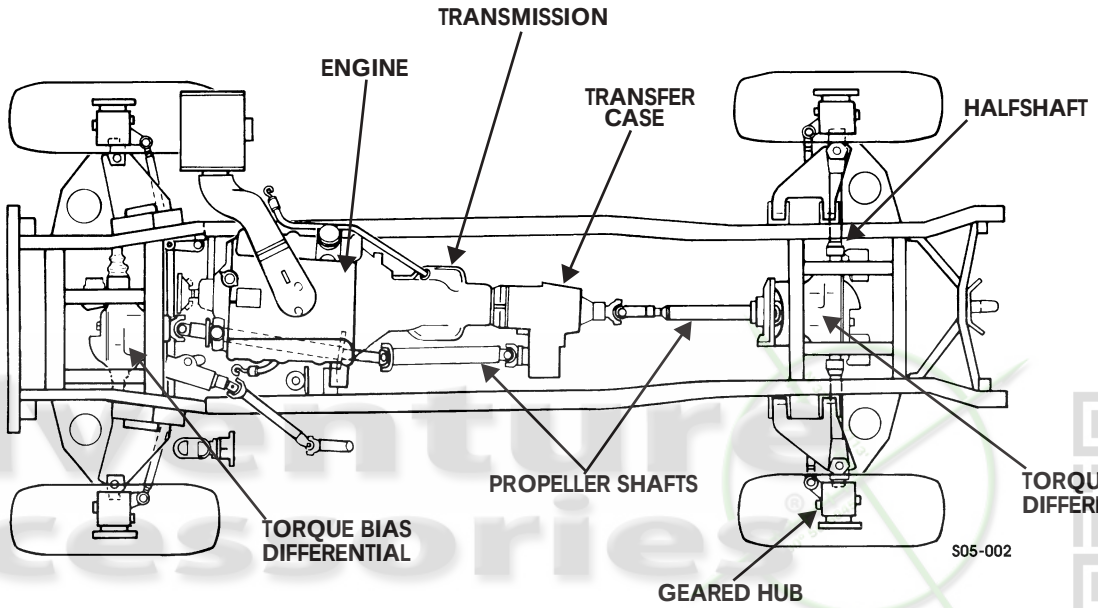


Figure 5-109: Drive System

Drive System Operation

The transfer case evenly distributes power form the transmission to the front and rear axle assemblies (Figure 5-109). Power is delivered from the transfer case through the propeller shafts which are linked to the differentials. Universal joints located at either end of the front and rear propeller shafts permit in-line driving power between the transfer case and the differentials. The differentials transfer driving power through the halfshafts and geared hubs. The differentials ensure that power is applied to the wheel which has traction, regardless of which wheel is slipping. This feature is called torque biasing. The geared hubs serve as the final drive components to the front and rear wheels.

Transfer Case Oil Cooler

The transfer case lubricant (Dexron III) is cooled by transmission fluid which flows from the transmission fluid cooler, through the transfer case cooler, back into the transmission, and then to the transmission fluid cooler (Figure 5-110).

Some transfer cases allow the driver to select either 2-wheel or 4-wheel drive. However, the HUMMER's transfer case provides full-time 4-wheel drive in all gear ranges. It also contains an internal differential that allows for independent drive or lockup between the front and rear axles. The transfer case is designed to compensate for the different speeds between the front and rear axles when driving over uneven terrain (such as bumpy or snowy roads). In this way, the transfer case permits the vehicle to be continuously operated in 4-wheel drive.

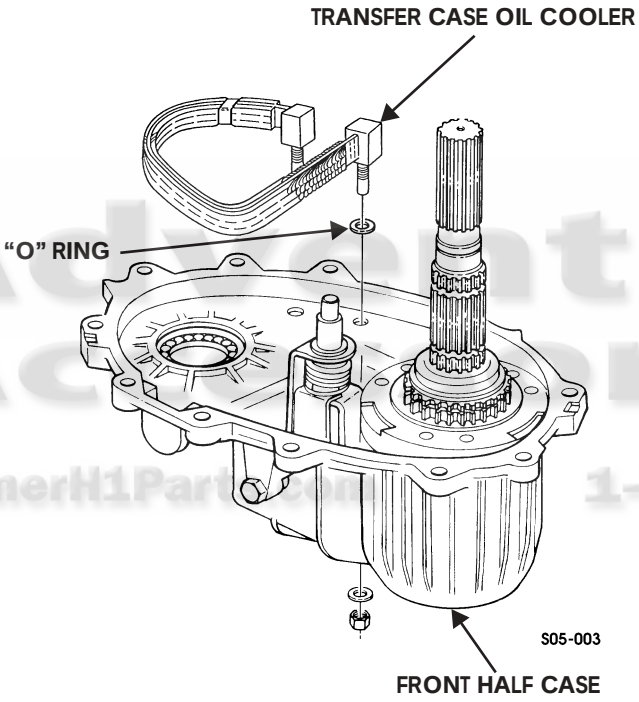


Figure 5-110: Transfer Case Oil Cooler

Transfer Case Gear Range Selection

The transfer case is operated by the transfer case shift lever (Figure 5-111).

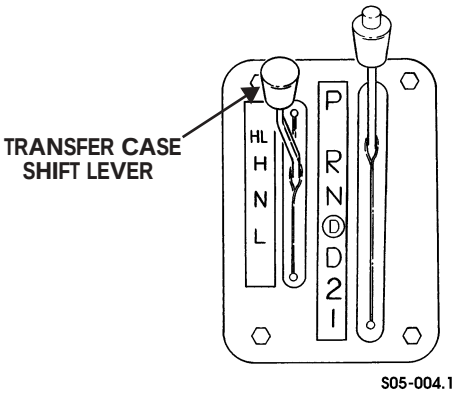


Figure 5-111: Transfer Case Gear Range Selection

HL (high-lock) - The HL position should *only* be used in moderate off-road conditions in which there is a chance of wheel slippage, such as bumpy or muddy secondary roads, snow covered roads, etc...

H (high) - The H position should be used under all "normal" operating conditions, such as highway and hard surface driving.

N (neutral) - The N position should only be used when towing the vehicle.

L (low-lock) - The L position should be used for adverse off-road conditions such as deep, loose sand; deep mud; very steep, rough hills; ditch crossing; log crossing; etc.

The H position permits the front and rear differential to operate independently through the differential inside of the transfer case and still maintain 4-wheel drive. The HL and L positions provide full-time 4-wheel drive with both differentials locked together, bypassing the differential in the transfer case. The L position also provides an additional gear reduction of 2.72:1 to the drivetrain. The N position disengages the transfer case.

The transfer case can be shifted from the H to the HL position "on-the-fly" (while the vehicle is moving). The differential within the transfer case is engaged only when the transfer case is in the H position. All other transfer case shifts should be made when the vehicle is stopped and the transmission is in N.

TRANSFER CASE DIAGNOSIS AND TROUBLESHOOTING

Transfer Case Difficult to Shift

1. Check transfer case shift linkage for improper adjustment or damage which would interfere with operation. Adjust or replace shift rod.
2. Check transfer case fluid lever (Section 1). Add fluid, if necessary.
3. Repair or replace transfer case.

Transfer Case Noise

1. Check transfer case fluid level (Section 1). Add fluid, if necessary.
2. Repair or replace transfer case.

TRANSFER CASE SHIFT ROD MAINTENANCE

Removal

1. Remove cotter pin, washer, and shift rod from transfer case range lever. Discard cotter pin (Figure 5-112).
2. Remove cotter pin, washer, and shift rod trunnion from bearing and arm assembly. Discard cotter pin.

NOTE: Mark trunnion position on shift rod for installation.

3. Remove trunnion from shift rod.

Installation

1. Install trunnion on shift rod (Figure 5-112).
2. Install shift rod and trunnion on bearing and arm assembly with washer and cotter pin. Do not spread cotter pin.
3. Insert end of shift rod into transfer case range lever and secure with washer and cotter pin.
4. Check transfer case shifting detents with positions on transfer range indicator (Figure 5-113).

Adjustment

NOTE: Transfer case shift rod must be adjusted so that detents of transfer case shift lever align shifter lever with position on transfer range indicator.

1. Remove cotter pin, washer, and trunnion from bearing and arm assembly (Figure 5-112).
2. Engage parking brake, and place transmission shift lever in D (drive) position (Figure 5-113).
3. Place transfer case shift lever forward in HL (high lock) position and hold in position.
4. Ensure transfer case range lever is in most rearward position (HL) (Figure 5-112).
5. Adjust trunnion on shift rod so that trunnion end slides easily into bearing and arm assembly.
6. Secure trunnion to bearing and arm assembly with washer and cotter pin.
7. Ensure all transfer case detent positions align with transfer range indicator positions.

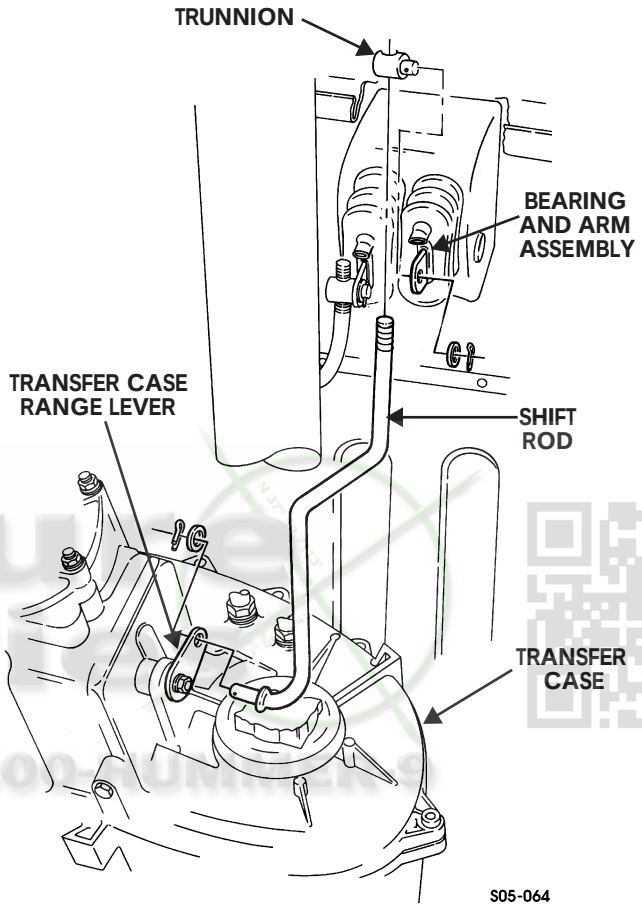


Figure 5-112: Transfer Case Shift Rod

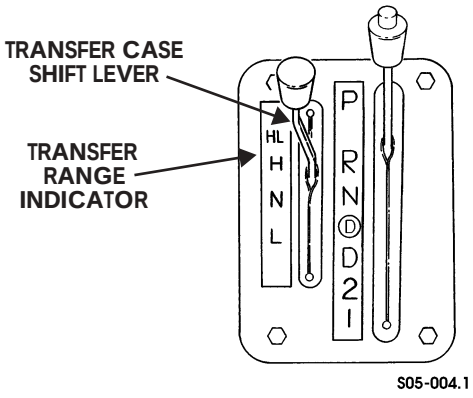


Figure 5-113: Transfer Case Range Indicator

SPEEDOMETER SPEED SENSOR AND TRANSFER CASE LOCK SWITCH REPLACEMENT

Removal

1. Disconnect engine wiring harness connector from speed sensor (Figure 5-114).
2. Remove bolt, speed sensor, and O-ring from transfer case. Discard O-ring (Figure 5-115).
3. Disconnect wiring harness connector from transfer case lock switch (Figure 5-114).
4. Remove lock switch from transfer case.

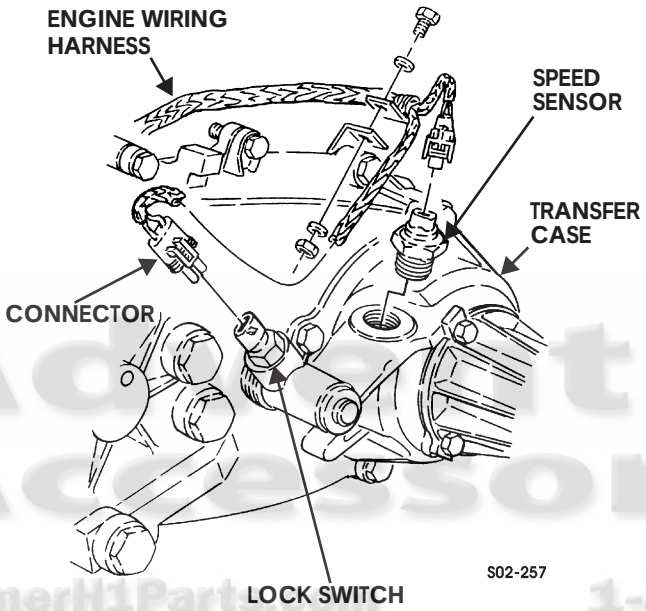


Figure 5-114: Speedometer Speed Sensor and Lock Switch

Installation

1. Install lock switch in transfer case (Figure 5-114).
2. Connect wiring harness connector to lock switch.
3. Install O-ring on speed sensor (Figure 5-115).
4. Install speed sensor in transfer case. Ensure speed sensor is seated in transfer case opening.

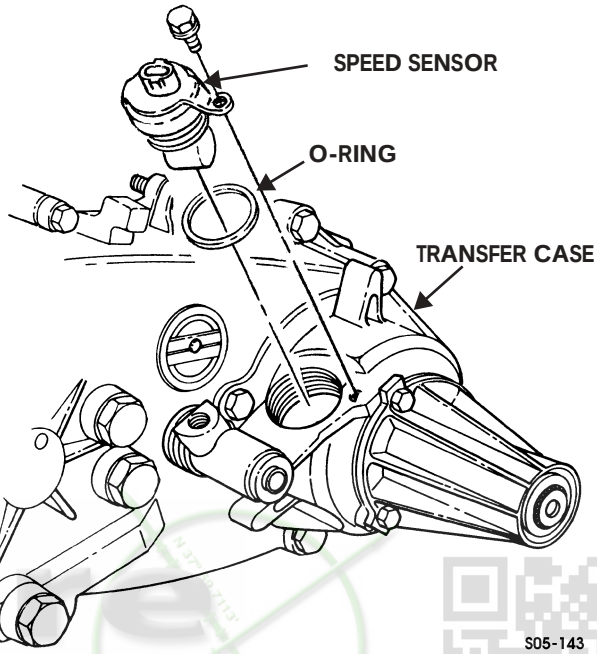


Figure 5-115: Speed Sensor

5. Secure speed sensor to transfer case with bolt. Tighten bolt to 15 lb-ft (20 N•m).
6. Connect engine wiring harness connector to speed sensor.

NOTE: In PCM diagnostics and troubleshooting, the speed sensor in the transfer case is referred to as Vehicle Speed Sensor (VSS).

TRANSFER CASE GUIDE CABLE REPLACEMENT

Removal

1. Remove nut, washer, screw, and spacer from muffler mounting bracket and guide cable bracket (Figure 5-116).
2. Remove two nuts and washers from transfer case and guide cable bracket.
3. Remove screw, washer, guide cable, washers, and brake line support bracket from left-hand frame rail.
4. Remove nut, washer, guide cable and washer from crossmember.

Installation

1. Install guide cable bracket on muffler mounting bracket with screw, spacer, washer, and nut (Figure 5-116).
2. Install guide cable bracket on transfer case with two washers and nuts.
3. Install guide cable and brake line support bracket on left-hand frame rail with two washers and screw. Tighten screw to 27-33 lb-ft (37-45 N•m).
4. Install guide cable on crossmember with two washers and nut.

TRANSFER CASE VENT LINE REPLACEMENT

Removal

1. Loosen clamp and remove vent line from fitting on rear of transfer case (Figure 5-117).
2. Remove bolt, clamp, and vent line from transmission.
3. Disconnect vent line from tee fitting and remove vent line from vehicle.
4. If a new vent line is to be installed, remove clamp from vent line.

Installation

1. If installing a new vent line, position clamp on vent line (Figure 5-117).
2. Connect vent line to tee fitting.
3. Install vent line to fitting on rear of transfer case and tighten clamp.
4. Install clamp and vent line on transmission with bolt. Tighten bolt to 16-20 lb-ft (22-27 N•m).

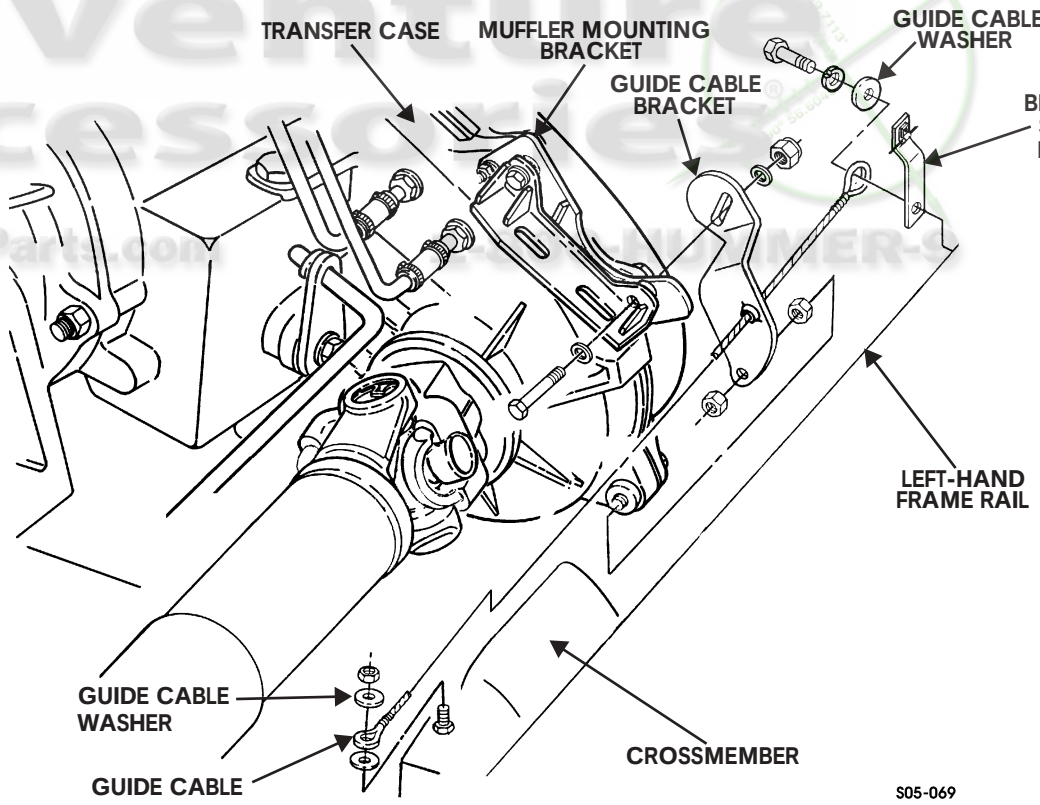


Figure 5-116: Transfer Case Guide Cable

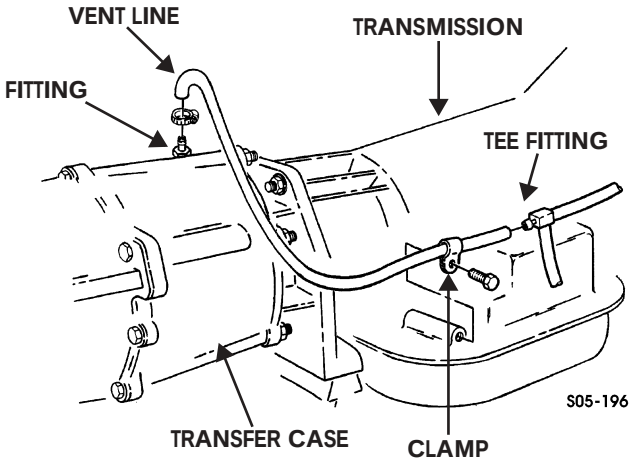


Figure 5-117: Transfer Case Vent Line

TRANSFER CASE OIL SEAL REPLACEMENT

NOTE: Replacement procedures for front and rear oil seals are basically the same except the rear Yoke is part of propeller shaft which must be removed. This procedure is for the front oil seal.

Removal

1. Remove four nuts, washers, two U-bolts, and front propeller shaft from output yoke (Figure 5-118).

NOTE: Have drainage container ready to catch oil.

2. Remove yoke nut, yoke washer, and output yoke from transfer case. Discard yoke washer (Figure 5-119).
3. Remove and discard oil seal.

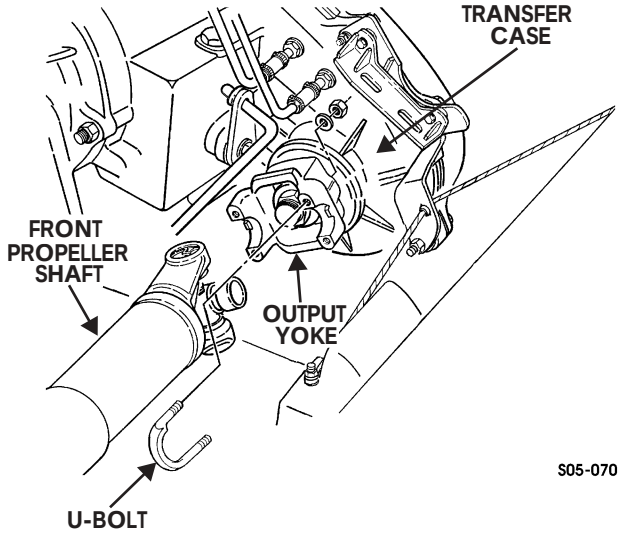


Figure 5-118: Output Yoke

Installation

1. Using output shaft seal installer, install oil seal in transfer case (Figure 5-119).
2. Install slinger, output yoke, yoke washer, and yoke nut on transfer case. Tighten nut to 110 lb-ft (149 N•m).
3. Connect front propeller shaft to output yoke with two U-bolts, four lockwashers, and nuts. Tighten nuts to 13-18 lb-ft (18-24 N•m) (Figure 5-118).

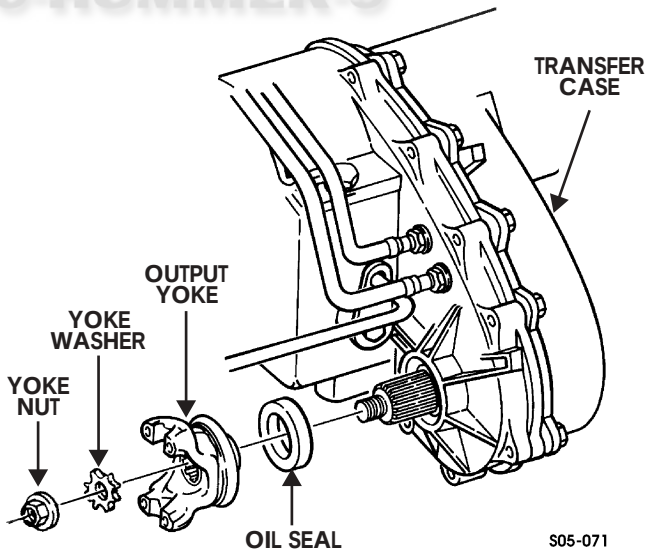


Figure 5-119: Oil Seal

TRANSFER CASE MAINTENANCE

WARNING: To avoid injury, support transfer case during removal. Allow hot transfer case to cool before performing maintenance.

***CAUTION**: Cover or plug all open lines, connections, and ports immediately after disconnection to prevent contamination.*

NOTE: Have drainage container ready to catch oil.

Removal

1. Remove drainplug and O-ring, and drain oil from transfer case. Reinstall drainplug and tighten to 35 lb-ft (47 N•m) (Figure 5-120).

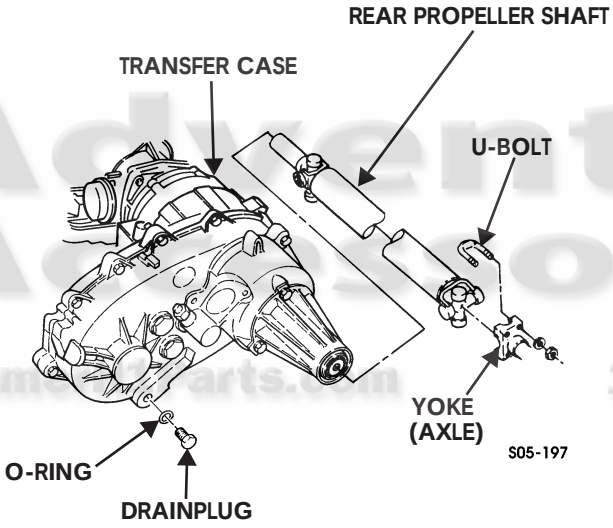


Figure 5-120: Transfer Case Drainplug

2. Remove four nuts, lockwashers, two U-bolts, and rear propeller shaft from axle. Remove shaft. Discard lockwashers.
3. Disconnect engine wiring harness connectors from output speed sensor and range lock switch (Figure 5-121).
4. Remove bolt, output speed sensor, and range lock switch from transfer case.
5. Remove nut, lockwasher, harness clamp, washer, and screw from transfer case.
6. Loosen clamp and remove vent line from fitting and tie vent line out of the way (Figure 5-122).

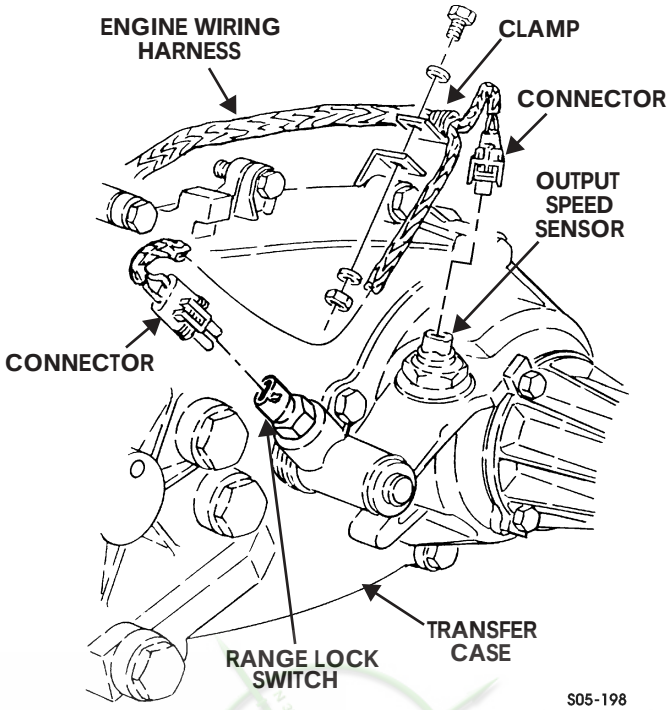


Figure 5-121: Speed Sensor and Lock Switch Connectors

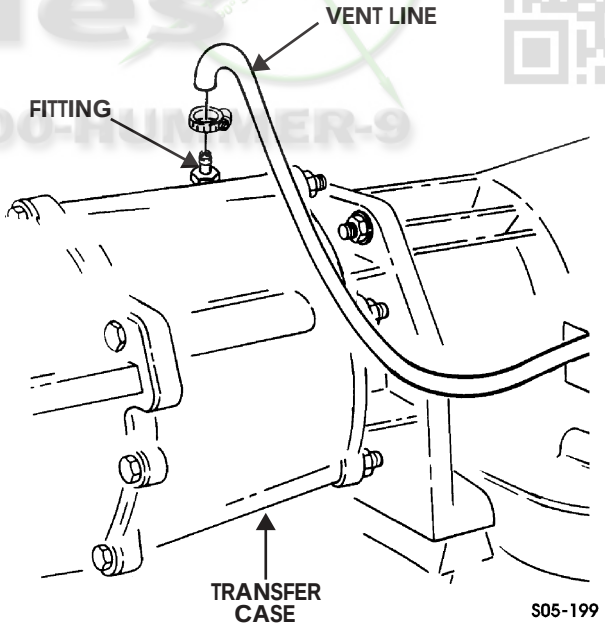


Figure 5-122: Vent Line

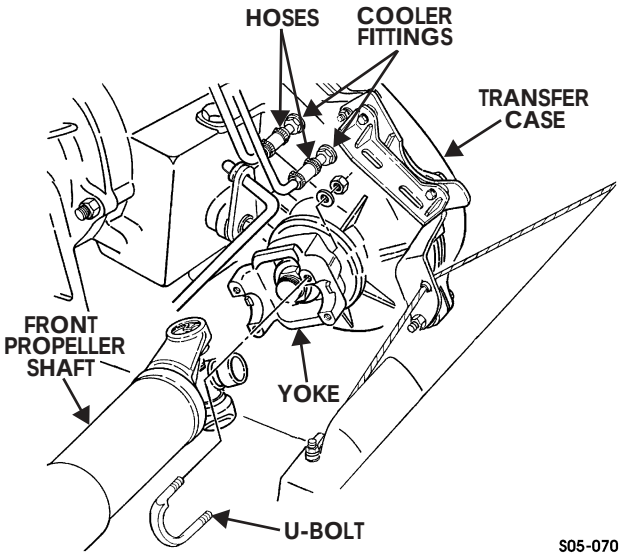


Figure 5-123: Front Propeller Shaft

7. Remove four nuts, lockwashers, two U-bolts and front propeller shaft from yoke. Discard lockwashers (Figure 5-123).
8. Loosen two clamps and remove hoses from transfer case cooler fittings.
9. Remove cotter pin, washer, and shift rod from range lever. Discard cotter pin (Figure 5-124).
10. Remove exhaust U-bolt pipe hanger and retainer cable bracket from transfer case.

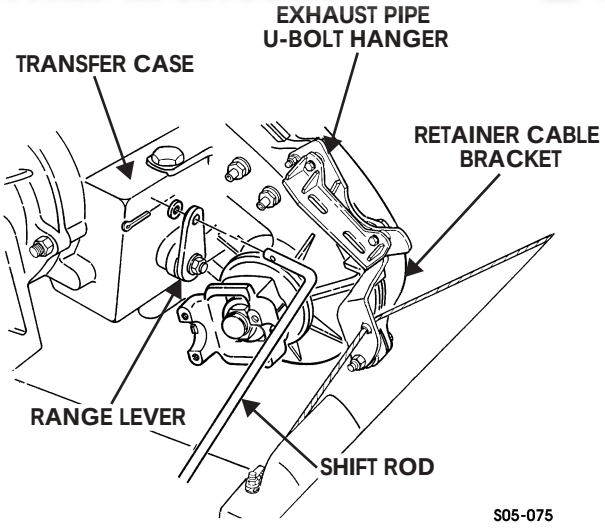


Figure 5-124: Range Lever

11. Place jack under transfer case. Secure transfer case to jack with chain and wood blocking.
12. Remove six locknuts securing transfer case to transfer case adapter. Discard locknuts (Figure 5-125).

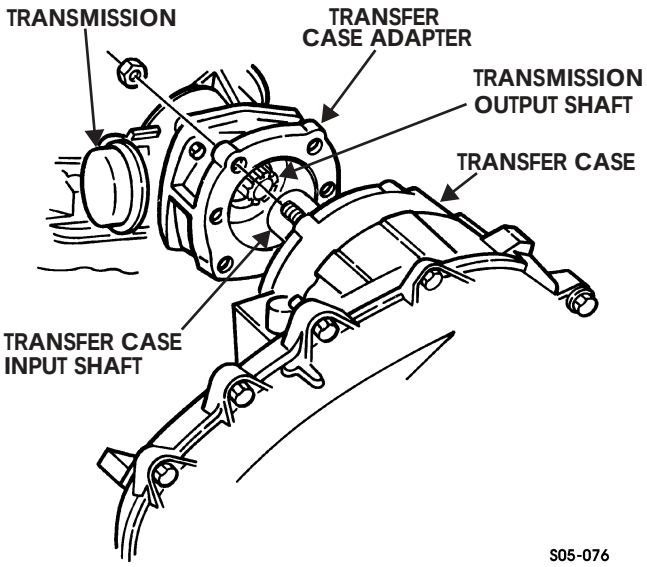


Figure 5-125: Transfer Case Adapter

13. Slide transfer case rearward from adapter and remove from transmission.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Clean sealant remains from transfer case and adapter (Figure 5-125).

Installation

1. Mount transfer case securely on jack with chain and blocking wood.
2. Apply anaerobic sealer to transfer case mounting surface on transfer case adapter (Figure 5-125).

NOTE: Ensure sufficient anaerobic sealer is applied to transfer case mounting surface to form a consistent bead of squeeze upon installation on transfer case adapter.

3. Align transfer case female input shaft with male transmission output shaft and install transfer case on adapter with six locknuts. Tighten locknuts to 37 lb-ft (50 N•m).
4. Remove jack.

5. Install shift rod on range lever with washer and cotter pin (Figure 5-126).
6. Install exhaust pipe U-bolt hanger and retainer cable bracket on transfer case.

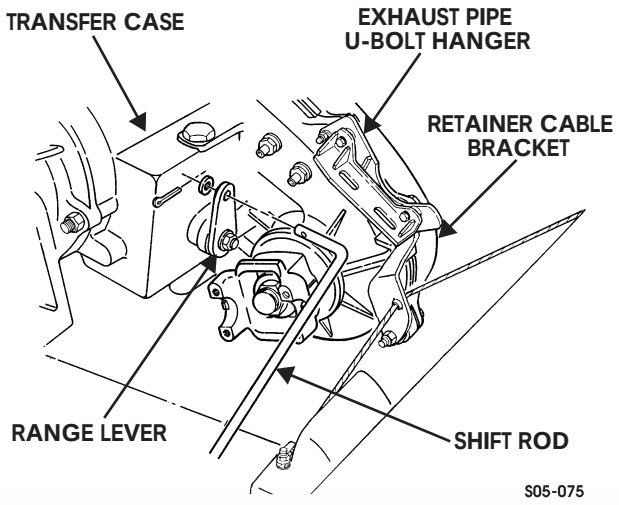


Figure 5-126: Range Lever

7. Install vent line to fitting on transfer case and tighten clamp (Figure 5-126).

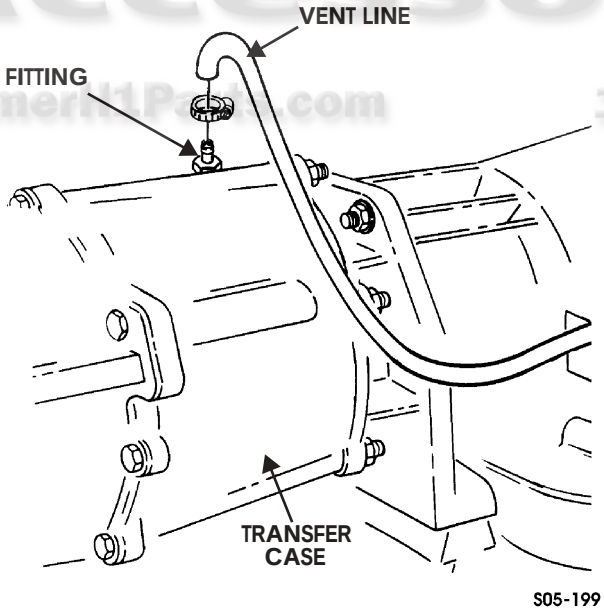


Figure 5-127: Vent Line

8. Install two hoses on transfer case cooler fittings and tighten clamps to 35-45 lb-in. (4-5 N•m) (Figure 5-128).
9. Connect front propeller shaft to yoke with two U-bolts, four lockwashers, and nuts. Tighten nuts to 13-18 lb-ft (18-24 N•m).

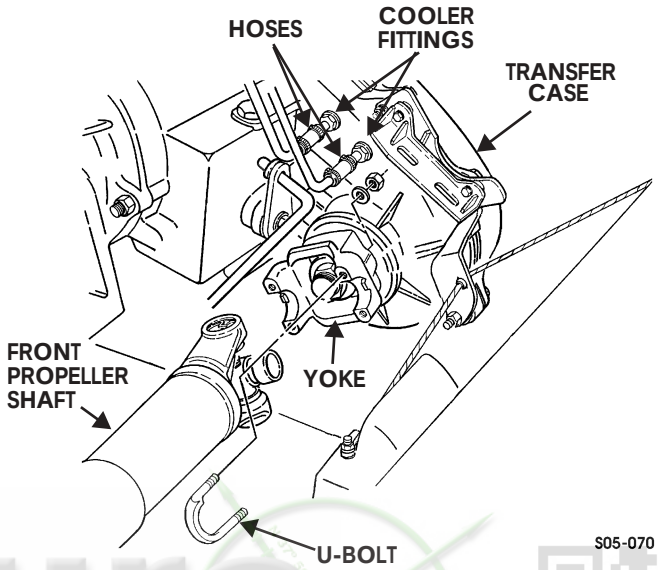


Figure 5-128: Front Propeller Shaft

10. Coat seal on output speed sensor with Dexron II and install speed sensor in transfer case with bolt. Tighten bolt to 15 lb-ft (20 N•m) (Figure 5-127).
11. Install range lock switch in transfer case (Figure 5-129).
12. Install harness clamp on transfer case with screw, washer, lockwasher, and nut.
13. Connect engine wiring harness connectors to output speed sensor and range lock switch (Figure 5-128). Ensure connectors are latched.

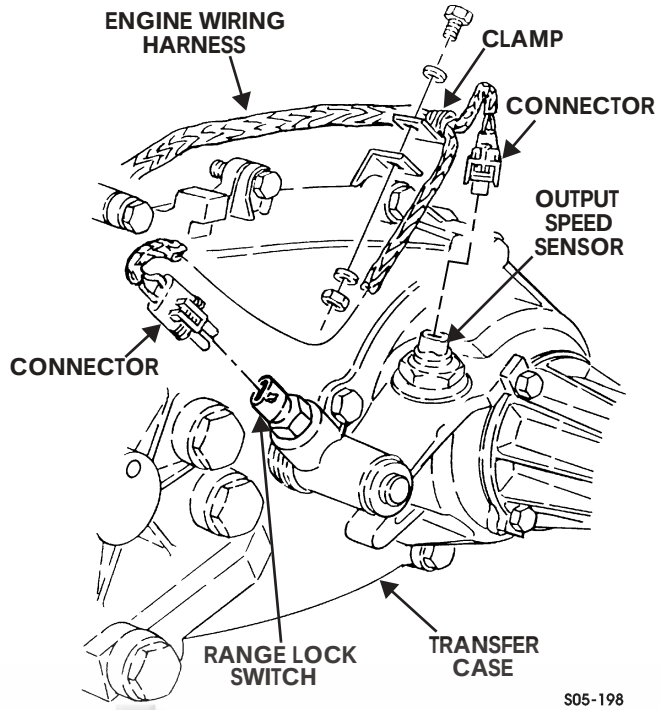


Figure 5-129: Speed Sensor and Lock Switch Connectors

14. Install rear propeller shaft on axle with two U-bolts, four lockwashers, and nuts. Tighten nuts to 21 lb-ft (28 N•m) (Figure 5-130).

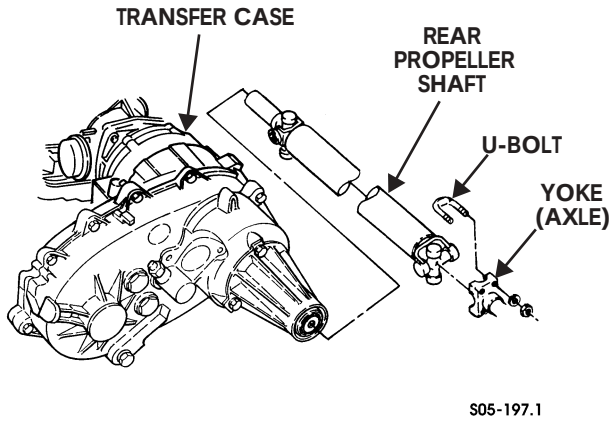


Figure 5-130: Rear Propeller Shaft

TRANSFER CASE REPAIR

WARNING: Transfer case is very heavy and tends to be unstable during disassembly and assembly. The work surface must be of sufficient size and strength to prevent the transfer case from falling and causing injury or damage to the case.

Disassembly

1. Remove transfer case from transmission.
2. Remove bolt and speed sensor from bearing retainer (Figure 5-131).

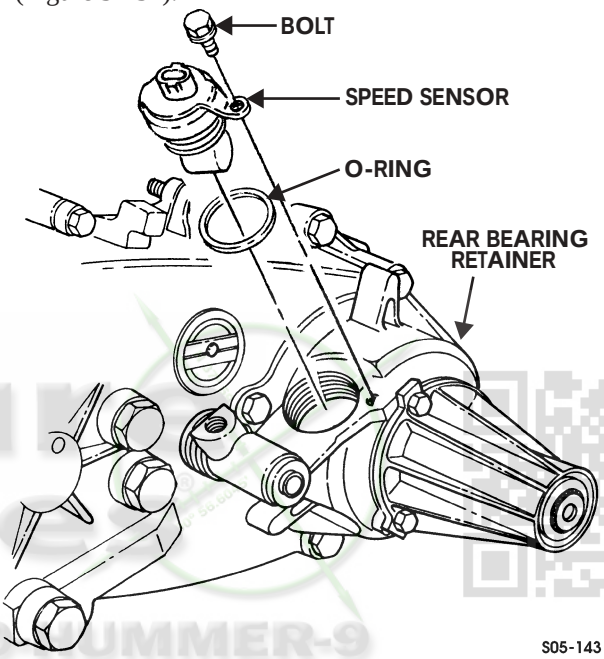


Figure 5-131: Front Seal

3. Remove and discard O-ring from speed sensor.
4. Remove yoke nut, yoke washer, and front output yoke from transfer case (Figure 5-132).

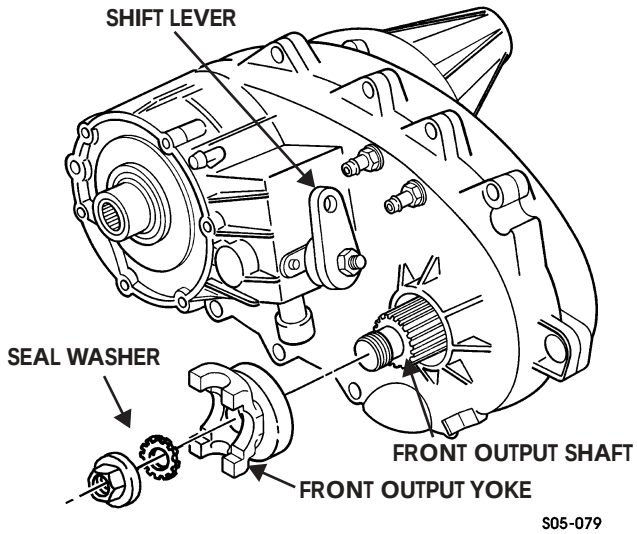


Figure 5-132: Front Output Yoke

5. Remove three capscrews securing rear extension to transfer case (Figure 5-133).
6. Using a soft-nosed hammer or mallet, tap on rear extension screw bosses to break seal between rear extension and rear bearing retainer. Remove rear extension.
7. Remove and discard encased seal.

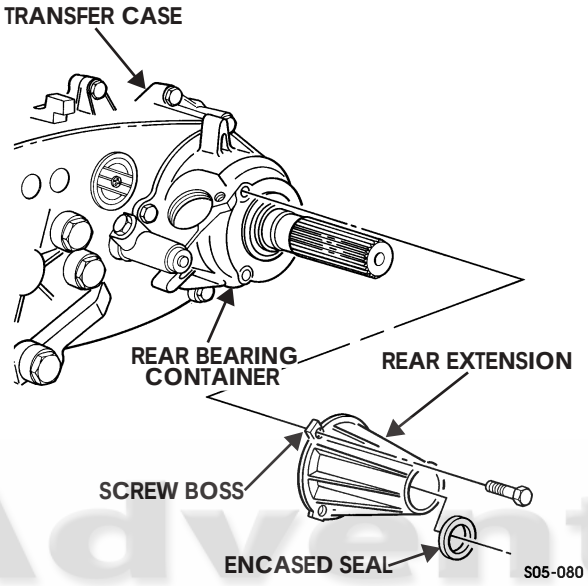


Figure 5-133: Rear Extension

8. Remove snapring from mainshaft (Figure 5-134).

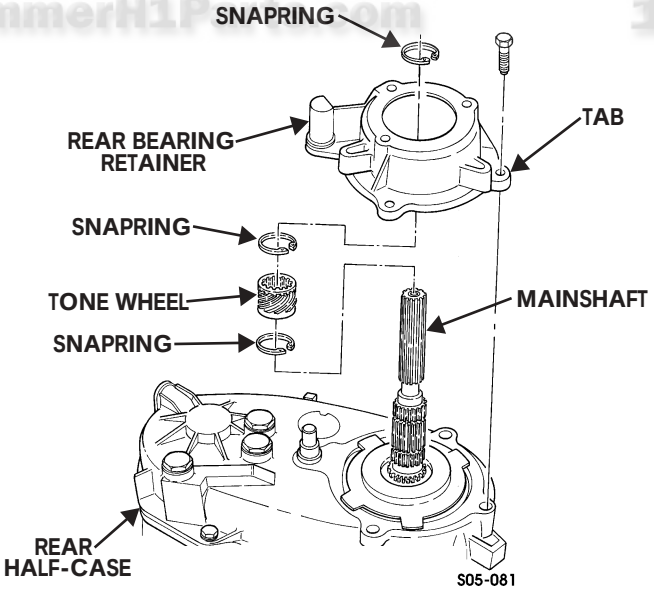


Figure 5-134: Mainshaft Snapring

9. Remove four capscrews securing rear bearing retainer to rear half-case.
10. Break seal to rear half-case by prying on tabs of rear bearing retainer, and remove rear bearing retainer from mainshaft.
11. Remove two snaprings and tone wheel from mainshaft.
12. Remove two screws and washers securing ends of rear half-case to front half-case (Figure 5-135).

NOTE: Mark position of long screws for installation.

13. Remove three long screws securing side of rear half-case to front half-case.
14. Remove seven screws securing rear half-case to front half-case.
15. Using slots in front half-case, break seal between half-cases, and remove rear half-case.
16. Remove magnetic pickup from front half-case.
17. Rotate oil pickup tube and oil screen out of rear half-case and disconnect oil pickup tube from oil pump inlet port (Figure 5-136).

NOTE: Mark position of oil pump on rear half-case for installation.

18. Remove oil pump.
19. Disconnect hose from oil pickup tube and screen.
20. Remove and discard O-ring from oil pump (Figure 5-137).

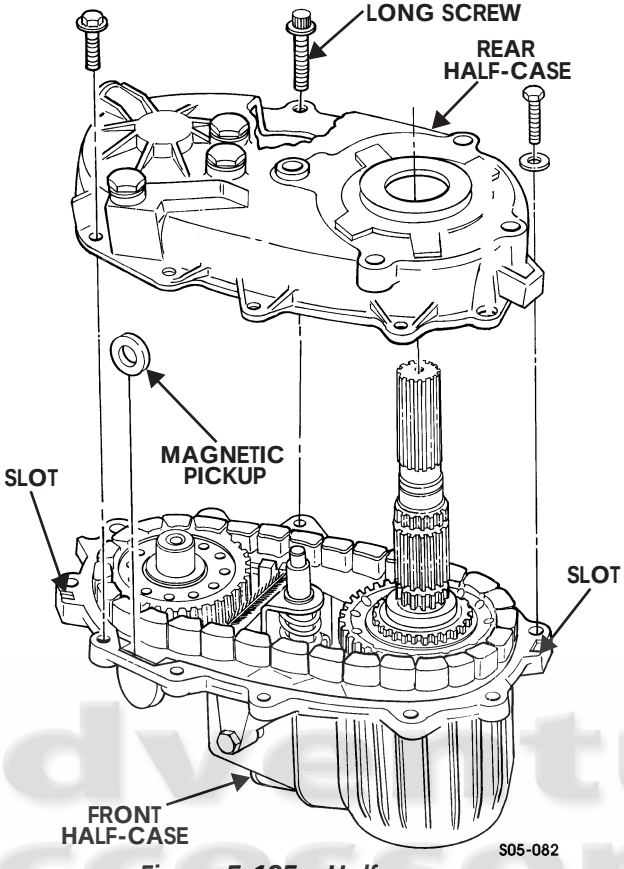


Figure 5-135: Half-cases

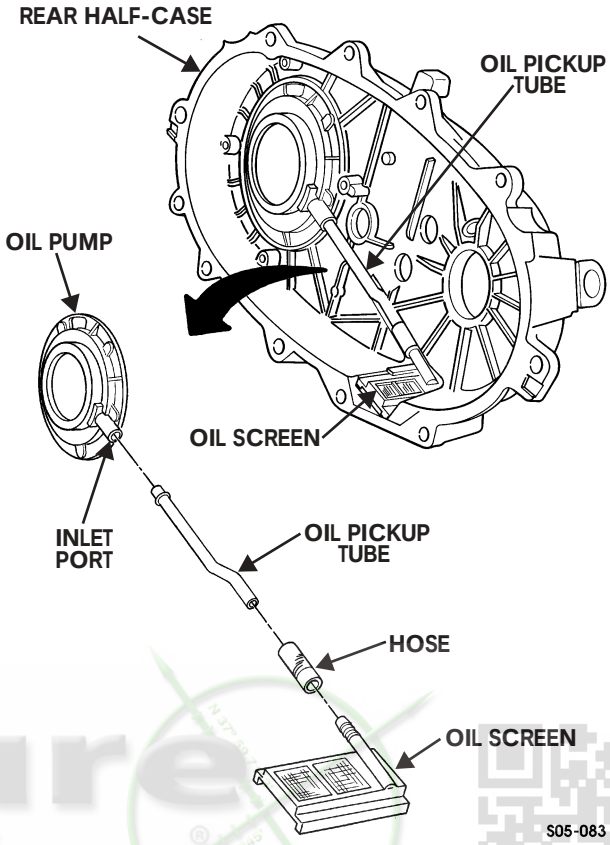


Figure 5-136: Rear Half-case

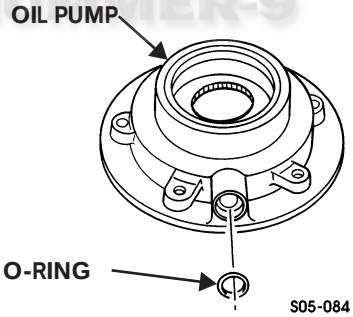


Figure 5-137: O-Ring

21. Remove snapring from mainshaft (Figure 5-137).
22. Remove snapring from front output shaft. (Figure 5-138)

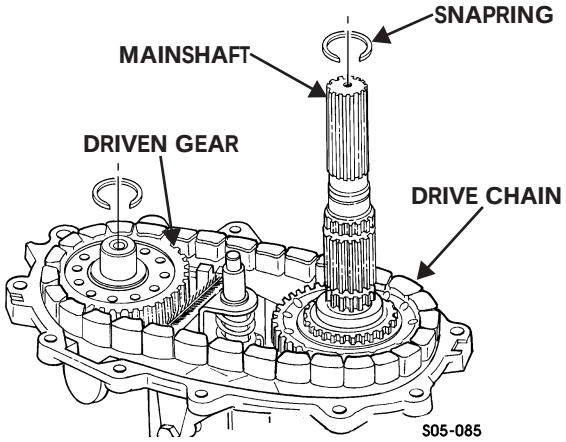


Figure 5-138: Mainshaft and Output Shaft Snaprings

23. Remove drive chain drive gear and driven gear from mainshaft and front output shaft.
24. Remove front output shaft from front half-case (Figure 5-139).

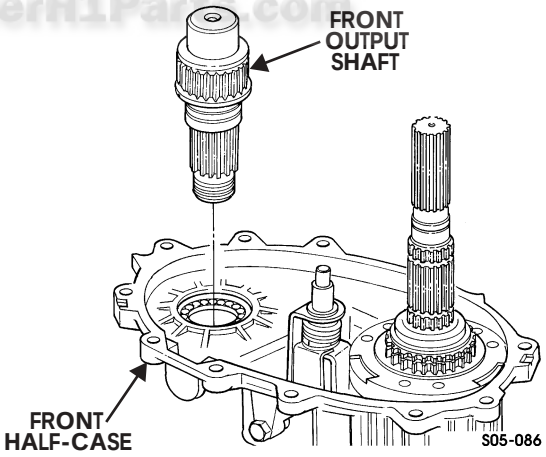


Figure 5-139: Front Half-case

25. Remove nut, washer, and shift lever from sector shaft (Figure 5-140).

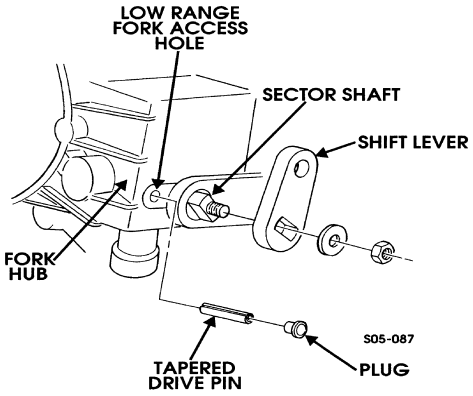


Figure 5-140: Shift Leve

26. Remove plug from low range fork access hole. Remove range switch.
27. Using screw extractor in tapered drive pin, turn pin counterclockwise and remove from fork hub.

28. Remove shifter detent plug, spring, and poppet from front half-case (Figure 5-141).

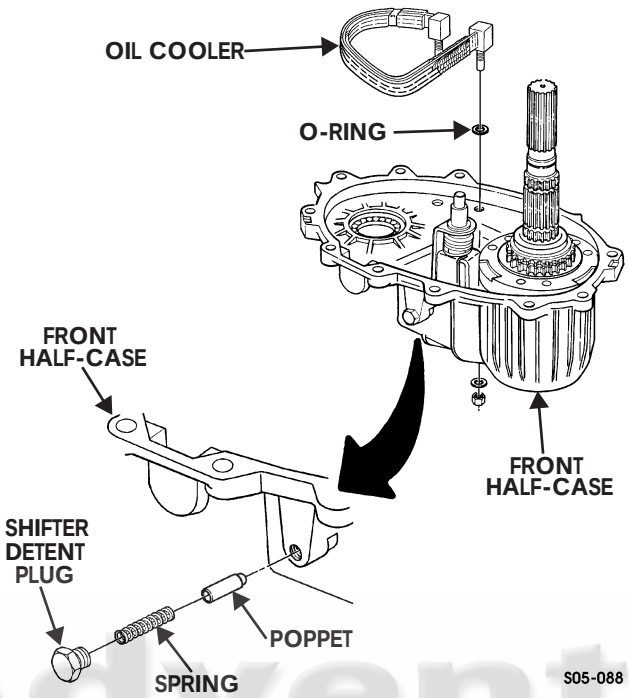


Figure 5-141: Plug, Spring, and Poppet

29. Remove two nuts, washers, O-rings, and oil cooler from front half-case. Discard O-rings.
30. Remove shift rail from mode fork assembly (Figure 5-142).
31. Remove mode fork assembly and mainshaft assembly from front half-case as a unit.
32. Remove mode fork assembly from mode shift sleeve.
33. Remove mode shift sleeve from mainshaft.
34. Remove snapring, thrust washer, and intermediate clutch shaft from mainshaft (Figure 5-143).

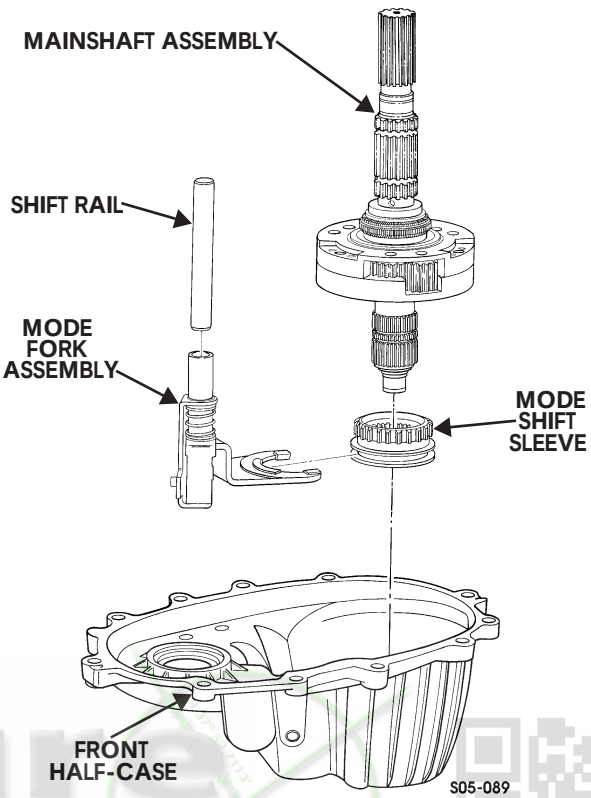


Figure 5-142: Mainshaft Assembly

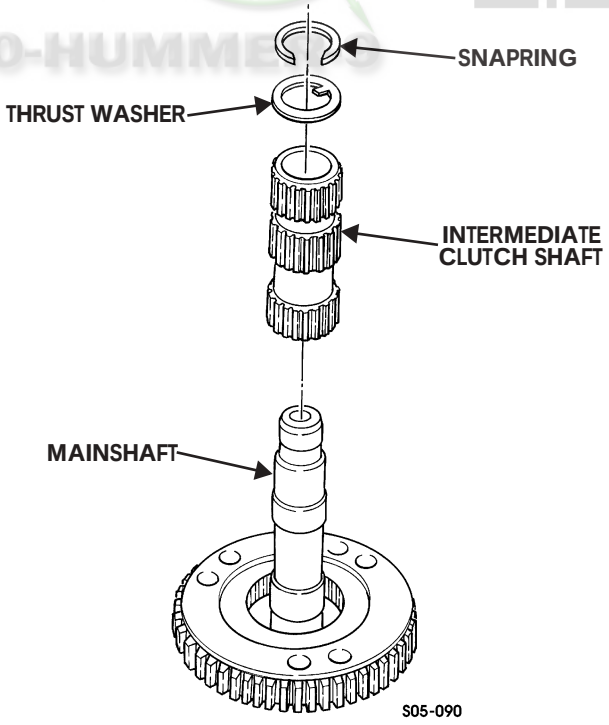


Figure 5-143: Mainshaft

NOTE: Needle bearings may fall free when differential assembly is removed from mainshaft.

35. Remove snapring and differential assembly from mainshaft (Figure 5-144).

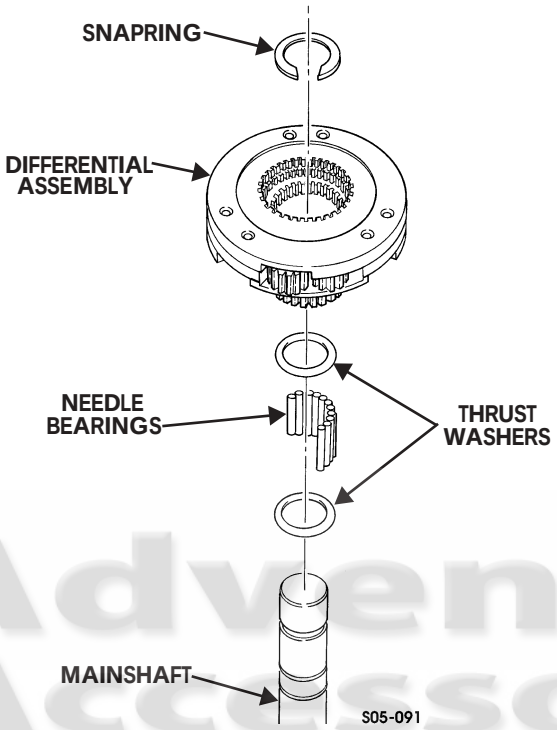


Figure 5-144: Differential Assembly

36. Remove two thrust washers and collect fifty-three needle bearings from differential assembly and mainshaft.
37. Twist range fork and range clutch sleeve to disengage stud from shift sector, and remove from front half-case and low range gear (Figure 5-145).
38. Remove range clutch sleeve from range fork.
39. Remove shift sector from front half-case.
40. Remove four screws and front bearing retainer from front half-case. Pry on front bearing retainer slots only (Figure 5-146).
41. Remove and discard seal from front bearing retainer.
42. Remove snapring from input gear shaft.

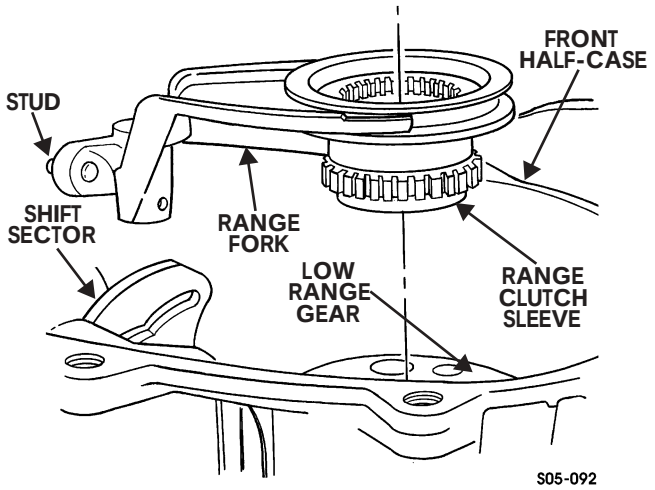


Figure 5-145: Range Fork and Range Clutch Sleeve

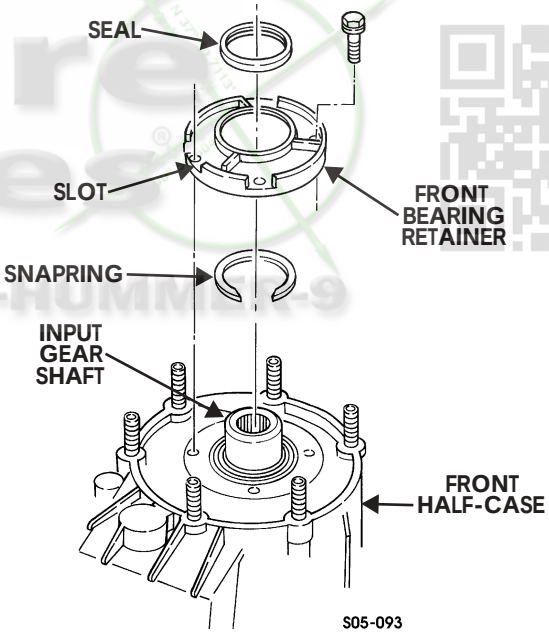


Figure 5-146: Front Bearing Retainer

43. Using driver handle and input gear bearing installer, press shaft of input gear from input bearing (Figure 5-147).

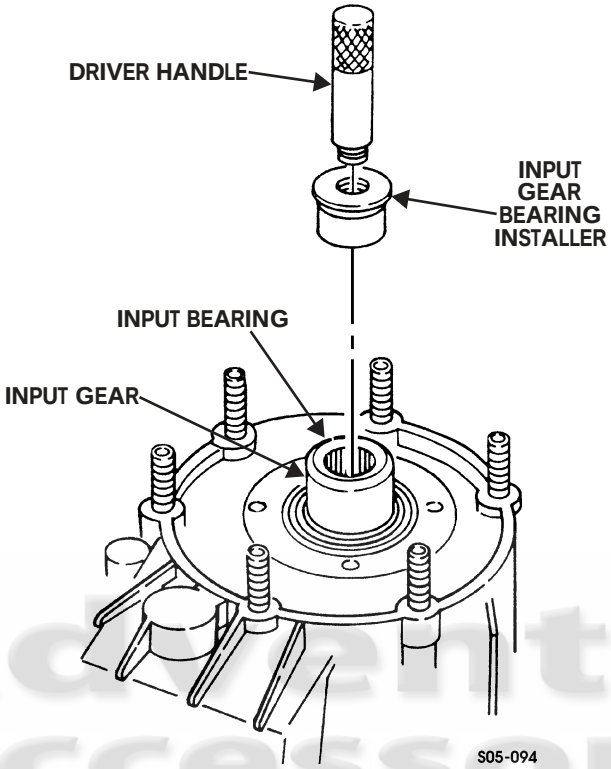


Figure 5-147: Input Bearing

44. Remove input gear and low range planetary gear from front half-case (Figure 5-148).
45. Remove snapring, retainer, two thrust washers, and input gear from low range planetary gear.

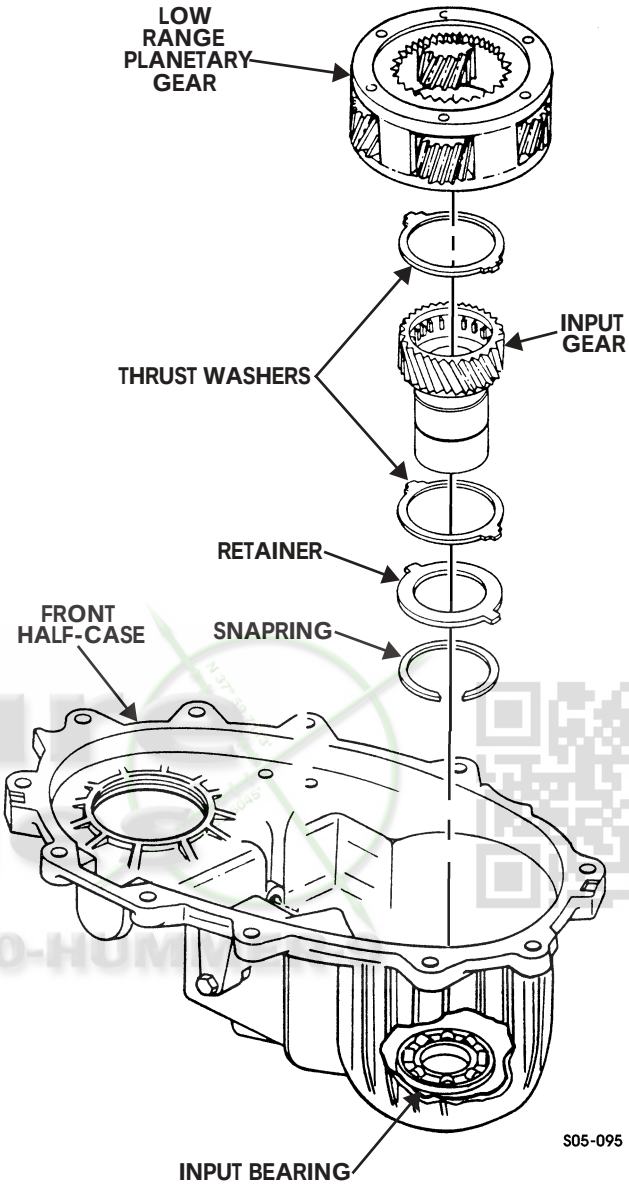


Figure 5-148: Planetary Gear

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Repair or replace all damaged or worn components.

Front Half-Case Repair

1. Inspect front half-case for damaged bearings, front output seal, cracked or broken casting, and damaged studs (Figure 5-149).
2. Replace half-case if casting is damaged, or if annulus gear is loose or damaged.
3. Replace input bearing if worn or damaged.
4. Using input gear bearing installer and driver handle, press input bearing out of half-case.
5. Remove snapring and install on replacement bearing.
6. Press in bearing until snapring is seated against half-case.
7. Remove snapring from front output bearing.
8. Using bearing tool and driver handle, remove front output bearing.

NOTE: If front output bearing is replaced due to damage or wear, replace front output seal.

9. Remove front output seal.
10. Press in new bearing and install snapring.
11. Using output shaft seal installer, install front output seal.
12. Inspect O-ring and retainer. Replace both if either is damaged.
13. Replace missing or damaged studs.

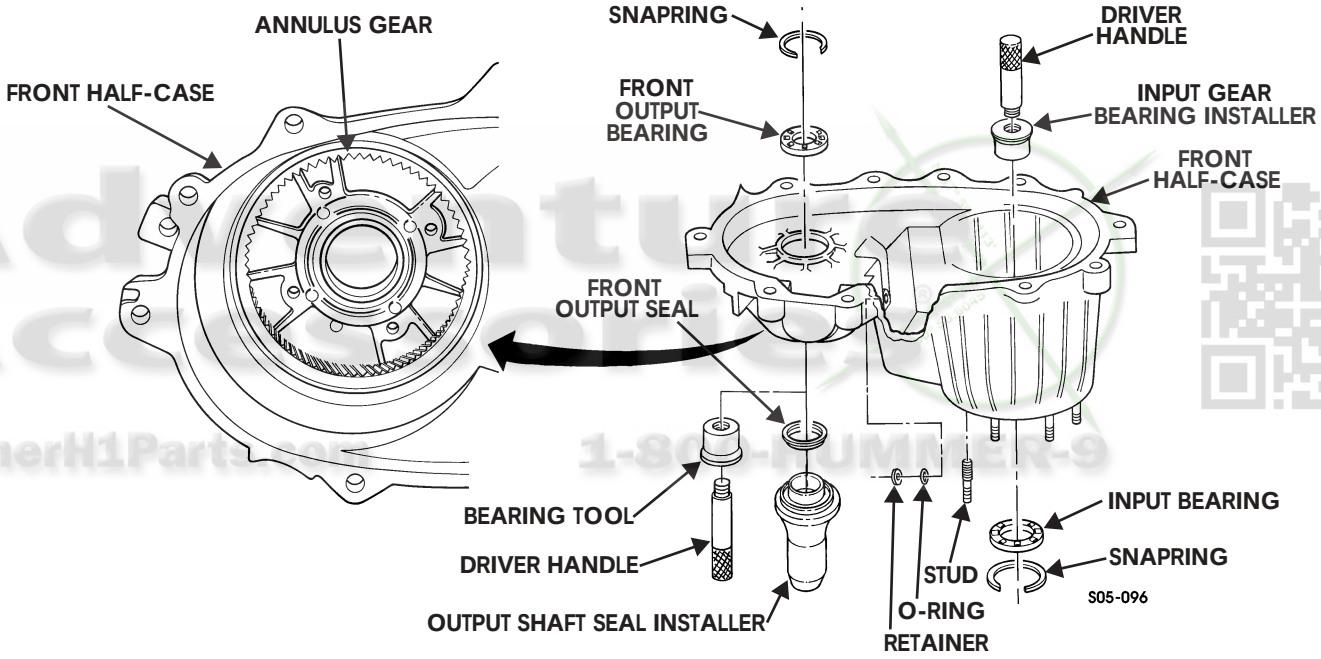


Figure 5-149: Front Seals

Rear Half-Case Repair

1. Inspect rear half-case for cracked or damaged casting, missing or damaged alignment dowels, and worn or damaged roller bearing (Figure 5-150).
2. Replace missing or damaged dowels.
3. Using slide hammer adapter and slide hammer, remove roller bearing.
4. Coat bearing with oil, and install in half-case using bearing installer and driver handle.

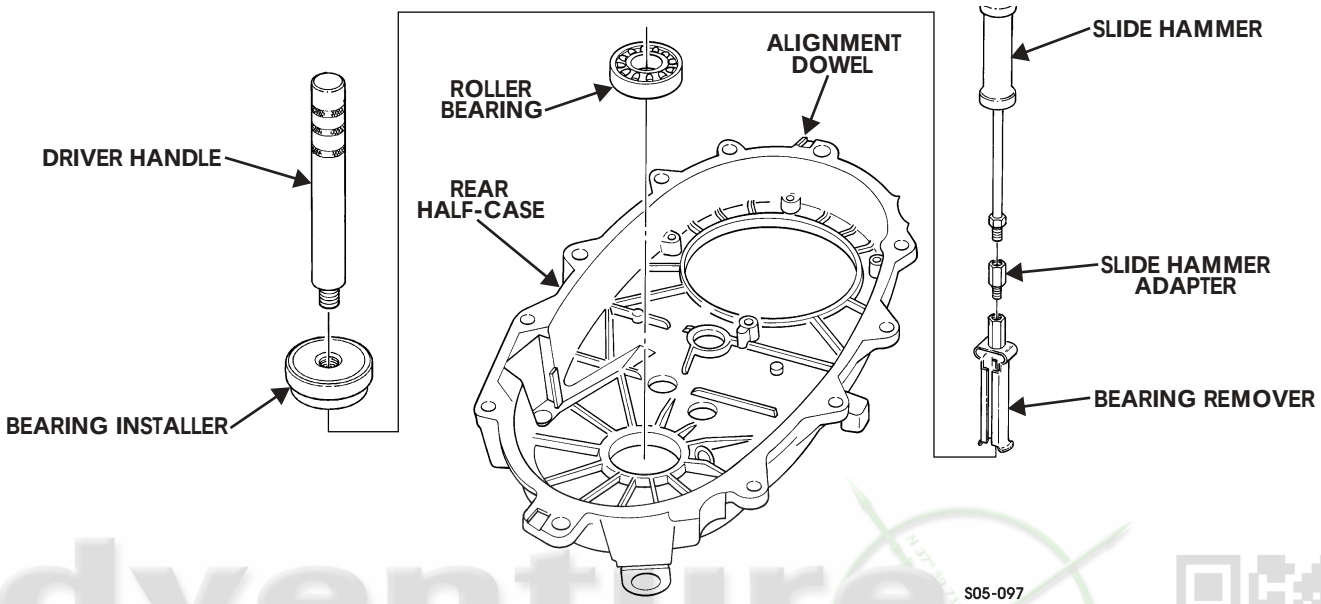


Figure 5-150: Front Bearing

Input Gear Repair

1. Inspect input gear for damaged main pilot bearing and snapring groove (Figure 5-151).
2. Using bearing remover, slide hammer adapter, and slide hammer, remove main pilot bearing from input gear.
3. Using main pilot bearing installer and driver handle, install bearing in input gear.

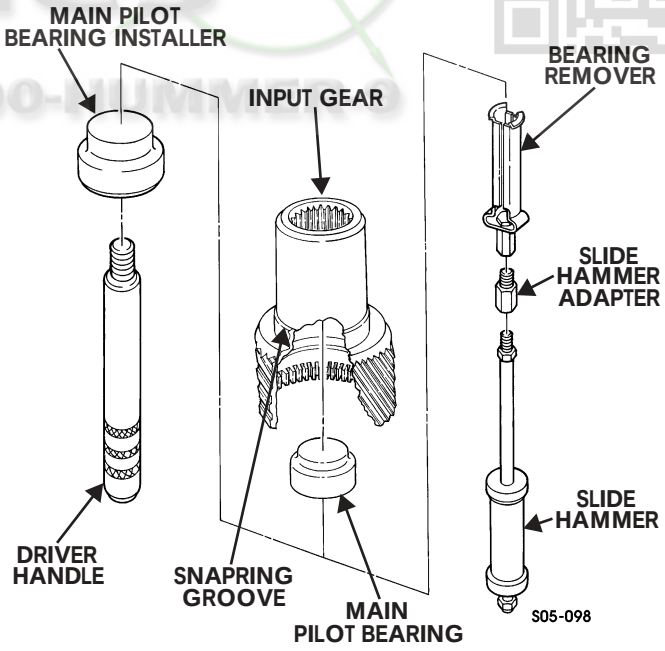


Figure 5-151: Pilot Bearing

Differential Repair

NOTE: Mark front and rear carriers for assembly.

1. Remove six screws securing front and rear carriers (Figure 5-152).

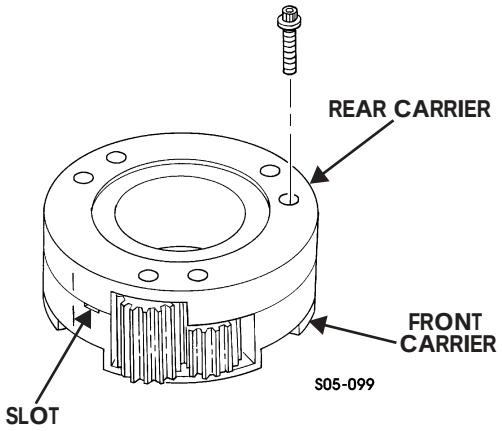


Figure 5-152: Differentia

2. Using slots, pry rear carrier off front carrier.

NOTE: Needle bearings may fall out when short pinion gears are removed.

3. Remove three pinion washers, long pinion gears, pinion washers, thrust washers, short pinion gears, fifty-four needle bearings and three thrust washers from front carrier pins (Figure 5-153).

NOTE: Record positions of mainshaft gear, sprocket gear, and front carrier for assembly.

4. Remove sprocket and mainshaft gears from front carrier.
5. Inspect front and rear carriers. Replace if damaged.
6. Inspect long and short pinion gears. Replace long or short gears as a set if any one is damaged.
7. Inspect thrust washers and pinion washers for breaks, cupping, and scoring. Replace all pinion and thrust washers if any one is damaged.
8. Inspect mainshaft and sprocket gears, and replace either if damaged. Inspect brass ring on bottom of mainshaft gear for gouging or deep scoring. Replace mainshaft gear if brass ring on bottom of mainshaft gear is damaged.
9. Inspect needle bearings. Replace all needle bearings if any one is damaged or missing.

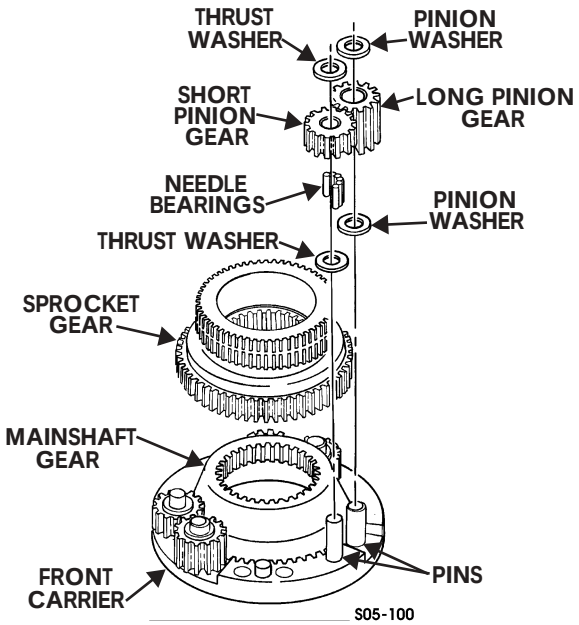


Figure 5-153: Differential Pinions

NOTE: Coat all differential parts with clean transmission oil before assembly.

10. Place mainshaft gear in front carrier, with cone surface up (Figure 5-154).

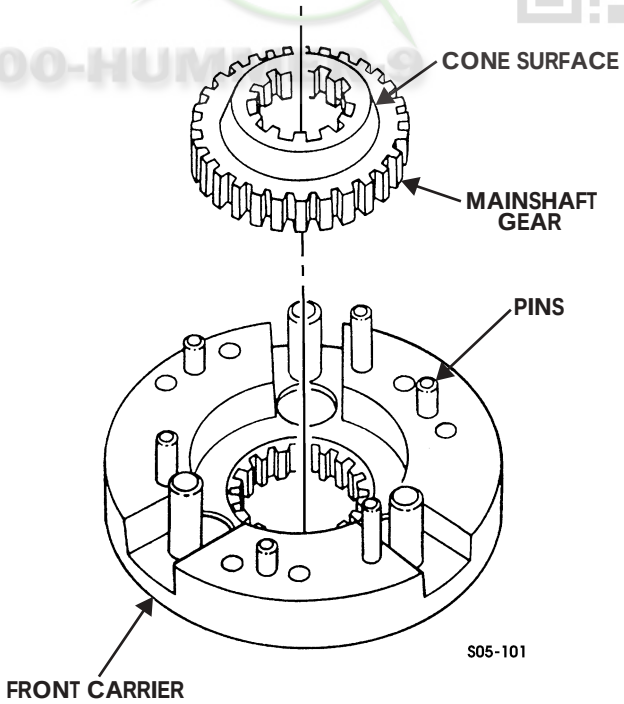


Figure 5-154: Mainshaft Gear

11. Place sprocket gear over mainshaft gear, with splined hub of sprocket gear up (Figure 5-155).

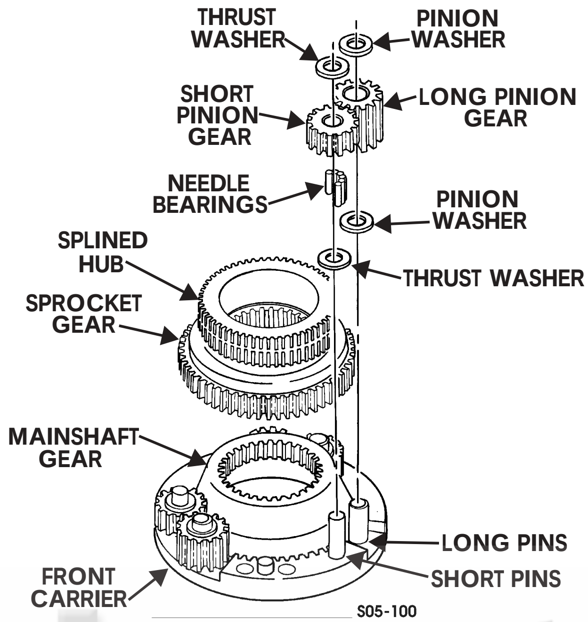


Figure 5-155: Pinion Location

NOTE: Use petrolatum to hold needle bearings in place during assembly.

12. Install three thrust washers, fifty-four needle bearings, three short pinion gears, and thrust washers on short pins.
13. Install three pinion washers, long pinion gears, and pinion washers on long pins.
14. Align index marks on front and rear carriers and set rear carrier over spacer pins (Figure 5-156).
15. Start six screws securing rear carrier to front carrier. Tighten screws evenly.

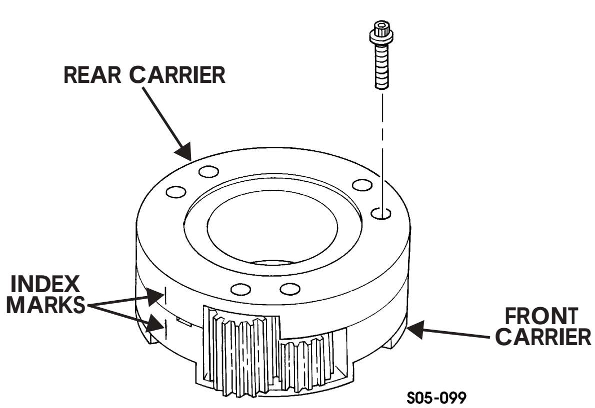


Figure 5-156: Differential

Mainshaft Repair

Inspect mainshaft gears, splines, bearing surfaces, oil passages, and snapring grooves. Remove minor scoring and burrs with crocus cloth. Replace mainshaft if otherwise damaged (Figure 5-157).

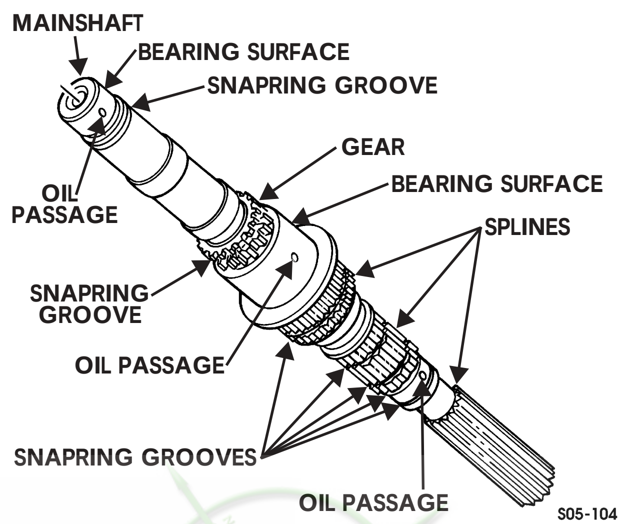


Figure 5-157: Pinion Location

Oil Pump Repair

Inspect oil pump for cracks, breaks, scoring, and damaged threads. Replace pump if any parts are damaged (Figure 5-158).

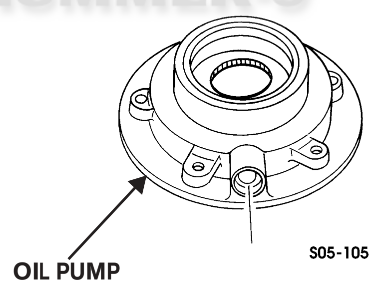


Figure 5-158: Oil Pump

Rear Bearing and Retainer Repair

1. Replace bearing if worn or damaged (Figure 5-159).
2. Using hammer and soft punch, remove bearing from rear bearing retainer.
3. Using output shaft front bearing installer and driver handle, install bearing in bearing retainer. Seat bearing to shoulder of retainer.
4. Replace alignment retainer dowel if loose, worn, or damaged.

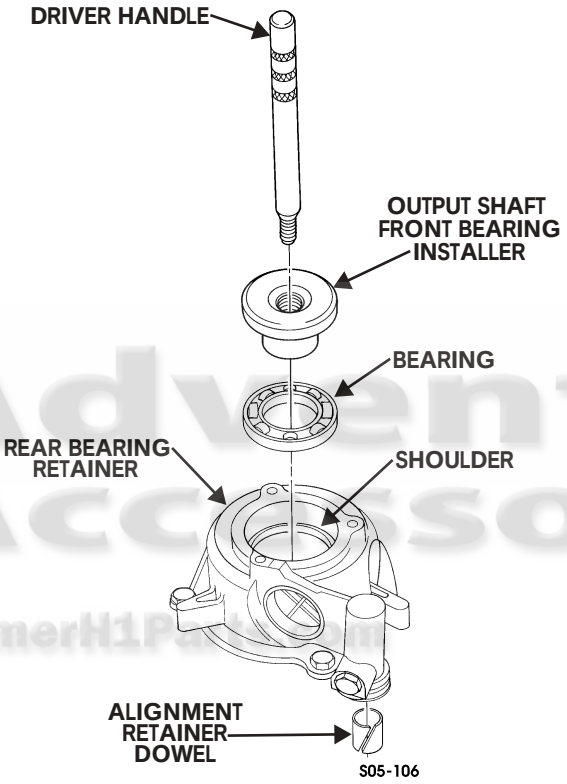


Figure 5-159: Rear Bearing

Rear Extension and Bushing Repair

1. Inspect rear extension and bushing. Replace if damaged or worn (Figure 5-160).
2. Using extension bushing remover and driver handle, remove bushing from rear extension.
3. Using bearing installer and driver handle, install bushing in rear extension.

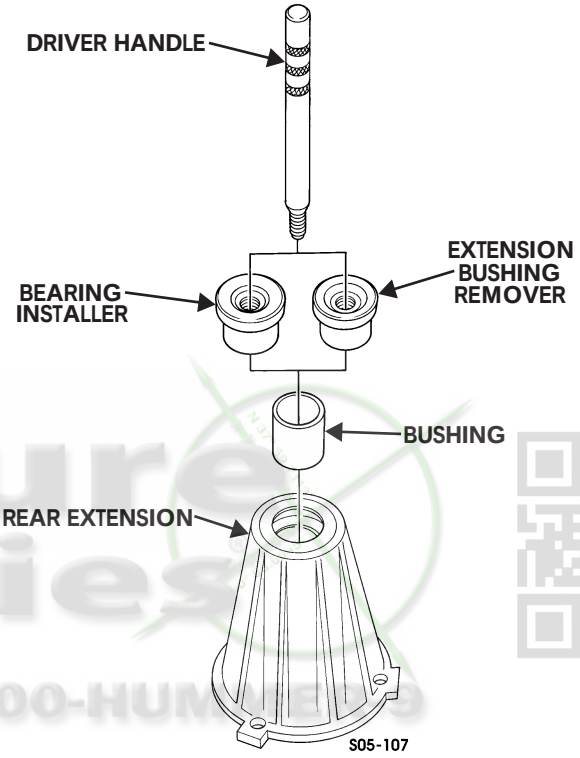


Figure 5-160: Extension Bushing

Intermediate Shaft Repair

Inspect intermediate shaft. Replace if damaged (Figure 5-161).

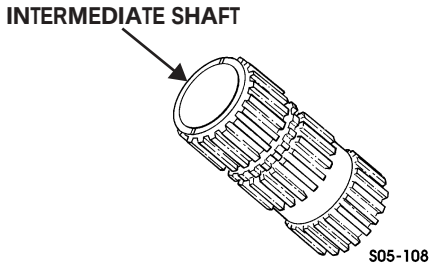


Figure 5-161: Intermediate Shaft

Sector Shaft Repair

Inspect sector shaft assembly for burrs, cracks, breaks, loose shaft, and damaged threads. Replace if damaged (Figure 5-162).

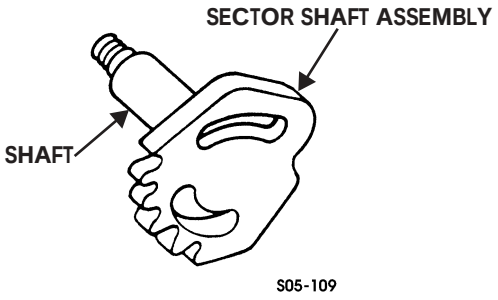


Figure 5-162: Sector Shaft

Oil Screen, Hose, and Pickup Tube Repair

Inspect oil screen, hose, and pickup tube. Clean screen, inspect for holes, and inspect components for bends or cracks that would prevent sealing. Replace damaged parts (Figure 5-163).

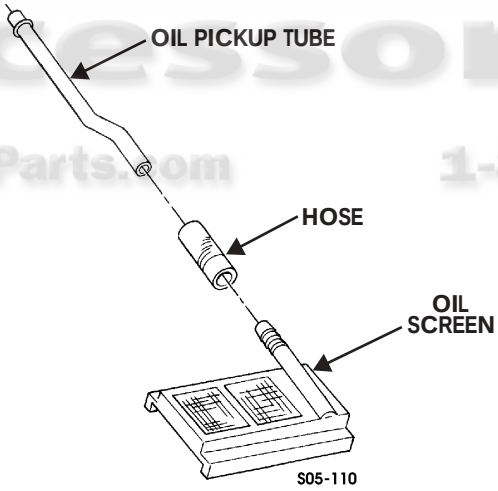


Figure 5-163: Oil Pickup Screen

Range Shift Fork and Clutch Sleeve Repair

1. Inspect range shift fork for burrs, bends, breaks, loose pin, and worn pads. Remove minor burrs and replace worn or missing pads. Replace fork if otherwise damaged (Figure 5-164).
2. Inspect range clutch sleeve for burrs, cracks, breaks, and damaged splines or gear teeth. Remove minor burrs, or replace if otherwise damaged.

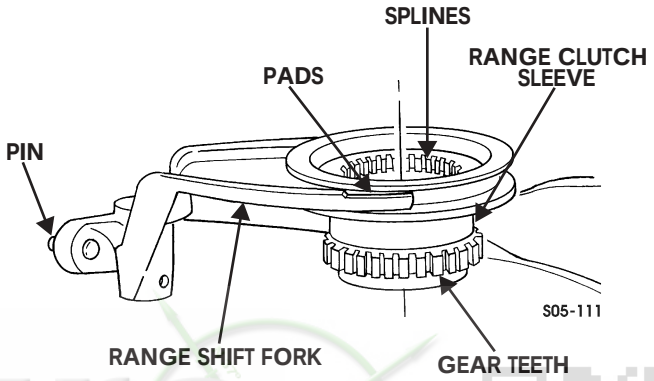


Figure 5-164: Fork Location

Mode Shift Fork Assembly Repair

1. Position mode shift fork assembly in vise, with jaws clamped on long bracket only (Figure 5-165).

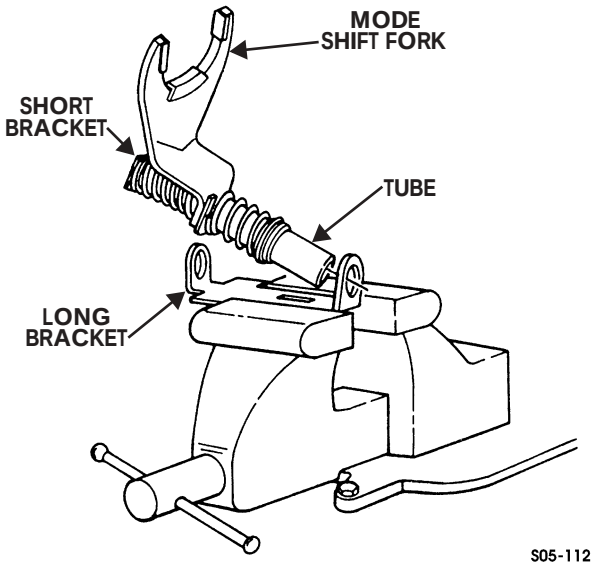


Figure 5-165: Fork Assembly

***CAUTION**: Components of mode shift fork assembly are under spring tension. Exercise caution when releasing fork.*

2. Press mode shift fork forward and disengage tube from rear of long bracket. Ease fork and short bracket out of long bracket (Figure 5-166).
3. Remove bushing, spring, and thrust washer from long end of tube.
4. Remove short bracket, cup, spring, and bushing from short end of tube.
5. Remove long bracket from vise.
6. Inspect mode shift fork, brackets, and fork-to-tube bonding for cracks, bends, or breaks, and replace if damaged. Inspect tab on short bracket, and replace if bent or broken. Replace worn, missing, or damaged pads and springs.
7. Ensure mode shift fork tube slides easily on shift rail. Remove minor burrs, or replace if otherwise damaged.
8. Inspect mode shift sleeve for burrs, cracks, breaks, and damaged spline or gear teeth. Remove minor burrs or replace if otherwise damaged.

NOTE: Assemble parts named and use technique shown in illustrations (Figures 5-165 and 5-166).

9. Clamp long bracket in vise (Figure 5-166).
10. Install spring, cup, bushing, and short bracket on short end of tube. Ensure open end of short bracket is under lip of mode shift fork.
11. Install thrust washer, spring, and bushing on long end of tube.
12. Insert long end of tube in long bracket. Turn short bracket until tab will align in slot of long bracket.
13. Press long end of tube through end of long bracket until short bracket and tube align with rear of long bracket. Seat short end of tube in long bracket. Tab must be in slot.

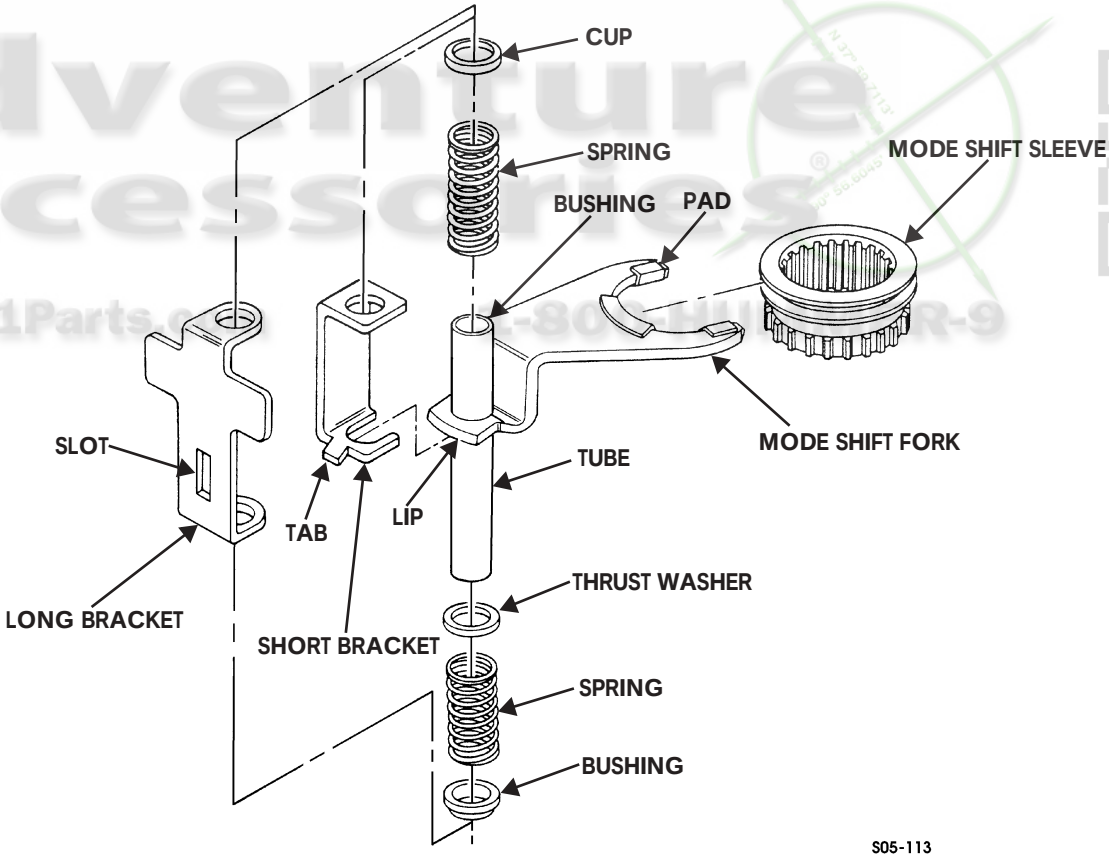


Figure 5-166: Shift Fork Components

Shift Rail, Detent, and Drive Chain Repair

1. Inspect shift rail for bends, cracks, and grooving. Replace if damaged (Figure 5-167).
2. Inspect detent assembly for broken or kinked spring, broken or burred poppet, or damaged plug. Replace O-ring and any other damaged parts.
3. Inspect drive chain for breaks, missing parts, kinks, and scratching on contact surfaces. Replace if damaged.

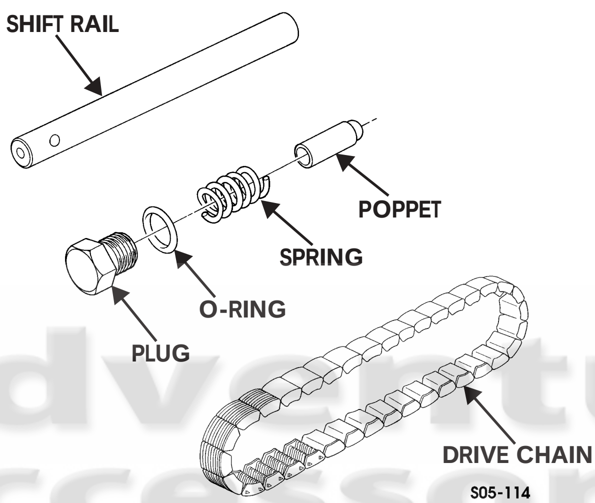


Figure 5-167: Drive Chain

Sprocket and Output Shaft Repair

1. Inspect drive and driven sprockets. Replace if damaged (Figure 5-168).
2. Inspect front output shaft. Replace if damaged.

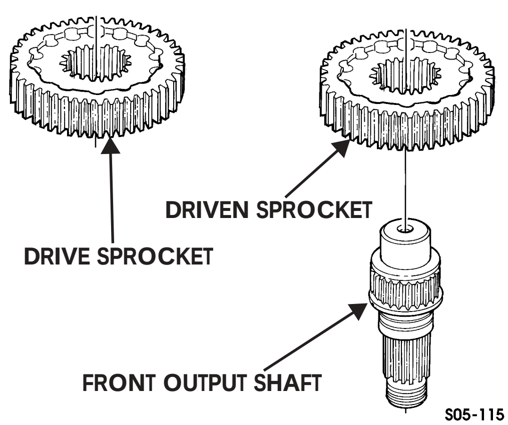


Figure 5-168: Chain Sprockets

Low Planetary Gear Repair

Inspect low planetary gear assembly for cracks, breaks, chipped or broken pinion gear teeth, pinion side play, and smooth rotation. If front and rear carriers are loose, tighten screws evenly. If carriers are still loose, or if other damage is present, replace low planetary gear assembly (Figure 5-169).

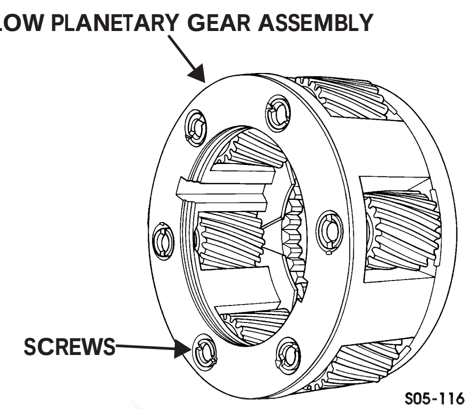


Figure 5-169: Planetary Gear

Oil Cooler Repair

Inspect oil cooler for bends, breaks, and leaks. Straighten bent fins. Fill with cleaning fluid to check for leaks. Replace cooler if tubes are bent, cracked, or leaking (Figure 5-170).

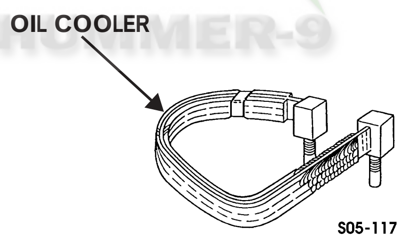


Figure 5-170: Oil Cooler

Assembly

1. Install thrust washer, input gear, thrust washer, and retainer into low planetary gear. Secure with snapring. Ensure snapring is completely seated in groove of low planetary gear (Figure 5-171).

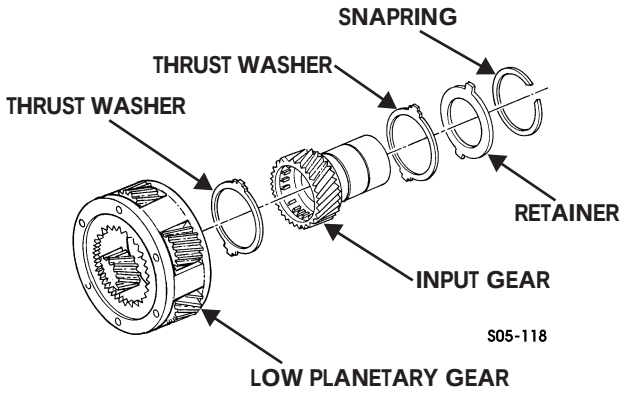


Figure 5-171: Input Gear

2. Using main pilot bearing installer and driver handle, press on input gear until gear is seated in input bearing (Figure 5-172).

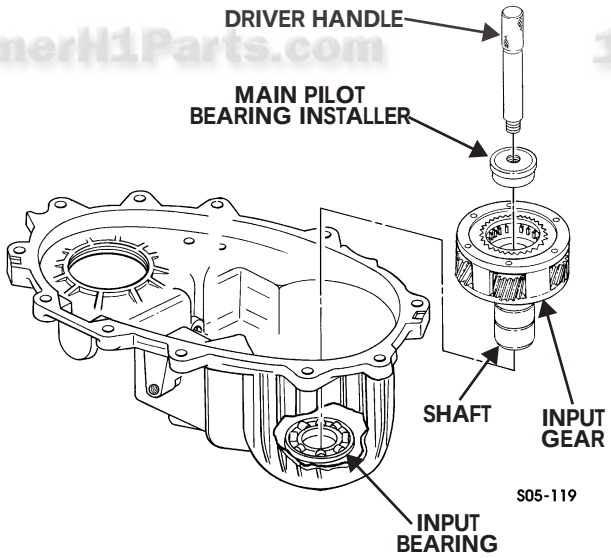


Figure 5-172: Pilot Bearing

3. Install snapring in front groove of input gear shaft (Figure 5-173).
4. Using input gear seal installer, install seal in front bearing retainer.
5. Apply sealant to contact surface of front bearing retainer, carefully align retainer over input gear shaft, and seat on front half-case.
6. Install front bearing retainer on half-case with four capscrews. Tighten capscrews to 12-20 lb-ft (16-27 N•m).

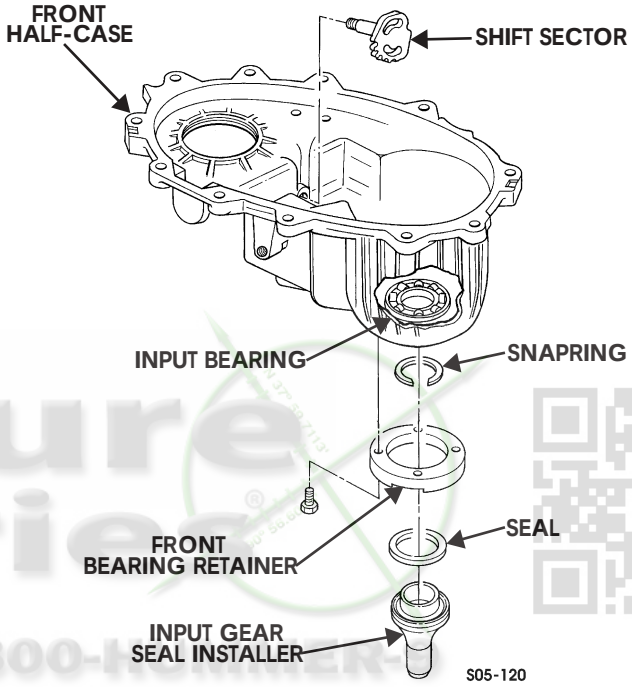


Figure 5-173: Front Seal

7. Install shift sector shaft in front half-case.
8. Install shift lever on shift sector shaft with washer and nut. Finger tighten nut.
9. Turn shift sector until teeth align on poppet bore and install poppet and spring in half-case with plug. Tighten plug to 12-18 lb-ft (16-24 N•m).
10. Position range shift fork in range clutch sleeve (Figure 5-174).
11. Hold range shift fork and range clutch sleeve together, insert sleeve into input gear (in low range planetary gear), and insert shift range fork pin into range slot in shift sector. Turn shift sector as necessary to align pin. (Figure 5-175)
12. Install rear thrust washer on front of mainshaft (Figure 5-176).

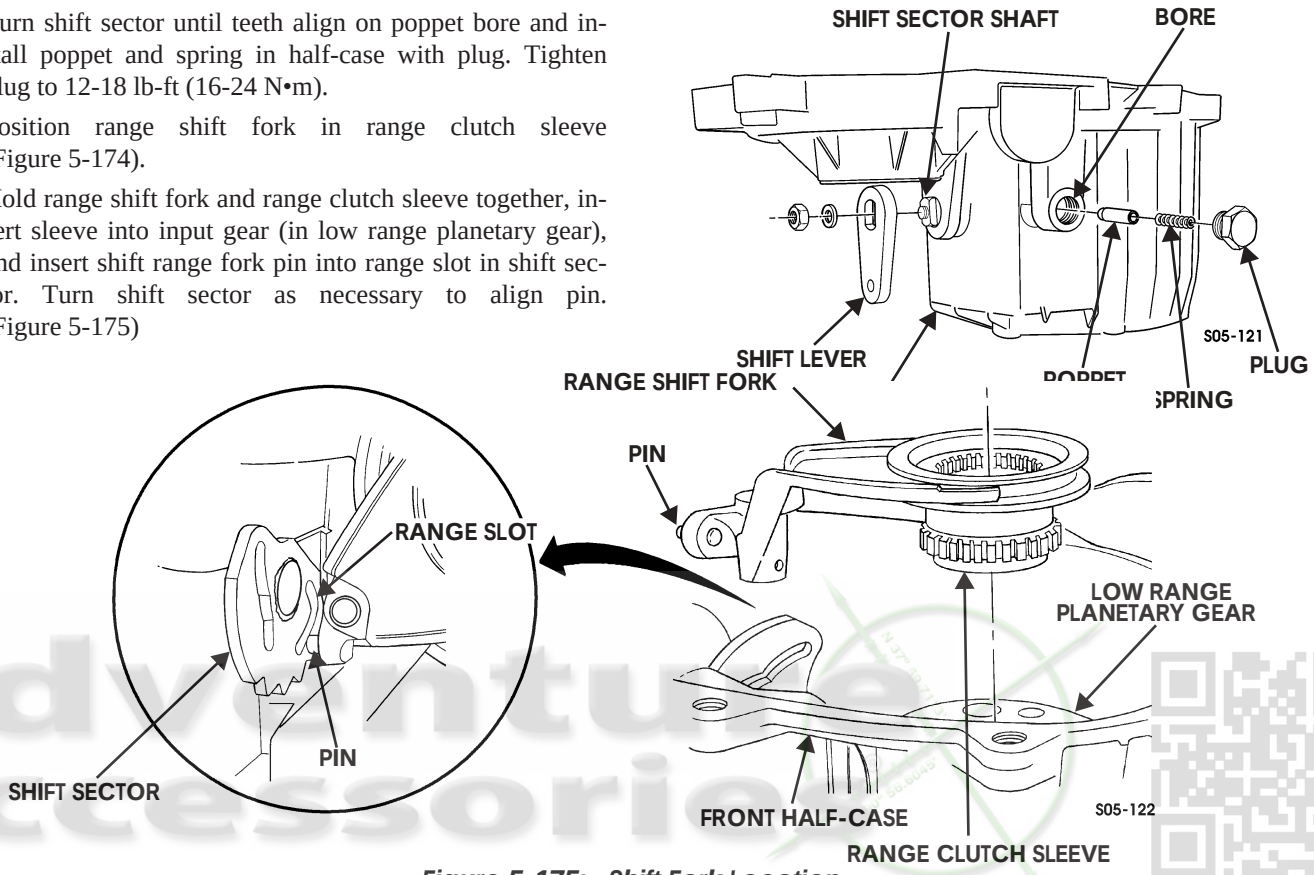


Figure 5-175: Shift Fork Location

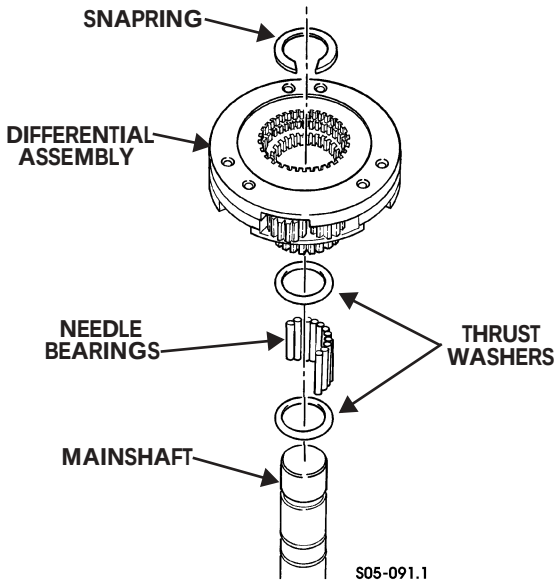


Figure 5-176: Mainshaft

13. Liberally coat mainshaft bearing journal with petrolatum and align fifty-three needle bearings on journal. Install front thrust washer on mainshaft against needle bearings.
14. Carefully slide differential assembly over front of mainshaft and align sprocket gear over needle bearings. Secure with snapring.
15. Place intermediate shaft over main shaft and engage in mainshaft gear (inside differential assembly). Double groove of intermediate shaft is up (Figure 5-177).
16. Place tab washer over mainshaft and secure with snapring in groove in end of mainshaft.
17. Slide mode shift sleeve onto mode fork (Figure 5-178).
18. Hold mode shift sleeve and mode fork together, slide sleeve over intermediate shaft, and engage in differential assembly (Figure 5-177).
19. Lifting on long end of mainshaft, and holding mode fork assembly in place, set short end of mainshaft assembly in input gear.
20. Align mode fork pin in long shift sector slot.

NOTE: Mainshaft rail drive pin hole must align with range fork hole.

21. Align mode fork and range fork, and insert shift rail through both forks into front half-case.

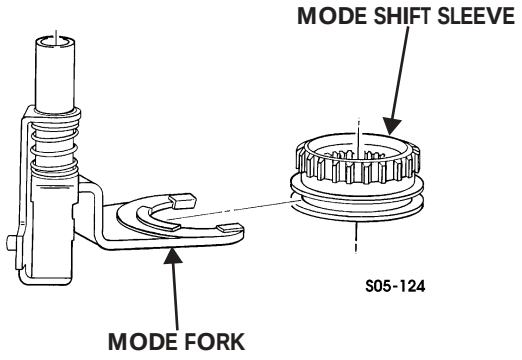


Figure 5-177: Shift Fork and Sleeve

NOTE: Use screw extractor, and move shift lever if necessary to start drive pin in range fork.

22. Ensure range fork and shift rail holes are aligned, and install tapered drive pin into range fork and shift rail, through access hole in front of half-case.
23. Install plug in access hole.

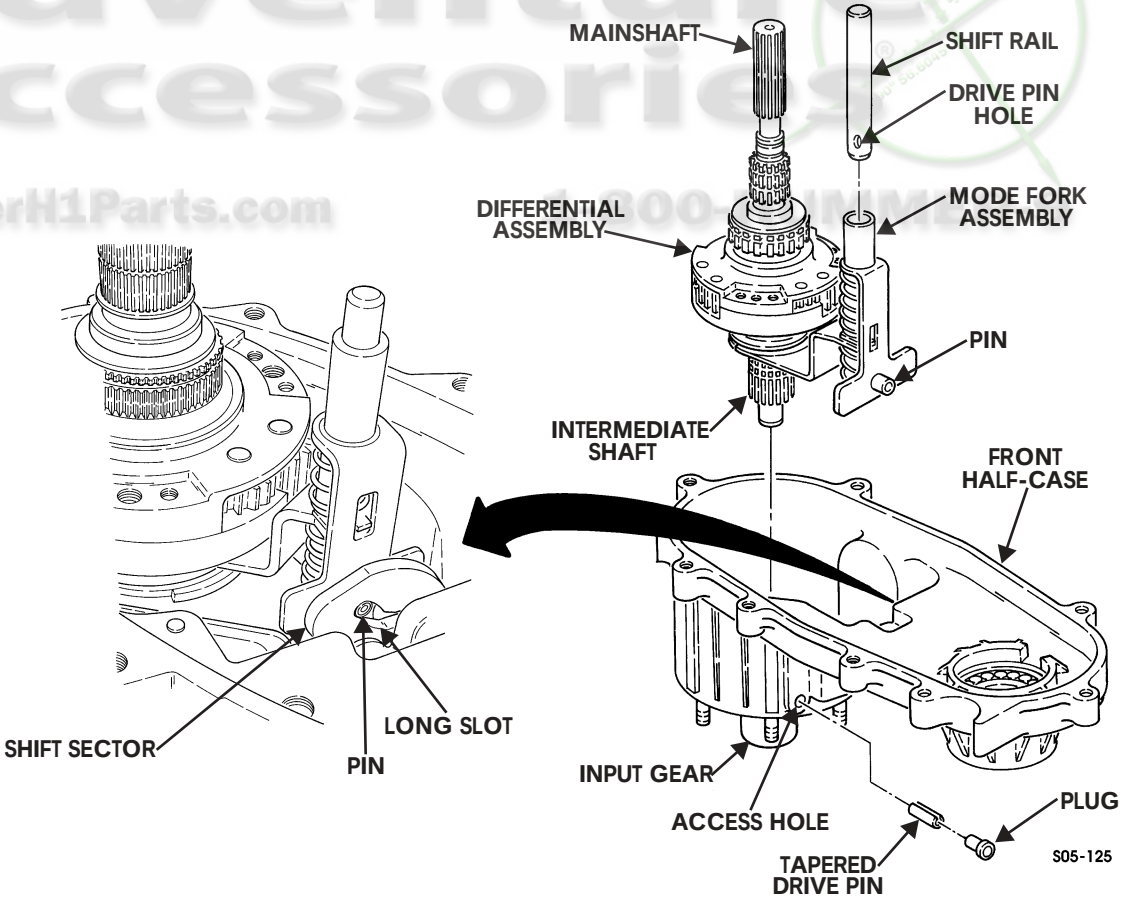


Figure 5-178: Shift Sector

24. Install two O-rings and oil cooler in front half-case with two washers and nuts (Figure 5-179).

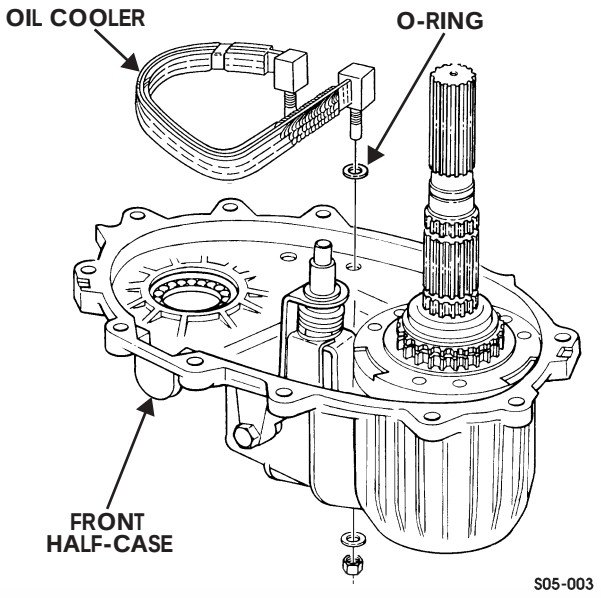


Figure 5-179: Oil Cooler

25. Install driven gear on front output shaft with snapring (Figure 5-180).

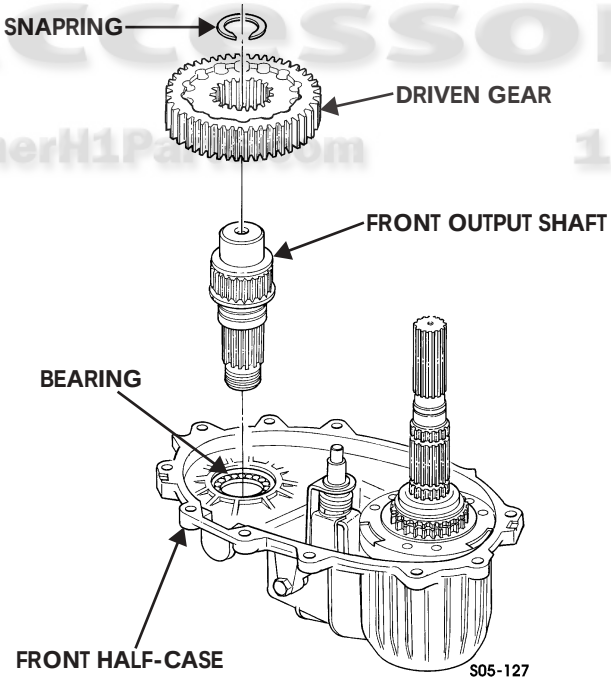


Figure 5-180: Sprocket Snapring

26. Install front output shaft and driven gear in half-case bearing.
27. Position drive chain over mainshaft and driven gear (Figure 5-181).

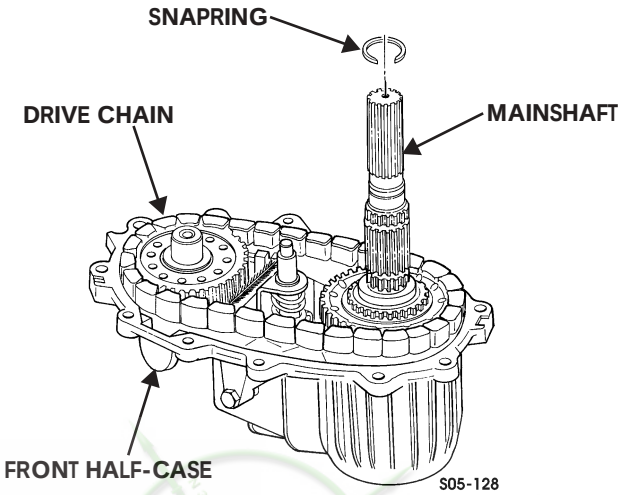


Figure 5-181: Drive Chain

28. Work drive gear onto mainshaft and into drive chain, and secure with snapring.

29. Install O-ring in oil pump inlet port (Figure 5-182).
30. Install oil pump pickup tube in oil pump.
31. Connect hose to oil pickup tube and oil screen.
32. Guide oil screen through outside of rear half-case and seat in notch.

NOTE: Support oil pump by holding against rear half-case.

33. Ensure oil pickup tube is in notch in rear half-case and turn half-case flat, with outside surface up.
34. Install magnet in pocket of front half-case (Figure 5-183).

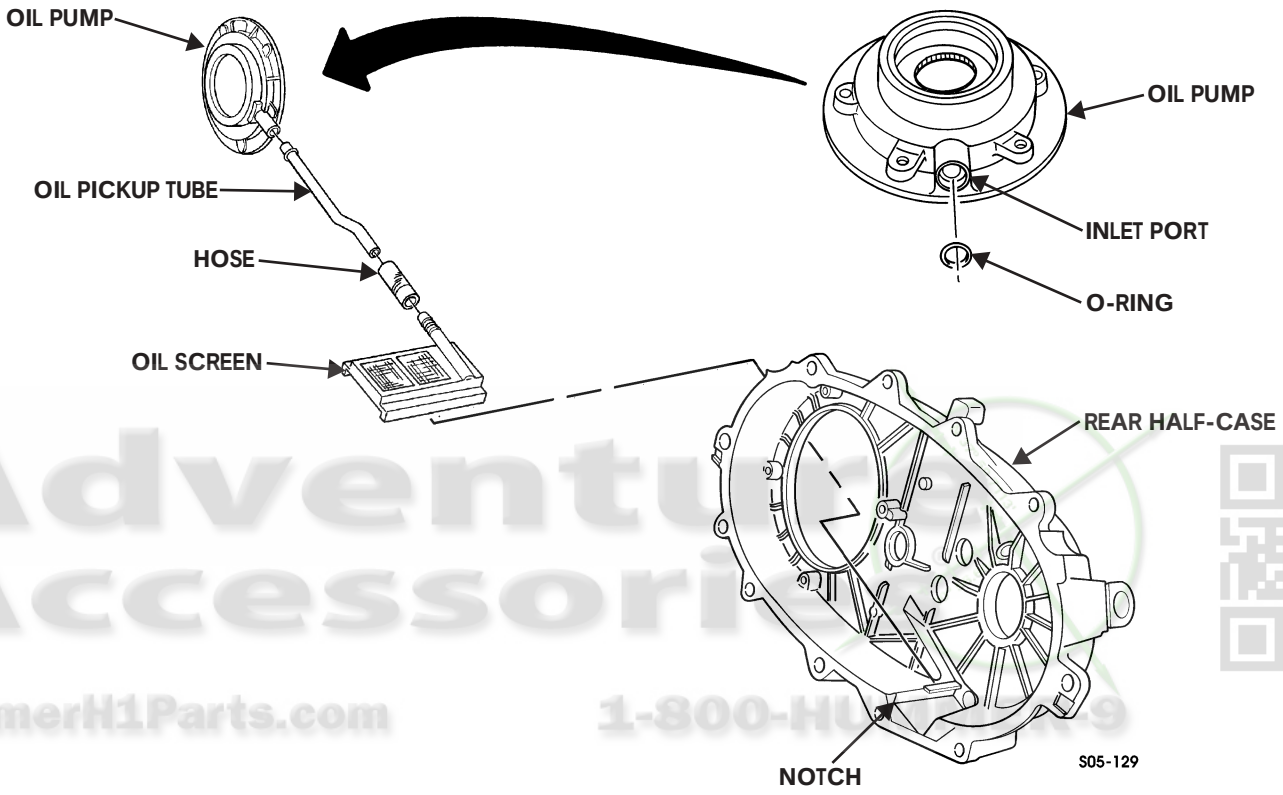


Figure 5-182: Oil Pump and Pickup

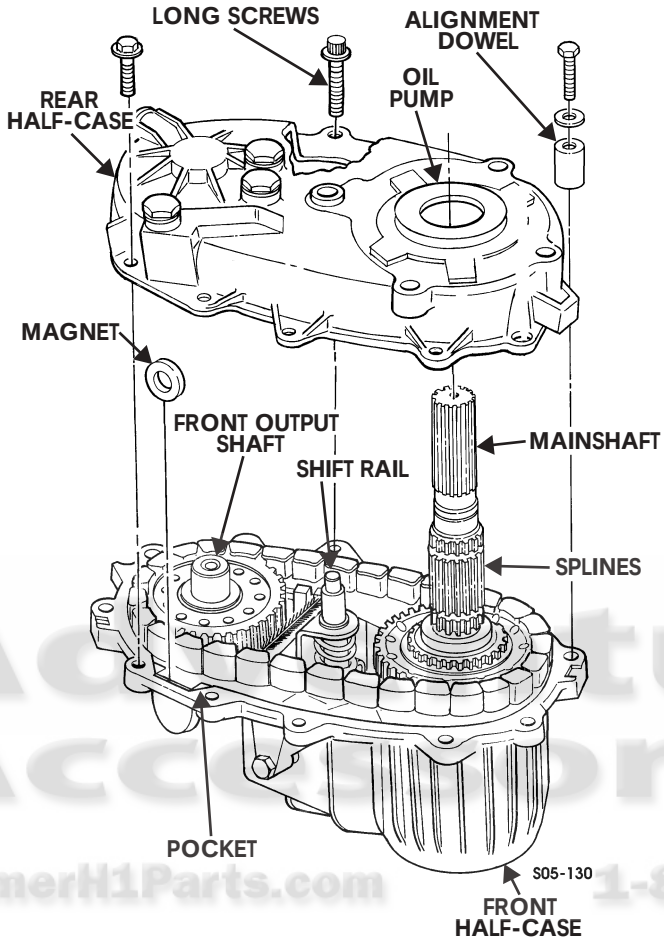


Figure 5-183: Case Half Assembly

35. Install two alignment dowels in rear half-case, if removed.
36. Apply a 1/8 in. (3 mm) bead of sealant on contact surface of front half-case mating flange.
37. Position rear half-case over mainshaft, and guide oil pump in to mesh with mainshaft mating splines. Turn mainshaft as necessary.
38. Ensure front output shaft and shift rail are properly seated in rear half-case. Both half-case flanges must be in full contact.
39. Install two washers and screws through front half-case alignment dowels.
40. Install two long screws in positions marked and seven screws securing rear half-case to front half-case.
41. Tighten all screws to 26-34 lb-ft (35-46 N•m).
42. Install tone wheel on mainshaft with two snaprings (Figure 5-184).

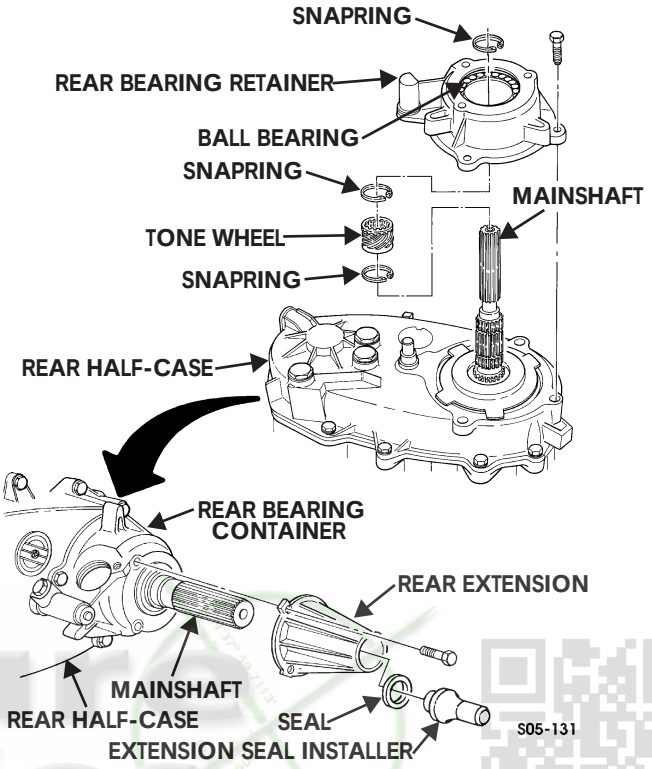


Figure 5-184: Rear Extension

43. Apply a 1/8 in. (3 mm) bead of sealant on transfer case side of rear bearing retainer, and install retainer on rear half-case with four capscrews. Tighten capscrews to 26-34 lb-ft (35-46 N•m).
44. Lifting on mainshaft as necessary, install snapring on mainshaft over ball bearing in rear bearing retainer. Ensure snapring is fully seated in mainshaft groove.
45. Using 05742583 extension seal installer, install seal in rear extension.
46. Apply a 1/8 in. (3 mm) bead of sealant on rear extension contact surface, and install on rear bearing retainer with three capscrews. Tighten capscrews to 26-34 lbft (35-46 N•m).

47. Install seal washer and front output yoke on front output shaft with nut. Tighten nut to 110 lb-ft (149 N•m) (Figure 5-185).

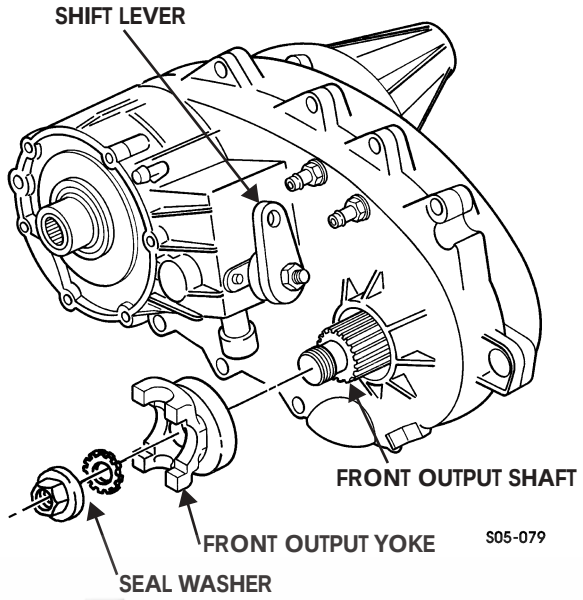


Figure 5-185: Front Seal

48. Install O-ring and speed sensor in rear bearing retainer with bolt. Tighten bolt to 15 lb-in. (2.0 N•m) (Figure 5-186).

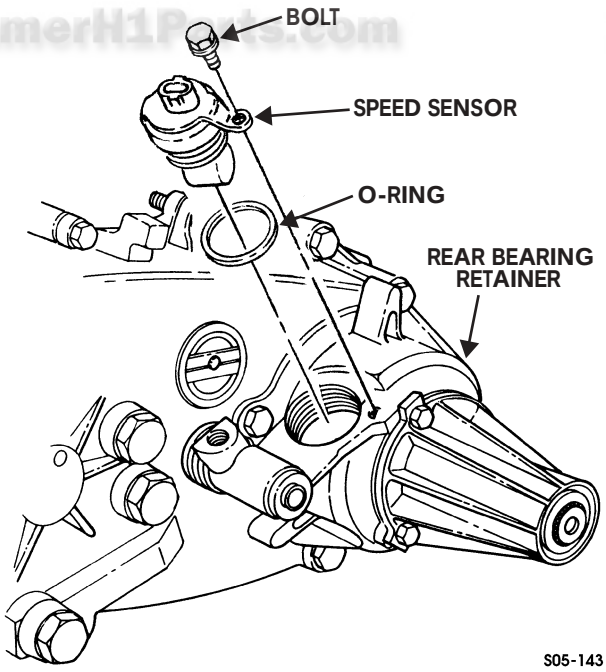


Figure 5-186: Speed Sensor

49. Move shift lever into all four detent positions and ensure shafts are turning. Shafts may need to be turned to obtain engagement in detent positions.
50. Install transfer case to transmission.

FRONT PROPELLER SHAFT ASSEMBLY MAINTENANCE

NOTE: Propeller shaft bearing caps should be taped together to prevent loss of bearings.

Removal

1. Remove four capscrews, two bearing straps, and front propeller shaft assembly from differential pinion yoke (Figure 5-187).

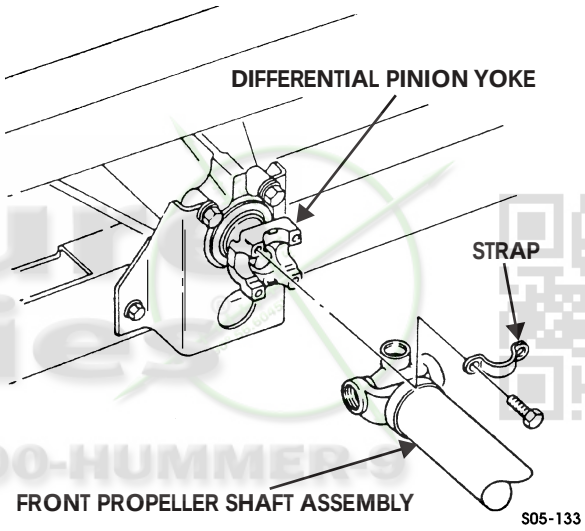


Figure 5-187: Front Propshaft

2. Remove four nuts, washers, two U-bolts, and front propeller shaft assembly from transfer case output yoke (Figure 5-188).

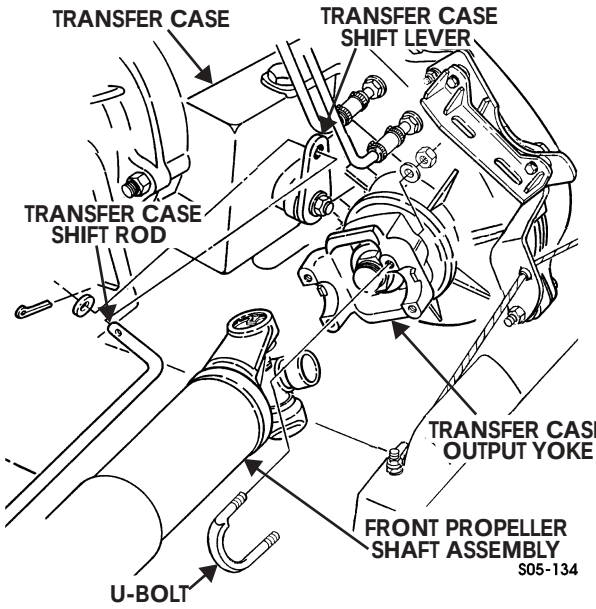


Figure 5-188: Propeller Shaft to Transfer Case

3. Remove cotter pin, washer, and transfer case shift rod from transfer case shift lever. Discard cotter pin.
4. Remove two locknuts, washers, capscrews, washers, and center bearing assembly from engine mount. Discard locknuts (Figure 5-189).

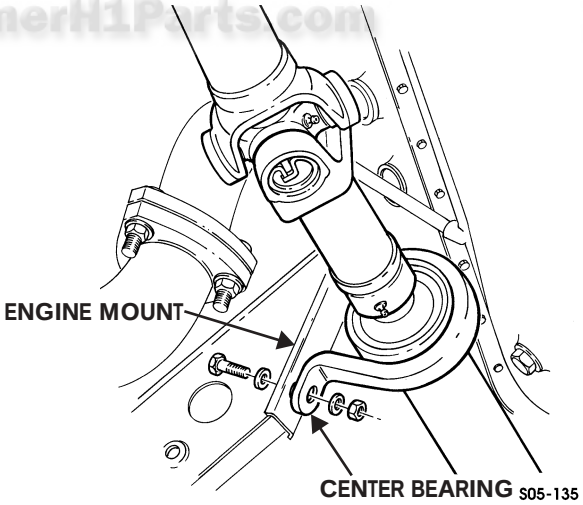


Figure 5-189: Center Bearing

5. Move front propeller shaft assembly forward, then rearward over top of transfer case and remove from vehicle.

Disassembly

NOTE: Prior to disassembly, mark alignment of slip yoke, universal yoke, and front propeller shaft for reassembly.

1. Place slip yoke in vise. Pry dust cap off slip yoke (Figure 5-190).
2. Pull slip yoke apart from front propeller shaft. Discard dust cap.
3. Place universal yoke in vise. Pry dust cap off universal yoke.
4. Pull universal yoke apart from front propeller shaft. Discard dust cap.
5. Install bearing puller between center bearing and shield (Figure 5-191).
6. Remove center bearing and retainer from front propeller shaft.
7. Remove shield from front propeller shaft.

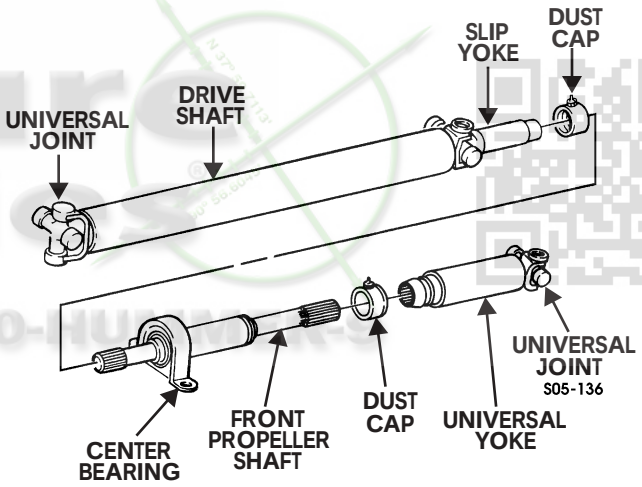


Figure 5-190: Front Shaft

Cleaning and Inspection

***CAUTION**: To avoid damage to equipment, do not allow solvent to contact U-joint.*

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean all metallic parts with solvent.
2. Inspect drive shaft, front propeller shaft, slip yoke, and universal yoke for cracks or dents (Figure 5-191).
3. Inspect splined ends of front propeller shaft, slip yoke, and universal yoke for damage.
4. Inspect center bearing for roughness or damage.
5. Replace unserviceable universal joints and grease fittings.

Assembly

1. Install shield on front propeller shaft (Figure 5-191).

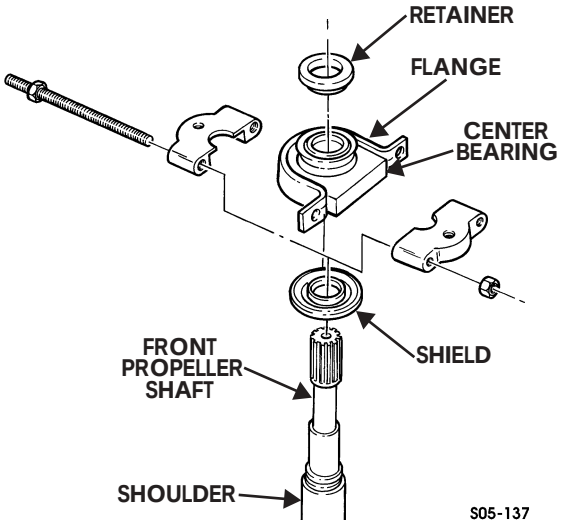


Figure 5-191: Center Bearing

2. Install retainer on center bearing.
3. Press center bearing on front propeller shaft until seated against shoulder. Ensure flange on center bearing faces up.

NOTE: Ensure grease fittings on dust caps are aligned with wide splines in slip yoke and universal yoke.

4. Install dust caps on front propeller shaft (Figure 5-190).
5. Coat front propeller shaft and drive shaft splines with grease.

NOTE: Ensure wide splines on front propeller shaft are aligned with grease fittings on slip yoke and universal yoke.

6. Align marks and install front propeller shaft into slip yoke and universal yoke. Secure with dust caps.

Installation

1. Position front propeller shaft assembly over exhaust pipe and transfer case (Figure 5-192).
2. Connect transfer case shift rod to transfer case shift lever with washer and cotter pin.
3. Connect front propeller shaft assembly to transfer case output yoke with two U-bolts, four nuts, and washers. Tighten nuts to 13-18 lb-ft (18-24 N•m).

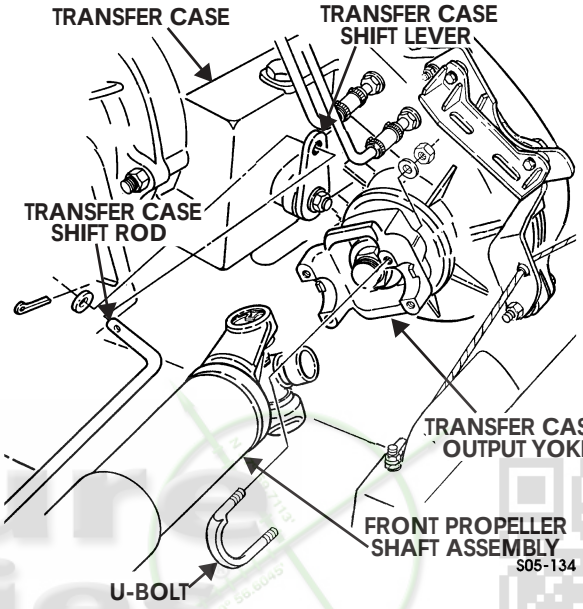


Figure 5-192: Front Propeller Shaft

4. Connect front propeller shaft assembly to differential pinion yoke with two bearing straps and four capscrews. Tighten capscrews to 13-18 lb-ft (18-24 N•m) (Figure 5-193).

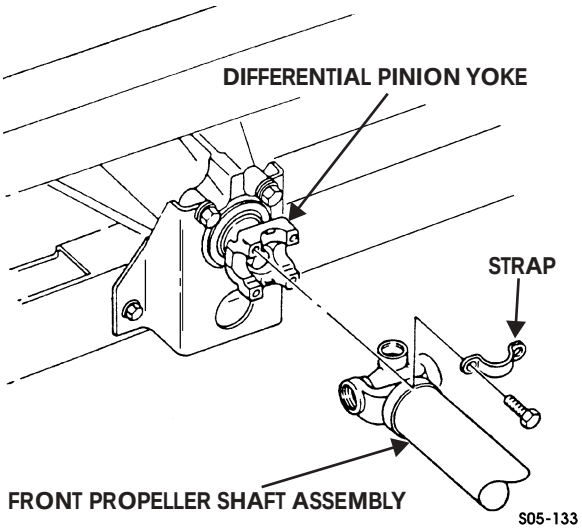


Figure 5-193: Front Propeller Shaft to Axle

5. Secure center bearing to engine mount with two washers, capscrews, washers, and locknuts. Tighten capscrews to 60 lb-ft (81 N•m) (Figure 5-194).
6. Lubricate propeller shaft assembly.

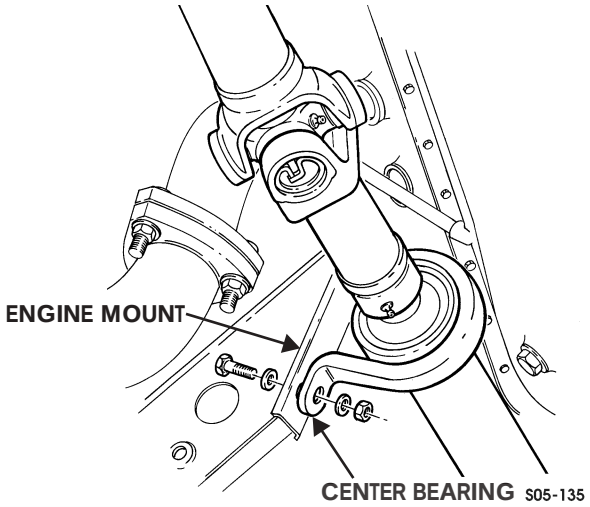


Figure 5-194: Center Bearing

REAR PROPELLER SHAFT MAINTENANCE

Removal

1. Chock wheels and set parking brake.
2. Remove four nuts, lockwashers, and two straps, and rear propeller shaft from differential pinion yoke (Figure 5-195).
3. Slide propeller shaft end yoke out of transfer case extension and remove propeller shaft.

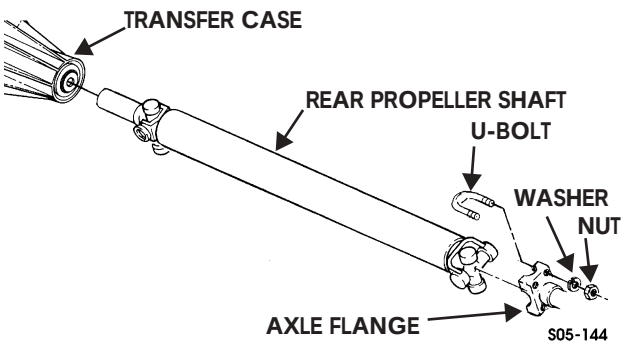


Figure 5-195: Rear Propeller Shaft

Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect propeller shaft for cracks and dents (Figure 5-196).
2. Inspect grease fittings and universal joints for serviceability. Replace if damaged.
3. Inspect splined end of end yoke for damage.

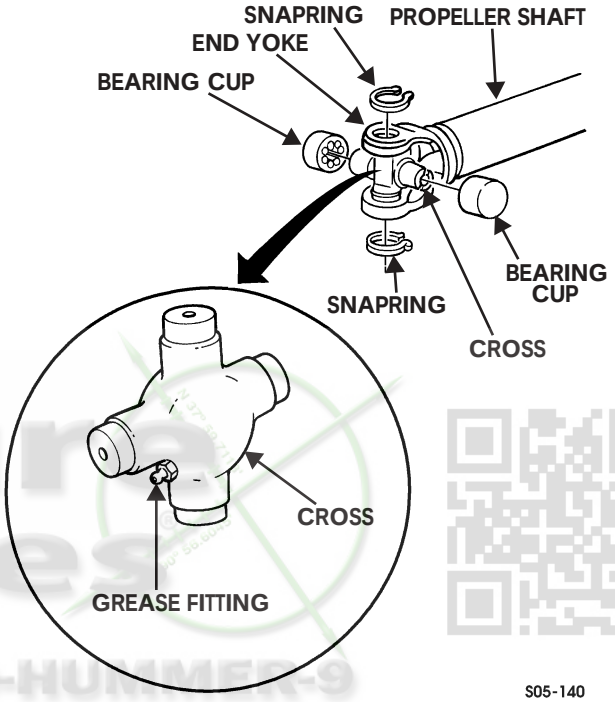


Figure 5-196: Universal Joint

Installation

1. Slide propeller shaft end yoke into transfer case extension (Figure 5-195).
2. Connect rear propeller shaft to differential pinion yoke with two straps, four lockwashers, and nuts. Tighten to 13-18 lb-ft (18-24 N•m).
3. Lubricate propeller shaft.

UNIVERSAL JOINT REPLACEMENT

Disassembly

***CAUTION**: Do not drop bearing cups. Needle bearings can be easily lost.*

1. Remove propeller shaft.
2. Remove grease fitting from cross (Figure 5-196).
3. Remove two bearing cups from cross.
4. Remove two snaprings from end yoke.
5. Position propeller shaft in vise with 1-1/8 in. socket between vise jaw and bearing cup being removed. Ensure open end of socket is facing bearing cup (Figure 5-197).

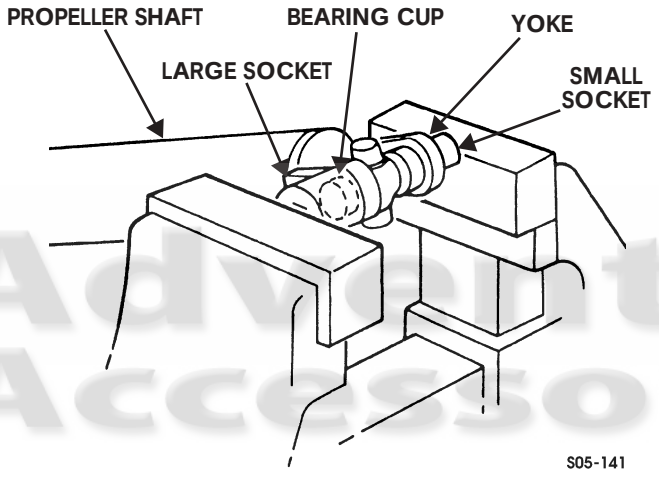


Figure 5-197: Bearing Installation

6. Place 11/16 in. socket between opposite bearing cup and vise jaw. Ensure open end of socket is facing vise jaw.
7. Press bearing cup out of yoke and remove bearing cup from cross (Figure 5-196).
8. Reverse position of sockets and press remaining bearing cup out of yoke (Figure 5-198).
9. Remove cross from yoke.

Assembly

***CAUTION**: Ensure grease fitting on cross faces yoke. Damage to equipment will result if improperly installed.*

1. Install cross into yoke (Figure 5-198).
2. Install bearing cup into yoke.

***CAUTION**: Ensure bearing cup is aligned with yoke before pressing in with vise. Damage to cross and bearing cups will result if forced into yoke.*

3. Place yoke in vise with 11/16 in. socket between vise jaw and bearing cup (Figure 5-197).
4. Press bearing cup into yoke far enough to install snapring and install snapring into yoke (Figure 5-198).
5. Install bearing cup into yoke.
6. Place yoke in vise with 11/16 in. socket between bearing cup and vise jaw (Figure 5-197).
7. Press bearing cup into yoke far enough to install snapring and install snapring into yoke (Figure 5-198).
8. Install two bearing cups on cross.
9. Install grease fitting into cross (Figure 5-196).
10. Install propeller shaft.
11. Grease joint(s) and slip yoke as required.

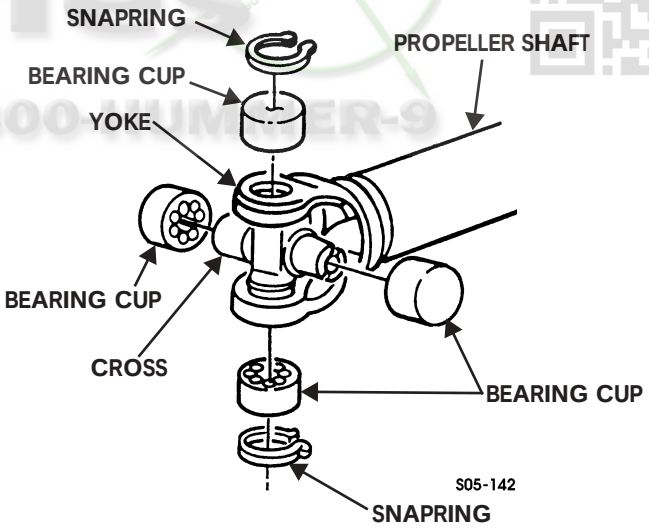


Figure 5-198: Universal Joint Components

Section 6 Wheels and Tires/Axles/Central Air Inflation System (CTIS)

TABLE OF CONTENTS

WHEEL REPLACEMENT

WARNING: Always take the wheel to an authorized service center for proper servicing. Use 16.5 inch diameter tires only. Mismatching tire and rim diameters is dangerous. A mismatched tire and rim assembly may explode and can result in serious injury or death.

WARNING: Put transmission into the PARK position, apply parking brake, and chock opposite wheel before removing wheel. Avoid removing any wheel when vehicle is on sloping terrain. Injury or damage to equipment may result. Remove only the inner group of lug nuts when removing a wheel from the vehicle. Removing the outer nuts which hold the rim together while the assembly is inflated could result in serious injury or death.

WARNING: Never mix tires of different size or design. Mixing tire types will adversely affect road handling and can lead to loss of vehicle control, and could result in serious injury or death. Match-mark wheel assembly to spindle for correct installation. Depress the quick-disconnect valve tab attached to the opposite side valve spindle nut to prevent air loss from the other tire.

NOTE: One- and two-piece tire and wheel assemblies are replaced basically the same. Match-mark wheel assembly to spindle for correct installation. Depress the quick-disconnect valve tab attached to the opposite side valve spindle nut to prevent air loss from the other tire.

Removal

NOTE: Perform step 1 for vehicles equipped with central tire inflation system (CTIS).

1. Remove tube and quick-disconnect valve from spindle.
2. Loosen eight lug nuts, but do not remove (Figure 6-1).
3. Raise and support corner of vehicle.
4. Remove eight lug nuts and wheel from geared hub spindle.

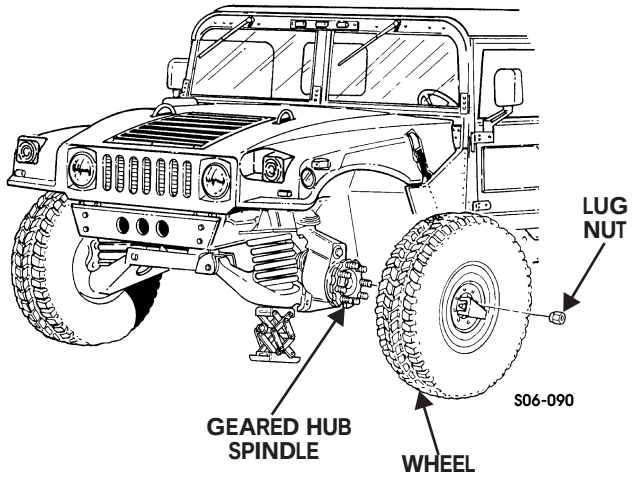


Figure 6-1: Geared Hub Spindle

Installation

NOTE: The Wrangler GS-A, 37 X 12.50R16.5 LTD touring radial tire has a directional tire tread. The heavier, stiffer tread on the outside shoulder of tire must face outward when being installed. Before installing, inspect sidewall of tire and ensure THIS SIDE OUTWARDS imprint is facing outward (Figure 6-2).

NOTE: Install lug nuts with fingers to full engagement. If nuts resist finger tightening, discard nuts. Examine studs for damage and replace if damaged.

1. Install wheel on geared hub spindle with eight lug nuts (Figure 6-1).

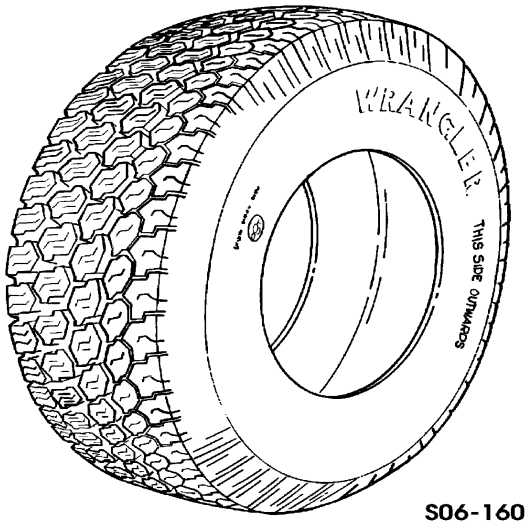


Figure 6-2: This Side Outwards

2. Remove support and lower corner of vehicle.
3. Tighten eight lug nuts to 99-121 lb-ft (134-164 N•m) in tightening sequence shown (Figure 6-3).

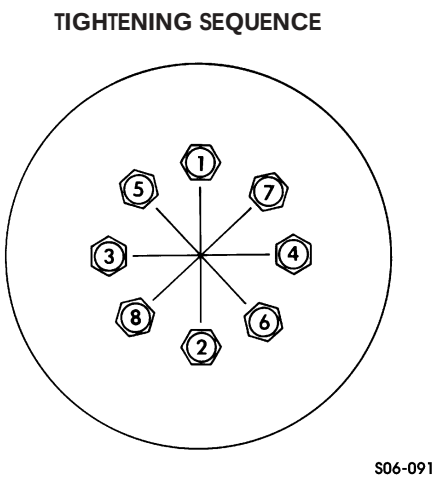


Figure 6-3: Lug Nut Tightening Sequence

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Perform step 4 for vehicles equipped with central tire inflation system.

4. Install quick-disconnect valve and tube on spindle.

TIRE, TWO-PIECE WHEEL, AND RUBBER RUNFLAT MAINTENANCE

WARNING: Do not use tire machine. Injury or damage to equipment may result.

NOTE: The HUMMER is equipped with specially designed two-piece take-apart wheels, tires, and runflats. Care must be taken during disassembly and assembly.

Disassembly

1. Remove wheel from vehicle.
2. Place wheel in a tire inflation cage.

WARNING: In all disassembly operations, ensure tire is totally deflated before removing wheel locknuts. Failure to follow proper safety precautions could cause serious injury or death.

3. Remove valve core from valve bore and deflate tire. Run a piece of wire through valve bore to ensure it is not plugged (Figure 6-4).

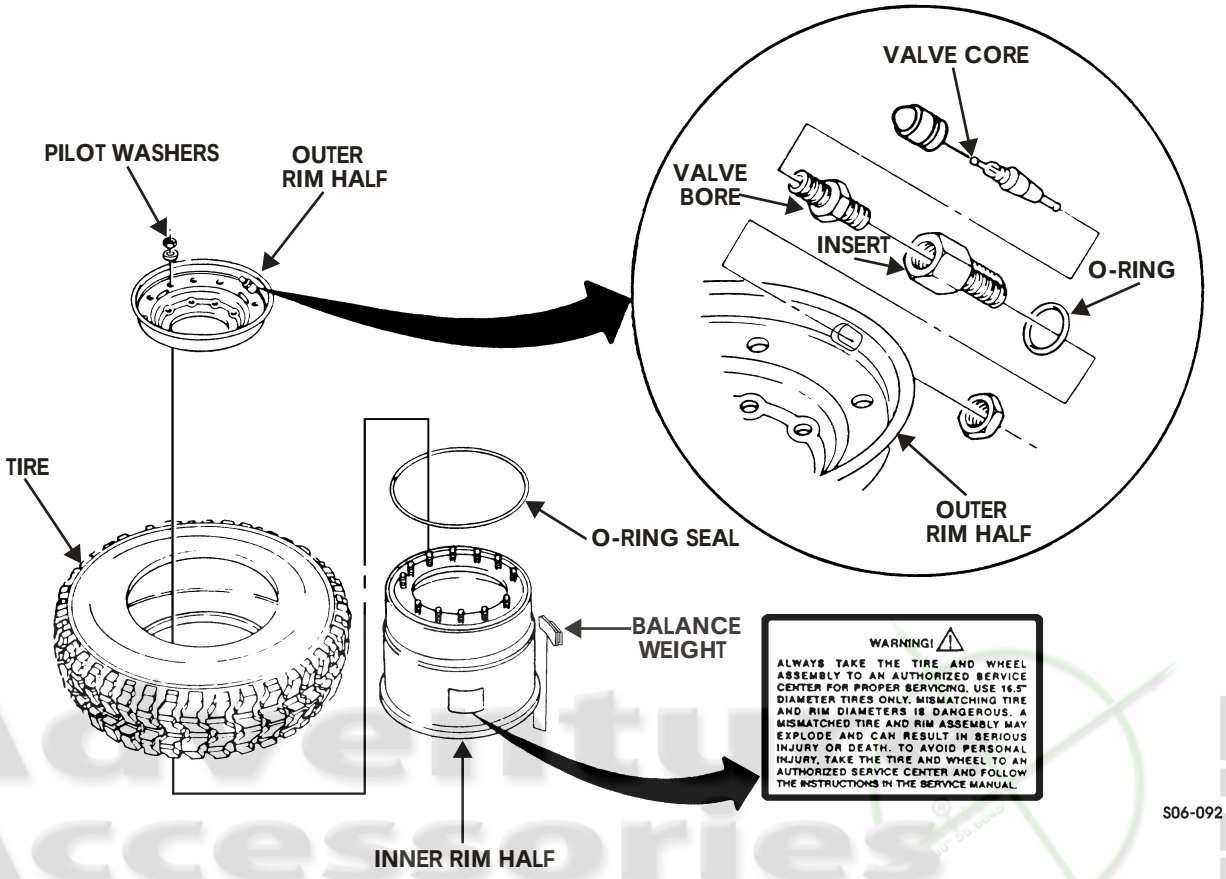


Figure 6-4: Two-Piece Wheel

NOTE: A special pentagon-shaped socket is required for removal and installation of two-piece wheel locknuts. Refer to Section 1, special tools.

WARNING: Do not use unauthorized tools. Damage to equipment, serious injury, or death may result.

4. When tire is fully deflated, use a circular pattern and loosen twelve wheel locknuts securing rim halves together. If you hear air escaping, do not proceed. Wait until the sound stops and recheck valve bore. When you are certain the tire is fully deflated, continue to remove wheel locknuts. Discard locknuts. Remove and discard three pilot washers.

WARNING: Never inflate a two-piece wheel assembly with the wheel locknuts removed in an attempt to separate inner and outer rim halves. The assembly will separate under pressure resulting in serious injury or death.

5. Remove outer rim half from tire.

NOTE: Perform steps 6, 7, and 8 only if damage to valve bore, insert, or O-ring is evident.

6. Inspect valve core and insert for damage. Replace if damaged.
7. Remove valve core housing from insert. Remove insert and locknut from outer rim half. Discard locknut.
8. Remove O-ring from insert. Discard O-ring.
9. Remove O-ring seal from inner rim half. Discard O-ring seal.
10. Remove tire from inner rim half.
11. Remove balance weights from rim halves. Discard balance weights.
12. Lay tire flat.

WARNING: To avoid injury, ensure runflat compressor strap is centered around runflat.

NOTE: Remove any gel lubricant from runflat prior to installing compressor.

13. Position runflat compressor on runflat so that runflat compressor hex drive is facing up and strap is centered around runflat (Figure 6-5).

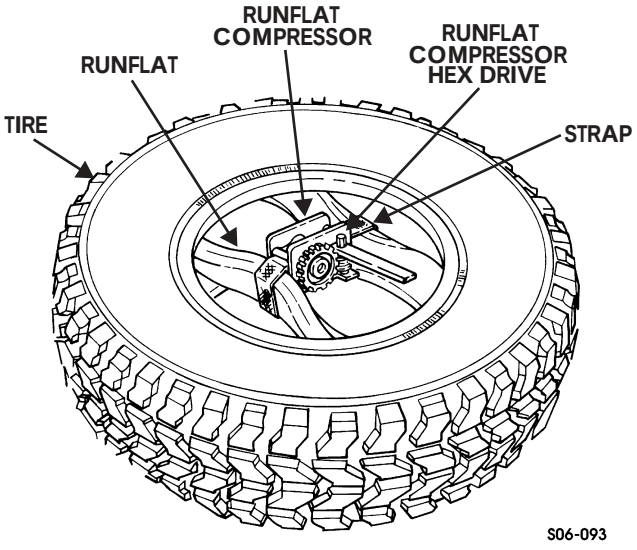


Figure 6-5: Runflat Compressor

NOTE: Compress runflat by rotating hex drive in either direction. Rotate hex drive in opposite direction to loosen.

14. Using runflat compressor, compress runflat.
15. Position runflat compressor on an outer edge of runflat with handle assembly facing up and strap centered around runflat (Figure 6-6).

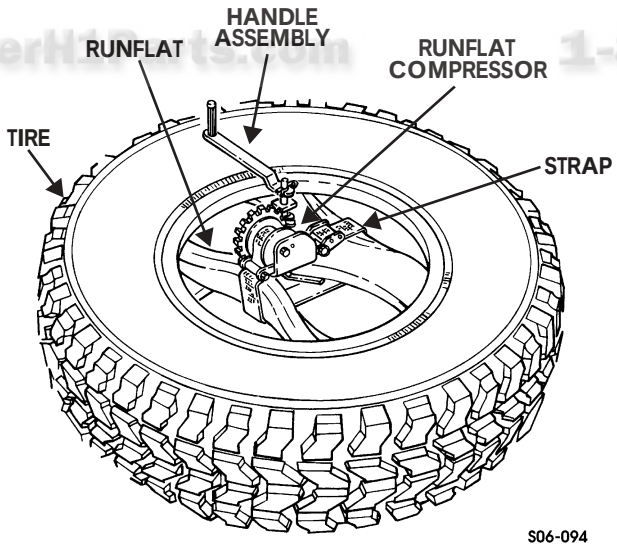


Figure 6-6: Handle Assembly

NOTE: Compress runflat by rotating the handle assembly in a clockwise direction. Rotate handle assembly counterclockwise to loosen.

16. Using runflat compressor, compress runflat.

NOTE: It may be necessary to use a tire spoon and tire soap to remove runflat from tire. When using runflat compressor with handle, it may be necessary to remove handle before removing runflat.

17. Remove runflat from tire and remove runflat compressor from runflat (Figure 6-7).

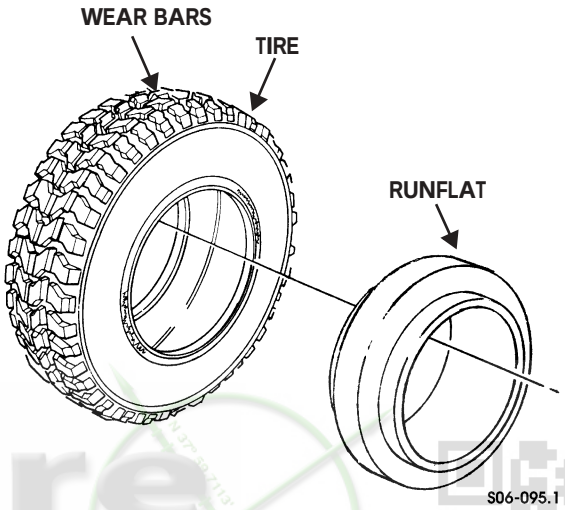


Figure 6-7: Runflat Tire Assembly

Inspection and Cleaning

***CAUTION**: Do not reuse a tire which has been run flat without thoroughly inspecting for damage. Failure to follow these instructions may result in damage to equipment.*

1. Remove any existing lubricant that has been previously applied to the inside of the tire using a mild detergent soap and water.
2. Dry all wheel and tire parts. Ensure inside of tire is free of any runflat lubricant, dirt, debris, rust, or moisture.
3. Inspect inside of tire for cord or belt separation and inner liner damage. Replace tire if damaged.
4. Inspect tire bead for abrasions. Replace tire if damaged.
5. Check for protruding objects inside tire which may not be visible from outside. If tire is damaged, repair with internal (05710215) or external (05710216) tire repair kit.
6. Check tread depth on tire. Tread should not be worn below level of wear bars. Markings on the sides of the tires (e.g., the letters "TWI" or a triangle) show the location of wear bars. Replace tire if tread is worn below wear bars or 3/32 inch (2.38 mm).
7. Inspect runflat for splitting, wear, or excessive chafing. Replace runflat if damaged (Figure 6-7).
8. Inspect outside of tire for sidewall damage. Replace tire if damaged.
9. Inspect outside of tire for tread damage. If beyond inside patch repair, replace tire.

WARNING: O-ring sealing surfaces and pressure relief grooves must be kept clean and free from rust and dirt. Failure to do so could cause the wheel assembly to separate under pressure causing serious injury or death.

10. Using wire brush, clean studs. Clean all dirt and foreign material from rim halves with soap and water and allow to air dry. Ensure O-ring sealing surfaces on rim halves are smooth and clean (Figure 6-8).
11. Inspect rim halves for cracks, bent sealing surfaces, or oversized mounting holes. Replace rim halves if cracked, bent, or if mounting holes are oversized.

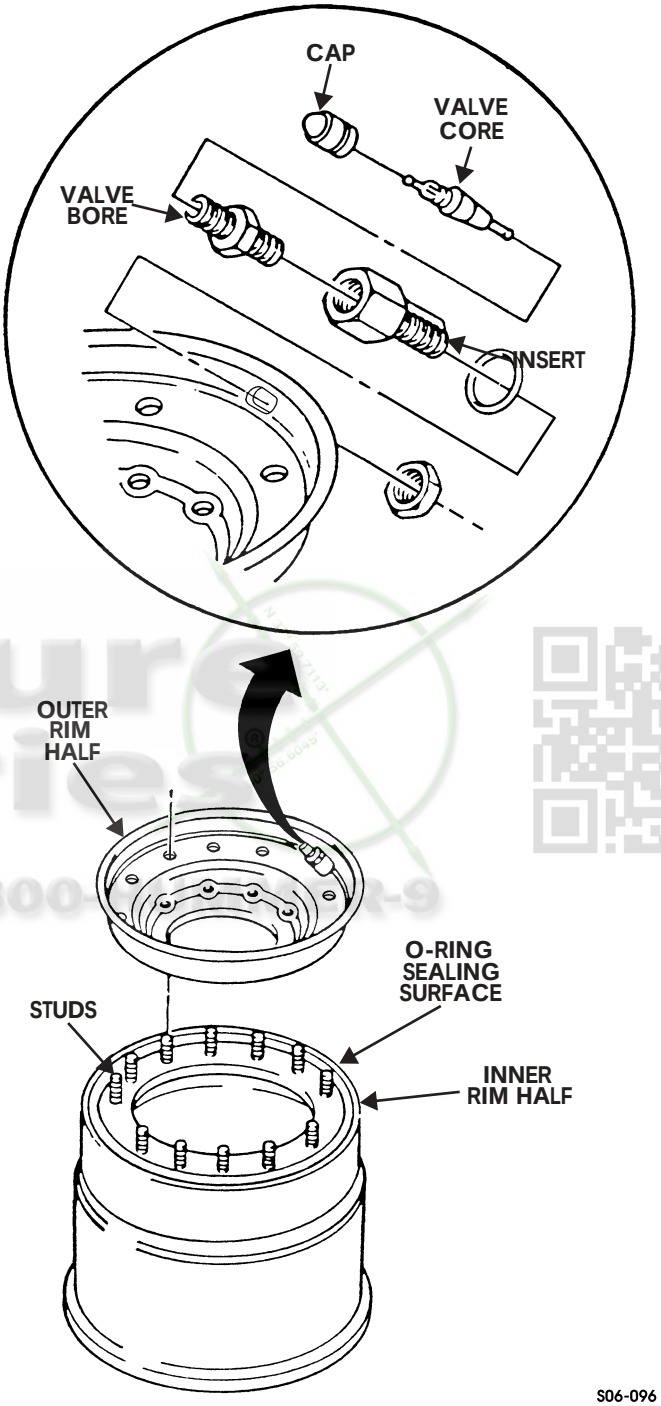


Figure 6-8: Rim Halves

WARNING: Never use wheel assemblies with studs that are damaged, loose, or have stripped threads. Damaged studs can cause improper assembly which could cause individual fasteners to fail. Any of these situations could cause serious injury or death.

NOTE: When replacing a damaged stud, also replace two adjacent studs.

12. Inspect inner rim half for cracked, broken, rusted, pitted, bent, loose, or stripped studs. Replace damaged studs along with two adjacent studs.
13. Inspect valve core for cracks or deterioration. Replace valve core if damaged (Figure 6-8).
14. Inspect valve bore for cracks or deterioration. Replace if damaged.
15. Inspect insert and cap for damage. Replace if damaged.

Repair

1. If studs are damaged, drive studs out of inner rim half. Discard studs (Figure 6-9).
2. Align splines on studs with splines in inner rim half and drive studs into inner rim half until shoulders seat against inner rim half.

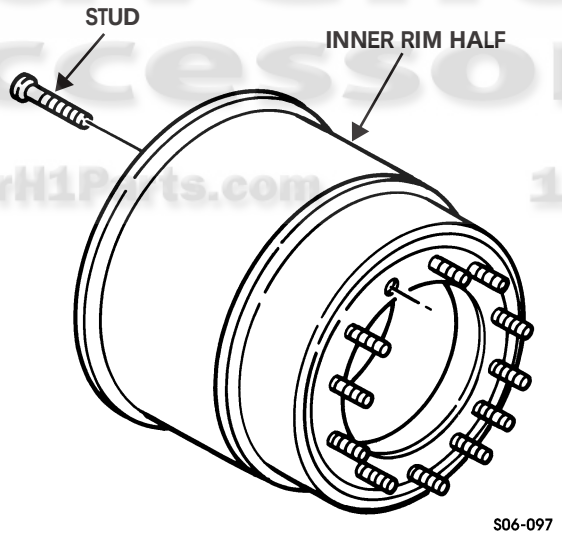


Figure 6-9: Inner Rim Half

Assembly

WARNING: Never use tubes in the wheel assemblies. Use of a tube defeats built-in safety features, and could cause the wheel to come apart under pressure, resulting in serious injury or death. Use only replacement parts specified in parts manual. Wheels assembled with components which do not meet specifications could cause the assembly to separate under pressure, resulting in serious injury or death. To avoid injury ensure runflat compressor strap is centered on runflat.

1. Apply one 11-ounce tube of gel lubricant around inside of tire at crown area. Using clean brush, evenly spread gel lubricant 4 to 5 inches wide on tire crown area (Figure 6-10).

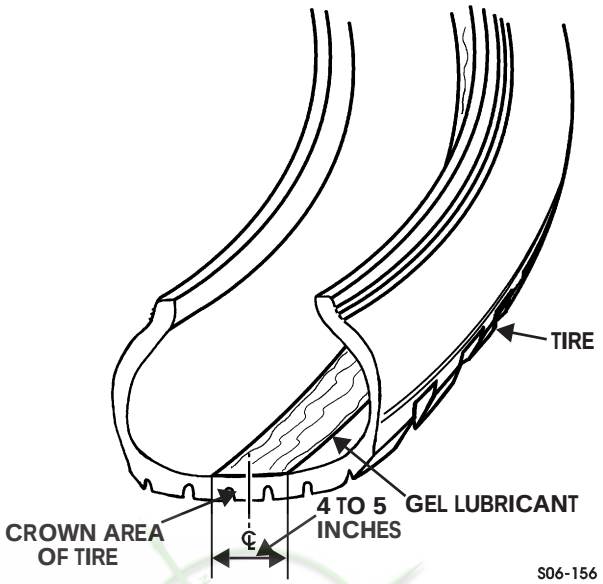


Figure 6-10: Runflat Gel Lubricant

NOTE: Perform steps 2 and 3 when using runflat compressor without handle. Perform steps 4 and 5 when using runflat compressor with handle.

2. Position runflat compressor on runflat so that runflat compressor hex drive is facing up and strap is centered around runflat (Figure 6-11).

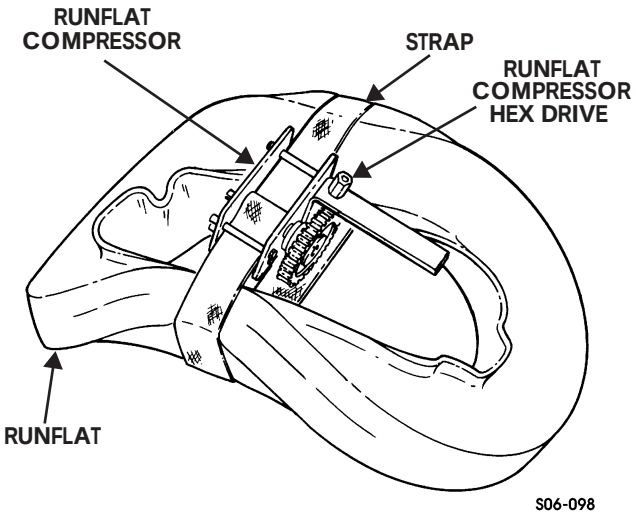


Figure 6-11: Runflat Compressor

NOTE: Compress runflat by rotating hex drive in either direction. Rotate hex drive in opposite direction to loosen.

3. Using runflat compressor, compress runflat.
4. Position runflat compressor on an outer edge of runflat with handle assembly facing up and strap centered around runflat (Figure 6-12).

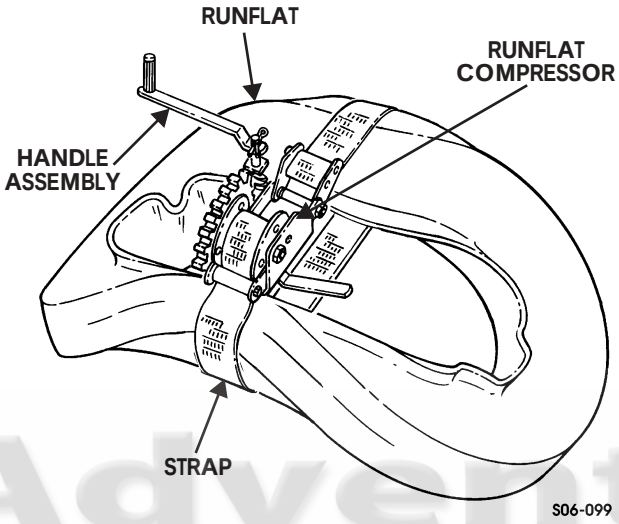


Figure 6-12: Runflat Compression

NOTE: Compress runflat by rotating the handle assembly in a clockwise direction. Rotate handle assembly counterclockwise to loosen.

5. Using runflat compressor, compress runflat.
6. Stand tire up and lubricate tire bead and runflat with tire soap (Figure 6-13).

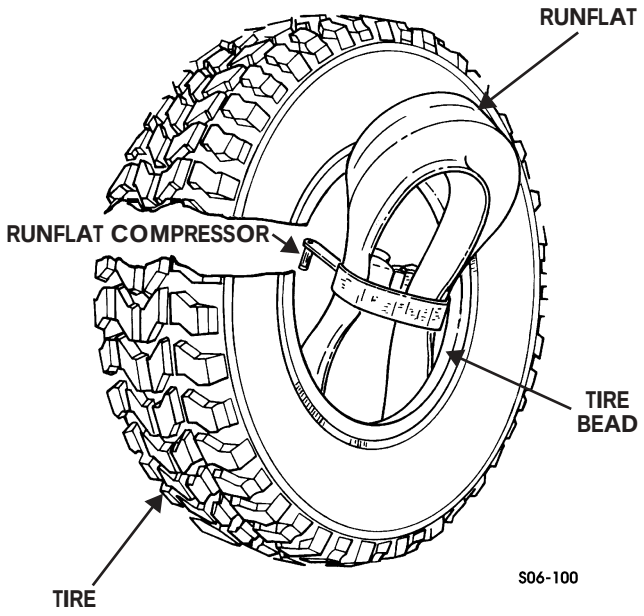


Figure 6-13: Runflat Insertion

NOTE: It may be necessary to remove the handle assembly on runflat compressor before inserting runflat into tire.

7. Insert runflat compressor side first as far as possible into tire.
8. Lay tire flat on side. Slowly loosen compressor. Runflat should insert itself inside tire. If not, repeat steps 6 through 8 and/or use a tire spoon to assist in installation.

NOTE: If required, clean and lubricate bearing assembly on runflat compressor after removal.

9. Loosen runflat compressor and remove from tire.

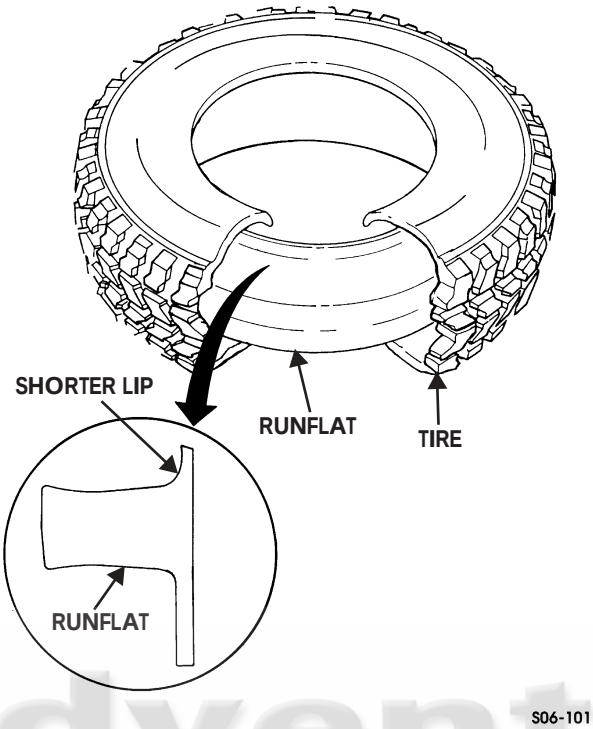


Figure 6-14: Runflat

NOTE: Ensure shorter lip of runflat faces inner rim side of tire (Figure 6-14).

10. Lubricate O-ring seal with tire soap and install O-ring seal on first ledge of inner rim half. Ensure O-ring seal is not twisted and is uniformly positioned in the groove outside of the studs. Do not overstretch O-ring seal (Figure 6-15).
11. Lubricate tire bead and rim bead seat areas with tire soap.

NOTE: Before installing tire on inner rim half, inspect tire sidewalls for a "paint dot." Paint dots are often painted on tires to indicate the tire's light spot for balancing purposes. If paint dot is present, position tire on rim halves so that paint dot is aligned with insert hole on outer rim half.

NOTE: The Wrangler GS-A, 37 X 12.50R16.5 LTD touring radial tire has a directional tire tread. The heavier, stiffer tread on the outside shoulder of tire must face outward when being installed. Before installing, inspect sidewall of tire and ensure THIS SIDE OUTWARDS imprint is facing outward (Figure 6-16).

1. Center runflat in tire. Carefully lower tire over inner rim half. Check to ensure O-ring seal has not been disturbed (Figure 6-15).

***CAUTION**: Ensure the runflat is properly aligned with the valve stem in the wheel. Improper alignment can result in non-uniform bead pressure and improper runflat operation.*

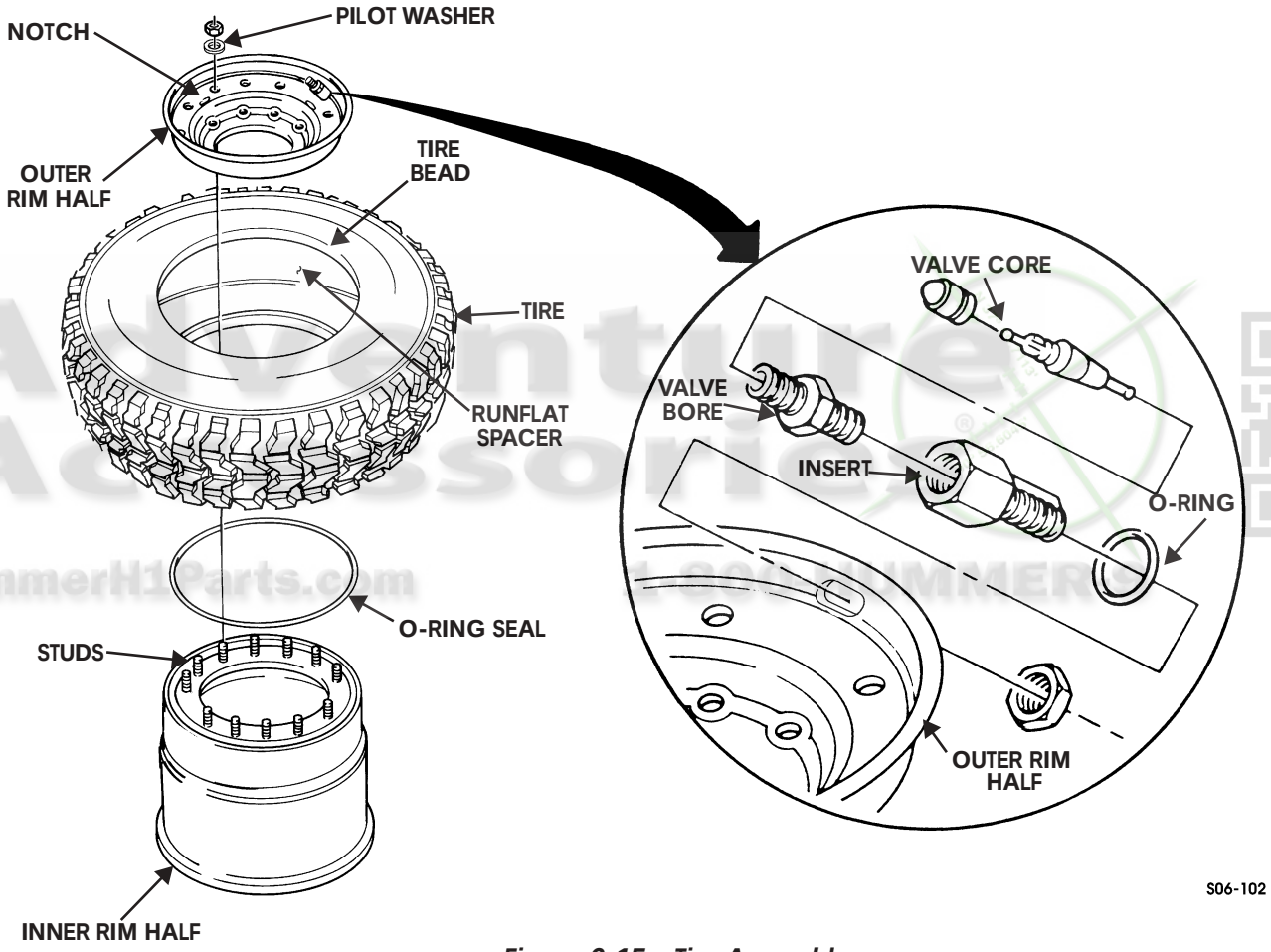


Figure 6-15: Tire Assembly

12. Ensure runflat is not binding on flat portion of inner rim half. Runflat should clear inner rim half.
13. Install valve core in valve bore.

NOTE: Perform step 15 only if valve bore and insert were removed.

14. Install O-ring into pocket on insert. Install insert into valve hole of outer rim half with locknut. Tighten locknut to 40-60 lb-in. (5-7 N•m). Apply thread-locking compound to valve bore and install valve bore into insert. Tighten valve bore to 25-30 lb-ft (34-41 N•m).
15. Install outer rim half on inner rim half.
16. Install three pilot washers spaced equally apart on studs located left of outer rim half notches (ensure washers are seated in outer rim half).

***CAUTION**: Tighten locknuts gradually to avoid bent and broken studs, or damage to wheel components.*

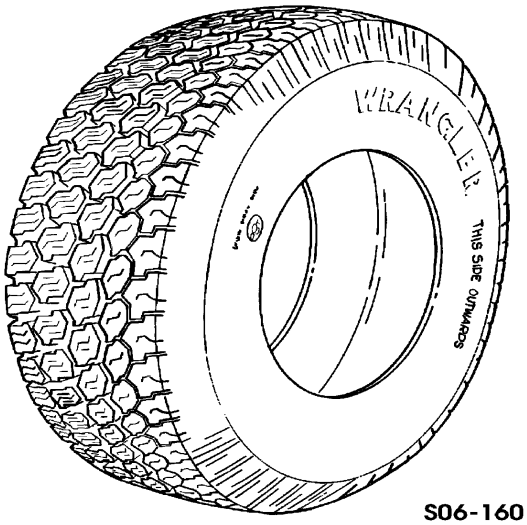


Figure 6-16: This Side Outwards

NOTE: If vehicle is equipped with central tire inflation system, position shield bracket on outer rim.

17. Secure outer rim half on inner rim half with twelve locknuts.

NOTE: If tire bead does not seat on the rim flange after inflation, deflate tire completely and remove from rim. Check to ensure that a 16.5 inch diameter tire is being used. Also check for bent or damaged components and replace if necessary. Apply tire soap to tire bead and rim mating surfaces and reinstall tire on rim.

NOTE: Never tighten locknuts when tire is in an inflated condition. This will result in a less effective torque. Tighten locknuts to proper torque specifications every 6,000 miles (9600 km).

18. Tighten locknuts to 85 lb-ft (115 N•m) in tightening sequence shown (Figure 6-17).

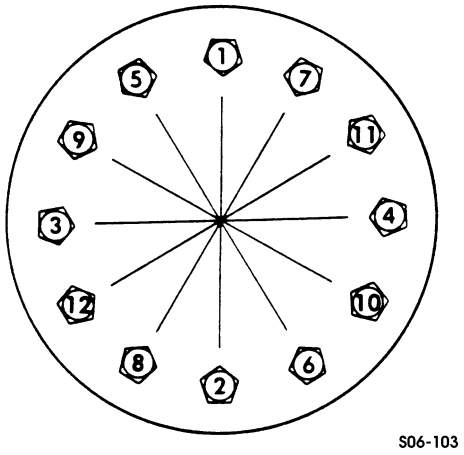


Figure 6-17: Locknut Tightening Sequence

19. Retighten locknuts to 125 lb-ft (170 N•m) in sequence shown.
20. Check wheel assembly for gaps at each stud. Use a 0.0015 inch (0.038 mm) thickness gauge to detect gaps. If gaps are detected, disassemble and reassemble wheel assembly and recheck for gaps. If gaps are still detected, replace outer rim half (Figure 6-18).

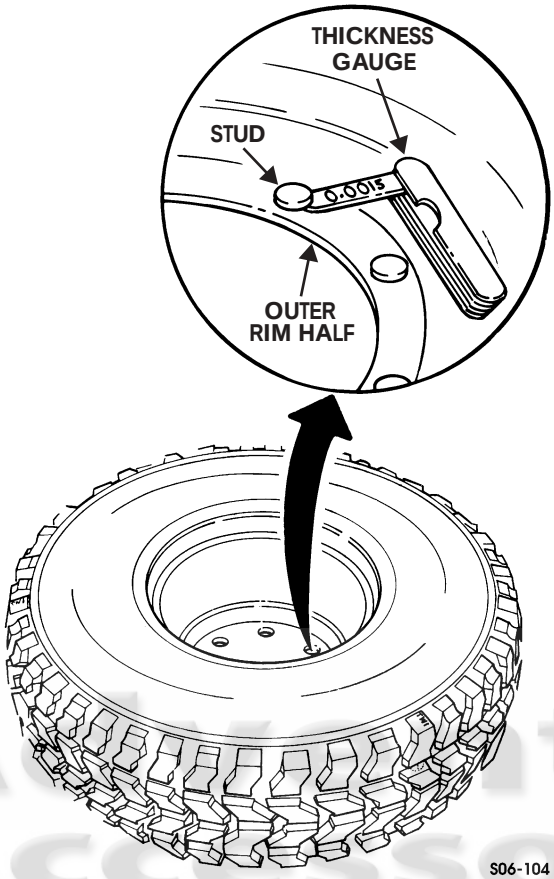


Figure 6-18: Gap Checking

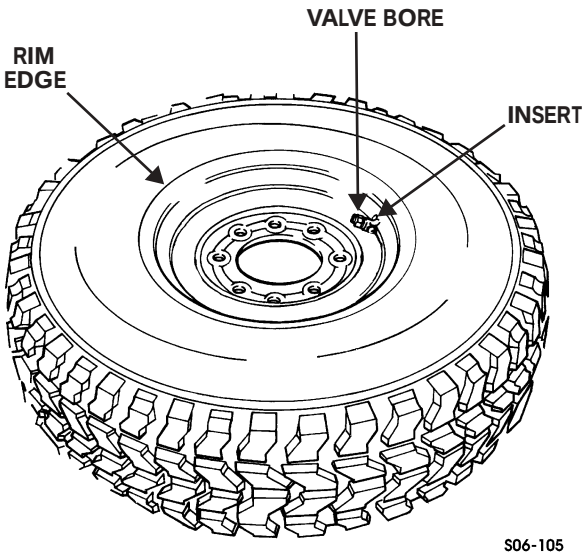


Figure 6-19: Check Areas

NOTE: Check alignment between outer rim half and inner rim half every 3,000 miles (4800 km).

WARNING: Never inflate a tire without having checked wheel locknut torques to ensure the wheel locknuts are tightened to specifications. A wheel with improperly tightened locknuts could separate under pressure, resulting in serious injury or death. Always use a tire inflation cage for inflation purposes. Stand on one side of cage during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate tire to recommended pressure using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

21. Place wheel in safety cage and inflate tire to recommended tire pressure.
22. Check for leaks around rim edges, insert, and valve bore with soapy solution (Figure 6-19).

TIRE, ONE-PIECE WHEEL, AND TWO-PIECE RUNFLAT MAINTENANCE

WARNING: Do not use tire machine. Injury or damage to equipment may result.

Disassembly

1. Remove wheel from vehicle.
2. Place wheel in a tire inflation cage.
3. Remove valve core from valve bore and deflate tire. Run a piece of wire through valve bore to ensure it is not plugged (Figure 6-20).
4. Remove outboard side of tire from outboard side of wheel (Figure 6-21).
5. Inspect valve bore and insert for damage. Replace either if damaged (Figure 6-20).

NOTE: Perform steps 6, 7, and 8 only if damage to valve bore, insert, or O-ring is evident.

6. Remove valve bore, insert, and locknut from wheel. Discard locknut.
7. Remove O-ring from insert. Discard O-ring.
8. Remove balance weights from wheel if present. Discard balance weights.
9. Remove two capscrews, screws, lock-clips, and runflat halves from wheel (Figure 6-21).

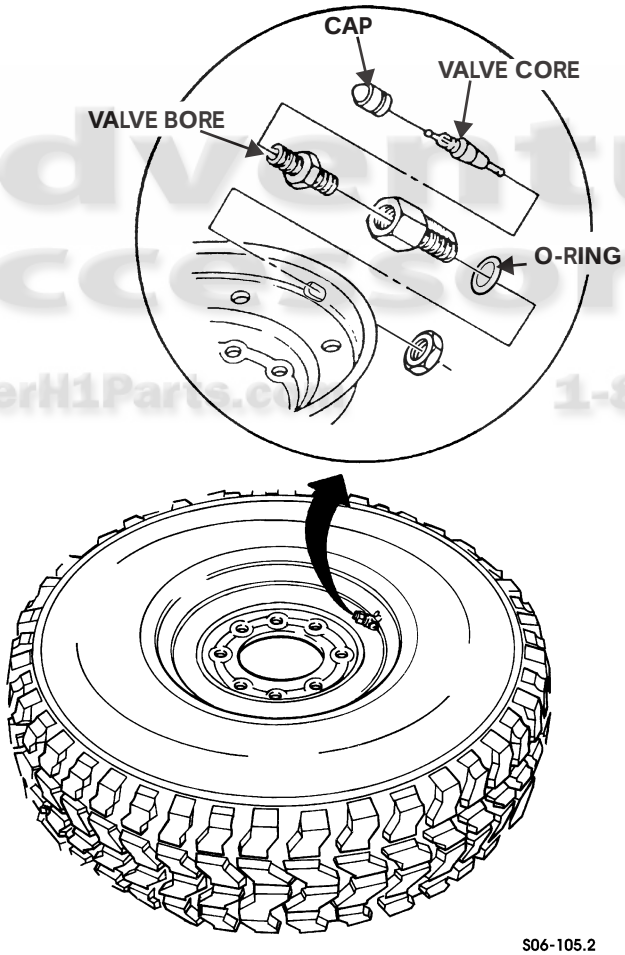


Figure 6-20: One-Piece Wheel

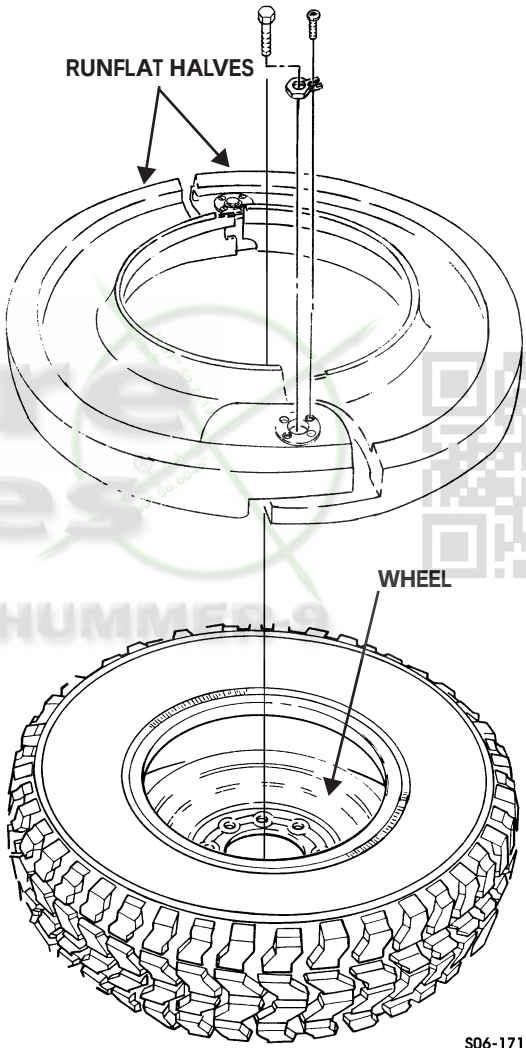


Figure 6-21: Two-piece Runflat

Inspection and Cleaning

***CAUTION**: Do not reuse a tire which has been run flat without thoroughly inspecting for damage. Failure to follow these instructions may result in damage to equipment.*

1. Remove any existing lubricant that has been applied to the inside of the tire, using a mild detergent soap and water.
2. Dry all wheel and tire parts. Ensure inside of tire is free of any runflat lubricant, dirt, debris, rust or moisture.
3. Inspect inside of tire for cord or belt separation and inner liner damage. Replace tire if damaged.
4. Inspect tire bead for abrasions caused from runflat. Replace tire if damaged.
5. Check for protruding objects inside tire which may not be visible from outside. If tire is damaged, repair with internal (05710215) or external (05710216) tire repair kit.
6. Check tread depth on tire. Tread should not be worn below level of wear bars. Markings on the sides of the tires (e.g., the letters "TWI" or a triangle) show the location of wear bars. Replace tire if tread is worn below wear bars or 3/32 inch (2.38 mm).
7. Inspect runflat for splitting, wear, or excessive chafing. Replace runflat if damaged.
8. Inspect wheel. Replace wheel if cracked or bent.
9. Inspect valve core for cracks or deterioration. Replace if damaged.
10. Inspect valve bore for cracks or deterioration. Replace if damaged.
11. Inspect insert and cap for damage. Replace if damaged.

Assembly

1. Apply one 11-ounce tube of gel lubricant around inside of tire at crown area. Using clean brush, evenly spread gel lubricant 4 to 5 inches wide on tire crown area (Figure 6-22).

NOTE: It may be necessary to use two steel mounting rods and adjustment band to install runflat on wheel.

NOTE: Ensure shorter lip of runflat faces inboard side of tire.

NOTE: Ensure that a 16.5 inch diameter tire is being used.

2. Lubricate tire bead and wheel bead seat areas with tire soap.

NOTE: Before installing tire inspect tire sidewalls for a "paint dot." Paint dots are often painted on tires to indicate the tire's light spot for balancing purposes. If paint dot is present, position tire on wheel so that paint dot is aligned with insert hole on wheel.

3. Install inboard side of tire on outboard side of wheel (Figure 6-23).
4. Install runflat halves on wheel with two capscrews. Tighten capscrews to 240 lb-in. (27 N•m) (Figure 6-24).

NOTE: Perform adjustment procedure if runflat is not tightly seated on wheel. Then continue to step 5.

5. Install two lock-clips, capscrews, and screws on runflat (Figure 6-21).

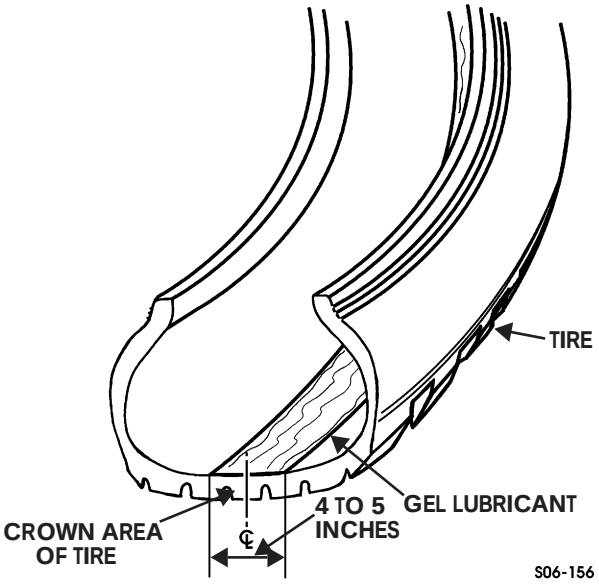


Figure 6-22: Runflat Gel Lubricant

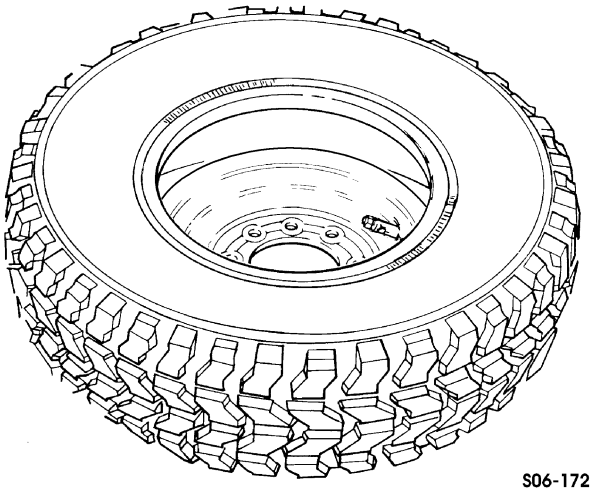


Figure 6-23: Partial Tire Installation

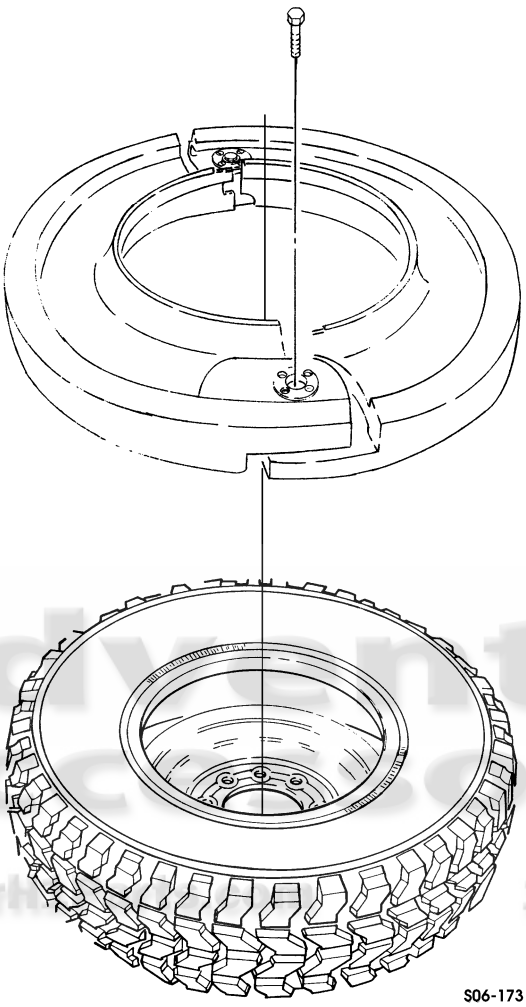


Figure 6-24: Two-Piece Runflat

6. Install valve core in valve bore (Figure 6-25).
7. Install O-ring into pocket on insert. Install insert into valve hole. Install locknut on insert and tighten to 40-60 lb-in. (5-7 N•m). Apply thread-locking compound to valve bore and install valve bore into insert. Tighten valve bore to 25-30 lb-ft (24-41 N•m).
8. Install outboard side of tire on outboard side of wheel (Figure 6-26).

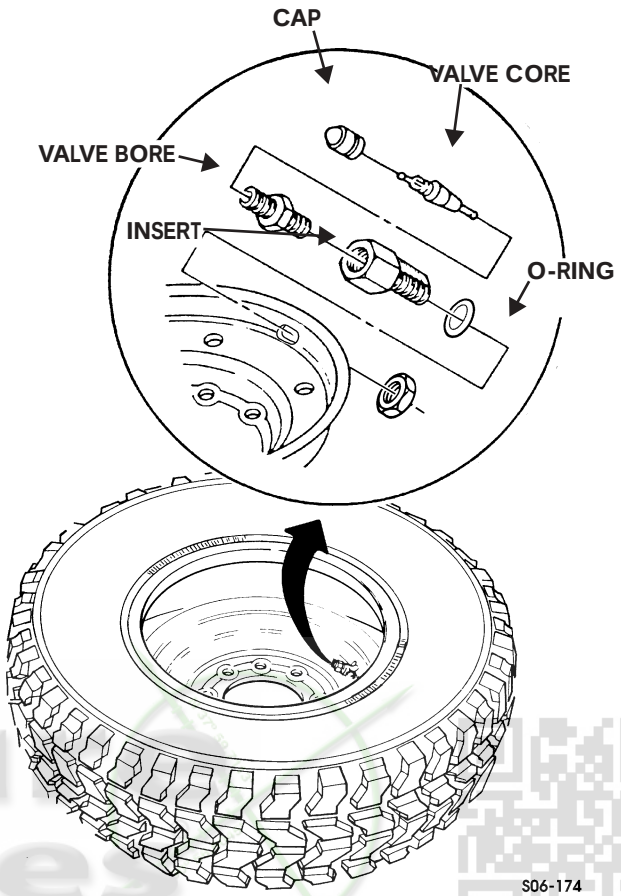


Figure 6-25: Valve Assembly

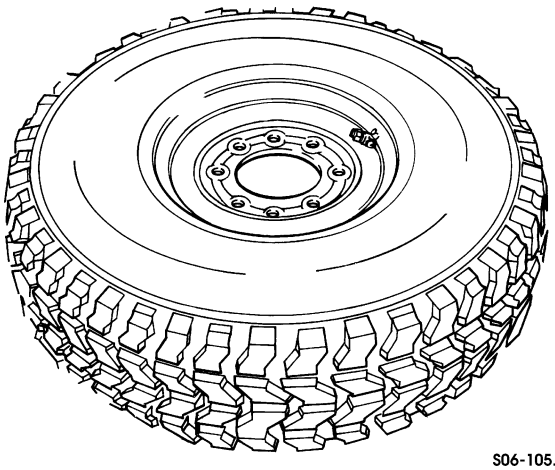


Figure 6-26: Tire

WARNING: Always use a tire inflation cage for inflation purposes. Stand one side of cage during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate assembly to recommended pressure using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

9. Inflate tire to recommended tire pressure.
10. Check for leaks around wheel edges, insert, and valve bore with soapy solution (Figure 6-27).

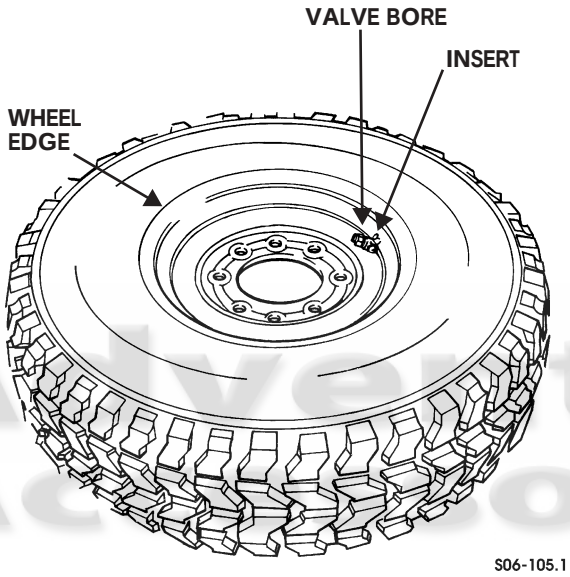


Figure 6-27: Leak Check Areas

11. Install wheel on vehicle.

Adjustment

CAUTION: *Do not make adjustments on only one eccentric washer. Failure to alternate between the two eccentric washers, when required, will result in damage to equipment.*

1. Remove three screws from eccentric washer (Figure 6-21).
2. Rotate eccentric washer 180 degrees.

NOTE: If runflat seating is not corrected, perform steps 1 and 2 for the other eccentric washer.

NOTE: If runflat seating is not corrected, perform step 2 alternating between the two eccentric washers.

NOTE: Perform step 3 for both washers if necessary.

3. Install 3 screws on eccentric washers.

RUNFLAT COMPRESSOR BELT REPLACEMENT

Removal

NOTE: Perform steps 1 through 3 for runflat compressor without handle. Perform step 4 for runflat compressor with handle. Note position of belts for installation.

1. Remove small pin from belt and worm gear shaft assembly. Discard small pin (Figure 6-28).

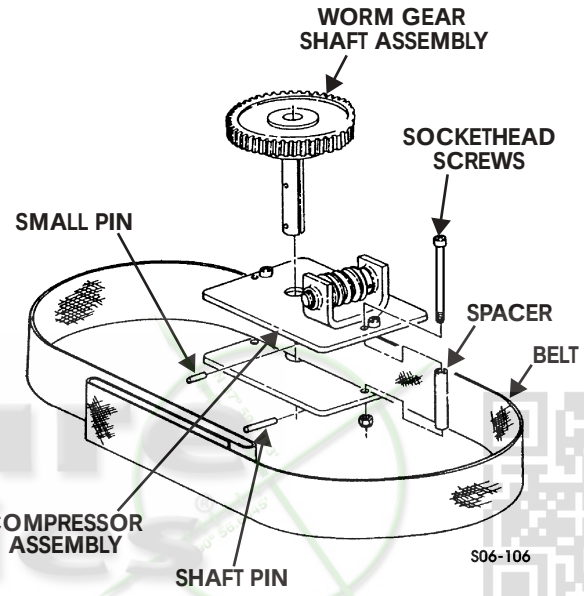


Figure 6-28: Remove and Discard Small Pin

2. Remove shaft pin and worm gear shaft assembly from compressor assembly. Discard shaft pin.
3. Remove two locknuts, sockethead screws, and spacers from belt and compressor assembly. Discard locknuts.
4. Remove locknut, capscrew, and belt from compressor. Discard locknut (Figure 6-28).

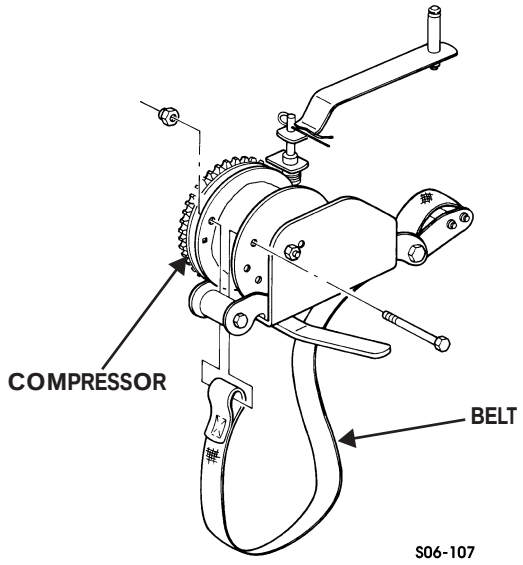


Figure 6-29: Removing Runflat Compressor Belt

Installation

NOTE: Belt overlap is to be positioned so that you have equal amount of belt on each side of the worm gear shaft assembly. Perform steps 1 through 3 for runflat compressor without handle. Perform steps 4 and 5 for runflat compressor with handle.

1. Install belt on compressor assembly with two spacers, sockethead screws, and locknuts (Figure 6-29).
2. Install worm gear shaft assembly on compressor assembly with shaft pin.
3. Secure belt on worm gear shaft assembly with small pin.
4. Install belt on compressor with capscrew and locknut (Figure 6-29).
5. Loop free end of belt around retaining bracket (Figure 6-30).

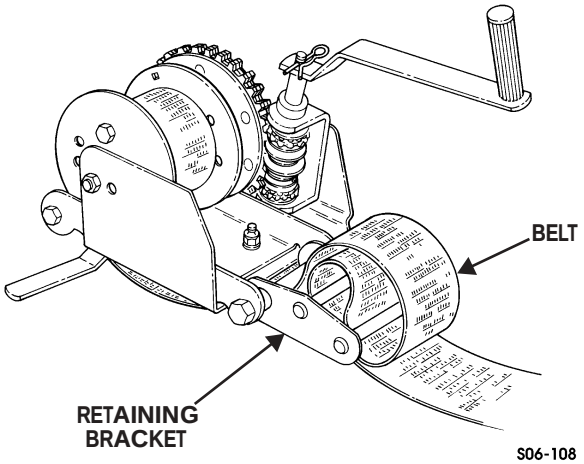


Figure 6-30: Loop Belt Around Retaining Bracket

WHEEL AND TIRE BALANCING

General

There are two types of tire and wheel balancing: static and dynamic. Static balance is the equal distribution of weight around the wheel. Wheel that are statically unbalanced cause a bouncing action called vehicle shake and possible steering nibble or oscillation. This condition will eventually cause uneven tire wear (Figure 6-31).

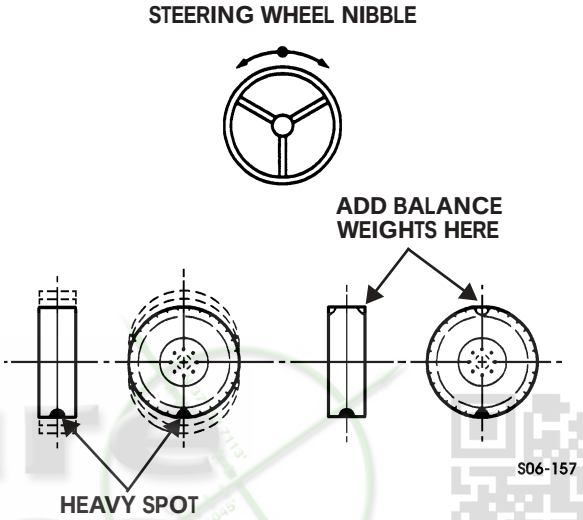


Figure 6-31: Steering Nibble

Dynamic balance is the equal distribution of weight on each side of the centerline, so that when the wheel spins there is no tendency for it to move from side to side. Wheels that are dynamically unbalanced may cause wheel shimmy, vehicle shake or a steering wheel vibration called nibble or oscillation (Figure 6-32).

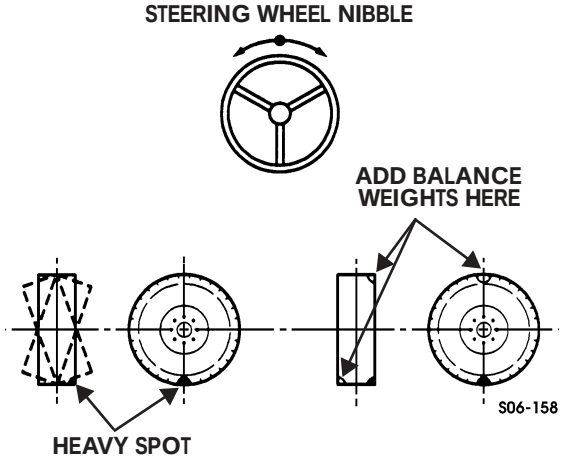


Figure 6-32: Dynamic Imbalance and Lateral Runout

NOTE: Most electronic off-vehicle balancers are more accurate than on-vehicle spin balancers. They are easy to use and give a dynamic (two-plane) balance. On-vehicle balancing is not recommended. When balancing off-vehicle, the wheel should be on the balancer with a cone through the back side of the center pilot hole or by the wheel (spindle) stud holes. The spindle stud method is recommended for CTIS wheels.

Balancing

1. Remove wheel and tire assembly from the vehicle.

WARNING: Remove all stones and foreign material from the tire tread before spin balancing. Failure to follow this warning may result in injury.

NOTE: Deposits of foreign material must be cleaned from the inside of the wheel and the tire tread to obtain a good balance. The tire should be inspected for obvious damage, then balanced according to the equipment manufacturers recommendations.

2. Mount wheel and tire assembly, curb side out, on dynamic balancer and start balance cycle (Figure 6-33).

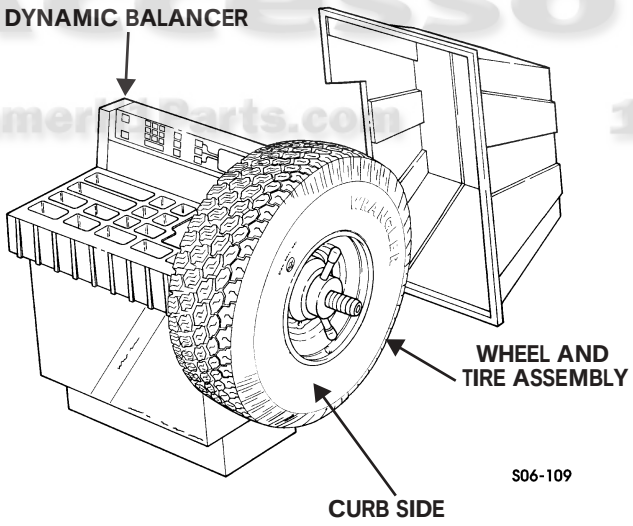


Figure 6-33: Dynamic Balancer

3. Locate and mark light spot on tire (Figure 6-34).
4. Record weight and position readings.

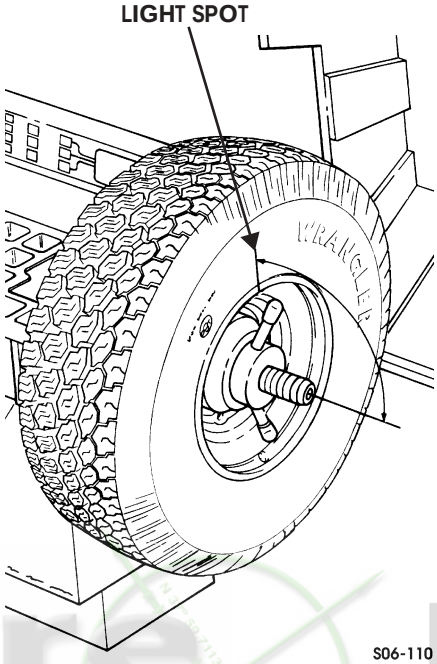


Figure 6-34: Light Spot

NOTE: If more than 15 oz. of weight is required to balance tire, wheel and runflat (if installed) must be disassembled and tire rotated 180° on wheel. Tires can be balanced using either adhesive backed tape-on or clip-on type weights. Do not use wheel balancing liquids to balance wheel and tire assembly.

5. Attach weights to inner and/or outer edges of wheel (indicated by dynamic balancer), ensuring weight clips are centered on light spot, or weights are placed evenly to sides of light spot if more than one weight is used. If installing weight clips, use a small hammer or clip-clawhammer tool. Tap weights to conform to wheel edge contour (Figure 6-35).
6. Start balance cycle and repeat steps 3 through 5 until tire is properly balanced.

7. Remove wheel and tire assembly from dynamic balancer and install on vehicle.

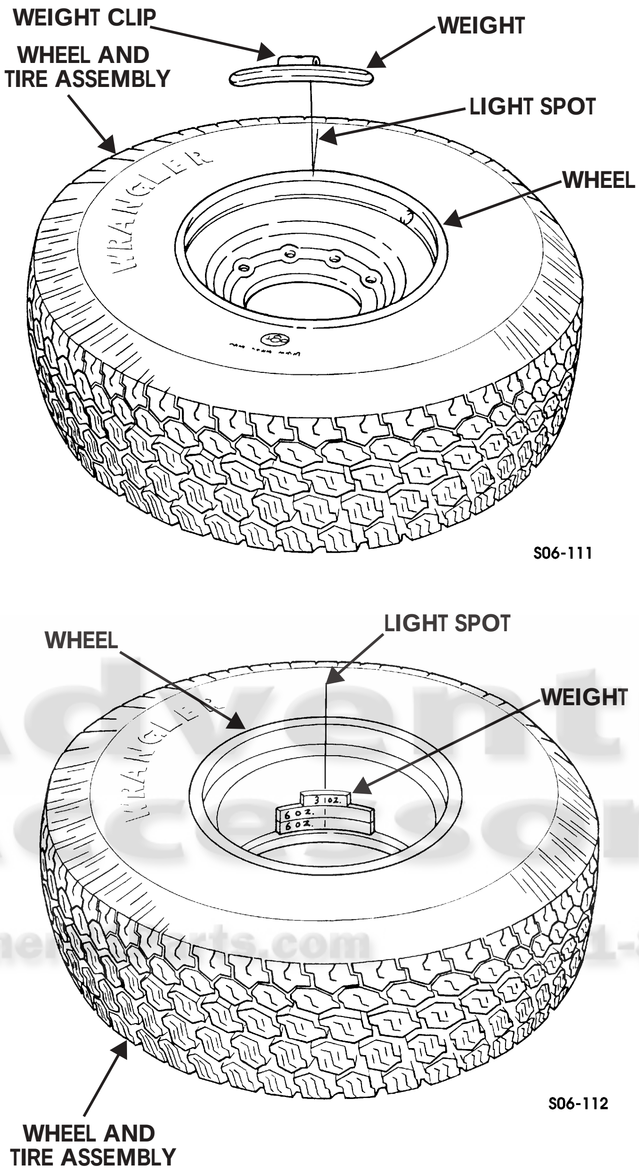


Figure 6-35: Weight Clips Placement

Non-Balancing Wheel and Tire Assembly

NOTE: If a wheel and tire assembly cannot be balanced, or balance cannot be maintained, any of the following conditions may be causing the problem:

- A ruptured or loose lubricant packet (grease pack) in a tire that had been driven with low tire pressure.
- Runflat movement on the runflat spacer and rim.
- Excessive runout condition on the wheel rim.
- Improper seating of tire bead on the rim flange.

NOTE: Perform steps 1 through 6 if a lubricant packet has ruptured, becomes loose, or the runflat is moving on the runflat spacer and rim. If an excessive runout condition on the rim is suspected, proceed to Wheel Runout Inspection.

1. Disassemble wheel and remove runflat from tire.
2. If lubricant packet has ruptured, remove existing adhesive tape, ruptured lubricant packet, and strapping tape from the runflat.
3. Clean inside of tire, rim, runflat spacer, and O-ring seal with cleaning fluid. Allow parts cleaned with fluid to dry prior to assembly.
4. Apply gel lubricant at crown area on inside tire area.
5. Install runflat into tire and assemble wheel.
6. Balance wheel and tire assembly.

WHEEL RUNOUT INSPECTION

NOTE: It is suggested that the lateral runout check be done first, as excessive lateral runout can affect radial runout.

1. Clean dirt, debris, or rust from wheel.
2. Inspect wheel and wheel centering washers for wear or damage. Repair as needed.

NOTE: Ensure measurements are taken from the inboard and outboard rim flanges for radial and lateral runout. Ensure measurements are taken on a smooth rim surface area having no welds, paint runs, or scratches (Figure 6-36). Runout measuring can be performed with the wheel completely assembled or just with the rim(s). If an improperly seated tire bead on the rim flange is suspected, perform steps 4 through 7.

1. With wheel or rim on wheel balancer, place dial indicator in position and slowly rotate wheel one revolution. Record measurement (Figure 6-36).
2. If **lateral** runout exceeds 0.060 in. (1.52 mm), replace inner or outer rim (as applicable) on wheels equipped with two-piece rims and entire rim on wheels equipped with one-piece rims.
3. If **radial** runout exceeds 0.060 in. (1.52 mm), replace inner or outer rim (as applicable) on wheels equipped with two-piece rims and entire rim on wheels equipped with one-piece rims.
4. With new rim(s), assemble and balance wheel and tire assembly.
5. Ensure that the tire is properly mounted and seated on the rim. Check the distance between the GG rings on the tire and the rim flange. The distance between the GG rings and the rim flange should be the same (concentric) all the way around the tire (Figure 6-37).
6. Ensure GG rings are not recessed below the rim flange at any point around the rim.
7. If the GG rings are recessed below the rim flange, remove the tire from the rim and reinstall it.
8. Balance wheel and tire assembly.

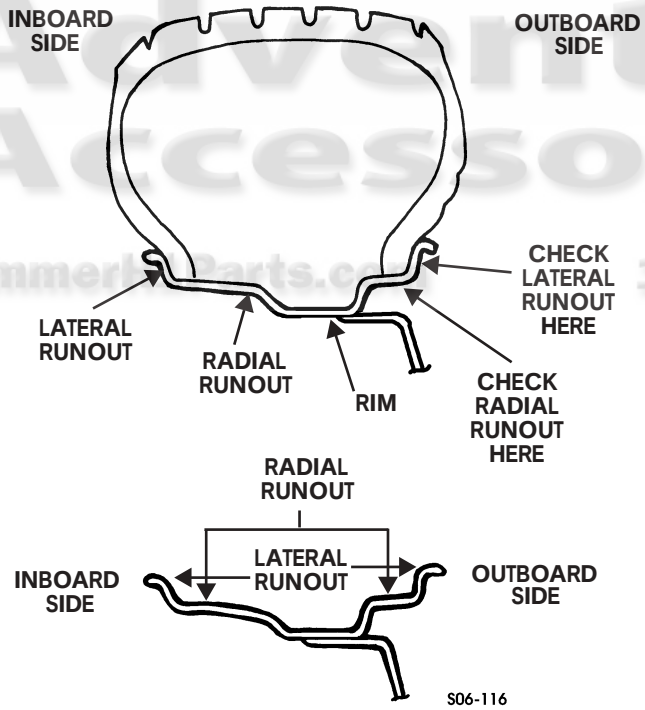


Figure 6-36: Wheel Runout Inspection Points

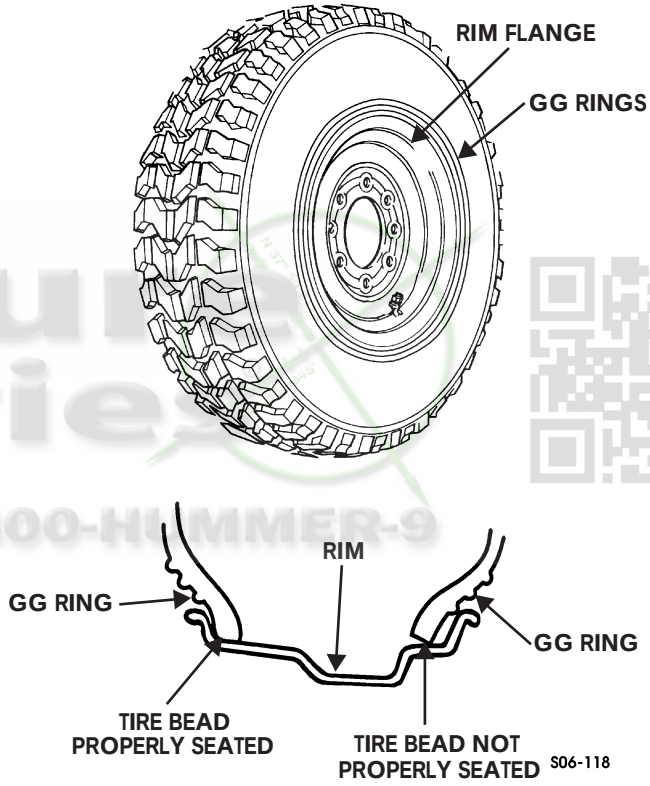
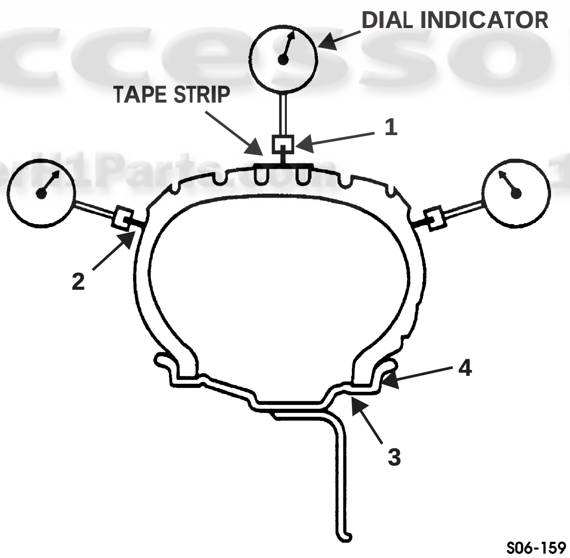


Figure 6-37: Checking the Bead Seating

Wheel And Tire Assembly Runout

NOTE: Before measuring the runout of a tire and wheel assembly, drive the vehicle long enough to warm up the tires. Then do the following:

1. Install tire and wheel assembly on wheel balancer.
2. Apply 2 inch wide tape strip around tire circumference (Figure 6-38).
3. Position a dial indicator with a magnetic base and a roller tip on the balancer so the different runout checks can be done (Figure 6-38).
4. DO NOT start the wheel balancer with the dial indicator in place. The checks should be done by slowly rotating the tire BY HAND ONLY.
5. Slowly rotate the assembly one complete turn and zero the dial indicator on the low spot.
6. Rotate assembly one more complete turn and note amount of runout.
7. When measuring at points 1 and 3 the maximum allowable wheel and tire radial runout is 0.210 in. and maximum allowable lateral runout is 0.120 in. (Figure 6-38).



1. Tire Radial Runout Checkpoint
2. Tire Lateral Runout Checkpoint
3. Wheel Radial Runout Checkpoint
4. Wheel Lateral Runout Checkpoint

Figure 6-38: Tire and Wheel Runout Checkpoints

Geared Hubs Spindle and Stud Runout

When wheel and tire runout occurs on the vehicle and does not occur in off-vehicle testing, the geared hub spindle should be checked (Figure 6-39).

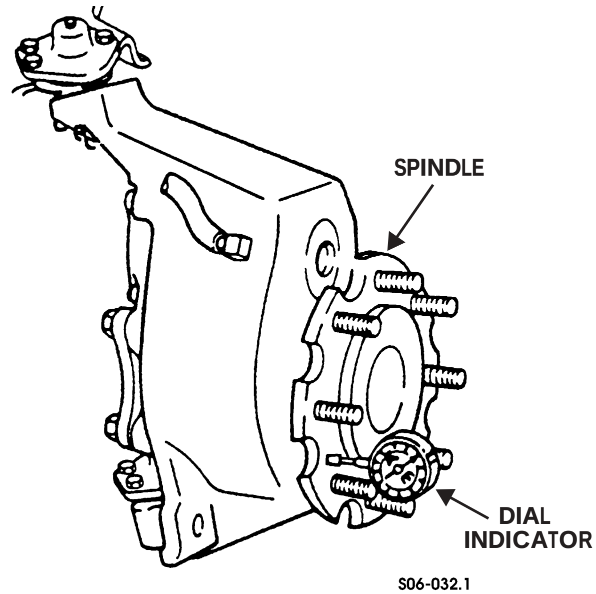


Figure 6-39: Geared Hub Spindle Runout Check

Geared Hub Spindle Runout

Using a dial indicator, position the roller tip on the machined surface outside the bolts on the spindle face.

Measure the runout using the following method:

1. Turn the spindle to locate the low spot.
2. Zero the dial indicator.
3. Turn the spindle to check the total lateral runout.
4. 0.005 inch is the acceptable lateral runout.

Measuring Spindle Stud Runout

Position the dial indicator roller to contact the outer edge of each spindle stud. Ensure that stud(s) are fully pressed in, if not replace the stud(s) (Figure 6-40).

Measure the runout using the following method:

1. Turn the spindle to register on each of the studs.
2. Zero the dial indicator on the lowest stud.
3. Check the total runout on the remaining studs.

4. 0.020 inch is the acceptable radial runout.

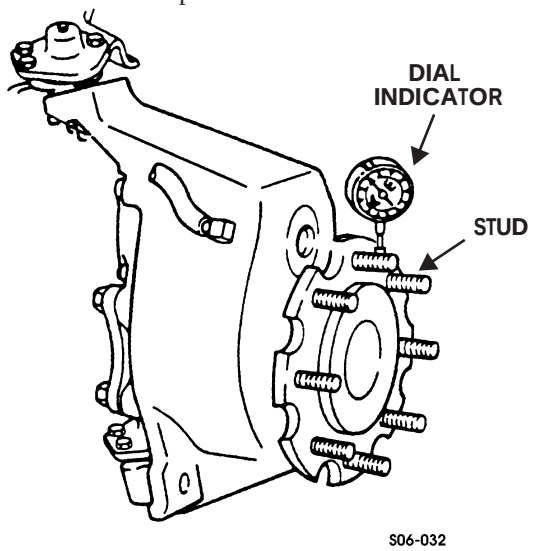


Figure 6-40: Spindle Studs Runout Check

WHEEL ALIGNMENT

Perform alignment checks on an alignment rack with the front tires in a straight-ahead position. Refer to illustration for component identification as necessary (Figure 6-41).

To complete the toe check and settings, position the vehicle so that both wheels are on the alignment turntables. Set the turntables to zero with both wheels in the straight-ahead position.

Preliminary Inspection

1. Check all tires for condition, uniform tread wear, excessive run-out, and proper inflation.
2. Raise and support the vehicle. Secure the steering wheel.
3. Check geared hubs for output spindle end play or side-to-side movement by grasping the edge of the tire and attempting to move the tire up and down (Figure 6-42).

NOTE: If any spindle movement is apparent, adjust the spindle bearings.

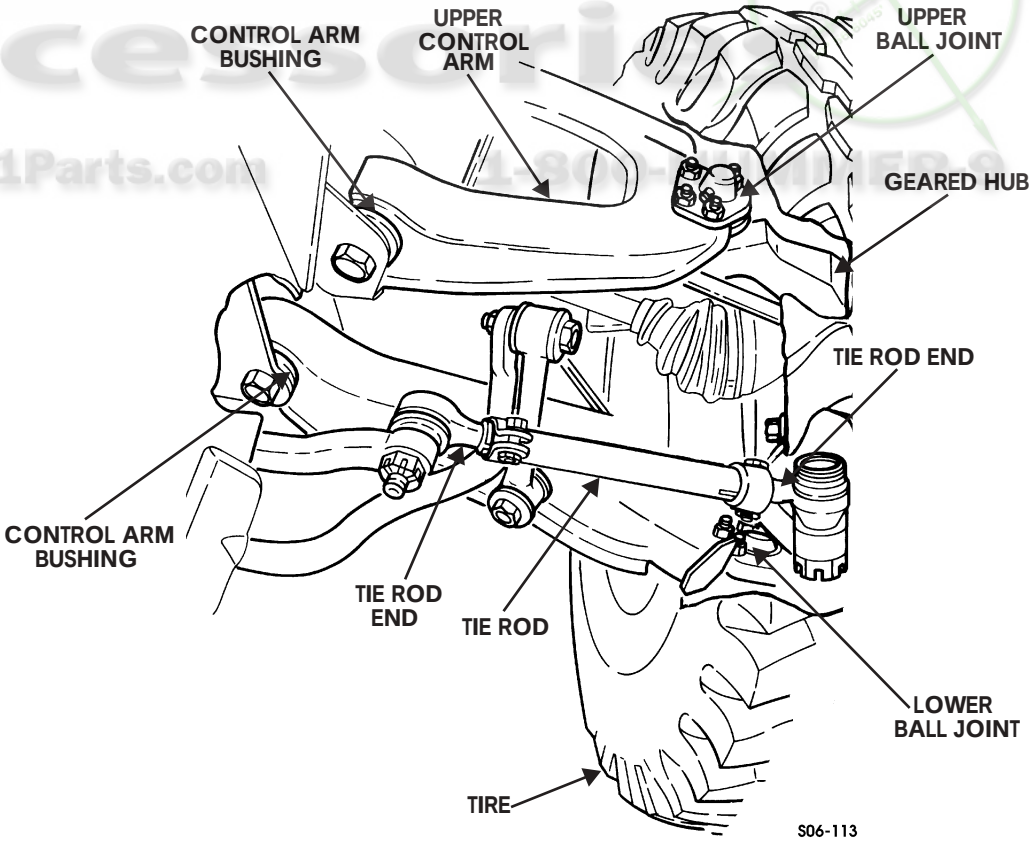


Figure 6-41: Suspension Components

4. Check the upper ball joints for looseness by grasping the top of the tire and attempting to move the tire in and out. Replace the upper ball joint(s) if tire movement at the tire's top outer edge is 3/8 inch (10 mm) or more.

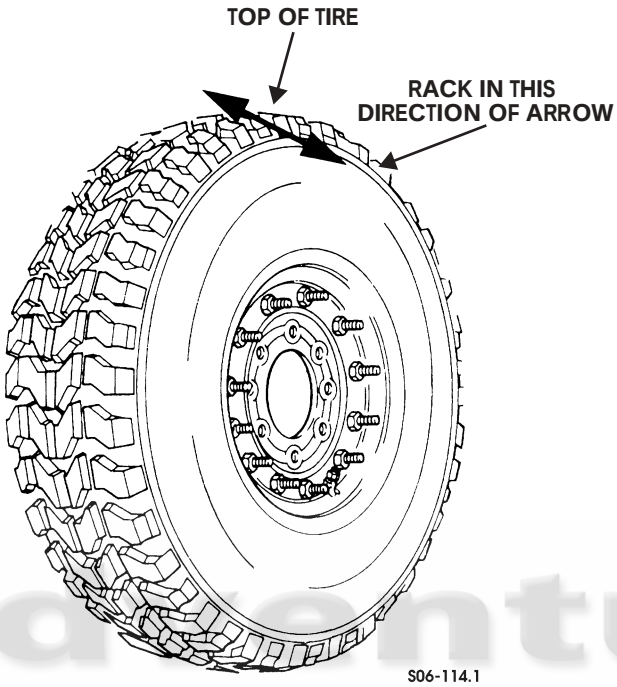


Figure 6-42: Spindle and Ball Joint Check

5. Inspect for worn, missing, or damaged control arm bushings. Replace bushings if necessary.
6. Check the lower ball joints for looseness by grasping the bottom of the tire and attempting to move the tire in and out. Replace the lower joint(s) if tire movement at the bottom outer edge of the tire is 1/2 inch (13 mm) or more.
7. Check for looseness in the idler arm and pitman arm by grasping the tires at the front and rear outer edges and moving the tires in and out. Replace the idler arm if vertical motion at the center link exceeds 5/16 inch (8 mm) or if the ball joint lateral motion exceeds 1/8 inch (3 mm). Replace the steering shaft if vertical motion at the center link exceeds 1/8 inch (3 mm) or if the ball joint lateral motion exceeds 1/32 inch (0.8 mm) (Figure 6-43).
8. Lower the vehicle.
9. Check the tie rod ends for looseness by attempting to move the tie rod vertically and horizontally. Replace the tie rod end(s) if any movement is apparent.
10. Inspect the center link for distortion. Center link deformation may be indicated by noticeable front wheel toe-out. If center link deformation is suspected, remove the suspect center link from the vehicle and place it on a level surface next to a new center link. Carefully compare the two parts, checking for distortion and tapered hole wear. Replace the suspect center link if tapered holes are worn or if the center link is found to be distorted.
11. Check the center link and stabilizer bar for nicks, cracks, or bends. Replace if necessary.
12. Inspect the stabilizer bar bushings for excessive wear and/or distortion. Replace if necessary.
13. Check the steering gear for looseness-to-frame, proper

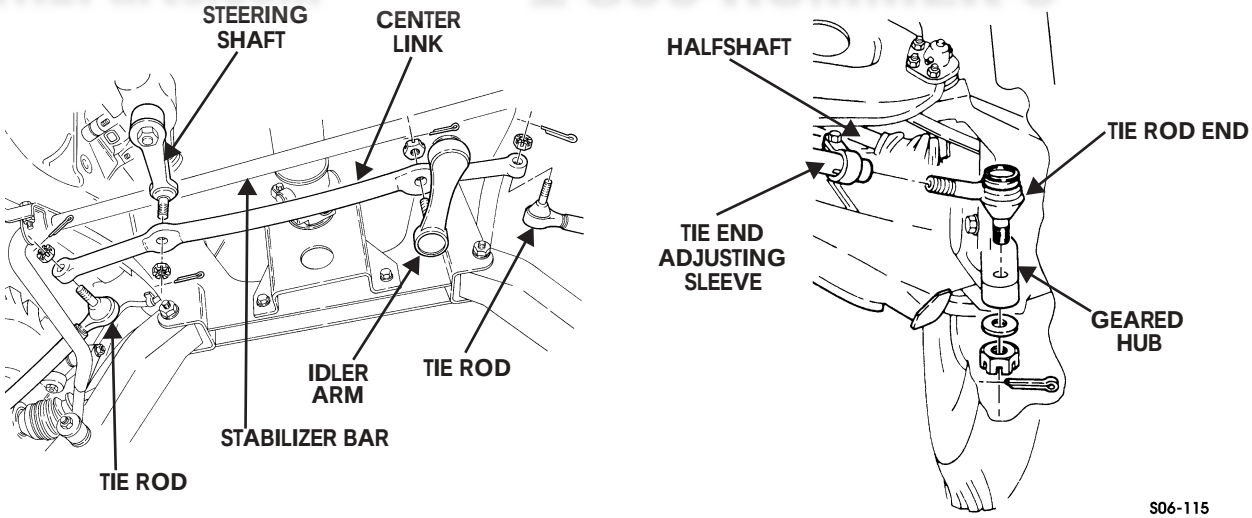


Figure 6-43: Suspension Component

CHECKING WHEEL ALIGNMENT

1. Move vehicle onto alignment rack and position front tires on alignment rack turntables.
2. Place front wheels in straight ahead position and zero turntables.
3. Install alignment measuring equipment on vehicle wheels. Follow manufacturers instructions to avoid incorrect measurements.
4. Measure and record caster, camber, toe-in, and toe-out. Refer to alignment specifications (Figure 6-44).
5. If alignment angles are within specified limits, move vehicle from rack. However, if angles are incorrect, leave vehicle on alignment rack and proceed to Wheel Alignment Correction.

WHEEL ALIGNMENT SPECIFICATIONS

		SERVICE CHECKING			SERVICE SETTING		
Wheel Suspension	**Tire Pressure (PSI)**	**Caster (Degrees)**	**Camber (Degrees)**	**Toe-Total (Degrees)**	**Caster (Degrees)**	**Camber (Degrees)**	**Toe-Total (Degrees)**
Front	26	+ 1.5 to + 4.0 (b)	-0.2 to +1.75 (b)	0 to +0.25 (c)	+ 2.5 to + 3.5 (a)	+ 0 to + 0.50 (a)	+ 0 to +0.19 (e)
Rear	28	na	-0.2 to +1.75 (b)	(-0.25 to 0) (d)	na	+.25 to +0.75 (a)	(-0.19 to 0) (e)

(a) Left and right side to be equal within 0.5 degrees.

(b) Left and right side to be equal within 1.0 degrees.

(c) Toe-in (Positive sense) left and right sides to be set separately per wheel. Steering wheel must be held in a center position within + or - 5 degrees.

(d) Toe-out (negative sense) left and right side to be set separately per wheel.

(e) Left and right sidetoe settings to be equal within 0.10 degree

NOTE: Alignment settings should be checked and adjusted on a rack that allows all four wheels/tires to support vehicle weight.

Set wheel alignment while the vehicle is in a normally loaded condition.

Vehicles regularly operated with heavy, on-board loads should have alignment adjusted with the load in the vehicle.

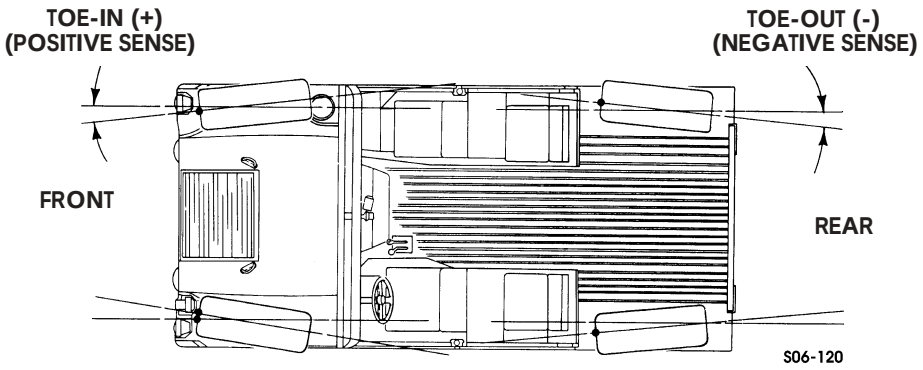


Figure 6-44: Wheel Alignment Specifications

WHEEL ALIGNMENT CORRECTION

Alignment adjustments should be performed one at a time and in sequence to avoid errors. Recommended adjustment sequence is:

a. caster

b. camber

c. front toe setting

d. rear toe setting

e. steering stops

Leave the vehicle on the alignment rack for each of the adjustment procedures. This way, angle correction can be monitored continuously during actual adjustment.

Caster Adjustment

Caster adjustment applies to the front wheels only. It is controlled by a shim installed between the airlift bracket and upper control arm front bracket (Figure 6-45). A positive caster angle is required on all Hummer vehicles.

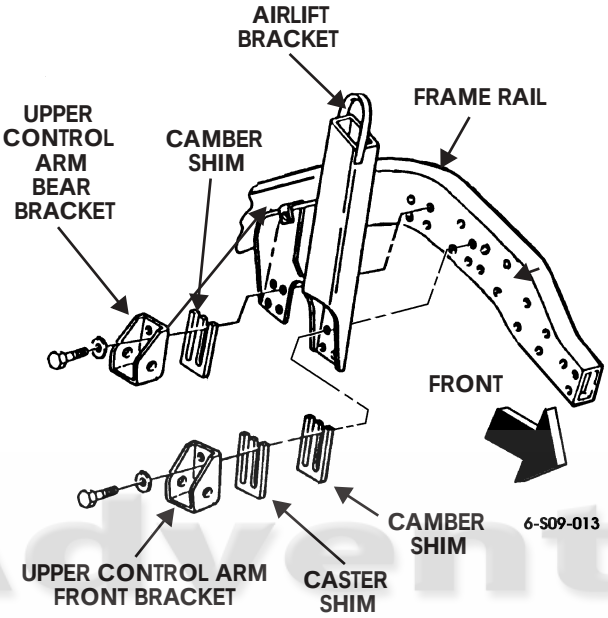


Figure 6-45: Caster Shim Location (Front Passenger Side Shown)

Preferred caster angle is +2.5 to +3.5 degrees. Maximum allowable side-to-side variation is 0.5 degree.

1. Support lower control arms and geared hubs with jack built into alignment rack. Or, use floor jack and jack stands if rack is not equipped with built-in jack.
2. Remove front wheels.
3. Remove upper control arm pivot bolts (Figure 6-46). Retain bolts and washers but discard nuts if they are lock-type.
4. Loosen bolts that attach upper control arm brackets to airlift bracket and frame (Figure 6-46). Do not remove the bolts; just loosen them.
5. Adjust caster angle by changing caster shim between control arm front bracket and airlift bracket (Figure 6-43):
   - Preferred caster is +2.5 to +3.5 degrees and left-right variation must not exceed 0.5 degree
   - A thicker shim increases positive caster while a thinner shim decreases it
   - Shims are available in 0.060 inch and 0.120 inch (1.5 and 3.0 mm) thicknesses for adjustment purposes. An 0.060 inch shim will change caster approximately 0.3 degrees and a 0.120 inch shim will change caster approximately 0.6 degrees.
6. Add or remove shims as needed. Then tighten control arm and airlift bracket attaching bolts to 60 ft.lbs. (81 N.m) torque.
7. Install but do not fully tighten upper control arm pivot bolts.
8. Install front wheels.
9. Remove supports and position front wheels on turntables.
10. Tighten control arm pivot bolts to 260 ft. lbs. (352 N.m) torque.
11. Verify correct caster angle at both front wheels. Be sure side-to-side caster variation does not exceed 0.5 degree.
12. Leave vehicle on rack for camber and toe adjustments.

Camber Adjustment

Camber adjustment applies to the front and rear wheels equally. It is controlled by shims installed between each upper control arm bracket and the airlift bracket (Figure 6-44).

Preferred camber for all Hummer vehicles is zero to +0.5 degrees at the front and +0.25 to +0.75 degrees at the rear. Maximum allowable side-to-side variation is 0.5 degree front and rear.

1. Support lower control arms and geared hubs with jack built into alignment rack. Or, use floor jack and jack stands if rack is not equipped with built-in jack.
2. Remove front and/or rear wheels as needed.
3. Remove upper control arm pivot bolts (Figure 6-44). Retain bolts and washers but discard nuts if they are lock-type.
4. Loosen bolts that attach upper control arm brackets to airlift bracket and frame (Figures 6-43 and 6-44). Do not remove the bolts; just loosen them.
5. Adjust camber angle by changing shim between each control arm bracket and airlift bracket (Figure 6-44):
   - Use the same thickness shims between each control arm bracket and the airlift bracket
   - Do not disturb the previously installed front wheel caster shims. Simply insert the camber shims behind, or in front of the caster shims.
   - A thicker shim increases positive camber. A thinner shim decreases positive camber. Shims are available in 0.060 inch and 0.120 inch (1.5 and 3.0 mm) thicknesses for adjustment purposes.
6. Add or remove shims as needed. Then tighten control arm and airlift bracket attaching bolts to 60 ft.lbs. (81 N.m) torque.
7. Install but do not fully tighten upper control arm pivot bolts.
8. Install front and/or rear wheels as needed.
9. Remove supports and position front wheels on turntables.
10. Tighten control arm pivot bolts to 260 ft. lbs. (352 N.m) torque.
11. Verify correct camber angle at both front wheels. Be sure side-to-side variation does not exceed 0.5 degree.
12. Leave vehicle on rack for toe settings and steering stop adjustment

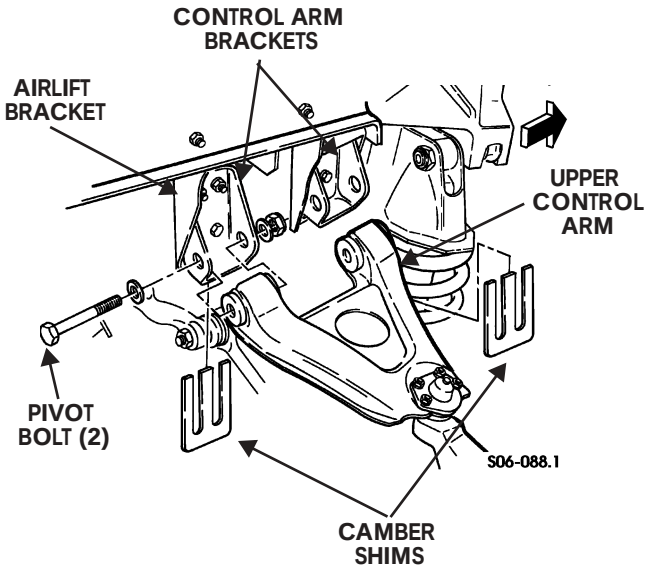


Figure 6-46: Camber Shim Locations (Front Passenger Side Shown)

Front Wheel Toe Adjustment

1. Position the vehicle so that both front wheels are on turn tables. Set the turn tables to zero with the front wheels in the straight-ahead position. Center the steering gear to set the front wheels in the straight-ahead position.
2. Loosen four locknuts securing clamps on two tie rod assemblies. Turn the adjusting sleeves until toe measurement is within specifications. Tighten the adjusting sleeve clamp nuts and recheck toe adjustment. Compare with alignment specifications (Figure 6-47).

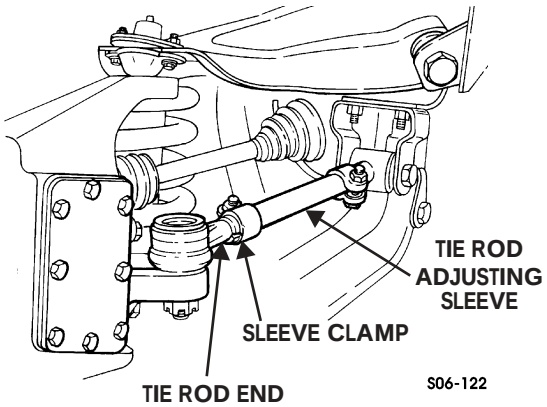


Figure 6-47: Front Wheel Toe Adjustment Point

***CAUTION**: Ensure that the bolt and nut on the adjusting sleeve clamp nut nearest to the geared hub is facing the halfshaft. The bolt and nut on the adjusting sleeve clamp nearest to the frame must be facing away (180 degrees) from the stabilizer bar. After adjustment, the lengths of*

both tie rod end assemblies should be the same, plus or minus 1/16 inch (1.6 mm) (Figure 6-48).

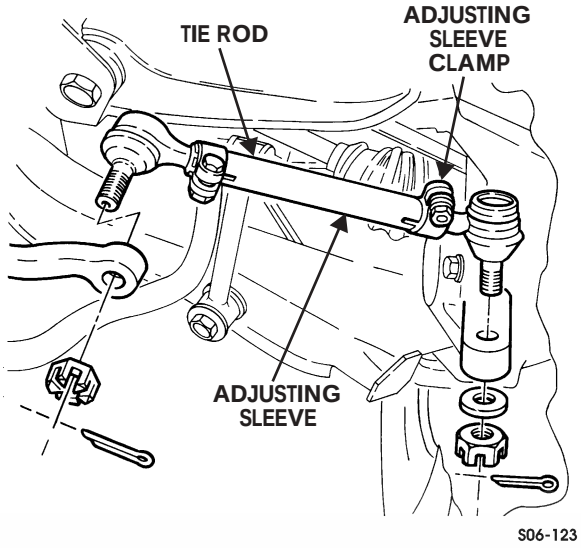


Figure 6-48: Tie Rod Adjusting Sleeve Location

3. Check steering wheel orientation. If incorrect, reposition to the straight-ahead position.

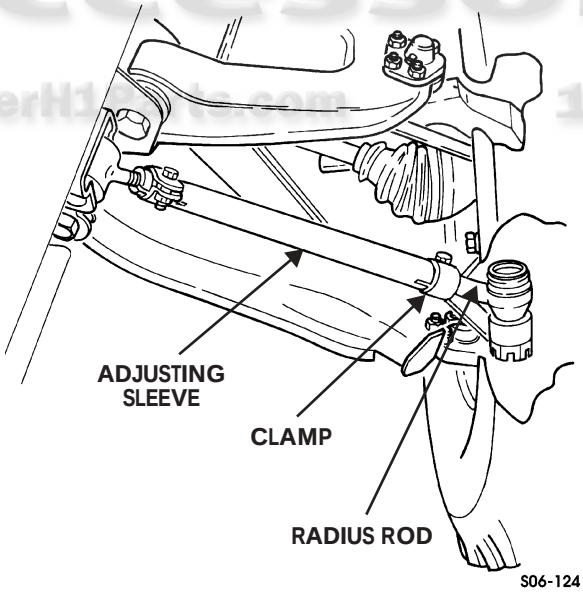


Figure 6-49: Rear Wheel Toe Adjustment Point

Rear Wheel Toe Adjustment

1. Position the vehicle so that both rear wheels are on turntables.
2. Loosen four locknuts securing four clamps on two rods. Turn the adjusting sleeves until toe measurement is within specifications (Table 2). Tighten the adjusting clamp nuts and recheck toe adjustment. Compare with alignment specifications (Figure 6-49).

Steering Stop Adjustment

1. Position the vehicle so that both front wheels are on turn tables. Set the turn tables to zero with front wheels in the straight-ahead position.
2. Turn the steering wheel full left and record the steering stop angle.
3. Turn the steering wheel full right and record the steering stop angle.
4. If both of the steering stop angles are within 34-36 degrees, no adjustment is necessary.
5. To adjust the steering stop angle, loosen the jamnut and turn the capscrew all the way in (Figure 6-50).
6. Turn the steering wheel until the wheel requiring adjustment obtains the steering stop angle.
7. Loosen the capscrew until the head makes contact with the wheel stop on the lower control arm.
8. Secure the steering stop capscrew with jamnut.
9. Be sure there is adequate clearance between the tie rod clamp and the rim. If clip-on wheel weights are mounted on the rim, ensure that they do not hit the tie rod clamp or geared hub.

***CAUTION**: Ensure that the bolt and nut on the adjusting sleeve clamp nut nearest to the geared hub is facing the halfshaft. The bolt and nut on the adjusting sleeve clamp nearest to the frame must be facing away (180 degrees) from the stabilizer bar. After adjustment, the lengths of both tie rod end assemblies should be the same, plus or minus 1/16 inch (1.6 mm).*

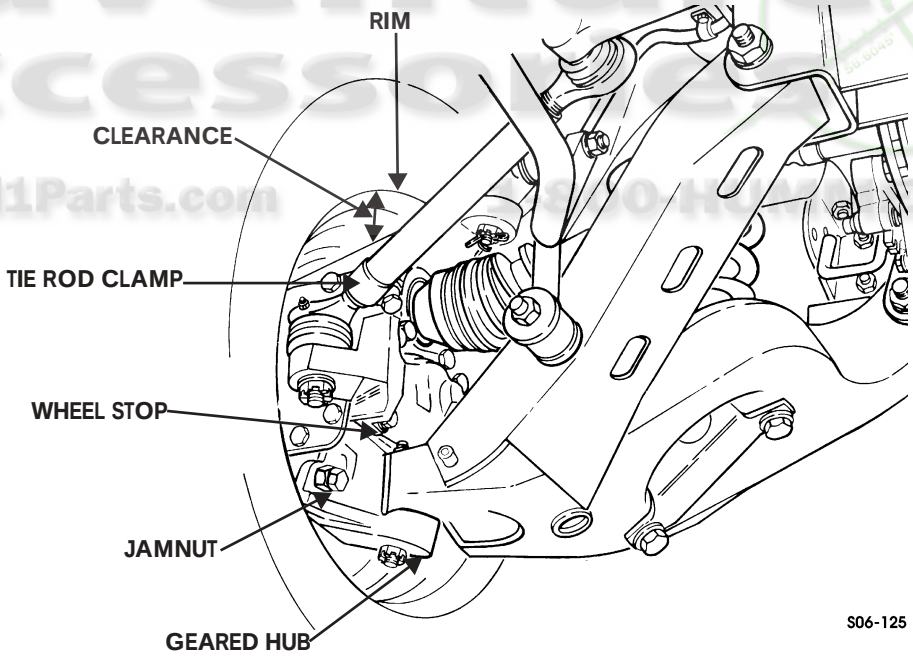


Figure 6-50: Steering Stop Adjustment

HALFSHAFT BOOT MAINTENANCE

Removal

NOTE: Inner and outer boots are replaced similar. This procedure covers the inner boot only.

1. Remove wheel.
2. Remove access plug and washer from geared hub (Figure 6-51).
3. Remove halfshaft retaining capscrew, lockwasher, and halfshaft from geared hub. Discard lockwasher.
4. Remove six capscrews, lockwashers, and halfshaft from rotor. Discard lockwashers.

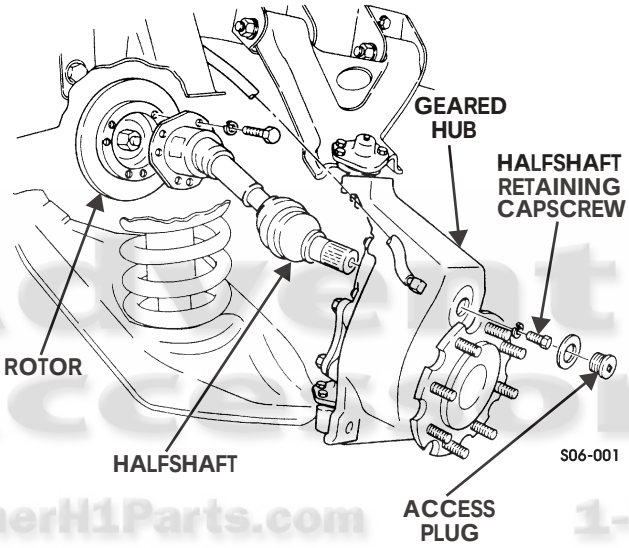


Figure 6-51: Halfshaft Retaining Capscrew

5. Loosen two clamps securing inner boot to inner joint and shaft (Figure 6-52).
6. Remove inner boot from inner joint and slide up on shaft.
7. Clamp shaft in soft-jawed vise.
8. Remove retainer clip from inner joint.
9. Remove inner joint, retainer clip, and six ball bearings from bearing assembly.

NOTE: Remove excess grease from bearing assembly.

10. Use boot clamp pliers, special tool 5743141, remove spacer ring from groove and slide spacer and bearing assembly up on shaft - 3/8 in. (Figure 6-53).
11. Pry exposed retaining ring from shaft. Discard retaining ring.
12. Remove bearing assembly and spacer ring from shaft. Discard spacer ring (Figure 6-53).

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace halfshaft if necessary.

1. Clean all metallic parts with solvent.
2. Inspect shaft assembly for damage, and replace if damaged.
3. Inspect splined end of halfshaft for damage.

Installation

1. Clamp shaft in soft-jawed vise.
2. Position two clamps on shaft (Figure 6-55).
3. Install inner boot on shaft. Push boot past groove on shaft.
4. Install the spacer ring and retaining ring into ring grooves on shaft (Figures 6-53 and 6-54).
5. Align chamfer splines of inner bearing assembly with spline of shaft. Use press or rawhide hammer to install bearing assembly until it snaps in place - flush against spacer ring.
6. Position six ball bearings into bearing assembly and retain with a slight amount of grease (Figure 6-52).

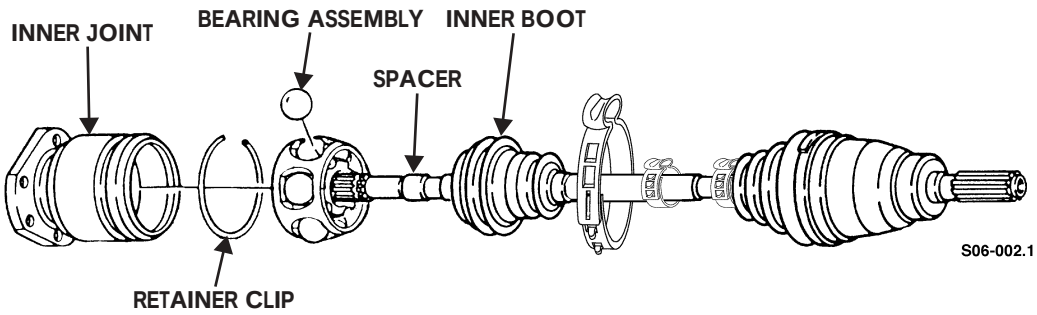


Figure 6-52: Halfshaft Assembly

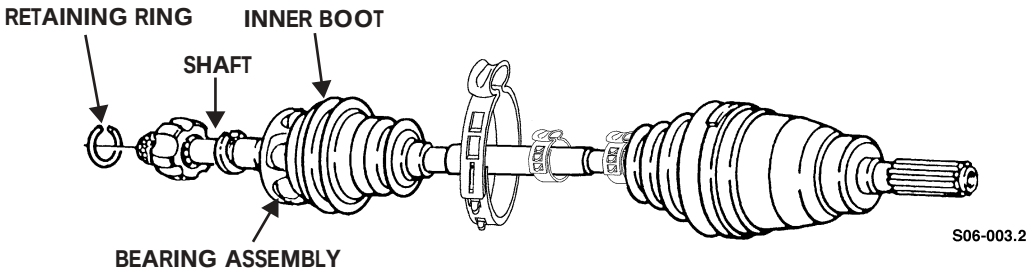


Figure 6-53: Halfshaft Assembly

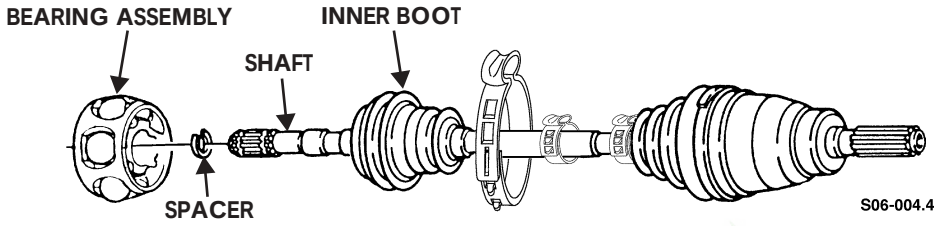


Figure 6-54: Halfshaft Assembly

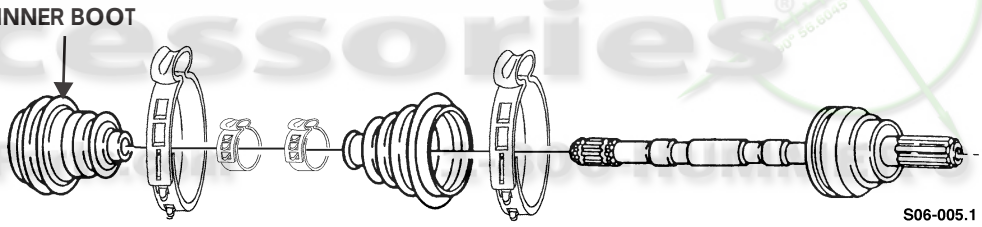


Figure 6-55: Halfshaft Assembly

7. Position joint inner housing over bearing assembly.

NOTE: Ensure all ball bearings are in the tracks of the inner joint.

8. Secure retainer clip in groove of inner joint housing.
9. Fill inner joint with grease from grease packet.
10. Move inner boot on shaft until boot seats in groove of shaft.
11. Secure inner boot on shaft with clamp.
12. Install inner boot on inner joint. Ensure boot seats in groove of joint.
13. Secure inner boot on inner joint with clamp. Use boot clamp plier, special tool 05743141.
14. Install halfshaft into geared hub.
15. Apply thread-locking compound to halfshaft retaining capscrew and install halfshaft on geared hub with lockwasher and halfshaft retaining capscrew. Tighten halfshaft retaining capscrew to 37 lb-ft (50 N•m) (Figure 6-51).
16. Install washer and access plug into geared hub. Tighten access plug to 8-13 lb-ft (11-18 N•m).

NOTE: Ensure all six capscrew holes in the rotor align with holes in output flange.

17. Apply Loctite 272 to six capscrews. Install halfshaft to rotor with six lockwashers and capscrews. Tighten capscrews to 48 lb-ft (65 N•m).
18. Install wheel.

GEARED HUB REPLACEMENT

NOTE: Replacement procedures are basically the same for front and rear geared hubs. This procedure covers the front geared hub.

Removal

1. Remove wheel.
2. Remove drainplug from geared hub and drain geared hub (Figure 6-56).

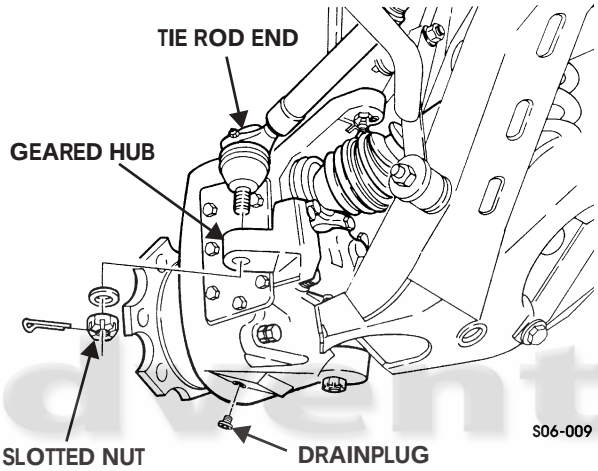


Figure 6-56: Geared Hub and Drainplug

3. Install drainplug in geared hub.
4. Remove capscrew, washer, and vent line bracket from geared hub (Figure 6-57).
5. Disconnect vent line from geared hub fitting.
6. Remove cotter pin, slotted nut, and washer from tie rod end. Discard cotter pin (Figure 6-56).
7. Using puller, disconnect tie rod end from geared hub.
8. Remove access plug, washer, halfshaft retaining capscrew, lockwasher, and halfshaft from geared hub. Discard lockwasher (Figure 6-57).

WARNING: Geared hub must be supported during removal and installation. Failure to support geared hub may cause injury to personnel or damage to equipment.

9. Remove cotter pin and slotted nut from upper ball joint. Discard cotter pin.
10. Remove cotter pin and slotted nut from lower ball joint. Discard cotter pin.
11. Lower support and remove geared hub.

Installation

WARNING: To avoid injury and damage to equipment, support geared hub during removal and installation.

1. Position geared hub between upper and lower control arms and install upper ball joint to geared hub with slotted nut, but do not tighten (Figure 6-57).
2. Install lower ball joint to geared hub with slotted nut, but do not tighten.

***CAUTION**: Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

3. Tighten slotted nut securing upper ball joint to geared hub to 65 lb-ft (88 N•m). Install cotter pin.
4. Install halfshaft into geared hub.
5. Apply thread-locking compound to halfshaft retaining capscrew and install halfshaft on geared hub with lockwasher and halfshaft retaining capscrew. Tighten halfshaft retaining capscrew to 37 lb-ft (50 N•m).
6. Install washer and access plug to geared hub. Tighten access plug to 8-13 lb-ft (11-18 N•m).

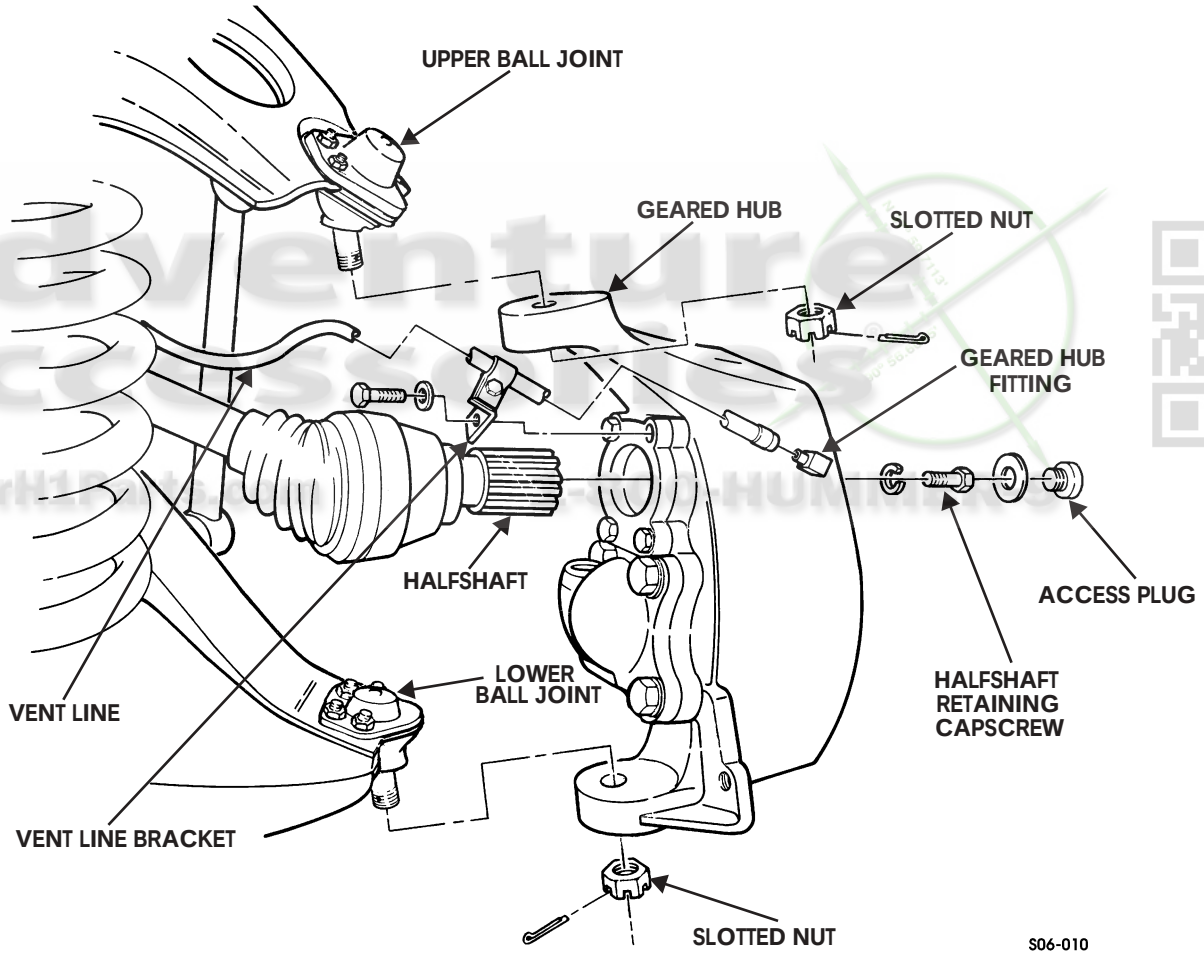


Figure 6-57: Geared Hub Assembly

***CAUTION**: Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

7. Tighten slotted nut securing lower ball joint to geared hub to 73 lb-ft (99 N•m). Install cotter pin.
8. Install tie rod end into geared hub and secure with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m). Install cotter pin (Figure 6-56).
9. Connect vent line to geared hub fitting (Figure 6-59).

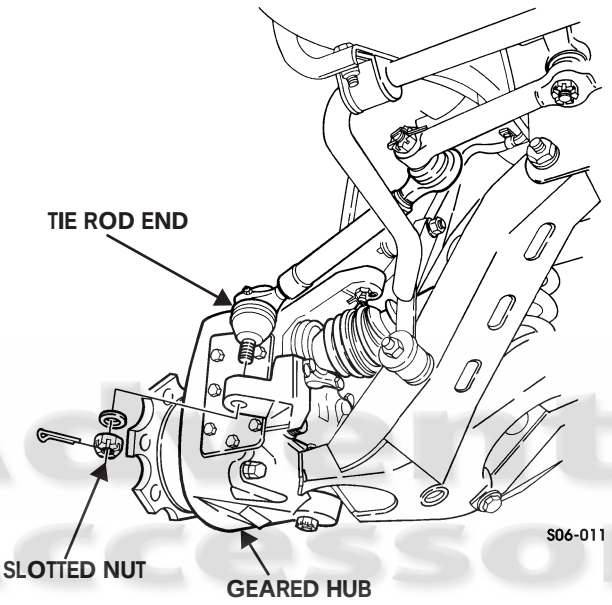


Figure 6-58: Tie Rod End Into Geared Hub

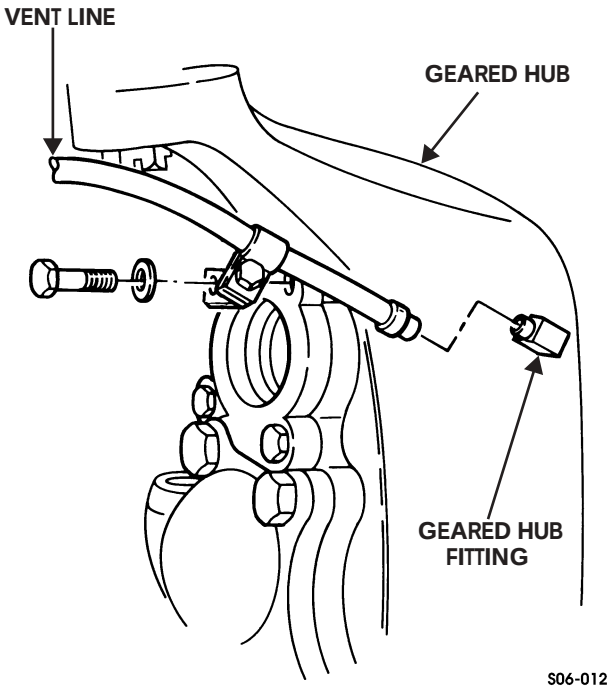


Figure 6-59: Vent Line

10. Install vent line and clamp to geared hub with washer and capscrew. Tighten capscrew to 38 lb-ft (52 N•m).
11. Remove fill plug and washer from geared hub (Figure 6-60).

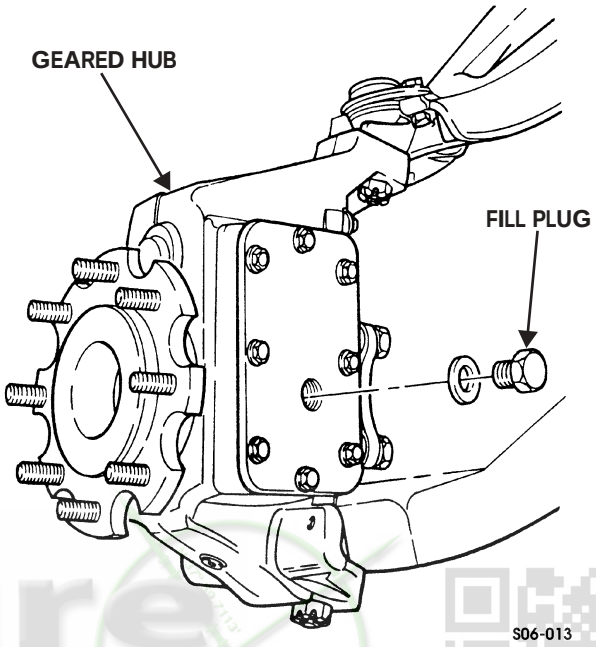


Figure 6-60: Geared Hub Fill Hub

12. Fill geared hub to proper oil level (Section 1).
13. Install washer and fill plug on geared hub. Tighten fill plug to 8-13 lb-ft (11-18 N•m).
14. Install wheel.
15. Check alignment.

GEARED HUB SIDE COVER MAINTENANCE

NOTE: Geared hub side cover replacement procedures are basically the same for front and rear covers. This procedure covers the front side cover.

Removal

1. Remove wheel.
2. Remove drainplug from geared hub and drain geared hub (Figure 6-61).
3. Install drainplug in geared hub.
4. Remove eight capscrews, washers, and side cover from geared hub.

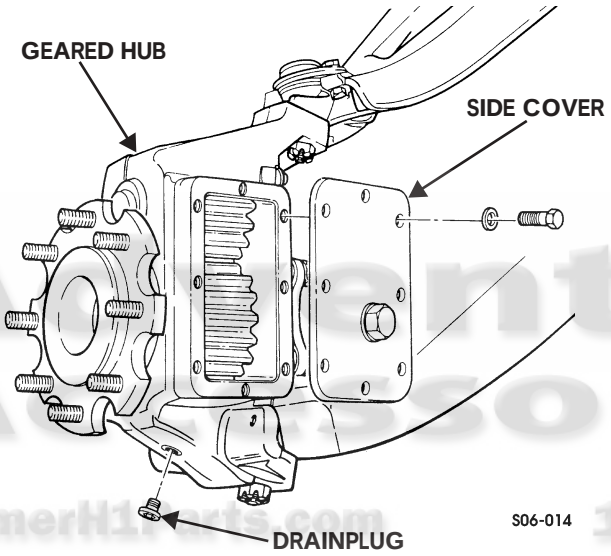


Figure 6-61: Geared Hub Side Cover

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Using solvent, clean side cover.
2. Inspect side cover for damage.

Installation

1. Apply anaerobic sealant to side cover and install side cover on geared hub.
2. Apply thread-locking compound to capscrews and install side cover to geared hub with eight washers and capscrews. Tighten capscrews to 15 lb-ft (20 N•m).
3. Fill geared hub to proper oil level (Section 1).
4. Install wheel.

GEARED HUB INPUT SEAL REPLACEMENT

Removal

1. Remove wheel.
2. Remove access plug and washer from geared hub (Figure 6-57).
3. Remove halfshaft retaining capscrew, lockwasher, and halfshaft from geared hub. Discard lockwasher.

NOTE: Shim gaskets must be reused to maintain proper drive gear bearing adjustment.

4. Remove capscrew, washer, and vent line bracket from drive gear retainer (Figure 6-62).

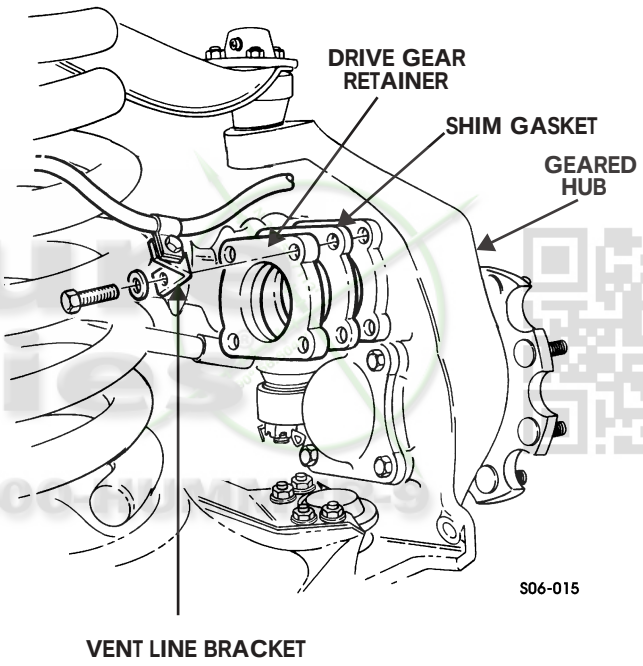


Figure 6-62: Geared Hub Shim Gaskets

5. Remove three capscrews, washers, drive gear retainer, and shim gasket(s) from geared hub.
6. Secure drive gear retainer in vise with inserts and remove input seal. Discard input seal (Figure 6-63).

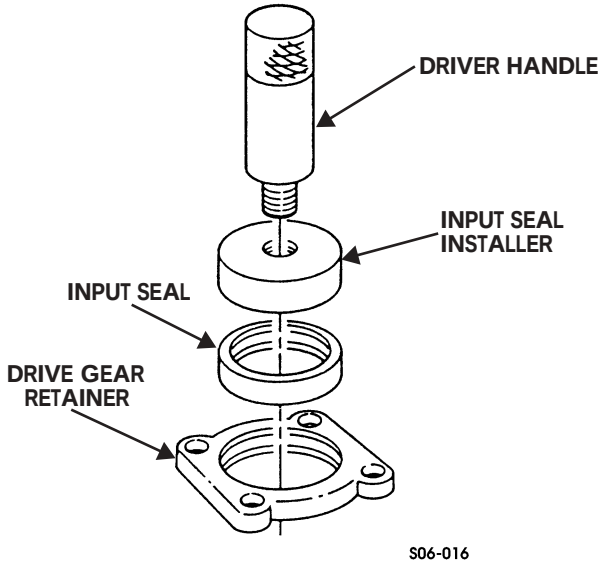


Figure 6-63: Drive Gear Retainer

Installation

1. Using driver handle and input seal installer, install input seal in drive gear retainer, seal will be recessed 0.200". Ensure radius on outer diameter of input seal faces toward inside of geared hub (Figure 6-63).
2. Install shim gasket(s) and drive gear retainer to geared hub and secure with three washers and capscrews. Tighten capscrews to 38 lb-ft (52 N•m) (Figure 6-62).
3. Install vent line bracket to drive gear retainer with washer and capscrew. Tighten capscrew to 38 lb-ft (52 N•m).
4. Coat lip of input seal with lubricating oil (Figure 6-63).
5. Apply thread-locking compound to halfshaft retaining capscrew and install halfshaft on geared hub with lockwasher and halfshaft retaining capscrew. Tighten halfshaft retaining capscrew to 37 lb-ft (50 N•m) (Figure 6-64).
6. Install washer and access plug into geared hub. Tighten access plug to 8-13 lb-ft. (11-18 N•m).
7. Install wheel.

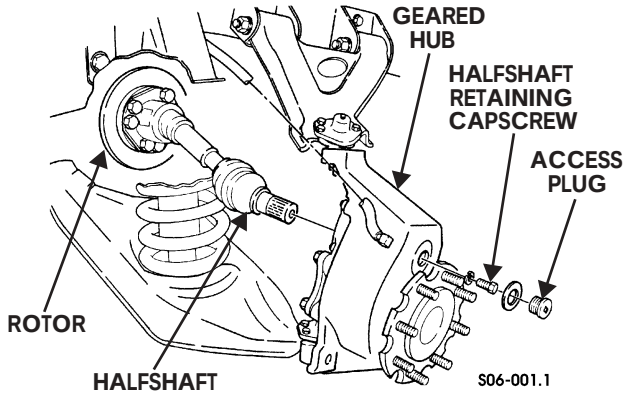


Figure 6-64: Halfshaft and Geared Hub

GEARED HUB REPAIR

Disassembly

1. Remove geared hub.
2. Position geared hub with spindle supporting geared hub (Figure 6-65).

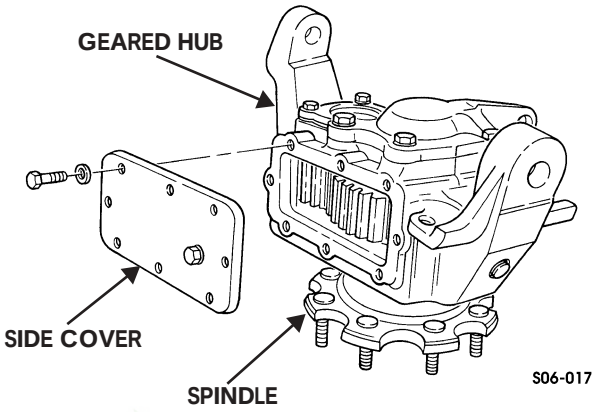


Figure 6-65: Geared Hub and Spindle

3. Remove eight capscrews, washers, and side cover from geared hub.

NOTE: If backlash between drive and driven gears is more than 0.018 inch (0.46 mm), both gears must be replaced.

4. Mount dial indicator on geared hub and index indicator to register from one drive gear tooth. Move drive gear back and forth while holding driven gear stationary to read backlash (Figure 6-66).

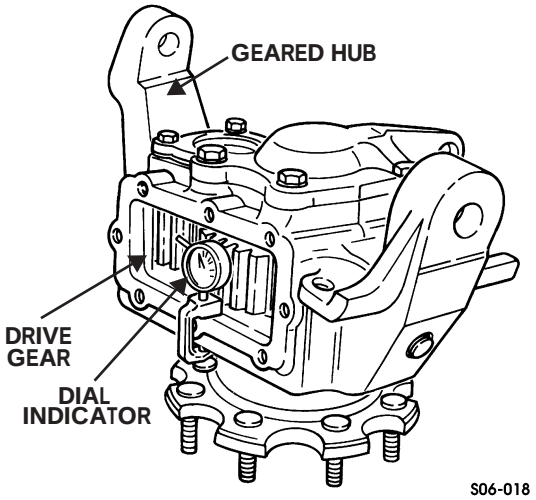


Figure 6-66: Dial Indicator

5. Remove four capscrews, washers, and steering arm cover from geared hub (Figure 6-67).

6. Remove clamp nut lock screw from clamp nut.
7. Using spanner socket, remove clamp nut and keyed washer from spindle.

NOTE: It may be necessary to lightly tap threaded end of spindle to release it from the inner spindle bearing.

8. Lift geared hub off spindle.
9. Remove inner bearing, bearing spacer, and driven gear from geared hub.
10. Remove outer bearing spacer from spindle.
11. Remove four capscrews, washers, drive gear retainer, shim gasket, inboard bearing cup, and drive gear from geared hub (Figure 6-68).
12. Remove retaining washer from inside drive gear or geared hub.
13. Remove spindle seal from geared hub. Discard seal.

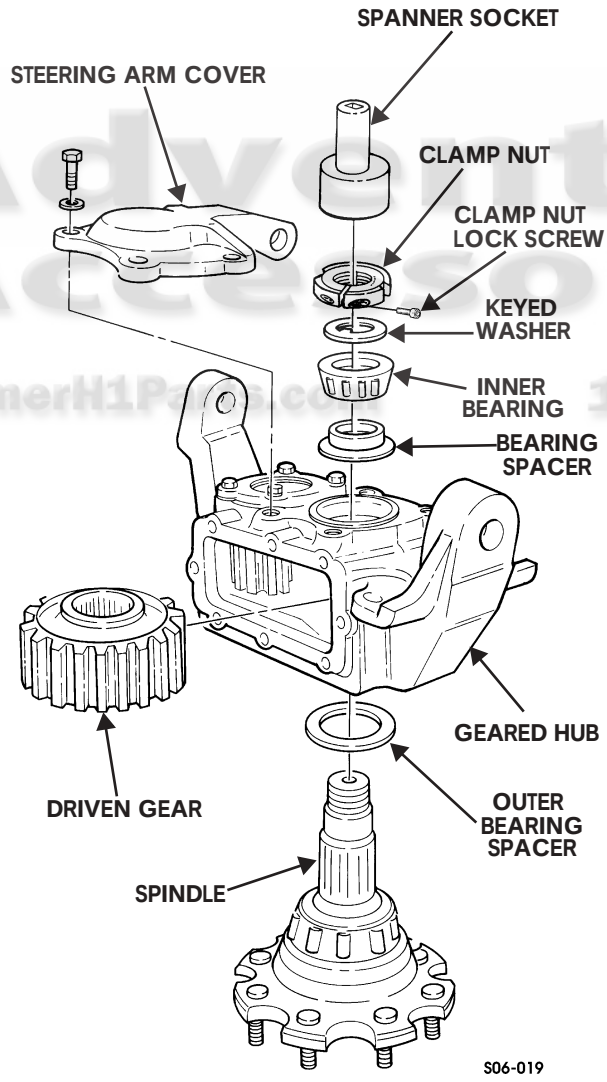


Figure 6-67: Geared Hub

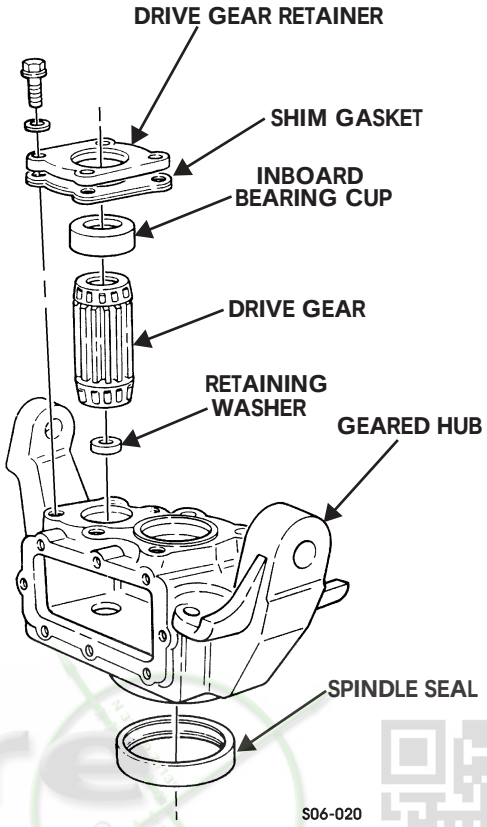


Figure 6-68: Drive Gear

14. Remove input seal from drive gear retainer. Discard seal (Figure 6-69).

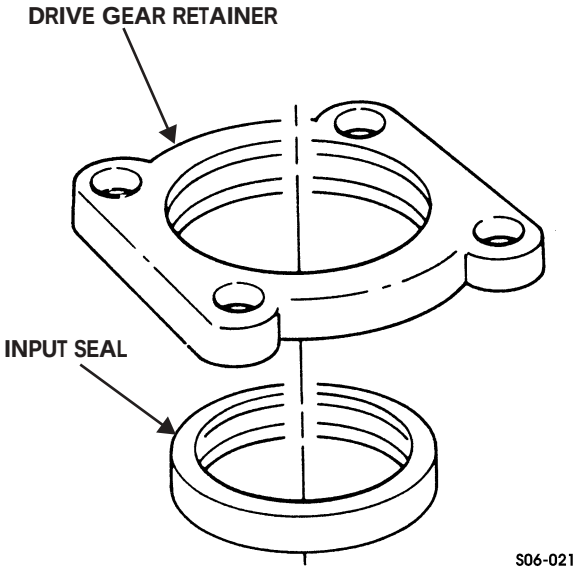


Figure 6-69: Drive Gear Retainer

Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary. Drive and driven gears must be replaced as matched set (Figure 6-70).

1. Inspect splines and gear teeth on drive gear and driven gear for damage.
2. Inspect spindle for damage and rough or corroded sealing surface.
3. Inspect all bearings and bearing races for damage.
4. Inspect steering arm cover for damage.
5. Inspect geared hub and all threaded holes for damage. Repair any damaged holes using thread repair inserts.

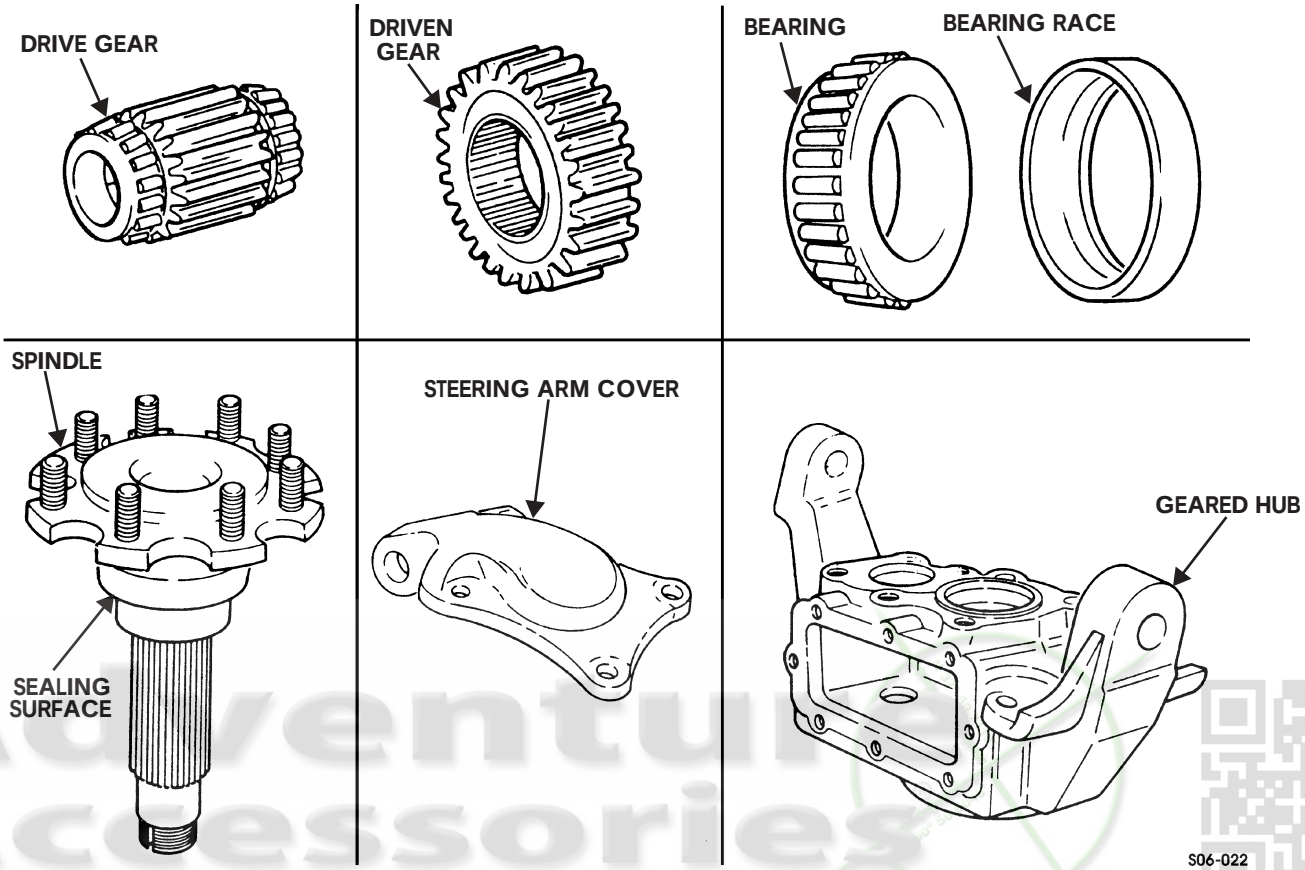


Figure 6-70: Drive Gear Assembly

Assembly

1. Using driver handle and spindle seal installer, install spindle seal in geared hubuntil seal bottoms in housing (Figure 6-71).

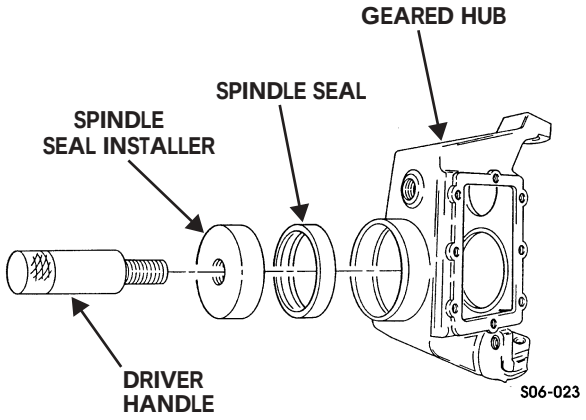


Figure 6-71: Spindle Seal

2. Ensure radius on outer diameter of input seal faces inside drive gear retainer. Using input seal installer and driver handle, install input seal in drive gear retainer, seal will be recessed 0.200" (Figure 6-72).

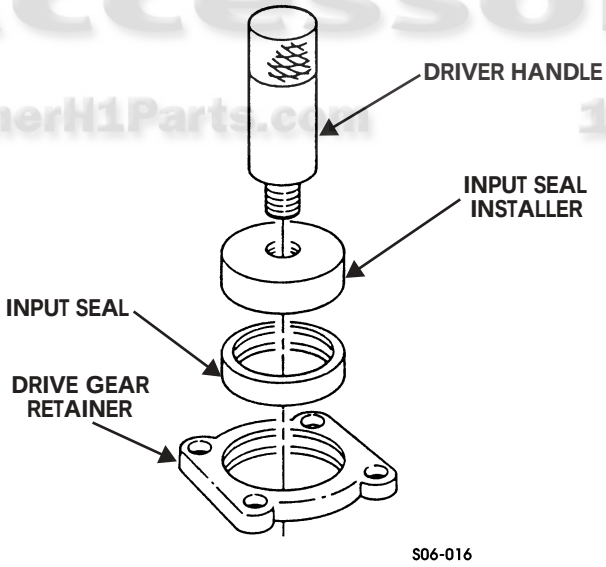


Figure 6-72: Input Seal

3. Install retaining washer in shallow end of drive gear (Figure 6-73).

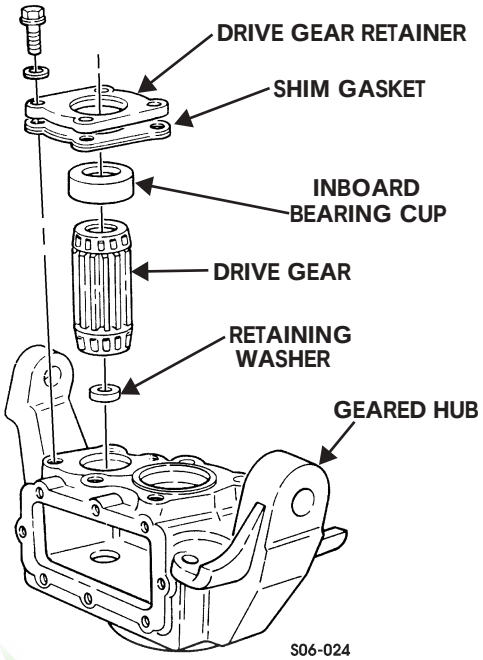


Figure 6-73: Drive Gear Assembly

4. Install drive gear and inboard bearing cup in geared hub.
5. Apply thread-locking compound on capscrews. Install shim gasket and drive gear retainer on geared hub and secure with four washers and capscrews. Tighten capscrews to 25-35 lb-ft (40-48 N•m).
6. Mount dial indicator on geared hub and index indicator to register on end of drive gear (Figure 6-74).

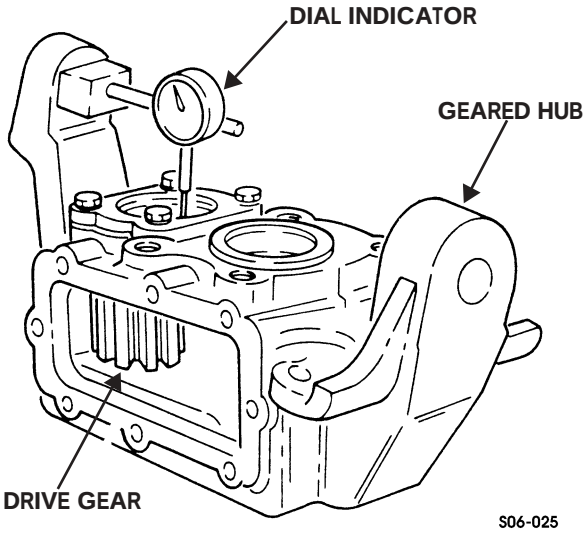


Figure 6-74: Dial Indicator on Geared Hub

7. Move drive gear up and down to read end play. End play should be 0.001-0.006 inch (0.03-0.15 mm). If end play is incorrect, add or subtract shim gaskets and recheck end play.

8. Install driven gear and bearing spacer in geared hub (Figure 6-75).

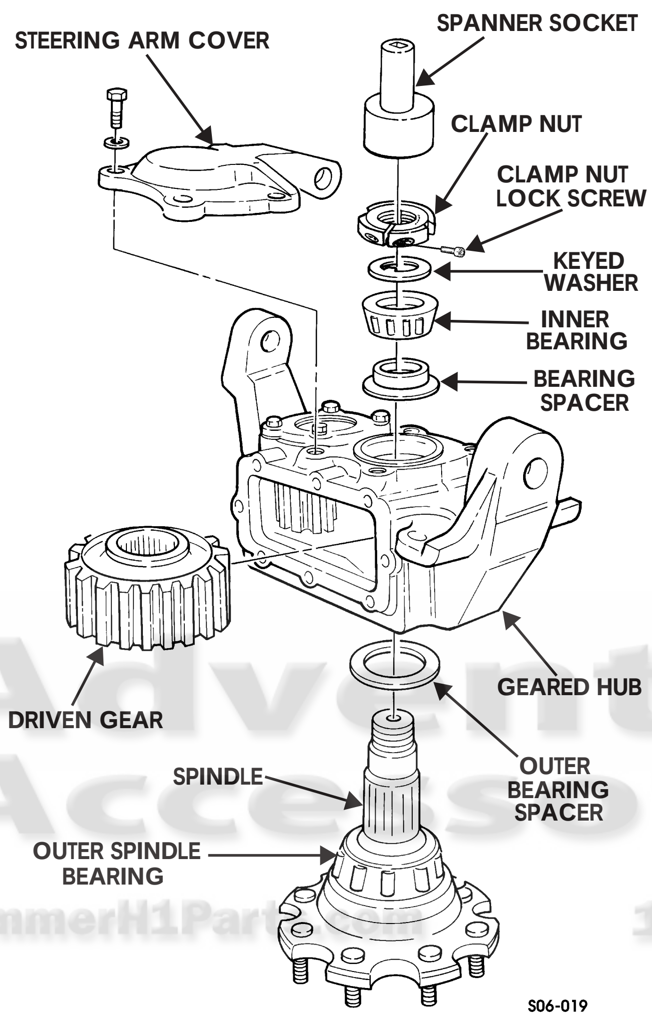


Figure 6-75: Driven Gear into Geared Hub

9. Install outer bearing spacer on spindle.
10. Lower geared hub onto spindle and align splines on driven gear with splines on spindle. Ensure outer spindle bearing seats in bearing cup.
11. Install inner bearing and keyed washer on spindle.

NOTE: After clamp nut lock screw is installed into clamp nut, clamp nut must be completely installed on spindle within a ten minute limit.

12. Install clamp nut lock screw three to five turns into clamp nut.

***CAUTION**: Ensure clamp nut is installed on spindle with boss (protruding side) facing inward toward bearing and large chamfer side with engraved part number facing away from bearing.*

13. Apply a thin coat of grease to boss (protruding side) of clamp nut and install clamp nut on spindle.

NOTE: If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten clamp nut lock screw to remove clamp nut wobble, remove screw. Ensure threads of clamp nut are clean and free of Loctite. Replace screw with a new one, or remove all previously applied Loctite from threads of old screw and apply fresh Loctite 272 to old screw threads prior to reinstallation. Use a hexagon-head socket with a calibrated torque wrench to tighten and check torque of screw.

14. Tighten clamp nut lock screw until all clamp nut wobble is removed and clamp nut can still be rotated by hand.
15. Using spanner socket, tighten clamp nut to 40 lb-ft (54 N•m). Rotate spindle five revolutions both clockwise and counterclockwise to seat bearings.
16. Loosen and retighten clamp nut to 25 lb-ft (34 N•m).

NOTE: Ensure clamp nut does not move while clamp nut lock screw is being tightened.

17. Using a hexagon-head socket and pre-set calibrated torque wrench, tighten clamp nut lock screw to 90 lb-in. (10 N•m).
18. Mark a temporary line across end of spindle and clamp nut.

NOTE: Using a feeler gauge, ensure a gap exists between clamp nut joint surfaces. If no gap exists, remove and discard clamp nut lock screw and clamp nut. Acquire new screw and nut and repeat steps 12-18.

19. Using preset torque wrench, apply pressure to clamp nut in a counterclockwise direction until torque wrench clicks, indicating 90 lb-ft (122 N•m) of loosening torque was applied to clamp nut.

NOTE: Clamp nut should not move. To verify no movement occurred, check temporary mark across spindle and clamp nut. If clamp nut moves, remove and discard clamp nut lock screw and clamp nut. Repeat steps 12-19 with new screw and nut.

20. Paint or scribe a permanent line across end of spindle and clamp nut.

NOTE: Immediately install steering arm cover after application of sealer.

21. Clean sealing surfaces on geared hub and steering arm cover. Apply anaerobic sealer to steering arm cover and install steering arm cover on geared hub.

22. Apply thread-locking compound to capscrews. Install steering arm cover to geared hub with four washers and capscrews. Tighten capscrews to 65 lb-ft (88 N•m).
23. Clean sealing surfaces on geared hub and side cover. Apply anaerobic sealer to side cover and install on geared hub (Figure 6-76).

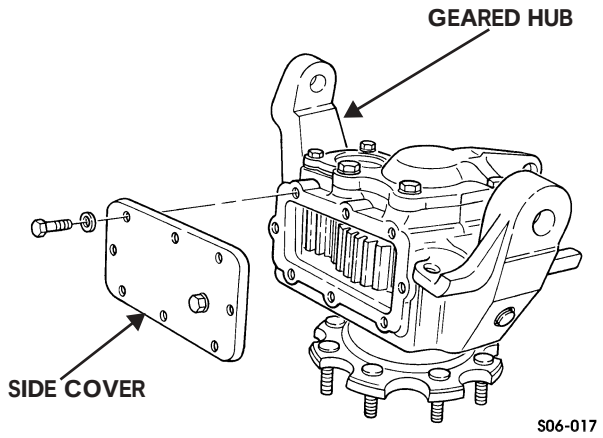


Figure 6-76: Side Cover on Geared Hub

24. Apply thread-locking compound to capscrews. Install side cover to geared hub with eight washers and capscrews. Tighten capscrews to 8-13 lb-ft (11-18 N•m).
25. Install geared hub.

GEARED HUB SPINDLE SEAL MAINTENANCE

Removal

1. Remove wheel.
2. Remove drainplug from geared hub and drain geared hub oil. Install drainplug in geared hub. Tighten drainplug to 8-13 lb-ft (11-18 N•m) (Figure 6-77).

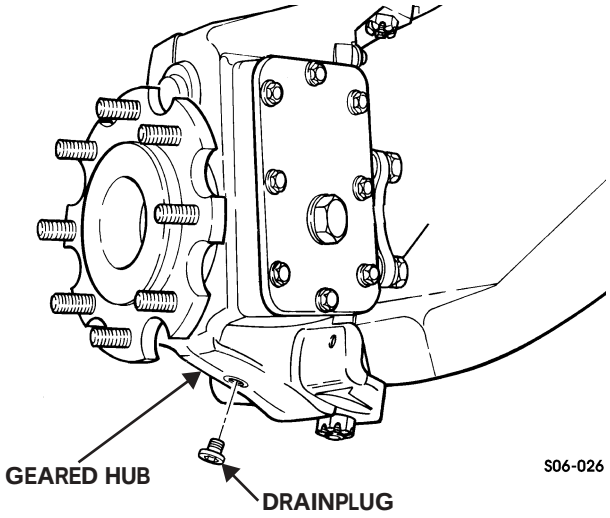


Figure 6-77: Geared Hub and Drainplug

3. Remove four capscrews, washers, and steering arm cover from geared hub (Figure 6-78).

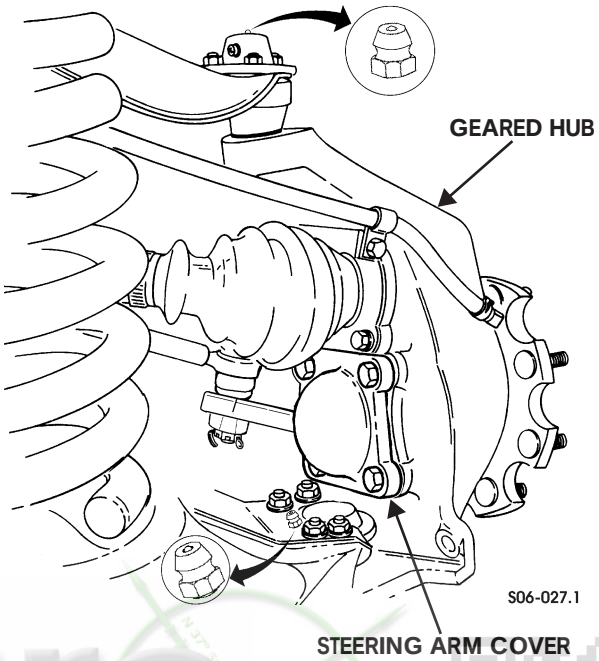


Figure 6-78: Steering Arm Cover And Geared Hub

4. Remove clamp nut lock screw from clamp nut (Figure 6-79).

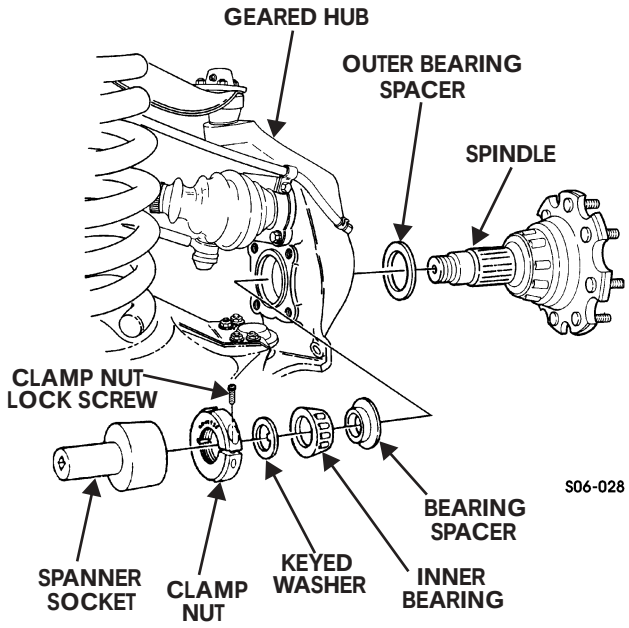


Figure 6-79: Clamp Nut

5. Using spanner socket, remove clamp nut and keyed washer from spindle.
6. Remove spindle, bearing spacer, inner bearing, and outer bearing spacer from geared hub.
7. Remove spindle seal from geared hub. Discard spindle seal (Figure 6-80).

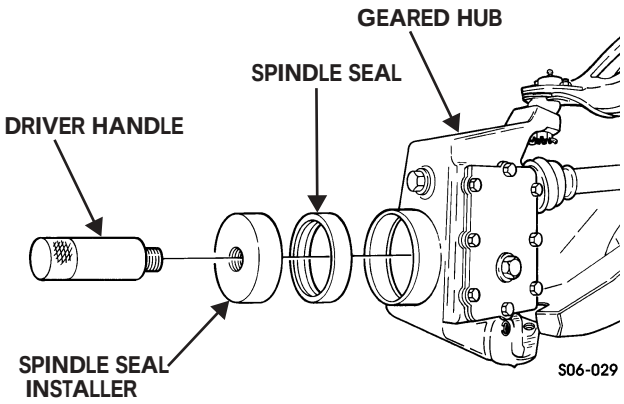


Figure 6-80: Removing Spindle Seal

Cleaning and Inspection

1. Inspect spindle for rough or corroded sealing surface. Replace if damaged (Figure 6-79).
2. Inspect bearings for damage. Replace if damaged.

Installation

1. Using driver handle and spindle seal installer, install spindle seal in geared hub (Figure 6-80).
2. Coat seal with lubricating oil.
3. Install outer bearing spacer and spindle in geared hub (Figure 6-79).
4. Install bearing spacer, inner bearing, and keyed washer on spindle.

NOTE: After clamp nut lock screw is installed into clamp nut, clamp nut must be completely installed on spindle within a ten minute limit.

5. Install clamp nut lock screw three to five turns into clamp nut.

***CAUTION**: Ensure clamp nut is installed on spindle with boss (protruding side) facing inward toward bearing and large chamfer side with engraved part number facing away from bearing.*

6. Apply a thin coat of grease to boss (protruding side) of clamp nut and install clamp nut on spindle.

NOTE: If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten clamp nut lock screw to remove clamp nut wobble, remove clamp nut lock screw. Ensure threads of clamp nut are clean and free of Loctite. Replace screw with a new one or remove all previously applied Loctite from threads of old screw and apply fresh Loctite 272 to old screw threads prior to reinstallation. Use hexagon-head socket with a calibrated torque wrench to tighten and check torque of screw.

7. Tighten clamp nut lock screw until all clamp nut wobble is removed and clamp nut can still be rotated by hand.
8. Using spanner socket, tighten clamp nut to 40 lb-ft (54 N•m). Rotate spindle five revolutions both clockwise and counterclockwise to seat bearings.
9. Loosen and retighten clamp nut to 25 lb-ft (34 N•m).

NOTE: Ensure clamp nut does not move while clamp nut lock screw is being tightened.

10. Using a hexagon-head socket and pre-set calibrated torque wrench, tighten clamp nut lock screw to 90 lb-in. (10 N•m).
11. Mark a temporary line across end of spindle and clamp nut.

NOTE: Using a feeler gauge, ensure a gap exists between clamp nut joint surfaces. If no gap exists, remove and discard clamp nut lock screw and clamp nut. Acquire new screw and nut and repeat steps 5-11.

12. Using pre-set torque wrench, apply pressure to clamp nut in a counterclockwise direction until torque wrench clicks, indicating 90 lb-ft (122 N•m) of loosening torque was applied to clamp nut (Figure 6-81).

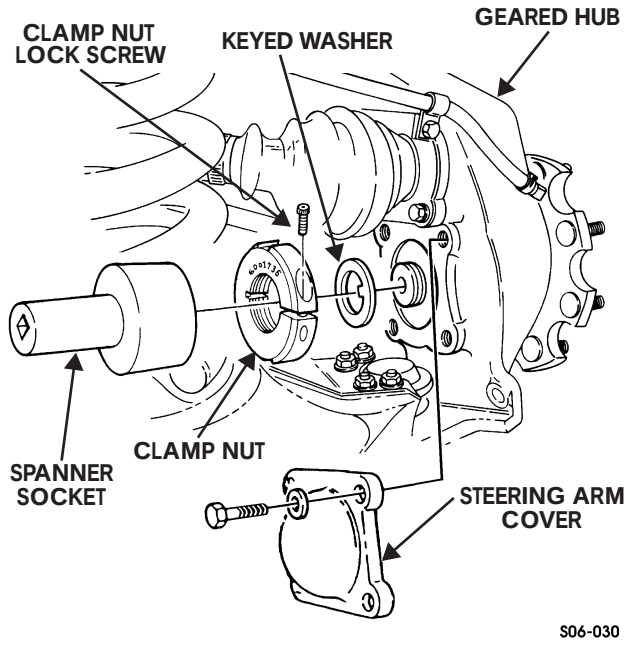


Figure 6-81: Clamp Nut

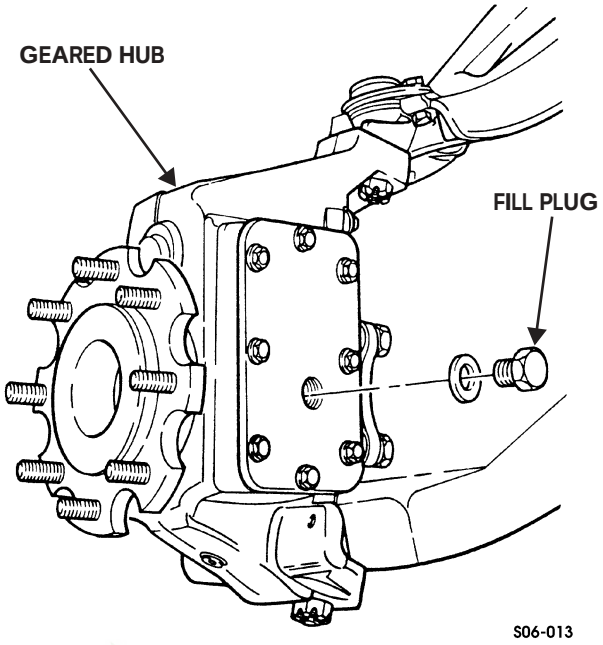


Figure 6-82: Geared Hub Drainplug

NOTE: Clamp nut should not move. To verify no movement occurred, check temporary mark across spindle and clamp nut. If clamp nut moved, remove and discard clamp nut lock screw and clamp nut. Repeat steps 5-12 with new screw and nut.

13. Paint or scribe a permanent line across end of spindle and clamp nut.

NOTE: Immediately install steering arm cover after application of sealant.

14. Clean sealing surfaces on geared hub and steering arm cover. Apply anaerobic sealant to steering arm cover and install on geared hub.
15. Apply thread-locking compound to capscrew threads and install steering arm cover on geared hub with four washers and capscrews. Tighten capscrews to 65 lb-ft (88 N•m).
16. Remove fill plug and washer from geared hub (Figure 6-82).
17. Fill geared hub to proper oil level (Section 1).
18. Install washer and fill plug to geared hub. Tighten fill plug to 8-13 lb-ft (11-18 N•m).
19. Install wheel and check alignment.

GEARED HUB SPINDLE BEARING ADJUSTMENT

Adjustment

1. Remove wheel.
2. Remove drainplug and drain geared hub oil. Install drainplug into geared hub. Tighten drainplug to 8-13 lb-ft (11-18 N•m) (Figure 6-83).

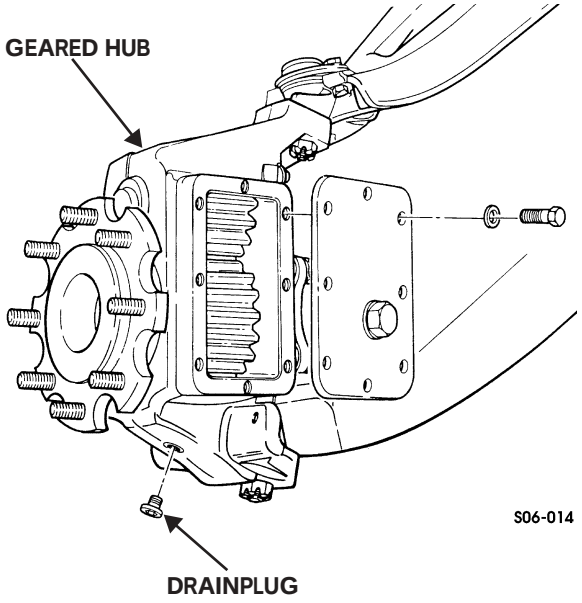


Figure 6-83: Geared Hub Drainplug

3. Remove four capscrews, washers, and steering arm cover from geared hub. Push steering arm cover away from geared hub (Figure 6-85).
4. Remove clamp nut lock screw from clamp nut.
5. Using spanner socket, remove clamp nut and keyed washer from spindle.

NOTE: After clamp nut lock screw is installed into clamp nut, clamp nut must be completely installed on spindle within a ten minute limit.

6. Install clamp nut lock screw three to five turns into clamp nut.

***CAUTION**: Ensure clamp nut is installed on spindle with boss (protruding side) facing inward toward bearing and large chamfer side with engraved part number facing away from bearing.*

7. Apply a thin coat of grease to boss (protruding side) of clamp nut and install clamp nut on spindle.

NOTE: If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten clamp nut lock screw to remove clamp nut wobble, remove screw. Ensure threads of clamp nut are clean and free of Loctite. Replace screw with a new one or remove all previously applied Loctite from threads of old screw and apply fresh Loctite 272 to old screw threads prior to reinstallation. Use a hexagon-head socket with a calibrated torque wrench to tighten and check torque of screw.

8. Tighten clamp nut lock screw until all clamp nut wobble is removed and clamp nut can still be rotated by hand.
9. Using spanner socket, tighten clamp nut to 40 lb-ft (54 N•m). Rotate spindle five revolutions both clockwise and counterclockwise to seat bearings (Figure 6-84).

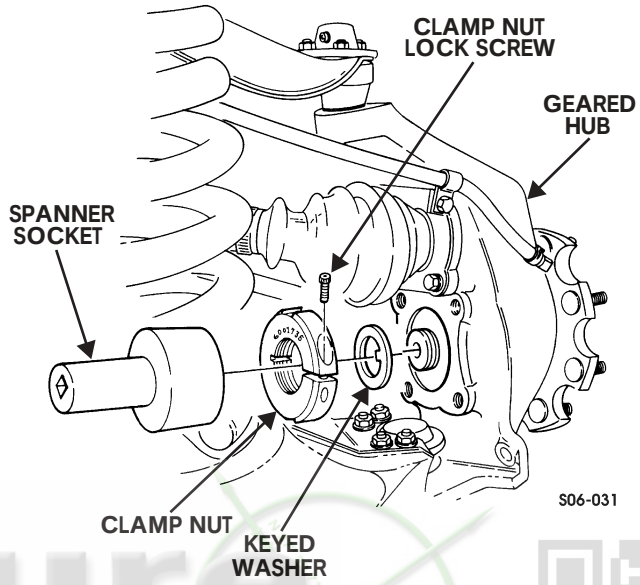


Figure 6-84: Clamp Nut

10. Loosen and retighten clamp nut to 25 lb-ft (34 N•m).

NOTE: Ensure clamp nut does not move while clamp nut lock screw is being tightened.

11. Using a hexagon-head socket and pre-set calibrated torque wrench, tighten clamp nut lock screw to 90 lb-in. (10 N•m).
12. Mark a temporary line across end of spindle and clamp nut.

NOTE: Using a feeler gauge, ensure a gap exists between clamp nut joint surfaces. If no gap exists, remove and discard clamp nut lock screw and clamp nut. Acquire new screw and nut and repeat steps 6-12.

13. Using pre-set torque wrench, apply pressure to clamp nut in counterclockwise direction until torque wrench clicks, indicating 90 lb-ft (122 N•m) of loosening torque was applied to clamp nut.

NOTE: Clamp nut should not move. To verify no movement occurred, check temporary mark across spindle and clamp nut. If clamp nut moved, remove and discard clamp nut lock screw and clamp nut. Repeat steps 6-13 with new screw and nut.

14. Paint or scribe a permanent line across end of spindle and clamp nut.

NOTE: Immediately install steering arm cover after application of sealant.

15. Clean sealing surfaces on geared hub and steering arm cover. Apply anaerobic sealant to steering arm cover and install on geared hub (Figure 6-85).

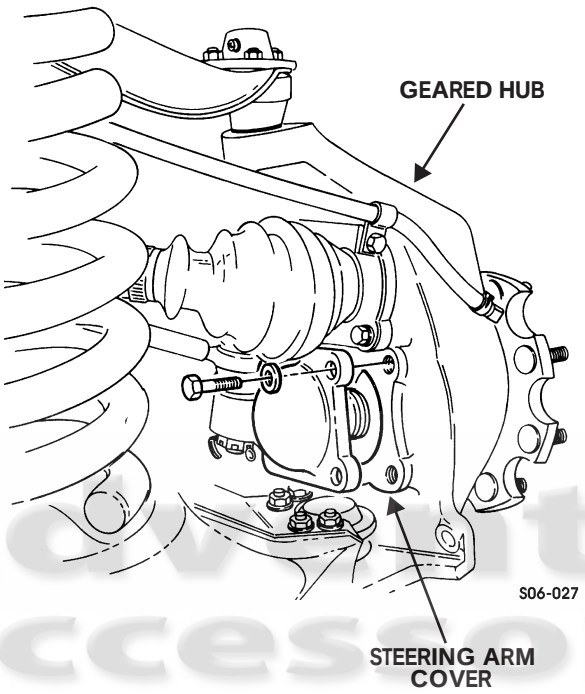


Figure 6-85: Steering Arm Cover

16. Apply thread-locking compound to capscrew threads and secure steering arm cover to geared hub with four washers and capscrews. Tighten capscrews to 65 lb-ft (88 N•m).
17. Remove fill plug and washer from geared hub (Figure 6-82).
18. Fill geared hub to proper oil level (Section 1).
19. Install washer and fill plug to geared hub. Tighten fill plug to 8-13 lb-ft (11-18 N•m).

GEARED HUB SPINDLE STUD REPLACEMENT

WARNING: Always wear eye protection when replacing spindle studs. Severe eye injury may result if metal chips contact eyes.

Removal

1. Remove wheel.
2. Rotate spindle to allow clearance for removal of stud from spindle (Figure 6-86).
3. Drive stud from spindle. Discard stud.

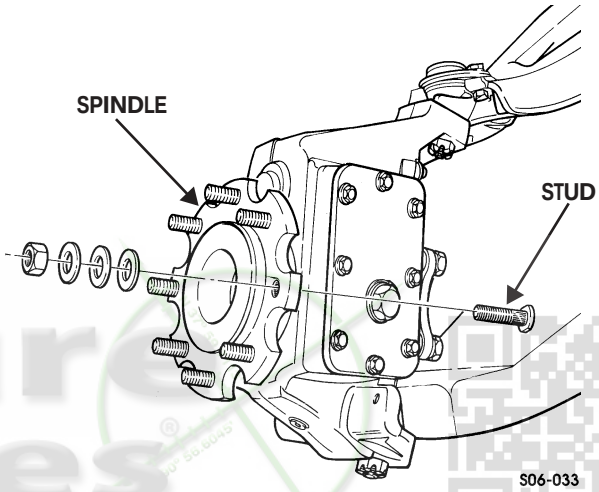


Figure 6-86: Geared Hub Spindle Stud

Installation

1. Install stud in spindle (Figure 6-86).
2. Install three flat washers and hex nut on stud.
3. Tighten hex nut until head on stud seats against spindle.
4. Remove and discard hex nut and three flat washers.

AXLE VENT LINE REPLACEMENT

NOTE: Axle vent line replacement procedures are basically the same. This procedure covers the rear axle vent line.

Removal

1. Disconnect vent line from axle fitting and tee fitting and remove vent line (Figure 6-87).
2. Remove two line clips and vent line from brake line.
3. Disconnect vent line from two tee fittings and remove vent line.

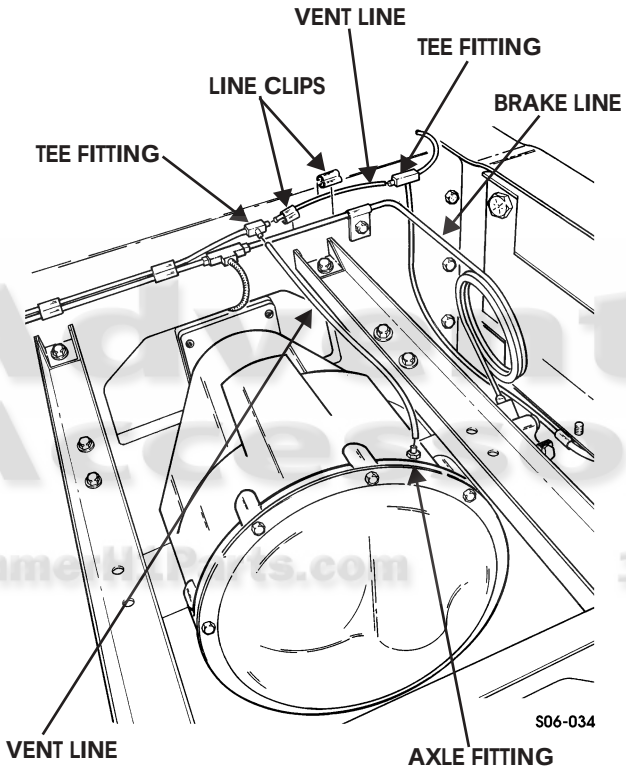


Figure 6-87: Axle Vent Line

Installation

1. Install vent line and connect to two tee fittings (Figure 6-87).
2. Secure vent line to brake line with two line clips.
3. Connect vent line to axle fitting and tee fitting.

GEARED HUB VENT LINE REPLACEMENT

NOTE: All geared hub vent line replacement procedures are basically the same. This procedure covers the right rear geared hub vent line.

Removal

1. Disconnect vent line from geared hub fitting (Figure 6-88).
2. Remove capscrew, clamp, and vent line from bracket.
3. Remove capscrew, clamp, and vent line from control arm.
4. Remove capscrew, clamp, and vent line from bracket.
5. Remove capscrew, clamp, and vent line from frame (Figure 6-89).
6. Disconnect vent line from tee fitting.

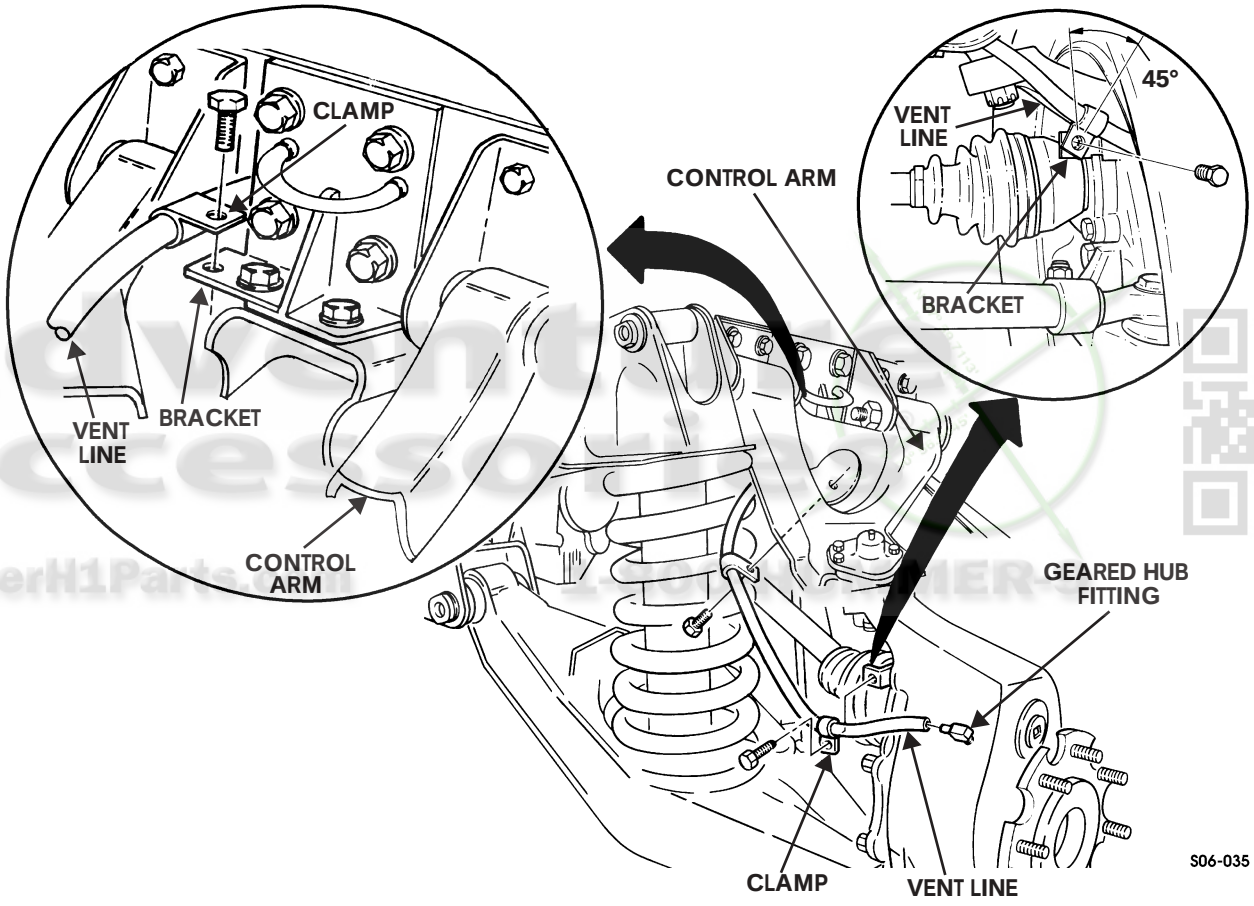


Figure 6-88: Geared Hub Vent Line

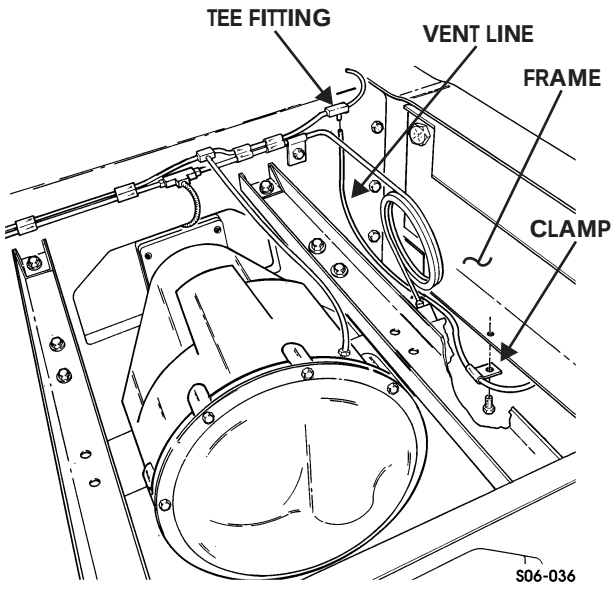


Figure 6-89: Vent Line

Installation

1. Install vent line to frame with clamp and capscrew (Figure 6-89).
2. Install vent line to bracket with clamp and capscrew (Figure 6-88).
3. Connect vent line to tee fitting and geared hub fitting (Figures 6-88 and 6-89).
4. Install vent line to control arm with clamp and capscrew (Figure 6-88).

NOTE: Position clamp at a 45 degree angle toward the wheel before securing with capscrew.

5. Install vent line to bracket with clamp and capscrew.

STEERING STOP ADJUSTMENT

NOTE: Alignment equipment currently used in the automotive field should be used for steering stop adjustment procedure. This procedure should be followed if alignment equipment is not available.

Removal

1. Loosen jamnut and remove capscrew and jamnut from geared hub (Figure 6-90).
2. Remove jamnut from capscrew.

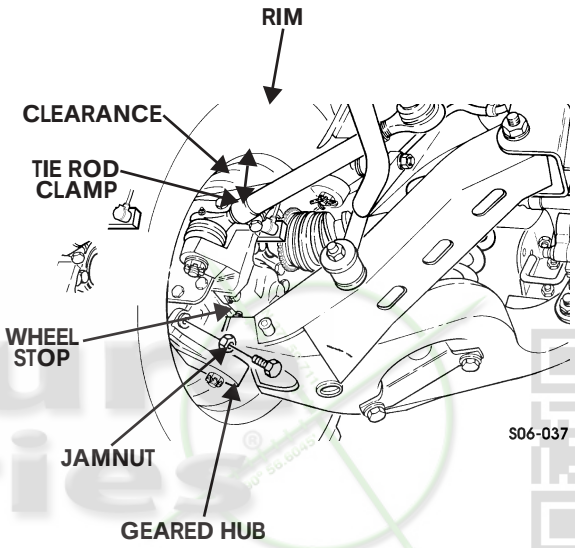


Figure 6-90: Steering Stop Adjustment

Installation

1. Apply thread-locking compound to capscrew (Figure 6-90).
2. Install jamnut on capscrew.
3. Install capscrew and jamnut on geared hub. Tighten capscrew finger tight.

Adjustment

NOTE: Prior to adjustment, ensure length of each tie rod is the same. If tie rod lengths are not the same ± 1/8 in. (3 mm), check toe-in alignment.

1. Draw a reference chalk line 30 feet long. Mark this line A (Figure 6-91).

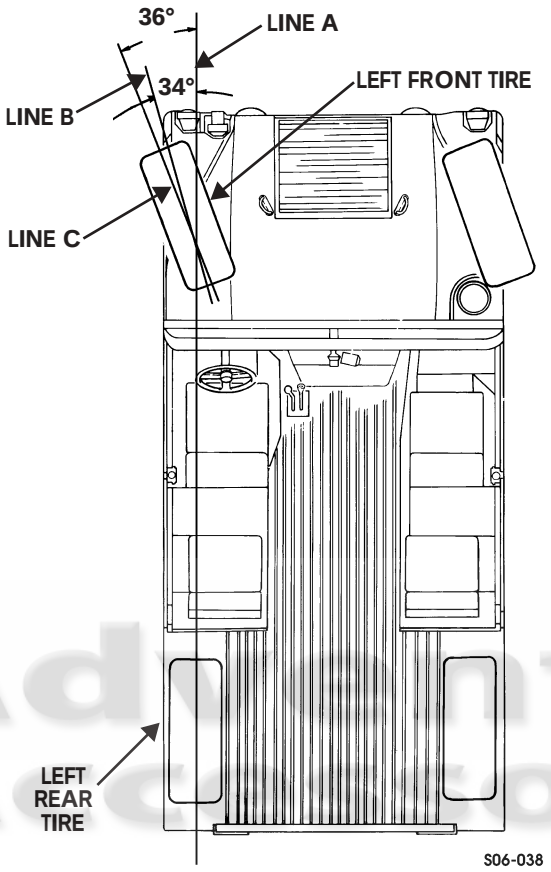


Figure 6-91: Checking Alignment

2. Position vehicle so that center of left rear and left front tires are positioned directly on reference line A.
3. Using a protractor, draw a reference line at 34 degrees from line A. Mark this line B.
4. Again, using a protractor, draw a reference line at 36 degrees from line A. Mark this line C.
5. Roll vehicle forward until center of left front tire is over intersection of lines A, B, and C.
6. Turn steering wheel full left.
7. If centerline of front and rear of left front tire is over area between lines B and C, no adjustment is necessary.
8. If centerline of front and rear of left front tire is not over area between lines B and C, loosen jamnut and turn capscrew all the way in.
9. Turn steering wheel until centerline of front and rear of left front tire is over area between lines B and C.
10. Unscrew capscrew until head makes contact with wheel stop on lower control arm (Figure 6-90).
11. Secure capscrew with jamnut.
12. Check for clearance between tie rod clamp and the rim.
13. Repeat adjustment procedure for opposite side.

AXLE ASSEMBLY COVER MAINTENANCE

Removal

1. Remove drainplug from axle assembly and drain axle assembly (Figure 6-92).
2. Remove twelve capscrews and cover from axle assembly.

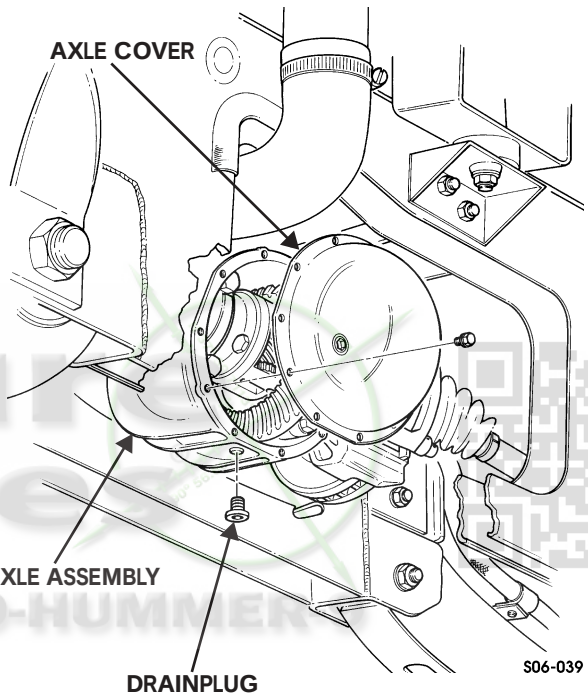


Figure 6-92: Axle Assembly And Cover

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean axle assembly cover, capscrews, and axle assembly with solvent (Figure 6-92).
2. Inspect axle assembly cover for cracks, wear, or breaks.

Installation

1. Apply RTV sealant to cover sealing surface and install cover on axle assembly with twelve capscrews. Tighten capscrews to 16 lb-ft (22 N•m).
2. Install drainplug into axle assembly and tighten to 13-18 lb-ft (18-25 N•m) (Figure 6-92).
3. Fill axle assembly to proper oil level (Section 1).

AXLE OUTPUT SHAFT SEAL REPLACEMENT

Removal

1. Remove axle assembly support bracket (Section 9).
2. Remove output shaft seal from axle (Figure 6-93).

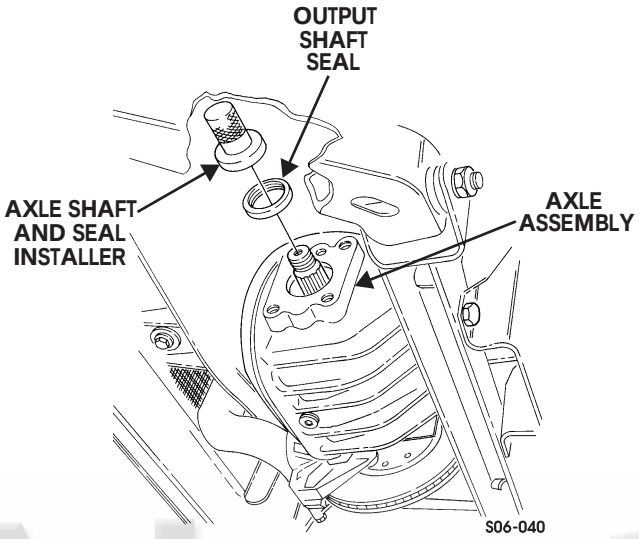


Figure 6-93: Axle Output Shaft Seal

Installation

1. Using axle shaft and seal installer, install output shaft seal in axle assembly (Figure 6-93).
2. Install axle assembly support bracket (Section 9).

PINION SEAL REPLACEMENT

NOTE: Removal and installation procedures for pinion seals are basically the same for front and rear axle assemblies. This procedure covers the rear axle assembly pinion seal.

Removal

1. Remove six capscrews, lockwashers, and halfshaft from each output flange rotor (Figure 6-51).
2. Remove four capscrews, two straps, and rear propeller shaft from pinion yoke (Figure 6-94).
3. Using a lb-in. torque wrench, measure torque required to rotate pinion and record measurement.
4. Count and record number of exposed threads on end of pinion and mark locknut and pinion for assembly.
5. Remove locknut and pinion yoke from pinion.
6. Remove pinion seal from pinion.

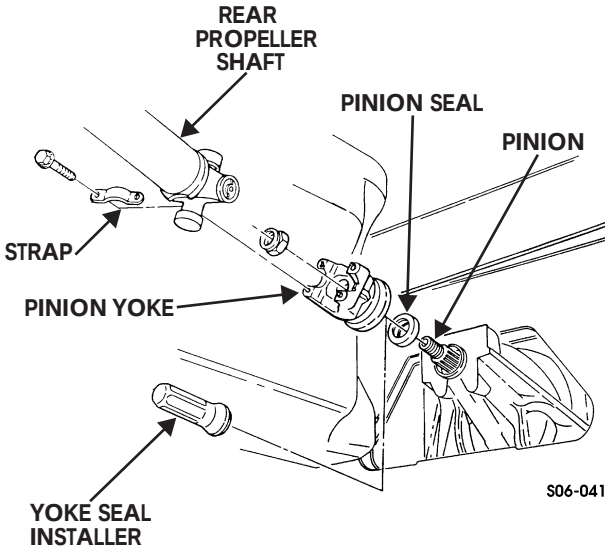


Figure 6-94: Pinion Seal

Installation

1. Using yoke seal installer, install pinion seal on pinion (Figure 6-94).
2. Install pinion yoke on pinion with locknut.
3. Tighten locknut to original position.
4. Tighten locknut in small increments, until torque required to rotate pinion exceeds original measurement by 2 lb-in. (0.2 N•m).
5. Install rear propeller shaft on pinion yoke with four capscrews and two straps. Tighten capscrews to 60 lb-ft (81 N•m).
6. Apply Loctite 272 to capscrews.
7. Install halfshaft on each output flange rotor with six lockwashers and capscrews. Tighten to 48-lb-ft (65 N•m).

AXLE ASSEMBLY REPLACEMENT

Removal

NOTE: Removal and installation procedures are basically the same for front and rear axle assemblies. This procedure covers both front and rear axle assemblies except where noted.

1. Remove service brake rotor (Section 7).
2. Remove drainplug from axle assembly. Allow oil to drain and install drainplug (Figure 6-95).

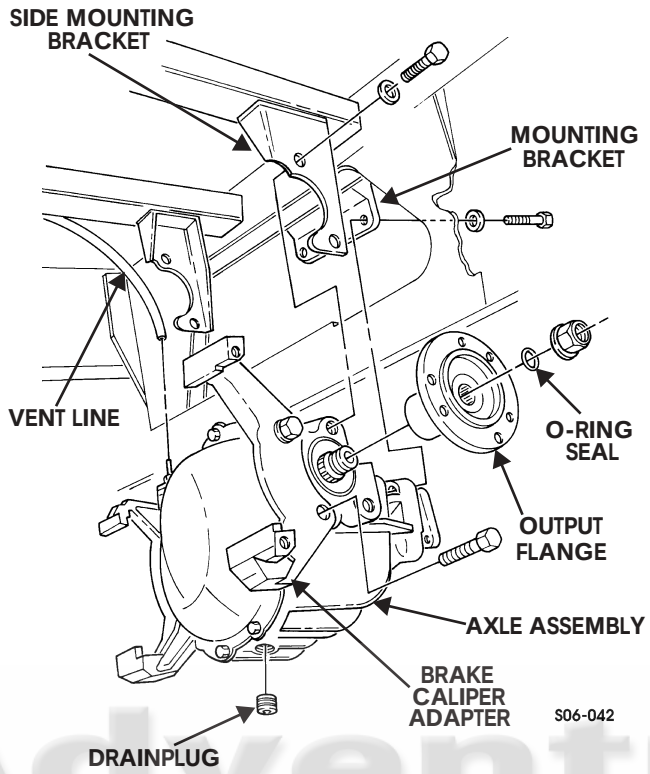


Figure 6-95: Rear Axle Assembly

3. Remove four capscrews, two straps, and rear propeller shaft from pinion yoke (Figure 6-96).
4. Remove rear propeller shaft from transfer case.

NOTE: No washers are required when securing front axle assembly to mounting bracket.

5. Remove two capscrews and washers securing axle assembly to mounting bracket (Figure 6-95).
6. Remove two locknuts, two O-ring seals and two output flanges from axle assembly. Discard locknuts and O-ring seals.

WARNING: Axle assembly must be supported during removal and installation. Failure to do this may cause injury or damage to equipment.

7. Support axle assembly.
8. Remove four capscrews and washers securing axle assembly to side mounting brackets.
9. Lower axle assembly slightly and disconnect vent line from axle assembly.
10. Remove axle assembly.
11. Remove four capscrews and two brake caliper adapters from axle assembly.
12. Using a lb-in. torque wrench, measure torque required to rotate pinion and record measurement.
13. Count and record number of exposed threads on end of pinion and mark locknut and pinion for assembly.
14. Remove locknut and rear pinion yoke from axle assembly (Figure 6-97).

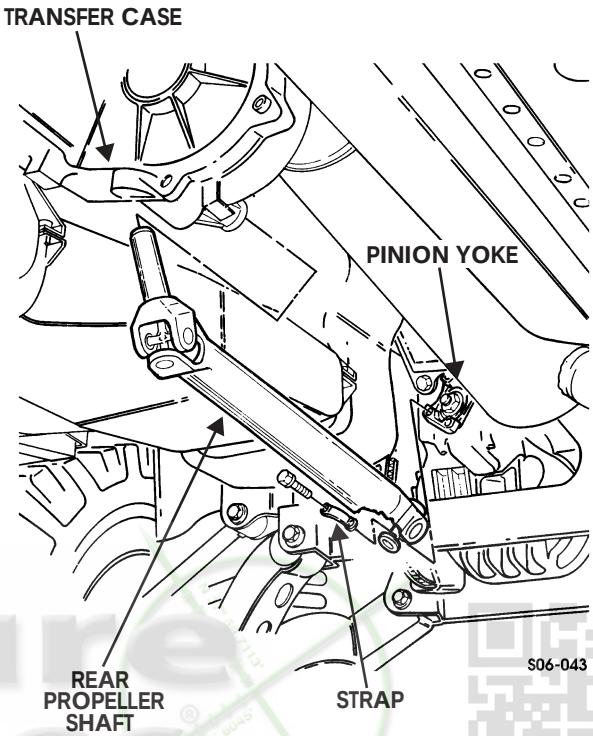


Figure 6-96: Rear Propeller Shaft

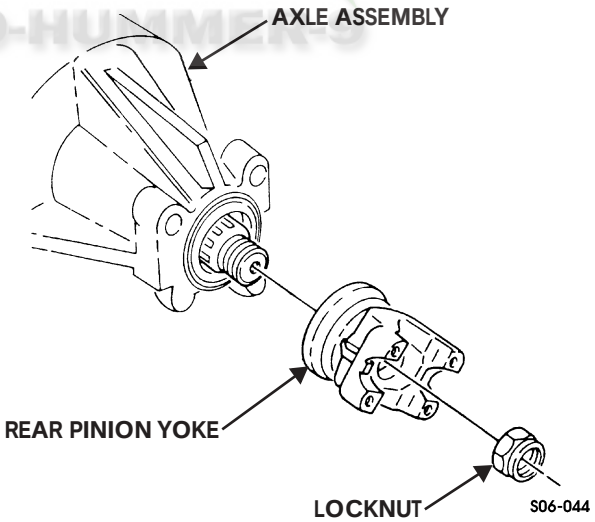


Figure 6-97: Rear Pinion Yoke and Axle Assembly

Installation

1. Install rear pinion yoke on axle assembly with locknut (Figure 6-97).
2. Tighten locknut in small increments, until torque required to rotate pinion yoke exceeds original measurement by 2 lb-in. (0.2 N•m).

3. Apply thread-locking compound to axle assembly tapped holes. Install two brake caliper adapters on axle assembly with four capscrews. Tighten capscrews to 110-140 lb-ft (149-190 N•m) (Figure 6-98).

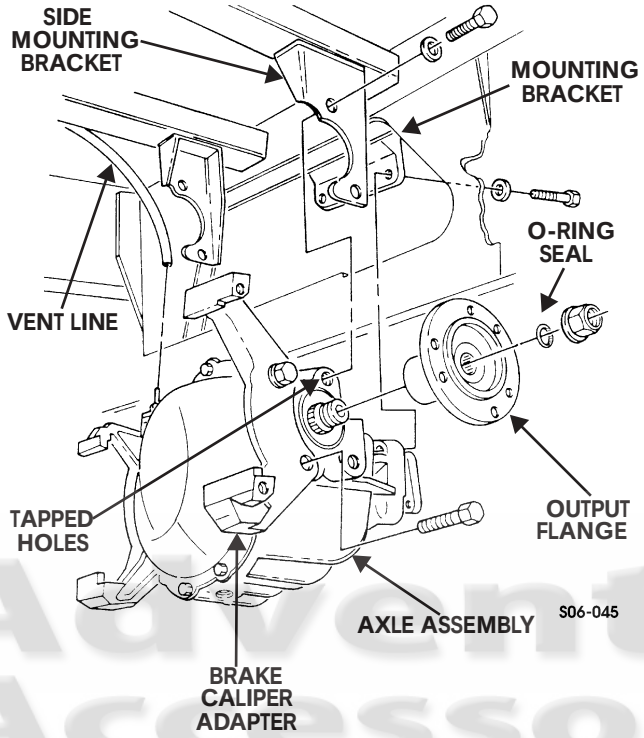


Figure 6-98: Rear Axle Assembly

4. Raise axle assembly into place and connect vent line.
5. Apply thread-locking compound to axle assembly tapped holes. Install axle assembly on side mounting brackets with four washers and capscrews.
6. Install two output flanges and two O-ring seals to axle assembly with two locknuts. Tighten locknuts to 165-195 lb-ft (224-264 N•m).

NOTE: No washers required when securing front axle assembly to mounting bracket.

7. Apply thread-locking compound to capscrews. Install two washers, capscrews, and axle assembly to mounting bracket.
8. Tighten six capscrews securing axle assembly to brackets to 110-139 lb-ft (149-188 N•m).
9. Install rear propeller shaft in transfer case (Figure 6-96).
10. Install rear propeller shaft to pinion yoke with four capscrews and two straps. Tighten capscrews to 60 lb-ft (81 N•m) (Figure 6-96).
11. Install service brake rotors (Section 7).
12. Fill axle assembly to proper oil level (Section 1).
13. Install vent line to axle assembly.

AXLE ASSEMBLY REPAIR

Disassembly

1. Remove axle assembly.

NOTE: Work area should be a clean, well-ventilated place, free from blowing dirt and dust.

2. Loosen locknut on output shaft assembly (Figure 6-99).

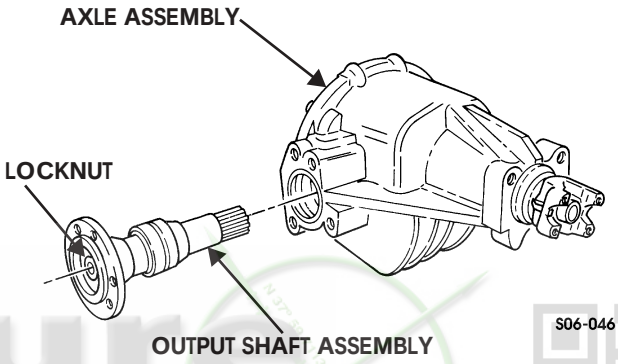


Figure 6-99: Output Shaft and Axle Assembly

3. Using a slide hammer, remove output shaft assembly from axle assembly.
4. Remove locknut, one O-ring seal, output flange and output shaft seal from output shaft. Discard O-ring seal, output shaft seal, and locknut (Figure 6-100).

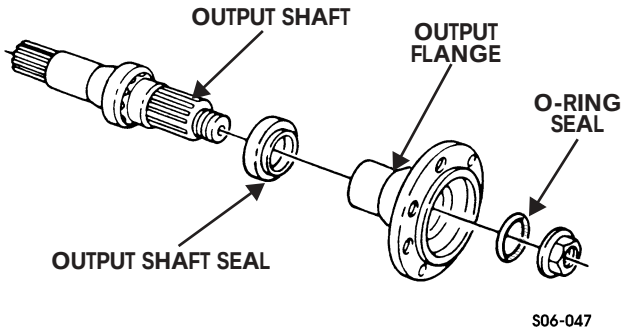


Figure 6-100: Output Shaft Assembly

5. Repeat steps 2 through 4 for opposite side.
6. Install two axle holding fixture adapters on housing with four capscrews. Place housing in holding stand (Figure 6-101).

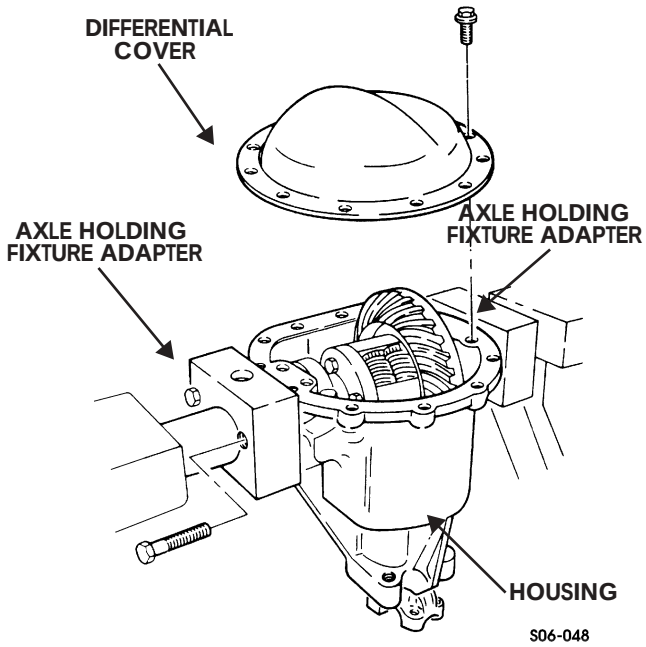


Figure 6-101: Axle Holding Fixture Adapters

7. Position housing so cover faces up. Remove twelve capscrews and cover from housing.
8. Mark bearing caps and housing for assembly and remove four capscrews and two bearing caps from housing (Figure 6-102).

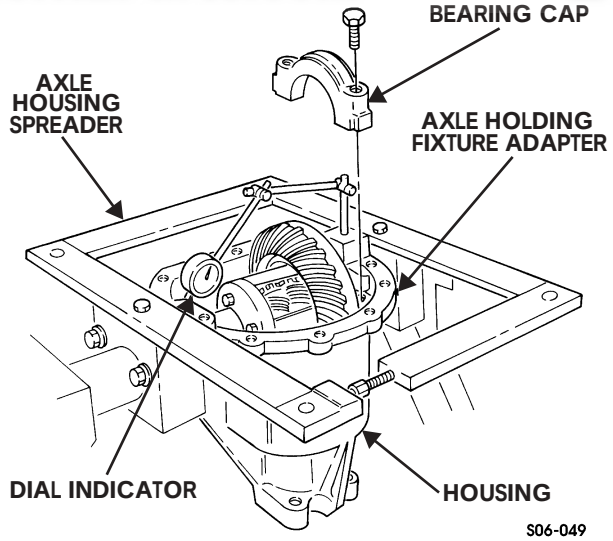


Figure 6-102: Housing

9. Install axle housing spreader into holes in axle holding fixture adapters and install dial indicator to read from each end of housing. Dial indicator must have preload setting of 0.020 inch (0.5 mm).

***CAUTION**: Over-tightening of axle housing spreader will damage axle housing.*

10. Spread housing 0.010 inch (0.25 mm) and remove dial indicator.

NOTE: Tag bearing shims and bearing cups for assembly.

11. Remove differential assembly, two bearing cups, and shims from housing (Figure 6-103).

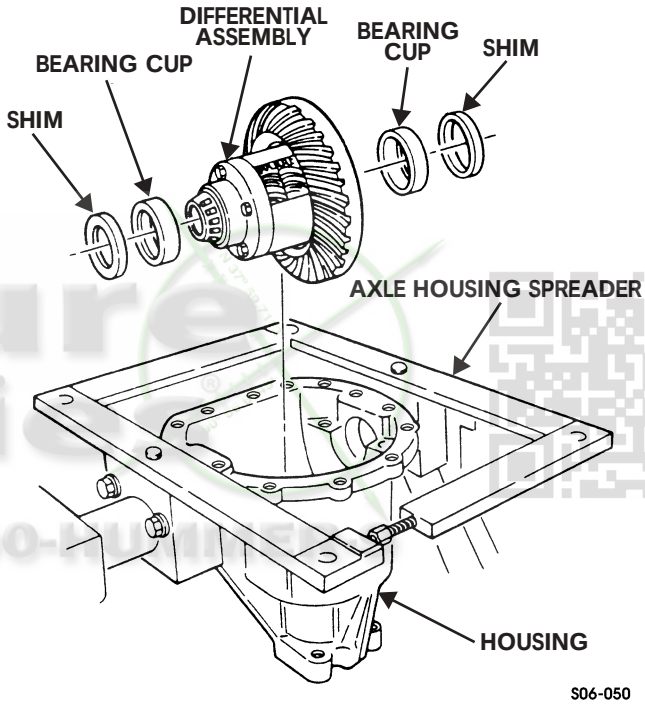


Figure 6-103: Differential Assembly

12. Relieve pressure on axle housing spreader and remove from housing.

***CAUTION**: To avoid damage, do not chisel or wedge ring gear from axle assembly.*

13. Remove eight capscrews and ring gear from differential assembly (Figure 6-104).

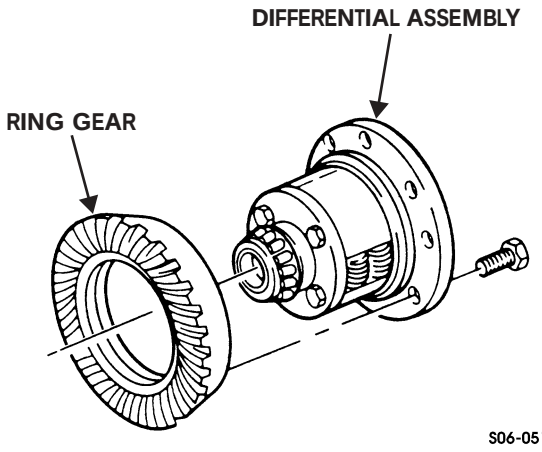


Figure 6-104: Differential Assembly and Ring Gear

14. Rotate housing 90 degrees. Install cover on housing with two capscrews (Figure 6-105).
15. Remove pinion nut and pinion yoke from pinion gear.
16. Drive pinion gear out of front pinion bearing.

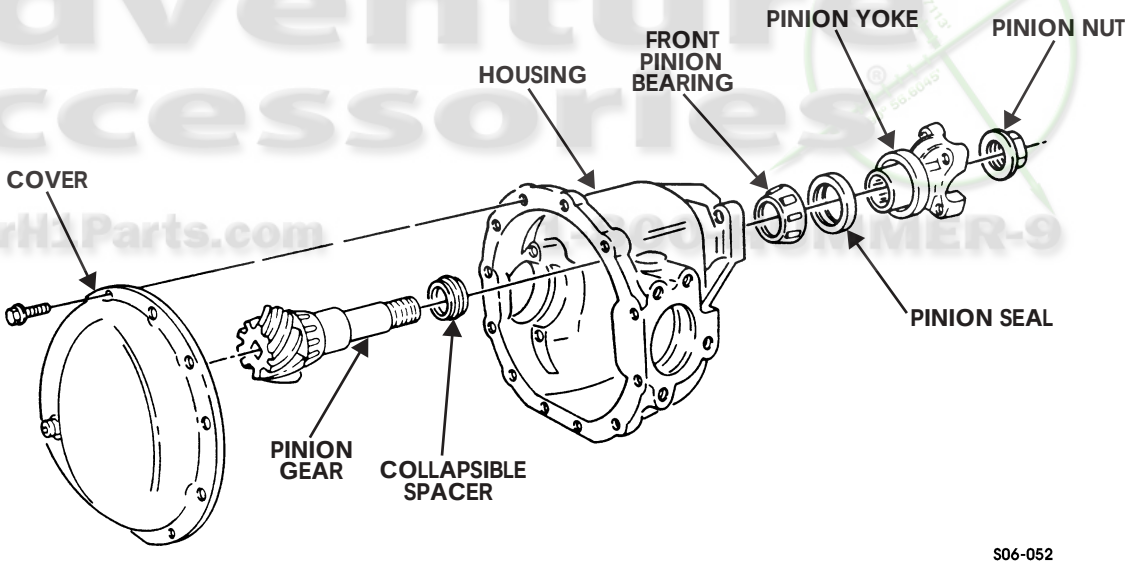


Figure 6-105: Axle Housing

17. Remove cover, pinion gear, and collapsible spacer from housing. Discard collapsible spacer.
18. Remove pinion seal and front pinion bearing from housing. Discard pinion seal.
19. Rotate front of housing upward 90 degrees. Using driver handle and rear pinion bearing cup remover, remove rear pinion bearing cup and pinion depth shim from housing (Figure 6-106).

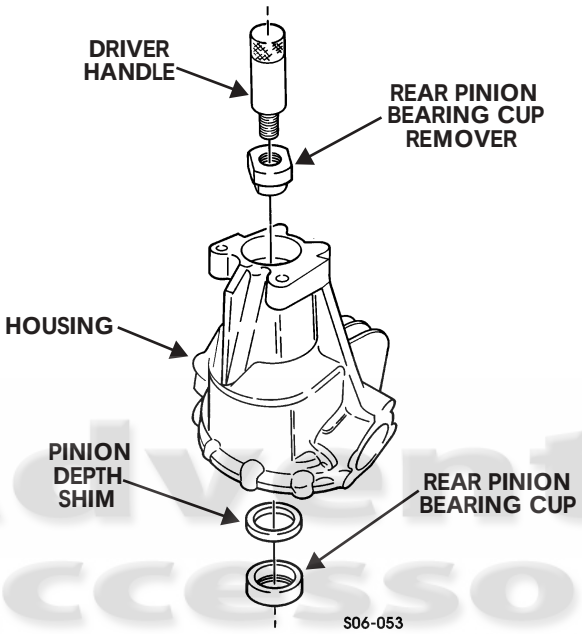


Figure 6-106: Rear Pinion Bearing Cup

20. Rotate housing 180 degrees. Using driver handle and front pinion bearing cup remover, remove front pinion bearing cup from housing (Figure 6-107).

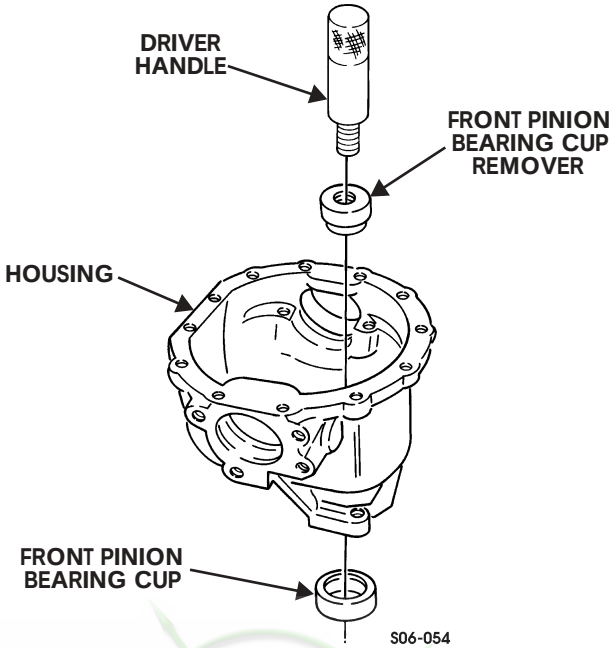


Figure 6-107: Front Pinion Bearing Cup

21. Remove two differential side bearings from differential assembly (Figure 6-108).

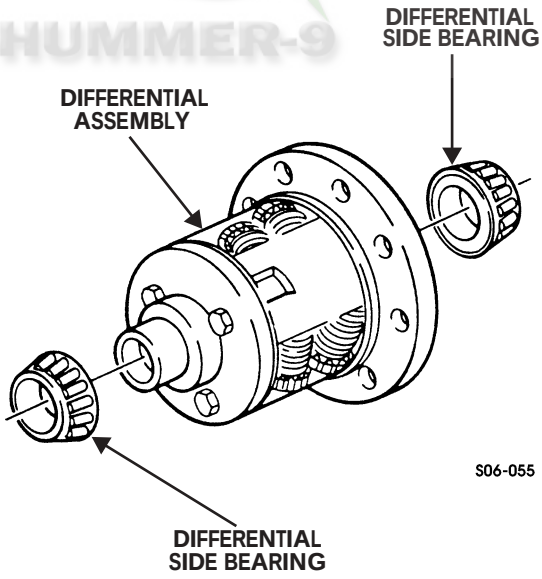


Figure 6-108: Differential Side Bearings

22. Remove rear pinion bearing from pinion gear (Figure 6-109).

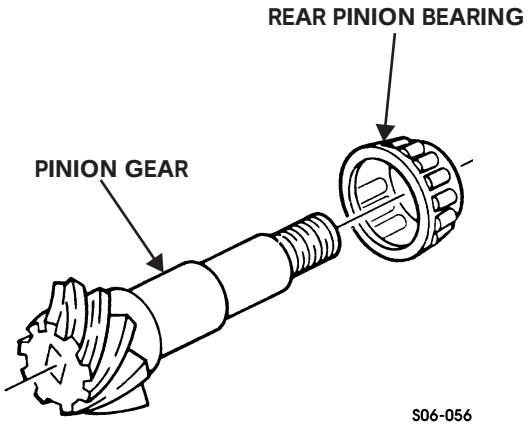


Figure 6-109: Pinion Gear

23. Remove bearing from output shaft (Figure 6-110).

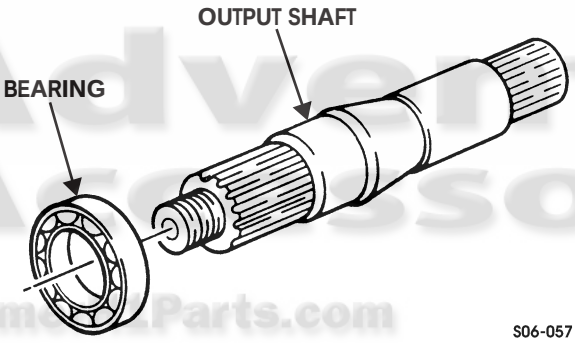


Figure 6-110: Output Shaft

Cleaning and Inspection

NOTE: Clean all components. Examine for wear or damage and replace if necessary.

1. Inspect housing and all threaded holes for damage. Repair any damaged threads with thread repair inserts. Replace axle assembly if housing is damaged (Figure 6-111).

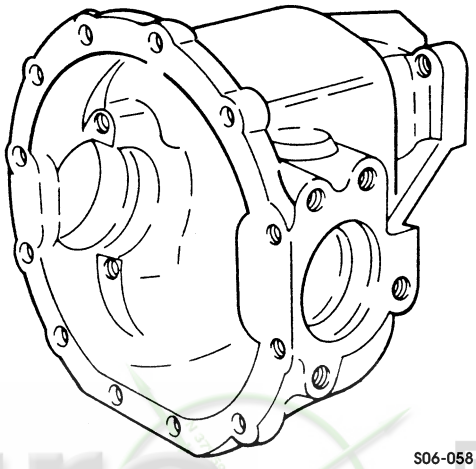


Figure 6-111: Housing

NOTE: Ring and pinion gears must be replaced as matched set.

2. Inspect splines and gear teeth on pinion gear and ring gear for damage. Replace both pinion gear and ring gear if either are damaged (Figures 6-112 and 6-113).

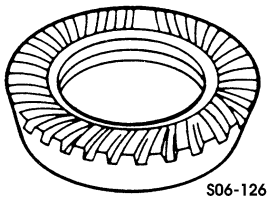


Figure 6-112: Ring Gear

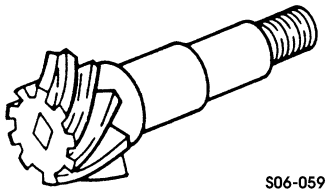


Figure 6-113: Pinion Gear

3. Inspect splines and sealing surfaces on output flanges, pinion yoke, and output shaft for damage (Figures 6-114, 6-115, and 6-116).

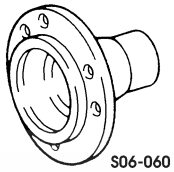


Figure 6-114: Output Flange

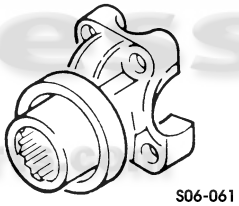


Figure 6-115: Pinion Yoke

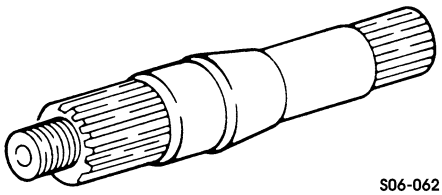


Figure 6-116: Output Shaft

4. Inspect all bearings and bearing cups for damage (Figure 6-117).

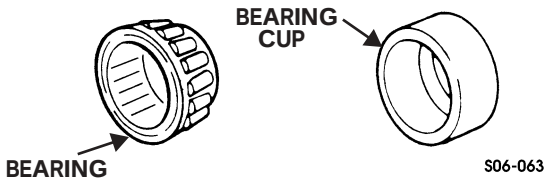


Figure 6-117: Bearing and Bearing Cup

5. Inspect differential assembly case for damage (Figure 6-118).

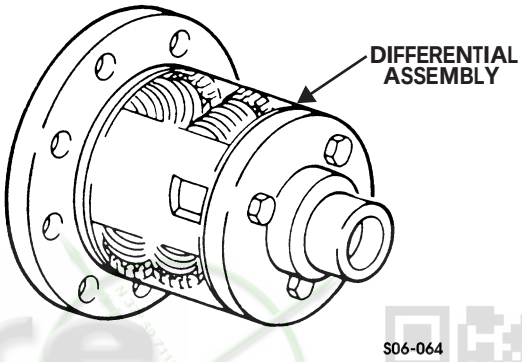


Figure 6-118: Differential Assembly

Assembly

NOTE: For general assembly instructions, refer to Section 1. Pinion gear depth is the distance from the end face of the pinion to the center line of the output shafts. The dimension is controlled by shims between pinion gear rear bearing cup and differential housing. The pinion gear is etched with two identifying numbers. The first number identifies ring gear and pinion gear as a matched set, and the second number represents pinion depth variance. The second number is preceded by a plus (+) or minus (-) which represents the amount the gear set varies from the standard setting of 2.547 inch (6.46 cm). If using original gear set, use original pinion depth shim as a starter shim and proceed to step 4.

1. Measure thickness of original pinion depth shim and record for reference (Figure 6-119).

Figure 6-119: Pinion Depth Shim

2. Check pinion depth variance number marked on old and new pinion gears and record (Figure 6-120) (Table 1).

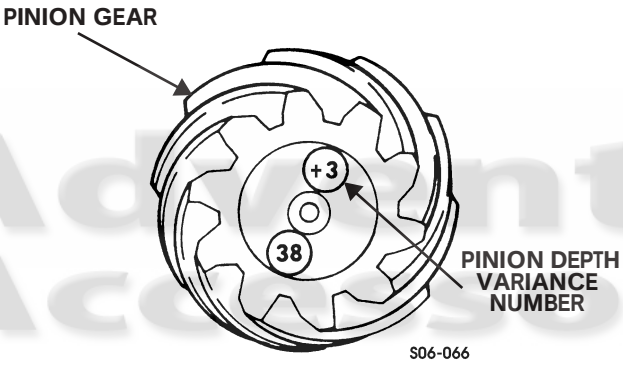


Figure 6-120: Pinion Depth Variance Number

NOTE: If the old pinion is marked -3 and the new pinion is marked +2, the procedure would be as follows: Refer to Old Pinion Marking column at left side of table and locate -3 in this column. Then read to right, across table, until under +2 in New Pinion Marking column. The box where two columns intersect is amount of shim thickness change required. In this case, the number in the intersecting box is -0.005 inch (0.13 mm) which represents the amount to be subtracted from the old shim thickness. If the box number had been a (+) figure, this amount would be added to the old shim thickness. The actual pinion depth measurement must be performed and final shim thickness adjusted as necessary. Pinion shims are available from 0.084-0.111 inch (2.13-2.82 mm) in increments of 0.0005 inch (0.0127 mm).

3. Refer to Old and New Pinion Marking columns on pinion variance table. Note on table where old and new pinion depth variances intersect. This will determine amount to be added or subtracted from original pinion depth shim for desired pinion depth starter shim.

Table 1: Pinion Variance Table - Inches (millimeters)

OLD PINION MARKING	NEW PINION MARKING								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008 (0.20)	+0.007 (+0.18)	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0
+3	+0.007 (+0.18)	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)
+2	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)
+1	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)
0	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)
-1	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)
-2	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)
-3	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)	-0.007 (-0.18)
-4	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)	-0.007 (-0.18)	-0.008 (-0.20)

4. Rotate housing so front pinion bearing cup bore faces up (Figure 6-121).

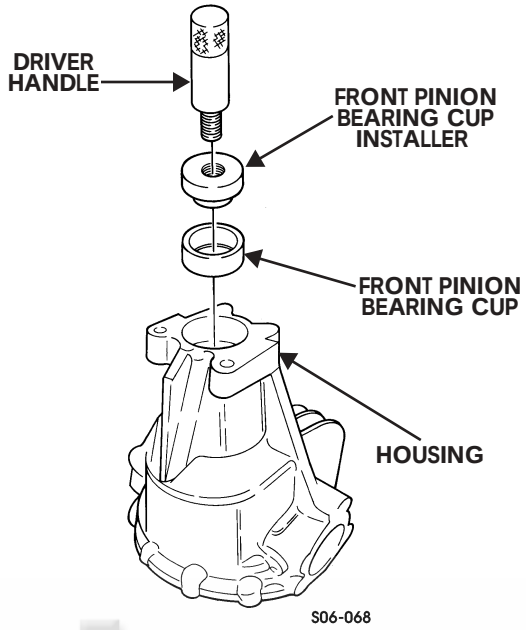


Figure 6-121: Front Pinion Bearing Cup

5. Lubricate outside diameter of front pinion bearing cup with lubricating oil. Using a driver handle and front pinion bearing cup installer, install cup in housing.
6. Install rear pinion bearing on pinion gear (Figure 6-122).

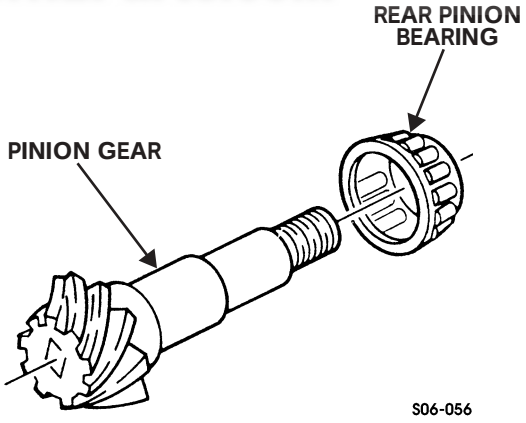


Figure 6-122: Rear Pinion Bearing and Pinion Gear

7. Using pinion setting gauge set, install gauge block, rear pinion bearing cup, rear pinion bearing, and pilot washer on stud and secure with gauge block (Figure 6-123).

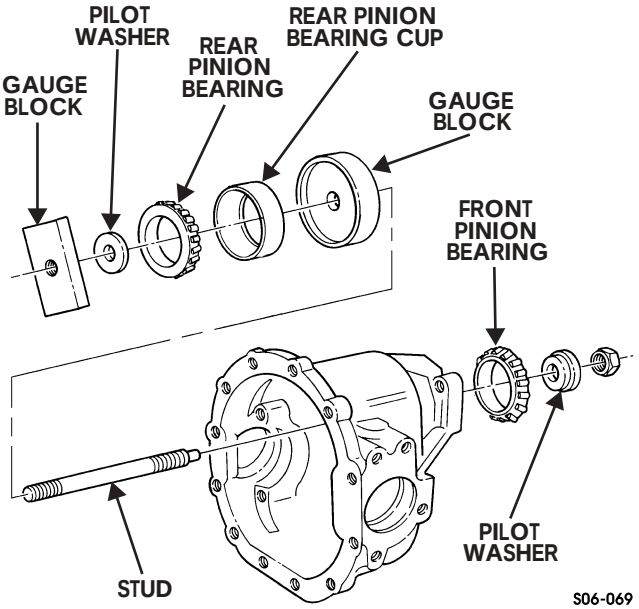


Figure 6-123: Pinion Setting Gauge Set

8. Position stud assembly in housing and secure with front pinion bearing, pilot washer, and nut. Tighten nut to 10 lb-inch (1.1 N•m). Rotate the assembly several revolutions to seat the bearing and recheck the torque.
9. Rotate front of housing downward 90 degrees. Assemble arbor and two discs and install in housing (Figure 6-124).

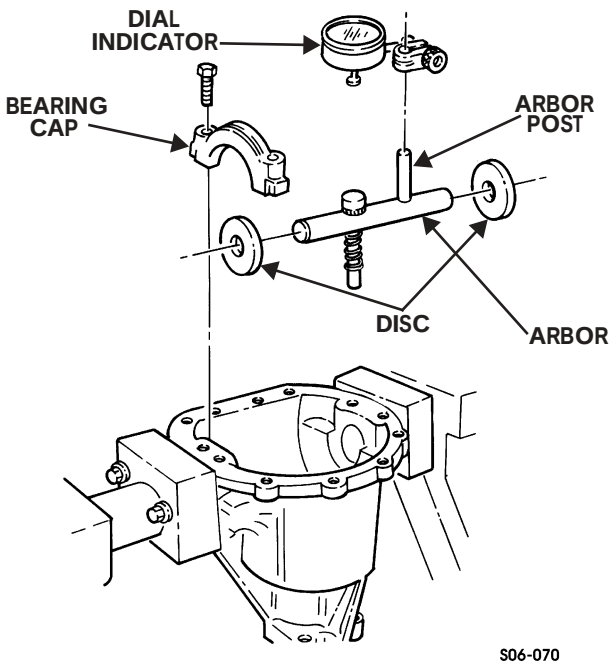


Figure 6-124: Arbor and Discs In Housing

10. Install two bearing caps and four capscrews in housing and finger tighten capscrews.
11. Install the dial indicator on the arbor post. Push the dial indicator downward until the needle rotates approximately one full turn clockwise. Tighten the dial indicator in this position and recheck.
12. Rotate the gauge shaft slowly back and forth until the dial indicator reads the greatest deflection. At the point of greatest deflection, set the dial indicator to zero. Repeat the rocking action of the gauge shaft to verify the gauge setting (Figure 6-125).

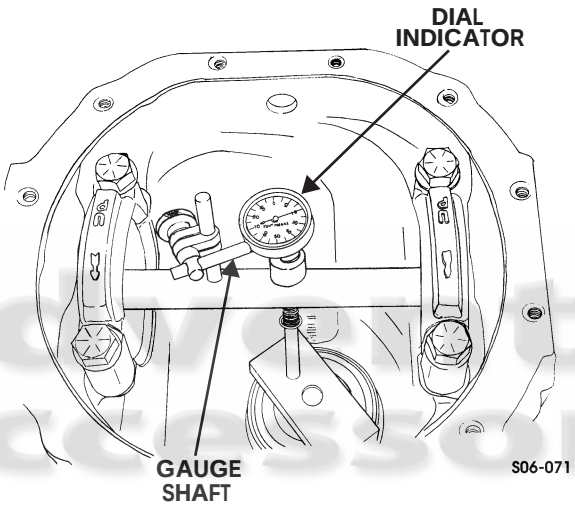


Figure 6-125: Gauge Setting

13. After the zero setting is obtained, rotate the gauge shaft until the dial indicator plunger does not touch the gauge block.
14. Record the dial indicator reading. Example: If the pointer moved counterclockwise and stops between 0 and 11, add 100 inches to measurement for shim thickness. If the pointer moves counterclockwise and stops between 84 and 99, correct shim thickness is indicated.
15. This reading indicates the shim thickness required for a pinion etched with a zero (0) on the pinion head. If the pinion being installed has a plus (+) or minus (-) etching, then an adjustment of the shim thickness is required. Example: If a pinion is etched +3, then 0.003 inches less shim thickness is required. Subtract 0.003 inches from the indicator reading. If a pinion is etched -3, then 0.003 inches more shim thickness is required. Add 0.003 inches to the indicator reading.
16. Remove dial indicator from arbor (Figure 6-124).
17. Remove four capscrews, two bearing caps, discs, and arbor from housing.
18. Remove nut, pilot washer, front pinion bearing, and stud assembly from housing (Figure 6-126).

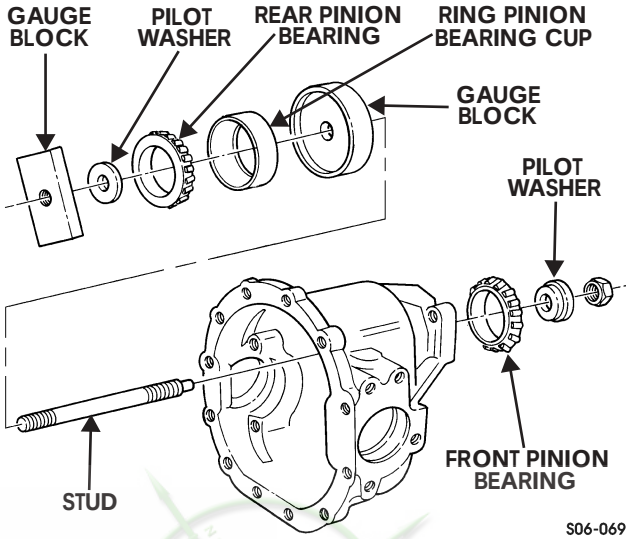


Figure 6-126: Bearing Assemblies

19. Remove gauge block, pilot washer, rear pinion bearing, rear pinion bearing cup, and gauge block from stud.
20. Note pinion depth variance marked on pinion gear. If number is preceded by a plus (+) sign, add that amount in thousands to standard setting of 2.547 inch (6.46 cm). If number is preceded by minus (-) sign, subtract that amount in thousands from standard setting of 2.547 inch (6.46 cm). The result of this addition or subtraction is desired pinion depth. Record for reference (Figure 6-127).

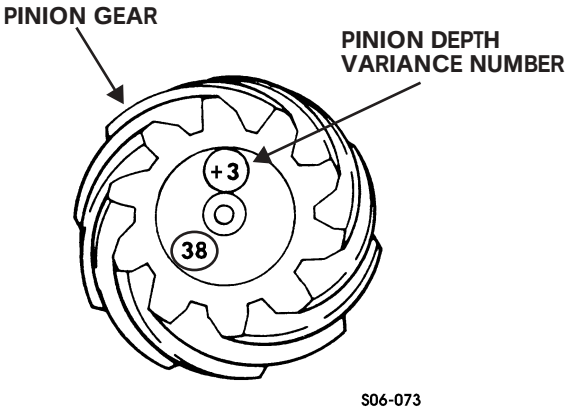


Figure 6-127: Pinion Depth Variance Number

21. Subtract desired pinion depth (step 14) from total measured pinion depth (step 15). Result of this subtraction is correct pinion depth shim thickness.
22. Lubricate front pinion bearing and pinion seal with lubricating oil. Using yoke seal installer, install front pinion bearing and pinion seal in housing (Figure 6-128).

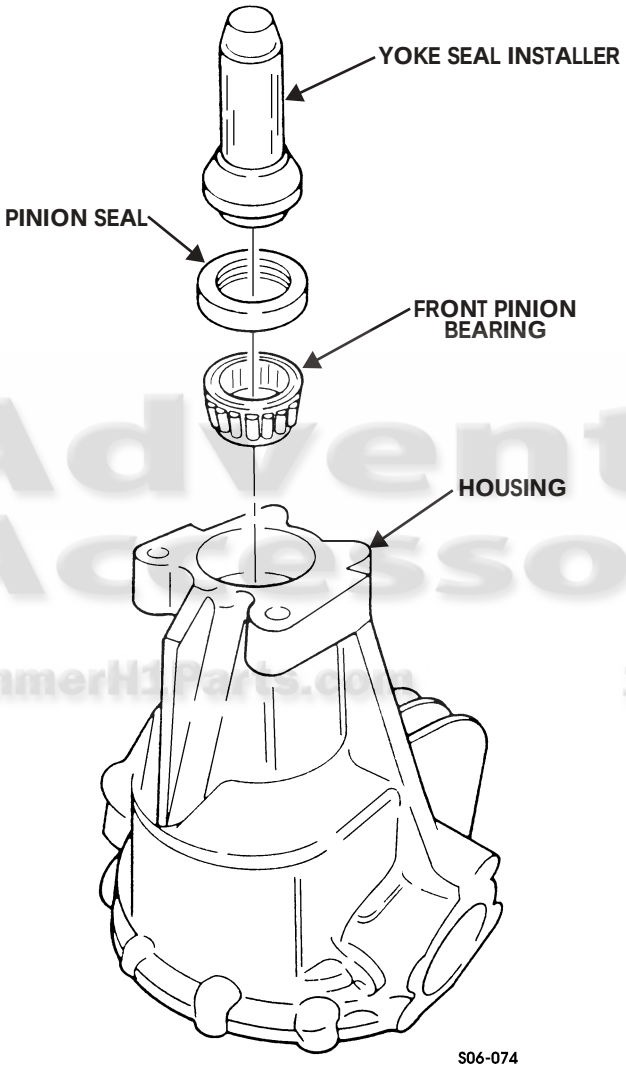


Figure 6-128: Yoke Seal

23. Rotate housing 180 degrees. Lubricate outside diameter of rear pinion bearing cup with lubricating oil (Figure 6-129).

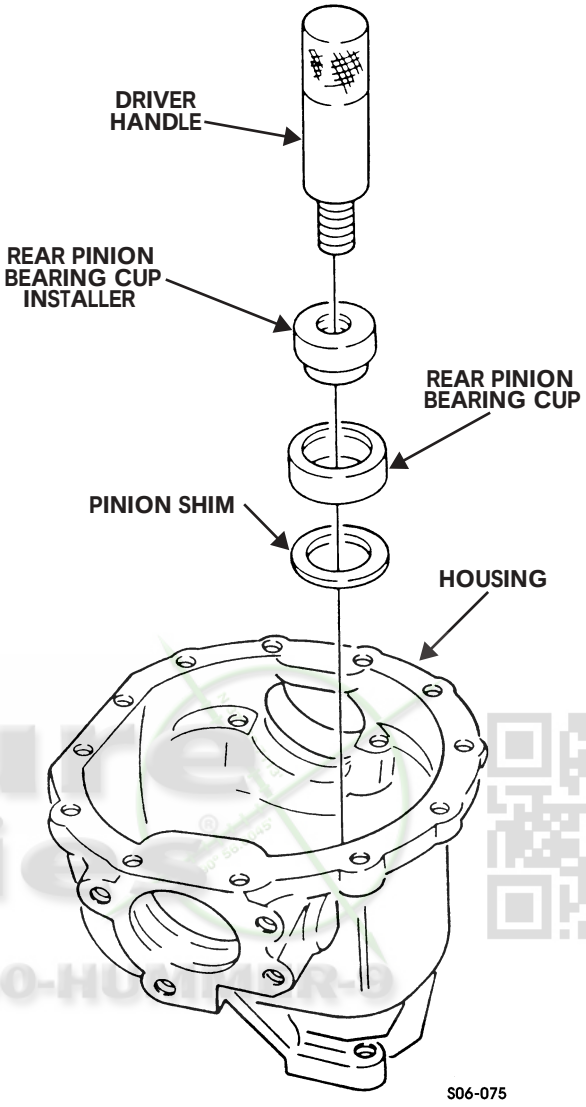


Figure 6-129: Rear Pinion Bearing

NOTE: If pinion shim is beveled, ensure beveled side faces bottom of bearing cup bore.

24. Using driver handle and rear pinion bearing cup installer, install correct thickness pinion shim and rear pinion bearing cup in housing.
25. Rotate housing 90 degrees. Lubricate rear pinion bearing with lubricating oil (Figure 6-130).

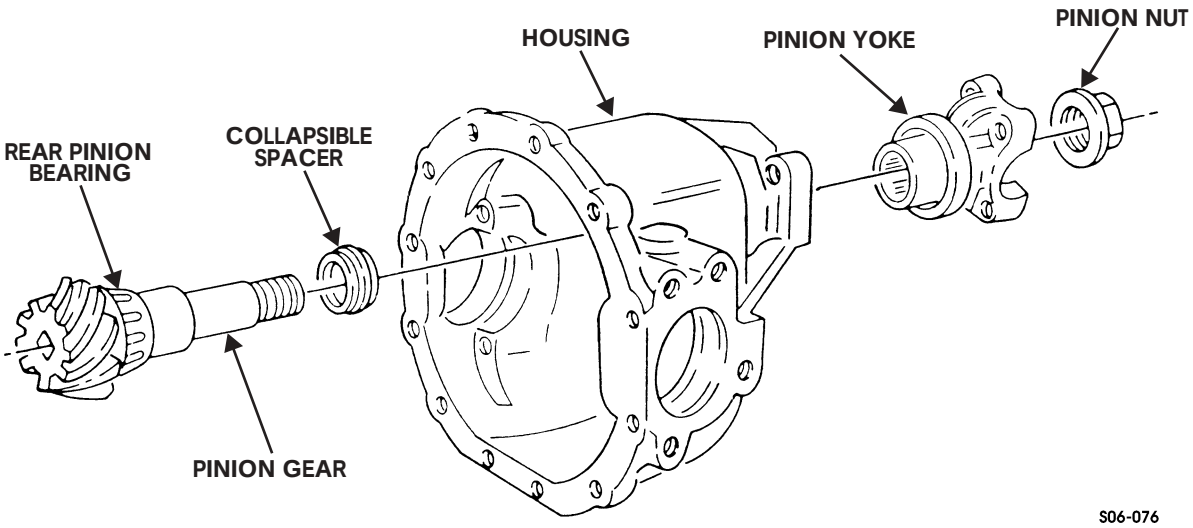


Figure 6-130: Rear Pinion Bearing Assembly

***CAUTION**: Collapsible spacer controls pinion bearing preload. Do not reuse old spacer, or pinion bearing damage may result.*

26. Install collapsible spacer on pinion gear and install pinion gear in housing.
27. Install pinion yoke on pinion gear with pinion nut.

***CAUTION**: Do not exceed specified preload torque on pinion bearings. Do not loosen locknut to replace preload torque or pinion bearing damage may result. If specified torque is exceeded, remove pinion gear and replace collapsible spacer and locknut and adjust preload again.*

28. Tighten pinion nut only enough to remove end play and seat pinion bearings in housing. Rotate pinion yoke while tightening to seat bearings evenly.
29. Measure torque required to rotate pinion gear. Correct pinion bearing preload torque is 17-25 lb-in. (2-3 N•m) with new bearings and 10-15 lb-in. (1-2 N•m) with used bearings.
30. Continue to tighten pinion nut in small increments until pinion bearing preload torque meets specifications.
31. Install two side bearings on differential assembly (Figure 6-131).

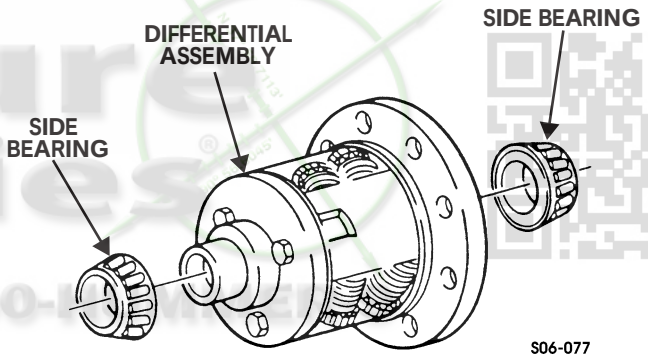


Figure 6-131: Side Bearings

NOTE: Side bearing shims are available in thickness from 0.077-0.117 in. (1.96-2.97 mm) in increments of 0.001 in. (0.025 mm).

32. Rotate housing downward 90 degrees. Install side bearing cups and side bearing shims on side bearings. Use 0.080 inch (2 mm) shims as a starting point (Figure 6-132).

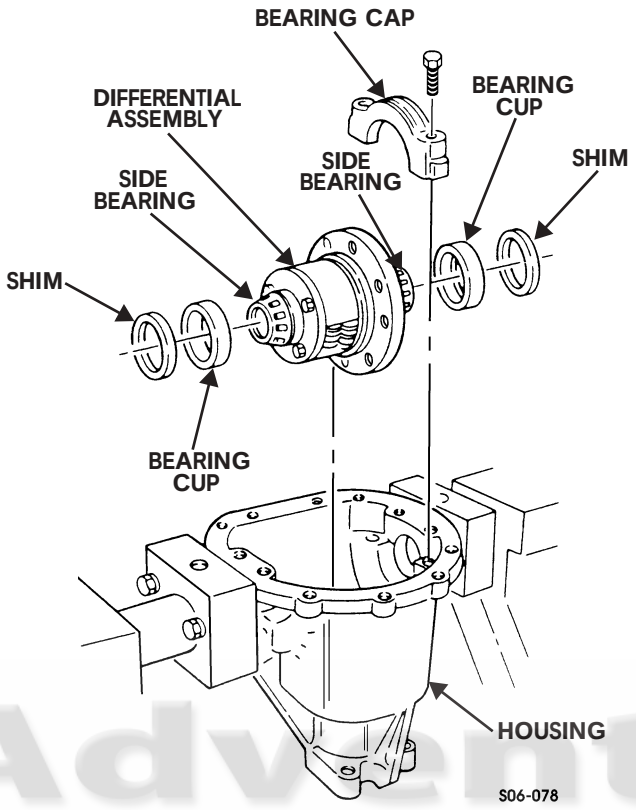


Figure 6-132: Side Bearing Cups and Shims

33. Install differential assembly, bearing cups, and shims in housing.
34. Install two bearing caps and four capscrews in housing. Snug capscrews.
35. Mount dial indicator on housing and position indicator to read off ring gear mounting surface of differential assembly (Figure 6-133).

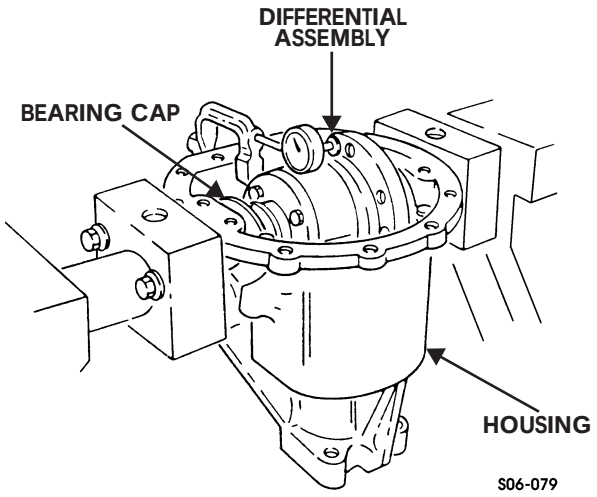


Figure 6-133: Differential Assembly in Housing

36. Pry between differential assembly and bearing cap on one side of indicator. Pry on opposite side to read end play.
37. Amount read on indicator is shim thickness that should be added to side bearing shims to arrive at zero end play. Add necessary shims and repeat procedure to ensure accuracy.

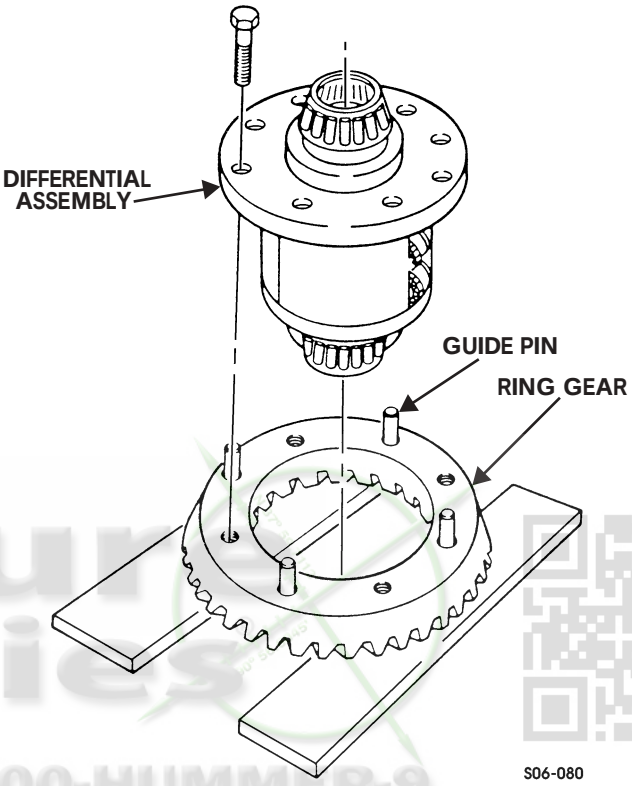


Figure 6-134: Guide Pins in Ring Gear

38. Tighten four capscrews to 87 lb-ft (118 N•m).
39. Rotate differential assembly and check runout. Runout should not exceed 0.002 in. (0.05 mm).
40. Remove dial indicator from housing.

NOTE: Tag shims and bearing cups for assembly.

41. Remove four capscrews, two bearing caps, bearing cups, shims, and differential assembly from housing (Figure 6-135).
42. Install four guide pins in ring gear (Figure 6-134).

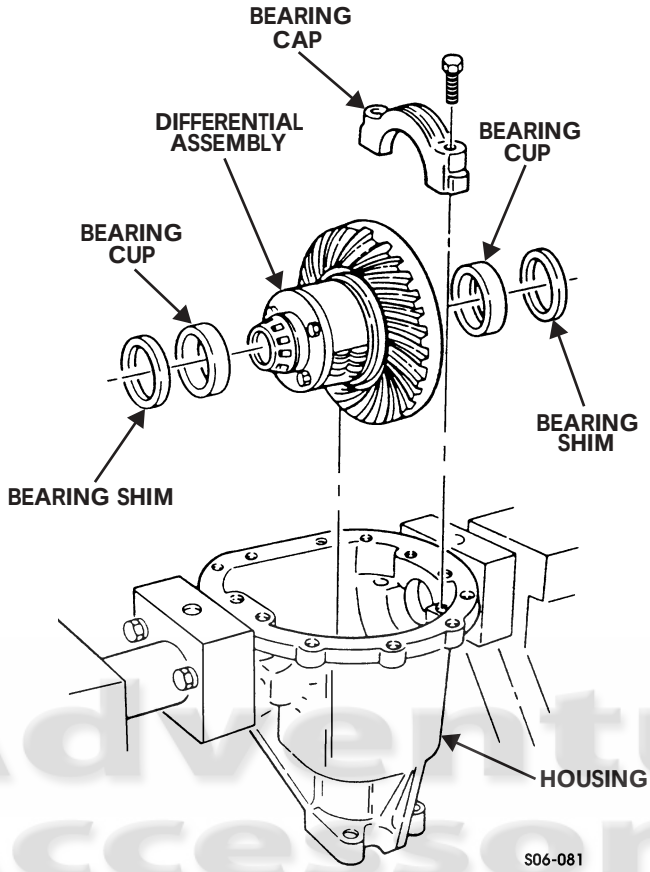


Figure 6-135: Differential Assembly

43. Support ring gear with wood blocks in press.
44. Press differential assembly on ring gear.
45. Remove four guide pins from ring gear.
46. Install ring gear on differential assembly with eight capscrews. Tighten capscrews to 95-115 lb-ft (129-156 N•m).
47. Install side bearing shims, previously selected to remove differential assembly side play, slide bearing cups, and differential assembly in housing (Figure 6-135).
48. Install two bearing caps in housing with four capscrews. Tighten capscrews to 87 lb-ft (118 N•m).
49. Attach dial indicator to housing and position indicator to read off drive side of ring gear tooth at a right angle (Figure 6-136).

NOTE: Backlash must be checked at four equally spaced points on ring gear and must not vary more than 0.002 in. (0.05 mm) between four points checked.

50. Move ring gear back and forth while holding pinion yoke stationary. Note backlash registered on indicator.
51. Ring gear backlash should be 0.005-0.009 inch (0.13-0.23 mm) with 0.008 inch (0.20 mm) desired. If backlash must be adjusted perform steps 52 through 55, if not go to step 56.

NOTE: Tag shims and bearing cups for assembly.

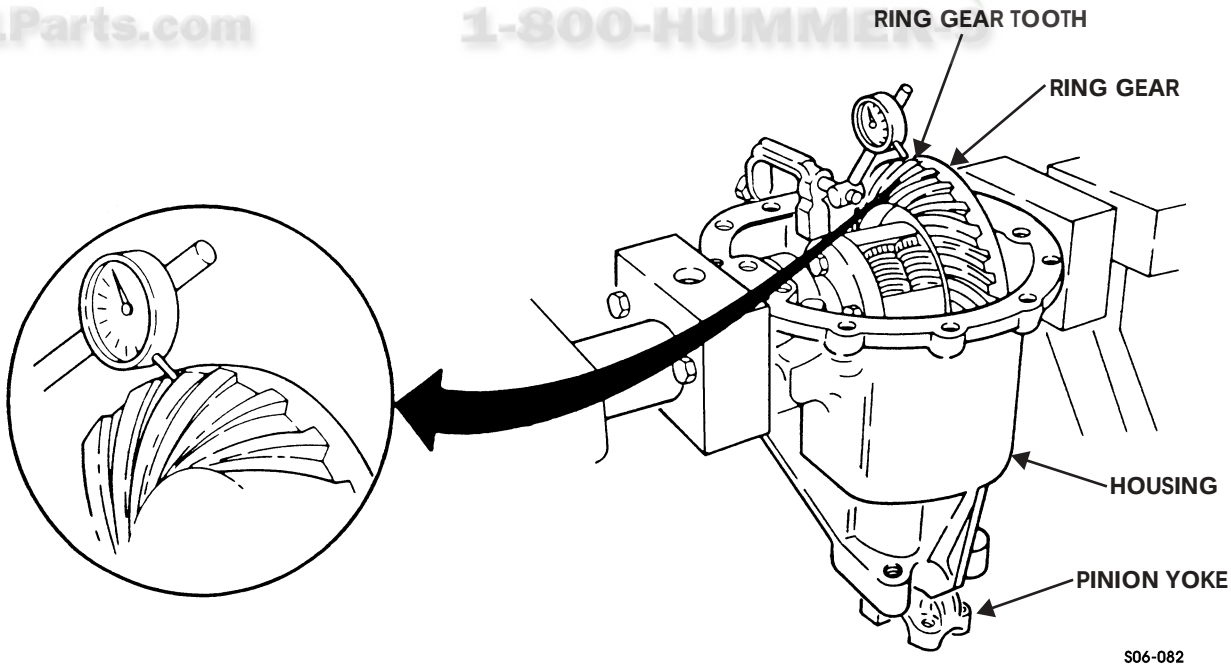


Figure 6-136: Dial Indicator Attached To Housing

52. Remove four capscrews, two bearing caps, bearing cups, shims, and differential assembly from housing (Figure 6-135).

NOTE: The following example will explain the procedure for adjusting backlash: If side play was removed us-

ing 0.090 inch (2.29 mm) shims on each side totaling 0.180 inch (4.57 mm) and backlash, when checked, is found to be 0.011 inch (0.28 mm), add 0.004 inch (0.10 mm) to shim on ring gear side and subtract 0.004 inch (0.10 mm) from shim on opposite side to correct backlash. This will result in 0.094 inch (2.39 mm) shim on ring gear side and 0.086 inch (2.18 mm) shim on other side. Backlash will be approximately 0.007-0.008 inch (0.18 to 0.20 mm). Total Shim Thickness remains 0.180 inch (4.57 mm).

53. To increase backlash, install thinner shim on ring gear side and thicker shim on opposite side. To decrease backlash, install thicker shim on ring gear side and thinner shim on opposite side. Do not change total shim thickness.
54. Install shims, bearing cups, differential assembly, and bearing caps in housing and secure with four capscrews. Tighten capscrews to 87 lb-ft (118 N•m).
55. Mount dial indicator and recheck backlash. If necessary, repeat steps 52 through 54.

NOTE: Tag shims and bearing cup for assembly.

56. Remove four capscrews, bearing caps, bearing cup, shims, and differential assembly from housing.
57. Install axle housing spreader into holes in axle holding fixture adapters and install dial indicator to read from each end of housing. Indicator must have preload setting of 0.020 inch (0.50 mm) (Figure 6-137).

CAUTION: Over-spreading of axle housing spreader will damage housing.

58. Spread housing 0.010 inch (0.25 mm) and remove dial indicator.

NOTE: Differential bearings must be preloaded to compensate for heat and loads during operation.

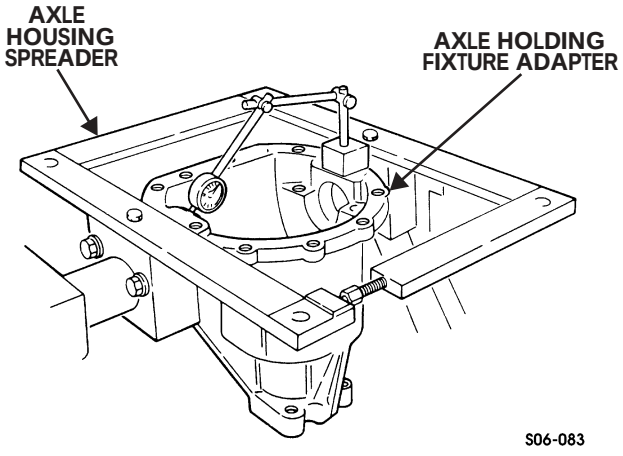


Figure 6-137: Axle Housing Spreader

59. Preload differential side bearings by increasing shim thickness at each side of differential assembly by 0.004 inch (0.10 mm) for a total bearing preload of 0.008 inch (0.20 mm) (Figure 6-135).
60. Lubricate side bearings with lubricating oil and install differential assembly, bearing cups, shims, and bearing caps in housing and secure with four capscrews (Figure 6-135).

NOTE: Preloaded differential bearings may change backlash setting. Check and correct backlash if necessary.

61. Remove housing spreader and tighten capscrews to 87 lb-ft (118 N•m).
62. Apply silicone sealant to cover sealing surface and install cover on housing with twelve capscrews. Tighten capscrews to 16 lb-ft (22 N•m) (Figure 6-138).

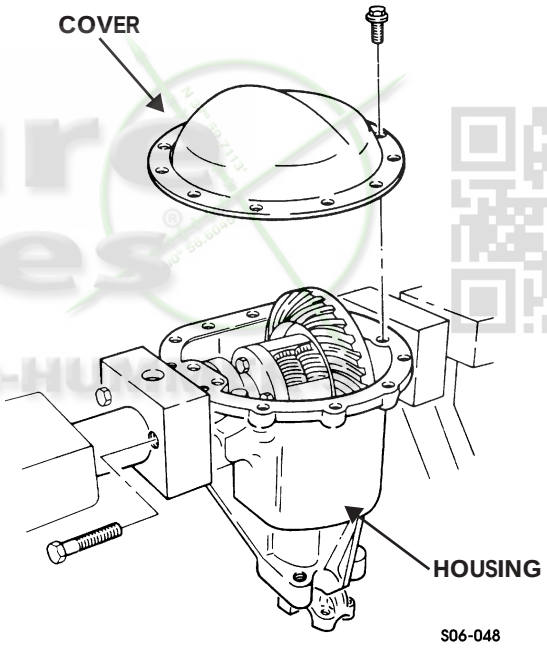


Figure 6-138: Housing and Cover

63. Remove housing from holding fixture.
64. Remove four capscrews and two axle holding fixture adapters from housing.
65. Using press, install output shaft bearings on output shafts (Figure 6-139).

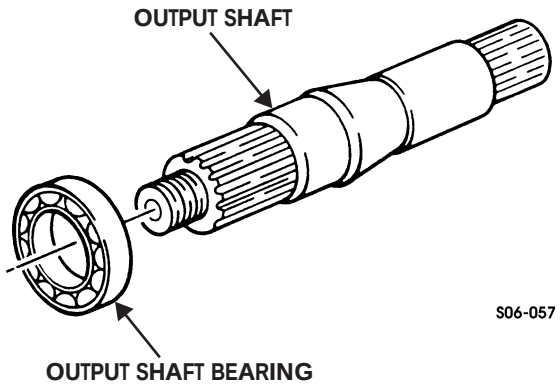


Figure 6-139: Output Shaft And Bearing

66. Using axle shaft and seal installer, install output shaft assemblies into axle assembly (Figure 6-140).

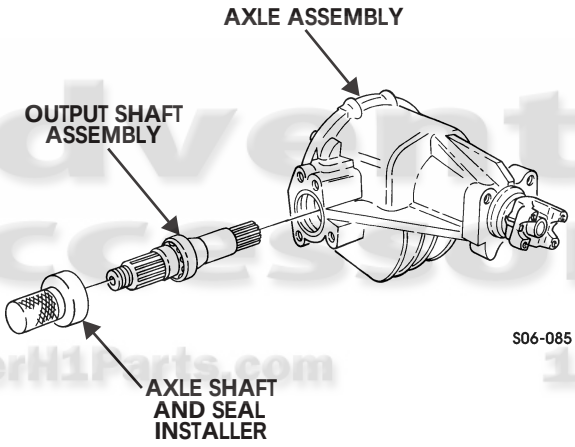


Figure 6-140: Axle Shaft And Seal Installer

67. Using axle shaft and seal installer, install output shaft seals in axle assembly (Figure 6-141).

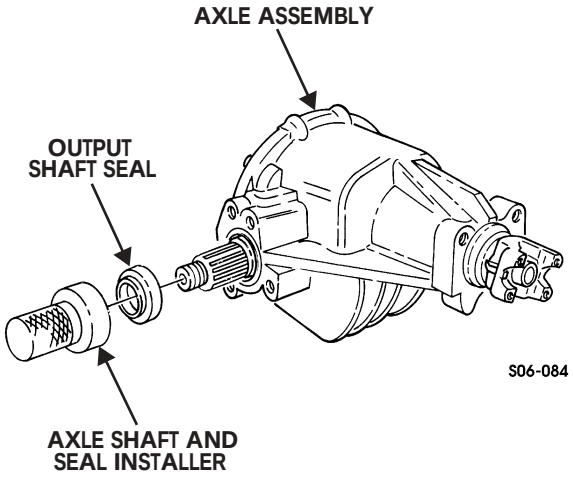


Figure 6-141: Output Shaft Seal

68. Lubricate sealing surface on output flanges with lubricating oil (Figure 6-142).

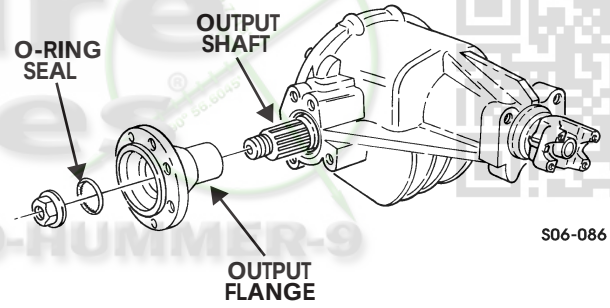


Figure 6-142: Output Shaft O-Ring Seals

69. Install two output flanges, two O-ring seals, and two locknuts on output shafts. Finger tighten locknuts.
70. Install axle assembly.

CONTROL ARM BUSHING REPLACEMENT

Removal

NOTE: Control arm bushings must be replaced as a set (Figure 6-143).

1. Remove control arm (Section 9).
2. Support control arm and press bushing out of control arm.

Installation

1. Lubricate outside diameter of bushing with grease.
2. Insert bushing in control arm (Figure 6-143).
3. Support control arm and press bushing into control arm until flange on bushing seats on control arm.
4. Install control arm (Section 9).
5. Adjust caster and camber.

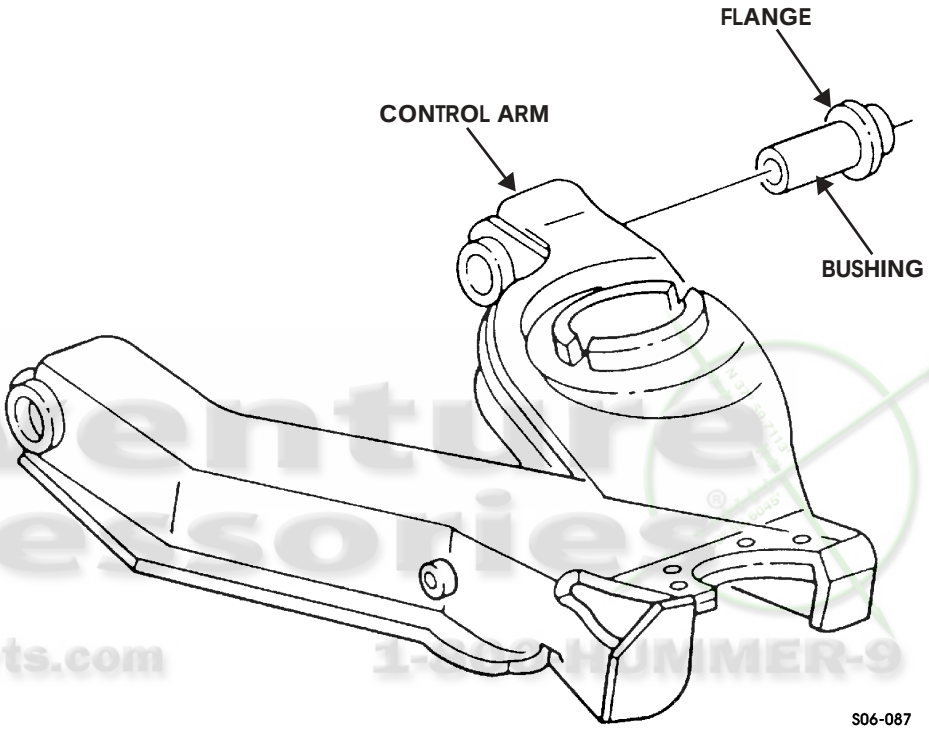


Figure 6-143: Control Arm Bushing

CENTRAL TIRE INFLATION SYSTEM

The optional Central Tire Inflation System (CTIS) is unique to the HUMMER. The CTIS allows the driver to increase or decrease tire pressure based on terrain and climate conditions. The system can also be used to direct air to a tire that has a leak.

The CTIS controls are located on the instrument panel. An inflate/deflate switch determines if air is added to the tires or released from the tires. When the tires are being inflated, an indicator light on the instrument panel illuminates. If the pressure in any of the tires drops to 8 psi (55 kPa) or below, the low pressure indicator light will illuminate and an alarm will sound. If the tire pressure ever exceeds 45 psi (310 kPa), a relief valve automatically relieves any excess pressure. The tire selector valve position determines whether the pressure in the front, rear or all four tires will be adjusted. The air pressure gauge indicates the current pressure in the tires. Refer to the short, white needle for front tire pressure and the longer, orange needle for the pressure in the rear tires. Temperature rise and fall affects air pressure in a tire. As the vehicle is operated it is typical for the air pressure to rise 3-5 psi (21-34 kPa). As the wheels and tires cool down, the air pressure will drop. This is normal and such a drop in tire pressure does not indicate any leaks in the system.

The CTIS consists of an electric air compressor that pumps air through a series of valves, tubes, and hoses to the front and/or rear tires. Air from the compressor travels to a three-port, two-way tire selector valve, where it is directed to the front and/or rear tires. When deflation is selected, air is routed from the tires through the tire selector valves and is exhausted through the deflate valves (Figure 6-144).

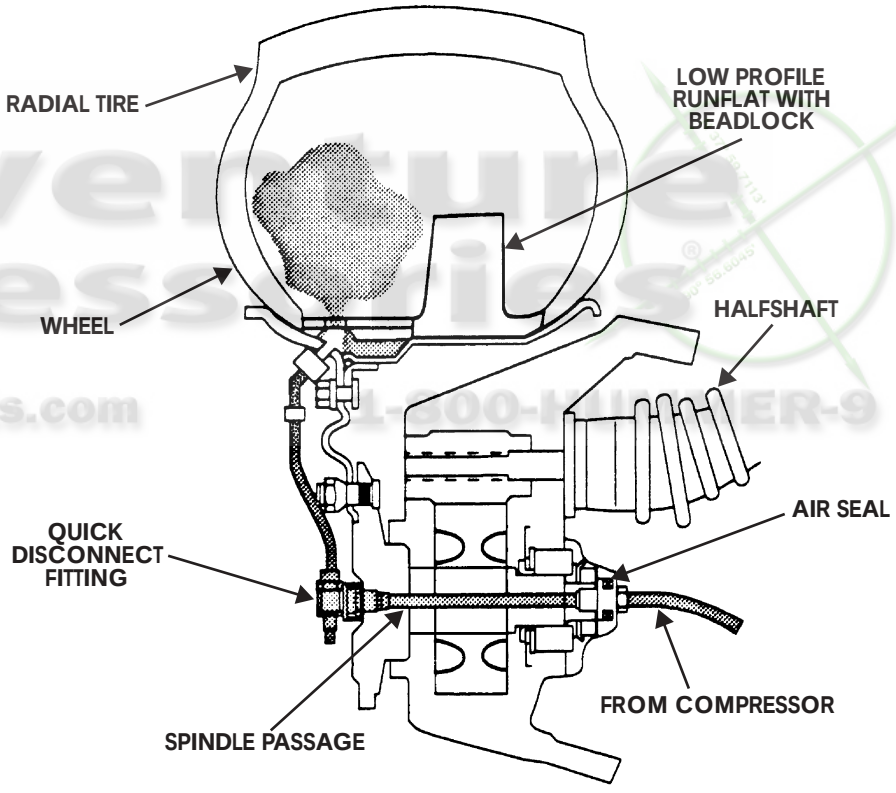


Figure 6-144: Central Tire Inflation System (CTIS)

Each wheel assembly has a manual quick-disconnect valve which can be used to prevent air flow to and from the tire, such as during long-term storage or while changing a tire. If the vehicle will remain dormant for two weeks or more, it is a good practice to disconnect the system at the wheels. These quick-disconnect valves are also used to restrict air flow to the operational tires when the driver wants to direct air flow to the damaged tire. For example, if a tire has a small puncture and has a leak, the quick-disconnect valves on the operational tires can be disconnected, enabling compressed air to be directed exclusively to the leaking tire. This may maintain enough tire pressure in the leaking tire to allow the driver to get the vehicle to an appropriate location for safe tire repair or replacement (Figure 6-145).

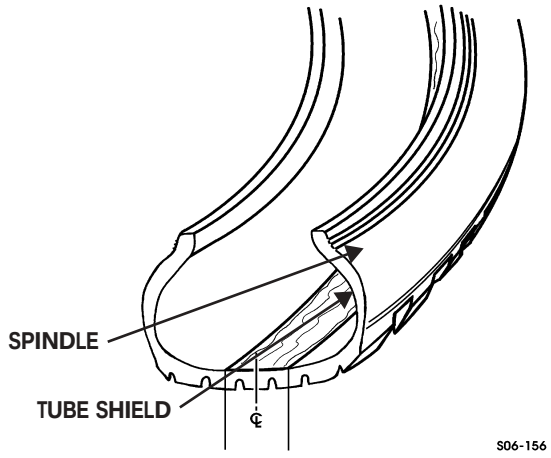


Figure 6-145: Quick-Disconnect Valve

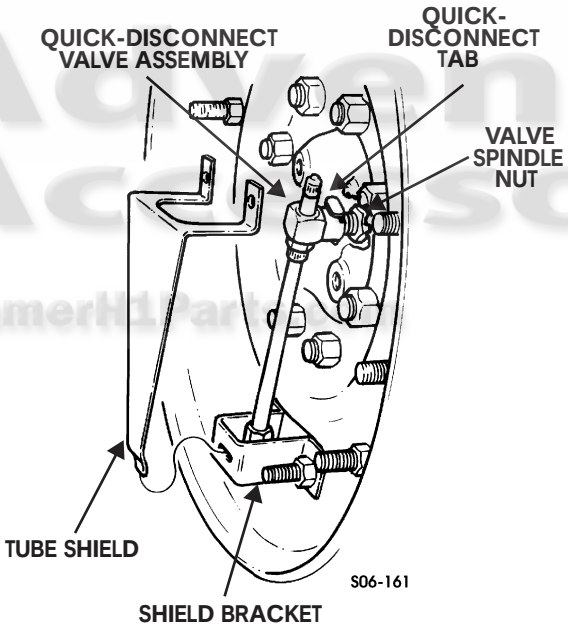


Figure 6-146: Quick-Disconnect Tab

To disconnect the CTIS from the wheel assemblies, first turn the tire selector valve to the OFF position. Release the four quick-disconnect valve assemblies from all four spindles by depressing the quick-disconnect valve tabs attached to the valve spindle nuts (Figure 6-146). When the tabs are depressed, the valve assemblies will spring away from the spindles about 1/2 inch (12.7 mm). To reconnect the quick-disconnect valve assemblies, push the valve assemblies toward the spindles until they click into place.

Compressor Maintenance

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure hood.
2. Disconnect leads from compressor (Figure 6-147).
3. Loosen clamp securing air intake hose to fitting and disconnect hose from fitting.
4. Disconnect compressor-to-deflate valve tube from elbow.
5. Loosen two clamps securing compressor to bracket and remove compressor.
6. Remove relief valve, elbow, tee, and fitting from compressor.
7. Remove four locknuts, upper brackets, clamps, and four isolators from lower brackets. Discard locknuts.

Cleaning and Inspection

Clean and inspect compressor, leads, fittings, and mounting hardware. Check for cracks, frayed wire, stripped threads, and improper operation. Replace defective parts.

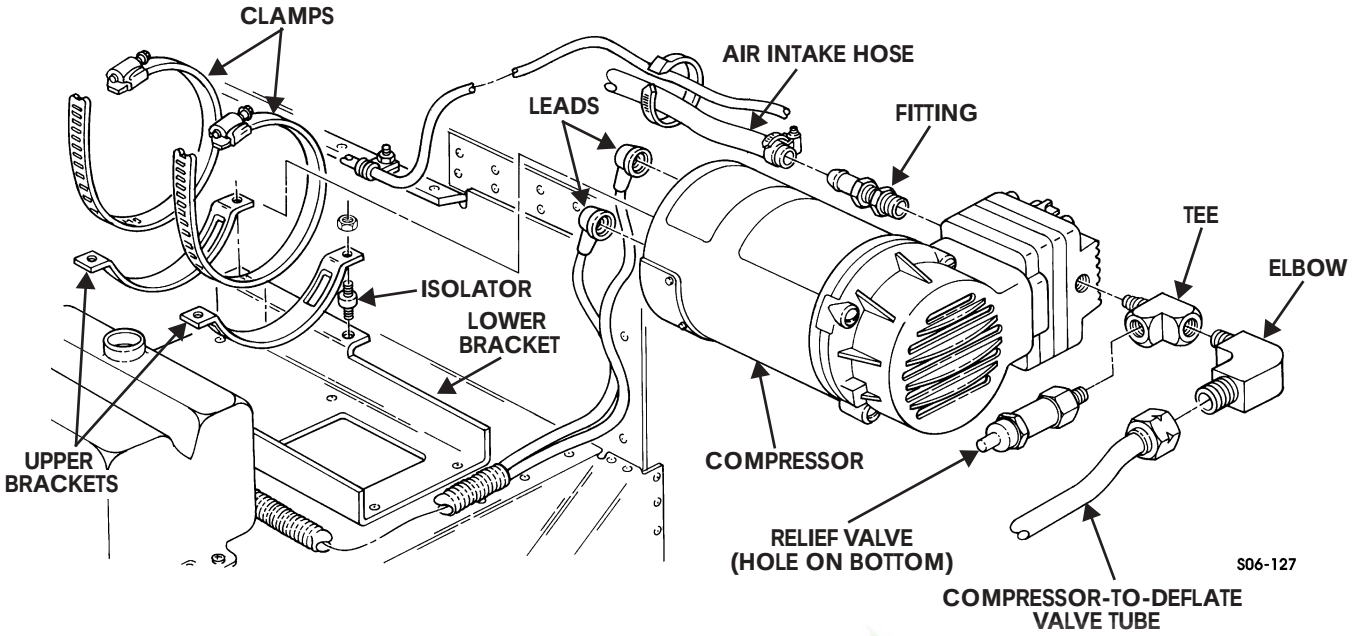


Figure 6-147: CTIS Compressor

Installation

1. Install four isolators, two upper brackets, and clamps to lower bracket with four locknuts (Figure 6-147).
2. Install fitting, tee, elbow, and relief valve to compressor.

NOTE: Ensure that the breather hole in the pressure relief valve is pointed downward.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to all threads before installation.

3. Install compressor on bracket with two clamps.
4. Connect compressor-to-deflate valve tube to elbow.
5. Connect air intake hose to fitting and secure with hose clamp.
6. Connect leads to compressor.
7. Lower and secure hood.

CTIS INSTRUMENT PANEL MAINTENANCE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove four capscrews and CTIS instrument panel from instrument panel. Discard CTIS instrument panel if damaged. (Figure 6-148).

Disassembly

1. Remove inflate/deflate switch.
2. Remove compressor/pressure indicator light.
3. Remove air pressure gauge.

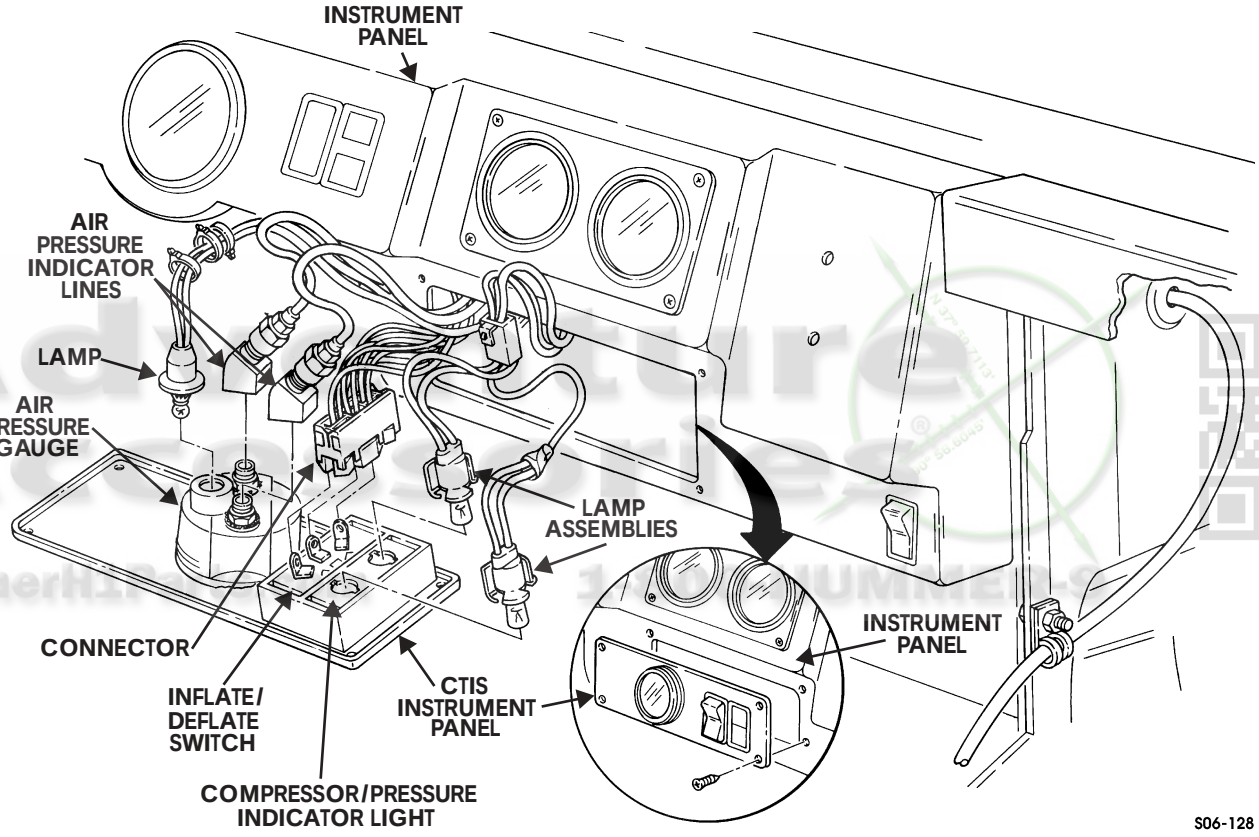


Figure 6-148: CTIS Instrument Panel

Assembly

1. Install air pressure gauge.
2. Install compressor/pressure indicator light.
3. Install inflate/deflate switch.

Installation

1. Install CTIS instrument panel on instrument panel with four capscrews (Figure 6-148).
2. Connect battery ground cable (Section 12).

INFLATE/DEFLATE SWITCH MAINTENANCE

Removal

1. Remove CTIS instrument panel.
2. Disconnect connector from inflate/deflate switch (Figure 6-149).
3. Remove two lamp assemblies from compressor/pressure indicator light.
4. Remove inflate/deflate switch from CTIS instrument panel and housing.

Cleaning and Inspection

Clean and inspect inflate/deflate switch and lamp assemblies for damage. Replace defective parts.

Installation

1. Install inflate/deflate switch in housing on CTIS instrument panel (Figure 6-149).
2. Install two lamp assemblies in compressor/pressure indicator light.
3. Connect connector to inflate/deflate switch.
4. Install CTIS instrument panel.
5. Start engine and ensure lamp and inflate/deflate switch operate properly.

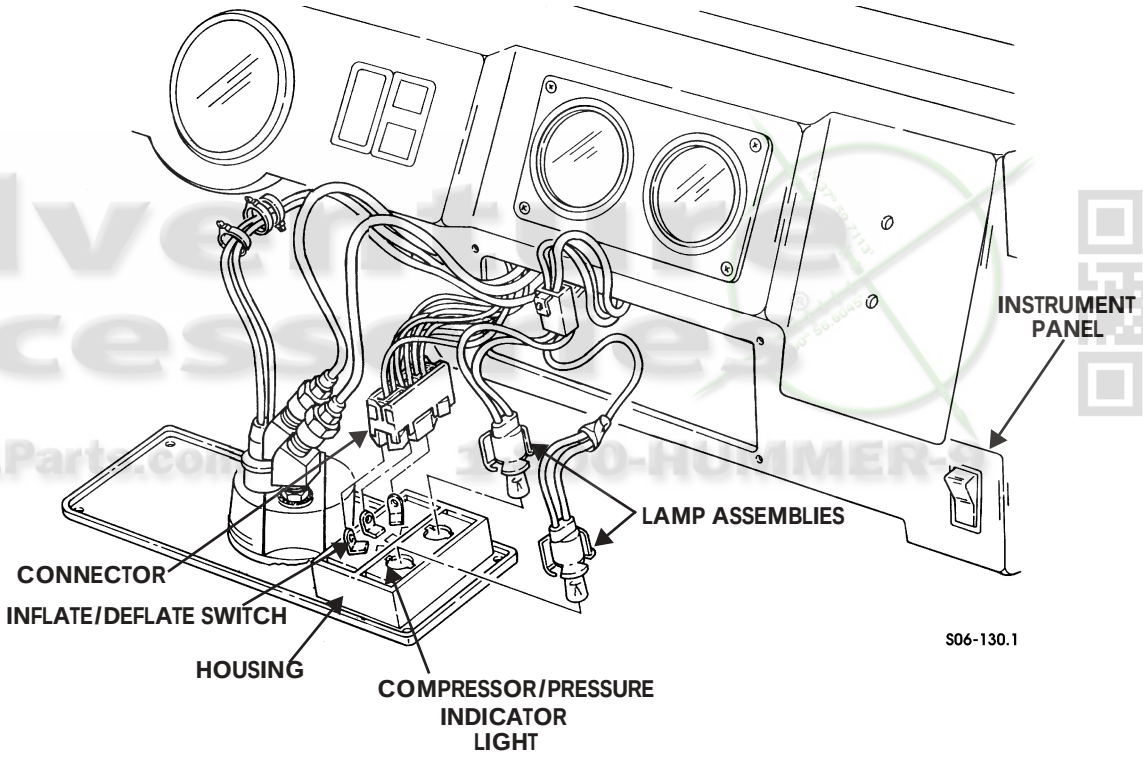


Figure 6-149: Inflate/Deflate Switch and Indicator Light

INFLATE/DEFLATE SWITCH INDICATOR LIGHT MAINTENANCE

Removal

1. Remove CTIS instrument panel.
2. Remove lamp assemblies from compressor/pressure indicator light (Figure 6-149).
3. Turn lamp one quarter turn, and remove lamps from sockets.

Cleaning and Inspection

Clean and inspect inflate/deflate switch and lamps for damage. Replace defective parts.

Installation

1. Install lamps in sockets and turn one quarter turn (Figure 6-149).
2. Install lamp assemblies in compressor/pressure indicator light.
3. Install CTIS instrument panel.
4. Start engine, and ensure lamp and switch operate properly.

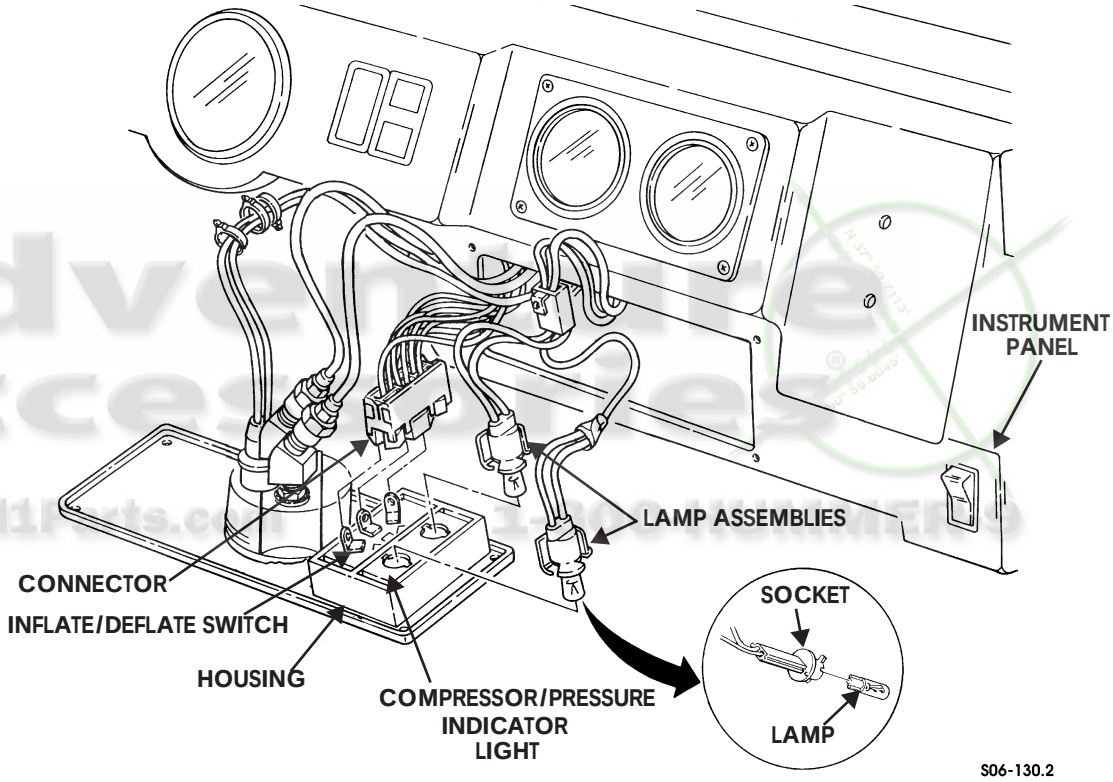


Figure 6-150: Inflate/Deflate Switch Indicator Light

AIR PRESSURE GAUGE MAINTENANCE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Remove CTIS instrument panel.
2. Remove lamp from air pressure gauge (Figure 6-151).
3. Disconnect two air pressure indicator lines from air pressure gauge.
4. Remove two nuts, lockwashers, air pressure gauge, and bracket from CTIS instrument panel. Discard lockwashers.

Cleaning and Inspection

Clean and inspect air pressure gauge and lamp. Check for cracks and stripped threads. Replace defective parts.

CAUTION: Do not allow sealant into air system. Sealant will damage CTIS components.

NOTE: Apply sealant to threads prior to installation.

Installation

1. Install air pressure gauge and bracket on CTIS instrument panel with two nuts and lockwashers. Tighten nuts to 8 lb-in. (0.9 N•m) (Figure 6-151).
2. Connect two air pressure indicator lines to air pressure gauge.
3. Install lamp in air pressure gauge.
4. Install CTIS instrument panel.
5. Start engine and ensure air pressure gauge operates properly.

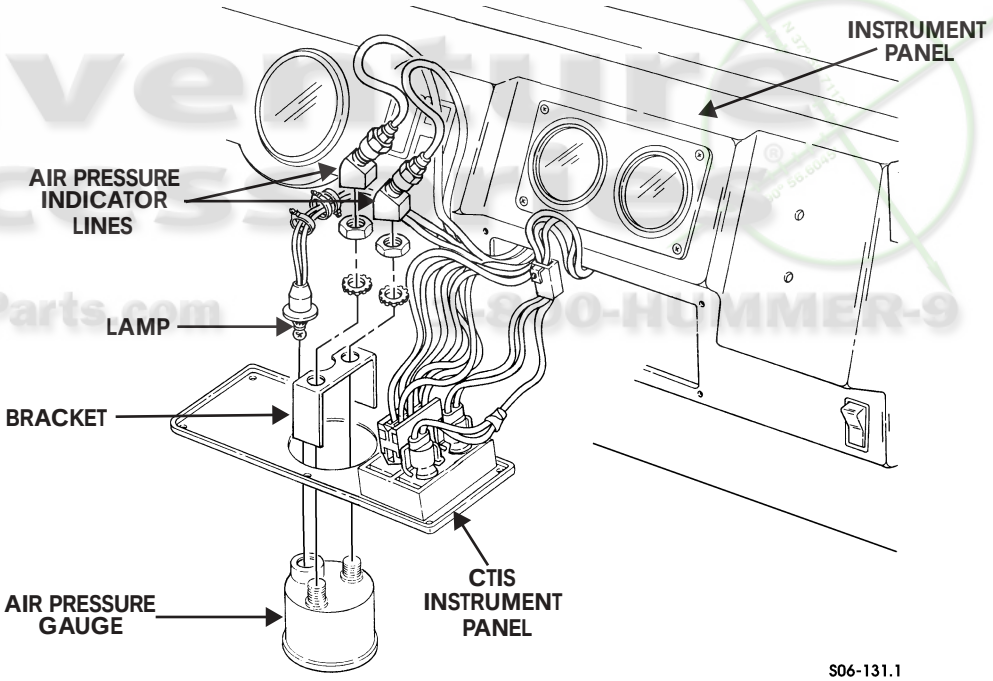


Figure 6-151: Air Pressure Gauge

AIR PRESSURE GAUGE LAMP REPLACEMENT

Removal

1. Remove CTIS instrument panel.
2. Remove lamp from air pressure gauge (Figure 6-152).
3. Remove lamp from socket. Discard lamp if defective.

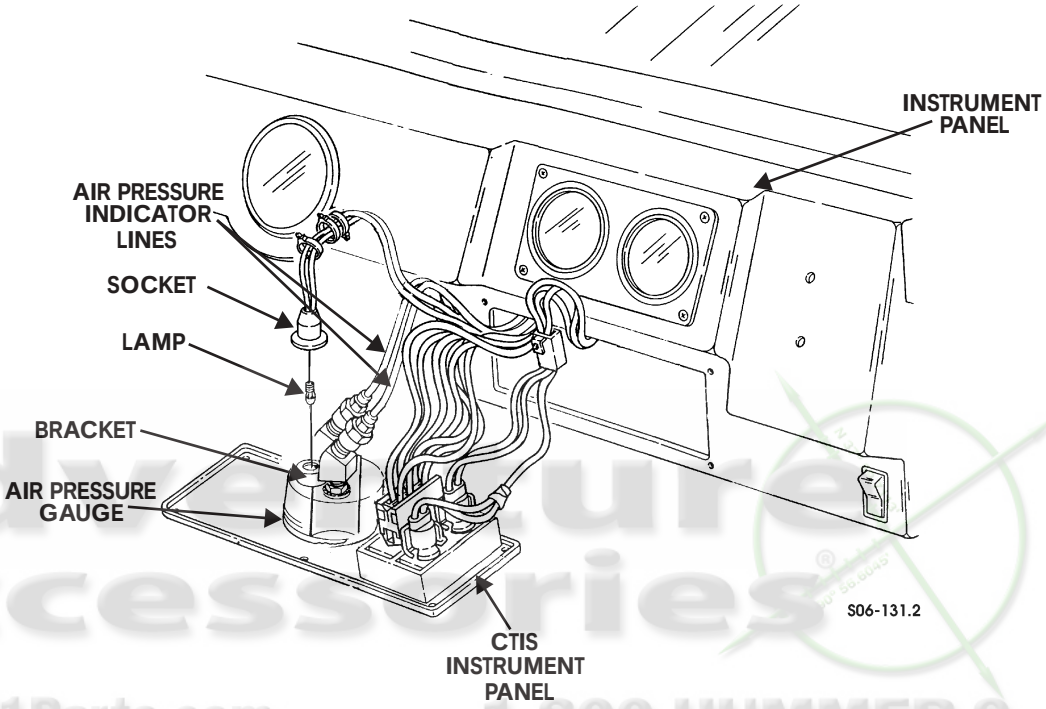


Figure 6-152: Air Pressure Gauge Lamp

Installation

1. Install lamp in socket (Figure 6-152).
2. Install lamp in air pressure gauge.
3. Install CTIS instrument panel.
4. Start engine and ensure air pressure gauge lamp operates properly.

CTIS LOW PRESSURE ALARM REPLACEMENT

Removal

1. Remove CTIS instrument panel.
2. Remove low pressure alarm from flasher connector (Figure 6-153).

Installation

1. Install low pressure alarm on flasher connector
2. Install CTIS instrument panel (Figure 6-153).

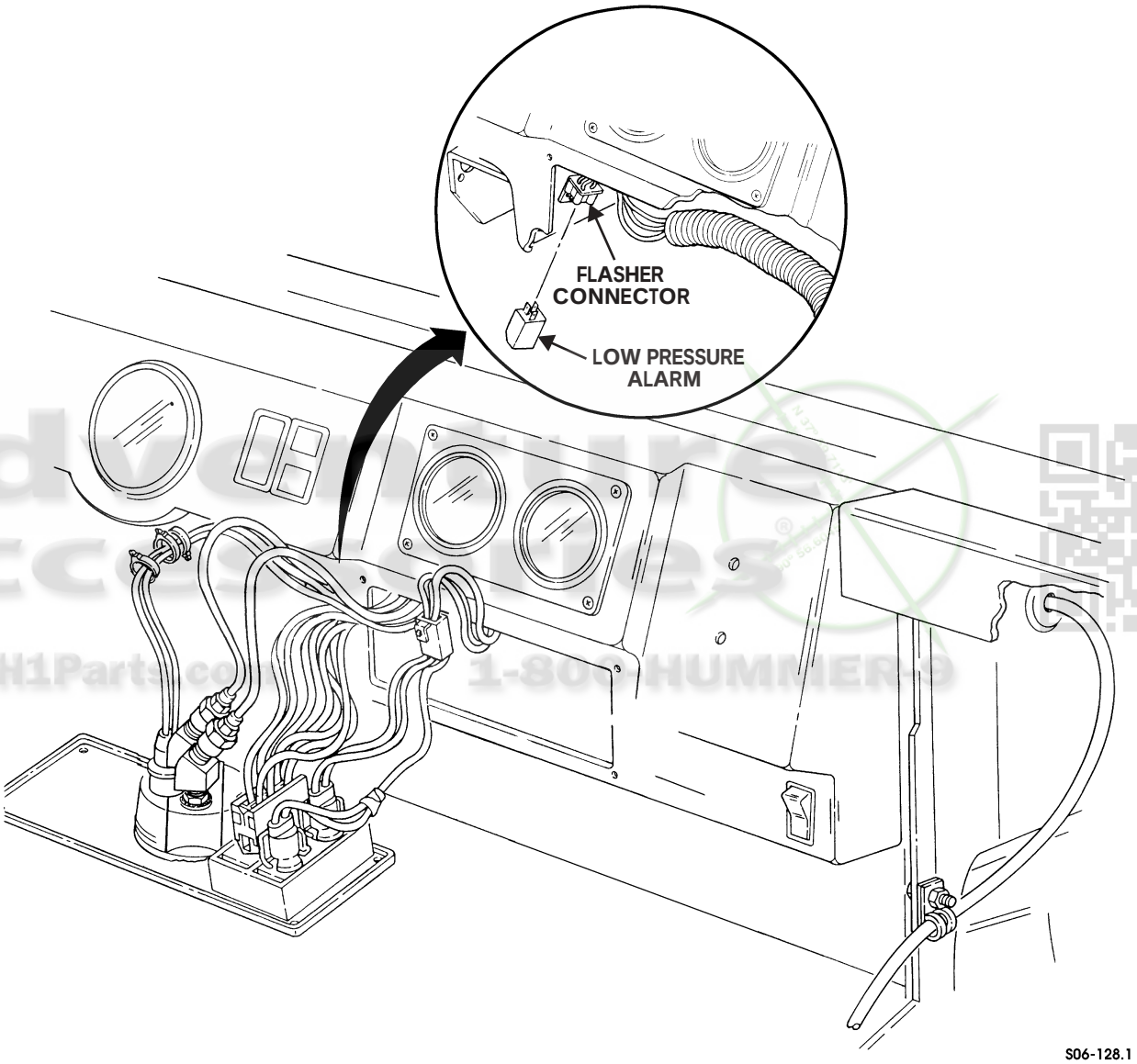


Figure 6-153: Low Pressure Alarm

CTIS INTERIOR HARNESS MAINTENANCE

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove CTIS instrument panel.
3. Disconnect connector from inflate/deflate switch (Figure 6-154).
4. Remove two lamp assemblies from compressor/pressure indicator light.
5. Remove lamp from air pressure gauge.
6. Remove low pressure alarm.
7. Remove two screws and flasher connector from steering column mounting bracket.
8. Disconnect harness connector from body harness connector and remove interior harness.

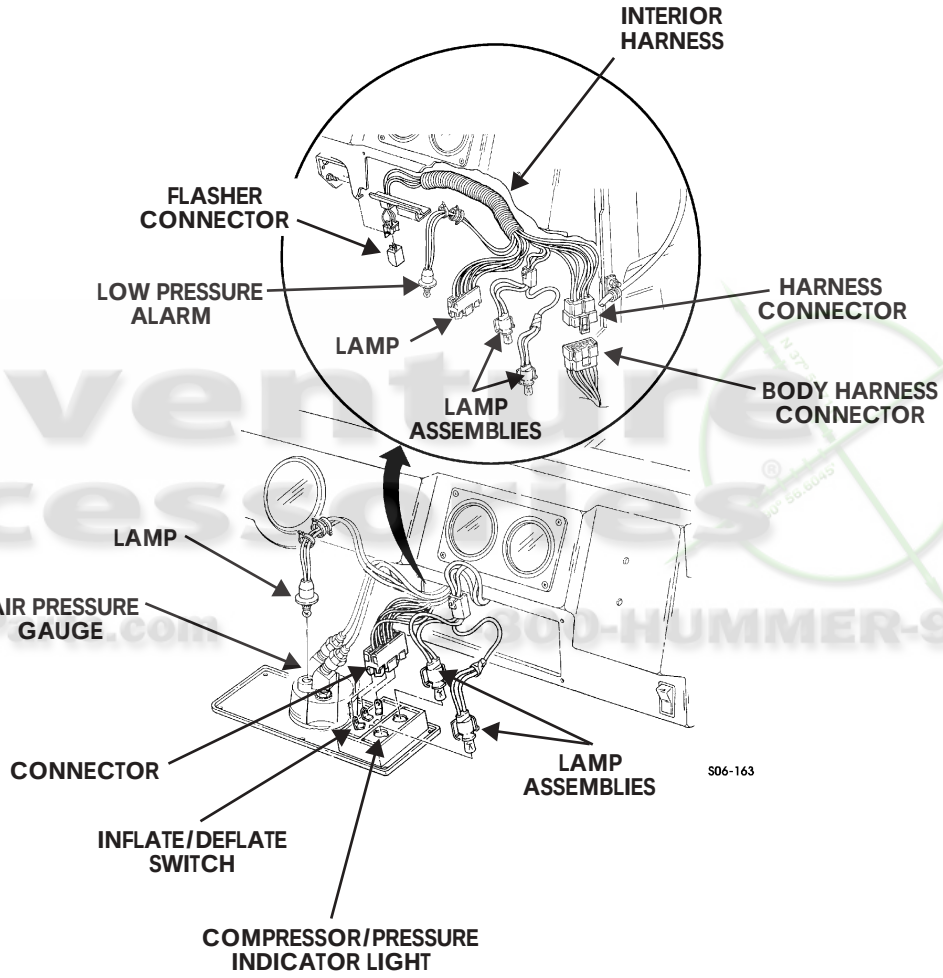


Figure 6-154: CTIS Interior Harness Assembly

Cleaning and Inspection

Clean and inspect CTIS harness and connectors. Check for defects such as frayed wires and cracks. Repair or replace defective parts.

Installation

1. Position interior harness in approximate mounting location and connect harness connector to body harness connector (Figure 6-154).
2. Install flasher connector on steering column mounting bracket with two screws.
3. Install low pressure alarm on flasher connector.
4. Install lamp in air pressure gauge.
5. Install two lamp assemblies to compressor/pressure indicator light.
6. Connect connector to inflate/deflate switch.
7. Install CTIS instrument panel.
8. Connect battery ground cable.

AIR PRESSURE SWITCH REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

NOTE: Replacement procedures for the front and rear air pressure switches are basically the same. This procedure covers the front air pressure switch.

1. Remove two front indicator lines and tee from bulkhead connector (Figure 6-155).

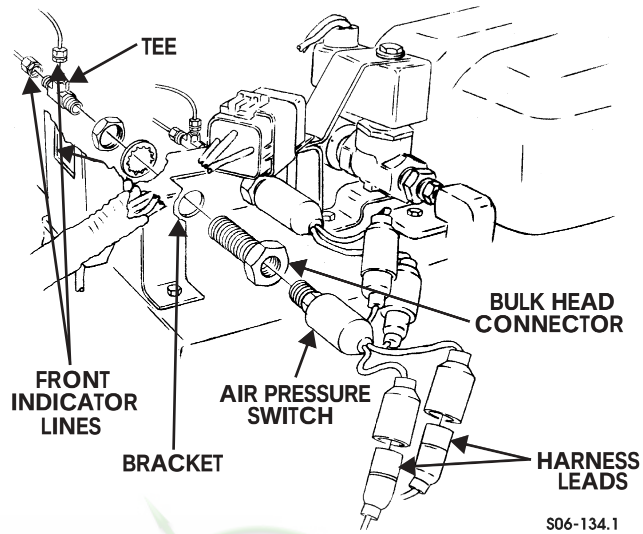


Figure 6-155: Air Pressure Switch

2. Disconnect harness leads from air pressure switch.
3. Remove nut, star washer, air pressure switch, and bulkhead connector assembly from bracket.
4. Remove air pressure switch from bulkhead connector. Discard air pressure switch if damaged.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

Installation

1. Install bulkhead connector on air pressure switch (Figure 6-155).
2. Install bulkhead connector and air pressure switch on bracket with star washer and nut.
3. Connect harness leads to air pressure switch.
4. Install tee and two front indicator lines on bulkhead connector.

AIR PRESSURE INDICATOR LINES REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

NOTE: Replacement procedures for the front and rear air pressure indicator lines are basically the same. This procedure covers the front air pressure indicator line.

1. Remove CTIS instrument panel.
2. Disconnect front air pressure indicator line from air pressure gauge (Figure 6-156).
3. Disconnect front air pressure indicator line from tire selector valve (Figure 6-157).
4. Remove two front indicator lines from tee (Figure 6-158).

***CAUTION:** Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

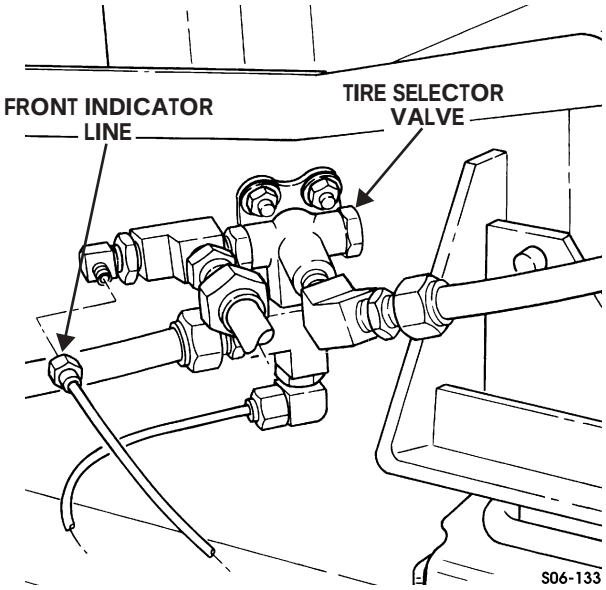


Figure 6-157: Bulk Head Connector

Installation

1. Install two front indicator lines on tee. (Figure 6-158).
2. Connect front air pressure indicator line to tire selector valve (Figure 6-157).
3. Connect front air pressure indicator line to air pressure gauge (Figure 6-156).
4. Install CTIS instrument panel.

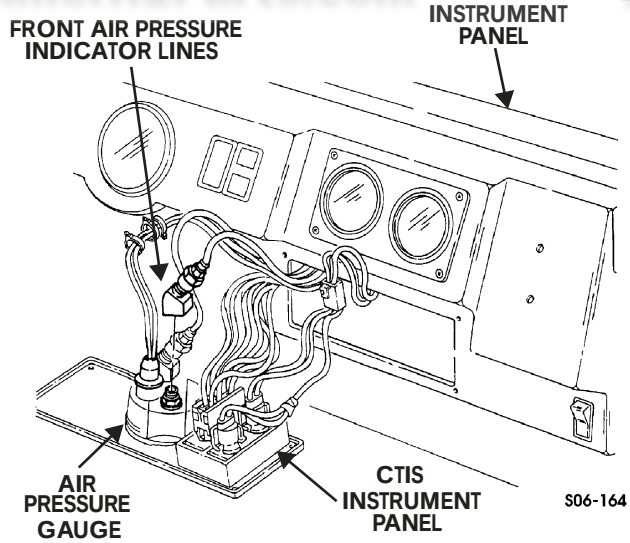


Figure 6-156: Front Air Pressure Indicator Line

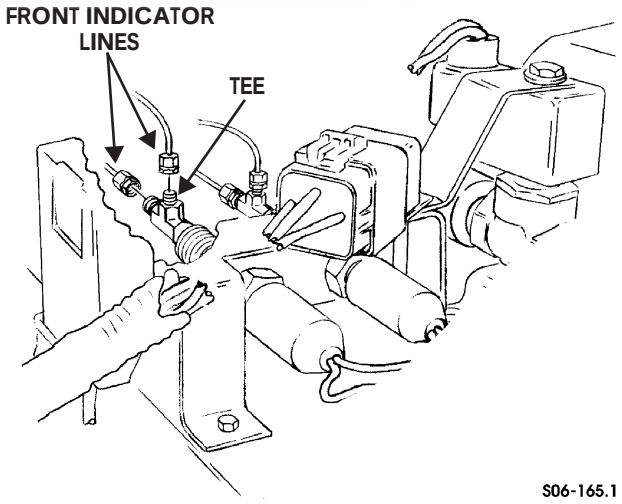


Figure 6-158: Front Indicator Lines

TIRE SELECTOR VALVE ASSEMBLY MAINTENANCE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Remove engine access cover (Section 10).
2. Remove front pressure indicator line, elbow, and bushing from tee (Figure 6-159).
3. Remove selector-to-front tee tube and connector from tee.
4. Remove rear pressure indicator line, elbow, and bushing, from tee.
5. Remove selector-to-union tube and connector from tee.
6. Remove selector-to-deflate valve tube, connector, and elbow from tire selector valve.
7. Remove two tees from tire selector valve.
8. Remove socket plug from tire selector valve.
9. Remove handle from tire selector valve (Figure 6-160).
10. Remove tire selector valve nameplate decal from body panel.
11. Remove interior trim panel (Section 10).
12. Remove two nuts, washers, capscrews, and tire selector valve from body panel.

Cleaning and Inspection

Clean and inspect tire selector valve, fittings, and lines. Check for cracks and stripped threads. Replace defective parts.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

Installation

1. Install tire selector valve on body panel with two capscrews, washers, and nuts (Figure 6-160).
2. Install interior trim panel (Section 10).
3. Install tire selector valve nameplate decal on body panel.
4. Install handle on tire selector valve.
5. Install socket plug on tire selector valve (Figure 6-159).
6. Install two tees on tire selector valve.
7. Install elbow, connector, and selector-to-deflate valve tube on tire selector valve.
8. Install connector and selector-to-union tube on tee.
9. Install bushing, elbow, and rear pressure indicator line on tee.
10. Install connector and selector-to-front tee tube on tee.
11. Install bushing, elbow, and front pressure indicator line on tee.
12. Install engine access cover.

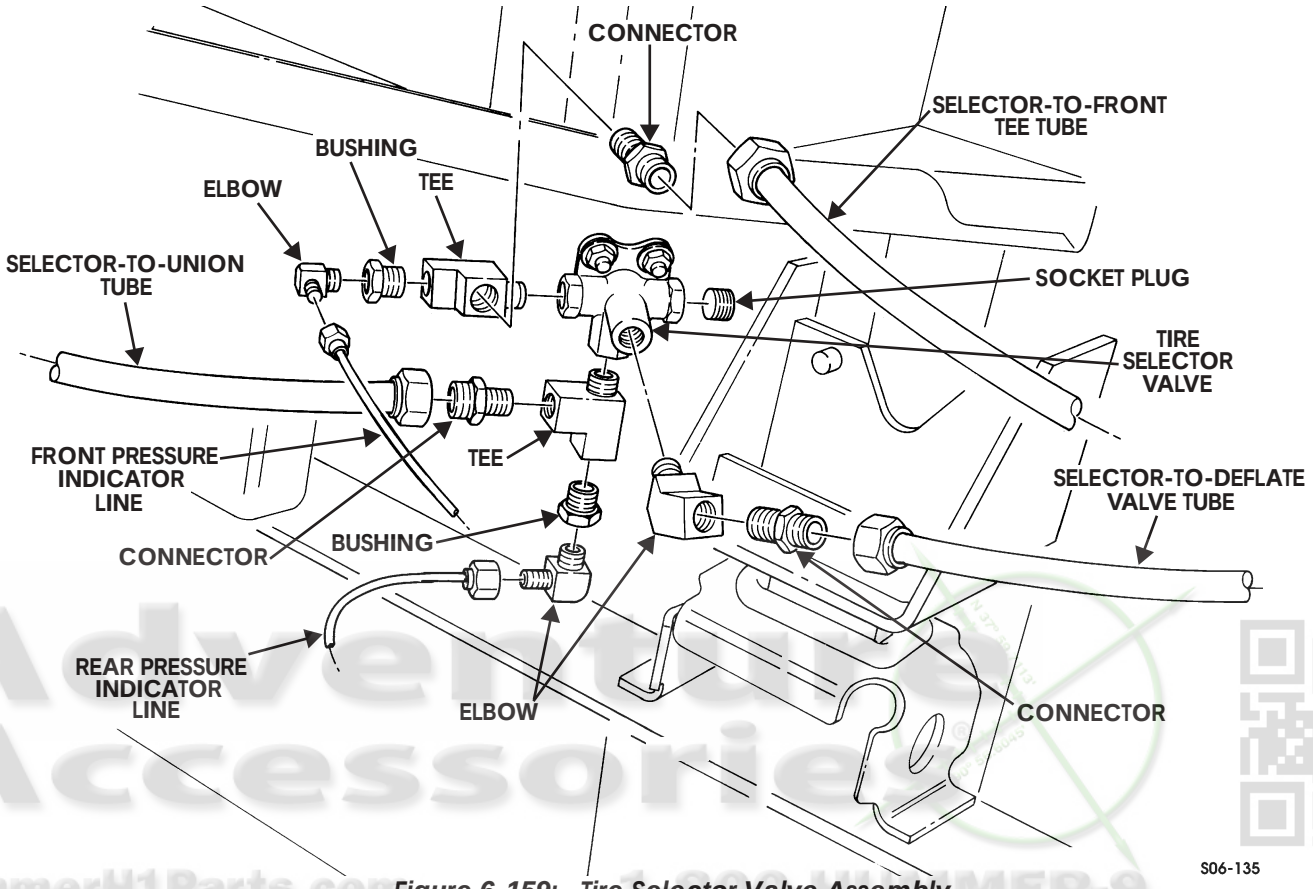


Figure 6-159: Tire Selector Valve Assembly

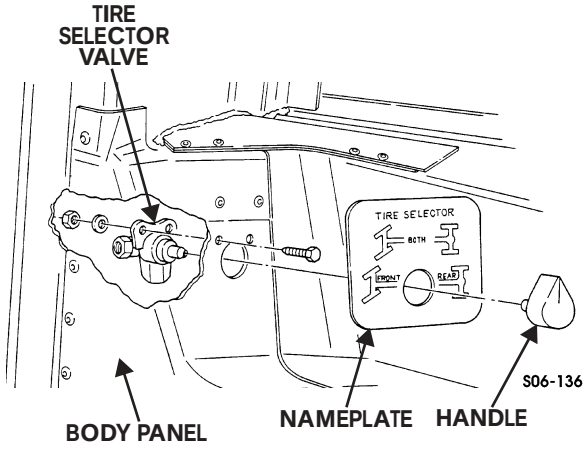


Figure 6-160: Tire Selector Valve Controls

CTIS JUMPER HARNESS MAINTENANCE

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Remove two nuts, red lead, and black lead from power/ground stud (Figure 6-161).
4. Remove plastic cover from fuse housing.
5. Remove two screws, yellow lead, and red lead from fuse housing.
6. Disconnect connector from wiring harness.
7. Disconnect connector from relay.
8. Disconnect four leads from pressure switches.
9. Disconnect two leads from deflate valve leads.
10. Slide two boots off compressor terminals.
11. Remove two nuts and leads from compressor and remove jumper harness from vehicle.

Inspection

Inspect CTIS leads, connectors, and wiring. Check for cracks, shorts, and frayed wires. Replace defective parts.

Installation

1. Position jumper harness in approximate mounting location on vehicle.
2. Install two leads on compressor with nuts and slide two boots over terminals (Figure 6-161).
3. Connect two leads to deflate valve lead.
4. Connect four leads to pressure switches.
5. Connect connector to relay.
6. Connect connector to wiring harness.
7. Secure yellow lead and red lead to fuse with two screws.
8. Install plastic cover on fuse housing.
9. Connect black and red leads to power/ground stud.
10. Connect battery ground cable (Section 12).
11. Lower and secure hood.

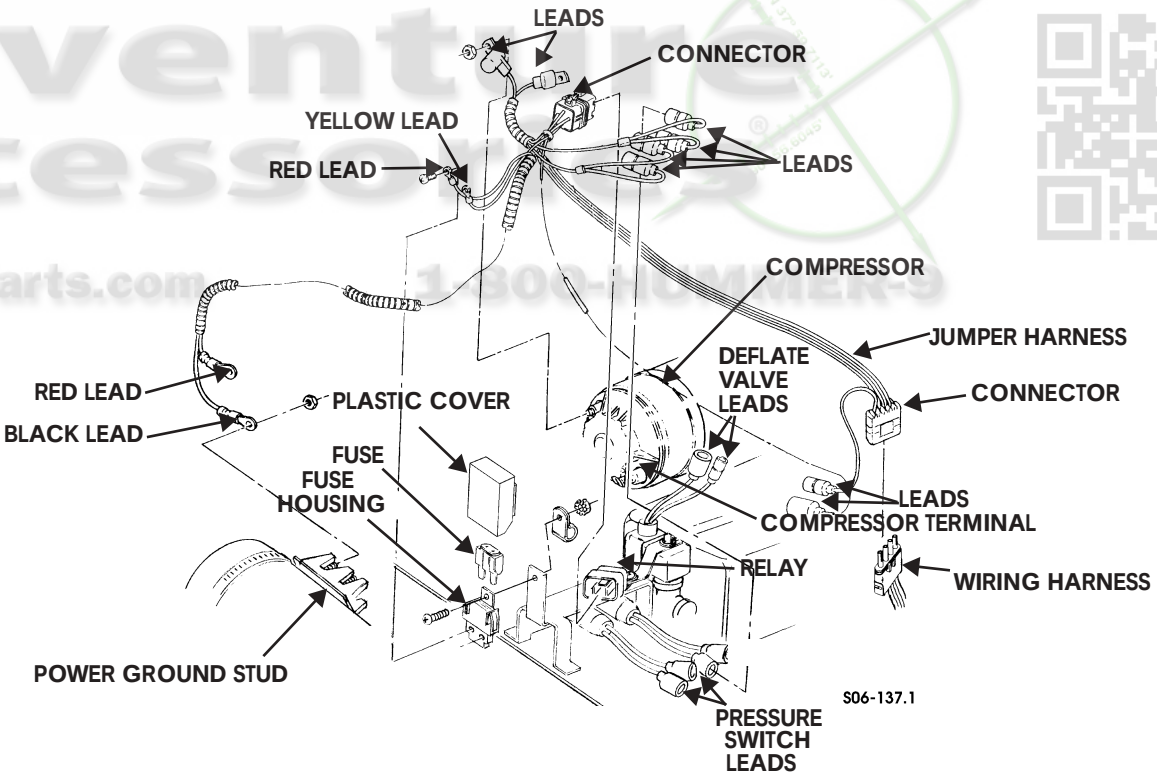


Figure 6-161: CTIS Jumper Harness

CTIS COMPRESSOR FUSE MAINTENANCE

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Remove plastic cover from fuse housing (Figure 6-162).
4. Remove two screws and leads from fuse housing.
5. Remove fuse from housing.

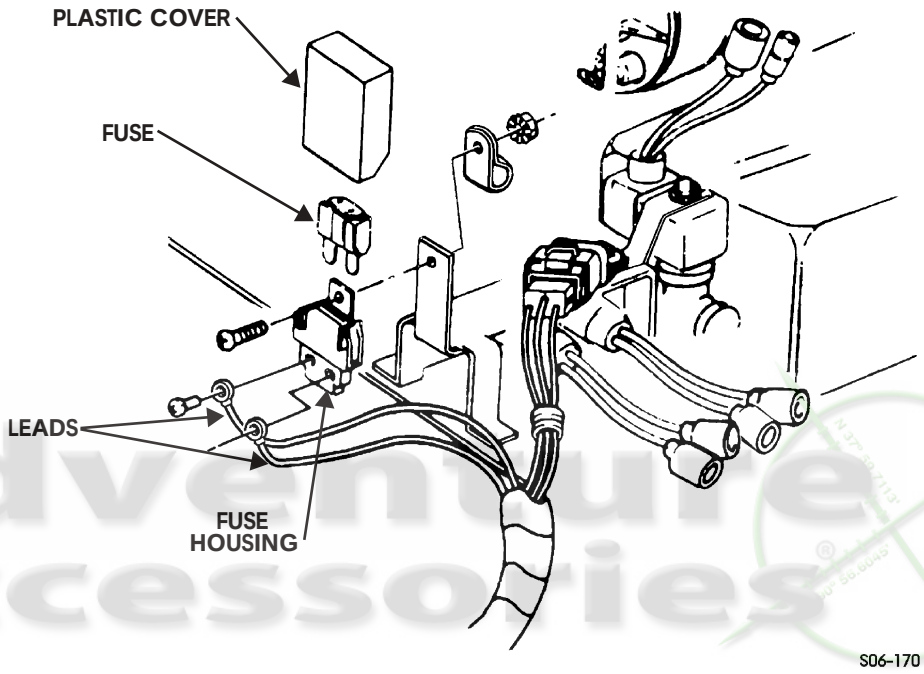


Figure 6-162: CTIS Compressor Fuse

Inspection

Inspect CTIS leads, connectors, and wiring. Check for cracks, shorts, and frayed wires. Replace defective parts.

Installation

1. Install fuse in housing (Figure 6-162).
2. Install two leads on fuse housing with screws.
3. Install plastic cover on fuse housing.
4. Connect battery ground cable (Section 12).
5. Lower and secure hood.

CTIS COMPRESSOR RELAY MAINTENANCE

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Disconnect connector from relay (Figure 6-163).
4. Remove nut, lockwasher, screw, and relay from bracket. Discard lockwasher.

Inspection

Inspect CTIS leads, connectors, and wiring. Check for cracks, shorts, and frayed wires. Replace defective parts.

Installation

1. Install relay on bracket with screw, lockwasher, and nut (Figure 6-163).
2. Connect connector to relay.
3. Connect battery ground cable (Section 12).
4. Lower and secure hood.

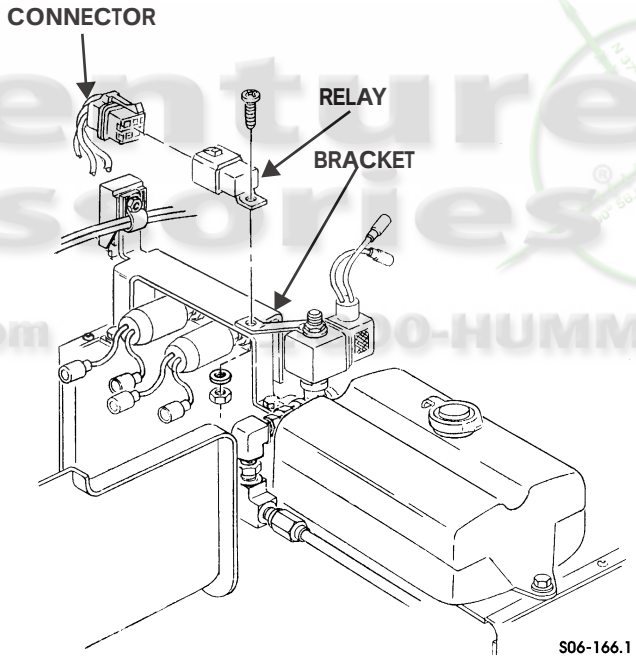


Figure 6-163: CTIS Compressor Relay

CHECK VALVE REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Remove check valve from tee (Figure 6-164).
4. Remove check valve from hose.

Cleaning and Inspection

Clean and inspect check valve for stripped threads. Replace if defective.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install hose on check valve (Figure 6-164).
2. Install check valve on tee.
3. Connect battery ground cable (Section 12).
4. Lower and secure hood.

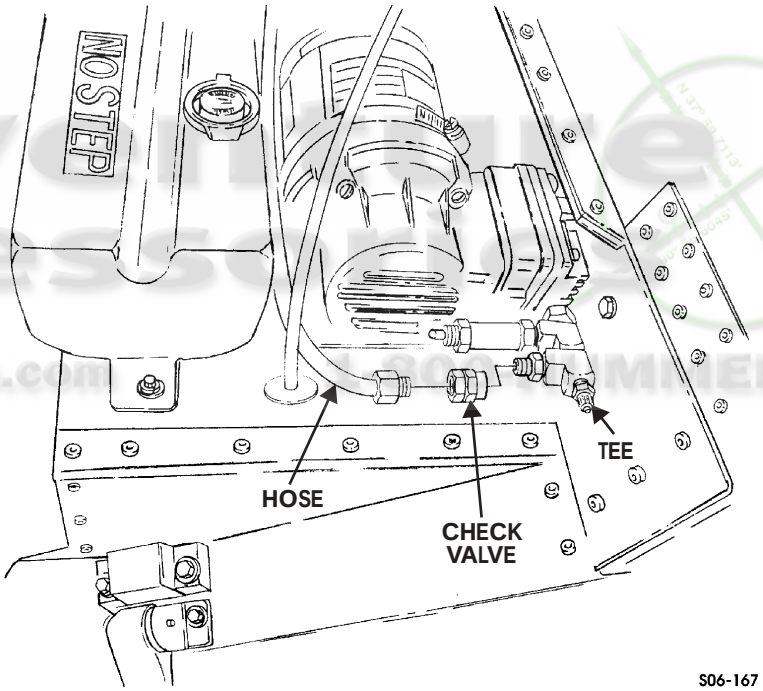


Figure 6-164: Check Valve Assembly

DEFLATE VALVE ASSEMBLY MAINTENANCE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Disconnect leads 438A and 57R from deflate valve leads (Figure 6-165).
4. Remove two capscrews, lockwashers, washers and deflate valve from bottom of bracket. Discard lockwashers.
5. Remove nut and washer securing deflate valve to top of bracket and remove deflate valve.
6. Remove deflate valve from connector.

Cleaning and Inspection

Clean and inspect deflate valve and bracket. Check for cracks and stripped threads. Replace if defective.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install deflate valve on connector (Figure 6-165).
2. Install deflate valve on bottom of bracket with two washers, lockwashers, and capscrews.
3. Secure deflate valve top of bracket with washer and nut.
4. Connect leads 438A and 57R to deflate valve leads.
5. Connect battery ground cable (Section 12).
6. Lower and secure hood.

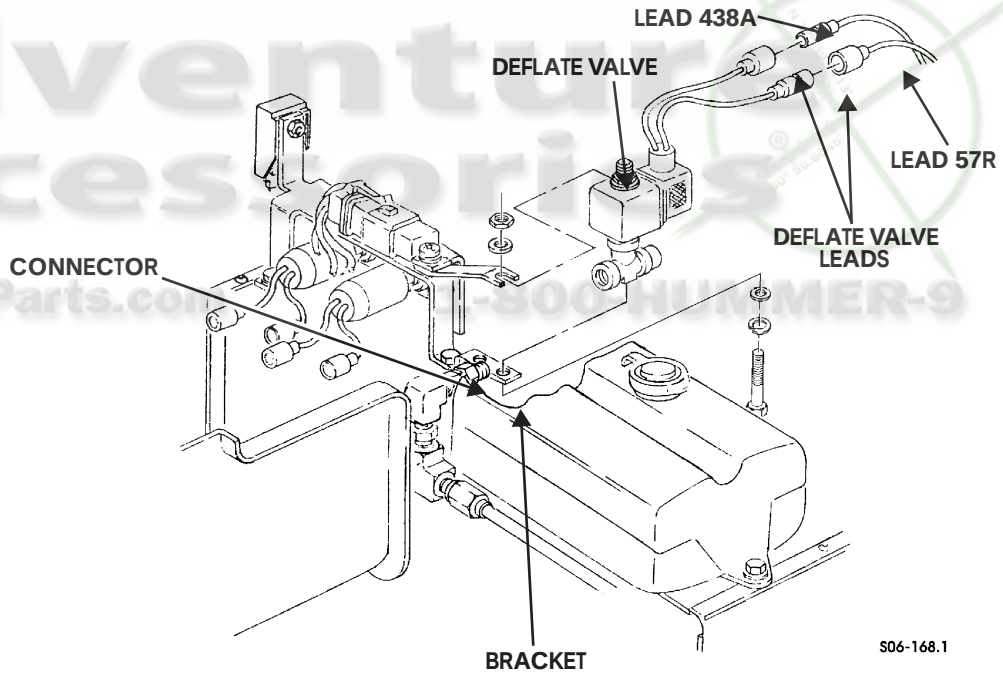


Figure 6-165: Deflate Valve Assembly

DUST EXCLUDER MAINTENANCE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Remove dust excluder from deflate valve (Figure 6-164).

Cleaning and Inspection

Clean and inspect dust excluder. Check for cracks and stripped threads. Replace if defective.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install dust excluder on deflate valve (Figure 6-164).
2. Connect battery ground cable.
3. Lower and secure hood.

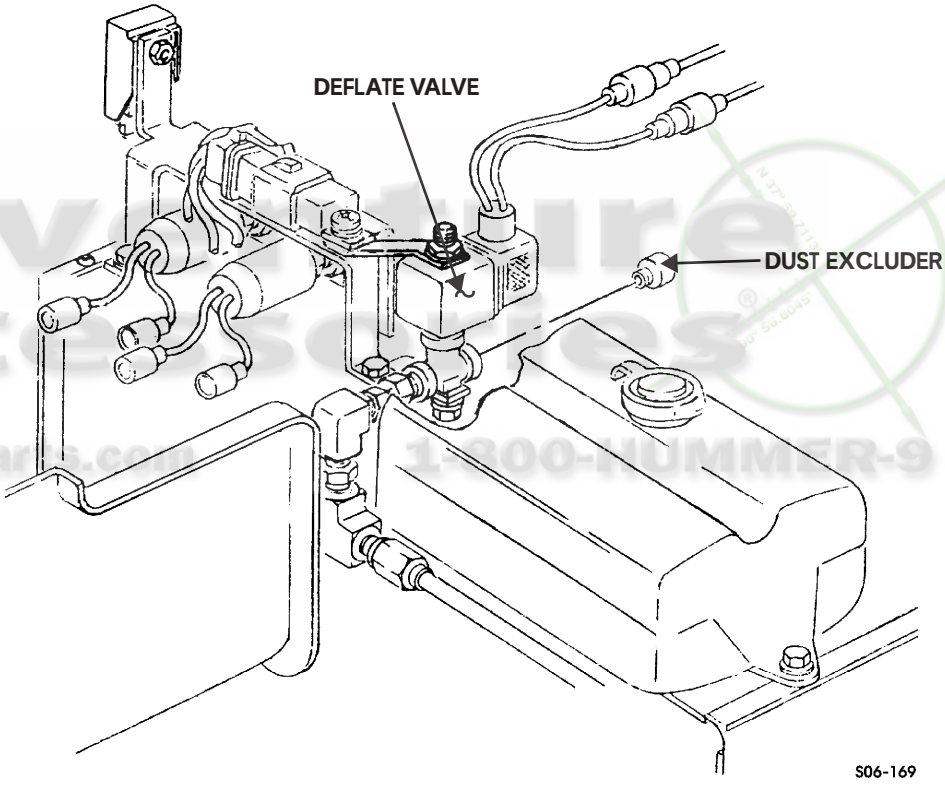


Figure 6-166: Dust Excluder

FRONT SUPPLY TUBE AND HOSE REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: The HUMMER CTIS uses two types of air lines: rubber hoses and nylon tubing. Damaged portions of any air line type should be removed, discarded, and replaced with a new section. Leaks in air lines usually develop where there is constant rubbing or friction against another component, existing air lines, fasteners, frame rail, or air line clamp. Such leaks are usually small and difficult to detect unless adequate air pressure of approximately 20-30 psi (138-207 kPa) is in the line. If a leak is suspected, apply soap suds to the affected area for easier detection and replace damaged section.

Removal

1. Disconnect tee-to-selector tube from connector on tire selector valve. Remove nut and sleeve assembly and insert from tube (Figure 6-167).
2. Remove tiedown straps securing tee-to-selector tube to oil cooler lines. Discard tiedown straps.
3. Disconnect tee-to-selector tube and connector from tee. Remove nut and sleeve assembly and insert from tube (Figure 6-168).
4. Remove self-tapping screw and clamp securing tee-to-selector tube to oil cooler line support.

NOTE: The removal of the left and right front wheel-to-tee hose is basically the same. The following steps cover the right front wheel-to-tee hose.

5. Loosen hose clamp and disconnect wheel-to-tee hose from elbow on tee.
6. Remove elbow from tee.
7. Remove tiedown straps securing wheel-to-tee hose and vent line together. Discard tiedown straps.
8. Remove self-tapping screws and clamps securing wheel-to-tee hose to frame.
9. Loosen hose clamp and disconnect wheel-to-tee hose from connector (Figure 6-169).
10. Remove self-tapping screw, clamp, and wheel-to-tee hose from support bracket on lower control arm.
11. Remove capscrew, lockwasher, and support bracket from lower control arm. Discard lockwasher.

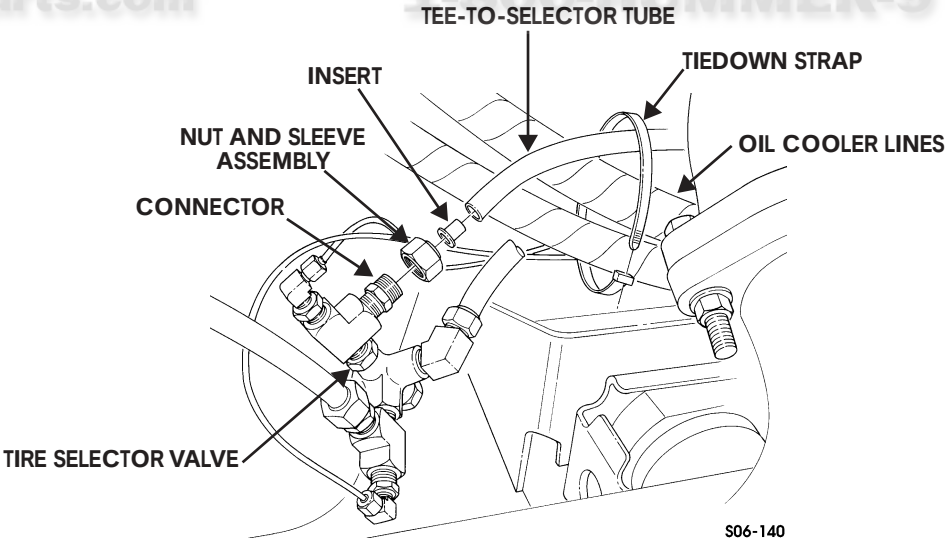


Figure 6-167: Front Supply Tubes

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install nut and sleeve assembly and insert on tee-to-selector tube and connect to tire selector valve (Figure 6-167).
2. Secure tee-to-selector tube to oil cooler lines with tiedown straps.
3. Install connector to tee (Figure 6-168).
4. Install nut and sleeve assembly and insert on tee-to-selector tube and connect tube to connector on tee.
5. Secure tee-to-selector tube to oil cooler line support with self-tapping screw and clamp.

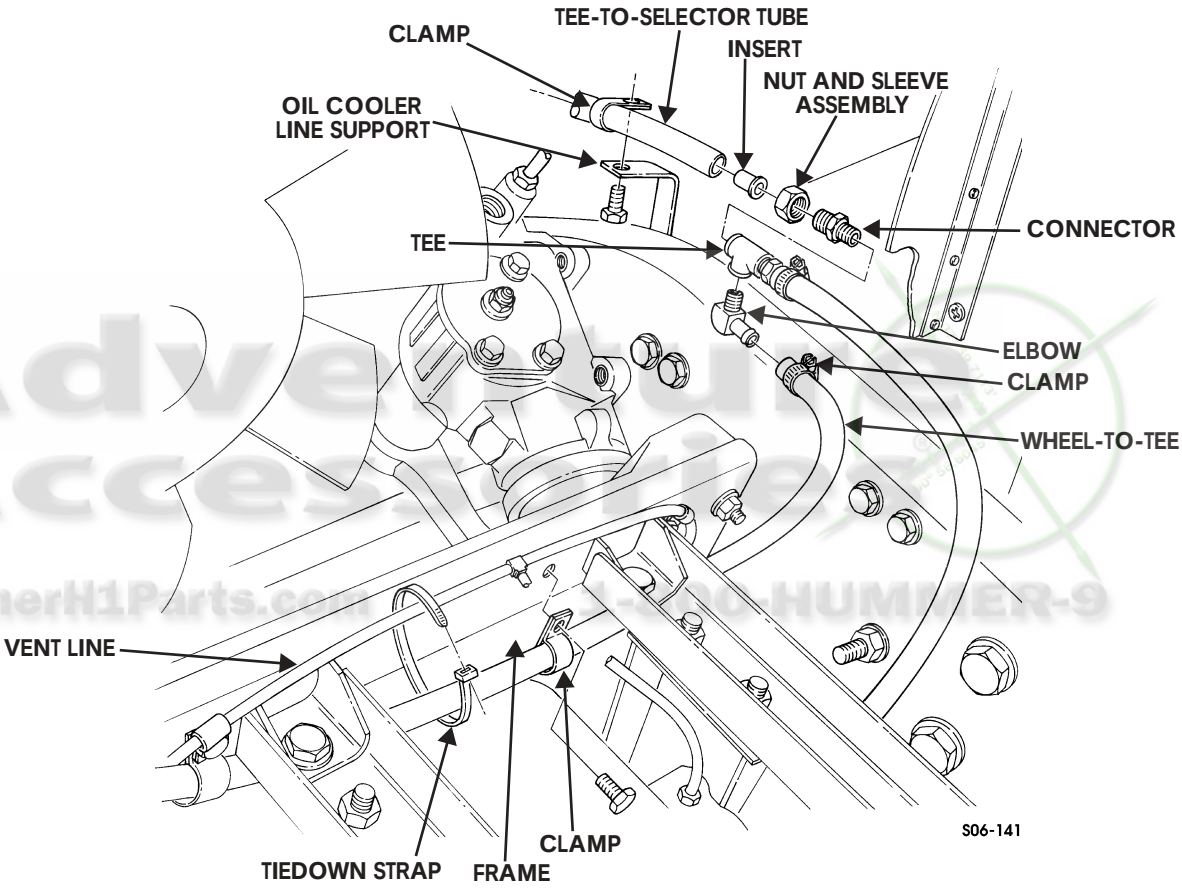


Figure 6-168: Tee-To-Selector Tube

NOTE: The installation of the left and right front wheel-to-tee hose is basically the same. The following steps cover the right front wheel-to-tee hose.

6. Install elbow on tee.
7. Connect wheel-to-tee hose to elbow and secure with hose clamp.
8. Secure wheel-to-tee hose to frame with self-tapping screws and clamps.
9. Secure wheel-to-tee hose to vent line with tiedown straps.
10. Connect wheel-to-tee hose to connector in steering arm cover and secure with hose clamp (Figure 6-169).
11. Install support bracket on lower control arm with capscrew and lockwasher.
12. Install wheel-to-tee hose on support bracket with self-tapping screw and clamp.
13. Start engine. Allow vehicle's air system to build up to normal operating pressure.
14. Apply soap suds to hose connections. Inspect for leaks and replace as needed.

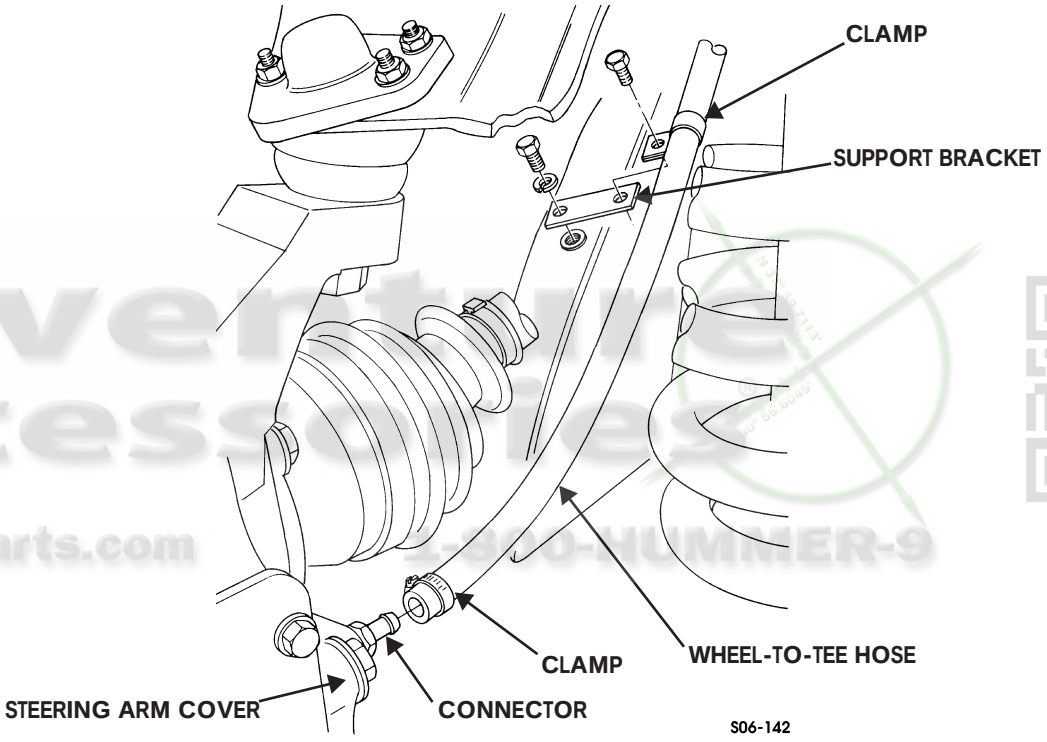


Figure 6-169: Wheel-to-Tee Hose

REAR SUPPLY TUBES REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Disconnect selector-to-union tube from connector on tire selector valve. Remove nut and sleeve assembly and insert from tube (Figure 6-170).
2. Remove two screws, nut and lockwasher assemblies, clamps, and selector-to-union tube from crossmember. Discard nut and lockwasher assemblies.
3. Remove fuel tank (Section 3).
4. Disconnect selector-to-union tube from union. Remove nut and sleeve assembly and insert from tube (Figure 6-171).

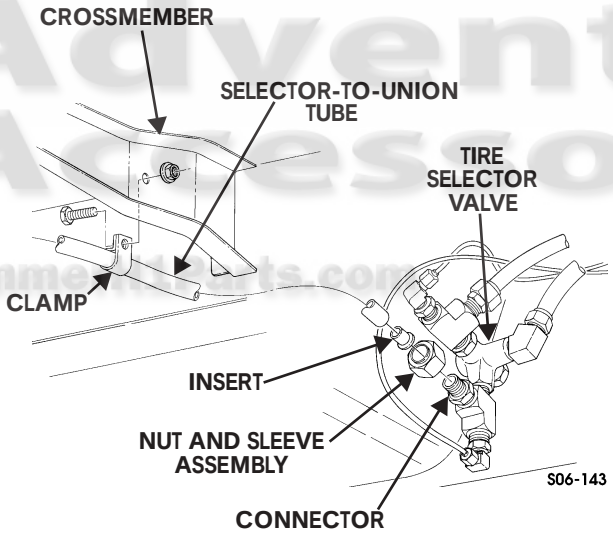


Figure 6-170: Wheel-to-Tee Hose

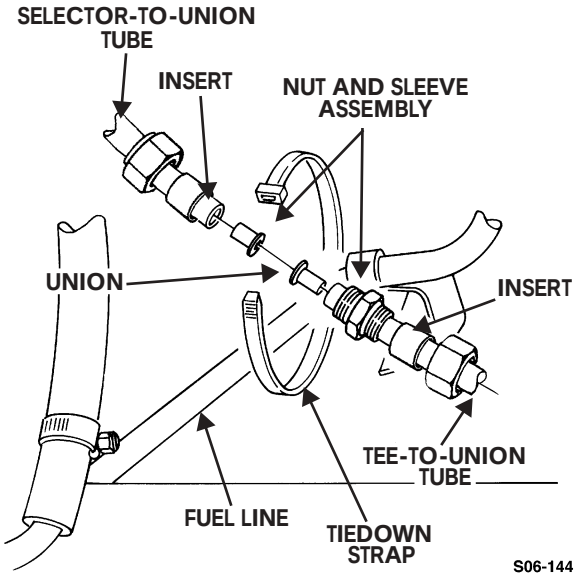


Figure 6-171: Selector-to-Union Tube

5. Disconnect tee-to-union tube from union. Remove nut and sleeve assembly and insert from tube.
6. Disconnect tee-to-union tube from connector on tee. Remove nut and sleeve assembly and insert from tube (Figure 6-172).

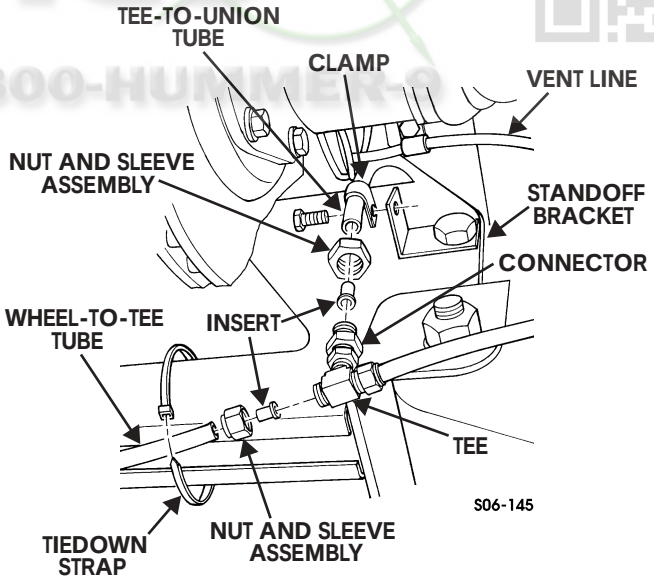


Figure 6-172: Tee-to-Union Tube

7. Remove self-tapping screw, clamp, and tee-to-union tube from standoff bracket.
8. Remove tiedown straps and rear tee-to-union tube from fuel lines and vent lines. Discard tiedown straps (Figures 6-171 and 6-172).

NOTE: The removal of the left and right rear wheel-to-tee tube is basically the same. The following steps cover the left rear wheel-to-tee tube.

9. Disconnect wheel-to-tee tube from tee. Remove nut and sleeve assembly, insert, and tiedown strap from tube. Discard tie down strap.
10. Disconnect wheel-to-tee tube from connector in steering arm cover. Remove nut and sleeve assembly and insert from tube (Figure 6-173).

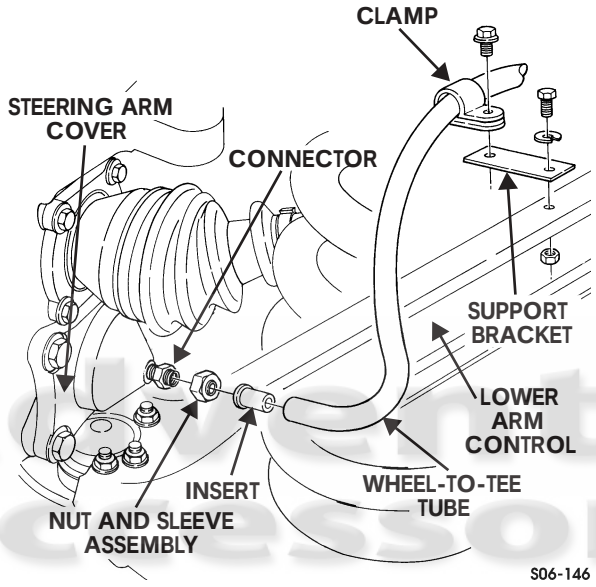


Figure 6-173: Wheel-to-Tee Tube

11. Remove self-tapping screw, clamp, and tube from support bracket on lower control arm.
12. Remove capscrew, lockwasher, support bracket, and nut from lower control arm. Discard lockwasher.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install nut and sleeve assembly, insert, and selector-to-union tube to connector on tire selector valve (Figure 6-170).
2. Install selector-to-union tube on cross-member with two clamps, nut and lockwasher assemblies, and screws.
3. Install nut and sleeve assembly, insert, and selector-to-union tube on union (Figure 6-171).
4. Install nut and sleeve assembly, insert, and tee-to-union tube on union.
5. Install fuel tank (Section 3).
6. Install nut and sleeve assembly, insert, and tee-to-union tube on connector (Figure 6-172).
7. Install tee-to-union tube on standoff bracket with clamp and self-tapping screw.
8. Secure tee-to-union tube to fuel lines and vent lines with tiedown straps (Figures 6-171 and 6-172).

NOTE: The installation of the left and right rear wheel-to-tee tube is basically the same. The following steps cover the left rear wheel-to-tee tube.

9. Install nut and sleeve assembly, insert, and wheel-to-tee tube on tee.
10. Install nut and sleeve assembly, insert, and wheel-to-tee tube on connector in steering arm cover (Figure 6-173).
11. Install support bracket on lower control arm with capscrew and lockwasher.
12. Install wheel-to-tee tube on support bracket with self-tapping screw, clamp, and nut.
13. Start engine. Allow vehicle's air system to build up to normal operating pressure.
14. Apply soap suds to hose connections. Inspect for leaks and replace as needed.

AIR INTAKE LINE AND ASSEMBLY MAINTENANCE

Removal

1. Raise and secure hood.
2. Loosen hose clamp and disconnect air intake hose from connector (Figure 6-174).

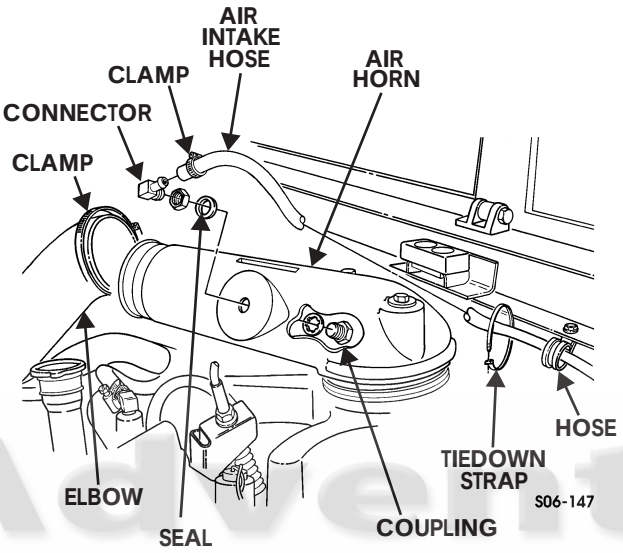


Figure 6-174: Air Intake Hose

3. Loosen clamp and disconnect air cleaner elbow from air horn.
4. Remove nut, washer, coupling, connector, and seal from air horn.
5. Loosen hose clamp securing air intake hose to fitting (Figure 6-175).

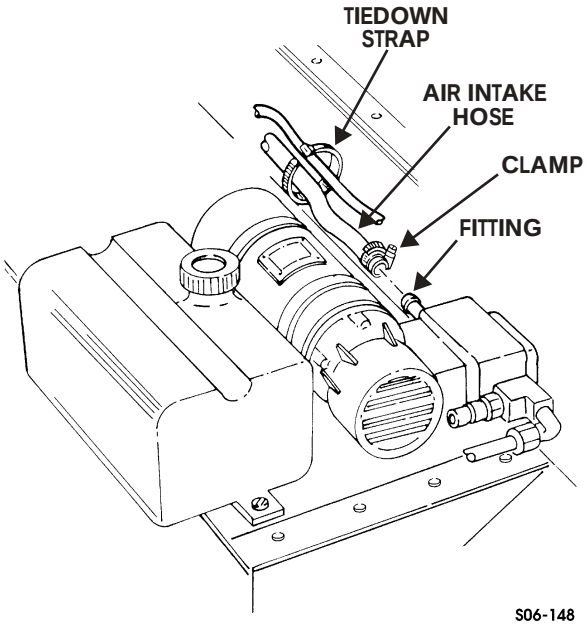


Figure 6-175: Air Intake Hose to Fitting

6. Remove tiedown straps and air intake hose from hoses.

Cleaning and Inspection

Clean and inspect air intake hose, elbow, coupling assembly and seal. Check for leaks, cracks, and stripped threads.

CAUTION: Do not allow sealant into air system. Sealant will damage CTIS components.

NOTE: Apply sealant to threads prior to installation.

Installation

1. Connect air intake hose to fitting and secure with hose clamp (Figure 6-175).
2. Install seal, coupling, washer, nut, and connector to air horn (Figure 6-174).
3. Connect air cleaner elbow to air horn and secure with clamp.
4. Connect air intake hose to air horn connector and secure with hose clamp.
5. Secure air intake hose to hoses with tiedown straps (Figure 6-175).
6. Lower and secure hood.

TUBE SHIELD REPLACEMENT

NOTE: The replacement of the front and rear tube shields is basically the same. This procedure covers the rear tube shield.

Removal

1. Raise and support vehicle.
2. Remove valve core from manual air fill stem and deflate tire completely.
3. Remove four capscrews, lockwashers, and tube shield from spindle. Discard lockwashers (Figure 6-176).

WARNING: In all disassembly operations, ensure the tire is totally deflated before removing wheel locknuts. Failure to follow proper safety precautions could cause serious injury or death.

4. Remove two wheel locknuts and shield bracket from outer rim. Discard wheel locknuts.

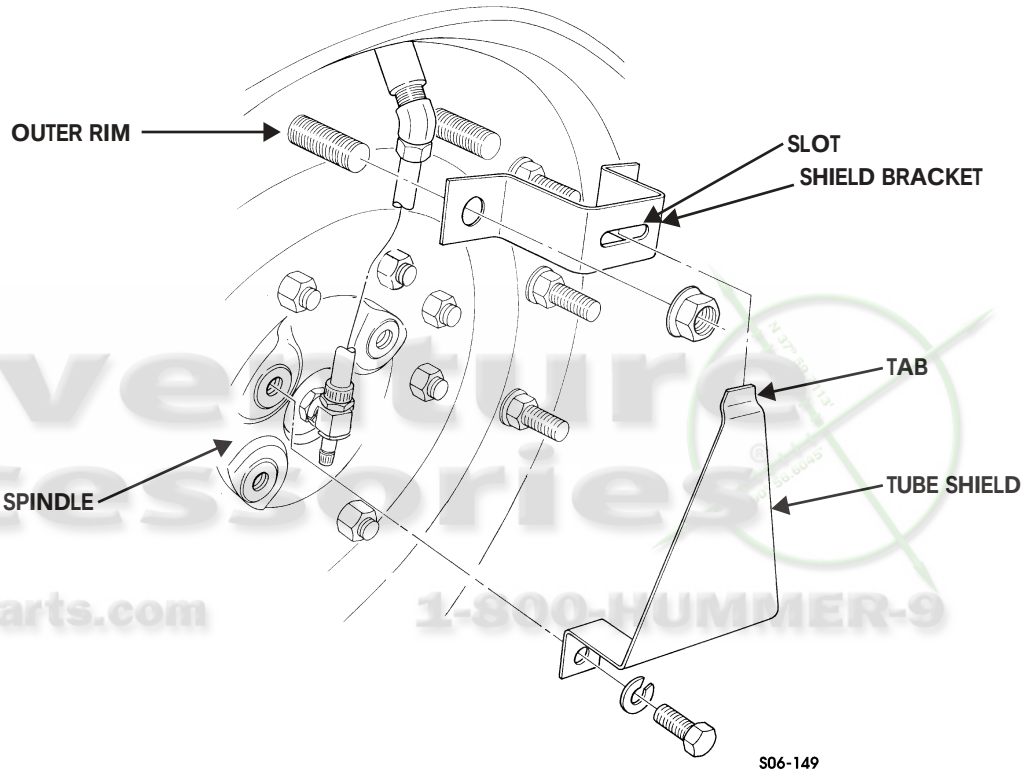


Figure 6-176: Tube Shield Assembly

Installation

1. Install shield bracket to outer rim with two wheel locknuts. Tighten wheel locknuts to 43 lb-ft (58 N•m) (Figure 6-176).
2. Insert tube shield tab into slot in shield bracket.
3. Install tube shield on spindle with four lockwashers and capscrews. Tighten capscrews to 43 lb-ft (58 N•m).
4. Lower vehicle.

QUICK-DISCONNECT VALVE AND TUBE MAINTENANCE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: The replacement of all four quick-disconnect valves and tube assemblies is identical.

Removal

1. Raise and support vehicle.
2. Remove tube shield.
3. Remove tube and nut from quick-disconnect valve (Figure 6-177).

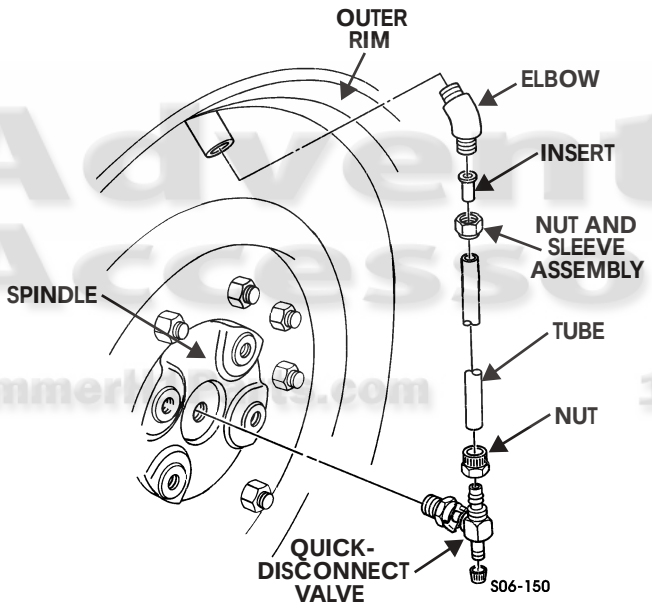


Figure 6-177: Quick-Disconnect Valve Assembly

CAUTION: *Do not force apart quick-disconnect valve. The quick-disconnect valve is a one-piece component. Damage to quick-disconnect valve will result if forced apart.*

4. Remove quick-disconnect valve from spindle.
5. Disconnect tube from elbow and remove nut and sleeve assembly and insert from tube.
6. Remove elbow from outer rim.

Cleaning and Inspection

Clean and inspect tube and quick-disconnect valve. Check for leaks, stripped threads, and cracks. Replace defective parts.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install quick-disconnect valve into spindle (Figure 6-177).
2. Install elbow to outer rim.
3. Install nut on tube and connect tube to quick-disconnect valve.
4. Install nut and sleeve assembly and insert on tube and connect tube to elbow.
5. Install tube shield.
6. Lower vehicle.

REAR TUBE CONNECTION SHIELD MAINTENANCE

NOTE: The replacement of the left and right rear tube connection shields is basically the same. This procedure covers the left rear tube connection shield.

Removal

Remove two capscrews, washers, shield, and two washers from steering arm cover (Figure 6-178).

Cleaning and Inspection

Clean and inspect shield and mounting hardware. Check for cracks and stripped threads. Replace defective parts.

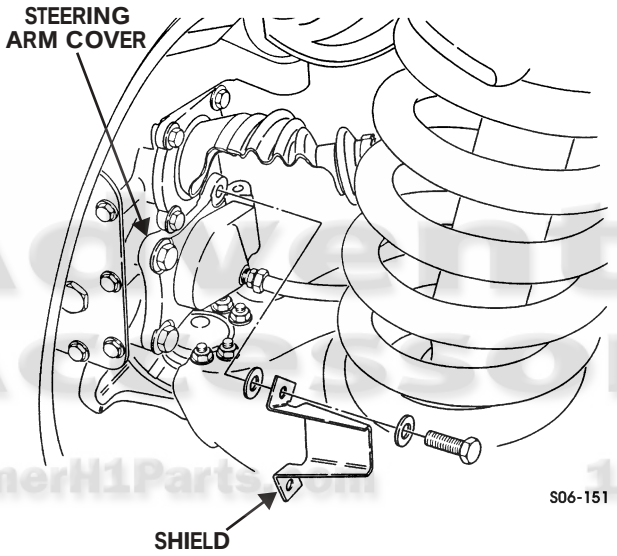


Figure 6-178: Rear Tube Connection Shield

Installation

Install shield on steering arm cover with two washers, capscrews, and two washers. Tighten capscrew to 75 lb-ft (102 N•m) (Figure 6-178).

GEARED HUB REPLACEMENT (CTIS)

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: The geared hub spindle has been bored to allow a direct air passage through the spindle to the quick-disconnect valve assembly. The front of the spindle is bored and tapped to allow installation of a quick-disconnect coupling. The rear of the spindle is bored for the insertion of a spindle extension, which creates an air-tight passageway into the steering arm cover. A bored hole in the steering arm cover allows the installation of a rotary seal and an air line, which routes compressed air to the tires.

Removal

1. Remove tube shield.
2. Remove rear tube connection shield.
3. Loosen clamp and disconnect hose from connector (front hose only) (Figure 6-179).

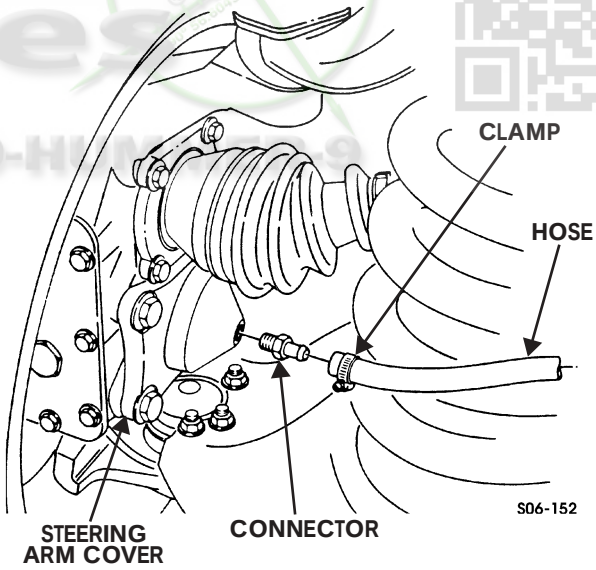


Figure 6-179: Front Geared Hub Connector

4. Disconnect tube from connector (rear tube only) (Figure 6-180).

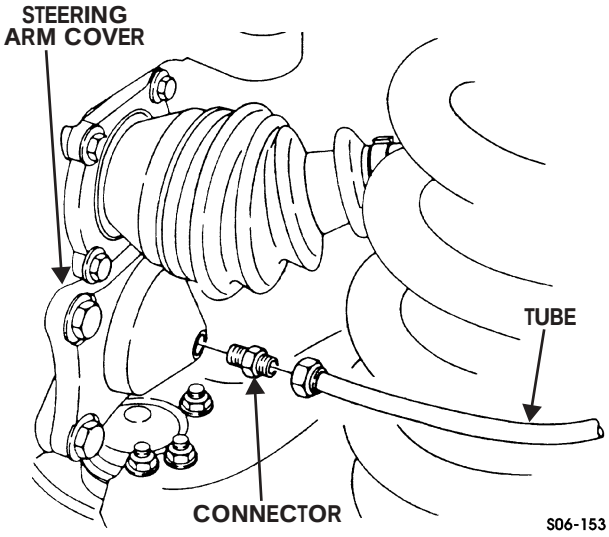


Figure 6-180: Steering Arm Cover

5. Remove connector from steering arm cover (Figures 6-179 and 6-180).
6. Remove geared hub.

Installation

1. Install geared hub.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

2. Apply sealant to connector and install in steering arm cover (Figures 6-179 and 6-180).
3. Connect hose to connector and tighten clamp (front hose only) (Figure 6-179).
4. Connect tube to connector and tighten nut (rear tube only) (Figure 6-180).
5. Install rear tube connection shield.
6. Install tube shield.

SPINDLE EXTENSION AND SEAL MAINTENANCE

Removal

1. Remove rear tube connection shield.
2. Remove four capscrews, washers, and steering arm cover from geared hub (Figure 6-181).
3. Remove retaining ring and seal from steering arm cover.
4. Remove spindle extension from spindle.

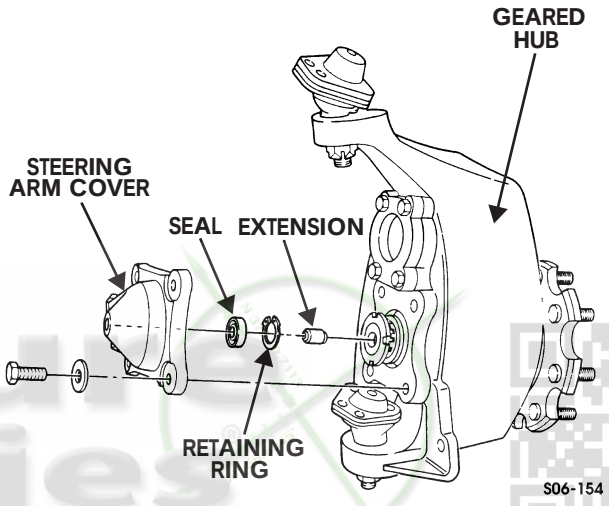


Figure 6-181: Spindle Extension and Seal

Cleaning and Inspection

Clean and inspect spindle extension and seal. Check for leaks and cracks. Replace defective parts.

Installation

CAUTION: *Do not allow sealant or adhesive into air system. Sealant will damage CTIS components.*

1. Apply sealant to seal and install seal in steering arm cover (Figure 6-181).
2. Secure seal to steering arm cover with retaining ring.
3. Apply a small amount of adhesive to end of spindle extension and install into spindle.
4. Install steering arm cover on geared hub with four washers and capscrews. Tighten capscrews to 75 lb-ft (102 N•m).
5. Install rear tube connection shield.

INNER RIM STUD MAINTENANCE

Removal

1. Remove wheel from vehicle.
2. Place wheel in tire inflation cage.

WARNING: Ensure the tire is totally deflated before removing wheel locknuts. Failure to follow proper safety precautions may result in serious injury or death.

3. Remove valve core from valve bore and deflate tire. Run a wire through valve bore to ensure it is not plugged (Figure 6-182).

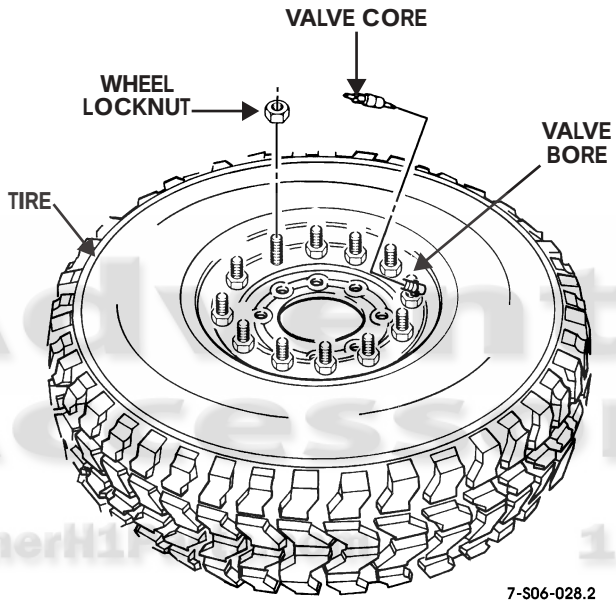


Figure 6-182: Valve Core and Valve Bore

NOTE: When replacing broken rim stud(s), replace studs on both sides of broken stud(s).

4. When tire is fully deflated, loosen wheel locknuts on each side of the broken stud(s). If you hear escaping air, do not proceed. Wait until the sound stops and recheck valve bore. When you are certain tire is fully deflated, proceed to remove wheel locknut. Discard locknut.
5. Drive studs out of inner rim. Discard studs (Figure 6-183).

Cleaning and Inspection

1. Using wire brush, clean remaining studs. Clean all dirt and foreign material from rim with soap and water and allow to air dry.

WARNING: Never use wheel assemblies with studs that are damaged, loose, or have damaged threads. Damaged studs can cause improper assembly, which could cause individual fasteners to fail. Any of these situations may result in serious injury or death.

2. Inspect inner rim for cracked, broken, rusted, pitted, bent, or loose studs, and studs with damaged, mutilated, or deformed threads. Replace defective parts (Figure 6-183).

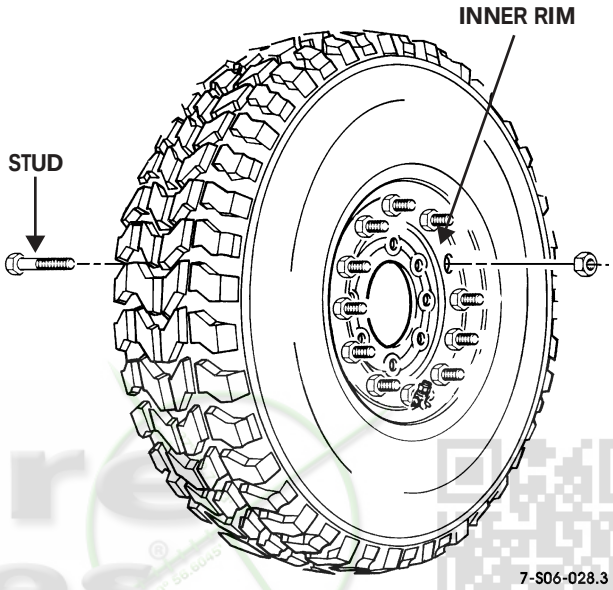


Figure 6-183: Inner Rim Stud

Installation

1. Align stud with splines in inner rim and drive stud into inner rim until stud shoulder seats against inner rim (Figure 6-183).
2. Repeat step 1 for all studs being replaced.

***CAUTION**: Tighten locknuts gradually to avoid bent and broken studs, or damage to wheel components will result.*

3. Install locknuts on new studs.

NOTE: After replacing broken stud(s), all wheel locknuts must be re-torqued.

4. Tighten locknuts to 85 lb-ft (115 N•m) in sequence shown (Figure 6-184).
5. Tighten locknuts to 125 lb-ft (170 N•m) in sequence shown.

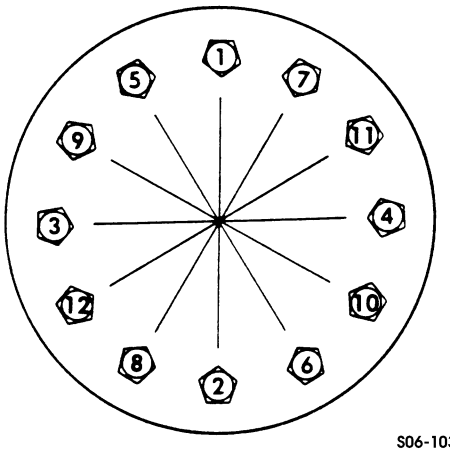


Figure 6-184: Lug Nut Tightening Sequence

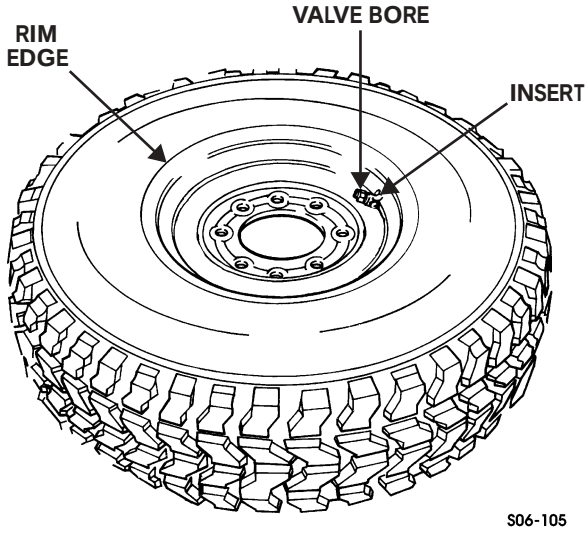


Figure 6-185: Leak Check Areas

6. Check wheel assembly for gaps at each stud. Use a 0.0015 inch (0.038 mm) thickness gauge to detect gaps. If gaps are detected, disassemble and reassemble wheel assembly and recheck for gaps. If gaps are still detected, replace outer rim half.

WARNING: Never inflate a wheel assembly without having checked wheel locknut torques to ensure the wheel locknuts are tightened to specifications. An assembly with improperly tightened locknuts could separate under pressure, resulting in serious injury or death.

WARNING: Always use a tire inflation cage for inflation purposes. Stand on one side of the cage during inflation, never directly in front. Keep hands out of cage during inflation. Inflate assembly to recommended pressure, using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

7. Place wheel in safety cage and inflate tire to the recommended tire pressure.
8. Check for leaks around rim edges and valve bore with soapy water (Figure 6-185).
9. Install wheel on vehicle.

Section 7 Brake System

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POWER BRAKE SYSTEM DESCRIPTION

The hydraulic power disc brake system is a four-wheel, inboard-mounted design. The dual reservoir master cylinder stores brake fluid and converts mechanical brake pedal force to hydraulic pressure. The proportioning valve provides balanced front-to-rear braking and activates the brake warning lamp in case of a brake system malfunction. The dual reservoir master cylinder provides fluid for separate front and rear brake systems (Figure 7-1).

The hydro-boost system is equipped with an accumulator. The accumulator stores nitrogen gas under pressure in the event that both the normal assist and accumulator assist are not available. The power steering pump provides hydraulic oil pressure to operate the brake system's hydro-boost feature. If the power steering pump fails to supply hydraulic pressure to the hydro-boost, the pressure stored in the accumulator will provide enough hydraulic pressure for approximately four power-assisted stops. Applying the parking brake prevents the rear brake rotors from rotating and can also be used to help stop the vehicle in emergency situations.

The disc brakes are mounted on the output flanges of the front and rear axle assemblies.

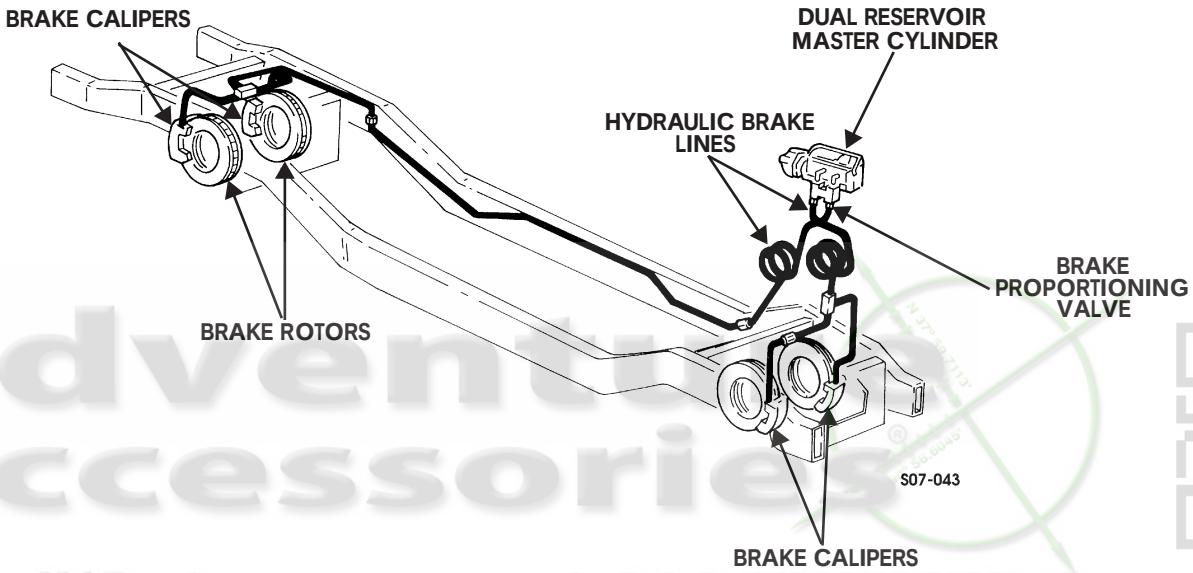

Figure 7-1: Brake System

BRAKE SYSTEM TROUBLESHOOTING AND DIAGNOSIS

Parking Brake

Parking Brake Does Not Hold Vehicle

1. Check parking brake adjustment and ensure linkage and cables operate freely. Adjust parking brake lever and/or cables or replace damaged and worn parts.
2. Inspect rear brake caliper brake pads for serviceability. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace all rear brake pads if any pad does not meet thickness specifications.
3. Check caliper for binding or dragging. Check for binding caliper guide pins.

Service Brakes

Low or Spongy Brake Pedal on First Application or Pedal Goes to Floor

NOTE: The HUMMER is equipped with DOT 5 silicone brake fluid. **Do not mix with other brake fluids**.

NOTE: When low or spongy brakes exist, the brake light on the instrument panel should illuminate when the brake pedal is applied.

WARNING: Always wear eye protection when bleeding brakes. Failure to do this may cause injury if brake fluid comes in contact with eyes.

1. Remove master cylinder cover and visually check reservoirs for low fluid level or contamination.
   a. If fluid is contaminated, flush system with clean brake fluid.

b. If fluid is low, check for worn brake pads, observe for leakage, broken, cracked or kinked lines, worn master cylinder, etc. Replace any worn parts.

2. If fluid is not contaminated, bleed master cylinder then bleed brakes.
3. Check hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.

Decreased Brake Pedal Travel or Slow Return

1. Check for worn brake pedal return spring. Replace if worn.
2. Check brake pedal bushings for signs of wear or binding. Replace if worn and lubricate as needed.
3. Check for kinked or damaged brake lines which may restrict brake fluid. Replace any damaged lines.
4. Check hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.
5. Check brake calipers for binding as a result of corrosion or dirt. Check brake rotors for free movement. If rotors do not move freely, remove calipers and clean caliper guide pins.
6. Check parking brake cable for proper operation. Repair as required.

Excessive Pedal Pressure Required to Stop Vehicle

1. Remove master cylinder cover and visually check reservoirs for low fluid level or contamination.
   a. If fluid is contaminated, flush system with clean brake fluid.
   b. If fluid is low, check for worn brake pads, observe for leakage, broken, cracked or kinked lines, worn master cylinder, etc. Replace any worn parts.
2. Check fluid in power steering pump reservoir. Fill fluid to proper level (Section 1).
3. Check power steering pump belt tension. Adjust tension or replace belt (Section 8).
4. Check brake pads for proper installation, contamination, or distortion. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace brake pads as axle sets (front or rear) if any pad does not meet specifications

NOTE: To preserve even braking, both calipers must be in equal condition.

5. Check brake calipers for binding as a result of corrosion or dirt. Check brake rotors for free movement. If rotors do not move freely, remove calipers and clean caliper guide pins.
6. Check for frozen piston in brake caliper. If inner pad is not worn to limit, but piston cannot be retracted, rebuild or replace both calipers.
7. Check for pinched or kinked supply and return lines to hydro-boost. Reposition or replace any damaged lines.
8. Check for damaged brake lines. Replace any damaged brake lines.
9. Check for malfunctioning hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.
10. Check power steering system. Refer to step 6 in the Diagnostic portion of *Hard Steering* in Section 8.

Noisy Brakes

1. Check brake pads for proper installation, contamination, or distortion. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace brake pads as sets (front or rear) if any pad does not meet specifications.
2. Check rotor for glazing or scoring. Turn the rotor if glazed or scored. Do not exceed the minimum thickness shown on the inside of the rotor hat section. It is not recommended that rotors be turned when spotted or heat checked.
3. Check halfshaft mounting.
   a. Apply a thread-locking compound to the halfshaft-to-rotor capscrews and torque to 48 lb-ft (65 N•m).
   b. Apply a thread-locking compound to the halfshaft retaining capscrew (in geared hub) and torque to 40 lb-ft (54 N•m). Tighten any loose fasteners.

Brake Chatter Noise

On some new vehicles, roughness or a chatter sound from the brakes may be noticed during low speed brake application. The noise is a result of the lining edges of an unburnished brake pad rubbing against the rotor. Burnishing is a part of the vehicle break-in process which fully seats and conditions new brake pads. Although annoying, the brake noise is not detrimental to vehicle safety or performance, and will eventually be eliminated through normal brake use.

If roughness or chatter persists on a new vehicle, then chamfering of the brake pad lining edges can be performed.

Chamfering of the brake pad is done by slightly grinding or filing the edge of the pad lining on a grinding wheel.

To complete the chamfering procedure:

1. Remove the eight service brake pads from the vehicle. Mark each pad for vehicle and caliper location.
2. Chamfer (grind) the brake pad lining edges. Ensure both brake pad lining edges are chamfered on each of the eight brake pads (Figure 7-2).
3. Install eight service brake pads at the original vehicle and caliper location.
4. Operate vehicle and check brakes for proper operation.

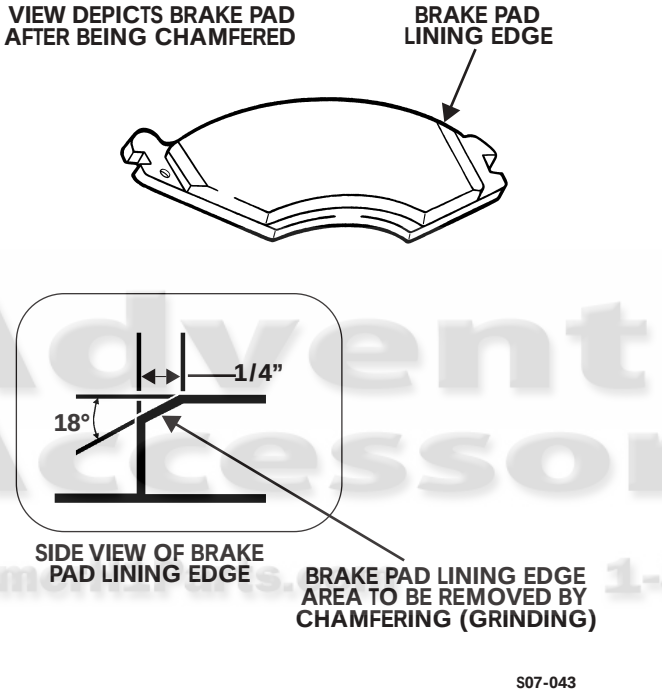

Figure 7-2: Chamfering Brake Pad

Booster or Pedal Pulsation

1. Check hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.
2. Check halfshaft-to-rotor mounting for missing or loose capscrews. Torque capscrews to 48 lb-ft (65 N•m) and apply a thread locking compound.
3. Check brake rotor lateral run-out. Refinish any rotor not meeting specifications. Refer to *Checking Lateral Runout* in this section for more information.

Erratic Braking Action

1. Check for correct tire pressure.
2. Check brake pads for binding as a result of corrosion or dirt. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace brake pads as sets (front or rear) if any pad does not meet specifications.

3. Check brake calipers for binding as a result of corrosion or dirt. Check for seized or binding brake caliper pistons. Repair any binding or seized caliper pistons. Check brake rotors for free movement. If rotors do not move freely, remove calipers and clean caliper guide pins (Figure 7-3).

NOTE: Calipers must be rebuilt or replaced in pairs.

4. Check for leaking caliper piston seals. Replace or rebuild any calipers with leaking seals.
5. Check rotor for glazing or scoring. Turn the rotor if glazed or scored. Do not exceed the minimum thickness shown on the inside of the rotor hat section. It is not recommended that rotors be turned when spotted or heat checked.
6. Check for damaged brake lines. Replace any damaged brake lines.
7. Check for faulty proportioning valve. With the vehicle at curb weight, decelerate from 20 mph (32 kph) on dry concrete road and apply sufficient pressure to lock up the brakes. If the front brakes lock up before rear brakes, replace the proportioning valve.
8. Check toe adjustment. Adjust toe, if necessary. Refer to Section 5.

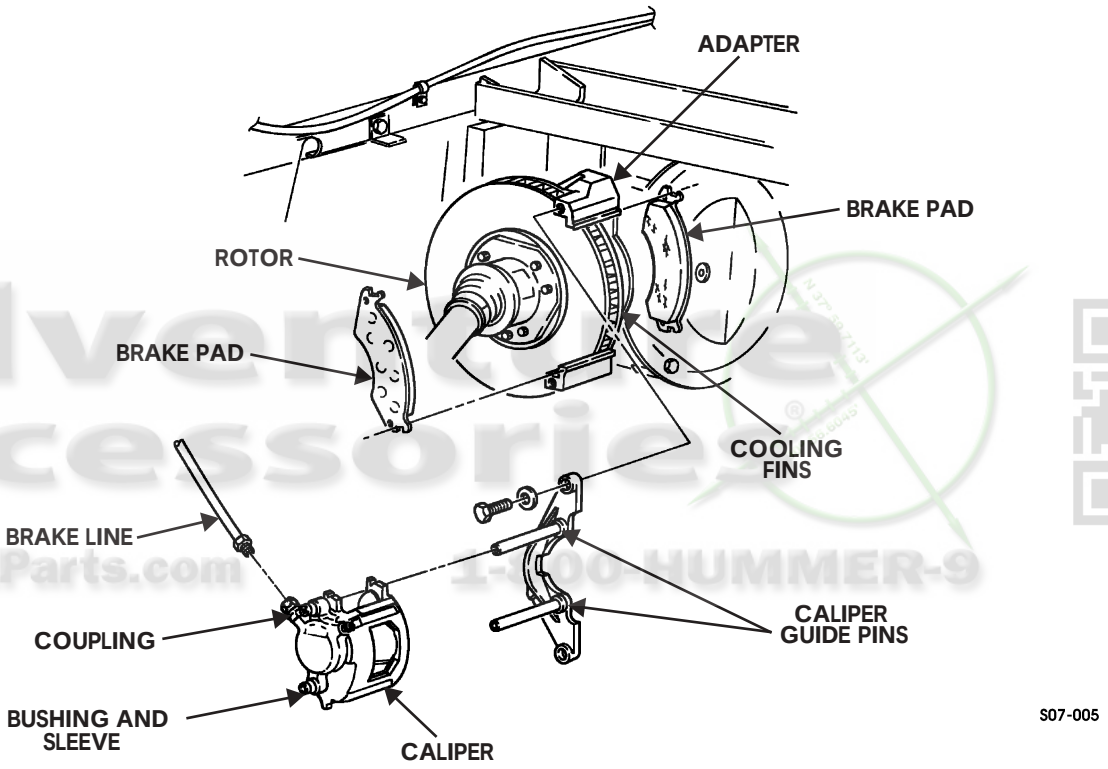

Figure 7-3: Brake Caliper and Brake Pads

HYDRO-BOOST SYSTEM DIAGNOSIS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Slow Brake Pedal Return	1. Excessive seal friction in booster. 2. Faulty spool action. 3. Restriction in return line from booster to pump reservoir. 4. Damaged input rod end.	1. Replace the hydro-boost. 2. Flush the steering system while pumping the brake pedal. 3. Replace the line. 4. Replace the input rod and piston assembly.
Grabby Brakes or Booster Chatters - Pedal Vibrates	1. Faulty spool action caused by contamination. 2. Power steering pump belt slips. 3. Low fluid level in power steering pump.	1. Flush steering system while pumping brake pedal. 2. Tighten belt. 3. Fill reservoir and check for external leaks.
Accumulator Leak-Down System Does Not Hold Charge	1. Contamination in steering hydro-boost system. 2. Internal leakage in accumulator system	1. Flush steering system while pumping brake pedal. 2. Replace hydro-boost.
Excessive Brake Pedal Efforts	1. Loose, glazed, or broken pump belt. 2. No fluid in pump reservoir. 3. Leaks in system hoses. 4. Leaks at tube fittings and connections. 5. Leakage at pneumatic accumulator seal. 6. Leakage at piston seal. 7. Leakage at input seal. 8. Leakage at cover-to-housing seal. 9. Leakage at spool plug seal. 10. Leakage at ball plug	1. Tighten or replace belt. 2. Fill reservoir and check for external leaks. 3. Replace faulty parts. 4. Tighten fittings or replace tube seats or O-rings. 5. Replace O-ring. 6. Overhaul with new seal kit. 7. Overhaul with new seal kit. 8. Overhaul with new seal kit. 9. Overhaul with spool plug seal kit. 10. Replace hydro-boost.
NOTE: The power steering fluid and brake fluid cannot be mixed. If the brake seals contact steering fluid or the steering seals contact brake fluid, seal damage will result.		

Noise Diagnosis

The following noises are associated with the hydro-boost and may or may not be cause for concern. Some noises are normal and for the most part temporary in nature. Other noises may be a sign of excessive wear or the presence of air in either the booster or the steering system.

1. A moan or low frequency hum usually accompanied by a vibration in the pedal or steering column may be observed during parking maneuvers or other low-speed maneuvers. This may be caused by a low fluid level in the power steering pump or by air in the fluid. Holding the pump at relief pressure (steering wheel held all the way in one direction) for more than five seconds will cause air to enter the system. Check the fluid level and fill if needed. The system must then sit for one hour to remove the air.
2. A high-speed fluid noise may be heard when the brake pedal is fully depressed. This condition is normal.
3. Whenever the accumulator pressure is used, a slight hiss may be noticed. It is the sound of the hydraulic fluid escaping through the accumulator valve, and is completely normal.
4. After the accumulator has been emptied and the engine is started again, another hissing sound may be heard during the first brake application or the first steering maneuver. This is caused by the fluid rushing through the accumulator charging orifice. It is normal and will only be heard once after the accumulator is emptied. If this sound continues however, even though no apparent accumulator pressure assist was made, it could be an indication that the accumulator is not holding pressure and should be

checked using the procedure *Accumulator Leakdown Test* in this section.

Booster Functional Test

With the engine off, apply the brake pedal several times until the accumulator is completely depleted. Depress the brake pedal using 40 lb-ft (54 N•m) of force and start the engine. The pedal will fall and then push back against your foot.

Accumulator Leakdown Test

1. Start the engine and charge the accumulator by applying the brake pedal or by turning the steering wheel from stop to stop. Turn off the engine and let the vehicle sit for one hour. After one hour there should be at least two power-assisted applications with the engine off.
2. If the reserve system will not retain a charge for one hour, but functions normally immediately following charging, the accumulator valves are at fault. The booster must be disassembled and the accumulator valves replaced.
3. If the accumulator can be heard charging and discharging but does not hold a charge, disassemble the booster and replace the accumulator valves.
4. Deplete the accumulator by pressing the brake pedal several times. If the accumulator can has lost its charge, it is possible to rotate or wobble the accumulator can with respect to the housing. Replace the accumulator assembly.

Handling - The booster should not be carried by the accumulator nor should the booster ever be dropped on the accumulator. The snap ring which holds the accumulator into the housing should be checked for proper positioning before the booster is used. The accumulator contains high pressure gas and with any high pressure gas a certain degree of danger is present if mishandled.

Disposal - The accumulator should not be exposed to excessive heat, fire or incineration. Before discarding accumulator following replacement, drill a 1/16 in. diameter hole in the end of accumulator can to relieve the pressure. BE SAFE! Protect your eyes. Wear approved safety glasses.

SERVICE BRAKE SYSTEM BLEEDING

NOTE: If only the front or rear half of the system has been serviced, it is usually necessary to bleed only that half of the system. However, if a firm brake pedal cannot be obtained after bleeding, it will be necessary to bleed the entire system. The brake hydraulic system can be bled manually or by using a pressure tank and adapters. Each method is outlined in the following procedures.

WARNING: Always wear eye protection when bleeding brakes. Failure to do this may cause injury if brake fluid comes in contact with eyes.

Pressure Bleeding

***CAUTION**: When using a pressure bleeding tank, follow the manufacturer's instructions for its use. Use only DOT 5 silicone brake fluids when bleeding. Do not exceed the recommended working pressure when pressurizing the tank. A tank pressure of 15-20 psi (103-138 kPa) is sufficient to bleed the brake hydraulic system. Release all air pressure from the tank after using it.*

NOTE: This procedure covers bleeding at one wheel. Repeat bleeding task for remaining wheels.

1. Remove cover from master cylinder. Fill master cylinder if necessary.
2. Install pressure tank bleeder adapter to master cylinder (Figure 7-4).
3. Connect line from pressure tank to adapter.

NOTE: Bleed calipers in the following order: right rear, left rear, right front, left front.

4. Remove protective cap from bleeder screw on caliper assembly (Figure 7-5).
5. Connect short piece of hose to bleeder screw, and place other end of hose in container 3/4 full of brake fluid.
6. Open valve on line from pressure tank to master cylinder allowing pressurized brake fluid to enter system (Figure 7-4).
7. Open bleeder screw 3/4 turn and observe brake fluid in container. Close bleeder screw when brake fluid flows free of air bubbles (Figure 7-5).
8. Disconnect hose from bleeder screw and install protective cap on bleeder screw.
9. Close valve on line from pressure tank to master cylinder (Figure 7-4).
10. Disconnect line from adapter.
11. Remove adapter from master cylinder and fill master cylinder if necessary.
12. Install master cylinder cover.

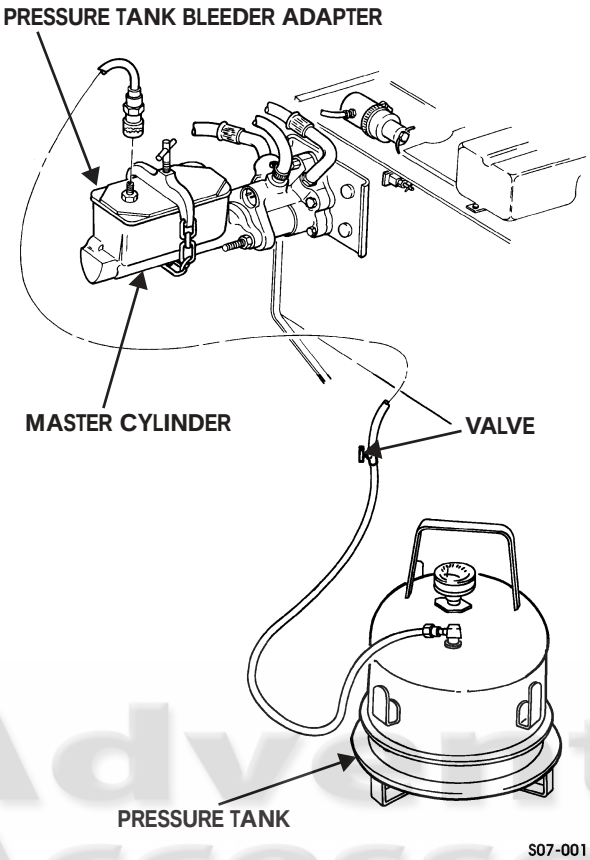

Figure 7-4: Pressure Bleeding Brake System

Manual Bleeding

NOTE: This procedure covers bleeding at one wheel. Repeat bleeding task for remaining wheels. Assistance is required to depress the brake pedal when manually bleeding brakes while mechanic opens and closes bleeder screw.

NOTE: Bleed calipers in the following order: right rear, left rear, right front, left front.

1. Remove protective cap from bleeder screw on caliper assembly (Figure 7-5).
2. Connect short piece of hose to bleeder screw, and place other end of hose in container 3/4 full of brake fluid.

***CAUTION**: Check the master cylinder fluid level frequently during the bleeding operation and refill the reservoirs as necessary. Do not allow the master cylinder to run out of fluid at any time, or additional air will be drawn into the system.*

3. Have an assistant depress the brake pedal. Open bleeder screw 3/4 turn.

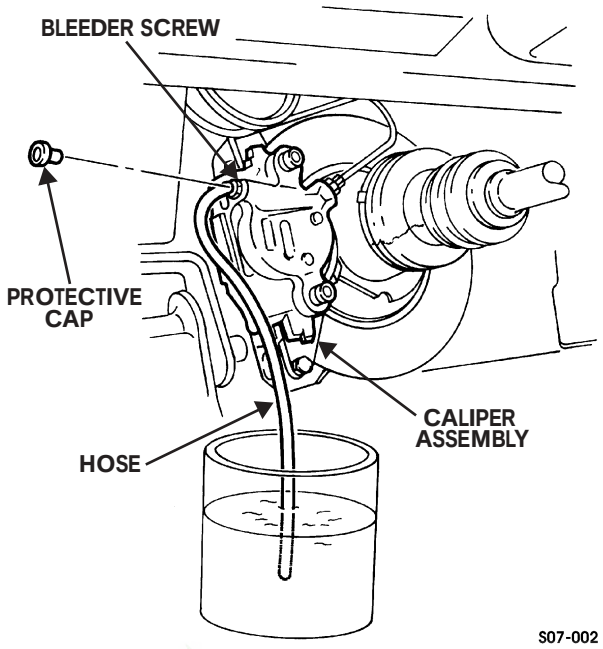

Figure 7-5: Manually Bleeding Brake System

4. When pedal reaches floor, tighten bleeder screw and have assistant slowly release brake pedal.
5. Repeat steps 3 and 4 until fluid flows clear and free of air bubbles.
6. Disconnect hose from bleeder screw and install protective cap on bleeder screw.
7. Operate vehicle and check brakes for proper operation.

SERVICE BRAKE PAD REPLACEMENT

NOTE: The following procedure applies to the front brake system only.

Removal

1. Using crowfoot, remove two capscrews and washers securing yoke and caliper to adapter.

NOTE: Note positioning of brake pad surfaces for installation.

2. Remove yoke, caliper, and two brake pads.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect dust boot for tears or deterioration (Figure 7-6).
2. Inspect rotor for heat checks, spotting, discoloration, pitting, or scoring. Resurface rotors if discolored, pitted, or scored. It is not recommended that rotors be turned when spotted or heated checked.

NOTE: If operation in wet and muddy conditions is expected, replace brake pads if brake lining thickness is 1/8 in. (3.2 mm) or less.

3. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace brake pads. Brake pads should be replaced as an axle set (front or rear).

Installation

WARNING: Ensure brake pads are installed with linings facing rotor. Failure to do this will cause poor performance, damage to equipment, and may result in injury.

1. Position brake pads on adapter.

NOTE: When installing yoke and caliper, use a suitable tool to compress the piston.

2. Apply a thread-locking compound to tapped holes of adapter. Using crowsfoot, secure yoke and caliper to adapter with two washers and capscrews. Tighten capscrews to 30-40 lb-ft (41-54 N•m).

LINING AND ROTOR BURNISHING

After you replace brake pads and/or refinish rotors, it is recommended that the new braking surface be broken in, or "burnished." To do this, make 20 stops, one every two miles at 30 mph, using medium pedal effort. The amount of time it takes to stop should be approximately five seconds. During this procedure, use care to avoid overheating the brakes.

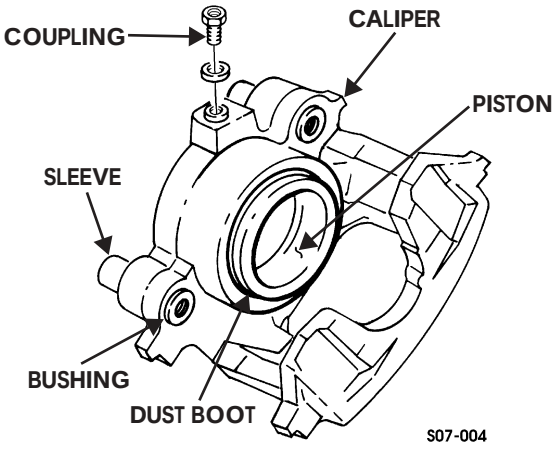

Figure 7-6: Caliper Assembly

SERVICE BRAKE CALIPER MAINTENANCE

NOTE: The following procedure applies to the front brake system only. If removing left front caliper, half-shaft must be removed.

Removal

1. Disconnect brake line from coupling (Figure 7-7).
2. Using crowfoot, remove two capscrews and washers securing yoke and caliper to adapter.

NOTE: Note positioning of brake pad surfaces for installation.

3. Remove yoke, caliper, and two brake pads from adapter.
4. Slide yoke and caliper guide pins out from caliper. Remove coupling and washer from caliper.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean mating surfaces of caliper and adapter (Figure 7-7).
2. Inspect caliper and caliper piston for pitting, or damage (Figure 7-6).
3. Inspect caliper guide pins and sleeves for wear.
4. Inspect dust boot and bushings for tears or deterioration.
5. Inspect yoke and caliper guide pins for corrosion. Perform step 6 if corroded. If not, perform step 8 (Figure 7-7).
6. Remove caliper guide pins from yoke. Discard caliper guide pins.
7. Inspect rotor for heat checks, discoloration, pitting, or scoring. Check rotor thickness variation.

NOTE: Replace brake pads in sets only. Replace brake pads if brake lining thickness is less than 1/8 in. (3.2 mm) and operation in wet and muddy conditions is expected.

8. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace both pads and pads from opposite caliper.

Installation

1. Install a washer and coupling to caliper (Figure 7-6).

WARNING: Ensure brake pads are installed with linings facing rotor. Failure to do this will cause poor performance and damage to equipment and may result in injury.

2. Position brake pads on adapter (Figure 7-7).

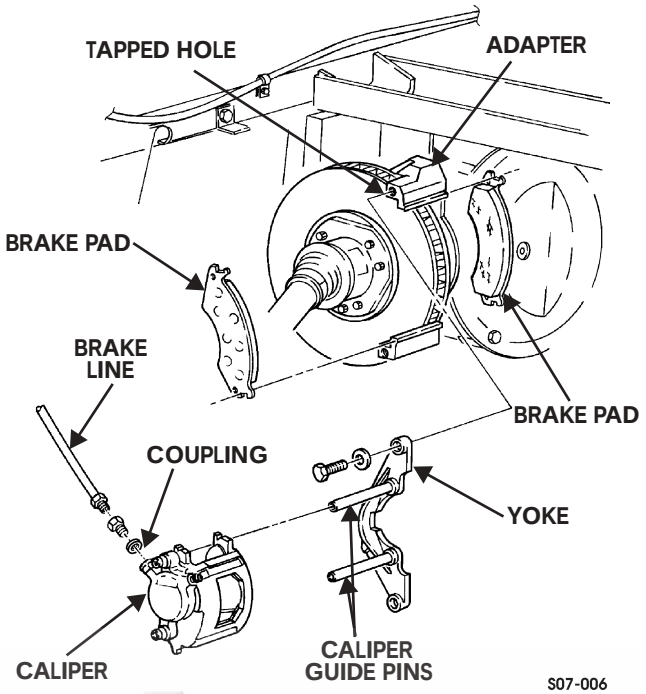

Figure 7-7: Service Brake Components

3. Apply thread-locking compound to threads of caliper guide pins and install pins into yoke (if removed during cleaning and inspection). Tighten caliper guide pins to 30 lb-ft (41 N•m).
4. Position caliper onto yoke.

NOTE: When installing calipers, use a suitable tool to bottom out piston in caliper if needed.

5. Apply thread-locking compound to tapped holes of adapter. Using crowfoot, secure yoke and caliper to adapter with two washers and capscrews. Tighten two capscrews to 40 lb-ft (54 N•m).
6. Connect brake line to coupling.
7. Bleed brake system.

MASTER CYLINDER REPLACEMENT

Removal

1. Disconnect front and rear brake lines from master cylinder (Figure 7-8).
2. Remove locknut, washer, and proportioning valve from right master cylinder mounting stud and master cylinder. Discard locknut.
3. Remove locknut, washer, capscrew, and washer securing bracket to splash shield. Discard locknut (Figure 7-9).
4. Remove locknut, washer, and bracket from hydro-boost. Discard locknut.

***CAUTION**: Do not apply excessive pressure or force on master cylinder.*

5. Remove two locknuts and master cylinder from hydro-boost. Discard locknuts (Figure 7-8).

Installation

1. Bench-bleed master cylinder.

***CAUTION:** Ensure O-ring is properly seated on master cylinder prior to installation. Damage to master cylinder may result if O-ring is not properly seated.*

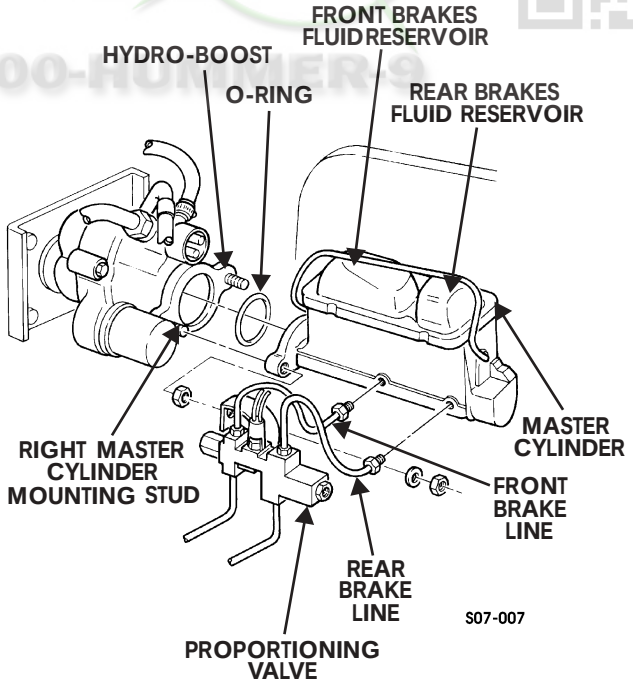

Figure 7-8: Master Cylinder

2. Install master cylinder to hydro-boost with two locknuts. Tighten locknuts to 22 lb-ft (30 N•m) (Figure 7-8).
3. Install bracket on hydro-boost with washer and locknut. Tighten locknut to 22 lb-ft (30 N•m) (Figure 7-9).
4. Install bracket to splash shield with washer, capscrew, washer, and locknut. Tighten locknut to 26 lb-ft (35 N•m).
5. Install proportioning valve to right master cylinder mounting stud with washer and locknut. Tighten locknut to 22 lb-ft (30 N•m) (Figure 7-8).
6. Install front and rear brake lines to master cylinder.

Bleeding

NOTE: Master cylinder must be filled and kept at least half full during bleeding operation (Figure 7-8).

1. Depress brake pedal slowly and hold. Loosen front brake line to purge air from the front reservoir (closest to the hydro-boost).
2. Tighten front brake line and release brake pedal.
3. Repeat steps 1 and 2 until front reservoir is purged of air.
4. Repeat steps 1 through 3 for rear reservoir with rear brake line.
5. Bleed brake system.

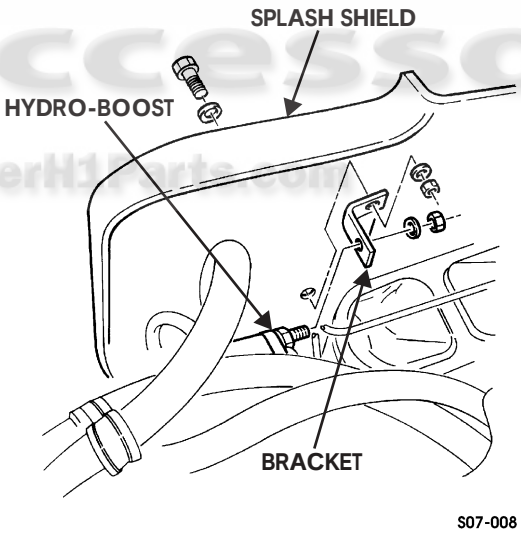

Figure 7-9: Hydro-boost Bracket

MASTER CYLINDER BENCH BLEEDING

Bleeding

NOTE: Master cylinder must be filled and kept at least half full during bleeding operation. Perform this procedure prior to installing master cylinder on vehicle.

1. Secure master cylinder flange in vise.
2. Remove cover and fill reservoirs with silicone brake fluid.
3. Screw threaded end of bleeder hose into brake line port on master cylinder and insert opposite end into reservoir. Repeat step for other bleeder hose (Figure 7-10).
4. Slowly push piston into master cylinder. Do not release piston. Air will be forced into hoses. Repeat as needed until no bubbles noted from lines. Lines must stay in fluid until installed.
5. Refill reservoirs with silicone brake fluid and repeat step 4 until no air bubbles remain in brake fluid.
6. Remove bleeder hoses from brake line ports on master cylinder.
7. Install cover on master cylinder and remove from vise.
8. Install master cylinder.
9. Bleed brake system.

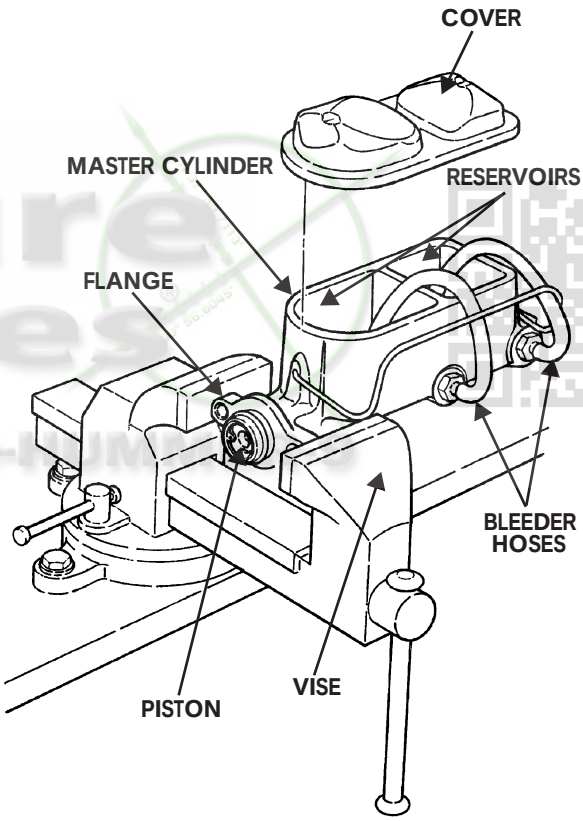

Figure 7-10: Brake Master Cylinder

HYDRO-BOOST REPLACEMENT

Removal

1. Remove master cylinder.
2. Disconnect two high pressure lines and one return line from hydro-boost (Figure 7-11).
3. Remove cotter pin, washer, and pushrod from brake pedal bellcrank. Remove spring washer from brake pedal bellcrank and discard cotter pin and spring washer.
4. Remove four nuts, lockwashers, washers, gasket, and hydro-boost from cowl. Discard lockwashers.

Installation

1. Install gasket and hydro-boost on cowl with four washers, lockwashers, and nuts (Figure 7-11).
2. Install spring washer on brake pedal bellcrank. Connect hydro-boost pushrod to brake pedal bellcrank. Install washer and cotter pin.
3. Tighten nuts to 21 lb-ft (28 N•m).
4. Connect two high pressure lines and one return line to hydro-boost.
5. Install master cylinder.
6. Bleed hydro-boost system.

BLEEDING THE HYDRO-BOOST SYSTEM

Whenever the booster is removed and installed, the steering system should be bled.

NOTE: The power steering fluid and brake fluid cannot be mixed. If the brake seals contact the steering fluid, or the steering seals contact brake fluid, seal damage will result.

1. Fill the power steering pump reservoir to the proper level and let the fluid remain undisturbed for at least two minutes.
2. Start the engine and run momentarily. Add fluid if necessary.
3. Repeat steps 1 and 2 until the fluid level remains constant after running the engine.
4. Raise the front of the vehicle so the wheels are off the ground. Support the vehicle with suitable safety stands.
5. Turn the wheels from stop to stop. Add fluid if necessary.
6. Lower the vehicle from the safety stands.
7. Start the engine and depress the brake pedal several times while rotating the steering wheel from stop to stop.
8. Turn the engine off and pump the brake pedal 4 to 5 times.
9. Check the brake fluid level. Add fluid if necessary.
10. If the fluid is extremely foamy, allow the vehicle to stand a few minutes with the engine on. Then repeat steps 7, 8, and 9.
11. Check for the presence of air in the oil. Air in the oil will give the fluid a milky appearance. Air in the system will also cause the fluid level in the pump to rise when the engine is turned off.

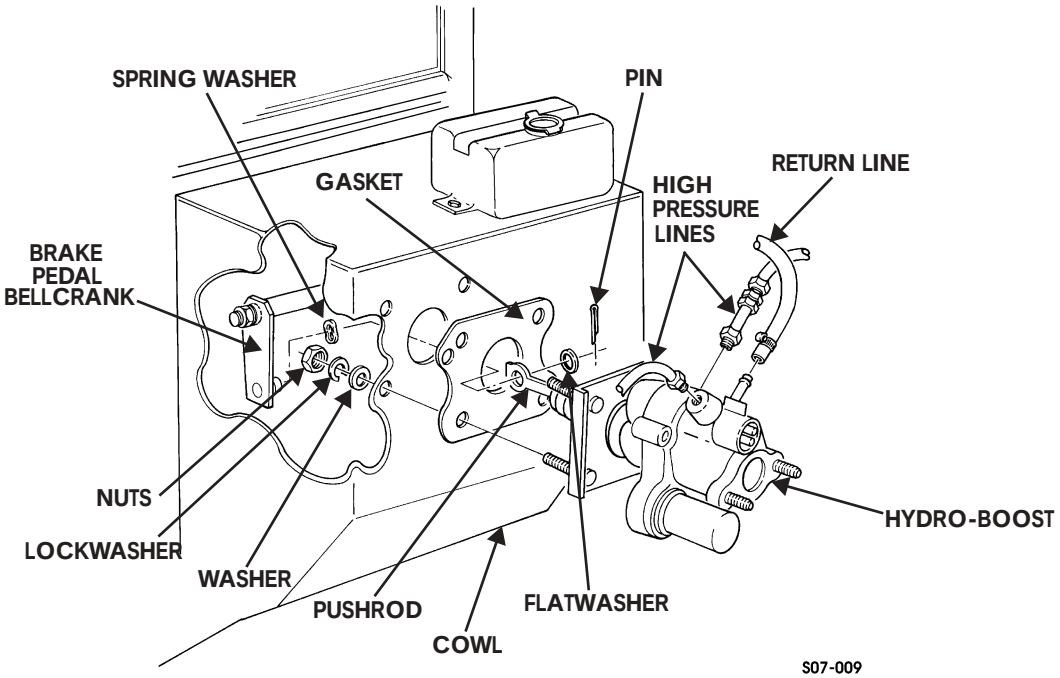

Figure 7-11: Hydro-boost Replacement Procedure

BRAKE LINES REPLACEMENT

NOTE: Brake line replacement procedures for the service brake system and the rear dual service/parking brake system are basically the same. Service brake system is shown.

NOTE: After servicing the brake system, bleed the brakes and refill as necessary.

Caliper-to-Tee Brake Line Removal

NOTE: Removal and installation procedures are basically the same for all caliper-to-tee brake lines. This procedure covers the left rear caliper-to-tee line (Figure 7-12).

1. Disconnect brake line from caliper.
2. Disconnect brake line from rear tee at forward-rear crossmember.
3. Remove capscrew and clamp securing brake line and vent line to forward-rear crossmember, and remove brake line.

Caliper-to-Tee Brake Line Installation

1. Connect brake line to rear tee at forward-rear crossmember (Figure 7-12).
2. Connect brake line to caliper.
3. Install clamp on brake line and vent line.
4. Install brake line, vent line, and clamp on forward-rear crossmember with capscrew.

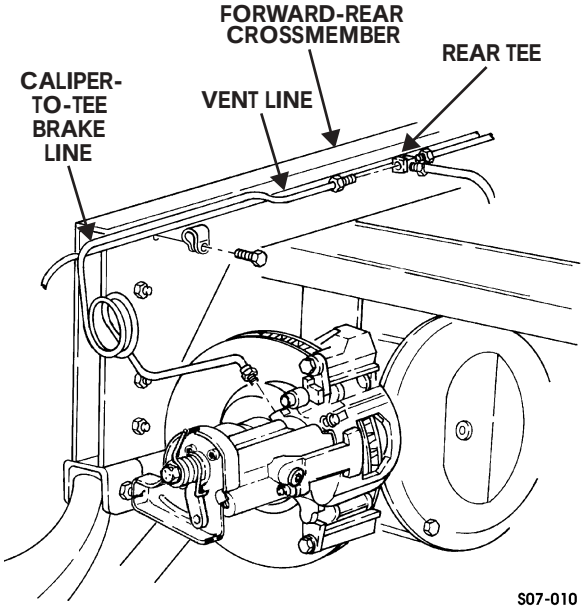

Figure 7-12: Caliper-to-Tee Brake Line

Rear Brake Line Removal

1. Disconnect rear brake line from rear tee (Figure 7-13).
2. Remove capscrew and clamp securing rear brake line to forward-rear crossmember (Figure 7-14).
3. Disconnect rear brake line from intermediate brake line and remove rear brake line.

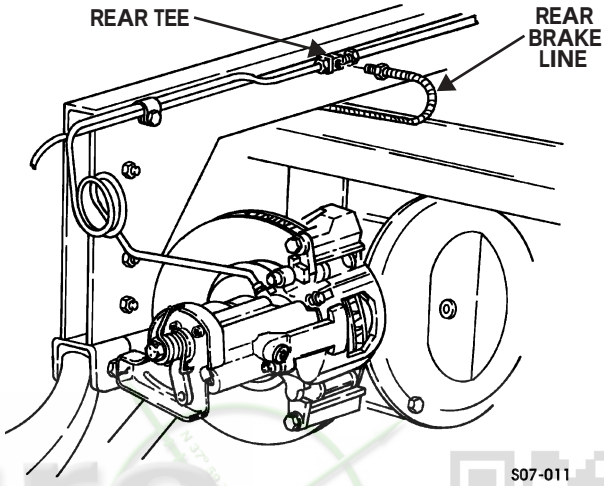

Figure 7-13: Rear Brake Line

Rear Brake Line Installation

1. Connect rear brake line to intermediate brake line (Figure 7-14).
2. Install rear brake line and clamp on forward-rear crossmember with capscrew.
3. Connect rear brake line to rear tee (Figure 7-13).

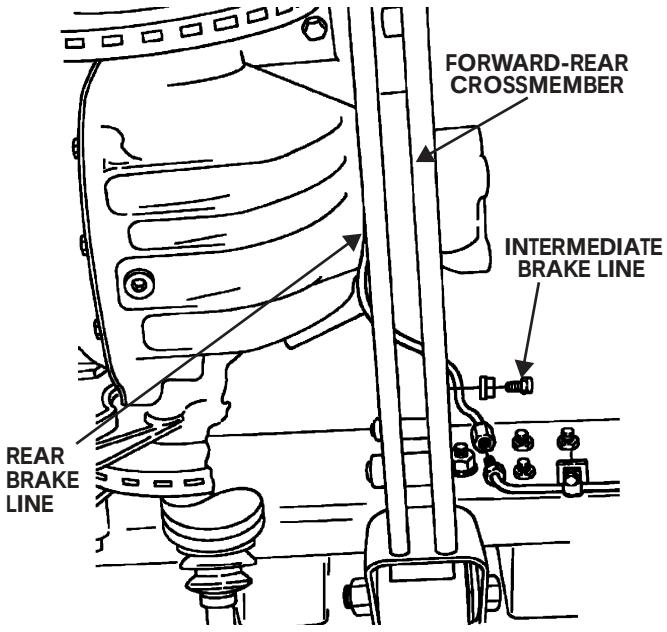

Figure 7-14: Rear Brake Line

Intermediate Brake Line Removal

1. Disconnect intermediate brake line from rear brake line (Figure 7-14).
2. Remove five capscrews, clamps, and intermediate brake line from frame (Figures 7-13 and 7-16).
3. Disconnect intermediate brake line from union brake line and remove brake line (Figure 7-17).

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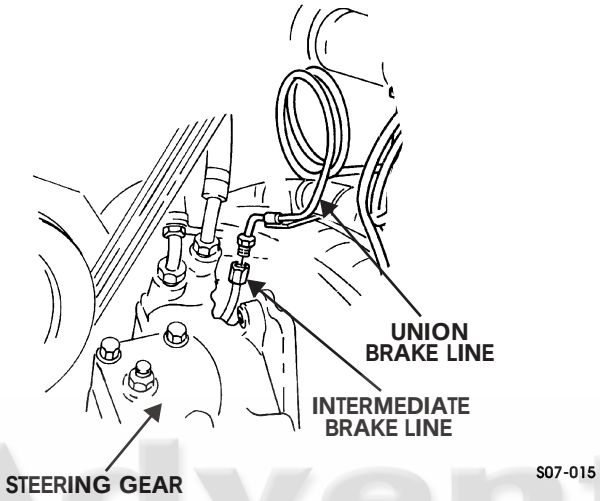

Figure 7-15: Intermediate Brake Line

Intermediate Brake Line Installation

1. Connect intermediate brake line to union brake line (Figure 7-15).
2. Connect intermediate brake line to rear brake line (Figure 7-16).
3. Install intermediate brake line and five clamps on frame with five capscrews (Figure 7-17).

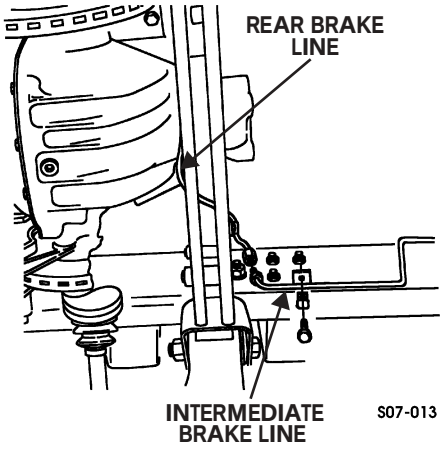

Figure 7-16: Intermediate Brake Line

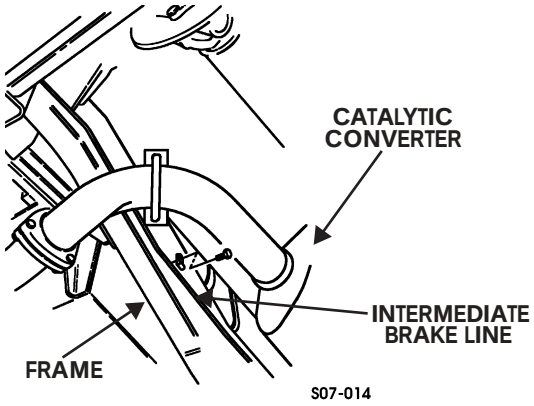

Figure 7-17: Intermediate Brake Line

Proportioning Valve to Union Brake Line Removal

1. Disconnect union brake line from proportioning valve (Figure 7-18).
2. Remove nut, washer, capscrew, and clamp securing union brake line to bracket.
3. Disconnect and remove union brake line from intermediate brake line.

Proportioning Valve to Union Brake Line Installation

1. Connect union brake line to intermediate brake line (Figure 7-18).
2. Install union brake line and clamp on bracket with capscrew, washer, and nut.
3. Connect union brake line to proportioning valve.

Proportioning Valve to Front Tee Brake Line Removal

1. Disconnect rear brake line from proportioning valve (Figure 7-18).
2. Disconnect and remove rear brake line from front tee.

Proportioning Valve to Front Tee Brake Line Installation

1. Connect rear brake line to front tee (Figure 7-18).
2. Connect rear brake line to proportioning valve.
3. Bleed brake system.

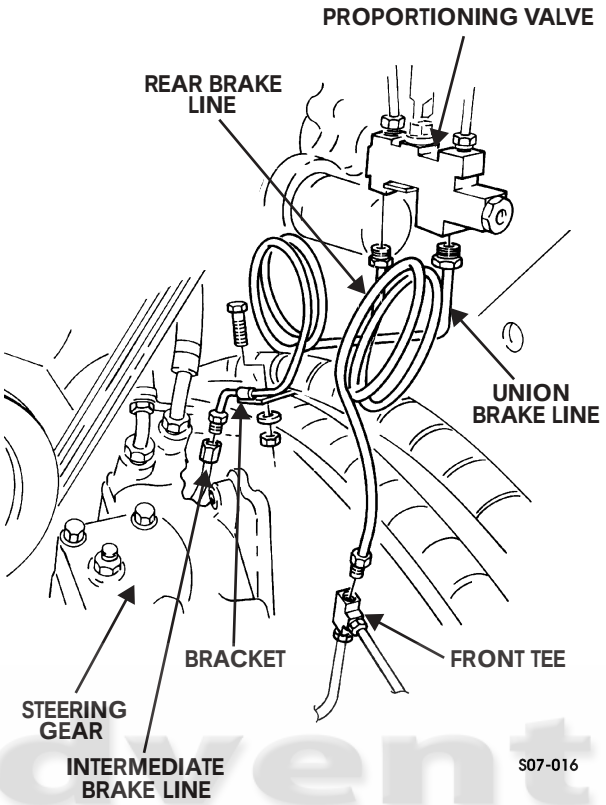

Figure 7-18: Proportioning Valve

SERVICE BRAKE PEDAL REPLACEMENT

Removal

1. Disconnect the stoplight switch (Figure 7-19).
2. Remove pushnut and disconnect stoplight switch rod (if so equipped) from brake pedal assembly. Discard pushnut. (Figure 7-19).
3. Disconnect return spring from brake pedal assembly.
4. Remove cotter pin and washer securing hydro-boost push-rod to brake pedal bellcrank, and disconnect hydro-boost pushrod from brake pedal bellcrank. Remove spring washer. Discard cotter pin and spring washer.
5. Remove nut, two washers, pivot pin, and brake pedal assembly from bracket.
6. Remove two bushings from brake pedal assembly. Discard two bushings.

Installation

1. Apply silicone grease to inside of two bushings. Install two bushings in brake pedal assembly.
2. Install brake pedal assembly on bracket with pivot pin, two washers, and nut. Using adapter and crowfoot, tighten nut to 60 lb-ft (81 N•m).
3. Install spring washer on brake pedal bellcrank. Connect hydro-boost pushrod to brake pedal bellcrank with washer and cotter pin.
4. Connect return spring to brake pedal assembly.
5. Use the pushnut to install the stoplight switch rod (if so equipped) to brake pedal assembly.

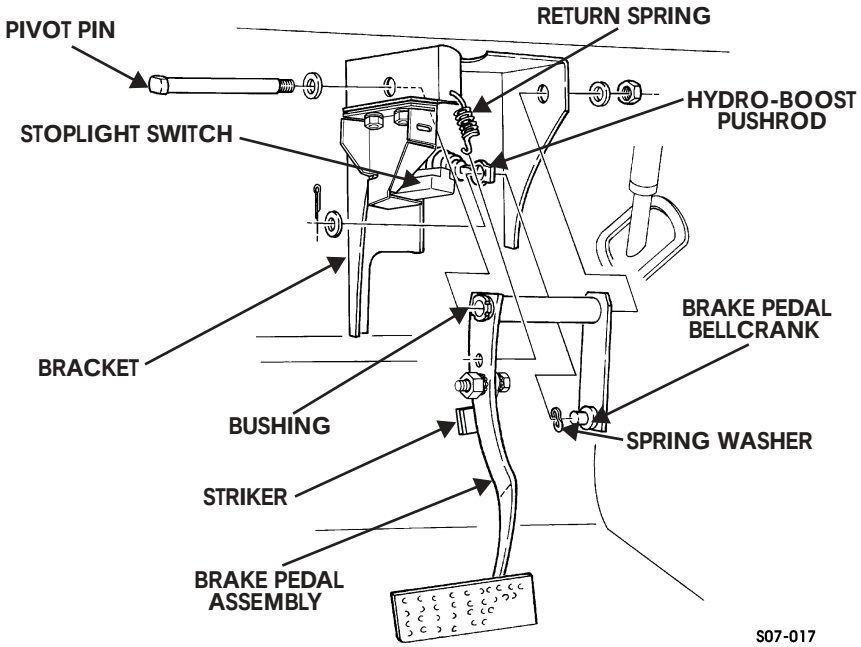

Figure 7-19: Service Brake Pedal Components

6. Connect the stoplight switch.
7. Operate vehicle and check brakes for proper operation.
8. Check brake lights for proper operation.

PROPORTIONING VALVE REPLACEMENT

Removal

1. Disconnect battery ground cable.

***CAUTION**: Do not attempt to disassemble proportioning valve. Damage to equipment will result.*

2. Disconnect electrical connector from proportioning valve (Figure 7-20).
3. Disconnect four brake lines from proportioning valve.
4. Remove locknut, washer, and proportioning valve from hydro-boost. Discard locknut.

Installation

1. Install proportioning valve on hydro-boost with washer and locknut. Tighten locknut to 22 lb-ft (30 N•m) (Figure 7-20).
2. Connect four brake lines to proportioning valve.
3. Apply lubricating oil to pin on proportioning valve.
4. Connect electrical connector to proportioning valve.
5. Connect battery ground cable.
6. Bleed brake system.
7. Operate vehicle and check brakes for proper operation.
8. Check brake lines at proportioning valve for leaks.

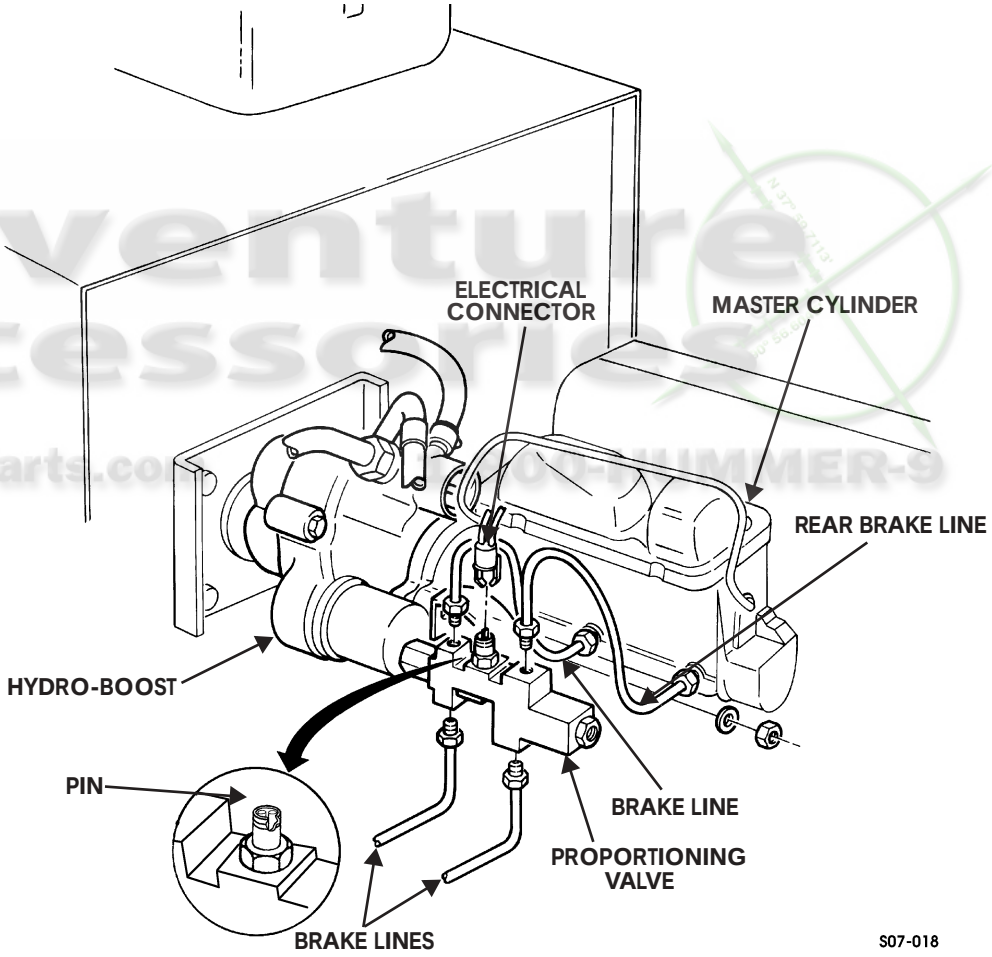

Figure 7-20: Proportioning Valve

SERVICE BRAKE ROTOR REPLACEMENT

Removal

1. Remove service brake caliper.
2. Remove six capscrews, lockwashers, halfshaft, and rotor from output flange. Discard lockwashers (Figure 7-21).

Installation

1. Apply thread-locking compound to threads of capscrews.
2. Install rotor on output flange.
3. Secure halfshaft and rotor to output flange with six lockwashers and capscrews. Tighten capscrews to 48 lb-ft (65 N•m).

4. Install service brake caliper.

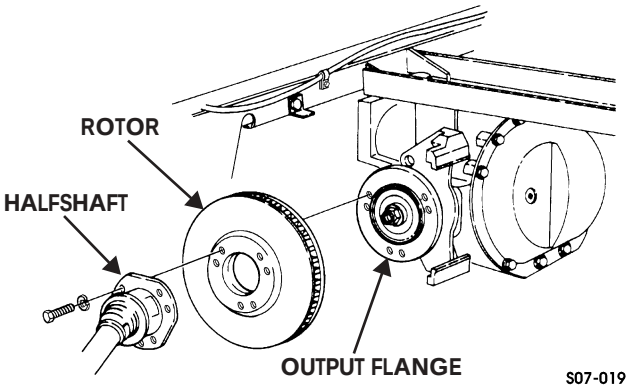

Figure 7-21: Service Brake Rotor

REAR DUAL SERVICE/PARKING BRAKE PAD REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, and clevis pin securing parking brake cable to lever. Discard cotter pin (Figure 7-22).
3. Remove clip securing parking brake cable to caliper cable bracket and disconnect cable from caliper cable bracket. Discard clip.

***CAUTION**: Caliper must be supported during removal to prevent damage to brake line.*

4. Remove two capscrews and washers securing yoke and caliper to adapter, and pull yoke and caliper away from rotor (Figure 7-23).

NOTE: Note positioning of brake pad surfaces for installation.

5. Remove two brake pads from adapter and rotor.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean mating surfaces of caliper and adapter and lightly lubricate adapter slides with grease (Figure 7-23).

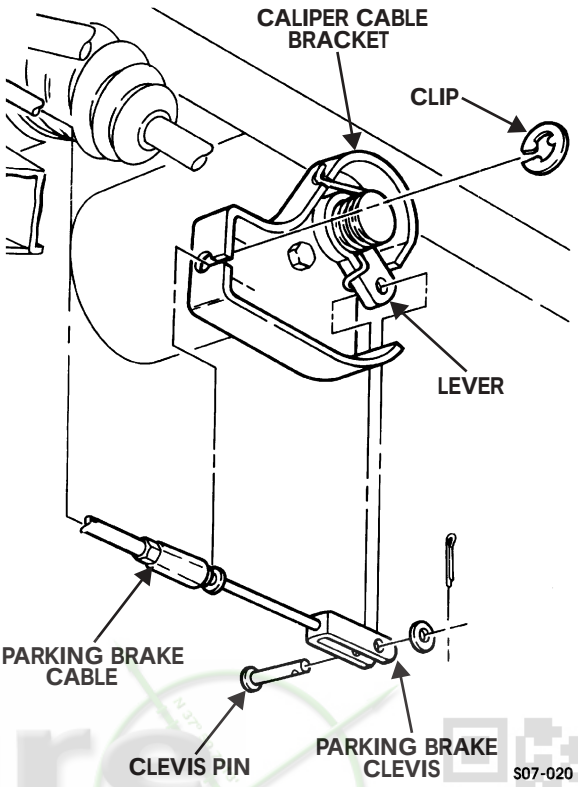

Figure 7-22: Rear Dual Brake Components

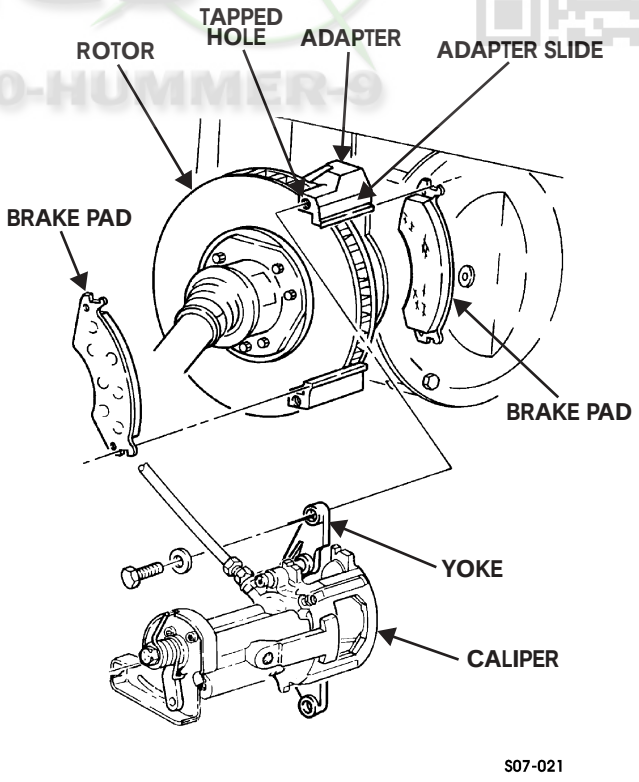

Figure 7-23: Rear Dual Brake Pad and Rotor

2. Inspect caliper and caliper piston face for pitting or damage (Figure 7-24).
3. Inspect piston dust boot and bushings for tears or deterioration.
4. Inspect caliper cable bracket for looseness, damage, and rotation.
5. Thoroughly clean and inspect rotor for heat checks, discoloration, pitting, or scoring (Figure 7-23).

***CAUTION**: Ensure that grease and oil are not in contact with rotor and/or brake pad friction surface. Failure to do so will result in damage to equipment and poor performance.*

NOTE: Replace brake pads in sets only. If operation in wet and muddy conditions are expected, replace brake pads if brake lining thickness is less than 1/8 in. (3.2 mm).

6. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace both pads and pads on opposite caliper.

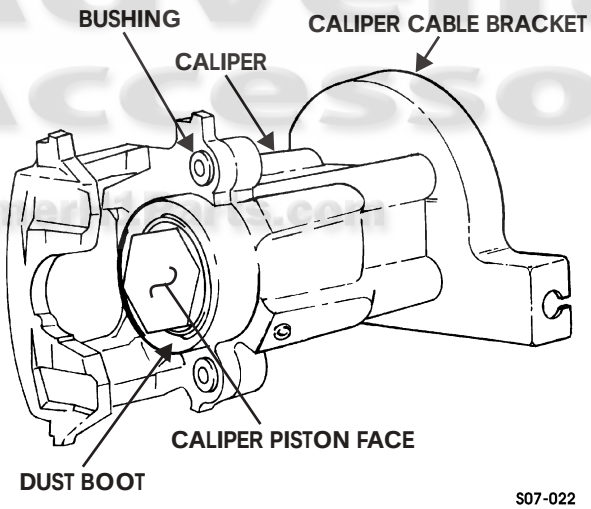

Figure 7-24: Rear Dual Brake Caliper

Installation

WARNING: Ensure brake pads are installed with linings facing rotor. Failure to do this will cause poor performance and damage to equipment and may result in injury.

1. Position linings facing rotor in adapter (Figure 7-23).

NOTE: Always apply thread-locking compound to the tapped holes.

2. Apply thread-locking compound to tapped holes of adapter.
3. Rotate caliper piston in a clockwise direction, and at the same time apply force on outer piston face until caliper piston is seated in piston bore (Figure 7-24).
4. Position caliper and yoke on adapter and rotor. Secure yoke to adapter with two washers and capscrews. Using a crowsfoot, tighten capscrews to 40 lb-ft (54 N•m) (Figure 7-23).
5. Install parking brake cable to caliper cable bracket and secure with clip (Figure 7-25).

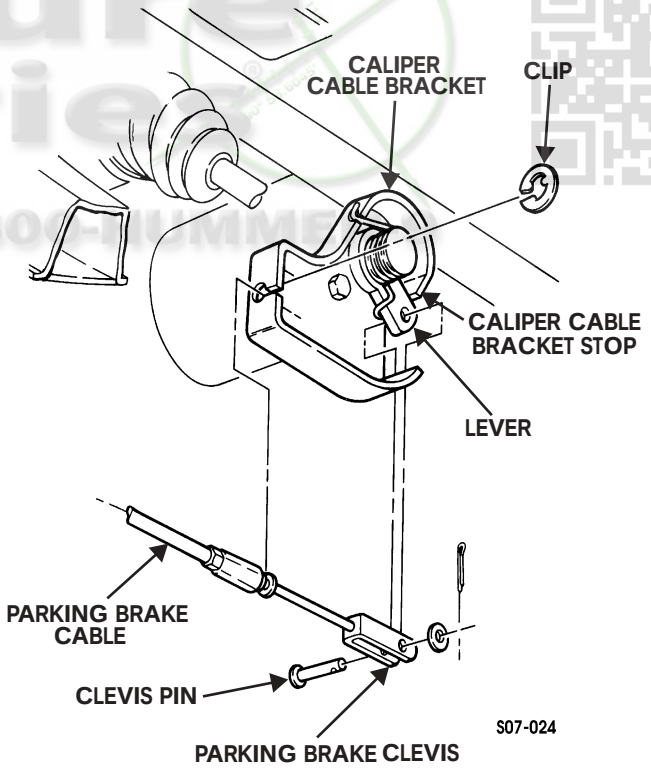

Figure 7-25: Rear Dual Brake Caliper Cable

***CAUTION**: Ensure lever is in contact with caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly. Ensure that clevis and clevis pin are aligned to the lever. Do not move lever to accommodate a maladjusted clevis. Damage to equipment and poor performance will result.*

6. Install parking brake clevis to lever with clevis pin, washer, and cotter pin. Check position of lever and ensure it is in contact with caliper cable bracket stop.
7. Adjust rear dual service/parking brake.

REAR DUAL SERVICE/PARKING BRAKE CALIPER REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, and clevis pin securing parking brake clevis to lever. Discard cotter pin (Figure 7-25).
3. Remove clip and parking brake cable from caliper cable bracket. Discard clip.
4. Disconnect brake line from coupling (Figure 7-26).
5. Remove coupling and copper washer from caliper.

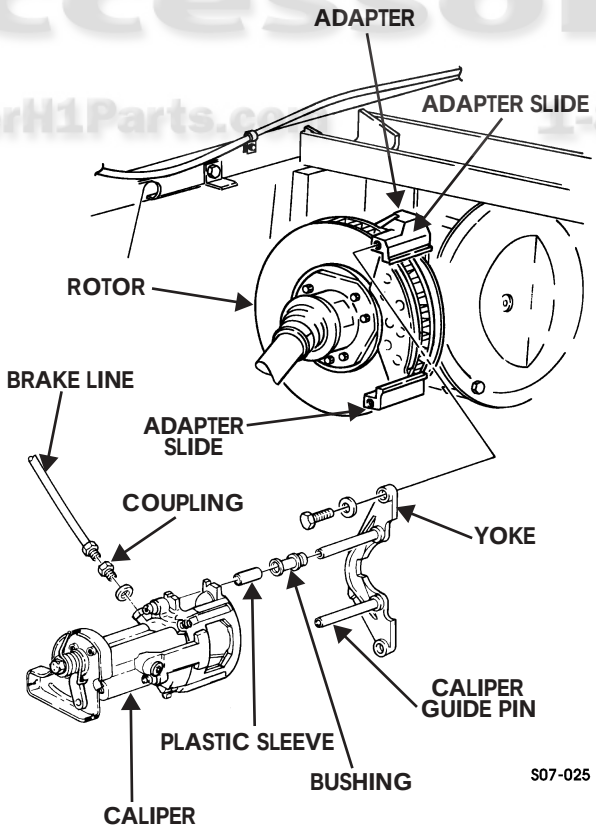

Figure 7-26: Rear Dual Brake Components

***CAUTION**: Caliper must be supported during removal to prevent damage to brake line.*

6. Remove two capscrews, washers, yoke, and caliper from adapter.
7. Slide yoke and caliper guide pins out from caliper.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary. Apply a light coat of grease on adapter slides.

1. Clean mating surfaces of caliper and adapter and lubricate adapter slides with silicone grease (Figures 7-25 and 7-27).
2. Inspect caliper and caliper piston face for pitting or damage (Figure 7-28).
3. Inspect caliper cable bracket for looseness, damage, and rotation
4. Inspect piston dust boot and bushing for tears or deterioration.
5. Clean cooling fins of rotor (Figure 7-26).
6. Inspect rotor for heat checks, discoloration, pitting, or damage.
7. Inspect yoke and caliper guide pins for corrosion. Perform step 8 if corroded, if not, perform step 9.
8. Remove caliper guide pins from yoke. Discard caliper guide pins.
9. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace both pads and pads on opposite caliper.

***CAUTION:** Ensure that grease and oil are not in contact with rotor and/or brake pad friction surfaces. Failure to do so will result in damage to equipment and poor performance.*

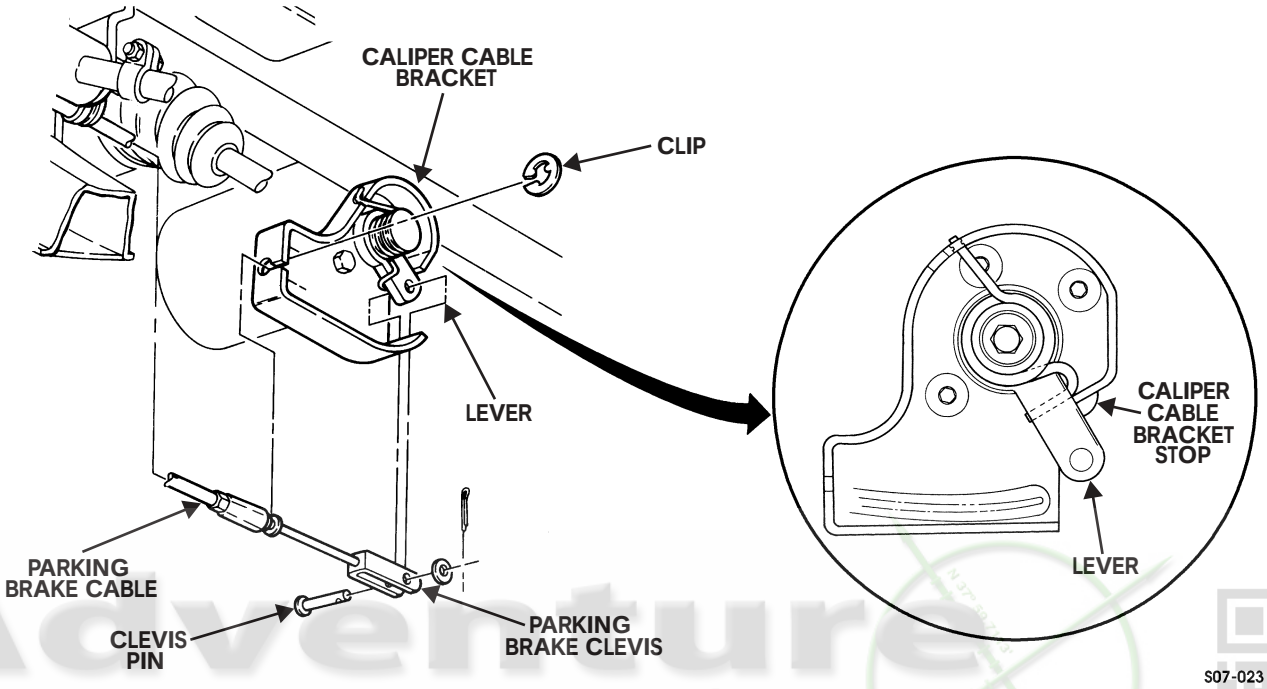

Figure 7-27: Rear Dual Service/Parking Brake Caliper Cable Bracket

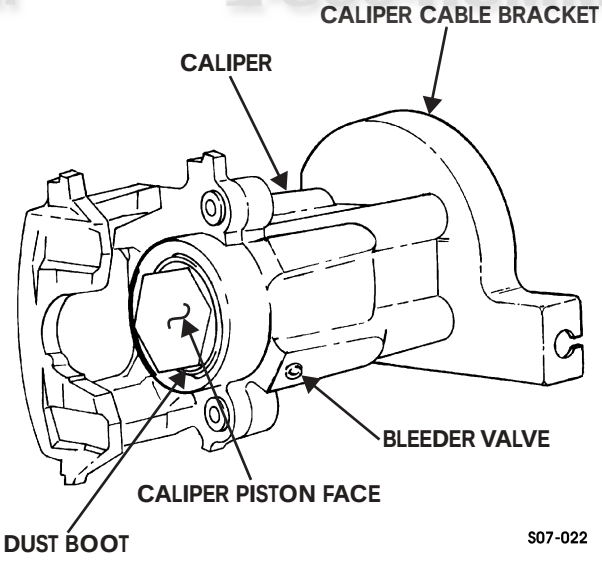

Figure 7-28: Rear Caliper and Bleeder Valve

Installation

1. Open bleeder valve and depress piston into caliper while rotating piston in a clockwise direction, and at the same time apply pressure until piston is seated in piston bore (Figure 7-28).

NOTE: Perform step 2 only if caliper guide pins were replaced.

2. Apply thread-locking compound to threads of caliper guide pins and install caliper guide pins in yoke. Tighten caliper guide pins to 30 lb-ft (41 N•m) (Figure 7-29).
3. Clean caliper guide pins and slide yoke and caliper guide pins into caliper
4. Apply thread-locking compound to tapped holes of adapters.
5. Position caliper and yoke on adapter and rotor. Install caliper and yoke on adapter with two washers and capscrews. Using crowfoot, tighten capscrews to 40 lb-ft (54 N•m).
6. Install copper washer and coupling on caliper and connect brake line to coupling.
7. Install parking brake cable on caliper cable bracket and secure with clip (Figure 7-27).

***CAUTION**: Ensure lever is in contact with caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly. Ensure that clevis and clevis pin are aligned to lever. Do not move lever to accommodate a misadjusted clevis, or damage to equipment and poor performance will result.*

8. Install parking brake clevis on lever and secure with clevis pin, washer, and cotter pin.
9. Check position of lever and ensure it is in contact with caliper cable bracket stop.
10. Bleed brake system.
11. Adjust rear dual service/parking brake.

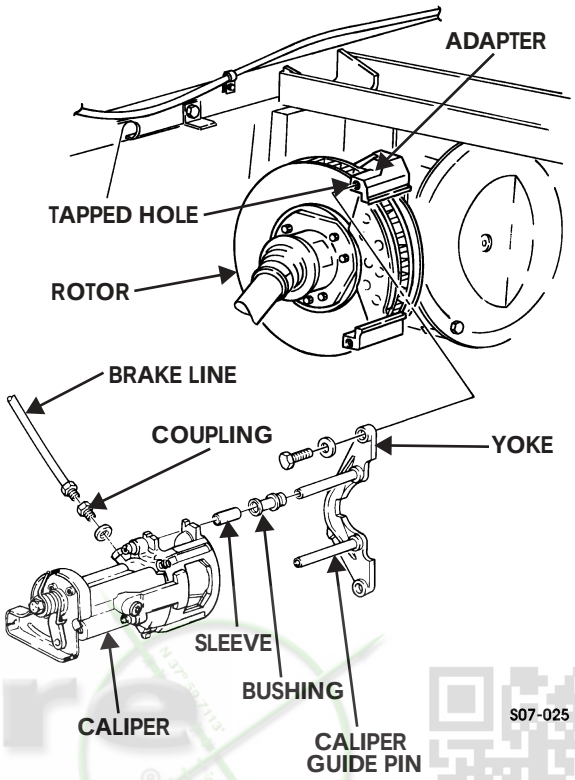

Figure 7-29: Rear Brake Components

RIGHT PARKING BRAKE CABLE REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, clevis pin, and brake clevis from lever. Discard cotter pin (Figure 7-30).
3. Remove clip securing cable sleeve to caliper cable bracket and remove parking brake cable assembly from caliper cable bracket. Discard clip.
4. Slide parking brake cable through parking brake cable assembly. Remove clip securing cable sleeve to C-beam. Disconnect parking brake cable from equalizer bar. Discard clip.
5. Remove two capscrews securing two clamps and parking brake cable assembly to frame.
6. Remove capscrew, lockwasher, and clamp from bracket. Discard lockwasher.

NOTE: Perform step 7 if bracket is damaged. If not replacing bracket, proceed to installation. Note position of cable, bracket, and clamp prior to removal.

7. Remove two capscrews and bracket from support bracket.

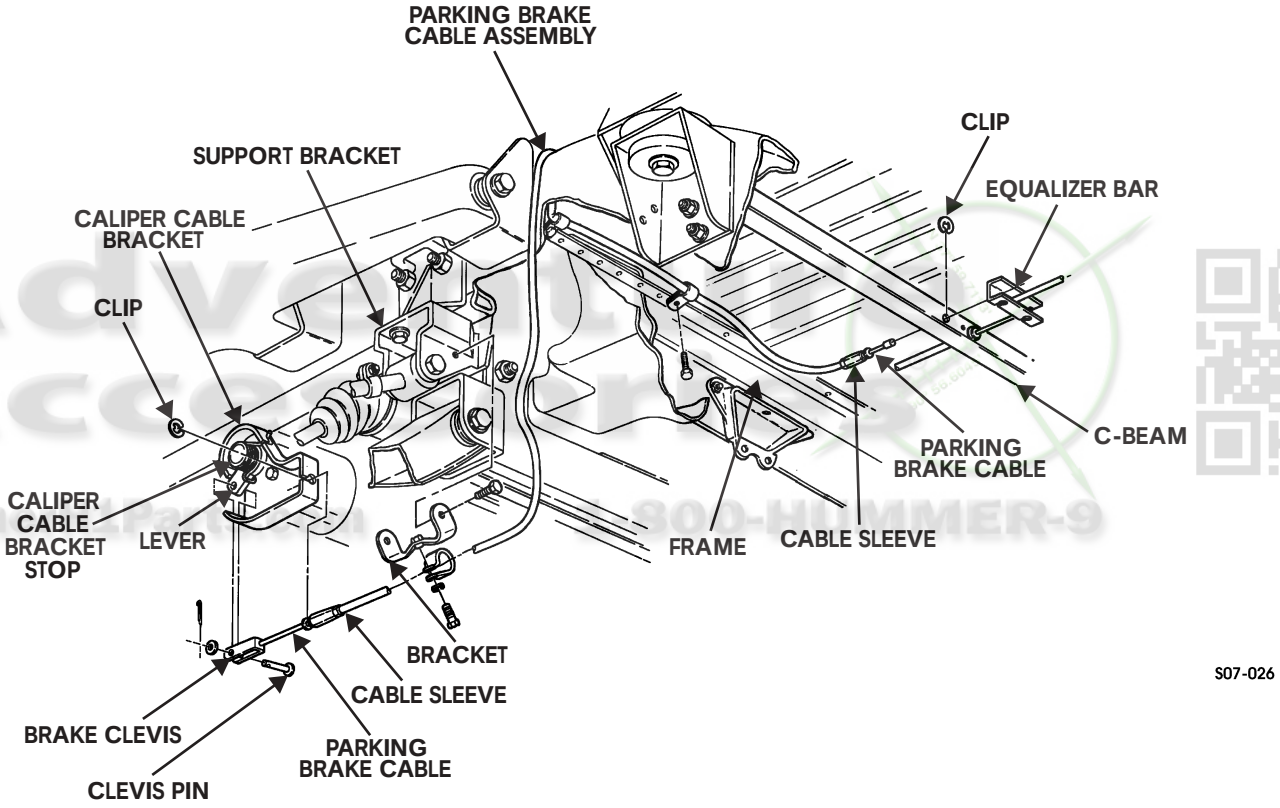

Figure 7-30: Right Parking Brake Cable Components

Installation

NOTE: Perform step 1 if clamp bracket was removed, if not, proceed to step 2.

1. Rotate bracket inward on support bracket and secure with two capscrews.
2. Install clamp on parking brake cable assembly and install clamp to bracket with lockwasher and capscrew.
3. Install two clamps on parking brake cable assembly and install clamps on frame with two capscrews.
4. Install cable sleeve on C-beam and parking brake cable on equalizer bar and secure with cable clip.

***CAUTION**: Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

5. Install cable sleeve on caliper cable bracket with brake cable clip.

6. Install brake clevis on lever with clevis pin, washer, and cotter pin.
7. Adjust parking brake lever.

LEFT PARKING BRAKE CABLE REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, clevis pin, and brake clevis from lever. Discard cotter pin (Figure 7-31).
3. Remove clip and cable sleeve from caliper cable bracket. Discard clip.
4. Slide parking brake cable through parking brake cable assembly. Remove clip securing cable sleeve to C-beam. Disconnect parking brake cable from equalizer bar. Discard clip.
5. Remove capscrew, washer, nut and lockwasher assembly and washer securing clamp to mounting bracket and parking brake cable assembly. Discard nut and lockwasher assembly.
6. Remove capscrew, lockwasher, clamp, and parking brake cable assembly from bracket. Discard lockwasher.

NOTE: Perform step 7 if clamp bracket is damaged. If not replacing bracket, proceed to installation. Note position of cable, bracket, and clamp prior to removal.

7. Remove two capscrews and bracket from support bracket.

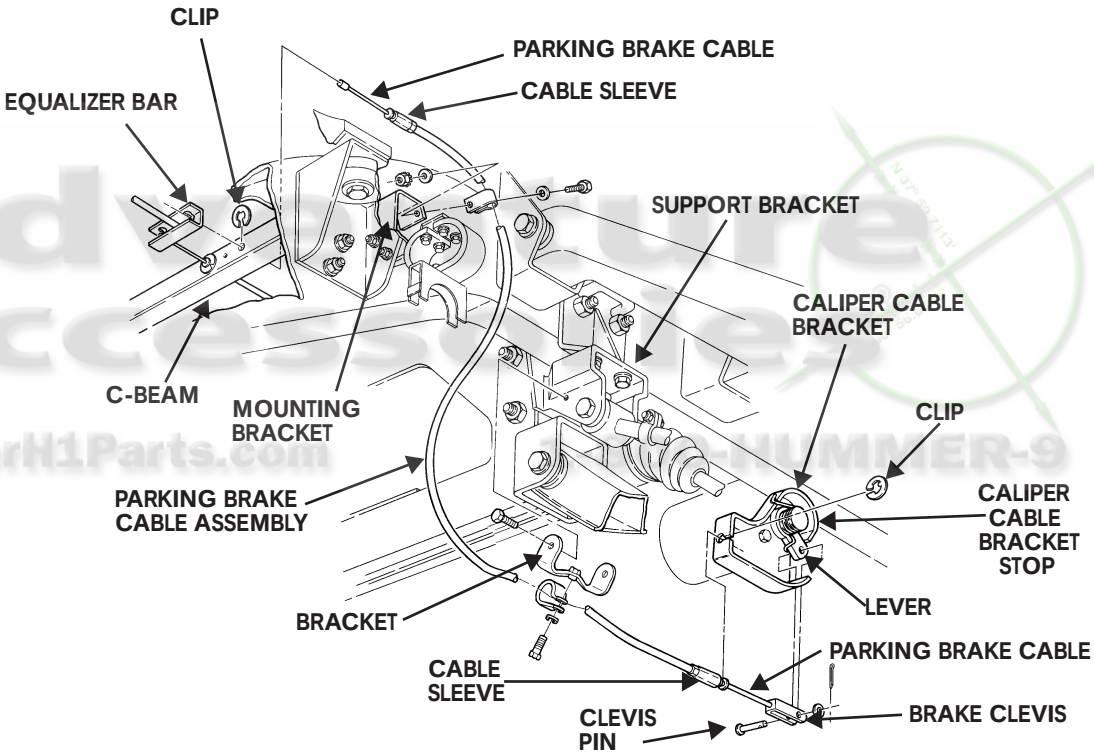

Figure 7-31: Left Parking Brake Cable Components

Installation

NOTE: Perform step 1 if clamp bracket was removed. If not, proceed to step 2.

1. Rotate bracket inward on support bracket and secure with two capscrews (Figure 7-31).
2. Install clamp on parking brake cable assembly and bracket with lockwasher and capscrew.
3. Install clamp on parking brake cable assembly and mounting bracket with washer, capscrew, washer, and nut and lockwasher assembly.
4. Install cable sleeve on C-beam and parking brake cable to equalizer bar and secure with clip.

***CAUTION**: Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

5. Install cable sleeve on caliper cable bracket with clip.
6. Install brake clevis on lever with clevis pin, washer, and cotter pin.
7. Adjust parking brake lever.

REAR DUAL SERVICE/PARKING BRAKE ROD REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, clevis pin, and brake clevis from lever. Discard cotter pin (Figure 7-32).
3. Remove six clips and spread boot to allow access to cotter pin (Figure 7-33).
4. Remove cotter pin, washer, clevis pin, and clevis securing brake rod to bellcrank. Discard cotter pin.
5. Disconnect spring from bracket.
6. Remove locknut from conical washer, and brake rod from equalizer bar. Discard locknut.
7. Remove clevis, nut and spring from brake rod.

Installation

1. Install spring, nut, and clevis on brake rod.
2. Install brake rod on equalizer bar with conical washer and locknut. Tighten locknut far enough to expose 3-5 threads on the end of brake rod.
3. Connect spring to bracket.
4. Spread boot and install clevis to bellcrank with clevis pin, washer and cotter pin.
5. Install six clips on boot.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop.*

6. Install brake clevis on lever with clevis pin, washer, and cotter pin (Figure 7-34).
7. Adjust rear dual service/parking brake.

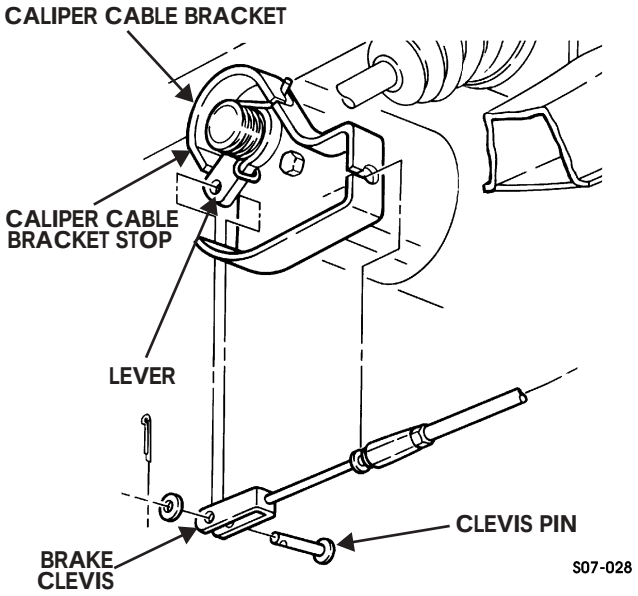

Figure 7-32: Rear Dual Brake Rod

REAR DUAL SERVICE/PARKING BRAKE ADJUSTMENT

NOTE: The integral parking/service brake mechanism has an automatic adjusting feature and does not require periodic manual adjustment. When parking brake components or rear brake pads are replaced, the parking brake linkage must be initially positioned to ensure proper parking brake system operation. The only additional adjustment necessary is accomplished with the parking brake hand lever.

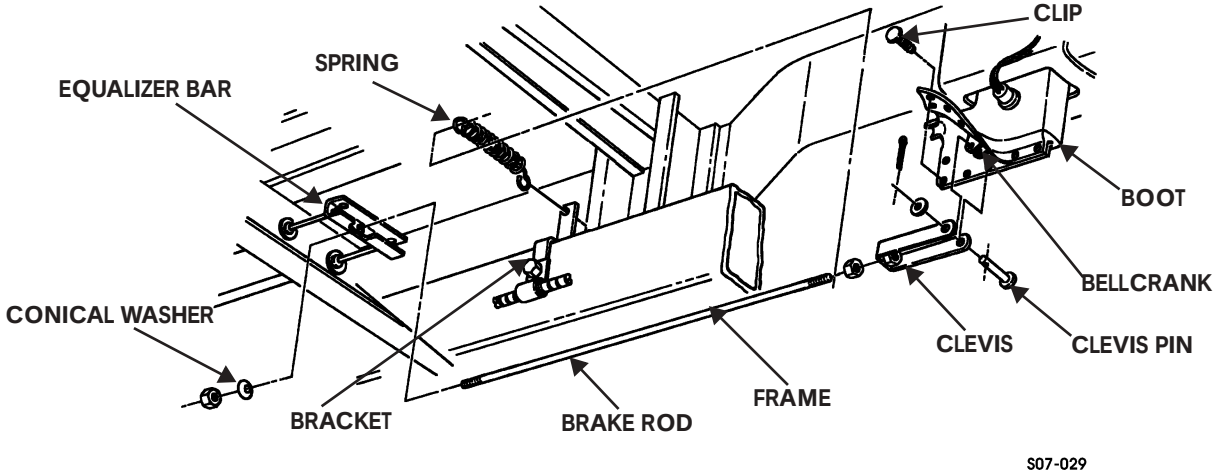

Figure 7-33: Rear Service/Parking Brake Rod Location

Adjustment

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove six clips and spread boot to allow access to cotter pin (Figure 7-34).
3. Remove cotter pin, washer, and clevis pin securing clevis to bellcrank. Discard cotter pin.
4. Repeatedly apply and adjust parking brake hand lever until bellcrank linear travel is 0.75 in. (19 mm).

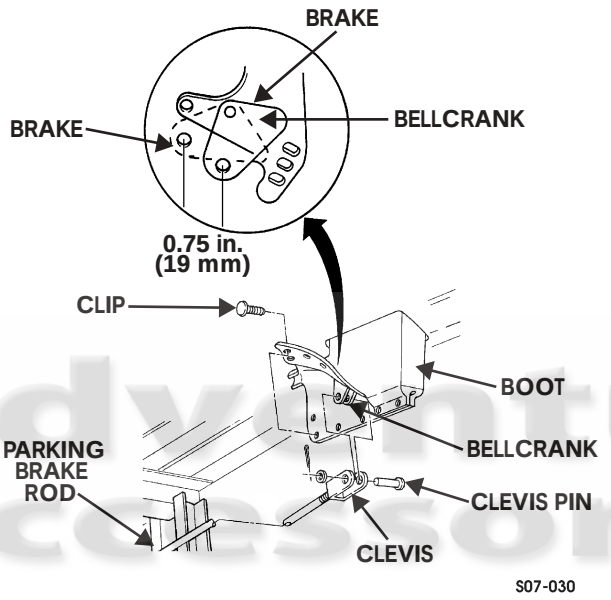

Figure 7-34: Rear Dual Brake

***CAUTION**: Holes in parking brake clevis must align with holes in adjusting bellcrank without force for proper parking brake adjustment. Failure to do this may result in damage to equipment and poor performance.*

5. Release parking brake. Loosen nut and adjust clevis so holes in clevis align with holes in bellcrank. Secure clevis to bellcrank with clevis pin, washer, and cotter pin.

***CAUTION**: Do not overtighten parking brake rod. Overtightening parking brake rod may result in dragging brakes.*

6. If necessary, remove excess slack in parking brake cables by turning the parking brake rod clockwise or counterclockwise into the clevis.

***CAUTION**: Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

NOTE: Perform step 7 on both sides of vehicle.

7. Parking brake rod is properly adjusted if lever is in contact with caliper cable bracket stop (Figure 7-36).
8. Tighten nut against clevis.
9. Install six clips in boot (Figure 7-34).
10. Adjust parking brake lever.

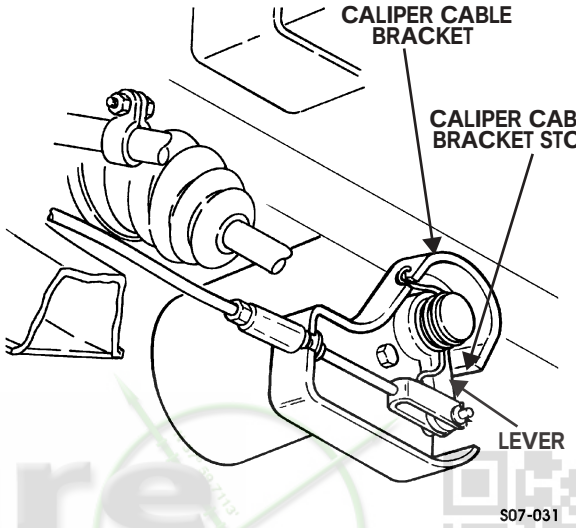

Figure 7-35: Caliper Cable Bracket Stop

PARKING BRAKE LEVER REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove parking brake switch.
3. Remove six clips and open lower boot to allow access to clevis pin. Discard clips (Figure 7-35).
4. Remove cotter pin, washer, and clevis pin from clevis and bellcrank. Discard cotter pin.
5. Remove nut and lockwasher assembly, wiring harness clamp, nut and lockwasher assembly, and capscrew securing parking brake lever to body. Discard nut and lockwasher assemblies (Figure 7-38).
6. Remove three locknuts, washers, and capscrews securing parking brake lever to body. Discard locknuts.
7. Remove two locknuts, washers, capscrews, and washers securing parking brake lever to body and remove parking brake lever. Discard locknuts.
8. Remove upper boot from parking brake lever.
9. Remove boot from body.

Installation

1. Install boot on body. Install upper boot on parking brake lever.
2. Install parking brake lever on body and secure with two washers, capscrews, washers, and locknuts.
3. Secure parking brake lever on body with capscrew, nut and lockwasher assembly, wiring harness clamp, and nut and lockwasher assembly.
4. Secure parking brake lever on body with three capscrews, washers, and locknuts (Figure 7-37).
5. Apply parking brake lever and tighten three capscrews to 96 lb-in. (11 N•m).
6. Install clevis on bellcrank with clevis pin, washer, and cotter pin (Figure 7-36).

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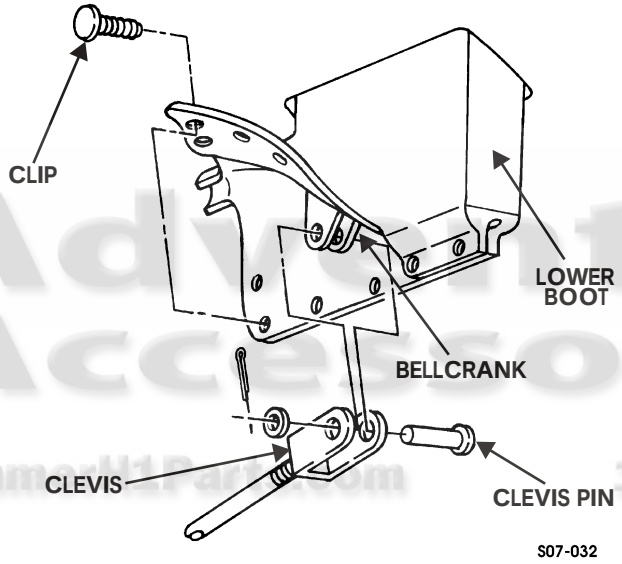

Figure 7-36: Parking Brake Lever

7. Install six clips and close lower boot.
8. Install parking brake switch.
9. Adjust parking brake lever.

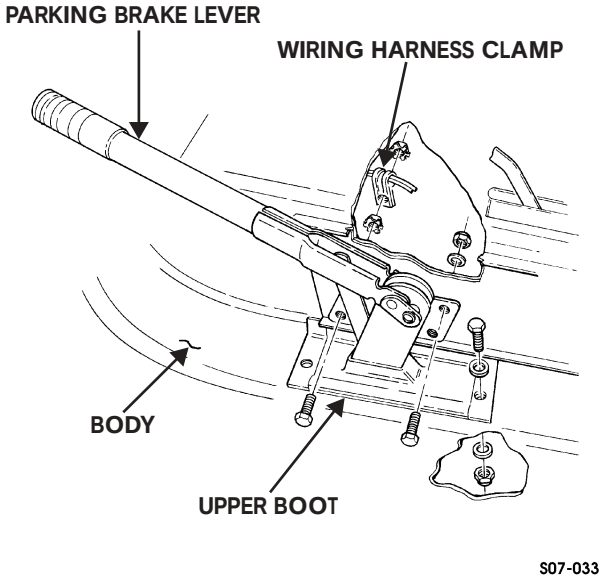

Figure 7-37: Parking Brake Lever Assembly

FRONT DISC BRAKE CALIPER REPAIR

Disassembly

1. Remove disc brake caliper.

WARNING: To avoid injury, hold caliper so piston is facing away from your body and keep fingers out of space between piston and wood block. Compressed air used for cleaning should not exceed 30 psi (207 kPa).

2. Insert wood block between jaw of caliper and piston (Figure 7-38).
3. Remove piston from caliper by applying air pressure to hose inlet of caliper.
4. Remove piston dust boot and seal from caliper bore. Discard dust boot and seal (Figure 7-39).
5. Remove bleeder screw from caliper.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary (Figure 7-39).

1. Inspect caliper bore for scoring, nicks, or corrosion. Minor corrosion can be polished with abrasive crocus cloth or hone. Replace caliper if bore is not repairable.
2. Inspect piston outside diameter for scoring, nicks, corrosion, and worn or damaged chrome plating. Replace piston if there are any surface defects.
3. Inspect bleeder screw for damage or stripped threads. Replace if damaged.
4. Inspect bushing for damage. Replace if damaged.

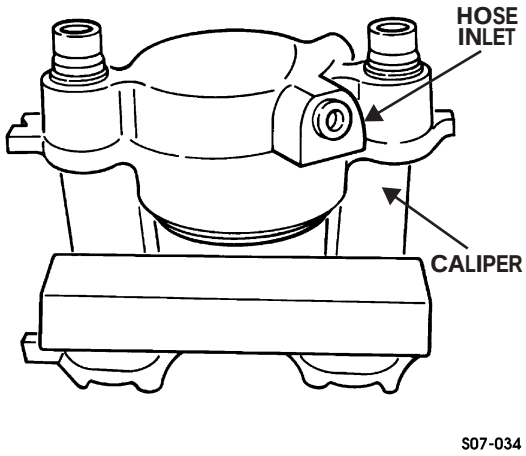

Figure 7-38: Front Disc Brake Caliper

Assembly

***CAUTION**: The HUMMER is equipped with DOT 5 silicone brake fluid. **Do not mix with other brake fluids**. Failure to use the proper brake fluid will damage brake system.*

NOTE: For general assembly instructions, refer to Section 1.

1. Lubricate caliper bore and seal with Dow Corning 111 or 103 silicone lubricant or equivalent (Figure 7-39).
2. Install seal in groove of caliper bore.
3. Lubricate piston with Dow Corning 111 or 103 silicone lubricant or equivalent and install dust boot on piston.
4. Work piston and dust boot into caliper bore.
5. Seat dust boot in caliper.
6. Install bleeder screw in caliper finger tight.
7. Install disc brake caliper.

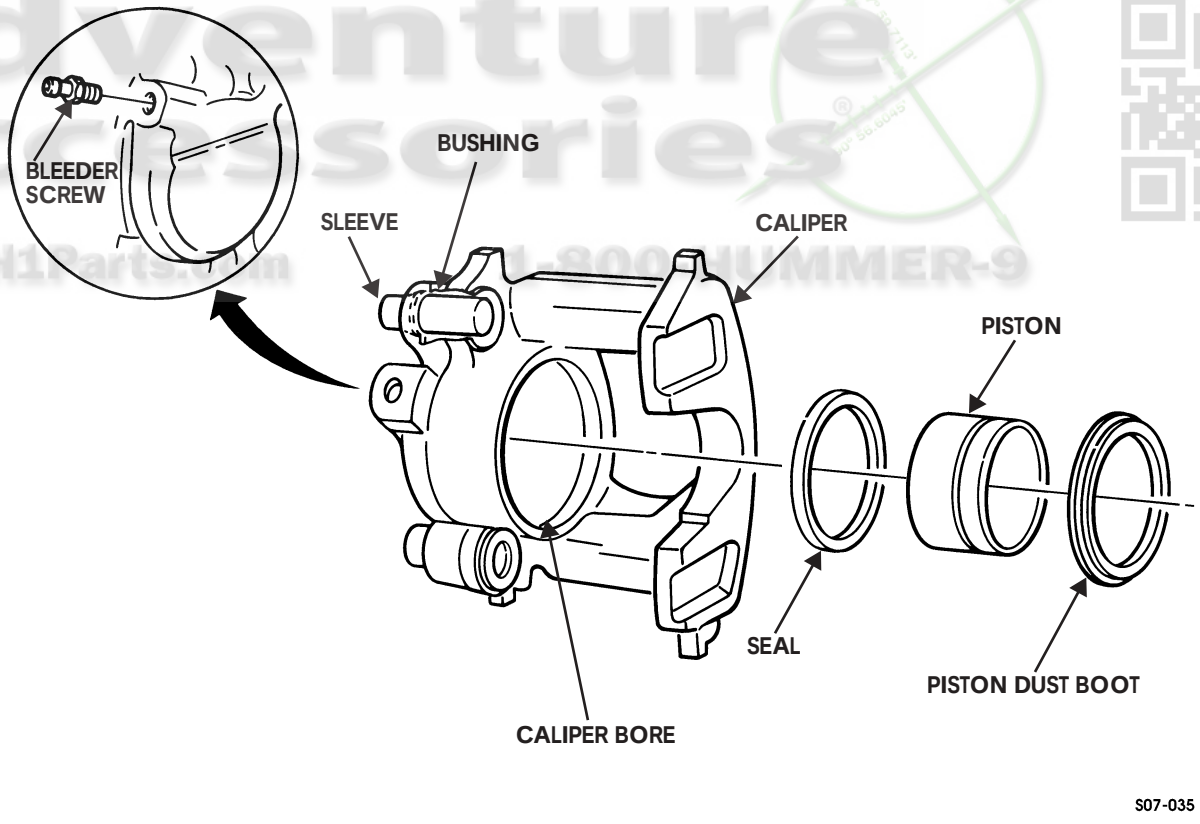

Figure 7-39: Front Disc Brake Caliper Assembly

REAR CALIPER OVERHAUL

Rear Caliper Disassembly (Figure 7-40)

1. Mount caliper in vise so parking brake lever and spring are facing upward.
2. Unseat and remove parking brake lever spring. Use large gripping pliers such as Craftsman Robo-Grip or Channel-Lock.
3. Remove bolt that secures lever retainer to thrust screw. Then remove retainer, but do not remove parking brake lever at this time.
4. Remove caliper piston as follows:
   a. Remove dust cover. Remove piston retaining screw with hex key and pencil magnet. Use magnet to withdraw screw after loosening it.
   b. Extend piston by rotating parking brake lever.
   c. Rotate caliper piston in counter-clockwise direction until it comes off thrust screw. Rotate piston by hand, or with spanner wrench positioned on piston flats.
   d. Pull piston out of dust boot and remove it from caliper.
5. Remove piston dust boot with pry tool.

***CAUTION**: Exercise care when removing the boot. Do not allow the pry tool to scratch the caliper piston bore.*

6. Remove thrust screw retaining ring. Carefully unseat ring with long, thin, flat blade screwdriver. Apply single wrap of electrical tape around screwdriver blade to avoid scratching bore, or thrust screw spring shield.
7. Grasp thrust screw and slide screw, shield, and spring out of bore as assembly. Rotate brake lever to assist removal.
8. Remove parking brake lever from actuator shaft.
9. Remove actuator shaft bearing balls with pencil magnet.
10. Remove thrust screw centering pin plug and spacer. Then reach inside caliper piston bore and push centering pin out of caliper with finger pressure.
11. Push bearing plate and actuator shaft out of caliper bore using finger pressure.
12. Remove caliper piston seal from groove in piston bore. Use wood pencil to remove seal. Do not use metal tools that will scratch bore.
13. Remove and discard actuator shaft dust seal. Discard seal.
14. Remove and discard centering pin plug O-ring.
15. Remove and discard centering pin O-ring.
16. Remove O-ring from actuator shaft. Then remove thrust bearing and race from shaft. Discard O-ring but retain bearing and race if in good condition.
17. Disassembly caliper piston as follows:
    a. Remove retaining ring with internal type ring pliers.
    b. Remove wave washer.
    c. Remove thrust washer and bearing.
    d. Remove cone clutch.

Caliper Cleaning and Inspection

Clean the caliper parts in standard parts cleaning solvent, or denatured alcohol. Dry the parts with compressed air or lint free shop towels.

Replace the caliper piston if corroded, rusted, or scored. Do not attempt to salvage any piston where rust or scoring has broken through the piston plating. Also, do not use any type of abrasive material on the piston surface. This practice will damage the plating and cause the piston to stick or seize in the bore.

Check condition of the caliper piston bore. Moderate surface discoloration is normal and not a cause for replacement. However, the caliper should be replaced if the bore is corroded, pitted, or scored. The bore can be lightly polished with crocus cloth but must not be honed or sanded.

Inspect the thrust screw and actuator shaft parts. Replace the thrust screw, spring shield, and retaining ring if damaged, or distorted. Replace the actuator shaft, bearing plate, and bearing balls if scored, cracked, worn, corroded, or pitted. Also replace the shaft bearing and race as a set if either part is worn, rough, pitted, or scored.

Replace the caliper piston cone clutch, bearing and race, or wave washer if worn, scored, or damaged.

Assembly (Figure 7-40)

1. Install new actuator shaft dust seal in caliper. Use one-inch socket to seat seal in housing. The open portion of seal metal retainer faces out. Lubricate seal lip with Dow Corning 111 silicone lubricant afterward.
2. Lubricate actuator shaft, bearings, race, and plate with Dow Corning silicone lubricant 111. Then install thrust bearing and race on shaft and secure with new O-ring.
3. Install actuator shaft in caliper. Then install plastic bearing plate and the three ball bearings.
4. Install new O-ring on thrust screw centering pin and install pin in caliper. Position pin so blade will align with slot in thrust screw.
5. Lubricate thrust screw with Dow Corning 111 silicone grease. Then install spring and retaining ring on thrust screw.
6. Install thrust screw as follows:

   a. Align slot in thrust screw with centering pin.

   b. Insert thrust screw in caliper and seat it on centering pin and on ball bearings.

   c. Compress thrust screw retaining ring with fingers and install it in caliper bore below piston seal groove.

***CAUTION**: Do not use metal tools to install the retaining ring. Metal tools will score or scratch the caliper bore.*

   d. Push assembly into bore as far as possible.

   e. Seat retaining ring using unassembled caliper piston. Lightly coat piston with silicone grease and insert it in bore. Then push piston sharply downward two or three times to seat retaining ring. Remove piston after ring is seated.

7. Install new O-ring on centering pin plug. Then position spacer on top of centering pin and install plug. Tighten plug securely with hex wrench or socket.
8. Install new caliper piston seal. Start square cut seal into groove at top of bore and work it into place with your fingers. Lubricate seal and bore with fresh brake fluid, or Dow Corning silicone grease.
9. Assembly caliper piston as follows;

   a. Install cone clutch in piston.

   b. Lubricate bearing and race with Dow Corning 111 grease and install them on cone clutch. The open side of bearing goes toward race.

   c. Install wave washer (either side up).

   d. Install retaining ring with internal-type ring pliers. Flat side of ring goes toward wave washer.

10. Install caliper piston as follows:

   a. Install new dust boot on caliper piston.

   b. Lubricate caliper piston with fresh brake fluid. Then insert it through dust boot, into caliper bore, and onto thrust screw.

   c. Install parking brake lever on actuator shaft and rotate lever to extend thrust screw.

   d. Rotate piston onto thrust screw by hand, then with suitable size socket.

   e. Turn parking lever to normal (non-applied) position and complete piston installation as needed.

   f. Seat piston dust boot in groove at top of caliper bore. Use suitable size boot installer tool or flat punch.

11. Install new O-ring on piston retaining screw and install screw. Tighten screw securely.
12. Install parking brake lever retainer and bolt. Apply 1-2 drops Loctite to bolt threads before installation.
13. Install and seat parking brake lever return spring in cable housing slot.
14. Install bleed screw, if removed. Apply anti-seize compound to screw threads beforehand.

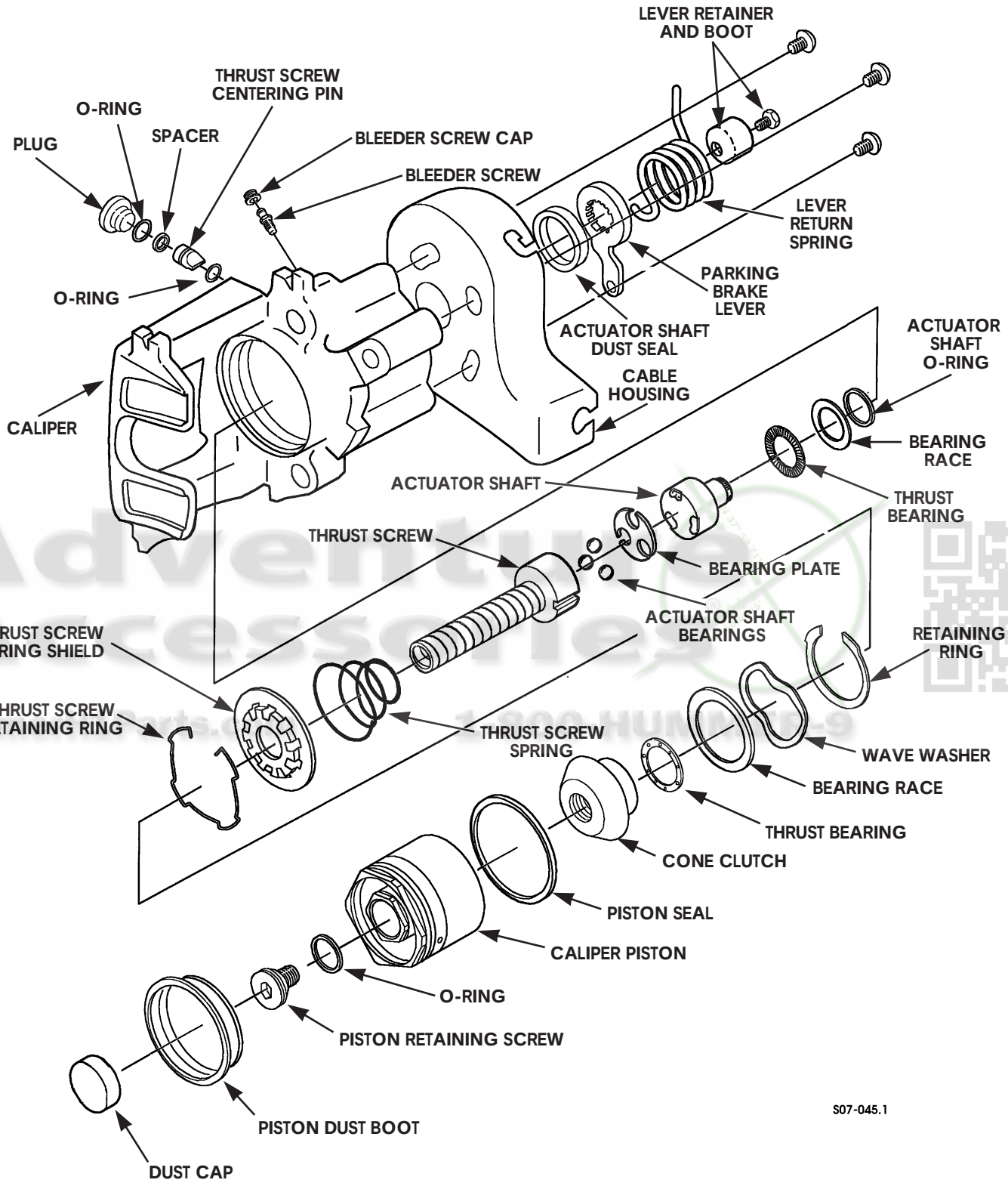

Figure 7-40: Rear Caliper

BRAKE ROTOR

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary (Figure 7-41).

1. Remove brake rotor.

NOTE: Clean rusted or scaled rotor braking surfaces before attempting inspection or measurement.

2. Mount rotor in brake lathe and turn while cleaning surfaces with abrasive crocus cloth.
3. Inspect rotor for heat checks, nicks, broken cooling fins, scoring, discoloration, and pitting. It is not recommended that rotors be turned when spotted or heat checked.

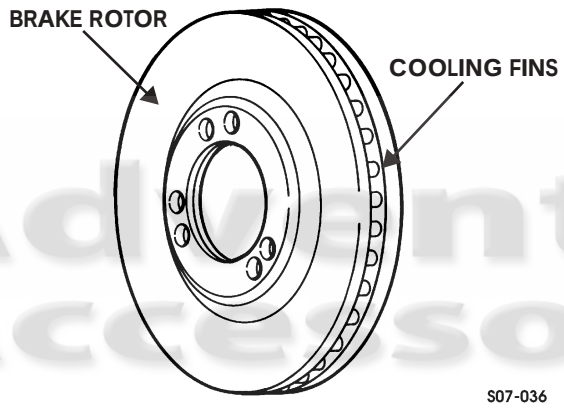

Figure 7-41: Brake Rotor and Cooling Fins

NOTE: Clean debris from cooling fins if necessary.

REFINISHING BRAKE ROTORS

Refinish rotors only under the following circumstances:

1. There is a complaint of brake pulsation.
2. There is excessive scoring.

Brake rotors have a minimum thickness dimension cast into them. This dimension is the minimum wear dimension and not a refinish dimension. Do not use a brake rotor that will not meet the dimensions shown in the specifications.

Accurate control of rotor tolerances is necessary for the proper performance of disc brakes. Machining should be done only with precision equipment. Service the machining equipment on a regular basis following the manufacturer's recommended maintenance procedures.

When you refinish rotors, make sure the attaching adapters, tool holders, vibration dampeners, and tool bits are in good condition. Always use sharp cutting tools or bits and use only replacement cutting bits recommended by the equipment manufacturer. Dull or worn tools leave a poor surface finish that will affect initial brake performance. Vibration dampening attachments should always be used when refinishing braking surfaces. These attachments eliminate tool chatter to allow for a better surface finish. Make sure these adaptors are clean and free of nicks.

Checking Lateral Runout

1. Mount dial indicator with stylus contacting rotor surface 1 in. (25 mm) in from outer edge (Figure 7-42).
2. Turn rotor 360° and note total indicator reading (TIR).

If lateral runout exceeds 0.004 in. (0.10 mm) TIR, replace or refinish rotor.

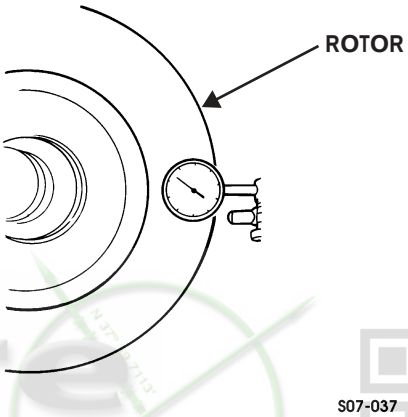

Figure 7-42: Checking Rotor for Lateral Runout

Checking Thickness Variation

1. Measuring thickness variation of rotor with micrometer at four equally-spaced points around rotor. Measure 1 in. (25 mm) in from outer edge (Figure 7-43).

NOTE: Rotor must be replaced if minimum thickness falls below 0.815 in. (20.7 mm).

2. If thickness variation exceeds 0.005 in. (0.13 mm), replace or refinish rotor.

Refinishing

1. Mount rotor on brake lathe and refinish surface.
2. Replace rotor if refinishing causes rotor to fall below minimum thickness of 0.815 in. (20.7 mm).
3. Install brake rotor.

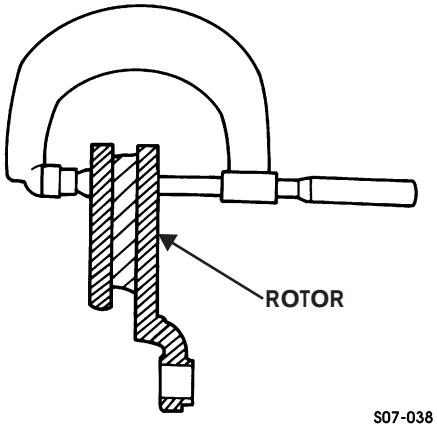

Figure 7-43: Checking Rotor Thickness

PARKING BRAKE LEVER ADJUSTMENT

Adjustment

1. Adjust linkage.
2. Put transmission in PARK, chock wheels, and release parking brake handle.
3. Turn adjusting knob clockwise as tightly as possible by hand (Figure 7-44).

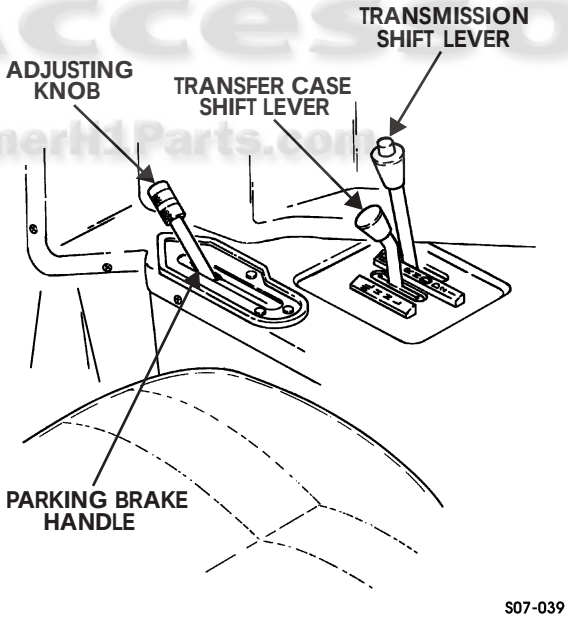

Figure 7-44: Parking Brake Lever Location

4. Apply parking brake handle.
5. If parking brake cannot be applied, turn adjusting knob counterclockwise until parking brake can be applied.
6. Test parking brake.
   a. Remove chocks.
   b. Depress service brake pedal and start engine.
   c. Place transfer case shift lever in “H” (high) and transmission shift lever in “D” (drive).
   d. Slowly let up on service brake pedal. Parking brake should hold vehicle stationary.

***CAUTION**: The HUMMER is equipped with DOT 5 silicone brake fluid. **Do not mix with other brake fluids**. Failure to use the proper brake fluid will damage brake system.*

NOTE: After operating in mud or sand, use a low pressure water source to ensure that the parking brake pads, rotor, pad-rotor contact areas, actuating lever, and spring are thoroughly cleaned of mud, sand, or other debris. Lubricate actuating lever as soon as possible (Figure 7-45).

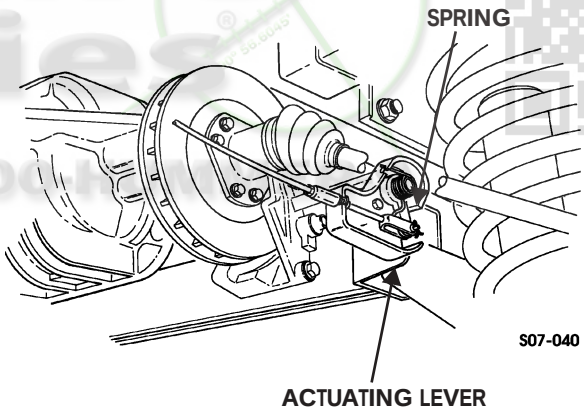

Figure 7-45: Spring and Actuating Lever for Parking Brake

PARKING BRAKE SWITCH REPLACEMENT

Removal

1. Disconnect the two harness leads from the switch leads (Figure 7-46).
2. Remove the switch from the parking brake lever.

Installation

1. Install the switch on the parking brake lever (Figure 7-46).
2. Connect two switch leads to the harness leads.
3. Ensure parking brake switch operates properly.

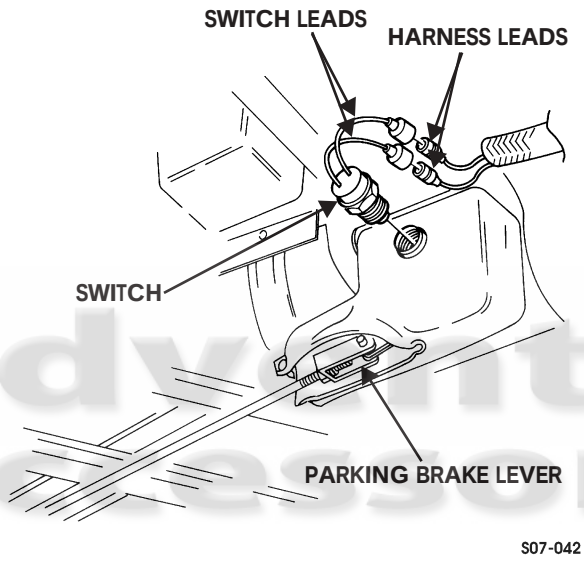

Figure 7-46: Parking Brake Switch

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Section 8 Steering System

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STEERING SYSTEM DESCRIPTION

Power steering systems are designed to reduce steering effort by using hydraulic pressure to enhance the normal torque developed by the steering gearbox (Figure 8-1).

The hydro-boost converts hydraulic power (from the power steering pump) into mechanical power and diverts it to the master cylinder where it provides power assist during braking.

The power steering pump provides hydraulic oil pressure to operate the brake system's hydro-boost feature. The power steering cooler directs power steering fluid through a series of fins or baffles so outside air can dissipate excess heat before the fluid is recirculated through the steering system.

The standard power steering system on the HUMMER allows the driver to enjoy a more responsive steering system with less effort. The steering linkage is fairly typical with the exception of the steerable geared hubs. The geared hub enables a gear reduction of 1.92:1 at the wheel end. This allows for smaller and lighter components and provides an additional 4 inches of ground clearance.

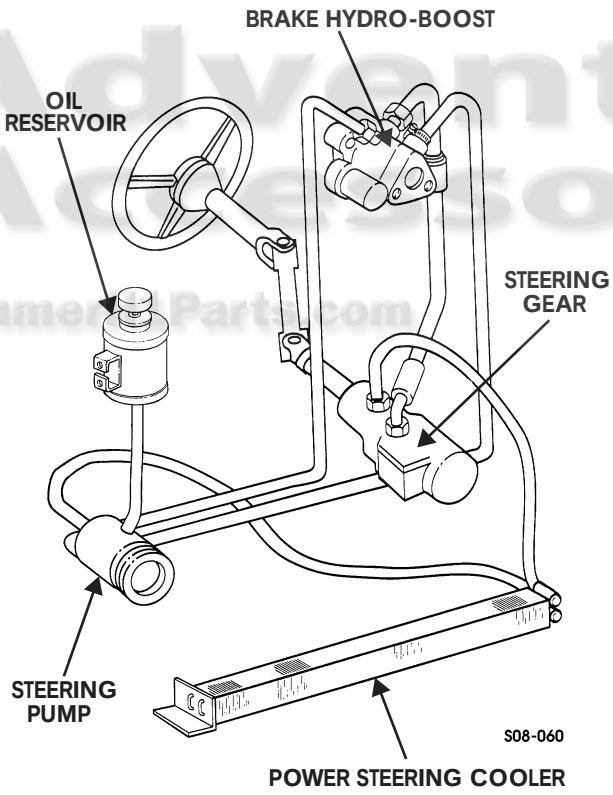

Figure 8-1: Steering System

DIAGNOSIS AND TROUBLESHOOTING

Hard Steering

1. Check for correct tire pressure. Adjust tire pressure.
2. Check power steering fluid level. Refer to lubrication chart (Section 1). If low, fill to proper level and check for leaks.
3. Check drivebelt for frays, cracks, or fluid contamination. Replace if damaged or contaminated.
4. Check serpentine belt tension.
5. Lubricate steering linkage, steering shaft, and check for damage. Refer to lubrication chart (Section 1). Replace any damaged components.
6. Check power steering system using power steering analyzer and analyzer adapter.
   a. Disconnect high pressure hose from hydro-boost leading to power steering pump and connect analyzer to hydro-boost and high pressure hose. Open valve on analyzer.
   b. Check fluid level in power steering pump and add if necessary.
   c. Connect tachometer for purpose of recording engine rpm in step h.
   d. Start engine and allow to idle. Check for leaks at connections.
   e. Record pump pressure and flow. Pressure should be 140-170 psi (965-1172 kPa) and flow should be 2.5-2.75 gpm (9.5-10.4 Lpm).
      (1) If pressure or flow is too low, check for restriction in pressure line from power steering pump.
      (2) If pressure is too high, check for restriction in pressure line from hydro-boost to steering gear. If no restrictions are found, replace power steering pump.
   f. Partially close valve on analyzer so pressure increases to 200 psi (1379 kPa) and record flow. Subtract this flow rate from flow rate obtained in step e. If there is more than 1 gpm (3.8 Lpm) difference in flow rates, replace power steering pump.

***CAUTION**: Do not leave valve fully closed for more than 5 seconds or pump damage will result.*

   g. Close and partially open valve on analyzer three times; record highest pressure reading each time. All three readings must be 1300 psi (8964 kPa) or above. If not, replace power steering pump.
   h. Open valve on analyzer and increase engine speed to 1500 rpm. Record flow. If flow varies more than 1 gpm (3.8 Lpm) from flow rate recorded in step f, replace power steering pump.

Excessive Play In Steering

1. Check for correct tire pressure. Adjust tire pressure.
2. Raise vehicle and support under lower control arms. Check for looseness in upper and lower ball joints by grasping tires at top and bottom outer edges and moving in and out.
   a. Replace upper ball joints if movement at top outer edge of tire is 3/8 in. (10 mm) or more.
   b. Replace lower ball joints if movement at bottom outer edge of tire is 1/2 in. (13 mm) or more.
3. Raise and support vehicle under frame. Secure steering wheel. Check for looseness in idler arm and steering arm by grasping tires at front and rear outer edges and moving in and out.
   a. Replace idler arm if vertical motion at center link exceeds 5/16 in. (8 mm), or if ball stud lateral motion exceeds 1/32 in. (0.8 mm).
   b. Replace steering arm if vertical motion at center link exceeds 1/8 in. (3 mm), or if ball stud lateral motion exceeds 1/32 in. (0.8 mm).

NOTE: Worn, missing, or damaged control arm bushings affect braking and steering, and can cause noise in suspension during operation.

4. Check for worn, missing, or damaged rubber bushings in control arms. Replace both bushings in control arm if one is defective. Recheck wheel alignment after bushing replacement.

***CAUTION**: Do not loosen slotted nut to install cotter pin. Doing this may cause damage to equipment.*

5. Check tie rod or radius rod to geared hub steering arm mounting. Remove and discard cotter pin. Back off ball stud nut and retorque to 80 lb-ft (108 N•m). If cotter pin hole is not aligned with nut slots, advance nut until cotter pin can be installed. Install cotter pin. Check for free play. If free play is evident, replace worn part.
6. Check front wheel alignment.

Increase In Steering Effort When Turning From Lock-to-Lock Conditions

1. Check power steering fluid level. If low, fill to proper level and check for leaks (Section 1).
2. Purge air from power steering system.
3. Check serpentine belt tension.
4. Check steering gear mounting capscrews for looseness. Torque capscrews to 60 lb-ft (81 N•m).
5. Check pump pressure and flow. Refer to *Hard Steering*, step 6.
6. Lubricate steering linkage, steering shaft, and ball joints.

STEERING ARM REPLACEMENT

NOTE: Ensure front wheels are in straight-ahead position while steering arm is removed and installed.

Removal

1. Raise and support front of vehicle.
2. Remove nut, lockwasher, and steering arm from steering gear shaft. Discard lockwasher (Figure 8-2).
3. Remove cotter pin and slotted nut from steering arm. Discard cotter pin.
4. Using puller, remove steering arm from center link.

Installation

1. Install steering arm on steering gear shaft with lockwasher and nut (Figure 8-2).

2. Install steering arm on center link with slotted nut. Tighten slotted nut to 80 lb-ft (108 N•m).
3. Tighten nut on steering gear shaft to 185 lb-ft (251 N•m).

***CAUTION**: Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

4. Install cotter pin in slotted nut.
5. Lubricate steering arm.
6. Remove supports and lower front of vehicle.
7. Inspect wheel alignment.

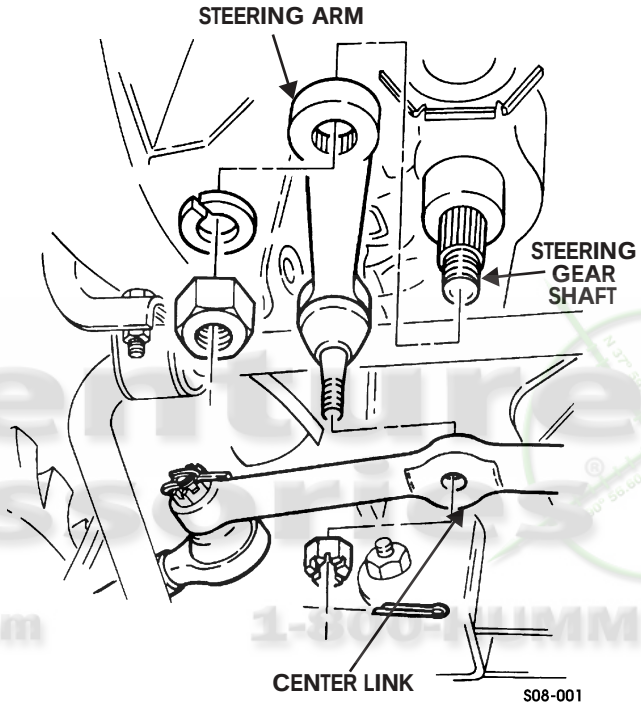

Figure 8-2: Steering Arm

CENTER LINK REPLACEMENT

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin and slotted nut securing idler arm to center link. Discard cotter pin (Figure 8-3).
3. Remove cotter pin and slotted nut securing steering arm to center link. Discard cotter pin.
4. Remove two cotter pins and slotted nuts securing two tie rods to center link. Discard cotter pins.
5. Using puller, remove center link from two tie rods, idler arm, and steering arm.

Installation

***CAUTION**: Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

1. Install center link on steering arm and idler arm with two slotted nuts. Tighten slotted nuts to 80 lb-ft (108 N•m) (Figure 8-3).
2. Install two cotter pins in slotted nuts.
3. Install two tie rods to center link with two slotted nuts. Tighten slotted nuts to 70 lb-ft (95 N•m).
4. Install two cotter pins in slotted nuts.
5. Remove supports and lower front of vehicle.
6. Inspect wheel alignment.

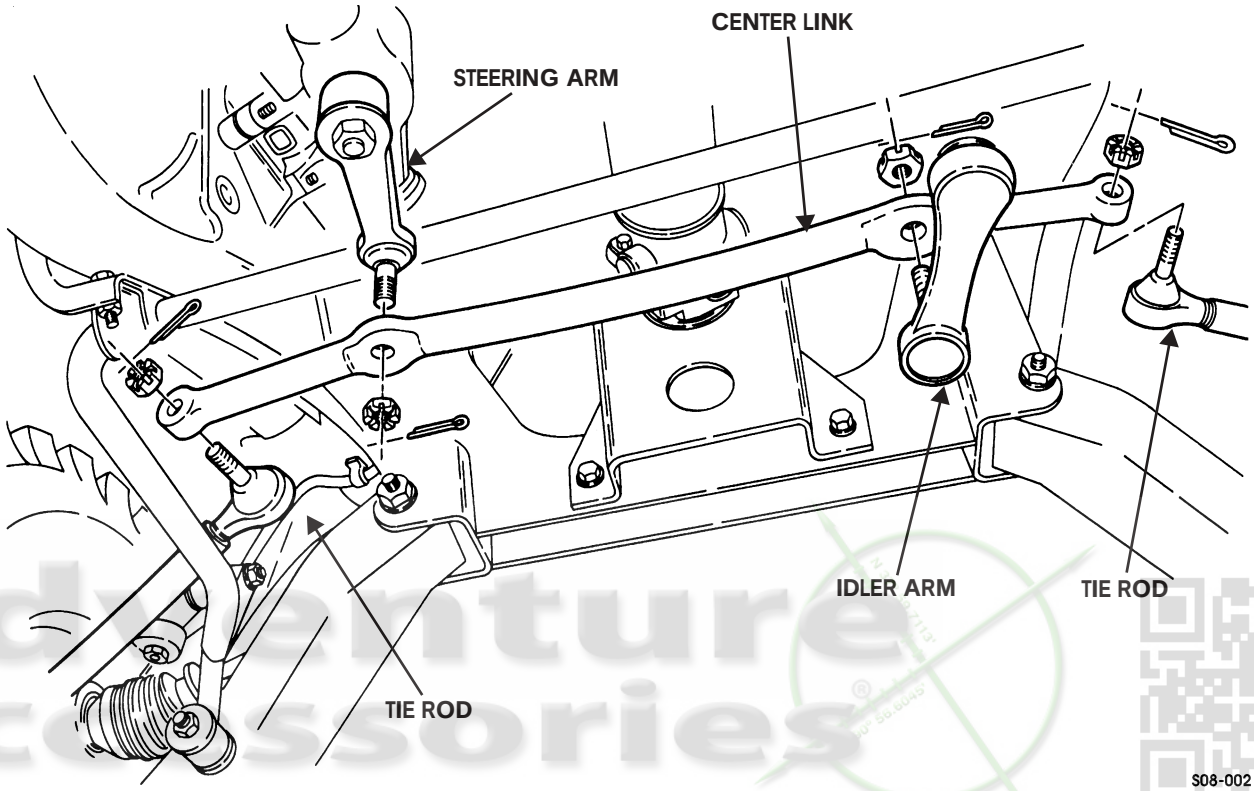

Figure 8-3: Center Link

TIE ROD END REPLACEMENT

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin, slotted nut, and washer securing tie rod end to geared hub. Discard cotter pin (Figure 8-4).
3. Using puller, remove tie rod end from geared hub.

NOTE: Note number of threads exposed on each tie rod end for installation. Approximately the same number of threads should be exposed on each tie rod end.

4. Loosen locknut on clamp securing tie rod end to adjusting sleeve and remove tie rod end (Figure 8-4).

Installation

***CAUTION**: Ensure clamp faces halfshaft or damage to equipment may result.*

1. Install tie rod end into adjusting sleeve and tighten clamp (Figure 8-4).

***CAUTION:** Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

2. Install tie rod end on geared hub with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m) (Figure 8-4).
3. Install cotter pin in slotted nut.
4. Lubricate tie rod end.
5. Remove supports and lower front of vehicle.

6. Align toe-in (Section 6).

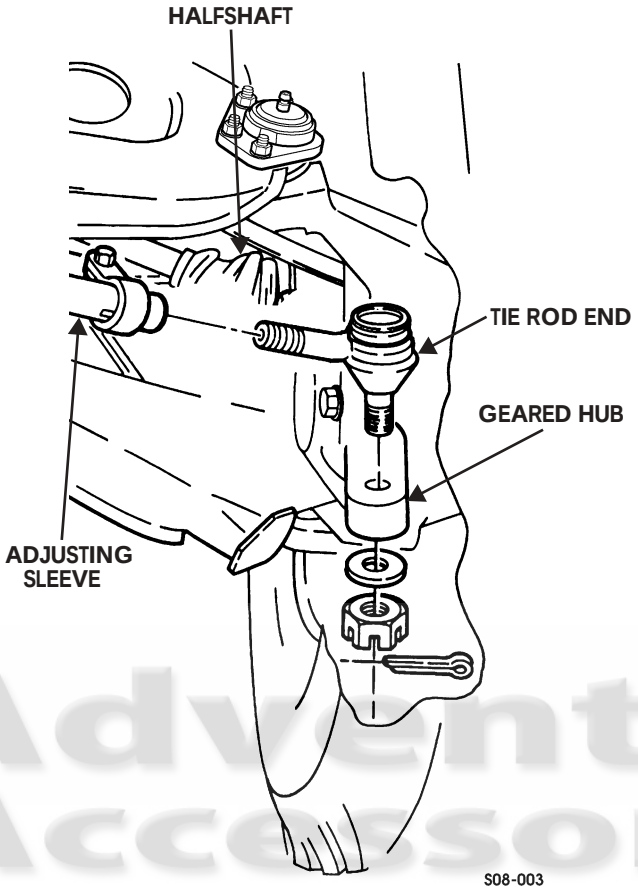

Figure 8-4: Tie Rod End

TIE ROD MAINTENANCE

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin and slotted nut securing tie rod to center link. Discard cotter pin (Figure 8-5).
3. Remove cotter pin, slotted nut, and washer securing tie rod to geared hub. Discard cotter pin.
4. Using puller, remove tie rod from center link and geared hub.

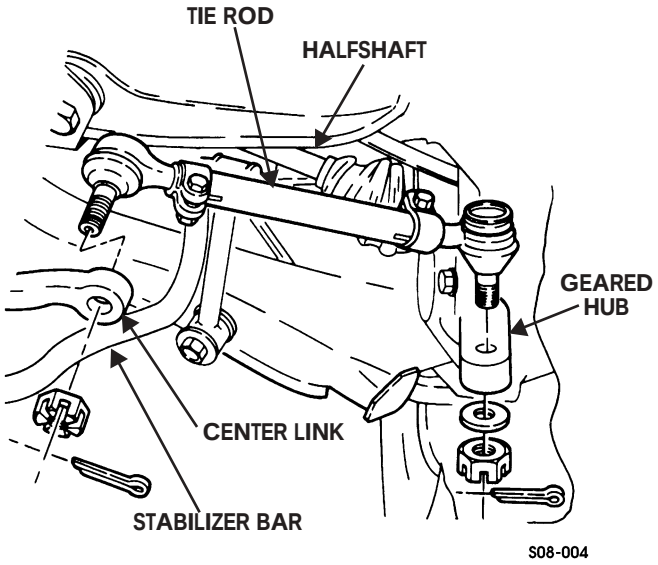

Figure 8-5: Tie Rod

Disassembly

1. Loosen two locknuts and clamps securing tie rod ends to adjusting sleeve (Figure 8-6).

NOTE: Note number of threads exposed on each tie rod end for installation. Approximately the same number of threads should be exposed on each tie rod end.

2. Remove two tie rod ends from adjusting sleeve.
3. Remove two locknuts, capscrews, and clamps from adjusting sleeve. Discard locknuts.

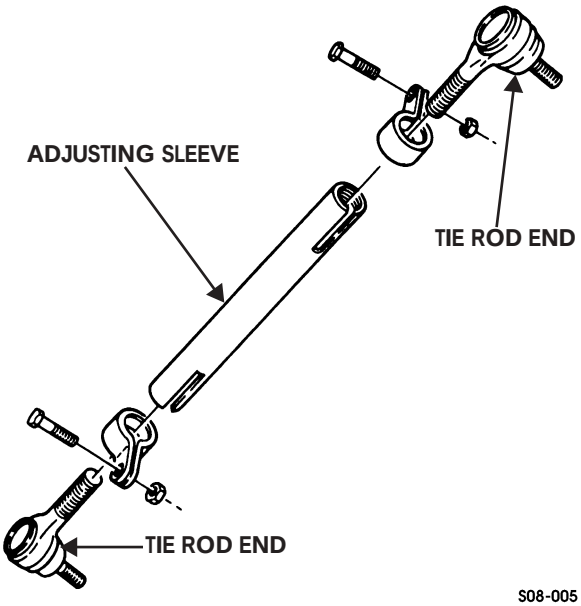

Figure 8-6: Adjusting Sleeve

Assembly

1. Install two clamps, capscrews, and locknuts on adjusting sleeve (Figure 8-6).
2. Install two tie rod ends into adjusting sleeve, turning tie rod ends equally but in opposite directions.

Installation

1. Install tie rod on center link with slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m) (Figure 8-5).

CAUTION: *Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

2. Install tie rod on geared hub with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m).
3. Install cotter pins in slotted nuts.

CAUTION: *Ensure the outboard clamp faces the half-shaft and the inboard clamp faces away from the stabilizer bar (front only) or damage to equipment may result.*

4. Tighten two locknuts on clamps.
5. Lubricate tie rod end.
6. Remove supports and lower front of vehicle.
7. Align toe-in (Section 6).

IDLER ARM REPLACEMENT

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin and slotted nut securing idler arm to center link. Discard cotter pin (Figure 8-7).
3. Using puller, disconnect center link from idler arm.
4. Remove two locknuts, washers, capscrews, washers, and idler arm from frame. Discard locknuts.

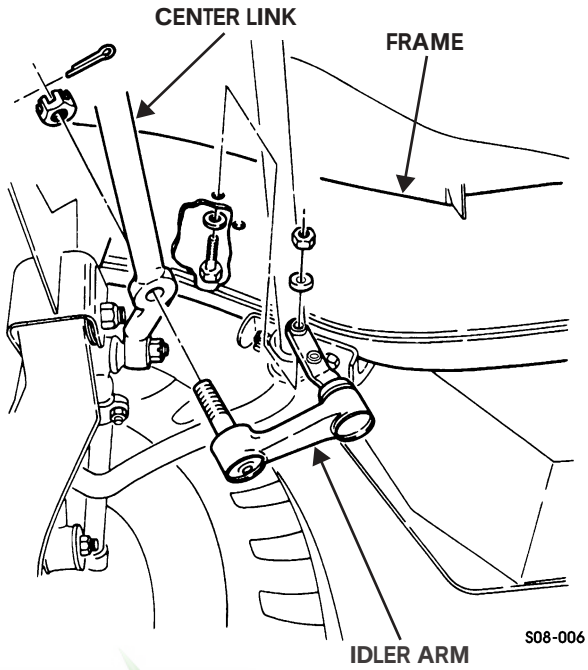

Figure 8-7: Idler Arm

Installation

1. Install idler arm on frame with two washers, capscrews, washers, and locknuts. Tighten locknuts to 60 lb-ft (81 N•m) (Figure 8-7).
2. Install idler arm on center link with slotted nut. Tighten slotted nut to 80 lb-ft (108 N•m).

CAUTION: *Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

3. Install cotter pin in slotted nut.
4. Lubricate idler arm.
5. Remove supports and lower front of vehicle.
6. Inspect wheel alignment.

STEERING WHEEL REPLACEMENT

Removal

1. Remove front cover from steering wheel and rear cover (Figure 8-8).
2. Remove nut securing steering wheel and rear cover to shaft. Discard nut.
3. Using puller, remove steering wheel from shaft.
4. Remove rear cover from shaft.

Installation

NOTE: Ensure front wheels are in a straight ahead position.

1. Install rear cover on shaft (Figure 8-8).
2. Align splines on steering wheel with splines on shaft.
3. Install steering wheel on shaft with nut. Tighten nut to 35 lb-ft (47 N•m).
4. Peen nut.
5. Install front cover on rear cover and steering wheel.
6. Operate vehicle and verify steering wheel alignment is properly timed.

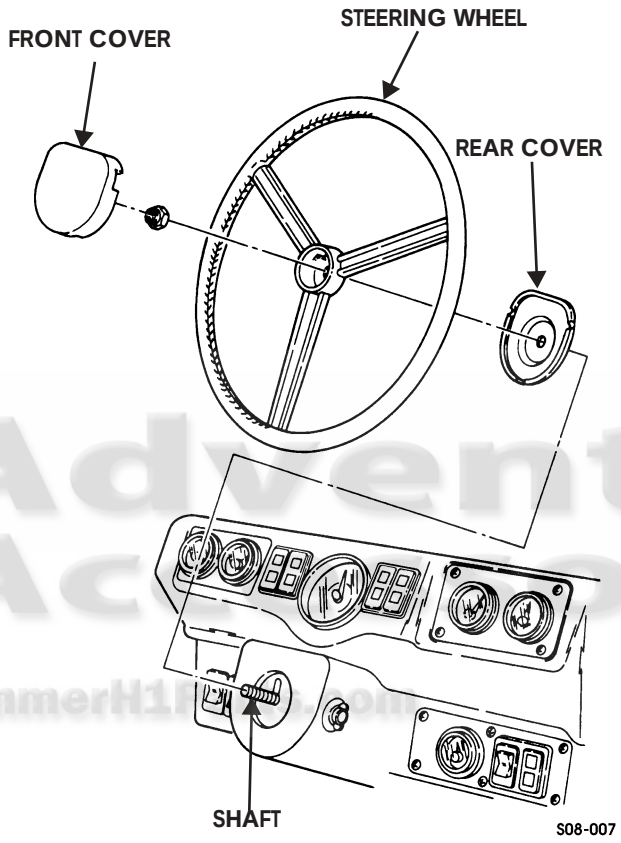

Figure 8-8: Steering Wheel

STEERING COLUMN REPLACEMENT

Removal

NOTE: When performing step 1, turn steering column to gain access to intermediate shaft mounting hardware.

1. Remove steering wheel.
2. Remove close-out panel.
3. Remove locknut, washer, capscrew, and washer securing intermediate shaft to steering column (Figure 8-9).
4. Remove locknut, lockwasher, three washers, and bolt securing steering column to mounting bracket. Discard lockwasher and locknut.
5. Remove two locknuts, washer, shoulder bolts, and steering column from mounting bracket. Discard locknut.
6. Remove five screws and two covers from steering column.
7. Disconnect two multi-switch connectors from multi-switch.
8. Disconnect two ignition switch connectors from ignition switch.
9. Remove multi-switch and ignition switch from steering column.

Installation

1. Install ignition switch and multi-switch on steering column (Figure 8-9).
2. Connect two ignition switch connectors to ignition switch.
3. Connect two multi-switch connectors to multi-switch.
4. Install cover on steering column with five screws.
5. Install steering column on mounting bracket with two shoulder bolts, washers, and locknuts. Finger tighten locknut.
6. Install steering column on mounting bracket with bolt, three washers, lockwasher, and locknut. Finger tighten locknuts.
7. Install intermediate shaft on steering column with washer, capscrew, washer, and locknut. Tighten locknut to 60 lb-ft (81 N•m).
8. Position steering column in upright position and tighten locknut to 31 lb-ft (42 N•m).
9. Tighten shoulder bolt locknuts to 10 lb-ft (14 N•m).
10. Install steering wheel.
11. Install close-out panel.
12. Operate vehicle to verify steering wheel alignment is properly timed.

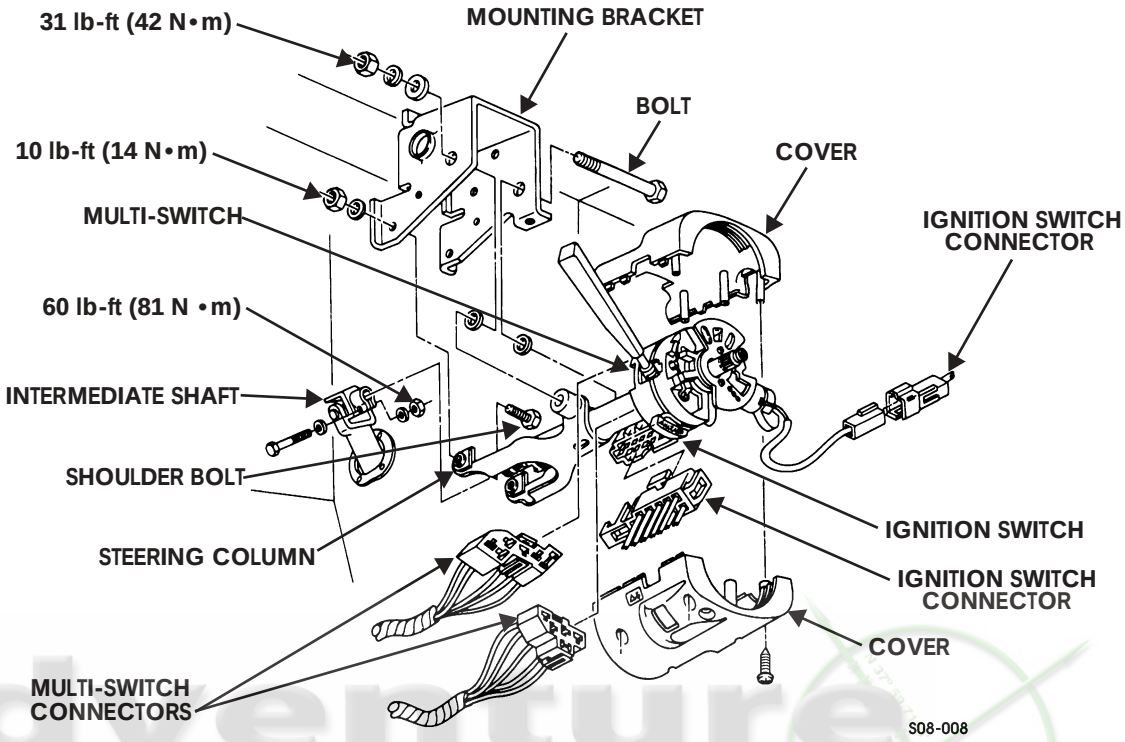

Figure 8-9: Steering Column

STEERING COLUMN MULTI-SWITCH REPLACEMENT

NOTE: This procedure covers the directional signal, horn, high beam, and hazard light switches.

Removal

1. Disconnect battery ground cable.
2. Remove steering column.
3. Remove two screws and multi-switch from steering column (Figure 8-10).
4. Remove control handle from multi-switch.

Installation

1. Install control handle on multi-switch (Figure 8-10).
2. Install multi-switch on steering column with two screws.
3. Install steering column.
4. Connect battery ground cable.

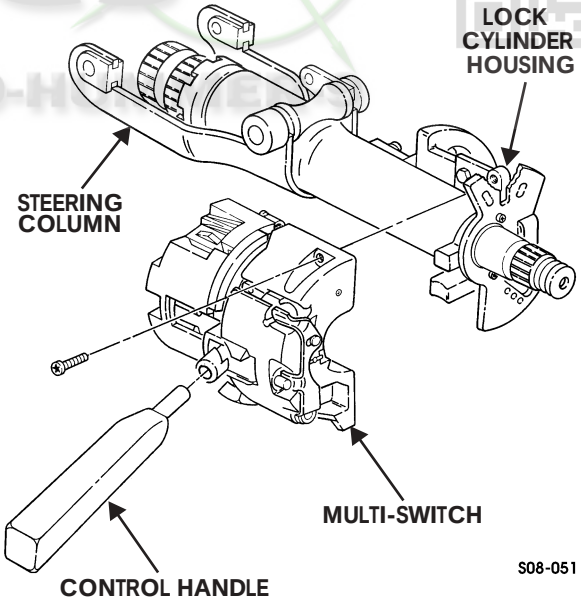

Figure 8-10: Steering Column Multi-Switch

LOCK AND SWITCH HOUSING ASSEMBLY REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove steering column.
3. Remove multi-switch.
4. Remove screw and interlock cable from ignition switch (Figure 8-11).
5. Remove two capscrews and lock and switch housing assembly from steering column.

Installation

1. Apply thread-locking compound to capscrew threads and install lock and switch housing assembly on steering column with two capscrews (Figure 8-11).
2. Install interlock cable on ignition switch with screw.
3. Install multi-switch.
4. Install steering column.
5. Connect battery ground cable.
6. Ensure ignition switch operates properly.

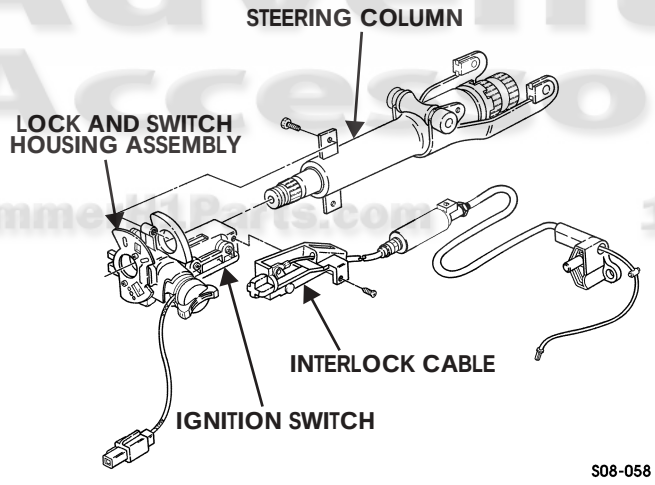

Figure 8-11: Lock and Switch Housing Assembly

STEERING COLUMN REPAIR

Lock And Switch Housing Assembly

Disassembly

NOTE: The key must stay in the ignition switch at all times.

1. Remove the lock cylinder and key assembly from the lock cylinder housing (Figure 8-12).
2. Remove two screws securing the upper retainer plate to the lock cylinder housing. Remove the retainer plate, the upper bearing assembly and upper bearing sleeve from the lock cylinder housing.
3. Remove two screws and the multi-switch assembly from the lock cylinder housing (Figure 8-10).
4. Remove two screws securing the ignition switch assembly to the lock cylinder housing. Remove the ignition switch assembly (Figure 8-12).
5. Remove six stakes from the tube and bracket assembly (Figure 8-13).
6. Remove two screws and remove the lock cylinder housing from the tube and bracket assembly.
7. Remove the retainer ring, shaft, and bearing from the tube and bracket assembly.

Assembly

1. Install the shaft, bearing, and retainer ring into tube and bracket assembly (Figure 8-13).
2. Install the lock cylinder housing on the tube and bracket assembly with two screws. Tighten screws to 6-7 lb-ft (8.1-9.4 N•m).
3. Stake bearing securely in six (6) places (Figure 8-13).
4. Install the ignition switch assembly on the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m) (Figure 8-12).
5. Install the multi-switch assembly on the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m) (Figure 8-10).
6. Install the upper bearing assembly and upper bearing sleeve in the lock cylinder housing (Figure 8-12).
7. Install the retainer plate on the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m).
8. Install the lock cylinder and key assembly in the lock cylinder housing assembly.
9. Ensure ignition switch operates properly.

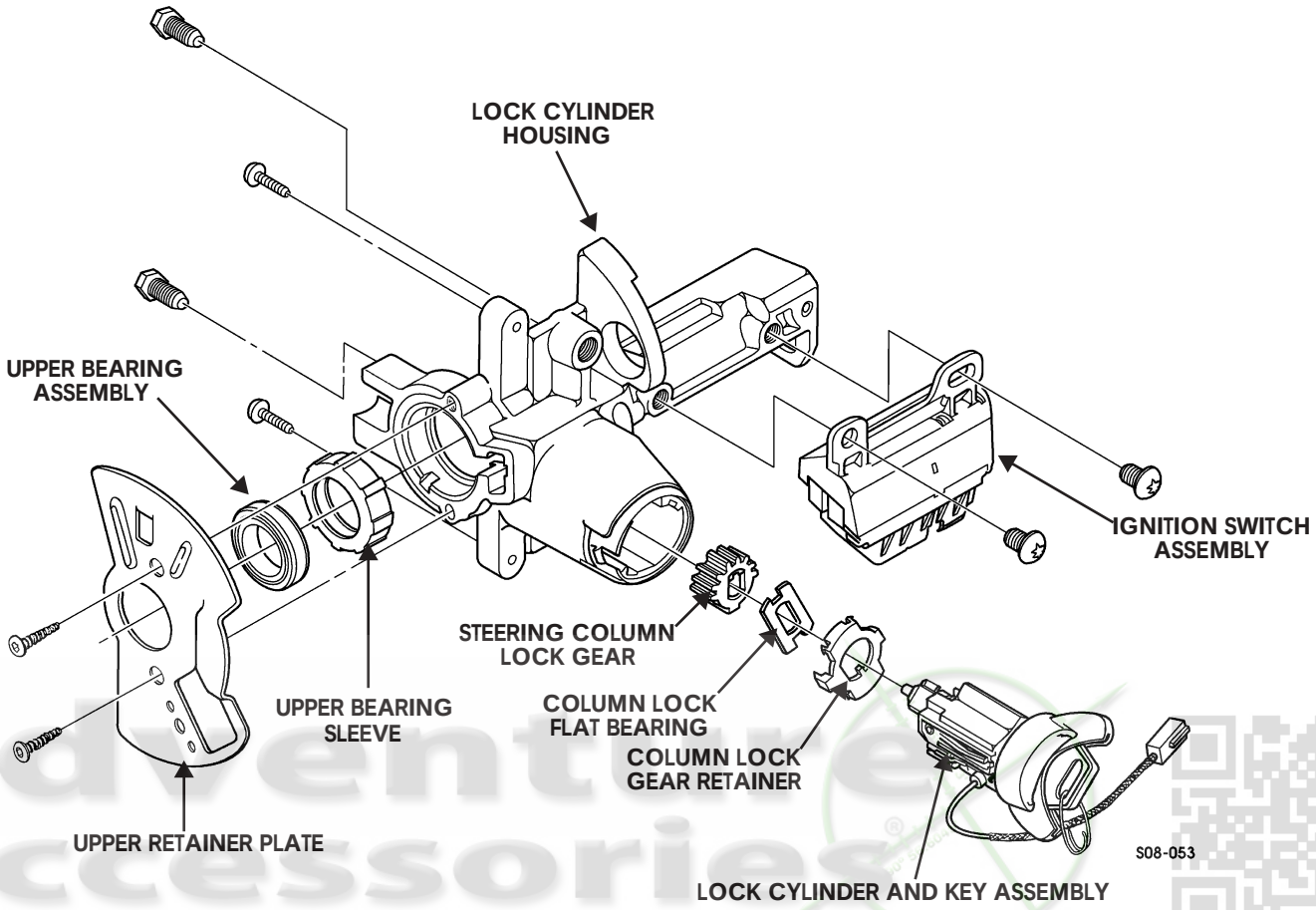

Figure 8-12: Lock And Switch Housing Assembly

Steering Column and Shaft

Disassembly

1. Remove two screws and the multi-switch assembly from the lock and switch housing (Figure 8-10).
2. Remove two screws and lock and switch housing assembly from steering column (Figure 8-11).
3. Remove six stakes from the tube and bracket assembly (Figure 8-13).
4. Remove the shaft, retainer ring, and bearing from tube and bracket assembly.
5. Remove retainer ring and bearing from the shaft.

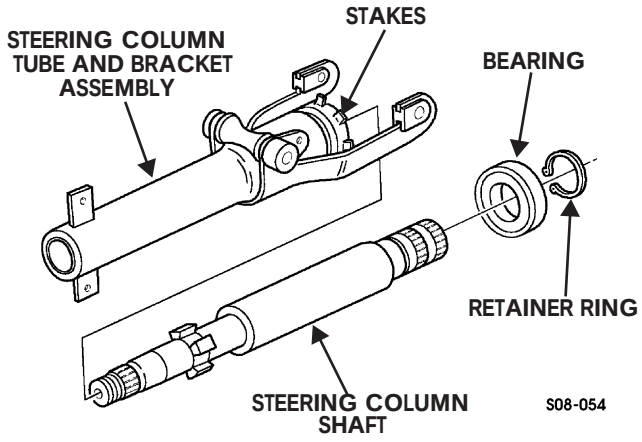

Figure 8-13: Steering Column and Shaft

Assembly

1. Install retainer ring and bearing onto shaft (Figure 8-13).
2. Install the shaft into the tube and bracket assembly.
3. Install six stakes into the tube and bracket assembly.
4. Install lock and switch housing assembly on steering column with two screws (Figure 8-11).

5. Connect the multi-switch assembly to the lock and switch housing with two screws (Figure 8-10).

STEERING WHEEL HUB AND STEERING COLUMN SHROUD REPLACEMENT

Removal

1. Remove three locking screws, steering wheel hub trim and adapter from steering wheel.
2. Remove five tapping screws and upper and lower steering column shrouds from steering column.

Installation

1. Install upper and lower steering column shrouds on steering column with five tapping screws.
2. Install adapter and steering wheel hub trim with three tapping screws.

IGNITION SWITCH LOCK CYLINDER REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove close-out panel.
3. Remove five screws and lower steering column cover (Figure 8-14).
4. Disconnect lock cylinder connector from ignition switch connector.
5. Turn ignition switch to RUN position.
6. Depress lock cylinder detent pin through detent pin hole and remove lock cylinder from steering column.

Installation

1. Insert lock cylinder into steering column (Figure 8-14).
2. Turn ignition switch to LOCK position.
3. Connect lock cylinder connector to ignition switch connector.
4. Install lower steering column cover on steering column with five screws.
5. Install close-out panel.
6. Connect battery ground cable.
7. Ensure ignition switch lock cylinder operates properly.

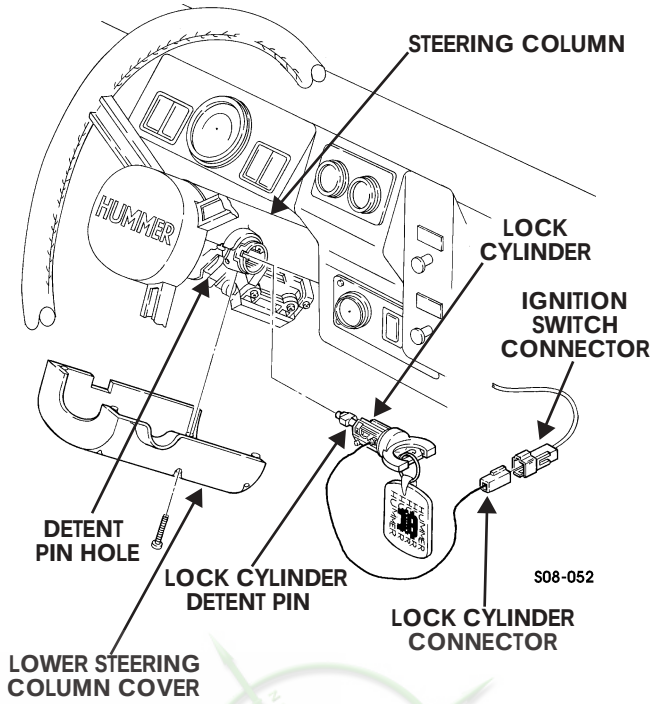

Figure 8-14: Ignition Switch Lock Cylinder

IGNITION INTERLOCK CABLE REPLACEMENT

Removal

1. Remove five screws and lower cover from steering column (Figure 8-15).
2. Loosen two locknuts securing steering column to mounting bracket.
3. Remove locknut, lockwasher, three washers, and bolt securing steering column to mounting bracket. Discard lockwasher and locknut.
4. Lower steering column and remove upper cover.
5. Remove screw and interlock cable from ignition switch (Figure 8-16).

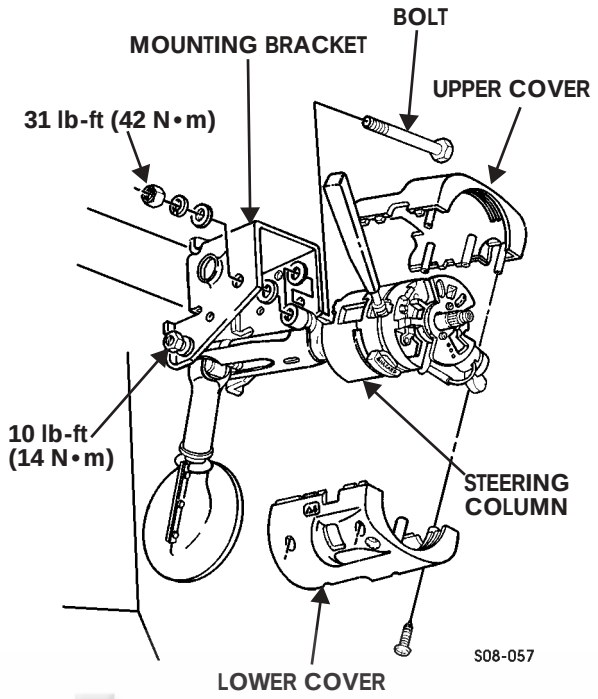

Figure 8-15: Steering Column Covers

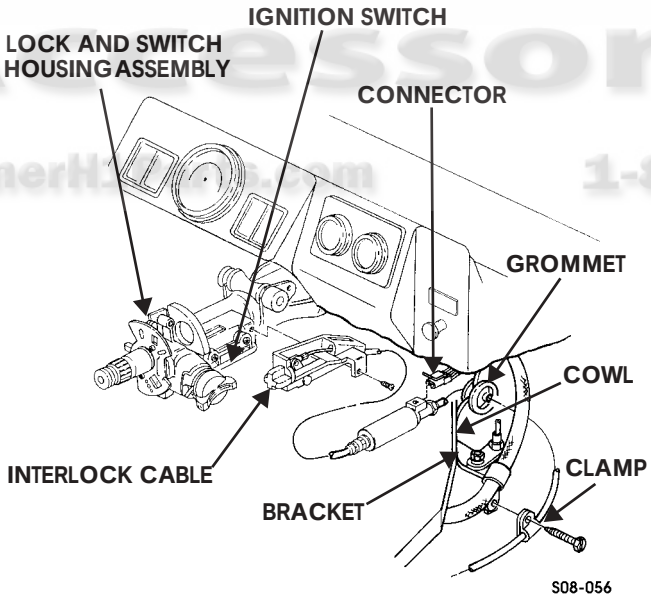

Figure 8-16: Interlock Cable/Ignition Switch

6. Disconnect connector from interlock cable.
7. Raise and secure hood.
8. Remove screw securing clamp and interlock cable to bracket. Remove clamp from interlock cable.
9. Remove close-out panel (Section 10).
10. Remove shifter (Section 5).
11. Remove nut and screw securing interlock cable to shifter (Figure 8-17).
12. Remove interlock cable and grommet from vehicle.

Installation

1. Install interlock cable on shifter with screw and nut. Tighten nut to 8 lb-ft (11 N•m) (Figure 8-17).

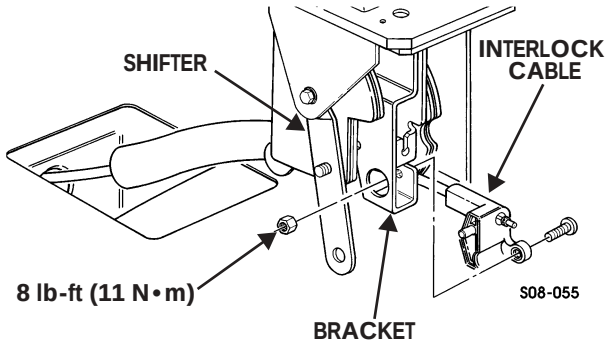

Figure 8-17: Interlock Cable and Shifter

2. Route interlock cable through bracket and install shifter (Section 5).
3. Secure interlock cable to bracket with clamp and screw (Figure 8-16).
4. Route interlock cable through cowl and secure with grommet.
5. Lower and secure hood.
6. Secure interlock cable to ignition switch with screw.
7. Connect connector to interlock cable.
8. Position upper steering column cover on steering column (Figure 8-15).
9. Raise steering column and secure steering column on mounting bracket with bolt, three washers, lockwasher, and locknuts. Tighten locknuts to 31 lb-ft. (42 N•m).
10. Replace two locknuts securing steering column to mounting bracket. Tighten locknuts to 10 lb-ft (14 N•m).
11. Secure lower steering column cover to upper cover with five screws.
12. Install close-out panel (Section 10).

Test

1. With transmission lever in P, turn ignition key to run.
2. Activate brake switch and move transmission lever to N.
3. Without turning ignition key off, move transmission shift lever to P.
4. Turn ignition key off. To pass test, it should not be possible to move transmission lever out of P unless an extremely high effort is applied.
5. Turn ignition key on. To pass test, it should not be possible to move transmission lever out of P unless an extremely high effort is applied.
6. Activate brake switch. To pass test, transmission lever should be moved from P to N with normal shift effort.

7. Turn ignition key off. To pass test, it should not be possible to remove ignition key without a high effort being applied to ignition key while transmission lever is in N.
8. Move transmission lever to P. To pass test, it must be possible to remove ignition key with normal effort applied to ignition key.

STEERING GEAR REPLACEMENT

Removal

NOTE: Ensure front wheels are in the straight-ahead position. Have drainage container ready to catch fluid.

1. Disconnect two power steering lines from steering gear (Figure 8-18).
2. Turn steering wheel left and right several times to bleed off power steering fluid.
3. Remove locknut, washer, capscrew, and washer and disconnect intermediate shaft and yoke from steering gear. Discard locknut.
4. Remove nut and lockwasher from steering arm. Discard lockwasher (Figure 8-19).
5. Remove steering arm from shaft.
6. Remove three capscrews, lockwashers, washers, and steering gear from frame. Discard lockwashers (Figure 8-18).

Installation

1. Align steering gear with mounting holes in frame and secure with three washers, lockwashers, and capscrews. Tighten capscrews to 54-66 lb-ft (73-89 N•m) (Figure 8-18).
2. Align hole in yoke with notch on steering gear splines and slide intermediate shaft on steering gear splines.
3. Install intermediate shaft and yoke on steering gear splines with washer, capscrew, washer, and locknut. Tighten locknut to 60 lb-ft (81 N•m).
4. Connect two power steering lines to steering gear.

NOTE: Ensure front wheels are in the straight ahead position.

5. Install steering arm on shaft with lockwasher and nut. Tighten nut to 167-203 lb-ft (227-275 N•m) (Figure 8-19).
6. Fill power steering reservoir.
7. Purge air from power steering system.
8. Inspect wheel alignment.

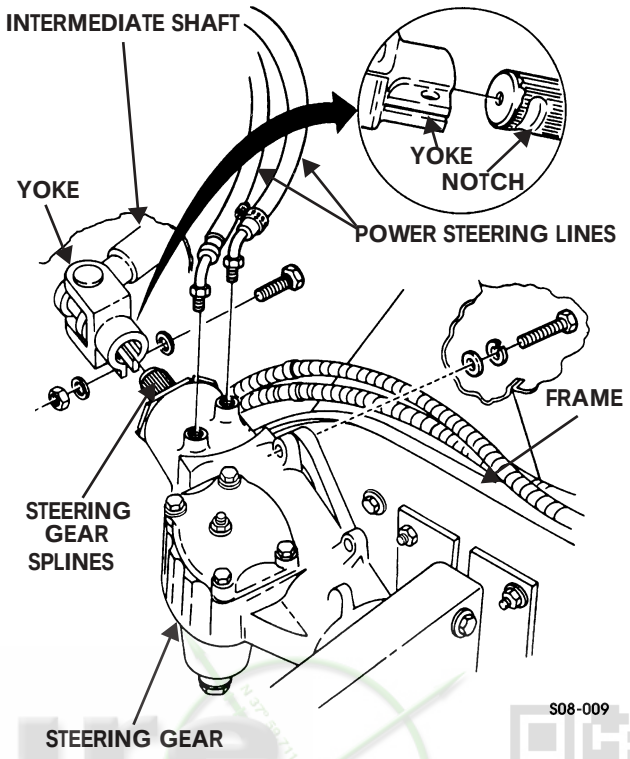

Figure 8-18: Steering Gear

INTERMEDIATE STEERING SHAFT REPLACEMENT

NOTE: Ensure front wheels are in straight-ahead position while removing and installing intermediate steering shaft.

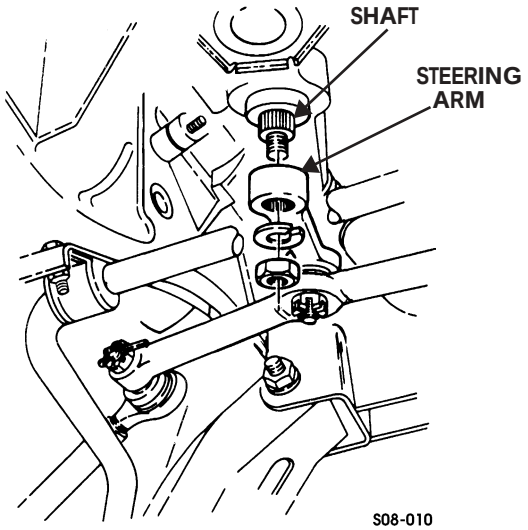

Figure 8-19: Steering Gear Shaft

Removal

1. Remove close-out panel.
2. Remove three nuts, six washers, and three screws from dust boot (Figure 8-20).
3. Remove locknut, washer, capscrew, and washer securing intermediate steering shaft to steering gear. Discard locknut.
4. Remove locknut, washer, capscrew, washer, and intermediate steering shaft from steering column. Discard locknut.

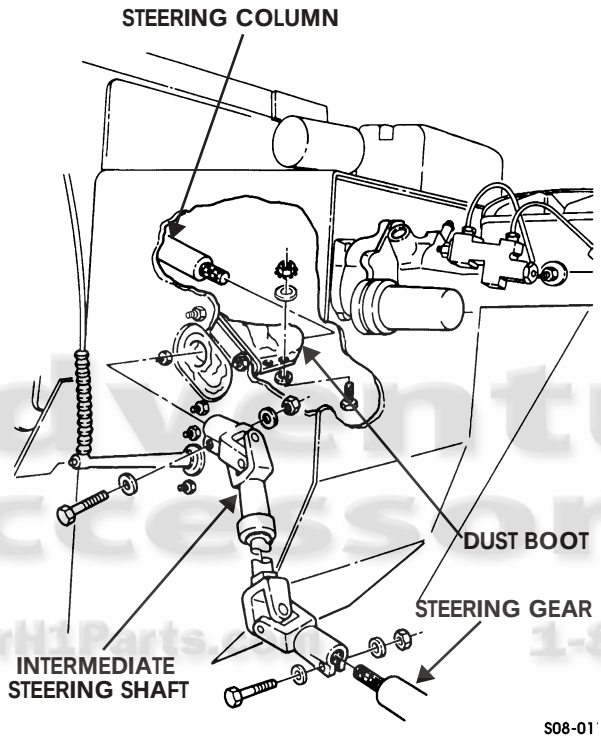

Figure 8-20: Intermediate Steering Shaft

Installation

1. Install intermediate steering shaft on steering gear with washer, capscrew, washer, and locknut. Tighten locknut to 60 lb-ft (81 N•m) (Figure 8-20).
2. Install intermediate steering shaft on steering column with washer, capscrew, washer, and locknut. Tighten locknut to 60 lb-ft (81 N•m).
3. Install three screws, six washers, and three nuts on dust boot.
4. Lubricate steering shaft.
5. Install close-out panel.

INTERMEDIATE STEERING SHAFT DUST BOOT REPLACEMENT

Removal

1. Remove close-out panel.
2. Remove three nuts, six washers, and three screws from dust boot (Figure 8-21).
3. Remove locknut, washer, capscrew, washer, and intermediate steering shaft from steering column. Discard locknut.
4. Remove four locknuts, eight washers, four screws, spacer, and dust boot from cowl panel and intermediate steering shaft.

Installation

1. Install spacer and dust boot on cowl panel with four screws, eight washers, and four locknuts. Tighten locknuts to 60 lb-ft (81 N•m) (Figure 8-21).
2. Install intermediate steering shaft through dust boot and connect to steering column. Secure steering shaft to steering column with washer, capscrew, washer, and locknut. Tighten locknut to 60 lb-ft (81 N•m).
3. Install three screws, six washers, and three nuts on dust boot.
4. Install close-out panel.

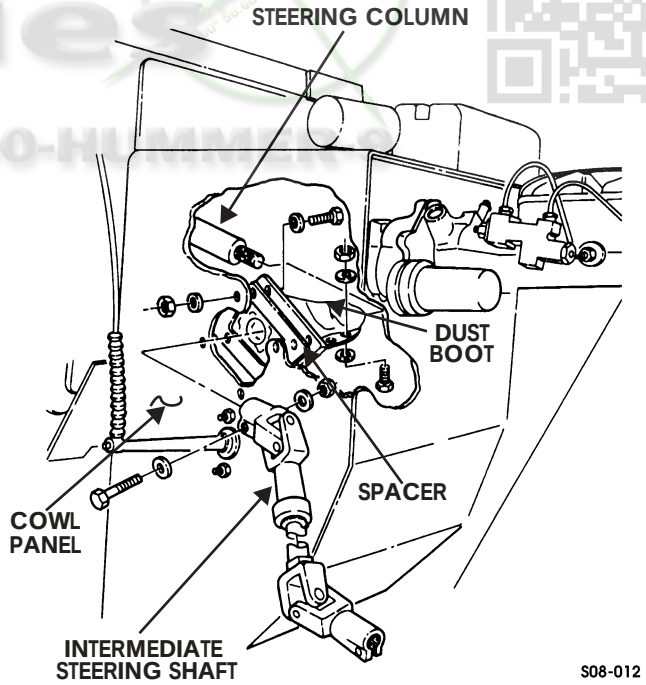

Figure 8-21: Intermediate Steering Shaft Dust Boot

POWER STEERING PUMP, PULLEY, AND BRACKET MAINTENANCE

Removal

NOTE: Have drainage container ready to catch fluid.

1. Disconnect two return lines and high pressure line from power steering pump. Remove O-ring seal from high pressure line. Discard O-ring seal (Figure 8-22).
2. Disconnect reservoir hose from power steering pump.
3. Loosen adjusting capscrew on front of power steering bracket (Figure 8-23).
4. Loosen adjusting capscrew on rear of power steering bracket.
5. Loosen engine mounting capscrew and push power steering bracket toward engine. Remove serpentine belt from power steering pump pulley.
6. Remove capscrew and lockwasher securing power steering bracket to bracket. Discard lockwasher.
7. Remove adjusting capscrew, lockwasher, and washer securing power steering bracket to bracket. Discard lockwasher.
8. Remove adjusting capscrew, lockwasher, and washer securing power steering bracket to power steering support bracket. Discard lockwasher.
9. Remove power steering pump, pulley, and power steering bracket from support bracket.
10. Remove two screws and bracket from engine.
11. Inspect support bracket for breaks or cracks. Perform step 12 if support bracket is defective.
12. Remove two nuts and support bracket from studs.

Disassembly

1. Remove screw, washer, and pulley from power steering pump (Figure 8-23).
2. Remove four capscrews and power steering pump from power steering bracket.

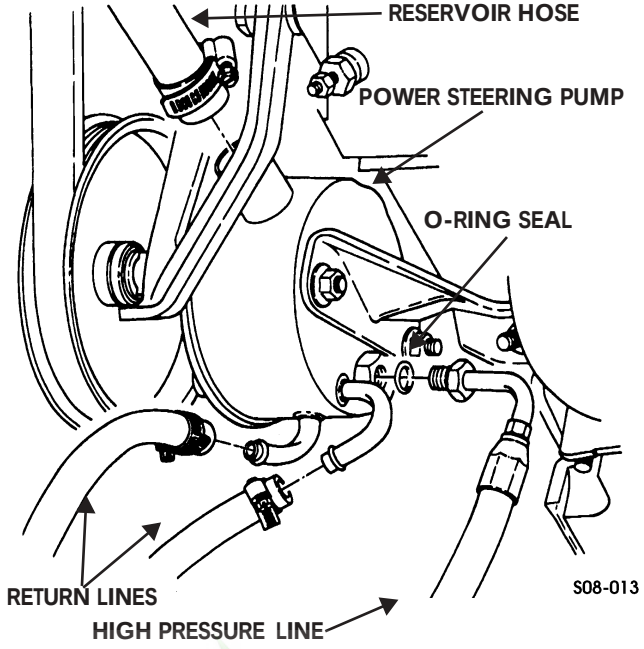

Figure 8-22: Power Steering Pump

Assembly

1. Apply sealing compound adhesive to threads of capscrews.
2. Install power steering pump on power steering bracket with four capscrews. Tighten capscrews to 40 lb-ft (54 N•m) (Figure 8-23).
3. Use a pulley installer to install pulley on power steering pump.
4. Install pulley to power steering pump with washer and capscrew. Tighten capscrew to 37 lb-ft (50 N•m).

Installation

NOTE: Perform step 1 if support bracket was removed.

1. Apply sealing compound to studs and install support bracket to studs with two nuts. Tighten nuts to 45 lb-ft (61 N•m) (Figure 8-23).
2. Install bracket on engine with two screws.
3. Install power steering pump, pulley, and power steering bracket on bracket with washer, lockwasher, and adjusting capscrew.
4. Install power steering bracket on support bracket with washer, lockwasher, and adjusting capscrew.
5. Install serpentine belt on pulley.
6. Pull power steering bracket away from engine and install power steering bracket to bracket with lockwasher and engine mounting capscrew.
7. Connect two return lines to power steering pump (Figure 8-22).

8. Install O-ring seal on high pressure line and connect high pressure line to power steering pump.
9. Install reservoir hose on power steering pump.
10. Purge air from power steering system.
11. Start engine and check for leaks.

PURGING AIR FROM POWER STEERING SYSTEM

Air will enter the system whenever the fluid lines are disconnected, or components removed for service. This air must be purged before returning the vehicle to service. Failure to do so will cause initial steering response to be slow and heavy; unwanted pump and gear wear can also result.

The purging procedure is as follows:

1. Fill steering reservoir with Dexron III fluid. Allow level to stabilize between HOT and COLD marks.
2. Run engine at curb idle speed for 30-60 seconds. Then stop engine and add fluid if necessary.
3. Raise and support vehicle front end.
4. Run engine at curb idle speed and slowly turn steering left and right. Turn wheel about 1-1/2 turns in each direction.

***CAUTION**: Do not turn the steering wheel far enough to contact either steering stop, and never hold the wheel against the stops. This action can result in pump damage.*

5. Continue turning wheel back and forth until fluid is free of bubbles and level has stabilized.
6. Stop engine, remove supports and lower vehicle.
7. Check reservoir fluid level. If fluid is now hot, fill to HOT mark. If fluid is still cool or just warm set level at or just above COLD mark.

NOTE: If the fluid appears slightly foamy, simply allow it to stand a few minutes before checking and adjusting fluid level.

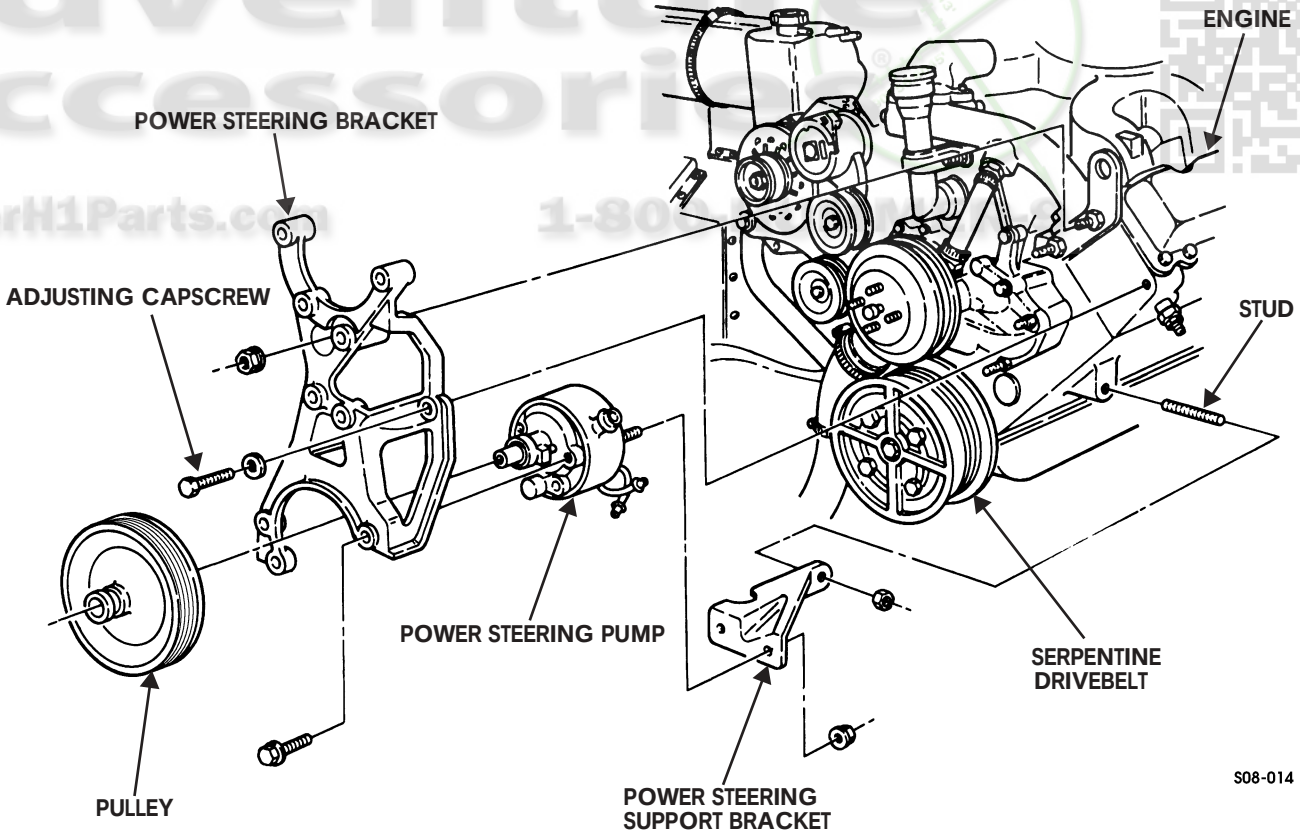

Figure 8-23: Power Steering Pump Assembly

POWER STEERING FLUID RESERVOIR REPLACEMENT

Removal

1. Disconnect hose from the power steering fluid reservoir and drain the power steering fluid before removing reservoir.
2. Remove two bolts, lockwashers, and washers from the mounting bracket. Remove the power steering fluid reservoir from the fan shroud assembly. Discard lockwashers (Figure 8-24).

Installation

1. Mount the power steering fluid reservoir to the fan shroud assembly using the mounting bracket, two bolts, lockwashers, and washer.
2. Connect the hose to the power steering fluid reservoir and fill with power steering fluid.

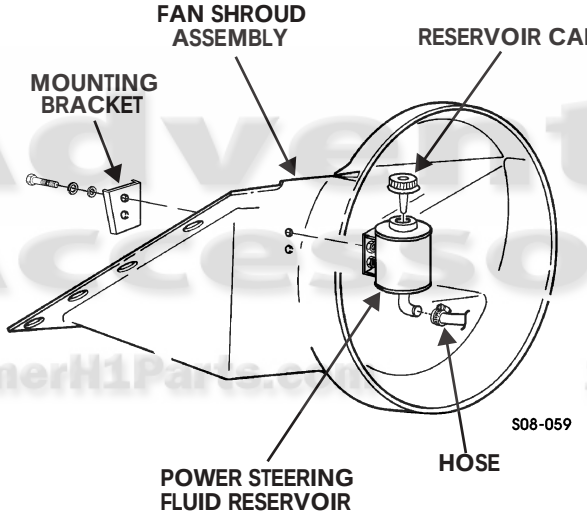

Figure 8-24: Power Steering Fluid Reservoir

POWER STEERING HYDRAULIC SYSTEM PRESSURE AND RETURN HOSE REPLACEMENT

NOTE: Removal and installation procedures are basically the same for all hydraulic system pressure and return hoses. This procedure covers the power steering pump to hydro-boost return hose and the steering gear to hydro-boost pressure hose.

Removal

1. Disconnect battery ground cable.
2. Disconnect return hose from power steering pump and hydro-boost (Figures 8-22 and 8-25).
3. Remove locknut, washer, capscrew, and two clamps from control valve hose and return hose. Discard locknut (Figure 8-25).
4. Remove locknut, two washers, and capscrew securing two clamps and harness clamp to power steering line bracket.
5. Disconnect pressure hose from hydro-boost and steering gear and remove pressure hose. Remove two O-ring seals from pressure hose. Discard O-ring seals (Figures 8-25 and 8-26).

Installation

1. Install two O-ring seals on pressure hose and connect pressure hose to steering gear and hydro-boost (Figure 8-26).
2. Connect return hose to power steering pump and hydro-boost with two clamps (Figures 8-22 and 8-25).
3. Install two clamps on return hose and control valve hose. Secure return hose, control valve hose, and two clamps together with capscrew, washer, and locknut (Figure 8-25).
4. Install harness clamp and two clamps on power steering lines bracket with capscrew, two washers, and locknut.
5. Connect battery ground cable.
6. Purge air from power steering system.

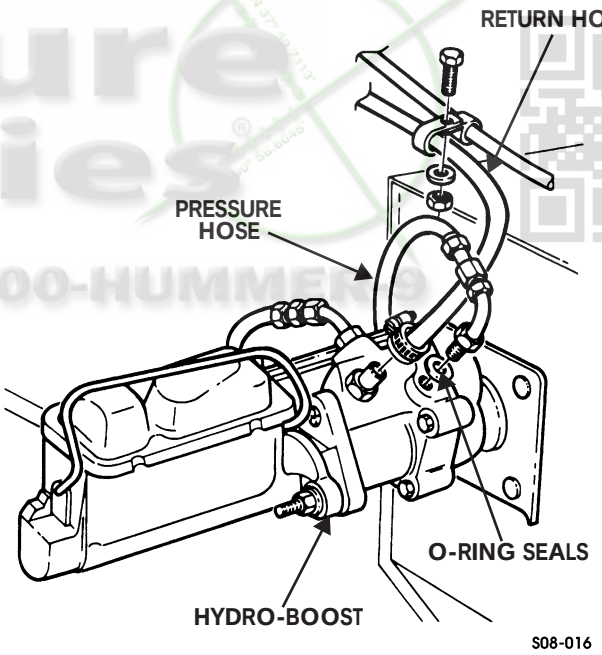

Figure 8-25: Power Steering Hydro-Boost

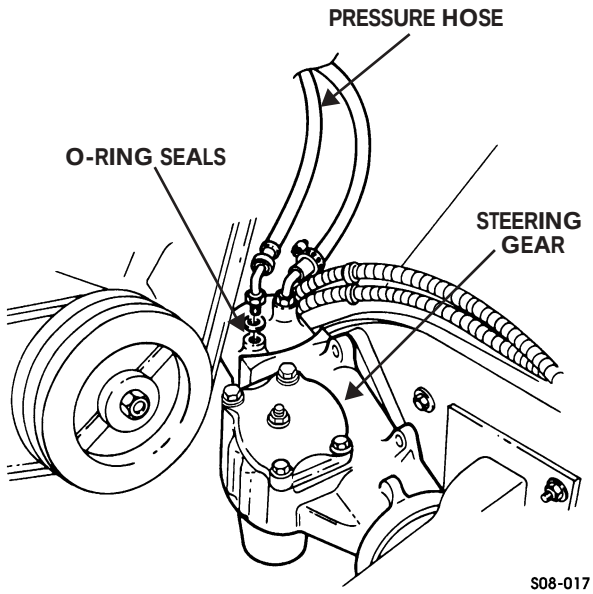

Figure 8-26: Hydro-Boost Hoses

POWER STEERING COOLER HOSE REPLACEMENT

Removal

1. Disconnect two hoses from cooler (Figure 8-27).
2. Remove tiedown strap securing oil cooler lines and two hoses. Discard tiedown strap.
3. Loosen clamp and remove hose from steering gear.
4. Loosen clamp and remove hose from power steering pump.

Installation

1. Connect hose to power steering pump and secure with clamp (Figure 8-27).
2. Connect hose to steering gear and secure with clamp.
3. Connect two hoses to cooler and secure with two clamps. Tighten clamps to 3-4 lb-ft (4-5 N•m).
4. Install tiedown strap to oil cooler lines and two hoses.
5. Purge air from power steering system.

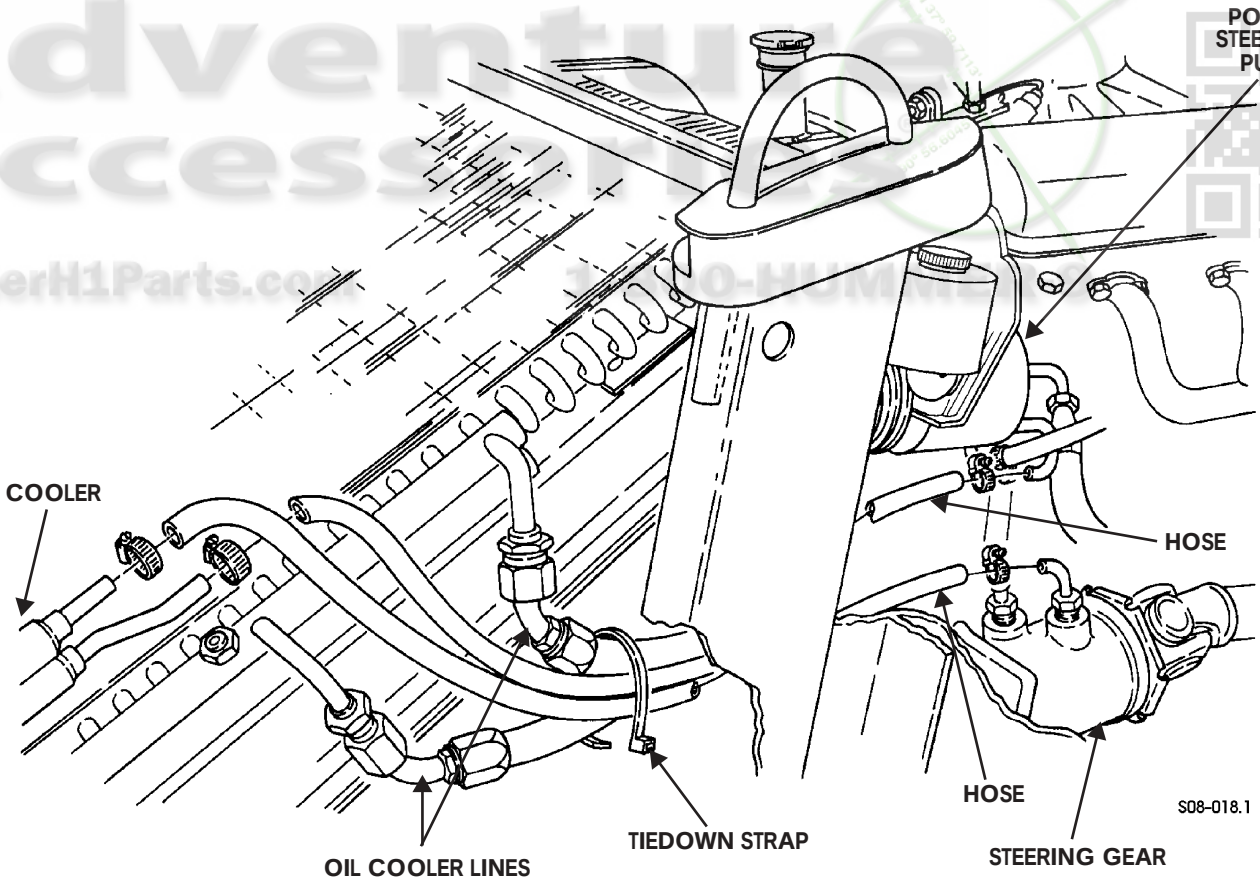

Figure 8-27: Power Steering Cooler Hose

POWER STEERING COOLER REPLACEMENT

Removal

1. Disconnect two hoses from power steering cooler (Figure 8-28).
2. Remove two screws, lockwashers, washers, and cooler from oil cooler. Discard lockwashers.

Installation

1. Install power steering cooler on oil cooler with two washers, lockwashers, and screws. Tighten screws to 10-13 lb-ft (14-18 N•m) (Figure 8-28).
2. Connect two hoses to cooler with two clamps. Tighten clamps to 3-4 lb-ft (4-5 N•m).
3. Purge air from power steering system.

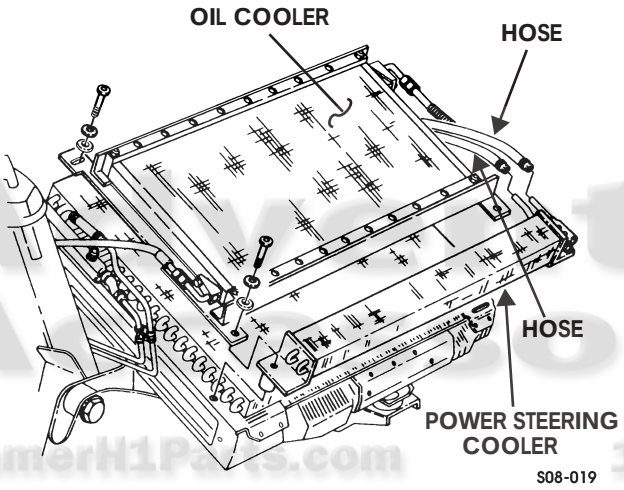

Figure 8-28: Power Steering Cooler

STEERING GEAR REPAIR

Disassembly

1. Remove steering gear.
2. Hold adjuster screw and remove lash adjuster nut (Figure 8-29).
3. Unscrew four capscrews securing side cover to housing.
4. Remove side cover from adjuster screw.
5. Remove gasket from side cover. Discard gasket.
6. Insert punch through access hole and remove retaining ring. Discard retaining ring.
7. Rotate stub shaft counterclockwise to force end plug from housing.
8. Rotate stub shaft clockwise and remove O-ring seal. Discard O-ring seal.
9. Remove plug from rack piston (Figure 8-30).

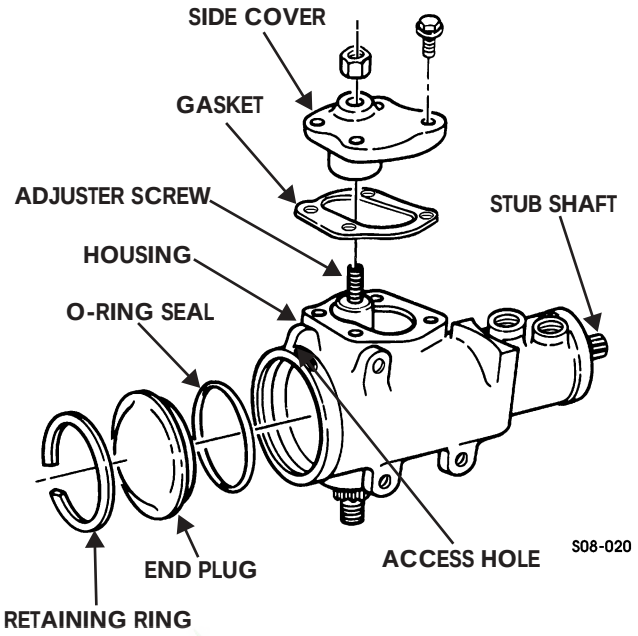

Figure 8-29: Steering Gear Assembly

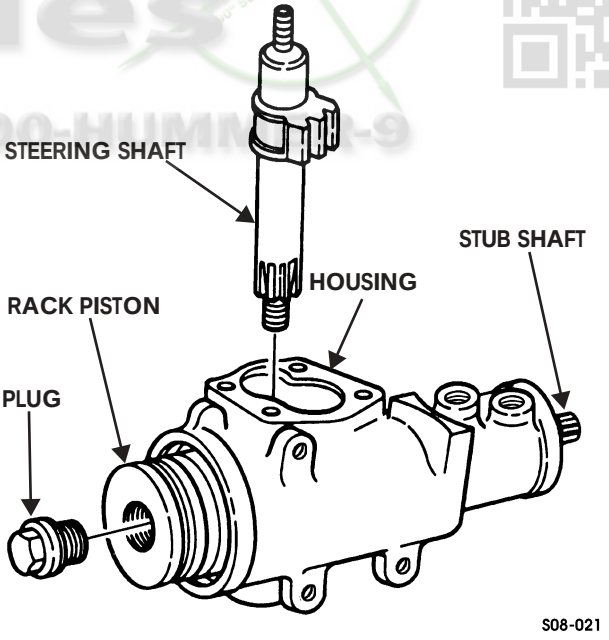

Figure 8-30: Steering Shaft in Steering Gear Housing

10. Rotate stub shaft to center and remove steering shaft from housing.
11. Insert rack piston arbor in rack piston and hold tightly while turning stub shaft counterclockwise (Figure 8-31).
12. Remove rack piston and rack piston arbor together from gear housing.

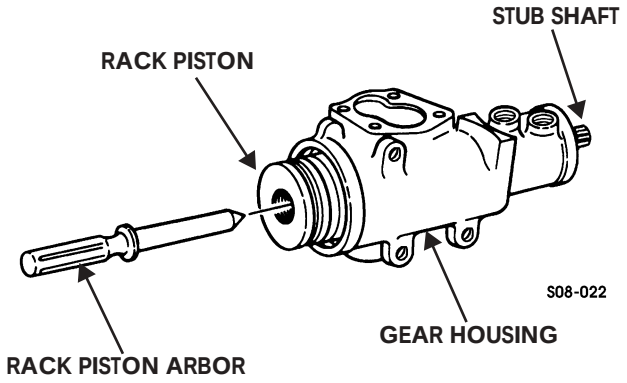

Figure 8-31: Rack Piston and Rack Piston Arbor

13. Remove locknut from adjuster plug (Figure 8-32).

NOTE: Worm and valve may come out with adjuster plug. If so, separate adjuster from worm and valve.

14. Using spanner wrench, remove adjuster plug from housing.

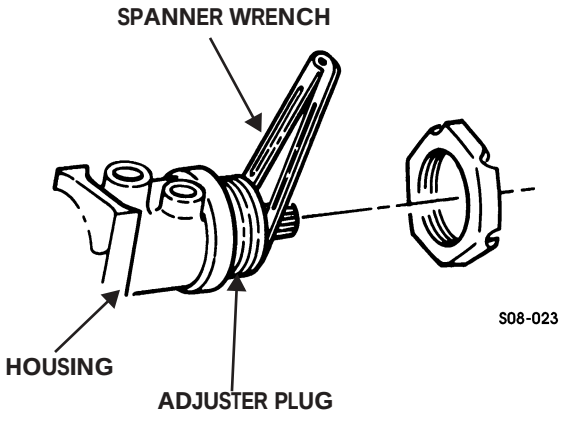

Figure 8-32: Adjuster Plug

15. Pry off bearing retainer at raised area (Figure 8-33).

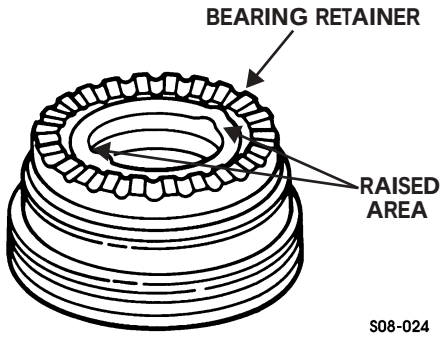

Figure 8-33: Bearing Retainer

16. Remove thrust bearing spacer, small bearing race, upper thrust bearing, and large bearing race (Figure 8-34).
17. Remove O-ring seal. Discard O-ring seal.
18. Remove retaining ring from opposite side of adjuster plug. Discard retaining ring.
19. Remove stub shaft dust seal and stub shaft oil seal. Discard stub shaft dust seal and stub shaft oil seal.

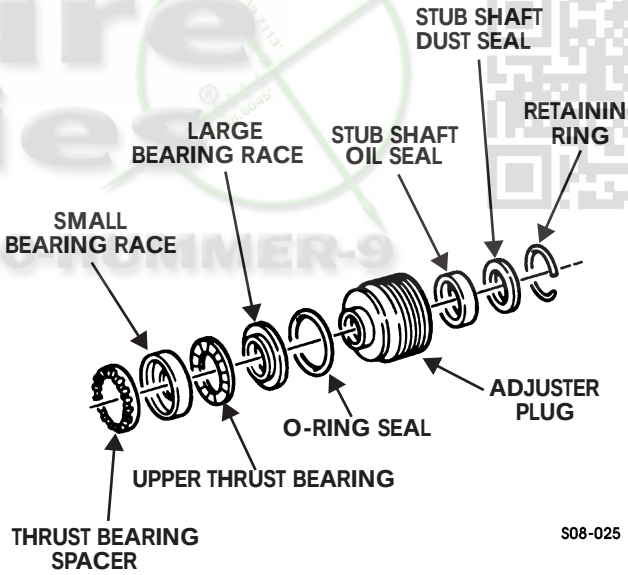

Figure 8-34: Adjuster Plug Assembly

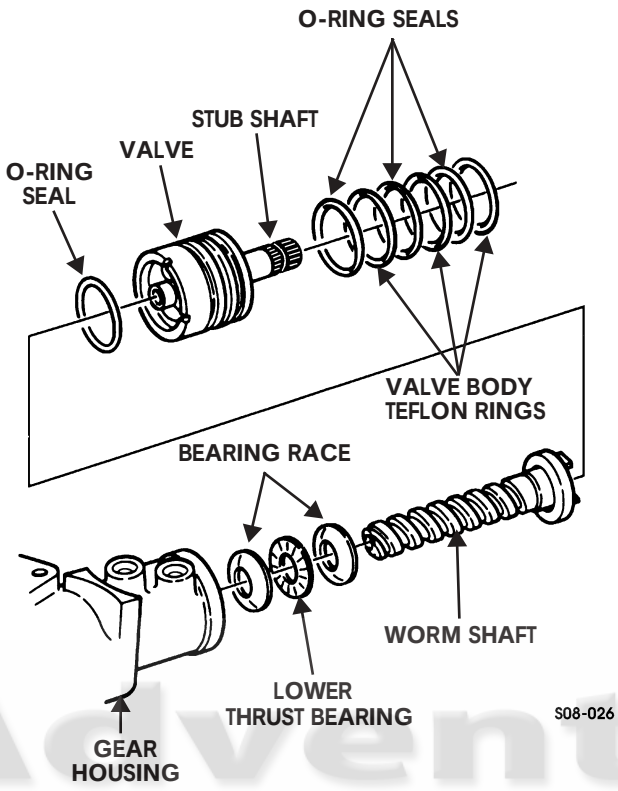

Figure 8-35: Worm Shaft Assembly

20. Hold stub shaft and remove valve and worm shaft together from gear housing (Figure 8-35).
21. Remove bearing race, lower thrust bearing, and bearing race from worm shaft.
22. Clamp worm shaft in soft-jawed vise and pull valve from worm shaft.
23. Remove and discard three valve body teflon rings and O-ring seals from valve body.
24. Remove stub shaft O-ring seal from valve body. Discard O-ring seal.
25. Tap splined end of stub shaft lightly on wood block until shaft cap is free of valve body (Figure 8-36).
26. Pull shaft outward 0.24 in. (6 mm).
27. Press locating pin inward and remove stub shaft from valve body

NOTE: Rotate spool to remove from valve body.

28. Remove spool from valve body.
29. Remove O-ring seal from spool. Discard O-ring seal.

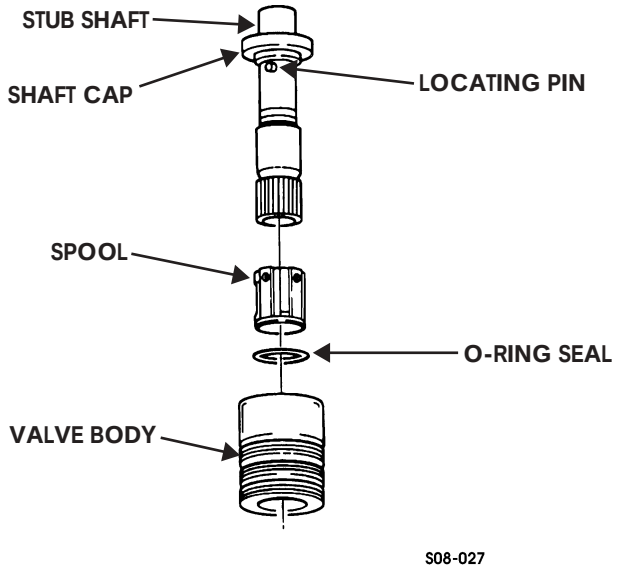

Figure 8-36: Stub Shaft

30. Remove two screw-assembled washers and clamp from rack piston (Figure 8-37).

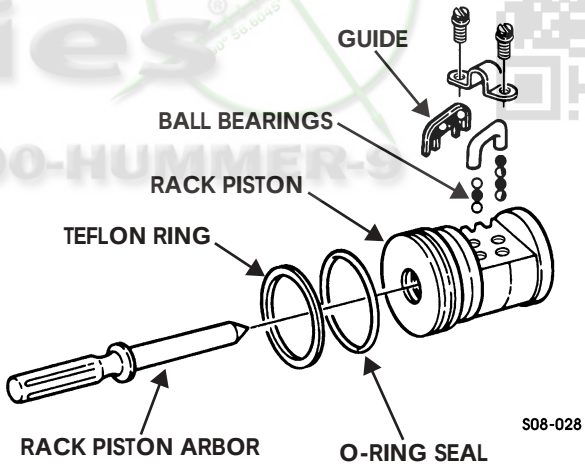

Figure 8-37: Rack Piston and Ring Seals

31. Remove and separate two halves of guide.
32. Remove black and chrome ball bearings.
33. Tip rack piston so remaining ball bearings fall out. The total number of ball bearings should be twenty-four, twelve black and twelve chrome-colored.
34. Remove rack piston arbor from rack piston.
35. Remove teflon ring and O-ring seal from rack piston. Discard teflon ring and O-ring seal.

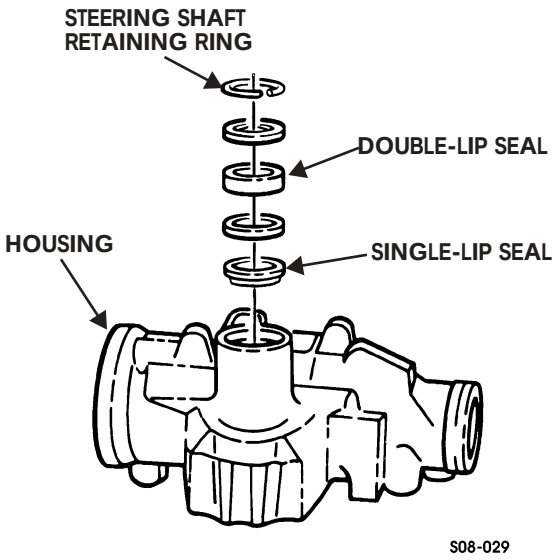

Figure 8-38: Steering Shaft Retaining Ring

36. Remove steering shaft retaining ring from housing. Discard retaining ring (Figure 8-38).
37. Remove washer, double-lip seal, washer, and single-lip seal from housing. Discard two seals and washers.

Cleaning

Clean all parts (Section 1).

Housing Group Cleaning, Inspection, and Repair

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect housing for cracks, chipped or broken retaining ring grooves, and damaged sealing surfaces. Replace steering gear if housing is damaged (Figures 8-39 and 8-41).

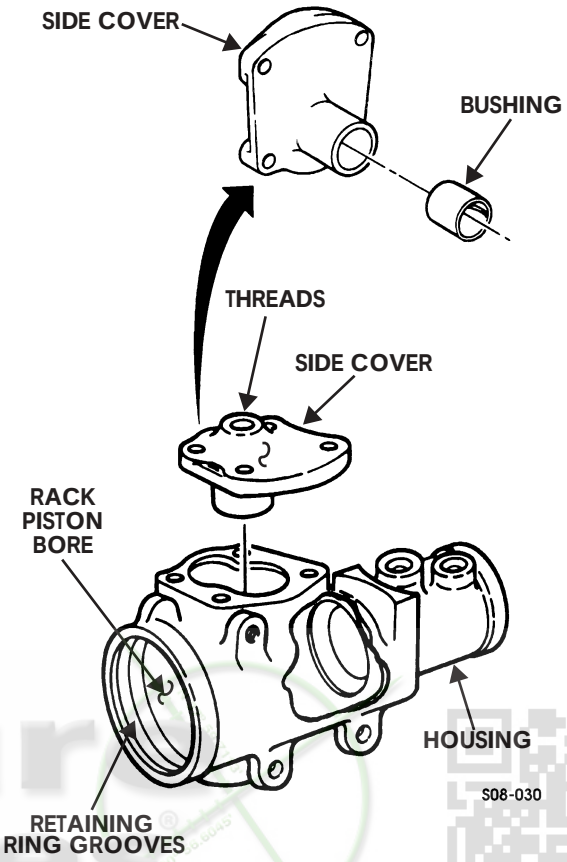

Figure 8-39: Steering Gear Housing Assembly

2. Inspect housing for crossed or stripped threads. Repair if necessary (Section 1). Replace steering gear if housing threads cannot be repaired.
3. Inspect needle bearing for damage or wear. Replace needle bearing if damaged or inside diameter is worn below 1.25 in. (31.750 mm). If damaged or worn, replace needle bearing as follows (Figure 8-40).

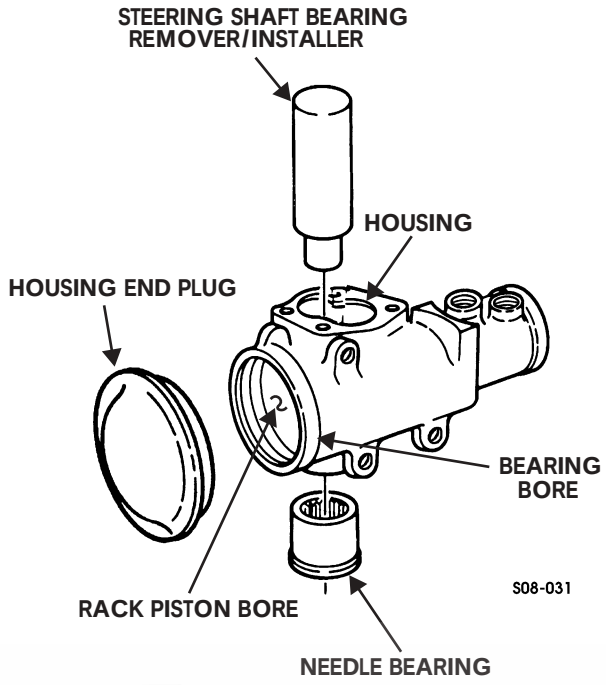

Figure 8-40: Needle Bearing

a. Using steering shaft bearing remover/ installer, remove bearing from housing.

b. Lubricate bearing bore and bearing with hydraulic fluid.

c. Using steering shaft bearing remover/ installer and adapter ring, install bearing until seated in housing (Figure 8-41).

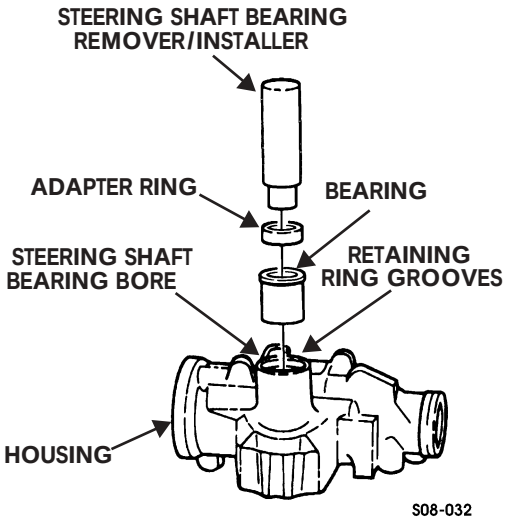

Figure 8-41: Steering Shaft Bearing

4. Inspect valve bore, rack piston bore, worm shaft support bore, and steering shaft bearing bore for rust, pitting, scoring, galling, and wear. Wear limits for bore I.D. are: valve bore 2.033 in. (51.64 mm) and rack piston bore 3.128 in. (79.45 mm.) Remove minor rust, pitting, and scoring with crocus cloth. If bore(s) does not meet specifications, or if there is other unrepairable damage, replace steering gear (Figures 8-39, 8-40, 8-41, 8-42, and 8-43).

5. Inspect check valve for freedom of movement. If damaged, replace. Check valve as follows (Figure 8-42):

   a. Pry check valve out of housing with a small screwdriver.

   b. Lubricate housing and check valve with hydraulic fluid.

   c. Install check valve using 0.375 in. (9.52 mm) outside diameter (O.D.) tubing, 4 in. (10.16 cm) long.

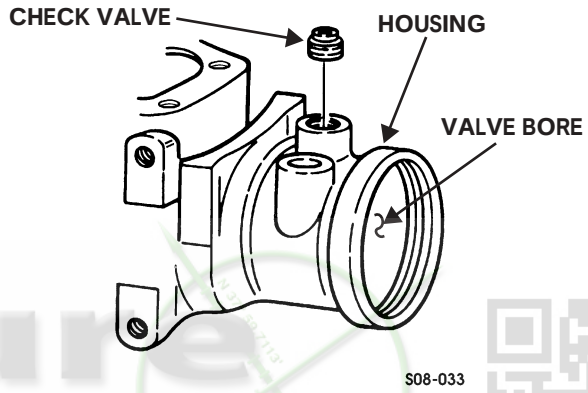

Figure 8-42: Check Valve

6. Inspect side cover for breaks, cracks, stripped or crossed threads, warped or damaged sealing surface, and scored or worn bushing. Repair minor scoring and thread damage. Replace side cover if bushing is worn through or loose in bore. Replace bushing if I.D. is worn over 1.249 in. (31.70 mm) (Figure 8-39).

7. Inspect housing end plug for cracks, and chipped edges. Replace housing end plug if damaged (Figure 8-40).

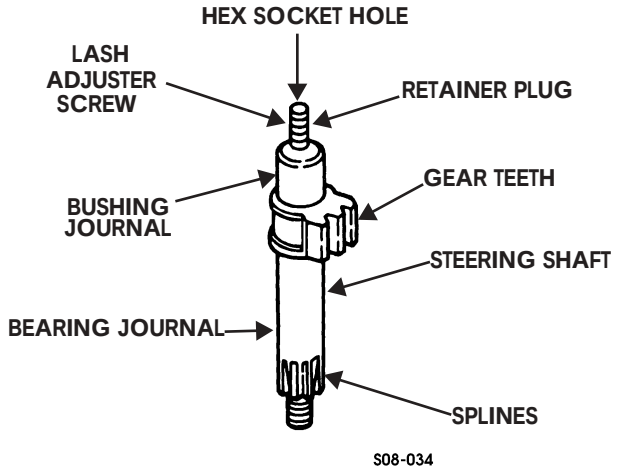

Figure 8-43: Steering Shaft Assembly

Steering Shaft Cleaning, Inspection, and Repair

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect steering shaft for breaks, chipped, cracked, or broken gear teeth, wear on bushing journal or bearing journal, crossed or stripped threads, and bent or twisted splines. Bushing journal minimum O.D. is 1.2480 in. (31.699 mm) and bearing journal minimum O.D. is 1.25 in. (31.750 mm). Repair minor thread damage. Replace steering shaft if worn or unrepairable (Figure 8-43).
2. Inspect lash adjuster screw for free rotation in shaft, tight retainer plug, crossed or stripped threads, and rounded hex socket hole. Repair minor thread damage. Replace steering shaft if damaged.

Rack Piston Group Cleaning, Inspection, and Repair

NOTE: Clean all components, examine for wear or damage, and replace if necessary. If rack piston internal worm thread, worm thread, or ball bearings are broken, chipped, or moderately or badly scored, replace all three parts.

1. Inspect rack piston for breaks, burrs, chipped seal grooves, crossed or stripped threads, cracked or broken gear teeth, and broken, chipped or scored internal worm thread. Repair minor burrs and scoring with fine mill file or crocus cloth. Repair minor thread damage. Replace rack piston if gear teeth are cracked or broken or other damage is unrepairable (Figure 8-44).
2. Inspect twenty-four ball bearings for breaks, chipped surface, flats, and scoring. Minor scoring on ball bearings is acceptable. Replace ball bearings as a set if any one or more fails inspection.
3. Inspect ball bearing guides and clamp for bends, dents, and breaks. Replace damaged parts.
4. Inspect screw-assembled washers for crossed or stripped threads. Replace screw-assembled washers if damaged.
5. Inspect rack piston plug for burred or rounded hex, flats, and stripped or crossed threads. Replace rack piston plug if damaged.

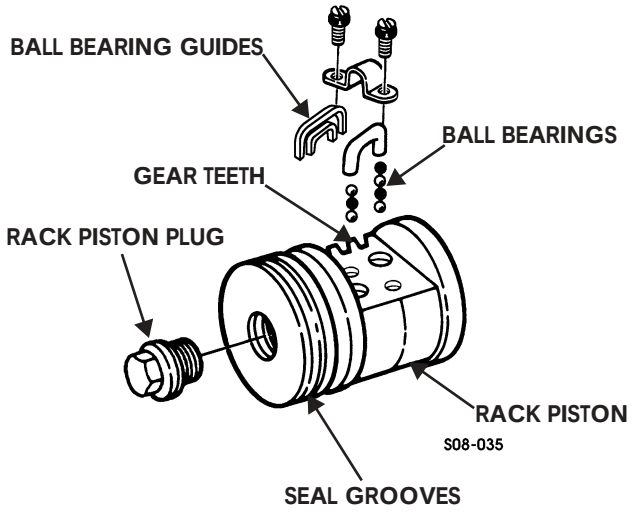

Figure 8-44: Rack Piston

Valve and Adjuster Group Cleaning, Inspection, and Repair

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect valve body for burrs, chipped or broken seal ring grooves, scoring or inner bore wear. Repair minor burrs and scoring with crocus cloth. Valve body bore maximum I.D. is 1.1557 in. (29.355 mm) and valve body minimum O.D. is 2.0150 in. (51.181 mm). Replace valve body if worn or unrepairable (Figure 8-45).

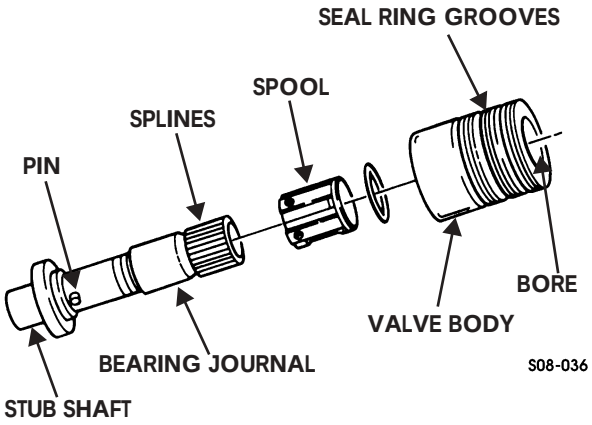

Figure 8-45: Valve Body

2. Inspect spool for burrs, cracks, blocked oil passages, chipped or cracked seal ring groove, scoring, and wear. Spool minimum O.D. is 1.152 in. (29.26 mm). Remove minor burrs and scoring with crocus cloth and clear blocked oil passages. Replace spool if worn or unrepairable.

3. Inspect stub shaft for bends, cracks, breaks, damaged pin, bent or twisted splines, and worn bearing journal. Bearing journal minimum O.D. is 1.2495 in. (31.623 mm). Replace stub shaft if worn or damaged.
4. Inspect worm for bends, breaks, burrs, chipped threads, and scoring. Remove minor burrs and scoring with fine mill file or crocus cloth. Replace worm if damage is unrepairable (Figure 8-46).

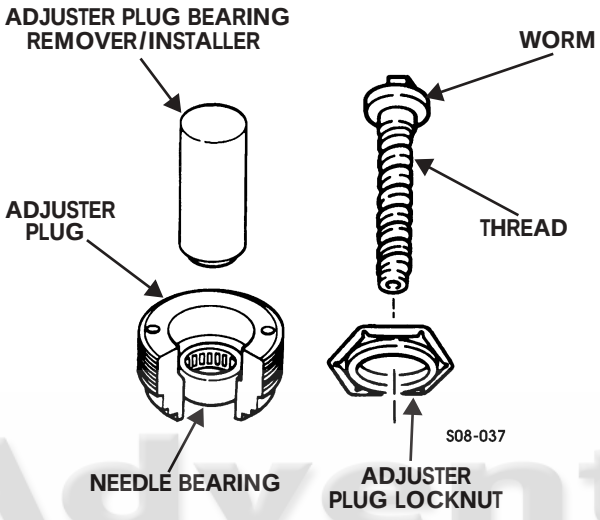

Figure 8-46: Worm Shaft Assembly

5. Inspect adjuster plug for cracks, breaks, crossed or stripped threads, chipped retainer grooves, and seal ring surface. Replace plug if damaged.
6. Inspect adjuster plug needle bearing for damage and wear. Replace needle bearing if damaged or I.D. is worn over 1.2550 in. (31.877 mm). If damaged or worn, replace needle bearing as follows:
   a. Using adjuster plug bearing remover/installer, remove bearing from adjuster plug.
   b. Lubricate adjuster plug and bearing with hydraulic fluid.
   c. Using adjuster plug bearing remover/ installer, install bearing 0.630 in. (16 mm) deep in adjuster plug.
7. Inspect adjuster plug locknut for cracks, burred flats or notches, and stripped or crossed threads. Replace locknut if damaged.

NOTE: Outer edge of bearing retainer is marked with identification number.

8. Inspect bearing retainer, thrust bearing spacer, small race, upper thrust bearing, and large race for damage. Replace all items if one item is damaged (Figure 8-47).

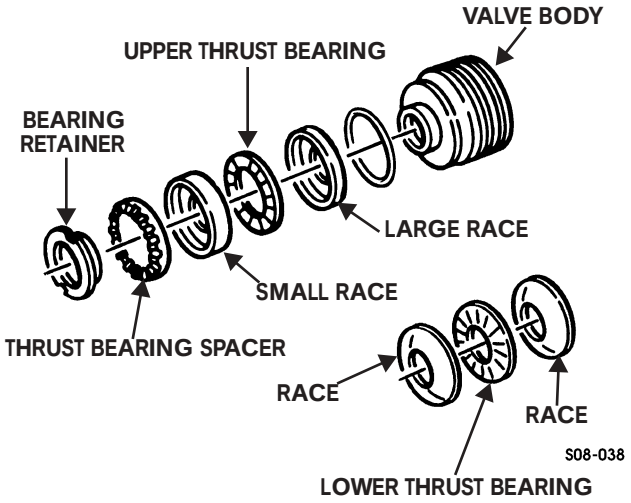

Figure 8-47: Bearing Retainer

9. Inspect lower thrust bearing and two races for damage. Replace all items if any one is damaged.

Assembly

NOTE: For general assembly instructions refer to Section 1.

1. Using steering shaft bearing remover/installer and adapter ring, install single-lip seal and one washer in housing only far enough to provide clearance for next seal and washer (Figure 8-48).
2. Using steering shaft bearing remover/installer and adapter ring, install seal and second washer in housing only far enough to provide clearance for retaining ring.
3. Install retaining ring in housing.

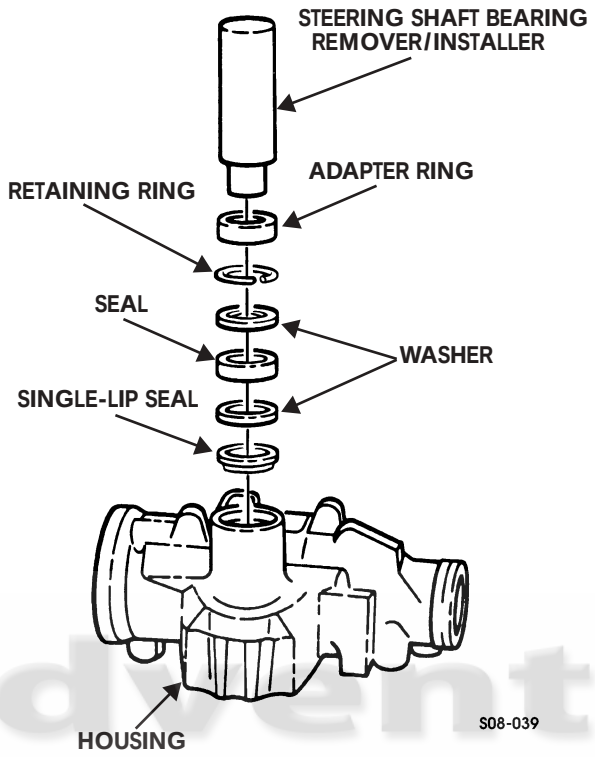

Figure 8-48: Steering Gear Housing

NOTE: Soak teflon ring in warm water to ease assembly.

4. Install O-ring seal and teflon ring on rack piston (Figure 8-49).

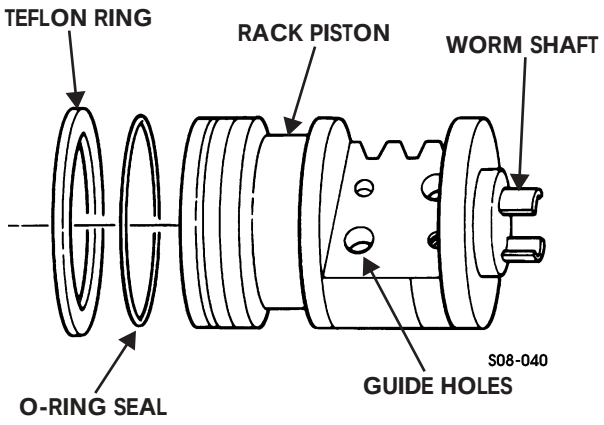

Figure 8-49: Rack Piston With Teflon Ring

5. Install worm shaft in rack piston.
6. Align lower ball return guide hole with worm shaft groove.
7. Alternately install eight black and chrome ball bearings into lower guide hole while rotating worm shaft counter-clockwise (Figure 8-50).

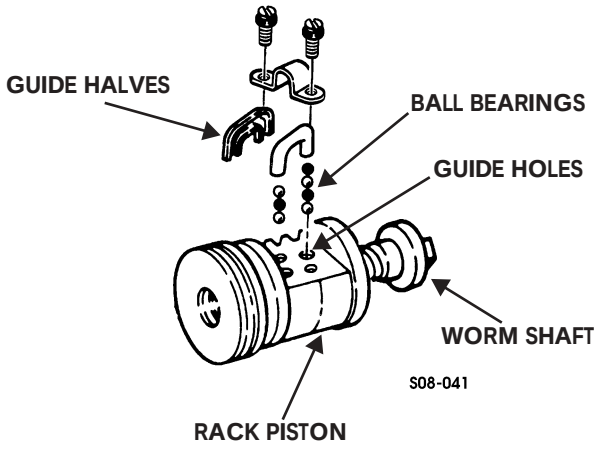

Figure 8-50: Worm Shaft

NOTE: Keep ball bearings in alternating sequence when installing guide in rack piston. Ensure a total of 24 ball bearings are installed.

8. Install eight remaining ball bearings in guide half and retain with grease.
9. Assemble both guide halves together and install guide in guide holes.
10. Secure clamp over guide with two screw-assembled washers. Tighten screw-assembled washers to 4 lb-ft (5 N•m).
11. Rotate worm shaft clockwise until flush with rack piston (Figure 8-51).

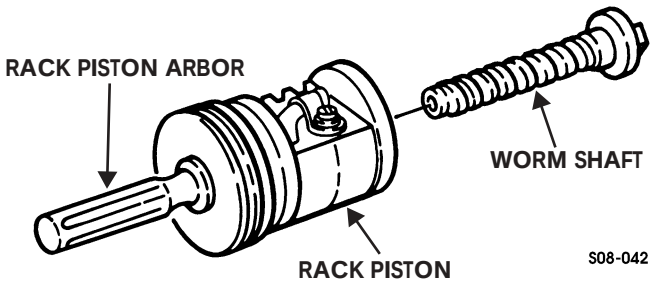

Figure 8-51: Worm Shaft and Rack Piston

12. Install rack piston arbor into rack piston and hold firmly against worm shaft. Remove worm shaft.

NOTE: Soak teflon rings in warm water to ease assembly.

13. Starting on inner seal ring groove, install O-ring seal and a backup teflon ring on valve body (Figure 8-52).

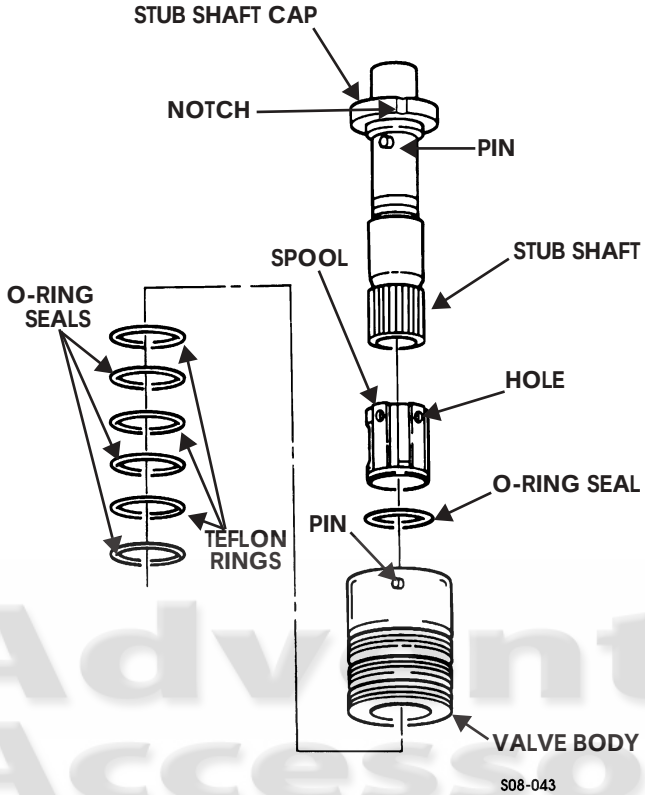

Figure 8-52: Valve Body Assembly With Stub Shaft

14. Repeat step 13 for innermost seal ring groove and install two remaining O-ring seals and teflon rings on valve body.

NOTE: Rotate spool to install in valve body.

15. Install O-ring seal on spool and install spool into valve body until flush with notched end of valve body.
16. Install stub shaft in spool so pin on stub shaft engages hole in spool.
17. Align notch in stub shaft cap with pin in valve body and press stub shaft and spool into valve body.
18. Install O-ring seal in valve (Figure 8-53).
19. Install worm shaft into valve.
20. Engage locating pin on worm shaft with slot in valve.
21. Install lower thrust bearing race, lower thrust bearing, and lower thrust bearing race on worm shaft.
22. Install assembled valve and worm shaft into housing.
23. Install O-ring seal, large upper bearing race, upper thrust bearing, small upper bearing race, thrust bearing spacer, and bearing retainer on adjuster plug. Press retainer onto adjuster plug with a brass drift (Figure 8-54).

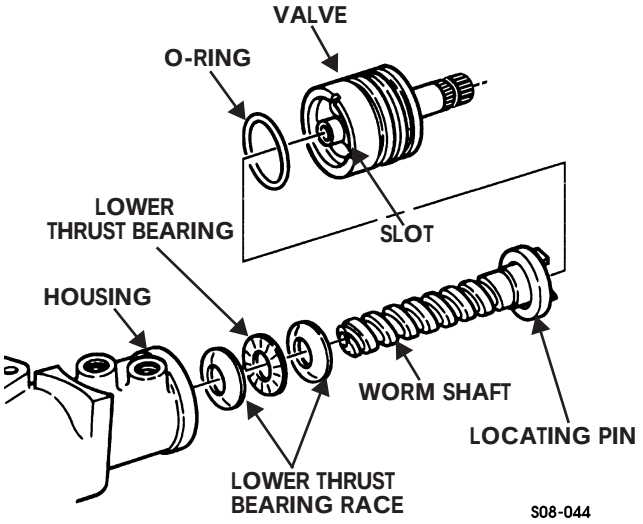

Figure 8-53: Worm Shaft Assembly

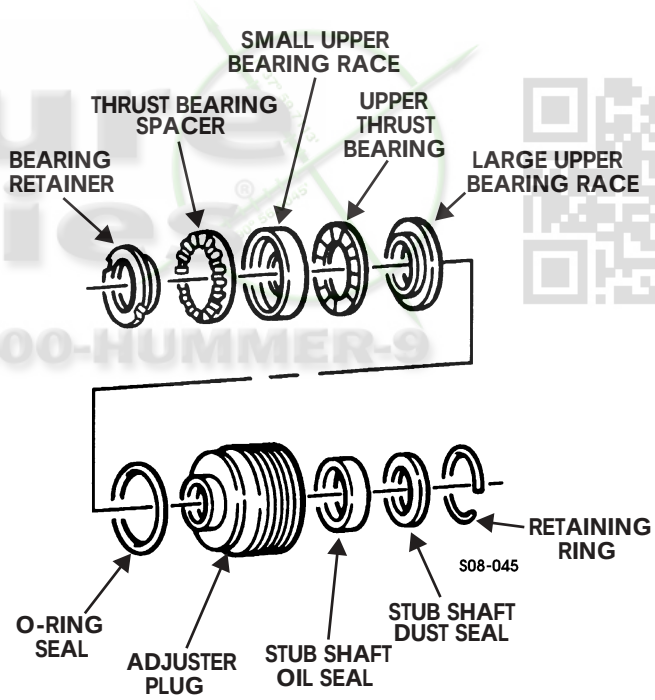

Figure 8-54: Adjuster Plug Assembly

NOTE: Coned surface of races face toward housing.

24. Install stub shaft oil seal in adjuster plug. Install far enough to provide clearance for stub shaft dust seal and retaining ring.
25. Install stub shaft dust seal and retaining ring in adjuster plug.
26. Using spanner wrench, install adjuster plug in housing. Do not tighten (Figure 8-55).
27. Install locknut over adjuster plug. Do not tighten.

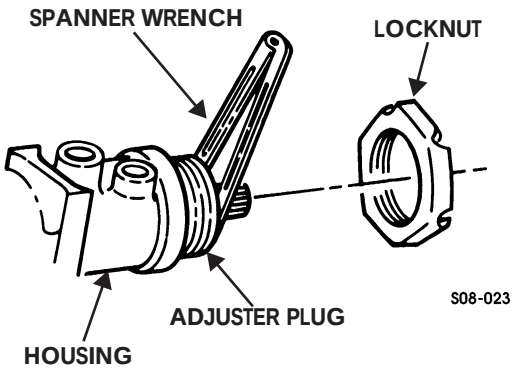

Figure 8-55: Adjuster Plug Housing

28. Install rack piston and rack piston arbor into gear housing so gear teeth on rack piston align with gear teeth on steering shaft (Figure 8-56).
29. Hold rack piston arbor tightly against rack piston while turning stub shaft clockwise. Remove piston arbor.
30. Install rack piston plug into rack piston. Do not tighten.
31. Center rack piston and install steering shaft in housing.

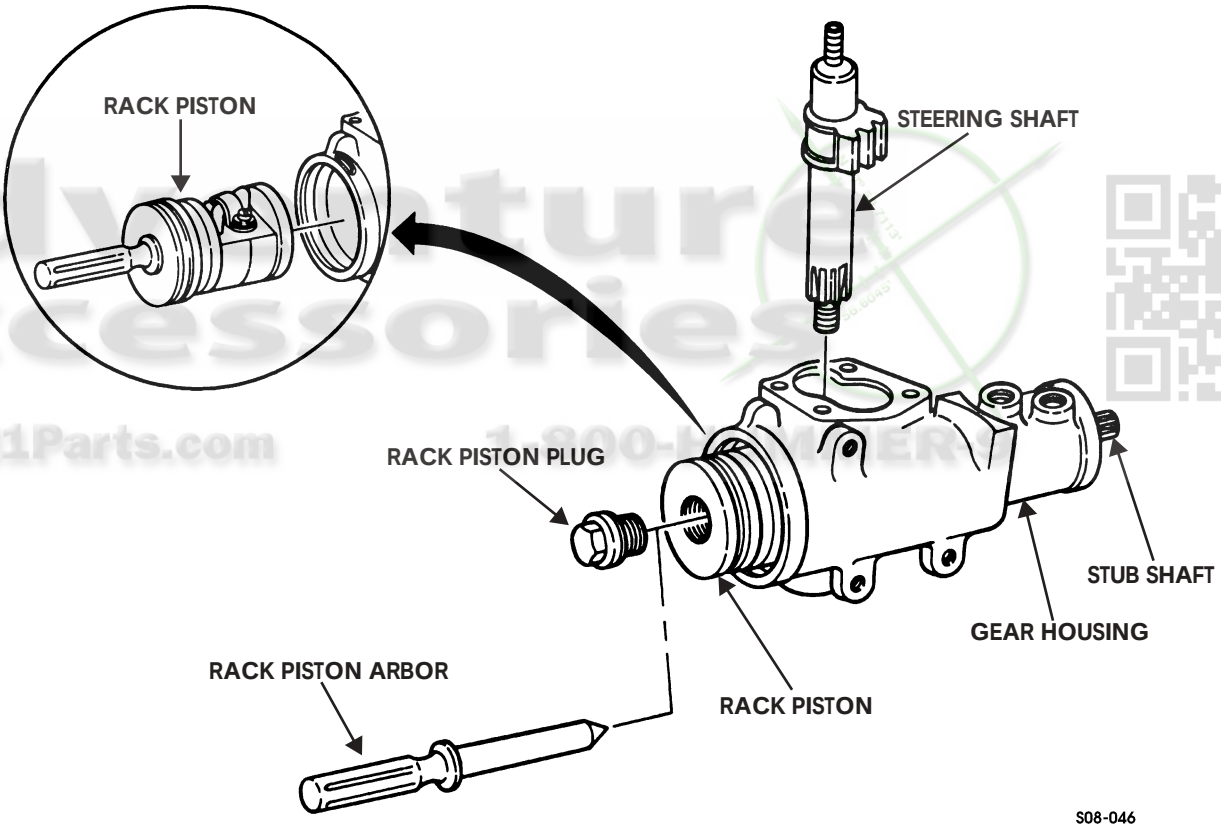

Figure 8-56: Rack Piston Plug and Steering Shaft Gear Housing

32. Tighten rack piston plug to 75 lb-ft (102 N•m).
33. Install O-ring seal and gear housing end plug in housing (Figure 8-57).

NOTE: Opening in retaining ring should be located approximately 1 in. (25 mm) from access hole.

34. Install retaining ring in gear housing.
35. Install side cover gasket on side cover by bending tabs around side cover edge.
36. Install screw side cover on adjuster screw.
37. Install four capscrews on side cover. Tighten capscrews to 40 lb-ft (54 N•m).
38. Install lash adjuster nut on steering shaft adjuster screw.

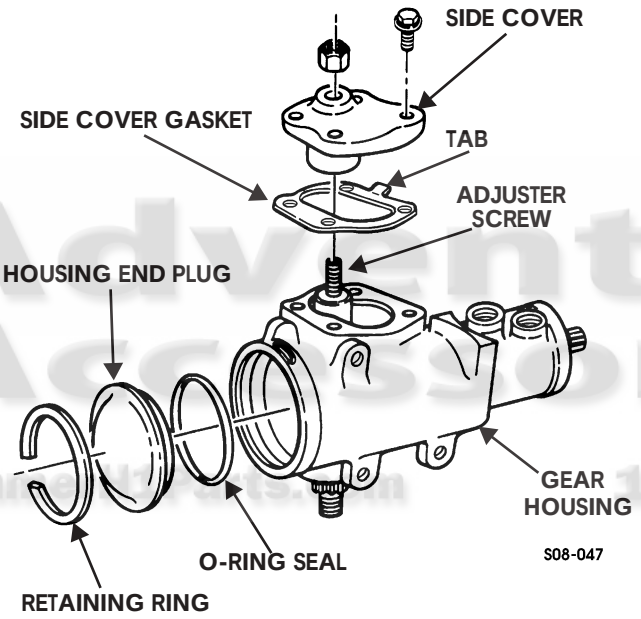

Figure 8-57: Gear Housing End Plug

Adjustment

1. For worm shaft bearing preload adjustment, remove locknut (Figure 8-58).

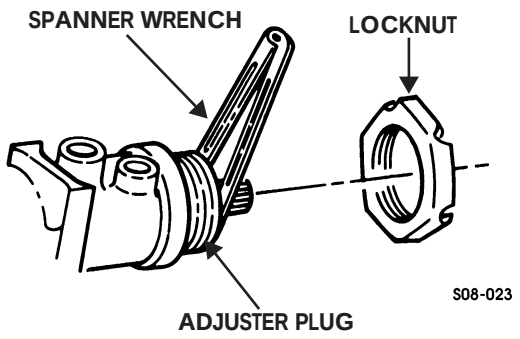

Figure 8-58: Adjuster Plug Into Gear Housing

2. Using spanner wrench, tighten adjuster plug clockwise until thrust bearing is firmly bottomed.
3. Match mark on housing and adjuster plug face (Figure 8-59).

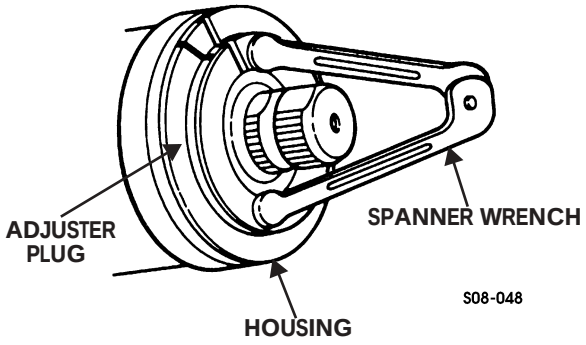

Figure 8-59: Housing and Adjuster Plug Faces

4. Measure back counterclockwise 0.5 in. (13 mm) and place second mark on housing.
5. Using spanner wrench, turn adjuster plug counterclockwise until mark on face of adjuster plug aligns with second mark on housing.
6. Install locknut on adjuster plug (Figure 8-58).
7. Hold adjuster plug using spanner wrench and tighten locknut (Figure 8-60).

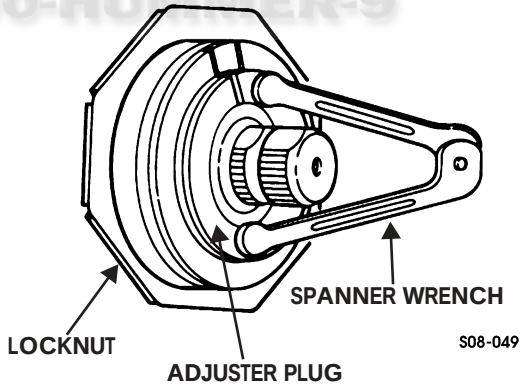

Figure 8-60: Tightening Locknut on Adjuster Plug

8. Turn stub shaft clockwise to stop, then back one-quarter turn (Figure 8-61).

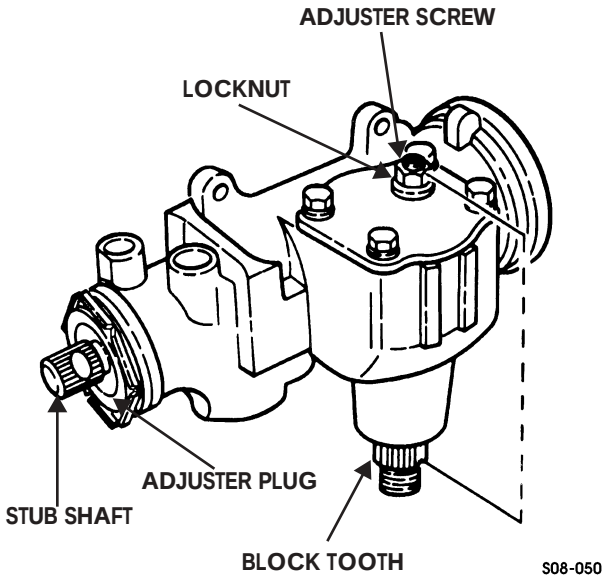

Figure 8-61: Stub Shaft

9. Check torque required to turn stub shaft. Reading should be 4.425-8.850 lb-in. (0.5-1 N•m).
10. If reading is not correct, turn adjuster plug in or out and repeat steps 7 through 9 until torque required to turn stub shaft is 4.425-8.850 lb-in. (0.5-1 N•m).
11. For steering shaft-over-center adjustment, loosen adjuster screw locknut.
12. Turn adjuster screw counterclockwise until fully extended, then turn clockwise one full turn.
13. Rotate stub shaft from stop-to-stop and count number of turns.
14. Back off stub shaft one-half number of turns counted.
15. Center gear flat on stub shaft so that it faces upward. Block tooth should be in line with adjuster screw.
16. With gear at center of travel, check torque to turn stub shaft.
17. Turn adjuster screw clockwise until torque for stub shaft is 6.195-8.850 lb-in. (0.7-1 N•m) more than reading obtained in step 16.
18. Hold adjuster screw and tighten locknut to 20 lb-ft (27 N•m).

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Section 9 Suspension and Frame

TABLE OF CONTENTS

SUSPENSION SYSTEM DESCRIPTION

The suspension system on the HUMMER delivers double A-arm independent suspension at all four wheels. This suspension system provides for a smoother ride and allows for more positive control of the vehicle. The system consists of a heavy-duty coil spring, a heavy-duty hydraulic shock absorber, and an upper and lower control arm at each wheel. The shock absorber controls wheel travel and dampens spring compression (jounce) and extensions (rebound) (Figure 9-1). When the wheel strikes a bump, it is driven upward. This causes the upper and lower control arms to pivot upward, which compresses the spring and shock absorber.

Ball joints allow the control arms and geared hubs to change angles for smooth steering during turns. A stabilizer bar is located on the front suspension to aid in stabilizing the vehicle when it is turning. Each end of the stabilizer bar is attached to the lower control arms. If one end of the vehicle's frame attempts to tip, one end of the bar is down while the other is up. This results in a twisting force within the stabilizer bar which causes it to resist the tipping action.

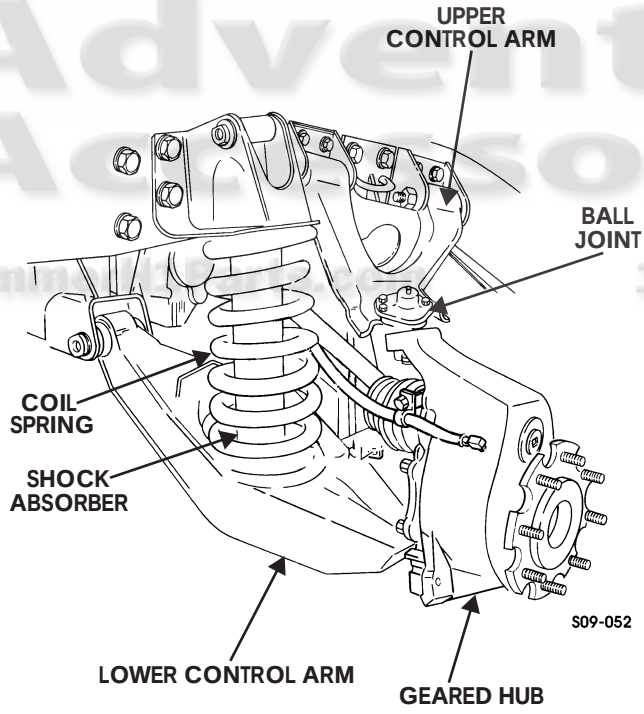

Figure 9-1: Suspension System

STABILIZER BAR REPLACEMENT

Removal

NOTE: Stabilizer bar must be removed from bar links at each end of lower control arms.

1. Remove two locknuts, three washers, and pin securing bar link to stabilizer bar. Discard locknuts (Figure 9-2).
2. Remove two locknuts, washers, clamp, and stabilizer bar from frame bracket. Discard locknuts.
3. Remove bushing from stabilizer bar.

Installation

1. Install bushing on stabilizer bar (Figure 9-2).
2. Install stabilizer bar on frame bracket with clamp, two washers, and locknuts. Tighten locknuts to 60 lb-ft (81 N•m).
3. Install stabilizer bar on bar link with pin, three washers, and two locknuts. Tighten locknuts to 75 lb-ft (102 N•m).

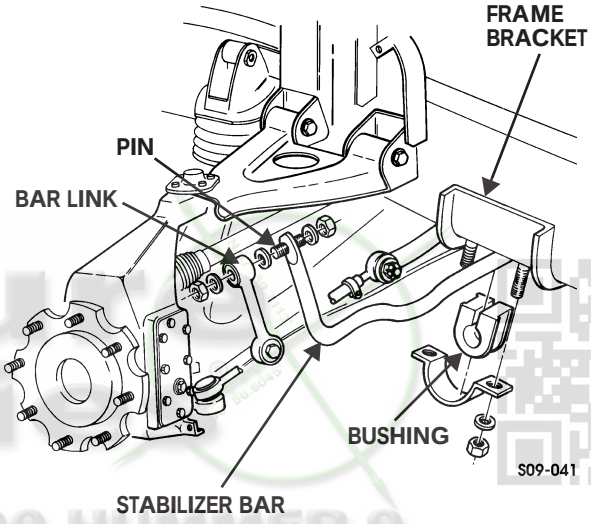

Figure 9-2: Stabilizer Bar

STABILIZER BAR LINK REPLACEMENT

Removal

1. Remove locknut and two washers securing bar link to stabilizer bar. Discard locknut (Figure 9-3).
2. Remove capscrew, two washers, and bar link from lower control arm.

Installation

1. Apply thread-locking compound to threads of capscrew. Install bar link to lower control arm with two washers and capscrew. Tighten capscrew to 70 lb-ft (95 N•m) (Figure 9-3).
2. Install bar link on stabilizer bar with two washers and locknut. Tighten locknut to 75 lb-ft (102 N•m).

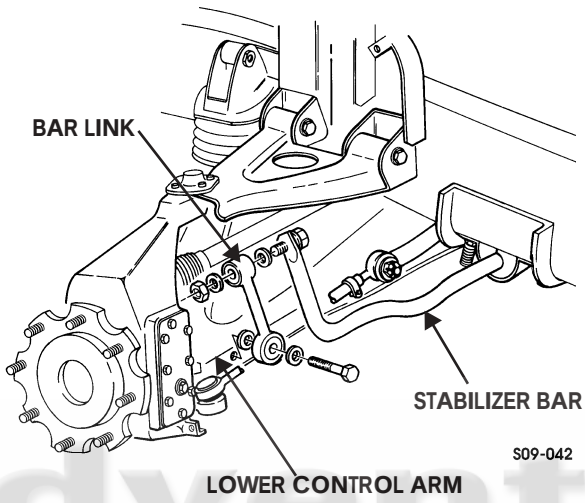

Figure 9-3: Stabilizer Bar Link

RADIUS ROD REPLACEMENT

Removal

1. Remove wheel (Section 6).
2. Remove cotter pin, slotted nut, and washer securing radius rod to geared hub. Discard cotter pin (Figure 9-4).
3. Using puller, separate radius rod from geared hub.
4. Remove locknut, washer, capscrew, washer, and radius rod from bracket. Discard locknut.

Installation

1. Install radius rod on bracket with washer, capscrew, washer, and locknut. Tighten locknut to 260 lb-ft (353 N•m) (Figure 9-4).

CAUTION: *Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

2. Install radius rod on geared hub with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m). Install cotter pin in slotted nut.
3. Install wheel (Section 6).

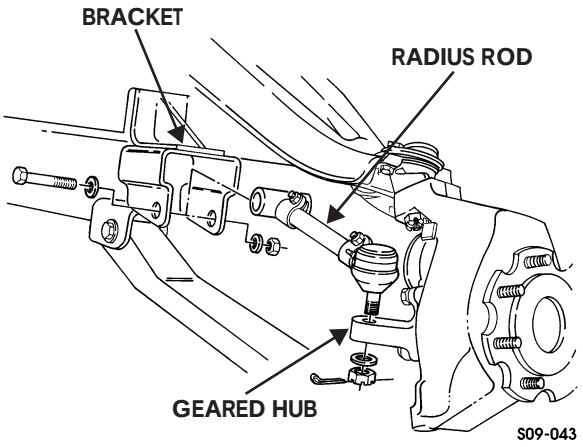

Figure 9-4: Radius Rod

UPPER BALL JOINT REPLACEMENT

Removal

1. Remove wheel (Section 6).
2. Raise and support lower control arm.
3. Remove cotter pin and slotted nut from upper ball joint. Discard cotter pin (Figure 9-5).
4. Remove four locknuts, washers, capscrews, washers, and upper ball joint from upper control arm. Discard locknuts.
5. Using puller, separate upper ball joint from geared hub and remove ball joint.

Installation

1. Position upper ball joint on upper control arm, ensuring upper ball joint is placed above upper control arm (Figure 9-6).

NOTE: Check upper ball joint torque 15 minutes after initial installation. Adjust if necessary.

2. Install upper ball joint on upper control arm with four washers, capscrews, washers, and locknuts. Tighten locknuts to 37 lb-ft (50 N•m).

CAUTION: *Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

3. Install upper ball joint on geared hub with slotted nut. Using crowfoot and adapter, tighten slotted nut to 65 lb-ft (88 N•m). Install cotter pin in slotted nut.
4. Lubricate upper ball joint (Section 1).
5. Install wheel (Section 6).

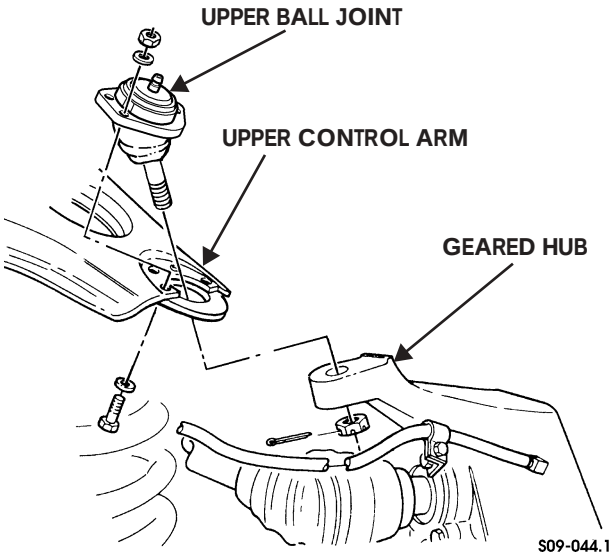

Figure 9-5: Upper Ball Joint

LOWER BALL JOINT REPLACEMENT

Removal

1. Remove wheel (Section 6).
2. Raise and support lower control arm (Figure 9-6).
3. Remove cotter pin and slotted nut from lower ball joint. Discard cotter pin.
4. Remove four locknuts, washers, capscrews, washers, and lower ball joint from lower control arm. Discard locknuts.
5. Using puller, separate lower ball joint from geared hub and remove lower ball joint.

Installation

1. Install lower ball joint on lower control arm, ensuring lower ball joint is placed below lower control arm and secure with four washers, capscrews, washers, and locknuts. Tighten front locknuts to 37 lb-ft (50 N•m) and rear locknuts to 70 lb-ft (95 N•m) (Figure 9-6).

CAUTION: *Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

2. Install ball joint on geared hub with slotted nut. Tighten slotted nut to 73 lb-ft (99 N•m) and install cotter pin in slotted nut.
3. Lubricate lower ball joint (Section 1).
4. Install wheel (Section 6).

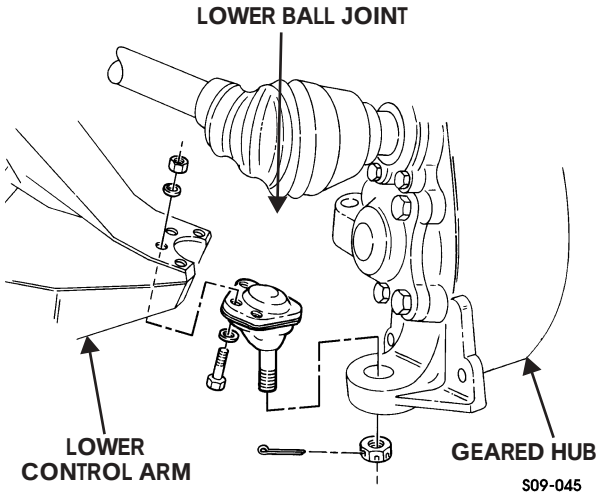

Figure 9-6: Lower Ball Joint

UPPER CONTROL ARM REPLACEMENT

NOTE: The procedure for removing and installing the front and rear upper control arms is basically the same. This procedure covers the left front upper control arm.

Removal

1. Remove wheel (Section 6).
2. Remove capscrew and washer securing vent line bracket to geared hub (Figure 9-7).
3. Disconnect vent line from fitting.
4. Remove capscrew, bracket, and vent line from upper control arm (Figure 9-8).
5. Remove four locknuts, washers, capscrews, and washers securing upper ball joint to upper control arm. Discard locknuts.
6. Remove cotter pin and slotted nut from upper ball joint. Discard cotter pin.
7. Using puller, separate upper ball joint from geared hub, and remove upper ball joint.
8. Remove two locknuts, washers, capscrews, washers, and upper control arm from brackets and remove upper control arm. Discard locknuts.

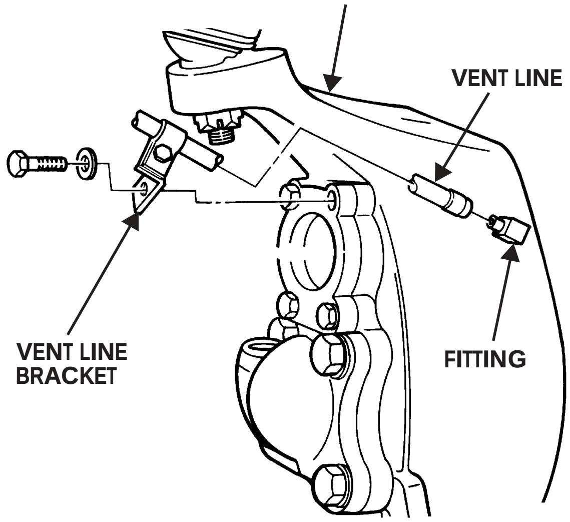

Figure 9-7: Vent Line Connection

Installation

NOTE: On front upper control arms, capscrew heads are toward rear of vehicle. On rear upper control arms, capscrew heads are toward front of vehicle.

1. Install upper control arm on brackets with two washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 9-8).
2. Secure upper ball joint to upper control arm with four washers, capscrews, washers, and locknuts. Tighten locknuts to 37lb-ft (50 N•m).

CAUTION: *Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

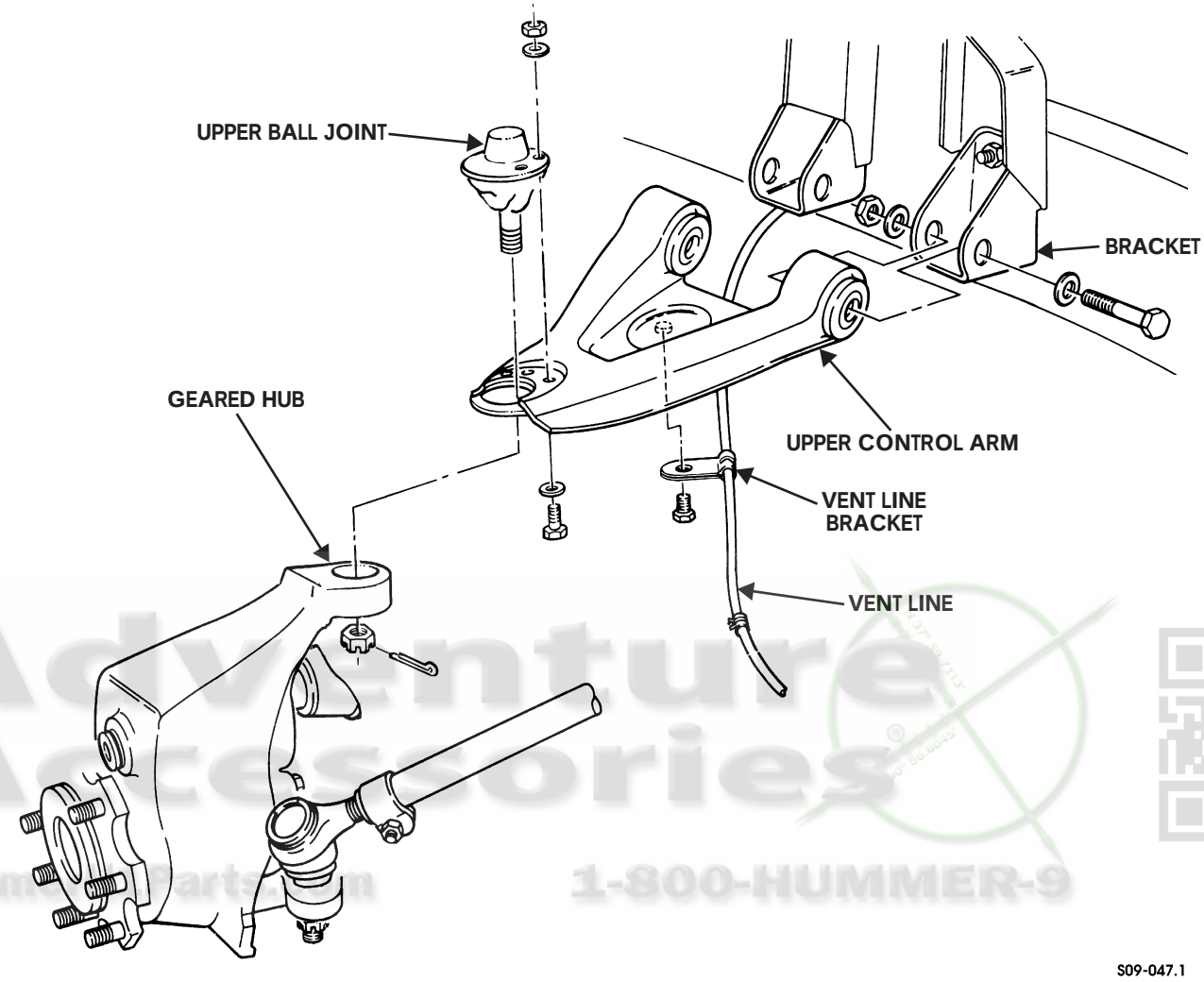

Figure 9-8: Upper Control Arm Assembly

3. Install upper ball joint on geared hub with slotted nut. Using crowfoot and adapter, tighten slotted nut to 65 lb-ft (88 N•m). Install cotter pin in slotted nut.
4. Tighten locknuts on brackets to 260 lb-ft (353 N•m).
5. Install bracket and vent line on upper control arm with capscrew.
6. Connect vent line to fitting (Figure 9-7).
7. Secure vent line bracket to geared hub with clamp, washer, and capscrew. Tighten capscrew to 37 lb-ft (50 N•m).
8. Install wheel (Section 6).

LOWER CONTROL ARM REPLACEMENT

NOTE: The procedure for removing and installing the front and rear lower control arms is basically the same. This procedure covers the left front lower control arm.

Removal

WARNING: Lower control arm must be supported during removal and installation. Failure to support lower control arm may cause personal injury or damage to equipment.

1. Remove wheel (Section 6).
2. Remove shock absorber.
3. Remove capscrew, two washers, and bar link (front only) from lower control arm (Figure 9-9).
4. Remove four locknuts, washers, capscrews, and washers from lower ball joint and lower control arm. Discard locknuts (Figure 9-10).
5. Raise and support lower control arm, and remove lower ball joint from arm.
6. Lower the lower control arm and remove coil spring.
7. Remove two locknuts, washers, capscrews, washers, and lower control arm from brackets. Discard locknuts.

NOTE: Removing the lower ball joint from the geared hub will ease installation.

8. Remove cotter pin and slotted nut from lower ball joint. Discard cotter pin.
9. Using puller, separate lower ball joint from geared hub and remove lower ball joint.

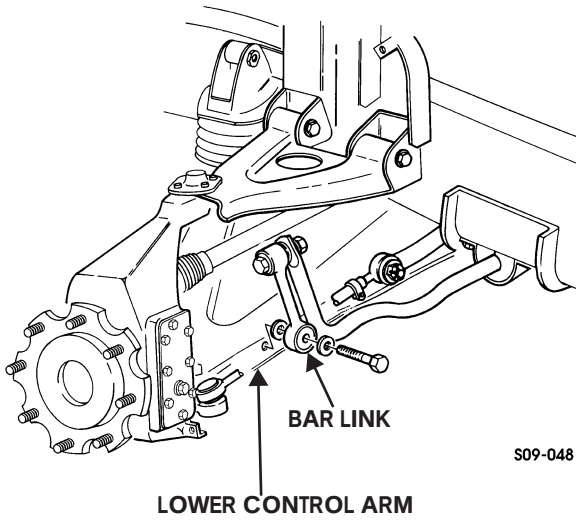

Figure 9-9: Bar Link

Installation

WARNING: Lower control arm must be supported during removal and installation. Failure to support lower control arm may cause personal injury or damage to equipment.

NOTE: On lower control arms, capscrew heads are toward front of vehicle.

1. Install lower control arm on brackets with two washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 9-10).

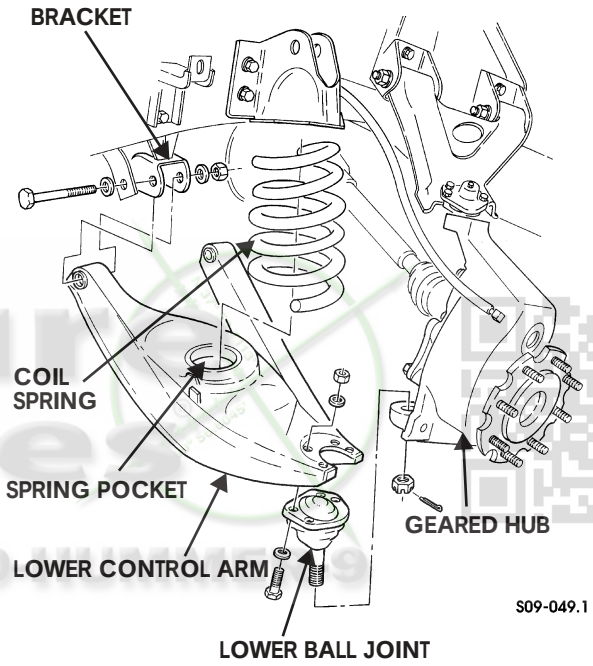

Figure 9-10: Lower Control Arm

2. Install coil spring on lower control arm ensuring end of coil spring fits in spring pocket of lower control arm.
3. Install lower ball joint on lower control arm, ensuring ball joint is placed below lower control arm.
4. Secure lower ball joint to lower control arm with four washers, capscrews, washers, and locknuts. Tighten front locknuts to 37 lb-ft (50 N•m) and rear locknuts to 70 lb-ft (95 N•m).
5. Install lower ball joint on geared hub with slotted nut. Tighten slotted nut to 73 lb-ft (99 N•m), and install cotter pin in slotted nut.
6. Tighten locknuts on brackets to 260 lb-ft (353 N•m).
7. Apply thread-locking compound to threads of capscrew. Install bar link on lower control arm with two washers and capscrew. Tighten capscrew to 70 lb-ft (95 N•m) (Figure 9-9).
8. Install shock absorber.
9. Install wheel (Section 6).

COIL SPRING REPLACEMENT

NOTE: The procedure for removing and installing all four coil springs is basically the same. This procedure covers the left front coil spring.

Removal

1. Remove wheel (Section 6).
2. Remove capscrew, two washers, and bar link from lower control arm (Figure 9-8).
3. Remove four locknuts, washers, capscrews, washers, lower ball joint, and geared hub from lower control arm. Discard locknuts.
4. Place jack under lower control arm and raise lower control arm slightly to relieve tension on shock pin.
5. Remove locknut, shock pin, washer, and shock absorber from spring seat and collapse shock absorber. Discard locknut.

NOTE: It may be necessary to loosen lower control arm capscrews to allow lower control arm to be lowered.

6. Pull geared hub and lower ball joint away from lower control arm and remove coil spring from lower control arm and shock absorber.

Installation

NOTE: Index coil spring in spring pocket for a slight gap (1/16 - 1/8 in. (1.59 - 3.18 mm) when spring is in position.

1. Install coil spring over shock absorber and onto lower control arm ensuring end of coil spring fits in spring pocket of lower control arm (Figure 9-11).
2. Ensure coil spring is aligned with spring seat flange, and raise lower control arm.
3. Extend shock absorber into spring seat and install with washer, shock pin, and locknut. Tighten locknut to 300 lb-ft (407 N•m).
4. Install lower ball joint and geared hub on lower control arm ensuring lower ball joint is placed below lower control arm. Secure lower ball joint to lower control arm with four washers, capscrews, washers, and locknuts. Tighten front locknuts to 37-lb-ft (50 N•m) and rear locknuts to 70 lb-ft. (95 N•m).
5. Apply thread-locking compound to threads of capscrew. Install bar link on lower control arm with two washers and capscrew. Tighten capscrew to 70 lb-ft (95 N•m).
6. Install wheel (Section 6).

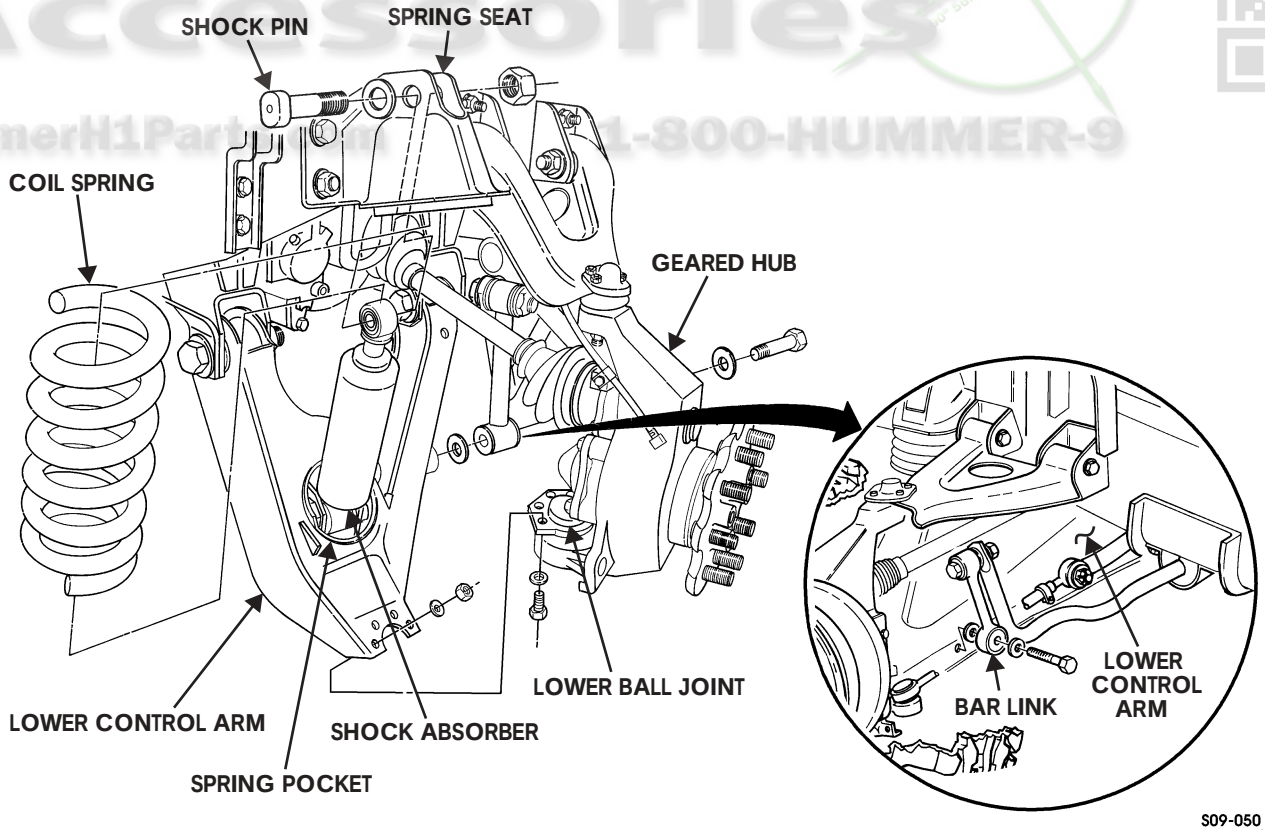

Figure 9-11: Coil Spring

SHOCK ABSORBER REPLACEMENT

NOTE: The procedure for removing and installing all shock absorbers is the same, except rear lower shock pins must be installed with head of pin facing rearward. This procedure covers the left front shock absorber.

NOTE: Do not jack up vehicle with shock absorber removed.

Removal

1. Remove two capscrews, lockwashers, washers, shock absorber, and bracket from lower control arm. Discard lockwashers (Figure 9-12).
2. Remove locknut, shock pin, washer, and shock absorber from spring seat. Note position of pin for installation. Discard locknut.
3. Compress shock absorber and remove shock absorber and bracket.

NOTE: Note alignment of shock absorber and bracket for installation reference.

4. Position shock absorber in vise and remove locknut, pin, washer, and bracket from shock absorber. Discard locknut.

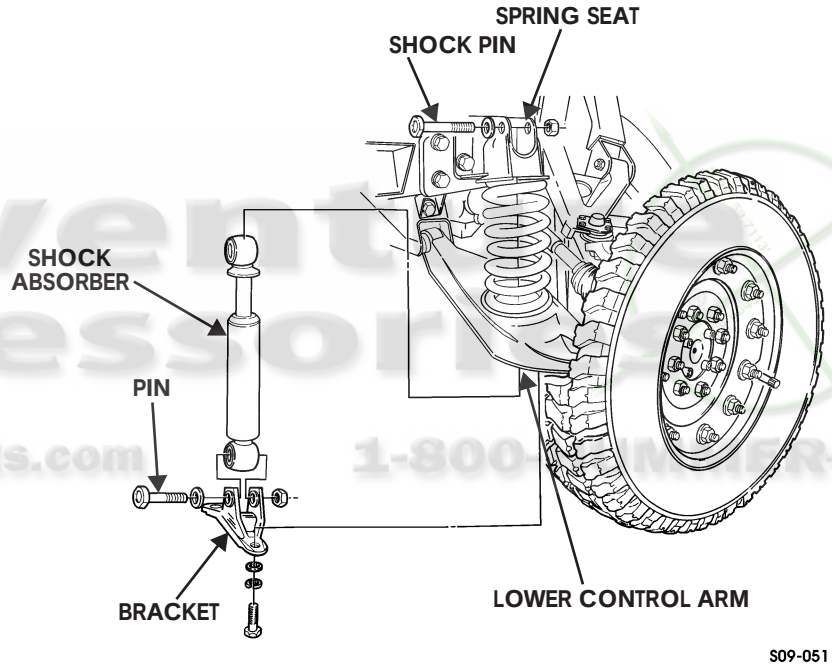

Figure 9-12: Shock Absorber

Installation

NOTE: It may be necessary to spread spring seat to allow installation of shock absorber.

1. Position shock absorber in vise, and install bracket on shock absorber with washer, pin, and locknut. Tighten locknut to 300 lb-ft (407 N•m) (Figure 9-12).

CAUTION: *Do not pry or use sharp tools on shock absorber piston rod. A damaged rod will cause shock failure.*

2. Install shock absorber and bracket through lower control arm.
3. Extend shock absorber and secure piston rod end of shock absorber to spring seat with washer, shock pin, and locknut. Tighten locknut to 300 lb-ft (407 N•m).
4. Install bracket on lower control arm with two washers, lockwashers, and capscrews. Tighten capscrews to 178 lb-ft (241 N•m).

FRONT BUMPER AND TOWING BRACKETS REPLACEMENT (VEHICLES WITHOUT WINCH)

Removal

1. Remove brushguard, if installed (Section 10).
2. Remove four locknuts, washers, capscrews, washers, two towing brackets, and front bumper from mounting brackets. Discard locknuts (Figure 9-13).

Installation

1. Install front bumper and two towing brackets on mounting brackets with four washers, capscrews, washers, and locknuts. Tighten capscrews to 90 lb-ft (122 N•m) (Figure 9-13).
2. Install brushguard, if removed (Section 10).

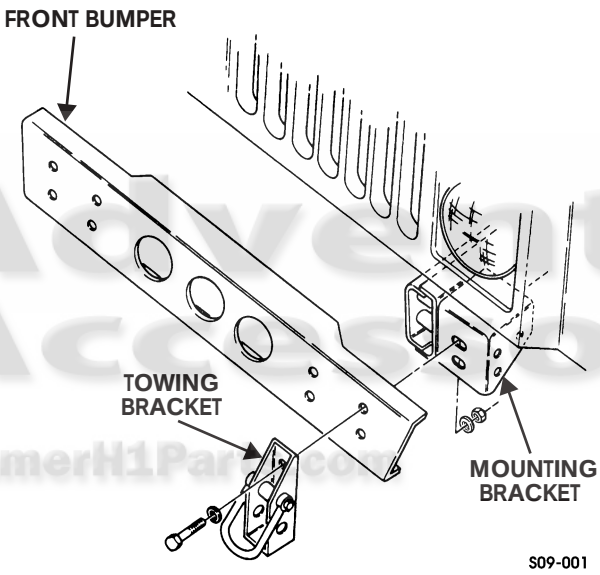

Figure 9-13: Front Bumper and Towing Brackets for Vehicles Without Winch

FRONT BUMPER AND TOWING BRACKETS REPLACEMENT (VEHICLES WITH WINCH)

Removal

CAUTION: *Winch must be supported prior to performing step 1. Failure to observe this caution will result in damage to equipment.*

1. Remove four capscrews and washers securing winch to front bumper (Figure 9-14).
2. Remove four locknuts, washers, capscrews, washers, and two towing brackets from front bumper and frame extensions. Discard locknuts.
3. Remove five locknuts, washers, six capscrews, washers, and front bumper from frame extensions. Discard locknuts.

Installation

1. Install front bumper on frame extensions with six washers, capscrews, five washers, and locknuts. Tighten capscrews to 90 lb-ft (122 N•m) (Figure 9-14).
2. Install two towing brackets on front bumper and frame extensions with four washers, capscrews, washers, and locknuts. Tighten capscrews to 90 lb-ft (122 N•m).
3. Install four capscrews and washers securing front bumper to winch. Tighten capscrews to 60 lb-ft (81 N•m).

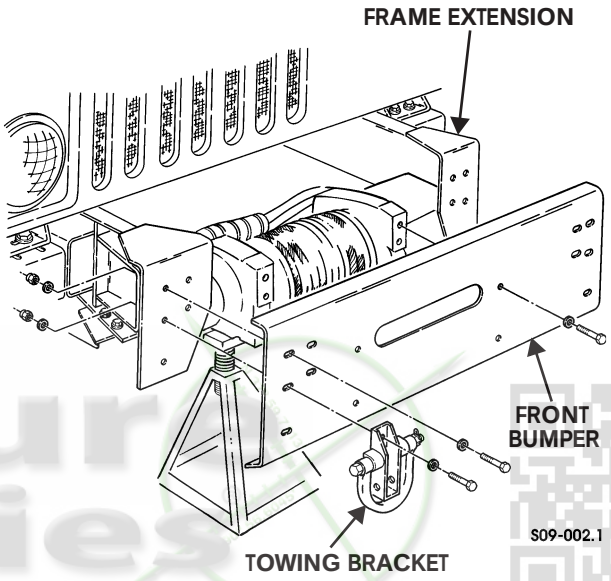

Figure 9-14: Front Bumper and Towing Brackets for Vehicles With Winch

FRONT BUMPER MOUNTING BRACKET REPLACEMENT

Removal

NOTE: Mark location of capscrews for installation.

1. Support hood in position with jacks.
2. Remove three locknuts, washers, capscrews, and washers securing mounting bracket to frame rail. Discard locknuts (Figure 9-15).
3. Remove two locknuts and plate securing mounting bracket to hinge. Discard locknuts.
4. Remove two locknuts, washers, capscrews, washers, towing bracket, and mounting bracket from front bumper. Discard locknuts.

Installation

1. Install mounting bracket and towing bracket on front bumper with two washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 9-15).
2. Install mounting bracket on frame rail with three washers, capscrews, washers, and locknuts. Do not tighten locknuts.
3. Install mounting bracket on hinge with plate and two locknuts.
4. Tighten hinge locknuts to 28 lb-ft (38 N•m), front bumper locknuts to 90 lb-ft (122 N•m), and frame rail locknuts to 178 lb-ft (241 N•m).
5. Remove jacks supporting hood.

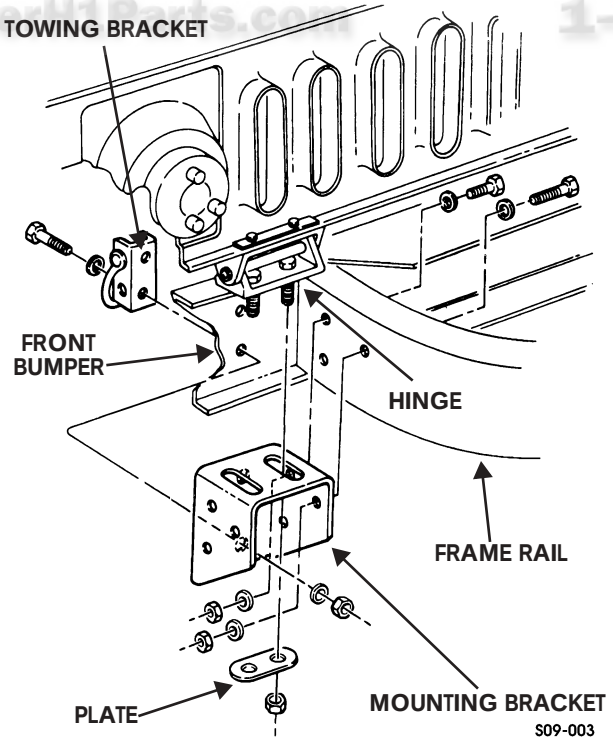

Figure 9-15: Front Bumper Mounting Bracket

RADIATOR FRONT MOUNT BRACKET REPLACEMENT

Removal

1. Remove locknut, washer, capscrew, washer, and spacer securing radiator to front mount bracket. Discard locknut (Figure 9-16).
2. Remove two locknuts, washers, capscrews, washers, and front mount bracket from suspension crossmember. Discard locknuts.
3. Remove mount from front mount bracket.

Installation

1. Install mount in front mount bracket. (Figure 9-16).
2. Install front mount bracket on suspension crossmember with two washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m).
3. Install radiator on front mount bracket with spacer, washer, capscrew, washer, and locknut. Tighten locknut to 30 lb-ft (41 N•m).

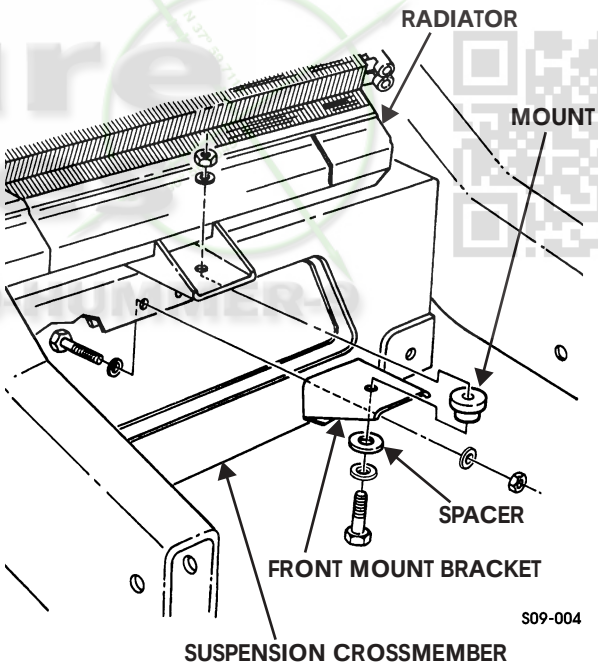

Figure 9-16: Radiator Front Mount Bracket

LIFTING SHACKLE REPLACEMENT

Removal

Remove cotter pin, slotted nut, capscrew, spring washer, and shackle from tiedown bracket. Discard cotter pin (Figure 9-17).

Installation

1. Install shackle on tiedown bracket with spring washer, capscrew, and slotted nut. Tighten slotted nut enough to allow movement of shackle (Figure 9-17).
2. Install cotter pin in slotted nut.

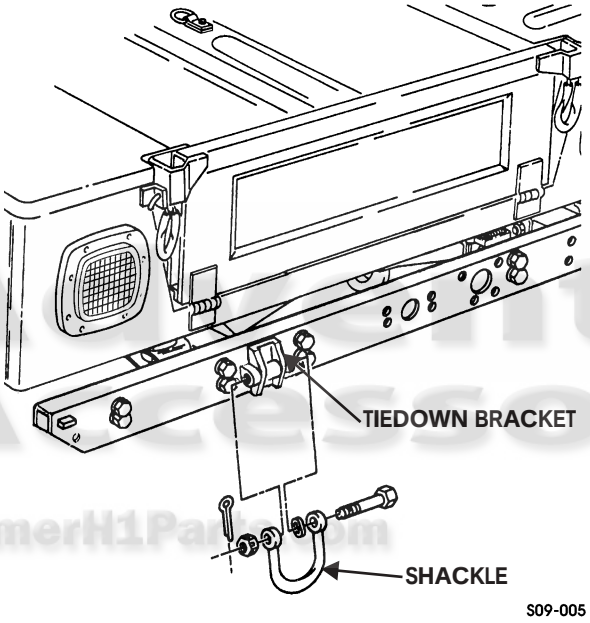

Figure 9-17: Lifting Shackle

FRAME EXTENSION REPLACEMENT

Removal

1. Remove front bumper.
2. Remove hood and hinge (Section 10).
3. Remove two locknuts, washers, capscrews, and washers securing front suspension brace to frame extension (Figure 9-18).

NOTE: Note position of winch cable bracket for installation.

4. Remove three locknuts, washers, capscrews, and washers securing winch cable bracket, frame extension, and bumper mounting bracket to frame. Discard locknuts.

Installation

1. Install bumper mounting bracket, frame extension, and winch cable bracket on frame with three washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 9-18).
2. Secure front suspension brace to frame extension with two washers, capscrews, washers, and locknuts.
3. Tighten all locknuts to 178 lb-ft (241 N•m).
4. Install hinge and hood (Section 10).
5. Install front bumper.

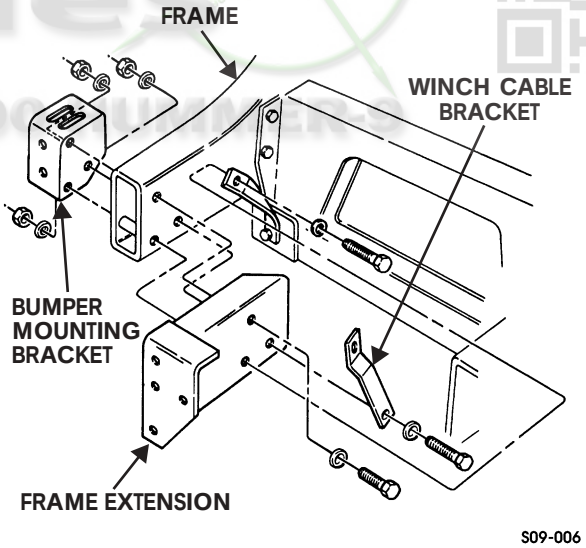

Figure 9-18: Frame Extension

LEFT AIRLIFT BRACKET AND FRONT UPPER CONTROL ARM BRACKETS REPLACEMENT

Removal

1. Remove left engine splash shield (Section 10).
2. Raise and support front of vehicle.
3. Remove three screws and clamps securing harness to airlift bracket (Figure 9-19).
4. Remove two locknuts, washers, and capscrews securing radiator support to airlift bracket. Discard locknuts.

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation.

5. Remove two locknuts, washers, capscrews, washers, and upper control arm from two control arm brackets. Discard locknuts.

NOTE: Note direction of capscrews for installation.

NOTE: Mark location and number of shims for installation.

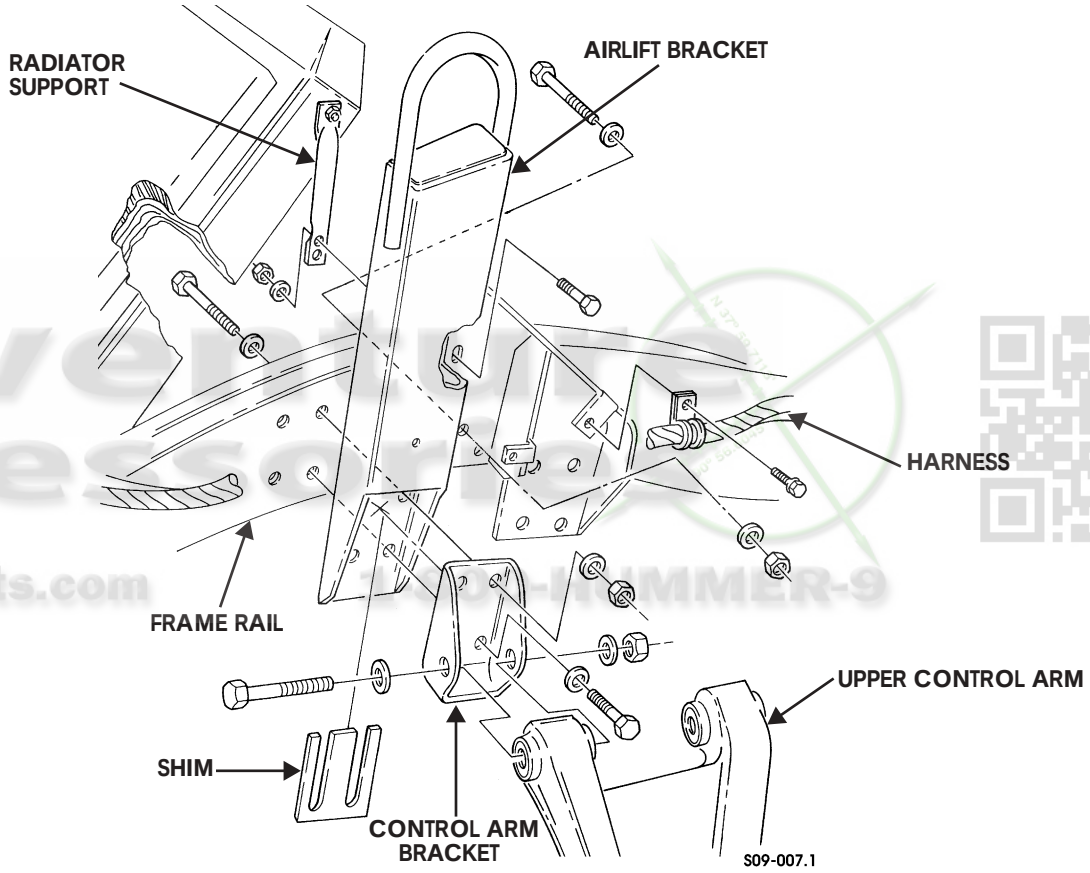

Figure 9-19: Left Airlift Bracket and Front Upper Control Arm Brackets

6. Remove eight locknuts, washers, capscrews, washers, two control arm brackets, and shim(s) from airlift bracket. Discard locknuts.
7. Remove two capscrews, washers, and airlift bracket from frame rail.

Installation

1. Install airlift bracket, shim(s), and two control arm brackets on frame rail with eight washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-19).
2. Apply thread-locking compound to two capscrew holes and secure airlift bracket and control arm brackets to frame rail with two washers and capscrews. Tighten capscrews to 90 lb-ft (122 N•m).
3. Install upper control arm on control arm brackets with two washers, capscrews, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
4. Secure radiator support to airlift bracket with two capscrews, washers, and locknuts. Tighten locknuts to 37 lb-ft (50 N•m).
5. Secure harness to airlift bracket with three clamps and screws.
6. Lower front of vehicle.
7. Install left engine splash shield (Section 10).

RIGHT AIRLIFT BRACKET AND FRONT UPPER CONTROL ARM BRACKETS REPLACEMENT

Removal

1. Remove battery tray (Section 12).
2. Raise and support front of vehicle.
3. Remove two locknuts, washers, and capscrews securing radiator support to airlift bracket. Discard locknuts (Figure 9-20).

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation

4. Remove two locknuts, washers, capscrews, washers, and upper control arm from two control arm brackets. Discard locknuts.

NOTE: Note direction of capscrews for installation.

5. Remove ten locknuts, washers, capscrews, and washers securing control arm brackets, cooler line bracket, and airlift bracket to frame rail. Discard locknuts.

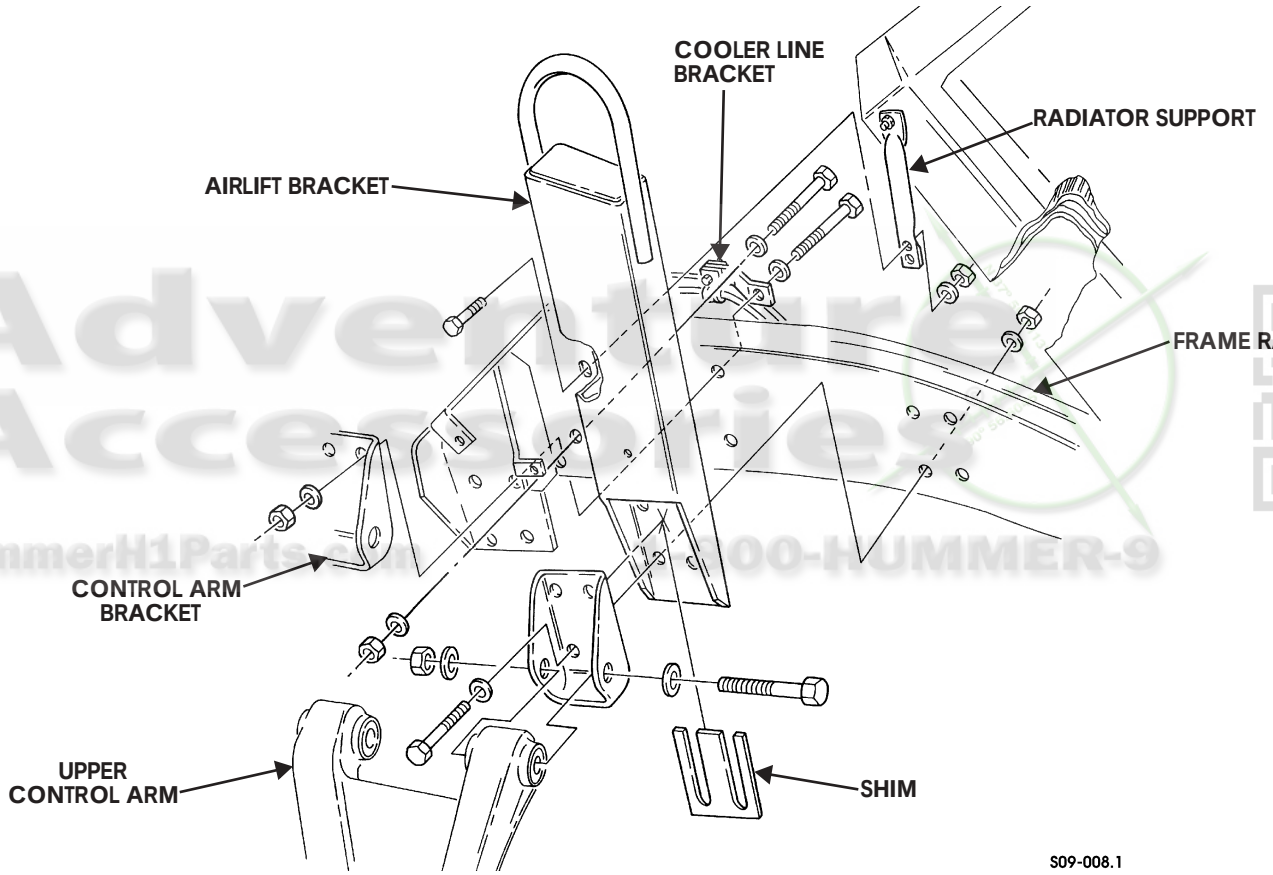

Figure 9-20: Right Airlift Bracket and Front Upper Control Arm Brackets

NOTE: Mark location and number of shims for installation.

6. Remove two control arm brackets, shim(s), and airlift bracket from frame rail.

Installation

1. Install airlift bracket, shim(s) two control arm brackets, and cooler line bracket on frame rail with ten washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-20).
2. Secure upper control arm to two control arm brackets with two washers, capscrews, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
3. Install radiator support on airlift bracket with two capscrews, washers, and locknuts. Tighten locknuts to 37 lb-ft (50 N•m).
4. Lower front of vehicle.
5. Install battery tray (Section 12).

FRONT SUSPENSION BRACE REPLACEMENT (VEHICLES WITHOUT WINCH)

Removal

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation.

1. Remove locknut, washer, capscrew, and washer securing brace to frame rail. Discard locknut (Figure 9-21).
2. Remove locknut, washer, capscrew, washer, and brace from crossmember and lower control arm. Discard locknut.

Installation

1. Install brace on crossmember and lower control arm with washer, capscrew, washer, and locknut. Do not tighten locknuts (Figure 9-21).
2. Install brace on frame rail with washer, capscrew, washer, and locknut.
3. Tighten crossmember locknut to 261 lb-ft (354 N•m) and frame rail locknut to 178 lb-ft (241 N•m).

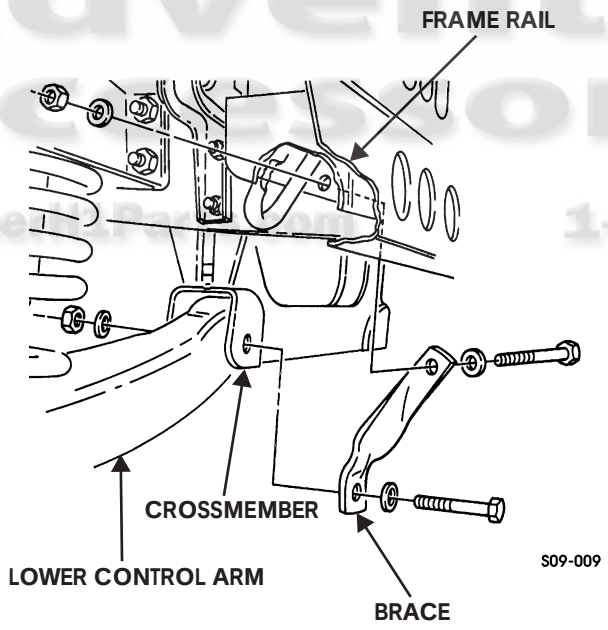

Figure 9-21: Front Suspension Brace for Vehicles Without Winch

FRONT SUSPENSION BRACE REPLACEMENT (VEHICLES WITH WINCH)

Removal

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation.

NOTE: The left and right front suspension braces are replaced basically the same. This procedure covers the left front suspension brace.

1. Remove two locknuts, washers, capscrews, and washers securing front suspension brace to frame extension. Discard locknuts (Figure 9-22).
2. Remove locknut, washer, capscrew, washer, and brace from crossmember and lower control arm. Discard locknut.

Installation

1. Install brace on crossmember and lower control arm with washer, capscrew, washer, and locknut. Do not tighten locknut (Figure 9-22).
2. Secure brace to frame extension with two washers, capscrews, washers, and locknuts.
3. Tighten crossmember locknut to 261 lb-ft (354 N•m) and frame extension locknuts to 178 lb-ft (241 N•m).

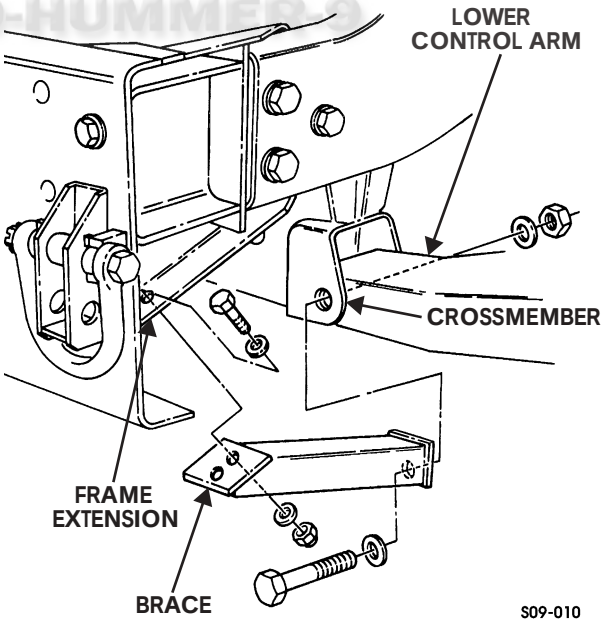

Figure 9-22: Front Suspension Brace for Vehicles With Winch

SPLASH SHIELD SUPPORT BRACKET REPLACEMENT

Removal

1. Remove locknut, washer, capscrew, and washer securing splash shield to bracket. Discard locknut (Figure 9-23).

NOTE: Note direction of capscrews for installation.

2. Remove two locknuts, washers, capscrews, washers, and bracket from frame rail. Discard locknuts.

Installation

1. Install bracket on frame rail with two washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-23).
2. Install splash shield on bracket with washer, capscrew, washer, and locknut. Tighten capscrew to 15 lb-ft (20 N•m).

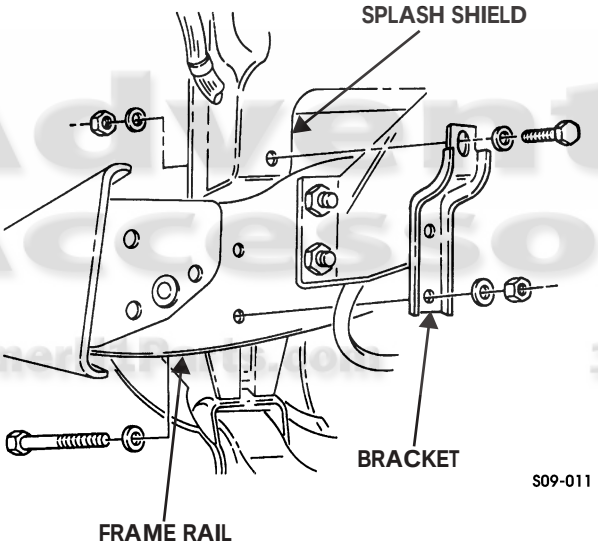

Figure 9-23: Splash Shield Support Bracket

REAR BUMPER REPLACEMENT

Removal

1. Remove swing-away spare tire carrier, if equipped (Section 6).
2. Remove rear license plate bracket (Section 10).
3. Remove trailer hitch, if equipped (Section 13).
4. Remove two locknuts, washers, capscrews, and washers securing trailer harness to rear bumper. Discard locknuts (Figure 9-24).
5. Disconnect trailer harness from body harness, and pull trailer harness through hole in rear bumper.
6. Remove four locknuts, washers, capscrews, and washers securing two tiedown brackets to rear bumper, two mounting brackets, and outer mounting brackets. Discard locknuts.

NOTE: Perform step 7 only if the vehicle is equipped with a swing-away spare tire carrier.

7. Remove two locknuts, washers, capscrews, and washers securing rear bumper to outer brace. Discard locknuts.

NOTE: Perform step 8 only if the vehicle is not equipped with a trailer hitch.

8. Remove four locknuts, washers, capscrews, and washers securing rear bumper to two inner braces. Discard locknuts.
9. Remove eight capscrews, washers, and rear bumper from two mounting brackets.

Installation

1. Install rear bumper on two mounting brackets and secure with eight washers and capscrews. Do not tighten capscrews (Figure 9-24).

NOTE: Perform step 2 only if the vehicle is not equipped with a trailer hitch.

2. Secure rear bumper to two inner braces with four washers, capscrews, washers, and locknuts. Do not tighten locknuts.

NOTE: Perform step 3 only if the vehicle is equipped with a swing-away spare tire carrier.

3. Secure rear bumper to outer brace with two washers, capscrews, washers, and locknuts. Do not tighten locknuts.
4. Install two tiedown brackets on rear bumper, two mounting brackets, and outer mounting brackets, with four washers, capscrews, washers, and locknuts. Do not tighten locknuts.
5. Tighten capscrews installed in step 1 and locknuts installed in steps 2, 3, and 4 to 90 lb-ft (122 N•m).
6. Insert trailer harness through hole in rear bumper and connect trailer harness to body harness.
7. Secure trailer harness to rear bumper with two washers, capscrews, washers, and locknuts.
8. Install trailer hitch, if removed (section 13).
9. Install rear license plate bracket (Section 10).
10. Install swing-away spare tire carrier, if removed (Section 6).

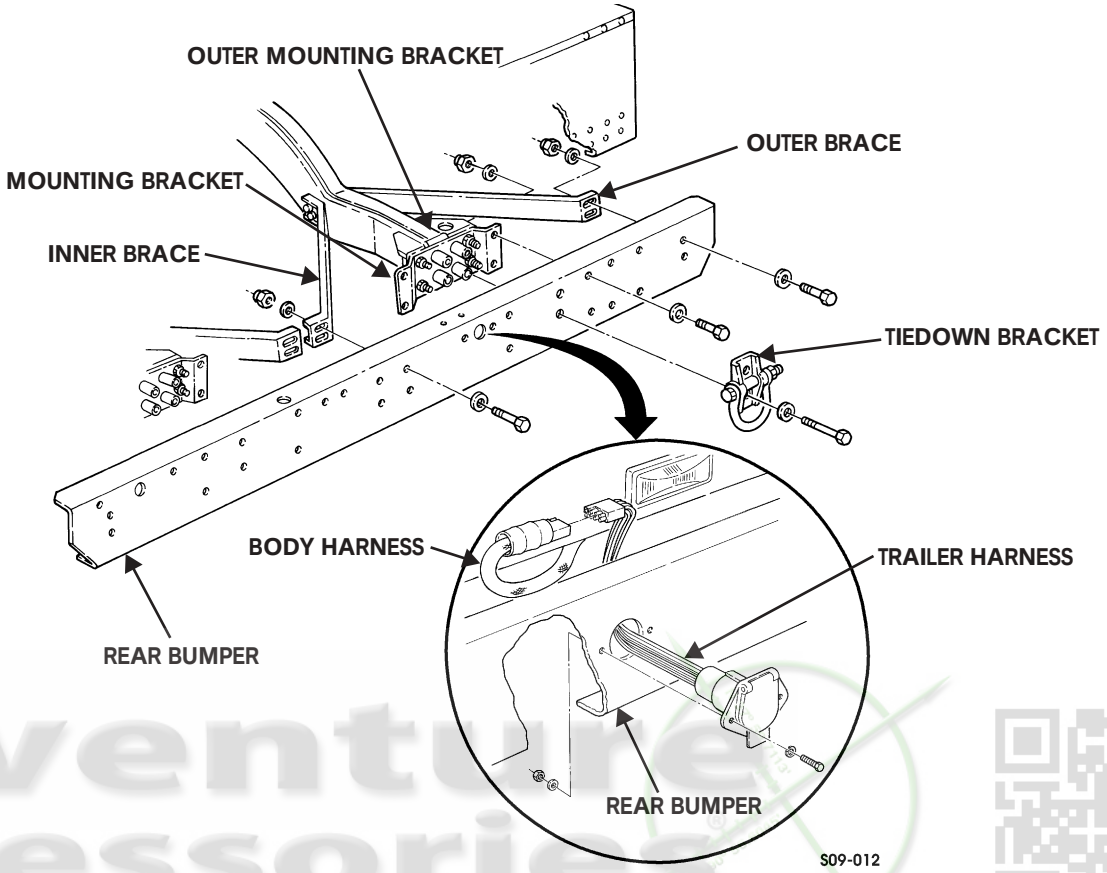

Figure 9-24: Rear Bumper

REAR BUMPER INNER MOUNTING BRACKET REPLACEMENT

Removal

1. Remove two capscrews and washers securing inner mounting bracket to mounting bracket (Figure 9-25).
2. Remove four locknuts, washers, capscrews, washers, inner mounting bracket, and spacer from frame rail and outer mounting bracket. Discard locknuts.

Installation

NOTE: Ensure spacer on outer side of frame rail is in position before installing spacer and inner mounting bracket.

1. Install spacer and inner mounting bracket on frame rail and outer mounting bracket and secure with four washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-25).
2. Secure inner mounting bracket to mounting bracket with two washers and capscrews. Tighten capscrews to 90 lb-ft (122 N•m).

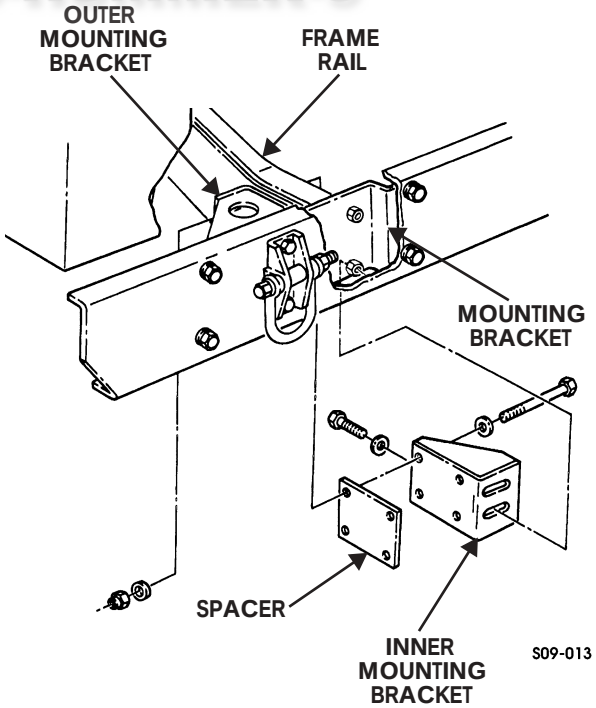

Figure 9-25: Rear Bumper Mounting Bracket

SPRING SEAT REPLACEMENT

NOTE: Replacement of the four spring seats is basically the same. This procedure covers the right front spring seat.

Removal

1. Remove coil spring.
2. Remove four locknuts, washers, capscrews, washers, spring bracket, and front spring seat from frame rail. Discard locknuts (Figure 9-26).

Installation

1. Install spring bracket and front spring seat on frame rail with four washers, capscrews, washers, and locknuts. Tighten locknuts to 261 lb-ft (354 N•m) (Figure 9-26).
2. Install coil spring.

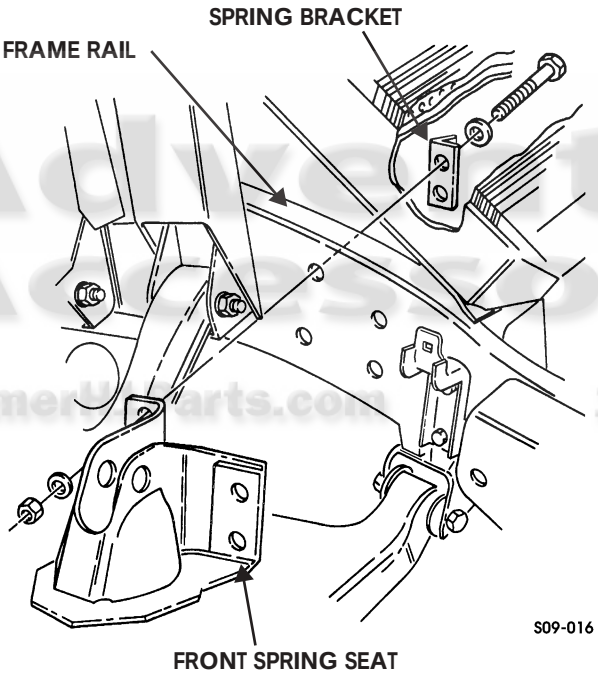

Figure 9-26: Front Spring Seat

REAR BUMPER OUTER MOUNTING BRACKET AND TIEDOWN BRACKET REPLACEMENT

Removal

1. Remove rear body mount (Section 10).
2. Remove two locknuts, washers, capscrews, and washers securing tiedown bracket and outer mounting bracket to mounting bracket and rear bumper. Discard locknuts (Figure 9-27).
3. Remove two capscrews and washers securing outer mounting bracket to mounting bracket.
4. Remove four locknuts, washers, capscrews, washers, outer mounting bracket, and spacer from frame rail and inner mounting bracket. Discard locknuts.

Installation

NOTE: Ensure spacer on inner side of frame rail is in position before installing spacer and outer mounting bracket.

1. Install spacer and outer mounting bracket on frame rail and inner mounting bracket with four washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 9-27).
2. Secure outer mounting bracket to mounting bracket with two washers and capscrews. Do not tighten capscrews.
3. Install tiedown bracket on rear bumper and secure tiedown bracket and outer mounting bracket to mounting bracket and rear bumper with two washers, capscrews, washers, and locknuts.
4. Tighten all locknuts and capscrews to 90 lb-ft (122 N•m).
5. Install rear body mount (Section 10).

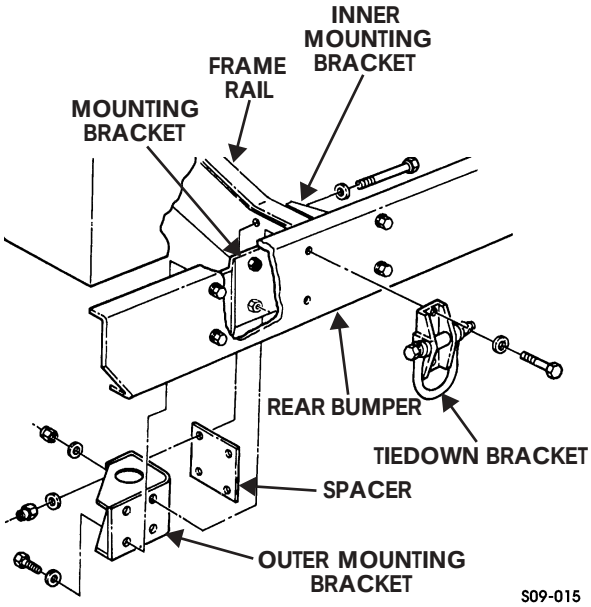

Figure 9-27: Rear Bumper Mounting Bracket

REAR BUMPER BRACE REPLACEMENT

NOTE: Replacement of the inner and outer rear bumper brace is basically the same. The outer rear bumper brace is found only on vehicles equipped with a swing-away spare tire carrier and only on the right side of the rear bumper.

Removal

1. Remove locknut, washer, capscrew, and washer securing rear bumper brace to frame rail. Discard locknut (Figure 9-28).
2. Remove two locknuts, washers, capscrews, washers, and rear bumper brace from rear bumper. Discard locknuts.

Installation

1. Install rear bumper brace on rear bumper with two washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 9-28).
2. Secure rear bumper brace to frame rail with washer, capscrew, washer, and locknut.
3. Tighten all locknuts to 90 lb-ft (122 N•m).

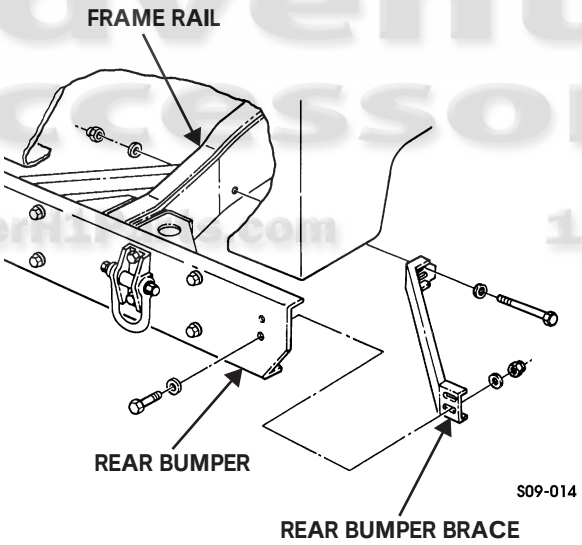

Figure 9-28: Rear Bumper Brace

LEFT ENGINE MOUNT BRACKET REPLACEMENT

Removal

1. Remove two capscrews securing brake line and oil line clamps to engine mount bracket (Figure 9-29).
2. Remove two locknuts and washers securing engine mount bracket to insulator. Discard locknuts.

***CAUTION**: To avoid engine oil pan damage, wood block must completely cover bottom of oil pan.*

3. Support engine under engine oil pan with wood block and jack stand (Figure 9-30).
4. Remove four locknuts, washers, capscrews, washers, and engine mount bracket from frame rail. Discard locknuts (Figure 9-29).

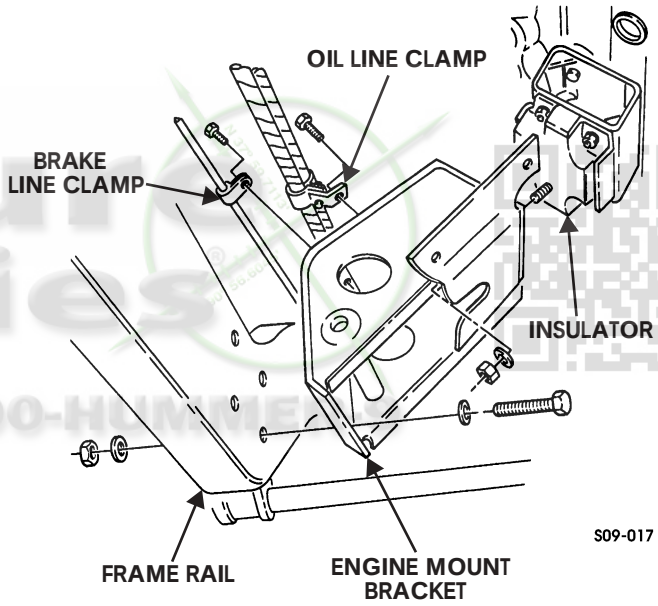

Figure 9-29: Left Engine Mount Bracket

Installation

1. Install engine mount bracket on frame rail with four washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-29).
2. Remove wood block and jack stand from under engine oil pan (Figure 9-30).
3. Secure engine mount bracket to insulator with two washers and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-29).
4. Secure brake line and oil line clamps to engine mount bracket with two capscrews.

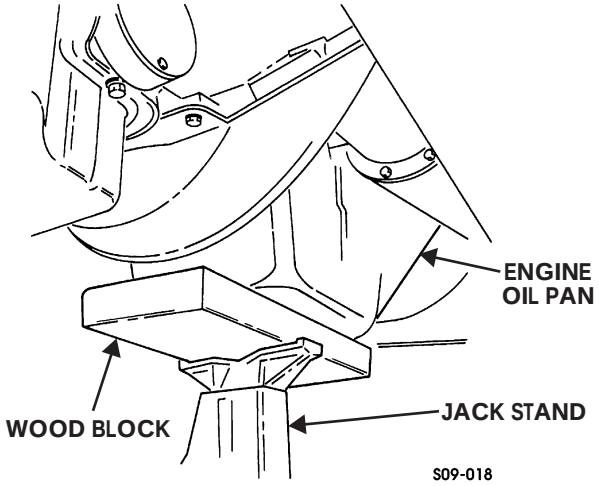

Figure 9-30: Engine Oil Pan

RIGHT ENGINE MOUNT BRACKET REPLACEMENT

Removal

1. Remove right engine mount and insulator (Section 2).
2. Remove two locknuts, washers, capscrews, and washers securing support bracket to engine mount bracket. Discard locknuts (Figure 9-31).
3. Remove capscrew securing vent tube clamp to engine mount bracket.
4. Remove three locknuts, washers, capscrews, washers, support bracket, and engine mount bracket from frame rail. Discard locknuts.

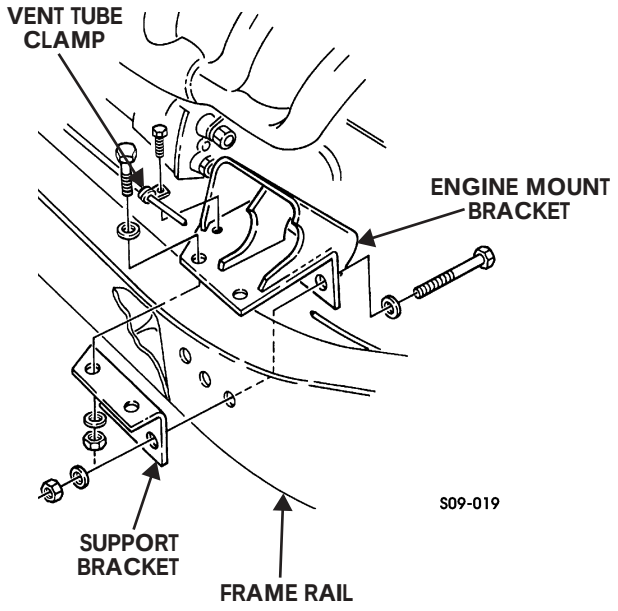

Figure 9-31: Right Engine Mount Bracket

Installation

1. Install support bracket and engine mount bracket on frame rail with three washers, capscrews, washers, and locknuts (Figure 9-31).
2. Install support bracket on engine mount bracket with two washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m).
3. Install vent tube clamp on engine mount bracket with capscrew.
4. Install right engine mount and insulator (Section 2).

RIGHT FRONT BODY MOUNT BRACKET REPLACEMENT

Removal

1. Remove right front body mount (Section 10).
2. Remove three locknuts, washers, capscrews, washers, and right front body mount bracket from frame rail. Discard locknuts (Figure 9-32).

Installation

1. Install right front body mount bracket on frame rail with three washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-32).
2. Install right front body mount (Section 10).

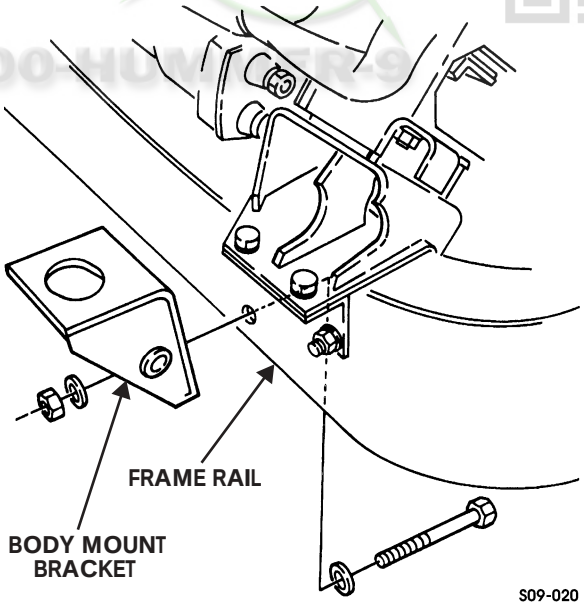

Figure 9-32: Right Front Body Mount Bracket

TRANSMISSION MOUNT CROSSMEMBER REPLACEMENT

Removal

CAUTION: *To prevent equipment damage during removal and installation of transmission mount crossmember, transmission must be supported.*

1. Place support under transmission and remove two locknuts, washers, capscrews, and washers securing transmission mount crossmember to two transmission support brackets. Discard locknuts (Figure 9-33).
2. Remove two locknuts, washers, and transmission mount crossmember from transmission mount. Discard locknuts.

Installation

1. Install transmission mount crossmember on two transmission support brackets with two washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-33).
2. Install crossmember on transmission mount with two washers and locknuts. Tighten locknuts to 28 lb-ft (38 N•m).
3. Remove support.

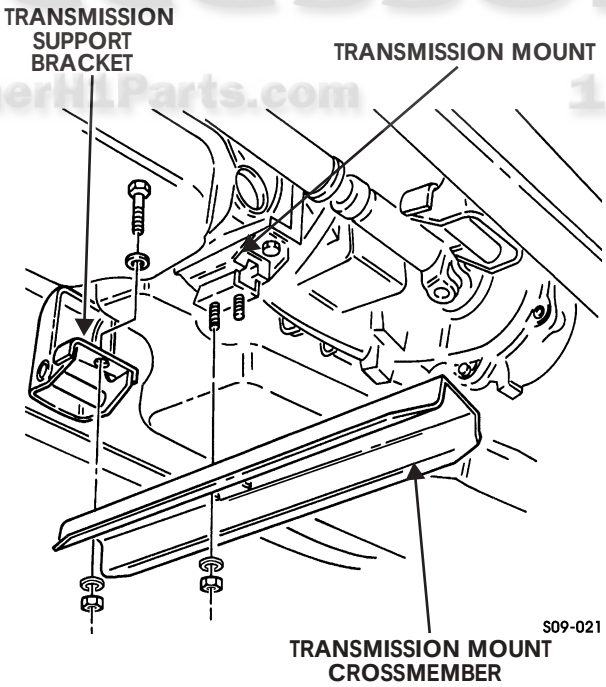

Figure 9-33: Transmission Mount Crossmember

TRANSMISSION MOUNT REPLACEMENT

Removal

1. Remove transmission mount crossmember.
2. Remove two capscrews, lockwashers, and transmission mount from adapter. Discard lockwashers (Figure 9-34).

Installation

1. Install transmission mount on adapter with two lockwashers and capscrews. Tighten capscrews to 65 lb-ft (88 N•m) (Figure 9-33).
2. Install transmission mount crossmember.

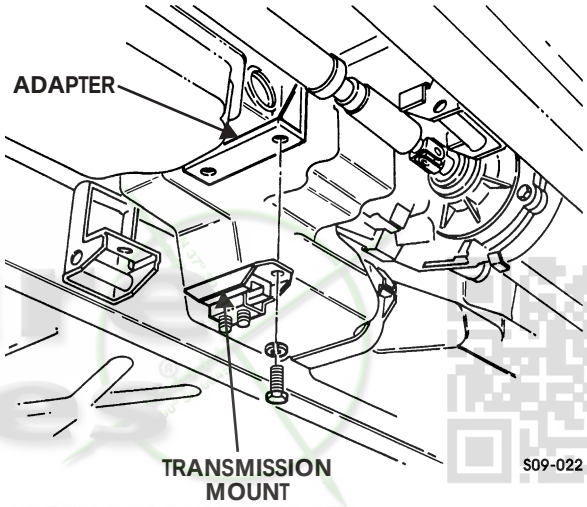

Figure 9-34: Transmission Mount Replacement

TRANSMISSION CROSSMEMBER SUPPORT BRACKET REPLACEMENT

Removal

1. Remove transmission mount crossmember.
2. Remove two locknuts and washers securing transmission crossmember support bracket to frame rail. Discard locknuts (Figure 9-35).

Installation

1. Install transmission crossmember support bracket on two capscrews and frame rail with two washers and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-35).
2. Install transmission mount crossmember.

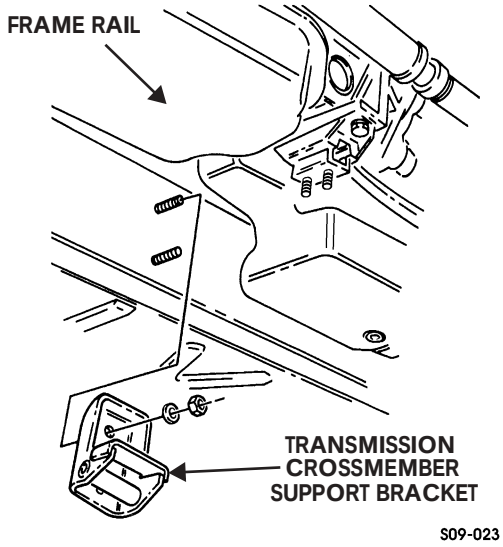

Figure 9-35: Transmission Crossmember Support Bracket

RIGHT INTERMEDIATE BODY MOUNT BRACKET REPLACEMENT

Removal

1. Remove right intermediate body mount (Section 10).
2. Remove three capscrews, washers, and body mount bracket from frame rail (Figure 9-36).

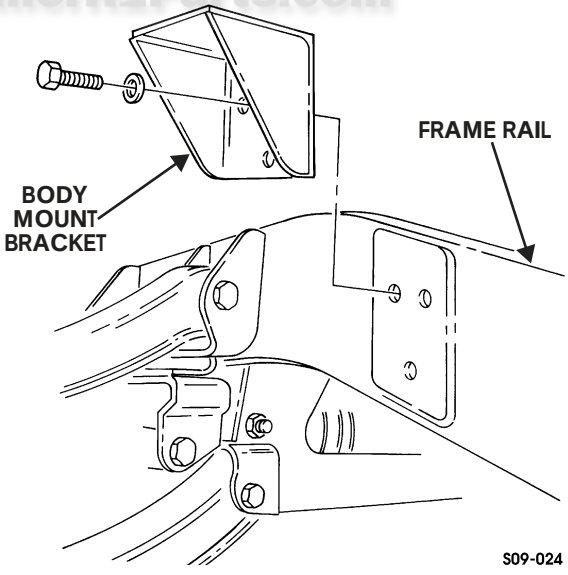

Figure 9-36: Right Intermediate Body Mount Bracket

Installation

1. Apply thread-locking compound to three capscrews and install body mount bracket on frame rail with three washers and capscrews. Tighten capscrews to 90 lb-ft (122 N•m) (Figure 9-36).
2. Install right intermediate body mount (Section 10).

LEFT INTERMEDIATE BODY MOUNT BRACKET REPLACEMENT

Removal

1. Remove left intermediate body mount (Section 10).
2. Remove tailpipe hanger (Section 11).
3. Remove three locknuts, washers, and body mount bracket from frame rail. Discard locknuts (Figure 9-37).

Installation

1. Install body mount bracket on three capscrews and frame rail with three washers and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-37).
2. Install tailpipe hanger (Section 11).
3. Install left intermediate body mount (Section 10).

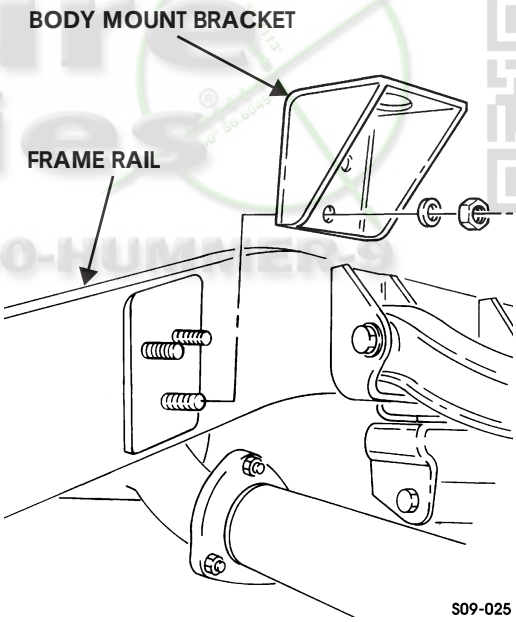

Figure 9-37: Left Intermediate Body Mount Bracket

REAR-REAR TIEDOWN BRACKET REPLACEMENT

Removal

Remove two locknuts, washers, capscrews, washers, and tiedown bracket from frame rail. Discard locknuts (Figure 9-38).

Installation

Install tiedown bracket on frame rail with two washers, capscrews, washers, and locknuts. Tighten locknuts to 261 lb-ft (354 N•m) (Figure 9-38).

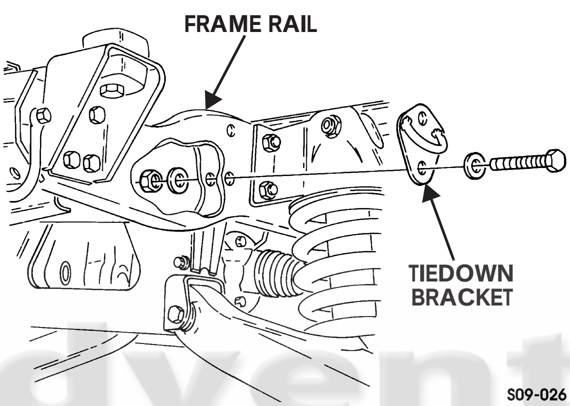

Figure 9-38: Tiedown Bracket

REAR UPPER CONTROL ARM BRACKET REPLACEMENT

NOTE: The procedure for removing and installing the four rear upper control arm brackets is basically the same. This procedure covers the right rear upper control arm front bracket.

Removal

1. Remove wheel (Section 6).
2. Remove capscrew, clamp, and vent line from bracket, and disconnect vent line from fitting (Figure 9-39).
3. Remove two locknuts, washers, capscrews, washers, and upper control arm from two control arm brackets. Discard locknuts (Figure 9-40).
4. Remove four locknuts, washers, capscrews, washers, spacer, shim(s), if present, vent line mounting bracket, and control arm bracket from frame rail. Discard locknuts.

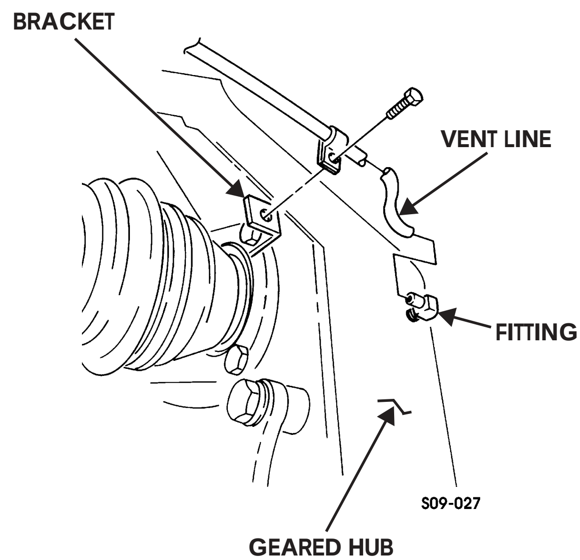

Figure 9-39: Rear Upper Control Arm Vent Line

Installation

1. Install spacer, shim(s), if present, control arm bracket, and vent line mounting bracket on frame rail with four washers, capscrews, washers, and locknuts. Tighten locknuts to 172 lb-ft (233 N•m) (Figure 9-40).
2. Attach upper control arm to two upper control arm brackets with two washers, capscrews, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
3. Connect vent line to fitting and secure clamp and vent line to bracket with capscrew (Figure 9-39).
4. Install wheel (Section 6).

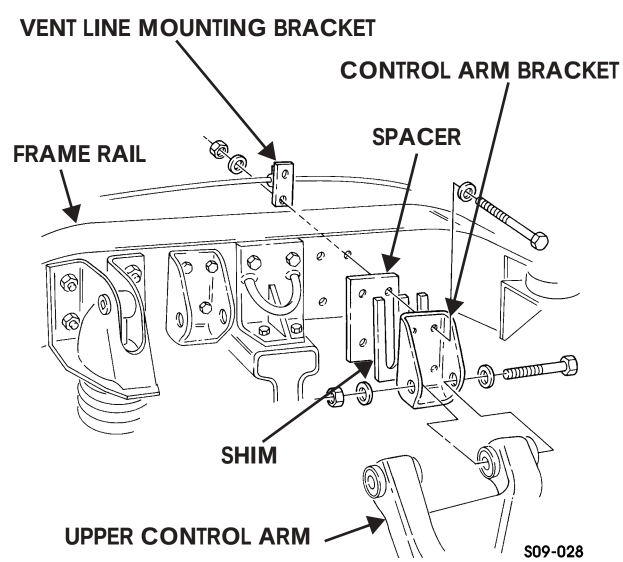

Figure 9-40: Rear Upper Control Arm Bracket

REAR-FRONT TIEDOWN BRACKET REPLACEMENT

Removal

1. Remove wheel (Section 6).
2. Remove four locknuts, washers, capscrews, washers, and tiedown bracket from frame rail. Discard locknuts (Figure 9-41).
3. Remove two locknuts, washers, capscrews, washers, vent tube mounting bracket, and tiedown bracket from rear suspension front crossmember mounting bracket. Discard locknuts.

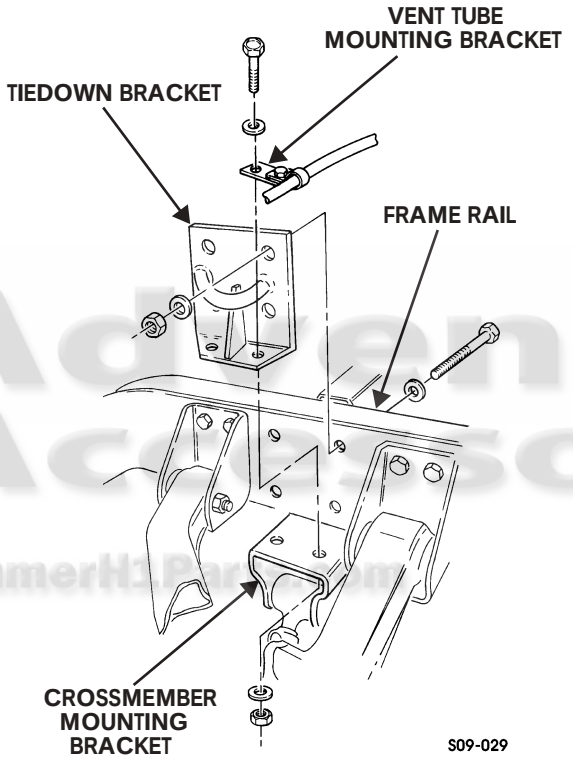

Figure 9-41: Rear-Front Tiedown Bracket

Installation

1. Install tiedown bracket and vent tube mounting bracket on rear suspension front crossmember mounting bracket with two washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-41).
2. Install tiedown bracket on frame rail with four washers, capscrews, washers, and locknuts. Tighten locknuts to 261 lb-ft (354 N•m).
3. Install wheel (Section 6).

AXLE SUPPORT BRACKET AND SIDE MOUNTING BRACKET REPLACEMENT

Removal

1. Remove service brake rotor (Section 7).
2. Remove locknut, seal washer, and output flange from output shaft. Discard seal washer and locknut (Figure 9-42).
3. Remove two capscrews and brake adapter from axle.
4. Remove two capscrews and washers securing side mounting bracket to axle (Figure 9-43).
5. Remove two locknuts, washers, capscrews, washers, support bracket, and side mounting bracket from crossmember. Discard locknuts.
6. Remove two locknuts, washers, capscrews, washers, and side mounting bracket from support bracket. Discard locknuts (Figure 9-44).

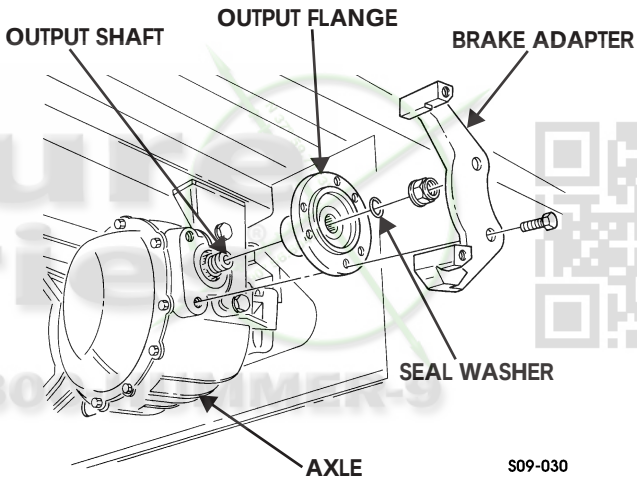

Figure 9-42: Brake Adapter and Output Flange

Installation

1. Install side mounting bracket on support bracket with two washers, capscrews, washers, and locknuts (Figure 9-44).
2. Install support bracket and side mounting bracket on crossmember with two washers, capscrews, washers, and locknuts (Figure 9-43). Do not tighten capscrews.
3. Apply thread-locking compound to tapped holes of axle and install two washers, capscrews, and side mounting bracket on axle. Tighten side mounting bracket capscrews to 110-139 lb-ft (149-189 N•m) and support bracket capscrews to 90 lb-ft (122 N•m).
4. Apply thread-locking compound to tapped holes of axle and install brake adapter on axle with two capscrews. Tighten capscrews to 110-139 lb-ft (149-189 N•m) (Figure 9-42).
5. Install output flange on output shaft with seal washer and locknut. Tighten locknut to 170 lb-ft (231 N•m).
6. Install service brake rotor (Section 7).

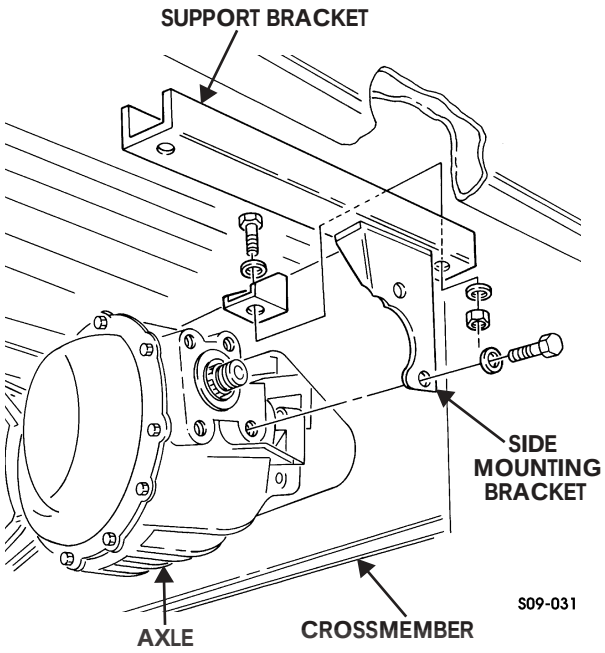

Figure 9-43: Side Mounting Bracket Removal

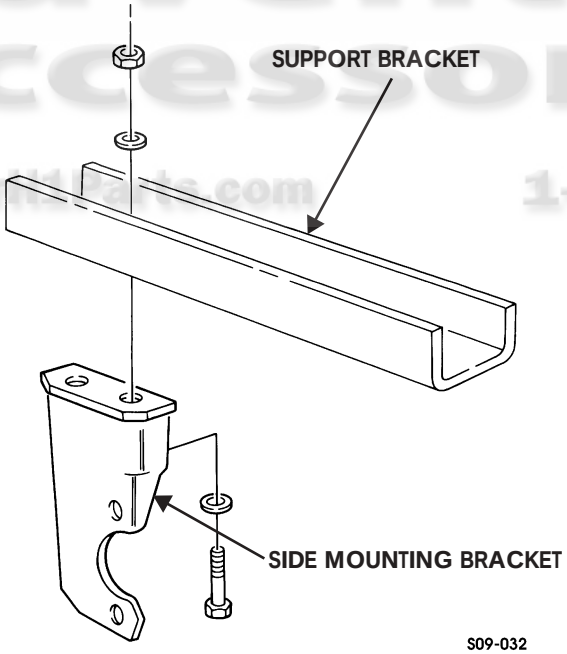

Figure 9-44: Support Bracket

FRONT SUSPENSION FRONT CROSSMEMBER REPLACEMENT

Removal

1. Remove front lower control arms.
2. Remove lower radiator hose (Section 4).
3. Remove horn (Section 10).
4. Remove radiator front mounting bracket.
5. Remove two nuts, washers, capscrews, and washers securing front crossmember to support bracket (Figure 9-43).

NOTE: Note direction of capscrews for installation.

6. Remove four locknuts, washers, capscrews, and washers securing two splash shield brackets to frame rails. Discard locknuts (Figure 9-45).

WARNING: To avoid injury, support crossmember during removal.

7. Remove capscrew and clamp securing harness to front crossmember (Figure 9-46).
8. Remove four locknuts, washers, capscrews, and washers securing crossmember mounting brackets to frame rails. Discard locknuts.
9. Slide crossmember and mounting brackets down and out from under vehicle.
10. Remove six locknuts, washers, capscrews, washers, and left and right mounting brackets from crossmember. Discard locknuts.

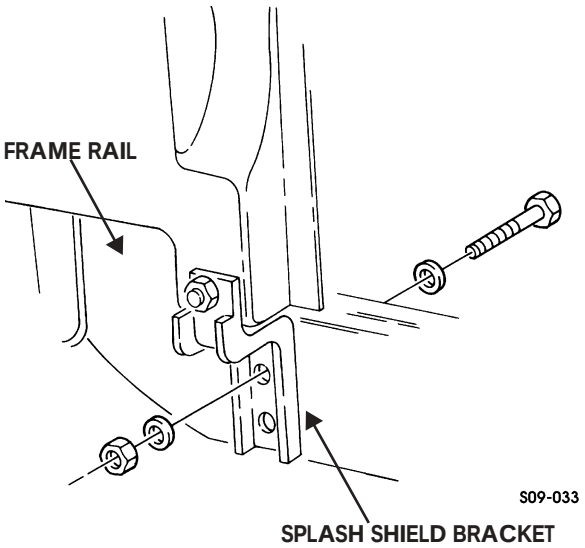

Figure 9-45: Splash Shield

Installation

1. Position left and right crossmember mounting brackets on crossmember (Figure 9-46).
2. Install crossmember and mounting brackets on frame rails with four washers, capscrews, washers, and locknuts. Do not tighten locknuts.
3. Install left and right mounting brackets on crossmember with six washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m).
4. Tighten mounting bracket-to-frame rail locknuts to 261 lb-ft (354 N•m).
5. Secure harness to crossmember with clamp and capscrew.
6. Install four washers, capscrews, washers, locknuts, and two splash shield brackets on frame rails. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-45).
7. Secure front crossmember to support bracket with two washers, capscrews, washers, and nuts (Figure 9-43).
8. Install horn (section 10).
9. Install lower radiator hose (Section 4).
10. Install radiator front mounting bracket.
11. Install front lower control arms.

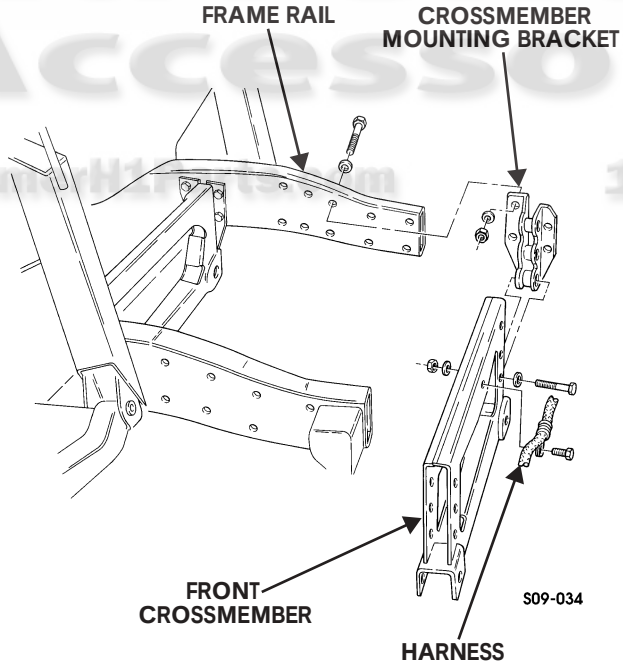

Figure 9-46: Front Crossmember

FRONT SUSPENSION REAR CROSSMEMBER REPLACEMENT

Removal

1. Remove radiator (Section 4).
2. Remove right front upper control arm.
3. Remove lower radiator tube (Section 4).
4. Remove right front caliper-to-tee brake line (Section 7).
5. Remove lower control arms.
6. Remove axle (Section 6).
7. Remove axle support brackets and side mounting brackets.
8. Remove three capscrews, lockwashers, and washers and pull steering gear away from left frame rail. Discard lockwashers (Figure 9-47).
9. Remove three capscrews and clamps from two vent line brackets and crossmember (Figure 9-48).

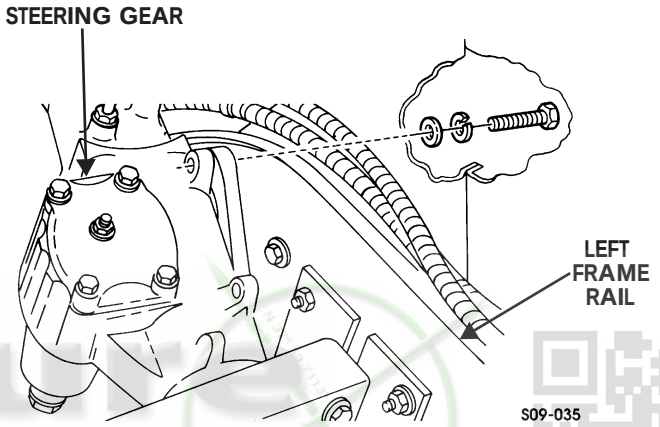

Figure 9-47: Steering Gear and Left Frame Rail

WARNING: To avoid injury, support crossmember during removal.

NOTE: Note direction of capscrews for installation.

10. Remove four locknuts, washers, capscrews, washers, and vent line bracket securing rear crossmember to right frame rail. Discard locknuts.
11. Remove three locknuts, washers, capscrews, washers, and vent line bracket securing rear crossmember to left frame rail. Discard locknuts.
12. Remove capscrew and washer securing rear crossmember to left frame rail.
13. Remove six locknuts, washers, capscrews, and washers securing rear crossmember to left and right rear crossmember mounting brackets. Discard locknuts.
14. Slide rear crossmember and mounting brackets down and out from under vehicle.
15. Remove mounting brackets from rear crossmember.

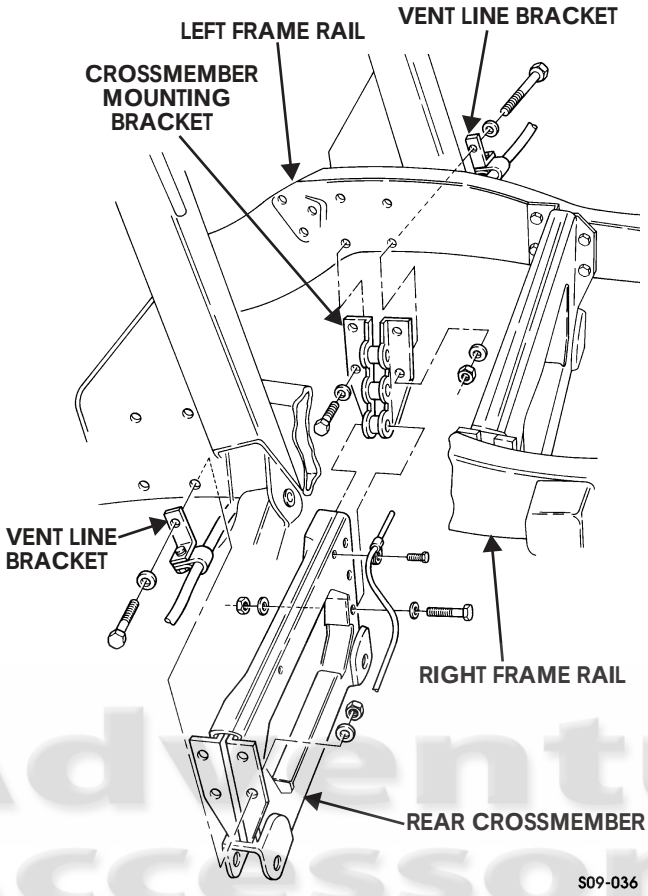

Figure 9-48: Rear Crossmember

Installation

1. Install left and right rear crossmember mounting brackets on rear crossmember (Figure 9-48).
2. Install rear crossmember and mounting brackets on frame rails.
3. Apply thread-locking compound to hole and secure crossmember mounting bracket to left frame rail with washer and capscrew. Tighten capscrew to 65-78 lb-ft (88-106 N•m).
4. Secure crossmember mounting bracket to left frame rail with vent line bracket, three washers, capscrews, washers, and locknuts. Do not tighten capscrews.
5. Secure crossmember mounting bracket to right frame rail with vent line bracket, four washers, capscrews, washers, and locknuts. Do not tighten capscrews.
6. Install six washers, capscrews, washers, and locknuts securing rear crossmember to left and right mounting brackets. Tighten capscrews to 90 lb-ft (122 N•m).
7. Tighten three capscrews on mounting bracket and left frame rail to 90 lb-ft (122 N•m).
8. Tighten four capscrews on mounting bracket and right frame rail to 90 lb-ft (122 N•m).
9. Secure vent line to rear crossmember and two vent line brackets with three clamps and capscrews.
10. Secure steering gear to left frame rail with three washers, lockwashers, and capscrews. Tighten capscrews to 60 lb-ft (81 N•m) (Figure 9-47).
11. Install axle support brackets and side mounting brackets.
12. Install axle (Section 6).
13. Install lower control arms.
14. Install right front caliper-to-tee brake line (Section 7).
15. Install right front upper control arm.
16. Install lower radiator tube (Section 4).
17. Install radiator (Section 4).

REAR SUSPENSION FRONT CROSSMEMBER REPLACEMENT

Removal

1. Remove rear-front tiedown brackets.
2. Remove axle (Section 6).
3. Remove axle support brackets and side mounting brackets.
4. Remove rear lower control arms.
5. Remove three capscrews and clamps securing brake line and two vent lines to front crossmember (Figures 9-49 and 9-50).
6. Remove brake line from tee and tube coupling.

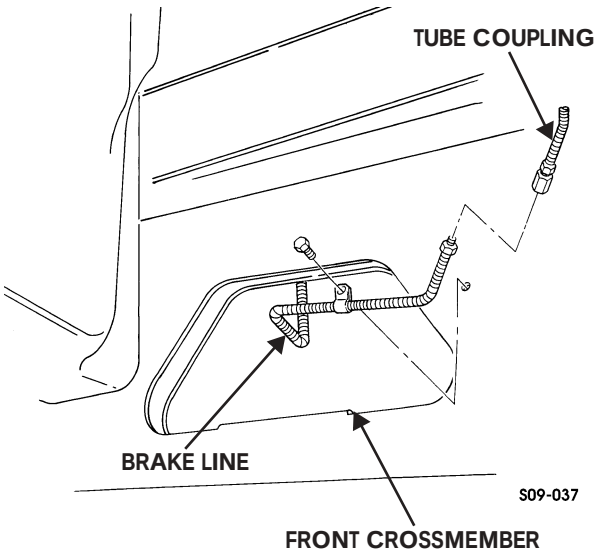

Figure 9-49: Brake Line and Tube Coupling

7. Remove two locknuts, washers, capscrews, washers, and two radius rods from crossmember mounting brackets. Discard locknuts (Figure 9-51).

WARNING: To avoid injury, support crossmember during removal.

8. Loosen six locknuts securing front crossmember to crossmember mounting brackets.
9. Slide front crossmember down and out from under vehicle.
10. Remove six locknuts, washers, capscrews, washers, and two crossmember mounting brackets from front crossmember. Discard locknuts.

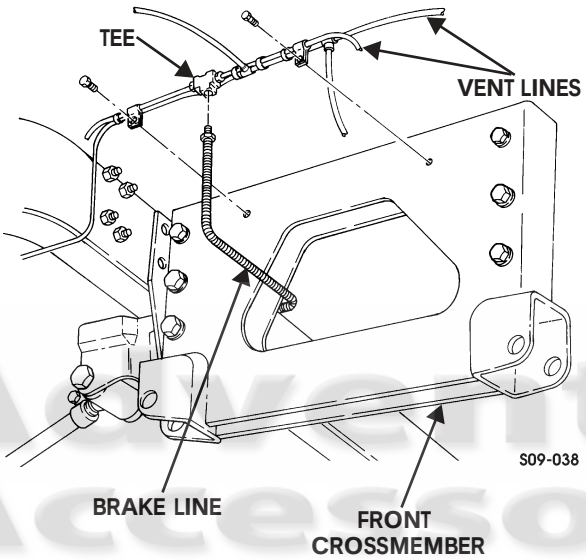

Figure 9-50: Brake Line and Vent Lines

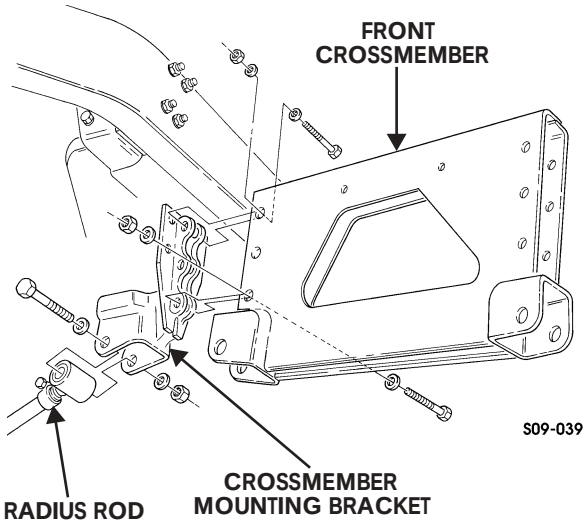

Figure 9-51: Front Crossmember Assembly

Installation

1. Install two crossmember mounting brackets on front crossmember with six washers, capscrews, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-51).
2. Install front crossmember on frame rails.
3. Install rear-front tiedown brackets.
4. Install radius rods in crossmember mounting brackets with two washers, capscrews, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
5. Install brake line on tee and tube coupling (Figure 9-49) and (Figure 9-50).
6. Secure brake line and two vent lines to front crossmember with three clamps and capscrews.
7. Install axle support brackets and side mounting brackets.
8. Install axle (Section 6).
9. Install rear lower control arms.
10. Bleed rear brakes (Section 7).

When it is necessary to replace the front springs on a vehicle, refer to the following chart to determine the appropriate part number. The chart is applicable to all model years. Front springs must be changed as a set. Any front spring upgrade will be done at the customer's expense.

Coil Spring Replacement Chart

Diesel

Model	Front Axle Weight (+/-100 lb)	954 lb/in-13.36 in. Free Length 12338316-1 Wire Diameter .904 (Yellow Tie Wrap)	954 lb/in-14.0 in. Free Length 6005787 Wire Diameter .925 (Red Tie Wrap)	1250 lb/in-13.36 in. Free Length 6005786 Wire Diameter .980 (Orange Tie Wrap)
2-Door	3200	X		
2-Door w/Winch	3550		X	
4-Door Soft Top	3400		X	
4-Door Soft Top w/Winch	3750			X
4-Door Hard Top	3450		X	
4-Door Hard Top w/Winch	3800			X
Station Wagon	3400		X	
Station Wagon w/Winch	3750			X

Gasoline

Model	Front Axle Weight (+/-100 lbs)	954 lb/in-13.36 in. Free Length 12338316-1 Wire Diameter .904 (Yellow Tie Wrap)	954 lb/in-14.06 in. Free Length 6005787 Wire Diameter .925 (Red Tie Wrap)	1250 lb/in-13.36 in. Free Length 6005786 Wire Diameter .980 (Orange Tie Wrap)
2-Door	2900	X		
2-Door w/Winch	3250	X		
4-Door Soft Top	3100	X		
4-Door Soft Top w/Winch	3450		X	
4-Door Hard Top	3150	X		
4-Door Hard Top w/Winch	3500		X	
Station Wagon	3100	X		
Station Wagon w/Winch	3450		X	

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Section 10 Body

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GENERAL BODY INFORMATION

1. The HUMMER body is constructed from aluminum alloys that have been heat-treated to obtain high strength. Welding cannot be performed to make body repairs. Heat generated by welding will reverse the heat treatment process, causing a reduction in material strength.
2. The hood and engine access covers are made of fiberglass (sheet molding compound). Cracks, splits, or holes may be repaired with a glass-reinforced plastic laminate.
3. Solid 0.1875 in. (4.8 mm) diameter aluminum rivets are the primary method of joining body components. Each rivet is inserted into a hole through two pieces of metal, and a second head is formed by manual or pneumatic impacting, or by squeezing the rivet. A bucking bar is used to back up the rivet to form a rivet head. When making repairs, use blind rivets of the same size, or oversize, with the appropriate grip length.
4. Blind structural aluminum rivets of 0.1875 in. (4.8 mm) diameter are used in applications where there is access from only one side of the part. Blind rivets are installed using a tool that pulls on the rivet stem causing a bulbed head to form on the back side of the part. Fastening is complete when stem breaks off. High strength is obtained in blind rivets by mechanically locking the remaining stem inside the rivet body.
5. Steel pull-type lockbolt fasteners of 0.1875 in. (4.8 mm) and 0.25 in. (6.4 mm) diameters are used where tension or high-shear loads exist. Lockbolts are two-piece unthreaded fasteners. One part is a high-strength, steel-headed, bolt-like part with serrations on its shank. The mating part is a collar which is swagged over the serrations causing the fastener to be locked in place.
6. To facilitate body repairs, it is acceptable to replace lockbolt fasteners and rivets with 0.25 in. (6.4 mm) series bolts. Do not replace lockbolt fasteners with rivets. Standard threaded fasteners should not be used, as these will quickly wear the aluminum structure. Bolt lengths should be chosen so that the cylinder portion of bolt is bearing on all members being joined. Bolts are designed as AN4-XX or AN4-C-XX, where XX defines grip length. Tighten all bolts to 71 lb in. (8 N•m).
7. Fatigue strength of riveted joints and seams is increased by epoxy adhesive application. Epoxy adhesive requires special material storage and metal preparation along with a low temperature heat cycle for curing. Where possible, extra rivets and thicker metal gauges should be used instead of adhesives when making repairs. Parts may be difficult to separate, even after rivets are removed.

BODY INSPECTION AND REPAIR

General Information

Damaged areas should be thoroughly cleaned and inspected to determine the cause and extent of damage. Body parts should be inspected for holes, cracks, dents, distortion, or breaks. Fasteners should be inspected for breaks, stretching, looseness, cracked heads, or hole elongation. Seams, flanges, and joints should be inspected for straightness or local deformation as an indication that fasteners may have been stretched or holes elongated. It is possible for this to happen and fasteners will still appear to be tight in their holes. In addition, thoroughly inspect adjacent areas to determine if high loads have been transmitted from the damaged area to other areas. This can result in secondary damage in the form of distorted panels or seams, loosened or sheared fasteners, elongated fastener holes, and/or cracks.

Classification

After the extent of damage has been determined, affected parts should be classified into one of the following categories:

- Negligible damage
- Damage repairable by patching
- Damage repairable by insertion
- Damage necessitating replacement of parts

1. Negligible damage.

Minor dents, nicks, scores, cracks, and holes in a body panel which are within, or are brought within, reasonable limits by a simple procedure without extensive rework are considered negligible damage. These defects should be considered more serious if located in main structural members such as frame rails, A-pillars, or floor crossmembers rather than in body panels such as cowls or rear wheelhouses. Deep wrinkles of undetermined origin in body panels should not be classed as negligible until the source of the wrinkles has been investigated and positively identified. Damage other than small dents, holes, nicks, and scratches will require repair or replacement of the part.

- Negligible Cracks. Isolated cracks less than 0.50 in. (1.27 cm) long may be classified as negligible cracks provided they are stop drilled at each end to stop propagation.
- Negligible Holes. Isolated holes no more than 0.50 in. (1.27 cm) in diameter (after they are made round with smooth edges) are classified as negligible holes, provided the distance from the edge of the holes to the nearest line of rivets exceeds the diameter of the hole.
- Negligible Dents and Distortion. Small dents and distorted areas may be classed as negligible if they can be repaired by hammering or bending without causing the material to crack. Heat will not be used for reforming.

2. Damage repairable by patching.

Non-negligible damage must be repaired; or the section must be replaced. Patches can often be applied over damaged body panels, provided the damaged area is first trimmed to remove sharp edges or notches which could cause the start of new cracks. The patch must then be sized to overlap the area to allow for attaching rivets.

3. Damage Repairable by Insertion.

In certain cases, patch repairs may not be desirable because of impracticality or because a flush surface is desired. In this case, the damaged area must be cut away and replaced with equivalent material inserted flush with adjacent areas, and backed up with a doubler.

4. Damage requiring replacement of parts.

Parts too badly damaged for repair, or cases where replacement is easier than repair, fall into this category. Repair of welded assemblies such as body mounts are also included. Welded assemblies cannot be rewelded without destroying the strength of the part, and must be replaced.

Rivet Failure

Signs of rivet failure include tipped heads, looseness, and sometimes chipped or cracked paint. If heads are tipped in the same direction and rivets are loose in consecutive groups, the joint has undergone excessive load. Rivet heads which are tipped in different directions and are not in groups may be improperly installed. With chipped or cracked paint, it may be necessary to remove paint to check the true condition of rivets. Rivets subjected to critical loads, but showing no distortion should be inspected if failure is suspected. The head should be drilled off, and the shank should be carefully punched out. Failure is indicated by notched rivet shanks and misaligned holes. Flush rivets showing head slippage within the dimple or countersink indicate either sheet bearing or rivet shear failure, and must be removed for replacement. If rivet failure cannot be detected by visual inspection, the joint can be checked by drilling and punching out several rivets. If rivet shanks are notched, rivets should be replaced with the next larger size rivets. If rivet holes show elongation due to local failure in tearing of the sheet, the next larger size rivet must be used in replacement. Any deformation of the sheet around the rivet, tear outs, or cracks between rivets usually indicates partially failed or damaged rivets. Complete repair of the joint will require replacement by the next larger size rivets. Use the next 0.031 in. (0.79 mm) larger diameter rivet to obtain a tight joint when original hole has been enlarged. If original size rivet is installed, the rivet will not be able to carry its share of the shear load, and the joint will not meet its strength requirements.

Lockbolt Fastener Failure

Lockbolts are used to withstand tension loads and high-shear loads. These fasteners are installed in their holes with an interference fit. No looseness can be permitted. Lockbolts showing evidence of being stretched, broken, loose in their holes, or having heads that do not set flat against the surface must be replaced. Guidelines used for detecting rivet failures also apply to lockbolts.

Lockbolt Removal

1. Working from head side of lockbolt, if accessible, file a small flat surface on head, if rounded.
2. Center punch the head.
3. Using a hardened drill bit slightly smaller than lockbolt, drill through the head. In cases where lockbolts are too hard to be drilled with available drills, grind the head down using a cutoff wheel or carbide bit in a die grinder. When using grinder method, cut the head down until it is very thin, but do not grind it off completely, or touch the body part with grinding tool.
4. Use a pin punch to pry off head, or shear it off with a sharp chisel. Ensure part is adequately supported while performing this step.
5. Drive lockbolt out of its hole with a pin punch. Care must be taken so that hole or part is not distorted.

NOTE: In cases where the lockbolt head is inaccessible, the locking collar must be removed. Remove collar by grinding, or by splitting axially with a sharp chisel.

Rivet Replacement

NOTE: When removing rivets, care should be taken not to enlarge rivet holes. Enlarged rivet holes require oversize or larger replacement rivets.

Solid Rivet Removal

1. File a flat surface on the manufactured head, if accessible. It is always preferable to work on a manufactured head rather than one that is bucked over, since the former will always be more symmetrical around the shank.
2. Indent center of the filed surface with a center punch.
3. Drill through rivet head, using a drill bit slightly smaller than diameter of rivet shank to avoid oversizing rivet hole.
4. Shear weakened rivet head off with a sharp chisel. To prevent panel distortion, support back side of rivet and cut rivet head along direction of rivet line or panel edge.
5. Firmly support the panel from the opposite side and drive out the shank with a pin punch. If rivet is unduly tight due to swelling between sheets, drill the rivet shank out with an undersized drill bit.

Blind Rivet Removal

1. File a small, flat surface on rivet head.
2. Center punch the flat surface. Support the back side of the rivet, if possible.
3. Using a small drill bit about the size of rivet pin, drill off tapered end of pin which forms the lock.
4. Shear lock, using pin punch to drive out pin.

5. Pry out remainder of locking collar.
6. Using a drill bit slightly smaller than rivet shank, drill almost through rivet head.
7. Pry off rivet head with pin punch.
8. Tap out rivet shank with pin punch.

Rivet Hole Drilling

1. Center punch all new rivet locations. Center punch mark must be large enough to prevent drill from slipping out of position, yet it must not dent the surface of the material. To prevent denting, place a bucking bar behind material during punching.
2. Ensure drill bit is the correct size, and points properly ground ((Table 1, “Drill Bit Sizes for Solid Shank Rivets,” on page 10–5) and (Table 2, “Drill Bit Sizes for Blind Rivets,” on page 10–5)). A no. 10 drill bit is used to install standard 1.875 in. (48 mm) blind rivets.
3. Place drill bit in center mark for new rivet locations, or align drill bit with old hole when replacing old rivets with oversize rivets. When using a power drill, give the bit a few turns with fingers before starting motor to ensure drill does not jump out of position when motor is started.

NOTE: Hold drill at 90 degree angle to material surface. Avoid excessive pressure, or letting the drill wobble. Do not push the drill through material.

4. Remove all bumps with metal countersink or file.
5. Clean away all drill chips. Ensure that no chips are trapped between metal sheets.
6. Apply corrosion-resistant sealing compound to hole and surrounding area.

Table 1: Drill Bit Sizes for Solid Shank Rivets

RIVET DIAMETER	DRILL BIT SIZE	DRILL BIT DIAMETER
0.0625 in. (1.65 mm)	# 51	0.0670 in. (1.70 mm)
0.0938 in. (2.38 mm)	# 41	0.0960 in. (2.44 mm)
0.1250 in. (3.18 mm)	# 30	0.1295 in. (3.29 mm)
0.1563 in. (3.97 mm)	# 21	0.1590 in. (4.04 mm)
0.1875 in. (4.76 mm)	# 10	0.1910 in. (4.85 mm)
0.2500 in. (6.35 mm)	F	0.2570 in. (6.53 mm)
0.3125 in. (7.94 mm)	W	0.3230 in. (8.20 mm)
0.3750 in. (9.53 mm)	W	0.3869 in. (9.83 mm)

.

Table 2: Drill Bit Sizes for Blind Rivets

RIVET DIAMETER	DRILL BIT SIZE	MINIMUM	MAXIMUM
0.1250 in. (3.18 mm)	#30	0.129 in. (3.28 mm)	0.132 in. (3.35 mm)
0.1563 in. (3.97 mm)	#20	0.160 in. (4.06 mm)	0.164 in. (4.17 mm)
0.1875 in. (4.76 mm)	#10	0.192 in. (4.88 mm)	0.196 in. (4.98 mm)
OVERSIZE DIAMETER			
RIVET DIAMETER	**DRILL BIT SIZE**	**MINIMUM**	**MAXIMUM**
0.1250 in. (3.18 mm)	#27	0.143 in. (3.63 mm)	0.146 in. (3.71 mm)
0.1563 in. (3.97 mm)	#16	0.177 in. (4.50 mm)	0.181 in. (4.60 mm)
0.1875 in. (4.76 mm)	#5	0.205 in. (5.21 mm)	0.209 in. (5.31 mm)

Hole Countersinking

NOTE: Some rivet installations in the body require the rivet to be flush with the rivet material surface. In these instances, countersunk or flush-head rivets are used.

1. When using countersunk rivets, rivet holes must be countersunk with a tool having a 100 degree taper, so rivet head will fit flush with surface.
2. When using a hand-operated countersinker, the hole must be tried with a rivet so the recess will not be too deep or too shallow. It is best to use a countersinker with a stop on it so depth of the countersink can be controlled. Typical countersinking dimensions for blind rivets are shown in (Table 3, "Countersinking Dimensions for 100 Degree Countersunk Blind Rivets," on page 10–6) . The minimum sheet thickness that can be machined for 100 degree countersunk rivets is given in (Table 4, "Minimum Sheet Gauge for 100 Degree Machine Countersunk Rivets," on page 10–6) .
3. Do not remove edge of hole on blind side of joint.

Blind Rivet Driving Practices and Precautions

1. Rivets should be inspected for proper installation. The grip length of each rivet is marked on top of its head to provide positive identification. Use of proper grip length will produce a rivet installation where locking collar is flush with top surface of rivet head. Tolerance limit on flushness is 0.020 in. (0.51 mm).
2. For proper rivet installation, it is imperative that holes be properly prepared, tools be in good working order, and rivets properly installed. When problems occur, the source of trouble could be in any of these areas.

Table 3: Countersinking Dimensions for 100 Degree Countersunk Blind Rivets

COUNTERSINKING DIMENSIONS (100 Degree)		
RIVET DIAMETER	**MINIMUM**	**MAXIMUM**
0.1250 in. (3.18 mm)	0.222 in. (5.64 mm)	0.228 in. (5.79 mm)
0.1563 in. (3.97 mm)	0.283 in. (7.19 mm)	0.289 in. (7.34 mm)
0.1875 in. (4.76 mm)	0.350 in. (8.89 mm)	0.356 in. (9.0 mm)

Table 4: Minimum Sheet Gauge for 100 Degree Machine Countersunk Rivets

RIVET SIZE	0.0938 in. (2.38 mm)	0.1250 in. (3.18 mm)	0.1563 in. (3.97 mm)	0.1875 in. (4.76 mm)	0.2500 in. (6.35 mm)
GAUGE	0.040 in. (1.02 mm)	0.050 in. (1.27 mm)	0.064 in. (1.63 mm)	0.072 in. (1.83 mm)	0.072 in. (1.83 mm)

Blind Rivet Installation

NOTE: Ensure the proper rivet grip length is selected for each application ((Table 5, “Rivet Grip,” on page 10–7)). Rivets can tolerate only 0.0468 in. (1.19 mm) variation in material thickness for each particular rivet length. For double dimpled sheets, add countersink head height to materials thickness.

1. Insert rivet stem into pulling head of rivet gun or adapter.
2. Hold rivet gun in line with axis of rivet as accurately as possible.
3. Apply a steady, firm pressure against rivet head.
4. Squeeze handles of manual gun. The rivet clamping action will pull sheets together, seat rivet head, and break stem flush with head of rivet.

Table 5: Rivet Grip

MATERIAL THICKNESS RANGE		RIVET GRIP NO.
MINIMUM	MAXIMUM	
	0.0625 in. (1.65 mm)	1
	0.1250 in. (3.18 mm)	2
0.1250 in. (3.18 mm)	0.1875 in. (4.76 mm)	3
0.1875 in. (4.76 mm)	0.2500 in. (6.35 mm)	4
0.2500 in. (6.35 mm)	0.3125 in. (7.94 mm)	5
0.3125 in. (7.94 mm)	0.3750 in. (9.53 mm)	6
0.3750 in. (9.53 mm)	0.4375 in. (11.11 mm)	7
0.4375 in. (11.11 mm)	0.5000 in. (12.70 mm)	8
0.5000 in. (12.70 mm)	0.5625 in. (14.29 mm)	9
0.5625 in. (14.29 mm)	0.6250 in. (15.88 mm)	10
0.6250 in. (15.88 mm)	0.6875 in. (17.46 mm)	11
0.6875 in. (17.46 mm)	0.9750 in. (24.77 mm)	12

Aluminum Repair

CAUTION: *Repairs should not be made on the body using welding or heat for forming. Heat will only weaken material and cause further problems.*

Material

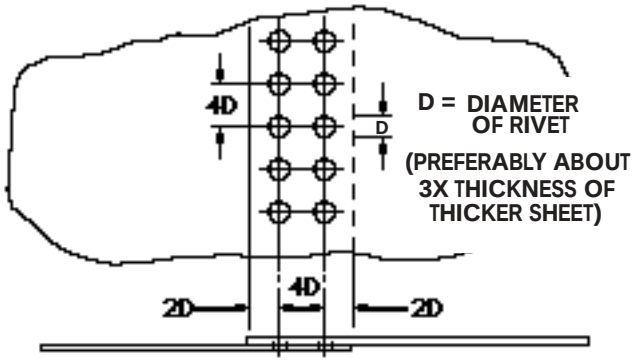
Aluminum material used for repairs should be of the same alloy and temper as the original if possible. In general, 6061-T6 aluminum alloy should be used. Material thickness must be the same or thicker. This alloy will work well for flat repairs, but is not well suited to bending because it is quite hard and cracks easily when bent sharply. When bends must be made, use softer 6061-T4 aluminum alloy and increase material thickness by at least 50 percent. As a general rule of thumb, 6061-T4 aluminum alloy should be bent with a minimum bend radius of one to two times material thickness, whereas 6061-T6 aluminum alloy requires at least three times material thickness radius for bends. In all cases, bends should be closely inspected for cracks. A suitable method for avoiding bending cracks is to obtain angles that are extruded from 6061-T6 aluminum alloy or use preformed angles for repairs.

Epoxy Adhesive

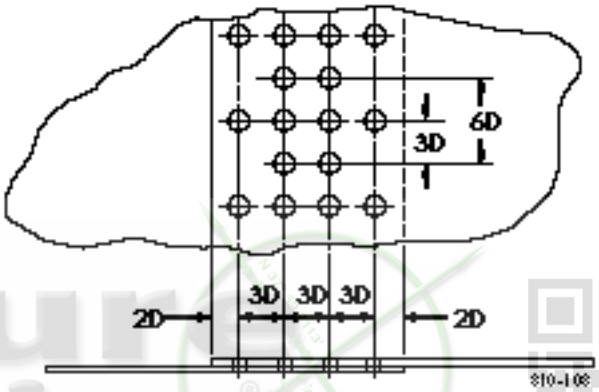
Where it is necessary to remove parts, note that epoxy adhesive is used in joints. Use care in parts removal to avoid unnecessary distortion. Parts should be separated by peeling action. Before parts are reassembled, it will be necessary to remove any remaining cured epoxy from joints so parts will fit together with good, even contact. Use of epoxy requires special storage and application procedures which do not lend themselves to repair. For this reason, epoxy will not be used for repair. To compensate for the lack of epoxy, additional rivets should be used when making repairs to existing joints.

Rivet Patterns

1. Rivet patterns are denoted by rivet spacing and rivet edge distance. Rivet edge distance is the distance from center of rivet to nearest edge of sheet. Rivet spacing is defined as the distance from center of rivet to center of adjacent rivet (Figure 10-1).
2. Required rivet spacing is determined by strength needed in the joint. A general feel for strength required can be obtained by inspecting rivet patterns in surrounding areas. Body repairs made using single rows of rivets should be performed using rivet spacing not greater than 1.6 in. (4.1 cm) and not less than 0.625 in. (15.9 mm). Use 1 in. (25.4 mm) rivet spacing as a general practice for repairs. Rivet spacing used in original construction may be greater due to additional strength obtained by using epoxy adhesive. Do not use rivet edge distances less than 0.375 in. (9.5 mm).
3. High strength joints or large area patterns may require use of double or multiple rows of rivets to obtain sufficient strength.



DOUBLE ROW RIVETING PATTERN



TRIPLE OR MULTIPLE ROW RIVETING PATTERN

Figure 10-1: Riveting Patterns

4. Care must be taken to assure rivet hole patterns are transferred accurately in cases where a part with no holes is mated to one which already has rivet holes. Hole patterns may be transferred using one of the following patterns:
   a. Lay new part in place, and use holes in mating part as a drill template. This requires the new part to be underneath the mating part. Care must be taken not to distort original holes.
   b. Use the removed part as a drill template by clamping the old and new parts together. This requires that parts rest flat and rivet flange be undistorted.

Joint Design

1. Loads are applied through a joint to fasteners that hold it together. These loads are applied to fasteners in the form of shear loads or tension loads. If load is perpendicular to axis of fasteners, the fasteners are loaded in shear. The fasteners are loaded in tension when load is along axis of fastener, causing a pull on each end of fastener.
2. Rivets are designed to be loaded in shear. Do not create any new joints during repairs which cause rivets to be used in a tension application. Bolts should be used for tension applications or substituted for rivets in very high shear load applications (Figures 10-2 and 10-3).

Repair Parts

1. Paint repair parts or patches with epoxy primer before installation.
2. Apply sealing compound to mating surfaces to prevent corrosion.
3. Install part or patch.
4. Paint repaired area with epoxy primer.
5. Paint repaired area with polyurethane as required.

Negligible Damage

1. Negligible cracks are repaired by drilling a small hole at each end of crack to stop crack propagation. This is called stop-drilling. Table 6 gives proper drill sizes for stop-drilling cracks.
2. Caution: Never use heat to reform parts, as is greatly reduces part strength.
3. Small dents and distorted areas may be repaired by bending or hammering as long as the operation does not cause materials to crack or tear. Sharp bends should not be attempted.

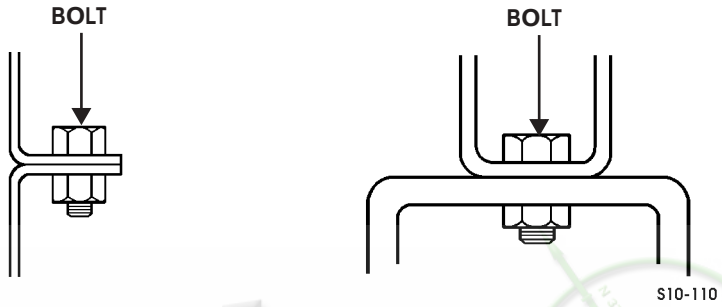


Figure 10-2: Bolts Replacing Rivets

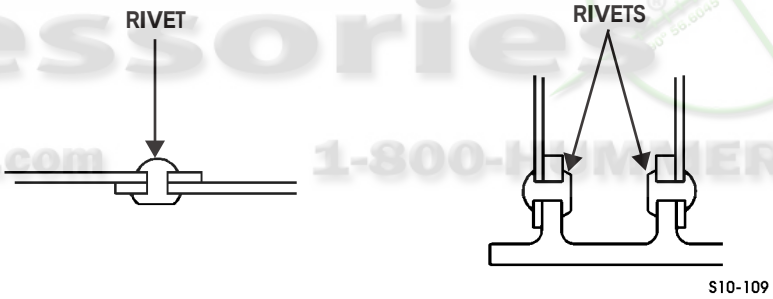


Figure 10-3: Rivet Loads in Shear

Repair by Patching

Table 6: Stop-Drill Sizes for Negligible Cracks

SHEET THICKNESS	MINIMUM STOP DRILL BIT SIZE NO.
0-0.032 in. (0-081 mm)	40
0.033 in. (0.84 mm) and thicker	30

Most body panel damage that exceeds the limits of negligible damage may be repaired by patching. This procedure involves removal of damaged area and application of a patch to cover the area. The damaged area is prepared by rounding or smoothing of all corners and edges to ensure cracks will not spread into undamaged areas (Figure 10-4). In case of a large crack, it may be desirable to stop-drill the crack rather than cut out a portion of the panel or structural member. Repair is completed by applying a large overlapping patch over the damaged area (Figure 10-5). The overlap must be sufficient to allow the observance of proper rivet edge distance. Large areas of damage are best repaired by attaching patch with multiple rows of rivets (Figure 10-6).

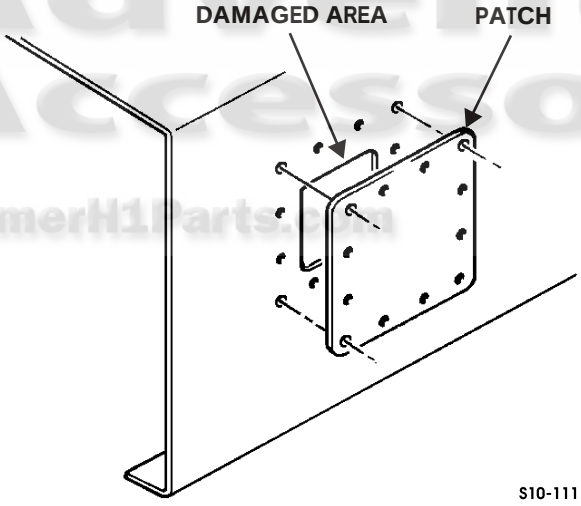


Figure 10-4: Patching

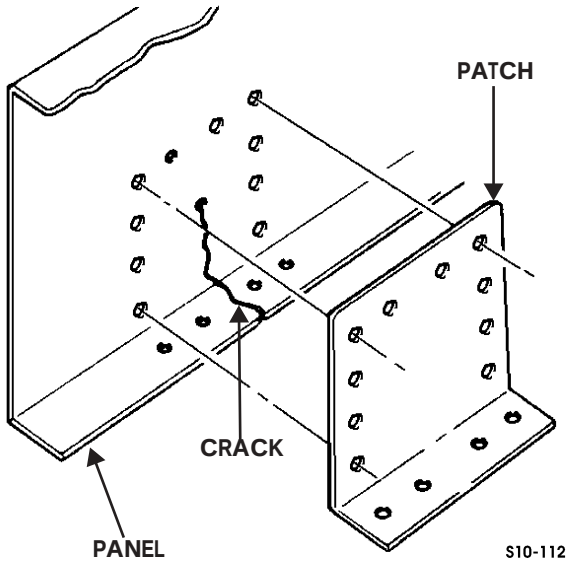


Figure 10-5: Patching Cracked Areas

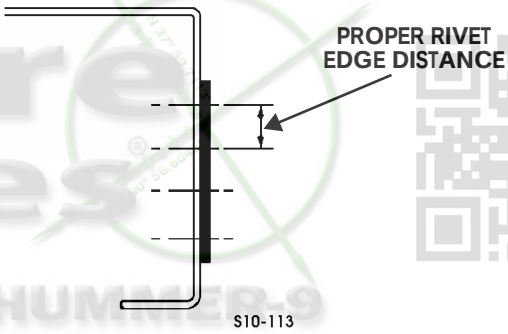


Figure 10-6: Proper Rivet Distance

Repair by Insertion

For damage that is large or more severe in nature than a crack or hole, it is often desirable to remove damaged area, insert a piece of material into removed area and reinforce with a doubler. This is termed repair by insertion. This method of repair is typically stronger and stiffer than an added patch (Figures 10-7, 10-8, 10-9, and 10-10).

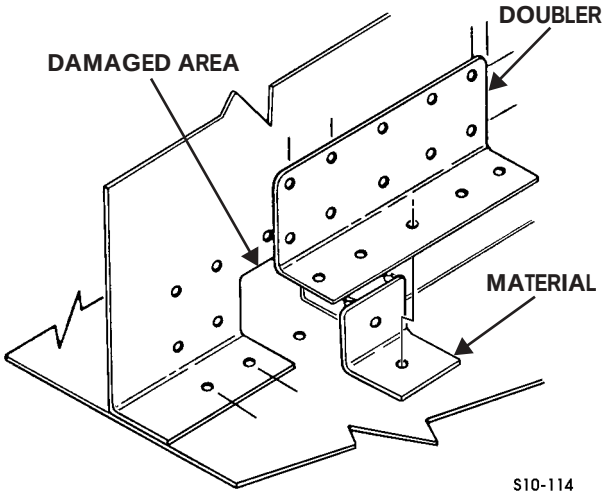


Figure 10-7: Reinforcing Damaged Area

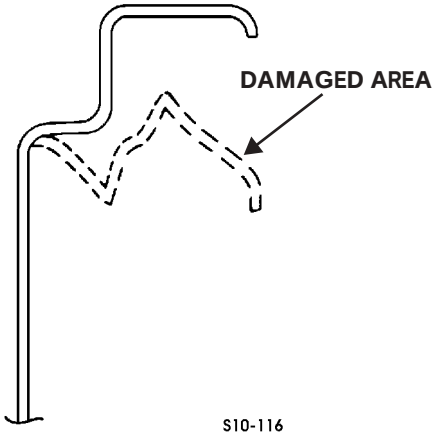


Figure 10-9: Damaged Body Area

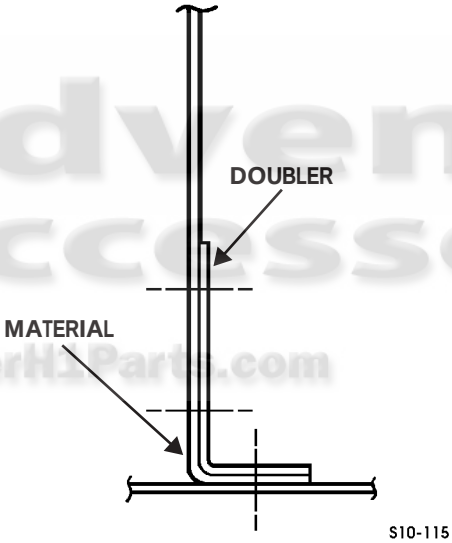


Figure 10-8: Doubler

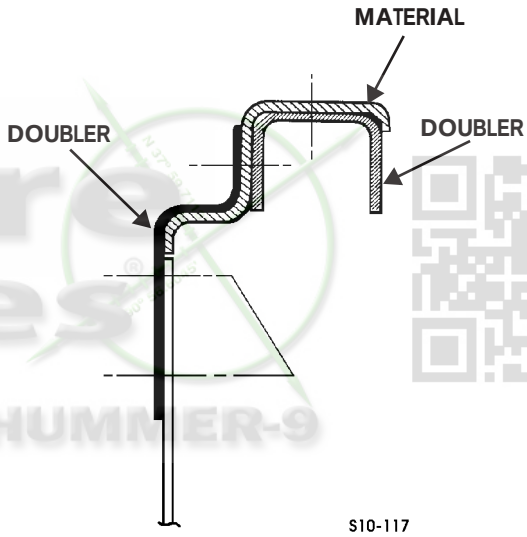


Figure 10-10: Side View of Doubler

Fiberglass Repair

General Information

The HUMMER hood and engine access cover are made of fiberglass (sheet molding compound). Crack, splits, or holes may be repaired with a glass reinforced plastic laminate repair kit.

Inspection

NOTE: Hood surface has a thin layer of gel coat that may appear cracked in a spider web-like pattern due to hood flexing. No repair is required.

1. Examine cracks to determine if they are on surface only, or are deep breaks into material thickness.
2. If filler material chips off at bonding flanges, and appears as cracked but not broken through, the area need not be repaired.
3. If total penetration crack greater than 1 in. (25.4 mm) exists in critical areas: hinges, latches, or hood stop areas, repair immediately (Figure 10-11).
4. If total penetration cracks exist in noncritical areas, do not repair until size is greater than 3 in. (76 mm).
5. If severe breaks develop in one area, remove fragmented material and use repair procedure for holes.

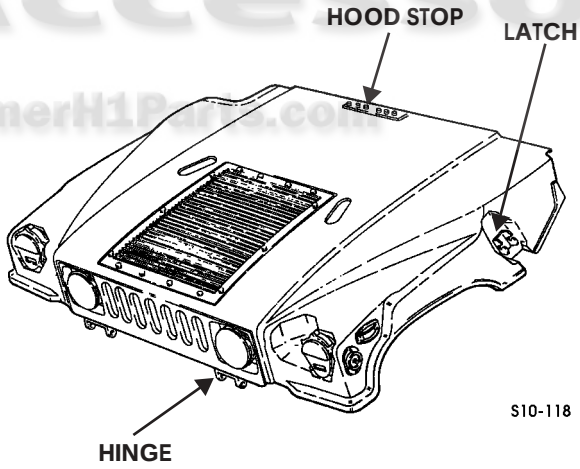


Figure 10-11: Hood Stop and Hinge

Repair

NOTE: Complete procedures for fiberglassing are provided with repair kit (AM General part number 5742835).

1. Repairing cracks or splits.

WARNING: When sanding fiberglass, personal protective equipment (respirator, goggles/shield, gloves, coveralls, etc.) must be used. Failure to do this may result in injury.

   a. Using sandpaper, remove dirt and paint 3-4 in. (8-10 cm) around area of crack.
   b. Rough-sand surface to which mat will be added and underside of surface, if possible. Surface must be dry.
   c. Bevel edges of crack in a broad "V ".
   d. Cut a piece of mat and apply to underside of surface with resin mixture. Extend patch beyond break about 2 in. (5 cm). Press patch firmly into place. Saturate patch with additional layer of resin and then allow 1-3 hours to cure.
   e. At the same time, cover top exposed surface with resin, allowing 1 to 3 hours to cure.
   f. For stressed areas, lightly sand first patch and add another patch layer, repeating steps a through c.
   g. Finish-sand exposed surface.
   h. Prime and paint.

2. Repairing holes.
   a. Remove damaged material.
   b. Using sandpaper, remove dirt and paint in area of hole extending away 3-4 in. (8-10 cm).
   c. Rough-sand top and underside of surface to which mats will be added.
   d. Cut two same size pieces of fiberglass mat that will extend about 2 in. (5 cm) past edge of hole.
   e. Coat both top and underside of surface, and saturate both pieces of mat with the resin mixture.
   f. When tacky, apply one mat to the inner surface and one to the outer surface. Press the two patches together.
   g. Allow 1-3 hours to cure. Additional coats of resin may be added if necessary for appearance purposes. Sand lightly between coats.
   h. Finish-sand exposed surface.
   i. Prime and paint.

WATER LEAK DETECTION AND REPAIR

If water has leaked into the vehicle, inspect for leakage points. Spray water, under pressure, against the vehicle in the general area where the leak is believed to be located. Have an assistant inside the vehicle locate and mark the point(s) where any water appears.

Water that appears at a certain place inside the vehicle may actually be entering the vehicle from another point. It may be necessary to remove the floor mat, interior trim panels, insulation, dash pad, instrument panel, etc. to gain access and diagnose the leak. Back track the path of water to the point of entry. If it is still not possible to locate the point of entry, try the following:

1. Close all windows and doors.
2. Run a small stream of water over the suspected area(s) of leakage.
3. Using a leak detector-type solution (commercially available), spray a film over the suspect area on the exterior surface.
4. From inside the vehicle, use an air wand and force air onto the suspect leak area and check for pressure bubbles that indicate air is escaping from the vehicle.
5. Repair the leak.

If the leak is between body panels or around rivet heads, use Silaprene sealant (P/N 05593929) and wipe the sealant into and/or around the leak area. Be sure to remove any excess sealant while it is still pliable.

If the leak is around a door, it may be because the door is not properly aligned. Refer to Door Replacement in this section for instructions on door adjustment. If the door is contacting the weather seal correctly, make sure the weather seal is not damaged and is properly sealed on the door. If the weather seal is not properly sealed, rubber cement can be used to hold it in place. If the weather seal is damaged, replace it.

If the leak is around a window held by a weather seal (i.e., door glass), completely dry the area and apply a new window glass seal. If the new seal still does not close out against the glass, the window opening flange may need to be adjusted inward. If the weather seal is damaged, it should be replaced. Check the flange that holds the weather seal for any nicks or burrs that may have caused the damage.

Windshield leaks should be repaired by removing the glass and the weather seal that is leaking. Clean off any remaining sealer on the windshield frame and the weather seal, and lay a new bead of sealer evenly around the windshield frame and between the glass and the weather seal. Install the glass and weather seal as an assembly into the frame. Attach the retainers, and allow sealer to harden.

6. Retest the entire vehicle for leaks.

CENTER CONSOLE REPLACEMENT

Removal

1. Remove four screw and washer assemblies from center console. (Figure 10-12).
2. Disconnect four air ducts and hoses from air vents and remove center console from tunnel.
3. Remove two beverage containers and four air vents from center console.

Installation

1. Install two beverage containers and four air vents in center console (Figure 10-12).
2. Route and connect four air ducts and hoses to vents.
3. Install center console on tunnel with four screw and washer assemblies.

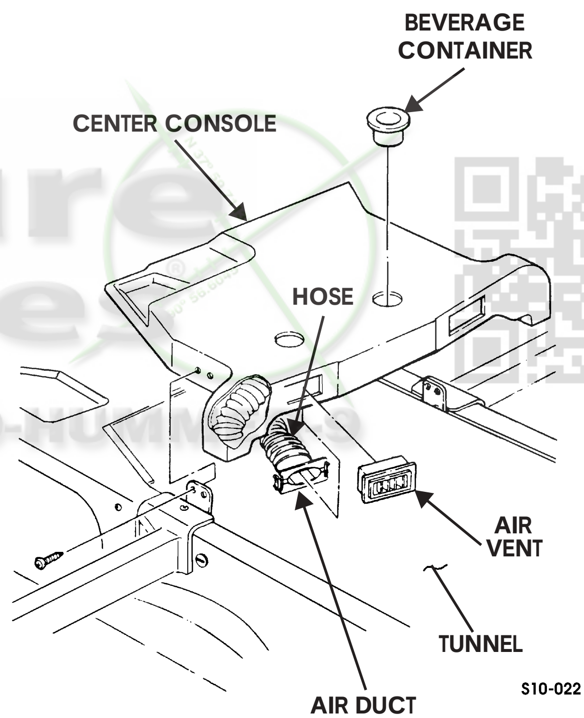


Figure 10-12: Center Console

FRONT CONSOLE REPLACEMENT

Removal

1. Remove center console.
2. Remove two capscrews securing front console to two body brackets (Figure 10-13).

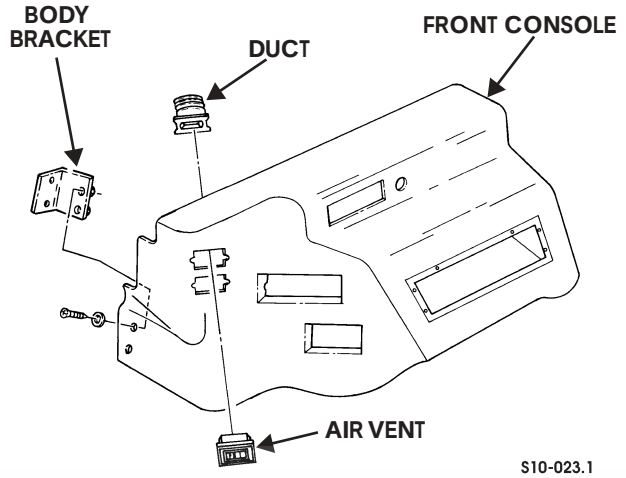


Figure 10-13: Front Console

3. Pull front console away from dashboard.
4. Disconnect three air ducts and hoses from air vents and remove air vents from front console.
5. Disconnect remote lead from radio (Figure 10-14).
6. Disconnect converter box connector from radio.
7. Disconnect antenna lead from radio.
8. Disconnect audio harness connector from radio.
9. Remove converter box from top of sleeve.
10. Disconnect two line output leads from radio.
11. Remove fastener and radio mount bracket from radio (Figure 10-15).
12. Remove lamp from bracket.
13. Remove ashtray receptacle, two capscrews, frame, bracket, and radio mount bracket from front console.
14. Remove trim plate from radio.
15. Press side springs and remove radio from sleeve.
16. Bend sleeve mount tabs and remove sleeve from front console.
17. Disconnect electrical lead from cigarette heater.

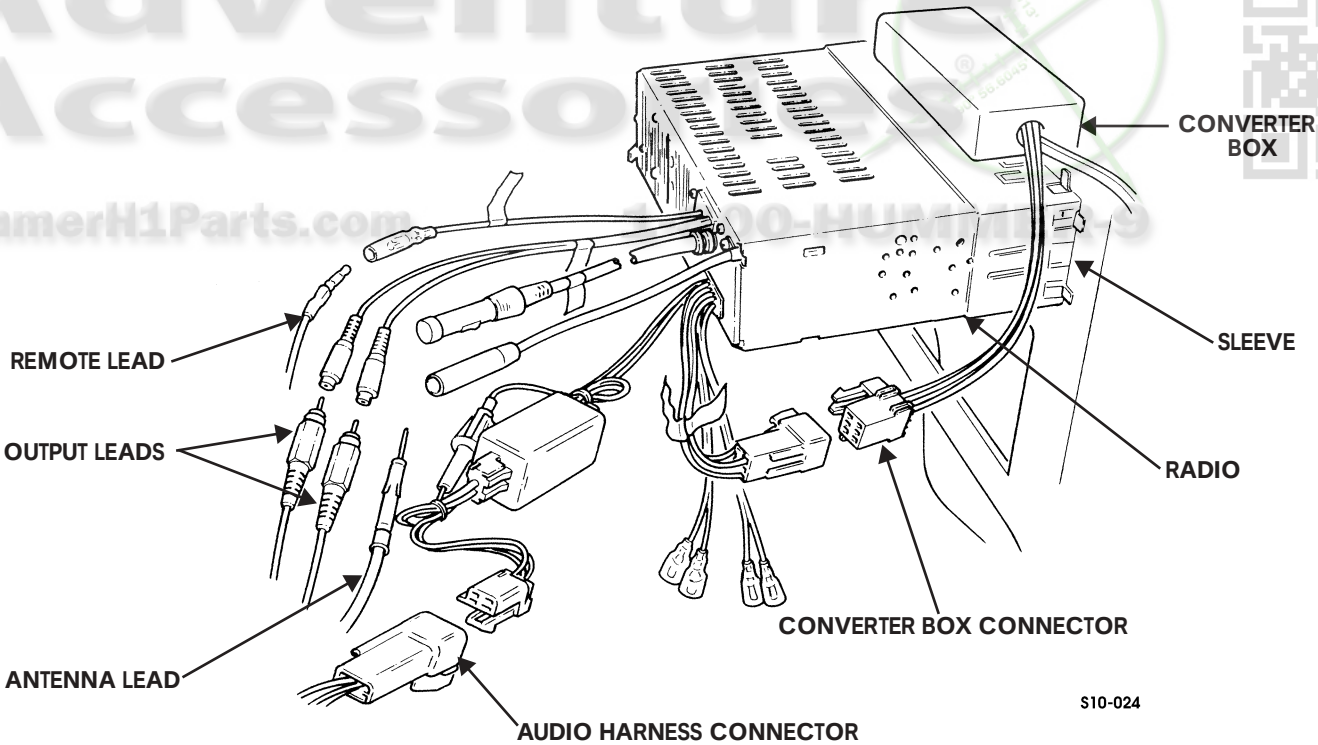


Figure 10-14: Radio and Radio Leads

18. Remove cigarette lighter element, shell, heater, and bezel from console.
19. Remove six capscrews, speednuts, and glovebox from front console (Figure 10-16).
20. Remove four capscrews, bezel, and climate control assembly from front console (Figure 10-17).

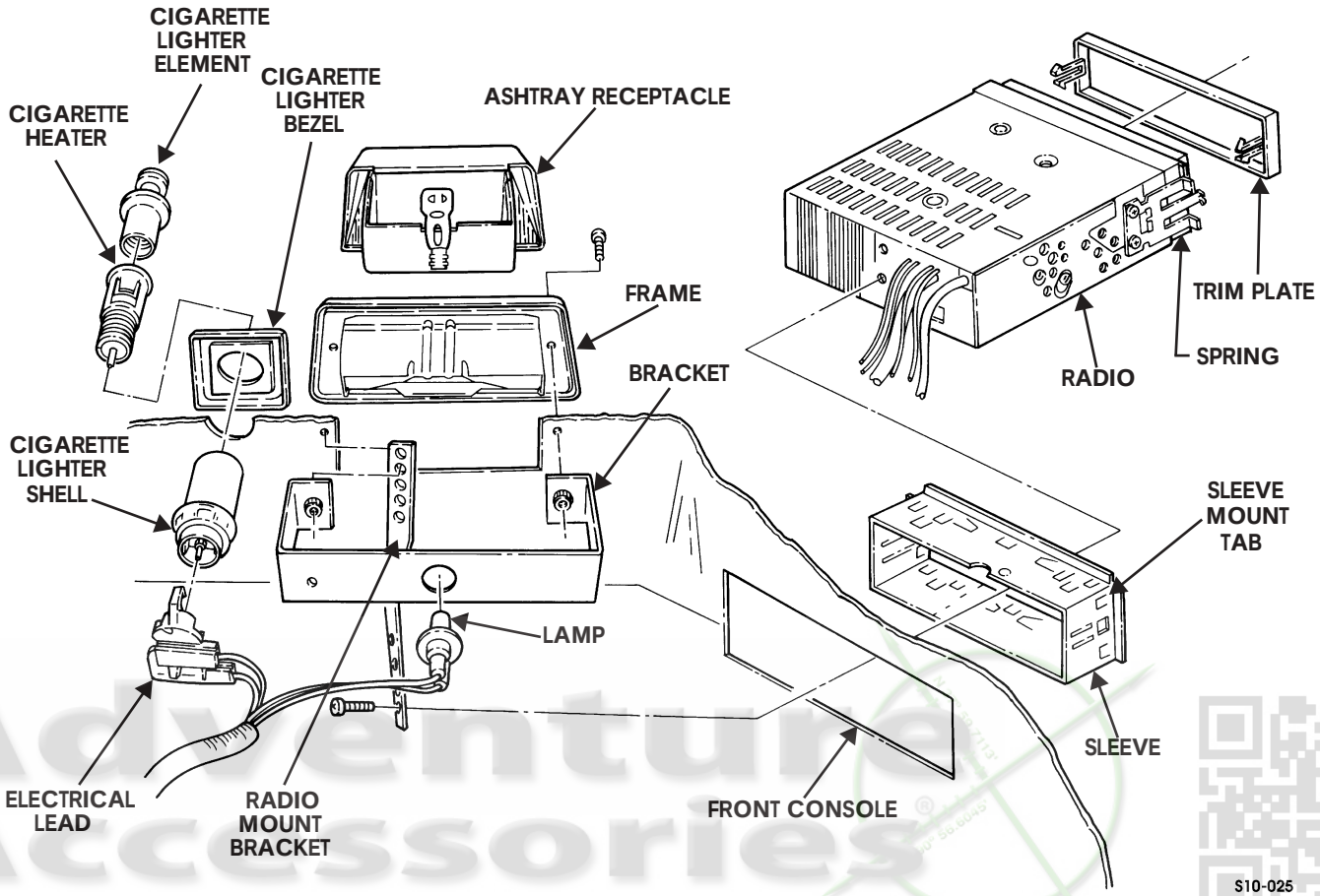


Figure 10-15: Radio Mounting Bracketry

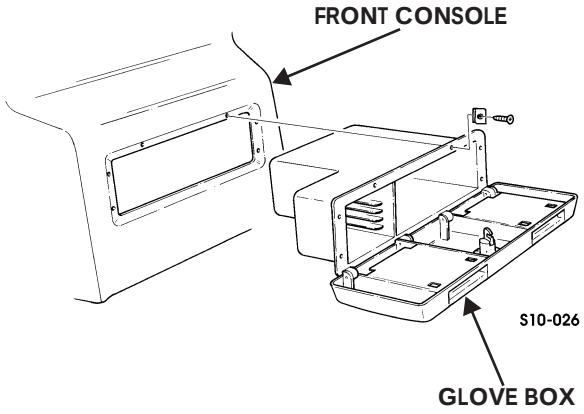


Figure 10-16: Glovebox

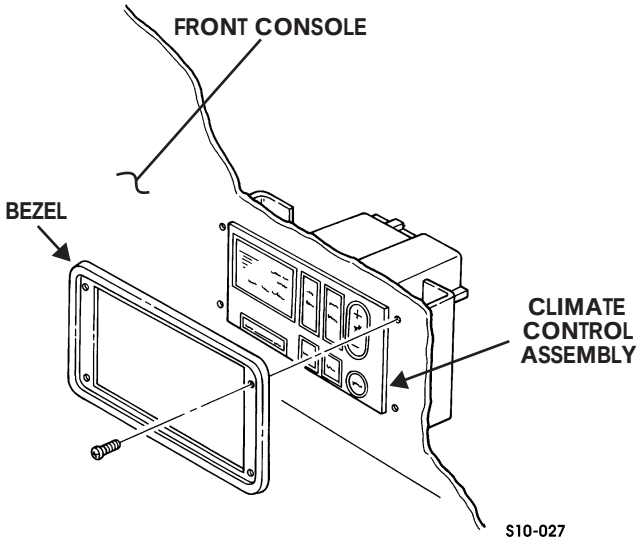


Figure 10-17: Climate Control Assembly

Installation

1. Install bezel and climate control assembly on console with four capscrews (Figure 10-17).
2. Install glovebox in front console with six speednuts and capscrews (Figure 10-16).
3. Install cigarette lighter bezel, heater, shell, and element in front console (Figure 10-15).
4. Connect electrical lead to cigarette heater.
5. Install sleeve in front console and secure by bending mount tabs.
6. Install radio in sleeve.
7. Install trim plate on radio.
8. Install radio mount bracket, bracket, and frame on console with two capscrews.
9. Install ashtray receptacle in frame.
10. Install lamp in bracket.
11. Install radio mount bracket to radio with fastener.
12. Connect two line output leads to radio (Figure 10-14).
13. Position converter box on top of sleeve.
14. Connect audio harness connector to radio.
15. Connect antenna lead to radio.
16. Connect converter box connector to radio.
17. Connect remote lead to radio.
18. Install three air vents in front console and connect air hoses and ducts to air vents (Figure 10-18).
19. Install front console to body brackets with two capscrews.
20. Install center console.

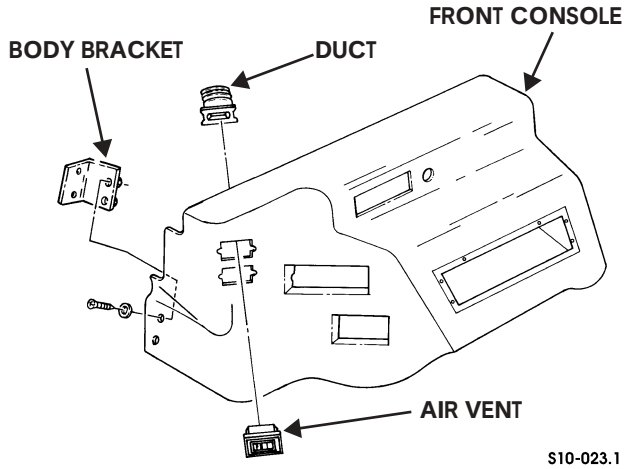


Figure 10-18: Front Console

INSTRUMENT PANEL, GAUGES, AND SWITCHES

Instrument Panel Replacement

Removal

NOTE: Tag all leads prior to removal for installation. If replacing instrument panel, refer to procedures in this section to remove and/or disconnect the various lamps, switches, and gauges.

1. Disconnect battery ground cable (Section 12).
2. Remove two nuts, washers, capscrews, and washers securing instrument panel to body (Figure 10-19).
3. Remove screw securing instrument panel to body.
4. Remove two nuts, washers, capscrews, washers, and instrument panel from steering column mounting bracket.
5. Remove four capscrews, window vent, and vent duct from instrument panel.
6. Disconnect vent duct from air hose.

Installation

NOTE: Coat vent duct and air hose with sealant.

1. Install vent duct and window vent on instrument panel with four capscrews (Figure 10-19).
2. Connect air hose to vent duct.
3. Install instrument panel on steering column mounting bracket with two washers, capscrews, washers, and nuts.
4. Secure instrument panel to body with screw.
5. Secure instrument panel to body with two washers, capscrews, washers, and nuts.
6. Connect battery ground cable (Section 12).

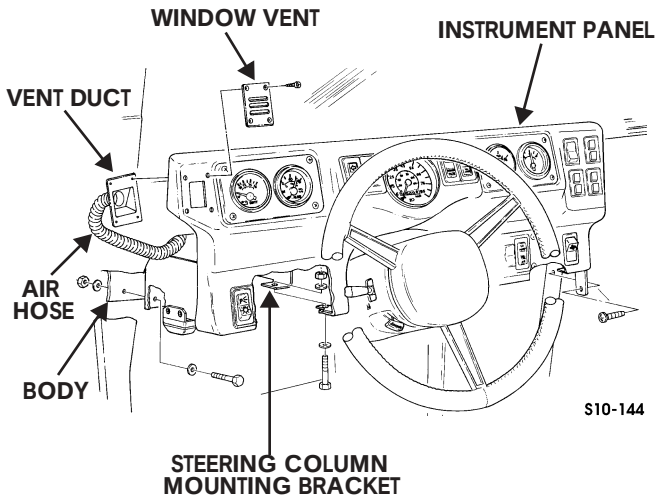


Figure 10-19: Instrument Panel

Crash Pad Replacement

Removal

1. Remove five screw and washer assemblies, two panel fasteners, and crash pad from dashboard (Figure 10-20).
2. Disconnect air hose from vent duct.
3. Remove four capscrews, window vent, and vent duct from crash pad.

Installation

NOTE: Coat vent duct and air hose with sealant.

1. Install vent duct and window vent on crash pad with four capscrews (Figure 10-20).
2. Connect air hose to vent duct.
3. Install crash pad to dashboard with five screw and washer assemblies and two panel fasteners.

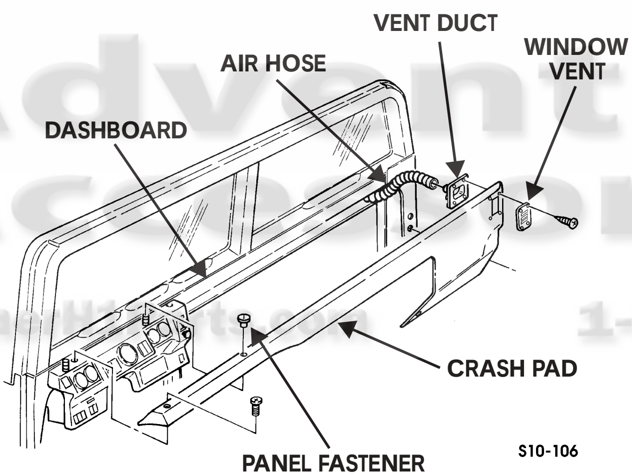


Figure 10-20: Crash Pad

Electrical Gauge Replacement

NOTE: Electrical gauge replacement is basically the same for all instrument panel gauges. This procedure covers the oil pressure gauge.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove four screws and pull gauge panel away from instrument panel (Figure 10-21).

NOTE: Tag all leads prior to removal for installation.

3. Remove three nut and lockwasher assemblies securing three leads to gauge. Discard nut and lockwasher assemblies.
4. Remove nut and lockwasher assembly securing hold-down bracket and gauge to gauge panel. Discard nut and lockwasher assembly.
5. Disconnect lamp connector from gauge.
6. Remove gauge through front of gauge panel.

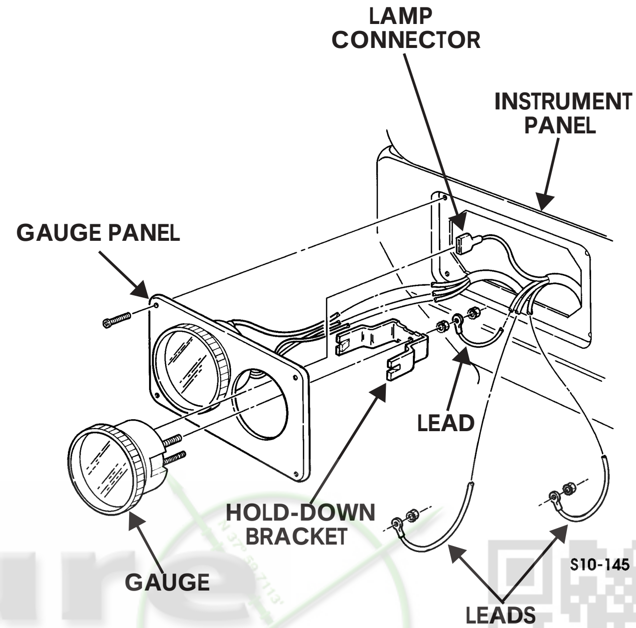


Figure 10-21: Electrical Gauge

Installation

1. Install gauge in gauge panel (Figure 10-21).
2. Connect lamp connector to back of gauge.
3. Install hold-down bracket and gauge on gauge panel with nut and lockwasher assembly.
4. Install three leads on gauge with nut and lockwasher assemblies.
5. Connect battery ground cable (Section 12).
6. Start engine and ensure gauge operates properly.
7. Install gauge panel on instrument panel with four screws.

Instrument Panel Indicator Lamp Replacement

NOTE: All instrument panel indicator lamps are replaced basically the same.

Removal

1. Remove instrument panel.
2. Remove lamp from indicator light housing (Figure 10-22).
3. Turn lamp one-quarter turn, and remove lamp from socket.

Installation

1. Install lamp in socket and secure by turning one-quarter turn (Figure 10-22).
2. Install lamp in indicator light housing.
3. Install instrument panel.
4. Start engine and ensure lamp operates properly.

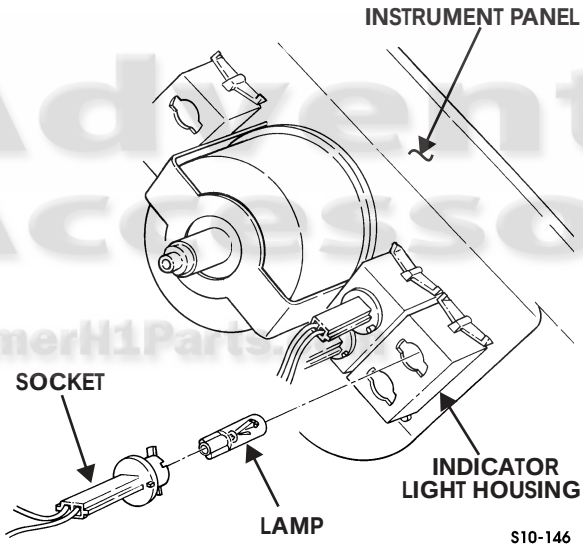


Figure 10-22: Instrument Panel Indicator Light

Speedometer/Odometer Replacement

Removal

1. Remove instrument panel.
2. Remove two plastic caps from studs on speedometer/odometer (Figure 10-23).

NOTE: Tag all leads prior to removal for installation.

3. Remove two nut and lockwasher assemblies securing ground lead and sending lead to speedometer/odometer. Discard nut and lockwasher assemblies.
4. Remove two nut and lockwasher assemblies, leads, and hold-down bracket securing speedometer/odometer to instrument panel and remove speedometer/odometer. Discard nut and lockwasher assemblies.

Installation

1. Install speedometer/odometer on instrument panel and secure with hold-down bracket, two leads, and nut and lockwasher assemblies (Figure 10-23).
2. Install ground lead and sending lead on speedometer/odometer with two nut and lockwasher assemblies.
3. Install two plastic caps on studs of speedometer/odometer.
4. Install instrument panel.

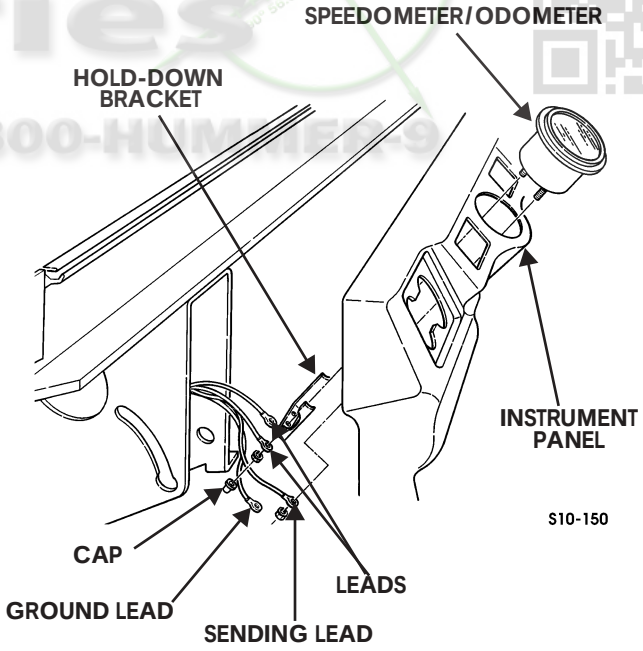


Figure 10-23: Speedometer/Odometer

Instrument Panel Switch Replacement

NOTE: All instrument panel switches are replaced basically the same, with the exception of the dimmer control switch. This procedure covers the main light switch.

Removal

1. Remove instrument panel.
2. Remove connector from switch (Figure 10-24).
3. Remove switch from switch housing.

Installation

1. Install switch in switch housing.
2. Install connector on switch (Figure 10-24).
3. Install instrument panel.

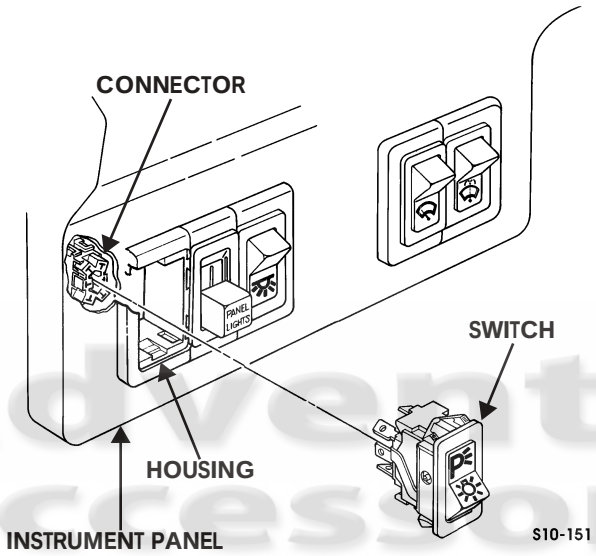


Figure 10-24: Instrument Panel Switch

Dimmer Control Switch Replacement

Removal

1. Remove instrument panel.

NOTE: Tag leads prior to removal for installation.

2. Disconnect connector from wiring harness (Figure 10-25).
3. Remove switch from switch housing.

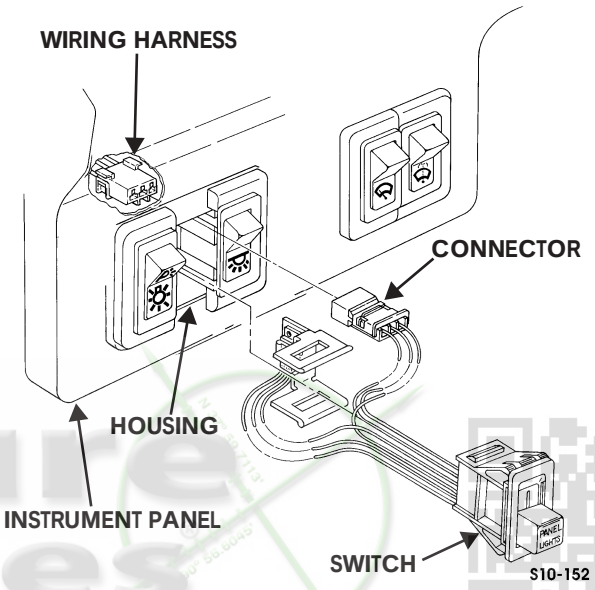


Figure 10-25: Dimmer Control Switch

Installation

1. Install switch in switch housing (Figure 10-25).
2. Connect connector to wiring harness.
3. Install instrument panel.

Tachometer Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Pull front console away from crash pad enough to gain access to tachometer mounting plate (Figure 10-26).
3. Disconnect tachometer connector from body harness connector.
4. Remove two nuts, mounting plate, tachometer, and grommet from front console.

Installation

1. Install grommet, tachometer, and mounting plate on front console with two nuts (Figure 10-26).
2. Connect tachometer connector to body harness connector.
3. Install front console.
4. Connect battery ground cable (Section 12).

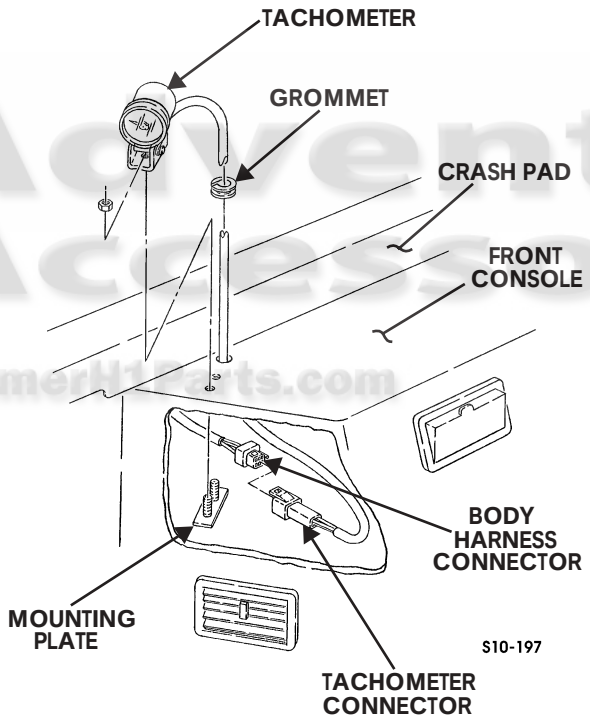


Figure 10-26: Tachometer

CIGARETTE LIGHTER REPLACEMENT

Removal

1. Disconnect battery ground cable (Section 12).
2. Pull front console away from crash pad enough to gain access to wiring harness connector.
3. Remove element from lighter assembly heater (Figure 10-27).
4. Remove wiring harness connector from lighter assembly.
5. Remove shell from heater, and remove shell, heater, and bezel from console.

Installation

1. Install bezel and heater in console (Figure 10-27).
2. Install shell on heater.
3. Install wiring harness connector on lighter assembly.
4. Install element in lighter assembly.
5. Connect battery ground cable (Section 12).
6. Engage cigarette lighter to ensure proper operation.
7. Install front console.

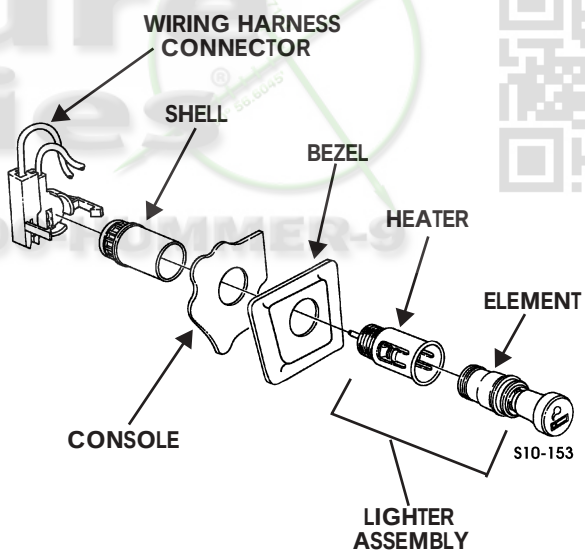


Figure 10-27: Cigarette Lighter

ASHTRAY REPLACEMENT

Removal

1. Pull front console away from crash pad to gain access to ashtray mounting bracket.
2. Remove ashtray receptacle, two capscrews, and frame from console and bracket (Figure 10-28).

Installation

1. Install frame and ashtray receptacle on bracket and console with two capscrews (Figure 10-28).
2. Install front console.

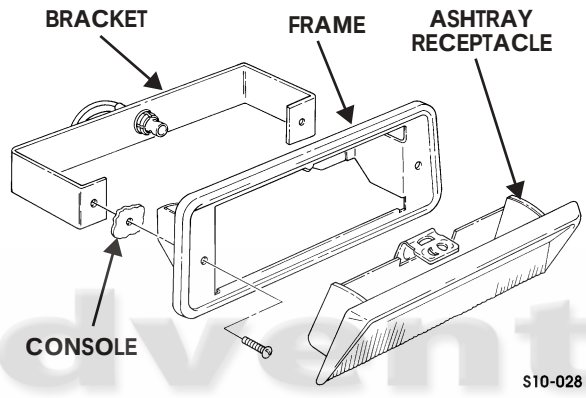


Figure 10-28: Ashtray

GLOVEBOX REPLACEMENT

Removal

Remove six capscrews, speednuts, and glovebox from front console (Figure 10-29).

Installation

Install glovebox in front console with six speednuts and capscrews (Figure 10-29).

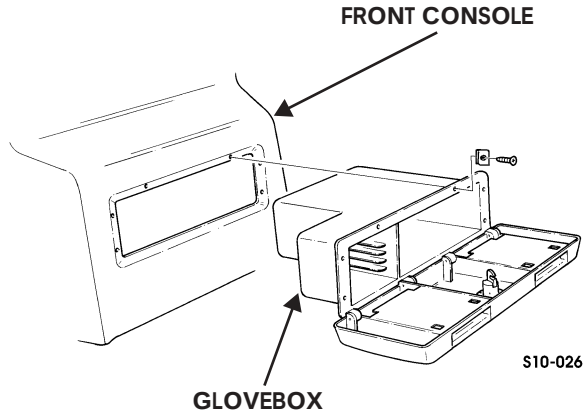


Figure 10-29: Glovebox

ENGINE ACCESS COVER

Inner Engine Access Cover Flexible Latch and Hold-Down Striker Replacement

Removal

1. Remove engine access cover.
2. Remove two rivets and hold-down striker from body (Figure 10-30).
3. Remove two rivets and flexible latch from cargo floor.

Installation

1. Install flexible latch on cargo floor with two rivets (Figure 10-30).
2. Install hold-down striker on body with two rivets.
3. Install engine access cover.

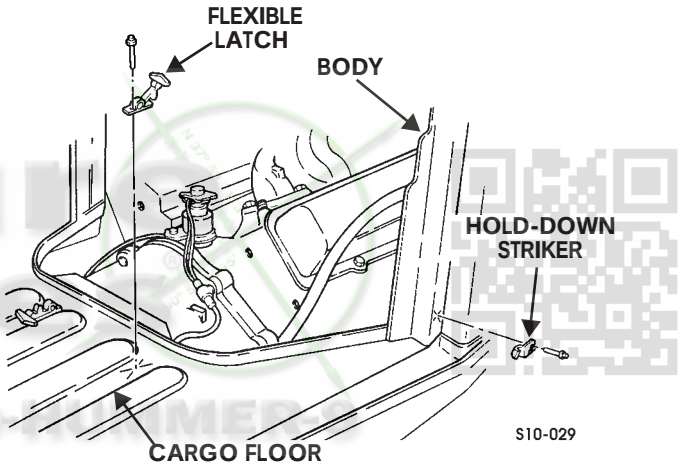


Figure 10-30: Inner Engine Access Cover Latch

Engine Access Cover Maintenance

Removal

1. Remove console.
2. Unlatch two flexible latches from keepers on engine access cover hold-down brackets (Figure 10-31).
3. Unlatch two engine access cover hold-down latches from engine access cover hold-down strikers.
4. Turn two ring studs and remove access cover.

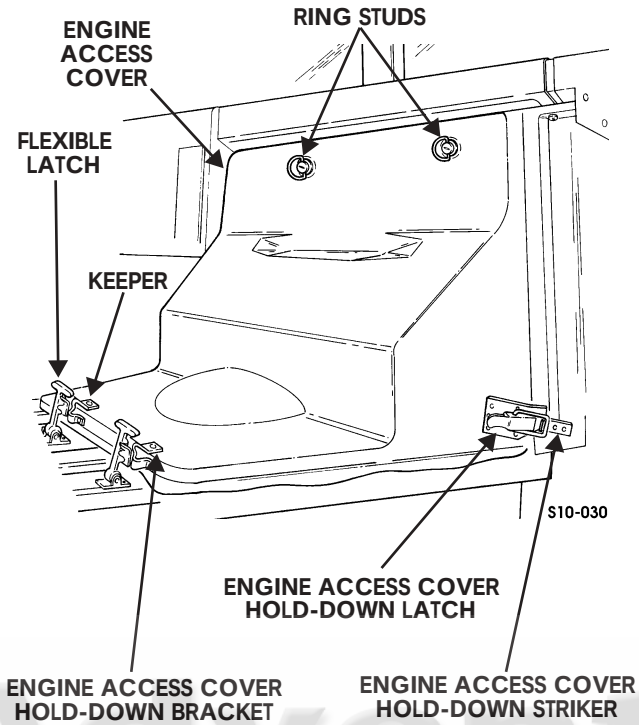


Figure 10-31: Engine Access Cover

Disassembly

1. Remove seven rivets, retainers, and insulation from engine access cover (Figure 10-32).
2. Remove seal from access cover.
3. Remove four retaining rings, washers, and two ring studs from access cover (Figure 10-33).
4. Remove two locknuts and shoulder bolts securing two latch guide plates and back plates to access cover and remove latches. Discard locknuts.
5. Remove four rivets, two latch guide plates, and back plates from access cover.
6. Remove two rivets and keepers from hold-down brackets.
7. Remove four rivets, nuts, washers, capscrews, two hold-down brackets, and backing plates from access cover.

Assembly

1. Install two hold-down brackets and backing plates on access cover with four rivets, capscrews, washers, and nuts (Figure 10-33).
2. Install two keepers on hold-down brackets with two rivets.
3. Install two latch guide plates and back plates on access cover with four rivets.
4. Install two latch guide plates on back plates and access cover with two shoulder bolts and locknuts. Install latches.
5. Install two washers and ring studs on access cover with two washers and four retaining rings.
6. Install seal on access cover (Figure 10-32).
7. Install insulation on access cover with seven rivets and retainers.

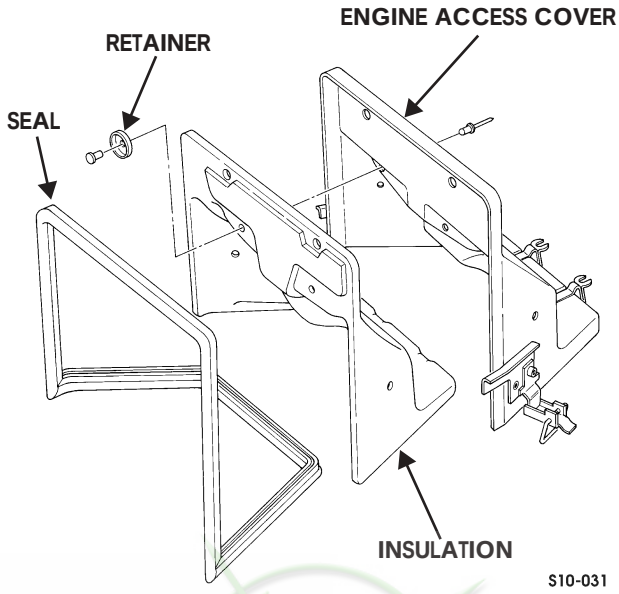


Figure 10-32: Engine Access Cover, Insulation, and Seal

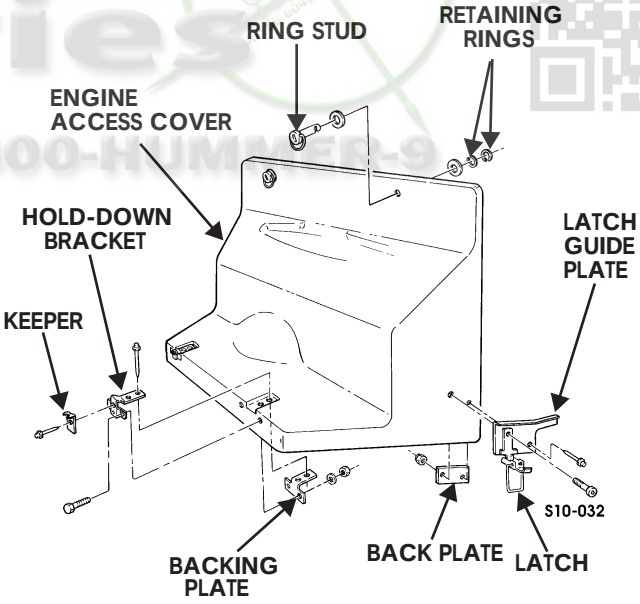


Figure 10-33: Engine Access Cover Fasteners

Installation

1. Install engine access cover with two ring studs (Figure 10-31).
2. Secure two hold-down latches on hold-down strikers.
3. Latch two flexible latches on keepers on hold-down brackets.
4. Install console.

SEAT BELT ASSEMBLY REPLACEMENT

NOTE: Replacement of the seat belt assembly is basically the same for all seat locations on all vehicle models. This procedure covers the left front seat belt on four-door hard top vehicles.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove seat.
3. Remove screw and washer assembly, seat buckle, and washer from body (Figure 10-34).
4. Remove inner kick panel enough to gain access to seat buckle electrical connector.
5. Disconnect seat buckle electrical connector from roof harness connector and pull seat buckle electrical connector through grommet in inner kick panel.

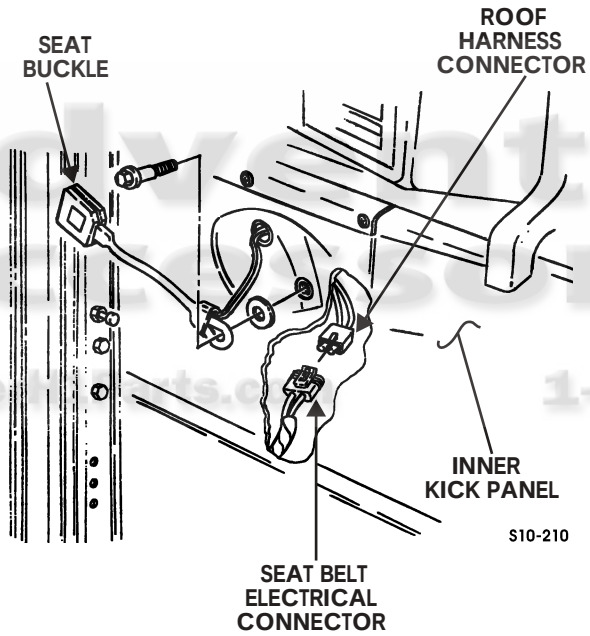


Figure 10-34: Seat Belt Electrical Connector

6. Remove screw and washer assembly, D-ring, webbing guide cover, and washer from B-pillar (Figure 10-35).

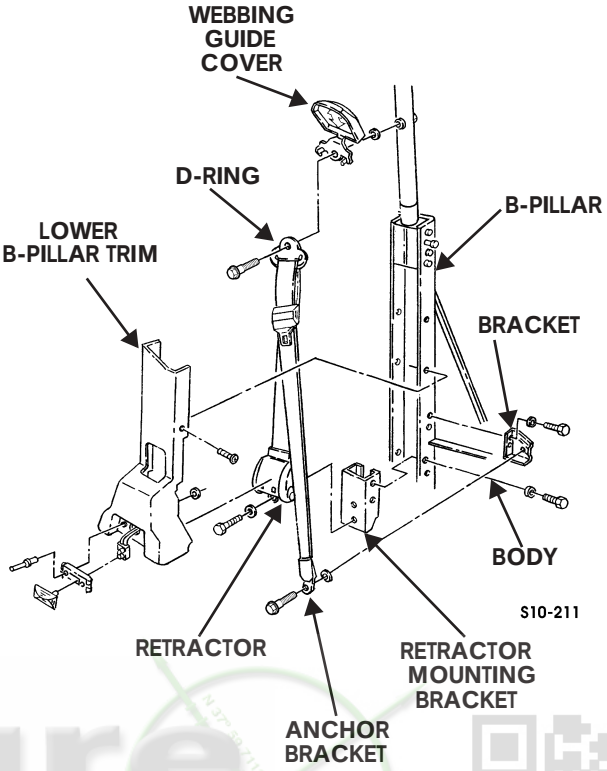


Figure 10-35: Seat Belt Assembly

7. Remove screw and washer assembly, anchor bracket, and washer from bracket.

NOTE: Steps 8 and 9 are applicable to all vehicles except two-door vehicles with the enlarged cab.

8. Remove courtesy light lamp assembly, two rivets, mounting bracket, and two washers from lower B-pillar trim.
9. Disconnect body harness connector from courtesy light lamp assembly.
10. Remove four screw and washer assemblies securing lower B-pillar trim to B-pillar.
11. Remove capscrew, washer, and retractor from retractor mounting bracket. Remove seatbelt assembly from lower B-pillar trim.
12. Remove four capscrews, washers, and retractor mounting bracket from B-pillar.
13. Remove four capscrews, washers, and bracket from B-pillar and body.

Installation

1. Install bracket on B-pillar and body with four washers and capscrews (Figure 10-35).
2. Install retractor mounting bracket on B-pillar with four washers and capscrews.
3. Route seat belt assembly through opening in lower B-pillar trim and install retractor to retractor mounting bracket with washer and capscrew.
4. Install lower B-pillar trim on B-pillar with four screw and washer assemblies.

NOTE: Steps 5 and 6 are applicable to all vehicles except two-door vehicles with the enlarged cab.

5. Connect body harness connector to courtesy light lamp assembly.
6. Install courtesy light lamp assembly and mounting bracket to lower B-pillar trim on B-pillar with two washers and rivets.
7. Install anchor bracket on bracket with washer and screw and washer assembly.
8. Install D-ring and webbing guide cover on B-pillar with washer and screw and washer assembly.
9. Route seat buckle electrical connector through grommet in inner kick panel and connect seat buckle electrical connector to roof harness connector (Figure 10-34).
10. Install inner kick panel.
11. Install seat buckle on body with washer and screw and washer assembly.
12. Install seat.
13. Connect battery ground cable (Section 12).

DRIVER'S AND FRONT PASSENGER'S SEATS

Reclining Driver's and Front Passenger's Seat Replacement

NOTE: Reclining driver's and front passenger's seats are replaced basically the same. This procedure covers the passenger's seat.

Removal

Remove four capscrews, washers, and passenger's seat from seat base (Figure 10-36).

Installation

Install passenger's seat on seat base with four washers and capscrews. Tighten capscrews to 15 lb-ft (20 N•m) (Figure 10-36).

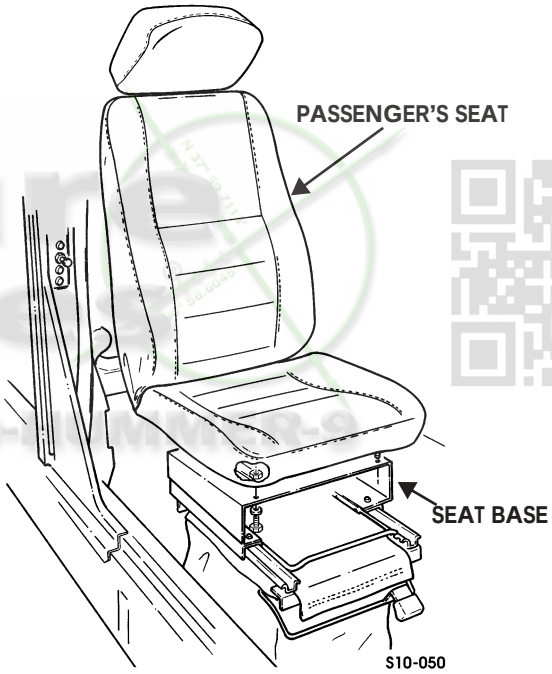


Figure 10-36: Reclining Front Seat

Standard Driver's and Front Passenger's Seat Pedestal Replacement

NOTE: Seat pedestal replacement for driver's and front passenger's seats is basically the same. This procedure covers the driver's seat pedestal.

Removal

1. Remove seat from seat pedestal.
2. Remove four capscrews, lockwashers, and washers securing seat pedestal to floor. Discard lockwashers (Figure 10-37).
3. Remove seat pedestal and four spacers from vehicle.

Installation

1. Install four spacers and seat pedestal in vehicle (Figure 10-37).
2. Secure seat pedestal to floor with four washers, lockwashers, and capscrews.
3. Install seat on seat pedestal.

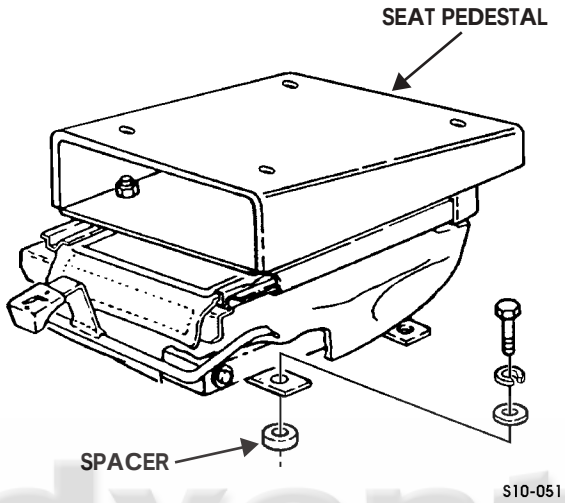


Figure 10-37: Front Seat Pedestal

Standard Driver's and Passenger's Seat Pedestal Replacement

NOTE: Seat pedestal replacement is basically the same for driver's and front passenger's seats. This procedure covers the driver's seat pedestal.

Removal

1. Remove driver's seat pedestal.
2. Remove bag from height adjuster (Figure 10-38).
3. Remove four nuts, lockwashers, and capscrews securing height adjuster to slide set and remove height adjuster and cover. Discard lockwashers.
4. Remove four nuts, lockwashers, and capscrews securing riser to slide set and remove riser. Discard lockwashers.

Installation

1. Install riser on slide set with four capscrews, lockwashers, and nuts (Figure 10-38).
2. Install cover and height adjuster on slide set with four capscrews, lockwashers, and nuts.
3. Install bag on height adjuster.
4. Install driver's seat pedestal.

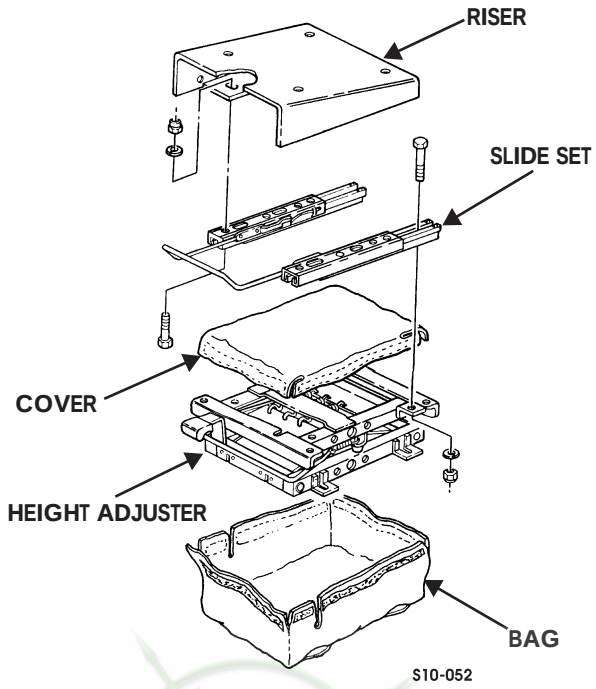


Figure 10-38: Seat Pedestal Assembly

Driver's Seat Armrest Replacement

Removal

1. Remove three plastic caps covering exposed screws (Figures 10-39 and 10-40).
2. Remove two short screws and lockwashers attaching armrest to bracket.
3. If bracket needs to be replaced, remove two long screws attaching bracket to seat support.

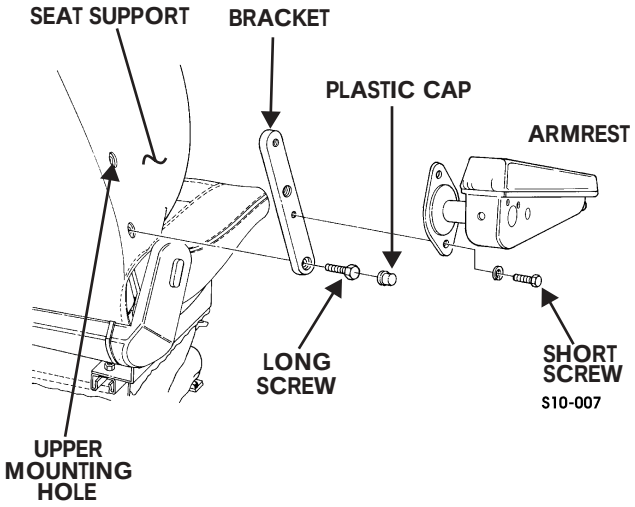


Figure 10-39: Driver's Seat Armrest

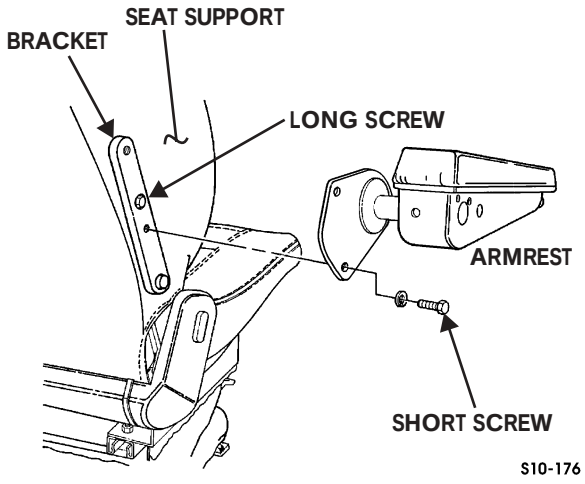


Figure 10-40: Driver's Seat Wide Armrest

Installation

NOTE: If bracket was removed, perform steps 1 through 3.

1. Secure bracket to seat support with one of two long screws. Do not tighten screw (Figures 10-39 and 10-40).
2. Use large center hole in bracket to locate upper bracket mounting hole in seat support.
3. Secure top section of bracket to seat support with other long screw. Tighten both long screws to 120 lb-in. (14 N•m).
4. Secure the armrest to the bracket with the two short screws and lockwashers. Tighten the short screws to 120 lb-in. (14 N•m).
5. Position three plastic caps over three exposed screw heads.

NOTE: The entire armrest can be positioned vertically or horizontally by pushing the armrest up or down. To adjust the angle of the armrest while it is in the horizontal position, use the adjusting knob located under the front end of the armrest.

6. Use the adjusting knob to position the armrest as necessary.

REMOVABLE LOAD BARRIER AND MOUNTING BRACKETS MAINTENANCE (STATION WAGON)

Removal

1. Remove twelve drive screws and carpet assembly from front and back of removable load barrier (Figure 10-41).
2. Remove necessary interior trim to gain access to two mounting brackets.
3. Remove removable load barrier by lifting barrier up and out of mounting brackets on inner wheel house panels.
4. Remove ten rivets and mounting bracket from left inner wheel house panel.
5. Remove ten rivets and mounting bracket from right inner wheel house panel.

Inspection

Inspect bumper strips. If damaged, replace.

Installation

1. Install mounting bracket on left inner wheel house panel with ten rivets (Figure 10-41).
2. Install mounting bracket on right inner wheel house panel with ten rivets.
3. Install removable load barrier in mounting brackets.
4. Install interior trim.
5. Install carpet assembly on front and back of removable load barrier with twelve drive screws.

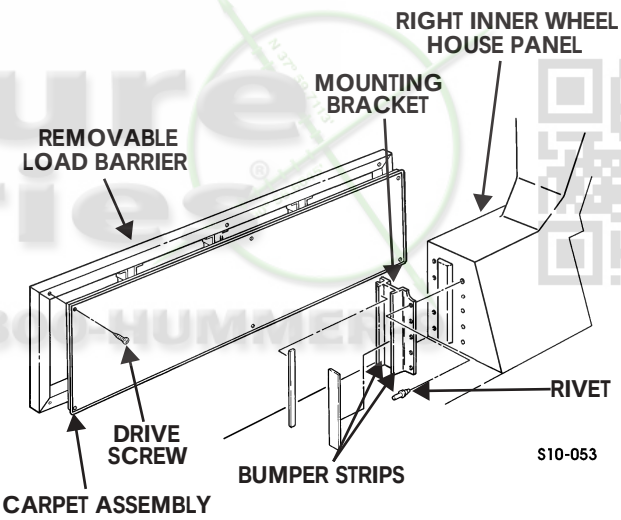


Figure 10-41: Removable Load Barrier

INTERIOR TRIM

B-Bar Replacement

NOTE: This procedure covers replacement of the B-bar for all vehicles except open top models and 2-door models without an enlarged cab.

Removal

1. Remove seat belt assemblies.
2. Remove trim from B-bar.
3. Remove domelight.

NOTE: It may be necessary to remove any duct tape or tie straps securing electrical wiring harnesses to B-bar.

4. Remove eight screws, washers, and headliner support from B-bar (Figure 10-42).
5. Remove four screws, lockwashers, and two mounting brackets from mounting blocks. Discard lockwashers.
6. Remove two B-pillar seals and rabbet seals from B-pillar. Inspect and discard seals if damaged.
7. Remove two locknuts, washers, and strikers from B-pillar. Discard locknuts.
8. Remove six locknuts, washers, capscrews, washers, and four mounting blocks from B-pillar. Discard locknuts
9. Remove B-bar.
10. Remove four screws, washers, and two trim mounting brackets from B-bar.

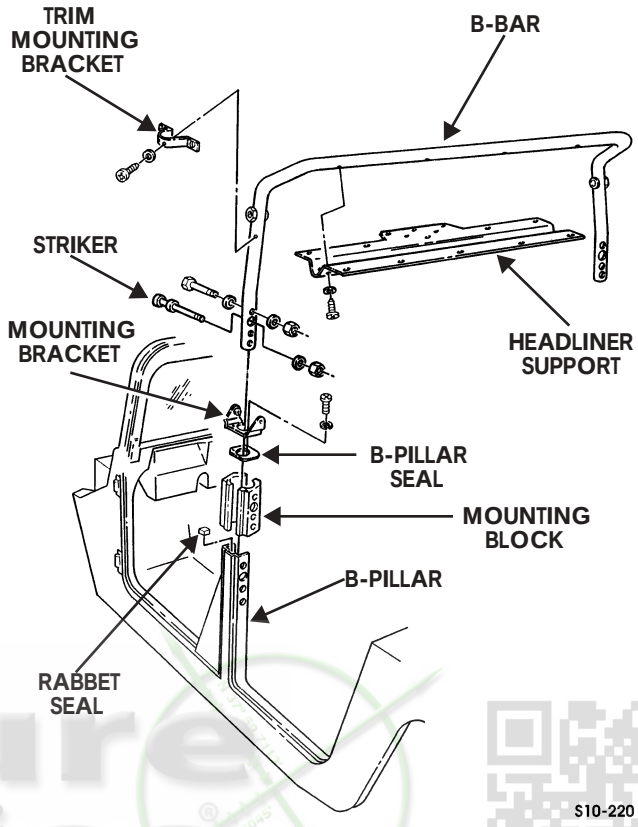


Figure 10-42: B-Bar

Installation

1. Install two trim mounting brackets on B-bar with four washers and screws (Figure 10-42).
2. Install B-bar.
3. Install four mounting blocks on B-pillar with six washers, capscrews, washers, and locknuts.
4. Install two strikers on B-pillar with washers and locknuts.
5. Install two B-pillar seals and rabbet seals on B-pillar.
6. Install two mounting brackets on mounting blocks with four lockwashers and screws.
7. Install headliner support on B-bar with eight washers and screws.
8. Install domelight.
9. Install trim on B-bar.
10. Install seat belt assemblies.

Driver's Compartment Trim Replacement

Removal

1. Remove overhead speakers from driver's compartment and passenger's compartment (if applicable) (Section 12).
2. Remove visors.
3. Remove seat belt assemblies.
4. Remove two covers, screws, and grab handle from trim. (Figure 10-43).

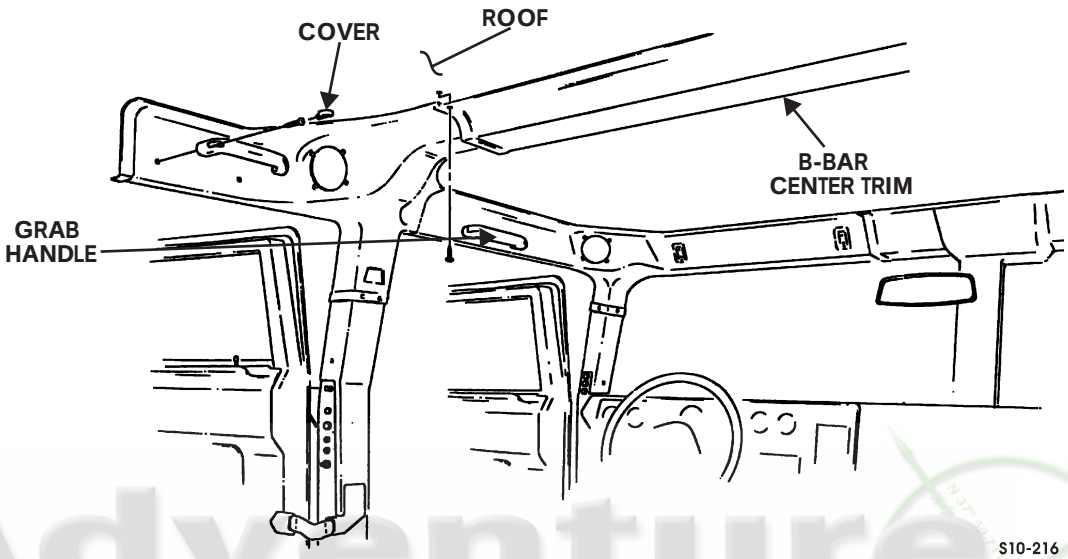


Figure 10-43: Driver's Compartment Trim

5. Remove ten screw and washer assemblies and B-bar center trim from roof.
6. Remove eight screw and washer assemblies and center trim from windshield frame and roof (Figure 10-44).
7. Remove nine screw and washer assemblies and upper A-pillar trim from roof.

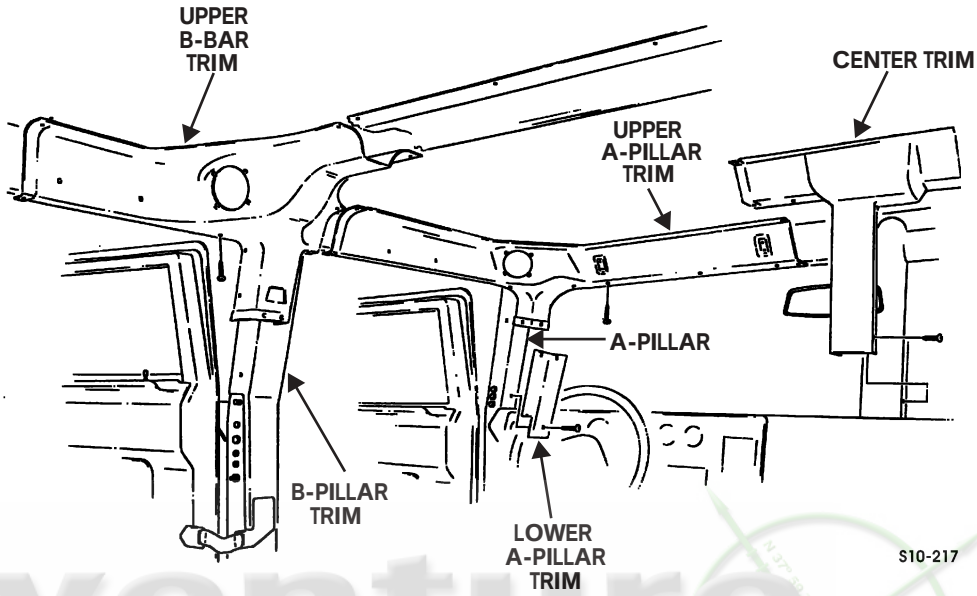


Figure 10-44: A-Pillar and B-Bar Interior Trim

8. Remove screw and washer assembly and lower A-pillar trim from A-pillar.
9. Remove six screw and washer assemblies and upper B-bar trim from roof.
10. Remove two screws, washers, and B-pillar trim from B-pillar.

NOTE: Replacement of the rear driver's compartment trim for 2-door vehicles with and without an enlarged cab is basically the same. Steps 11 through 13 cover 2-door vehicles without an enlarged cab.

11. Remove seats.
12. Remove ten screw and washer assemblies and trim from upper rear compartment wall (Figure 10-45).

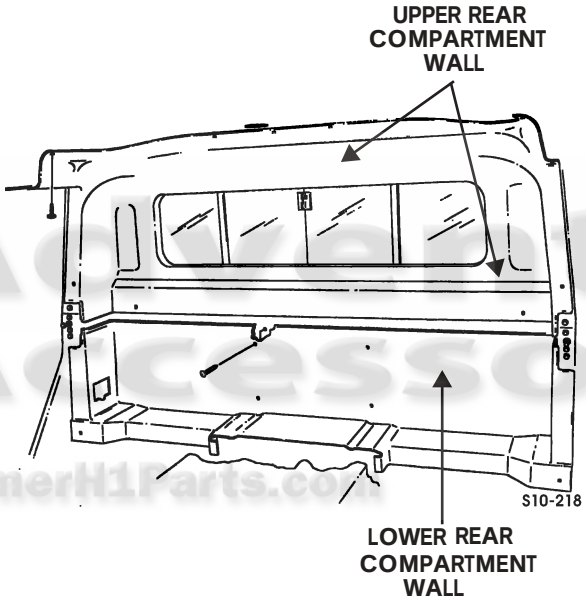


Figure 10-45: Rear Compartment Wall

13. Remove two screw and washer assemblies, B-beam trim, and rear edge trim from B-beam and lower rear compartment wall.
14. Remove domelight.
15. Remove two panel fasteners and headliner from roof (Figure 10-46).

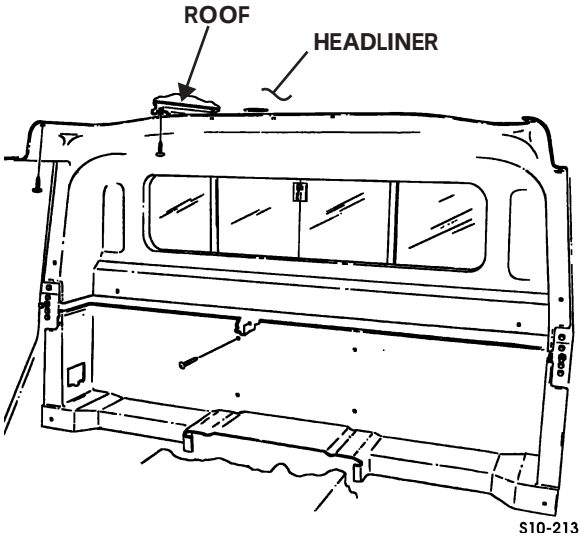


Figure 10-46: Headliner

Installation

1. Position headliner on roof and install with two panel fasteners (Figure 10-46).
2. Install domelight.

NOTE: Perform steps 3 through 5 for 2-door vehicles without an enlarged cab.

3. Install rear edge trim and B-beam trim on B-beam and rear compartment wall with two screw and washer assemblies (Figure 10-45).
4. Install trim on upper rear compartment wall with ten screw and washer assemblies.
5. Install seats.
6. Install B-pillar trim on B-pillar with two washers and screws (Figure 10-47).

7. Install upper B-bar trim on roof with six screw and washer assemblies.
8. Install lower A-pillar trim on A-pillar with screw and washer assembly.
9. Install upper A-pillar trim on roof with nine screw and washer assemblies (Figure 10-44).
10. Install center trim on windshield frame and roof with eight screw and washer assemblies (Figure 10-47).
11. Install B-bar center trim on roof with ten screw and washer assemblies.
12. Install grab handle on trim with two screws and covers.
13. Install seat belt assemblies.
14. Install visors.
15. Install overhead speakers (if equipped) (Section 12).

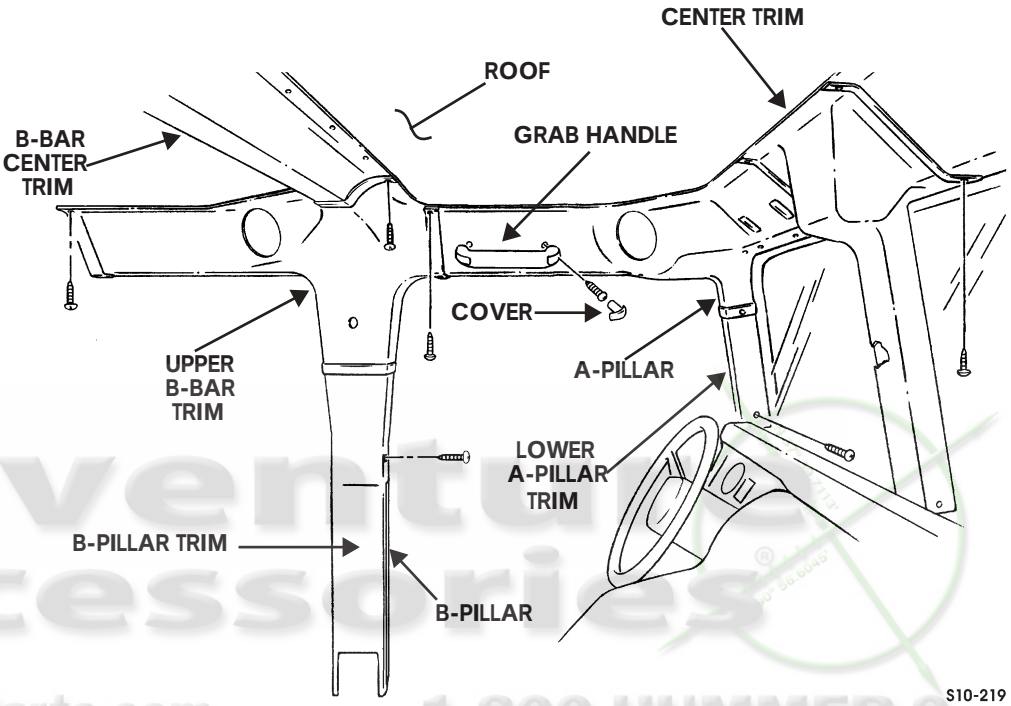


Figure 10-47: A-Pillar and B-Bar Interior Trim

Passenger's Compartment Trim Replacement

Removal

1. Remove rear seats.
2. Remove overhead speakers (Section 12).
3. Remove seat belt assemblies.
4. Remove ten screw and washer assemblies and B-bar center trim from roof (Figure 10-48).

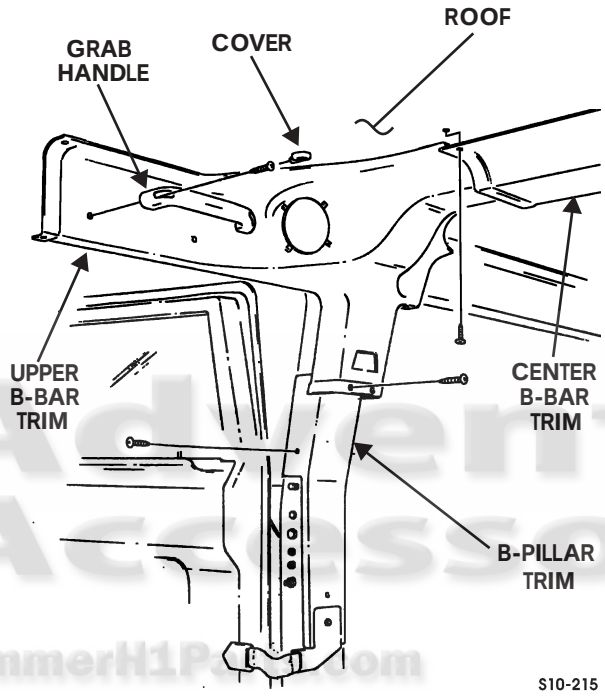


Figure 10-48: Passenger's Side Interior Trim

5. Remove two covers, screws, and grab handle from trim.
6. Remove six screw and washer assemblies and upper B- bar trim from roof.
7. Remove two screws, washers, and lower B-pillar trim from B-pillar.

NOTE: Perform steps 8 through 10 for station wagon models only.

8. Remove eight screw and washer assemblies and C-pillar center trim from roof (Figure 10-49).
9. Remove nine screw and washer assemblies and upper C-pillar trim from roof.
10. Remove four screw and washer assemblies and lower C-pillar trim from lower C-pillar.

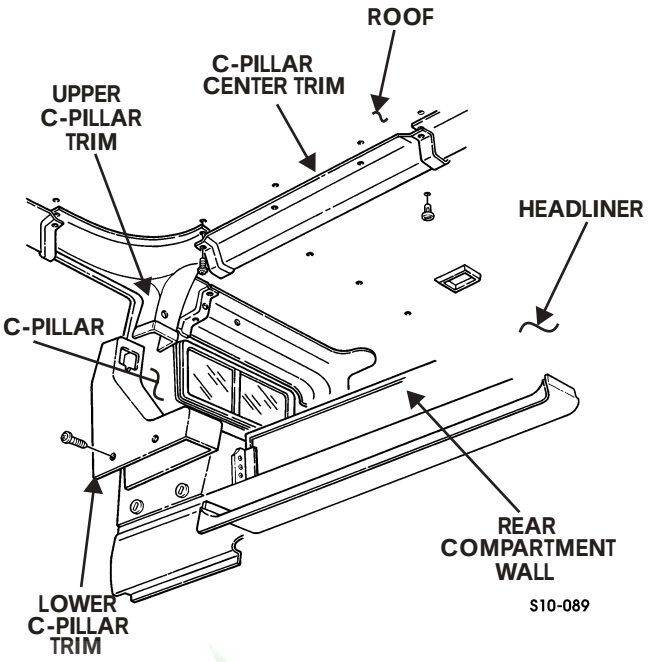


Figure 10-49: Station Wagon Compartment

11. Remove four screw and washer assemblies and trim panel from rear compartment wall (Figure 10-50)

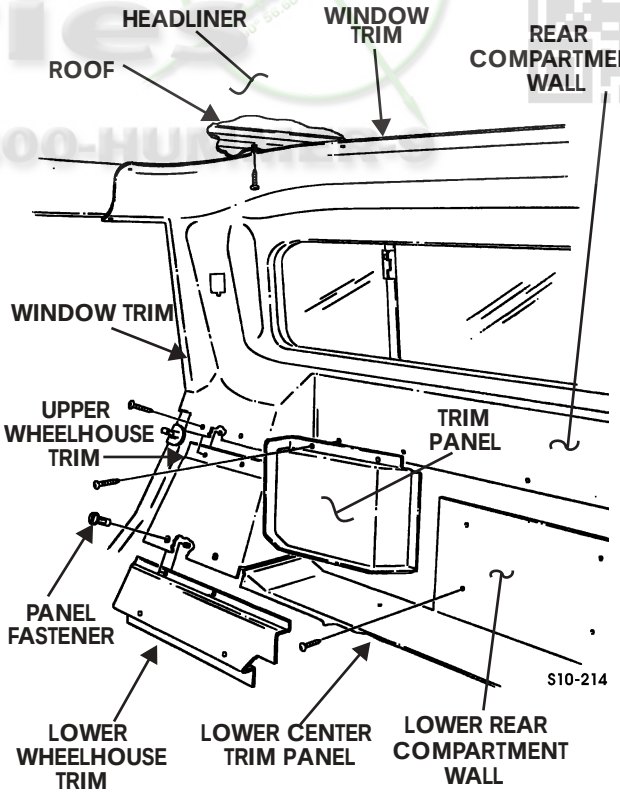


Figure 10-50: Four-Passenger Vehicle

12. Remove fifteen screw and washer assemblies and window trim from rear compartment wall and roof.

13. Remove two panel fasteners and upper wheelhouse trim from wheelhouse.
14. Remove two screw and washer assemblies and lower wheelhouse trim from wheelhouse.
15. Remove eight screw and washer assemblies and lower center trim panel from lower rear compartment wall.
16. Remove domelight.
17. Remove two panel fasteners and headliner from roof.

Installation

1. Install headliner on roof with two panel fasteners (Figure 10-50).
2. Install domelight.
3. Install lower center trim panel on lower rear compartment wall with eight screw and washer assemblies.
4. Install upper and lower wheelhouse trim panels to wheelhouse with two screw and washer assemblies and panel fasteners.
5. Install window trim on rear compartment wall and roof with fifteen screw and washer assemblies.
6. Install trim panel on rear compartment wall with four screw and washer assemblies.

NOTE: Perform steps 7 through 9 for station wagon models only.

7. Install lower C-pillar trim on lower C-pillar with four screw and washer assemblies (Figure 10-49).
8. Install upper C-pillar trim on roof with nine screw and washer assemblies.
9. Install C-pillar center trim on roof with eight screw and washer assemblies.
10. Install B-pillar trim on B-pillar with two washers and screws (Figure 10-51).
11. Install upper B-bar trim on roof with six screw and washer assemblies.
12. Install B-bar center trim on roof with ten screw and washer assemblies.

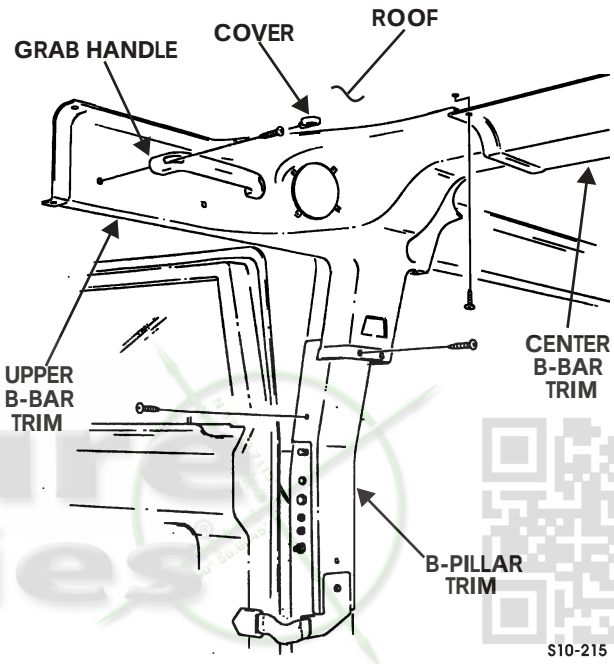


Figure 10-51: B-Pillar and Interior Trim

13. Install grab handle on trim with two screws and covers.
14. Install seat belt assemblies.
15. Install overhead speakers (Section 12).
16. Install rear seats.

Station Wagon Rear Compartment Trim Replacement

Removal

1. Remove rear seats.
2. Remove two capscrews, washers, upper seat belt bracket, and seat belt assembly from C-pillar (Figure 10-52).

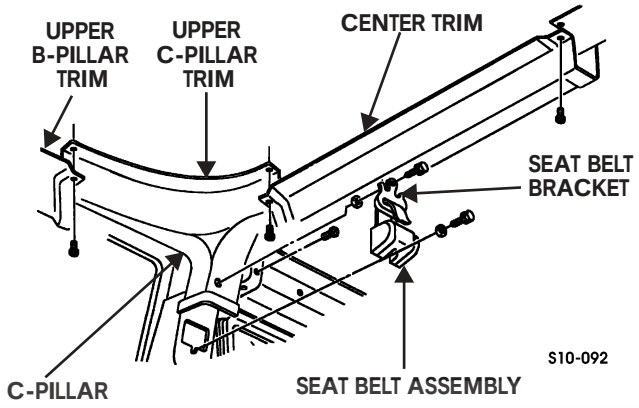


Figure 10-52: C- and B-Pillar Trim

3. Remove eight screw and washer assemblies and center trim from C-pillar.
4. Remove two screw and washer assemblies from edge of trim on upper B-pillar trim.
5. Remove six screw and washer assemblies and upper C-pillar trim from C-pillar.
6. Remove four screw and washer assemblies and trim from station wagon compartment side wall (Figure 10-53).

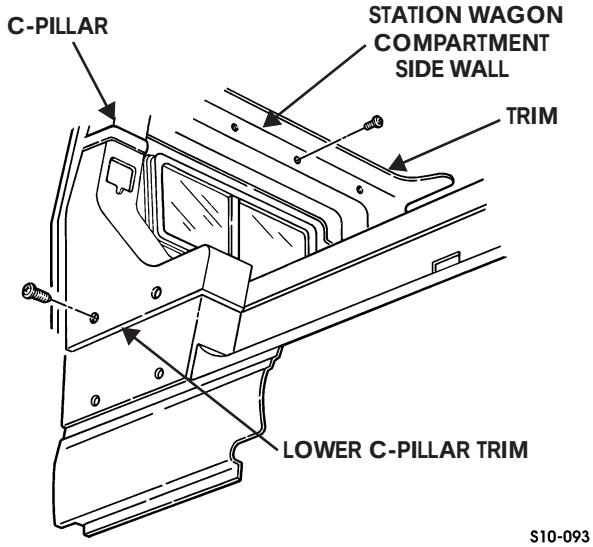


Figure 10-53: C-Pillar Trim

7. Remove four screw and washer assemblies and lower C-pillar trim from C-pillar.
8. Remove eight screw and washer assemblies and two trim panels from lower rear compartment wall (Figure 10-54).

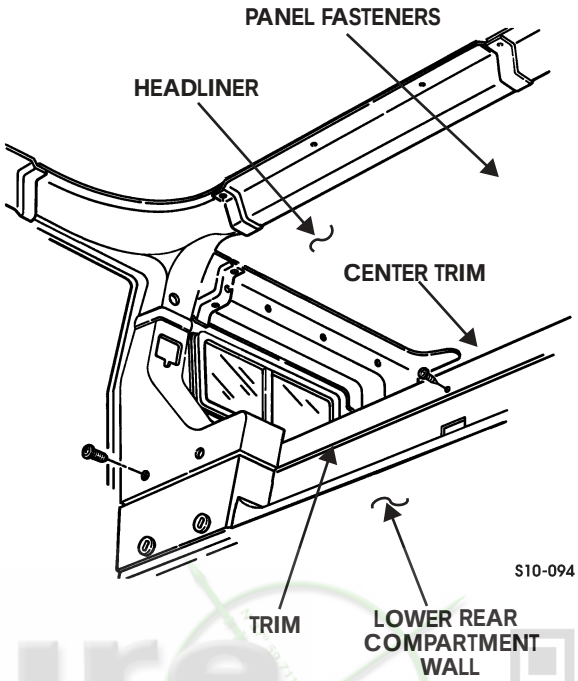


Figure 10-54: Headliner and Trim

9. Remove two panel fasteners and trim panel from rear compartment wall.
10. Remove domelight.
11. Remove four panel fasteners and rear headliner from roof.
12. Remove trim from bottom of rear window (Figure 10-55).

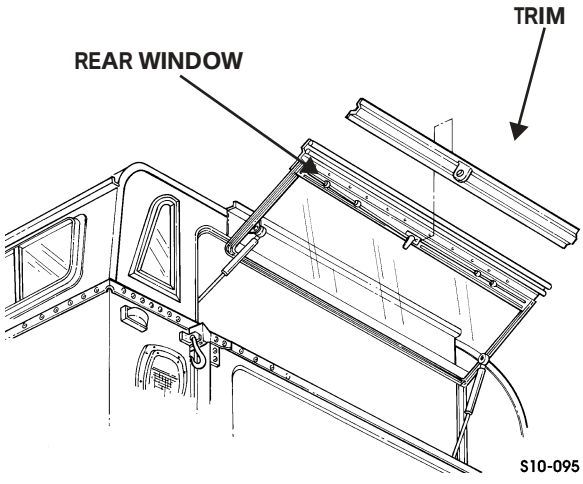


Figure 10-55: Rear Window Trim

Installation

1. Install trim on bottom of rear window (Figure 10-55).
2. Install rear headliner on roof with four panel fasteners (Figure 10-54).
3. Install domelight.
4. Secure trim panel to compartment wall with two panel fasteners.
5. Install two trim panels on lower rear compartment wall with eight screw and washer assemblies.
6. Install lower C-pillar trim on lower side of C-pillar with four screw and washer assemblies (Figure 10-56).
7. Install trim to upper station wagon compartment side wall with four screw and washer assemblies.
8. Install upper C-pillar trim on C-pillar with six screw and washer assemblies.
9. Install two screw and washer assemblies on edge of upper trim on B-pillar.
10. Install center trim on C-pillar with eight screw and washer assemblies.
11. Install seat belt assembly, washer, capscrew, washer, seat belt bracket, and capscrew to C-pillar.
12. Install rear seat.

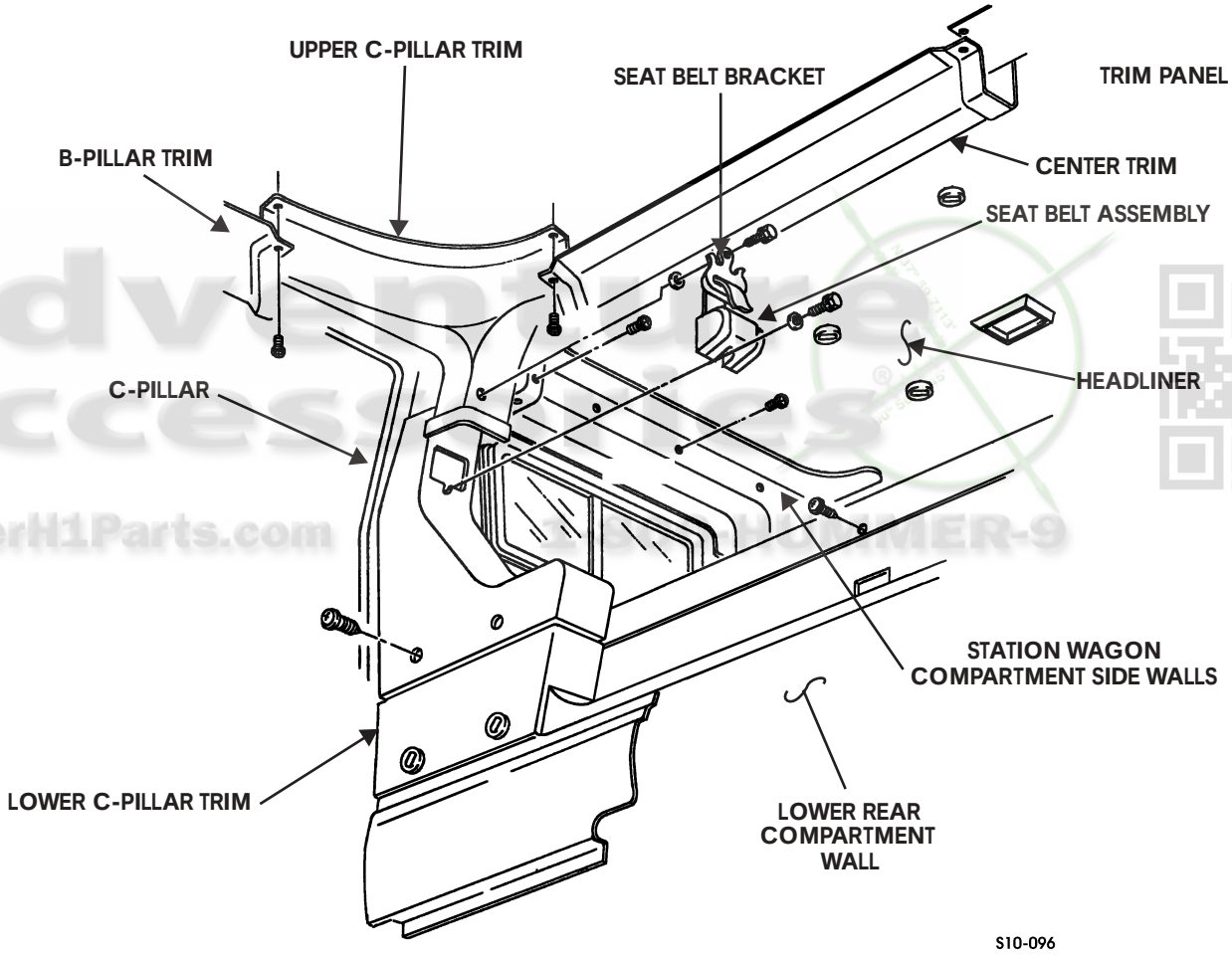


Figure 10-56: Station Wagon Side Wall

Inner Kick Panels Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove seats.

NOTE: Remove one capscrew, washer, and seat buckle for two-passenger models.

3. Remove two capscrews, washers, and seat buckles from front and rear of tunnel (Figure 10-57).

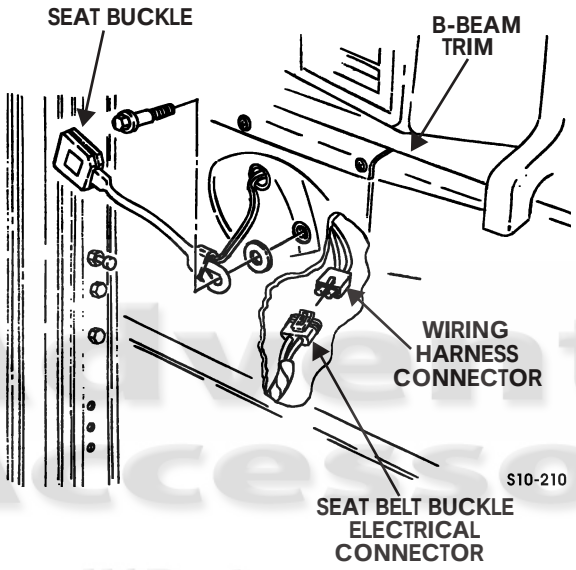


Figure 10-57: Seat Belt Buckle Electrical Connector

NOTE: Ensure seat belt buckle electrical connector or wiring harness is pulled out and away from kick panel for ease of installation.

4. Disconnect seat belt buckle electrical connector from wiring harness connector on driver's side.

NOTE: Perform steps 5 and 6 for four-passenger models only.

5. Remove two panel fasteners, four screw and washer assemblies, and rear wall trim from rear compartment wall (Figure 10-58).

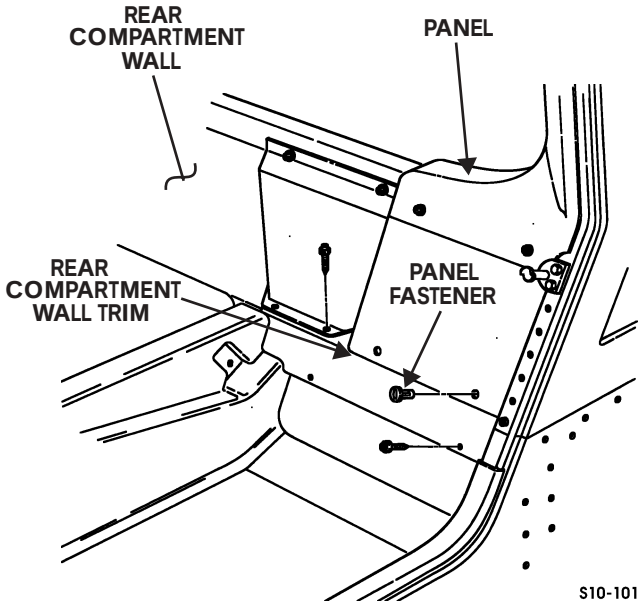


Figure 10-58: Rear Compartment Trim

6. Remove five panel fasteners and rear inner kick panel from tunnel (Figure 10-59).

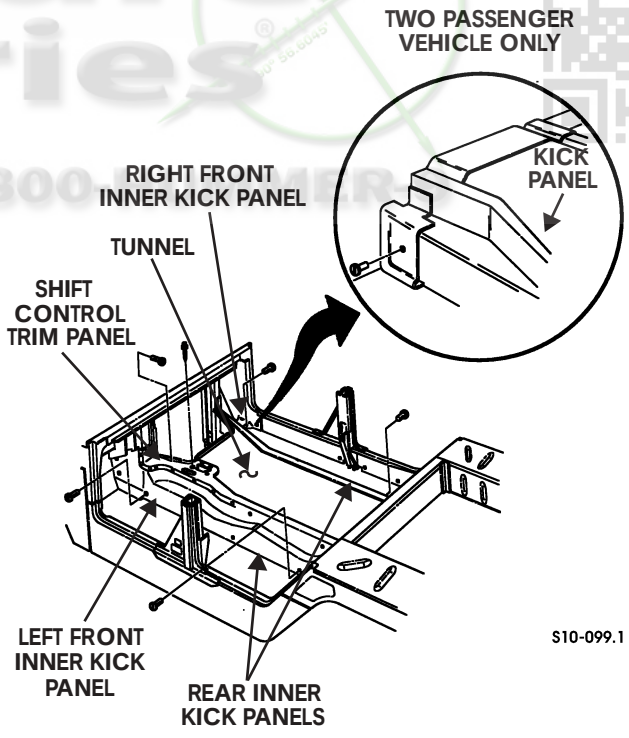


Figure 10-59: Inner Kick Panels

7. Remove front and center consoles.
8. Remove eleven screw and washer assemblies, panel fastener, and shift control panel from tunnel (Figure 10-59).

9. Remove three panel fasteners and left front inner kick panel from tunnel.

10. Remove five panel fasteners and right front inner kick panel.

NOTE: Perform step 11 for two-passenger models only.

11. Remove panel fastener and inner kick panel from rear of tunnel.

Installation

NOTE: Perform step 1 for two-passenger models only.

1. Install rear inner kick panel on right rear of tunnel with panel fastener (Figure 10-59).
2. Install right front inner kick panel to tunnel with five panel fasteners.
3. Install left front inner kick panel to tunnel with three panel fasteners.
4. Install shift control trim panel to tunnel with eleven screw and washer assemblies and panel fastener.
5. Install center and front consoles.

NOTE: Perform steps 5 and 6 for four-passenger models only.

6. Install rear inner kick panels with five panel fasteners (Figure 10-58).
7. Install rear wall trim to rear compartment wall with two panel fasteners and four screw and washer assemblies.
8. Connect seat belt buckle electrical connector for driver's side (Figure 10-57).

NOTE: Install one seat buckle for two-passenger models.

9. Install two seat buckles to tunnel with washers and capscrews.
10. Install seats.
11. Connect battery ground cable (Section 12).

Outer Kick Panel Replacement

Removal

NOTE: Soft top models require removal of speakers from front outer kick panels before performing the following task.

1. Remove door stop straps.
2. Remove two panel fasteners and right front outer kick panel from frame (Figure 10-60).
3. Remove four panel fasteners and left front outer kick panel from frame.
4. Remove two panel fasteners and left center outer kick panel from frame.
5. Remove panel fastener and right center outer kick panel from frame.
6. Remove two screws, washers, and rear lower seat belt brackets from frame.
7. Remove six panel fasteners and left and right rear outer kick panels from frame.

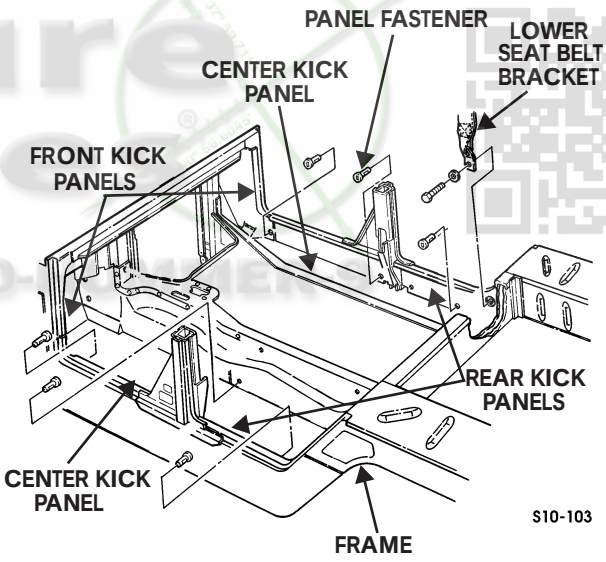


Figure 10-60: Outer Kick Panels

Installation

1. Install left and right rear outer kick panels on frame with six panel fasteners (Figure 10-60).
2. Install two rear lower seat belt brackets on frame with washers and capscrews.
3. Install right center outer kick panel on frame with panel fastener.
4. Install left center outer kick panel on frame with two panel fasteners.
5. Install left front outer kick panel on frame with four panel fasteners.

6. Install right front outer kick panel to frame with two panel fasteners.
7. Install door stop straps.

Tunnel Carpet, Padding, and Hardboard Replacement

Removal

NOTE: Tunnel carpet, padding, and hardboard replacement is basically the same for all models. This task represents four-passenger model carpet replacement.

1. Remove inner kick panels.
2. Remove carpet from tunnel (Figure 10-61).
3. Remove padding from tunnel.
4. Remove four panel fasteners and hardboard from tunnel.

Installation

1. Install hardboard on tunnel with four panel fasteners (Figure 10-61).
2. Install padding on tunnel.
3. Install carpet on tunnel.
4. Install inner kick panels.

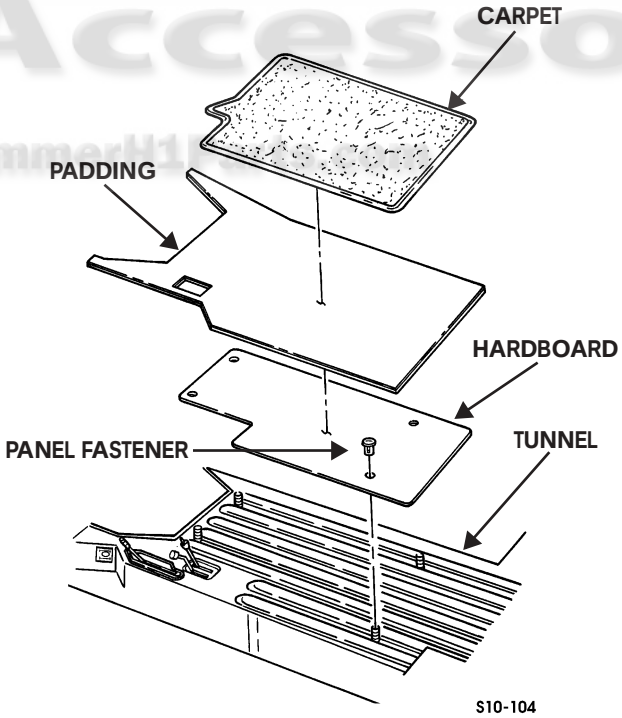


Figure 10-61: Carpet and Padding

VISOR REPLACEMENT

Removal

NOTE: Visor replacement is the same for each side of the vehicle. This procedure covers the driver's side.

NOTE: If your vehicle has the lighted visor mirror, disconnect the visor mirror lead from the roof harness connector before removing the visor (Figure 10-63).

Remove four screws, lockwashers, washers, and remove visor from body (Figure 10-62).

Installation

Install visor on body with four screws, lockwashers, and washers (Figure 10-62).

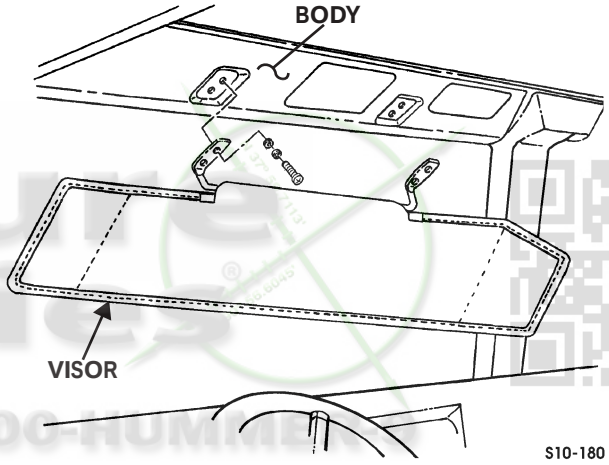


Figure 10-62: Visor

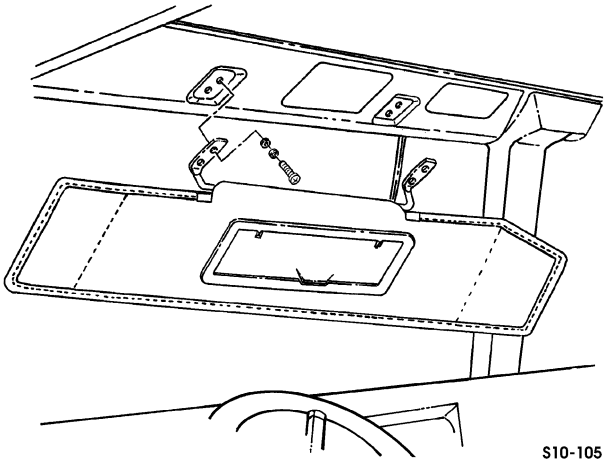


Figure 10-63: Visor With Lighted Mirror

DOOR MAINTENANCE

NOTE: Door maintenance is basically the same for all doors.

Removal

CAUTION: *To avoid damage, support door during removal.*

NOTE: Go to step 2 for front doors on vehicles equipped with power mirrors.

1. Remove side mirror (front doors only).
2. Remove power mirror assembly (Section 13).

NOTE: Go to step 4 for vehicles equipped with power windows.

3. Remove power door locks harness from pillar (Section 12).
4. Remove power windows and door locks harness from pillar (Section 12).
5. Remove door stop strap assembly.
6. Remove two twelve-point screws and washers securing upper door hinge to pillar (Figure 10-64).

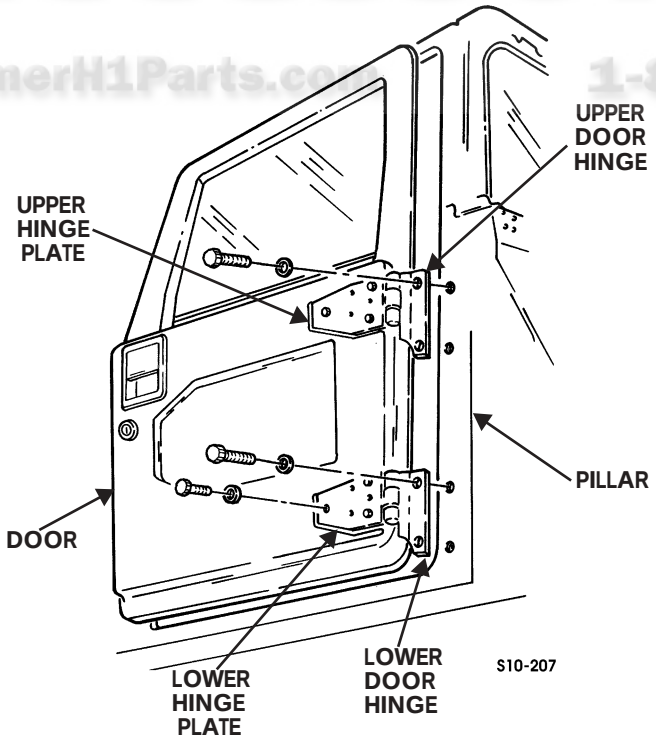


Figure 10-64: Door Hinges

7. Close door.
8. Remove two twelve-point screws and washers securing lower door hinge to pillar and remove door.

Disassembly

1. Remove six twelve-point screws, washers, and upper and lower hinge plates from door (Figure 10-64).

NOTE: Go to step 4 for front doors on vehicles equipped with power windows. Go to step 5 for rear doors on vehicles equipped with power windows.

2. Remove power door locks switch (Section 13).
3. Slide cover from top of window regulator handle, and remove screw and handle from regulator (Figure 10-65).

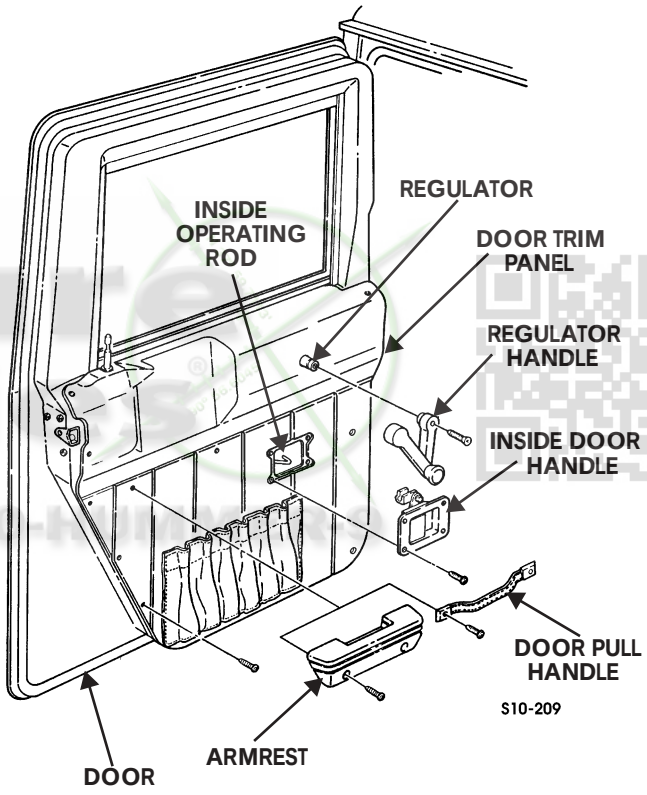


Figure 10-65: Door

4. Remove power windows and door locks switches from door (Section 13).
5. Remove power windows switch from door (Section 13).
6. Remove two screws and door pull handle or armrest from door trim panel.
7. Remove four screws securing inside door handle to door trim panel. Pull handle away from trim panel, and disconnect inside operating rod from handle.
8. Remove seven screw and washer assemblies and door trim panel from door.
9. Remove vapor barrier and moisture barrier flap from door (Figure 10-66).

10. Disconnect inside operating rod from door latch assembly and remove rod (Figure 10-67).

NOTE: Perform steps 11 and 12 for front doors only.

11. Remove lock cylinder clip from lock cylinder.
12. Push lock cylinder through outside of door. Remove clip securing lever and lock operating rod to cylinder and remove cylinder from door (Figure 10-68).

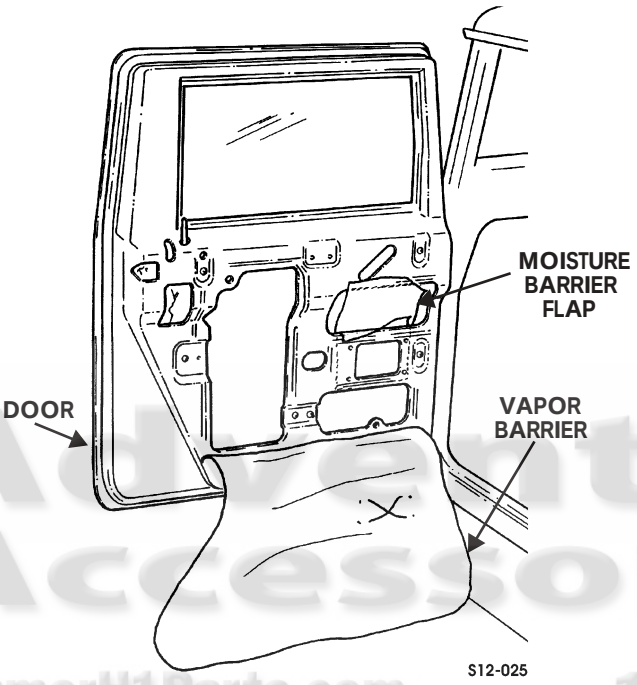


Figure 10-66: Vapor Barrier and Moisture Barrier Flap

13. Remove four nuts and lockwashers securing gasket and outside door handle to door. Disconnect outside operating rod from handle, and remove handle. Discard lockwashers.
14. Remove three screws, lockwashers, and latch assembly from door. Discard lockwashers (Figure 10-69).
15. Remove all rods from door latch assembly.

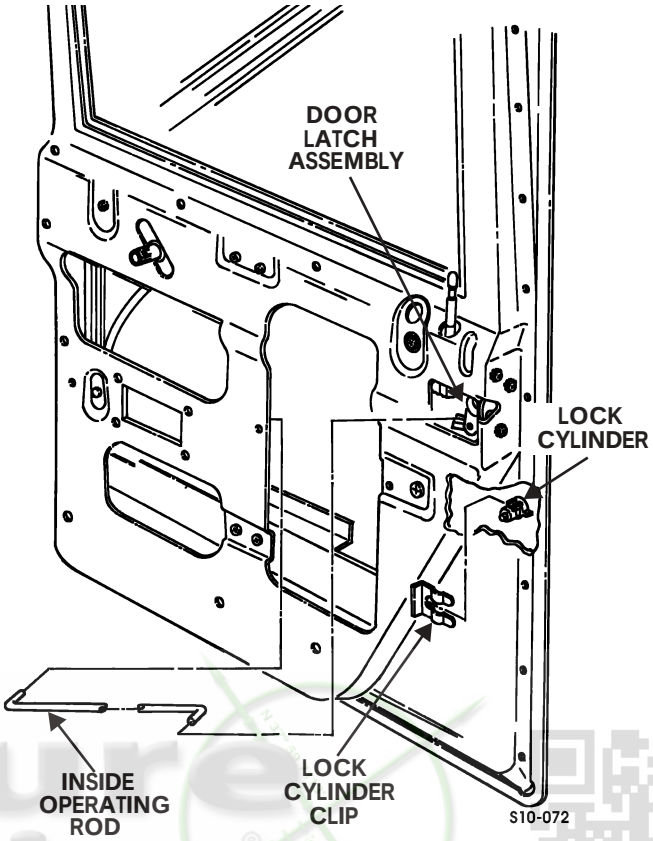


Figure 10-67: Inside Operating Rod

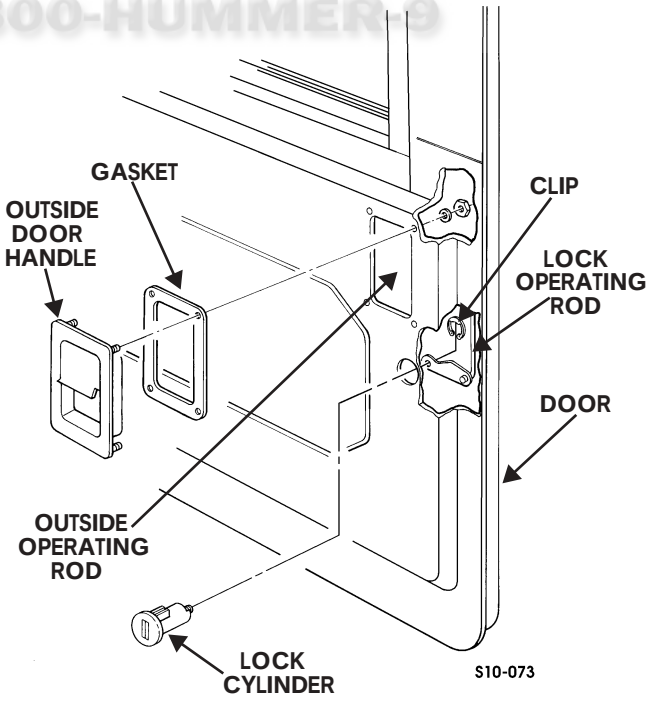
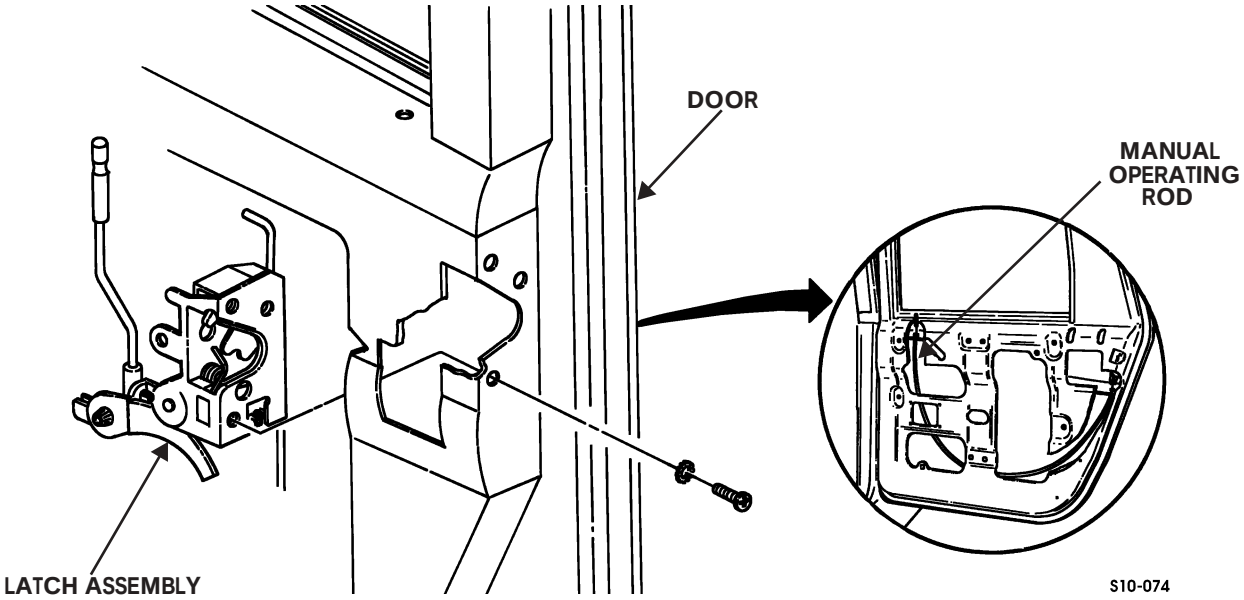


Figure 10-68: Lock Cylinder and Outside Door Handle



FRONT DOOR REAR DOOR

Figure 10-69: Latch Assembly

CAUTION: *Firmly support glass during regulator removal to avoid damage.*

NOTE: Prior to removal, mark location of screws for installation.

NOTE: Go to step 19 for vehicles equipped with power windows.

16. Remove two nuts and lockwashers securing regulator post to window assembly. Discard lockwashers (Figure 10-70).
17. Remove four capscrews and lockwashers securing regulator post to door. Discard lockwashers.
18. Remove two capscrews, lockwashers, and regulator from door. Discard lockwashers.
19. Remove power windows regulator (Section 13).

Cleaning and Inspection

NOTE: Clean all components, and examine for wear or damage. Replace if necessary.

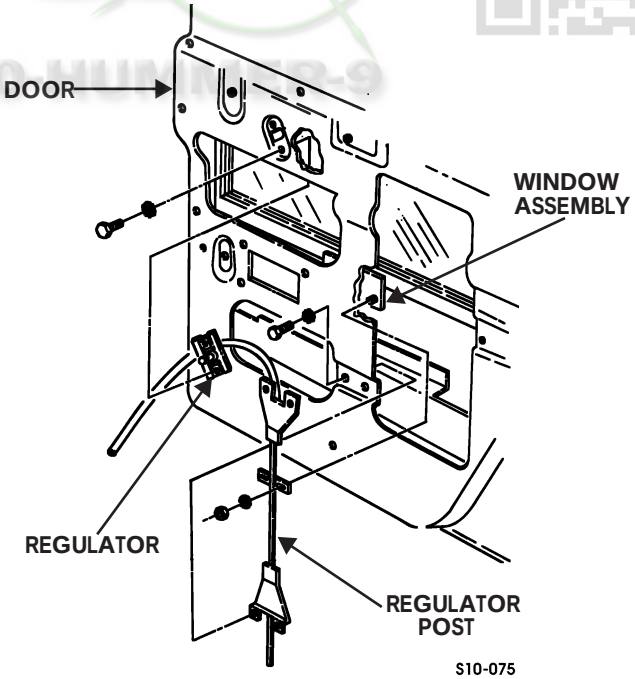


Figure 10-70: Window Regulator

Assembly

NOTE: Go to step 4 for vehicles equipped with power windows.

1. Install regulator on door with two lockwashers and capscrews (Figure 10-70).
2. Secure regulator post to door with four lockwashers and capscrews.
3. Secure regulator post to window assembly with two lockwashers and nuts.
4. Install power windows regulator (Section 13).
5. Install all rods on door latch assembly (Figure 10-69).

WARNING: Screws securing latch assembly have metric threads. Substituting non-metric threaded screws can result in door opening during vehicle operation. Do not substitute screws.

6. Install latch assembly in door with three lockwashers and screws.
7. Connect outside operating rod to outside door handle, and install gasket and outside door handle on door with four nuts and lockwashers (Figure 10-71).

NOTE: Perform steps 8 and 9 for front doors only.

8. Install lock cylinder in door and secure lock operating rod and lever to lock cylinder with clip.
9. Secure lock cylinder in door with lock cylinder clip (Figure 10-72).
10. Install inside operating rod on door latch assembly.

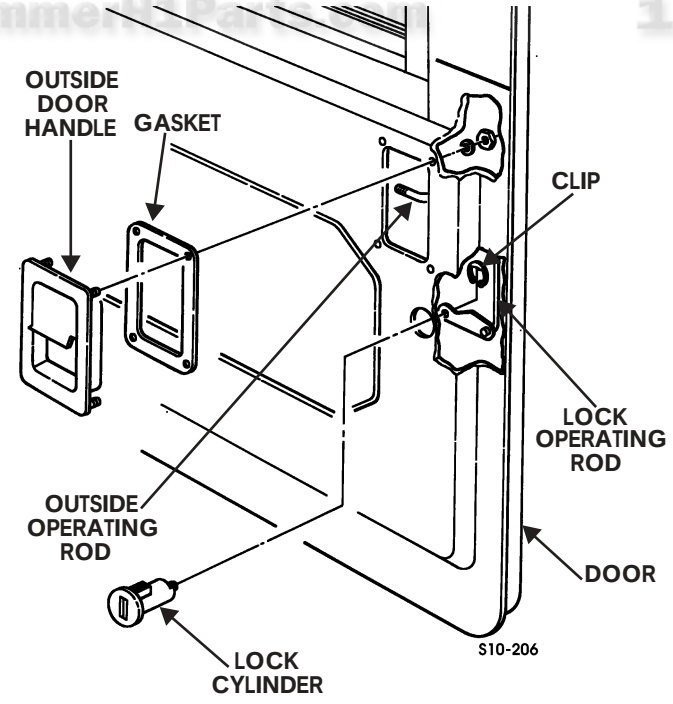


Figure 10-71: Lock Cylinder and Outside Door Handle

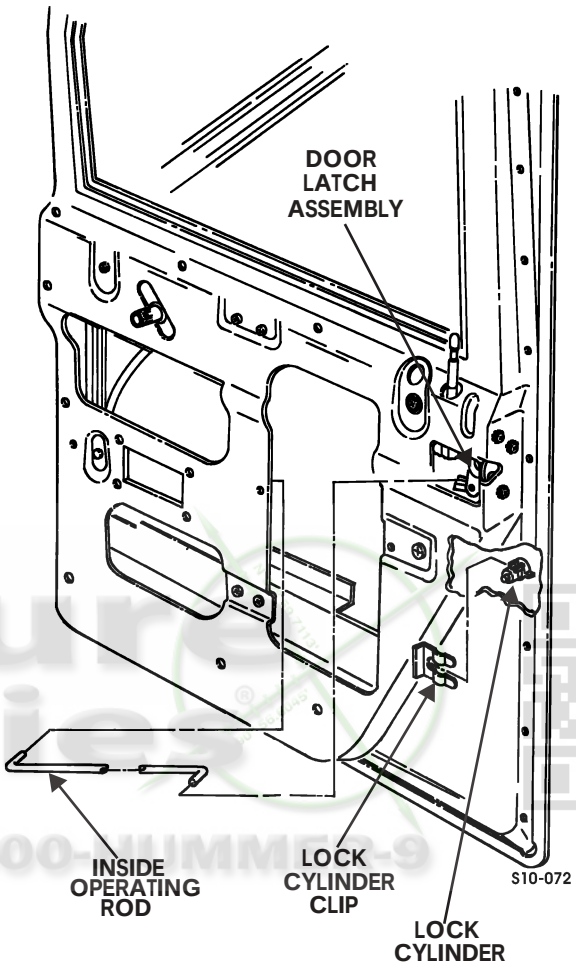


Figure 10-72: Inside Operating Rod

11. Install moisture barrier flap and vapor on door (Figure 10-73).
12. Install door trim panel on door with seven screw and washer assemblies (Figure 10-74).
13. Connect inside operating rod to inside door handle, and install inside door handle on door trim panel with four screws.
14. Install door pull handle or armrest on door trim panel with two screws.

NOTE: Go to step 18 for front doors on vehicles equipped with power windows. Go to step 19 for rear doors on vehicles equipped with power windows.

15. Install window regulator handle on regulator with screw, and snap handle cover into place.
16. Install power door locks switch (Section 13).
17. Install power windows and door locks switches on door (Section 13).
18. Install power windows switch on door (Section 13).
19. Install upper and lower hinge plates on door with six washers and twelve-point screws (Figure 10-75).

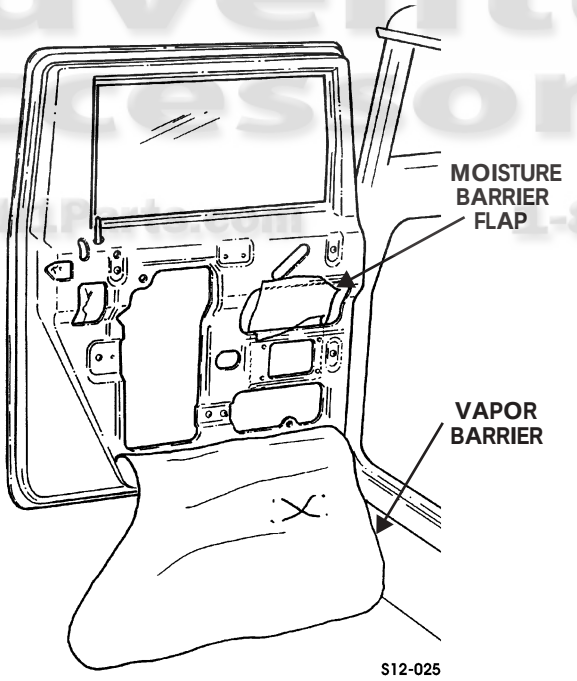


Figure 10-73: Vapor Barrier and Moisture Barrier Flap

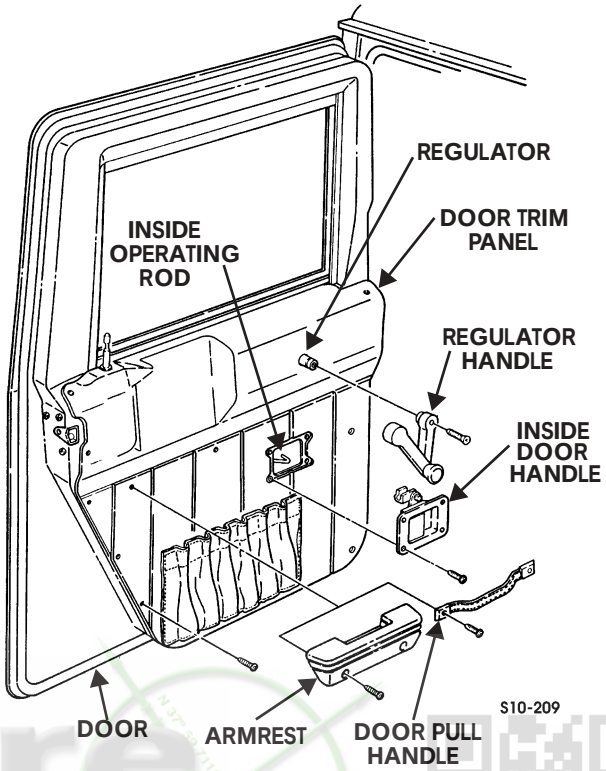


Figure 10-74: Door

Installation

CAUTION: To avoid damage, support door during installation.

1. Install lower door hinge on pillar with two washers and twelve-point screws. Do not tighten screws (Figure 10-75).
2. Install upper door hinge on pillar with two washers and twelve-point screws. Do not tighten screws.
3. Install door stop strap assembly.

NOTE: Go to step 5 for vehicles equipped with power windows.

4. Install power door locks harness on pillar (Section 12).
5. Install power windows and door locks harness on pillar (Section 12).

NOTE: Go to step 7 for front doors on vehicles equipped with power mirrors.

6. Install side mirror (front doors only).
7. Install power mirror assembly (Section 13).

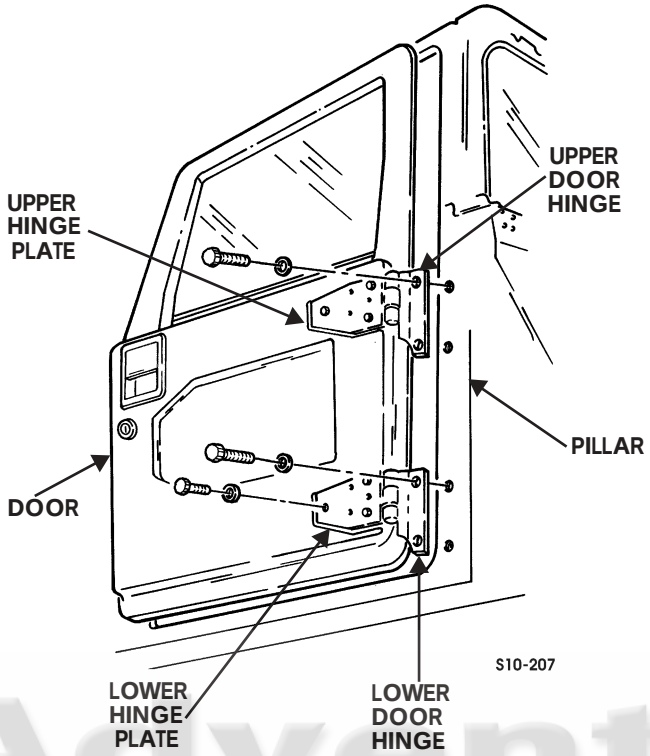


Figure 10-75: Door Hinges

Adjustment

1. Loosen the four twelve-point screws securing the upper and lower door hinges to the pillar (Figure 10-75).
2. Raise the door as high as possible. Push the hinges toward the front of the vehicle as far as they will go, and tighten the four twelve-point screws 10 lb-ft (13 N•m).
3. Loosen the six twelve-point screws securing the upper and lower hinge plates to the door.
4. Close the door and tighten the six twelve-point screws 10 lb-ft (13 N•m).

DOOR SEALS REPLACEMENT

NOTE: The door seals come in bulk and must be cut to the appropriate lengths. For hard top vehicles, cut 12 feet for the doors and 10 feet for the body opening. For soft-top vehicles, cut 6 feet for the doors and 5 feet for the body opening.

Vehicles with Full Doors (Hard-Top Vehicles)

Removal

Remove the old seal from the door frame and the body area with adhesive remover. Clean any remaining adhesive residue from the door surface.

Installation

1. Cut the door and body seals to the proper lengths (see note above).
2. Beginning at the bottom of the door, press door seal around the outside of the door frame (Figure 10-76).

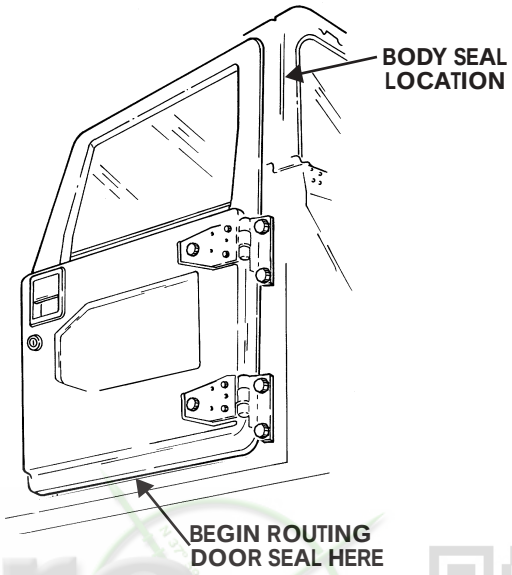


Figure 10-76: Door Seals Location

3. Apply body seal in the same location as the seal that was removed. (Figure 10-77)

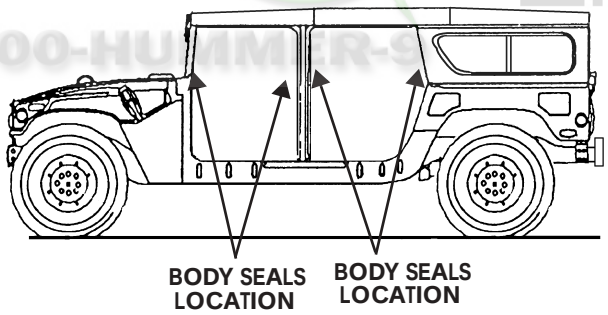


Figure 10-77: Body Seals Location

DOOR STOP STRAP ASSEMBLY REPLACEMENT

Removal

1. Remove capscrew, washer, and door stop strap assembly from door (Figure 10-78).
2. Remove two capscrews, washers, door stop strap assembly, and courtesy light from A-pillar (**front door only**).
3. Remove capscrew, washer, and door stop strap assembly from B-pillar (**rear door only**).

Installation

1. Install door stop strap assembly on door with washer and capscrew. Tighten capscrew 12 lb-ft (16 N•m) (Figure 10-78).
2. Install courtesy light and door stop strap assembly on A-pillar with two washers and capscrews. Tighten capscrews to 12 lb-ft (16 N•m) (**front door only**).
3. Install door stop strap assembly on B-pillar with two washers and capscrews. Tighten capscrews to 78 lb-ft (106 N•m) (**rear door only**).

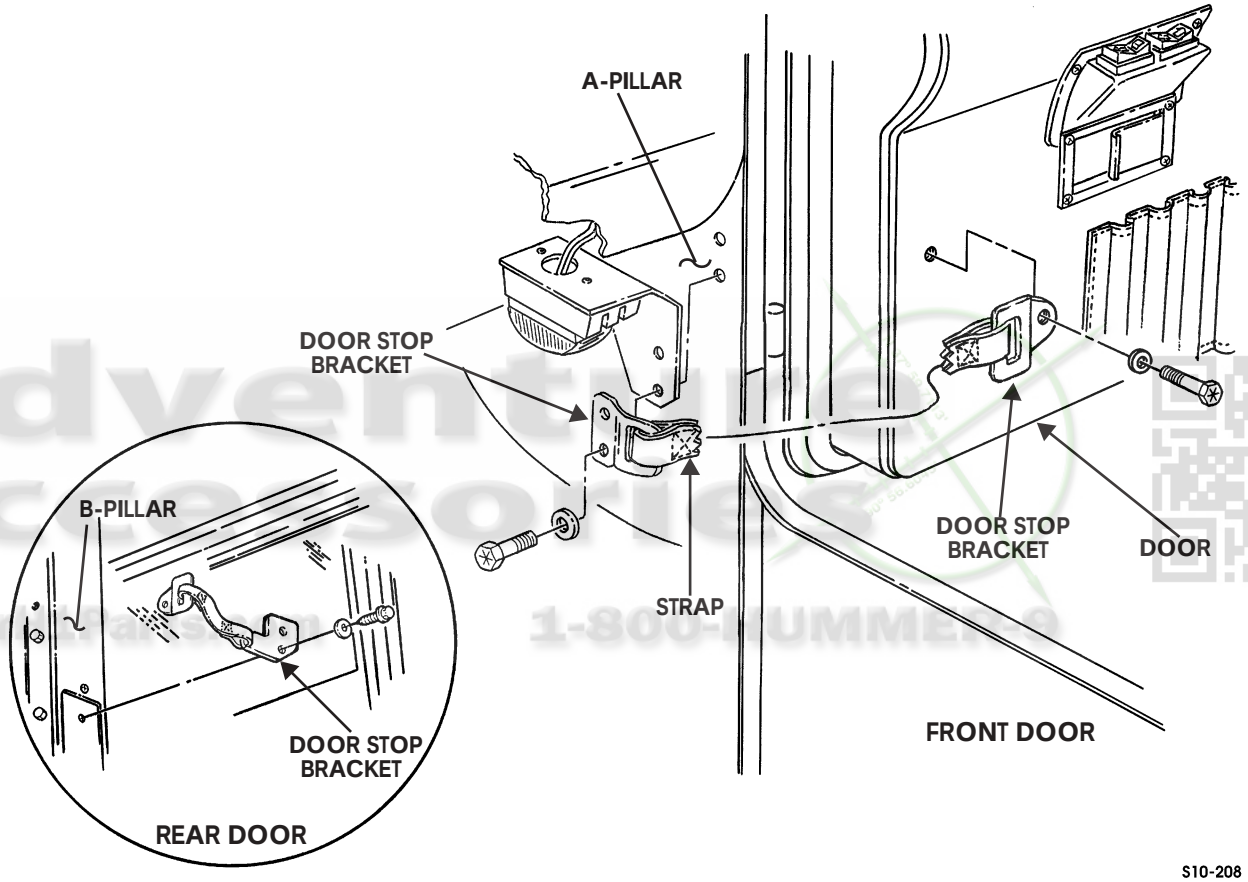


Figure 10-78: Door Stop Strap Assembly

DOOR GLASS

Door Glass Maintenance

NOTE: Door glass replacement is the same for all doors. This procedure covers the right front door.

Removal

1. Remove window regulator.
2. Remove upper and lower window channels (Figure 10-79).

NOTE: Mark location of screws prior to removal for installation.

3. Remove four screws, lockwashers, left and right channel brackets, and left and right channels from door. Discard lockwashers.
4. Rotate glass 90 degrees and remove through window (Figure 10-80).

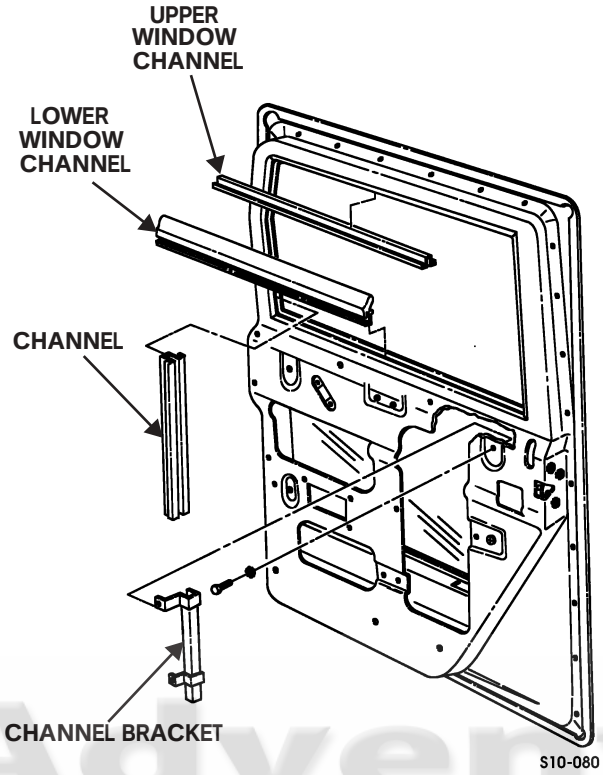


Figure 10-79: Window Channels

Disassembly

Remove glass from lower channel bracket (Figure 10-80).

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Remove all glass remains from channel bracket and bottom of door (Figures 10-79 and 10-80).

Assembly

Install glass in lower channel bracket (Figure 10-80).

Installation

1. Apply a strip of adhesive tape along the bottom of the glass on each side.
2. Insert glass into door through window (Figure 10-80).
3. Install glass in left and right channels and channel brackets, and secure channels and channel brackets to door with four lockwashers and screws (Figure 10-79).
4. Install upper and lower window channels.
5. Install window regulator.
6. Roll window up and down several times to ensure glass is properly aligned.

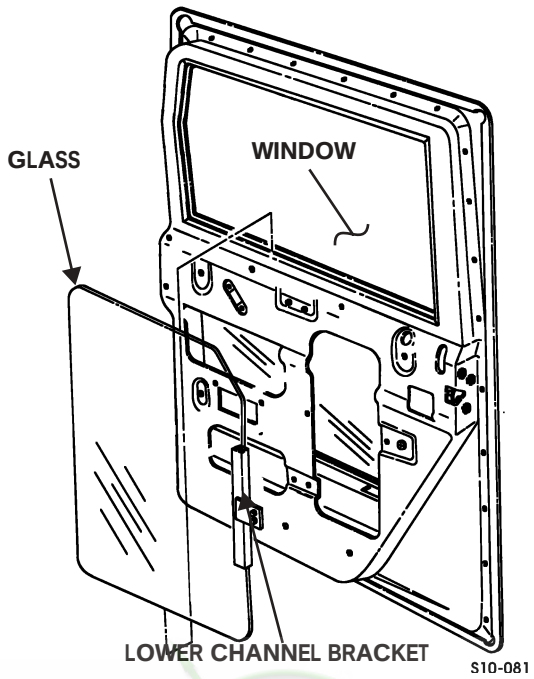


Figure 10-80: Lower Channel Bracket

Door Glass "Wind Noise" Diagnosis and Repair

Wind noise or whistle generating from the side windows at highway speeds is the result of inadequate sealing of the glass at the top channel. If pushing gently against the glass stops the wind noise, use the following procedure for a permanent fix.

1. Cut a 24 inch strip of 1/4 in. square closed cell foam.
2. Roll down window. Remove adhesive backing from strip of foam.
3. Insert end of strip into the corner of the window channel. Continue inserting strip along the top channel (Figure 10-80).
4. Use a wide scraper or suitable blunt tool to ensure that the foam strip is properly seated in the channel.
5. Roll up window to check for proper operation and fit.
6. Road test vehicle to verify the absence of wind noise.

REAR WINDOW GLASS REPLACEMENT

Removal

1. Temporarily secure rear window frame to body exterior with duct tape. Apply tape strips at each end of frame. Tape will hold window assembly in place when interior capscrews are removed.
2. Remove capscrews that attach window retainers to window frame. Total of 24 screws are used on two and four door models. Retain for use in installing new glass assembly.

3. Remove window assembly with aid of helper. Remove tape strips securing window assembly in body. Then tilt window assembly outward and remove it from body opening.
4. Clean flange in rear window opening with 3M all purpose cleaner or similar product.
5. On station wagon models, remove liftgate window as follows:
   a. Disconnect and remove shock at each side of liftgate. Shocks are secured with a clip at each end (Figure 10-81).
   b. Remove screws that attach liftgate window to body, and remove window assembly. Retain screws for installation of new window (Figure 10-82).
   c. Clean window mounting surfaces of liftgate with 3M all purpose cleaner or similar product.

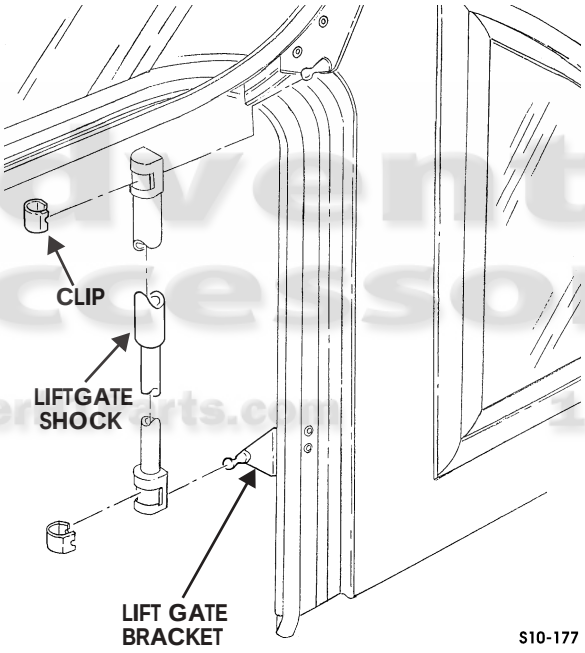


Figure 10-81: Liftgate Shock Attachment

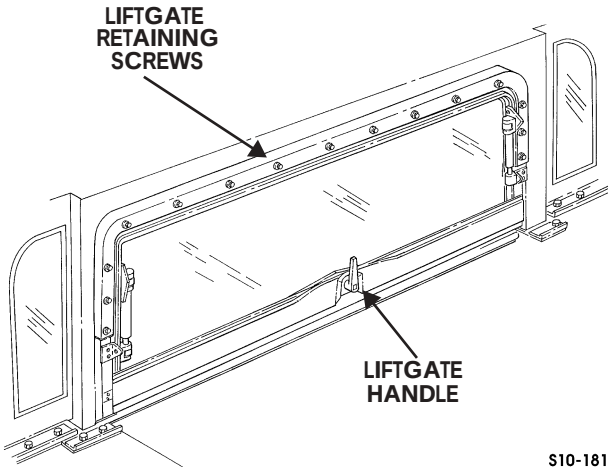


Figure 10-82: Liftgate Retainer Screws

Installation

1. Align and position window assembly in body opening with aid of helper. Temporarily secure window in place with duct tape.
2. Position first U-shaped retainer on window frame. Install retainers one at a time to avoid misalignment problems (Figure 10-83).

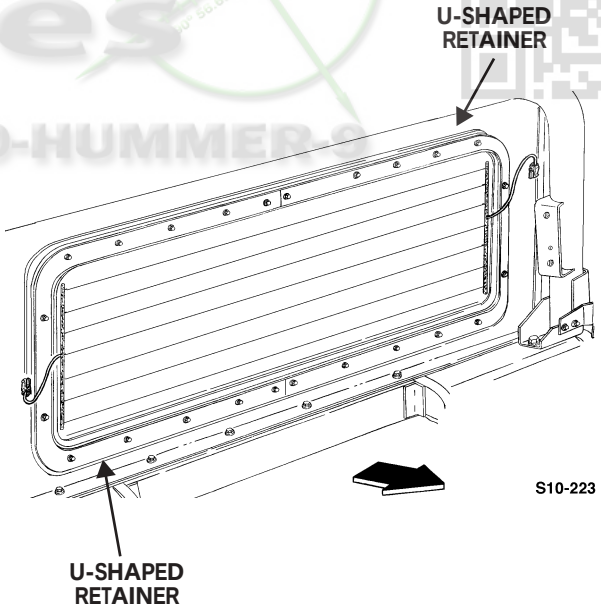


Figure 10-83: U-Shaped Window Retainers

3. Align retainer screw holes with matching dimples in window frame. Then install one or two self-drilling capscrews to hold frame and retainer in place. Do not fully tighten capscrews at this time.
4. Align and install opposite retainer and remaining capscrews. Total of 24 capscrews are required.

5. Verify proper alignment of window frame and retainer halves in body opening. Loosen screws and adjust window position if necessary before proceeding.
6. For station wagon models:
   a. Position window assembly in liftgate.
   b. Install window frame screws. Total of 15 are required (Figure 10-82).
   c. Install liftgate shock absorbers (Figure 10-81).

HOOD, HOOD LATCH, AND PROP ROD

Hood Latch and Bracket Maintenance

Removal

NOTE: If only the rubber latch is to be replaced, the spring pin does not have to be completely out of base.

1. Remove spring pin and rubber latch from base (Figure 10-84).
2. Remove two locknuts, washers, capscrews, washers, and base from body.
3. Remove five locknuts, washers, capscrews, latch bracket, latch plate, and hood latch stop bracket from hood. Discard locknuts (Figure 10-85).

Disassembly

Remove cotter pin, pin, two rollers, and hood latch from rubber latch. Discard cotter pin. (Figure 10-84).

Assembly

Install hood latch on rubber latch with two rollers, pin, and cotter pin (Figure 10-84).

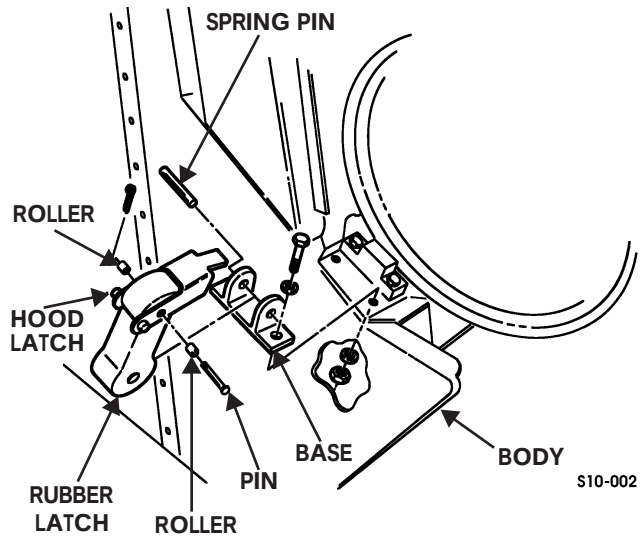


Figure 10-84: Hood Latch

Installation

1. Install latch plate and hood latch stop bracket on hood with three capscrews, washers, and locknuts. Tighten locknuts to 10 lb-ft (14 N•m) (Figure 10-85).
2. Install latch bracket on latch plate with two capscrews, washers, and locknuts. Tighten locknuts to 10 lb-ft (14 N•m).
3. Add sealing compound before installing base on body with two washers, capscrews, washers, and locknuts. Tighten capscrews to 6 lb-ft (8 N•m) (Figure 10-84).
4. Install rubber latch on base with spring pin.

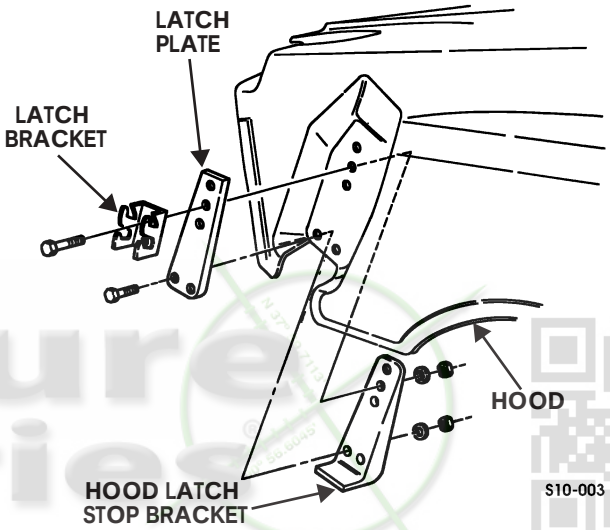


Figure 10-85: Hood Latch Bracket and Latch Plate

Hood Release Cable Assembly Replacement

Removal

1. Raise and secure hood.
2. Remove cable handle, two nuts, lockwasher, nut, and cable assembly from cable mounting bracket. Discard lockwasher (Figure 10-86).
3. Remove cable assembly from cable clamp bracket (Figure 10-87).
4. Remove cable assembly and grommet from body.
5. Remove lock pin from cable assembly.

Installation

1. Install lock pin on cable assembly (Figure 10-87).
2. Install grommet and cable assembly on body.
3. Install cable assembly on cable clamp bracket.
4. Install cable assembly on cable mounting bracket with nut, lockwasher, two nuts, and cable handle (Figure 10-86).
5. Lower hood.

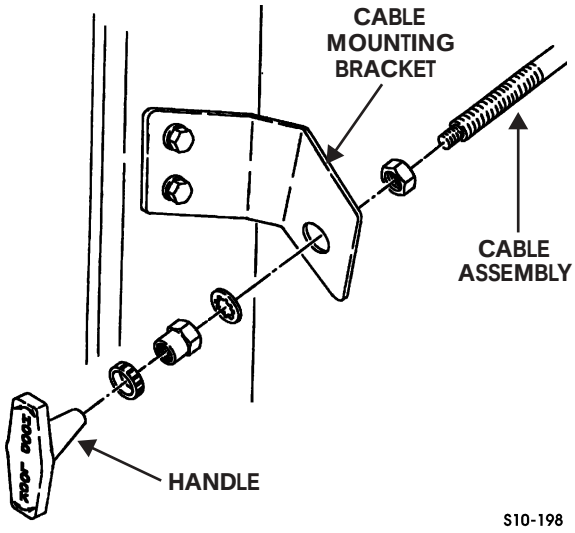


Figure 10-86: Hood Release Handle Assembly

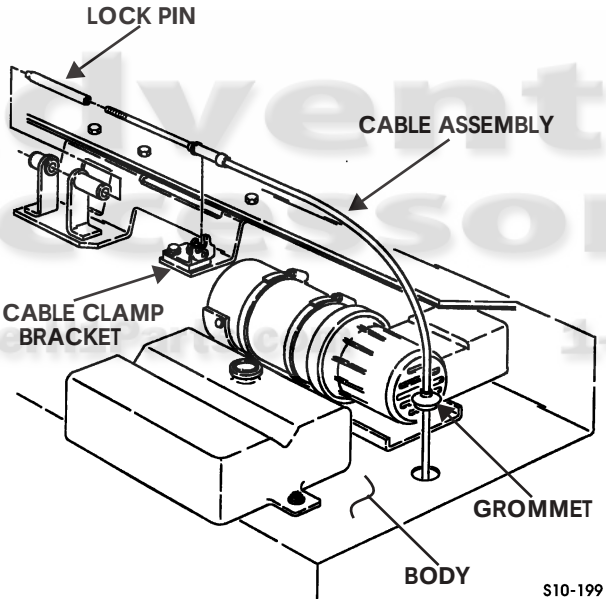


Figure 10-87: Hood Release Cable Assembly

Hood Release Latch and Bracket Assembly Replacement

Removal

1. Raise and secure hood.
2. Remove two capscrews, lockwashers, and latch assembly from hood. Discard lockwashers (Figure 10-88).
3. Remove pin, spring, and lock arm from latch assembly (Figure 10-89).
4. Remove cable assembly from cable clamp bracket (Figure 10-87).
5. Remove three nuts, lockwashers, capscrews, and bracket assembly from body. Discard lockwashers (Figure 10-90).
6. Remove two nut and lockwasher assemblies, screws, cable clamp bracket, and spacer from bracket assembly. Discard nut and lockwasher assemblies.
7. Inspect three nylon bushings in bracket assembly. Remove and discard bushings if damaged.

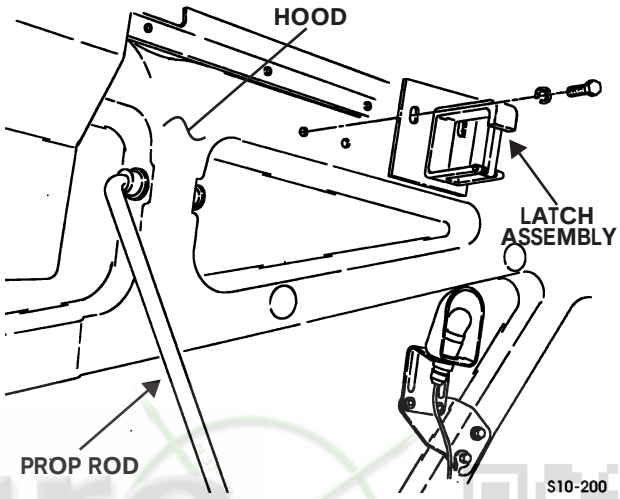


Figure 10-88: Hood Release Latch and Bracket Assembly

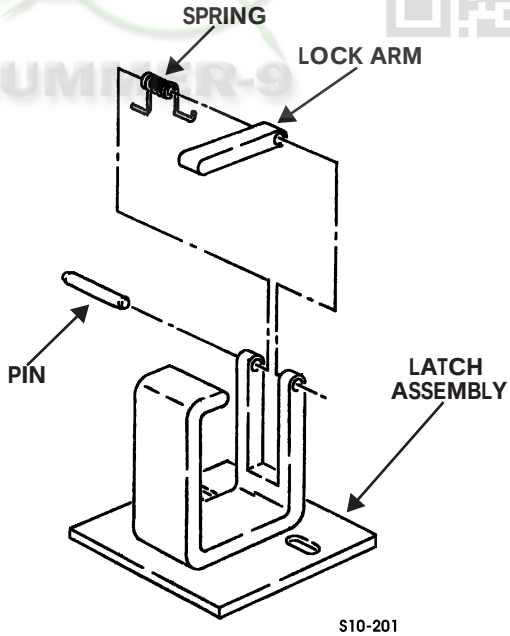


Figure 10-89: Pin, Spring, and Lock Arm

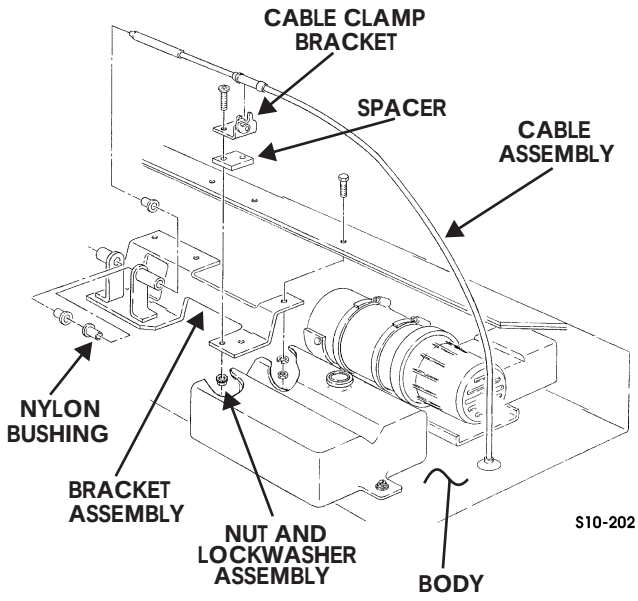


Figure 10-90: Cable Clamp Bracket Assembly

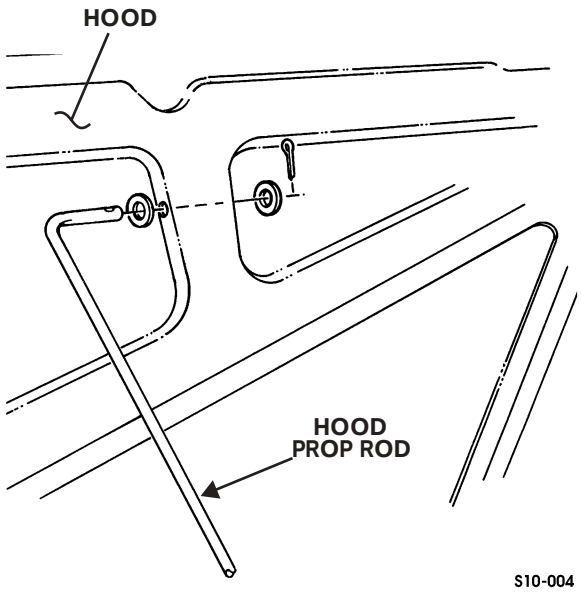


Figure 10-91: Hood Prop Rod

Installation

1. Install three nylon bushings into bracket assembly, if removed (Figure 10-90).
2. Install spacer and cable clamp bracket on bracket assembly with two screws and nut and lockwasher assemblies.
3. Install bracket assembly on body with three capscrews, lockwashers, and nuts.
4. Install cable assembly on cable clamp bracket (Figure 10-87)
5. Install spring and lock arm on latch assembly with pin (Figure 10-89).
6. Install latch assembly on hood with two lockwashers and capscrews (Figure 10-88).
7. Lower hood.

Hood Prop Rod and Bracket Maintenance

Removal

WARNING: To avoid injury or damage to equipment, support hood during hood prop rod and bracket maintenance.

1. Raise and support hood.
2. Remove cotter pin, two washers, and hood prop rod from hood. Discard cotter pin (Figure 10-91).
3. Remove four screws, lockwashers, bracket, and hood prop rod from airlift bracket. Discard lockwashers (Figure 10-92).

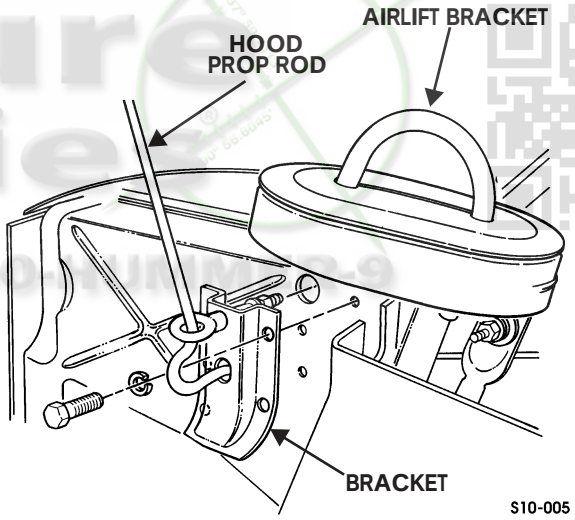


Figure 10-92: Hood Prop Rod and Bracket

Disassembly

1. Remove hood prop rod from eyebolt (Figure 10-93).
2. Remove locknut, washer, bushing, spring, snapring, bushing, washer, and eyebolt from bracket. Discard lockwasher.

Cleaning and Inspection

NOTE: Clean all components, and examine for wear or damage. Replace if necessary.

Inspect two bushings and spring for cracks, wear, or distortion (Figure 10-93).

Assembly

1. Install bushing on bracket with snapring (Figure 10-93).

NOTE: Length of spring with bracket assembled is 2-1/4 in. (5.7 cm).

2. Install washer, eyebolt, spring, bushing, washer, and locknut on bracket.
3. Install hood prop rod into eyebolt.

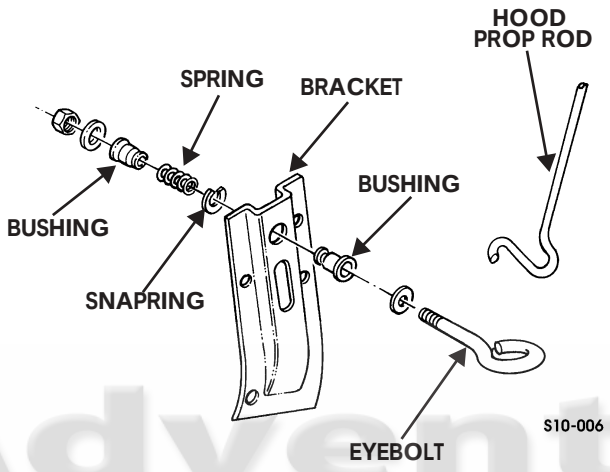


Figure 10-93: Hood Prop Rod and Bracket Assembly

Installation

1. Install hood prop rod and bracket on airlift bracket with four lockwashers and screws. Tighten screws to 6 lb-ft (8 N•m) (Figure 10-92).
2. Install hood prop rod on hood with two washers and cotter pin (Figure 10-91).
3. Lower hood.

Hood and Hinge Maintenance

Removal

1. Disconnect battery ground cable (Section 12).
2. Raise and secure hood.

WARNING: To avoid injury, or damage to equipment, support hood during removal and installation.

3. Disconnect two connector plugs from connector receptacles (Figure 10-94).
4. Remove four cotter pins, washers, and two hinge pins securing upper hinge halves to lower hinge halves. Discard cotter pins.
5. Remove cotter pin, two washers, and prop rod from hood. Discard cotter pin (Figure 10-94).
6. Remove hood.

NOTE: Perform steps 7 and 8 if replacing hinges.

7. Remove four capscrews, washers, two upper hinge halves, and hinge plates from hood (Figure 10-94).
8. Remove four locknuts, washers, two hinge plates, four capscrews, washers, and two lower hinge halves from brackets. Discard locknuts.

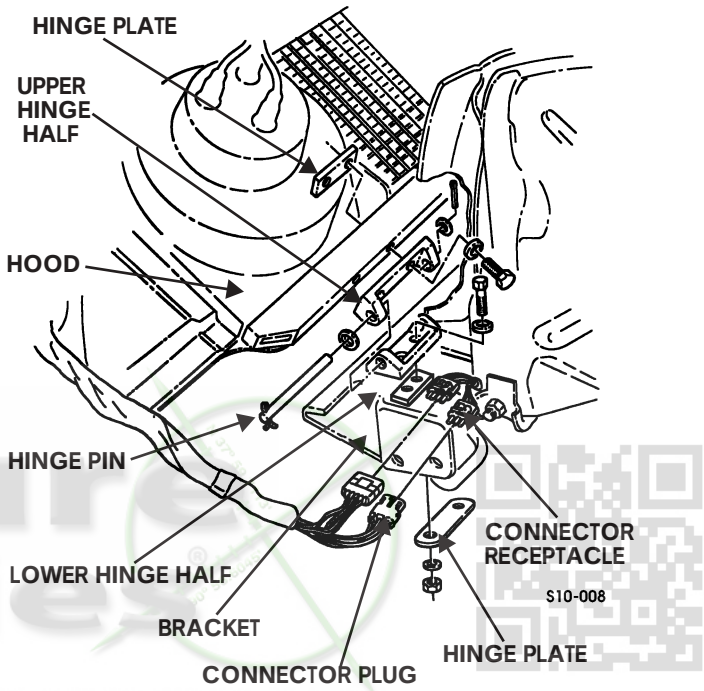


Figure 10-94: Hood and Hinge Assembly

Inspection and Repair

NOTE: Refer to Fiberglass Repair for inspection and repair of hood.

Installation

NOTE: Perform steps 1 and 2 if hinges were removed.

1. Install two lower hinge halves and hinge plates on two brackets with four washers, capscrews, washers, and locknuts. Do not tighten capscrews (Figure 10-94).
2. Apply sealing compound on two hinge plates and install hinge plates and two upper hinge halves on hood with four washers and capscrews. Tighten capscrews to 28 lb-ft (38 N•m).
3. Install hood with two upper hinge halves on lower hinge halves with washers, hinge pins, washers, and four cotter pins.
4. Connect two connector plugs to connector receptacles.
5. Install hood prop rod on hood with two washers and cotter pin (Figure 10-94).

6. Connect battery ground cable (Section 12).
7. Align hood.

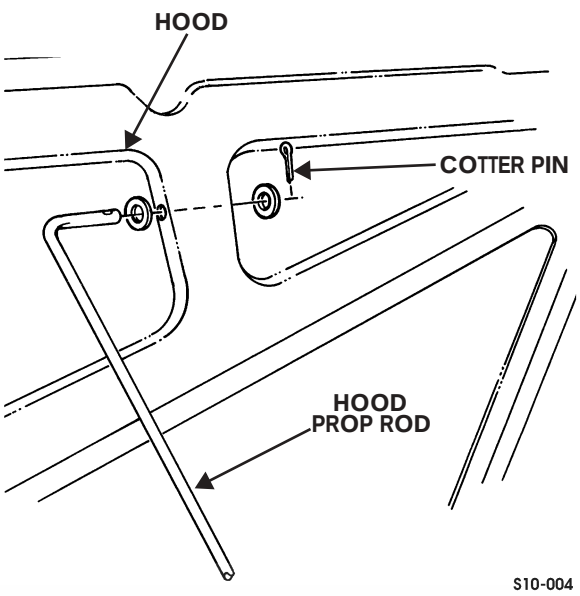


Figure 10-95: Hood Prop Rod

Alignment

Alignment should be checked whenever replacing the hood stops, hinges, or latches. Surfaces that adjoin hood seals should be checked for signs of wear from hood movement.

1. Inspect hood prior to adjustment to determine condition of seals, hinges, and stops. Replace or repair any worn parts.

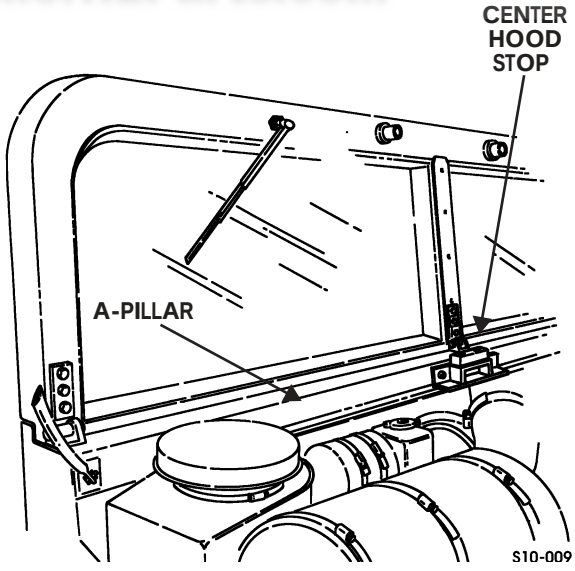


Figure 10-96: Center Hood Stop

2. Open hood and loosen center hood stop guide (Figure 10-96).
3. Gently close hood and loosen lower hinge half locknuts (Figure 10-97).

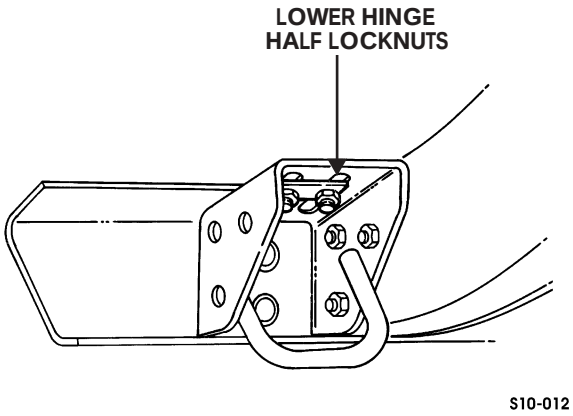


Figure 10-97: Lower Hinge Half Locknuts

4. Gently position hood to obtain proper and even clearance with windshield and both front cowl panels.
5. Tighten lower hinge half locknuts to lock adjustment. Open hood gently and position center hood stop guide brackets to contact center hood stop. Gently close hood to check guide bracket position (Figures 10-96 and 10-98).
6. Tighten and recheck hood stop guide position. When properly positioned, tighten to 10 lb-ft (14 N•m) (Figure 10-96).
7. Tighten front lower hinge half locknuts to 28 lb-ft (38 N•m) and recheck hood position (Figure 10-97).

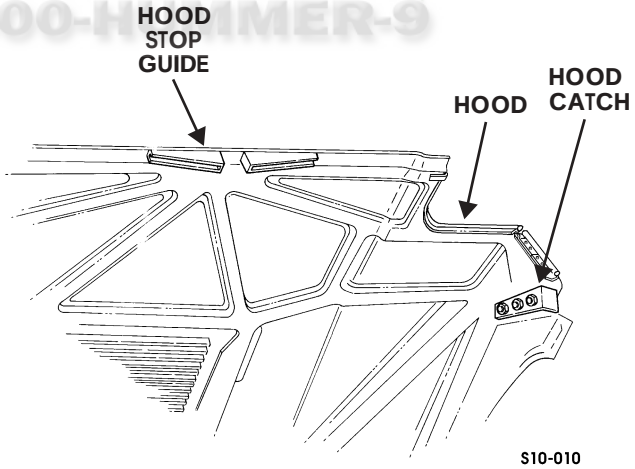


Figure 10-98: Hood Stop Guide and Hood Catch

8. Lube all hood stops, hinges, and guide brackets. Latch hood (Figure 10-99).
9. Test drive to ensure proper alignment (no squeaks).

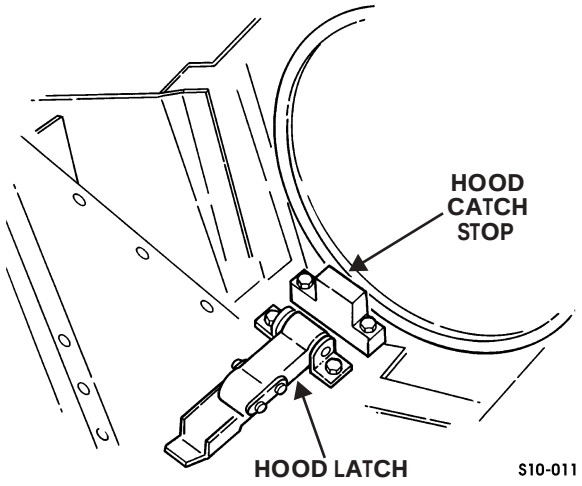


Figure 10-99: Bump Stop

Outer Hood Seal Replacement

Removal

Remove two capscrews, seal retainer, and hood seal from body (Figure 10-100).

Installation

Install hood seal on body with seal retainer and two capscrews (Figure 10-100).

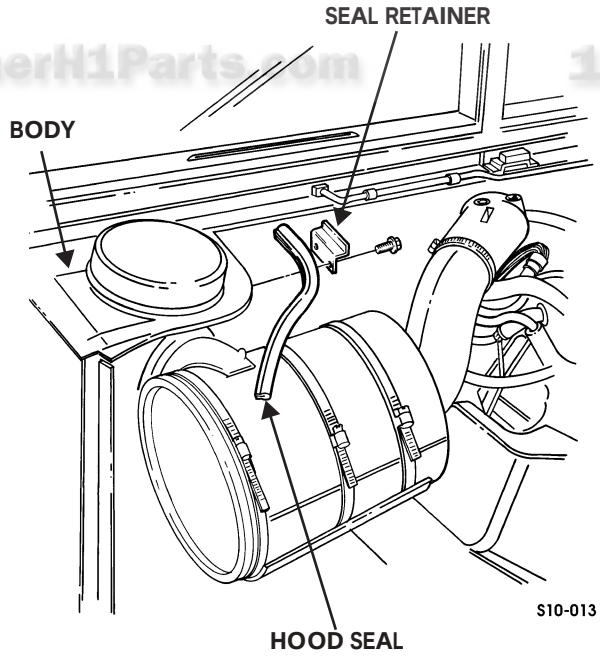


Figure 10-100: Outer Hood Seal

Side Hood Stop Replacement

Removal

Remove two locknuts, washers, capscrews, washers, and side hood stop from body. Discard locknuts (Figure 10-101).

Installation

Install side hood stop on body with two washers, capscrews, washers, and locknuts. Tighten capscrews to 6 lb-ft (8 N•m) (Figure 10-101).

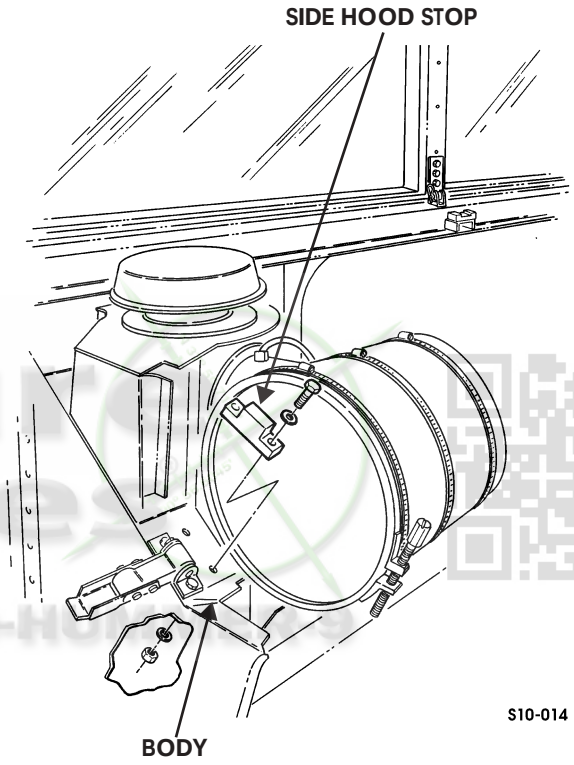


Figure 10-101: Side Hood Stop

Hood Grille and Screen Replacement

Removal

1. Remove six locknuts, washers, capscrews, washers, and grille from hood. Discard locknuts (Figure 10-102).
2. Remove six locknuts, washers, screws, washers, and screen from grille. Discard locknuts.

Installation

1. Install screen on grille with six washers, screws, washers, and locknuts. Tighten locknuts to 6 lb-ft (8 N•m) (Figure 10-102).
2. Install grille on hood with six washers, capscrews, washers, and locknuts. Tighten locknuts to 7 lb-ft (9 N•m).

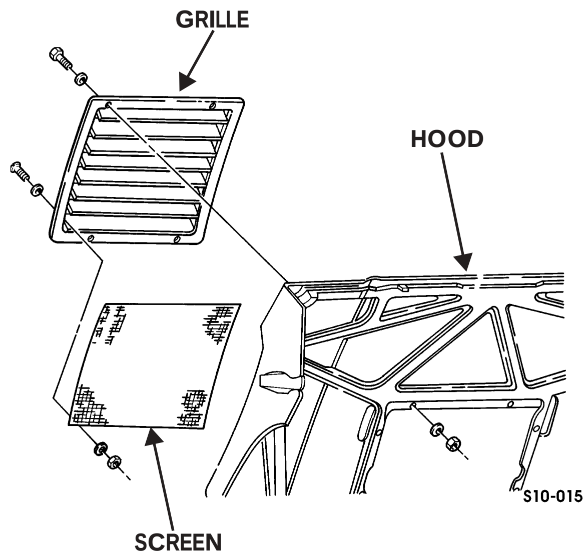


Figure 10-102: Hood Grille and Screen

Center Hood Stop Replacement

Removal

Remove two capscrews, washers, center hood stop, and plate from A-beam (Figure 10-103).

Installation

Install center hood stop and plate on A-beam with two washers and capscrews. Tighten capscrews to 12 lb-ft (16 N•m) (Figure 10-103).

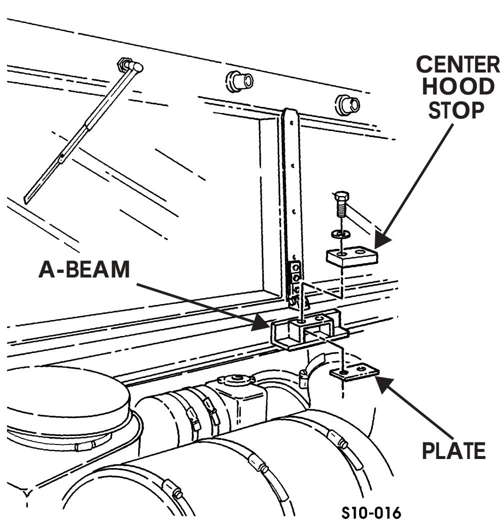


Figure 10-103: Center Hood Stop

Center Hood Stop Guide Bracket Replacement

Removal

Remove six locknuts, washers, two guide brackets, guide plate, six capscrews, washers, and guide plate from hood. Discard locknuts (Figure 10-104).

Installation

Install two guide plates and guide brackets on hood with six washers, capscrews, washers, and locknuts. Tighten locknuts to 10 lb-ft (14 N•m) (Figure 10-104).

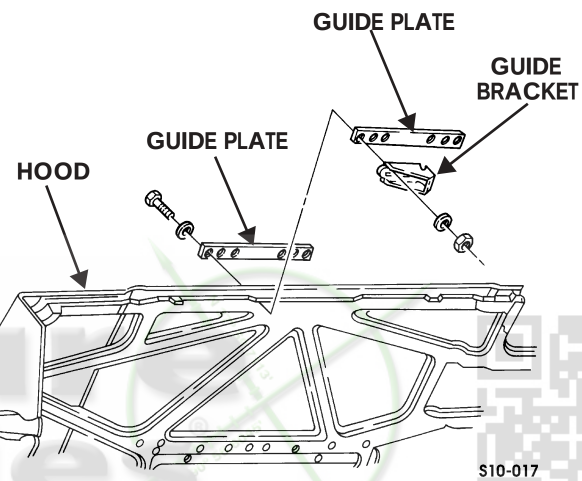


Figure 10-104: Center Hood Stop Guide

Front Hood Screen Replacement

Removal

1. Remove three locknuts, washers, and carriage bolts securing front hood screen to hood. Discard locknuts (Figure 10-105).
2. Remove three capscrews, harness clamps, washers, and front hood screen from hood.

Installation

1. Install front hood screen on hood with three washers, harness clamps, and capscrews. Tighten capscrews to 20-30 lb in. (2-3 N•m) (Figure 10-105).
2. Secure front hood screen to hood with three carriage bolts, washers, and locknuts. Tighten locknuts to 21 lb-ft (29 N•m).

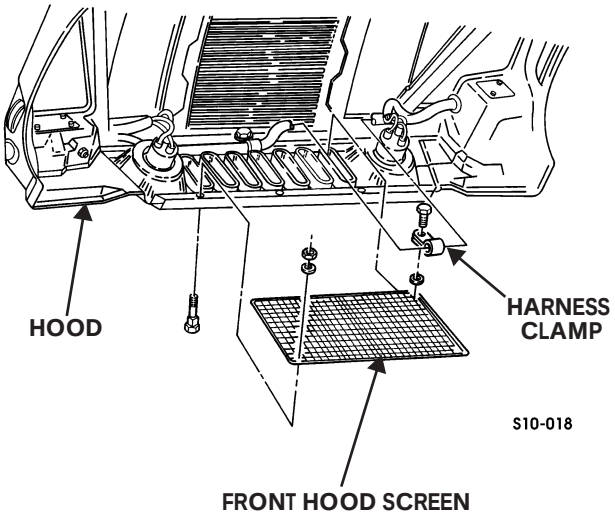


Figure 10-105: Front Hood Screen

Right Hood Retainer Bracket Replacement

Removal

Remove four bolts, lockwashers, washers, right hood retainer bracket, and spacer from hood. Discard lockwashers (Figure 10-106).

Installation

Install right hood retainer bracket and spacer on hood with four washers, lockwashers, and bolts (Figure 10-106).

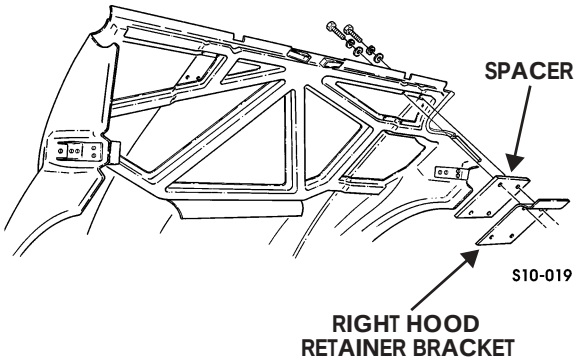


Figure 10-106: Right Hood Retainer Bracket

Left Hood Retainer Bracket Replacement

Removal

Remove four bolts, lockwashers, washers, left hood retainer bracket, and four washers from hood. Discard lockwashers (Figure 10-107).

Installation

Install left hood retainer bracket on hood with eight washers, four lockwashers, and bolts (Figure 10-107).

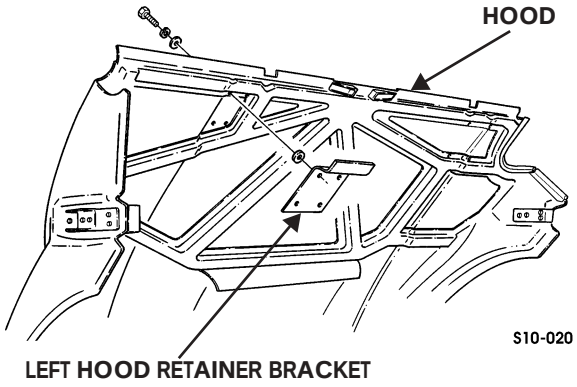


Figure 10-107: Left Hood Retainer Bracket

Right Hood Close-Out Seal and Retainer Replacement

Removal

1. Remove two screws and upper seal retainer from close-out seal and hood (Figure 10-108).
2. Remove two screws, lower seal retainer, and close-out seal from hood.

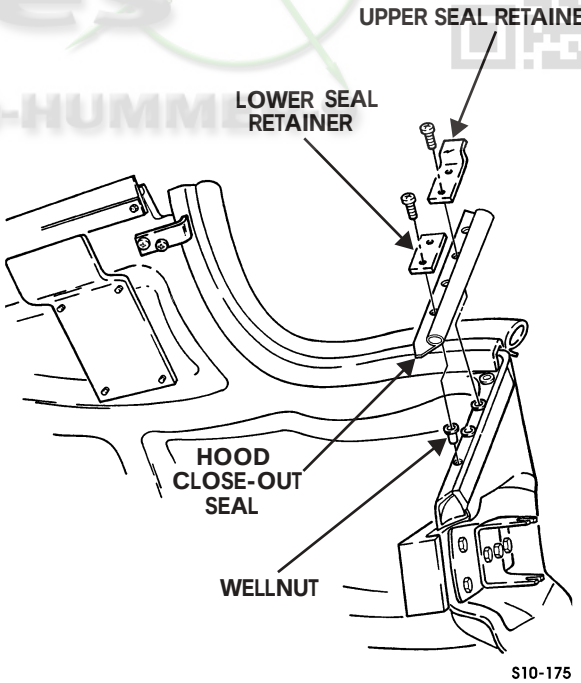


Figure 10-108: Right Hood Close-Out Sea

3. Inspect four wellnuts for damage. Replace if defective or damaged.

Installation

1. Install close-out seal and lower seal retainer on hood with two screws (Figure 10-108).
2. Install upper seal retainer on close-out seal and hood with two screws.

Airlift to Hood Seal Replacement

Removal

Remove protector and seal from airlift bracket (Figure 10-109).

Installation

Install seal and protector on airlift bracket (Figure 10-109).

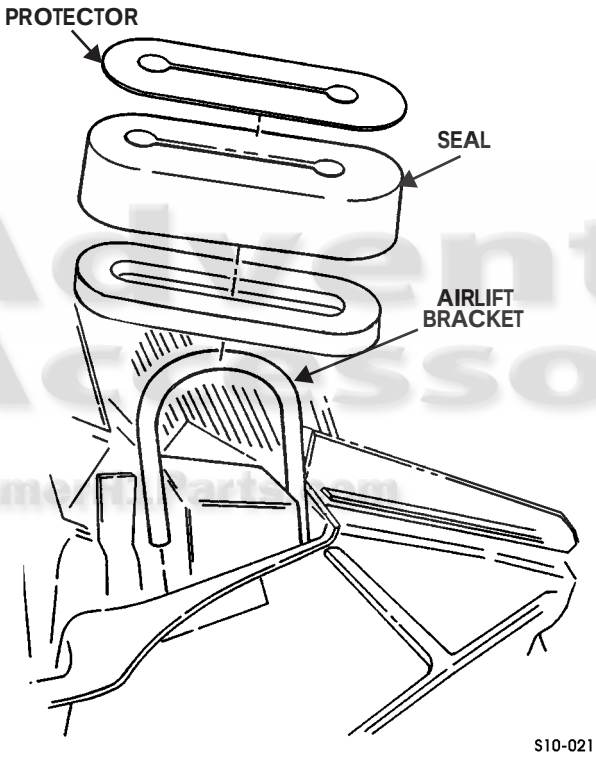


Figure 10-109: Airlift Bracket

ENGINE SPLASH SHIELD MAINTENANCE

Removal

1. Disconnect battery ground cable (Section 12).

WARNING: To avoid injury, or damage to equipment, raise and support hood during removal and installation.

2. Remove hood prop rod and bracket.
3. Disconnect hood harnesses from connector receptacles (Figure 10-110).
4. Remove locknut, washer, capscrew, and washer securing splash shield to support bracket. Discard locknut.
5. Remove locknut, three washers, and capscrew securing splash shield to airlift bracket. Discard locknut.
6. Remove capscrew, lockwasher, and washer securing splash shield to airlift bracket. Discard lockwasher.
7. Remove screw, two lockwashers, locknut, clamp, and two connector receptacles from splash shield. Discard lockwashers and locknut.
8. Remove nut and lockwasher assembly and screw securing harness and clamp to splash shield. Discard nut and lockwasher assembly (Figure 10-111).
9. Remove locknut, two washers, capscrew and splash shield from bracket. Discard locknut (Figure 10-110).

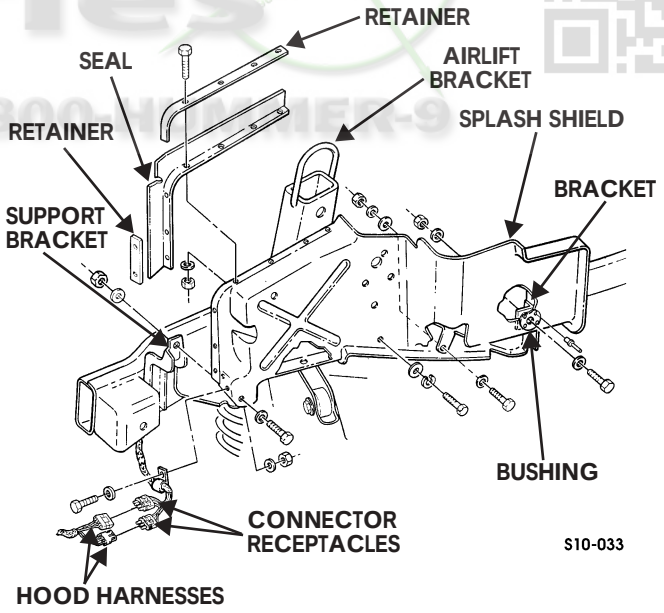


Figure 10-110: Engine (Left) Splash Shield Assembly

Disassembly

1. Remove seven locknuts, washers, capscrews, seal, and two retainers from splash shield (Figure 10-110).
2. Remove two locknuts, washers, capscrews, washers, and bracket from splash shield.
3. Remove four rivets and bushing from splash shield.

Assembly

1. Install bushing on splash shield with four rivets (Figure 10-110).
2. Install bracket on splash shield with two washers, capscrews, washers, and locknuts. Tighten locknuts to 6 lb-ft (8 N•m).
3. Install seal and two retainers on splash shield with seven capscrews, washers, and locknuts.

Installation

1. Install splash shield on bracket with washer, capscrew, washer, and locknut (Figure 10-110).
2. Install harness and clamp on splash shield with screw and nut and lockwasher assembly (Figure 10-111).
3. Install two connector receptacles on splash shield with clamp, screw, two lockwashers, and locknut (Figure 10-110).
4. Secure splash shield on airlift bracket with washer, lockwasher, and capscrew. Tighten capscrew to 10 lb-ft (14 N•m).
5. Secure splash shield on airlift bracket with washer, capscrew, two washers, and locknut. Tighten capscrew to 10 lb-ft (14 N•m).
6. Secure splash shield on support bracket with washer, capscrew, washer, and locknut. Tighten capscrew to 6 lb-ft (8 N•m).
7. Connect hood harnesses on connector receptacles.
8. Install hood prop rod and bracket.
9. Connect battery ground cable (Section 12).

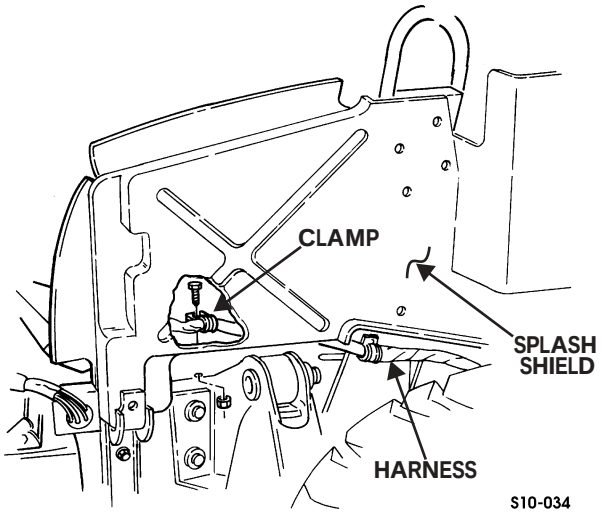


Figure 10-111: Splash Shield and Hood Harness

HORN

Horn Assembly Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Disconnect harness connector from horn assembly.
3. Remove capscrew and horn assembly from mounting bracket (Figure 10-112).

Installation

1. Install horn assembly on mounting bracket with capscrew (Figure 10-112).
2. Connect harness connector to horn assembly.
3. Connect battery ground cable (Section 12).

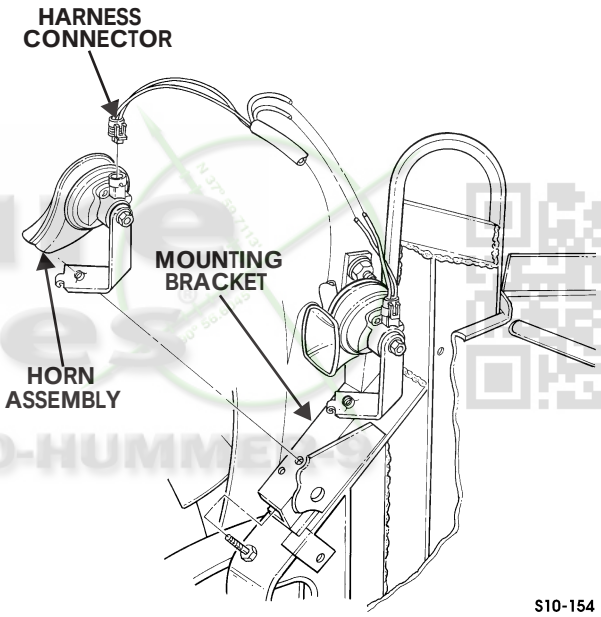


Figure 10-112: Horn Assembly

Horn Mounting Bracket Replacement

Removal

1. Remove two horns.
2. Remove two capscrews, inserts, bracket, and horn mounting bracket from airlift bracket (Figure 10-113).

Installation

1. Install bracket and horn mounting bracket on airlift bracket with two capscrews and inserts (Figure 10-113).
2. Install two horns.

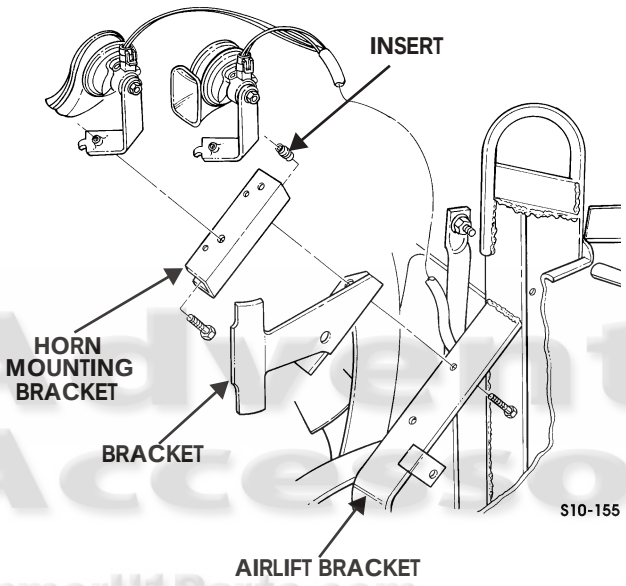


Figure 10-113: Horn Mounting Bracket

WINDSHIELD ASSEMBLY

Windshield Glass and Weatherstrip Replacement

Removal

1. Remove windshield wiper arm and blade.
2. Remove six capscrews and upper retainer from windshield frame (Figure 10-114).
3. Remove four capscrews and center retainer from windshield frame.
4. Remove weatherstrip and glass from windshield frame.
5. Clean sealing compound from windshield frame.

Installation

1. Apply a 1/8 in. (3-mm) bead of sealing compound to edge of glass and windshield frame (Figure 10-114).
2. Install weatherstrip on glass.
3. Install glass and weatherstrip on windshield frame with center retainer and four capscrews.
4. Install upper retainer on windshield frame with six capscrews.
5. Apply a thin bead of sealing compound to top edge of outside weatherstrip.
6. Install windshield wiper arm and blade.

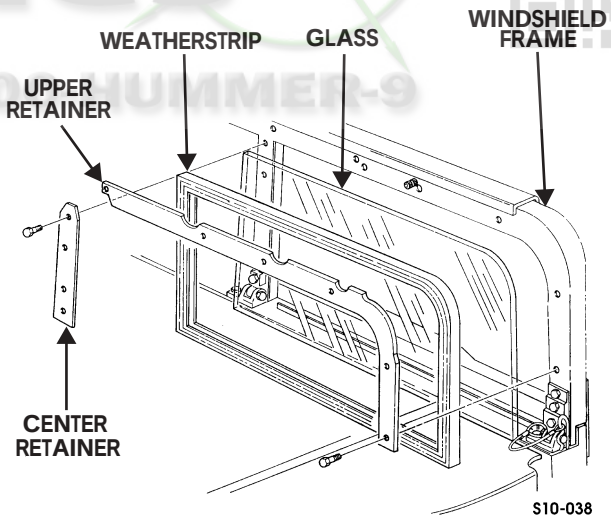


Figure 10-114: Windshield Glass Weatherstrip

Windshield Assembly Maintenance

WARNING: To avoid injury, or damage to equipment, support windshield during removal and installation.

Removal

1. Remove soft top.
2. Remove windshield wiper blade and arm.
3. Remove windshield wiper linkage.
4. Remove windshield wiper arm pivots.
5. Remove two locknuts and screws securing windshield assembly to A-pillar. Discard locknuts (Figure 10-115).

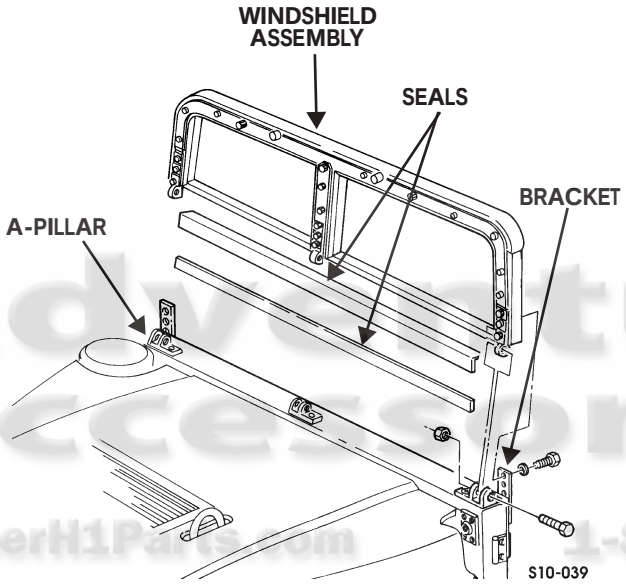


Figure 10-115: Windshield Assembly

6. Remove grommet from windshield center pillar and disconnect two jumper harness leads from body harness leads (Figure 10-116).
7. Remove six capscrews and washers securing windshield assembly to two brackets (Figure 10-115).
8. Remove windshield assembly from A-pillar.
9. Remove two seals from windshield assembly. Discard seals.
10. Clean remains of seals from windshield.

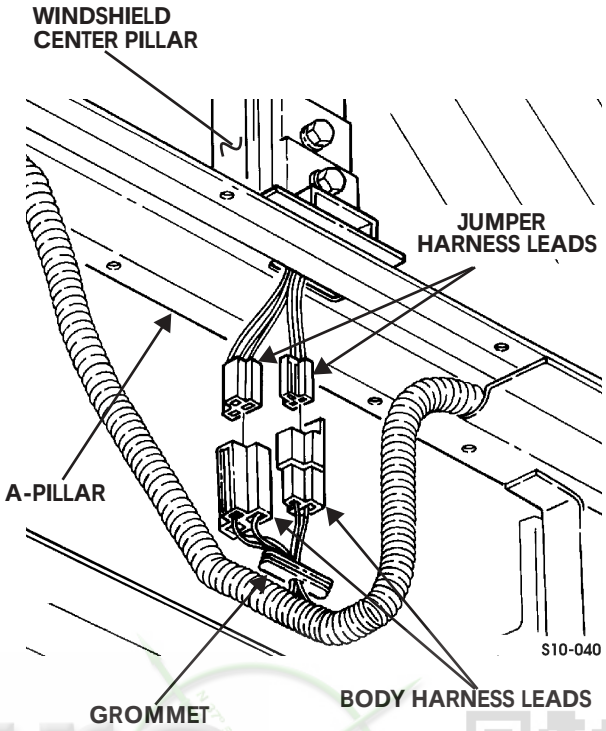


Figure 10-116: Center Pillar and Harness Leads

Disassembly

NOTE: Perform steps 1 and 2 for open-top models. Perform step 3 for all other models.

1. Remove eleven rivets, former, and seal from windshield assembly (Figure 10-117).
2. Inspect eight rivets and two corner caps from windshield assembly, and replace if damaged.
3. Remove thirteen rivets, former, and seal from windshield assembly (Figure 10-117).
4. Clean remains of seal from windshield assembly.

Assembly

NOTE: Perform step 1 for open-top models. Perform step 2 for all other models.

1. Install seal and former on windshield assembly with eleven rivets (Figure 10-117).
2. Install seal and former on windshield assembly and secure with thirteen rivets (Figure 10-117).

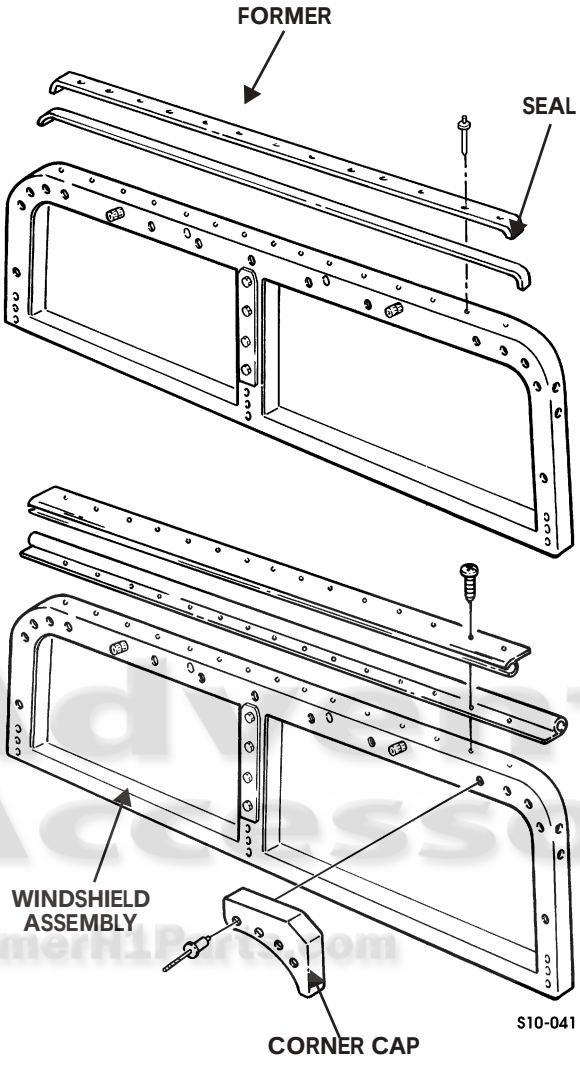


Figure 10-117: Windshield Assembly

Installation

1. Install two seals on windshield assembly (Figure 10-115).
2. Install windshield assembly on A-pillar.
3. Install windshield assembly on two brackets with six capscrews and washers.
4. Connect two jumper harness leads to body harness leads and install grommet on windshield center pillar (Figure 10-116).
5. Install windshield assembly on A-pillar with two screws and locknuts (Figure 10-115).
6. Install windshield wiper arm pivots.
7. Install windshield wiper linkage.
8. Install windshield wiper arm and blade.
9. Install soft top.

WINDSHIELD WIPER SYSTEM AND COMPONENTS

Windshield Wiper Motor Assembly Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove center trim from windshield assembly.
3. Disconnect windshield wiper motor assembly harness from jumper harness (Figure 10-118).
4. Remove three capscrews, washers, and lockwashers securing windshield wiper motor assembly to windshield assembly.
5. Remove retainer securing windshield wiper linkage to windshield wiper motor cranking pin and remove windshield wiper motor assembly.

Installation

1. Lubricate windshield wiper motor cranking pin with lubricant and install windshield wiper linkage on windshield wiper motor cranking pin with retainer (Figure 10-118).
2. Install windshield wiper motor assembly on windshield assembly with three lockwashers, washers, and capscrews.
3. Connect windshield wiper motor assembly harness to jumper harness.
4. Install center trim on windshield assembly.
5. Connect battery ground cable (Section 12).

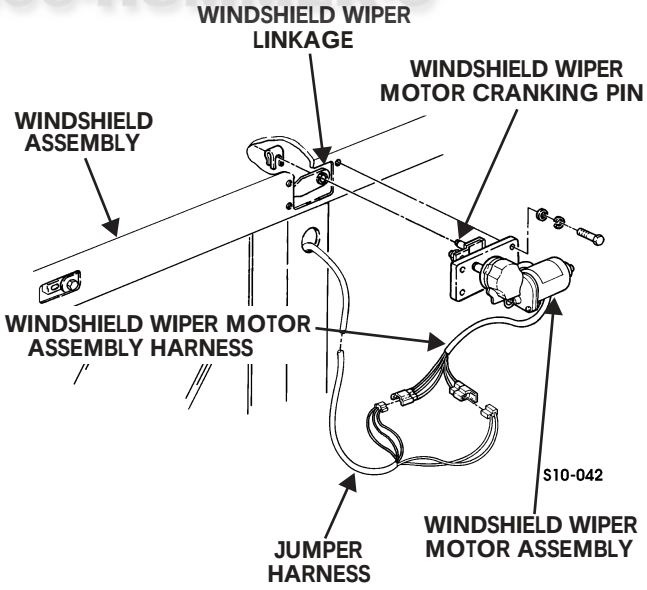


Figure 10-118: Windshield Wiper Motor Assembly

Windshield Wiper Linkage Replacement

Removal

NOTE: Left and right side windshield wiper linkage replacement procedure is the same. This procedure covers the left side.

1. Remove windshield wiper motor assembly from windshield assembly.
2. Remove upper A-pillar trim.
3. Disconnect windshield wiper linkage from windshield wiper pivot cranking lever pin and remove windshield wiper linkage (Figure 10-119).

Installation

1. Install windshield wiper linkage on windshield wiper pivot cranking lever pin (Figure 10-119).
2. Install upper A-pillar trim.
3. Install windshield wiper motor assembly on windshield assembly.

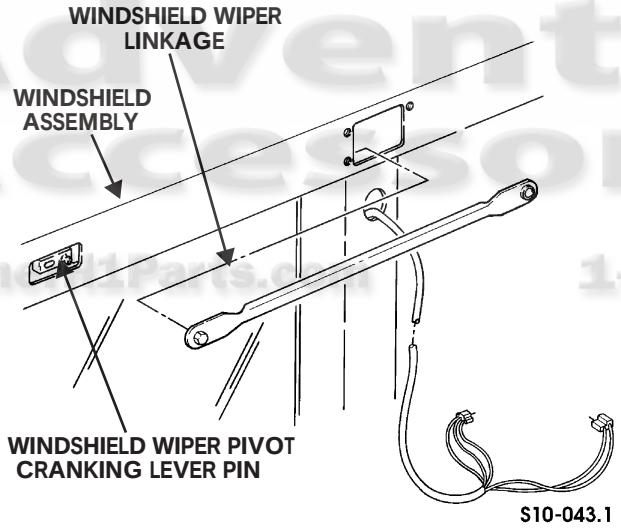


Figure 10-119: Windshield Wiper Linkage

Windshield Wiper Pivot Replacement

Removal

NOTE: Left and right side windshield wiper pivot replacement procedure is the same. This procedure covers the left side.

1. Remove windshield wiper arm assembly.
2. Remove upper A-pillar trim.
3. Remove windshield wiper linkage from windshield wiper pivot cranking lever pin (Figure 10-120).
4. Remove nut, washer, and rubber washer securing windshield wiper pivot to windshield assembly and remove windshield wiper pivot.

Installation

1. Install windshield wiper pivot on windshield assembly with rubber washer, washer, and nut (Figure 10-120).
2. Install windshield wiper linkage on windshield wiper pivot cranking lever pin.
3. Install upper A-pillar trim.
4. Install windshield wiper arm assembly.

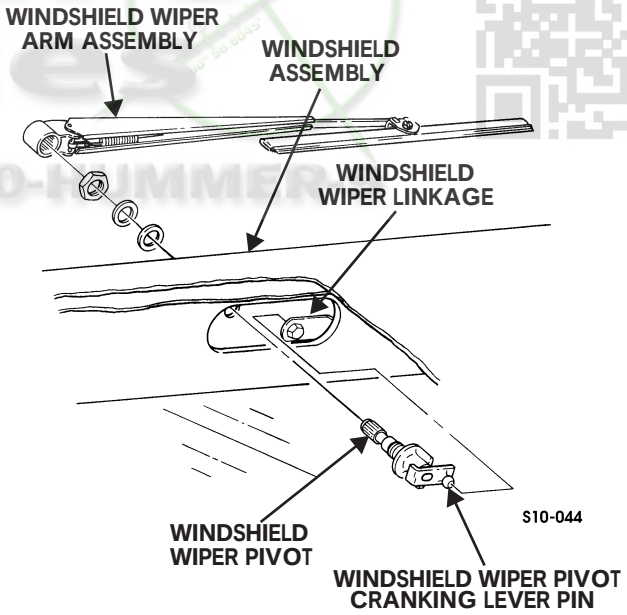


Figure 10-120: Windshield Wiper Pivot

Windshield Wiper Jumper Harness Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove center trim from windshield assembly.
3. Remove windshield wiper motor assembly from windshield assembly.
4. Remove console.
5. Remove engine access cover.
6. Remove eight locknuts, retainer, eight capscrews, and screw securing close-out panel to A-beam. Discard locknuts (Figure 10-121).
7. Remove three locknuts, clamp, three capscrews, and clamps securing close-out panel to A-beam and remove close-out panel. Discard locknuts.
8. Disconnect jumper harness from body electrical harness and remove jumper harness and two grommets from windshield assembly.

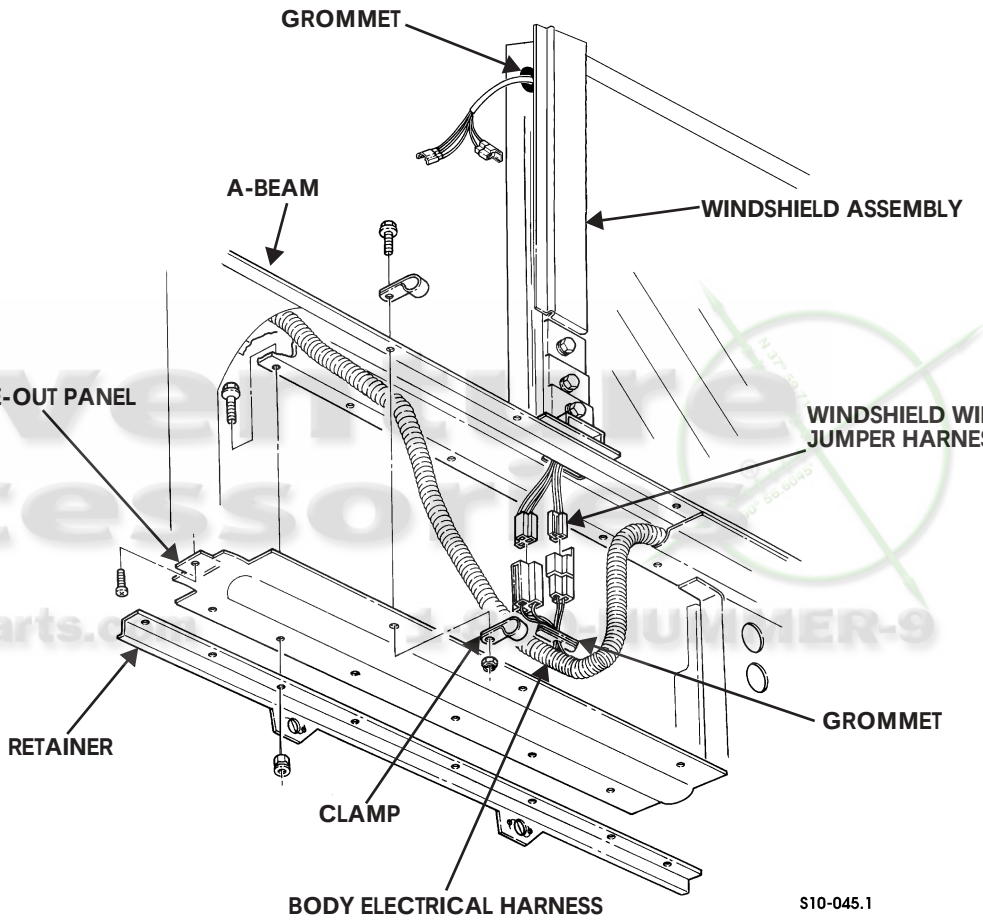


Figure 10-121: Windshield Wiper Jumper Harness

Installation

1. Connect jumper harness to body electrical harness and install jumper harness and two grommets on windshield assembly (Figure 10-121).
2. Install close-out panel on A-beam with three clamps, capscrews, clamp, and three locknuts.
3. Secure close-out panel to A-beam with retainer, eight capscrews, locknuts, and screw.
4. Install engine access cover.
5. Install console.
6. Install windshield wiper motor assembly on windshield assembly.
7. Install center trim on windshield assembly.
8. Connect battery ground cable (Section 12).

WINDSHIELD WASHER SYSTEM AND COMPONENTS

Reservoir and Pump Assembly Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Drain reservoir.
3. Disconnect pump connector from reservoir and pump assembly (Figure 10-122).
4. Disconnect windshield washer hose from reservoir and pump assembly.
5. Remove two capscrews, lockwashers, and reservoir and pump assembly from cowl. Discard lockwashers.
6. Inspect two wellnuts for damage. Replace if defective or damaged.

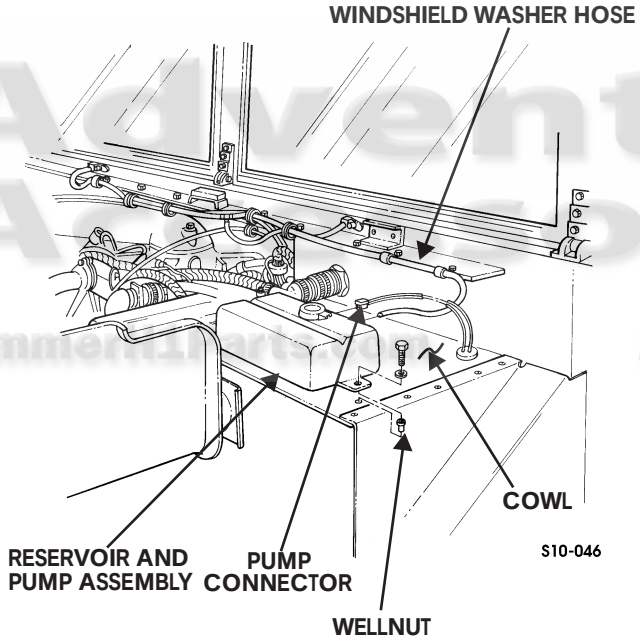


Figure 10-122: Windshield Washer Fluid Reservoir and Pump

Installation

1. Install reservoir and pump assembly on cowl with two lockwashers and capscrews. Tighten capscrews to 8 lb-ft (11 N•m) (Figure 10-122).
2. Connect windshield washer hose on reservoir and pump assembly.
3. Connect pump connector to reservoir and pump assembly.
4. Fill reservoir.
5. Connect battery ground cable (Section 12).

Windshield Washer Hoses Replacement

Removal

1. Remove three nuts, washers, capscrews, washers, and clamps securing hose to body (Figure 10-123).
2. Disconnect washer hose from pump and tee. Remove clamps from hose.
3. Disconnect two hoses from tee and nozzles and remove from clamps.

Installation

1. Install two hoses through clamps and connect to tee and nozzles (Figure 10-123).
2. Install hose through clamps and connect to tee and pump.
3. Secure hose on body with three clamps, washers, capscrews, washers, and nuts.

Windshield Washer Nozzle Replacement

Removal

1. Disconnect hose from nozzle (Figure 10-124).
2. Remove screw and nozzle from body.

Installation

1. Install nozzle on body with screw (Figure 10-124).
2. Connect hose to nozzle.

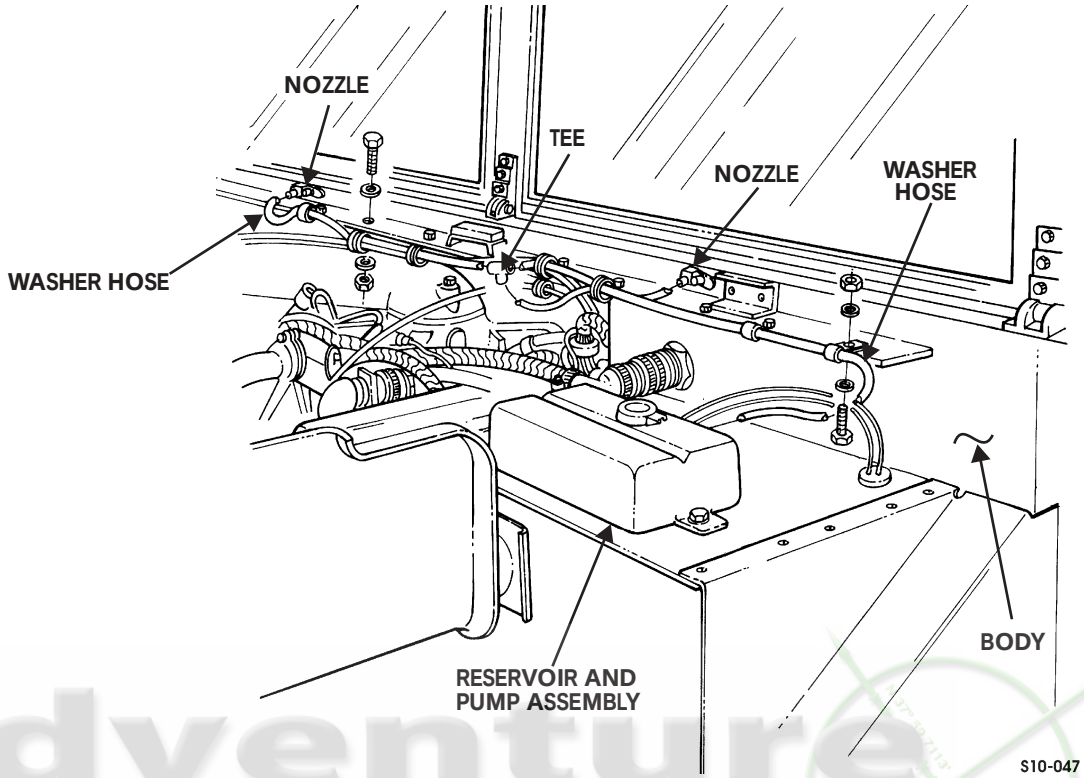


Figure 10-123: Windshield Washer Hoses

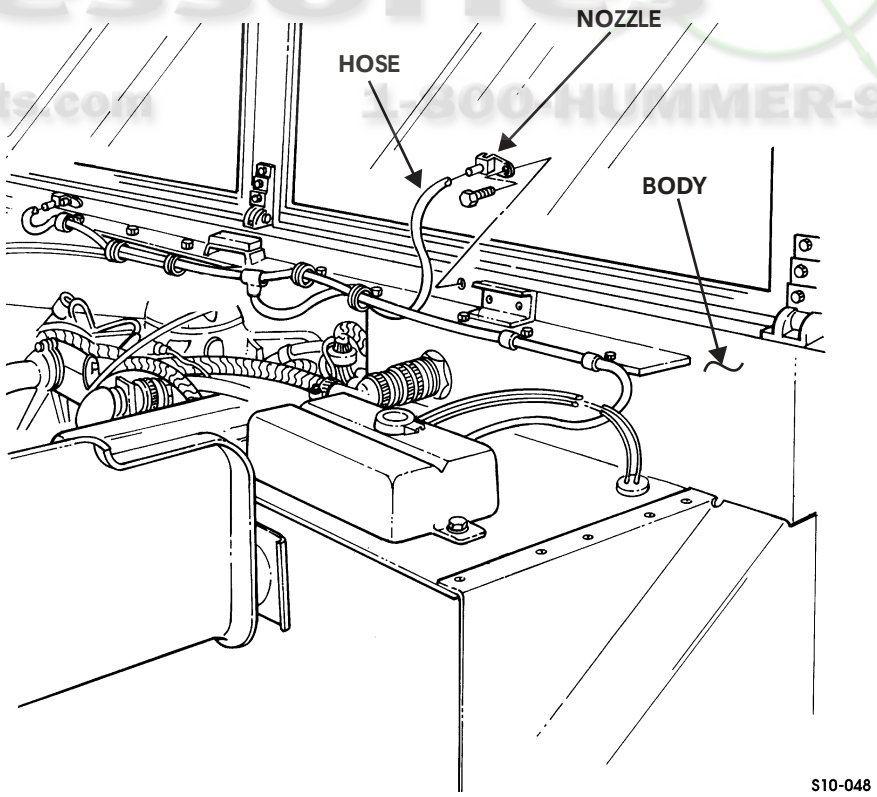


Figure 10-124: Windshield Washer Nozzle

MIRRORS

Side Mirror Replacement

Removal

Remove three screws, mirror, and gasket from door hinge (Figure 10-125).

Installation

Install gasket and mirror on door hinge with three screws (Figure 10-125).

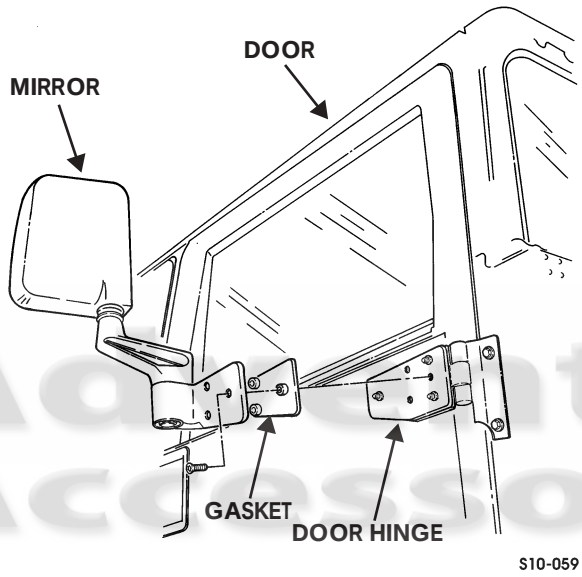


Figure 10-125: Side Mirror Assembly

Rearview Mirror Maintenance

Removal

1. Remove screw and rearview mirror from mirror bracket (Figure 10-126).

NOTE: Perform step 2 only if bracket requires replacement. Mark location of bracket prior to removal.

2. Remove bracket from windshield.

Cleaning and Inspection

Clean epoxy remains from windshield.

Installation

NOTE: Perform step 1 only if bracket was removed.

1. Install mirror bracket on windshield with quick-drying epoxy. Allow to dry (Figure 10-126).
2. Install rearview mirror on mirror bracket with screw .

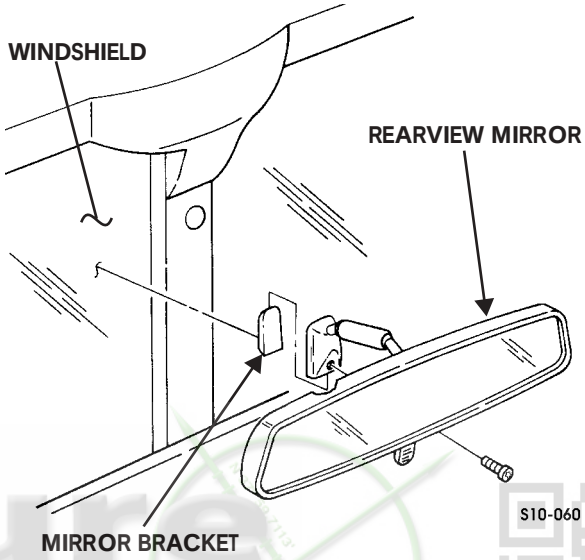


Figure 10-126: Rearview Mirror

A-PILLAR FORMER ASSEMBLY MAINTENANCE (SOFT TOP ONLY)

Removal

1. Remove soft top.
2. Remove thirteen screws and A-pillar former from A-pillar (Figure 10-127).
3. Clean mounting surface on A-pillar.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect wellnuts. Replace if defective or damaged.

Installation

1. Peel backing paper from A-pillar former and install former on A-pillar with thirteen screws (Figure 10-127).
2. Install soft top.

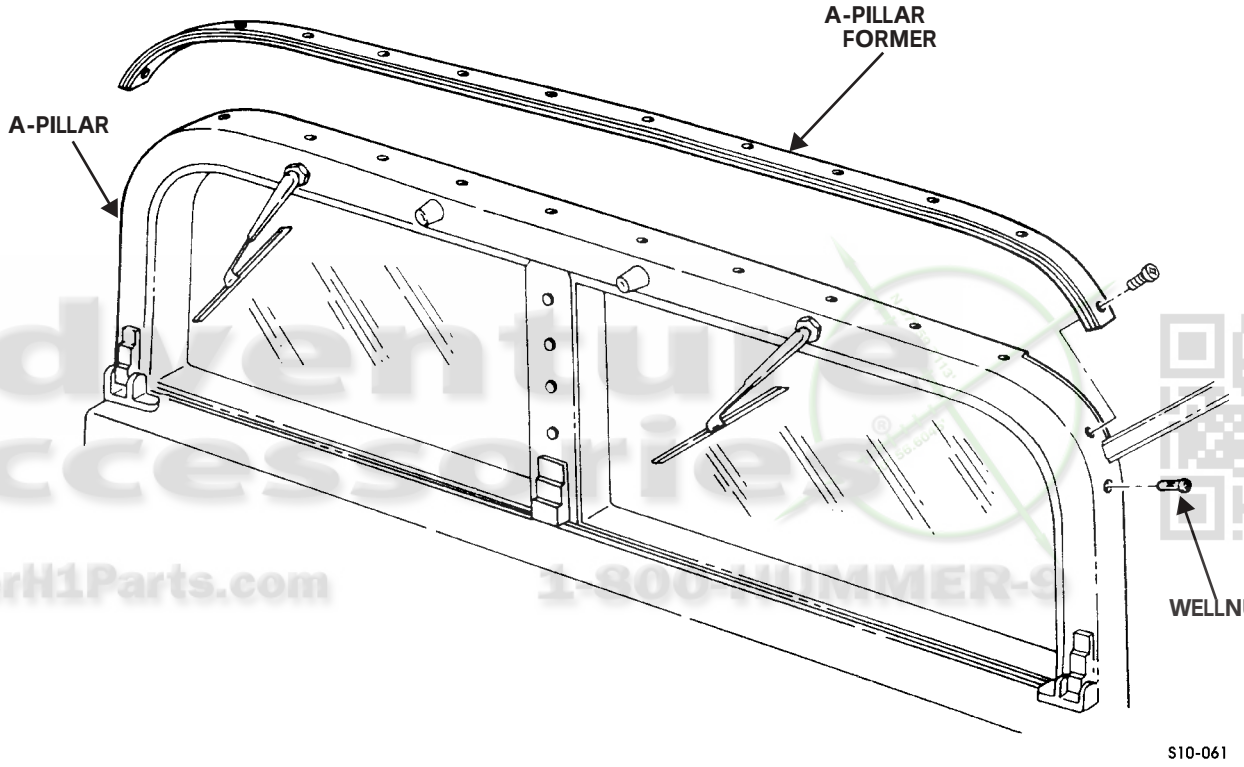


Figure 10-127: A-Pillar Former Assembly

REAR SUPPORT BOW BRACKET REPLACEMENT

Removal

1. Remove rear support bow assembly.
2. Remove two screws and support bow bracket from body (Figure 10-128).

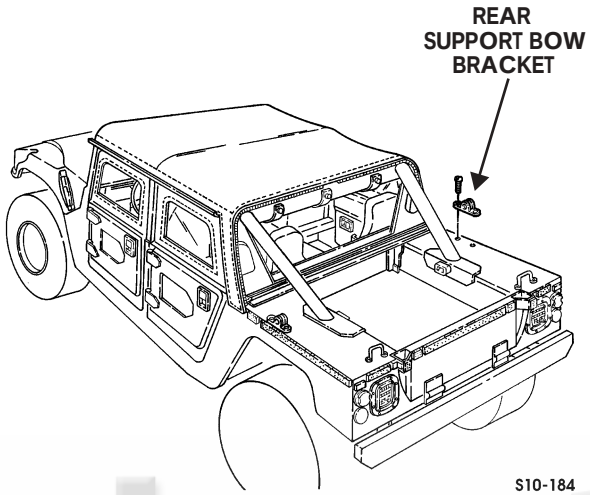


Figure 10-128: Rear Support Bow Bracket

Installation

1. Install bracket on body with two screws (Figure 10-128).
2. Install rear support bow assembly.

FRONT STRIKER REPLACEMENT

Removal

Remove locknut, washer, backing plate, two isolators, and front striker assembly from front door pillar. Discard locknut (Figure 10-129).

Installation

Install front striker assembly on front door pillar with two isolators, backing plate, washer, and locknut (Figure 10-129).

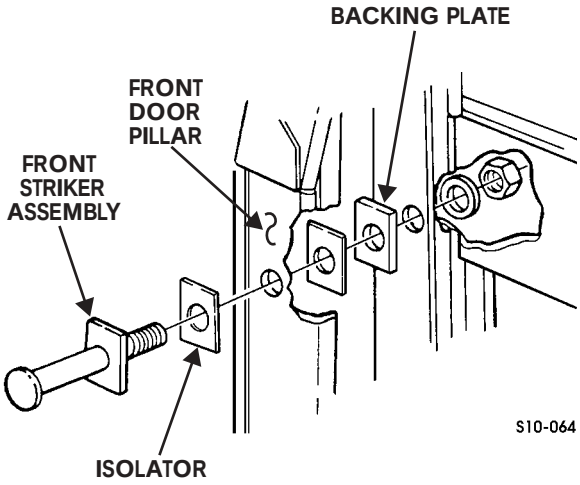


Figure 10-129: Front Striker Assembly

REAR STRIKER ASSEMBLY REPLACEMENT

Removal

Remove two screws, washers, backing plate, and rear striker assembly from rear door pillar (Figure 10-130).

Installation

Install rear striker assembly on rear door pillar with backing plate, two washers, and screws (Figure 10-130).

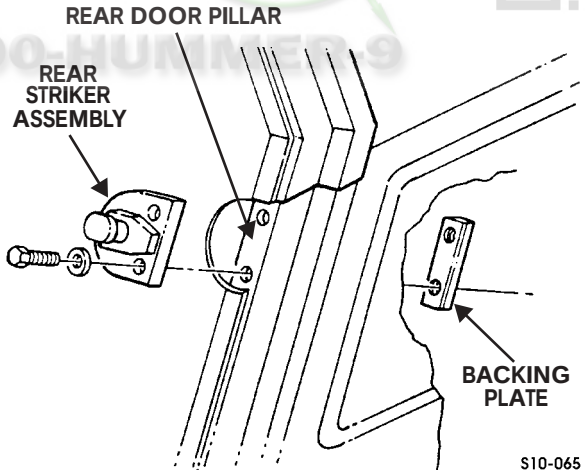


Figure 10-130: Rear Striker Assembly

BODY MOUNT REPLACEMENT

Removal

NOTE: Removal and installation procedures for intermediate and rear body mounts are the same. This procedure covers the left intermediate body mount.

1. Remove locknut, washer, capscrew, washer, and spacer securing sleeve, upper cushion, and lower cushion to body bracket and frame bracket. Discard locknut (Figure 10-131).
2. Raise the vehicle at the body reinforcement adjacent to body mount to be removed (Figure 10-132).
3. Raise the body far enough to separate the upper cushion from lower cushion and remove sleeve, upper cushion, and lower cushion (Figure 10-131).

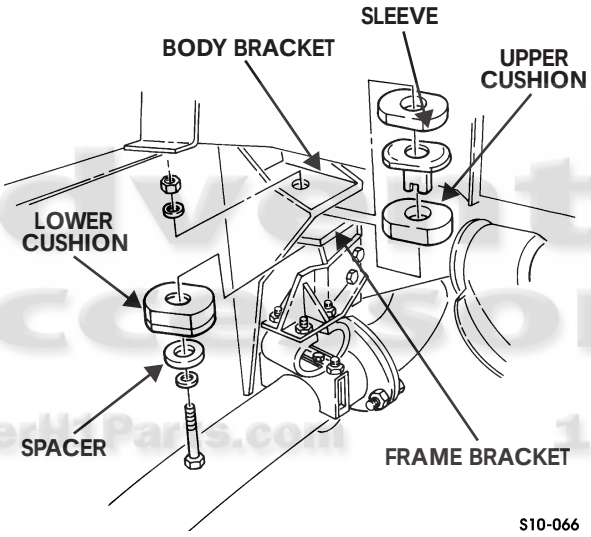


Figure 10-131: Body Mount Cushions

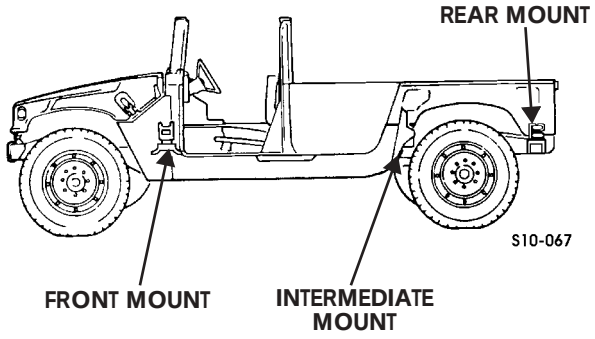


Figure 10-132: Left Side Body Mount Locations

Installation

1. Install lower cushion, upper cushion, and sleeve between body bracket and frame bracket (Figure 10-131).
2. Lower body and ensure lower cushion, sleeve, upper cushion, and body bracket align. Secure with spacer, washer, capscrew, washer, and locknut. Tighten locknut to 90 lb-ft (122 N•m).

LICENSE PLATE BRACKETS

Rear License Plate Bracket Replacement

Removal

1. Remove two screws, lockwashers, license plate, and two grommets from bracket. Discard lockwashers (Figure 10-133).
2. Remove two capscrews and lockwashers securing bracket to bumper. Discard lockwashers.
3. Disconnect two leads from light bracket, and remove bracket.
4. Remove two nut and lockwasher assemblies, screws, and light bracket from bracket. Discard nut and lockwasher assemblies.

Installation

1. Install light bracket on bracket and secure with two screws and nut and lockwasher assemblies (Figure 10-133).
2. Connect two leads to light bracket.
3. Install bracket on bumper with two lockwashers and capscrews.
4. Install license plate on bracket with two grommets, lockwashers, and screws.

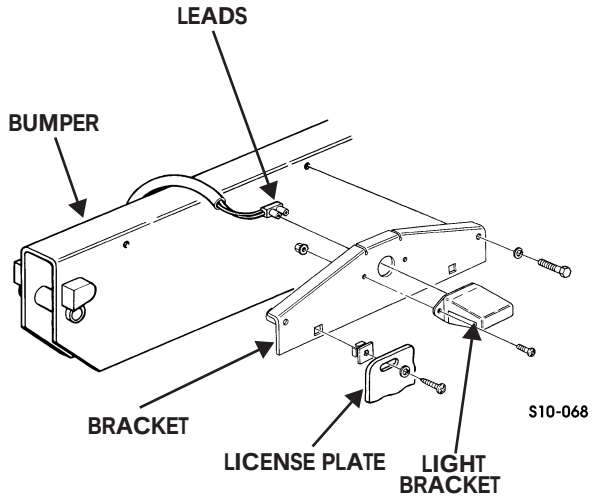


Figure 10-133: Rear License Plate Bracket

Front License Plate Bracket Replacement

Removal

1. Remove two capscrews, lockwashers, license plate, and two grommets from bracket. Discard lockwashers (Figure 10-134).
2. Remove two screws, lockwashers, and bracket from bumper. Discard lockwashers.

Installation

1. Install bracket on bumper with two lockwashers and screws (Figure 10-134).
2. Install license plate on bracket with two grommets, lockwashers, and capscrews.

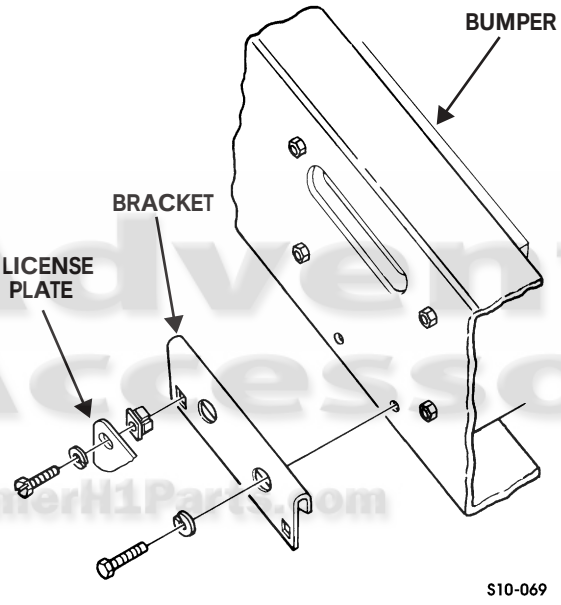


Figure 10-134: Front License Plate Bracket

FUEL FILLER HOUSING REPLACEMENT

Removal

1. Remove filler cap from filler spout (Figure 10-135).
2. Remove three nuts, washers, capscrews, and washers securing fuel filler housing to filler spout.
3. Remove six screws and washers securing fuel filler housing to right outer wheelhouse panel.
4. Push filler cap through filler housing and remove fuel filler housing.
5. Inspect six speednuts for damage. Replace if defective or missing.

Installation

1. Pull filler cap through fuel filler housing and install housing on right outer wheelhouse panel with six washers and screws. Tighten screws to 18 lb in. (2 N•m) (Figure 10-135).
2. Secure fuel filler housing to filler spout with three washers, capscrews, washers, and nuts.
3. Install filler cap on filler spout.

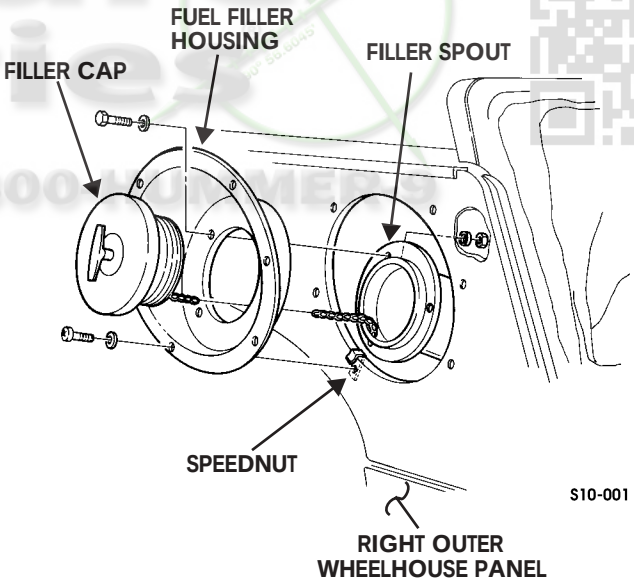


Figure 10-135: Fuel Filler Housing

ROADSIDE EMERGENCY EQUIPMENT

Tire Jack and Triangle Warning Kit Hold-Down Bracket Replacement (For Two-Passenger Model)

Removal

1. Remove two wingnuts, washers, and hold-down brackets (Figure 10-136).
2. Remove tire jack and triangle warning kit.
3. Remove two studs from bracket.

Installation

1. Place tire jack and triangle warning kit in place (Figure 10-136).
2. Install two studs on bracket.
3. Install two hold-down brackets on studs with two washers and wing nuts.

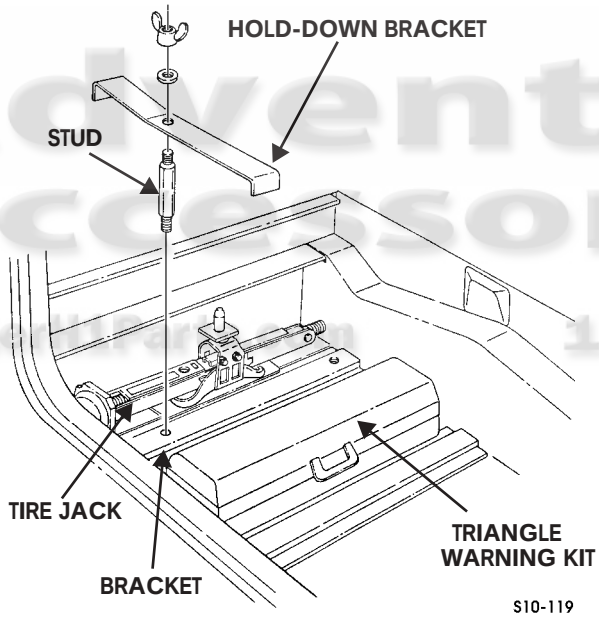


Figure 10-136: Emergency Equipment Hold-Down Bracket - Two-Passenger Vehicle

Tire Jack and Triangle Warning Kit Hold-Down Replacement (Four-Passenger Vehicle, Station Wagon, and Open Body)

Removal

1. Remove triangle warning kit and tire jack from under right rear seat.
2. Remove two wing nuts, washers, screws, clamp bracket, and hold-down bracket from seat support (Figure 10-137).
3. Remove nut, washer, screw, washer, and strap bracket from seat support.
4. Remove nut, washer, screw, washer, and strap from strap bracket.

Installation

1. Install strap on strap bracket with screw, two washers, and nut (Figure 10-137).
2. Install strap bracket on seat support with screw, two washers, and nut.
3. Install hold-down bracket and clamp bracket on seat support with two screws, washers, and wing nuts.
4. Position tire jack and triangle warning kit in place, and secure with strap.

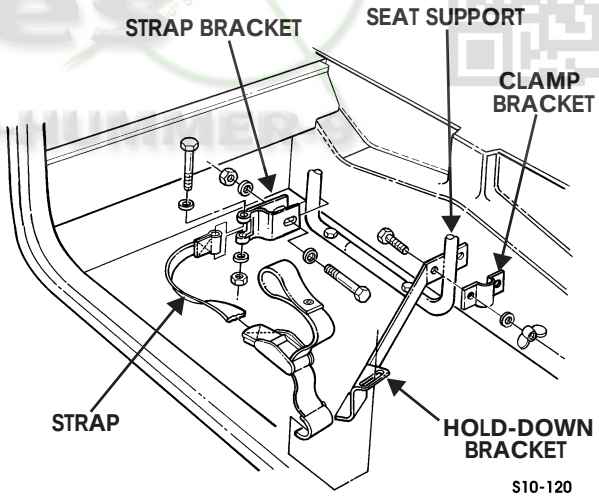


Figure 10-137: Emergency Equipment Hold-Down Bracket - Four-Passenger Vehicle

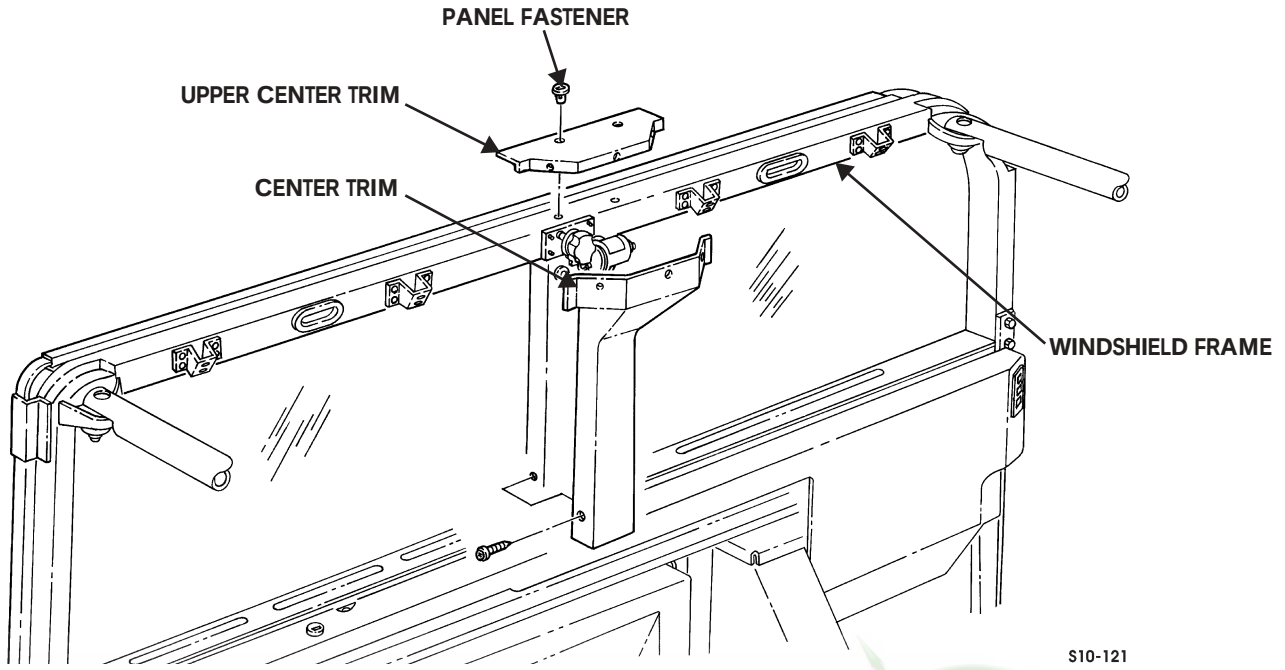


Figure 10-138: Upper Trim and Windshield Frame

FOUR-PASSENGER SOFT TOP

Interior Trim Replacement

Removal

1. Remove front and rear seats.
2. Remove front and center consoles.
3. Remove speakers from rear wall (Section 12).
4. Remove two panel fasteners from upper center trim of windshield frame (Figure 10-138).
5. Remove two panel fasteners from upper center trim of windshield frame (Figure 10-138).
6. Remove five screw and washer assemblies and upper center and center trim from windshield frame.
7. Remove four screw and washer assemblies and trim from side of rear compartment wall (Figure 10-140).
8. Remove four screw and washer assemblies and lower B-pillar trim from B-pillar (Figure 10-139).

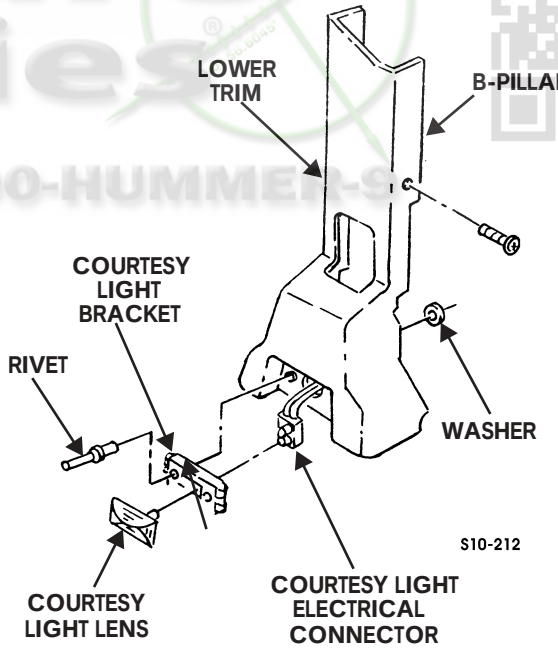


Figure 10-139: Courtesy Light Electrical Connector

9. Disconnect courtesy light electrical connector, and remove courtesy light lens, two rivets, washers, and courtesy light from trim.

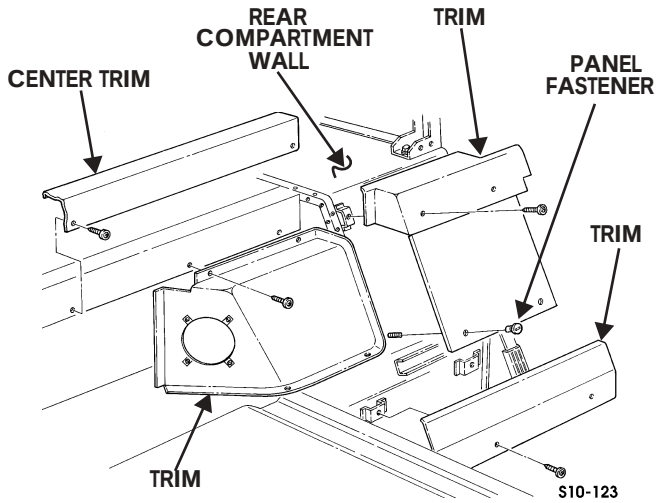


Figure 10-140: Rear Wall Compartment

10. Remove four screw and washer assemblies, two panel fasteners, lower trim, and trim from rear compartment wall (Figure 10-140).
11. Remove screw and washer assembly and center trim from rear compartment wall.

Installation

1. Place center trim on rear compartment wall with screw and washer assembly (Figure 10-140).
2. Install lower trim and trim on rear compartment wall with two panel fasteners and four screw and washer assemblies.
3. Install trim on rear compartment wall with four screw and washer assemblies.
4. Connect courtesy light electrical connector, and install courtesy light on trim with two washers and rivets.
5. Install courtesy light lens on courtesy light.
6. Secure lower B-pillar trim on with four screw and washer assemblies.
7. Install center trim on windshield frame with two screw and washer assemblies (Figure 10-141).
8. Install upper center trim on windshield frame and center trim with two panel fasteners and three screw and washer assemblies.
9. Install speakers on rear wall (Section 12).
10. Install front and center consoles.
11. Install front and rear seats.

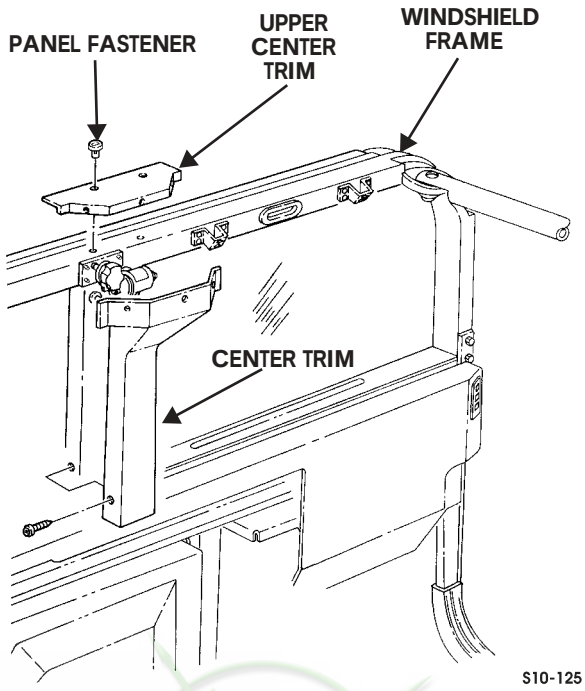


Figure 10-141: Upper Trim and Windshield Frame

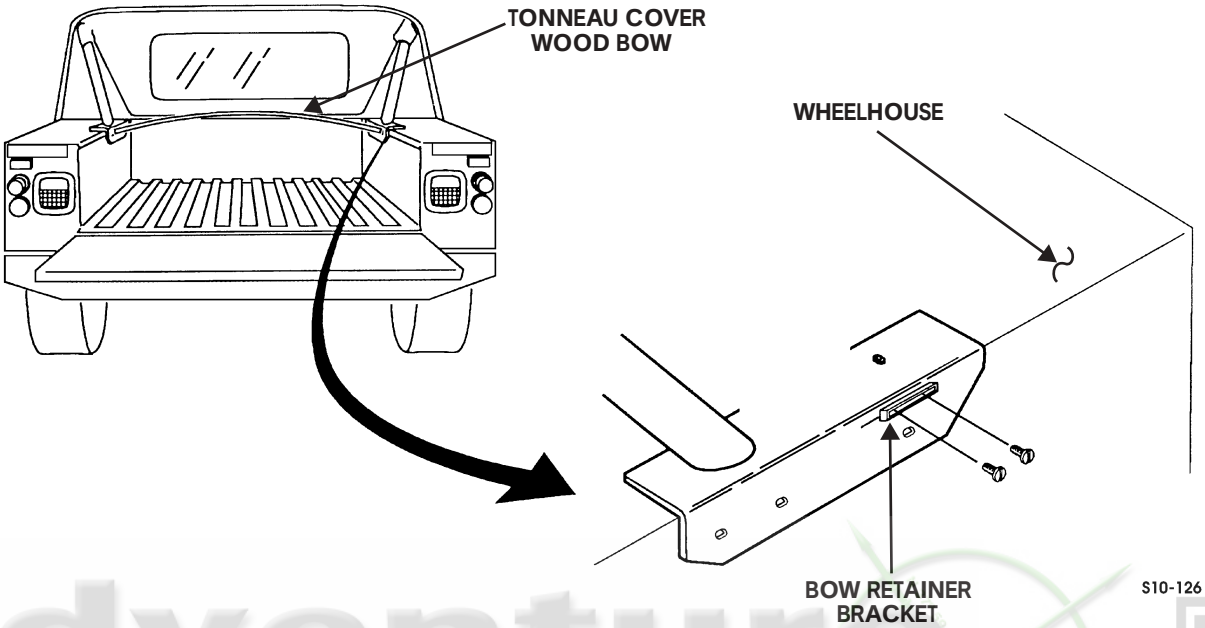


Figure 10-142: Tonneau Cover Wood Bow

Soft Top Mounting Components and Accessories Replacement

NOTE: The following removal and installation instructions include replacement of all soft top mounting components and accessories. Use only the applicable steps for replacing specific components.

Removal

1. Remove four-passenger soft top, tonneau cover, and slant back soft top or station wagon soft top, if applicable. Refer to the owner's manual for proper procedure.
2. Remove tonneau cover wood bow from two retainer brackets (Figure 10-142).
3.
4. Remove four screws and two bow retainer brackets from wheelhouses.
5. Remove four upper door assemblies from lower door assemblies (Figure 10-143).

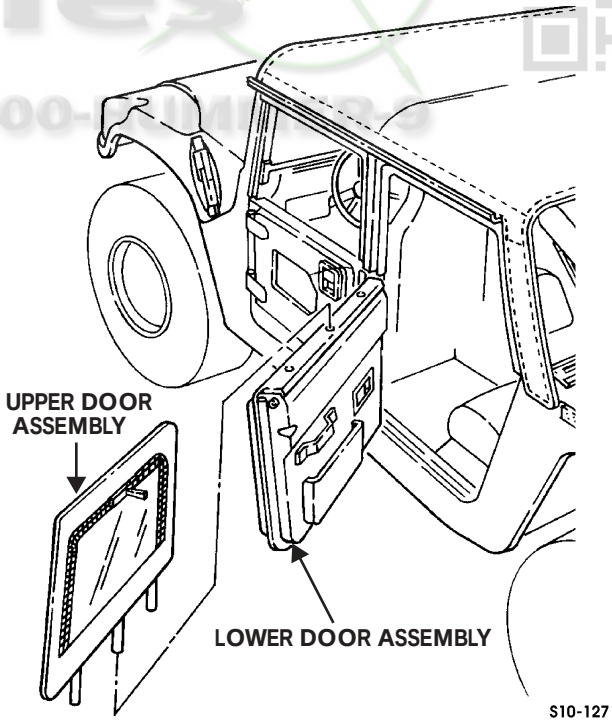


Figure 10-143: Door Assemblies

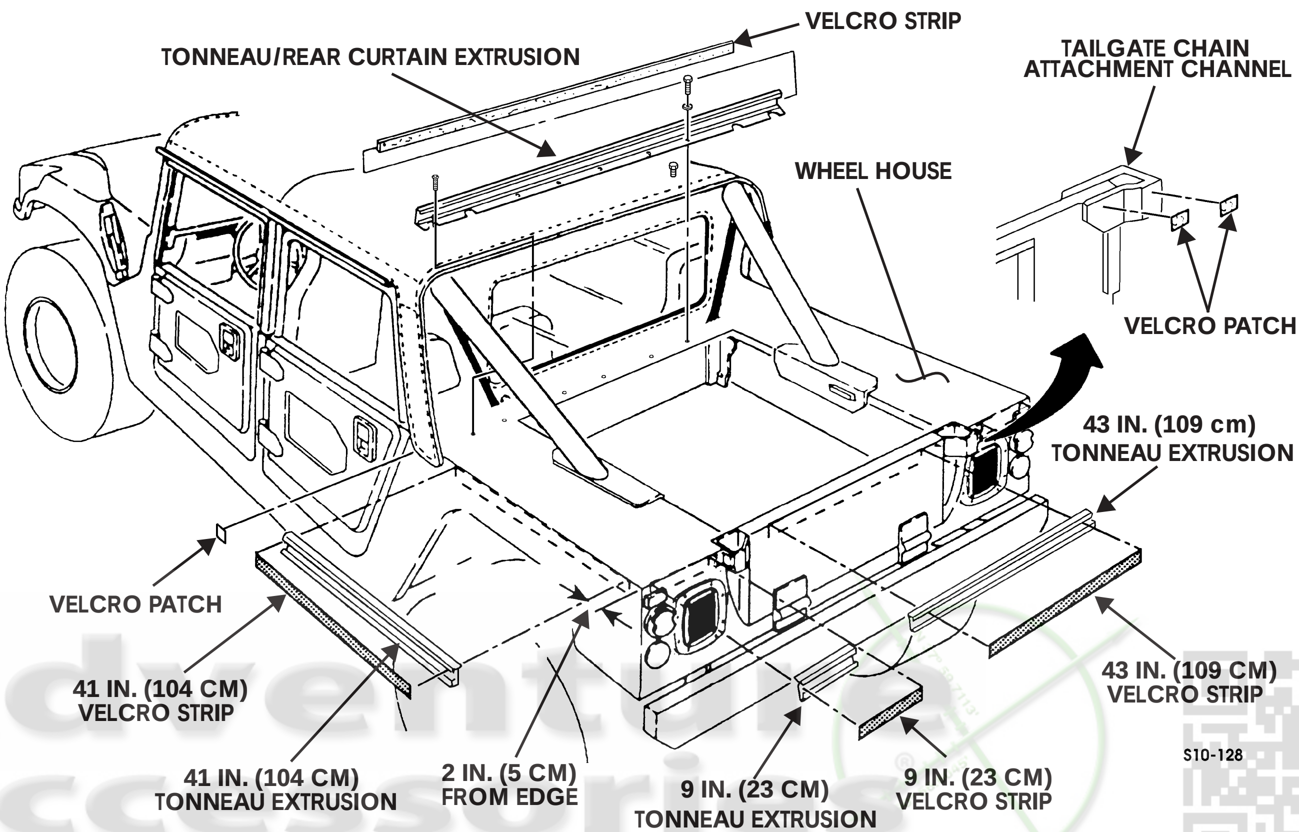


Figure 10-144: Velcro Strips on Cargo Bed and Tonneau Extrusion

6. Remove velcro strips and patches from tonneau area (Figure 10-144)

NOTE: Perform steps 6 and 7 for both sides of the vehicle. The left side is shown.

7. Remove 41 in. (104 cm) tonneau extrusion from side of wheelhouse.
8. Remove 9 in. (23 cm) tonneau extrusion from rear of wheelhouse.
9. Remove 43 in. (109 cm) tonneau extrusion from tailgate.
10. Remove five capscrews, lockwashers, four self-tapping screws, and tonneau/rear curtain extrusion from body. Discard lockwashers.

NOTE: Perform steps 10 through 13 for both sides of the vehicle. The left side is shown.

11. Remove front and rear door seals (Figure 10-145).

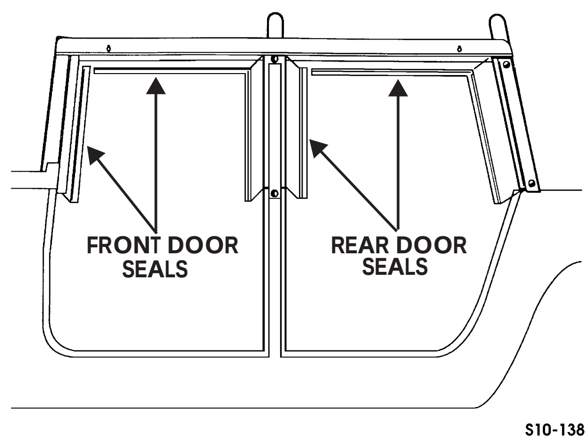


Figure 10-145: Door Seals

12. Remove ten rivets securing front and rear wind deflectors to A-pillar and B-pillar (Figure 10-146).

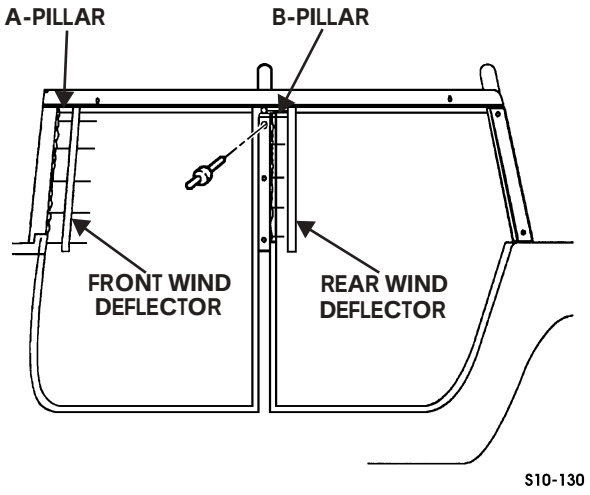


Figure 10-146: Wind Deflectors

13. Remove capscrew, washer, and self-tapping screw securing B-pillar extrusion to B-pillar and remove B-pillar extrusion (Figure 10-147).

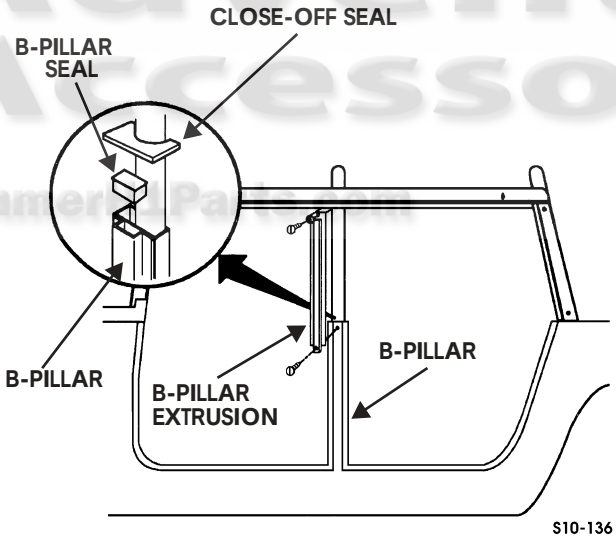


Figure 10-147: B-Pillar and Close-Off Seal

14. Remove close-off seal and B-pillar seal from B-pillar.
15. Remove D-strip seal from windshield frame. Do not remove P-strip seal (Figure 10-148).

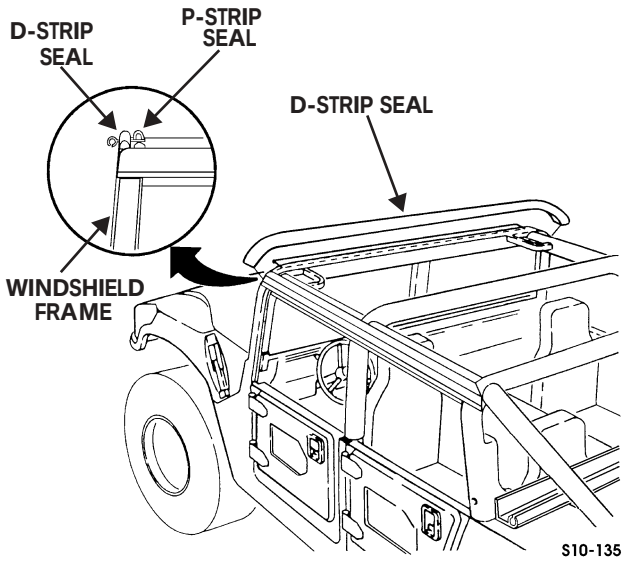


Figure 10-148: Windshield Frame Seals

NOTE: Perform steps 15 through 17 for both sides of the vehicle. The left side is shown.

16. Remove two screws and spacers securing velcro strip and horizontal rail (H-rail) to support structure (Figure 10-149). Remove any spacer washers, if applicable.
17. Remove 3 in. (8 cm) piece of P-strip seal from windshield frame.
18. Remove two screws, washers, and C-pillar extrusion from C-pillar.

Installation

NOTE: Perform steps 1 through 3 for both sides of the vehicle. The left side is shown.

1. Install C-pillar extrusion on C-pillar with two washers and screws (Figure 10-149).

NOTE: Clean all surface residue with an alcohol base cleaner before installing seals.

2. Install 3 in. (8 cm) piece of P-strip seal on windshield frame at the end of P-strip seal. Do not trim excess seal yet.

NOTE: If shimming is necessary, use spacer washers and longer screws to secure H-rail and to align H-rail door face with windshield frame door face and C-pillar extrusion door face.

3. Install H-rail and velcro strip on support structure with two spacers and screws. Trim excess seal installed in step 2 to bottom of H-rail.
4. Install D-strip seal on windshield frame in front of P-seal. Trim as necessary (Figure 10-150).

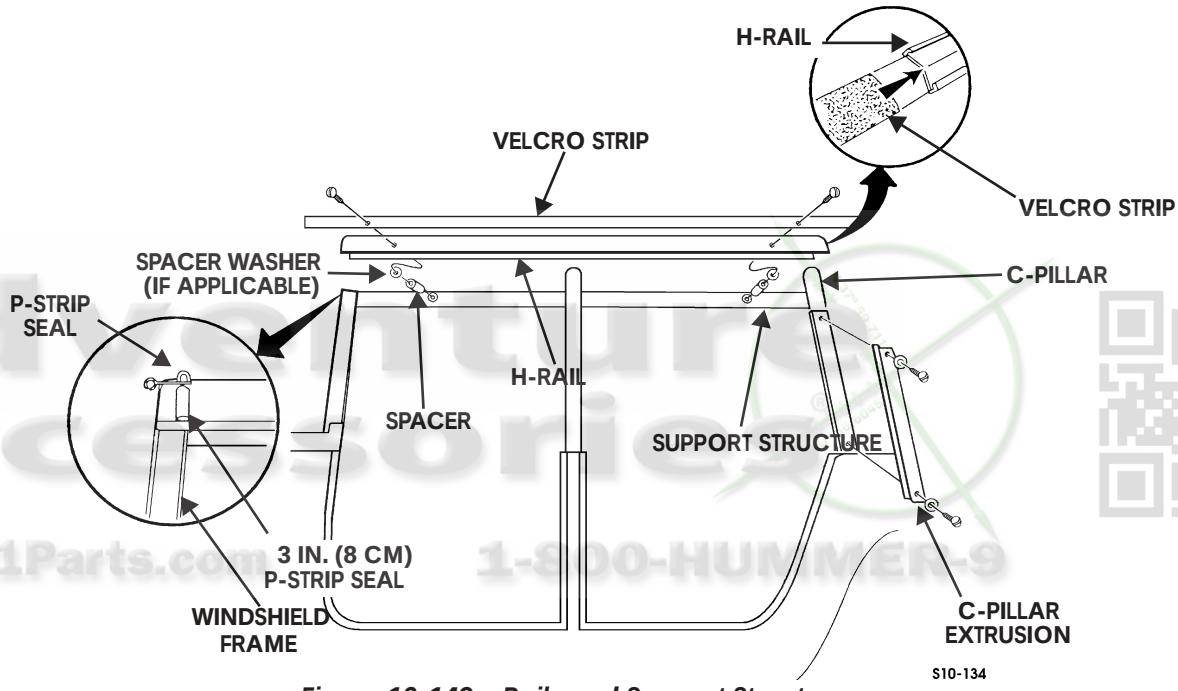


Figure 10-149: Rails and Support Structures

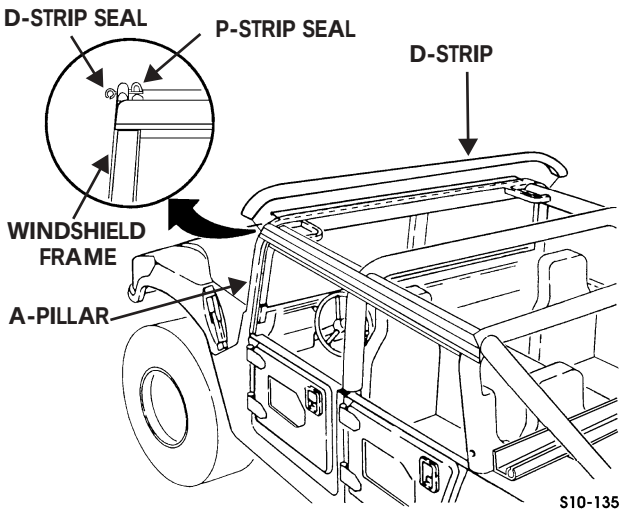


Figure 10-150: Windshield Seals

NOTE: Perform steps 5 through 9 for both sides of the vehicle. The left side is shown.

5. Coat mating surfaces of close-off seal and B-pillar seal with silaprene adhesive and install seals on B-pillar (Figure 10-151).

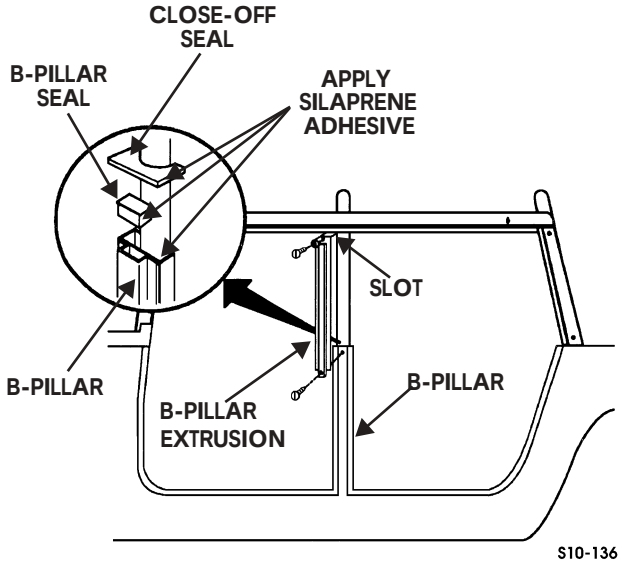


Figure 10-151: B-Pillar and Close-Off Seal

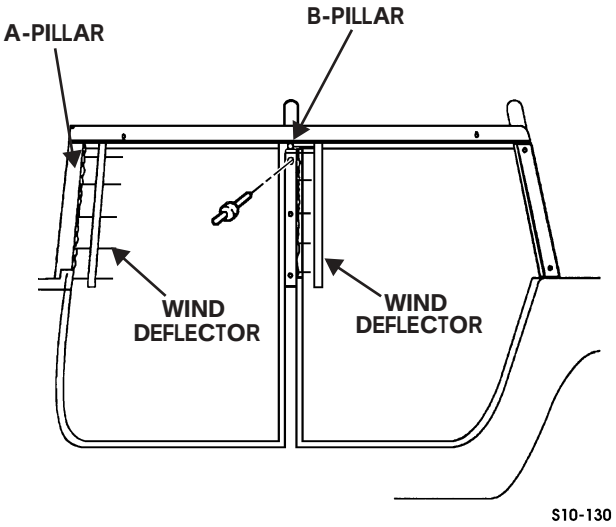


Figure 10-152: Wind Deflectors

6. Coat mating surface of B-pillar extrusion with silaprene adhesive and install on B-pillar. Secure with washer, capscrew, and self-tapping screw. Seal slot in B-pillar extrusion with silaprene adhesive.
7. Coat mating surfaces of front and rear wind deflectors with silaprene adhesive and install on A-pillar and B-pillar with ten rivets (Figure 10-152).
8. Install shorter seals on front and rear door frames and cut ends to fit. Trim seals at bottom of wind deflector (Figure 10-153).
9. Starting with mitered corner, install longer seals on front and rear door frames and cut ends to fit.

NOTE: Clean all surface residue with an alcohol base cleaner before installing extrusions.

10. Install tonneau/rear curtain extrusion on body with five lockwashers, capscrews, and four self-tapping screws (Figure 10-144).
11. Install 43 in. (109 cm) tonneau extrusion on tailgate.

NOTE: Perform steps 12 and 13 for both sides of the vehicle. The left side is shown.

12. Install 9 in. (23 cm) tonneau extrusion on rear of wheelhouse.
13. Install 41 in. (104 cm) tonneau extrusion on side of wheelhouse, 2 in. (5 cm) from rear corner edge of wheelhouse.

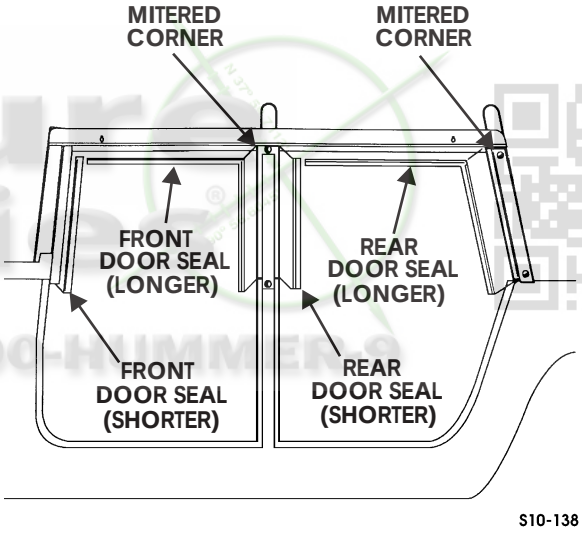


Figure 10-153: Door Seals

NOTE: Before installing a new velcro strip (of larger size), crease the strip approximately 8 in. (20 cm) from each end by folding the strip back on itself. Unfold the strip before inserting it into the rail or extrusion. The crease will keep the velcro strip from moving excessively inside the extrusion channel.

14. Install velcro strips in extrusions.
15. Install one velcro patch on each wheelhouse side and two velcro patches on each tailgate chain attachment channel.
16. Coat door pins of four upper door assemblies with silicone lubricant and install upper door assemblies on lower door assemblies (Figure 10-154). Press upper door assemblies firmly into place.

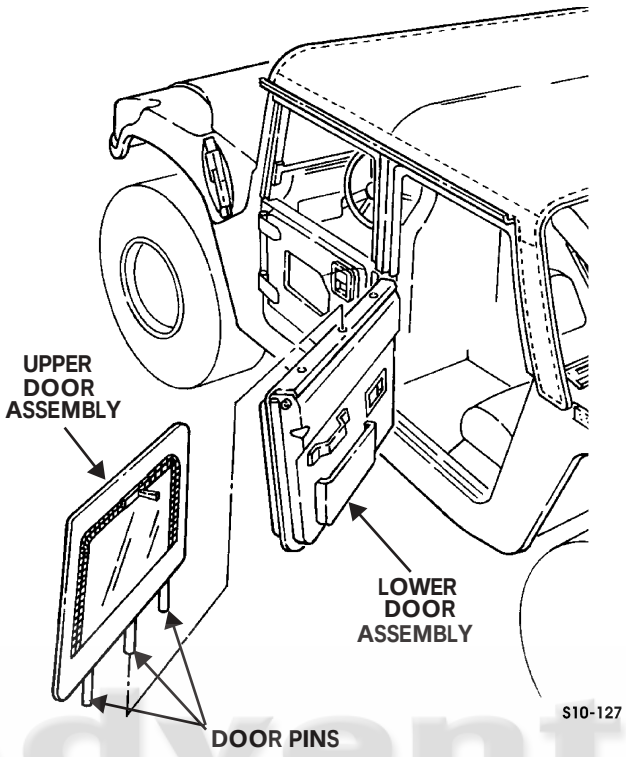


Figure 10-154: Door Assemblies

17. Lift the outer flap of each upper door assembly and check for gaps between the upper door assembly and lower door assembly. If a gap exists, unzip the window and tap on the base of the window frame with an open hand to seat the upper door assembly.
18. Check tightness of fit for each upper door assembly by inserting a sheet of paper or similar material between the upper door frame and door opening. Close door. Remove paper or similar material. Slight tension should be felt. Use additional seal material if the fit of the door assembly to the wind deflector is inadequate.
19. Install two bow retainer brackets on wheelhouses with four screws (Figure 10-155).

***CAUTION**: The ideal crown height of the bow is shown. If there is excessive crowning of the bow, cut the end of the wood bow with a saw to reduce the crown. Do not cut more than 0.25 in. (6 mm) at a time, or the bow may become too short.*

20. Measure and record the distance across the cargo bed, between each rear support bar brace. Add 0.25 to 0.50 in. (6 to 13 mm) to this dimension and mark and cut the wood bow to this dimension.
21. Position wood bow in two retainer brackets.
22. Install the four-passenger soft top, tonneau cover, and slant-back soft top or station wagon soft top, if applicable. Refer to the owner's manual.

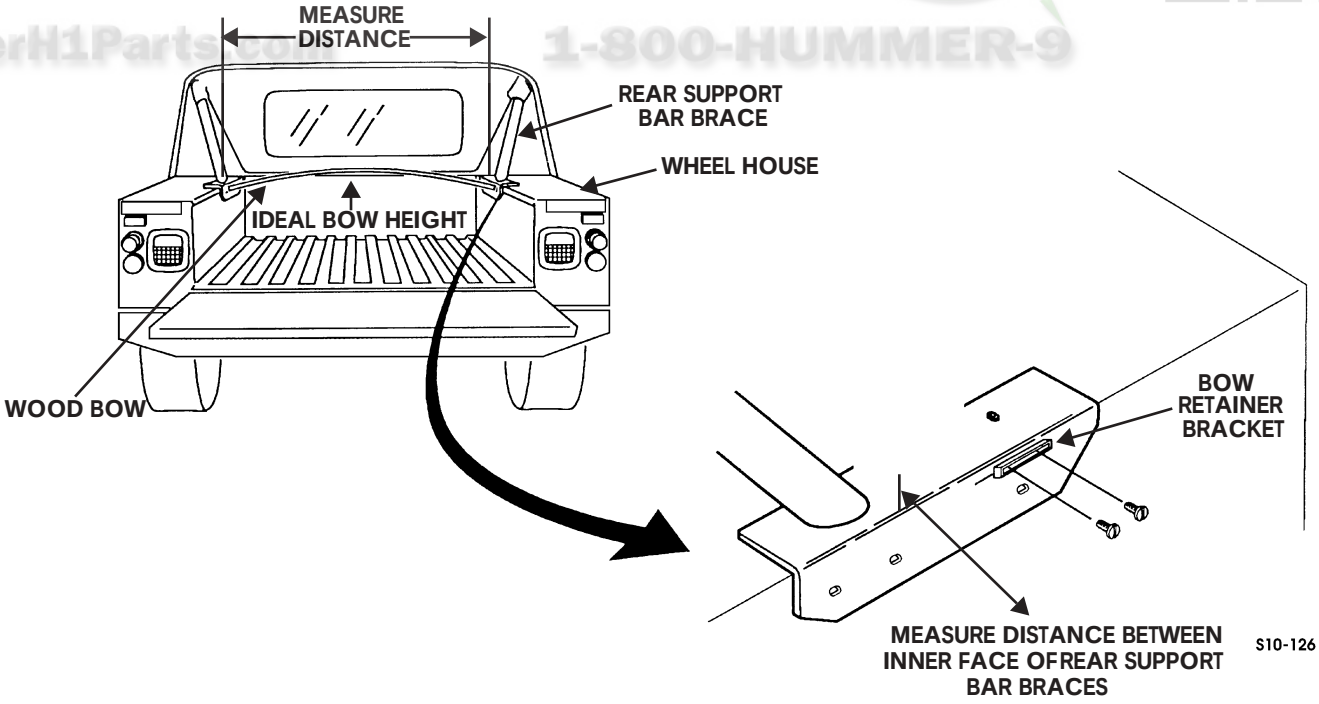


Figure 10-155: Wood Bow

TAILGATE

Tailgate Chain and Latch Brackets Replacement

Removal

Remove four locknuts, washers, capscrews, washers, chain bracket, and latch bracket from body. Discard locknuts (Figure 10-156).

Installation

Install chain bracket and latch bracket on body with four washers, capscrews, washers, and locknuts. Tighten capscrews to 15 lb-ft (20 N•m) (Figure 10-156).

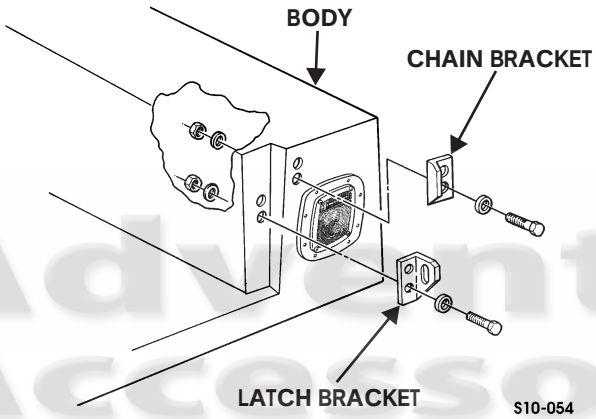


Figure 10-156: Tailgate Brackets

Cargo Tiedown Replacement

NOTE: Cargo tiedown replacement is basically the same for all tiedowns.

Removal

Remove locknut, washer, hex-head screw, and cargo tiedown from cargo floor. Discard locknut (Figure 10-157).

Installation

Install cargo tiedown on cargo floor with hex-head screw, washer, and locknut. Tighten locknut to 65 lb-ft (88 N•m) (Figure 10-157).

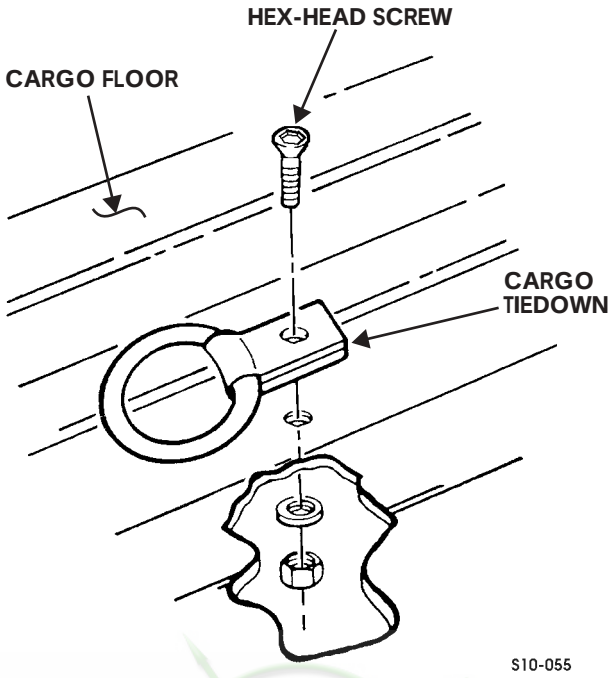


Figure 10-157: Cargo Tiedown

Tailgate and Seals Replacement

Removal

1. Remove six locknuts, washers, and capscrews securing tailgate to body. Discard locknuts (Figure 10-158).
2. Disconnect two chains from tailgate and remove tailgate and shims from body.

NOTE: Perform step 3 for two- and four-door models. Perform step 4 and 5 for station wagon and open body models.

3. Remove two vertical seals from tailgate. Discard seals.
4. Remove two vertical and horizontal seals from body and four vertical seals and one horizontal seal from tailgate. Remove two corner seals (station wagon model only). Discard seals (Figure 10-159).
5. Remove two corner seals from tailgate (station wagon model only).
6. Remove two grommets from tailgate.
7. Clean adhesive from tailgate and body.

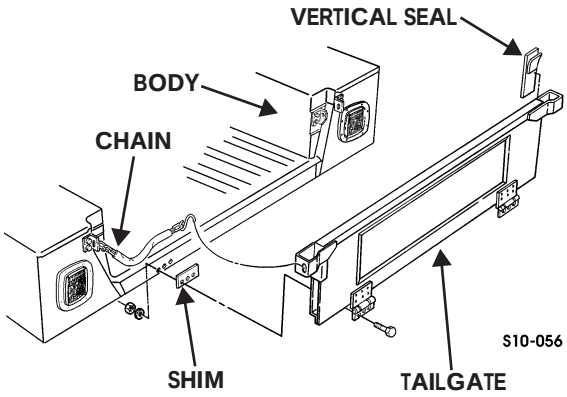


Figure 10-158: Tailgate and Seals

Installation

1. Install two grommets on tailgate (Figure 10-159).

NOTE: Perform steps 2 through 4 for station wagon and open body models. Perform step 5 for two- and four-door models.

2. Remove paper backing and install four vertical seals and one horizontal seal on tailgate. Ensure upper vertical seals overlap lower seals.
3. Remove paper backing from two horizontal and vertical seals and install on body.
4. Remove paper backing from two corner seals and install on tailgate (station wagon model only).
5. Remove paper backing from two vertical seals and install seals on tailgate (Figure 10-158).
6. Install tailgate on body with six capscrews, washers, and locknuts. Shim hinges as needed to align tailgate with body. When aligned, tighten capscrews 26 lb-ft (35 N•m).
7. Secure tailgate to body with two chains.

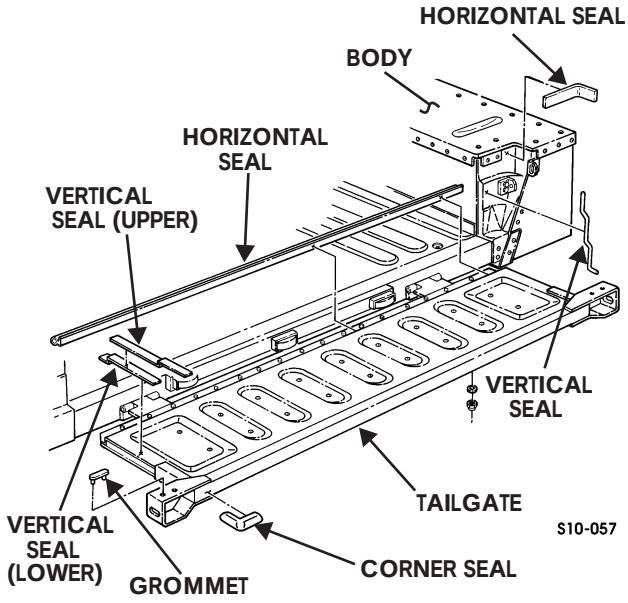


Figure 10-159: Tailgate Mounting Bracketry and Seals

Tailgate Chain Replacement

Removal

1. Lower tailgate.
2. Open chain cap link and disconnect chain from bracket (Figure 10-160).
3. Unhook chain from chain bracket.

Installation

1. Hook chain to chain bracket (Figure 10-160).

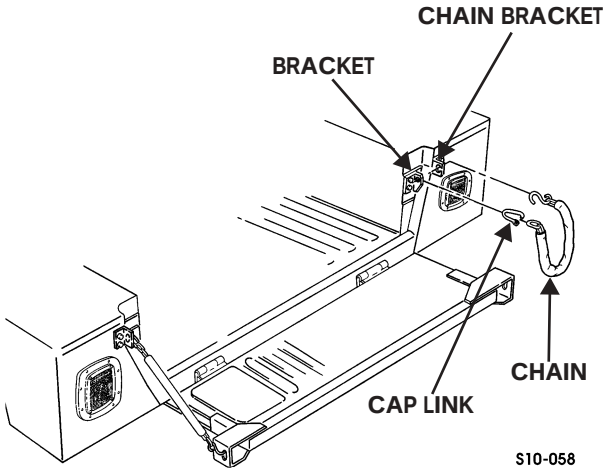


Figure 10-160: Tailgate Chain

2. Connect chain to bracket.
3. Raise tailgate.

TAILGATE HINGE MAINTENANCE

NOTE: To facilitate alignment when replacing hinges, place a small strip of masking tape along each side and bottom of hinge before removal.

Removal

Remove tailgate by removing six locknuts, washers, and capscrews from the tailgate while still closed. Discard locknuts. Note number of shims under each hinge and set them aside. Remove tailgate by releasing tailgate chains (Figure 10-161).

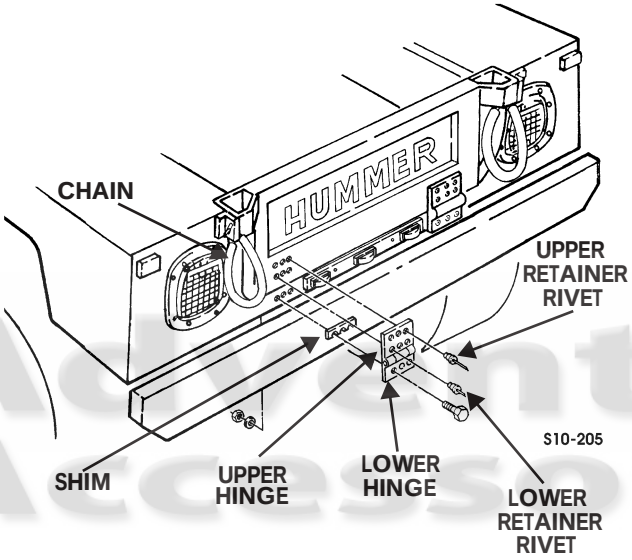


Figure 10-161: Tailgate Hinge

Disassembly

1. Place tailgate on padded work surface and remove hinge retainer rivets. Remove hinge and clean any debris from rivet holes.
2. Clean tailgate and apply a light coat of seam sealant to hinge mounting area.

Assembly

1. Using three 0.187 in. x 0.626 in. rivets, fasten hinge to lower set of holes on tailgate.

NOTE: Install rivets from tailgate into hinge to avoid interference with body and or seals.

2. Fasten hinge to upper set of holes on tailgate with three 0.187 in. x 0.563 in. rivets into tailgate.

Installation

1. Install tailgate into opening and secure with tailgate chains. Loosely install capscrews, washers, and locknuts into hinges. Insert proper amount of shims under each hinge.
2. Slightly tighten capscrews, but not tight enough to restrict movement into alignment with tape marks.
3. Align hinges and tailgate into proper position and torque capscrews to 26 lb-ft (35 N•m). Remove any excess sealant from hinges and body.
4. Refinish hinges and fasteners as required.

LIFT GATE ASSEMBLY

Lift Gate Assembly Replacement

Removal

1. Remove two lift gate shocks.
2. Remove fifteen screws, retainer, and insulation securing lift gate assembly to cargo shell and remove lift gate assembly (Figure 10-162).

Installation

1. Install lift gate assembly on cargo shell with insulation, retainer, and fifteen screws (Figure 10-162).
2. Install lift gate shocks.

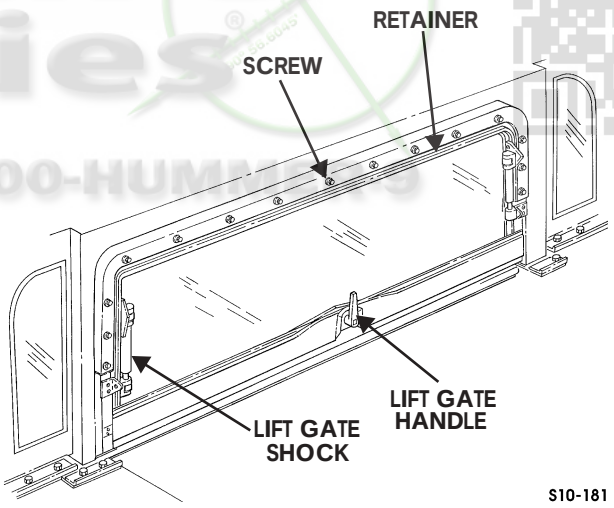


Figure 10-162: Lift Gate Assembly

Lift Gate Shock Replacement

NOTE: Lift gate shock replacement is the same for the left and right side. This procedure covers the right side.

Removal

1. Open and secure lift gate.
2. Pry off two clips securing lift gate shock to lift gate assembly and remove lift gate shock (Figure 10-163).

Installation

1. Install lift gate shock on lift gate assembly and secure with two clips (Figure 10-163).
2. Close lift gate.

Lift Gate Linkage Replacement

Removal

1. Pull inner lift gate handle out of the lift gate linkage cover (Figure 10-164).
2. Remove lift gate linkage cover from velcro strip on liftgate.
3. Remove two screws securing lift gate linkage assembly to lift gate and remove lift gate linkage assembly.

Installation

1. Install lift gate linkage assembly on lift gate with two screws (Figure 10-164).
2. Secure lift gate linkage cover to velcro on lift gate.
3. Press inner lift gate handle into the lift gate linkage cover.

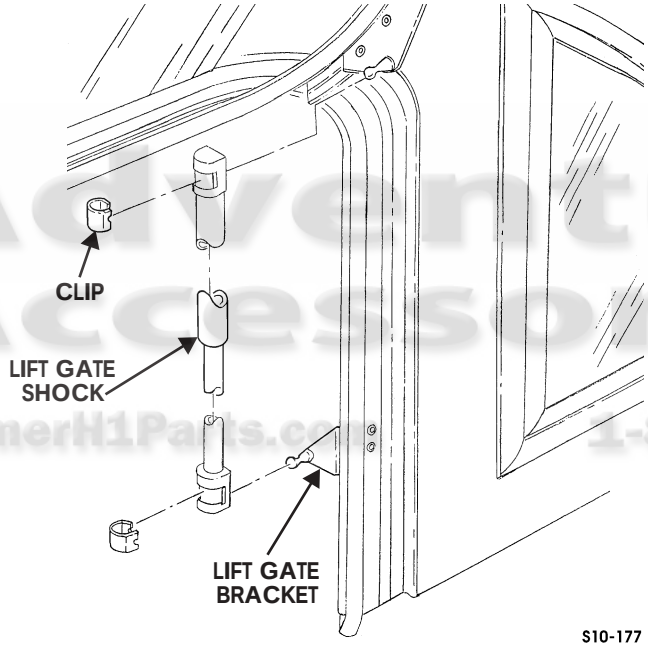


Figure 10-163: Lift Gate Shocks

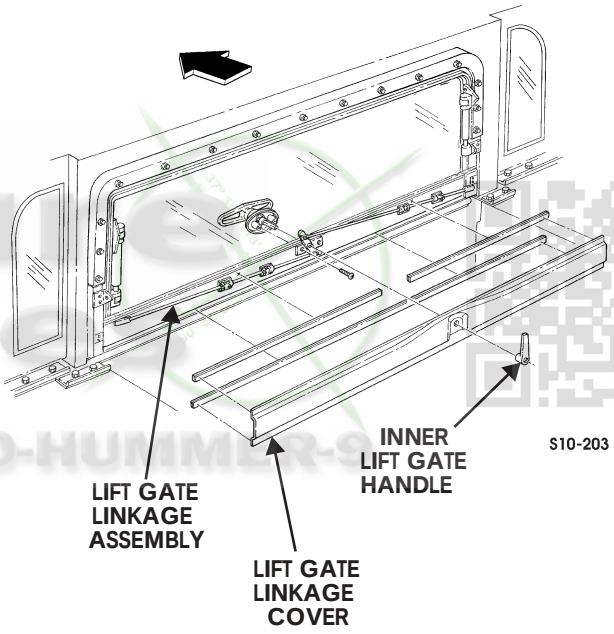


Figure 10-164: Lift Gate Linkage

REAR VERTICAL DOOR MAINTENANCE

Door Replacement

Removal

1. Remove eight screws and rear vertical door from hinge (Figure 10-165).
2. Remove eight screws and hinge from door frame.

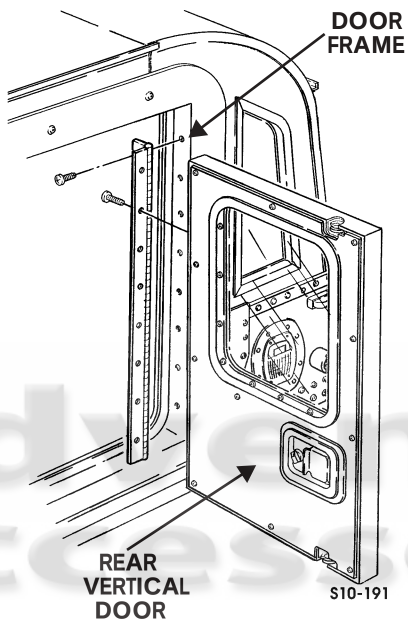


Figure 10-165: Rear Vertical Door

Installation

1. Install hinge on door frame with eight screws (Figure 10-165).
2. Install rear vertical door on hinge with eight screws.

Window Replacement

Removal

Remove eleven screws, window retainer bracket, and window from rear vertical door (Figure 10-166).

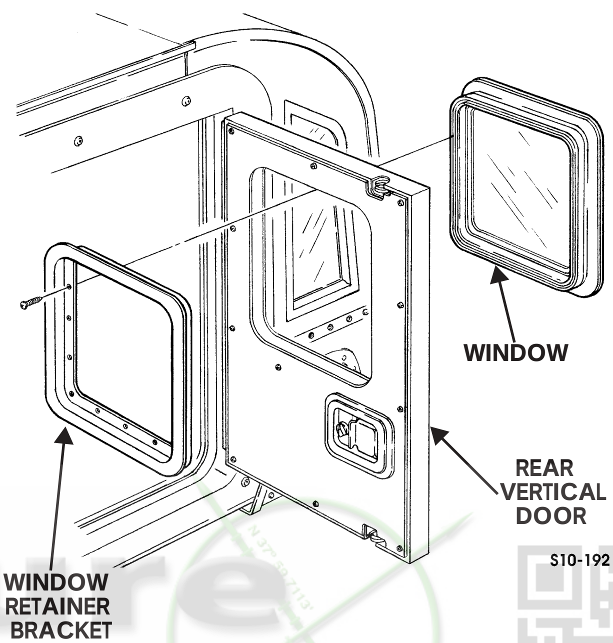


Figure 10-166: Door Window

Installation

Install window in rear vertical door with window retainer bracket and eleven screws (Figure 10-166).

Door Handle Replacement

Removal

1. Remove rear door window.
2. Remove four screws and interior door handle from door (Figure 10-167).
3. Remove twelve screws and close-out panel from door.
4. Remove two cotter pins, washers, and latch rods from exterior door handle. Discard cotter pins.
5. Remove four spacers and exterior door handle from door.

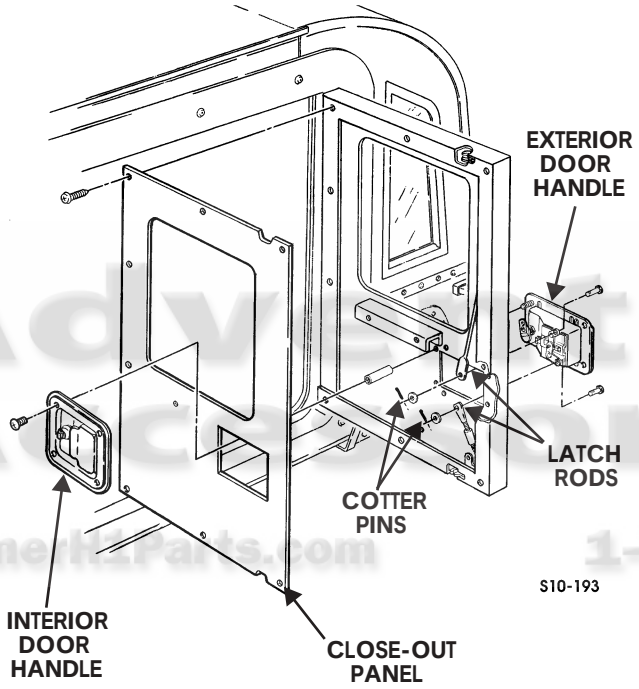


Figure 10-167: Door Handle

Installation

1. Install exterior door handle on door with four spacers (Figure 10-167).
2. Install latch rods on exterior door handle with two washers and cotter pins.
3. Install close-out panel on door with twelve screws.
4. Install interior door handle on door with four screws.
5. Install rear door window.

Door Latch and Latch Rod Replacement

Removal

1. Remove rear door window.
2. Remove four screws and interior door handle from door (Figure 10-168).
3. Remove twelve screws and close-out panel from door.
4. Remove cotter pin, washer, and latch rod from exterior door handle. Discard cotter pin.
5. Remove locknut, washer, capscrew, and latch rod from lower door latch. Discard locknut.
6. Remove three nuts, lockwashers, screws, and lower door latch from door. Discard lockwashers.

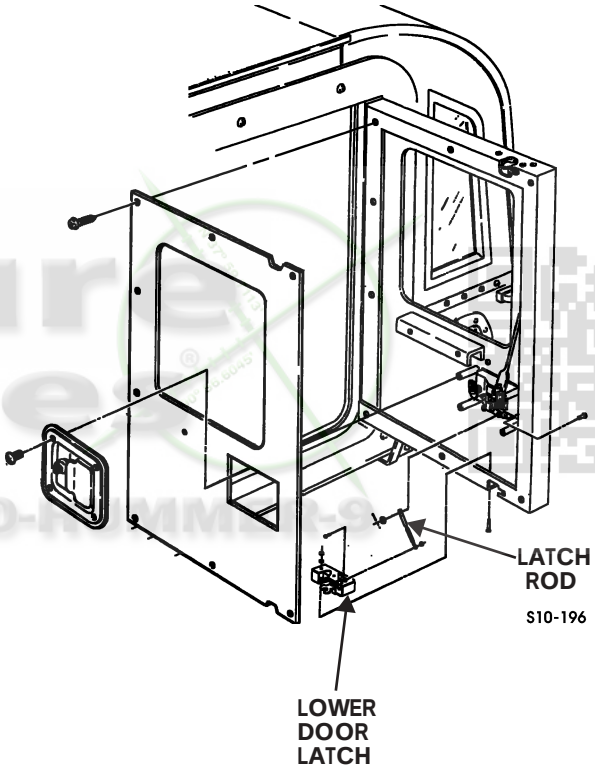


Figure 10-168: Door Latch and Latch Rod

Installation

1. Install lower door latch on door with three screws, lockwashers, and nuts (Figure 10-168).
2. Install latch rod on lower door latch with capscrew, washer, and locknut.
3. Install latch rod on exterior door handle with washer and cotter pin.
4. Install close-out panel on door with twelve screws.
5. Install interior door handle with four screws.
6. Install rear door window.

Door Stop Replacement

Removal

1. Remove rear door window.
2. Remove four screws and interior door handle from door (Figure 10-168).
3. Remove twelve screws and close-out panel from door.
4. Remove capscrew, door stop ball, and retainer from door (Figure 10-169).
5. Remove capscrew, washer, door stop socket, and retainer from right rear wheelhouse.

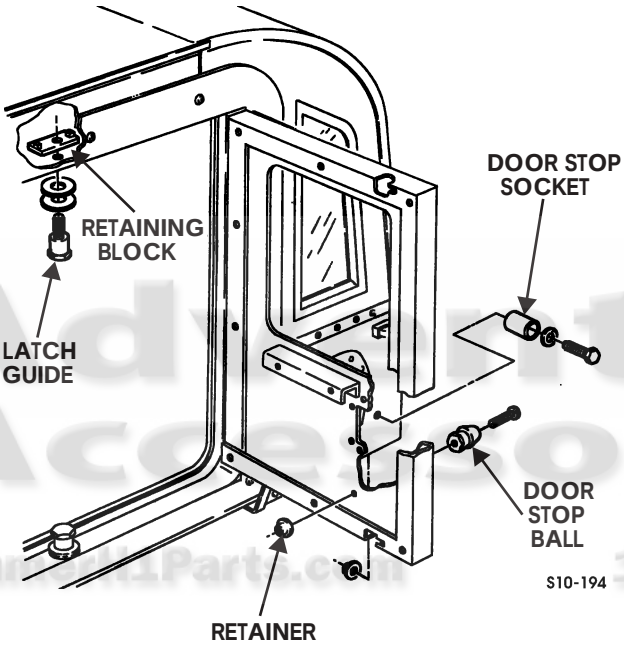


Figure 10-169: Door Stop and Latch Guide

Installation

1. Install door stop socket on right rear wheelhouse with washer, capscrew, and retainer (Figure 10-169).
2. Install door stop ball on door with capscrew and retainer.
3. Install close-out panel on door with twelve screws (Figure 10-168).
4. Install interior door handle on close-out panel with four screws.
5. Install rear door window.

Latch Guide Replacement

Removal

Remove latch guide, two washers, and retaining block from door frame (Figure 10-169).

Installation

Install latch guide on door frame with two washers and retaining block (Figure 10-169).

Adjustment

Close door and check alignment, then adjust latch guide as necessary.

Door Frame and Seal Replacement

Removal

1. Remove vertical doors from door frame.
2. Remove upper and lower latch guides.
3. Remove fourteen screws and door frame from vehicle (Figure 10-170).
4. Remove seal from door frame.

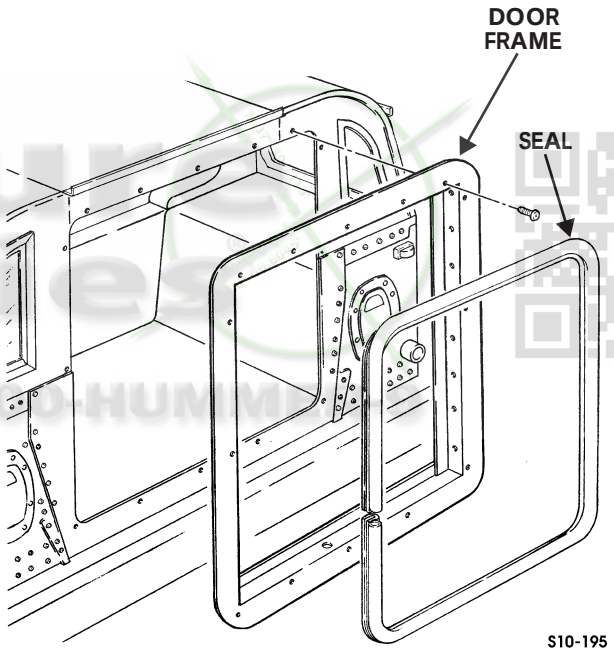


Figure 10-170: Door Frame and Seal

Installation

1. Install seal on door frame (Figure 10-170).
2. Install door frame on vehicle with fourteen screws.
3. Install upper and lower latch guides.
4. Install vertical doors on door frame.

INTERIOR AND EXTERIOR LIGHTING REPLACEMENT

Service Headlight Assembly Replacement

Removal

NOTE: To remove headlight only, perform steps 1 through 3. To remove the entire assembly, continue with steps 5 through 7.

1. Disconnect battery ground cable (Section 12).
2. Loosen three screws and remove retaining ring from headlight mount (Figure 10-171).
3. Disconnect headlight jumper harness from headlight, and remove headlight.
4. Loosen two screws securing headlight mount to headlight housing, and remove mount from housing and spring.
5. Disconnect headlight jumper harness from headlight housing and remove harness.
6. Disconnect three leads from back of housing.
7. Remove three nuts, lockwashers, washers, and housing from hood. Discard lockwashers.

Installation

NOTE: To install headlight only, perform steps 5 and 6. To install entire assembly, perform all steps.

1. Connect three leads to back of housing (Figure 10-171).
2. Install headlight housing on hood with three washers, lockwashers, and nuts.
3. Install headlight mount on spring and housing, and tighten two screws.
4. Connect headlight jumper harness to headlight housing.
5. Connect headlight to jumper harness and install on headlight assembly with retaining ring. Tighten three screws.
6. Connect battery ground cable (Section 12).
7. Check headlight for proper operation.

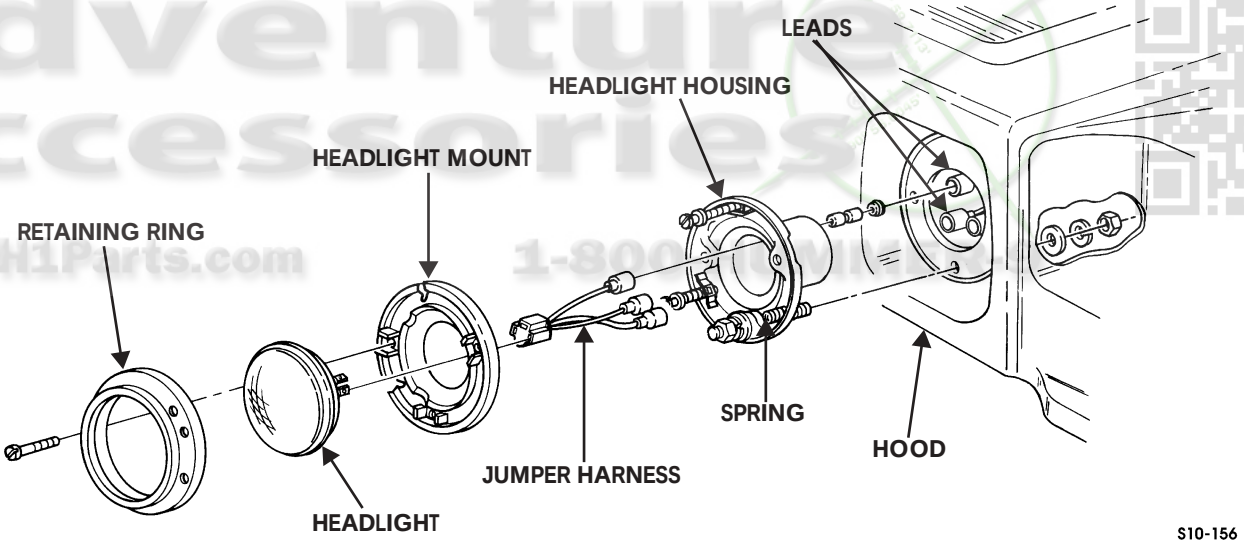


Figure 10-171: Headlight Assembly

Side Marker Light Lens and Lamp Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove two screws, door, lens, and lamp from light body (Figure 10-172).

Installation

1. Install lamp, lens, and door on light body with two screws (Figure 10-172).
2. Connect battery ground cable (Section 12).
3. Ensure side marker light operates properly.

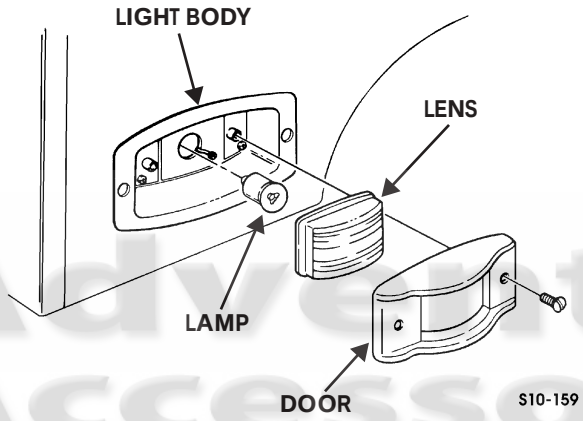


Figure 10-172: Side Marker Light Assembly

Identification Light Replacement

NOTE: All identification lights are replaced the same.

Removal

1. Carefully pry identification light from light bracket (Figure 10-173).
2. Disconnect light from wiring harness.

Installation

1. Connect identification light to wiring harness (Figure 10-173).
2. Install light on light bracket.

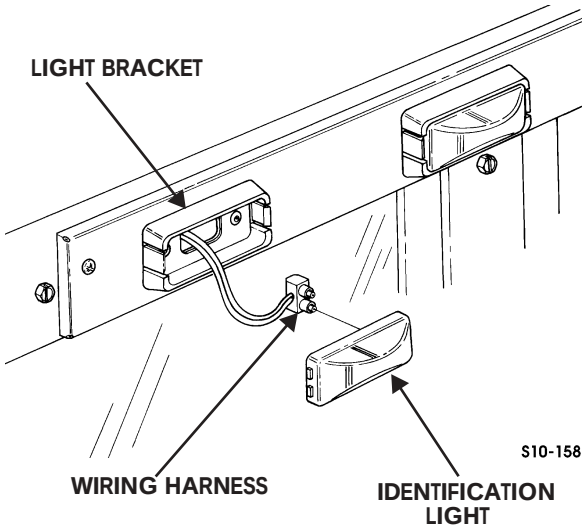


Figure 10-173: Identification Light

Side Marker Light Assembly Replacement

NOTE: Replacement of front and rear light assemblies is basically the same. This procedure covers the left front side marker.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove four screws, washers, and close-off cover from hood (Figure 10-174).
3. Disconnect harness lead from marker light lead (Figure 10-175).
4. Remove two screws, door, and lens from marker light.
5. Remove four locknuts, washers, ground lead, gasket, four screws, and marker light from hood. Discard locknuts.

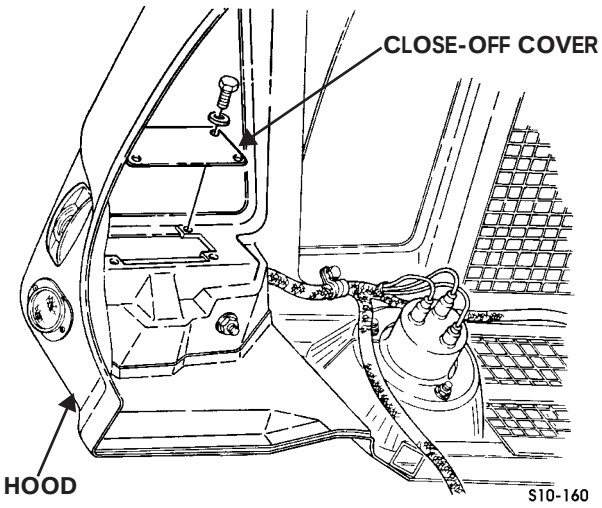


Figure 10-174: Side Marker Light Location

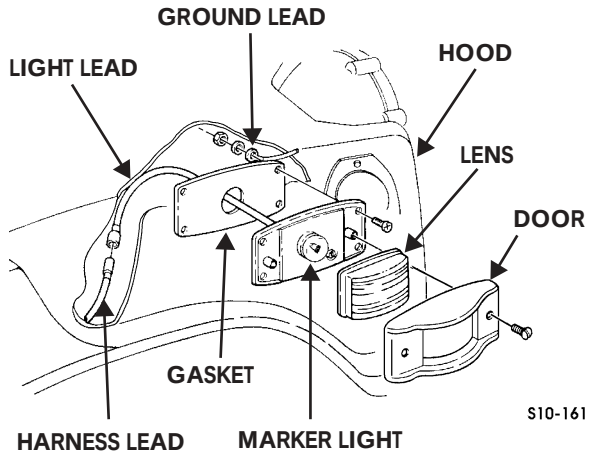


Figure 10-175: Side Marker Light Assembly

Installation

1. Install gasket, marker light, and ground lead on hood with four screws, washers, and locknuts (Figure 10-175).
2. Install lens and door on marker light with two screws.
3. Connect marker light lead to harness lead.
4. Install close-off cover on hood with four washers and screws (Figure 10-174).
5. Connect battery ground cable (Section 12).
6. Ensure side marker light operates properly.

Front Turn Signal Light Replacement

NOTE: Both front turn signal lights are replaced basically the same.

Removal

1. Disconnect battery ground cable (Section 12).

NOTE: To remove lamp only, perform steps 2 and 3.

2. Remove four screws, lens, and gasket from turn signal light (Figure 10-176).
3. Remove lamp from socket
4. Remove four screws, washers, and close-off cover from hood.
5. Disconnect two connectors from wiring harness.
6. Remove two nut and lockwasher assemblies, washers, bracket, and light from hood. Discard nut and lockwasher assemblies (Figure 10-177).
7. Remove two screws, lockwashers, and light from bracket. Discard lockwashers.

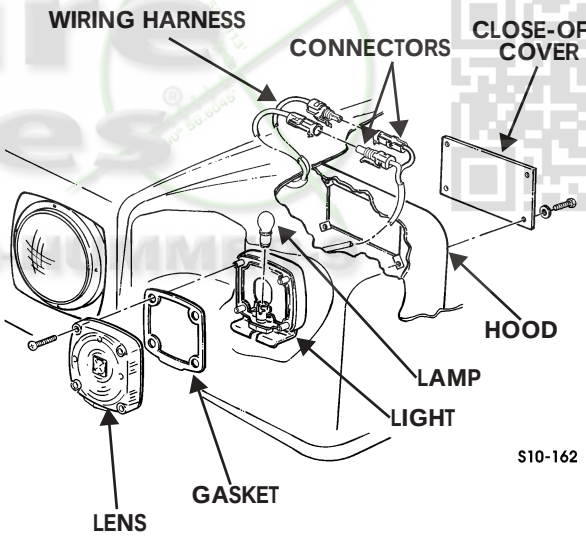


Figure 10-176: Front Turn Signal Assembly

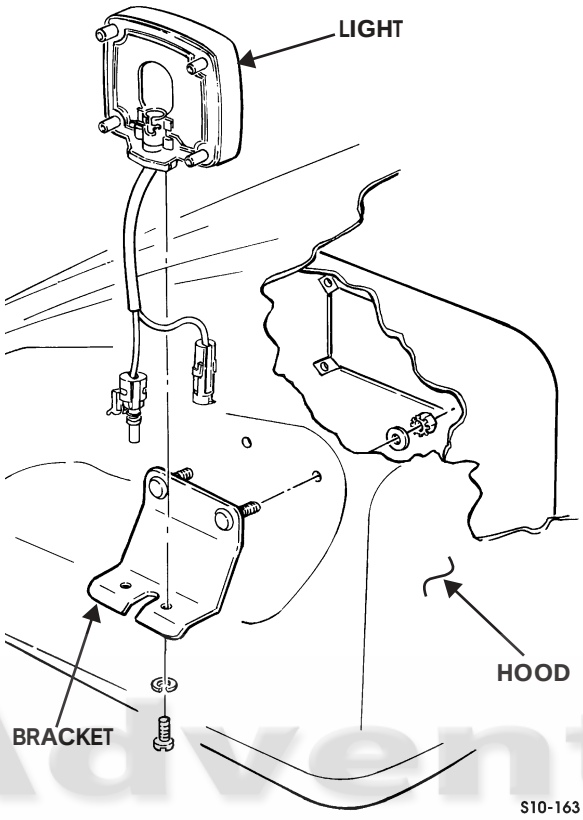


Figure 10-177: Front Turn Signal Bracket

Installation

NOTE: To install lamp only, perform steps 5 and 6.

1. Install light on bracket with two lockwashers and screws (Figure 10-177).
2. Install bracket and light on hood with two washers and nut and lockwasher assemblies.
3. Connect two connectors to wiring harness (Figure 10-176).
4. Install close-off cover on hood with four screws and washers.
5. Install lamp in socket.
6. Install gasket and lens on light with four screws.
7. Connect battery ground cable (Section 12).
8. Ensure turn signal and light work properly.

Rear Turn Signal Light Replacement

NOTE: Both rear turn signal lights are replaced the same.

Removal

1. Disconnect battery ground cable (Section 12).

NOTE: To remove lamps only, perform steps 2 and 3.

2. Remove four screws, lens, and gasket from turn signal light (Figure 10-178).

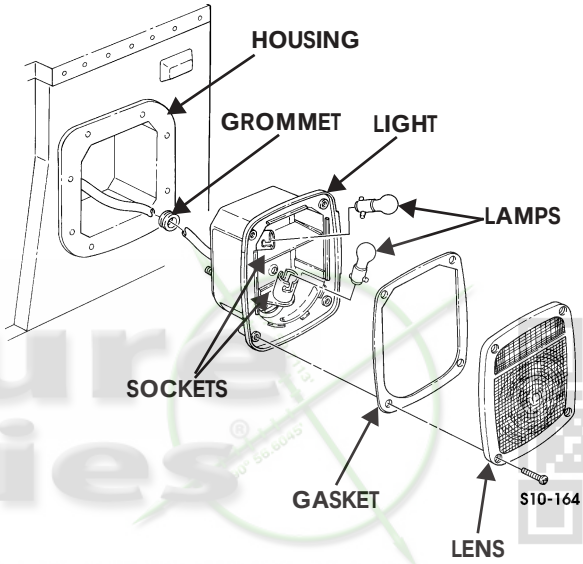


Figure 10-178: Rear Turn Signal Light Assembly

3. Remove two lamps from sockets.
4. From behind the light, remove three nuts, lockwashers, four leads, and three washers securing light to light housing. Discard lockwashers (Figures 10-178 and 10-179).
5. Remove two nuts, clamps, and capscrews securing harness to shield (Figure 10-179).
6. Remove two capscrews, lockwashers, and shield from beam. Discard lockwashers.
7. Disconnect two connectors from wiring harness.
8. Remove light and grommet from housing (Figure 10-178).

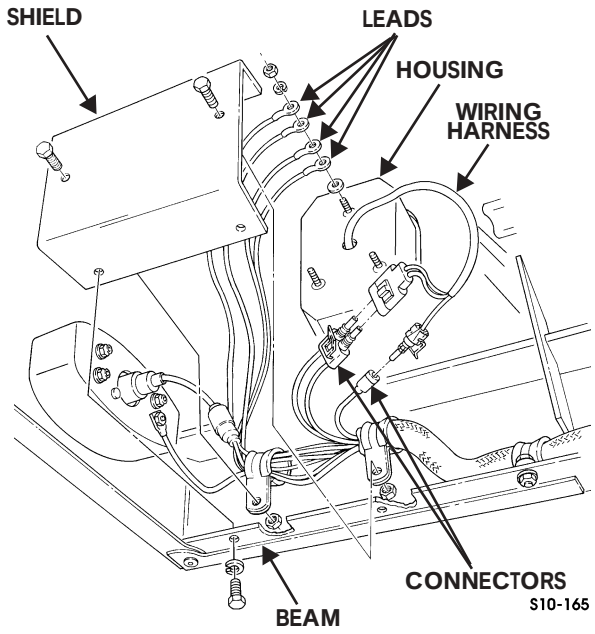


Figure 10-179: Rear Turn Signal Light Location

Installation

NOTE: To install lamps only, perform steps 6 and 7.

1. Install light and grommet in housing (Figure 10-178).
2. Connect two connectors to wiring harness (Figure 10-179).
3. Secure harness to shield with two capscrews, clamps, and nuts.
4. Install shield on beam with two lockwashers and capscrews.
5. Secure light to light housing with three washers, four leads, three lockwashers, and nuts (Figures 10-178 and 10-179).
6. Install two lamps in sockets (Figure 10-178).
7. Install gasket and lens on light with four screws.
8. Connect battery ground cable (Section 12).
9. Ensure turn signal and backup lights work properly.

Standard Domelight Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove domelight lens (Figure 10-180).
3. Remove lamp from domelight.
4. Remove two screws securing domelight to ground lead and connector.
5. Remove screw and domelight from roof bracket.

Installation

1. Secure domelight, connector, and ground lead to roof bracket with three screws (Figure 10-180).
2. Install lamp in domelight.
3. Install domelight lens.
4. Connect battery ground cable (Section 12).

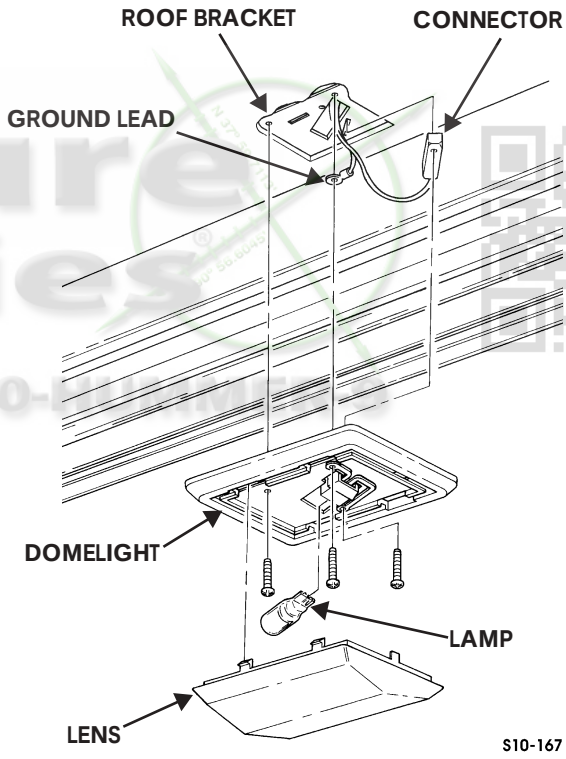


Figure 10-180: Standard Domelight

Optional Maplight Replacement

NOTE: The maplight will illuminate when the optional remote entry feature is activated.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove maplight assembly from bezel (Figure 10-181).

Installation

1. Install maplight assembly into bezel.
2. Connect battery ground cable (Section 12).

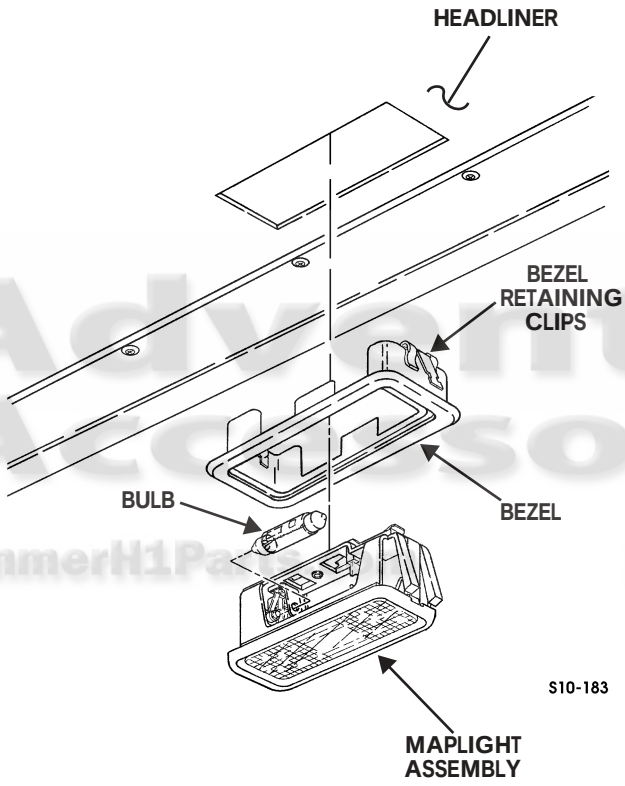


Figure 10-181: Optional Maplight

Optional Trouble Light Replacement

NOTE: Parking lights or headlights must be on in order to activate the trouble light or the underhood light.

Removal

1. Disconnect wiring harness from trouble light (Figure 10-182).
2. Remove three nut and lockwasher assemblies and trouble light from mounting bracket. Discard nut and lockwasher assemblies.

Installation

1. Install trouble light on mounting bracket with three nut and lockwasher assemblies (Figure 10-182).
2. Connect wiring harness to trouble light.

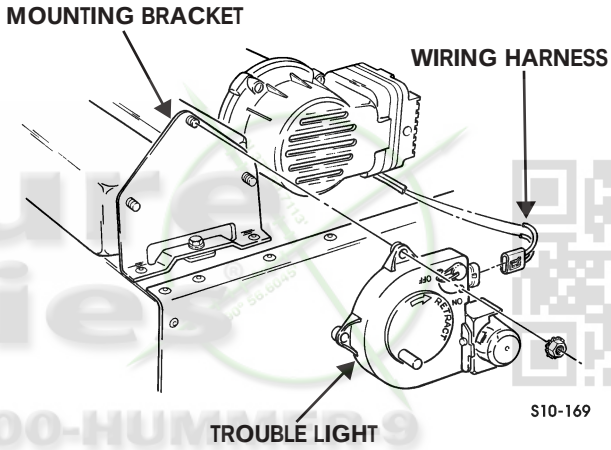


Figure 10-182: Optional Trouble Light

Underhood Light Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Disconnect two connectors from wiring harness (Figure 10-183).
3. Remove two capscrews, washers, ground lead, bracket, and light from hood.
4. Remove lamp from light.

Installation

1. Install lamp in light (Figure 10-183).
2. Install light, bracket, and ground lead on hood with two washers and capscrews.
3. Connect two connectors to wiring harness.
4. Connect battery ground cable (Section 12).

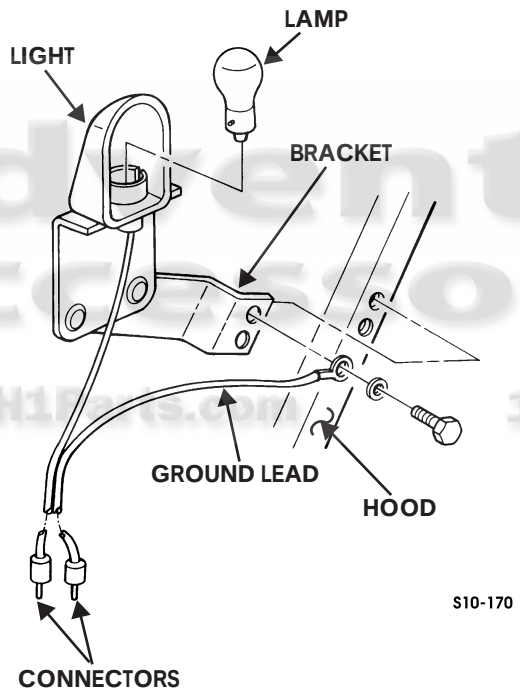


Figure 10-183: Underhood Light

Lighted Visor Mirror Replacement

Removal

1. Pull mirror assembly from visor (Figure 10-184).
2. Remove lamp.

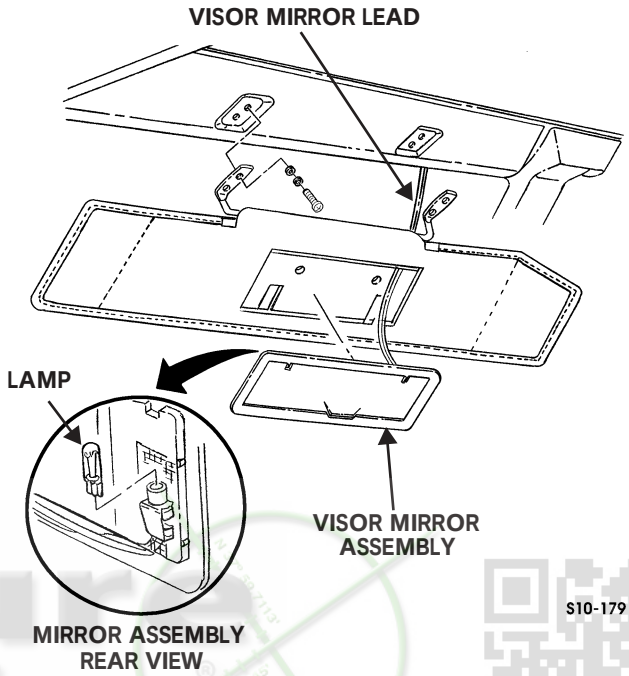


Figure 10-184: Lighted Visor Mirror

Installation

1. Install lamp (Figure 10-184).
2. Install mirror assembly by pressing it into the visor.

Driver's Courtesy Light Replacement

Removal

1. Carefully pry courtesy light from mounting bracket (Figure 10-185).
2. Disconnect light from wiring harness.

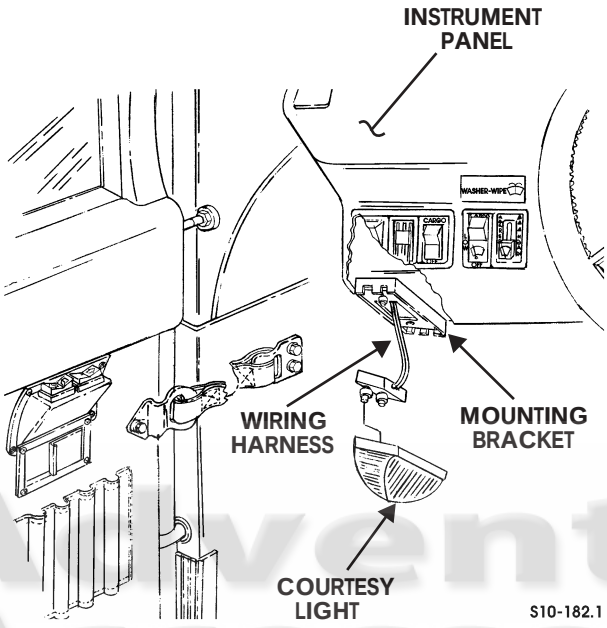


Figure 10-185: Driver's Courtesy Light

Installation

1. Connect courtesy light to wiring harness (Figure 10-185).
2. Install light in mounting bracket.

Front Passenger Courtesy Light Replacement

Removal

1. Carefully pry courtesy light from bracket (Figure 10-186).
2. Disconnect light from wiring harness.

Installation

1. Connect light to wiring harness (Figure 10-186).
2. Install the courtesy light assembly to the courtesy light mounting bracket.

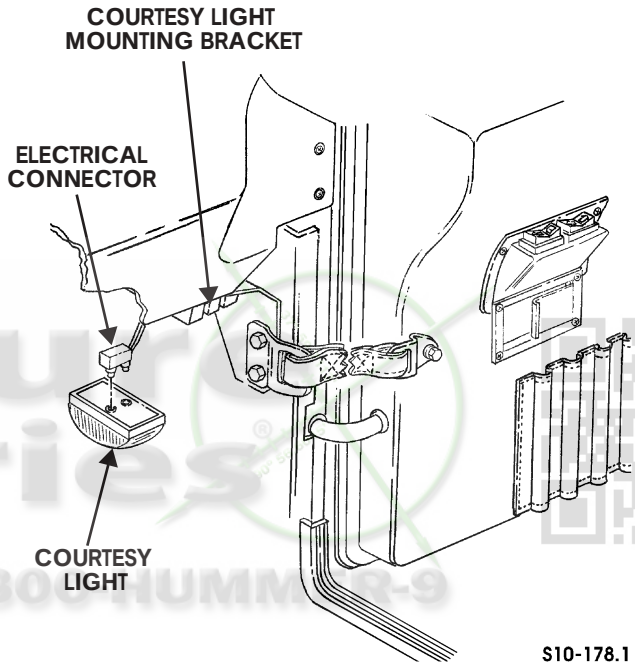


Figure 10-186: Front Passenger Courtesy Light

Rear Seat Courtesy Light Replacement

Removal

1. Carefully pry courtesy light from mounting bracket (Figure 10-187).
2. Disconnect light from electrical connector.

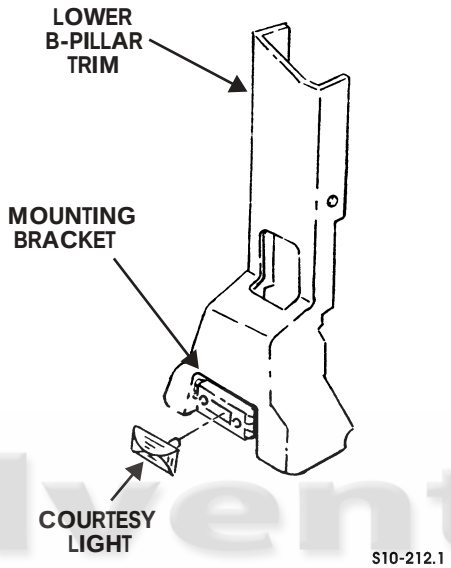


Figure 10-187: Rear Seat Courtesy Light

Installation

1. Connect courtesy light to the electrical connector (Figure 10-187).
2. Install courtesy light into bracket.

Ashtray Lamp Replacement

Removal

1. Remove front console.
2. Remove light from bracket (Figure 10-188).
3. Remove cover and lamp from light.

Installation

1. Install lamp and cover in light (Figure 10-188).
2. Install light in bracket.
3. Install front console.

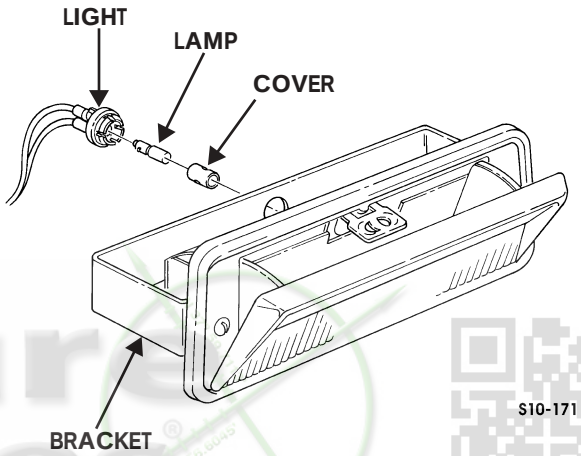


Figure 10-188: Ashtray Lamp

Daytime Running Lights (DRL) Module Replacement (Canada Only)

Removal

1. Disconnect the Daytime Running Lights (DRL) connector from the harness assembly (Figure 10-189).
2. Remove two screws, washers, nuts, and DRL module from the kick panel.

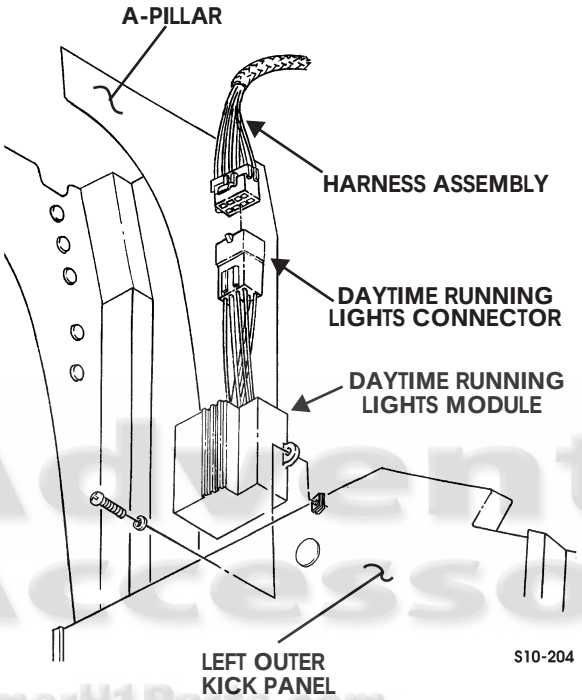


Figure 10-189: Daytime Running LIghts Module

Installation

1. Install DRL module to kick panel with two screws, washers, and nuts (Figure 10-189).
2. Connect the DRL connector to the harness assembly.

Service Headlight Electrical Connector and Grommet Replacement

Removal

1. Remove headlight and jumper harness.
2. Remove connector from grommet (Figure 10-190).
3. Remove grommet from headlight housing.

Installation

1. Install grommet in headlight housing (Figure 10-190).
2. Install connector in grommet.
3. Install jumper harness and headlight.

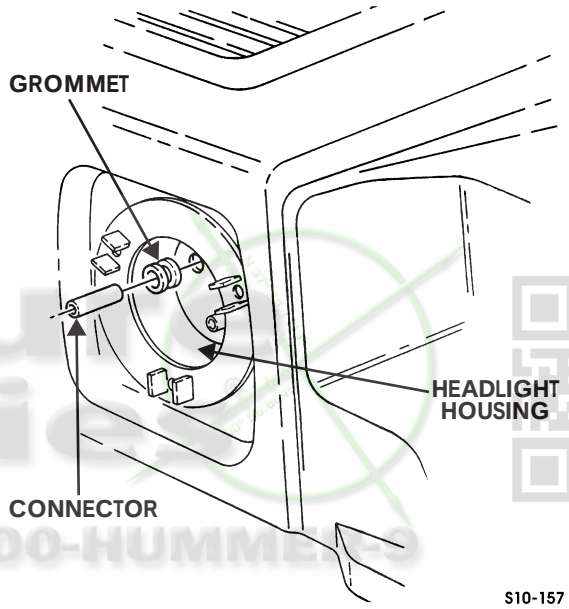


Figure 10-190: Headlight Electrical Connector

BACKUP LIGHT SWITCH REPLACEMENT

Removal

1. Remove shift controls housing (Section 5).
2. Pull neutral start switch leads, backup light switch leads, and light lead through boot and remove boot from shift controls housing (Figure 10-191).
3. Remove two screws and lockwashers securing backup light switch to housing. Discard lockwashers.
4. Remove tiedown strap securing backup light switch to neutral start switch, and remove backup light switch.

Installation

1. Secure backup light switch to neutral start switch with tiedown strap (Figure 10-191).
2. Install backup light switch on shift controls housing with two lockwashers and screws.
3. Position neutral start switch leads, backup light switch leads, and light lead through boot, and install boot on housing.
4. Install shift controls housing (Section 5).

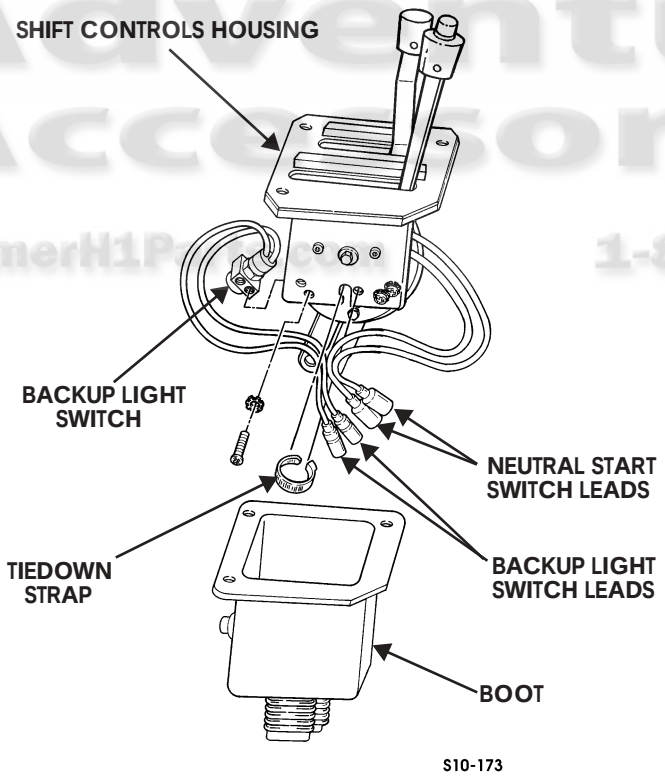


Figure 10-191: Backup Light Switch Replacement

STOPLIGHT SWITCH MAINTENANCE

Removal

1. Disconnect battery ground cable (Section 12).
2. Disconnect two harness leads from stoplight switch (Figure 10-192).
3. Remove stoplight switch from bracket.

Installation

1. Install stoplight switch into bracket (Figure 10-192).
2. Connect two harness leads to stoplight switch.
3. Connect battery ground cable (Section 12).

Adjustment

1. Push switch into bracket with brake depressed.
2. Pull brake pedal forward. Switch should ratchet outward to proper position.
3. Check function with engine running.

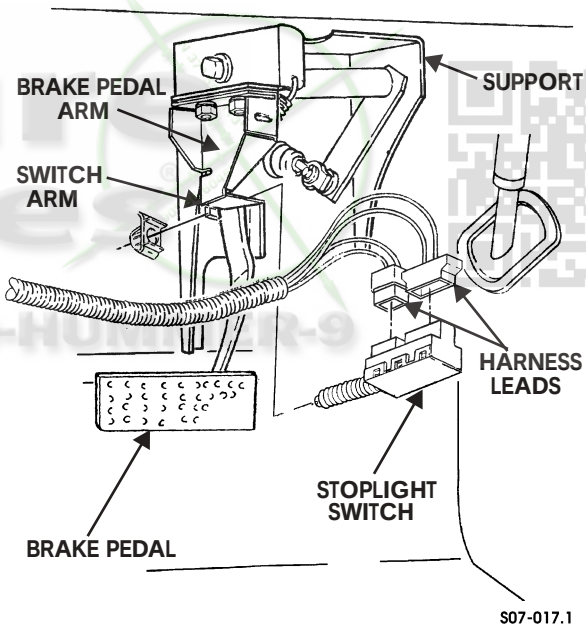


Figure 10-192: Stoplight Switch

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Section 11 Heating/Air Conditioning (HVAC)

TABLE OF CONTENTS

HVAC SYSTEM OPERATION

The heating, ventilating, air-conditioning (HVAC) system is operated by using the climate control panel located on the console (Figure 11-1). The lighted display that occupies the upper left side of the panel indicates which settings are selected. During normal operation, all the lights will not come on at the same time. Only those displaying the current settings will light. The customer can easily determine the direction of the airflow along with the amount and relative temperature of airflow.

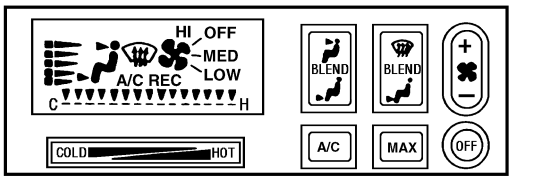


Figure 11-1: Climate Control Panel

Temperature Control Bar (Figure 11-2)

This bar is used to select the temperature of the air flowing into the passenger area of the vehicle. Depress the left side of the bar (COLD) for cooler air and the right side of the bar (HOT) for warmer air. When the control bar is depressed, the temperature display arrows will light up accordingly. The illuminated arrow will indicate the selected temperature.

Figure 11-2: Temperature Control Bar

Air Flow Control Buttons (Figure 11-3)

The two blend buttons offer adjustment of airflow pattern. The button on the left side regulates air flowing through the instrument panel ducts and the floor ducts. Press the top of the button to receive airflow from the instrument panel vents and the bottom of the button to open the floor outlet. The amount of blending is shown on the display by an arrow moving between the figure's feet (floor airflow) and head (vent airflow).

Figure 11-3: Air Flow Control Buttons

The blend button on the right side regulates airflow to the windshield. Press the top of the button to direct air through the windshield defroster outlets only. Press the bottom of the button to divide air flow between defroster outlets and the floor air ducts. To blend between positions press the side of the button showing the area where more air flow is desired. The system will automatically blend toward the position chosen. To stop the system between positions, just press the same side of the button again.

Fan Control Button (Figure 11-4)

The fan control button regulates air flow velocity. Press the top of the button to increase the flow and the bottom of the button to decrease the air flow. The display will indicate HI, MED HI, MED LOW, or LOW fan speed.

Figure 11-4: Fan Control Button

OFF Button (Figure 11-5)

Press this button to turn off the heating/air conditioning system. This will erase any mode of operation from the system's memory. Pressing the OFF button does not close the air ducts, and outside fresh air will still flow through the outlets when the vehicle is moving forward.

If the vehicle is shut off while the HVAC system is on, the last setting selected will remain in the system memory. The exception is the MAX (recirculation mode), which will not be retained.

Figure 11-5: Off Button

MAX Button (Figure 11-6)

WARNING: Do not use the MAX button when attempting to defrost or defog the windshield. Using this button during humid or cold weather for long periods of time can have the opposite effect, and fog the windows.

Depressing this button allows for recirculation of interior air only. At all other times, the system uses outside fresh air. MAX should only be used when the outside air contains smoke, odors, or high humidity. When the air conditioning is on, use MAX to get maximum cooling.

Figure 11-6: MAX Button

A/C Control Button (Figure 11-7)

Press this button to turn air-conditioning ON or OFF. The A/C will illuminate on the display panel, and the fan will automati-

cally be set on LOW. Use the other controls to regulate temperature and direction of air flow. The display will indicate each setting chosen.

The air-conditioning compressor automatically comes on each time the defrost mode is selected. This will help remove humidity from the air.

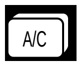


Figure 11-7: A/C Button

Window Fogging

In mild, but rainy or humid weather, windows will fog on the inside. To clear the fog off all windows, turn on the air-conditioning. Adjust the temperature and fan control to maintain comfort. Press the defroster symbol on the blend button to quickly remove windshield fogging.

System Features

A low refrigerant charge detection feature shuts the air-conditioning system down and gives a warning when the system needs service. When a problem is detected, the A/C light will flash for about 2 minutes, and then turn off. It will flash every time the vehicle is started until the service is performed.

Seasonal Operation

Summer Operation

Air-conditioned vehicles must be protected with a high-quality antifreeze coolant during summer to provide proper corrosion protection and to raise the boiling point of the coolant for protection against overheating. A 50% concentration is recommended.

Winter Operation

If the air-conditioning is operated during the winter months, the air intake must be free of ice, slush, snow, or other obstructions.

HVAC SYSTEM TROUBLESHOOTING

The HUMMER heating, ventilating, and air-conditioning system operates the same as other motor vehicles with R-134a refrigerant systems. While this system provides a high degree of heating and cooling flexibility, AM General Corporation recognizes the need to provide a troubleshooting guide to help dealer service technicians correct minor HVAC problems.

Some of the specific features of the system are:

- R-134a refrigerant
- Harrison HD 6 compressor, with serpentine belt drive
- Evaporator core temperature-controlled expansion valve
- Electrically-controlled water valve
- 4-speed blower
- High efficiency tube and fin condenser
- Electrically-operated mode control doors
- Electronic control panel
- PAG oil

System troubleshooting can be divided into two areas: improper airflow or improper air temperature. Improper airflow is a lack of proper air outlet velocity, air exiting from improper outlet, or no airflow at all. Improper air temperature is air that is too warm or too cold when compared to the temperature and mode settings on the control panel.

Troubleshooting For Improper Air Flow

No Air Flow at All

Check fuses. If the control panel does not light up, or the blower does not seem to be running, check fuses 2C, 2F, 6C, 7D, and 7F.

Air Does Not Flow Out of Correct Duct When Changing Modes

Remove crash pad and check operation of mode control motor and linkage while changing modes. Look for binding or disconnected air duct hoses. If all appears normal, the linkage arm on the control motor may be improperly adjusted.

If this is the case, loosen the bolt connecting the linkage arm to the control motor, set control panel to defrost mode, and manually rotate linkage arms until the mode doors are set to full defrost mode and retighten the bolt.

Air Flow Seems Weak at Outlets

If you have an airflow meter and proper adapters, use it to check the flow at all duct outlets. If a meter is not available, the following numbers will help determine relative airflow between ducts. Set the control panel to the mode being checked: e.g., set in A/C mode to check A/C ducts; set in heater mode to check heater ducts, etc. The engine should be idling and the blower(s) set to the HI position.

If the airflow appears significantly impeded at any outlet, remove the console and check for improperly operating diverter assembly. Inspect air intake elbow located in air intake housing for improper positioning. Ensure elbow does not restrict airflow into evaporator coil assembly.

A/C CHARGE AND AIR FLOW SIGN-OFF SHEET

1) A/C Charge Tested By _____ Date _____ Charge & Leak Test _____

Heat-A/C Air Flow Test Blower Adapters = (5)

	Mode	Minimum Air Flow	Actual Reading	Accept	Reject	Repair
1. Driver's Side Defrost Adapters (1 & 2)	Defrost Mode	434				
2. Driver's Side Window Vent Adapter (3)	Defrost Mode	150				
3. Top Front Driver's Side Vent (Console) Adapter (2)	Face Mode	422				
4. Bottom Front Driver's Side Vent (Console) Adapter (2)	Face Mode	195				
5. Driver's Side Foot Vent Adapter (4)	Floor Mode	509				
6. Driver's Side Frt. Vent (Aux. Unit) Adapter (2)	Aux. Fan	250				
7. Driver's Side Rear Vent (Aux. Unit) Adapter (2)	Aux. Fan	800				
8. Driver's Side Knee Vent	Face Mode	75				
9. Passenger Side Rear Vent (Aux. Unit) Adapter (2)	Aux. Fan	1100				
10. Pass. Side Defrost Adapters (1 & 2)	Defrost Mode	369				
11. Pass. Side Window Vent Adapter (3)	Defrost Mode	150				
12. Pass. Side Foot Vent Adapter (5)	Floor Mode	338				
13. Pass. Side Vent (Front Console) Adapter (2)	Face Mode	493				

Meets Minimum Air Flow Requirement _____ Temperature A/C _____

24 Degrees minimum between input & output temperatures All readings are in feet per minute (FPM)

Recheck of Repairs OK _____

Troubleshooting For Improper Air Temperature

1. Air does not seem warm enough in heat mode. Check comfort level.
2. Check engine temperature. Normal engine operating temperature should be between 180°-240° Fahrenheit (82°-116° Celsius).
3. Check heater air temperature at outlets. Air temperature should be approximately 40° less than radiator coolant temperature. However, this figure varies considerably depending on ambient temperature.
4. Remove plastic cover from water valve, and check to ensure that water valve is completely open when control panel is set to full hot position.
5. Check heater hose temperature by feeling the hoses. Both hoses should be about the same temperature (hot) with water valve open. If one or both hoses feel cold, there is a blockage in the heater water circuit, low coolant, or a water pump failure.
6. Check temperature control door on the heater unit for proper operation. This can be accomplished by watching the linkage on the temperature control motor (on main unit) while changing the control panel from cold to hot position.

Air Temperature Too Warm in A/C Mode

Front passenger A/C duct temperature should range between 30° to 40° lower than the ambient temperature measured at the air intake of the unit. If this is not the case, check the following items:

1. Check water valve and temperature control (blend) door for proper operation. Water valve should be fully closed when control is set to cold position.
2. Check to ensure that compressor is operating. If compressor is not running when control panel is set to A/C position, disconnect switch connector from the body harness lead and the pressure switch lead and use a jumper wire between the two pins on the connector (Figure 11-8). If compressor begins operating, there is a low refrigerant charge, a defective ambient temperature switch or pressure switch. If the compressor does not operate, check fuse 2C, related wiring and connectors, and A/C relay.

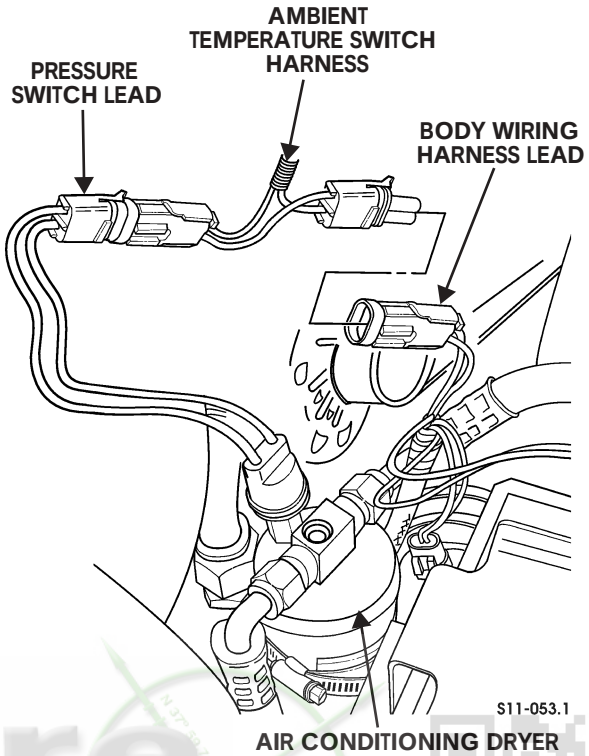


Figure 11-8: Ambient Temperature Switch

3. If compressor operates and duct temperature is high, connect a set of gauges to the high and low sides of the system and check system pressures with the engine idling, A/C on, and blower on high. The average pressures for a given ambient temperature are provided below:

NOTE: Pressures are averages only and may vary depending on evaporator air flow, engine cooling fan engagement, sun load, etc.

Ambient Temp.		Low Side Pressure		High Side Pressure	
°F	°C	(psig)	(kPa)	(psig)	(kPa)
70	21	18	124	176	1214
75	24	22	152	184	1269
80	27	28	193	197	1358
85	29	31	214	210	1448
90	32	33	228	220	1517
95	35	35	241	233	1607
100	38	40	276	249	1717

4. A low side pressure that is too high, accompanied by a high side pressure that is too high, usually indicates an overcharge of the system. Reclaim a portion of the refrigerant. If the pressures normalize, the system was overcharged. A blockage in the refrigerant system, or a faulty expansion valve may also cause this condition.
5. If both the low side and high side pressures are too low, this usually indicates an undercharged system. Other causes are a loose compressor drive belt, inoperative blower fan, or damaged compressor valves.
6. If the low side is too low and the high side is too high, this usually indicates a blockage in the refrigerant lines, a defective expansion valve, or a defective evaporator temperature switch.

WARNING: Do not use the sight glass on the receiver dryer as an indication of system charge. The synthetic oil used with R-134a refrigerant may cause streaking in the sight glass which will resemble excess air in the system, causing a tendency to overcharge the system. If a proper charge cannot be obtained using system pressures as a guide, completely evacuate the system and recharge, using the amounts below.

System Refrigerant Capacity

Without Aux. rear A/C	1 lb. 2 oz. (.51 kg)
With Aux. rear A/C	1 lb. 9 oz. (.71 kg)

MECHANICAL TROUBLESHOOTING FOR THE HVAC SYSTEM

Preliminary Checks

Before performing any air conditioning repair, perform the following:

1. Check drivebelt for damage: i.e., burned, cracked, and proper belt tension. Replace drivebelt as necessary.
2. Check compressor for secure mounting and proper alignment. Tighten loose hardware and align as necessary.
3. Check for obvious problems before attempting to operate system. Visually check compressor, hoses (especially connections and ferrules), drivebelt, and other accessible parts of system for damage or signs of leaks. Look for patches of dirt, dust, and oil build-up. Slow refrigerant leaks usually involve compressor oil loss. This is especially applicable to clutch end of compressor.
4. Verify correct operation of the climate control system by performing the following sequence of operations (Figure 11-9):

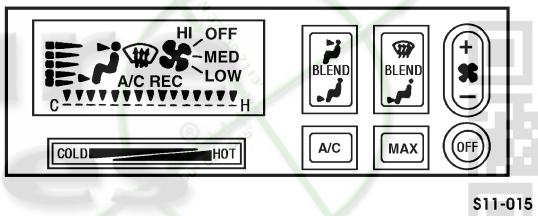


Figure 11-9: Climate Control System

   a. Press the OFF button to turn the system off and erase the mode of operation from the system memory.
   b. Run the engine until normal operating temperature is achieved, 180°-240° F (82°-116°C).
   c. Press the COLD position on the temperature control bar and release it when the arrow reaches the far left side. Press the HOT position on the temperature control bar and release it when the arrow reaches the far right side. The temperature is shown on the display by the arrow moving between C and H.
   d. Press the bottom of the right airflow button to heat the inside of the vehicle. Heated air will come out near the floor. An arrow will show at the figure's feet on the display. At this point, if the vehicle has auxiliary heat and air conditioning, press the auxiliary fan button and check for heat and air flow in the HI and LOW fan positions at the left and right air ducts.

e. Press the top of the left airflow button to adjust the airflow between the front console vents and floor ducts. Press the bottom of the button to direct air to the floor ducts. Press the top of the button to direct air through the front console ducts. To stop the system between positions, press the same end of the button again. Placing the display arrow between the figure's feet and head will equally distribute the air through the front console and floor ducts.

f. Press the top of the fan control button until the fan speed reads HI on the display for maximum airflow. Adjust the control from HI through LOW checking for a drop in airflow in each position: HI, MED HI, MED LOW, AND LOW.

g. To defrost the windshield, press the top of the right airflow button. Heated air will come out of the windshield ducts and the small side window vents. Adjust the fan control button to HI for maximum defrosting.

h. Press the bottom of the right airflow button to blend between the windshield and the floor ducts. To stop the system between positions, press the same end of the right airflow button again.

i. To cool the interior of the vehicle press the A/C button. The A/C symbol will light on the display and air will come out of the front console vents. The fan will automatically be set on LOW. Press the COLD position on the temperature control bar and release it when the arrow reaches the coldest position. Press the top of the fan control button until the fan speed reads HI. Pressing the top of the button will cause air to be directed through the floor ducts. To stop the system between positions, press the same end of the button again. Placing the display arrow between the figure's feet and head will equally distribute the air through the front console and floor ducts.

j. For maximum cooling, press the MAX button, put the fan on HI, and the temperature at the coldest setting. At this point, if the vehicle has auxiliary air conditioning, press the auxiliary fan button and check for cold air and airflow in the HI and LOW fan positions at the left and rear air ducts.

k. To check the system memory, set the display to HI FAN, and press the top of the right airflow button for defrost. Without pressing the OFF button, shut the vehicle off. Turn the vehicle back on and check the display to make sure it comes back to the same position.

5. Check blower motor and air distribution controls for proper operation.

   a. Check that blower motor delivers air at four different speeds. If not, perform electrical troubleshooting. Repair or replace blower motor, switch, or relay.

   b. Operate MAX button and check that recirculate air door opens. If not, perform electrical troubleshooting and/or check electrical actuator adjustment.

   c. Operate BLEND buttons and ensure that proper doors open and close. If not, refer to diverter installation and adjust or repair controls.

   d. Ensure defrost door opens and provides air stream from all defrost/demist louvres and ports. If not, refer to diverter installation and adjust or repair controls.

   e. Ensure that heater water control valve shuts completely off.

Leak Testing

1. Detection systems. There are several methods of leak testing, each having a use and degree of reliability and accuracy. However, due preparation, care, and diligence by the operator are the keys, in many cases, to successful leak detection.

   a. Electronic Halogen Leak Detector. This device has virtually superseded the propane/butane flame-type detector. This is probably the most sensitive detection device, when properly used. This system is very sensitive and requires continuous operator attention (Figure 11-10).

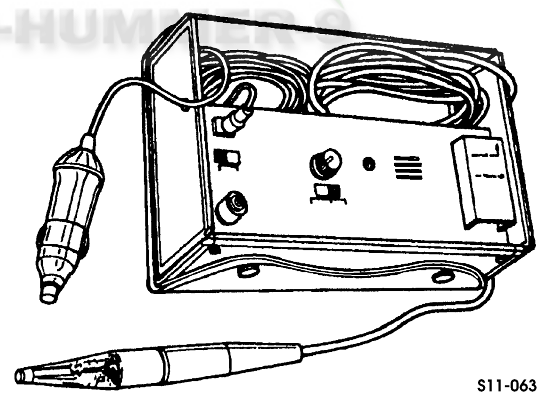


Figure 11-10: Electronic Halogen Leak Detector

   b. Soap and water. This method is quite sensitive when properly used, but does require a cleanup step. Apply a thin coat of solution to all suspected leak points, then look for bubbles.

2. Leak Detection Techniques.
   a. Look for leaks under the following circumstances (Figure 11-11):
      1. There is significant refrigerant loss in less than a year.
      2. Any component is replaced or if the pressurized system is opened.
      3. The system is not operating properly.
   b. There should be at least 30-50 psi (207-345 kPa) in a stabilized A/C system to perform reliable leak testing.
   c. A clean and draft-free environment is best for electronic systems. Remember R-134a is heavier than air. Follow up on detection points. Maintain instrument calibration.
   d. Follow system routing to ensure full coverage of the A/C system.
   e. Ensure service ports are capped following service.

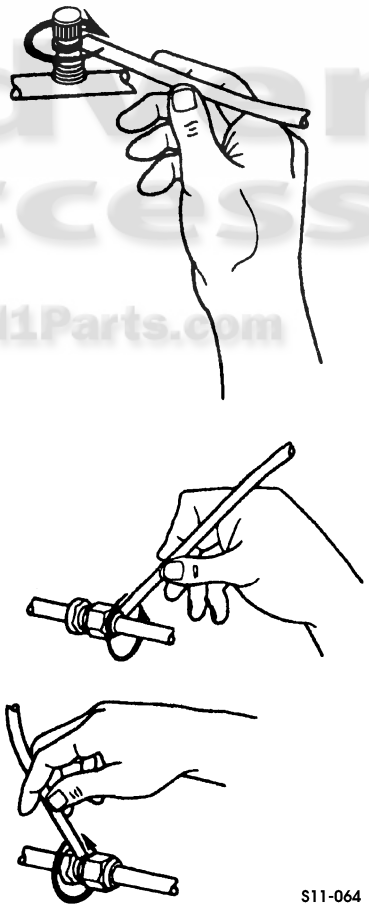


Figure 11-11: Leak Detection Techniques

3. Connect service manifold gauges to appropriate connectors on hose union at rear of compressor. The A/C system is a closed pressurized system and should always have at least 30-50 psi (207-345 kPa) at ambient 70° F (21° C) temperature. If the pressure is lower or zero, there is a leak in the system. Add a partial charge of refrigerant and perform leak test. Repair cause of leak and service A/C system.
4. Start engine and set throttle for 1200-1500 rpm. Turn A/C Switch to ON and set temperature lever for maximum COLD. Turn blower to run at HI speed. If compressor does not engage, go to malfunction 1 below.
5. Let A/C system run at maximum COLD and HI blower speed for at least five minutes to ensure A/C system is stabilized.

NOTE: Insert thermometer in A/C duct outlet in driver's bottom air outlet louver to check output air temperature. Temperature output should be between 35°-45° F (2-7° C). Adjust up or down if shop ambient temperature is not 70° F (21° C), with moderate humidity.

   a. If system operates with no noticeable noises, and temperature of output air drops 20°-30° F (-7 to -1° C) below ambient temperature, and holds for ten minutes, go to step 6.
   b. If the compressor is noisy when engaged, go to malfunction 2.
   c. If the compressor is noisy when not engaged, go to malfunction 3.
   d. If the output air is not sufficiently cool, go to malfunction 4.
   e. If the outlet air is intermittently cool, go to malfunction 5.
6. Set blower speed to LOW and check that compressor cycles ON and OFF and inlet temperature holds under 40-45° F (4-7° C) at A/C duct outlet in driver's bottom air outlet louver.

Malfunction 1 - Inoperative Compressor

1. Check for battery voltage at clutch electrical connector.
   a. If battery voltage is not present, go to A/C system electrical troubleshooting. Correct electrical problem, if present.
   b. If battery voltage is present, try to turn compressor clutch end plate to check for mechanical seizure. If not seized, check for clutch-to-pulley clearance (air gap) of 0.015-0.025 in. (0.381-0.635 mm).
2. Disconnect ambient temperature switch harness from body harness and jumper across body harness connector (Figure 11-12).

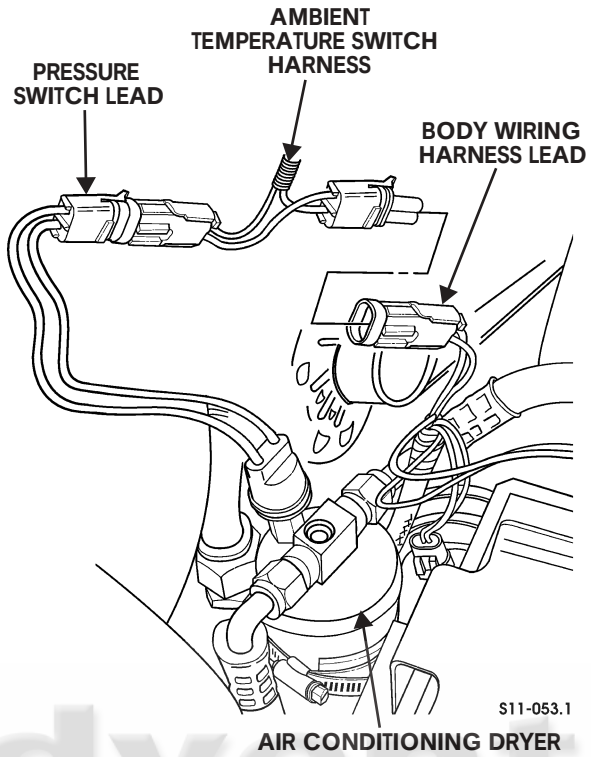


Figure 11-12: Ambient Temperature Switch

a. If compressor engages, check for low refrigerant level, and low reading on LOW SIDE and HIGH SIDE gauges. Add a partial refrigerant charge, connect low pressure switch, and retest. If A/C system operates correctly, check for leak and repair or service system.

b. If there is excessive noise and both LOW SIDE and HIGH SIDE gauges read high, there may be excessive refrigerant charge. Discharge and add correct charge. Test system operation by performing steps 4 and 5 under Preliminary Checks.

c. If clutch doesn't engage, replace clutch coil.

Malfunction 2 - Unusual Noise With Clutch Engaged

1. Disconnect belt and operate engine at idle to isolate engine noise from air-conditioner compressor noise. If noise condition stops, continue to step 2. If noise condition still exists, refer to mechanical troubleshooting.
2. Check for proper refrigerant charge. Low refrigerant charge can cause unusual noise.
3. Check clutch air gap (space between pulley and front clutch plate) with feeler gauge. Gap must be within range of 0.015-0.025 in. (0.381-0.635 mm).
4. Rotate pulley by hand and listen for bearing noise while feeling for hard spots. If noise or hard spots are excessive, replace pulley front clutch plate assembly or bearing.
5. Check refrigerant oil level. Insufficient amount of oil may cause compressor to be noisy. Restore oil to correct level. (Remove compressor, drain, and refill with correct amount of refrigerant oil.) Recharge A/C system.

Malfunction 3 - Unusual Noise With Clutch Disengaged

1. Check clutch-to-plate air gap for dragging or intermittent clutch contact. The gap should be 0.015-0.025 in. (0.381-0.635 mm). Adjust air gap, or replace clutch and pulley.
2. Check for rough or damaged pulley bearing. Replace damaged pulley bearing.

Malfunction 4 - Insufficient Cooling

1. Check compressor.
   a. Perform malfunction 1. Check to ensure compressor is operating properly.
   b. Operate A/C system for five minutes to stabilize system and observe manifold gauges for changes
2. Check for refrigerant loss.
   a. Connect manifold gauges to LOW and HIGH service connectors.
   b. Start vehicle engine and adjust speed to 1500 rpm.
   c. Set temperature lever to maximum COOL position and fan switch to HI.
   d. Run vehicle with air conditioner on for five minutes.
   e. Check LOW SIDE manifold gauge for normal to low reading and HIGH SIDE for low reading. If these conditions occur, perform leak test, repair leaks, evacuate, and recharge as necessary.

3. Check for air or moisture in system.
   a. Perform step 2a through 2d.
   b. Check LOW SIDE manifold gauge for normal to high reading. If these conditions occur, perform leak test, repair leaks, evacuate, and recharge as necessary.
4. Check expansion valve.
   a. Perform step 2a through 2d.
   b. Check HIGH SIDE of manifold gauge for high reading and LOW SIDE for low reading (possible vacuum). If discharge (evaporator) air is cool, or expansion valve is sweating or frosted, replace expansion valve.
   c. Check HIGH SIDE manifold gauge for high reading and LOW SIDE for high reading. If discharge (evaporator) air is warm, replace expansion valve.
5. Check thermostatic switch.
   a. Perform step 2a through 2d.
   b. Set blower speed to LOW and check for compressor cycling on and off. Check for operation with recirculated air. If compressor does not cycle, replace thermostat unit.
6. Check condenser.
   a. Perform steps 2a through 2d.
   b. Check LOW SIDE manifold gauge for normal or high reading and HIGH SIDE for high reading. If discharge (evaporator) air is warm, and liquid line is hot, air flow through condenser is restricted. Clean condenser exterior, if dirty. Use low pressure air to flush condenser, or replace condenser if damaged.

NOTE: If full or partial blockage occurs in liquid lines, condenser, receiver dryer, or expansion valve, frost may buildup just beyond point of restriction.

7. High side restriction.
   a. Perform steps 2a through 2d.
   b. Check LOW SIDE manifold gauge for low reading and HIGH SIDE for normal to high reading. If discharge (evaporator) air is cool and high side refrigerant lines (any place) are cold, wet, or frosted, replace liquid line, flush line, or replace receiver dryer.
8. Check for overcharged condition.
   a. Perform steps 2a through 2d.
   b. Check LOW SIDE manifold gauge for normal to high reading and HIGH SIDE gauge for high reading. If system runs continuously, compressor is noisy on start-up, and discharge (evaporator) air is warm, a partial system discharge is required. Continue to next step.
   c. Connect center hose of manifold gauge set to refrigerant recovery system.
   d. Turn engine off.
   e. Turn LOW SIDE gauge valve counterclockwise slightly to permit refrigerant to slowly escape through center hose to recovery equipment.
   f. Start engine and check for correct LOW SIDE pressure and HIGH SIDE pressure. Repeat as necessary until refrigerant level is correct and A/C system operates properly.

Malfunction 5 - Intermittent Cooling

1. Check air conditioner output for temperature variation. If air is intermittently warm and cold, perform the following:
   a. Using a thermometer, check for output temperature variations caused by air or moisture in system by performing step 3 of malfunction 4.
   b. Ensure temperature sensing probe is inserted properly in the evaporator fins near the outlet.
2. If excess oil is found in system, replace receiver dryer bottle.
   a. Perform step 7 of malfunction 4 and check for HIGH SIDE restriction. (Sweating or frosting in HIGH SIDE is a sign of restriction.) HIGH SIDE pressures will rise to high level and HI-LOW switch on receiver dryer may cut out compressor operation.
   b. Check for evaporator freeze up (LOW SIDE has low reading and may go into vacuum).

AIR CONDITIONING SYSTEM SERVICING

WARNING: Air conditioning system components are subject to high pressure refrigerant R-134a gas. Always discharge pressure and contain R-134a using approved service equipment.

Always wear eye protection around R-134a, or when servicing air conditioning system. Injury will result if R-134a comes in contact with eyes. Exercise extreme care when handling R-134a. Direct contact between R-134a and skin may cause frostbite.

Never smoke in areas where R-134a is used or stored. Injury may result.

Persons with a history of cardiac rhythm abnormalities should be made aware of potential aggravation as a result of exposure to R-134a. Failure to do so may result in injury.

Do not attempt to connect servicing equipment while engine is running. Injury to personnel or damage to equipment may result.

CAUTION: *The air conditioning refrigerant and recycling station must meet UL standards for moisture and contamination removal. Recovery systems which cannot meet these standards are not approved for warranty repairs. Reuse of moisture or particulate-contaminated refrigerant will result in premature compressor and other component failure.*

NOTE: Whenever any air conditioning system component needs replacement, the system must be discharged, and a new receiver dryer bottle installed.

Discharging System

1. Install manifold gauge set.
2. Connect center hose of manifold gauge set to a recovery system.

NOTE: When high-pressure and low-pressure gauges read zero, the discharging procedure is complete. Under no circumstances should alcohol be used in the system in an attempt to remove moisture. Damage to the system components could occur.

3. Turn low-pressure and high-pressure gauge valves counterclockwise (open), slightly, to permit refrigerant to slowly escape through center hose until gauges read zero.
4. Turn low- and high-pressure gauge valves clockwise to OFF position.
5. Measure any significant accumulation of oil in discharge bottle and record for oil charging purposes.
6. Disconnect manifold gauge set.

Evacuating the System

CAUTION: *Never attempt to evacuate A/C system if system has not been completely discharged.*

1. Connect manifold gauge set.
2. Discharge A/C system.
3. Connect vacuum pump to center hose on manifold gauge set.

NOTE: Follow service equipment manufacturer's instructions for checkout, calibration, and operation for evacuation procedures.

4. Turn vacuum pump on, and open low-pressure and high-pressure gauge valves on manifold gauge set.

NOTE: HIGH SIDE gauge should drop to zero or below. If not, a blockage in A/C system is indicated. A properly functioning vacuum system may not be able to achieve 29-30 inches of mercury (in. Hg) vacuum if the service facility is much above sea level. Deduct 1 in. Hg from maximum attainable reading for each 1000 ft elevation above sea level.

5. Evacuate unit until low pressure gauge reads 29-30 in. Hg vacuum.
6. Turn vacuum pump off and check for vacuum leaks.
7. Continue evacuation for thirty minutes after correct gauge reading of 29-30 in. Hg vacuum has been achieved.
8. Turn low-pressure and high-pressure gauge valves on manifold gauge set to closed position after evacuation is complete.
9. Turn off vacuum pump and disconnect center hose from vacuum pump.

NOTE: 29-30 inches of mercury (in. Hg) vacuum should be sustained on low pressure gauge for at least ten minutes. If not, a leak in A/C system is indicated. Identify source of leak and repair as necessary.

NOTE: Manifold gauge set can remain connected if charging A/C system will follow immediately.

10. Disconnect manifold gauge set.

Checking /Adding Refrigerant Oil

NOTE: It is not necessary to check or add oil as routine maintenance. It is necessary to add oil when the evaporator, condenser, compressor, or receiver dryer has been replaced, or there was an obvious oil leak. When a system is discharged, it is also necessary to replace any oil carried out with the refrigerant.

NOTE: All replacement compressors are shipped with 8 oz. (237 ml) of oil in the crankcase. This oil must be drained completely. Failure to do so will cause an overcharge of oil in the system and will lower cooling efficiency. An extreme overcharge condition may cause early compressor failure.

NOTE: Up to four oz. (118 ml) of oil can collect in the crankcase of the compressor. After removing the compressor, drain and measure the amount of oil. If less than one ounce (30 ml) is drained, add two ounces (59 ml) to the new compressor. If more than one ounce (30 ml) is drained, add the same amount to the new one.

1. If a major component was replaced, add clean PAG refrigerant oil as follows.
   a. Condenser –.7 oz. (21 ml).
   b. Evaporator – 3 oz. (84 ml).
   c. Receiver/Dryer – 1 oz. (30 ml).
   d. Compressor – see step 3.
   e. Any other known quantity of oil.
2. Add oil before evacuating the system. Add directly into component.
3. Check oil in compressor:
   a. Discharge A/C system.
   b. Remove compressor.
   c. Tip compressor on hose connection end and drain into a clean container. Allow to drain for ten minutes. Measure and discard oil.
   d. Replace with new oil directly into compressor rear ports. Refer to note above for quantity of oil.
   e. Plug ports.
   f. Plug or block ports and turn compressor over slowly several times.
   g. Holding compressor horizontally rotate clutch plate and drive shaft ten times. Compressor is now ready for installation.
4. Perform evacuation, recharging, and leak testing of system.

Charging the System

NOTE: If A/C system requires replacement of a major component, refrigerant oil must be added to system to compensate for loss.

NOTE: Follow manufacturer's recommended service procedures of the equipment being used.

1. Evacuate A/C system.
2. Connect refrigerant source to center hose of manifold gauge set.
3. Open refrigerant R-134a source to allow refrigerant to flow into center hose.
4. Purge center hose, low-pressure hose, and high-pressure hose as follows:
   a. Slightly loosen center hose at manifold gauge set center port until refrigerant escapes, then tighten hose.
   b. Open high-pressure and low-pressure gauge valves to allow refrigerant to flow into high-pressure and low-pressure hoses.
   c. Turn high-pressure and low-pressure gauge valves clockwise to OFF position.
   d. Purge high-pressure and low-pressure hoses at service ports of compressor.

WARNING: Make sure high-pressure gauge valve is in closed position on manifold gauge set during charging. Failure to do so will cause compressor to build pressure in refrigerant container, causing injury to personnel or damage to equipment.

5. Start engine and set engine speed to 1500 rpm.
6. Turn on A/C system and blower fans on high speed.

NOTE: Keep refrigerant container upright at all times so refrigerant enters system as a gas.

7. Open low-pressure gauge valve on manifold gauge set until system is fully charged.
8. Close low-pressure gauge valve on manifold gauge set.
9. Return engine to normal idle.
10. Remove refrigerant R-134a source from center hose of manifold gauge set.
11. Check A/C system performance.
12. Remove manifold gauge set.

COMPRESSOR REPLACEMENT

WARNING: Air conditioning system components are subject to high-pressure refrigerant R-134a gas. Always discharge pressure and contain R-134a using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

1. Discharge air conditioning system.
2. Disconnect electrical connector from compressor (Figure 11-13).
3. Remove serpentine belt from pulley.
4. Remove bolt, washer, two pressure hoses, and sealing washers.
5. Remove nut, bolt, and longitudinal compressor brace from compressor and engine.
6. Remove nut, bolt, and transverse compressor brace from compressor and engine.
7. Remove stud from support bracket and compressor.
8. Remove two bolts, washer, nut, and compressor from support bracket.

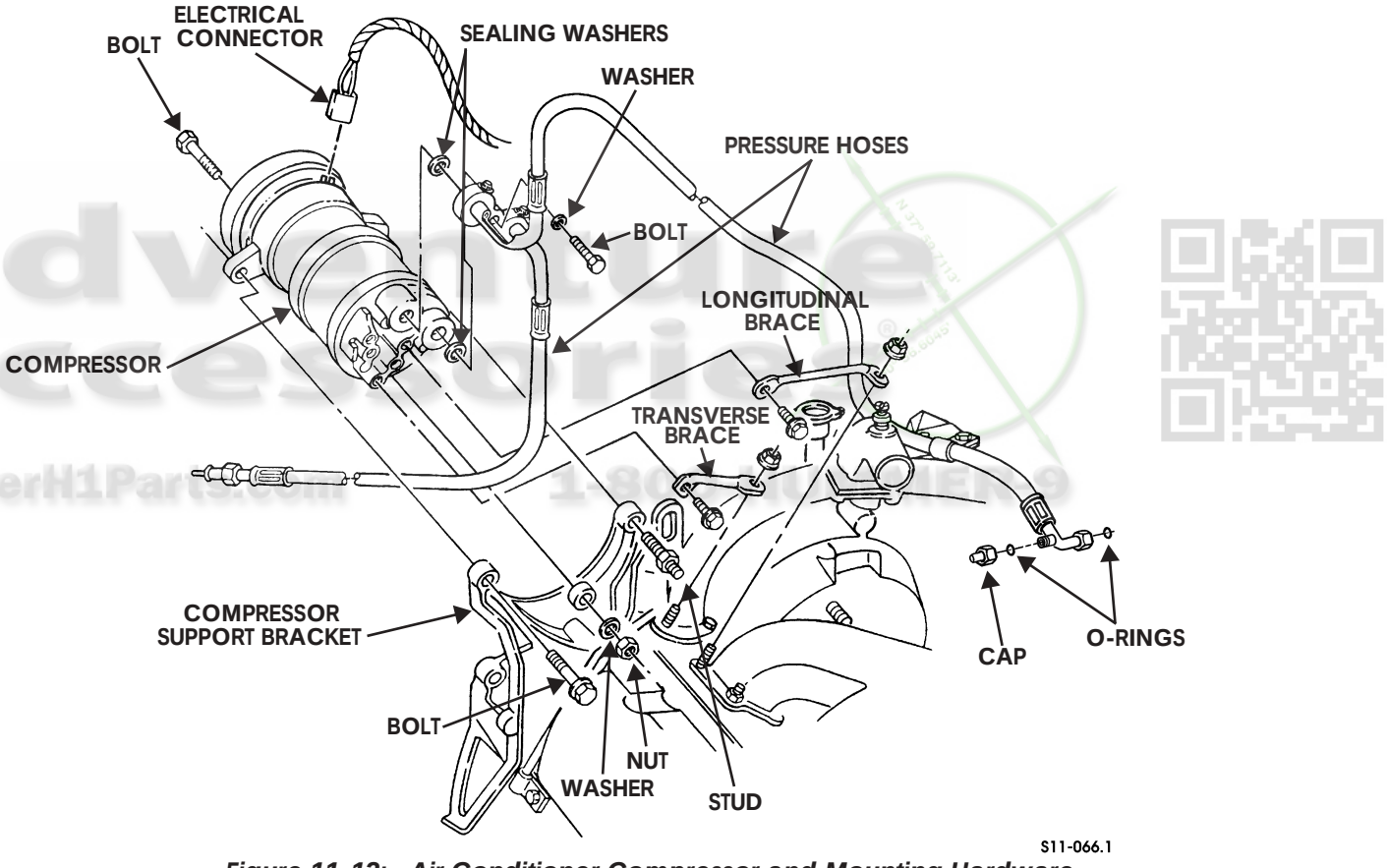


Figure 11-13: Air Conditioner Compressor and Mounting Hardware

Installation

NOTE: Sealing washers, by design, do not require lubrication. Lubricating sealing washers during replacement will increase the possibility of contamination, which may result in refrigerant leaks.

1. Install compressor on support bracket with two bolts, washers, and nuts (Figure 11-13).
2. Secure compressor to support bracket with stud.
3. Install transverse compressor brace on compressor and engine with nut and bolt.
4. Install longitudinal compressor brace on compressor and engine with nut and bolt.
5. Install two sealing washers on pressure hoses with washer and bolt.
6. Install pressure hoses on compressor with washer and bolt.
7. Evacuate and charge air conditioning system.
8. Check for leaks and perform air conditioning system service.

COMPRESSOR REPAIR

Compressor Clutch Plate and Hub Assembly

Removal

NOTE: Removal and installation of external compressor parts, and disassembly and assembly of internal parts, must be performed on a clean workbench. The work area, tools, and parts must be kept clean at all times.

1. Remove compressor.
2. Clamp the holding fixture in a vise and attach compressor to holding fixture with thumb-screws (Figure 11-14).

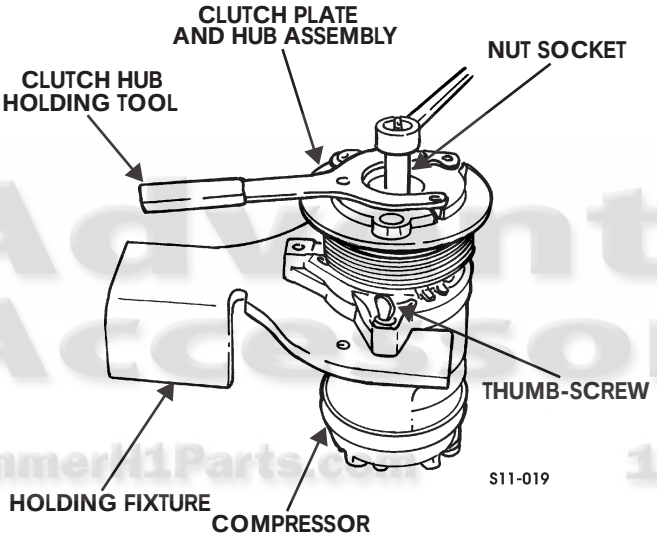


Figure 11-14: Compressor

3. Keep the clutch plate and hub assembly from turning by using the clutch hub holding tool. Remove the shaft nut using nut socket.
4. With center screw forcing tip in place to thrust against the end of the shaft, thread the hub and clutch drive plate assembly remover/installer into the hub. Hold the body of the remover with a wrench, and turn the center screw into the remover body to remove the clutch plate and hub assembly (Figure 11-15).

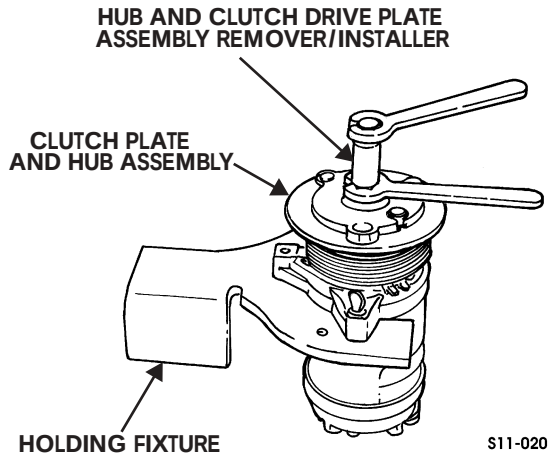


Figure 11-15: Clutch Plate and Hub Assembly

CAUTION: *Do not drive or pound on the clutch hub or shaft. Internal damage to compressor may result. The forcing tip on remover/installer center screw must be flat, or the end of the shaft/axial plate assembly will be damaged.*

5. Remove the shaft key and retain for reassembly (Figure 11-16).

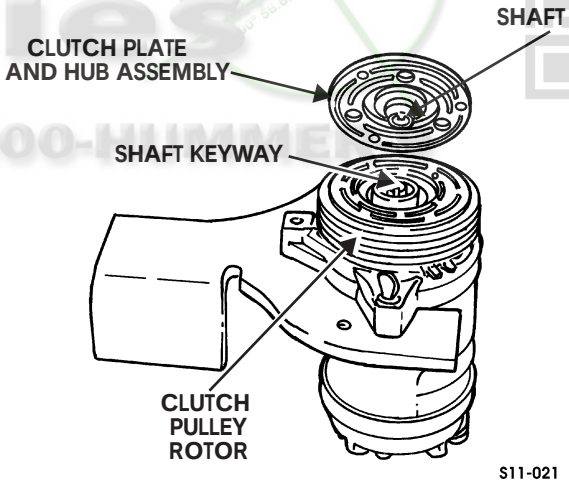


Figure 11-16: Shaft Key

Installation

1. Install the shaft key into the hub key groove. Allow the key to project approximately 1/8 in. (3.2 mm) out of the keyway. The shaft key is curved slightly to provide an interference fit in the hub key groove (Figure 11-16).
2. Be sure the frictional surface of the clutch plate and the clutch pulley rotor are clean before installing the clutch plate and hub assembly.
3. Align the shaft key with the shaft keyway, and place the clutch plate and hub assembly onto the compressor shaft.

4. Remove the forcing tip on clutch plate and hub assembly installer/remover center screw and reverse the body direction on the center screw (Figure 11-17).

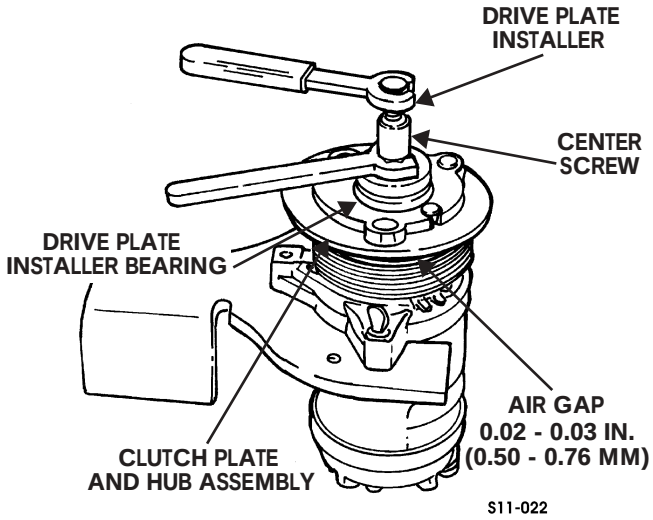


Figure 11-17: Drive Plate Installation

5. Install the clutch plate and hub assembly remover/installer.

NOTE: The body of the remover/installer should be backed off sufficiently to allow the center screw to be threaded onto the end of the compressor shaft.

6. Hold the center screw with a wrench. Tighten the hex portion of the remover/installer body to press the hub onto the shaft. Tighten the body several turns, remove the installer, and check to see that the shaft key is still in place in the keyway before installing the clutch plate and hub assembly to its final position. The air gap between frictional surfaces of the clutch plate and clutch rotor should be 0.020-0.030 in. (0.50-0.76 mm).

CAUTION: *If the center screw is threaded fully onto the end of the compressor shaft, or if the body of the installer is held and the center screw is rotated, the key will wedge and will break the clutch hub.*

7. Remove the remover/installer and check for proper positioning of the shaft key (even or slightly above the clutch hub). Install the shaft nut. Hold the clutch plate and hub assembly with clutch hub holding tool, and using nut socket, tighten the nut against the compressor shaft shoulder to 8-16 lb-ft (11-22 N•m) (Figure 11-14).
8. Spin the pulley rotor by hand to see that the rotor is not rubbing the clutch drive plate (Figure 11-16).
9. Install compressor.

COMPRESSOR CLUTCH ROTOR AND/OR BEARING REPLACEMENT

Removal

1. Remove the clutch plate and hub assembly.
2. Using snapring pliers, remove retaining ring (Figure 11-18).

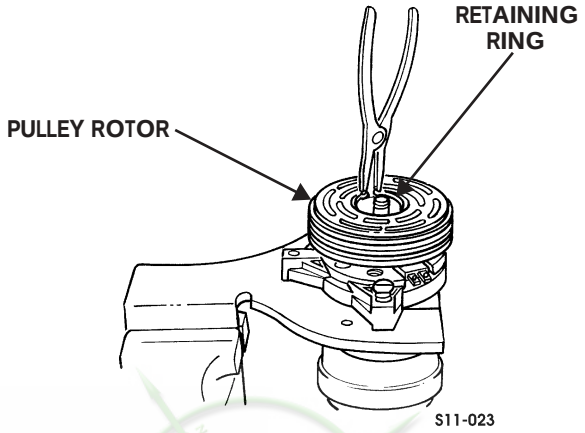


Figure 11-18: Retaining Ring

3. Install pulley rotor and bearing puller guide on the compressor, and install pulley rotor and bearing puller down into the inner circle of slots in the rotor. Turn the puller clockwise in the slots in the rotor (Figures 11-19 and 11-20).

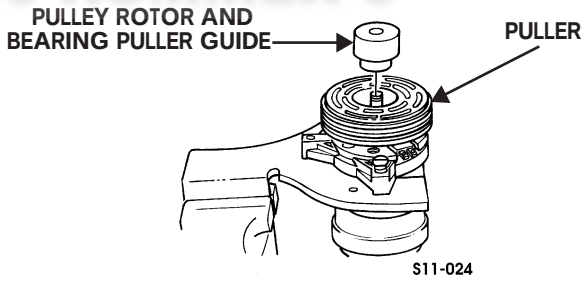


Figure 11-19: Pulley Rotor and Bearing Puller Guide

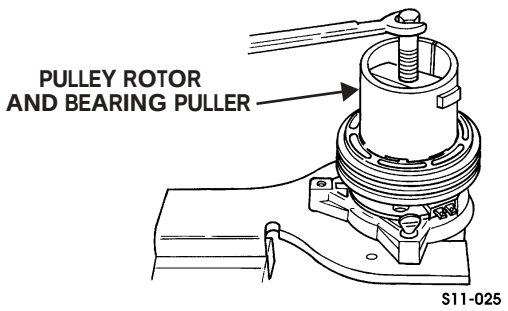


Figure 11-20: Pulley Rotor and Bearing Puller

4. Hold the puller in place and tighten the puller screw against the puller guide to remove the pulley rotor and bearing assembly.
5. To prevent damage to the pulley during bearing removal, the rotor hub must be properly supported. Remove the forcing screw from puller, and with the puller tangs still engaged in the rotor slots, invert the assembly onto a solid flat surface or blocks (Figure 11-21).

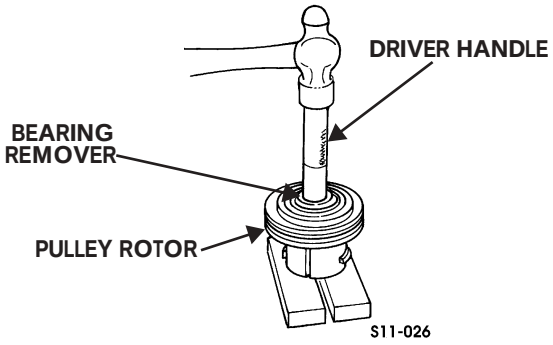


Figure 11-21: Bearing Remover

6. Drive the bearing out of the rotor hub with bearing remover and driver handle.

CAUTION: *It is not necessary to remove the staking in front of the bearing to remove the bearing, however, it will be necessary to file away the old stake metal for proper clearance for the new bearing to be installed into the rotor bore, or the bearing may be damaged.*

Installation

1. Place the pulley rotor on support block to fully support the rotor hub during bearing installation (Figure 11-21).

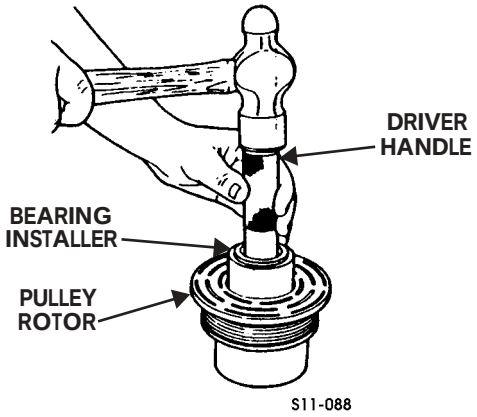


Figure 11-22: Bearing Installer

CAUTION: *Do not support the rotor by resting the pulley rim on a flat surface during the bearing installation or the rotor face will bend.*

2. Align the new bearing squarely with the hub bore, and using puller and bearing installer with driver handle, drive the bearing pulley into the hub. The installer will apply force to the outer race of the bearing if used as shown (Figure 11-22).
3. Place bearing staking guide and bearing staking pin in the hub bore. Shift the rotor and bearing assembly on the support block to give full support of the hub under the staking pin location. A heavy-duty rubber band may be used to hold the stake pin in the guide, and the stake pin should be properly positioned in the guide after each impact on the pin (Figure 11-23).

CAUTION: *Noisy bearing operation and reduced bearing life may result if outer bearing race is deformed while staking. The stake metal should not contact the outer race of the bearing. Stake three places, 120 degrees apart* (Figure 11-24).

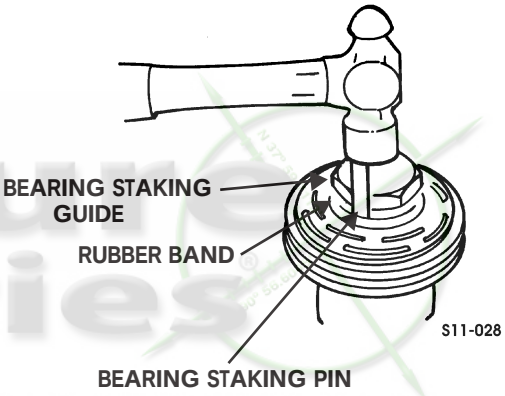


Figure 11-23: Bearing Staking Guide and Pin

4. Using care to prevent personal injury, strike the staking pin with a hammer until a metal stake, similar to the original, is formed down to, but not touching, the bearing.

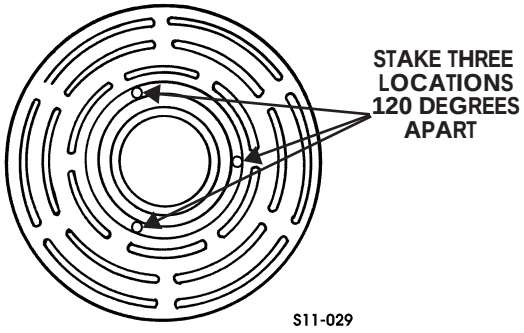


Figure 11-24: Stake Locations

5. With the compressor mounted to the holding fixture, position the rotor and bearing assembly on the front head (Figure 11-25).

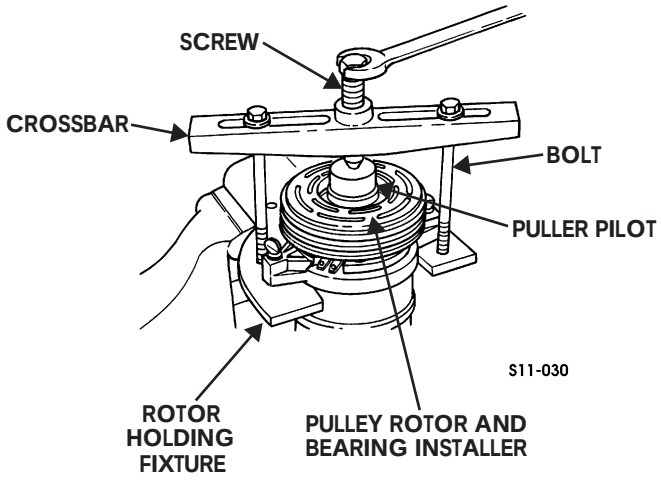


Figure 11-25: Pulley Rotor and Bearing

6. Position the pulley rotor and bearing installer, and puller pilot directly over the inner race of the bearing.
7. Position puller crossbar on the puller pilot, and assemble two through-bolts and washers through the puller bar slots, and thread them into the holding fixture. The thread of the through-bolts should engage the full thickness of the holding fixture.
8. Tighten the center screw in the puller crossbar to force the pulley rotor and bearing assembly onto the compressor. Should the pulley rotor and bearing installer slip off direct in-line contact with the inner race of the bearing, loosen the center forcing screw and realign the installer and pilot so that the installer will properly clear the compressor.
9. Using snapring pliers, install retaining ring (Figure 11-26).
10. Reinstall clutch plate and hub assembly.

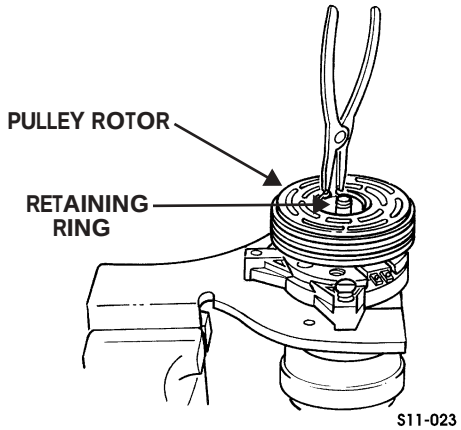


Figure 11-26: Retaining Ring

COMPRESSOR CLUTCH COIL

Removal

1. Perform steps 1 through 4 of Clutch Rotor and/or Bearings replacement procedure. Mark clutch coil terminal location on compressor.
2. Install puller pilot and puller crossbar with puller legs on compressor (Figure 11-27).
3. Tighten forcing screw against the puller pilot to remove the clutch coil.

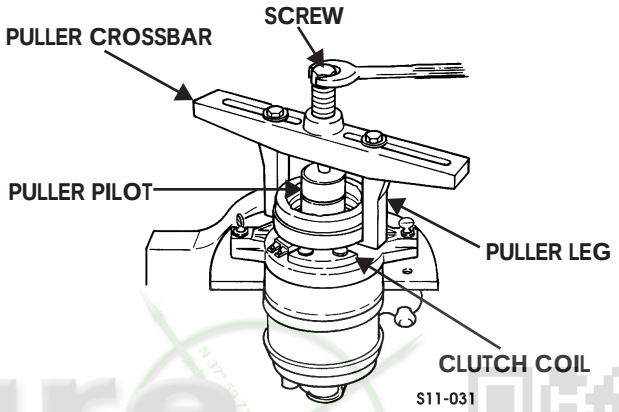


Figure 11-27: Clutch Coil

Installation

1. Place the clutch coil on compressor with the terminal positioned at the marked location (Figure 11-27).
2. Place the clutch coil installer over the internal opening of the clutch coil housing and align installer with the compressor.
3. Center the puller crossbar in the countersunk center hole of the clutch coil installer. Install the through-bolts and washers through the crossbar slots, and thread them into holding fixture. The thread of the through-bolts should engage the full thickness of the holding fixture. (Figure 11-28).

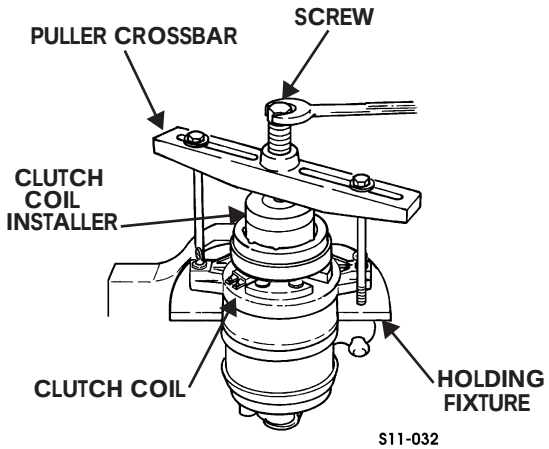


Figure 11-28: Clutch Coil Installer

4. Turn the center forcing screw of the puller crossbar to force the clutch coil into the compressor. Be sure clutch coil and installer stay aligned during installation.
5. When coil is fully seated on the compressor, use a 1/8-in. diameter drift punch and stake the front head at three places, 120 degrees apart, to ensure clutch coil remains in positioning (Figure 11-29).

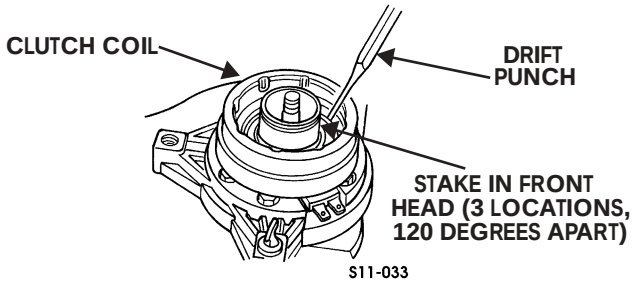


Figure 11-29: Drift Punch

NOTE: Stake size should be only one-half the area of the punch tip and approximately 0.010-0.015 in. (0.25-0.38 mm) deep.

6. Install rotor and bearing assembly and clutch plate and hub assembly.

COMPRESSOR SHAFT SEAL MAINTENANCE

Removal

1. Remove clutch plate and hub assembly.
2. Using snapring pliers, remove the shaft seal retaining ring (Figure 11-30).

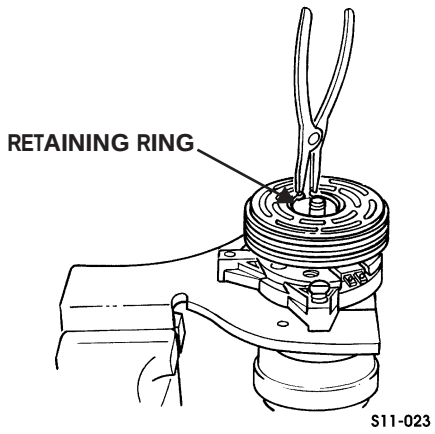


Figure 11-30: Shaft Seal Retainer Ring

CAUTION: *The handle must be hand-tightened securely. Do not use a wrench or pliers.*

NOTE: Thoroughly clean inside of compressor neck area surrounding the shaft, the exposed portion of the seal, the retainer ring groove and the shaft itself. Any dirt or foreign material getting into compressor may cause damage.

3. Fully engage the knurled tangs of seal remover/installer into recessed portion of seal by turning handle clockwise. Remove seal from the compressor with a rotary-pulling motion. Discard seal (Figure 11-31).

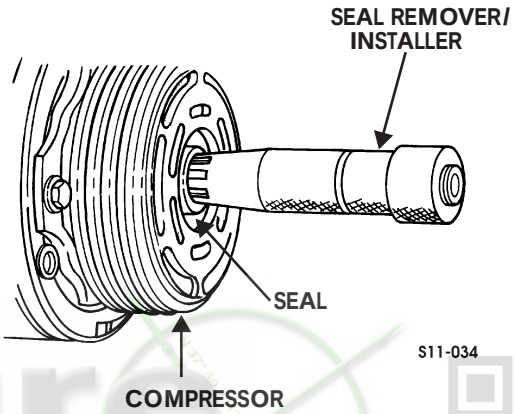


Figure 11-31: Seal Remover

4. Using O-ring remover, remove and discard seal seat O-ring from the compressor neck (Figure 11-32).

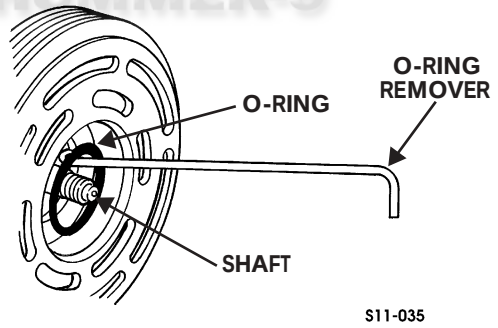


Figure 11-32: O-Ring

5. Recheck shaft and inside of the compressor neck for dirt or foreign material and be sure these areas are clean before installing new parts.

Cleaning

Thoroughly clean seal seat O-ring groove in front head.

Installation

CAUTION: *Seals should not be reused. Always use a new specification service seal. Be sure that the seal to be installed is not scratched or damaged in any way. Make sure that the seal seat and seal are free of lint and dirt that could damage the seal surface or prevent sealing.*

1. Dip new seal seat O-ring in clean PAG oil and install onto O-ring installer (Figure 11-33).

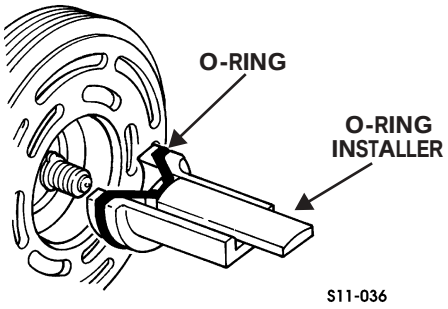


Figure 11-33: O-Ring Installer

2. Insert O-ring installer into the compressor neck until installer bottoms. Lower the moveable slide of the O-ring installer to release the O-ring into the seal seat O-ring lower groove. (The compressor neck top groove is for the shaft seal retainer ring.) Rotate the installer to seat the O-ring and remove the installer.
3. Dip new seal in clean PAG oil and assemble seal onto seal installer by turning handle clockwise. The stamped steel case side of the lip seal must be engaged with knurled tangs of installer so that the flared-out side of lip seal is facing and installed towards the compressor. Install seal protector in the seal lip and place over the compressor shaft, and push the seal in place with a rotary motion, or place the seal protector over end of compressor shaft, and slide the new seal onto the shaft with a rotary motion until it stops. Take care not to dislodge the O-ring. Be sure the seal makes good contact with the O-ring. Disengage the installer from the seal and remove the installer and the seal protector (Figure 11-34).

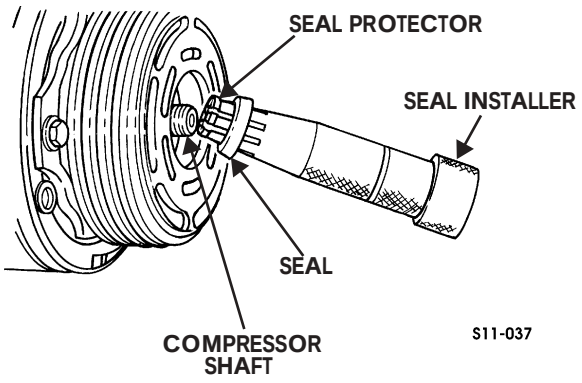


Figure 11-34: Seal Installer

CAUTION: *Handling and care of seal protector is important. If seal protector is nicked or the bottom flared, the new seal may be damaged during installation.*

4. Using snapring pliers, install new seal retaining ring with its flat side against the seal (Figure 11-35).

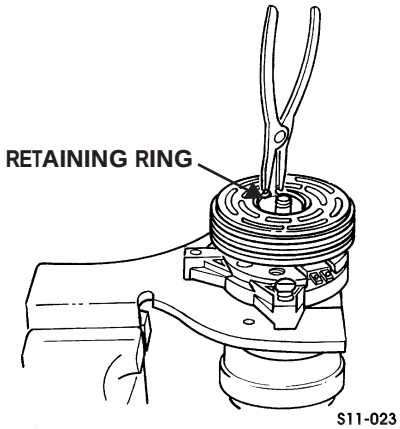


Figure 11-35: Seal Retaining Ring

5. Remove any excess oil from the shaft and inside the compressor neck.
6. Install the clutch plate and hub assembly.

CONDENSER REPLACEMENT

Removal

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

1. Discharge air conditioning system.
2. Remove power steering cooler (Section 8).

NOTE: Cover all open lines to prevent contamination.

3. Disconnect two pressure lines from condenser and remove O-rings. Discard O-rings.

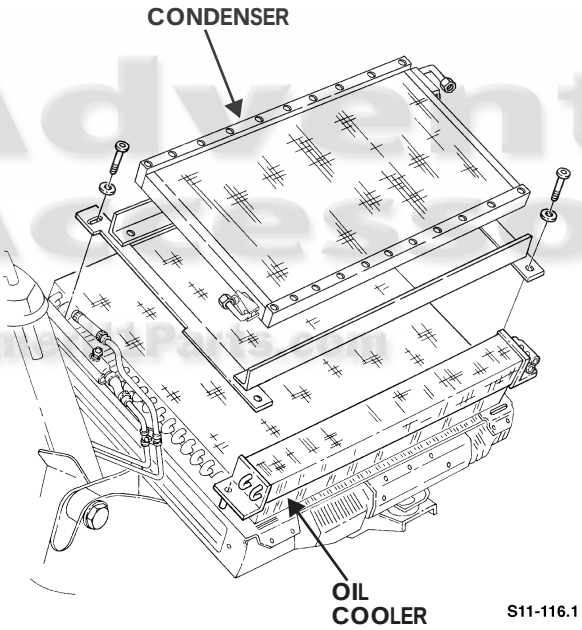


Figure 11-36: Condenser Replacement

4. Remove four screws, washers, two spacers, and condenser from oil cooler (Figure 11-36).

Installation

1. Install condenser on oil cooler with two spacers, four washers, and screws (Figure 11-36).
2. Lubricate two O-rings with refrigerant PAG oil and install on pressure lines.
3. Connect two pressure lines to condenser.
4. Install power steering cooler (Section 8).
5. Evacuate and charge air conditioning system.

EVAPORATOR COIL ASSEMBLY REPLACEMENT

NOTE: The evaporator coil assembly is a sealed unit. If the evaporator, heater core, expansion valve, fresh air door or heat door malfunctions, a complete replacement of the evaporator coil assembly is required. Serviceable components of the evaporator coil assembly include the diverter assembly, blower motor housing assembly, blower motor, blower wheel, thermostatic switch, mode door actuators, blower motor relays, air conditioning relay, drain tube, elbow, and duck bill.

Removal

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain R-134a using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

NOTE: Disconnect both negative battery terminals to prevent electrical damage.

1. Discharge air conditioning system.
2. Drain cooling system or use hose pinch pliers to pinch off heater hoses to and from engine.
3. Remove air intake bonnet.
4. Remove air cleaner assembly, air induction tube, and air intake elbow (Section 3).
5. Loosen two clamps and move surge tank out of the way.

NOTE: Cover all open hoses to prevent contamination.

6. Loosen two clamps and disconnect heater hoses from evaporator coil assembly.
7. Disconnect two pressure hoses from evaporator coil assembly and remove O-rings. Discard O-rings.
8. Remove three nuts, washers, and hose clamp from inner cowl area. Inspect for an additional nut on studs.
9. Remove drain tube, elbow, and duck bill.
10. Remove crash pad (Section 10).
11. Remove four screws securing HVAC control head to front console.
12. Remove front console.
13. Remove front passenger's seat (Section 13).
14. Remove front passenger's side kick panels and lamp assembly (Section 13).
15. Disconnect evaporator coil assembly wiring harness from vehicle body harness and HVAC control head, and mode door actuator.

16. Disconnect electric water valve from evaporator coil assembly.
17. Remove five screws from diverter assembly, and remove assembly.
18. Locate and remove two nuts, bolts, and washers from inside air intake housing securing evaporator coil assembly.
19. Separate evaporator coil assembly from air intake housing by pulling out and down on top of evaporator coil assembly.
20. Remove evaporator coil assembly from the vehicle by shifting assembly to the right. When left side mounting studs are free from the inner cowl, the unit may be lifted out.

Installation

1. Position a strip of permagum around outer circumference of evaporator coil assembly fresh-air intake opening.
2. Install evaporator coil assembly into vehicle, aligning left side mounting studs to holes in inner cowl.
3. Install three nuts, washers, and hose clamp to mounting studs in inner cowl.
4. Install two nuts, bolts, and washers in air intake housing securing evaporator coil assembly.
5. Install diverter assembly with five screws.
6. Connect electric water valve connection to evaporator coil assembly.
7. Lubricate and install an O-ring on the high-pressure hose, and install high-pressure hose on evaporator coil assembly. Tighten to 11-13 lb-ft (15-18 N•m).
8. Lubricate and install O-ring onto low pressure hose and install low pressure hose onto evaporator coil assembly. Tighten to 21-27 lb-ft (29-37 N•m).
9. Install heater hoses with clamps onto evaporator coil assembly. Remove hose pinch pliers, if used. Install drain tube, elbow, and duck bill.
10. Install surge tank, and secure with two clamps.
11. Install air cleaner assembly, air induction tube, and intake air elbow. Ensure air intake elbow does not restrict entry of fresh air into evaporator coil assembly (Section 3).
12. Connect vent line to air cleaner assembly shield.
13. Install air intake bonnet.
14. Connect evaporator coil assembly wiring harness to vehicle body harness and HVAC control head.
15. Connect and install water valve connector.
16. Install front passenger side kick panels and lamp assembly (Section 13).
17. Install HVAC control head into front console and secure with four screws.
18. Install front console (Section 10).
19. Install crash pad.
20. Perform complete air conditioning service, evacuate, charge, and test for leaks.
21. Add engine coolant as necessary.
22. Check for proper air conditioning operation.

EVAPORATOR COIL ASSEMBLY COWL INSULATION REPLACEMENT

Removal

1. Remove air intake weathercap (Section 3).
2. Remove air cleaner assembly shield.
3. Remove vent line from air cleaner assembly.
4. Remove air cleaner assembly and air induction tube.
5. Loosen and remove two clamps and move surge tank out of the way.
6. Remove drain tube.
7. Remove trim screws, as necessary, from insulation on air intake housing (Figure 11-37).
8. Remove screws and washers, as necessary, from insulation on upper cowl.
9. Remove bolts, nuts, and fasteners, as necessary, from insulation on front of cowl.
10. Remove three nuts and washers from insulation on evaporator coil assembly mounting studs.
11. Remove cowl insulation.

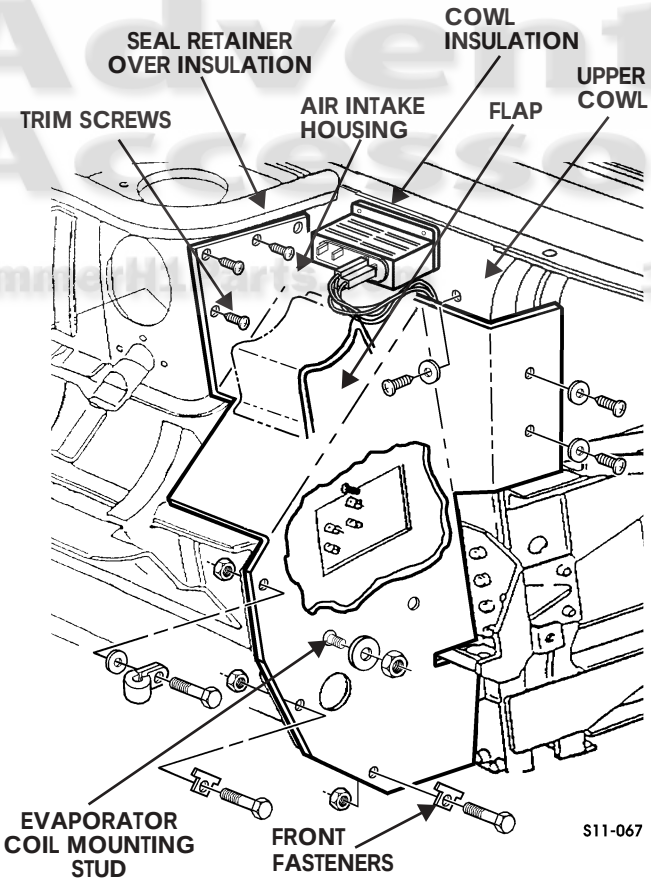


Figure 11-37: Cowl Insulation

Installation

1. Position cowl insulation so that flap side is inserted under surge tank bracket (Figure 11-37).
2. Install three nuts and washers to secure insulation to evaporator coil assembly mounting studs.
3. Install bolts, nuts, and retainers as necessary to secure insulation to front of cowl.
4. Install screws and washers as necessary to secure insulation to upper cowl.
5. Install trim screws as necessary to secure insulation to air intake housing.
6. Install drain tube.
7. Install two surge tank screw clamps to secure surge tank.
8. Install air cleaner assembly and air induction tube (Section 3).
9. Install air cleaner assembly vent line.
10. Install air cleaner assembly shield.
11. Install air intake weathercap.

DRAIN TUBE REPLACEMENT

Removal

Remove duck bill, elbow, and drain tube from evaporator coil assembly inner cowl area by pulling straight out. If drain tube grommet pulled out with drain tube, it will need to be reinstalled. It may be necessary to loosen drain tube from evaporator coil assembly drain outlet.

Installation

Install drain tube and grommet, if removed, to drain tube outlet on evaporator coil assembly (Figure 11-38). Ensure drain tube is attached to evaporator coil assembly drain outlet.

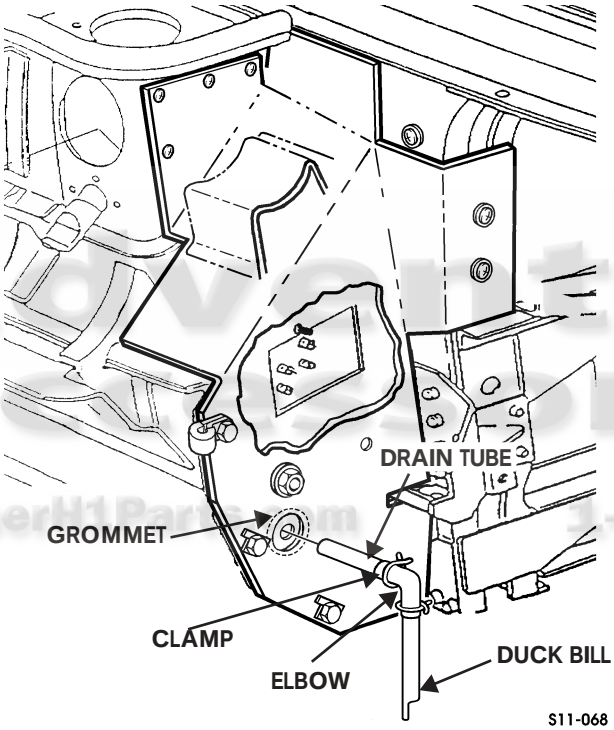


Figure 11-38: Drain Tube

RECEIVER DRYER REPLACEMENT

Removal

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

1. Discharge air conditioning system.
2. Remove air induction tube.
3. Disconnect electrical connector from high/low pressure switch (Figure 11-39).

NOTE: Cover all open lines to prevent contamination.

4. Disconnect two hoses from receiver dryer and remove O-rings. Discard O-rings.
5. Remove two clamps and receiver dryer from bracket.

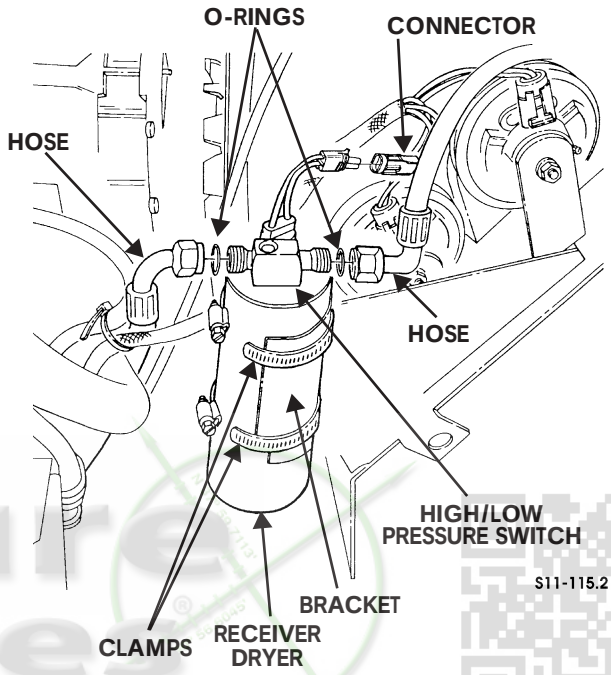


Figure 11-39: Receiver Dryer

Installation

1. Install receiver dryer on bracket with two clamps (Figure 11-39).
2. Lubricate two O-rings with PAG oil and install on hose fittings.
3. Connect two hoses to receiver dryer.
4. Connect electrical connector to high/low pressure switch.
5. Install air induction tube.
6. Test the system for leaks.

RECEIVER DRYER PRESSURE SWITCH REPLACEMENT

Removal

1. Disconnect pressure switch jumper connector from receiver dryer pressure switch (Figure 11-40).

NOTE: Unscrew the pressure switch as quickly as possible to avoid excessive loss of refrigerant.

2. Using a wrench, remove the pressure switch from the receiver dryer.

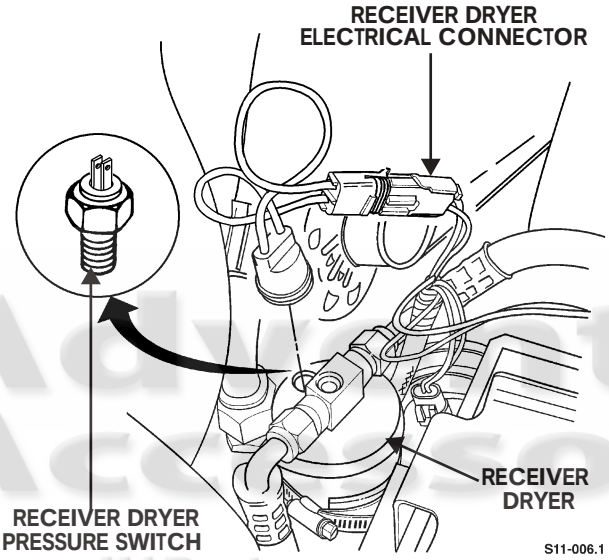


Figure 11-40: Receiver Dryer Pressure Switch

Installation

1. Thread the new pressure switch on the receiver dryer fitting by hand and use a wrench to finish installing the pressure switch. (Figure 11-40).

NOTE: Install the pressure switch as quickly as possible to avoid excessive loss of refrigerant.

2. Connect the pressure switch jumper electrical connector to the pressure switch.
3. Check the pressure switch fitting for leaks using suitable leak-testing equipment.

AMBIENT TEMPERATURE SWITCH REPLACEMENT

Removal

1. Disconnect harness connector from ambient temperature switch (Figure 11-41).
2. Remove screw, star-washer, and washer from ambient temperature switch.
3. Remove ambient temperature switch from power steering cooler.

Installation

1. Secure ambient temperature switch to power steering cooler with washer, star-washer, and screw (Figure 11-41).
2. Connect harness connector to ambient temperature switch. Ensure connection makes full contact.

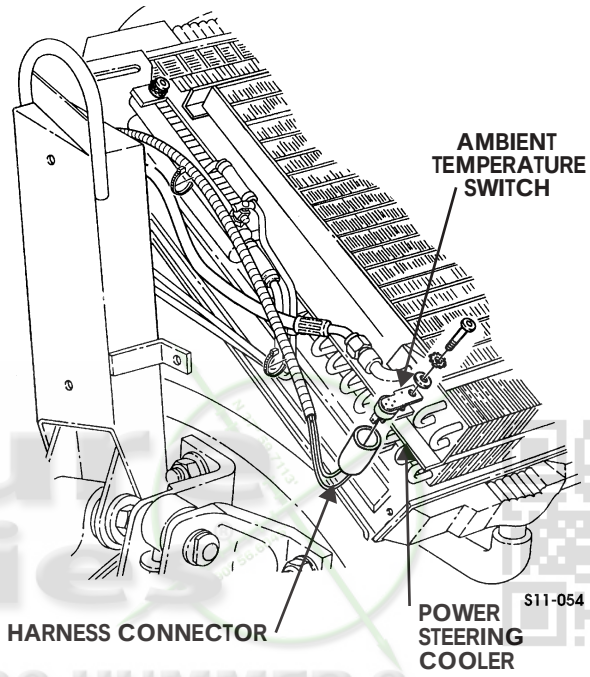


Figure 11-41: Ambient Temperature Switch

HEATER SHUTOFF VALVE REPLACEMENT

Removal

1. Disconnect the negative battery cables.
2. Place a drain container under the vehicle directly below the heater shutoff valve (Figure 11-42).

NOTE: Use extreme caution when working on a hot engine. Let the engine cool down before attempting the following procedure.

3. Relieve pressure from the cooling system by loosening the coolant pressure cap.
4. Remove the air intake hoses.
5. Remove the retaining screw and shutoff valve cover.

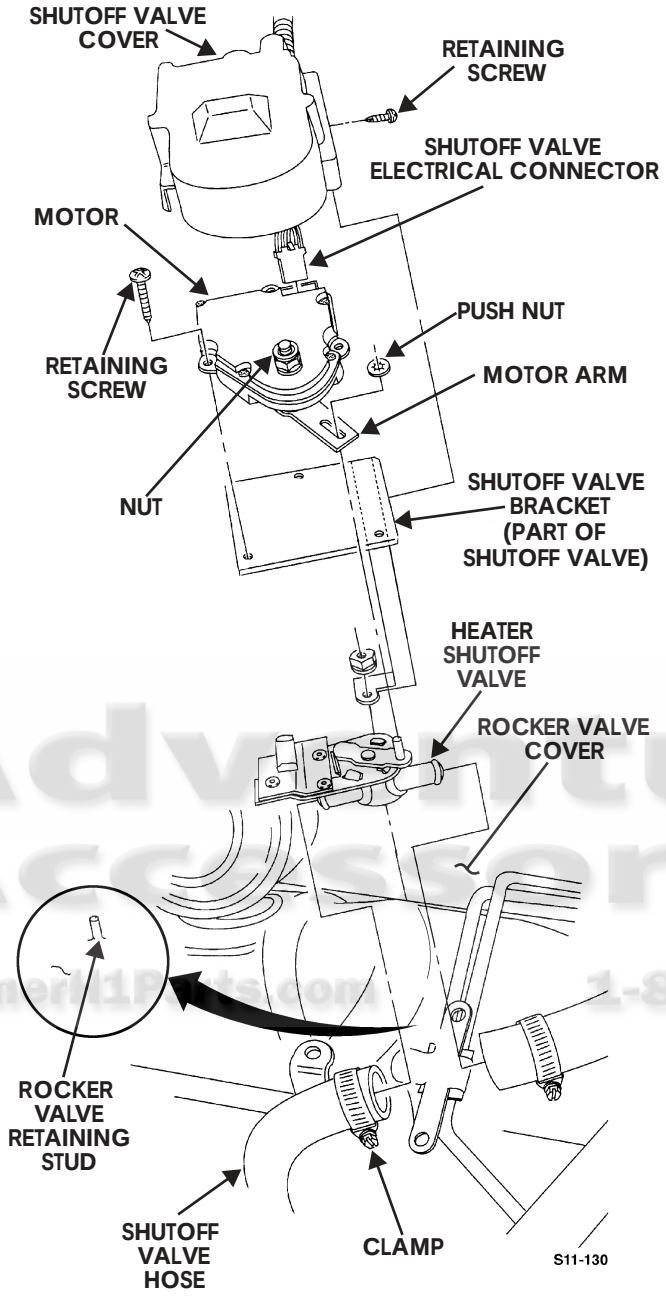


Figure 11-42: Heater Shutoff Valve

6. Disconnect the shutoff valve electrical connector.
7. Clamp shutoff valve hoses with heater hose clamp pliers or equivalent tool (Figure 11-43).

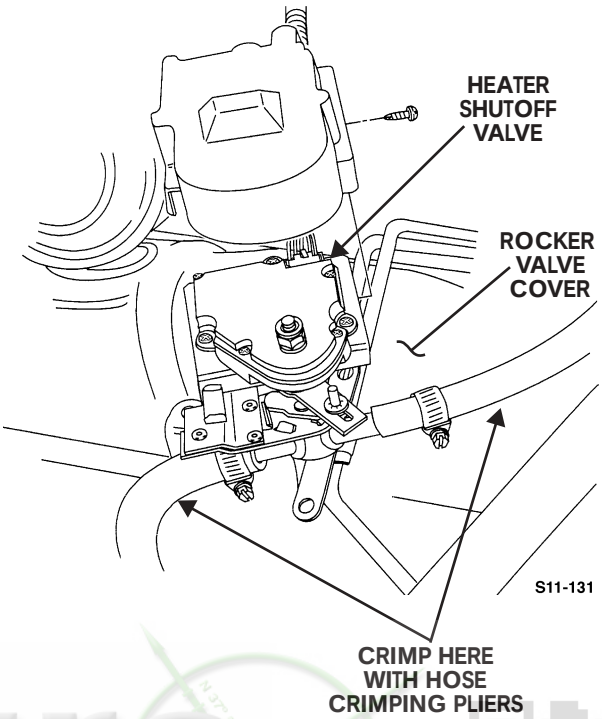


Figure 11-43: Heater Shutoff Valve

8. Remove retaining screws, push nuts, motor, nut and shutoff valve bracket from the shutoff valve (Figure 11-42).

Installation

1. Install heater shutoff valve, nut, mounting bracket and motor with retaining screws and push nuts (Figure 11-42).
2. Install hoses on shutoff valve and tighten clamps.
3. Release and remove hose clamp pliers or equivalent tools from shutoff valve hoses.
4. Connect the shutoff valve electrical connector (Figure 11-42).
5. Check the shutoff valve for leaks and proper operation.
6. Check the coolant level and add coolant if necessary.
7. Connect the negative battery cables.
8. Pressurize the system and check for leaks.
9. Tighten coolant pressure cap.

BLOWER MOTOR REPLACEMENT

NOTE: The evaporator coil assembly will need to be loosened from its mounting hardware to allow for additional clearance to remove blower housing.

Removal

1. Disconnect the negative battery cables.
2. Remove the crash pad (Section 10).
3. Remove front console.
4. Remove air cleaner, air intake elbow, and weathercap (Section 3).
5. Remove screw, nuts, washers, and evaporator coil assembly from air intake housing.
6. Remove passenger floor duct from floor duct assembly.
7. Disconnect electrical connector from diverter mode door actuator.
8. Remove five screws and diverter assembly.
9. Remove screw and water valve connector from blower housing.
10. Remove two screws and blower motor relays from blower housing.
11. Remove eight screws from blower housing and evaporator coil assembly.
12. Pull blower housing rearward separating blower housing from evaporator coil assembly.

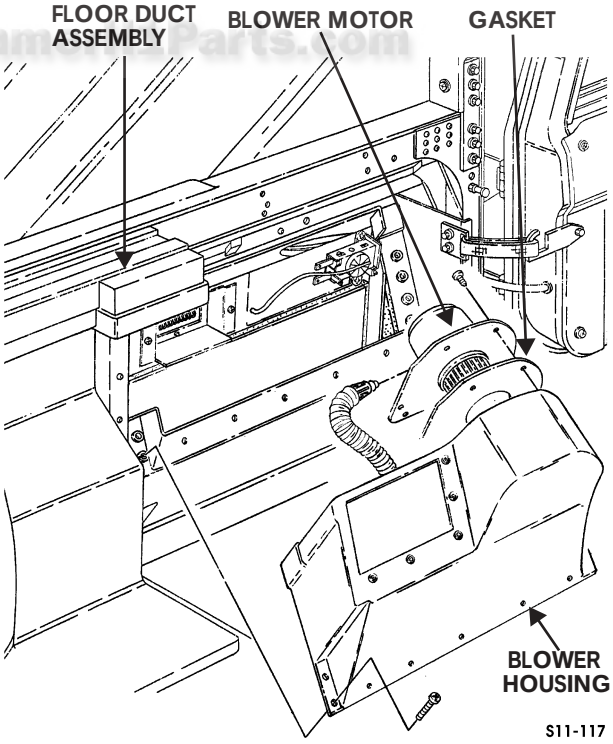


Figure 11-44: Blower Motor

13. Disconnect positive and negative electrical connectors from blower motor.
14. Remove blower housing from vehicle (Figure 11-44).
15. Remove six screws, starwasher, electrical spade connector, and blower motor from blower housing.

Installation

1. Install blower motor on blower housing with six screws, starwasher, and electrical spade connector (Figure 11-44).
2. Connect positive and negative electrical connectors to blower motor and install blower housing on evaporator coil assembly. Insure that housing is well seated to main unit. Secure blower housing to evaporator coil assembly with eight screws.
3. Install blower motor relays on blower housing with two screws.
4. Install water valve connector on blower housing with a screw.
5. Install diverter assembly on blower housing with five screws.
6. Install passenger floor duct on floor duct assembly (Section 3).
7. Connect electrical connector to distributor mode door actuator.
8. Install evaporator coil assembly with screw, nuts, and washers inside air intake housing.
9. Install air cleaner, air intake elbow, and weather cap.
10. Install front console (Section 10).
11. Install crash pad.
12. Connect negative battery terminals.
13. Check operation of blower motor.

BLOWER MOTOR RESISTOR REPLACEMENT

Removal

1. Disconnect battery negative terminals
2. Remove blower motor housing.
3. Remove two screws and blower motor resistor bracket from evaporator coil assembly (Figure 11-45).
4. Disconnect resistor electrical connections.
5. Remove two screws and resistor assembly from resistor bracket.

Installation

1. Apply Permagum to resistor assembly mating surfaces, being careful not to get Permagum on resistor coils, and install resistor assembly on bracket with two screws (Figure 11-45).
2. Apply Permagum on resistor bracket and evaporator coil assembly mating surfaces.
3. Connect resistor assembly electrical connections.
4. Install resistor bracket on evaporator coil assembly with two screws.
5. Install blower motor housing.
6. Connect negative battery terminals.
7. Check operation of blower motor.

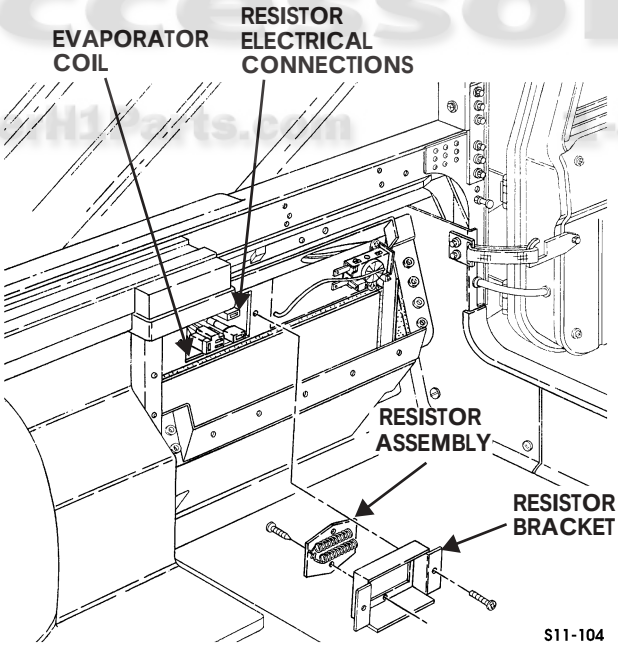


Figure 11-45: Blower Motor Resistor

THERMOSTAT REPLACEMENT

Removal

1. Remove evaporator coil assembly.
2. Remove eight screws and blower housing from evaporator coil assembly housing (Figure 11-46).
3. Disconnect thermostat electrical connections.
4. Remove seven screws and front cover from evaporator housing.
5. Remove thermostat capiliary tube from evaporator coil.
6. Remove two screws from thermostat, and remove thermostat by pulling capiliary tube through platform.

Installation

1. Route thermostat capiliary tube through platform and insert tube into evaporator coil (Figure 11-47).
2. Install thermostat on platform with two screws.
3. Install front cover on evaporator housing with seven screws.
4. Position blower housing so that thermostat electrical connections may be connected.
5. Install blower housing on evaporator coil assembly housing with eight screws.
6. Install evaporator coil assembly.

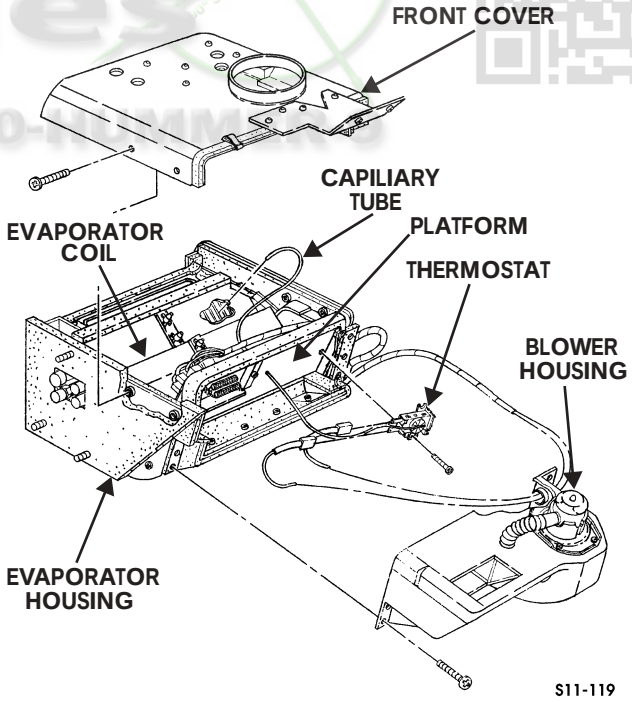


Figure 11-46: Thermostat

BLEND (HEAT) DOOR ACTUATOR REPLACEMENT

Removal

1. Disconnect negative battery terminals.
2. Remove right side passenger's kick panel (Section 10).
3. Disconnect electrical connection (Figure 11-47).
4. Remove three screws and blend (heat) door actuator from bracket.

Installation

1. Install blend (heat) door actuator on bracket with three screws.
2. Connect electrical connector (Figure 11-47).
3. Install right side passenger kick panel (Section 10).
4. Connect negative battery terminals.
5. Check operation of blend door.

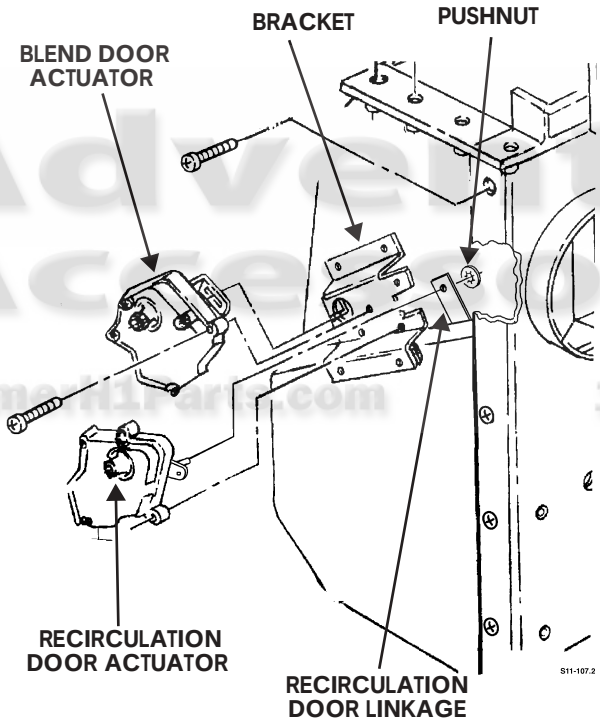


Figure 11-47: Blend Door and Recirculation Door Actuators

RECIRCULATION DOOR ACTUATOR REPLACEMENT

Removal

1. Disconnect negative battery terminals.
2. Remove right side kick panel (Section 10).
3. Disconnect electrical connection (Figure 11-47).
4. Remove three screws and actuator from bracket.

Installation

1. Install recirculation door actuator on bracket with three screws. Ensure actuator arm pin engages recirculation door linkage (Figure 11-47).
2. Install pushnut on actuator arm pin. Connect electrical connection.
3. Connect negative battery terminals.
4. From climate control panel, operate recirculation actuator to recirculate position and back to fresh air position.
5. Install right side kick panel (Section 10).
6. Check operation of recirculation door actuator.

FRONT CONSOLE PLENUM REPLACEMENT

Removal

1. Remove front console (Section 10).
2. Remove plenum intermediate duct and hose (Figure 11-48).
3. Support plenum with hand, and remove six screws, driver's top and bottom louvers, and passenger's side louver from front console.
4. Remove plenum from front console.
5. Remove J-clips from plenum.

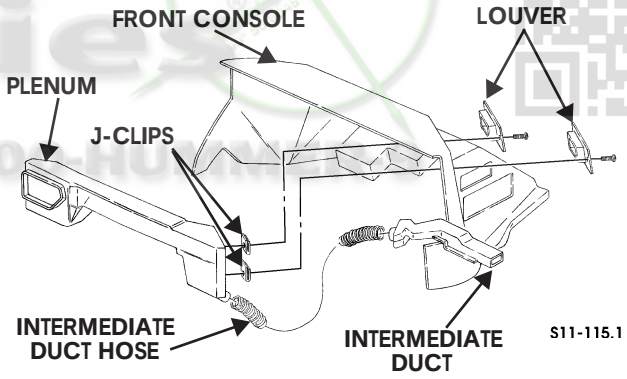


Figure 11-48: Front Console Plenum

Installation

1. Position plenum in front console (Figure 11-48).
2. Insert driver's side top and bottom louvers and passenger's side louver into openings.
3. Using louvers as a template, mark and drill six 1/16 in. holes in plenum.
4. Remove louvers and plenum from front console.
5. Install J-clips onto plenum where holes were drilled.
6. Reposition plenum in front console and install louvers on plenum with six screws.
7. Install plenum intermediate duct and hose.
8. Install front console (Section 10).

AIR CONDITIONING/HEATER DUCT REPLACEMENT

Passenger Floor Duct

Removal

1. Remove crash pad (Section 10).
2. Remove passenger's side floor duct hose from floor duct assembly (Figure 11-47).
3. Remove two screws and floor duct from evaporator coil assembly floor outlet.

Installation

1. Route duct from blower housing to evaporator coil assembly floor duct and secure with two screws (Figure 11-49).
2. Route opposite end of duct to floor duct and secure with screw.
3. Install crash pad.
4. Check operation of passenger's side floor duct.

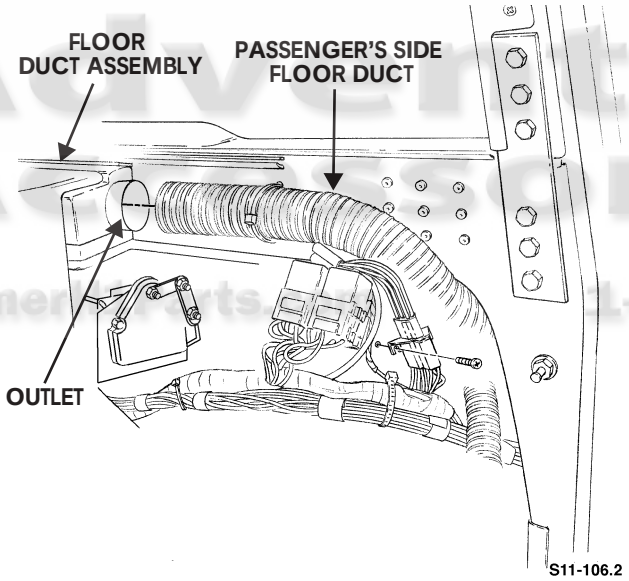


Figure 11-49: Passenger Floor Duct

Driver Floor Duct

Removal

1. Remove five screws and driver's side closeout panel (Figure 11-50).
2. Remove two screws, floor duct louver, and floor duct hose from closeout panel duct louver.
3. Remove duct hose from floor duct assembly. It may be necessary to remove CTIS panel for easier access.

Installation

1. Install duct hose on floor duct assembly (Figure 11-50).
2. Install floor duct louver to closeout panel with two screws.
3. Install duct hose on driver's side closeout panel floor duct louver.
4. Install driver's side closeout panel with five screws.
5. Check operation of driver's side floor duct.

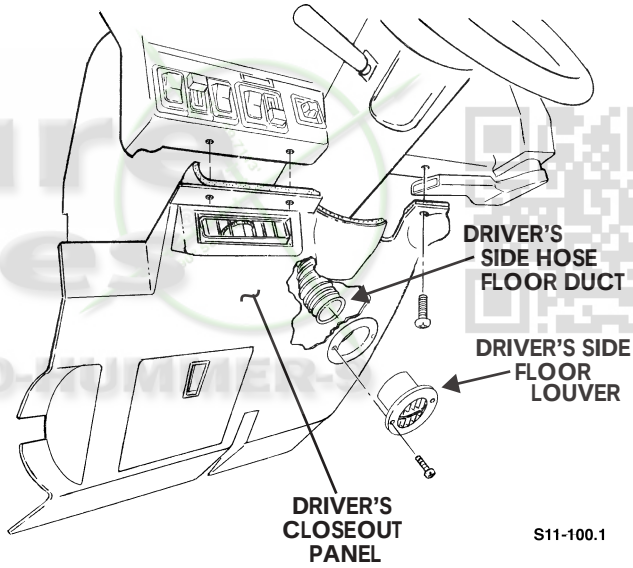


Figure 11-50: Driver's Floor Duct Hose Assembly

DEFROST DUCT AND WINDSHIELD NOZZLES REPLACEMENT

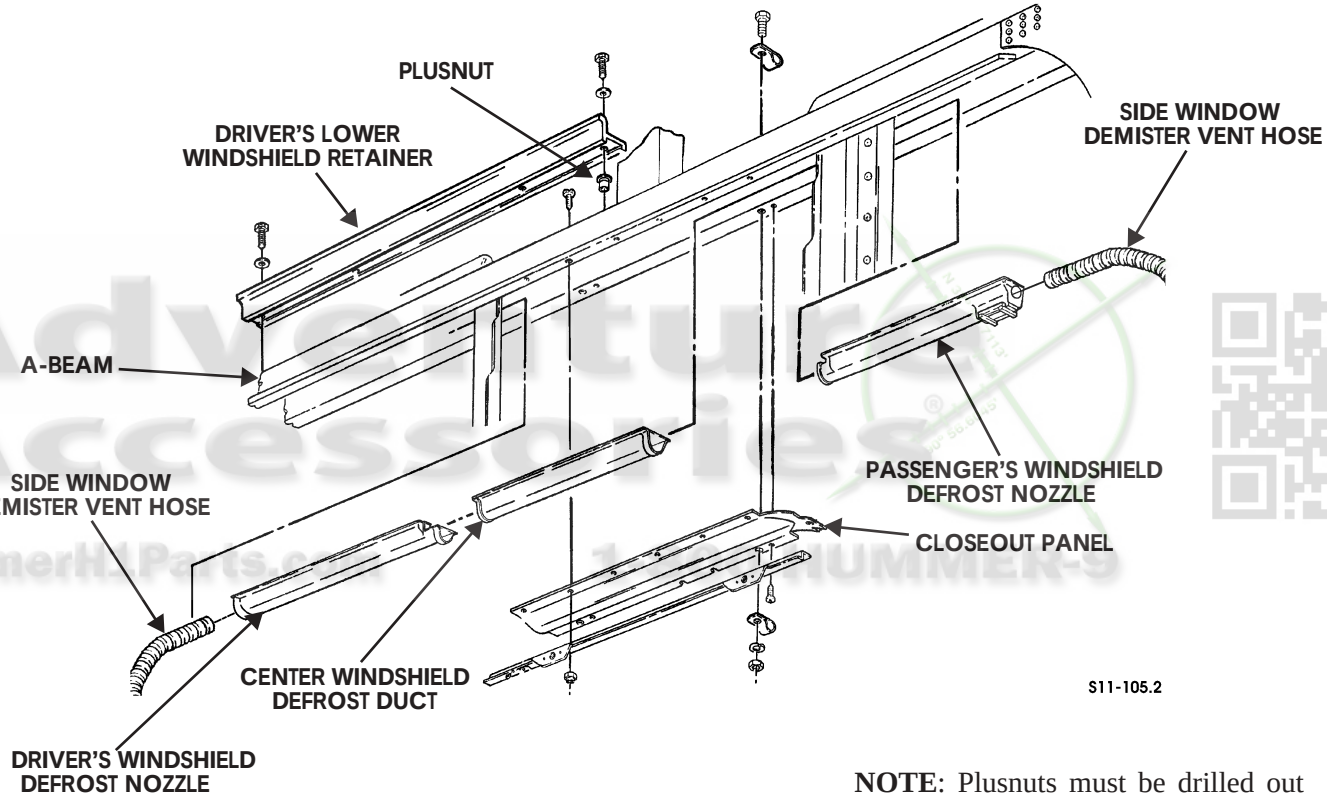
Defrost Duct

Removal

1. Disconnect negative battery terminals.
2. Remove crash pad (Section 10).
3. Remove front console (Section 10).
4. Remove diverter assembly.
5. Remove engine cover (Section 10).
6. Remove twelve screws, nuts, washers, and closeout panel from A-beam (Figure 11-51).
7. Remove eight screws, washers, and driver's and passenger's lower windshield retainers from A-beam.

NOTE: Plusnuts must be drilled out in order to remove any ducts. New plusnuts are installed in the same holes.

8. Remove defrost duct from A-beam.



NOTE: Plusnuts must be drilled out in order to remove ducts. New plusnuts are installed in the same holes.

Figure 11-51: Windshield Defrost Ducts and Nozzles

Installation

1. Install windshield defrost duct into A-beam (Figure 11-51).

NOTE: Apply Silaprene Sealant 05593929 in a continuous bead around the new plusnuts making sure to cover both the edge of the plusnut and the vehicle body. This will provide better sealing.

2. Install new plusnuts into A-beam.
3. Install driver's and passenger's lower windshield retainers on A-beam with eight screws and washers.
4. Install closeout panel on A-beam with twelve screws, plusnuts, and washers.
5. Install engine cover (Section 10).
6. Install diverter assembly
7. Install front console (Section 10).
8. Install crash pad (Section 10).
9. Connect negative battery terminals.
10. Check operation of windshield defrosters.

Passenger's Side Windshield Defrost Nozzle

Removal

1. Disconnect negative battery terminals.
2. Remove crash pad (Section 10).
3. Remove front console (Section 10).
4. Remove diverter assembly.
5. Remove evaporator coil assembly blower housing.
6. Remove four screws, lockwashers and passenger's lower windshield retainer from A-beam. Remove plusnuts (Figure 11-51).
7. Remove passenger's windshield defrost nozzle and side window demister vent hose from A-beam.
8. Remove side window demister vent hose from defroster nozzle.

Installation

1. Install side window demister vent hose on defrost nozzle (Figure 11-51).
2. Install defrost nozzle and demister vent hose on A-beam. Install plusnuts (Figure 11-51).
3. Install four screws, lockwashers and lower windshield retainer on A-beam.
4. Install evaporator coil assembly blower housing.
5. Install diverter assembly.
6. Install front console (Section 10).
7. Install crash pad.
8. Connect negative battery terminals.
9. Check operation of windshield defrosters.

Driver's Side Windshield Defrost Nozzle

Removal

1. Disconnect negative battery terminals.
2. Remove crash pad (Section 10).
3. Remove front console (Section 10).
4. Remove four screws, lockwashers and driver's lower windshield retainer from A-beam. Remove plusnuts (Figure 11-51)
5. Remove center windshield defrost duct.
6. Remove side window demister vent hose and defrost nozzle.
7. Remove defrost nozzle from side window demister hose (Figure 11-51).

Installation

1. Install defrost nozzle on side window demister hose (Figure 11-51).
2. Install side defrost nozzle and window demister vent hose on A-beam.
3. Install four screws, lockwashers and lower windshield retainer on A-beam.
4. Install center windshield defrost duct.
5. Install front console (Section 10).
6. Install crash pad (Section 10).
7. Connect negative battery terminals.
8. Check operation of windshield defrosters.

AIR CONDITIONING PRESSURE HOSES REPLACEMENT

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

NOTE: Cover all open lines to prevent contamination.

Compressor-to-Condenser and Evaporator Coil Hoses

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and air induction tubes (Section 3).
3. Disconnect compressor low-pressure hose from evaporator coil and remove O-ring. Discard O-ring (Figure 11-52).

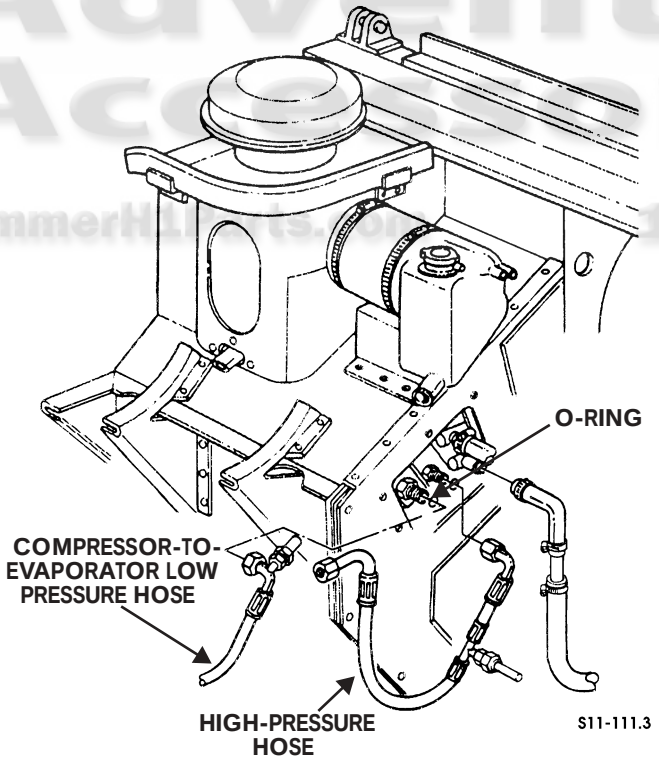


Figure 11-52: Evaporator Low-Pressure and High-Pressure Hose

4. Disconnect compressor high-pressure hose from condenser and evaporator coil. Remove and discard O-rings (Figure 11-53).
5. Remove driver's side engine splash shield (Section 10).

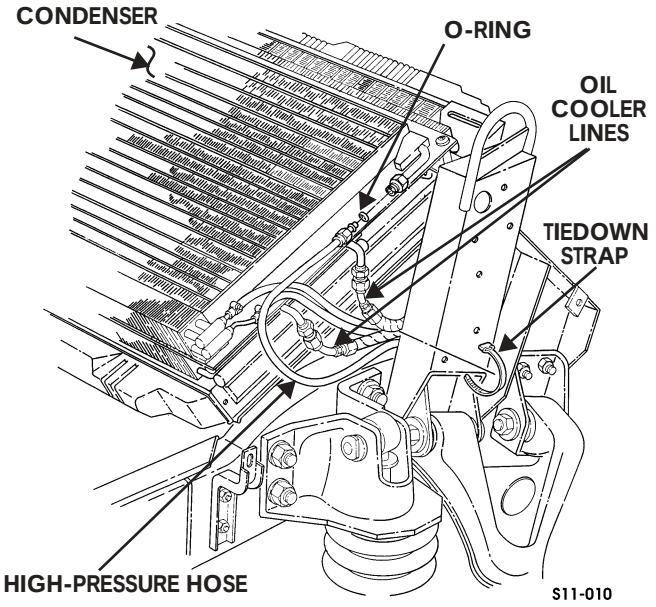


Figure 11-53: Condenser

6. Remove tiedown strap securing high-pressure hose to oil cooler lines. Discard tiedown strap.
7. Remove screw, washer, pressure hoses, and two sealing washers from compressor (Figure 11-54).

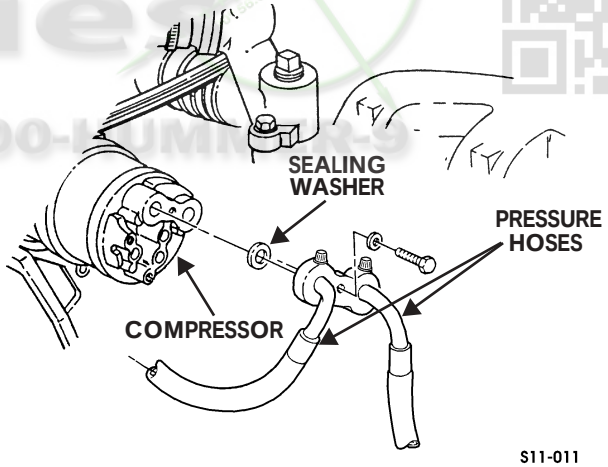


Figure 11-54: Suction/Discharge Hose Assembly

Installation

1. Install two sealing washers on suction/discharge hose assembly (Figure 11-54).
2. Install suction/discharge hose assembly on compressor with washer and screw.
3. Lubricate O-ring, install on compressor high pressure hose, and connect hose to condenser. Using two wrenches for equalized support, tighten to 11-13 ft-lb (15-18 N•m).
4. Install tiedown strap on compressor high-pressure hose and oil cooler lines.
5. Install driver's side engine splash shield.

6. Lubricate O-ring, install on compressor low-pressure hose and install hose on evaporator coil assembly. Using two wrenches for equalized support, tighten to 11-13 ft-lb (15-18 N•m).
7. Install air cleaner assembly and induction tubes (Section 3).
8. Evacuate and charge air conditioning system.
9. Check for system leaks.
10. Check A/C operation.

Condenser-to-Receiver Dryer Hose

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

1. Discharge air conditioning system.
2. Disconnect hose from condenser and remove O-ring. Discard O-ring (Figure 11-55).
3. Remove hose and O-ring from receiver dryer. Discard O-ring.

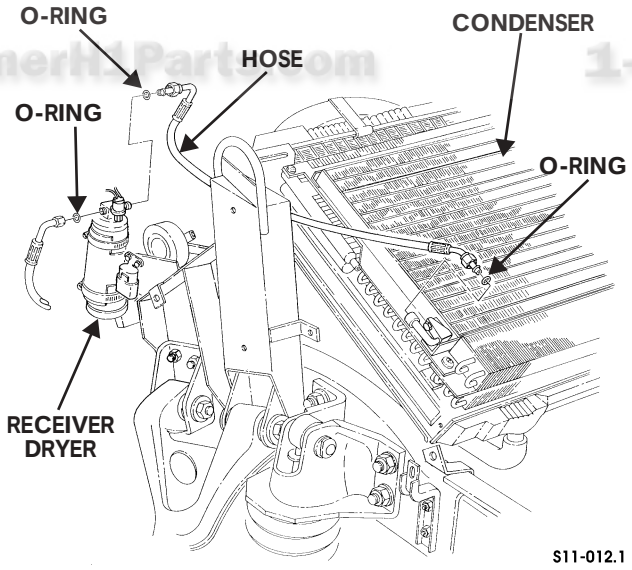


Figure 11-55: Receiver Dryer

Installation

1. Lubricate O-ring with PAG oil, install on hose, and install hose on condenser. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m).
2. Lubricate O-ring with PAG oil, install on hose, and install hose on receiver dryer. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m).
3. Evacuate and charge air conditioning system.
4. Check system for leaks.
5. Check air conditioning system operation.

Receiver Dryer-To-Evaporator Coil Hose

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and induction tube (Section 3).
3. Disconnect hose from receiver dryer and remove O-ring. Discard O-ring (Figure 11-55).
4. Remove hose and O-ring from evaporator coil. Discard O-ring (Figure 11-56).

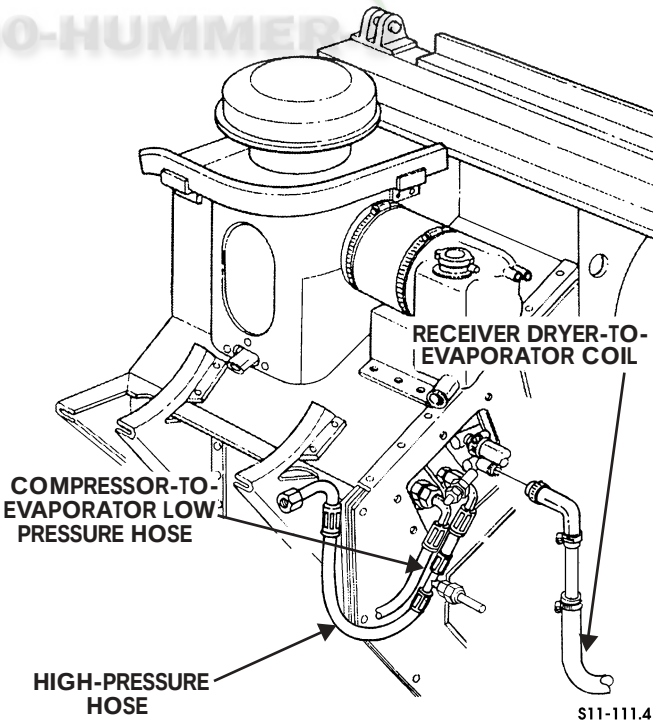


Figure 11-56: Evaporator Low-Pressure and High-Pressure Hoses

Installation

1. Lubricate two O-rings with PAG oil and install on hose (Figure 11-56).
2. Install hose on evaporator coil. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m).
3. Install hose to receiver dryer. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m) (Figure 11-55).
4. Install air cleaner assembly and induction tube (section 3).
5. Leak test system.

CLIMATE CONTROL PANEL ASSEMBLY REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove console (Section 10).
3. Remove four screws, speednuts and plate from climate control panel assembly and console (Figure 11-57).
4. Disconnect connector from panel assembly and remove panel assembly.
5. Remove four nuts, lockwashers, nuts and side bracket from each side of the climate control panel assembly.

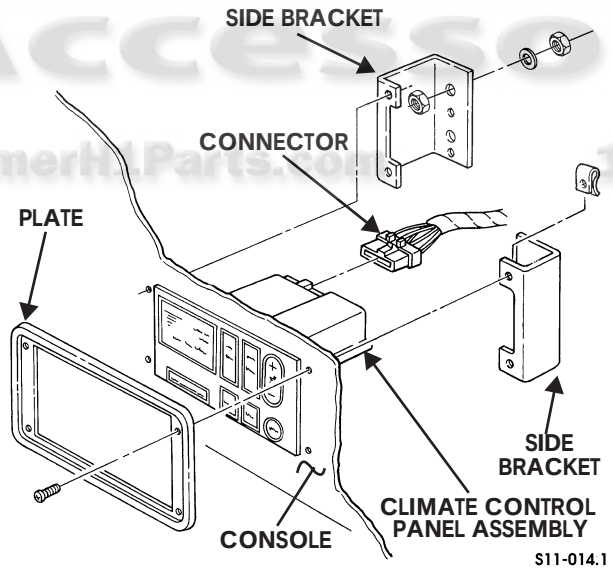


Figure 11-57: Climate Control Panel Assembly

Installation

1. Install each side bracket on climate control panel assembly and secure with four nuts, lockwashers, and nuts (Figure 11-57).
2. Install panel assembly in console and connect connector to panel assembly.
3. Secure panel assembly to console with plate, four screws and speednuts.
4. Install console (Section 10).
5. Connect battery ground cable.

HEATER OUTLET/INLET HOSE REPLACEMENT

NOTE: This procedure applies only to vehicles without the auxiliary A/C and heating unit. This procedure is different for vehicles with the auxiliary unit.

Removal

1. Drain cooling system (Section 4).

NOTE: Procedures for installing and removing outlet and inlet hoses are basically the same. This procedure covers the outlet hose.

2. Loosen clamp and disconnect heater outlet hose from water pump nipple (Figure 11-58).
3. Loosen clamp and disconnect hose from heater outlet port.
4. Inspect water pump nipple.

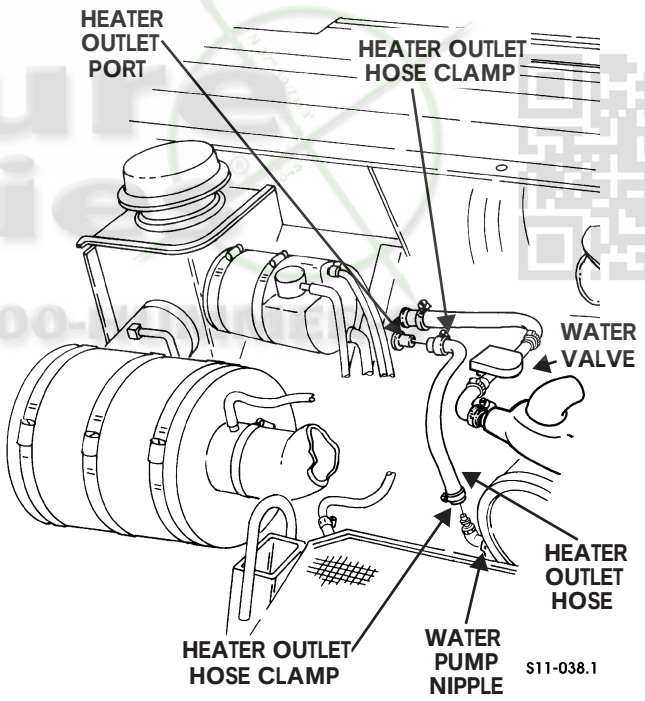


Figure 11-58: Heater Outlet/Inlet Hose

Installation

1. Connect hose to water pump nipple and tighten hose clamp (Figure 11-58).
2. Connect hose to heater outlet port and tighten hose clamp.
3. Fill surge tank with engine coolant to the cold fill mark and secure pressure cap to surge tank.
4. Start engine and check for hose leakage.

WARNING: It may be necessary to allow engine to cool down before additional coolant is added to prevent injury.

5. Inspect cooling system for proper coolant level. Fill as necessary.

DIVERTER REPLACEMENT

Removal

NOTE: Mode door actuator is not serviceable. Entire diverter assembly must be replaced to repair mode door actuator.

1. Remove crash pad (Section 10).
2. Remove front console.
3. Disconnect mode door actuator electrical connection from mode door actuator (Figure 11-59).
4. Remove five screws and diverter assembly from evaporator coil assembly.

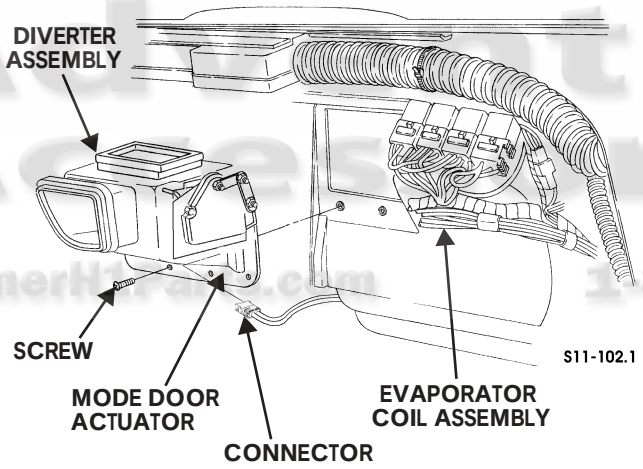


Figure 11-59: Diverter Assembly

Installation

1. Install diverter assembly on evaporator coil assembly with five screws (Figure 11-59).
2. Connect mode door actuator electric connection on mode door actuator.
3. Install front console (Section 10).
4. Install crash pad.
5. Check operation of diverter assembly.

REAR CONSOLE REPLACEMENT

Removal

1. Remove six screws, two rear console louvers on (vents) and one driver's front louver from rear console. Disconnect duct hose from driver's front louver (Figure 11-60).
2. Remove four screws securing rear console to side brackets.
3. Raise rear console and disconnect electrical connection from blower switch. Disconnect ground connection.
4. Remove rear console.

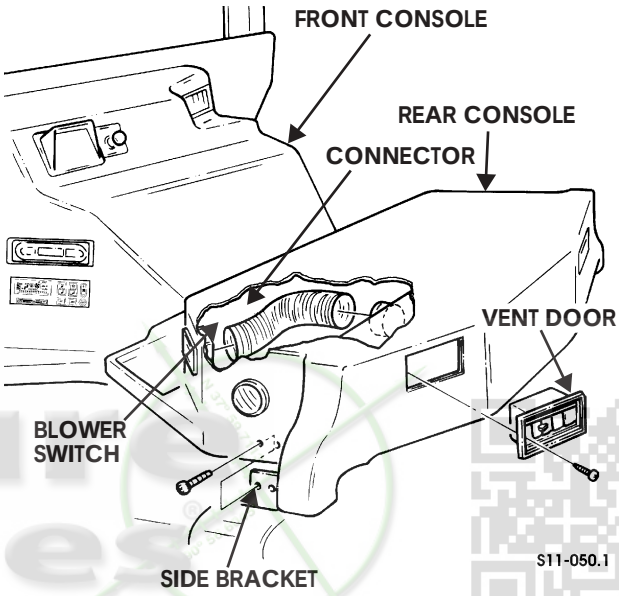


Figure 11-60: Rear Console

Installation

1. Position rear console over auxiliary unit and connect blower switch electrical connection and ground connection (Figure 11-60).
2. Install rear console on side brackets with four screws.
3. Install two rear louvers on rear console with four screws.
4. Connect duct hose to driver's front louver and install louver on rear console with two screws.

AUXILIARY AIR CONDITIONING/HEATING UNIT REPLACEMENT

Removal

1. Disconnect battery negative terminals.
2. Discharge air conditioning system.
3. Remove rear console (Section 10).
4. Remove heater hoses from auxiliary unit (Figure 11-61).

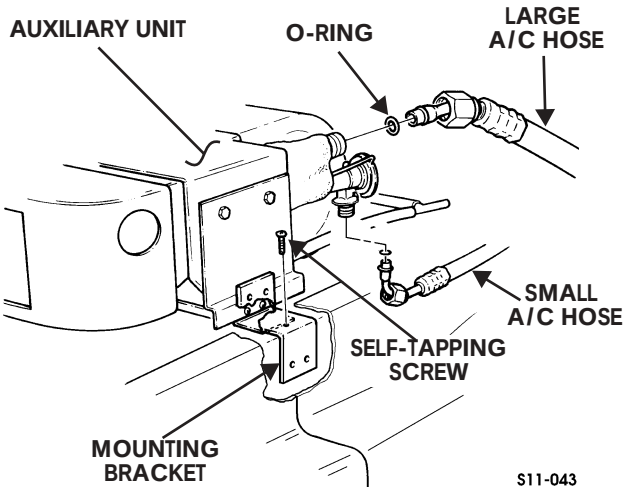


Figure 11-61: Auxiliary A/C Components

5. Remove pressure hoses from auxiliary unit.
6. Remove drain tubes from auxiliary unit (Figure 11-62).

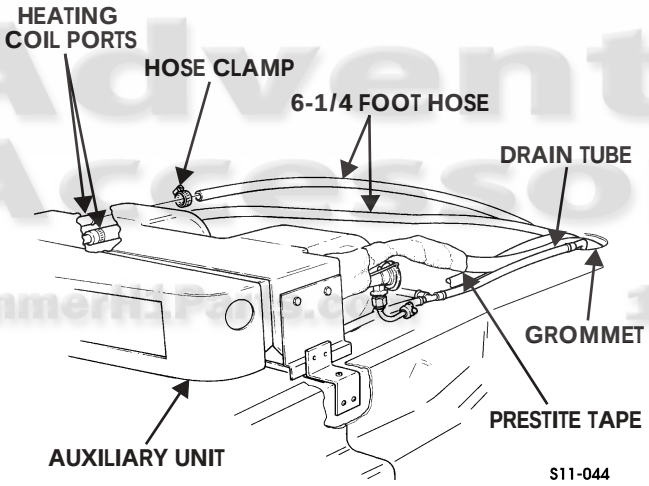


Figure 11-62: Heater Hose

7. Remove screws securing side brackets to tunnel mounting bracket.
8. Remove auxiliary unit from vehicle.

Installation

1. Install auxiliary unit in vehicle and secure side brackets to tunnel mounting bracket with screws (Figure 11-61).
2. Install drain tubes on auxiliary unit (Figure 11-62).
3. Install pressure hoses on auxiliary unit.
4. Wrap low pressure fitting with prestite tape.
5. Install heater hoses to heater tubes on auxiliary unit. Secure with screw clamps. Remove hose pinch pliers.
6. Evacuate, charge, and leak test air conditioning system.
7. Check engine coolant level and add coolant as necessary.
8. Connect battery negative terminals.
9. Start engine and operate auxiliary and front air conditioning system to check for proper operation.
10. Check coolant connections for leakage; repair if necessary.
11. Stop engine, recheck coolant level, and add coolant if necessary.
12. Install rear console (Section 10).

AUXILIARY EXPANSION VALVE REPLACEMENT

Removal

1. Discharge air conditioning system.
2. Remove rear console.
3. Remove prestite tape and bulb clamp.
4. Using two wrenches for equalized support, remove high-pressure hose from expansion valve. Remove O-ring from hose and discard O-ring (Figure 11-63).
5. Using two wrenches for equalized support, remove expansion valve from auxiliary unit. Remove and discard O-ring (Figure 11-61).

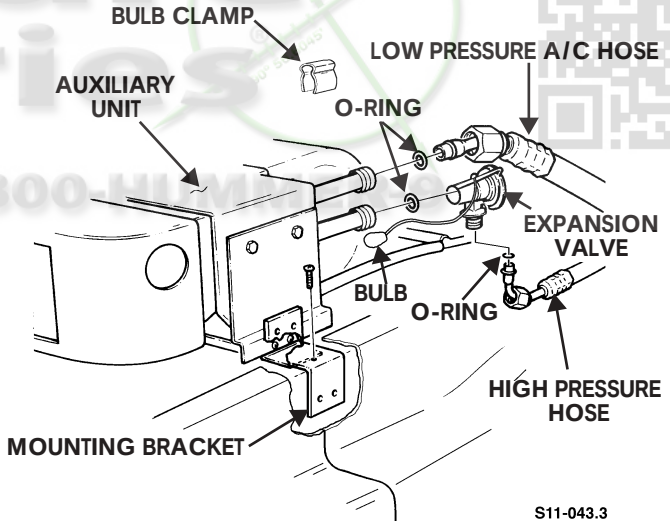


Figure 11-63: Auxiliary High-Pressure Hose

Installation

1. Install O-ring and expansion valve on auxiliary unit. Using two wrenches for equalized support, tighten to 15-20 lb-ft (20-27 N•m) (Figure 11-61).
2. Install O-ring onto high pressure hose and install onto expansion valve. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-17 N•m) (Figure 11-63).
3. Install prestite tape and bulb clamp.
4. Evacuate, charge, and leak test system.
5. Install rear console.
6. Start engine and check operation of auxiliary unit.

AUXILIARY BLOWER SWITCH REPLACEMENT

Removal

1. Disconnect battery negative terminals.
2. Remove rear console.
3. Remove blower switch from rear console (Figure 11-64).

Installation

1. Install blower switch in rear console (Figure 11-64).
2. Install rear console.
3. Connect battery negative terminals.
4. Start engine and check operation of blower switch

.

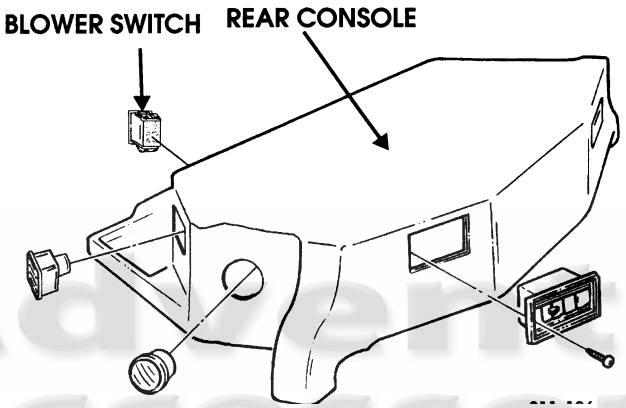


Figure 11-64: Blower Switch Replacement

DRAIN HOSE(S) REPLACEMENT

Removal

1. Remove rear console.
2. Remove hose clamps from drain hose section being replaced (Figure 11-65).
3. Remove drain hose.

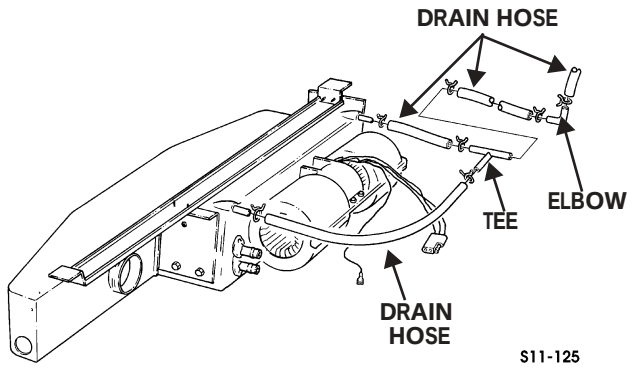


Figure 11-65: Auxiliary A/C Drain Hose Replacement

Installation

1. Install drain hose section and secure with hose clamps (Figure 11-65).
2. Install rear console.

AUXILIARY HEATER HOSE REPLACEMENT

NOTE: Heater hose replacement is the same for both heater hoses.

Removal

1. Drain cooling system (Section 4).
2. Remove air cleaner induction tube (Section 3).
3. Select heater hose to replace, remove reflective tape from hose, loosen hose clamp, and remove heater hose from hose splice.
4. Remove two P-clamps from underbody securing auxiliary hoses.
5. Remove front and rear consoles.
6. Remove screw clamp securing heater hose to heating coil port on auxiliary unit (Figure 11-62).
7. Pull heater hose through tunnel grommet.
8. Remove heater hose.

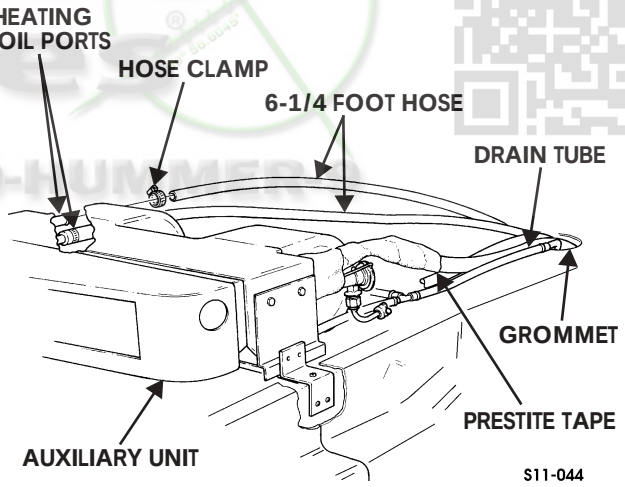


Figure 11-66: Heater Hose

Installation

1. Install 6-1/4 foot hose end to auxiliary unit heating coil port and secure with screw clamp (Figure 11-62).
2. Wrap hose in reflective tape and route hose through grommet to engine area.
3. Connect hose to hose splice and secure with screw clamp.
4. Install two P-clamps to underbody securing installed hose to existing hoses.
5. Fill cooling system (Section 4).
6. Install air cleaner induction tube (Section 3).
7. Pressure test cooling system and check for leaks.

8. Install front and rear consoles.
9. Start engine and run until engine warms up.
10. Check heating units for proper operation.

AUXILIARY HIGH-PRESSURE HOSE REPLACEMENT

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and air induction tube (Section 3).
3. Using two wrenches to equalize support, remove high-pressure hose from receiver dryer. Remove and discard O-ring (Figure 11-55).
4. Using two wrenches for equalized support, remove high pressure hose from evaporator coil assembly. Remove and discard O-ring (Figure 11-67).

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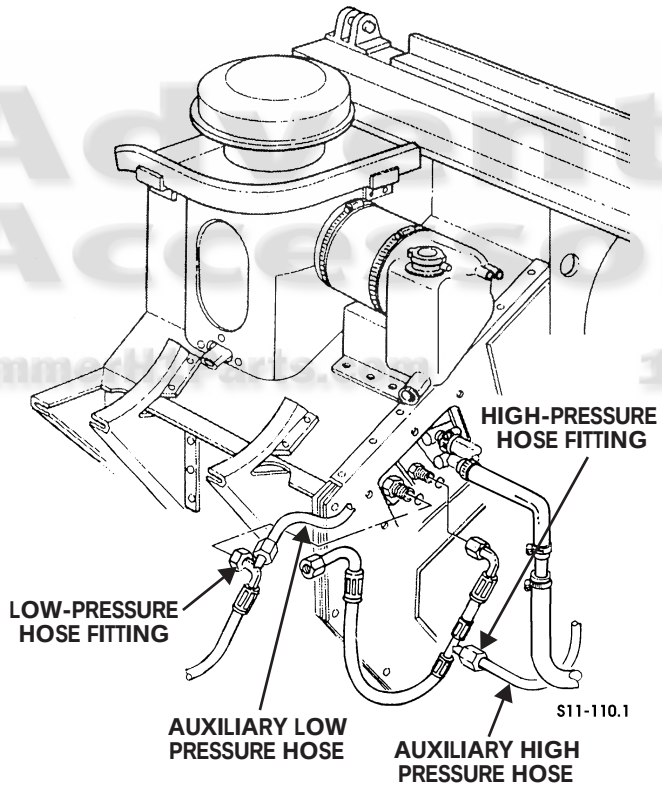


Figure 11-67: High Pressure Hose

5. Remove two P-clamps securing hose to underbody.
6. Remove reflective wrap from hose.
7. Remove rear console.
8. Remove front console.
9. Using two wrenches for equalized support, remove high-pressure hose from expansion valve. Remove and discard O-ring (Figure 11-68).
10. From under the vehicle pull high-pressure hose through grommet

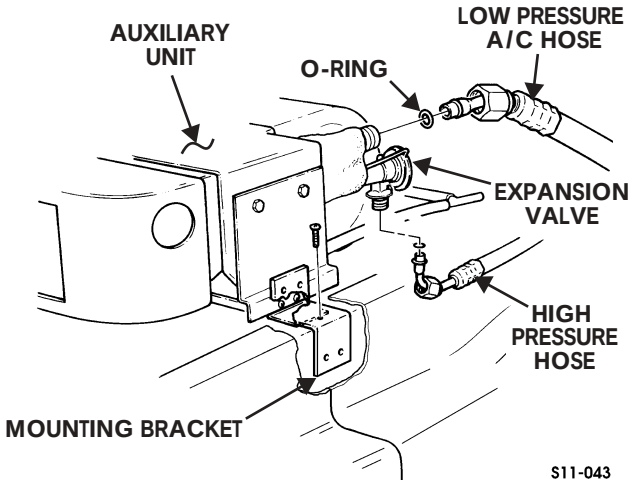


Figure 11-68: Auxiliary High-Pressure Hose

Installation

1. Route single-end fitting through grommet to auxiliary unit.
2. Lubricate and install O-ring onto high pressure hose and install hose on expansion valve. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m) (Figure 11-68).
3. Route other end of high-pressure hose to receiver dryer and evaporator coil assembly.
4. Lubricate and install O-ring on hose and install on receiver dryer. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m) (Figure 11-55).
5. Lubricate and install O-ring on hose and install on evaporator coil assembly. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m) (Figure 11-67).
6. Install two P-clamps to secure hoses to underbody.
7. Install reflective wrap on hoses.
8. Install front and rear consoles.
9. Evacuate, charge, and leak test system.
10. Start engine and check A/C operation.

AUXILIARY LOW-PRESSURE HOSE REPLACEMENT

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and air induction tube (Section 3).
3. Using two wrenches for equalized support, remove auxiliary low-pressure hose from low-pressure hoses. Remove and discard O-ring (Figure 11-67).
4. Remove two P-clamps securing hoses to underbody.
5. Remove front and rear consoles.
6. Remove prestite tape from low-pressure hose. Using two wrenches for equalized support, remove hose from auxiliary unit. Remove and discard O-ring (Figure 11-68).
7. From under the vehicle, pull low-pressure hose through grommet.

Installation

1. Route single-end fitting through grommet to auxiliary unit.
2. Lubricate and install O-ring on low-pressure hose and install hose to auxiliary unit. Using two wrenches for equalized support, tighten to 21-27 lb-ft (29-37 N•m) (Figure 11-68).
3. Route other end of low-pressure hose to under hood low pressure fittings.
4. Lubricate and install O-ring and install auxiliary low pressure hose fitting to existing low pressure hoses. Using two wrenches for equalized support, tighten to 24-28 lb-ft (33-38 Nm) (Figure 11-67).
5. Install two P-clamps to secure hoses to underbody.
6. Install front and rear consoles.
7. Evacuate, charge, and leak test system.
8. Start engine and check A/C operation.

AUXILIARY EVAPORATOR/HEATER COIL AND BLOWER MOTOR REPLACEMENT

Removal

1. Remove auxiliary unit from vehicle.
2. Remove four screws and plenum from housing.
3. With auxiliary unit on bench, remove six plastic locking pins securing unit housing halves together (Figure 11-69).
4. Remove four screws from blower motor support.
5. Remove four screws securing side brackets to upper housing half.
6. Separate housing halves.
7. Remove blower motor assembly from bottom housing.
8. Remove evaporator/heater coil assembly from bottom housing.
9. Remove plastic stick pins and mesh filter from evaporator/heater coil assembly.

NOTE: If expansion valve is to be reused, remove from evaporator/heater coil assembly and install on replacement unit.

Installation

1. Install mesh filter on evaporator/heater coil assembly with plastic stick pins (Figure 11-69).
2. Install evaporator/heater coil assembly in bottom housing.
3. Install blower motor assembly in bottom housing.
4. Install upper housing to lower housing with six plastic locking pins, four blower motor support screws, and four screws securing side brackets to upper housing.
5. Install plenum on housing with four screws.
6. Install auxiliary unit into vehicle.
7. Evacuate, charge, and leak test A/C and heating system.

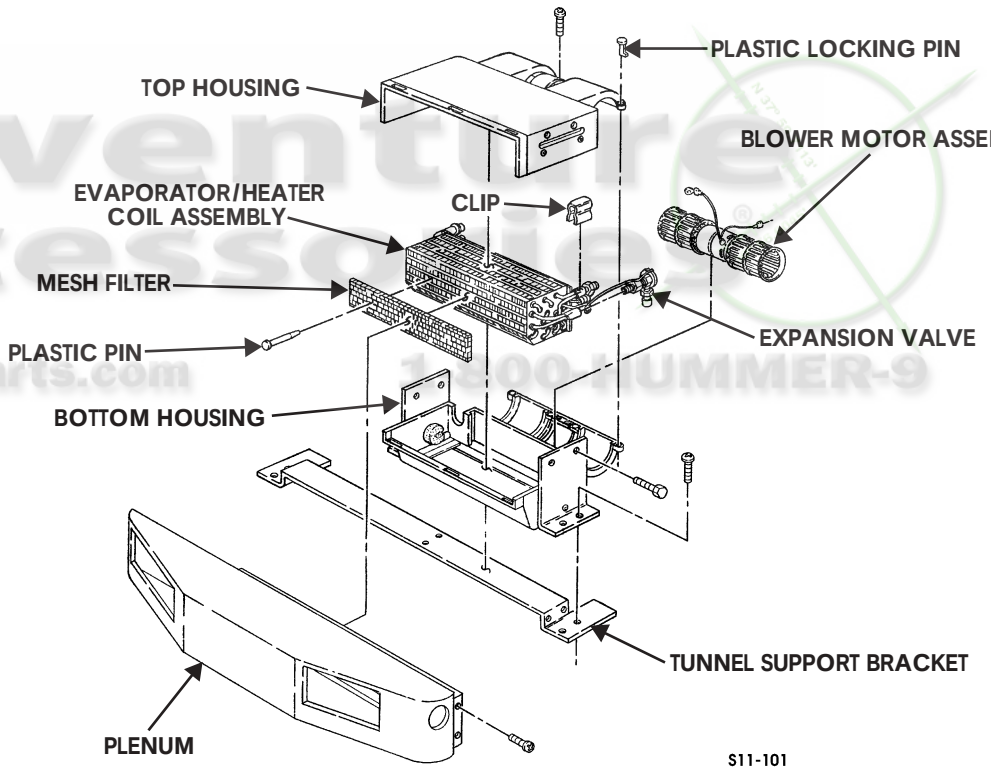


Figure 11-69: Auxiliary Air Conditioning Break-Down

Section 12 Electrical System

TABLE OF CONTENTS

GENERAL

The HUMMER is equipped with an electrical system that meets the rigorous demands of the vehicle and its systems.

Initial power for starting the vehicle is provided by a pair of maintenance-free storage batteries.

The starter motor is a marine-grade sealed unit to allow for the HUMMER's water fording capabilities.

Electricity to recharge the batteries and operate the vehicle while running is provided by a Delco-Remy, internally-regulated alternator. This unit is driven by a self-tensioning serpentine belt for improved reliability and service.

Both the starter and alternator are serviceable with instructions included in this section.

The HUMMER is equipped with a weather-resistant electrical system. The harness uses a positive seal on all exterior connectors to resist water intrusion when operating in wet conditions.

NOTE: Ensure all connections below the standard thirty inch fording depth are watertight when repairing or replacing electrical connections or components.

NOTE: Due to the vehicle's capabilities, do not pierce wire insulation when checking circuitry. Back probe connectors, or disconnect and insert jumper wires, into the harness.

INSTALLATION OF AFTERMARKET ELECTRICAL ACCESSORIES

Three spare fuse circuits (Figure 12-1) are available for the installation of aftermarket electrical accessories. There is one each for battery power, ignition accessory power, and lights power. Each is terminated with a connector and can be found behind the instrument panel near the fuse box.

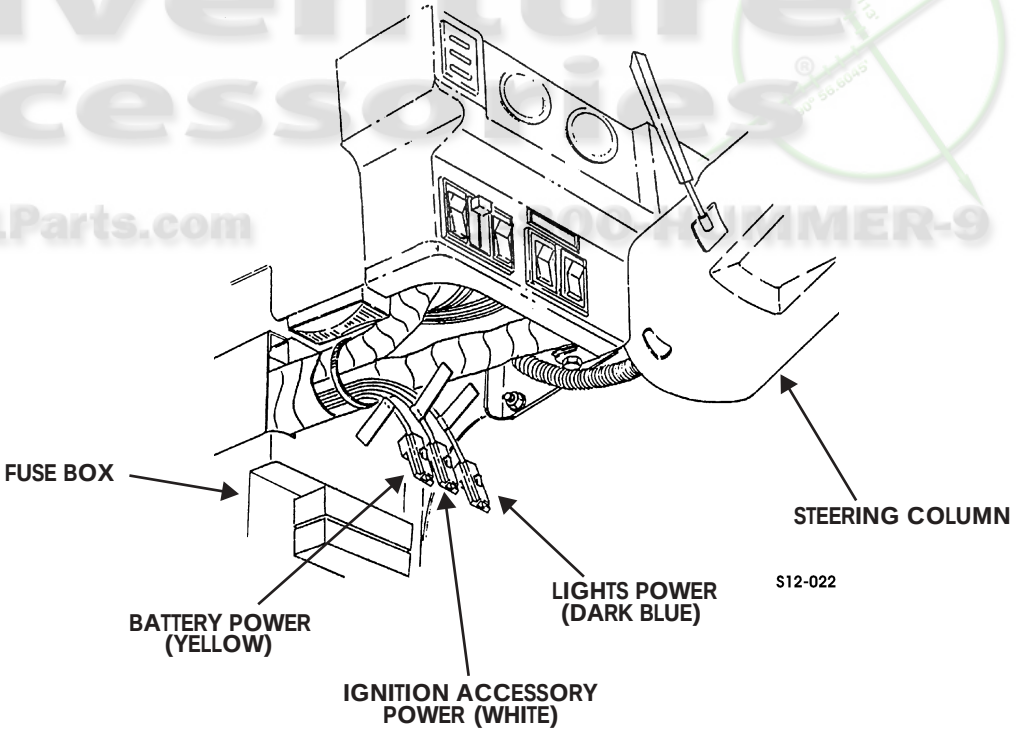


Figure 12-1: Spare Fuse Circuits

There is a permanent tag on each circuit, indicating the type of power available and the maximum usable amperage. These spare circuits provide electrical hookup of accessories such as a car phone or a CB radio.

POWER DOOR LOCKS SWITCH REPLACEMENT

NOTE: Power door lock switch replacement for all doors is similar.

Removal

1. Remove four capscrews, mounting plate, and switch from switch bezel.
2. Disconnect door harness from switch (Figure 12-2).
3. Separate switch from mounting plate.

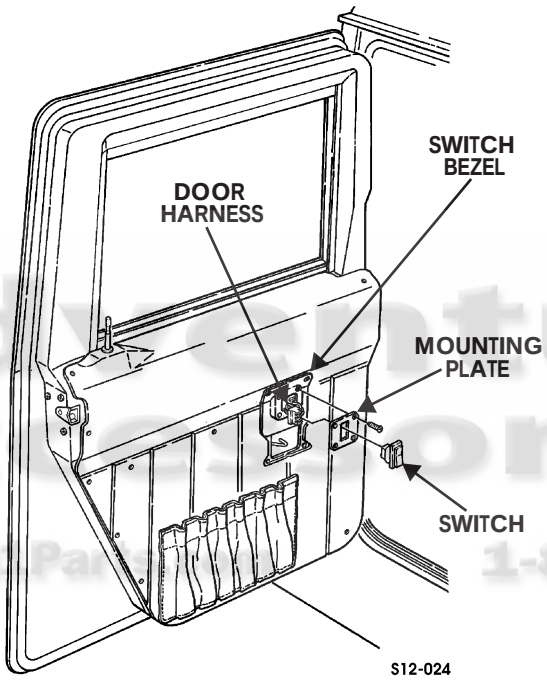


Figure 12-2: Power Door Locks

Installation

1. Assemble switch and mounting plate.
2. Connect switch and door harness.
3. Install switch and mounting plate on switch bezel with four capscrews.

POWER DOOR LOCKS ACTUATOR REPLACEMENT

Removal

NOTE: Actuator replacement for all doors is similar, with exceptions noted.

1. Raise window as far as possible.
2. Remove door trim.
3. Remove vapor barrier (Figure 12-3).

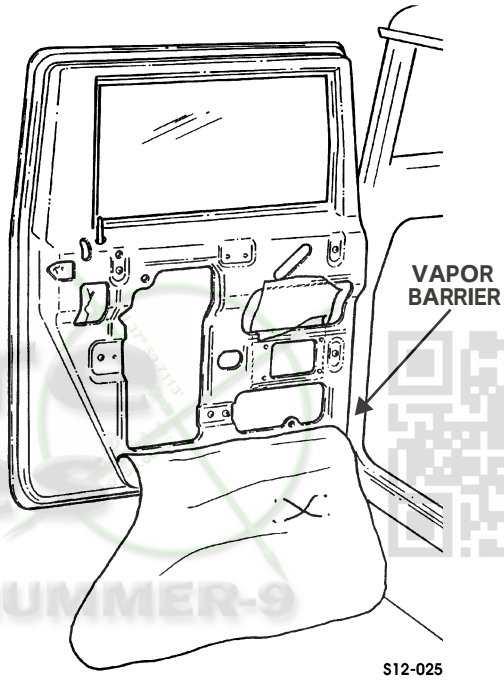


Figure 12-3: Vapor Barrier

4. Disconnect actuator power lead from door actuator (Figure 12-4).

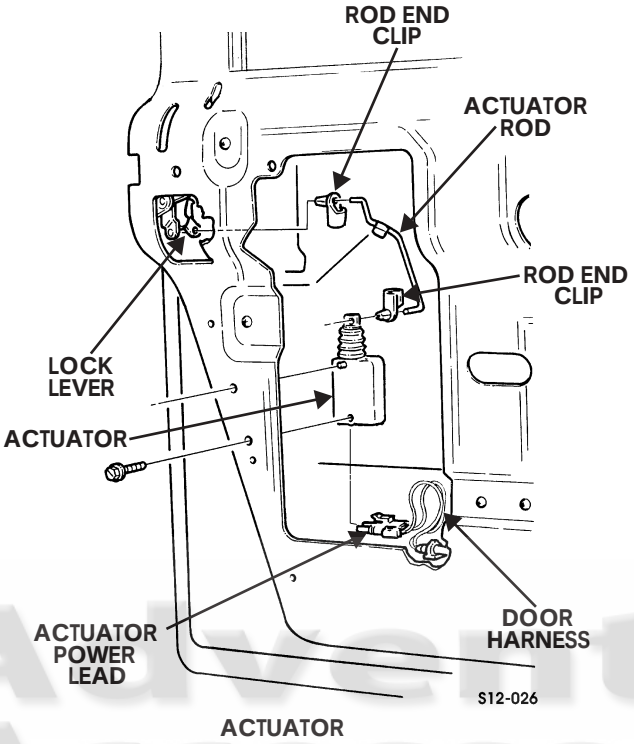


Figure 12-4: Door Lock Actuator

5. Remove capscrew from door and actuator.
6. Remove actuator from door and disconnect actuator rod from rod end clip and actuator.
7. Remove rod end clip from actuator.
8. Remove rod end clip and actuator rod from lock lever.

Installation

NOTE: Color coding on actuator rod is positioned away from actuator during installation. Actuator rods are color coded as follows: left front, red; right front, green; left rear, yellow; and right rear, blue.

1. Install end clip and actuator rod on lock lever (Figure 12-4).
2. Install end clip on actuator, position in door with pin in top mount hole, and connect actuator rod.

CAUTION: *Actuator threads could strip if care is not used when installing mounting capscrew.*

3. Secure actuator in door with capscrew in bottom mount hole.
4. Connect actuator power lead to door actuator.
5. Install vapor barrier (Figure 12-3).
6. Install door trim.

BATTERY CABLE MAINTENANCE

***WARNING:** Batteries emit explosive hydrogen gas. Keep flames or sparks away from batteries. Battery acid is extremely harmful. If acid contacts eyes or skin, flush affected area(s) liberally with clear water and seek medical help immediately. If acid contacts clothing, remove and discard affected clothing. Always disconnect ground cable, and remove all jewelry before working on batteries.*

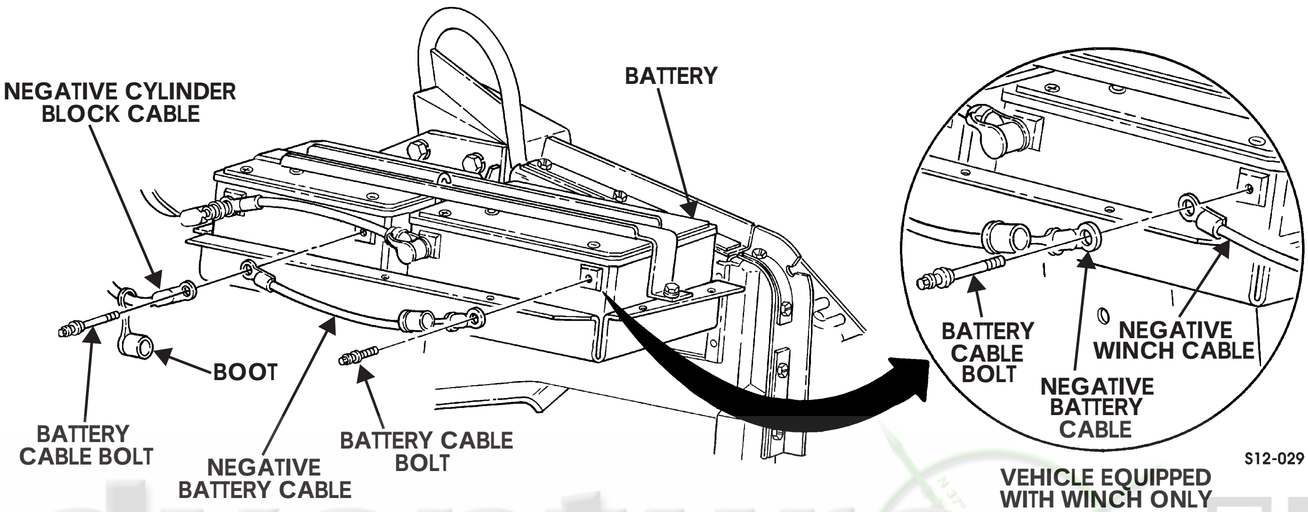


Figure 12-5: Negative Battery Cable

NOTE: Prior to removal, tag all wires and harnesses for installation.

NOTE: Remove tie straps as necessary.

Removal – Negative Battery Cables

1. Remove boots from negative battery cable and negative cylinder block cable bolts (Figure 12-5).
2. Remove battery cable bolt and negative cylinder block cable from battery.
3. Remove battery cable bolt, negative battery cable, and negative winch cable, if equipped, from battery.
4. Remove nut, lockwasher, clamp, and stud securing engine wiring harness and negative cylinder block cable to cylinder block. Discard lockwasher (Figure 12-6).

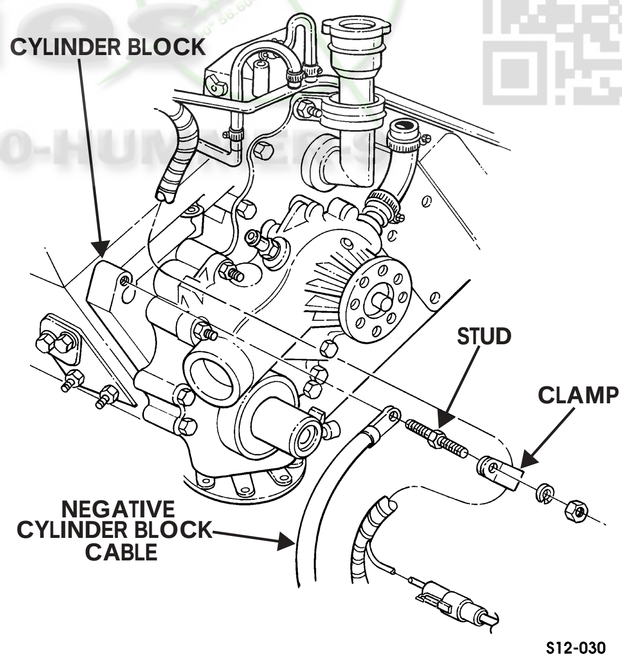


Figure 12-6: Negative Cylinder Block Cable

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean acid from cables and battery cable studs with wire brush and sodium bicarbonate solution.
2. Inspect anti-chafe wrap on cables. If damaged, replace.
3. Inspect cables for corrosion and insulation cracks. If damaged, replace.

Removal – Positive Battery Cables

1. Disconnect negative battery cables from battery.
2. Remove boots from positive battery cable and positive starter bolts (Figure 12-7).
3. Remove battery cable bolt and positive starter cable from battery.
4. Remove battery cable bolt, positive battery cable, and positive winch cable, if equipped, from battery.
5. Remove locknut, washer, capscrew, and clamp securing positive starter cable to bracket. Discard locknut.
6. Remove nut, lockwasher, and positive starter cable from starter. Discard lockwasher.

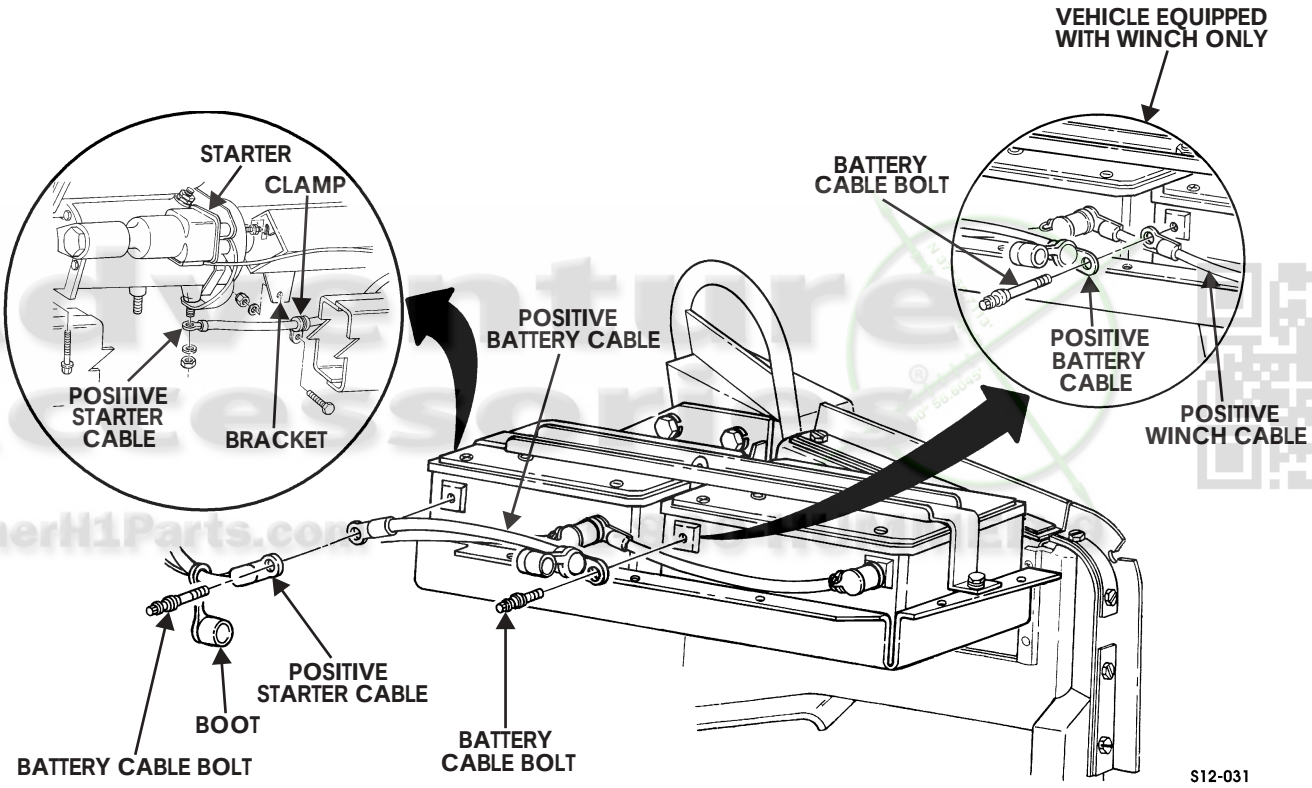


Figure 12-7: Positive Battery Cable

NOTE: Prior to removal, tag engine harness wire connector to aid in installation.

7. Disconnect positive battery wire from engine wiring harness and remove positive battery wire and positive starter cable (Figure 12-8).

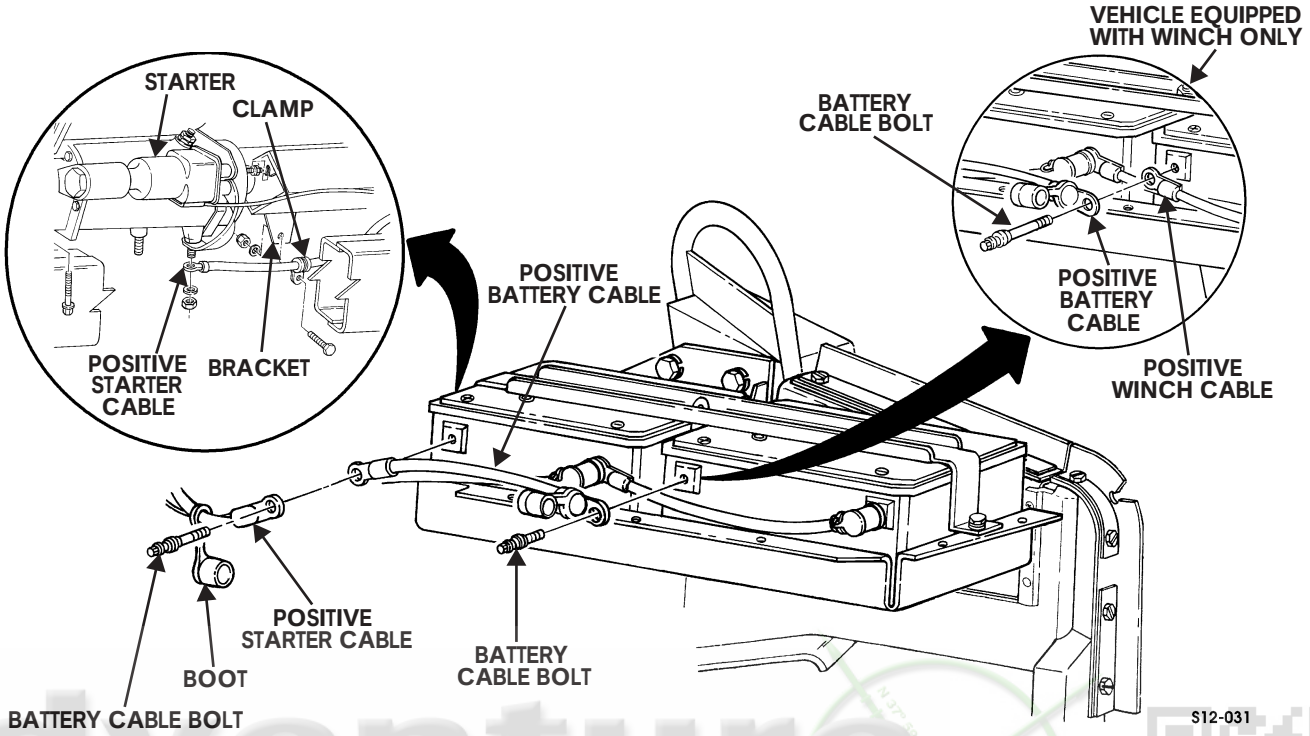


Figure 12-8: Battery Cables

Installation – Positive Battery Cables

NOTE: Install tie straps as necessary.

1. Install positive starter cable on starter with lockwasher and nut. Tighten nut to 12-16 lb-ft (16-22 N•m) (Figure 12-8).
2. Secure positive starter cable to bracket with clamp, cap-screw, washer, and locknut.
3. Connect positive battery wire to engine wiring harness (Figure 12-9).

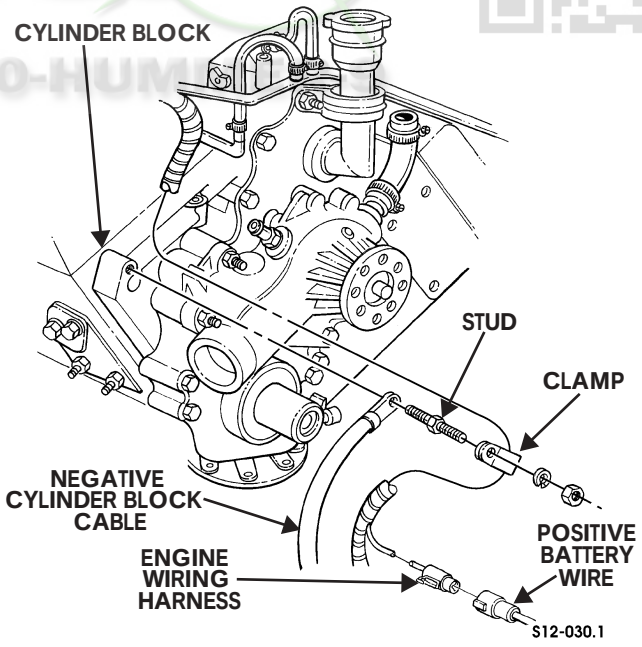


Figure 12-9: Cylinder Block

NOTE: If vehicle is equipped with a winch, proceed to step 5.

4. Using shorter battery cable bolt, secure positive battery cable to battery. Tighten battery cable bolt to 8-12 lb-ft (11-16 N•m) (Figure 12-8).
5. Using longer battery cable bolt, secure positive winch cable and positive battery cable to battery. Tighten bolt to 8-12 lb-ft (11-16 N•m).
6. Using longer battery cable bolt, secure positive starter cable and positive battery cable to battery. Tighten bolt to 8-12 lb-ft (11-16 N•m).
7. Install boots on battery cable bolts.
8. Connect negative battery cables to battery.

Installation – Negative Battery Cables

NOTE: Clean mounting area of cylinder block and cable. Remove any dirt, debris, or paint.

1. Secure negative cylinder block cable and engine wiring harness on cylinder block by installing stud, clamp, lockwasher, and nut on cylinder block (Figure 12-9).

NOTE: If vehicle is equipped with a winch, proceed to step 3.

2. Using shorter battery cable bolt, install negative battery cable on battery. Tighten battery cable bolt to 8-12 lb-ft (11-16 N•m) (Figure 12-10).
3. Using longer battery cable bolt, install negative winch cable and negative battery cable on battery. Tighten battery cable bolt to 8-12 lb-ft (11-16 N•m).
4. Using longer battery cable bolt, install negative cylinder block cable and negative battery cable on battery. Tighten battery cable bolt to 8-12 lb-ft (11-16 N•m).
5. Install boots on battery cable bolts at battery.

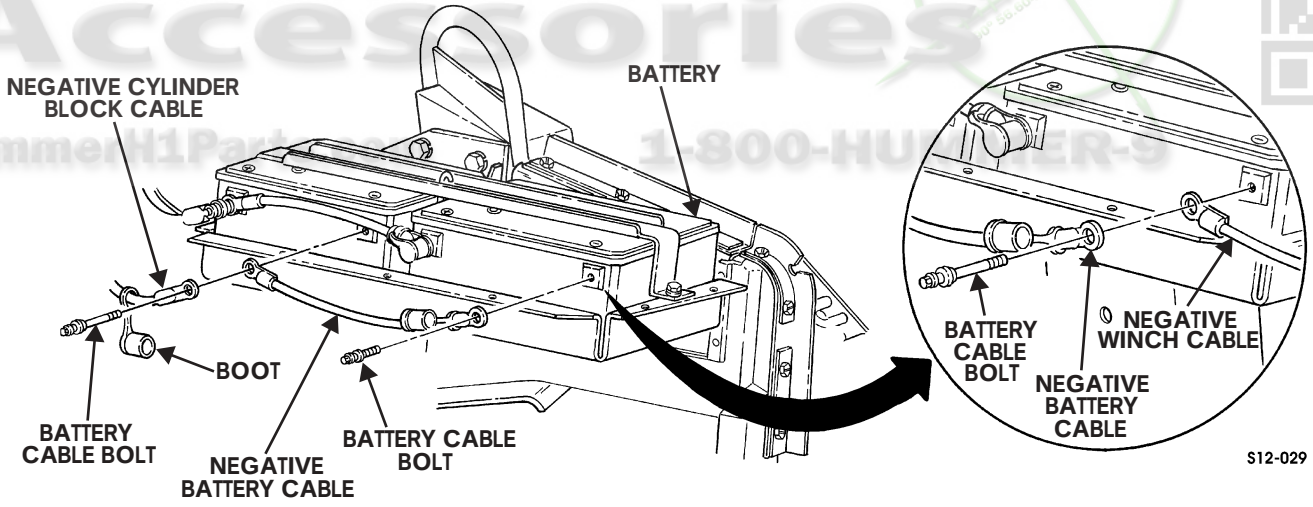


Figure 12-10: Negative Battery Cable

BATTERY AND BATTERY HOLDDOWN BRACKET MAINTENANCE

WARNING: Batteries emit explosive hydrogen gas. Keep flames or sparks away from batteries. Battery acid is extremely harmful. If acid contacts eyes or skin, flush affected area(s) liberally with clear water and seek medical help immediately. If acid contacts clothing, remove and discard affected clothing. Always disconnect ground cable, and remove all jewelry before working on batteries.

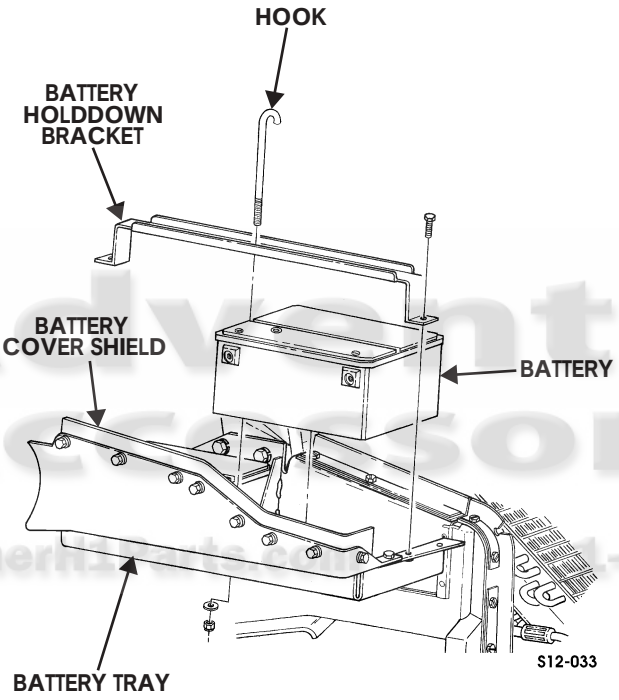


Figure 12-11: Battery Holddown Bracket

Removal

1. Remove battery cables from batteries.
2. Remove two capscrews, locknut, washer, hook, and battery holddown bracket from battery tray. Discard locknut (Figure 12-11).
3. Remove two batteries from battery tray.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

NOTE: Clean acid from batteries and battery components with sodium bicarbonate solution.

Installation

1. Install two batteries in battery tray (Figure 12-11).
2. Install battery holddown bracket on batteries with hook, washer, locknut, and two capscrews.
3. Install battery cables on batteries.

BATTERY TRAY REPLACEMENT

Removal

1. Remove batteries from battery tray.
2. Remove battery tray splash shields and seals.
3. Remove two capscrews, lockwashers, and battery tray from airlift bracket. Discard lockwashers (Figure 12-12).

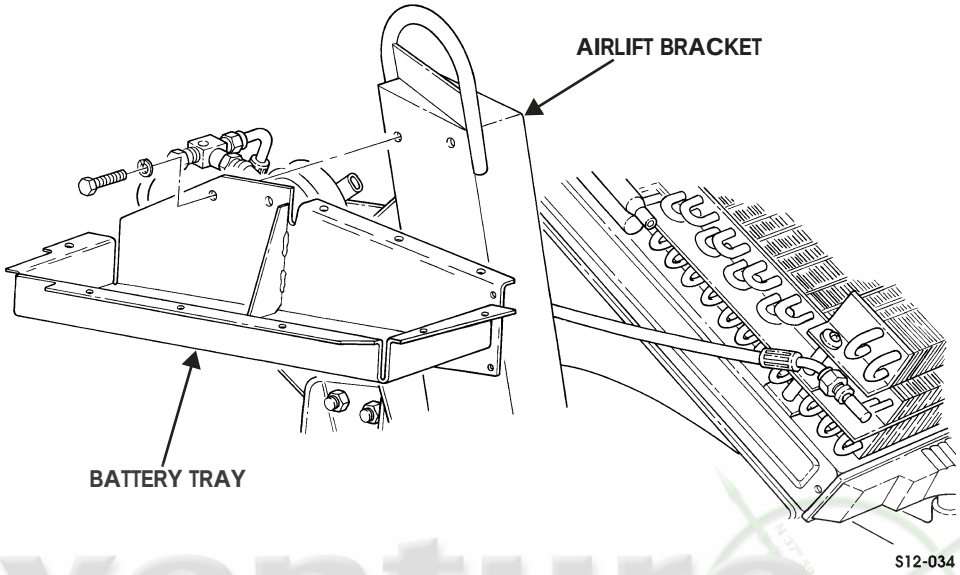


Figure 12-12: Battery Tray

Installation

1. Install battery tray on airlift bracket with two lockwashers and capscrews (Figure 12-12).
2. Install battery tray splash shields and seals.
3. Install batteries in battery tray.

BATTERY SPLASH SHIELDS AND SEALS REPLACEMENT

Removal

1. Remove battery cables.
2. Remove three locknuts, washers, capscrews, and washers from upper battery splash shield and battery seal. Discard locknuts (Figure 12-13).
3. Remove two locknuts, washers, capscrews, and retainer from upper battery splash shield and seal. Discard locknuts.
4. Remove three locknuts, washers, capscrews, retainer, and seal from upper battery splash shield. Discard locknuts.
5. Remove five locknuts, washers, capscrews, and upper battery splash shield from battery tray. Discard locknuts.
6. Remove seven locknuts, washers, capscrews, and three retainers and two seals from battery tray and lower battery splash shield. Discard locknuts (Figure 12-14).

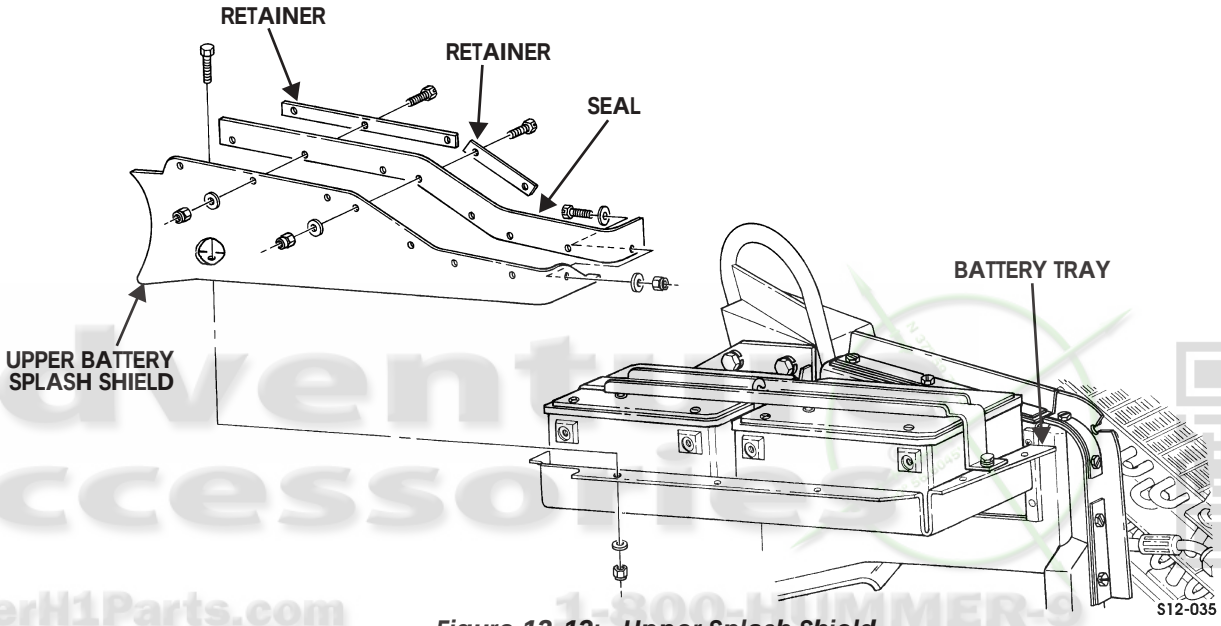


Figure 12-13: Upper Splash Shield

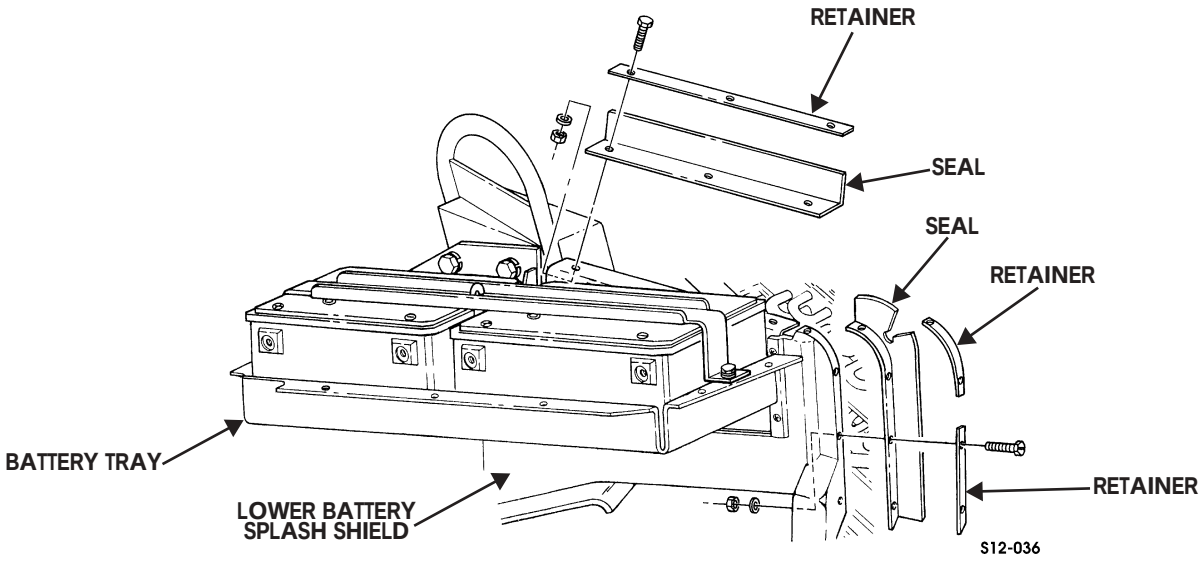


Figure 12-14: Seal End Retainer

7. Remove locknut, washer, capscrew, and washer from lower battery splash shield and frame. Discard locknut (Figure 12-15).
8. Remove locknut, washer, capscrew, and washer from lower battery splash shield and battery tray. Discard locknut.
9. Remove capscrew and two washers from lower battery splash shield and airlift bracket.
10. Remove locknut, two washers, capscrew, washer and lower battery splash shield from bracket. Discard locknut.

Installation

1. Install lower battery splash guard on bracket with washer, capscrew, two washers, and locknut (Figure 12-15).
2. Install two washers and capscrew on lower battery splash shield and airlift bracket.
3. Install washer, capscrew, washer, and locknut on lower battery splash shield and battery tray.
4. Install washer, capscrew, washer, and locknut on lower battery splash shield and frame.
5. Install two seals and three retainers on battery tray and lower battery splash shield with seven capscrews, washers, and locknuts (Figure 12-14).

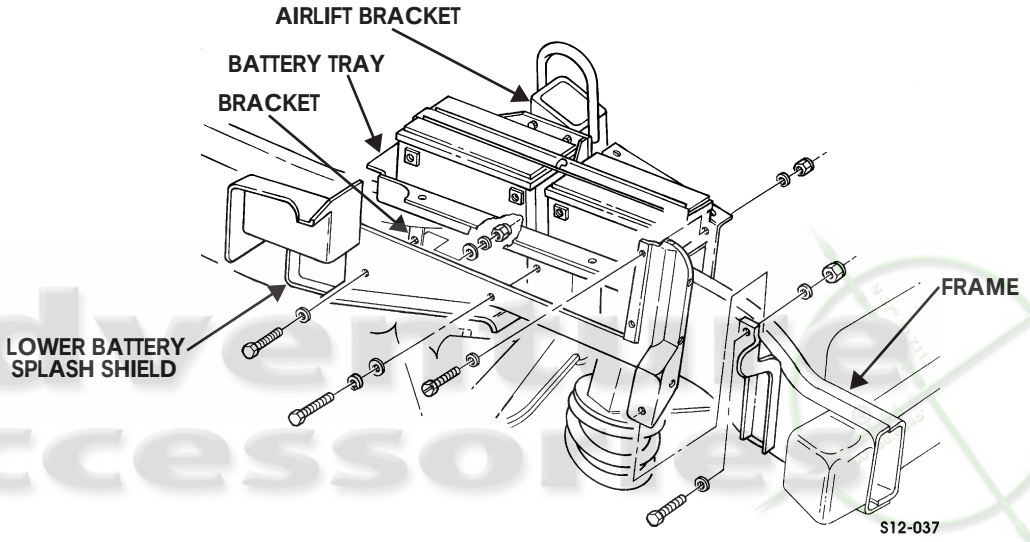


Figure 12-15: Lower Splash Shield

6. Install upper battery splash shield on battery tray with five capscrews, washers, and locknuts.
7. Install retainer and seal on upper battery splash shield with three capscrews, washers, and locknuts.
8. Install retainer on seal and upper battery splash shield with two capscrews, washers, and locknuts.
9. Install three washers, capscrews, washers, and locknuts on upper battery splash shield and battery seal.
10. Install battery cables.

STARTER REPLACEMENT

Removal

WARNING: Starter must be supported during removal and installation. Failure to do this may cause injury or damage to equipment.

NOTE: Tag leads for installation.

1. Disconnect negative battery cable.
2. Remove converter housing cover (Section 2).
3. Remove cap and/or adhesive sealant from positive terminal of starter (Figure 12-16).
4. Remove nut, lockwasher, and positive starter cable from starter positive terminal. Discard lockwasher.
5. Remove screw, clip, and solenoid lead from solenoid.
6. Remove locknut, washer, and capscrew from clamp securing positive starter cable to bracket. Discard locknut.
7. Loosen locknut and washer securing stud on front of starter and bracket on engine mount.
8. Supporting starter, remove two capscrews, starter, and shim(s) from engine. Record thickness of shim(s).

Installation

1. Position shim pack on starter (Figure 12-16).
2. Position starter, with shim pack, on flywheel housing, with solenoid facing away from engine.
3. Slide front stud of starter into bracket on engine mount, ensuring bracket is between washer and starter.
4. Install starter on engine with two capscrews. Tighten capscrews to 40 lb-ft (54 N•m).
5. Secure stud on front of starter and bracket on engine mount with washer and locknut. Tighten locknut to 24 lb-ft (33 N•m).
6. Secure positive starter cable to bracket with clamp, capscrew, washer, and locknut. Do not tighten capscrew.
7. Connect solenoid lead to solenoid with clip and screw. Tighten screw to 22 lb-in. (2 N•m).
8. Connect positive starter cable to starter positive terminal with lockwasher and nut. Tighten nut to 25-31 lb-ft (34-42 N•m).
9. Seal and/or cap positive terminal, cable, and lead ends. Cover all exposed metal if using sealant alone.
10. Tighten capscrew securing positive starter cable clamp to bracket.
11. Install upper converter housing (Section 2).
12. Install negative battery cable.

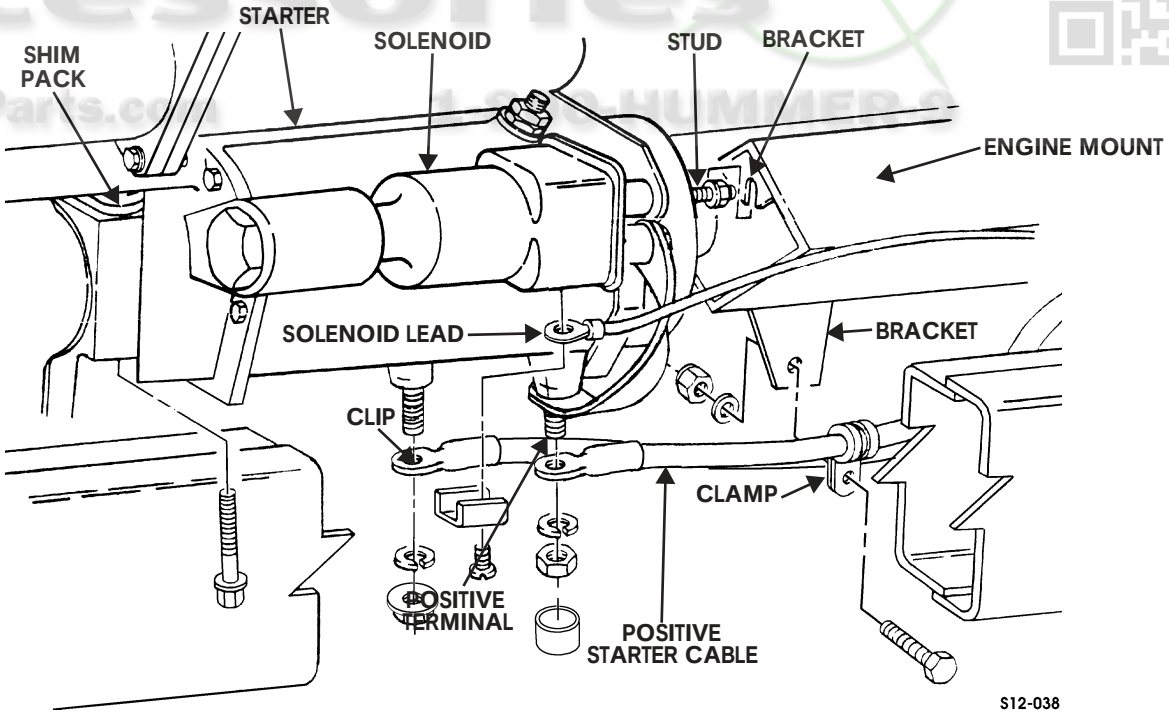


Figure 12-16: Starter

STARTER REPAIR

Disassembly

1. Remove starter.
2. Remove plug and gasket from pinion housing. Discard gasket (Figure 12-17).

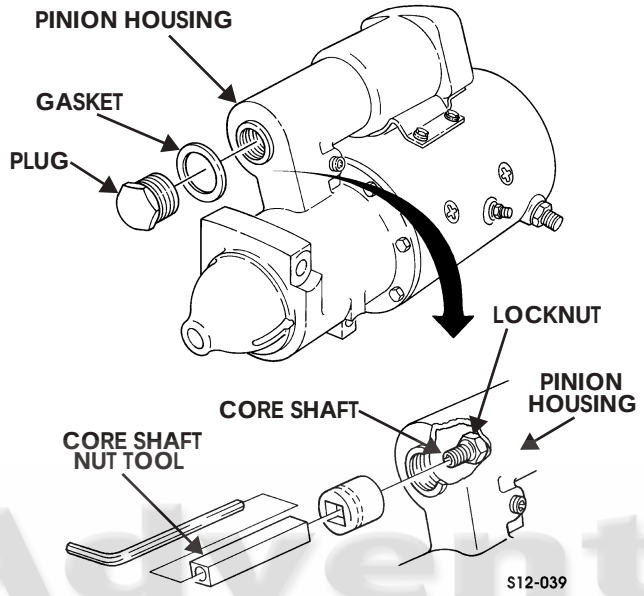


Figure 12-17: Core Shaft Nut

3. Using core shaft nut tool, remove locknut from end of core shaft inside pinion housing. Discard locknut.
4. Remove four nuts, lockwashers, and two solenoid connectors from frame assembly and solenoid. Discard lockwashers (Figure 12-18).

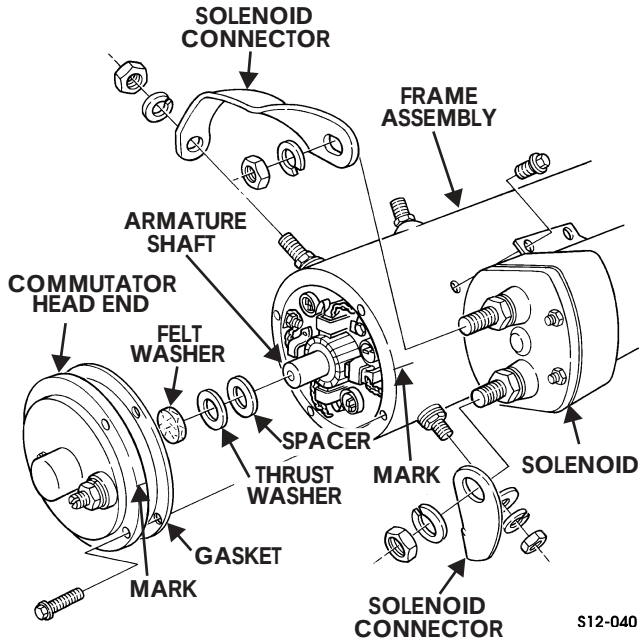


Figure 12-18: End Plate

5. Remove four capscrews and solenoid from frame assembly.
6. Scribe index marks on commutator head end and frame assembly.
7. Remove four capscrews, commutator head end, and gasket from frame assembly. Discard gasket.
8. Remove thrust washer(s) and spacer from armature shaft.
9. Remove felt washer from head end. Discard felt washer.
10. Scribe index marks on pinion housing and frame assembly (Figure 12-19).

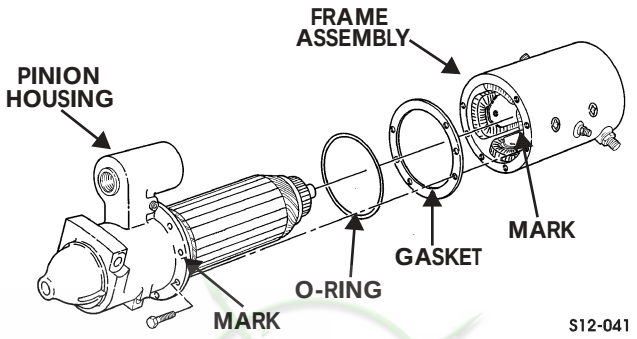


Figure 12-19: Starter Housing

11. Remove seven capscrews securing pinion housing to frame assembly.
12. Remove frame assembly, gasket, and O-ring from pinion housing. Discard gasket and O-ring.
13. Remove two plugs and pin from pinion housing and shift lever (Figure 12-20).

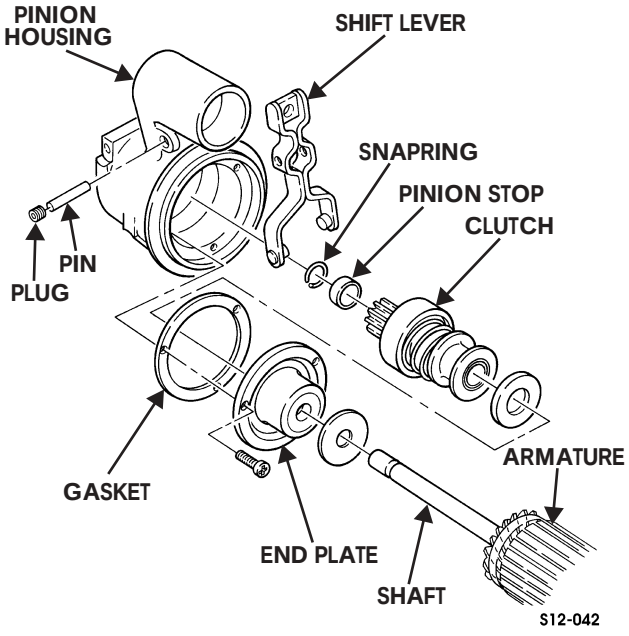


Figure 12-20: Starter Drive

14. Clamp pinion housing in vise and remove three screws from end plate and pinion housing (Figure 12-21).
15. Slide armature, end plate, and shift lever out of pinion housing.

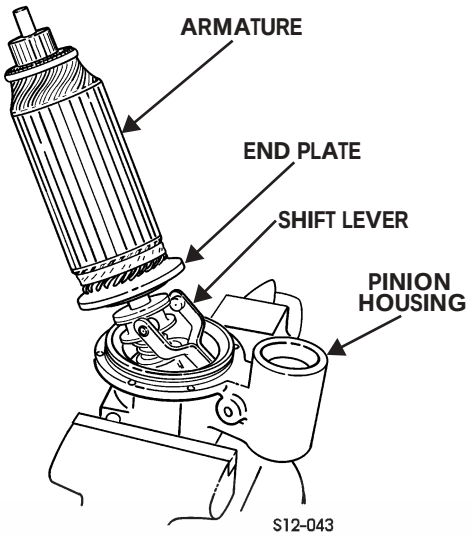


Figure 12-21: Armature

16. Remove snapring and pinion stop from armature shaft, and slide clutch off armature shaft. Discard snapring and pinion stop (Figure 12-20).
17. Remove washer, end plate, and washer from armature shaft.
18. Remove gasket from end plate. Discard gasket.
19. Remove two nuts, lockwashers, screws, copper washers, and negative brush leads from frame assembly. Remove brushes from brush holders. Discard lockwashers (Figure 12-22).

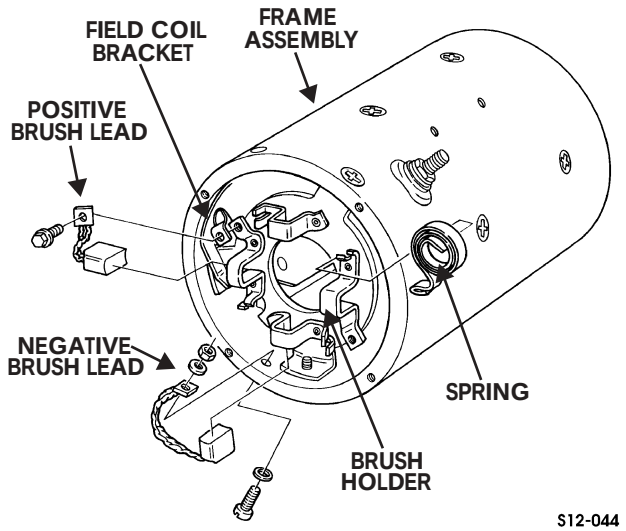


Figure 12-22: Brushes and Holder

20. Remove two screws and positive brush leads from field coil brackets. Remove brushes from holders.
21. Remove four springs from brush holders.
22. Remove four nut and lockwasher assemblies and rubber washers from solenoid housing. Discard rubber washers (Figure 12-23).

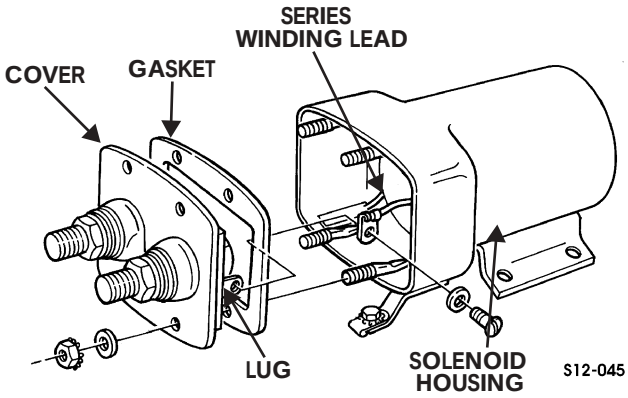


Figure 12-23: Solenoid Housing

23. Pull cover away from solenoid housing and remove screw and washer from lug on cover and series winding lead.
24. Remove cover and gasket from solenoid housing. Discard gasket.
25. Holding core shaft, remove locknut, washer, and contact from core shaft. Discard locknut (Figure 12-24).
26. Remove and separate spring from core shaft and washer.
27. Remove snapring, spring retainer, spring, spring retainer, rubber boot, and washer from core shaft.

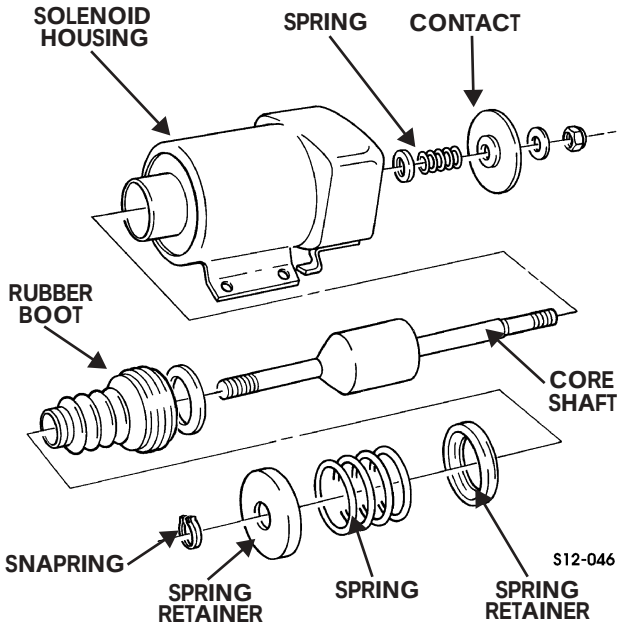


Figure 12-24: Solenoid Components

Inspection

1. Inspect clutch for broken spring, damaged gear or splines, and non-lockup. Replace clutch if damaged (Figure 12-25).

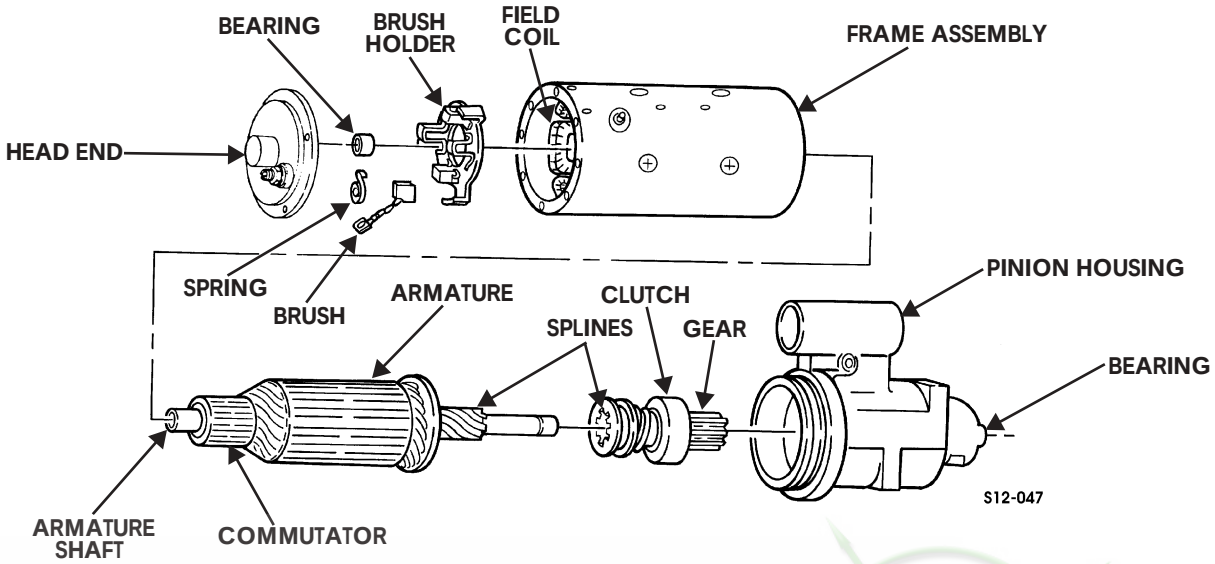


Figure 12-25: Starter Components

2. Inspect brushes for cracks, roughness, galling, wear, or damaged lead. If one brush length is less than 0.315 in. (8 mm) or has other damage, replace all brushes as a set.
3. Inspect springs for breaks, distortion, or other damage. Replace any damaged springs (Figures 12-25 and 12-26).

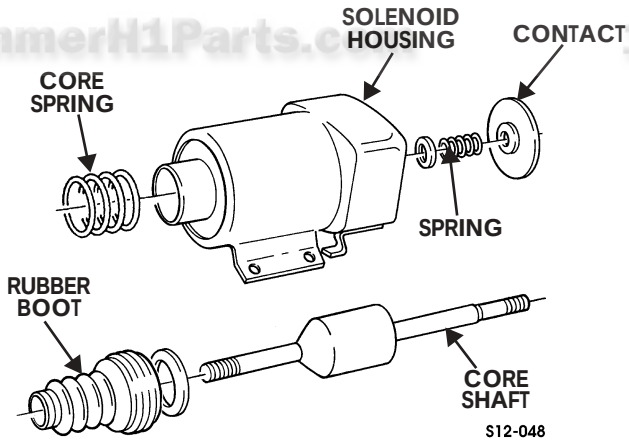


Figure 12-26: Core Shaft

4. Inspect bearings in head end and pinion housing for cracks, roughness, galling, or damage. Replace bearings if defective (Figure 12-25).
5. Inspect pinion housing for cracks, damaged pinion bearing, and damaged threads. Repair minor thread damage. Replace starter if otherwise damaged.
6. Inspect commutator for damage due to arcing (burned spots and pitting), damaged shaft, splines, or threads. Replace starter if commutator is damaged.
7. Test armature, field coils, and brush holders for shorts, grounds, and open circuits with an armature test set. Replace starter if any one of these parts is defective.
8. Inspect core spring, core shaft, and rubber boot for damage. Replace parts if damaged (Figure 12-26).
9. Inspect contact for burns or damage. Replace contact if burned or damaged.
10. Inspect housing of frame assembly, head end, and solenoid housing for cracks or damage. Replace starter if any part is damaged (Figures 12-25 and 12-26).

Assembly

1. Assemble washer, rubber boot, spring retainer, spring, and spring retainer on core shaft and secure with snapring (Figure 12-27).

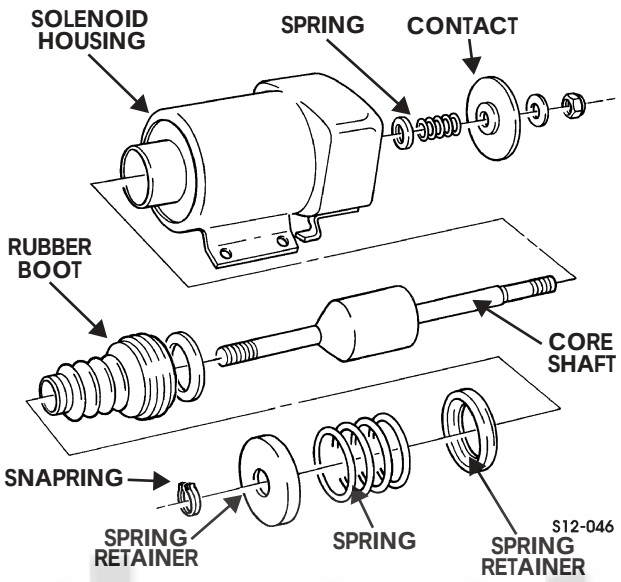


Figure 12-27: Solenoid Components

2. Place core shaft assembly into solenoid housing.
3. Install washer, spring, contact, washer and locknut on core shaft.
4. Place gasket on cover and secure series winding lead on lug with screw and washer (Figure 12-28).

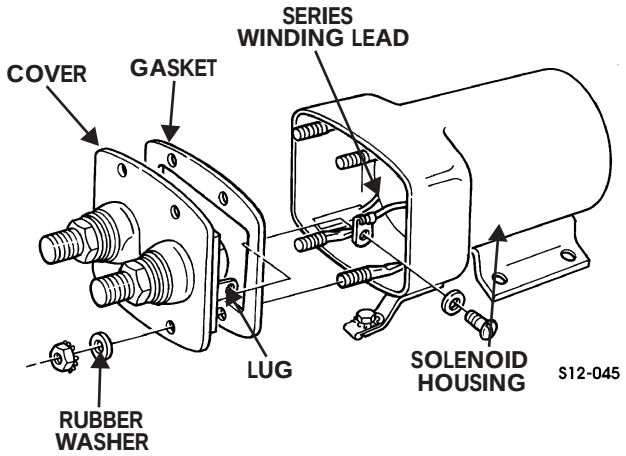


Figure 12-28: Solenoid End Cover

5. Install cover and gasket on solenoid housing with four rubber washers and nut and lockwasher assemblies.
6. Install two negative brushes and two positive brushes on brush holders and retain with four springs (Figure 12-29).

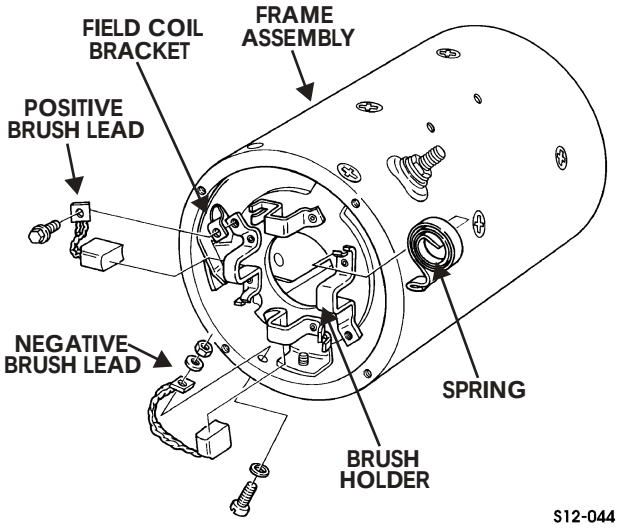


Figure 12-29: Brushes and Holder

7. Connect two positive brush leads to two field coil brackets with two screws.
8. Connect two negative brush leads to frame assembly with two copper washers, screws, lockwashers, and nuts.
9. Cover negative lead screw heads with adhesive sealant.
10. Apply a coating of aircraft grease to armature shaft, shift lever studs, groove of clutch, and inside diameter of end plate (Figure 12-30).
11. Place washer, end plate, and gasket over armature shaft.

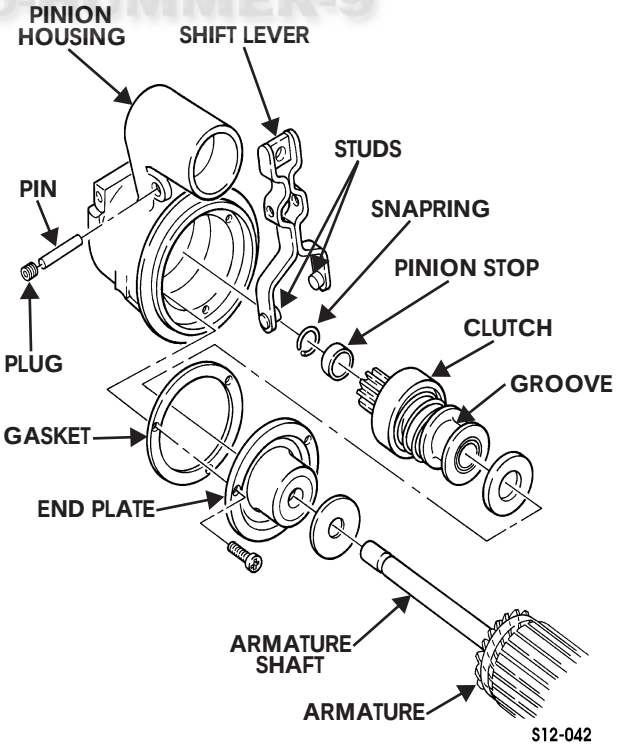


Figure 12-30: Starter Drive Gear

12. Place washer, clutch, and pinion stop on armature shaft and retain with snapring.

NOTE: Position armature and shift lever in position shown for installation.

13. Place shift lever over clutch with shift lever studs engaged in clutch groove.

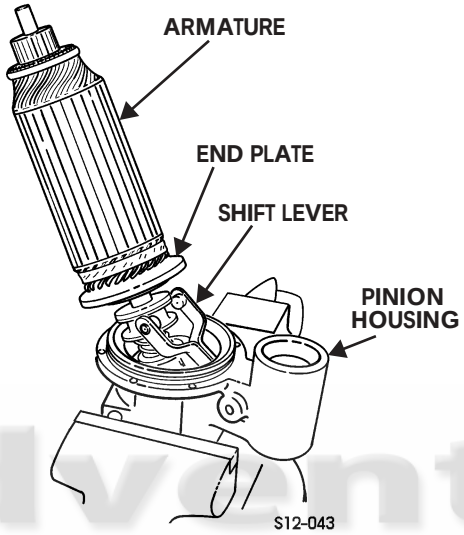


Figure 12-31: Armature

14. Feed shift lever into pinion housing as armature is positioned in large bore of pinion housing and install with three screws through end plate into pinion housing. Tighten screws to 40 lb-in. (5 N•m) (Figure 12-31).
15. Install pin through pinion housing and shift lever. Retain with two plugs in pinion housing (Figure 12-30).
16. Place O-ring and gasket on pinion housing (Figure 12-32).
17. Coat seven screws with adhesive sealant.

CAUTION: *As armature is inserted into frame assembly, carefully align brushes on commutator. Brushes chip and break easily.*

18. Align index marks on frame assembly and pinion housing and install armature and pinion housing on frame assembly with seven capscrews. Tighten capscrews to 50 lb-in. (6 N•m).
19. Saturate felt washer with lubricating oil and install on commutator end head (Figure 12-33).
20. Place spacer and thrust washer(s) on armature shaft.
21. Coat threads of capscrews with adhesive sealant.

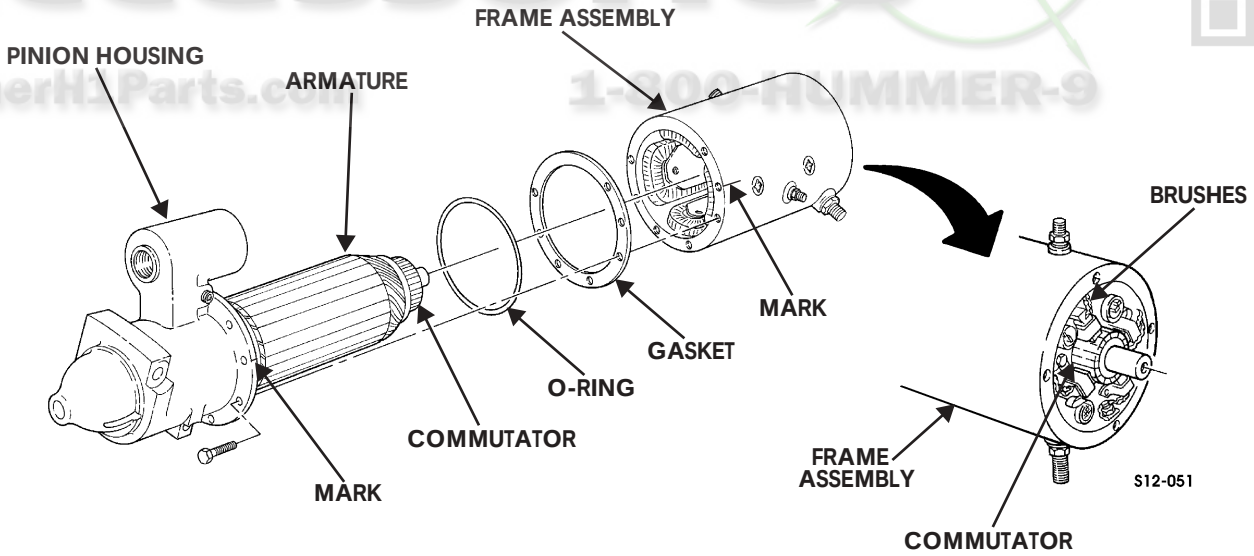


Figure 12-32: Starter Housing

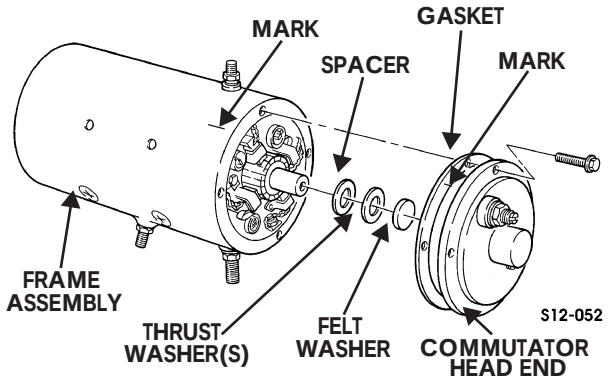


Figure 12-33: Starter End Plate

22. Align index marks and install commutator end head and gasket on frame assembly with four capscrews. Tighten capscrews to 25 lb-in. (3 N•m).
23. Coat threads of capscrews with adhesive sealant.
24. Coat ribbed area of rubber boot with lithium grease (Figure 12-34).
25. Align end of core shaft into hole in shift lever and install solenoid on frame assembly with four capscrews. Tighten capscrews to 50 lb-in. (6 N•m).
26. Using core shaft nut tool, install locknut on core shaft (Figure 12-35).

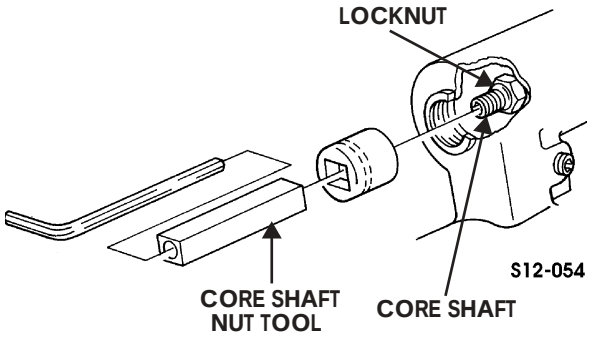


Figure 12-35: Core Shaft Nut

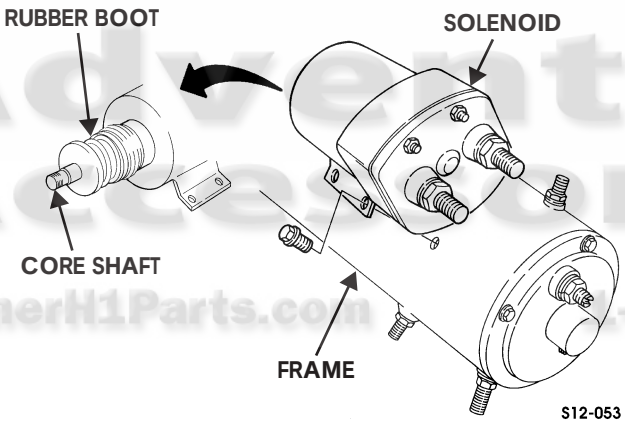


Figure 12-34: Solenoid Boot

Adjustment

NOTE: Measure armature end play between snapring and pinion housing or on end of armature shaft in nose piece.

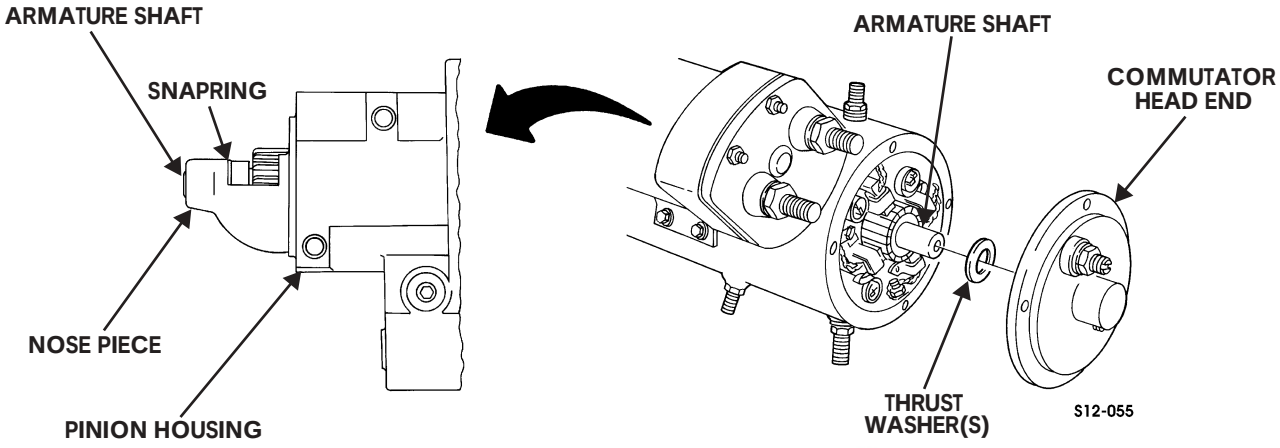


Figure 12-36: Armature End Play

1. Armature end play should be 0.005-0.030 in. (0.127-0.762 mm). If adjustment is necessary, remove commutator head end and add or remove thrust washer(s) (Figure 12-36).
2. Connect 12 volt power supply (DC) and momentarily connect jumper wire. This shifts clutch into cranking position (Figure 12-37).

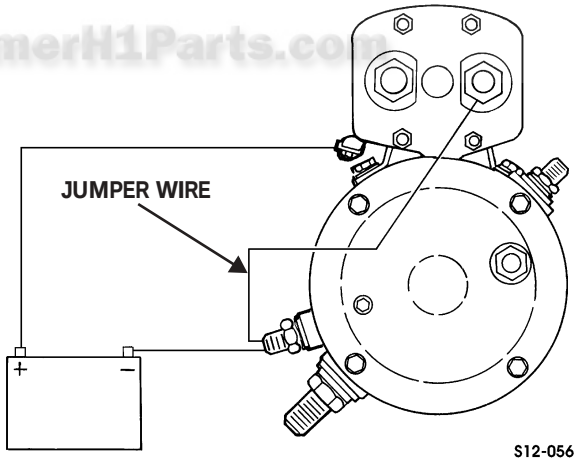


Figure 12-37: Jumper Connections

3. Push clutch toward disengage position to remove slack. Measure gap between edges of clutch and pinion stop (Figure 12-38). Gap should be 0.020-0.050 in. (0.508-1.27 mm).

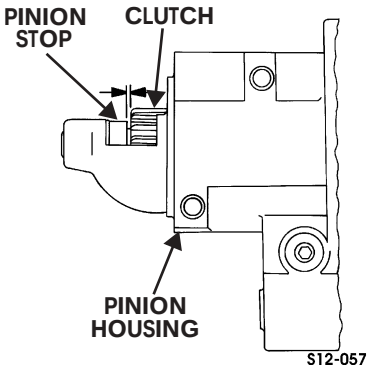


Figure 12-38: Pinion Stop Clearance

NOTE: Core shaft must be held while adjusting position of locknut.

4. Adjust clutch end play by turning locknut in or out (Figure 12-39).

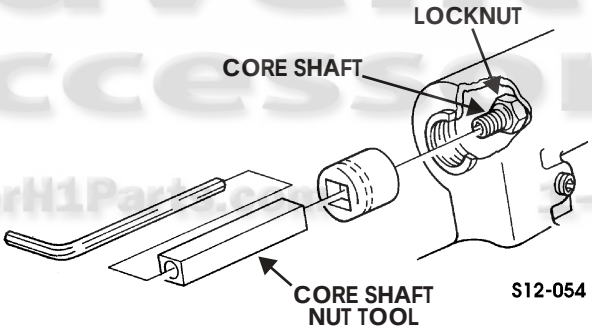


Figure 12-39: Pinion Adjustment

5. Install gasket and plug in pinion housing (Figure 12-40).

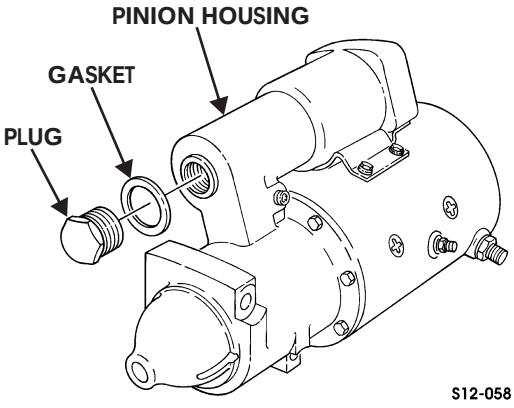


Figure 12-40: Pinion Housing Plug

6. Install two solenoid lead connectors on solenoid terminals and frame assembly terminals with four lockwashers and nuts (Figure 12-41).

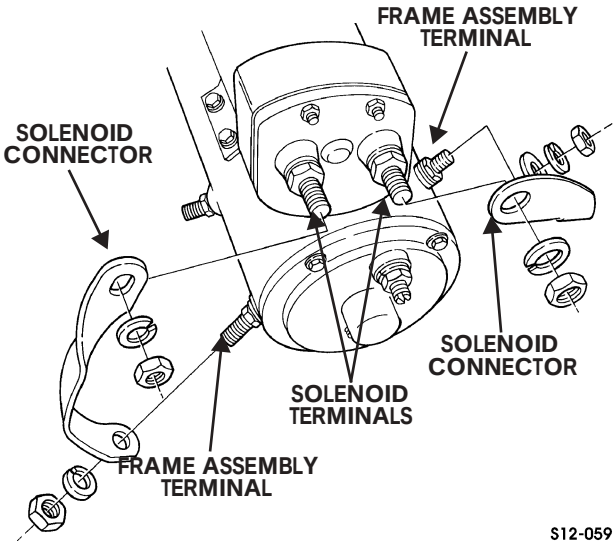


Figure 12-41: Positive Strap

7. Connect 12-volt supply (DC) to starter motor (Figure 12-42).

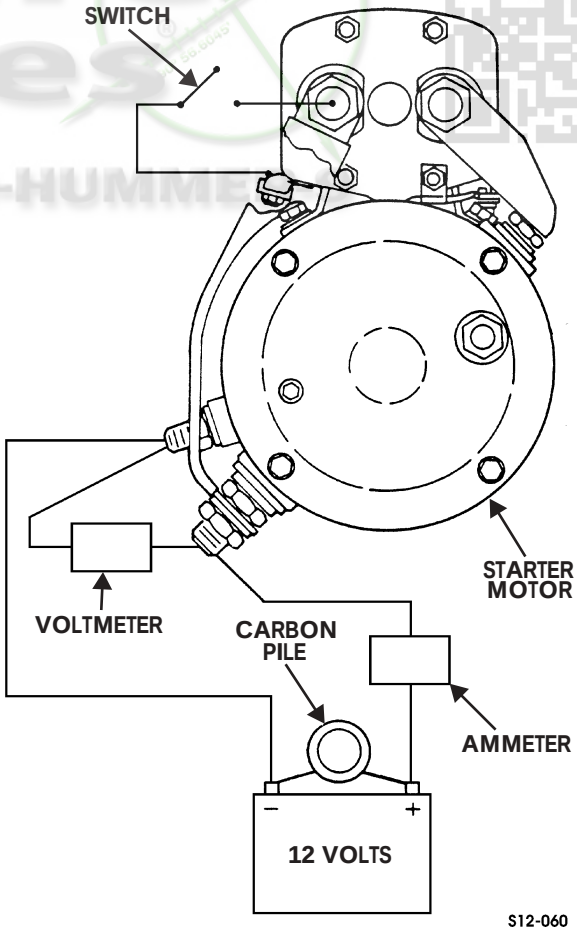


Figure 12-42: Test Connections

CAUTION: *Do not operate starter motor for more than 30 seconds at a time. Allow starter motor to cool at least 2 minutes between tests, or damage to starter motor may result.*

8. Close switch, adjust voltage to 9.5 volts on voltmeter using carbon pile. Check rotating speed of armature with tachometer. Current draw can be read on ammeter.
9. Maximum current draw should be 65 amps with a minimum armature speed of 5000 rpm. If a low speed, high current condition exists, check armature for shorts or grounds. If a low speed, low current draw exists, inspect starter motor for bad connections or poor brush contact.
10. Install starter.

ALTERNATOR REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Loosen pivot bolt and remove front and rear short bolts (Figure 12-43).
3. Remove serpentine drivebelt from alternator pulley.
4. Pull alternator away from engine. Remove nut and lockwasher and disconnect three battery wires from battery terminal of alternator. Discard lockwasher (Figure 12-44).
5. Unlock and disconnect ignition lead connector from side of alternator.
6. Remove pivot bolt and alternator from engine (Figure 12-43).

Installation

1. Position alternator in upper bracket and finger tighten pivot bolt (Figure 12-43).
2. Connect three battery wires on terminal of alternator (Figure 12-44). Secure with lockwasher and nut. Tighten nut to 62-80 lb-in (7-9 N•m).
3. Install ignition lead connector and ensure connector latch is locked.
4. Position serpentine drivebelt on alternator pulley.
5. Move alternator into alignment with lower bracket and install front and rear short bolts. Tighten bolts 18 lb-ft (25 N•m) (Figure 12-43).
6. Tighten pivot bolt to 37 lb-ft. (50 N•m).
7. Connect battery ground cable.

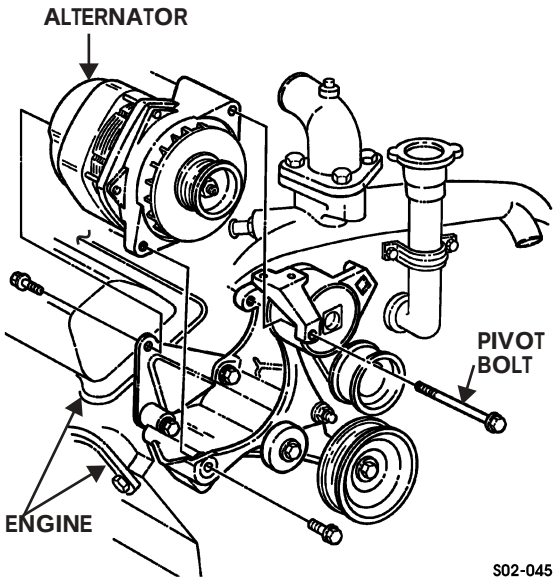


Figure 12-43: Alternator Mounting

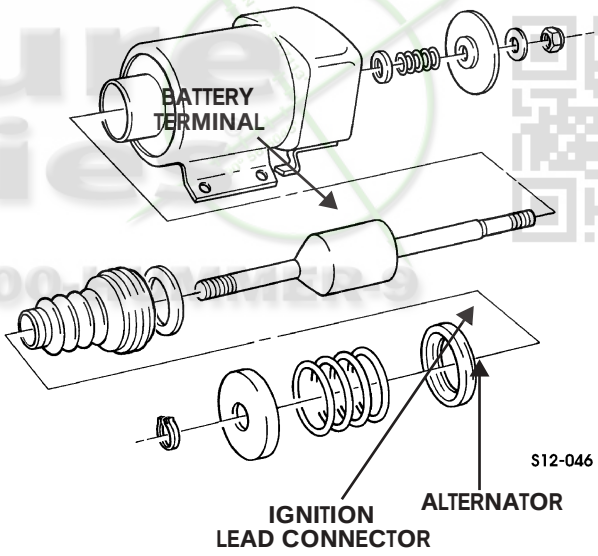


Figure 12-44: Alternator

124 AMPERE ALTERNATOR REPAIR

Disassembly

1. Remove alternator.

NOTE: Bench testing procedure may be used to determine or confirm alternator problems (refer to last section of this procedure). Mark drive end frame and slip ring end frame for assembly.

2. Holding rotor shaft with allen wrench, remove nut, washer, pulley, fan, and thin collar from rotor shaft (Figure 12-45).
3. Remove four through-bolts from slip ring end frame and drive end frame.
4. Remove drive end frame and thick collar from rotor shaft.
5. Remove three nuts from stator leads and rectifier bridge.
6. Remove stator from slip ring end frame.

NOTE: Record fasteners and parts positions for assembly.

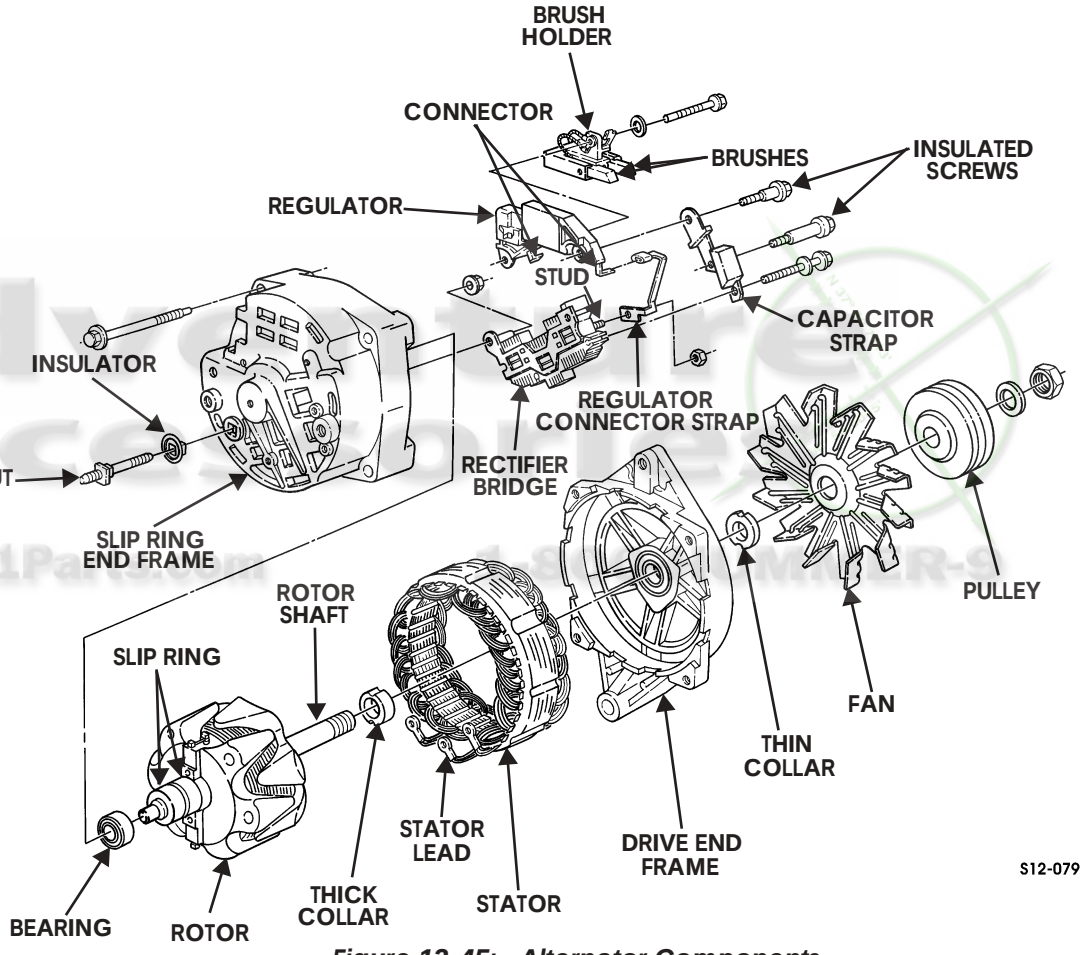


Figure 12-45: Alternator Components

7. Remove three screws, two insulated screws and washer from components in slip ring end frame.
8. Remove nut and output stud with insulator from slip ring end frame.
9. Remove rectifier bridge, capacitor strap, regulator connector strap, and brush holder from slip ring end frame.

NOTE: Perform steps 9, 10, and 11 only if parts must be replaced.

10. Unsolder and separate brush holder and regulator connector.
11. Unsolder and separate connector strap from regulator.

NOTE: Perform step 11 only if bearing is obviously defective.

12. Remove bearing from slip ring end of rotor shaft. Discard bearing.

Cleaning

CAUTION: *Encapsulated items and insulating coatings on wires in field coil and stator can be damaged by liquid or paste-type solvents. Use these solvents only for cleaning bare metal items.*

Clean encapsulated and exposed wire items by wiping with soft cloth and low pressure air.

Inspection and Repair

NOTE: Refer to Section 2 for general instructions on inspection and repairs.

a. Rotor

1. Inspect for cracked slip rings, damaged threads, and galling or scoring on bearing journal surfaces on shaft (Figure 12-46).
2. Corrosion or light scoring may be removed with 400 grit polishing material or turning on lathe to remove a minimum of material. Hold roundness to 0.002 in. (0.05 mm) maximum indicator reading. Repair minor thread damage per Section 2.
3. If there is other damage to rotor, wires, slip rings, and shaft, replace rotor and shaft as an assembly.
4. Test slip rings and field coil for opens (high resistance), shorts (very low resistance), and grounds (low resistance) to frame and shaft. Replace rotor and shaft as an assembly if any test is failed.
5. If ball bearing remained on rotor shaft during removal, inspect ball bearing for free play, roughness, leaking seals, and other damage. Replace bearing if damaged. Seat new ball bearing to shoulder of rotor shaft by pressing on inner race of bearing.

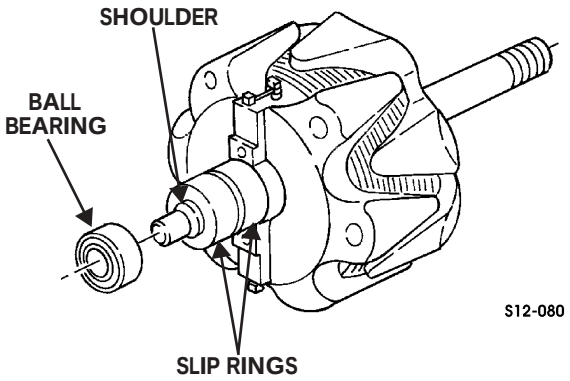


Figure 12-46: Rotor

b. Stator

NOTE: Standard VOM cannot reliably test delta wired stators for shorts and opens.

1. Check each pair of stator wires for continuity to laminations. Any continuity indicates defective stator (grounded) (Figure 12-47).
2. Visually examine stator wiring for discoloration due to overheating (which is a sign of short or ground). Normal color is reddish brown to purple. Bare copper, dark spots, or char (dull black) indicates trouble spots.
3. There are no repairs (except for replacing eye ends) possible for stator. Replace stator if damaged or discolored.

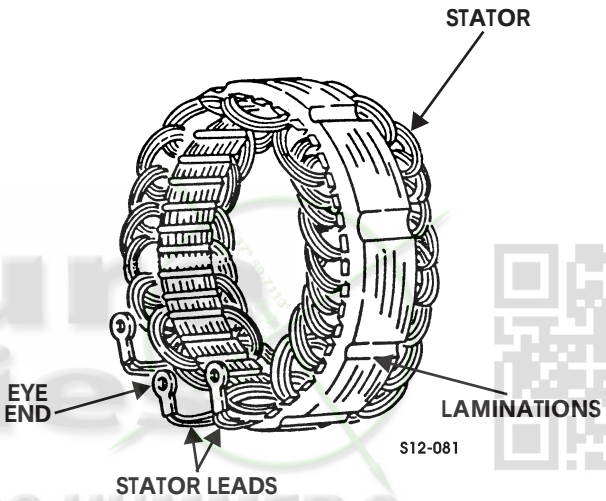


Figure 12-47: Stator

c. Rectifier Bridge

CAUTION: *Check ohmmeter manual before performing diodes check, as some meters can be damaged or can damage diodes during check.*

NOTE Studs are embedded in insulation. To obtain diode readings, probe must contact copper strap.

1. Connect ohmmeter leads to grounded side and strap as shown and take readings at each strap (Figure 12-48).
2. Repeat process of step 1 with leads reversed.

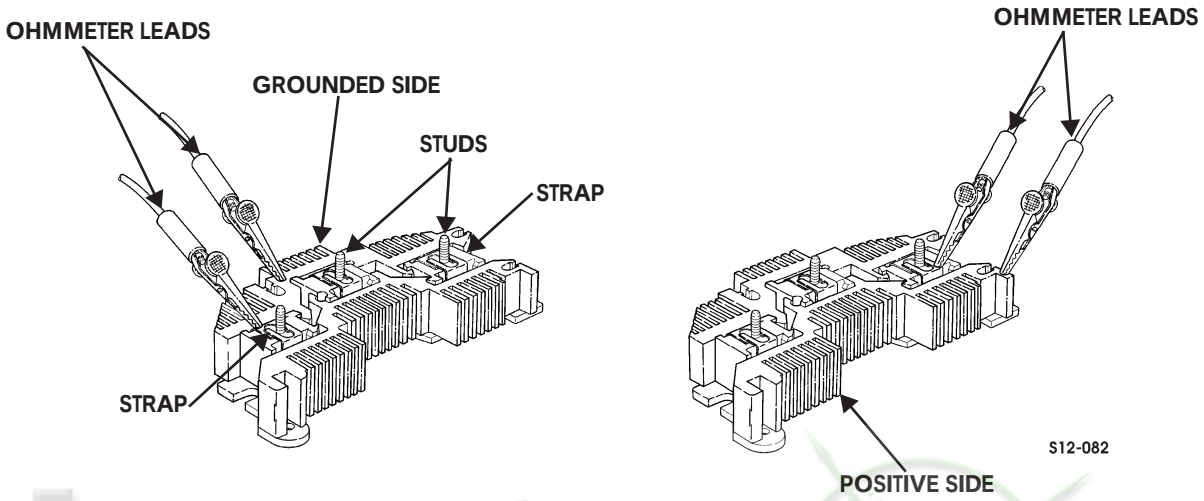


Figure 12-48: Rectifier Bridge

3. All three readings in steps 1 or 2 should read high resistance in one case and low resistance in other case.
4. Connect ohmmeter leads on positive side and strap as shown, and take readings at each strap (Figure 12-48).
5. Repeat process of step 4 with leads reversed.
6. All three readings in steps 4 and 5 should be the same, with resistance high in one set and low in the other set.
7. If any one reading in the sets of three readings of steps 1, 2, 3, and 4 is not the same as the other two readings, replace rectifier bridge.

d. Regulator

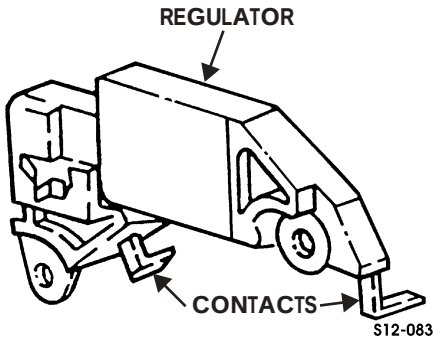


Figure 12-49: Regulator

NOTE Bench testing prior to disassembly often can determine if regulator is defective. Special equipment is required to perform an independent test of the regulator.

1. Inspect regulator for cracks, breaks, broken contacts, or surface defects. Replace if damaged (Figure 12-49).
2. Special equipment is required to perform a functional test. Bench check is only practical test for regulator functioning.

e. Brushes and Brush Holders

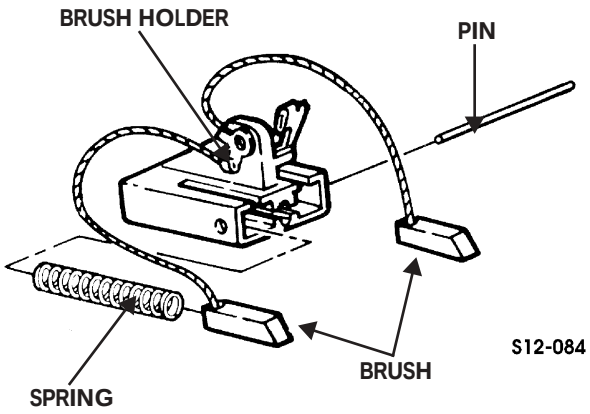


Figure 12-50: Brush Holder and Brushes

1. Inspect for broken or disconnected brushes, worn brushes with length less than 0.5 in. (12.7 mm), and broken or distorted springs. Replace brush holder and brushes as an assembly (Figure 12-50).

NOTE Pin to retain brushes can be made from local material. A standard unbent paper clip works well.

2. Assemble springs and brushes in brush holder. Compress springs and brushes in brush holder and hold compressed with pin (Pin will be removed after assembly) (Figure 12-50).

f. Drive End Frame and Bearing

1. Inspect bearing for roughness, looseness in bore, inner race free play, and damaged seals. Replace drive end frame and bearing as an assembly if damaged (Figure 12-51).

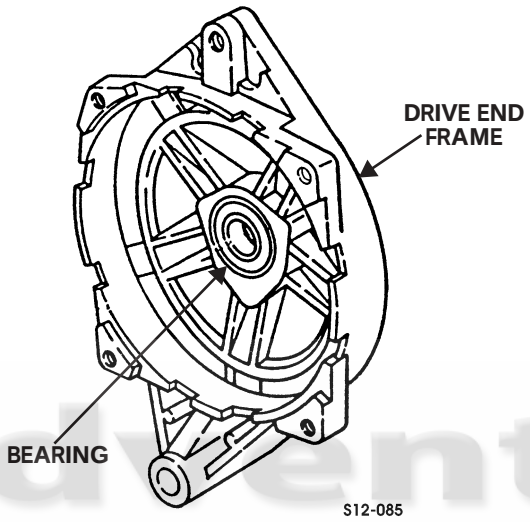


Figure 12-51: Drive End Frame

2. Inspect drive end frame for cracks, breaks, or damaged threads. Replace if casting is cracked or broken.
3. Repair minor through-bolt and adjusting bolt thread damage using a tap. For more serious through-bolt thread damage, replace drive end frame.

g. Fan

Inspect fan for bends and breaks. Minor bending repair is permissible. For broken or missing blade ends, cracks or breaks, replace fan (Figure 12-52).

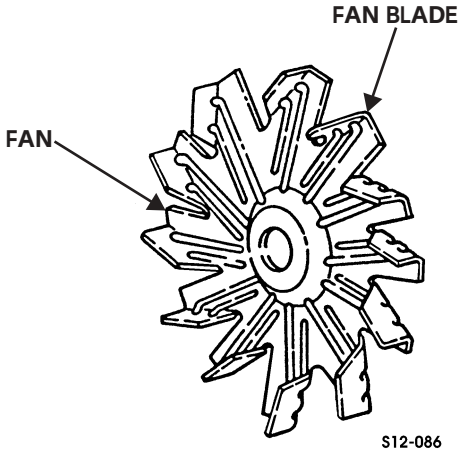


Figure 12-52: Fan

h. Slip Ring End Frame and Bearing

NOTE Bearing may remain on rotor shaft when end frames are separated. If bearing remains in slip ring end frame, inspect in place. Remove only to replace bearing.

1. Inspect bearing for roughness, looseness in retainer ring, free play or inner race, and damaged seals. Replace bearing if damaged or loose (Figure 12-53).

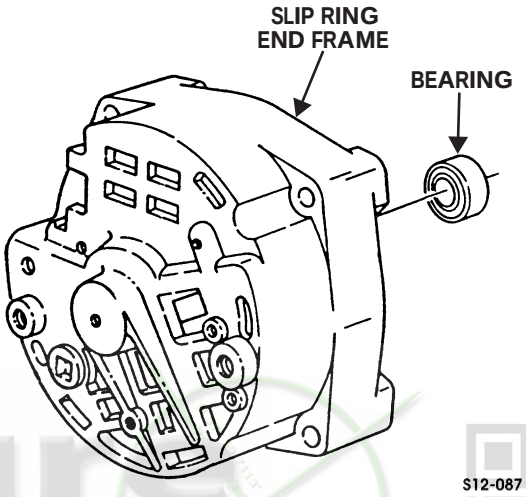


Figure 12-53: Rear Housing

2. Inspect slip ring end frame for breaks, cracks, evidence of spun ball bearing, and damaged threads. Repair minor thread damage. Replace if otherwise damaged.

i. Collars

Inspect collars for cracks, bends, and scoring. Replace if damaged (Figure 12-54).

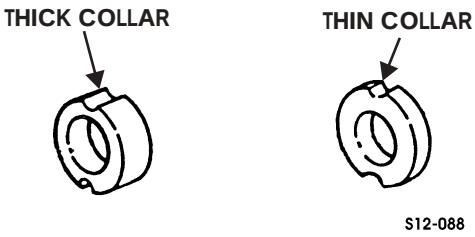


Figure 12-54: Fan Spacers

j. Output Stud Assembly

Inspect output stud assembly for cracked or broken insulator, bends, or damaged threads. Replace stud assembly if any part is damaged (Figure 12-55).

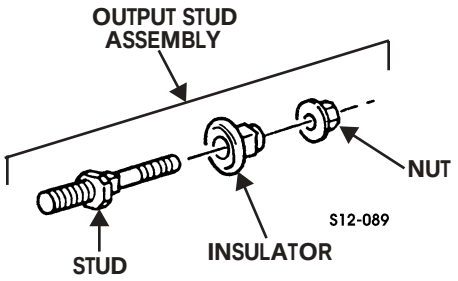


Figure 12-55: Output Stud

k. pulley

Inspect pulley for bends, breaks, and sharp edges on belt groove. Remove minor burrs and sharp edges with fine mill file. Replace pulley if otherwise damaged (Figure 12-56).

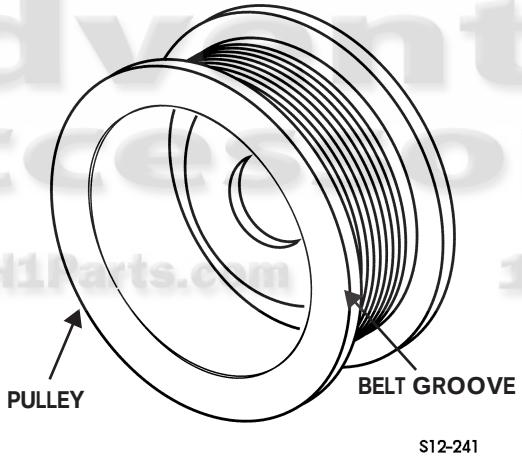


Figure 12-56: Alternator Pulley

l. Capacitor Strap

Inspect capacitor strap for breaks, cracks, bulged case, or surface defects. Replace if damaged (Figure 12-57).

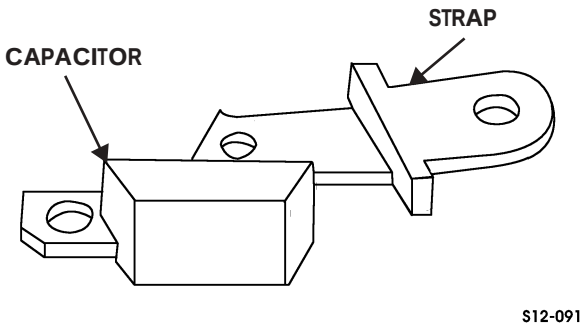


Figure 12-57: Noise Suppressor

Assembly

NOTE: Perform step 1 if slip ring end frame bearing is replaced.

1. Pressing on inner race, install bearing on rotor shaft. Seat to shoulder on shaft (Figure 12-58).

NOTE: Perform step 2 if new brushes and brush holder are replaced.

2. Assemble springs and brushes in brush holder and retain with pin. Pin holds brushes compressed in brush holder. (Pin will be removed after assembly).
3. Install rectifier bridge in slip ring end frame with screw, output stud insulator, and nut.
4. Assemble brush holder and regulator and install with washer and screw. Solder slip connection between brush holder and regulator if either was replaced.

NOTE: Perform step 5 if regulator is replaced.

5. Slide regulator regulator connector strap into regulator contact and solder union.

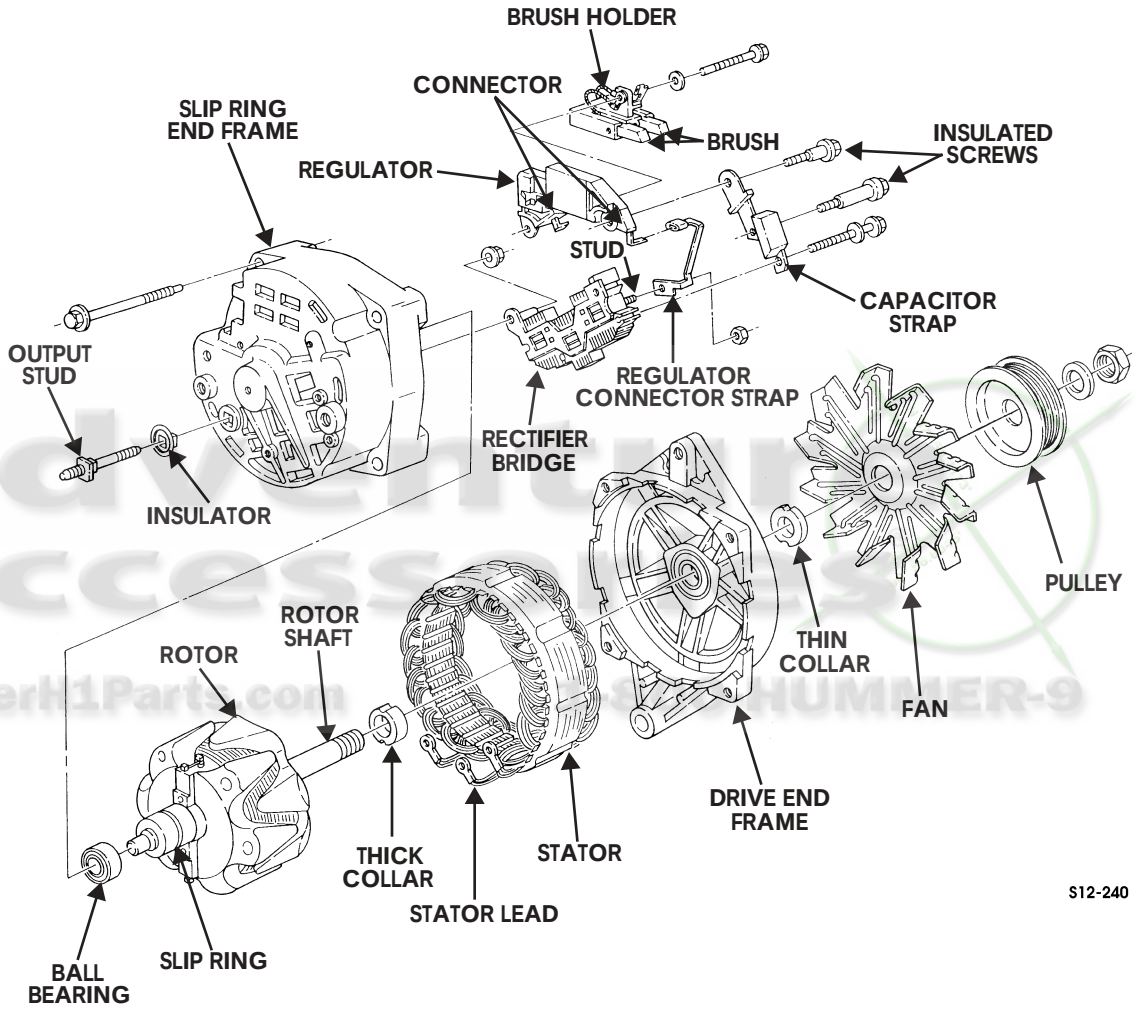


Figure 12-58: Alternator Components

6. Slip capacitor strap under connector strap and position on rectifier bridge and regulator. Secure capacitor strap with screw and two insulated screws. Tighten screws and nuts (Figures 12-58 and 12-59).

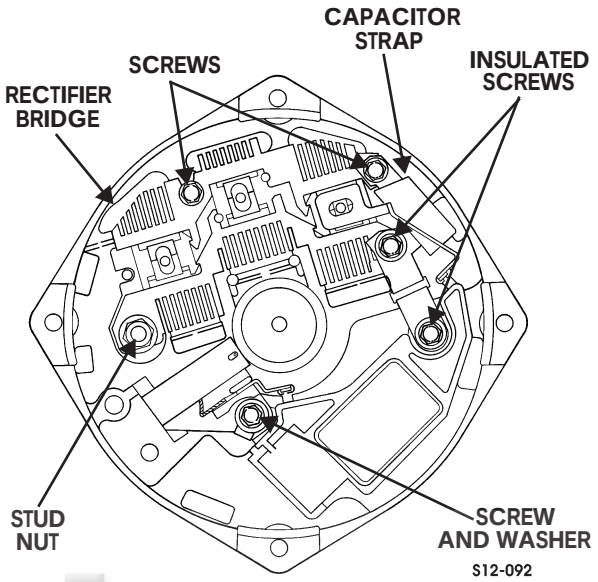


Figure 12-59: Alternator Rectifier

7. Position stator to align three stator lead eyes on three studs of rectifier bridge. Secure stator leads to studs with three nuts.
8. Place thick collar over rotor shaft up to rotor (Figure 12-58).
9. Insert rotor shaft through drive end frame. Seat bearing in drive end frame on thick collar.
10. Position thin collar, fan, and pulley over rotor shaft and secure with washer and nut. Tighten nut to 40-80 lb-ft (54-109 N•m).
11. Carefully position rotor through stator and seat ball bearing in slip ring end frame. At same the time, ensure drive end frame and stator mate.
12. If stator and two end frames mate, secure assembly with four through-bolts. Tighten through-bolts evenly to remove any slack.
13. Ensure rotor turns evenly and smoothly in alternator.
14. Remove brush retaining pin from brush holder. Ensure brushes extend out of brush holder and contact slip rings.
15. Install and check output.

JUNCTION BLOCK REPLACEMENT

WARNING: Batteries emit explosive hydrogen gas. Keep flames or sparks away from batteries. Battery acid is extremely harmful. If acid contacts eyes or skin, flush affected area(s) liberally with clear water, and seek medical help immediately. If acid contacts clothing, remove and discard affected clothing. Always disconnect ground cable, and remove all jewelry before working on batteries.

When removing battery clamps, disconnect ground cable first. Ensure all switches are off before disconnecting battery ground cable. Do not allow tools to come in contact with vehicle when disconnecting cable clamps. Indirect short can result, causing instant heating of tools, tool damage, battery damage, or battery explosion.

Removal

1. Disconnect battery ground cable at battery box negative stud.
2. Loosen two nuts and remove cover from terminal board (Figure 12-60).
3. Remove top nut, lockwasher, washer, and wires (one orange, two black, and one red) from terminal board. Discard lockwasher.
4. Remove bottom nut, lockwasher, washer and wires (five black and one white) from terminal board. Discard lockwasher.
5. Remove two nuts, two screws, and terminal board from terminal board plate.
6. Remove two screws and terminal board plate from bracket.

Installation

1. Install terminal board plate and install on bracket with two screws (Figure 12-60).
2. Install terminal board on terminal board plate with two nuts and screws.
3. Install five black wires and one white wire on bottom lug of junction block with washer, lockwasher, and nut.
4. Install one orange wire, two black, and one red wire on top lug of junction block with washer, lockwasher, and nut.
5. Install junction block cover on terminal board and tighten two nuts.
6. Install battery ground cable at battery box stud.

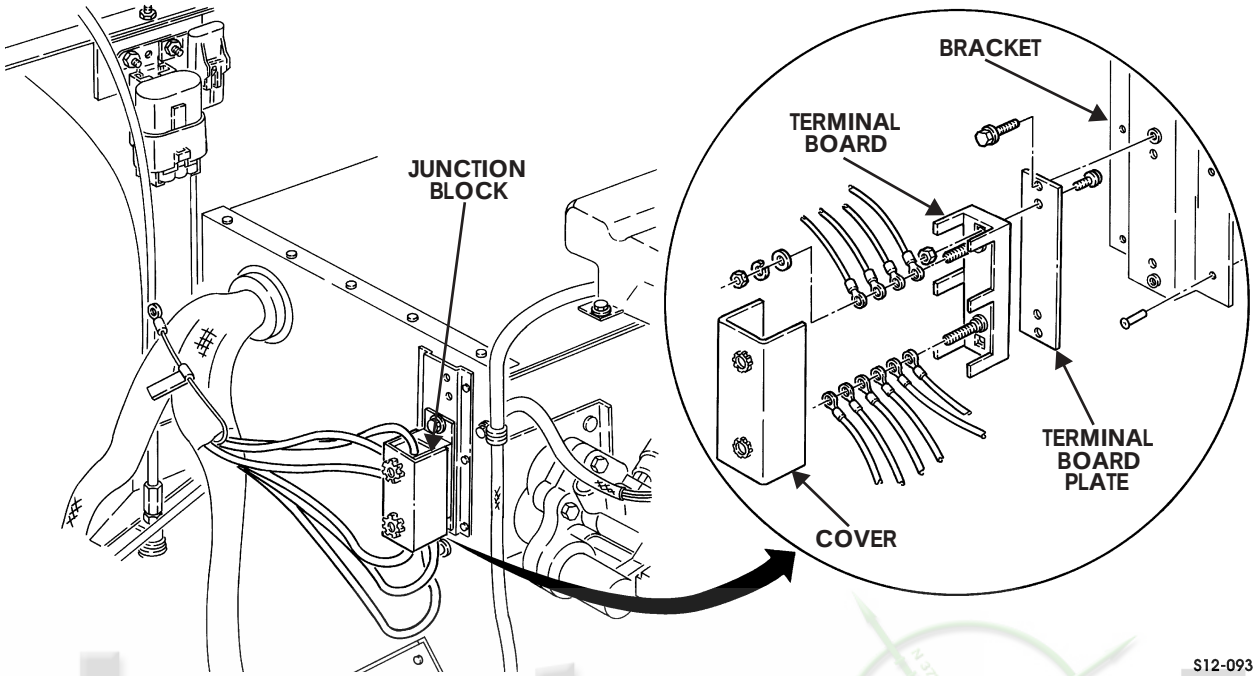


Figure 12-60: Power Junction Block

HOOD ELECTRICAL HARNESS REPLACEMENT

NOTE: Prior to removal, tag all leads. Note location of clamps and ground leads.

Removal - Left Side

1. Disconnect battery ground cable.
2. Disconnect four-wire hood harness connector from body harness connector.
3. Disconnect three-wire hood harness connector from body harness connector.
4. Disconnect three connectors from left side headlight.
5. Remove composite light/side marker cover and clearance lamp cover.
6. Disconnect ground lead and two connectors from left side composite light.
7. Remove ground lead and connector from left side marker lamp.
8. Disconnect two-wire connector from left side clearance lamp.
9. Disconnect two connectors from under hood lamp.

Removal - Right Side

1. Disconnect three connectors from right side headlight.
2. Remove composite light/side marker cover and clearance lamp cover.
3. Remove ground lead and connector from right side marker lamp.
4. Remove ground lead and two connectors from right side composite light.
5. Disconnect two-wire connector from right side clearance lamp.
6. Remove seven clamps securing hood electrical harness to hood.
7. Remove tie strap as required.
8. Remove hood harness from vehicle.

Installation

1. Place hood electrical harness in position for installation.
2. Install seven clamps on hood. Do not tighten clamps.

Installation - Right Side

1. Connect two-wire connector to right side clearance lamp.
2. Connect two connectors and install ground lead to right side composite light.
3. Connect connector and install ground lead to right side marker lamp.
4. Connect three connectors to right side headlight.
5. Install composite light/side marker cover and clearance lamp cover.

Installation - Left Side

1. Connect two-wire connector to left side clearance lamp.
2. Connect connector and install ground lead to left side marker lamp.
3. Connect two connectors and install ground lead to left side composite light.
4. Install composite light/side marker cover and clearance lamp cover.
5. Connect two connectors to under hood lamp.
6. Connect three connectors to left side headlight.
7. Connect three-wire hood harness connector to body harness connector.
8. Connect four-wire hood connector to body harness connector.
9. Connect battery ground cable.
10. Test all lamps/lights for proper operation.
11. Remove all tags.
12. Tighten seven clamps.
13. Install tie straps as required.

ENGINE ELECTRICAL HARNESS REPLACEMENT

Removal

NOTE: Prior to removal, tag all leads for installation. Note location of clamps and tie straps.

1. Disconnect battery ground cable.
2. Remove engine access covers.
3. Remove engine harness quick-disconnect (Figure 12-61).
4. Loosen two nuts and remove cover from junction box.

NOTE: Only remove engine harness leads from junction box studs.

5. Remove two nuts, lockwashers, washers, and one engine harness lead from each junction box stud. Reinstall remaining leads with two washers, lockwashers, and nuts.
6. Install junction box cover and tighten two nuts.
7. Disconnect harness connector from fuel pump fuse.
8. Disconnect harness connector from fuel pump relay.
9. Disconnect two harness connectors from fuel filter connectors.

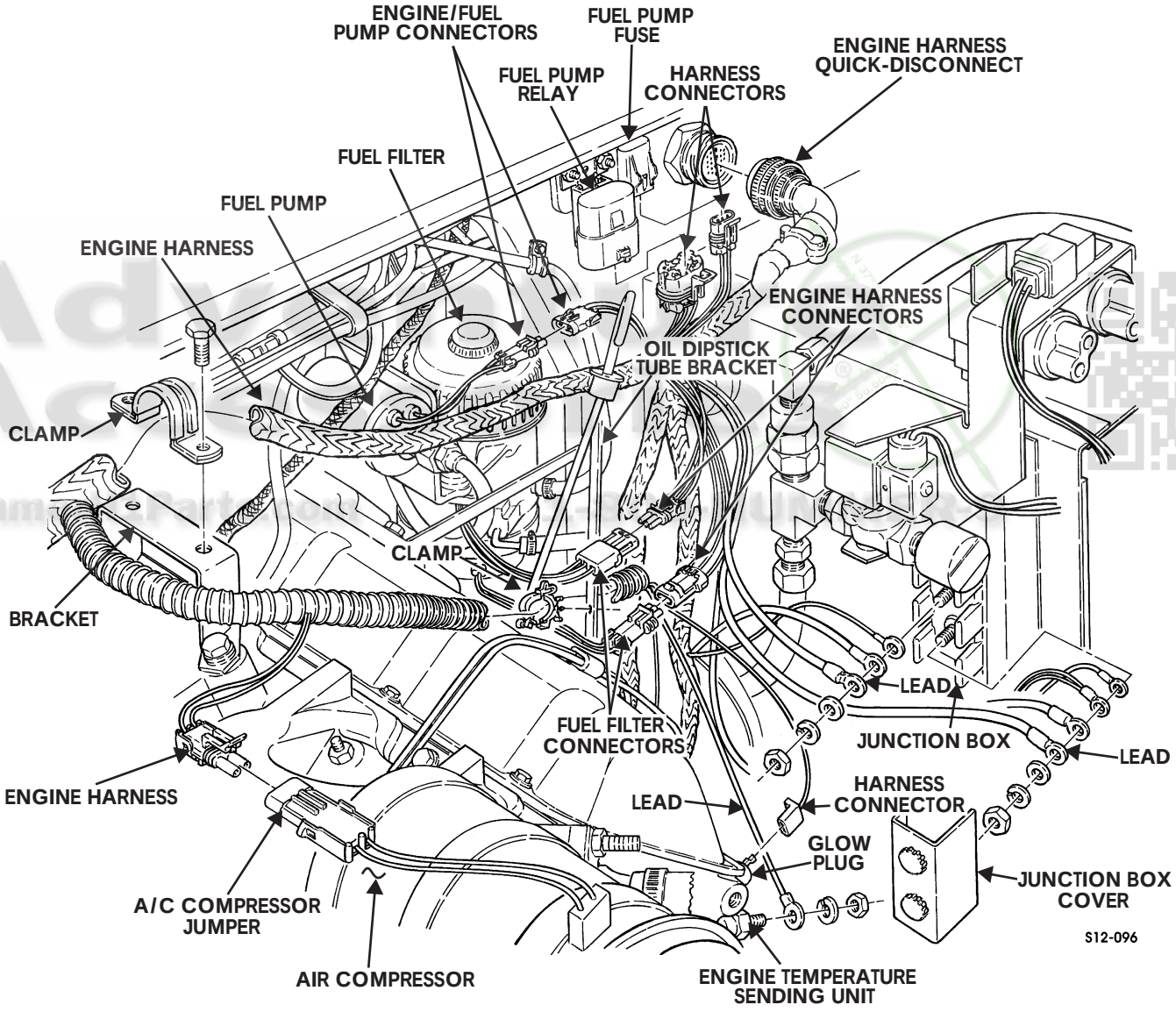


Figure 12-61: Engine Harness Connections

10. Disconnect harness connector from fuel pump connector.
11. Remove nut, lockwasher, and lead from engine temperature sending unit. Discard lockwasher.
12. Remove two capscrews and clamp securing engine harness to bracket.
13. Remove clamp from oil dipstick tube bracket.
14. Disconnect four harness connectors from left side glow plugs.
15. Disconnect engine harness from air conditioner compressor jumper harness connector.
16. Disconnect four harness connectors from right side glow plugs (Figure 12-62).
17. Disconnect harness connector from oil pressure switch.
18. Remove nut and three ground leads from right rear engine ground point.
19. Remove nut and clamp securing harness to engine.
20. Remove screw and clamp securing engine harness to engine bracket.
21. Remove nut, lockwasher, washer, and lead from oil pressure sending unit. Discard lockwasher.
22. Disconnect harness connector from glow plug controller.
23. Pull back boot and remove nut and two leads from glow plug controller.

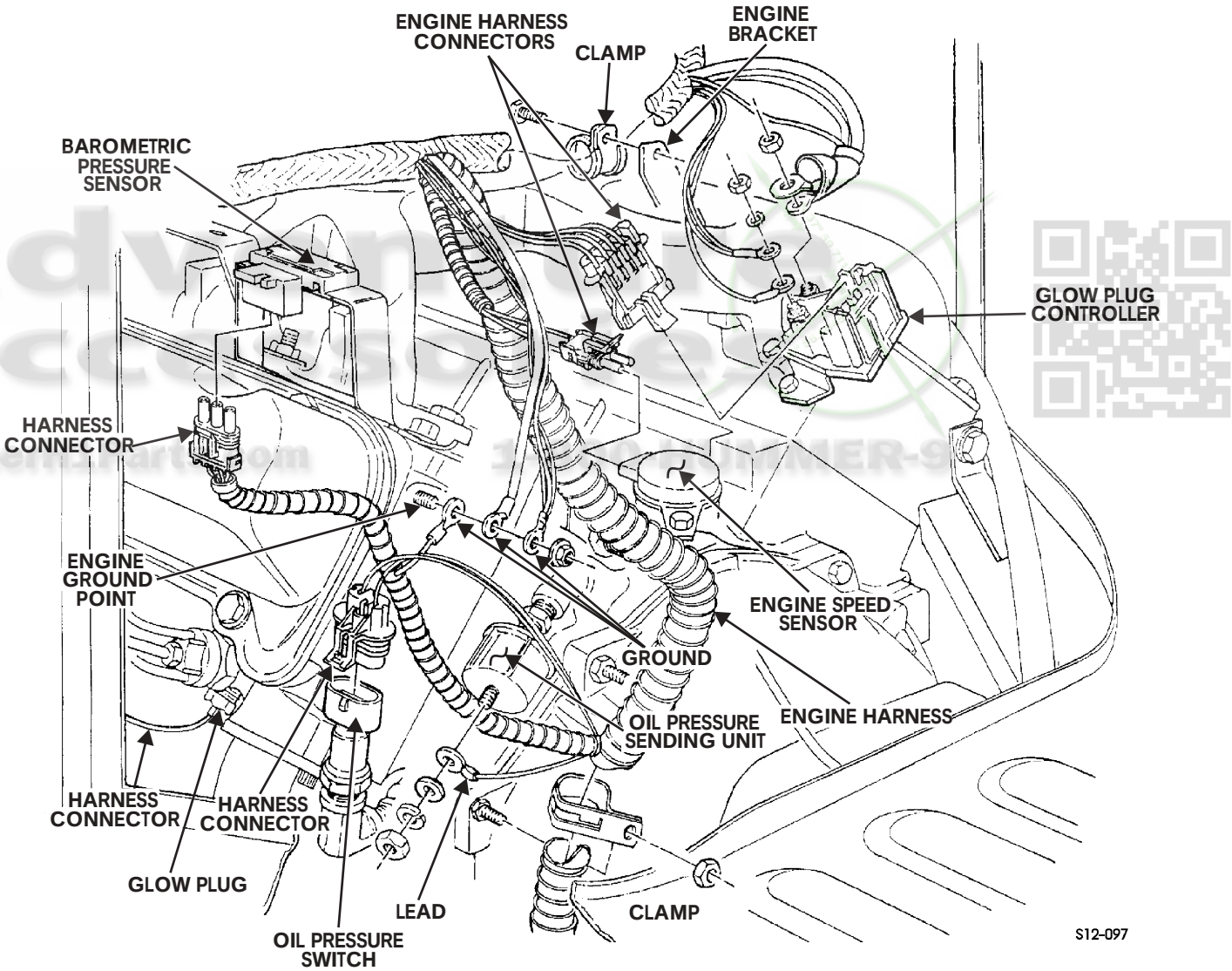


Figure 12-62: Engine Harness Connections

24. Remove nut, lockwasher, and two leads from glow plug controller. Discard lockwasher.
25. Disconnect harness connector from engine speed sensor.
26. Disconnect harness connector from barometric pressure sensor.
27. Disconnect harness connector from cold-advance/fast-idle switch (Figure 12-63).

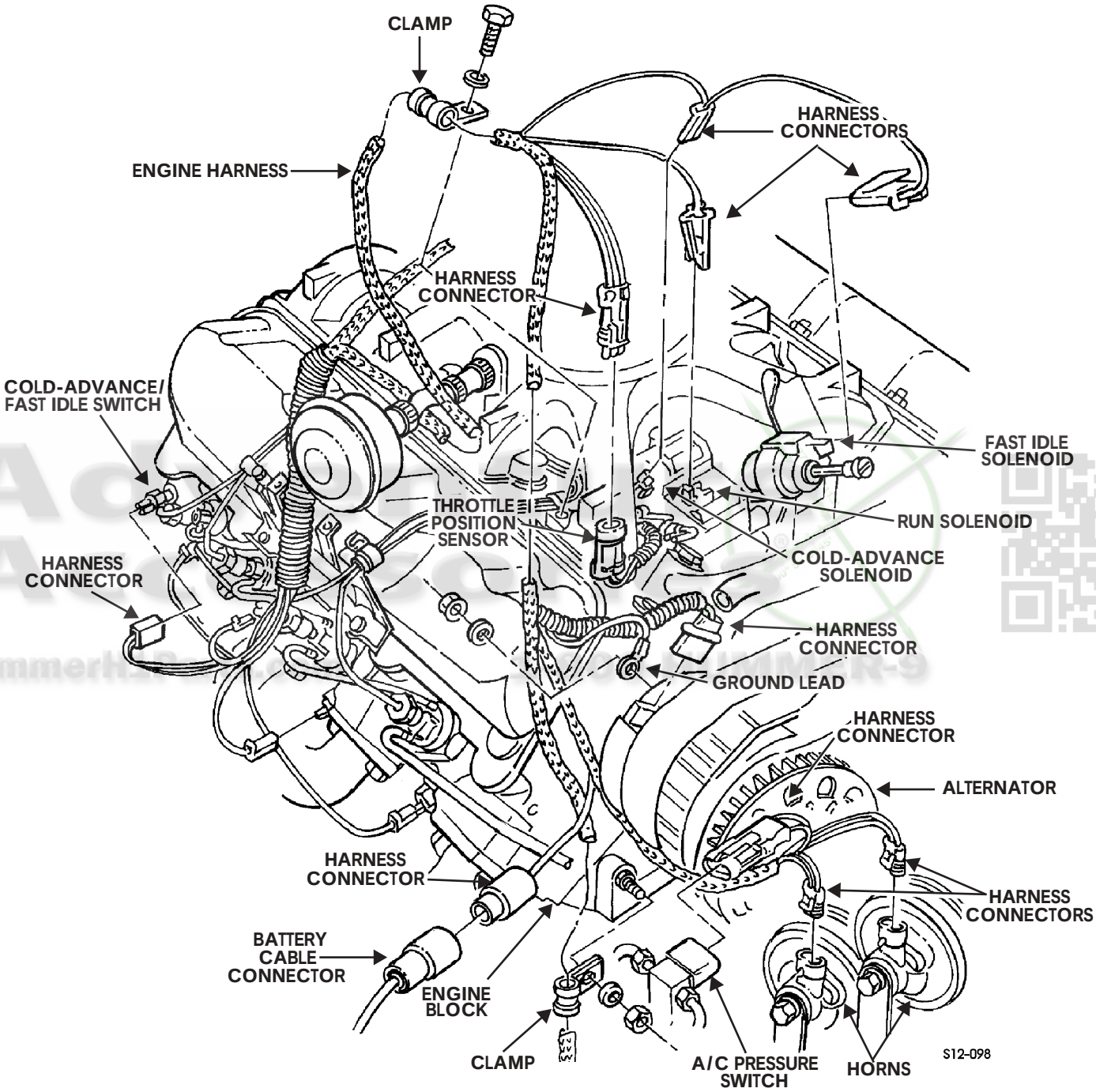


Figure 12-63: Engine Harness Connectors

28. Disconnect three harness connectors from idle, cold-advance, and run solenoids.
29. Disconnect harness connector from throttle position sensor connector.
30. Remove nut, washer, clamp, and engine harness from engine block.
31. Remove nut, washer, and ground lead from back of alternator.

32. Disconnect two harness connectors from horns.
33. Disconnect harness connector from A/C pressure switch.
34. Disconnect engine harness from battery cable connector.
35. Remove screw, washer, clamp, and engine harness from engine.
36. Disconnect harness connector from alternator.
37. Remove capscrew, nut, clamp, and engine harness from oil pan bracket (Figure 12-64).

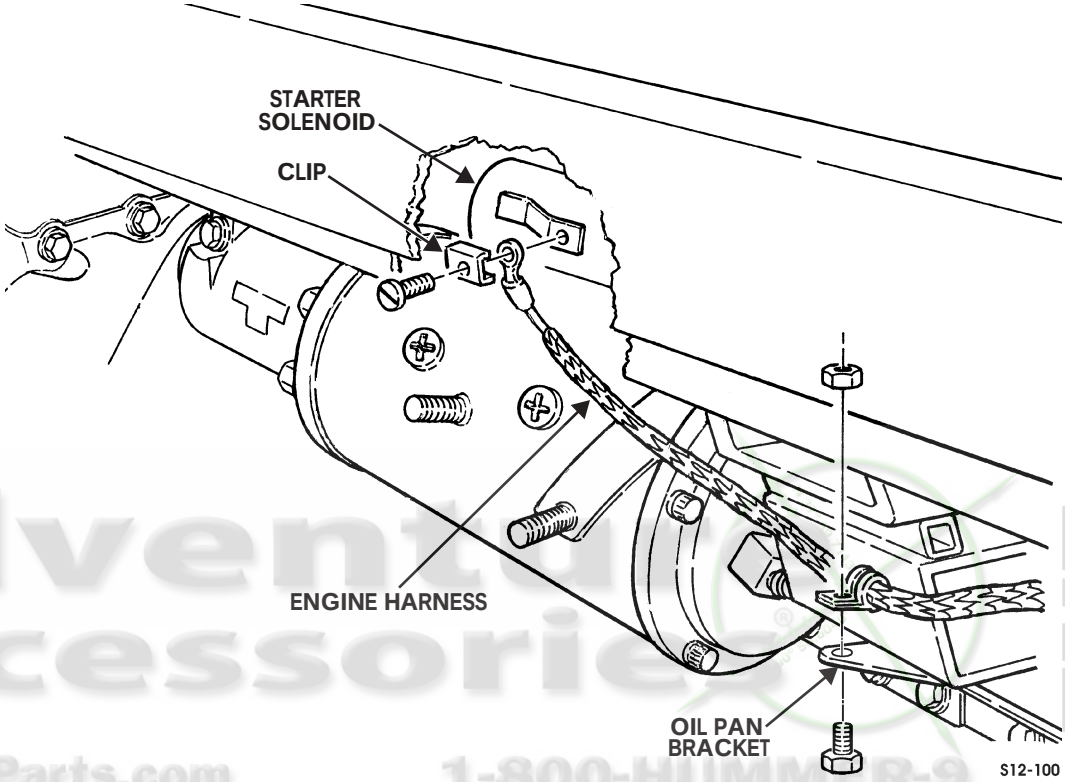


Figure 12-64: Starter Solenoid Connections

38. Disconnect harness connector from transmission input speed sensor (Figure 12-65).
39. Disconnect harness connector from transmission speed output speed sensor.
40. Disconnect engine harness from transmission connector.
41. Disconnect harness connector from transfer case lock switch.
42. Disconnect engine harness connector from vehicle speed sensor.
43. Remove two clamps and engine harness from transmission.
44. Remove screw, two washers, nut, clamp and engine harness from transfer case bracket.
45. Remove screw, clip, and engine harness from starter solenoid (Figure 12-64).

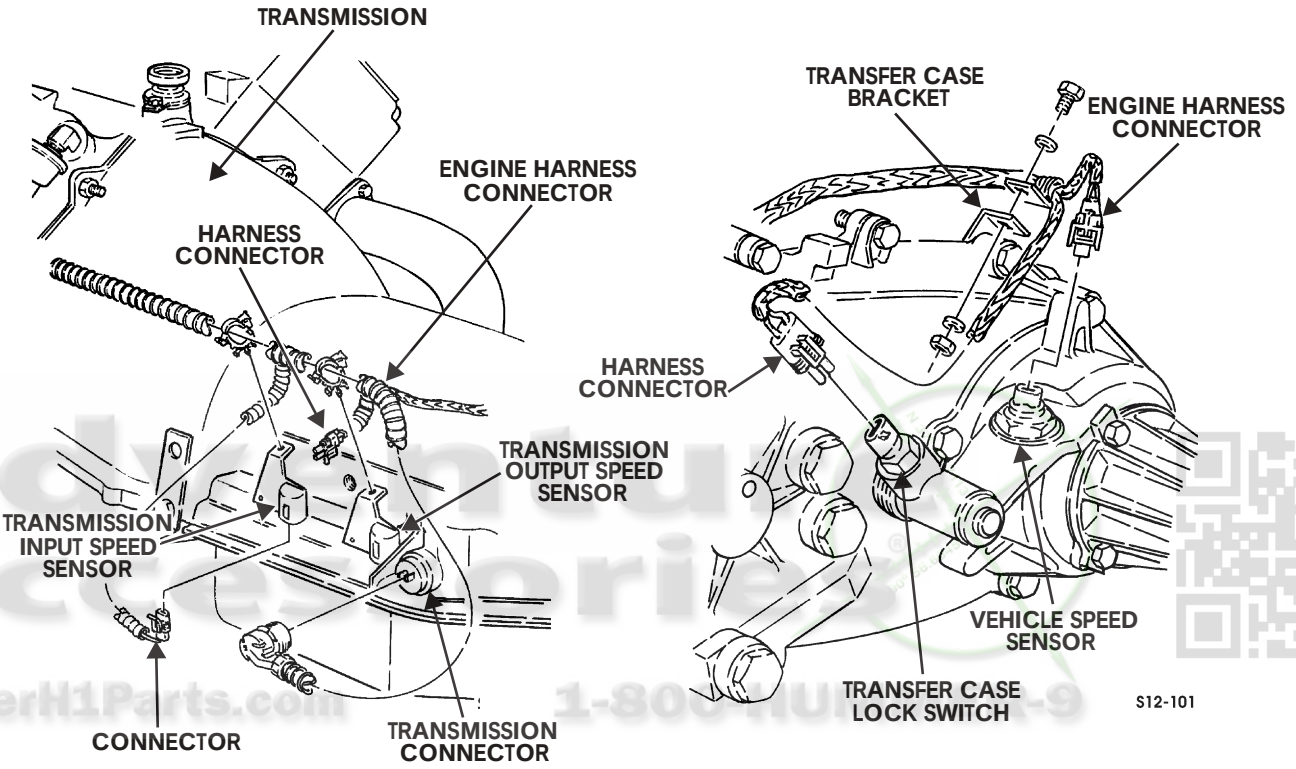


Figure 12-65: Transmission and Transfer Case Connections

46. Disconnect two harness connectors from transmission control module (Figure 12-66).
47. Disconnect harness connector from digital ratio adapter.
48. Remove grommet and engine harness from vehicle body.
49. Disconnect engine harness from body harness and carefully remove engine harness from vehicle.

Installation

1. Carefully place engine harness in position on vehicle and connect engine harness to body harness.
2. Connect harness connector to digital ratio adapter (Figure 12-66).
3. Connect two harness connectors to transmission control module.

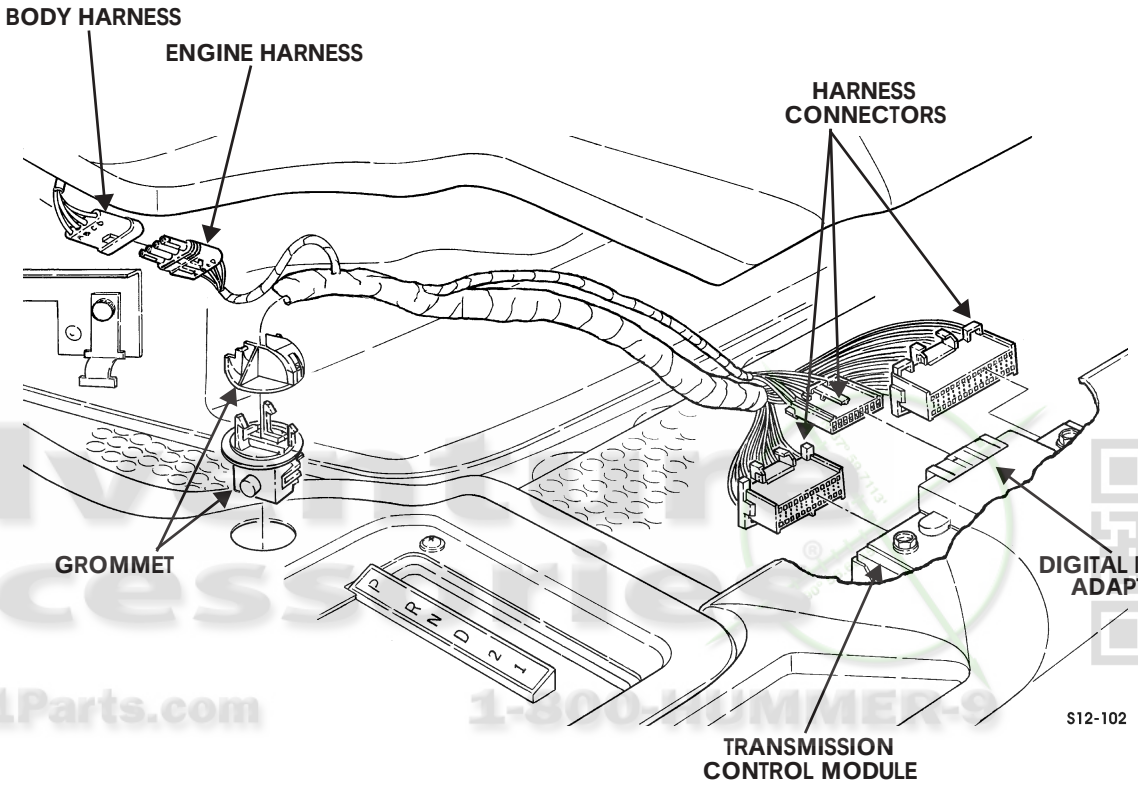


Figure 12-66: TCM and Digital Ratio Adapter

4. Install grommet and engine harness on vehicle body.
5. Install engine harness and clip on starter solenoid with screw (Figure 12-67).
6. Install engine harness and clamp on oil pan bracket with capscrew and nut.

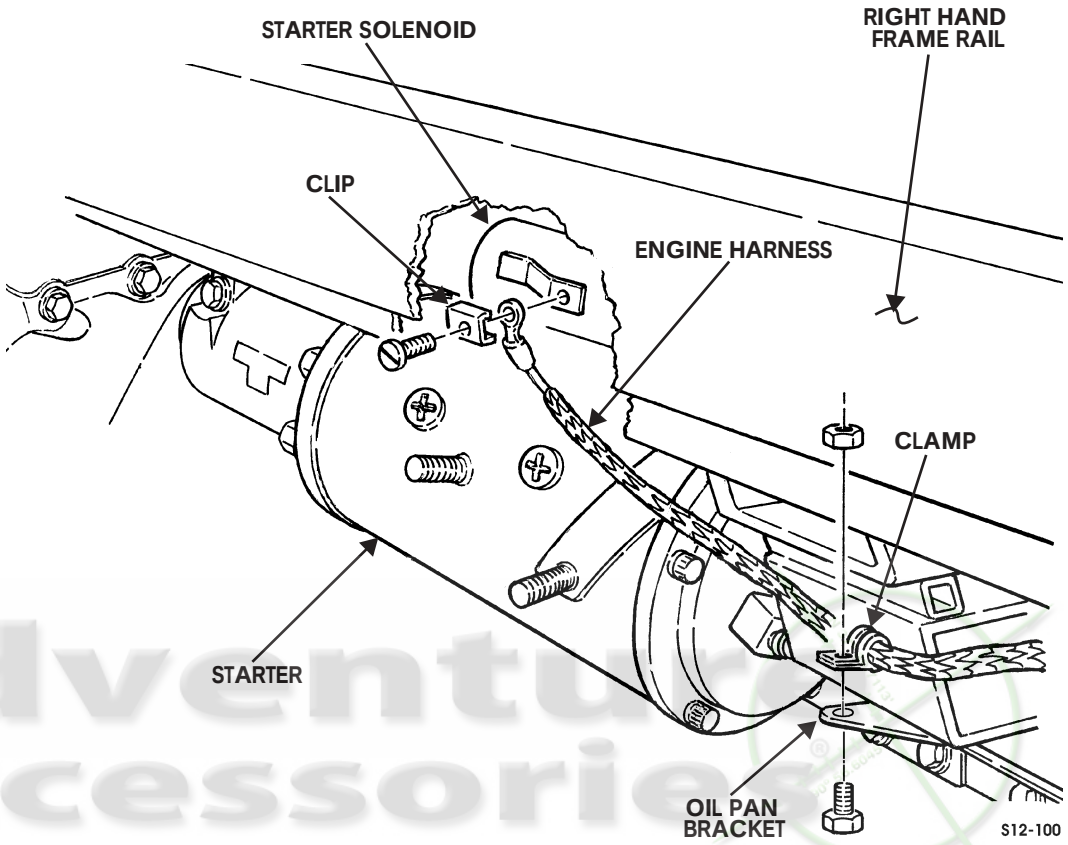


Figure 12-67: Starter Solenoid Connections

7. Install engine harness on transfer case bracket with washer, capscrew, clamp, washer, and nut (Figure 12-68).
8. Install two clamps and engine harness on transmission.
9. Connect engine harness connector to vehicle speed sensor.
10. Connect harness connector to transfer case lock switch.
11. Connect engine harness to transmission connector.
12. Connect engine harness connector to transmission output speed sensor.

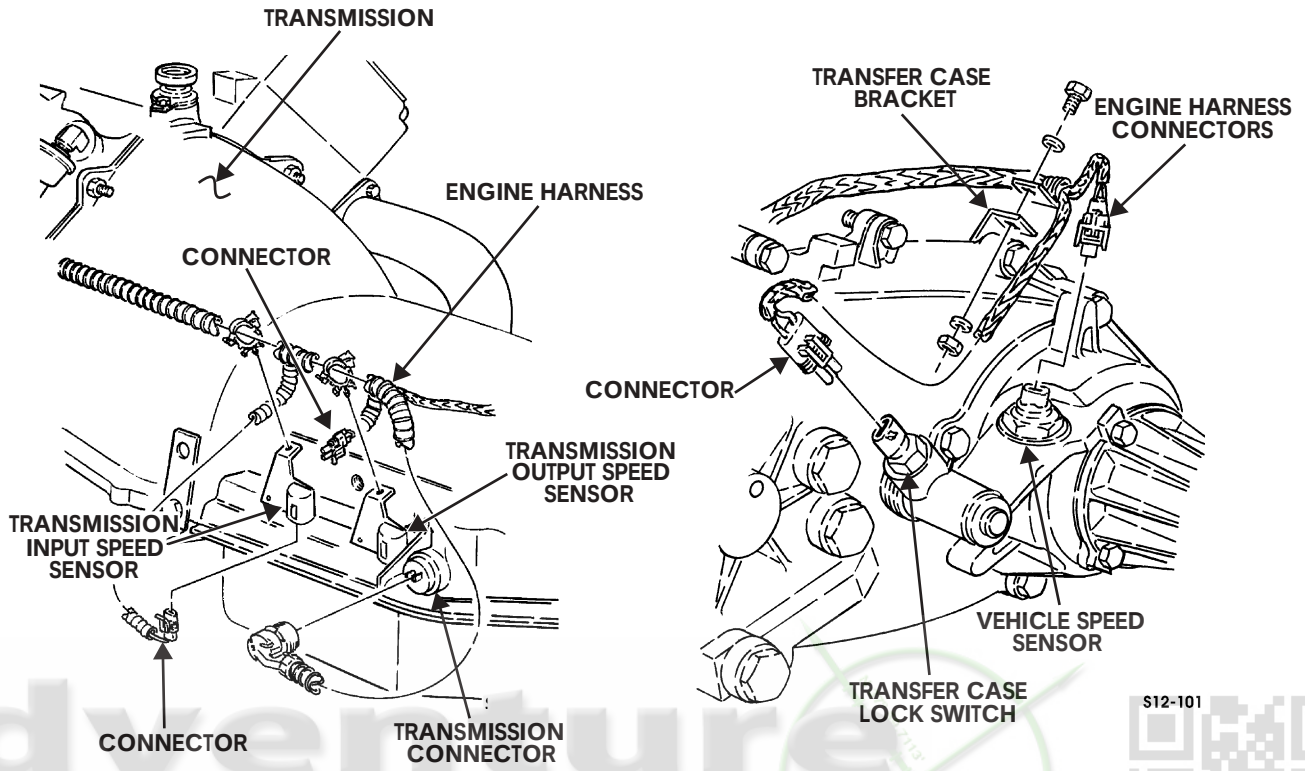


Figure 12-68: Transmission and Transfer Case Connections

13. Connect engine harness connector to transmission input speed sensor.
14. Connect harness connector to alternator (Figure 12-69).
15. Install engine harness on engine block with clamp, washer, and nut.
16. Connect engine harness to battery cable connector.
17. Connect harness connector to A/C pressure switch.
18. Connect two harness connectors on horns.
19. Install ground lead on back of alternator with washer and nut.
20. Install engine harness on engine with clamp, washer, and screw.
21. Connect harness connector on throttle position sensor connector.
22. Connect three harness connectors to fast-idle, cold-advance, and run solenoids.
23. Connect harness connector to cold advance/fast idle switch

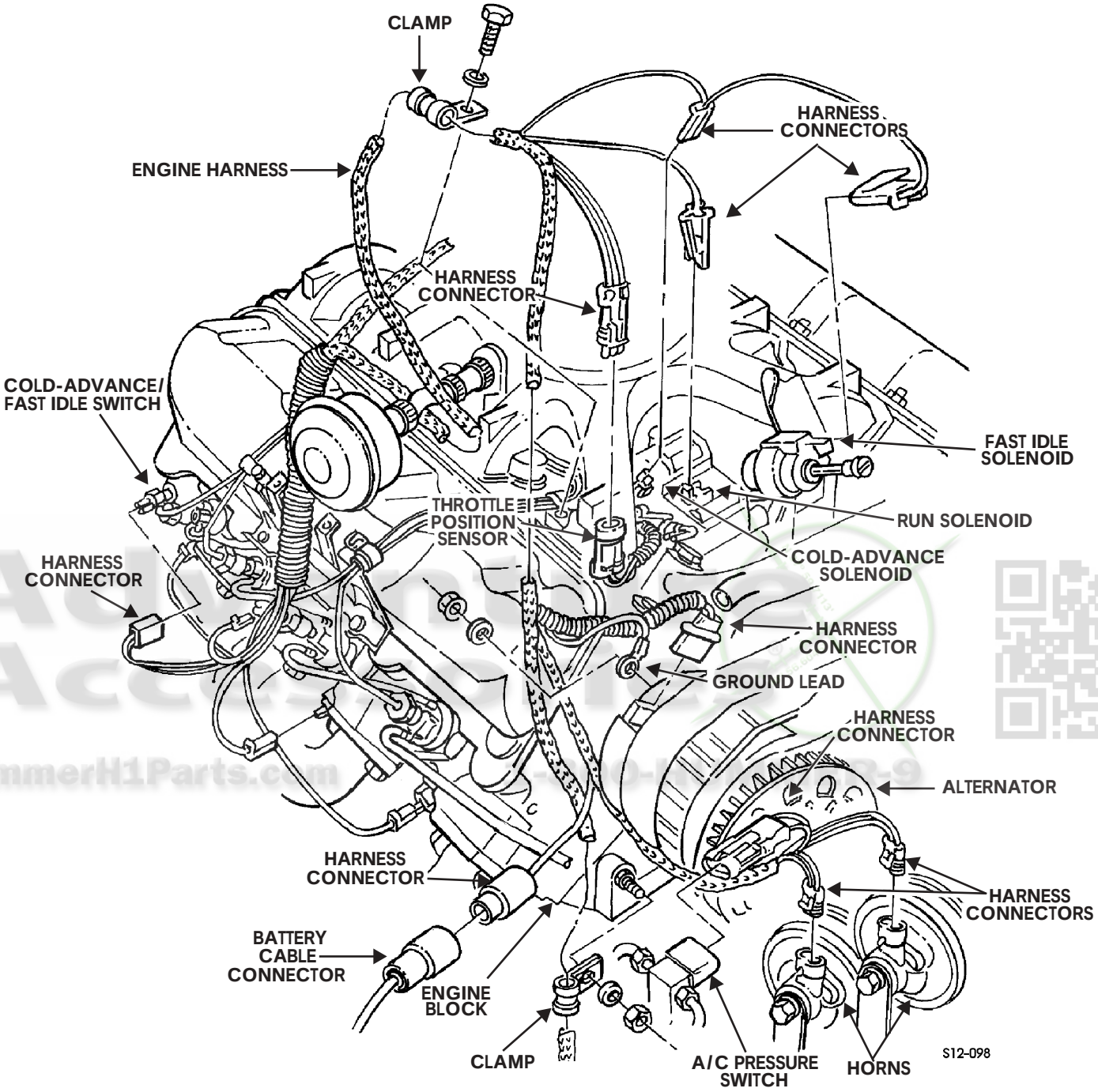


Figure 12-69: Engine Harness Connections

24. Connect harness connector to barometric pressure sensor (Figure 12-70).
25. Connect harness connector to engine speed sensor.
26. Install two leads on glow plug controller with lockwasher and nut.
27. Install two leads on glow plug controller with nut and cover with boot.
28. Connect harness connector to glow plug controller.
29. Install lead on oil pressure sending unit with washer, lockwasher, and nut.
30. Install engine harness on engine bracket with clamp and screw.
31. Install engine harness on engine with clamp and nut.
32. Install three ground leads on right rear engine ground point with nut.
33. Connect harness connector to oil pressure switch.
34. Connect four harness connectors at right side glow plugs.

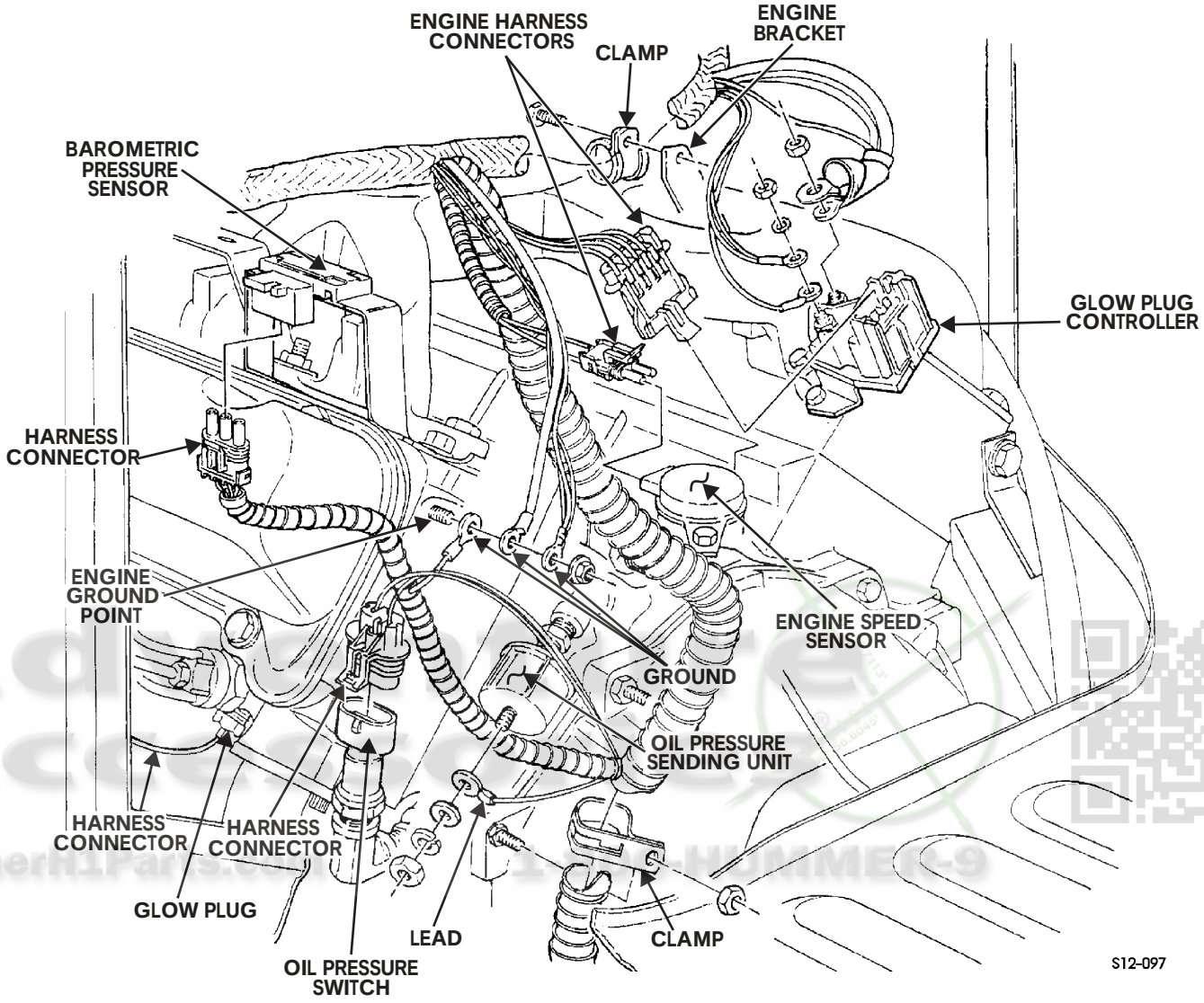


Figure 12-70: Engine Harness Connections

35. Connect engine harness to A/C compressor jumper harness connector (Figure 12-71).
36. Connect four harness connectors to left side glow plugs.
37. Install clamp and engine harness on oil dipstick tube bracket.
38. Install engine harness on bracket with clamp and two capscrews.
39. Install lead on engine temperature sending unit with lockwasher and nut.
40. Connect engine harness connector to fuel pump connector.
41. Connect two harness connectors to fuel filter connectors.
42. Connect harness connector to fuel pump relay.
43. Connect harness connector to fuel pump fuse.
44. Loosen two nuts and remove cover from junction box.
45. Install two engine harness leads on junction box studs with two washers, lockwashers, and nuts.
46. Install junction box cover and tighten two nuts.
47. Install engine harness quick-disconnect.
48. Install engine access covers.
49. Connect battery ground cable.
50. Remove tags from engine harness.

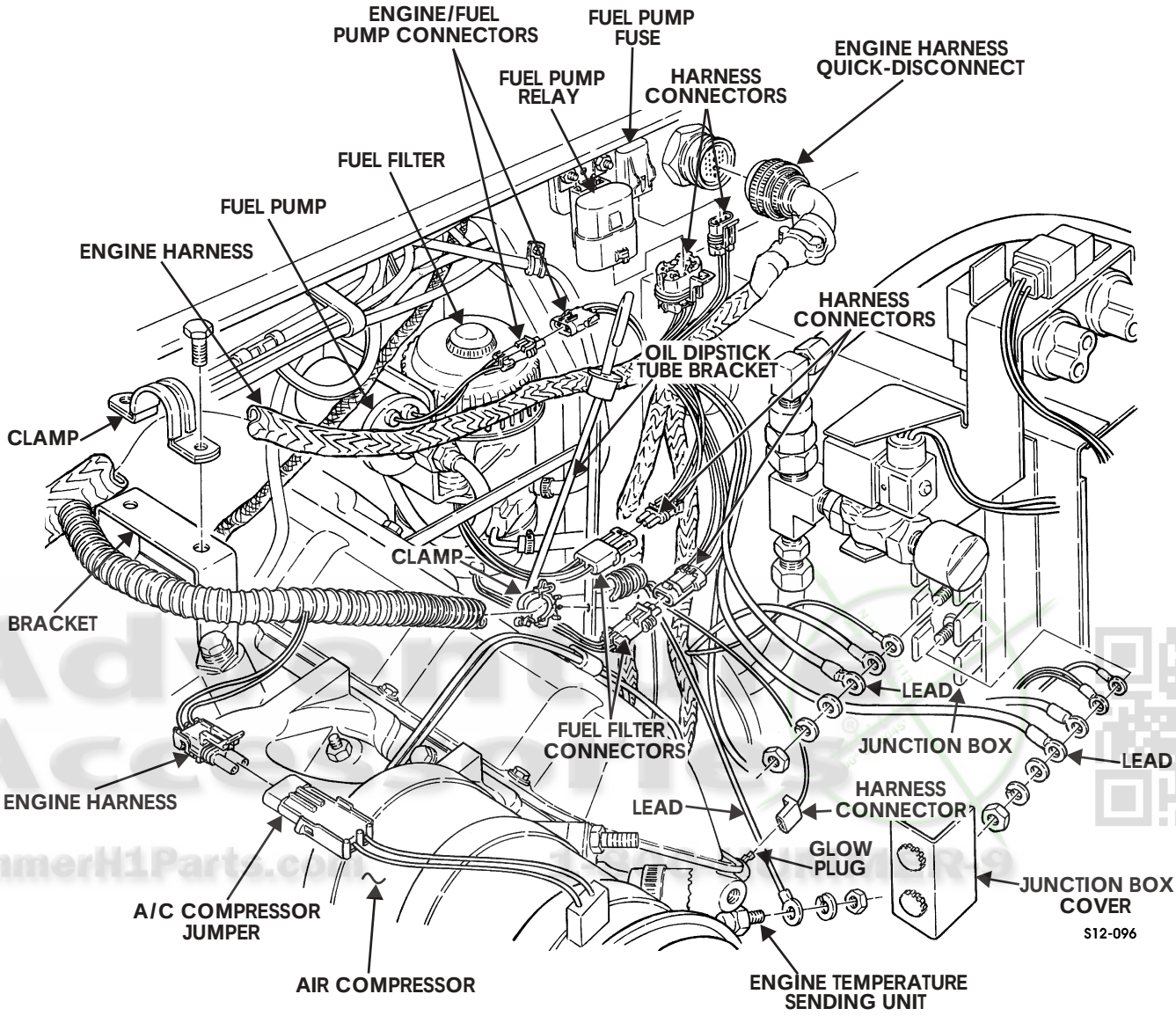


Figure 12-71: Engine Harness Connections

BODY WIRING HARNESS REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove eight screws and two gauge panels from instrument panel (Figure 12-72)
3. Remove eleven nuts and lockwashers from four gauges and remove fifteen body wiring harness gauge leads.
4. Disconnect two body wiring harness gauge illumination leads.
5. Remove eleven nuts and lockwashers from four gauges and remove fifteen body wiring harness gauge leads.
6. Disconnect two body wiring harness gauge illumination leads (Figure 12-73).
7. Remove body wiring harness connectors from rear of instrument panel (Figures 12-74 and 12-75).

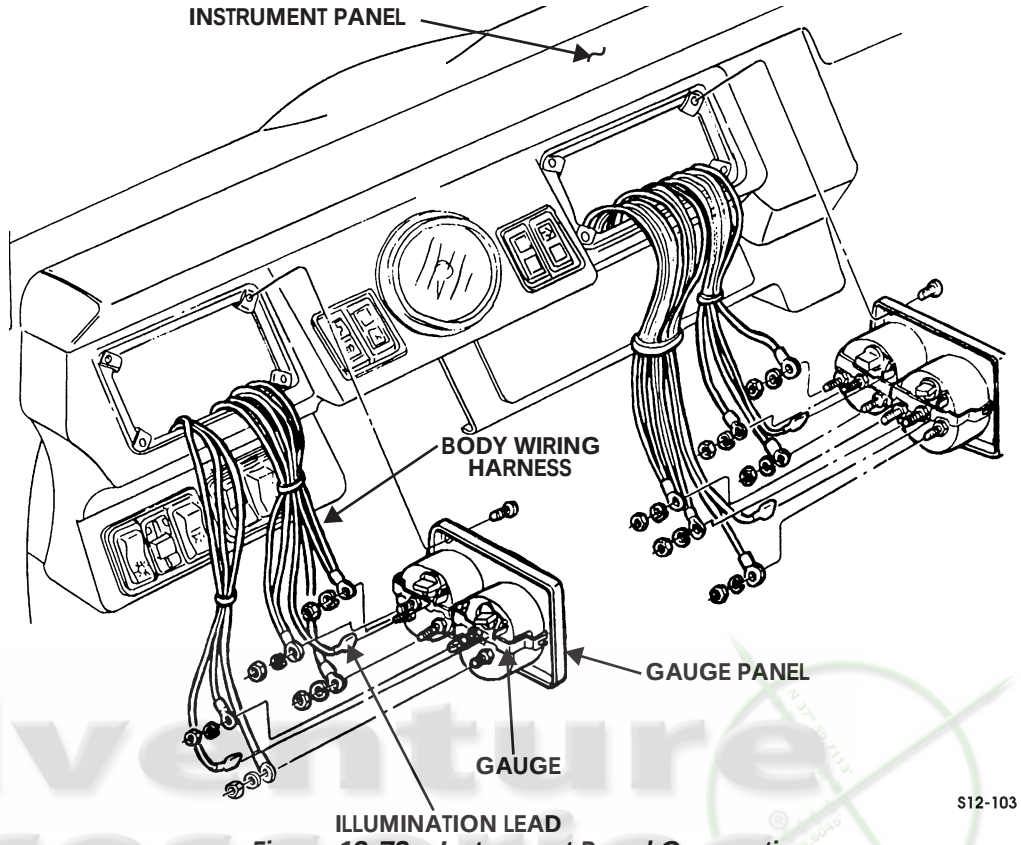


Figure 12-72: Instrument Panel Connections

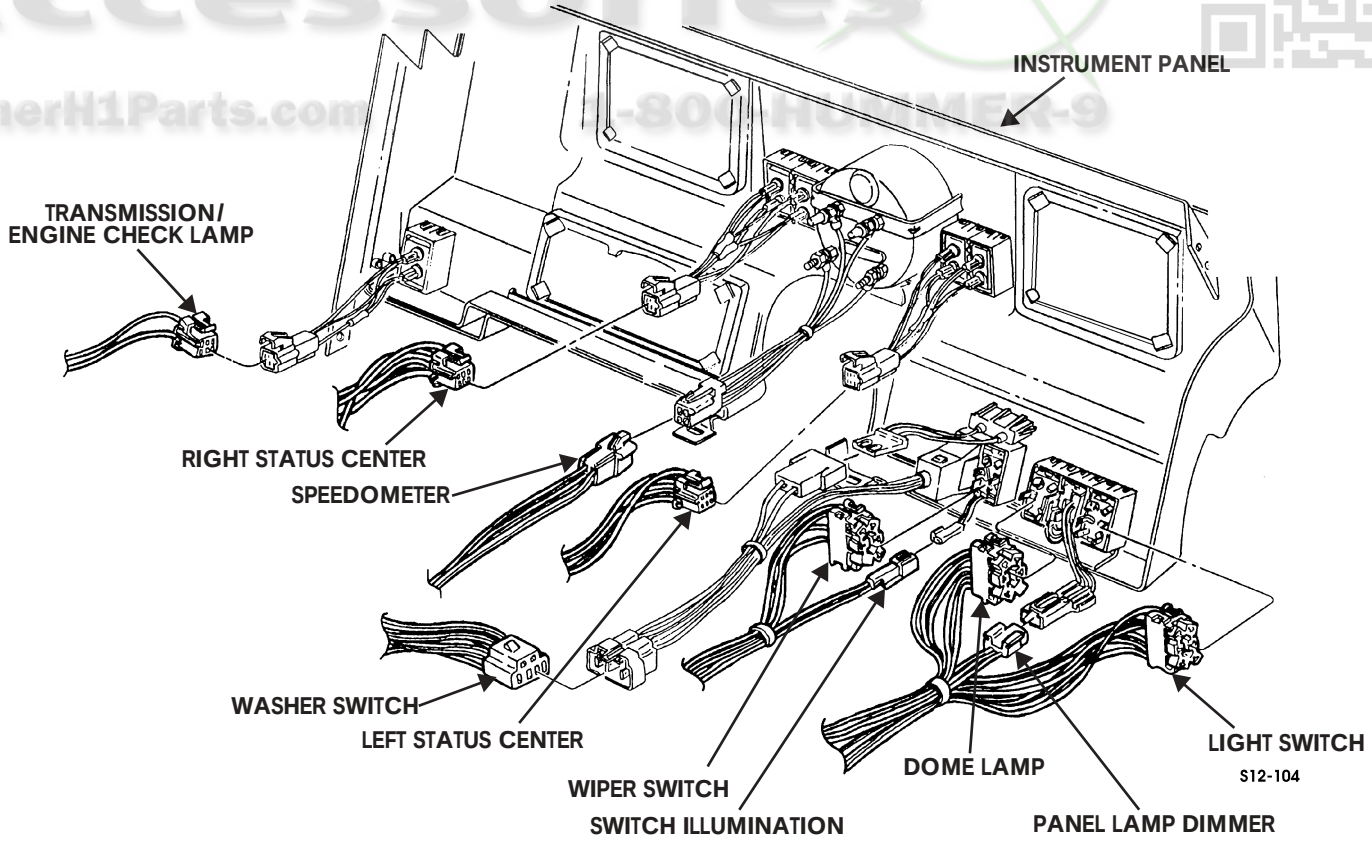


Figure 12-73: Status Center and Switch Connections

8. Remove harness connectors from jumper harness (not shown) if power windows or power mirrors are installed.
9. Remove nut and ground leads from ground stud (Figure 12-74).
10. Remove body wiring harness connectors from radio, engine console, and heating and air conditioning controller (Figure 12-75).

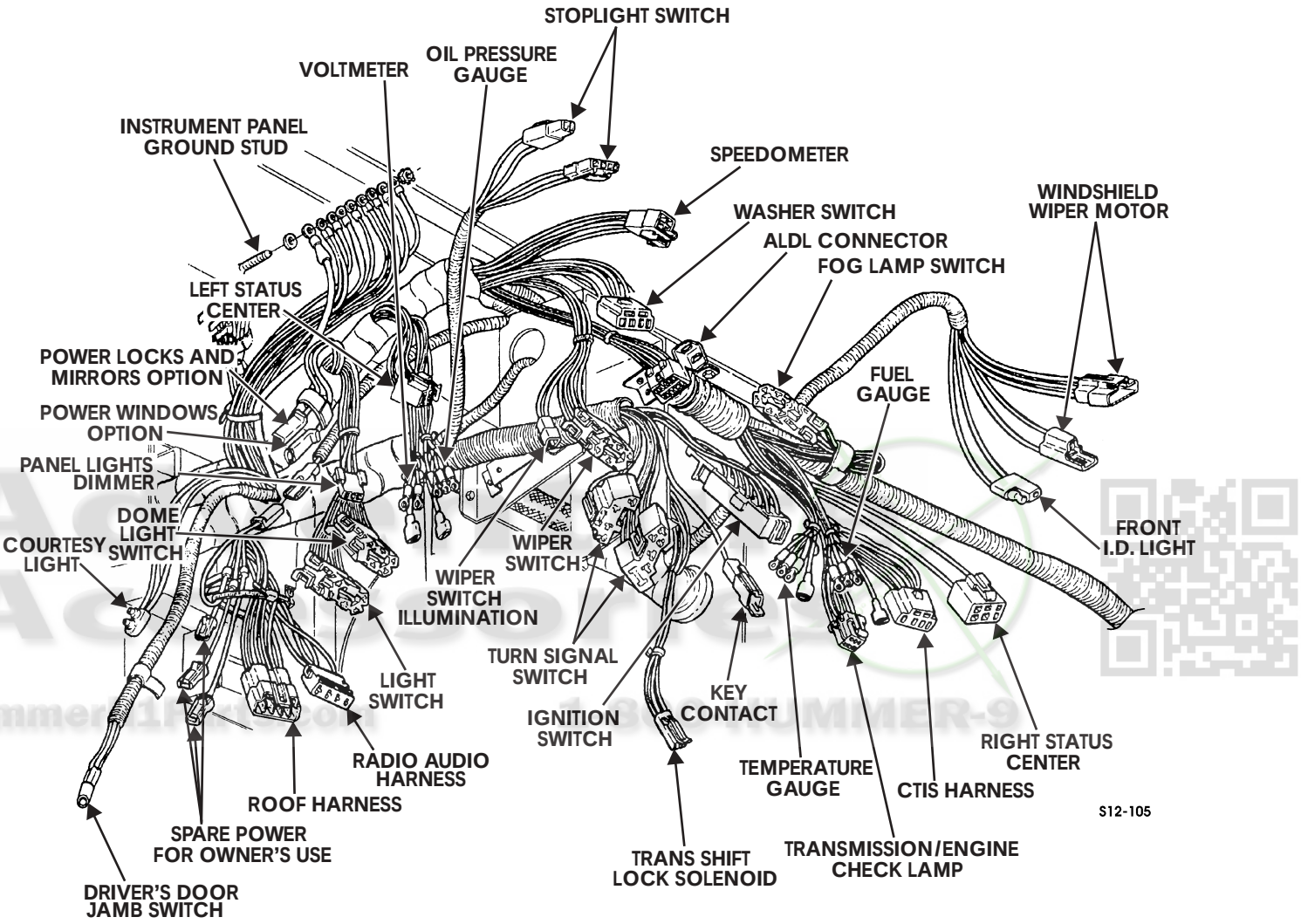


Figure 12-74: Body Harness-to-Dash Connections

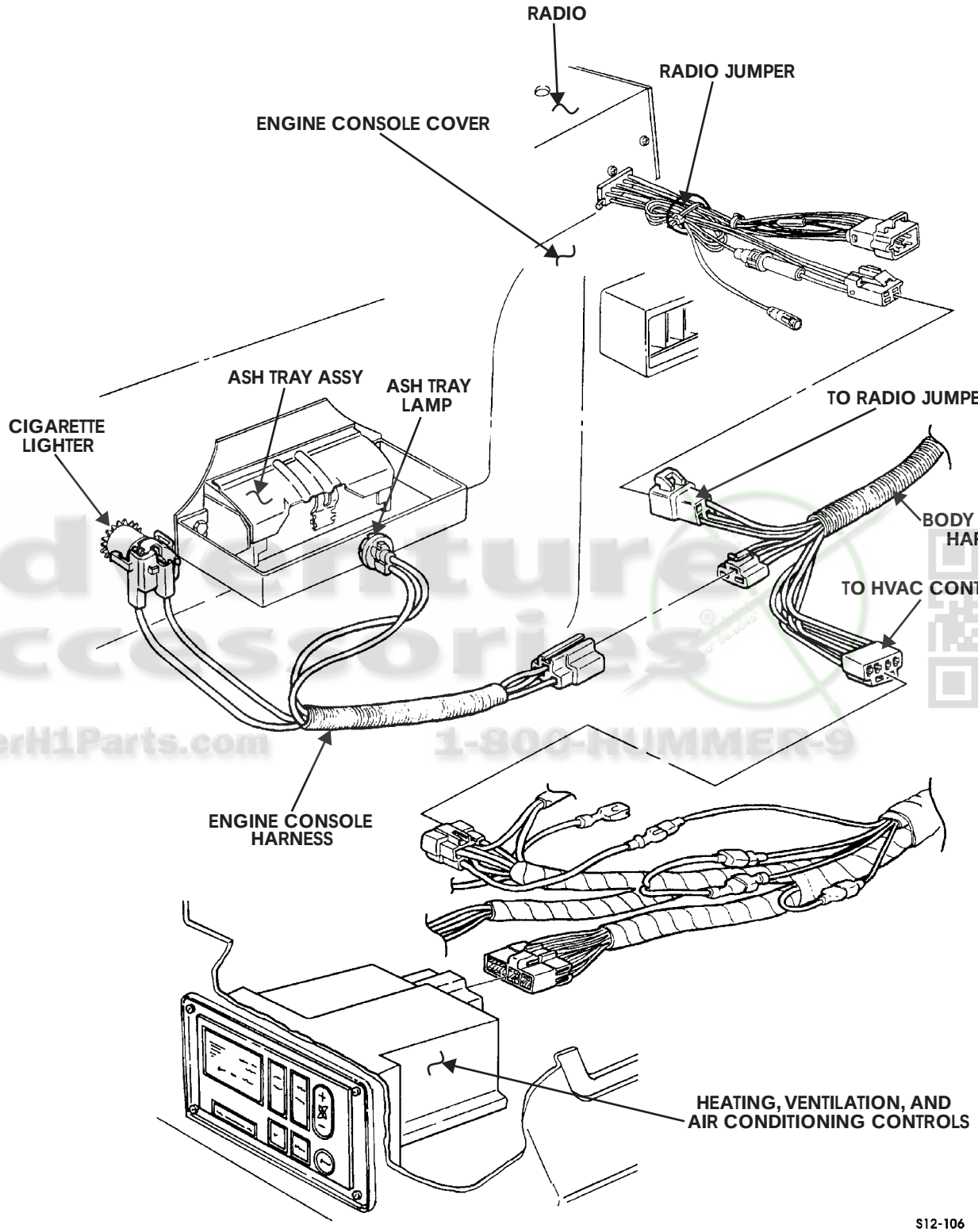


Figure 12-75: Engine Cover Console Connections

11. Remove body wiring harness connectors from turn signals, ignition, and key contact connectors on steering column (Figure 12-76).
12. Remove cable tie securing body harness to steering column support bracket. Discard cable tie.
13. Remove screw, nut, and two body wiring harness ground leads from steering column.

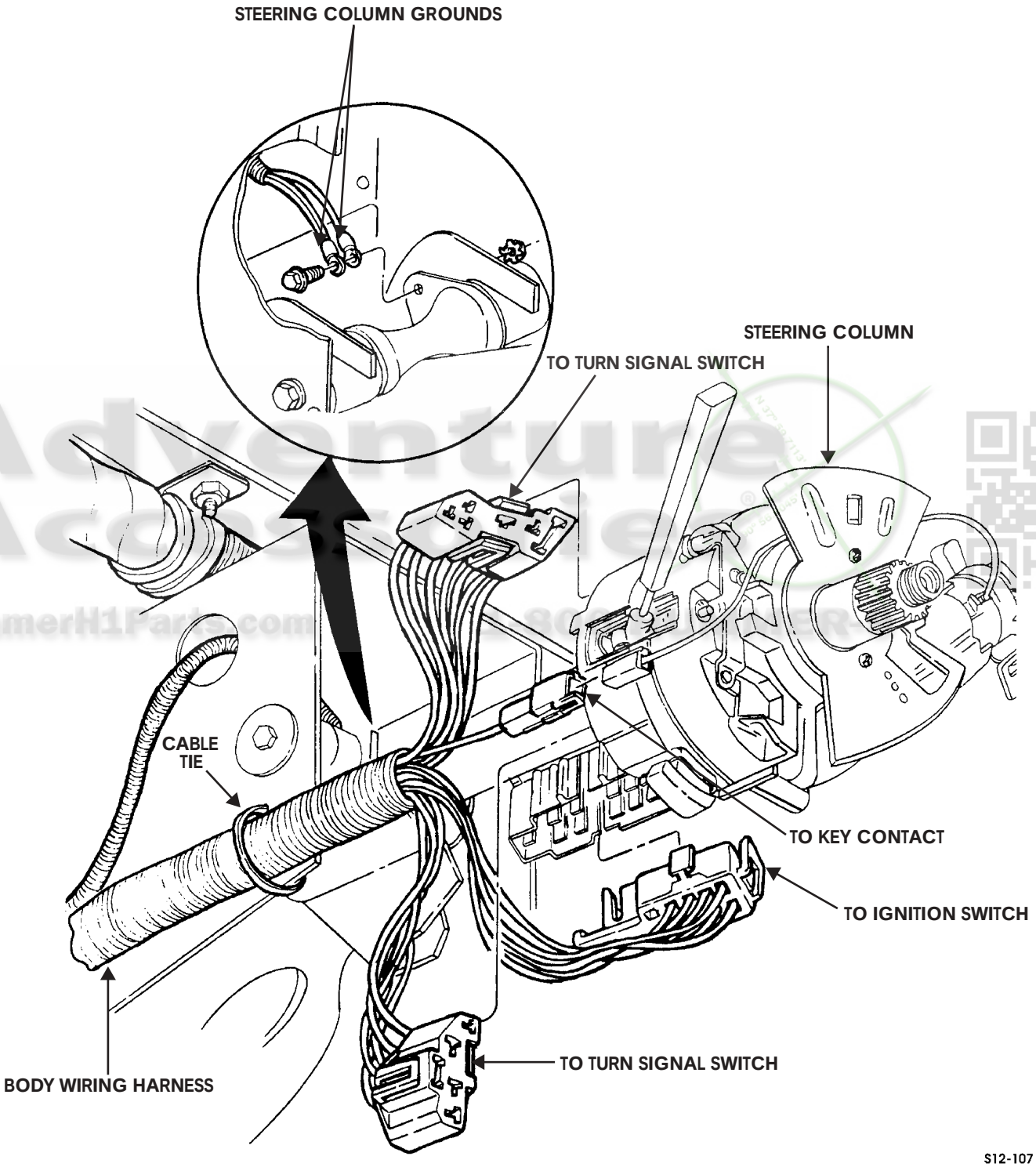


Figure 12-76: Steering Column Connections

14. Remove body wiring harness connectors from door jamb switch and roof harness connector (Figure 12-77).

15. Remove body wiring harness connectors from door jamb Remove body wiring harness connector from stoplight switch (Figure 12-78).

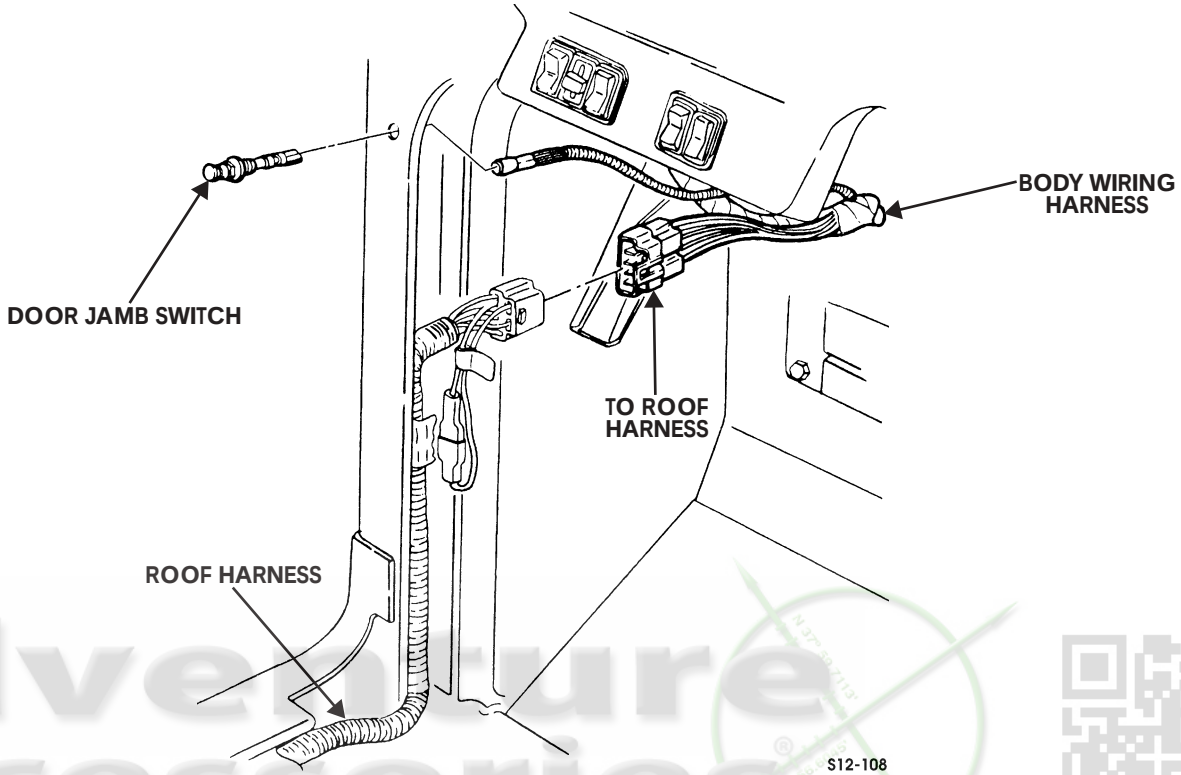


Figure 12-77: . Body Harness-to-Roof Harness Connection

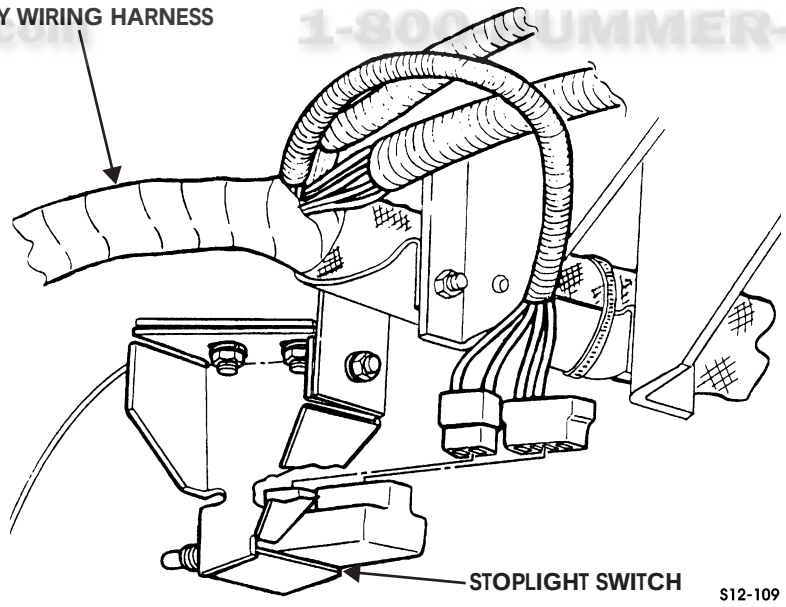


Figure 12-78: Stoplight Switch Connections

16. Remove body wiring harness connectors from wiper motor and front identification light jumper harness (Figure 12-79).

17. Remove body wiring harness connectors from transmission shift lock solenoid connector (Figure 12-80).

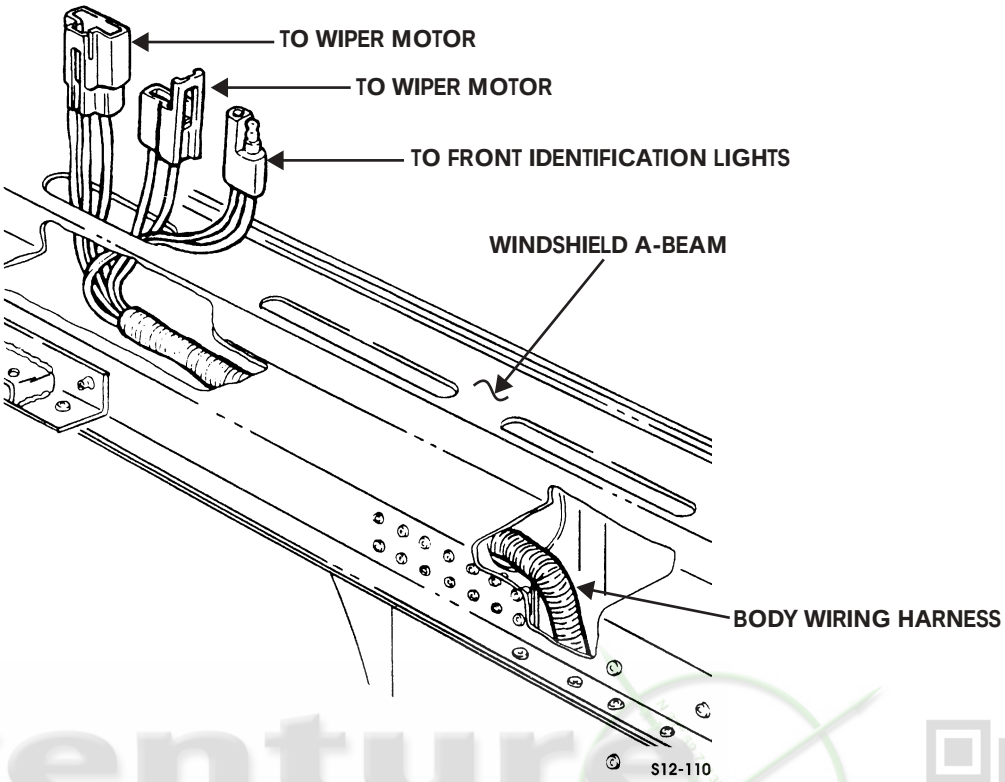


Figure 12-79: Windshield Frame Connections

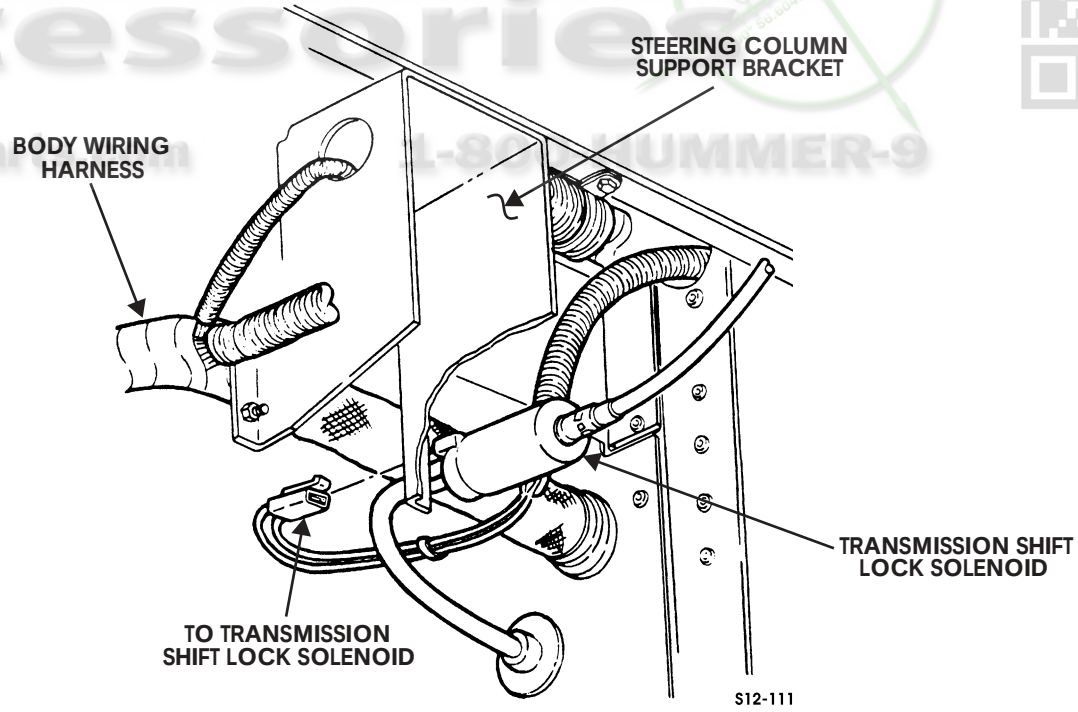


Figure 12-80: Shifter Interlock

NOTE: Fuse box is an integral part of the body wiring harness.

18. Remove two screws, lockwashers, washers, fuse box, and body wiring harness from supports on body. Discard lockwashers (Figure 12-81).

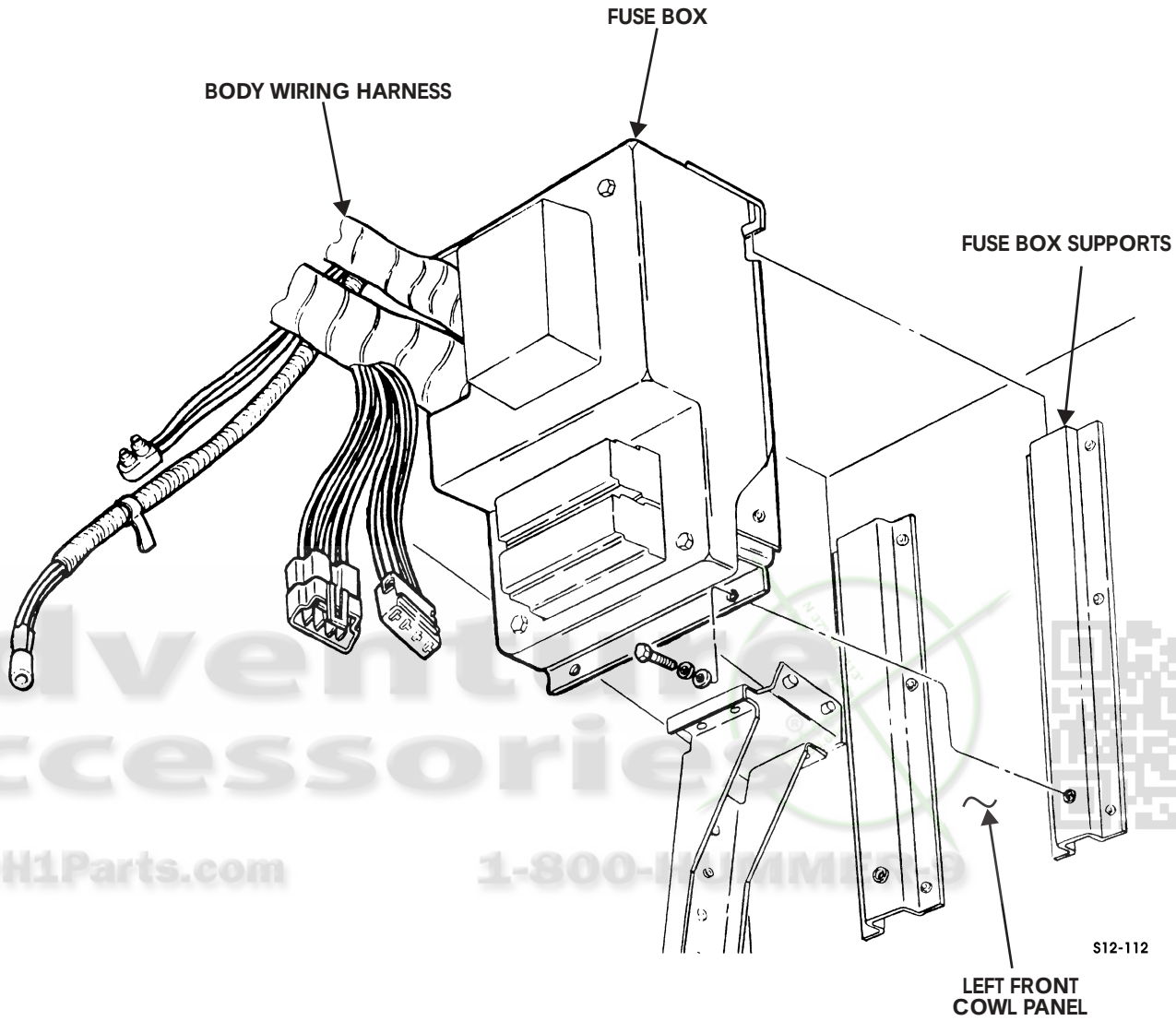


Figure 12-81: Fuse Box Mounting

19. Remove two screws and ALDL body wiring harness connector from support bracket (Figure 12-82).
20. Remove body wiring harness connector from cowl panel by first disconnecting engine connector then removing jamnut
21. Remove two tie straps, screws, lockwashers, washers, nuts, washers, harness support bracket and body wiring harness from steering column bracket.
22. Remove two screws, clamps and body wiring harness from A-beam..

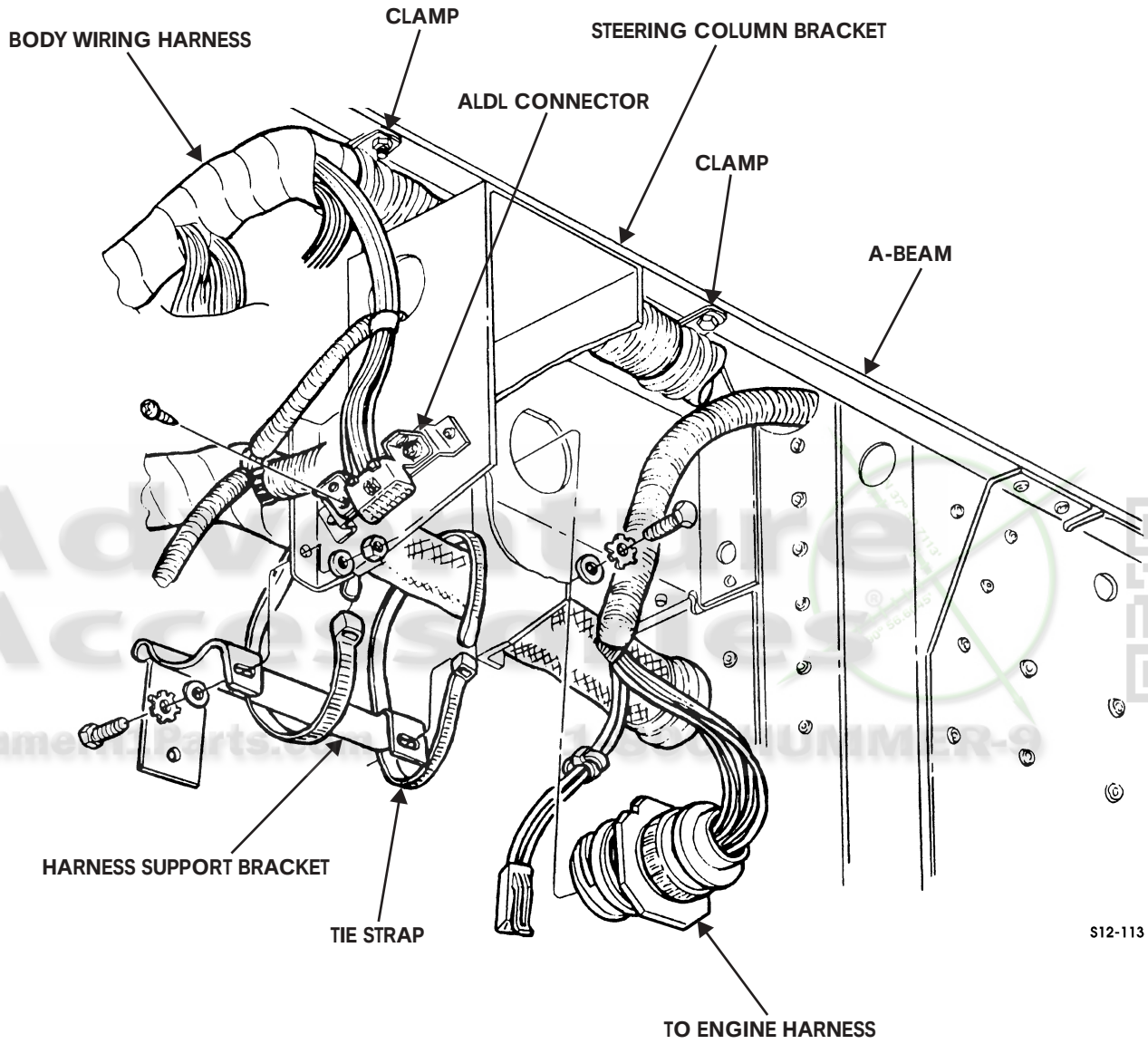


Figure 12-82: Body Harness Under Dash Mounting

23. Remove body wiring harness connector from windshield washer bottle (Figure 12-83).
24. Remove body wiring harness from CTIS harness connector, if installed.
25. Remove body wiring harness from trouble light harness, if installed.
26. Loosen two nuts and remove terminal block cover.
27. Remove two nuts, lockwashers, and washers from terminal block and remove body wiring harness power and ground leads. Discard lockwashers.
28. Install terminal block cover and tighten two nuts.
29. Remove body wiring harness connector from brake warning light switch.
30. Remove three screws, two nuts, three clamps, and two tie straps securing body wiring harness to left cowl inner panel.

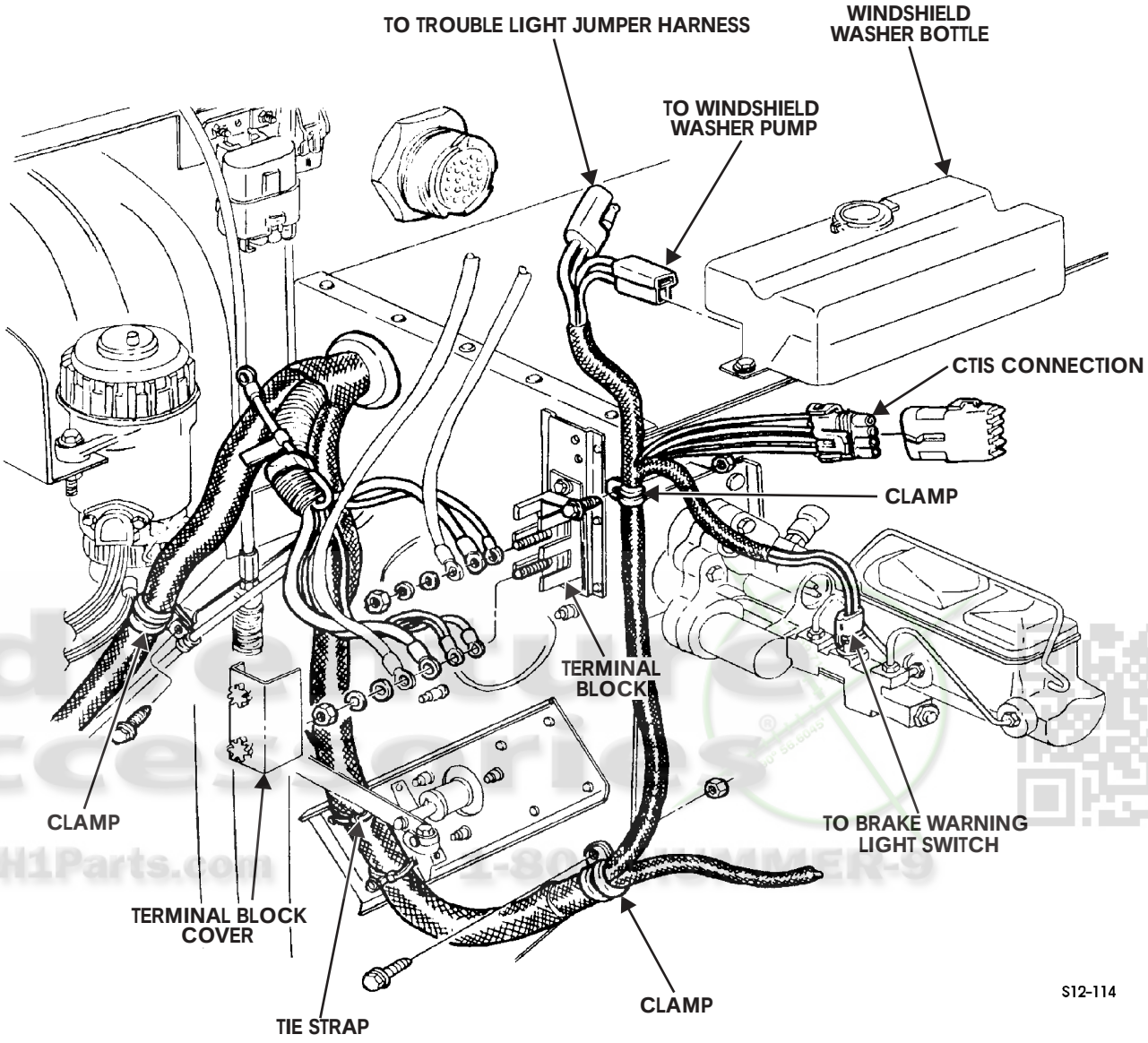


Figure 12-83: Underhood Connections

31. Remove two body wiring harness connectors from hood harness connectors (Figure 12-84).
32. Remove body wiring harness connector from fog lamp harness connector if installed.
33. Remove four screws, three nuts, four clamps and body wiring harness from splash shield and frame.
34. Remove body wiring harness connector from fuel tank sender harness (Figure 12-85).

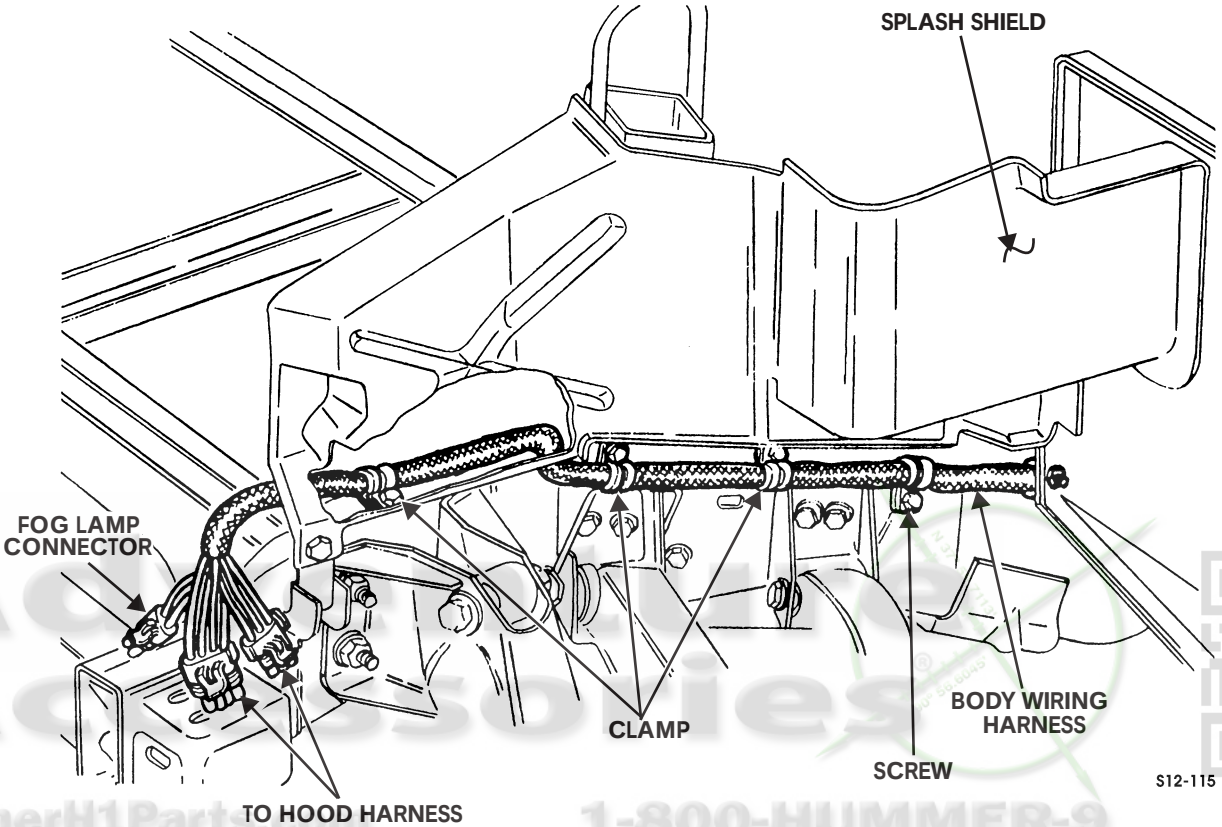


Figure 12-84: Harness to Splash Shield Retainers

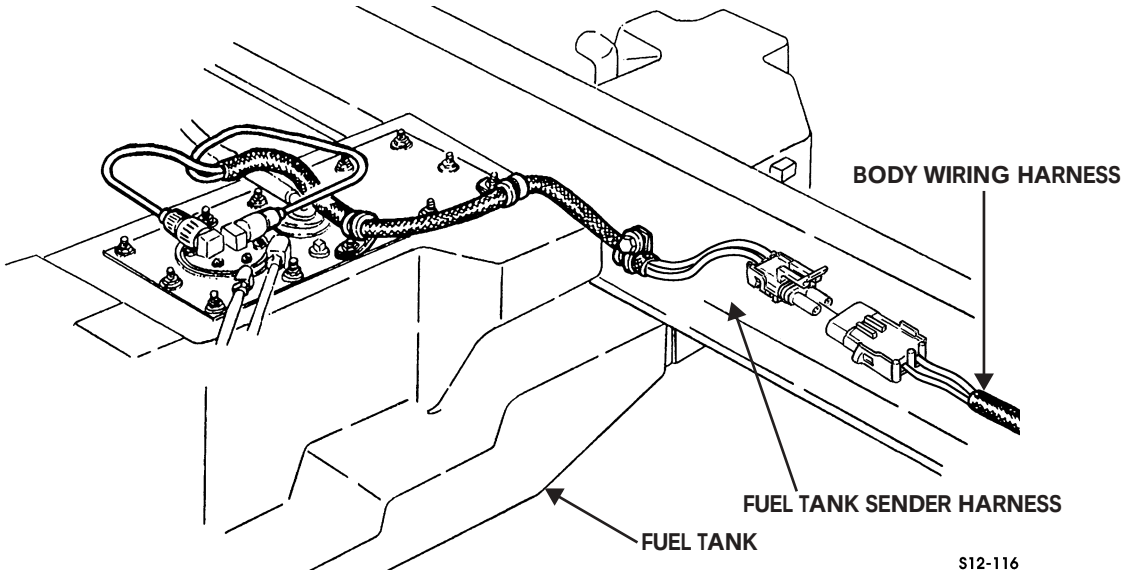


Figure 12-85: Fuel Tank Connections

35. Remove body wiring harness connector from trailer harness connector if installed. If no trailer harness exists, remove dummy plug from body wiring harness trailer connector (Figure 12-86).
36. Remove clamp and hardware.

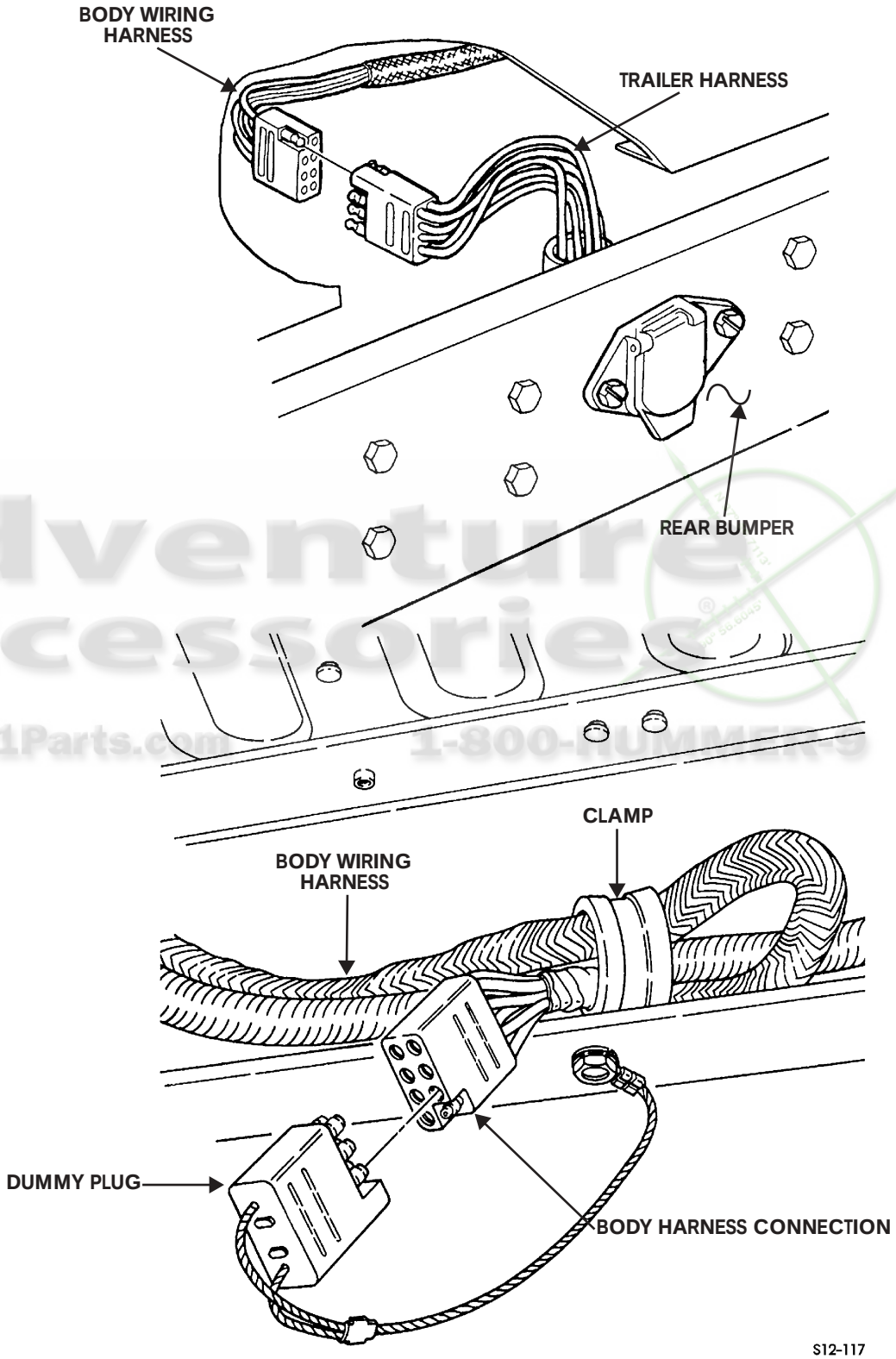


Figure 12-86: Trailer Jumper

37. Remove four screws, nuts and shield from body panel and body wiring harness clamps (Figure 12-87).
38. Remove locknut, washer, four body wiring harness ground leads, and washer from taillight. Discard locknut.
39. Remove two body wiring harness taillight connectors from taillight connectors.
40. Remove nut, washer, and body wiring harness ground lead from side marker light. Remove body wiring harness connector from side marker light.
41. Remove clamp, screw, nut and body wiring harness from D-beam.
42. Remove body wiring harness connector from clearance light.
43. Perform steps 37 through 42 for left side body wiring harness removal.

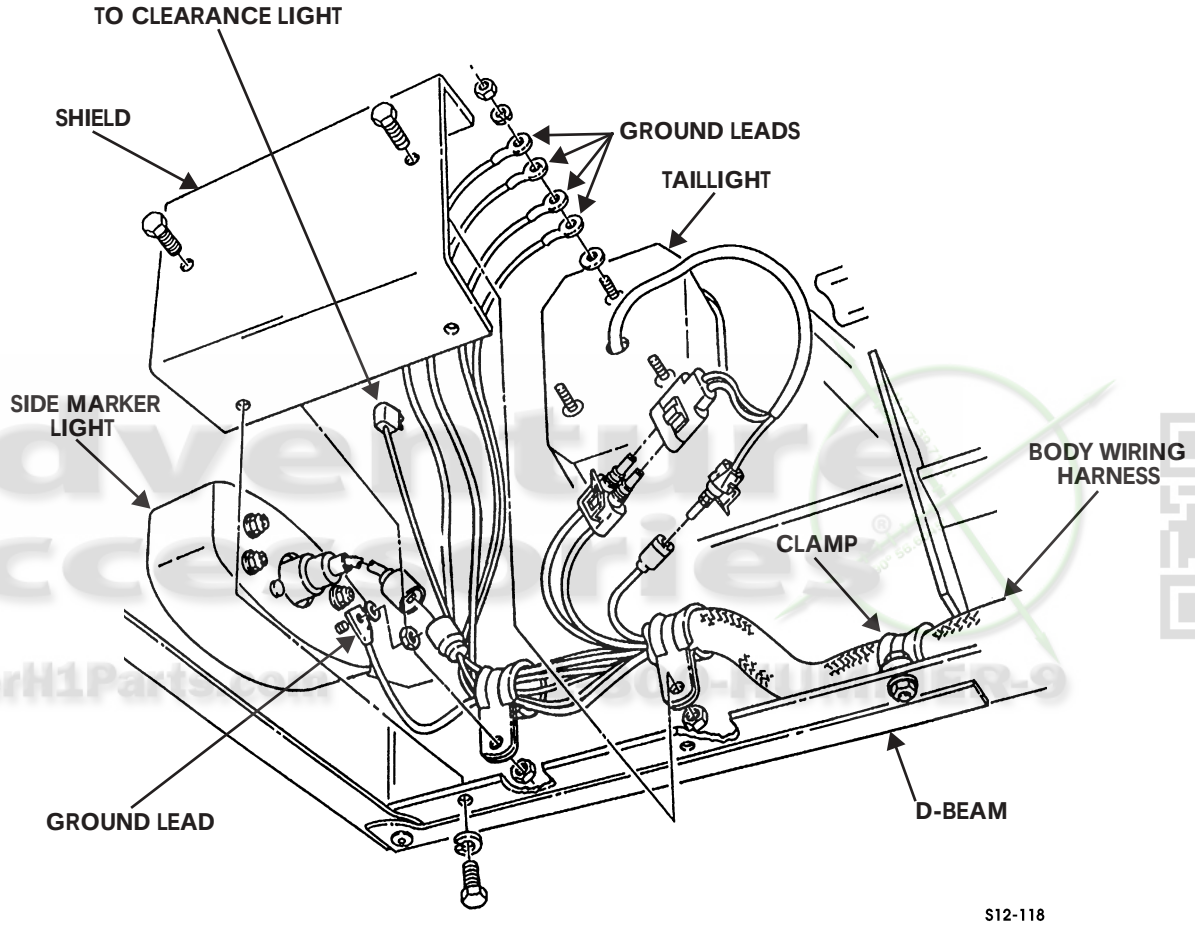


Figure 12-87: Marker and Taillight Connections

44. Remove two screws and rear identification light bar from vehicle. Remove body wiring harness connector from rear identification light bar (Figure 12-88)

45. .Remove body wiring harness connector from rear license plate light (Figure 12-89).

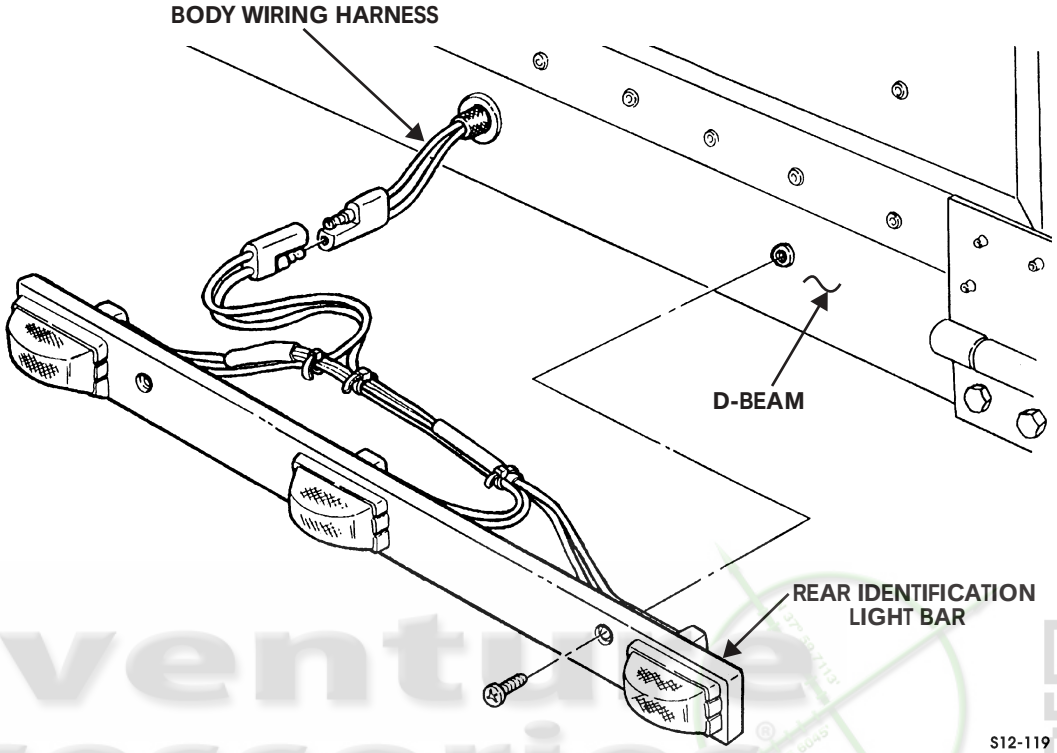


Figure 12-88: Identification LIghts

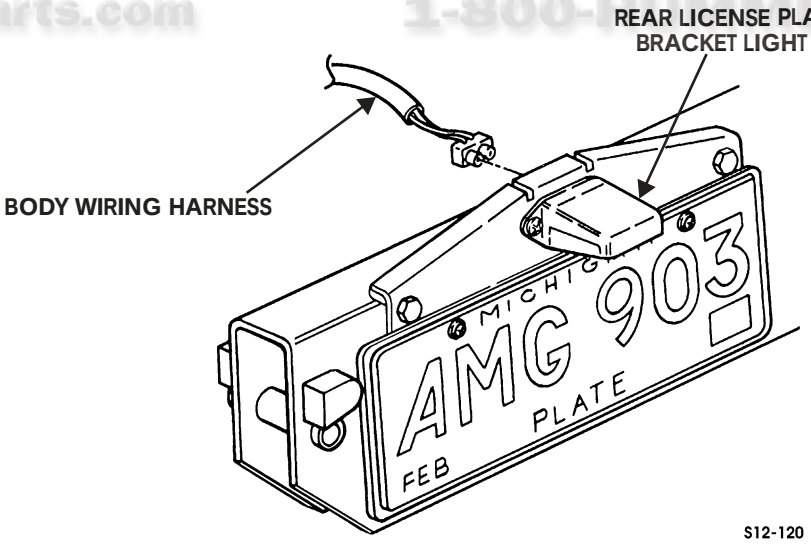


Figure 12-89: License Plate Light

46. Remove five transmission shifter and two parking brake switch connectors from body wiring harness connectors (Figure 12-90)
47. Remove five screws, two nuts and body wiring harness clamps from left tunnel side floor panel area.

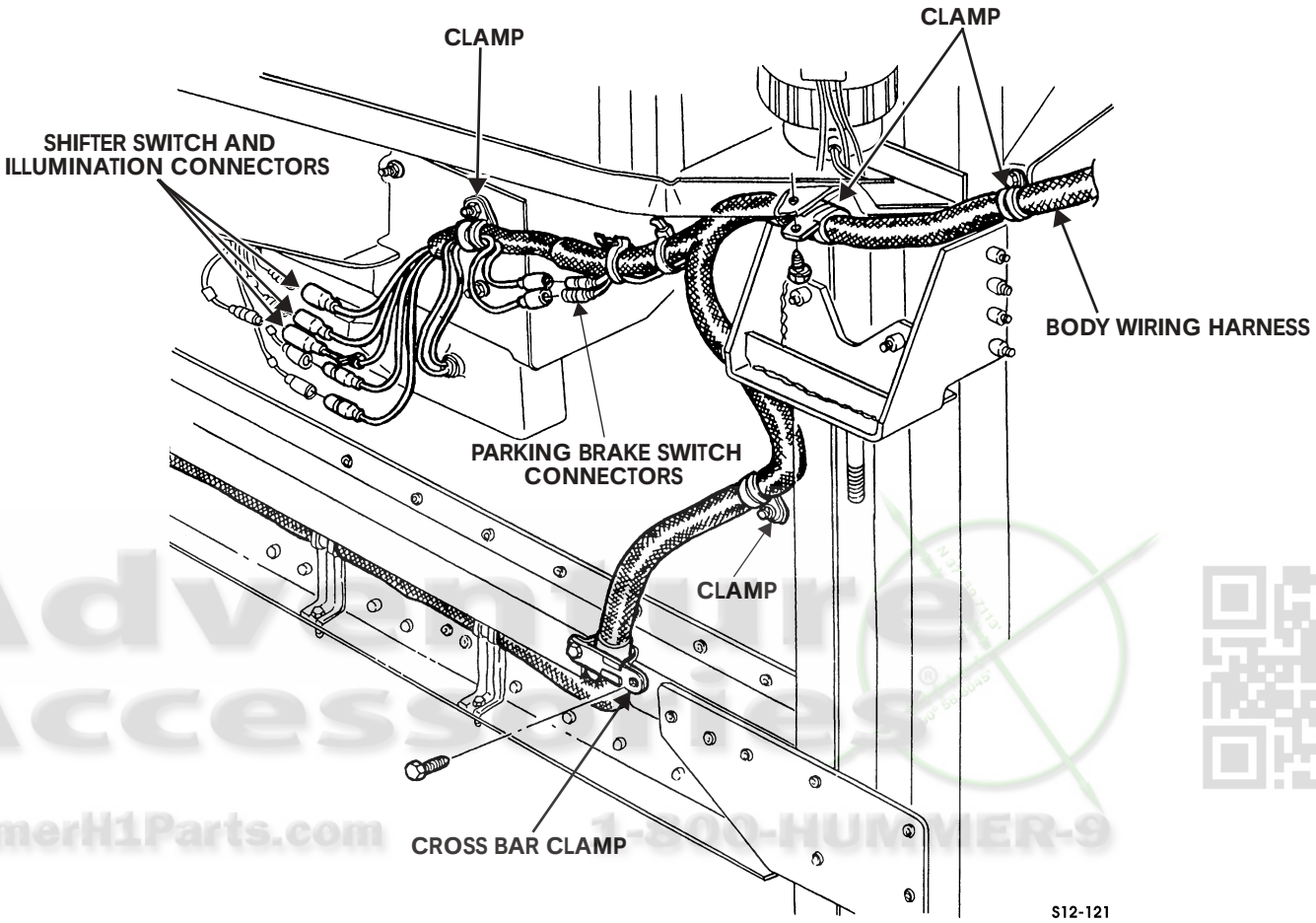


Figure 12-90: Shifter and Parking Brake Connections

48. Remove four screws, nuts, four harness retaining clamps and body wiring harness from body (Figure 12-91).
49. Remove thirteen self-tapping screws, clamps and body wiring harness from body.
50. Pull body wiring harness outer branches through body and into instrument panel and fuse box area of cab.
51. Remove body wiring harness and fuse box from vehicle.

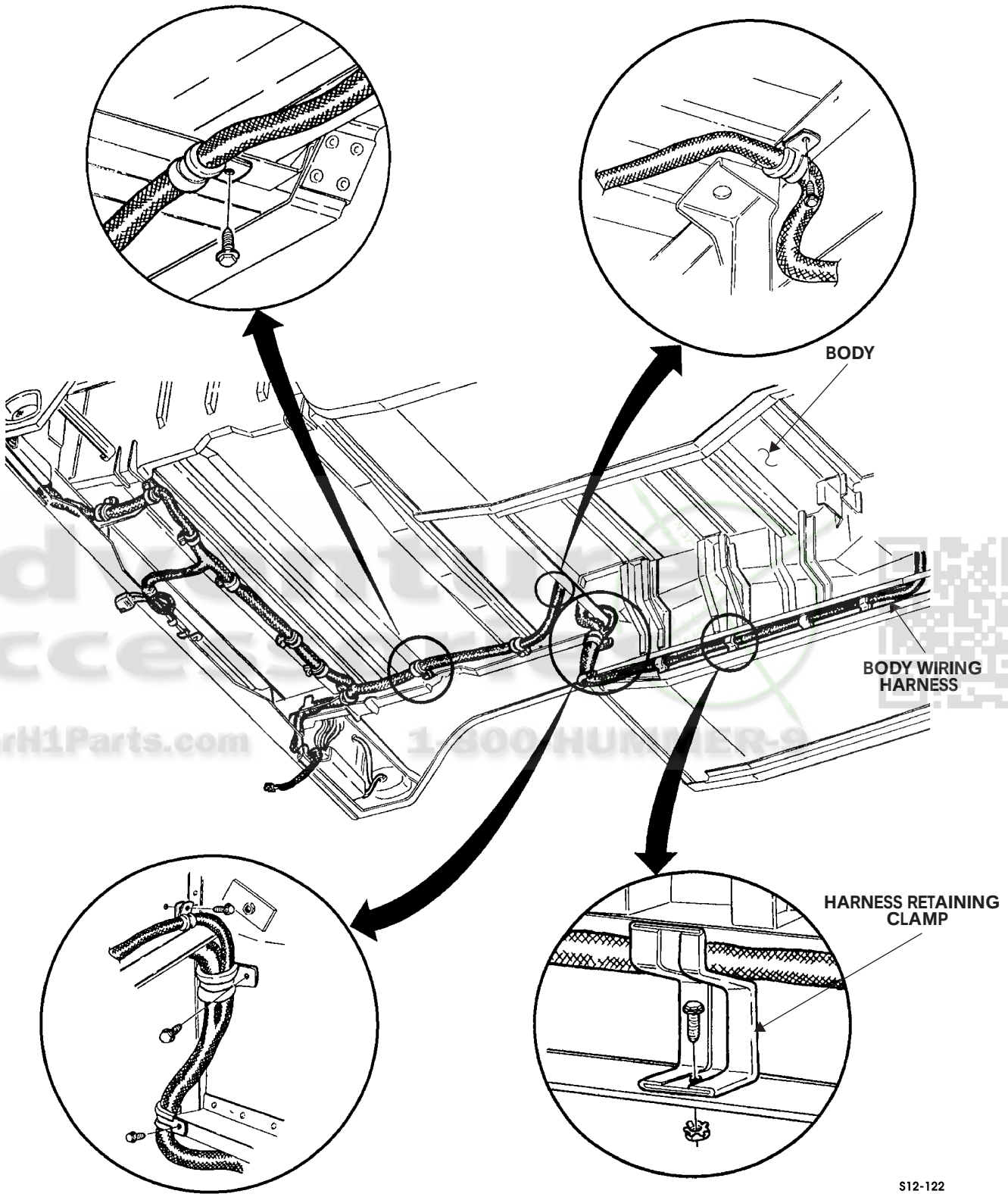


Figure 12-91: Harness Retainers

Installation

1. Position body wiring harness and fuse box in cab area of vehicle.
2. Position outer branches of body wiring harness through body into underbody area.
3. Install body wiring harness on body with thirteen clamps and self-tapping screws (Figure 12-92).
4. Install body wiring harness on body with four harness retaining clamps, screws, and nuts.

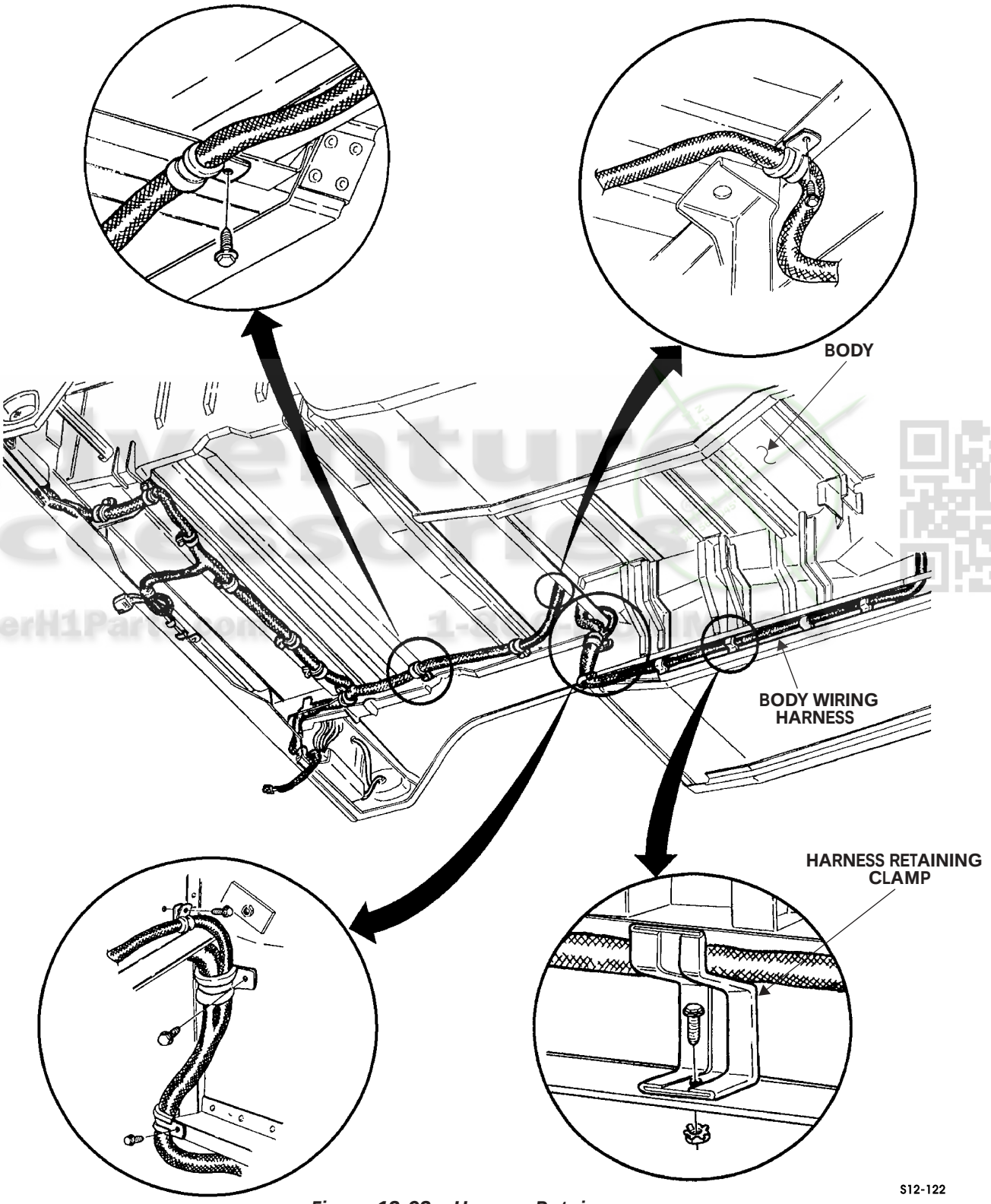


Figure 12-92: Harness Retainers

5. Install body wiring harness on left tunnel side floor panel area with four clamps, five screws, and two nuts (Figure 12-93).
6. Connect five transmission shifters and two brake illumination switch connectors to body wiring harness connectors.

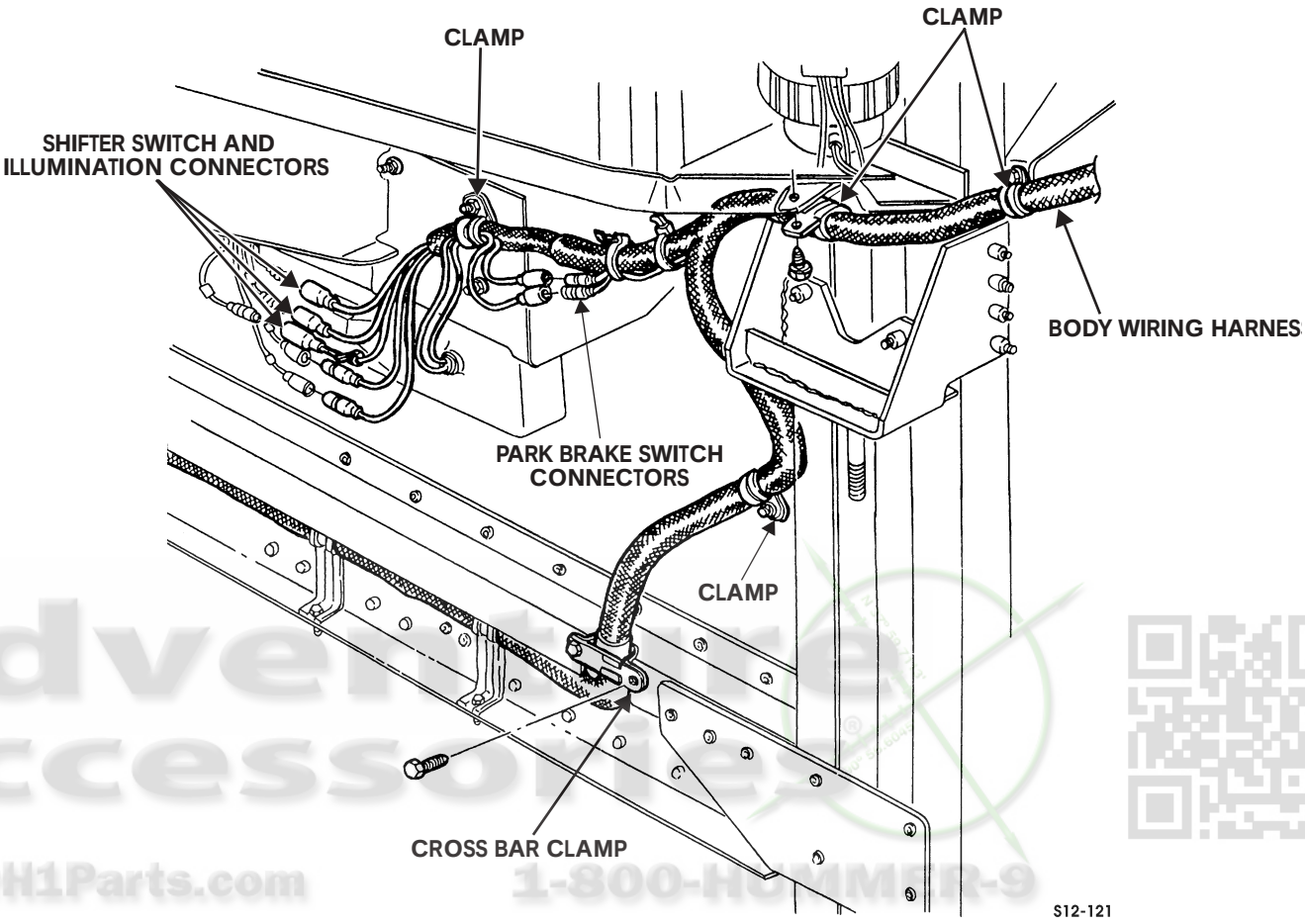


Figure 12-93: Parking Brake and Shifter Connections

7. Connect body wiring harness license plate light connector to license plate light (Figure 12-94).
8. Connect body wiring harness rear identification light connector to rear identification light bar. Install rear identification light bar on D-beam with two screws (Figure 12-95).

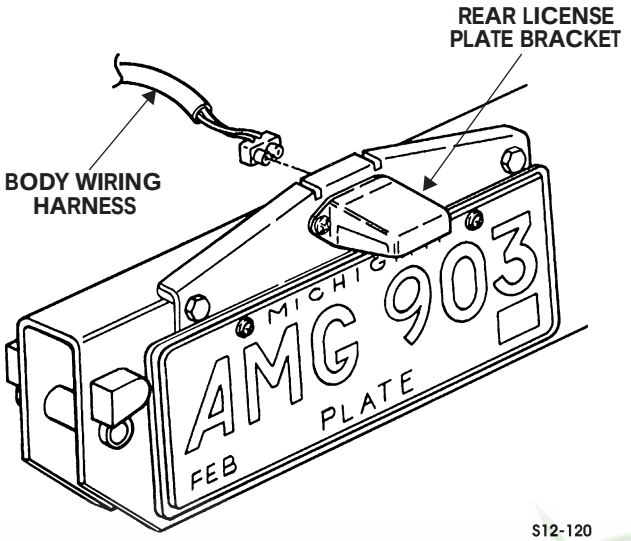


Figure 12-94: License Plate Light

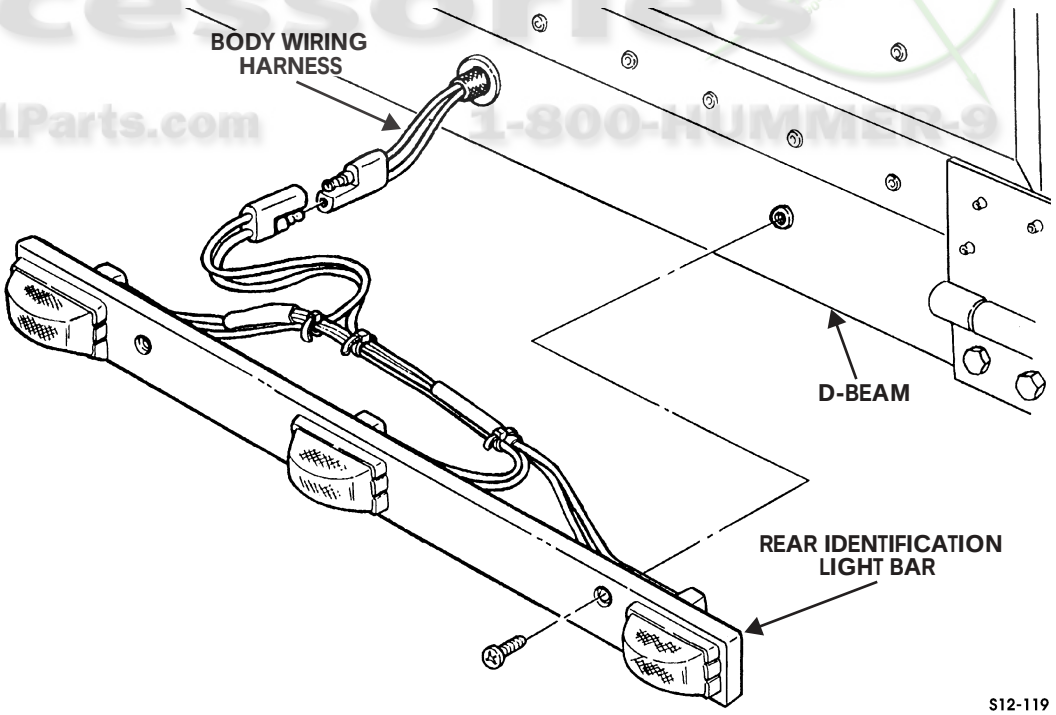


Figure 12-95: Identification Lights

9. Connect body wiring harness clearance light connector to clearance light (Figure 12-96).
10. Install body wiring harness to D-beam with clamp, screw, and nut.
11. Connect body wiring harness connector to side marker light. Install body wiring harness ground lead to side marker light with washer and nut.
12. Connect two body wiring harness connectors to two taillight connectors.
13. Install body wiring harness ground leads on taillight with washer, locknut, and washer.
14. Install shield on body panel and body wiring harness with two clamps, screws, and nuts.
15. Install shield to D-beam with two screws and nuts.
16. Perform steps 10 through 15 for left rear side body wiring harness installation.

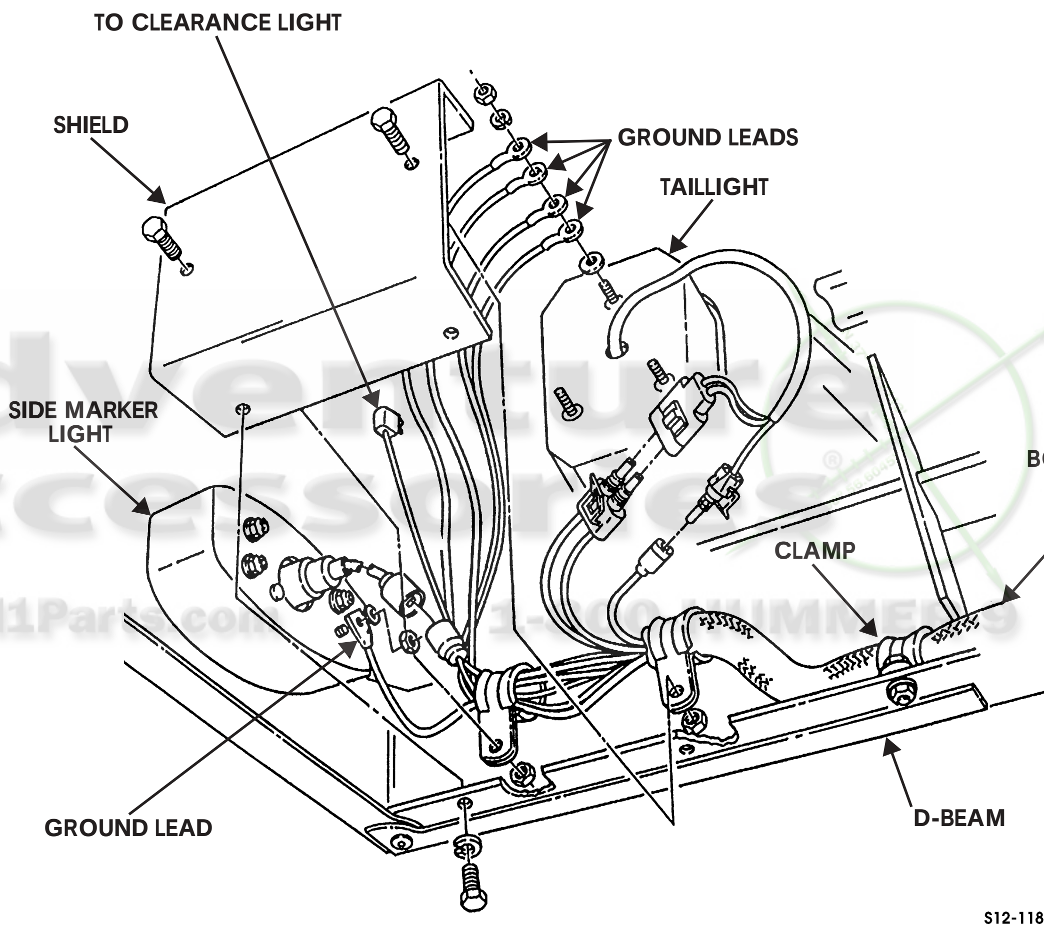


Figure 12-96: Marker and Taillight Connections

17. Connect body wiring harness connector to trailer harness connector if installed. If no trailer harness exists, connect dummy plug to body wiring harness trailer connector (Figure 12-97).
18. Install clamp and hardware.

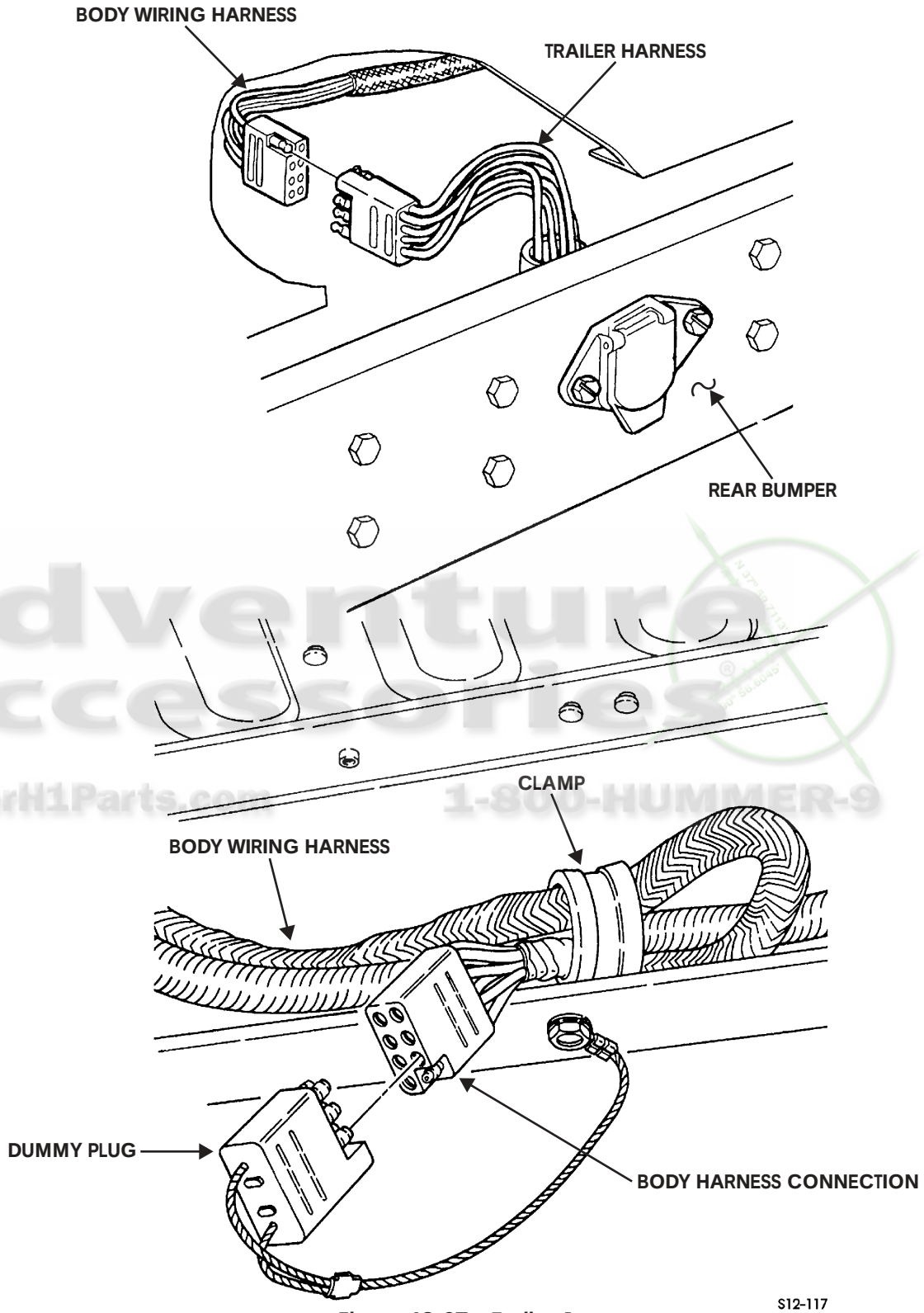


Figure 12-97: Trailer Jumper

19. Connect body wiring harness connector to fuel tank sender harness (Figure 12-98).
20. Secure body wiring harness to splash shield and frame with four screws, three nuts, and four clamps (Figure 12-99).

21. Connect body wiring harness connector to fog lamp harness connector, if installed.
22. Connect two body wiring harness connectors to hood harness connectors.

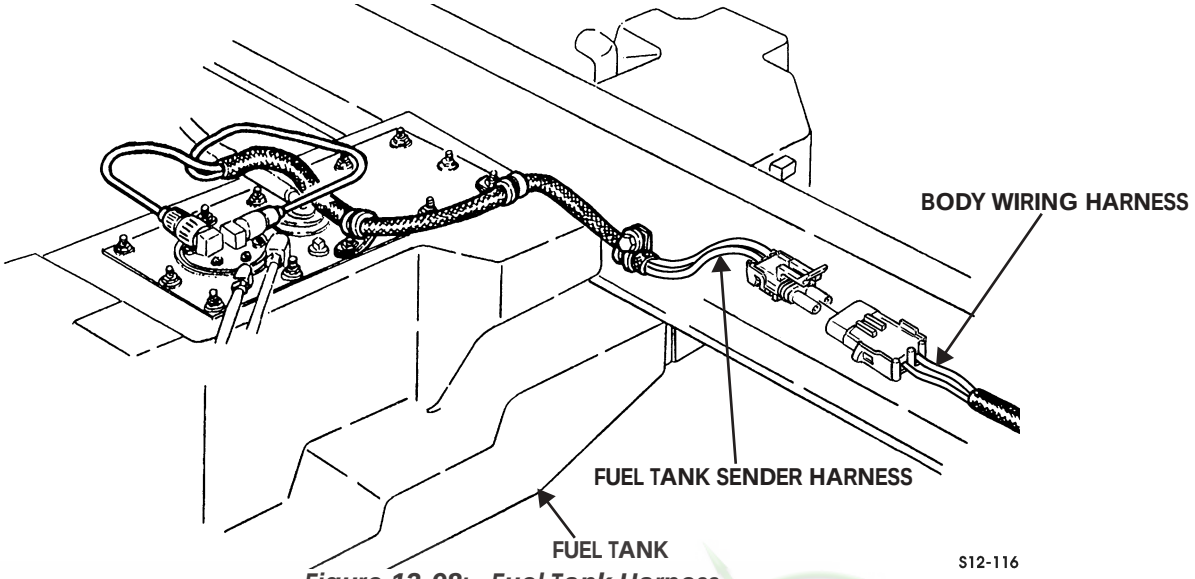


Figure 12-98: Fuel Tank Harness

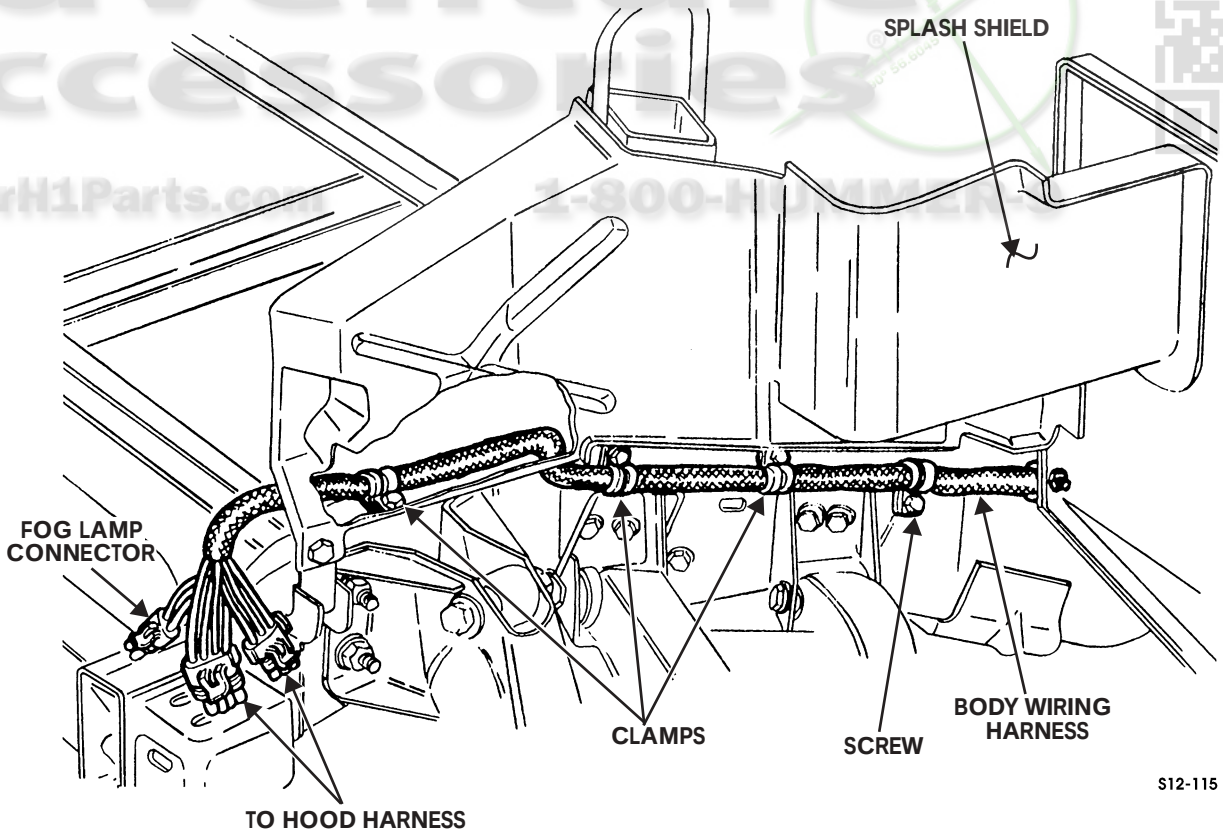


Figure 12-99: Splash Shield Harness Retainers

23. Secure body wiring harness to left cowl inner panel with three screws, two nuts, three clamps, and two tie straps (Figure 12-100).
24. Connect body wiring harness connector to brake warning light switch.
25. Loosen two nuts and remove terminal block cover.
26. Install body wiring harness ground and power cables on terminal block studs with two nuts, lockwashers, and washers. Tighten nuts to 96-120 lb-in. (11-14 N•m)
27. Connect body wiring harness connector to trouble light harness if installed.
28. Connect body wiring harness connector to CTIS harness connector if installed.
29. Connect body wiring harness connector to windshield washer bottle.

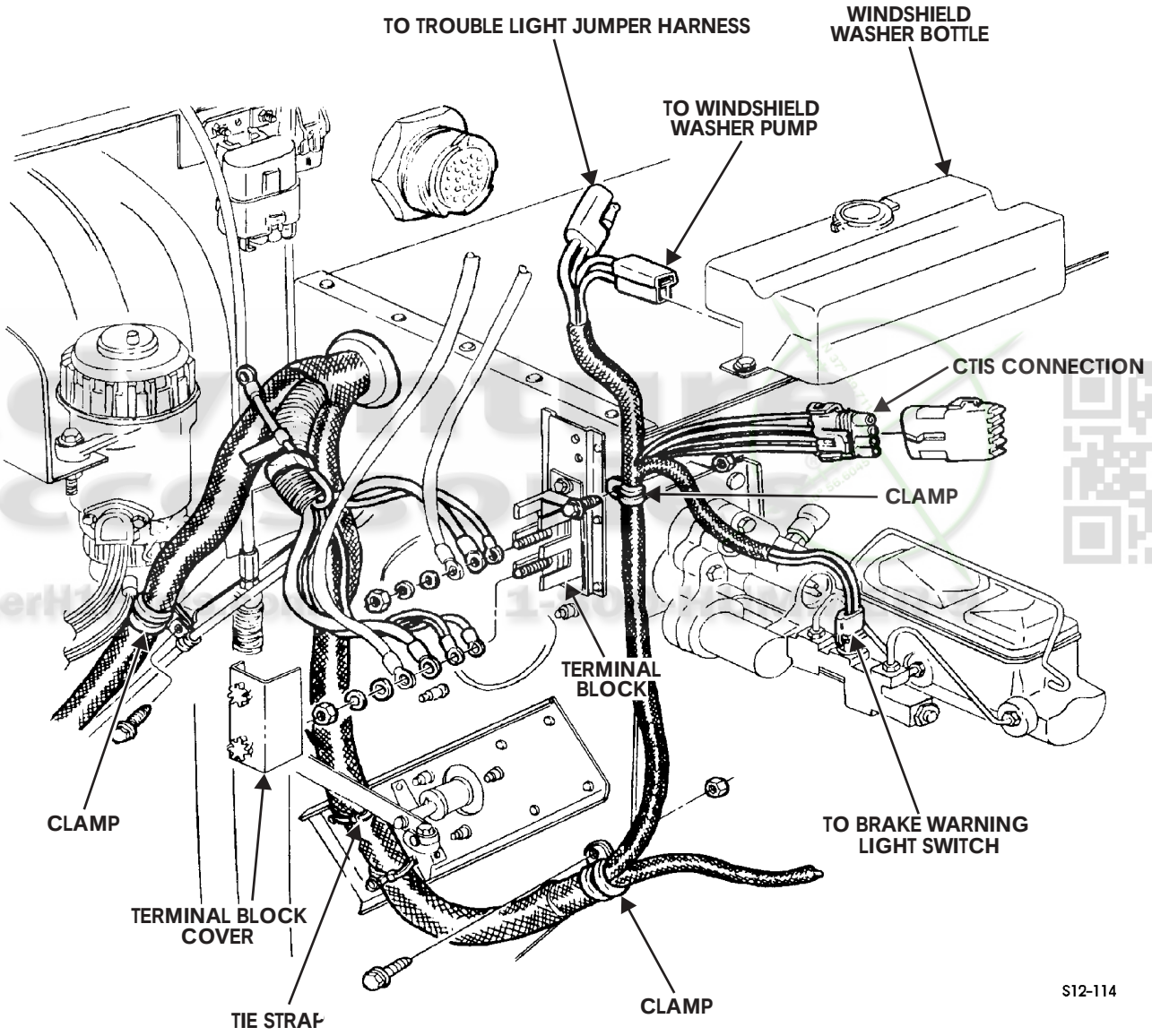


Figure 12-100: Under Hood Connections

30. Secure body wiring harness to A-beam with two screws and clamps. Secure body wiring harness to harness support bracket with two tie straps. Install support bracket on steering column bracket with two screws, lockwashers, washers, nuts, and washers (Figure 12-101).
31. Install body wiring harness engine connector to cowl panel.
32. Install ALDL body wiring harness connector to support bracket with two screws.

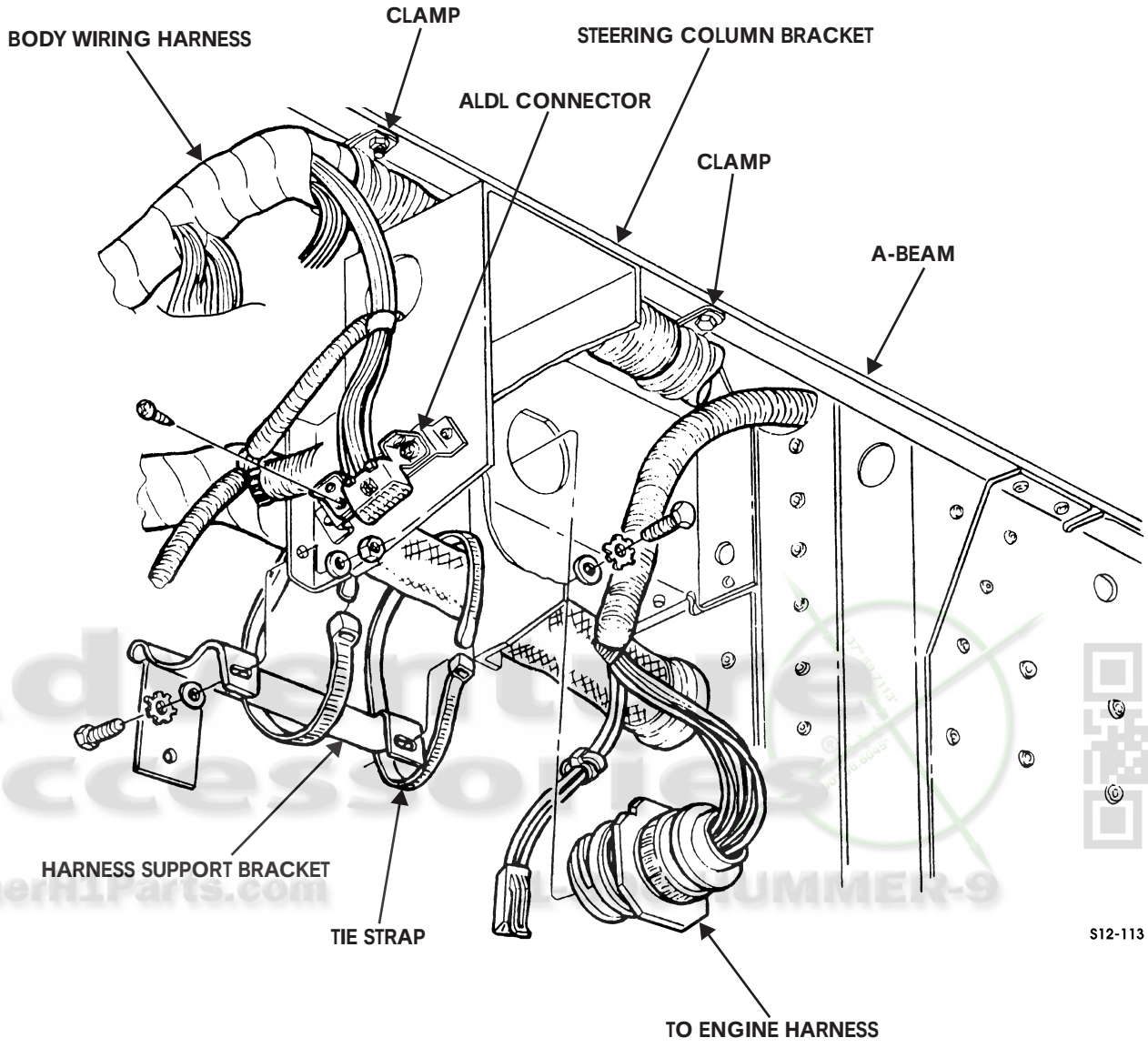


Figure 12-101: Under Dash Harness Mounting

33. Install fuse box on supports with two screws, lockwashers, and washers (Figure 12-102).

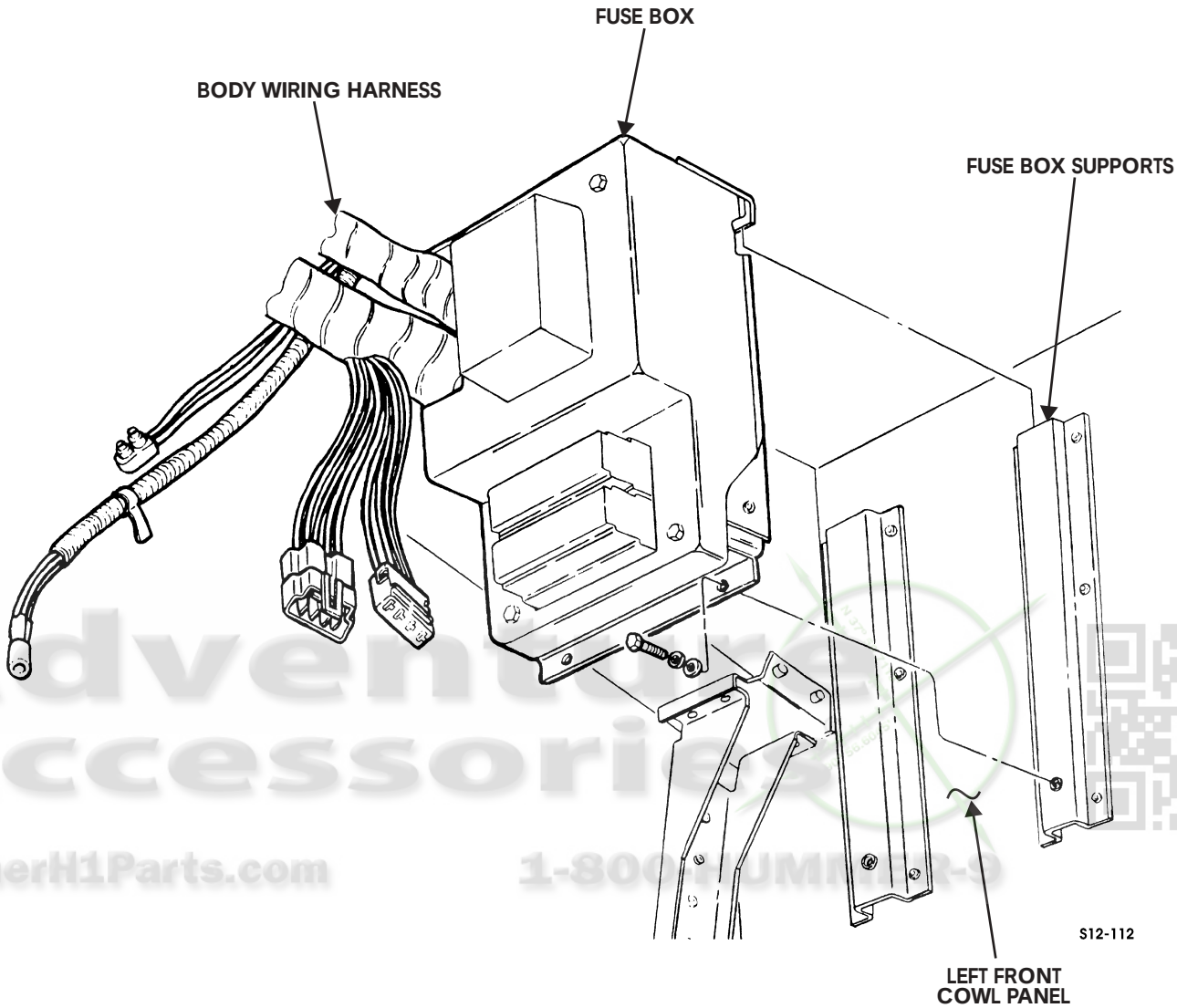


Figure 12-102: Fuse Box Mounting

34. Secure body wiring harness connector to transmission shift lock solenoid (Figure 12-103).

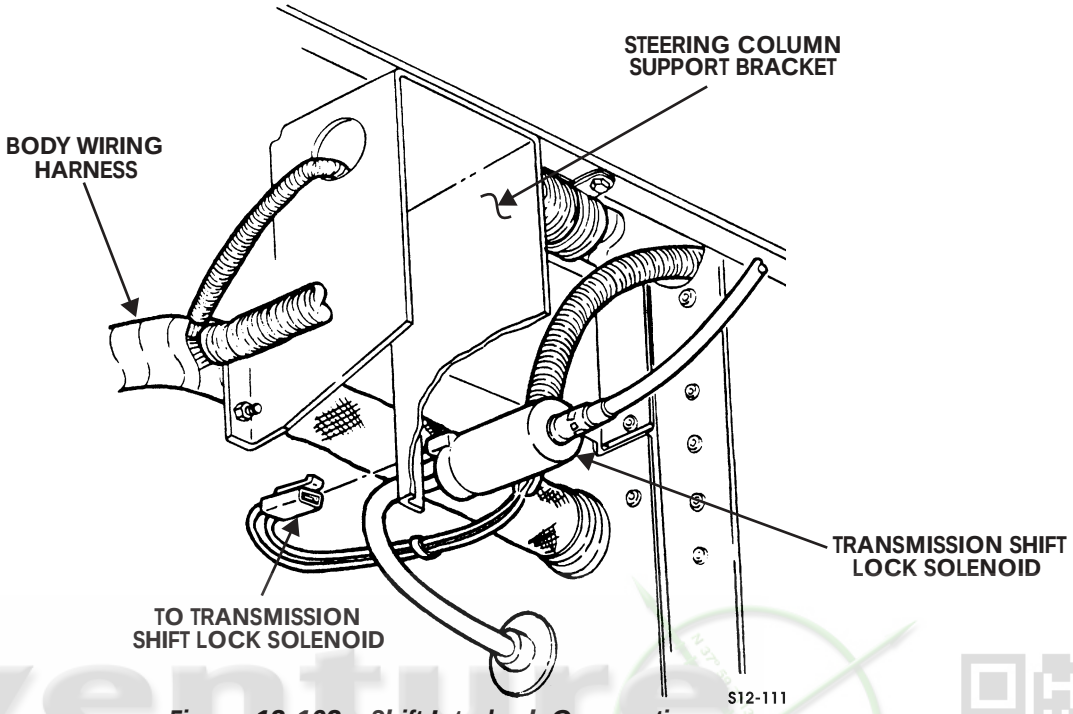


Figure 12-103: Shift Interlock Connections

35. Secure body wiring connectors to wiper motor and front identification light jumper harness connectors (Figure 12-104).

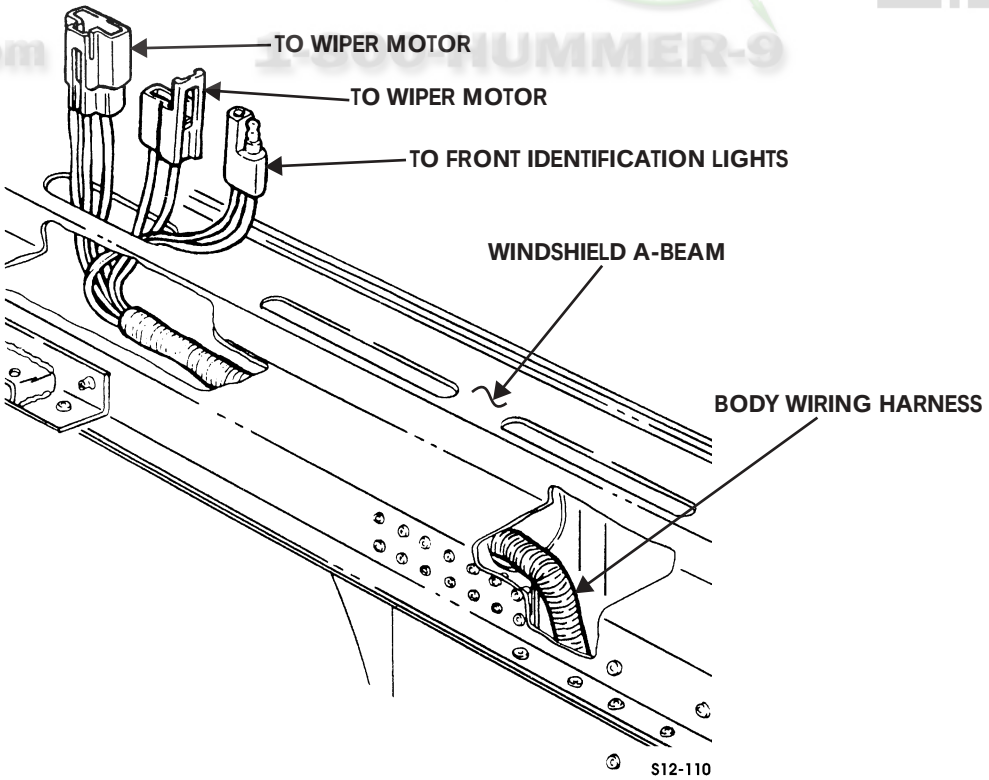


Figure 12-104: Windshield Frame Connections

36. Connect body wiring harness connectors to stoplight switch (Figure 12-105).

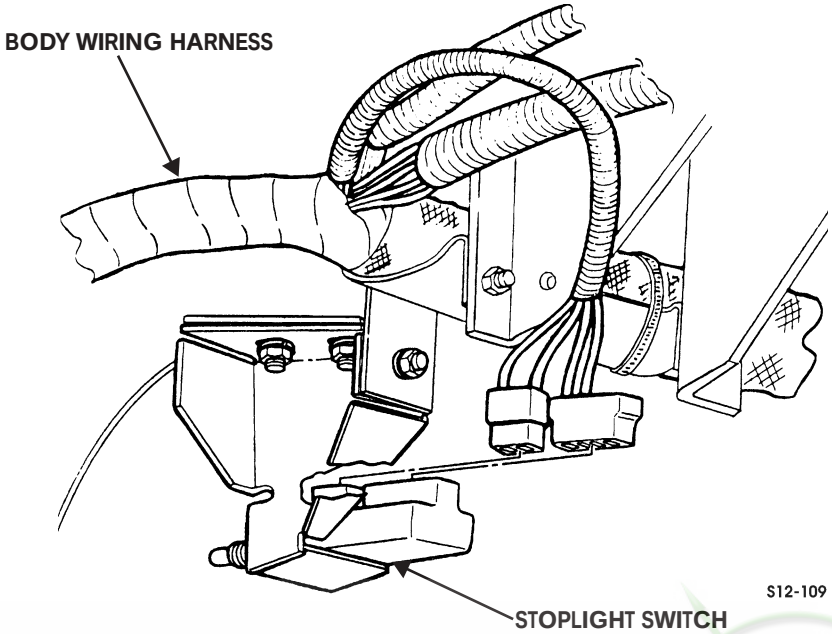


Figure 12-105: Stoplight Switch

37. Connect body wiring harness connectors to door jamb switch and roof harness connector (Figure 12-106).

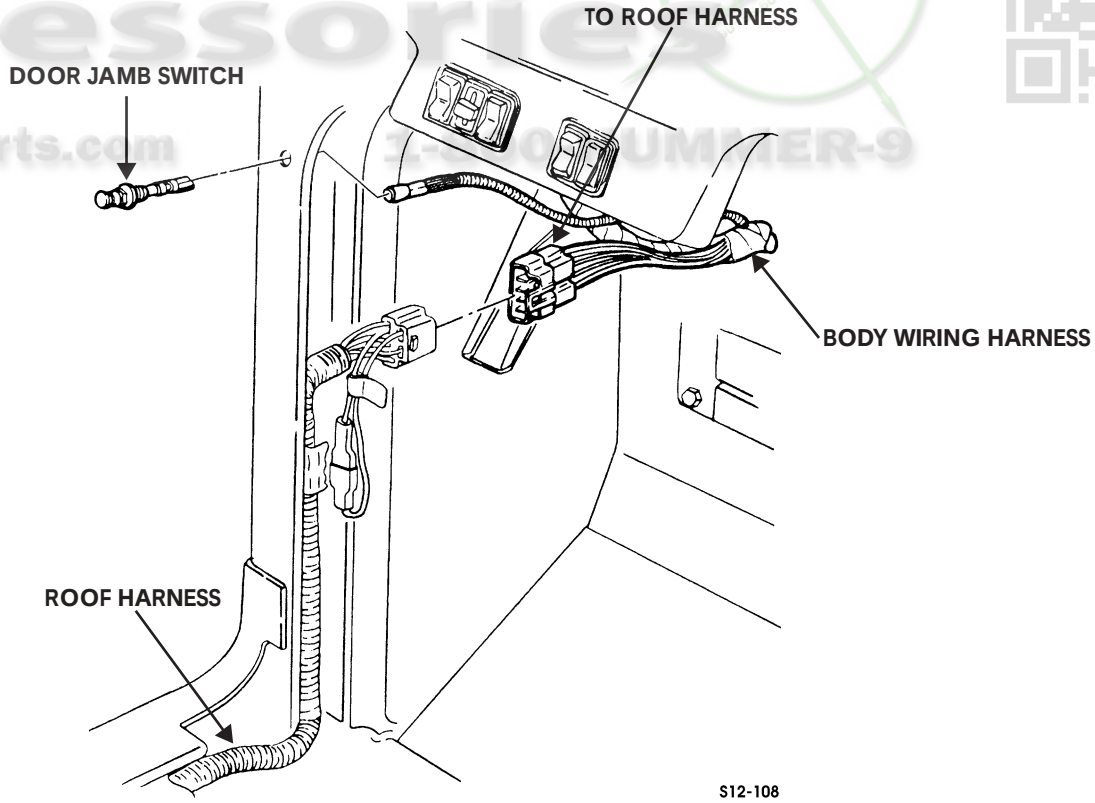


Figure 12-106: Body-to-Roof Harness Connection

38. Install body wiring harness ground leads on steering column with screw and nut (Figure 12-107).

39. Secure body wiring harness turn signal, ignition, and key contact connectors to steering column.

40. Install cable tie and body wiring harness on steering column bracket.

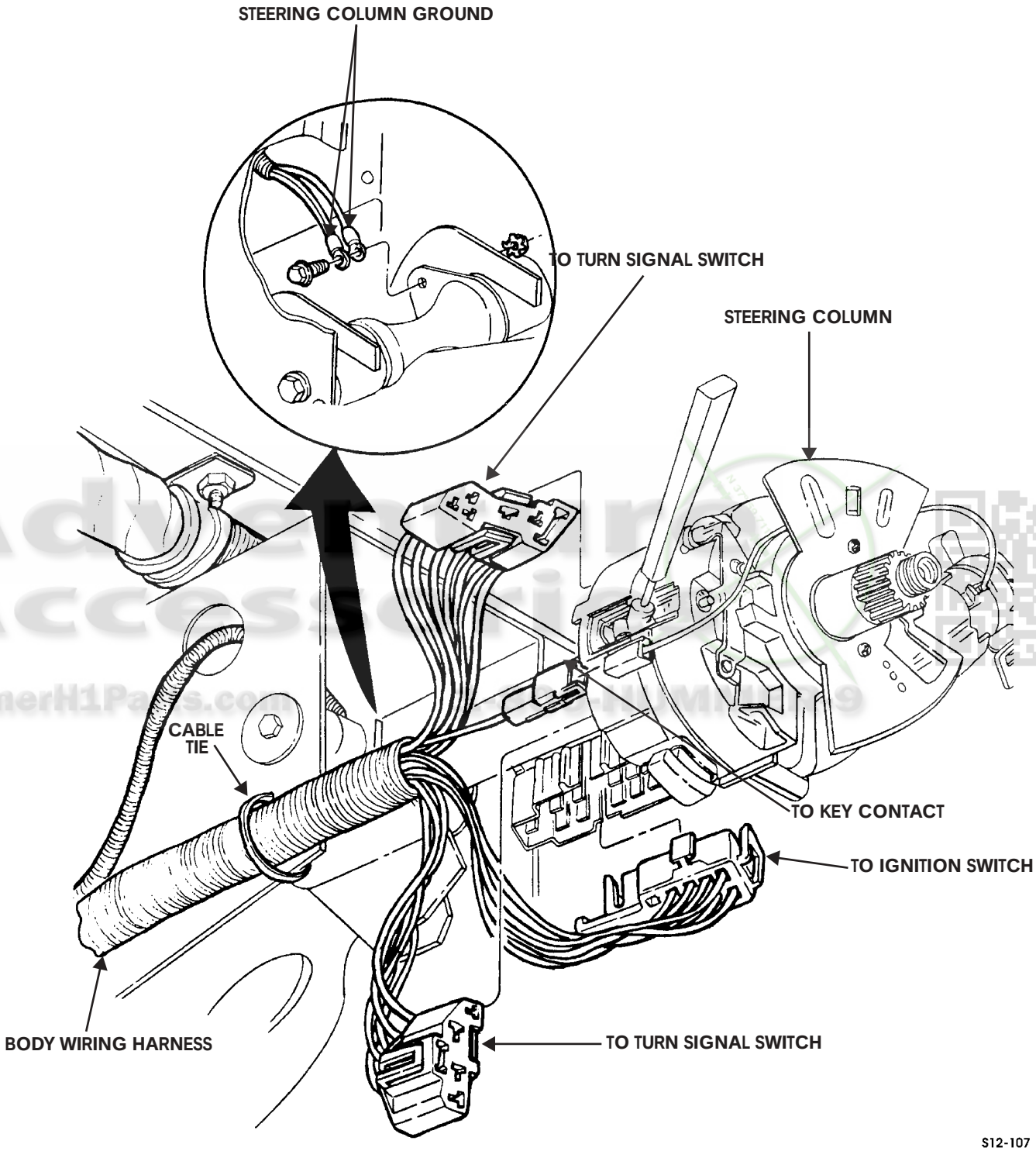


Figure 12-107: Steering Column Connection

41. Connect body wiring harness connectors to radio, engine console, and heat and A/C controller connectors (Figure 12-108).
42. Install ground leads on ground stud with nut (Figure 12-109).
43. Connect harness connector to jumper harness if power windows or power mirrors are installed.

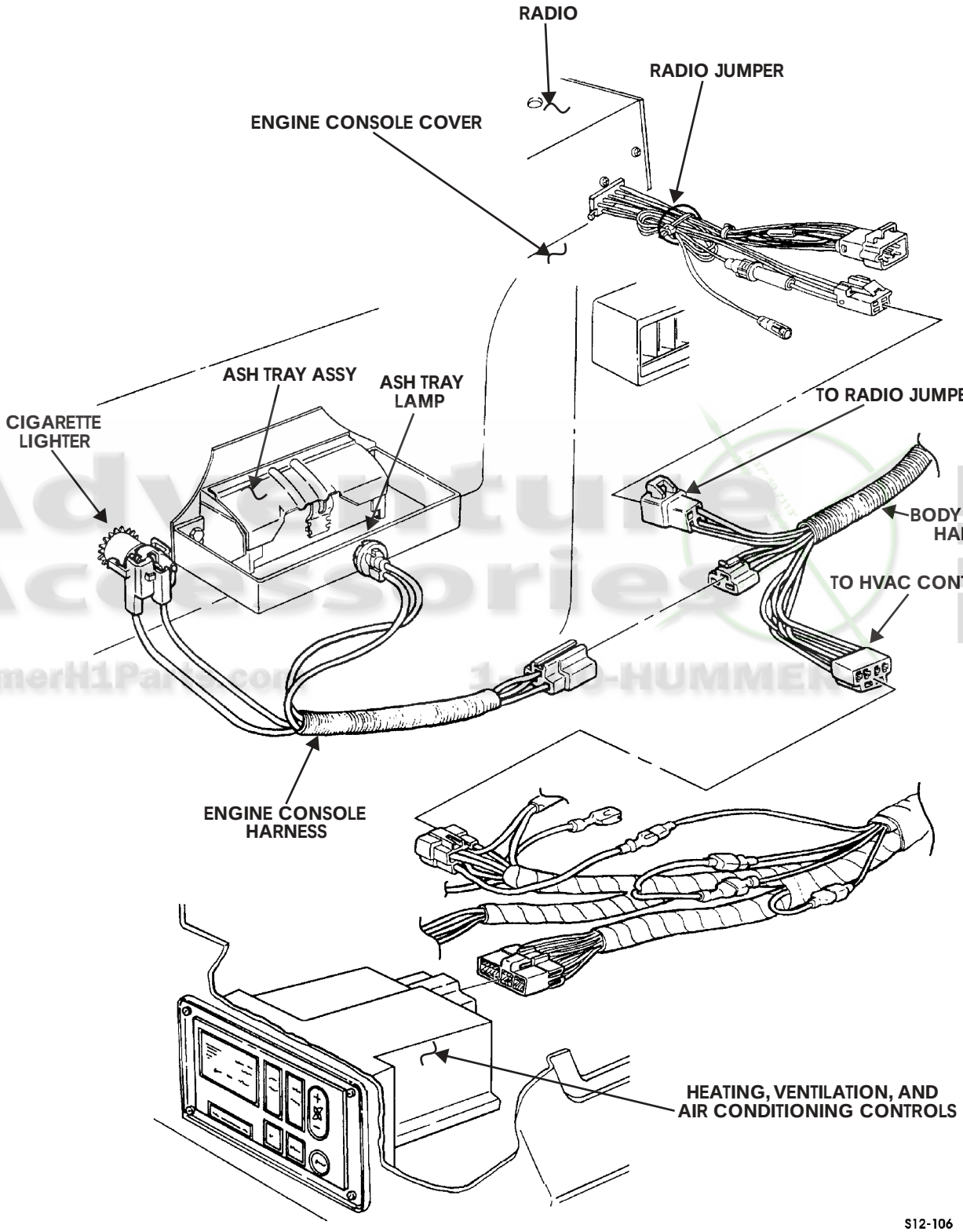


Figure 12-108: Engine Cover Console Connections

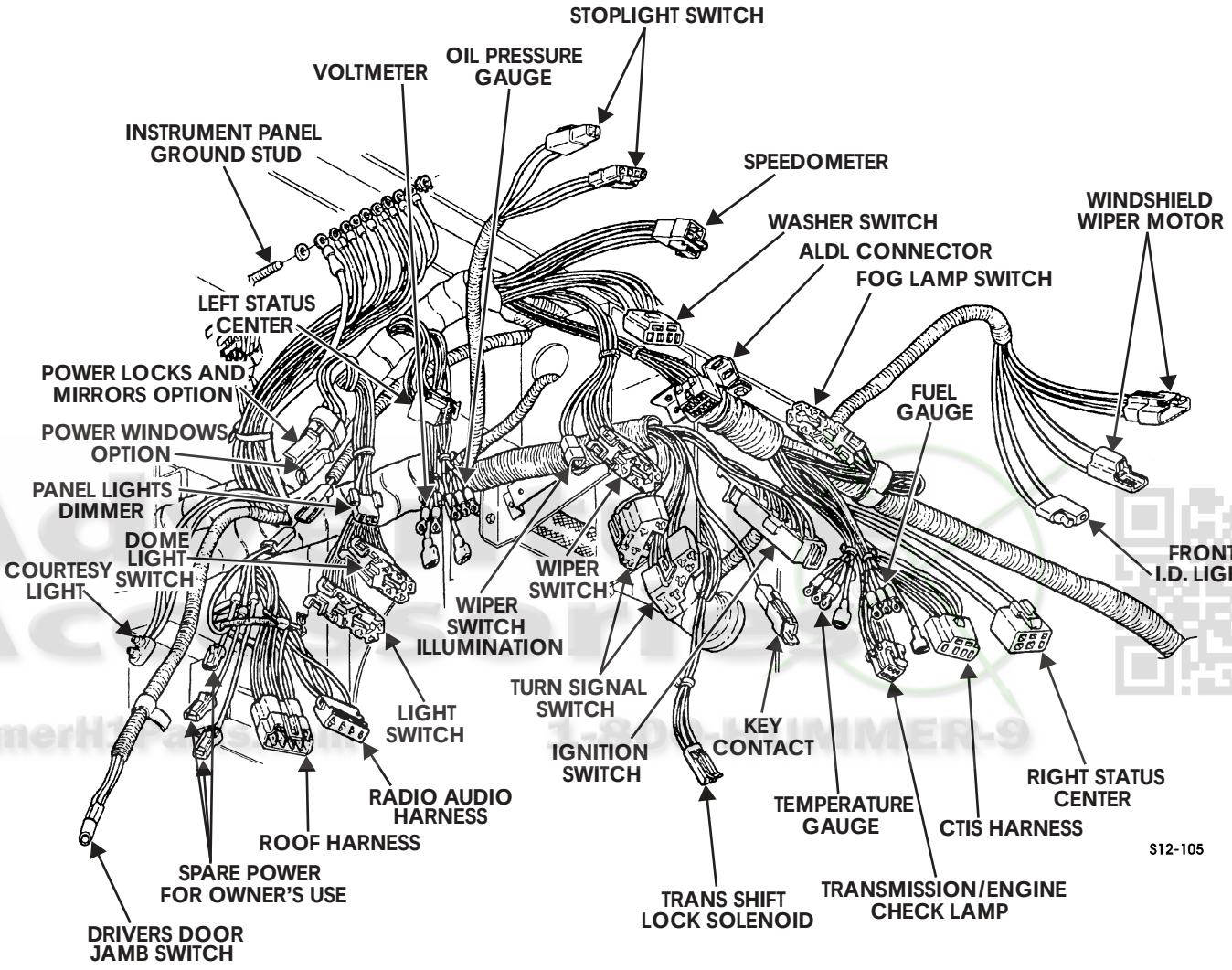


Figure 12-109: Body Harness-to-Dash Panel

44. Connect body wiring harness connectors to rear of instrument panel (Figure 12-110).

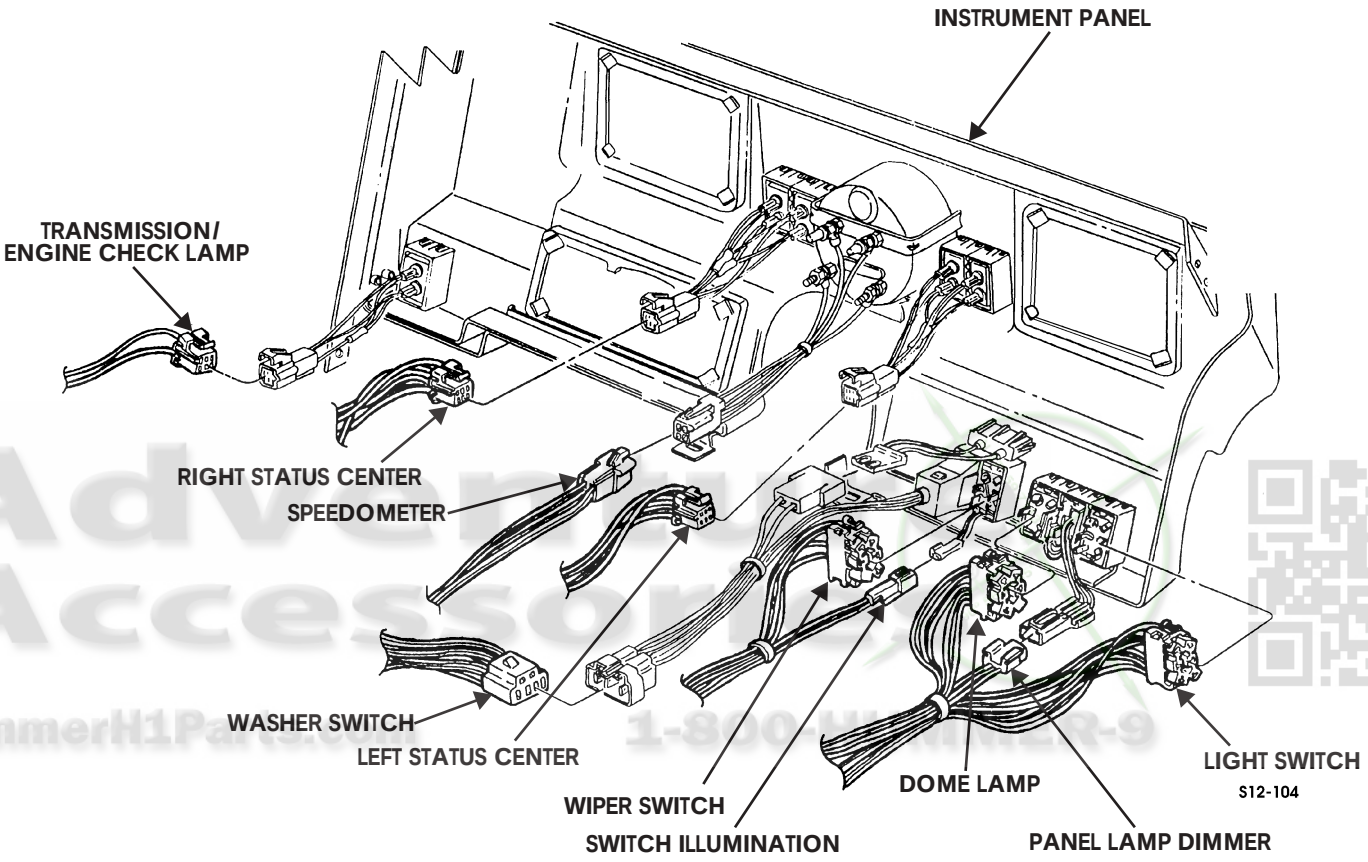


Figure 12-110: Status Indicator and Switch Connections

45. Install fifteen body wiring harness gauge leads on four gauges with eleven nuts and lockwashers (Figure 12-111).
46. Connect two body wiring harness gauge illumination leads to gauges.
47. Install two gauge panels to instrument panel with eight screws.
48. Connect battery ground cable.
49. Test electrical system for proper operation.

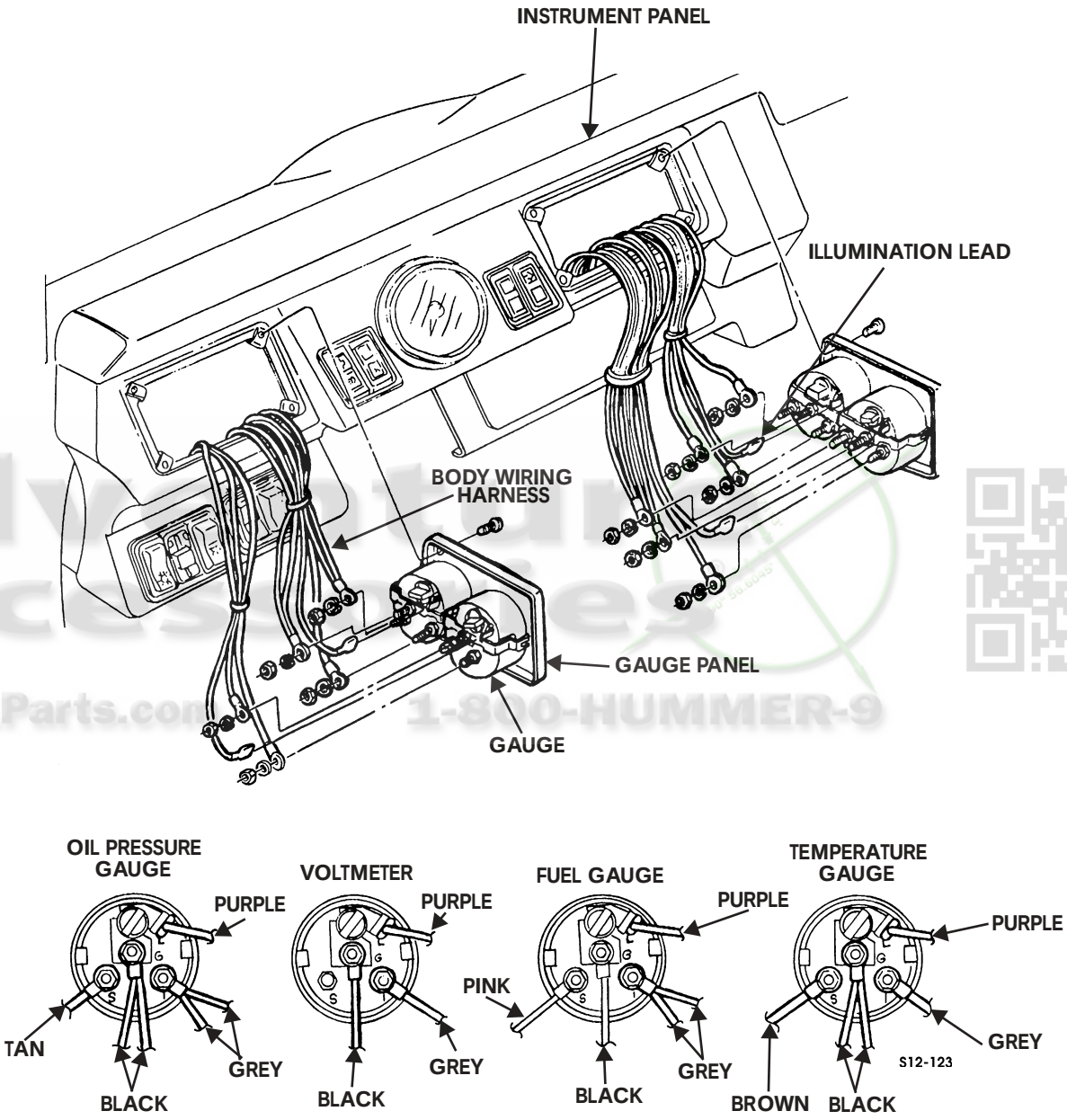


Figure 12-111: Body Harness to Gauge Connections

ROOF ELECTRICAL HARNESS (2-DOOR) REPLACEMENT

Removal

1. Remove trim as necessary to gain access to roof harness (Section 10).
2. Disconnect battery ground cable.

NOTE: Prior to removal, tag all leads. Use of a fish wire is recommended during removal to aid harness installation.

3. Remove domelight (Section 10).
4. Disconnect roof harness connector from body harness (Figure 12-112).

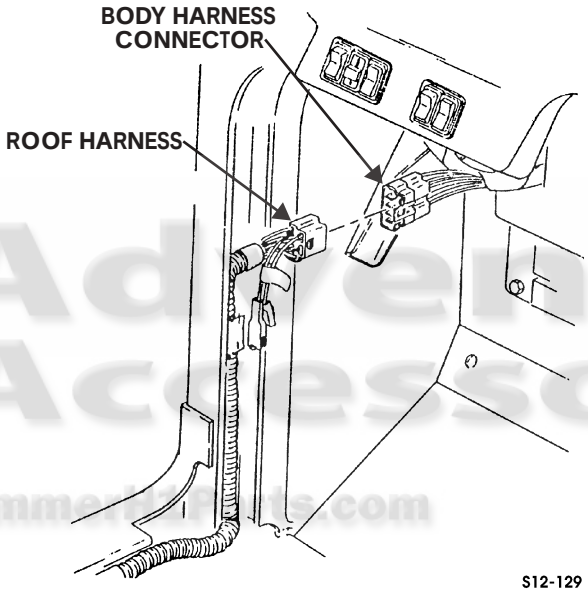


Figure 12-112: Roof Harness Connection

5. Disconnect roof harness connector from seat belt buckle switch (Figure 12-113).

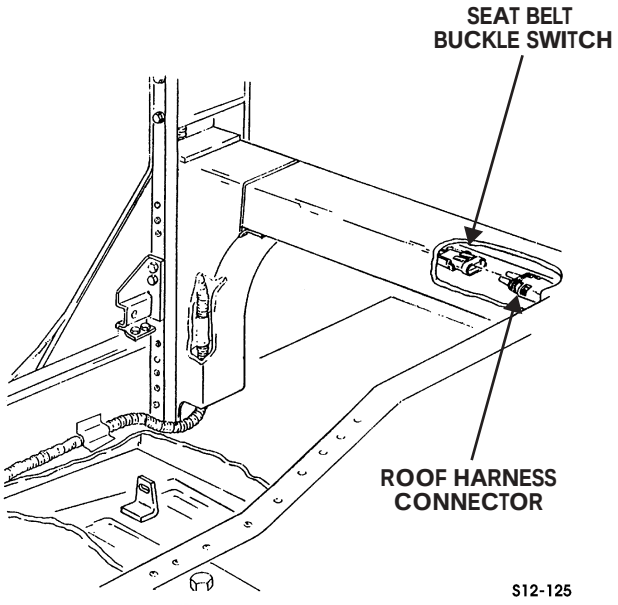


Figure 12-113: Seat Belt Switch Connection

6. Disconnect roof harness connector from right door jamb switch (Figure 12-114).
7. Disconnect roof harness connector from right courtesy light, if installed.
8. Remove two screws and cargo light from rear bulkhead, if installed (Figure 12-115).

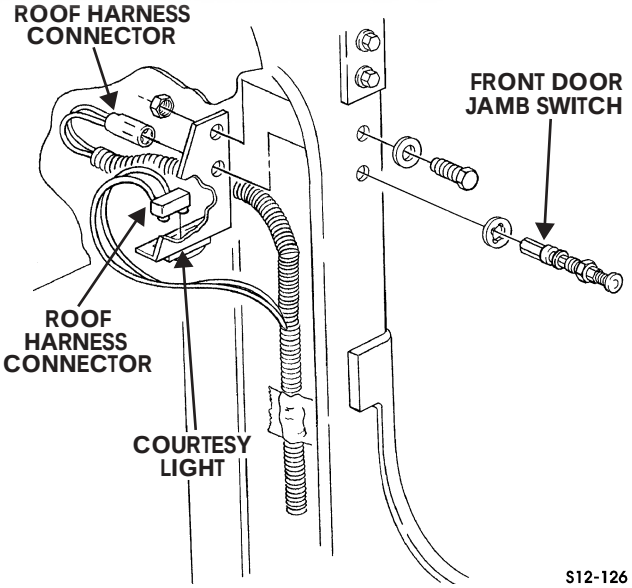


Figure 12-114: Door Jamb Switch

9. Disconnect roof harness connector from cargo light, if installed (Figure 12-115).
10. Remove roof harness from vehicle.

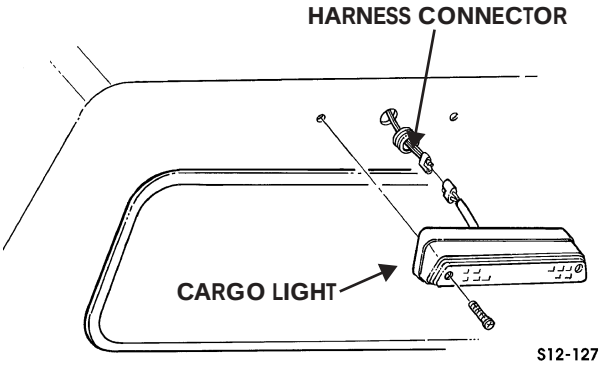


Figure 12-115: Cargo Light

Installation

1. Route roof harness to approximate mounting position.
2. Secure roof harness to vehicle with duct tape, where necessary.
3. Connect roof harness connector to cargo light, if removed (Figure 12-115).
4. Install cargo light on rear bulkhead with two screws, if removed.
5. Connect roof harness connector to right courtesy light, if installed (Figure 12-114).
6. Connect roof harness connector to right door jamb switch.
7. Connect harness connector to seat belt buckle switch (Figure 12-113).
8. Connect roof harness connector to body harness (Figure 12-112).
9. Install domelight (section 10).
10. Install trim (section 10).

ROOF ELECTRICAL HARNESS (4-DOOR/ STATION WAGON AND OPEN CAB) REPLACEMENT

Removal

NOTE: The roof electrical harnesses for the 4-door, station wagon, and open cab are installed the same, except the open cab harness crosses the rear cargo bulkhead. Also, the open cap harness is not equipped with a dome light or cargo light (Figure 12-116).

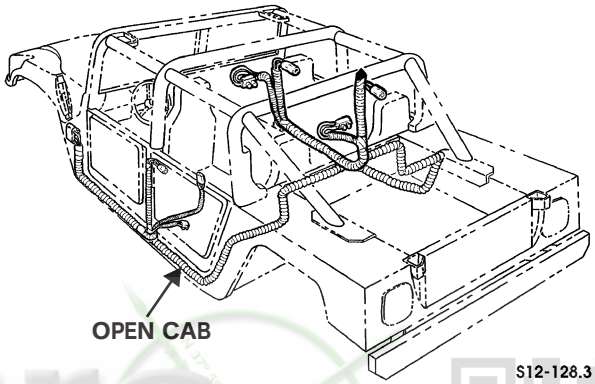


Figure 12-116: Roof Harness Routing

1. Remove trim as necessary to gain access to the harness (Section 10).

NOTE: Prior to removal, tag all leads. Use of a fish wire is recommended during removal to aid harness installation.

2. Disconnect battery ground cable.
3. Remove domelight (Section 10).

4. Disconnect roof harness connector from body harness (Figure 12-117).

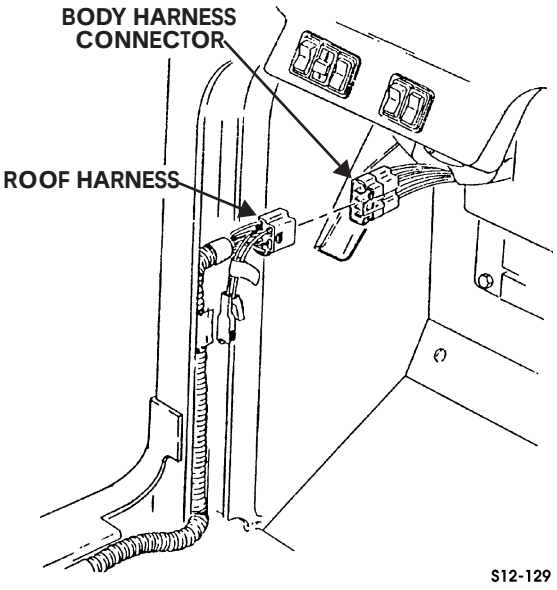


Figure 12-117: Roof Harness Connector

5. Disconnect roof harness connector from seat belt buckle switch (Figure 12-118).

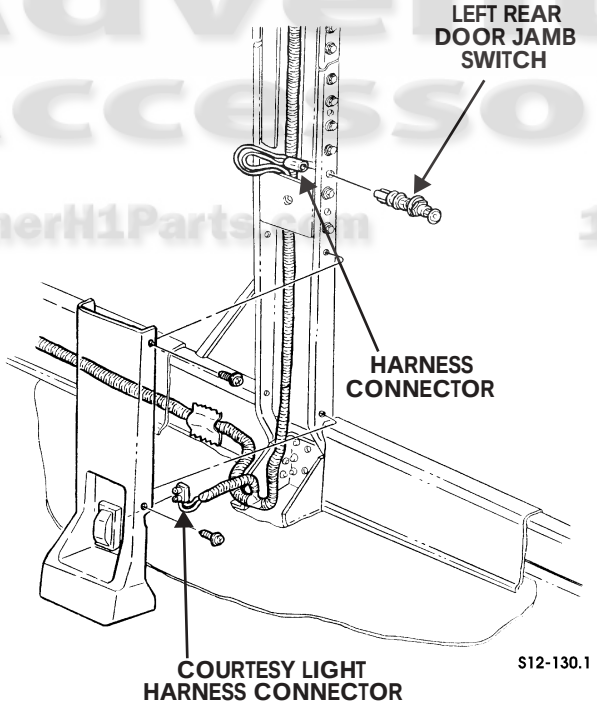


Figure 12-118: Seatbelt Connector

6. Disconnect roof harness connector from left rear courtesy light, if installed.
7. Disconnect roof harness connector from left rear door jamb switch.
8. Disconnect roof harness connector from right front door jamb switch (Figure 12-119).

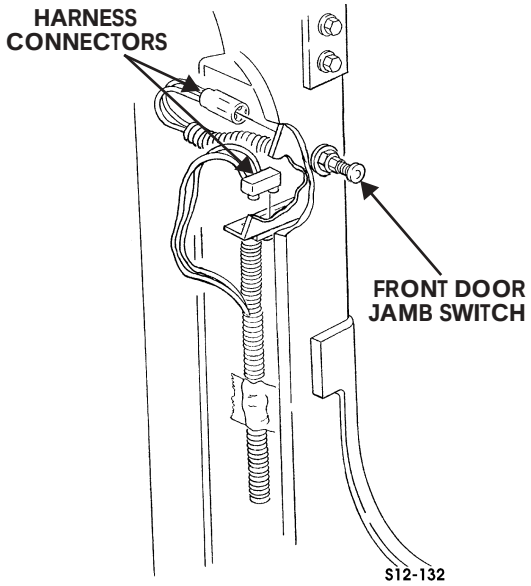


Figure 12-119: Door Jamb Switch

9. Disconnect roof harness connector from right front courtesy light, if installed.
10. Disconnect roof harness connector from right rear door jamb switch (Figure 12-120).

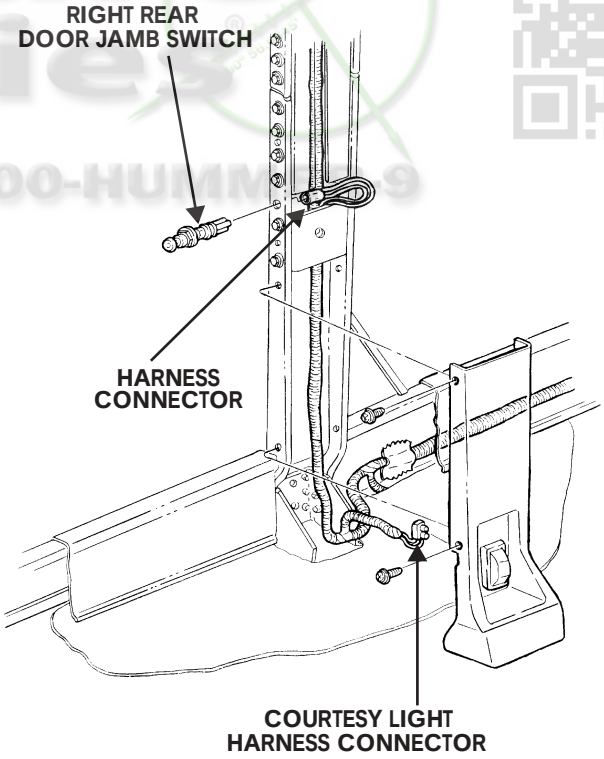


Figure 12-120: Courtesy Light

11. Disconnect roof harness connector from right rear courtesy light, if installed.
12. Remove two screws and cargo light from rear bulkhead, if installed (Figure 12-121).

13. Disconnect harness connector from cargo light, if installed.
14. Remove harness from vehicle.

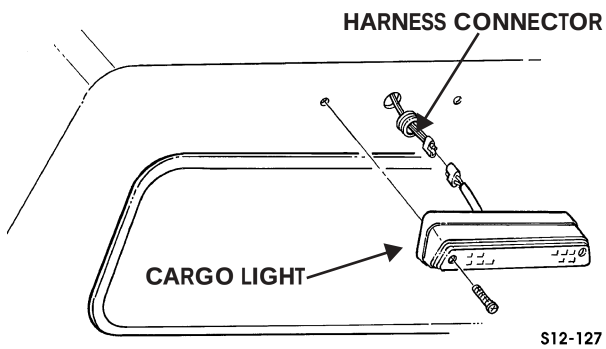


Figure 12-121: Cargo Light

Installation

1. Route roof harness to approximate mounting position.
2. Secure roof harness to vehicle with duct tape, where necessary.
3. Connect roof harness connector to cargo light, if removed (Figure 12-121).
4. Install cargo light on rear bulkhead with two screws, if removed.
5. Connect roof harness connector to right rear courtesy light, if installed (Figure 12-120).
6. Connect roof harness connector to right rear door jamb switch.
7. Connect roof harness connector to right front courtesy light, if removed (Figure 12-119).
8. Connect roof harness connector to right front door jamb switch.
9. Connect roof harness connector to left rear door jamb switch (Figure 12-118).
10. Connect roof harness connector to left rear courtesy light, if removed.
11. Connect roof harness connector to seat belt buckle switch.
12. Connect roof harness connector to body harness (Figure 12-117).
13. Install domelights (Section 10).
14. Connect battery ground cable.
15. Install trim (Section 10).

STEREO (BASIC) ELECTRICAL HARNESS (2-DOOR) REPLACEMENT

Removal

1. Remove front console (Section 10).

NOTE: Prior to removal, tag all leads. Use of a fish wire is recommended during removal to aid harness installation.

2. Disconnect stereo harness lead from harness connector (Figure 12-122).

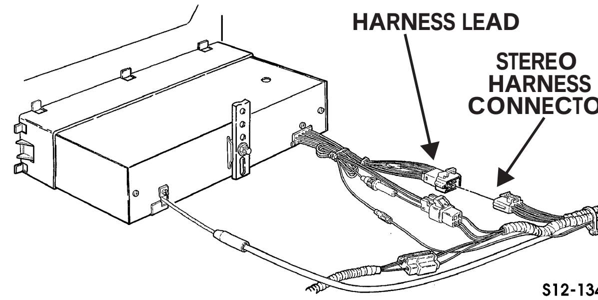


Figure 12-122: Radio Connections

3. Remove four screws, clips, cover, and right speaker from trim (Figure 12-123).

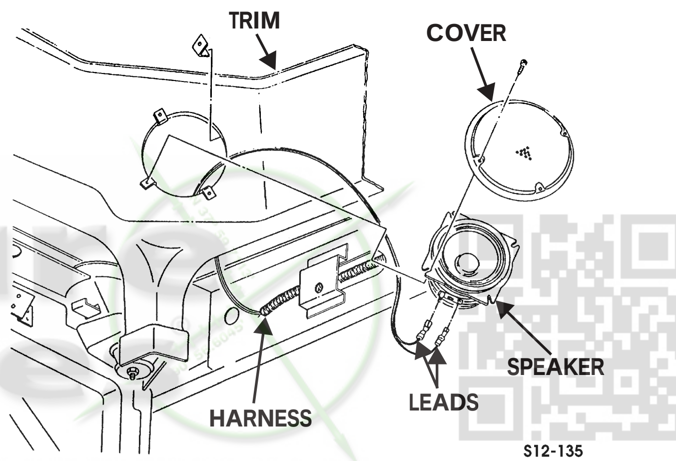


Figure 12-123: Speaker Mounting

4. Disconnect two leads from right speaker.
5. Repeat steps 3 and 4 for left speaker.
6. Remove trim as necessary to gain access to stereo harness (Section 10).
7. Remove stereo harness from vehicle.

Installation

1. Route stereo harness to approximate mounting position.
2. Secure stereo harness to vehicle with duct tape, where necessary.
3. Install trim (Section 10).
4. Connect two leads to right speaker (Figure 12-123).
5. Install right speaker and cover on trim with four clips and screws.
6. Repeat steps 4 and 5 for left speaker.
7. Connect harness lead to stereo harness connector (Figure 12-122).
8. Install front console (Section 10).

STEREO (BASIC) ELECTRICAL HARNESS (4-DOOR AND STATION WAGON) REPLACEMENT

Removal

1. Remove front console (Section 10).

NOTE: Prior to removal, tag all leads. Use of a fish wire is recommended during removal to aid harness installation.

2. Disconnect harness lead from stereo harness connector (Figure 12-124).

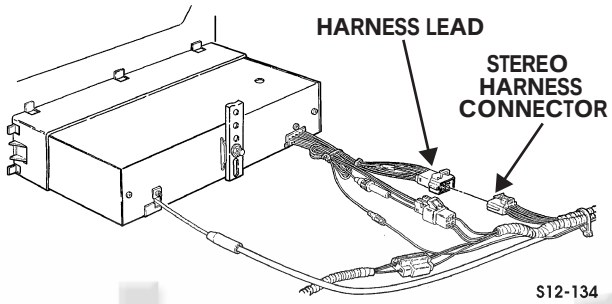


Figure 12-124: Radio Connections

3. Remove four screws, clips, cover, and right front speaker from trim (Figure 12-125).
4. Disconnect two leads from right front speaker.
5. Repeat steps 3 and 4 for left front speaker.

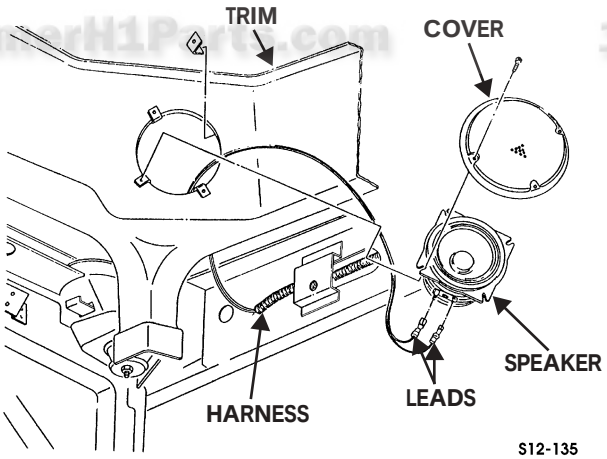


Figure 12-125: Front Speaker Mounting

6. Remove four screws, clips, cover, and right rear speaker from trim (Figure 12-126).
7. Disconnect two leads from right rear speaker.
8. Repeat steps 7 and 8 for left rear speaker.
9. Remove trim as necessary to gain access to stereo harness (Section 10).
10. Remove stereo harness from vehicle.

Installation

1. Route stereo harness to approximate mounting position.
2. Secure stereo harness to vehicle with duct tape, where necessary.
3. Install trim (Section 10).
4. Connect two leads to right rear speaker (Figure 12-126).

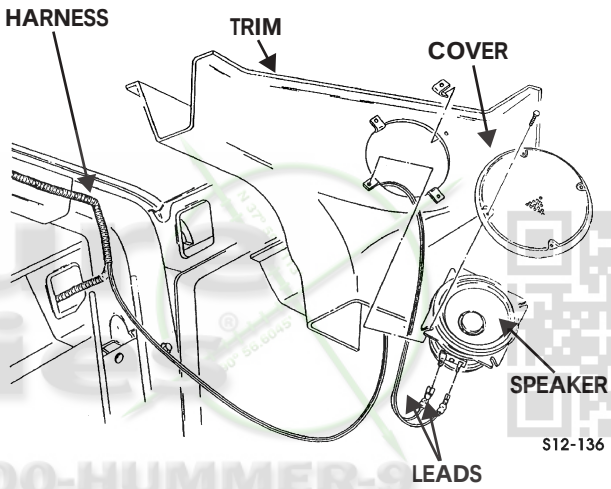


Figure 12-126: Rear Speaker Mounting

5. Install right rear speaker and cover on trim with four clips and screws.
6. Repeat steps 4 and 5 for left rear speaker.

7. Connect two leads to right front speaker (Figure 12-127).

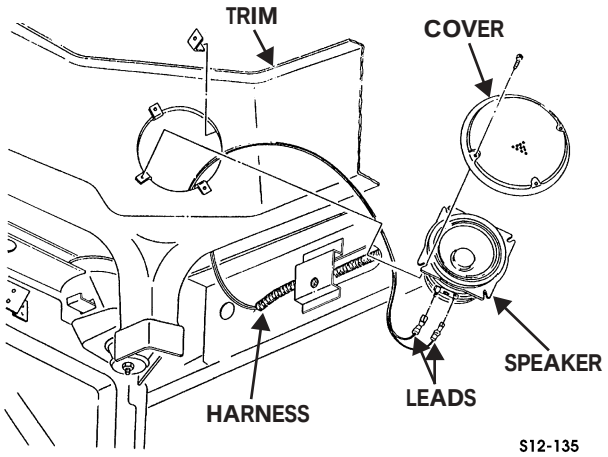


Figure 12-127: Front Speaker Mounting

8. Install right front speaker and cover on trim and secure with four clips and screws.
9. Repeat steps 7 and 8 for left front speaker.
10. Connect harness lead to stereo harness connector (Figure 12-124).
11. Install front console (Section 10).

STEREO (BASIC) ELECTRICAL HARNESS (4-DOOR OPEN CAB) REPLACEMENT

Removal

1. Remove front console (Section 10).

NOTE: Prior to removal, tag all leads. Use of a fish wire is recommended during removal to aid harness installation.

2. Disconnect harness lead from stereo harness connector (Figure 12-128).

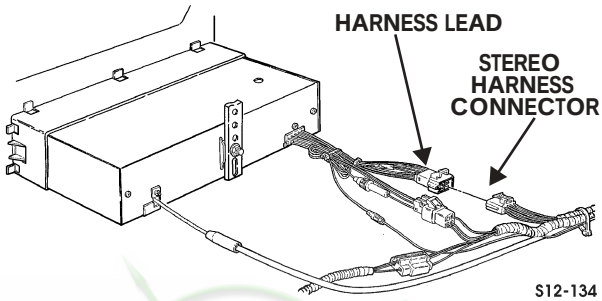


Figure 12-128: Radio Connections

3. Remove four screws, clips, cover, and right front speaker from trim (Figure 12-129).

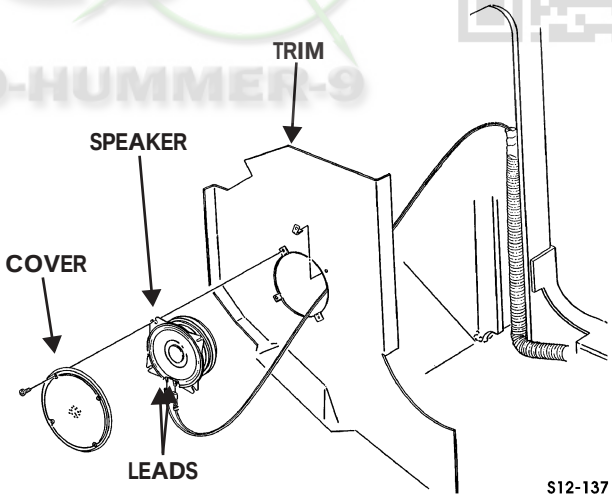


Figure 12-129: Front Speaker Mounting

4. Disconnect two leads from right front speaker.
5. Repeat steps 3 and 4 for left front speaker.
6. Remove four screws, clips, cover, and right rear speaker from trim (Figure 12-130).

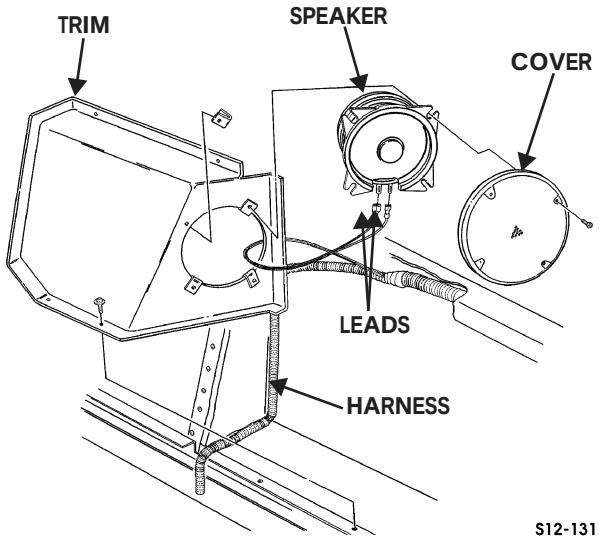


Figure 12-130: Rear Speaker Mounting

7. Disconnect two leads from right rear speaker.
8. Repeat steps 7 and 8 for left rear speaker.
9. Remove trim as necessary to gain access to harness (Section 10).
10. Remove stereo harness from vehicle.

Installation

1. Route stereo harness to approximate mounting position.
2. Secure harness to vehicle with duct tape, where necessary.
3. Install trim (Section 10).
4. Connect two leads to right rear speaker (Figure 12-130).
5. Install right rear speaker and cover on trim and secure with four clips and screws.
6. Repeat steps 4 and 5 for left rear speaker.

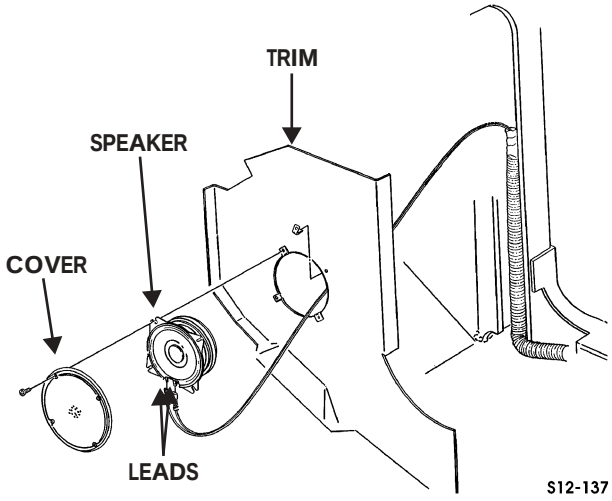


Figure 12-131: Front Speaker Mounting

7. Connect two leads to right front speaker (Figure 12-131).
8. Install right front speaker and cover on trim with four clips and screws.
9. Repeat steps 7 and 8 for left front speaker.

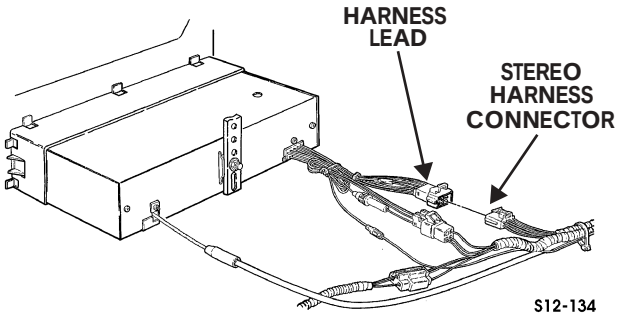


Figure 12-132: Radio Harness

10. Connect harness lead to stereo harness connector (Figure 12-132).
11. Install front console (section 10).

DASH HARNESS REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove driver's seat (Section 10).
3. Remove outer kick panels (Section 10).
4. Remove capscrew on left side of front console and two capscrews on right side of console (Figure 12-133).
5. Slide front console away from dash four inches to allow for routing of dash harness.

NOTE: Gauge cluster removal is for ease of crashpad removal and installation.

6. Remove eight screws and two gauge clusters from instrument panel but do not disconnect gauges.
7. Remove five capscrews and two turnbuttons from crashpad.

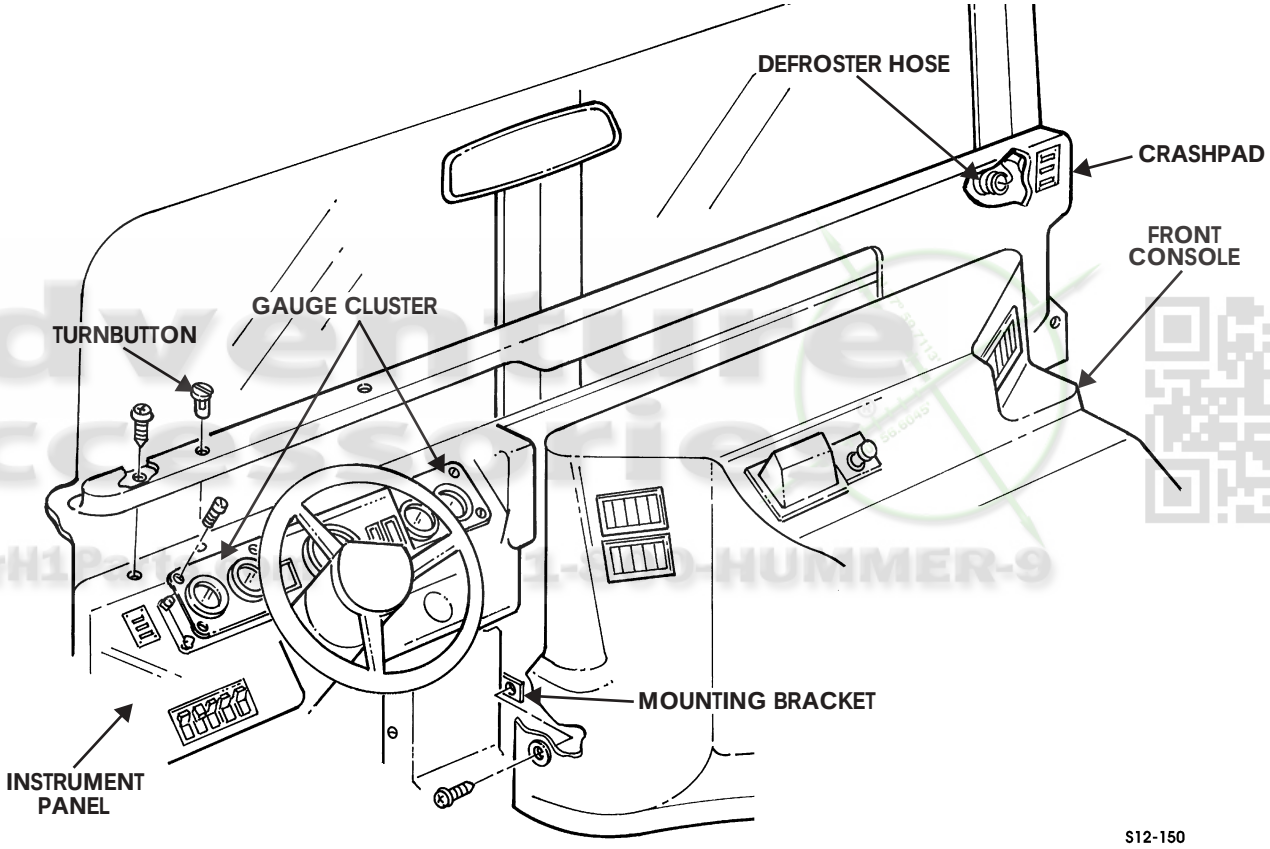


Figure 12-133: Front Trim and Instrument Panel

8. Disconnect defroster hose from crashpad and remove crashpad.
9. Remove capscrews, washers and nuts from instrument panel and dash.
10. Disconnect dash harness from door harnesses and jumper harnesses (4-door only) (Figure 12-134).

11. Disconnect pink power wire on dash harness from yellow spare circuit wire on body harness.

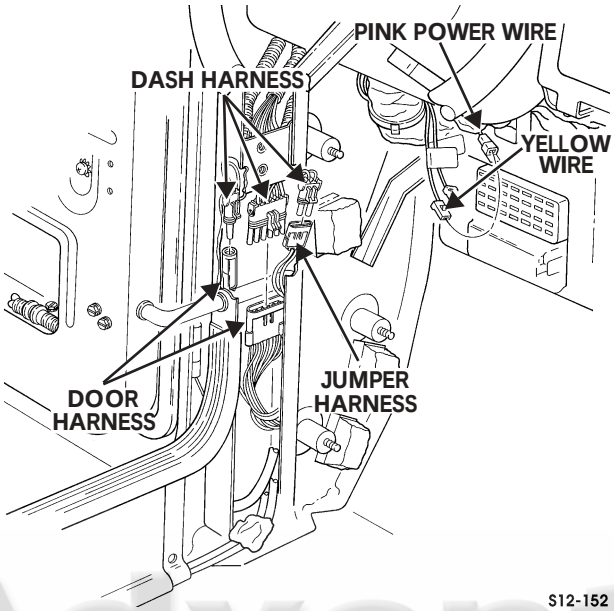


Figure 12-1 Harness Connections

Figure 12-134: Harness Connections

12. Remove nut and washer from instrument panel ground bolt and disconnect dash harness ground wire (Figure 12-135).
13. Remove two tie straps securing dash harness to defroster hose. Discard tie straps.
14. Remove dash harness.

Installation

1. Route dash harness to approximate mounting position.

NOTE: Ensure remote entry wires on dash harness are connected and ground wire and pink power wire are routed to the left side of vehicle.

2. Secure dash harness to defroster hose with two tie straps (Figure 12-135).
3. Install dash harness ground wire on instrument panel ground bolt with nut and washer.
4. Connect pink power wire on dash harness to yellow spare circuit wire on body harness (Figure 12-134).
5. Connect dash harness to door harnesses and jumper harnesses (4-door only).
6. Install instrument panel on dash with capscrews, washers, and nuts (Figure 12-133).
7. Install defroster hose in crashpad and install crashpad on instrument panel with five capscrews and two turnbuttons.
8. Install two gauge clusters in instrument panel with eight screws.
9. Install front console on mounting brackets with three capscrews.
10. Install outer kick panels (section 10).
11. Install driver's seat (section 10).
12. Connect battery ground cable.

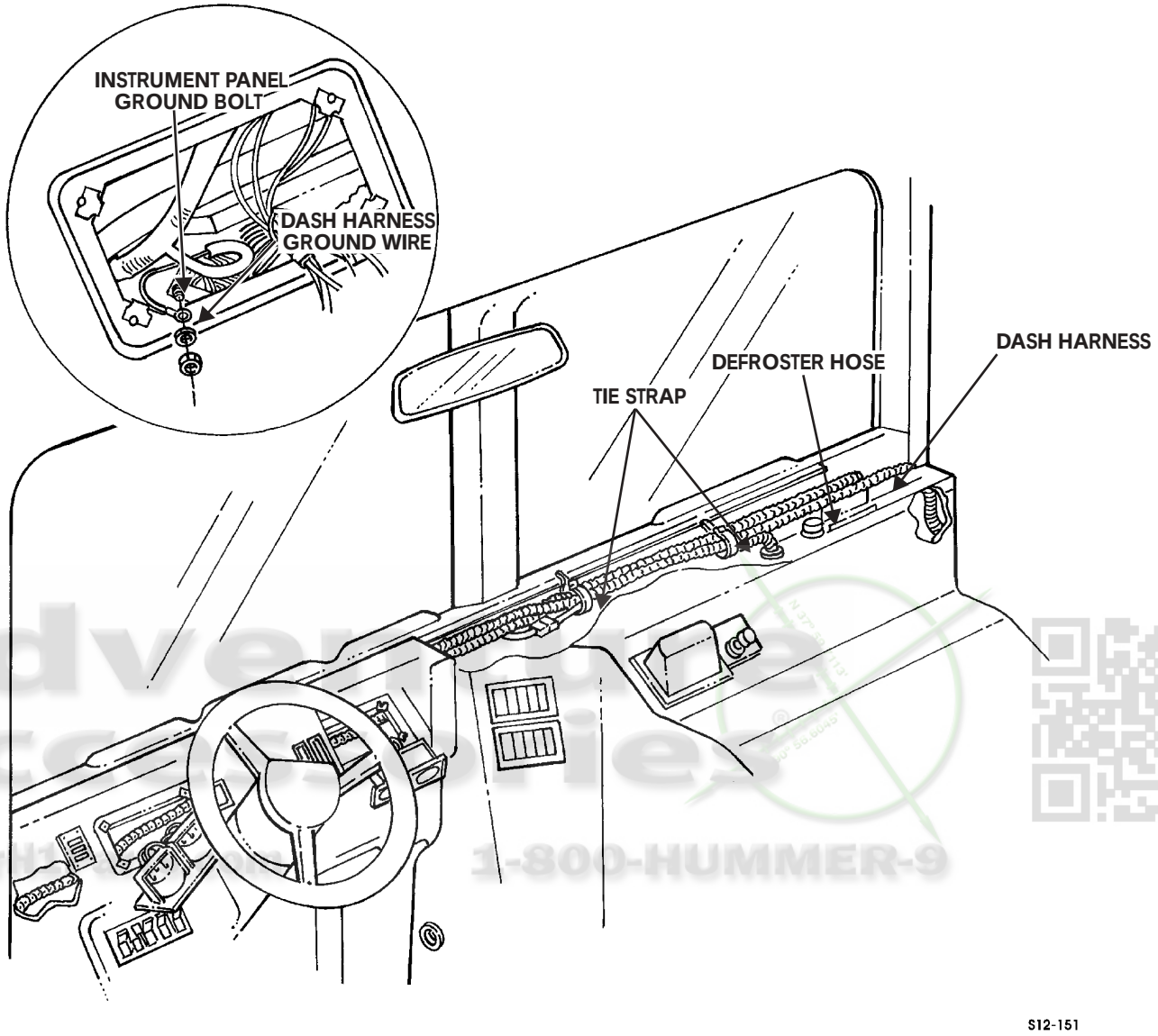


Figure 12-135: Harness Ground and Retainers

POWER DOOR LOCKS FRONT DOOR HARNESS REPLACEMENT

Removal

NOTE: Left and right front power door locks harness replacement procedures are similar.

1. Disconnect battery ground cable.
2. Remove front seat (Section 10).
3. Remove outer kick panels (Section 10).
4. Remove power door locks switch from door trim (Section 10).
5. Remove front door trim (Section 10).

NOTE: Vapor barrier may be positioned under velcro strip, if so, cut around velcro strip to remove vapor barrier.

6. Remove vapor barrier and moisture barrier flap from door (Figure 12-136).

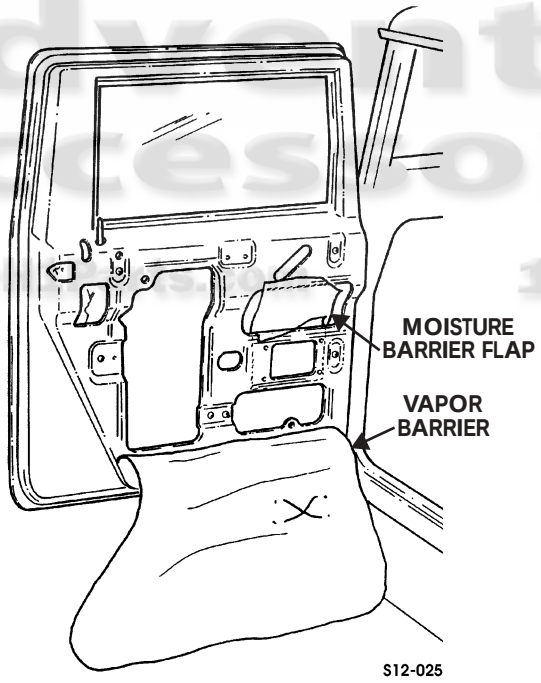


Figure 12-136: Vapor Barrier

7. Remove capscrew and P-clamp securing door harness to door reinforcement (Figure 12-137).
8. Remove capscrew, nut and lockwasher assembly, and P-clamp securing door harness to A-pillar.
9. Disconnect one-lead and six-lead connectors. Remove door harness wires from connectors with extraction tool.

NOTE: Lubricate bushings, grommet, and door harness teflon cover with silicone spray.

10. Pull harness through A-pillar rubber grommet.
11. Remove and inspect A-pillar rubber grommet. Discard if damaged.
12. Remove two capscrews and support bracket from inner door.
13. Pull harness through door bushing. Inspect door bushing. Replace if damaged.
14. Pull support bracket from harness. Inspect support bracket bushing. Replace if damaged.

NOTE: On vehicles equipped with power windows, it may be necessary to loosen motor mounting screws.

15. Disconnect harness connector from actuator.
16. Disconnect clip from door reinforcement and remove from door harness.

NOTE: Tie strap on access hole applies to left front door only.

17. Remove tie strap securing door harness to access hole and remove harness. Discard tie strap.

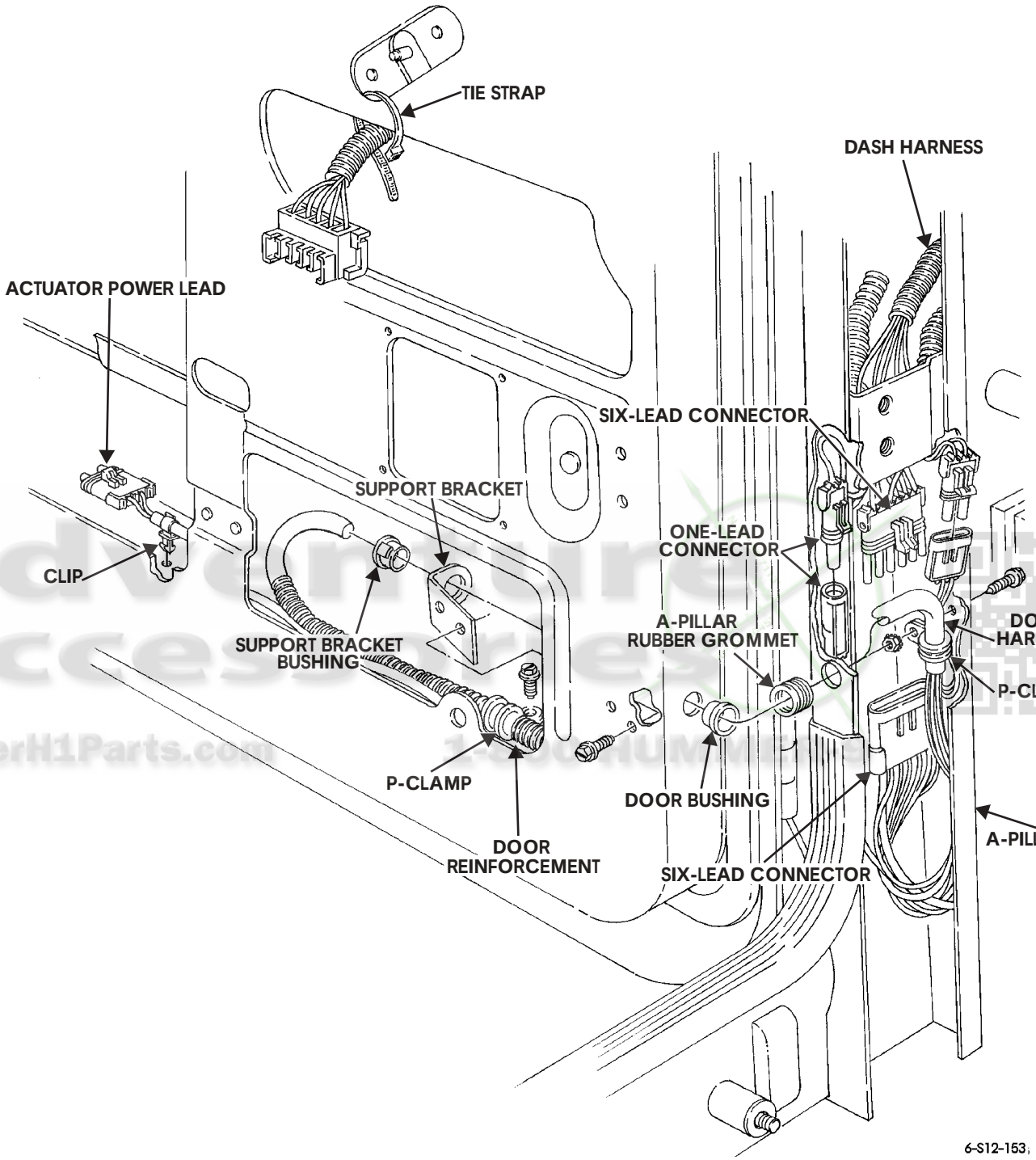


Figure 12-137: Door Harness

Installation

NOTE: Left and right front power door locks harness replacement procedures are similar.

1. Install harness in support bracket (Figure 12-138).
2. Install harness through door bushing and support bracket. Install support bracket on inner door with two capscrews.

NOTE: Lubricate A-pillar rubber grommet and door harness teflon cover with silicone spray.

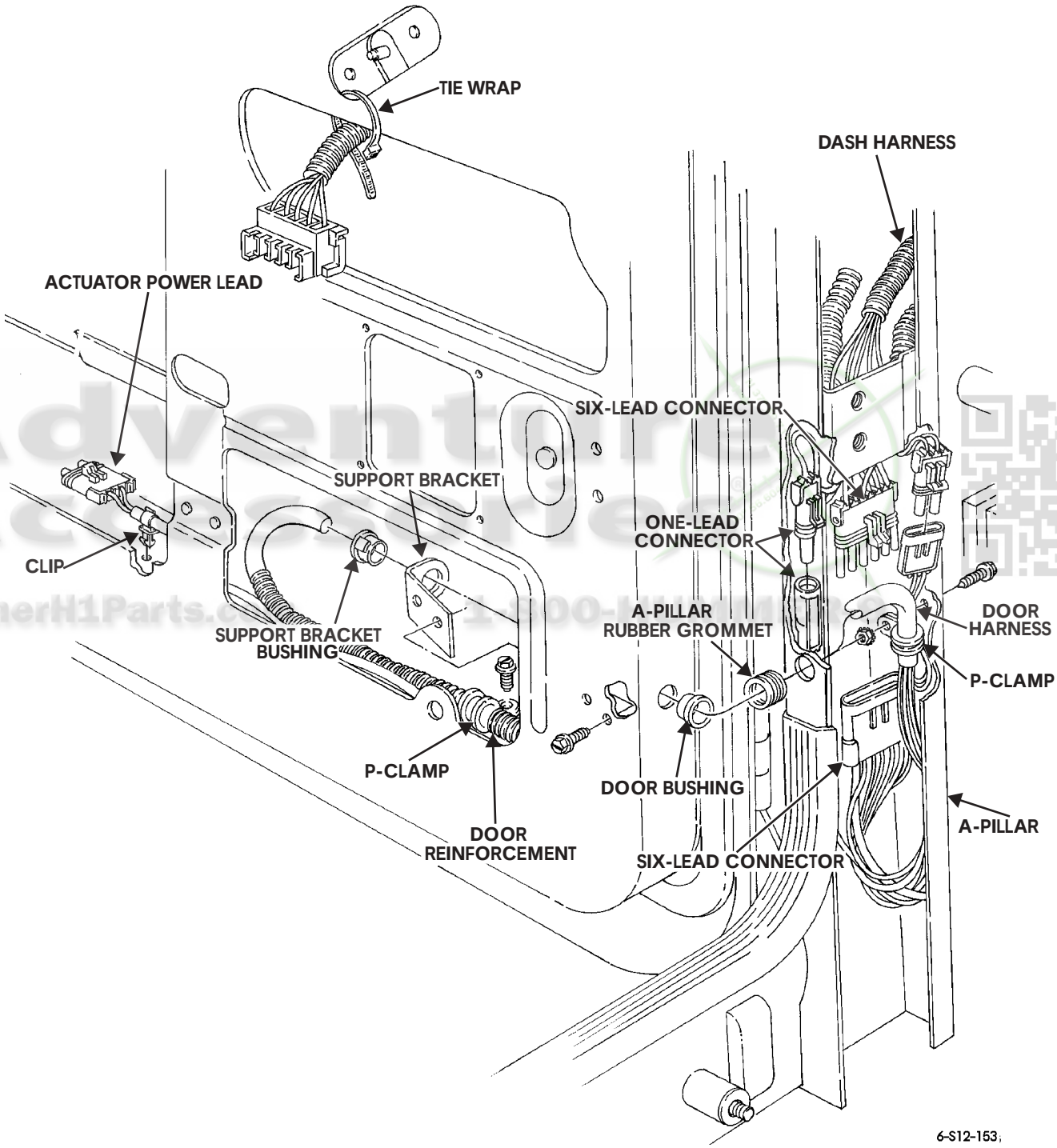


Figure 12-138: Door Harness

3. Install rubber grommet in A-pillar.
4. Install harness through grommet until yellow tape touches A-pillar front.
5. Install six-lead and one-lead connectors to door harness leads, matching colors to dash harness. Connect door harness to dash harness.
6. Install P-clamp and door harness on A-pillar with capscrew and nut and lockwasher assembly.
7. Install P-clamp and door harness at yellow tape area with capscrew.
8. Install clip on door harness and connect harness to actuator. Install clip in door reinforcement. Tighten power window motor mounting screws, if loose.
9. Lower window.
10. Route lock switch lead up through lower access hole between support bracket and window channel. Secure at top access hole with tie strap (left front door only).
11. Route lock switch lead through vapor barrier and moisture barrier flap and install moisture barrier and vapor barrier flap on door (Figure 12-139).

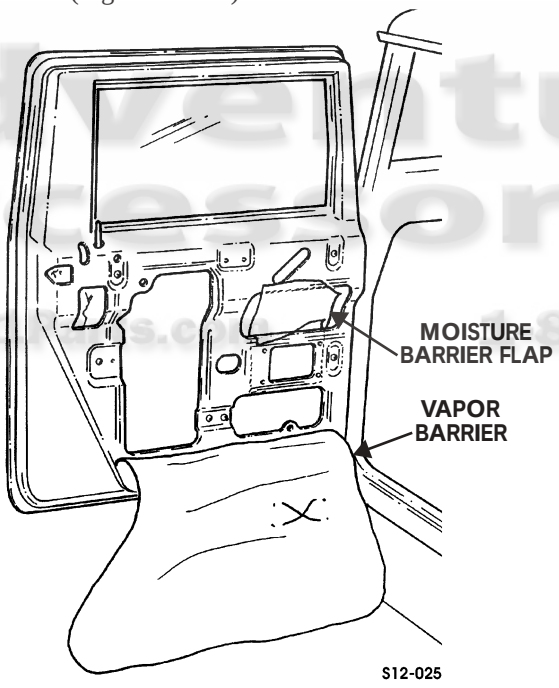


Figure 12-139: Vapor Barrier

12. Install front door trim (Section 10).
13. Install power door locks switch (Section 10).
14. Install outer kick panels (Section 10).
15. Install front seat (Section 10).
16. Connect battery ground cable.

POWER DOOR LOCKS REAR DOOR AND JUMPER HARNESS REPLACEMENT

Removal

NOTE: Left and right rear power door locks harness replacement procedures are identical.

1. Disconnect battery ground cable.
2. Remove front seat (Section 10).
3. Remove trim from B-beam and B-pillar (Section 10).
4. Remove side trim and outer kick panel (Section 10).
5. Remove rear door trim (Section 10).

NOTE: Vapor barrier may be positioned under velcro strip If so, cut around velcro strip to remove vapor barrier.

6. Remove vapor barrier and moisture barrier flap (Figure 12-140).

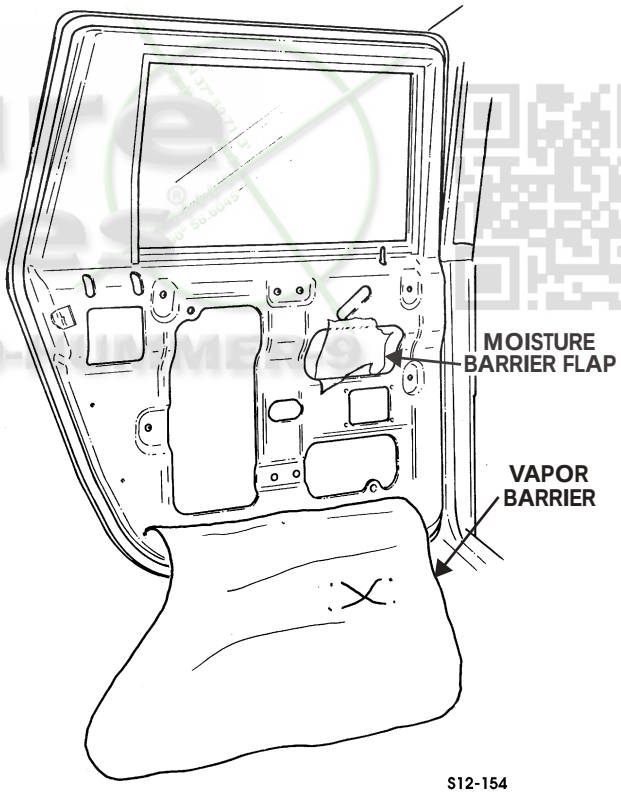


Figure 12-140: Vapor Barrier

7. Remove capscrew and P-clamp securing rear door harness to door reinforcement (Figure 12-141).
8. Disconnect rear door harness from jumper harness.
9. Remove plastic tubing from rear door harness.
10. Remove two-lead connector from rear door harness with pin extraction tool.
11. Remove capscrew, washer, nut and lockwasher assembly, and P-clamp from rear door harness and B-pillar.

NOTE: Lubricate bushings, rubber grommet, and door harness teflon cover with silicone spray.

12. Pull harness through rubber grommet in B-pillar.
13. Remove and inspect grommet. Discard if damaged.
14. Remove two capscrews and support bracket from rear door.
15. Pull harness through door bushing and remove support bracket from harness. Inspect support bracket bushing. Replace if damaged.
16. Inspect bushing in rear door. Replace if damaged.

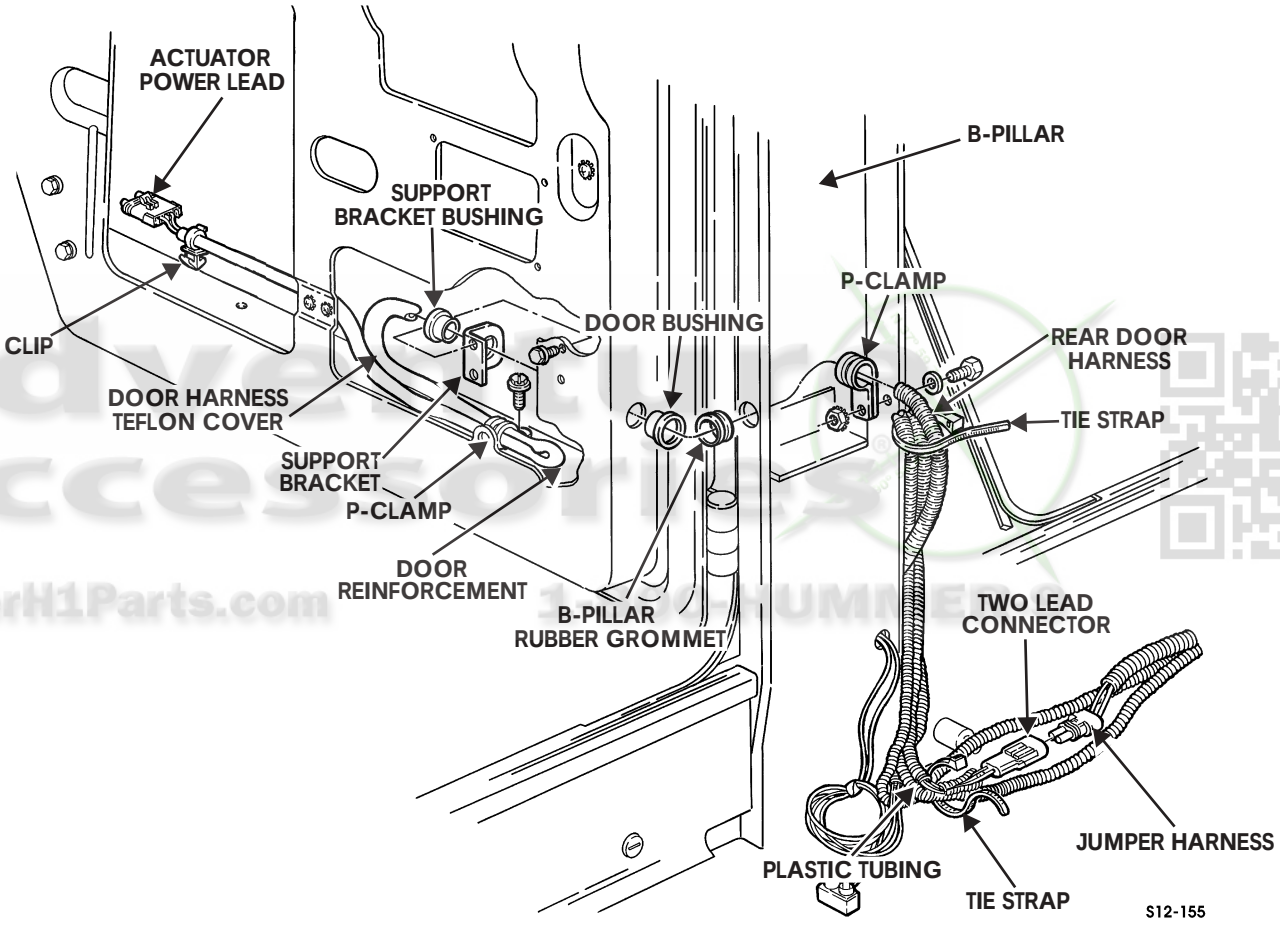


Figure 12-141: Door Harness

NOTE: On vehicle, equipped with power windows, it may be necessary to loosen motor mounting screws.

17. Disconnect door harness power lead from actuator lead.
18. Disconnect clip from door reinforcement and remove from rear door harness.
19. Remove rear harness from door.
20. Disconnect jumper harness from dash harness at A-pillar. Remove tie straps and jumper harness (Figure 12-142).

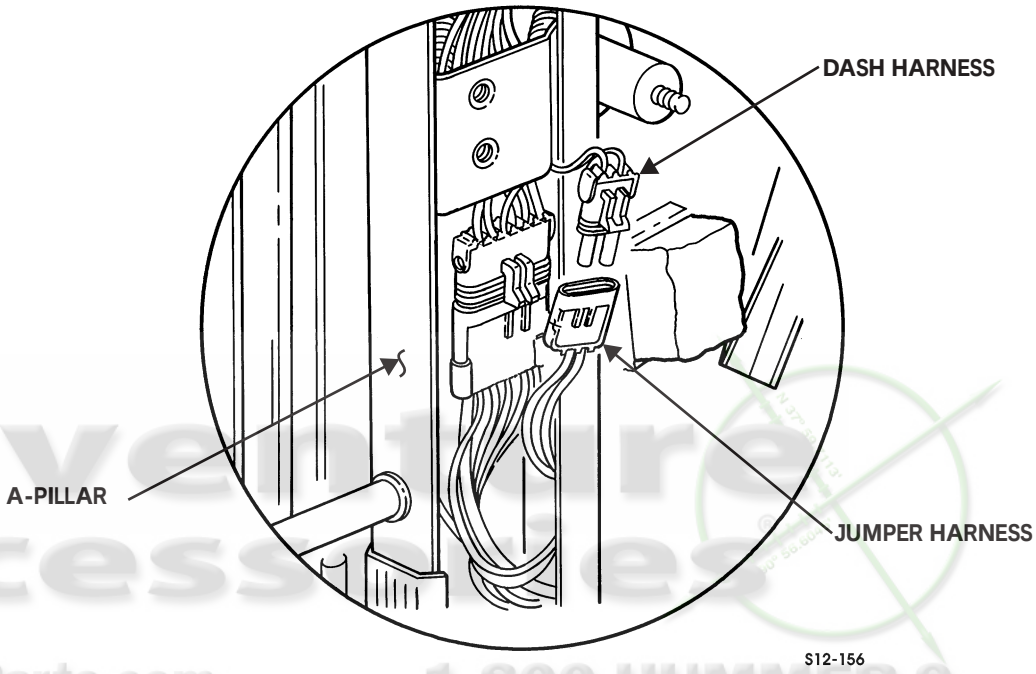


Figure 12-142: Door Harness Connection

Installation

NOTE: Left and right rear door harness replacement procedures are identical.

NOTE: Lubricate bushings, rubber grommet, and door harness teflon cover with silicone spray.

1. Secure jumper harness to existing harness along side panel with tie straps. Connect jumper harness to dash harness at A-pillar (Figure 12-142).

2. Install clip and support bracket on rear door harness (Figure 12-143).
3. Install harness in door bushing.
4. Install support bracket in rear door with two capscrews.
5. Install rubber grommet in B-pillar.
6. Install harness through grommet until yellow tape touches the back of B-pillar.
7. Install P-clamp on harness at yellow tape and B-pillar with capscrew, washer and lockwasher and nut assembly.
8. Install two-lead connector on rear door harness, matching wire colors to jumper harness. Connect harness to jumper harness.
9. Route rear door harness along bottom of rear door. Secure harness to door reinforcement with clip.
10. Connect door harness to actuator lead. Tighten power window motor mounting screws, if loose.
11. Install plastic tubing on rear door harness wires and secure with black electrical tape.
12. Install P-clamp on rear door harness at yellow tape area and secure to door reinforcement with one capscrew.

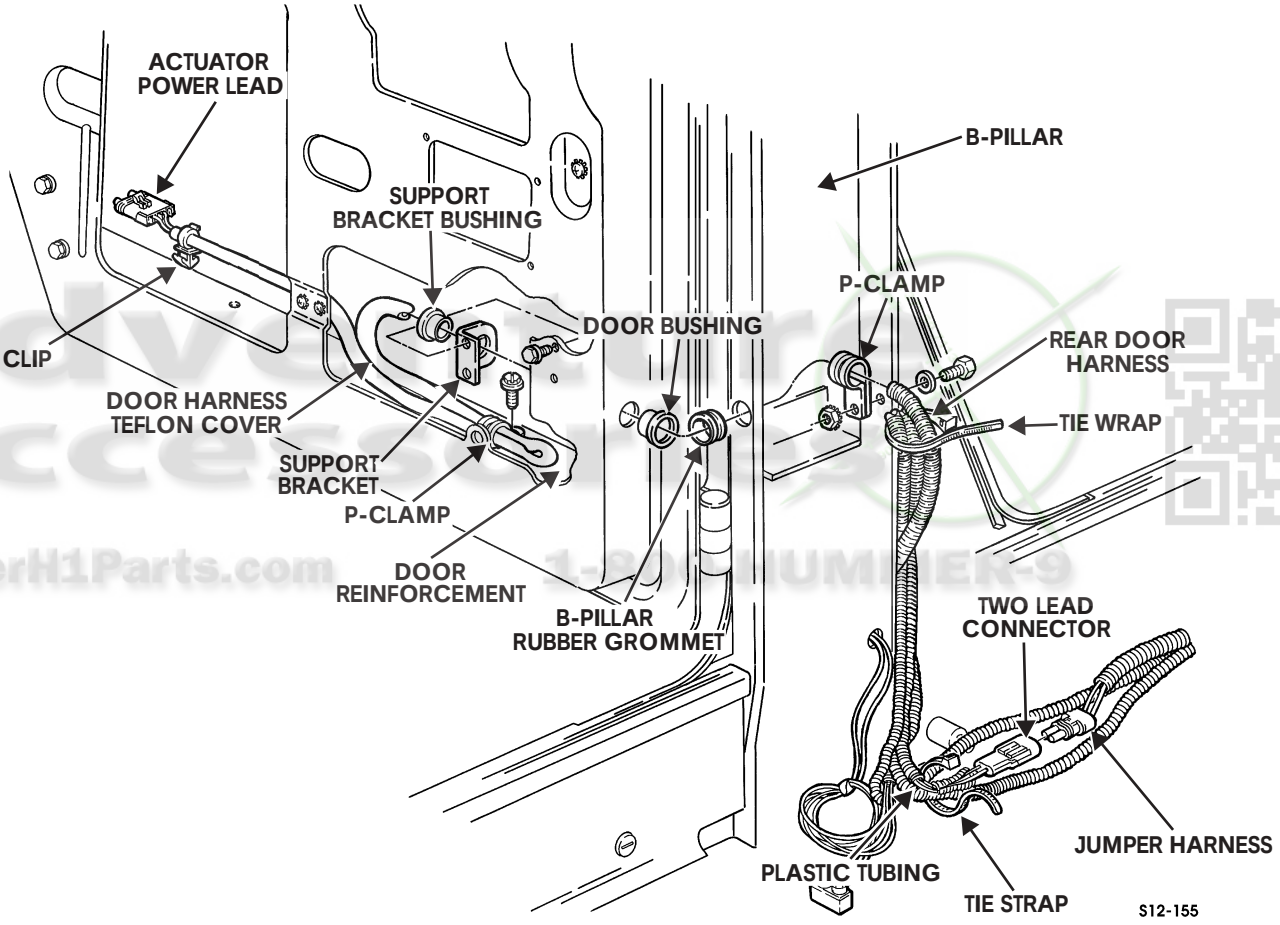


Figure 12-143: Door Harness

13. Install vapor barrier and moisture barrier flap (Figure 12-144).

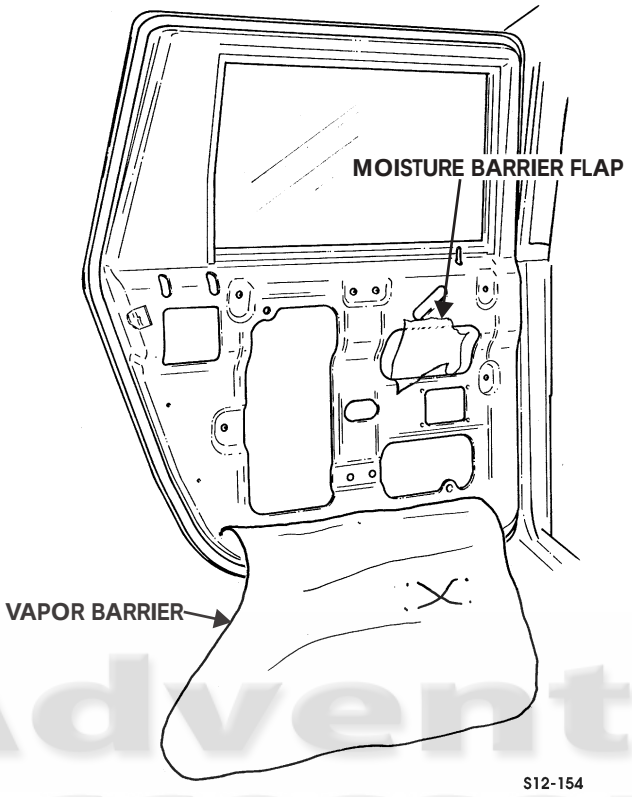


Figure 12-144: Vapor Barrier

14. Install rear door trim (Section 10).
15. Install side trim and outer kick panel (Section 10).
16. Install trim on B-pillar and B-beam (Section 10).
17. Install front seat (Section 10).
18. Connect battery ground cable.

REMOTE ENTRY HARNESS REPLACEMENT

Removal

NOTE: Tag all harnesses for installation.

1. Disconnect two battery ground cables.
2. Remove screw from left side and two screws from right side of front console (Figure 12-145).

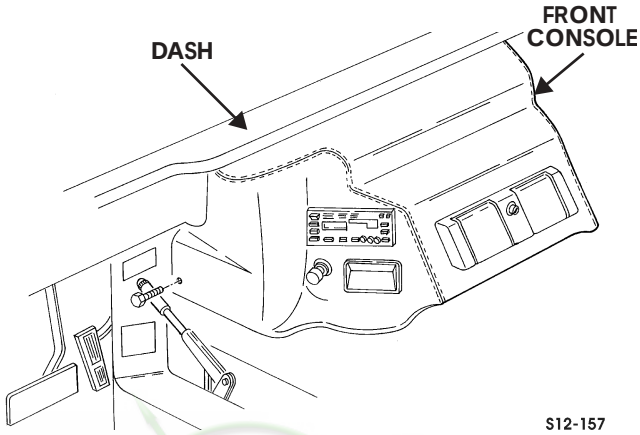


Figure 12-145: Engine Cover Console

3. Slide front console four inches toward rear of vehicle to allow access to dash harness.
4. Disconnect two dash harness connectors from remote entry harness connectors (Figure 12-146).

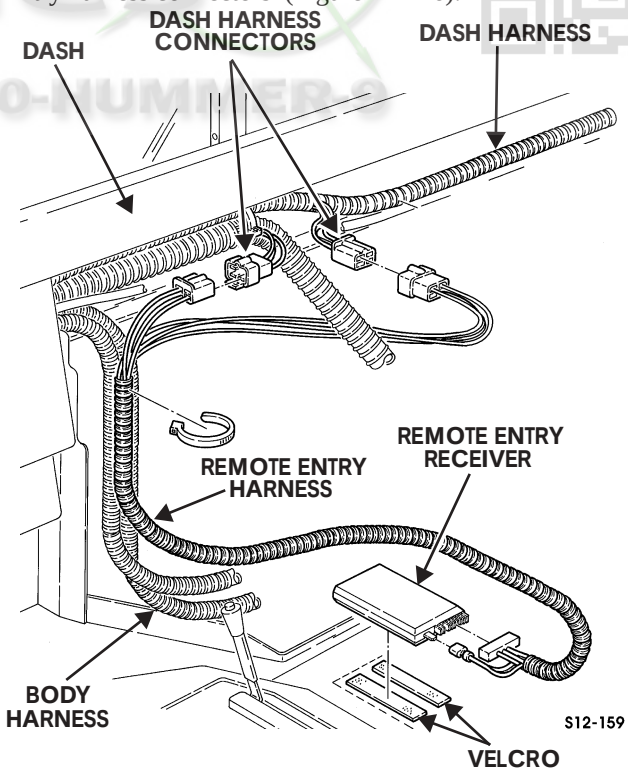


Figure 12-146: Receiver Harness

5. Disconnect remote entry harness connector from remote entry receiver.
6. Cut tie wraps as required and remove remote entry harness and remote entry receiver from vehicle.

Installation

1. Install remote entry receiver on velcro strips.
2. Connect remote entry harness connector at remote entry receiver (Figure 12-146).
3. Connect two dash harness connectors to remote entry harness connectors.
4. Secure remote entry harness to body and dash harness with tie straps as required.
5. Slide front console forward to dash.
6. Install front console with two screws on right side and one screw on left side (Figure 12-145).
7. Connect two battery ground cables.

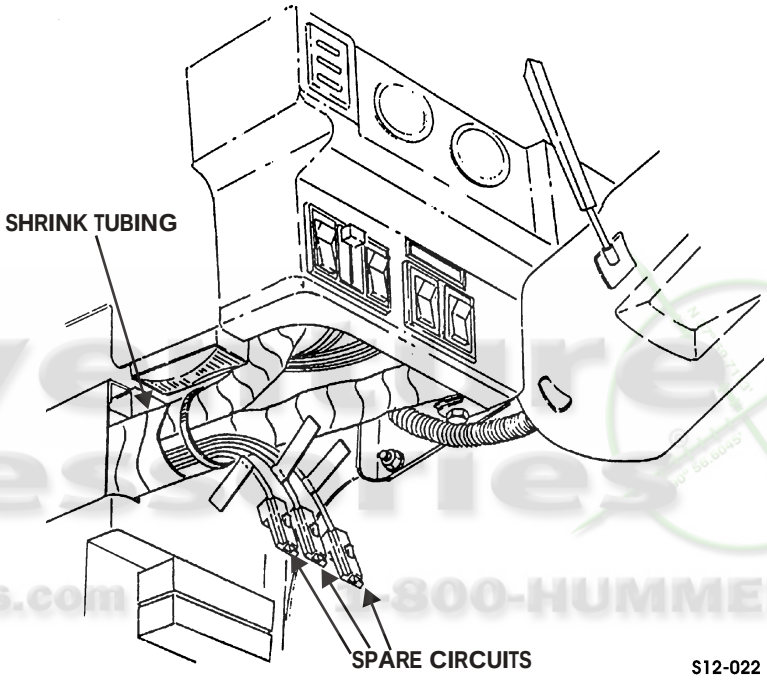


Figure 12-147: Spare Wires Location

TRAILER TOWING CONNECTOR ASSEMBLY

NOTE: The following procedure provides instructions to assemble a trailer towing connector needed when installing a trailer brake controller.

NOTE: Spare wires have been provided in the body harness (Figure 12-147) and routed from the instrument panel/fuse box area to the trailer connector at the rear of the vehicle.

1. Disconnect battery ground cable.
2. Install the brake controller using manufacturer's instructions.
3. Carefully remove and discard heat shrink tubing covering body harness and trailer harness connectors (Figure 12-148).
4. Cut dark blue (43A) wire and purple (50A) wire 2 in. (5 cm) from back of body harness trailer connector.
5. Slide adhesive wall heat shrink tubing over one end of dark blue and purple wires (Figure 12-149).
6. Connect dark blue body harness wire to purple connector wire. Secure connection using meltable adhesive crimp butt splices.
7. Connect purple body harness wire to dark blue connector wire. Secure connection using meltable adhesive crimp butt splices.
8. Cover both splices with heat shrink tubing, and shrink tubing with heat gun.
9. Slide large piece of heat shrink tubing over body harness connector.
10. Plug connector halves together, and position heat shrink tubing over mated connector.
11. Shrink tubing with heat gun.
12. Install a fuse in fuse position 7H as required per brake controller and trailer manufacturer's recommendations.
13. Connect battery ground cable, and test circuits for proper operation.

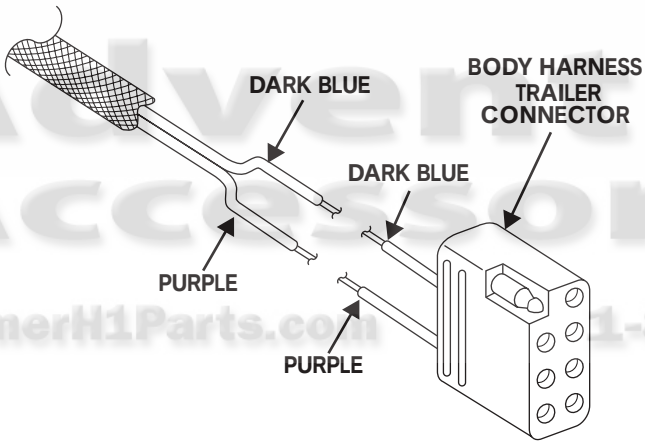


Figure 12-148: Wire Splice Locations

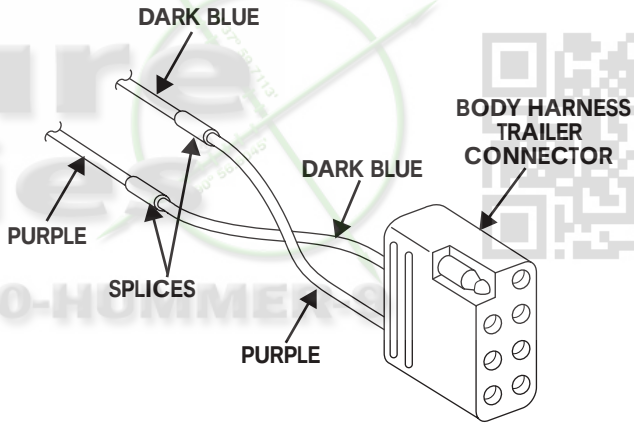


Figure 12-149: Spliced Connections

AUXILIARY AIR-CONDITIONING AND HEATING JUMPER HARNESS REPLACEMENT

NOTE: Tag leads for installation.

Removal

1. Remove auxiliary air-conditioning and heating fan switch (Section 11).
2. Remove front console enough to gain access to leads (Section 10).
3. Disconnect jumper harness connector from auxiliary unit blower motor connector.
4. Disconnect jumper harness purple, black, and red connectors from air-conditioning wiring harness connectors.

Installation

1. Connect jumper harness purple, black, and red connectors to air-conditioning wiring harness connectors.
2. Connect jumper harness connector to auxiliary unit blower motor connector.
3. Install front console (Section 10).
4. Install auxiliary air-conditioning and heating fan switch (Section 11).

FUSIBLE LINK MAINTENANCE

The following procedure covers the replacement of fusible links encountered through circuit diagnosis.

1. Disconnect battery ground cable.
2. Carefully remove old fusible link from termination (alternator, power stud, starter).
3. Locate original wiring harness splice between fusible link and wiring harness (Figure 12-150).
4. Cut fusible link splice on harness side. Do not splice into original fusible link; this may be weakened and cause a premature failure and repeat problem.
5. Identify the original fuse link size and length of fuse link cut from vehicle.
6. Matching the wire size, cut a length of fusible link wire to the total length cut from vehicle in Step 4. Be sure to compensate for any harness wire removed with original wire. This will avoid overtight wiring that may become separated with normal operation.
7. Install a new crimp on connector of the same type and size as the original lug or connector. Seal connection with low temperature heat shrink tubing.
8. Place a piece of heat shrink tubing onto the wire and install a butt connector onto the fusible link.
9. Install the fusible link by connecting it to the wiring harness with the butt connector and heat shrink tubing.
10. Connect terminal end to original location, alternator, power stud, or starter. Reconnect battery ground cable and check circuit(s) affected for proper operation.

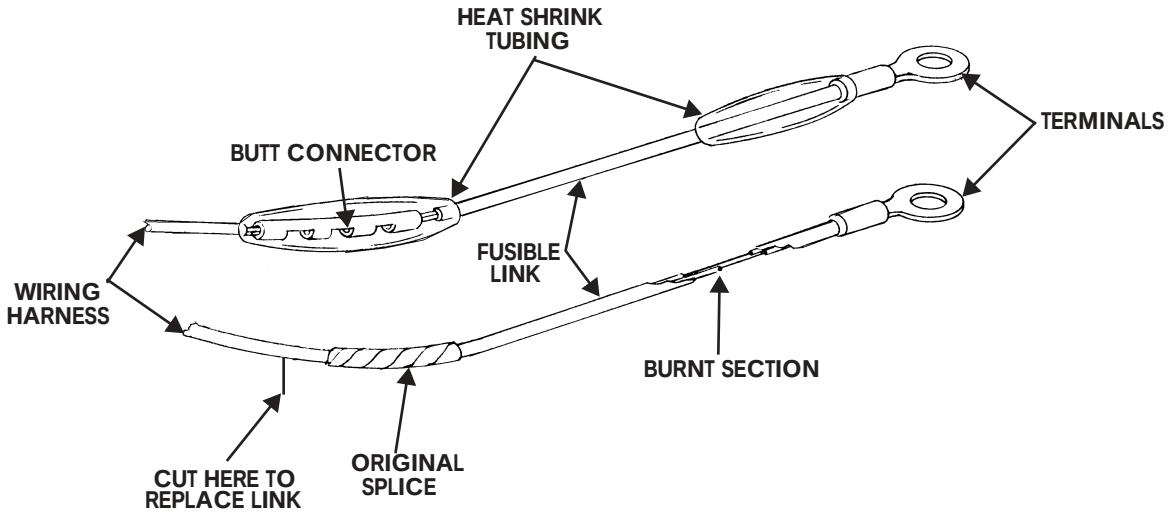


Figure 12-150: Fusible Link

IGNITION SWITCH REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove steering column (Section 8).
3. Remove multi-switch.
4. Remove screw and interlock cable from ignition switch (Figure 12-151).

5. Remove two capscrews and ignition switch from steering column.

Installation

1. Apply thread-locking compound to capscrew threads and install ignition switch on steering column with two capscrews (Figure 12-151).
2. Install interlock cable on ignition switch with screw.
3. Install multi-switch.
4. Install steering column (Section 8).
5. Connect battery ground cable.
6. Ensure ignition switch operates properly.

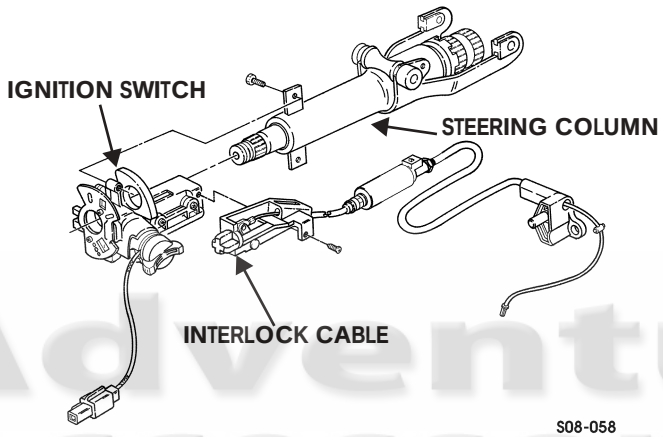


Figure 12-151: Ignition Switch

Section 12T Electrical Troubleshooting

TABLE OF CONTENTS

GENERAL

Because of its complexity, the electrical system is divided into the following functional systems for troubleshooting:

- Battery
- Starting system
- Fuel system
- Brake system
- Windshield wiper and washer system
- Transmission system
- Indicators, gauges, and warning system
- Lighting system
  Front
  Rear
  Cab
- Trailer connection system
- Heat and air conditioning system
- Winch
- Power door locks
- Power mirrors
- Power window
- The wiring schematics provided with this manual, fold-outs 1 through 12 show the interrelationship of all electrical systems and should be used when performing electrical troubleshooting.

BASIC ELECTRICAL CIRCUITS

WARNING: Batteries emit explosive hydrogen gas. Keep flames or sparks away from batteries. Battery acid is extremely harmful. If acid contacts eyes or skin, flush affected area(s) liberally with clear water, and seek medical help immediately. If acid contacts clothing, remove and discard affected clothing. Always disconnect ground cable, and remove all jewelry before working on batteries.

WARNING: When removing battery cables, disconnect ground cable first. Ensure all switches are off before disconnecting battery ground cable. Do not allow tools to come in contact with vehicle when disconnecting the cables. Indirect short can result causing instant heating of tools, tool damage, battery damage, or battery explosion.

WARNING: Never wear loose or baggy clothing around moving machinery. Remove ties and tie back long hair.

General

An electrical circuit is a number of electrical devices which are connected in a loop from a positive voltage source (battery positive) to a negative voltage source (battery negative).

Parallel Circuits

The Hummer electrical system is a parallel circuit. In a parallel circuit, the electrical devices are connected to form more than one current path to and from the power supply. The supply voltage is the same in each path.

Circuit Components

A normal circuit path usually starts at the power supply (battery system or alternator). Next is the circuit protection fusible link, fuse, or circuit breaker. The current then goes on to the circuit load, which may be lights, motors, or solenoids and returns to the power supply through the ground system.

Fusible Links

A fusible link is a section of wire, usually two gauge sizes smaller than the circuit it protects. A special insulation swells when heated, and the fusible link melts open, preventing damage to the circuit.

Circuit Controllers

Circuit controllers are manually-operated switches or relays. Switches are usually found at the beginning of a circuit, such as the headlight switch. Relays are used in high current circuits controlled by sensors, and are designed so that a small current circuit will be able to control a large current circuit.

Circuit Breakers

Circuit breakers used in the HUMMER are automatic reset circuit breakers, which will continue to cycle until excess electrical current is corrected, or the circuit is disconnected from the power supply.

Fuses

The most common protector in the vehicle electrical circuit is the fuse. A fuse is designed to melt before the wiring in a circuit can be damaged.

Maxi-Fuses

Maxi-fuses allow a greater electrical load while still providing protection to the wiring circuit. Maxi-fuses are often used in place of fusible links.

The maxi-fuse block is located in the convenience center of the fuse box. The circuits protected are shown in the chart below.

FUSE	AMPERAGE	
1	20	HEADLIGHTS
2	30	RUNNING LIGHTS
3	30	REAR WINDOW DEFROSTER
4	20	BLANK
5	30	POWER WINDOW
6	40	IGNITION

Circuit Diagnosis

Before taking any action to correct a possible malfunction, the following rules should be followed:

- Question the operator for any information that may help determine the cause of the problem.
- Never overlook the chance that the problem could be of simple origin, and corrected with minor adjustment.
- Use test instruments or gauges to help determine the problem.
- Always isolate the system where the problem occurs, then locate the defective equipment.
- Use standard automotive theories and principles when troubleshooting this vehicle.
- Always use the electrical harness wiring schematics (foldouts 1 through 12). These diagrams show how each component or device depends on others, and allows you to see how the entire system works.
- If a charging or low battery charge problem exists, check the accessory drivebelt.
- Check the battery for damage and charge, and clean, tight connections.
- Visually inspect wires and connectors. Verify terminal pins are clean and that no loose pins or terminals are present.
- Before checking a circuit by means of a multimeter, check to see if other components or systems fed or grounded by the circuit are operating properly.
- Based on the symptoms and your understanding of the circuit operation, identify one or more possible causes of the problem. You can either test for the most likely cause of failure, or perform those tests which are most easily and quickly done.

The following are the four electrical fault conditions that can cause a non-working circuit: an open circuit, a short circuit, a grounded circuit, or a high resistance connection.

Open Circuit

An open circuit occurs whenever there is a break in the circuit continuity. The break can be caused by a connector disconnect, a broken wire, or a defective component (Figure 12-1).

Short Circuit

A short circuit happens when the current bypasses part of the normal circuit. This bypassing is usually caused by wire pinching or chaffing. Usual symptoms are inappropriate activation of a load device (Figure 12-2).

Grounded Circuit

A grounded circuit is also a short circuit, except the current flows directly to ground with very little restriction. This is usually caused by wire pinching or chaffing against the frame or body (Figure 12-3).

High Resistance Connection

A high resistance connection is an electrical connection that is corroded or loose. High resistance connections cause a decrease in current flow that can affect the proper operation of an electrical load.

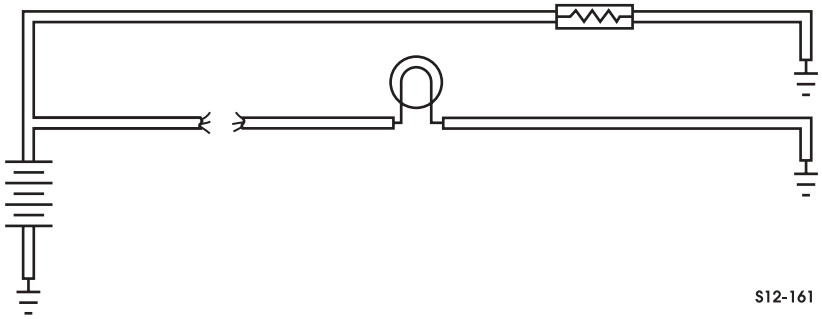


Figure 12-1: Open Circuit

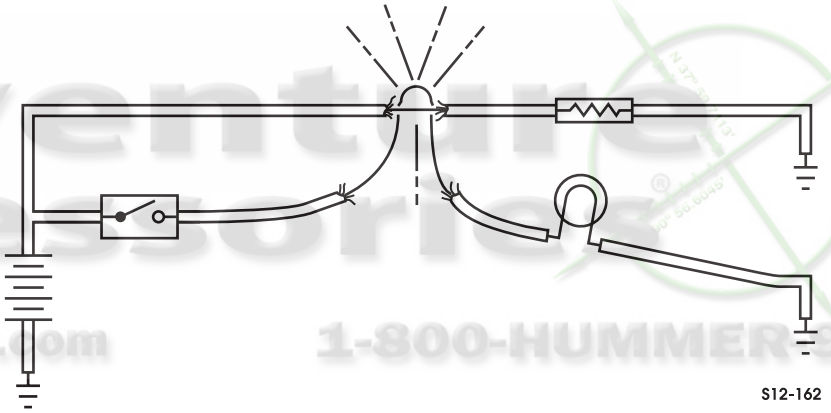


Figure 12-2: Short Circuit

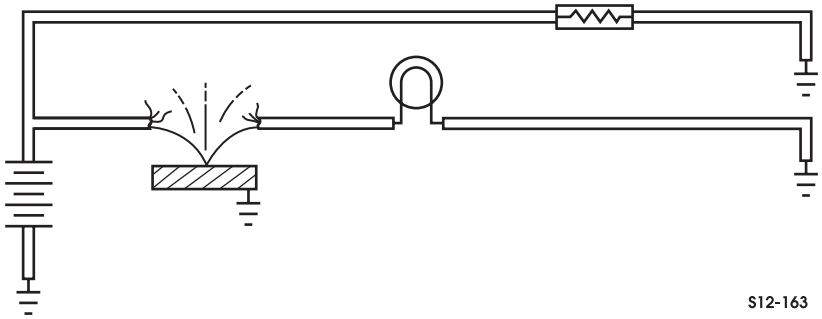


Figure 12-3: Grounded Circuit

DIAGNOSTIC TOOLS

Digital Multimeter

A digital multimeter is required to safely test for electrical malfunctions within the Hummer. Due to the complexity of the electrical system, a test light should not be used to test electrical circuits.

- Troubleshooting with a test light cannot be used to determine the difference between 6 volts and 7 volts. A digital multimeter displays exact voltage.
- Sharp test light probes may break wire strands, causing circuit failure.
- Breaks in the insulation allow moisture and contaminants to enter connectors and components, increasing the chances for corrosion. Even a small increase in resistance can give false readings from a sensor to an electronic component.

A digital multimeter performs all the tests a test light can perform with a greater degree of accuracy. In addition, a multimeter can be used to test for current in a circuit.

DIAGNOSTIC TESTS

NOTE: Follow all manufacturer's recommendations when testing for current. All multimeters have a maximum current rating. Not all multimeters contain a fuse that protects the multimeter from larger current draw.

Amperage Test

Use caution when testing for current. Always check multimeter owner's manual for maximum current to be tested. Most multimeters are fuse-protected when measuring current. However, some meters are not protected and therefore can be damaged by excessive current. Position multimeter leads after closed switch and before load (Figure 12-4).

Voltage Test

Multimeters have a number of different voltage scales to choose from. Always use the lowest scale possible to test the circuit. For example, if you select the 200 volt scale and you are testing for battery voltage, most multimeters will display 12 volts. By selecting the next smallest scale, 20 volts, the display will read 12.8 volts, a more accurate measurement. Position multimeter leads on each side of the load (Figure 12-5).

OHM Test

CAUTION: *Before using a multimeter, ensure the circuit is not energized. Even a small voltage applied to an multimeter will damage it.*

Continuity - Testing for continuity in a circuit requires the use of the lowest ohm scale available. Position the multimeter leads on each side of the circuit or component being tested. A reading of less than one ohm is acceptable continuity (Figure 12-6).

Resistance - To test for resistance, first touch the meter leads together to ensure that the meter zeros out, then position the leads of the multimeter on each side of the circuit or component. Adjust the multimeter ohm setting until an acceptable reading is observed. Verify the reading with the specification.

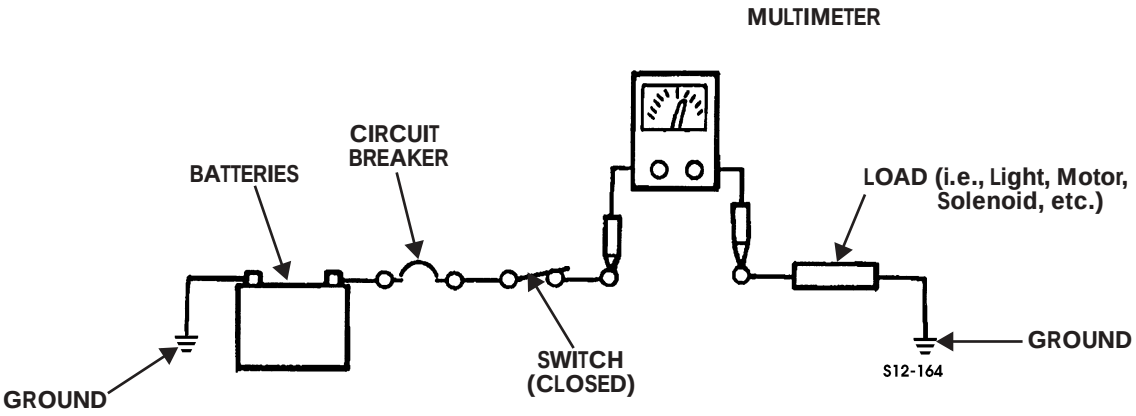


Figure 12-4: Amperage Test

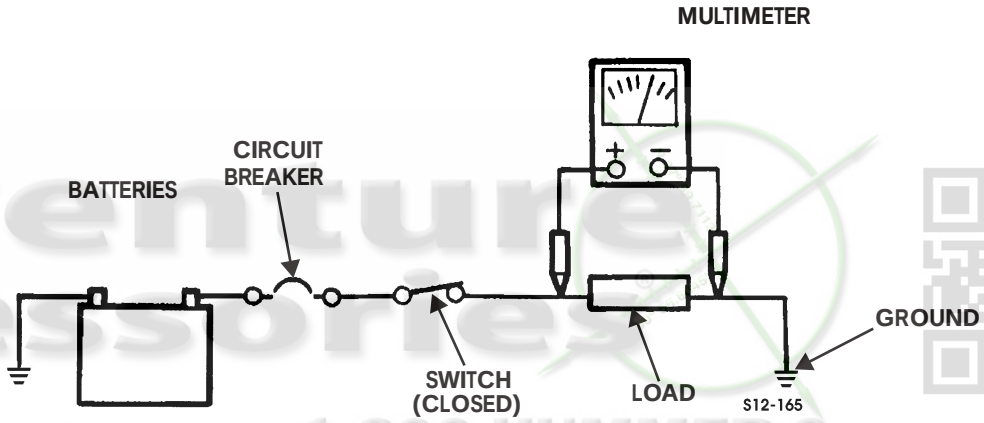


Figure 12-5: Voltage Test

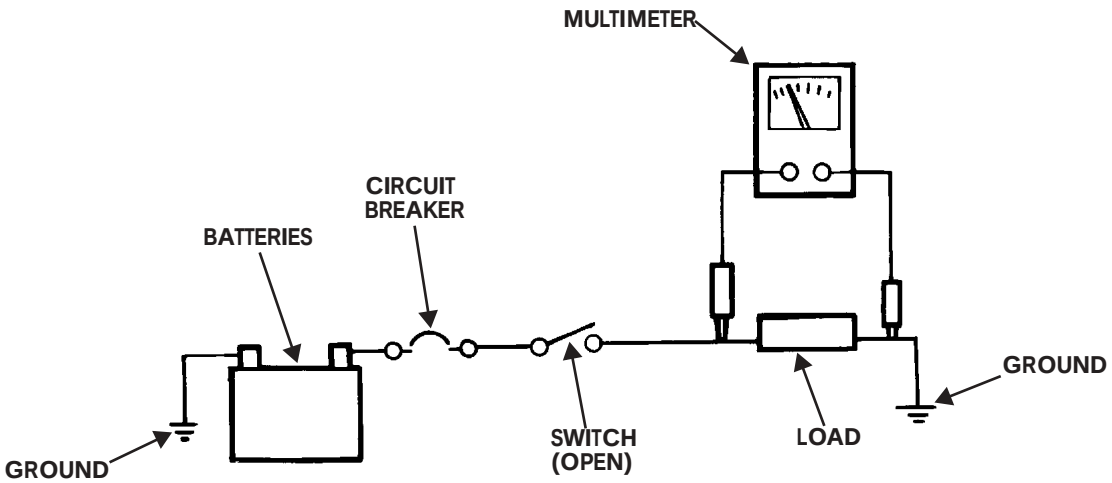


Figure 12-6: Ohm Test

CIRCUIT MAINTENANCE AND REPAIR

All electrical connections must be kept clean and tight. Loose or corroded connections may cause a discharged battery, weak starting, dim lights, or possible electrical system damage.

Wires must be replaced or repaired if insulation becomes burned, cracked, or deteriorated. When replacing a wire, it is important that the same gauge size wire be used. Refer to wiring diagram for proper wire gauge sizes. Never replace a wire with one of a smaller size or replace a fusible link wire with a wire of a larger size. It should also be noted that fusible link wire utilizes a special insulation covering. When replacing a fusible link wire, the replacement wire should be the type in accordance with SAE J156. Further, fusible link wire should never be shortened or spliced. If a repair is necessary, entire fusible link wire must be replaced with one of the proper gauge size, length and insulation type.

Any wire repair must maintain the waterproof integrity of the vehicle. Any splice located below the 30 in. (76 cm.) fording level or in a high splash area must be waterproof and heavy duty adhesive wall shrink tubing should be used as a minimum in these areas.

Each harness or wire must be held securely in position to prevent damage to insulation caused by vibrating and chafing.

NOTE: Before performing any wire repair, disconnect battery ground cable.

Wiring Repair

Wiring harness and wires - All wires are of a specific insulation color indicated on the wiring diagrams. Insulation color helps to identify circuits and make correct connections. Insulation colors and their abbreviations are as follows:

BK - Black	PK - Pink
BR - Brown	PP - Purple
DB - Dark Blue	RD - Red
DG - Dark Green	RT - Rust
GY - Gray	TN - Tan
LB - Light Blue	WH - White
LG - Light Green	YL - Yellow
OR - Orange	

Wire repair is very important for the continued, reliable operation of the vehicle. This repair must be done as described in the following procedure:

Single Wire Repair (Exposed)

1. Remove damaged area, removing as little wire as possible (Figure 12-7).

NOTE: Care should be exercised in stripping the wire insulation to avoid cutting wire conductor strands.

2. Strip wire ends to the appropriate length required by the splice clip (Figure 12-8).

NOTE: Heat shrink tubing is available in various diameters. Typically the heat shrink tubing will shrink to approximately one-half of its original diameter, therefore the tubing diameter selected for the repair should not be greater than twice the wire insulation diameter to ensure a proper seal.

3. Slide heat shrink tubing over one of the wire ends (Figure 12-8).

NOTE: Splice clips are available for different wire gauge sizes. Therefore, it is important to select the appropriate size for the wire gauge being repaired.

4. Slide both ends of wire into splice clip and crimp splice clip to wire ends (Figure 12-9).
5. Pull wires, by hand, in opposite directions to test the crimp of the splice clip.
6. Center heat shrink tubing over splice clip (Figure 12-10).
7. Using a heat gun or equivalent heat source, apply heat to heat shrink tubing until tubing conforms to splice clip and wire insulation (Figure 12-11).
8. After the splice cools, apply two layers of vinyl adhesive electrical tape to complete the repair (Figure 12-12).

Single Wire Repair (In a Harness)

1. Remove harness covering in the affected area (Figure 12-13).
2. Repair damaged wire using the exposed single wire repair procedures. (Go to Step 1.)
3. After completing the wire repair, apply two layers of vinyl adhesive electrical tape over the affected area to complete the repair (Figure 12-14).

Multiple Wire Repair (In a Harness)

NOTE: Since more than one splice is required in this case, stagger the wire splices such that they are no closer than 3 in. (7.6 cm) from each other.

Repair affected wires using the single wire repair (in a harness) procedures (Figure 12-15).

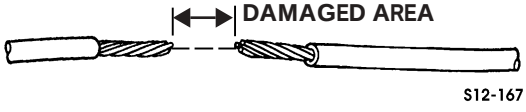


Figure 12-7: Damaged Wire

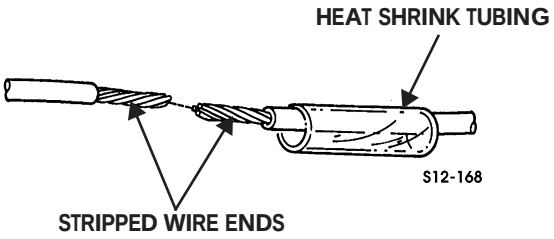


Figure 12-8: Heat Shrink Tubing

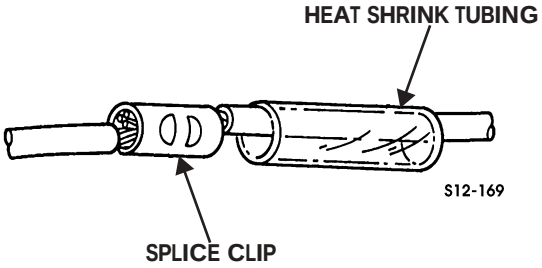


Figure 12-12: Splice Clip

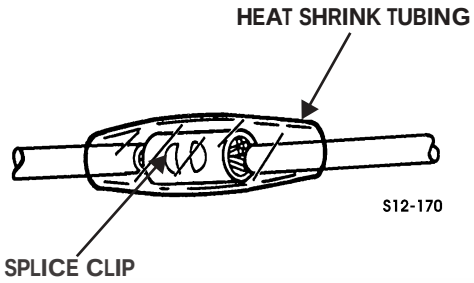


Figure 12-9: Splice Clip

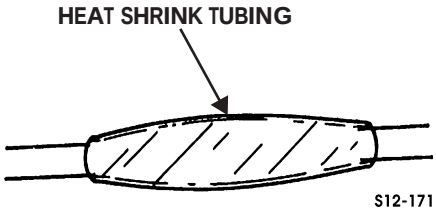


Figure 12-13: Heat Shrink Tubing

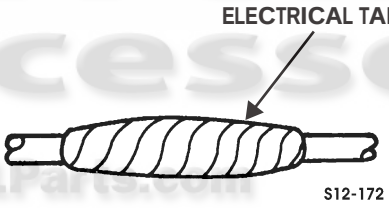


Figure 12-10: Electrical Tape

Figure 12-14: Damaged Wire

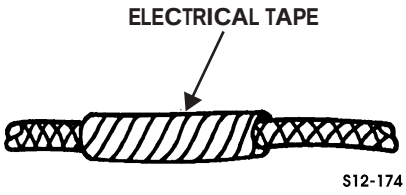


Figure 12-11: Electrical Tape

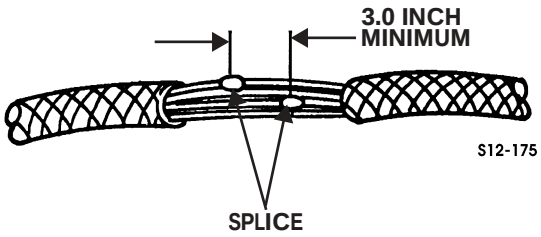


Figure 12-15: Multiple Wire Splice

FUSE/RELAY LOCATION AND IDENTIFICATION

Power Distribution Center

The power distribution center, or fuse box, is located under the instrument panel to the left of the steering column. The fuse box is divided into two mini-fuse junction blocks, a maxi-fuse junction block, five relays, and a convenience center. The mini-fuse blocks may be accessed without removing the main fuse box cover (Figure 12-16).

Fuses

Fuses and circuit breakers protect the vehicle's electrical system from damage caused by overloading. If any electrical components are not working, there is a good chance that there has been an overload in the electrical system. In such a case, a blown fuse or tripped circuit breaker is usually the problem or it is an indicator of a more serious problem.

They have separate upper and lower access covers. To access the maxi-fuse block and relays, the main fuse box cover must be removed. The convenience center, as the name implies, may be conveniently accessed without having to remove any covers. Before removing any of the fuse box access covers, refer to the illustrations and charts in this section for the location of specific fuses, relays, and circuit breakers. Doing this will enable you to go directly to the fuse or circuit breaker you want to inspect.

Whenever a fuse blows or a circuit breaker opens a circuit, all electrical components using that circuit will not operate. Therefore, before replacing any of these electrical components, check the appropriate fuses and circuit breakers for damage (Figure 12-17).

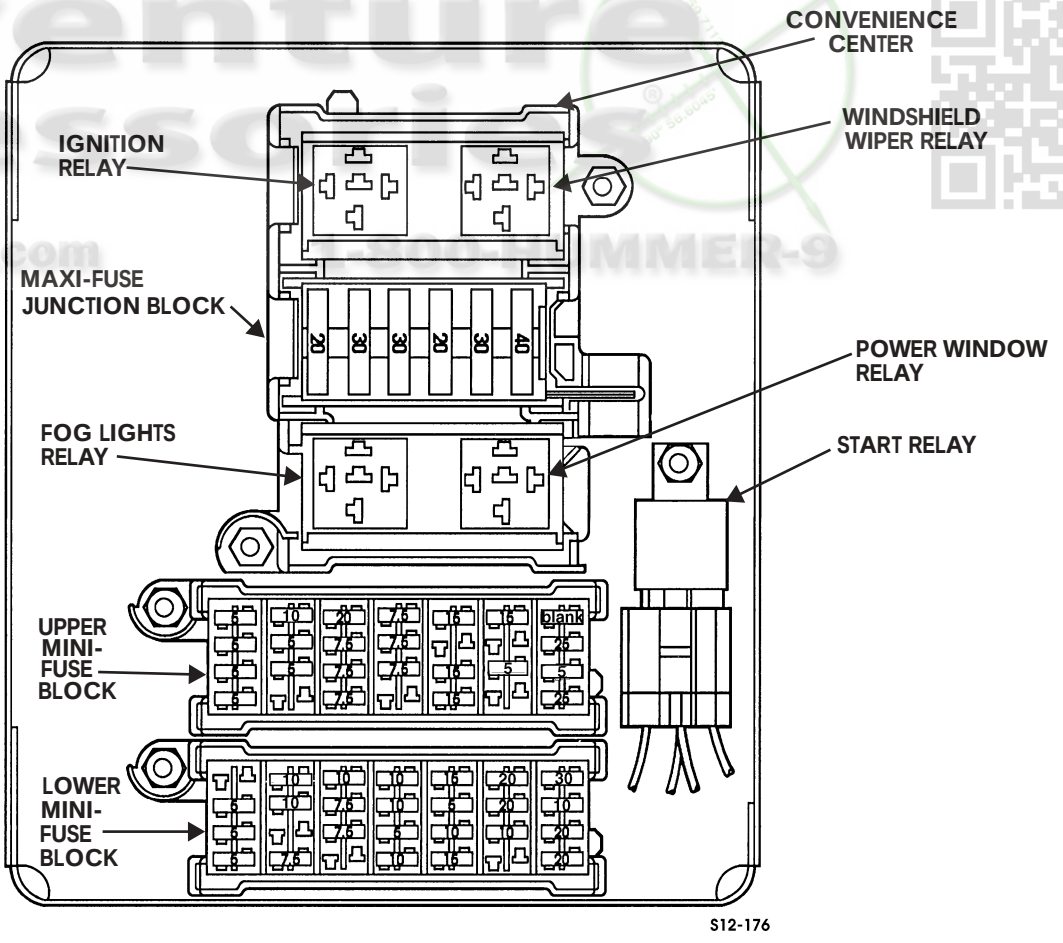


Figure 12-16: Fuse Panel and Convenience Center

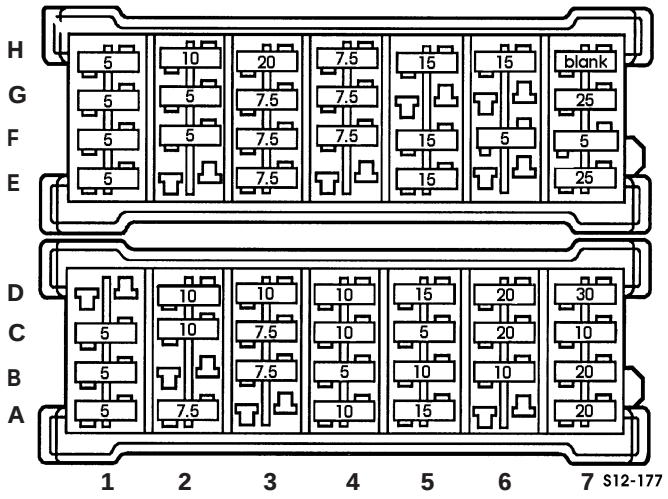
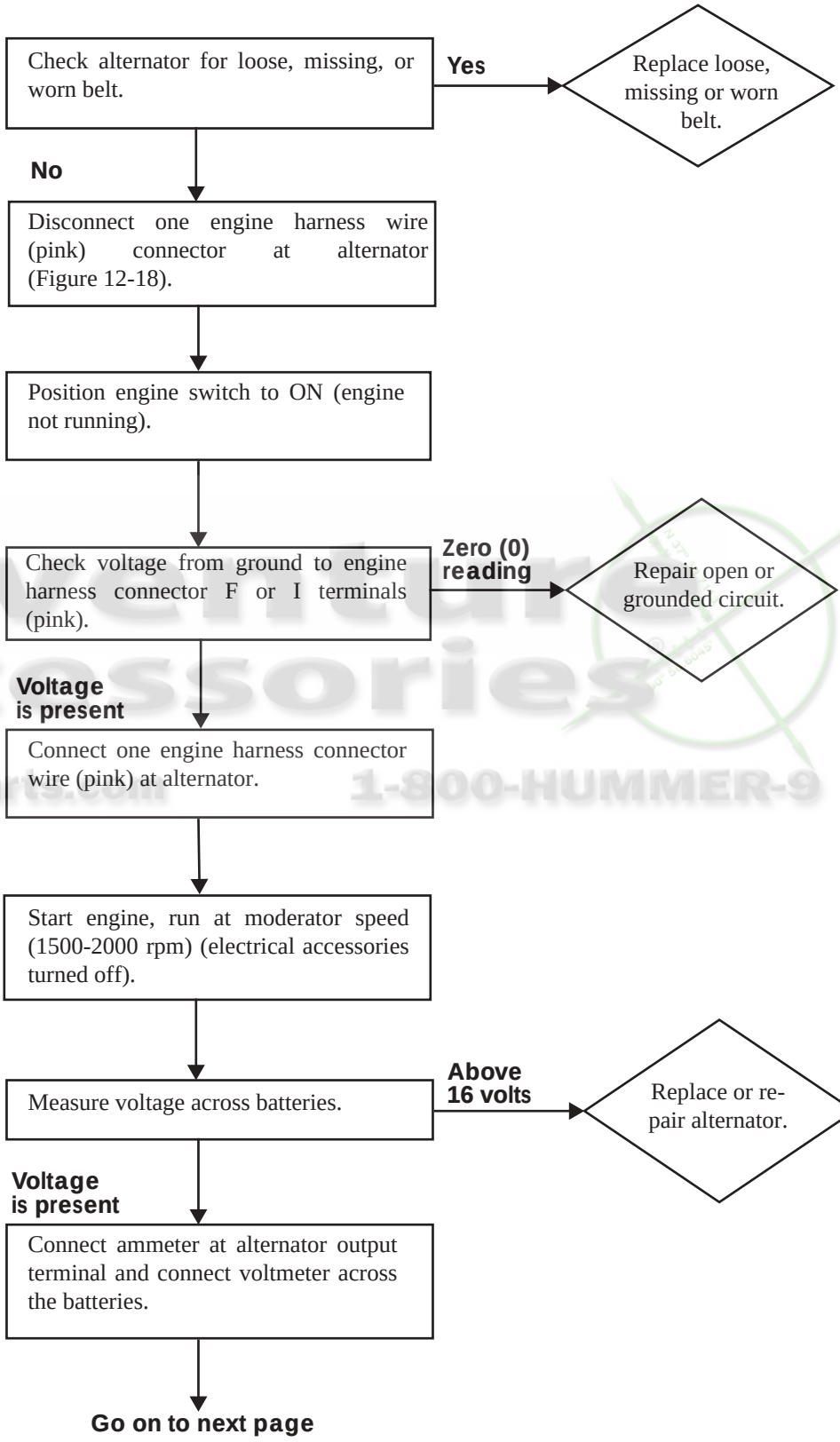


Figure 12-17: Fuse Identification

FUSE	AMPERAGE	CIRCUIT PROTECTED
1E	5	Spare Fuse
2E	–	Blank
3E	7.5	Spare Fuse
4E	–	Blank
5E	15	Spare Fuse
6E	–	Blank
7E	25	Spare Fuse
1F	5	Spare Circuit-Lights
2F	5	Panel Lights Dimmer Module
3F	7.5	Front Parking/Running Lights
4F	7.5	Rear Parking/Running Lights
5F	15	Trailer Lights
6F	5	Underhood and Trouble Lights
7F	5	Light Circuit to Chime and HVAC
1G	5	CTIS/Key Buzzer
2G	5	Power Windows
3G	7.5	Spare Circuit/Ignition Acc
4G	7.5	Radio
5G	–	Blank
6G	–	Blank
7G	25	Windshield Wiper/Washer
1H	5	ALDL Power
2H	10	Radio Memory
3H	20	Power Door Locks
4H	7.5	Spare Circuit-Battery
5H	15	Dome/Courtesy Lights
6H	15	Fog Lamp
7H	–	Trailer Brake Controller
1A	5	Spare Fuse
2A	7.5	Spare Fuse
3A	–	Blank
4A	10	Spare Fuse
5A	15	Spare Fuse
6A	–	Blank
7A	20	Spare Fuse

FUSE	AMPERAGE	CIRCUIT PROTECTED
1B	5	Glow Plug Controller
2B	–	Blank
3B	7.5	Glow Plug Controller/Gas Engine Injectors
4B	5	Gauges
5B	10	Transmission/Ignition
6B	10	TCM/Ignition
7B	20	Engine Ignition Feed
1C	5	Transmission Shift Lock
2C	10	A/C Clutch/Rear Defrost
3C	7.5	Backup Lights
4C	10	Turn Signals
5C	5	Digital Ratio Adapter/ Speedometer
6C	20	Rear A/C
7C	10	Cruise Control
1D	–	Blank
2D	10	TCM/PCM Battery
3D	10	Lighter
4D	10	Stoplights
5D	15	Hazard
6D	20	Horn Relay
7D	30	Additional Equipment

BATTERIES AND CHARGING SYSTEM — Alternator Troubleshooting



BATTERIES AND CHARGING SYSTEM — Alternator Bench Test

Refer to (Figure 12-19) and make connections as shown.

The ground polarity of alternator and battery must be the same. The battery must be fully charged. Use a resistor of any value between 35 ohm, 5 watt and 500 ohm, 1/2 watt between battery and I/F terminal.

Slowly increase alternator speed and observe voltage (battery must be fully charged when making this test).

- If voltage is uncontrolled and increases above 16 volts, the rotor is shorted or grounded, the regulator is defective, or both.
- If voltage is below 16 volts, increase speed, adjust carbon pile to obtain max. amp output and maintain voltage above 13 volts.
- If amps are within 15 of rated output, the alternator is good. → Replace batteries.
- If amps are not within 15 of rated output, the alternator is defective. → Repair or replace alternator.

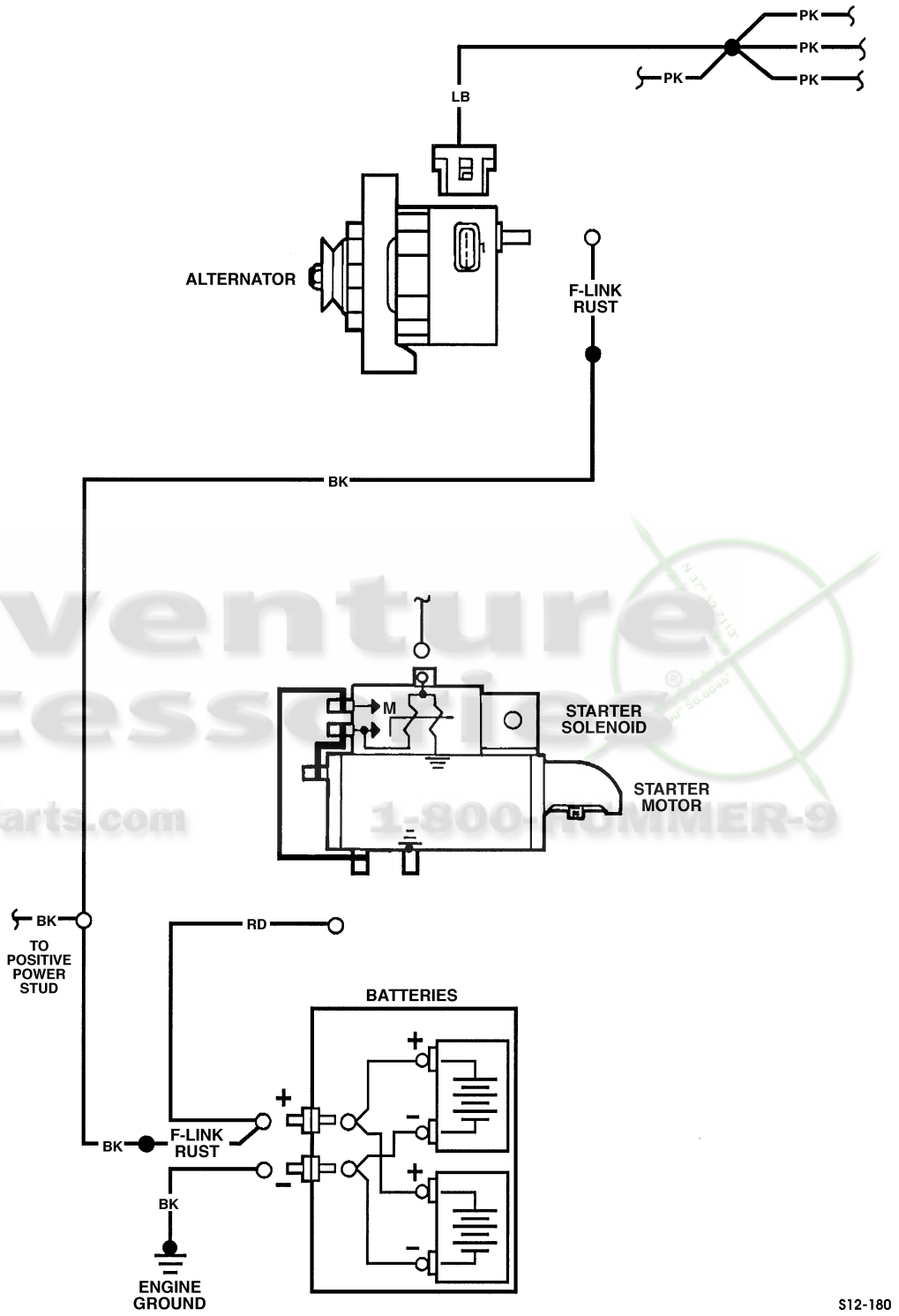
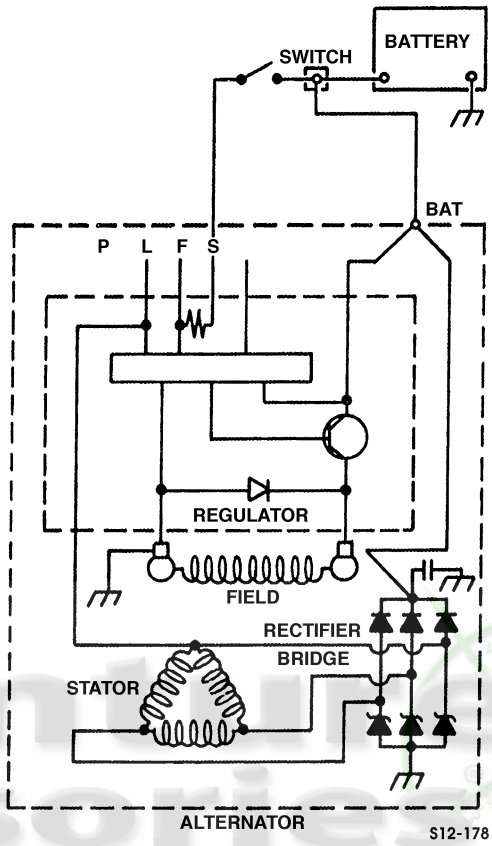


Figure 12-18: Batteries, Starter, and Alternator



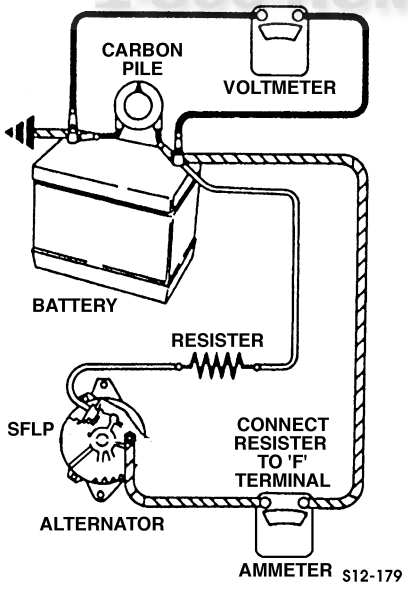
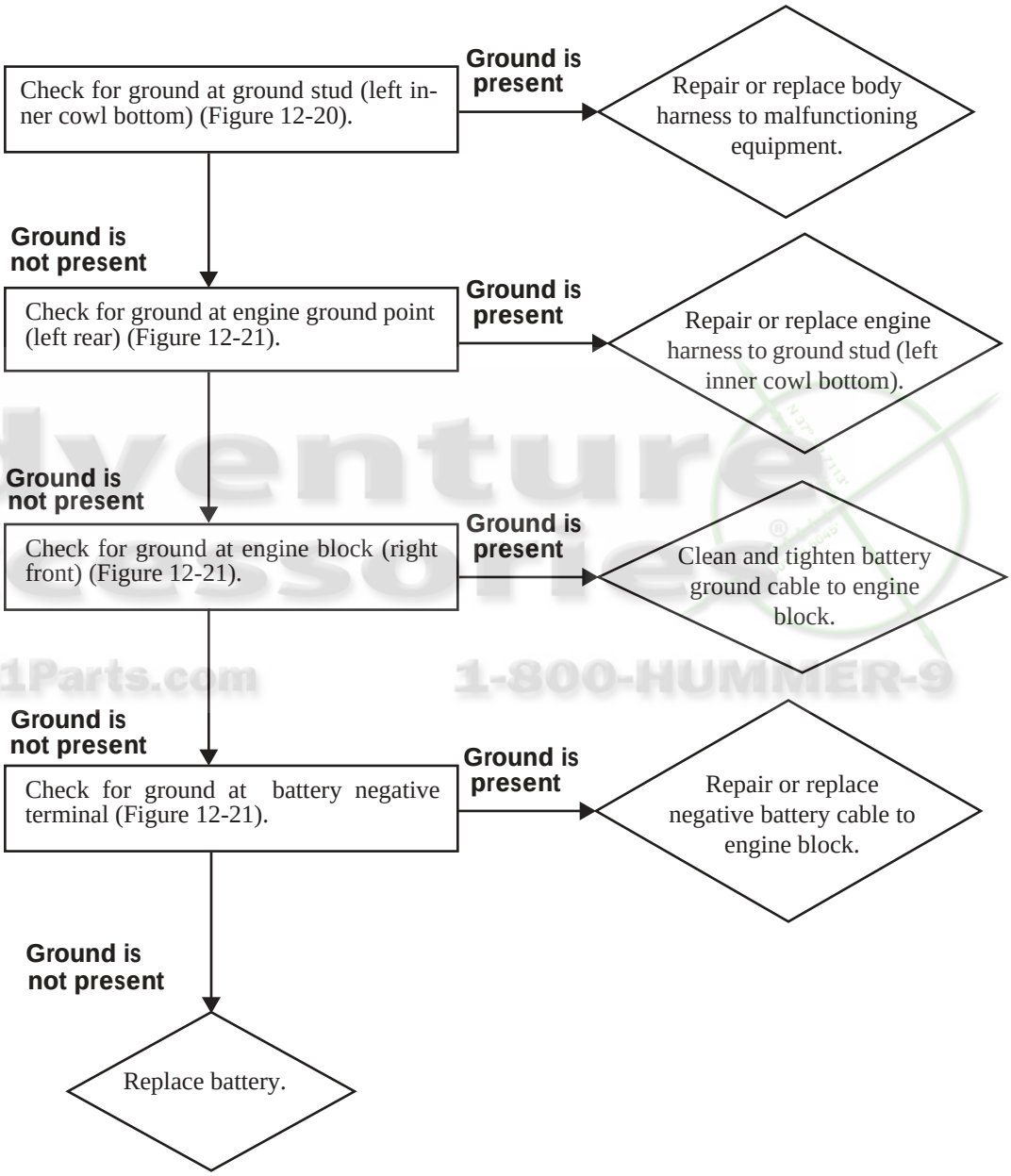
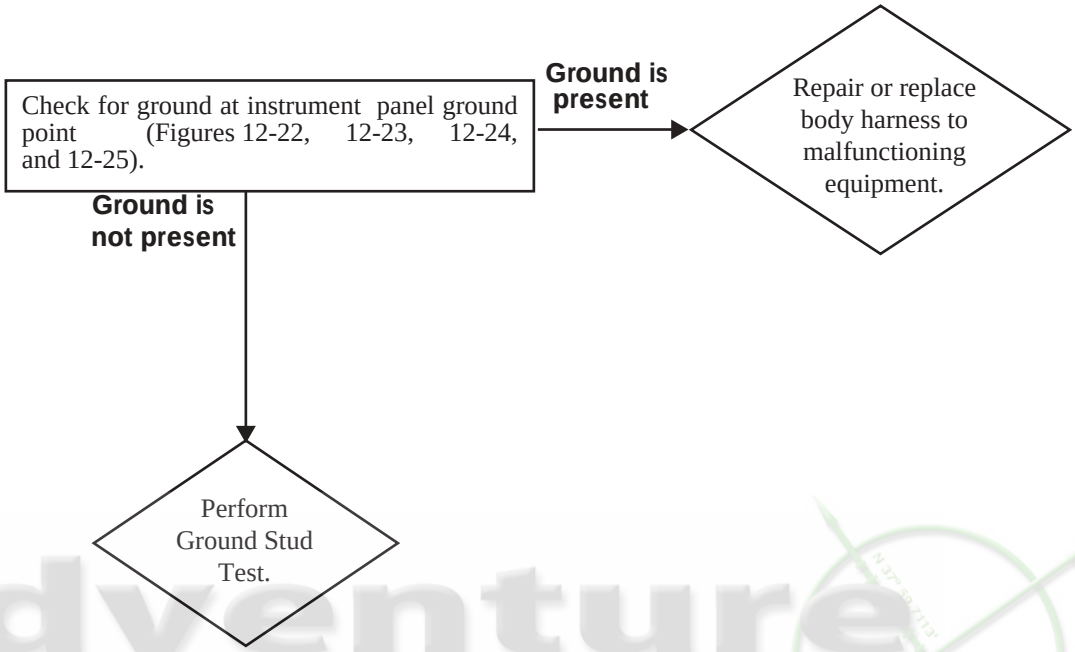


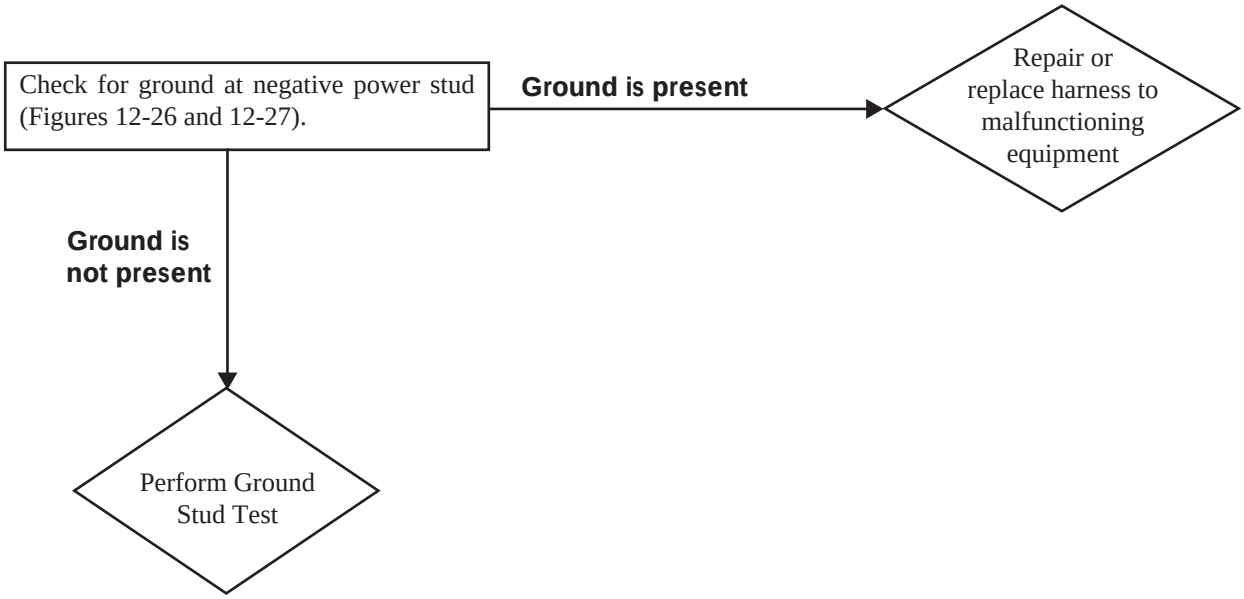
Figure 12-19: Alternator Test

GROUND STUD TEST



INSTRUMENT PANEL GROUND POINT TEST





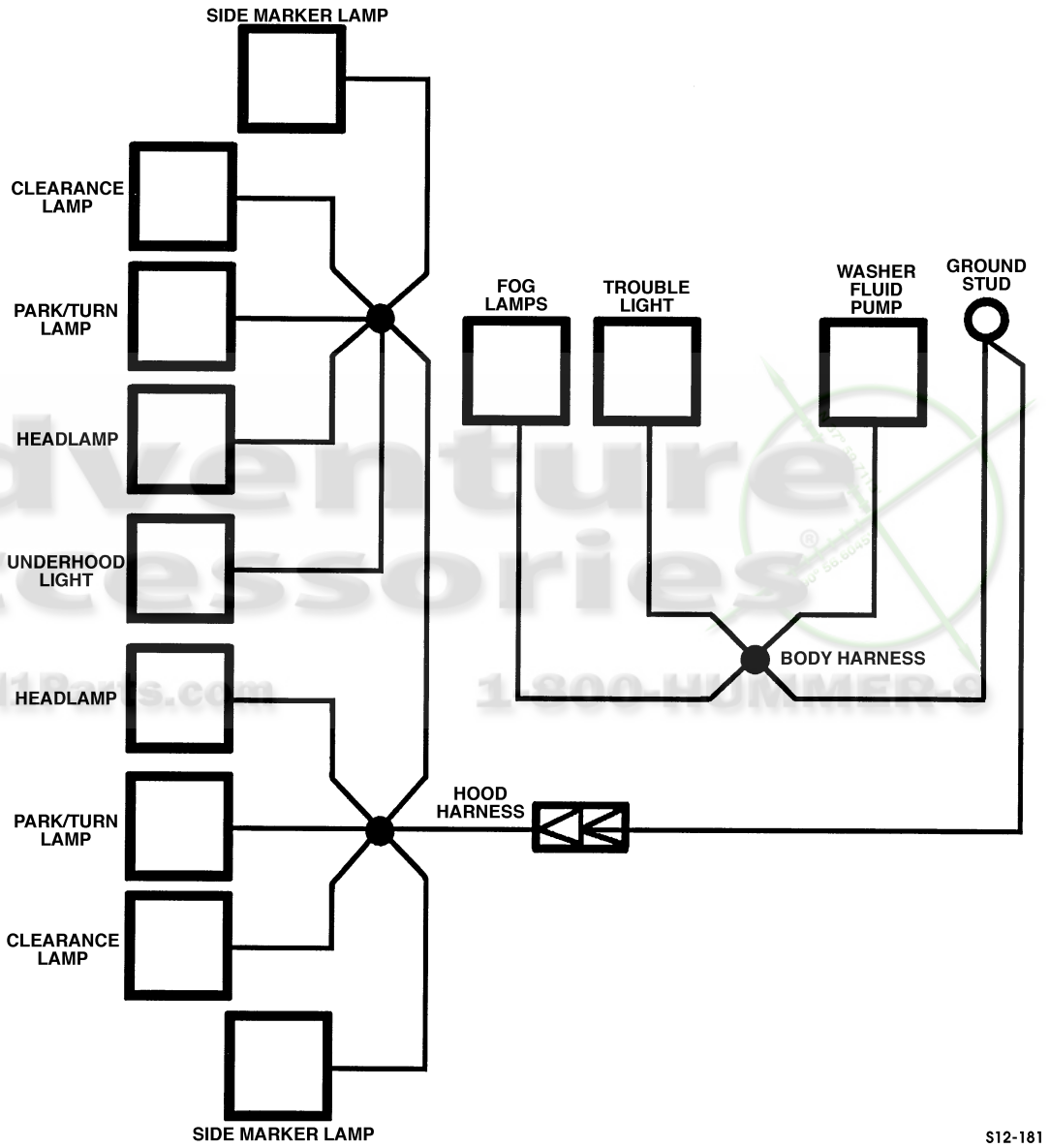


Figure 12-20: Front Grounds

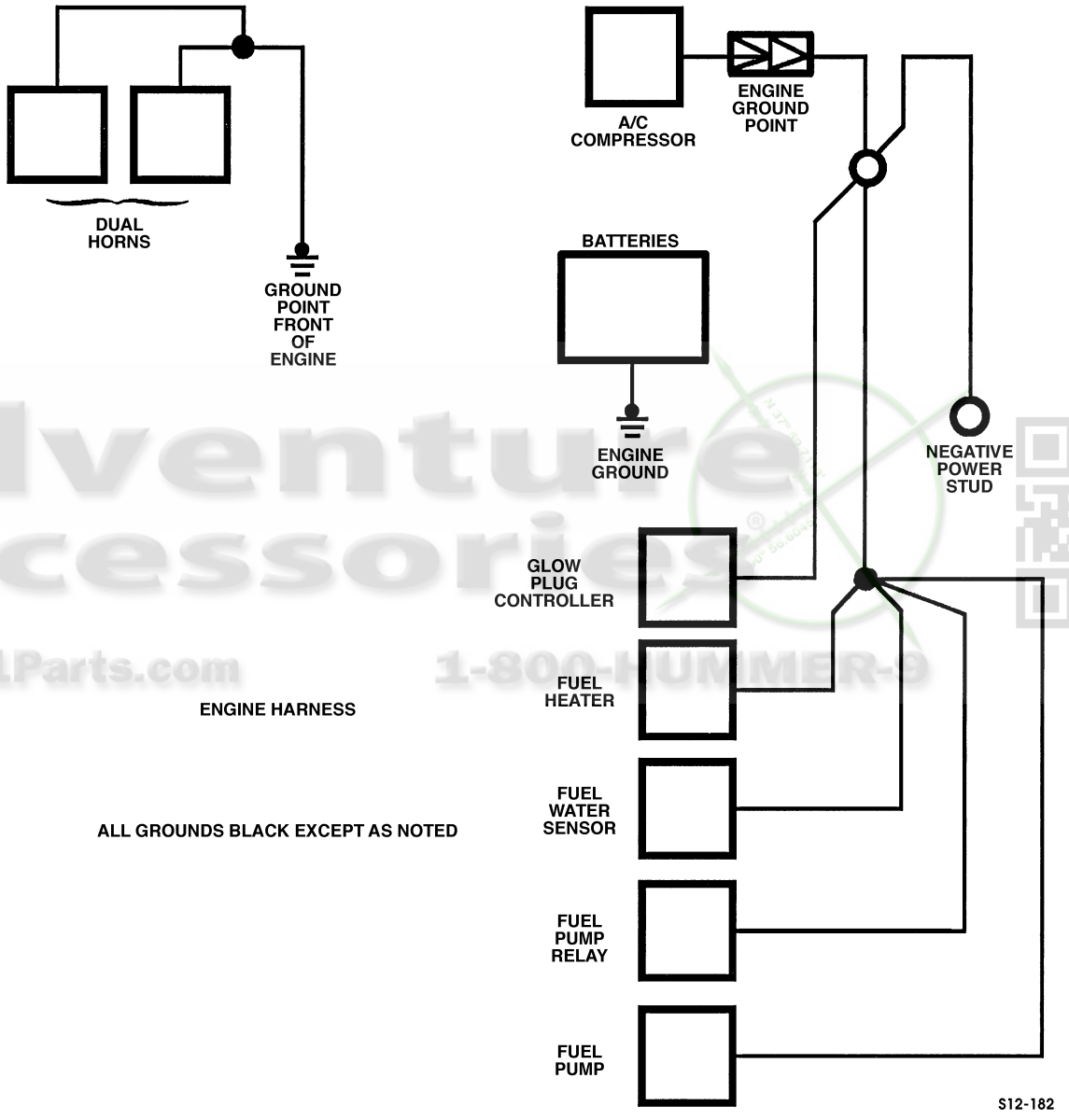


Figure 12-21: Engine Grounds

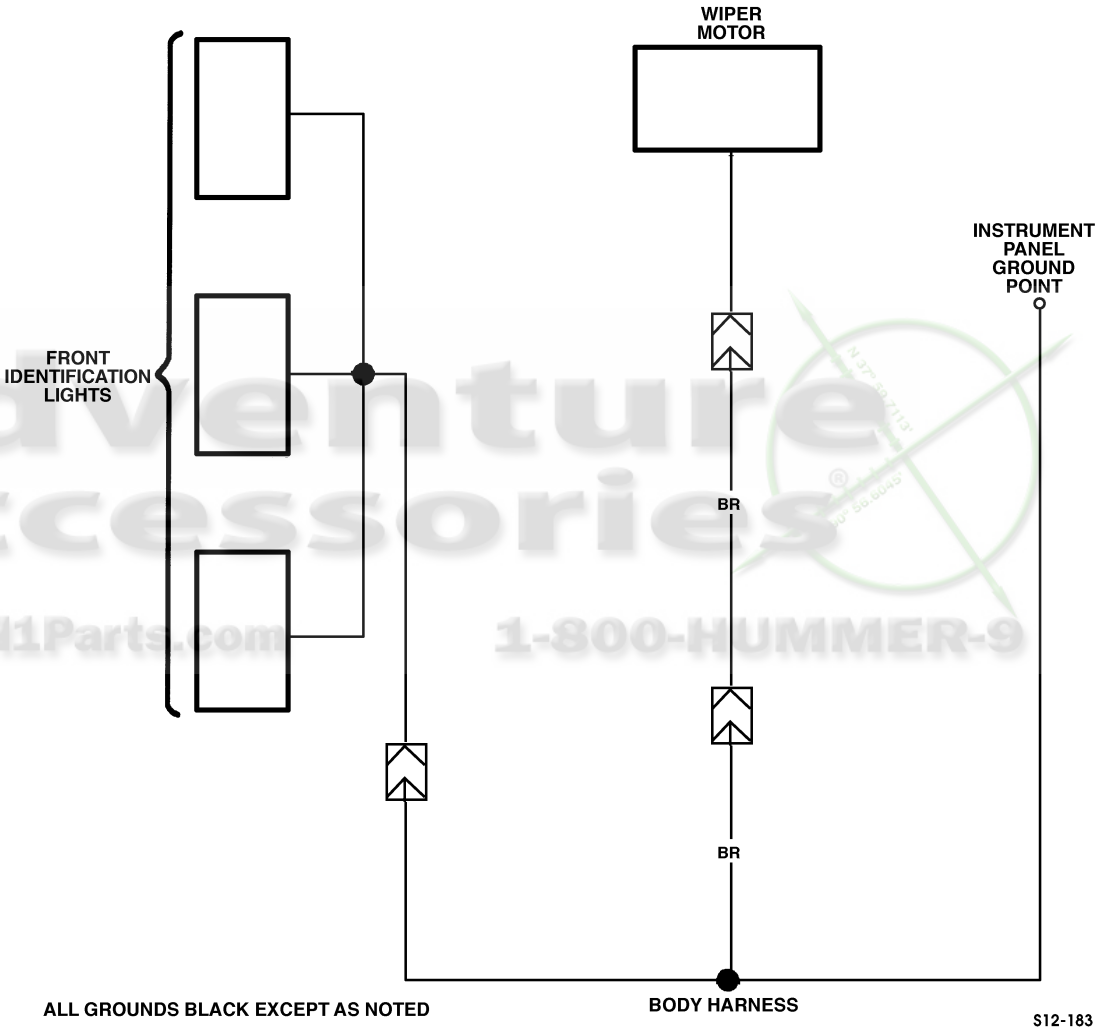


Figure 12-22: Body Front Grounds

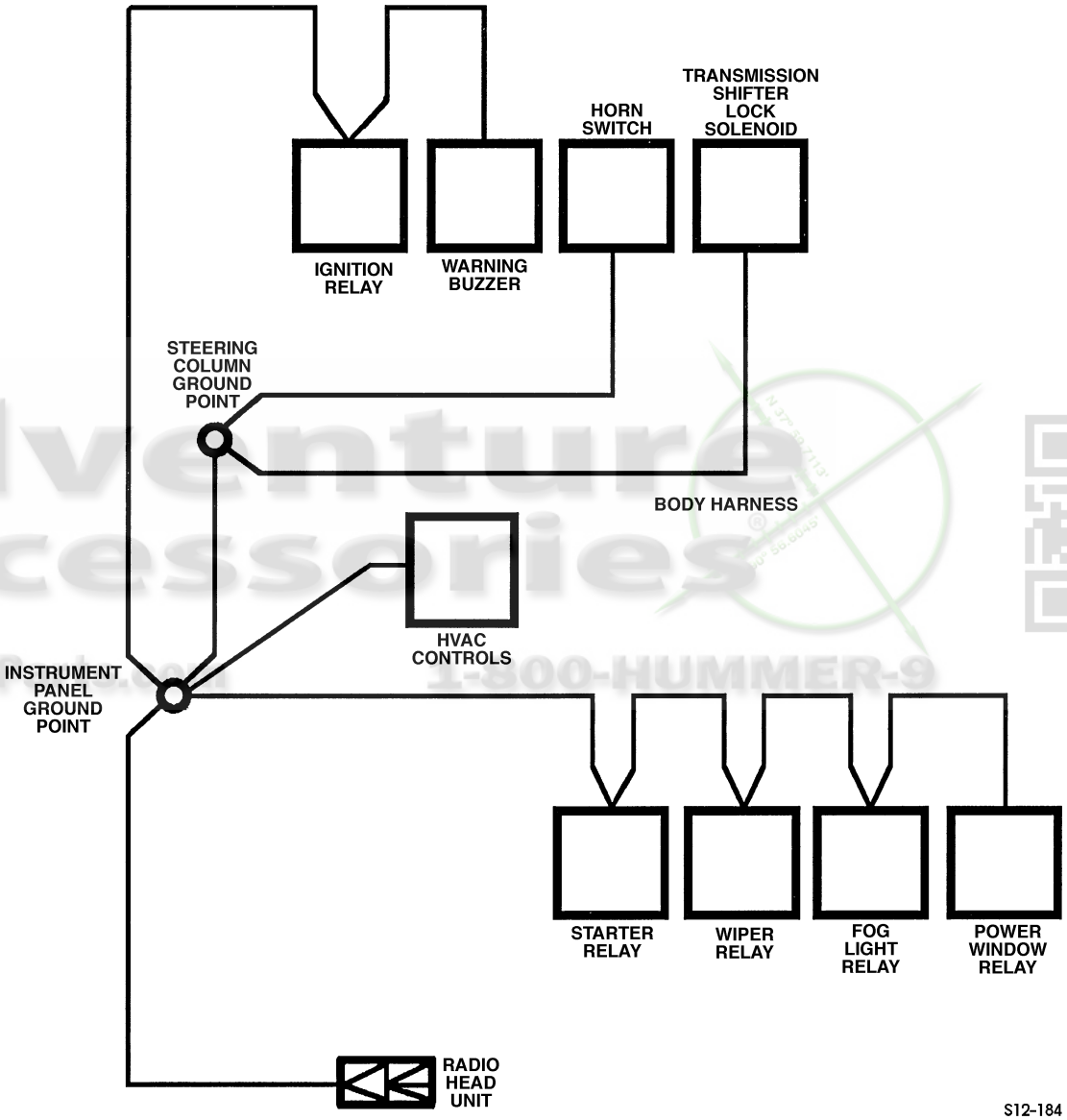


Figure 12-23: Power Distribution Center Grounds

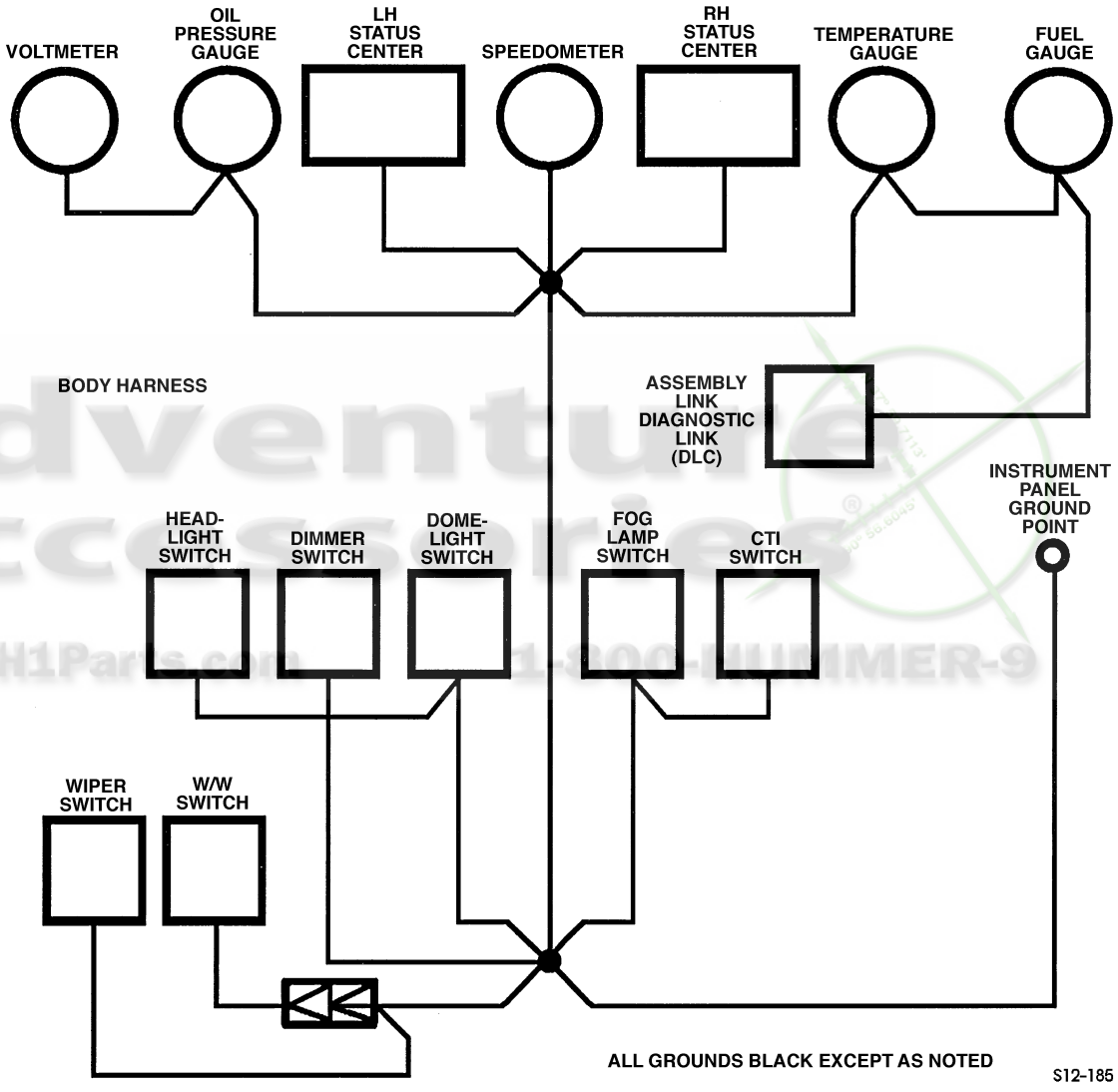


Figure 12-24: Instrument Panel Gauge Grounds

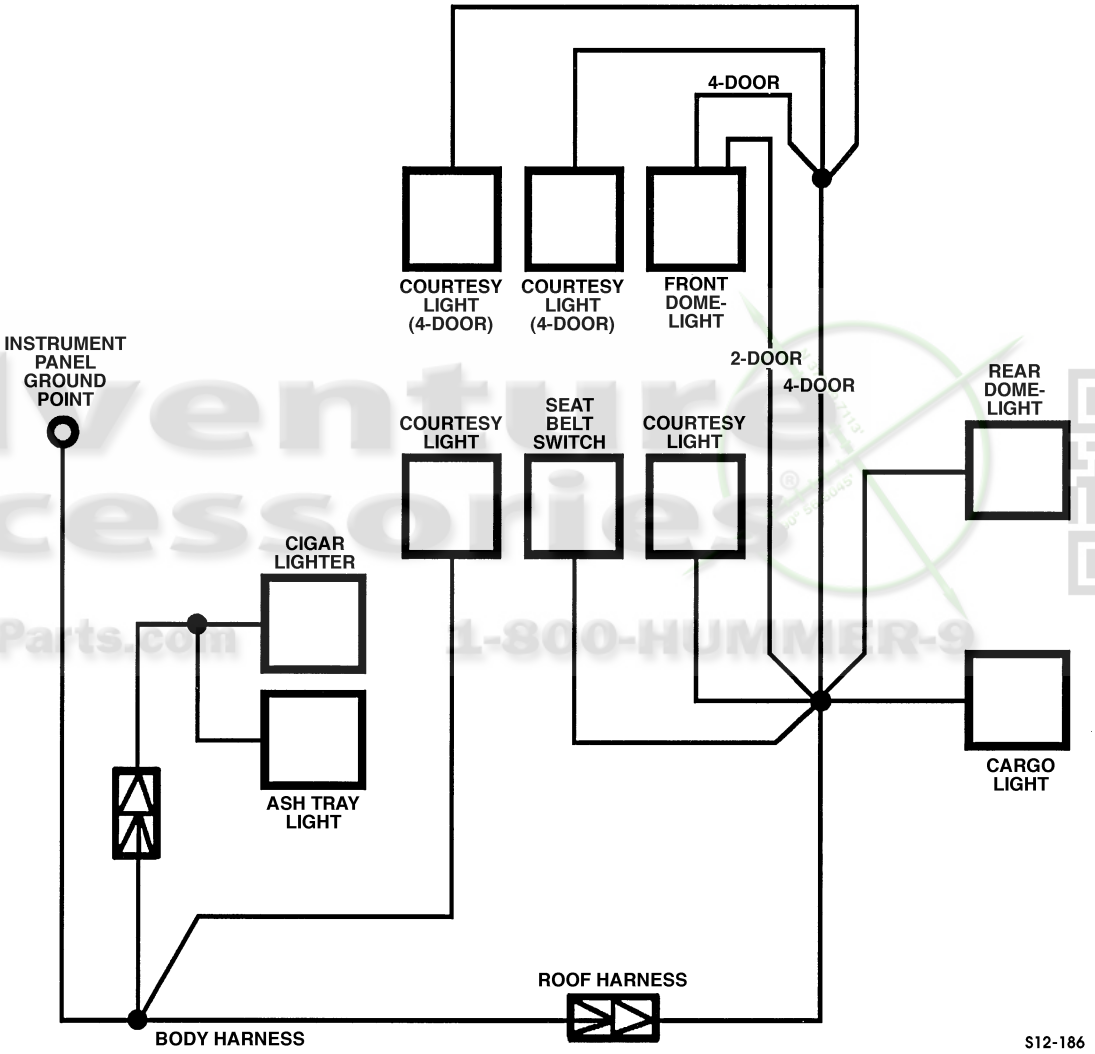


Figure 12-25: Mid-Body Grounds

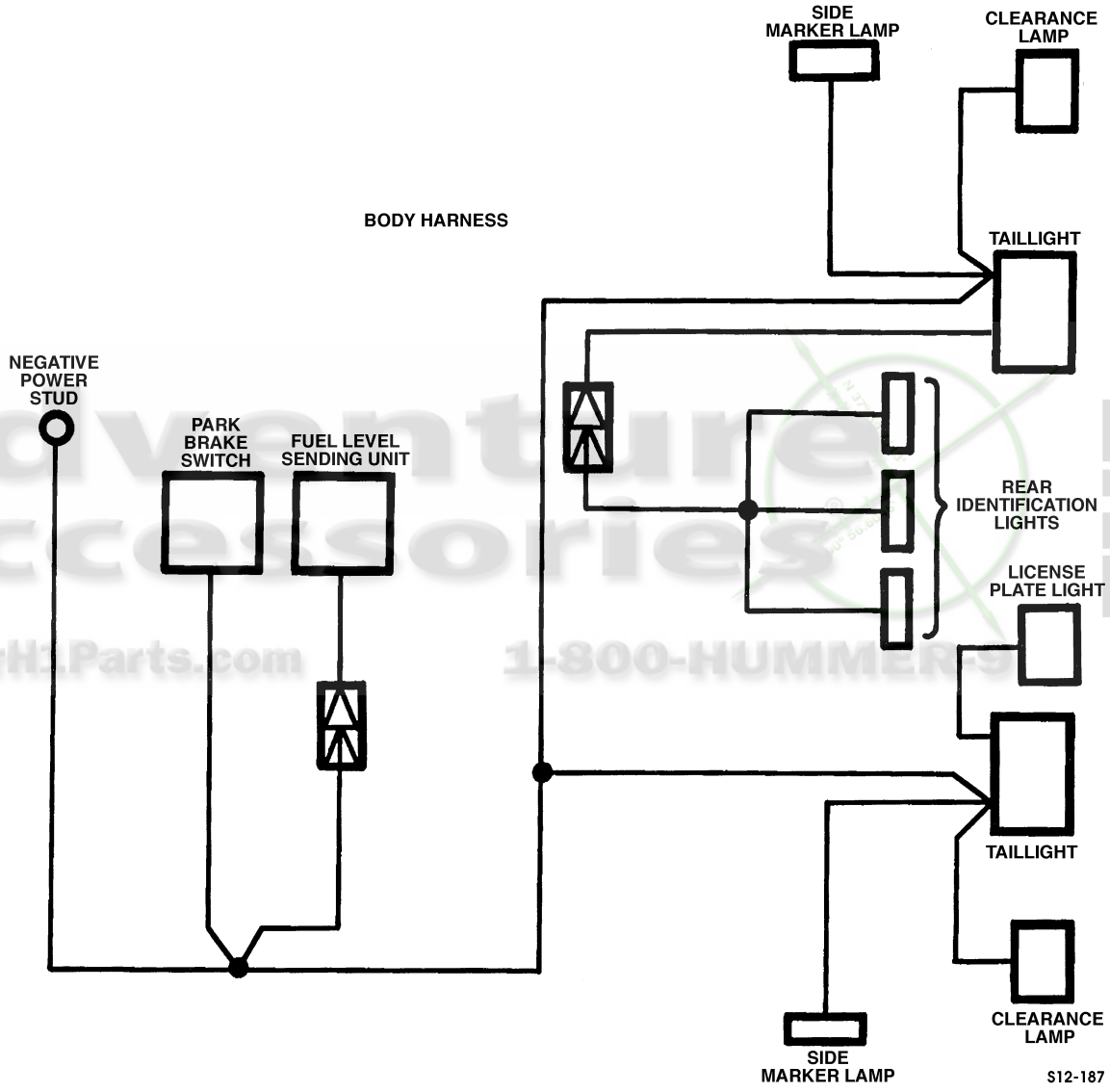


Figure 12-26: Rear Body Grounds

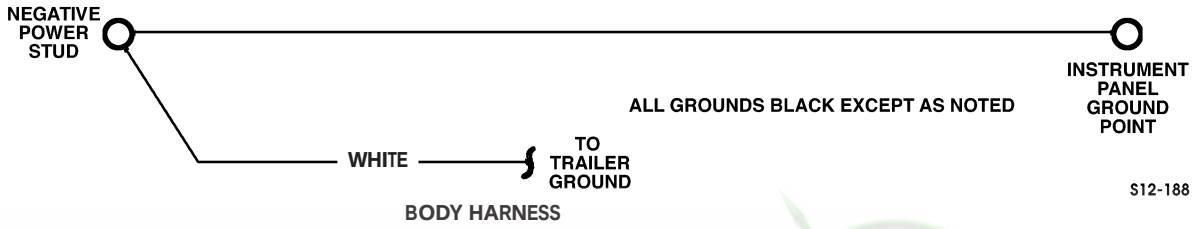
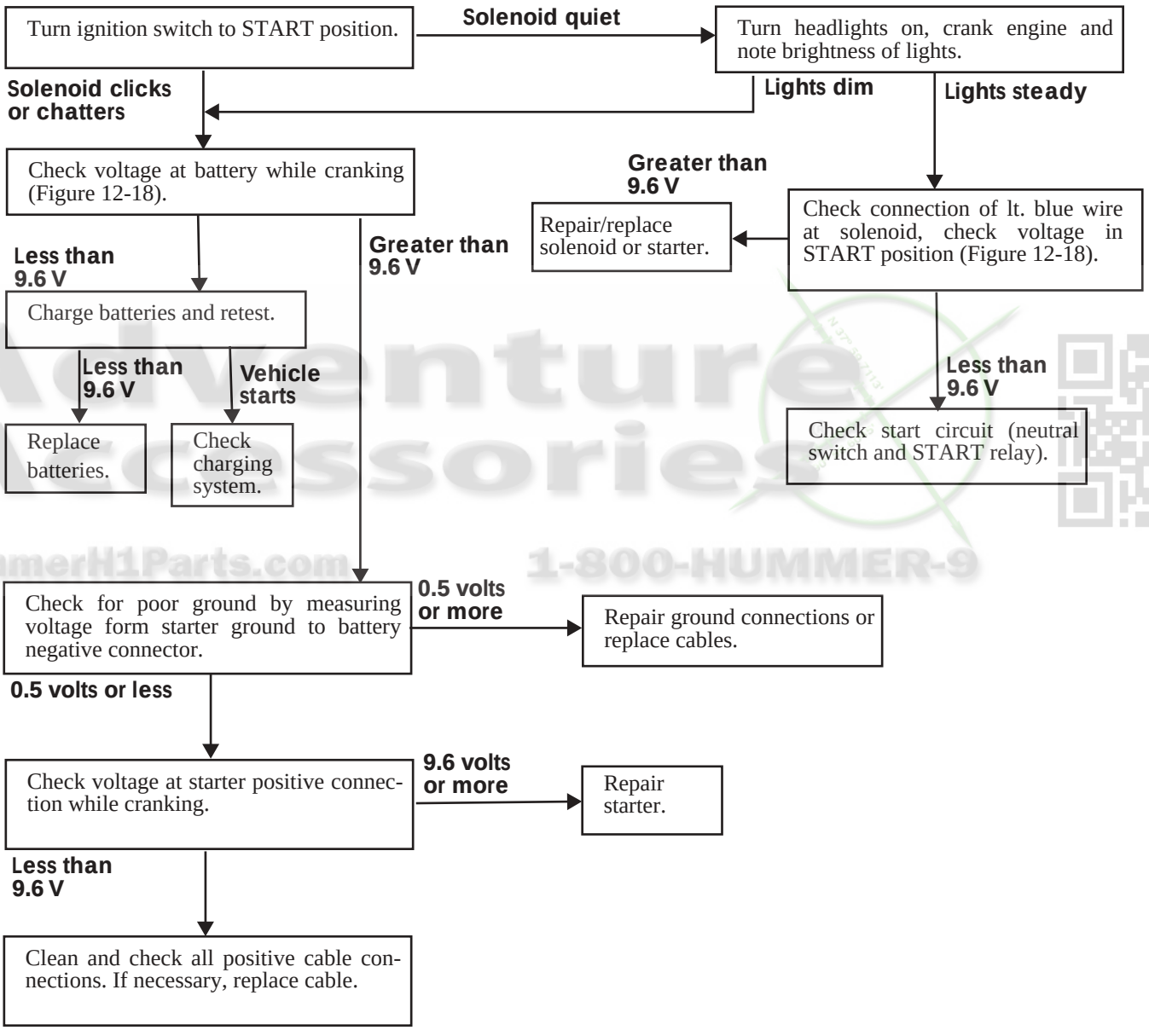


Figure 12-27: Trailer Grounds

STARTER MOTOR INOPERATIVE

The following chart will assist in diagnosing an inoperative or weak starting system.

If no-start condition is corrected, stop and ensure permanent repair is made before releasing vehicle to customer.



GLOW PLUG SYSTEM DESCRIPTION

The glow plug controller circuit operates the relay with cycling action that varies in length, based on the underhood air temperature and engine temperature sensed at its mounting bracket.

At room temperature, the glow plug system operates as follows:

4. When the ignition switch is positioned to RUN, the following things occur (Figure 12-28):
   a. The controller circuit completes the relay coil circuit, causing glow plug and indicator lamp operation for 4 to 6 seconds.
   b. Based on the temperature and feedback inputs, the controller circuit opens the relay coil circuit for 4 to 5 seconds.

NOTE: At this time, the ignition switch would normally be positioned to the crank position to start the engine.

5. If the ignition switch remains in the RUN position, the following things occur:
   a. The controller circuit completes the relay coil circuit again, causing glow plug and indicator lamp operation for 1 to 2 seconds.
   b. Based on the temperature and feedback inputs, the controller circuit opens the relay coil circuit for 4 to 5 seconds.
   c. The on/off cycling action will continue until a total cycling time of approximately 20 seconds has elapsed.
6. If the ignition switch is positioned to crank during or after the previous cycling sequence, the following things occur (Figure 12-29):
   a. The controller circuit completes the relay coil circuit again, causing glow plug and indicator lamp operation for 1 to 2 seconds.
   b. Based on the temperature and feedback inputs, the controller circuit opens the relay coil circuit for 4 to 5 seconds.
   c. The on/off cycling action will continue until the total cycling time after the ignition switch has returned to the RUN position is approximately 20 seconds.

NOTE: The maximum length of glow plug cycling does not depend on whether or not the engine runs after cranking.

Glow plug system cycling times are approximate, because temperature and feedback voltage inputs vary. As a rule, colder ambient starting temperatures result in longer initial ON times and total duration of cycling.

A controller/relay that applies power to the glow plugs for longer than five seconds may cause damage to the glow plugs. If all eight glow plugs are replaced because of open circuit faults, the controller/relay should also be replaced.

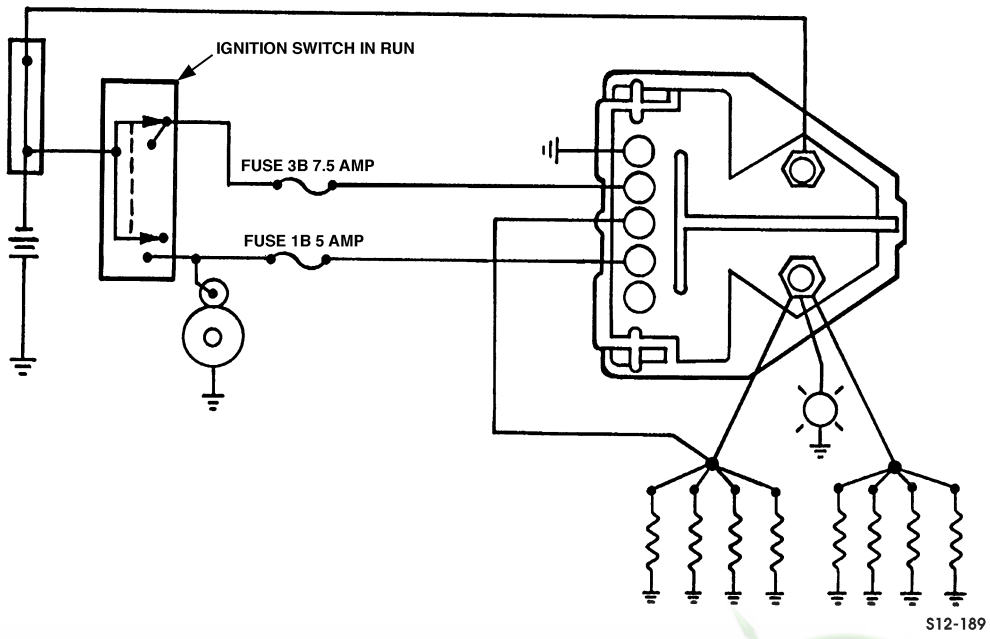


Figure 12-28: Glow Plug System Cycling – Before Cranking

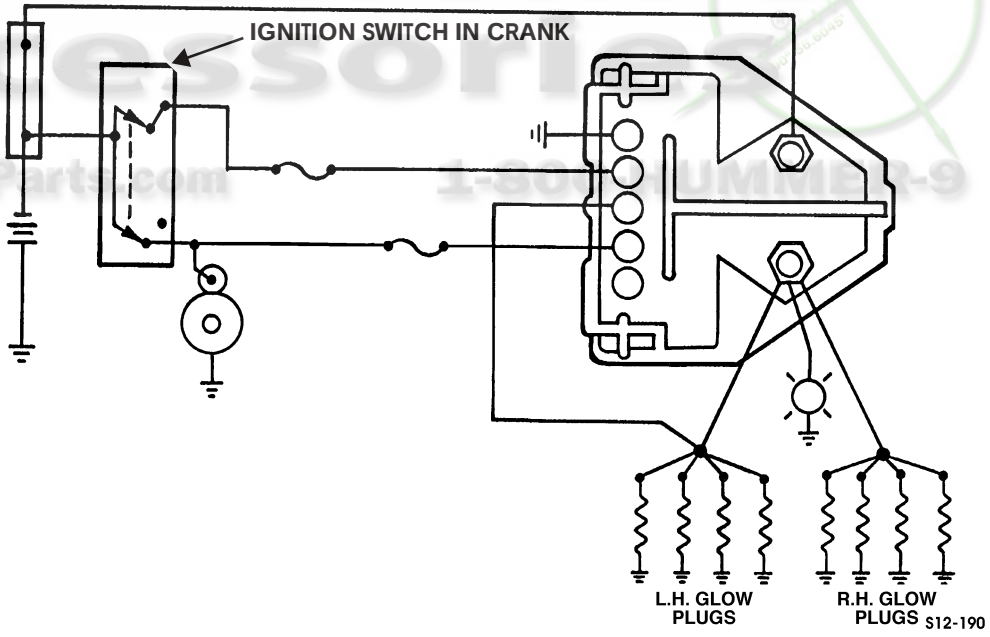
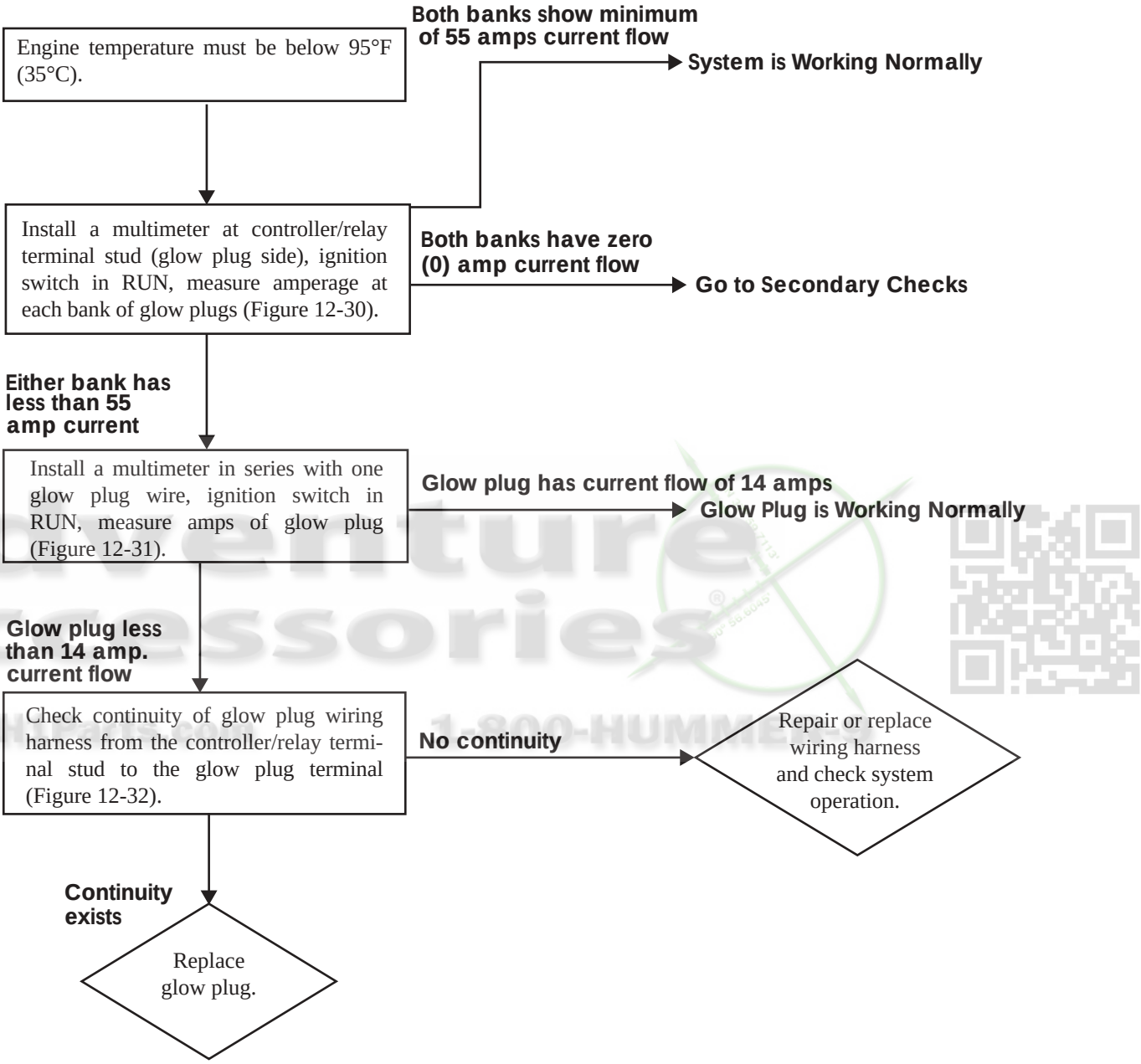


Figure 12-29: Glow Plug System Cycling – After Cranking

GLOW PLUG SYSTEM PRIMARY CHECKS



Use an AC-type 9G glow plug. Repeat checks for all glow plugs.

When all plugs have 14 amps of current flow, end the diagnosis.

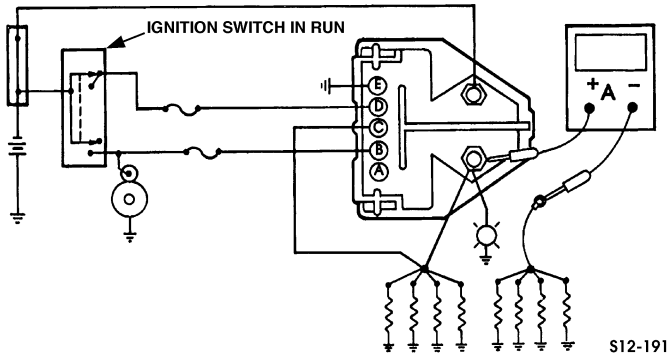


Figure 12-30: Ignition Switch in RUN

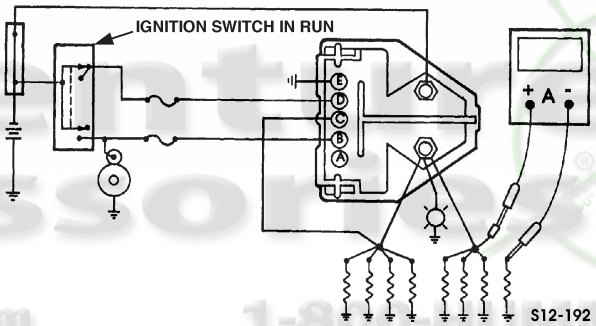


Figure 12-31: Ignition Switch in RUN

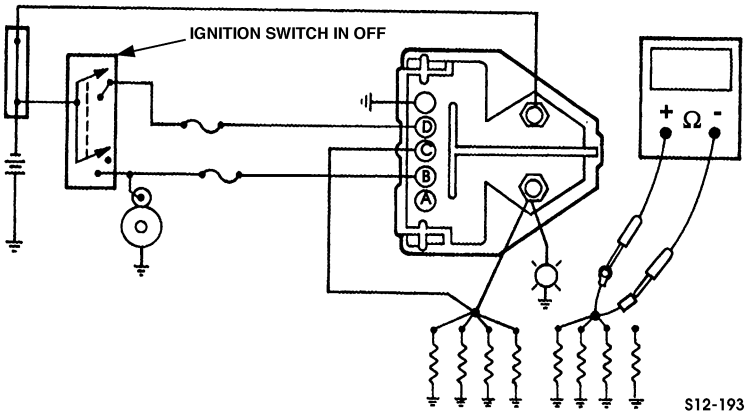


Figure 12-32: Ignition Switch in OFF

GLOW PLUG SYSTEM SECONDARY CHECKS

Prepare for test. Check the following items:

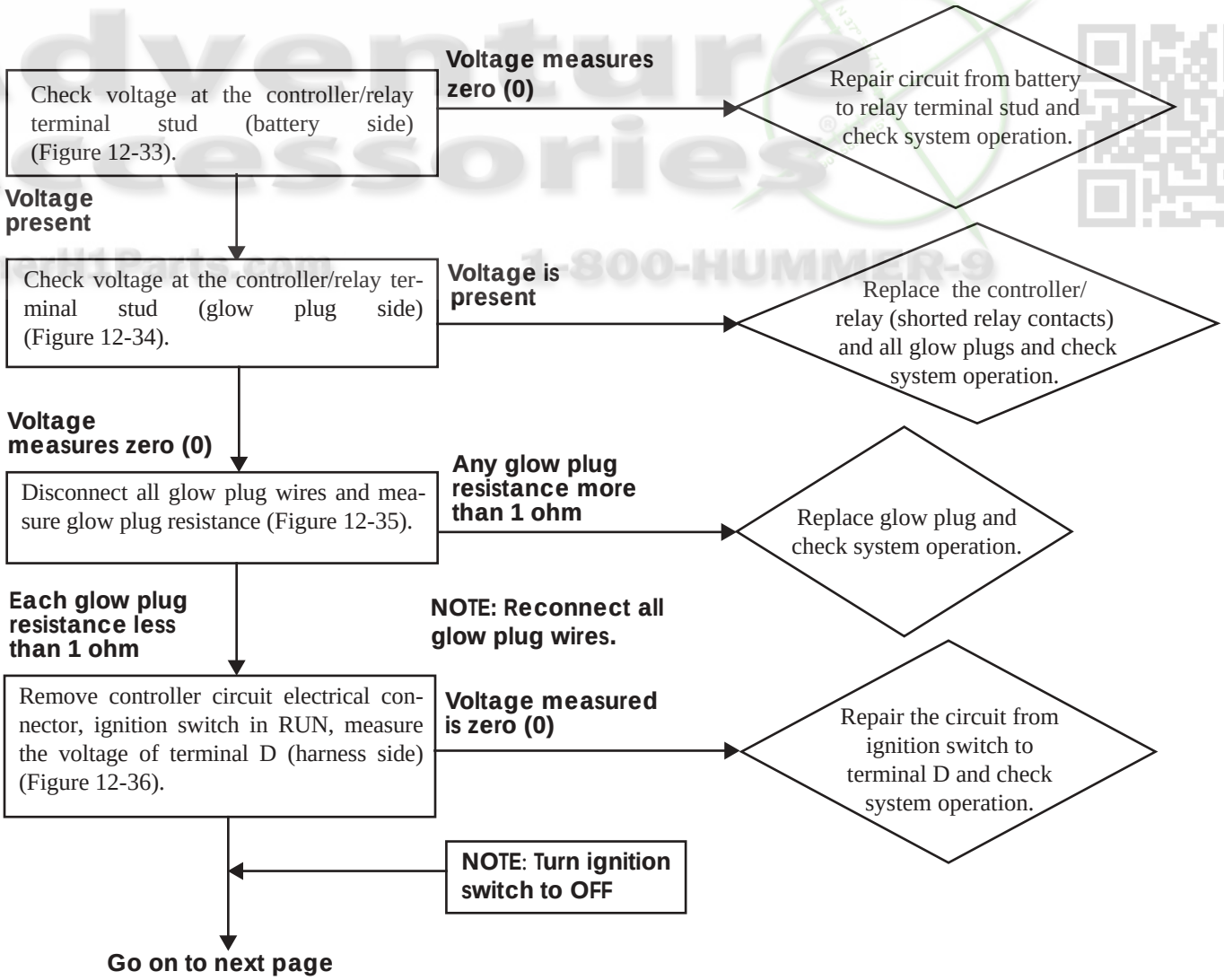
Fuel system must check OK.

Cranking/charging system (battery must have 12.3 volts minimum).

Cranking speed must be at 100 rpm minimum.

While performing the Glow Plug System Check it may be necessary to refer to the following chart:

Terminal	Circuit	Electrical Check
A	None	
B	Crank Input	Battery voltage while cranking
C	Feedback Input	Continuity (less than 1 ohm)
D	Power Supply	Battery voltage in RUN
E	Power Ground	Continuity (less than 1 ohm)



GLOW PLUG SYSTEM SECONDARY CHECKS – CONTINUED

Reconnect the controller circuit electrical connector.

Battery voltage measured

With controller circuit electrical connector removed, measure the resistance between terminal E (harness side) and the cylinder case (Figure 12-37).

Resistance measures more than 1 ohm → Repair the circuit from terminal E and the vehicle ground and check system operation.

Resistance less than 1 ohm

Connector still removed, measure resistance between terminals C and E (harness side) (Figure 12-38).

Resistance measures more than 2 ohms → Repair circuit from the glow plug wiring harness to terminal C and check system operation.

Resistance less than 2 ohms

Ignition switch in RUN, measure voltage at the controller/relay terminal stud (glow plug side) (Figure 12-39).

Voltage measures zero (0) → Replace glow plug controller/relay and check system operation.

Voltage measures battery voltage

Ignition switch in RUN, measure voltage at any glow plug on each cylinder bank (Figure 12-40).

Voltage measures zero (0) → Repair circuit between controller/relay and glow plugs and check system operation.

Voltage measures battery voltage

Note glow plugs lamp operation (Figure 12-41).

Lamp does not cycle on and off when controller/relay cycles → Repair lamp circuit and check system operation.

Lamp cycles on and off

End the diagnosis.

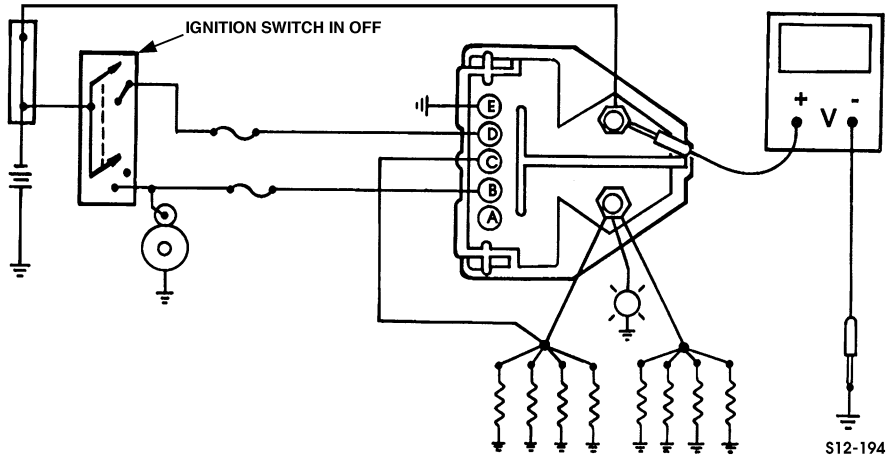


Figure 12-33: Ignition Switch in OFF

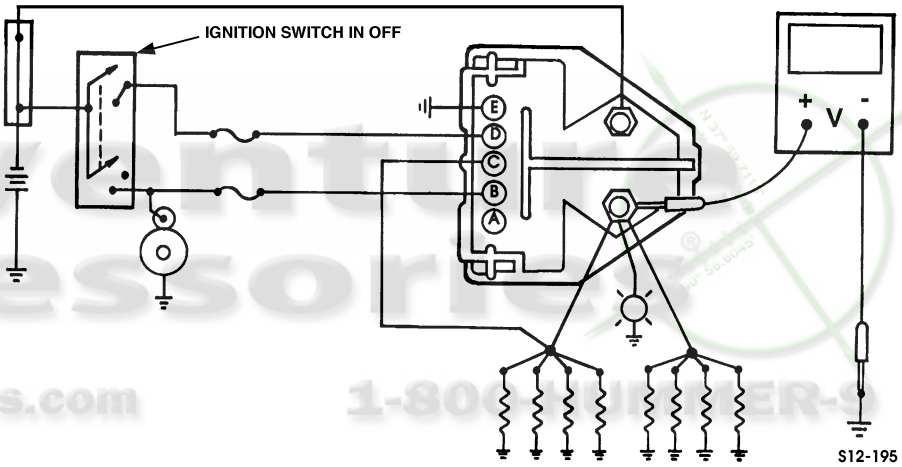


Figure 12-34: Ignition Switch in OFF

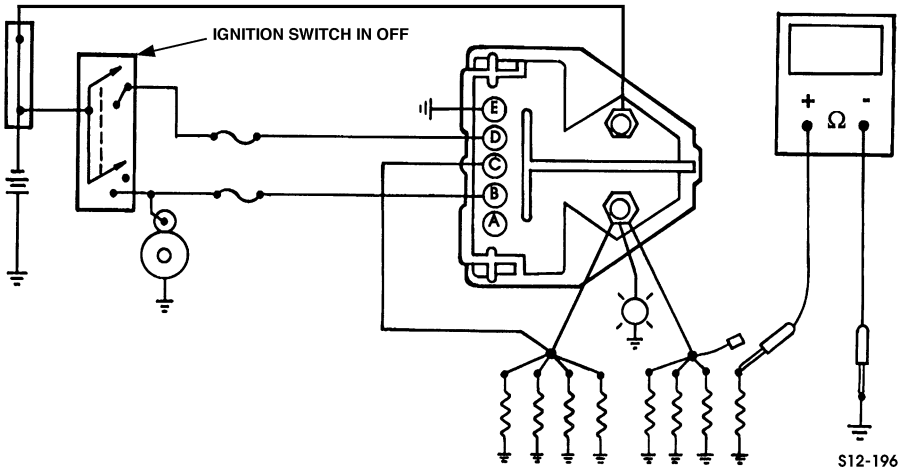


Figure 12-35: Ignition Switch in OFF

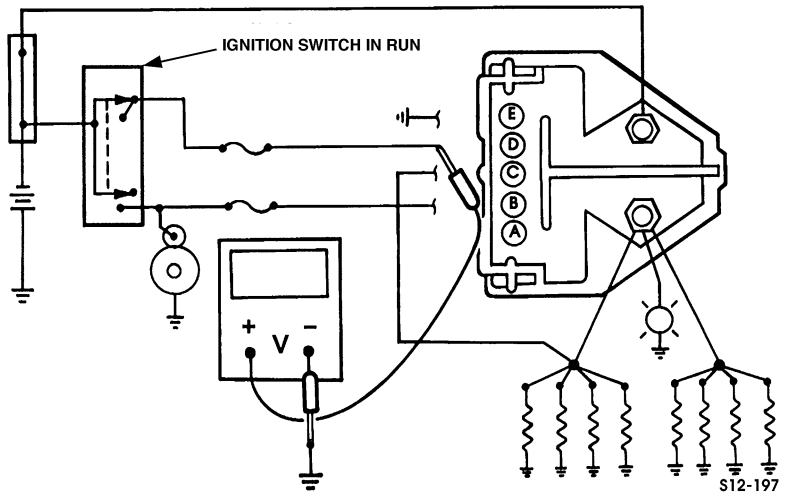


Figure 12-36: Ignition Switch in RUN

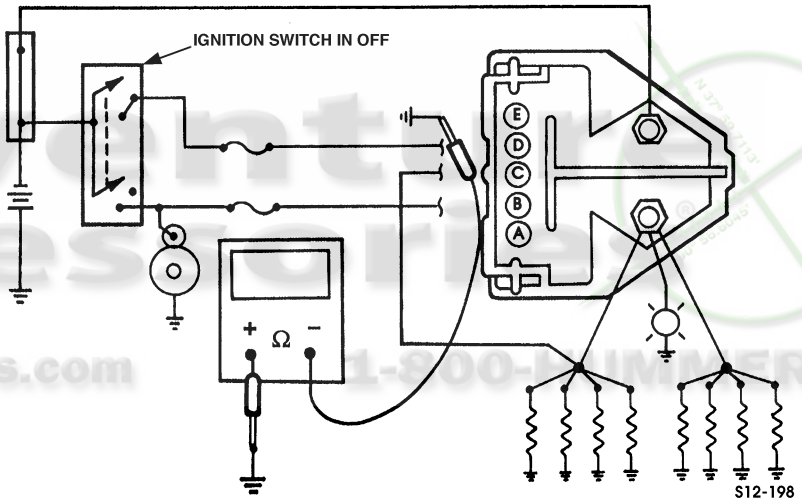


Figure 12-37: Ignition Switch in OFF

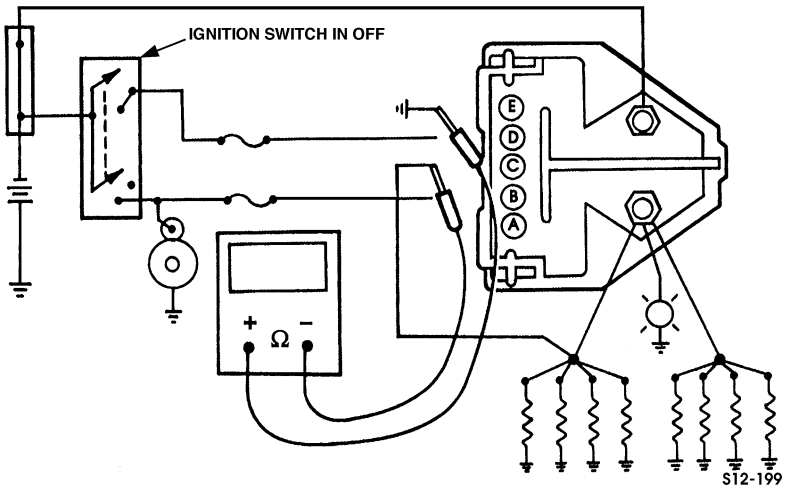


Figure 12-38: Ignition Switch in OFF

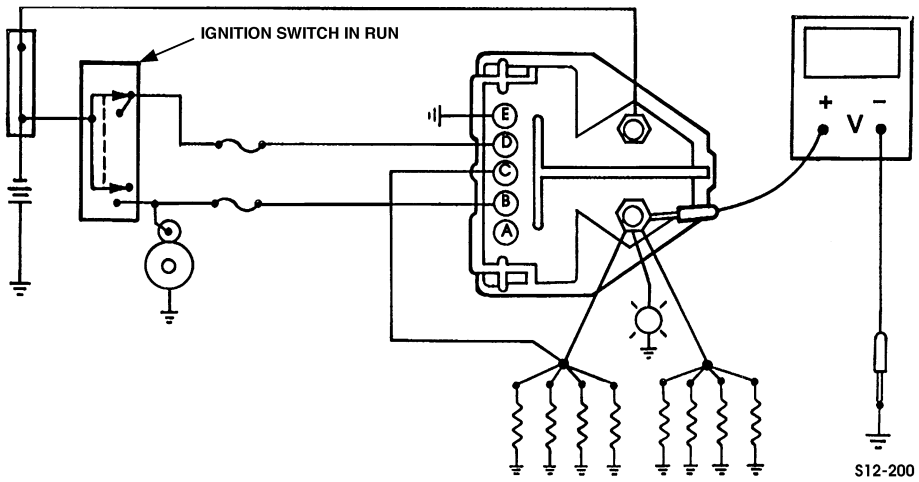


Figure 12-39: Ignition Switch In RUN

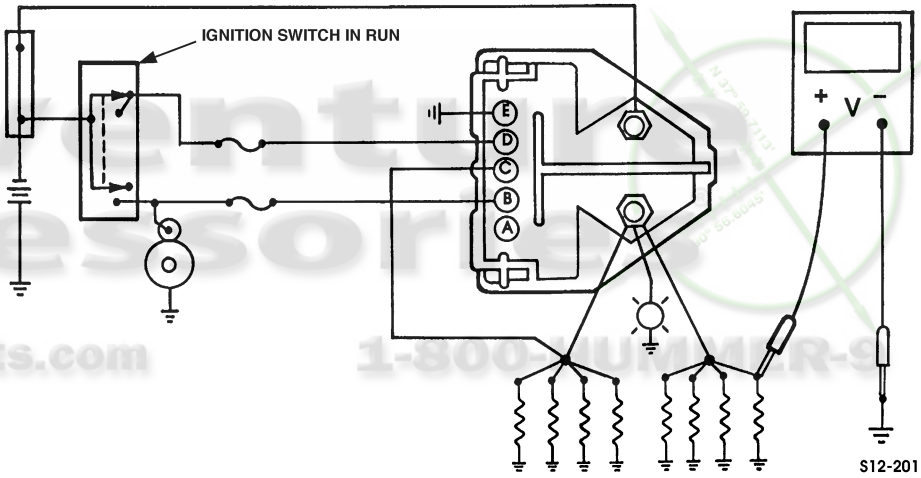


Figure 12-40: Ignition Switch In RUN

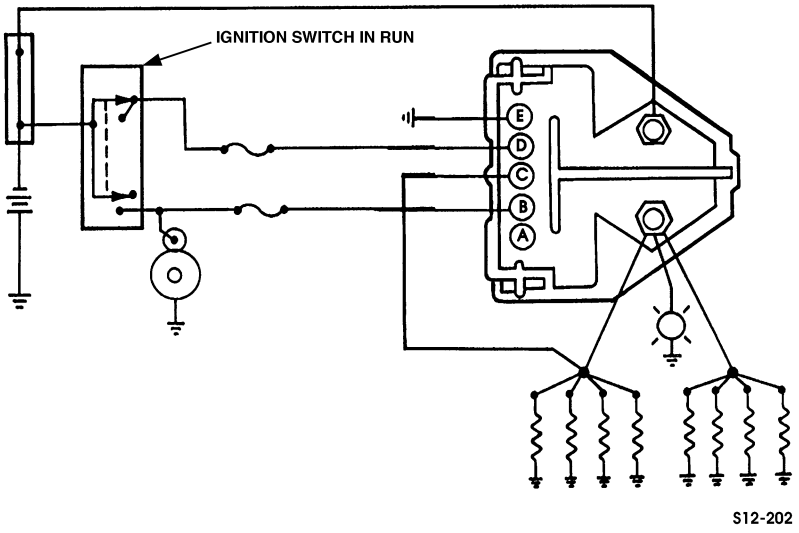


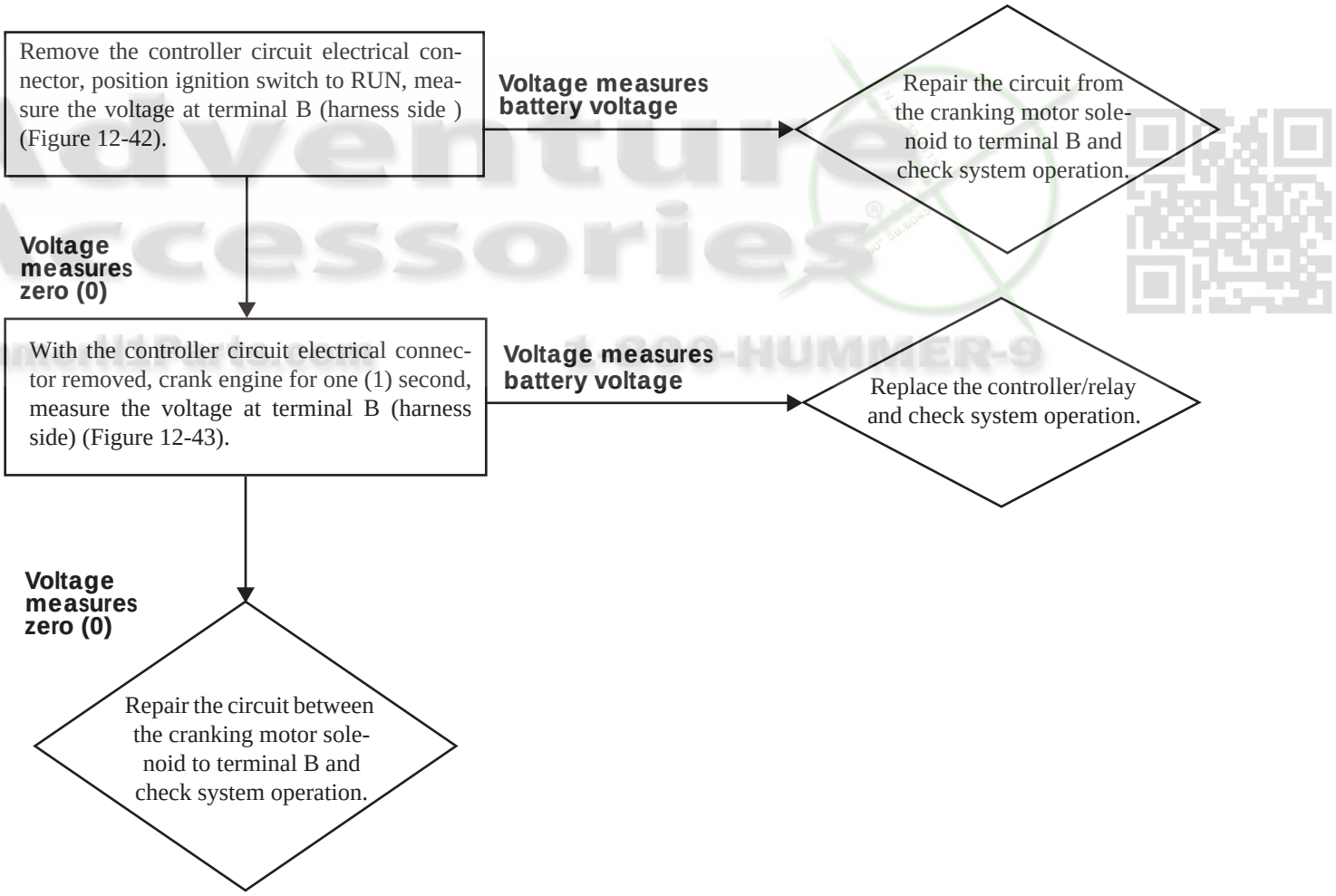
Figure 12-41: Ignition Switch In RUN

GLOW PLUG AFTERSTART CHECK

NOTE: Follow this procedure to diagnose the cause of excessive white smoke and/or poor idle quality after start.

- Begin the test with the engine at 80°F (27°C).
- Turn ignition switch to RUN and allow plug system to cycle for 2 minutes.
- Start the engine and observe that the glow plug system continues to cycle at least one after cranking (indicated by fluctuation in voltmeter).

If the glow plug system does not cycle, stop the engine.



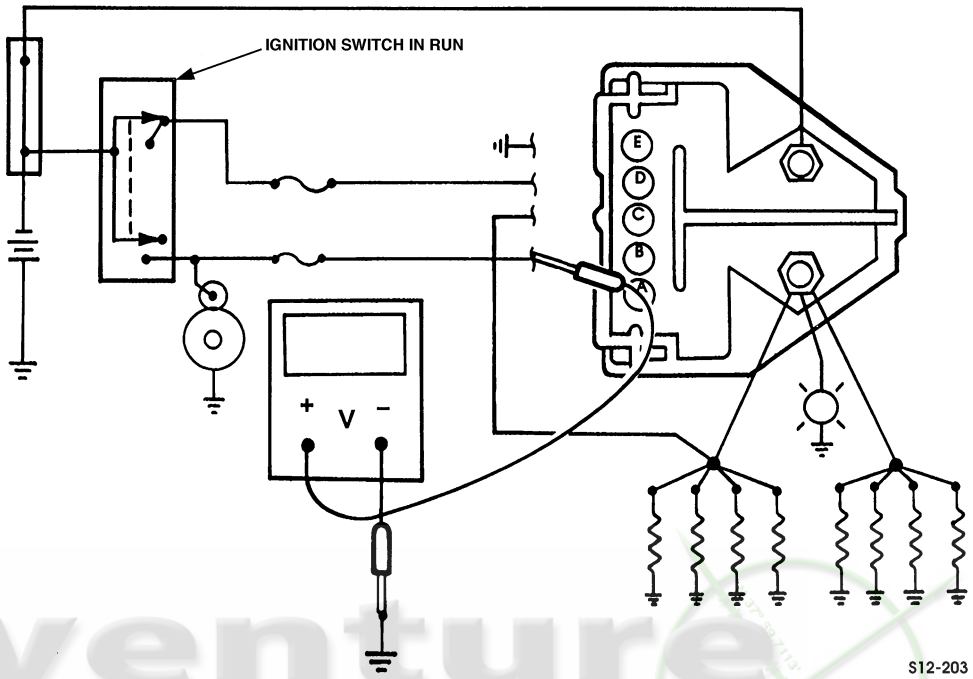


Figure 12-42: Ignition Switch in RUN

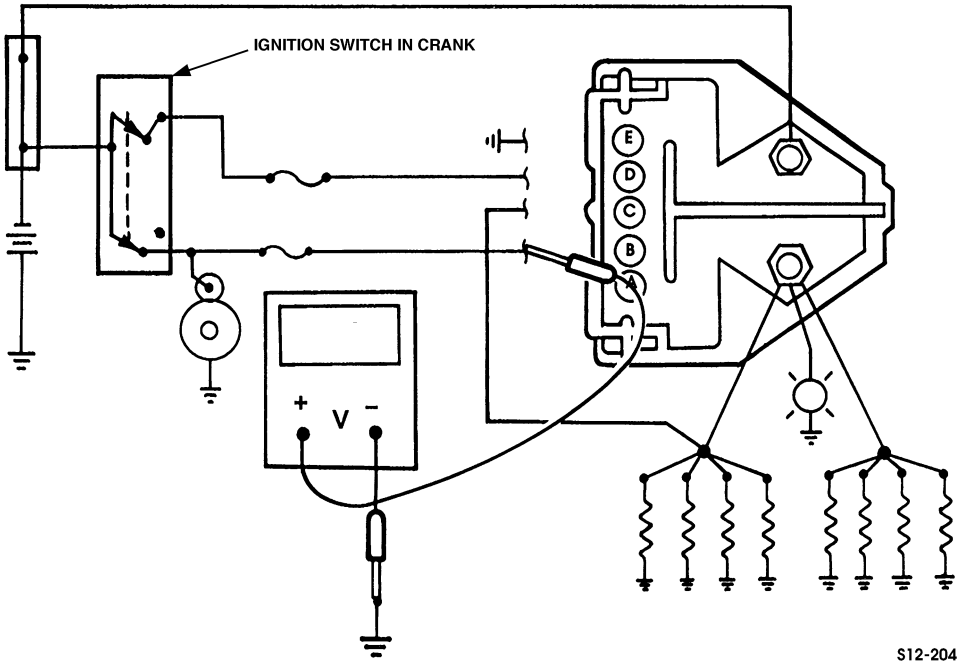


Figure 12-43: Ignition Switch in CRANK

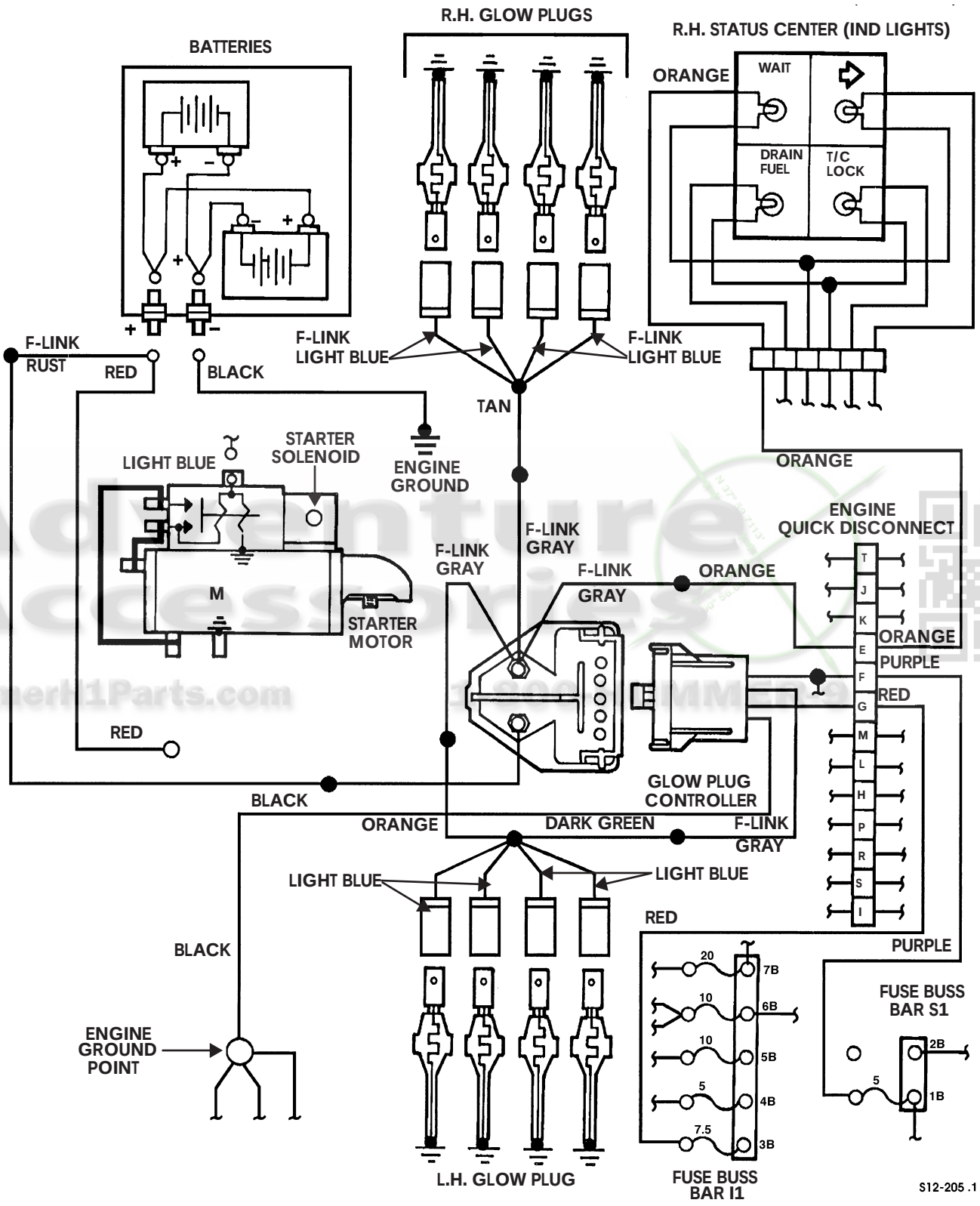
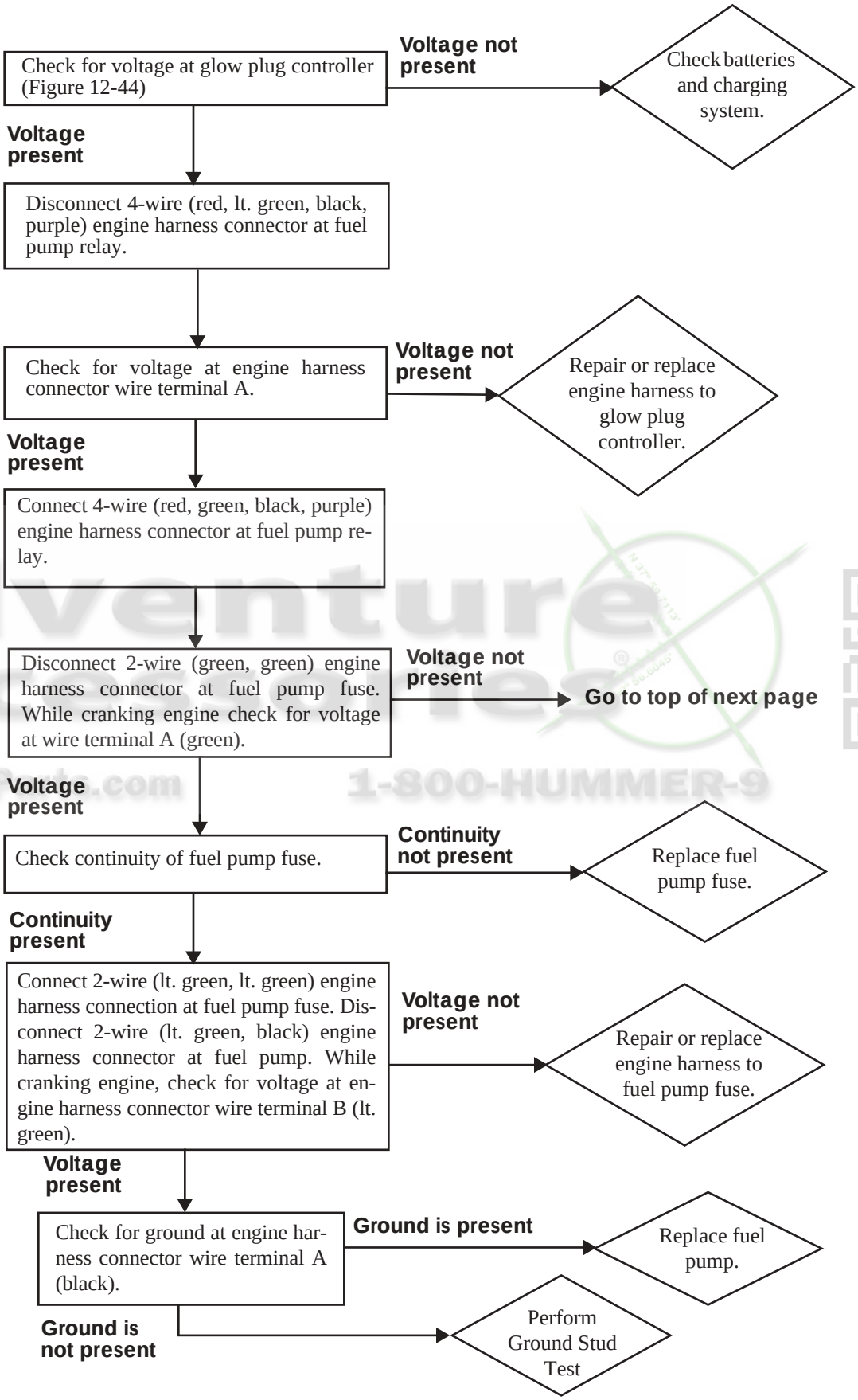
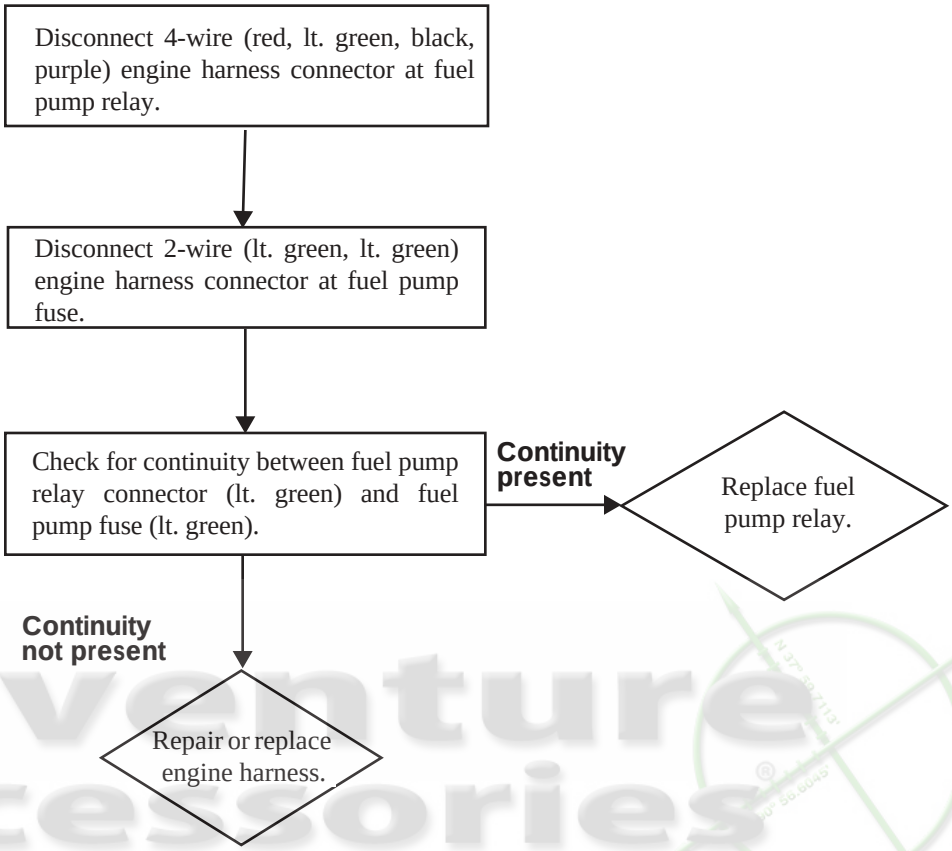


Figure 12-44: Glow Plugs

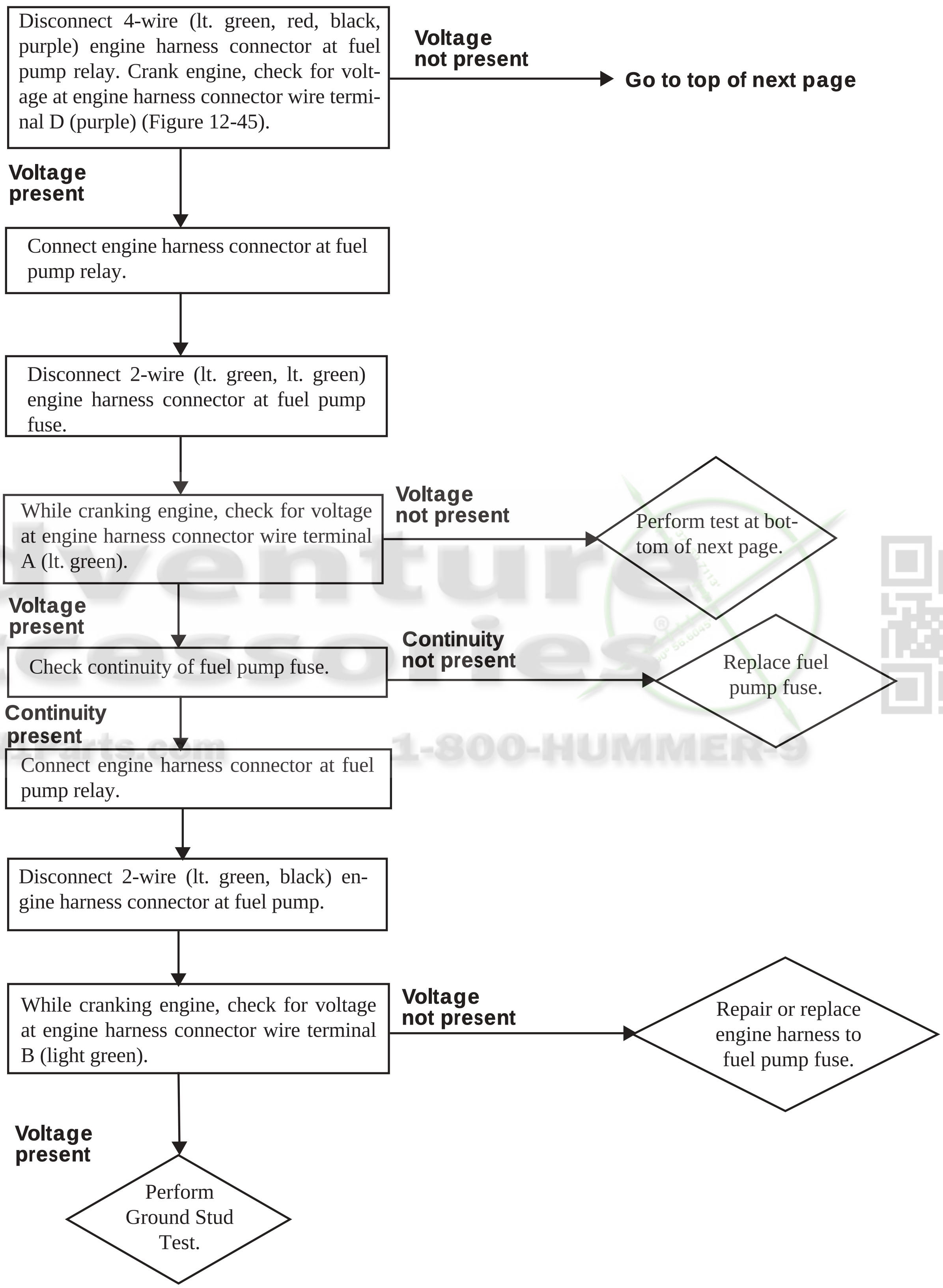
FUEL PUMP INOPERATIVE (ENGINE FAILS TO START)



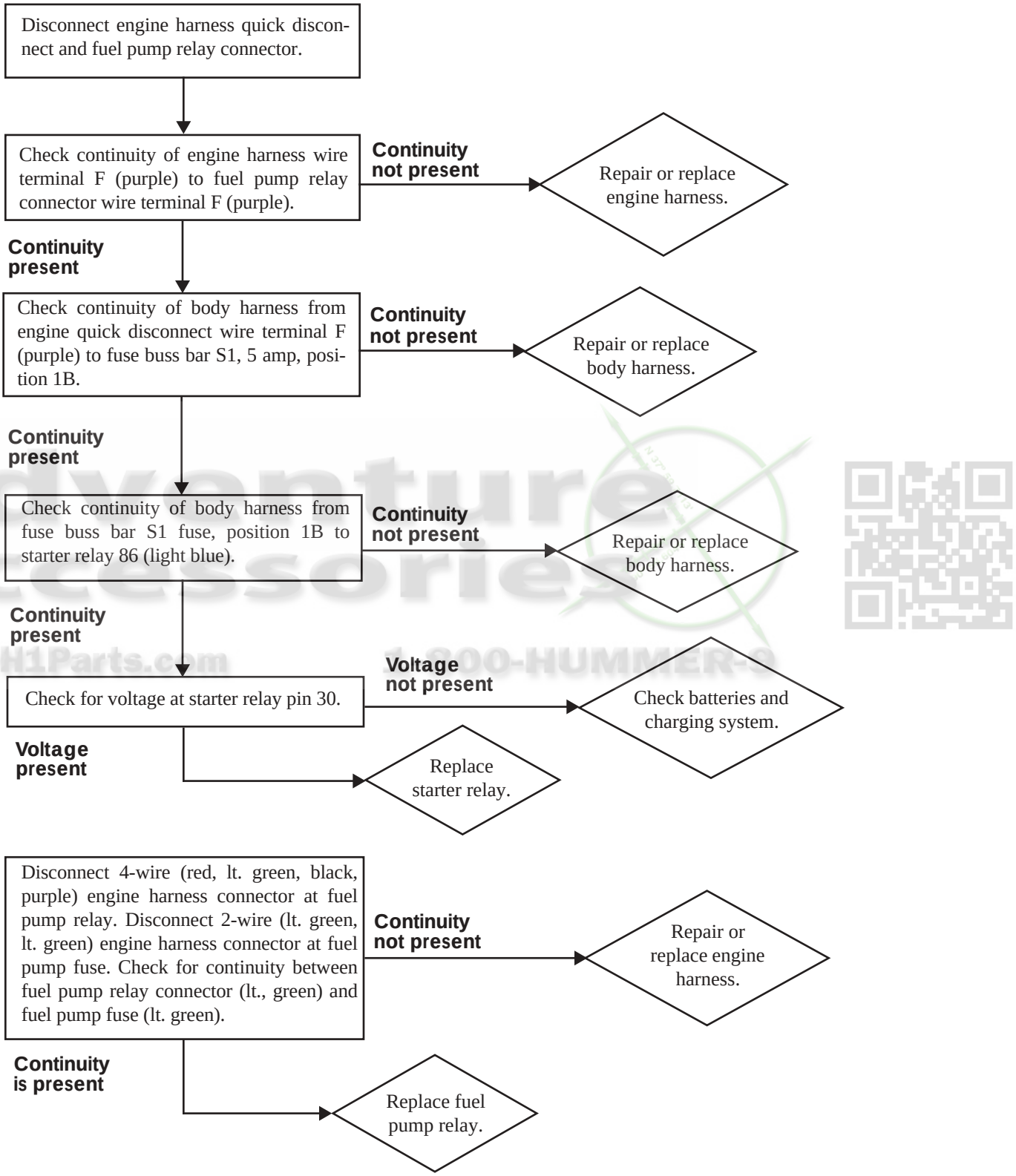
FUEL PUMP INOPERATIVE – CONTINUED



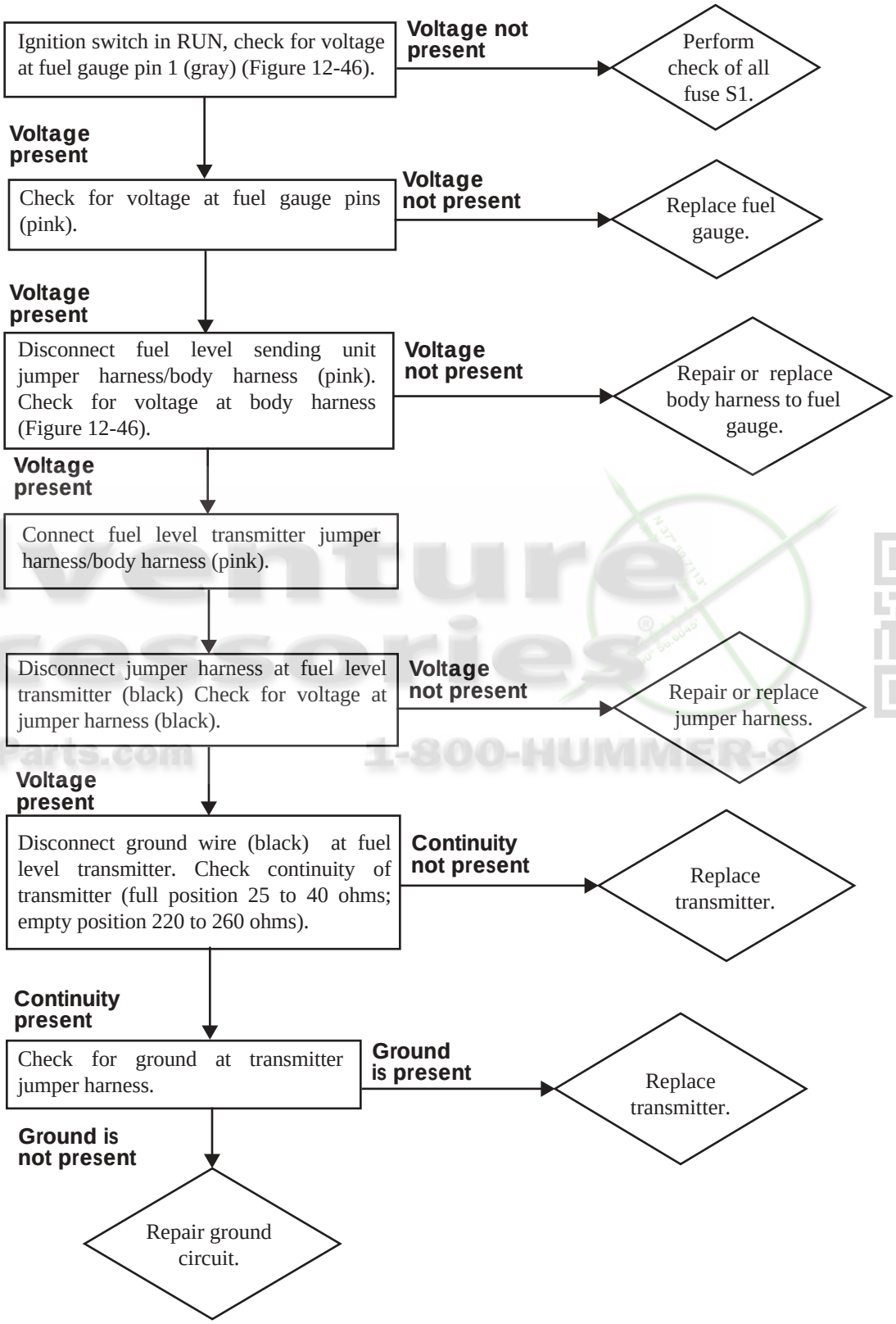
FUEL PUMP INOPERATIVE (ENGINE STALLS)



FUEL PUMP INOPERATIVE — CONTINUED



FUEL TANK SENDING UNIT INOPERATIVE



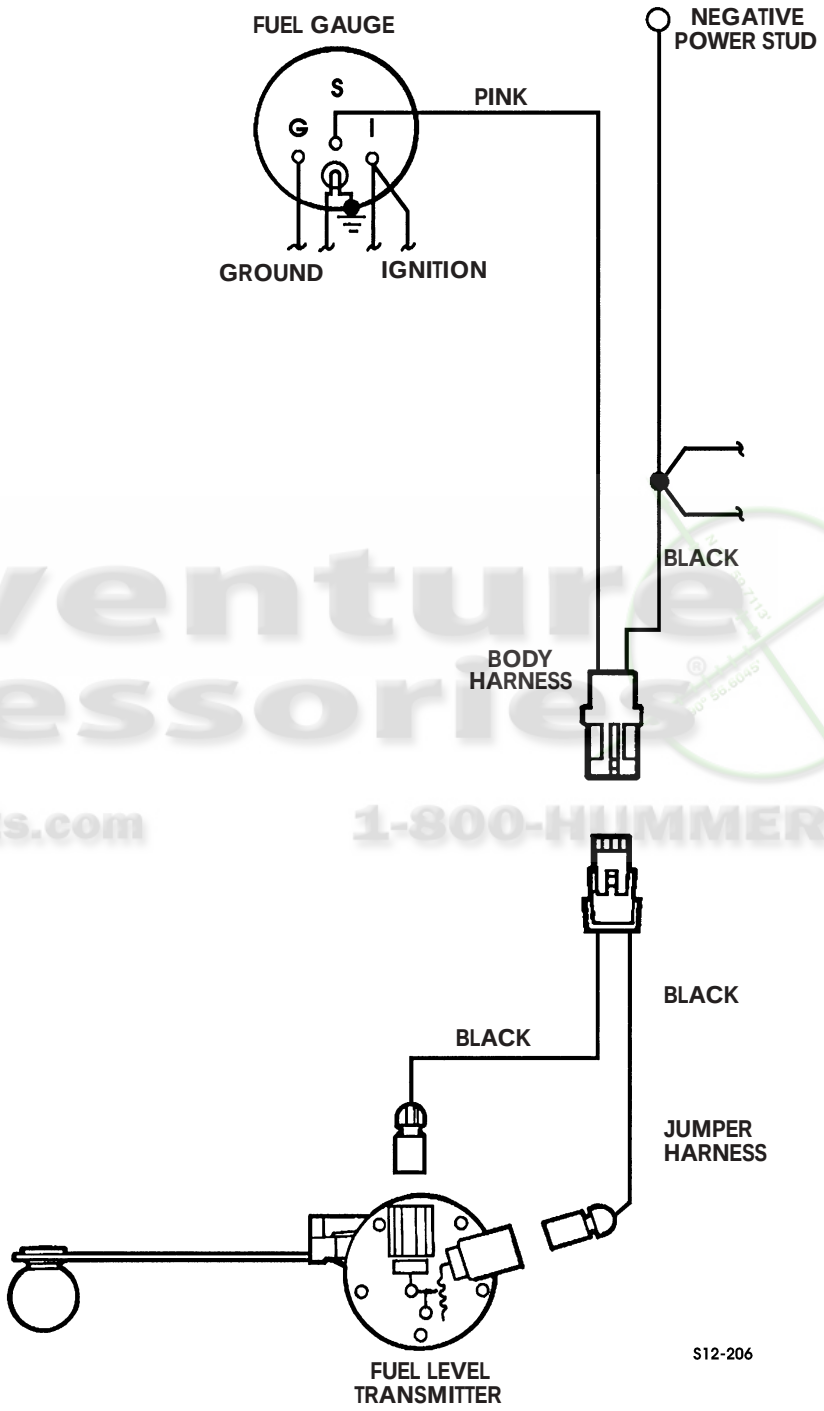


Figure 12-45: Fuel System (Sheet 1 of 2)

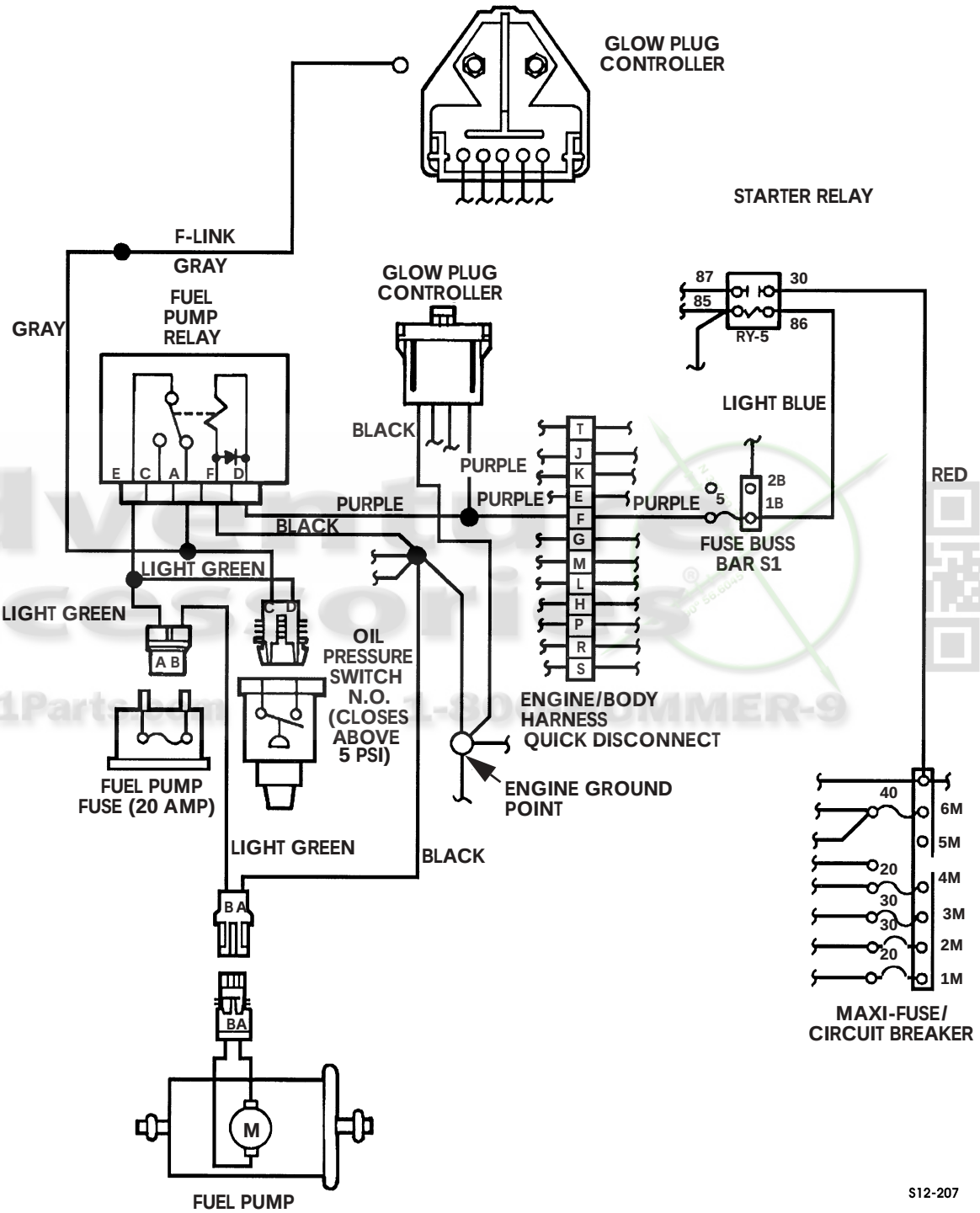
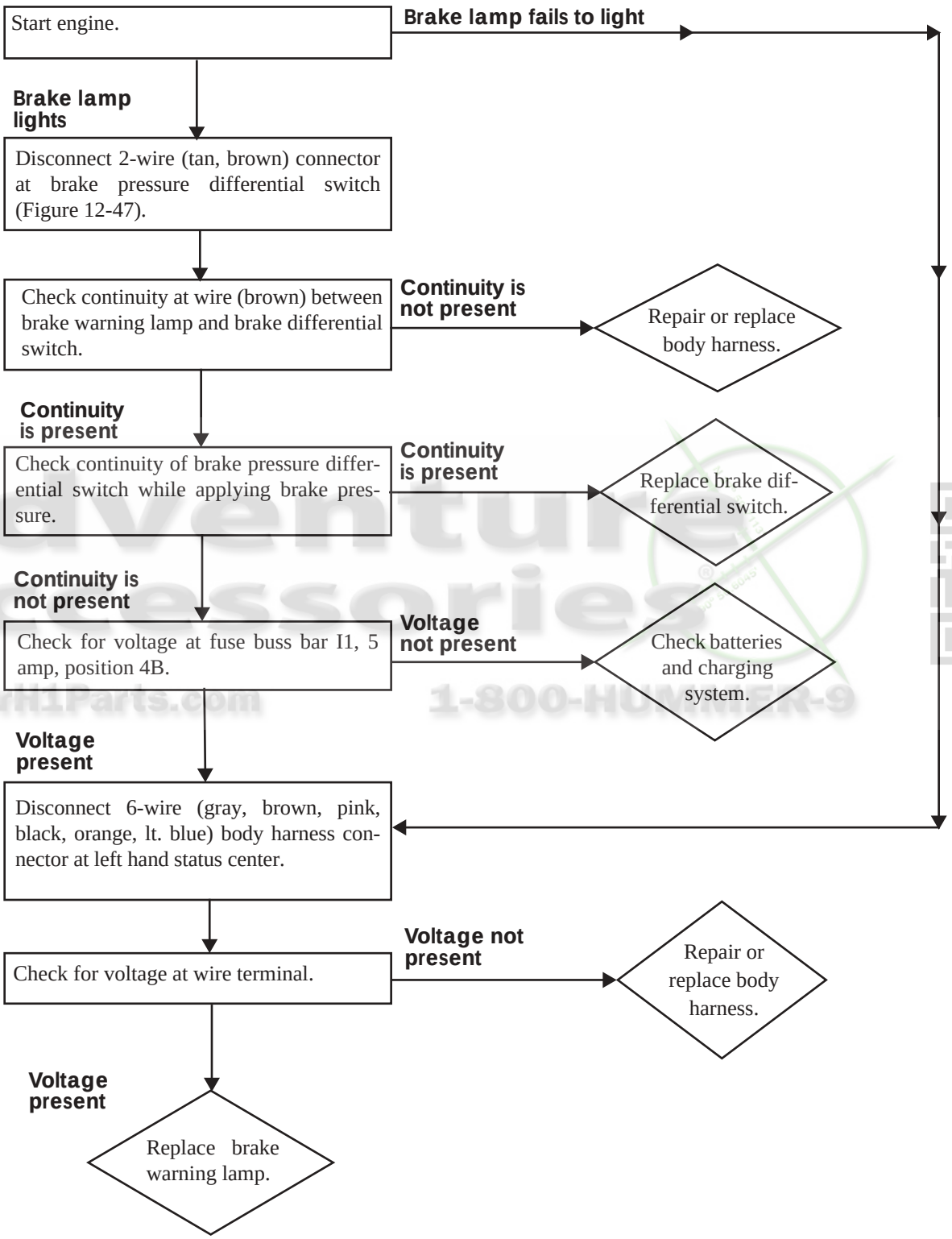
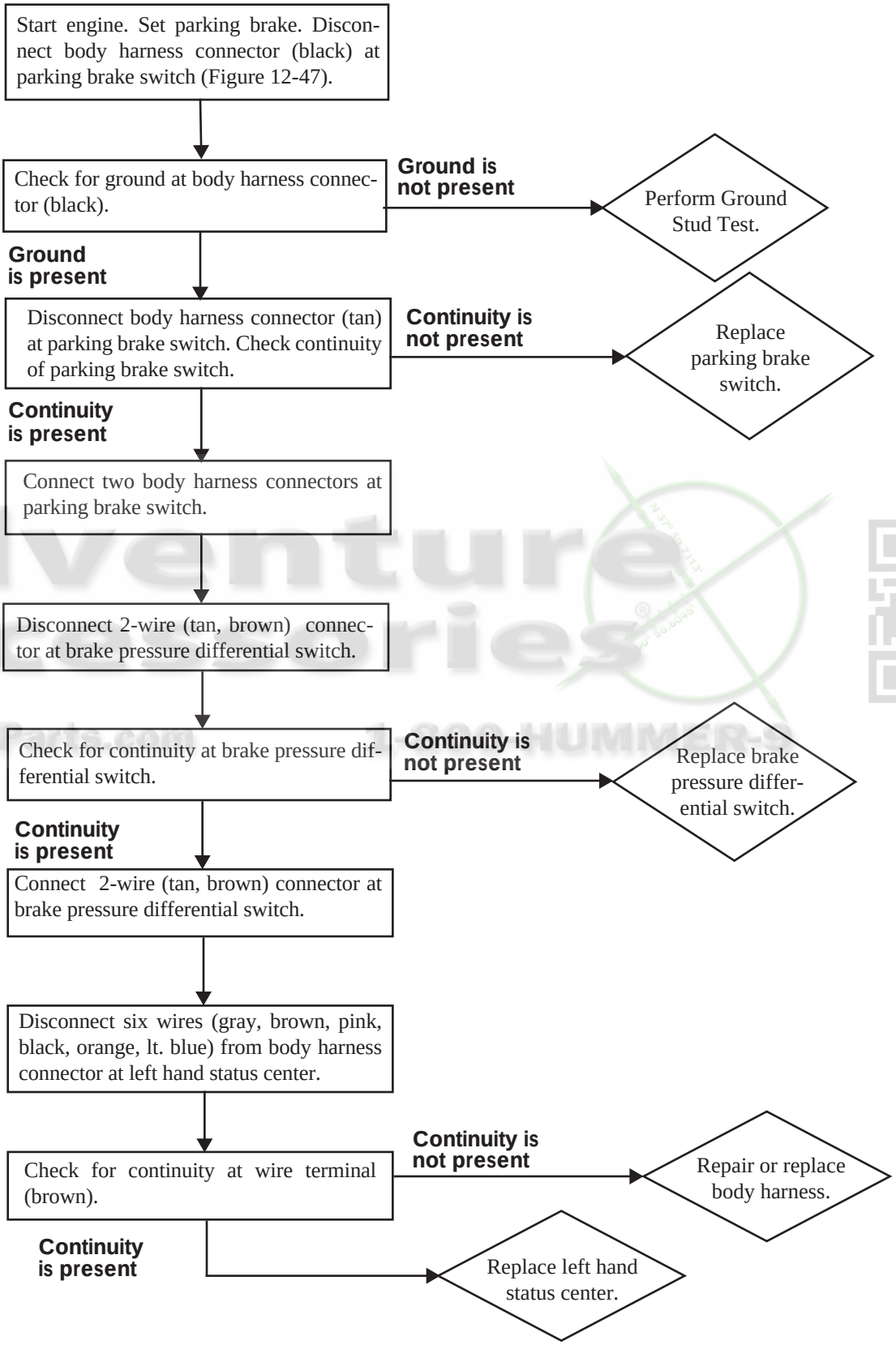


Figure 12-46: Fuel System (Sheet 2 of 2)

BRAKE PRESSURE DIFFERENTIAL SWITCH INOPERATIVE



PARKING BRAKE LIGHT FAILS TO LIGHT



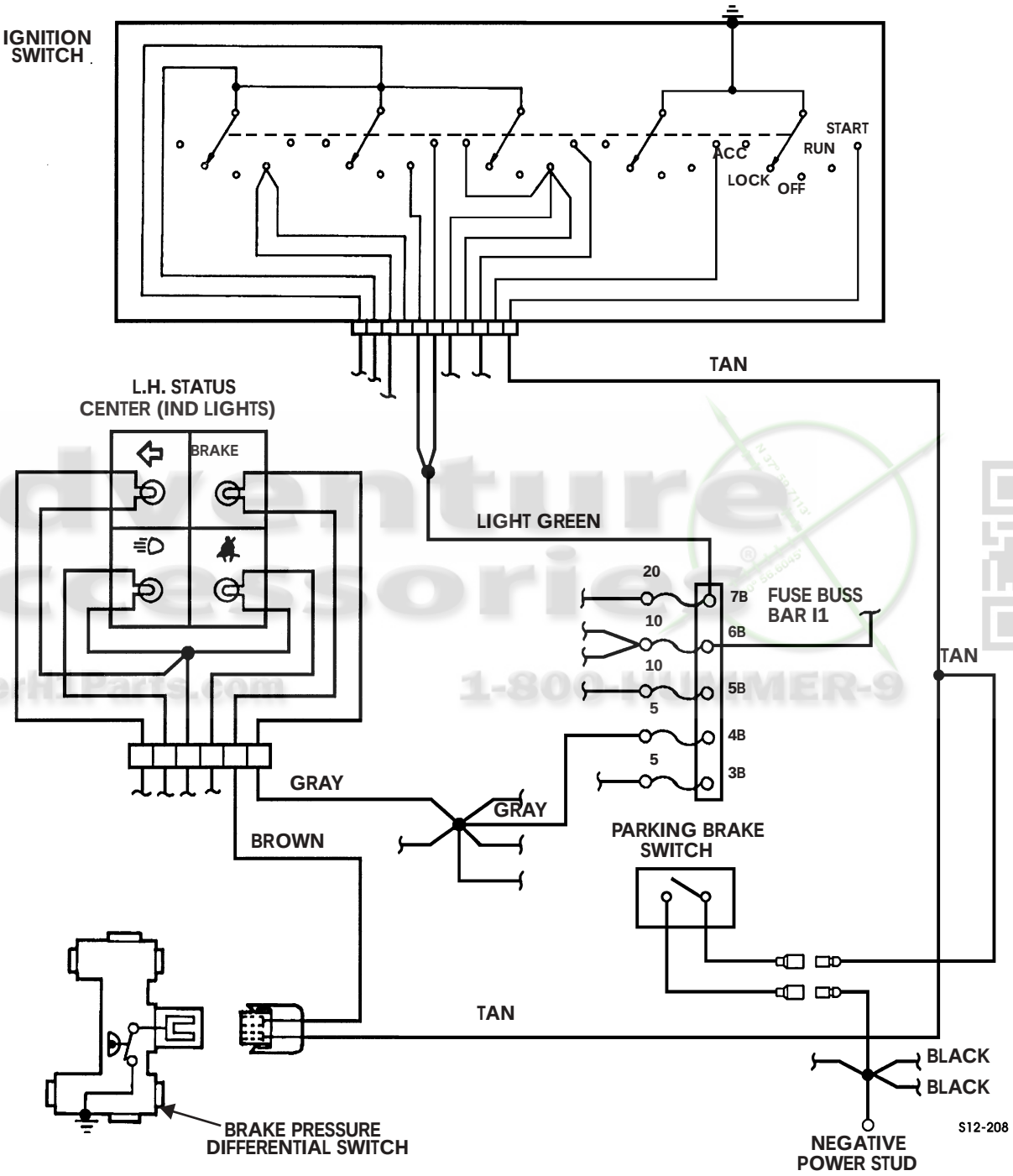
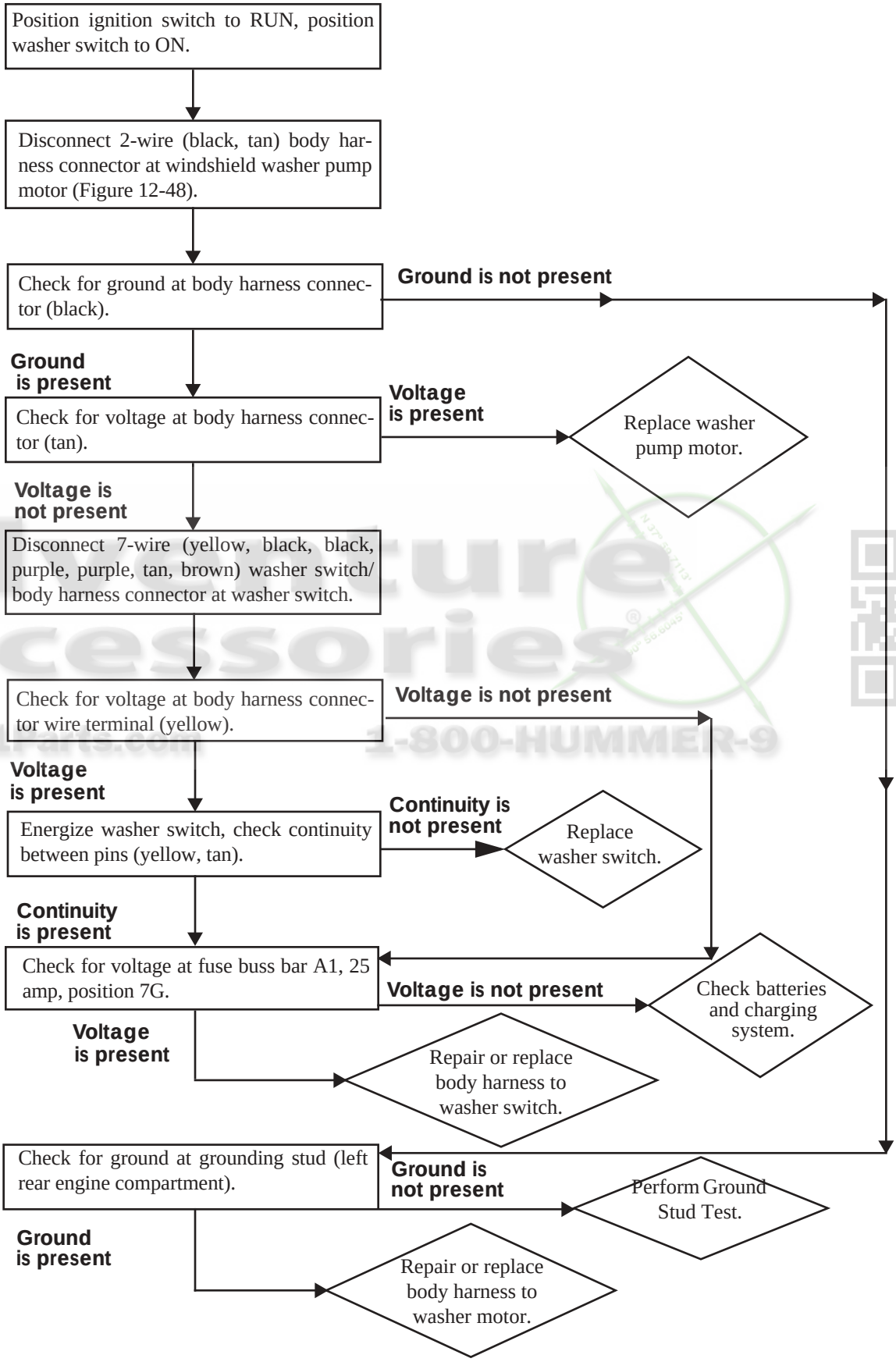
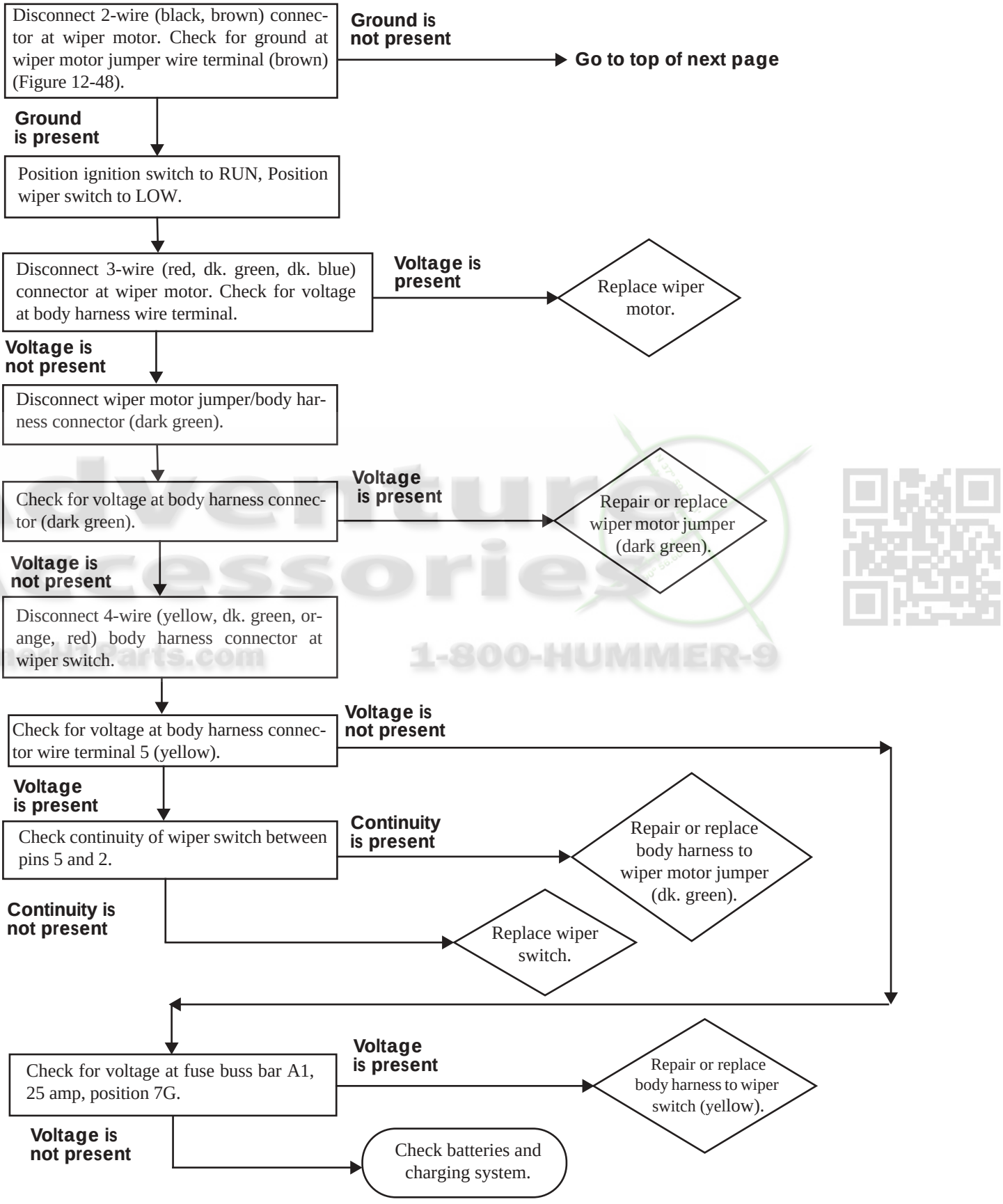


Figure 12-47: Brake System

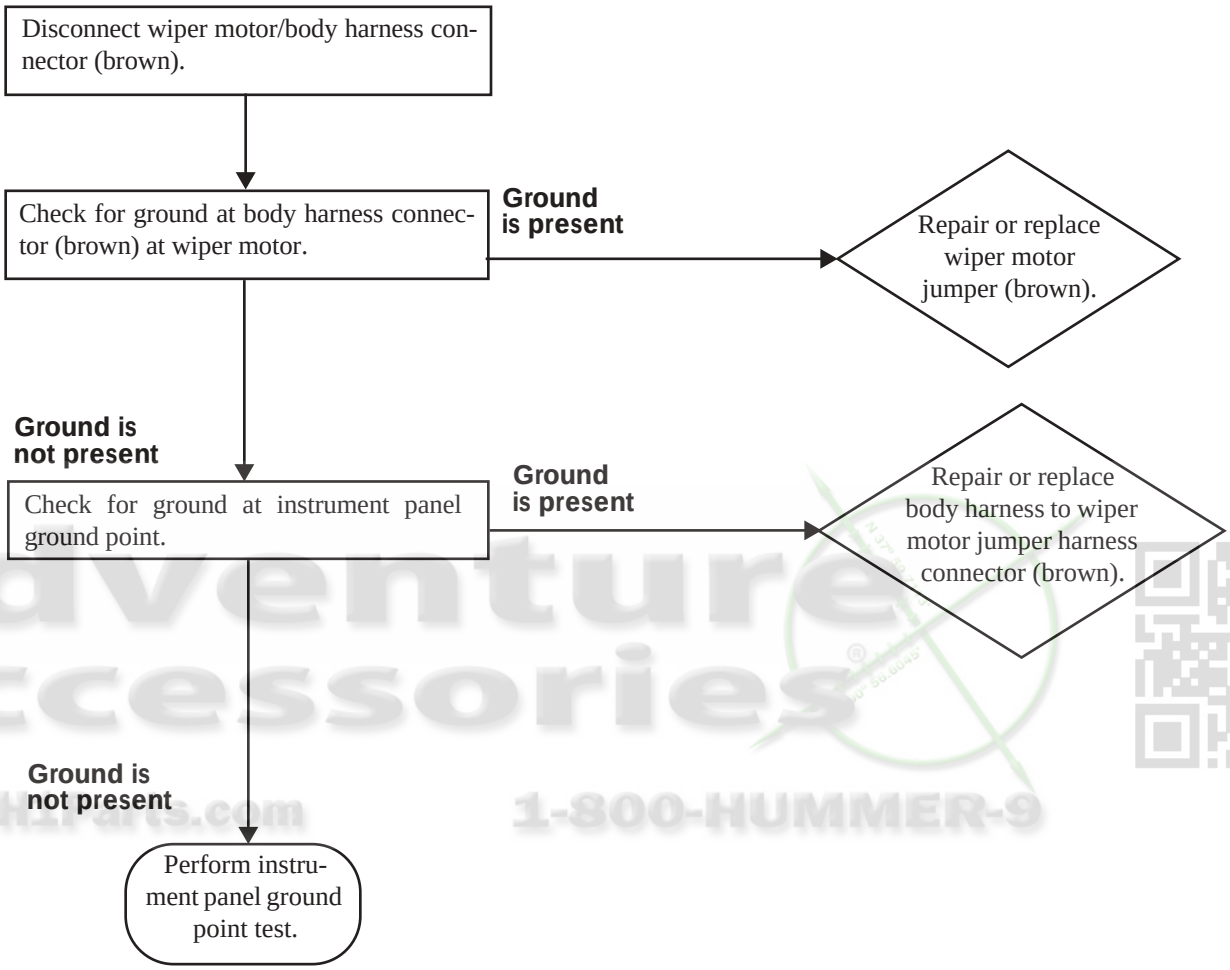
WINDSHIELD WASHER PUMP MOTOR INOPERATIVE



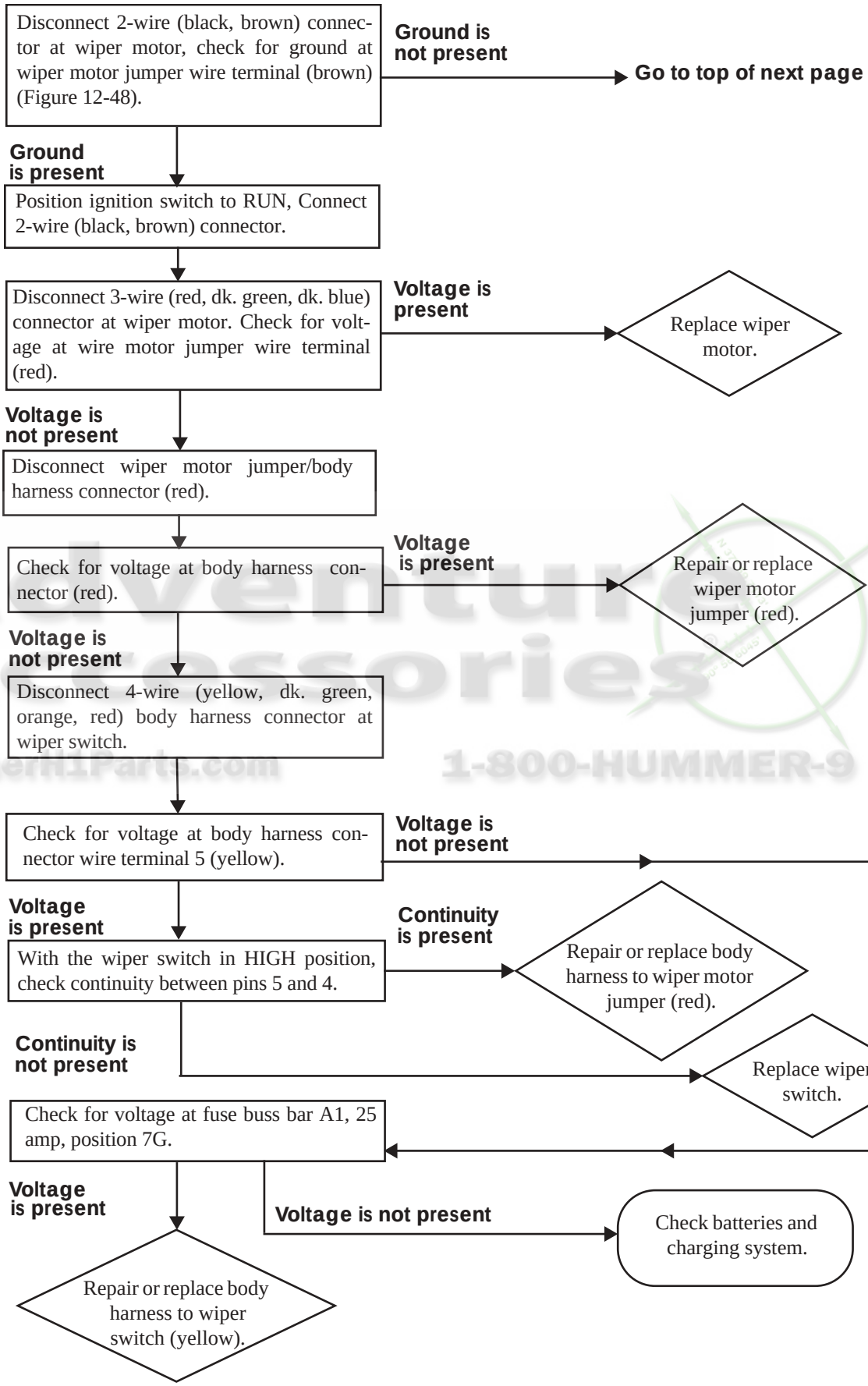
WINDSHIELD WIPERS (LOW) INOPERATIVE



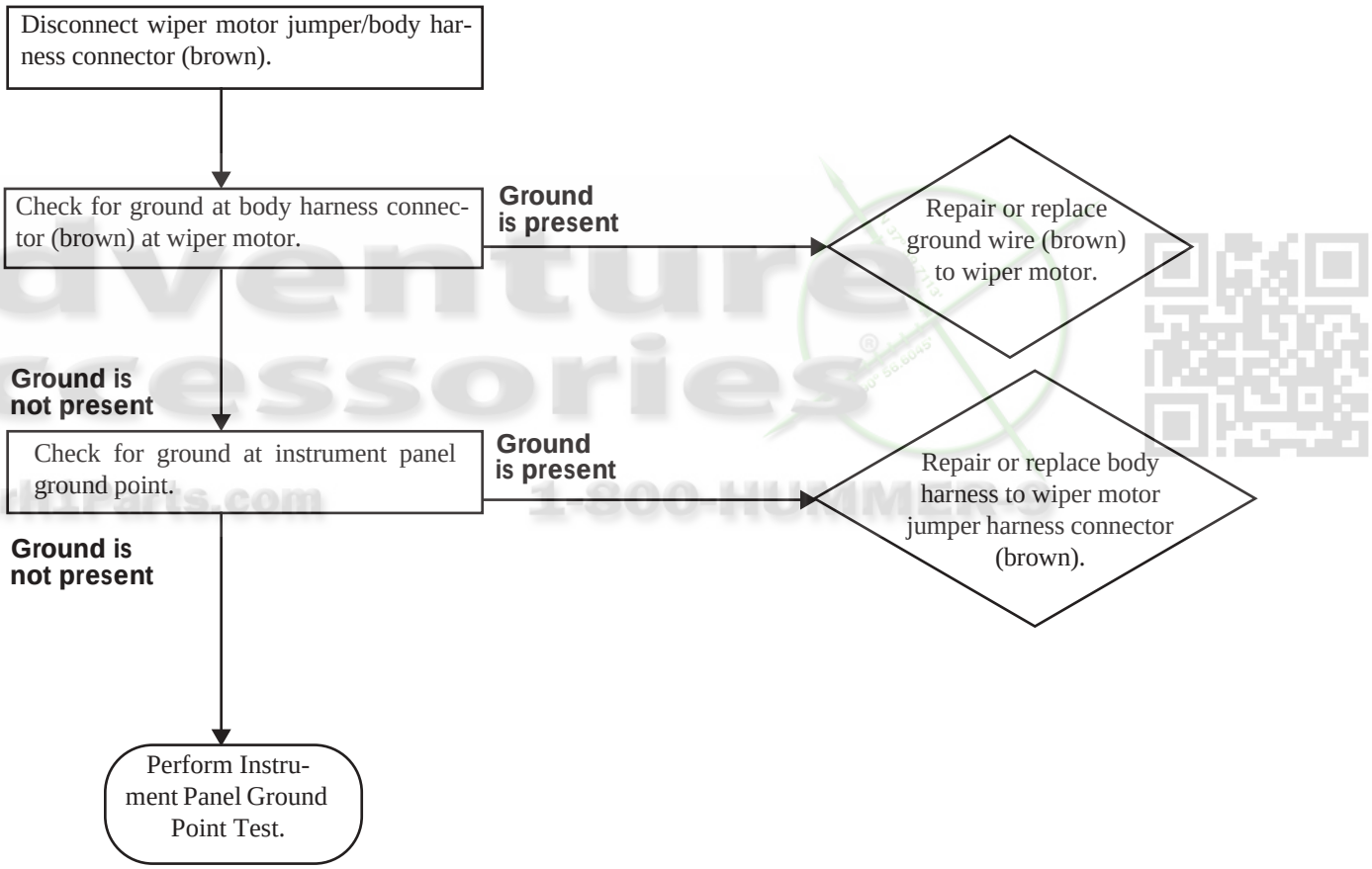
WINDSHIELD WIPERS (LOW) INOPERATIVE — CONTINUED



WINDSHIELD WIPERS (HI) INOPERATIVE



WINDSHIELD WIPERS (HI) INOPERATIVE — CONTINUED



WINDSHIELD WIPERS FAIL TO PARK IN PROPER POSITION

Position ignition to RUN. Position wiper switch to OFF. Disconnect wiper motor/jumper harness connector (Figure 12-48).

Check for voltage at jumper harness connector (black).

Voltage is present → Reconnect 2-wire (black, brown) wiper motor/jumper harness connector. Disconnect 3-wire (red, green, blue) wiper motor/jumper harness connector.

Voltage is not present

Connect wiper motor jumper/body harness connector (black). Disconnect 2-wire (black, brown) wiper motor jumper/body harness connector.

Check for voltage at body harness (black).

Voltage is present → Repair or replace wiper motor jumper harness.

Voltage is not present → Repair or replace body harness to wiper motor jumper.

NOTE: Motor should be stopped in a position other than the normal park position.

Reconnect 2-wire (black, brown) wiper motor/jumper harness connector. Disconnect 3-wire (red, green, blue) wiper motor/jumper harness connector.

Check for voltage at wiper motor connector (blue).

Voltage is not present → Replace wiper motor.

Voltage is present

Connect 3-wire (red, dk. green, dk. blue) wiper motor/jumper harness connector. Disconnect wiper motor jumper/body harness connector (dk. blue).

Check for voltage at jumper harness (dk. blue).

Voltage is not present → Replace wiper motor jumper harness.

Voltage is present

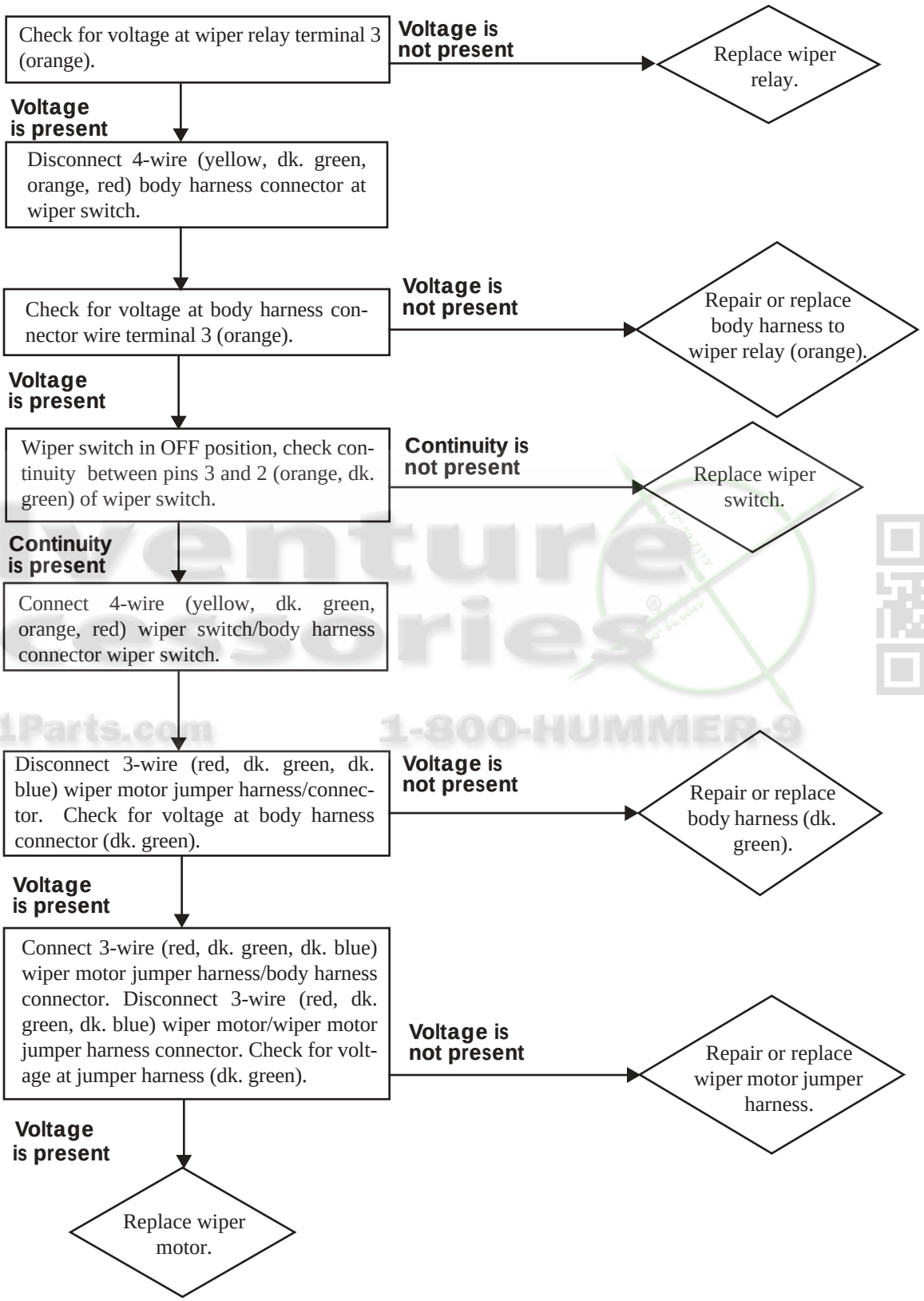
Check for voltage at wiper relay terminal 4 (dk. blue).

Voltage is not present → Repair or replace body harness to wiper motor jumper.

Voltage is present

Go to top of next page

WINDSHIELD WIPERS FAIL TO PARK IN PROPER POSITION — CONTINUED



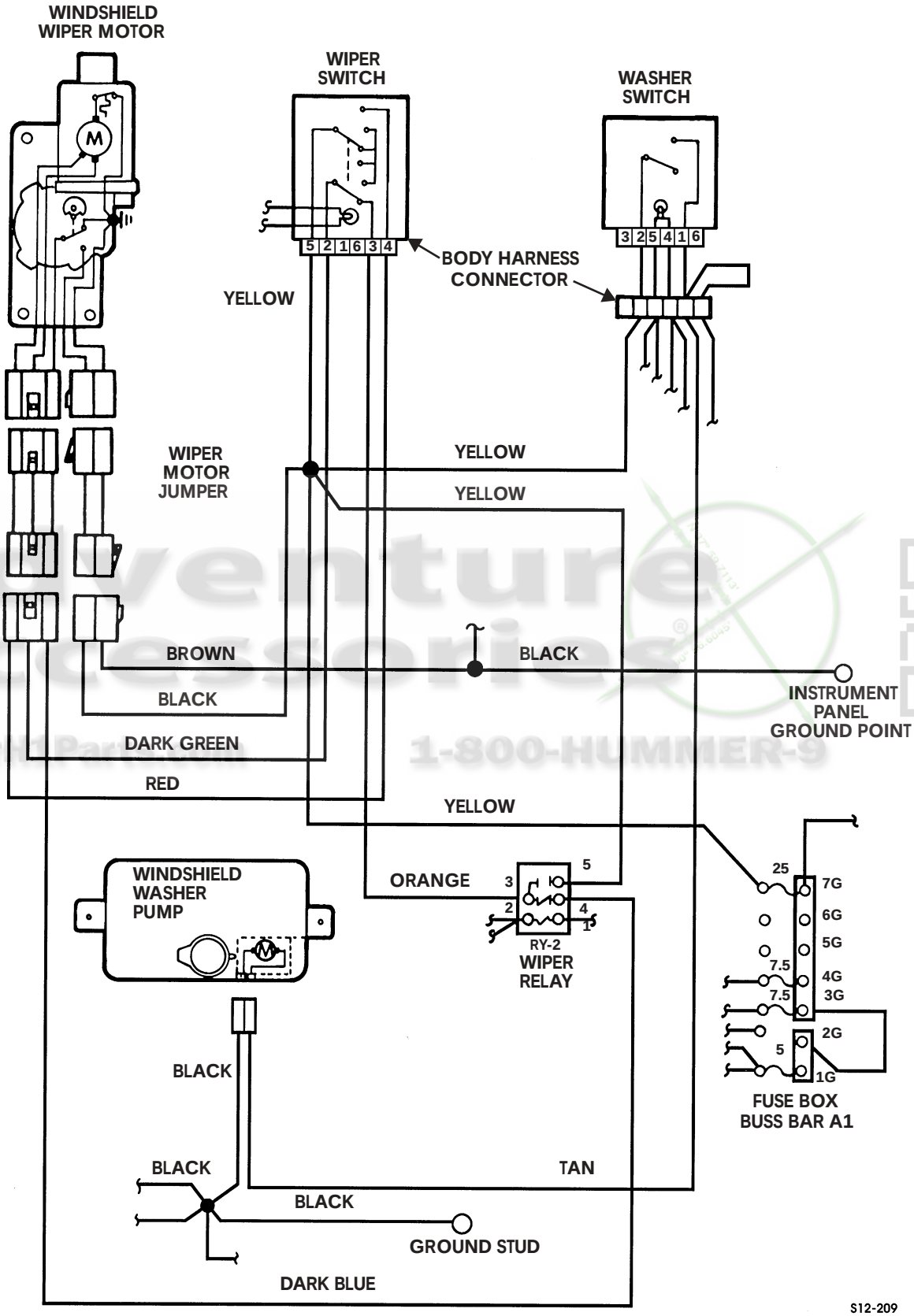
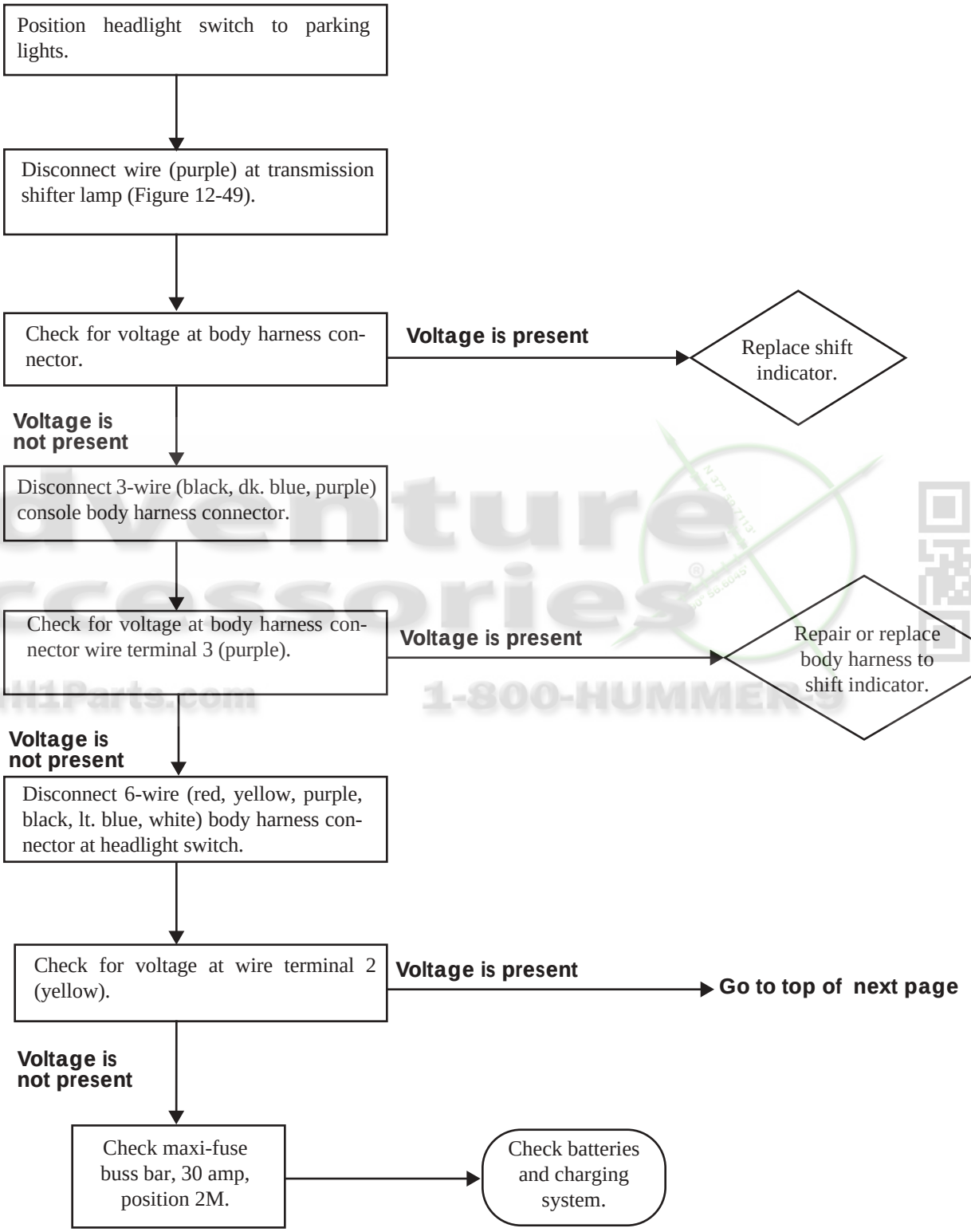
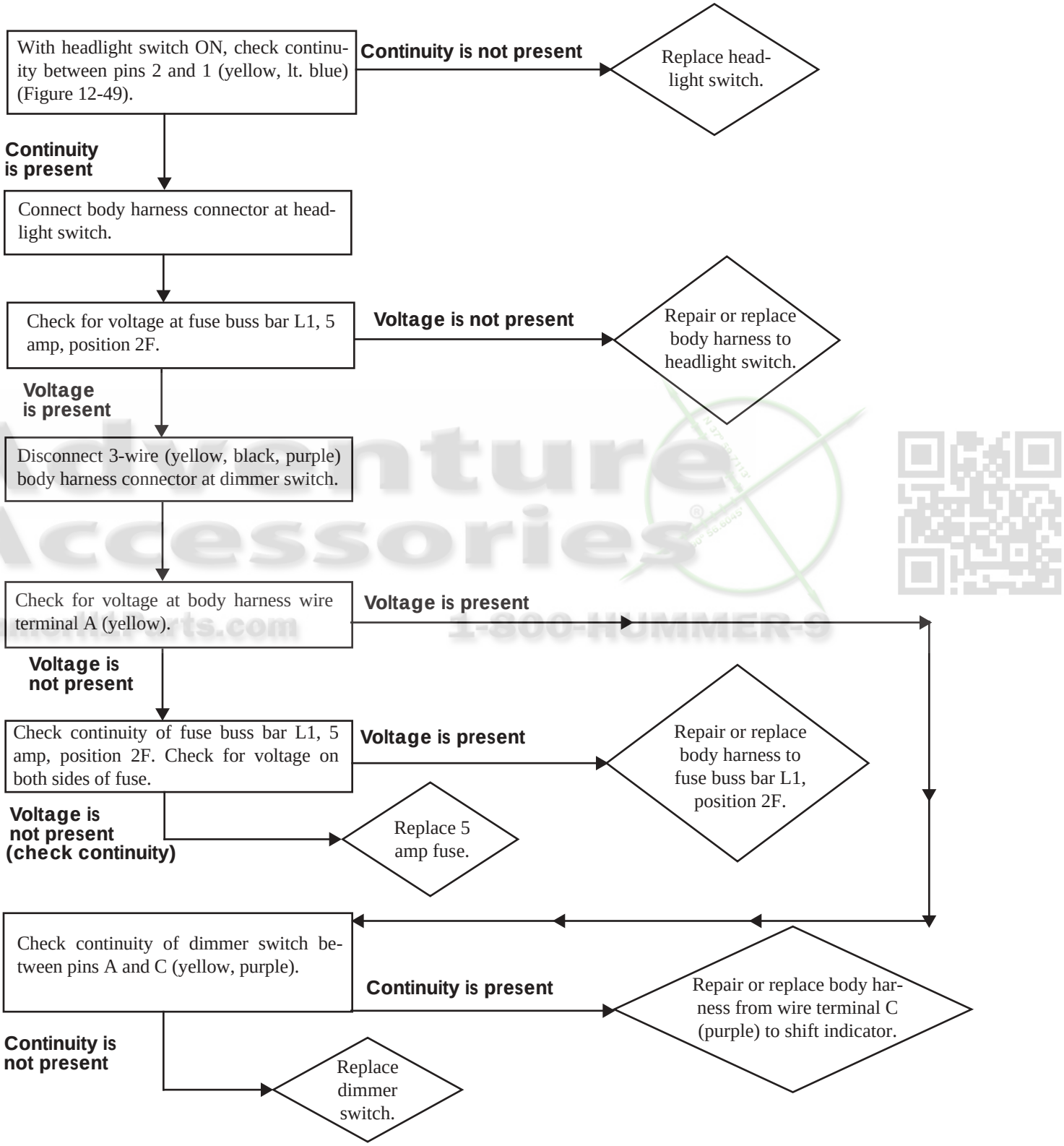


Figure 12-48: Windshield Wiper and Washer System

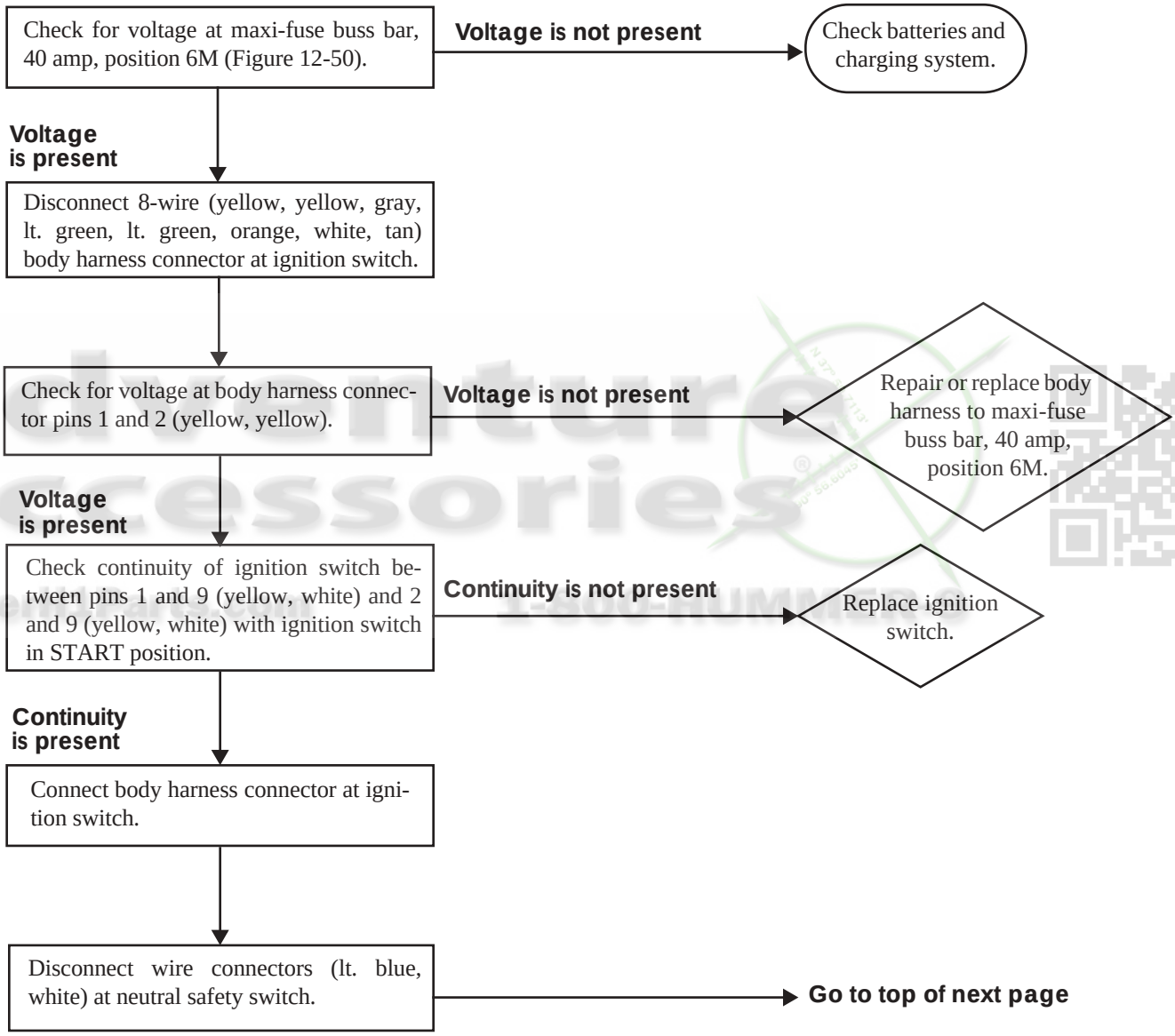
SHIFT INDICATOR INOPERATIVE



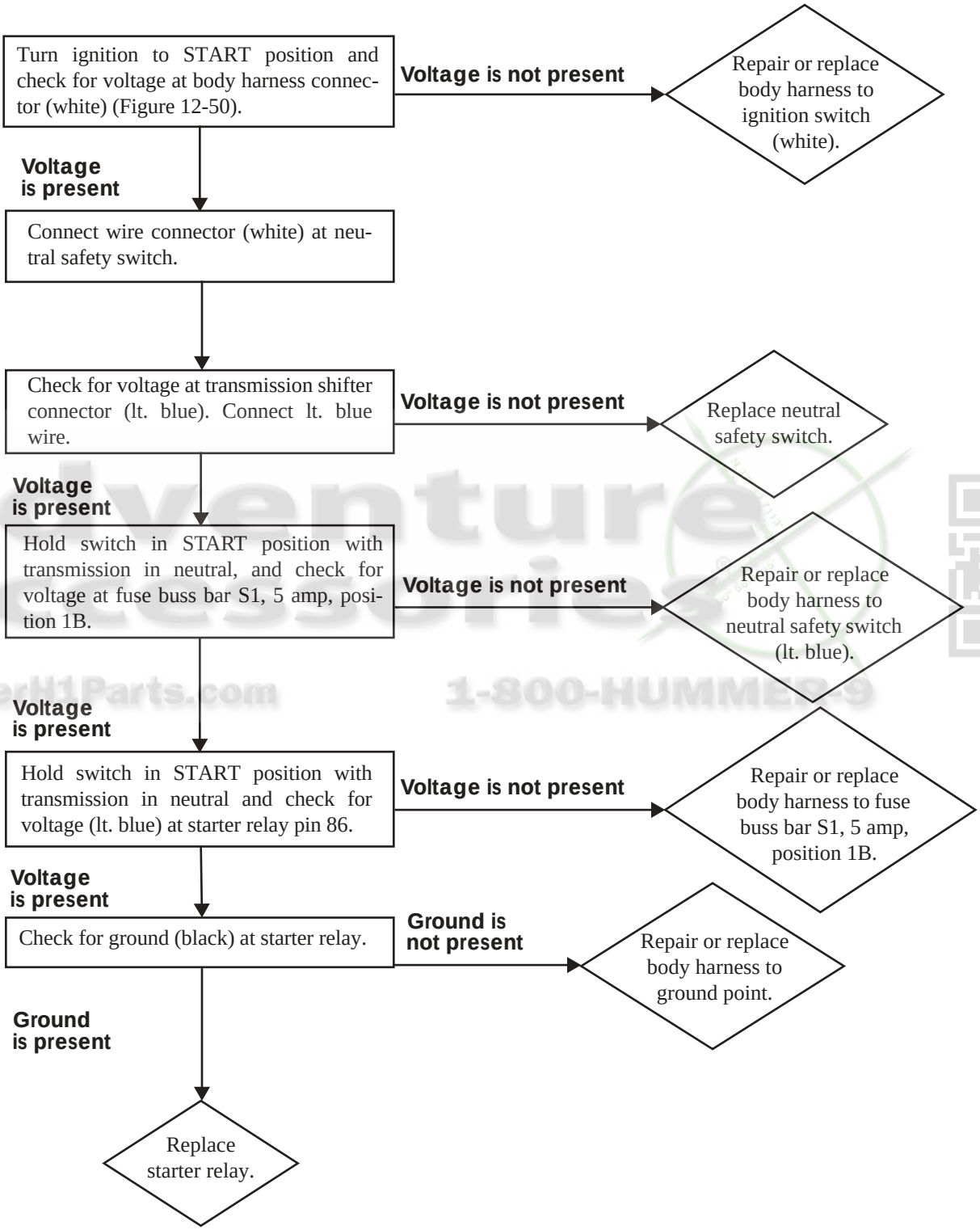
SHIFT INDICATOR INOPERATIVE – CONTINUED



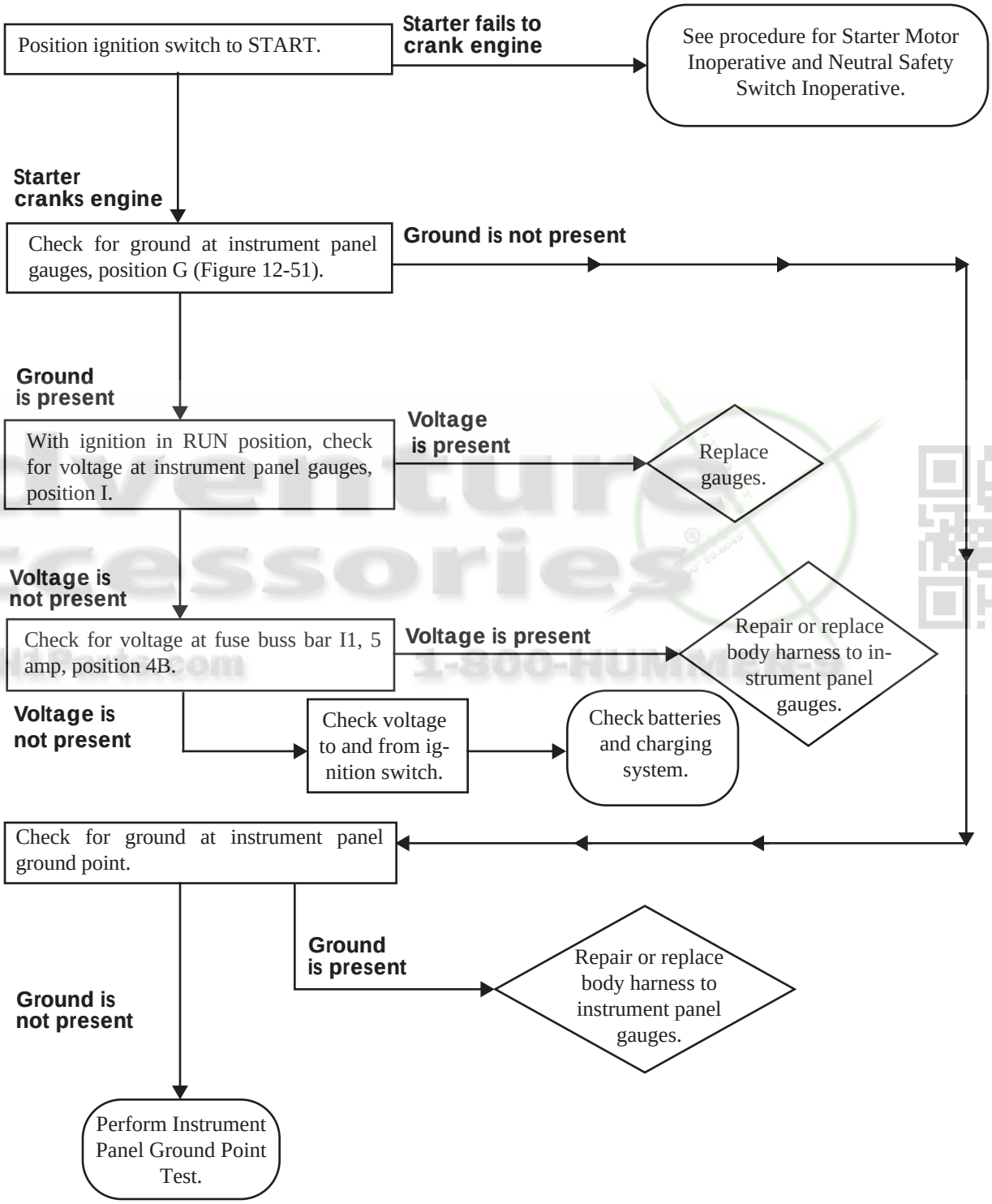
NEUTRAL SAFETY SWITCH INOPERATIVE



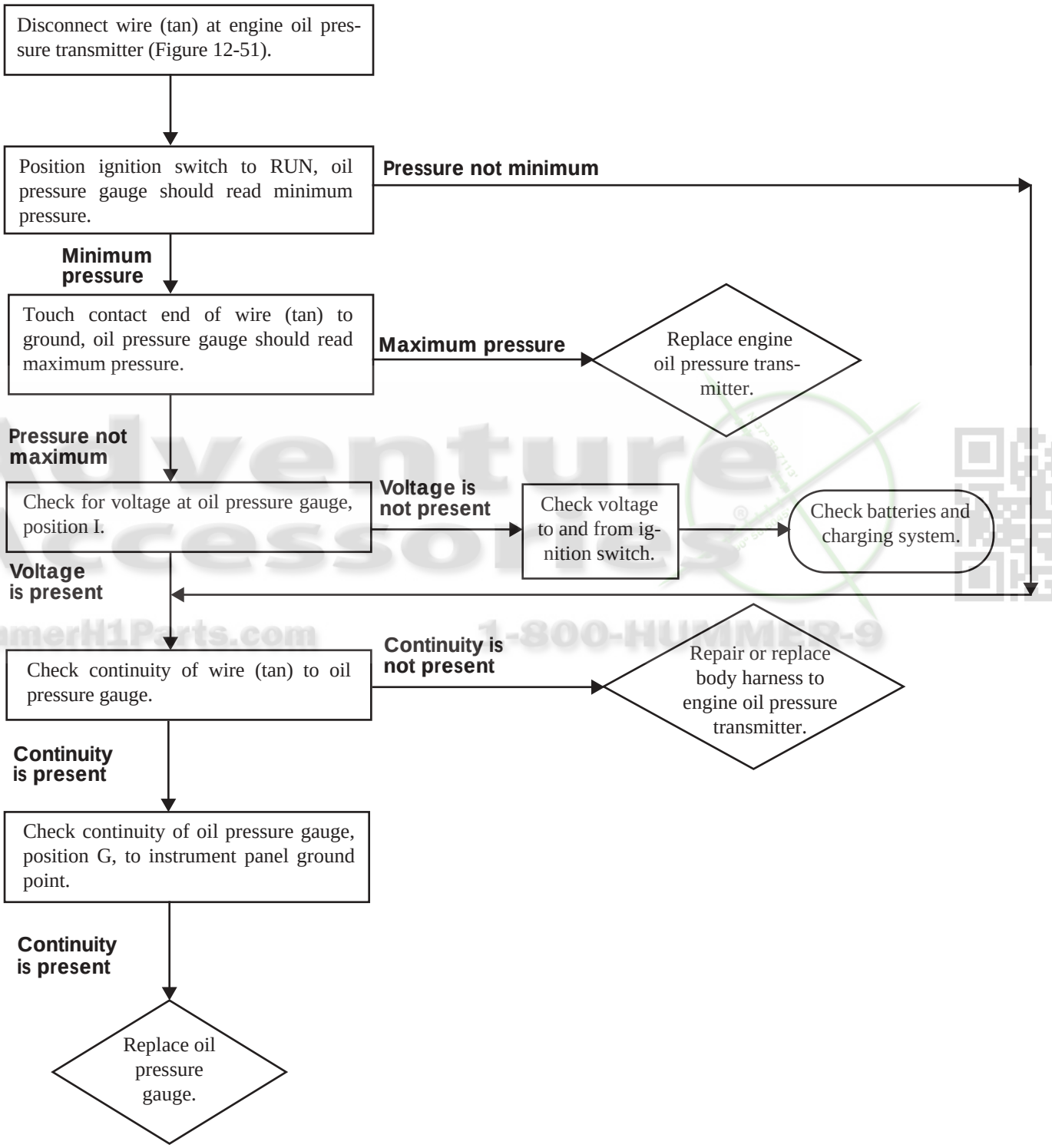
NEUTRAL SAFETY SWITCH INOPERATIVE – CONTINUED



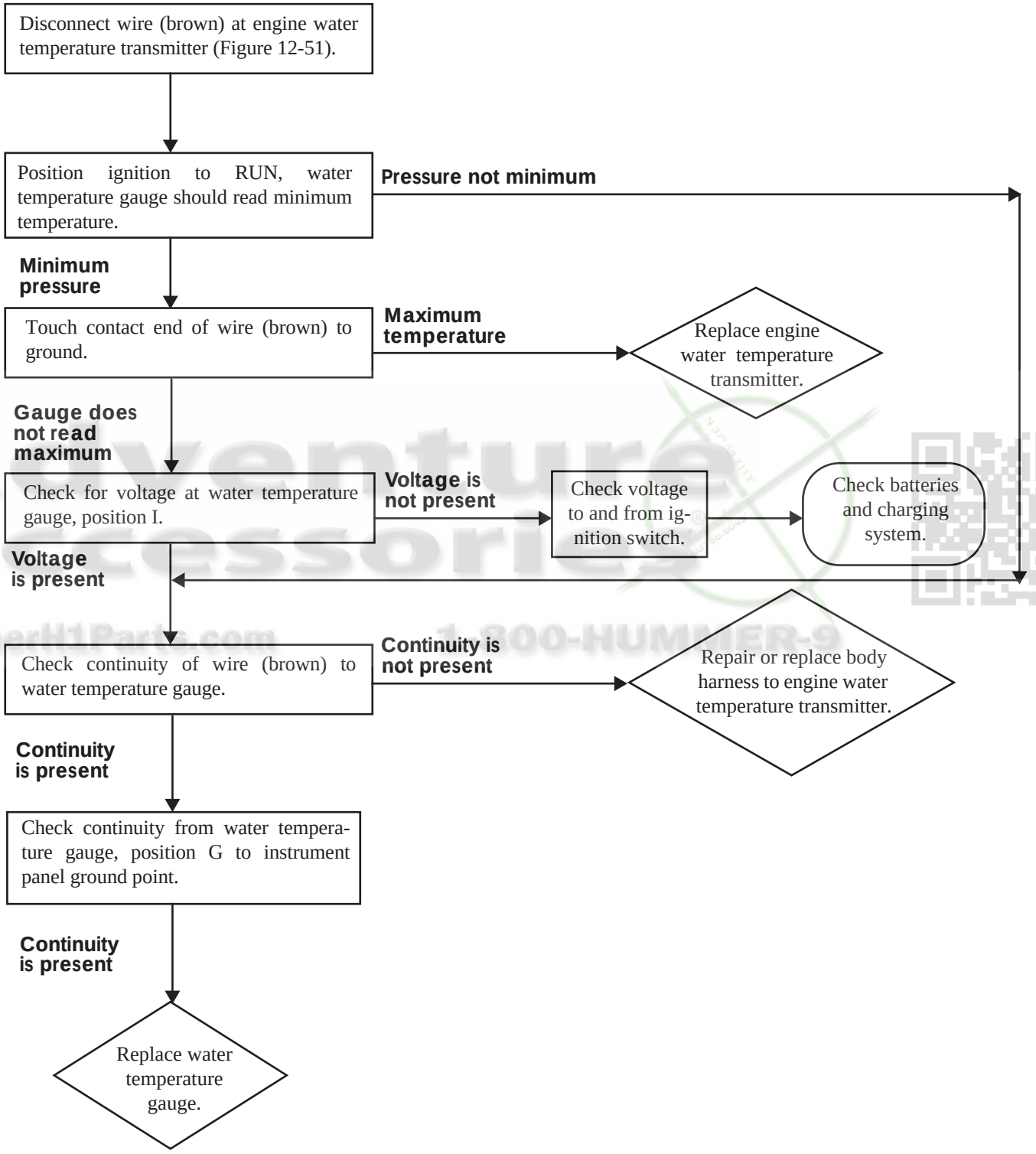
ALL GAUGES INOPERATIVE



OIL PRESSURE GAUGE INOPERATIVE

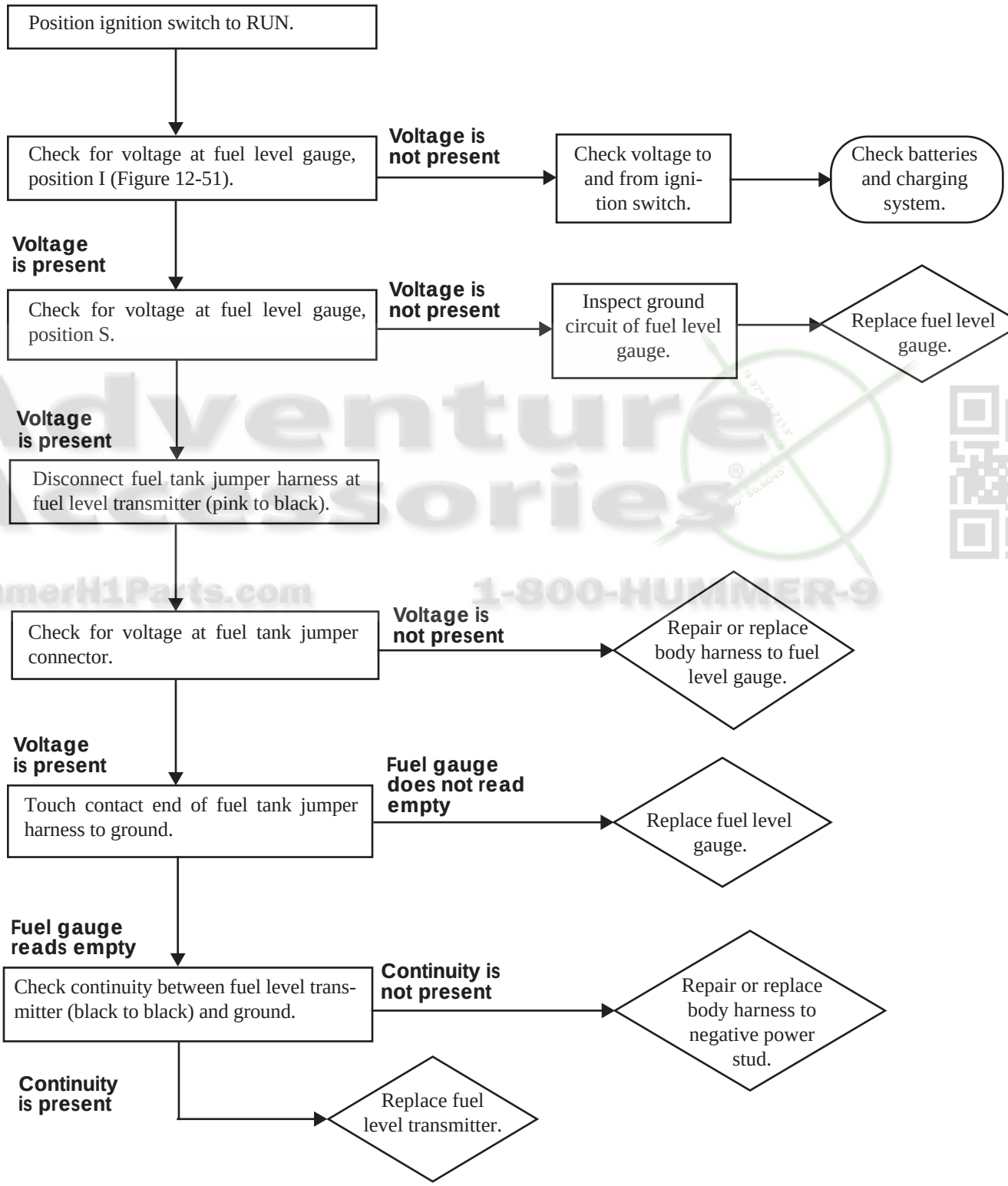


WATER TEMPERATURE GAUGE INOPERATIVE

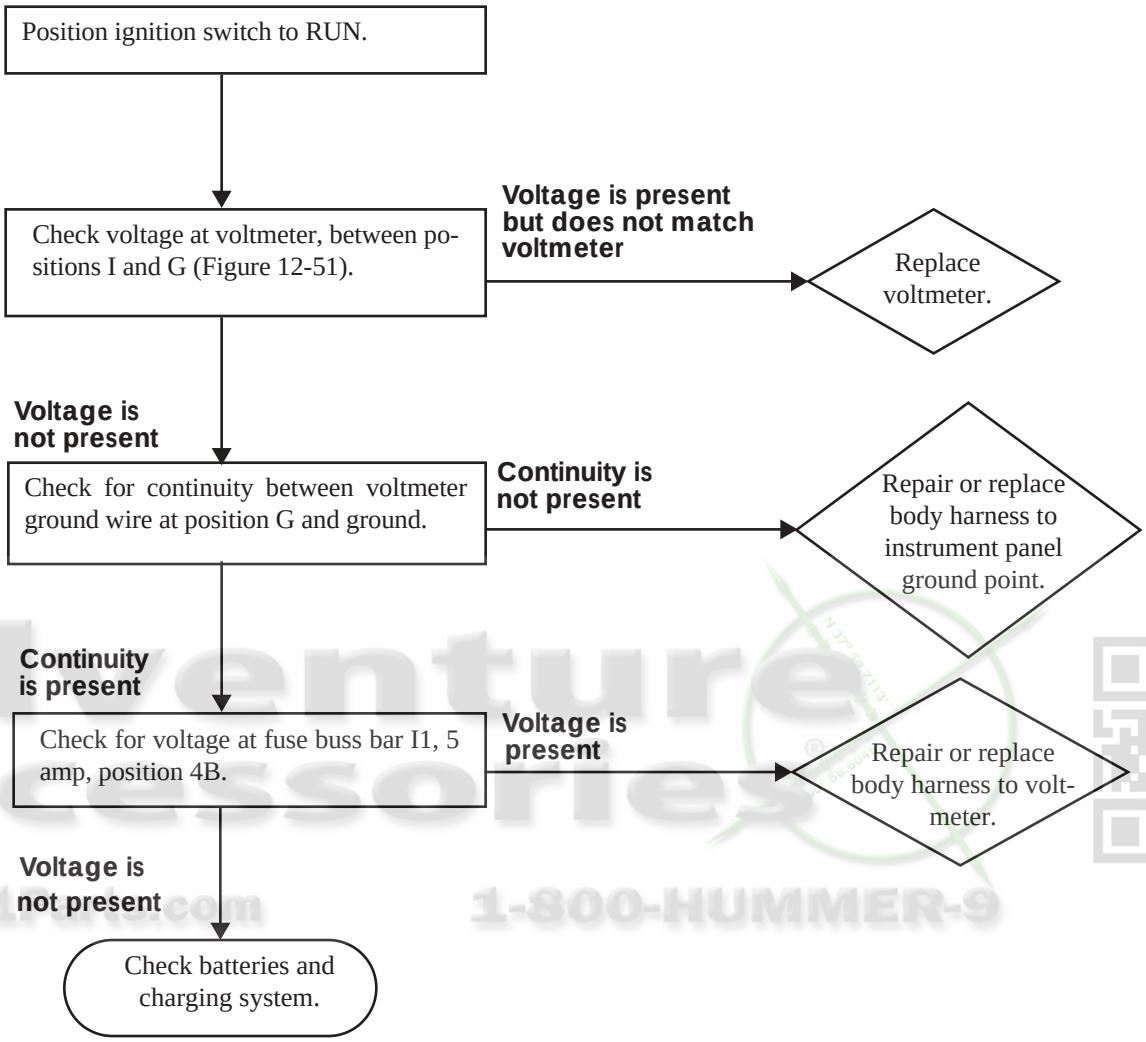


FUEL LEVEL GAUGE INOPERATIVE

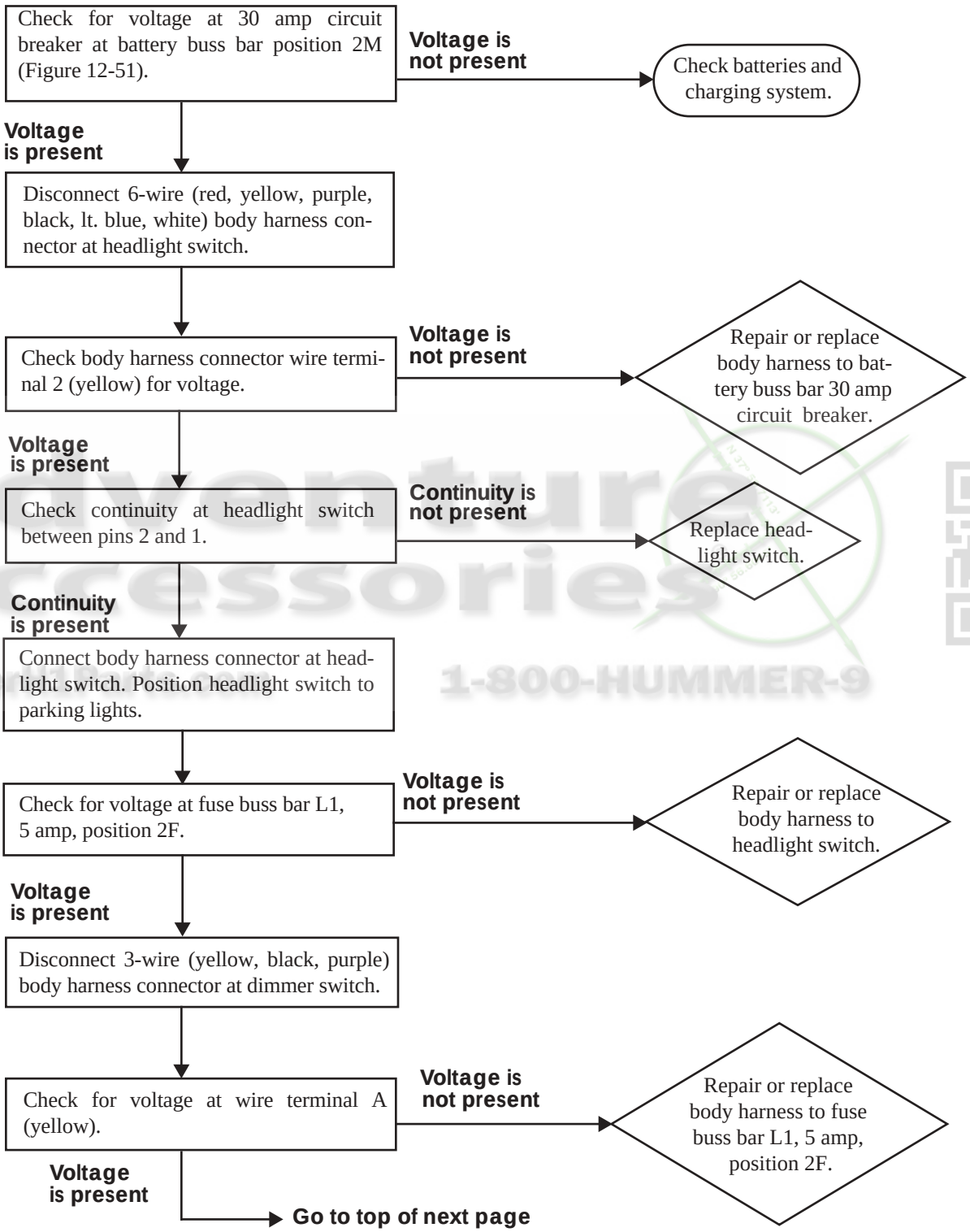
WARNING: Do not perform electrical troubleshooting near fuel tank with fill cap or sending unit removed. Fuel may ignite and cause injury.



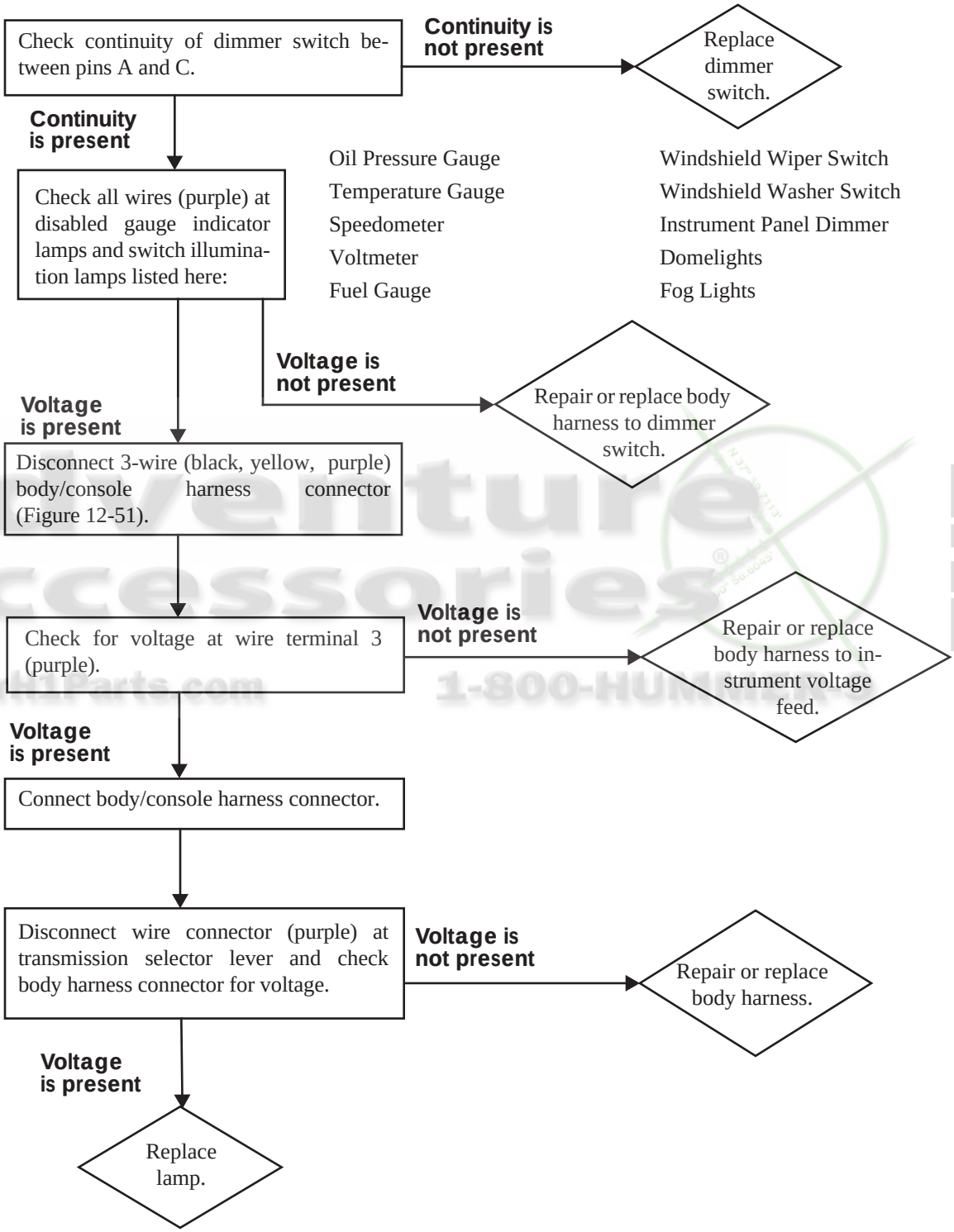
VOLTMETER GAUGE INOPERATIVE



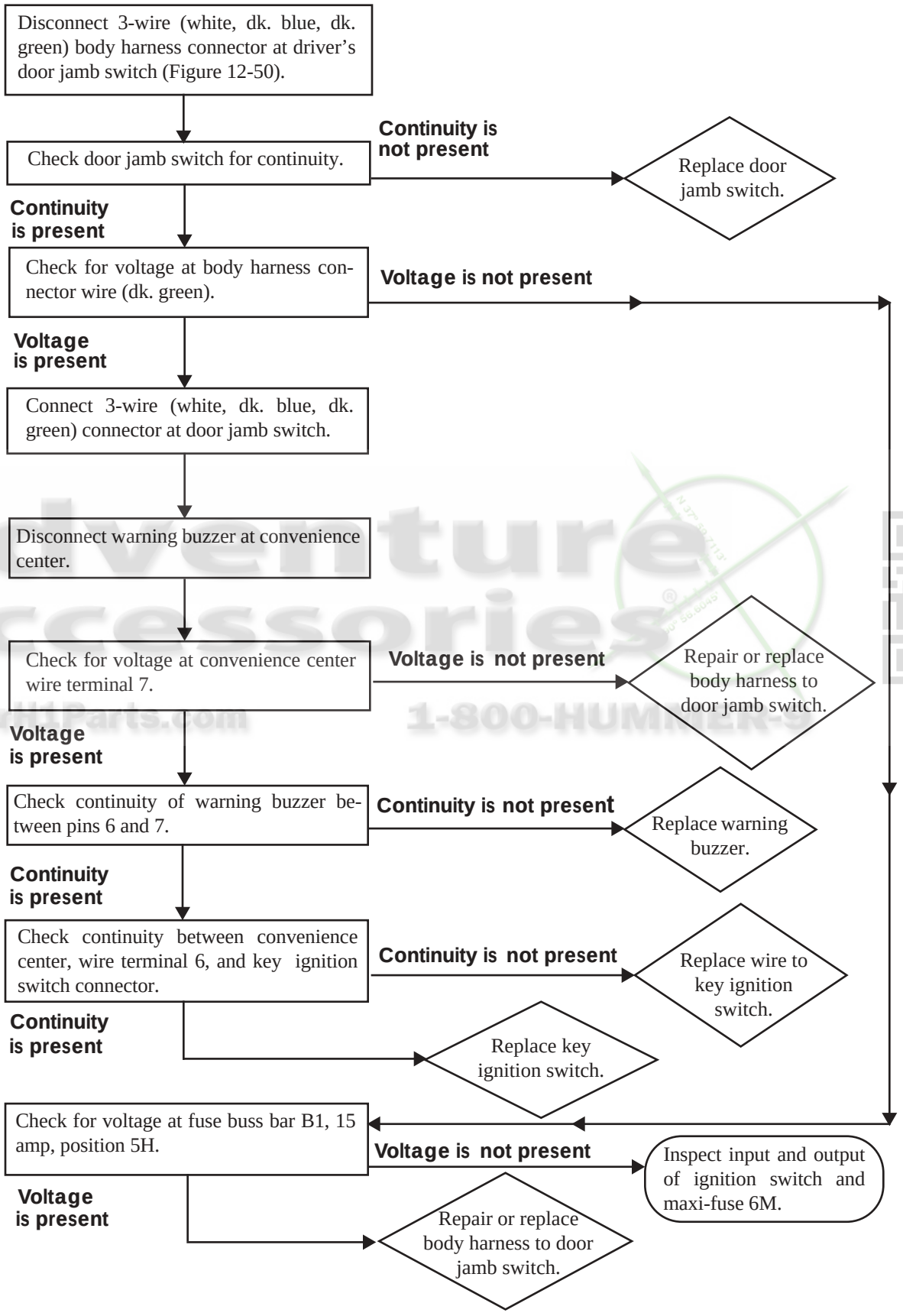
GAUGE INDICATOR LAMP(S) INOPERATIVE



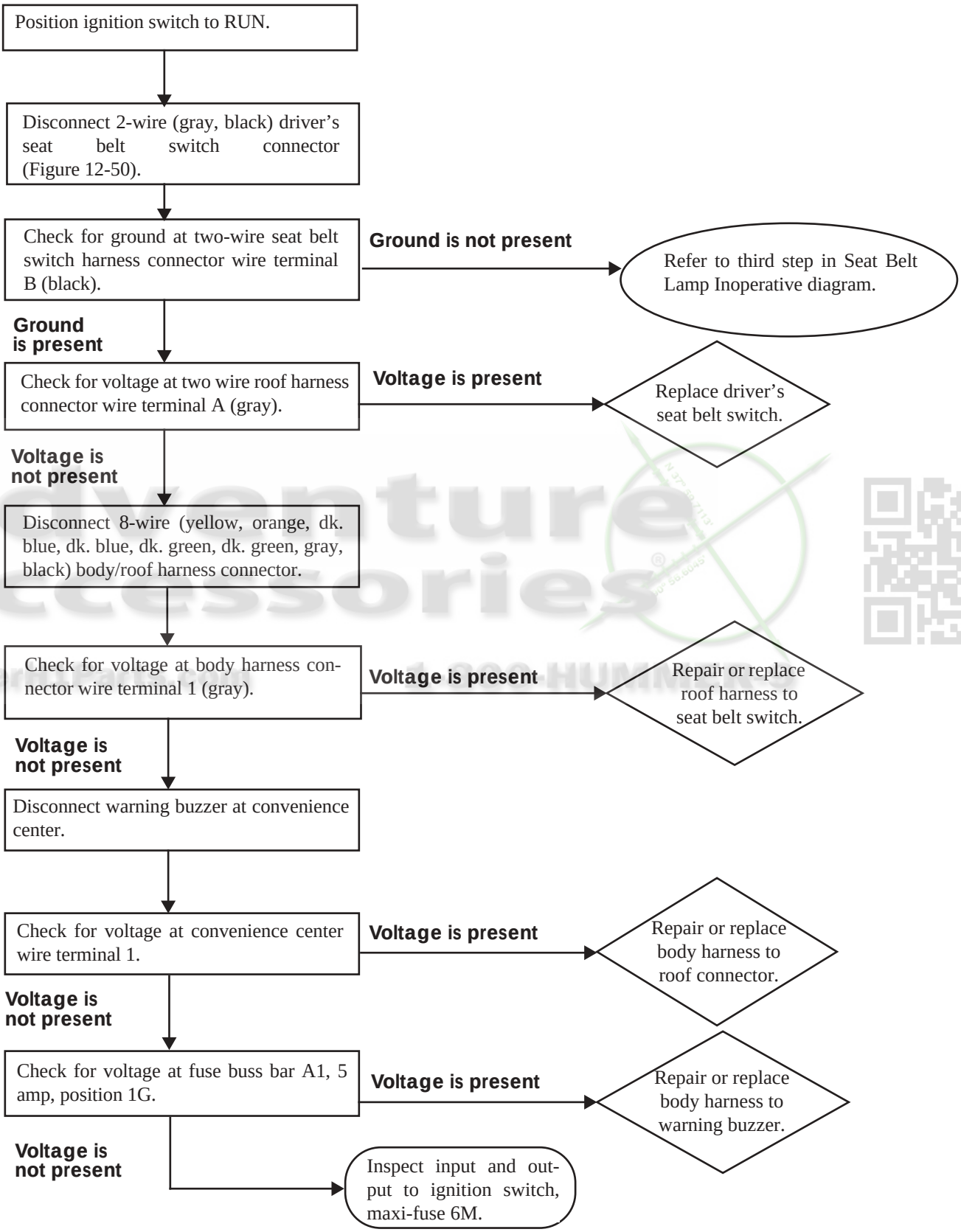
GAUGE INDICATOR LAMP(S) INOPERATIVE – CONTINUED



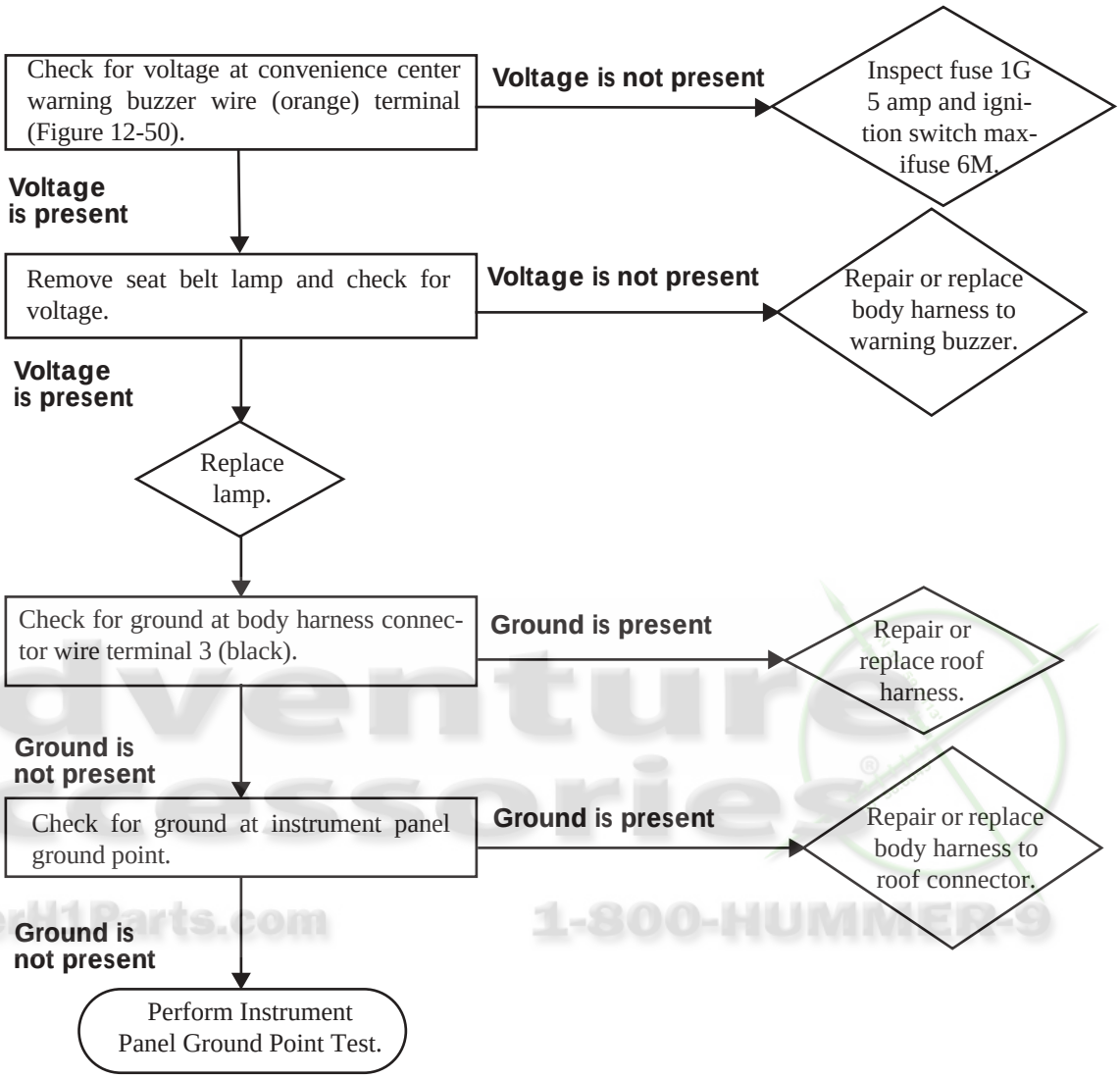
ANTI-THEFT KEY BUZZER INOPERATIVE



SEAT BELT BUZZER ALARM INOPERATIVE



SEAT BELT LAMP INOPERATIVE



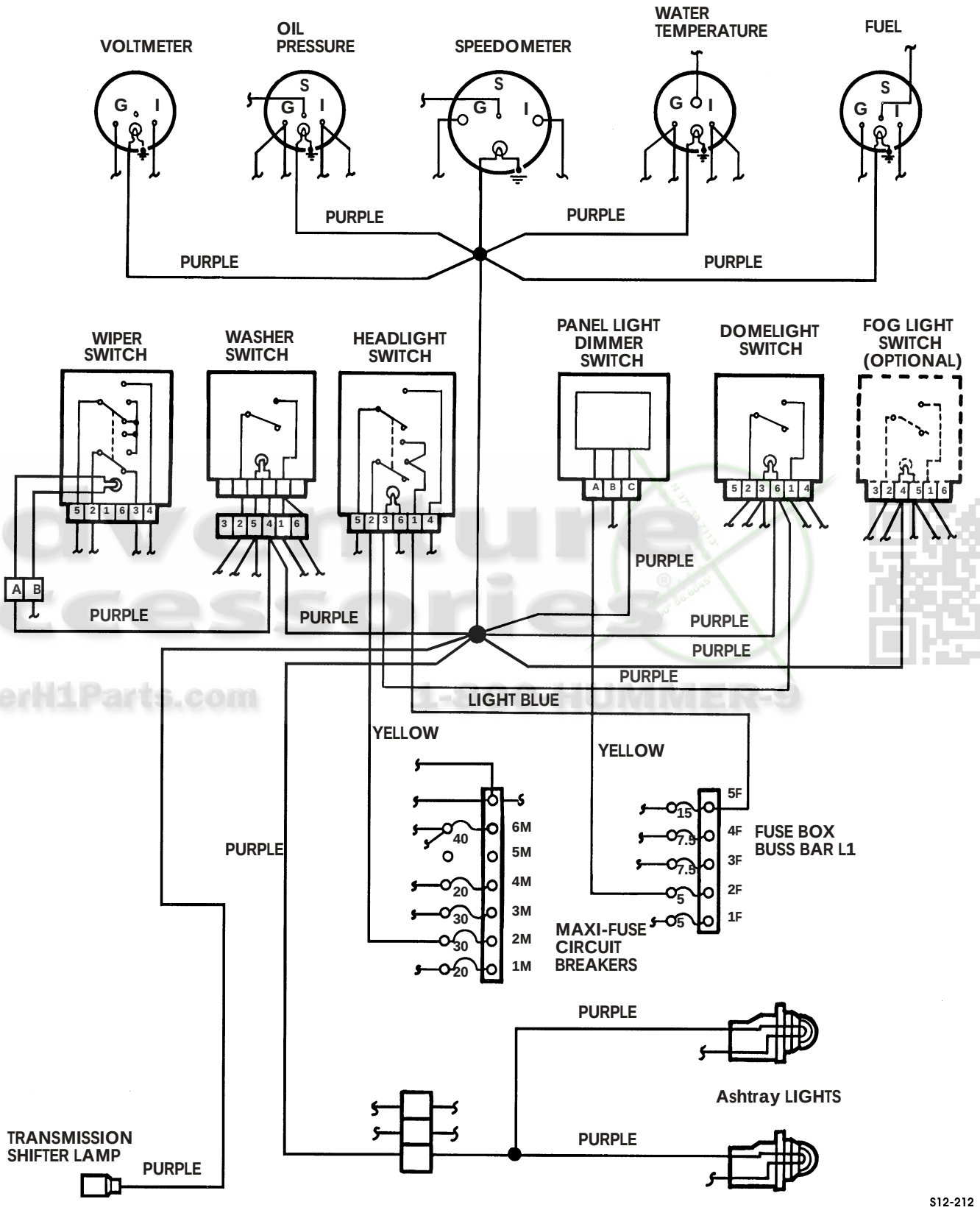


Figure 12-49: Gauge Indicator Lamps

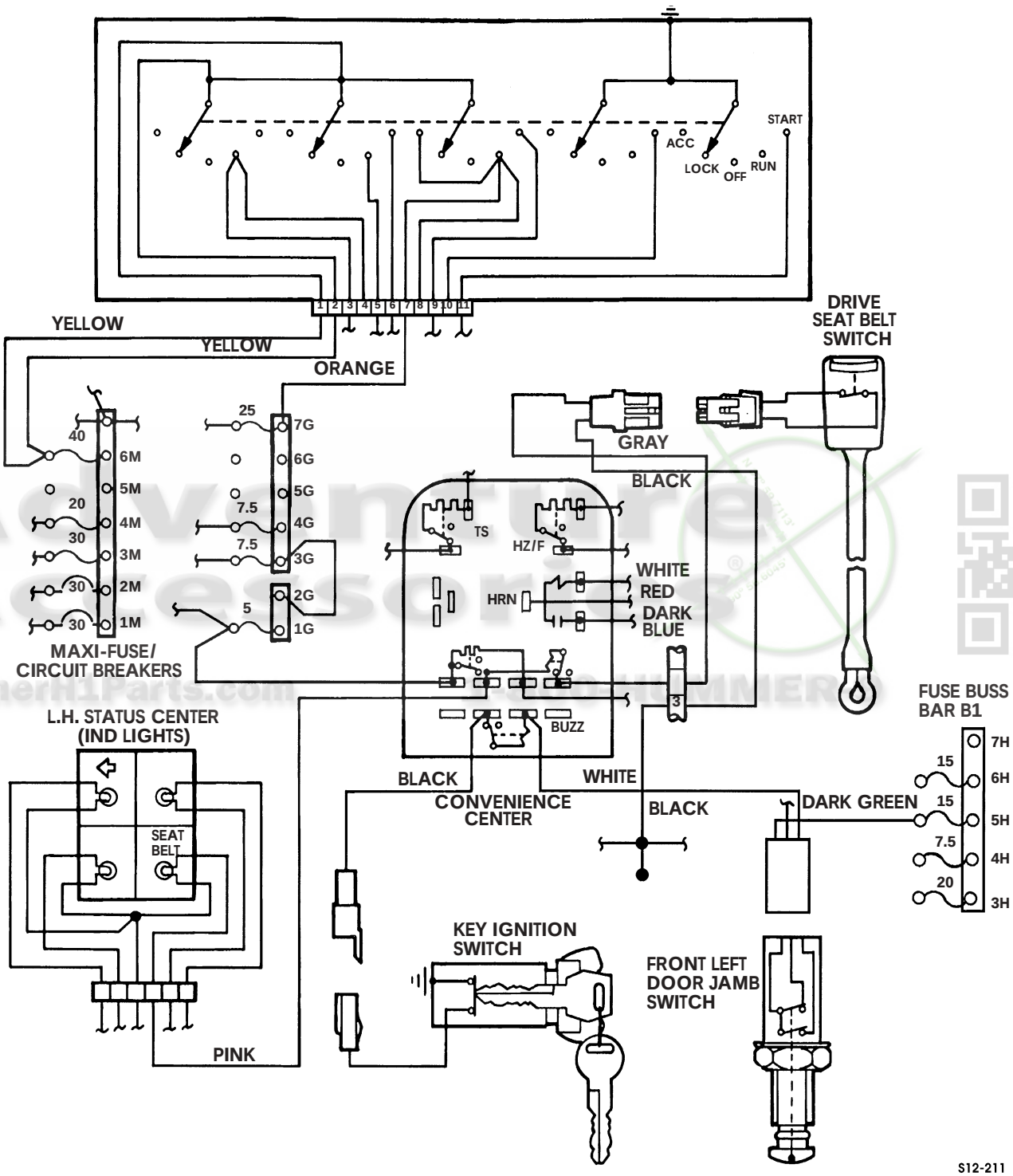


Figure 12-50: Seat Belt Buzzer

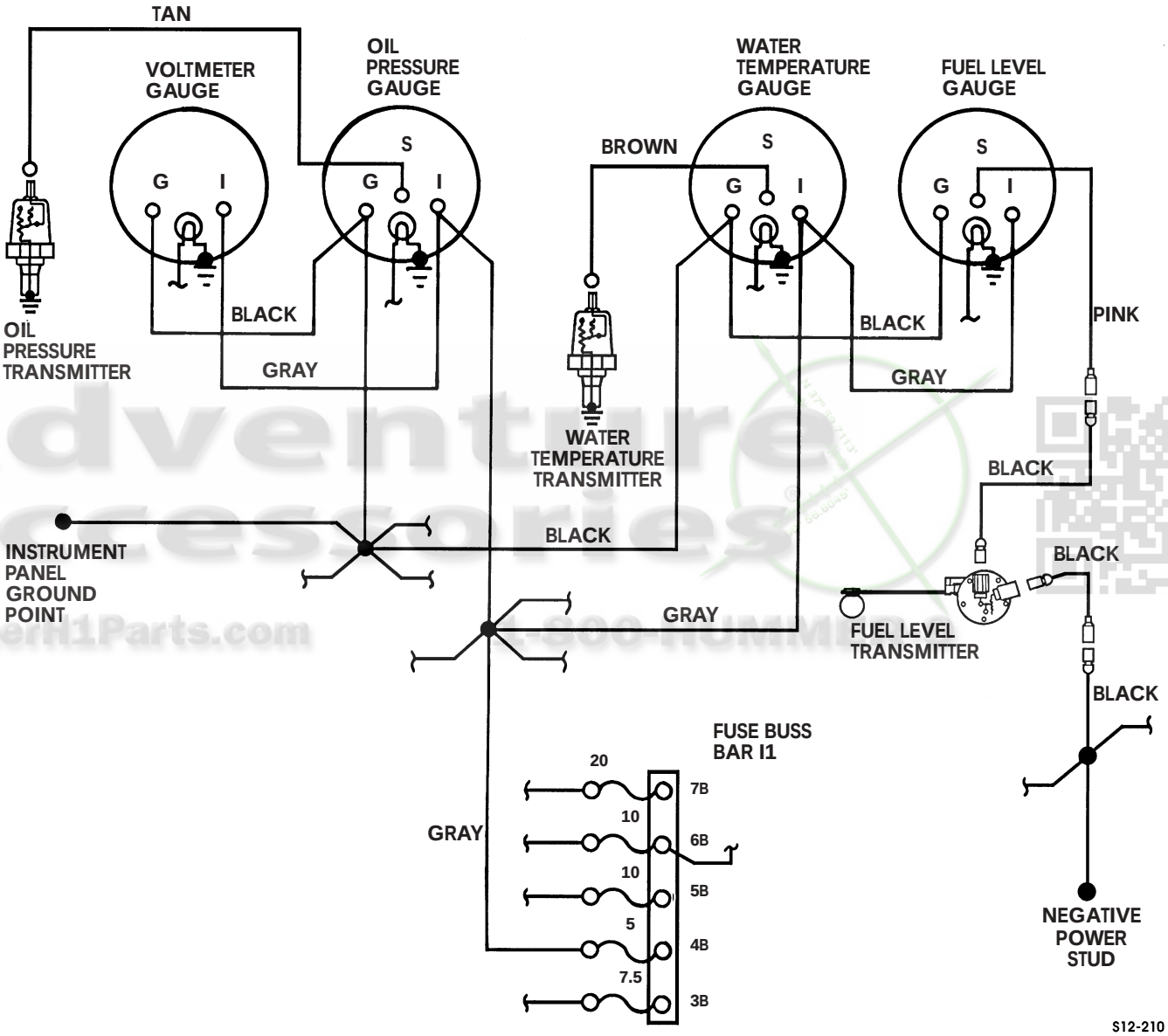
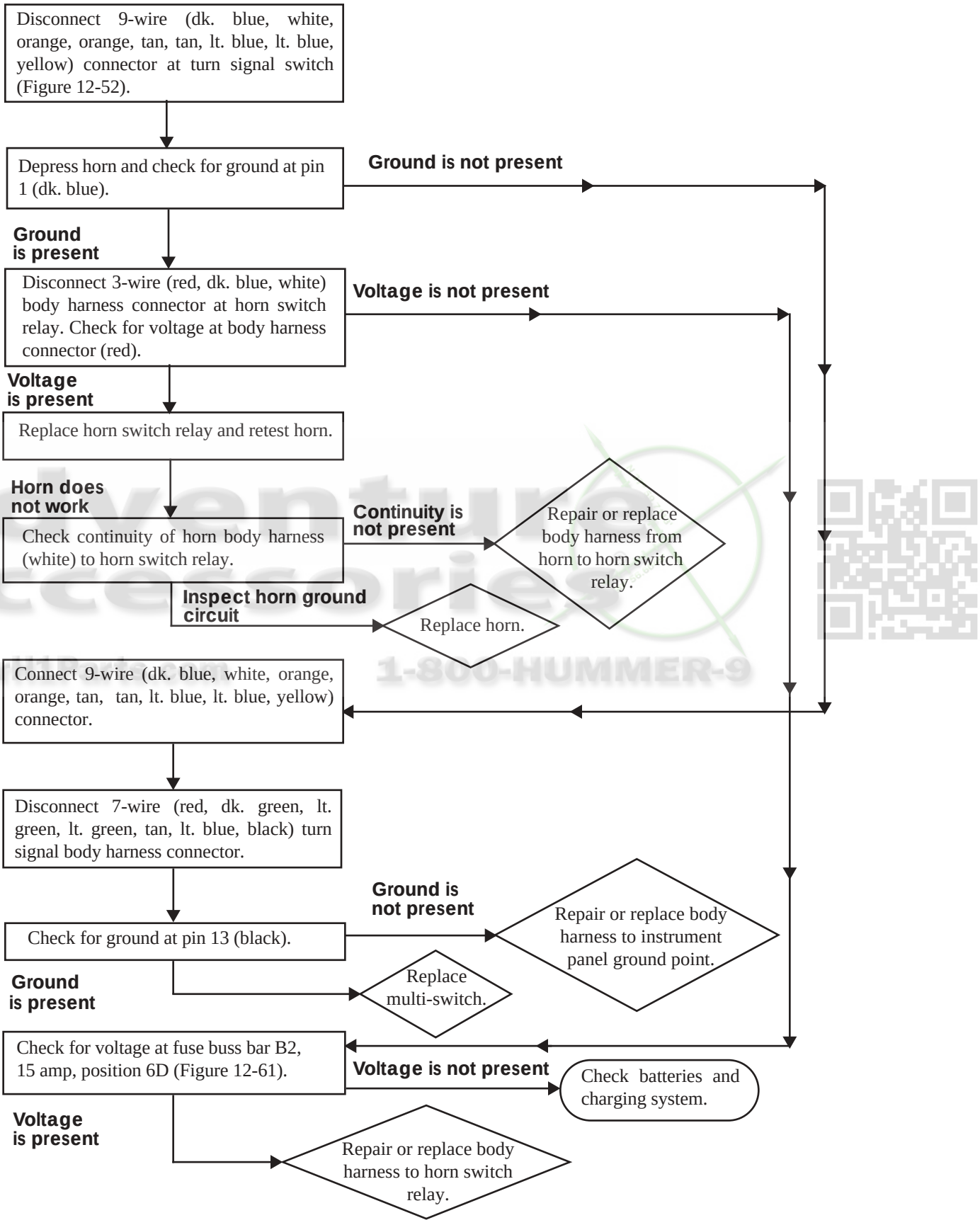
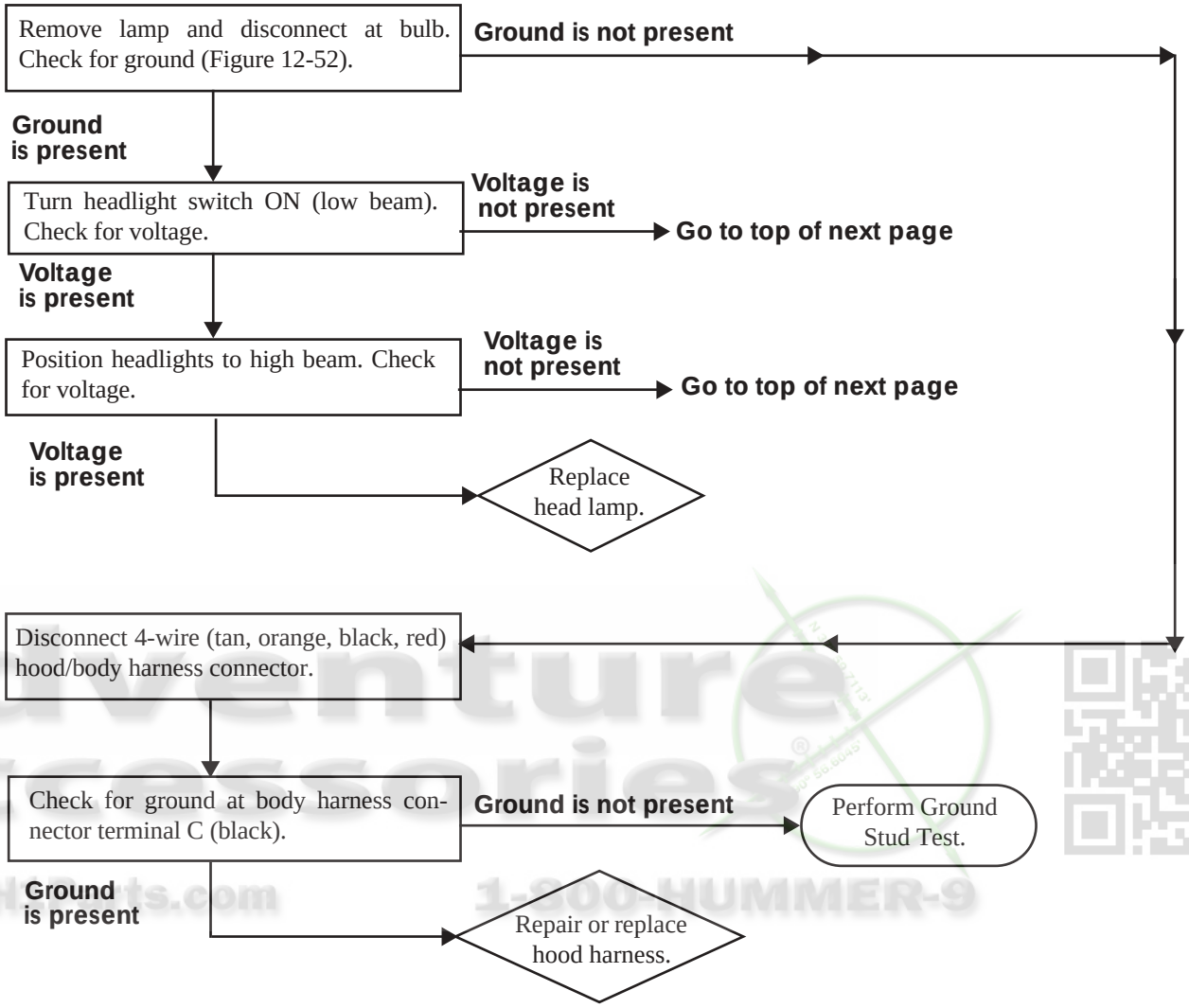


Figure 12-51: Instrument Panel Gauges

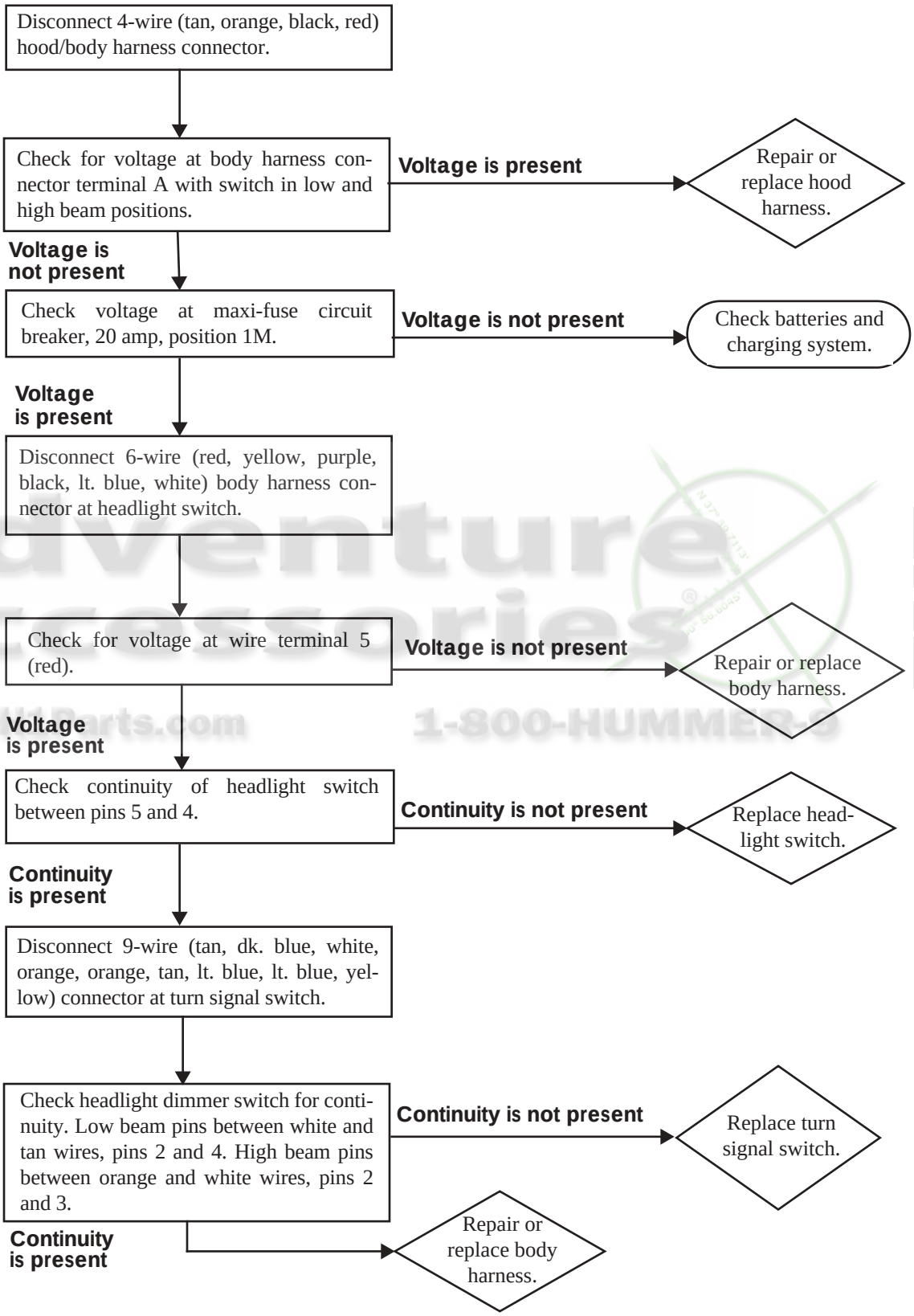
HORN INOPERATIVE



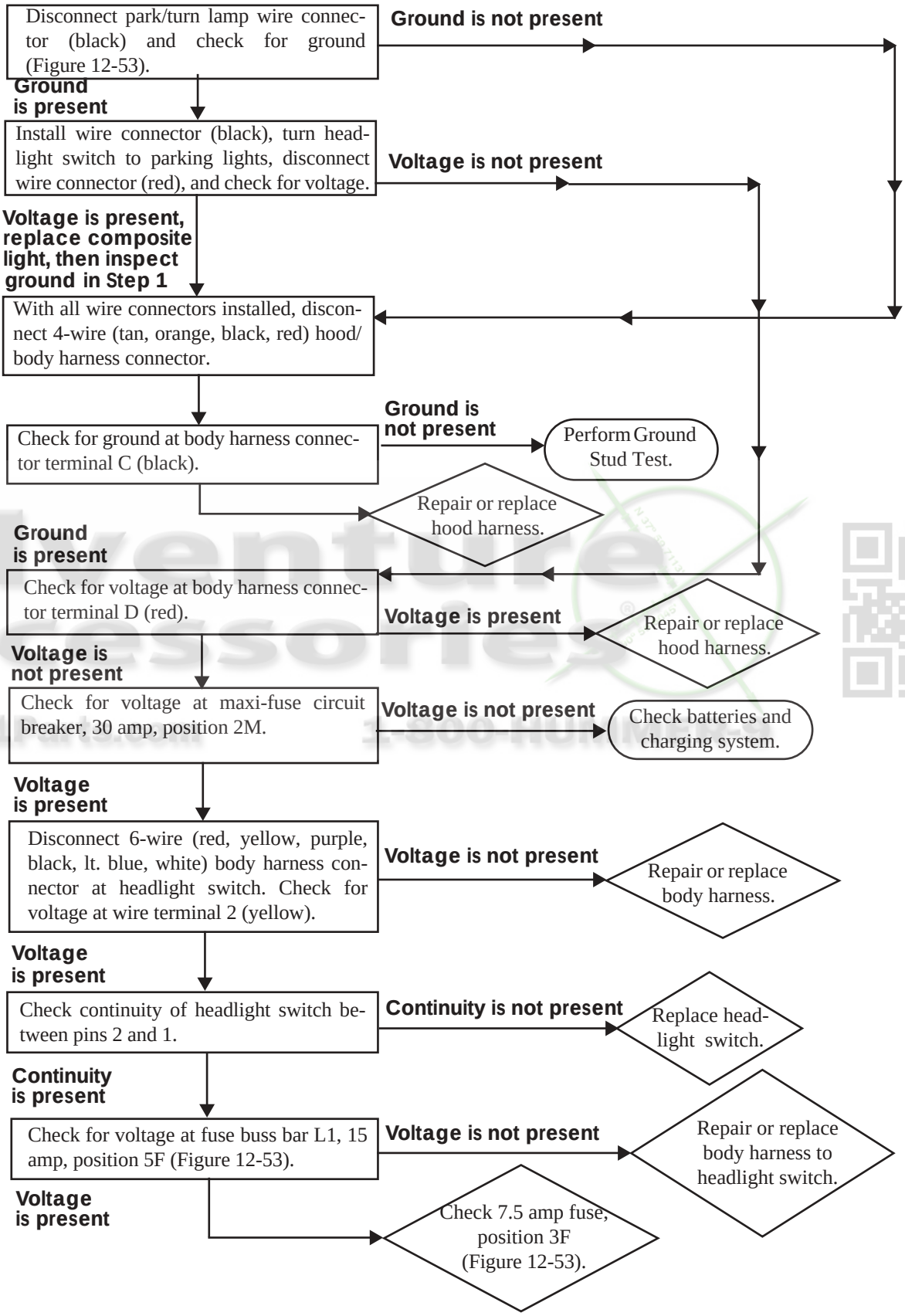
HEADLIGHT(S) INOPERATIVE



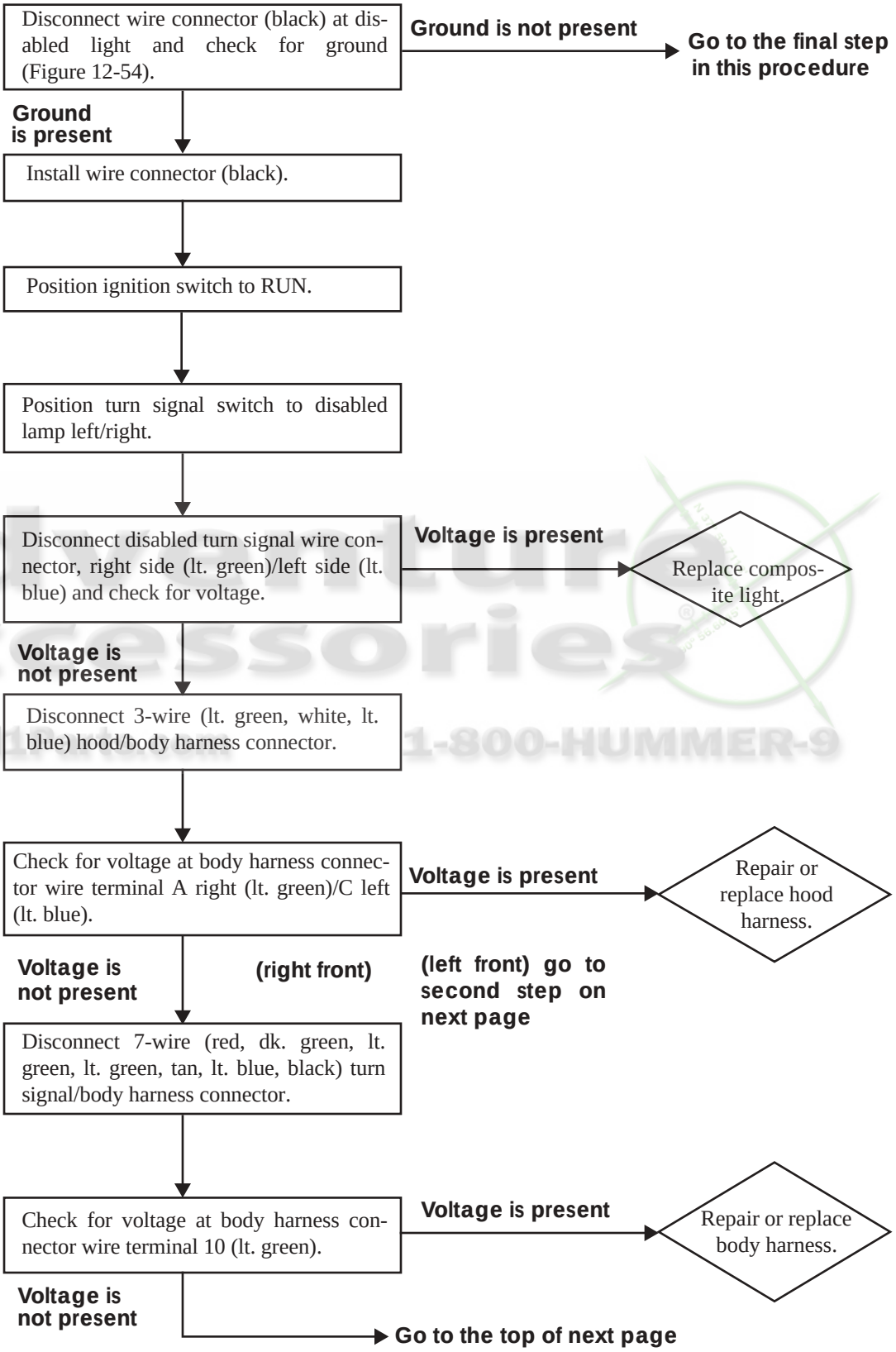
HEADLIGHT(S) INOPERATIVE – CONTINUED



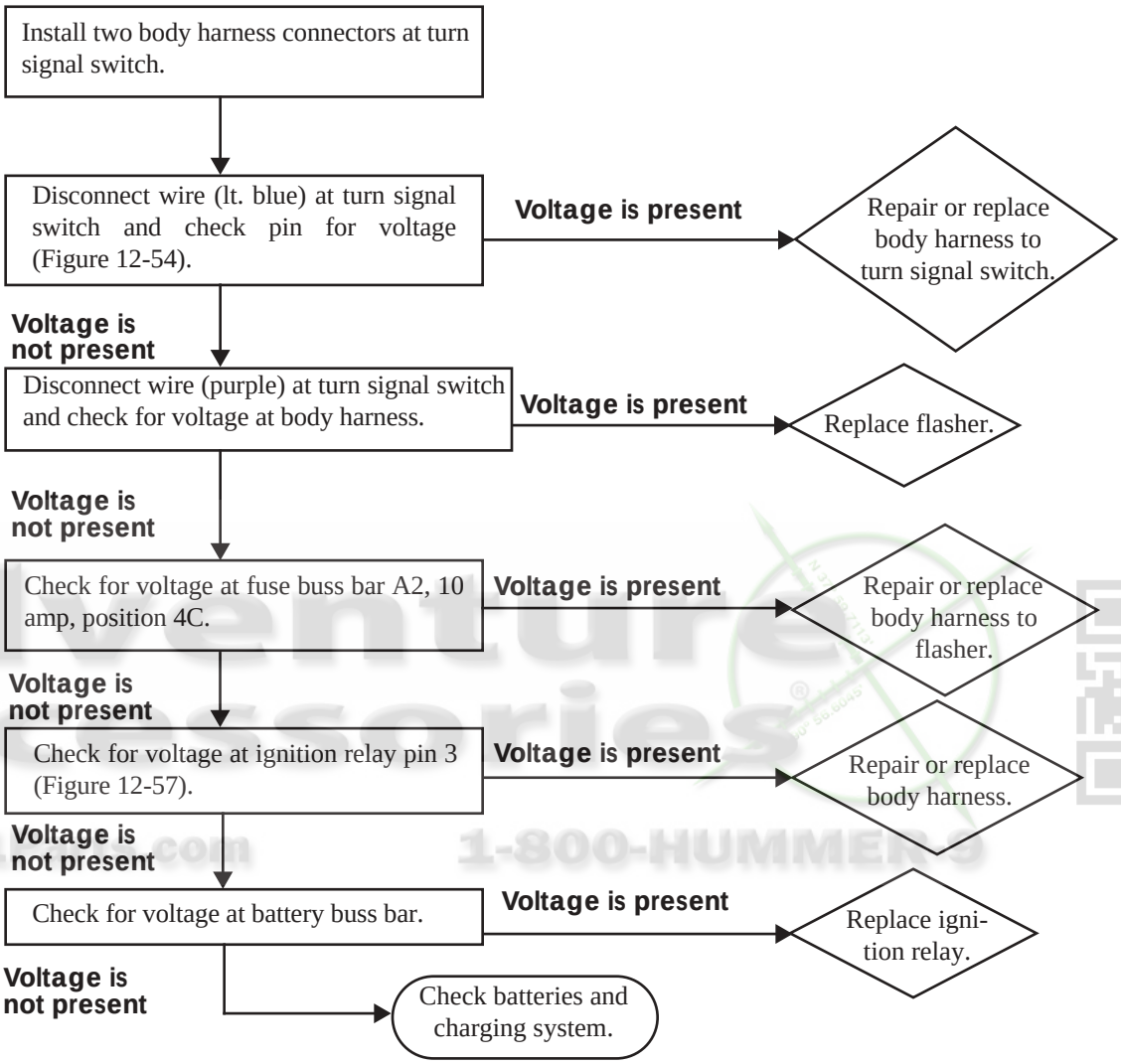
PARKING LIGHT(S) INOPERATIVE

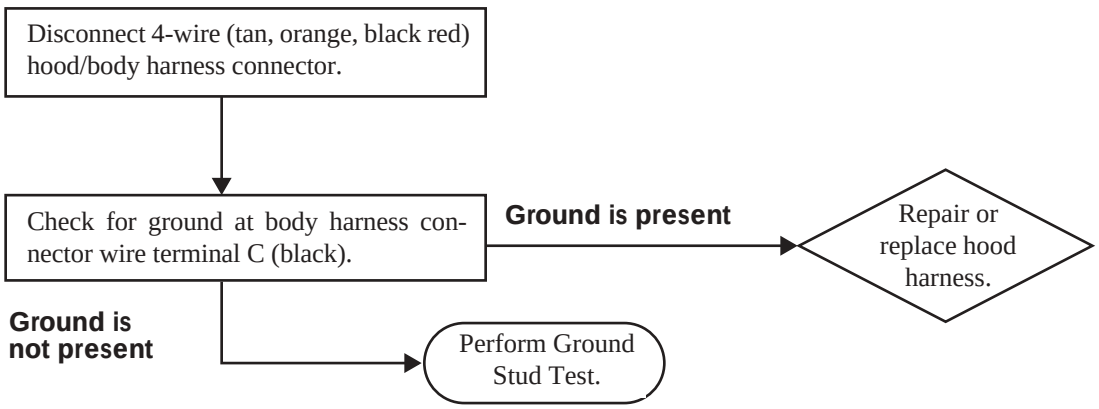


TURN SIGNAL(S) INOPERATIVE

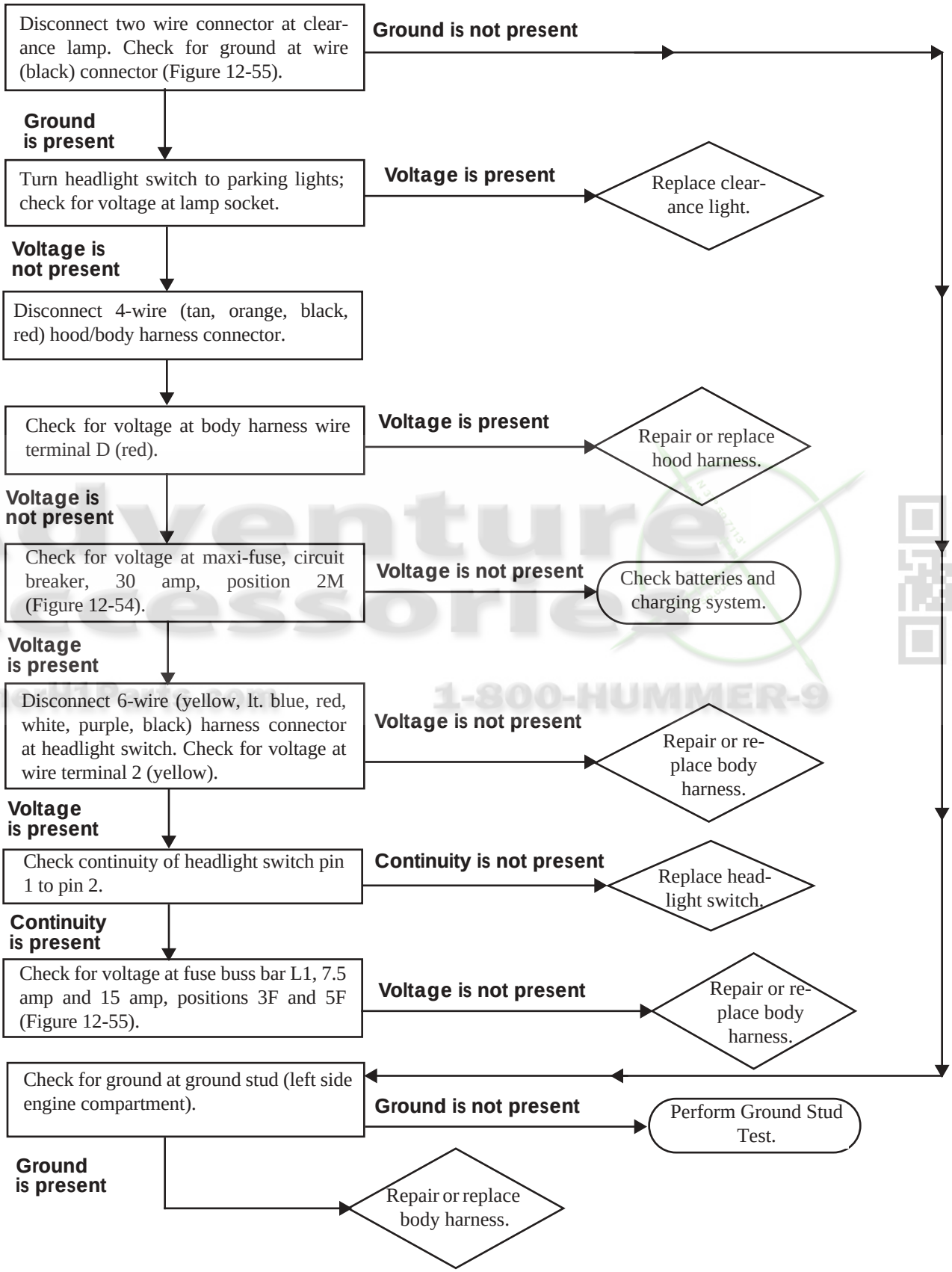


TURN SIGNAL(S) INOPERATIVE – CONTINUED

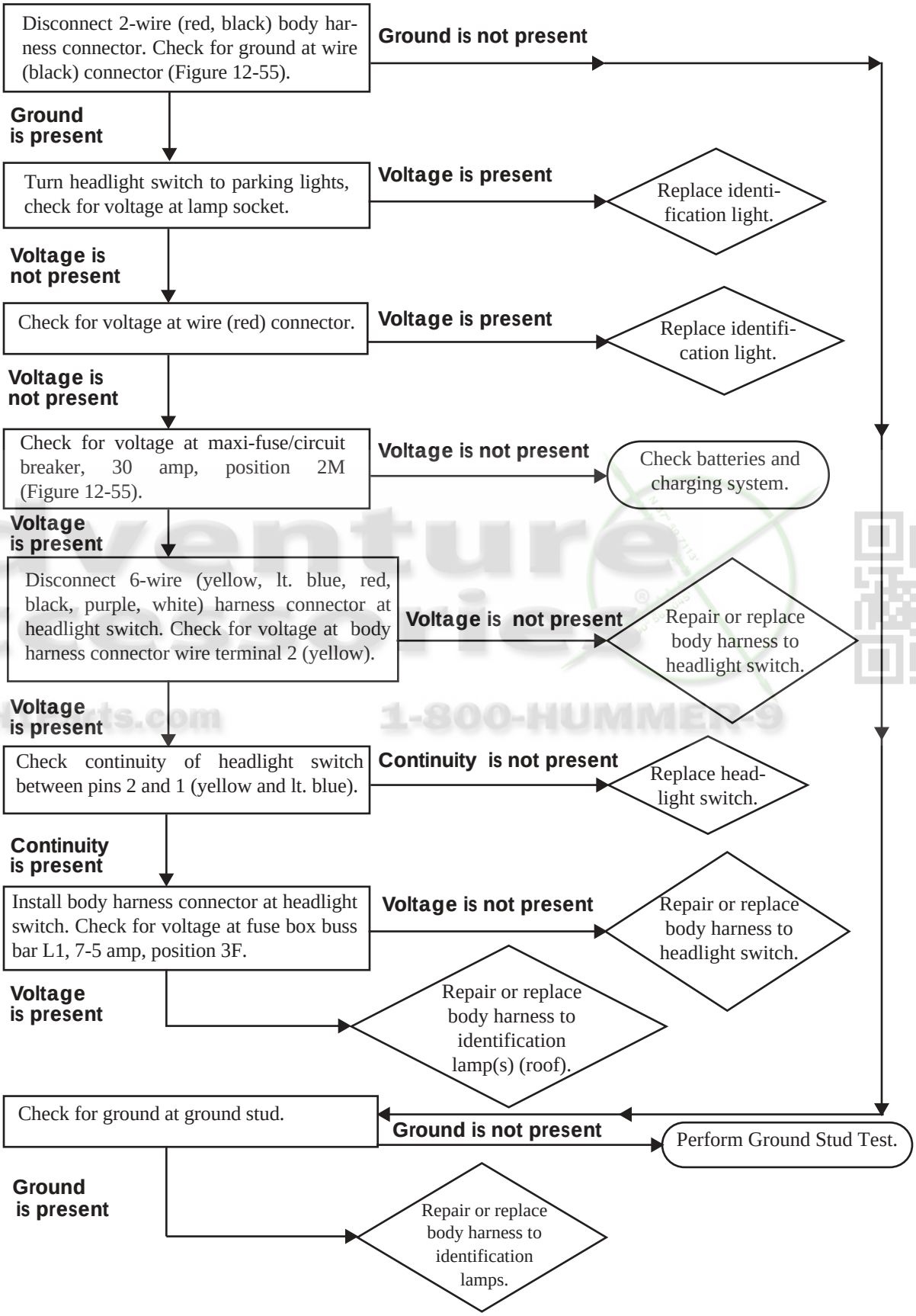




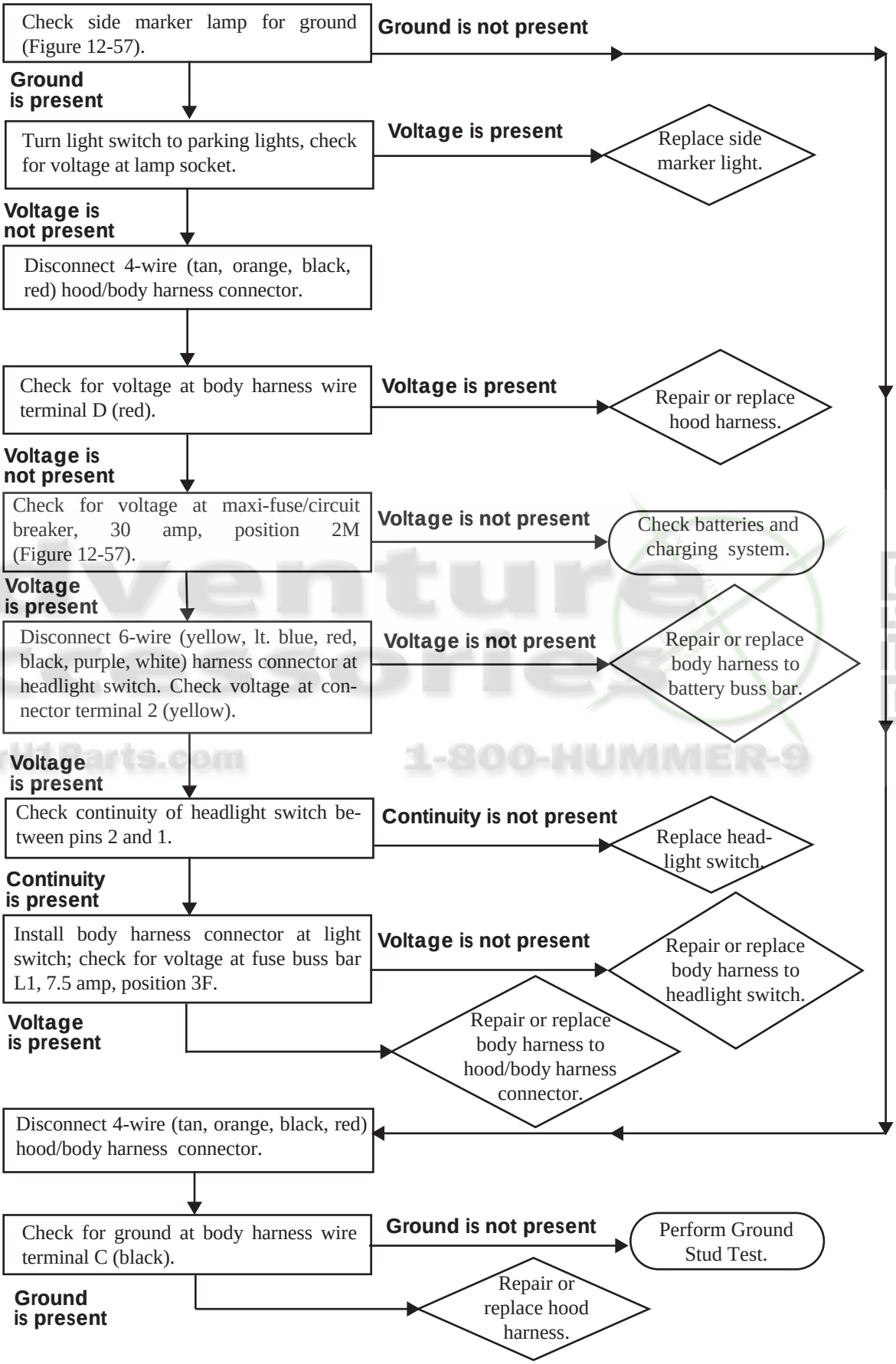
HOOD CLEARANCE LIGHT(S) INOPERATIVE



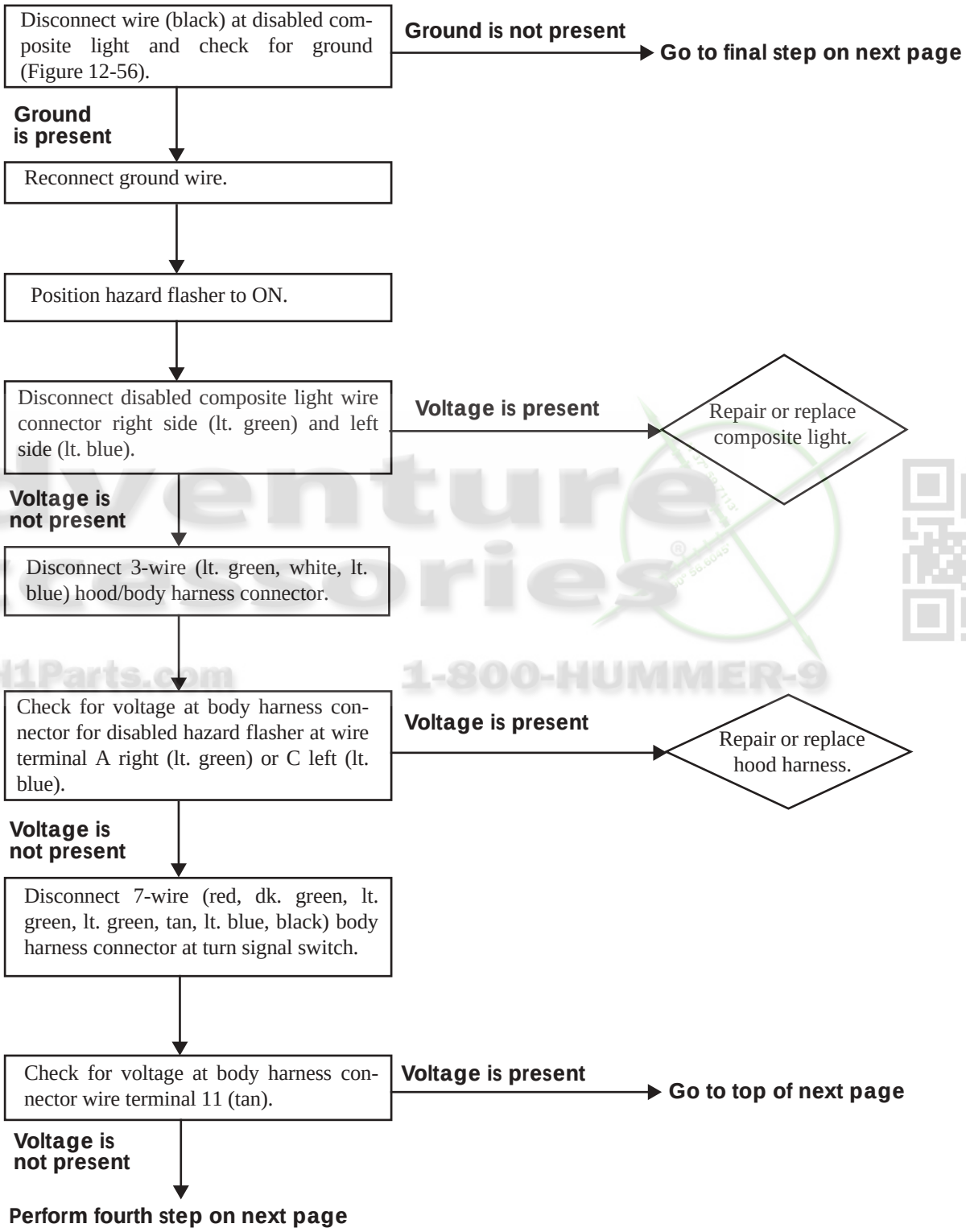
ROOF IDENTIFICATION LIGHT(S) INOPERATIVE



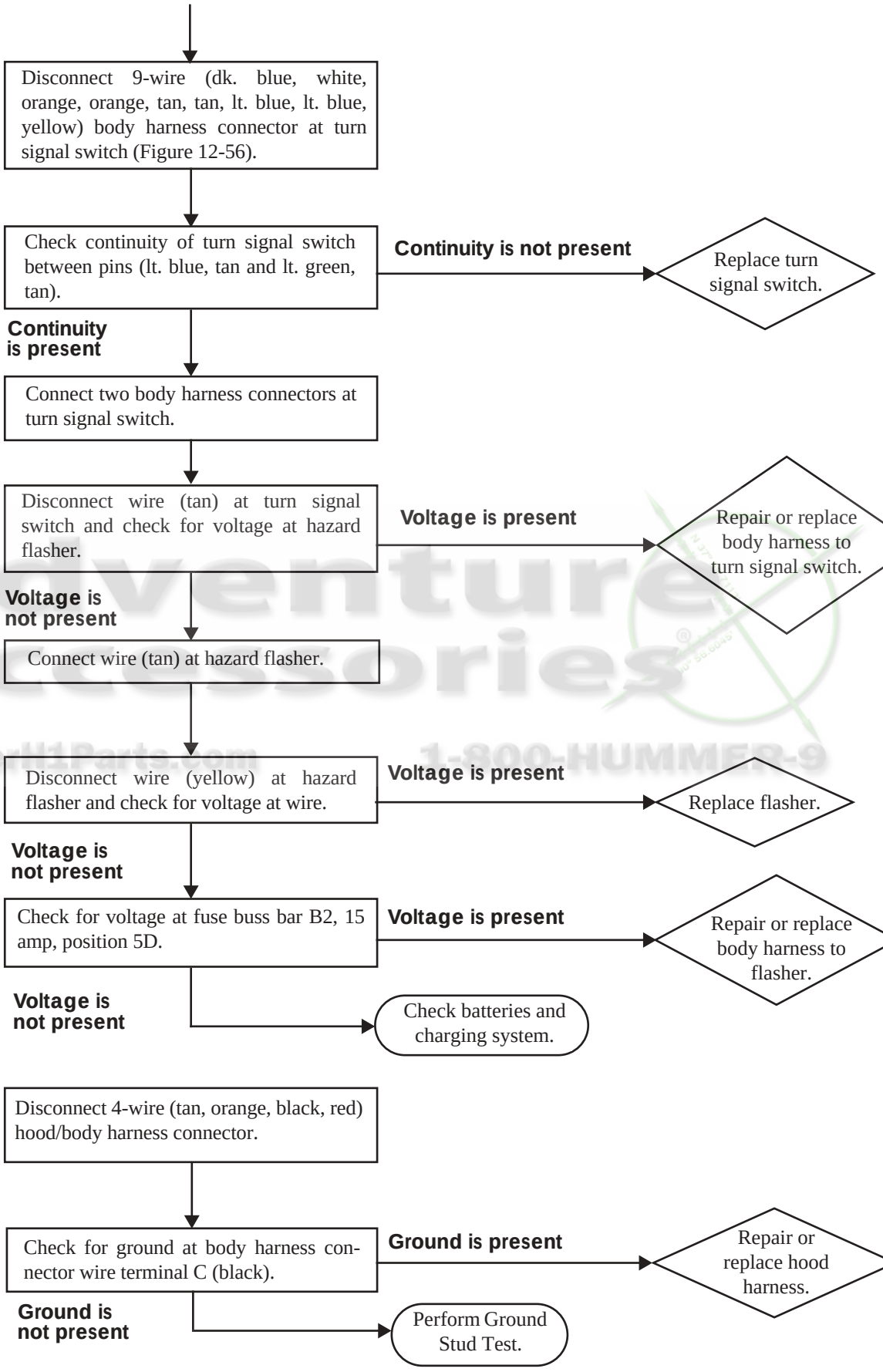
SIDE MARKER LIGHT(S) INOPERATIVE



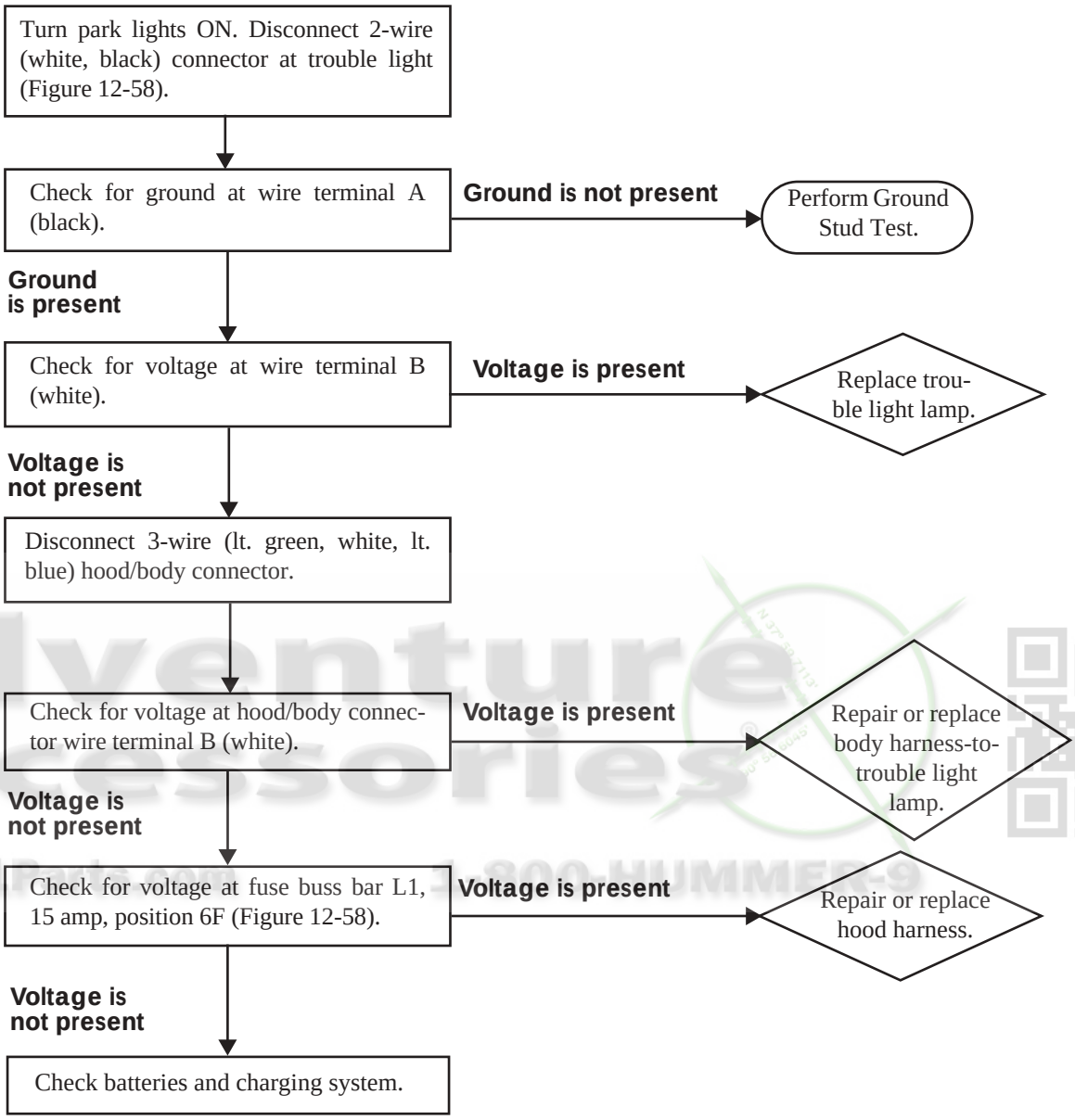
HAZARD FLASHER(S) (HOOD HARNESS) INOPERATIVE



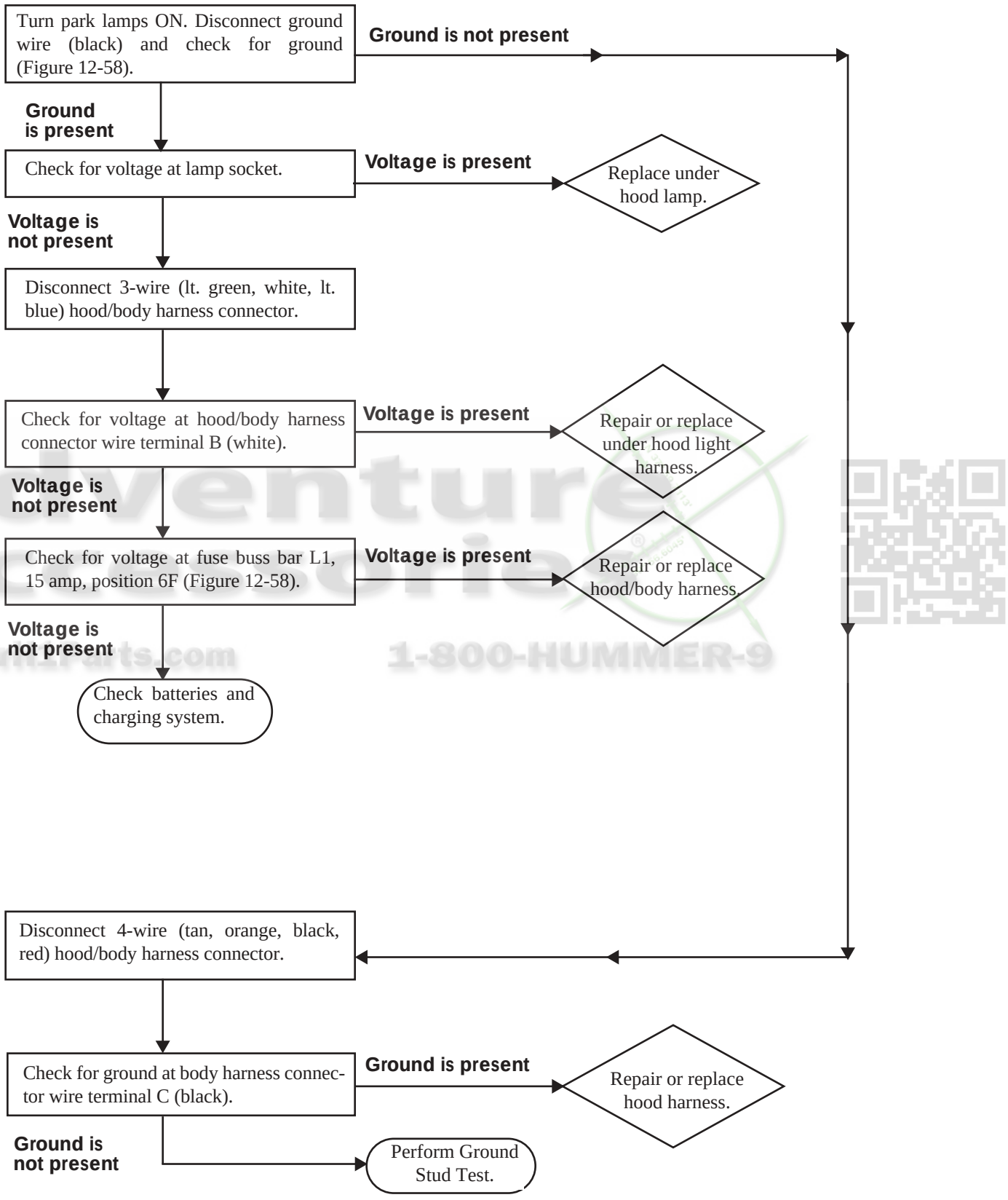
HAZARD FLASHER(S) (HOOD HARNESS) INOPERATIVE – CONTINUED



TROUBLE LIGHT INOPERATIVE



UNDER HOOD LIGHT INOPERATIVE



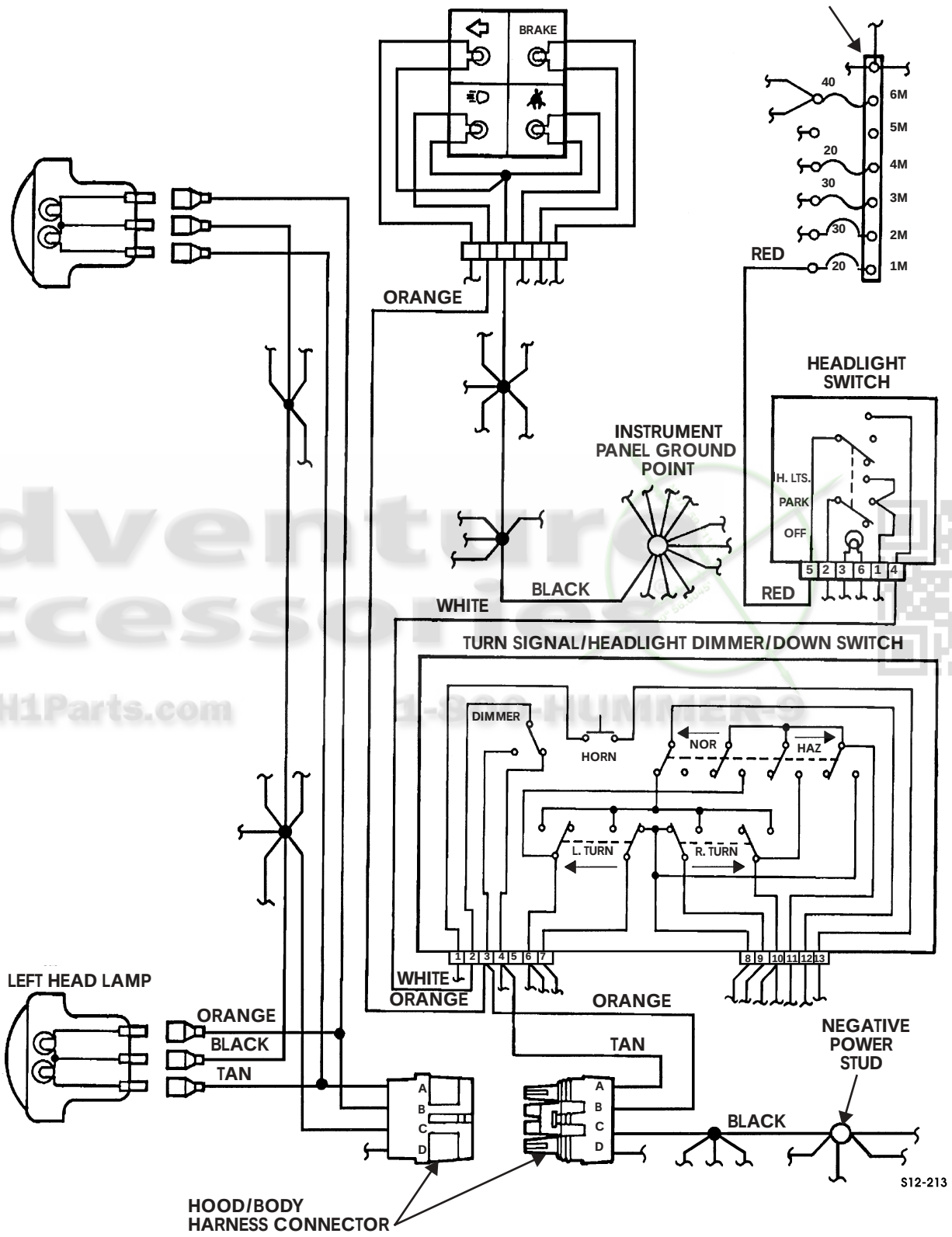


Figure 12-52: Headlights

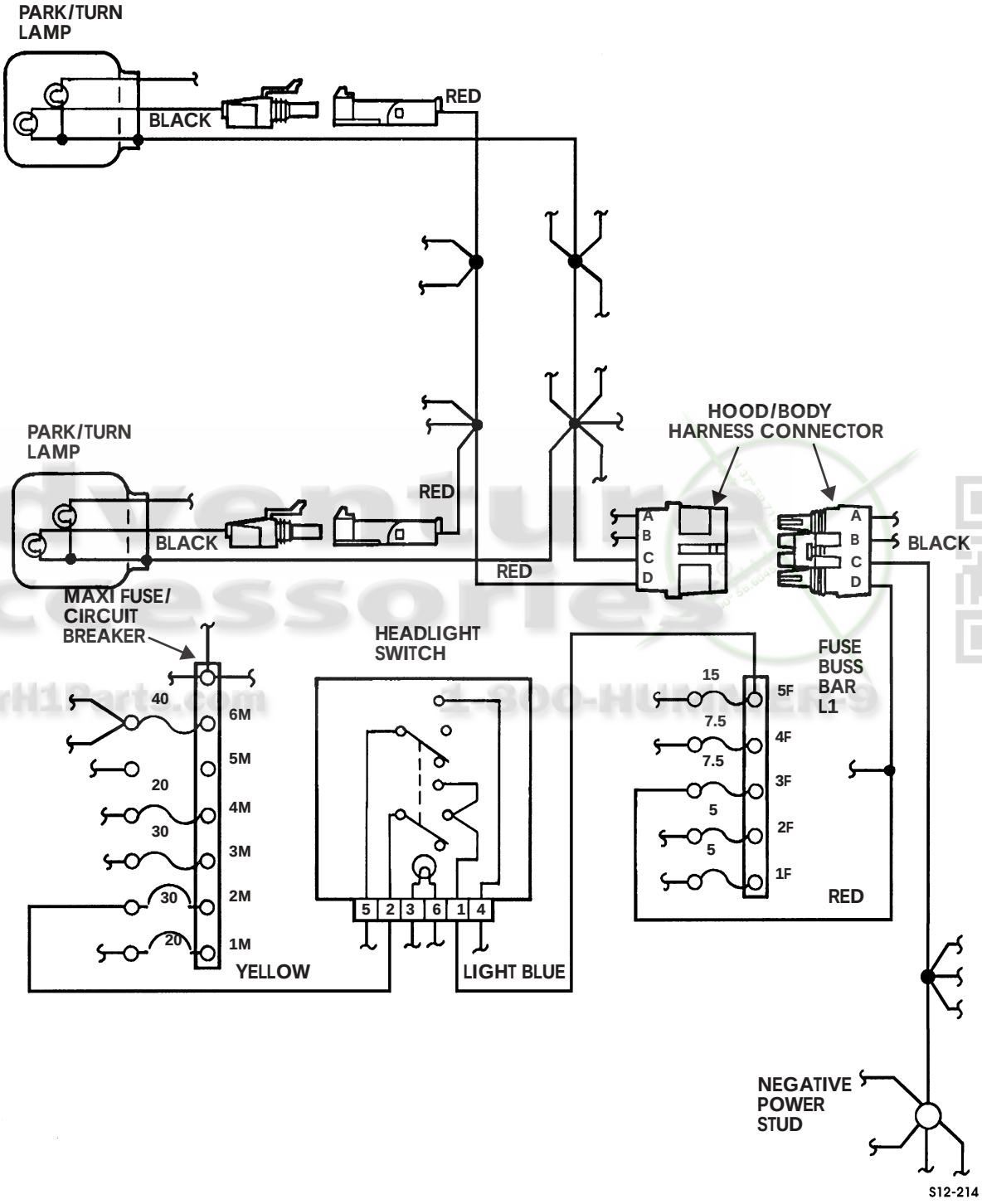


Figure 12-53: Front Parking Lights

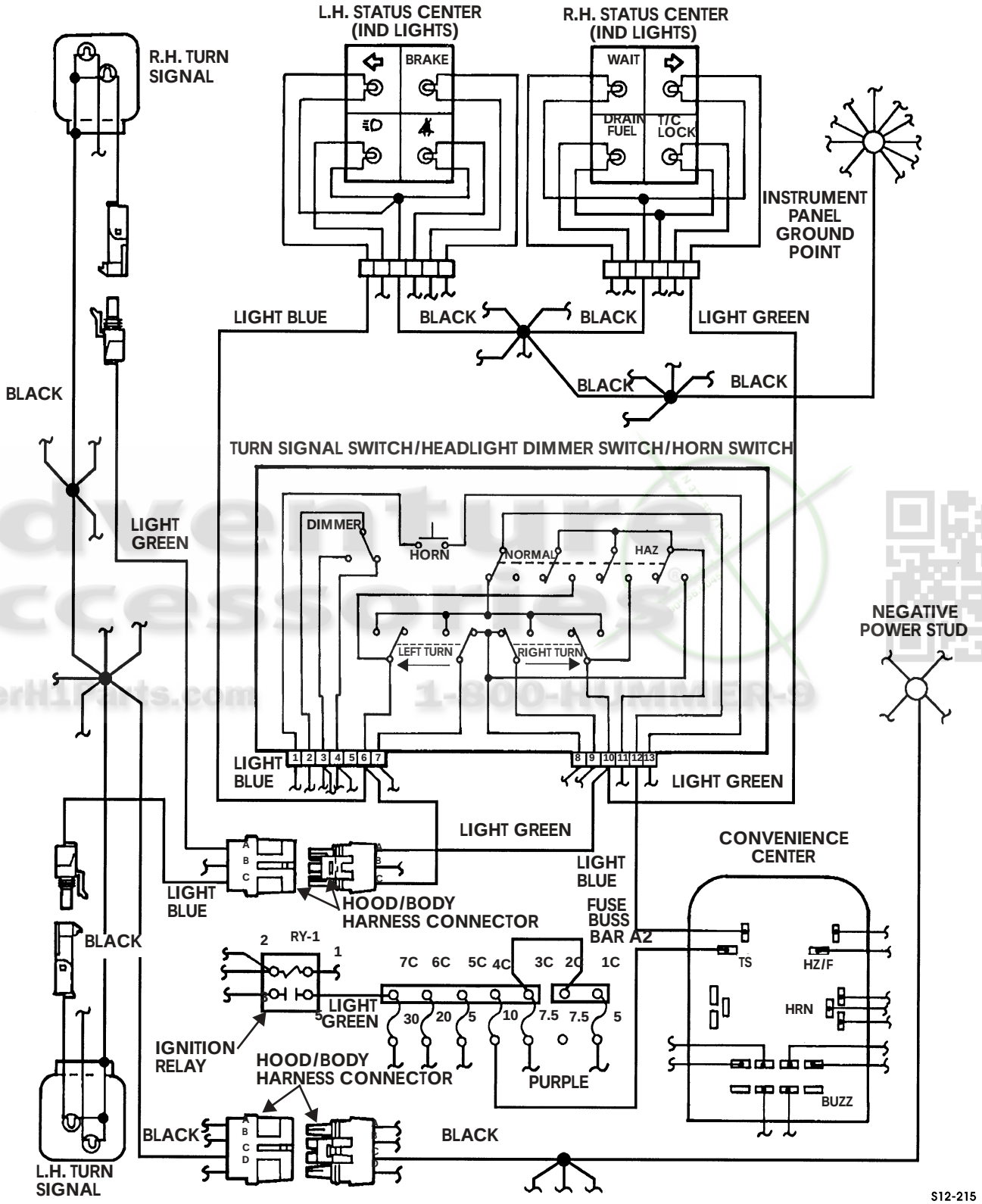


Figure 12-54: Front Turn Signals

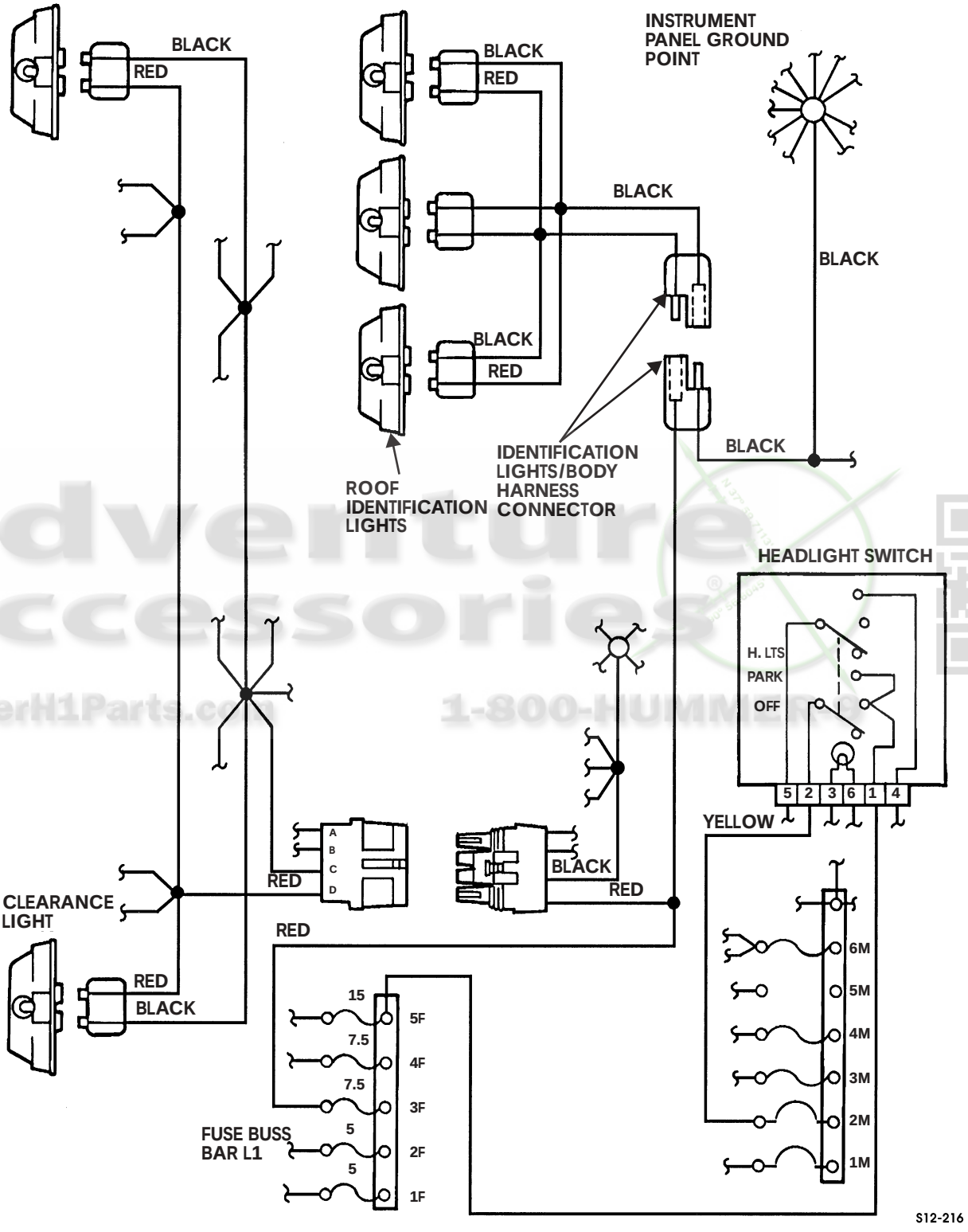


Figure 12-55: Hood and Roof Identification Lights

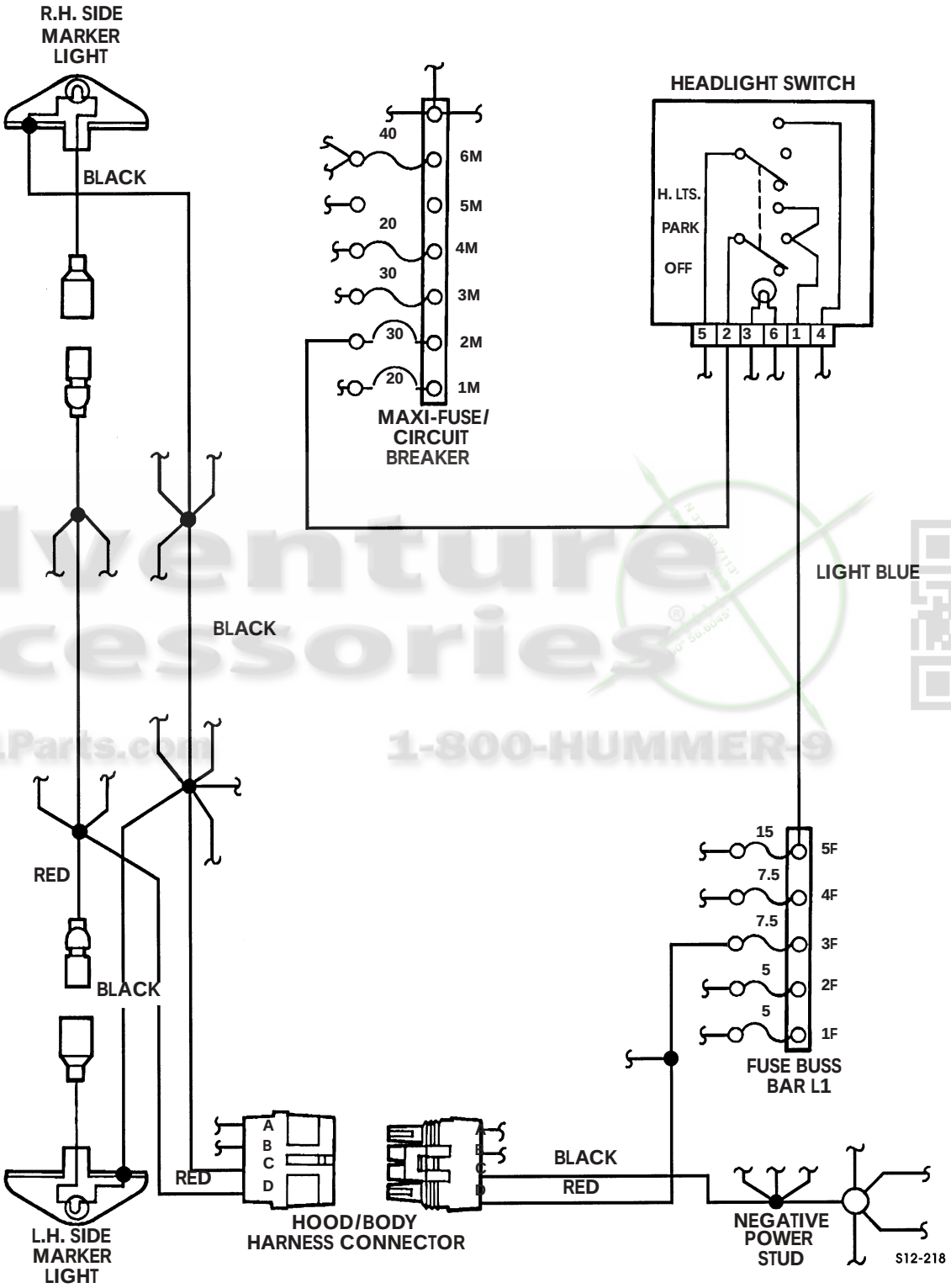


Figure 12-56: Front Side Marker Lights

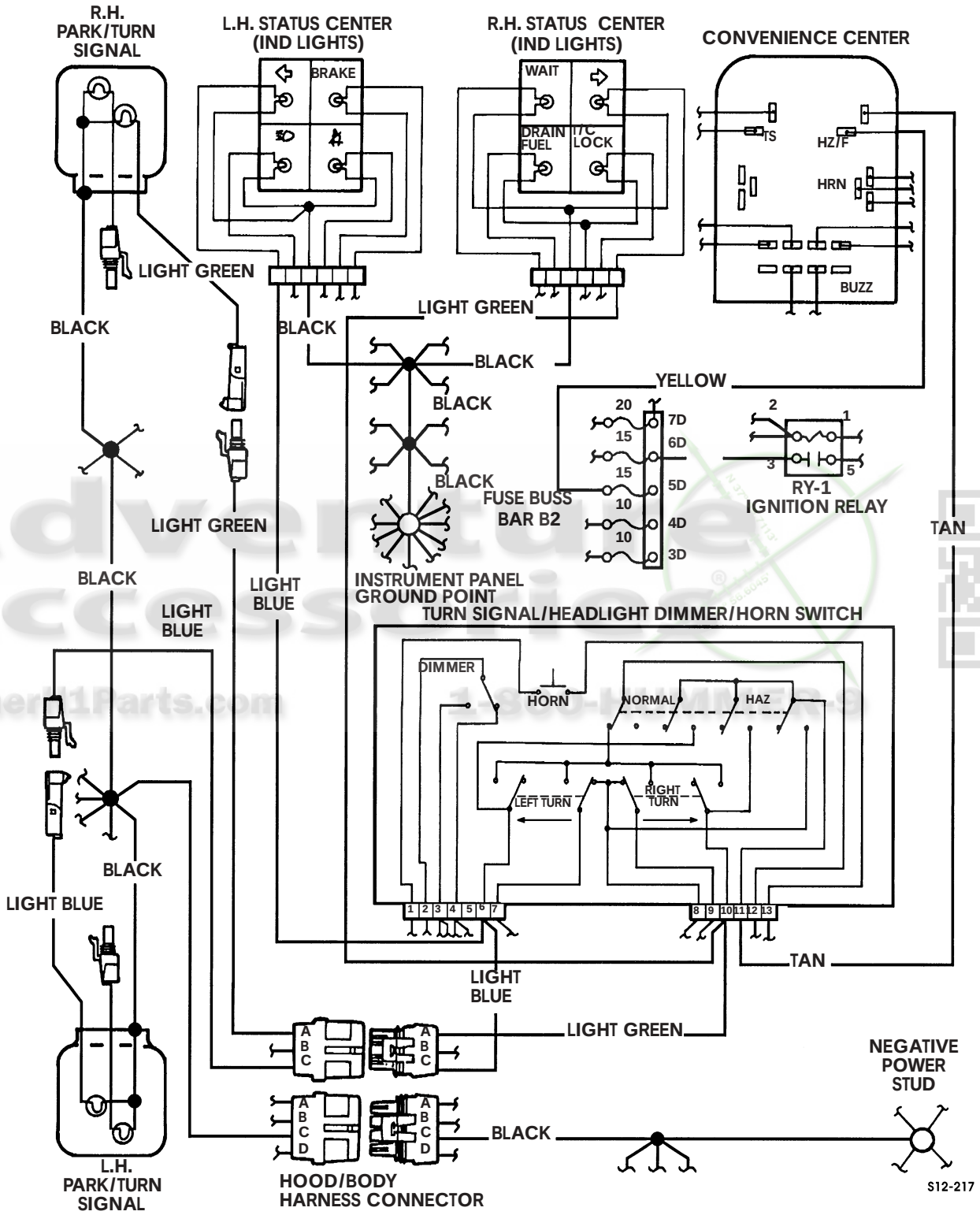


Figure 12-57: Hazards Flashers

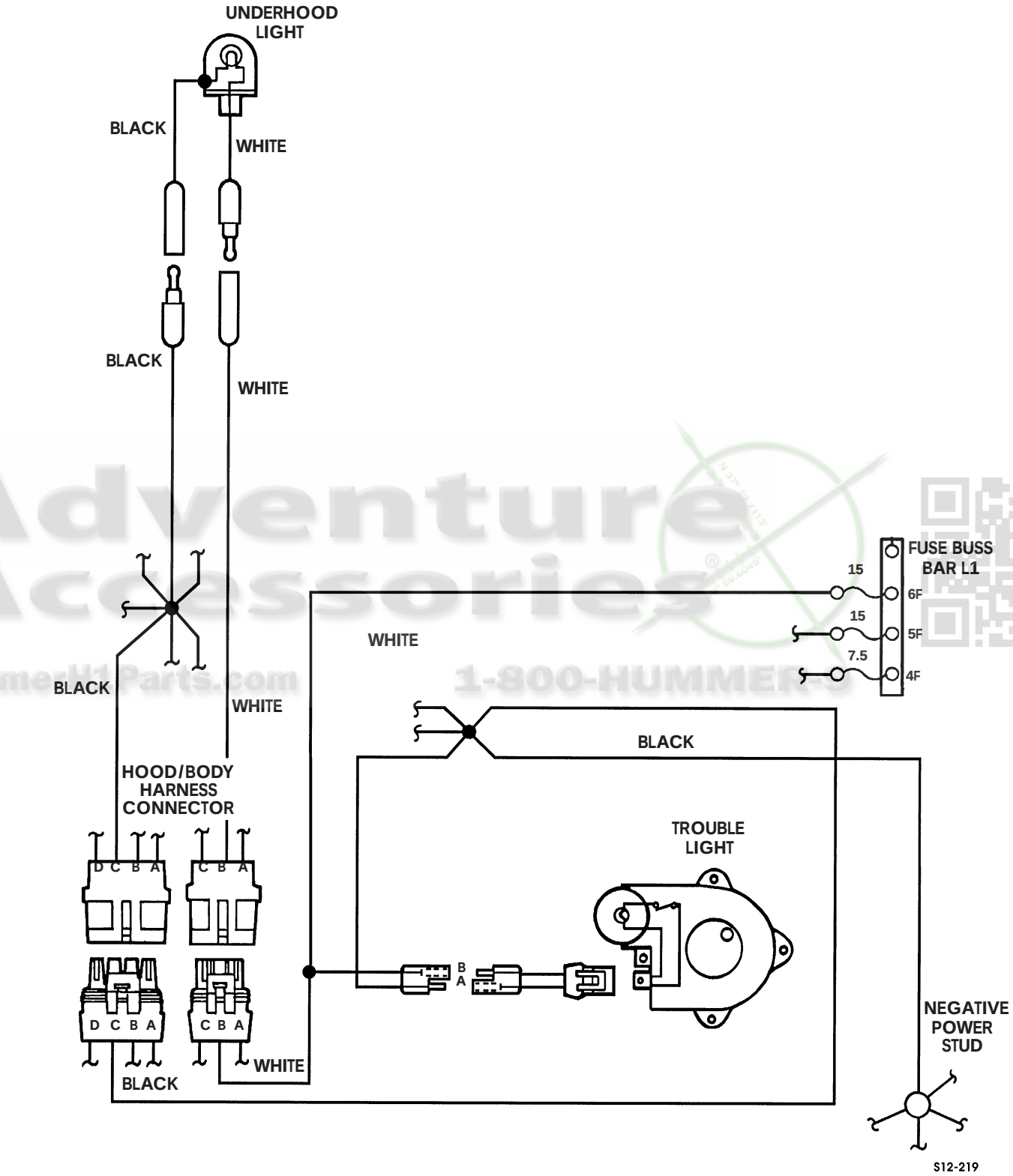
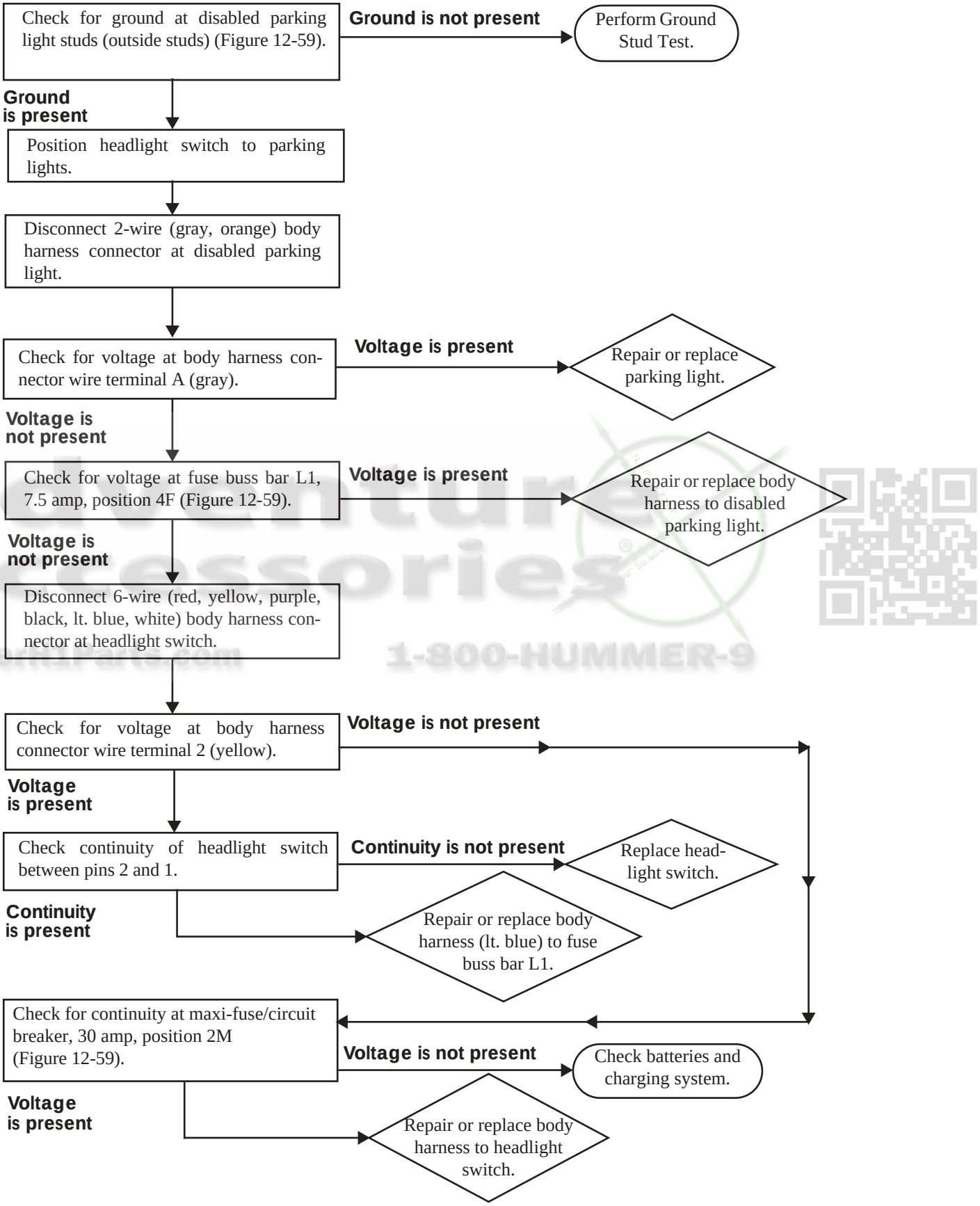
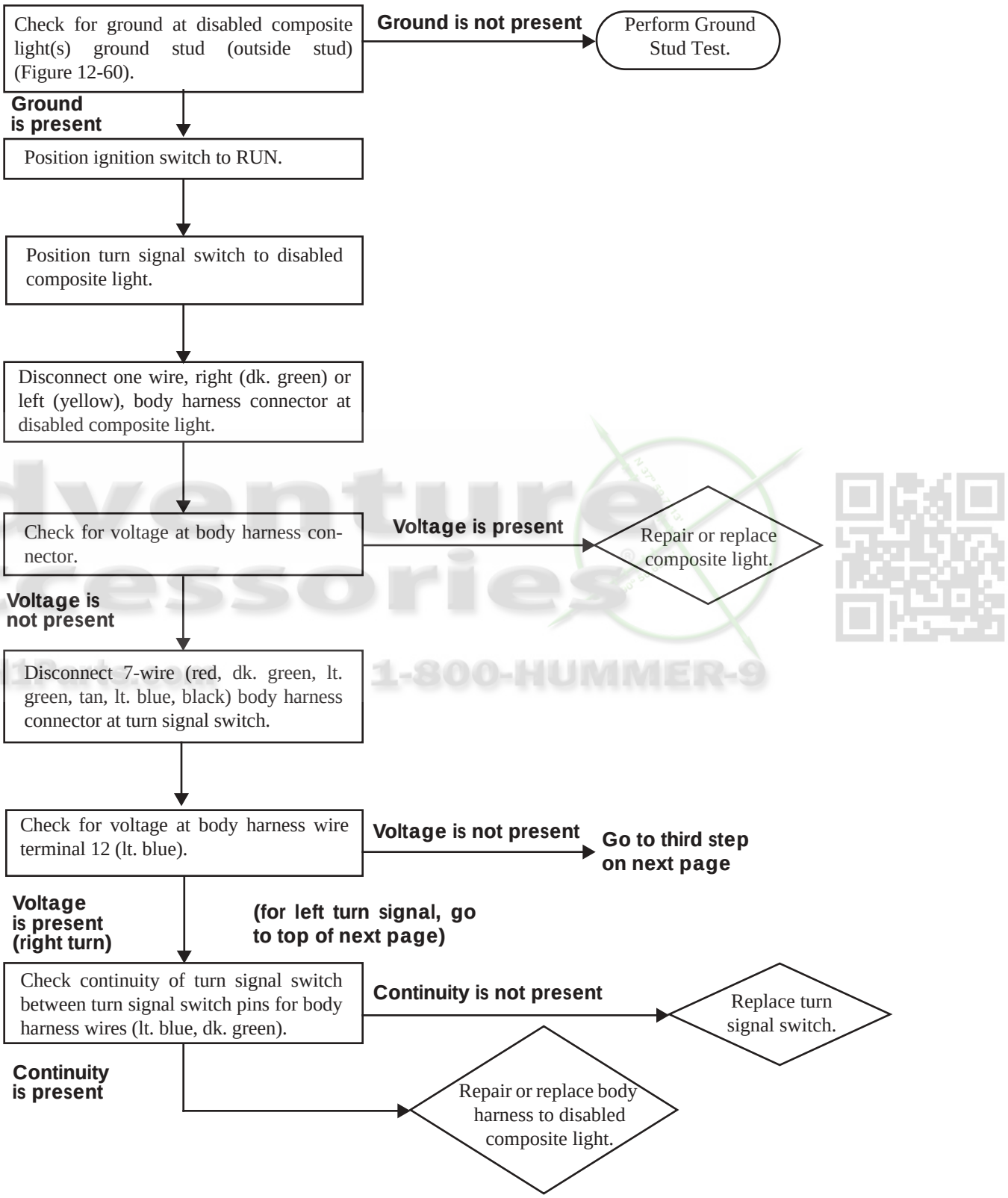


Figure 12-58: Under Hood and Trouble Lights

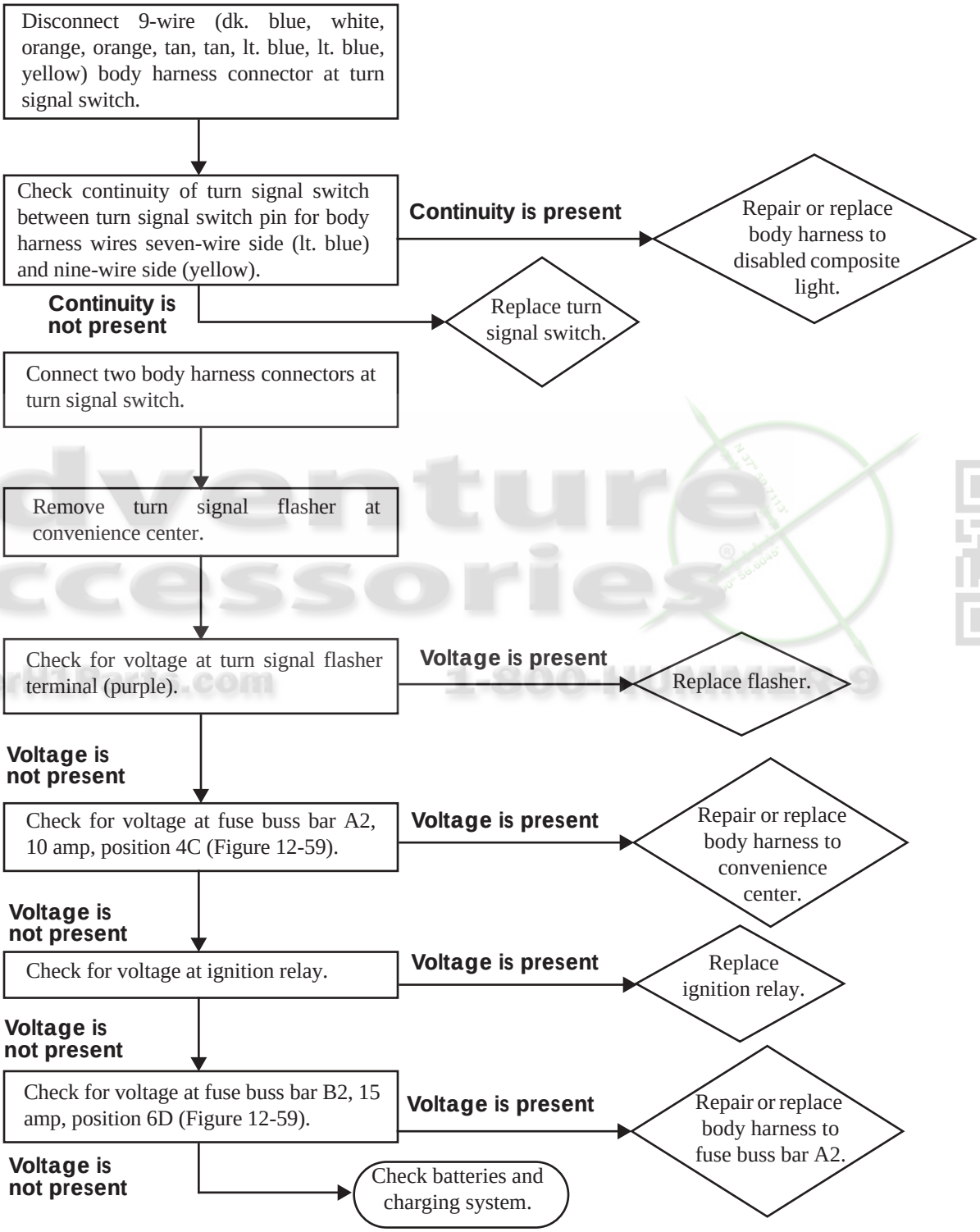
PARKING LIGHT(S) (REAR) INOPERATIVE



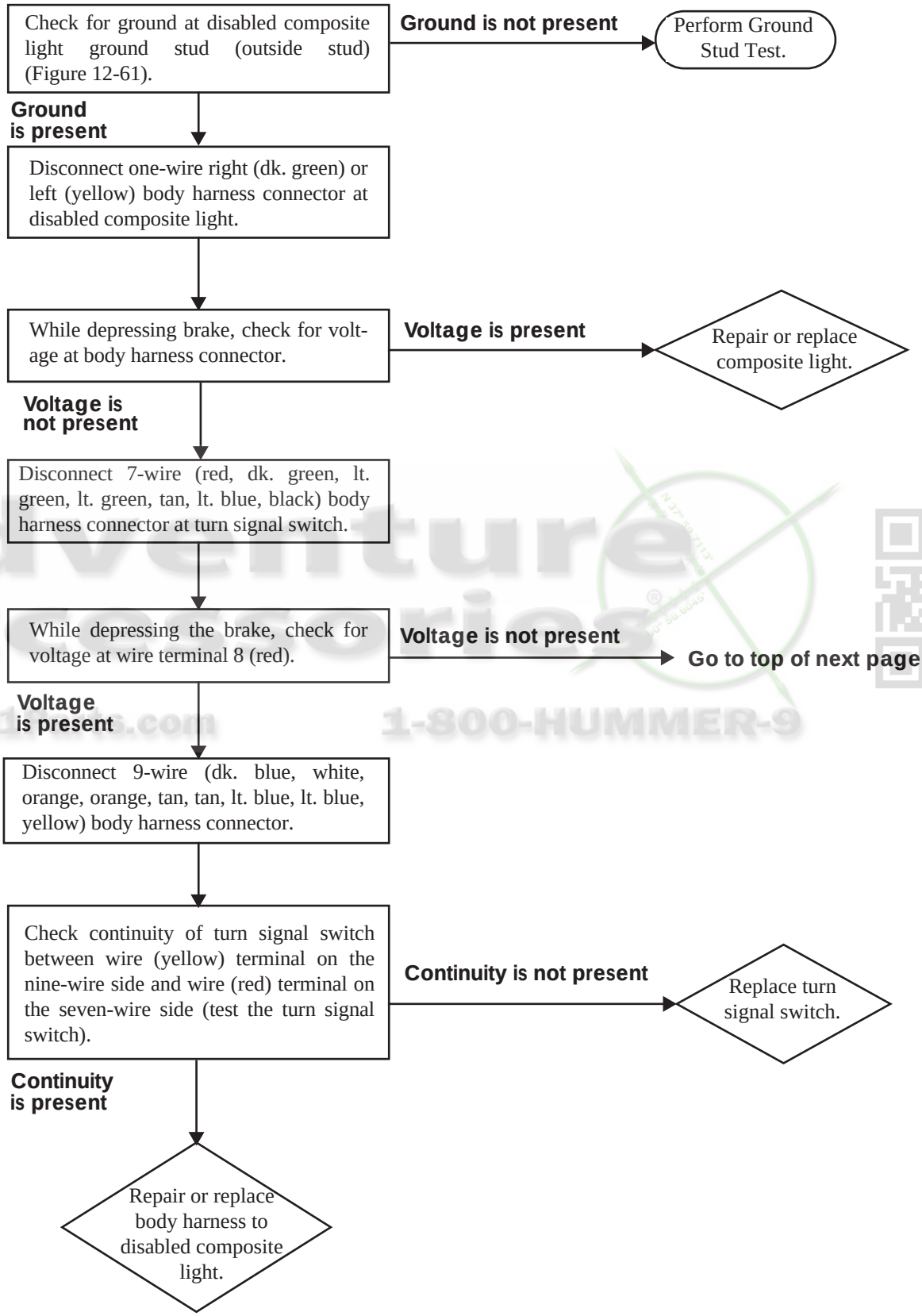
TURN SIGNAL LIGHT(S) (REAR) INOPERATIVE



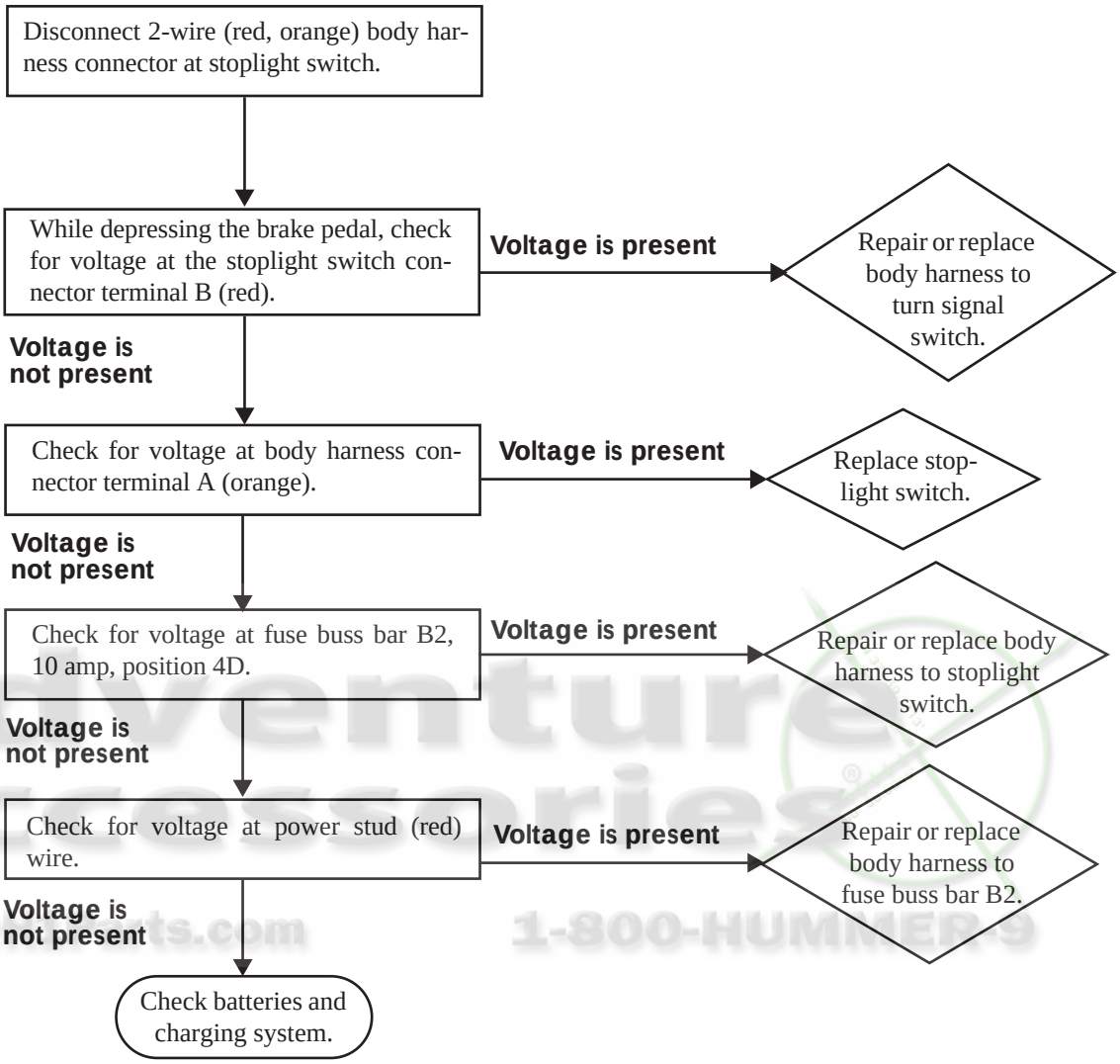
TURN SIGNAL LIGHT(S) (REAR) INOPERATIVE — CONTINUED



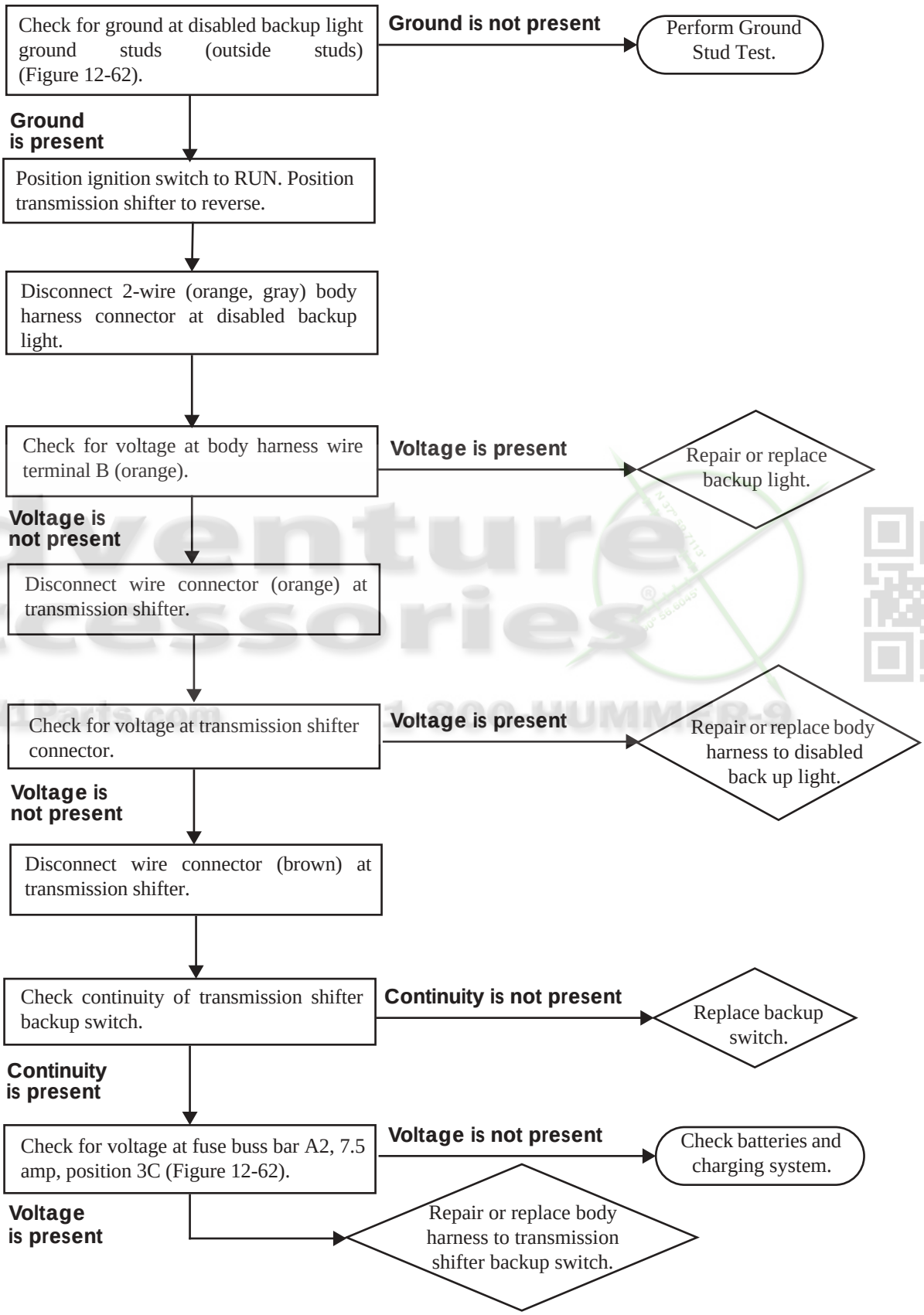
STOPLIGHT(S) INOPERATIVE



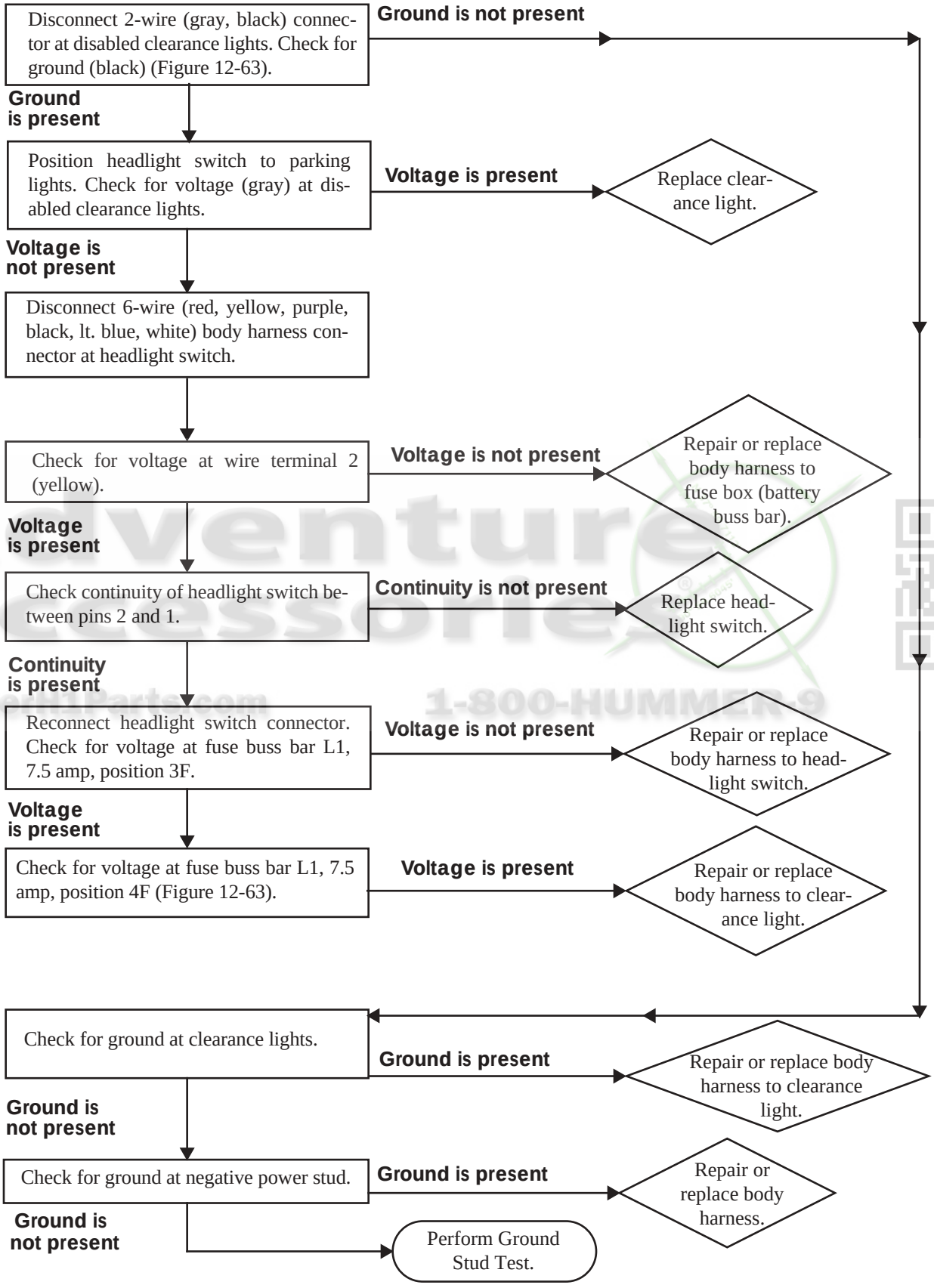
STOPLIGHT(S) INOPERATIVE – CONTINUED



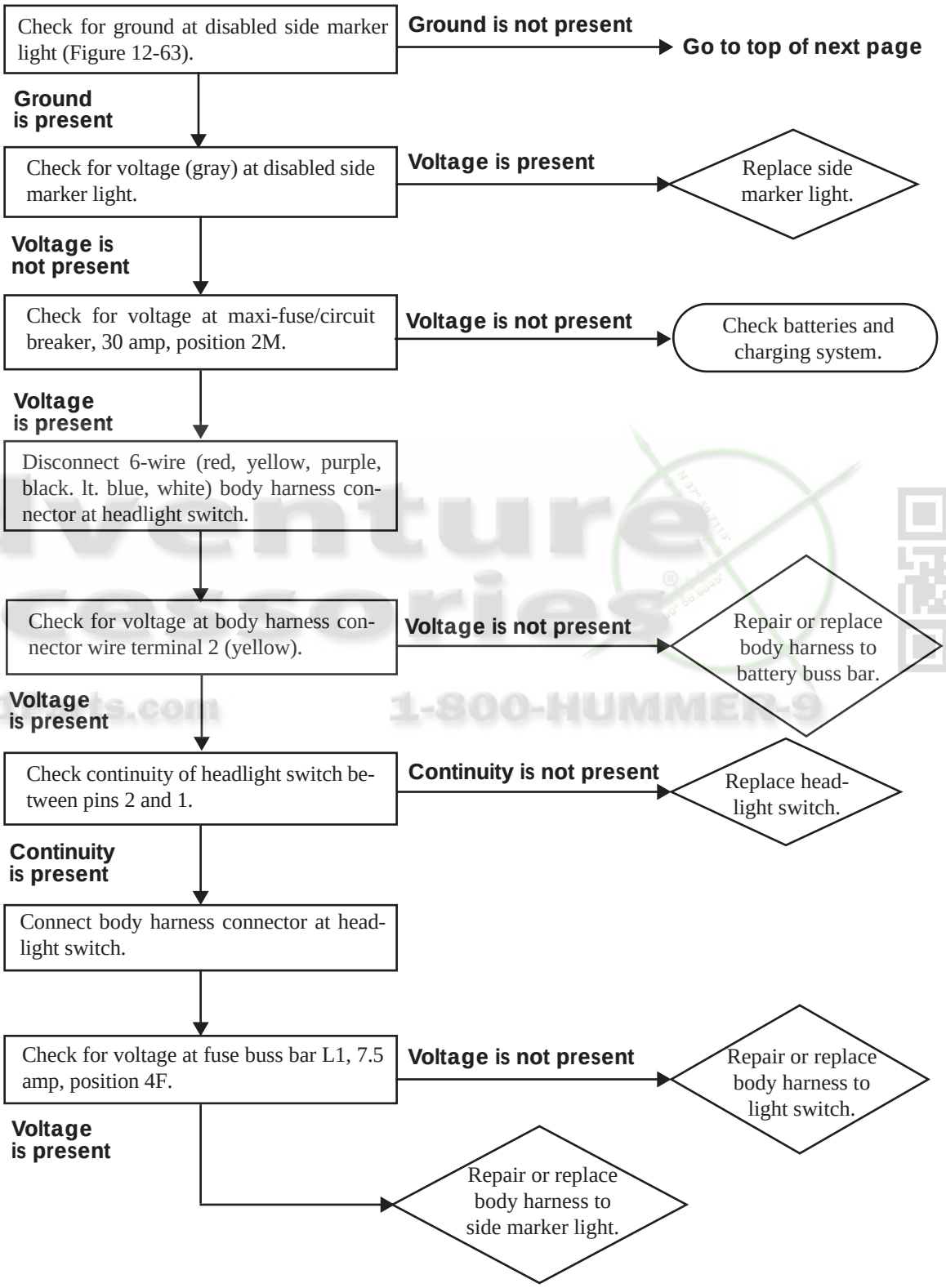
BACKUP LIGHT(S) INOPERATIVE



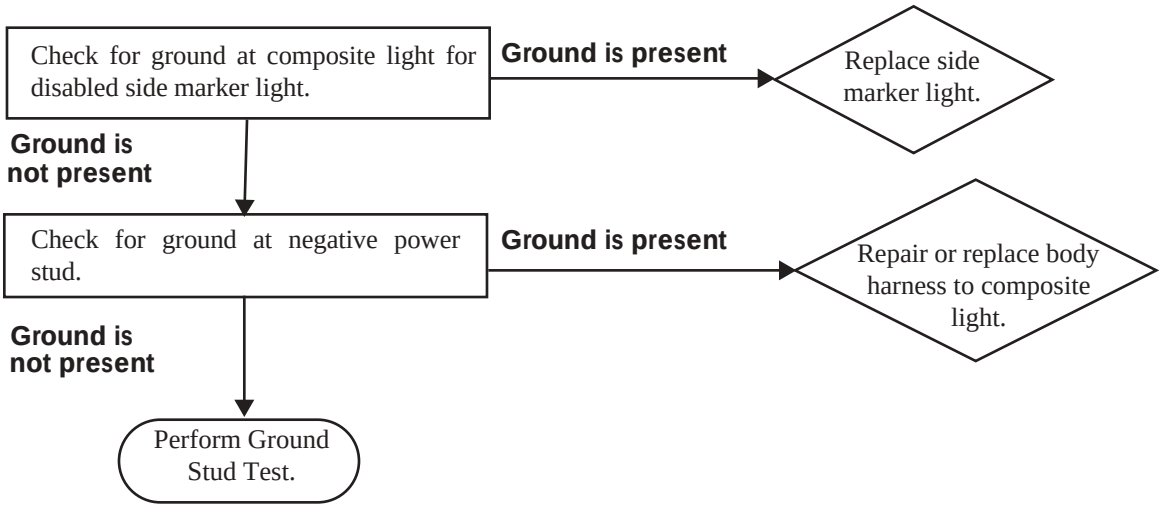
CLEARANCE LIGHT(S) INOPERATIVE



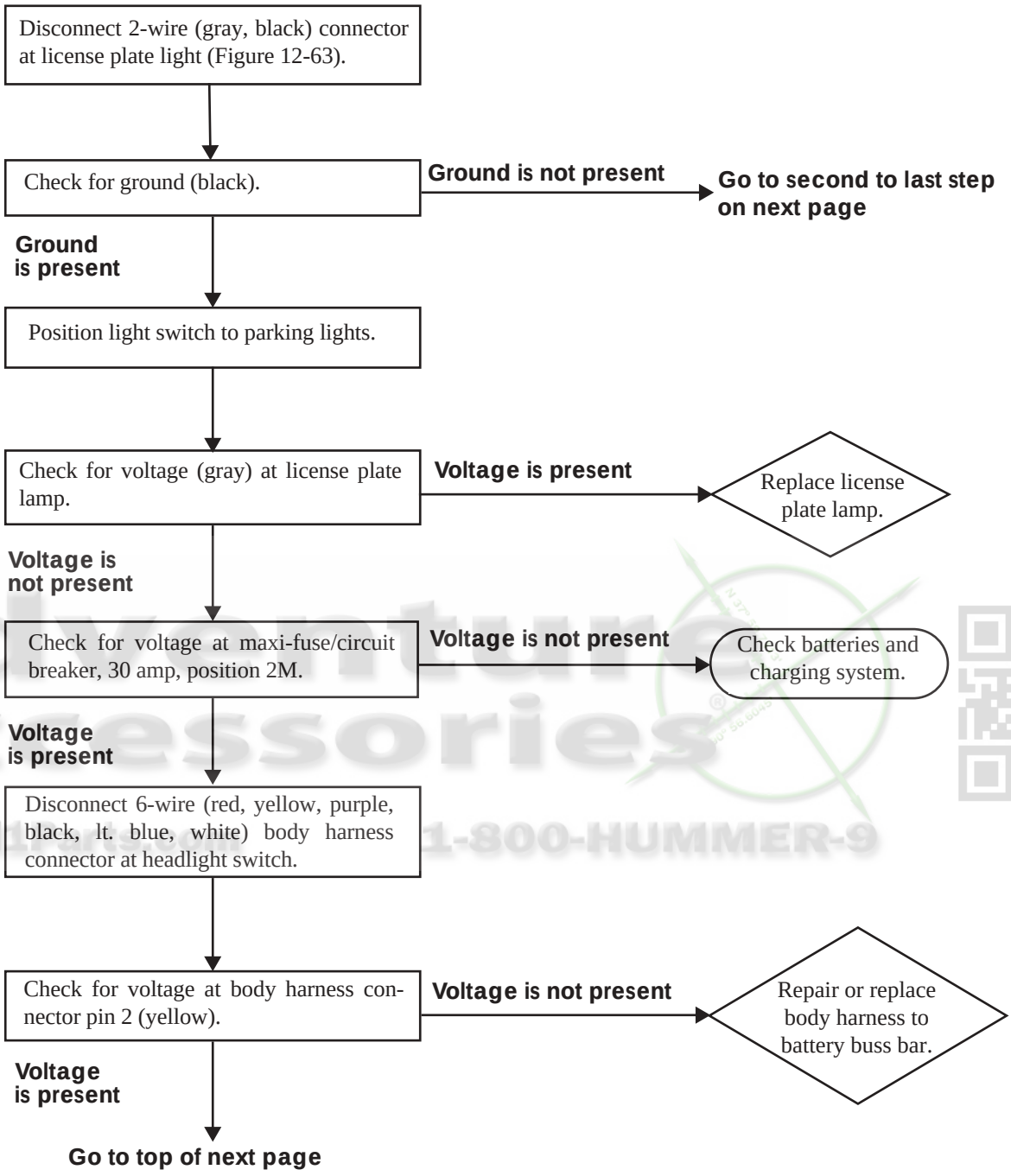
SIDE MARKER LIGHT(S) (REAR) INOPERATIVE



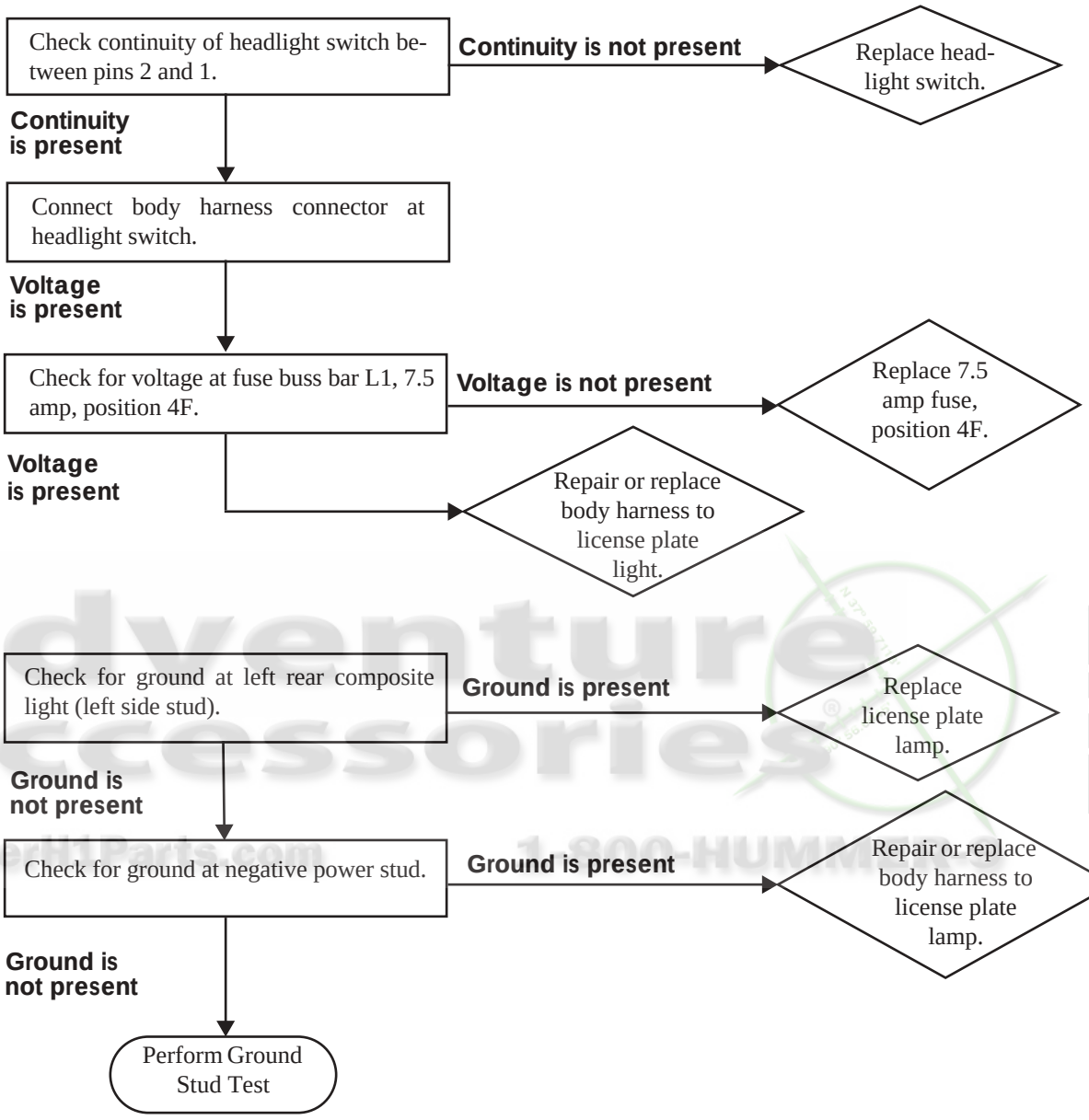
SIDE MARKER LIGHT(S) (REAR) INOPERATIVE – CONTINUED



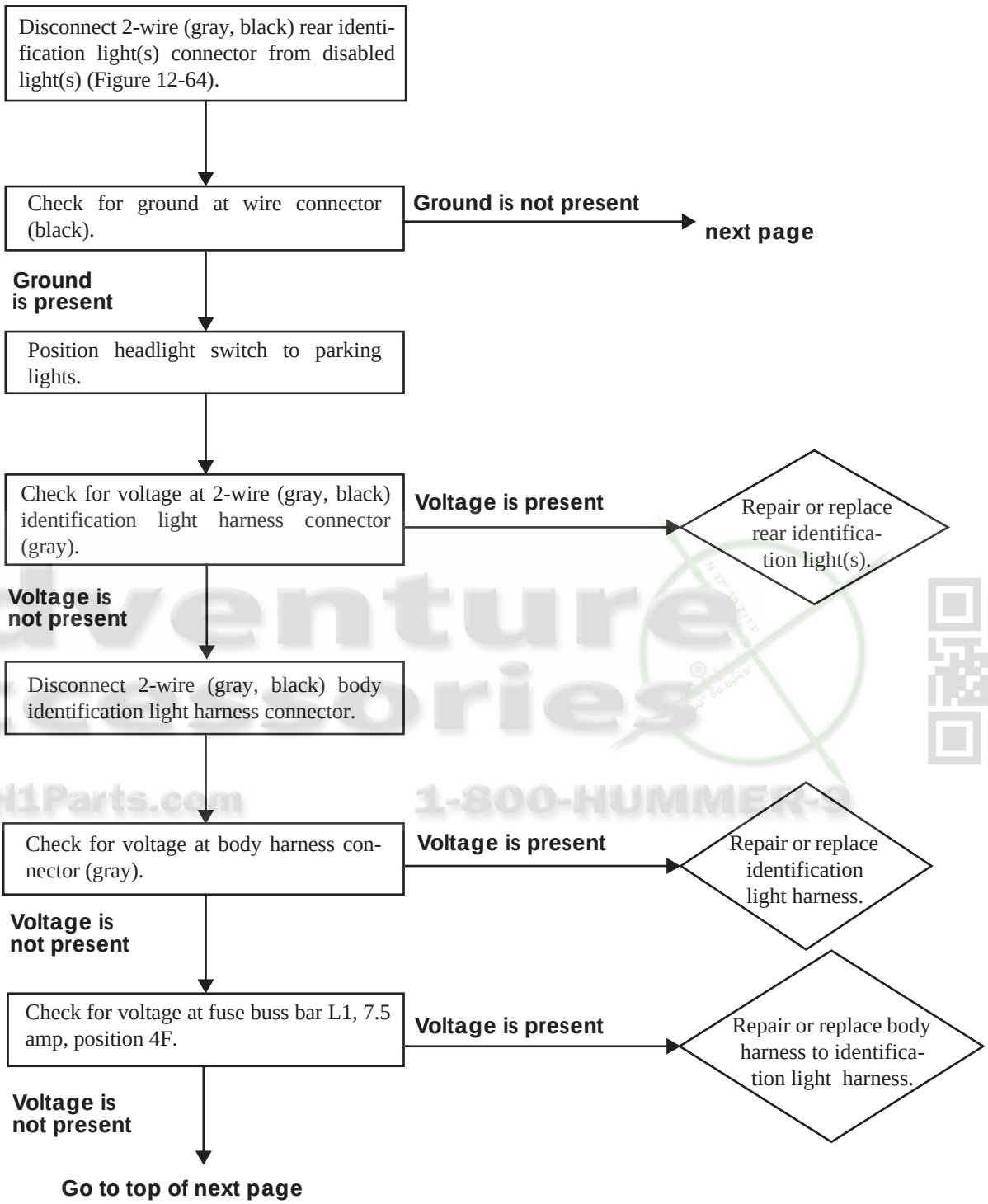
LICENSE PLATE LIGHT INOPERATIVE



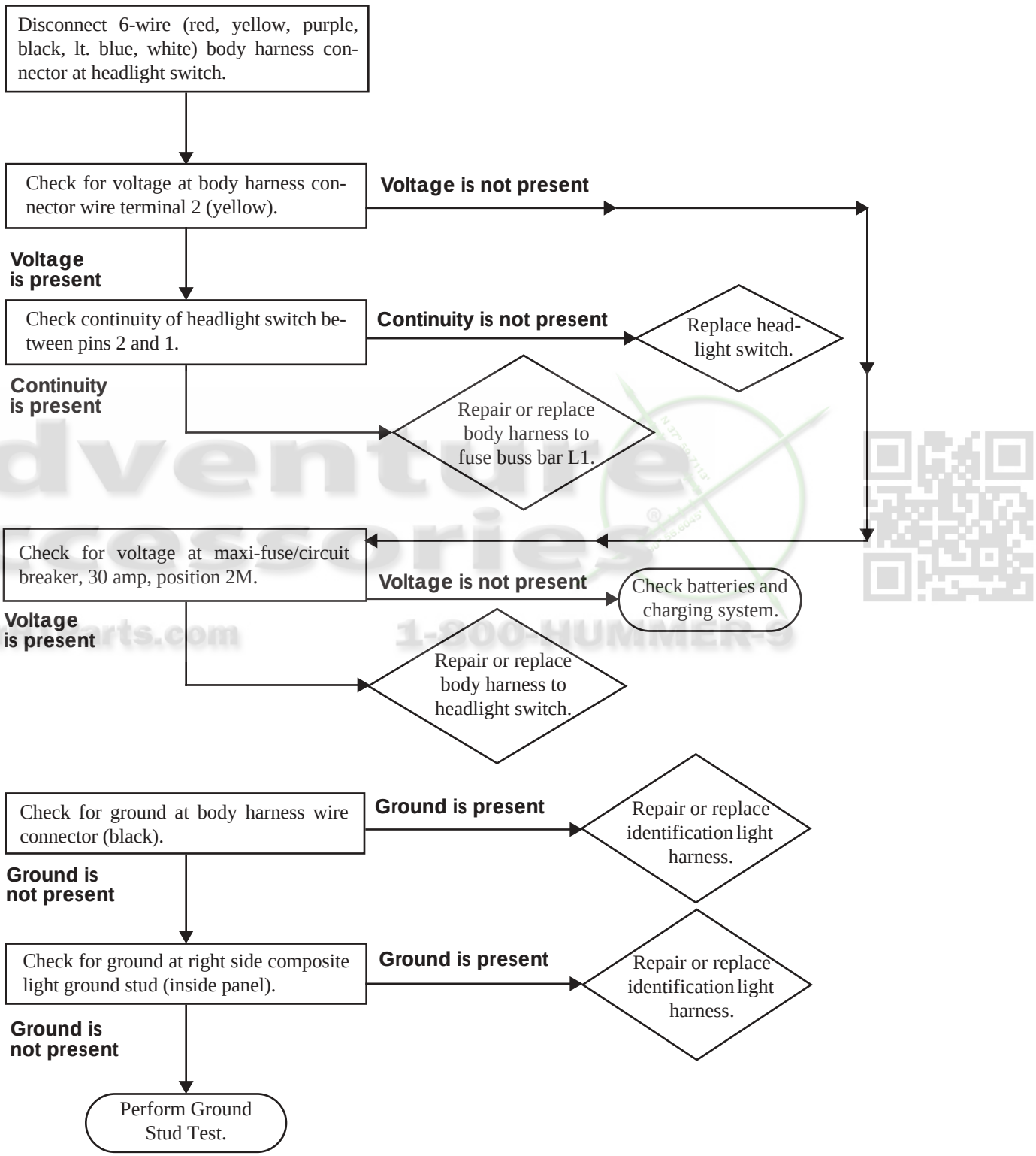
LICENSE PLATE LIGHT INOPERATIVE – CONTINUED



REAR IDENTIFICATION LIGHT(S) INOPERATIVE



REAR IDENTIFICATION LIGHT(S) INOPERATIVE – CONTINUED



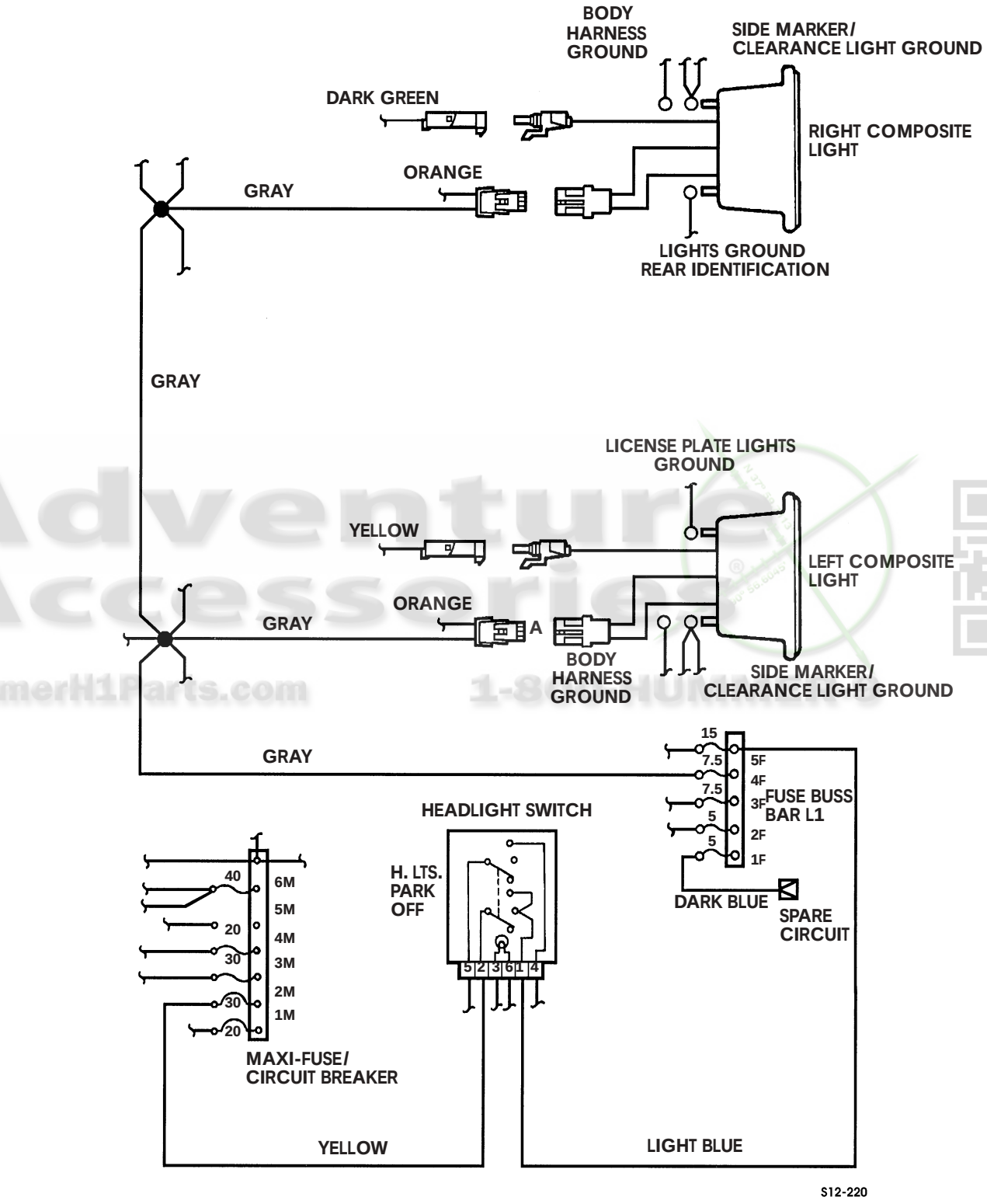


Figure 12-59: Rear Parking Lights

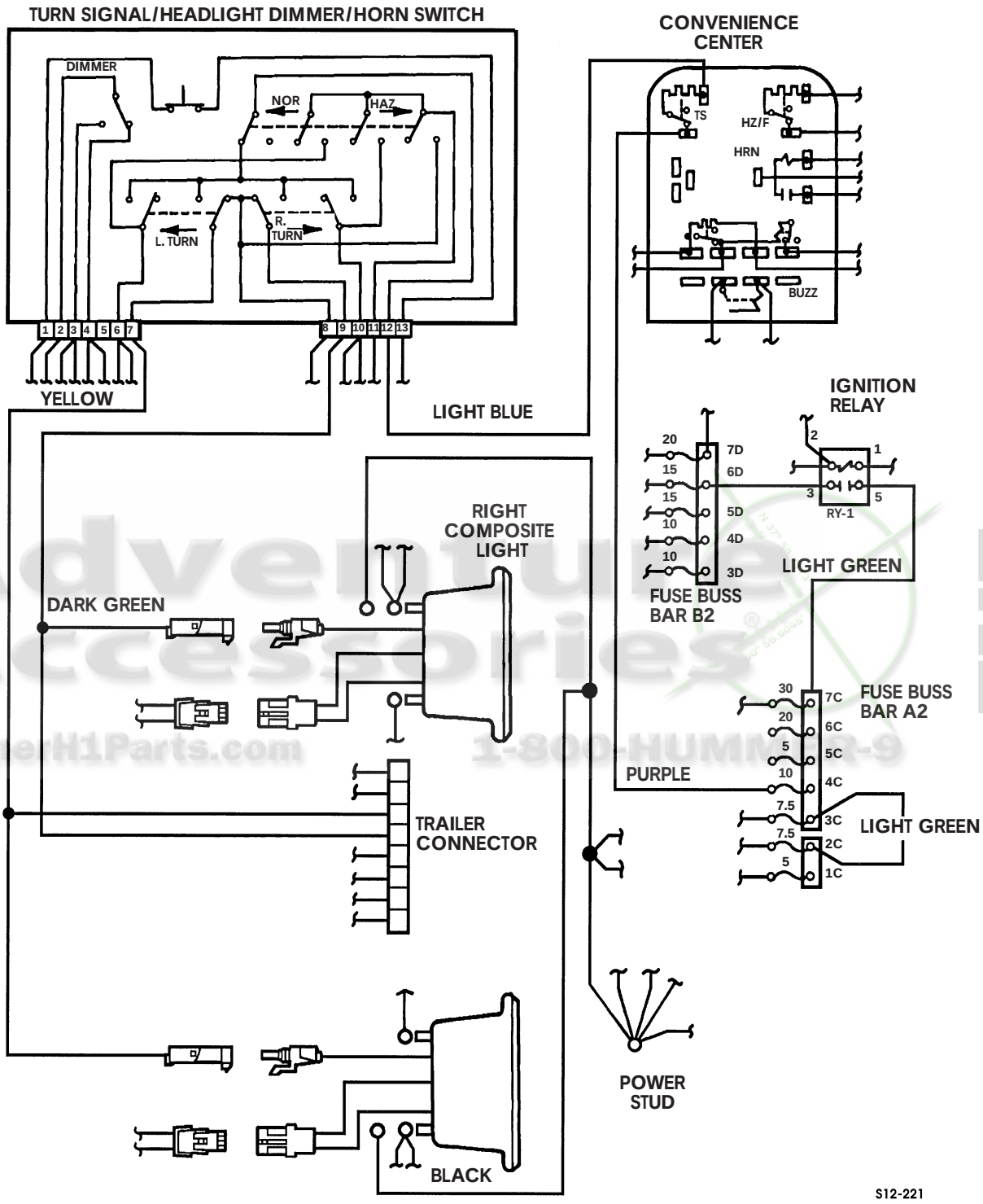


Figure 12-60: Rear Turn Signal

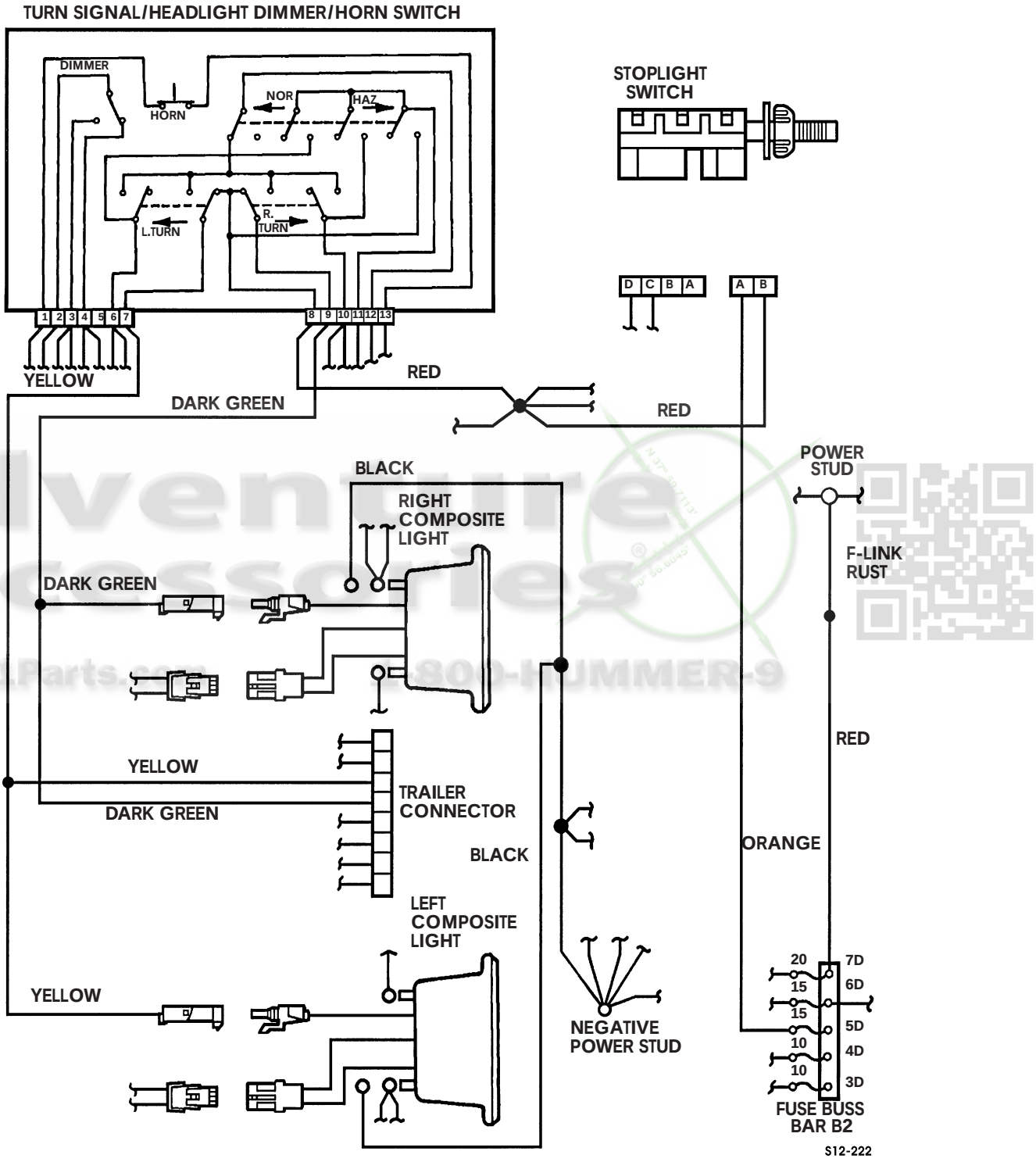


Figure 12-61: Stoplights

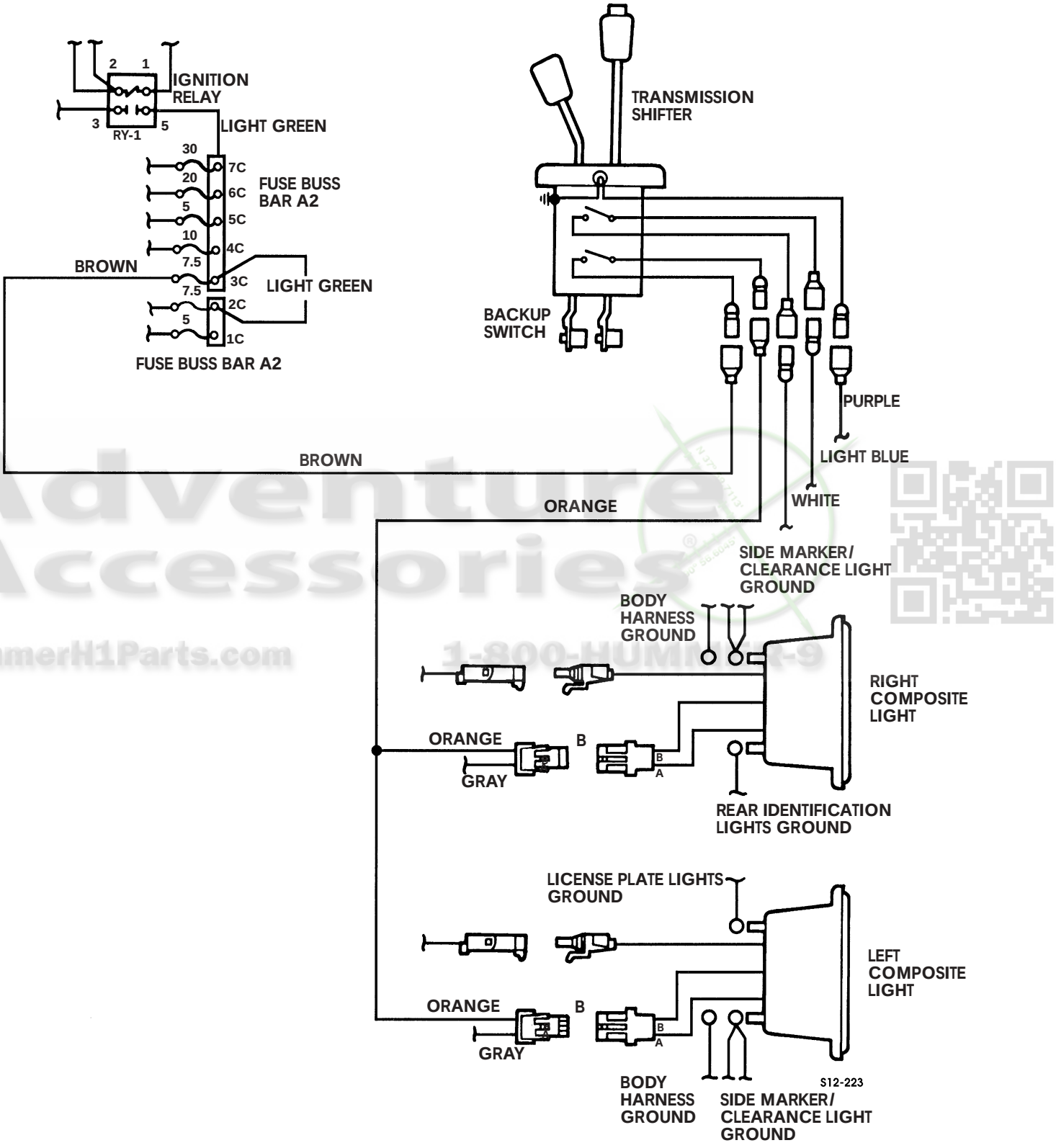


Figure 12-62: Backup LIghts

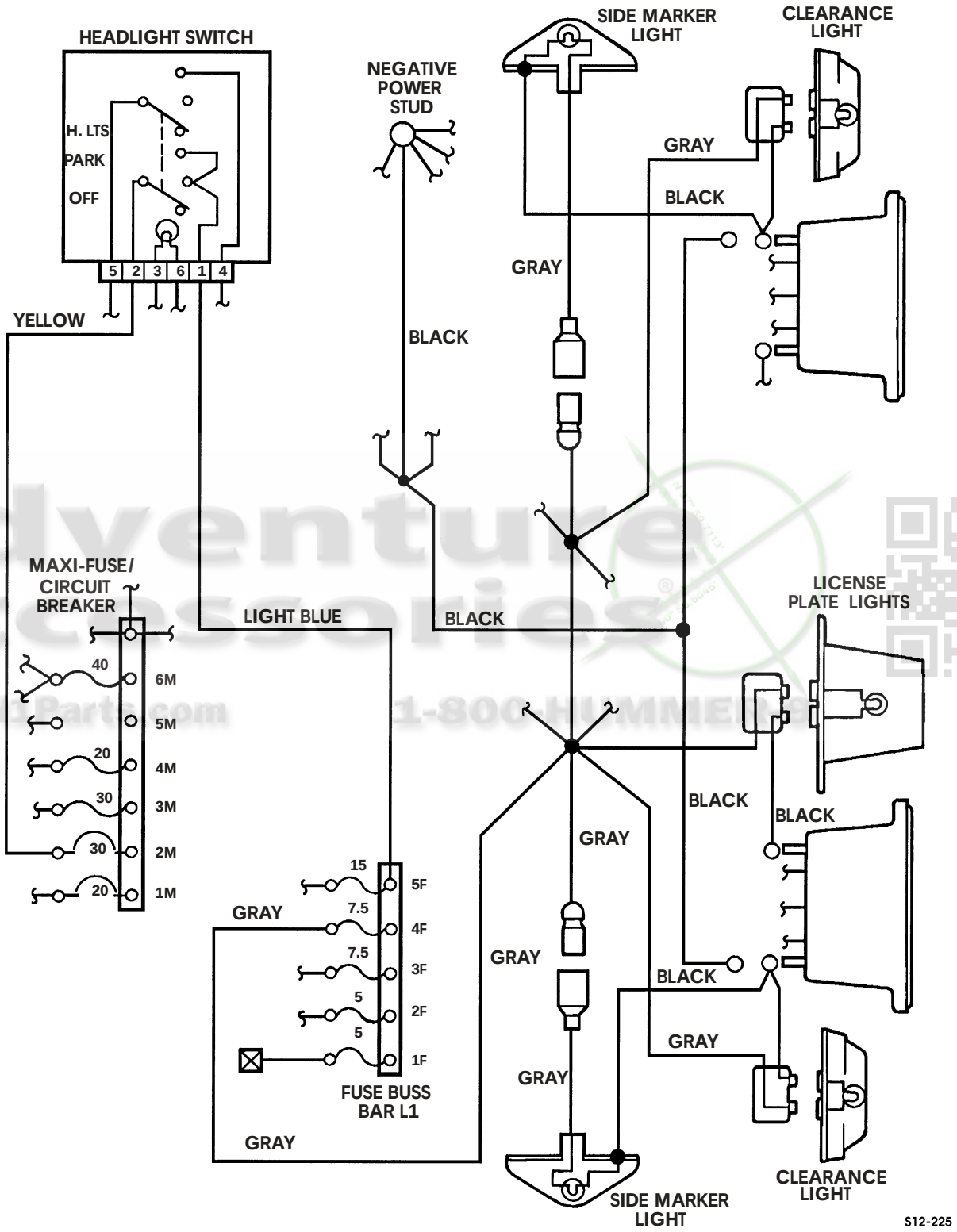


Figure 12-63: Clearance, Side Markers, and License Plate Lights

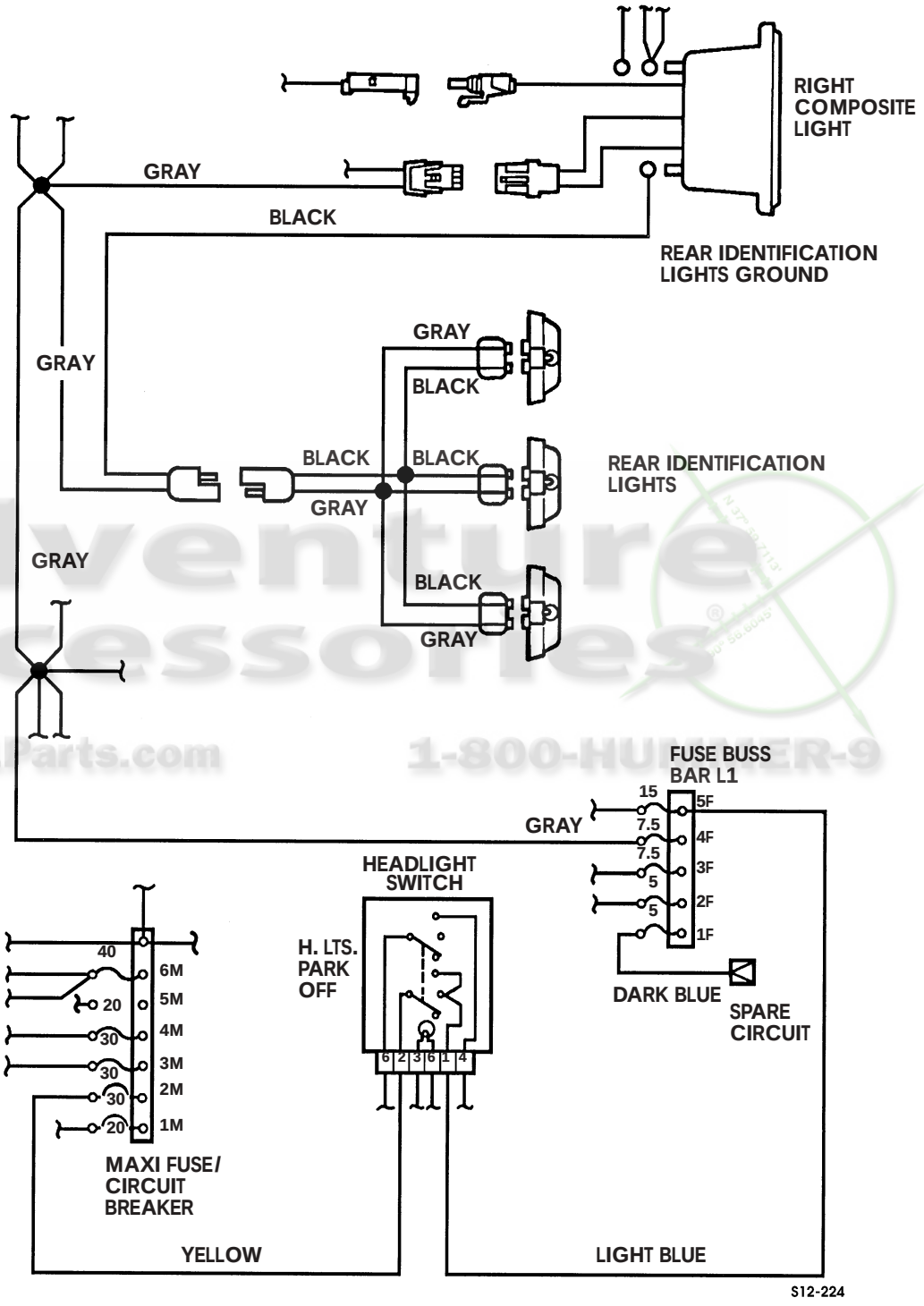
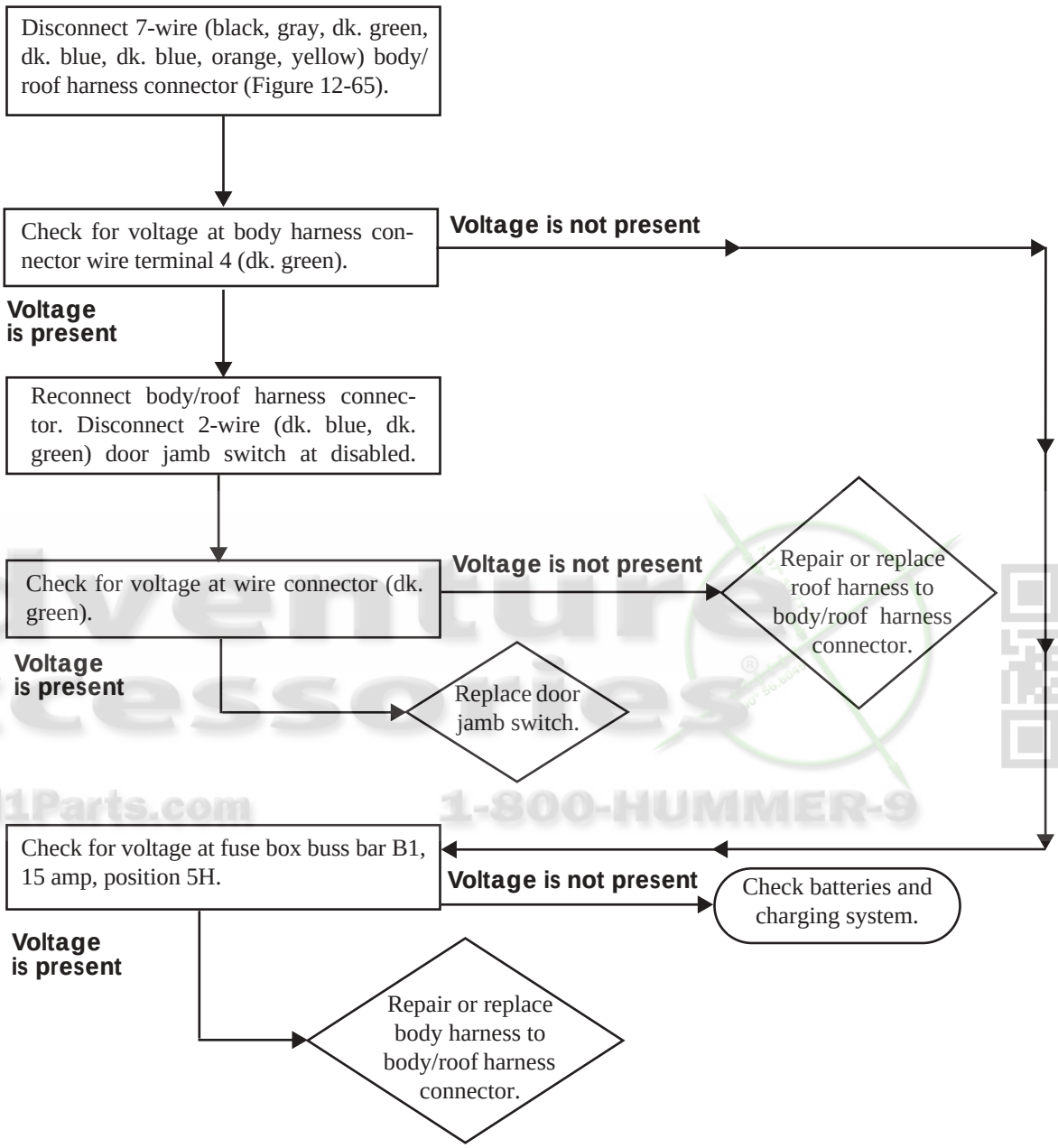


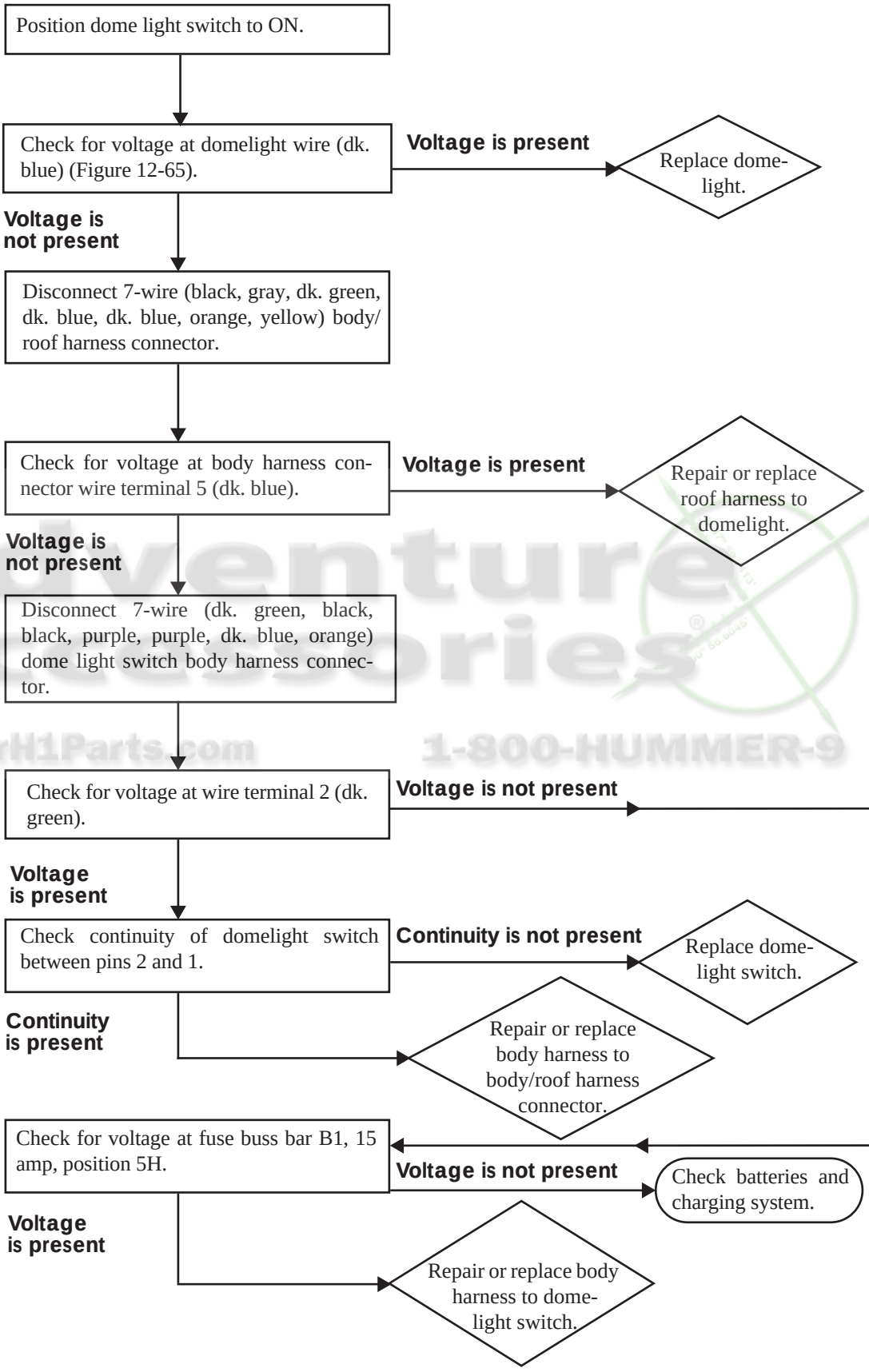
Figure 12-64: Rear Identification Lights

DOMELIGHT(S) (DOOR SWITCH) INOPERATIVE

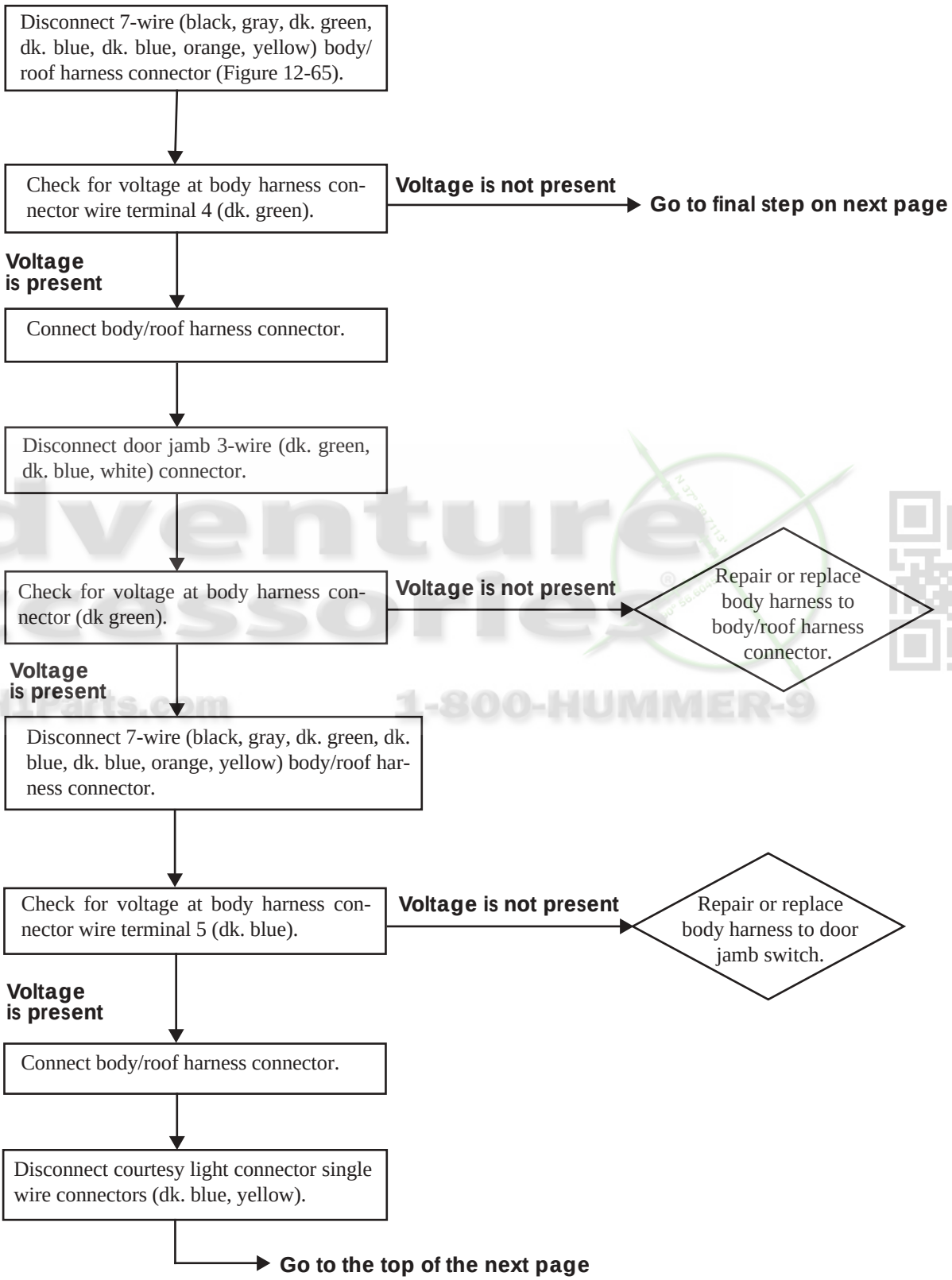
NOTE: Before testing, check domelight door switches by opening other doors.



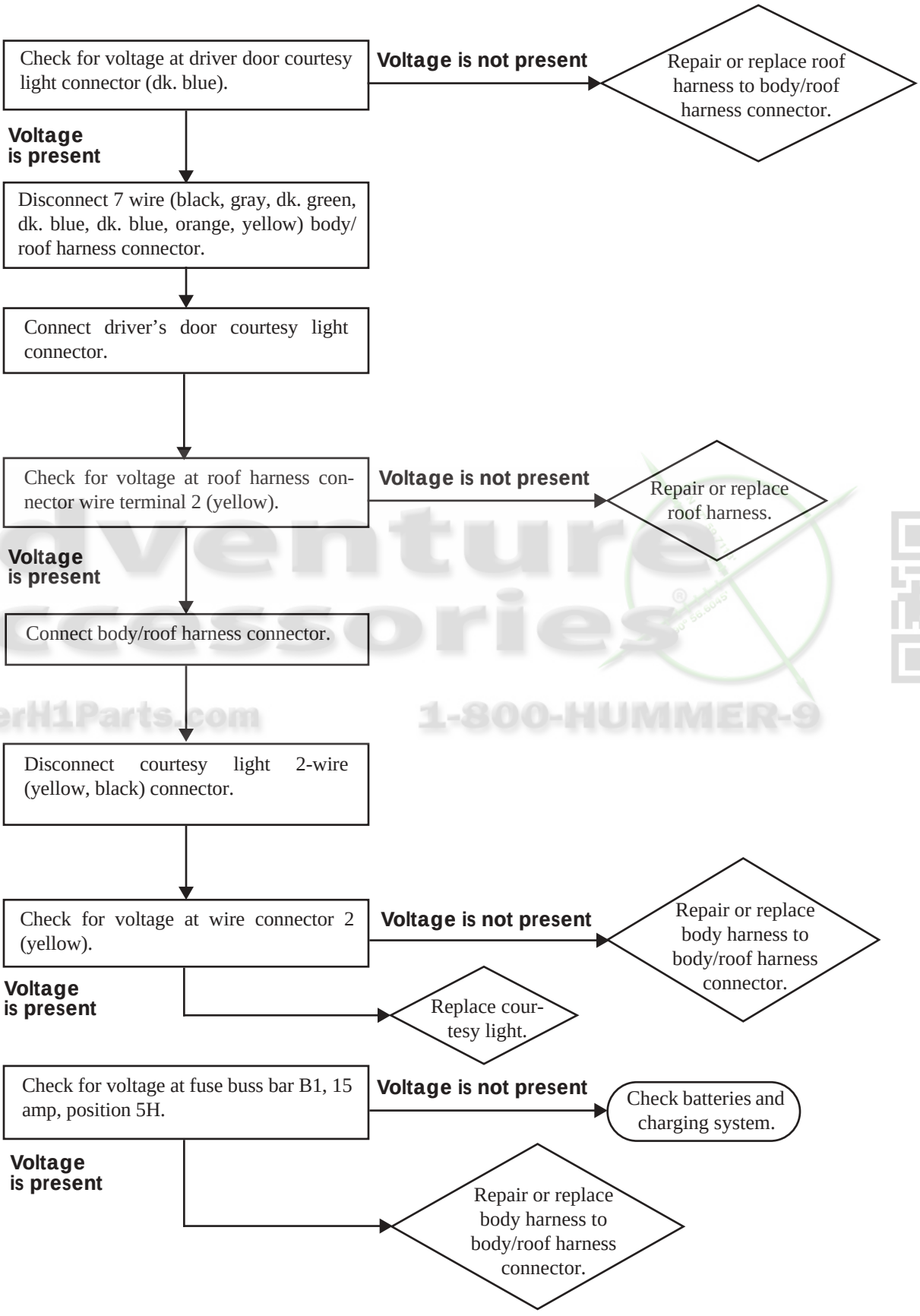
DOMELIGHT(S) (DOME SWITCH) INOPERATIVE



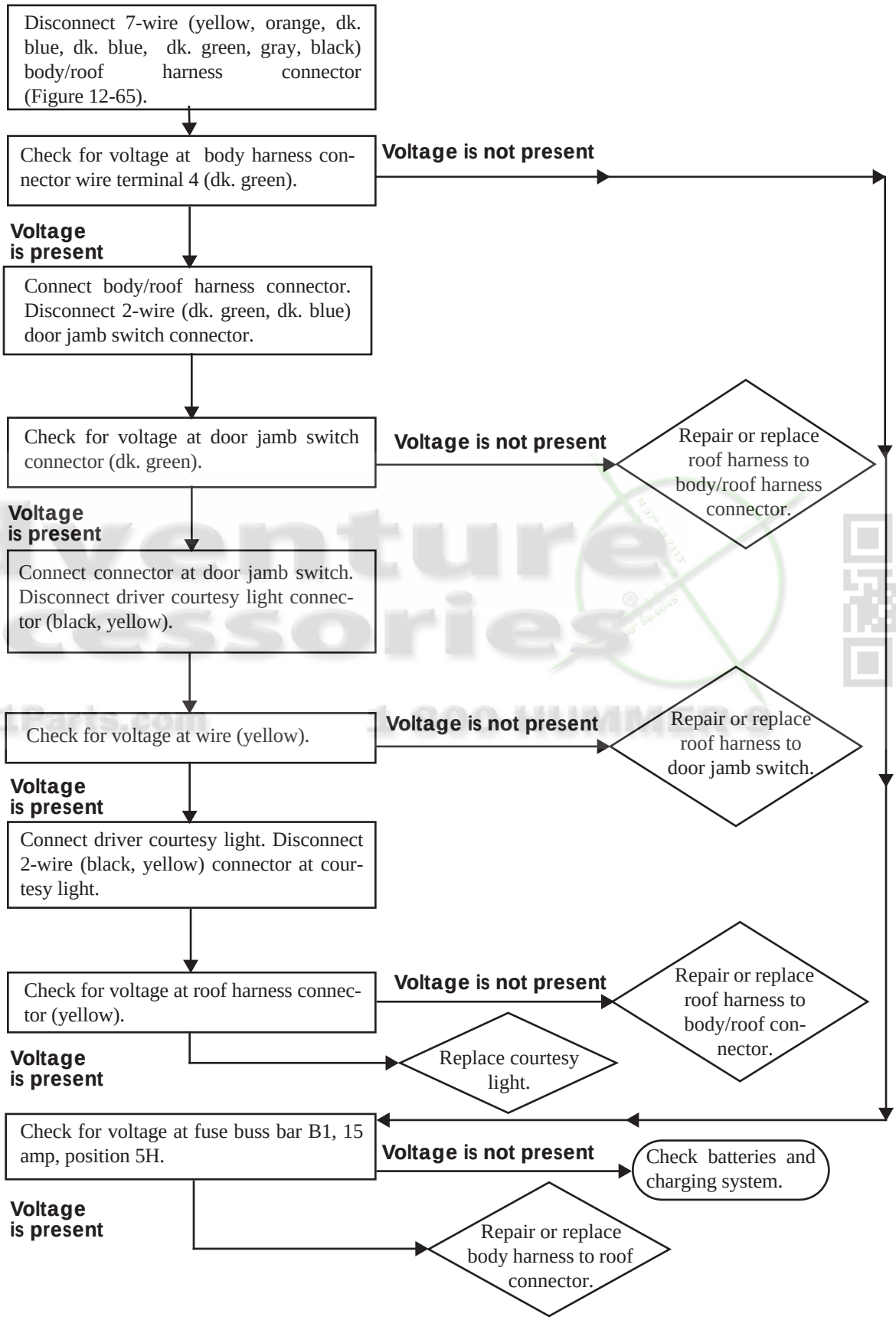
COURTESY LIGHT(S) (DRIVER'S) INOPERATIVE



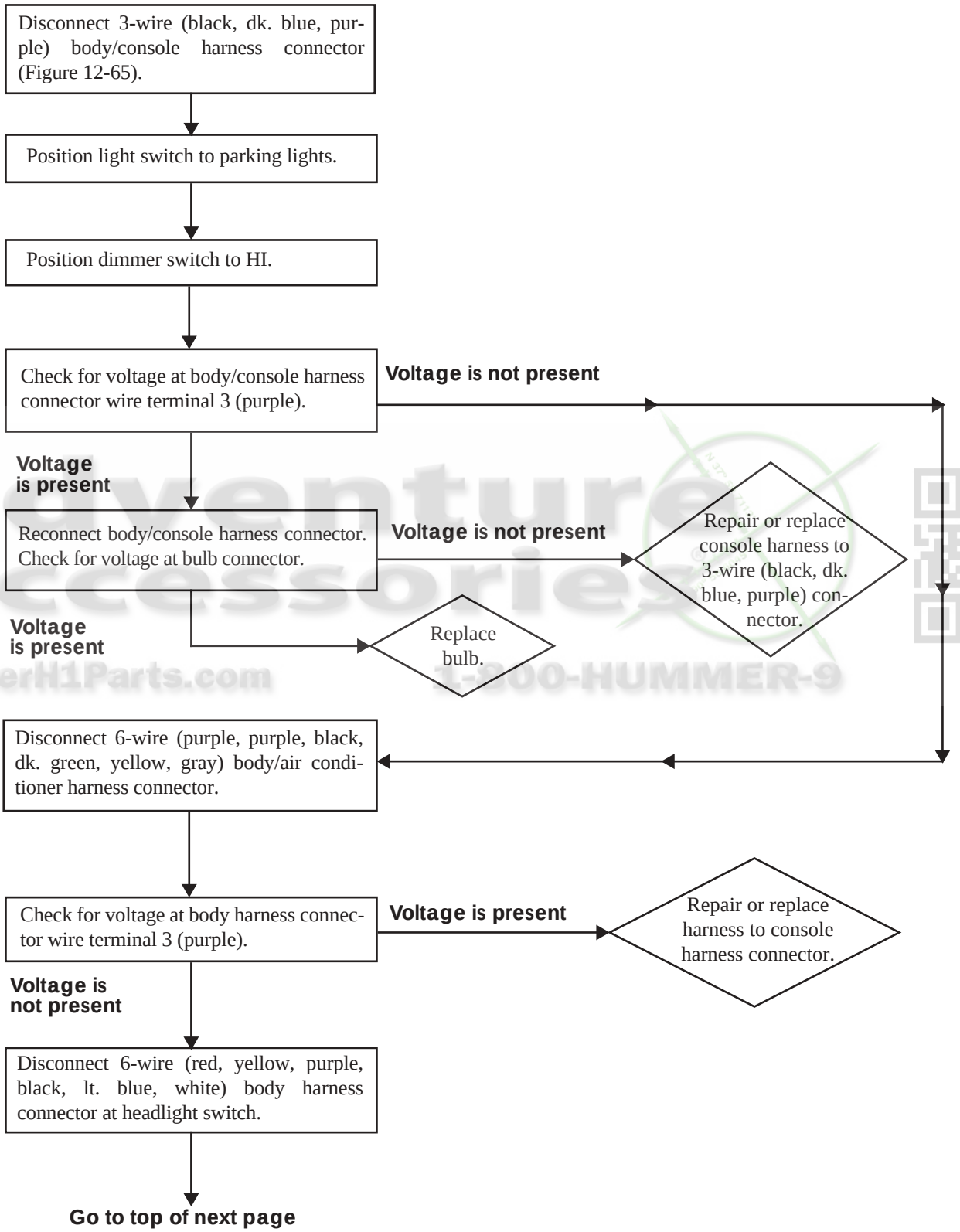
COURTESY LIGHT(S) (DRIVER'S) INOPERATIVE — CONTINUED



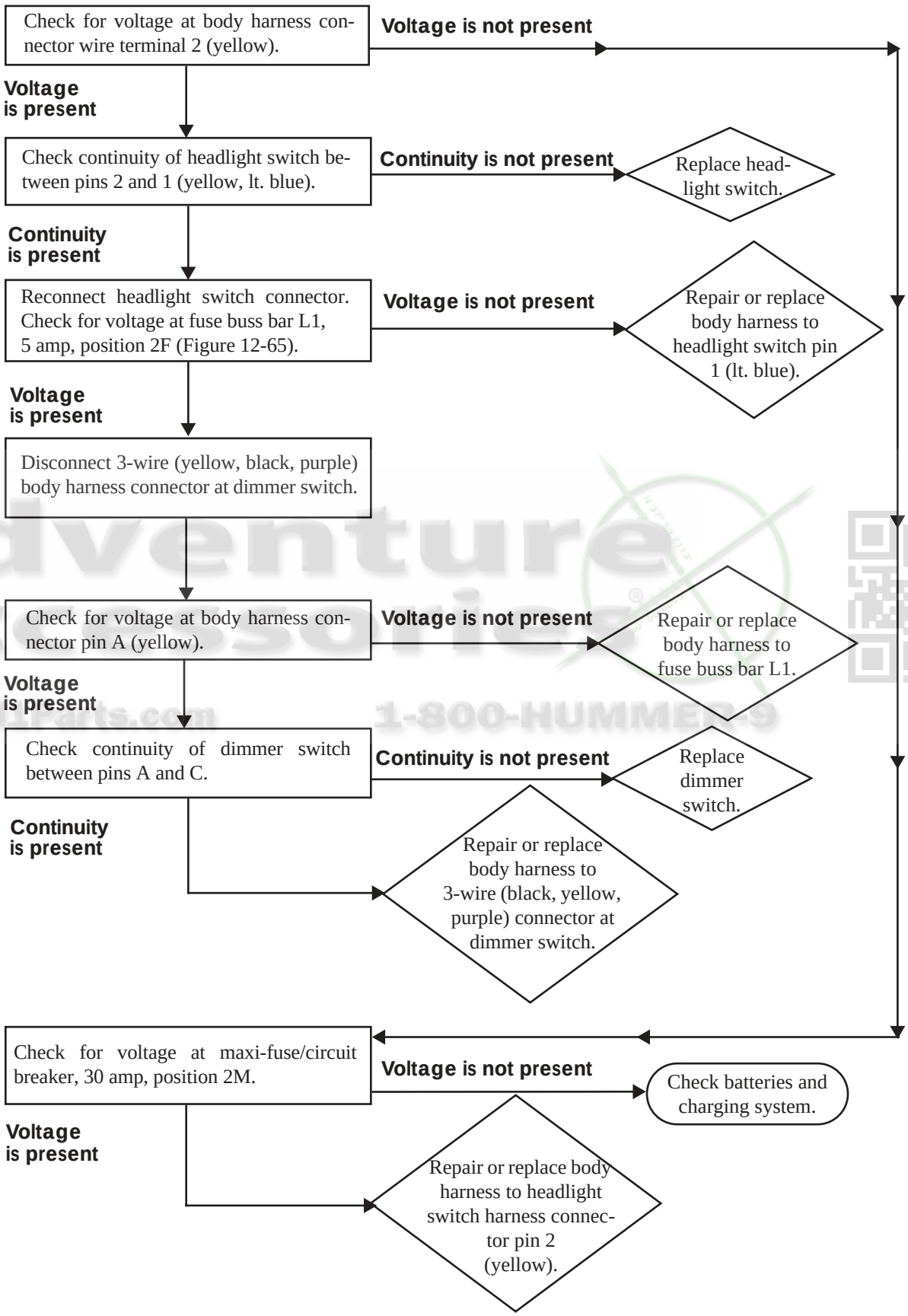
COURTESY LIGHT(S) (PASSENGER'S AND REAR) INOPERATIVE



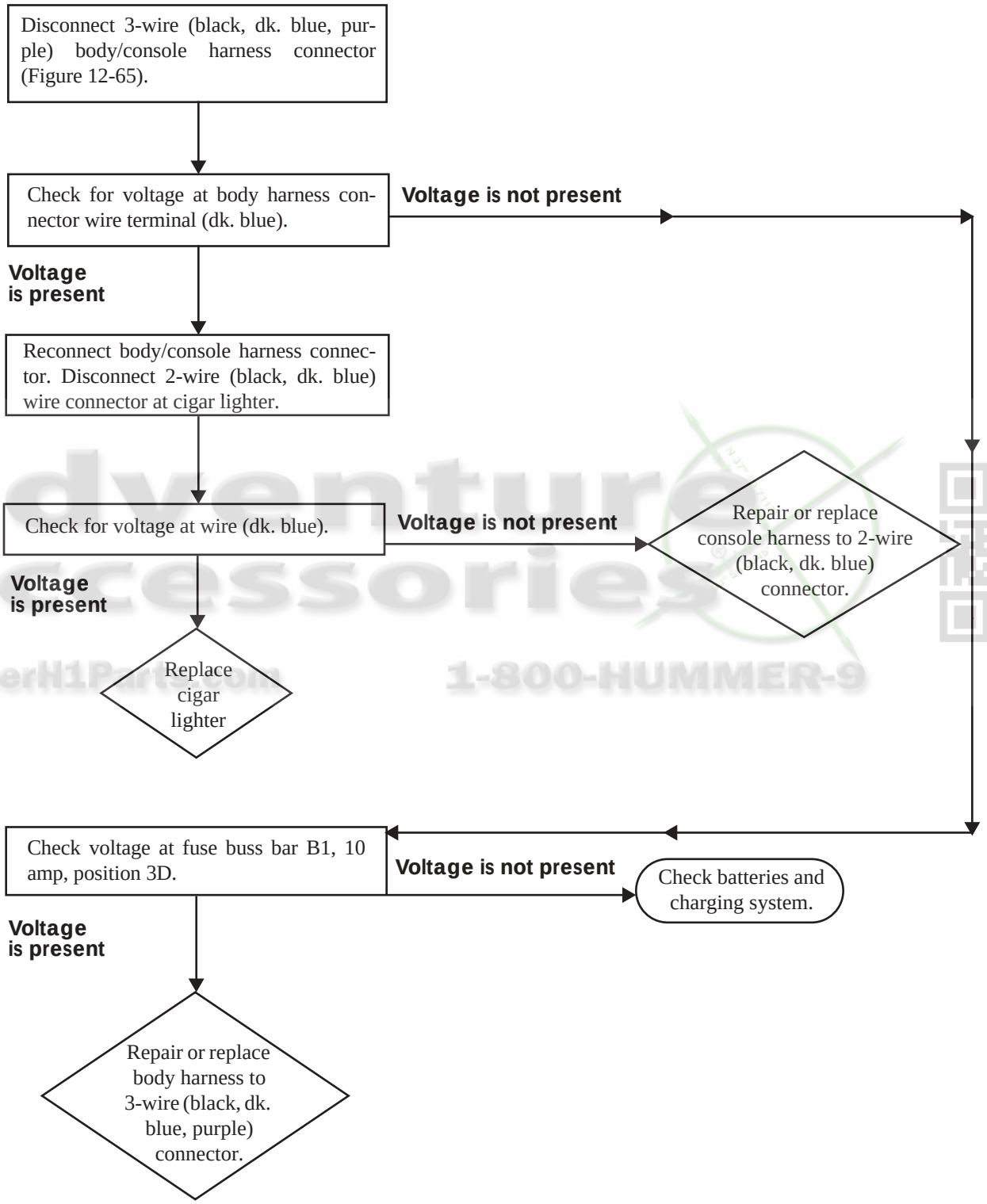
ASHTRAY LIGHT(S) INOPERATIVE



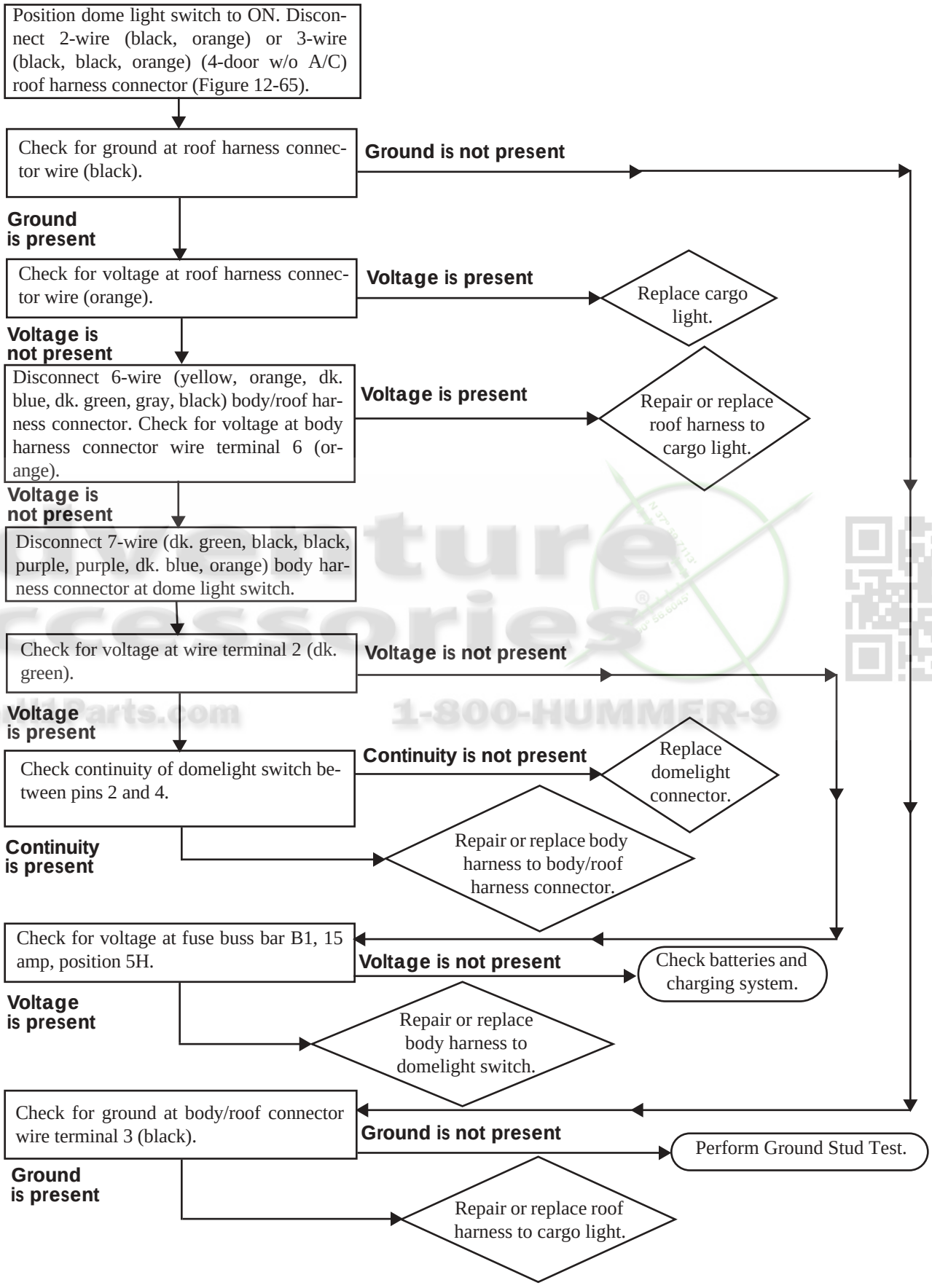
ASHTRAY LIGHT(S) INOPERATIVE – CONTINUED



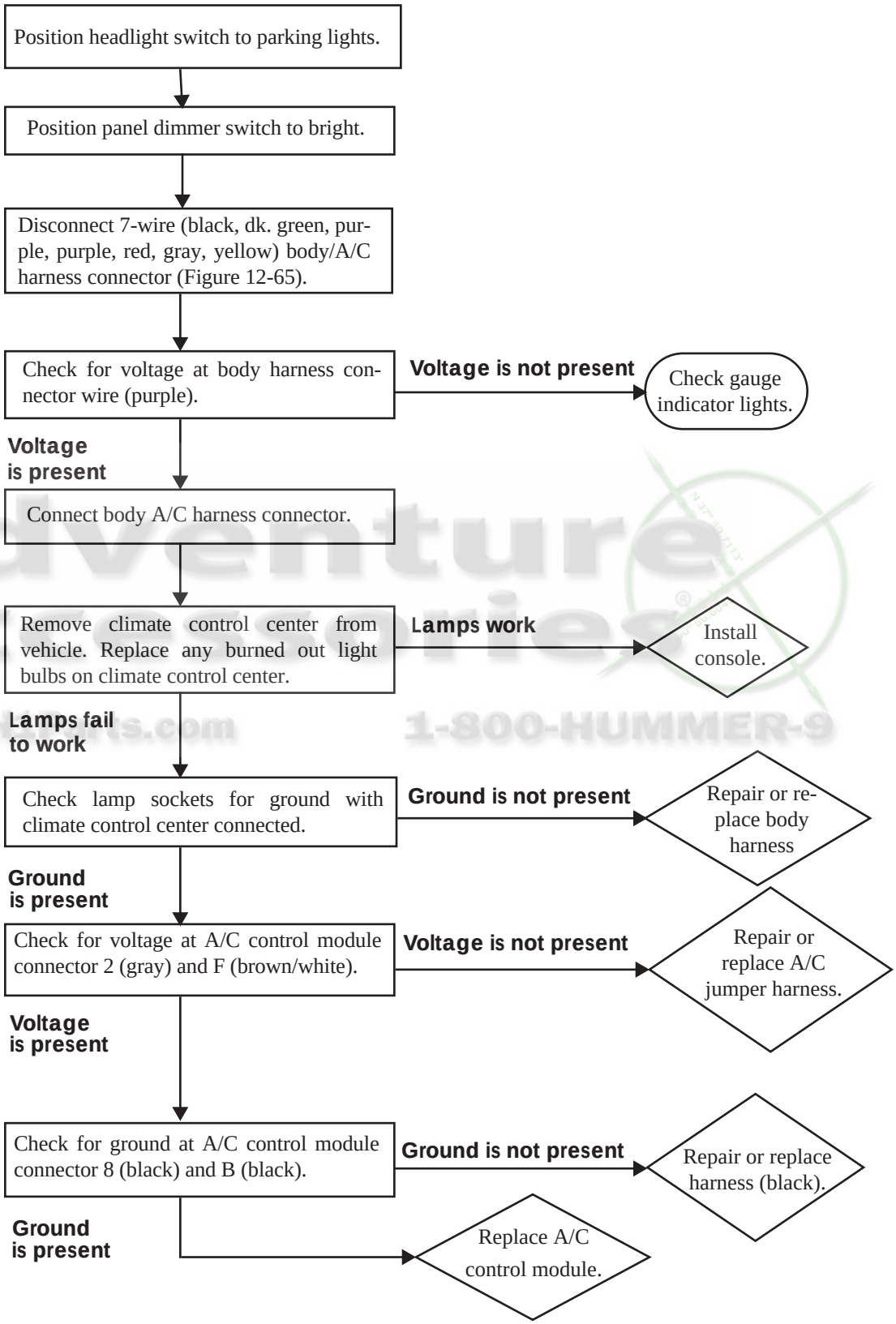
CIGAR LIGHTER INOPERATIVE



CARGO LIGHT INOPERATIVE



CLIMATE CONTROL LAMP(S) INOPERATIVE



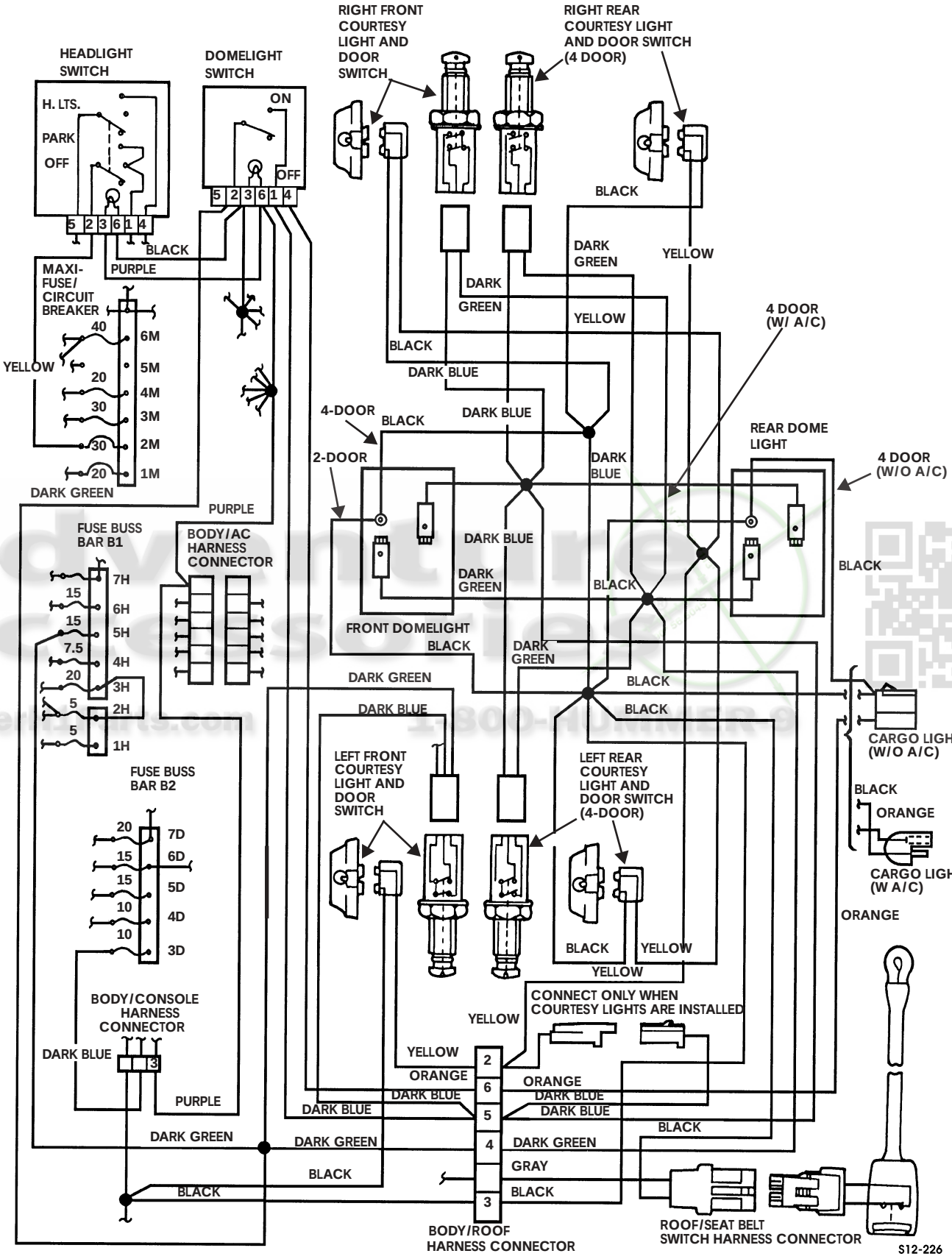


Figure 12-65: Courtesy, Dome, and Cargo Lights

TRAILER CONNECTION SYSTEM

NOTE: Check fuse panel for blown fuse(s) before performing electrical troubleshooting. Ensure inoperative lamp(s) and bulb(s) are replaced or known to be good before performing electrical troubleshooting.

Trailer Connector Inoperative (One or More Pins)

Step 1. Position ignition switch and light switch to circuit being tested (electrical harness foldouts 1-12).

Step 2. Check trailer connector pin (electrical harness foldouts 1-12) for voltage.

a. Nominal voltage is present, repair or replace trailer wiring harness.

b. Nominal voltage is not present, go to body wiring harness troubleshooting specific to trailer connector circuit being tested.

__ Ground

__ Trailer, I.D. clearance

__ Left turn

__ Right turn

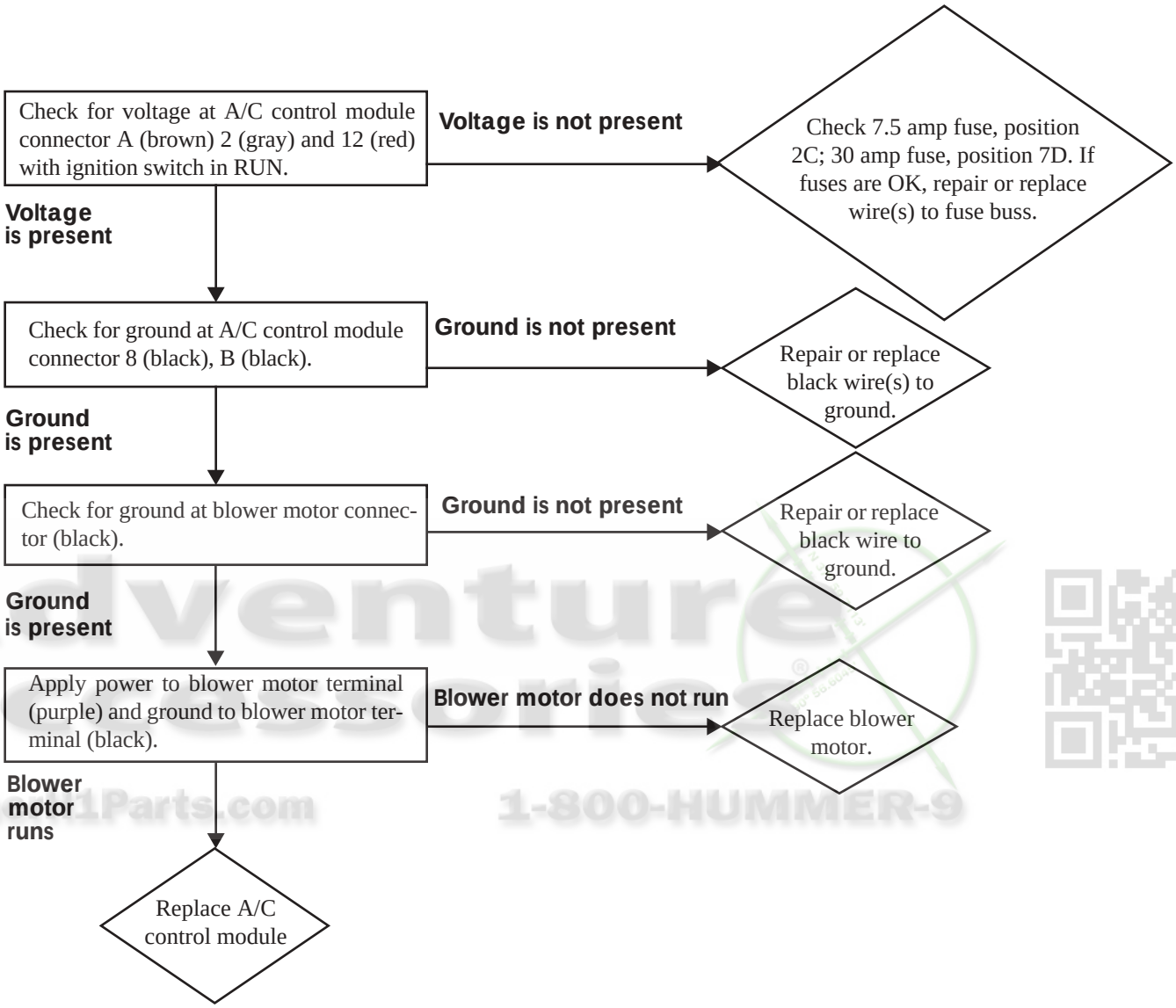
__ Independent stop

__ Brake control unit

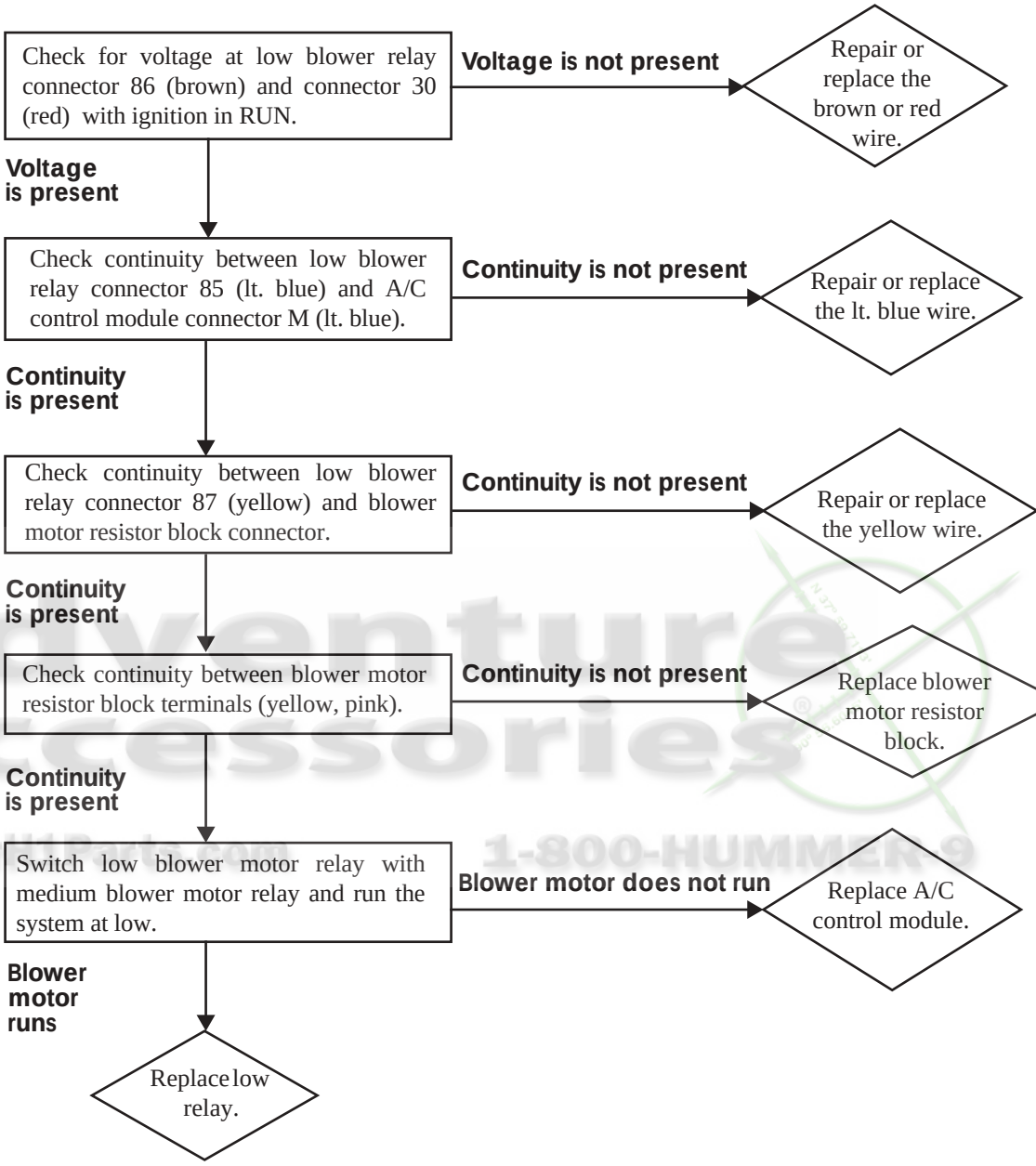
__ Auxiliary

__ Battery charge

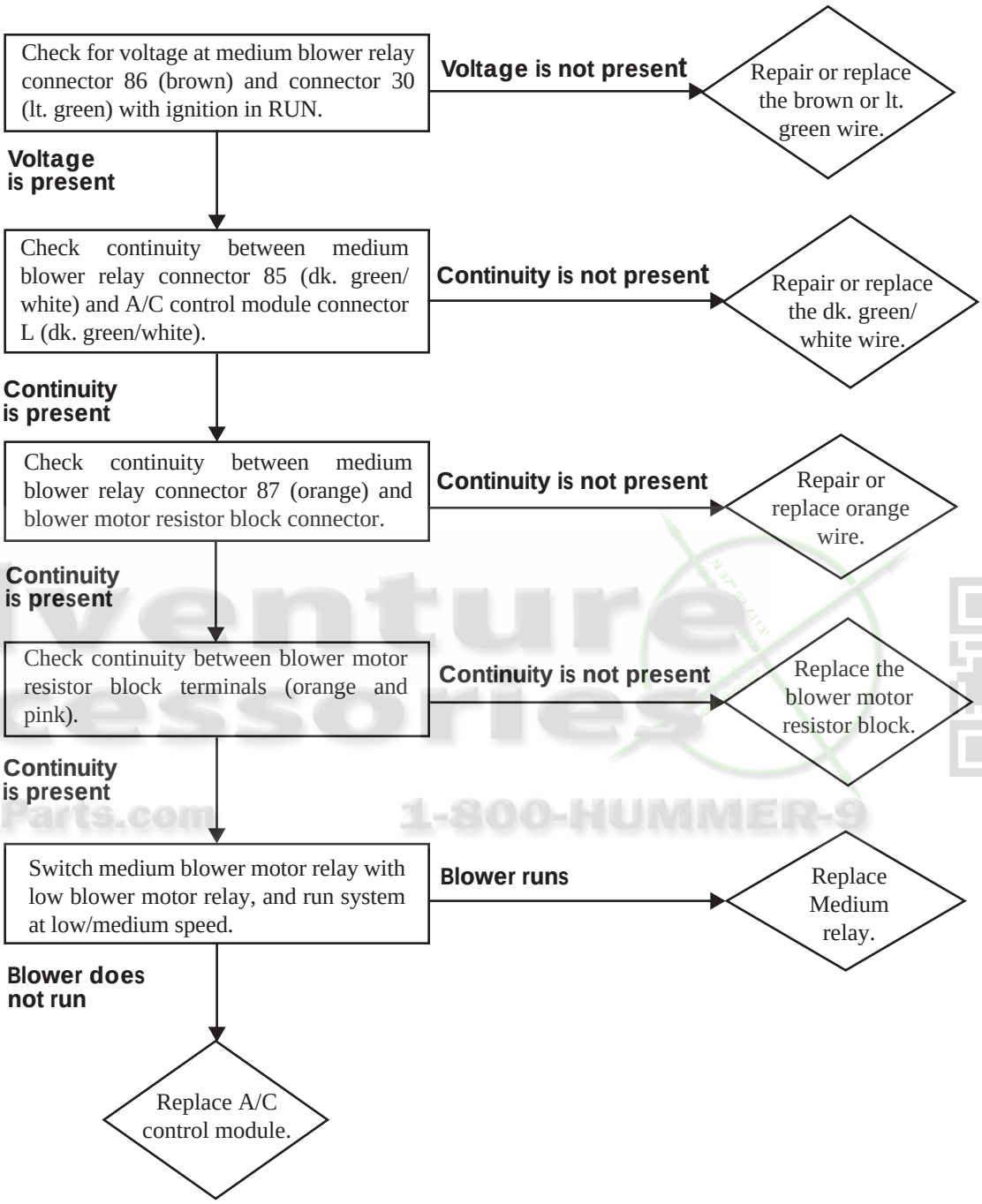
A/C BLOWER MOTOR DOES NOT FUNCTION AT ANY SPEED



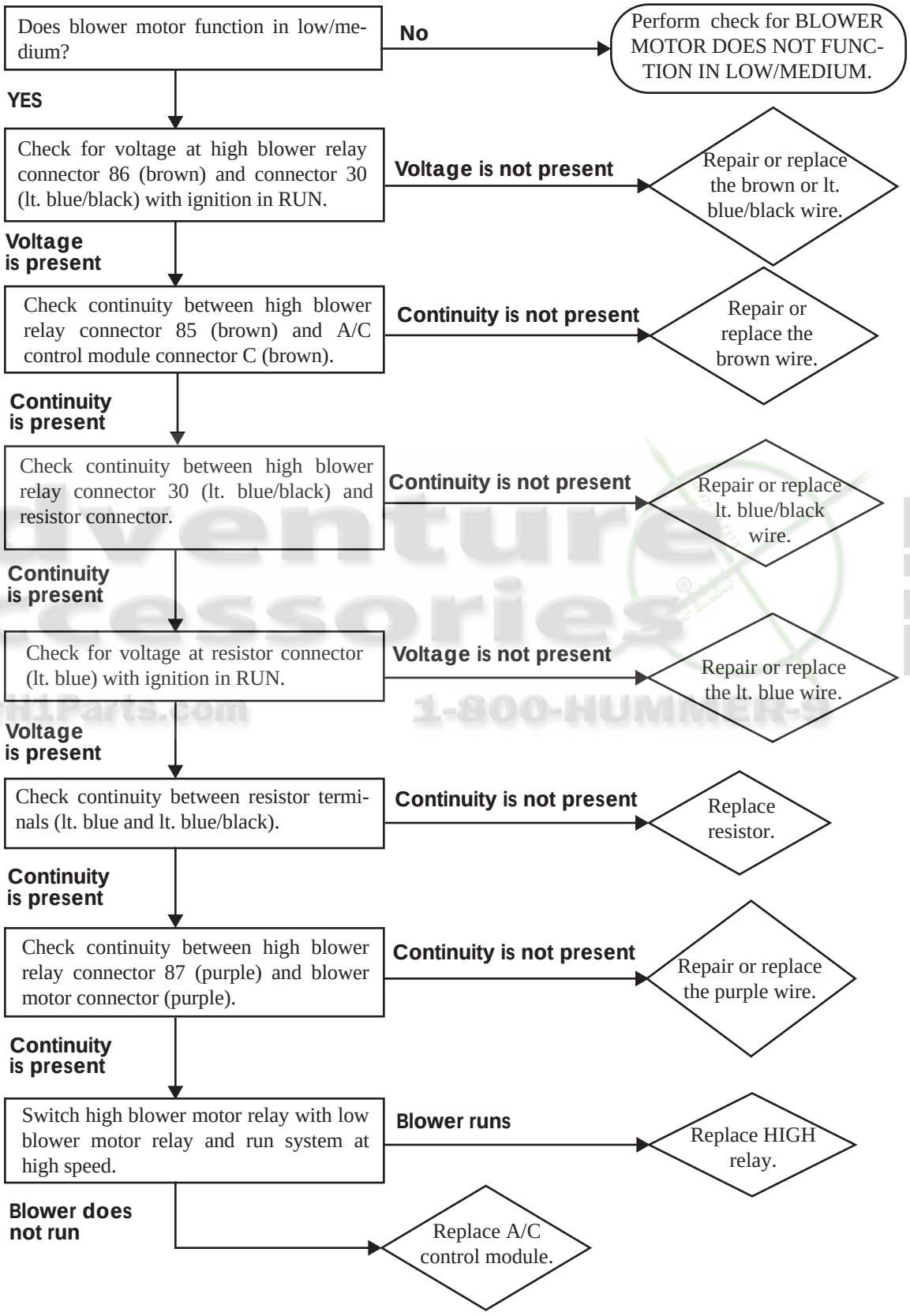
A/C BLOWER MOTOR DOES NOT FUNCTION IN "LOW"



A/C BLOWER MOTOR DOES NOT FUNCTION IN "LOW/MEDIUM"

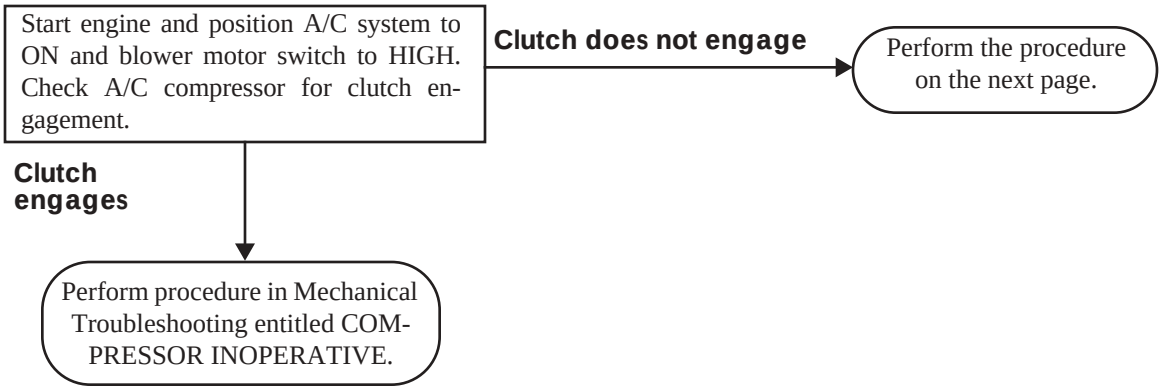


A/C BLOWER MOTOR DOES NOT FUNCTION IN "MEDIUM/HIGH" OR "HIGH" MODE

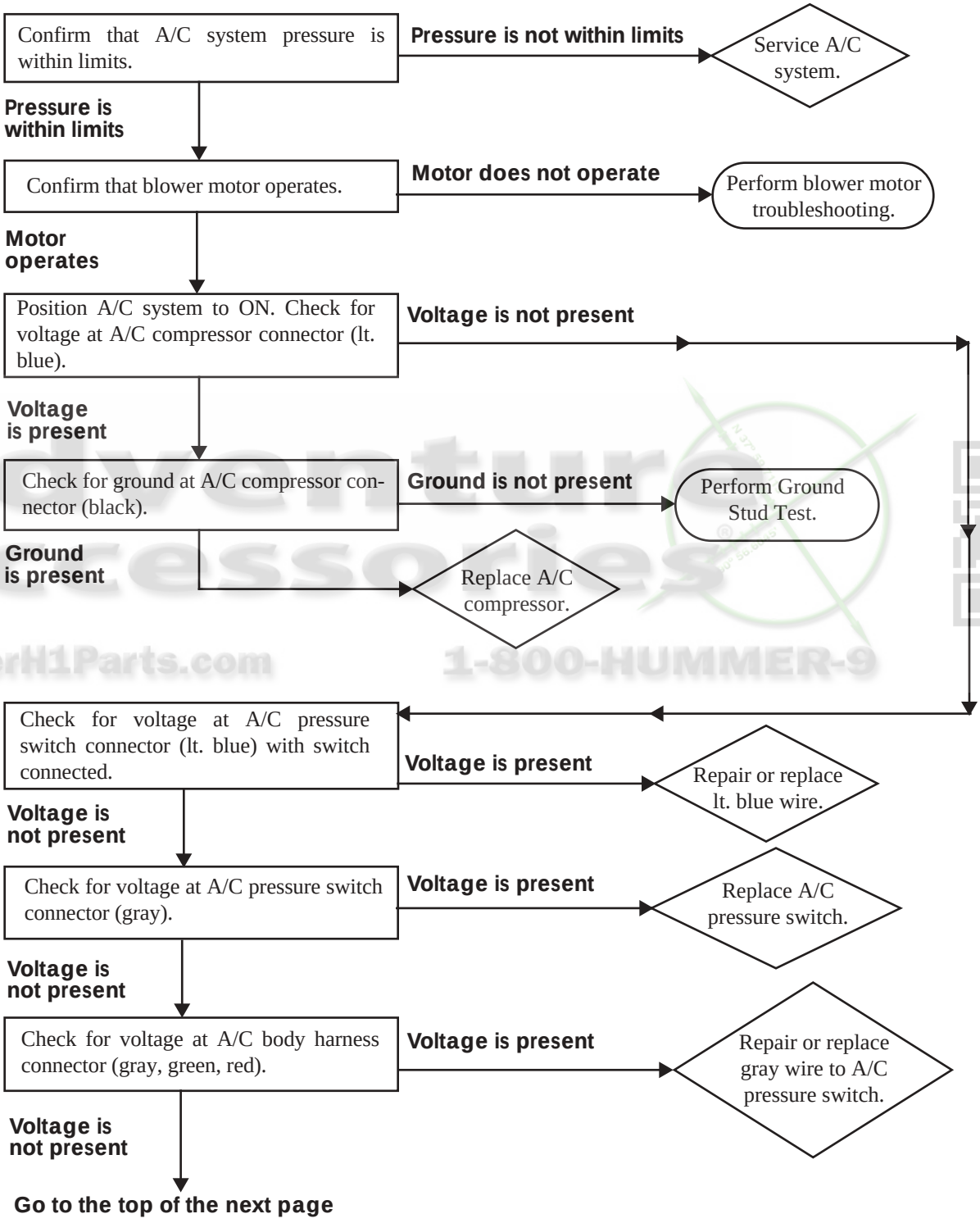


AIR CONDITIONING SYSTEM FAILS TO COOL

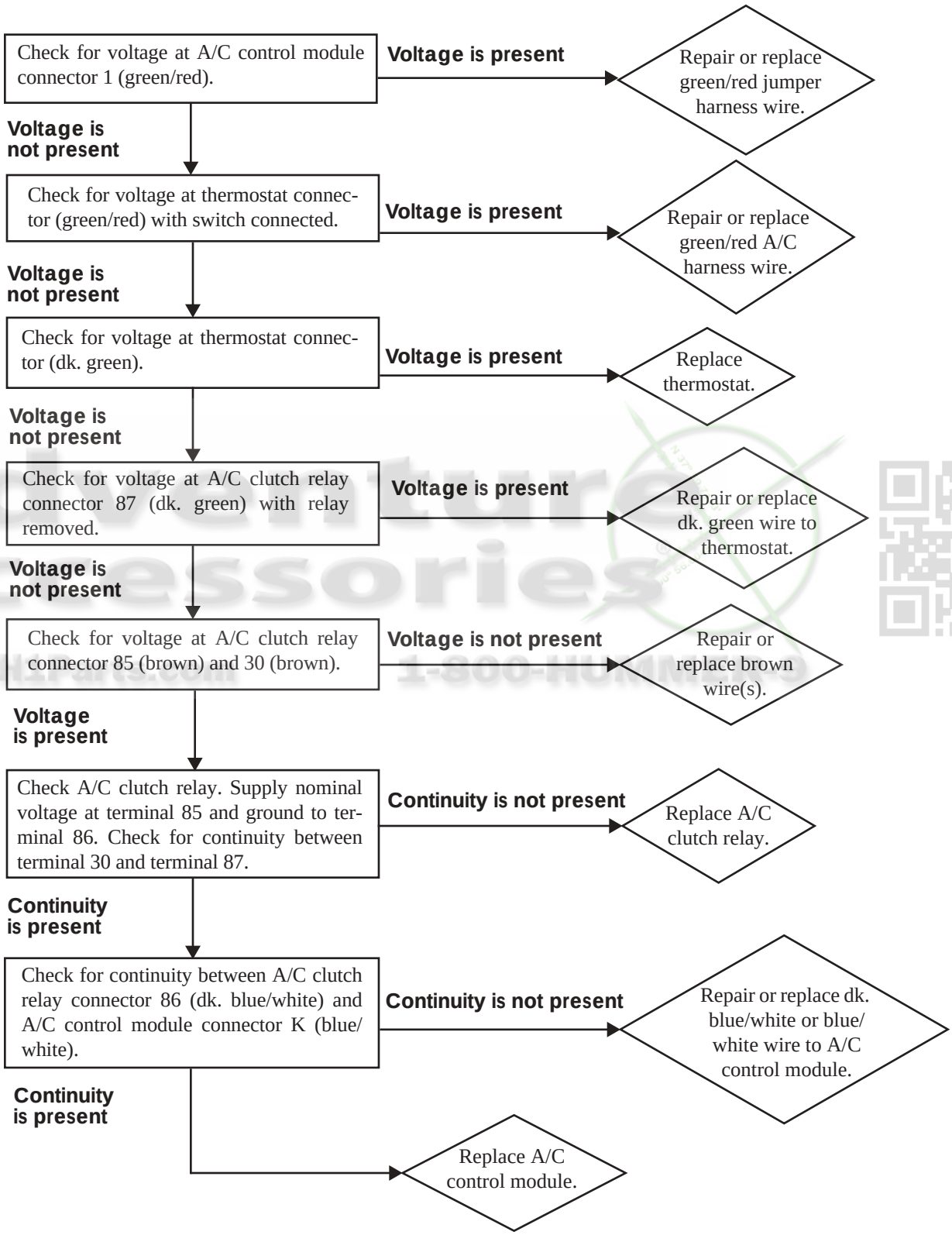
NOTE: Check fuse panel for blown fuse(s) and/or circuit breaker(s) before performing electrical troubleshooting. Check engine accessory drivebelts for wear and tension.



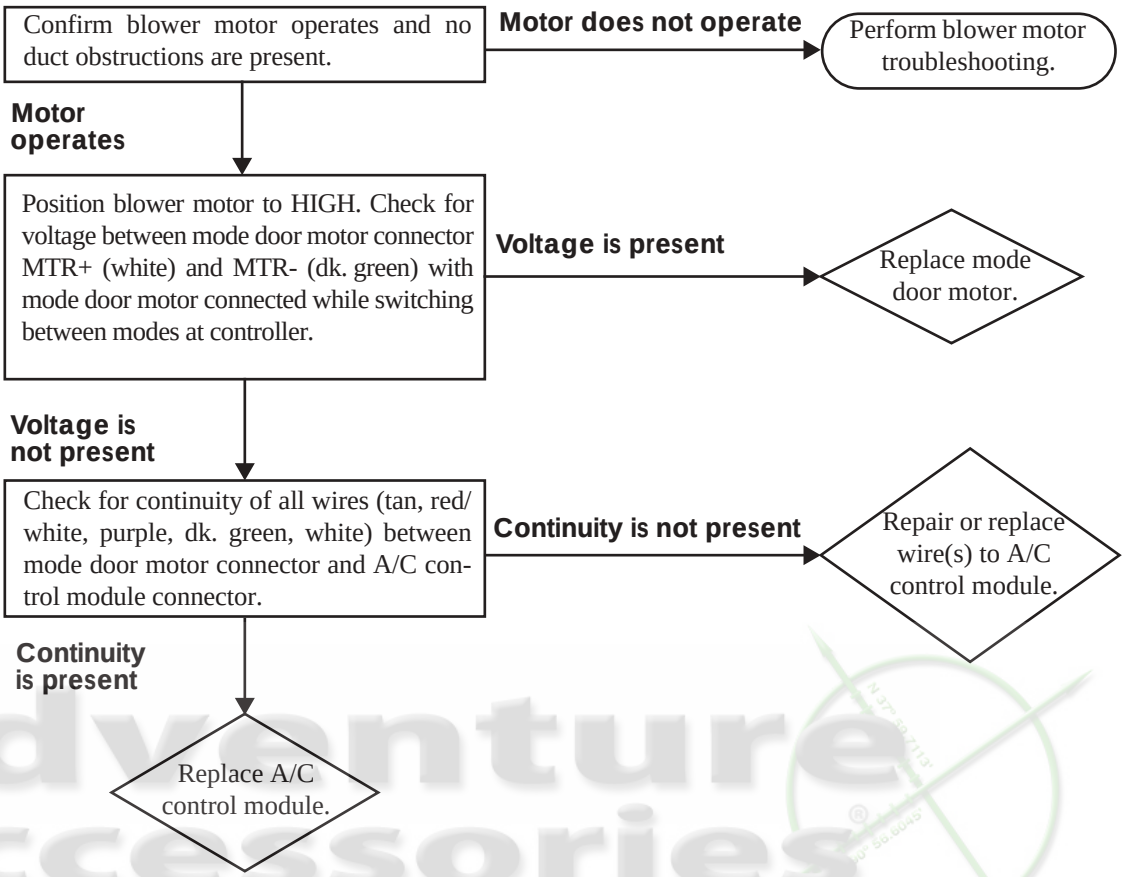
A/C COMPRESSOR CLUTCH DOESN'T OPERATE (ENGAGE)



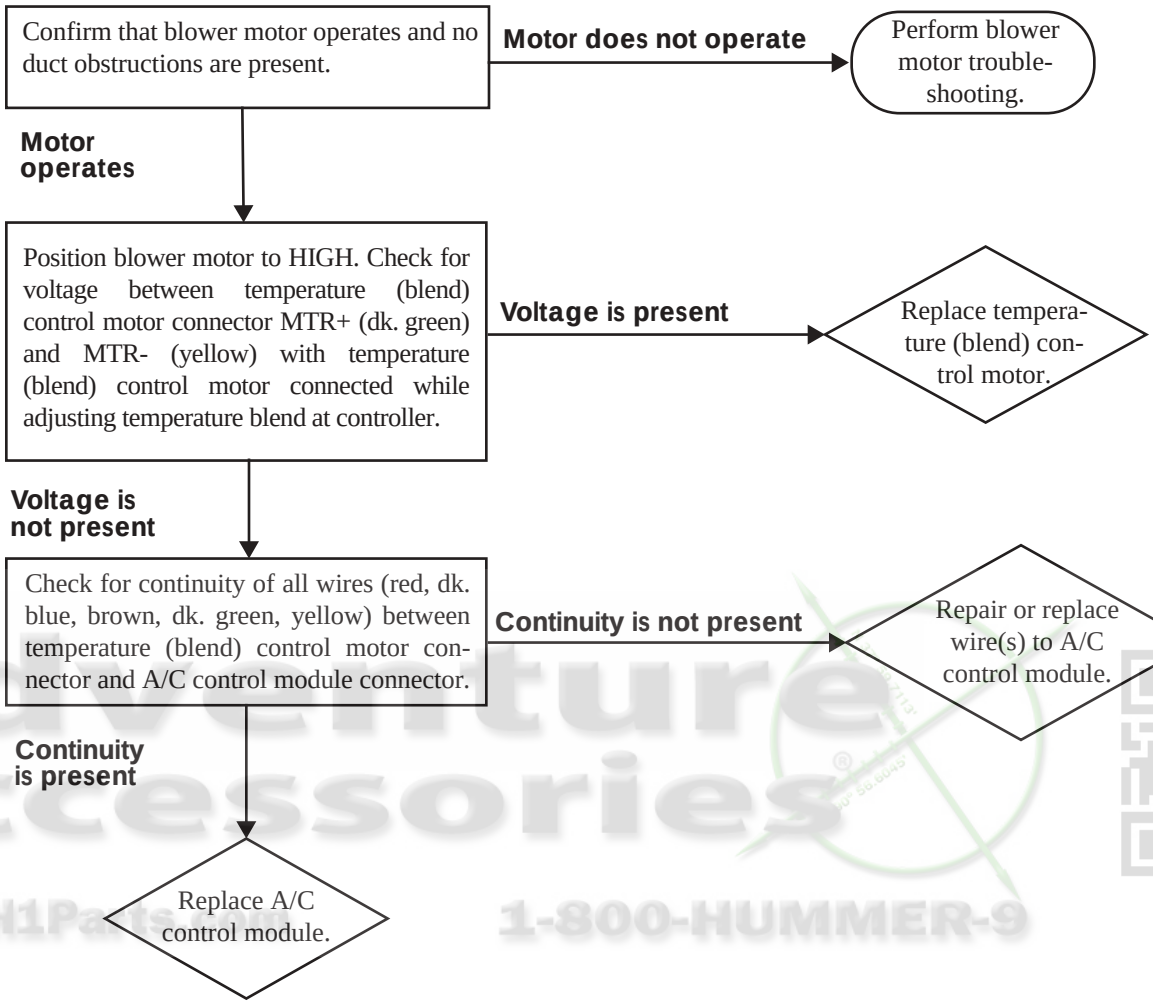
A/C COMPRESSOR CLUTCH DOESN'T OPERATE (ENGAGE) – CONTINUED



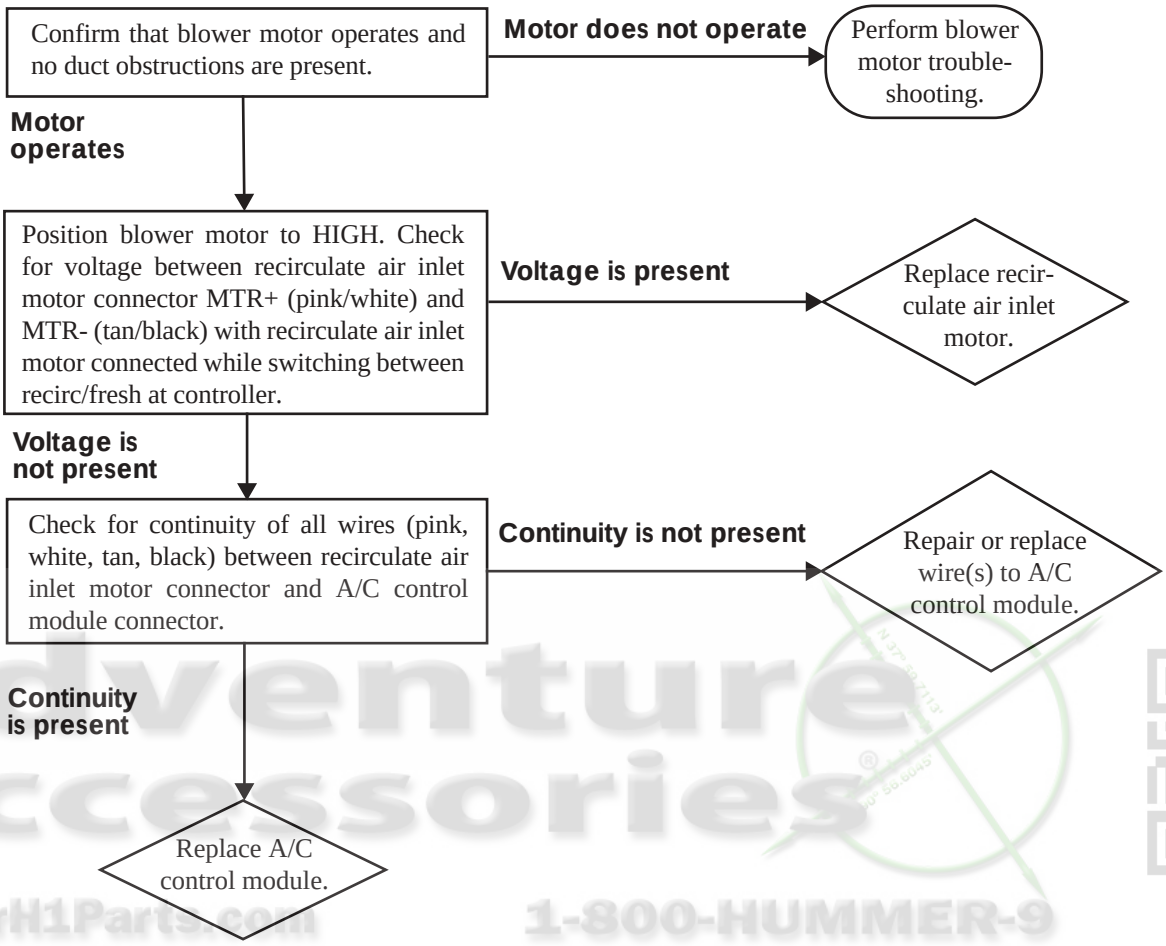
MODE DOOR MOTOR FAILS TO OPERATE



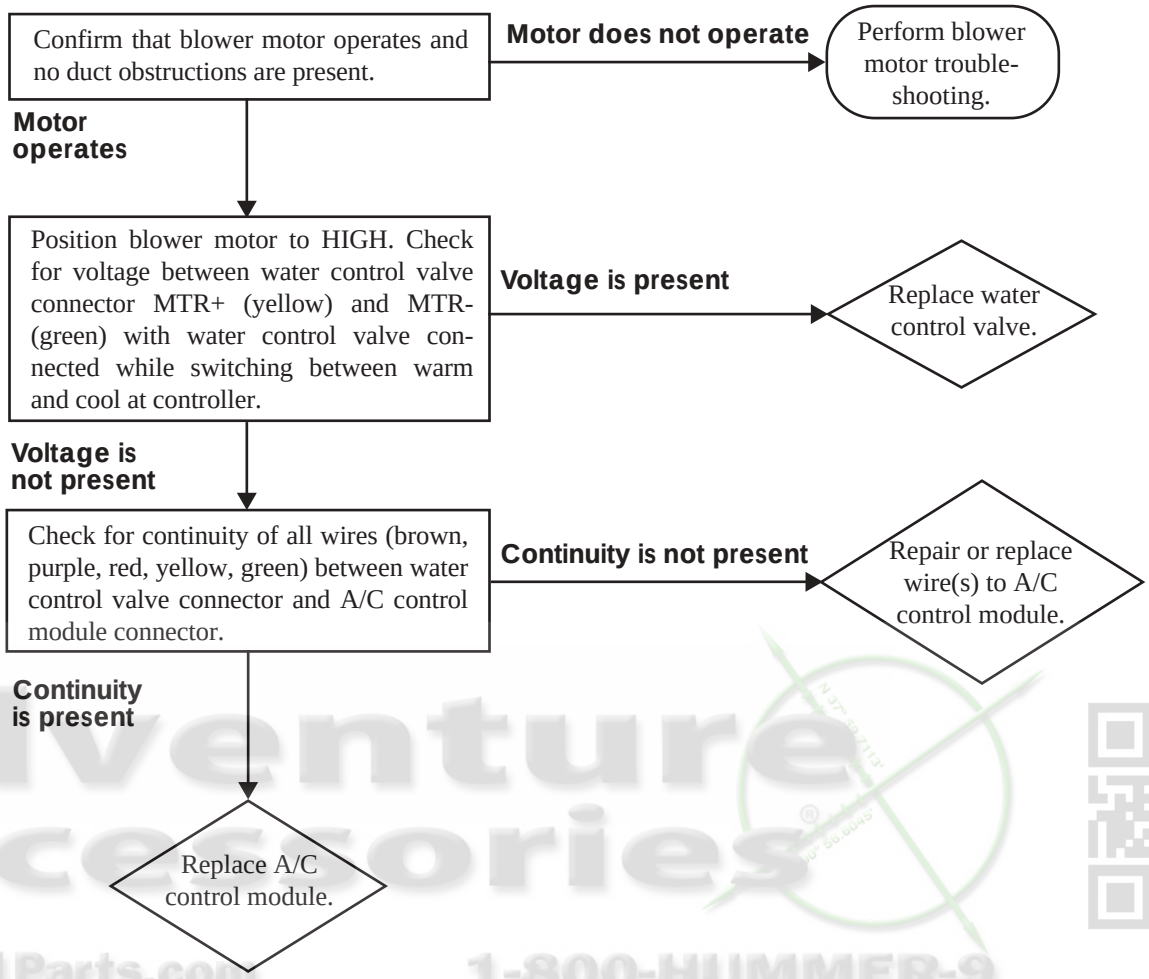
TEMPERATURE (BLEND) CONTROL MOTOR FAILS TO OPERATE



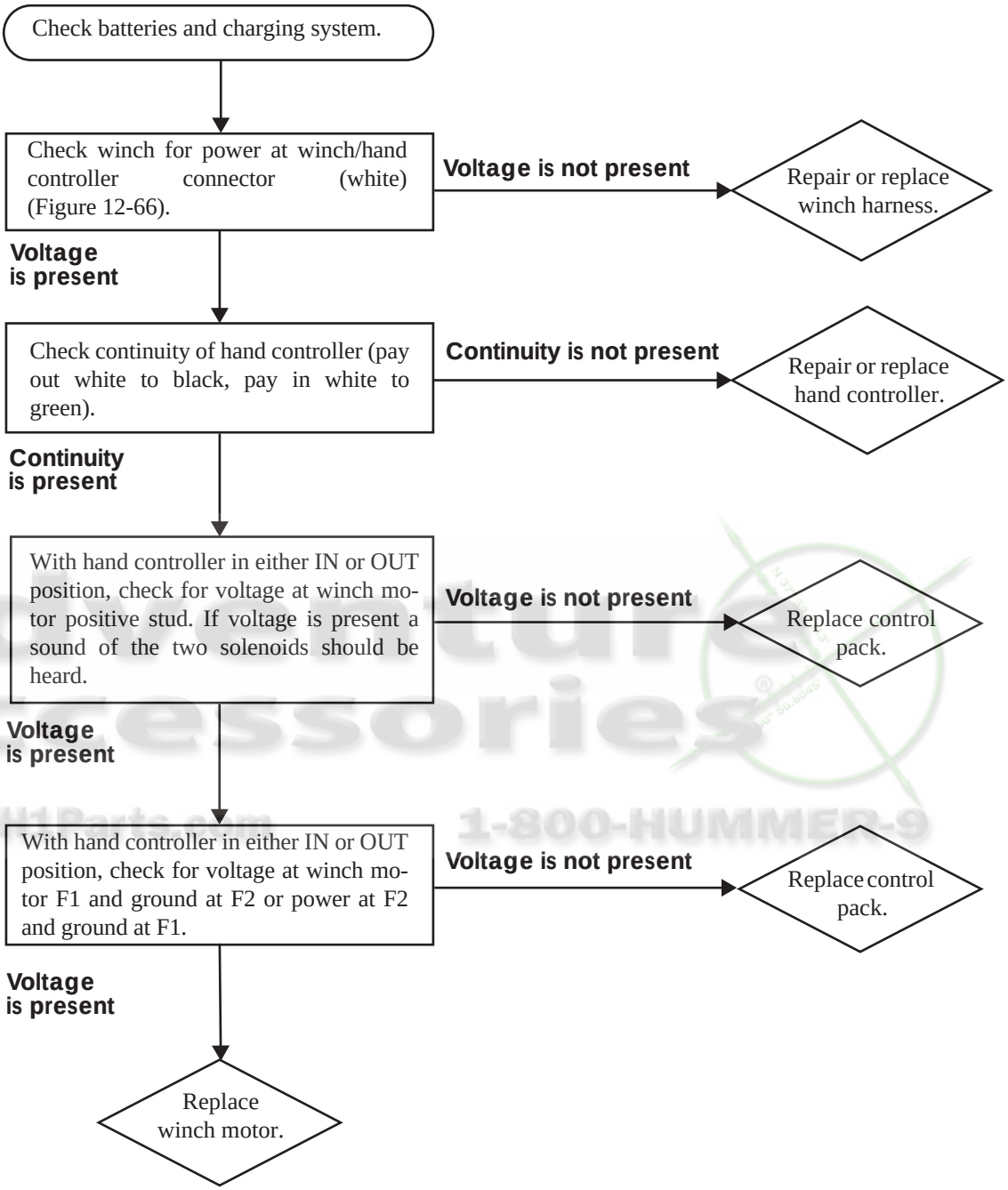
RECIRCULATE AIR INLET MOTOR FAILS TO OPERATE



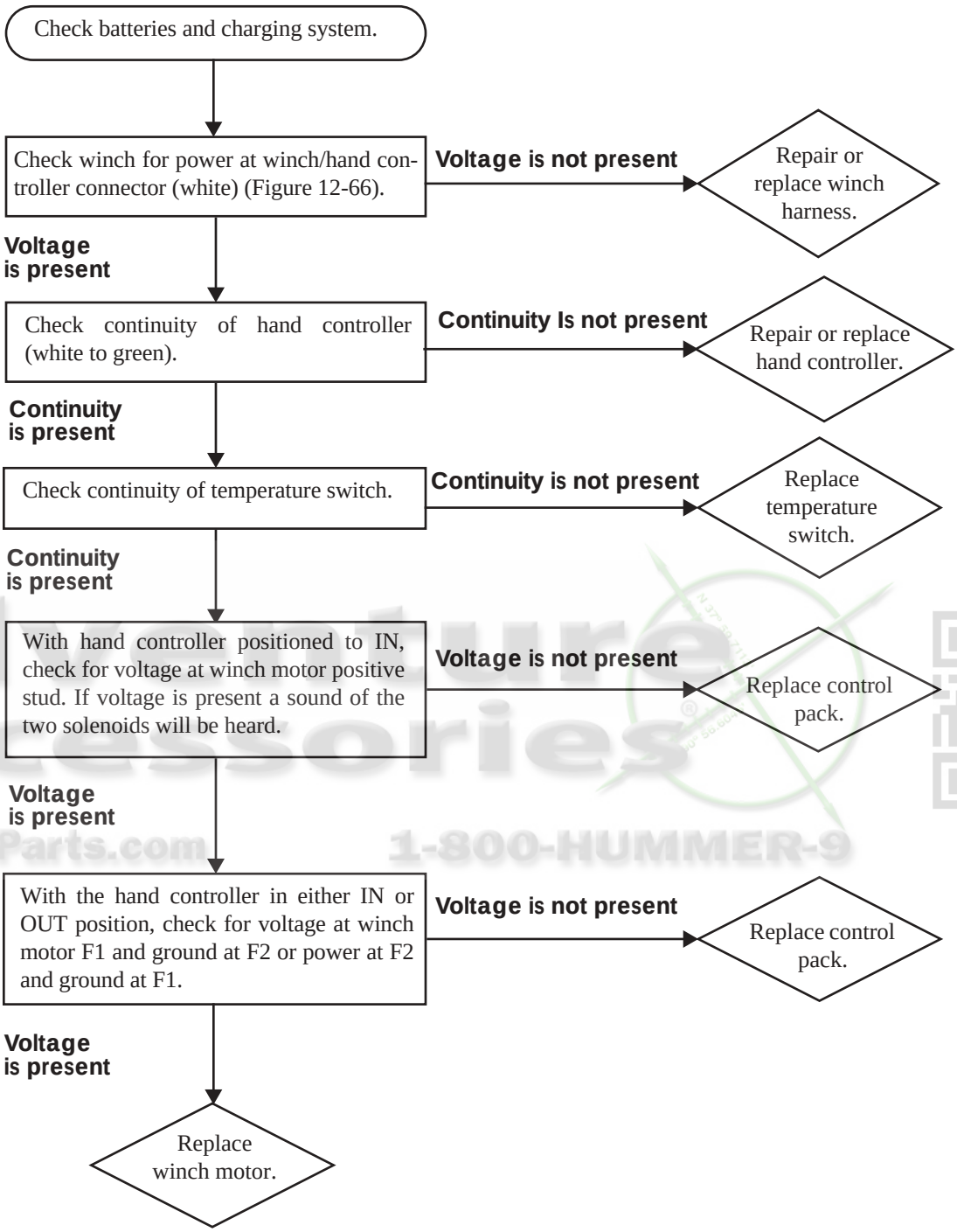
WATER CONTROL VALVE FAILS TO OPERATE



WINCH FAILS TO REEL OUT OR TO OPERATE IN BOTH DIRECTIONS



WINCH FAILS TO REEL IN



WINCH SHUTS OFF DURING OPERATION

7. Electronic Current Limiter

   The winch is equipped with an Electronic Current Limiter (ECL). This device will automatically shut off the winch on “power in” operation if the rated capacity of 12,000 lbs. is exceeded. When this occurs, you should “power out” some line to prevent damage to the winch. (“Power out” operation is not affected by the ECL.) The load must somehow be lightened, or a double line may be used in conjunction with a snatch block to reduce the load on the winch. When the ECL has tripped, it will reset itself within 5 to 10 seconds and “power in” will again be available.

8. Temperature Switch

   The winch is equipped with a motor temperature switch. When the motor approaches stall speed, a very rapid heat buildup occurs which could cause permanent motor damage. This device will automatically shut off the winch. The switch will automatically reset as the motor cools.

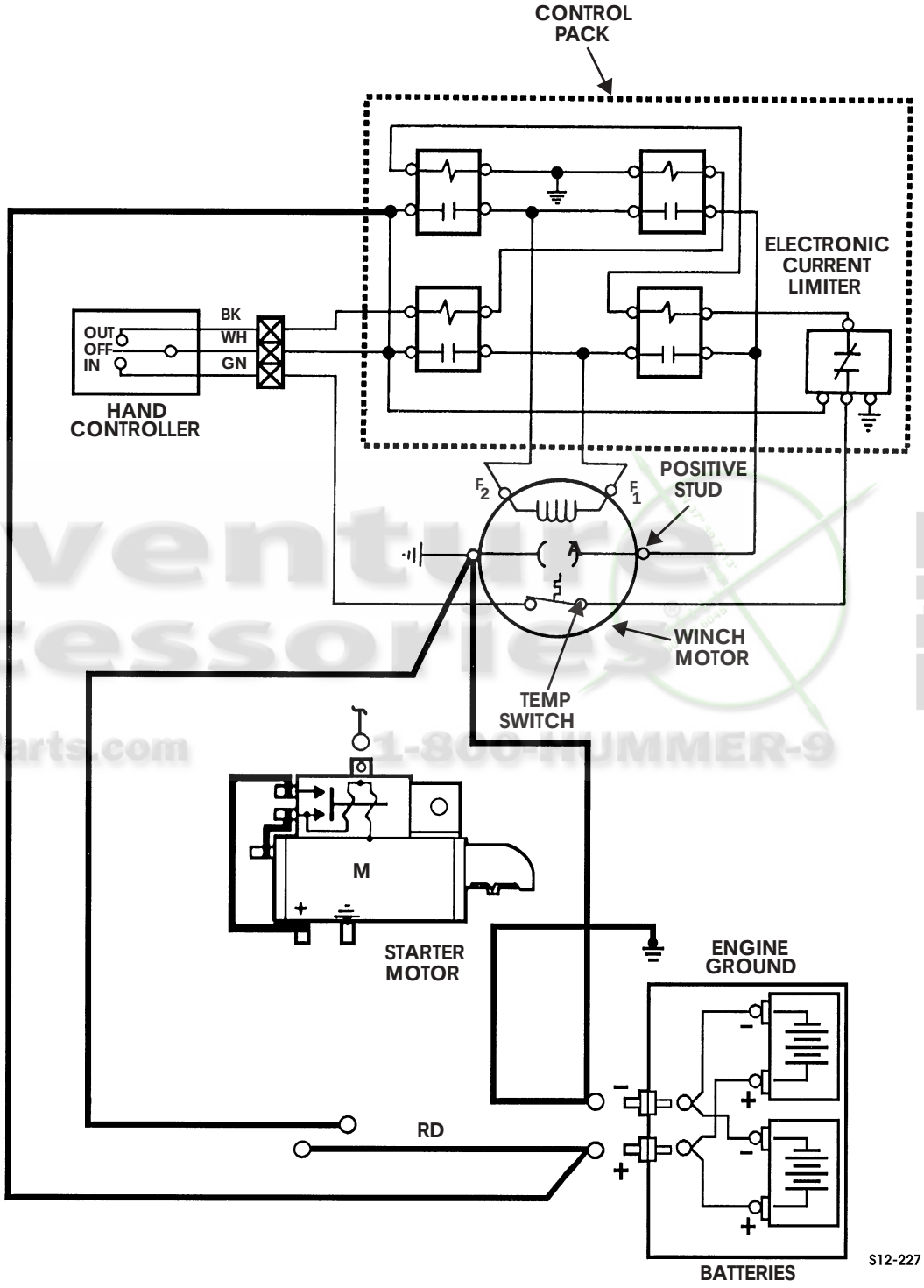
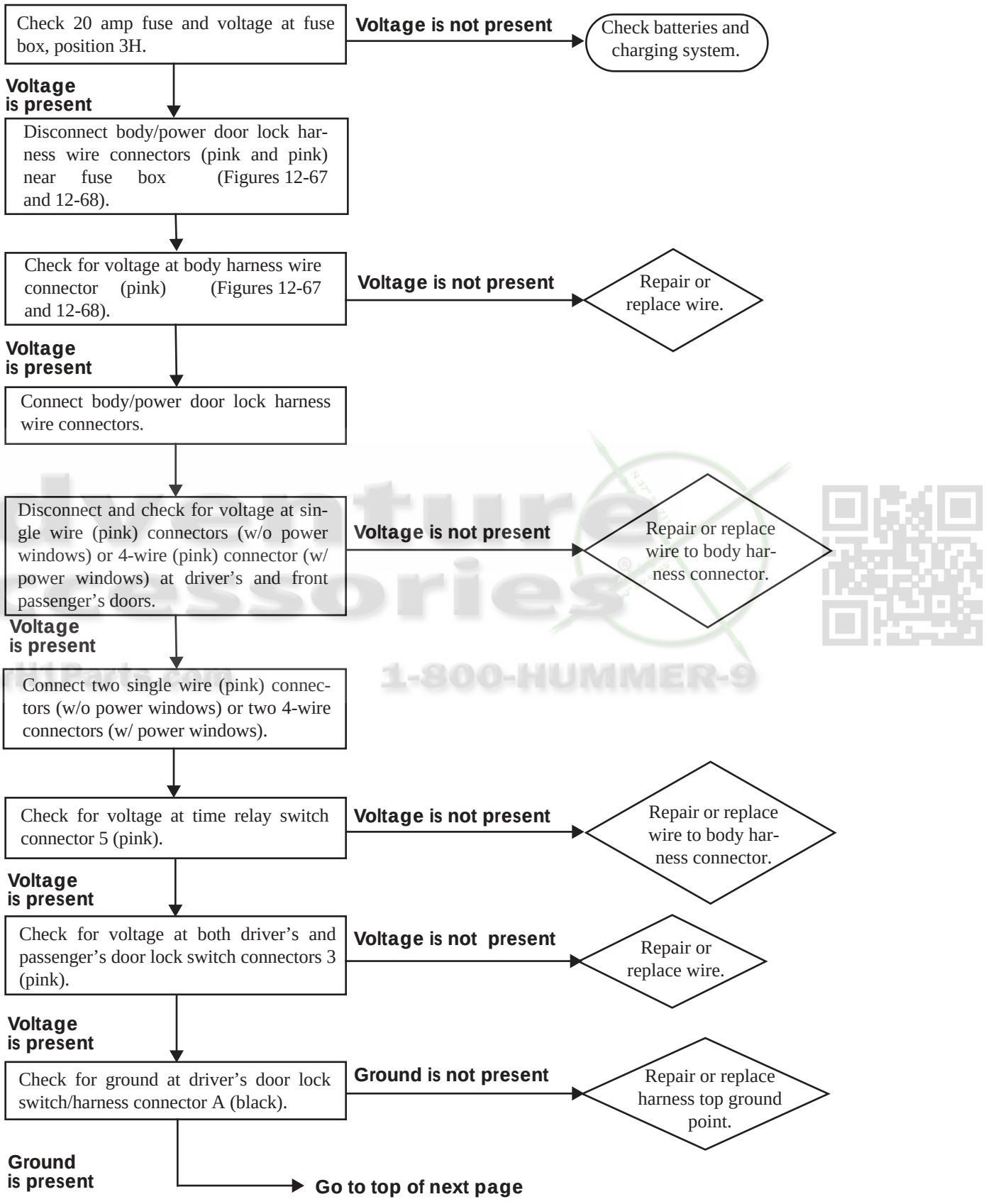
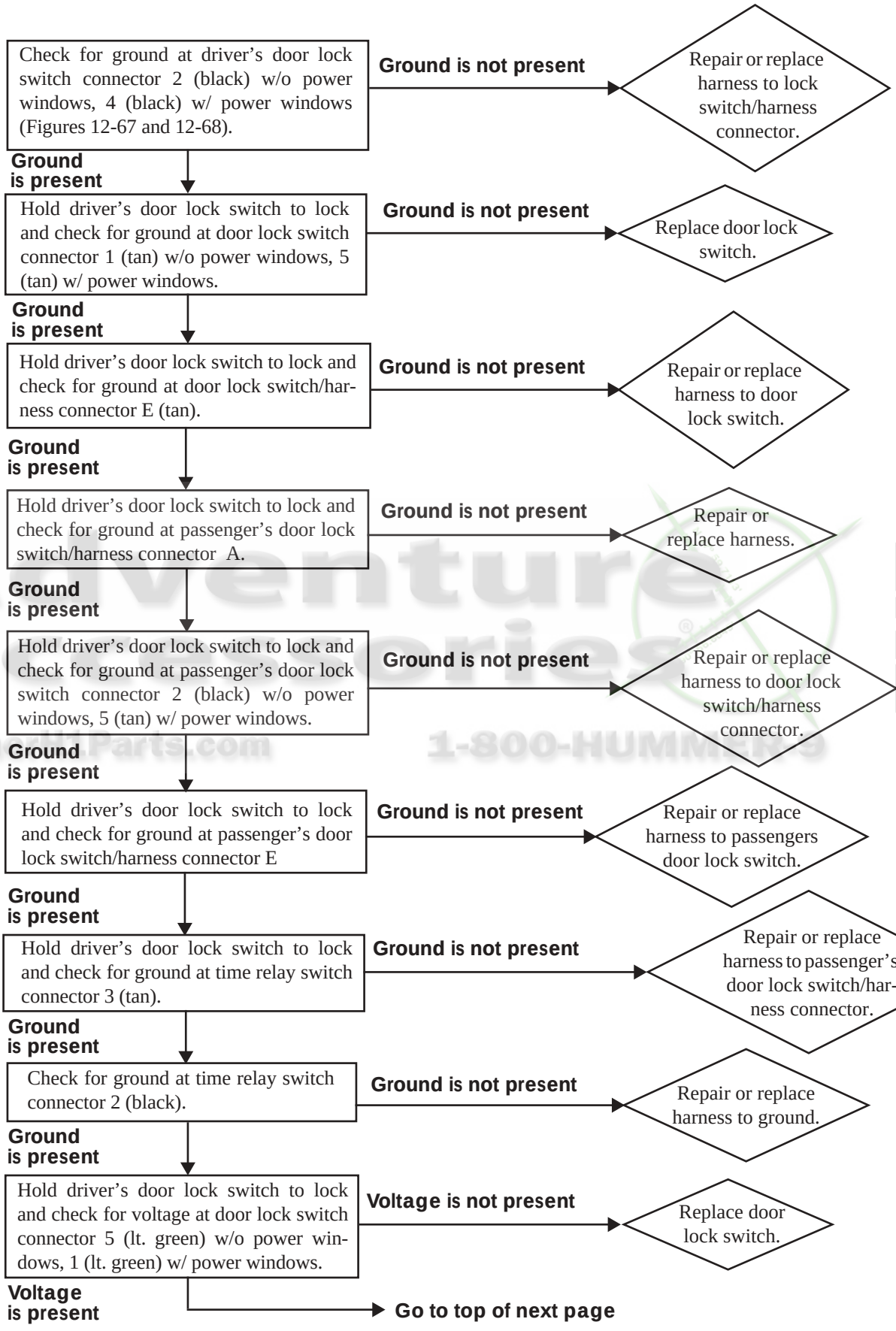


Figure 12-66: Winch System

POWER DOOR LOCKS FAIL TO LOCK

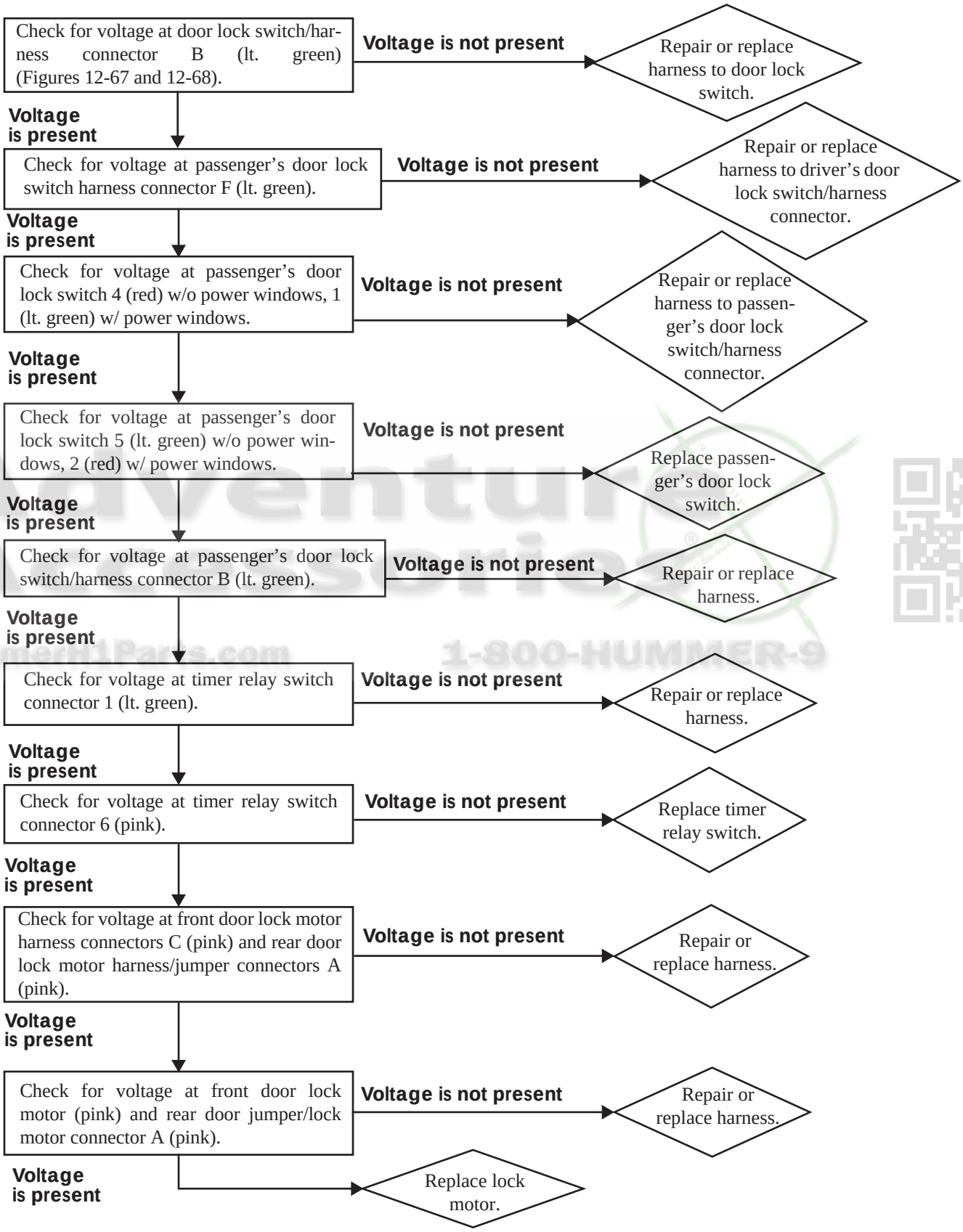


POWER DOOR LOCKS FAIL TO LOCK – CONTINUED

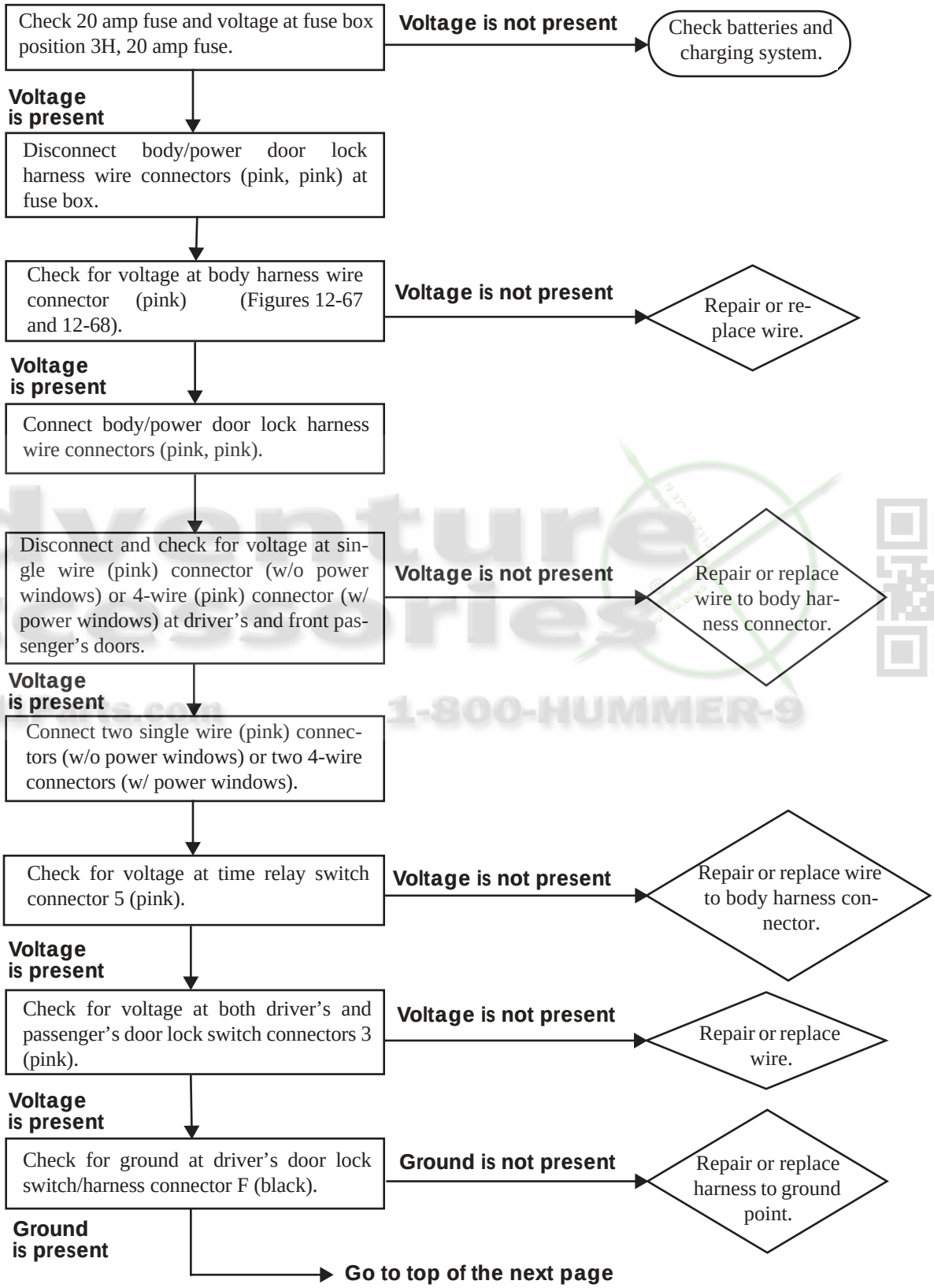


POWER DOOR LOCKS FAIL TO LOCK – CONTINUED

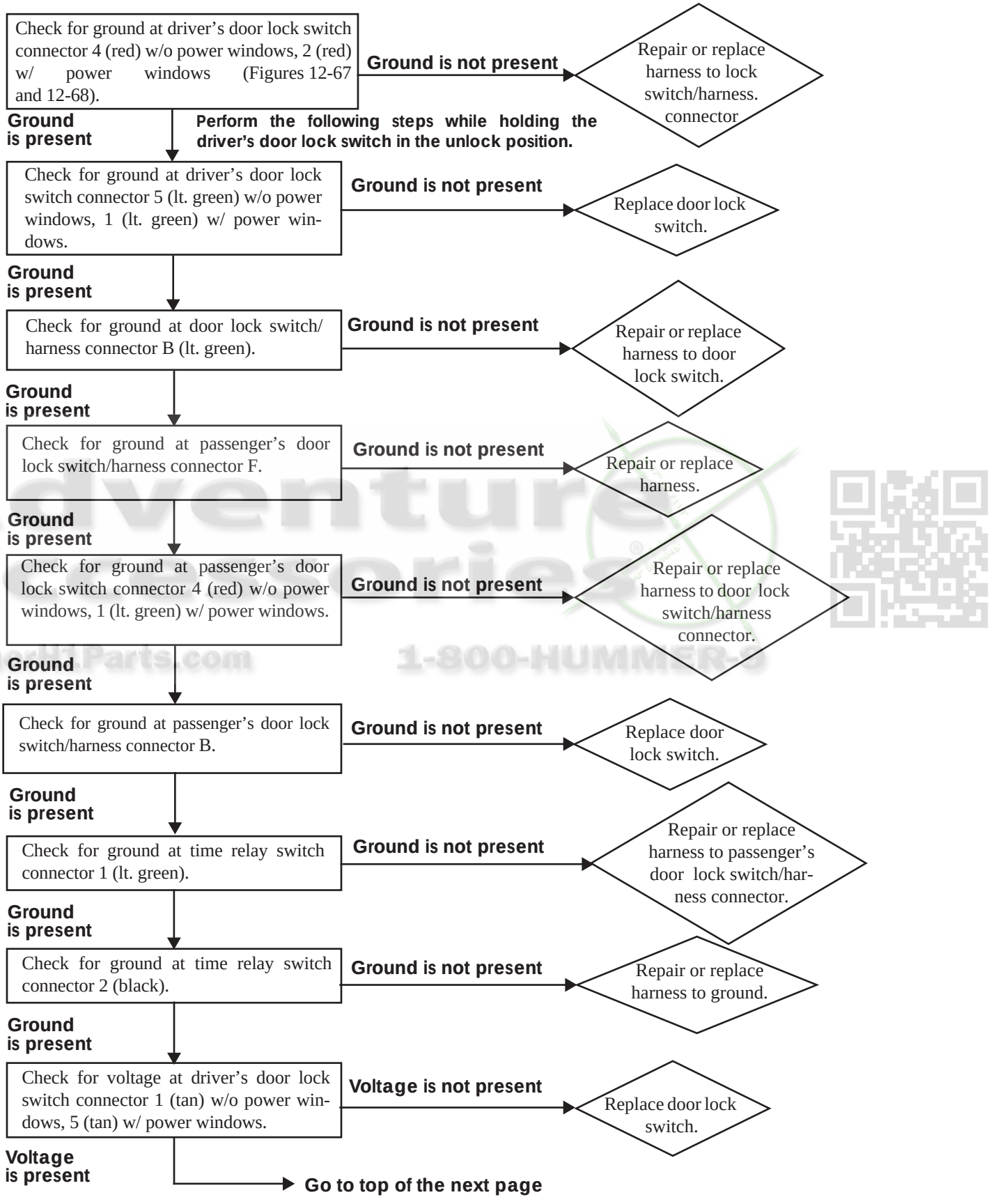
Perform all of the following steps while holding the driver's door lock switch to lock.



POWER DOOR LOCKS FAIL TO UNLOCK

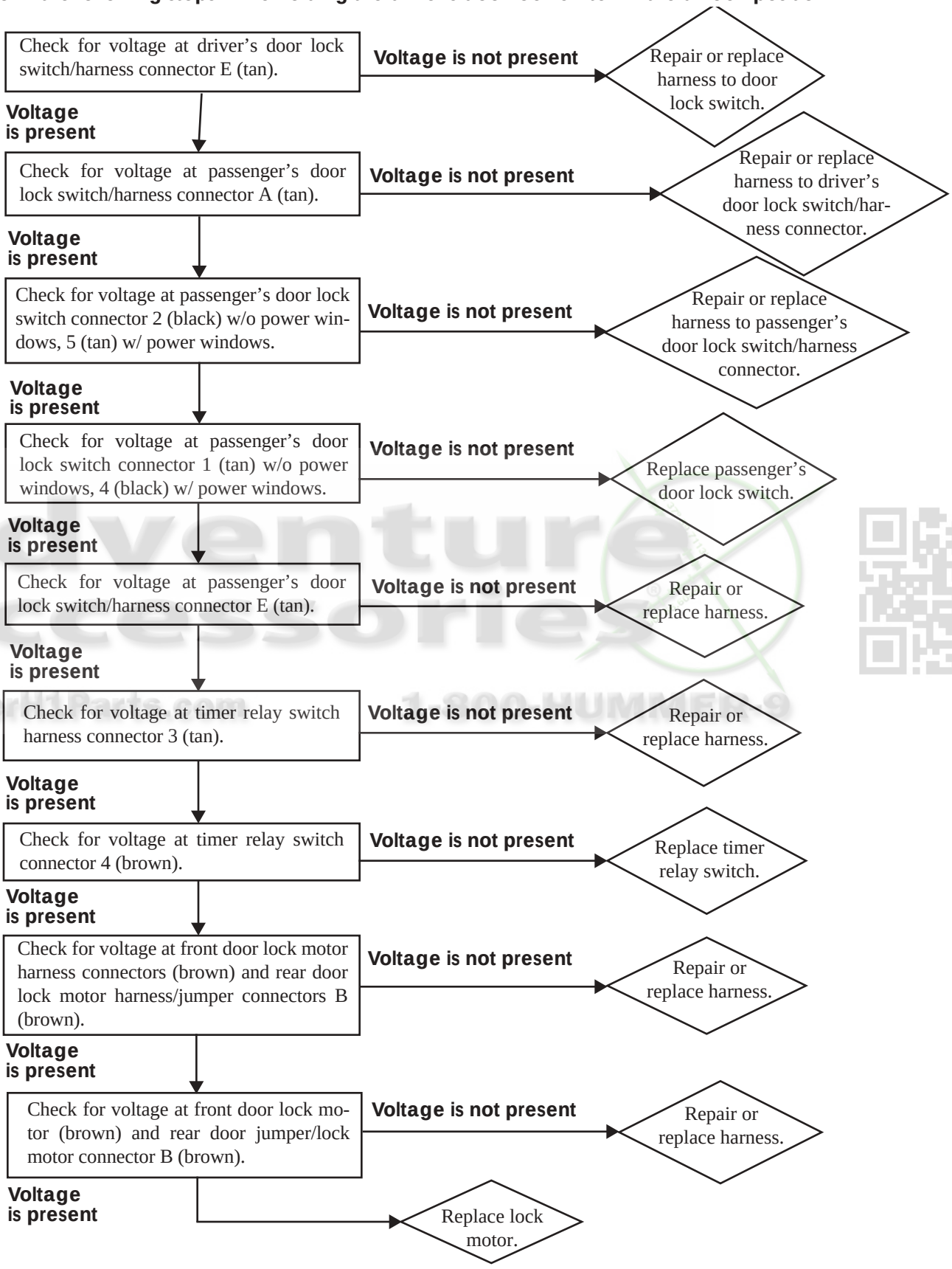


POWER DOOR LOCKS FAIL TO UNLOCK – CONTINUED



POWER DOOR LOCKS FAIL TO UNLOCK – CONTINUED

Perform the following steps while holding the driver's door lock switch in the unlock position.



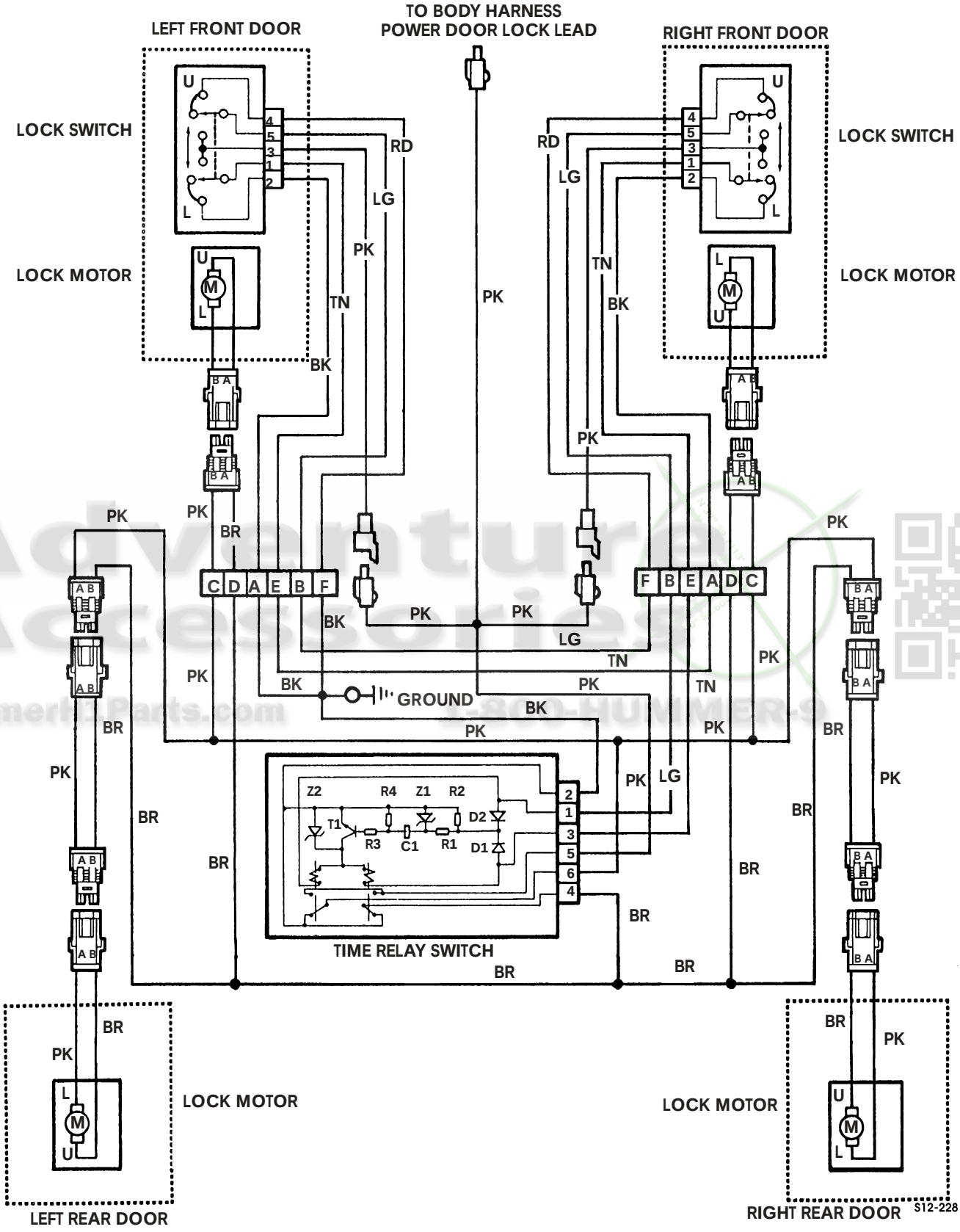


Figure 12-67: Power Door Locks (w/o Power Windows)

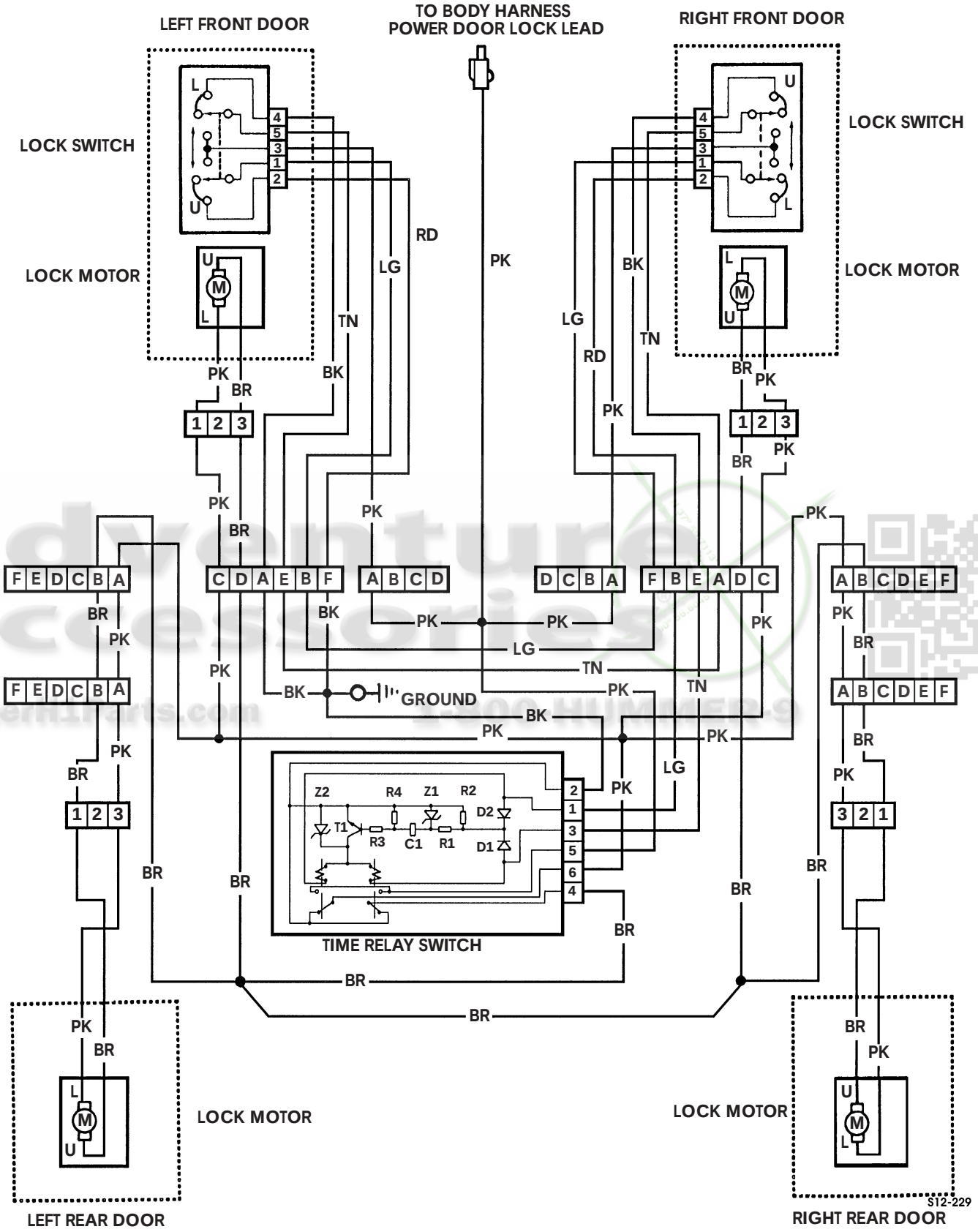
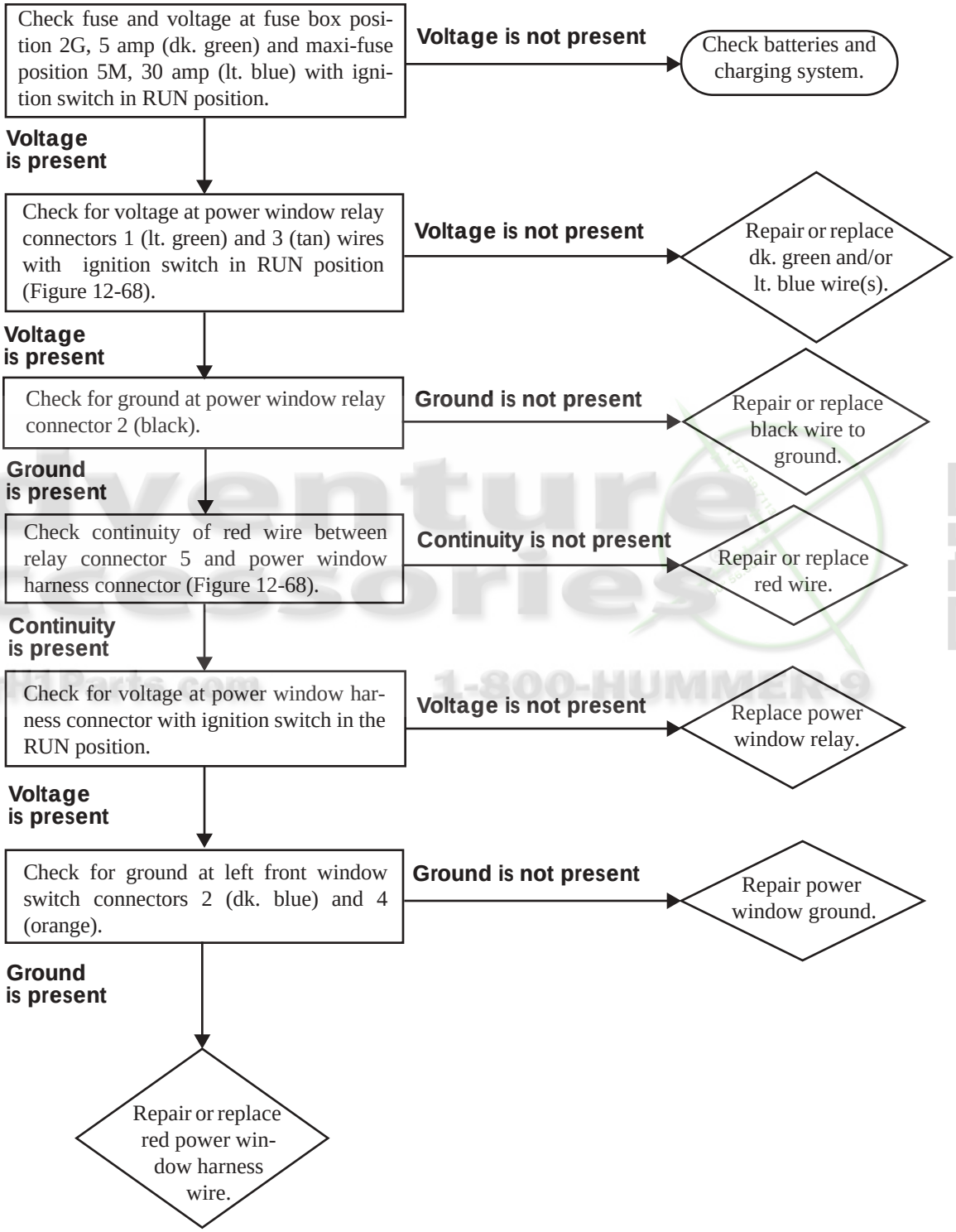
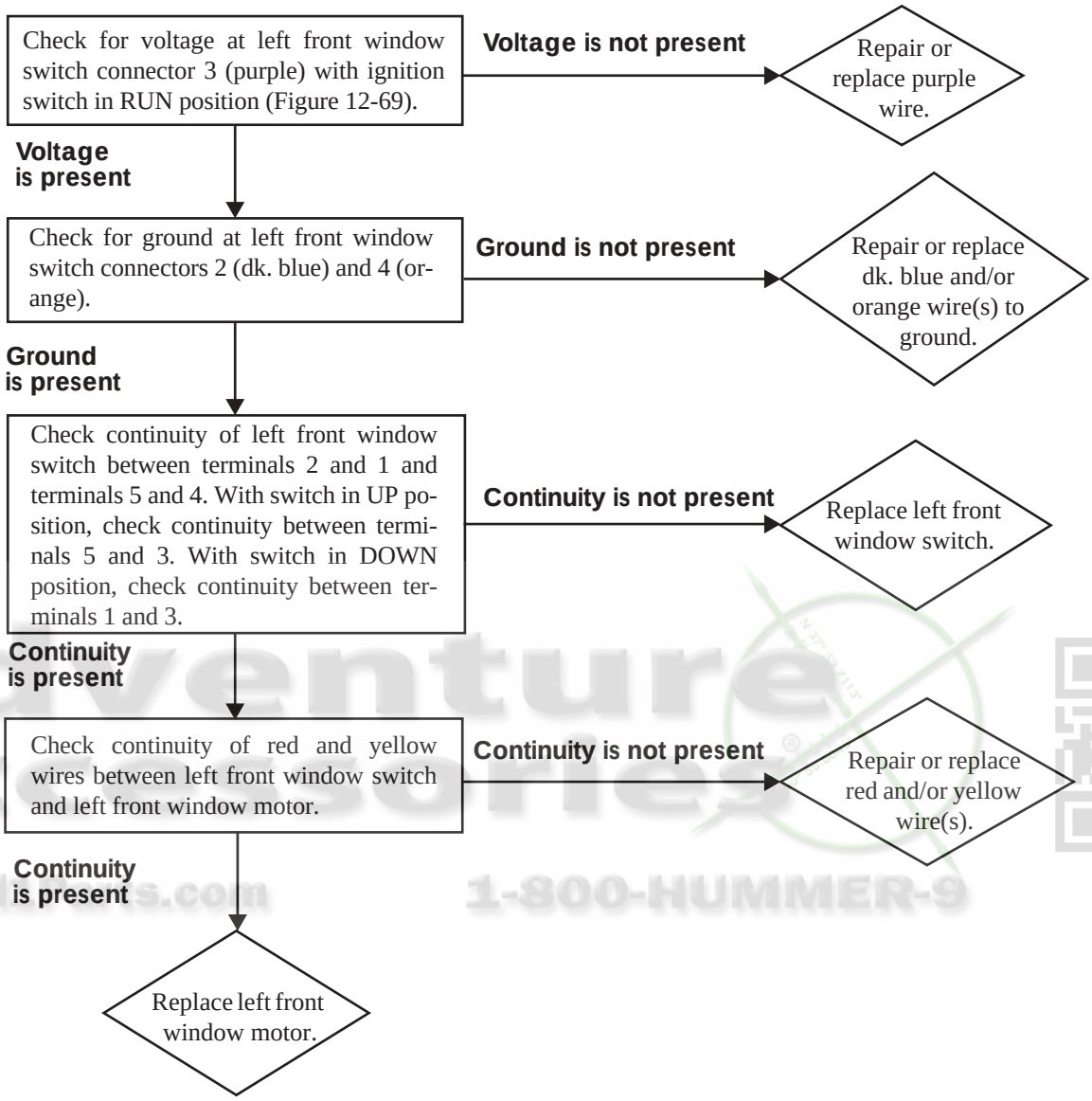


Figure 12-68: Power Door Locks (w/ Power Windows

ALL POWER WINDOWS INOPERATIVE



DRIVER'S POWER WINDOW INOPERATIVE



RIGHT FRONT, RIGHT REAR, OR LEFT REAR WINDOW INOPERATIVE

Check for voltage at window lock switch connector 3 (red) with ignition switch in RUN position (Figure 12-69).

Voltage is not present → Repair or replace red wire.

Voltage is present

Check for voltage at driver controlled window switch connector 3 (red) of inoperative window with ignition in RUN position.

Voltage is not present → Repair or replace red wire.

Voltage is present

Check continuity of inoperative window's driver controlled window switch between terminals 1 and 2, and terminals 4 and 5. With switch in UP position, check continuity between terminals 3 and 5. With switch in DOWN position, check continuity between terminals 1 and 3.

Continuity is not present → Replace driver controlled window switch.

Continuity is present

Check continuity of window lock switch between terminals 1 and 3 with the switch in the UNLOCK position.

Continuity is not present → Replace the window lock switch.

Continuity is present

Check continuity between window lock switch connector 1 (purple) and window switch connector 3 (purple) located at inoperative window.

Continuity is not present → Repair or replace purple wire.

Continuity is present

Check continuity of wires between driver controlled window switch and window switch located at inoperative window (rear window wire colors are lt. green and tan; front window wire colors are dk. blue and orange).

Continuity is not present → Repair or replace wires.

Continuity is present

At driver controlled window switch of inoperative window, check for ground at connectors 2 (black) and 4 (black).

Ground is not present → Repair or replace black wire(s) to ground.

Ground is present

Check continuity of window switch located at inoperative window between terminals 1 and 2, and terminals 4 and 5. With switch in UP position, check continuity between terminals 1 and 3. With switch in DOWN position check continuity between terminals 3 and 5.

Continuity is not present → Replace window switch.

Continuity is present

Check continuity of yellow and red wires between window motor and window switch located at inoperative window.

Continuity is not present → Repair or replace red and/or yellow wire(s).

Continuity is present → Replace window motor.

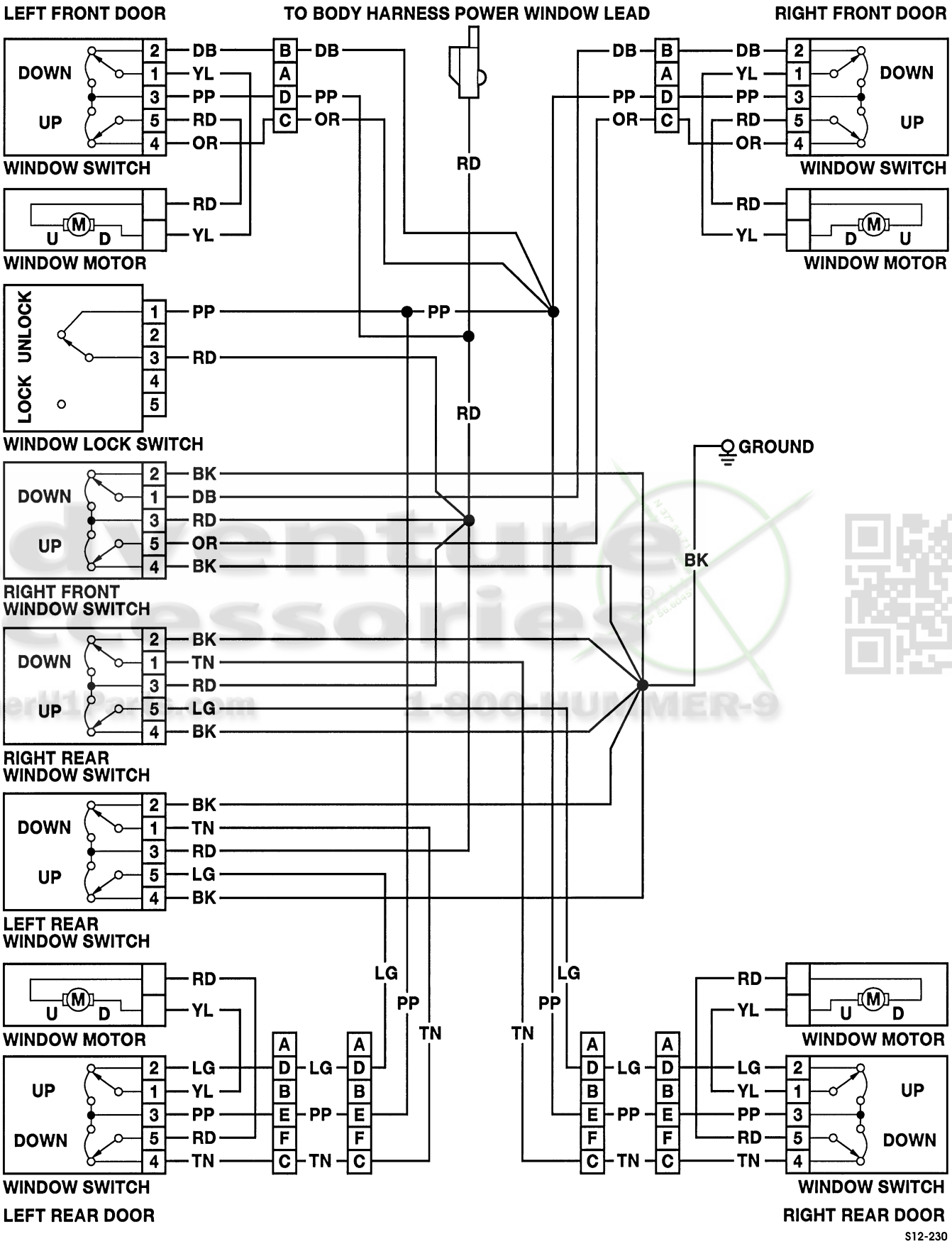
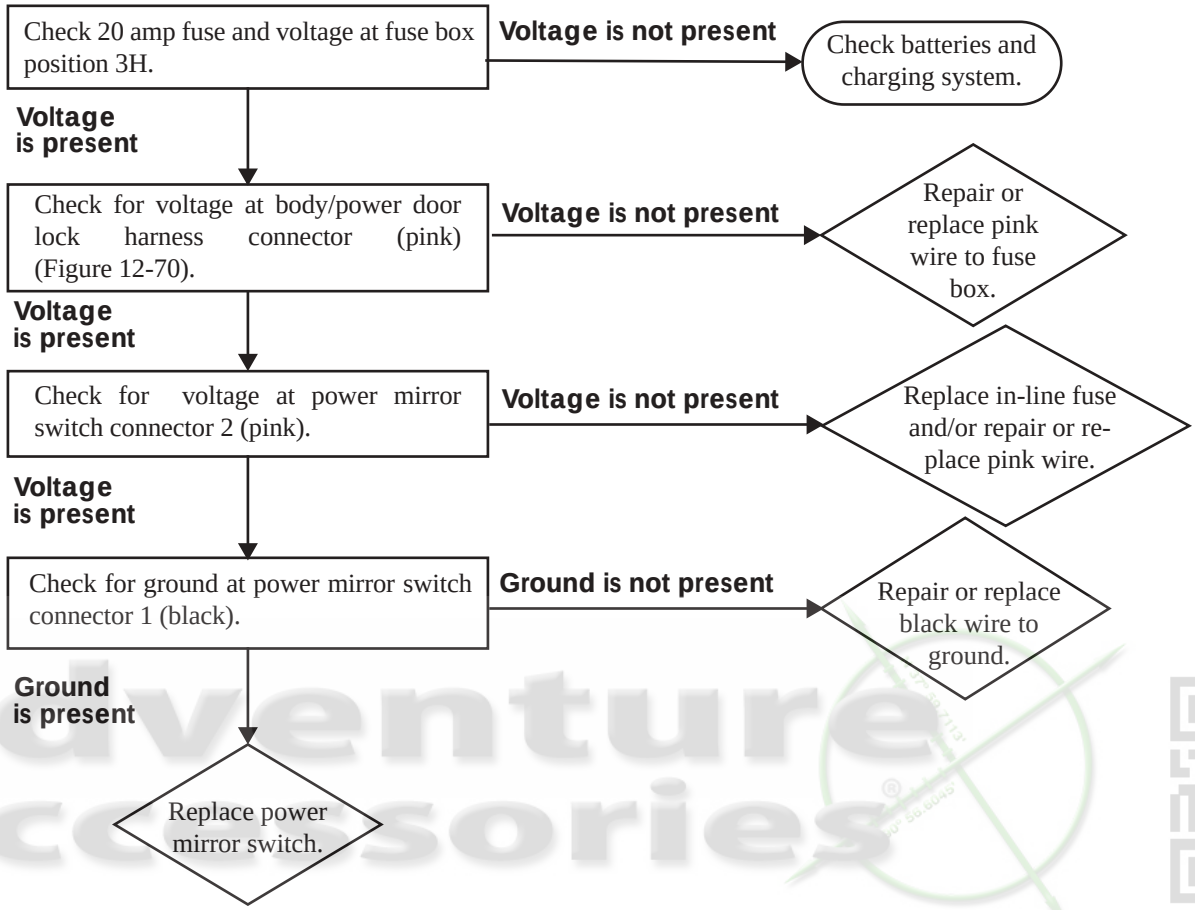
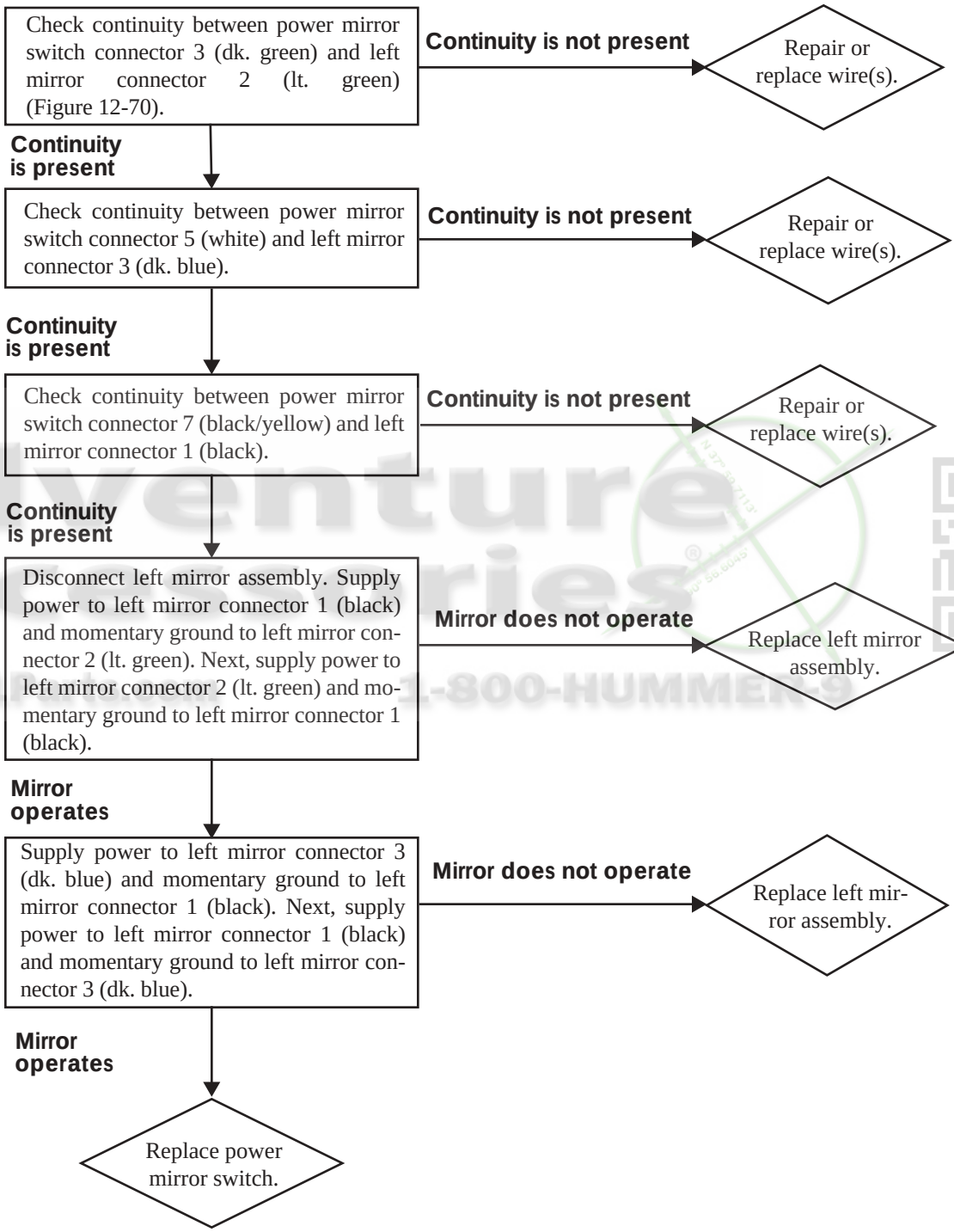


Figure 12-69: Power Windows

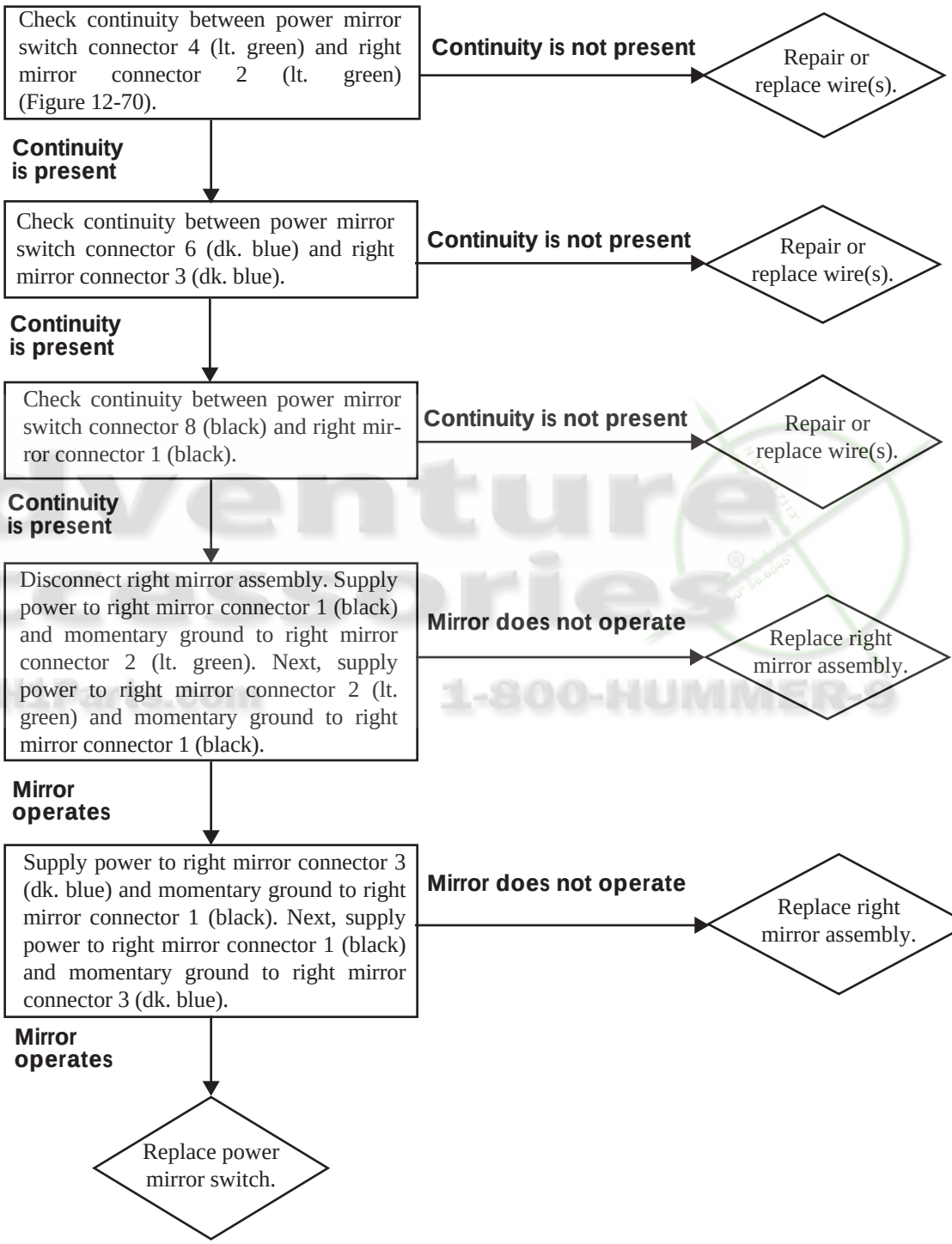
BOTH POWER MIRRORS INOPERATIVE



LEFT POWER MIRROR INOPERATIVE



RIGHT POWER MIRROR INOPERATIVE



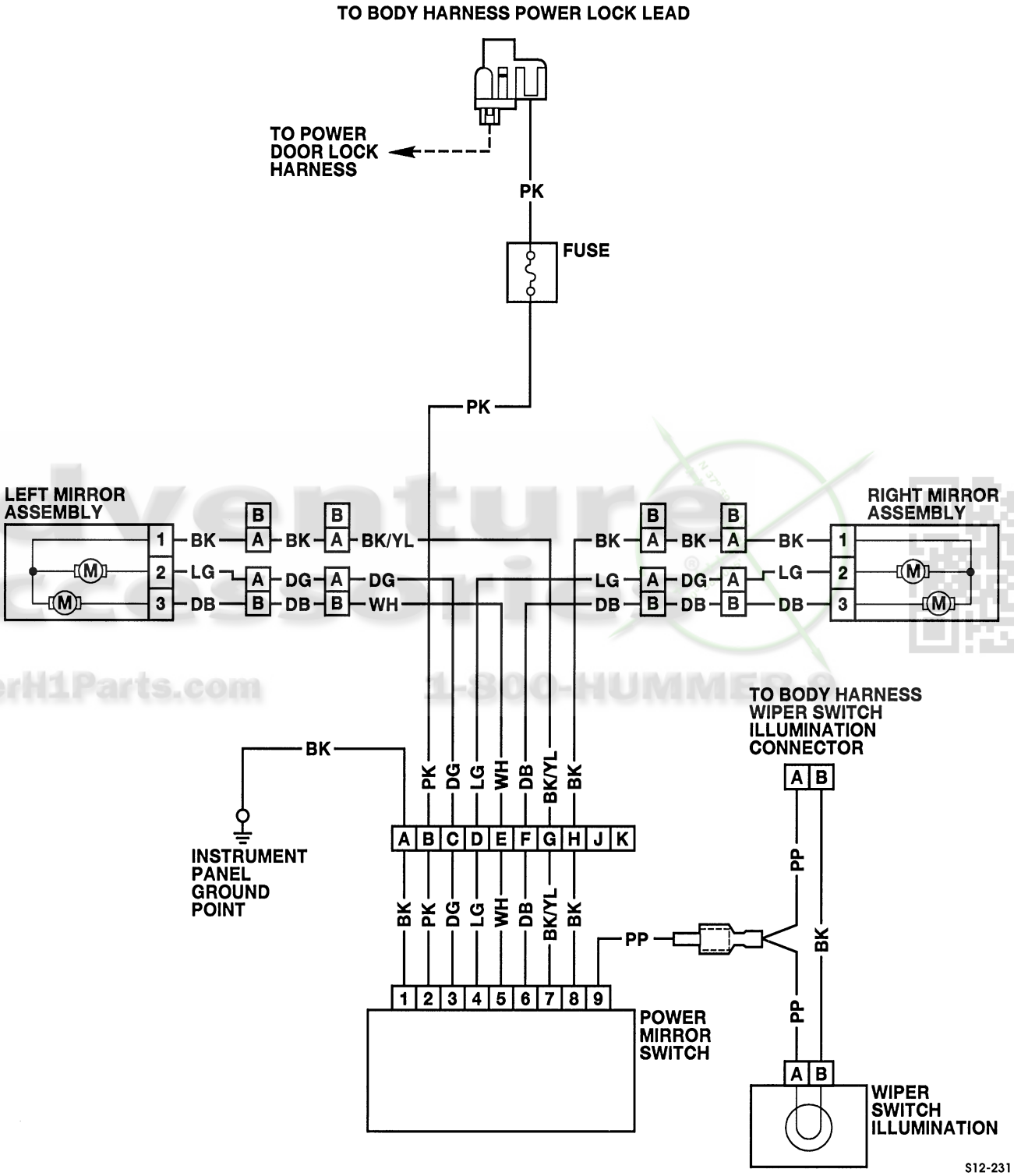


Figure 12-70: Power Mirrors

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Section 13 Accessories

TABLE OF CONTENTS

WINCH TROUBLESHOOTING

Winch Inoperative

1. Check for bound winch cable.
2. Check winch control cable connector for corrosion or looseness. Clean corroded connector or secure loose connection.
3. Check for loose or damaged winch power cables. Using voltmeter, connect positive meter lead to positive power cable (red), and negative meter lead to good ground. If voltage is not present, repair or replace winch power cables.
4. Disconnect winch control from winch. Using a voltmeter, check for continuity between common terminals on winch control while holding control in OUT position. If continuity is present in both positions, replace winch. If continuity is not present in both positions, replace winch control.

WINCH

Winch Replacement

Removal

CAUTION: *To avoid injury or damage, support winch during removal.*

1. Disconnect battery ground cable (Section 12).
2. Remove two battery cable bolts, battery cables, and winch cables from battery (Figure 13-1).

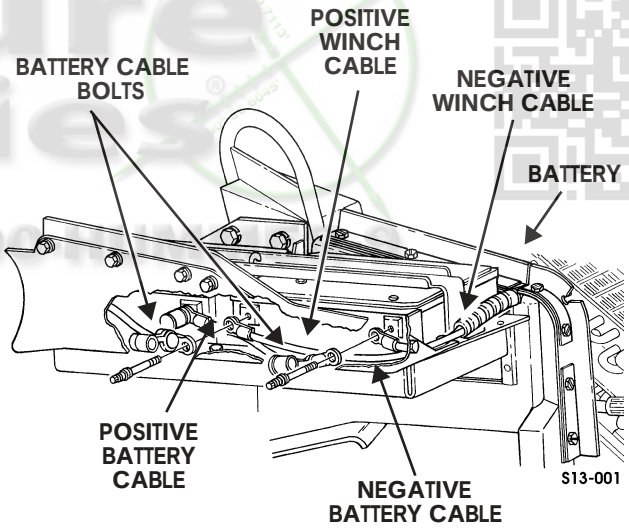


Figure 13-1: Winch Cables On Battery

3. Remove nut, lockwasher, capscrew, and clamp from frame bracket. Discard lockwasher. Pull winch cables to front of vehicle (Figure 13-2).

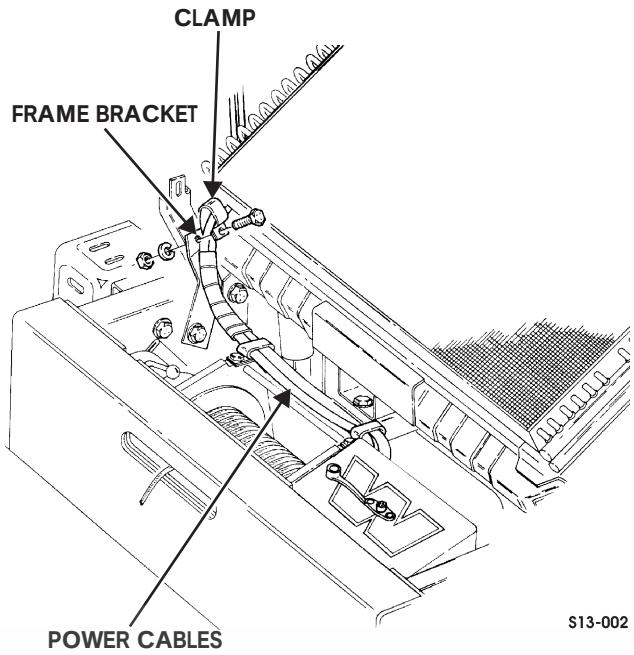


Figure 13-2: Frame Bracket

4. Remove four nuts, washers, capscrews, and winch from front bumper (Figure 13-3).

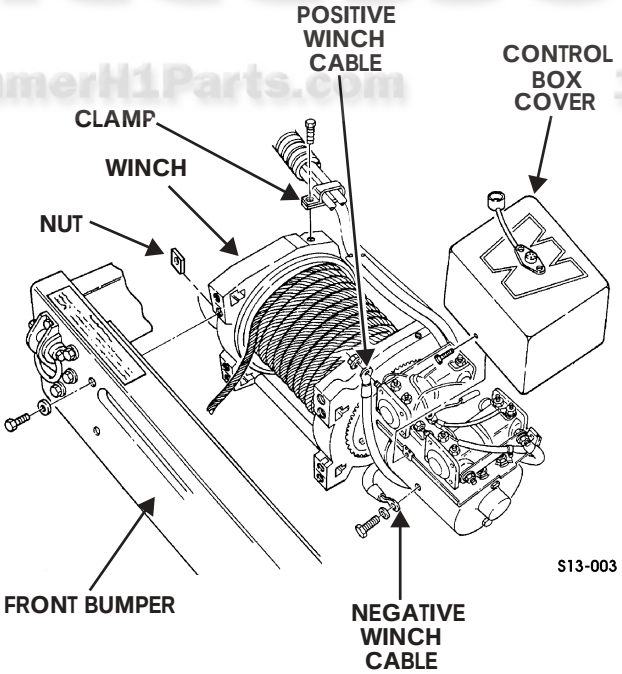


Figure 13-3: Winch and Winch Cables

5. Remove two capscrews and clamps securing winch cables to winch.
6. Remove three capscrews and control box cover from winch.

NOTE: It may be necessary to remove plastic coating compound from winch in order to perform steps 7 and 8.

7. Remove capscrew, washer, and negative winch cable from winch.
8. Remove locknut and positive winch cable from winch. Discard locknut.

Installation

NOTE: Positive winch cable must be positioned to align with the opening in the control box cover.

1. Install positive winch cable on winch with locknut (Figure 13-3).
2. Install negative winch cable on winch with washer and capscrew.
3. Coat motor end of winch with coating compound.
4. Install control box cover on winch with three capscrews.
5. Secure two winch cables to winch with two clamps and capscrews.
6. Install winch on front bumper with four washers, capscrews, and nuts. Tighten capscrews to 60 lb-ft (81 N•m).
7. Install two winch cables and battery cables on battery with two battery cable bolts (Figure 13-1).
8. Install winch cables on frame bracket with clamp, capscrew, lockwasher, and nut (Figure 13-2).
9. Connect battery ground cable (Section 12).

Winch Cable Replacement

WARNING: To avoid injury, wear gloves when handling winch cable.

Removal

1. Disconnect battery ground cable (Section 12).
2. Unwind winch cable.
3. Remove capscrew and winch cable from drum assembly (Figure 13-4).
4. Loosen connector, and remove connector and hook from winch cable.

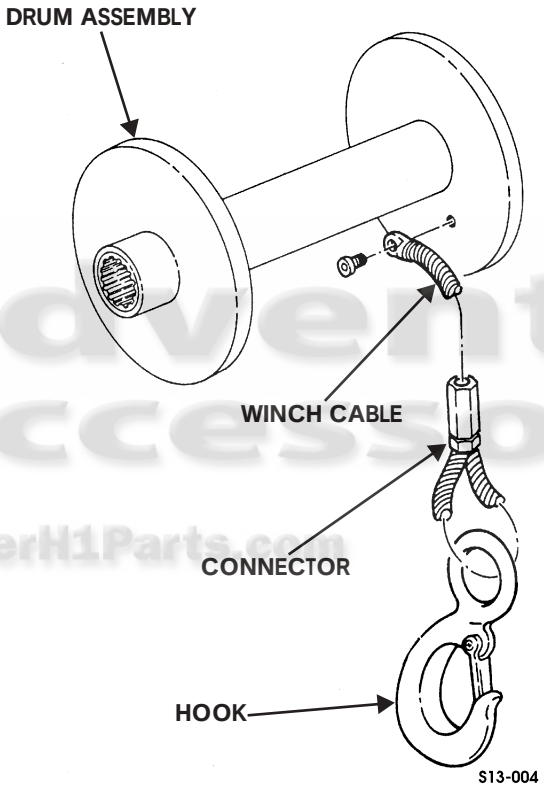


Figure 13-4: Winch Cable

Installation

1. Install hook and connector on winch cable. Tighten connector (Figure 13-4).
2. Install winch cable on drum assembly with capscrew.

CAUTION: *Install winch cable on drum under a load of at least 500 lb (227 kg), or outer wraps will draw into inner wraps and damage cable.*

NOTE: Spool winch cable according to rotation label on winch or brake will not function.

3. Connect battery ground cable (Section 12).
4. Rewind and lubricate winch cable.

Winch Assembly Repair

Disassembly

1. Remove winch and winch cable.

NOTE: Tag leads for assembly.

NOTE: It may be necessary to remove plastic coating from winch in order to perform steps 2 through 5.

2. Remove three nuts and control leads from motor (Figure 13-5).

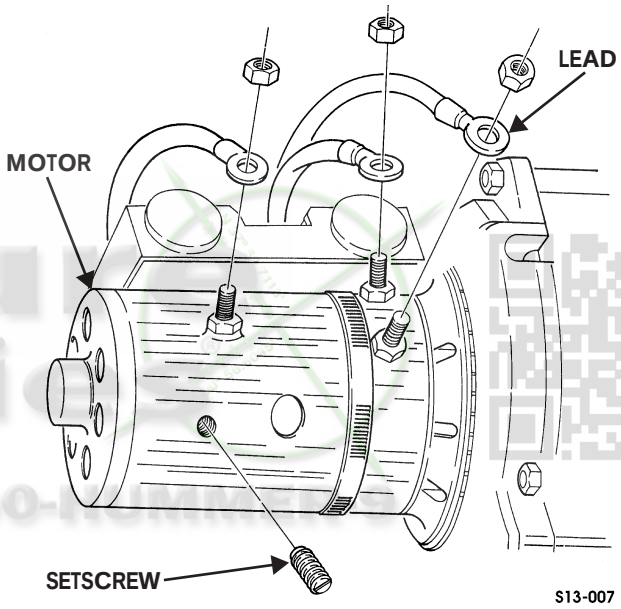


Figure 13-5: Control Leads

3. Remove setscrew from motor.
4. Loosen two clamps and remove control from motor (Figure 13-6).

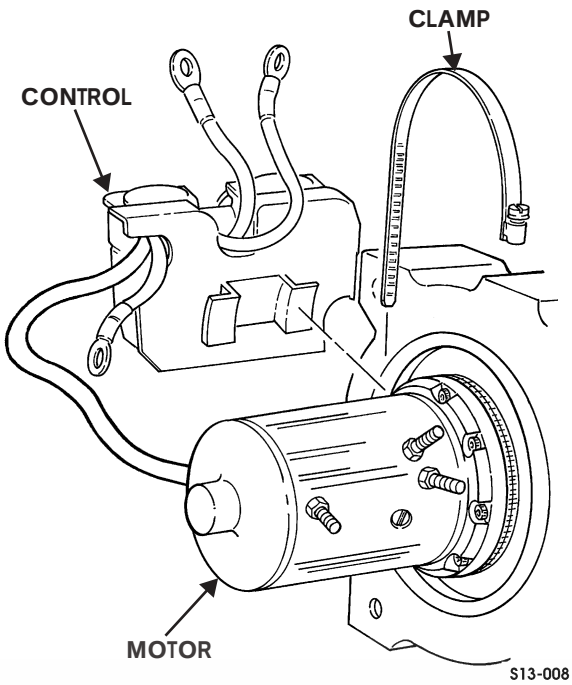


Figure 13-6: Control Unit

5. Remove clamps from motor.
6. Mark motor end drum support, gear train assembly, and gear end drum support for assembly (Figure 13-7).

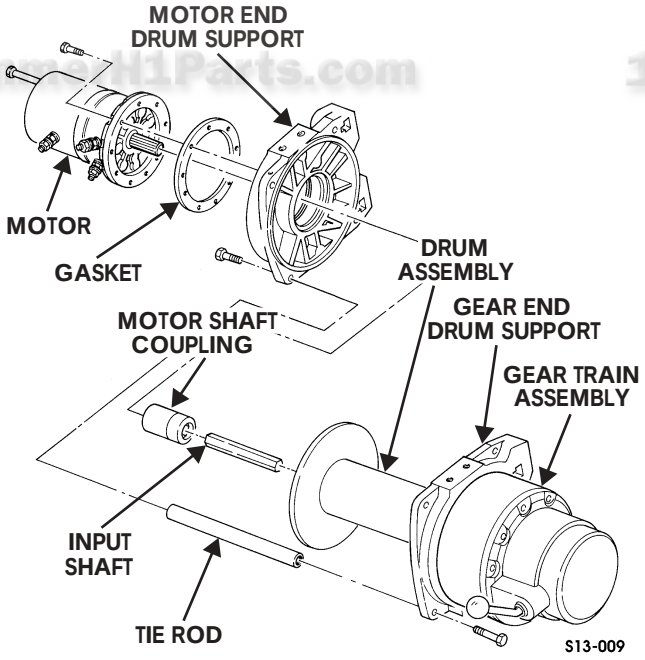


Figure 13-7: Drum Support and Gear Train Assembly

7. Remove six capscrews, three tie rods, motor end and gear end drum supports from winch.
8. Place winch on end with motor end up and remove ten hex- head screws and motor from motor end drum support.
9. Remove motor, gasket, and motor end drum support from drum assembly. Discard gasket.
10. Remove motor shaft coupling and input shaft from drum assembly.
11. Remove drum assembly from gear train assembly.
12. Remove two nylon thrust washers from drum (Figure 13-8).

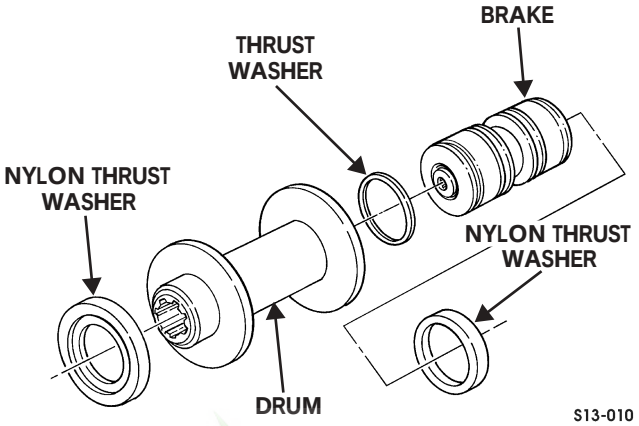


Figure 13-8: Thrust Washers and Brake

13. Push brake through open end of drum and remove.
14. Remove thrust washer from brake.
15. Remove driveshaft from gear train assembly (Figure 13-9).
16. Turn gear train assembly over with gear end drum support down. Remove ten hex-head screws and gear housing from gear end drum support.
17. Remove gasket from gear end drum support. Discard gasket.

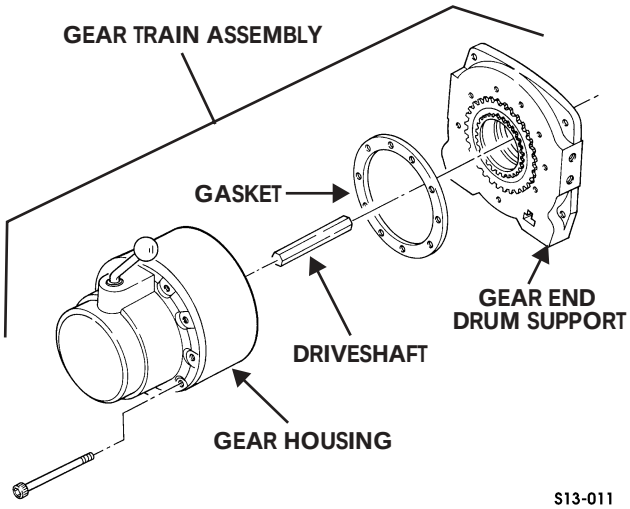


Figure 13-9: Gear Train Assembly

18. Remove detent spacer, spring, and detent ball from gear housing (Figure 13-10).

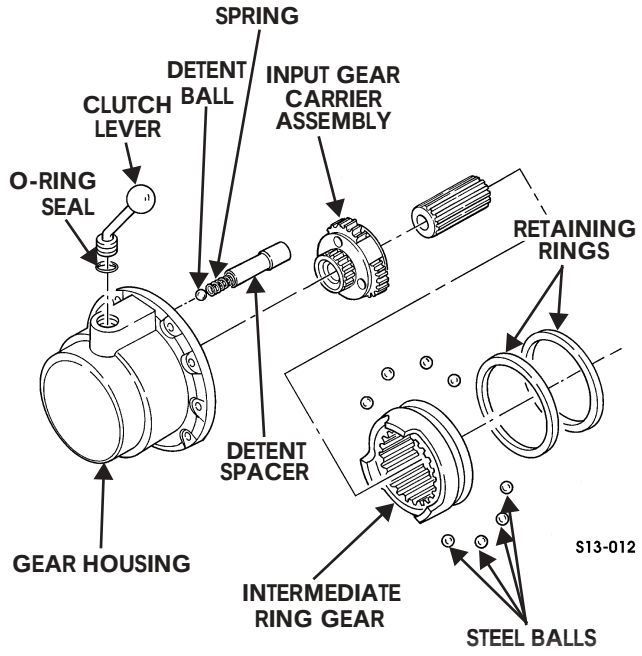


Figure 13-10: Gear Housing

19. Remove clutch lever and O-ring seal from gear housing. Discard O-ring seal.
20. Remove two retaining rings from gear housing.

NOTE: Intermediate ring gear comes out with 85 to 87 steel balls. Be sure to catch all 85 to 87 steel balls.

21. Remove intermediate ring gear and 85 to 87 steel balls from gear housing.
22. Remove input gear carrier assembly from gear housing.
23. Remove intermediate gear carrier and output gear carrier from output ring gear and gear end drum support (Figure 13-11).

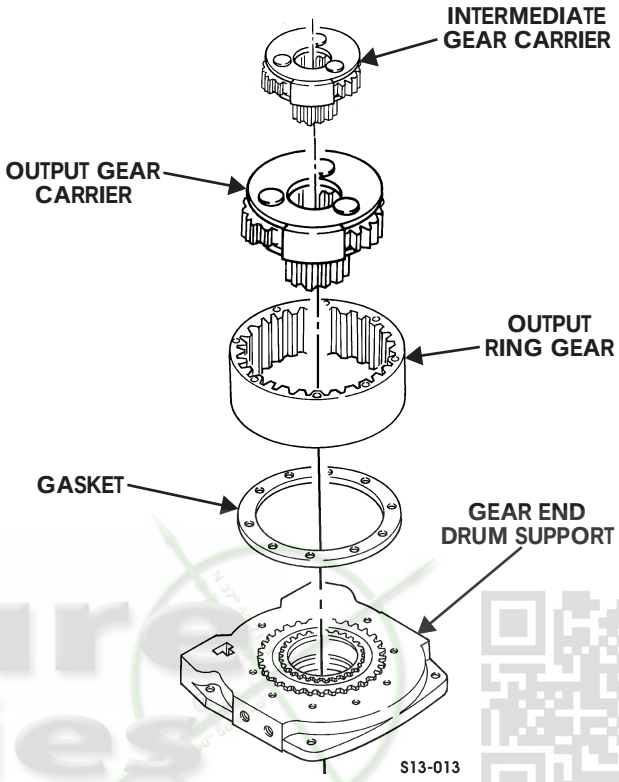


Figure 13-11: Gear Carriers

24. Remove output ring gear and gasket from gear end drum support.

Cleaning

CAUTION: *To avoid damage to equipment, do not clean brake assembly. Clean and inspect all winch components. Replace defective parts.*

Inspection

1. Inspect drum for damage to splined end flanges and tube (Figure 13-12). Replace winch if damaged.

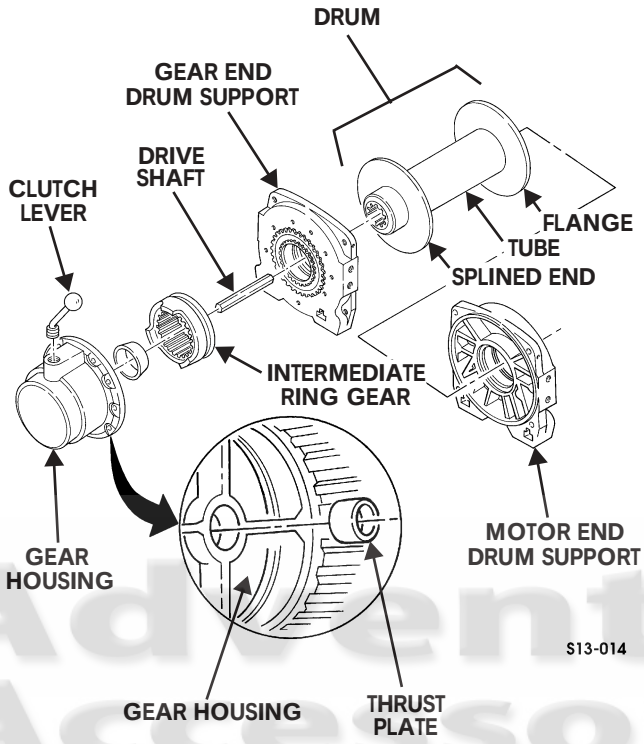


Figure 13-12: Drum Assembly and Gear Housing Assembly

2. Inspect gear end and motor end drum supports for damage. Replace if damaged.
3. Inspect gear housing for damage. Replace if damaged.
4. Inspect thrust plate for damage or wear. Replace if damaged or worn. Apply grease on thrust plate for assembly.
5. Inspect clutch lever and driveshaft for damage. Replace if damaged.
6. Inspect gear teeth and machined surfaces of intermediate ring gear for damage. Replace if damaged.
7. Inspect gear teeth, splines, and machined surfaces of output ring gear, output gear carrier, intermediate gear carrier, and input gear carrier assembly for damage. Replace any damaged parts (Figure 13-13).

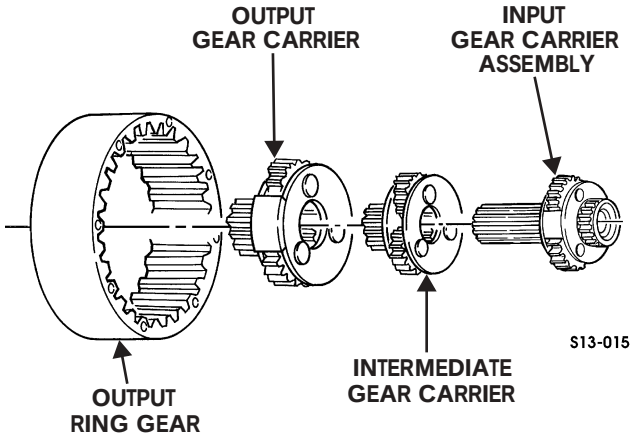


Figure 13-13: Gear Carrier

8. Inspect brake assembly for damage (Figure 13-14).

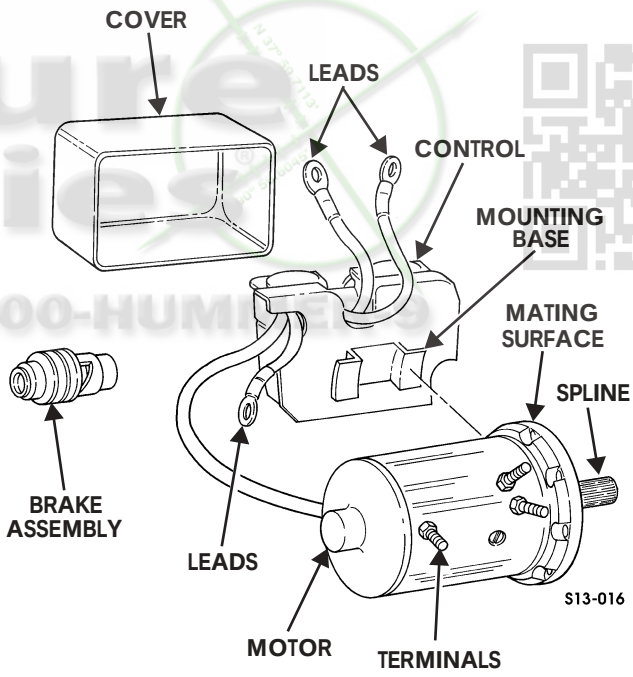


Figure 13-14: Motor and Control Unit

9. Inspect motor, spline, mating surface, and terminals for damage. Replace motor if damaged.
10. Inspect cover for damage. Replace if damaged.
11. Inspect control for damaged leads, breaks in plastic coating, and damaged mounting base. Replace control if damaged or repair plastic coating.

Assembly

1. Position 85 to 87 steel balls in groove of intermediate ring gear and install intermediate ring gear in gear housing (Figure 13-15).

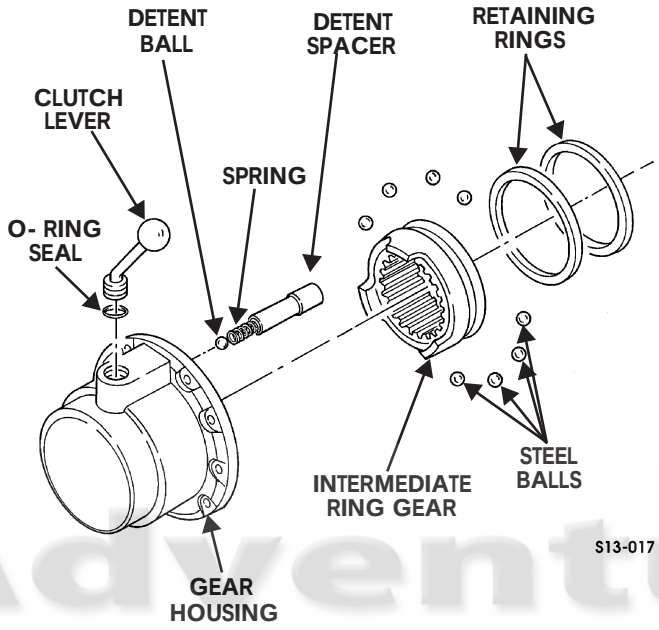


Figure 13-15: Intermediate Ring Gear and Gear Housing

NOTE: Openings in retaining rings should be opposite of each other and 90 degrees from clutch lever.

2. Install two retaining rings in gear housing.
3. Apply light oil to steel balls through the clutch lever hole.
4. Apply grease to clutch lever hole and install O-ring seal and clutch lever in gear housing.
5. Install detent ball, spring, and detent spacer in gear housing.
6. Apply aircraft grease to output gear carrier, intermediate gear carrier, and input gear carrier assembly (Figure 13-16).

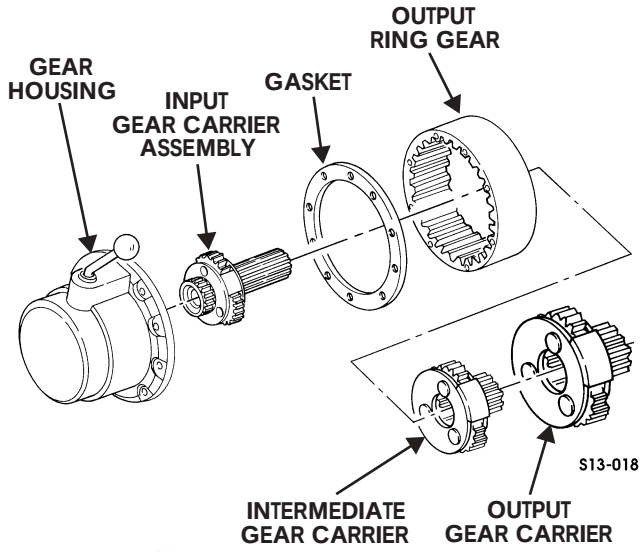


Figure 13-16: Gear Carriers

7. Install input gear carrier assembly in gear housing.

NOTE: Be sure ring gear engages in gear housing.

8. Install gasket and output ring gear on gear housing.
9. Install intermediate gear carrier on gear housing.
10. Install output gear carrier on intermediate gear carrier.
11. Install gasket on output ring gear (Figure 13-17).

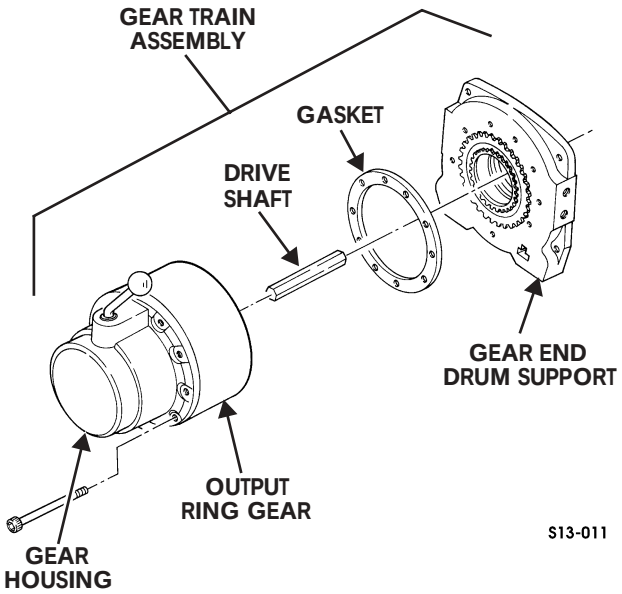


Figure 13-17: Gear Train Assembly

NOTE: Ensure spline on drum support engages in output ring gear.

12. Install gear end drum support on output ring gear and gear housing.
13. Secure gear housing assembly to drum support with ten hex-head screws. Tighten hex-head screws to 100 lb-in. (11 N•m).
14. Turn gear train assembly over with drum support facing up.
15. Install driveshaft in gear train assembly.
16. Apply grease to drum bushings, seals, brake, and output spline (Figure 13-18).

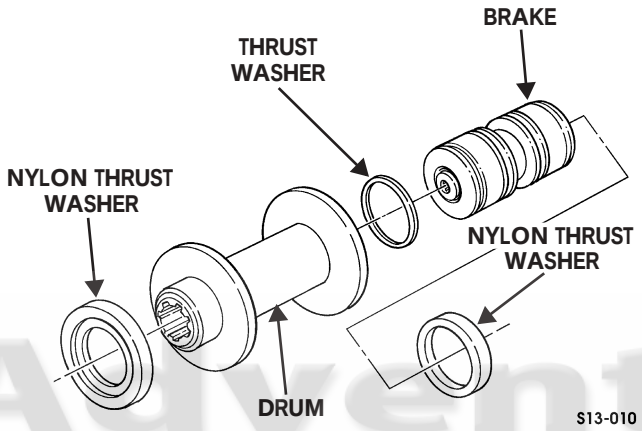


Figure 13-18: Thrust Washers and Brakes

17. Install thrust washer on brake.
18. With drum horizontal, install brake into drum.
19. Install two nylon thrust washers on drum.
20. Install drum assembly on gear train assembly. Rotate drum assembly as needed to engage driveshaft, brake, and output spline (Figure 13-19).

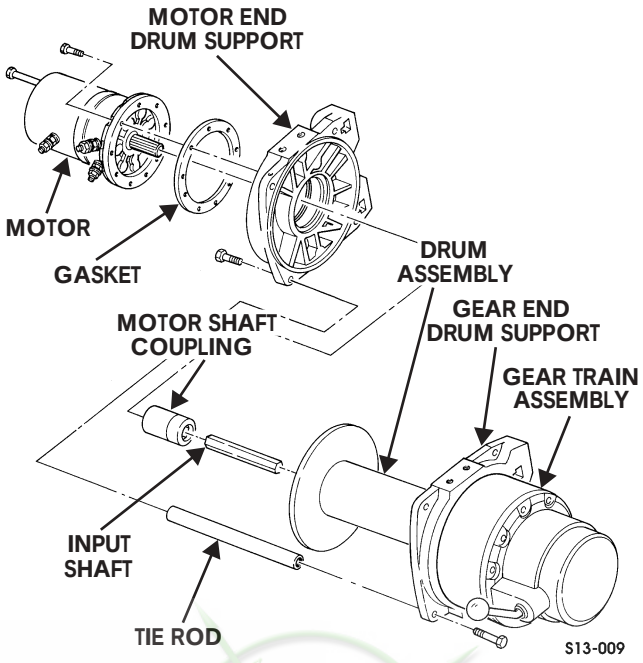


Figure 13-19: Drum Assembly and Gear Train Assembly

21. Install input shaft and motor shaft coupling in drum assembly.
22. Install motor end drum support on drum assembly.
23. Install gasket on motor end drum support.
24. Install motor on motor end drum support, ensuring to engage motor shaft into motor shaft coupling.
25. Secure motor to motor end drum support with ten hex-head screws. Tighten hex-head screws to 35 lb-in. (4 N•m).
26. Install three tie rods between drum supports and secure with six capscrews. Tighten capscrews to 18 lb-ft (24 N•m).

NOTE: If motor or control have been precoated with sealing compound, remove compound from between motor case and control mounting gear contact area. Failure to do so may cause improper grounding of control.

27. Install two clamps on motor (Figure 13-20).

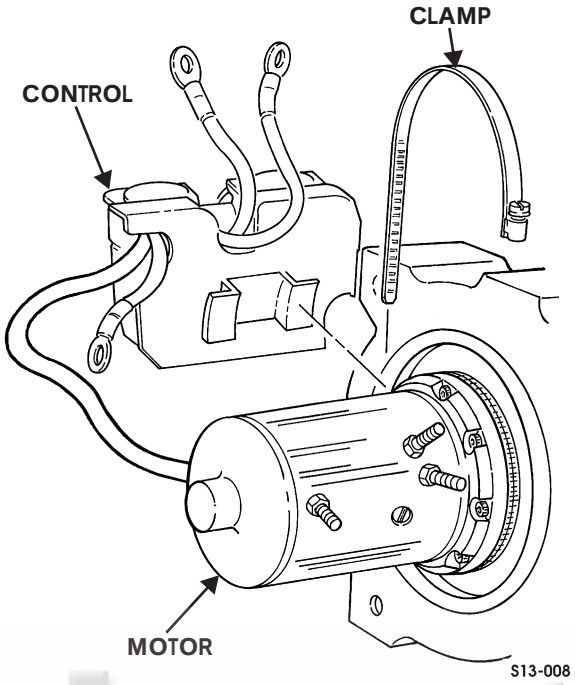


Figure 13-20: Control Unit and Motor

28. Install control on motor.
29. Connect three control leads to terminals and secure with nuts (Figure 13-21).

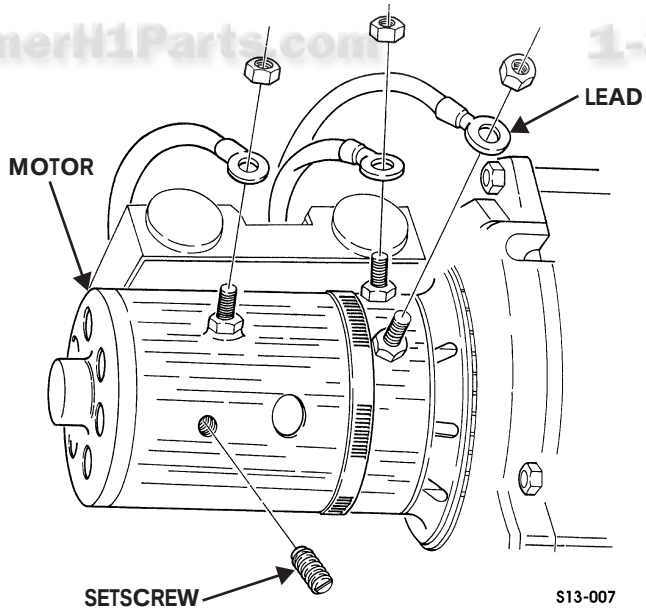


Figure 13-21: Control Leads

30. Secure control to motor with two clamps.
31. Apply pipe sealant to threads of setscrew and install on motor.
32. Install winch assembly and winch cable.

Winch Electric Thermal Switch/Brush Assembly Replacement

Removal

1. Remove winch and winch cable.

NOTE: Tag leads for assembly.

NOTE: It may be necessary to remove plastic coating from winch in order to perform steps 2 through 5.

2. Remove three nuts and control leads from motor (Figure 13-22).

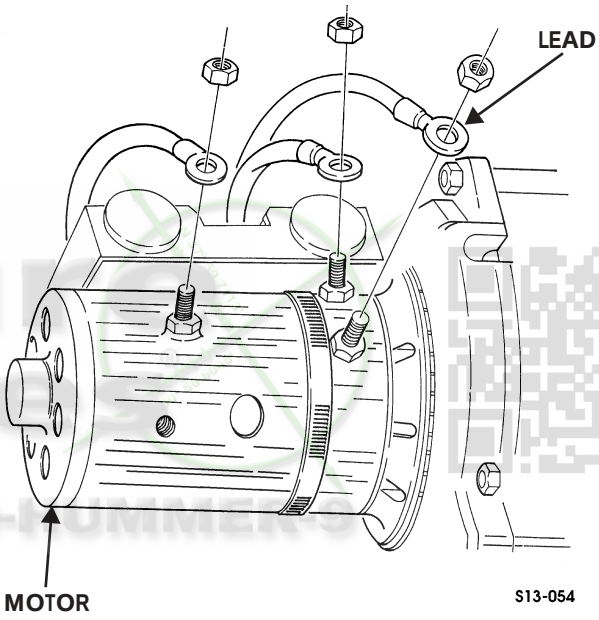


Figure 13-22: Control Leads

3. Loosen two clamps and remove control from motor (Figure 13-23).

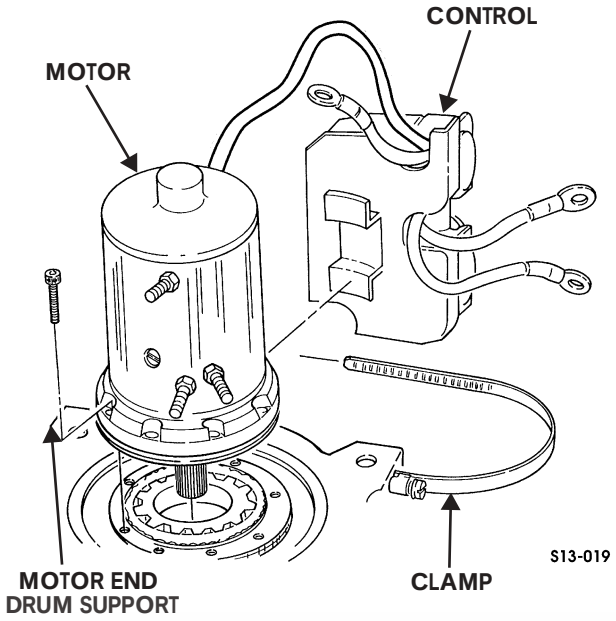


Figure 13-23: Control Unit and Motor

4. Remove clamps from motor.
5. Place winch on end with motor end up and remove ten hex-head screws and motor from motor end drum support.
6. Remove motor and gasket from drum support assembly (Figure 13-24). Discard gasket.
7. Remove two bolt assemblies, front cover, spacer, rear cover, and spacer from motor housing.

NOTE: Perform steps 8 through 12 only if replacing brush assembly.

8. Remove electric thermal switch from two electric thermal switch leads.
9. Remove armature assembly from brush assembly (Figure 13-25).
10. Remove nut, lockwasher, washer, and insulator securing brush assembly power stud to motor housing. Discard lockwasher.
11. Remove three nuts, screws, and brush assembly from motor housing.
12. Remove spacer, insulator, and washer from brush assembly power stud.

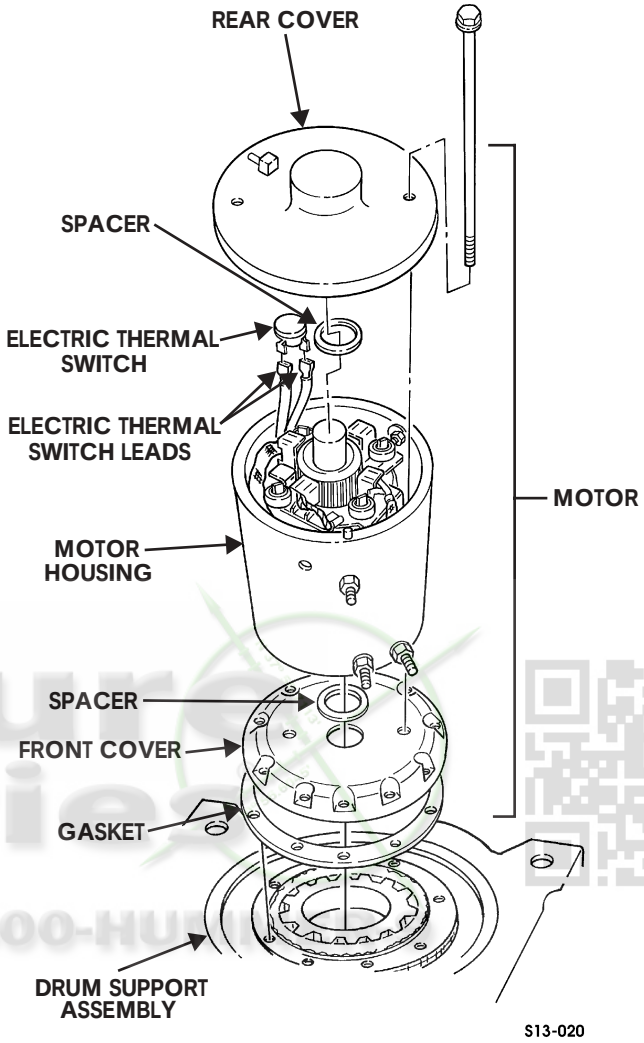


Figure 13-24: Motor and Gasket

Installation

NOTE: Do not apply coating to any electrical contacts of the armature assembly. Perform steps 1 through 5 only if replacing brush assembly.

1. Install washer, insulator, and spacer on brush assembly power stud (Figure 13-25).
2. Install brush assembly in motor housing with three screws and nuts.

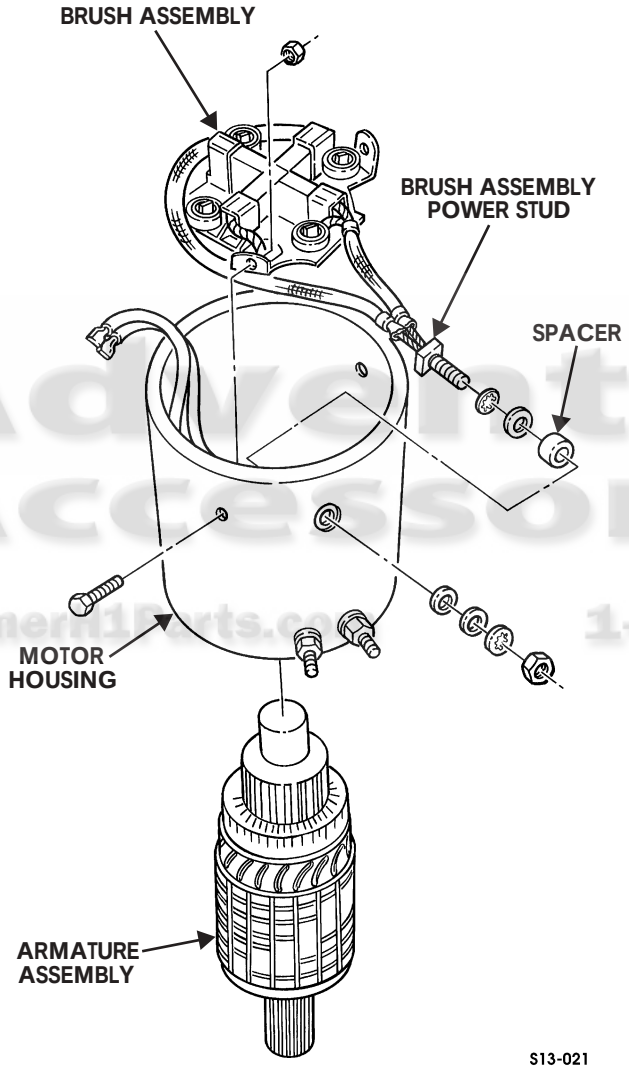


Figure 13-25: Brush Assembly and Armature Assembly

3. Secure brush assembly power stud to motor housing with insulator, washer, lockwasher, and nut.
4. Coat armature shaft with lubricant and install in brush assembly.
5. Coat head of electric thermal switch with lubricant and connect to two electric thermal switch leads (Figure 13-24).
6. Position spacer on inside of front and rear covers, and install front and rear covers on motor housing with two bolt assemblies.
7. Install gasket on motor drum support assembly.
8. Install motor on drum support assembly ensuring to engage motor shaft into motor shaft coupling.
9. Secure motor to motor end drum support with ten hex-head screws. Tighten hex-head screw to 35 lb-in. (4 N•m) (Figure 13-26).

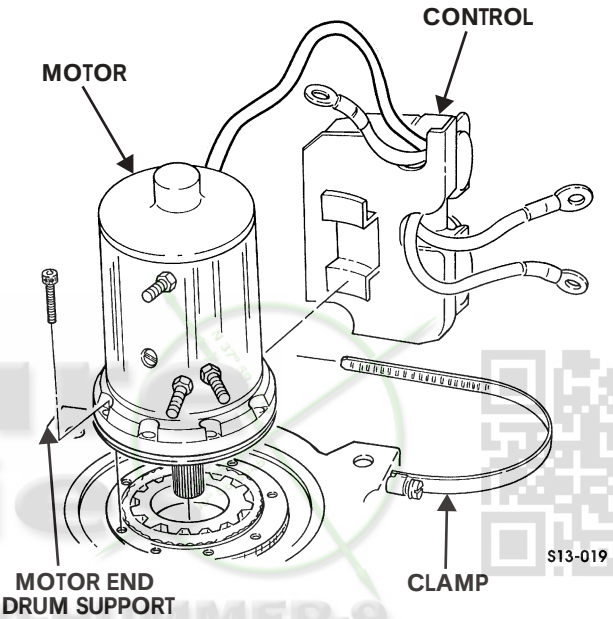


Figure 13-26: Control Unit and Motor

NOTE: If motor or control have been precoated with sealing compound, remove compound from between motor and control mounting gear contact area. Failure to do so may cause improper grounding or control.

10. Install two clamps on motor.
11. Install control on motor.

12. Connect three control leads to terminals and secure with nuts (Figure 13-27).

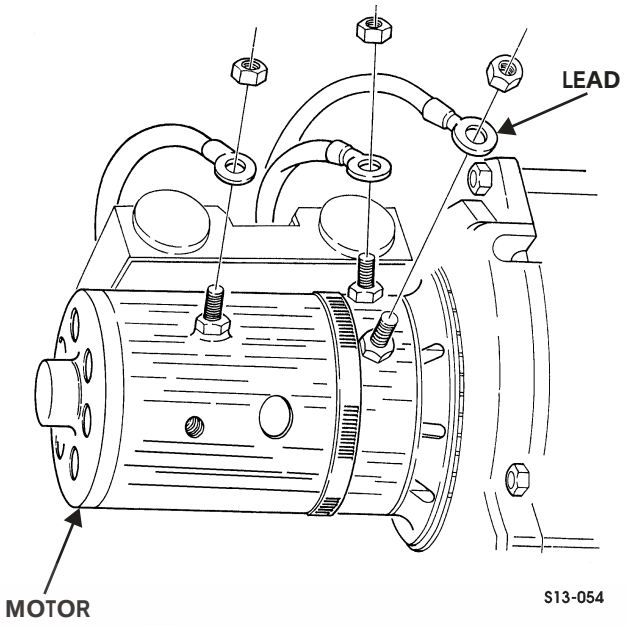


Figure 13-27: Control Leads

13. Secure control to motor with two clamps.
14. Install winch assembly and winch cable.

BRUSHGUARD ASSEMBLY REPLACEMENT

NOTE: Brushguard assemblies may be used on vehicles with or without a winch assembly. The following procedure applies to vehicles without a winch assembly.

Removal

1. Remove two hitch pins from locking pins (Figure 13-28).

WARNING: Stand clear of brushguard after removal of locking pins. Brushguard may swing down, causing personal injury.

2. Remove two locking pins from support brackets and lower brushguard.
3. Remove two locknuts, washers, capscrews, washers, and brushguard from support brackets.
4. Remove four locknuts, washers, capscrews, washers, and two support brackets from bumper

Installation

1. Install two support brackets on bumper with four washers, capscrews, washers, and locknuts. Tighten locknuts to 68 lb-ft (92 N•m) (Figure 13-28).
2. Position brushguard in brackets and secure with two washers, capscrews, washers, and locknuts.

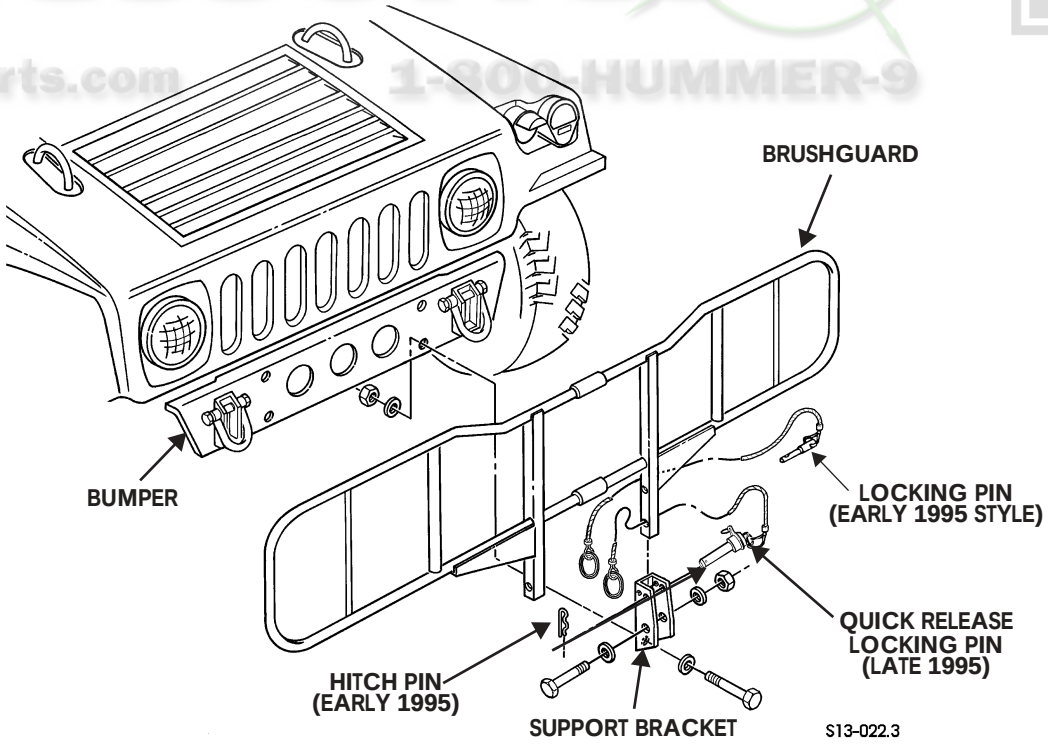


Figure 13-28: Brushguard Assembly

3. Secure brushguard in upward position with two locking pins.
4. Install two hitch pins into locking pins.

SWING-AWAY SPARE TIRE CARRIER REPLACEMENT

Removal

WARNING: Support tire when removing lug nuts. Failure to do so may result in personal injury.

NOTE: Some vehicles may use two lug nuts to secure tire to frame assembly.

1. Remove three lug nuts and tire from frame assembly (Figure 13-29).
2. Remove self-tapping screw and washer securing lanyard assembly to frame assembly and remove lanyard assembly and lock pin.
3. Remove two self-tapping screws and guide block from rear bumper.
4. Remove two locknuts, washers, stop plate, reinforcement stop mounting bracket, two capscrews, washers, and stop bracket from rear bumper. Discard locknuts.
5. Remove capscrew, lockwasher, and retaining plate from bracket assembly. Discard lockwasher.
6. Remove frame assembly from bracket assembly.
7. Remove three plugs from frame assembly.
8. Remove four locknuts, washers, reinforcement bracket, four capscrews, washers, and bracket assembly from rear bumper. Discard locknuts.
9. Remove grease fitting from bracket assembly.

Installation

1. Install grease fitting in bracket assembly (Figure 13-29).
2. Install bracket assembly on rear bumper with four washers, capscrews, reinforcement bracket, four washers, and locknuts. Do not tighten locknuts.
3. Install three plugs into frame assembly.
4. Install frame assembly on bracket assembly.
5. Secure retaining plate to bracket assembly with lockwasher and capscrew.
6. Install stop bracket, reinforcement stop mounting bracket, and stop plate on rear bumper with two washers, capscrews, washers, and locknuts. Do not tighten locknuts.
7. Install guide block on rear bumper with two self-tapping screws.
8. Secure lanyard assembly to frame assembly with washer and self-tapping screw.
9. Install lock pin in frame assembly.
10. Adjust bracket assembly and bracket to allow 0.020-in. (0.5-mm) clearance between frame assembly and guide block. Tighten six locknuts to 90 lb-ft (122 N•m).

NOTE: Some vehicles may use two lug nuts to secure tire to frame assembly.

11. Install tire on frame assembly and secure with three lug nuts.

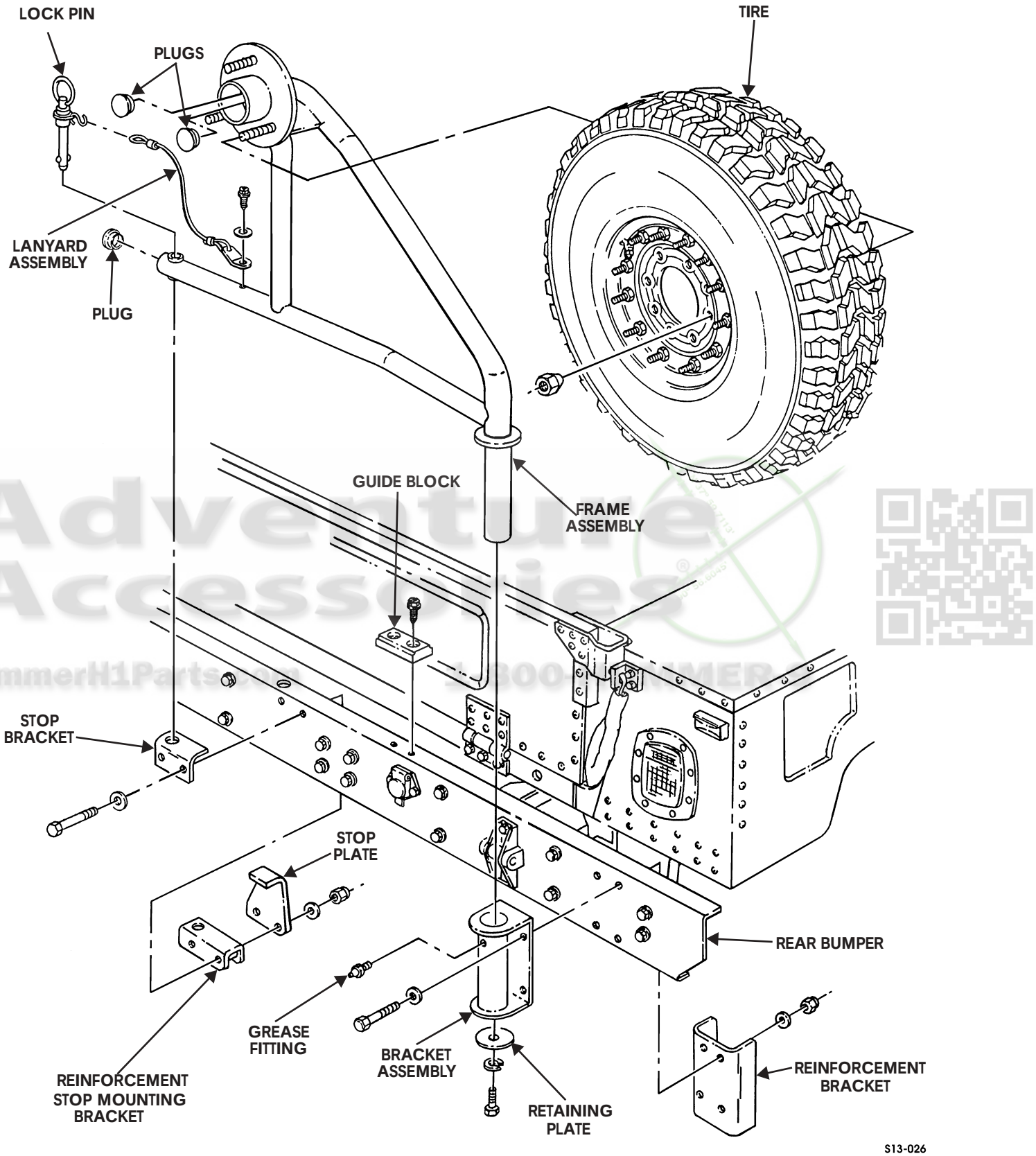


Figure 13-29: Swing-Away Spare Tire Carrier

CARGO DECK MOUNTED SPARE TIRE CARRIER REPLACEMENT

NOTE: Cargo deck mounted spare tire carrier may be located either directly behind the cab or at the left wheelhouse on two door models. On four door models, spare tire carrier will be located at the left wheelhouse.

Removal

NOTE: Perform steps 1 and 2 on vehicles with frame assembly stowed in down position.

1. Disconnect two lock pins and raise frame assembly to upright position (Figure 13-30).

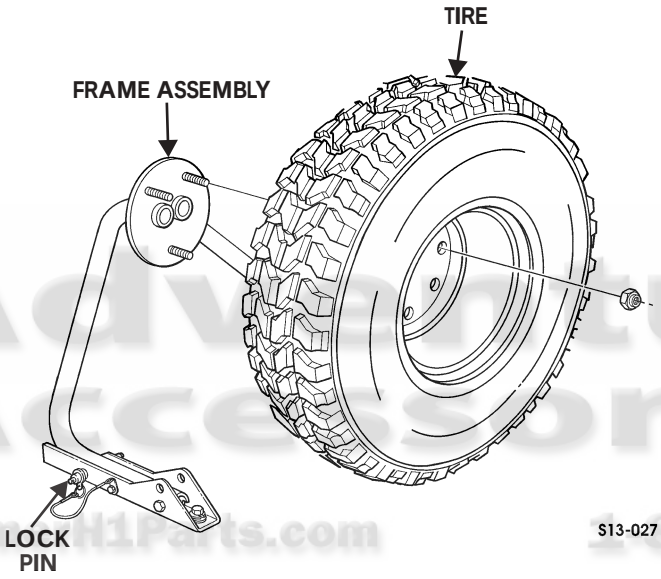


Figure 13-30: Cargo Deck Mounted Spare Tire

2. Secure frame assembly in upright position with two lock pins.
3. Remove three lug nuts securing tire to frame assembly and remove tire.
4. Remove two self-tapping screws, lockwashers, and two lanyard and lock pin assemblies from mounting brackets. Discard lockwashers (Figure 13-31).
5. Remove two locknuts, capscrews and frame assembly from mounting brackets. Discard locknuts.

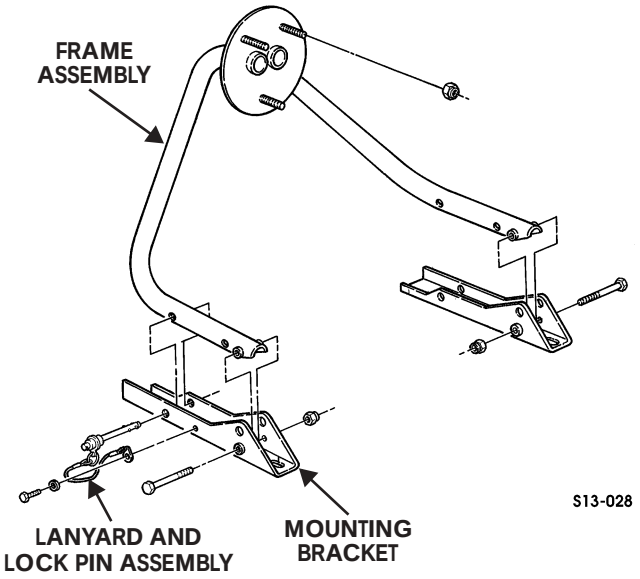


Figure 13-31: Frame Assembly

6. Remove four screws securing mounting brackets to cargo floor (Figure 13-32).

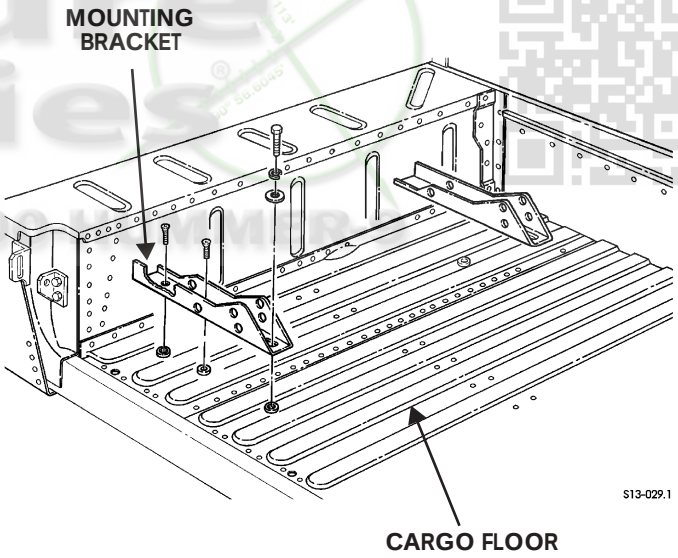


Figure 13-32: Mounting Brackets

7. Remove two capscrews, lockwashers, washers, and mounting brackets from cargo floor. Discard lockwashers.

Installation

1. Install mounting brackets on cargo floor with two washers, lockwashers, and capscrews (Figure 13-32).
2. Secure mounting brackets to cargo floor with four screws. Tighten screws to 16 lb-ft (22 N•m).
3. Install frame assembly on mounting brackets with two capscrews and locknuts (Figure 13-31).

4. Install two lanyard and lock pin assemblies on two mounting brackets and frame assembly with two lockwashers and self-tapping screws.
5. Install tire on frame assembly with three lug nuts (Figure 13-30).

NOTE: Perform steps 6 and 7 to stow frame assembly in down position.

6. Disconnect two lock pins and lower frame assembly to down position.
7. Connect two lock pins.

UNDERBODY PROTECTION

Skid Plate Replacement

Removal

1. Remove three locknuts, washers, capscrews, and washers securing skid plate to front shield. Discard locknuts (Figure 13-33).

NOTE: Go to step 3 for vehicles equipped with a winch.

2. Remove three locknuts, washers, capscrews, washers, and skid plate from front bumper. Discard locknuts.
3. Remove two locknuts, washers, capscrews, washers, and winch skid plate from winch bumper. Discard locknuts.

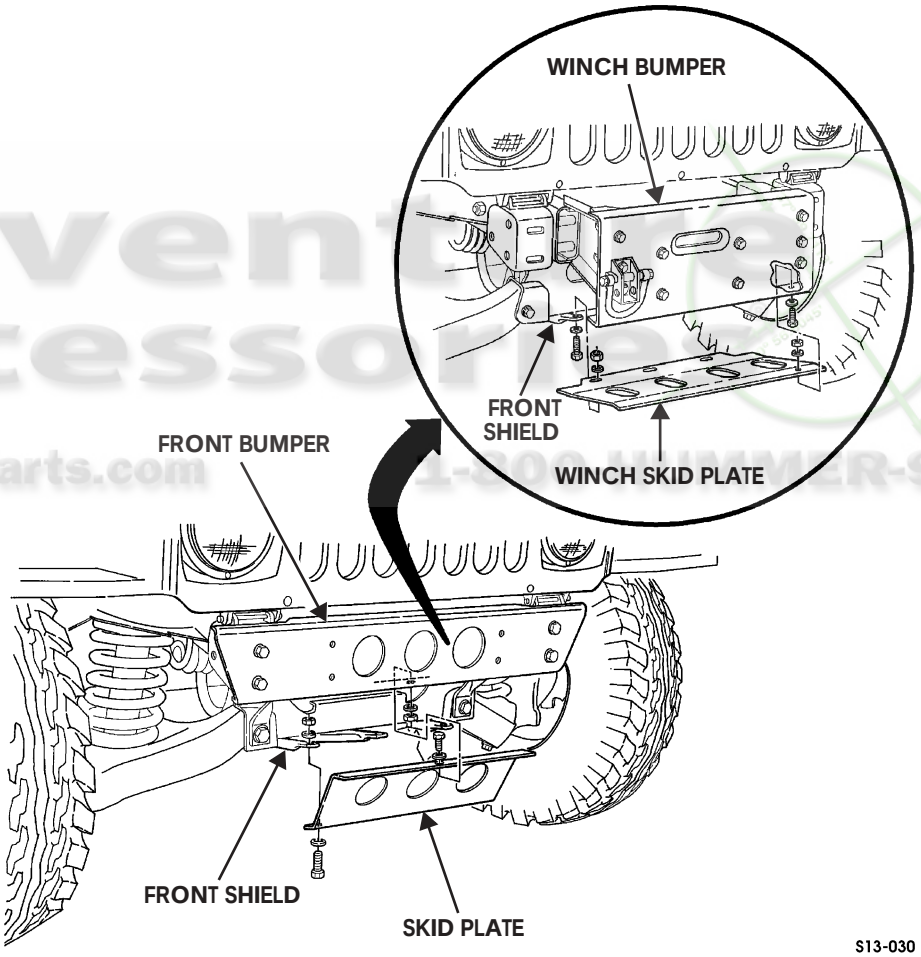


Figure 13-33: Skid Plate

Installation

NOTE: Go to step 2 for vehicles equipped with a winch.

1. Install skid plate on front bumper with three washers, capscrews, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m) (Figure 13-33).
2. Install winch skid plate on winch bumper with two washers, capscrews, washers, and locknuts (Figure 13-33). Tighten locknuts to 24 lb-ft (33 N•m).
3. Secure skid plate to front shield with three washers, capscrews, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m).

Front Shield Replacement

Removal

1. Remove three locknuts, washers, capscrews, washers, and two spacers securing front shield to front crossmember and intermediate shield. Discard locknuts (Figure 13-34).
2. Remove three locknuts, washers, capscrews, washers, and front shield from skid plate. Discard locknuts.

Installation

1. Install front shield on skid plate with three washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 13-34).
2. Secure front shield to front crossmember and intermediate shield with two spacers, three washers, capscrews, washers, and locknuts.
3. Tighten locknuts securing front shield to skid plate to 24 lb-ft (33 N•m). Tighten locknuts securing front shield to crossmember and intermediate shield to 44 lb-ft (60 N•m).

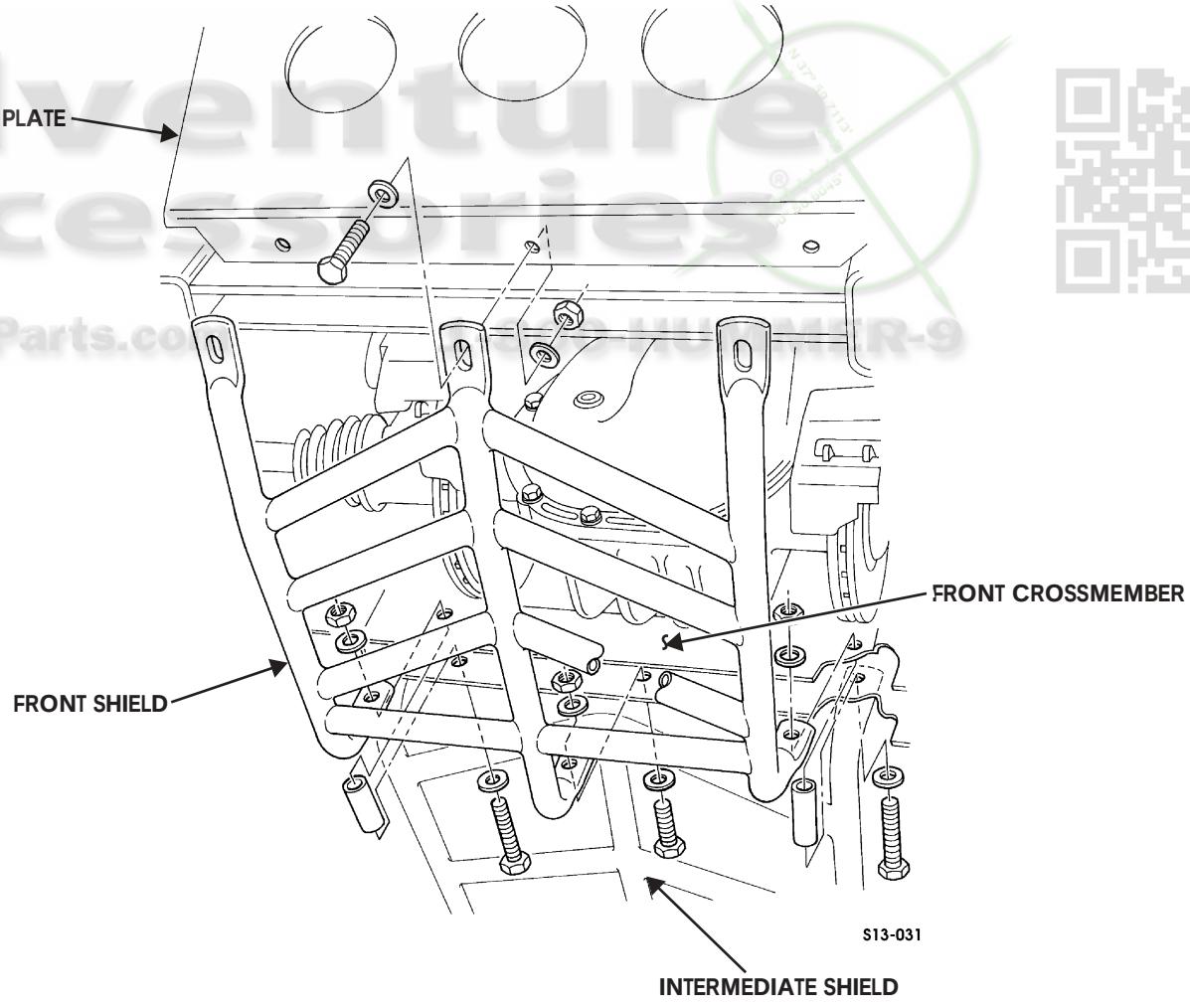


Figure 13-34: Front Shield

Intermediate Shield Replacement

Removal

1. Remove six locknuts, washers, capscrews, washers, and four rubber washers securing two transmission support brackets and intermediate shield to transmission mount crossmember. Remove support brackets. Discard locknuts (Figure 13-35).

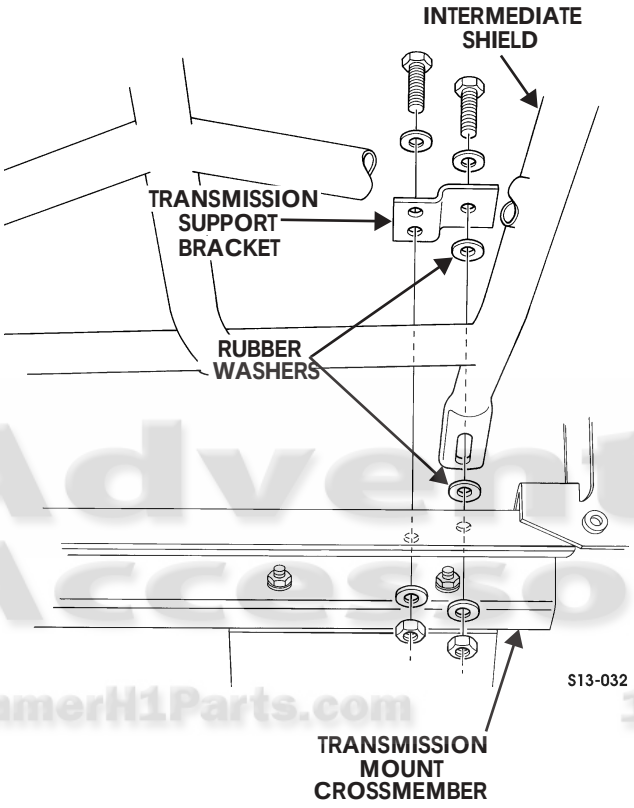


Figure 13-35: Intermediate Shield

2. Remove locknut, washer, capscrew, and washer securing left support bracket to engine mount bracket and frame rail. Discard locknut (Figure 13-36).
3. Remove four locknuts, washers, capscrews, washers, and left support bracket from left mounting bracket. Discard locknuts.

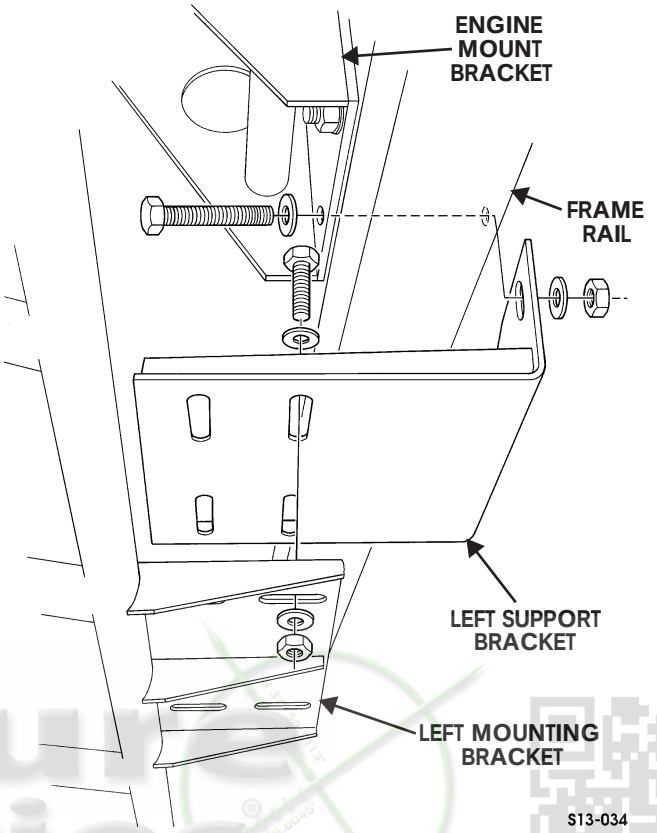


Figure 13-36: Left Support Bracket

4. Remove locknut, washer, capscrew, and washer securing right support bracket to frame rail. Discard locknut (Figure 13-37).
5. Remove four locknuts, washers, capscrews, washers, and right support bracket from right mounting bracket. Discard locknuts.
6. Remove two locknuts, washers, capscrews, washers, spacers, and intermediate shield from front crossmember and front shield. Discard locknuts (Figure 13-38)

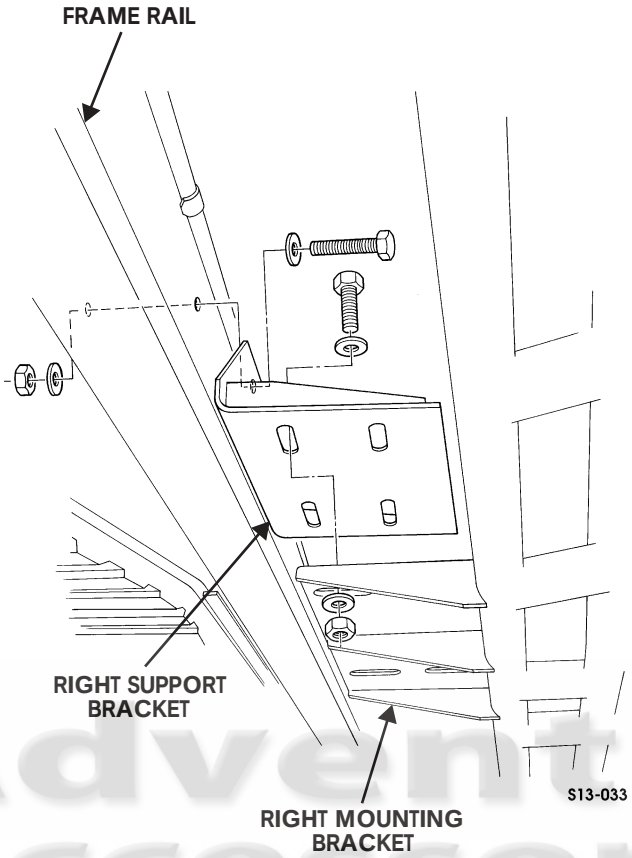


Figure 13-37: Right Support Bracket

Installation

1. Install intermediate shield to front crossmember and front shield with two spacers, washers, capscrews, washers, and locknuts. Tighten locknuts to 44 lb-ft (60 N•m) (Figure 13-38).
2. Install right support bracket on right mounting bracket with four washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 13-37).
3. Secure right support bracket to frame rail with washer, capscrew, washer, and locknut. Tighten locknut to 105 lb-ft (142 N•m).
4. Install left support bracket on left mounting bracket with four washers, capscrews, washers, and locknuts. Do not tighten locknuts (Figure 13-36).
5. Secure left support bracket to engine mount bracket and frame rail with washer, capscrew, washer, and locknut. Tighten locknut to 105 lb-ft (142 N•m).
6. Install two transmission support brackets on transmission mount crossmember with four washers, capscrews, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m) (Figure 13-35).
7. Secure intermediate shield to transmission mount crossmember and transmission support brackets with four rubber washers, two washers, capscrews, washers and locknuts. Tighten locknuts to 26 lb-in. (3 N•m).
8. Tighten locknuts securing support brackets to mounting brackets to 24 lb-ft (33 N•m).

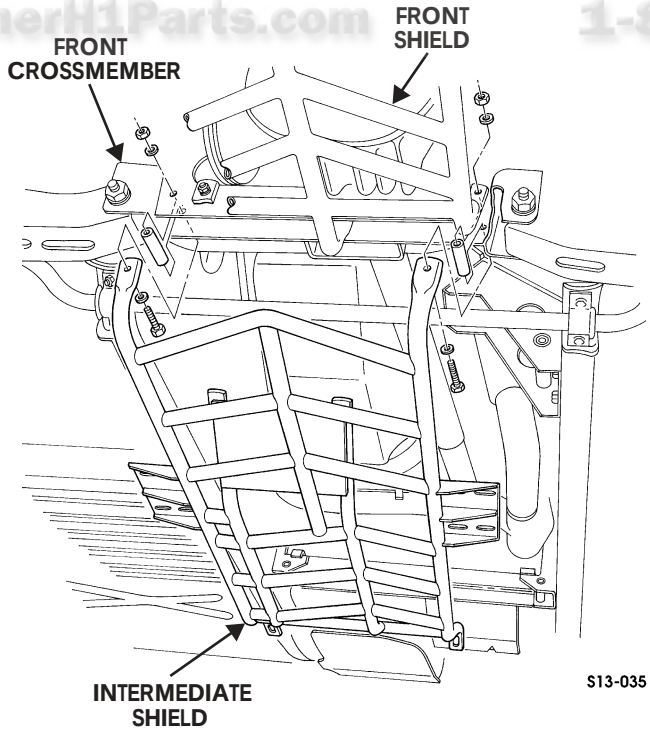


Figure 13-38: Intermediate Shield

Transfer Case Shield Replacement

Removal

Remove two locknuts, washers, capscrews, washers, and transfer case shield from crossmember. Discard locknuts (Figure 13-39).

Installation

Install transfer case shield on crossmember with two washers, capscrews, washers, and locknuts (Figure 13-39).

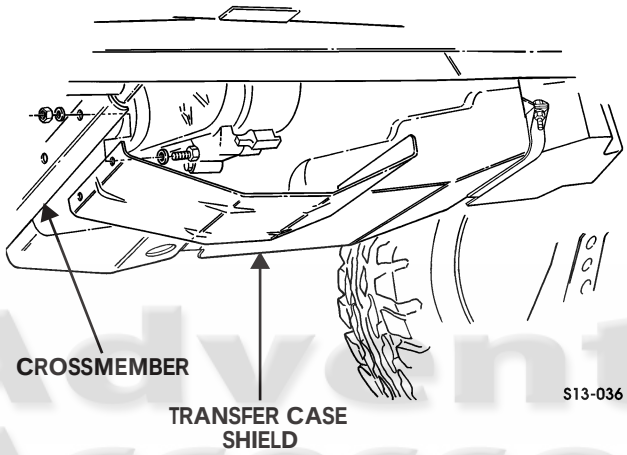


Figure 13-39: Transfer Case Shield

Rear Shield Replacement

Removal

1. Remove three locknuts, washers, capscrews, washers, and spacers securing rear shield to rear-front crossmember. Discard locknuts (Figure 13-40).
2. Remove three locknuts, washers, capscrews, washers, and shield from mounting brackets. Discard locknuts.
3. Remove six locknuts, washers, capscrews, washers, spacers, and three mounting brackets from rear-rear crossmember. Discard locknuts.

Installation

1. Install three mounting brackets on rear-rear crossmember with six spacers, washers, capscrews, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m) (Figure 13-40).
2. Position shield on mounting brackets and secure with three washers, capscrews, washers, and locknuts. Do not tighten locknuts.
3. Secure shield to rear-front crossmember with three spacers, washers, capscrews, washers, and locknuts. Tighten capscrews to 44 lb-ft (60 N•m).
4. Tighten locknuts securing rear shield to mounting brackets to 24 lb-ft (33 N•m).

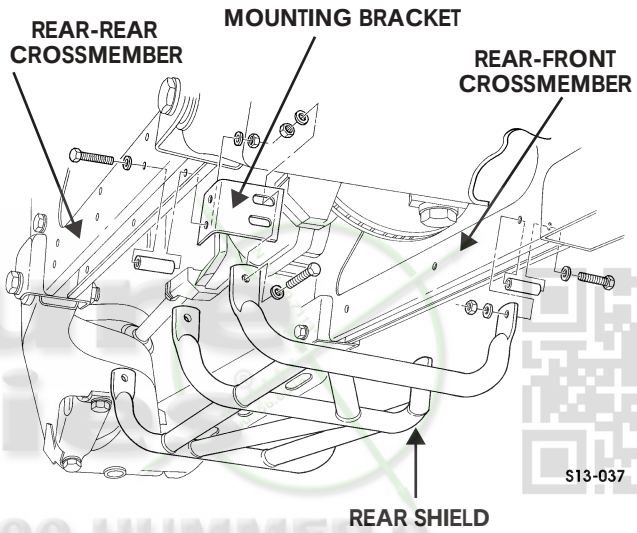


Figure 13-40: Rear Shield

UNDERBODY SKID PANEL REPLACEMENT

Removal

NOTE: Removal of underbody skid panel is similar for both sides. This procedure covers one side only.

1. Remove outer kick panels (Section 10).
2. Pull back carpet from front footwell and rear footwell (4-door models only).

NOTE: Hex-head screws are secured in place with Loctite 242 and may require considerable effort to break loose.

3. Remove nine hex-head screws securing underbody skid panel to body. Support underbody skid panel with floor jack (Figure 13-41).

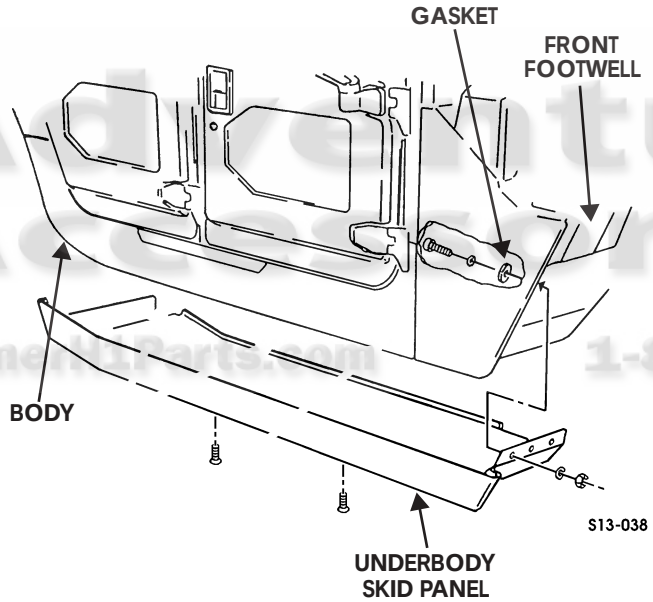


Figure 13-41: Underbody Skid Panel

4. Remove three nuts, washers, capscrews, washers, and gaskets securing skid panel to front footwell. Discard gaskets.
5. Remove three nuts, washers, capscrews, washers, and gaskets securing spacer (if present) and skid panel to rear footwell (Figure 13-42).

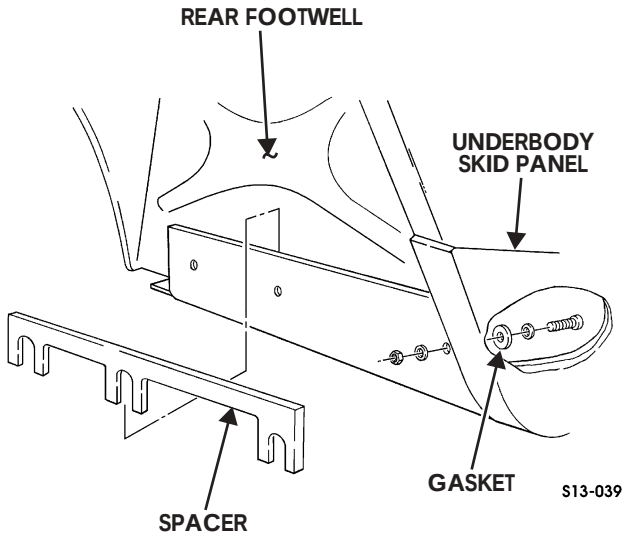


Figure 13-42: Rear Footwell

CAUTION: *Underbody skid panel is heavy. Remove with a floor jack.*

6. Remove underbody skid panel from body.
7. Inspect three retainer nuts on body. Discard if damaged.

Installation

CAUTION: *Underbody skid panel is heavy. Raise into place with a floor jack.*

1. Raise underbody skid panel to body.
2. Secure skid panel to rear footwell with three gaskets, washers, capscrews, washers, and nuts. Do not tighten nuts (Figure 13-42).
3. Secure skid panel to front footwell with three gaskets, washers, capscrews, washers, and nuts. Do not tighten nuts (Figure 13-41).
4. Install spacer between rear footwell and underbody skid panel if necessary. Tighten nuts at front and rear footwells to 37 lb-ft (50 N•m) (Figures 13-39 and 13-42).

NOTE: Apply Loctite 242 to threads of hex-head screws.

5. Remove floor jack and secure underbody skid panel to body with nine hex-head screws. Tighten hex-head screws to 37 lb-ft (50 N•m) (Figure 13-41).
6. Push carpet back in place.
7. Install outer kick panels (Section 10).

TRAILER TOWING CONNECTOR

Assembly Instructions

NOTE: The following procedure provides instructions to assemble a trailer towing connector needed when installing a trailer brake controller. Spare wires have been provided in the body harness and routed from the instrument panel/fuse box area to the trailer connector at the rear of the vehicle (Figure 13-43).

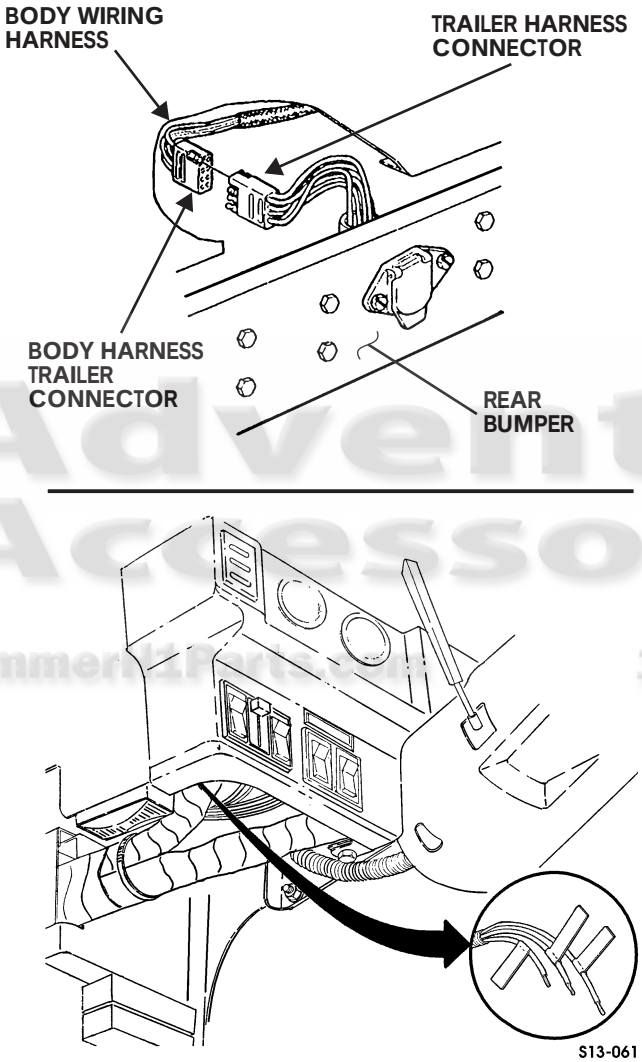


Figure 13-43: Location of Spare Body Harness Wires

1. Disconnect the battery ground cable (Section 12).
2. stall the brake controller using manufacturer's instructions.
3. Carefully remove and discard the heat shrink tubing covering the body harness and trailer harness connectors.
4. Cut the dark blue (43A) wire and the purple (50A) wire 2 in. (5 cm) from the back of the body harness trailer connector (Figure 13-44).

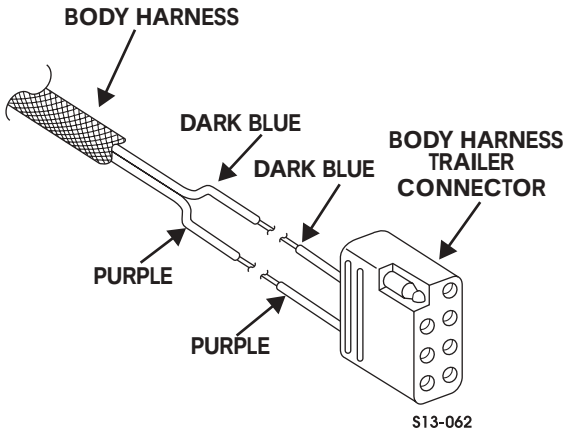


Figure 13-44: Body Harness Wires

5. Slide adhesive wall heat shrink tubing over one end of the dark blue and purple wires.
6. Connect the dark blue body harness wire to the purple connector wire (Figure 13-45).
7. Connect the purple body harness wire to the dark blue connector wire. Secure connections using meltable adhesive crimp butt splices.

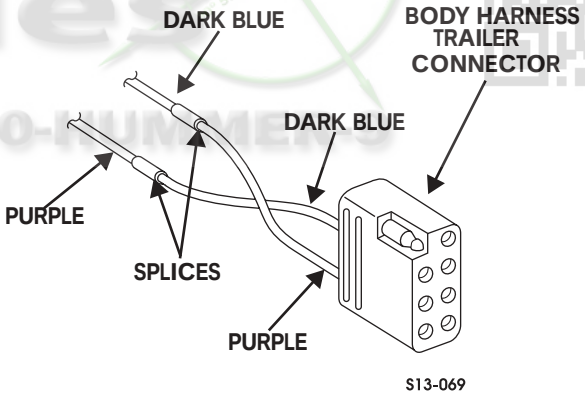


Figure 13-45: Body Harness Trailer Connector

8. Cover both splices with the heat shrink tubing and shrink the tubing with a heat gun.
9. Slide large piece of heat shrink tubing over the body harness connector.
10. Plug connector halves together and position heat shrink tubing over the mated connector.
11. Shrink the tubing with heat gun.
12. Install a fuse in fuse position 7H as required per the brake controller and trailer manufacturer's recommendations.
13. Connect the negative battery cable(s) (Section 12) and test the circuits for proper operation.

TRAILER HITCH REPLACEMENT

Removal

1. Remove four locknuts, washers, capscrews, and washers securing trailer hitch to rear bumper braces. Discard locknuts (Figure 13-46).
2. Remove four locknuts, washers, capscrews, washers, and trailer hitch from rear bumper. Discard locknuts.

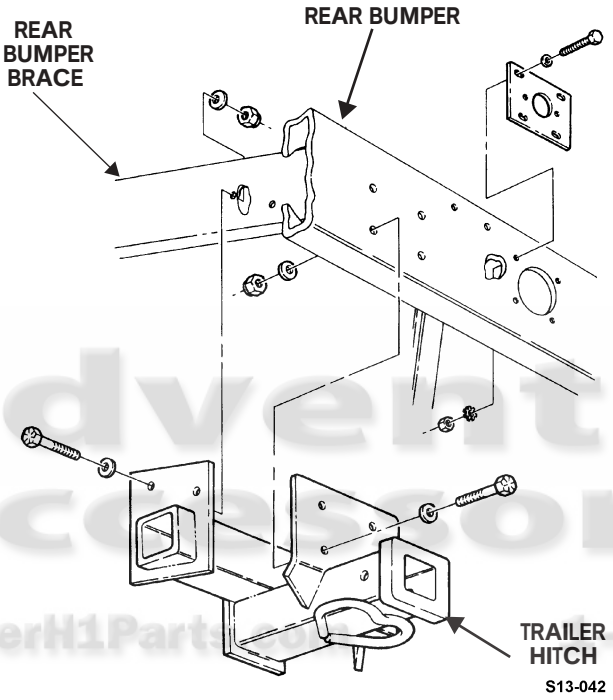


Figure 13-46: Trailer Hitch

Installation

1. Install trailer hitch on rear bumper with four washers, capscrews, washers, and locknuts (Figure 13-46). Do not tighten locknuts.
2. Secure trailer hitch to rear bumper braces with four washers, capscrews, washers, and locknuts.
3. Tighten all locknuts to 107 lb-ft (145 N•m).

RUNNING BOARD REPLACEMENT

Removal

1. Remove two clips and pins securing the right and left curved tubes to the receiver (Figures 13-47 and 13-48).

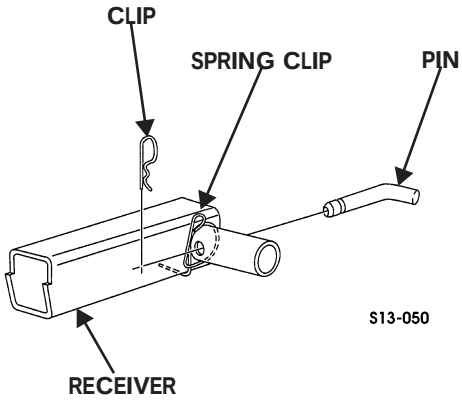


Figure 13-47: Receiver

2. Remove screw, nut, and screw securing the left end cap to the left curved tube (Figure 13-48).

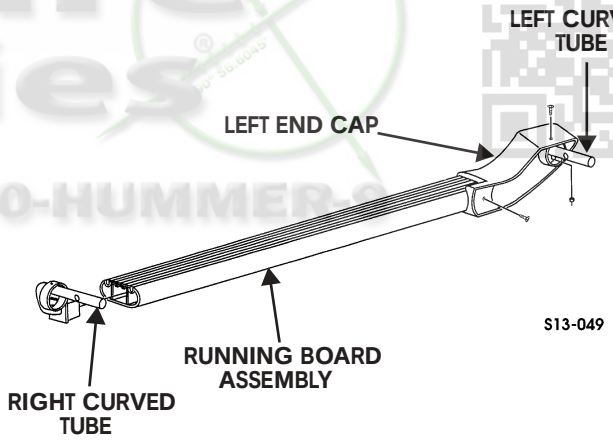


Figure 13-48: Left End Cap Secured to Left Curved Tube

3. Remove screw, nut, and screw securing the right end cap to the right curved tube.
4. Remove left curved tube from running board.
5. Remove right curved tube from running board.

NOTE: If vehicle has underbody skid panels, remove the extra clamp plate used on the forward mounting area between the mounting bracket and receiver.

6. Remove four nuts, washers, and two clamp plates securing two receivers to studs on mounting brackets (Figure 13-49).

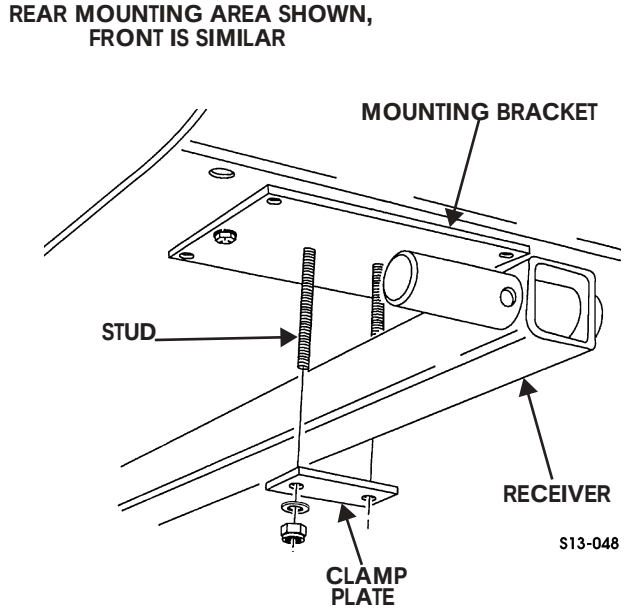


Figure 13-49: Receiver and Clamp Plate

NOTE: If vehicle does not have underbody skid panels, perform steps 7 and 8. If vehicle is equipped with underbody skid panels, perform steps 9 and 10.

7. Remove two capscrews, lockwashers, and rear mounting bracket from body (Figure 13-50).

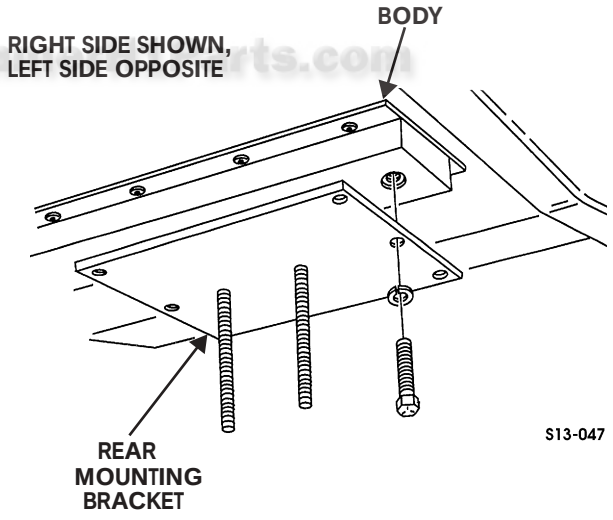


Figure 13-50: Rear Mounting Bracket

8. Remove four capscrews, lockwashers, J-nuts, and front mounting bracket from body (Figure 13-51).

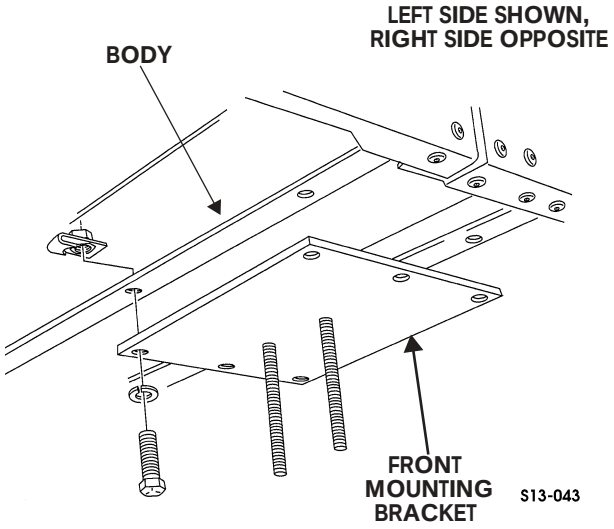


Figure 13-51: Front Mounting Bracket and J-Nut

9. Remove four capscrews, lockwashers, and front mounting bracket from underbody skid panel and body (Figure 13-52).

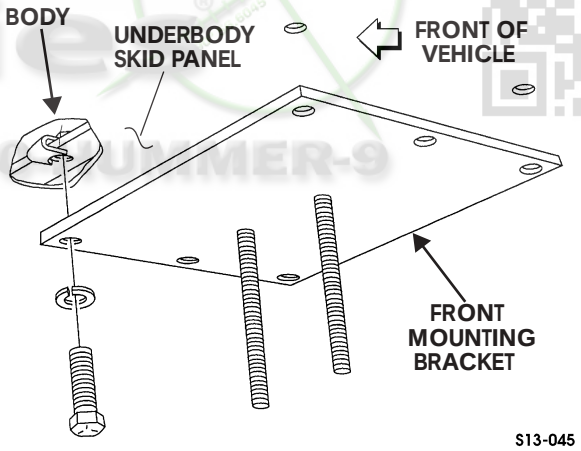


Figure 13-52: Front Mounting Bracket

10. Remove two capscrews, lockwashers, and rear mounting bracket from underbody skid panel and body (Figure 13-53).

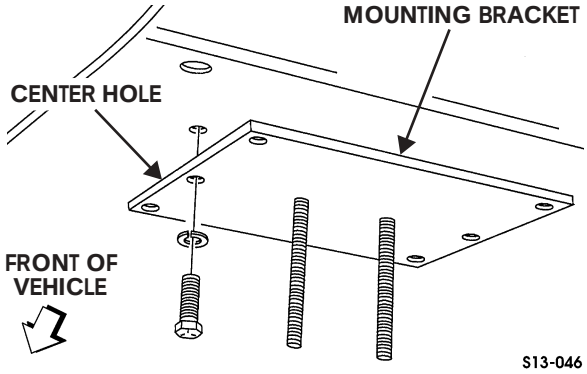


Figure 13-53: Rear Mounting Bracket

Installation

NOTE: If vehicle does not have underbody skid panels, perform steps 1 and 2. If vehicle is equipped with underbody skid panels, perform steps 3 and 4.

1. Install front mounting bracket on body with four J-nuts, lockwashers, and capscrews. Tighten capscrews to 29-31 lb-ft (39-42 N•m) (Figure 13-51).
2. Install rear mounting bracket on body with two lockwashers and capscrews. Tighten capscrews to 29-31 lb-ft (39-42 N•m) (Figure 13-50).
3. Install front mounting bracket on underbody skid panel and body with four lockwashers and capscrews. Tighten capscrews to 29-31 lb-ft (39-42 N•m) (Figure 13-52).

NOTE: If the vehicle does not have underbody protection, an extra clamp plate must be used on the forward mounting area between the mounting bracket and receiver.

4. Install rear mounting bracket on underbody skid panel and body with two lockwashers and capscrews. Tighten capscrews to 29-31 lb-ft (39-42 N•m) (Figure 13-53).
5. Install receiver to studs on two mounting brackets with two clamp plates, four washers, and nuts (Figure 13-49).
6. Remove any extra mounting bracket stud lengths by cutting the stud four thread lengths from the nut.
7. Position right curved tube (with orange plastic bushing) into running board. Ensure right curved tube points toward the side of the running board with the "this side toward frame" decal (Figure 13-48).
8. Position left curved tube (with black plastic bushing) into running board.
9. Position right end cap on right curved tube with screw, nut, and screw.
10. Position left end cap on the left curved tube with screw, nut, and screw.
11. Position two spring clips on receiver. Ensure the spring clips are positioned 180 degrees from each other (Figure 13-47).
12. Secure the right and left curved tubes to the receiver with two pins and clips.

ROOF RACK

Roof Rack Replacement

NOTE: The roof rack is available in three foot, six foot, and nine foot lengths. The following procedure is for a six foot roof rack installed on a station wagon. Three foot and nine foot procedures are similar.

Removal

WARNING: Roof rack is extremely heavy. Several people may be required to remove and install rack safely. Use care in determining ability to lift the rack. Failure to do so may result in injury.

1. Loosen eight support screws on clamps (Figure 13-54).
2. Loosen eight locknuts securing clips to gutter rails.
3. Remove eight clips from under gutter rails and remove rack from vehicle.

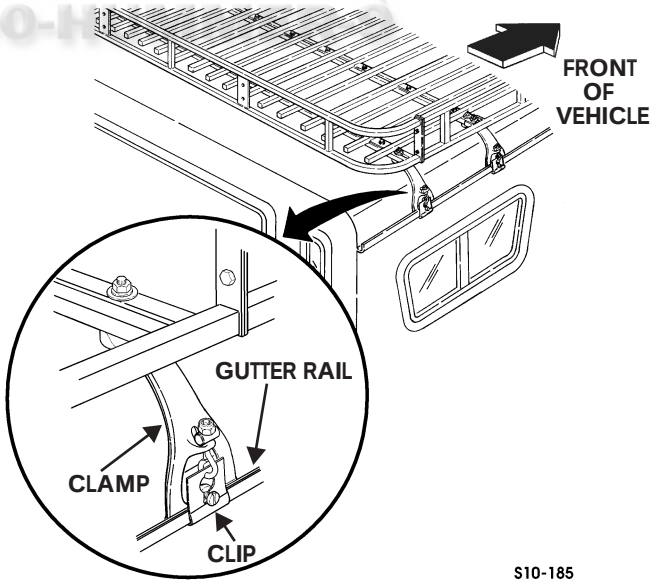


Figure 13-54: Roof Rack Clamp

Installation

CAUTION: *Clamps are made of aluminum. Over-tightening may cause the clamps to crack.*

1. Position roof rack on top of vehicle with rack ends toward front and rear of vehicle (Figure 13-54).
2. Position eight clips (on clamps) under gutter rails and over support screws. Tighten locknuts to 20-25 lb-in. (2-3 N•m).
3. Tighten support screws on clamps.

Roof Rack Floor Piece Replacement

Removal

1. Remove four end caps on floor piece.
2. Remove four locknuts, washers, capscrews, washers, and floor piece from crossbars and rack ends (Figure 13-55).

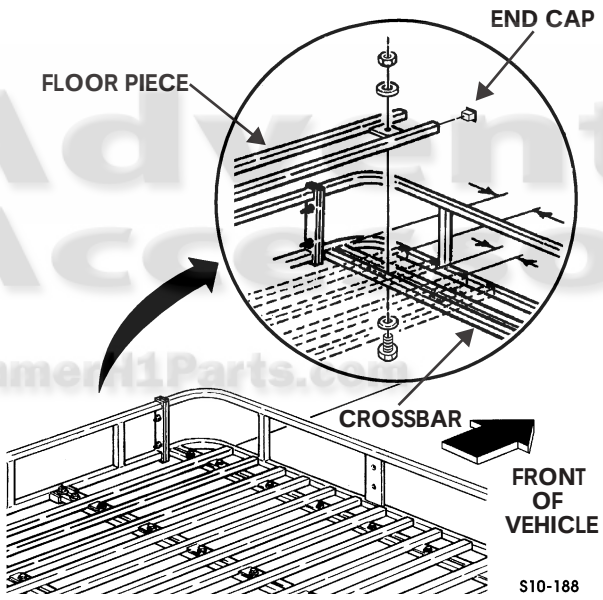


Figure 13-55: Roof Rack Floor Piece

Installation

NOTE: Floor pieces should be positioned 5 inches (13 cm) from the ends and 3 inches (8 cm) apart.

1. Install floor piece on crossbars and rack ends with four washers, capscrews, washers, and locknuts. Tighten locknuts to 25 lb-ft (34 N•m) (Figure 13-55).

NOTE: Apply a small amount of adhesive to each end cap before installing it on the floor piece.

2. Install four end caps on floor piece.

Roof Rack Crossbar Replacement

Removal

1. Remove roof rack from vehicle.
2. Remove ten floor pieces from roof rack.
3. Remove four locknuts, washers, capscrews, washers, and crossbar from sides (Figure 13-56).

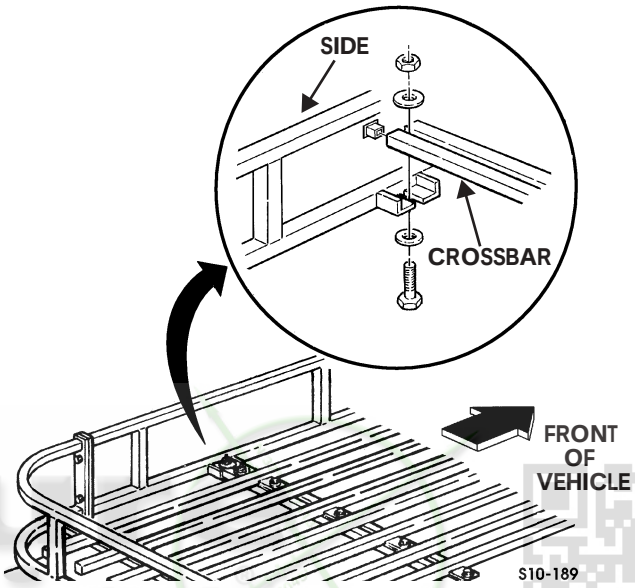


Figure 13-56: Roof Rack Crossbar

Installation

1. Install crossbar on sides with four washers, capscrews, washers, and locknuts. Tighten locknuts to 25 lb-ft (34 N•m) (Figure 13-56).
2. Install ten floor pieces on roof rack.
3. Install roof rack onto vehicle.

Roof Rack End Replacement

Removal

Remove four capscrews, locknuts, and rack end from sides (Figure 13-57).

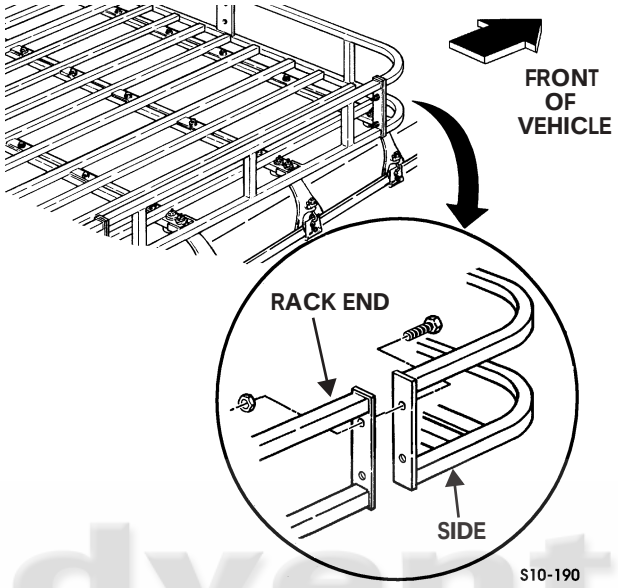


Figure 13-57: Roof Rack End

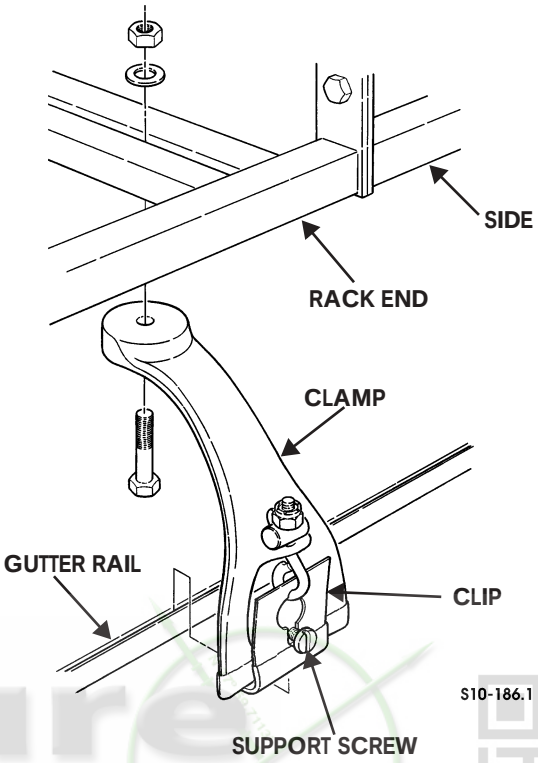


Figure 13-58: Roof Rack Clamp

Installation

Install rack end on sides with four capscrews and locknuts. Tighten locknuts to 15 lb-ft (20 N•m) (Figure 13-57).

Roof Rack Clamp Replacement

Removal

1. Loosen support screw on clamp securing clip to clamp (Figure 13-58).
2. Loosen locknut securing clip to gutter rail.
3. Remove clip from under gutter rail.
4. Remove locknut, washer, capscrew, and clamp from roof rack.

Installation

1. Install clamp on roof rack with capscrew, washer, and locknut.
2. Position clip under gutter rail and over support capscrew.
3. Tighten locknut securing clip to gutter rail to 20-25 lb-in (2-3 N•m).
4. Tighten support screw on clamp. Tighten locknut installed in step 1 to 25 lb-ft (34 N•m).

AUXILIARY AIR HOSE REPLACEMENT

Removal

1. Raise and secure hood.
2. Turn tire selector switch and CTIS inflate/deflate switch to OFF, then shut off engine.

WARNING: CTIS air system components are subject to high air pressure. Always relieve air pressure before loosening or removing air system component(s) by disconnecting quick-disconnect valves. Failure to follow this warning may result in serious personal injury.

3. Disconnect CTIS by depressing metal tab on quick-disconnect valve body. The valve body will pop out approximately 1/4 in. (6 mm) from shuttle. Perform this procedure on remaining three wheels (Figure 13-59).
4. Remove nut securing CTIS hose to connector and remove the ferrule and insert. The nut, ferrule, and insert are part of connector (Figure 13-60).
5. Remove connector and auxiliary air valve from tee.
6. Remove auxiliary tee from existing tee.

Installation

1. Ensure tire selector control knob is in the OFF position.

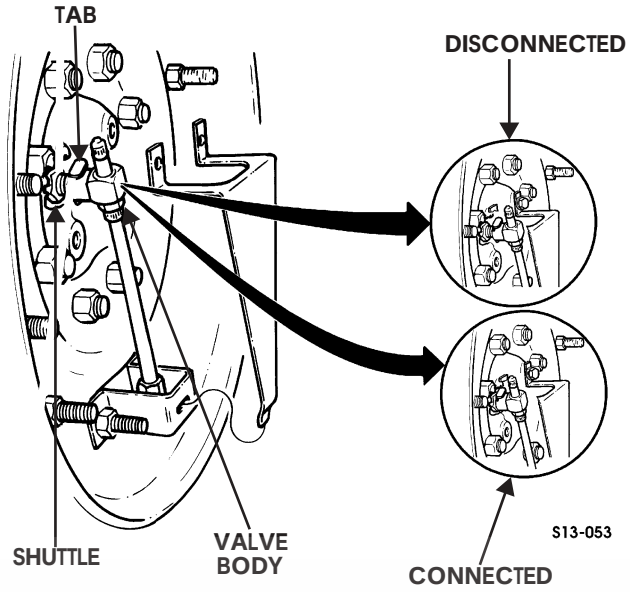


Figure 13-59: CTIS Quick-Disconnect Valve

NOTE: Ensure that any new fittings have pipe sealant pre-applied to threads. If none is present, apply a pipe sealant to fitting threads.

2. Secure auxiliary air hose tee to existing tee on compressor (Figure 13-60).
3. Secure connector and auxiliary air valve to tee.
4. Secure CTIS hose to connector with the nut, ferrule, and insert.
5. Connect CTIS by pushing in quick-disconnect valve body until valve tee section locks (clicks) into place. Perform this procedure on remaining three wheels (Figure 13-59).
6. Start engine and check CTIS for air leaks around installed fittings.
7. Position tire selector switch and CTIS inflate/deflate switch to OFF, then shut off engine.
8. Lower and secure hood.

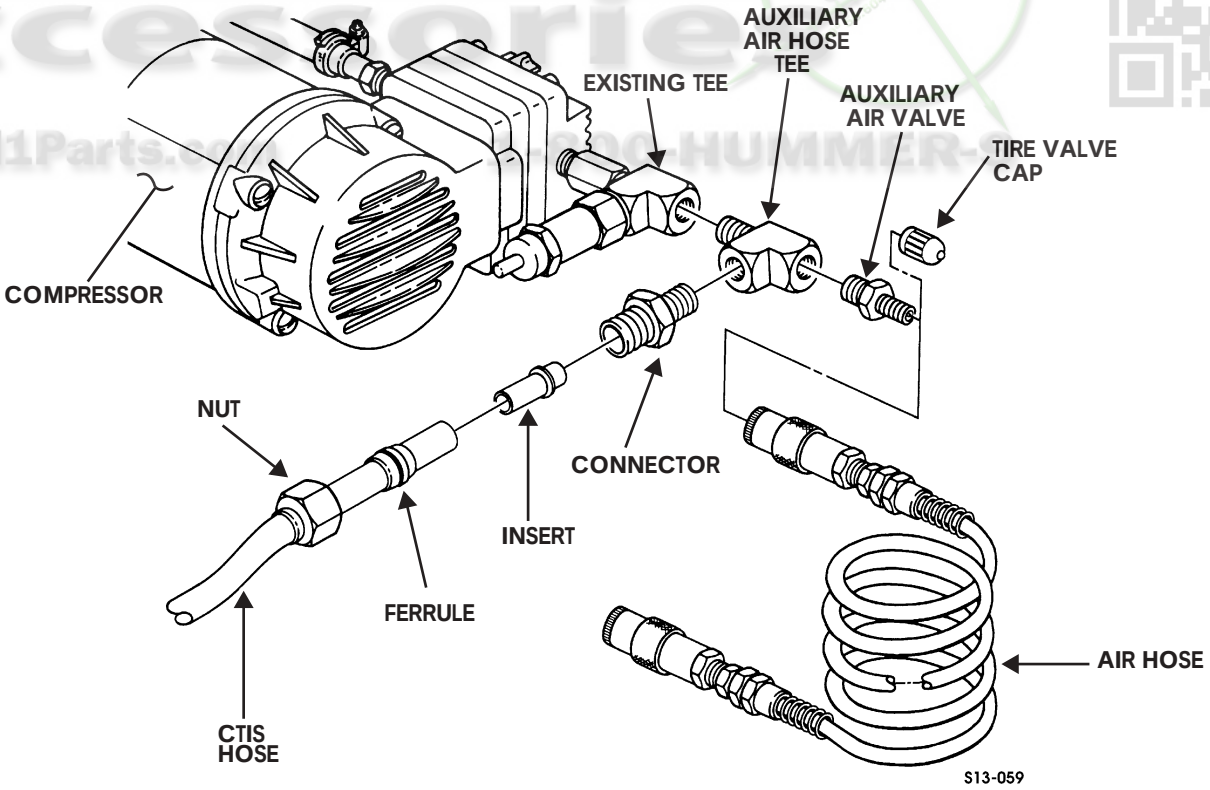


Figure 13-60: CTIS Auxiliary Air Hose

CRUISE CONTROL SYSTEM

General

HUMMERS may be equipped with an electronic cruise control system. This system operates without vacuum, enabling it to be used on the HUMMER regardless of which engine is used.

This system has three major components:

1. Cruise Control Module. This module collects data and inputs from several areas of the vehicle and sends appropriate commands to the control actuator unit (Figure 13-61).

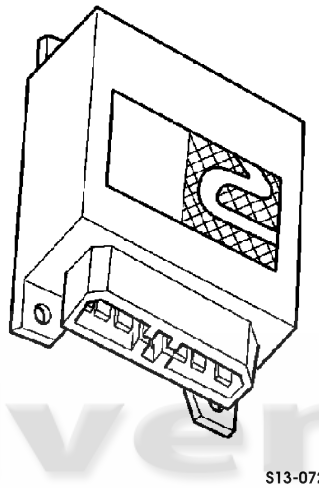


Figure 13-61: Cruise Control Module

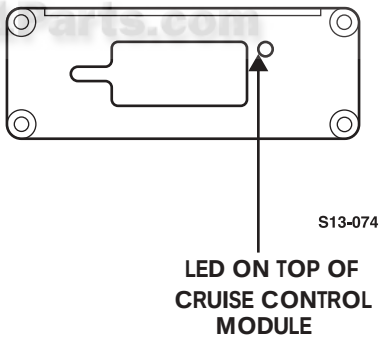


Figure 13-62: LED On Cruise Control Module

2. Electronic Control Actuator. This component is capable of controlling the throttle movement and has the ability to release the throttle to idle rapidly when brakes are applied (Figure 13-63).

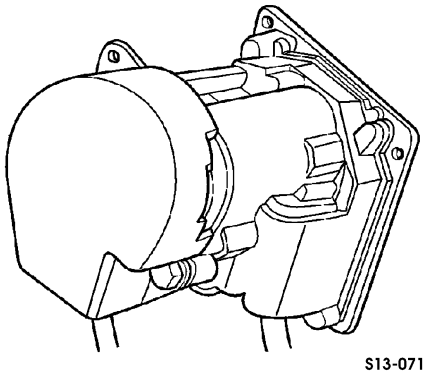


Figure 13-63: Electronic Control Actuator

3. Turn Signal Stalk Lever Assembly. This unit replaces the standard turn signal lever. This new stalk incorporates all of the functions of the original lever and adds the SET OFF, ON, and RESUME/ACCEL functions of the cruise control. The slide switch is on the face of the lever. The SET button is recessed into the end (Figure 13-64).

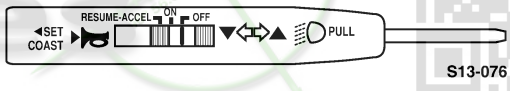


Figure 13-64: Turn Signal Lever With Cruise Control

Diagnosing Problems

1. Road test vehicle to determine if cruise is operating and verify complaint. Look for proper operation at steady speeds and check all switch positions. Verify operation of speedometer.
2. If cruise does not function at all, check LED per following procedure:
   a. Locate cruise control module located to left of steering column under instrument panel.
   b. Gently disengage velcro retainer and position module where LED on opposite end from harness can be seen (Figures 13-61 and 13-62).
   c. Turn cruise control OFF, set parking brake and place transmission in overdrive position.
   d. Turn key to RUN but do not start.
   e. Turn cruise switch ON - LED should not light. If LED is lit, check brake switch and/or neutral switch adjustment.

f. Depress the SET button - LED should illuminate. If not, check fuse # 7C (10 amp) and 10 amp fuse in harness. If there is 12V present at switch connector, replace switch.

g. Press switch to RESUME - LED should be on. If not, check per step f.

h. Press brake switch - LED should be on. If not, check brake switch or fuse 4D (15 amp).

i. Place transmission in P or N position - LED should be ON. If not, check neutral switch circuit.

3. Perform functional test per following steps:

a. With transmission in overdrive, set parking brake, and block wheels.

b. Turn cruise control switch to OFF. Turn ignition to RUN. Do not start.

c. Depress and hold SET button, and slide cruise switch to ON position.

d. Release then depress the SET button to activate the actuator unit. The actuator will slowly move the throttle to Wide Open Throttle (WOT).

e. Verify that throttle is in WOT position when actuator stops movement.

f. When unit has reached WOT, slide the switch to the RESUME/ACCEL position. The throttle should slowly return to idle position. Release when throttle returns to idle.

g. Press and hold SET button until WOT is obtained. Step on brake pedal. Throttle should quickly return to idle.

h. Press SET button again to achieve WOT. Place transmission in P or N. Throttle should return to idle quickly.

Table 13-1 Cruise Control Harness Connector

PIN	Circuit Description	Body Harness Wire Color	Cruise Control Harness Wire Color
A	Brake Switch	DK Green	Black
B	Brake Switch	DK Blue	Black
C	Blank	Blank	Blank
D	Brake Switch - Cold Side	Red	Violet
E	Brake Switch - Hot Side	Orange	Red
F	Neutral Switch	White	DK Blue
G	Speed Signal	Gray	Gray
H	Ground	Blank	Blank
J	Blank	Blank	Blank
K	Ignition +12 Volt DC	Brown	Brown

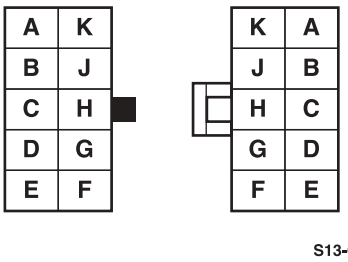


Figure 13-65: Cruise Control Harness

4. Should a unit pass the LED test but fail the functional test procedures, check the actuator module for a disconnected or broken cable. If no mechanical problems found, replace actuator and retest system.

5. Should a unit not pass LED testing, refer to each test and check the designated switch or circuit. See Table 13-1 for more information on the Cruise Control Harness Connector. (Figure 13-65)

6. If the unit passes both tests but does not operate on road, drive vehicle with module LED where it can be seen. The LED should flash with vehicle moving down the road (speed approximately 30 mph.)

7. If no LED flash is noted in step 6, check connections to Digital Ratio Adapter.

Cruise Control Actuator and Mounting Bracket Replacement - Early Build Vehicles

NOTE: The following procedure applies to early 1995 vehicles.

NOTE: There are two different types of actuator/cruise control cables. Early 1995 vehicles have adjusting nuts and a separate spacer (Figure 13-67). Late 1995 vehicles have a “snap-in” mounting grommet and integrated spacer (Figure 13-71).

Removal

1. Disconnect the actuator/cruise control cable electrical connectors from the cruise control harness connectors (Figure 13-66).

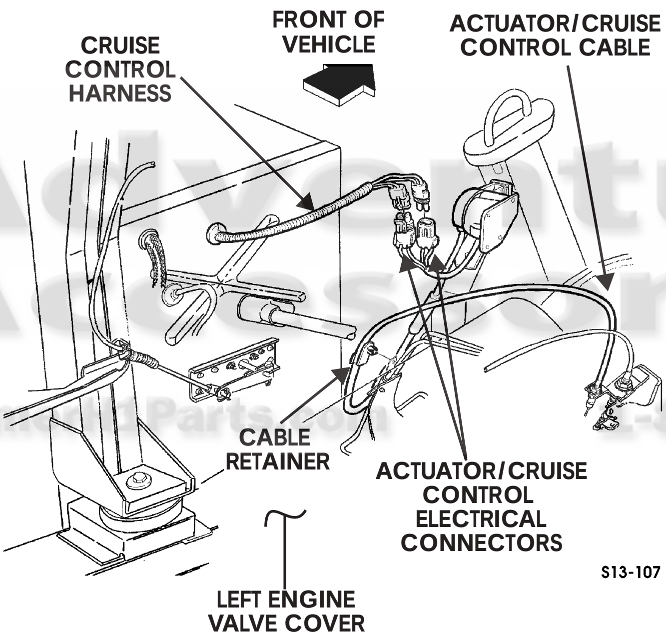


Figure 13-66: Actuator Electrical Connector Location

2. Remove cable retainer and actuator/cruise control cable from injector tube retainer on engine valve cover (Figure 13-66).
3. Remove retaining clip, accelerator cable, washer, cruise control cable linkage, and spacer from throttle shaft stud (Figure 13-67).
4. Loosen adjusting nuts and remove actuator/cruise control cable from cruise control bracket (Figure 13-67).
5. Remove bolts, nuts, washers, and actuator from actuator mounting bracket (Figure 13-68).
6. Remove bolts, nuts, washers, and mounting bracket from vehicle frame.

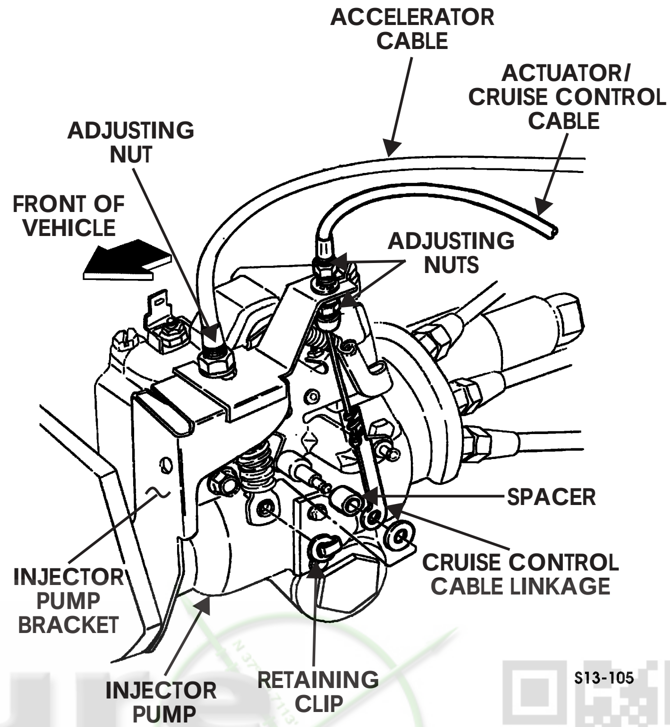


Figure 13-67: Actuator/Cruise Control Cable Mounting

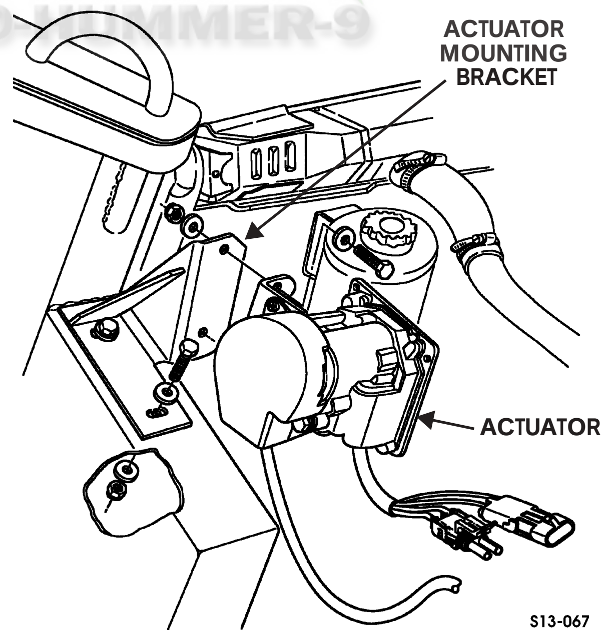


Figure 13-68: Actuator and Mounting Bracket Breakdown

Installation

1. Secure actuator mounting bracket to vehicle frame with bolts, washers, and nuts.
2. Secure actuator to actuator mounting bracket with bolts, washers, and nuts (Figure 13-68).
3. Connect actuator/cruise control electrical connectors to cruise control harness connectors (Figure 13-66).
4. Route actuator/cruise control cable to the top of the engine and secure cable to cruise control bracket on injector pump with adjusting nuts (Figure 13-67).
5. Secure spacer, cruise control cable linkage, washer, and accelerator cable to throttle shaft stud with retaing clip (Figure 13-67).

NOTE: Actuator/Cruise control cable eyelet must face the front of the vehicle.

6. Secure cable retainer and actuator/cruise control cable to injector tube retainer on engine valve cover (Figure 13-66).

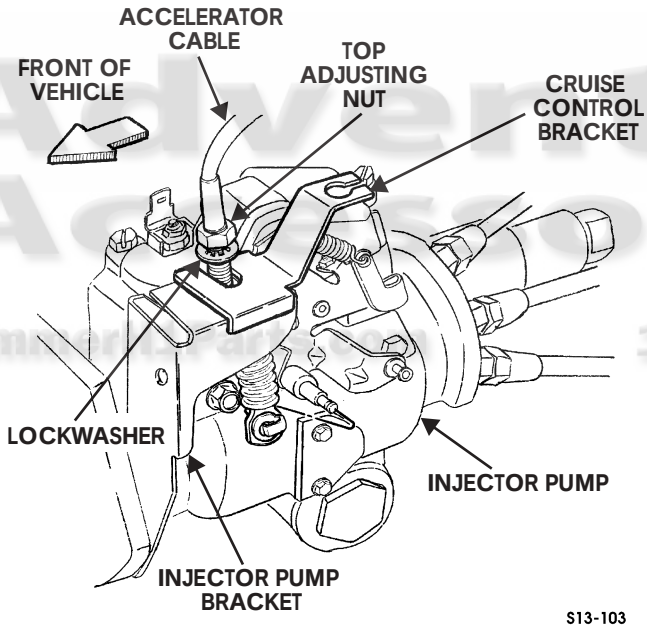


Figure 13-69: Accelerator Cable Mounting

Adjustment

1. Depress accelerator pedal, and hold throttle shaft lever in full throttle position.
2. Adjust accelerator cable adjusting nuts so cable end holds throttle shaft lever in full throttle position. Tighten adjusting nuts (Figure 13-69).
3. Release accelerator pedal. Ensure throttle shaft lever returns to idle position.
4. Loosen actuator/cruise control cable adjusting nuts and position cable in cruise control bracket with one adjusting nut and lockwasher on either side of bracket (Figure 13-67).
5. Adjust cable in bracket to allow for 1/4 inch of horizontal movement of cable at idle. Tighten adjusting nuts.

Cruise Control Actuator and Mounting Bracket Replacement - Late Build Vehicles

NOTE: The following procedure applies to late 1995 vehicles.

NOTE: There are two different types of actuator/cruise control cables. Early 1995 vehicles have adjusting nuts and a separate spacer (Figure 13-67). Late 1995 vehicles have a "snap-in" mounting grommet and integrated spacer (Figure 13-71).

Removal

1. Disconnect the actuator/cruise control cable electrical connectors from the cruise control harness connectors (Figure 13-70).

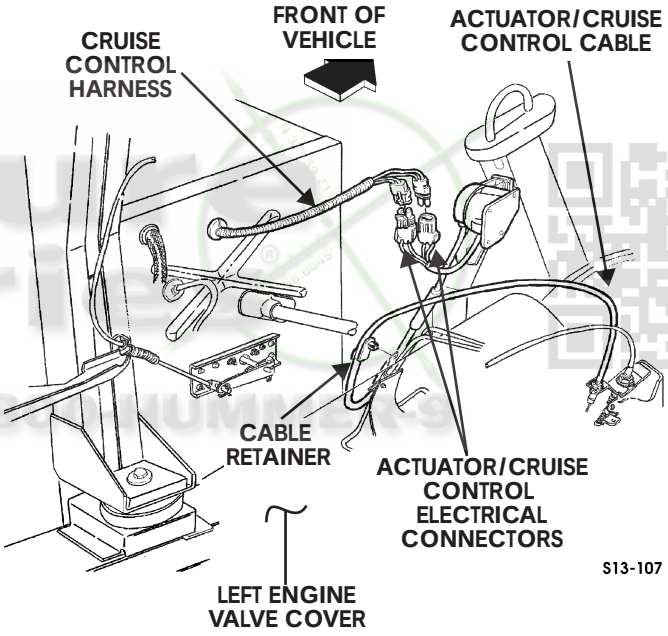


Figure 13-70: Actuator Electrical Connector Location

2. Remove cable retainer and actuator/cruise control cable from injector tube retainer on engine valve cover (Figure 13-70).
3. Remove retaining clip, accelerator cable and cruise control cable linkage from throttle shaft stud (Figure 13-71).
4. Depress plastic tabs on cable mounting grommet. Pull grommet and actuator/cruise control cable from cruise control bracket (Figure 13-71).
5. Remove bolts, nuts, washers and actuator from actuator mounting bracket (Figure 13-72).
6. Remove nuts, washers, bolts, and mounting bracket from vehicle frame.

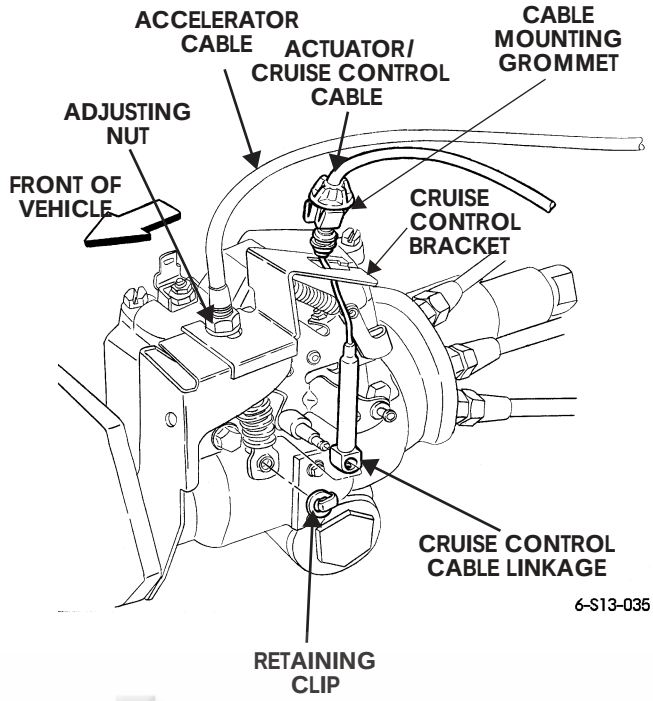


Figure 13-71: Actuator /Cruise Control Cable Mounting

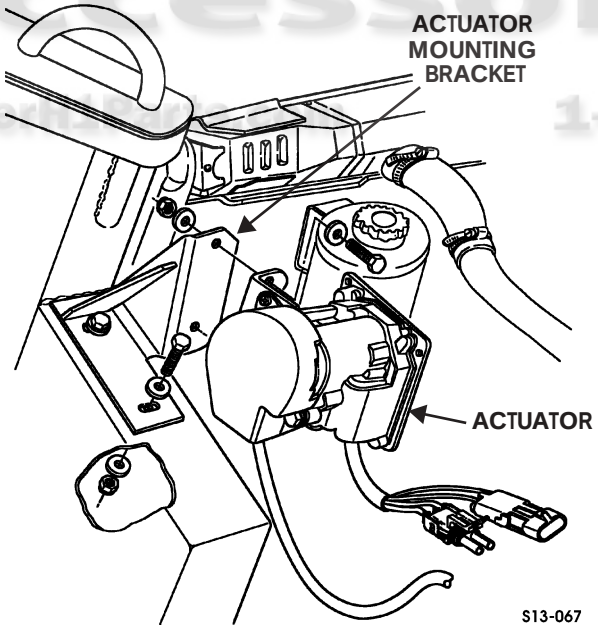


Figure 13-72: Actuator and Mounting Bracket Breakdown

Installation

1. Secure actuator mounting bracket to vehicle frame with bolts, washers, and nuts.
2. Secure actuator to actuator mounting bracket with bolts, washers, and nuts (Figure 13-72).
3. Connect actuator/cruise control electrical connectors to cruise control harness connectors (Figure 13-70).
4. Route actuator/cruise control cable to the top of the engine and snap cable mounting grommet securely into cruise control bracket. (Figure 13-71).
5. Secure cruise control cable linkage and accelerator cable to throttle shaft stud with retaining clip (Figure 13-71).

NOTE: Actuator/Cruise control cable eyelet must face the front of the vehicle.

6. Secure cable retainer and actuator/cruise control cable to injector tube retainer on engine valve cover (Figure 13-70).

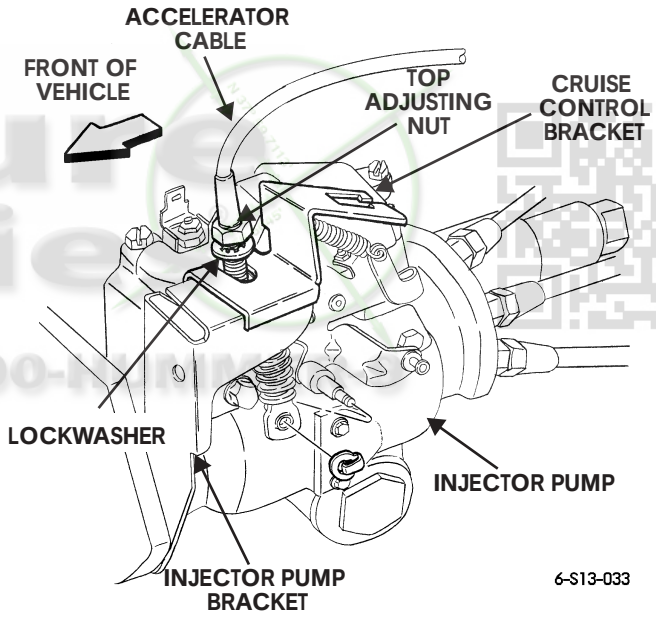


Figure 13-73: Accelerator Cable Mounting

Adjustment

1. Depress accelerator pedal, and hold throttle shaft lever in full throttle position.
2. Adjust accelerator cable adjusting nuts so cable end holds throttle shaft lever in full throttle position. Tighten adjusting nuts (Figure 13-73).
3. Release accelerator pedal. Ensure throttle shaft lever returns to idle position.
4. Adjust actuator/cruise control cable to allow for 1/4 inch of horizontal movement of cable at idle.

Cruise Control Module Replacement

Removal

1. Disconnect cruise control harness connector from module (Figure 13-74).

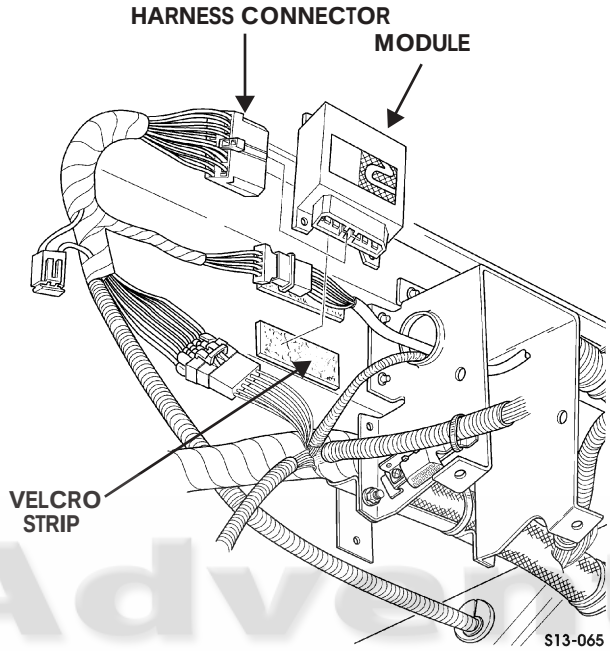


Figure 13-74: Cruise Control Module

2. Remove module from two velcro strips.
3. Inspect two velcro strips and replace if damaged.

Installation

1. Install module on two velcro strips.
2. Connect cruise control harness connector to module (Figure 13-74).

Cruise Control/Turn Signal Switch Replacement

Removal

1. Remove steering column covers from steering column (Section 8).
2. Disconnect switch connector from cruise control harness connector (Figure 13-75).
3. Pull switch out of steering column.

Installation

1. Install switch in steering column (Figure 13-75).
2. Route switch connector through hole in steering column mounting bracket and connect to cruise control harness connector.
3. Install steering column covers on steering column (Section 8).

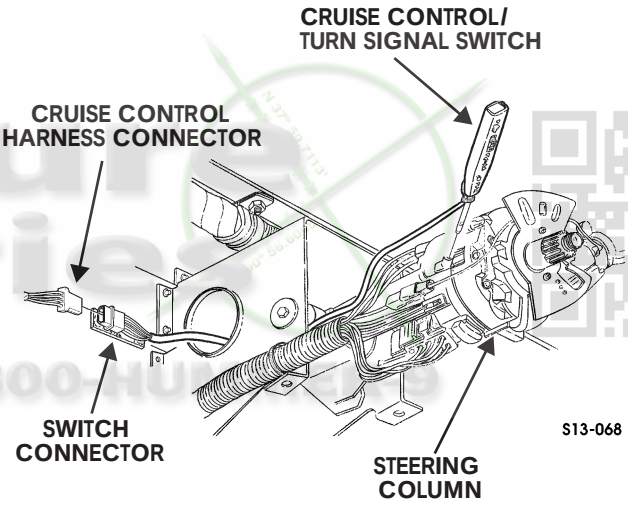


Figure 13-75: Cruise Control/Turn Signal Switch

Cruise Control Harness Replacement

NOTE: Tag leads for installation.

Removal

1. Disconnect two harness connectors from actuator connectors (Figure 13-76).
2. Disconnect harness connector from module (Figure 13-77).
3. Disconnect harness connector from cruise control/turn signal switch connector.
4. Disconnect harness connector from body wiring harness connector.
5. Remove harness and grommet from body.

Installation

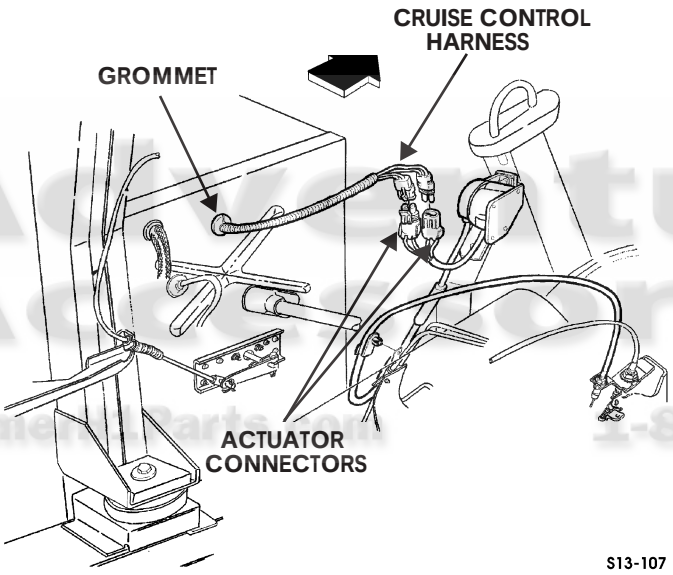


Figure 13-76: Actuator Connectors

1. Install grommet and harness on body (Figure 13-76).
2. Connect harness connector to body wiring harness connector.
3. Connect harness connector to cruise control/turn signal switch connector.
4. Connect harness connector to module.
5. Connect two harness connectors to actuator connectors (Figure 13-77).

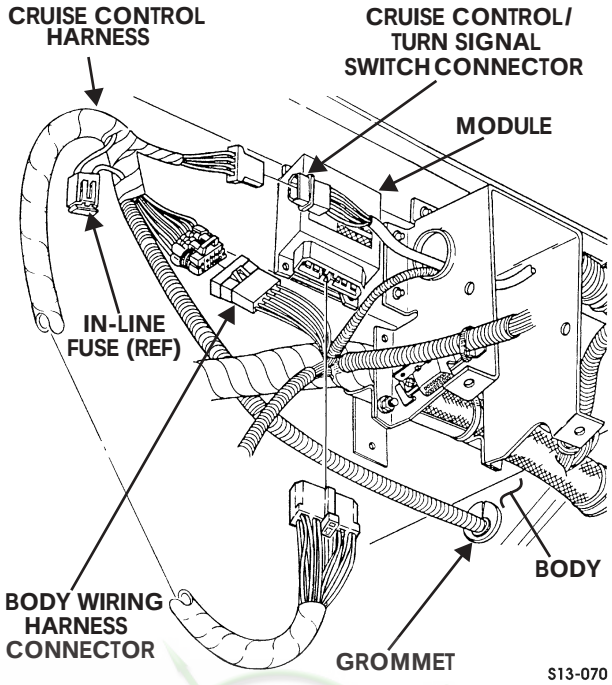


Figure 13-77: Cruise Control Harness

Static Test for Proper Operation of Cruise Control System

This static test should determine that the cruise control system:

- is operating correctly
- is adjusted so that it is capable of near wide open throttle (WOT)
- will disengage when the brake pedal is depressed and when the transmission is shifted to Neutral.

NOTE:
This is a static test and is to be performed with the engine not running and with the parking brake applied.

Static Test of Cruise Control System

1. Turn cruise control to OFF using turn signal stalk control and place transmission shift lever to Park position.
2. Turn ignition switch to the ON position, BUT DO NOT START THE ENGINE.
3. Put the transmission in Overdrive (engine is OFF).
4. Press the SET/COAST button on stalk control and hold it in.
5. Turn cruise control to the ON position on the stalk control.
6. Release the SET/COAST button; press it again and hold it in.
7. Throttle should move slowly to WOT (35-40 seconds).
8. Check for WOT.
9. Release SET/COAST button, press and hold the RESUME/ ACCEL button. Observe throttle pedal moving back to idle position.
10. Release RESUME/ ACCEL button when throttle pedal is returned to idle position.
11. Press SET/COAST button and hold until throttle pedal begins moving.
12. Step on brake and note that throttle pedal is returned to idle position.
13. Press SET/COAST button and hold until throttle begins to move.
14. Move transmission shift lever from Overdrive to Neutral and note that throttle pedal is returned to idle position.
15. Turn off cruise control and ignition switch and return shift lever to Park position.

Road Test of Cruise Control System

NOTE:
Road test should be performed only when weather conditions permit and all traffic laws are obeyed.

1. Accelerate vehicle speed to 40-50 MPH with transmission in Overdrive.
2. Engage the cruise system by depressing the SET/COAST button and then releasing it (slider switch must be in the ON position). The cruise speed will be the vehicle speed at the time the push button is released.
3. Move the slider to the OFF position. The cruise should become disengaged and vehicle speed should decrease.
4. Repeat steps 1 and 2.
5. Depress the brake pedal. The cruise system should disengage and vehicle speed should decrease.
6. Repeat steps 1 and 2.
7. Move transmission shift lever into neutral position. The cruise system should disengage and vehicle speed should decrease. Cruise control system should not engage when transmission is shifted back into Overdrive.
8. Repeat steps 1 and 2.
9. Depress the accelerator pedal to accelerate vehicle speed then release accelerator pedal. Vehicle speed should return to set cruise speed.
10. Hold in SET/COAST button. Vehicle speed should decrease.
11. Release SET/COAST button. Vehicle speed should set at the time the SET/COAST button is released.
12. Accelerate vehicle to 40-50 MPH by moving and holding the slider to RESUME/ACCEL position. Vehicle should accelerate at a controlled rate. The cruise should set at the time the slider is released.
13. Depress the brake pedal allowing the vehicle speed to drop 5-10 MPH. Move and hold the slider to the RESUME/ACCEL position for less than 1.5 seconds then release. Vehicle should accelerate at a controlled rate until vehicle speed returned to the last speed stored in memory.
14. With the cruise control engaged and maintaining a speed of 50 MPH, tap and release set button; vehicle speed should decrease 1 MPH. For additional speed reduction, tap and release again for an additional 1 MPH decrease. To increase the speed in 1 MPH increments, move the RESUME/ACCEL switch to the left and release, and repeat for additional speed increases.

NOTE:If you have static tested and road tested the Cruise Control System and the system still isn't operating properly, refer to the diagnostic portion of Section 13 in the Service Manual.

POWER WINDOWS

Power Window Regulator Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove power window and door lock switches from door. Disconnect switches from power window and door lock harness connectors.
3. Remove door trim and vapor barrier (Section 10).

CAUTION: *Support window during regulator removal to avoid damage.*

NOTE: Prior to removal, mark location of screws for installation.

4. Disconnect power window and door lock harness connector from regulator motor (Figure 13-78).
5. Remove two screws and lockwashers securing regulator bracket to door. Discard lockwashers.
6. Remove screw, lockwasher, and regulator bracket from regulator. Discard lockwashers.
7. Remove screw securing regulator motor to door.
8. Remove four screws and lockwashers cable and bracket assembly to door. Discard lockwashers.
9. Remove two screws, lockwashers, and washers securing regulator cable and bracket assembly to window bracket. Discard lockwashers.
10. Remove tie strap and regulator from door. Discard tie strap.

Installation

1. Install regulator in door and secure with tie strap (Figure 13-78).
2. Secure regulator cable and bracket assembly to window bracket with two washers, lockwashers, and screws.
3. Secure regulator cable and bracket assembly to door with four lockwashers and screws.
4. Secure regulator motor to door with screw.
5. Install regulator bracket on door with two lockwashers and screws.
6. Secure regulator bracket to regulator with lockwasher and screw.
7. Connect power window and door lock harness connector to regulator motor.
8. Install door trim and vapor barrier (Section 10).
9. Install power window and door switches on door. Connect power window and door lock harness connectors to switches.
10. Connect battery ground cable (Section 12).

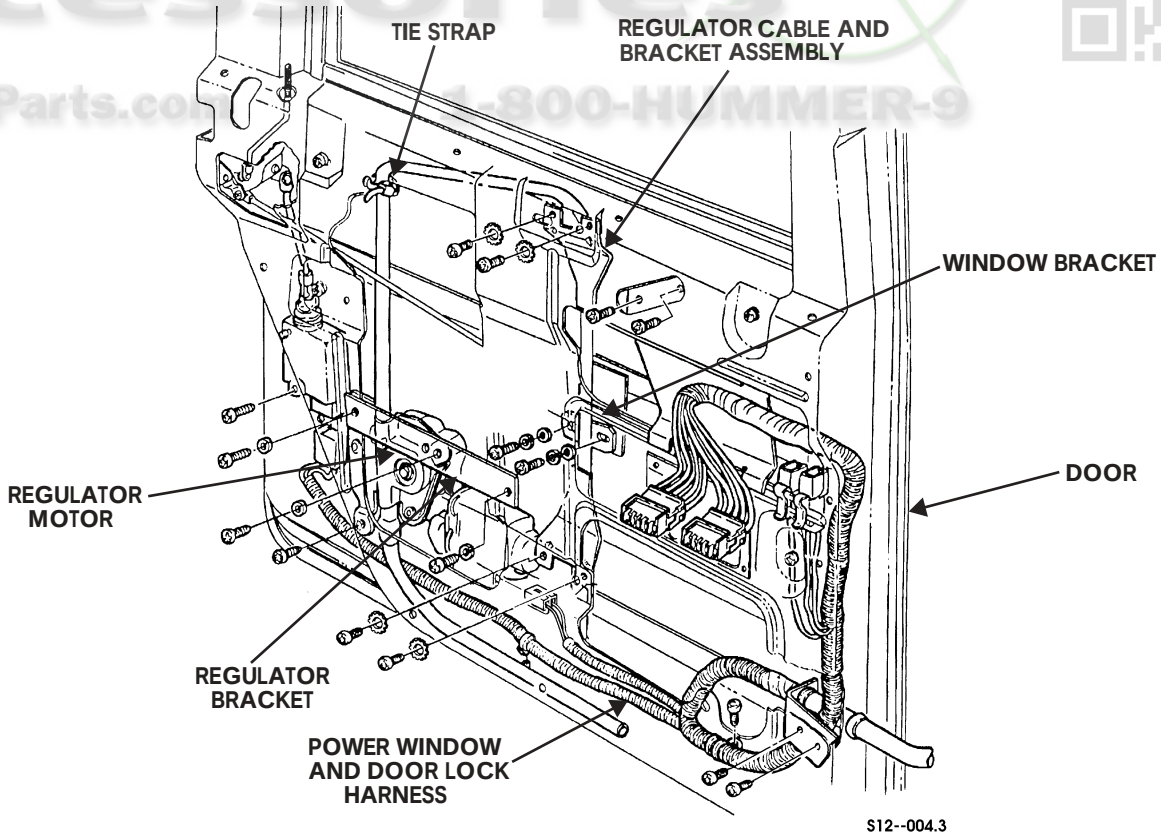


Figure 13-78: Power Window Regulator

Power Window and Lock Switches Replacement (Instrument Panel Mounted)

NOTE: This procedure covers replacement of the power window and lock switches mounted on the instrument panel. For replacement of the power window switches mounted on the front and rear doors, refer to this section.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove four screws, power window plate, and four J-nuts from instrument panel (Figures 13-79 and 13-80).

NOTE: Tag leads for installation.

NOTE: Perform step 3 for two-door models. Perform step 4 for four-door models.

3. Disconnect harness connector from power window switch and harness connector from power windows lock switch (Figures 13-79 and 13-80).
4. Disconnect three harness connectors from power window switches and one harness connector from power window lock switch (Figures 13-79 and 13-80).
5. Remove switches from plate.

Installation

1. Install power window and lock switches on plate (Figures 13-79 and 13-80).

NOTE: Perform step 2 for two-door models. Perform step 3 for four-door models.

2. Connect harness connector to power window switch, and harness connector to power windows lock switch (Figures 13-79 and 13-80).
3. Connect three harness connectors to power window switches, and one harness connector to power window lock switch (Figures 13-79 and 13-80).
4. Install plate on instrument panel with four J-nuts and screws.
5. Connect battery ground cable (Section 12).
6. Check power window and lock switches for proper operation.

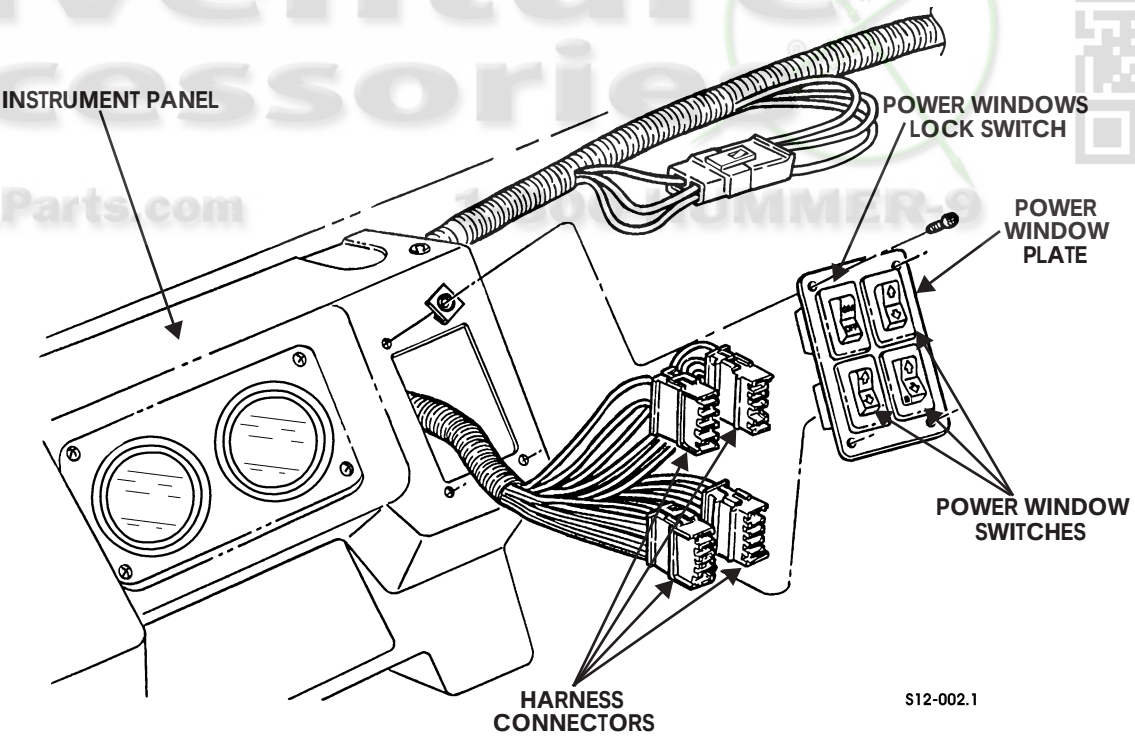


Figure 13-79: Power Windows and Lock Switches - 4-Door Models

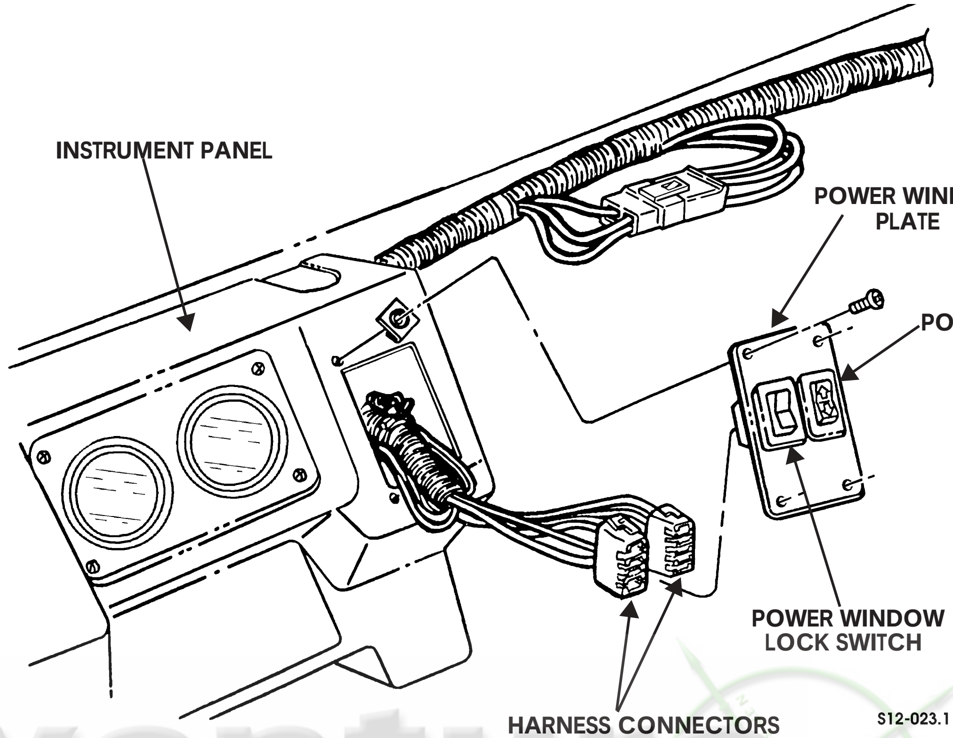


Figure 13-80: Power Window and Lock Switches - 2-Door Models

Power Window And Door Lock Switches Replacement (Front Door Mounted)

NOTE: This procedure covers replacement of the power window and door lock switches mounted on the dual switch bezel on the front door. For replacement of the power door locks switch mounted on a single switch bezel (not including the power window switch), refer to Section 12. For replacement of the power window switches on the rear doors and on the instrument panel, refer to this section.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove two screws, dual switch bezel, and two J-nuts from door (Figure 13-81).

NOTE: Tag leads for installation.

3. Remove two door harness connectors from power window switch and power door locks switch.
4. Remove switches from dual switch bezel

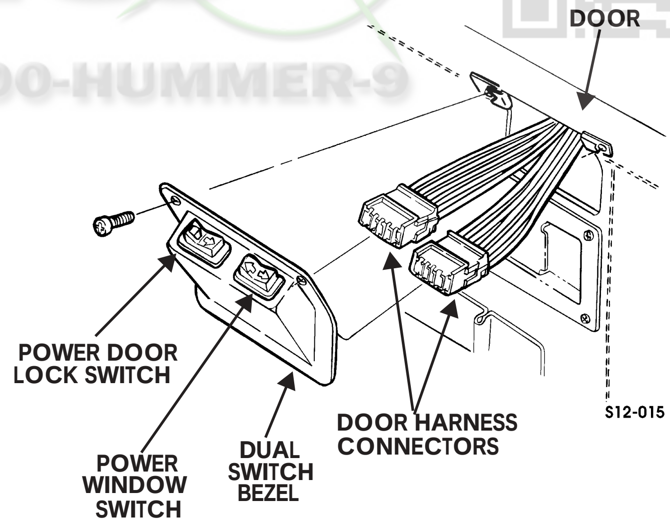


Figure 13-81: Power Window and Door Lock Switches (Front Door Mounted)

Installation

1. Install power window and power door lock switches on dual switch bezel (Figure 13-81).
2. Connect two door harness connectors to power windows switch and power door locks switch.
3. Install dual switch bezel on door with two J-nuts and screws.
4. Connect battery ground cable (Section 12).
5. Check power windows and door locks for proper operation.

Power Window Switch Replacement (Rear Door Mounted)

NOTE: This procedure covers replacement of the power window switch mounted on the rear door. For replacement of the power windows switches mounted on the front doors and on the instrument panel, refer to this section.

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove two screws, single switch bezel, and two J-nuts from door (Figure 13-82).
3. Remove door harness connector from power window switch.
4. Remove switch from single switch bezel.

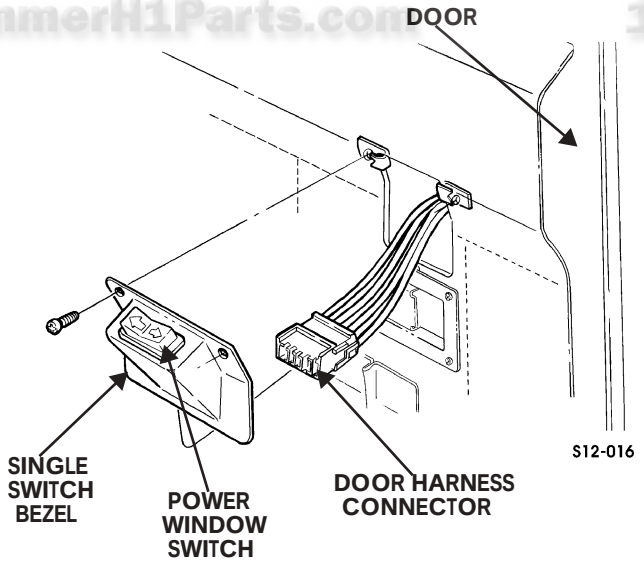


Figure 13-82: Power Window Switch (Rear Door Mounted)

Installation

1. Install power window switch on single switch bezel.
2. Connect door harness connector to switch.
3. Install single switch bezel on door with two J-nuts and screws.
4. Connect battery ground cable (Section 12).
5. Check power window for proper operation.

Power Window and Door Locks Front Door Harness Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove front outer kick panels (Section 10).
3. Remove power window and door lock switches from door.
4. Remove front door trim, vapor barrier, and moisture barrier flap from door (Section 10).

NOTE: Tag leads for installation.

5. Disconnect 4-way and 6-way harness connectors from power windows and door locks body harness connectors (Figure 13-83).

NOTE: Perform step 6 for vehicles equipped with power mirrors.

6. Disconnect two harness connectors from power mirrors body harness connectors.
7. Remove screw, nut and lockwasher assembly, and clamp securing harness to A-pillar. Discard nut and lockwasher assembly
8. Remove harness wires from 4-way and 6-way connectors.

NOTE: Lubricate bushings, grommet, and harness teflon cover with silicone spray.

9. Pull harness through A-pillar rubber grommet.
10. Remove and inspect A-pillar rubber grommet. Replace if damaged.

NOTE: Perform step 11 for vehicles equipped with power mirrors.

11. Disconnect two harness connectors from power mirrors door jumper harness connectors (Figure 13-84).
12. Remove self-tapping screw and clamp securing harness to door reinforcement (Figure 13-85).

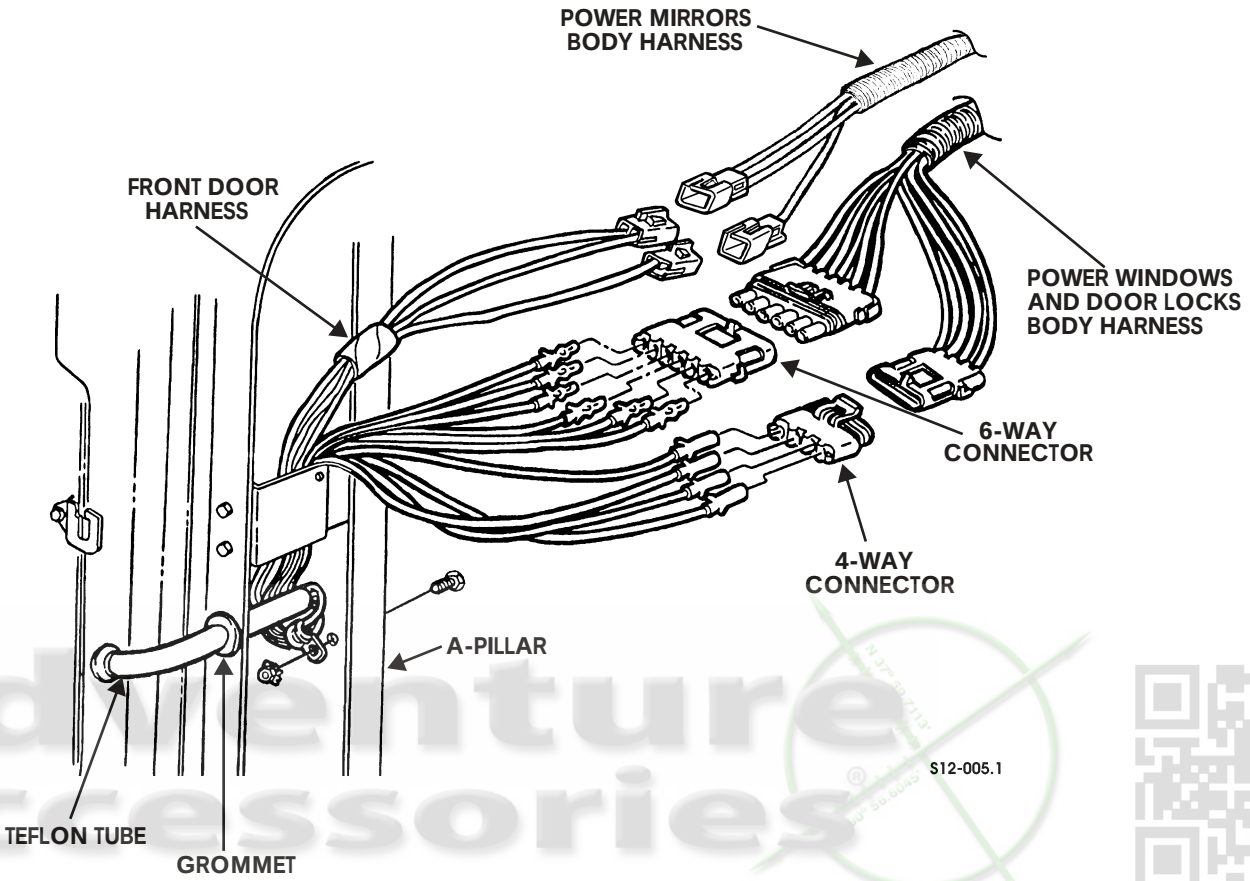
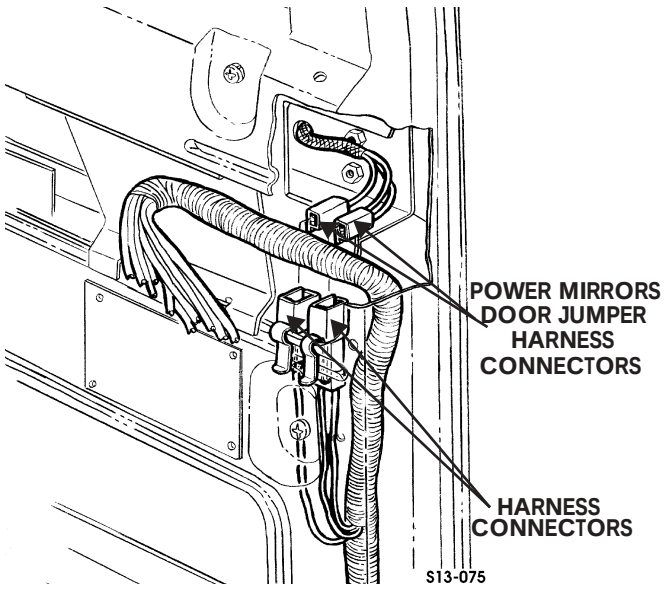


Figure 13-83: Power Windows and Door Locks Harness



13. Remove two self-tapping screws and harness mounting bracket from door assembly.
14. Pull harness through door bushing.
15. Inspect door bushing and replace if damaged.
16. Remove harness mounting bracket and mounting bracket bushing from harness. Inspect bushing and replace if damaged.
17. Disconnect harness connector from power window regulator.
18. Disconnect harness connector from power door locks actuator.
19. Remove retainer and harness from door assembly.

Figure 13-84: Power Mirrors Door Jumper Harness

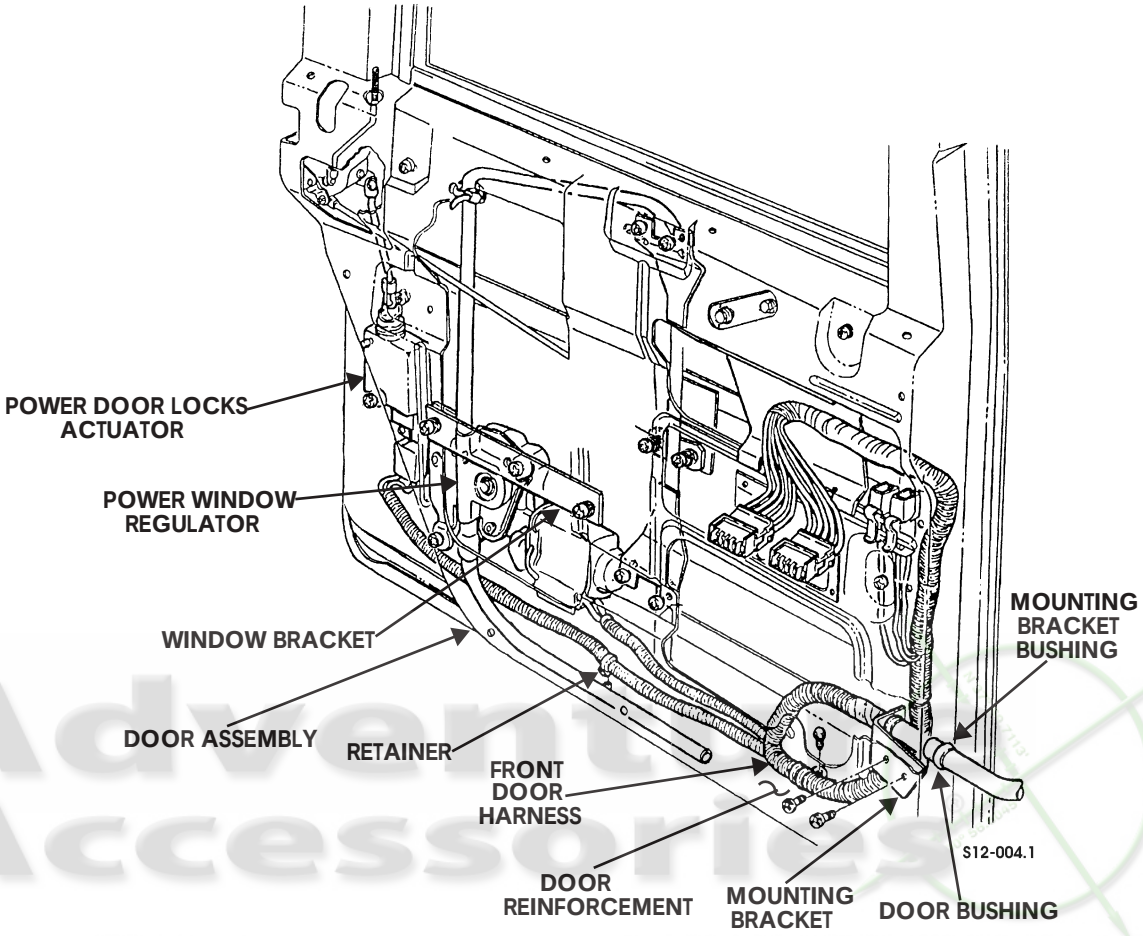


Figure 13-85: Power Windows and Door Locks Harness

Installation

NOTE: Lubricate bushing, grommet, and harness teflon cover with silicone spray.

1. Route harness through harness mounting bracket, mounting bracket bushing, and door bushing (Figure 13-85).
2. Install harness mounting bracket on door assembly with two self-tapping screws (Figure 13-85).
3. Route harness through A-pillar rubber grommet (Figure 13-86).

NOTE: When connecting harness wires to 4-way and 6-way connectors, ensure wire colors align with mating connector wires.

4. Connect harness wires to 4-way and 6-way connectors.
5. Connect 4-way and 6-way harness connectors to power windows and door locks body harness connectors.

NOTE: Perform step 6 for vehicles equipped with power mirrors.

6. Connect two harness connectors to power mirrors body harness connectors.
7. Secure harness to A-pillar with clamp, self-tapping screw, and nut and lockwasher assembly.

NOTE: Perform step 8 for vehicles equipped with power mirrors.

8. Connect two harness connectors to power mirrors door jumper harness connectors (Figure 13-86)

9. Connect harness connector to power window regulator (Figure 13-85).

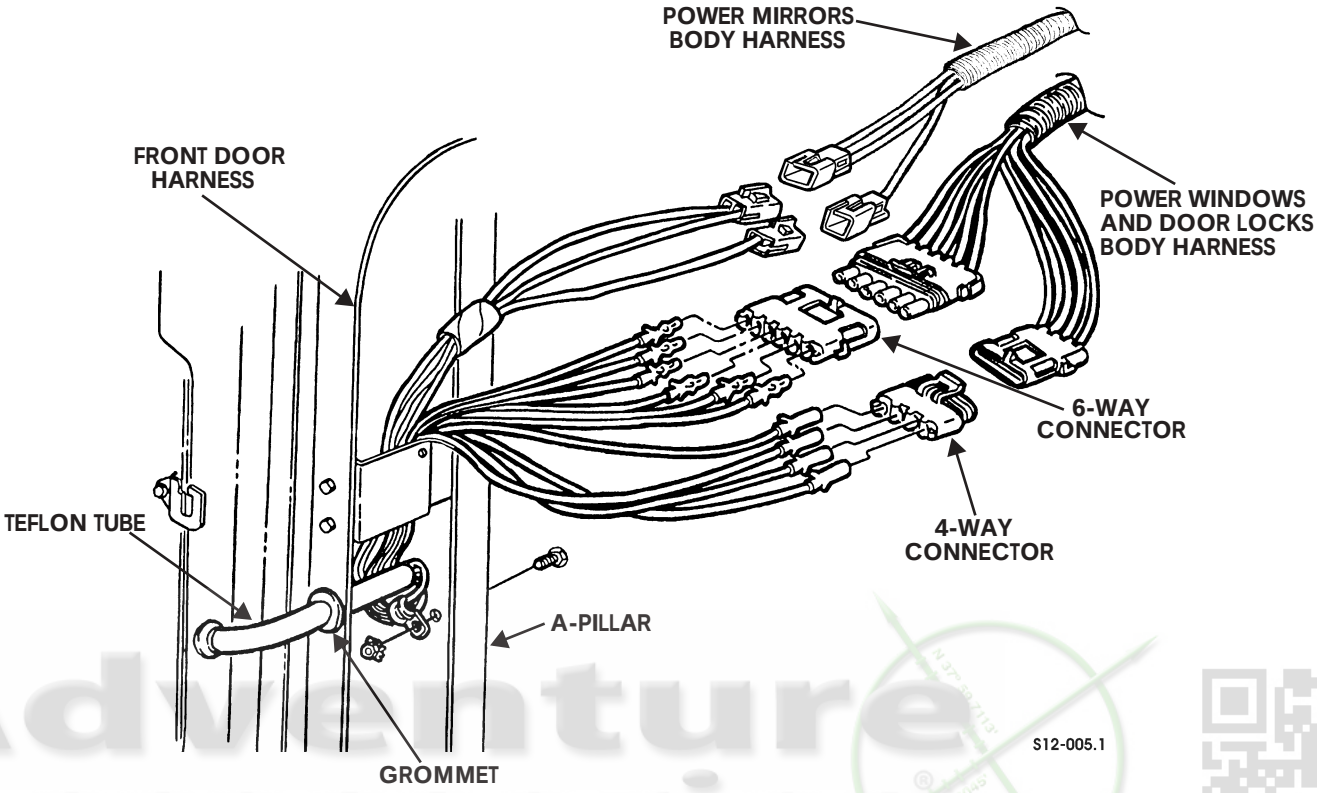


Figure 13-86: Power Windows and Door Locks Harness

10. Connect harness connector to power door lock actuator.
11. Secure harness to door reinforcement with clamp and self-tapping screw.
12. Secure harness to door assembly with retainer.
13. Install moisture barrier flap, vapor barrier, and door trim panel on door (Section 10).
14. Install power window and door lock switches on door.
15. Install front outer kick panels (Section 10).
16. Connect battery ground cable (Section 12).
17. Check power windows and door locks for proper operation.

Power Windows and Door Locks Rear Door Harness Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove center outer kick panel and lower B-pillar trim (Section 10).
3. Remove power windows switch from door.
4. Remove rear door trim, vapor barrier, and moisture barrier flap from door (Section 10).

NOTE: Tag leads for installation.

5. Disconnect 6-way harness connector from power windows and door locks rear door jumper harness connector (Figure 13-87).

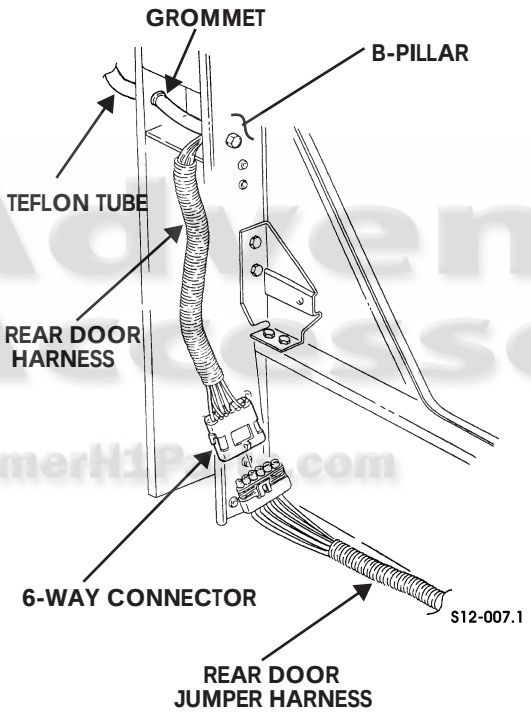


Figure 13-87: Rear Door Harness and Rear Door Jumper Harness

6. Remove harness wires from 6-way connector.
7. Remove screw, nut and lockwasher assembly, and clamp securing harness to B-pillar. Discard nut and lockwasher assembly.

NOTE: Lubricate bushings, grommet, and harness teflon cover with silicone spray.

8. Pull harness through B-pillar rubber grommet.
9. Remove and inspect B-pillar rubber grommet. Replace if damaged.
10. Remove two self-tapping screws and harness mounting bracket from door assembly (Figure 13-88).
11. Pull harness through door bushing.
12. Inspect door bushing and replace if damaged.
13. Remove harness mounting bracket and mounting bracket bushing from harness. Inspect bushing and replace if damaged.
14. Remove self-tapping screw and clamp securing harness to door reinforcement.
15. Disconnect harness connector from power window regulator.
16. Disconnect harness connector from power door lock actuator.
17. Remove retainer securing harness to door assembly.
18. Remove tie strap and harness from door assembly. Discard tie strap.

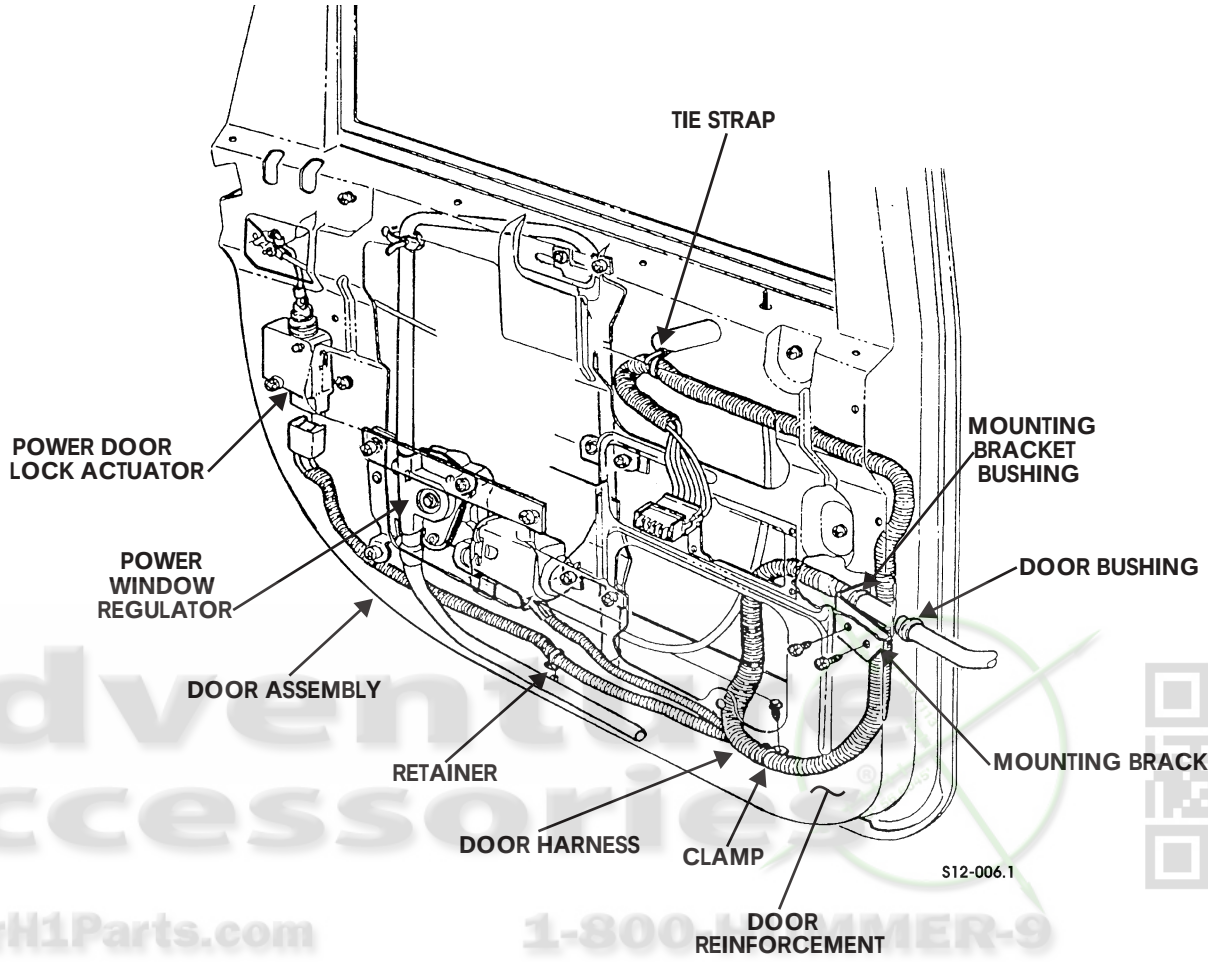


Figure 13-88: Rear Door Harness

Installation

NOTE: Lubricate bushings, grommet, and harness teflon cover with silicone spray.

1. Route harness through harness mounting bracket, mounting bracket bushing, and door bushing (Figure 13-88).
2. Install harness mounting bracket on door assembly with two self-tapping screws
3. Route harness through B-pillar rubber grommet (Figure 13-89).

NOTE: When connecting harness wires to 6-way connector, ensure wire colors align with mating connector wires.

4. Connect harness wires to 6-way connector.
5. Connect 6-way harness connector to power windows and door locks rear door jumper harness connector.
6. Secure harness to B-pillar with clamp, screw, and nut and lockwasher assembly.

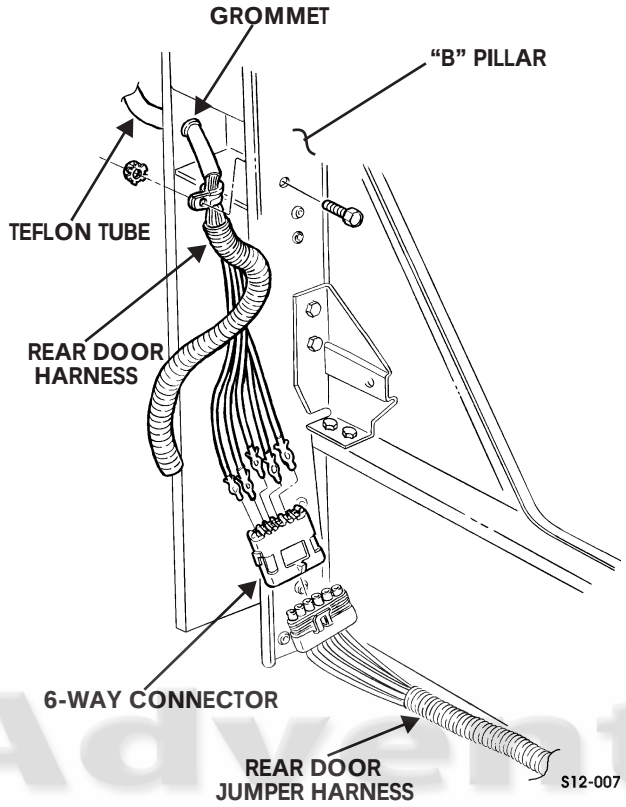


Figure 13-89: Rear Door Harness and Rear Door Jumper Harness

7. Connect harness connector to power window regulator (Figure 13-88).
8. Connect harness connector to power door lock actuator.
9. Secure harness to door reinforcement with clamp and self-tapping screw.
10. Secure harness to door assembly with retainer.
11. Secure harness to door assembly with tie strap.
12. Install moisture barrier flap, vapor barrier, and door trim panel on door (Section 10).
13. Install power windows switch on door.
14. Install lower B-pillar trim and center kick panel (Section 10).
15. Connect battery ground cable (Section 12).
16. Check power windows and door locks for proper operation.

Power Windows and Door Locks Rear Door Jumper Harness Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove front and center outer kick panels and lower B-pillar trim (Section 10).
3. Disconnect jumper harness connector from power windows and door locks body harness connector (Figure 13-90).

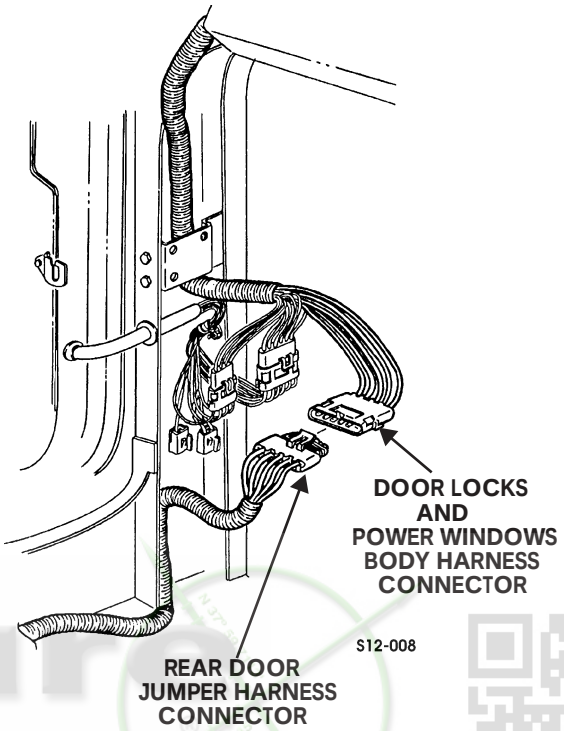


Figure 13-90: Power Windows and Door Locks Body Harness and Rear Door Jumper Harness

4. Disconnect jumper harness connector from power windows and door locks rear door harness connector (Figure 13-91).

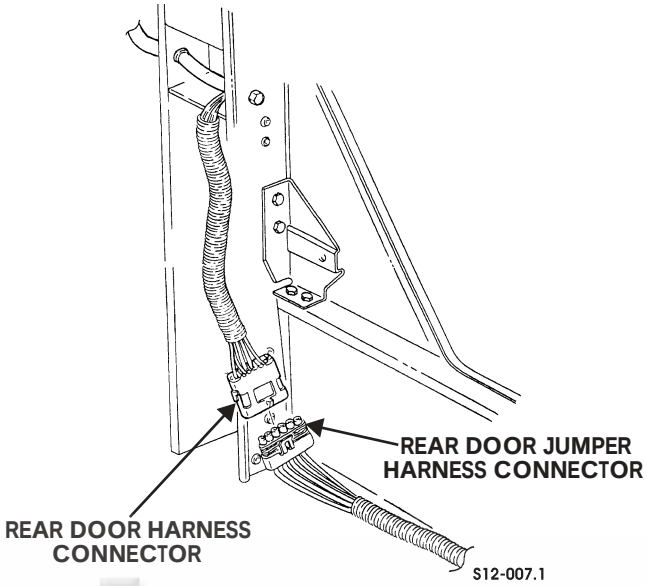


Figure 13-91: Power Windows and Door Locks Rear Door Harness and Rear Door Jumper Harness

Installation

1. Connect jumper harness connector to power windows and door locks rear door harness connector (Figure 13-91).
2. Connect jumper harness connector to power windows and door locks body harness connector (Figure 13-90).
3. Install lower "B" pillar trim and front and center outer kick panels (Section 10).
4. Connect battery ground cable (Section 12)

Power Windows And Door Locks Harness Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove crash pad (Section 10).
3. Remove front outer kick panels (Section 10).
4. Remove engine access cover (Section 10).
5. Remove eight screws and two gauge panels from instrument panel (Section 12).
6. Remove power windows and lock switch from instrument panel.

NOTE: Tag leads for installation.

NOTE: Perform step 7 for vehicles equipped with remote entry.

7. Disconnect two power windows and door locks harness connectors from receiver harness connectors (Figure 13-92).

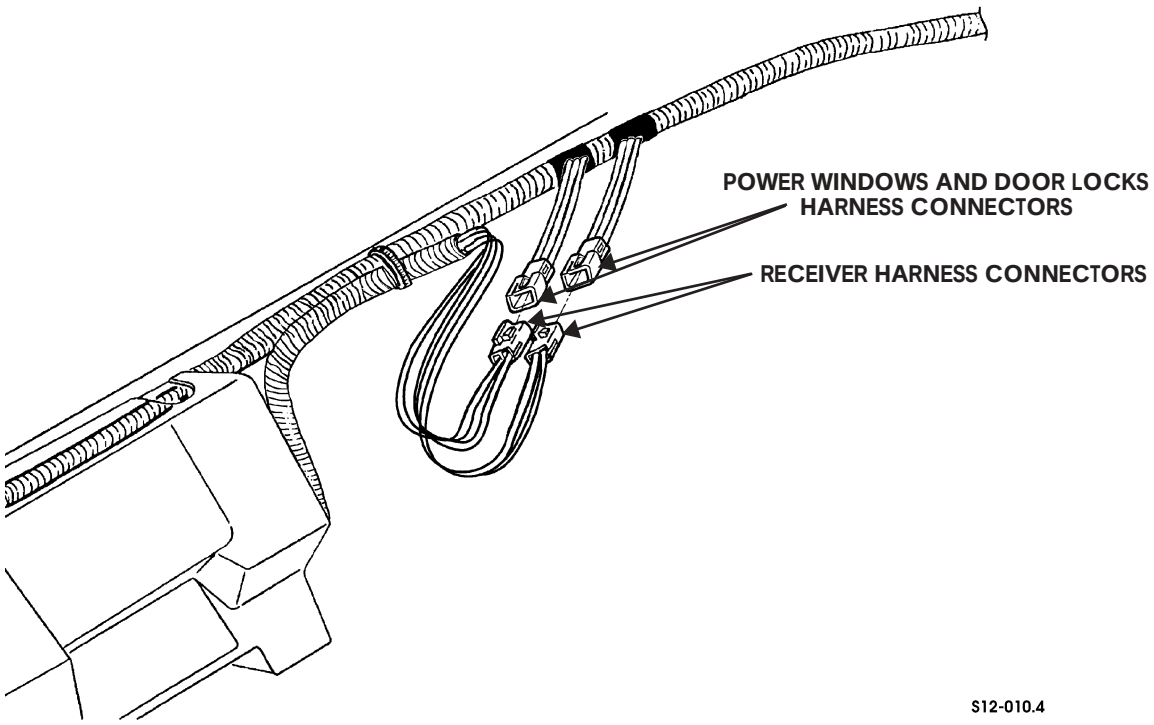


Figure 13-92: Power Windows and Door Locks Harness

8. Disconnect two harness leads from vehicle body harness power leads (Figure 13-93).

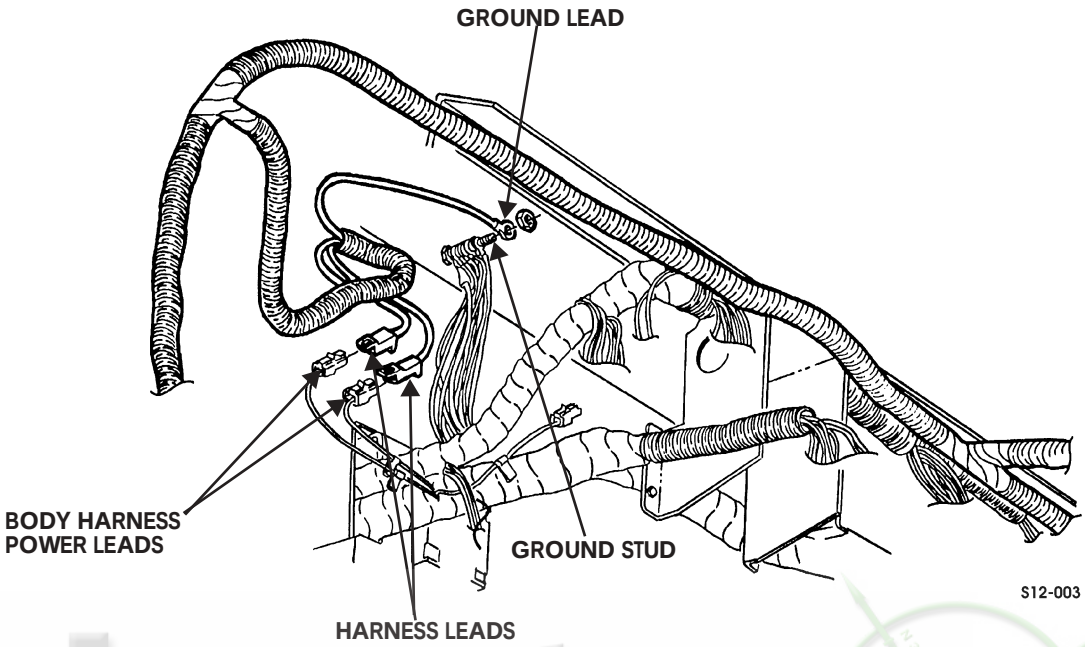


Figure 13-93: Power Windows and Door Locks Body Harness

9. Remove nut and ground lead from ground stud.
10. Disconnect two harness connectors from door harness connectors (Figure 13-94).
11. Repeat step 10 for opposite side.

NOTE: Perform steps 12 and 13 for 4-door vehicles.

12. Disconnect harness connector from rear door jumper harness connector (Figure 13-94).
13. Repeat step 12 for opposite side.
14. Remove seven tie straps securing harness to vehicle body harness and remove harness. Discard tie straps (Figure 13-92).

Installation

1. Route harness through instrument panel and along A- pillar to both sides of vehicle (Figure 13-94).

NOTE: Perform steps 2 and 3 for 4-door vehicles.

2. Connect harness connector to rear door jumper harness connector (Figure 13-94).
3. Repeat step 2 for opposite side.
4. Connect two harness connectors to door harness connectors.
5. Repeat step 4 for opposite side.
6. Install ground lead on ground stud with nut (Figure 13-93).
7. Connect two harness leads to vehicle body harness power leads.

NOTE: Perform step 8 for vehicles equipped with remote entry.

8. Connect two power windows and door locks harness connectors to receiver harness connectors (Figure 13-92).
9. Secure harness to vehicle body harness with seven tie straps.
10. Install power windows and lock switch on instrument panel.
11. Install two gauge panels on instrument panel with eight screws (Section 12).
12. Install engine access cover (Section 10).
13. Install front outer kick panels (Section 10).
14. Install crash pad (Section 10).
15. Connect battery ground cable (Section 12).
16. Check power windows and door lock for proper operation.

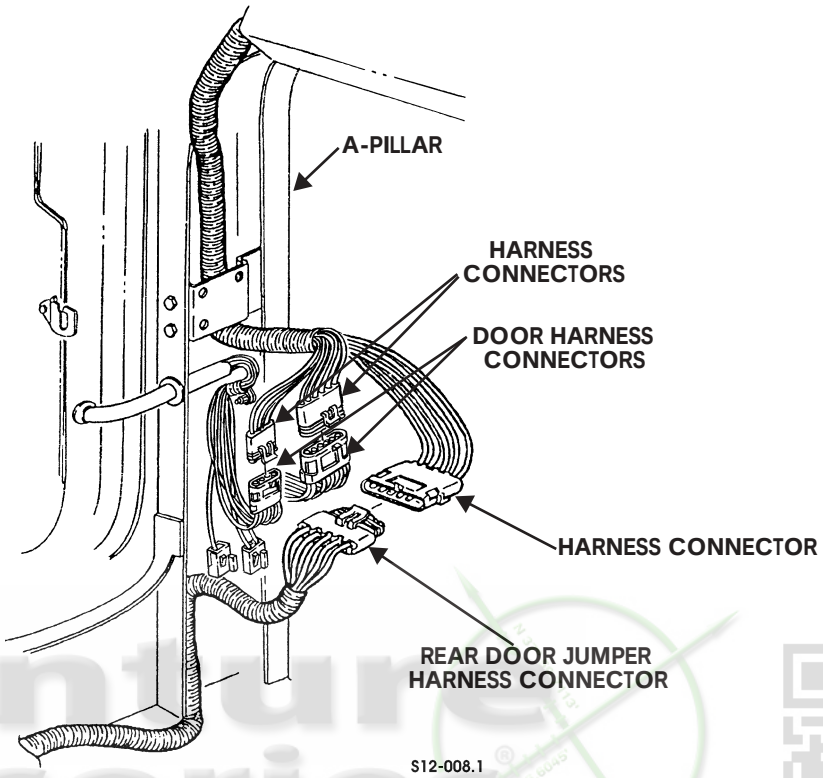


Figure 13-94: Door Harness Connectors

REMOTE ENTRY SYSTEM

Remote Entry Receiver and Harness Assembly Replacement

NOTE: This procedure covers the replacement of the remote entry receiver and harness assembly for vehicles equipped with power windows.

Removal

NOTE: Tag leads for installation.

1. Disconnect battery ground cable (Section 12).
2. Remove front console enough to gain access to receiver and harness assembly (Section 10).
3. Disconnect two receiver harness connectors from power windows and locks harness connectors (Figure 13-95).
4. Disconnect receiver harness connector from receiver.
5. Remove receiver from two velcro strips.
6. Disconnect receiver harness connector from body harness connector.
7. Remove all tie straps securing receiver harness to power windows and door locks body harness and body wiring harness, and remove receiver harness. Discard tie straps.

Installation

1. Install receiver harness and connect two receiver harness connectors to power windows and door locks harness connectors (Figure 13-96).
2. Install receiver on two velcro strips.
3. Connect receiver harness connector to receiver.
4. Connect body harness connector to receiver harness connector.
5. Secure receiver harness to power windows and door locks body harness, and body wiring harness with tie straps.
6. Install front console (Section 10).
7. Connect battery ground cable (Section 12).
8. Check remote entry system for proper operation.

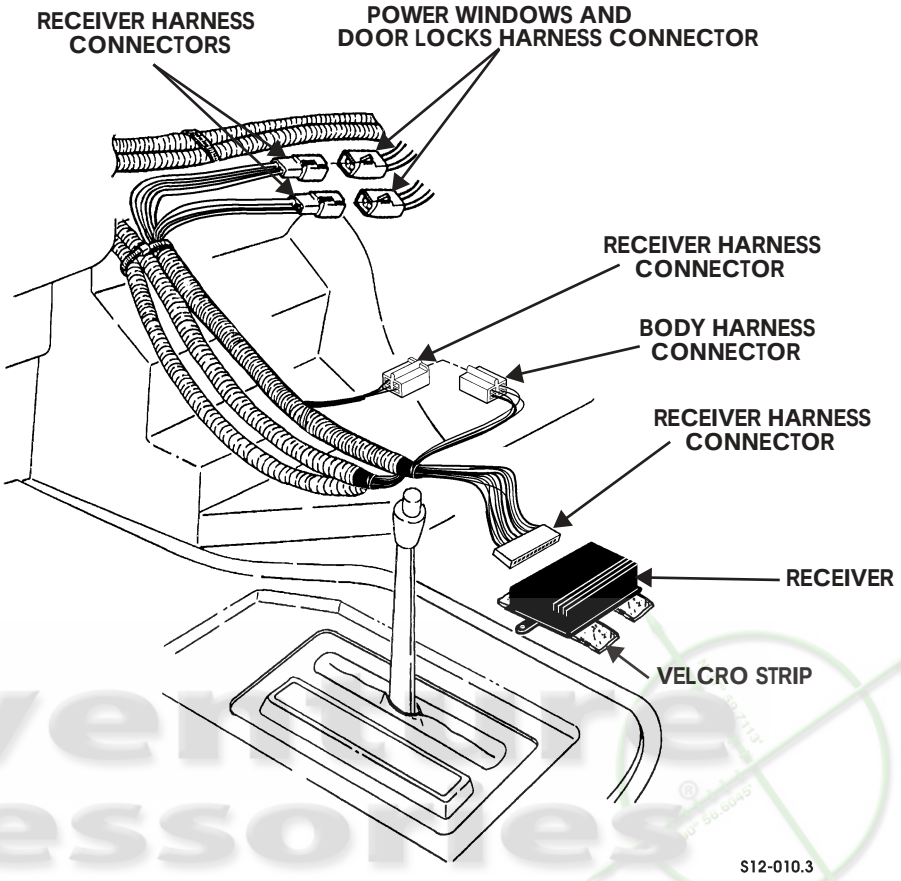


Figure 13-95: Remote Entry Receiver and Harness

POWER MIRRORS

Power Mirror Assembly Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove three screws securing power mirror assembly and gasket to mounting plate (Figure 13-96).
3. Disconnect power mirror assembly connector from door jumper harness.
4. Inspect gasket, and replace if damaged.

Installation

NOTE: Ensure door jumper harness is routed through gasket before connecting to power mirror assembly.

1. Connect power mirror assembly connector to door jumper harness (Figure 13-96).

NOTE: Wires from power mirror assembly must be coiled in mirror housing to ensure clearance of attachments.

2. Install gasket and power mirror assembly on mounting plate with three screws.
3. Connect battery ground cable (Section 12).

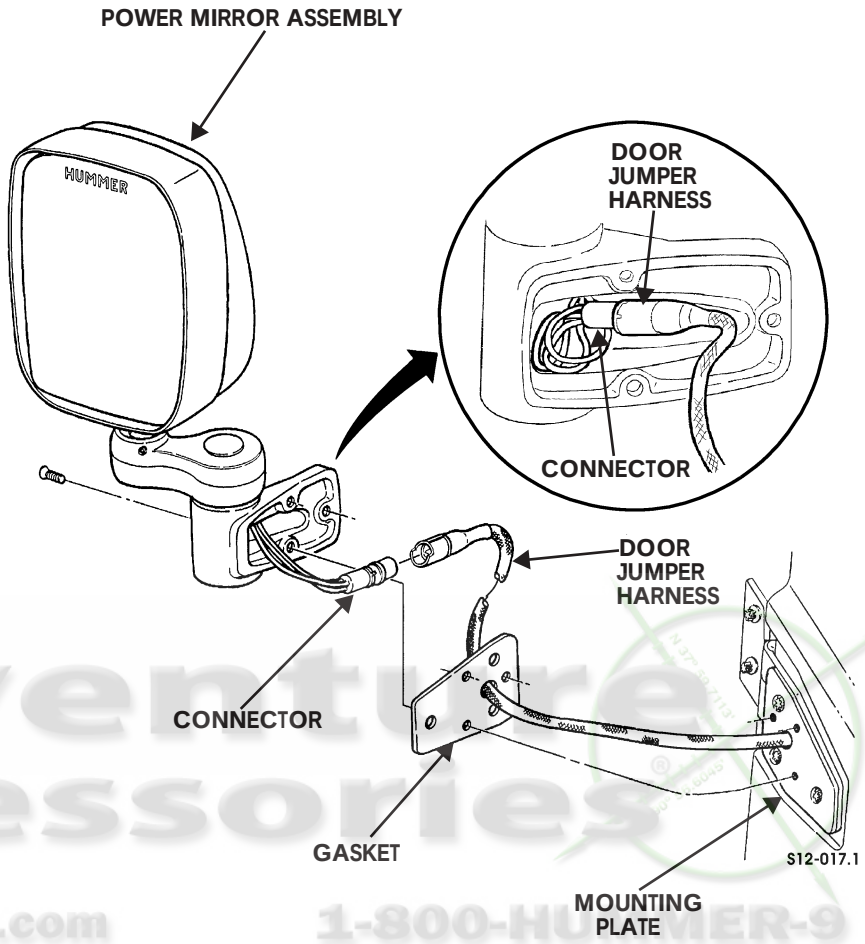


Figure 13-96: Power Mirror Assembly

Power Mirrors Body Harness Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove crash pad (Section 10).
3. Remove instrument panel (Section 12).
4. Remove front outer kick panels (Section 10).

NOTE: Tag leads for installation.

5. Disconnect harness switch connector from switch connector on jumper harness (Figure 13-97).

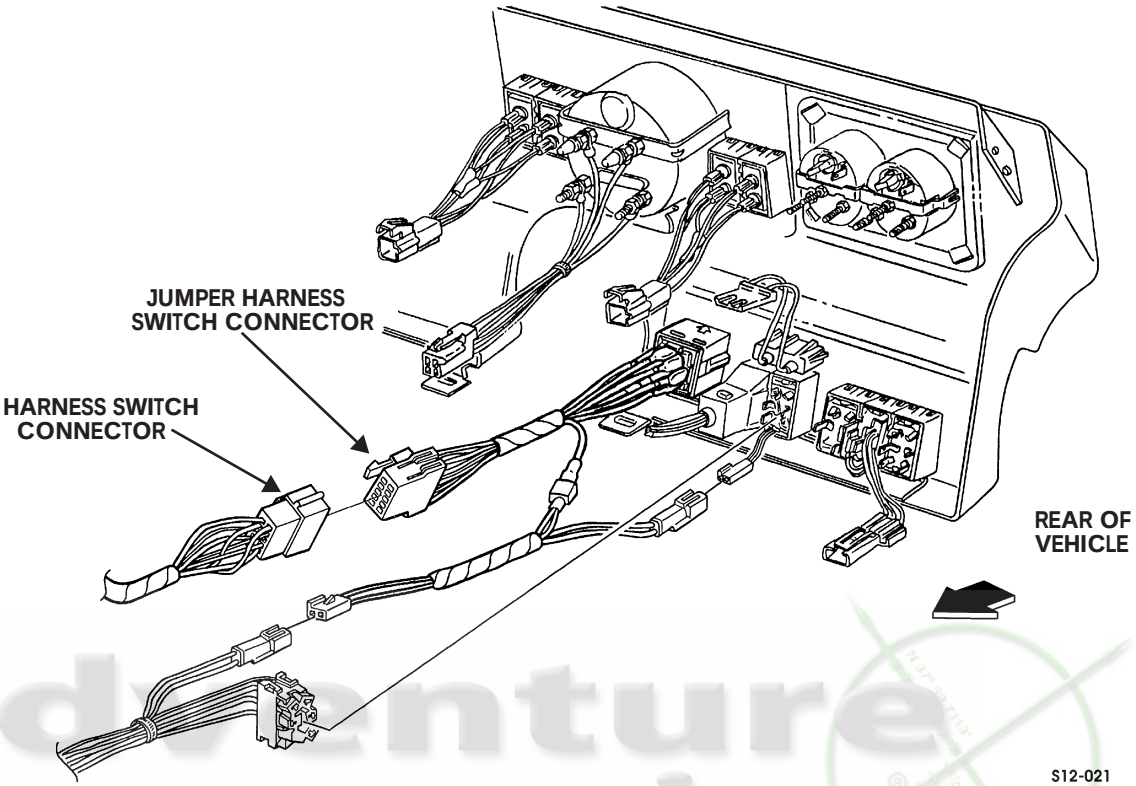


Figure 13-97: Jumper Harness Switch Connector

6. Disconnect two power lock leads from harness connector (Figure 13-98).
7. Remove nut and ground lead from ground stud.
8. Disconnect two harness leads from door harness leads (Figure 13-99).
9. Repeat step 7 for opposite side.
10. Remove five tie straps securing harness to power windows and door locks harness and remove harness. Discard tie straps.

Installation

1. Route harness along A-pillar (Figure 13-99).
2. Connect two harness leads to door harness leads.
3. Repeat step 2 for opposite side.
4. Secure ground lead to ground stud with nut (Figure 13-98).
5. Connect two power lock leads to harness connector.
6. Connect harness switch connector to switch connector on jumper harness (Figure 13-97).
7. Secure harness to power windows and door locks harness with five tie straps (Figure 13-98).
8. Connect battery ground cable (Section 12).
9. Test mirror operation.
10. Install front outer kick panels (Section 10).
11. Install instrument panel (Section 10).
12. Install crash pad (Section 10).

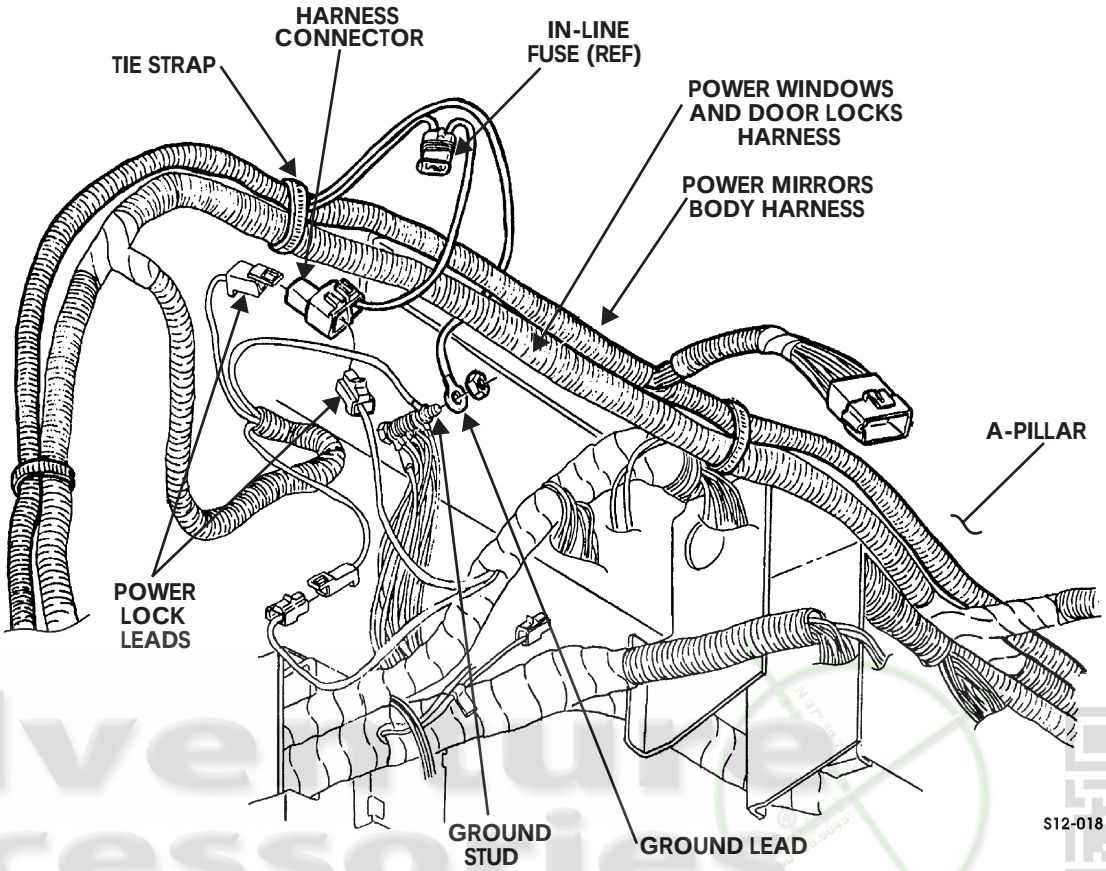


Figure 13-98: Power Mirrors Body Harness.

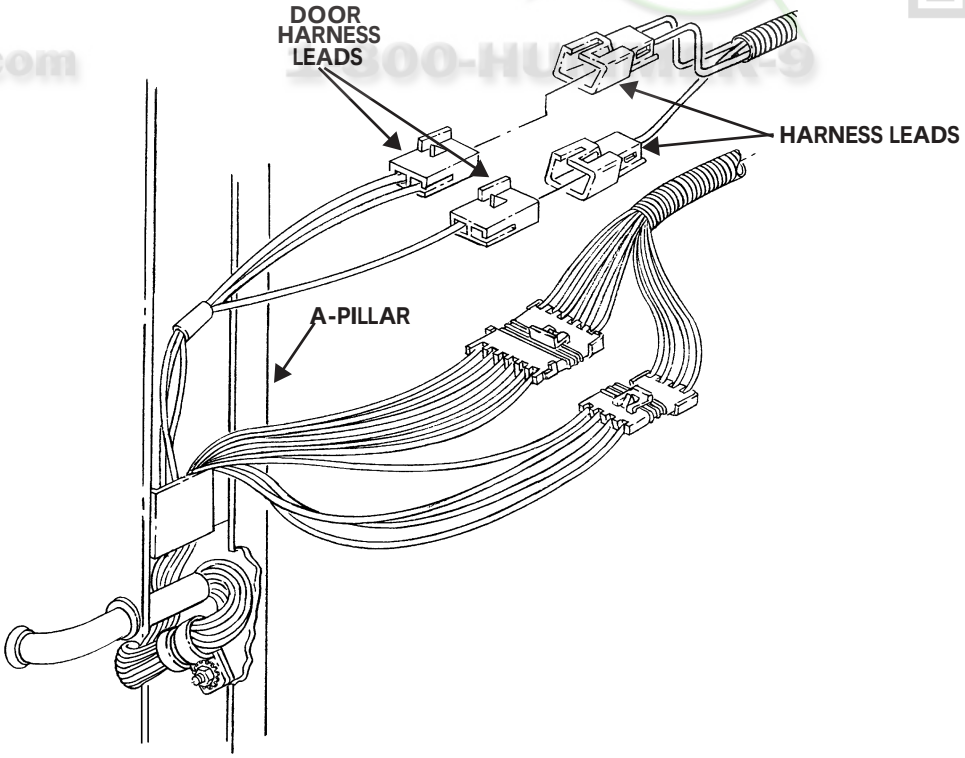


Figure 13-99: Door Harness Leads

Power Mirrors Door Jumper Harness Replacement

Removal

1. Remove power mirror assembly.
2. Remove door trim panel. Peel back portion of vapor barrier to gain access to harness (Section 10).

NOTE: Tag leads for installation.

3. Disconnect two door jumper harness leads from door harness leads (Figure 13-100). Pull door jumper harness through door.

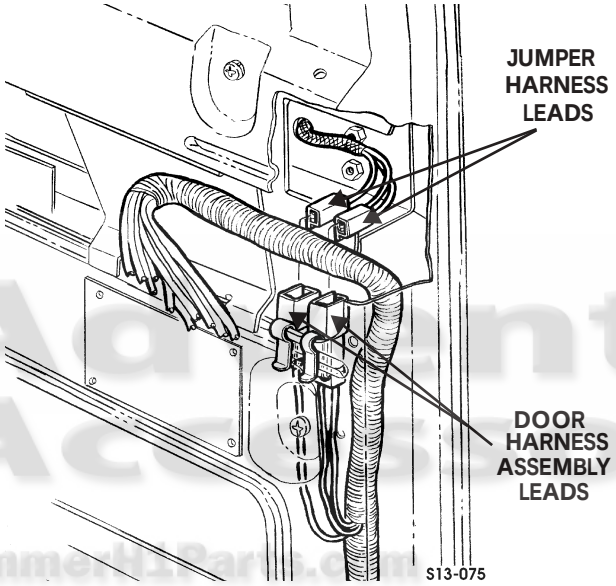


Figure 13-100: Power Mirrors Door Jumper Harness

Installation

1. Route door jumper harness through door (Figure 13-100).
2. Connect two door jumper harness leads to door harness leads.
3. Install power mirror assembly.
4. Test mirror operation.
5. Secure vapor barrier back into position and install door trim panel (Section 10).

Power Mirrors Switch Jumper Harness Replacement

Removal

1. Disconnect battery ground cable (Section 12).
2. Remove instrument panel (Section 12).
3. Disconnect jumper harness connector from connector on power mirrors body harness connector (Figure 13-101).
4. Disconnect jumper harness connector from wiper switch illumination connector on vehicle body harness.
5. Disconnect jumper harness connector from wiper switch illumination connector.
6. Push power mirrors control knob forward and pull jumper harness through square hole in instrument panel

Installation

NOTE: Ensure the top of the power mirrors control knob is positioned upward when installed.

1. Feed jumper harness through square hole in instrument panel until control knob on end of jumper harness snaps into place (Figure 13-101).
2. Connect jumper harness connector to wiper switch illumination connector.
3. Connect jumper harness connector to wiper switch illumination connector on body harness.
4. Connect jumper harness connector on power mirrors body harness connector.
5. Connect battery ground cable (Section 12).
6. Test mirror operation.
7. Install instrument panel (Section 10).

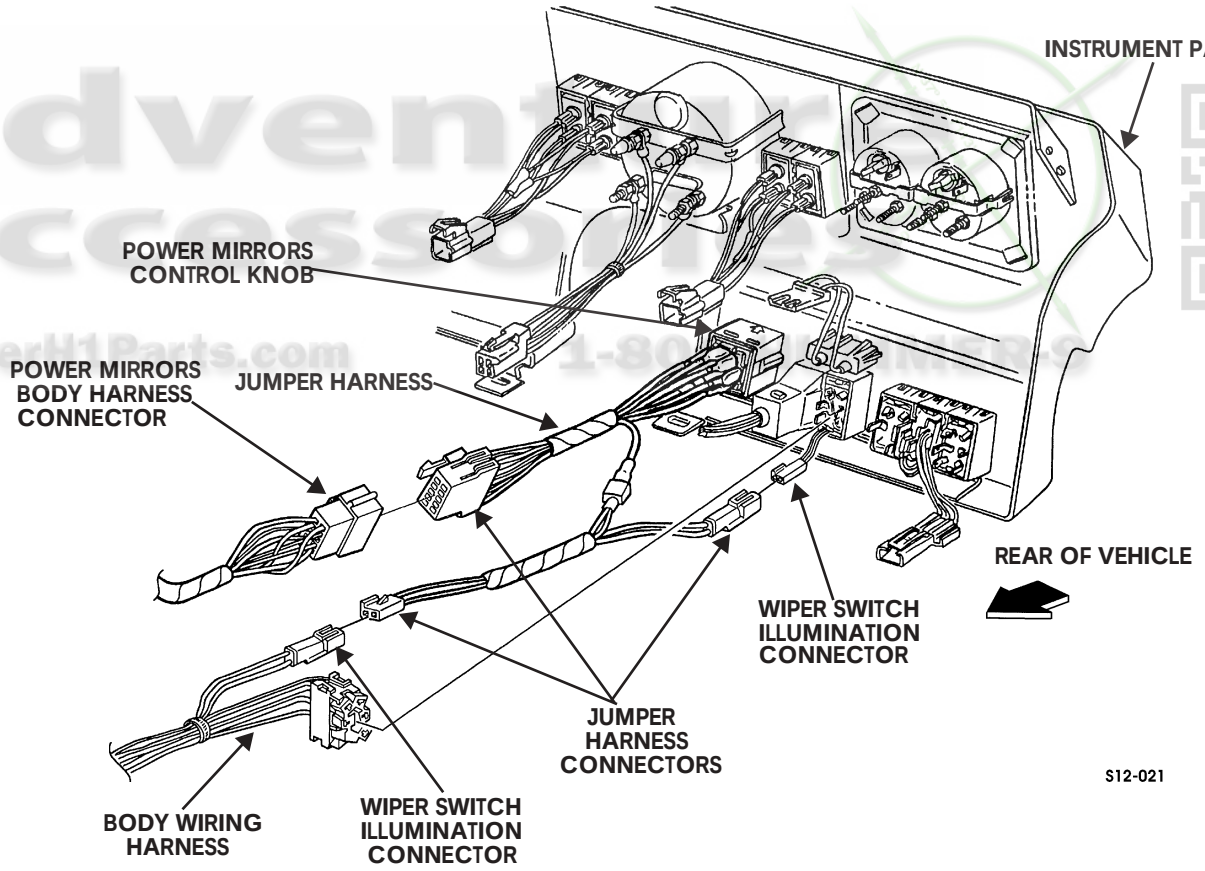


Figure 13-101: Power Mirrors Switch Jumper Harness

AUXILIARY SEAT

Auxiliary Seat Replacement

Removal

1. Release and remove four locking pins from auxiliary seat frame and auxiliary seat (Figure 13-102).
2. Remove auxiliary seat from auxiliary seat frame.

Installation

1. Install auxiliary seat on auxiliary seat frame.
2. Install and fasten four locking pins to auxiliary seat frame and auxiliary seat.

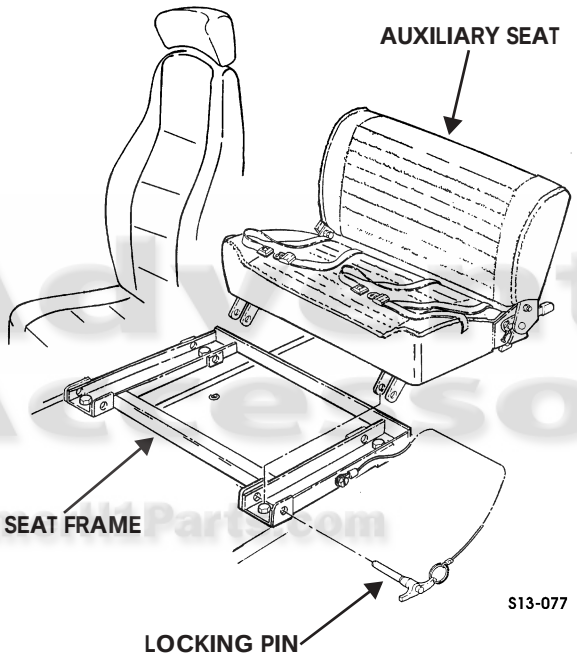


Figure 13-102: Auxiliary Seat

Auxiliary Seat Belt Replacement

Removal

1. Release and tilt forward auxiliary seat.

NOTE: Retain initial seat belt mounting positions during installation.

2. Remove four capscrews, washers, and two auxiliary seat belt assemblies from auxiliary seat (Figure 13-103).

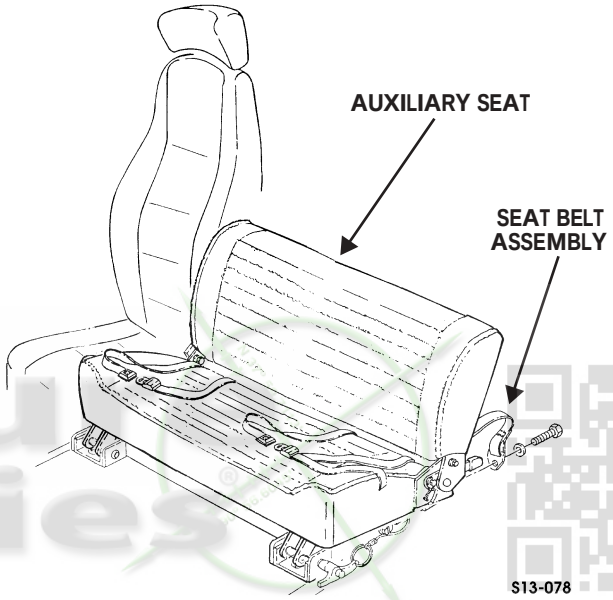


Figure 13-103: Auxiliary Seat Belt

Installation

1. Install two auxiliary seat belt assemblies on auxiliary seat with four washers and capscrews (Figure 13-103).
2. Tilt and fasten auxiliary seat back to normal position.

Auxiliary Seat Frame Replacement

Removal

1. Remove auxiliary seat.
2. Remove auxiliary seat locking pins.
3. Remove four capscrews, washers, and auxiliary seat frame from tunnel floor (Figure 13-104).

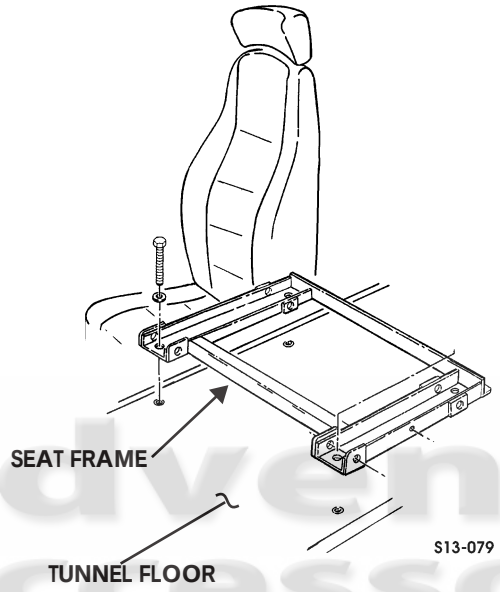


Figure 13-104: Auxiliary Seat Frame

Installation

1. Install auxiliary seat frame on tunnel floor with four washers and capscrews (Figure 13-104). Torque capscrews to 27-30 lb-ft (36-40 N•m).
2. Install auxiliary seat locking pins.
3. Install auxiliary seat.

Auxiliary Seat Locking Pin Replacement

Removal

NOTE: Left and right side locking pins are replaced the same. This procedure covers the left side only.

1. Remove two screws and locking pin cables from auxiliary seat frame (Figure 13-105).
2. Release and remove two locking pins from auxiliary seat frame and auxiliary seat.

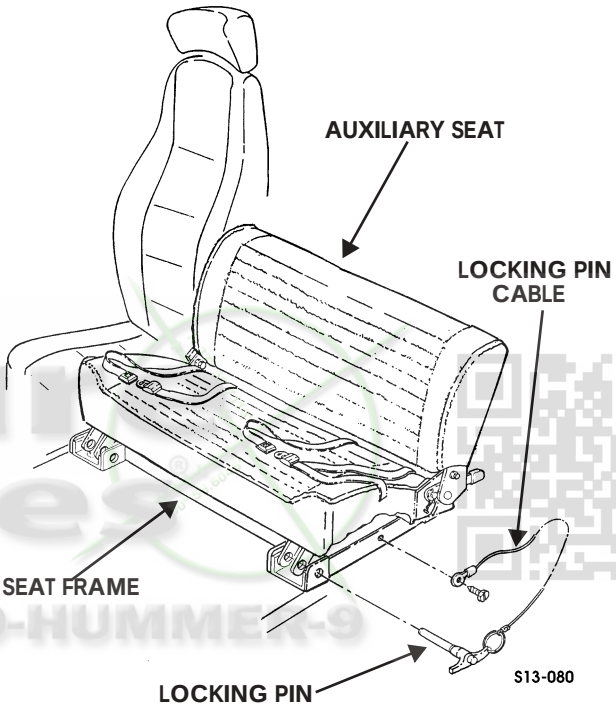


Figure 13-105: Auxiliary Seat Locking Pin

Installation

1. Install and fasten two locking pins on auxiliary seat frame and auxiliary seat (Figure 13-105).
2. Install two locking pin cables on auxiliary seat frame with two screws.

DUAL CONSOLE

Dual Console Replacement

Removal

Remove four screws, washers, and dual console from tunnel (Figure 13-106).

Installation

Install dual console on tunnel with four washers and screws (Figure 13-106).

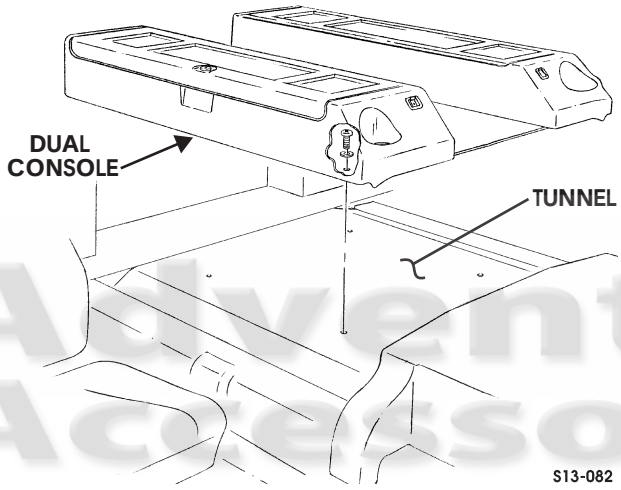


Figure 13-106: Dual Console

Dual Console Lock Cylinder Replacement

Removal

Remove retainer and lock cylinder from dual console (Figure 13-107).

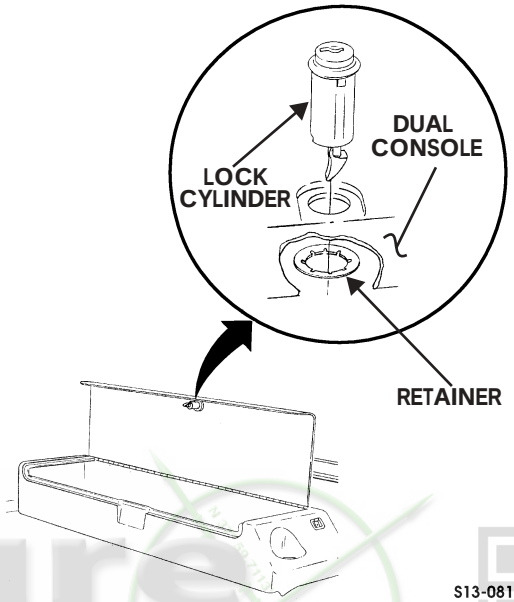


Figure 13-107: Dual Console Lock Cylinder

Installation

Install lock cylinder and retainer on dual console (Figure 13-107).

REAR WINDOW DEFROSTER REPLACEMENT

Rear Window Defroster Switch

Removal

1. Remove rear window defroster switch by gently prying it out of console (Figure 13-108).
2. Disconnect switch from rear defroster timer switch harness.
3. Remove the four screws securing bezel to console and backing plate.

Installation

1. Secure bezel to console and backing plate with four screws (Figure 13-108).
2. Connect defroster switch to rear defroster timer switch harness.
3. Press defroster switch into bezel until in clicks into place.

Rear Defrost Timer Switch Harness Replacement

Removal

1. Disconnect rear window defroster switch from rear defrost timer switch harness (Figure 13-108).
2. Disconnect rear defrost timer switch harness from body harness.

Installation

1. Connect rear defrost timer switch harness to body harness (Figure 13-108).
2. Connect rear window defroster switch to rear defrost timer switch harness.

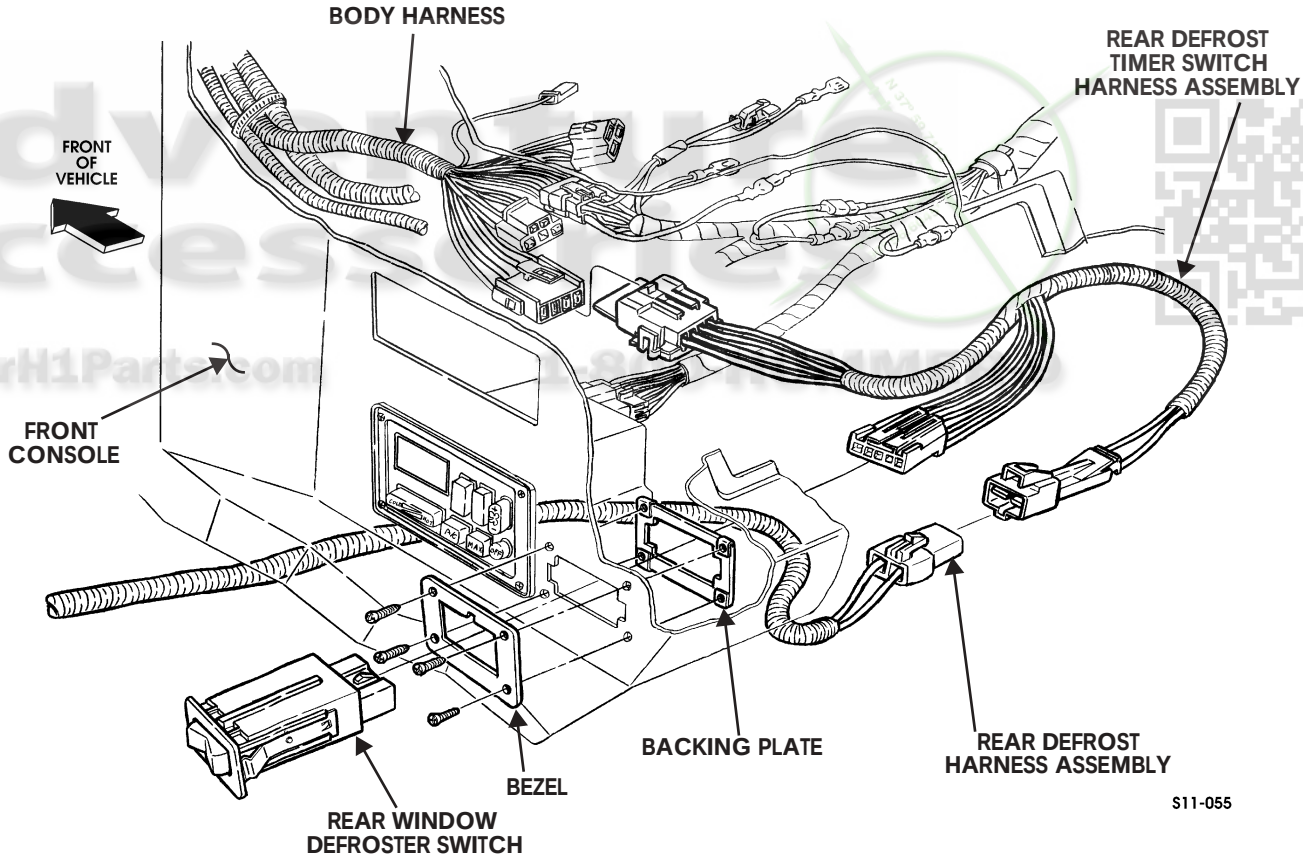


Figure 13-108: Rear Window Defroster Switch and Rear Defrost Timer Switch Harness

Rear Defrost Harness Replacement

Removal

1. Remove front console (Section 10).
2. Remove the front seats (Section 10).

NOTE: Steps 3 and 4 are for four passenger vehicles.

3. Remove center console (Section 10).
4. Remove rear seats (Section 10).
5. Remove rear wall trim (Section 10).
6. Remove trim from rear window (Section 10).
7. Remove carpeting and floor covering (Section 10).
8. Remove tape securing rear defrost harness to body (Figures 13-109, 13-110, 13-111, and 13-112).

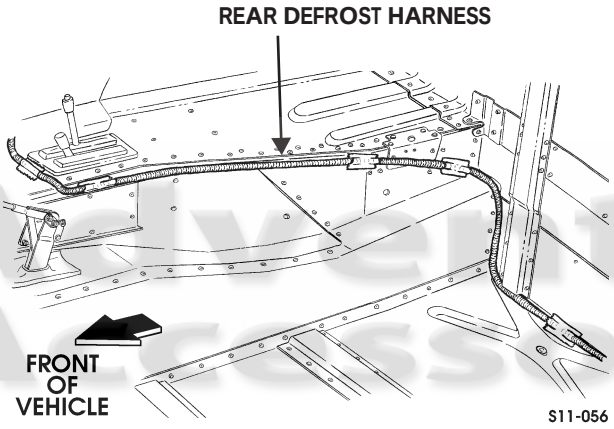


Figure 13-109: Rear Defrost Harness - Two Passenger Vehicle

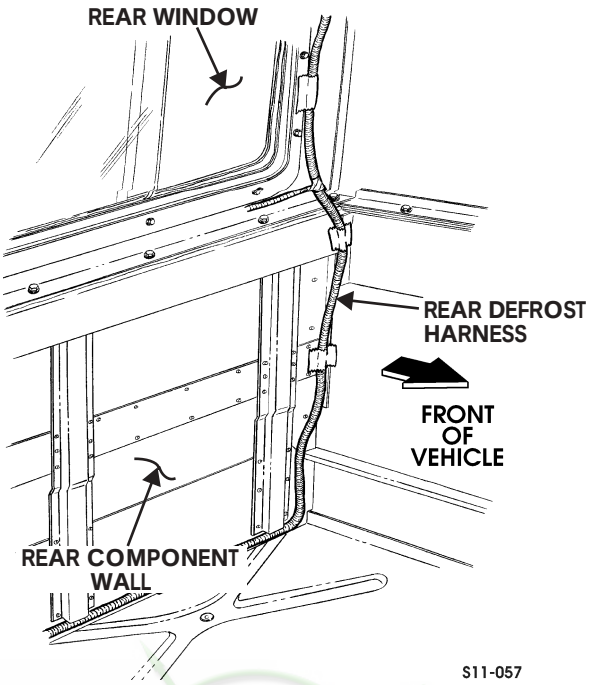


Figure 13-110: Rear Defrost Harness - Two Passenger Vehicle

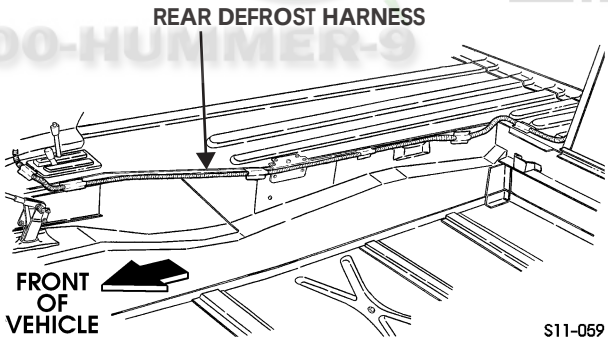


Figure 13-111: Rear Defrost Harness - Four Passenger Vehicle

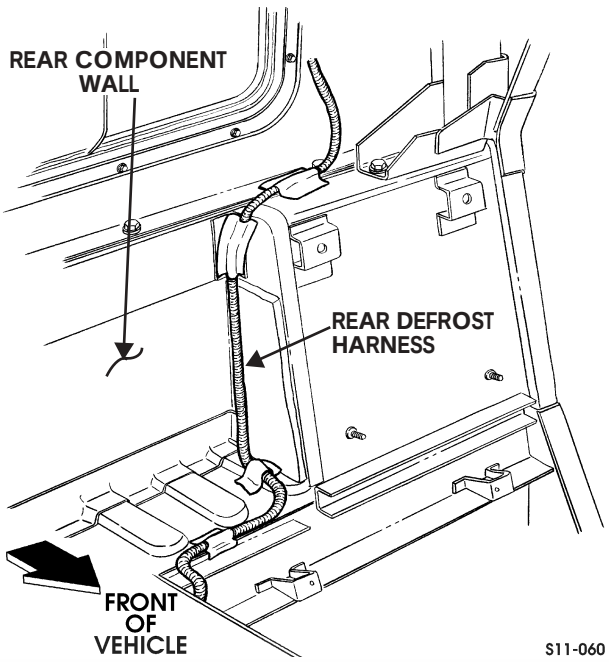


Figure 13-112: Rear Defrost Harness - Four Passenger Vehicle

9. Remove tape securing rear defrost harness around rear window and disconnect two harness connectors from rear window connectors (Figures 13-113, 13-114, and 13-115).

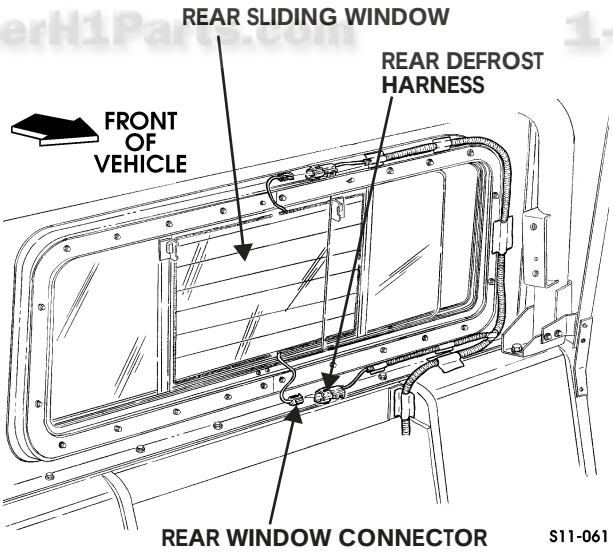


Figure 13-113: Four Passenger Vehicle with Sliding Windows

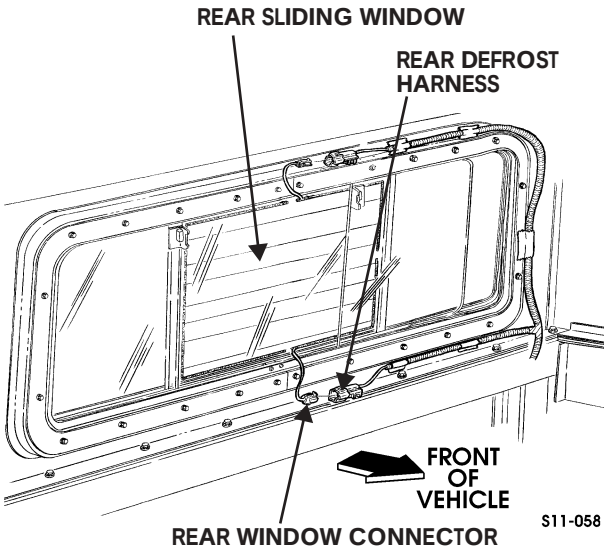


Figure 13-114: Two Passenger Vehicle with Sliding Windows

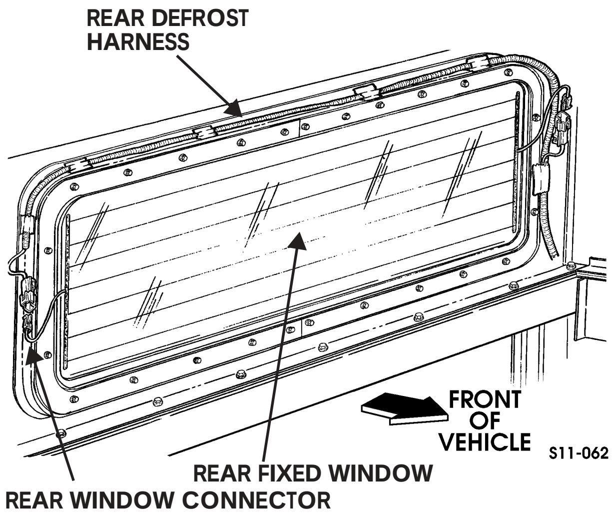


Figure 13-115: Fixed Window

Installation

1. Tape rear defrost harness around rear window and connect two harness connectors to rear window connectors (Figures 13-113, 13-114, and 13-115).
2. Secure rear defrost harness with tape to body (Figures 13-109, 13-110, 13-111, and 13-112)
3. Install the carpeting and floor covering (Section 10).
4. Install trim on rear window (Section 10).
5. Install trim on rear wall (Section 10).

NOTE: Steps 6 and 7 are for 4-passenger vehicles.

6. Install rear seats (Section 10).
7. Install center console (Section 10).
8. Install front seats (Section 10).
9. Install front console (Section 10).

COMPACT DISC (CD) CHANGER REPLACEMENT

Compact Disc Changer

Removal

1. Remove the four screw and washer assemblies securing the compact disc (CD) changer cover to the roof (Figure 13-116).
2. Disconnect the CD changer cable connector from the CD changer.
3. Remove four screws, flatwashers, lockwashers and CD changer from the roof.

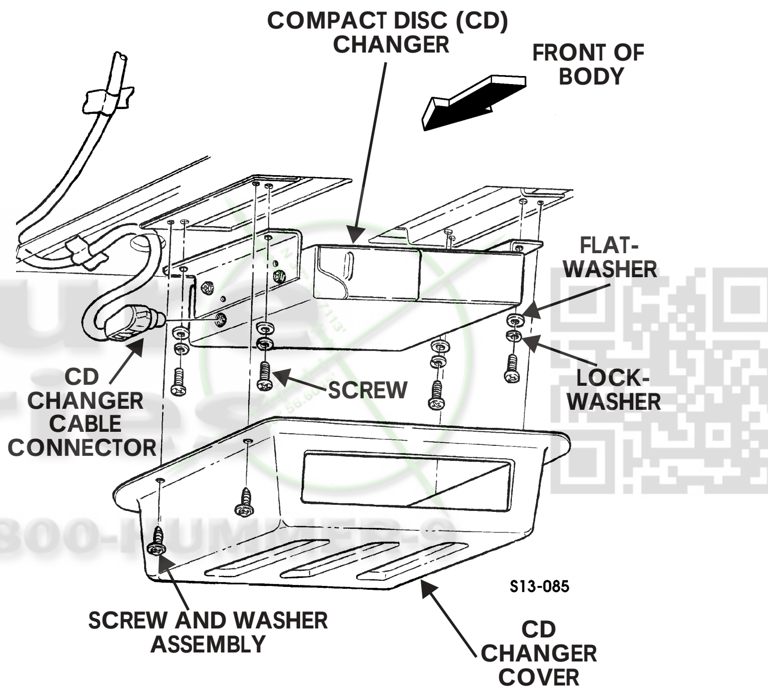


Figure 13-116: CD Changer

Installation

1. Secure CD changer to roof with four flatwashers, lock-washers, and screws (Figure 13-116).
2. Connect CD changer cable connector to the CD changer.
3. Secure CD changer cover to the roof with four screw and washer assemblies.

Compact Disc (CD) Changer Cable (Two-Door Vehicles)

Removal

1. Remove front console (Section 10).
2. Remove the seats (Section 10).
3. Remove the center console (Section 10).
4. Remove the rear wall trim (Section 10).
5. Remove the carpeting and floor covering (Section 10).
6. Remove compact disc changer from roof.
7. Remove the headliner (Section 10).
8. Disconnect the CD changer cable from the radio/compact disc player in the instrument panel (Figure 13-117).

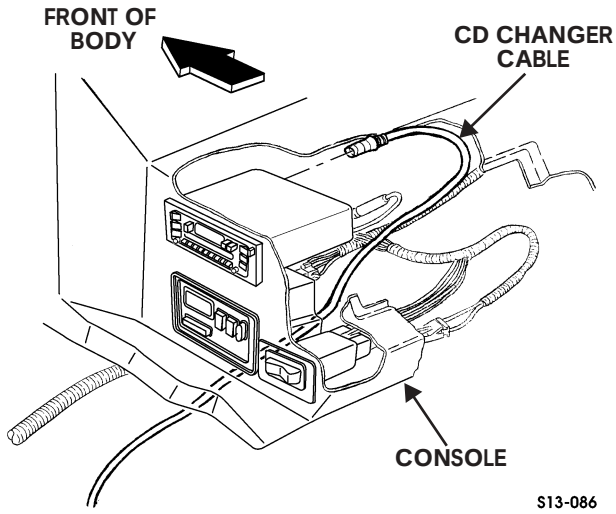


Figure 13-117: CD Changer Cable

9. Remove the tape securing the CD changer cable to the body (Figure 13-118).

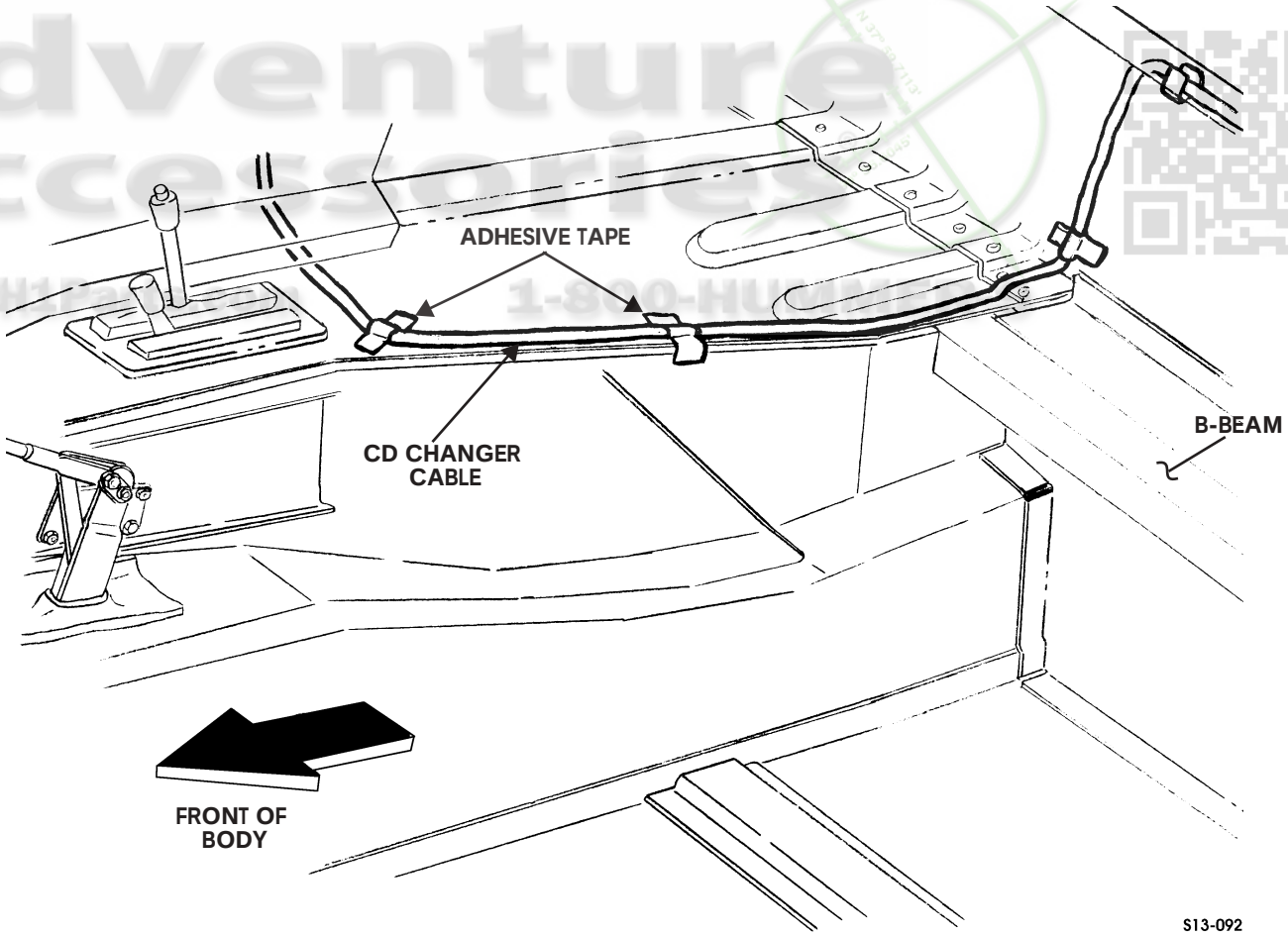


Figure 13-118: CD Changer Cable Routing - Standard Two-Door Vehicles

10. Remove tape securing the CD changer cable to the rear wall, B-pillar and roof ((Figures 13-112 and 13-119).

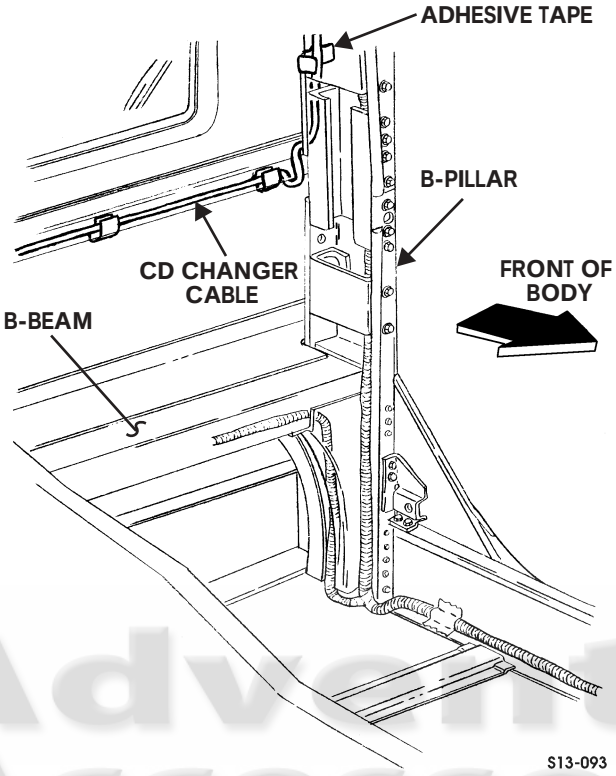


Figure 13-119: Cable Routing Along Rear Wall Standard Two-Door Vehicles

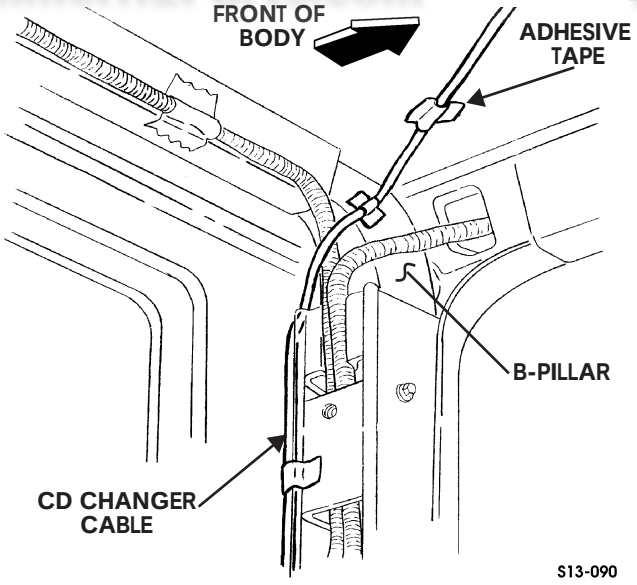


Figure 13-120: Cable Routing Along B-Pillar Standard Two-Door Vehicles

Installation

1. Connect the CD changer cable to the radio/compact disc player in the instrument panel (Figure 13-117).
2. Secure CD changer cable to the body with adhesive tape as shown (Figure 13-118).
3. Secure CD changer cable to roof, B-Pillar, and rear wall with adhesive tape as shown (Figures 13-119 and 13-120).
4. Install compact disc changer to roof.
5. Connect CD changer connector to CD changer.
6. Verify operation of the CD changer.
7. Install headliner (Section 10).
8. Install carpeting and floor covering (Section 10).
9. Install rear wall trim (Section 10).
10. Install the center console (Section 10).
11. Install the seats (Section 10).
12. Install front console (Section 10).

Compact Disc (CD) Changer Cable (Two-Door Extended Cab Vehicles)

Removal

1. Remove front console (Section 10).
2. Remove the seats (Section 10).
3. Remove the center console (Section 10).
4. Remove the rear wall trim (Section 10).
5. Remove the carpeting and floor covering (Section 10).
6. Remove the headliner (Section 10).
7. Disconnect the CD changer cable from the radio/compact disc player in the instrument panel (Figure 13-117).
8. Remove the tape securing the CD changer cable to the body (Figure 13-118).

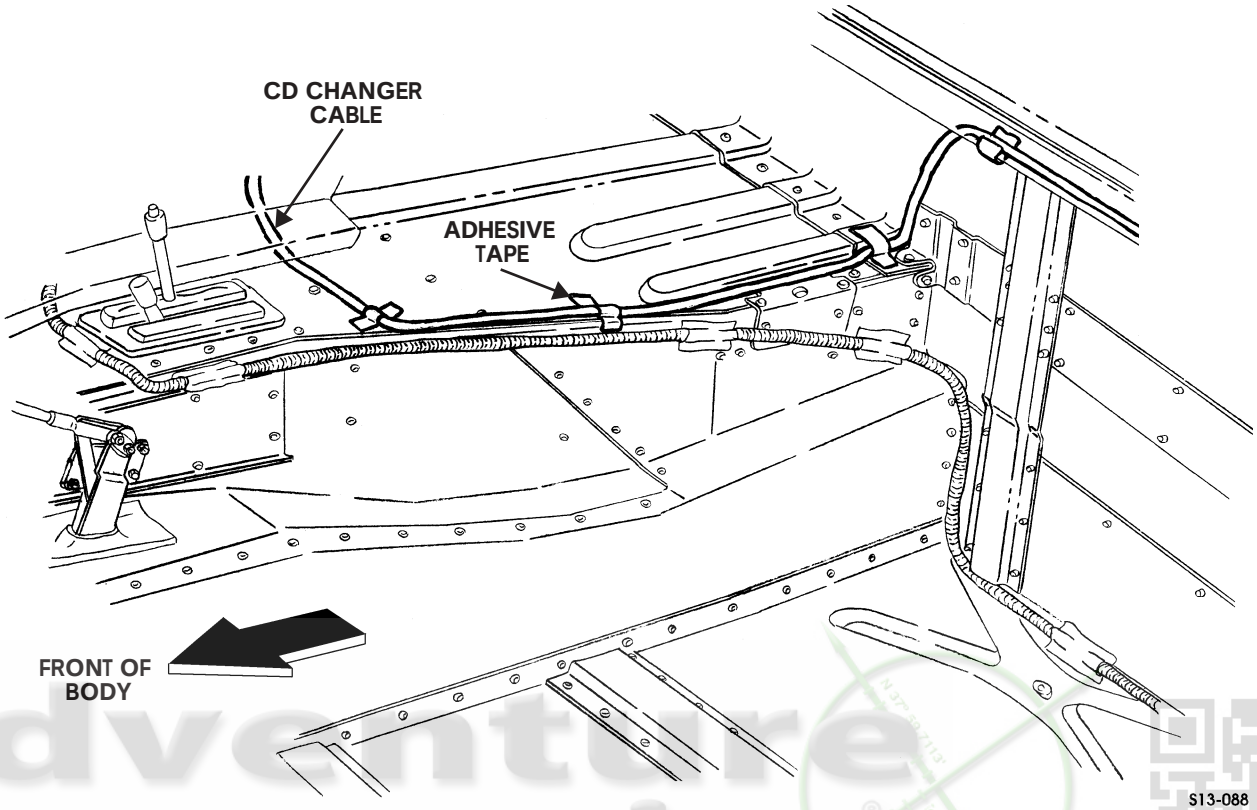


Figure 13-121: CD Changer Cable Routing -Two-Door Extended Cab Vehicles

9. Remove tape securing the CD changer cable to the rear wall, B-pillar and roof (Figures 13-122 and 13-123).

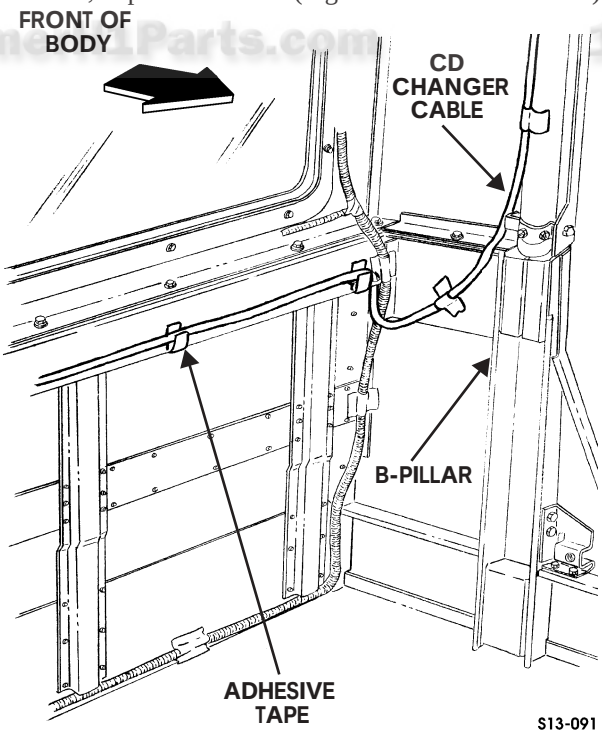


Figure 13-122: Cable Routing Along B-Pillar and Rear Wall - Two-Door Extended Cab Vehicles

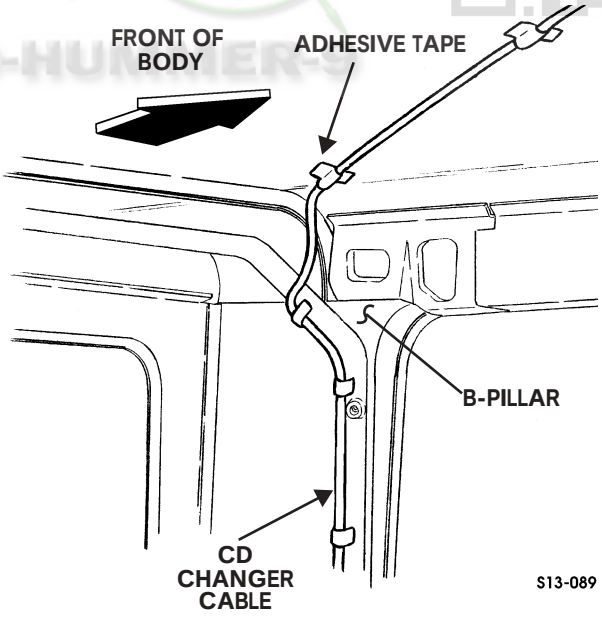


Figure 13-123: Cable Routing Along B-Pillar and Roof Two-Door Extended Cab Vehicles

Installation

1. Connect the CD changer cable to the radio/compact disc player in the instrument panel (Figure 13-117).
2. Secure CD changer cable to the body with adhesive tape (Figure 13-121).
3. Secure CD changer cable to roof, B-Pillar, and rear wall with adhesive tape (Figures 13-122 and 13-123).
4. Install compact disc changer to roof.
5. Connect CD changer connector to CD changer.
6. Verify operation of the CD changer.
7. Install carpeting and floor covering (Section 10).
8. Install rear wall trim (Section 10).
9. Install the center console (Section 10).
10. Install the seats (Section 10).
11. Install front console (Section 10).
12. Install headliner (Section 10).

Compact Disc (CD) Changer Cable (Standard Four-Door Vehicles)

Removal

1. Remove front console (Section 10).
2. Remove the seats (Section 10).
3. Remove the center console (Section 10).
4. Remove the rear wall trim (Section 10).
5. Remove the carpeting and floor covering (Section 10).
6. Remove the headliner (Section 10).
7. Disconnect the CD changer cable from the radio/compact disc player in the instrument panel (Figure 13-124).

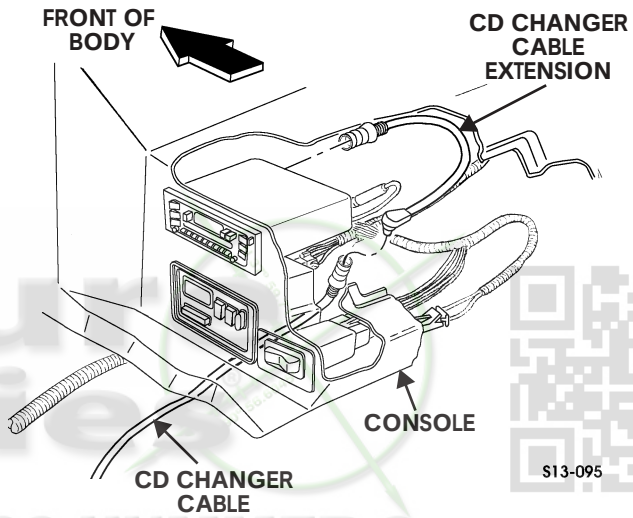


Figure 13-124: CD Changer Cable

8. Remove the tape securing the CD changer cable to the body (Figure 13-125).

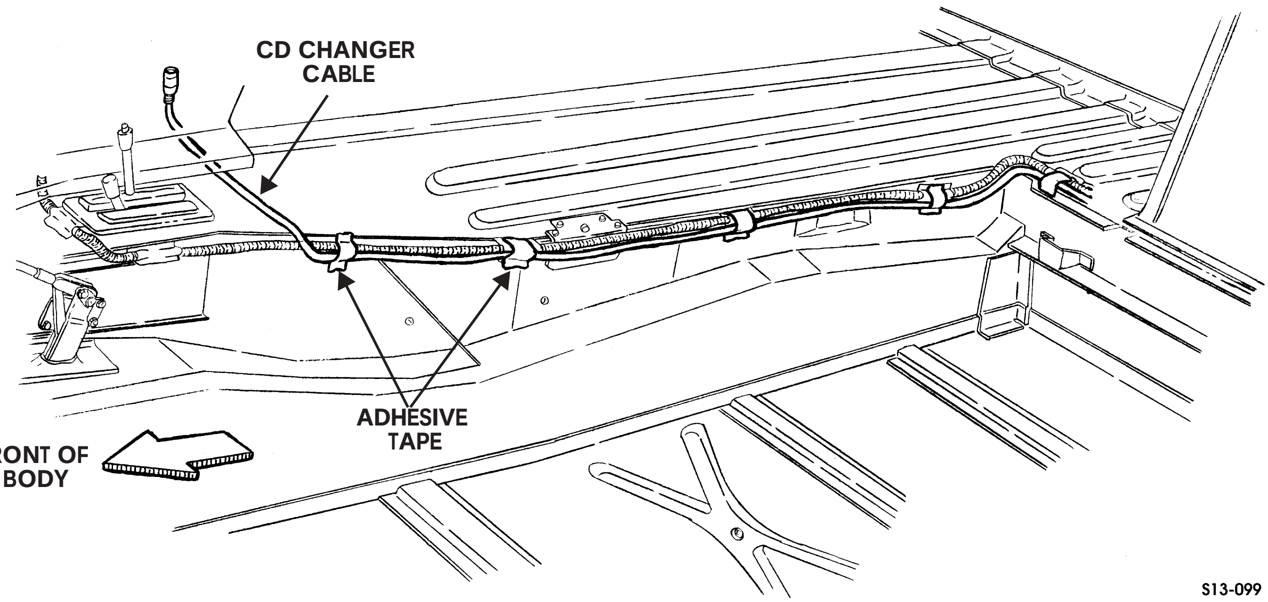


Figure 13-125: CD Changer Cable Routing - Four-Door and Station Wagon Vehicles

9. Remove tape securing the CD changer cable to the rear wall, B-pillar and roof (Figures 13-126, 13-127, and 13-128).

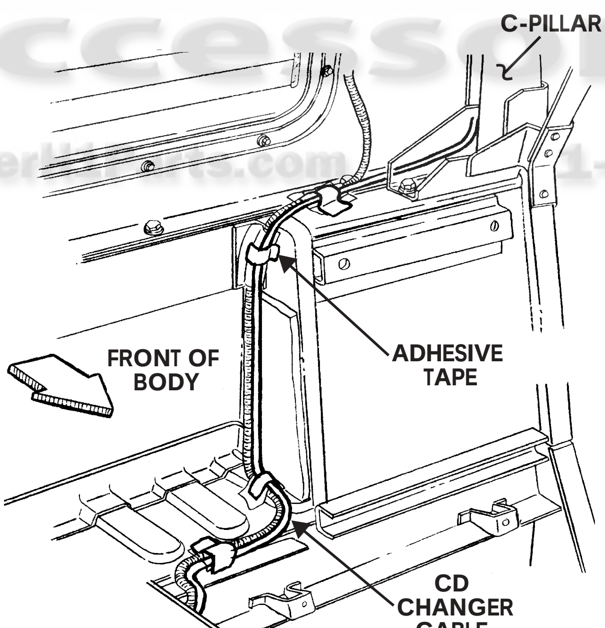


Figure 13-1 Cable Routing Along C-Pillar and Rear Wall - Standard Four-Door Vehicles

Figure 13-126: Cable Routing Along C-Pillar and Rear Wall - Standard Four-Door Vehicles

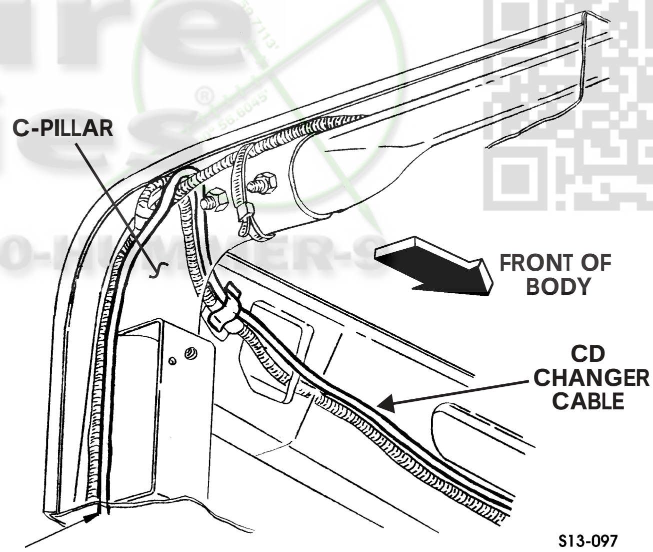


Figure 13-127: Cable Routing Along C-Pillar and Roof - Standard Four-Door Vehicles

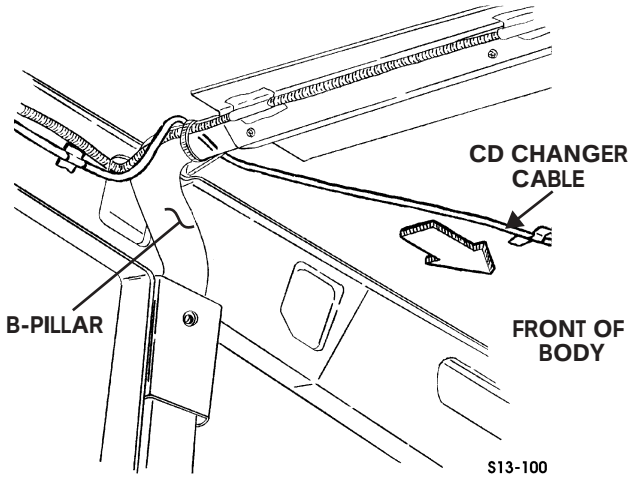


Figure 13-128: Cable Routing Along Roof Standard Four-Door Vehicles

Installation

1. Connect the CD changer cable to the radio/compact disc player in the instrument panel (Figure 13-124).
2. Secure CD changer cable to the body with adhesive tape as shown (Figure 13-125).
3. Secure CD changer cable to roof, B-Pillar, and rear wall with adhesive tape as shown (Figures 13-125, 13-126, 13-127, 13-128, 13-129, 13-130, and 13-131).
4. Install compact disc changer to roof.
5. Connect CD changer connector to CD changer.
6. Verify operation of CD changer.
7. Install carpeting and floor covering (Section 10).
8. Install rear wall trim (Section 10).
9. Install the center console (Section 10).
10. Install the seats (Section 10).
11. Install front console (Section 10).
12. Install headliner (Section 10).

Compact Disc (CD) Changer Cable (Four-Door Station Wagon Vehicles)

Removal

1. Remove front console (Section 10).
2. Remove the seats (Section 10).
3. Remove the center console (Section 10).
4. Remove the rear wall trim (Section 10).
5. Remove the carpeting and floor covering (Section 10).
6. Remove the headliner (Section 10).
7. Disconnect the CD changer cable from the radio/compact disc player in the instrument panel (Figure 13-124).
8. Remove the tape securing the CD changer cable to the body (Figure 13-125).
9. Remove tape securing the CD changer cable to the rear wall, C-pillar and roof (Figures 13-126 through 13-131).

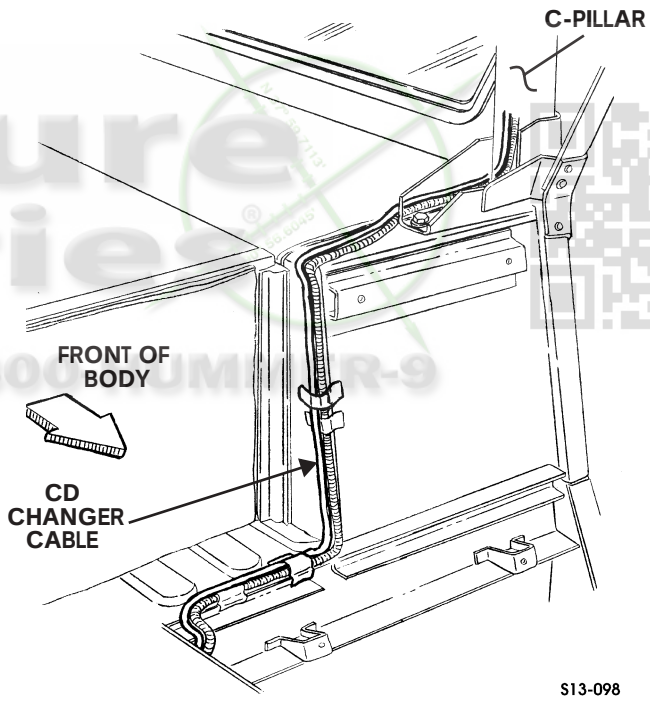


Figure 13-129: Cable Routing Along C-Pillar and Rear Wall - Four-Door Station Wagon Vehicles

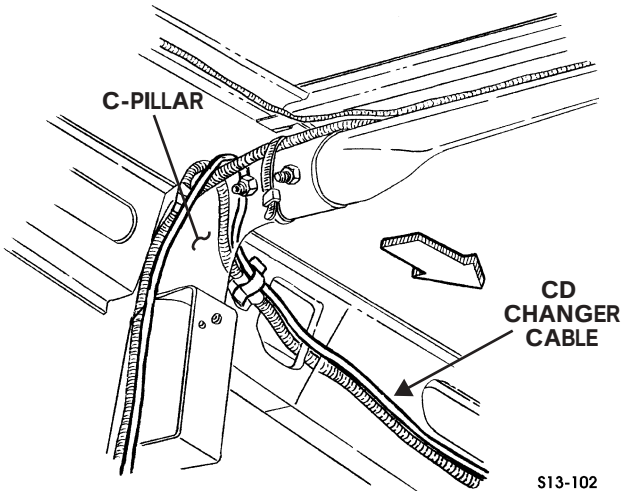


Figure 13-130: Cable Routing Along C-Pillar and Headliner - Four-Door Station Wagon Vehicles

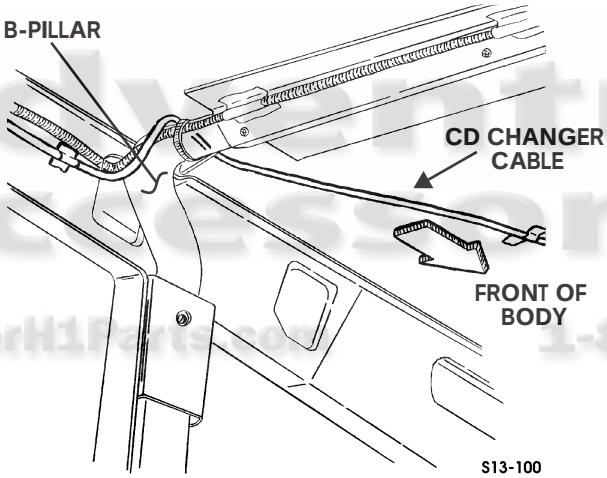


Figure 13-131: Cable Routing Along Roof Four-Door Station Wagon Vehicles

Installation

1. Connect the CD changer cable to the radio/compact disc player in the instrument panel (Figure 13-124).
2. Secure CD changer cable to the body with adhesive tape as shown (Figure 13-125).
3. Secure CD changer cable to roof, B-Pillar, and rear wall with adhesive tape as shown (Figures 13-126 through 13-128).
4. Install compact disc changer to roof.
5. Connect CD changer connector to CD changer.
6. Verify operation of the CD changer.
7. Install headliner (Section 10).
8. Install carpeting and floor covering (Section 10).
9. Install rear wall trim (Section 10).
10. Install the center console (Section 10).
11. Install the seats (Section 10).
12. Install front console (Section 10).

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