

Engine Cooling

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Coolant Crossover Housing to Cylinder Head Bolt or Stud (Diesel Engine)	42 N·m	31 lb ft
Coolant Outlet to Crossover Housing Bolt or Stud (Diesel Engine)	42 N·m	31 lb ft
Coolant Outlet to Intake Manifold Bolt or Stud (4.3L, 5.0L and 5.7L Engines)	28 N·m	21 lb ft
Coolant Outlet to Intake Manifold Bolt or Stud (7.4L Engine)	37 N·m	27 lb ft
Coolant Recovery Reservoir Bolts	10 N·m	89 lb in
Coolant Temperature Sensor	23 N·m	17 lb ft
Drive Belt Tensioner Bolt	50 N·m	37 lb ft
Engine Oil Cooler Line Bracket Bolt	9 N·m	71 lb in
Engine Oil Cooler Line Clamp Nut	13 N·m	115 lb in
Engine Oil Cooler Line Clip Bolt	6 N·m	53 lb in
Engine Oil Cooler Line Fittings	24 N·m	18 lb ft
Fan Clutch Nut to Water Pump Stud (4.3L, 5.0L, and 5.7L Engines)	56 N·m	41 lb ft
Fan Clutch Nut to Water Pump Stud (6.5L Engine)	120 N·m	162 lb ft
Fan Clutch to Water Pump Stud Nuts	24 N·m	18 lb ft
Fan to Fan Clutch Bolts and Nuts (7.4L Engine)	24 N·m	18 lb ft
Fan to Fan Clutch Bolts (4.3L, 5.0L, 5.7L and 6.5L Engines)	23 N·m	17 lb ft
Hose Support Bolt (5.7L Engine)	15 N·m	11 lb ft
Idler Pulley Bolt	50 N·m	37 lb ft
Lower Fan Shroud Bolts	9 N·m	71 lb in
Radiator Hose Clamps (Diesel Engine)	3 N·m	27 lb in
Radiator Inlet Hose Support Bolt (5.7L and 7.4L Engines)	3 N·m	27 lb in
Radiator Inlet Hose Support Bolt (Diesel Engine)	9 N·m	71 lb in
Upper Fan Shroud Bolts	9 N·m	71 lb in
Water Pump Bolts (Gasoline Engine)	41 N·m	30 lb ft
Water Pump Plate to Block Bolts (Diesel Engine)	23 N·m	17 lb ft
Water Pump Plate to Block Studs (Diesel Engine)	23 N·m	17 lb ft
Water Pump Plate to Water Pump Bolt (Diesel Engine)	23 N·m	17 lb ft
Water Pump to Block Bolts (Diesel Engine)	23 N·m	17 lb ft
Water Pump to Block Bolts (Diesel Engine)	42 N·m	31 lb ft
Water Pump to Block Stud (Diesel Engine)	42 N·m	31 lb ft

GM SPO Group Numbers

Application	GM SPO Group Number
Coolant Radiator	1.219
Coolant Recovery Reservoir	1.240
Coolant Recovery Reservoir Cap	1.240
Engine Coolant Thermostat	1.246
Engine Coolant Thermostat Housing	1.251
Engine Coolant Thermostat Housing Gasket	1.252
Engine Oil Cooler Line Inlet and Outlet Hoses	1.540
Fan and Coolant Pump Pulley Hub	1.062

GM SPO Group Numbers (cont'd)

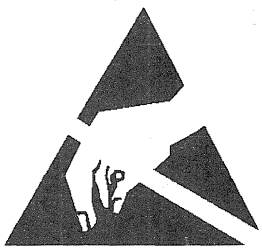
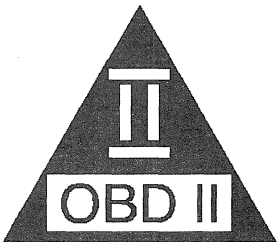
Application	GM SPO Group Number
Fan Blade	1.064
Fan Blade Clutch	1.050
Radiator Drain Cock	8.951
Radiator Fan Upper Shroud	1.277
Radiator Filler Cap	1.203
Radiator Inlet Hose	1.159
Radiator Inlet Tank	1.219
Radiator Lower Fan Shroud	1.277
Radiator Lower Insulator	1.270
Radiator Outlet Hose	1.173
Radiator Outlet Tank	1.219
Radiator Surge Tank Outlet Hose	1.240
Radiator Upper Bracket	1.270
Radiator Upper Insulator	1.270
Thermostat Bypass Hose	1.097
Coolant Pump Kit	1.069
Coolant Outlet	1.153

Schematic and Routing Diagrams

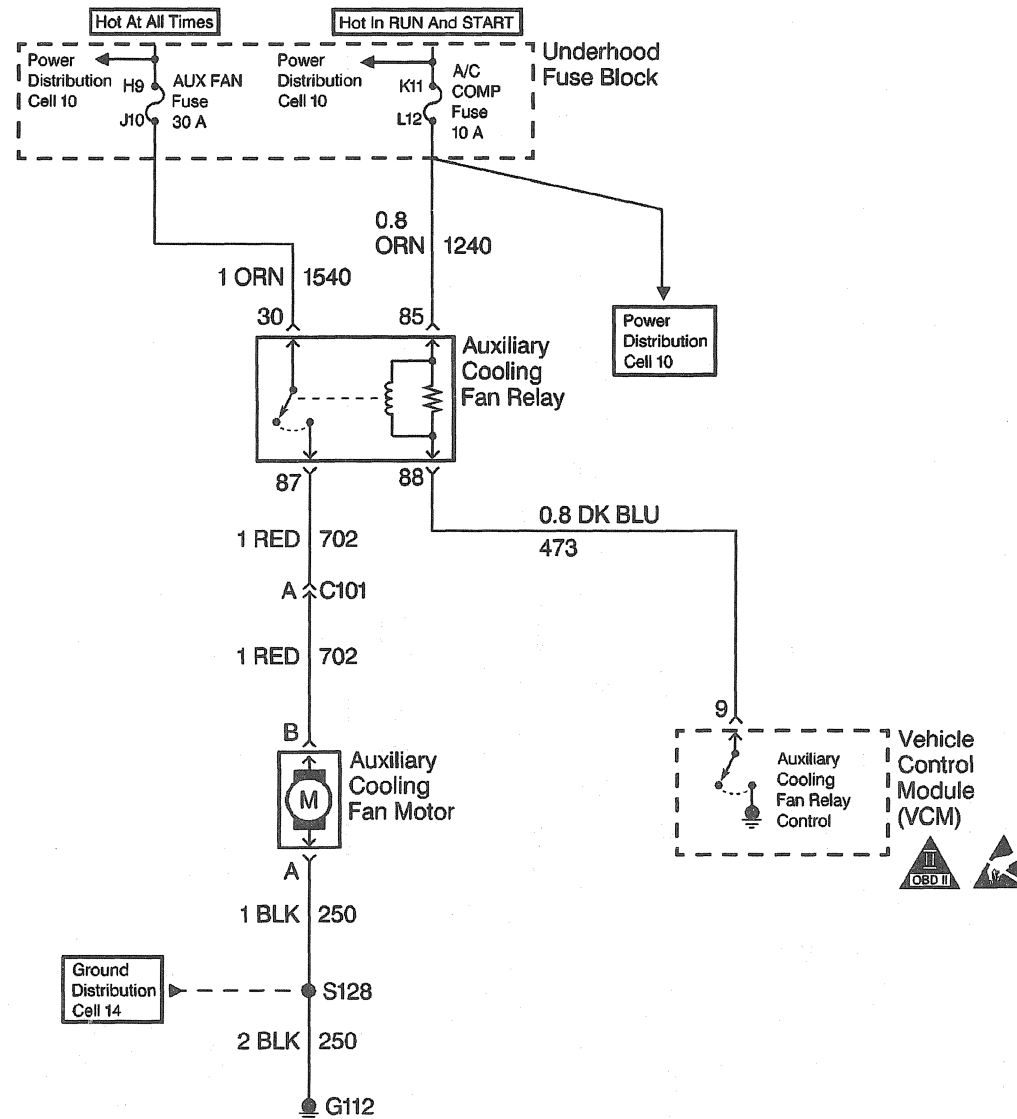
Cooling System Schematic References

Reference on Schematic	Section Number - Subsection Name
Ground Distribution - Cell 14	8-Wiring Systems
Power Distribution - Cell 10	8-Wiring Systems

Cooling System Schematic Icons

Icon	Icon Definition
 19384	Refer to <i>ESD Notice</i> in Cautions and Notices.
 19385	Refer to <i>OBD II Symbol Description Notice</i> in Cautions and Notices.

Cooling Fan Schematics (AUX FAN and A/C COMP Fuses, Auxiliary Cooling Fan Relay, Auxiliary Fan Motor)



LOC

DESC



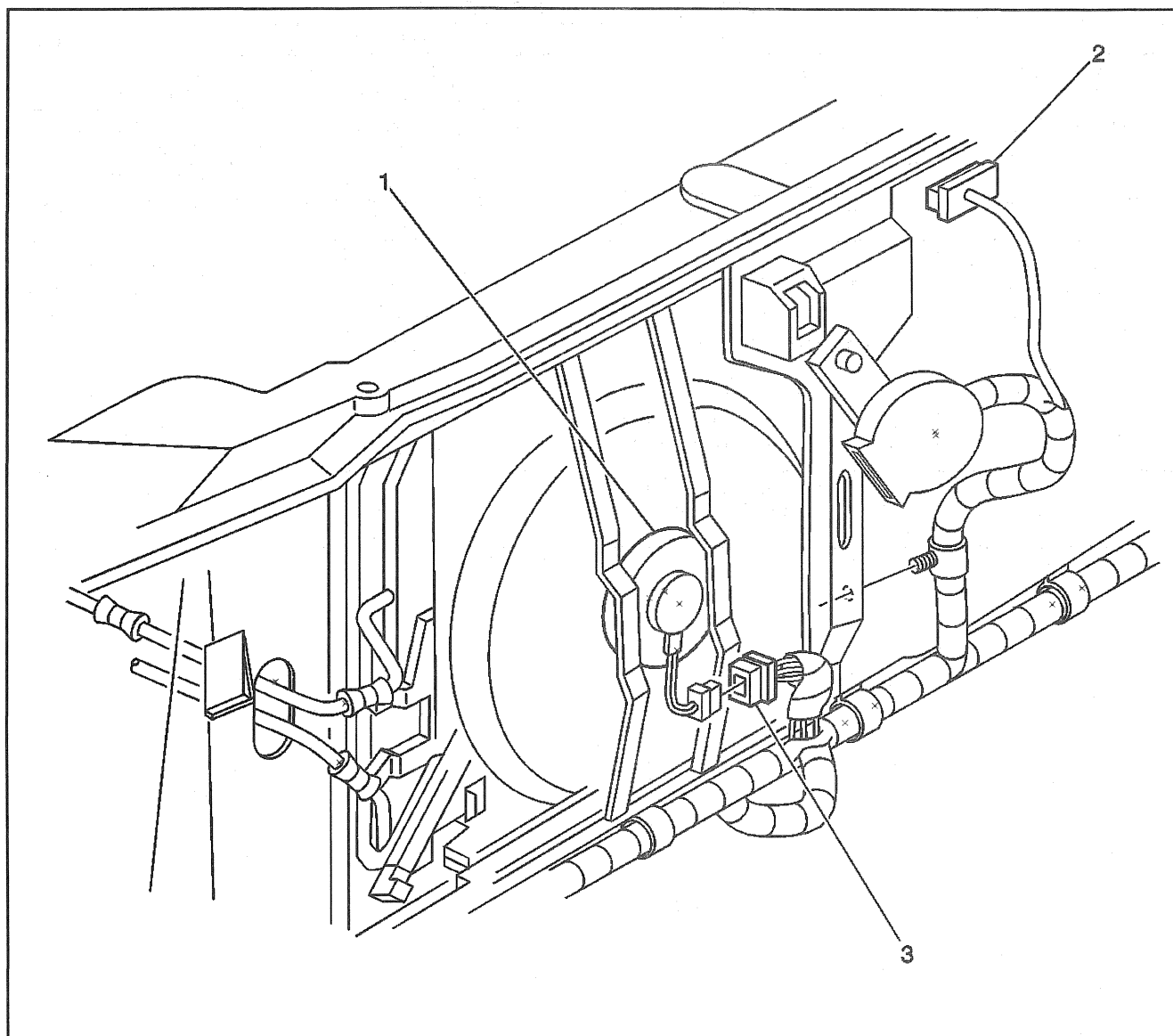
Component Locator

Cooling System Components

Name	Location	Locator View	Connector End View
Auxiliary Cooling Fan Motor	RH of Engine Compartment, front of Radiator	<i>Cooling System Component Views</i>	<i>Cooling System Connector End Views</i>
Auxiliary Cooling Fan Relay	LH of Engine Compartment	<i>Cooling System Component Views</i>	<i>Cooling System Connector End Views</i>
Underhood Fuse Block	In the left rear side of the engine compartment, on the fender	<i>Power and Grounding Components in Wiring Systems</i>	<i>Power and Grounding Connector End Views in Wiring Systems</i>
Vehicle Control Module (VCM) (Gas)	Engine Compartment, near EBCM	<i>Engine Controls Component Views in Engine Controls</i>	<i>VCM Connector End Views in Engine Controls</i>
C101	Engine harness, inline to Forward Lamp harness	<i>Harness Routing Views in Wiring Systems</i>	<i>Inline Harness Connector End Views in Wiring Systems</i>
G112	In the right front side of the engine compartment, at the wheelhousing	<i>Power and Grounding Component Views in Wiring Systems</i>	—
S128	Forward lamps harness, approx. 5 cm (2 in) from RH headlamp breakout, toward G112	—	—

Cooling System Component Views

Auxiliary Cooling Fan



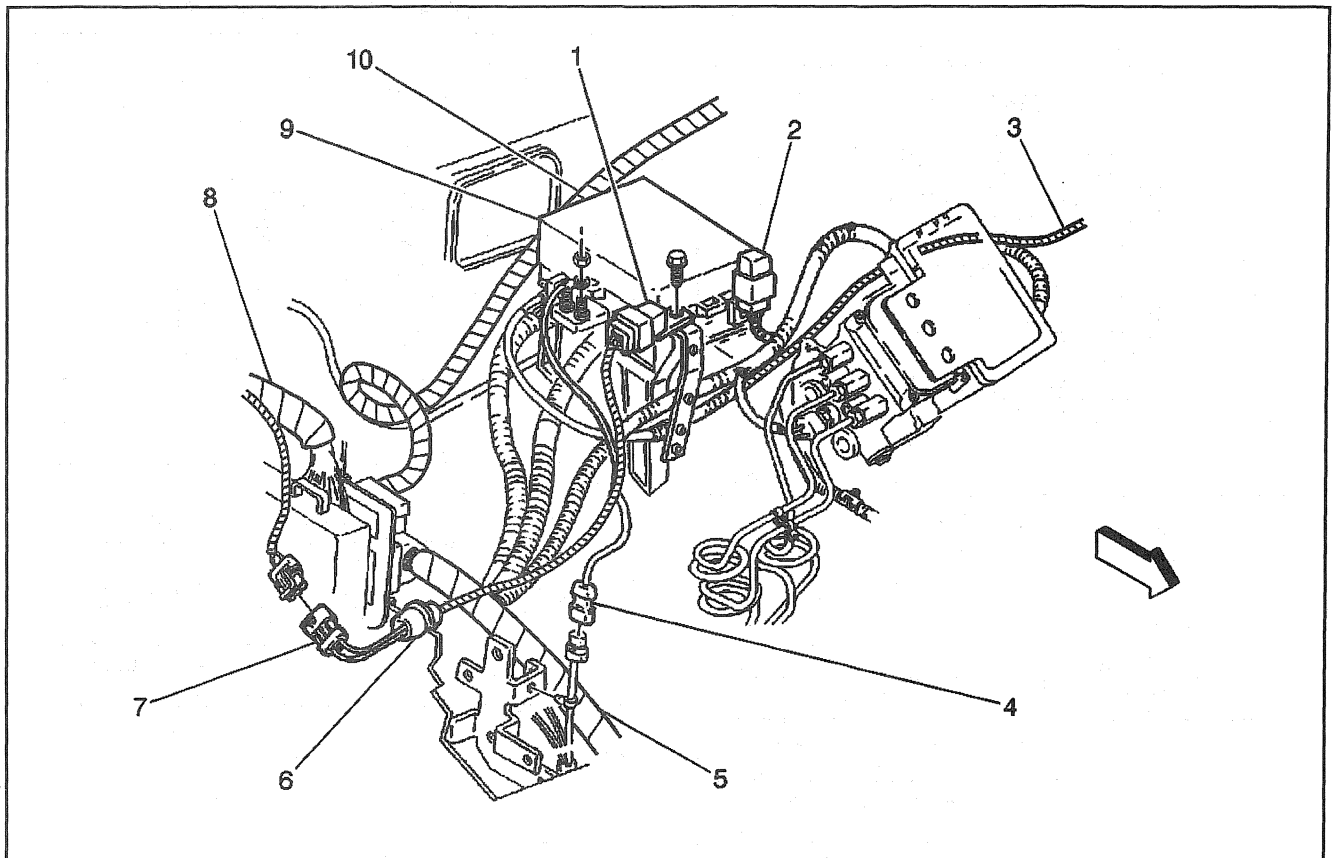
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Legend

- (1) Auxiliary Cooling Fan Motor
- (2) Map Sensor

- (3) Auxiliary Cooling Fan Motor Connector

Underhood Fuse Block, EBCM and Wiring



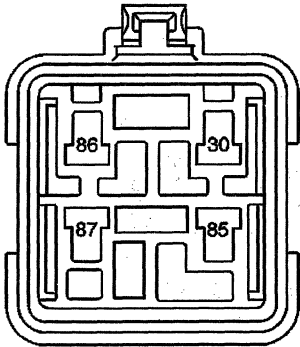
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Legend

- | | |
|----------------------------------|---------------------------|
| (1) Auxiliary Roof Lamp Relay | (6) P100 |
| (2) Auxiliary Cooling Fan Relay | (7) C238 |
| (3) Battery Positive Lead | (8) IP Harness |
| (4) Wheel Speed Sensor Connector | (9) Underhood Fuse Block |
| (5) Engine Harness | (10) Forward Lamp Harness |

Cooling System Connector End Views

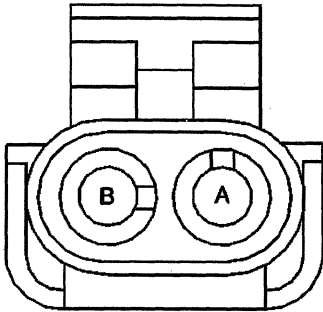
Auxiliary Fan Relay



306493

Connector Part Information		<ul style="list-style-type: none"> • 12129716 • CONN 4F M/P 280 FLXLK SLD (GRY) 	
Pin	Wire Color	Circuit No.	Function
30	ORN	1540	Fuse Output - Ignition 1 - Type III Fuse
85	ORN	1240	Fuse Output - Battery - Type III Fuse
86	ORN/BLK	473	TCS Signal - Torque Desire
87	RED	702	Fuse Output - Battery - Type 1 Fuse

Auxiliary Coolant Fan Motor



82413

Connector Part Information		<ul style="list-style-type: none"> • 12015792 • 2F W/P TWR (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	BLK	250	Ground
B	RED	702	Fuse Output - Battery Type I Fuse

Diagnostic Information and Procedures

Cooling Fan Inoperative - Auxiliary

Step	Action	Value(s)	Yes	No
1	1. Disconnect the auxiliary cooling fan relay. 2. Connect a test lamp between the auxiliary cooling fan relay connector cavity 30 to ground. Does the test lamp light?	—	Go to Step 2	Go to Step 8
2	1. Turn the ignition switch to the Run position. 2. Connect a test lamp between the auxiliary fan relay connector cavity 85 to ground. Does the test lamp light?	—	Go to Step 3	Go to Step 9
3	Connect a fused jumper between the auxiliary cooling fan relay connector cavities 30/87. Does the auxiliary cooling fan motor run?	—	Go to Step 5	Go to Step 4
4	Connect a test lamp between the auxiliary cooling fan motor connector cavity A and B+. Does the test lamp light?	—	Go to Step 10	Go to Step 11
5	1. Turn the ignition switch to the Off position. 2. Disconnect all the vehicle control module (VCM) connectors. 3. Connect a digital multimeter (DMM) between the VCM connector C4 terminal 9 and the auxiliary cooling fan relay connector cavity 86. Is there continuity?	—	Go to Step 6	Go to Step 12

Cooling Fan Inoperative - Auxiliary (cont'd)

Step	Action	Value(s)	Yes	No
6	1. Re-Connect the auxiliary cooling fan relay. 2. Move the ignition switch to the Run position. 3. Connect a fused jumper between the VCM connector C4 terminal 9 and ground. Does the auxiliary cooling fan motor run?	—	Go to Step 7	Go to Step 13
7	1. Leave the ignition switch in the Run position. 2. Place the recirculation button on the HVAC control panel to the On position. 3. Connect a test lamp between the VCM connector C4 terminal 7 and B+. Does the test lamp light?	—	System OK	Go to Step 14
8	Repair the open in the CKT 1540 (ORN) wire between the underhood fuse block and the auxiliary cooling fan relay. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	System OK	—
9	Repair open in CKT 1240 (ORN) wire between the underhood fuse block and the auxiliary power center. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	System OK	—
10	Inspect for an open in CKT 702 (RED) wire between the auxiliary cooling fan relay and the auxiliary cooling fan motor. Refer to <i>Wiring Repairs</i> . If OK, replace the auxiliary cooling fan motor. Refer to <i>Cooling Fan and Motor Replacement - Auxiliary</i> . Is the repair complete?	—	System OK	—
11	Repair open in CKT 250 (BLK) wire between the auxiliary cooling fan motor and G 112. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	System OK	—
12	Repair open in CKT 473 (DK BLU) wire between the VCM and the auxiliary cooling fan relay. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	System OK	—
13	Replace the auxiliary cooling fan relay. Refer to <i>Cooling Fan Relay Replacement - Auxiliary</i> . Is the repair complete?	—	System OK	—
14	Inspect for an open in CKT 1614 (DK GRN) wire between the VCM and the heater and A/C control module. Refer to <i>Wiring Repairs</i> . If OK, Replace the heater and A/C control module. Refer to <i>Control Assembly Replacement</i> . Is the repair complete?	—	System OK	—

Cooling Fan Runs Continuously - Auxiliary

Step	Action	Value(s)	Yes	No
1	Disconnect the auxiliary cooling fan relay. Does the auxiliary cooling fan motor stop?	—	Go to Step 2	Go to Step 4
2	1. Ensure that the ignition switch is in the Off position. 2. Disconnect all the vehicle control module (VCM) connectors. 3. Connect a test lamp between connector C4 terminal 9 and B+. Does the test lamp light?	—	Go to Step 5	Go to Step 3

Cooling Fan Runs Continuously - Auxiliary (cont'd)

Step	Action	Value(s)	Yes	No
3	1. Ensure that the recirculation button in the heater and A/C control module is out or in the Off position. 2. Connect a test lamp between VCM connector C4 terminal 7 and B+. Does the test lamp light?	—	Go to Step 6	Go to Step 7
4	Repair short to voltage in CKT 702 (RED) wire between auxiliary cooling fan relay and auxiliary cooling fan motor. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	System OK	—
5	Repair short to ground in CKT 473 (DK BLU) wire between auxiliary cooling fan relay and VCM. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	System OK	—
6	Repair short to ground in CKT 1614 (DK GRN) wire between the VCM and the heater and A/C control module. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	System OK	—
7	Replace auxiliary cooling fan relay. Refer to <i>Cooling Fan Relay Replacement - Auxiliary</i> . Is the repair complete?	—	System OK	—

Engine Overheating

Step	Action	Value(s)	Yes	No
1	Check for a loss of system pressure. Refer to <i>Cooling System Leak Testing (Radiator Leak Test)</i> . Is there a loss of system pressure?	—	Go to Step 2	Go to Step 3
2	Inspect and repair any faulty hose connections. Does the engine still overheat?	—	Go to Step 3	System OK
3	Check for low coolant protection (-37°C/-34°F). Refer to <i>Coolant Concentration Testing</i> . Is there low coolant protection (-37°C/-34°F)?	—	Go to Step 4	Go to Step 5
4	Replace the coolant. Refer to <i>Draining and Filling Cooling System</i> . Does the engine still overheat?	—	Go to Step 5	System OK
5	Check the drive belt for excessive wear or low tension. Is the drive belt worn or is the tension too low?	—	Go to Step 6	Go to Step 7
6	Replace the drive belt. Refer to the appropriate procedure: • <i>Drive Belt Replacement</i> in Engine Mechanical - 4.3L • <i>Drive Belt Replacement</i> in Engine Mechanical - 5.0L, 5.7L • <i>Drive Belt Replacement (6.5L Drive Belt)</i> in Engine Mechanical - 6.5L • <i>Drive Belt Replacement</i> in Engine Mechanical - 7.4L Does the engine still overheat?	—	Go to Step 7	System OK
7	Check the water pump. Is the water pump inoperative?	—	Go to Step 8	Go to Step 9
8	Replace the water pump. Does the engine still overheat?	—	Go to Step 9	System OK
9	Check the radiator fins for obstruction. Are the radiator fins obstructed?	—	Go to Step 10	Go to Step 11
10	Inspect and clean the radiator. Does the engine still overheat?	—	Go to Step 11	System OK

Engine Overheating (cont'd)

Step	Action	Value(s)	Yes	No
11	Check the cooling system passage for obstruction. Is the cooling system passage blocked?	—	Go to Step 12	Go to Step 13
12	Inspect and flush the system. Refer to <i>Flushing</i> . Does the engine still overheat?	—	Go to Step 13	System OK
13	Check the fan clutch, refer to <i>Fan Clutch Diagnosis</i> . Is the fan clutch inoperative?	—	Go to Step 14	Go to Step 15
14	Replace the fan clutch. For the 4.3L, 5.0L, 5.7L and 6.5L engines, refer to <i>Fan Clutch Replacement (4.3L, 5.0L and 5.7L)</i> . For the 7.4L engine, refer to <i>Fan Clutch Replacement (7.4L)</i> . Does the engine still overheat?	—	Go to Step 15	System OK
15	Check for a stuck thermostat, refer to <i>Thermostat Diagnosis (On-Vehicle)</i> . Is the thermostat stuck in the closed position?	—	Go to Step 16	Go to Step 17
16	Replace the thermostat. • For gasoline engines, refer to <i>Thermostat Replacement (Gasoline Engines)</i> . • For diesel engines, refer to <i>Thermostat Replacement (Diesel Engines)</i> . Does the engine still overheat?	—	Go to Step 17	System OK
17	Other factors, such as the following, may be causing the engine to overheat: • A heavy vehicle payload • The A/C system • Excess engine oil • Restricted air flow through the radiator • Extreme air temperature Correct or repair as necessary. Does the engine still overheat?	System OK	—	—

Loss of Coolant

Step	Action	Value	Yes	No
1	1. Make a visual check of the cooling system. 2. Check the ground under the vehicle. Is there coolant visible on the ground?	—	Go to Step 3	Go to Step 2
2	Inspect the cooling system for proper pressure retention. Does the cooling system maintain the correct pressure?	—	Go to Step 13	Go to Step 3
3	Check for a leaking radiator. Does the radiator leak?	—	Go to Step 4	Go to Step 5
4	Repair or replace the radiator. Refer to <i>Radiator Replacement</i> . Is there still a loss of coolant?	—	Go to Step 5	System OK
5	Check for a leaking coolant recovery reservoir or surge tank. Is there a leak in the reservoir or surge tank?	—	Go to Step 6	Go to Step 7
6	Replace the coolant recovery reservoir or surge tank. 1. For gasoline engine, refer to <i>Coolant Recovery Reservoir Replacement</i> . 2. For diesel engines, refer to <i>Surge Tank (Diesel) Replacement</i> . Is there still a loss of coolant?	—	Go to Step 7	System OK

Loss of Coolant (cont'd)

Step	Action	Value	Yes	No
7	Check for any loose or damaged radiator hoses or connections. Are any radiator hoses or hose connections damaged?	—	Go to Step 8	Go to Step 9
8	1. Reseat the clamps and hoses. 2. If necessary replace the hoses and the clamps. • For the 4.3L and 5.0L engines, refer to <i>Radiator Hose Replacement (4.3L and 5.0L)</i> . • For the 5.7L engine, refer to <i>Radiator Hose Replacement (5.7 L)</i> . • For the 7.4L engine, refer to <i>Radiator Hose Replacement (7.4 L)</i> . • For the 6.5L engine, refer to <i>Radiator Hose Replacement (6.5 L)</i> . Is there still a loss of coolant?	—	Go to Step 9	System OK
9	Check for a water pump gasket leak. Is there a leak at the water pump gasket?	—	Go to Step 10	Go to Step 11
10	Replace the water pump gasket. • For gasoline engines, refer to <i>Water Pump Replacement (Gasoline Engines)</i> . • For the diesel engine, refer to <i>Water Pump Replacement (Diesel Engines)</i> . Is there still a loss of coolant?	—	Go to Step 11	System OK
11	Check for a water pump seal leak. Is there a leak at the water pump seal?	—	Go to Step 12	Go to Step 13
12	Replace the water pump. • For gasoline engines, refer to <i>Water Pump Replacement (Gasoline Engines)</i> . • For the diesel engine, refer to <i>Water Pump Replacement (Diesel Engines)</i> . Is there still a loss of coolant?	—	Go to Step 13	System OK
13	Check the radiator filler cap. Refer to <i>Pressure Cap Description</i> . Is the radiator filler cap damaged?	—	Go to Step 14	Go to Step 15
14	Replace the radiator filler cap. Is there still a loss of coolant?	—	Go to Step 15	System OK
15	Check cylinder head gasket for leaks. Refer to <i>Cooling System Leak Testing (Exhaust Gas Leak Test)</i> . Is the cylinder head gasket leaking?	—	Go to Step 16	Go to Step 16
16	Replace the cylinder head gasket. Refer to the appropriate procedure: • <i>Cylinder Head Replacement (Left Side)</i> in Engine Mechanical - 4.3L • <i>Cylinder Head Replacement (Right Side)</i> in Engine Mechanical - 4.3L • <i>Cylinder Head Replacement</i> in Engine Mechanical - 5.0L, 5.7L • <i>Cylinder Head Replacement</i> in Engine Mechanical - 6.5L • <i>Cylinder Head Replacement</i> in Engine Mechanical - 7.4L Is there still a loss of coolant?	—	Go to Step 17	System OK
17	Inspect the cylinder head and cylinder block. Is the cylinder head or cylinder block cracked?	—	Go to Step 18	Go to Step 19

Loss of Coolant (cont'd)

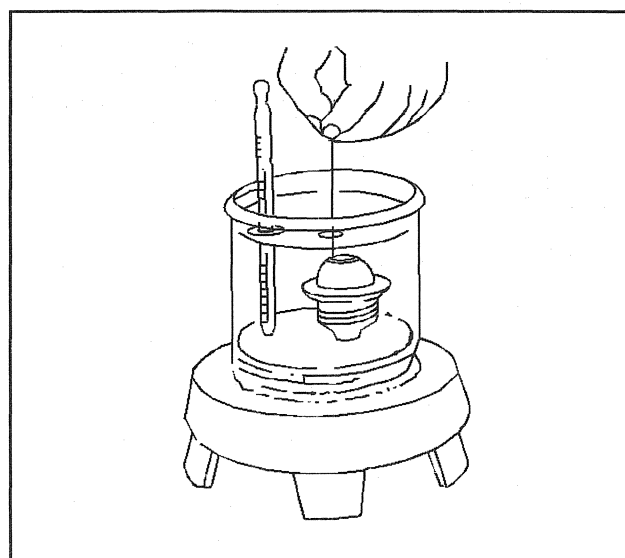
Step	Action	Value	Yes	No
18	Replace or resurface the cylinder head or cylinder block as necessary. Refer to the appropriate procedure: <ul style="list-style-type: none"> • <i>Cylinder Boring and Honing</i> in Engine Mechanical • <i>Cylinder Head Replacement (Left Side)</i> in Engine Mechanical - 4.3L • <i>Cylinder Head Replacement (Right Side)</i> in Engine Mechanical - 4.3L • <i>Cylinder Head Replacement</i> in Engine Mechanical - 5.0L, 5.7L • <i>Cylinder Head Replacement</i> in Engine Mechanical - 6.5L • <i>Cylinder Head Replacement</i> in Engine Mechanical - 7.4L Is there still a loss of coolant?	—	Go to Step 19	System OK
19	Check for a leaking heater core. Is the heater core leaking?	—	Go to Step 20	System OK
20	Make the necessary repairs or replace the components as necessary in order to repair the leak. Is there still a loss of coolant?	—	—	System OK

Thermostat Diagnosis (Off-Vehicle)

Thermostat Inspection and Testing

Do an operational test of the thermostat using the following procedure:

1. Drain the coolant to a level just below the thermostat. Refer to *Draining and Filling Cooling System*.
2. Remove the coolant outlet.
 - For 4.3L and 5.0L engines, refer to *Radiator Hose Replacement (4.3L and 5.0L)*.
 - For 5.7L engines, refer to *Radiator Hose Replacement (5.7 L)*.
 - For 7.4L engines, refer to *Radiator Hose Replacement (7.4 L)*.
 - For 6.5L diesel engines, refer to *Radiator Hose Replacement (6.5 L)*.
3. Remove the thermostat.
 - For gasoline engines, refer to *Thermostat Replacement (Gasoline Engines)*.
 - For diesel engines, refer to *Thermostat Replacement (Diesel Engines)*.



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4. Unless the thermostat is obviously faulty, test the thermostat before replacing the thermostat using the following procedure:

- 4.1. Place the thermostat and a thermometer in a container with a 50/50 solution of water and ethylene glycol antifreeze.

Important: While heating, do not rest the thermostat or the thermometer on the bottom of the container. This causes the thermostat and the thermometer to be at a higher temperature than the solution.

- 4.2. Place the container over a heater.
- 4.3. Agitate the solution in order to maintain a uniform temperature of the solution, the thermostat, and the thermometer.

The thermostat valve should start to open at the rated temperature. The thermostat should be fully open after the temperature has increased 15°C (27°F).

A used thermostat can be about 6°C (10°F) above or below these settings without adversely affecting the thermostat and you do not need to replace the

thermostat. If the thermostat does not operate at the temperatures specified, replace the thermostat. You cannot adjust the thermostat.

Thermostat Diagnosis (On-Vehicle)

Step	Action	Value(s)	Yes	No
Important: The temperature stick is a pencil-like device that has a wax material containing certain chemicals which melt at a given temperature. Use the temperature sticks to determine a thermostat's operating temperature by rubbing 87°C (188°F) and 97°C (206°F) sticks on the thermostat housing. The marks made by the sticks should melt when coolant temperatures reach 87°C (188°F) and 97°C (206°F), respectively. These temperatures are the normal operating range of the thermostat. If the coolant flows as indicated in the table, the thermostat may be worn.				
1	1. Remove the radiator cap. Refer to <i>Pressure Cap Description</i> . 2. Rub a 97°C (206°F) J 24731 on the thermostat housing. 3. Warm up the engine at fast idle. 4. Check for coolant flow before the mark begins to melt. Is there coolant flow before the mark melts?	—	Go to Step 2	Go to Step 3
2	The problem is caused from something other than the thermostat. Does the engine still overheat?	—	Go to Engine Overheating.	System OK
3	1. Replace the thermostat. <ul style="list-style-type: none"> For gasoline engines, refer to <i>Thermostat Replacement (Gasoline Engines)</i>. For diesel engines, refer to <i>Thermostat Replacement (Diesel Engines)</i>. 2. Check the system. Does the engine still overheat?	—	—	System OK

Fan Clutch Diagnosis

Fan Noise

Fan noise is sometimes evident under the following conditions:

- When the clutch is engaged for maximum cooling.
- During the first 15 seconds to one minute after start-up until the clutch can redistribute the silicone fluid back to the fluid's normal disengaged operating condition (after overnight settling).

Fan noise, or an excessive roar, generally occurs continuously under all high engine speed conditions (2500 RPM and up) if the clutch assembly is locked up because of an internal failure. If the fan cannot be rotated by hand, or if there is a rough grating feel as the fan is turned, replace the clutch. For the 4.3L, 5.0L, 5.7L, and 6.5L engines refer to *Fan Clutch Replacement (4.3L, 5.0L and 5.7L)*.

For the 7.4L engine, refer to *Fan Clutch Replacement (7.4L)*.

Looseness

Check a loose fan clutch assembly for wear. Replace the fan clutch as necessary.

Under various temperature conditions, a lateral movement is visible at the tip of the fan blade. About 6.5 mm (¼ in) maximum lateral movement, measured at the fan tip, is allowable. Replacement of the fan clutch is not necessary.

Make sure that the fan blade is installed properly. If the fan is installed incorrectly, it will cause an overheating problem.

Silicone Fluid Leaks

Small fluid leaks, occurring in the area around the bearing assembly, do not affect the operation of the fan blade clutch.

If leakage appears excessive, replace the fan blade clutch.

For the 4.3L, 5.0L, 5.7L, and 6.5L engines, refer to *Fan Clutch Replacement (4.3L, 5.0L and 5.7L)*.
 For the 7.4L engine, refer to *Fan Clutch Replacement (7.4L)*.

Engine Overheating

1. In order to ensure complete fan blade clutch disengagement, begin testing with a cool engine.
2. If the fan blade clutch assembly “free wheels” with no drag, (revolves more than 5 times when spun by hand), replace the fan blade clutch. For the 4.3L, 5.0L, 5.7L, and 6.5L engines, refer to *Fan Clutch Replacement (4.3L, 5.0L and 5.7L)*. For the 7.4L engine, refer to *Fan Clutch Replacement (7.4L)*. If the clutch performs properly with a slight drag, refer to step 3. Testing a fan blade clutch by holding the small hub with one hand, and rotating the aluminum housing in a clockwise/counterclockwise motion, causes the clutch to “free wheel.” Consider this operation normal and this test should not determine replacement.
3. Position a thermometer between the fan blades and the radiator. Do this by inserting the thermometer sensor through one of the existing holes in the fan shroud, or by placing the thermometer between the radiator and the fan shroud. On some models, you may have to drill a 5 mm (3/16 in) hole in the fan shroud in order to insert the thermometer.
4. With the thermometer in position, do the following steps:
 - 4.1. Sufficiently cover the radiator grille in order to induce a high engine temperature.
 - 4.2. Start the engine.
 - 4.3. Turn on the A/C.
 - 4.4. Operate the engine at 2000 RPM.
5. Check the thermometer reading when the clutch engages. Allow about 5 to 10 minutes for the temperature to become high enough to engage the fan blade clutch. This will be indicated by an increase, or roar, in fan air noise and by a drop in the thermometer reading of about 3–10°C (5–15°F).
 - If the clutch did not engage between 65–90°C (150–195°F), replace the assembly. Make sure that the fan blade clutch was disengaged at the beginning of the test.
 - If you observed no sharp increase in fan noise or temperature drop, and the fan noise level was constantly high from the start of the test to 88°C (190°F), replace the assembly. Do not continue this test past a thermometer reading of 88°C (190°F) in order to prevent engine overheating.
6. When the clutch engages, do the following steps:
 - 6.1. Remove the radiator grille cover.
 - 6.2. Turn off the A/C in order to assist in engine cooling.
 - 6.3. Operate the engine at about 1500 RPM.
7. After several minutes, the fan blade clutch should disengage as indicated by a reduction in fan speed and roar. If the fan blade clutch fails to function as described, replace the fan blade clutch.

Coolant Concentration Testing

Glycol Usage

Before you drain and refill the cooling system, inspect the system. Perform any service needed to ensure that the system is clean, does not leak, and is in proper working order.

Some coolant manufacturers mix other types of glycol into their coolant formulations. Propylene glycol is the most common new ingredient. However, do not use propylene glycol in GM vehicles that were manufactured with Dex-Cool coolant.

A hydrometer does not always provide a correct measurement of freeze protection when anything other than ethylene glycol and water is being tested. The degree of inaccuracy varies depending on the proportion of other glycols present in the coolant.

Hydrometers test the amount of glycol in a mixture by measuring the specific gravity of the mixture: the more ethylene glycol, the higher the float balls go, and the better the freeze protection. Because ethylene glycol and propylene glycol do not have the same specific gravities, hydrometer readings of mixtures containing propylene glycol give incorrect values. Use a refractometer when you test coolant. Refractometers test the amount of glycol in a coolant mixture by measuring the speed of light as the light passes through the fluid, and is not affected by the specific gravity of the glycol.

Testing Procedure

Tools Required

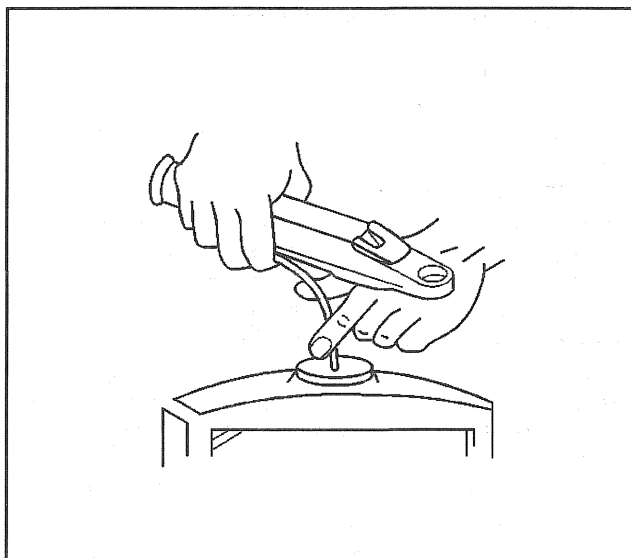
- J 23688 Coolant Tester (Fahrenheit Scale)
- J 26568 Coolant Tester (Centigrade Scale)

Important:

- Both J 23688 and J 26568 automatically compensate for temperature.
 - Before each use, swing back the plastic cover at the slanted end of the coolant tester, exposing the measuring window and the bottom of the plastic cover.
 - Wipe the measuring window dry with a tissue or a clean, soft cloth.
 - Close the plastic cover.
1. Release the tip of the pump from the housing of the J 23688 or the J 26568.
 2. Do not remove the clear plastic pump from the J 23688 or the J 26568.

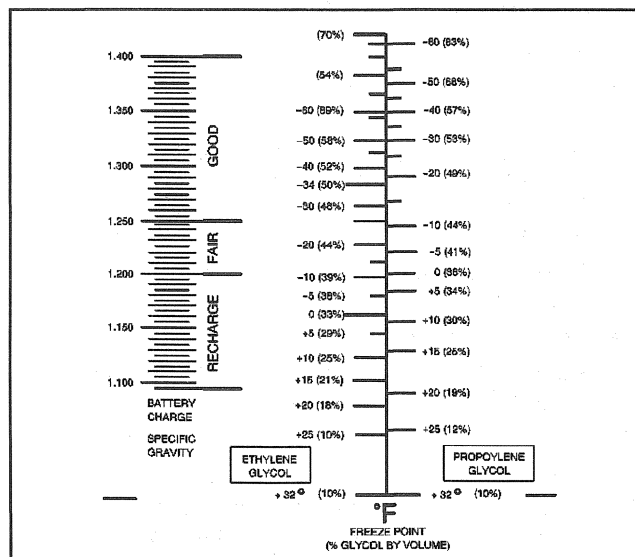
Caution: As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution in the radiator without causing the solution to boil. Removal of the pressure cap while the engine is hot and pressure is high will cause the solution to boil instantaneously — possibly with explosive force — spewing the solution over the engine, fenders and the person removing the cap.

3. Remove the surge tank/radiator cap.



13709

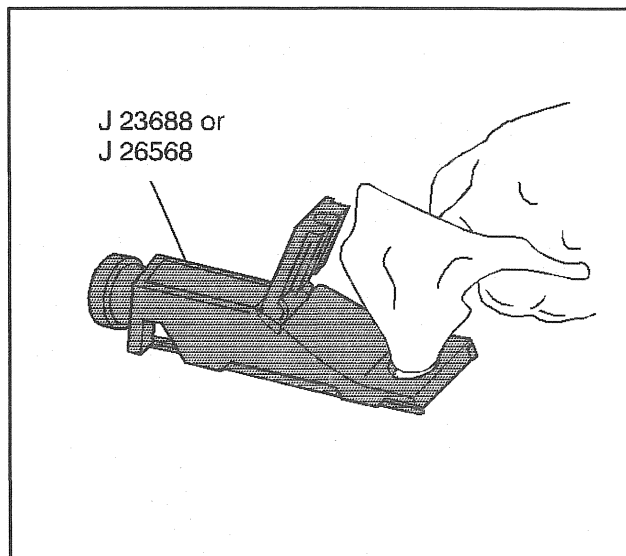
4. Insert the tip of the pump into the surge tank/radiator. The tip of the pump must be below the level of the coolant.
5. Press the bulb. Release the pump bulb in order to obtain a sample of the coolant.
6. Bend the tube around the *J 23688* or the *J 26568*. Insert the tip of the pump into the cover plate opening.
7. Press the pump bulb. Allow a few drops to fall onto the measuring surface. Do not open the plastic cover when taking readings because any water evaporation will change the reading.



13713

8. Point the coolant concentration tester toward any light source. Look into the eyepiece.
 - The coolant protection reading is at the point where the dividing line between light and dark crosses the scale. Antifreeze protection is the scale on the right.

- The temperature scale is reversed from a standard thermometer scale. Below zero readings are on the upper half of the scale.



13712

9. If the readings are not clear, properly clean and dry the measuring surface. Conduct a new test. Ensure that there is enough fluid on the measuring surface.

Cooling System Leak Testing (Radiator Leak Test)

Testing Procedure (On Vehicle)

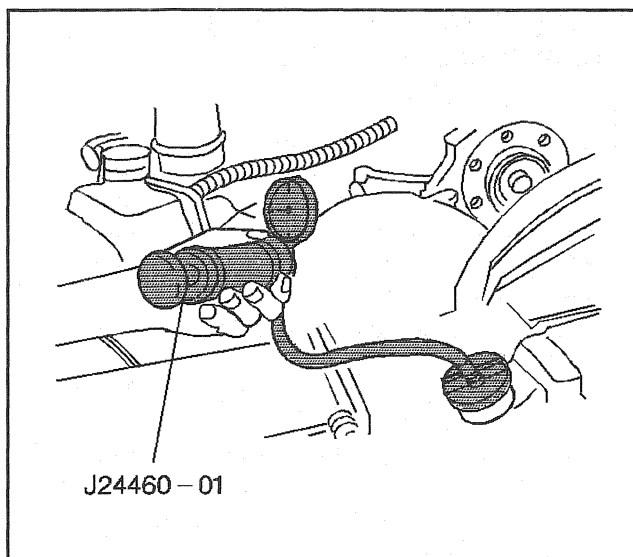
Tools Required

J 24460-01 Cooling System Tester

Caution: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

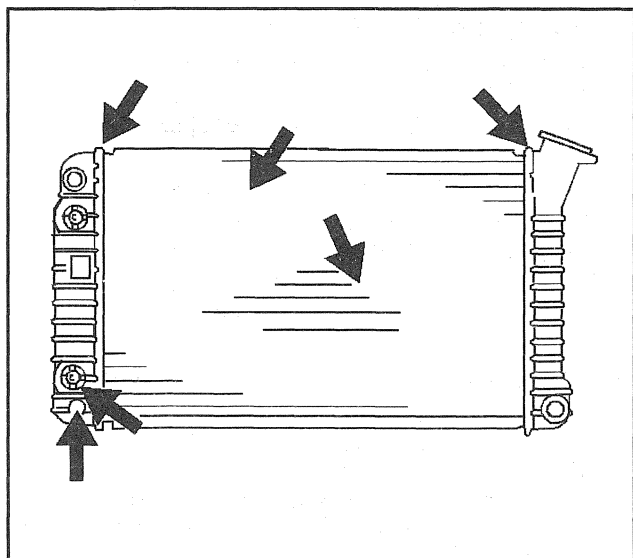
Caution: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

1. After the system has cooled, remove the radiator/surge tank pressure cap.

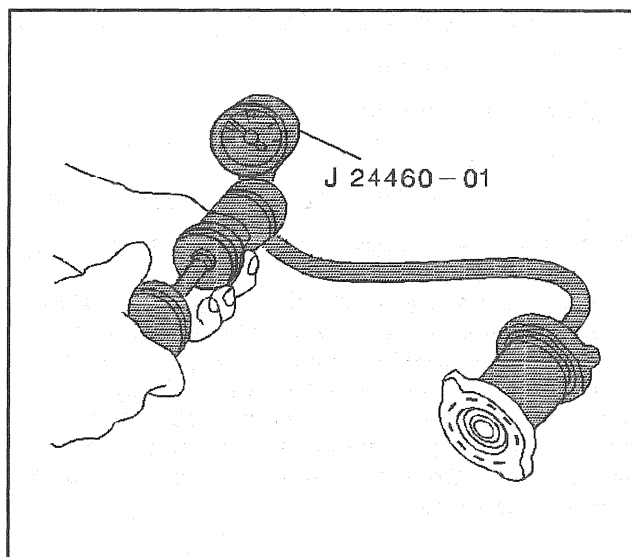


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2. Connect the cooling system tester *J 24460-01* to the radiator/surge tank.
3. Apply normal system operating pressure. Do not exceed 138 kPa (20 psi).



4. Watch the gauge needle for an indication of a leak. Examine all cooling system connections and components, including the radiator and the heater core, for leaking coolant.
5. Tighten the hose connections or repair as required.



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6. Inspect the radiator/surge tank cap with *J 24460-01* in order to ensure the cap maintains the correct pressure.
7. If the radiator leaks during the pressure test, mark the leak area so the leak can be located once the radiator has been removed from the vehicle.

Testing Procedure (Off Vehicle)

Tools Required

J 24460-01 Cooling System Tester

Notice: Do not use boil-out tanks or any other tank that has been used for copper or brass radiators. The remaining solutions or chemicals in these tanks could cause radiator failure.

1. Plug the inlet and outlet tubes. Ensure the drain cock is closed.
2. Attach the *J 24460-01* to the radiator.
3. Apply pressure to the radiator. Do not exceed 138 kPa (20 psi) of pressure.
4. Observe the gauge for any pressure loss.
5. Run water over the repair area and look for any bubbles. If a large tank is available, the radiator can be submerged in order to check for air bubbles.

Cooling System Leak Testing (Radiator Cap Leak Test)

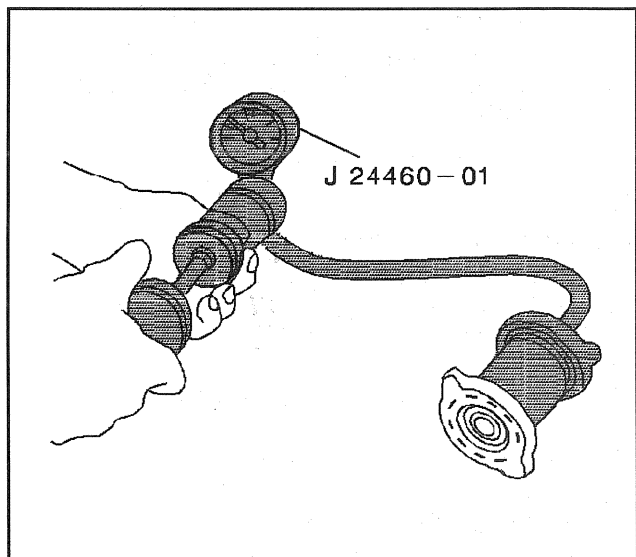
Radiator Cap Pressure Test

Tools Required

J 24460-01 Cooling System and Cap Pressure Tester

Caution: As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution in the radiator without causing the solution to boil. Removal of the pressure cap while the engine is hot and pressure is high will cause the solution to boil instantaneously — possibly with explosive force — spewing the solution over the engine, fenders and the person removing the cap.

1. Remove the radiator cap.
2. Wet the radiator cap gasket with water. Wash off any sediment from the sealing surface.



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3. Install the cap to J 24460-01.
4. Pump up the pressure to 103 kPa (15 psi) by operating the plunger handle of J 24460-01.
5. Note the rate of decrease in pressure.
6. The pressure reading should remain within the corresponding pressure segment of the scale for about 10 seconds.
7. If the cap does not hold the corresponding pressure, replace the cap.

Cooling System Leak Testing (Exhaust Gas Leak Test)

System Check

Notice: Exhaust gasses may enter the cooling system through a leaking cylinder head gasket. Exhaust gasses combine with water to form acids. These acids are harmful to the cooling system and the engine.

In order to check for exhaust gases leaking into the cooling system, do the following steps:

1. Drain the coolant system until the coolant level stands just above the top of the cylinder heads. Refer to *Draining and Filling Cooling System*.
2. Disconnect the upper radiator hose.
 - For the 4.3L and 5.0L engines, refer to *Radiator Hose Replacement (4.3L and 5.0L)*.
 - For the 5.7L engine, refer to *Radiator Hose Replacement (5.7 L)*.
 - For the 7.4L engine, refer to *Radiator Hose Replacement (7.4 L)*.
 - For the 6.5L engine, refer to *Radiator Hose Replacement (6.5 L)*.
3. Remove the thermostat. Refer to *Thermostat Replacement (Gasoline Engines)* or *Thermostat Replacement (Diesel Engines)*.
4. Remove the drive belt. Refer to the appropriate procedure:
 - *Drive Belt Replacement* in Engine Mechanical - 4.3L
 - *Drive Belt Replacement* in Engine Mechanical - 5.0L, 5.7L
 - *Drive Belt Replacement (6.5L Drive Belt)* in Engine Mechanical - 6.5L
 - *Drive Belt Replacement* in Engine Mechanical - 7.4L
5. Start the engine and accelerate several times.
6. Inspect the coolant level for the appearance of bubbles or a significant rise in the coolant level. If the coolant level rises or bubbles appear, coolant may be leaking into engine. Inspect the spark plugs. Refer to *Spark Plug Visual Diagnosis* in Engine Electrical.

Repair Instructions

Draining and Filling Cooling System

Draining Procedure

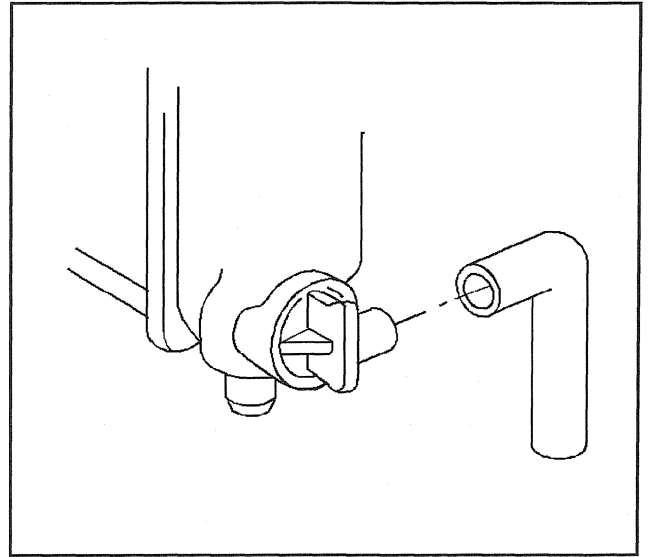
Caution: As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution in the radiator without causing the solution to boil. Removal of the pressure cap while the engine is hot and pressure is high will cause the solution to boil instantaneously — possibly with explosive force — spewing the solution over the engine, fenders and the person removing the cap.

Notice: When adding coolant, use DEX-COOL® coolant. If silicated coolant is added to the system, premature engine, heater core or radiator corrosion may result. In addition, the engine coolant will require change sooner—at 50,000 km (30,000 mi) or 24 months.

1. Allow the engine to cool completely.
2. Place a drain pan under the radiator drain cock.
3. Install a tube on the radiator drain. Place the end of the tube in the drain pan.
4. After the engine cools down, remove the radiator cap. Refer to *Pressure Cap Description*.
5. Completely open the radiator drain cock.
6. Allow the coolant to drain from the system until the flow stops.
7. Place a drain pan under the block drain hole plug.
8. Remove the drain hole plug from the engine block.
9. Allow the coolant to drain from the block until the flow stops. There may be more drainage from the radiator at this time.
10. Install the block drain hole plug.
11. Close the radiator drain cock.

Filling Procedure

1. Check to make sure that the radiator drain cock is closed.
2. Check to make sure that the block drain hole plug is tight.
3. Premix a 50/50 solution of antifreeze and clear, preferably distilled water. If you use the old coolant, make sure the solution is clean and clear, and that the solution is a 50/50 mixture of glycol and water.
4. Place a large top funnel in the radiator filler neck.
5. Slowly pour in the coolant. Because the thermostat is closed, filling the cooling system may be slow.
6. After you fill the cooling system to 13 mm (½ in) below the radiator filler neck, start the engine and let the cooling system warm up. When the thermostat opens, the coolant level may drop. If the level drops, add coolant to just below the filler neck.
7. Install the radiator cap.
8. Check the coolant level in the coolant recovery reservoir. Add coolant as necessary.



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Flushing

Flushing Procedure

You can use various methods and equipment to flush the cooling system. If special equipment is used (such as a back flusher) follow the manufacturer's instructions. However, always remove the thermostat before flushing the system.

Scale Removal

In order to remove hardened scale from the radiator, a direct chemical action is necessary.

1. Add a flushing compound, at the specified rate of 30 grams-per-liter (4 ounces-per-gallon) of radiator capacity, to the coolant water as a dissolved solution while the engine is running.
2. Operate the engine for 15 minutes.
3. Drain the cooling system. Then, flush the system with clean water.

There are various types of flushing compounds commercially available. Obtain these from a reliable source.

Most compounds attack metals and these should not remain in the engine for more than a few minutes. Use a neutralizer in the cooling system immediately after using a de-scaling solvent. For extremely hard, stubborn coatings, such as lime scale, use a stronger solution. The corrosive action of a stronger solution affects the thin metals of the radiator, reducing the operating life of the radiator. Because of this, flushing and rinsing the radiator is required.

After you use the solvent and the neutralizer, and after you flush the system, do the following:

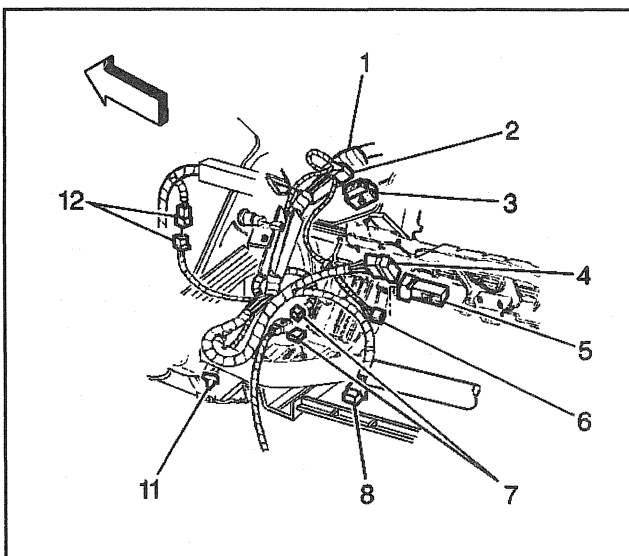
1. Drain the entire cooling system. Refer to *Draining and Filling Cooling System*.
2. After filling the cooling system, check the radiator and hoses for coolant leaks.

Coolant Level Module Replacement

Removal Procedure

Refer to *Battery Disconnect Caution* in Cautions and Notices.

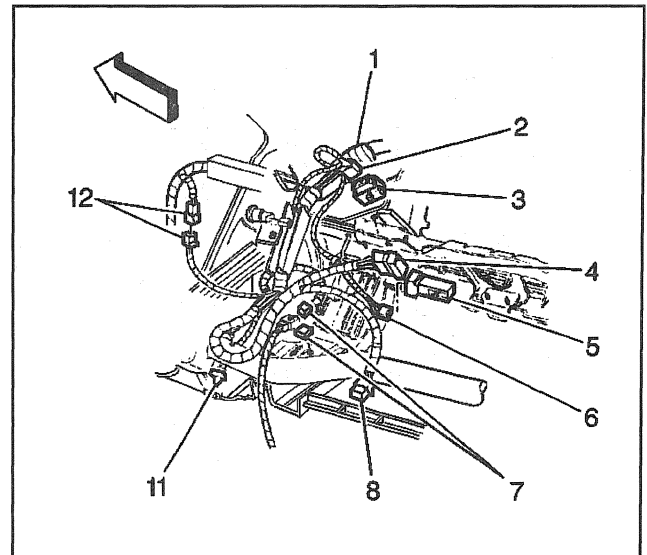
1. Remove the battery negative cable.
2. Remove the IP cluster to access the connector. Refer to *Compartment Replacement - IP* in Instrument Panel, Gauges and Console.
3. Remove the module (3) by detaching the mounting pin from the mounting hole.
4. Remove the module from the harness connector.



Installation Procedure

Important: Ensure that the retainer is installed correctly on the coolant module.

1. Install the coolant module (3) to the harness connector.
2. Attach the pin to the mounting hole in order to install the module.
3. Install the IP cluster to the IP. Refer to *Compartment Replacement - IP* in Instrument Panel, Gauges and Console.
4. Install the battery negative cable.

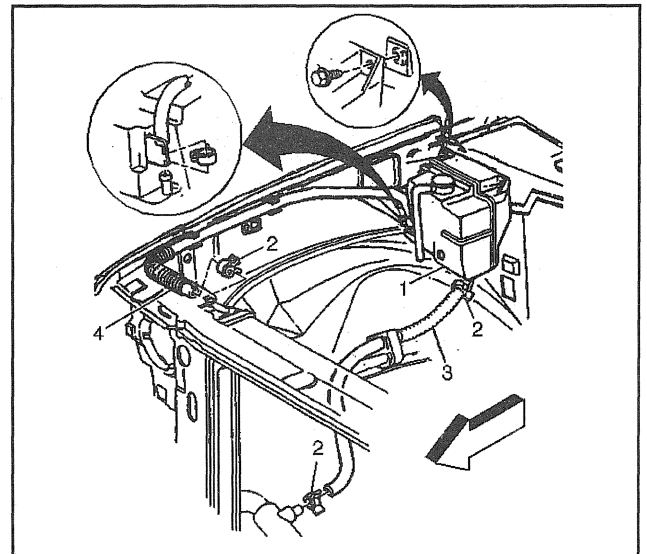


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Surge Tank (Diesel) Replacement

Removal Procedure

1. Drain the coolant from the surge tank.
2. Disconnect the surge tank outlet hose (3) and clamp (2) from the surge tank.
3. Disconnect the surge tank overflow hose (4) and clamp (2).
4. Remove the surge tank bolts.
5. Remove the surge tank (1) from the vehicle.



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Installation Procedure

1. Install the surge tank (1) into the vehicle.

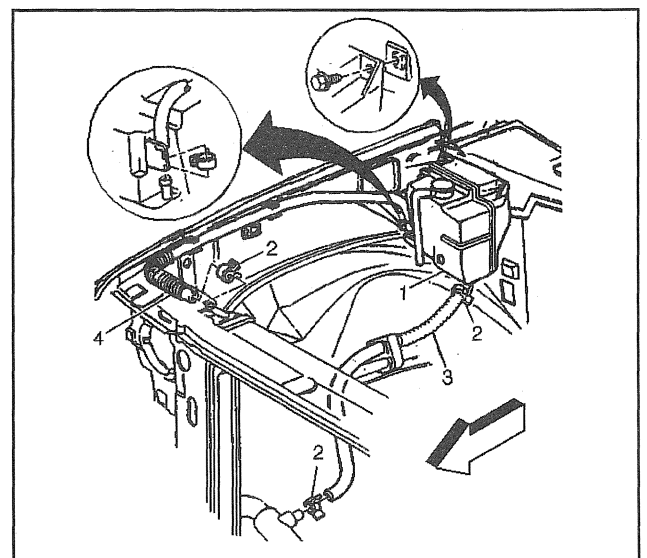
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the bolts.

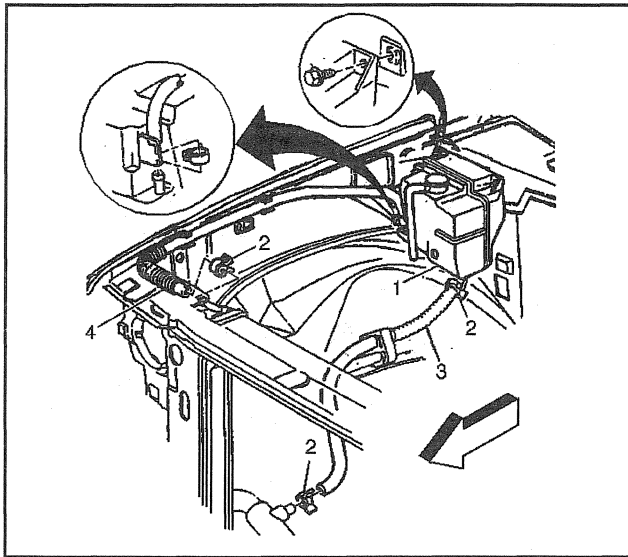
Tighten

Tighten the bolts to 10 N·m (89 lb in).

3. Connect the coolant overflow hose (4) and clamp (2) to the surge tank.
4. Connect the surge tank outlet hose (3) and the clamp (2) to the surge tank.
5. Refill the coolant to the surge tank.



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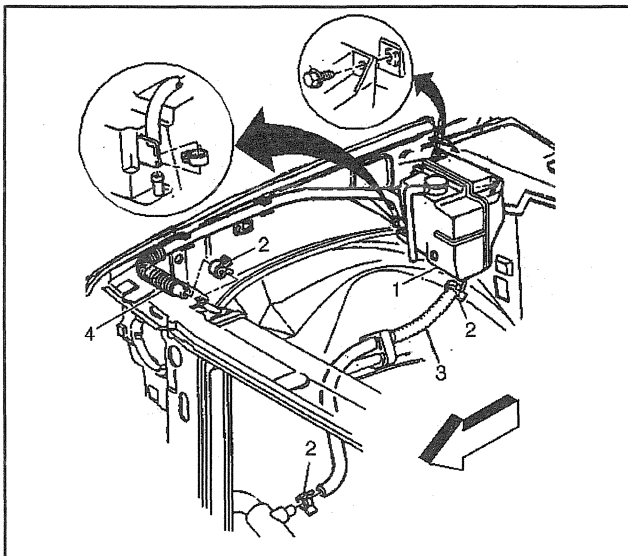


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Surge Tank Replacement

Removal Procedure

1. Drain the coolant from the surge tank.
2. Disconnect the surge tank outlet hose (3) and clamp (2) from the surge tank as needed. The hose, mounting, and clips may vary from engine to engine.
3. Disconnect the surge tank overflow hose (4) and clamp (2) as necessary. The overflow hose attachment may vary from engine to engine.
4. Disconnect the surge tank inlet hose as necessary. The hose, mounting, and clips may vary from engine to engine.
5. Remove the surge tank bolts.
6. Remove the surge tank (1) from the vehicle.



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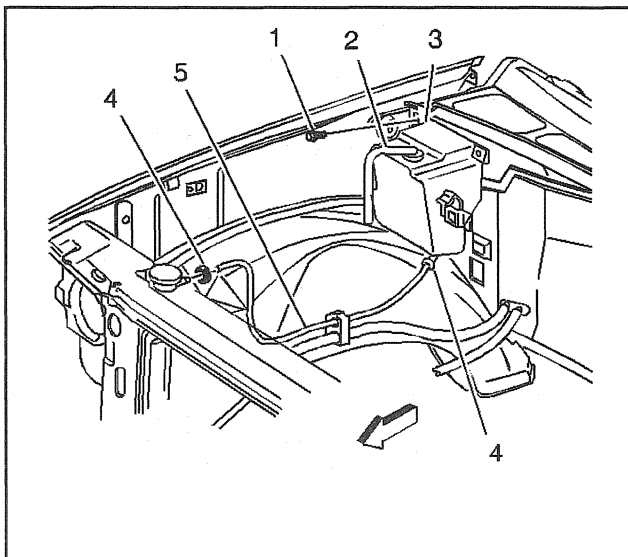
Installation Procedure

1. Install the surge tank (1) into the vehicle.
- Notice:** Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts.
- Tighten**
Tighten the bolts to 10 N·m (89 lb in).
3. Connect the surge tank inlet hose as needed. The hose, mounting, and clips may vary from engine to engine.
 4. Connect the coolant overflow hose (4) and clamp (2) to the surge tank as needed. The overflow hose attachment may vary from engine to engine.
 5. Connect the surge tank outlet hose (3) and the clamp (2) to the surge tank. The hose, mounting, and clips may vary from engine to engine.
 6. Refill the coolant to the surge tank.

Coolant Recovery Reservoir Replacement

Removal Procedure

1. Drain the coolant from the coolant recovery reservoir.
2. Remove the coolant recovery hose (5) and clamp (4) from the reservoir.
3. Disconnect the overflow hose (2) and clamp (4).
4. Remove the recovery reservoir bolts (1).
5. Remove the coolant recovery reservoir (3) from the vehicle.



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Installation Procedure

1. Install the coolant recovery reservoir (3) to the vehicle.

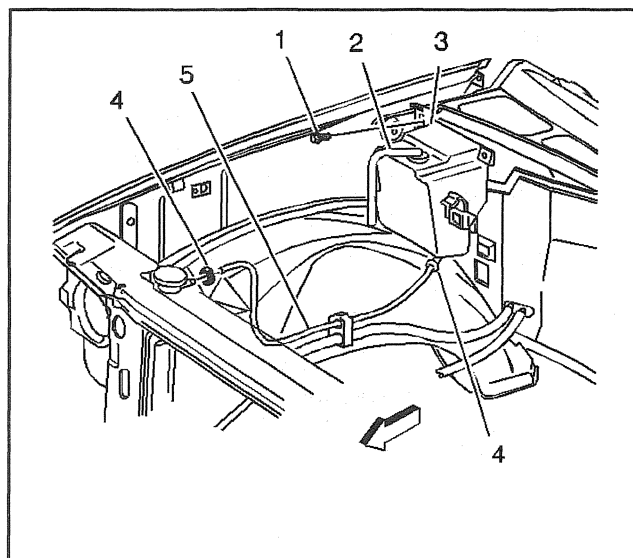
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the bolts (1).

Tighten

Tighten the bolts to 10 N·m (89 lb in).

3. Connect the coolant overflow hose (2) and clamp (4) to the recovery reservoir.
4. Connect the coolant recovery hose (5) and clamp (4) to the reservoir.
5. Refill the coolant in the reservoir.

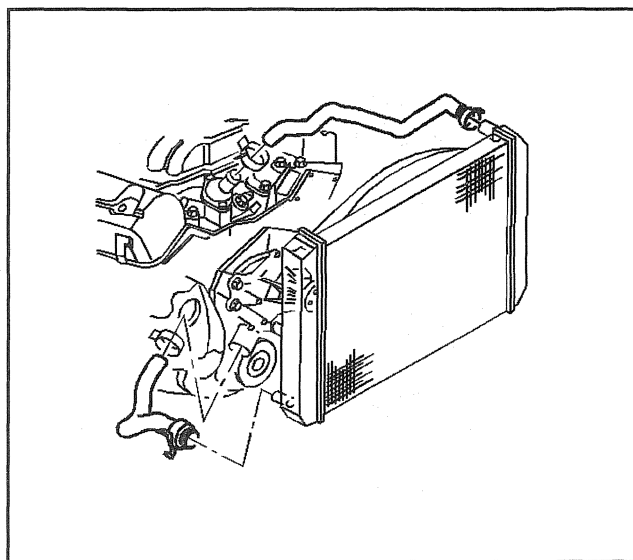


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Radiator Hose Replacement (4.3L and 5.0L)**Removal Procedure**

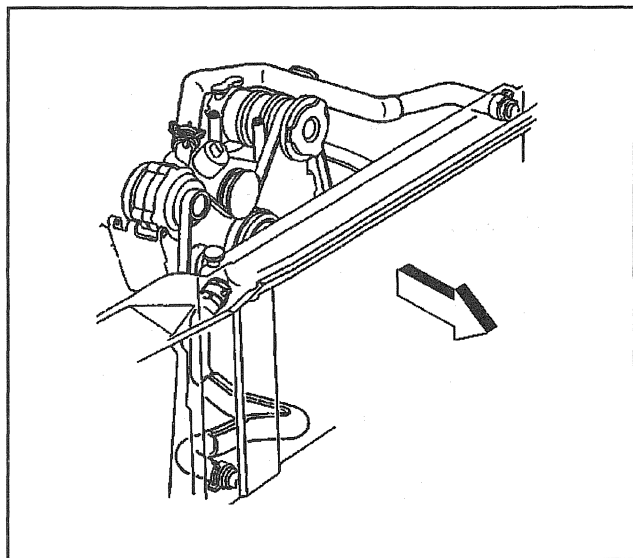
Important: Most C/K models use a spring-type clamp at the radiator hose connections. When using this type of clamp, install the radiator hoses on dry, non-painted surfaces in order to ensure proper sealing. Reusing the spring-type clamps on aftermarket hoses is not recommended.

1. Drain the coolant from the cooling system. Refer to *Draining and Filling Cooling System*.
2. For the 4.3L, remove the clamps from the inlet and outlet radiator hoses.
3. Remove the radiator inlet hose.
4. Remove the radiator outlet hose.

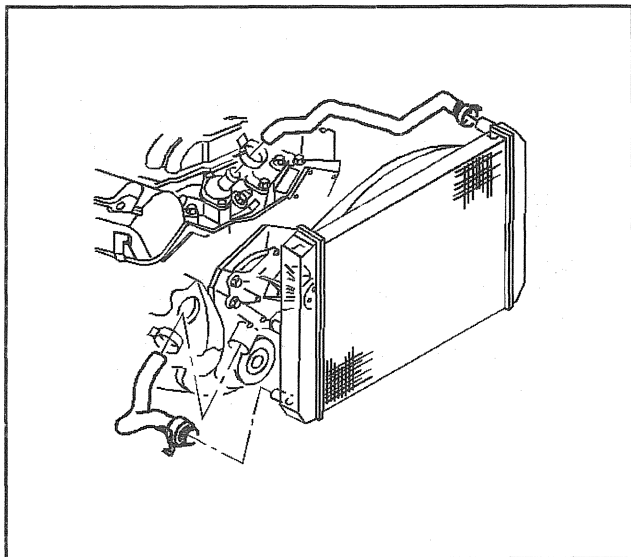


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5. For the 5.0L, remove the clamps from the inlet and outlet radiator hoses.
6. Remove the radiator inlet hose.
7. Remove the radiator outlet hose.



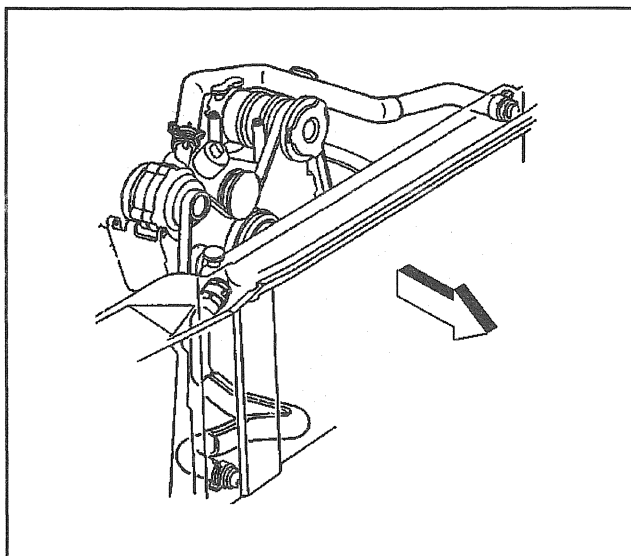
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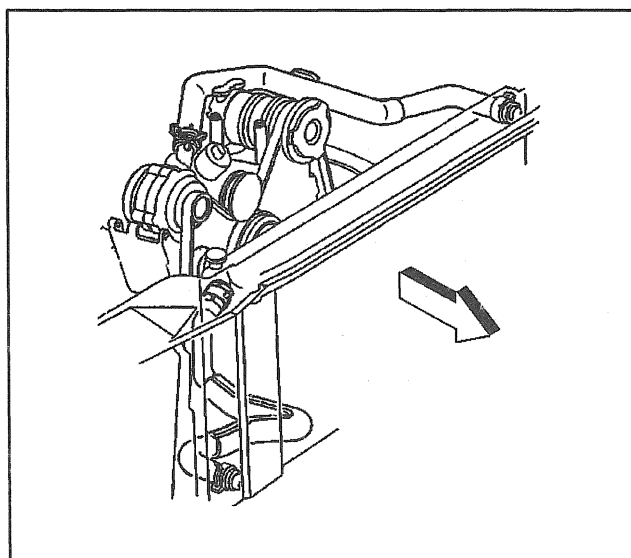
Installation Procedure

1. For the 4.3L, install the radiator outlet hose.
2. Install the radiator inlet hose.
3. Connect the clamps to the inlet and outlet radiator hoses.



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4. For the 5.0L, install the radiator outlet hose.
5. Install the radiator inlet hose.
6. Connect the clamps to the inlet and outlet radiator hoses.
7. Refill the coolant in the cooling system. Refer to *Draining and Filling Cooling System*.
8. Start the engine. When the engine reaches normal operating temperature, check for coolant leaks.



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Radiator Hose Replacement (5.7 L)

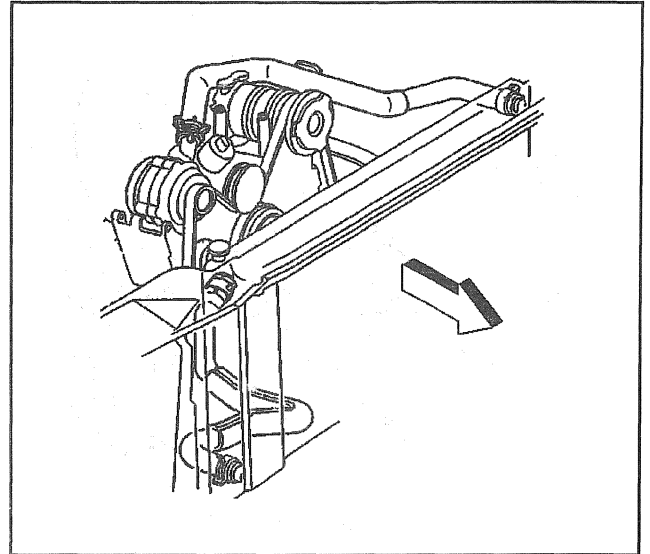
Removal Procedure

Important: Most C/K models use a spring - type clamp at the radiator hose connections. When using this type of clamp, install radiator hoses on dry, non - painted surfaces in order to ensure proper sealing. Reusing the spring - type clamps on aftermarket hoses is not recommended.

1. Drain the coolant from cooling system. Refer to *Draining and Filling Cooling System*.
2. Remove the hose clamps from the inlet and outlet hoses.
3. Remove the radiator inlet hose.
4. Remove the radiator outlet hose.

Installation Procedure

1. Install the radiator outlet hose.
2. Install the radiator inlet hose.
3. Install the clamps to the radiator inlet and outlet hoses.
4. Refill the coolant to the cooling system. Refer to *Draining and Filling Cooling System*.
5. Start the engine. After the engine reaches normal operating temperature, inspect for coolant leaks.

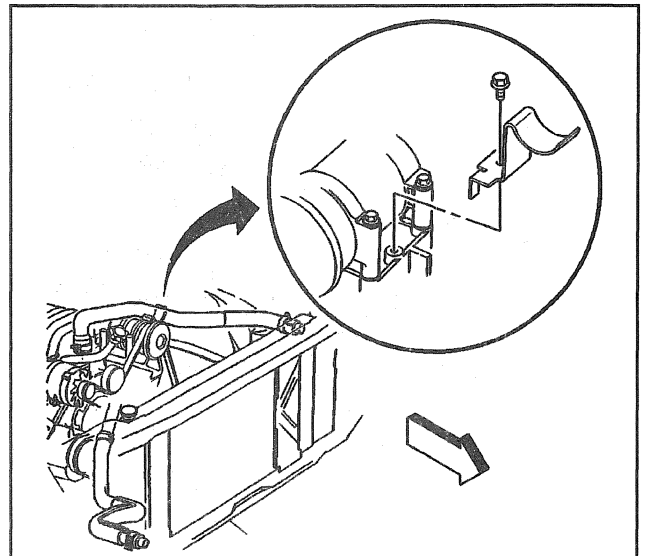


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Radiator Hose Replacement (7.4 L)**Removal Procedure**

Important: Most C/K models use a spring - type clamp at the radiator hose connections. When using this type of clamp, install radiator hoses on dry, non - painted surfaces in order to ensure proper sealing. Reusing the spring - type clamps on aftermarket hoses is not recommended.

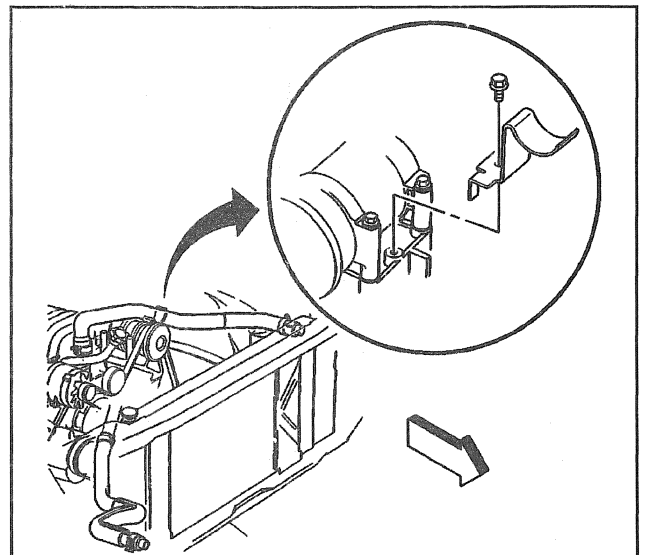
1. Drain the coolant from the cooling system. Refer to *Draining and Filling Cooling System*.
2. Remove the hose clamps from the inlet and outlet hoses.
3. Remove the radiator inlet hose.
4. Remove the radiator outlet hose.



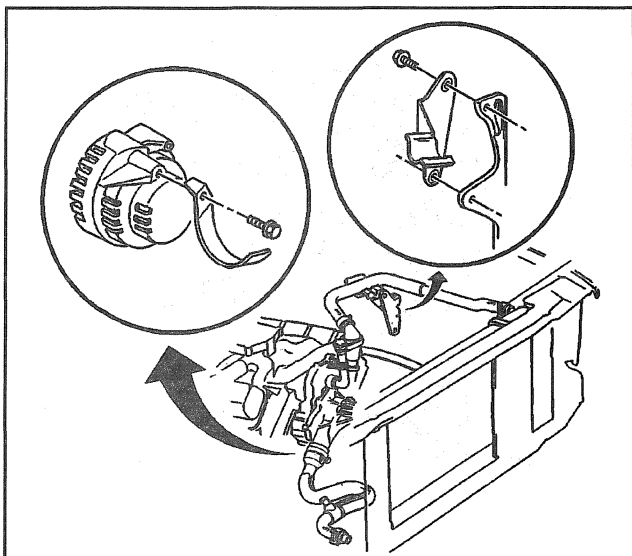
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Installation Procedure

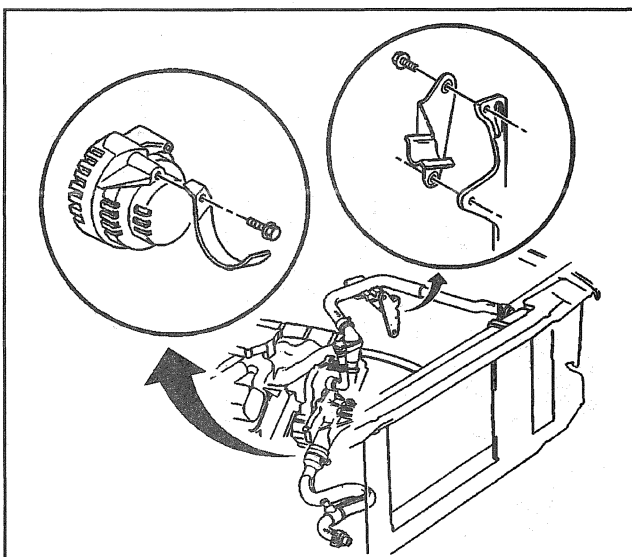
1. Install the radiator outlet hose.
2. Install the radiator inlet hose.
3. Install the clamps to the radiator inlet and outlet hoses.
4. Refill the coolant to the cooling system. Refer to *Draining and Filling Cooling System*.
5. Start the engine. After the engine reaches normal operating temperature, inspect for coolant leaks.



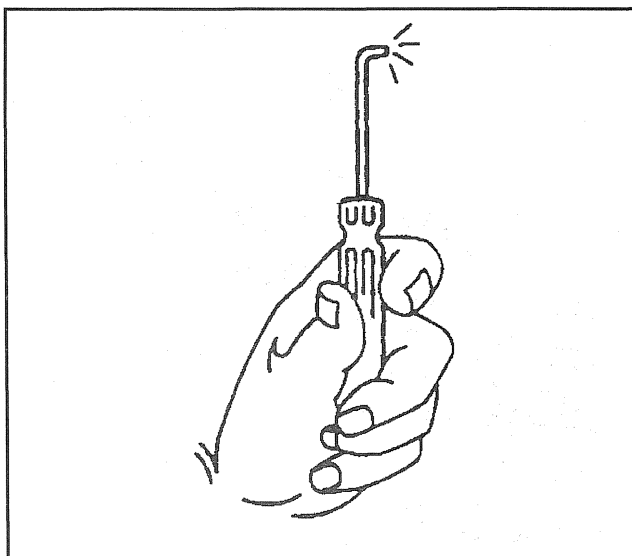
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Radiator Hose Replacement (6.5 L)

Removal Procedure

Important: Most C/K models use a spring - type clamp at the radiator hose connections. When using this type of clamp, install radiator hoses on dry, non - painted surfaces in order to ensure proper sealing. Reusing the spring - type clamps on aftermarket hoses is not recommended.

1. Drain the coolant from the cooling system. Refer to *Draining and Filling Cooling System*.
2. Remove the clamps.
3. Remove the radiator inlet hose.
4. Remove the radiator outlet hose.

Installation Procedure

1. Install the radiator outlet hose.
2. Install the radiator inlet hose.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the clamps.

Tighten

Tighten the outlet upper clamp bolt to 2.8 N·m (2 lb ft).

4. Refill the coolant in the cooling system. Refer to *Draining and Filling Cooling System*.
5. Start the engine. After the engine reaches normal operating temperature, inspect for coolant leaks.

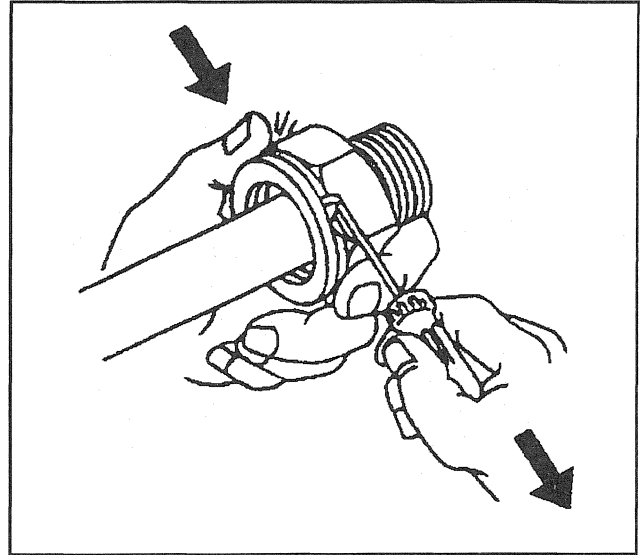
Engine Oil Cooler Line Replacement

Removal Procedure

The optional oil cooler is either an integral part of the radiator or this is a separate unit placed in front of the radiator. The cooler lines and hoses are serviceable.

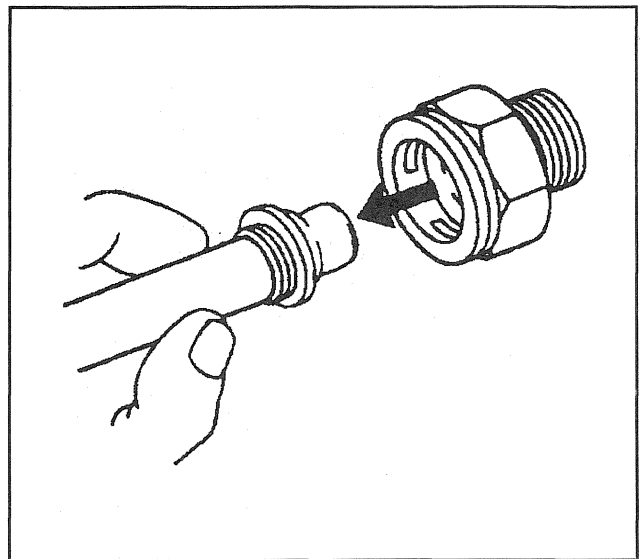
1. Set the parking brake.
2. Remove the plastic cap from the connector by pulling back along the pipe.
3. Use a small, pick-type tool or screwdriver in order to release one of the open ends of the retaining ring from the connector fitting.

4. Rotate the retaining ring out of position on the connector fitting and remove the ring completely.
5. Discard the retaining ring clip.



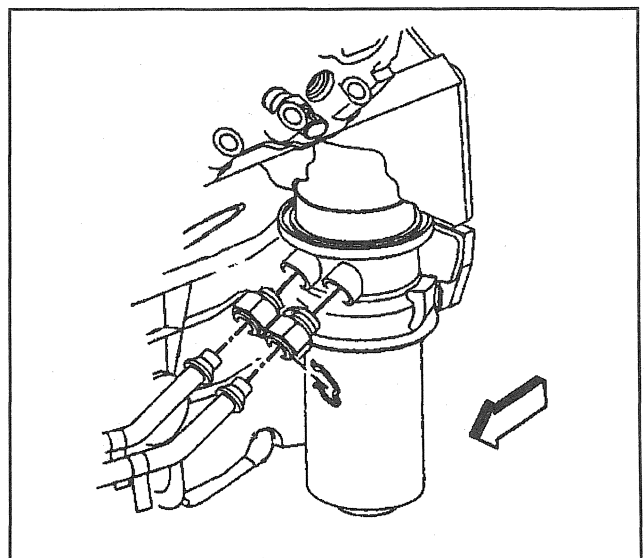
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6. Pull outward on the pipe in order to remove the pipe from the connector fitting.

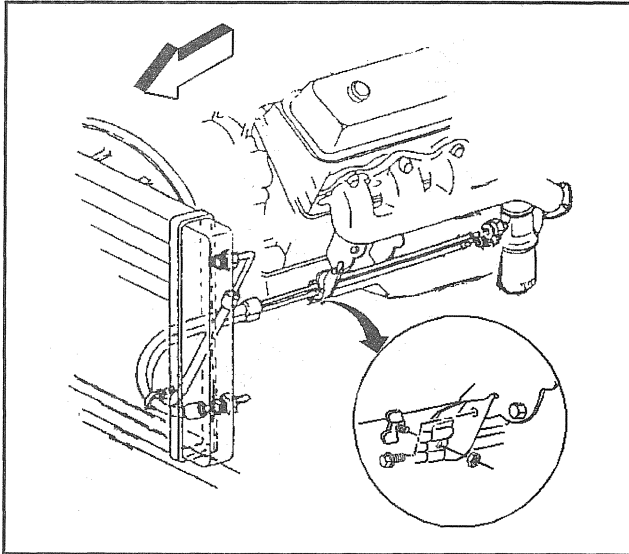


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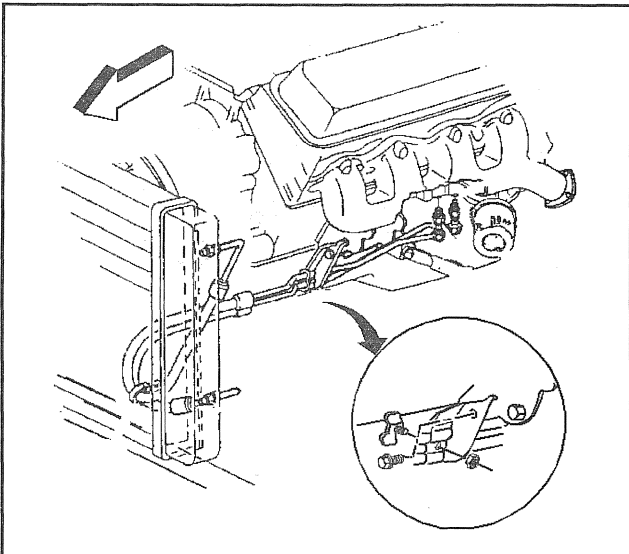
7. For the 4.3L, remove the bolt and the clamp from the bracket.
8. Remove the oil cooler lines from the oil cooler fittings.



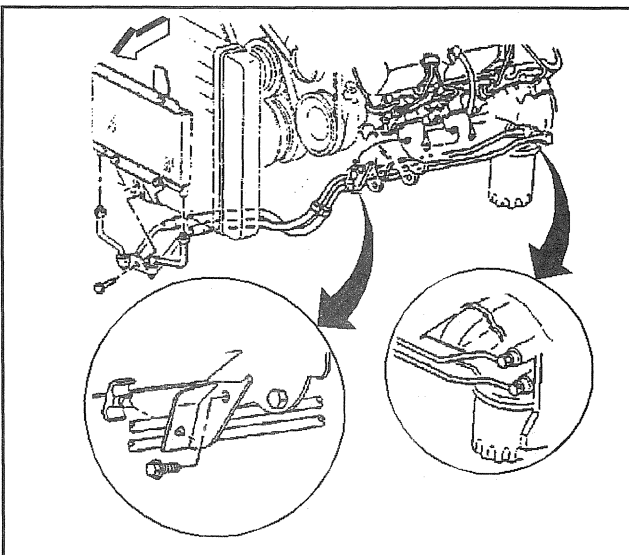
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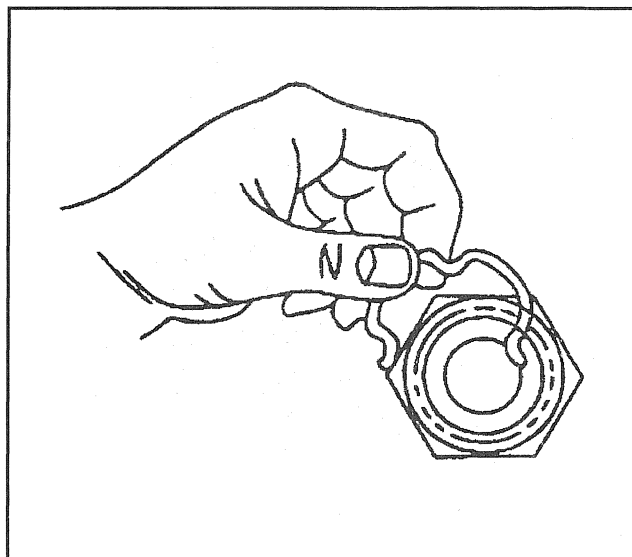
9. For the 5.0L and the 5.7L, remove the bolt and the clamp from the bracket.
10. Remove the oil cooler lines from the oil cooler fittings.

11. For the 7.4L, remove the bolt and the clamp from the bracket.
12. Remove the oil cooler lines from the oil cooler fittings.

13. For 6.5L, remove the bolt and the clamp from the bracket.
14. Remove the oil cooler lines from the oil cooler fittings.
15. Remove and discard the oil filter.
16. Clean all of the components in a suitable solvent, and dry them with compressed air.
 - Use a clean solvent and compressed air in order to backflush the oil the oil cooler and lines.
 - Use compressed air in order to remove the cleaning solvent.
 - Flush the system, using the same type of oil normally circulated through the cooler.
17. Inspect all of the fittings, connectors and cooler lines for damage or distortion.

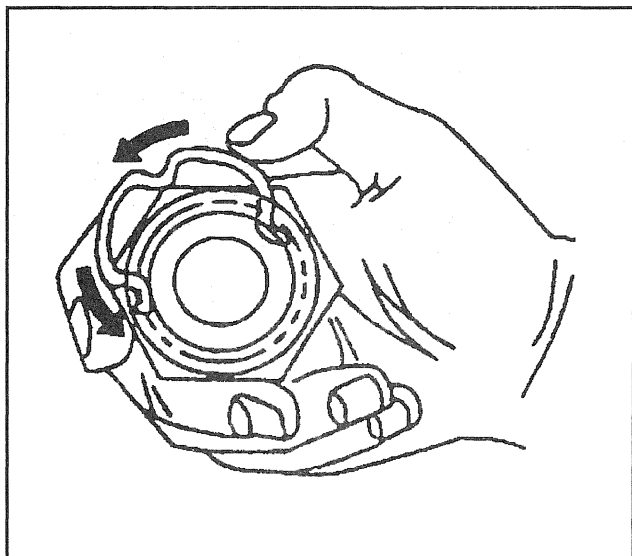
Installation Procedure

1. Install the oil filter.
2. Install the retaining clip into the connector fittings. Do not reuse the existing retaining clips removed from the cooler line connector fittings. The retaining clips being put into the cooler line connector fittings must be new.
3. Using your thumb and forefinger, insert a new retaining clip into one of the three connector fitting recesses. Make sure the retaining clip engages all three slots in the connector fittings. Failure to properly install the connector clips could cause the cooler lines to come loose and cause damage to the engine.



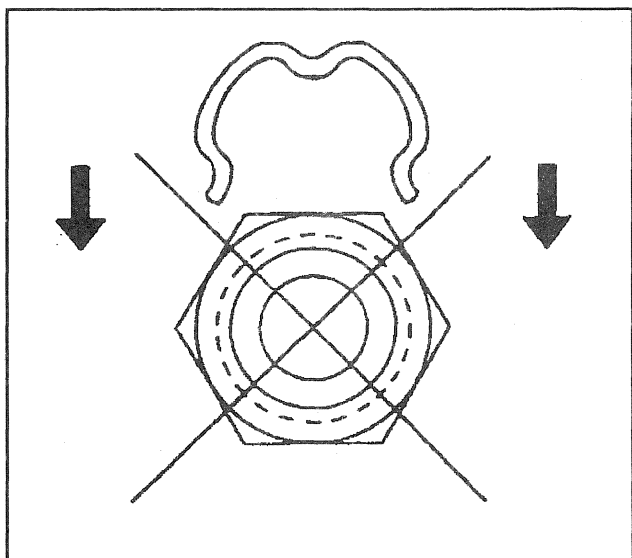
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4. With one end of the retaining clip engaged in the connector fitting slot, use your thumb to rotate the retaining clip around the connector fittings, until it snaps into place.

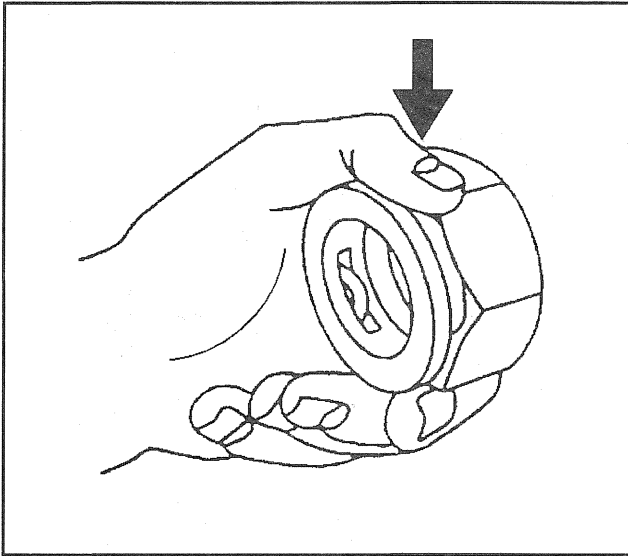


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5. Do not install the new retaining ring onto the fitting by pushing the retaining ring.

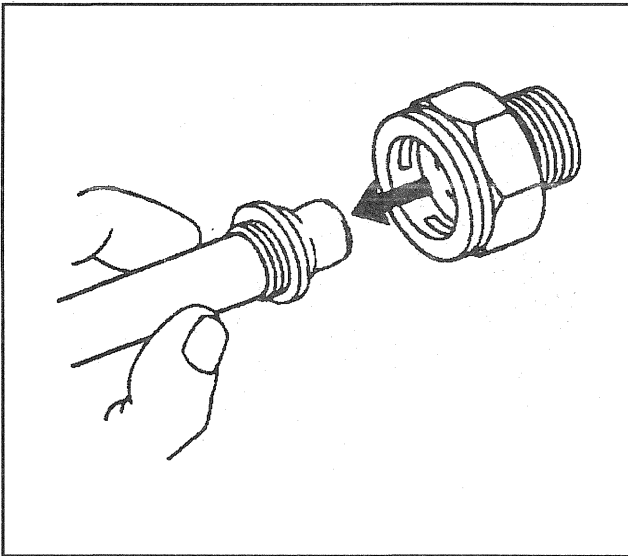


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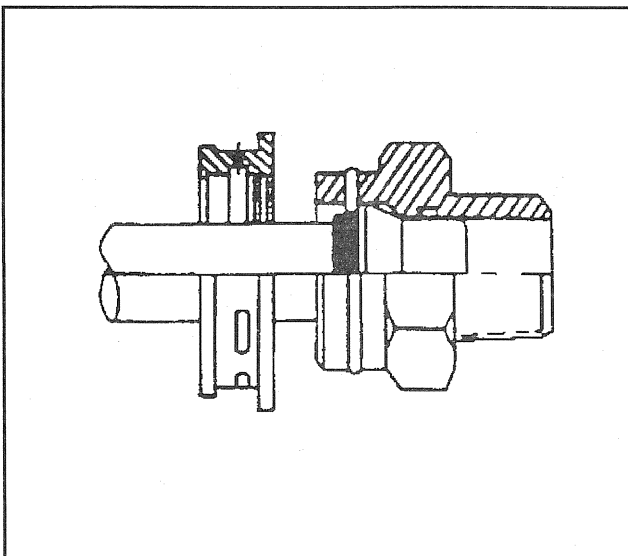
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6. Ensure that the three retaining ring ears are seen from inside the fitting and that the retaining ring moves freely in the fitting slots.
7. Install the new retaining ring into the remaining quick connect fittings.



104740

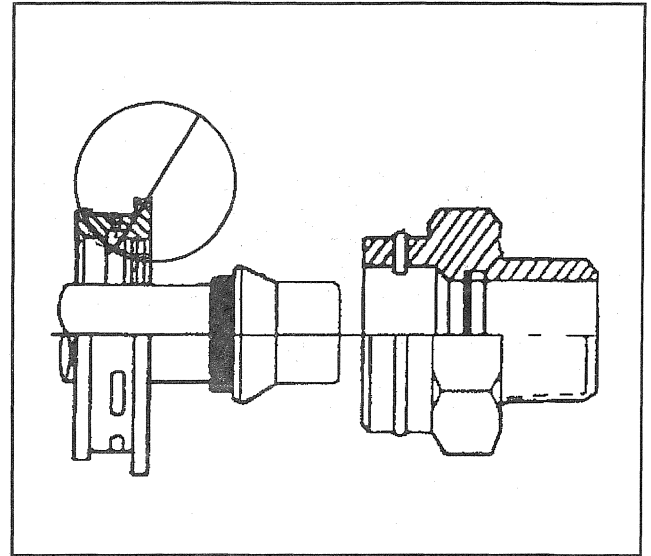
8. Install the cooler lines to the vehicle. Ensure the cooler line being installed has a plastic cap on each end that connects to the quick connect fitting. If no plastic cap exists, or the plastic cap is damaged, obtain a new cap and position on to the cooler line prior to the cooler line installation.
 - Before connecting the lines, test the oil flow through the cooler.
 - If oil flow restriction is not present, connect the oil lines to the connector fitting.
 - If oil flow restriction is present, replace the radiator. Refer to *Radiator Replacement*.



104752

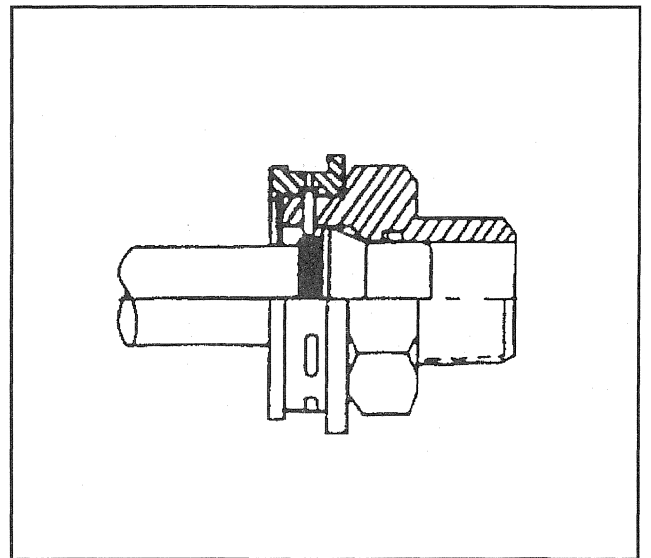
9. Install the cooler line into the quick connect fitting.
10. Insert the cooler line end into the quick connect fitting until a click is either heard or felt.

11. Do not use the plastic cap on the cooler line in order to install the cooler line into the fitting.
12. Pull back sharply on the cooler line in order to ensure that the cooler line is fastened into the quick connect fitting.



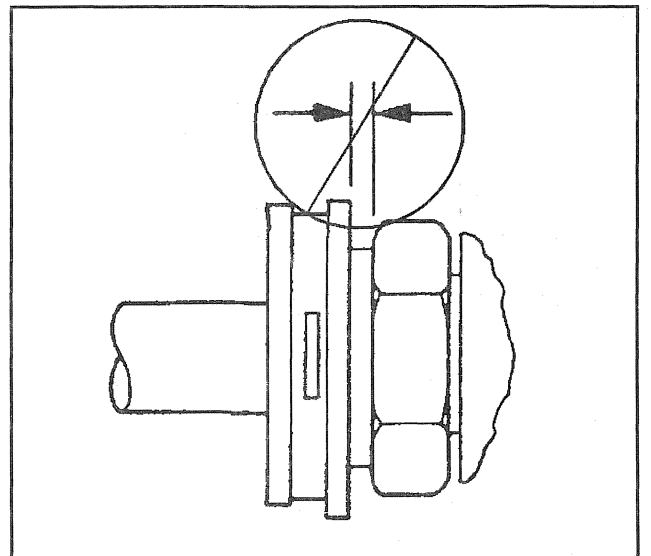
104750

13. Position (snap) the plastic cap onto the fitting. Do not manually depress the retaining ring when installing the plastic cap onto the quick connect fitting.
14. Ensure that the plastic cap is fully seated against the fitting.

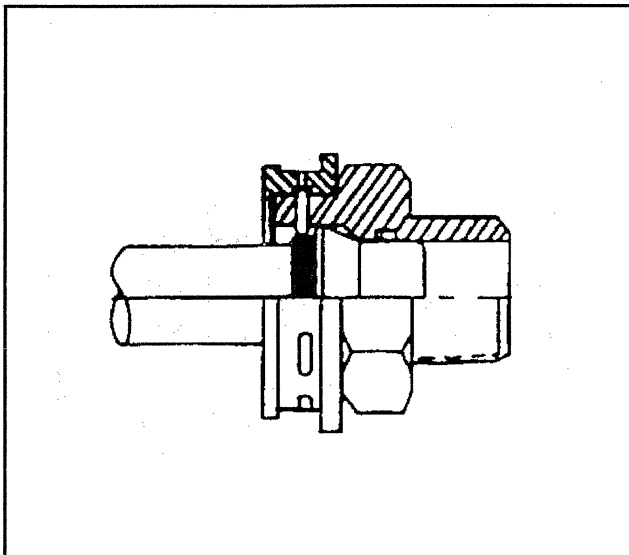


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15. Ensure that no gap is present between the cap and the fitting.

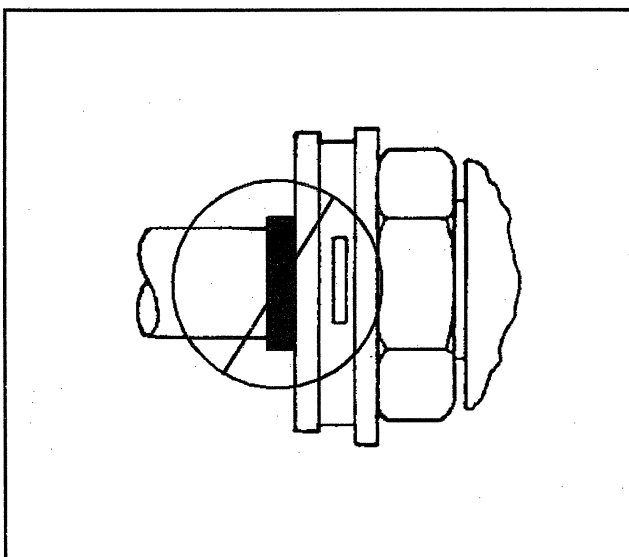


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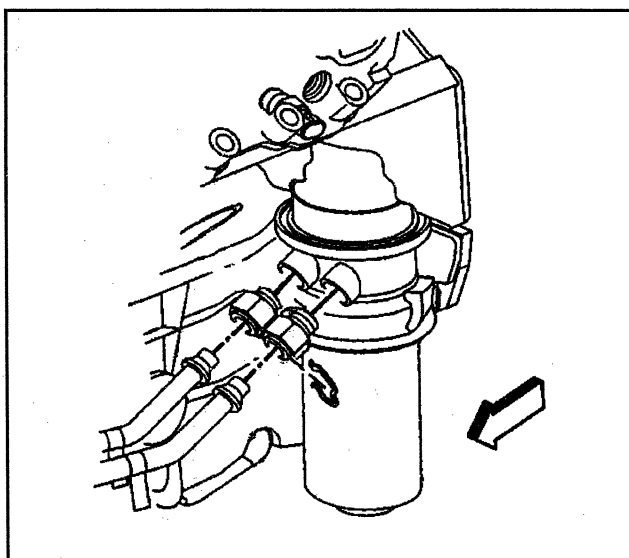
104753

16. Ensure that the yellow identification band on the tube is hidden within the quick connect fitting. A hidden yellow identification band indicates proper joint seating.



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17. Do not install the cooler line end into the fitting incorrectly.
18. If you cannot position the plastic cap against the fitting, remove the retaining ring from the quick connect fitting of the cooler line. Check the retaining ring and the tube end in order to ensure neither is bent. Replace the cooler line or the retaining ring if necessary.
19. Install the cooler line into the quick connect fitting again in order to install the remaining cooler lines into the remaining quick connect fittings.



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Notice: Refer to *Fastener Notice* in Cautions and Notices.

20. For the 4.3L, install the oil cooler lines to the oil cooler fittings.

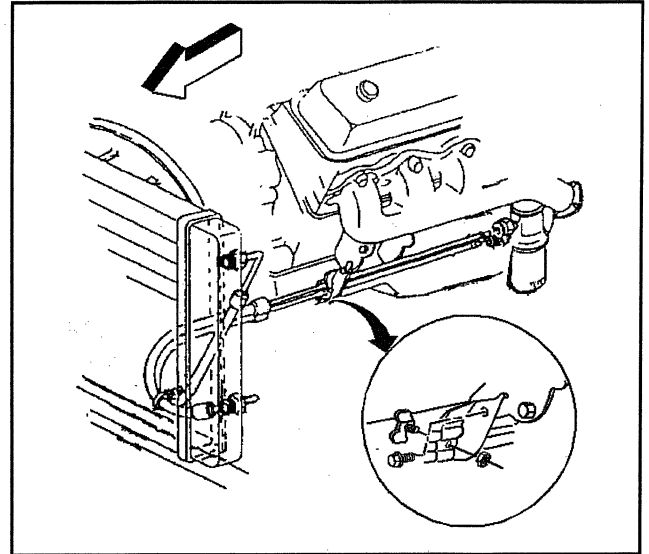
Tighten

Tighten the oil cooler fittings to 24 N·m (18 lb ft).

21. For the 5.0L and the 5.7L, install the oil cooler lines to the oil cooler fittings.

Tighten

Tighten the oil cooler fittings to 24 N·m (18 lb ft).



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22. For the 7.4L, install the oil cooler lines to the oil cooler fittings.

Tighten

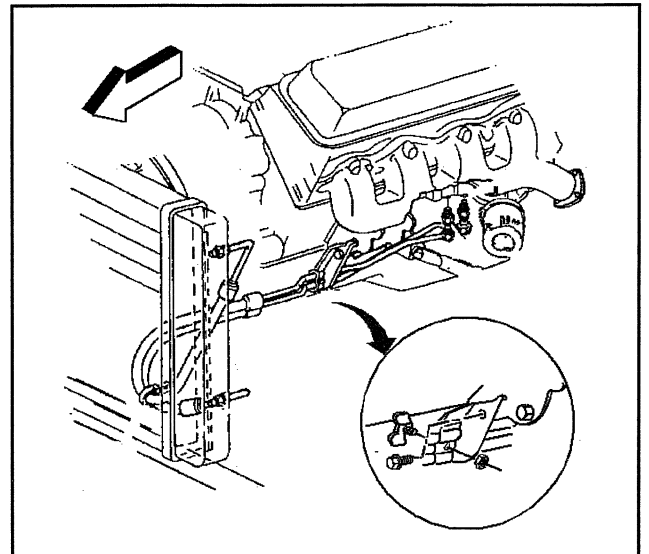
Tighten the oil cooler fittings to 24 N·m (18 lb ft).

23. Install the oil cooler lines to the clip.

24. Install the bolt to the clip.

Tighten

Tighten the bolt to 6 N·m (53 lb in).



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25. For diesel engines, install the oil cooler lines to the oil cooler fittings.

Tighten

Tighten the oil cooler fittings to 24 N·m (18 lb ft).

26. Install the oil cooler lines to the clip.

27. Install the bolt to the clip.

Tighten

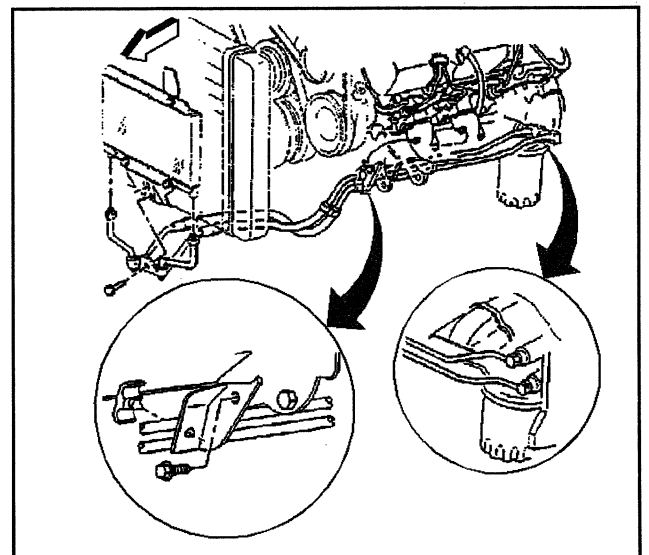
Tighten the bolt to 6 N·m (53 lb in).

28. Tighten the bolt and the clamp to the bracket.

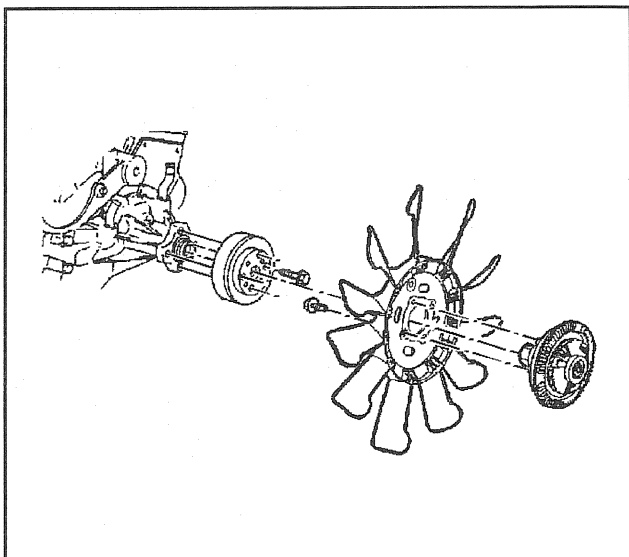
Tighten

Tighten the bolt to 9 N·m (80 lb in).

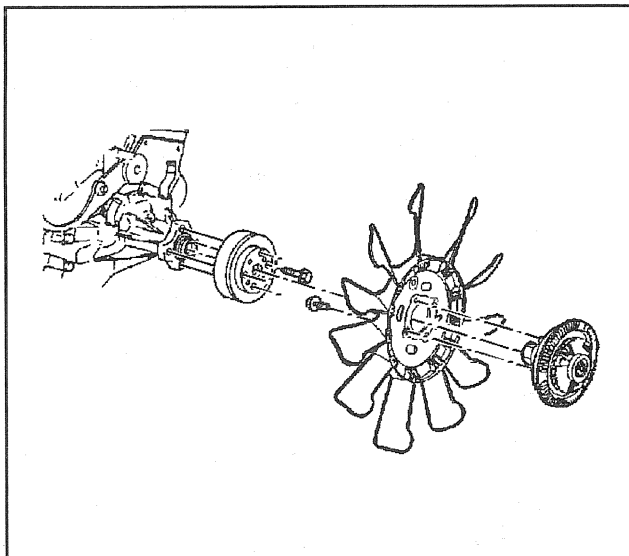
29. Run the engine. Check the cooling system for leaks.



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Fan Clutch Replacement (4.3L, 5.0L and 5.7L)

Removal Procedure

Tools Required

J 41240 Fan Clutch Wrench

Caution: Do not use or attempt to repair a damaged cooling fan assembly. Replace damaged fans with new assemblies. An unbalanced cooling fan could fly apart causing personal injury and property damage.

1. Remove the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.
2. Remove the accessory drive belt. Refer to the appropriate procedure:
 - *Drive Belt Replacement* in Engine Mechanical - 4.3L
 - *Drive Belt Replacement* in Engine Mechanical - 5.0L, 5.7L
 - *Drive Belt Replacement (6.5L Drive Belt)* in Engine Mechanical - 6.5L
3. Remove the fan and clutch assembly using the J 41240.
4. Remove the fan blade from the clutch.

Installation Procedure

Caution: Do not use or attempt to repair a damaged cooling fan assembly. Replace damaged fans with new assemblies. An unbalanced cooling fan could fly apart causing personal injury and property damage.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the fan blade to the clutch.

Tighten

Tighten the bolts to 23 N·m (17 lb ft).

2. Install the fan and clutch assembly using the J 41240.

Tighten

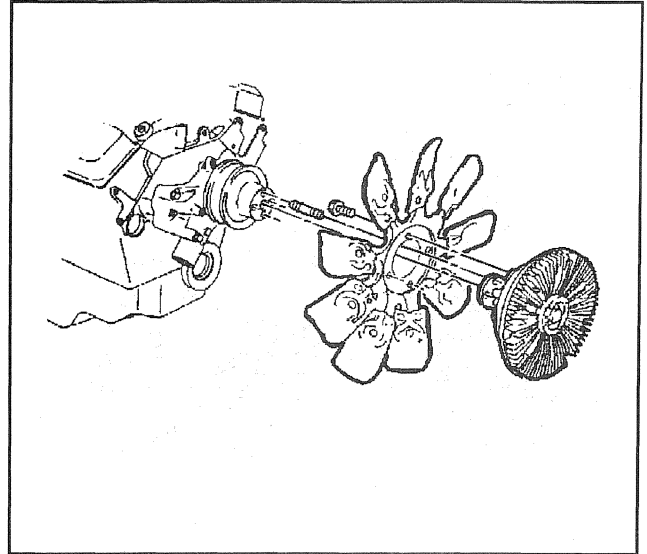
Tighten the fan clutch nut to 56 N·m (41 lb ft).

3. Install the accessory drive belt. Refer to the appropriate procedure:
 - *Drive Belt Replacement* in Engine Mechanical - 4.3L
 - *Drive Belt Replacement* in Engine Mechanical - 5.0L, 5.7L
 - *Drive Belt Replacement (6.5L Drive Belt)* in Engine Mechanical - 6.5L
4. Install the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.

Fan Clutch Replacement (7.4L)

Removal Procedure

1. Remove the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.
 - Locate the yellow dot on the fan clutch hub.
 - Mark the coolant pump pulley adjacent to the yellow dot.
2. Remove the nuts from the fan clutch hub.
3. Remove the fan and fan clutch from the coolant pump pulley.
4. Remove the bolts.
5. Remove the radiator fan from the fan clutch.
6. Inspect the mating surfaces of the coolant pump hub and the fan clutch hub for smoothness. Rework as needed in order to eliminate any burrs or other imperfections.



108015

Installation Procedure

Caution: Do not use or attempt to repair a damaged cooling fan assembly. Replace damaged fans with new assemblies. An unbalanced cooling fan could fly apart causing personal injury and property damage.

1. Install the radiator fan to the fan clutch.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the bolts.

Tighten

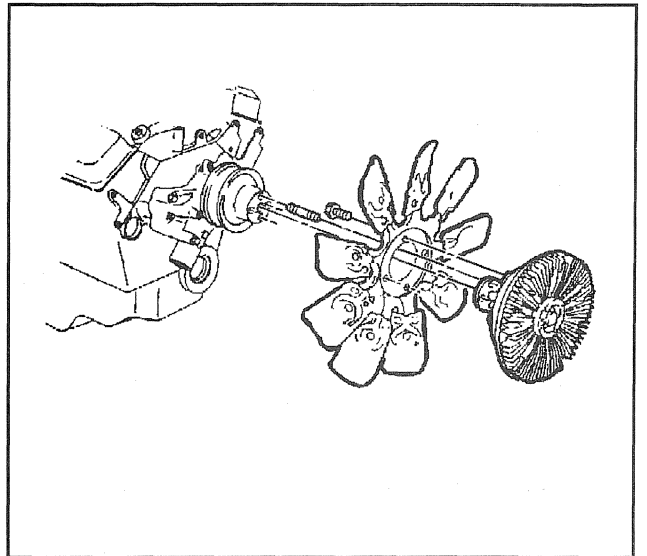
Tighten the bolts to 24 N·m (18 lb ft).

3. Install the fan and clutch assembly to the coolant pump pulley. Align the yellow marks on the coolant pump pulley and the fan clutch hub.
4. Install the nuts.

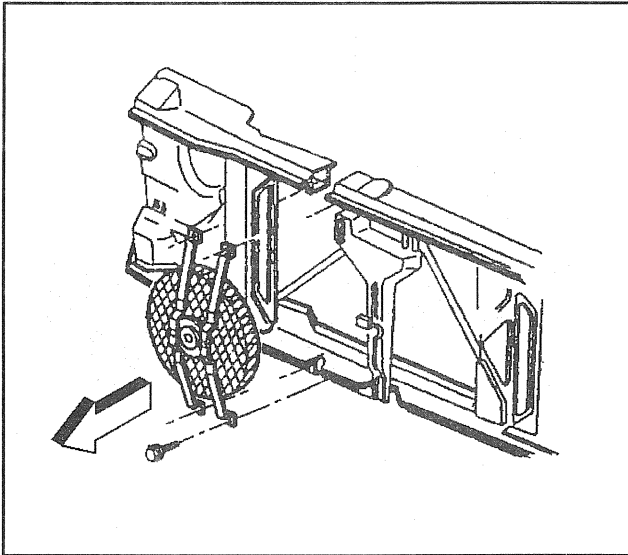
Tighten

Tighten the nuts to 24 N·m (18 lb ft).

5. Install the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.



108015



72751

Cooling Fan and Motor Replacement - Auxiliary

Removal Procedure

The auxiliary cooling fan, if equipped, provides additional cooling under the following conditions:

- Low speed vehicle operations
- Extended idle
- Stop-and-go conditions

In cases of extreme coolant temperatures, the fan runs after engine shutdown. The auxiliary cooling fan is behind the grille on the right side of the vehicle.

The auxiliary cooling fan circuit consists of the following components:

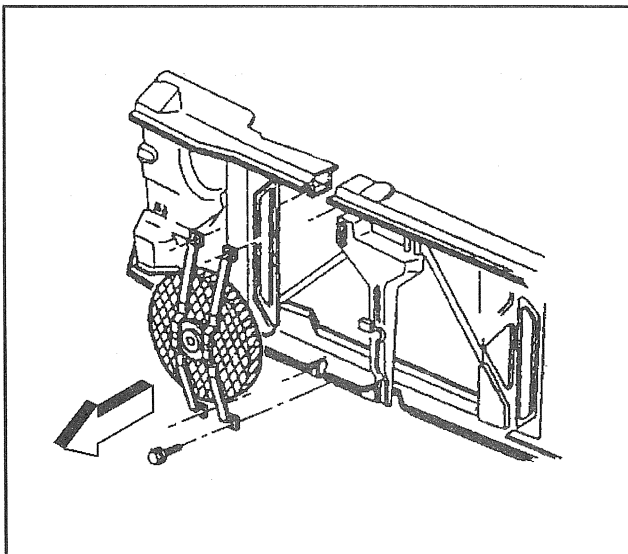
- The auxiliary fan
- A relay
- The vehicle control module (VCM)

Once the VCM determines that the fan activation is appropriate (a function of coolant temperature, vehicle speed, and A/C system status), the VCM completes the ground side of the circuit to the relay coil. This energizes the relay, providing 12 volts to the auxiliary fan.

When the VCM determines that the fan operation is no longer required, the relay is de-energized, and voltage is no longer applied to the fan.

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

1. Disconnect the negative battery cable. Refer to *Battery Cable* in Engine Electrical.
2. Remove the radiator grille assembly. Refer to *Air Inlet Grille Panel Replacement* in Body Front End.
3. Disconnect the connector from the auxiliary fan.
4. Remove the auxiliary fan.



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Installation Procedure

1. Install the auxiliary fan.
2. Connect the connector to the auxiliary fan.
3. Install the radiator grille. Refer to *Air Inlet Grille Panel Replacement* in Body Front End.
4. Connect the negative battery cable. Refer to *Battery Cable* in Engine Electrical.

Cooling Fan Relay Replacement - Auxiliary

Removal Procedure

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

1. Disconnect the negative battery cable. Refer to *Battery Cable* in Engine Electrical.
2. Remove the fan relay from the underhood fuse/relay center.

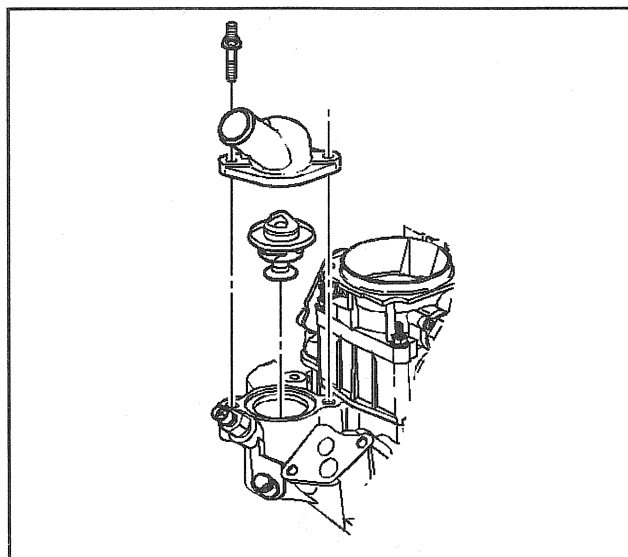
Installation Procedure

1. Install the fan relay to the underhood fuse/relay center.
2. Connect the negative battery cable. Refer to *Battery Cable* in Engine Electrical.

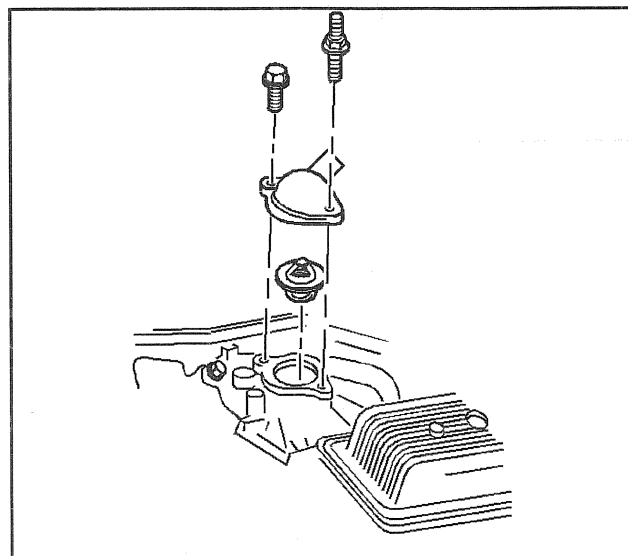
Thermostat Replacement (Gasoline Engines)

Removal Procedure

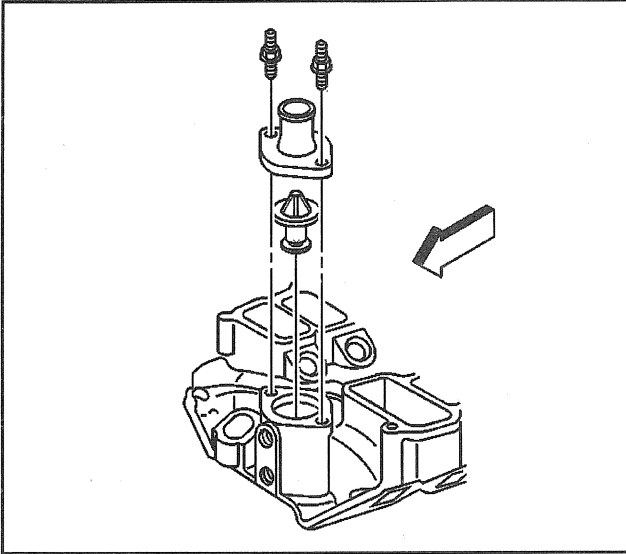
1. Drain the coolant until the radiator coolant level is below the thermostats. Refer to *Draining and Filling Cooling System*.
2. On the 4.3L, remove the following items:
 - 2.1. The bolts or studs
 - 2.2. The coolant outlet
 - 2.3. The thermostat from the housing
 - 2.4. The gasket (If necessary)
3. On the 5.0L and the 5.7L, remove the following items:
 - 3.1. The bolts or studs
 - 3.2. The coolant outlet
 - 3.3. The thermostat from the housing
 - 3.4. The gasket (If necessary)



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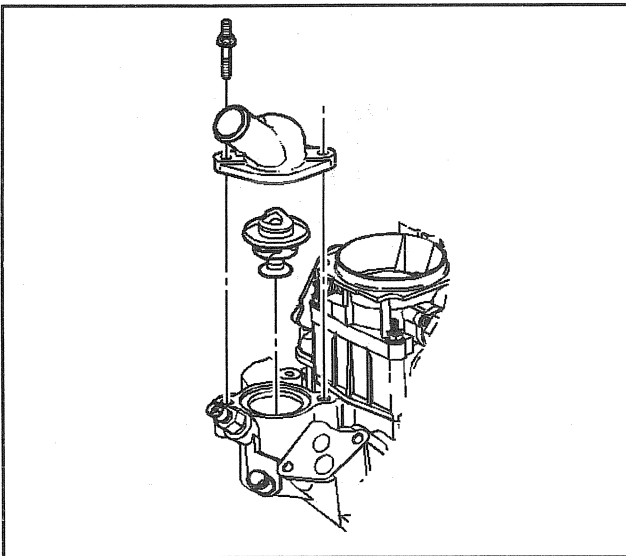


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4. On the 7.4L, remove the following items:
 - 4.1. The bolts or studs
 - 4.2. The coolant outlet
 - 4.3. The thermostat from the housing
 - 4.4. The gasket (If necessary)
5. Clean the thermostat housing and the cooling outlet sealing surfaces.



48323

Installation Procedure

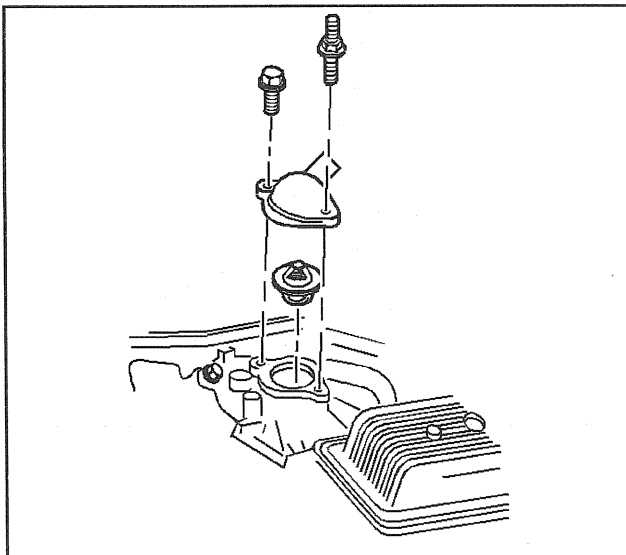
1. For the 4.3L, install the following items:
 - 1.1. The thermostat into the housing
 - 1.2. The gasket (If necessary)
 - 1.3. The coolant outlet

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the bolts or the studs

Tighten

Tighten the bolts or the studs to 28 N·m (21 lb ft).



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3. For the 5.0L and the 5.7L, install the following items:
 - 3.1. The thermostat into the housing
 - 3.2. The gasket (If necessary)
 - 3.3. The coolant outlet
 4. Install the bolts or the studs
- Tighten**
- Tighten the bolts or the studs to 28 N·m (21 lb ft).

5. For the 7.4L, install the following items:

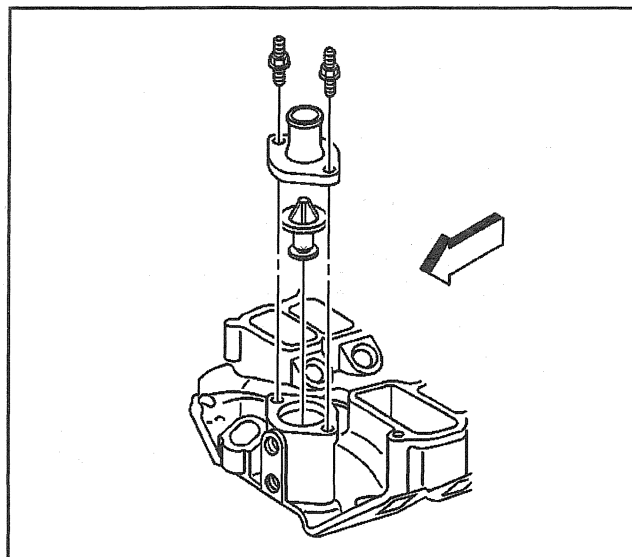
- 5.1. The thermostat into the housing
- 5.2. The gasket (if necessary)
- 5.3. The coolant outlet

6. Install the bolts or the studs

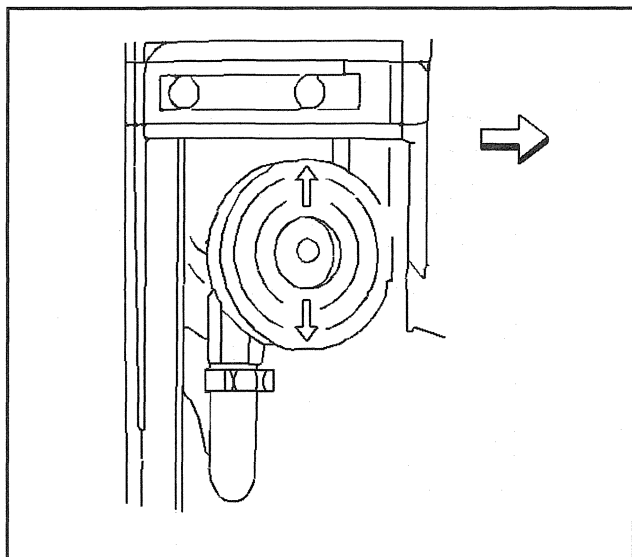
Tighten

Tighten the studs to 37 N·m (27 lb ft).

7. Refill the coolant to the cooling system. Refer to *Draining and Filling Cooling System*.
8. Start the engine. Run the engine, with the radiator cap removed, until the radiator upper hose becomes hot (This indicates that the thermostat is open).
9. With the engine idling, add the coolant to the radiator until the coolant level reaches the bottom of the filler neck.
10. Install the radiator cap to the radiator. Make sure that the cap arrows (1) line up with the overflow tube.
11. Inspect the cooling system for leaks.



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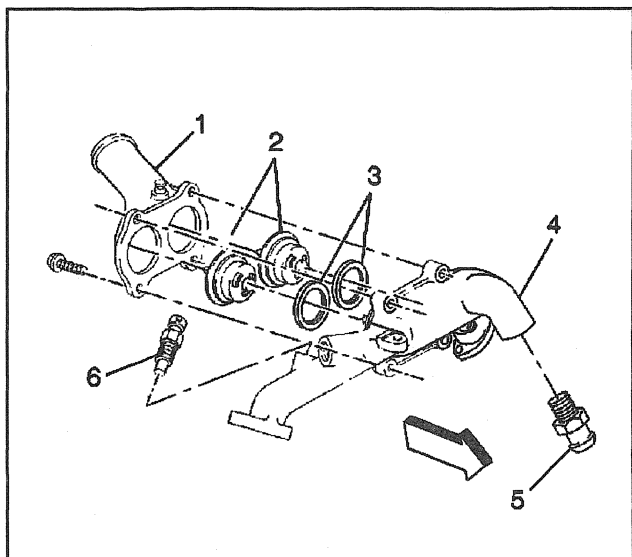


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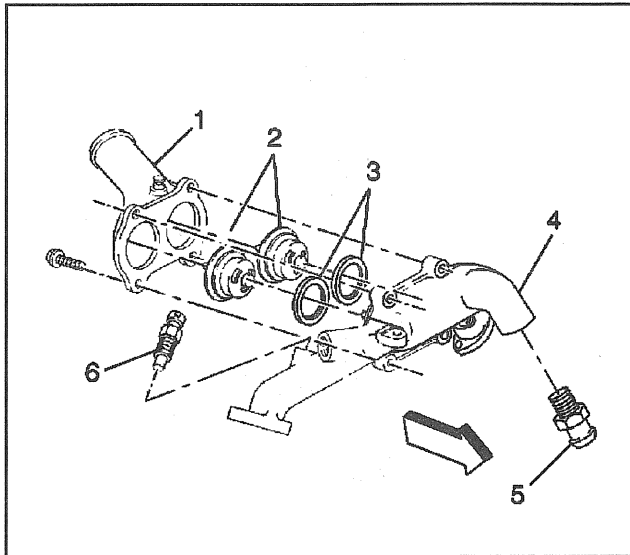
Thermostat Replacement (Diesel Engines)

Removal Procedure

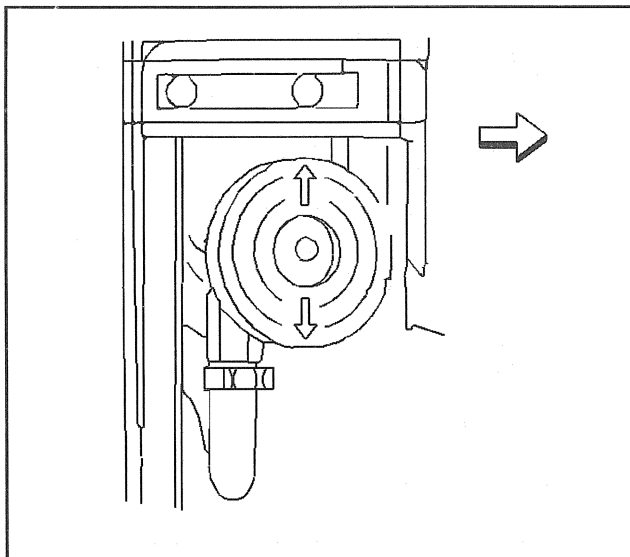
1. Drain the coolant until the radiator coolant level is below the thermostat. Refer to *Draining and Filling Cooling System*.
2. Disconnect the radiator inlet hose.
3. Remove the bolt, the stud and the coolant outlet (4).
4. Remove the gaskets (3).
5. Remove the thermostats (2) from the housing (1).
6. Clean the sealing surfaces of the thermostat housing (1) and the coolant outlet (4).



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Installation Procedure

1. Install the thermostats (2) into the housing (1). Replace both thermostats to ensure that the cooling system functions properly.
2. Install the gaskets (3) into position.
3. Install the coolant outlet.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the bolt and the stud.

Tighten

Tighten the bolt and the stud to 42 N·m (31 lb ft).

5. Connect the radiator inlet hose.
6. Refill the coolant into the cooling system. Refer to *Draining and Filling Cooling System*.
7. Start the engine. Run the engine, with the radiator cap removed, until the upper radiator hose becomes hot (This indicates that the thermostat is open).
8. With the engine idling, add coolant to the radiator until the coolant level reaches the bottom of the filler neck.
9. Install the radiator cap to the radiator. Make sure that the arrows line up with the overflow tube.
10. Inspect the cooling system for leaks.

Thermostat Housing Crossover Replacement

Removal Procedure

1. Drain the coolant from the radiator. Refer to *Draining and Filling Cooling System*.
2. Remove the compressor. Refer to the appropriate procedure in HVAC Systems with A/C - Manual:
 - *Compressor Replacement (4.3L, 5.0L, 5.7L)*
 - *Compressor Replacement (7.4L)*
 - *Compressor Replacement (Diesel)*
3. Remove the crankcase depression regulator valve.
4. Remove the generator upper bracket. Refer to *Generator Replacement (Gasoline Engines)* or *Generator Replacement (Diesel Engines)* in Engine Electrical.
5. Disconnect the bypass hose.
6. Disconnect the upper radiator hose. Refer to *Radiator Hose Replacement (6.5 L)*.
7. Disconnect the heater hose. Refer to *Heater Hoses Replacement* in HVAC Systems with A/C - Manual.
8. Remove the studs and the bolts.
9. Remove the coolant crossover housing assembly (4) from the vehicle. The thermostats (2) and the coolant outlet (1) attach to the crossover housing assembly, along with the thermostat bypass nipple (5).
10. Clean the crossover housing sealing surfaces.

Installation Procedure

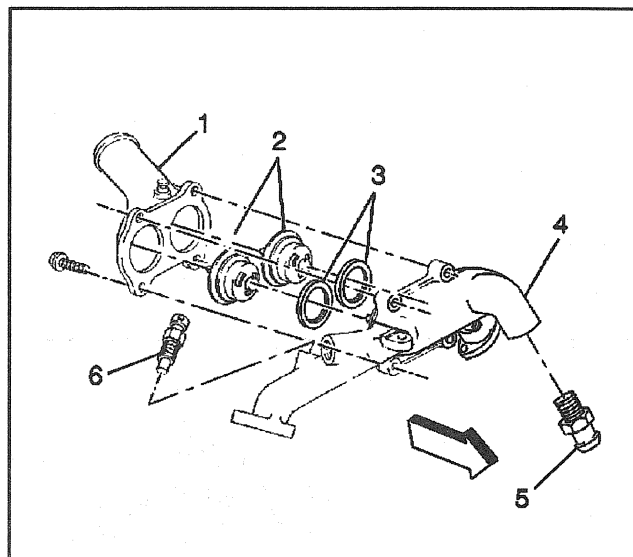
1. Install the new gaskets (3).
2. Install the coolant crossover housing assembly (4).
3. Install the studs and the bolts.

Tighten

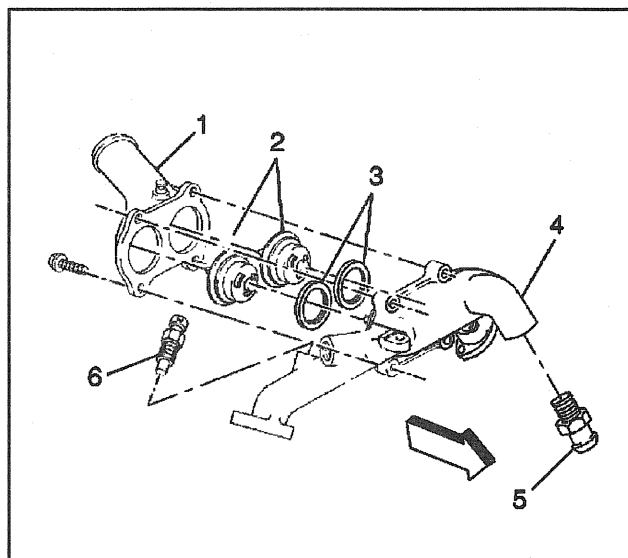
Tighten the studs and the bolts to 42 N·m (31 lb ft).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

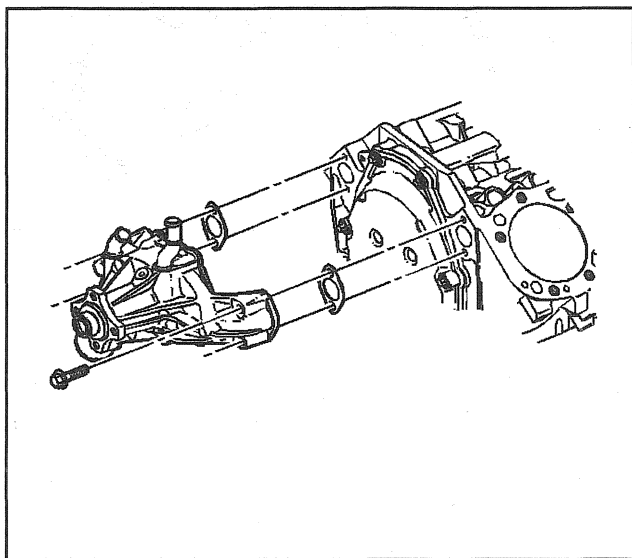
4. Connect the heater hose. Refer to *Heater Hoses Replacement* in HVAC Systems with A/C - Manual.
5. Connect the upper radiator hose. Refer to *Radiator Hose Replacement (6.5 L)*.
6. Connect the bypass hose.
7. Install the generator upper bracket. Refer to *Generator Replacement (Gasoline Engines)* or *Generator Replacement (Diesel Engines)* in Engine Mechanical.
8. Install the compressor. Refer to the appropriate procedure in HVAC Systems with A/C - Manual:
 - *Compressor Replacement (4.3L, 5.0L, 5.7L)*
 - *Compressor Replacement (7.4L)*
 - *Compressor Replacement (Diesel)*
9. Install the crankcase depression regulator valve.



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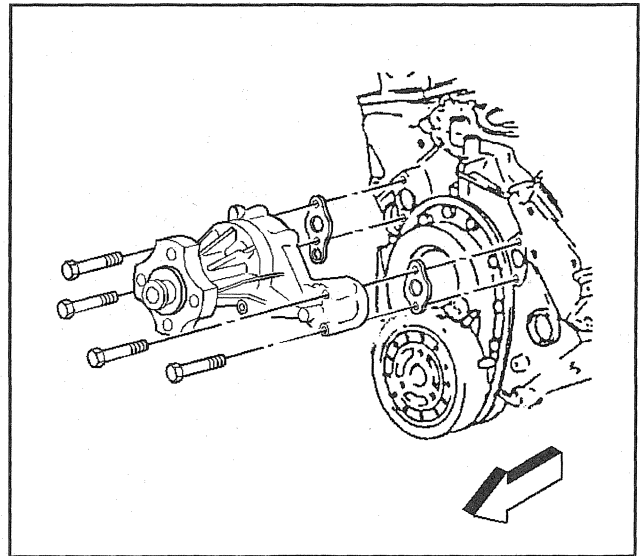
10. Fill the cooling system with coolant. Refer to *Draining and Filling Cooling System*.
11. Start the engine. Run the engine, with the surge tank cap removed, until the upper radiator hose becomes hot. This indicates that the thermostat is open.
12. Attach the surge tank cap to the surge tank. Make sure that the cap arrows line up with the overflow tube.
13. Inspect the cooling system for leaks.

Water Pump Replacement (Gasoline Engines)

Removal Procedure

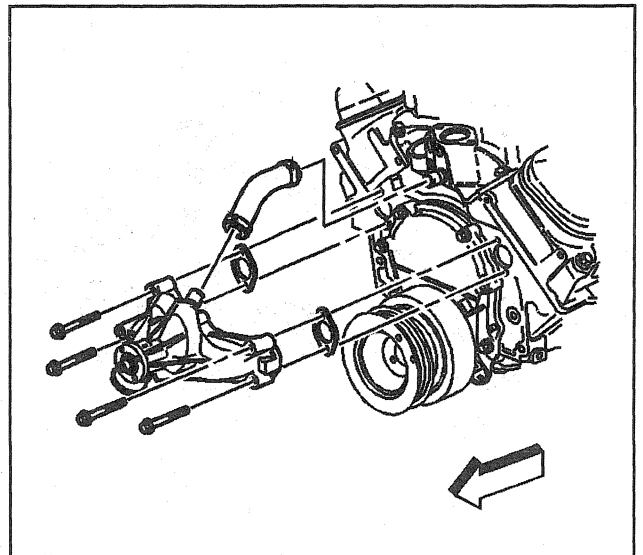
1. Drain the coolant from the radiator. Refer to *Draining and Filling Cooling System*.
2. Remove the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.
3. Remove the drive belt. Refer to the appropriate procedure:
 - *Drive Belt Replacement* in Engine Mechanical - 4.3L
 - *Drive Belt Replacement* in Engine Mechanical - 5.0L, 5.7L
 - *Drive Belt Replacement (6.5L Drive Belt)* in Engine Mechanical - 6.5L
 - *Drive Belt Replacement* in Engine Mechanical - 7.4L
4. Remove the fan, the fan clutch, and the pulley from the coolant pump.
 - For the 4.3L, 5.0L, and 5.7L engines refer to *Fan Clutch Replacement (4.3L, 5.0L and 5.7L)*.
 - For the 7.4L engine, refer to *Fan Clutch Replacement (7.4L)*.
5. Disconnect the radiator outlet hose from the coolant pump.
 - For the 4.3L and 5.0L, refer to *Radiator Hose Replacement (4.3L and 5.0L)*.
 - For the 5.7L, refer to *Radiator Hose Replacement (5.7 L)*.
 - For the 7.4L, refer to *Radiator Hose Replacement (7.4 L)*.
6. Disconnect the heater hose from the coolant pump. Refer to *Heater Hoses Replacement* in HVAC Systems with A/C - Manual.
7. On the 7.4L engine, disconnect the bypass hose.
8. For the 4.3L, remove the bolts.
9. Remove the coolant pump from the engine block.
10. Clean the mating surfaces on the coolant pump and the engine block.

11. For the 5.0L and 5.7L, remove the bolts.
12. Remove the coolant pump from the engine block.
13. Clean the mating surfaces on the coolant pump and the engine block.



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14. For the 7.4L, remove the bolts.
15. Remove the coolant pump from the engine block.
16. Clean the mating surfaces on the coolant pump and the engine block.



66263

Installation Procedure

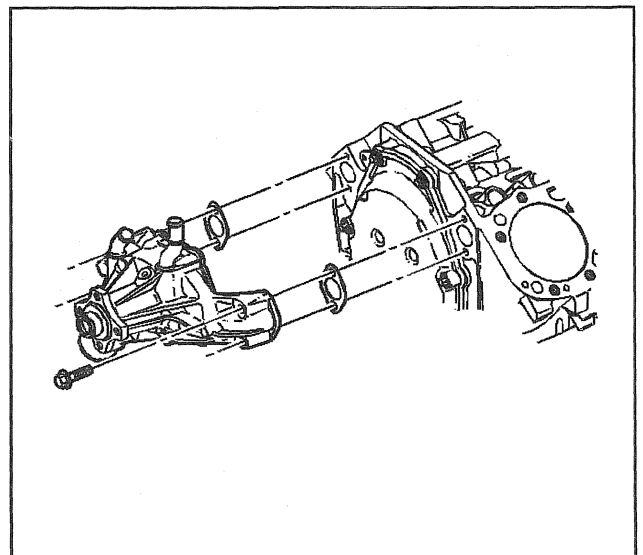
1. On the 4.3L, install the coolant pump to the engine block.
2. Install the new gaskets.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

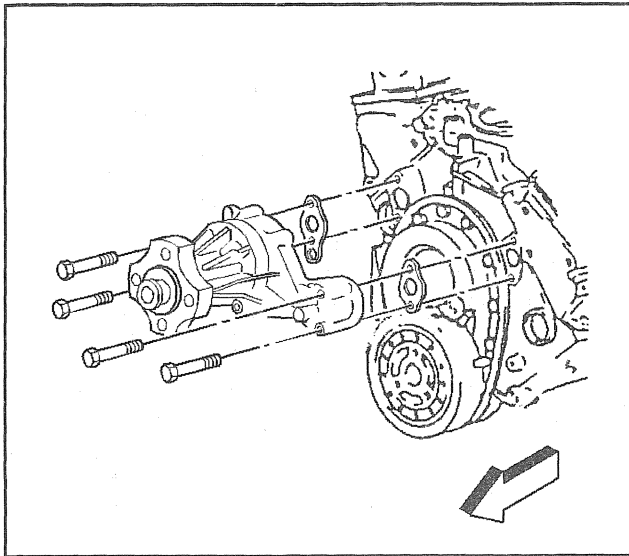
3. Install the bolts.

Tighten

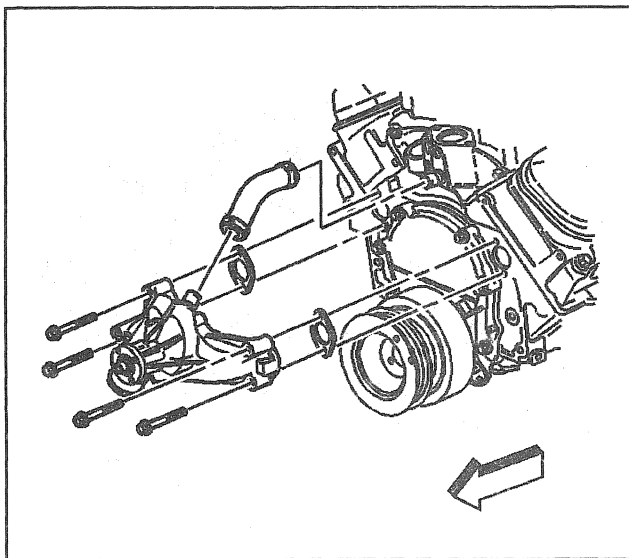
Tighten the bolts to 41 N·m (30 lb ft).



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4. On the 5.0L and 5.7L, install the coolant pump to the engine block.
5. Install the new gaskets.
6. Install the bolts.

Tighten

Tighten the bolts to 41 N·m (30 lb ft).

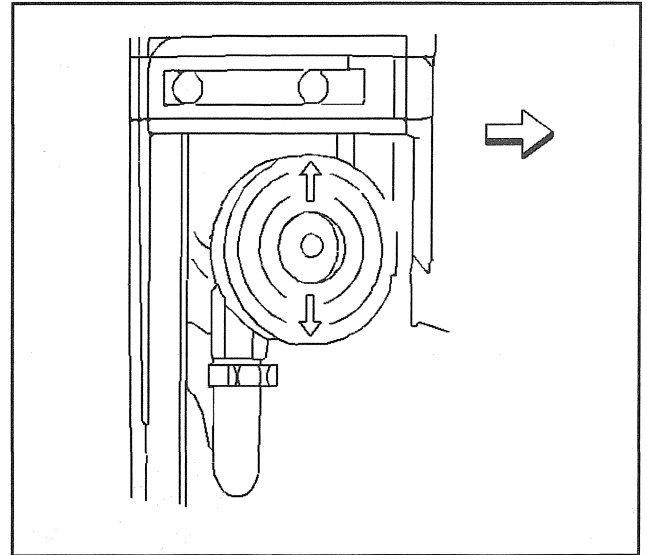
7. On the 7.4L, install the coolant pump to the engine block.
8. Install the new gaskets.
9. Install the bolts.

Tighten

Tighten the bolts to 41 N·m (30 lb ft).

10. Connect the radiator outlet hose to the coolant pump.
 - For the 4.3L and 5.0L, refer to *Radiator Hose Replacement (4.3L and 5.0L)*.
 - For the 5.7L, refer to *Radiator Hose Replacement (5.7 L)*.
 - For the 7.4L, refer to *Radiator Hose Replacement (7.4 L)*.
11. Connect the heater hose to the coolant pump. Refer to *Heater Hoses Replacement* in HVAC Systems with A/C - Manual.
12. On the 7.4L engine, connect the bypass hose.
13. Install the coolant pump pulley, the fan, and fan clutch to the coolant pump hub.
 - For the 4.3L, 5.0L, and 5.7L engines refer to *Fan Clutch Replacement (4.3L, 5.0L and 5.7L)*.
 - For the 7.4L, refer to *Fan Clutch Replacement (7.4L)*.
14. Install the drive belt. Refer to the appropriate procedure:
 - *Drive Belt Replacement* in Engine Mechanical - 4.3L
 - *Drive Belt Replacement* in Engine Mechanical - 5.0L, 5.7L
 - *Drive Belt Replacement (6.5L Drive Belt)* in Engine Mechanical - 6.5L
 - *Drive Belt Replacement* in Engine Mechanical - 7.4L
15. Install the upper fan shroud. Refer to *Fan Shroud Replacement (Lower)*.

16. Start the engine. Run the engine, with the radiator cap removed, until the upper radiator hose becomes hot (This indicates that the thermostat is open).
17. While the engine is running at idle speed, add coolant to the radiator, until the level reaches the bottom of the filler neck. Refer to *Draining and Filling Cooling System*.
18. Install the radiator cap. Make sure that the cap arrows line up with the overflow tube.
19. Inspect the cooling system for leaks.



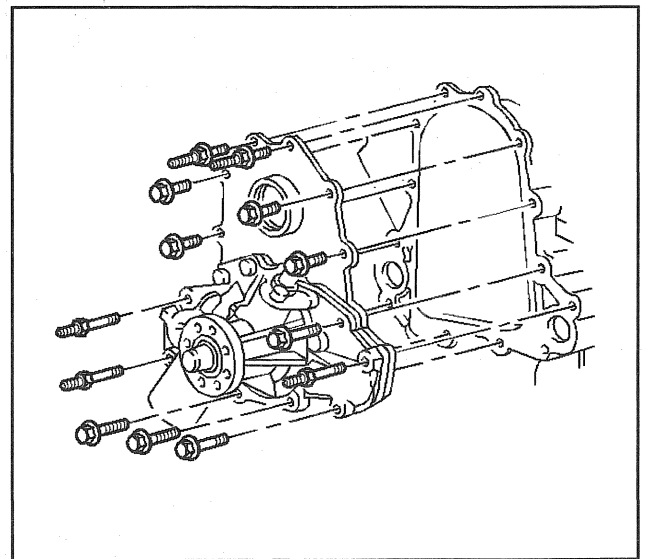
13762

Water Pump Replacement (Diesel Engines)

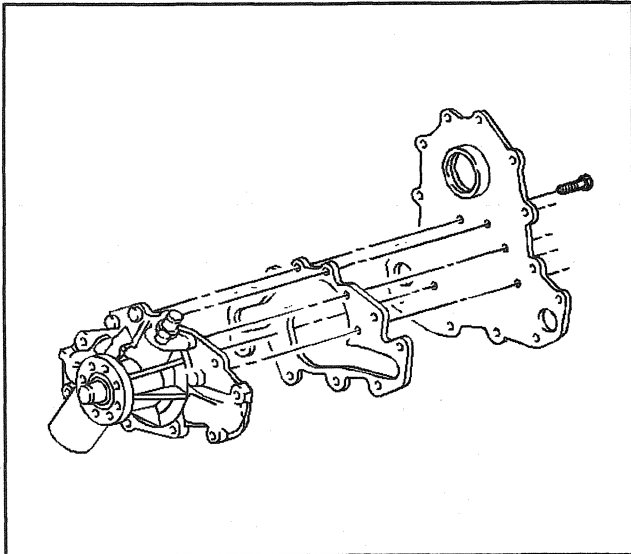
Removal Procedure

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

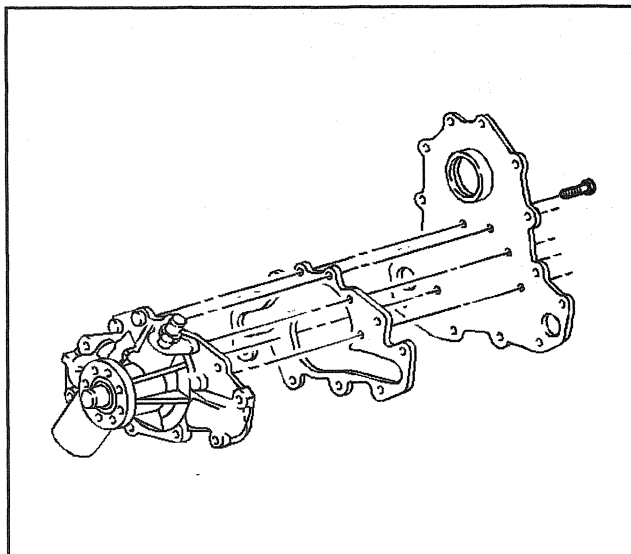
1. Disconnect the negative battery cable.
2. Drain the coolant from the radiator. Refer to *Draining and Filling Cooling System*.
3. Remove the fan shroud.
 - For the upper shroud, refer to *Fan Shroud Replacement (Upper)*.
 - For the lower shroud, refer to *Fan Shroud Replacement (Lower)*.
4. Remove the drive belt. Refer to the appropriate procedure:
 - *Drive Belt Replacement* in Engine Mechanical - 4.3L
 - *Drive Belt Replacement* in Engine Mechanical - 5.0L, 5.7L
 - *Drive Belt Replacement (6.5L Drive Belt)* in Engine Mechanical - 6.5L
 - *Drive Belt Replacement* in Engine Mechanical - 7.4L
5. Remove the fan and fan clutch. Refer to *Fan Clutch Replacement (4.3L, 5.0L and 5.7L)*.
6. Raise the vehicle. Support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.



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7. Remove the following vacuum pump components. Refer to *Vacuum Pump Replacement* in Vacuum Pump.
 - 7.1. The mounting bracket nuts
 - 7.2. The bolt securing the vacuum pump bracket and the generator
 - 7.3. The vacuum pump and the bracket
 8. Remove the power steering pump. Lay the pump aside. Refer to the appropriate procedure in Power Steering System:
 - *Power Steering Pump Replacement* (4.3L, 5.0L, 5.7L)
 - *Power Steering Pump Replacement* (7.4L)
 - *Power Steering Pump Replacement* (6.5L)
 9. Disconnect the lower radiator hose from the coolant pump. Refer to *Radiator Hose Replacement* (6.5 L).
 10. Disconnect the bypass hose from the coolant pump.
 11. Remove the bolts, the studs, the coolant pump backing plate and the coolant pump.
 12. Remove the bolt from the rear of the coolant pump backing plate.
 13. Remove the coolant pump and the gasket from the backing plate.
- Important:** All of the flanges must be free of oil.
14. Clean the following mating surfaces:
 - The coolant pump
 - The coolant pump backing plate (both sides)
 - The engine block

Installation Procedure

1. Install the gasket.
2. Install the coolant pump to the coolant pump backing plate.

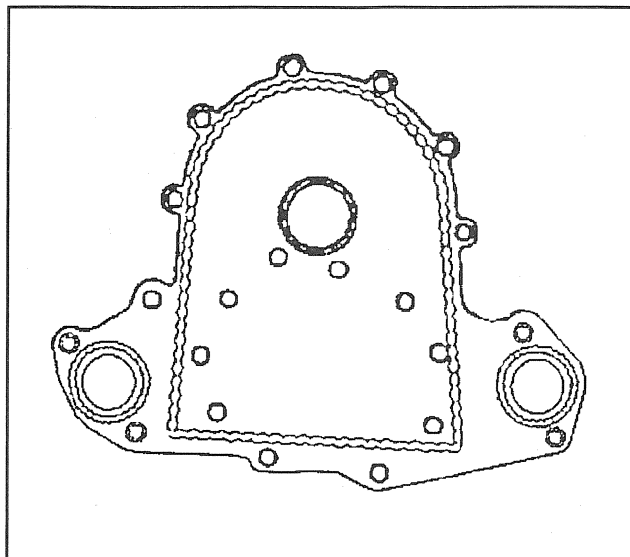
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the bolt.

Tighten

Tighten the bolt to 23 N·m (17 lb ft).

4. Apply anaerobic sealer GM P/N 1052357, or equivalent to the coolant pump backing plate. The sealer must be wet to the touch when tightening the bolts.



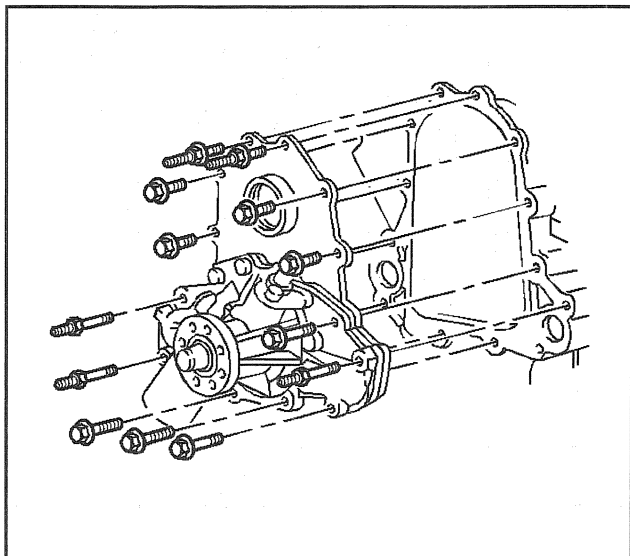
66579

5. Install the coolant pump and the coolant pump backing plate to the engine.
6. Install the bolts and the studs.

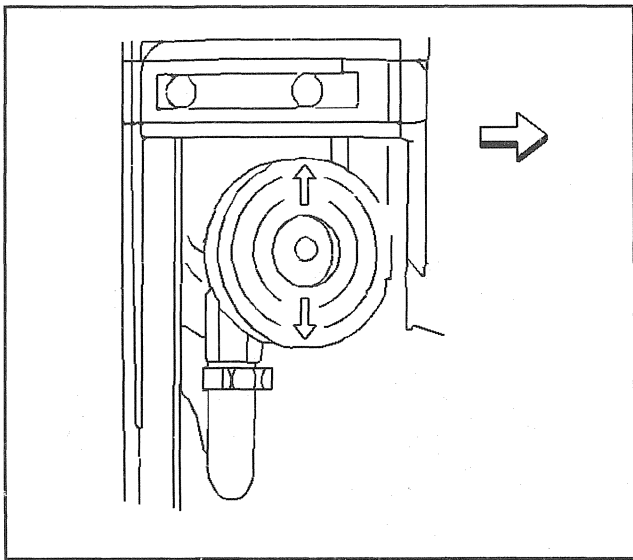
Tighten

Tighten the bolts and the studs to 42 N·m (31 lb ft).

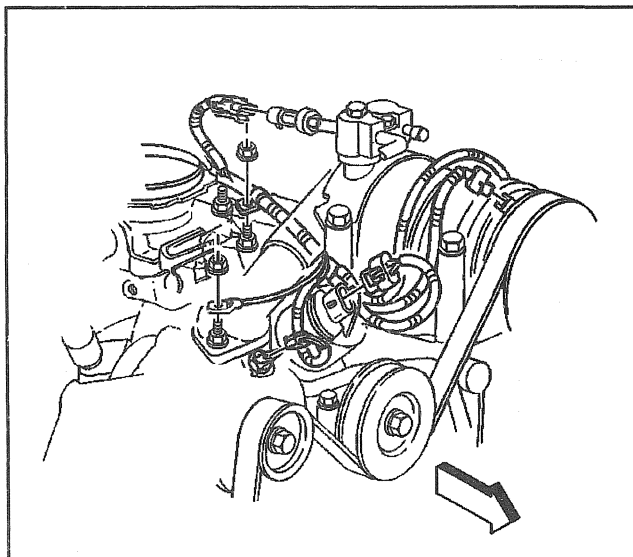
7. Connect the bypass hose.
8. Connect the lower radiator hose. Refer to *Radiator Hose Replacement* (6.5 L).
9. Install the power steering bracket and the pump. Refer to the appropriate procedure in Power Steering System:
 - *Power Steering Pump Replacement* (4.3L, 5.0L, 5.7L)
 - *Power Steering Pump Replacement* (7.4L)
 - *Power Steering Pump Replacement* (6.5L)
10. Install the vacuum pump and the bracket. Refer to *Vacuum Pump Replacement* in Vacuum Pump.
11. Install the bolt that holds the vacuum pump and the generator. Refer to *Vacuum Pump Replacement* in Vacuum Pump.
12. Install the fan and fan clutch assembly and the coolant pump pulley. Refer to *Fan Clutch Replacement* (4.3L, 5.0L and 5.7L).
13. Install the drive belt. Refer to the appropriate procedure:
 - *Drive Belt Replacement* in Engine Mechanical - 4.3L
 - *Drive Belt Replacement* in Engine Mechanical - 5.0L, 5.7L
 - *Drive Belt Replacement (6.5L Drive Belt)* in Engine Mechanical - 6.5L
 - *Drive Belt Replacement* in Engine Mechanical - 7.4L



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14. Install the fan shroud.
 - For the upper shroud, refer to *Fan Shroud Replacement (Upper)*.
 - For the lower shroud, refer to *Fan Shroud Replacement (Lower)*.
15. Connect the negative battery cable.
16. Fill the surge tank with coolant. Refer to *Draining and Filling Cooling System*.
17. Start the engine. Run the engine with the surge tank cap removed, until the upper radiator hose becomes hot. (This indicates that the thermostat is open).
18. While the engine is running at idle speed, add coolant to the surge tank until the level reaches the FULL mark. Refer to *Draining and Filling Cooling System*.
19. Install the surge tank cap. Make sure the cap arrows line up with the overflow tube.
20. Inspect the cooling system for leaks.

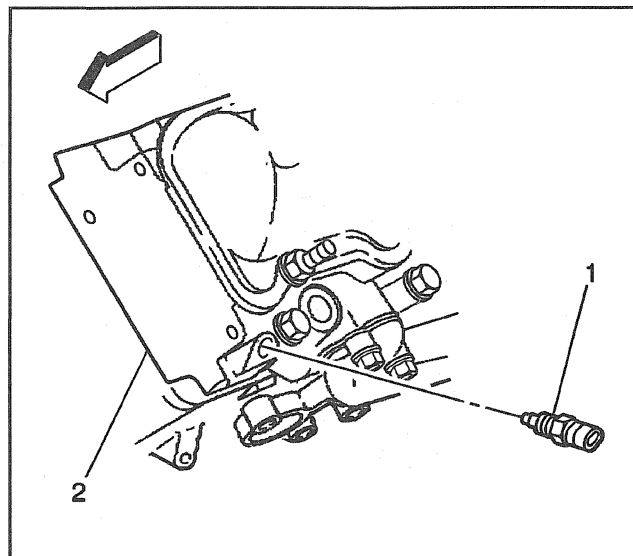
Engine Coolant Temperature Sensor Replacement

Removal Procedure

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

1. Disconnect the battery negative cable.
2. Disconnect the harness connector from the coolant temperature sensor.

3. Remove the coolant temperature sensor (1).
4. Drain the engine coolant into a suitable container as necessary. Refer to *Draining and Filling Cooling System*



200395

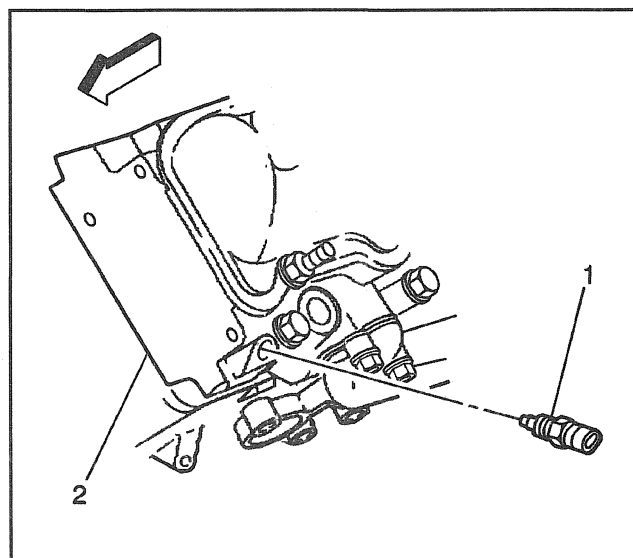
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the coolant sensor to the engine (1).

Tighten

Tighten the coolant sensor (1) to 20 N·m (15 lb ft).



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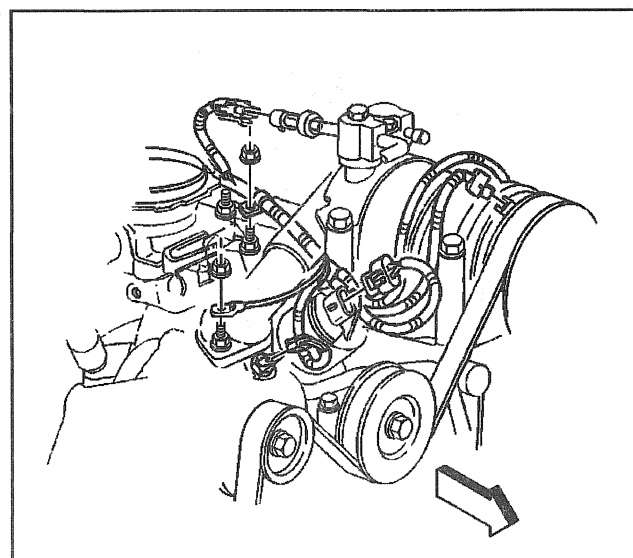
2. Install the harness connector.
3. Check the engine coolant level.
4. Refill the engine coolant as necessary. Refer to *Draining and Filling Cooling System*

Notice: Refer to *Fastener Notice* in Cautions and Notices.

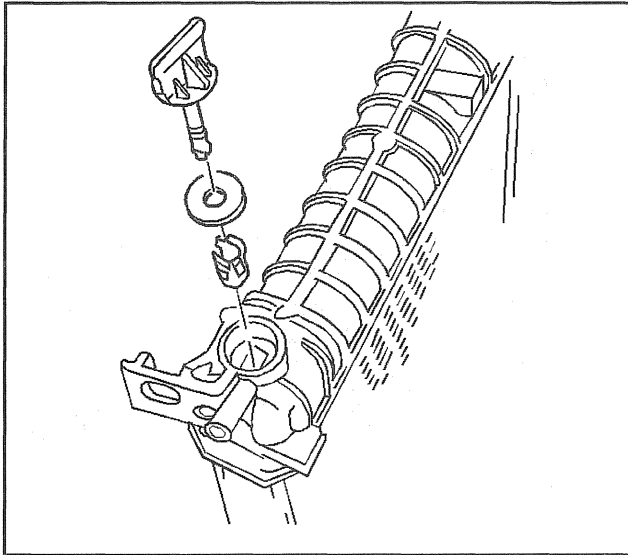
5. Connect the battery negative cable to the negative battery terminal.

Tighten

Tighten the battery negative cable bolt to 15 N·m (11 lb ft).



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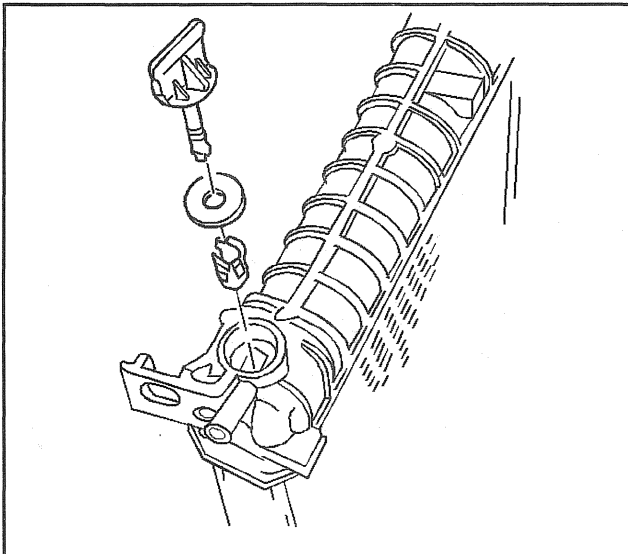
23699

Drain Cock Replacement

Removal Procedure

Notice: When adding coolant, use DEX-COOL® coolant. If silicated coolant is added to the system, premature engine, heater core or radiator corrosion may result. In addition, the engine coolant will require change sooner—at 50,000 km (30,000 mi) or 24 months.

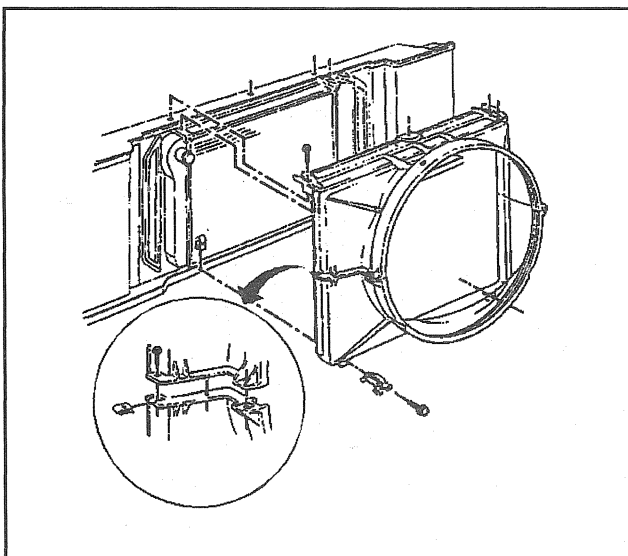
1. Drain the coolant from the radiator. Refer to *Draining and Filling Cooling System*.
2. Remove the radiator drain stem and seal. The seal usually comes out attached to the stem.
3. Remove the body of the drain cock. Use your fingers or needlenose pliers to disengage the locking tangs from the side tank.
4. Clean the drain.



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Installation Procedure

1. Install the drain cock body. Ensure that the body is fully seated in the side tank and that the locking tangs are engaged.
2. Install the seal on the drain cock stem.
3. Install the drain cock. Turn the stem clockwise to lock.
4. Refill the coolant to the proper level. Refer to *Draining and Filling Cooling System*.
5. Start the engine. After the engine reaches normal operating temperature, check for coolant leaks.



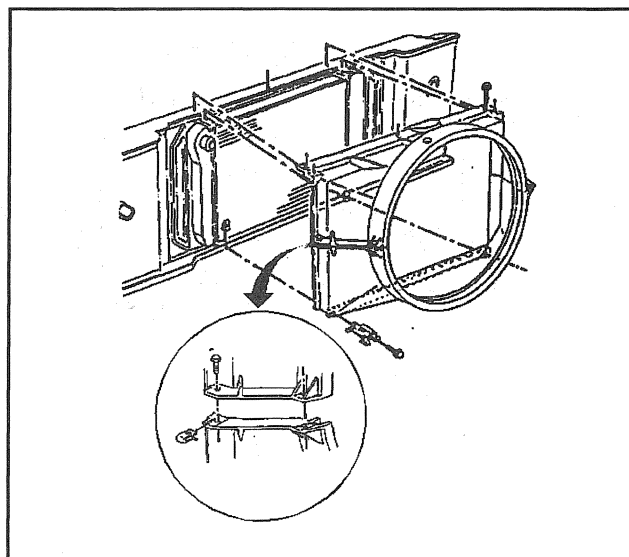
72746

Fan Shroud Replacement (Upper)

Removal Procedure

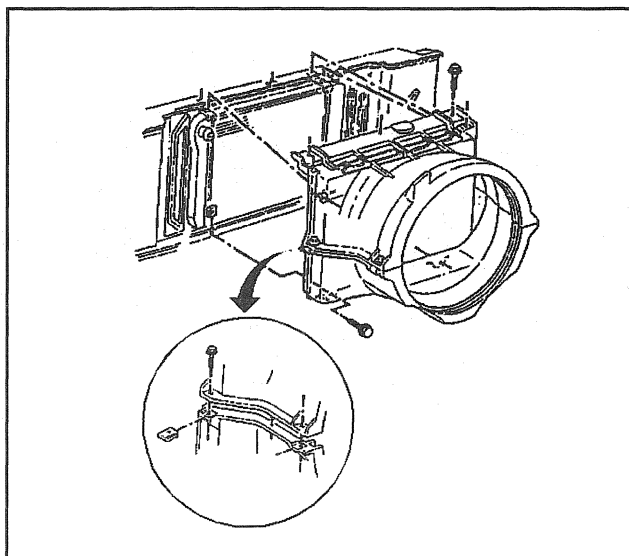
1. Disconnect the upper radiator hose from the radiator. For the 4.3L and the 5.0L engines, refer to *Radiator Hose Replacement (4.3L and 5.0L)*. For the 5.7L engines, refer to *Radiator Hose Replacement (5.7 L)*. For the 7.4L engines, refer to *Radiator Hose Replacement (7.4 L)*. For the 6.5L and the diesel engines, refer to *Radiator Hose Replacement (6.5 L)*.
2. Disconnect the negative battery cable (dual batteries only). Refer to *Battery Disconnect Caution* in General Information.
3. For the 5.0L, remove the upper fan shroud bolts and the upper fan shroud.

4. For the 5.7L, remove the upper fan shroud bolts and the upper fan shroud.



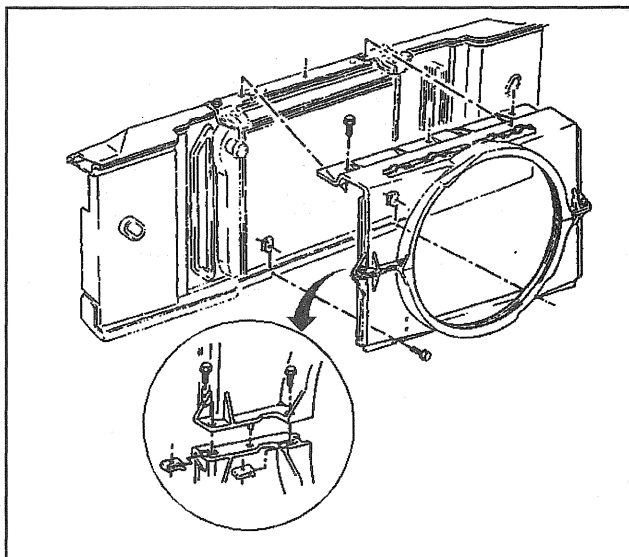
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5. For the 4.3L, remove the upper fan shroud bolts and the upper fan shroud.

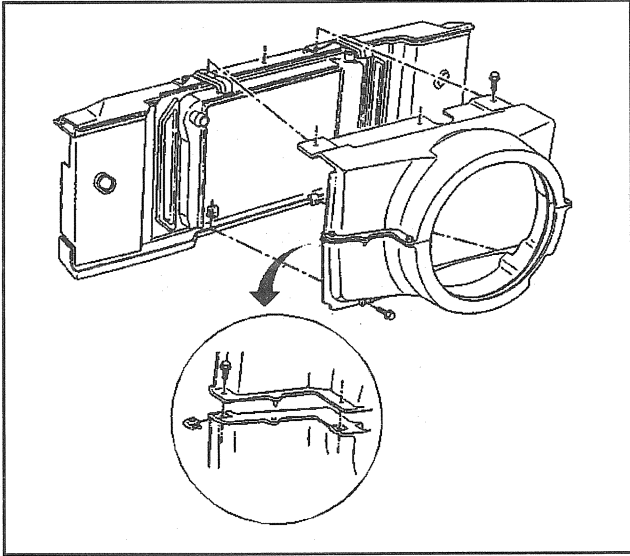


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6. For the 7.4L, remove the upper fan shroud bolts and the upper fan shroud.

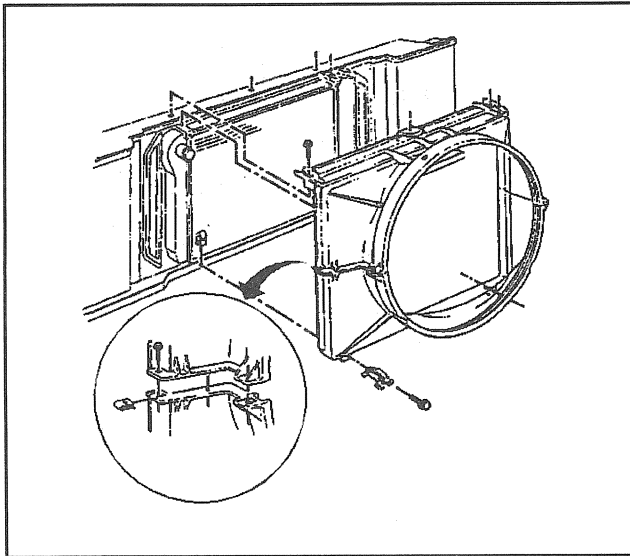


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7. For the 6.5L (Diesel), remove the upper fan shroud bolts and the upper fan shroud.
8. Inspect the upper fan shroud for signs of damage. If necessary, replace the upper fan shroud.



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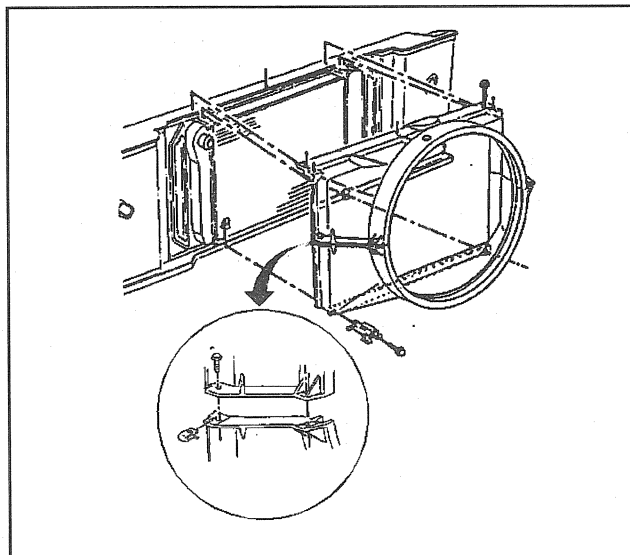
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. For the 5.0L, install the upper fan shroud and upper fan shroud bolts.

Tighten

Tighten the bolts to 9 N·m (71 lb in).



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2. For the 5.7L, install the upper fan shroud and upper fan shroud bolts.

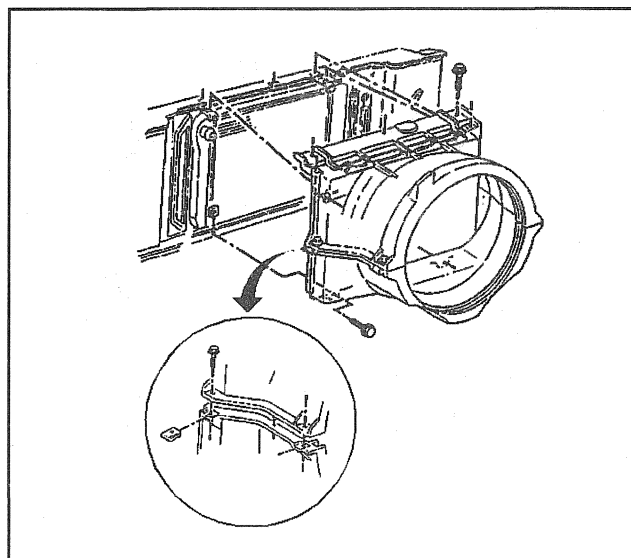
Tighten

Tighten the bolts to 9 N·m (71 lb in).

3. For the 4.3L, install the upper fan shroud and upper fan shroud bolts.

Tighten

Tighten the bolts to 9 N·m (71 lb in).

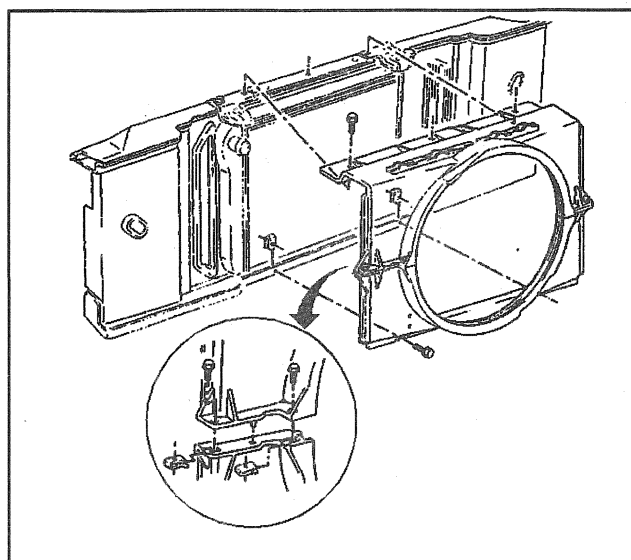


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4. For the 7.4L, install the upper fan shroud and upper fan shroud bolts.

Tighten

Tighten the bolts to 9 N·m (71 lb in).



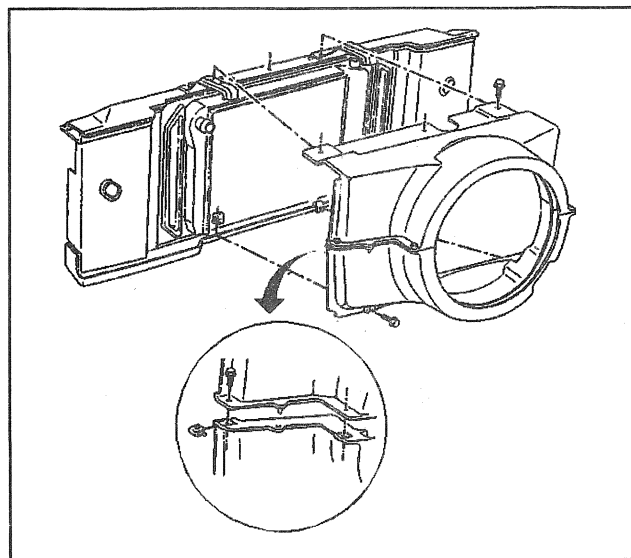
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5. For the 6.5L (Diesel), install the upper fan shroud and upper fan shroud bolts.

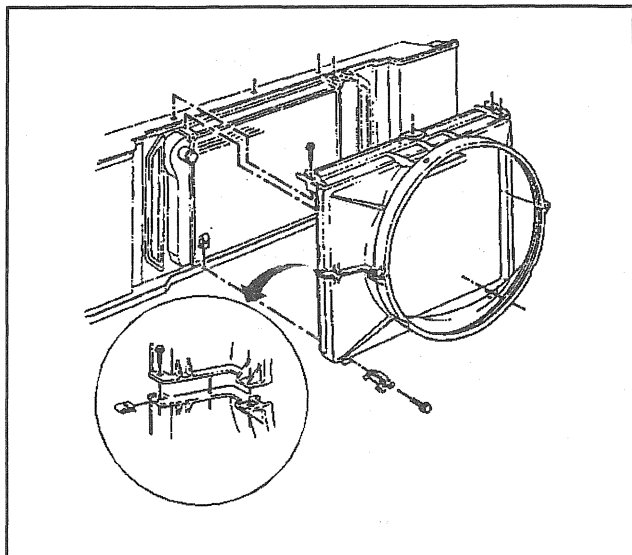
Tighten

Tighten the bolts to 9 N·m (71 lb in).

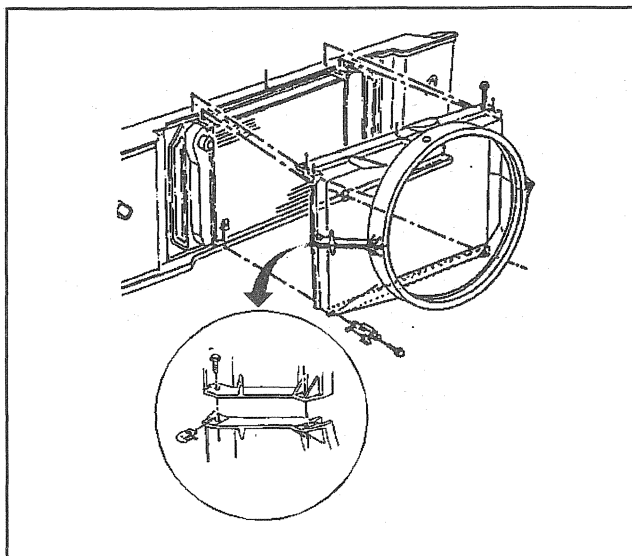
6. Connect the upper radiator hose to the radiator.
 - For the 4.3L and the 5.0L engines, refer to *Radiator Hose Replacement (4.3L and 5.0L)*.
 - For the 5.7L engines, refer to *Radiator Hose Replacement (5.7 L)*.
 - For the 7.4L engines, refer to *Radiator Hose Replacement (7.4 L)*.
 - For the 6.5L (Diesel), refer to *Radiator Hose Replacement (6.5 L)*.
7. Connect the negative battery cable (dual batteries only).



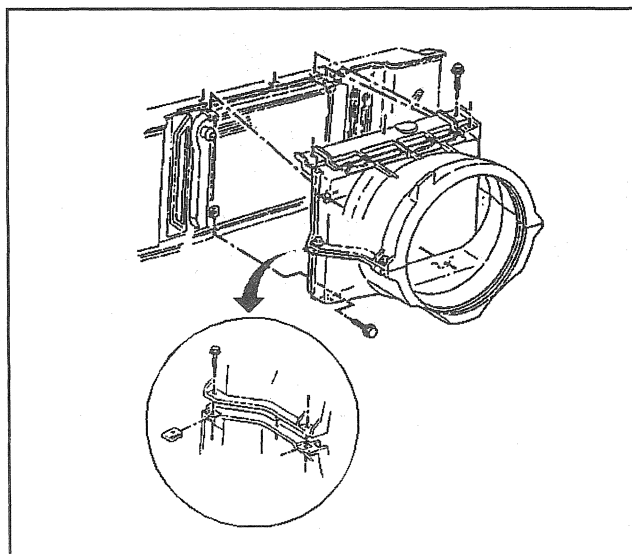
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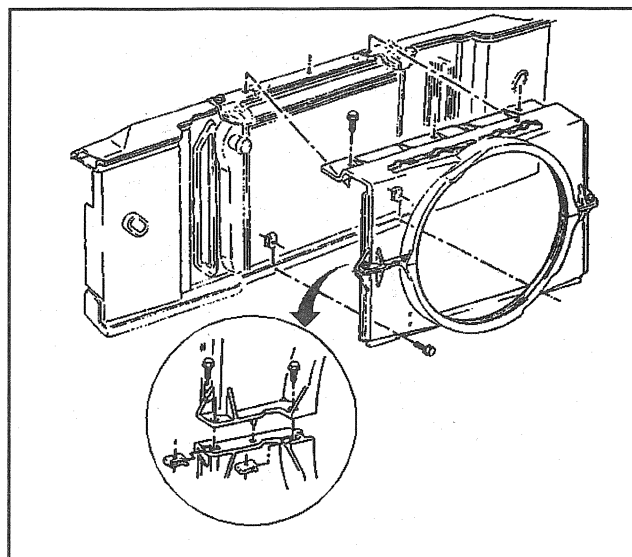
72742

Fan Shroud Replacement (Lower)

Removal Procedure

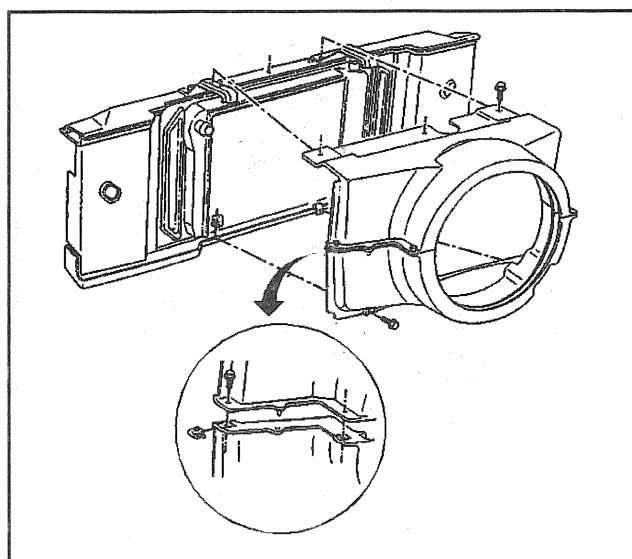
1. Remove the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.
2. Raise the vehicle.
3. Remove the front differential carrier shield (if equipped). Refer to *Shield Replacement* in Front Drive Axle.
4. For the 5.0L, remove the lower fan shroud bolts and the lower fan shroud.
5. For the 5.7L, remove the lower fan shroud bolts and the lower fan shroud.
6. For the 4.3L, remove the lower fan shroud bolts and the lower fan shroud.

7. For the 7.4L, remove the lower fan shroud bolts and the lower fan shroud.



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8. For the 6.5L (Diesel), remove the lower fan shroud bolts and the lower fan shroud.
9. Inspect the lower fan shroud for signs of damage. If necessary, replace the lower fan shroud.



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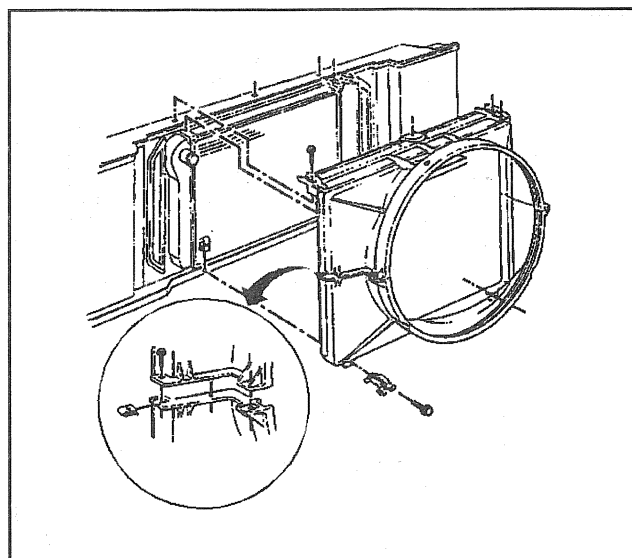
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

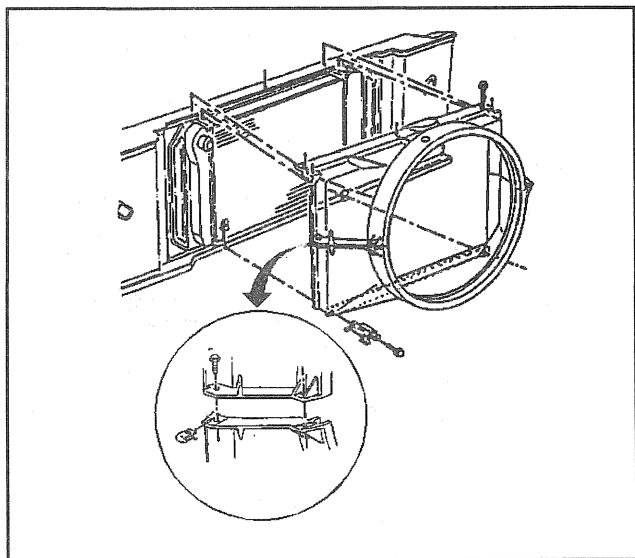
1. For the 5.0L, install the lower fan shroud and the lower fan shroud bolts.

Tighten

Tighten the bolts to 9 N·m (71 lb in).



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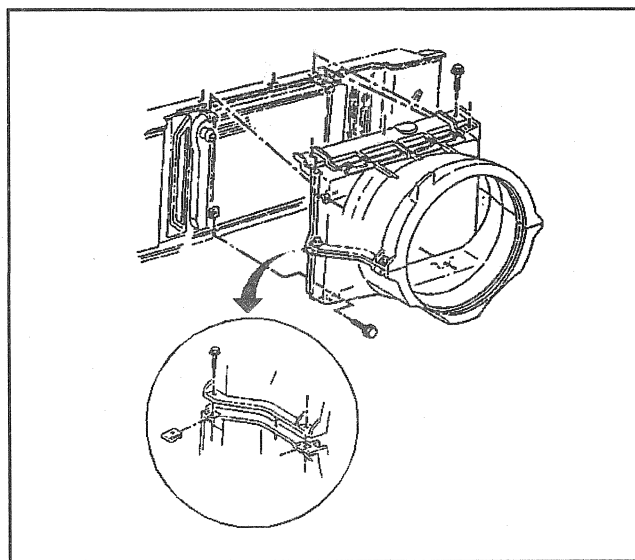


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2. For the 5.7L, install the lower fan shroud and the lower fan shroud bolts.

Tighten

Tighten the bolts to 9 N·m (71 lb in).

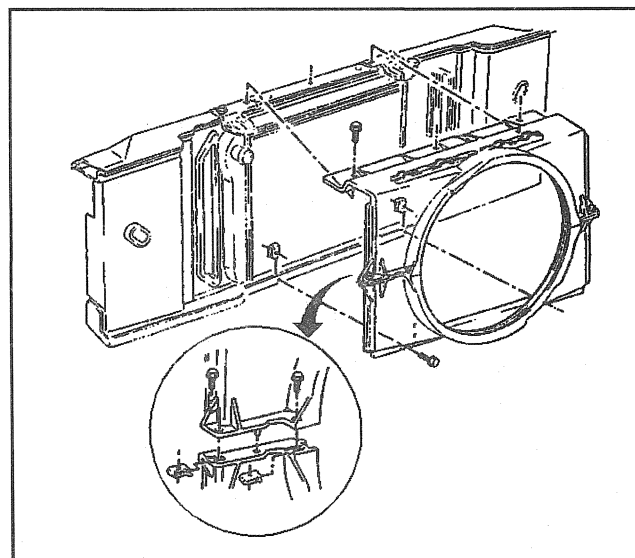


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3. For the 4.3L, install the lower fan shroud and the lower fan shroud bolts.

Tighten

Tighten the bolts to 9 N·m (71 lb in).



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4. For the 7.4L, install the lower fan shroud and the lower fan shroud bolts.

Tighten

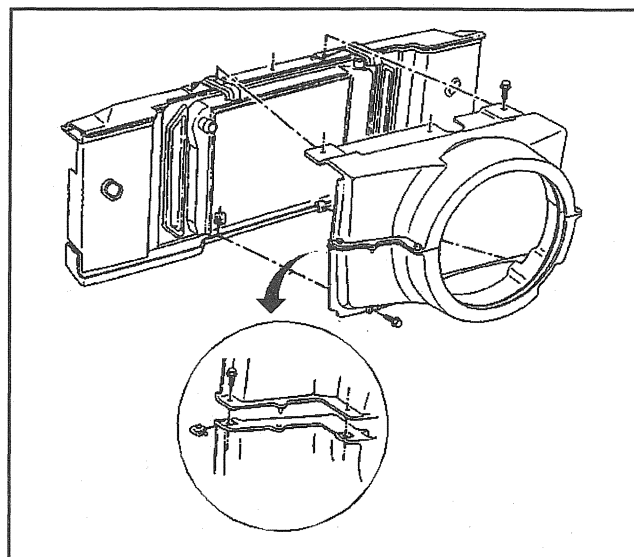
Tighten the bolts to 9 N·m (71 lb in).

5. For the 6.5L (Diesel), install the lower fan shroud and the lower fan shroud bolts.

Tighten

Tighten the bolts to 9 N·m (71 lb in).

6. Install the front differential carrier shield (if equipped). Refer to *Shield Replacement in Front Drive Axle*.
7. Lower the vehicle.
8. Install the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.

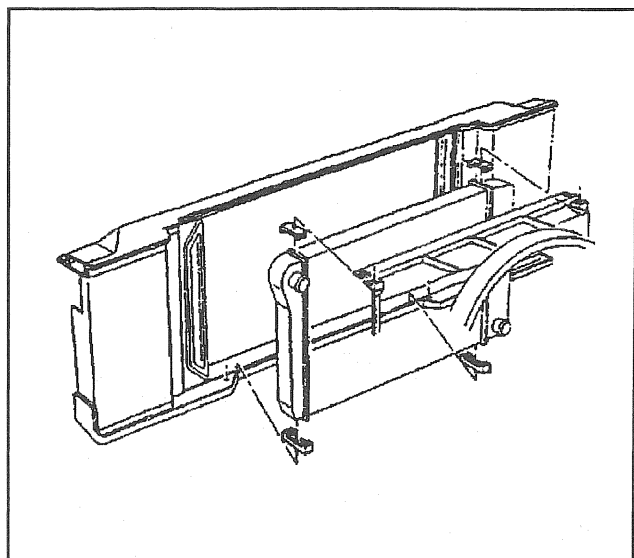


72741

Radiator Replacement

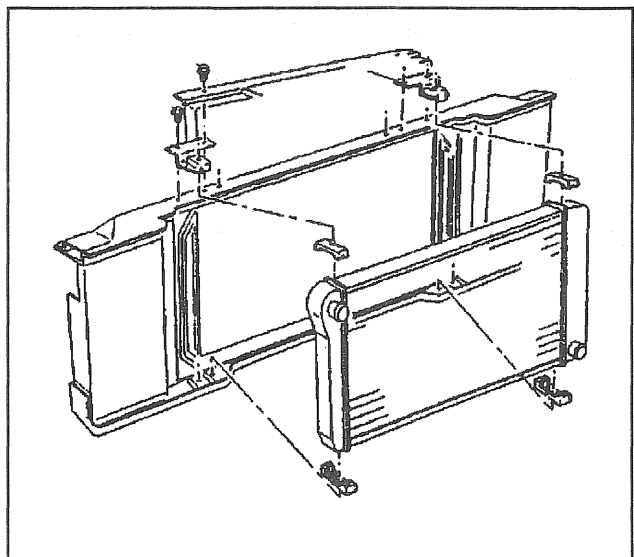
Removal Procedure

1. Drain the coolant from the cooling system. Refer to *Draining and Filling Cooling System*.
2. Remove the upper fan shroud. Refer to *Fan Shroud Replacement (Upper)*.
3. For the 4.3L, 5.0L, and the 5.7L engines, remove the upper insulators and brackets.

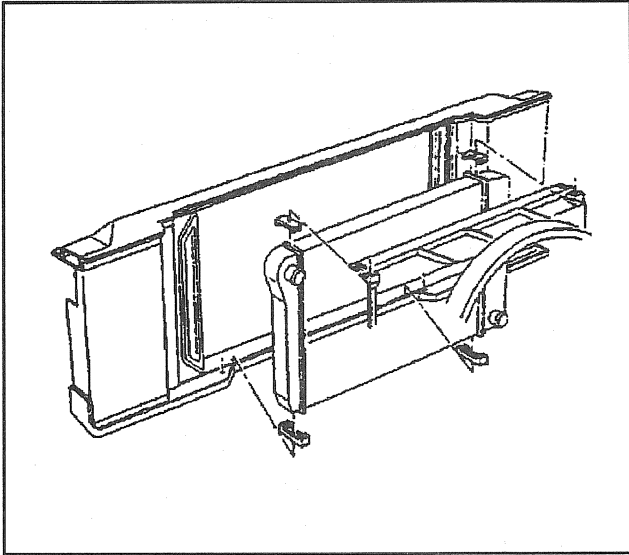


72748

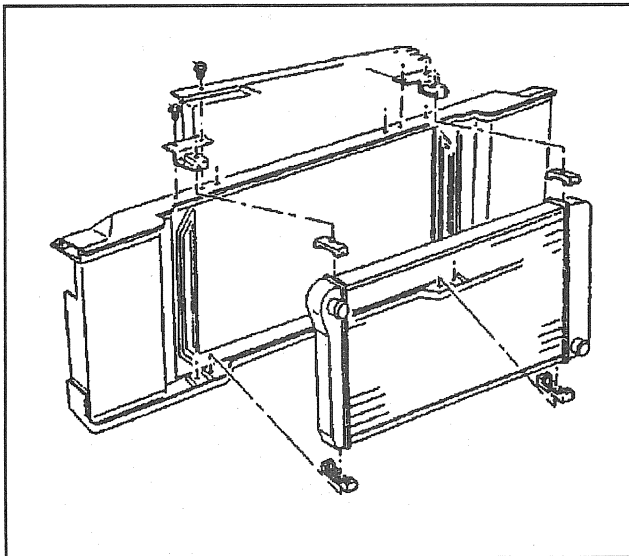
4. For the 6.5L and the 7.4L engines, remove the upper insulators and brackets.
5. Disconnect the upper and lower radiator hoses.
 - For the 4.3L and the 5.0L engines, refer to *Radiator Hose Replacement (4.3L and 5.0L)*.
 - For the 5.7L engine, refer to *Radiator Hose Replacement (5.7 L)*.
 - For the 7.4L engine, refer to *Radiator Hose Replacement (7.4 L)*.
 - For the 6.5L (Diesel), refer to *Radiator Hose Replacement (6.5 L)*.
6. Remove the transmission fluid cooler pipes.
7. Remove the engine oil cooler pipes. Refer to *Engine Oil Cooler Line Replacement*.



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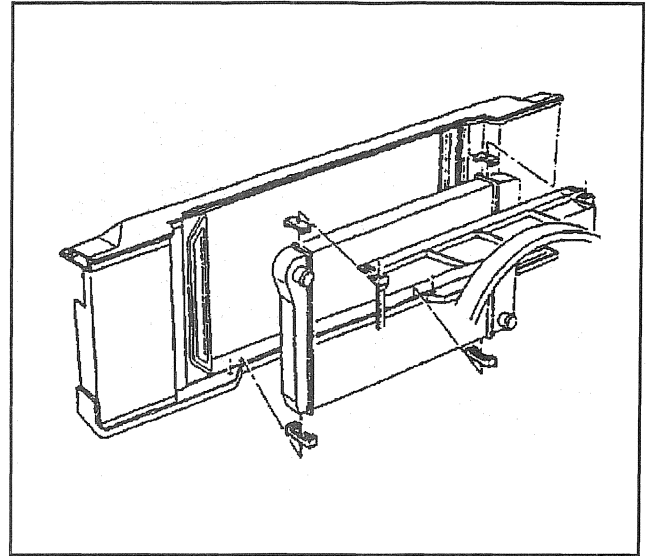
72749

8. Remove the lower fan shroud bolts and the lower fan shroud. Refer to *Fan Shroud Replacement (Lower)*.
9. Disconnect the coolant recovery reservoir/surge tank hose.
 - Refer to *Coolant Recovery Reservoir Replacement*.
 - For diesel engines, refer to *Surge Tank (Diesel) Replacement*.
10. For the 4.3L, 5.0L, and the 5.7L, remove the radiator from the lower insulators and brackets.

11. For the 6.5L and the 7.4L, remove the radiator from the lower insulators and brackets.
12. Inspect all of the parts and connections for leaks and wear.
13. Replace the parts and/or connections, as necessary.

Installation Procedure

1. For the 4.3L, 5.0L, and the 5.7L engines, install the radiator on the lower insulators.



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2. For the 6.5L and the 7.4L engines, install the radiator on the lower insulators.
3. Install the coolant recovery reservoir/surge tank hose.
 - Refer to *Coolant Recovery Reservoir Replacement*.
 - For diesel engines, refer to *Surge Tank (Diesel) Replacement*.
4. Install the lower fan shroud bolts and the lower fan shroud. Refer to *Fan Shroud Replacement (Lower)*.

Tighten

Tighten the bolts to 9 N·m (71 lb in).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the engine oil cooler pipes. Refer to *Engine Oil Cooler Line Replacement*.

Tighten

Tighten the fittings to 24 N·m (18 lb ft).

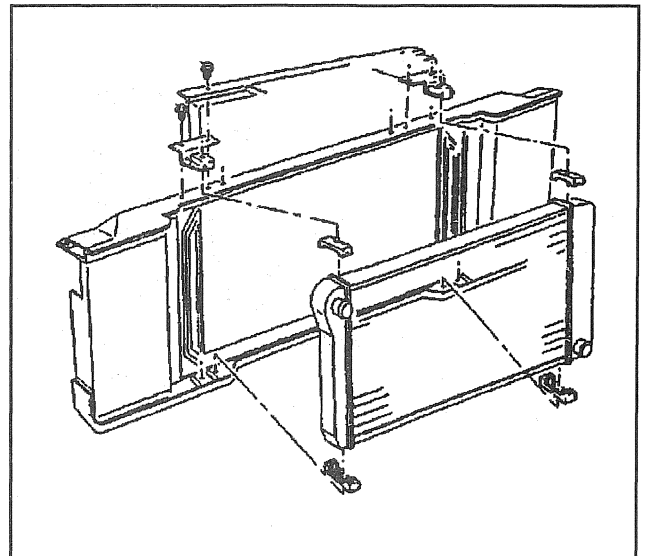
6. Install the transmission fluid cooler pipes.

Tighten

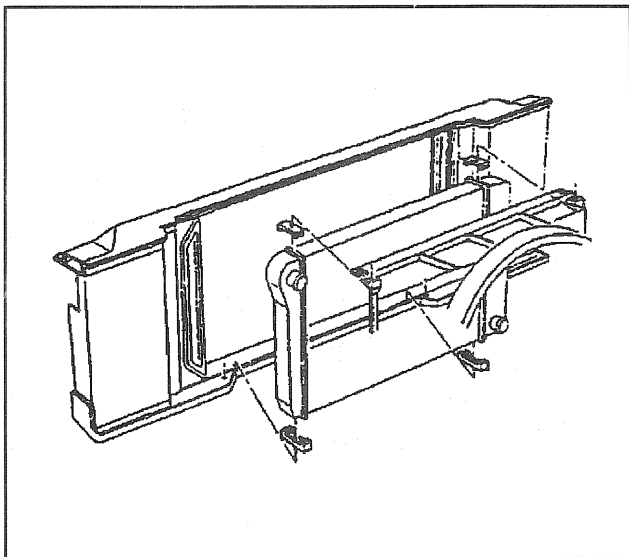
Tighten the fittings to 26 N·m (19 lb ft).

7. Install the upper and lower radiator hoses.

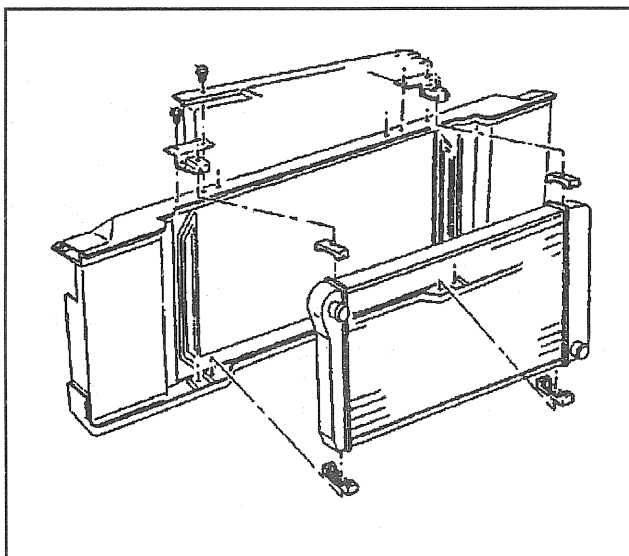
- For the 4.3L and the 5.0L engines, refer to *Radiator Hose Replacement (4.3L and 5.0L)*.
- For the 5.7L engine, refer to *Radiator Hose Replacement (5.7 L)*.
- For the 7.4L engine, refer to *Radiator Hose Replacement (7.4 L)*.
- For the 6.5L (Diesel), refer to *Radiator Hose Replacement (6.5 L)*.



72749



72748



72749

8. For the 4.3L, 5.0L, and the 5.7L engines, install the upper insulators.

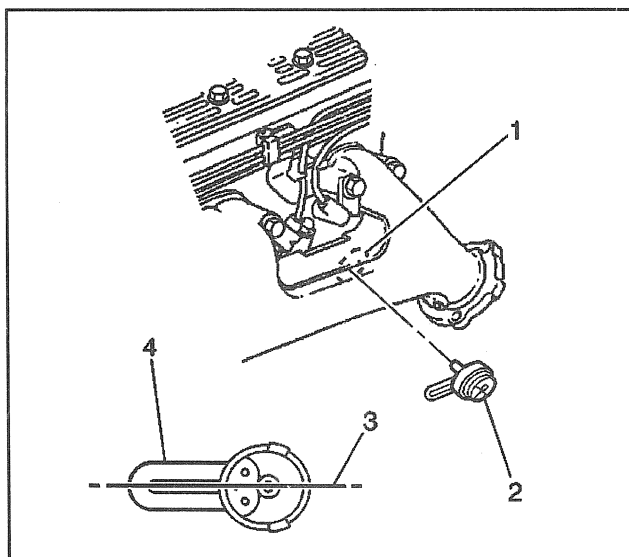
9. For the 6.5L and the 7.4L engines, install the upper insulators.

10. Install the upper fan shroud and the upper fan shroud bolts. Refer to *Fan Shroud Replacement (Upper)*.

Tighten

Tighten the bolts to 9 N·m (71 lb in).

11. Refill the coolant in the cooling system. Refer to *Draining and Filling Cooling System*.
12. Leak test on the cooling system. Refer to *Cooling System Leak Testing (Radiator Leak Test)*.



312953

Coolant Heater Replacement

Removal Procedure

1. Drain the engine coolant. Refer to *Draining and Filling Cooling System*.
2. Remove the heater cord from the engine coolant heater (2).
3. Loosen the bolt retaining the engine coolant heater to the block.
4. Remove the engine coolant heater from the engine block.
5. If the vehicle is not originally equipped with an engine coolant heater, remove the coolant jacket plug.
6. Carefully tap the coolant plug near the outer edge.
7. Rotate the coolant plug out of the core plug hole. Do not score the machined surface of the hole.
8. Grasp the plug with pliers.

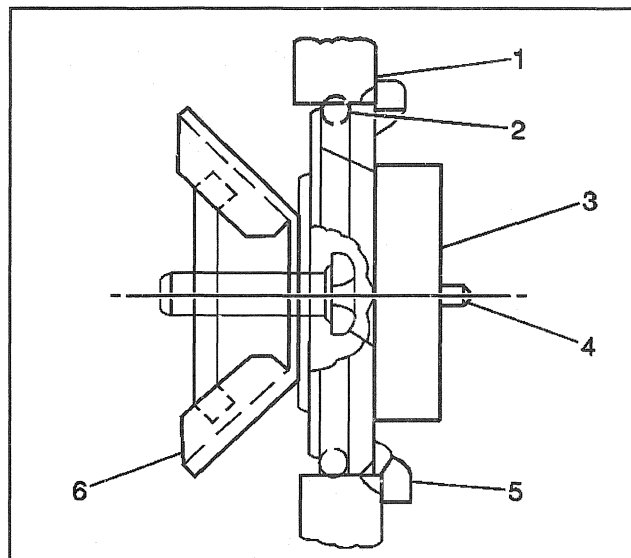
9. Pull the plug from the engine block.
10. Clean the core plug hole in order to remove the following substances:
 - Burrs
 - Compound
 - Paint
 - Rough spots

Installation Procedure

1. Coat the o-ring seal (2) and the cleaned surface of the plug opening with water resistant high-temperature grease lubricant GM P/N 9985164 or the equivalent.

Important: Avoid element contact with the inside walls of the engine block.

2. Install the coolant heater by pushing tightly into the engine block.



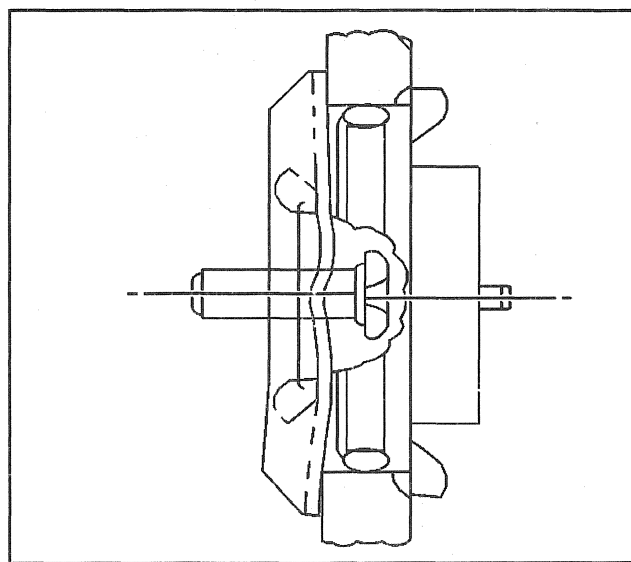
312935

Notice: Refer to *Fastener Notice* in Cautions and Notices.

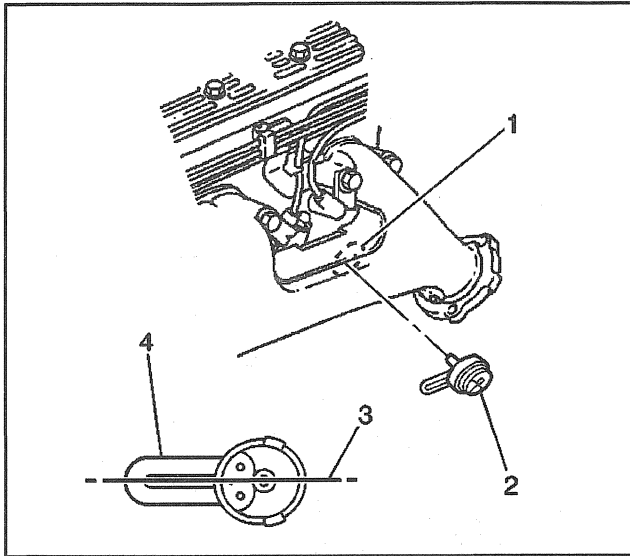
3. Tighten the bolt on the engine coolant heater until both of the locking wings draw tightly against the inner wall of the engine block.

Tighten

Tighten the bolt in order to retain the engine coolant heater to the engine block to 2 N·m (18 lb in).



312945

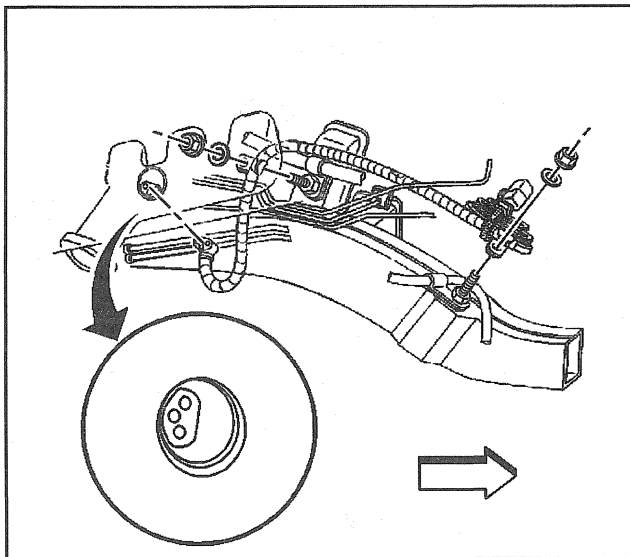


312953

Important: Do not allow the heater cord to touch the following areas:

- The engine
- Hot pipes
- The manifold
- Any moving parts.

4. Install the heater cord to the coolant heater (2).
5. Route the heater cord.
6. Fill the radiator and the engine with engine coolant. Refer to *Draining and Filling Cooling System*.
7. Inspect the system for leaks.

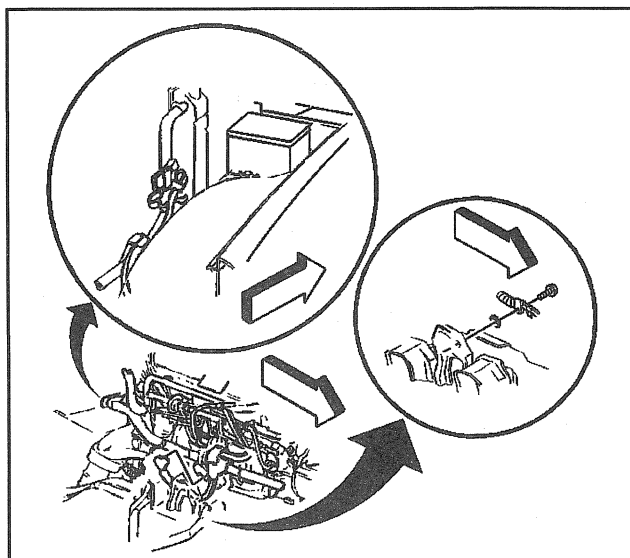


423360

Coolant Heater Cord Replacement

Removal Procedure

1. On the diesel and small block gas engines remove the nuts and washers retaining the clip to the stud.
2. On the large block gas engine remove the bolt and washer retaining the cord clip to the shock bracket.



423361

3. Remove the strap connecting the cord to the heater hose.
4. Remove the cord from the engine block heater.

Installation Procedure

Caution: A block heater electrical cord that is damaged creates a shock hazard, and must be replaced.

1. Apply lubricant to the front face of the heater cord connector, and connect heater cord to the block heater.
2. Route the heater cord along the heater hose.
3. On the large block gas engine install the washer to the shock bracket; then install the cord clip and finally the bolt retaining the cord to the bracket.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

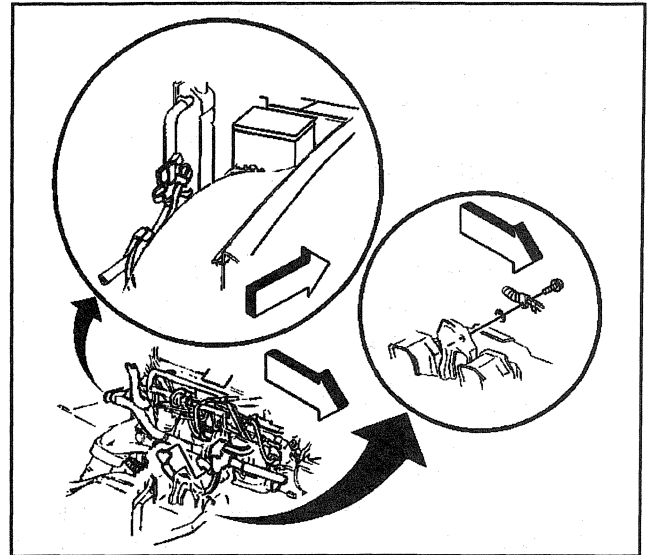
Tighten

Tighten the bolt retaining the engine coolant heater cord bracket to the engine to 8 N·m (6 lb ft).

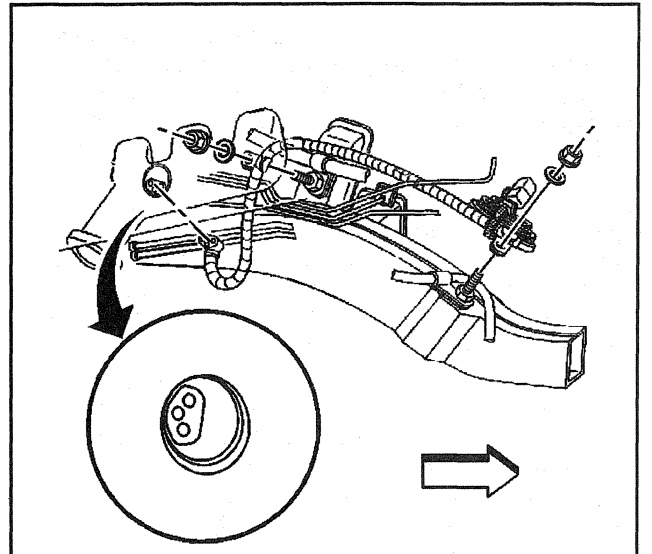
4. On the diesel and small block gas engines, install the cord clip, then the washers and nuts, at both the shock lower bracket and frame member.
5. Install the bolt (5) retaining the cord clip (6) to the bracket (2).

Tighten

Tighten the bolt retaining the engine coolant heater cord clip to the bracket to 12 N·m (106 lb in).



423361



423360

Description and Operation

Cooling System Description

This vehicle has a pressure-type engine cooling system. A thermostat controls the coolant circulation.

The cooling system consists of the following components:

- A radiator
- A radiator pressure cap (gasoline engines)
- A coolant recovery reservoir (gasoline engines)
- A coolant surge tank and surge tank cap (diesel engines)
- A cooling fan and fan clutch
- A coolant pump and pulley
- All related hoses

A 103 kPa (15 psi) radiator or surge tank cap seals the cooling system, causing the system to operate at a higher than atmospheric pressure. The high pressure operation raises the boiling point of the coolant to about 125°C (257°F), increasing the cooling efficiency of the radiator.

The pressure-vacuum valve radiator cap, used with gasoline engines, allows the coolant to expand through the pressure valve in the center of the cap without building up unnecessary pressure. The expanding coolant flows into the coolant recovery reservoir and the vent valve closes because of coolant expansion and flow. Any air in the system is forced into the coolant recovery reservoir and then out of the vent tube at the top of the reservoir. As the system cools, vacuum forces the coolant in the reservoir back to the radiator through the vent valve. Because of this, the radiator remains full at all times.

The diesel engine uses a cooling system with a surge tank. The pressure cap for the diesel engine differs from the gasoline engine pressure cap. The cap is on the surge tank. The diesel engine uses a pressurized surge tank. Coolant circulates through the surge tank. The surge tank allows the escape of any air in the system and provides room for coolant expansion when the coolant is hot.

The cooling system reaches 103 kPa (15 psi) in either system only after the system reaches normal operating temperature.

Engine Coolant

Notice: Pure coolant can be added to raise the boiling point of the coolant, but too much will affect the freezing point. Do not use a solution stronger than 70 percent, as the freeze level rises rapidly after this point. Pure coolant will freeze at -22°C (-8°F).

This vehicle was manufactured with GM Goodwrench DEX-COOL™. GM Goodwrench DEX-COOL™ was developed to last for 240 000 km (150,000 mi) or 5 years, whichever occurs first. Make sure only GM Goodwrench DEX-COOL™ is used when coolant is added or changed.

A 50/50 mixture of ethylene glycol (GM Goodwrench DEX-COOL™) and water will provide the following protection:

Notice: Pure coolant can be added to raise the boiling point of the coolant, but too much will affect the freezing point. Do not use a solution stronger than 70 percent, as the freeze level rises rapidly after this point. Pure coolant will freeze at -22°C (-8°F).

- Give freezing protection down to -37°C (-34°F).
- Give boiling protection up to 129°C (260°F).
- Protect against rust and corrosion.
- Help keep the proper engine temperature.
- Allow the warning lights and gauges to work correctly.

Uncommon Cooling System Problems

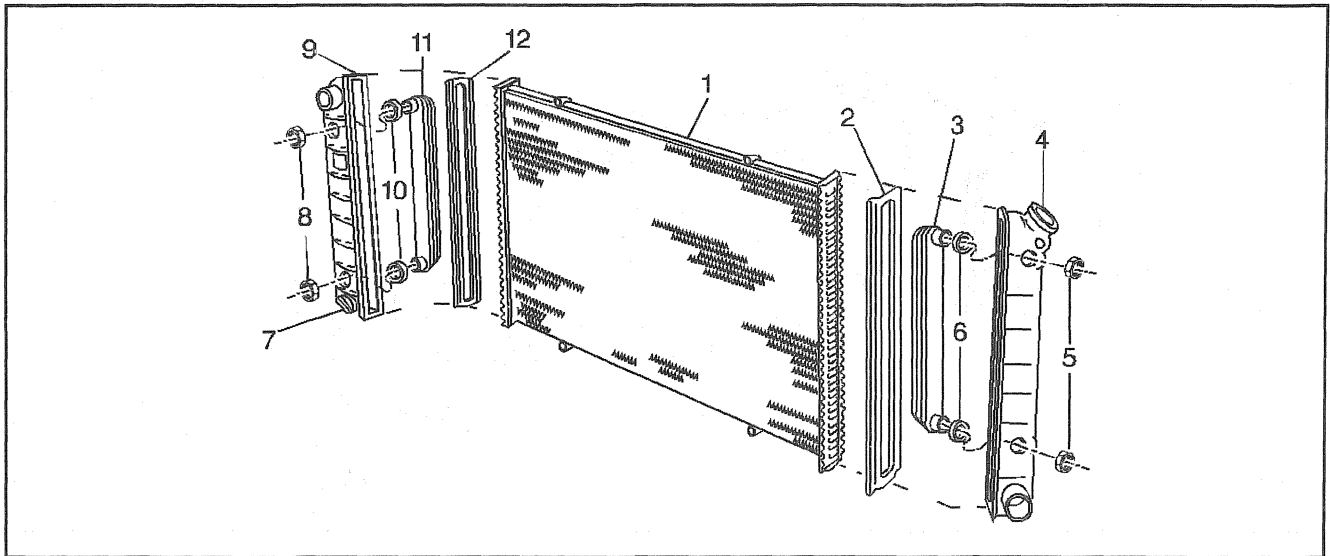
Problems not requiring disassembly of the cooling system:

- Large obstructions that block the radiator or the air conditioning condenser; The following are some examples of large obstructions:
 - Front mounted bike carriers
 - Front mounted tire carriers
 - Bug guards
 - Vehicle bras
- Auxiliary oil coolers
- Ice, mud, or snow
- Engine oil overfill
- Missing or damaged air baffle or lower air deflector

Problems requiring disassembly of the cooling system:

- An incorrect or damaged fan
- Faulty emission system components (could cause overheating at idle)
- Positive Crankcase Ventilation (PCV) valve
- Pressure testing the cooling system with the radiator cap installed
- A faulty water pump
- Plugged or incorrect radiator
- Internal system leaks
- The cylinder head gasket
- A cracked engine block
- A damaged intake manifold or intake manifold gasket
- Plugged coolant passages in the cylinder head(s)
- An incorrect thermostat that has been installed

Coolant Recovery System Description



47015

The radiator is a crossflow, tube type that has an aluminum core (1) with plastic side tanks.

The fan shrouds direct air flow through the radiator core and the shrouds also serve as a fan guard.

The right side end tank (4) houses the transmission oil cooler (3) that has inlet and outlet fittings (5) for transmission fluid circulation.

The left side end tank (9) houses an optional engine oil cooler (11) with inlet and outlet fittings (8) for engine oil circulation.

Vehicle equipped with A/C use a radiator with extra cooling capacity for greater cooling demands.

The radiator uses a plastic drain cock (7). This is on the bottom, left hand side end tank.

Coolant Heater Description

This vehicle has a pressure-type engine cooling system. A thermostat controls the coolant circulation.

The cooling system consists of the following components:

- A radiator
- A radiator pressure cap (gasoline engines)
- A coolant recovery reservoir (gasoline engines)
- A coolant surge tank and surge tank cap (diesel engines)
- A cooling fan and fan clutch
- A coolant pump and pulley
- All related hoses

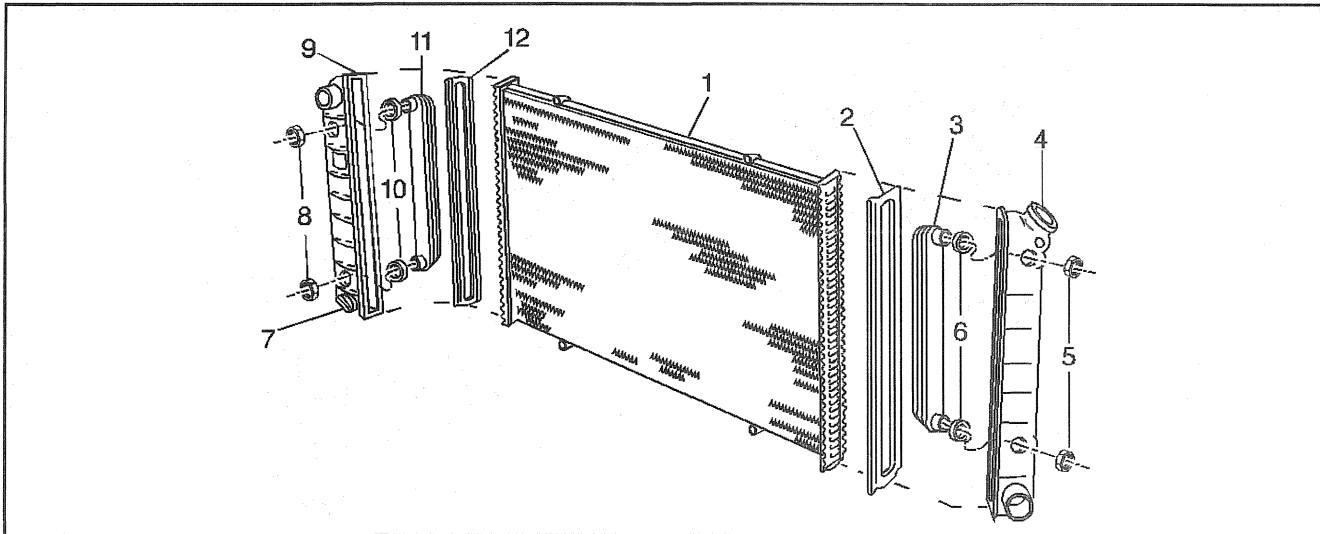
A 103 kPa (15 psi) radiator or surge tank cap seals the cooling system, causing the system to operate at a higher than atmospheric pressure. The high pressure operation raises the boiling point of the coolant to about 125°C (257°F), increasing the cooling efficiency of the radiator.

The pressure-vacuum valve radiator cap, used with gasoline engines, allows the coolant to expand through the pressure valve in the center of the cap without building up unnecessary pressure. The expanding coolant flows into the coolant recovery reservoir and the vent valve closes because of coolant expansion and flow. Any air in the system is forced into the coolant recovery reservoir and then out of the vent tube at the top of the reservoir. As the system cools, vacuum forces the coolant in the reservoir back to the radiator through the vent valve. Because of this, the radiator remains full at all times.

The diesel engine uses a cooling system with a surge tank. The pressure cap for the diesel engine differs from the gasoline engine pressure cap. The cap is on the surge tank. The diesel engine uses a pressurized surge tank. Coolant circulates through the surge tank. The surge tank allows the escape of any air in the system and provides room for coolant expansion when the coolant is hot.

The cooling system reaches 103 kPa (15 psi) in either system only after the system reaches normal operating temperature.

Radiator Assembly Description



47015

The radiator is a crossflow, tube type that has an aluminum core (1) with plastic side tanks.

The fan shrouds direct air flow through the radiator core and the shrouds also serve as a fan guard.

The right side end tank (4) houses the transmission oil cooler (3) that has inlet and outlet fittings (5) for transmission fluid circulation.

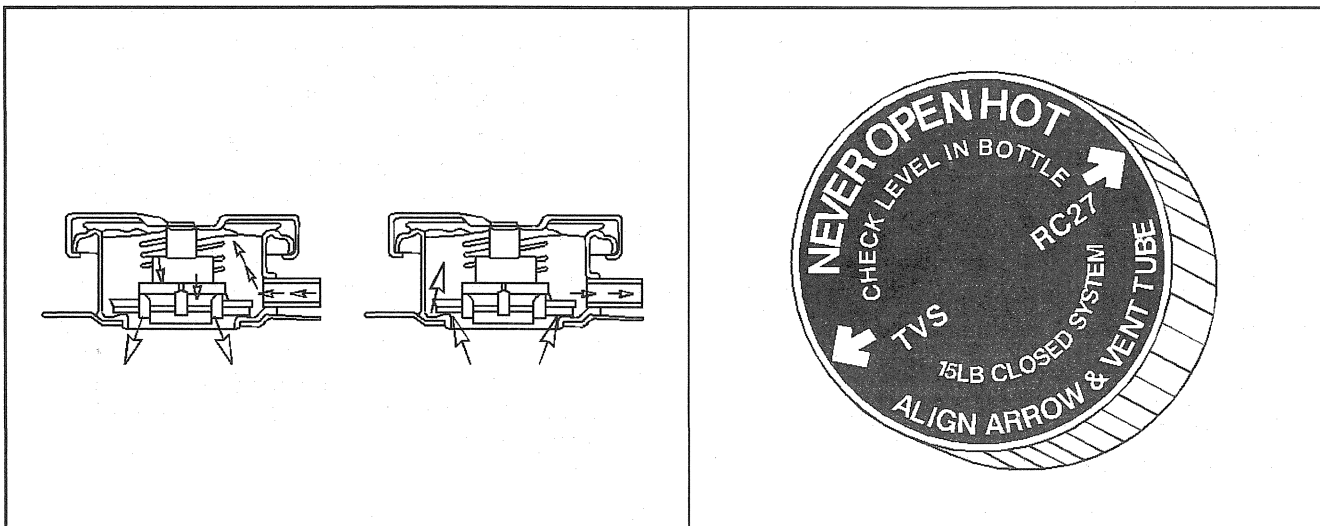
The left side end tank (9) houses an optional engine oil cooler (11) with inlet and outlet fittings (8) for engine oil circulation.

Vehicle equipped with A/C use a radiator with extra cooling capacity for greater cooling demands.

The radiator uses a plastic drain cock (7). This is on the bottom, left hand side end tank.

Pressure Cap Description

Caution: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.



48305

The crossflow radiator uses a pressure-vent filler cap to allow a buildup of 103 kPa (15 psi) in the cooling system. The cap allows the system to operate at a higher than atmospheric pressure. This pressure

raises the boiling point of the coolant to about 127°C (262°F) at sea level, which increases the cooling efficiency of the radiator.

The pressure-type cap contains a blowoff (pressure) valve (2) and a vacuum (atmospheric) valve (1). A spring of pre-determined strength holds the pressure valve against the valve's seat. This spring protects the radiator by relieving any pressure that exceeds design limits. A spring holds the vacuum valve against the valve's seat which permits opening of the valve in order to relieve vacuum created in the system when the system cools. This prevents radiator collapse.

Caution: Do not remove the radiator cap while the cooling system is hot. Serious personal injury may result. Only remove the radiator cap from a cool engine.

The radiator cap is designed to discourage unintentional removal. Safely remove the cap in the following way:

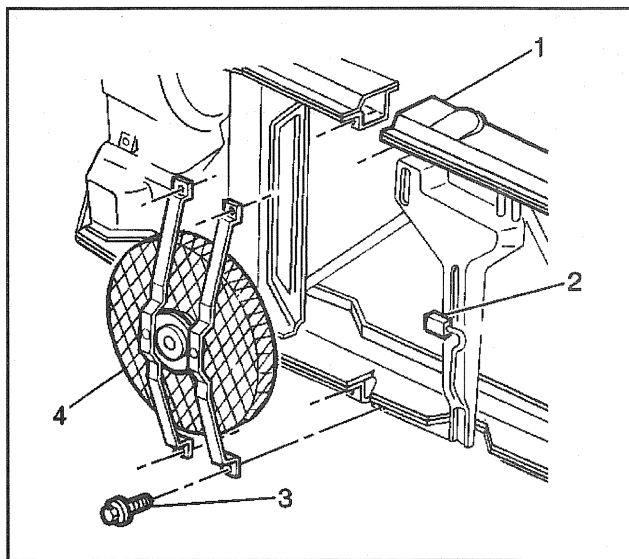
1. Slowly rotate the cap counterclockwise, do not press down, to the detent.
2. Allow any residual pressure, indicated by a hissing sound, to be relieved.
3. After the hissing stops, continue to rotate the cap counterclockwise until the cap is removed.

The following is embossed on the cap:

- A caution regarding opening of the cap
- Arrows that indicate the proper closed position

Engine Cooling Fan Description - Electric

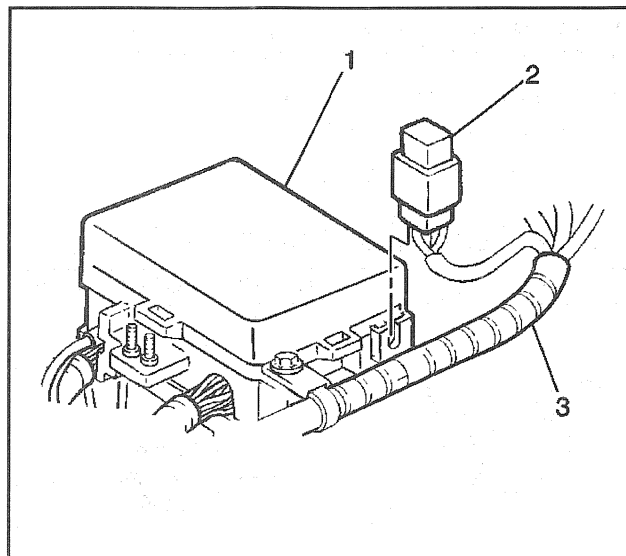
General Description



64996

The auxiliary electric cooling fan consists of (1) radiator support (2) wiring harness (3) bolt/scREW (4) auxiliary cooling fan assembly and provides additional cooling for low speed vehicle operations, extended idle, stop and go conditions, and running the air conditioning system.

Operation



64988

The auxiliary cooling fan is controlled by the VCM. The VCM controls the ground path for the cooling fan relay. The relay consists of (1) underhood fuse block (2) auxiliary cooling fan relay (3) wiring harness and is used to control the high current flow to run the cooling fan motor. The VCM determines operation of the independent fans based on various sensor inputs.

The cooling fan is controlled by the VCM based on the following inputs:

- The A/C system
- The Engine Coolant Temperature (ECT) sensor
- The Vehicle Speed Sensor (VSS).

The VCM will turn the auxiliary cooling fan ON when any of the following conditions exist:

- Certain VCM Diagnostic Trouble Codes (DTCs) are set.
- ECT above 107°C (225°F).
- A/C head pressure above 300 psi.

Once the auxiliary cooling fan has been turned ON by the Engine Coolant Temperature (ECT) sensor, the VCM will turn the fan OFF when that temperature has dropped about 4°C (7°F). If the auxiliary cooling fan has been turned ON by high A/C head pressure, the VCM will turn the fan OFF when the pressure has dropped to 250 psi. The minimum ON time for the auxiliary cooling fan is 30 seconds.

Water Pump Description

The die-cast coolant pump is a centrifugal vane impeller type. The impeller turns on a steel shaft that rotates in a permanently lubricated ball bearing.

The pump inlet connects to the bottom of the radiator with the rubber radiator outlet hose. Coolant from the pump passes through the engine front cover, then into the coolant passages in the engine block in order to absorb excess engine heat.

Thermostat Description

The cooling system uses a wax pellet-type thermostat. The thermostat performs the following functions:

- Controls the flow of coolant
- Provides fast engine warm-up
- Regulates the coolant temperature

Special Tools and Equipment

Illustration	Tool Number/ Description
 1409	J 23688 Coolant Tester (Fahrenheit Scale)
 1405	J 24460-01 Cooling System and Cap Pressure Tester
 23570	J 24731-188 Tempil Sticks

Illustration	Tool Number/ Description
 12869	J 26568 Coolant Tester (Celsius Scale)
 48304	J 41240 Fan Clutch Wrench
 48304	J 41240-5A Fan Clutch Wrench

Engine Electrical

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Retainer Hold Down Bolt	23 N·m	17 lb ft
Camshaft Position (CMP) Sensor Screws	2.2 N·m	20 lb in
Distributor Cap Screws	2.5 N·m	22 lb in
Distributor Clamp Bolt	25 N·m	18 lb ft
Distributor Rotor Screws	2 N·m	18 lb in
Generator BAT Terminal Nut	20 N·m	15 lb ft
Generator Bottom Bracket Bolt (4.3L, 5.0L, 5.7L)	50 N·m	37 lb ft
Generator Bottom Bracket Bolt (6.5L)	23 N·m	17 lb ft
Generator Bottom Bracket Bolt (7.4L)	25 N·m	18 lb ft
Generator Pulley Nut (CS -144)	100 N·m	74 lb ft
Generator Top Bracket Bolt (4.3L, 5.0L, 5.7L, 6.5L)	25 N·m	18 lb ft
Generator Top Bracket Bolt (7.4L)	50 N·m	37 lb ft
Ignition Coil Hold Down Stud	11 N·m	97 lb in
Ignition Coil Bolts (Vin J)	27 N·m	22 lb ft
Negative Battery Cable Terminal Nut	15 N·m	11 lb ft
Positive Battery Cable Terminal Nut	15 N·m	11 lb ft
Spark Plugs (New Cylinder Head)	30 N·m	22 lb ft
Spark Plugs (Used Cylinder Head)	14 N·m	10 lb ft
Starter Bracket Nut (Diesel)	8 N·m	71 lb in
Starter Brush Screws (MT-Series)	1.5 N·m	13 lb in
Starter Brush Plate Screws (MT-Series)	2.5 N·m	22 lb in
Starter Drive Housing Bolts (MT-Series)	8.5 N·m	75 lb in
Starter Heat Shield Bolt (Diesel)	17 N·m	13 lb ft
Starter Heat Shield Bolt (Gas)	12 N·m	106 lb in
Starter Motor Mounting Bolt (Diesel)	45 N·m	33 lb ft
Starter Motor Mounting Bolt (Gas)	40 N·m	30 lb ft
Starter Motor Through Bolts (SD-Series)	8.5 N·m	75 lb in
Starter Motor Through Bolts (MT-Series)	8.5 N·m	75 lb in
Starter Shield Nut (SD-Series)	8 N·m	71 lb in
Starter Shift Lever Nut (MT-Series)	4.5 N·m	40 lb in
Starter Solenoid Clamp Screw	11 N·m	97 lb in
Starter Solenoid Field Lead Nut (SD-Series)	11 N·m	97 lb in
Starter Solenoid Motor Terminal Nut (MT-Series)	11 N·m	97 lb in
Starter Solenoid Screws (MT-Series)	2.5 N·m	22 lb in

Battery Usage

Engine Application	Option	OE Catalog	CCA Rating (Amperes)	RC Rating (Minutes)	Load Test (Amperes)	Replacement Catalog No.
4.3L (L35)	All	810	600	115	300	78A-72
5.0L (L30)	All	810	600	115	300	78-6Y
5.7L (L31)	base	810	600	115	300	78-6YR
5.7L (L31)	w/Z56	814	770	115	390	78-7Yr
6.5L (L56)	All	810	600	115	300	78-6YR
6.5L (L65)	base	810	600	115	300	78-6YR
6.5L (L65)	w/YF2	812	690	115	350	78-7YR
7.4L (L29)	All	810	600	115	300	78-6YR

Battery Temperature vs Voltage Drop

°C	°F	VOLTAGE
Temperature vs Minimum Voltage		
21	70	9.6
10	50	9.4
0	32	9.1
-10	14	8.8
-18	0	8.5
Below -18	Below 0	8.0

Battery Temperature vs Minimum Voltage

Estimated Temperature °F	Estimated Temperature °C	Minimum Voltage
70 or above	21 or above	9.6
50	10	9.4
32	0	9.1
15	-10	8.8
0	-18	8.5
Below 0	Below -18	8.0

Starter Motor Usage (28-MT Starter Motor)

Application	Specification
Type	28-MT
Starter Part Number	1113296
Direction of Rotation	CW
Minimum AMPS Maximum AMPS	130–190 A
Minimum RPM Maximum RPM	3000—5600 RPM
Solenoid Switch Part Number	10456454
Switch Volts	12
Pull-In Winding Amps	52-59
Pull-In Winding Volts	10
Pull-In Winding Ohms	0.17-0.19
Hold-In Winding Amps	12-14
Hold-In Winding Volts	10
Hold-In Winding Ohms	0.76-0.81

Spark Plug Wire Resistance

Tools Required

J 39200

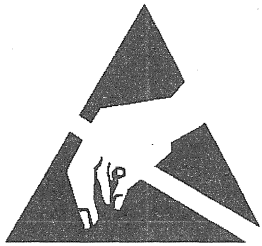
1. Inspect the routing of the wires. Improper routing can cause crossfiring.
2. Inspect each wire for any signs of
 - cracks
 - burns
 - damage
 - splits in the wire
3. Inspect each boot for signs of
 - tears
 - piercing
 - arc through
 - carbon tracking
4. If the boot needs to be replaced, twist the boot a half turn in either direction in order to break the seal before pulling on the boot in order to remove the wire.
5. With the engine ON, inspect for any arcing to ground or other components.
6. Connect an ohmmeter to the end of each suspect wire. If the meter reads over 30,000 Ω , replace the wire.

Schematic and Routing Diagrams

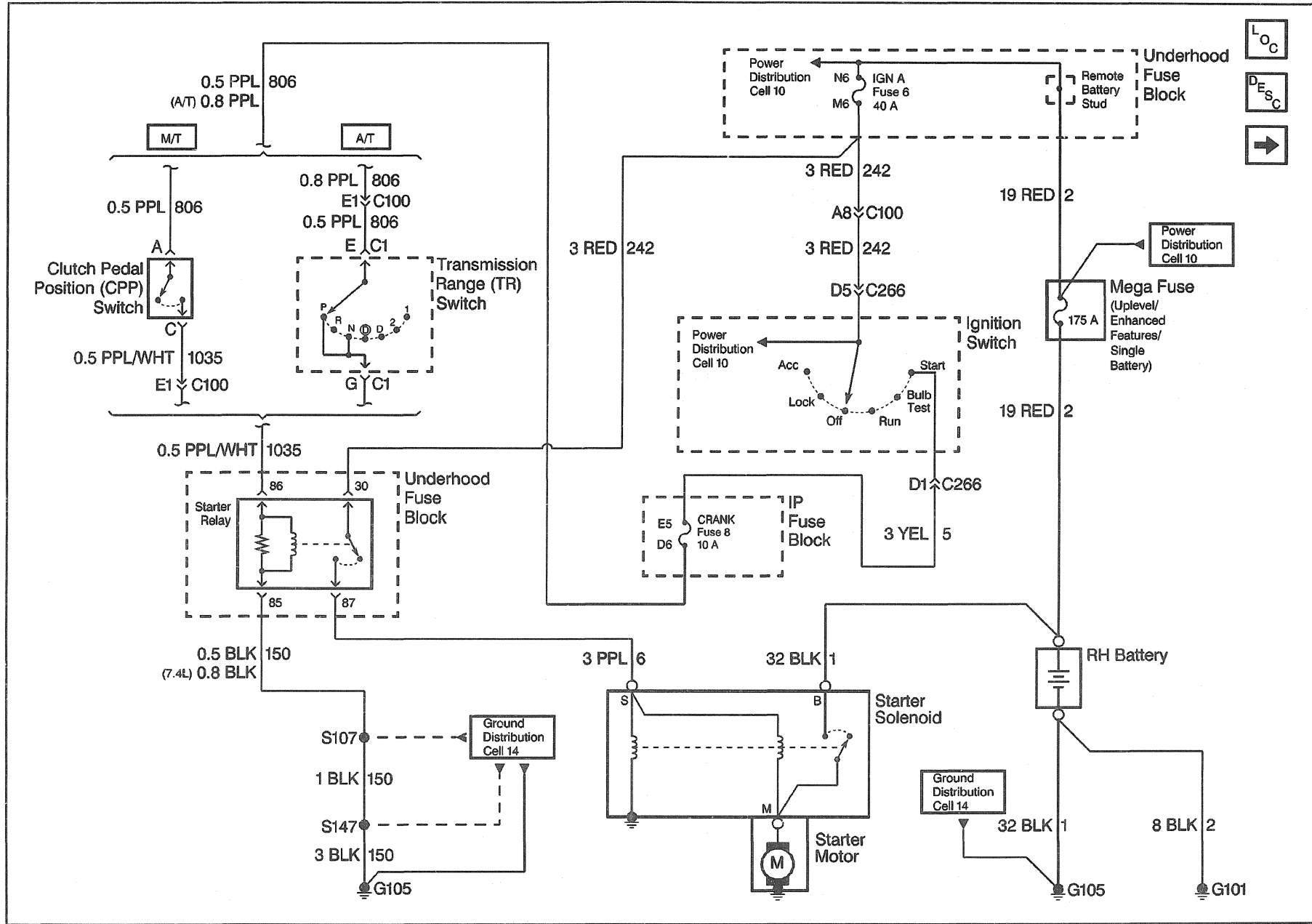
Engine Electrical Schematic References

Reference on Schematic	Section Number - Subsection Name
Ground Distribution Cell – 14	8–Wiring Systems
Instrument Cluster Cell – 81	8–Instrument Panel, Gauges and Console
Power Distribution Cell – 10	8–Wiring Systems

Engine Electrical Schematic Icons

Icon	Icon Definition
 <p>19384</p>	Refer to <i>ESD Notice</i> in Cautions and Notices.

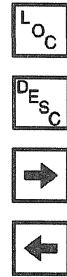
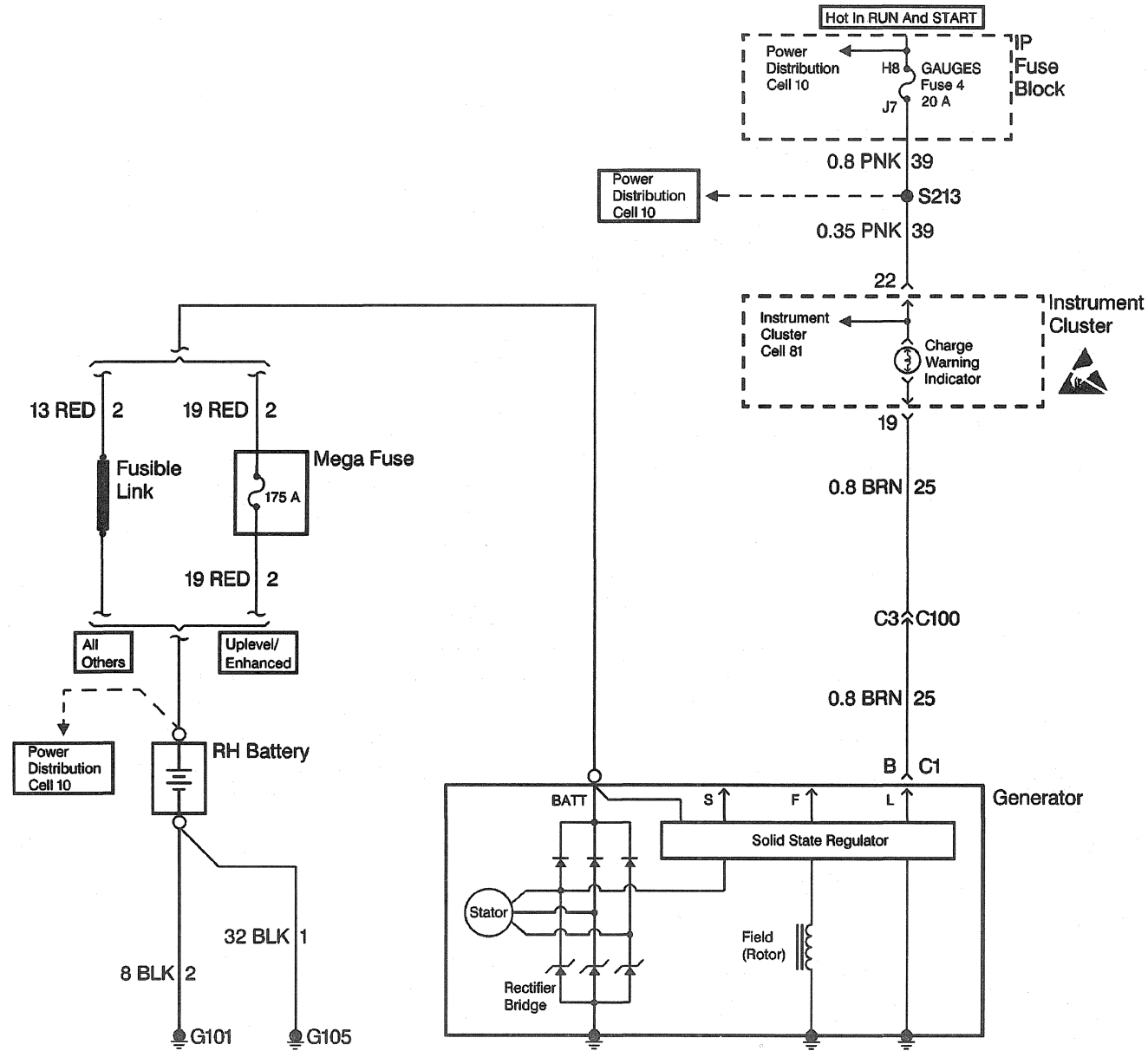
Starting and Charging Schematics (Starter Controls (Gas))



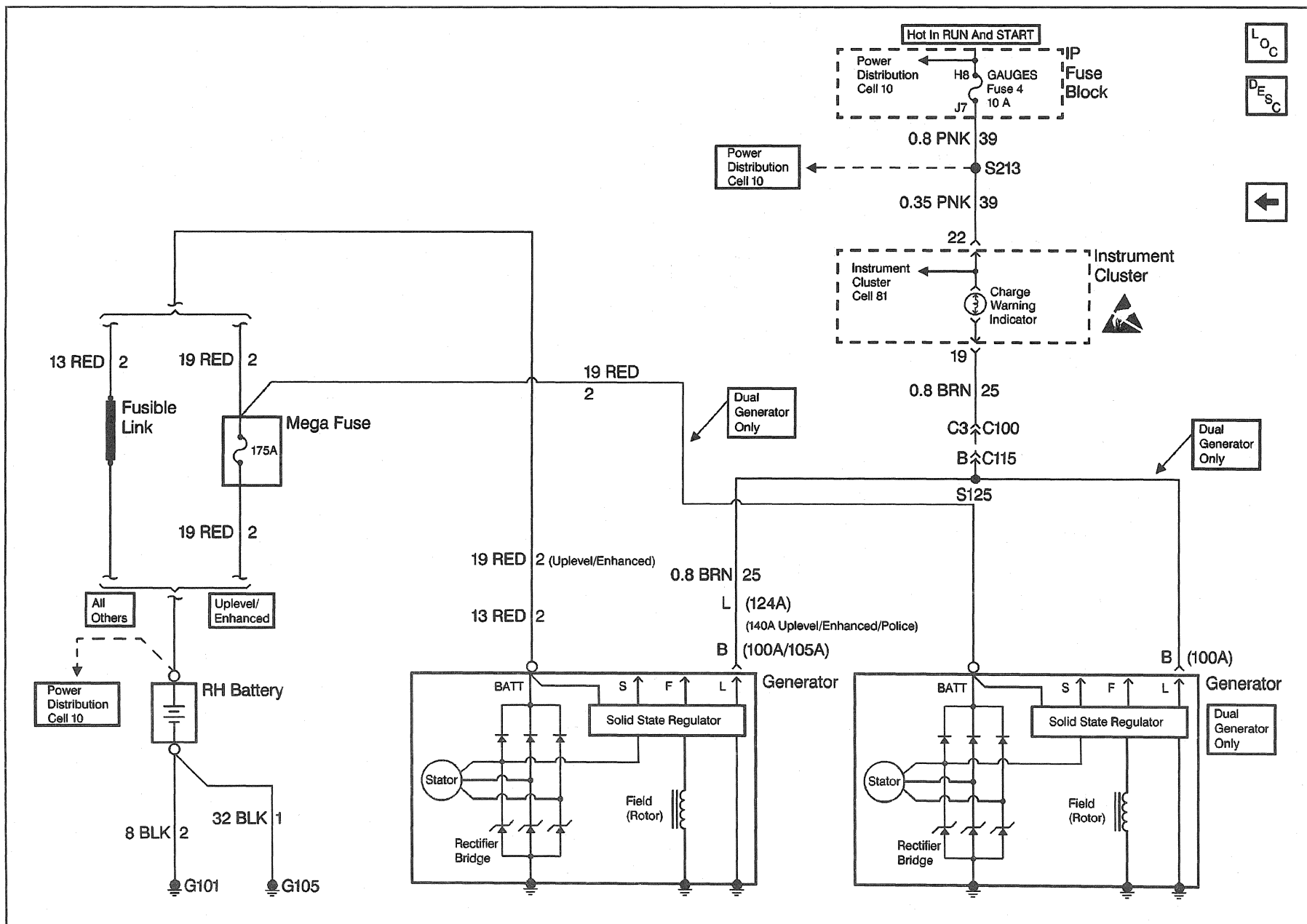
Engine



Starting and Charging Schematics (Generator Controls (Gas))



Starting and Charging Schematics (Generator Controls (Diesel))



Component Locator

Engine Electrical Components

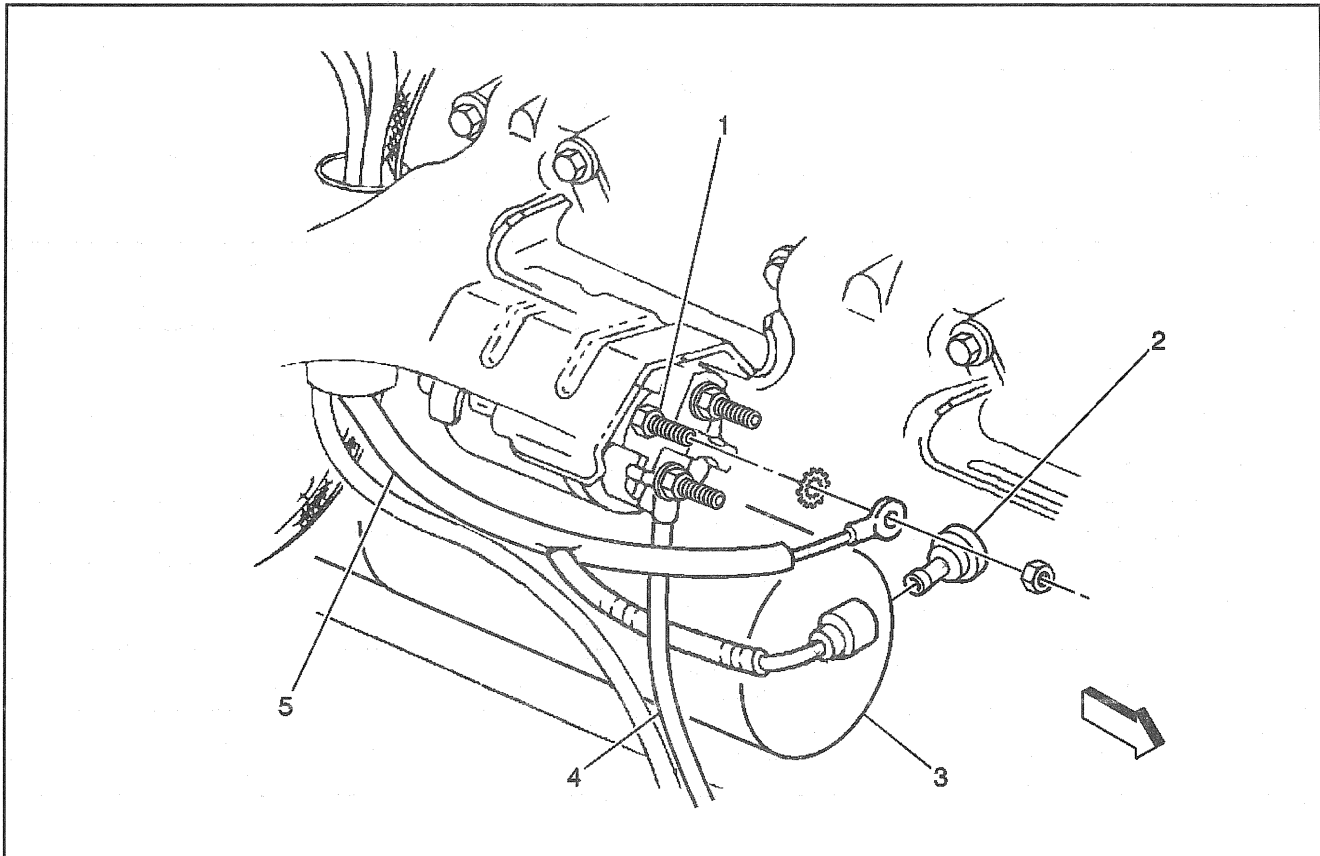
Name	Location	Locator View	Connector End View
Auxiliary Battery (Diesel)	In the left front side of the engine compartment	<i>Power and Grounding Component Views in Wiring Systems</i>	—
Battery, LH (w/Dual Battery Option)	In the left front of the engine compartment	<i>Power and Grounding Component Views in Wiring Systems</i>	—
Battery, RH	In the right front of the engine compartment	<i>Power and Grounding Component Views in Wiring Systems</i>	—
Clutch Pedal Position Switch	At the top of the clutch pedal	<i>Engine Electrical Component Views</i>	<i>Engine Electrical Connector End Views</i>
Fusible Link	Molded into the battery positive connector	<i>Power and Grounding Component Views in Wiring Systems</i>	<i>Power and Grounding Connector End Views in Wiring Systems</i>
Generator	At the LF of the engine	<i>Engine Electrical Component Views</i>	<i>Engine Electrical Connector End Views</i>
Ignition Switch	On the steering column, under the lock cylinder	<i>Standard Wheel/Column Component Views in Steering Systems</i>	<i>Standard Wheel/Column Connector End Views in Steering Systems</i>
Instrument Cluster	On the upper left end of the IP, above the steering column	<i>Instrument Cluster Component Views in Instrument Cluster</i>	<i>Instrument Cluster Connector End Views in Instrument Cluster</i>
IP Fuse Block	To the left of the IP, near the left front door jamb switch	<i>Power and Grounding Component Views in Wiring Systems</i>	<i>Power and Grounding Connector End Views in Wiring Systems</i>
Mega Fuse Block	In the RF of the vehicle	<i>Power and Grounding Component Views in Wiring Systems</i>	<i>Power and Grounding Connector End Views in Wiring Systems</i>
Remote Battery Stud	Part of the underhood fuse-relay center, in the left rear side of the engine compartment, on the fender	<i>Power and Grounding Component Views in Wiring Systems</i>	<i>Power and Grounding Connector End Views in Wiring Systems</i>
Starter Motor	At the lower RR of the engine	<i>Engine Electrical Component Views</i>	—
Starter Motor Solenoid	On the starter motor, to the rear of the engine	<i>Engine Electrical Component Views</i>	—
Starter Relay	In the underhood fuse-relay center, at the LR of the engine compartment, on the fender	<i>Engine Electrical Component Views</i>	<i>Engine Electrical Connector End Views</i>
Transmission Range Switch	On the LH of the transmission	<i>Engine Electrical Component Views</i>	<i>Engine Electrical Connector End Views</i>
Underhood Fuse Block	At the LR of the engine compartment, on the fender	<i>Power and Grounding Component Views in Wiring Systems</i>	<i>Power and Grounding Connector End Views in Wiring Systems</i>
C100	Part of the engine harness to IP harness, in the left rear side of the engine compartment, at the bulkhead	<i>Harness Routing Views in Wiring Systems</i>	<i>Inline Harness Connector End Views in Wiring Systems</i>
C115 (Diesel)	Inline from Engine harness to Alternator Jumper harness	<i>Harness Routing Views in Wiring Systems</i>	<i>Inline Harness Connector End Views in Wiring Systems</i>
C266	Part of the IP harness to steering column harness, to the left side of the steering column, near the bulkhead	<i>Harness Routing Views in Wiring Systems</i>	<i>Inline Harness Connector End Views in Wiring Systems</i>
G101	On the sheet metal, at the RF wheelhousing	<i>Power and Grounding Component Views in Wiring Systems</i>	—

Engine Electrical Components (cont'd)

Name	Location	Locator View	Connector End View
G102 (Diesel)	At the LF of the intake manifold	<i>Power and Grounding Component Views in Wiring Systems</i>	—
G105 (Gas)	At the RF of the engine block, near the damper pulley	<i>Power and Grounding Component Views in Wiring Systems</i>	—
G105 (Diesel)	Right rear of the cylinder head, cylinder #7 intake bolt	<i>Power and Grounding Component Views in Wiring Systems</i>	—
S107 (5.0L, 5.7L)	Engine harness, approx. 20 cm (8 in) from EGR valve breakout, toward taillamp harness breakout	—	—
S107 (6.5L-HD)	Engine harness, approx. 40 cm (15 in) from EBCM breakout, toward Transmission harness breakout	—	—
S107 (7.4L)	Engine harness, approx. 18 cm (7 in) from EBCM breakout, toward the EGR harness breakout	—	—
S125 (Dual Generator)	Alternator Jumper harness, approx. 18 cm (7 in) from the RH Generator	—	—
S147 (Gas)	Engine harness, approx. 5 cm (2 in) from EGR valve breakout, toward taillamp harness breakout	—	—
S147 (Diesel)	Engine harness, approx. 4 cm (1.5 in) from starter motor solenoid breakout	—	—
S213	IP harness, approx. 4 cm (1.5 in) from steering column harness breakout, towards the DLC	—	—

Engine Electrical Component Views

Starter Wiring (Gas)

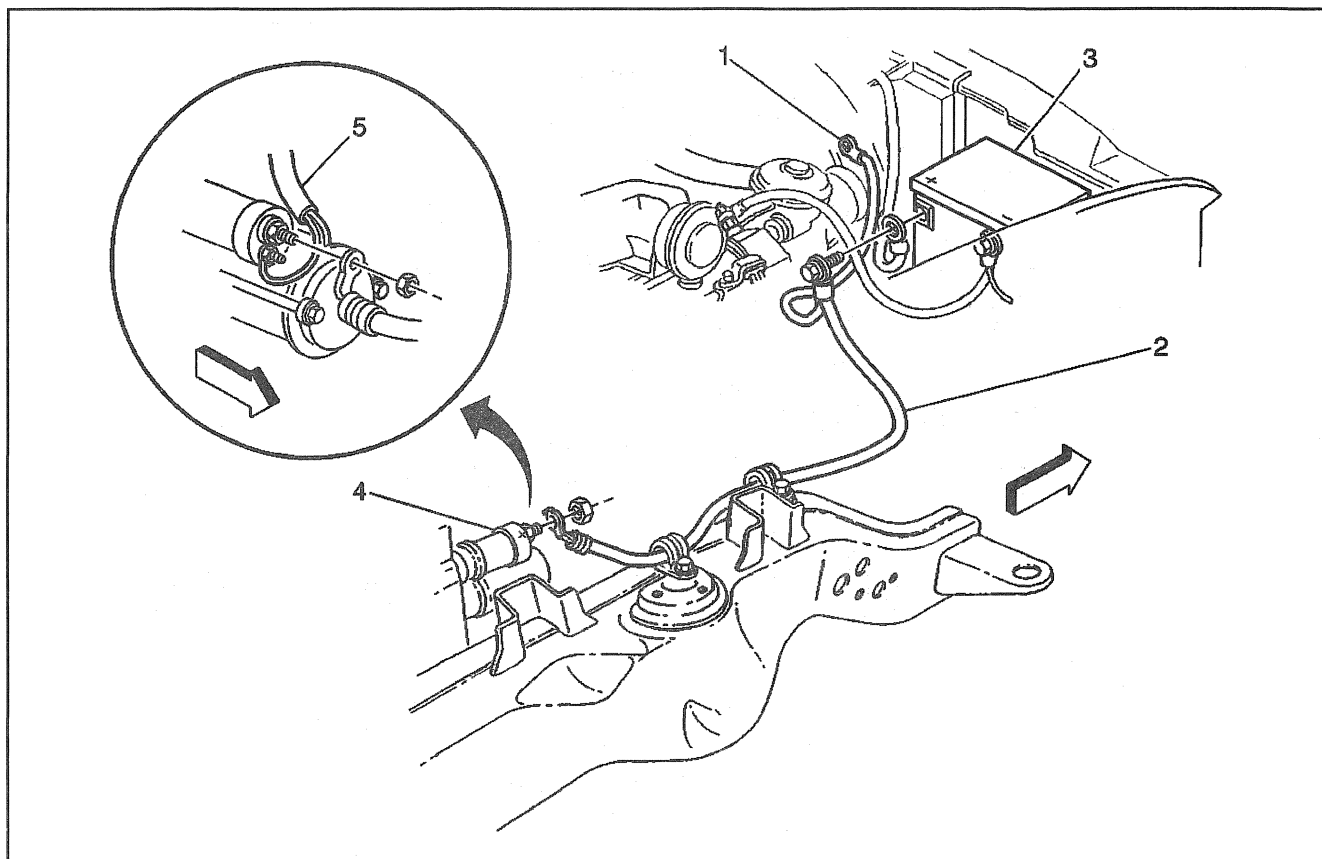


391545

Legend

- | | |
|----------------------|----------------------------|
| (1) Starter Solenoid | (4) Positive Battery Cable |
| (2) Knock Sensor | (5) Engine Wiring Harness |
| (3) Starter Motor | |

Starter Support Wiring (Diesel)



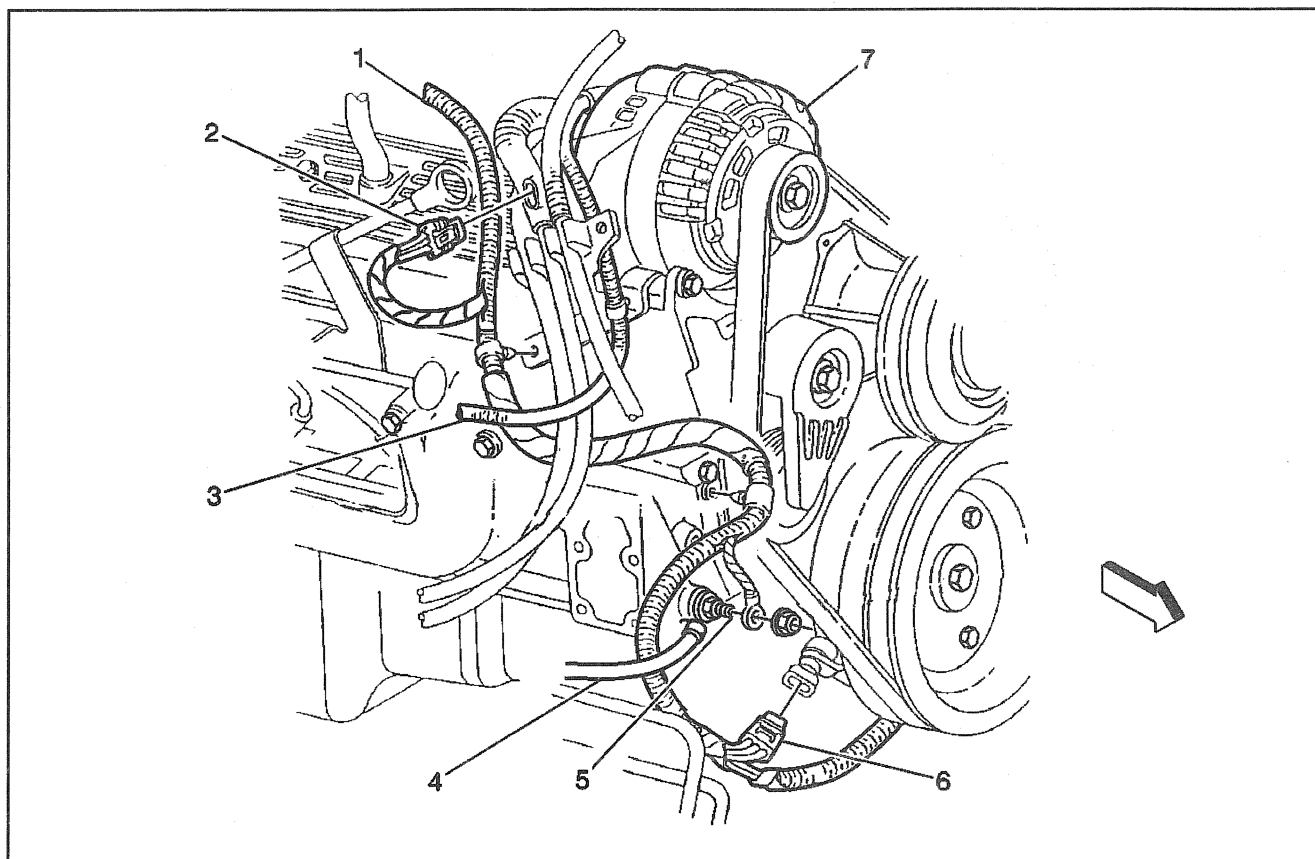
391546

Legend

- (1) Generator Cable
- (2) Positive Battery Cable
- (3) Battery, RH

- (4) Starter Solenoid
- (5) Engine Wiring Harness

Generator Support Wiring

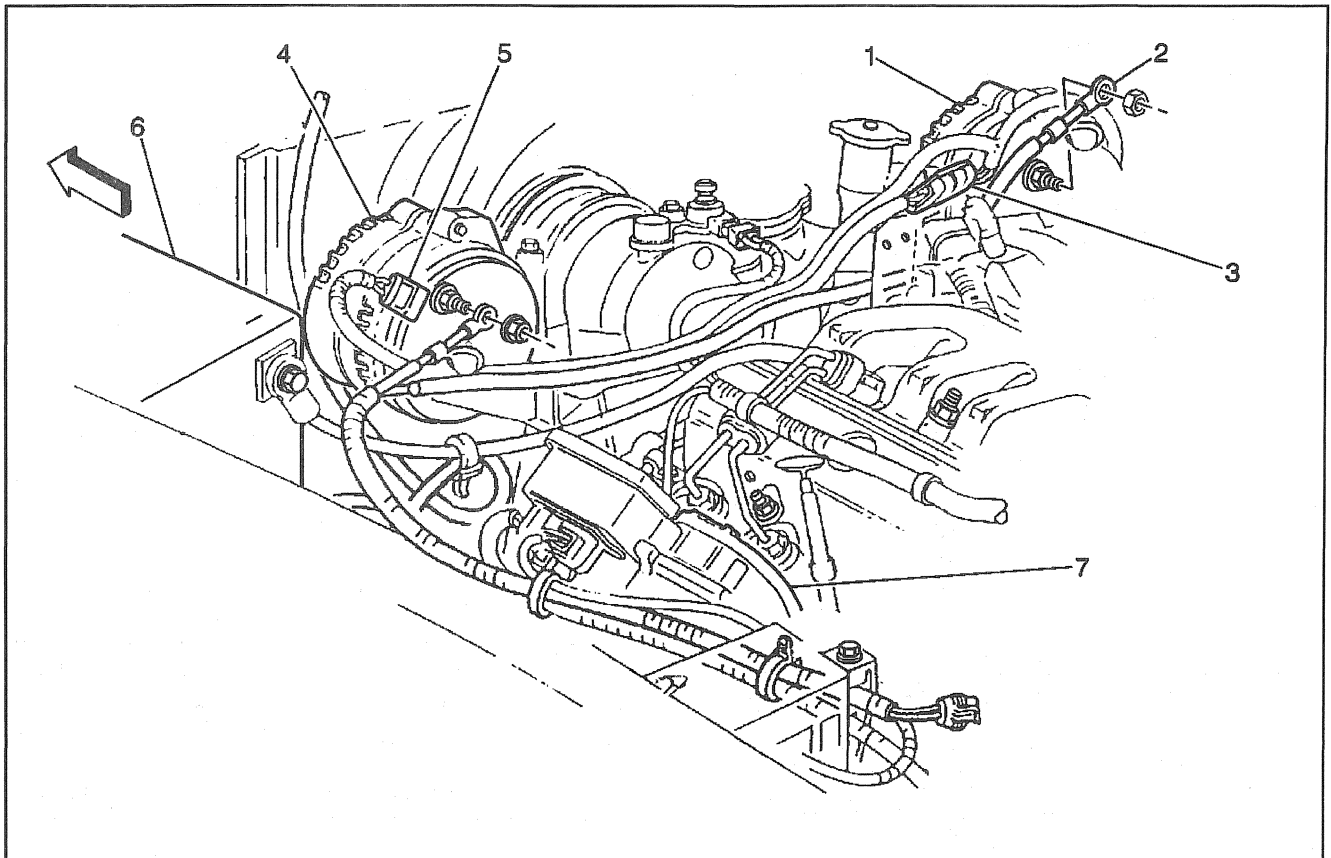


391537

Legend

- | | |
|----------------------------|--------------------------------|
| (1) Engine Wiring Harness | (5) G105 |
| (2) Generator Connector | (6) Crankshaft Position Sensor |
| (3) Generator Wiring | (7) Generator |
| (4) Negative Battery Cable | |

Dual Generator Support Wiring



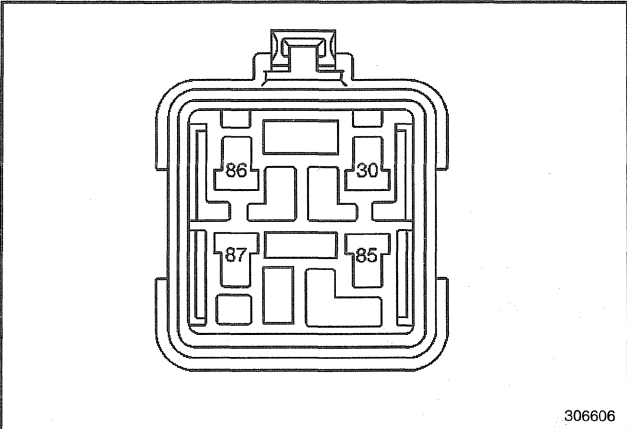
391542

Legend

- | | |
|---------------------|--|
| (1) Generator, RH | (5) Generator Connector, LH |
| (2) Generator Cable | (6) Battery, LH |
| (3) C115 | (7) Electronic Brake Control Module (EBCM) |
| (4) Generator, LH | |

Engine Electrical Connector End Views

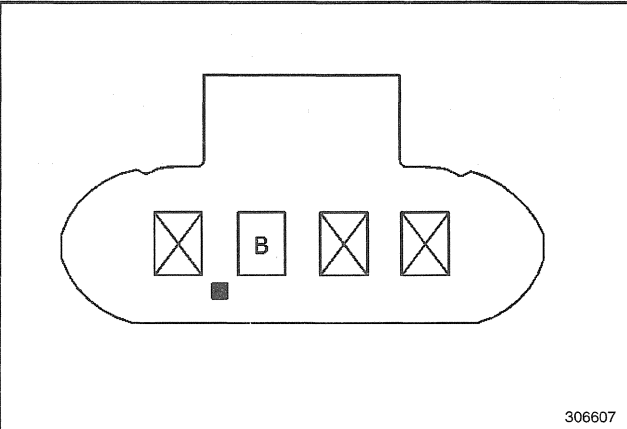
Starter Relay



306606

Connector Part Information		• 12129716 • CONN 4F M/P 280 FLXLK SLD (MD GRY)	
Pin	Wire Color	Circuit No.	Function
30	PPL	6	Starter Solenoid Feed
85	BLK	150	Ground
86	PPL/WHT	1035	Starter Relay Feed Coil
87	RED	242	Fuse Output - Battery Type II Fuse

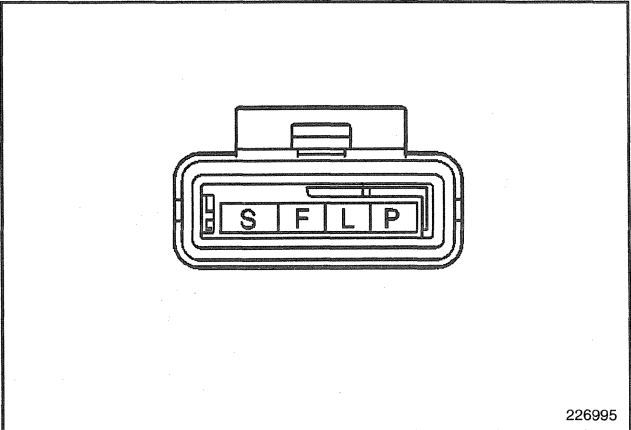
Generator Connector (Gas) (100A/105A)



306607

Connector Part Information		• 12186566 • ASM 1F M/P 150 Sealed (BLK)	
Pin	Wire Color	Circuit No.	Function
B	BRN	25	Charge Indicator Lamp Output

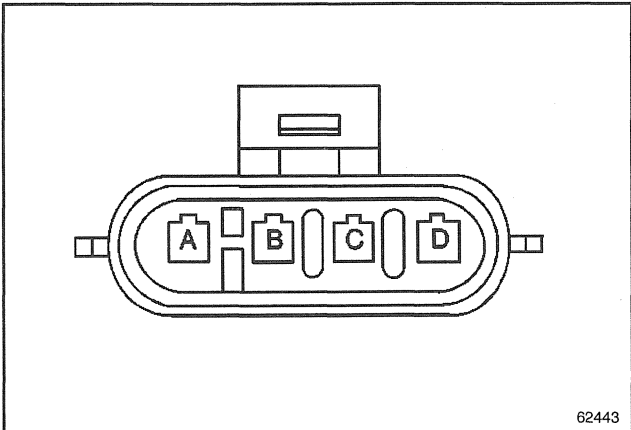
Generator Connector (Gas) (124A/140A)



226995

Connector Part Information		• 12124898 • ASM Conn 4F M/P Sealed (BLK)	
Pin	Wire Color	Circuit No.	Function
F	—	—	Not Used
L	BRN	25	Charge Indicator Lamp Output
P-S	—	—	Not Used

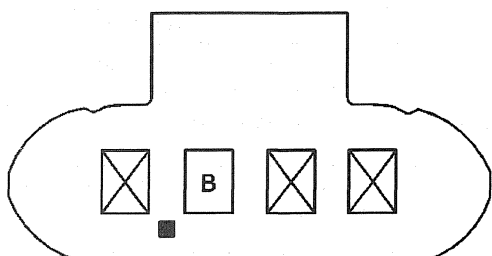
Generator Connector, RH (Dual, 100A)



62443

Connector Part Information		• 12047950 • ASM Conn 4F M/P 150 (BLK)	
Pin	Wire Color	Circuit No.	Function
A	WHT	121	Tachometer Signal
B	BRN	25	Charge Indicator Lamp Output
C-D	—	—	Not Used

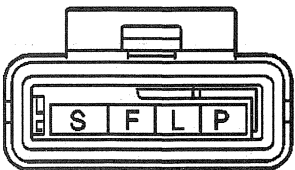
Generator Connector, LH (Dual, 100A)



306607

Connector Part Information		<ul style="list-style-type: none"> • 12047950 • ASM Conn 4F M/P 150 (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	—	—	Not Used
B	BRN	25	Charge Indicator Lamp Output
C-D	—	—	Not Used

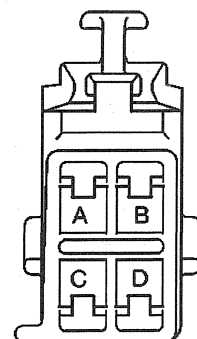
Generator Connector, (Diesel, 140A)



226995

Connector Part Information		<ul style="list-style-type: none"> • 12124898 • ASM Conn 4F M/P Sealed (BLK) 	
Pin	Wire Color	Circuit No.	Function
F	—	—	Not Used
L	WHT	121	Tachometer Signal
P	BRN	25	Charge Indicator Lamp Output
S	—	—	Not Used

Clutch Pedal Position Switch



306609

Connector Part Information		<ul style="list-style-type: none"> • 12129136 • CONN 4F M/P 280 FLXLK (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	PPL	806	Fuse Output - Crank - Type III Fuse
B	PPL	420	Stop Lamp Switch Output
C	PPL/WHT	1035	Starter Relay Feed - Coil
D	BRN/WHT	379	Cruise Control Clutch Pedal Position Switch Output

Diagnostic Information and Procedures

Starting System Check

Step	Action	Normal Result(s)	Abnormal Result(s)*
1	Visually inspect the Battery Hydrometer.	Battery Hydrometer displays a green eye.	Refer to <i>Battery Hydrometer Displays Dark or Yellow Dot</i> .
2	Visually inspect Battery cables.	Battery cables are clean and tightly connected.	Refer to <i>Battery Cable</i> .
3	Inspect IGN A Fuse 6, CRANK Fuse 8, GAUGES Fuse 4 and Fusible Link.	Fuses are not open.	Repair source of overload and Replace Fuse.
4	Inspect all grounds.	All grounds are clean and tightly connected.	Clean and tighten grounds.
5	Inspect Starter Motor and Starter Solenoid.	Both Starter Motor and Starter Solenoid are properly mounted and Starter Solenoid terminals S and B are clean and tight.	Ensure proper mounting and clean and tighten terminals.
6	Inspect the generator.	Generator drive belt is tight. The Generator connector and terminal are clean and tight.	Adjust Generator drive belt. Clean and tighten connectors and terminals.
7	Move the Ignition Switch from the OFF position to the RUN position.	BAT Indicator lamp turns on, engine does not run.	Refer to <i>Charge Indicator Inoperative</i> .
8	Move the Ignition Switch to the START position and then slowly release.	Starter motor runs, the Engine starts, and the BAT Indicator Lamp turns off.	Refer to <i>Starter Solenoid Clicks, Engine Does Not Crank, Starter Solenoid Does Not Click, or Engine Cranks/Cranks Slowly, but Does Not Start</i> .
9	Allow Engine to run for approximately 5-7 minutes. Measure voltage at the Battery terminals.	Voltage reading of 13-16 volts.	Refer to <i>Battery Load Test</i> .
* Refer to the appropriate symptom diagnostic table for the applicable abnormal result.			

Charging System Check

Charging System Check

- Visually inspect the hydrometer (built into the battery).
 - Green Eye — Battery is charged.
 - Dark Eye — CHARGE and LOAD TEST, Refer to *Battery Load Test*.
 - If battery passes load test, refer to Battery is Under Charged or Overcharged System Diagnosis
 - Clear or Yellow Eye — Battery electrolyte is low. REPLACE the battery.
- Check that the Generator(s) connector(s) and Generator BATTERY connections are clean and tight.
- Check the condition of the GAUGES Fuse 4. If the fuse is open, LOCATE and REPAIR source of overload and REPLACE the fuse.
- CHECK that the Battery connections are clean and tight.
- CHECK the Fusible Links for opens. If a Fusible Link is open, LOCATE and REPAIR the source of the overload and REPLACE the Fusible Link.
- CHECK the condition of the Generator drive belt. REPLACE as per Engine Cooling.
- CHECK that Grounds G100, G110, G103 and G300 are clean and tight.
- If more than one indicator lamp in the Instrument Cluster is not lighting, than CHECK for an open in the PNK 39 wire to the Instrument Cluster.
 - CHECK for a broken or partially broken wire inside the insulation which could cause system malfunction but prove GOOD in a Continuity/Voltage CHECK with a system disconnected. These circuits may be intermittent or resistive when loaded and should be checked by monitoring for a voltage drop with the system operational (under load).
 - CHECK for proper installation of aftermarket electronic equipment which may affect the integrity of other systems (Refer to Trouble Shooting Procedures, in Electrical Diagnosis).

Starter Solenoid Does Not Click

Step	Action	Value(s)	Yes	No
1	1. Place the transmission in park (A/T) or actuate the clutch pedal (M/T). 2. Move the ignition switch to the START position. 3. Measure the voltage between the starter solenoid terminal S, CKT 6 (PPL) and an engine ground. Is the voltage reading the same as the battery voltage?	—	Go to Step 13	Go to Step 2
2	1. Remove the starter relay from the underhood fuse block. 2. Connect a test lamp from the starter relay socket cavity 30 to ground. Does the test lamp light?	—	Go to Step 3	Go to Step 14
3	Connect a jumper wire between cavity 30 and 87 of the starter relay socket. Does the starter solenoid click?	—	Go to Step 4	Go to Step 15
4	1. Connect CKT 6 (PPL) at the starter solenoid. 2. Connect a test lamp between starter relay socket cavity 85 to B+. Does the test lamp light?	—	Go to Step 5	Go to Step 16
5	1. Place the transmission in park (A/T) or actuate the clutch pedal (M/T). 2. Move the ignition switch to the START position. 3. Measure the voltage between the starter relay socket cavity 86 and 85. Is the voltage reading the same as the battery voltage?	—	Go to Step 17	Go to Step 6
6	Is the vehicle equipped with a manual transmission?	—	Go to Step 7	Go to Step 9
7	1. Disconnect the clutch pedal position switch connector. 2. Move the ignition switch to the START position. 3. Measure the voltage between the clutch pedal position switch connector cavity A, CKT 806 (PPL), to ground. Is the voltage reading the same as the battery voltage?	—	Go to Step 8	Go to Step 11
8	1. Engage the parking brake. 2. Actuate the clutch pedal and place the transmission in neutral. 3. Connect a fused jumper between the clutch pedal position switch connector cavity A, CKT 806 (PPL), to cavity C, CKT 1035 (PPL/WHT). 4. Move the ignition switch to the START position. Does the engine crank?	—	Go to Step 18	Go to Step 19
9	1. Disconnect the transmission range switch connector. 2. Move the ignition switch to the START position. 3. Measure the voltage between the transmission range switch connector C1 cavity E, CKT 806 (PPL), to ground. Is the voltage reading the same as the battery voltage?	—	Go to Step 10	Go to Step 11
10	1. Connect a fused jumper between transmission range switch connector C1 cavity E, CKT 806 (PPL), to cavity G, CKT 1035 (PPL/WHT). 2. Move the ignition switch to the START position. Does the engine crank?	—	Go to Step 20	Go to Step 21
11	1. Move the ignition switch to the START position. 2. Measure the voltage between the ignition switch connector C266 cavity D1, CKT 5 (YEL), to ground. Is the voltage reading the same as the battery voltage?	—	Go to Step 22	Go to Step 12

Starter Solenoid Does Not Click (cont'd)

Step	Action	Value(s)	Yes	No
12	Measure the voltage between the connector C266 cavity D5 and ground. Is the voltage reading the same as the battery voltage?	—	Go to Step 23	Go to Step 24
13	1. Clean the starter motor, the starter motor mounting surfaces, and the mounting bolts. Refer to <i>Starter Motor Inspection (28-MT Series)</i> . 2. Repeat the test. If the starter motor does not pass the test, replace the starter motor. Is the repair or replacement complete?	—	Go to Starting System Check	—
14	Install the starter relay and repair the open in CKT 244 (RED) between fuse 6 and the starter relay. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	Go to Starting System Check	—
15	Install the starter relay and repair the open in CKT 6 (PPL) between the starter relay and the starter solenoid. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	Go to Starting System Check	—
16	Install the starter relay and repair the open in CKT 150 (BLK) between the starter relay and ground G105. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	Go to Starting System Check	—
17	Replace the starter relay. Is the replacement complete?	—	Go to Starting System Check	—
18	1. Adjust the clutch pedal position switch. 2. Retest the system. 3. If the starter motor does not operate, replace the clutch pedal position switch. Refer to <i>Clutch Start Switch Replacement</i> . Is the repair or replacement complete?	—	Go to Starting System Check	—
19	Repair the open in CKT 1035 (PPL) between the clutch pedal position switch and the starter relay. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	Go to Starting System Check	—
20	Replace the transmission range switch. Refer to <i>Park/Neutral Back Up Switch Replacement</i> . Is the replacement complete?	—	Go to Starting System Check	—
21	Repair the open in CKT 5 (YEL) between the transmission range switch and the starter relay. Refer to <i>Wiring Repairs</i> . Is the repair complete?	—	Go to Starting System Check	—
22	1. Check for an open in CKT 5 (YEL) between the ignition switch and the IP fuse block. 2. If OK, repair the open in CKT 806 (PPL) between the IP fuse block and the clutch pedal position switch (M/T) or the transmission range switch (A/T). Refer to <i>Wiring Repairs</i> . Is the repair or replacement complete?	—	Go to Starting System Check	—
23	Replace the ignition switch. Refer to <i>Ignition Lock Cylinder Replacement - On Vehicle</i> . Is the replacement complete?	—	Go to Starting System Check	—
24	Repair the open in CKT 242 (RED) between the ignition switch and the underhood fuse block. Refer to <i>Wiring Repairs</i> . Is the replacement complete?	—	Go to Starting System Check	—

Starter Solenoid Clicks, Engine Does Not Crank

Step	Action	Value(s)	Yes	No
1	Are there any other engine problems that could affect starting?	—	Go to <i>Starting System Check</i>	Go to <i>Step 2</i>
2	1. Ensure the battery is fully charged. 2. Move Ignition Switch to the Start Position. 3. Measure Voltage across the RH Battery. Is the voltage reading greater than the value after 15 seconds?	—	Go to <i>Step 3</i>	Go to <i>Step 6</i>
3	Measure battery voltage at terminal B of the starter solenoid. Is the voltage reading the same as battery voltage?	—	Go to <i>Step 4</i>	Go to <i>Step 8</i>
4	Measure voltage between the negative RH Battery terminal and the Engine Block. Is the voltage reading less than the value?	—	Go to <i>Step 5</i>	Go to <i>Step 9</i>
5	Replace the Negative Battery cable. Refer to <i>Battery Cable</i> . Is the repair complete?	—	Go to <i>Starting System Check</i>	—
6	Perform a Battery Load test. Is the battery good?	—	Go to <i>Step 7</i>	Go to <i>Step 11</i>
7	Replace the Stator Motor. Refer to <i>Starter Motor Replacement (Gasoline Engines)</i> . Is the repair complete?	—	Go to <i>Starting System Check</i>	—
8	Replace the Positive Battery cable between the RH Battery and the Starter Solenoid. Refer to <i>Battery Cable</i> . Is the repair complete?	—	Go to <i>Starting System Check</i>	—
9	1. Connect an auxiliary ground wire between the starter casing and Battery Negative terminal. 2. Turn the Ignition Switch to the start position. Does the engine crank?	—	Go to <i>Step 10</i>	Go to <i>Step 7</i>
10	1. Remove the starter motor. 2. Clean the starter motor mounting surfaces. Refer to <i>Starter Motor Inspection (28-MT Series)</i> . 3. Re-install the starter motor. 4. Turn the ignition switch to the start position. Does the engine crank?	—	Go to <i>Starting System Check</i>	Go to <i>Step 7</i>
11	Replace the Battery. Refer to <i>Battery Replacement</i> . Is the repair complete?	—	Go to <i>Starting System Check</i>	—

Engine Cranks/Cranks Slowly, but Does Not Start

Step	Action	Value(s)	Yes	No
1	1. Ensure the battery is fully charged. 2. Turn the ignition switch to START. 3. Wait 15 seconds and measure the voltage at the battery while cranking the engine. Is the reading greater than the specified value?	9.5 V	Go to <i>Step 2</i>	Go to <i>Step 3</i>
2	Measure the voltage between the B (neg) terminal and the engine block while cranking the engine. Is the reading greater than the specified value?	0.5 V	Go to <i>Step 4</i>	Go to <i>Step 5</i>
3	Load test the battery. Is the battery OK?	—	Go to <i>Step 6</i>	Go to <i>Step 7</i>
4	Replace the negative battery cable. Refer to <i>Battery Cable</i> . Does the starter solenoid continue to click and the engine to crank slowly or not at all?	—	Go to <i>Step 5</i>	Go to <i>Starting System Check</i>

Engine Cranks/Cranks Slowly, but Does Not Start (cont'd)

Step	Action	Value(s)	Yes	No
5	Measure the voltage between the B (pos) terminal and the starter solenoid terminal B, CKT 1 (BLK), while cranking the engine. Is the reading greater than the specified value?	0.5 V	Go to Step 8	Go to Step 6
6	Repair or replace the starter motor. Refer to <i>Starter Motor Replacement (Gasoline Engines)</i> . Does the starter solenoid continue to click and the engine to crank slowly or not at all?	—	Go to Step 7	Go to Starting System Check
7	Replace the battery. Refer to <i>Battery Replacement</i> . Does the starter solenoid continue to click and the engine to crank slowly or not at all?	—	Go to Step 8	Go to Starting System Check
8	Replace the positive battery cable. Refer to <i>Battery Cable</i> . Is the repair complete?	—	Go to Starting System Check	—

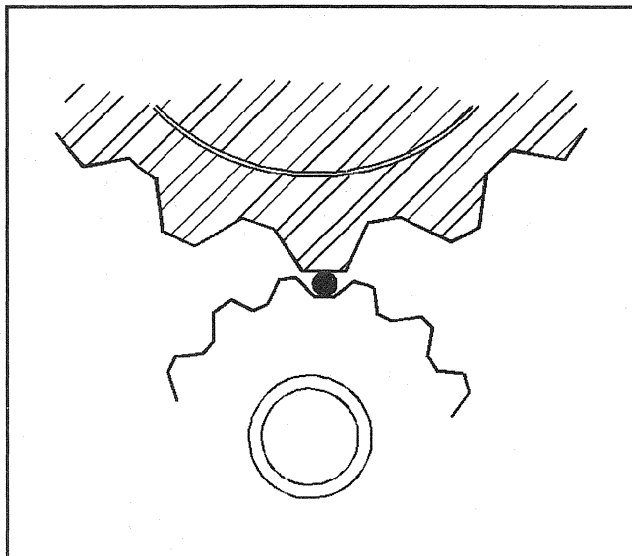
Starter Motor Noise Diagnosis (General Diagnosis)

Step	Action	Value	Yes	No
1	Do you hear a high pitched whine during cranking (before the engine fires) but the engine cranks and fires normally?	—	Go to Step 2	Go to Step 3
2	Reduce the distance between the starter pinion and the flywheel. Refer to Starter Noise. Has the noise stopped?	—	System OK	—
3	As the key is being turned, do you hear a high-pitched whine after the engine fires? (The engine cranks and fires normally. This is often diagnosed as starter hang-in or a weak solenoid.)	—	Go to Step 4	Go to Step 5
4	Increase the distance between the starter pinion and the flywheel. Refer to Starter Noise. (Flywheel runout makes this appear to be intermittent.) Has the noise stopped?	—	System OK	—
5	Is there a loud whoop after the engine fires, but while the starter is still held engaged? (It may sound like a siren if the engine is revved while the starter is engaged.)	—	Go to Step 6	Go to Step 7
6	1. Remove the starter motor. Refer to <i>Starter Motor Replacement (Gasoline Engines)</i> or <i>Starter Motor Replacement (Diesel Engines)</i> . 2. Check the starter motor clutch. 3. Replace worn parts. Has the noise stopped?	—	System OK	—
7	Do you hear a rumble, a growl, or, in severe cases, a knock as the starter is coasting down to a stop after starting the engine?	—	Go to Step 8	System OK
8	1. Remove the starter motor. Refer to <i>Starter Motor Replacement (Gasoline Engines)</i> or <i>Starter Motor Replacement (Diesel Engines)</i> . 2. Check for a bent or unbalanced starter armature. 3. Replace worn parts. Has the noise stopped?	—	System OK	—

Starter Motor Noise Diagnosis (Pinion Clearance)

Pinion Clearance

1. Remove the lower flywheel housing cover.
2. Inspect the flywheel for signs of unusual wear such as chipped or missing gear teeth or the flywheel being bent.
3. Start the engine and gently touch the outside diameter of the rotating flywheel ring gear with chalk or crayon to show the high point of tooth runout after the engine is turned off. Turn the engine off and rotate the flywheel so the marked teeth are in the area of the starter pinion gear.
4. Disconnect the negative battery cable to prevent accidental cranking of the engine.



1051

5. Measure the clearance between the top of the ring gear tooth and the bottom of the pinion tooth using the width of a wire gage or standard feeler stock. Normal clearance is 0.5 to 1.5 mm (0.02 to 0.06 inch). The pinion must be electrically or mechanically engaged to make this measurement.
6. If clearance is less than 0.5 mm (0.02 inch), and the starter whines after firing, shim the starter away from the flywheel.
7. Add 1.0 mm (0.04 inch) shims, one at a time, to both long bolts between starter mounting pads and the engine until the noise problem is corrected. Do not use more than 2 shims total.
8. If the pinion clearance is more than 1.5 mm (0.06 inch) and the starter whines during cranking, shim the starter toward the flywheel.

9. Add 0.33 mm (0.014 inch) shims between the outboard starter mounting pad and the engine mount until the noise stops. Do not add more than 4 shims total.
10. When shimming is done, tighten the mounting bolts.

Tighten

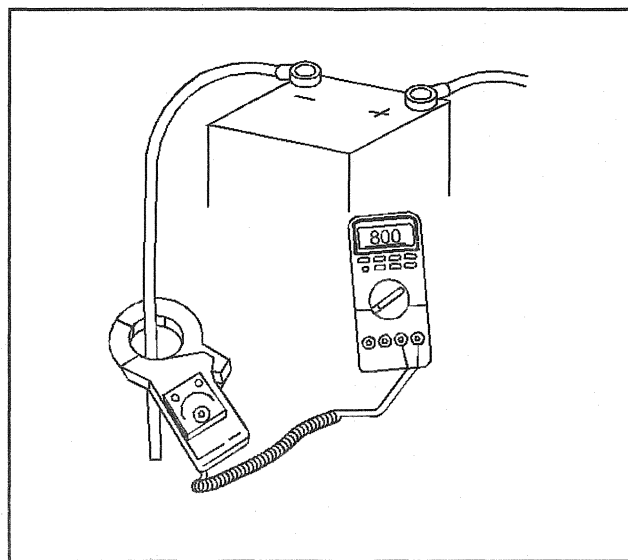
- Mounting bolts (diesel) to 45 N·m (33 lb ft).
- Mounting bolts (gas) to 40 N·m (30 lb ft).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

Starter No Load Test

Tools Required

1. J 39200 Digital Multimeter
2. J 35590 Adapters, or equivalent



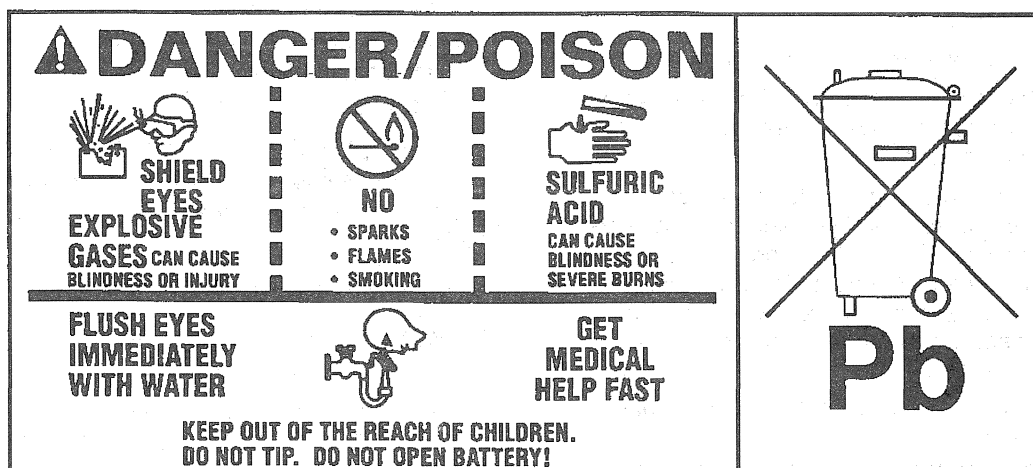
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Notice: Never operate the starter motor more than 15 seconds at a time without pausing in order to allow it to cool for at least 2 minutes. Overheating will damage the starter motor.

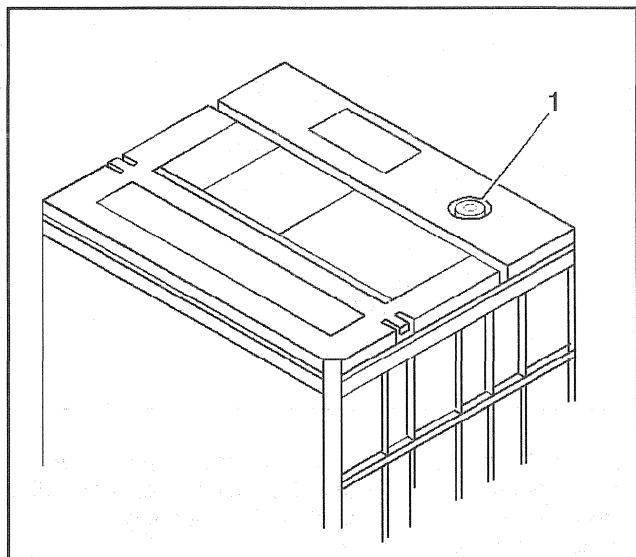
Important: Verify that both batteries are in good condition.

1. Disable the fuel system by removing the fuel solenoid fuse.
2. Calculate the current draw, and select the 200 A or 2000 A scale on the current clamp.
3. Zero the current clamp, and clamp the J 39200 to the negative battery cable.
4. Crank the engine and observe the meter readings. The reading should be 330 to 360 amps. If the amperage is over 360 amps, an internal starter failure may be the cause. If the amperage is under 330 amps, a battery cable or connection may be the cause.

Battery Hydrometer Displays Dark or Yellow Dot



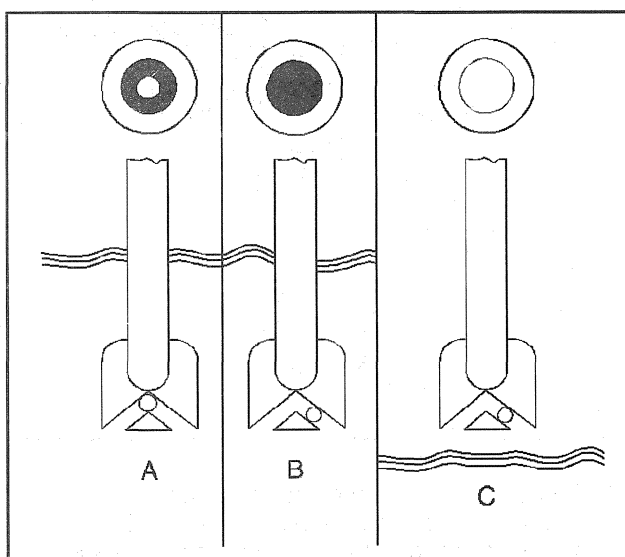
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1057

Molded into the top of the maintenance-free battery is a built-in temperature compensated hydrometer. Make sure that the battery top is clean when observing the hydrometer. Use a flashlight to observe the hydrometer in poorly lit areas. Do not produce any sparks. Use this hydrometer with the following diagnostic procedure.

Under normal operation, one of the following three indications will be observed:



1023

1. The green dot is visible (A).
 - Any green appearance in the hydrometer is interpreted as a green dot.
 - The green dot means the battery is at least 65% charged and is ready for testing.
2. When the green dot can not be seen (B). The charging is below 65%.
 - If there is a cranking complaint, refer to generator diagnosis for further testing.
 - To inspect the charging system for excessive draw, refer to *Battery (Parasitic) Load Test*.
3. The dot appears clear or light yellow (C).
 - A diagnosis can not be made at this fluid level.
 - A clear or light yellow dot means that the fluid level is below the bottom of the hydrometer.

The following can cause a low fluid condition:

- Overcharging
- A cracked battery case
- Tipping the battery

A battery found with a low fluid condition can indicate a high charging voltage, caused by a faulty charging system. The charging system must be inspected for specified output. The electrical system must be tested for a parasitic drain. Refer to *Charging System Check*.

Replace the battery when there is a yellow or clear hydrometer along with a cranking complaint.

Battery Load Test

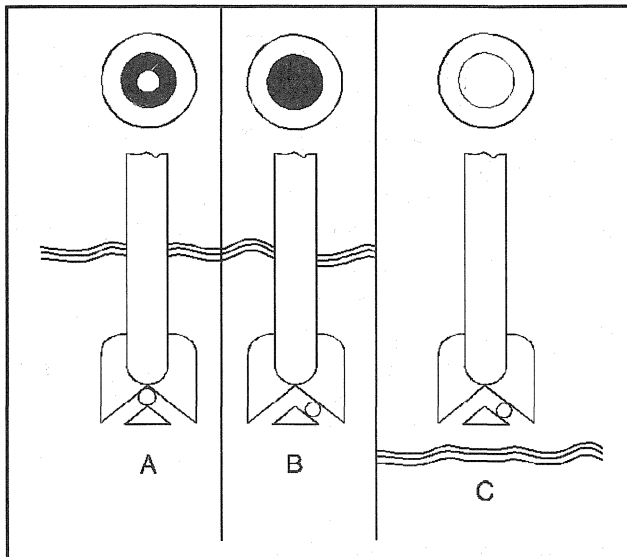
Tools Required

GM P/N 12303040

Visual Inspection

1. Before performing the load test, visually inspect the battery for obvious damage, such as a cracked or broken case.
2. Repair the cause of any damage or replace the battery. Refer to *Battery Replacement*.

Hydrometer Check

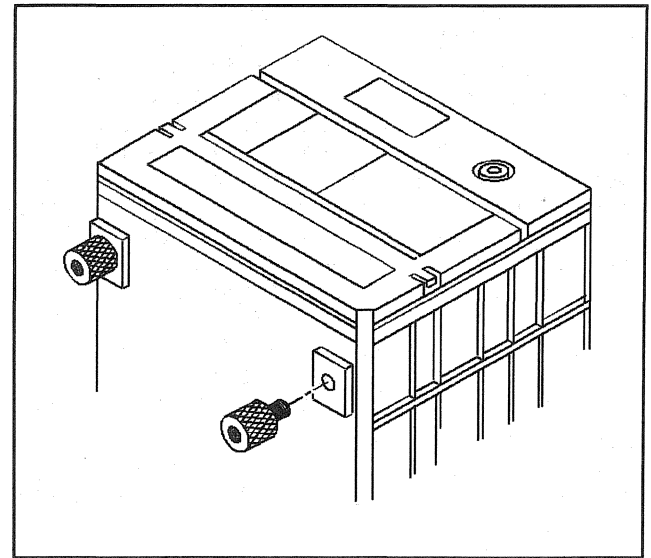


1023

- If the green dot is visible (A), perform the load test.
- If the green dot is not visible (B), charge the battery. Refer to *Battery Charging*.
- If the dot is clear or yellow (C), replace the battery. Refer to *Battery Replacement*.

Important: Do not load test a frozen battery. Replace it instead.

1. Use a voltmeter in order to check the voltage across the battery terminals. If the green dot is visible, the voltage should be 12 volts or above. Unless the battery has just been discharged (such as, by load testing or cranking the engine), replace the battery if the voltage is below 12 volts.



42433

2. Install battery side terminal adapters.
3. Connect a voltmeter and a battery lead tester across the battery terminals.

Important: Do not complete this step if the battery has not been recently charged.

4. If the battery has been charging, apply a 300 ampere load for 15 seconds in order to remove the surface charge from the battery. Remove the load.
5. Wait 15 seconds in order to let the battery recover, then apply the specified load from the specifications. Read the voltage after 15 seconds, then turn off the load.

Important: The battery temperature must be estimated by the feel and by the temperature the battery has been exposed to for the preceding few hours.

6. When the voltage does not drop below the minimum voltage, the battery is good and should be returned to service. If the voltage is less than the minimum, replace the battery. Refer to *Battery Temperature vs Voltage Drop*.

Battery (Parasitic) Load Test

Battery Electrical Drain

If the vehicle exhibits a low or dead battery after an overnight period, or discharges over a period of 2 or 3 days, the electrical system should be checked for an excessive electrical drain. This is referred to as Parasitic Current Drain.

If a battery needs recharging and no cause is evident, check the vehicle for excessive parasitic current drain.

One or more on-board solid state control modules, such as the PCM, may at some time, exhibit a failure mode that causes a high parasitic drain on the vehicle's battery. When the battery is disconnected to install an ammeter, etc., the excessive current drain may not occur once the circuit continuity is restored. Even though cycling the ignition key to the RUN and then to the OFF position may cause such a drain to recur, there may be drains that will not recur unless the vehicle systems are reactivated in a road test. Since the ignition switch must not be rotated to the ACCESSORY, RUN or START position with an ammeter installed between the battery terminal and the battery cable, a current drain test tool must be used as described in the following procedures.

Before starting this procedure, ensure that the ignition switch is in the LOCK position, all electrical accessories are turned OFF and the doors are closed.

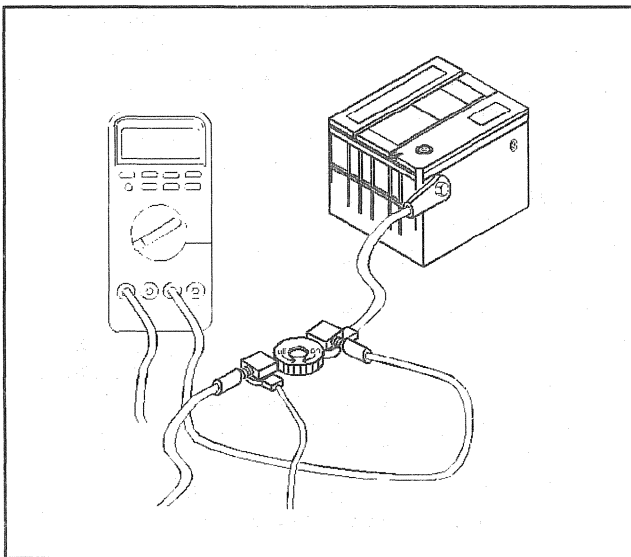
Tools Required

- J 38758 Parasitic Draw Test Switch
- J 39200 Digital Multimeter
- J 36169-A Fused Jumper Wire

Notice: Do not turn the parasitic draw test switch to the OFF position with the engine running. Damage will occur to the vehicle's electrical system.

Notice: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

1. Disconnect the negative battery cable. Refer to *Battery Disconnect Caution* in General Information.



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2. Install the male end of the J 38758 to the negative battery terminal.
3. Turn OFF the test switch.
4. Install the negative battery cable to the female end of the test switch.

5. Turn ON the test switch.
6. Road test the vehicle while activating all accessories, including the radio and the air conditioning.
7. Turn OFF the ignition switch. Remove the key.

Important: From this point on, electrical continuity must be maintained in the ground circuit of the battery through the J 38758 in the ON position or through the J 39200.

8. Components such as PCMs and VCMs have timers that draw several amps of current while they cycle down. This can give a false parasitic drain reading. Wait 15 minutes for these components to power down before continuing this test.

Important: If an ammeter other than the J 39200 is used, ensure that the vehicle does not have a high current drain that would damage the ammeter when connected to the circuit.

9. Connect a jumper wire with a 10 A fuse J 36169-A to the terminals of the Test switch.
10. Turn the test switch to the OFF position.
11. Wait ten seconds.
If the fuse does not blow, the current is less than 10 A.
The ammeter can be used safely.
12. Before the fused jumper wire is removed, turn the test switch to the ON position.
13. You can detect a high current drain using the following procedure:
Set the J 39200 to the 10 A scale.
14. Connect the ammeter to the test switch terminals.
15. Turn OFF the test switch. This allows the current to flow through the ammeter.
16. Wait one minute, then check the current reading.
 - When there is a current reading of 2 A or less, turn ON the test switch, this maintains continuity in the electrical system.
 - Then, switch the meter down to the 2 A scale, for a more accurate reading, when the test switch is reopened.
17. Take the reading in milliamps.
18. Note the reserve capacity of the battery. If the vehicle has a diesel engine with two batteries, add the reserve capacities together. If the vehicle is equipped with an auxiliary battery, use only the reserve capacity of the main battery. Refer to *Battery Usage*.
 - Divide this number by 4.
 - Compare this to the ammeter reading.
 - The current drain should not exceed this number.
 - Example: if a battery has a reserve capacity of 100 minutes, the current drain should not exceed 25 milliamps.

Notice: Always turn the test switch knob to the ON position before removing each fuse to maintain continuity in the electrical system and to avoid damaging the meter due to accidental overloading, such as opening a door to change a fuse.

19. When the current draw is too high, remove the electrical system fuses one at a time until the draw returns to a value less than or equal to specifications.
 - Start with the fuses that are hot all the time.
 - To remove the fuse, you must first open the door, which may cause a high enough current flow to damage the ammeter.
 - Protect the ammeter, without disturbing the electrical continuity, by turning ON the test tool before opening the door.
 - Remove the courtesy lamp fuse.
 - Note the ammeter reading.
 - If the parasitic load is still excessive start removing the remaining fuses one at a time.
 - Keep the courtesy lamp fuse out during diagnosis, so the door can remain open.
 - Perform Steps 11 through 13 each time a fuse is removed.

20. Removing the PCM or VCM fuse should cause a drop of less than 10 milliamps.

A drop greater than 10 milliamps indicates a possible short to ground.

21. Check the orange wires along with the components connected to the orange wires.
No drop in the milliamperage reading indicates the PCM or VCM is not drawing current.
22. Repeat the parasitic current drain test procedure after any repair has been completed.
23. When the cause of the excessive current draw has been located and repaired, remove the ammeter and the parasitic draw test switch.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

24. Connect the negative cable to the negative battery terminal.

Tighten

Tighten the battery cable attaching bolt to 15 N·m (11 lb ft).

Charge Indicator Always On

Step	Action	Value(s)	Yes	No
1	1. Turn OFF the engine. 2. Disconnect the generator connector. 3. Move the ignition switch to the RUN position. Does the battery indicator light?	—	Go to Step 3	Go to Step 2
2	Repair or replace the generator. Refer to <i>Generator Replacement (Gasoline Engines)</i> or <i>Generator Replacement (Diesel Engines)</i> Is the repair complete?	—	Go to Charging System Check	—
3	1. Remove n CKT 25 (BRN) from connector C100. 2. Turn ignition switch to the RUN position. Does the battery indicator light?	—	Go to Step 4	Go to Step 5
4	Locate and repair the short to ground in CKT 25 (BRN) between C100 and the battery indicator bulb. Refer to <i>Wiring Repairs</i> Is the repair complete?	—	Go to Charging System Check.	—
5	Locate and repair the short to ground in CKT 25 (BRN) between C100 and the generator. Refer to <i>Wiring Repairs</i> Is the repair complete?	—	Go to Charging System Check	—

Charge Indicator Inoperative

Step	Action	Value(s)	Yes	No
TOOLS REQUIRED: J 39200				
1	1. Disconnect the generator connector. 2. Turn the ignition switch to the RUN position. 3. Connect a fused jumper from cavity B, CKT 25 (BRN), of the generator connector, to ground. Does the battery indicator light?	—	Go to Step 4	Go to Step 2
2	1. Disconnect the instrument cluster connector. 2. Turn the ignition switch to the Run position. 3. Measure the voltage between the instrument cluster connector terminal 22 to ground. Is the voltage reading the same as battery voltage?	—	Go to Step 5	Go to Step 3
3	Repair the open in CKT 39 (PNK) between the IP fuse block and the instrument cluster. Refer to <i>Wiring Repairs</i> Is the repair complete?	—	Go to Charging System Check	—
4	Repair or replace the generator. Refer to <i>Generator Replacement (Gasoline Engines)</i> or <i>Generator Replacement (Diesel Engines)</i> . Is the repair or replacement complete?	—	Go to Charging System Check	—
5	1. Connect a jumper wire from cavity 22 of the IP Cluster to B+. 2. Connect a jumper wire from cavity 19 of the IP Cluster to ground. Does the battery indicator light?	—	Go to Step 7	Go to Step 6
6	Replace the instrument cluster. Refer to <i>IP Cluster Replacement</i> . Is the replacement complete?	—	Go to Charging System Check.	—
7	Repair the open in CKT 25 (BRN) between the instrument cluster and the generator. Refer to <i>Wiring Repairs</i> Is the repair complete?	—	Go to Charging System Check	—

Voltmeter Displaying High or Low

Step	Action	Value(s)	Yes	No
TOOLS REQUIRED: J 39200				
1	1. Start the vehicle. 2. Connect a J 39200 Is the voltage reading within specifications?	12.0 – 16.0 V	Go to Step 2	Go to Step 3
2	Replace the instrument cluster. Refer to <i>IP Cluster Replacement</i> . Is the replacement complete?	—	Go to Charging System Check	--
3	Inspect the generator. Refer to <i>Generator Assembly Bench Check (CS-130)</i> or <i>Generator Assembly Bench Check (CS-144)</i> . Is the repair complete?	—	Go to Charging System Check	—

Generator Noise Test

Generator noise may be caused by the following conditions:

- A loose drive belt.
- Loose mounting bolts.
- A loose or poor fitting terminal.
- A faulty component inside the generator.

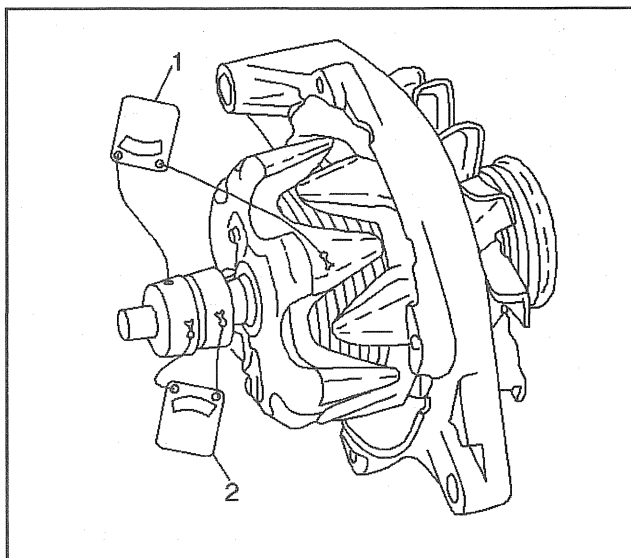
Replace the generator if the drive belt and the mounting bolts are snug and there is still excessive generator noise. Refer to *Generator Replacement (Gasoline Engines)* or *Generator Replacement (Diesel Engines)*.

Do not disassemble the generator. Separating the two end frames will damage the slip ring end frame bearing. CS-130 generator is serviceable by complete replacement only.

Generator Not Operating Properly

Except as stated, make the following tests with an ohmmeter on the low range scale.

Rotor Field Winding Test



17203

The rotor may be tested electrically with a self-powered test lamp or an ohmmeter.

Open Winding Test

To test for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open. Replace the rotor.

Grounded Winding Test

Connect a test lamp or ohmmeter from one slip ring to the shaft. If the lamp lights, or if the reading is low, the rotor winding is grounded. Replace the rotor.

Short Circuit or Resistance Test

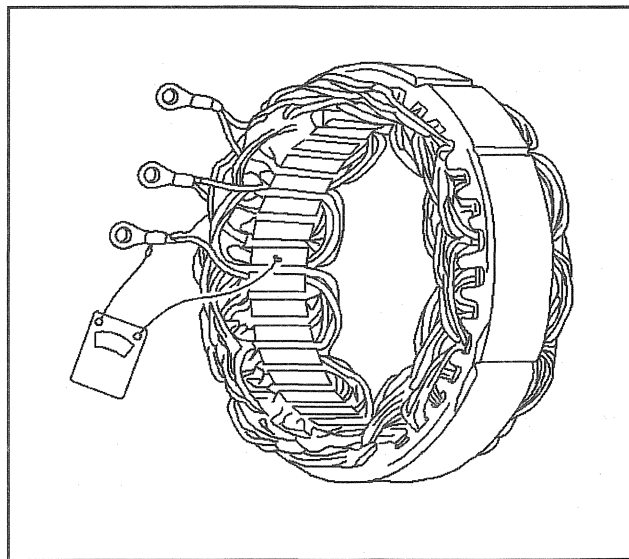
Test the winding for short circuits or excessive resistance by connecting a battery and ammeter in series with the edge of the two slip rings. Note the ammeter reading. An ammeter reading above the specified value indicates shorted windings.

An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings. If the resistance reading is above the specified value, the winding has excessive resistance; if below the specified value, the winding is shorted. The specified resistance value can be determined by dividing the voltage by the current.

Remember that the winding resistance and ammeter readings will vary slightly with winding temperature. If the rotor is not defective, but the generator fails to supply rated output, the problem is in the rectifier bridge, stator, or regulator.

If the rotor fails any of the above checks, replace it.

Stator Test

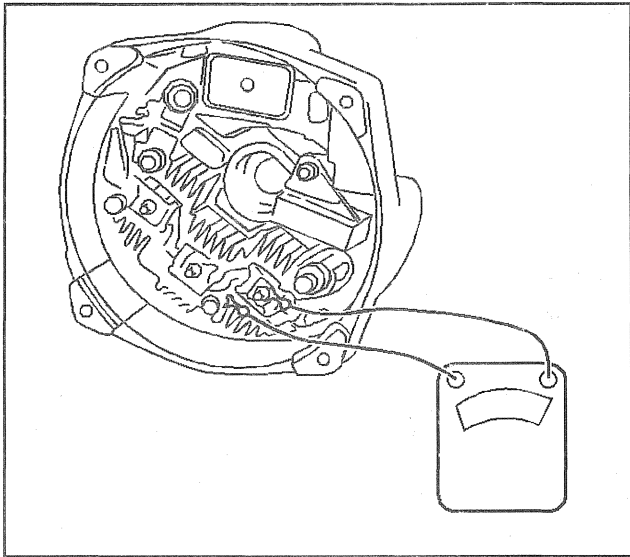


17205

Test the stator with a self-powered test lamp or an ohmmeter. If the ohmmeter reads low, or if the lamp turns when connected from any stator lead to bare metal on the stator frame, then the stator is grounded.

An ohmmeter cannot be used to test the delta stator for shorts or opens. Noticeable discoloration on the assembly usually indicates a problem in the stator windings.

Rectifier Bridge Test



17207

To test the rectifier bridge, connect an ohmmeter to the grounded heat sink and one of the three terminals. Press down firmly on the flat metal clip. Observe the ohmmeter reading. Then, reverse the connections to the grounded heat sink and the same metal clips. If both readings are the same, replace the rectifier bridge. A good rectifier bridge will give one high and one low reading. Repeat this procedure between the grounded heat sink and the other two terminals, and between the insulated heat sink and each of the three terminals. This makes a total of six tests, with two readings taken for each test.

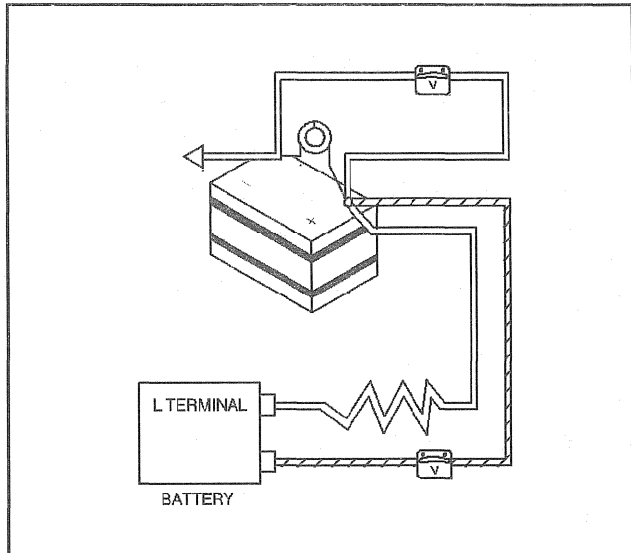
Some digital ohmmeters cannot be used to test diodes in the rectifier bridge. Consult the ohmmeter manufacturer to determine your ohmmeter capabilities.

Regulator

The regulator cannot be tested outside of the generator. If the rotor, stator, and rectifier bridge are OK, but the generator still produces more than 16 volts or does not produce within 15 amperes of the rated output during a generator output test, replace the regulator.

Generator Assembly Bench Check (CS-130)

This test requires both a fully charged battery and a generator test stand to operate the generator.



1049

1. Make connections as shown, except leave the carbon pile turned off. The ground polarity of the generator and battery must be the same. The battery must be fully charged. Use a 30–500 ohm resistor between the battery and the L terminal.
2. Slowly increase the generator speed and observe the voltage.
3. If the voltage is uncontrolled and increases above 16 volts, the rotor field is shorted, the regulator is not working properly, or both. A shorted rotor field coil can cause repeat regulator failure.
4. If the voltage is below 16 volts, increase speed and turn on and adjust the carbon pile to obtain maximum amperage output. Maintain the voltage above 13 volts.
5. If the output is with 15 amperes of the rated output, the generator is good.
6. If the output is not within 15 amperes of the rated output, replace the generator.

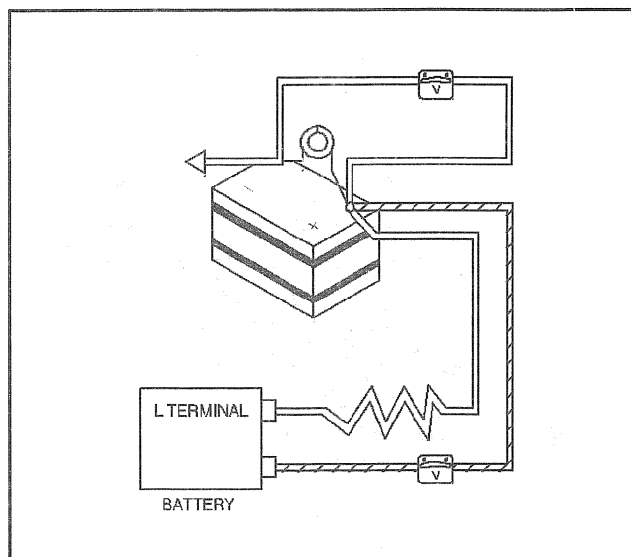
Generator Assembly Bench Check (CS-144)

Tools Required

J 39200 Digital Multimeter

Important: Perform the following inspection in order to verify operation of a repaired CS-144 generator:

1. Mount the generator in a test stand. Ensure that the test stand is capable of driving a generator at 6500 RPM.



1049

2. Make the connections as shown.

Important: Ensure that the battery is fully charged when making this test.

Run the engine at 2500 RPM and at ambient temperature.

3. Slowly increase the generator speed and observe the voltage using J 39200.
4. If the voltage is uncontrolled and increases above 16 Volts, repair or replace the generator.
5. If the voltage is below 16 Volts, perform the following steps:
 - Increase the generator speed.
 - Connect the carbon pile.
 - Adjust the carbon pile in order to obtain maximum amperage output.
 - Maintain 13 Volts or more.
6. Use an ammeter in order to check the amperage.
 - If the output is within 15 Amps of rated output, the generator is good.
 - If the output is not within 15 Amps of rated output, then repair or replace the generator.

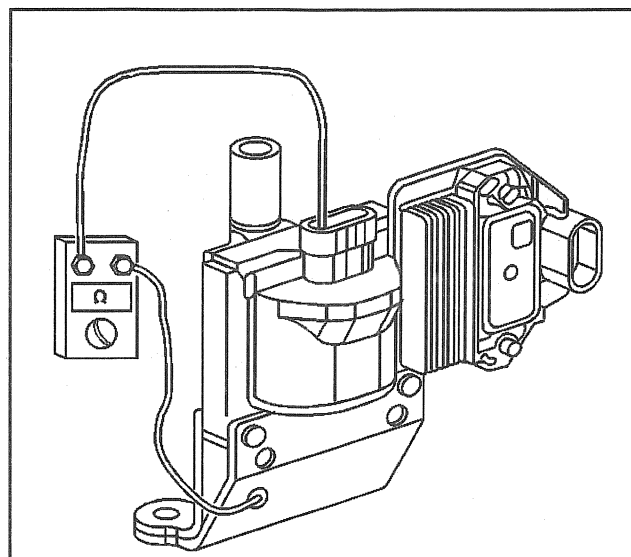
Ignition Coil(s) Not Operating Properly

Tools Required

J 39200 Digital Multimeter

1. Turn OFF the ignition switch.
2. Disconnect the distributor lead and wiring from the ignition coil.

Notice: Do not insert the J 39200 digital multimeter probe into the ignition coil connectors. The female terminals could be deformed, resulting in intermittent operation. Only make contact with the front edge of the terminals.

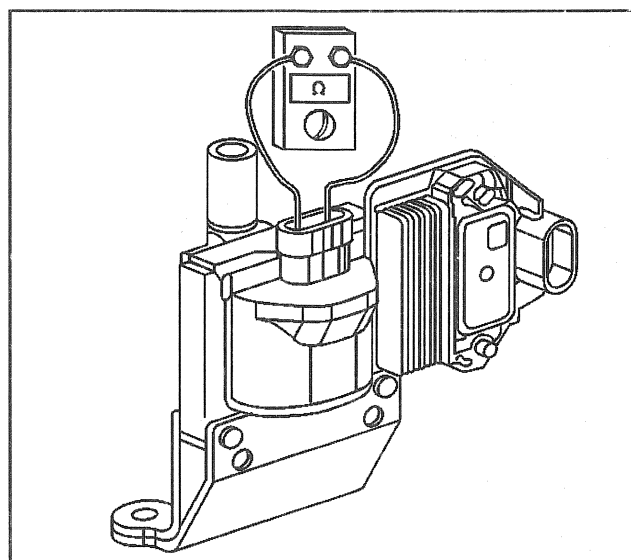


43746

3. Connect an ohmmeter as shown.

- Use the high scale.
- If the reading is not infinite, replace the coil.

Refer to *Ignition Coil and ICM Replacement (HVS)*.

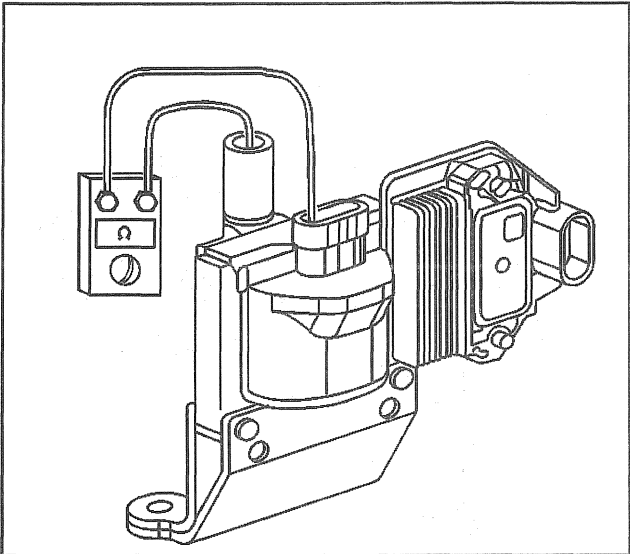


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4. Connect an ohmmeter as shown.

- Use the low scale.
- The reading should be 0.1 ohms. If not, replace the coil.

Refer to *Ignition Coil and ICM Replacement (HVS)*.



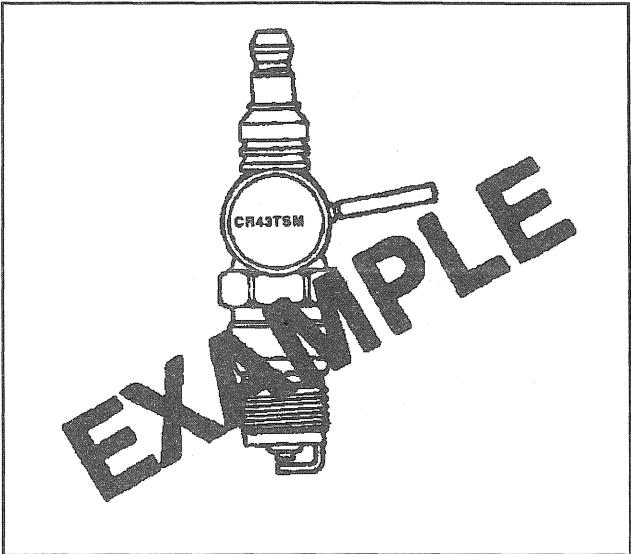
5. Connect an ohmmeter as shown.
 - Use the high scale.
 - If the reading is not 5–25k ohms, replace the coil.

Refer to *Ignition Coil and ICM Replacement (HVS)*.
6. Reconnect the distributor lead and wiring to the coil.

Spark Plug Visual Diagnosis

Notice: These spark plugs have a ceramic insulator that is 3.175 mm (1/8in) longer than earlier model spark plugs. Use a spark plug socket that is deep enough for these longer plugs (J 39358). Failure to do so could cause cracking of the insulator and arcing inside the plug resulting in an engine misfire.

Resistor type spark plugs with tapered seats are used. No gasket is needed on these plugs. These spark plugs are a High Efficiency (HE) spark plug that has a fine wire electrode, nickel plated shell and a platinum pad across from the electrode.



1. Normal service is a mixture of idling, low speed, and high speed operation.
 - Occasional high speed driving is essential to good spark plug performance.
 - Increased combustion heat burns away excess carbon deposits, which accumulate from frequent idling or stop-and-go driving.
2. The heat resistant, insulating boot covers the spark plug terminal.
 - The boot extends over a portion of the spark plug insulator.
 - These boots prevent engine misfiring.
3. Corona discharge is a steady blue light appearing (in darkness) around the insulator, just above the shell crimp.
 - Do not mistake this for a shorted insulator. This is visible evidence of a high-tension field.
 - This has no effect on ignition system performance.
 - This discharge repels dust particles.
 - This leaves a clear ring on the insulator just above the shell.
 - This is not evidence that combustion gases are escaping.

Spark Plug Visual Diagnosis

Step	Action	Value(s)	Yes	No
DEFINITION: A visual inspection of the spark plug firing end.				
1	1. Remove the spark plug from the engine. 2. Note which cylinder the plug is from. Do you see a brown to grayish tan deposit with a slight electrode wear?	—	Go to Step 2	Go to Step 3
2	1. This is normal wear. 2. Clean, regap and reinstall the plug. 3. Tighten the plug, refer to <i>Fastener Tightening Specifications</i> . Is the repair complete?	0.60" (2.2L) 0.45" (4.3L)	System OK	—
3	Do you see dry, fluffy, black carbon deposits?	—	Go to Step 4	Go to Step 6

Spark Plug Visual Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
4	This indicates poor ignition output, refer to <i>Spark Plug Wire Resistance</i> . Is the ignition coil to the distributor connection and/or the ignition coil(s) to the spark plug connections OK?	—	—	Go to Step 5
5	Repair or install new parts as necessary. Is the repair complete?	—	System OK	—
6	Do you see wet, oily deposits with very little electrode wear?	—	Go to Step 7	Go to Step 8
7	1. This results from either the break-in of a new or recently overhauled engine. 2. Or from failed piston rings. Degrease, gap and reinstall the spark plug.	0.60" (2.2L) 0.45" (4.3L)	Go to Step 5	Go to Step 11
8	Do you see red, brown, yellow and/or white colored coatings on the insulator?	—	Go to Step 9	Go to Step 11
9	These are the by-products of combustion. Is the insulator heavily coated?	—	Go to Step 10	Go to Step 2
10	Gap and install new spark plug(s). Tighten the spark plug, refer to <i>Fastener Tightening Specifications</i> .	—	—	—
11	Are there heavy deposits of dark colored coatings, especially on the side of the plug facing the intake valve?	—	Go to Step 12	Go to Step 13
12	1. This is the result of failed intake valve seals. 2. Or from excessive valve stem to valve guide clearances. 3. This may not occur in all cylinders.	—	Go to Step 5	—
13	Is there a shiny, yellow glaze coating on the spark plug insulator?	—	Go to Step 14	Go to Step 15
14	1. These are the melted by-products of combustion. 2. Avoid wide open throttle after long periods of low speed operation.	—	Go to Step 10	—
15	1. Are the insulator tips blistered or burned? 2. Are the electrodes badly eroded?	—	Go to Step 16	—
16	1. This is the result of overheating. 2. The spark plug heat range may be too hot. 3. The fuel octane rating is too low for the application, refer to General Information. Is the heat range correct?	—	Go to Step 17	Go to Step 5
17	Check the torque value to ensure good spark plug seat to engine contact. Are the spark plugs tightened according to specifications?	17 N·m (13 lb ft) (2.2L) or 15 N·m (11 lb ft) (4.3L)	Go to Step 18	Go to Step 5
18	The ignition timing may be over-advanced, refer to Section 6. Is the timing correct or are the components which control ignition timing operating properly?	—	Go to Step 19	Go to Step 5
19	Check for a lean air-fuel mixture, refer to Engine Controls. Is the air-fuel mixture too lean?	—	Go to Step 5	Go to Step 20
20	Check the cooling system, refer to Engine Cooling. Is the cooling system operating properly?	—	—	Go to Step 5

Spark Plug Wires Not Operating Properly

Tools Required

J 39200

1. Inspect the routing of the wires. Improper routing can cause crossfiring.
2. Inspect each wire for any signs of
 - cracks
 - burns
 - damage
 - splits in the wire
3. Inspect each boot for signs of
 - tears
 - piercing
 - arc through
 - carbon tracking
4. If the boot needs to be replaced, twist the boot a half turn in either direction in order to break the seal before pulling on the boot in order to remove the wire.
5. With the engine ON, inspect for any arcing to ground or other components.
6. Connect an ohmmeter to the end of each suspect wire. If the meter reads over 30,000 Ω , replace the wire.

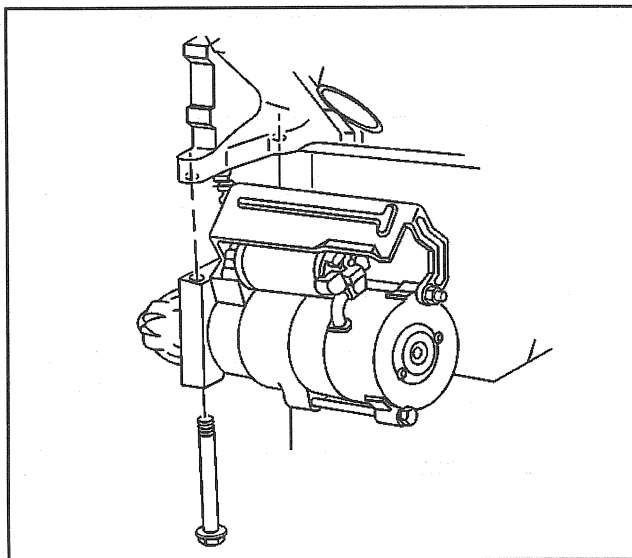
Repair Instructions

Starter Motor Replacement (Gasoline Engines)

Removal Procedure

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

1. Disconnect the negative battery cable.
2. Remove the starter brackets, if equipped.
3. Remove the starter shields, if equipped.
4. Disconnect the starter solenoid wires.
5. Raise the vehicle.
6. Remove the starter mounting bolts and washers, if equipped.
7. Remove the starter from the engine.



186803

Installation Procedure

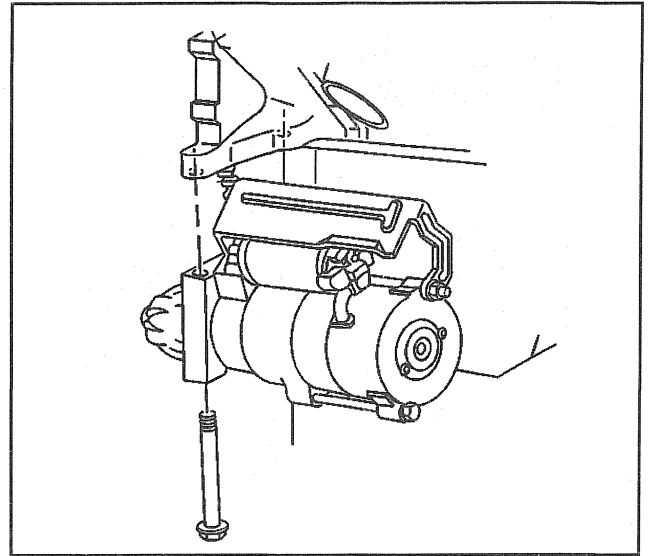
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Connect the starter mounting bolts and washers, if equipped, through the starter to the engine.

Tighten

Tighten the starter mounting through bolts to 47 N·m (35 lb ft).

2. Lower the vehicle.
3. Connect the starter wires to the solenoid terminals.
4. Install the starter brackets, if equipped.
5. Install the starter shields, if equipped.
6. Connect the negative battery cable.



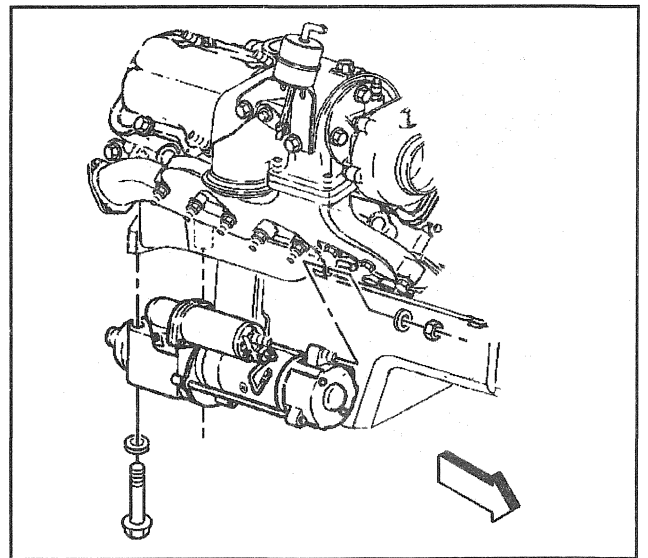
186803

Starter Motor Replacement (Diesel Engines)

Removal Procedure

Caution: Refer to *Battery Disconnect Caution* in Cautions and Notices.

1. Disconnect the negative battery cable.
2. Remove the starter brackets, if equipped.
3. Remove the starter shields, if equipped.
4. Disconnect the starter solenoid wires.
5. Raise the vehicle.
6. Remove the starter mounting bolts and washers, if equipped.
7. Remove the starter from the engine.



84601

Installation Procedure

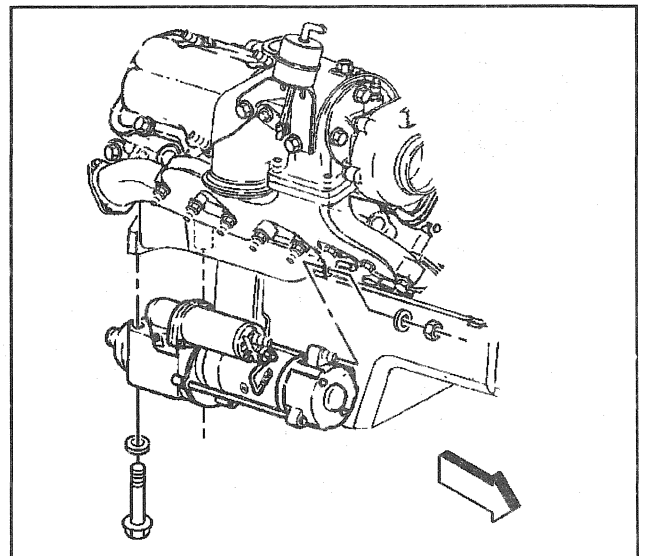
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Connect the starter mounting bolts and washers, if equipped, through the starter to the engine.

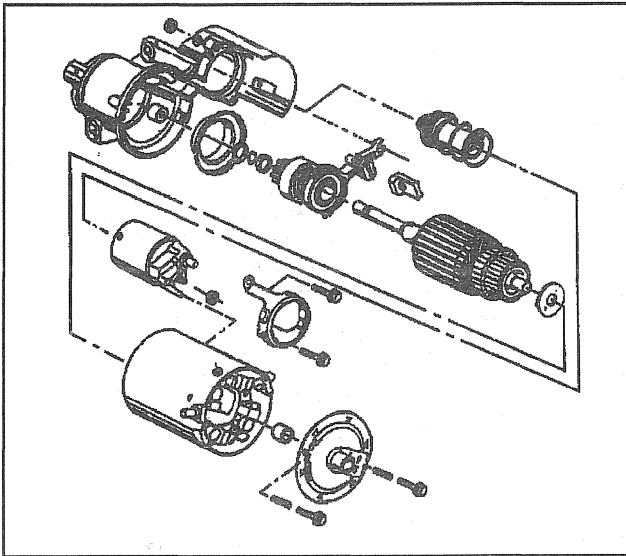
Tighten

Tighten the starter mounting through bolts to 45 N·m (35 lb ft).

2. Lower the vehicle.
3. Connect the starter wires to the solenoid terminals.
4. Install the starter brackets, if equipped.
5. Install the starter shields, if equipped.
6. Connect the negative battery cable.



84601

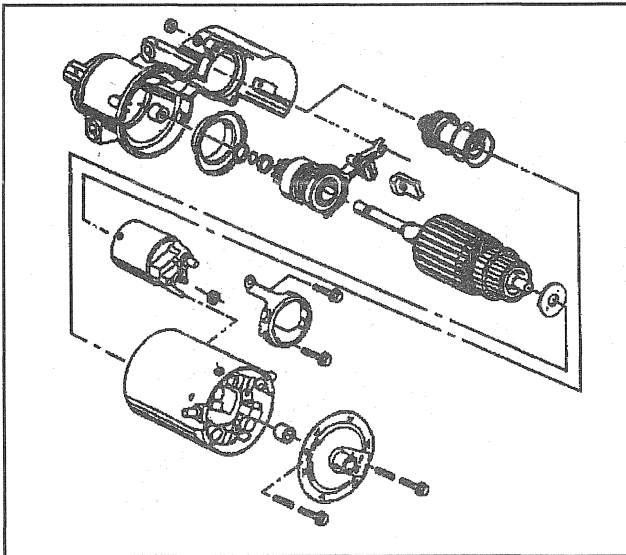


95994

Starter Motor Overhaul (SD Series)

Solenoid Disassembly Procedure

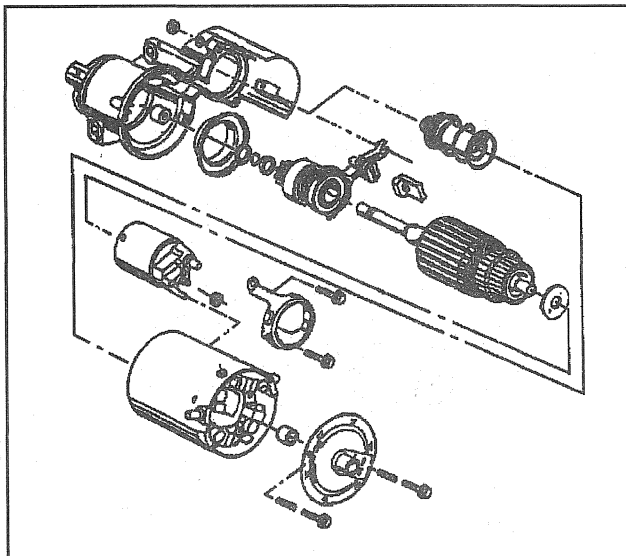
1. Clean the outside of the starter housing.
2. Make scribe marks to show the relationship of the drive end frame, frame and field assembly, and the end frame to aid in assembly.
3. Note the position of the through-bolts.
4. Models with solenoid shield:
 - Solenoid shield nuts from the solenoid clamp screws.
 - Shield from the solenoid.
 - Motor lead attaching nut and lead from the solenoid.
 - Solenoid clamp attaching screws, clamp, and solenoid from the frame assembly.



95994

Frame and Field Disassembly Procedure

1. Disassemble the through bolts from the end frame.
2. Disassemble the end frame.
3. Disassemble the brake washer from the armature assembly.
4. Disassemble the frame and field from the armature/drive and frame assembly.

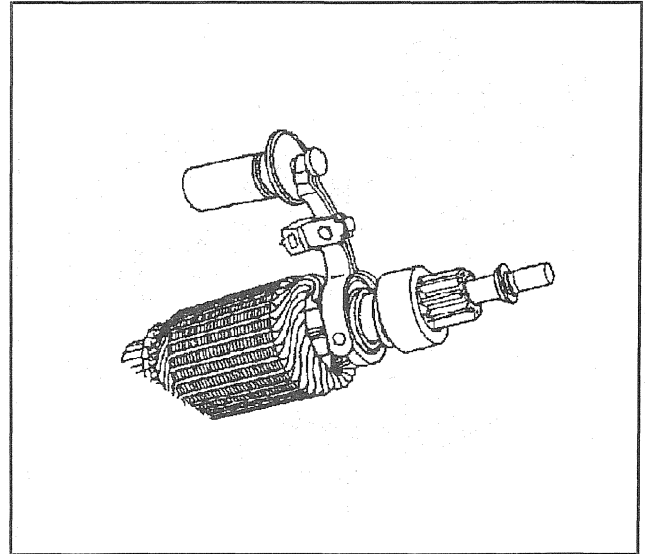


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Drive-End Frame Disassembly Procedure

1. Disassemble the plug from the drive end frame assembly.
2. Disassemble the armature with the drive assembly, shift lever, plunger and return spring from the drive end frame.
3. Disassemble the return spring from the plunger.
4. Disassemble the plunger from the shift lever.

5. Disassemble the shift lever from the drive assembly by spreading the lever arms slightly to snap them off the mating buttons on the drive collar.
6. Disassemble the drive assembly from the armature shaft in the following way:
 - Remove the thrust collar away from the armature shaft.
 - Drive the pinion stop collar away from the pinion stop retainer ring by sliding a metal cylinder onto the armature shaft. Strike the metal cylinder against the stop collar with a hammer.
 - Spread the pinion stop retainer ring to remove it from the groove in the armature shaft. Discard the old ring. The retainer ring must be replaced.
 - Slide the stop collar and the drive assembly off the armature shaft.



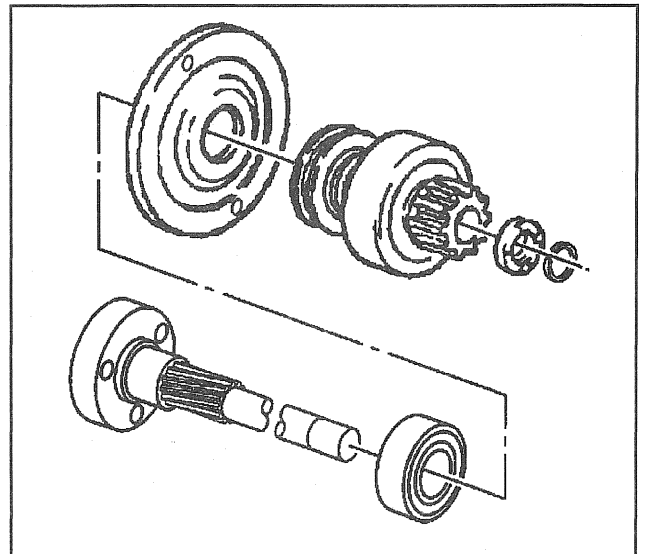
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Drive-End Frame Assembly Procedure

If disassembled, position the driveshaft on a work surface with the internal gear end down. Assemble the driveshaft and clutch group in the following way:

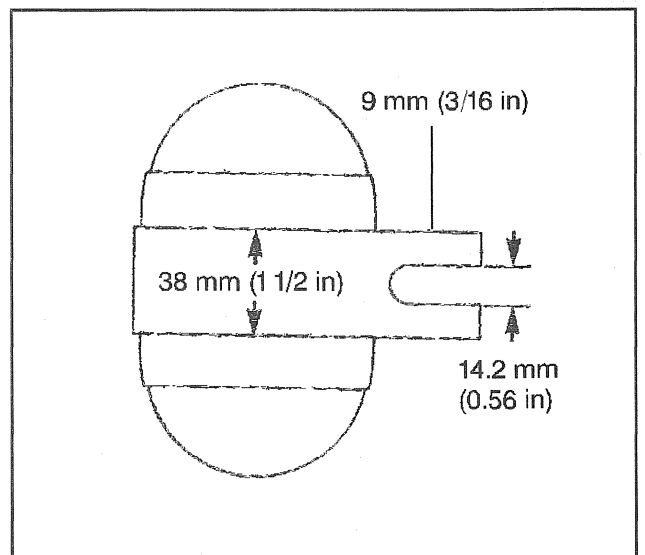
Important: If the center support bearing is being replaced, install it on the driveshaft.

1. Install the driveshaft support to the driveshaft, seating the bearing in the support.
2. Install the clutch drive assembly to the driveshaft.

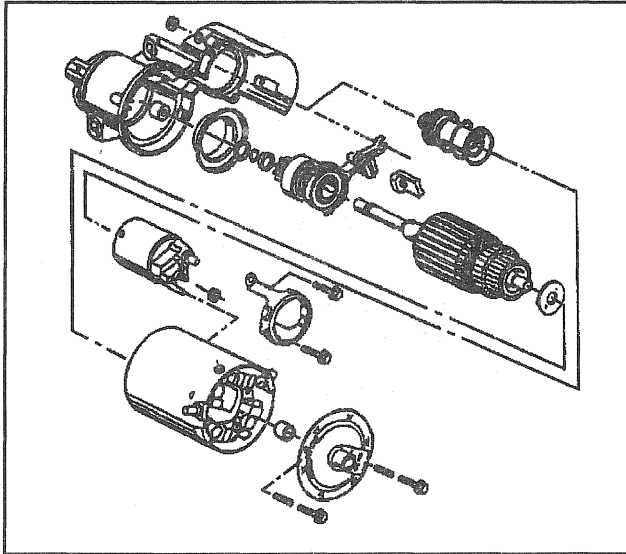


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3. Install the new pinion stop onto the driveshaft.
 - Slide the pinion stop onto the driveshaft until recess for the stop rings faces up.
 - Install the stop rings into the groove in the driveshaft.
 - Pick the assembly up and support it under the pinion stop. A metal block, with a U-shaped cutout that will slide over the shaft between the pinion gear and stop, can be clamped in a vise to provide support.
 - Make sure the stop rings are fully seated in the pinion stop recess. Stake the upper edge of the pinion stop over the stop ring at four equally spaced places. Do not allow the staked metal to contact the driveshaft.



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Frame and Field Assembly Procedure

1. Assemble the frame and field assembly onto the armature.
 - Clean the contact faces of the brushes and the commutator with a soft cloth.
 - Push the brushes into the brush holders and hold them in place while installing the frame.
 - Align the scribe mark on the frame with the scribe mark on the drive end frame.
 - Release the brushes onto the commutator, making sure all four brushes move freely and contact the commutator.
2. Assemble the brake washer to the armature assembly.
3. Assemble the drain tube to the frame, if it was removed.
4. Assemble the drive end frame to the field frame.
 - If the drive end frame bearing shows no lubrication or looks damaged, replace it.
 - Recess the new bearing 2 mm (0.08 in) into the housing. The bearing is pre-lubricated. Do not add any lubricant.
5. Assemble the identification tag over the hole in the drive end frame with the fluted end around the bearing well.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Assemble the through-bolts in their original locations

Tighten

Tighten the bolts to 8.5 N·m (75 lb in).

7. Assemble the motor field lead over the motor terminal on the solenoid.
8. Assemble the field lead attaching nut.

Tighten

Tighten the nut to 11 N·m (95 lb in).

9. Assemble the solenoid shield onto the protruding ends of the solenoid attachment screws.
10. Assemble the shield attaching nuts.

Tighten

Tighten the shield attaching nuts to 8 N·m (70 lb in).

Starter Motor Overhaul (28-MT)

Introduction

If the motor does not perform to specifications, the motor may be disassembled for further testing of the components. Normally, the starter motor should be disassembled only so far as is necessary to complete repair or replacement of parts.

For 28-MT starter motor and components, refer to *28-MT Components*.

Do not disassemble the following components that are serviced as assemblies:

- The solenoid assembly
- The clutch drive assembly
- The brush holder assembly
- The armature assembly
- The frame and field assembly

Unit Disassembly Procedure

Caution: Wear safety glasses in order to avoid eye damage.

Important: Use a colored pencil or marker that will show on all parts.

1. Make alignment marks completely down one side of the starter motor in order to ensure proper alignment of all components during reassembly.
2. Remove the nut of the motor lead to the solenoid assembly.
 - 2.1. Disconnect the motor lead from the solenoid assembly.
 - 2.2. Reinstall the nut.
3. Remove the two through bolts.
4. Remove the two brush plate screws.
5. Remove the commutator end frame and the O-ring seal.

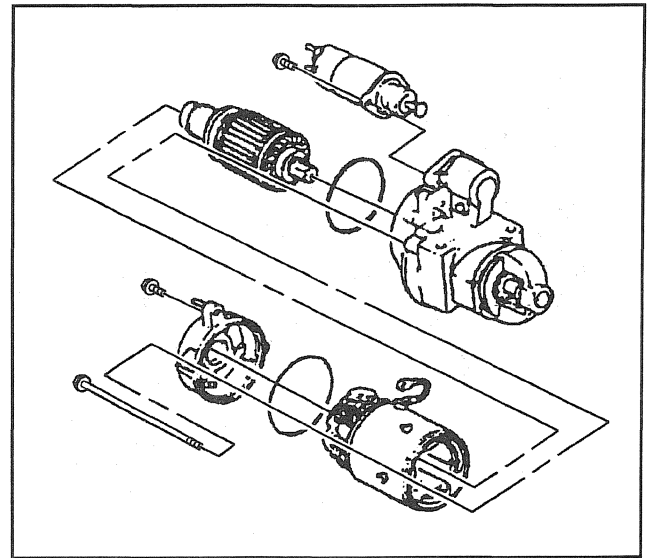
Important: Do not lose the small dowel pin installed between the frame assembly and the gear reduction and drive group. If the dowel pin is lost, replace the dowel pin with a 2 mm x 10 mm (0.079 in x 0.394 in) long pin obtained or manufactured locally.

Important: The armature assembly may come off with the frame, field, and brush holder group, or the armature assembly may be retained by the gear reduction and drive group.

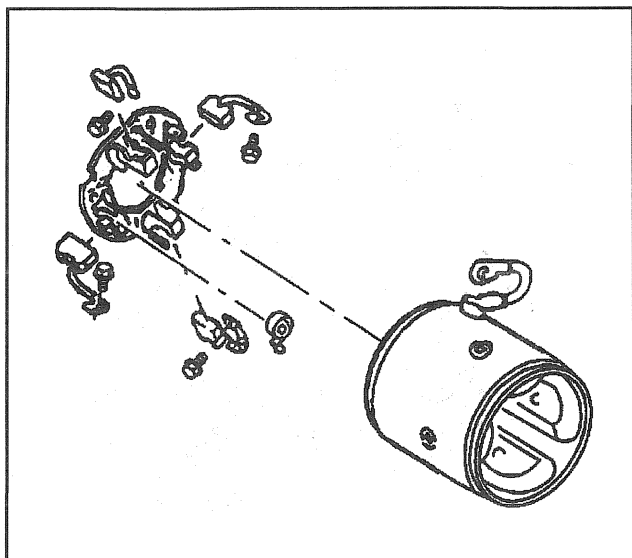
6. Remove the frame, field, and brush holder group, dowel pin, and O-ring seal.

Important: Do not remove the bearings from the armature assembly unless replacement is required. Refer to *Starter Motor Inspection (SD Series)* or *Starter Motor Inspection (28-MT Series)*.

7. Remove the armature assembly with the bearings.
8. Remove the solenoid screws.
9. Pivot the inside end of the solenoid assembly out of the engagement shift lever drive group.
10. Remove the solenoid assembly.



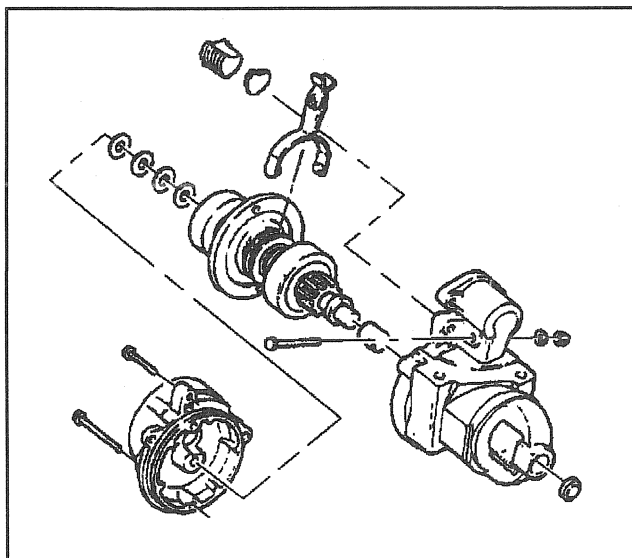
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Frame, Field, And Brush Holder Group Disassembly Procedure

1. Move the brush holder assembly with the brushes slightly away from the frame and field assembly. Remove the insulated brush screws.
2. Remove the frame and field assembly.
3. Remove the grounded brush screws.
4. Remove any brushes that need replacement.
5. Inspect for any brush springs that need replacement. Remove the brush springs.
 - 5.1. Grasp the brush end of each brush spring with needle-nose pliers.
 - 5.2. Twist the spring end away from the brush and remove the brush.
6. Inspect and test all electrical components. Refer to *Starter Motor Inspection (SD Series)* or *Starter Motor Inspection (28-MT Series)*.



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Gear Reduction And Drive Group Disassembly Procedure

1. Remove the housing bolts.
- Important:** Washers may stick to the bracket or to the driveshaft and clutch group as the bracket is removed. In either case, note the position and number of each of the washers.
2. Remove the armature support bracket.
 3. Remove the washers.
 4. Pry out the drive housing plug with a large screwdriver. Remove the plate.
 5. Remove the shift lever nut, washer, and screw.

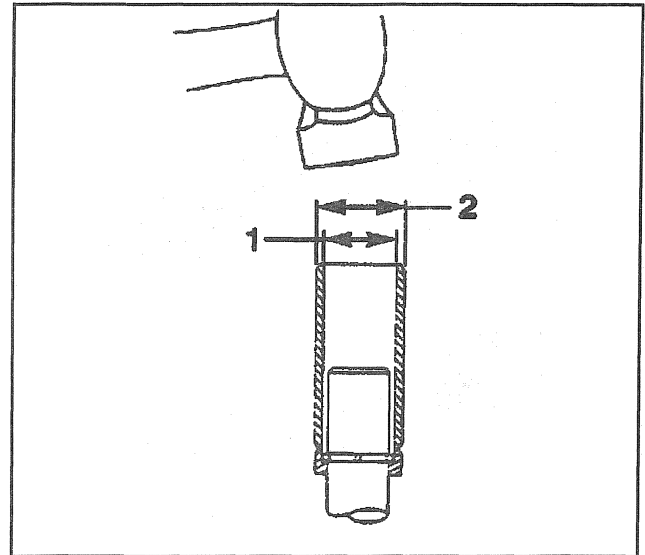
Important: Do not remove the bushing plug or the bushing from the drive housing unless replacement is indicated. Refer to *Starter Motor Inspection (SD Series)* or *Starter Motor Inspection (28-MT Series)*.

6. Remove the shift lever and driveshaft and clutch group from the drive housing together.
7. Separate the shift lever and driveshaft and clutch group.

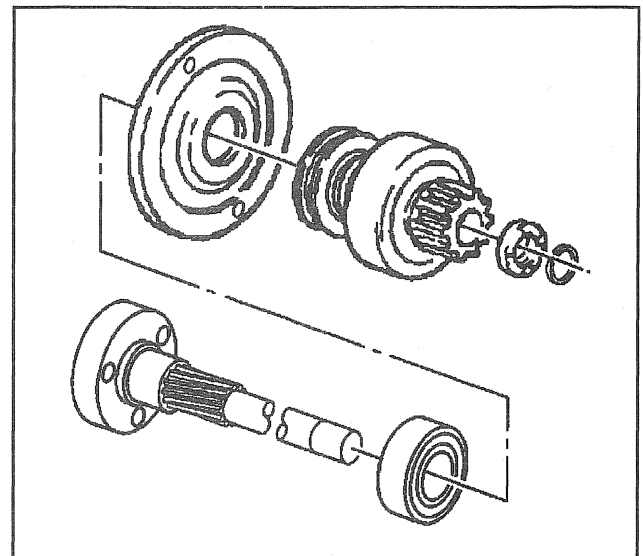
Driveshaft And Clutch Group Disassembly Procedure

Disassemble the driveshaft and clutch group only when necessary in order to clean, inspect, or replace one or more parts of the group separately.

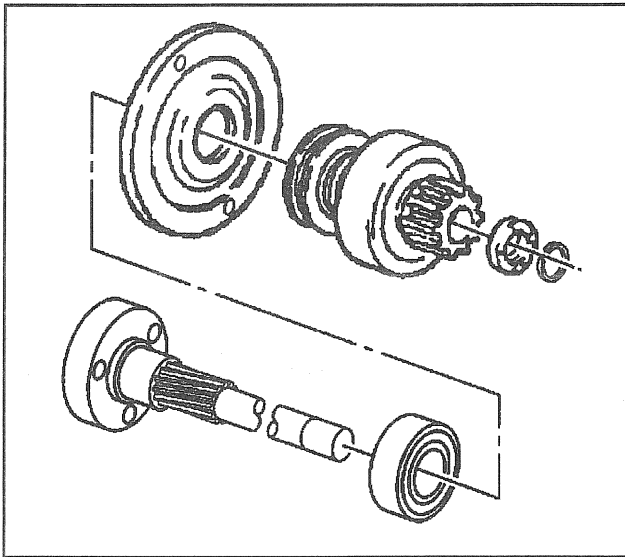
1. Remove the stop rings and the pinion stop.
 - 1.1. Position the driveshaft and clutch group on a work bench with the internal gear end down.
 - 1.2. Place an open tube with a diameter (2) of 22 mm (0.87 in) over the slightly smaller 14.2 mm (0.60 in) diameter (1) of the shaft.
 - 1.3. With the tube, drive the pinion stop toward the clutch drive until the pinion stop clears the stop ring.
 - 1.4. Pry the stop rings out of the driveshaft groove. Slide the stop rings off the shaft, being careful not to scratch the driveshaft.
 - 1.5. Inspect the edges of the shaft groove for burrs. Burrs may make removal of the pinion stop and clutch drive assembly difficult.
 - 1.5.1. If burrs are found, use a file in order to carefully remove the burrs without damaging the base metal.
 - 1.5.2. Thoroughly clean away any metal filings.
 - 1.6. Slide the pinion stop off the driveshaft. Discard the old pinion stop and stop rings.
2. Remove the clutch drive assembly from the driveshaft.
3. Remove the driveshaft support from the driveshaft.
4. Only if the bearing needs replacement, remove the bearing from the driveshaft. Refer to *Starter Motor Inspection (SD Series)* or *Starter Motor Inspection (28-MT Series)*.



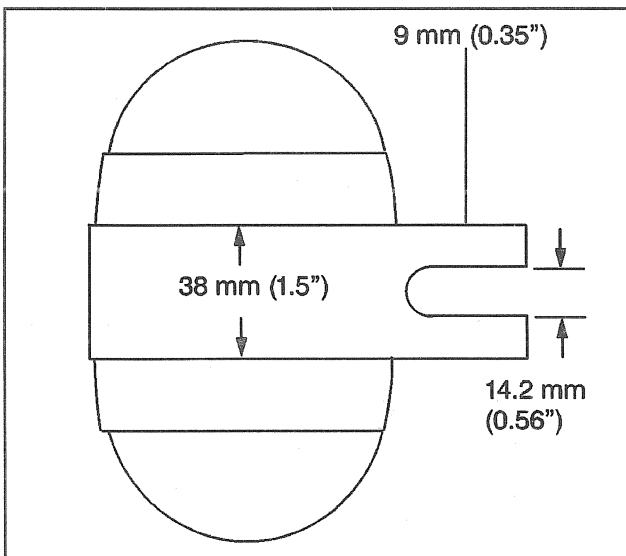
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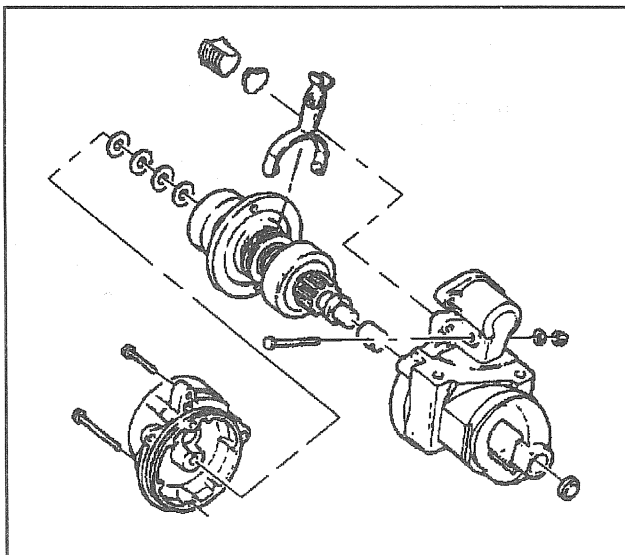
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Drive Shaft And Clutch Group Assembly Procedure

If disassembled, position the driveshaft on a work surface with the internal gear end down.

Important: If the center support bearing is being replaced, install the center support bearing on the driveshaft. Refer to *Starter Motor Inspection (SD Series)* or *Starter Motor Inspection (28-MT Series)*.

1. Install the driveshaft support to the driveshaft, seating the bearing in the support.
2. Install the clutch drive assembly to the driveshaft.

3. Install a new pinion stop and stop rings.

- 3.1. Slide the pinion stop with the recess for stop rings facing up onto the driveshaft.
- 3.2. Position a block at least 38 mm (1.5 in) wide in a vise.
- 3.3. Support the assembly under the pinion stop in the metal block with a U-shaped cutout with a width of 14.2 mm (0.56 in).
- 3.4. Make sure the stop rings in the driveshaft groove are fully seated in the recess of the pinion stop.

Important: Keep the staked metal from contact with the driveshaft.

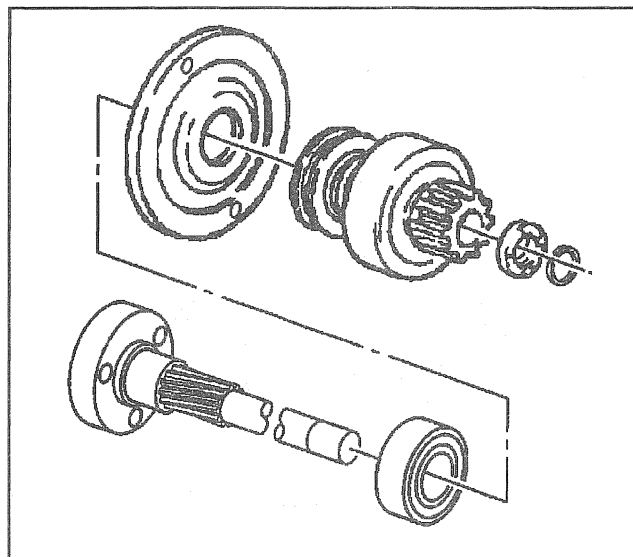
- 3.5. Stake the upper edge of the pinion stop over the stop ring at four places, equally spaced.

Gear Reduction And Drive Group Assembly Procedure

Important: If the drive end bushing and plug are being replaced, install the drive end bushing and plug in the drive housing. Lubricate the drive end housing bushing, shift lever, and driveshaft. Refer to *Starter Motor Inspection (SD Series)* or *Starter Motor Inspection (28-MT Series)*.

1. Install the arms of the shift lever with the shift collar onto the driveshaft and clutch group.

2. Install the assembled shift lever and driveshaft and clutch group into the drive housing.
 - 2.1. Align the holes in the driveshaft support with those in the drive housing.
 - 2.2. Make sure that the driveshaft support is fully seated in the drive housing and the driveshaft bearing remains fully seated in the driveshaft support.



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Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the shift lever screw, washer, and nut.

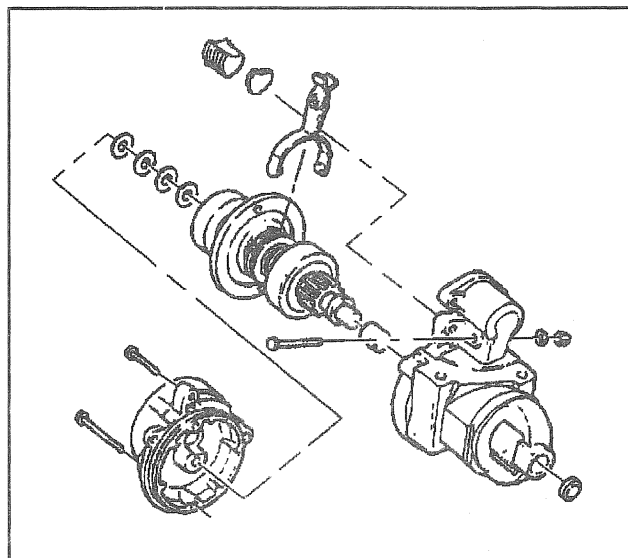
Tighten

Tighten the shift lever nut to 4.5 N·m (40 lb in).

4. Install the plate, if used, and the drive housing plug to the drive housing.
5. Install the washers in the same number and position as noted during disassembly.
6. Install the armature support bracket to the drive housing.
7. Install the drive housing bolts.

Tighten

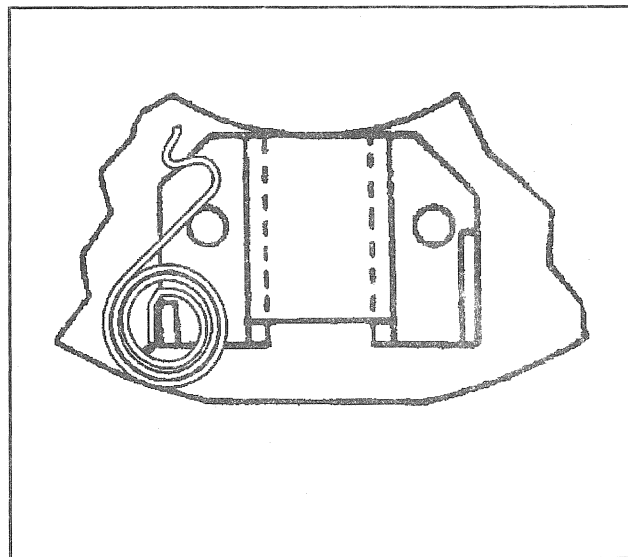
Tighten the drive housing bolts to 8.5 N·m (75 lb in).



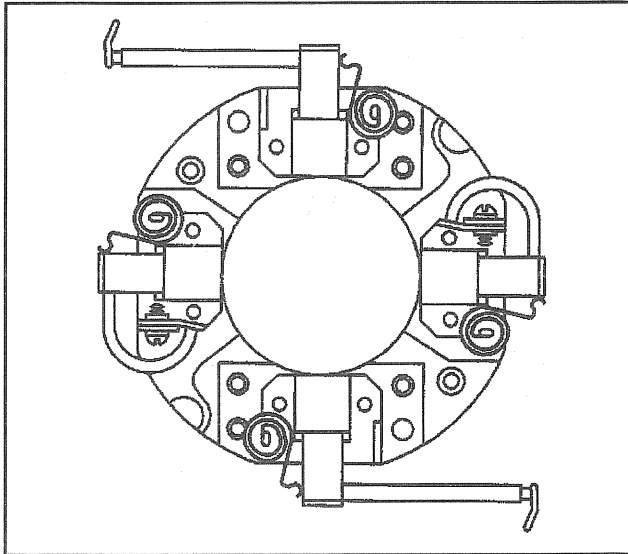
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Frame, Field, And Brush Holder Group Assembly Procedure

1. Install the brush springs, if removed.
 - 1.1. Start each spring onto the post on the brush holder assembly just enough in order to keep the inside end of the spring from turning.
 - 1.2. Grasp the free end of the spring with needle nose pliers and twist the spring to the right over the top of the brush socket.
 - 1.3. Push the spring fully onto the post and release the free end in order to engage the notch in the brush socket.



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Notice: Brush leads may be damaged by excessive handling. Do not overflex the leads near the clip welds or the clips may break

2. Install the brushes, if removed
 - 2.1. Make sure the insulated brushes go into the brush sockets of the brush holder assembly that mounts on the insulation.
 - 2.2. Grasp the free end of the brush spring with needle nose pliers.
 - 2.3. Twist the spring to the right in order to clear the brush socket. Insert the brush partly into the brush socket.

Important: This will hold the brushes retracted until the brush holder is installed over the armature commutator.

- 2.4. Gradually release the spring so that the end of the spring contacts the side, not the end, of the brush.
3. Install the grounded brush screws.
 - 3.1. Position the terminals of the grounded brush leads behind the terminal tabs on the brush holder.
 - 3.2. Insert the brush screws through the terminal tabs on the brush holder. Thread the screws into the brush lead terminals.

Tighten

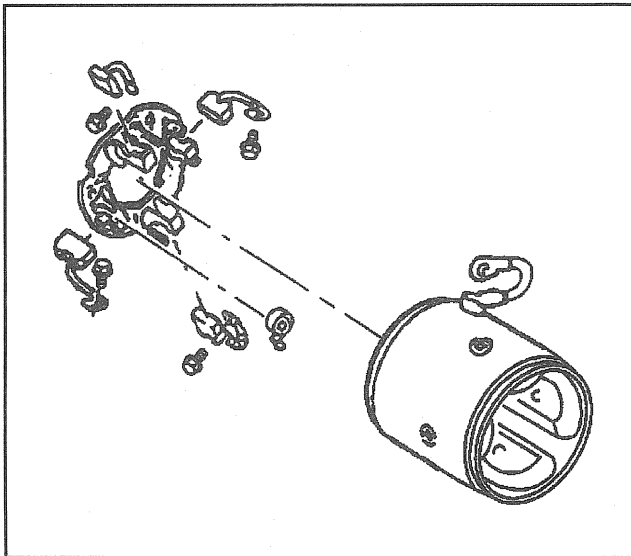
Tighten the grounded brush screws to 1.5 N·m (13 lb in).

4. Install the frame and field assembly to the brush holder assembly.

- 4.1. Position the brush holder assembly with the brushes installed over the terminal end of the frame and field assembly.
- 4.2. Attach the terminals of the insulated brush leads to the conductors in the frame and field assembly with insulated brush screws.

Tighten

Tighten the insulated brush screws to 1.5 N·m (13 lb in).



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Unit Assembly Procedure

1. Support the gear reduction and drive group with the pinion gear end down.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important: If the armature bearings are being replaced, install the armature bearings on the armature. Refer to *Starter Motor Inspection (SD Series)* or *Starter Motor Inspection (28-MT Series)*.

2. Install the solenoid assembly.
 - 2.1. Pivot the plunger of the solenoid assembly into the engagement with the shift lever in the gear reduction and drive group.
 - 2.2. Position the solenoid assembly mounting flange and install the solenoid mounting screws.

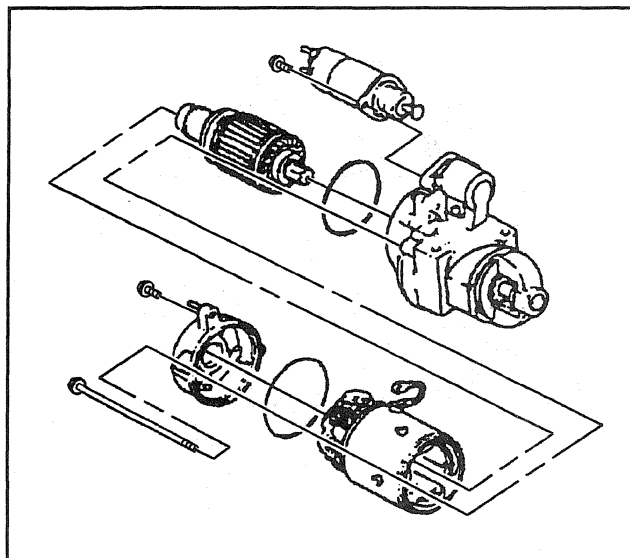
Tighten

Tighten the solenoid mounting screws to 2.8 N-m (25 lb in).

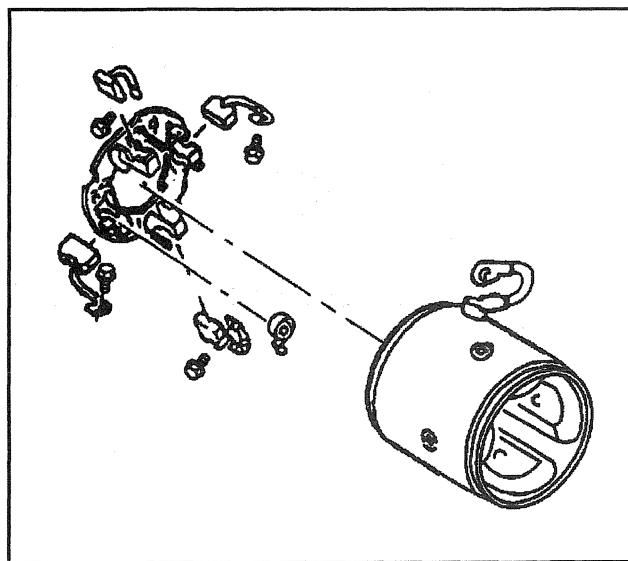
3. Install the frame seal.
4. Install the armature assembly with the bearings into the gear reduction and drive group.
 - 4.1. Make sure the gear teeth of the armature are aligned.
 - 4.2. Fully seat the bearing on the armature into the housing recess.
5. Install the frame, field, and brush holder group.
 - 5.1. Place the dowel pin in the hole of the armature support bracket of the gear reduction and drive group.
 - 5.2. Position the frame, field, and brush holder group over the armature assembly. Align the hole for the dowel pin and the alignment marks.
 - 5.3. Seat the frame, field, and brush holder group in the gear reduction and drive group.

Important: Brush spring tension should be 44.5 -49.0 N (10-11 lbs). If not, replace the springs before proceeding.

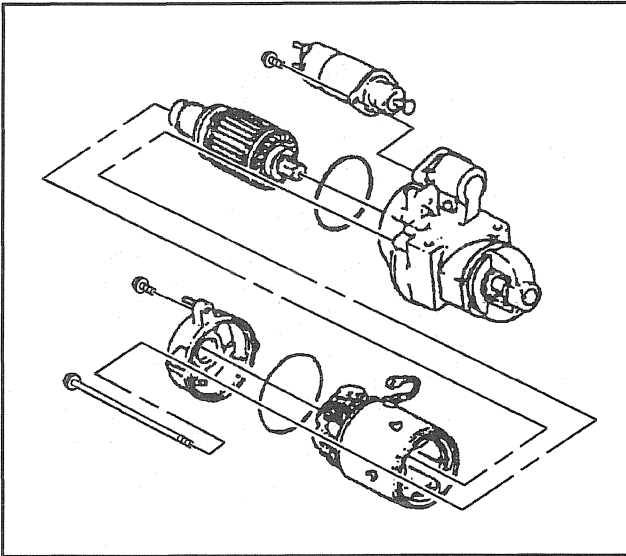
- 5.4. Twist the brush springs away from the brushes. Slide the brushes into contact with the commutator on the armature.
- 5.5. Release the brush springs in order to contact the ends of the brushes.



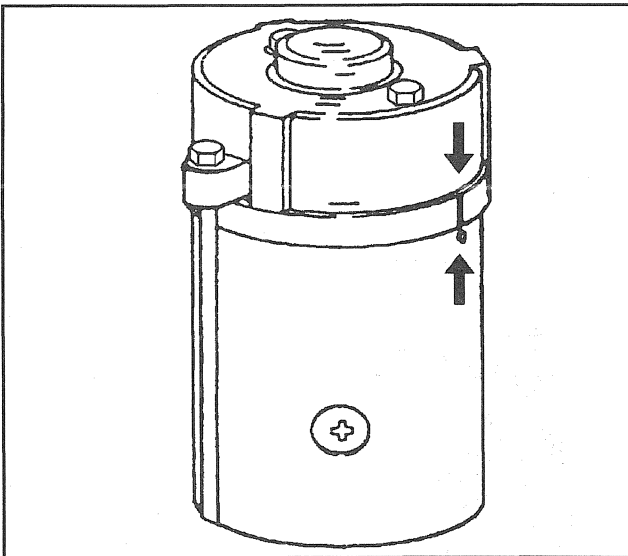
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Important: The O-ring seal can easily be damaged during installation of the commutator end frame. Carefully follow the installation procedure.

6. Install the O-ring seal on the frame, field, and brush holder group.
 - 6.1. Install the O-ring seal so that the seal is against the shoulder of the field frame that will abut the commutator end frame when installed.
 - 6.2. Carefully roll the O-ring seal out of the installed position and up onto the major outer diameter of the field frame.
 - 6.3. Allow the seal to remain in this position until the commutator end frame is partially installed.

7. Install the commutator end frame.

- 7.1. Align the marks made prior to disassembly on the commutator end frame and the frame and field assembly.
- 7.2. Start the commutator end frame onto the frame and field assembly, but leave a gap just slightly larger than the thickness of the O-ring seal.
- 7.3. Use a scribe or similar tool to align the tapped holes in the brush holder assembly with the screw holes in the commutator end frame.
- 7.4. Install the brush plate screws.

Tighten

Tighten the brush plate screws to 2.8 N·m (25 lb in).

8. Install the through-bolts.

- 8.1. Tighten the through-bolts by hand, but do not close the gap left for the seal between the end frame and the frame and field assembly.
- 8.2. Roll the O-ring seal into the installed position between the commutator end frame and the frame and field assembly.

Important: Marks are located in two places on the motor, but will only match one way in order to ensure proper alignment.

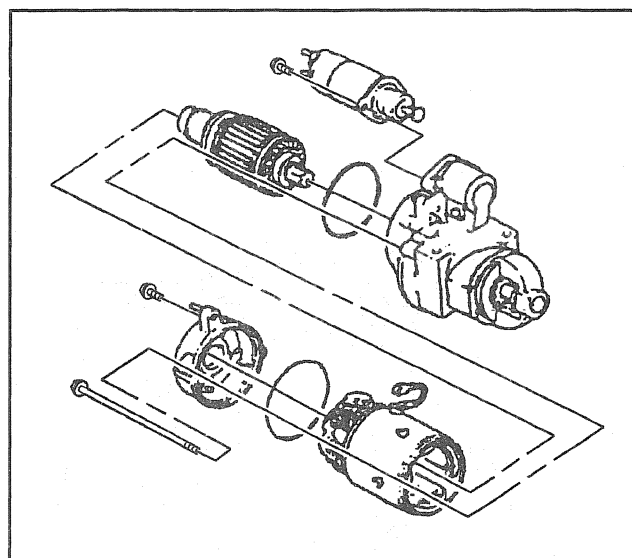
- 8.3. Align the timing ribs on the edge of the commutator end frame with the timing spots on the frame and field assembly.

Tighten

Tighten the through-bolts to 8.5 N·m (75 lb in).

9. Connect the motor lead onto the frame and field assembly.
 - 9.1. Remove the nut from the terminal on the solenoid.
 - 9.2. Install the motor lead terminal. Reinstall the nut.

Tighten
Tighten the solenoid motor terminal nut to 11 N·m (100 lb in).
10. After completion of the overhaul of the starter motor, do a starter no load test. Refer to *Starter No Load Test*.



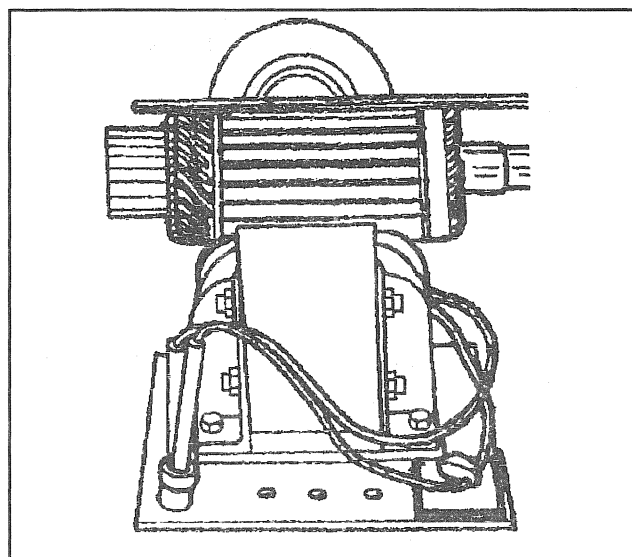
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Starter Motor Inspection (SD Series)

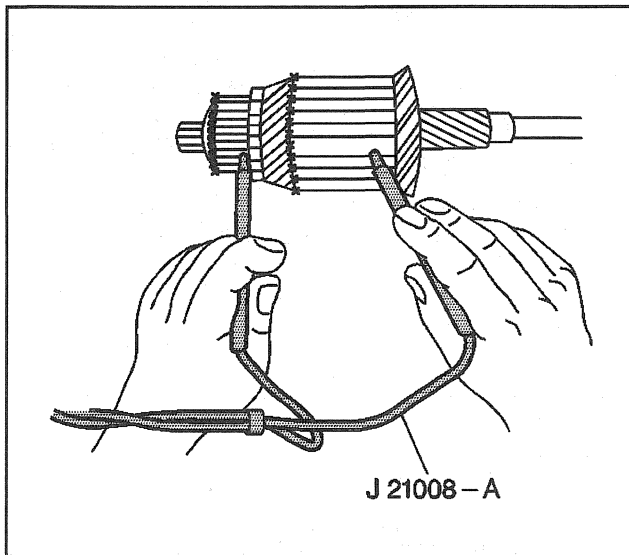
Cleaning, Inspection and Electrical Tests

Notice: Do not clean the starter motor parts in a degreasing tank. Soaking parts will dissolve the permanent lubrication and may damage the electrical insulation. This will shorten starter motor life.

1. Clean all parts by wiping with a clean cloth.
2. Inspect the bushing or armature bearing fit in the drive end frame, the lever housing, and the drive end frame housing. If the bushings or bearings are damaged or worn, replace them.
 - Lubricate the bushings before assembling the starter motor. Avoid excessive lubrication.
 - Do not lubricate the roller bearings. They are permanently lubricated.
3. Inspect the armature for runout or scoring. Replace the armature assembly if the condition of the armature shaft is questionable.
4. Inspect the commutator for discolored or uneven conductors.
 - Do not turn the commutator
 - Do not undercut the insulation
 - Clean the commutator with 240 grit emery cloth. Blow away any copper dust present. If the commutator cannot be cleaned, replace the armature.
5. Inspect the armature for short circuits.
 - Rotate the armature in a growler with a steel strip such as a hacksaw blade. Hold the blade on the armature parallel to the shaft. The steel strip will vibrate when it finds the short circuit.
 - Shorts between the commutator bars are sometimes produced by brush dust or copper dust.



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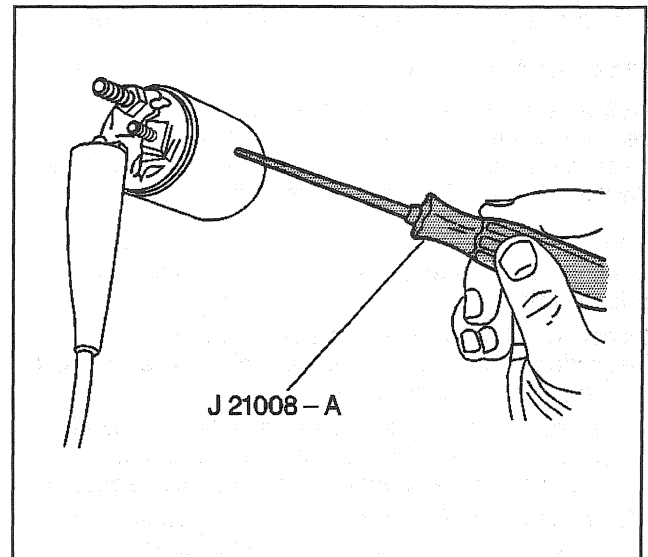


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6. Inspect armature for opens.
 - Look for loose connections where the conductors join the commutator bars.
 - Poor connections cause arcing and burning of the commutator.
7. Inspect the armature for grounds using a self powered test lamp. If the test lamp lights when one test probe is placed on the commutator and the other test lamp probe is placed on the armature core shaft, the armature is grounded. Replace the armature.
8. Inspect the brushes for wear. If the brushes are worn to half the size of a new brush, replace the assembly.
9. Inspect the brush holders for dirt or damage. Make sure that the brushes are not binding in the holders.
10. Inspect the brush springs for distortion or discoloring. If the springs are weak, bent, or discolored, replace the frame and field assembly.
11. Inspect the field coils.
 - Look for burned or damaged insulation, damaged connections or loose poles.
 - If the conditions of the coils is doubtful, replace the field and frame assembly.
12. Inspect the field coils for grounds.
 - Connect a self-powered test lamp between the field frame and the field connector. Make sure the brush ends do not contact the field frame.
 - If the test lamp lights, the field coils are grounded. Replace the field and frame assembly.
13. Inspect the field coils for opens.
 - Connect a self-powered lamp between the field connector and each of the brushes.
 - If the test lamp does not light at both brushes, the field coils are open. Replace the frame and field assembly
14. Inspect for field coils for shorts.
 - Shorts are indicated by poor motor performance after everything else has been checked out.
 - The coils cannot be replaced separately because of the integral frame construction. The frame and field assembly must be replaced.
15. Inspect the drive assembly (clutch) by turning the drive pinion in the cranking direction. If the drive pinion turns or slips in the cranking direction, replace the over-running clutch assembly.

16. Inspect the solenoid for grounds using a self-powered 12 volt test lamp.

- 16.1. Connect the test lamp between the BAT terminal and the case. The lamp should not light (terminal should not be grounded).
- 16.2. Connect the test lamp between the S terminal and the case. Then connect the test lamp between the M terminal and the S terminal or between the M terminal and the case. The lamp should turn on.
- 16.3. If the solenoid does not pass these checks, replace it.

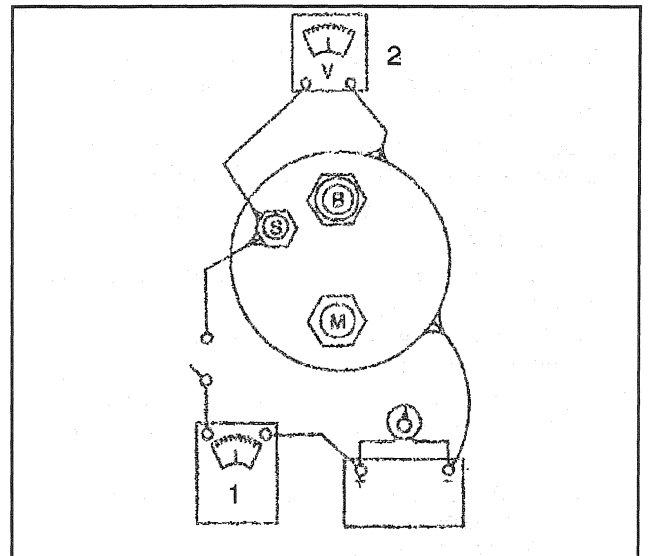


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Notice: To prevent overheating of the solenoid pull-in winding, do not leave the winding energized for more than 15 seconds. The current draw will decrease as the winding temperature increases.

17. Inspect the hold-in winding and the pull-in winding.

- 17.1. If the solenoid is not removed from the starter motor, the field lead must be removed from the terminal on the solenoid before making these tests.
- 17.2. To check both windings, connect an ammeter in series with a 12 volt battery and the switch terminal on the solenoid. Connect a carbon pile across the battery. Ground the solenoid motor terminal. Adjust the voltage to 10 volts and note the ammeter reading. It should be 60 to 85 amperes.
- 17.3. Note the ampere reading. A high reading indicates a shorted or grounded winding, and a low reading indicates excessive resistance.
 - The resistance of the windings can be read directly using a digital ohmmeter that can measure tenths of an ohm.
 - Coil resistance can be determined by dividing the voltage by the current (amperes).



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Starter Motor Inspection (28-MT Series)**Clean and Inspect**

Notice: Do not clean the starter motor parts in a degreasing tank. Soaking parts will dissolve the permanent lubrication and may damage the electrical insulation. This will shorten starter motor life.

Clean

Clean all starter motor parts with a clean soft cloth prior to testing.

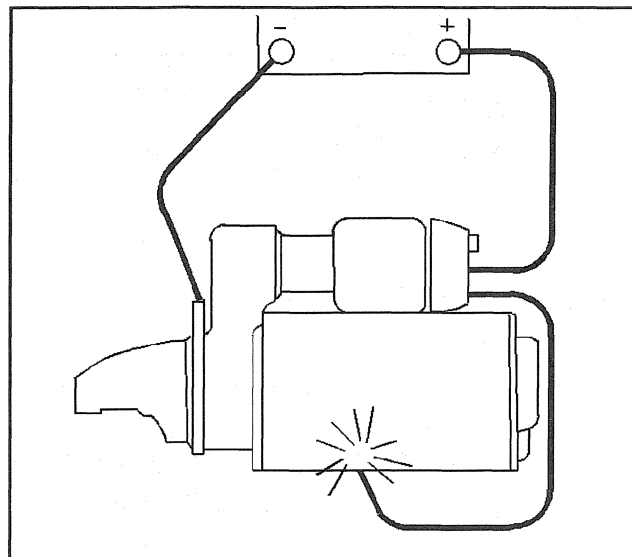
Inspection of the following steps refer to visual inspection of the starter motor parts and assemblies to determine their serviceability.

1. Inspect all parts for cracks, distortion, or other structural damage. Replace parts or assemblies that are cracked, bent or otherwise damaged.
2. Inspect threaded parts for stripped, crossed, or otherwise damaged threads. Replace the parts with thread damage that cannot be cleaned up using a suitable tap or die. Replace any items that have damaged threads.
3. Inspect the solenoid assembly for cut or torn boot. If the boot is damaged, replace the solenoid assembly.
4. Inspect the clutch drive assembly. Replace the assembly if the following conditions exist:
 - The pinion gear turns roughly or turns in both directions
 - The pinion gear teeth that are broken or show evidence of step wear
 - The shift lever collar shows deep scoring or other damage
5. Inspect the brush holder assembly for loose riveted joints and cracked or broken insulation. Replace if damaged.
6. Inspect the brushes for excessive wear. The minimum allowable brush length is 12 mm (0.472 inch). Replace excessively worn brushes in sets.
7. Inspect the drive end housing bushing for scoring or other damage. Replace the damaged bushing.
8. Inspect the ball bearings in the following way:
 - Hold the armature or driveshaft and slowly rotate the outer bearing race by hand
 - Check that the bearing turns freely without binding or the feel of flat spots
 - Replace damaged bearings
9. Inspect the armature assembly for the following conditions:
 - Gear teeth that are broken, or that show evidence of step wear or root interference.
 - A rough commutator surface. Polish with 400 grit polishing cloth if necessary. Thoroughly clean metal dusts from between the commutator bars. If the commutator surface cannot be repaired in this manner, replace the armature assembly. Do not turn the commutator in a lathe.
 - A worn commutator. Replace the armature assembly if the commutator outer diameter is less than 36 mm (1.378 inch) or if the undercut depth at any point is less than 0.2 mm (0.008 inch). Do not undercut the insulation.
10. Inspect the driveshaft for the following conditions and replace if necessary.
 - Scored or damaged shaft where it turns inside the bushing
 - Internal gear with teeth broken or showing evidence of step wear
 - A damaged spline. The clutch drive assembly must slide smoothly and easily over the full length the spline.

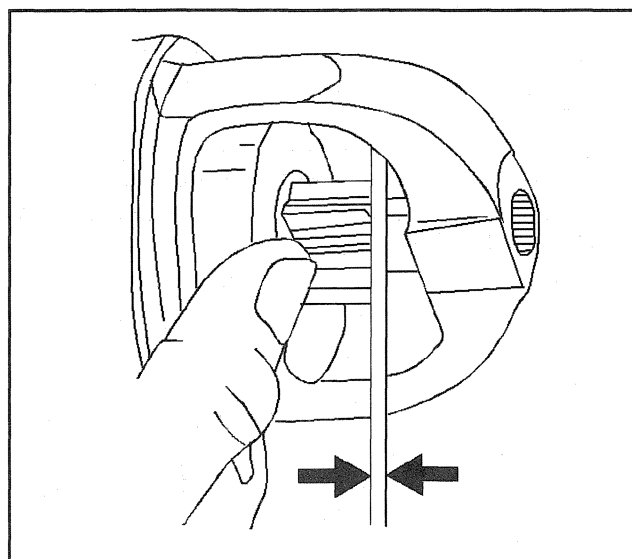
Starter Pinion Clearance Check

The pinion clearance should be checked after reassembly of the starter motor. The pinion clearance cannot be adjusted. Improper clearance is an indication of worn parts. In order to check the pinion clearance, perform the following procedure:

1. Disconnect the starter motor field connector from the solenoid "M" terminal.
 2. Insulate the starter motor field connector carefully.
 3. Connect a 12 V battery from the solenoid switch terminal to the solenoid frame.
 4. Momentarily flash a jumper lead from the solenoid motor terminal to the solenoid frame. This will shift the pinion into the cranking position. The pinion will remain in the cranking position until the battery is disconnected.
 5. Push the pinion back toward the commutator end to eliminate thrust movement.
 6. Measure the distance between the pinion and the pinion stop collar.
- The clearance should be from 0.25–4.06 mm (0.010–0.160 in.).

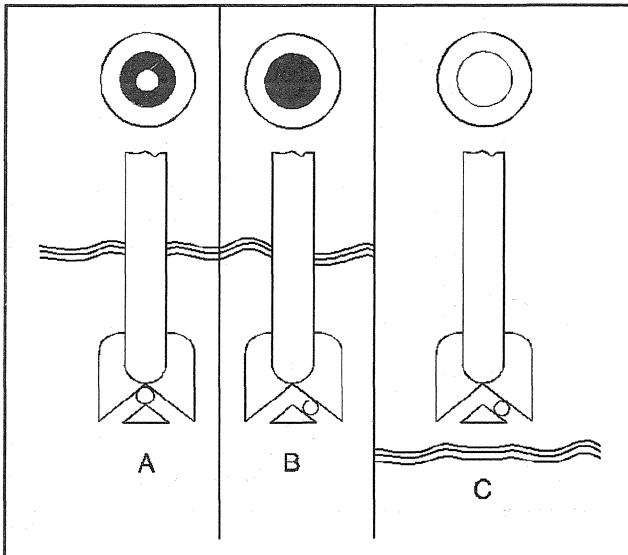


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Battery Charging



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1. Use a charger, with an end voltage of 16 V, equipped with a voltmeter that is accurate to within 1 percent.
The ambient temperature should be 15–38°C (60–100°F). A battery that is extremely cold will not accept immeasurable current for several hours after starting the charger.
2. The charging area should be well ventilated.
3. Do not charge the battery when the built in hydrometer is clear or yellow (C). Replace the battery if there is a cranking problem.
4. Do not charge a battery that appears to be frozen.
5. Batteries showing a green dot in the hydrometer (A) do not need to be charged unless they have just been discharged (such as cranking the engine).

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The size of the battery – A completely discharged, large, heavy-duty battery requires more than twice the recharging time as a completely discharged, smaller battery.
- The temperature – A longer time is needed to charge any battery at –18°C (0°F) than at 27°C (80°F). When a fast charger is connected to a cold battery, the current accepted by the battery is very low at first. Then, as the battery warms, the battery accepts a higher rate of current.
- The charging capacity – A charger which can supply only five amperes requires a much longer charging period than a charger that can supply 30 amperes or more.

- The state-of-charge – A completely discharged battery requires more than twice as much charge time as a half charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the battery accepts very low current at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current also increases.

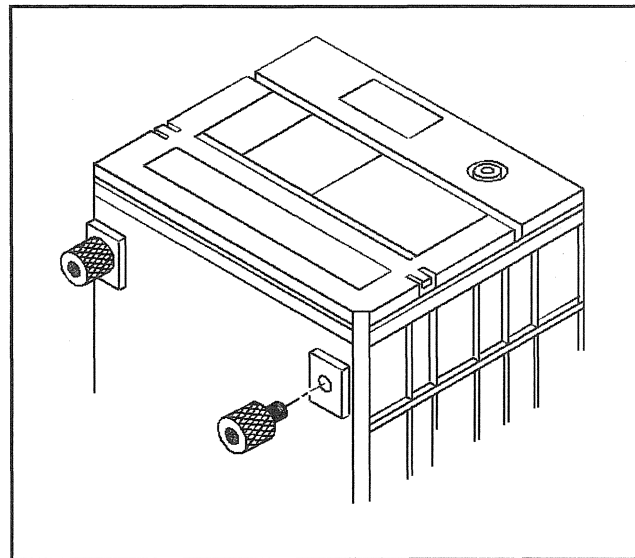
Charging Procedure

Tools Required

GM P/N 12303040 Battery Terminal Adapters

Notice: Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the PCM or other electronic components.

1. Do not charge a battery with a green hydrometer dot unless it has just been discharged, such as in cranking.
2. When charging side-terminal batteries while on-vehicle, use the following procedure:
 - 2.1. Turn OFF the charger.
 - 2.2. Connect the charger positive lead to the positive cable terminal located in the engine compartment on the right side.
 - 2.3. Connect the negative charger lead to a solid engine ground, such as the generator mounting bracket.



42433

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. When charging side-terminal batteries out of vehicle, install battery side terminal adapters.
Tighten
Tighten the battery side terminal adapters to 15 N·m (11 lb ft).
4. Make sure all battery terminals are clean and tight. Best results occur when charging a battery that is at room temperature. A battery that is extremely cold may not accept current for several hours.

5. Charge the battery until the hydrometer has a green dot.
6. Inspect the battery every half hour after starting the battery charger.
7. Tap the hydrometer lightly to dislodge any air bubbles. The bubbles may cause a false indication.
8. After charging, load test the battery. Refer to *Battery Load Test*.

Battery Charge Low or Completely Discharged

1. Measure the battery voltage at the battery terminals using a digital multimeter.
 - A reading of less than 11 V indicates that the initial charging will be very low.
 - It could take some time before the battery accepts current in excess of a few milliamperes.
2. Set the battery charger on the highest setting.
3. If necessary, disable the polarity protection circuitry:
 - This circuitry, available on most chargers, prevents charging unless the charger leads are properly connected to the battery terminals.
 - A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are properly connected, implying that the battery will not accept a charge.
 - Most chargers have an override or a bypass function so that the charger will turn ON and charge a low voltage battery.

Important: The required battery charge time varies according to the voltage capabilities of the battery charger. A charger of less than 14 volts could take up to 16 hours before it appears to be accepting current, followed up by several hours of the appearance of charging.

4. To determine the amount of hours the battery may need to be charged, the following calculation can be made:
 - The reserve capacity rating on the battery label is the number of ampere-hours of charge required in order to produce the green hydrometer dot.
 - After the meter on the charger starts to show current flow, note the number of amps being accepted.
 - Determine the reserve capacity of the battery. Refer to *Battery Usage*.
 - Divide the reserve capacity by the number of amps shown on the meter to determine how many hours of charging is needed.
5. When the green dot appears in the hydrometer, discontinue charging.
6. If the green hydrometer dot is not visible after an ampere-hour charge equal to twice the reserve capacity rating, replace the battery. Refer to *Battery Replacement*.
7. After charging, load test the battery. Refer to *Battery Load Test*.

Jump Starting in Case of Emergency

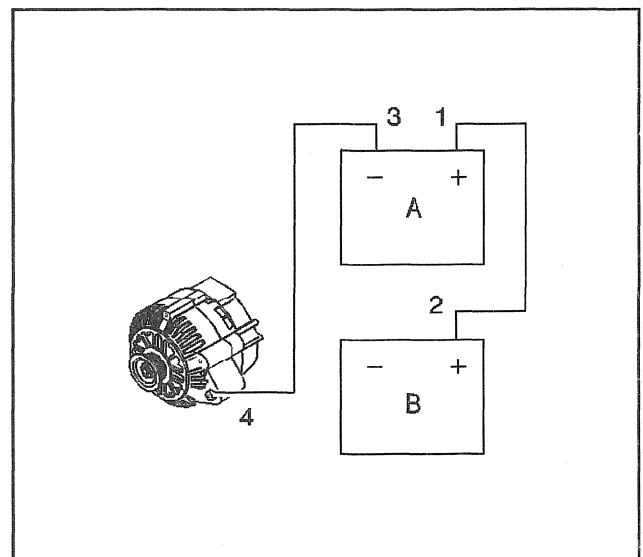
The booster battery and the discharged battery should be treated carefully when using jumper cables. Follow the procedure exactly. Do not cause sparks.

Notice: Push starting the vehicle can, under some conditions, cause damage to the catalytic converter and an automatic transmission.

This vehicle has a 12 Volt, negative ground electrical system. Make sure the vehicle or equipment being used to jump start the engine is also 12 Volt, negative ground. Use of any other type of system will damage the vehicle's electrical components.

1. Position the vehicle with the booster (charged) battery so that the jumper cables will reach.
 - Do not let the two vehicles touch.
 - Make sure that the jumper cables do not have loose ends, or missing insulation.
2. Place an automatic transmission in PARK.
3. Place the shift lever of a manual transmission in NEUTRAL.
4. Set the parking brake.
5. Block the wheels.
6. Turn off all electrical loads that are not needed (leave the hazard flashers ON).
7. Turn OFF the ignition switch.
8. Check the built-in battery hydrometer of the discharged battery.

If the hydrometer is clear or light yellow, do not jump (charge) the battery. Replace the battery.
9. Attach the end of one jumper cable to the positive terminal of the booster battery (A1). (A) is the booster battery, (B) is the discharged battery.

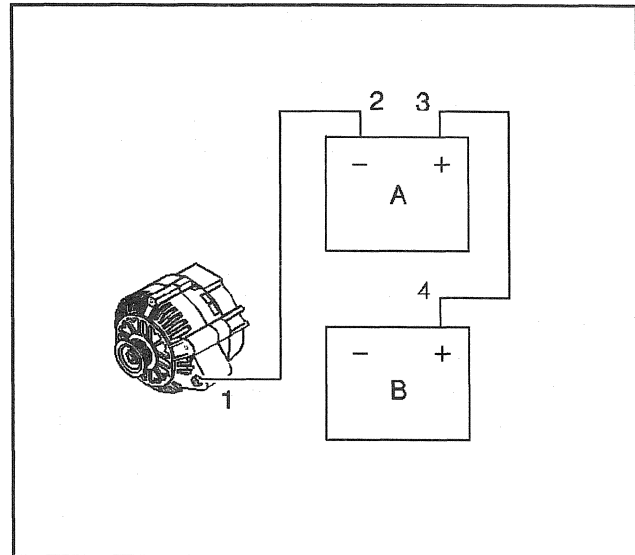


10. Attach the other end of the same cable to the positive terminal of the discharged battery (B2). (A) is the booster battery, (B) is the discharged battery.

11. Attach one end of the remaining jumper cable to the negative terminal of the booster battery (A 3).
12. The final connection (4) is made to a solid engine Ground (such as the A/C compressor bracket or the generator mounting bracket), at least 450 mm (18 in) from the discharged battery (B).

A spark could ignite an accumulation of hydrogen gas from the discharged battery.

13. Start the engine of the vehicle that is providing the boost.
14. Crank the engine of the vehicle with the discharged battery.
15. The negative jumper cable must be disconnected from the vehicle that was boosted, first (4). (A) is the booster battery, (B) is the discharged battery.



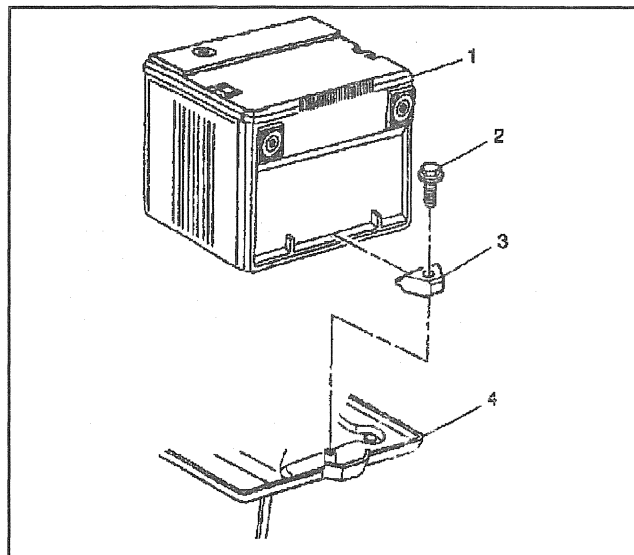
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16. Remove the other end of the negative jumper cable from the booster battery (A 2).
17. Remove the positive jumper cable from the booster battery (A 3).
Do not let the cable end touch any metal (until after the other cable end is disconnected).
18. Remove the positive jumper cable from the other battery (B 4).

Battery Replacement

Removal Procedure

1. Disconnect the negative battery cable from the negative battery terminal.
2. Disconnect the positive battery cable from the positive battery terminal.
3. Remove the battery hold-down retainer bolt (2) and retainer (3).
4. Remove the battery (1) from the battery tray (4).
5. Inspect the battery for:
 - Damage
 - Worn or corroded cables and connectors
 - Damage or foreign objects in the battery carrier
6. If damage is noted, find and correct the cause.
7. Clean any corrosion from the battery cables and connectors.
8. Clean the battery tray and remove any foreign objects from it.



84569

Installation Procedure

1. Install the battery (1) into the battery tray (4).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Connect the hold-down retainer (3) and bolt (2).

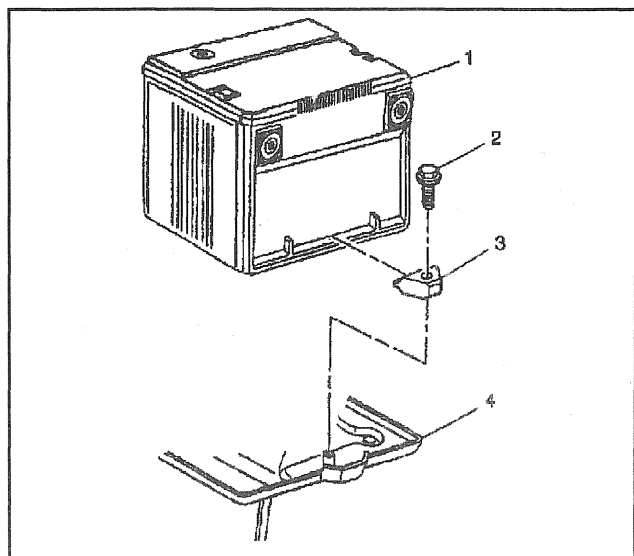
Tighten

Tighten the hold-down retainer bolt to 15 N·m (11 lb ft).

3. Connect the positive battery cable and the positive battery cable terminal to the battery.
4. Connect the negative battery cable and the negative battery cable terminal to the battery.

Tighten

Tighten the battery terminals to 15 N·m (11 lb ft).

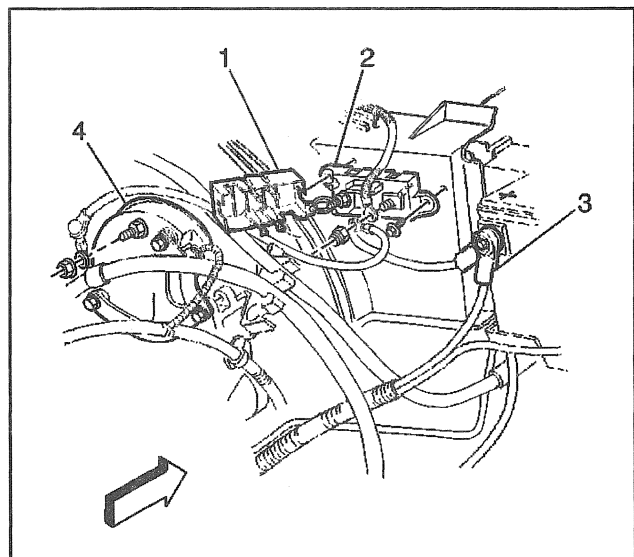


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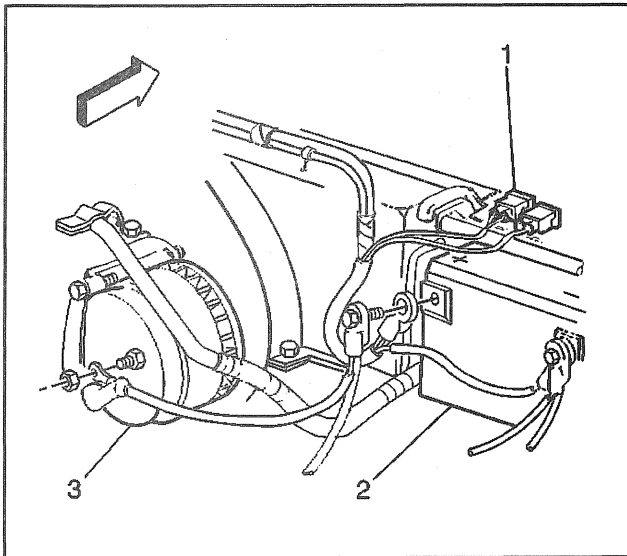
Battery Cable

Excessive resistance caused by poor terminal connections and partial short circuits through worn cable insulation will result in an abnormal voltage drop in the starter cable. Low voltage at the starter will prevent the normal starter operation and cause hard starting.

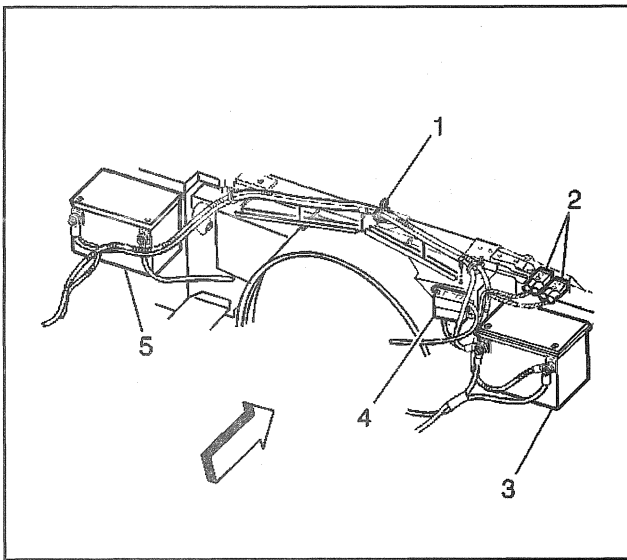
Whenever the battery cables are replaced, use a replacement cable that is the same in the type, the diameter, and the length. Some positive cables have additional feed wires attached to them and some of the negative cables have additional ground leads attached.



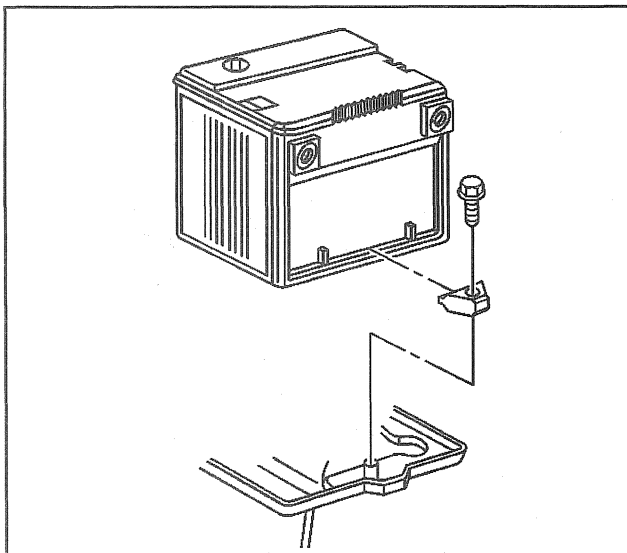
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Ensure that replacement battery cables are routed in the same manner as the original.

Caution: In order to prevent possible personal injury from a moving vehicle or from an operating engine, perform the following steps before performing the checks:

1. Place the transmission in park.
2. Engage the parking brakes and block the wheels.
3. Disconnect the battery feed at the distributor.

Notice: When installing the positive battery cable to the starter solenoid, the inner nut on the solenoid battery terminal must be tightened before the battery cable and the other leads are installed. Failure to do so will result in the solenoid or the solenoid terminal damage.

1. Check the voltage drop between the ground (the negative battery terminal) and the vehicle frame. Place one probe of the *J 39200* on the grounded battery post (not on the cable clamp) and the other on the frame. Operate the starter and note the voltage reading.
2. Check the voltage drop between the positive battery terminal and the starter terminal stud with the starter operating.
3. Check the voltage drop between the starter housing and the frame with the starter operating.
4. If the voltage drop in any of the above is more than 0.5 volts, there is excessive resistance in the circuit.

In order to eliminate resistance, the cables should be disconnected and the connections should be cleaned.

If the cables are frayed or the clamps are corroded, the cables should be replaced.

When selecting the new cables, ensure that the new cables are the same length and the same diameter as the original cables being replaced.

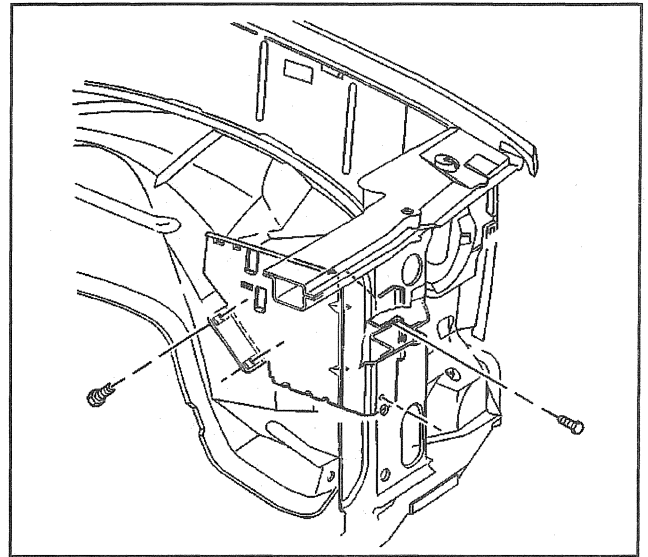
Battery Tray Replacement (Battery Tray Replacement - LH)

Removal Procedure

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

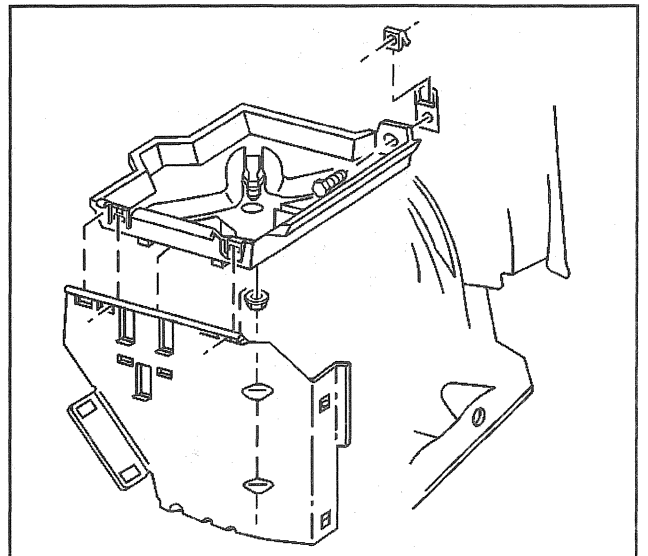
1. Disconnect the negative battery cable from the negative battery terminal.
2. Disconnect the positive battery cable from the positive battery terminal.
3. Remove the battery hold-down bolt and retainer.
4. Remove the battery.

5. Remove the battery tray reinforcement bolts.
6. Remove the battery tray reinforcement from the vehicle.



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7. Remove the battery tray bolts.
8. Remove the battery tray from the vehicle.



186821

Installation Procedure

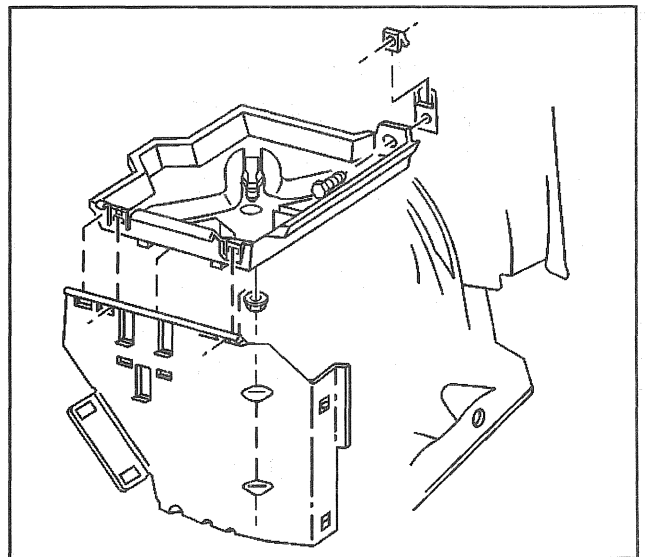
1. Install the battery tray to the vehicle.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

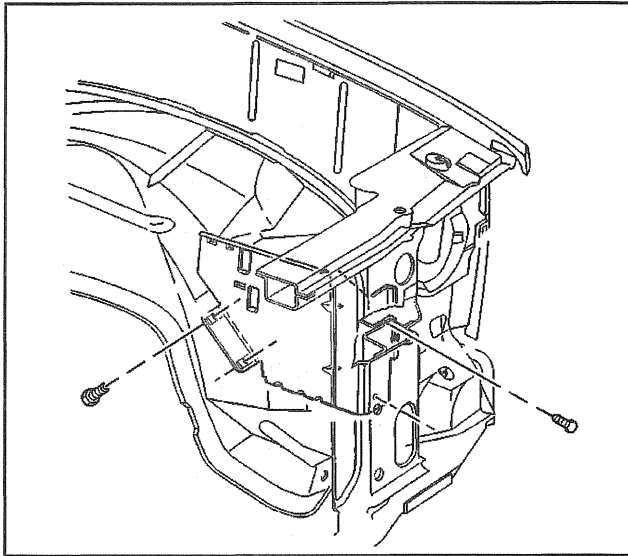
2. Install the battery tray bolts.

Tighten

Tighten the bolts to 25 N·m (18 lb ft).



186821

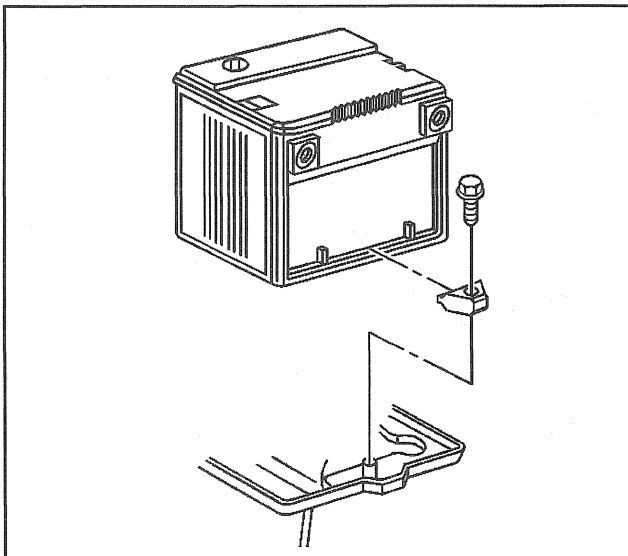


186823

3. Install the battery tray reinforcement to the vehicle
4. Install the battery tray reinforcement bolts.

Tighten

Tighten the retainer bolt to 25 N·m (18 lb ft).



106016

5. Install the battery.
6. Install the hold-down retainer and bolt.

Tighten

Tighten the retainer bolt to 15 N·m (11 lb ft).

7. Install the positive battery cable to the battery.

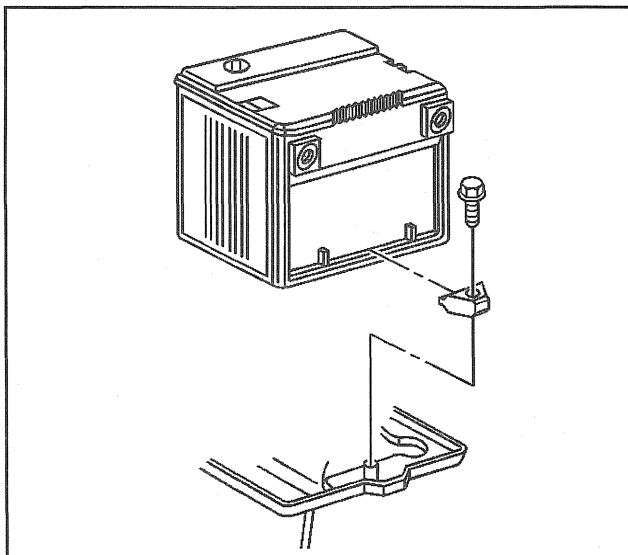
Tighten

Tighten the cable to 10 N·m (89 lb in).

8. Install the negative battery cable to the battery.

Tighten

Tighten the cable to 10 N·m (89 lb in).



106016

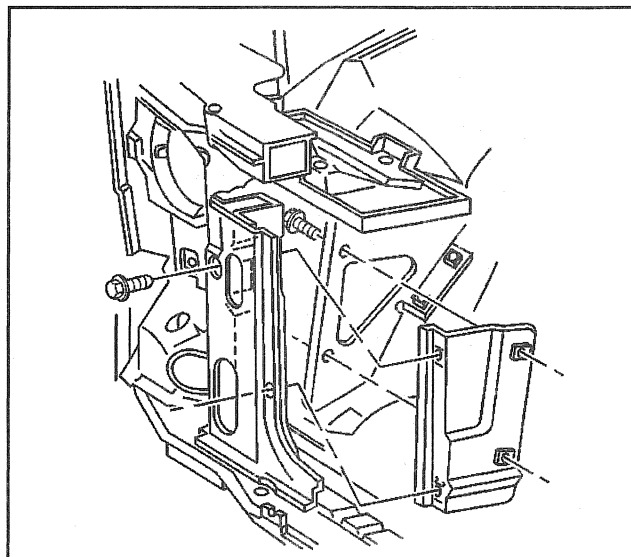
Battery Tray Replacement (Battery Tray Replacement - RH)

Removal Procedure

Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

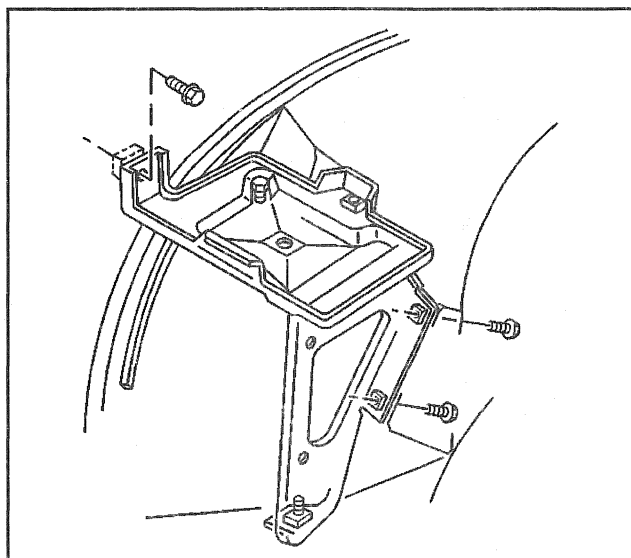
1. Disconnect the negative battery cable from the negative battery terminal.
2. Disconnect the positive battery cable from the positive battery terminal.
3. Remove the battery hold-down bolt and retainer.
4. Remove the battery.

5. Remove the battery tray reinforcement bolts.
6. Remove the battery tray reinforcement from the vehicle.



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7. Remove the battery tray bolts.
8. Remove the battery tray from the vehicle.



186812

Installation Procedure

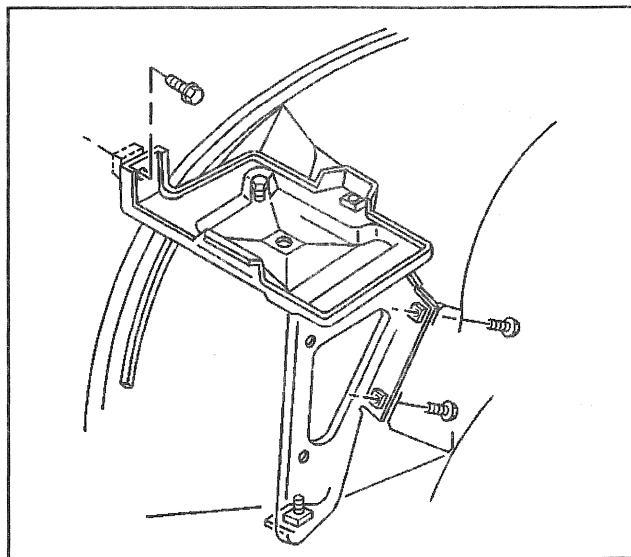
1. Install the battery tray to the vehicle.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

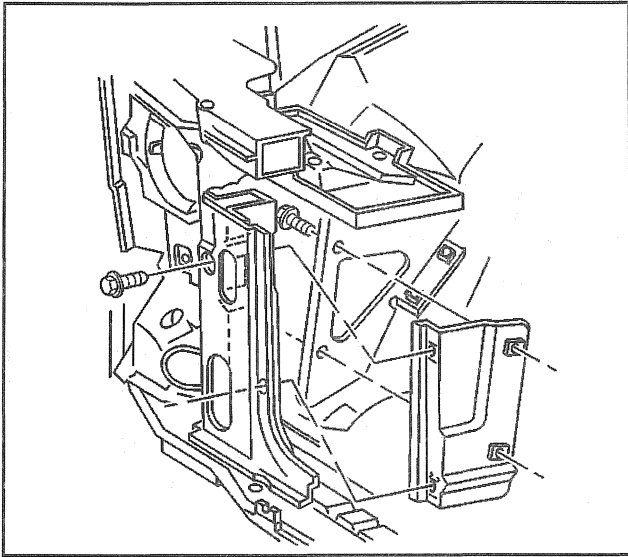
2. Install the battery tray bolts.

Tighten

Tighten the bolts to 25 N·m (18 lb ft).



186812

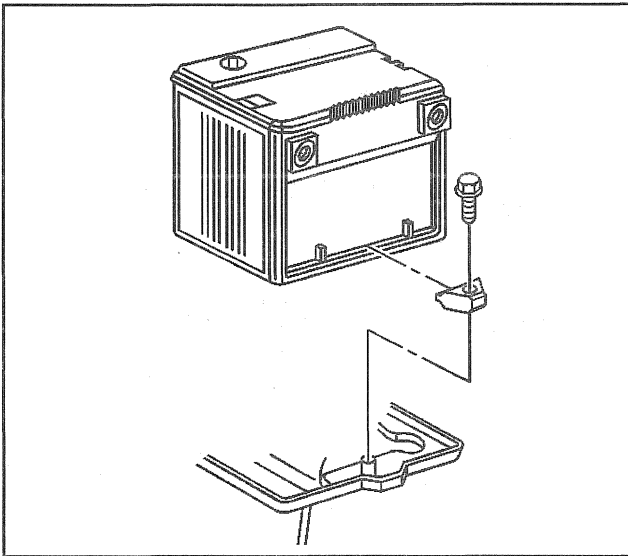


186825

3. Install the battery tray reinforcement to the vehicle
4. Install the battery tray reinforcement bolts.

Tighten

Tighten the retainer bolt to 25 N·m (18 lb ft).



106016

5. Install the battery.
6. Install the hold-down retainer and bolt.

Tighten

Tighten the retainer bolt to 15 N·m (11 lb ft).

7. Install the positive battery cable to the battery.

Tighten

Tighten the cable to 10 N·m (89 lb in).

8. Install the negative battery cable to the battery.

Tighten

Tighten the cable to 10 N·m (89 lb in).

Ground Strap Replacement

Additional ground straps are used to connect the body frame to the engine and the transmission. Always connect all ground straps to ensure a good ground path to the battery for all electrical components.

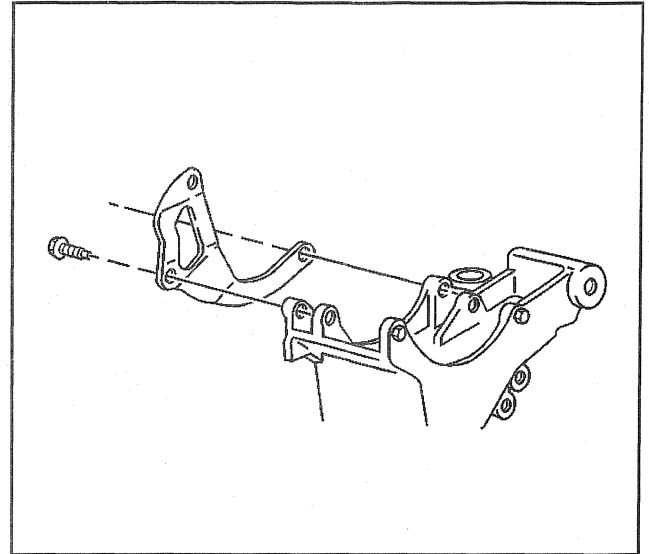
For illustrations and ground strap locations, refer to *Ground Distribution Schematics*.

Generator Replacement (Gasoline Engines)

Removal Procedure

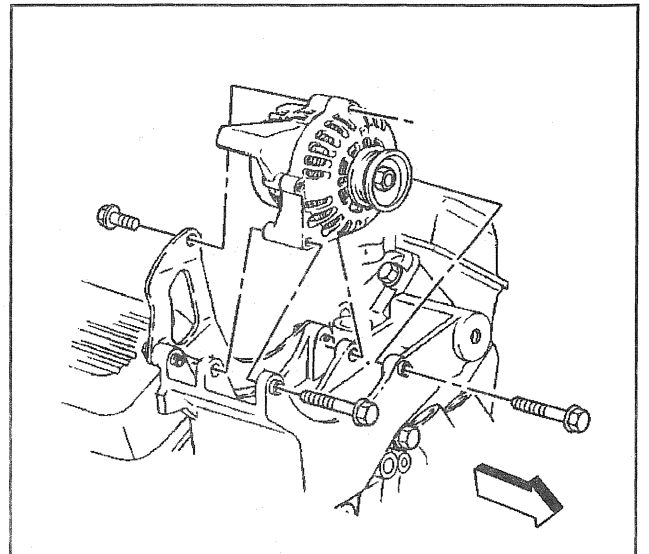
Caution: Refer to *Battery Disconnect Caution in Cautions and Notices*.

1. Disconnect the negative battery cable.
2. Disconnect the terminal plug from the back of the generator.
3. Disconnect the battery lead from the back of the generator.
4. Remove the drive belt. Refer to *Drive Belt Replacement* in Engine Mechanical.
5. Remove the generator mounting bolts.



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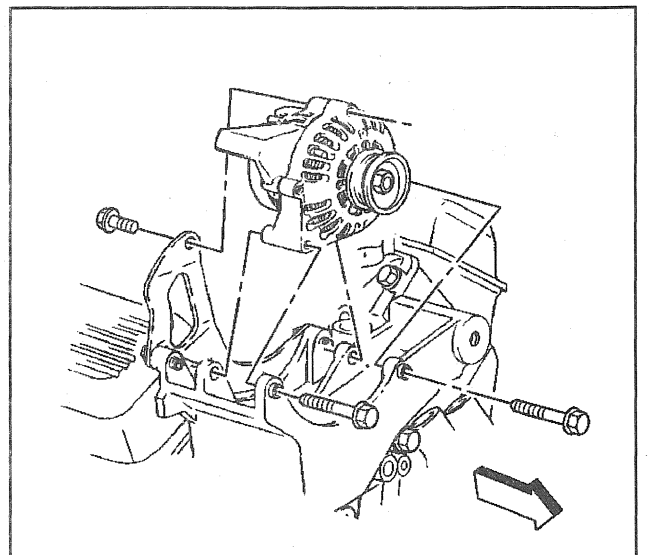
6. Remove the generator from the generator mounting bracket.



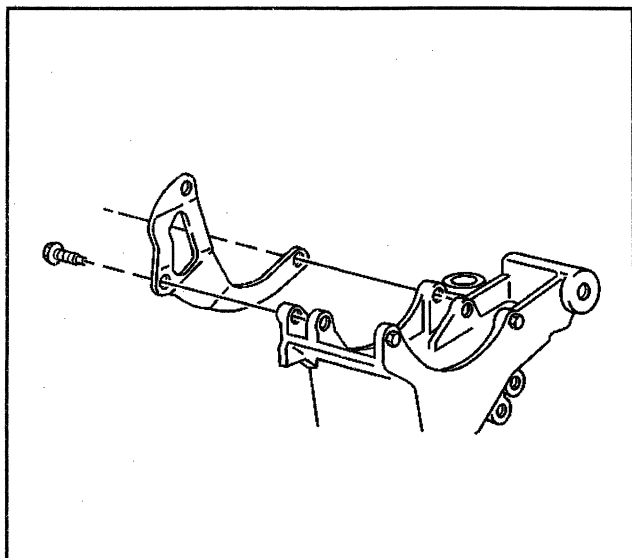
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Installation Procedure

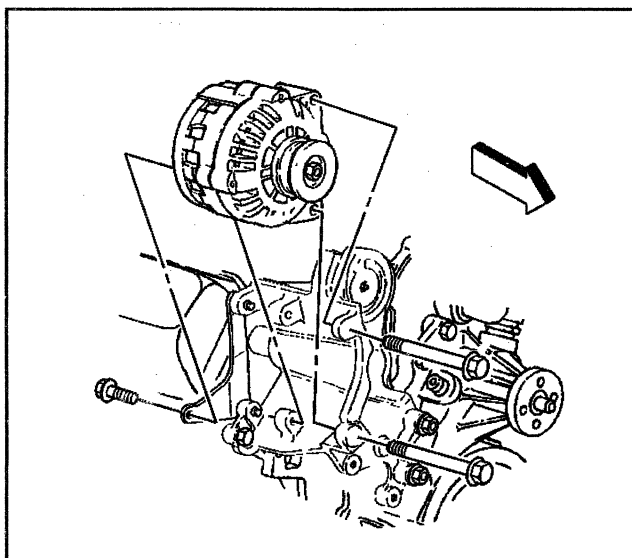
1. Install the generator into the generator mounting bracket.



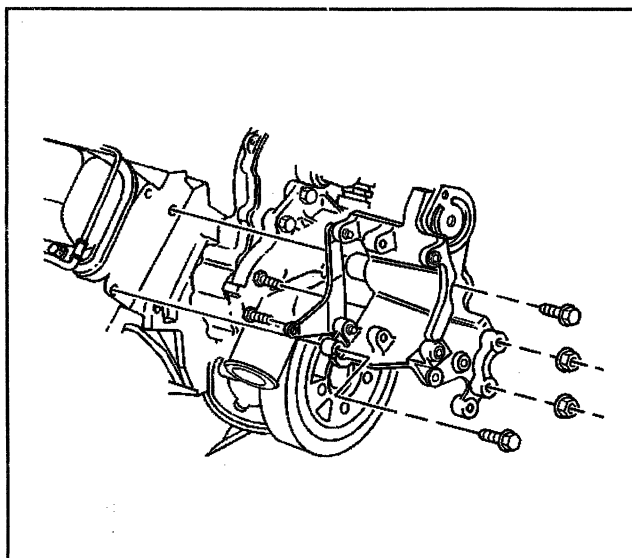
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Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Connect the generator mounting bolts.

Tighten

- 2.1. Tighten the right mounting bolt to 25 N·m (18 lb ft).
- 2.2. Tighten the left mounting bolt to 50 N·m (37 lb ft).
- 2.3. Tighten the mounting bracket bolt at the back of the generator to 25 N·m (18 lb ft).
3. Install the drive belt. Refer to *Drive Belt Replacement* in Engine Mechanical.
4. Connect the terminal plug to the back of the generator.
5. Connect the battery lead to the back of the generator.

Tighten

Tighten to battery terminal nut to 8 N·m (71 lb in).

6. Connect the negative battery cable.

Generator Replacement (Diesel Engines)

Removal Procedure

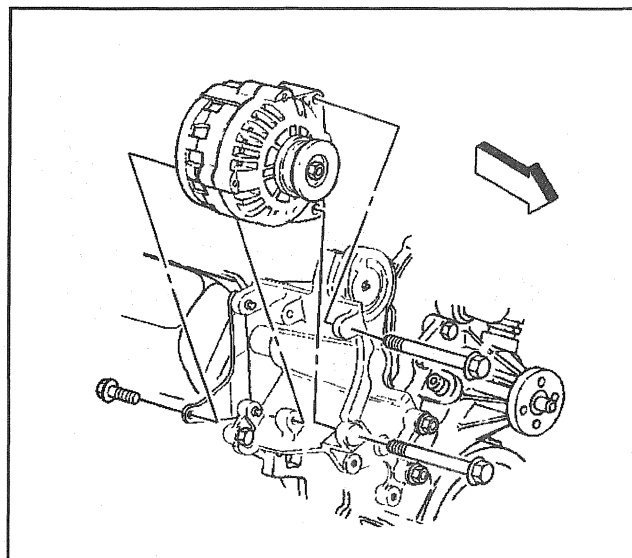
Caution: Refer to *Battery Disconnect Caution* in Cautions and Notices.

1. Disconnect the negative battery cable.
2. Disconnect the terminal plug from the back of the generator.
3. Disconnect the battery lead from the back of the generator.
4. Remove the drive belt. Refer to *Drive Belt Replacement* in Engine Mechanical.
5. Remove the generator mounting bolts.

6. Remove the generator from the generator mounting bracket.

Installation Procedure

1. Install the generator into the generator mounting bracket.



186800

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Connect the generator mounting bolts.

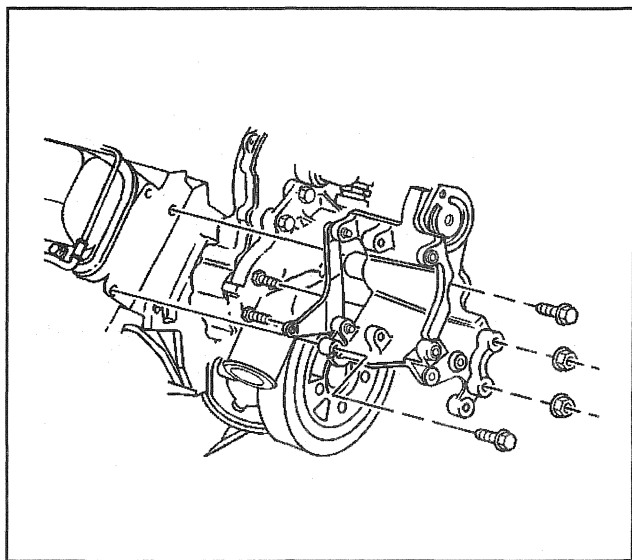
Tighten

- 2.1. Tighten the right mounting bolt to 25 N·m (18 lb ft).
 - 2.2. Tighten the left mounting bolt to 50 N·m (37 lb ft).
 - 2.3. Tighten the mounting bracket bolt at the back of the generator to 25 N·m (18 lb ft).
3. Install the drive belt. Refer to *Drive Belt Replacement* in Engine Mechanical.
 4. Connect the terminal plug to the back of the generator.
 5. Connect the battery lead to the back of the generator.

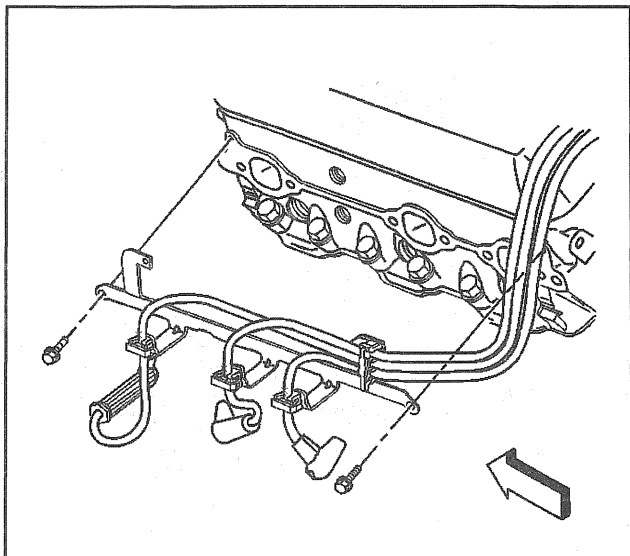
Tighten

Tighten to battery terminal nut to 8 N·m (71 lb in).

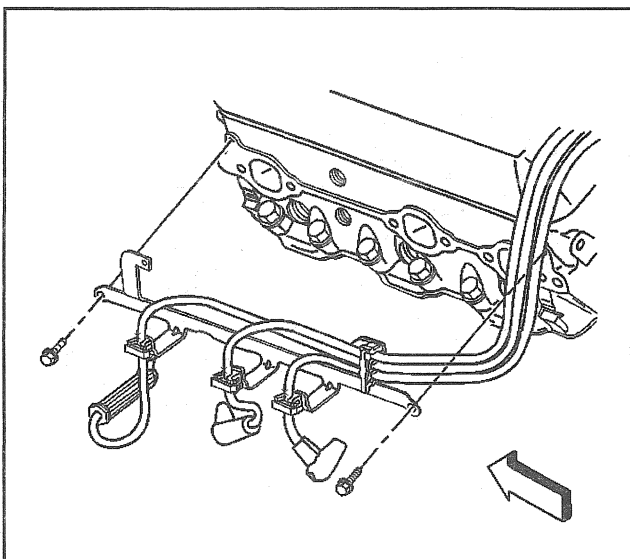
6. Connect the negative battery cable.



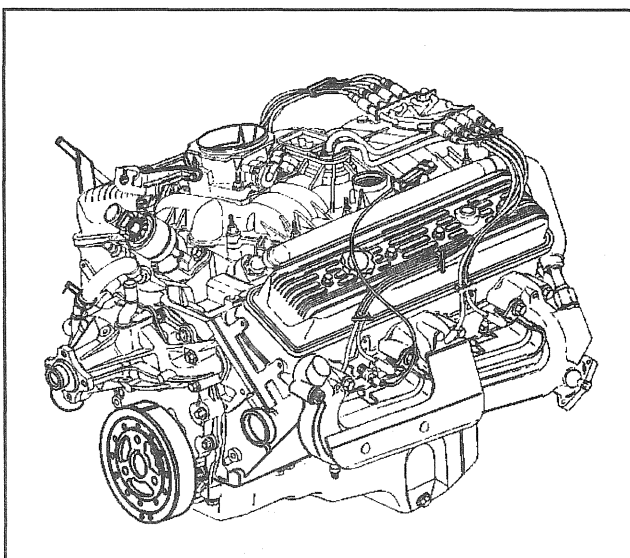
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317450



317450



367058

Spark Plug Wire Harness Replacement (4.3L)

Removal Procedure (4.3L)

1. Disconnect the spark plug wire at each spark plug.
 - Twist the boots one-half turn before removing.
 - Pull only on the boot or use a tool designed for this purpose in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from the Distributor.
 - Twist each spark plug boot 1/2 turn.
 - Pull only on the boot or use a tool designed for this purpose in order to remove the wires from the Distributor.

Installation Procedure (4.3L)

1. Install the spark plug wires at the Distributor.
2. Install the spark plug wire to each spark plug.
3. Inspect the wires for proper installation:
 - Push sideways on each boot in order to inspect the seating.
 - Reinstall any loose boot.

Notice: If the boot to wire movement has occurred, the boot will give a false visual impression of being fully seated. Ensure that the boots have been properly assembled by pushing sideways on the installed boots. Failure to properly seat the terminal onto the spark plug will lead to wire core erosion and result in an engine misfire or crossfire condition, and possible internal damage to the engine.

Spark Plug Wire Harness Replacement (5.0L, 5.7L)

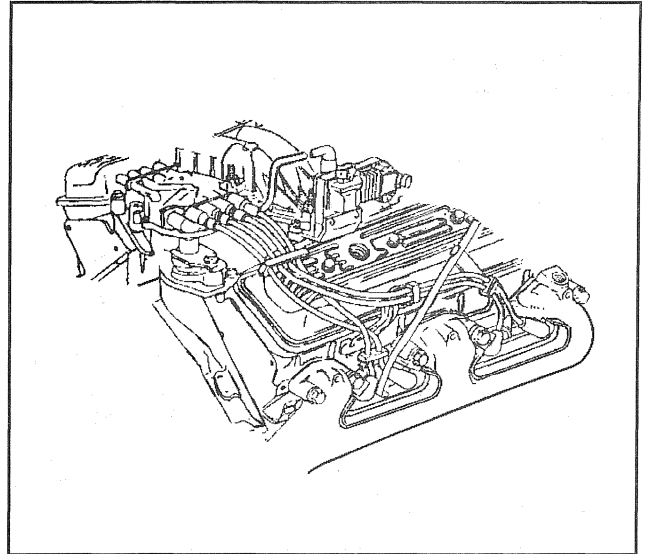
Removal Procedure 5.0L, 5.7L

1. Disconnect the spark plug wire at each spark plug for 5.0L, 5.7L.
 - Twist the boots one-half turn before removing.
 - Pull only on the boot or use a tool designed for this purpose in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from the Distributor.
 - Twist each spark plug boot 1/2 turn.
 - Pull only on the boot or use a tool designed for this purpose in order to remove the wires from the Distributor.

Installation Procedure 5.0L, 5.7L

1. Install the spark plug wires at the Distributor for 5.0L, 5.7L.
2. Install the spark plug wire to each spark plug.
3. Inspect the wires for proper installation:
 - Push sideways on each boot in order to inspect the seating.
 - Reinstall any loose boot.

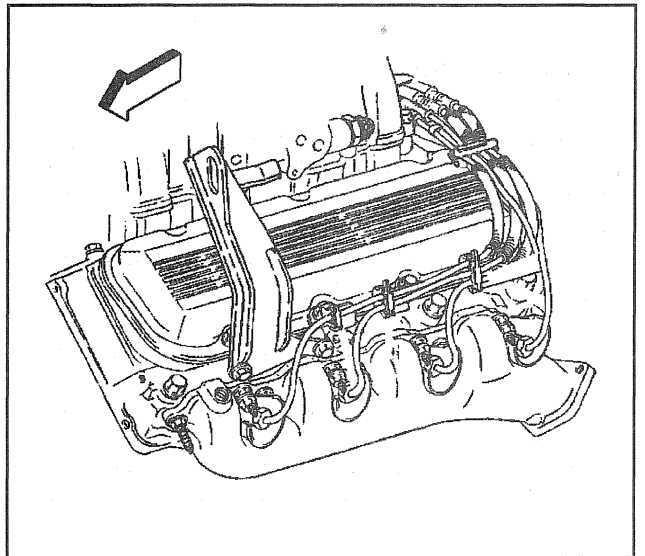
Notice: If the boot to wire movement has occurred, the boot will give a false visual impression of being fully seated. Ensure that the boots have been properly assembled by pushing sideways on the installed boots. Failure to properly seat the terminal onto the spark plug will lead to wire core erosion and result in an engine misfire or crossfire condition, and possible internal damage to the engine.



176070

**Spark Plug Wire Harness
Replacement (7.4L)**
Removal Procedure 7.4L

1. Disconnect the spark plug wire at each spark plug for 7.4L.
 - Twist the boots one-half turn before removing.
 - Pull only on the boot or use a tool designed for this purpose in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from the Distributor.
 - Twist each spark plug boot 1/2 turn.
 - Pull only on the boot or use a tool designed for this purpose in order to remove the wires from the Distributor.

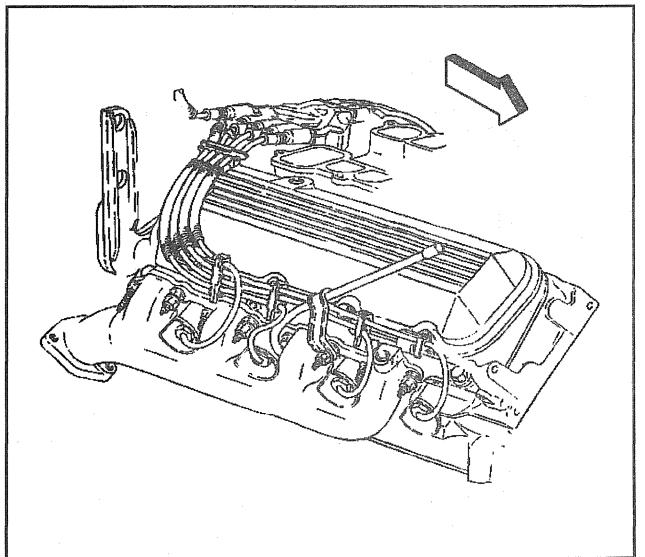


367056

Installation Procedure 7.4L

1. Install the spark plug wires at the Distributor for 7.4L.
2. Install the spark plug wire to each spark plug.
3. Inspect the wires for proper installation:
 - Push sideways on each boot in order to inspect the seating.
 - Reinstall any loose boot.

Notice: If the boot to wire movement has occurred, the boot will give a false visual impression of being fully seated. Ensure that the boots have been properly assembled by pushing sideways on the installed boots. Failure to properly seat the terminal onto the spark plug will lead to wire core erosion and result in an engine misfire or crossfire condition, and possible internal damage to the engine.



367065

Spark Plug Replacement

Tools Required

J 39358 Spark Plug Socket

Service Precautions

- Allow the engine to cool before removing the spark plugs. Attempting to remove the plugs from a hot engine may cause the plug to seize, causing damage to the cylinder head threads.
- Clean the spark plug recess area before removing the plug.

Failure to do so can result in engine damage due to dirt or foreign material entering the cylinder head or contamination of the cylinder head threads.

Contaminated threads may prevent proper seating of a new plug.

- Do not install the plugs that are either hotter or colder than the heat range specified.
- Using plugs of the wrong heat range may damage the engine.

Removal Procedure

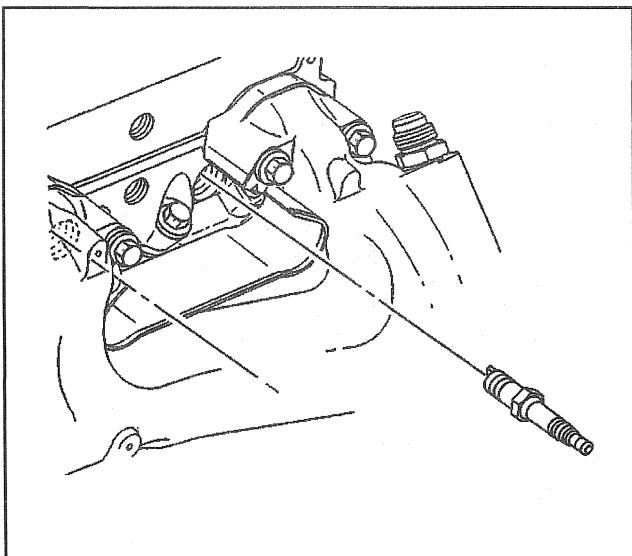
1. Turn OFF the ignition switch.

Notice: Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

2. Remove the spark plug wires using a twisting motion in order to release the boot from the spark plug.

The spark plug wires are numbered to assist in re-assembly.

Notice: Use the J 39358 or the equivalent. Failure to do so could cause cracking of the insulator and arcing inside the plug, resulting in engine misfire.

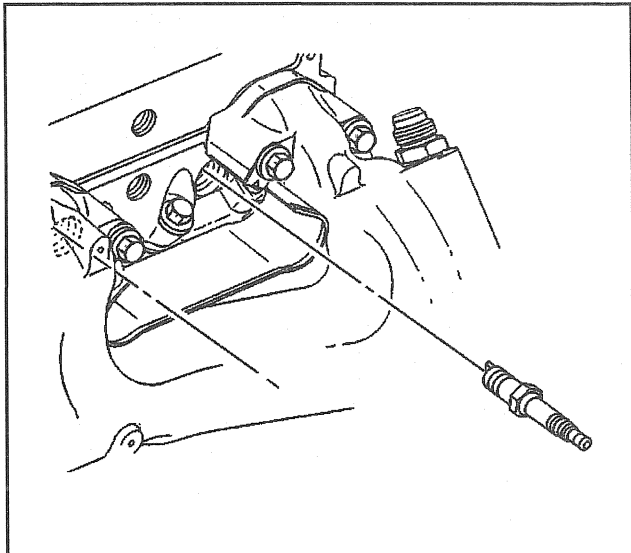


172979

3. Remove the spark plugs using the J 39358.
 4. Inspect each plug for wear.
- Refer to *Spark Plug Visual Diagnosis*.

Installation Procedure

Notice: Be sure plug threads smoothly into cylinder head and is fully seated. Use a thread chaser if necessary to clean threads in cylinder head. Cross-threading or failing to fully seat spark plug can cause overheating of plug, exhaust blow-by, or thread damage. Follow the recommended torque specifications carefully. Over or under-tightening can also cause severe damage to engine or spark plug.



172979

1. Install the spark plugs.

Tighten

Tighten the spark plugs to 15 N·m (11 lb ft).

2. Install the spark plug wires in their original locations.

Refer to *Spark Plug Wire Harness Replacement (4.3L)*.

Distributor Replacement (HVS)

Removal Procedure

Notice: There are two procedures available to install the distributor.

Use Installation Procedure 1 when the crankshaft has NOT been rotated from the original position.

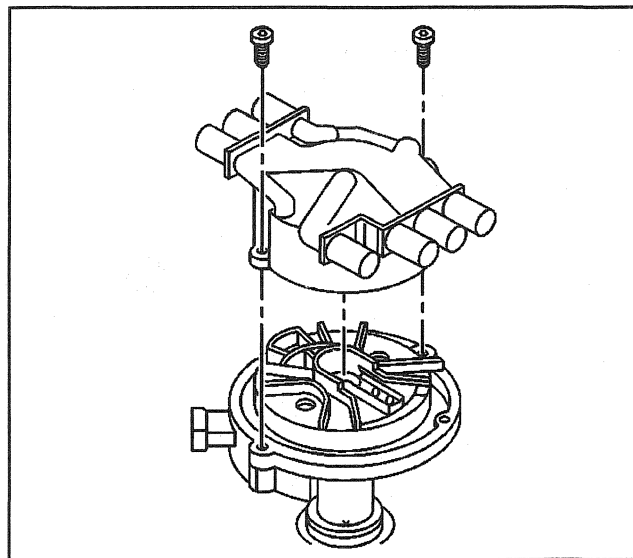
Use Installation Procedure 2 when any of the following components are removed:

- The intake manifold.
- The cylinder head.
- The camshaft.
- The timing chain or sprockets.
- The complete engine.

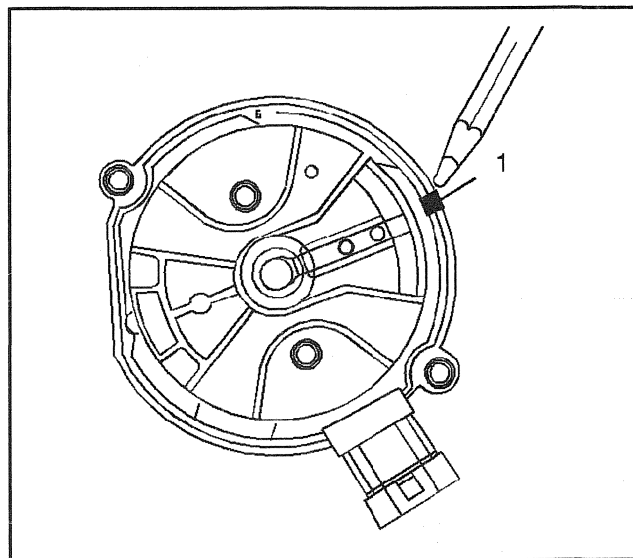
If the Malfunction Indicator Lamp turns on, and a DTC code P1345 sets after installing the distributor, this indicates an incorrectly installed distributor.

Engine damage or distributor damage may occur. Use Procedure 2 in order to install the distributor.

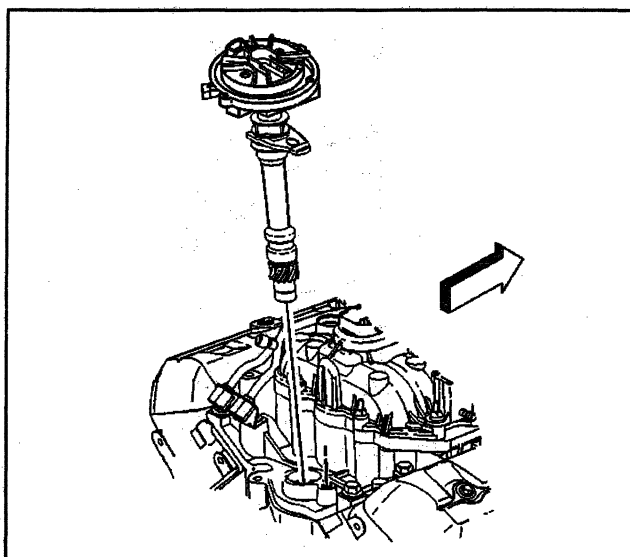
1. Turn OFF the ignition switch.
2. Remove the spark plug wires from the distributor cap.
3. Remove the electrical connector from the base of the distributor.
4. Remove the two screws that hold the distributor cap to the housing.
5. Discard the screws.
6. Remove the distributor cap from the housing.
7. Use a grease pencil in order to note the position of the rotor in relation to the distributor housing.
The mark is identified in the graphic with the number 1.
8. Mark the distributor housing and the intake manifold with a grease pencil.



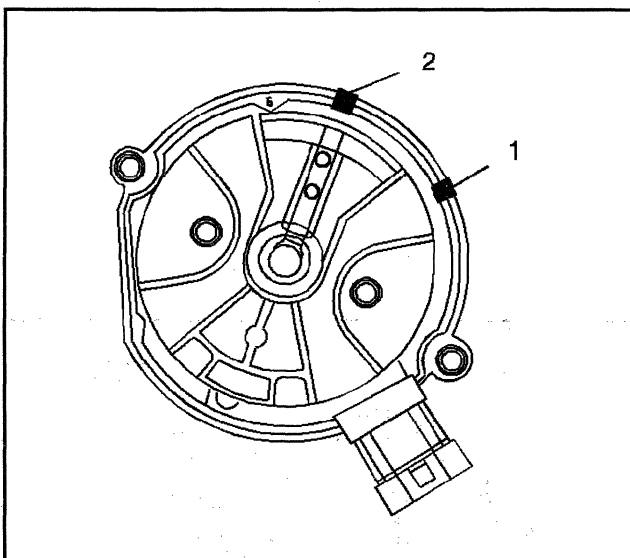
301393



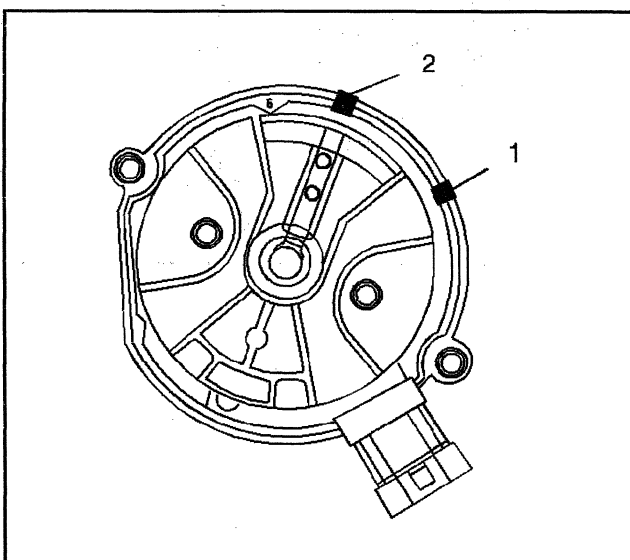
4373



34397



4376



4376

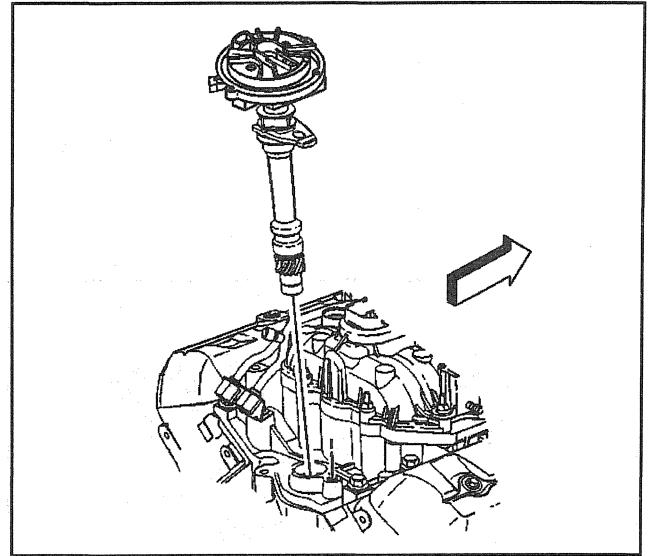
9. Remove the mounting clamp hold down bolt.
10. Remove the distributor.

11. As the distributor is being removed from the engine, watch the rotor move in a counter-clockwise direction about 42 degrees. This will appear as slightly more than one clock position.
12. Note the position of the rotor segment.
 - 12.1. Place a second mark on the base of the distributor. This will aid in achieving proper rotor alignment during the distributor installation.
 - 12.2. The second mark on the distributor housing is identified in the graphic as number 2.

Installation Procedure 1

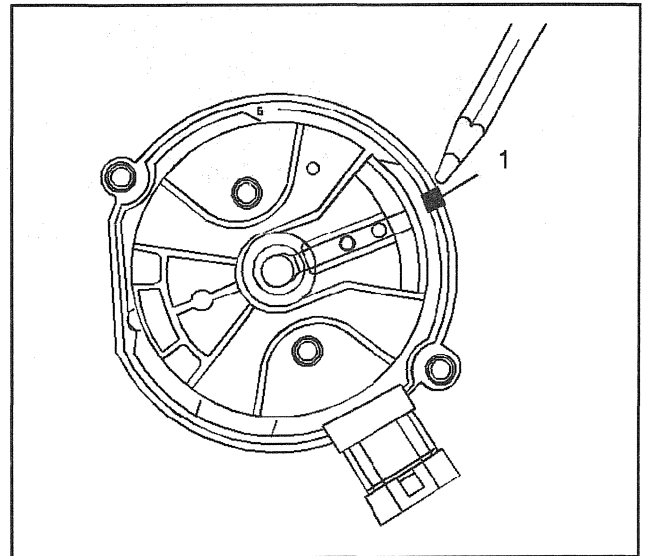
1. If installing a new distributor assembly, place two marks on the new distributor housing in the same location as the two marks on the original housing.
2. Remove the new distributor cap, if necessary.
3. Align the rotor with mark made at location 2.

4. Guide the distributor into the engine.
Make sure that the mounting hole in the distributor hold-down base is aligned over the mounting hole in the intake manifold.



34397

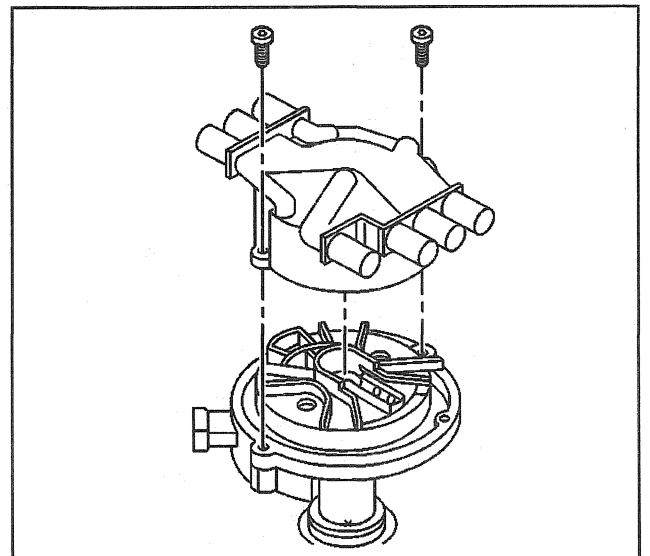
5. As the distributor is being installed, observe the rotor moving in a clockwise direction about 42 degrees.
6. Once the distributor is completely seated, the rotor segment should be aligned with the mark on the distributor base in location number 1.
 - If the rotor segment is not aligned with the number 1 mark, the driven gear teeth and the camshaft have meshed one or more teeth out of alignment.
 - In order to correct this condition, remove the distributor and reinstall it.



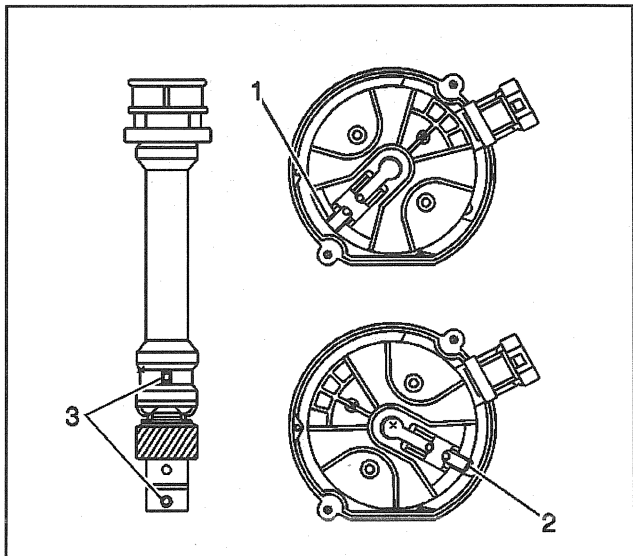
4373

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the distributor mounting clamp.
Tighten
Tighten the distributor clamp bolt to 25 N·m (18 lb ft).
Install the distributor cap.
8. Install two NEW distributor cap screws.
Tighten
Tighten the screws to 2.4 N·m (21 lb in).
9. Install the electrical connector to the distributor.



301393



301395

10. Install the spark plug wires to the distributor cap. Refer to *Spark Plug Wire Harness Replacement (4.3L)* or *Spark Plug Wire Harness Replacement (5.0L, 5.7L)*

Important: If the Malfunction Indicator lamp is turned on after installing the distributor, and a DTC P1345 is found, the distributor has been installed incorrectly. Refer to Installation Procedure 2 for proper distributor installation.

Installation Procedure 2

1. Rotate the number 1 cylinder to Top Dead Center (TDC) of the compression stroke.
2. Align white paint mark on the bottom stem of the distributor, and the pre-drilled indent hole in the bottom of the gear (3).
3. With the gear in this position, the rotor segment should be positioned as shown for a V6 engine (1) or V8 engine (2).
 - The alignment will not be exact.
 - If the driven gear is installed incorrectly, the dimple will be approximately 180 degrees opposite of the rotor segment when it is installed in the distributor.

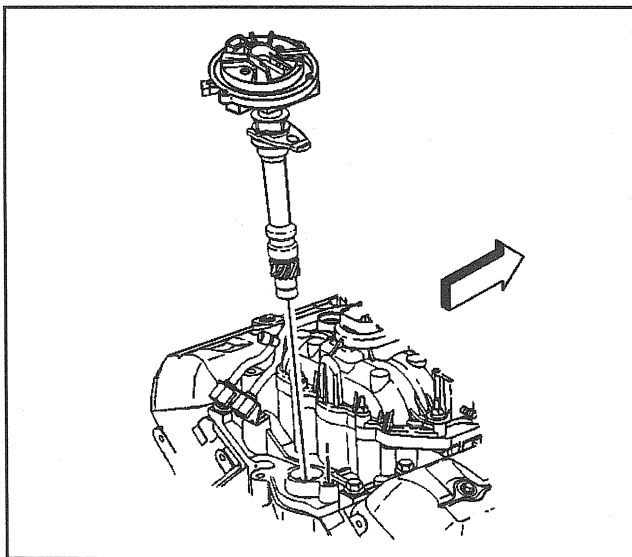
Notice: The OBD II ignition system distributor driven gear and rotor can be installed in multiple positions. In order to avoid mistakes, make sure to mark the distributor in the following positions:

- 3.1. The distributor driven gear.
- 3.2. The distributor shaft.
- 3.3. The rotor holes for the same mounting position upon reassembly.

Installing the driven gear 180 degrees out of alignment, or locating the rotor in the wrong holes, will cause a no-start condition. Premature engine wear or damage may result.

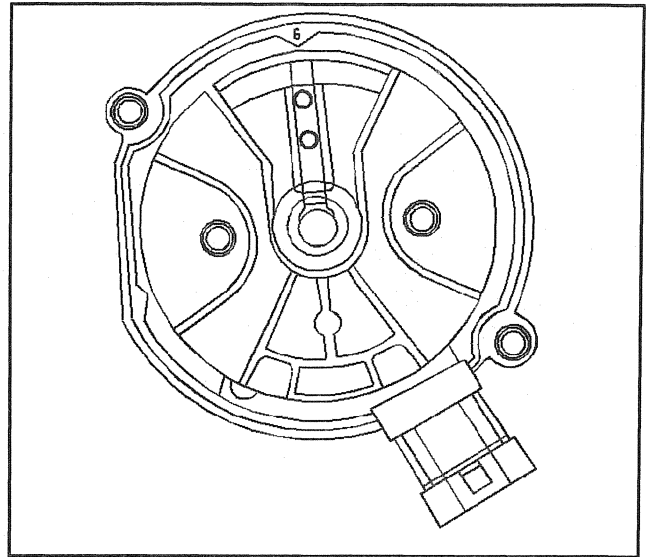
Notice: Installing the driven gear 180 degrees out of alignment, or locating the distributor rotor in the wrong holes, may cause a no-start condition. Premature engine wear and damage may result.

4. Using a long screw driver, align the oil pump drive shaft to the drive tab of the distributor.
5. Guide the distributor into the engine. Ensure that the spark plug towers are perpendicular to the centerline of the engine.



34397

6. Once the distributor is fully seated, the rotor segment should be aligned with the pointer cast into the distributor base.
 - This pointer may have a 6 cast into it, indicating that the distributor is to be used on a 6 cylinder engine or a 8 cast into it, indicating that the distributor is to be used on a 8 cylinder engine.
 - If the rotor segment does not come within a few degrees of the pointer, the gear mesh between the distributor and the camshaft may be off a tooth or more.
 - If this is the case, repeat the procedure again in order to achieve proper alignment.



4350

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the distributor mounting clamp.

Tighten

Tighten the distributor clamp bolt to 25 N·m (18 lb ft).

Install the distributor cap.

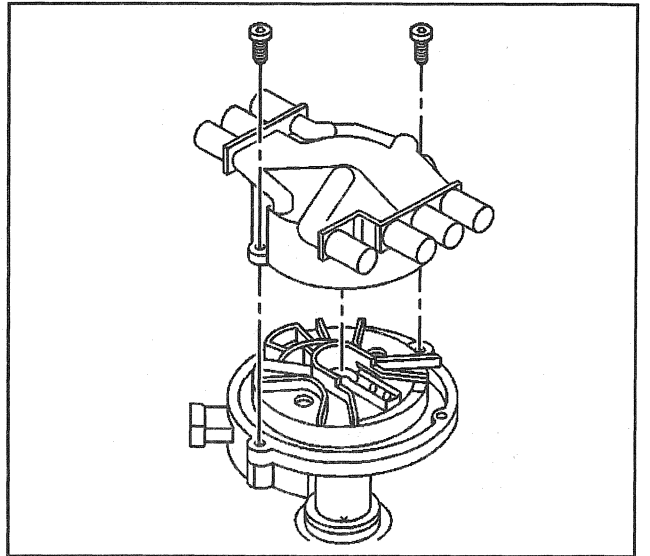
8. Install two NEW distributor cap screws.

Tighten

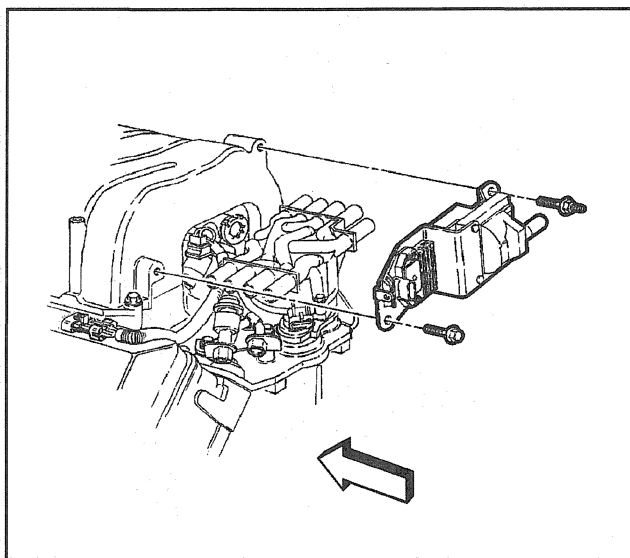
Tighten the screws to 2.4 N·m (21 lb in).

9. Install the electrical connector to the distributor.
10. Install the spark plug wires to the distributor cap. Refer to *Spark Plug Wire Harness Replacement (4.3L)* or *Spark Plug Wire Harness Replacement (5.0L, 5.7L)*

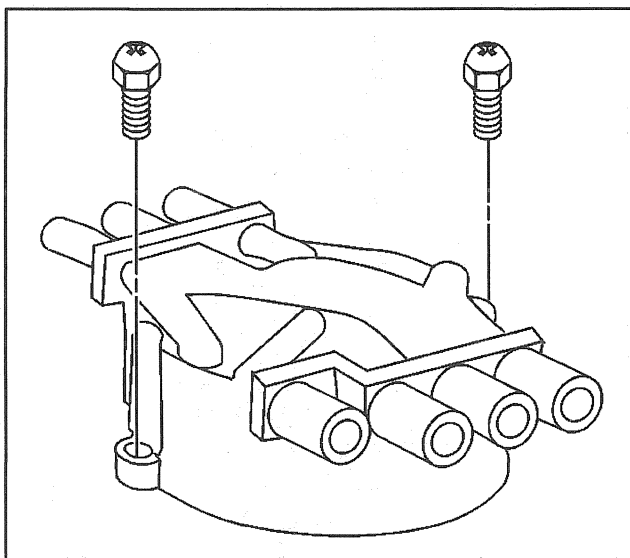
Important: If the Malfunction Indicator lamp is turned on after installing the distributor, and a DTC P1345 is found, the distributor has been installed incorrectly. Repeat Installation Procedure 2 for proper distributor installation.



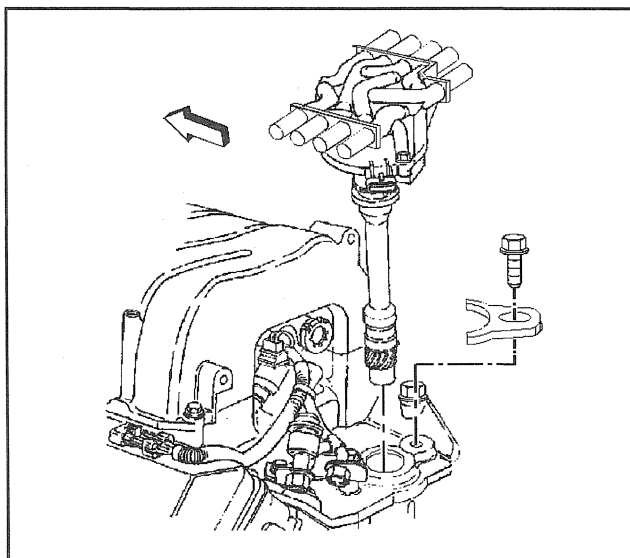
301393



68506



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68504

Distributor Replacement (VIN J)

Removal Procedure

1. Remove the engine cover, if equipped.
2. Remove the ignition coil.

Refer to *Ignition Coil and ICM Replacement (VIN J)*

3. Remove the spark plug wires from one side of the distributor cap and set them aside.
4. Remove the distributor cap.

5. Remove the distributor hold-down bolt and clamp.
6. Remove the distributor from the engine.

Installation Procedure

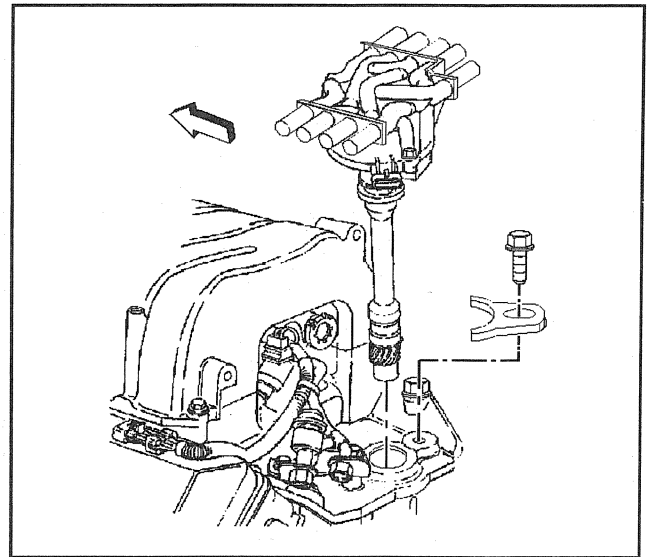
1. Install the distributor into the engine.
For additional information on installing distributors, refer to *Distributor Replacement (HVS)*.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the distributor hold-down bolt and clamp.

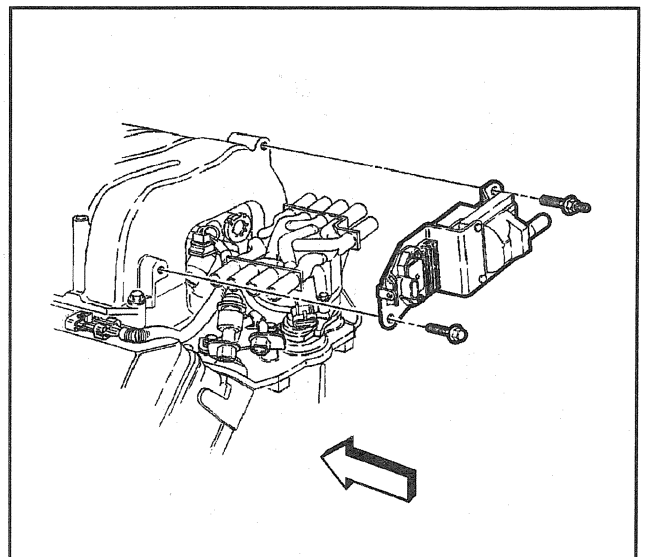
Tighten

Tighten the bolt to 25 N·m (18 lb ft).



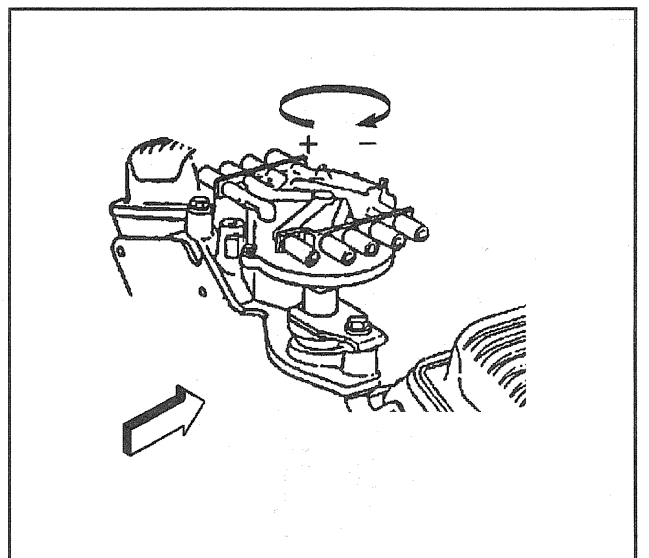
68504

3. Install the ignition coil.
Refer to *Ignition Coil and ICM Replacement (VIN J)*.
4. Install the engine cover, if equipped.

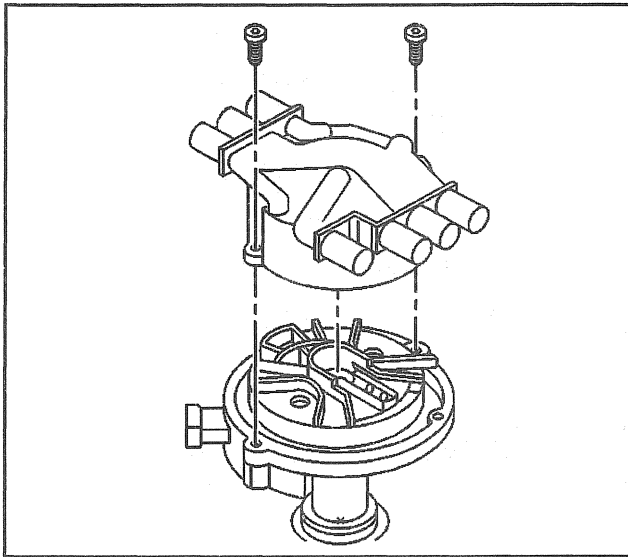


68506

5. For vehicles equipped with V8 engines, connect a scan tool.
6. Monitor the Camshaft Retard Offset value. Refer to *Camshaft Retard Offset Adjustment*.



18446



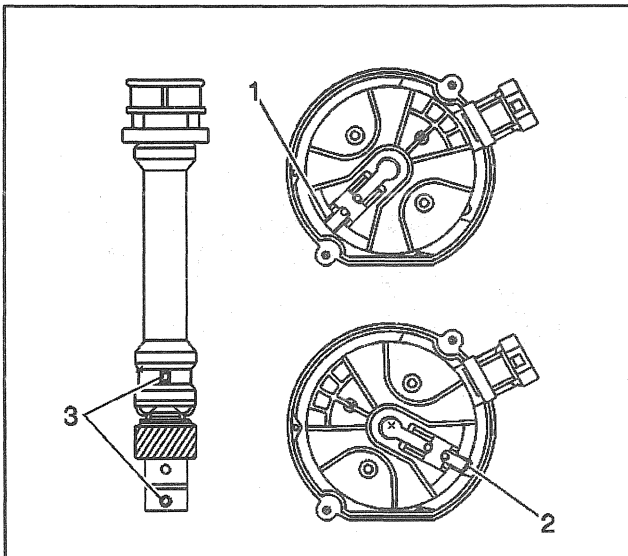
301393

Distributor Overhaul

Disassembly Procedure

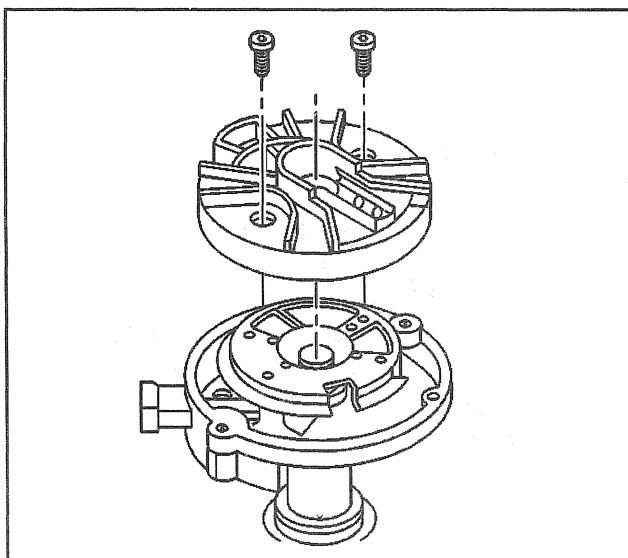
Notice: Refer to *Distributor Driven Gear Can Be Installed in Multiple Positions* in Cautions and Notices.

1. Remove the two screws that hold the distributor cap to the housing.
2. Discard the screws.
3. Remove the distributor cap from the housing.



301395

4. Align white paint mark on the bottom stem of the distributor, and the pre-drilled indent hole in the bottom of the gear (3).
5. With the gear in this position, the rotor segment should be positioned as shown for a V6 engine (1) or V8 engine (2). If not, replace the distributor.

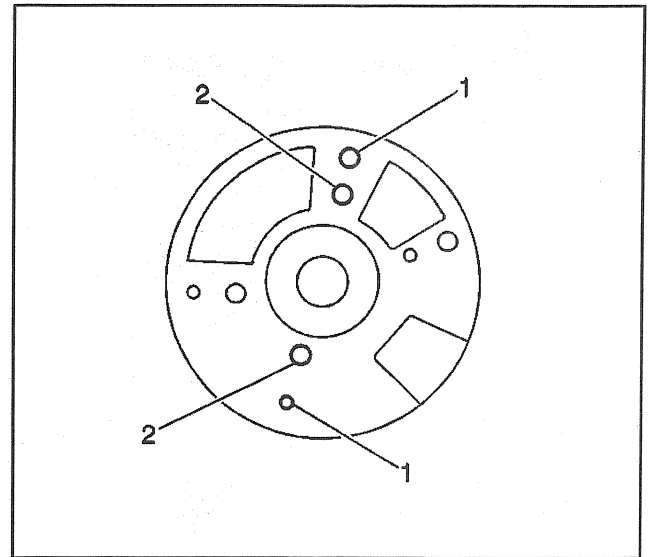


301396

6. Remove the two screws from the rotor.
7. Remove the rotor.

8. Note the locating holes that the rotor was removed from:

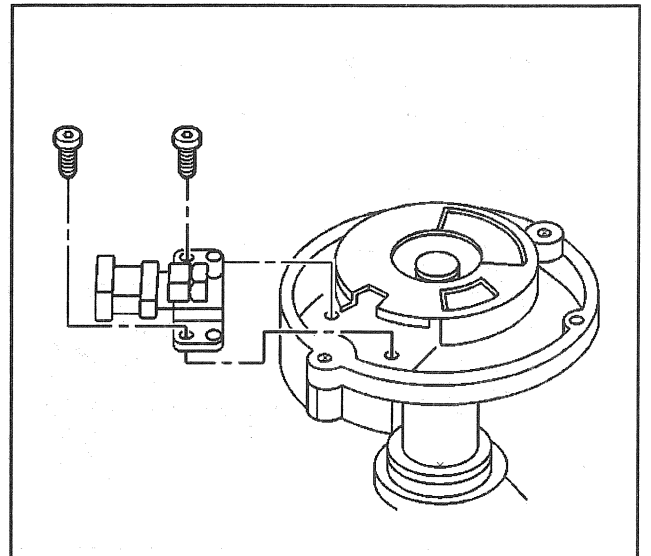
- (1) is the rotor screw holes.
- (2) is the rotor locator pin holes.



156752

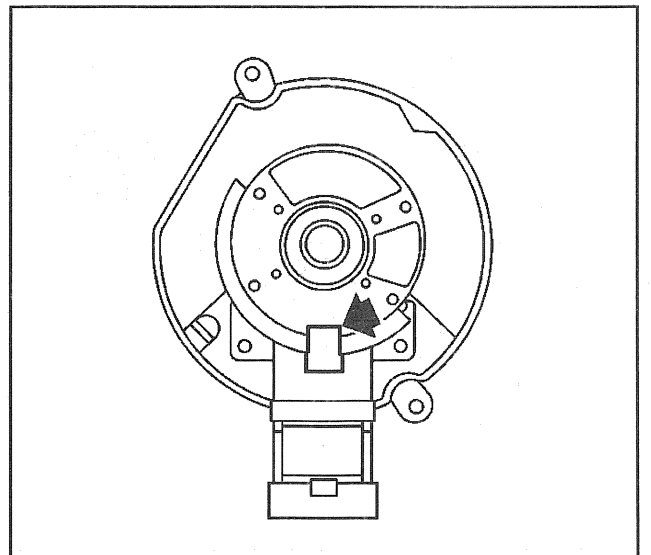
9. Remove the two screws that hold the camshaft position (CMP) sensor.

10. Discard the screws.

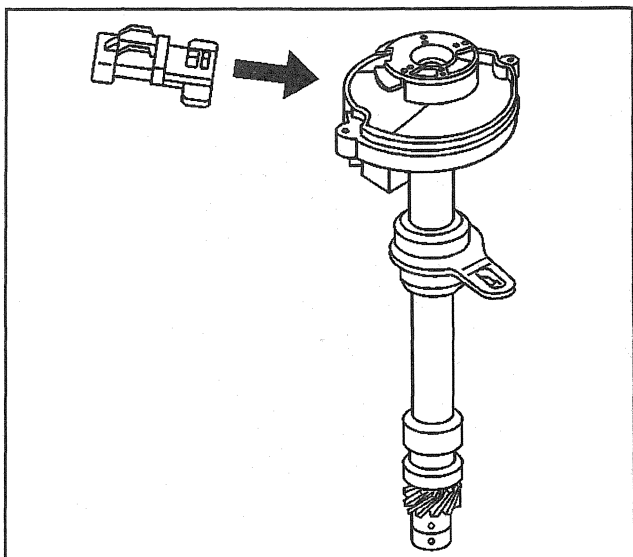


301398

11. Line up the square-cut hole in the vane wheel with the CMP sensor.



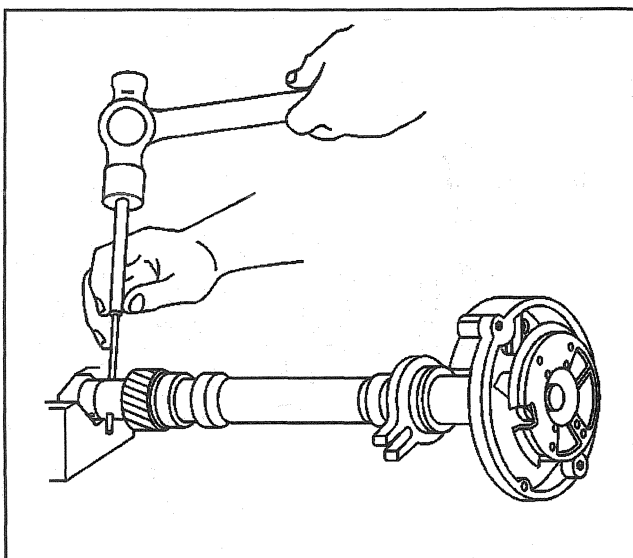
156754



156755

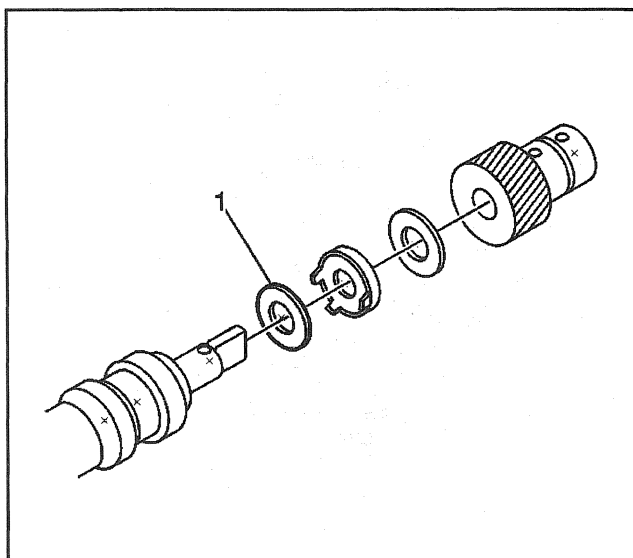
12. Remove the CMP sensor.
13. Note the dimple located below the roll pin hole on one side of the gear. The dimple will be used to properly orient the gear onto the shaft during reassembly.

Caution: Refer to Safety Glasses Caution in Cautions and Notices.



301198

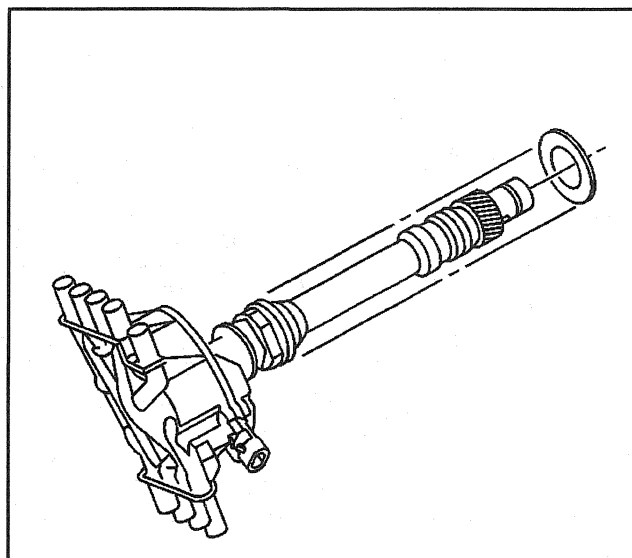
14. Support the distributor drive gear in a V-block or similar fixture.
15. Drive out the roll pin with a suitable punch.



301405

16. Remove the driven gear from the distributor shaft.
17. Remove the round washer.
18. Remove the tang washer.
19. Remove the round washer, if equipped (1), 7.4L engine only.

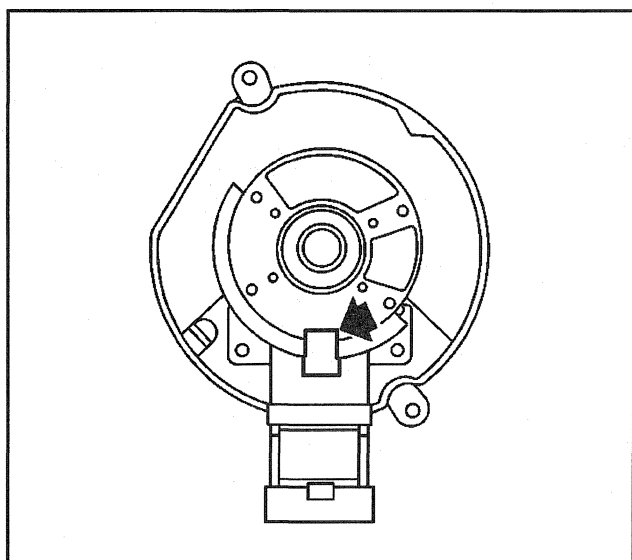
20. Remove the old oil seal.



301419

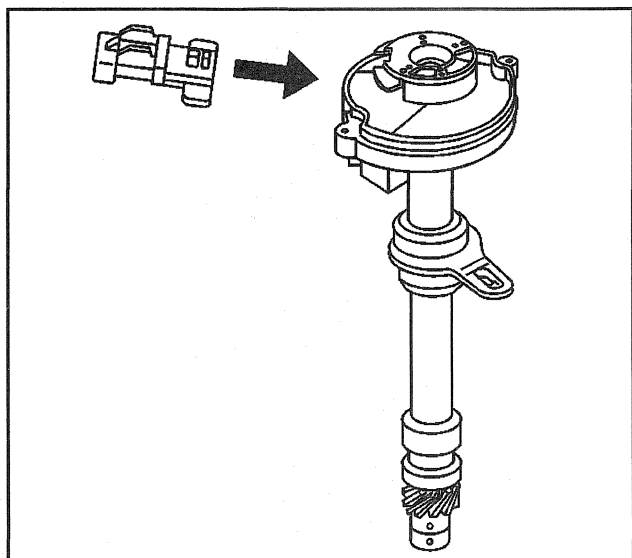
Assembly Procedure

1. Line up the square-cut hole in the vane wheel for the camshaft position (CMP) sensor.

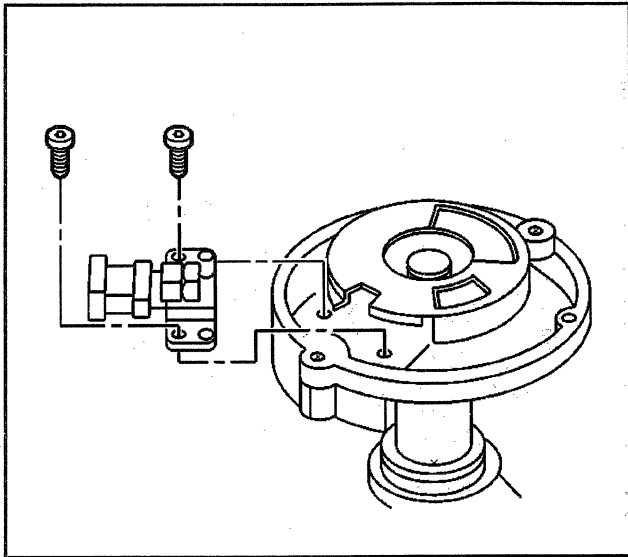


156754

2. Insert the sensor into the housing.



156755



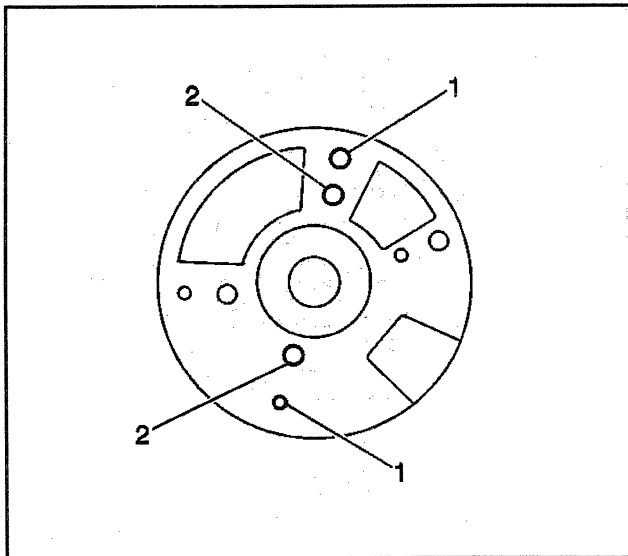
301398

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install two NEW screws for the camshaft position (CMP) sensor.

Tighten

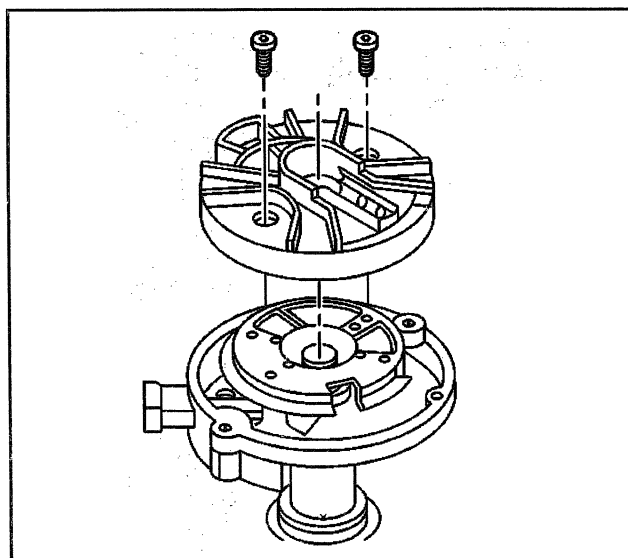
Tighten the screws to 2.2 N·m (20 lb in).



156752

4. Identify the correct rotor mounting position.

- (1) is the rotor screw holes.
- (2) is the rotor locator pin holes.



301396

5. Install the distributor rotor according to the index marks.

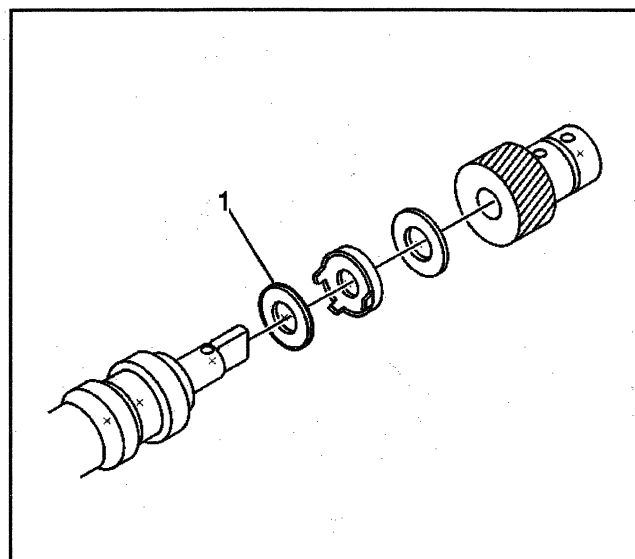
6. Install two rotor hold down screws.

Tighten

Tighten the screws to 1.9 N·m (17 lb in).

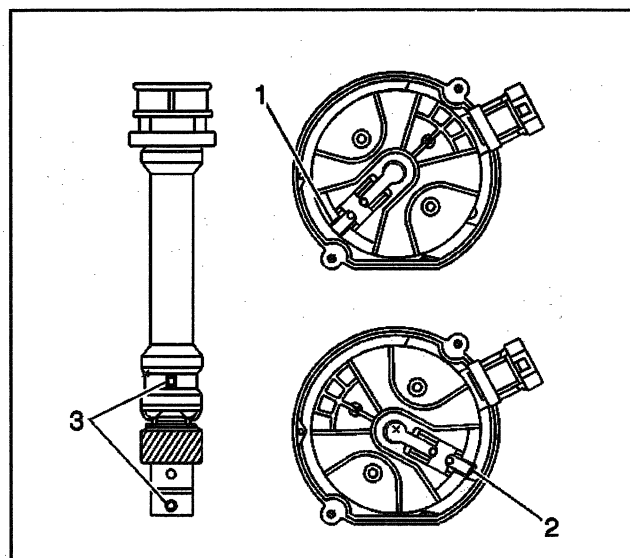
Notice: Refer to *Distributor Driven Gear Can Be Installed in Multiple Positions* in Cautions and Notices.

7. Install the round washer (1), 7.4L engine only.
8. Install the tang washer over the bottom of the distributor shaft.
9. Install the round washer.
10. Install the driven gear according to the index marks.



301405

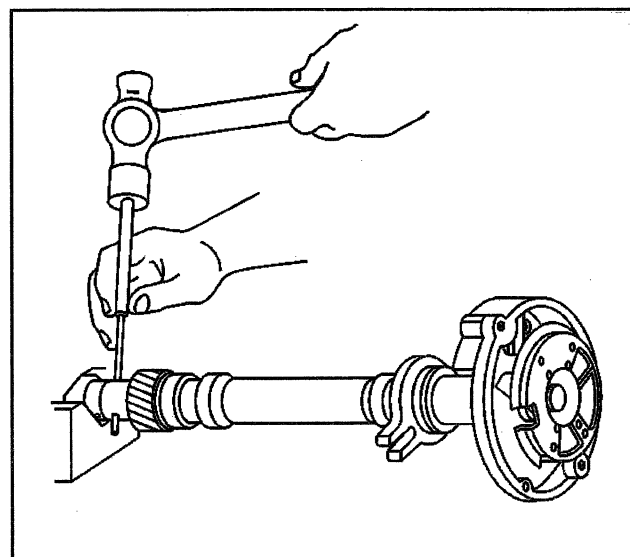
11. Align the rotor segment as shown for a V6 engine (1) or V8 engine (2).
12. Install the gear and align white paint mark on the bottom stem of the distributor, and the pre-drilled indent hole in the bottom of the gear (3).
13. Check to see if the driven gear is installed incorrectly, the dimple will be approximately 180 degrees opposite the rotor segment when it is installed in the distributor.



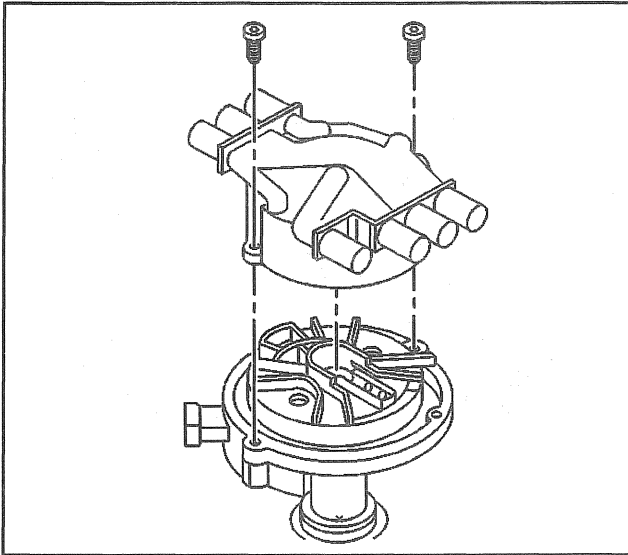
301395

Caution: Refer to *Safety Glasses Caution in Cautions and Notices*.

14. Support the distributor drive gear in a V-block or similar fixture.
15. Install the roll pin with a suitable punch and hammer in order to hold the driven gear in the correct position.



301198

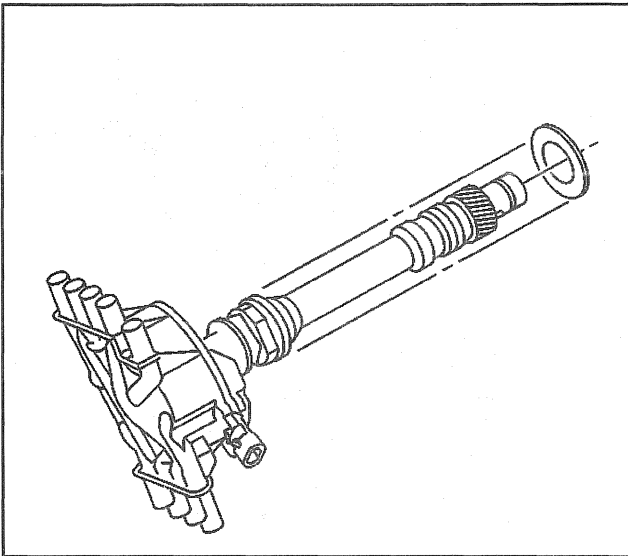


301393

16. Install the distributor cap.
17. Install two NEW distributor cap screws.

Tighten

Tighten the screws to 2.4 N·m (21 lb in).



301419

18. Install the new oil seal under the mounting flange of the distributor base.

Distributor Inspection

Important: Discoloration of the cap and some whitish build up around the cap terminals is normal. Yellowing of the rotor cap, darkening and some carbon build up under the rotor segment is normal. Replacement of the cap and rotor is not necessary unless there is a driveability concern.

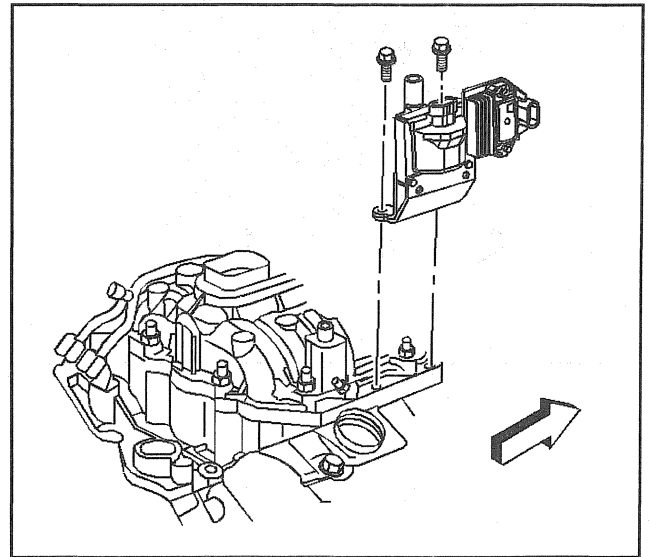
1. Inspect the cap for cracks, tiny holes or carbon tracks between the cap terminal traces. If the inside of the cap contains moisture or a filmy residue, wipe clean with a cloth lightly dampened with alcohol and allow to dry thoroughly. If the residue is hardened and cannot be removed, replace the cap.
2. Inspect the cap for excessive build-up of corrosion on the terminals. Scrape clean the terminals or replace the cap if the corrosion is excessive. Some buildup is normal

3. Inspect the rotor segment for excessive wear. Replace the rotor if excessive looseness in the rotor segment is present.
4. Inspect the shaft for shaft-to-bushing looseness.
5. If the shaft is loose inside the bushing, replace the distributor.
6. Inspect the housing for cracks or damage.

Ignition Coil and ICM Replacement (HVS)

Removal Procedure

1. Remove the air cleaner assembly.
2. Disconnect the electrical connectors.
3. Remove the ignition coil wire to the distributor.
4. Remove the studs holding the bracket and the ignition coil to the intake manifold.
5. Remove the bracket and the ignition coil.
6. Drill and punch out the two rivets holding the ignition coil to the bracket.
7. Remove the ignition coil from the bracket.



43755

Installation Procedure

A replacement ignition coil kit comes with two screws in order to attach the ignition coil to the bracket.

1. Install the ignition coil to the bracket with the two screws.

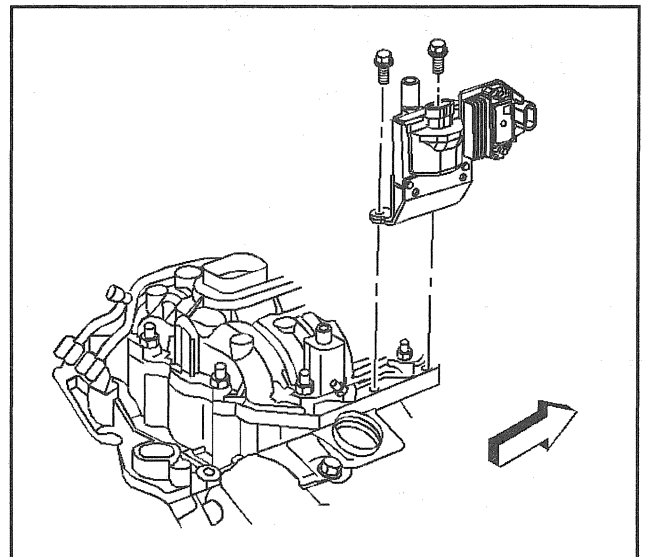
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the ignition coil and the bracket to the intake manifold with studs.

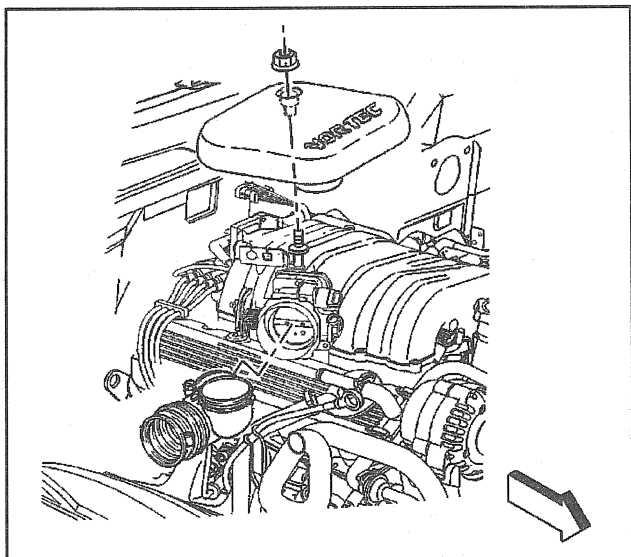
Tighten

Tighten the studs to 11 N·m (8 lb ft).

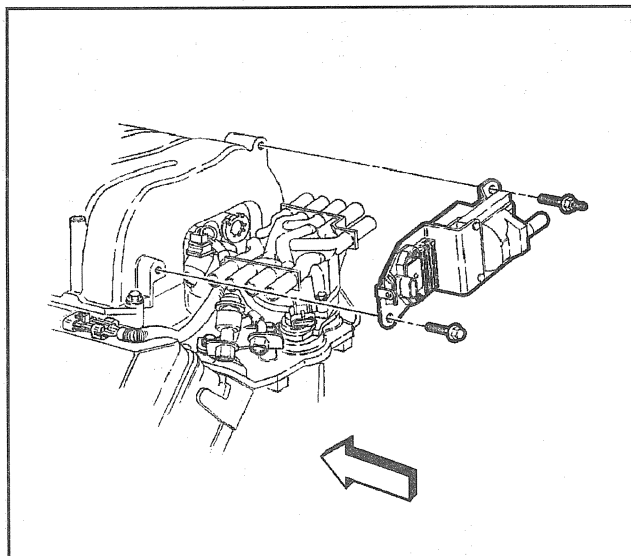
3. Install the ignition coil wire.
4. Install the electrical connectors.
5. Install the air cleaner assembly.



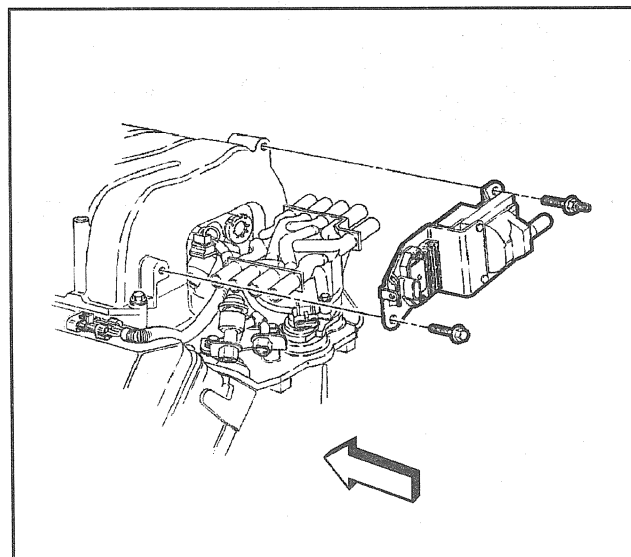
43755



175670



68506



68506

Ignition Coil and ICM Replacement (VIN J)

Removal Procedure

1. Remove the air cleaner assembly.
2. In order to gain access to the ignition coil, relocate the engine wiring harness at the left rear side of the engine.
3. Disconnect the electrical connectors for the ignition coil and the ICM.

4. Remove the bolts retaining the coil to the intake manifold.
5. Remove the ignition coil.

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

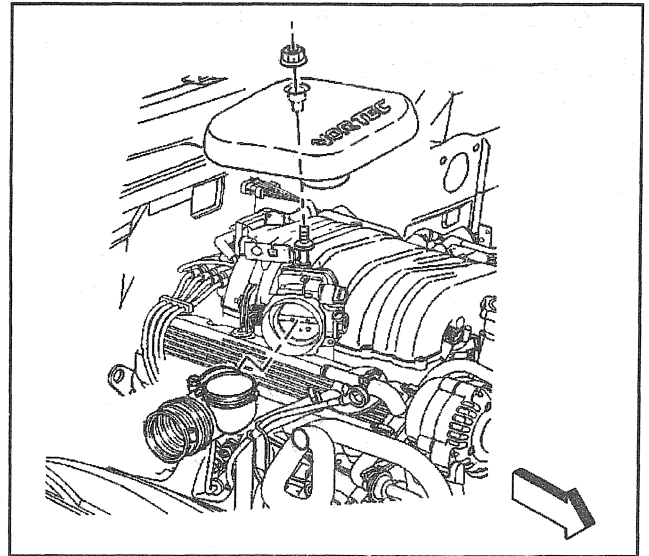
1. Install the ignition coil and the bolts to the intake manifold.

Tighten

Tighten the bolts to 27 N·m (22 lb in).

2. Connect the electrical connectors for the ignition coil and the ICM.

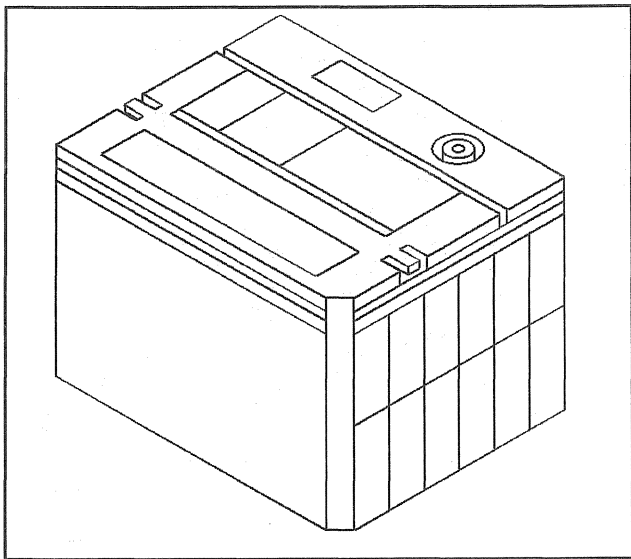
3. Relocate the engine wiring harness at the left rear side of the engine.
4. Install the air cleaner assembly.



175670

Description and Operation

Battery Replacement



42429

The maintenance-free battery is standard in all vehicles. The battery is completely sealed except for two small vent holes in the sides. These vent holes allow the small amount of gas produced in the battery to escape.

The battery has the three following functions in the electrical system:

- Provides a source of energy for cranking the engine
- Acts as a voltage stabilizer for the electrical system
- Provides, for a limited time, the energy when the electrical load used exceeds the output of the generator.

The battery specification label contains information pertinent to the servicing of the battery. This information includes test ratings and both of the original equipment and the recommended replacement part numbers. Refer to Battery Usage.

Battery Tray and Hold-Down Retainer Description

Clean any corrosion from the battery carrier and the hold-down clamp before installing the battery. Ensure the carrier is in sound condition in order to hold the battery securely and keep the battery level. Ensure there are no parts in the carrier before installing the battery. In order to prevent the battery from shaking in the carrier, tighten the hold-down bolts to the specification noted. Refer to Fastener Tightening Specifications.

Starting System Operation

Starter Circuit Operation

Voltage is applied at all times to the ignition switch from the IGN A fuse 6 through the RED (242) wire. When the ignition switch is turned to the START position, voltage is applied to the CRANK fuse 8 through the YEL (5) wire. From the CRANK fuse 8, voltage is either applied to the clutch pedal position switch (M/T) or the transmission range switch (A/T) through the PPL (806) wire. When either the clutch is disengaged (M/T) or the transmission is in park or neutral (A/T), voltage is applied to the coil of the starter relay through the PPL (1035) wire. Since the starter relay is permanently grounded at ground G105 through the BLK (150) wire, the starter relay energizes.

Voltage is applied at all times to the starter relay contacts from IGN A fuse 6 through the RED (242) wire. When the starter relay energizes, the starter relay contacts close, and voltage is applied to the starter motor solenoid. Since the starter motor solenoid is permanently case grounded, the starter motor solenoid will energize two coils. The pull-in winding coil energizes in order to pull the starter motor solenoid contacts closed. When the contacts close, a plunger on the contacts causes the pull-in winding coil circuit to open. The hold-in winding coil then holds the starter motor solenoid contacts closed. Voltage is then applied to the starter motor from the battery through the BLK (1) wire and the closed contacts of the starter motor solenoid. Since the starter motor is also permanently case grounded, the starter motor will run until the ignition switch is moved out of the START position. When this happens, a spring in the starter motor solenoid moves the starter motor solenoid contacts and the plunger back to the rest position.

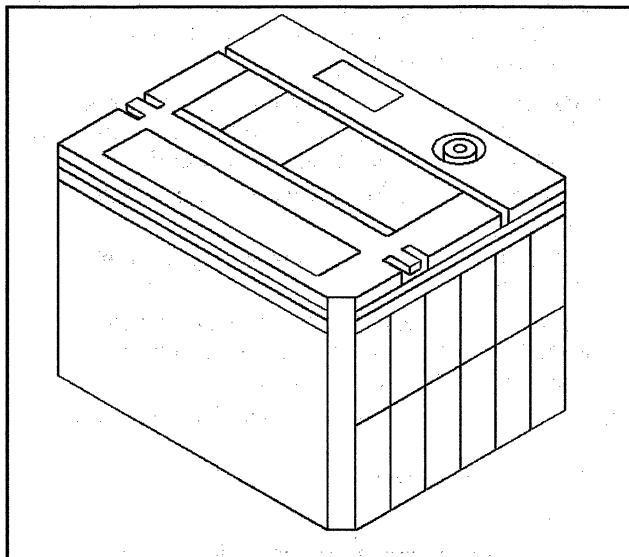
Starting System Circuit Description

Voltage is applied at all times to the ignition switch from the IGN A fuse 6 through CKT 242 (RED). When the ignition switch is turned to the START position, voltage is applied to the CRANK fuse 8 through CKT 5 (YEL). From the CRANK fuse 8, voltage is either applied to the clutch pedal position switch (M/T) or the transmission range switch (A/T) through CKT 806 (PPL). When either the clutch is disengaged (M/T) or the transmission is in park or neutral (A/T), voltage is applied to the coil of the starter relay through CKT 1035 (PPL/WHT). Since the starter relay is permanently grounded at ground G105 through CKT 150 (BLK), the starter relay energizes.

Voltage is applied at all times to the starter relay contacts from IGN A fuse 6 through CKT 242 (RED). When the starter relay energizes, the starter relay contacts close, and voltage is applied to the starter motor solenoid. Since the starter motor solenoid is permanently case grounded, the starter motor solenoid will energize two coils. The pull-in winding coil energizes in order to pull the starter motor solenoid contacts closed. When the contacts close, a plunger on the contacts causes the pull-in winding coil circuit to open. The hold-in winding coil then holds the starter motor solenoid contacts closed. Voltage is then applied to the starter motor from the battery through CKT 1 (BLK) and the closed contacts of the starter motor solenoid. Since the starter motor is also permanently case grounded, the starter motor will run until the ignition switch is moved out of the START position. When this happens, a spring in the starter motor solenoid moves the starter motor solenoid contacts and the plunger back to the rest position.

Battery Description

General Description



42429

The maintenance-free battery is standard equipment in all vehicles. Batteries with side or top terminals are available.

These vehicles may be equipped with more than one battery, depending on the powertrain used and optional equipment. The battery is completely sealed except for two small vent holes in the sides. These vent holes allow a small amount of gas produced in the battery to escape.

The battery has three functions in the electrical system:

- The battery provides a source of energy for cranking the engine.
- The battery acts as a voltage stabilizer for the electrical system.
- The battery can, for a limited time, provide energy when the electrical load used exceeds the output of the generator.

CAT. NO.	CCA	LOAD TEST	REPLACEMENT MODEL	
744	600	300	78A-72	1-2

106519

The battery specification label contains information pertinent to servicing the battery. This information includes test ratings and original equipment. The label also includes numbers for recommended replacement parts.

Battery Ratings

A battery has two ratings:

- Reserve capacity
- Cold cranking amperage

Reserve Capacity

The reserve capacity is an estimate of how long the vehicle can be driven with no generator output, the headlamps turned on, and a minimum electrical load (most of the accessories turned off). It is the maximum amount of time (in minutes) it will take for a fully charged battery, being discharged at a constant rate of 25 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Other temperature or current draws, the state of charge, or the condition of the battery will affect how long the battery will actually last when the vehicle is being driven without generator output.

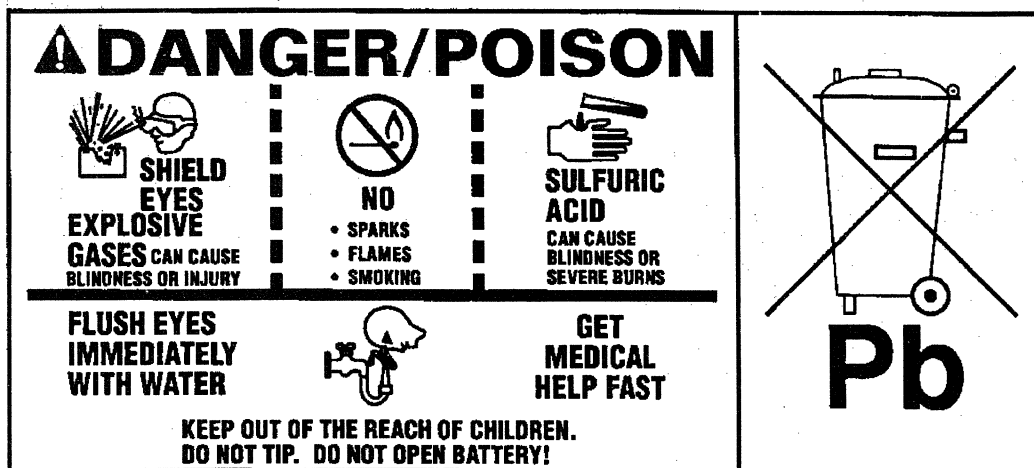
Cold Cranking Amperage

Cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. This rating is the minimum amperage that the battery must maintain for 30 seconds at -18°C (0°F), while maintaining at least 7.2 volts. The actual performance of a battery will vary with actual temperature.

Electrolyte Freezing

The freezing point of electrolyte depends on the specific gravity of the electrolyte, or state of charge. Since freezing may ruin a battery, protect the battery against freezing by keeping the battery charged. As long as the green dot shows in the built-in hydrometer, the battery will not freeze unless the temperature drops below -32°C (-25°F). A fully charged battery will not freeze unless the temperature drops below -54°C (-65°F).

Protection During Vehicle Storage



190959

Some electronic devices on the vehicle impose small continuous current drains on the battery. This is commonly called parasitic load. If the vehicle is not used for an extended time, these parasitic loads can discharge and eventually cause permanent damage to the battery. Discharged batteries can also freeze in cold weather. Refer to Electrolyte Freezing. Do the following steps in order to help keep the battery in a charged state while storing the vehicle:

- If the vehicle is likely to be stored over 30 days, check the built-in hydrometer and make sure the green dot is visible.

Notice: Always turn the ignition OFF when connecting or disconnecting battery cables, battery chargers, or jumper cables. Failing to do so may damage the Powertrain Control Module (PCM) or other electronic components.

- Disconnect the negative battery cable. This protects the battery from being discharged by parasitic current drains from the electrical system of the vehicle.

Important: Any time the green dot in the built-in hydrometer of the battery is not visible, promptly recharge the battery.

- If the battery cannot be disconnected, establish a regular schedule of recharging the battery every 20–45 days in order to maintain a high state of charge.

Important: Original equipment maintenance-free batteries will not be damaged by charge rates of 50 amps or more, as long as the battery does not spew electrolyte from the vents or heat to over 52°C (125°F).

- In order to keep the charging time low, use a battery charger that is capable of providing a charging voltage of at least 16 volts.
 1. Inspect the battery being charged every 45-60 minutes. Stop charging or reduce the charging rate as necessary.

2. Stop charging within one hour after the green dot appears in the hydrometer in order to avoid overcharging.

Important: A battery that remains in a discharged state for a long time may be difficult to recharge. The battery may also be permanently damaged.

- Allow ample time for charging. Refer to *Battery Charging*.

When it is time to reconnect the battery, do the following steps:

1. Using a wire brush, lightly clean any oxidation from the contact face of the battery terminal before reconnecting the cable.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Tighten the cable bolt.

Tighten

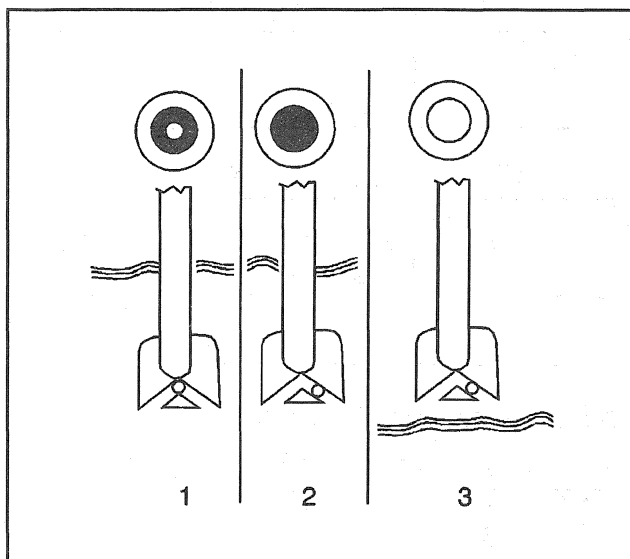
- Tighten the cable bolt on a side terminal battery to 12 N·m (106 lb ft).
- Tighten the cable bolt on top terminal battery to 18 N·m (13 lb ft).

3. Reset the clock, the push-button radio tuning, and other accessories before the vehicle is put back in service.

Built-in Hydrometer

A built-in temperature compensation hydrometer is molded into the top of the maintenance free battery. When observing the hydrometer, make sure the battery top is clean. Use a light in poorly-lit areas.

Under normal operating conditions, one of three indications can be observed:



181056

- Any green appearance in the hydrometer is interpreted as a green dot (1). This means the battery is ready for testing.

- A dark dot is visible (2). The green dot is not visible.
 - If the green dot is not visible and there is a complaint about cranking, refer to *Battery (Parasitic) Load Test*.
 - Check the output of the charging system.
 - Check the electrical system for excessive draws.
- A clear or light yellow dot (1) means the electrolyte level is below the bottom of the hydrometer and is too low for diagnosis. The yellow dot may have been caused by the following conditions:
 - Excessive or prolonged charging
 - A broken case
 - Excessive tipping
- When you find a battery in this condition, this may indicate high charging voltages caused by a faulty charging system. Because of this, the charging and electrical systems must be checked.
- Replace the battery if a cranking complaint exists, and the battery has a yellow or clear hydrometer.

Battery Operation (Undercharged or Overcharged)

Step	Action	Value(s)	Yes	No
1	1. Disconnect the generator connector. 2. Place the ignition switch in the RUN position. 3. Connect a voltmeter from BRN (25) wire at the generator connector to ground. Does voltmeter read battery voltage?	12 V	Go to Step 2	Go to Step 4
2	Connect the voltmeter from terminal BAT at generator to ground. Does voltmeter read battery voltage?	12 V	Go to Step 3	Go to Step 6
3	1. Connect the generator connector. 2. Have all accessories turned off and the engine running at fast idle. 3. Connect the voltmeter across battery terminals and note the voltage. Is the voltmeter reading within range?	13-16 V	Go to Step 7	Go to Step 8
4	Backprobe BRN (25) wire at the instrument cluster connector with a voltmeter to ground Does voltmeter read battery voltage?	12 V	Go to Step 9	Go to Step 5
5	Backprobe PNK (39) wire at the instrument cluster connector terminal 22 with a voltmeter to ground. Does battery voltage exist?	—	Go to Step 10	Go to Step 11
6	Repair or replace the black/red wire from the fusible link to generator. Is the repair complete?	—	System OK	—

Battery Operation (Undercharged or Overcharged) (cont'd)

Step	Action	Value(s)	Yes	No
7	Perform battery load test. Refer to <i>Battery Load Test</i> . Is the test complete?	—	System OK	—
8	Perform generator bench test. Refer to <i>Generator Assembly Bench Check (CS-144)</i> for the CS-144. Refer to <i>Generator Assembly Bench Check (CS-130)</i> for the CS-130. Is the generator okay?	—	Go to Step 7	—
9	Locate and repair open in BRN (25) wire from the instrument cluster to generator. Is the repair complete?	—	System OK	—
10	Check the charge indicator filament. Is the charge indicator filament okay?	—	Go to Step 12	—
11	Locate and repair open in PNK (39) wire from the I/P fuse block to the instrument cluster. Is the repair complete?	—	System OK	—
12	Replace the instrument cluster. Is the replacement complete?	—	System OK	—

Battery Operation (Causes of Battery Failure)

A battery is not designed to last forever. With proper care, however, the battery will provide years of good service. If the battery tests good but still fails to perform well, the following are some of the more common causes:

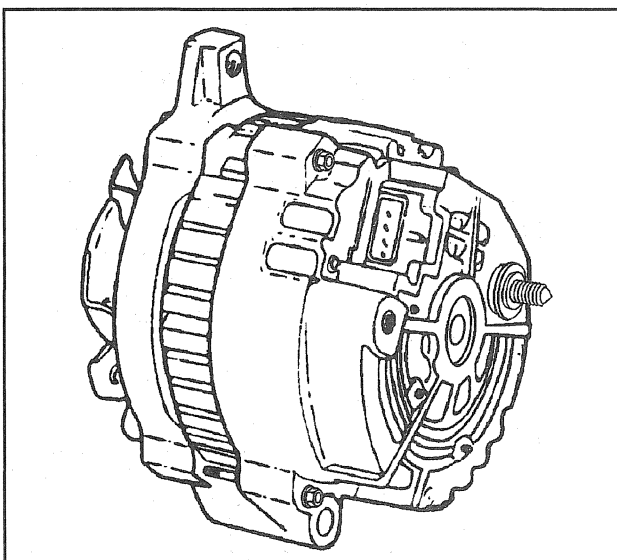
1. A vehicle accessory was left on overnight.
2. The driving speeds have been slow with frequent stops ("stop-and-go" driving).
3. The electrical load has exceeded the generator output (particularly with the addition of aftermarket equipment).
4. Existing conditions in the charging system, including the following possibilities (refer to Section 8A):
 - An electrical short
 - A slipping belt
 - A bad generator
 - A bad generator voltage regulator
5. The battery has not been properly maintained, including the following situations:
 - A failure to keep the terminals tight
 - A failure to keep the terminals clean
 - A loose battery hold down
6. There are mechanical conditions in the electrical system, such as a short or a pinched wire, attributing to power failure. (Refer to Section 8A).

Charging System Description

The charging system consists of the following components:

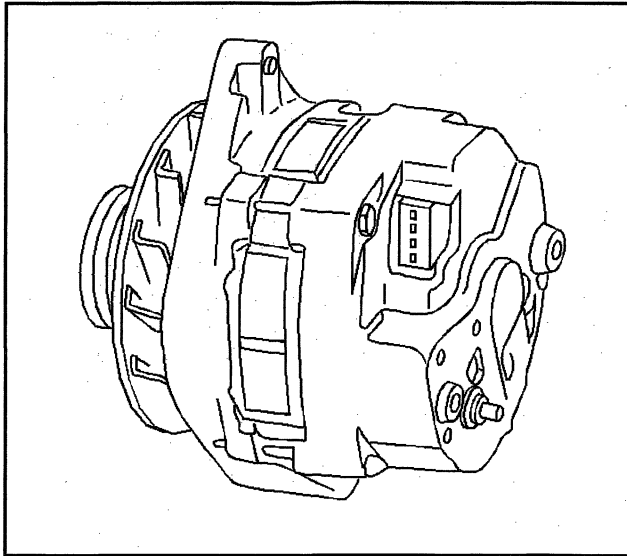
- The battery
- The generator
- A voltage regulator
- Indicator lamp or voltmeter circuitry

The generator supplies the electrical power for charging the battery and for operating the accessories.

CS-Series Generators

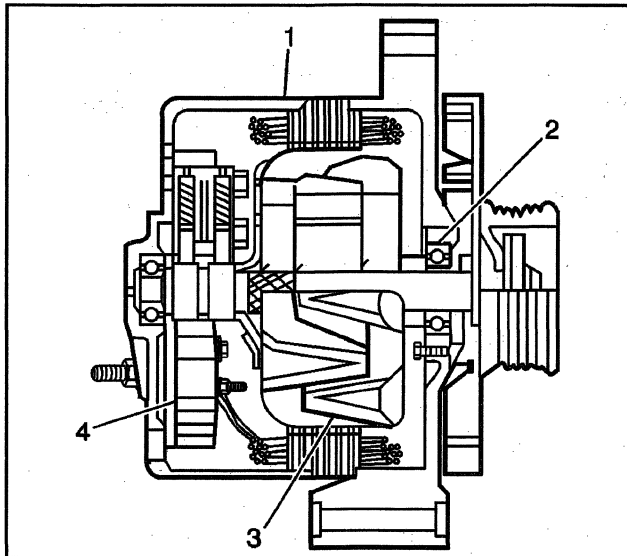
181767

CS-Series generators feature a high ampere output per pound of weight. The CS stands for charging systems. The 130 or 144 is the measurement, in millimeters, of the outside diameter of the stator laminations.



17202

The CS-144 generator is a larger version of the CS-130. Unlike the CS-130, the CS-144 is serviceable.



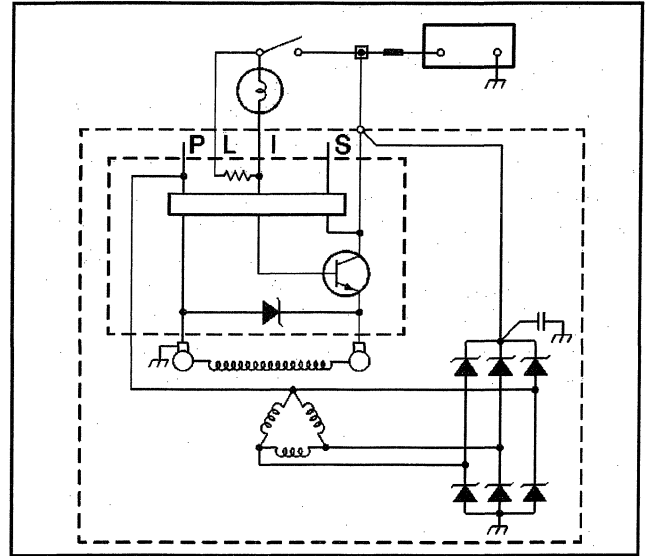
181768

The CS-144 generator, with an internal regulator, does not have a diode trio. The delta stator (1), the rectifier bridge (4), and the rotor with slip rings and brushes (3), are electrically similar to other CS Series generators.

The generator uses a conventional fan and pulley. An internal fan cools the slip rings, the end frame, the rectifier bridge, and the regulator.

The charge indicator turns on when the ignition switch (gasoline engines) or the engine control switch (diesel engines) is closed and the engine is not running, and turns off when the engine is running. If the charge indicator is on with the engine running, this indicates a charging system condition. The indicator will glow at full brilliance, not half lit, if any of the following conditions occur:

- Any charging condition
- System voltage is too high or too low



74064

The regulator limits system voltage by controlling the rotor field current. When the field current is on, the regulator switches the rotor field on and off at a fixed rate of about 400 cycles per second. By varying the overall on/off time, correct average field current for proper system voltage control is maintained. At high speeds, the on time may be 10 percent and the off time may be 90 percent. At low speeds, and with high electrical loads, the on/off time may be 90 percent and 10 percent respectively.

The regulator has four terminals—P, L, I, and S. On all P applications, P, L, I/F, and S is stamped on the regulator.

The L or the I terminal, or both, turns on the regulator and allows field current flow when the switch is closed. The L terminal must connect through an indicator lamp or a suitable resistor. The I terminal connects to B+ or through a resistor. These two terminals are often used in parallel and connected to two different vehicle circuits.

The P terminal connects internally to the stator and may be wired to a tachometer or other device. The S terminal may be used to “sense” voltage at another location on the vehicle for voltage control. If the S terminal is not used, the generator will use an integrated circuit in the regulator to “sense” voltage.

P model vehicles use a voltmeter in place of an indicator lamp. For schematics of the specific generator circuits, refer to *Starting and Charging Schematics*.

The CS-144 generator requires no periodic maintenance or adjustment. The CS-130 generator must be replaced. Do not disassemble the CS-130 generator.

Charging System Operation

Charging Circuit Operation

The generator provides the voltage that operates the electrical system and charges the battery. A magnetic field is created when current flows through the rotor windings. This field rotates as the engine rotates the rotor, creating an AC voltage in the stator windings. A rectifier bridge converts the AC voltage to a DC voltage. This DC voltage is then supplied to the electrical system at the battery terminal.

The current supplied to the rotor controls the amount of output voltage. The regulator in the generator uses digital techniques in order to control the current supplied to the rotor. The rotor current is a regulator-supplied series of electrical pulses. When the ignition switch is first placed in the RUN position, the pulse width is very narrow. This causes the rotor to produce a weak magnetic field. This produces a lower output voltage to the electrical system. Once the engine is running, the regulator monitors the output voltage through an internal wire and changes the pulse width accordingly.

The regulator in the generator also controls the BAT indicator located in the instrument cluster. Voltage is applied to the instrument cluster when the ignition switch is either in the RUN or START position from the GAUGES fuse 4 through the PNK (39) wire. When the regulator monitors that either a voltage high or voltage low condition exists with the engine running, a ground path to the BAT indicator will be provided through the BRN (25) wire.

With the diesel engines, the tachometer input to the instrument cluster is provided by the generator. The generator produces voltage pulses proportional to engine speed to the instrument cluster through the WHT (121) wire.

Charging System Circuit Description

The generator provides the voltage that operates the electrical system and charges the battery. A magnetic field is created when current flows through the rotor windings. This field rotates as the engine rotates the rotor, creating an AC voltage in the stator windings. A rectifier bridge converts the AC voltage to a DC voltage. This DC voltage is then supplied to the electrical system at the battery terminal.

The current supplied to the rotor controls the amount of output voltage. The regulator in the generator uses digital techniques in order to control the current supplied to the rotor. The rotor current is a regulator-supplied series of electrical pulses. When the ignition switch is first placed in the RUN position, the pulse width is very narrow. This causes the rotor to produce a weak magnetic field. This produces a lower output voltage to the electrical system. Once the engine is running, the regulator monitors the output voltage through an internal wire and changes the pulse width accordingly.

Current flowing between the generator(s) and the RH Battery runs through CKT 2 (RED). A 175A Mega Fuse is also placed inline between the generator(s) and battery on Uplevel/Enhanced Features/Single Battery for generator protection during jump starts.

The regulator in the generator also controls the BAT indicator located in the instrument cluster. Voltage is applied to the instrument cluster when the ignition switch is either in the RUN or START position from the GAUGES fuse 4 through CKT 39 (PNK). When the regulator monitors that either a voltage high or voltage low condition exists with the engine running, a ground path to the BAT indicator will be provided through CKT 25 (BRN).

With the diesel engines, the tachometer input to the instrument cluster is provided by the generator. The generator produces voltage pulses proportional to engine speed to the instrument cluster through CKT 121 (WHT).

Ignition System Description

Distributor Ignition (DI)

Notice: The distributor used with the OBD II ignition system is located in a fixed, non-adjustable position. Do not adjust the engine base timing by rotating this distributor. Otherwise, crossfiring and damage to the distributor will result.

These ignition systems consist of a distributor with the following components:

- Camshaft position (CMP) sensor
- Separate ignition coil with sealed connectors
- Secondary ignition wires
- Spark plugs
- Knock (KS) sensor
- Crankshaft position (CKP) sensor

The ignition system is controlled by the Vehicle Control Module (VCM). The VCM monitors information from various engine sensors. The VCM computes the desired spark advance timing, and controls the dwell. The VCM also controls the firing of the ignition coil via an ignition control line to the coil driver. For more detailed information, refer to *Enhanced Ignition System Description* in Engine Controls — 5.0L, 5.7L.

Special Tools and Equipment

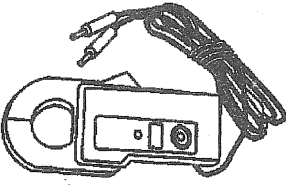
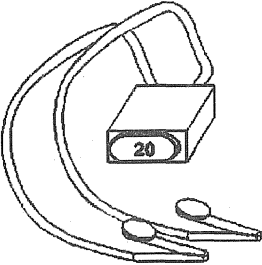
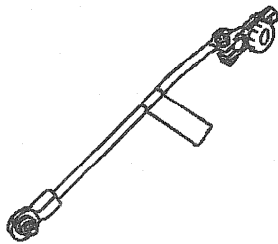

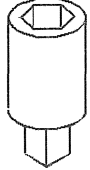
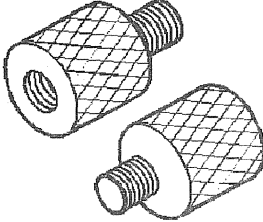
Illustration	Tool Number/ Description
 95591	J 35590 Current Clamp
 1025	J 36169-A Fused Jumper Wire
 3432	J 38758 Parasitic Draw Test Switch Tool

Illustration	Tool Number/ Description
 3430	J 39200 Digital Multimeter
 8443	J 39358 Long Reach Spark Plug Socket
 3431	ST-1201 Battery Side Terminal Adapters (Pair)